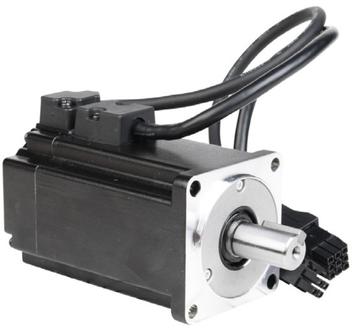
*Sure*Servo2™ AC Servo Systems
User Manual

SV2-USER-M-WO

Second Edition





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WARNING

WARNING: Always read this manual thoroughly before using *Sure*Servo™ series AC servo systems.

WARNING: Do not use the *Sure*Servo™ series AC servo system in a potentially explosive environment. Install the servo system components in a clean and dry location free from corrosive or flammable gases or liquids.

WARNING: AC input power must be disconnected before performing any maintenance. Do not connect or disconnect wires or connectors to the servo drive or motor while power is applied to the circuit. Maintenance must be performed only by a qualified technician.

WARNING: The servo motor or drive may be destroyed if incorrect cables are connected to the input/output terminals. Do not connect a power supply source to the U, V, W output terminals of the drive.

WARNING: Properly ground the servo drive and motor using the ground terminals. The grounding method must comply with the laws of the country where the AC servo is to be installed. Refer to "Wiring Diagrams" in CHAPTER 3.

WARNING: Before starting the servo system with a mechanical system connected, make sure that the emergency stop equipment can stop the servo at any time.

WARNING: Do not touch the servo drive heat sink or the servo motor during operation. Otherwise, serious personal injury may result.

WARNING: A charge with hazardous voltages may still remain in the DC-link capacitor even if the power has been turned off. To avoid personal injury, do not remove the cover of the AC servo drive. There are no user serviceable parts inside the drive.

WARNING: The mounting enclosure of the AC drive must comply with EN50178. Live parts shall be arranged in enclosures or located behind barriers that meet at least the requirements of the Protective Type IP20. The top surface of the enclosures or barrier that is easily accessible shall meet at least the requirements of the Protective Type IP40. Users must provide this environment for the *Sure*Servo™ AC servo drive.

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SureServo2™ AC Servo Systems User Manual

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1st Ed., Rev A	08/09/21	Fixed terminal description error on STO diagram in section 3.11.3 and 3.12
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Second Edition	08/10/23	Release of 460V servo systems, gantry mode, full-closed loop
2nd Ed., Rev A	01/30/24	Interim revision for error fixes and additions
2nd Ed., Rev B	02/28/25	Clarified configuration for gantry mode. Added P2.059. Added monitoring variables 28, 42, 71, and -207. Error fixes.

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Chapter

1

Chapter 1: Product Overview

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Manual Overview

Overview of This Publication

The SureServo™ AC Servo Systems User Manual describes the installation, wiring, configuration, inspection, and operation of the SureServo™ series AC servo drives and motors.

Who Should Read This Manual

This manual contains important information for people who will install, configure, maintain, and/or operate any of the SureServo™ series AC servo systems.

Supplemental Publications

The National Electrical Manufacturers Association (NEMA) publishes many different documents that discuss standards for industrial control equipment. Global Engineering Documents handles the sale of NEMA documents. For more information, you can contact Global Engineering Documents at:

15 Inverness Way East
Englewood, CO 80112-5776
1-800-854-7179 (within the U.S.)
303-397-7956 (international)
www.global.ihs.com

NEMA documents that might assist with your AC servo systems are:

- *NEMA ICS 16 - Motion/Position Control Motors, Controls, and Feedback Devices*

Technical Support

By Telephone: *800-633-0405*
(Mon.-Fri., 9:00 a.m.-6:00 p.m. E.T.)
On the Web: www.automationdirect.com

Our technical support group is glad to work with you in answering your questions. If you cannot find the solution to your particular application, or, if for any reason you need additional technical assistance, please call technical support at 800-633-0405. We are available weekdays from 9:00 a.m. to 6:00 p.m. Eastern Time (U.S.A.). We also encourage you to visit our web site where you can find technical and non-technical information about our products and our company. Visit us at www.automationdirect.com.

Special Symbols

When you see the "notepad" icon in the left-hand margin, the paragraph to its immediate right will be a special note.

WHEN YOU SEE THE "EXCLAMATION MARK" ICON IN THE LEFT-HAND MARGIN, THE PARAGRAPH TO ITS IMMEDIATE RIGHT WILL BE A WARNING. THIS INFORMATION COULD PREVENT INJURY, LOSS OF PROPERTY, OR EVEN DEATH (IN EXTREME CASES).

SureServo2™ AC Servo Systems Introduction

Before using the SureServo 2 series servo drive, please pay attention to the description of the inspection, nameplate, and model type. You can find a suitable motor model for your SureServo2 servo drive in the table in Section 1.3.

1.1 - Components of the Servo Set

A complete servo set includes:

- *A servo drive and a servo motor.*
- *A UVW motor power cable: one end of the U, V, and W wires connects to the servo drive and the other end to the motor.*
- *A green ground wire: connects to the ground terminal of servo drive.*
- *An encoder cable: one end of it connects the motor's encoder connection and other end to the CN2 connector on the servo drive.*
- *CN1 connector: A 50-pin cable and breakout board or a 20-pin breakout board that mounts to the drive.*
- *An ethernet patch cable for serial RS-485 (PLC/HMI) communication (Optional purchase).*
- *Mini-USB cable (CN4): for PC connection programming.*
- *Power supply for the servo drive:*

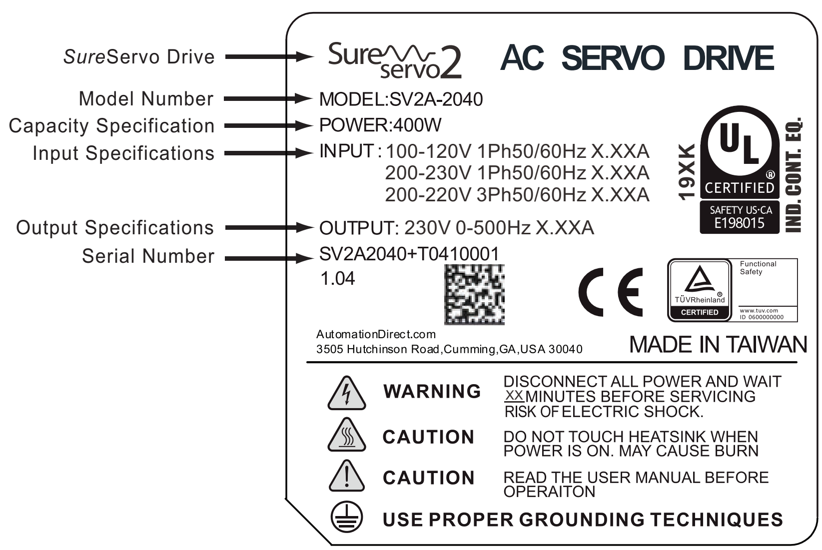
Model	*Control Circuit*	*Main Circuit*
100W - 400W	L1C, L2C, P1, P2, ⊖ quick connector	R, S, T quick connector

- *A 3-pin Motor quick connector (U, V, W). Included with drive.*
- *STO connector (CN10) on all drives. Included with drive.*
- *A 3-pin quick connector (P3, D, C). Included with drive.*
- *Two metal jumpers for short circuiting the connection terminals. Included with drive*
- *A plastic lever for inserting wires into the connectors. Included with drive.*

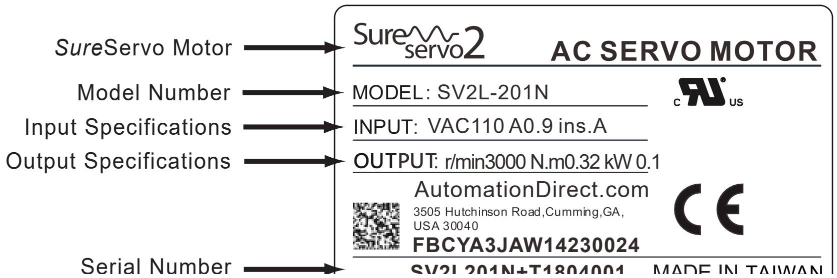
1.2 - Model Overview

1.2.1 - Nameplate Information

Example of servo drive nameplate:



Example of servo motor nameplate:



1.2.2 - Model Explanation

SV2 A - 2 04 0

Component Option
#: Drive
N: Motor without brake
B: Motor with brake

Rated Output Power

01: 100W	10: 1kW	45: 4.5 kW
02: 200W	15: 1.5 kW	55: 5.5 kW
04: 400W	20: 2kW	75: 7.5 kW
07: 750W	30: 3kW	B0: 11 kW
		F0: 15 kW

Nominal Input Voltage
2: 400W–2kW: 110/220 VAC 1-phase, 220VAC 3-phase
Over 2kW: 220VAC 3-phase
4: 400W–15kW: 460VAC 3-phase

Component Type
A: Drive
L: Low inertia motor
M: Medium inertia motor
H: High inertia motor

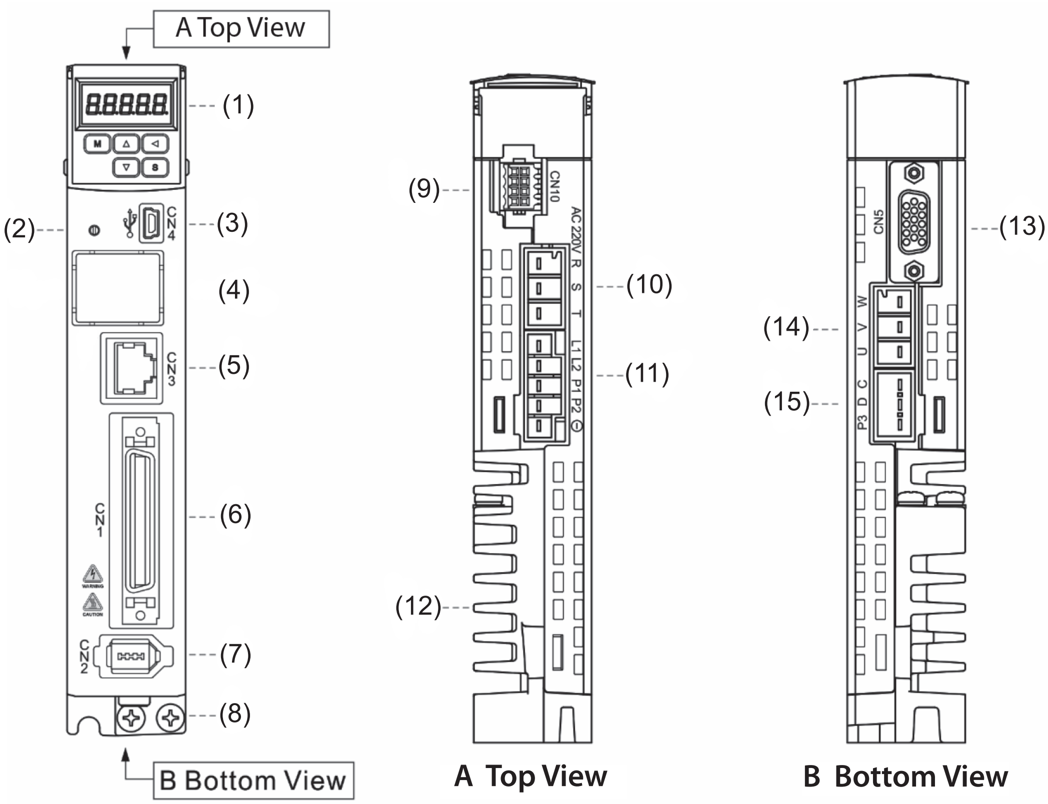
Series
SV2: SureServo2 AC servo

1.3 - SureServo2 Servo Drive and Motor Combinations

	Servo Motor			Servo Drive
Power	**Input (V)**	**Output (W)**	**Model Number**	**Model Number**
Low Inertia				
Single-/Three-phase	230	100	SV2L-201x	SV2A-2040
		200	SV2L-202x	
		400	SV2L-204x	
		750	SV2L-207x	SV2A-2075
		1000	SV2L-210x	SV2A-2150
Three-phase	460	400	SV2L-404x	SV2A-4040
		750	SV2L-407x	SV2A-4075
		1000	SV2L-410x	SV2A-4150
		1500	SV2L-415x	SV2A-4150
		2000	SV2L-420x	SV2A-4200
Medium Inertia				
Single-/Three-phase	230	1000	SV2M-210x	SV2A-2150
		1500	SV2M-215x	
		2000	SV2M-220x	SV2A-2200
Three- phase		3000	SV2M-230x	SV2A-2300
	460	1000	SV2M-410x	SV2A-4150
High Inertia				
Three-phase	230	4500	SV2H-245x	SV2A-2550
		5500	SV2H-255x	
		7500	SV2H-275x	SV2A-2750
		11000	SV2H-2B0x	SV2A-2F00
		15000	SV2H-2F0x	
	460	3000	SV2H-430x	SV2A-4300
		4500	SV2H-445x	SV2A-4550
		5500	SV2H-455x	
		7500	SV2H-475x	SV2A-4750
		11000	SV2H-4B0x	SV2A-4F00
		15000	SV2H-4F0x	

For motor and drive specifications, please see "A.2 - SureServo2 Series Drive Specifications" on page A–2 and "A.4 - SureServo2 Motor Specifications" on page A–13.

1.4 - Description of the Drive Interface



Number	Description
(1)	7-segment display
(2)	CHARGE: power indicator
(3)	CN4 - Mini USB connector: connects to PC
(4)	CN9 – Ethernet Card Connector (located on the right side of the drive)(card not shown)
(5)	CN3 - RS-485 communication connector: connects to PLC or controller’s communication ports.
(6)	CN1 - I/O signal interface: connects to PLC and controls I/O.
(7)	CN2 - Encoder connector: connects to the motor’s encoder.
(8)	Ground terminal: connects to grounding wire for the power supply and servo motor.
(9)	CN10 – STO (Safety Torque Off)
(10)	RST main circuit power terminal: connects to the commercial power source.
(11)	Control circuit power terminal (L1 c/ L2 c for 230v and 24V / 0V for 460V): Short circuit P1 and P2
(12)	Heat sink: for securing the servo drive and heat dissipation.
(13)	CN5 - Connector for receiving auxiliary feedback signals from a second encoder such as a linear tape or lay-on encoder.
(14)	UVW motor power output: connects to motor power connector (UVW). Do not connect to the main circuit power. Incorrect wiring will damage the servo drive.
(15)	Regenerative resistor: 1) Install the external regenerative resistor: P3 and C contacts connect to the resistor; P3 and D contacts are left open. 2) To use the built-in regenerative resistor: P3 and C contacts are left open; P3 and D contacts are short circuited (connected). All models (400W–15kW) have built-in regeneration braking resistors. 3) Connect external regenerative brake unit: P2 and ⊖ contacts connect to the brake unit; P3 & C contacts and P3 & D contacts are left open.

Chapter 2

Chapter 2: Installation

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SureServo2™ Installation

Please follow the instructions in this chapter during installation. This chapter includes information about the circuit breaker, fuse, EMI filter selection, and the regenerative resistor. For drive dimensions and mounting holes, please see Appendix A.

Safety Precautions

If the connection between the servo drive and servo motor is over 20 meters, please increase the gauge of the UVW connecting wire and the encoder cable. Please refer to Section 3.2.3 for the wire specification.

2.1 - Ambient Storage Conditions

Before installation, this product must be kept in the shipping carton. In order to retain the warranty coverage and for maintenance, please follow the instructions below for storage.

While the product is temporarily not in use:

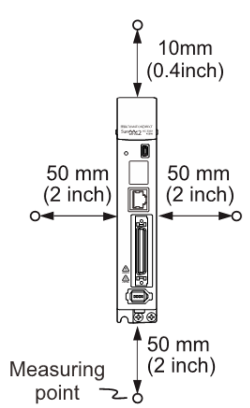
- *Store the product in an ambient temperature range of -20°C to +65°C.*
- *Store the product in a relative humidity range of 0% to 90% and a non-condensing environment.*
- *Avoid storing the product in an environment containing corrosive gas.*

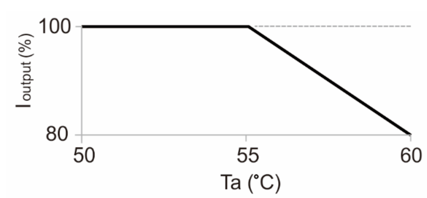
2.2 - Ambient Installation Conditions

Warning: *THE SERVO DRIVE INSTALLATION LOCATION SHOULD BE FREE OF DEVICES THAT GENERATE EXCESSIVE HEAT, WATER, VAPOR, DUST AND OILY DUST, CORROSIVE AND INFLAMMABLE GAS AND LIQUIDS, AIRBORNE DUST AND METAL PARTICLES, OR VIBRATION AND ELECTRONIC INTERFERENCE.*

Warning: *THE AMBIENT TEMPERATURE FOR THE MOTOR LOCATION SHOULD BE BETWEEN 0°C AND 40°C. THE INSTALLATION LOCATION SHOULD BE FREE OF HEAT-GENERATING DEVICES, WATER, VAPOR, DUST AND OILY DUST, CORROSIVE AND INFLAMMABLE GAS AND LIQUIDS, AIRBORNE DUST AND METAL PARTICLES.*

The ambient temperature for the servo drive should be between 0°C and 55°C. If the temperature is over 45°C, please place the product in a well-ventilated environment. During long-term operation, the ambient temperature should be under 45°C to ensure the servo drive's performance. If the product is installed in an electric box, make sure the servo drive is vertically mounted with a fan installed on the box. For SV2A-2040 and all 460V drives, keep a clearance of at least 10mm above the drives and keep the air flow above 0.5 m/s. For SV2A-2075, SV2A-2150, SV2A-2200, SV2A-2300, SV2A-2550, SV2A-2750, and SV2A-2F00, keep the speed of air flow above 1 m/s. Allow 5 cm of clearance beneath and on both sides of the servo drive. Its temperature must be kept under 55°C and it must be kept clear of heat sources. Ensure the size of the electric box and ventilation to prevent overheating and endangering the internal electronics of the device. In addition, check if the machine's vibration affects the electrical devices in the electric box.





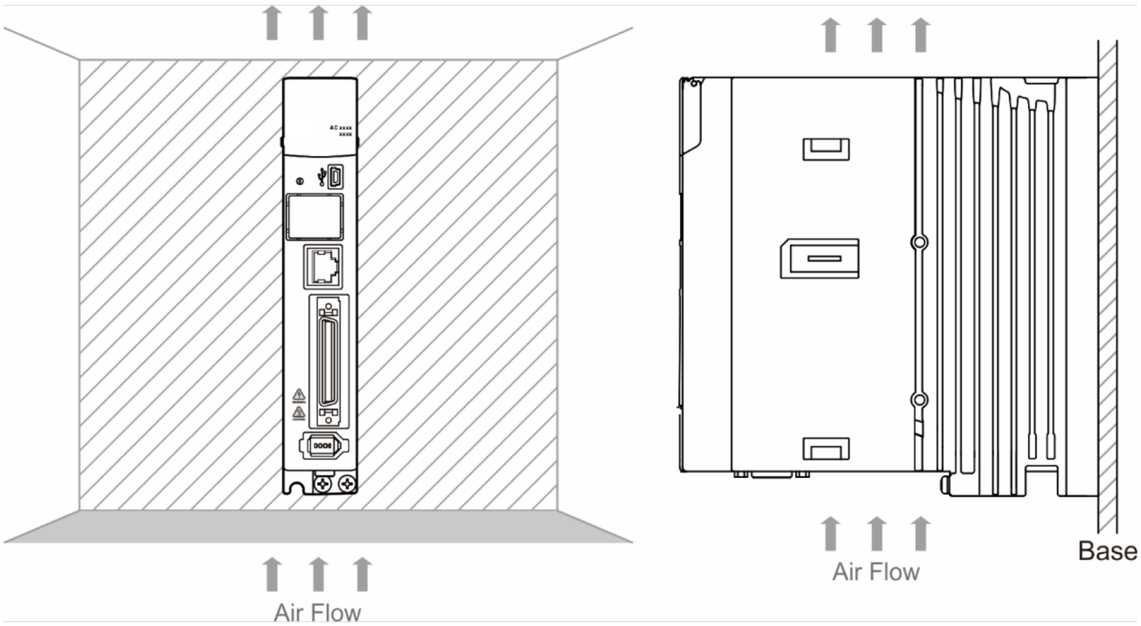
I output (%) is the current output in percent
Ta (°C) is the operation temperature

Note: The maximum operation temperature of models of 750W (or above) is 60°C, but the output current is reduced as shown in the figure above; the maximum operation temperature for models of 400W (or below) is 55°C.

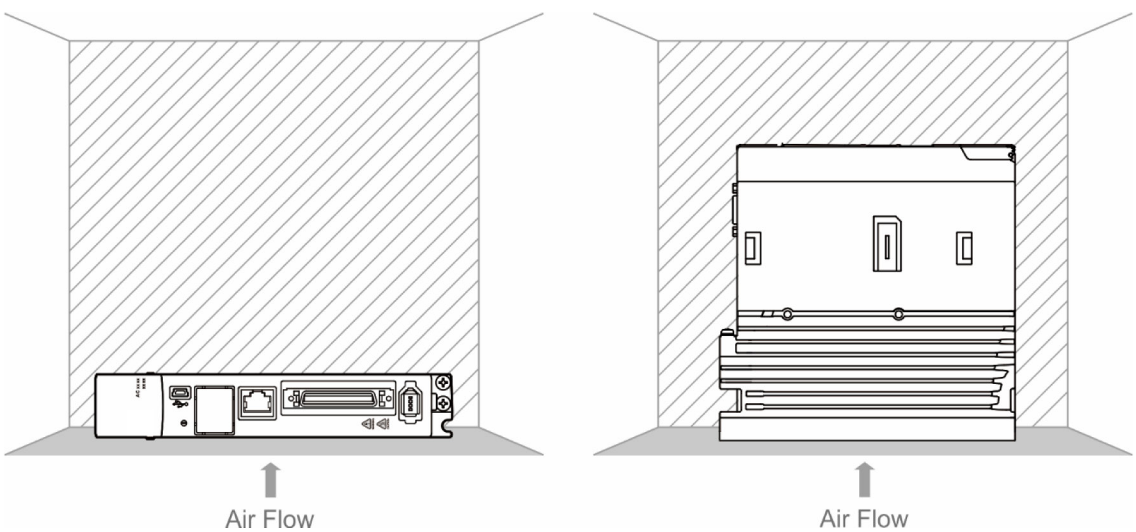
2.3 - Mounting direction and space

Attention:

- *Mount the servo drive according to the illustration below. The base of heat sink must be mounted vertically on the wall. Incorrect installation may result in a drive malfunction.*
- *For better ventilation and cooling, make sure there is sufficient space between the adjacent objects and the wall; otherwise, product malfunction may occur.*
- *Do not obstruct the ventilation holes when mounting the servo drive. Make sure you mount it in the correct orientation or malfunction may occur.*



CORRECT



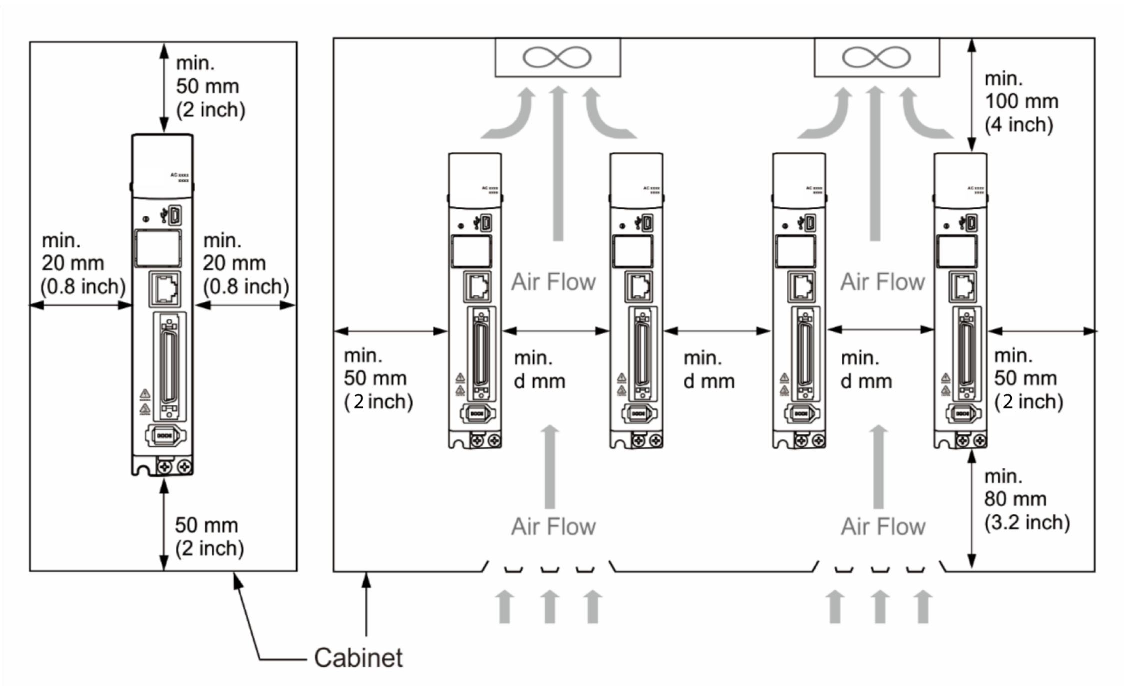
INCORRECT

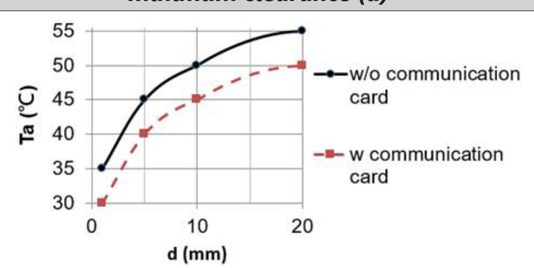
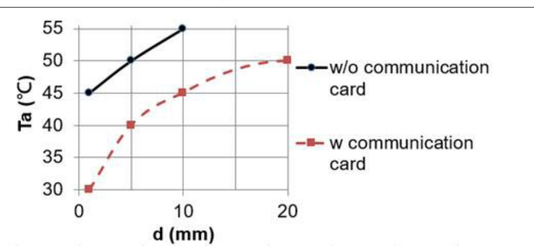
2.3.1 - Heat dissipation requirements:

In order to have adequate air flow for ventilation, please follow the suggested clearances when installing one or more servo drives (refer to the following diagrams). Avoid mounting one servo drive above another. Keep the bottom of the servo drive clear because the generated heat rises and causes higher temperature for the drives mounted above.

Note: The diagrams below are not to scale. Please refer to the annotations on the diagrams.

Single Servo Drive **Multiple Servo Drives**



<table>
<tr><th>Servo Drive Model</th><th>Cooling Method</th><th>Operating temperature (Ta) corresponding to minimum clearance (d)*</th></tr>
<tr><td>SV2A-2040</td><td>Natural cooling</td><td>
</td></tr>
<tr><td>SV2A-2075, 2150, 2200, 2300, 2550, 2750, 2F00, 4040, 4075, 4150, 4200, 4300, 4550, 4750, 4F00</td><td>Natural cooling and forced cooling</td><td>
</td></tr>
<tr><td colspan="3">* Due to the assembly tolerance, the minimum clearance for the servo drive is 1mm.</td></tr>
</table>

2.4 - Safety precautions for using motors

The SureServo2 AC servo motor is designed for industrial applications. It is necessary that you fully understand the motor specifications and operation manual. For your safety and correct use, please carefully read the manual, specifications, and precautions for the motor before connecting the motor to any equipment.

The safety precautions are as follows:

Handling, mounting, and storage

- *When removing or installing a servo motor, please hold the whole motor instead of holding the cable or only the motor shaft.*
- *Do not hit the motor shaft. Impact force will damage the encoder that is attached at the rear end of shaft.*
- *Keep the axial or radial load within the allowable range listed in the specifications.*
- *Do not use, install, or store the servo motor in a humid environment that contains water, oil, corrosive gases, or liquids.*
- *The material of motor shaft is not rust-proof. Although the rust-proof oil has been applied to the shaft during the manufacturing process, you must check the shaft condition and apply rust-proof oil every three (3) months if storing the motor for more than six (6) months.*
- *Ensure that the environmental conditions for storing the servo motor conform to the specifications in the instruction sheet.*
- *The encoder attached to the motor is easily damaged; please take the necessary steps to avoid electric interference, vibration, and abnormal temperature changes.*

Wiring

- *If the current exceeds the maximum current in the Specifications, the internal parts of the motor may lose their magnetism.*
- *Please check that the motor wiring and the voltage of the motor brake are correct. Also, ensure that the wiring of the encoder signal and power cables is correct. Incorrect wiring will lead to abnormal operation of motor, malfunction, or damage.*
- *To avoid capacitive coupling and noise, isolate the motor power cable from the encoder power and signal cables. Do not connect them to the same circuit.*
- *The AC servo motor must be correctly grounded.*
- *The encoder connector must not undergo any high-voltage component test because it will damage the encoder.*
- *When the motor or brake is undergoing high-voltage component tests, please cut off the power supply of the controller. You should perform this kind of test only when necessary so as to protect the product lifespan.*

Note: For more information on best wiring practices, please refer to the Applied EMI/RFI Techniques PDF on the technical support page.

Operation

- *AC servo motor operation is controlled by the servo drive. Do not directly connect a commercial type power source (100/200V, 50/60 Hz) to the servo motor circuit; otherwise, the motor cannot operate normally and may be permanently damaged.*
- *Follow the motor specifications when using the product. The motor's operation temperature must not exceed the specified range.*
- *The material of the motor shaft is not rust-proof. To ensure a longer motor life, please apply rust-proof oil during operation.*
- *The built-in brake is for clamping or holding rotor or shaft stationary. Do not use it for stopping or decelerating the motor.*

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Caution: *The built-in brake is not a device for safely stopping the machine. Please install another safety stopping device for the machine. When the built-in brake is clamping the motor, rotation backlash can still occur and the maximum rotation is 1° – 2°. When a motor with a brake is operating, the brake lining sometimes generates a noise (a swishing or clicking sound). This is caused by the structure of brake module and is not a malfunction. It will not affect the motor's function.*

- *If any odor, noise, smoke, vapor, or abnormal vibration occurs during motor operation, please stop the motor and turn off the power immediately.*

Others

- *SureServo2 servo motors have no user-replaceable parts.*
- *Do not disassemble the motor or change its parts. Permanent damage or malfunction of the motor may occur. This will void the warranty.*
- *Do not splash water or oil on the product.*

2.5 - Specifications for the Circuit Breaker and Fuse

Servo Drive Model	Main Voltage Level	Drive Rated Input	Circuit Breaker	Fuse	Fuse Class (current limiting)
SV2A-2040	100–120 VAC 1-phase 200–230 VAC 1-phase	3.98 A 4.69 A	10A	15A	Class CC
	200–230 VAC 3-phase	2.76 A	10A	10A	
SV2A-2075	100–120 VAC 1-phase 200–230 VAC 1-phase	7.73 A 8.71 A	20A	20A	
	200–230 VAC 3-phase	5.09 A	13A	15A	
SV2A-2150	100–120 VAC 1-phase 200–230 VAC 1-phase	12.56 A 14.82 A	30A	30A	
	200–230 VAC 3-phase	8.09 A	20A	25A	
SV2A-2200	100–120 VAC 1-phase 200–230 VAC 1-phase	18.03 A 20.83 A	40A	40A	Class J or High Speed J*
	200–230 VAC 3-phase	11.36 A	30A	35A	
SV2A-2300	200–230 VAC 3-phase	14.52 A	35A	50A	
SV2A-2550		27.06 A	60A	70A	
SV2A-2750		37.33 A	70A	80A	
SV2A-2F00		69.95 A	120A	125A	
SV2A-4040	380–480 VAC 3-phase	1.49 A	10A	10A	Class CC
SV2A-4075		2.31 A	10A	15A	
SV2A-4150		4.98 A	15A	20A	
SV2A-4200		6.29 A	20A	25A	Class J or High Speed J*
SV2A-4300		9.92 A	20A	30A	
SV2A-4550		16.83 A	35A	35A	
SV2A-4750		23.06 A	45A	45A	
SV2A-4F00		36.65 A	60A	90A	

Note: The values in the table above are maximum allowable values to be used with the listed drives. The maximum values are well above the drive rated input current. Most applications can use much lower fuse/breaker values. A smaller value of 125% - 175% of rated input current is recommended. This allows for temporary motor overloads without tripping the circuit protection. For lower rated fuse protection, please see section 3.2.4.

The SureServo2 drives have an SCCR rating of 5kA. For short circuit protection, choose a current-limiting fuse that limits the let-through current (at your installation's available fault current level) to less than 5,000 Amps. For SureServo2, ADC recommends Class CC or JHL High Speed Class J current-limiting fuses.

Example:

The time-current chart for JHL drive-rated fuses shows that a 30A JHL fuse will allow 50A for an extended period of time before blowing.

A smaller fuse/breaker rating also helps with SCCR. The 30A JHL fuse above has a peak let-through of less than 2,500A when connected to 100,000A RMS available fault current. A 60A JHL would allow a 5,000A peak with the same available RMS fault current. Using a smaller fuse is better for device protection and SCCR ratings.

Notes:

- *Operation mode: General*
- *If the servo drive is equipped with a residual-current circuit breaker for current leakage protection, to avoid incorrect operation of the RCD (Residual Current Device), please select a circuit breaker with sensitivity of at least 200mA and with minimum 0.1 sec working time.*
- *Select Type B residual-current circuit breaker (with time delay) ONLY if the system ground wire may contain DC electricity.*
- *Please use the circuit breaker and fuse that comply with the UL/CSA standard.*

2.6 - Ferrite Ring

The movable or round-shaped ferrite ring is usually made of Mn-Zn ferrite. The impedance of the ferrite ring varies with frequency. Normally, its impedance is relatively small to a low-frequency signal; however, when the frequency of the signal increases, the impedance may increase dramatically. Use the ferrite ring to optimize signal transmission and suppress high-frequency noise, and reduce high-frequency interference in the power and signal cables.

Ferrite Ring Model	Applicable Servo Drive Model
SV2-TOR1	All

Installation Precautions

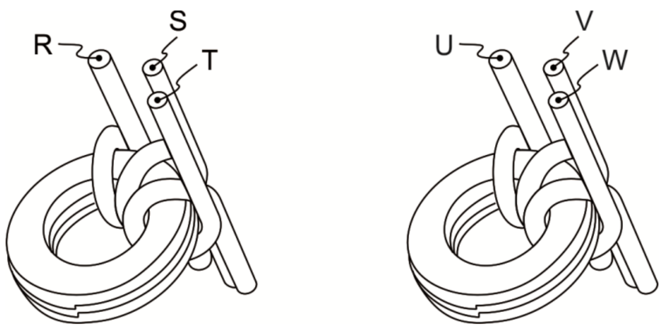
The ferrite ring is commonly used when peripheral devices (such as a controller) are affected by noise from conduction and radiation when the servo motor is in the Servo On state. The parasitic capacitance between the cables in the wiring panel and the ground is typically small. As the frequency of the signal increases (Servo On state), the resistance of the parasitic capacitance becomes small enough to let common-mode current flow through. Normally, common-mode current only leads to common-mode interference due to an unstable circuit caused by a poor connection between the power circuit and ground. If the common-mode current flows through the external cables, common-mode interference may also happen due to electrical interference caused by unstable electric potential.

The ferrite ring causes eddy current losses to the high-frequency signal and transforms it into heat when suppressing common-mode interference. The ferrite ring acts as a low-pass filter to effectively suppress high-frequency noise and ensure the stability of the circuit while the impedance to low-frequency signals is relatively small.

Winding several turns of wire onto the ferrite ring can increase inductance and the ability to filter out high-frequency noise.

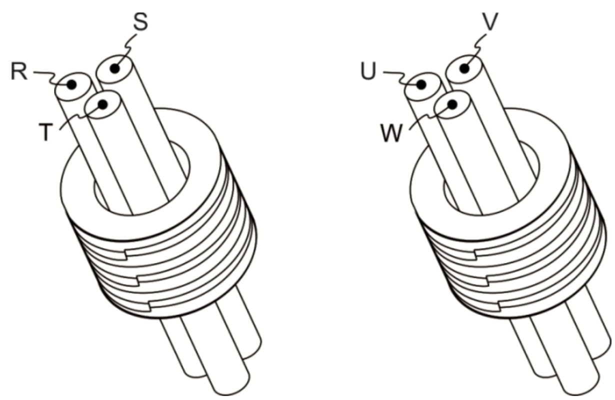
The suggested winding methods are shown below:

1) When the wire size (AWG) is small enough to wrap around the ferrite core at least once:



Recommended for up to 4.5 kW systems

2) When the wire size (AWG) is too large to wrap around the ferrite core at least once:



Recommended for 5.5 kW and larger systems

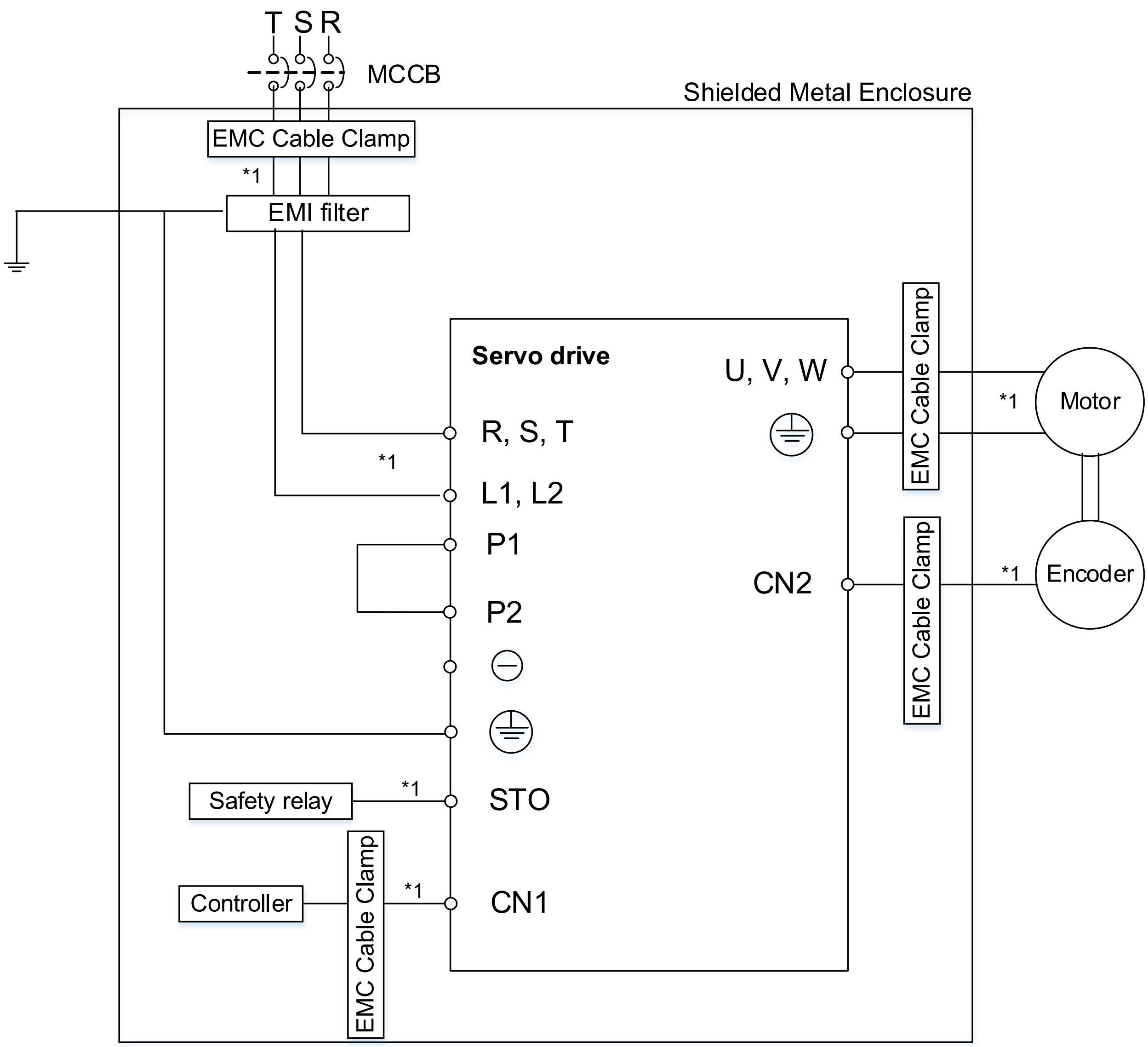
Notes:

- *Please refer to Section 3.2 for the selection of the motor power cable.*
- *Only the motor power cable or drive power cable can run through ferrite ring. If needed, please prepare extra ferrite rings for grounding.*
- *An EMI filter may be required for the drive input power for absorbing radiation when using a longer motor power cable.*

2.7 - Installation Requirements for EMC

This section illustrates the installation requirements for passing the EMC test. Please note that the EMC rating varies based on the installation structure or wiring. SureServo2 products are designed to conform to the specifications of the EMC test. Please refer to the following diagram for the standard installation. For further information and techniques on reducing EMI and its affects please see the EMI best practices paper here:

https://support.automationdirect.com/docs/emi_mitigation.pdf



*Note *1: Use of shielded cables is highly recommended.*

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2.7.1 - EMI Filters

All electronic equipment (including servo drives) generates high or low frequency noise during operation, which interferes with peripheral equipment through conduction or radiation. With an EMI filter and the correct installation, you can eliminate much of the interference. For better performance, using an EMI filter to suppress the interference is recommended.

Servo Drive Model	Main Voltage Level	Recommended EMI Filter		
		Standard Performance GS Series	Good Performance Roxburgh	High Performance Roxburgh
SV2A-2040	100-120VAC 1-phase	EMF11AM21A	RES90F10	MIF10
	200-230VAC 1-phase	EMF11AM21A	RES90F10	MIF10
	200-230VAC 3-phase	EMF10AM23A	KMF306A	MIF310
SV2A-2075	100-120VAC 1-phase	EMF27AM21B	RES90F16	MIF16
	200-230VAC 1-phase	EMF27AM21B	RES90F16	MIF16
	200-230VAC 3-phase	EMF10AM23A	KMF310A	MIF310
SV2A-2150	100-120VAC 1-phase	EMF27AM21B	RES90S20	MIF23
	200-230VAC 1-phase	EMF27AM21B	RES90S20	MIF23
	200-230VAC 3-phase	EMF24AM23B	KMF318A	MIF316
SV2A-2200	100-120VAC 1-phase	EMF27AM21B	RES90S30	MIF330B
	200-230VAC 1-phase	EMF27AM21B	RES90S30	MIF330B
	200-230VAC 3-phase	EMF24AM23B	KMF325A	MIF323
SV2A-2300	200-230VAC 3-phase	EMF24AM23B	KMF336A	MIF330B
SV2A-2550	200-230VAC 3-phase	n/a	KMF350A	MIF350
SV2A-2750	200-230VAC 3-phase	n/a	KMF350A	MIF350
SV2A-2F00	200-230VAC 3-phase	n/a	KMF3100A	MIF3100
SV2A-4040	460V 3-phase	EMF6A0M43A	KMF306A	MIF310
SV2A-4075	460V 3-phase	EMF6A0M43A	KMF306A	MIF310
SV2A-4150	460V 3-phase	EMF12AM43B	KMF310A	MIF310
SV2A-4200	460V 3-phase	EMF12AM43B	KMF318A	MIF316
SV2A-4300	460V 3-phase	EMF23AM43B	KMF325A	MIF323
SV2A-4550	460V 3-phase	NA	KMF336A	MIF330B
SV2A-4750	460V 3-phase	NA	KMF350A	MIF350
SV2A-4F00	460V 3-phase	NA	KMF370A	MIF375

General precautions for installation

To ensure the best performance of the EMI filter, apart from the instructions on installation and wiring of servo drive, please observe the precautions below:

- *The servo drive and EMI filter should be mounted on the same unpainted metal plate.*
- *The wiring should be as short as possible.*
- *The metal plate should be well grounded.*

More specifications for mounting the servo drive are listed below:

- *EN61000-6-4 (2001)*
- *EN61800-3 (2004) PDS of category C2*
- *EN55011+A2 (2007) Class A Group 1*

Motor cable selection and installation precautions

The selection of motor cables (please refer to Appendix B Accessories) and installation determines the performance of the EMI filter. Please follow the precautions below.

- *Use a cable that has braided shielding (the effect of double shielding is better).*
- *The shield on both ends of the motor cable should be grounded with the shortest cable length and the largest contact area.*

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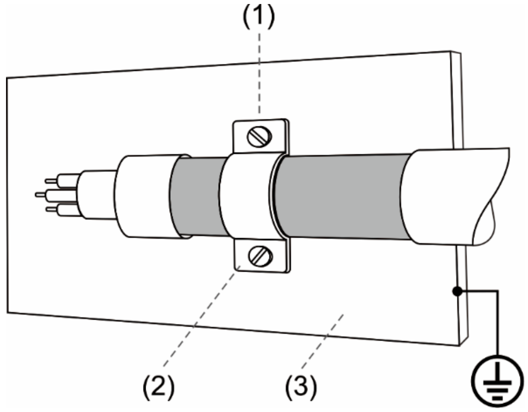
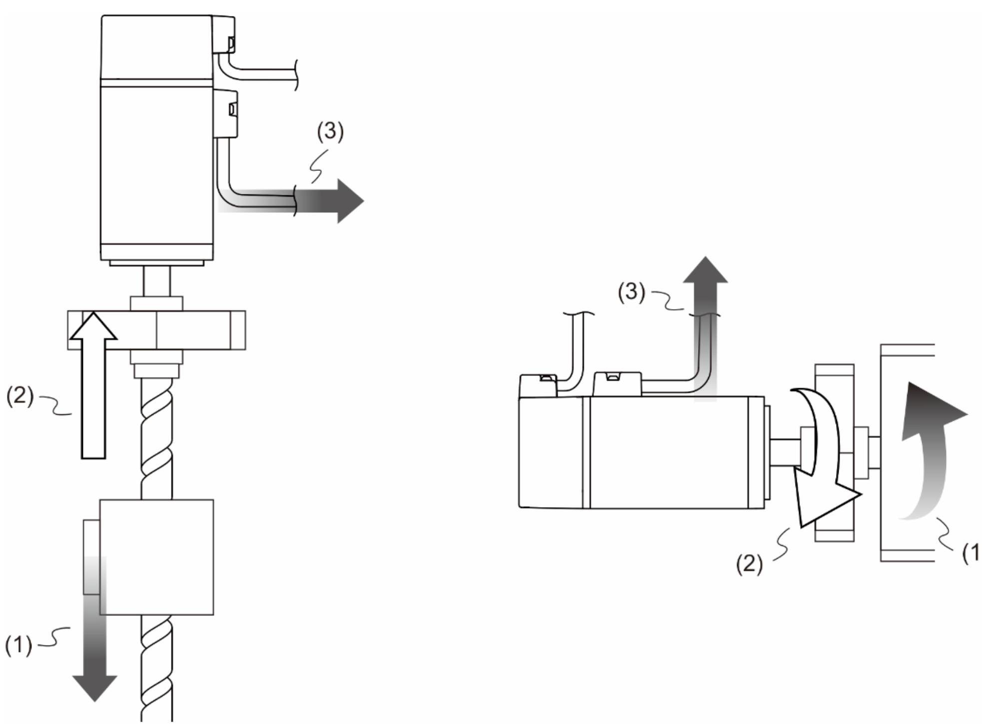
- *Remove the any protective paint on the U-shape saddle EMC cable clamp and metal plate in order to ensure good contact. Please see the figure below.*
- *A correct connection between the braided shielding of the motor cable and the metal plate is required. The braided shielding on both ends of the motor cable should be fixed by the EMC cable clamp U-shape saddle and metal plate. Please see the figure below for the correct connection.*



1) Any protective paint of the U-shape saddle EMC cable clamp and metal plate should be removed in order to ensure good contact.
2) EMC cable clamp U-shape saddle
3) Well-grounded metal plate

2.8 - Selecting the regenerative resistor for dynamic braking

When the direction of torque is different from the direction of rotation, the energy generated returns to the servo drive from the load. This energy is turned into electricity in the capacitor bank of the DC Bus and thus increases the voltage. When the voltage reaches a given value, it is consumed by a regenerative resistor. 230V servo drives up to 3kW and 460V servo drives up to 1.5 kW have a built-in regenerative resistor. You can also use the external regenerative resistor if needed. See the table on the following page for allowable external braking resistor values.



1) Moving direction of the object

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2) Direction of torque
3) Regenerative energy

The built-in regenerative resistor in the SureServo2 is as follows:

110/230V Series Drives				
Servo Drive (W)	***Built-in Regenerative Resistor Specifications***		***Regenerative Resistor Wattage for Internal Calculations (P1.053/2)(Watt)***	***Minimum Allowable Resistance* (Connected to external resistor) (Ohm)***
	Resistance (P1.052) (Ohm)	***Watts (P1.053)***		
400W	100	10	5	60
750W	100	28	14	60
1500W	100	28	14	30
2000W	30	40	20	15
3000W	20	40	20	15
5500W**	n/a	n/a		10
7500W**	n/a	n/a	See calculations below for recommended value	10
15000W**	n/a	n/a		5

** Using a resistance value lower than the minimum specified can cause too high of a current draw for the drive to handle. Note that there is no maximum resistance limit.*

*** 5.5 kW, 7.5 kW, and 15kW drives do not have an internal resistor. Enter your external resistance and wattage values here.*

460V Series Drives				
Servo Drive (W)	***Built-in Regenerative Resistor Specifications***		***Regenerative Resistor Wattage for Internal Calculations (P1.053/2)(Watt)***	***Minimum Allowable Resistance* (Connected to external resistor) (Ohm)***
	Resistance (P1.052) (Ohm)	***Watts (P1.053)***		
400W	80	20	10	80
750W	80	20	10	60
1500W	80	20	10	40
2000W**	n/a	n/a		40
3000W**	n/a	n/a		30
5500W**	n/a	n/a	See calculations below for recommended value	20
7500W**	n/a	n/a		15
15000W**	n/a	n/a		12

** Using a resistance value lower than the minimum specified can cause too high of a current draw for the drive to handle. Note that there is no maximum resistance limit.*

*** 2kW, 3kW, 5.5 kW, 7.5 kW, and 15kW drives do not have an internal resistor. Enter your external resistance and wattage values here.*

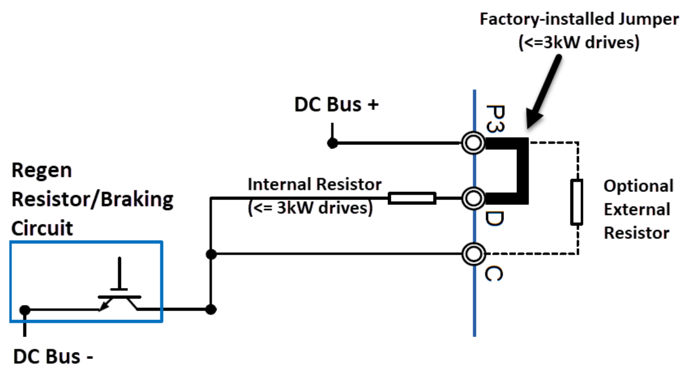
When the regenerative energy exceeds the capacity of built-in regenerative resistor, you should use an external regenerative resistor. Please pay special attention to the following when using an external regenerative resistor.

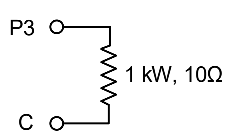
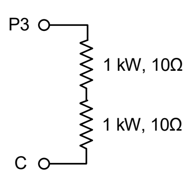
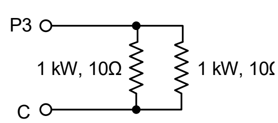
- *Please choose the correct resistance (P1.052) and wattage (P1.053) for the regenerative resistor; otherwise it might influence the performance, damage the drive, or overheat the resistor. For drives up to and including 3kW, the drives include a built-in resistor. For heat dissipation reasons the Wattage of the actual resistor is decreased in P1.053 vs. what is actually printed on the resistor. If the resistor was externally mounted with good airflow then the full Watt value of the resistor can be entered in P1.053. For further drive and resistor protection the drive's firmware uses half that value (P1.053/2) for energy regeneration calculations.*

- *When using an external regenerative resistor, please note that its resistance must be greater than the minimum allowable resistance for the servo drive in the table above. For general application, you can connect more than one resistor in series or in parallel depending on the resistance and wattage required. If you want to connect the resistors in parallel to increase the power of the regenerative resistor, please make sure the wattage and resistance capacity meet the requirements.*
  See the following diagram and settings for connecting the regenerative resistors in serial and parallel.

Note: If the internal AND an external resistor are both used (the P3-D jumper is NOT removed), make sure that the parallel resistance is still within the specified range for the drive in the table above).

This simplified diagram of the braking resistor circuitry shows the connections and usage of the internal regen resistor and factory-installed P3-D jumper (pre-installed on ≤ 3kW drives), and how the optional external resistor is used. External resistors are recommended (disconnect the P3-D jumper) in regen applications to remove heat from the drive that would be generated by using the internal regen resistor.



For 3kW and smaller drives, remove the P3-D jumper to disconnect the internal resistor	Connect to one external regenerative resistor 	Settings: P1.052 = 10 (Ω) P1.053 = 1000 (W)
	Connect to external regenerative resistors (serial connection) 	Settings: P1.052 = 20 (Ω) P1.053 = 2000 (W)
	Connect to external regenerative resistors (parallel connection) 	Settings: P1.052 = 5 (Ω) P1.053 = 2000 (W)

- *Normally, if the capacity of the regenerative resistor (the average value) is within the rated capacity, the temperature of the resistor can increase to 120°C or even higher (under the condition that the regenerative energy continues to be absorbed). For safety reasons, please use forced air cooling in order to reduce the temperature of the regenerative resistor. Alternatively, you can use regenerative resistors that are equipped with thermal switches.*

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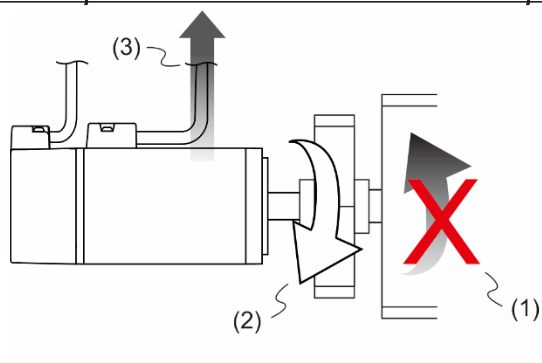
- *When installing an external regenerative resistor, connect the external resistor to P3 and C contacts. The P3 and D contacts are left open. It is recommended that you choose external regenerative resistor values equal to or greater than those listed in the table on the previous page. For easy calculation of the regenerative resistor capacity, there are two ways provided to calculate the capacity according to the selected motor.*

Rotary Motor:

Calculation of the regenerative power when there is no external torque, rotor inertia only



1) Direction of motion of the object
2) Direction of the motor torque
3) Regenerative power generated while the motor decelerates

If the motor is making a reciprocating motion, the regenerative resistor consumes energy quickly on each decel cycle. You can select the regenerative resistor by calculating the regenerative power. Refer to the following two tables when calculating and selecting the required regenerative resistor.

110/230V Series Drives				
Servo Drive (W)	***Motor***	***Rotor Inertia J (x 10^{-4} kg·m²)***	***Max Regenerative Power Generated when the Motor Decelerates from Rated Speed to 0 RPM without Load E_0 (joule)***	***Max Regenerative Absorbable Power of the Capacitor Bank E_C (joule)***
Low Inertia				
400	SV2L-201N	0.0627	0.20	6.24
	SV2L-201B	0.0689		
	SV2L-202N	0.25	0.43	
	SV2L-202B	0.28		
	SV2L-204N	0.45	0.74	
	SV2L-204B	0.48		
750	SV2L-207N	1.51	2.54	19.4
	SV2L-207B	1.66		
1500	SV2L-210N	2.65	13.1	19.4
	SV2L-210B	3.33		
Medium Inertia				
1500	SV2M-210N	8.41	18.48	19.4
	SV2M-210B	9.14		
	SV2M-215N	11.2	24.62	19.4
	SV2M-215B	11.9		
2000	SV2M-220N	34.7	76.26	24.95
	SV2M-220B	37.8		
3000	SV2M-230N	55	67.99	24.96
	SV2M-230B	57.1		
High Inertia				
5500	SV2H-245N	77.75	99.2	47.36
	SV2H-245B	80.65		
	SV2H-255N	99.78	126.23	47.36
	SV2H-255B	102.70		
7500	SV2H-275N	142.7	178.84	69.3
	SV2H-275B	145.55		

110/230V Series Drives				
Servo Drive (W)	**Motor**	**Rotor Inertia J (x 10^{-4} kg·m²)**	**Max Regenerative Power Generated when the Motor Decelerates from Rated Speed to 0 RPM without Load E_0 (joule)**	**Max Regenerative Absorbable Power of the Capacitor Bank E_C (joule)**
15000	SV2H-2B0N	338	428.37	155.93
	SV2H-2B0B	346.5		
	SV2H-2F0N	451	570.91	155.93
	SV2H-2F0B	461.8		

460V Series Drives				
Servo Drive (W)	**Motor**	**Rotor Inertia J (x 10^{-4} kg·m²)**	**Max Regenerative Power Generated when the Motor Decelerates from Rated Speed to 0 RPM without Load E_0 (joule)**	**Max Regenerative Absorbable Power of the Capacitor Bank E_C (joule)**
Low Inertia				
400	SV2L-404N	0.45	2.37	7.82
	SV2L-404B	0.48		
750	SV2L-407N	1.51	9.34	
	SV2L-407B	1.66		
1500	SV2L-410N	2.65	16.47	11.14
	SV2L-410B	3.33		
	SV2L-415N	11.2	26.15	
	SV2L-415B	11.9		
2000	SV2L-420N	34.7	83.08	22.28
	SV2L-420B	37.8		
Medium Inertia				
1500	SV2M-410N	8.41	20.09	11.14
	SV2M-410B	9.14		
High Inertia				
3000	SV2H-430N	54.95	70.59	26.54
	SV2H-430B	57.1		
5500	SV2H-445N	77.75	99.70	53.09
	SV2H-445B	80.65		
	SV2H-455N	99.78	126.96	
	SV2H-455B	102.70		
7500	SV2H-475N	142.7	179.94	77.74
	SV2H-475B	145.55		
15000	SV2H-4B0N	338	428.37	118.50
	SV2H-4B0B	346.5		
	SV2H-4F0N	451	570.91	
	SV2H-4F0B	461.8		

Assume that the load inertia is N times the motor inertia, and when motor decelerates from 3000 rpm to 0, the regenerative power is (N+1) × E_0 and the regenerative resistor needs to consume (N+1) × E_0-E_C joules. Assume that the reciprocate operation cycle is T sec, then the required power of regenerative resistor (P1.053) is Watts = 2 × (((N+1) × E_0) - E_C) / T. Note that the leading "2" in the equation is due to the drive firmware halving the Watt value.

The calculation is as follows:

Step	What to Do	Calculation and Setting Method
1	Set the wattage of the regenerative resistor to the maximum	Set P1.053 to the maximum value
2	Set the operation cycle (T)	Manual input (T=seconds)
3	Set the rotation speed in RPMs (wr)	Manual input or read the status with P0.002 Code (09h)
4	Set the load / motor inertia ratio (N)	Manual input or read the status with P0.002
5	Calculate the maximum regenerative resistor (E_0)	E_0= J * wr^2/182 Note, the value 182 comes from the formula below: $182 = \frac{1}{1/2 \times (2\pi/60)^2}$
6	Find the regenerative power that can be absorbed by the capacitor (E_c)	Refer to the table above
7	Calculate the required capacity (in Watts) of the regenerative resistor	$2 \times ((N+1) \times E_0 - E_c) / T$

Example 1:

For SV2L-204B (400W), the reciprocating motion cycle is T = 0.4 sec. One motion cycle here is defined as two complete moves, an acceleration followed by deceleration to a stop in the forward direction, then an immediate acceleration followed by deceleration to a stop in the reverse direction. Then repeat.

Its maximum speed is 3000 rpm and the load inertia is 15 times of the motor inertia.

Servo Drive (W)	Motor	Rotor Inertia J (x 10-4kg.m^2)	Regenerative Power Generated when the Motor Decelerates from 3000RPM to 0 without Load E_0 (joule)	Max Regenerative Power of the Capacitance E_c (joule)
400	SV2L-204x	0.15	0.74	6.24

Find the maximum regenerative power: E_0 = 0.74 joules (from the table).

Find the regenerative power that can be absorbed by the capacitor; E_c = 6.24 joules (from the table).

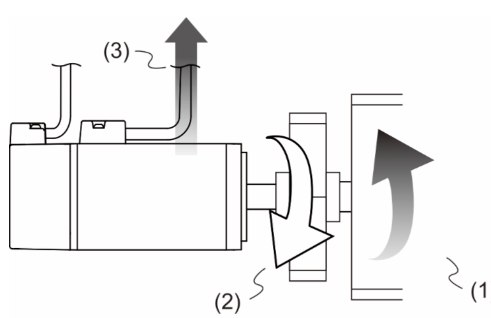
The required capacity of the regenerative resistor = $\frac{2 \times (N+1) \times E_0 - E_c}{T}$

Inserting the values for the variables gives:

$$\frac{2 \times ((15+1) \times 0.74) - 6.24}{0.4} = 43.6 \text{ W}$$

From the calculation above, the required power of regenerative resistance is 43.6 W, which is slightly greater than the specified capacity. In this case, a built-in 40W regenerative resistor does not quite fulfill the need. In general, the built-in regenerative resistor can meet the requirement when the external load is not too great. The leading "2" in the equation is for the protection of the resistor sizing and is why P1.053 is double what the drive uses for regen calculations.

Calculation of the regenerative power when there is external torque and the motor does the negative work.



1) Direction of motion of the object
2) Force direction of the motor
3) Regenerative power

Usually, the motor does positive work and the motor's torque direction is identical to the rotation direction. However, in some instances, the motor's torque direction is opposite to the rotation direction. This means the motor is doing negative work and the external power is applied to the servo drive through the motor. For instance, if the external force direction is identical to the rotation direction (such as vertical downward motion of the machine), the servo system outputs more power to counterbalance the excessive external load (the weight of vertical-mounted machine) in order to keep up with the specified target speed. In this case, considerable power returns to the servo drive. When DC Bus cannot store more power, this power is consumed by the regenerative resistor.

Example 2:

For a 400W motor (SV2L-204B) with an external torque load +70% of the rated torque (1.27 N·m), with rotation speed up to 3000 rpm, the required external regenerative resistance is:

$$2 \text{ x } (0.7 \text{ x } 1.27 \text{ Nm}) \text{ x } \frac{3000 \text{ rev/min x } 2 \text{ x } \pi}{60 \text{ sec/min}} = 560\text{W}$$

So, a minimum regenerative resistor of 560W and 60Ω is needed.

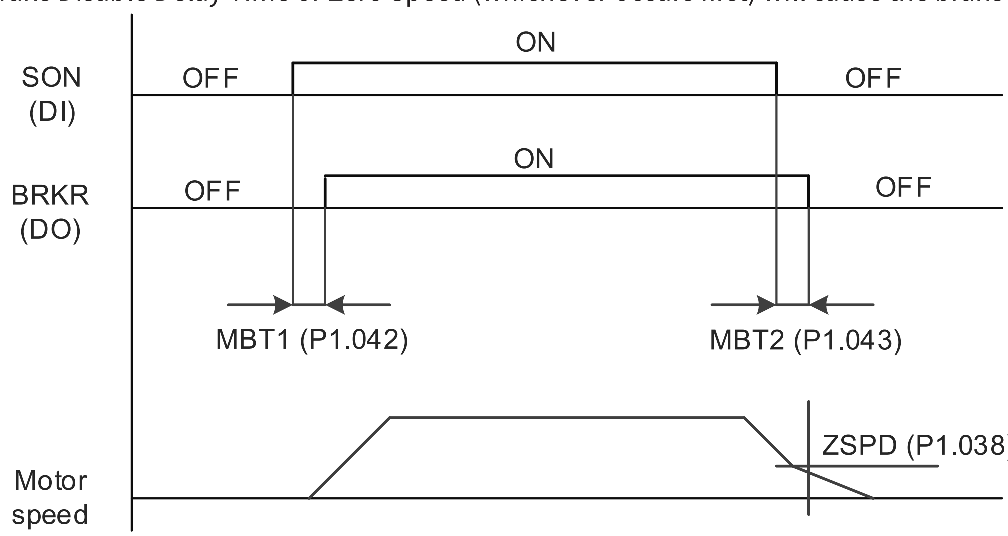
2.9 - The Use of Braking

A brake is usually used for motions in Z-axis direction because gravity causes the mechanism to fall. A brake can prevent the mechanism from falling and greatly reduce the motor's resistance output. The motor lifespan could be reduced due to resistance and excessive heat generation. To avoid incorrect operation, the brake should be enabled only when the servo is disabled. The brake is engaged (holding the motor) when no power is applied to the brake wires. The brake is disengaged (allowing the motor to spin) when power is applied to the brake wires.

The servo drive can control the brake with a digital output (DO). If DO.BRKR (Brake Relay - always use a relay to provide the higher current required by the brake) is set to off, it means the brake is engaged and the motor is clamped. If DO.BRKR is set to on, it means the brake is not engaged and the motor can run freely. You can use MBT1 (P1.042) and MBT2 (P1.043) to set the delay time. The timing diagrams below assume the DO definition code = 0x108. The output definition of 0x108 in P2.018 - P2.022 means that the DO is set for the Magnetic Brake and that the output functions as "Normally Open" (current is flowing when ON, and current is not flowing when OFF).

Timing diagram of brake control:

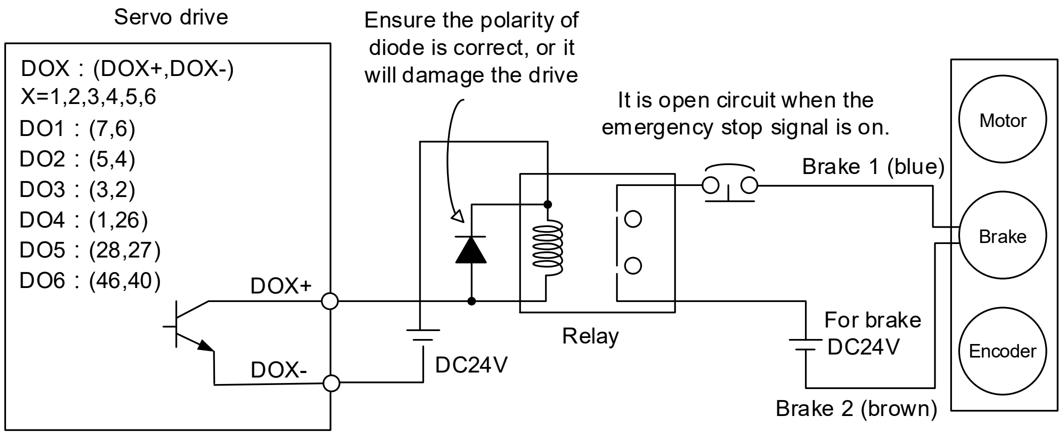
Brake Disable Delay Time or Zero Speed (whichever occurs first) will cause the brake to clamp.



Output timing of the BRKR signal:

- *When the servo drive is off and the time set for P1.043 is exceeded, but the motor speed is still higher than the speed set for P1.038, DO.BRKR ends off (the motor is clamped).*
- *When the servo drive is off and the time set for P1.043 is not yet reached, but the motor speed is already lower than the speed set for P1.038, DO.BRKR is off (the motor is clamped).*

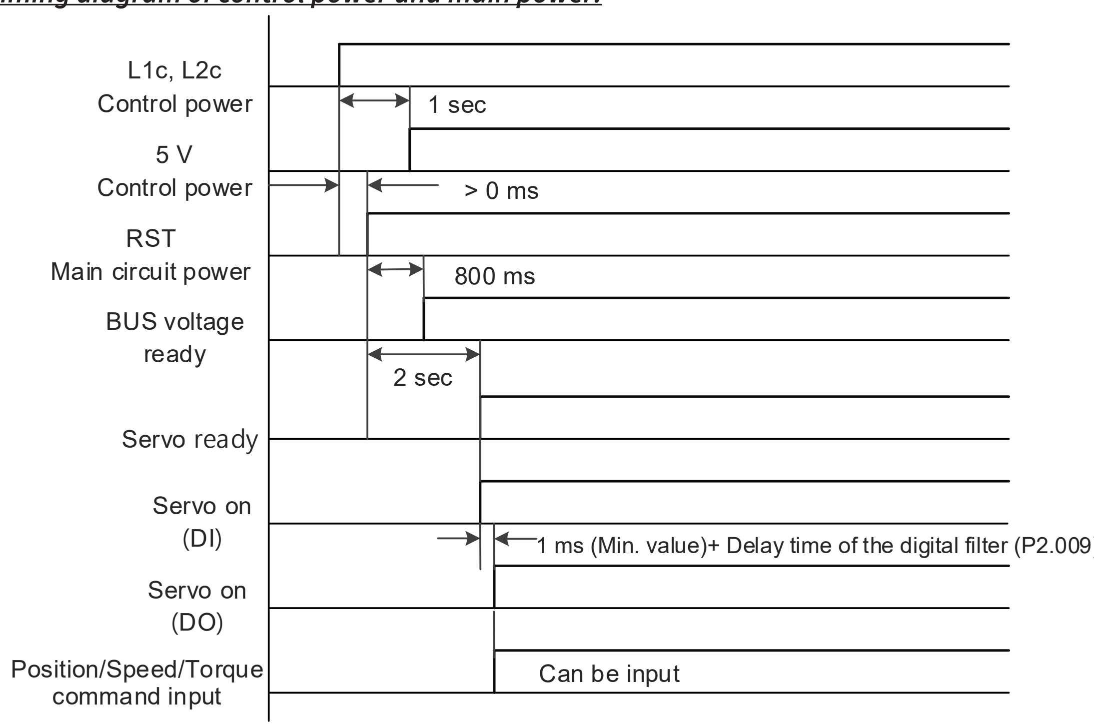
Wiring of the Brake:



Notes:

- *Please refer to Chapter 3 Wiring.*
- *Please use relay part number 781-1C-24D or equivalent.*
- *Please use diode part number AD-ASMD-250 or equivalent.*
- *The brake signal controls the solenoid, providing power to the brake and enabling the brake.*
- *Please note that there is no polarity for the coil brake. DC+ and DC- voltage can be connected to either the blue or brown wires.*

Timing diagram of control power and main power:



Calculating the brake's rated current (SV2L-204N is used as an example here).
Power consumption of the brake (20°C) = 6.5 W (refer to Appendix A Motor specifications),
so the brake's rated current = (6.5 W)/24V = 0.27 A.

Chapter 3

Chapter 3: Wiring

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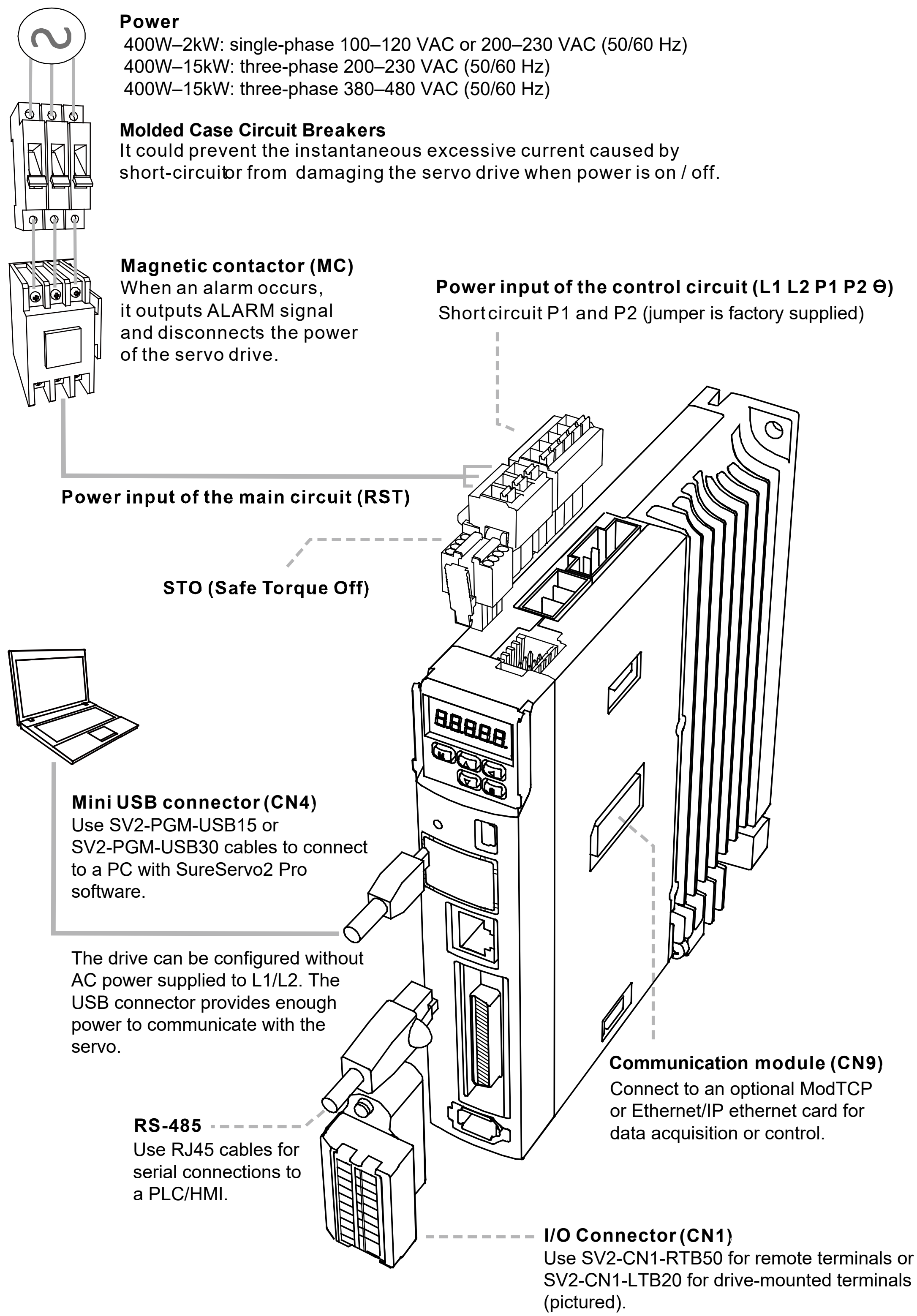
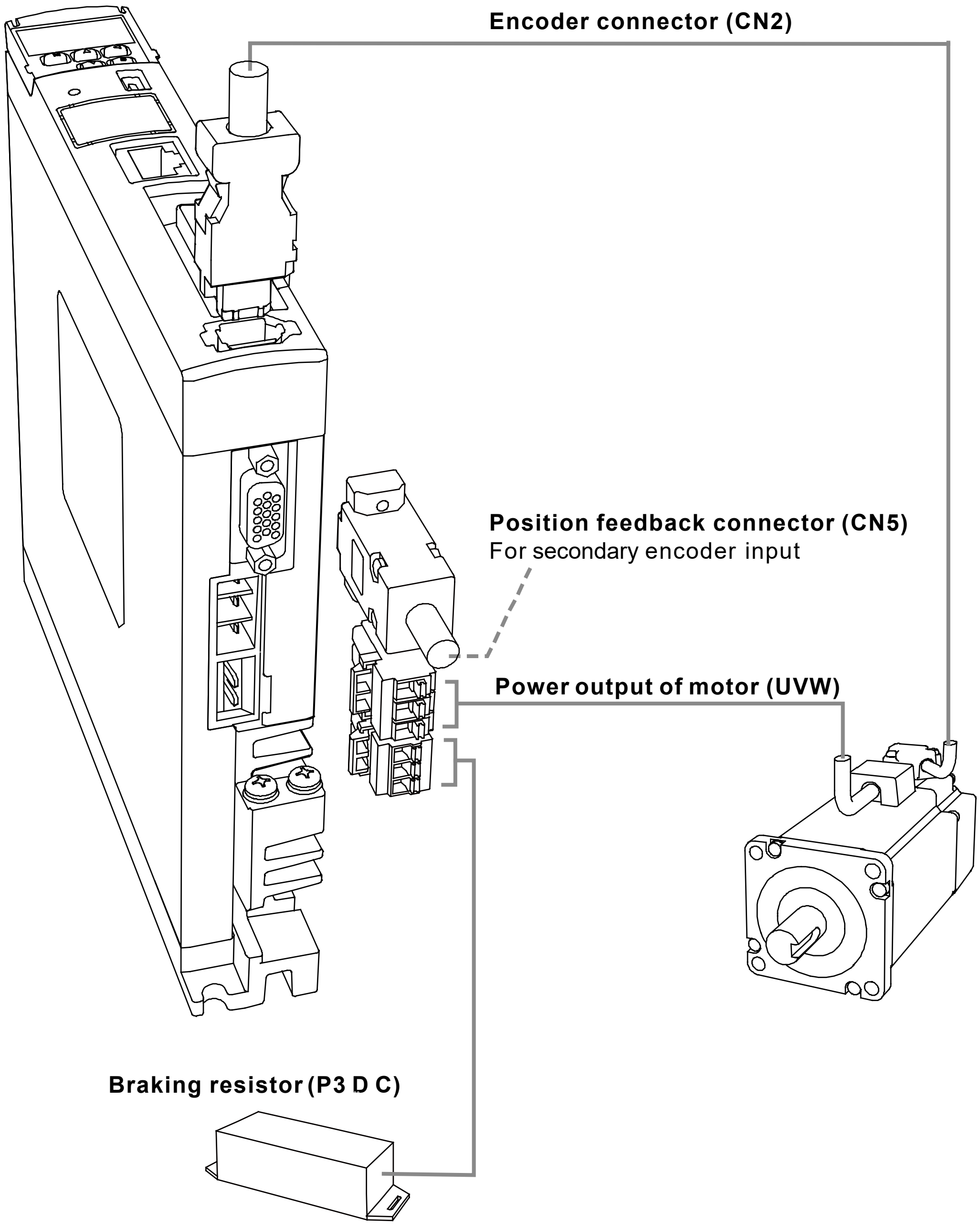
SureServo2™ Wiring

This chapter illustrates the power supply circuit, connectors, and wiring for each mode of the SureServo2.

3.1 - System Connection

3.1.1 - Connecting to Peripheral Devices





Installation safety precautions:

1) Make sure the power and wiring connections between the R, S, T, and L1, L2 are correct. Please refer to Appendix A Specifications in this user manual for the correct voltage input to avoid any damage to the servo drive and dangerous operating conditions.
2) Make sure the UVW terminal block is correctly wired to avoid abnormal operation of the motor.
3) When installing an external regenerative resistor, P3 and D contacts should be left open, and the external regenerative resistor should connect to P3 and C contacts. When using the built-in regenerative resistor, P3 and D contacts should be short-circuited, and P3 and C contacts should be left open.
4) When an alarm occurs or the system is under emergency stop status, please use DO.ALARM or DI.WARN to disconnect the power at the magnetic contactor (MC) so as to power off the servo drive.

3.1.2 - Connectors and Terminal Blocks

<table>
<tr><th>Symbol</th><th>Name</th><th>Description</th></tr>
<tr><td>L1c, L2c</td><td>Power input for the 110/230V control circuit</td><td>Connect to single-phase AC power (230V drives only). Please refer to the model specification for the proper input voltage.</td></tr>
<tr><td>24V, 0V</td><td>Power input for the 460V control circuit</td><td>Connect to 24VDC power (460V drives only).</td></tr>
<tr><td>P1, P2</td><td>Reserved</td><td>Short circuit P1 and P2 (there is a factory installed jumper).</td></tr>
<tr><td>R, S, T</td><td>Power input for the main circuit</td><td>Connect to AC power (please refer to the model specification for the proper input voltage). If using 1-phase power, connect to R and S.</td></tr>
<tr><td>U, V, W, FG</td><td>Motor power</td><td>Connect to the servo motor:
<table>
<tr><th>Symbol</th><th>Wire Color</th><th>Description</th></tr>
<tr><td>U</td><td>Red</td><td rowspan="3">Three-phase main power cable for the motor.</td></tr>
<tr><td>V</td><td>White</td></tr>
<tr><td>W</td><td>Black</td></tr>
<tr><td>FG</td><td>Green</td><td>Connect to ground terminal for the servo drive.</td></tr>
</table></td></tr>
<tr><td>P3, D, C, ⊖</td><td>Regenerative resistor terminal or braking unit</td><td>
<table>
<tr><th>Usage</th><th>Connection</th></tr>
<tr><td>Use internal resistor</td><td>The contact between P3 and D should be short-circuited. The contact between P3 and C should be open.</td></tr>
<tr><td>Use external resistor</td><td>Connect P3 and C to the resistor and the contact between P3 and D should be open.</td></tr>
<tr><td>Use external braking unit</td><td>Connect the braking unit to P3 and ⊖ of the servo drive. The connection between P3 & D, and P3 & C should be opened.</td></tr>
</table></td></tr>
<tr><td>⏚</td><td>Ground terminal</td><td>Connect to the ground wire for the power and servo motor.</td></tr>
<tr><td>CN1</td><td>I/O connector</td><td>Connect to the host controller. Please refer to section 3.4 for more information.</td></tr>
<tr><td>CN2</td><td>Connector for motor encoder</td><td>Connect to the encoder. Please refer to section 3.6 for more information.</td></tr>
<tr><td>CN3</td><td>Connector of RS-485</td><td>For RS-485. Please refer to section 3.7 for more information.</td></tr>
<tr><td>CN4</td><td>Mini USB connector</td><td>Connect to PC or laptop for use with SureServo2 Pro software. Please refer to section 3.8 for more information. The USB connector provides enough power to configure the drive without having AC power supplied.</td></tr>
<tr><td>CN5</td><td>Position feedback connector (Optional)</td><td>Connect to external linear scale or encoder for full-closed loop and motor feedback. Please refer to section 3.9 for more information. Suggested cables: ZL-HD15M-CBL-DB15F (with ZIPlink ZL-RTB-DB15 breakout module) or ZL-HD15M-CBL-2P HD15 to flying lead cable.</td></tr>
<tr><td>CN9</td><td>Expansion module</td><td>Connect to EtherNet IP or Modbus TCP communication modules.</td></tr>
<tr><td>CN10</td><td>STO</td><td>Connect to STO plug or safety circuit. Please refer to section 3.10 for more information.</td></tr>
</table>

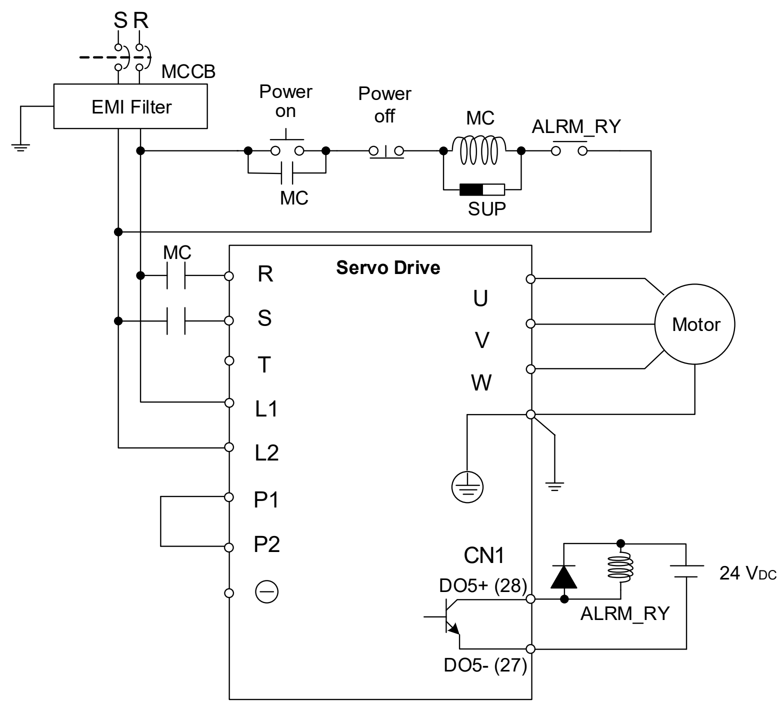
Pay special attention to the following when connecting the wiring:

1) When the power is off, do not touch R, S, T and U, V, W since the capacitor inside the servo drive can still contain a dangerously large amount of electric charge. Wait until the charging light is off.
2) Separate R, S, T and U, V, W from other wires. The separation should be at least 30 cm (11.8 inches).
3) If the connection cable for CN2 (encoder) or CN5 (position feedback) is not long enough, please use a 26 AWG shielded twisted-pair cable that conforms to UL2464 specifications. If it is over 20 meters (65.62 ft), please choose a signal cable with diameter two times greater than 26 AWG to avoid excessive signal attenuation.
4) When using RS-485 please use shielded twisted-pair cable to ensure the communication quality.
5) When selecting the wires, please refer to section 3.2.4.
6) Do not use any external capacitors or it might damage the servo drive.

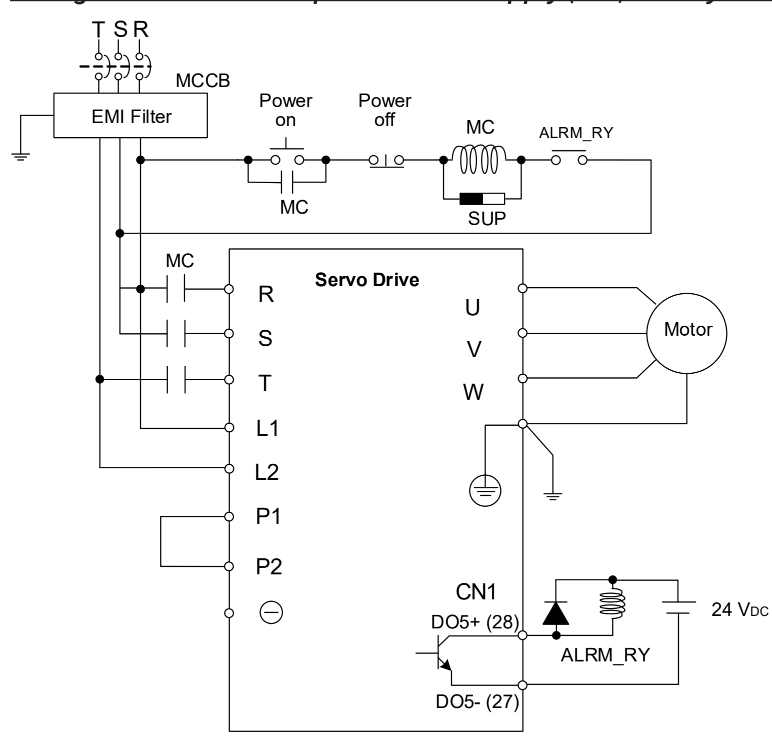
3.1.3 - Wiring for Power Supply

There are two methods for wiring the power supply: single-phase and three-phase. In the diagram below, Power On is normally open, Power Off and ALRM_RY are normally closed. DO5 function (P2.022) is set to 0x0007 by default (normally closed output). In the two diagrams below, set DO5 function to 0x0107 (normally open output). MC (magnetic contactor) is the power relay and the contact for the main power circuit.

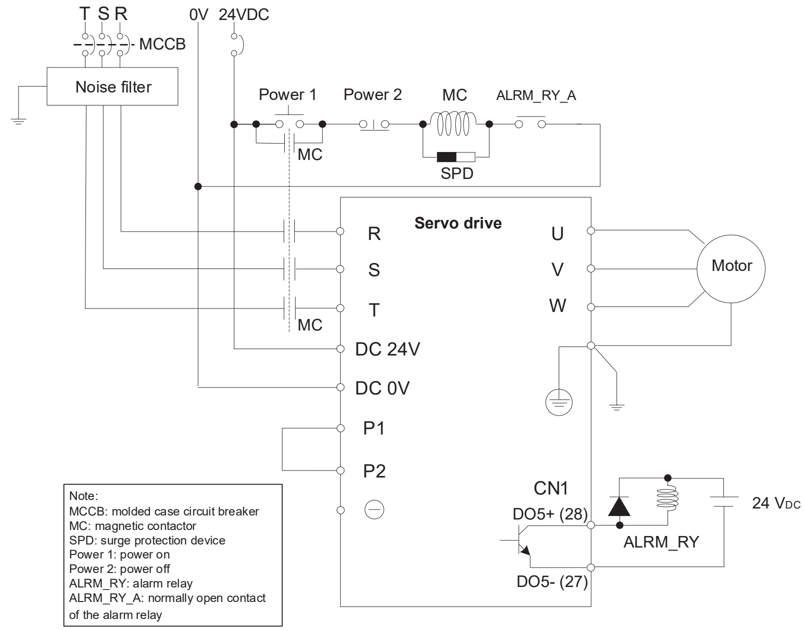
Wiring Method for Single-phase Power Supply



Wiring Method for Three-phase Power Supply (110/230V systems)



Wiring Method for Three-phase Power Supply (460V systems)



Note: The CN1 DO5 Digital Output shown in the diagram is the default Alarm Output for SureServo2 and is defaulted to normally closed.

3.2 - Cables and Connectors for SureServo2

<table>
<tr><th colspan="7">110/230V Motors</th></tr>
<tr><th>Motor</th><th>Motor Description</th><th>Power Cable</th><th>Replacement Power Connector</th><th>Encoder Cable</th><th>Replacement Encoder Connector</th><th>Drive End Replacement Encoder Connector</th></tr>
<tr><td>SV2L-201N</td><td>Motor, 0.1 kW, Low intertia</td><td rowspan="4">SV2C-PA18-xxxN</td><td rowspan="4">SV2C-PA-CON</td><td rowspan="4">SV2C-E122-xxxN</td><td rowspan="4">SV2C-E1-CON</td><td rowspan="14">SV2C-E3-CON</td></tr>
<tr><td>SV2L-202N</td><td>Motor, 0.2 kW, Low inertia</td></tr>
<tr><td>SV2L-204N</td><td>Motor, 0.4 kW, Low inertia</td></tr>
<tr><td>SV2L-207N</td><td>Motor, 0.75 kW, Low inertia</td></tr>
<tr><td>SV2L-210N</td><td>Motor, 1kW, Low inertia</td><td>SV2C-PC16-xxxN</td><td rowspan="3">SV2C-PC-CON</td><td rowspan="10">SV2C-E222-xxxN</td><td rowspan="10">SV2C-E2-CON</td></tr>
<tr><td>SV2M-210N</td><td>Motor, 1kW, Med inertia</td><td rowspan="2">SV2C-PC12-xxxN</td></tr>
<tr><td>SV2M-215N</td><td>Motor, 1.5 kW, Med inertia</td></tr>
<tr><td>SV2M-220N</td><td>Motor, 2kW, Med inertia</td><td rowspan="2">SV2C-PD12-xxxN</td><td rowspan="3">SV2C-PD-CON</td></tr>
<tr><td>SV2M-230N</td><td>Motor, 3kW, Med inertia</td></tr>
<tr><td>SV2H-245N</td><td>Motor, 4.5 kW, High inertia</td><td>SV2C-PD08-xxxN</td></tr>
<tr><td>SV2H-255N</td><td>Motor, 5.5 kW, High inertia</td><td rowspan="3">SV2C-PF06-xxxx</td><td rowspan="4">SV2C-PF-CON</td></tr>
<tr><td>SV2H-275N</td><td>Motor, 7.5 kW, High inertia</td></tr>
<tr><td>SV2H-2B0N</td><td>Motor, 11 kW, High inertia</td></tr>
<tr><td>SV2H-2F0N</td><td>Motor, 15 kW, High inertia</td><td>SV2C-PF04-xxxx</td></tr>
<tr><td>SV2L-201B</td><td>Motor, 0.1 kW, Low inertia</td><td rowspan="4">SV2C-PB18-xxxB</td><td rowspan="4">SV2C-PB-CON</td><td rowspan="4">SV2C-E122-xxxN</td><td rowspan="4">SV2C-E1-CON</td><td rowspan="14">SV2C-E3-CON</td></tr>
<tr><td>SV2L-202B</td><td>Motor, 0.2 kW, Low inertia</td></tr>
<tr><td>SV2L-204B</td><td>Motor, 0.4 kW, Low inertia</td></tr>
<tr><td>SV2L-207B</td><td>Motor, 0.75 kW, Low inertia</td></tr>
<tr><td>SV2L-210B</td><td>Motor, 1kW, Low inertia</td><td>SV2C-PC16-xxxB</td><td rowspan="3">SV2C-PC-CON</td><td rowspan="10">SV2C-E222-xxxN</td><td rowspan="10">SV2C-E2-CON</td></tr>
<tr><td>SV2M-210B</td><td>Motor, 1kW, Med inertia</td><td rowspan="2">SV2C-PC12-xxxB</td></tr>
<tr><td>SV2M-215B</td><td>Motor, 1.5 kW, Med inertia</td></tr>
<tr><td>SV2M-220B</td><td>Motor, 2kW, Med inertia</td><td rowspan="2">SV2C-PD12-xxxB</td><td rowspan="3">SV2C-PD-CON</td></tr>
<tr><td>SV2M-230B</td><td>Motor, 3kW, Med inertia</td></tr>
<tr><td>SV2H-245B</td><td>Motor, 4.5 kW, High inertia</td><td>SV2C-PD08-xxxB</td></tr>
<tr><td>SV2H-255B*</td><td>Motor, 5.5 kW, High inertia</td><td rowspan="3">SV2C-PF06-xxxx
+
SV2C-B120-xxxx</td><td rowspan="4">SV2C-PF-CON</td></tr>
<tr><td>SV2H-275B*</td><td>Motor, 7.5 kW, High inertia</td></tr>
<tr><td>SV2H-2B0B*</td><td>Motor, 11 kW, High inertia</td></tr>
<tr><td>SV2H-2F0B*</td><td>Motor, 15 kW, High inertia</td><td>SV2C-PF04-xxxx
+
SV2C-B120-xxxx</td></tr>
<tr><td colspan="7">* Brake wiring is separate from the motor power cable for 5.5–15 kW motors. Brake power cable SV2C-B120-xxxx is required.
The replacement connector for the brake cable is SV2C-B1-CON.
For 100W to 4.5 kW motors the brake wiring is inside the motor power cable and no brake power cable is required.</td></tr>
</table>

NOTE: Cable specifications (including diameter and bend radius) available in Appendix B.

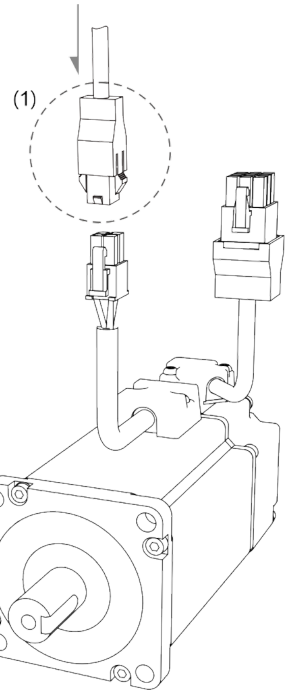
460V Motors

Motor	***Motor Description***	***Power Cable***	***Replacement Power Connector***	***Encoder Cable***	***Replacement Encoder Connector***	***Drive End Replacement Encoder Connector***
SV2L-404N	Motor, 0.4 kW, Low inertia	SV2C-PA18-xxxN	SV2C-PA-CON	SV2C-E122-xxxN	SV2C-E1-CON	SV2C-E3-CON
SV2L-407N	Motor, 0.75 kW, Low inertia					
SV2L-410N	Motor, 1kW, Low inertia	SV2C-PC16-xxxN	SV2C-PC-CON	SV2C-E222-xxxN	SV2C-E2-CON	
SV2M-410N	Motor, 1kW, Med inertia					
SV2L-415N	Motor, 1.5 kW, Low inertia					
SV2L-420N	Motor, 2kW, Low inertia					
SV2H-430N	Motor, 3kW, High inertia	SV2C-PD12-xxxN	SV2C-PD-CON			
SV2H-445N	Motor, 4.5 kW, High inertia	SV2C-PD08-xxxN				
SV2H-455N	Motor, 5.5 kW, High inertia					
SV2H-475N	Motor, 7.5 kW, High inertia					
SV2H-4B0N	Motor, 11 kW, High inertia	SV2C-PF08-xxxx	SV2C-PF-CON			
SV2H-4F0N	Motor, 15 kW, High inertia					
SV2L-404B	Motor, 0.4 kW, Low inertia	SV2C-PB18-xxxB	SV2C-PB-CON	SV2C-E122-xxxN	SV2C-E1-CON	SV2C-E3-CON
SV2L-407B	Motor, 0.75 kW, Low inertia					
SV2L-410B	Motor, 1kW, Low inertia	SV2C-PC16-xxxB	SV2C-PC-CON	SV2C-E222-xxxN	SV2C-E2-CON	
SV2M-410B	Motor, 1kW, Med inertia					
SV2L-415B	Motor, 1.5 kW, Low inertia					
SV2L-420B	Motor, 2kW, Low inertia					
SV2H-430B	Motor, 3kW, High inertia	SV2C-PD12-xxxB	SV2C-PD-CON			
SV2H-445B	Motor, 4.5 kW, High inertia	SV2C-PD08-xxxB				
SV2H-455B	Motor, 5.5 kW, High inertia					
SV2H-475B	Motor, 7.5 kW, High inertia					
SV2H-4B0B*	Motor, 11 kW, High inertia	SV2C-PF08-xxxx + SV2C-B120-xxxx	SV2C-PF-CON			
SV2H-4F0B*	Motor, 15 kW, High inertia					

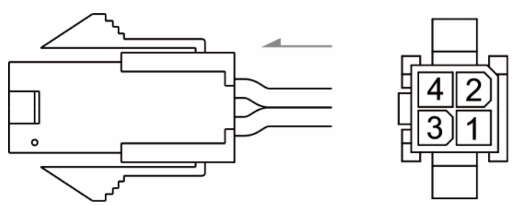
** Brake wiring is separate from the motor power cable for 11–15 kW motors. Brake power cable SV2C-B120-xxxx is required.*
The replacement connector for the brake cable is SV2C-B1-CON.
For 100W to 7.5 kW motors the brake wiring is inside the motor power cable and no brake power cable is required.

NOTE: Cable specifications (including diameter and bend radius) available in Appendix B.

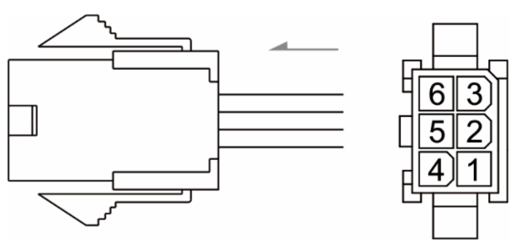
3.2.1 - UVW Connectors for the SureServo2 Drive



(1) Refer to the table below for UVW connector specifications:

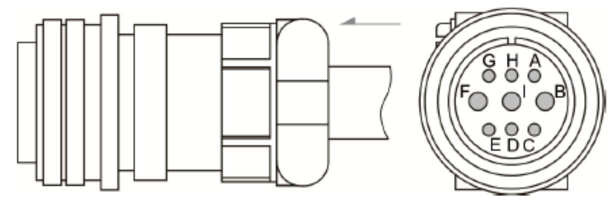
Motor Model	UVW Connector
SV2L-201N SV2L-202N SV2L-204N SV2L-207N SV2L-404N SV2L-407N	

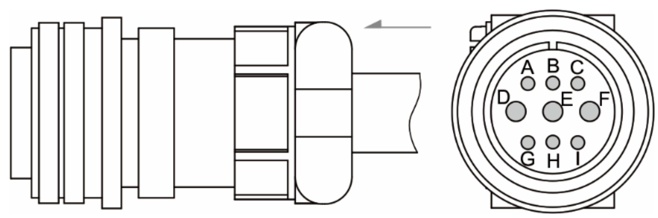
Pin Assignment for SV2C-PA-CON					
U (Red)	V (White)	W (Black)	Case Ground (Green)	Brake 1 (Yellow)	Brake 2 (Blue)
1	2	3	4	n/a	n/a

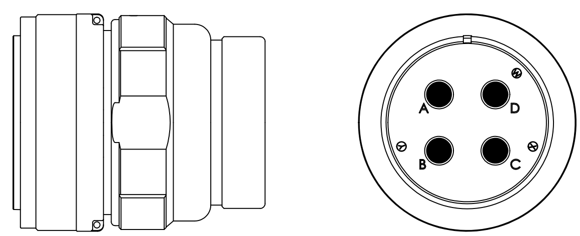
Motor Model	UVW Connector
SV2L-201B SV2L-202B SV2L-204B SV2L-207B SV2L-404B SV2L-407B	

Pin Assignment for SV2C-PB-CON					
U (Red)	V (White)	W (Black)	Case Ground (Green)	Brake 1 (Yellow)	Brake 2 (Blue)
1	2	4	5	3	6

Wiring
Parameters
DI/DO Codes
Monitoring
Alarms

<table>
<tr><th>Motor Model</th><th>UVW Connector</th></tr>
<tr><td>SV2L-210N
SV2L-210B
SV2M-210N
SV2M-210B
SV2M-215N
SV2M-215B
SV2L-410N
SV2L-410B
SV2M-410N
SV2M-410B
SV2L-415N
SV2L-415B
SV2L-420N
SV2L-420B</td><td>

<table>
<tr><th colspan="6">Pin Assignment for SV2C-PC-CON</th></tr>
<tr><th>U
(Red)</th><th>V
(White)</th><th>W
(Black)</th><th>Case Ground
(Green)</th><th>Brake 1
(Yellow)</th><th>Brake 2
(Blue)</th></tr>
<tr><td>F</td><td>I</td><td>B</td><td>E</td><td>G</td><td>H</td></tr>
</table></td></tr>
<tr><td>SV2M-220N
SV2M-220B
SV2M-230N
SV2M-230B
SV2H-245N
SV2H-245B
SV2H-430N
SV2H-430B
SV2H-445N
SV2H-445B
SV2H-475N
SV2H-475B</td><td>

<table>
<tr><th colspan="6">Pin Assignment for SV2C-PD-CON</th></tr>
<tr><th>U
(Red)</th><th>V
(White)</th><th>W
(Black)</th><th>Case Ground
(Green)</th><th>Brake 1
(Yellow)</th><th>Brake 2
(Blue)</th></tr>
<tr><td>D</td><td>E</td><td>F</td><td>G</td><td>A</td><td>B</td></tr>
</table></td></tr>
<tr><td>SV2H-255N
SV2H-255B
SV2H-275N
SV2H-275B
SV2H-2B0N
SV2H-2B0B
SV2H-2F0N
SV2H-2F0B
SV2H-4B0N
SV2H-4B0B
SV2H-4F0N
SV2H-4F0B</td><td>

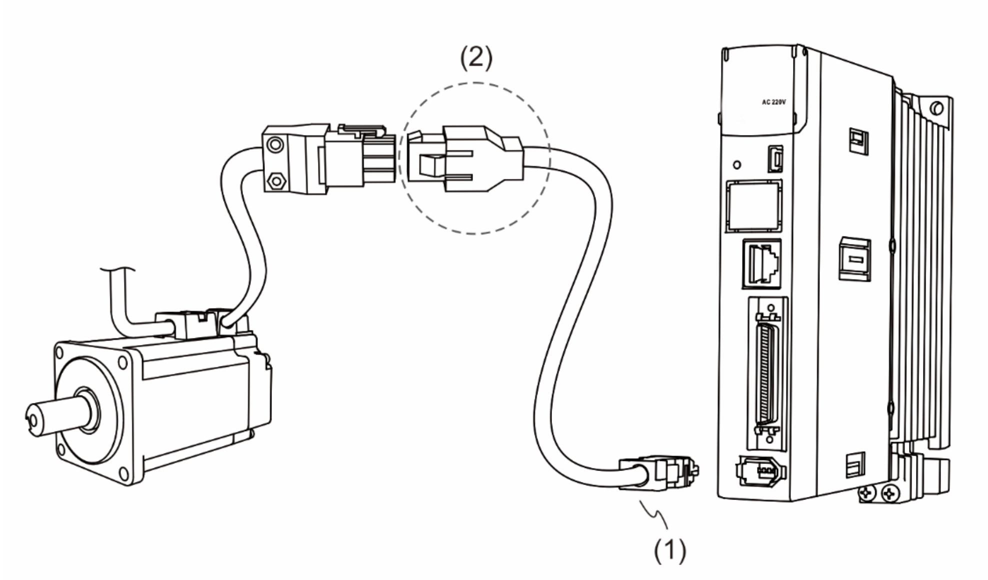
<table>
<tr><th colspan="4">Pin Assignment for SV2C-PF-CON</th></tr>
<tr><th>U
(Red)</th><th>V
(White)</th><th>W
(Black)</th><th>Case Ground
(Green)</th></tr>
<tr><td>A</td><td>B</td><td>C</td><td>D</td></tr>
</table></td></tr>
</table>

Wire selection: please use a 600V PVC cable. If it is longer than 30 meters, refer to the voltage drop (wire impedance) to select the cable size. See section 3.2.4 for more information on the separate brake cable (SV2C-B120-xxxx) required for 5.5 kW – 15kW SV2x-2xxx series brake motors, or 11kW–15kW SV2x-4xxx series brake motors.

NOTE: The brake coil has no polarity. Its pin symbols are Brake 1 and Brake 2.

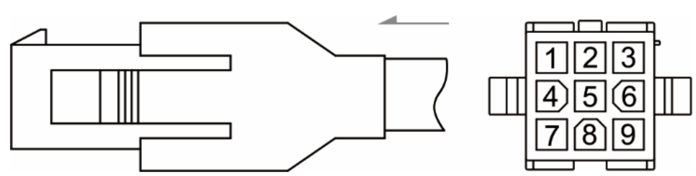
NOTE: Power supply for the brake is 24VDC. Do not share the same power supply with control signals.

3.2.2 - Specification for the Encoder Connector

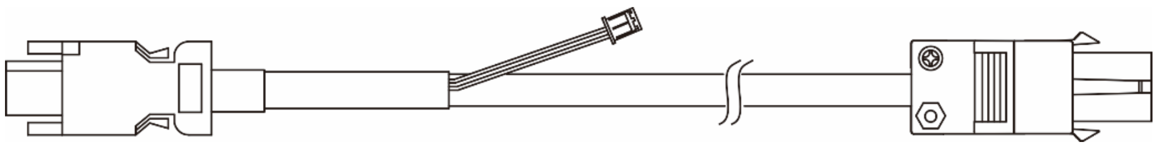


1) CN2 connector (p/n SV2C-E3-CON)
2) Quick connector (male)

NOTE: The diagram shows the connection between the servo drive and the encoder and is not drawn to scale. The specification is subject to change depending on the selected servo drive and motor models.

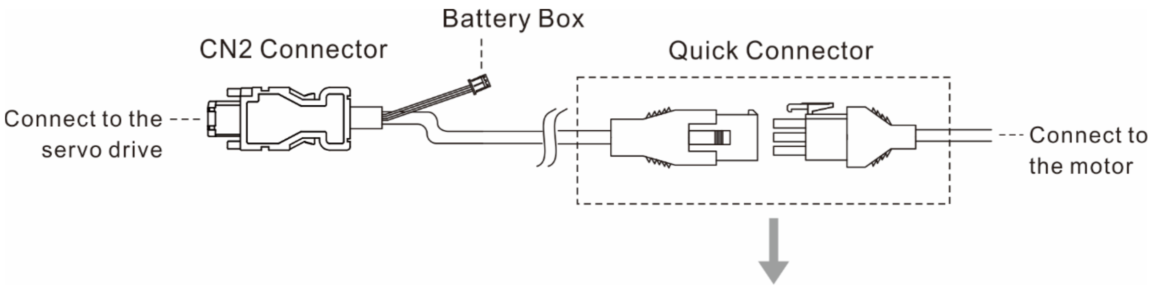
Motor Model	Quick Connector (Male) SV2C-E1-CON
SV2L-201N SV2L-202N SV2L-204N SV2L-207N SV2L-201B SV2L-202B SV2L-204B SV2L-207B SV2L-404N SV2L-404B SV2L-407N SV2L-407B	

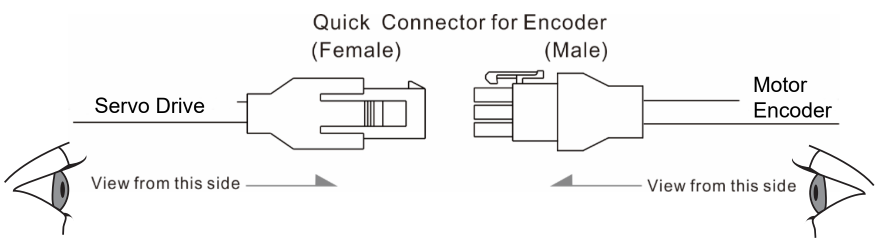
Specification and Pin assignment for the absolute encoder connector:



Connection method:

WARNING! *Failure to follow the wiring instructions below could result in battery explosion!*

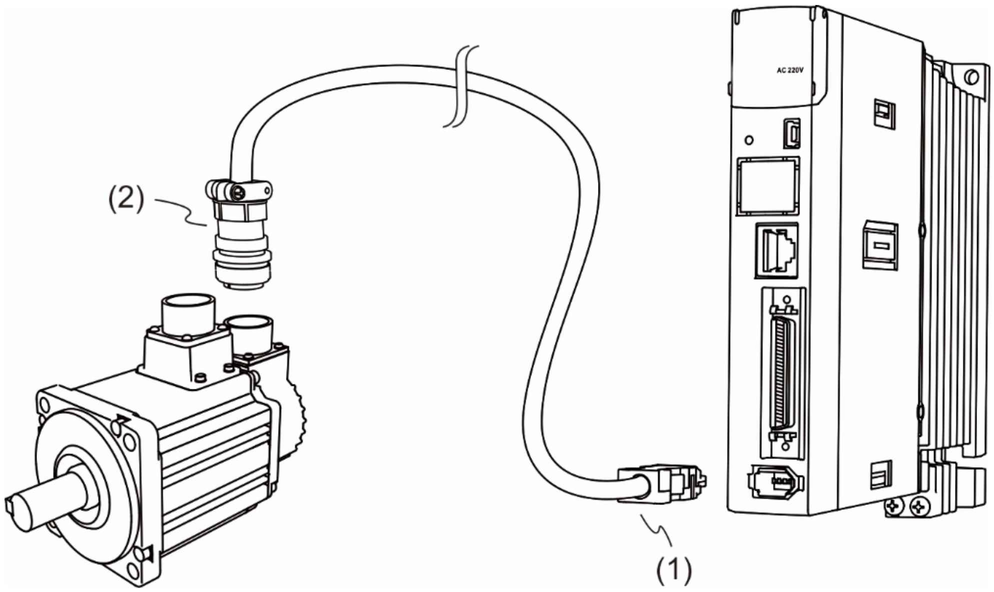




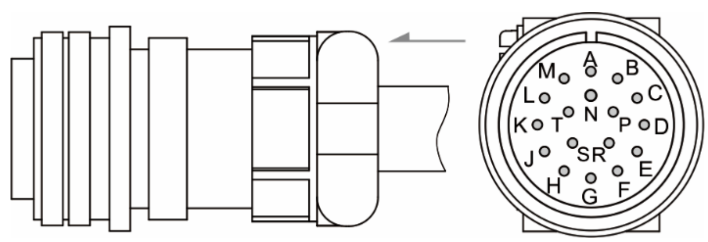
1	2	3
White T+	Red BAT+	Reserved
4	**5**	**6**
White/Red T-	Black BAT-	Reserved
7	**8**	**9**
Brown DC+5V	Blue GND	Shield

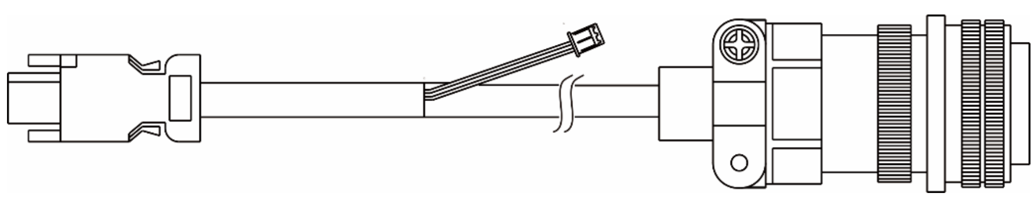
3	2	1
Reserved	Black BAT+	White T+
4	**5**	**4**
Reserved	Red BAT-	White/Red T-
9	**8**	**7**
Shield	Blue GND	Brown DC+5V

Encoder connection: Military connector



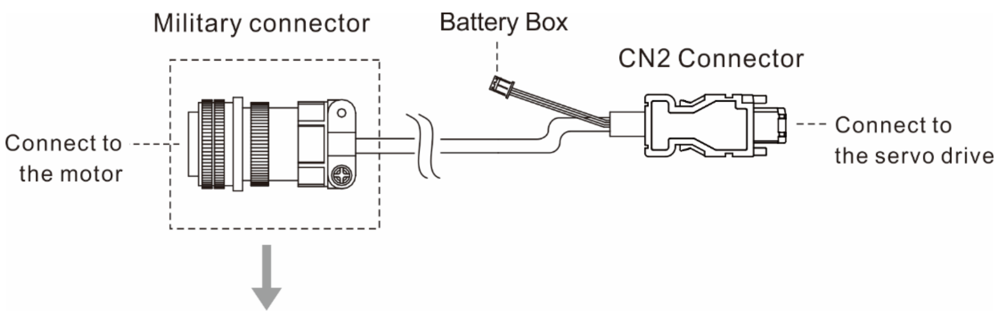
NOTE: the diagram shows the connection between the servo drive and the encoder and is not drawn to scale. The specification is subject to change according to the selected servo drive and motor models.

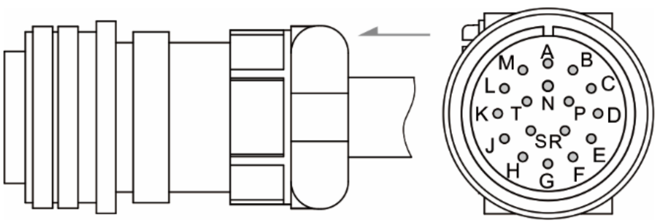
Motor Model	Military Connector
All 1kW to 15kW motors	



Connection method:

***WARNING!** Failure to follow the wiring instructions below could result in battery explosion!*

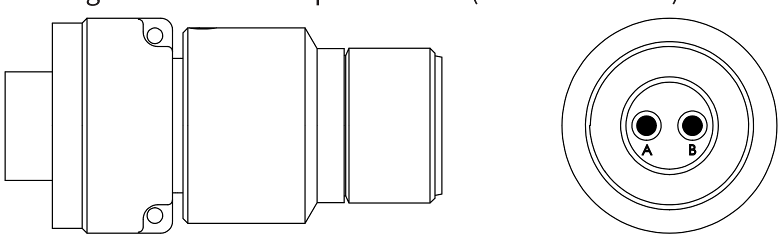




Pin Number	***Symbol***	***Color***
A	T+	White
B	T-	White / Red
C	BAT+	Red
D	BAT-	Black
S	DC+5V	Brown
R	GND	Blue
L	BRAID SHIELD	–

3.2.3 - Brake Power Cable and Connector

Pin assignments for brake power cable (SV2C-B120-xxxx) and connector (SV2C-B1-CON).



Pin Number	***Symbol***	***Color***
A	BR-	Black
B	BR+	Red

NOTE: The brake coil has no polarity. Its pin symbols are Brake 1 and Brake 2.

NOTE: Power supply for the brake is 24VDC. Do not share the same power supply with control signals.

3.2.4 - Wire selection

If you are not using an AutomationDirect motor power cable, please adhere to the cable specs below when selecting your own cable. The circuit protection values below for RST are recommended values for applications using full rated current of the motor and best protection. The values are for Class CC and Class J fuses or circuit breaker. For maximum circuit protection values see "2.5 - Specifications for the Circuit Breaker and Fuse" on page 2–6.

NOTE: The shield should connect to the ⏚ terminal. When wiring, please use the wires suggested in this section to avoid danger.

110/230 V Drives									
Servo Drive Model	***L1C L2C***		***RST***			***P1 P2***	***P3 C***	***UVW (motor)***	
	Wire Size mm2 (AWG)	***Fusing***	***Voltage Level***	***Wire Size mm2 (AWG)***	***Circuit Protection (A)***	***Wire Size mm2 (AWG)***	***Wire Size mm2 (AWG)***	***Wire Size mm2 (AWG)***	
SV2A-2040	0.8 (18AWG)	5A breaker 6A fuse	110-120 VAC 1-phase	1.3 (16AWG)	8	0.8 (18AWG)	0.8 (18AWG)	0.8 (18AWG)	
			200-230 VAC 1-phase	1.3 (16AWG)	10				
			200-230 VAC 3-phase	1.3 (16AWG)	5				
SV2A-2075			110-120 VAC 1-phase	2.1 (14AWG)	15	0.8 (18AWG)	0.8 (18AWG)	0.8 (18AWG)	
			200-230 VAC 1-phase	3.3 (12AWG)	16				
			200-230 VAC 3-phase	2.1 (14AWG)	10				
SV2A-2150			110-120 VAC 1-phase	3.3 (12AWG)	20	1.3 (16AWG)	0.8 (18AWG)	3.3 (12AWG)	
			200-230 VAC 1-phase	3.3 (12AWG)	20				
			200-230 VAC 3-phase	2.1 (14AWG)	15				
SV2A-2200			110-120 VAC 1-phase	5.3 (10AWG)	30	2.1 (14AWG)	1.3 (16AWG)	3.3 (12AWG)	
			200-230 VAC 1-phase	5.3 (10AWG)	30				
			200-230 VAC 3-phase	3.3 (12AWG)	20				
SV2A-2300			200-230 VAC 3-phase	5.3 (10AWG)	30	2.1 (14AWG)	2.1 (14AWG)	3.3 (12AWG)	
SV2A-2550			200-230 VAC 3-phase	8.4 (8AWG)	40	5.3 (10AWG)	3.3 (12AWG)	13.3 (6AWG)	
SV2A-2750			200-230 VAC 3-phase	8.4 (8AWG)	40	8.4 (8AWG)	3.3 (12AWG)	13.3 (6AWG)	
SV2A-21F0	2.1 (14AWG)		200-230 VAC 3-phase	21.2 (4AWG)	70	13.3 (6AWG)	8.4 (8AWG)	21.2 (4AWG)	

<table>
<tr><th colspan="8">460V Drives</th></tr>
<tr><th rowspan="2">Servo Drive Model</th><th colspan="2">24VDC, 0V</th><th colspan="3">RST</th><th>P1, P2, P3, D, C, ⊖</th><th>UVW (motor)</th></tr>
<tr><th>Wire Size mm^2 (AWG)</th><th>Fusing</th><th>Voltage Level</th><th>Wire Size mm^2 (AWG)</th><th>Circuit Protection (A)</th><th>Wire Size mm^2 (AWG)</th><th>Wire Size mm^2 (AWG)</th></tr>
<tr><td>SV2A-4040</td><td rowspan="8">0.82 (18AWG)</td><td rowspan="3">3A</td><td rowspan="8">380–480 VAC 3-phase</td><td rowspan="3">0.82 (18AWG)</td><td>3</td><td>2.1 (14AWG)</td><td rowspan="2">0.82 (18AWG)</td></tr>
<tr><td>SV2A-4075</td><td>5</td><td>3.3 (12AWG)</td></tr>
<tr><td>SV2A-4150</td><td>6</td><td rowspan="2">5.3 (10AWG)</td><td rowspan="2">1.3 (16AWG)</td></tr>
<tr><td>SV2A-4200</td><td rowspan="4">5A</td><td>1.3 (16AWG)</td><td>10</td></tr>
<tr><td>SV2A-4300</td><td>2.1 (14AWG)</td><td>15</td><td rowspan="2">8.4 (8AWG)</td><td>2.1 (14AWG)</td></tr>
<tr><td>SV2A-4550</td><td>5.3 (10AWG)*</td><td>25</td><td rowspan="2">5.3 (10AWG)</td></tr>
<tr><td>SV2A-4750</td><td>8.4 (8AWG)*</td><td>35</td><td>13.6 (6AWG)</td></tr>
<tr><td>SV2A-41F0</td><td>7A</td><td>13.6 (6AWG)*</td><td>50</td><td>21.2 (4AWG)</td><td>8.4 (8AWG)</td></tr>
</table>

** Ring lugs recommended*

Wiring
Parameters
DI/DO Codes
Monitoring
Alarms

Encoder Cable:

Use the wires specified below when wiring encoders:

Servo Drive Model	Encoder Cable - Wire Diameter (AWG)			
	Wire Size	Number	Specification	Standard Length
All	0.324 mm²-2C (22AWG–2C) + 0.205 mm²–2P (24AWG–2P)	2C + 2P	UL2464	L = 3–20 m (9.84–65.6 ft)

NOTE: Use shielded twisted-pair cable when wiring the encoder to reduce noise interference. The shield should connect to the ⏚ terminal.

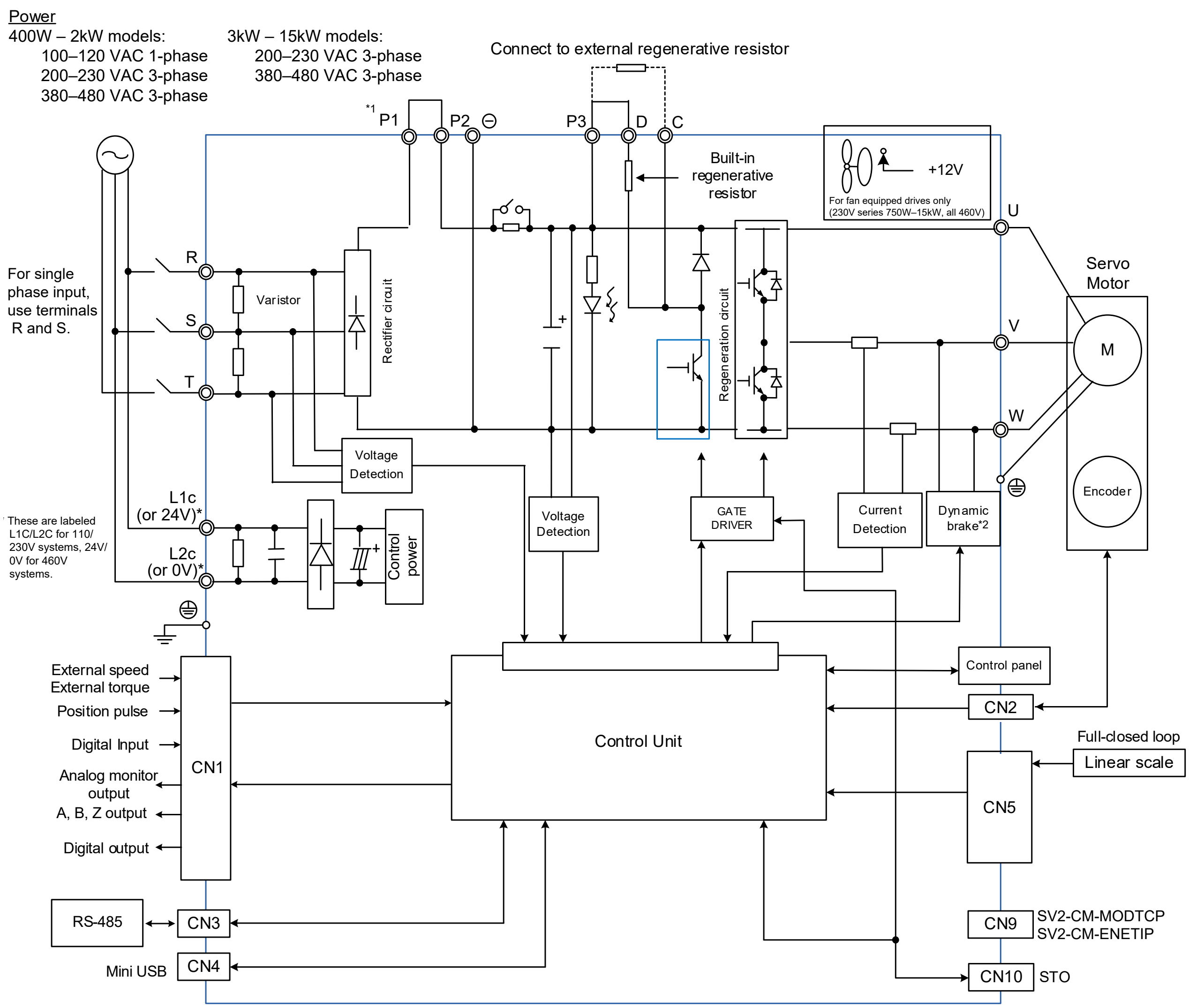
Brake Cable:

Use the wires specified below when wiring the external brake cable:

Servo Drive Model	Encoder Cable - Wire Diameter (AWG)	
	Wire Size	Number
SV2A-2550 SV2A-2750 SV2A-2F00 SV2A-4F00	20AWG	2 wires

Wiring
Parameters
DI/DO Codes
Monitoring
Alarms

3.3 - Wiring Diagram for the Servo System



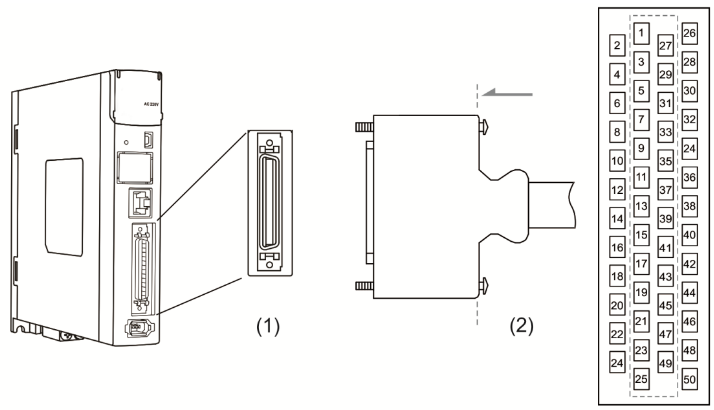
Notes:

1) Short circuit P1 and P2 as illustrated in the diagram (factory supplied jumper comes with the drive).
2) The Dynamic Brake is a relay which shorts phases V and W together.

3.4 - Wiring for CN1 (I/O signal)

3.4.1 - CN1 I/O connector

The SureServo2 provides 10 user-defined digital input (DI) points and 6 digital output (DO) points to provide highly flexible communication between the servo drive and the controller. For more information, please refer to section 3.5. In addition, differential type output signals for encoder A+, A-, B+, B-, Z+, and Z- are provided. Analog torque command input, analog speed/position command input, pulse position input are also available. The pin assignments are shown below:



1) CN1 connector (Female)
2) CN1 connector (Male)

Pin Assignment:

Pin	Signal	Function	Pin	Signal	Function	Pin	Signal	Function
1	DO4+	Digital output	18	T_REF	Analog torque input	35	PULL HI_S (Sign)	External power input of Sign pulse
2	DO3-	Digital output	19	GND	Analog input signal ground	36	SIGN	Position sign (+)
3	DO3+	Digital output	20	NC[1]	Not in use. Do not connect.	37	/SIGN	Position sign (-)
4	DO2-	Digital output	21	OA	Encoder A pulse output	38	DI10	Digital input
5	DO2+	Digital output	22	/OA	Encoder /A pulse output	39	PULL HI_P (Pulse)	External power input of pulse
6	DO1-	Digital output	23	/OB	Encoder /B pulse output	40	DO6-	Digital output
7	DO1+	Digital output	24	/OZ	Encoder /Z pulse output	41	/PULSE	Position pulse (-)
8	DI4-	Digital input	25	OB	Encoder B pulse output	42	V_REF	Analog command input speed (+)
9	DI1-	Digital input	26	DO4-	Digital output	43	PULSE	Position pulse (+)
10	DI2-	Digital input	27	DO5-	Digital output	44	GND	Analog input signal ground
11	COM+[2]	Power input (24 V ± 10%)	28	DO5+	Digital output	45	NC[1]	Not in use. Do not connect.
12	GND	Analog input signal ground	29	DI9-	Digital input	46	DO6+	Digital output
13	GND	Analog input signal ground	30	DI8-	Digital input	47	NC[1]	Not in use. Do not connect.
14	NC[1]	Not in use. Do not connect.	31	DI7-	Digital input	48	OCZ	Encoder Z pulse open-collector output
15	MON2	Analog monitor output 2	32	DI6-	Digital input	49	NC[1]	Not in use. Do not connect.
16	MON1	Analog monitor output 1	33	DI5-	Digital input	50	OZ	Encoder Z pulse line-driver output
17	NC[1]	Not in use. Do not connect.	34	DI3-	Digital input			

1: NC represents "No connection." Do not connect to NC or it may damage the drive.
2: COM+ can be wired to +24VDC or 0VDC determined by the use of a sinking or sourcing switch or sensor. See section 3.5.4

3.4.2 - Signal Explanation for Connector CN1

The following table details the signals listed in the previous section.

General signals

Signal		Pin No.	Function	Wiring Method
Analog command (Input)	V_REF	42	1) When motor speed command is set to -10V to +10V, it means the rotation speed is -3000 to +3000 r/min (default). You can set the corresponding range with parameters. 2) When motor position command is set to -10V to +10V, it means the range of the rotation position is -3 to +3 revolutions (default).	C1
	T_REF	18	When motor torque command is set to -10V to +10V, it means the rated torque is -100% to +100%.	C1
Analog Monitor (output)	MON1 MON2	16 15	The operation status of motor can be displayed in analog voltage, such as speed and current. This servo drive provides 2 output channels. You can select the data to be monitored with parameter P0.003. This signal is based on the power ground. The analog output resolution is 10-bit.	C2
Position Pulse (input)	PULSE /PULSE	43 41	Position pulse can be sent by Line Driver (single-phase max. frequency 4MHz) or open-collector (single-phase max. frequency 200 KHz). Three command types can be selected with P1.000, CW/CCW pulse, pulse and direction, and A/B pulse. If open collector type is used when sending position pulses, CN1 should be connected to an external power supply for pull high.	C3/C4
	SIGN /SIGN	36 37		
	PULL HI_P PULL HI_S	39 35		
Position Pulse (output)	OA/OA	21 22	Encoder signal output A, B, and Z (Line Driver).	C9/C10
	OB/OB	25 23		
	OZ/OZ	50 24		
	OCZ	48	Encoder Z pulse output (Open-collector). Max User-supplied voltage is 30VDC. Use a resistor to limit the output current to a maximum of 50mA.	C11
Power	COM+	11	NPN: COM+ is for DI voltage input and requires external power supply (24V ±10%). PNP: COM+ is for DI voltage input (negative end) and also requires external power supply (24V ±10%).	-
	GND	12, 13, 19, 44	GND for analog signal and differential signal output	
Other	NC	14	No connection. This is for internal use only. Do not connect to NC, or it may damage the servo drive.	

There are various operation modes available (refer to section 6.1) and the I/O configuration differs for each mode. The SureServo2 provides user-defined I/O for you to set functions according to the application requirements. Refer to "8.4.9 - Digital Input (DI) Function Assignments"and "8.4.10 - Digital output (DO) Function Assignments". The default DI/DO signal configuration for each operation mode includes the most commonly used functions and meets the requirements for general applications. The suggested DI and DO functions on the next page can be automatically assigned during configuration download using P1.001 (nibble U).

See the table on the next page for the suggested DI signal of each control mode:

Control Mode

DI	PT	PR	S/Sz	T/Tz	PT-S	PT-T	PR-S	PR-T	S-T
	Default DI Assignment when P1.001.U=1								
1	0x01	0x01	0x01	0x01	0x01	0x01	0x01	0x01	0x01
	SON	SON	SON	SON	SON	SON	SON	SON	SON
2	0x04	0x08	0x09	0x10	0x04	0x04	0x08	0x08	-
	CCLR	CTRG	TRQLM	SPDLM	CCLR	CCLR	CTRG	CTRG	
3	0x16	0x11	0x14	0x16	0x14	0x16	0x11	0x11	0x14
	TCM0	POS0	SPD0	TCM0	SPD0	TCM0	POS0	POS0	SPD0
4	0x17	0x12	0x15	0x17	0x15	0x17	0x12	0x12	0x15
	TCM1	POS1	SPD1	TCM1	SPD1	TCM1	POS1	POS1	SPD1
5	0x02	0x02	0x02	0x02	-	-	0x14	0x16	0x16
	ARST	ARST	ARST	ARST	-	-	SPD0	TCM0	TCM0
6	0x22	0x22	0x22	0x22	-	-	0x15	0x17	0x17
	NL	NL	NL	NL			SPD1	TCM1	TCM1
7	0x23	0x23	0x23	0x23	0x18	0x20	0x18	0x20	0x23
	PL	PL	PL	PL	S-P	T-P	S-P	T-P	PL
8	0x21	0x21	0x21	0x21	0x21	0x21	0x21	0x21	0x21
	OVRD	OVRD	OVRD	OVRD	OVRD	OVRD	OVRD	OVRD	OVRD
9	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-

NOTE: Please refer to section 3.5 for wiring (Method C7/C8).

NOTE: When P1.001.U=1, switching control modes will also switch the DI and DO function assignments.

The suggested DO signal is detailed in the table below (these are the default assignments when P1.001.U=1):

DO	PT/PR/Communication		Speed/Torque		Wiring Method (refer to 3.5.3)
	Assignment	Function	Signal	Function	
DO1	SRDY	Servo ready	SRDY	Servo ready	C5/C6
DO2	ZSPD	Zero motor speed	ZSPD	Zero motor speed	
DO3	HOME	Homing completed	TSPD	Target speed reached	
DO4	TPOS	Target position reached	TPOS	Target position reached	
DO5	ALRM	Servo alarm	ALRM	Servo alarm	

If the suggested DI/DO function cannot meet the application requirements, you can set the functions of DI1–10 and DO1–6 with the corresponding parameters listed in the following table. That is, you can specify the DI/DO functions by setting DI or DO code to the corresponding parameters.

DI Signal		Pin No.	Corresponded Parameter	DI Signal		Pin No.	Corresponded Parameter
Standard DI	DI1-	9	P2.010	Standard DI	DI6-	32	P2.015
	DI2-	10	P2.011		DI7-	31	P2.016
	DI3-	34	P2.012		DI8-	30	P2.017
	DI4-	8	P2.013		DI9-	29	P2.036
	DI5-	33	P2.014		DI10-	38	P2.037

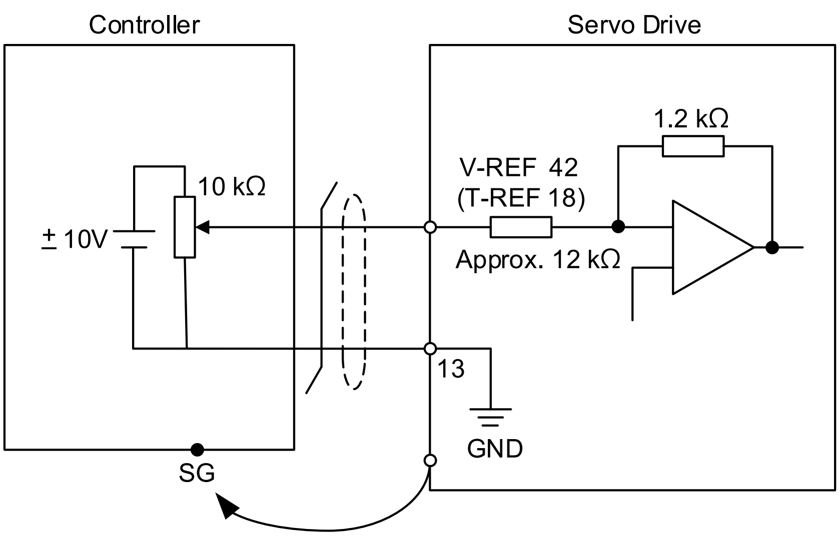
Do Signal		Pin No.	Corresponded Parameter	Do Signal		Pin No.	Corresponded Parameter
Standard DO	DO1+	7	P2.018	Standard DO	DO4+	1	P2.021
	DO1-	6			DO4-	26	
	DO2+	5	P2.019		DO5+	28	P2.022
	DO2-	4			DO5-	27	
	DO3+	3	P2.020		-		
	DO3-	2					

3.5 - Wiring Diagrams (CN1)

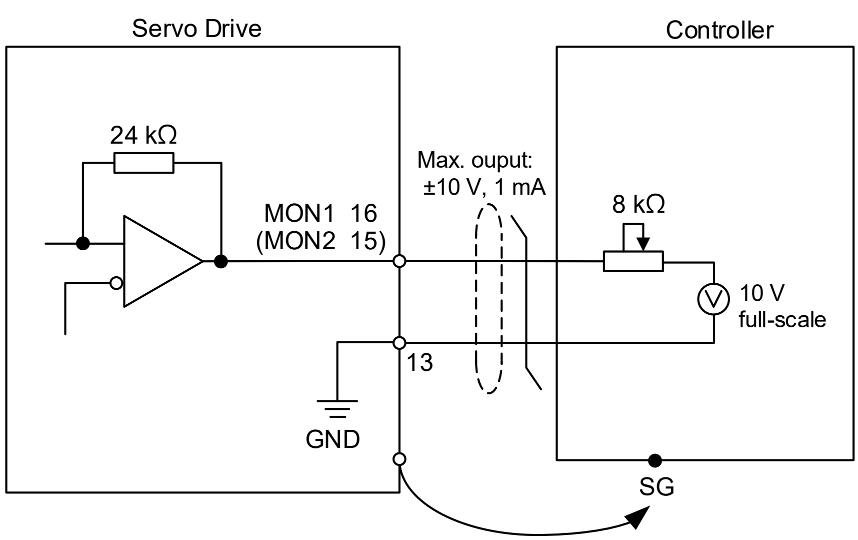
The valid voltage for the analog speed command and the analog torque command is between -10V and +10V. You can set the command value that corresponds to the voltage range with the relevant parameters.

3.5.1 - Analog Input/Output Suggested Wiring

C1: input for speed/torque (force) analog command



C2: output for analog monitoring command (MON1 and MON2)

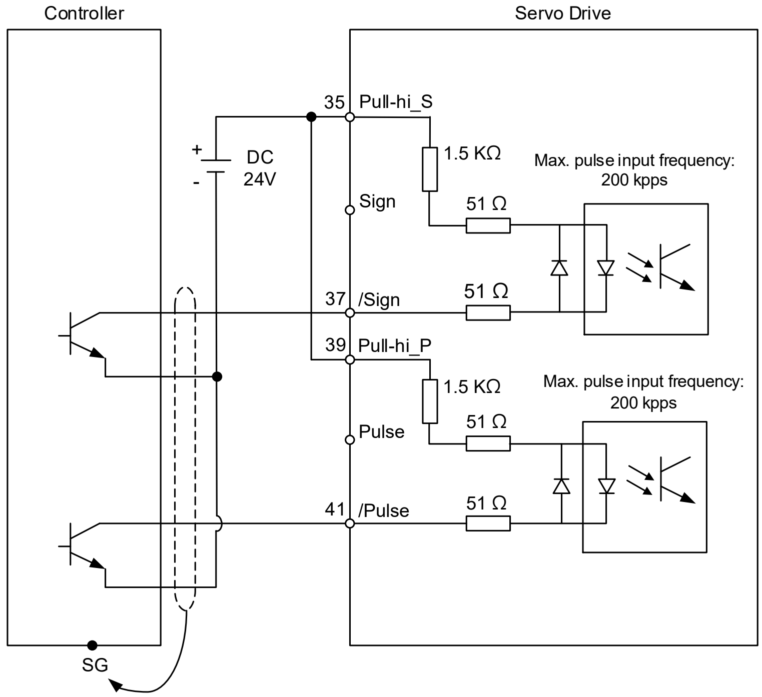


3.5.2 - Pulse/Sign Suggested Wiring

You can input the Pulse command with the open-collector or line driver. The maximum input pulse for the line driver is 4Mpps and 200kpps for open-collector.

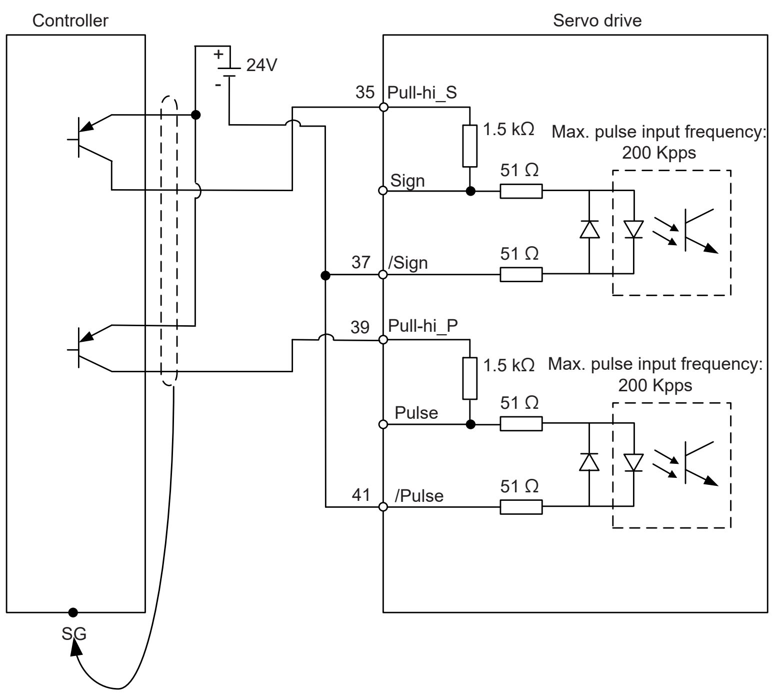
C3-1:

The source for the pulse input below is open-collector NPN (SINK) type, which uses an external power supply.



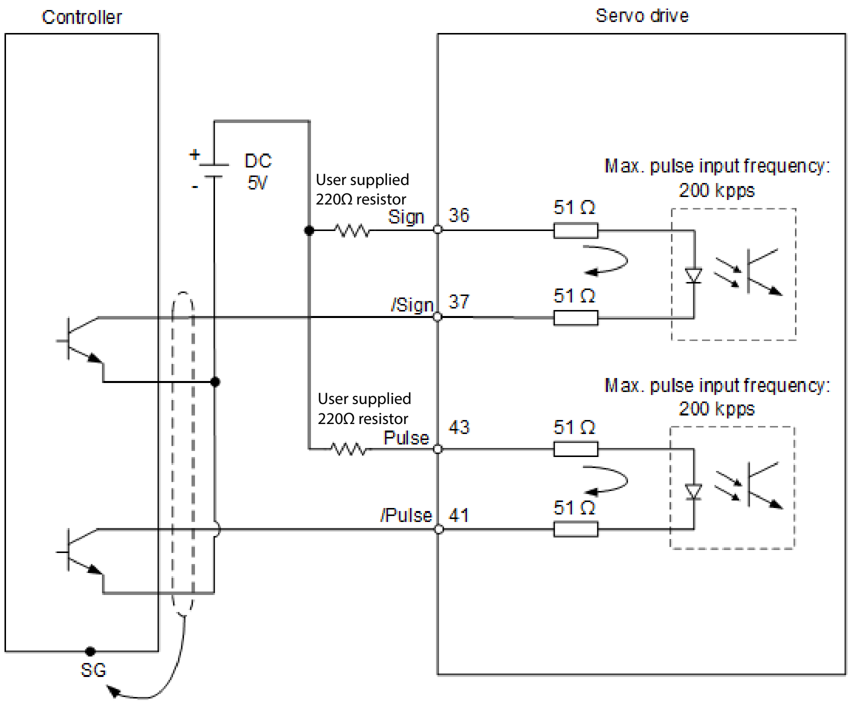
C3-2:

The source for the pulse input below is open-collector PNP (SOURCE) type, which uses an external power supply.



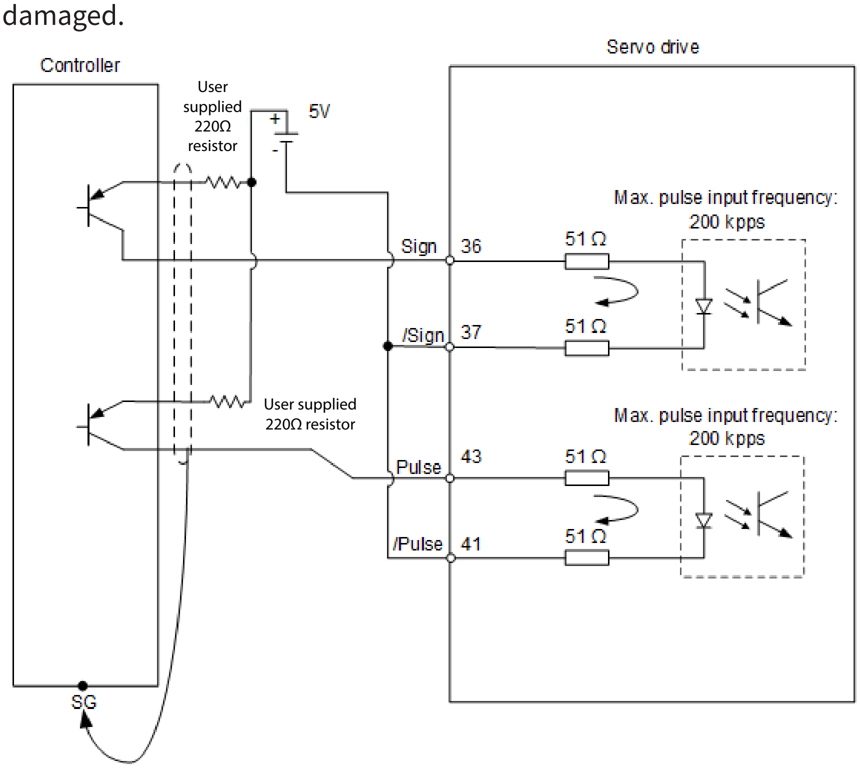
C3-3:

The source for the pulse input below is open-collector NPN (SINK) type, which uses an external power supply. Use a 220 Ohm resistor to limit the current, otherwise the drive will be damaged.



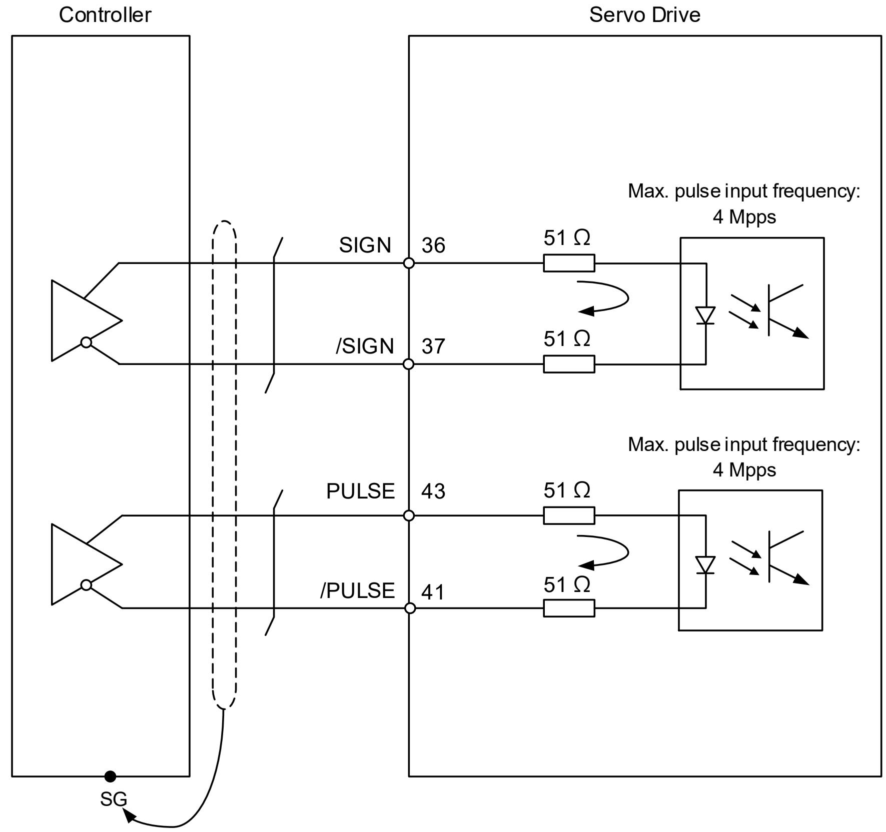
C3-4:

The source for the pulse input below is open-collector PNP (SOURCE) type, which uses an external power supply. Use 220 Ohm resistor to limit the current, otherwise the drive will be damaged.



C4:

The SIGN and PULSE inputs are designed for Line Driver (differential input) as shown below. Do not use terminals 36 and 43 with 24V power.

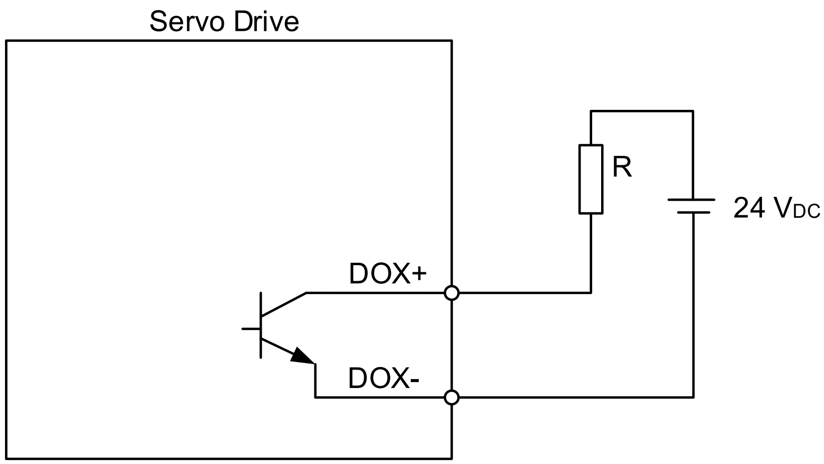


3.5.3 - Digital Output Suggested Wiring

When the drive connects to an inductive load, you must install the diode (permissible current: below 40mA; surge current: below 100mA; maximum voltage: 30V). A 5VDC source will also work as long as the continuous current does not exceed 40mA.

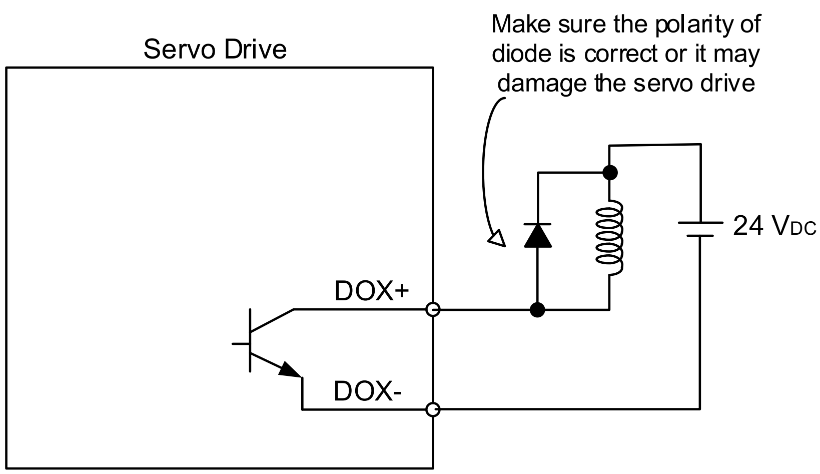
C5:

DO wiring - servo drive using an external power supply and a resistive load.



C6:

DO wiring - servo drive using an external power supply and an inductive load.



3.5.4 - Digital Input Suggested Wiring

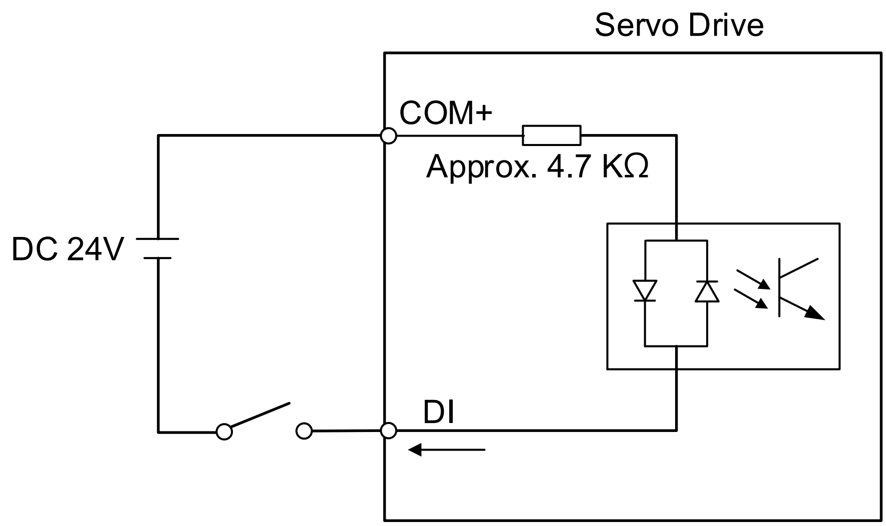
DI wiring - Input signals by relay or open-collector transistor. Maximum input frequency for all DI is 1kHz, not including Pulse and Sign.

Conditions of DI On/Off:

- *ON: 15V – 24V; Condition: Input current = 8mA*
- *OFF: below 5V; the input current must not be higher than 0.5 mA.*

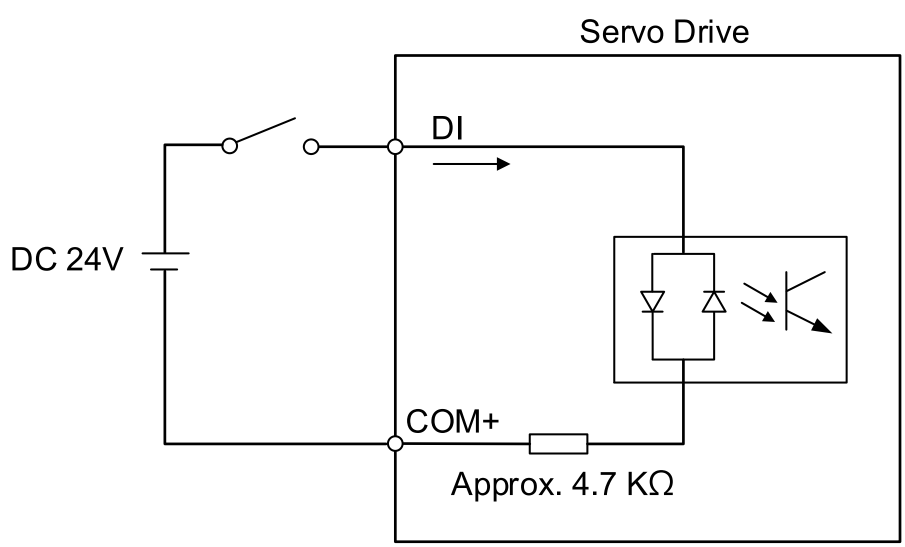
C7:

NPN sensor (SINK mode)



C8:

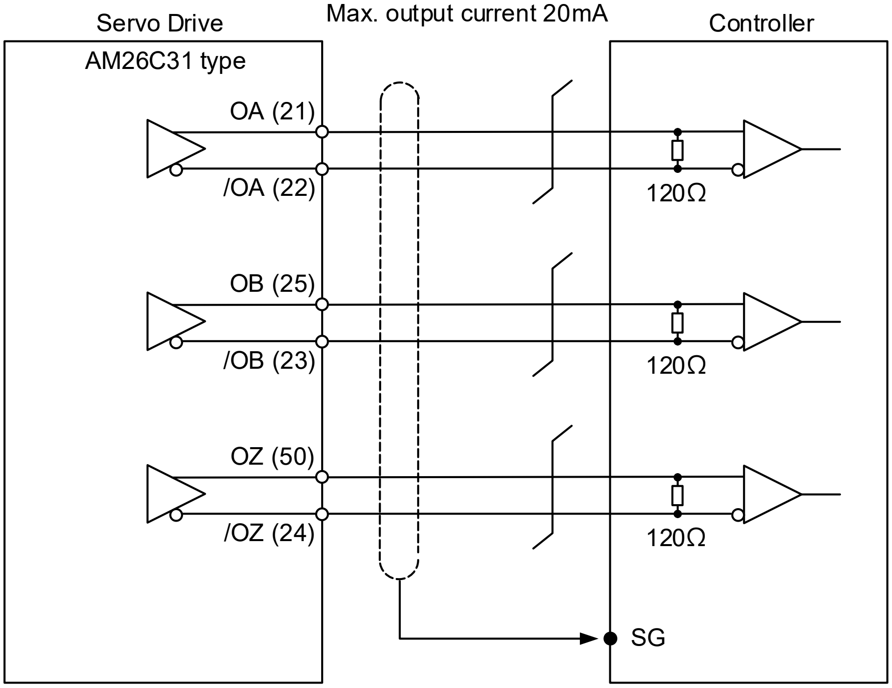
PNP sensor (SOURCE mode)



3.5.5 - Encoder Output Suggested Wiring

C9:

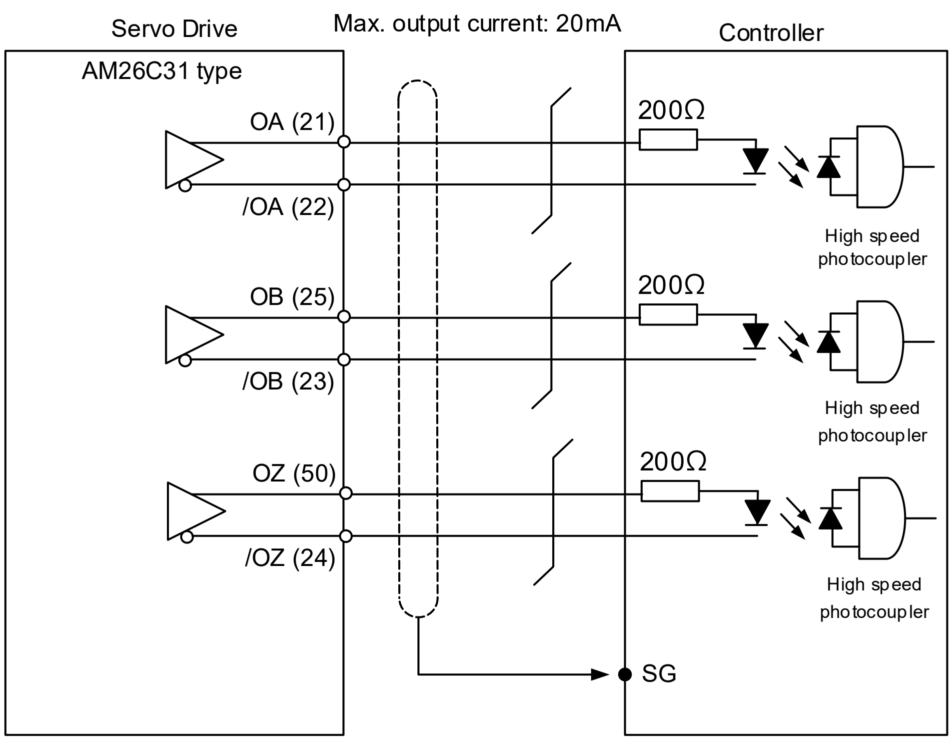
Output for encoder position signal (Line driver)



NOTE: Connect the two grounds of the controller and servo drive when the voltage ground potential is not the same for the controller and the servo drive.

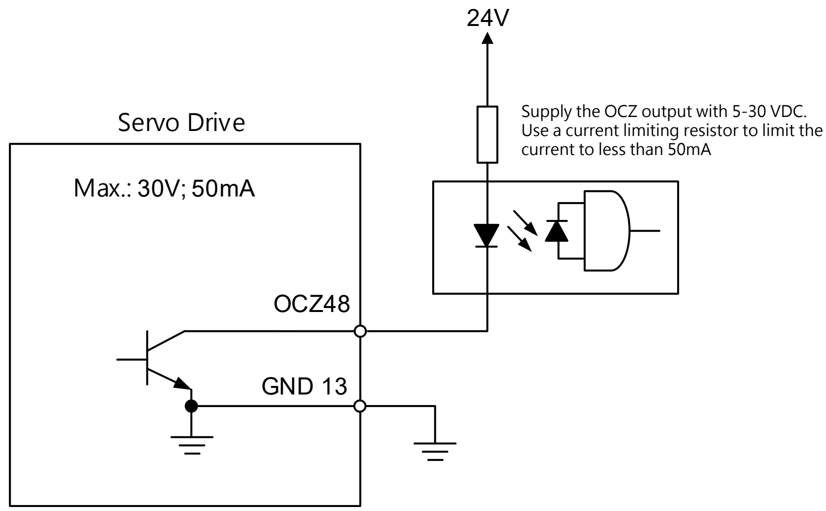
C10:

Output for encoder position signal (Opto-isolator)



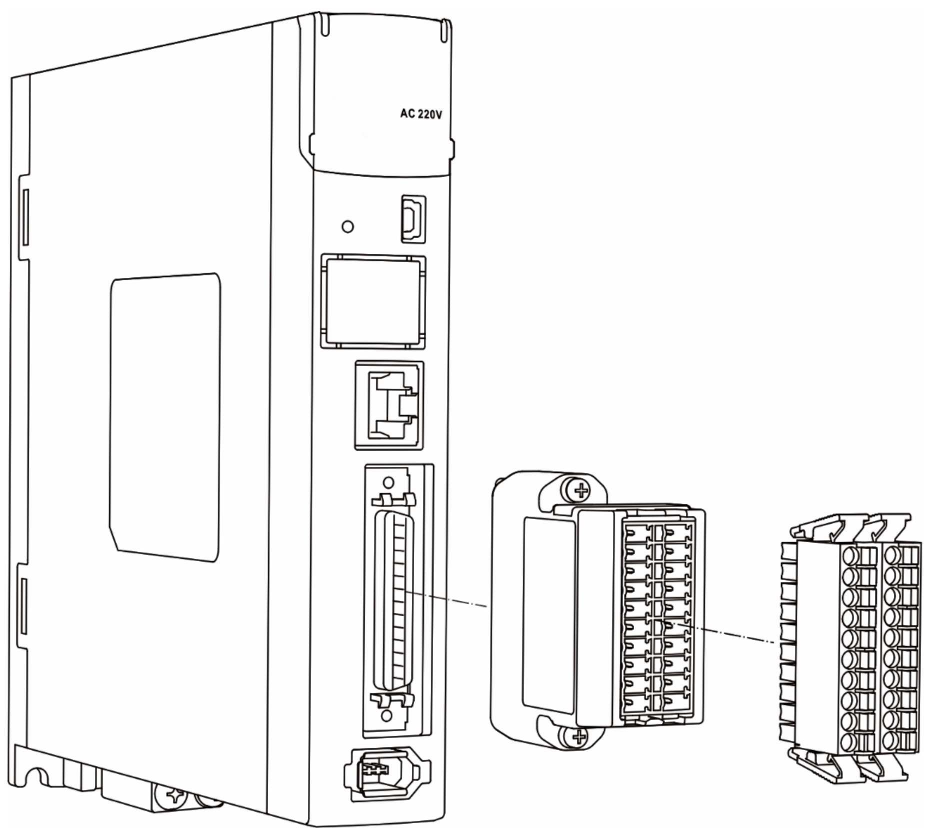
C11:

Encoder OCZ output (open-collector Z pulse output)



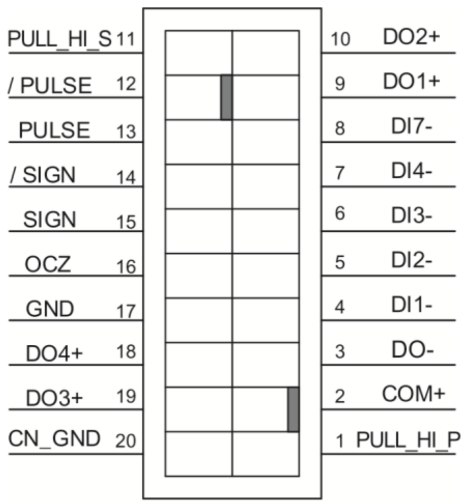
3.5.6 - Application: Using the CN1 Quick Connector for Wiring

The CN1 quick connector (SV2-CN1-LTB20) is designed for easy wiring. It can satisfy most needs of different DI/O applications. It is a good choice if you do not want to solder the wires or use up more panel space with the SV2-CN1-RTB50. Its spring terminal blocks prevent vibration from loosening the wire. It includes five digital inputs, four digital outputs, differential pulse command inputs and Z phase open-collector outputs.

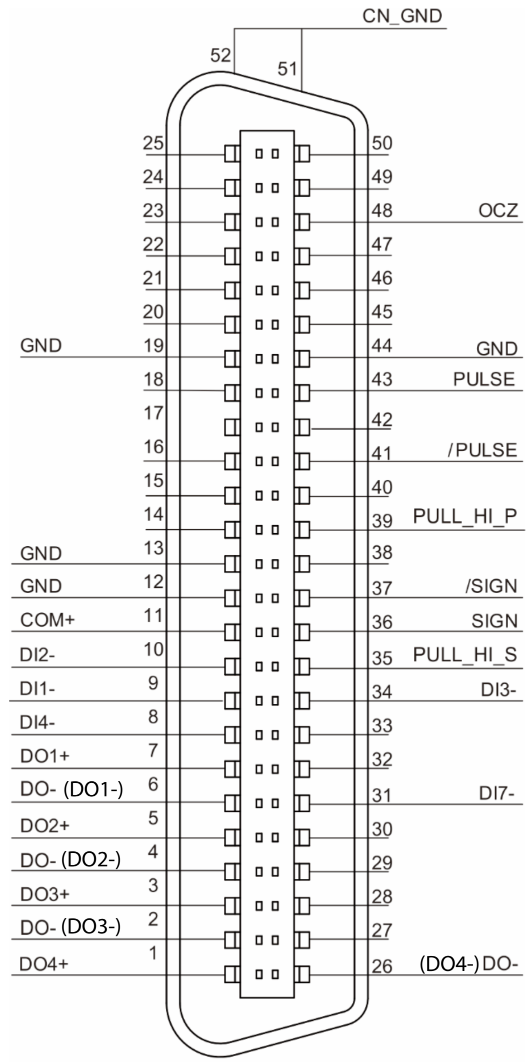


Pin assignment for the CN1 local terminal block (J2 and J1):

J2



J1



Note: *The LTB20 connector has internal jumpers that connect multiple terminals from the 50-pin connector to one pin on the LTB20 connector.*

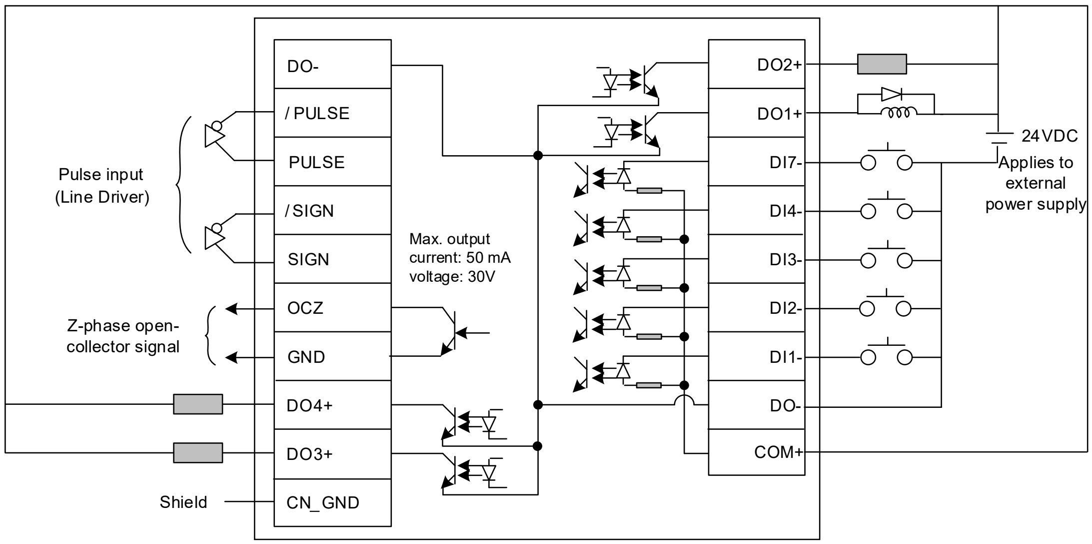
LTB20	***Internally- Jumpered CN1***
DO-	*DO1-, DO2-, DO3-, DO4-*
GND	*12, 13, 19, 44*

Combining the Digital Output commons results in one common for all 4 outputs (each output must use the same DC common if using the LTB20).

J2-PIN	***Signal***	***J1-PIN***
1	PULL_HI_P	39
2	COM+	11
3	DO-	2, 4, 6, 26
4	DI1-	9
5	DI2-	10
6	DI3-	34
7	DI4-	8
8	DI7-	31
9	DO1+	7
10	DO2+	5
11	PULL_HI_S	35
12	/PULSE	41
13	PULSE	43
14	/SIGN	37

J2-PIN	Signal	J1-PIN
15	SIGN	36
16	OCZ	48
17	GND	12, 13, 19, 44
18	DO4+	1
19	DO3+	3
20	CN_GND	Connector Shell (GND)

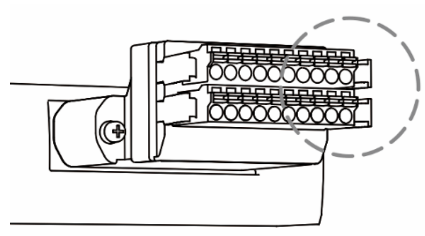
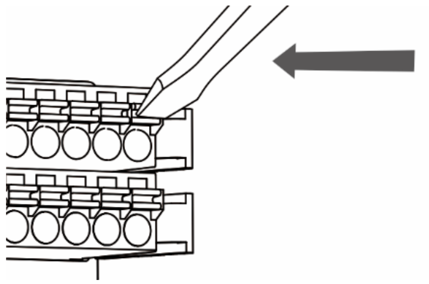
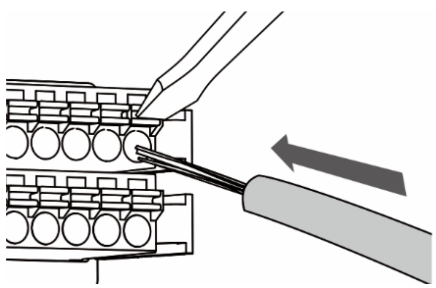
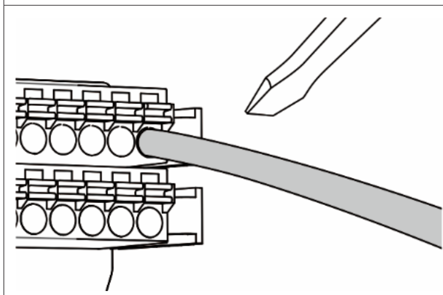
Wiring Example:



Circuitry internal to the drive and SV2-CN1-LTB20

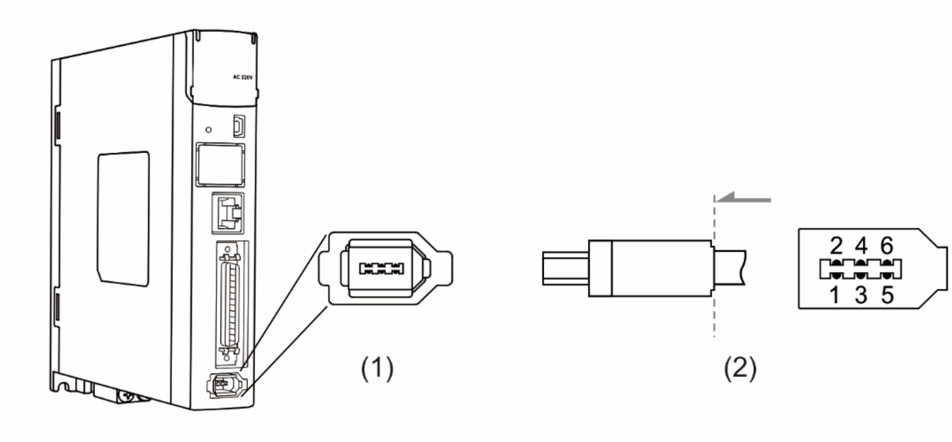
Wiring for CN1 quick connector and installation:

Wiring

	1. The CN1 quick connector has multiple spring terminals. Please determine which terminal is to be wired in advance.
	2. Use a flathead screwdriver to press the spring down to open the pin.
	3. Insert the stripped wire into the pin (18AWG to 22AWG acceptable).
	4. Withdraw the screwdriver to complete the wiring.

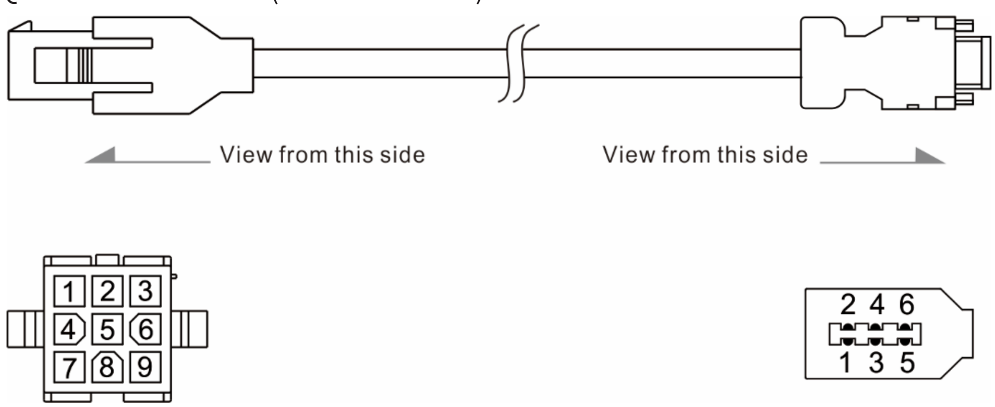
3.6 - Wiring for the CN2 Encoder Connector

The CN2 encoder signal connector is shown below:

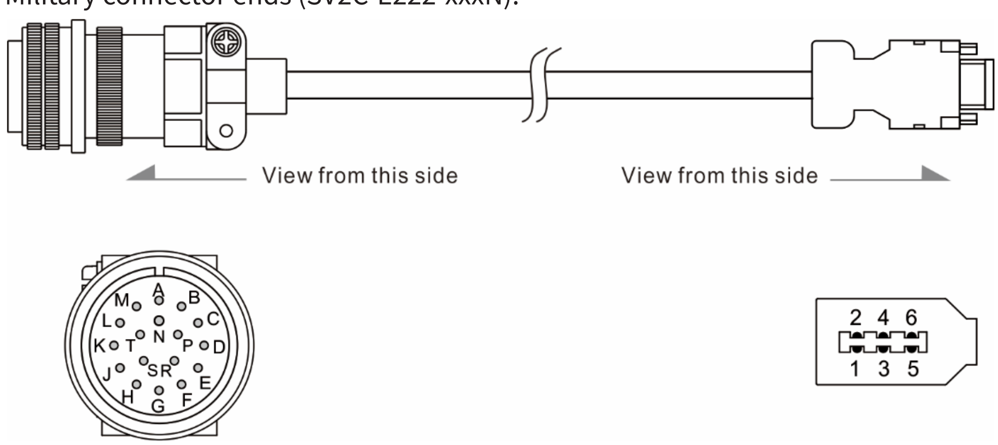


(1) CN2 connector (female) (2) CN2 connector (male)

Quick connector ends (SV2C-E122-xxxN):



Military connector ends (SV2C-E222-xxxN):



Wiring
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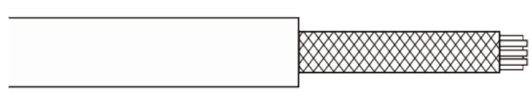
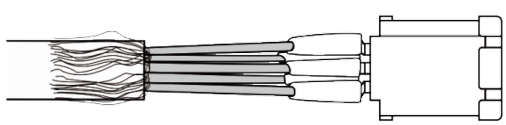
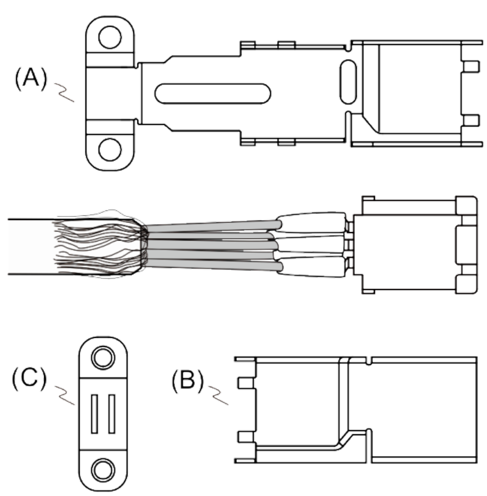
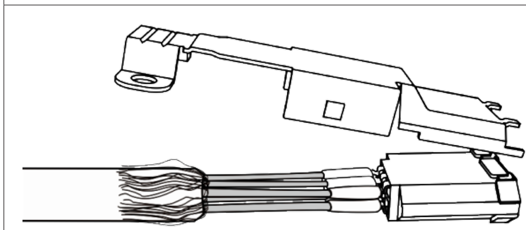
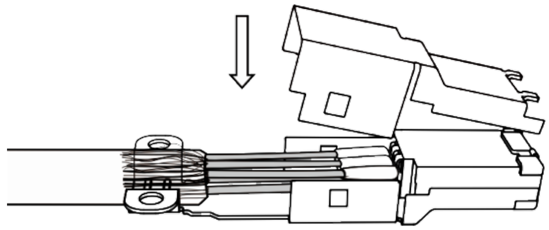
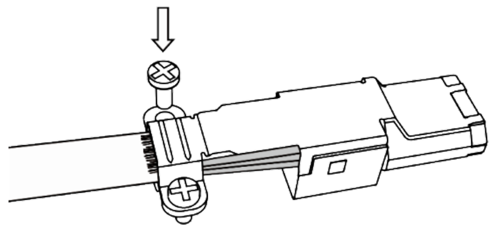
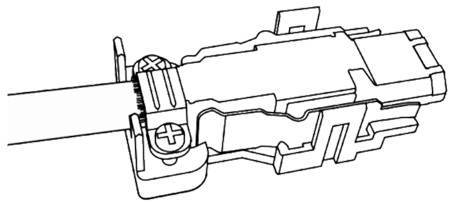
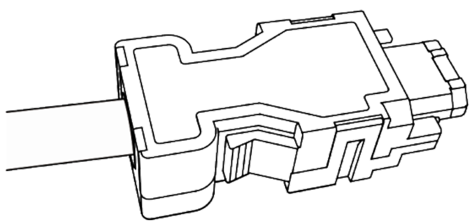
CN2 pin assignment:

Encoder End			***Servo Drive End***		
Military Connector	***Quick Connector***	***Color***	***Pin No.***	***Symbol***	***Description***
A	1	White	5	T+	Serial communication signal (+)
B	4	White / Red	6	T-	Serial communication signal (-)
S	7	Brown	1	+5V	+5V power supply
R	8	Blue	2	GND	Power ground
L	9	-	Case	Shielding	Shielding

NOTE: When using a battery box, the battery directly supplies the power to the encoder. Please refer to the detailed wiring description in section 3.2.2.

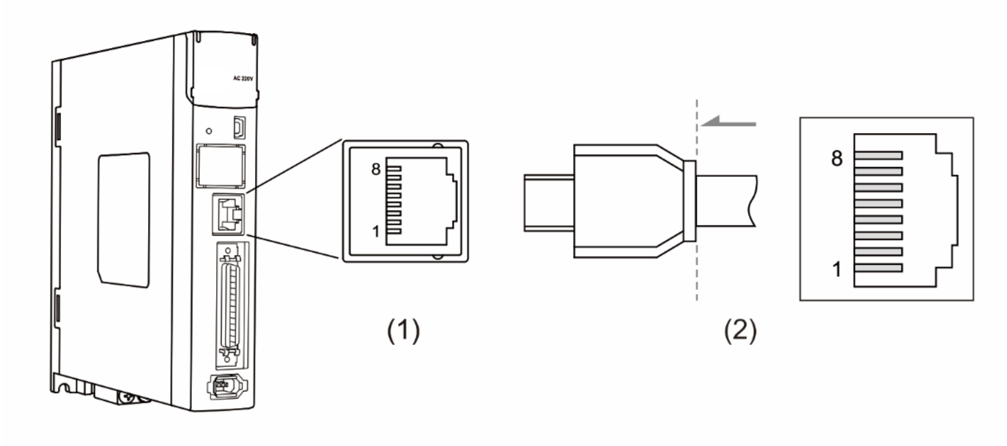
Connecting shielded wire to the CN2 encoder connector is shown below. The maximum reliable CN2 encoder length for CN2 wiring is 20 meters.

	1. Cut through the cable and expose the shielding. The exposed wire length should be 20 – 30 mm..
	2. Spread the metal shielding and fold it back. Refer to the CN2 pin assignment (see the table above) to connect the pins.
	3. You need the following items to assemble the connector: (A) Big metal case (B) Small metal case (C) Metal ring
	4. Place the metal case to cover the exposed wire shielding. Make sure the shielding is completed covered to maintain the integrity of the shielding. .

	5. Fasten the other side of the metal case.
	6. Tighten the screws of the metal case.
	7. Fit one side of the plastic case over the connector.
	8. Place and fasten the other side of the case to complete the connector.

3.7 - Wiring for the CN3 connector (RS-485)

When the servo drive is connected to the PC via CN3, you can operate the servo drive, PLC, or HMI through MODBUS. The CN3 connector supports RS-485 communication only. This enables you to connect multiple servo drives simultaneously.



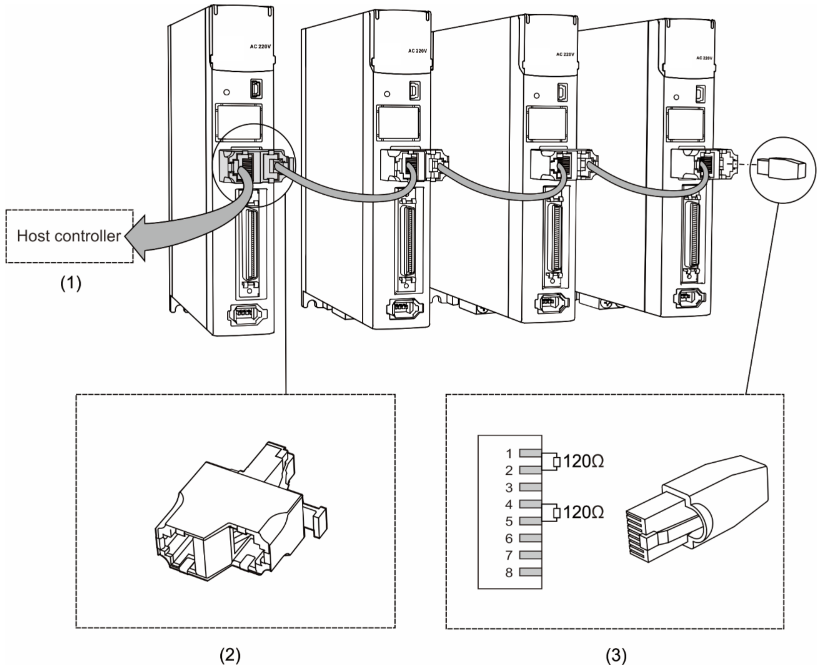
(1) CN3 connector (Female)   (2) CN3 connector (Male)

Pin assignment:

Pin Number	Signal	Function
1	-	-
2	-	-
3, 7	GND_ISO	Signal ground
4	RS-485-	The servo drive transmits the data to differential terminal (-)
5	RS-485+	The servo drive transmits the data to differential terminal (+)
6, 8	-	-

NOTE: Please refer to Chapter 9 for RS-485 wiring.

Connecting multiple servo drives:



1) Connect to the controller/PLC.
2) Modbus RJ45 splitter SV2-CN3-CON-2
3) RS-485 terminating resistor (SV2-CN3-TR2)

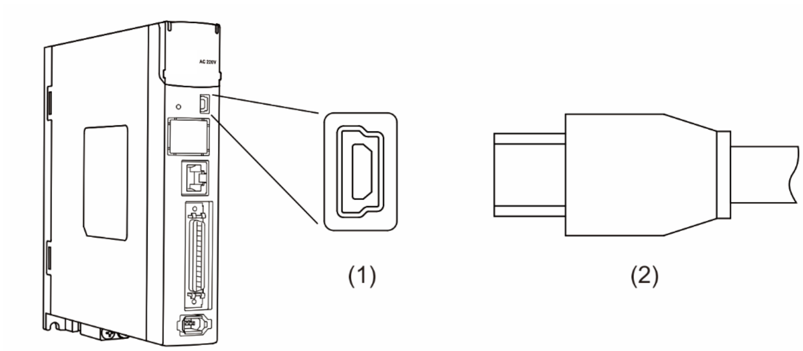
Notes:

1) This supports up to 32 axes via RS-485. The communication quality and the connectable axes are determined by the controller's specifications, quality of wires, grounding, interference, and whether the twisted-pair cable with shielding is used.
2) Use a terminal resistor of 120Ω (ohm) and 0.5 Watts or more.
3) To connect multiple servo drives, please use RS-485 connectors as shown above and put the terminating resistor in the last servo drive.

3.8 - CN4 Serial Connector (Mini USB)

CN4 is a serial connector that connects to a PC and allows you to operate the servo drive with the software. This is a Type B Mini-USB that is compatible with the USB 2.0 specification.

Note: when there is high EMI interference during operation, it is suggested that you install the USB isolator that is included with PN# SV2-PGM-USB15 and SV2-PGM-USB30. The USB connection supplies enough power to configure the drive w/o having AC power supplied. However, the USB Isolator will NOT work without control power supplied to the drive's L1c/L2c terminals.



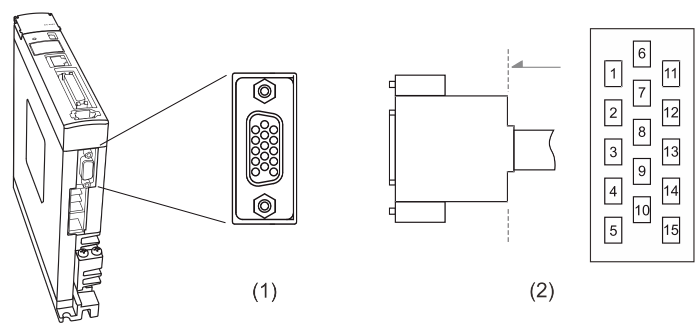
(1) USB connector (female) (2) USB connector (male)

3.9 - CN5 Connector

For machine position feedback, applicable to full-closed loop (sometimes called a dual closed looped). A full-closed loop servo system refers to one that has a secondary external encoder feedback for closing the position loop of the feedback algorithm versus relying on the motor encoder for position. This is useful when very high precision is needed in positioning the load. This external encoder is often a linear tape encoder (linear scale) and directly detects the position of the load. Some other examples of using an external linear scale are removing backlash from the performance of the application or compensating for lead screw pitch error.

A half-closed loop (or semi-closed) is what almost all servo motor applications use. The velocity and position loops are both closed using the encoder on the back of the motor. If you are unsure if you need a linear tape encoder for your application then most likely you do not.

The CN5 connects to an external encoder (A, B, and Z) and forms a full-closed loop with the servo system.



(1) CN5 connector (female) (2) CN5 connector (male)

Pin assignment:

Pin Number	Color	Signal	Function
1	Black/White	Opt_/Z	/Z phase input
2	Blue/White	Opt_/B	/B phase input
3	Blue	Opt_B	B phase input
4	Green	Opt_A	A phase input
5	Green/White	Opt_/A	/A phase input
6	Yellow/Black	0V/GND	Encoder grounding
7	Red/White	0V/GND	Encoder grounding
8	Red	+5V	Encoder power
9	Black	Opt_Z	Z phase input
10	Orange	Reserved	Reserved
11	Orange/White	Reserved	Reserved
12	Brown	Reserved	Reserved
13	Brown/White	Reserved	Reserved
14	Purple	Reserved	Reserved
15	Purple/White	Reserved	Reserved

NOTE: This only supports AB phase signal and an encoder of 5V. The maximum single-phase (Phase A or Phase B) pulse frequency for the encoder cannot exceed 1MHz.

NOTE: Use ZL-HD15M-CBL-DB15F cable + ZL-RTB-DB15 ZIPLink breakout board, or use ZL-HD15M-CBL-2P cable (HD15 to flying leads).

WARNING: Do not use a standard VGA HD15 cable. The typical VGA cable does not include a connection on pin 8.

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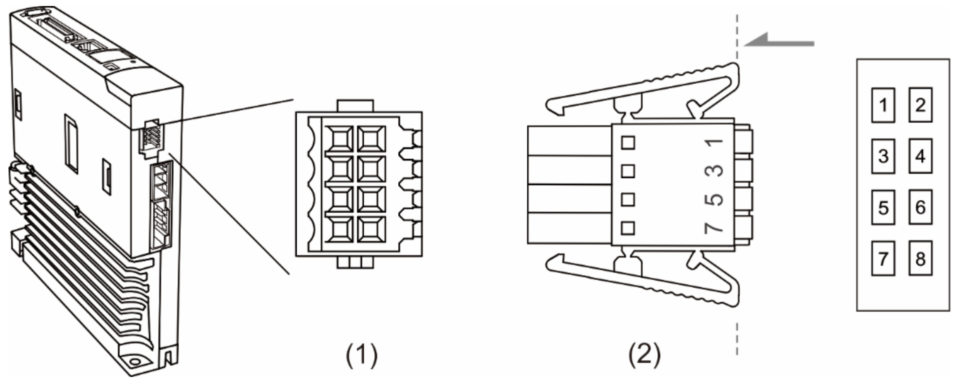
3.10 - CN10 STO Connector (Safe torque off)

This connector provides the STO function. More details are provided in the next section. Allowable wire gauges are 16–24 AWG.

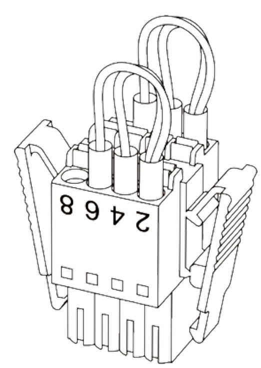


(1) CN10 STO connector socket (female)   (2) CN10 quick connector plug (male)

Pin assignment:

Pin Number	Signal	Description	Usage Notes
1	Reserved	Reserved	For deactivating the STO function. Do not connect these two pins if using the STO function is required.
2	Reserved	Reserved	
3	STO_A (SF1+)	STO input A+ (safety input 1+)	Input signal for the STO function. ON (close): servo drive is in normal operation OFF (open): STO is activated.
4	/STO_A (SF1-)	STO input A- (safety input 1-)	
5	STO_B (SF2+)	STO input B+ (safety input 2+)	
6	/STO_B (SF2-)	STO input B- (safety input 2-)	
7	FDBK+ (EDM+)	STO alarm output (+)	Monitoring outputs for STO input status and STO circuit failure. BJT Output Max.rating: 80VDC, 0.5 A
8	FDBK- (EDM-)	STO alarm output (-)	

If you choose to not use the STO function then you can use the STO connector plug to bypass this safety feature. The STO connector is included with each drive and can also be purchased as a spare (PN# SV2-CN10-STO). The default wiring has been done as shown in the figure on the right. The wiring diagram can be seen in section "3.11.3 - Wiring for STO" on page 3–42. If external safety control is needed and is intended for the STO function then please refer to section 3.11 STO Function (Safe Torque Off) for sample wiring information.

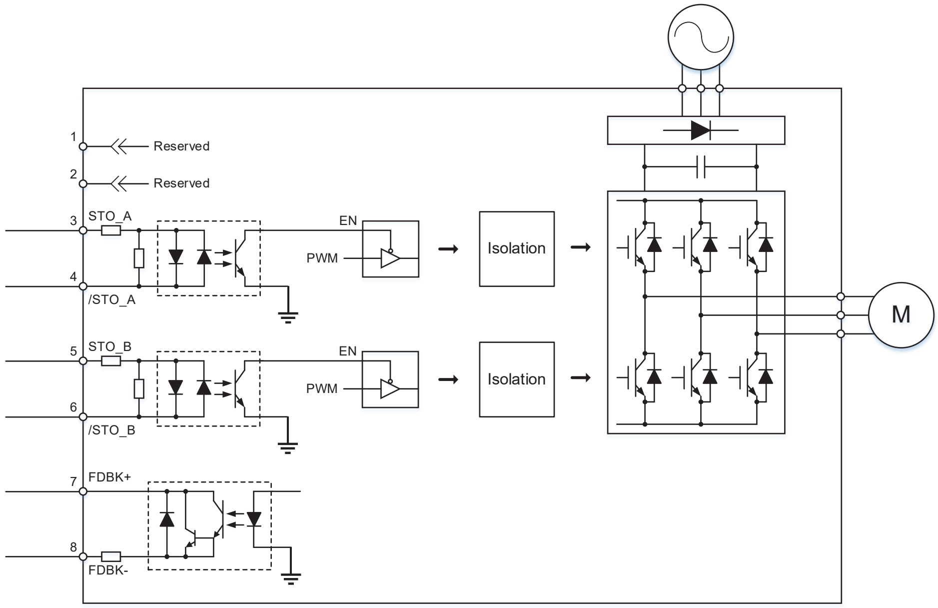


NOTE: The alloweable wire size is 16-24 AWG.

3.11 - STO function (Safe torque off)

3.11.1 - Introduction to STO

Once the STO function is activated, the servo drive stops supplying current to the motor, cutting off the power supply and torque force. Do not repeatedly use this function unnecessarily. It cannot control the time it takes for the motor to stop once the power outputs to the motor are shut off. The STO function should never be used as a routine stop function.



3.11.2 - The potential dangers of STO and precautions for using STO

After the STO function is activated, the motor is no longer controlled by the servo drive and the motor movement is controlled solely by external forces such as existing spinning inertia, back driving, gravity, and external load forces.. Thus, the potential danger from STO must be taken into consideration when designing and wiring the machine. AutomationDirect is not liable for mechanical damage and personnel injury if you fail to observe the following instructions:

1) For a safety circuit design, make sure the selected components conform to the safety specifications.
2) Before installation, read the safety instructions for any external STO related components such as a safety relay.
3) To avoid electric shock, do not touch the servo drive even when the STO function is activated. Although the power to the motor is cut off, there is residual electricity since the power supply is not completely removed from the servo drive.
4) When the STO function is enabled, the servo drive can no longer control, stop or decelerate the motor.
5) After the STO function is activated, the servo drive no longer controls the motor, but the motor can still be moved by other external forces.
6) The feedback monitoring output signal (FDBK) is only for inspecting the STO function status rather than for safety output.
7) The STO function must be powered by the safety extra-low voltage (SELV) power source with reinforced insulation.
8) Power the STO signals with single power supply, or the leakage current will result in STO malfunction.
9) When performing maintenance on the servo drive, use a molded-case circuit breaker (MCCB) or a magnetic contactor (MC) to cut off the power.

10) Only qualified personnel fully understanding the safety standards can design, install, and operate the system after reading this operation manual.
11) Use products with safety certifications or machines compliant with safety specifications to build a safe electrical circuit.
12) Before installation and wiring, read the operation manuals of all the peripheral devices carefully.
13) If the motor is moved by external forces when the STO function is activated, take safety measures such as using the mechanical brake.
14) Evaluate the risk of using the machine or the connecting devices.
15) To avoid malfunction caused by accumulated errors, you must check the safety functions at least once every 3 months.

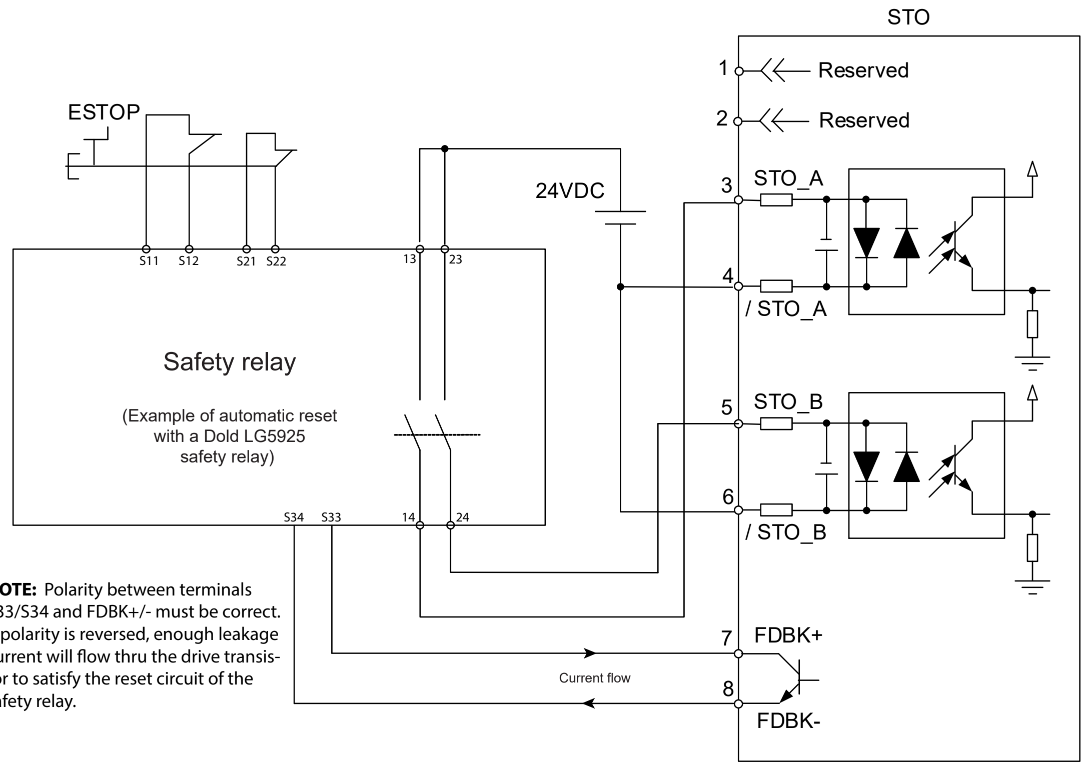
The SureServo2 series servo drive conforms to the following safety specifications:

Item	***Description***	***Standard***	***Safety Data***
SFF	Safe failure fraction	IEC61508	Channel1: 80.08% Channel2: 68.91%
HFT (Type A subsystem)	Hardware fault tolerance	IEC61508	1
SIL	Safety integrity level	IEC61508	SIL2
		IEC62061	SILCL2
PFH	Probability of dangerous failure per hour (h^{-1})	IEC61508	9.56×10^{-10}
PFD_{av}	Average probability of failure on demand	IEC61508	4.18×10^{-6}
Category	Category	ISO13849-1	Category 3
PL	Performance level	ISO13849-1	d
$MTTF_d$	Mean time to dangerous failure	ISO13849-1	High
DC	Diagnostic coverage	ISO13849-1	Low

3.11.3 - Wiring for STO

To use a safety relay to trigger the STO function, example wiring is shown in the following diagrams:

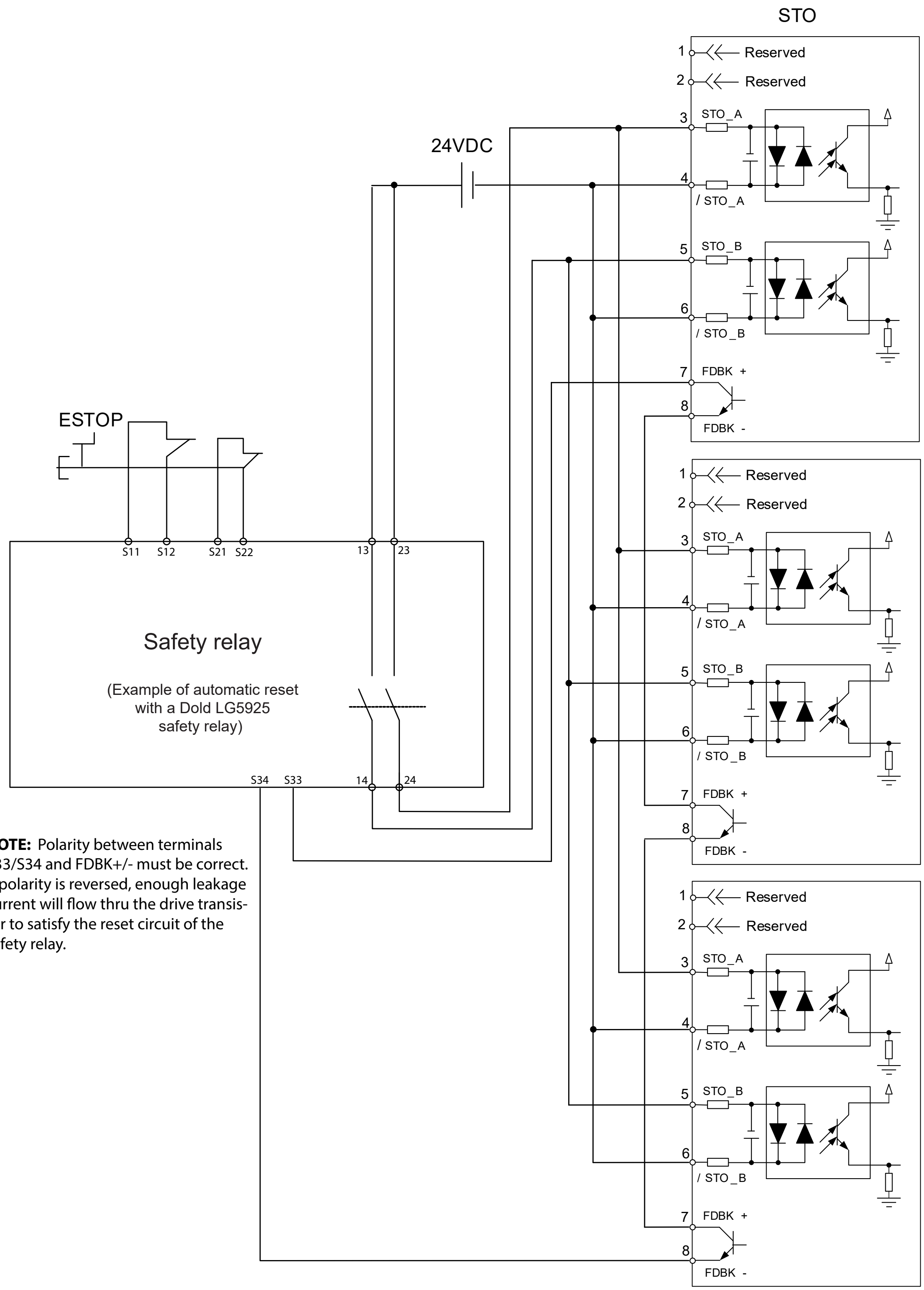
Single



NOTE: Polarity between terminals S33/S34 and FDBK+/- must be correct. If polarity is reversed, enough leakage current will flow thru the drive transistor to satisfy the reset circuit of the safety relay.

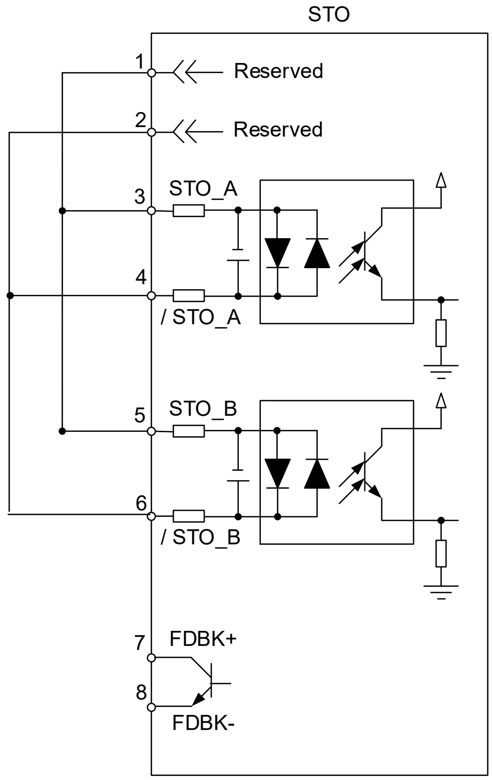
Multiple

In a multi-drive system, the values of (PFD x number of drives) and (PFH x number of drives) must not exceed the specified safety values of the device.



NOTE: Polarity between terminals S33/S34 and FDBK+/- must be correct. If polarity is reversed, enough leakage current will flow thru the drive transistor to satisfy the reset circuit of the safety relay.

If you are not using the STO function, you can short-circuit the connector or plug in the connector that has been wired (provided with the servo drive).



3.11.4 - How does the STO function work?

The STO function is controlled by the motor current from two individual circuits. It cuts off the power supply to the motor when needed, after which the motor is free from the drive's torque force. The table below details how this function works.

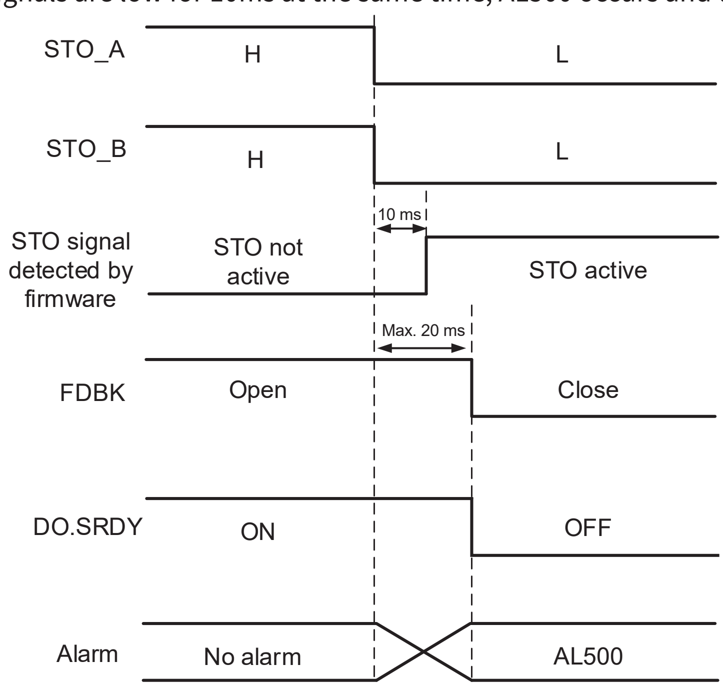
Signal	***Channel***	***Status of Opto-isolator***			
STO	STO_A /STO_A	ON	ON	OFF	OFF
	STO_B /STO_B	ON	OFF	ON	OFF
Servo Drive Output Status		Ready	Torque off (STO_B lost)	Torque off (STO_A lost)	Torque off (STO Mode)
Feedback monitoring (FDBK status)		Open	Open	Open	Close
Alarm		N/A	AL502	AL501	AL500

Note:

1) ON=24V, OFF=0V.
2) Open=open circuit, Close=closed circuit.
3) The status of the feedback monitoring signals changes at once according to the status of the safety signals (STO_A and STO_B signals).
4) Contact AutomationDirect if AL503 (STO self-diagnostic error) occurs. Refer to "Chapter 11: Troubleshooting" on page 11–1 for mopre details of the alarms.

Description of the STO alarm:

See the diagram below. When the motor runs normally (Servo On), but both STO_A and STO_B signals are low for 10ms at the same time, AL500 occurs and the drive is in the Servo Off state.



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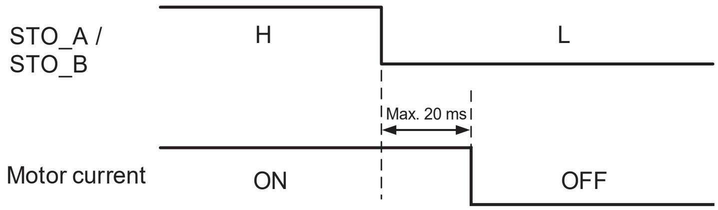
3.11.5 - STO Response Time

When either STO_A or STO_B signal (safety signal source) is low, the circuit cuts off the motor current within 20 ms.

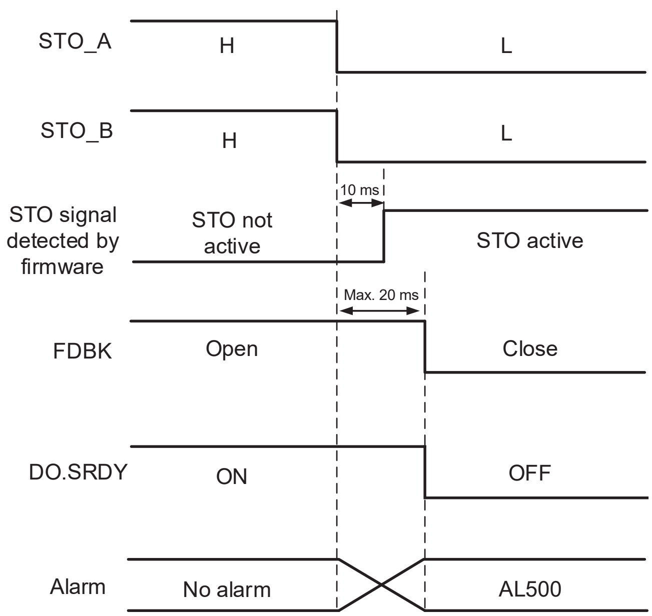


3.11.6 - Alarm Triggering

AL500 (STO function is activated)

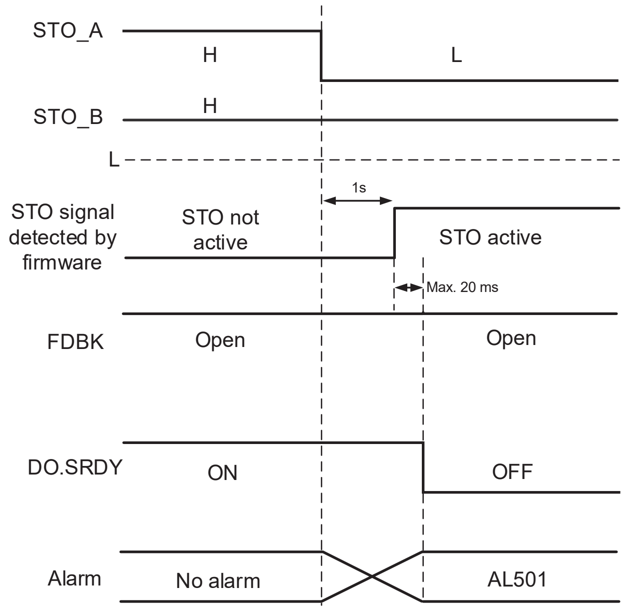
When either STO_A signal or STO_B signal becomes OFF, the STO function is activated, the circuit cuts off the current to the motor within 10ms, and the servo drive is Off, triggering AL500.

When both STO_A and STO_B signals become OFF, the servo drive still displays AL500. Refer to the following diagrams:



__AL501 (STO_A lost) / AL502 (STO_B lost) (signal loss or signal error)__

When either STO_A signal or STO_B signal becomes OFF, the STO function is activated, the circuit cuts off the current to the motor.



NOTE: When STO_A becomes OFF, AL501 occurs. When STO_B becomes OFF, AL502 occurs.

__**Notes:**__

1) Contact AutomationDirect if AL503 (STO self-diagnostic error) occurs.
2) Refer to section 3.11.4 on page 3–45 for the FDBK signal.

3.11.7 - STO Feedback Behavior

__FDBK behavior__

The FDBK signal is only configured for non-latching and is used for external device monitoring (EDM). There is no way to make it latch. Once the STO circuit is reset to the running state, the FDBK output will open. During an STO event when both channels A and B are open (AL500) the FDBK signal is closed. If only one channel opens or there is an internal STO error then the STO circuit will still remove power to the motor but the FDBK signal will remain open.

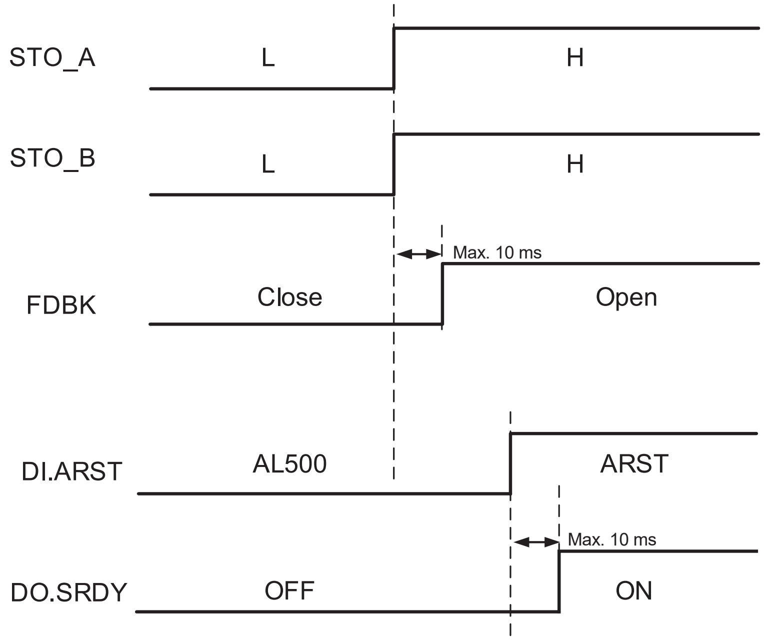
Example:

The FDBK status is closed when the safety signal is lost and AL500 occurs.

1) Since the FDBK signal is non-latching, when the safety signals return to normal, the FDBK status automatically changes from short-circuited to normal when AL500 occurs.
2) After the FDBK status is restored, you can clear the alarms by the normal corrective actions. In this case, you can clear AL500 by DI.ARST.

3.11.8 - Deactivation Status

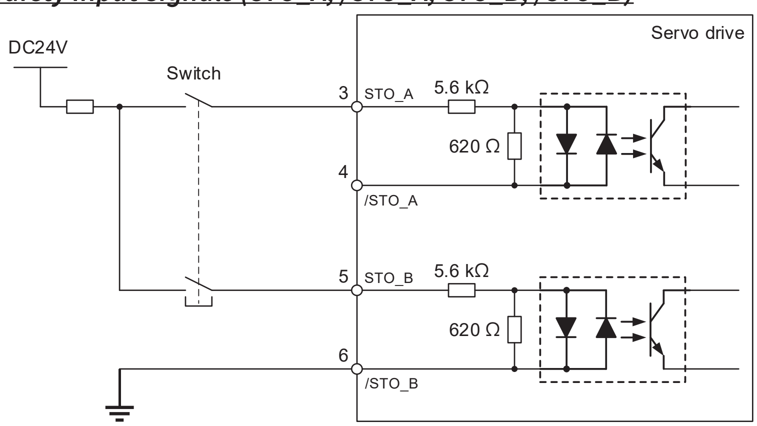
When the safety signal source (STO_A and STO_B signals) switches back to high, the alarm will not be cleared automatically. Of all the STO alarms, only AL500 can be cleared with DI.ARST.



NOTE: Refer to section 3.11.4 on page 3-45 for the FDBK signal.

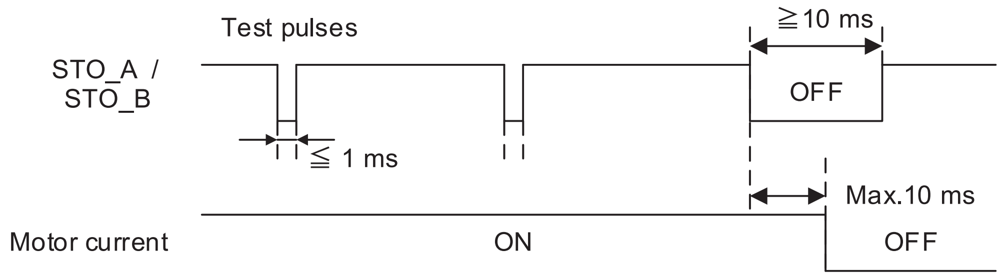
3.11.9 - Input/Output SIgnal Specification

Safety Input Signals (STO_A, /STO_A, STO_B, /STO_B)

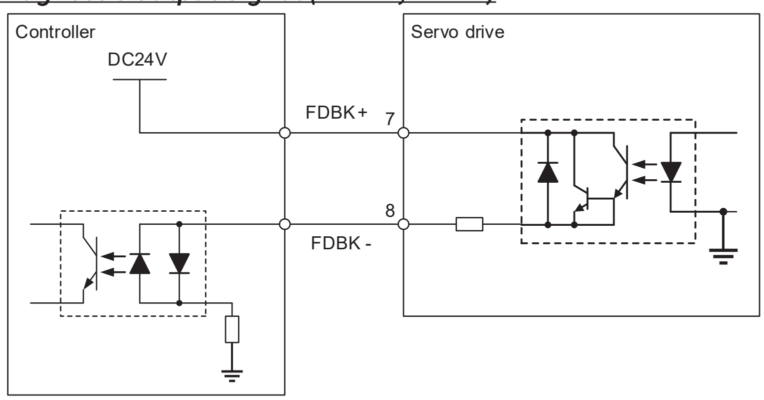


Item	Specification	Note
Internal impedance	5.6 kΩ	–
Operable voltage	24VDC ± 20%	Use the SELV power source.
Maximum delay time	10ms	The time duration from STO signal OFF to STO function activated.

The OFF time curation of the external test pulse input should be less than 1ms.



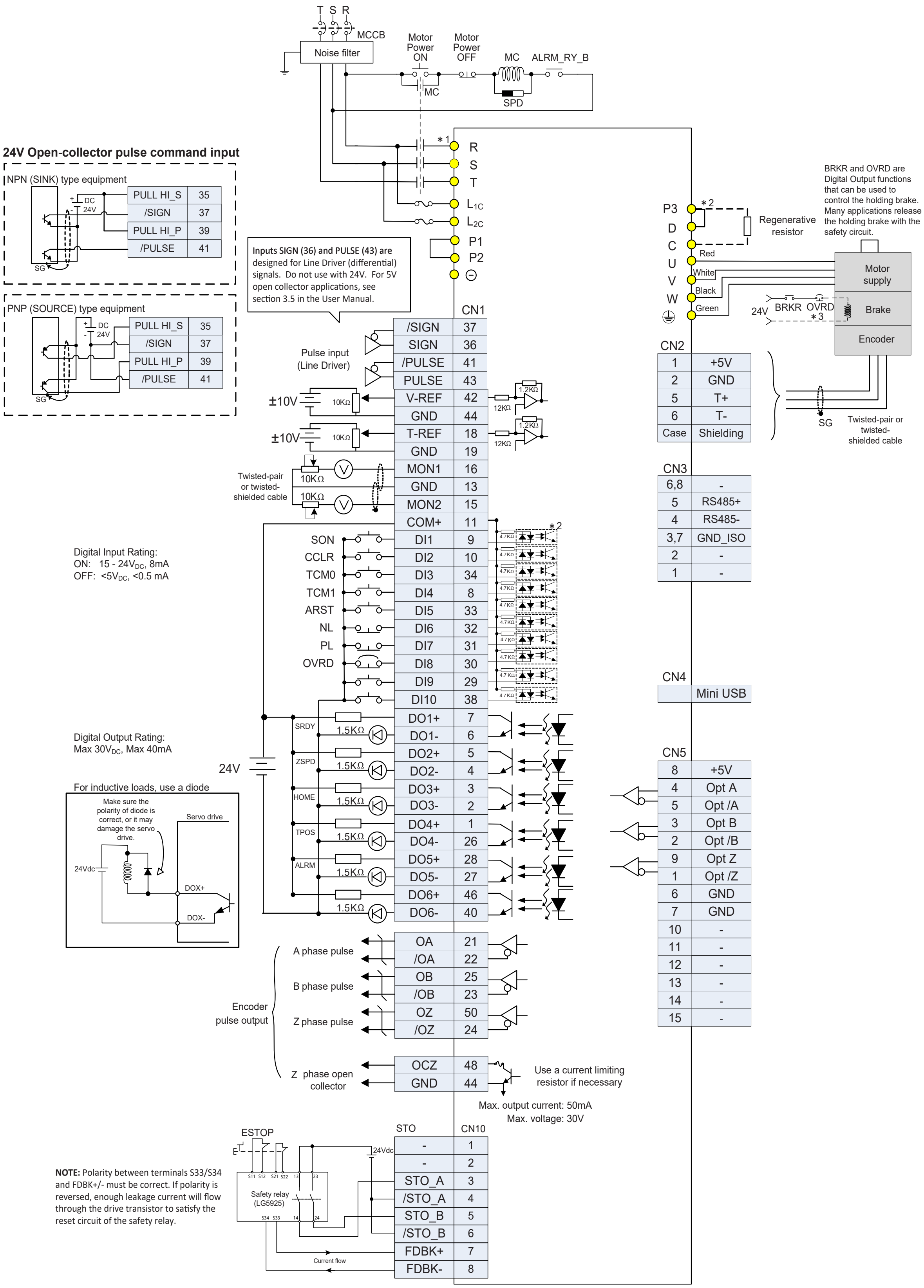
Diagnostic Output Signal (FDBK+, FDBK-)



Item	Specification	Note
Maximum allowable voltage	24VDC	Use the SELV power source.
Maximum alloweable current	50mA	–
Maximum voltage drop	1.5 V	When the current is 50mA.

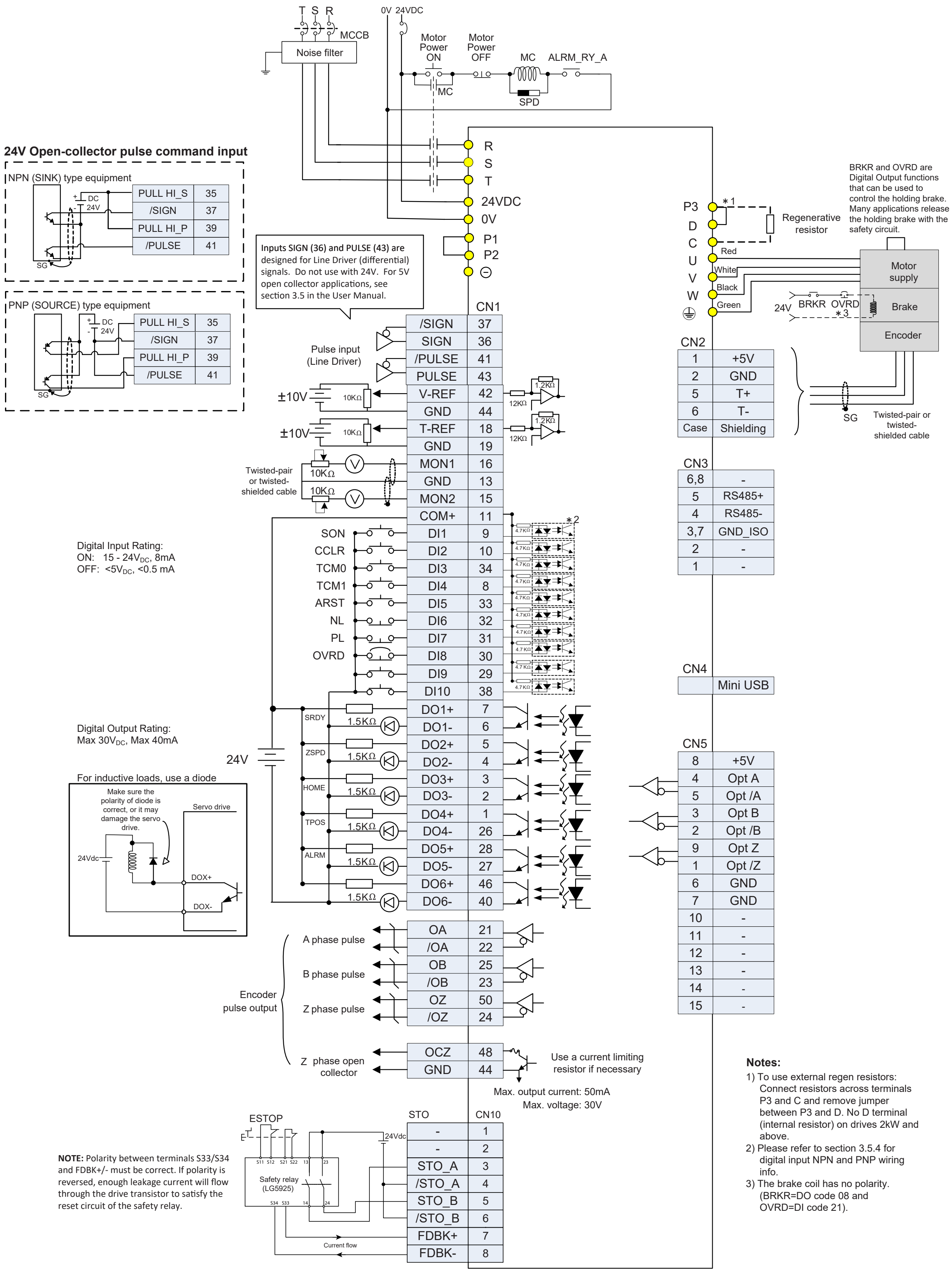
3.12 - Standard Wiring Example

110/230V Sytems



Notes: (see page 3–52)

460V Systems



Notes: (see next page)

__Notes:__

1) Please refer to section 3.5.1 for C4 wiring diagram.
2) Please refer to section 3.5.4 for wiring diagram C7 SINK / C8 SOURCE.
3) The motor's brake coil has no polarity.
4) Connect to Mini-USB (for PC communication).
5) Models of 2kW and below can use single-phase power supply.

3.12.1 - STO Safety Specifications

The SureServo2 series servo drive conforms to the following safety specifications:

Item	Description	Standard	Safety Data
SFF	Safe failure fraction	IEC61508	Channel1: 80.08% Channel2: 68.91%
HFT (Type A subsystem)	Hardware fault tolerance	IEC61508	1
SIL	Safety integrity level	IEC61508	SIL2
		IEC62061	SILCL2
PFH	Probability of dangerous failure per hour (h^{-1})	IEC61508	9.56×10^{-10}
PFD_{av}	Average probability of failure on demand	IEC61508	4.18×10^{-6}
Category	Category	ISO13849-1	Category 3
PL	Performance level	ISO13849-1	d
$MTTF_d$	Mean time to dangerous failure	ISO13849-1	High
DC	Diagnostic coverage	ISO13849-1	Low

Chapter 4: Test Operation and Drive Display

Chapter 4

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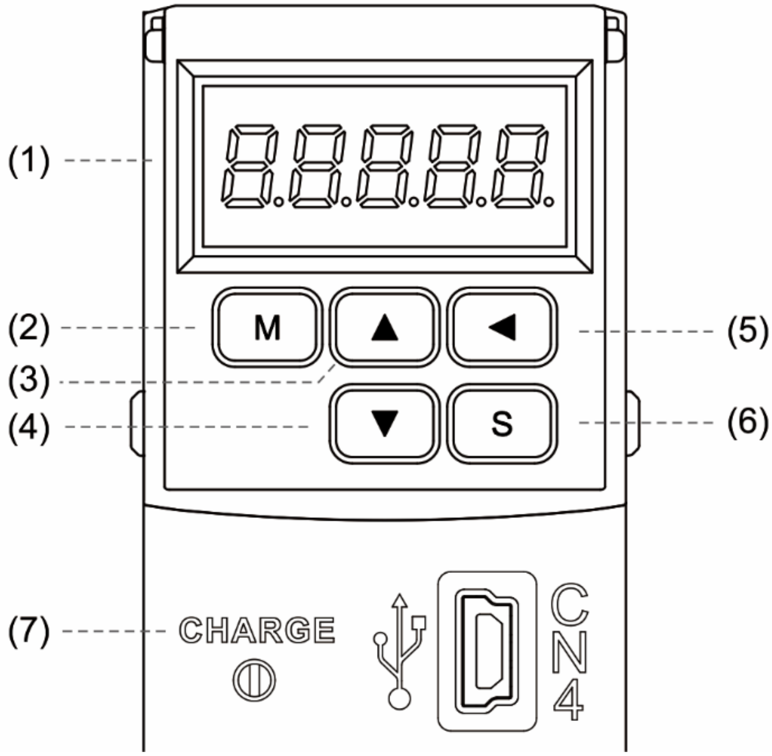
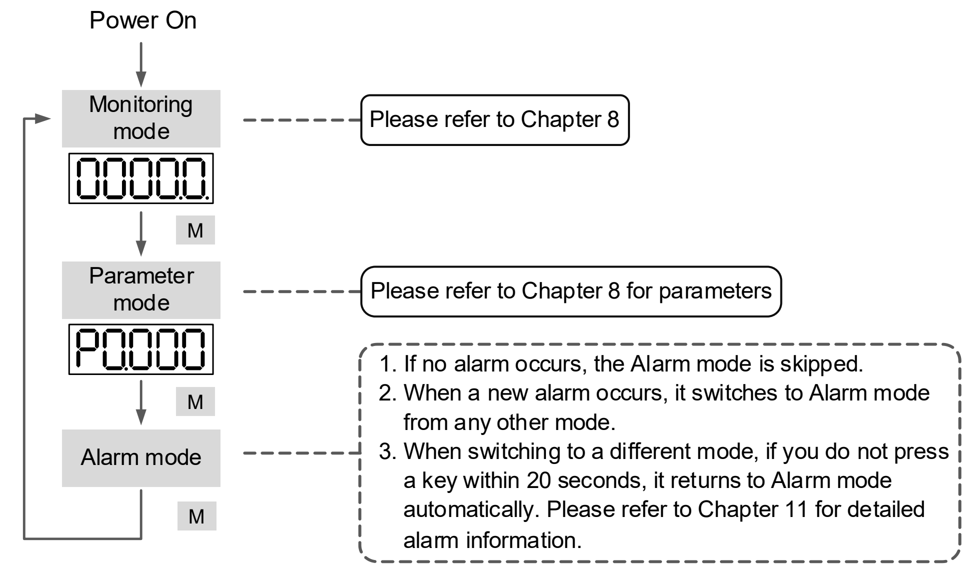
4.1 - Display Description



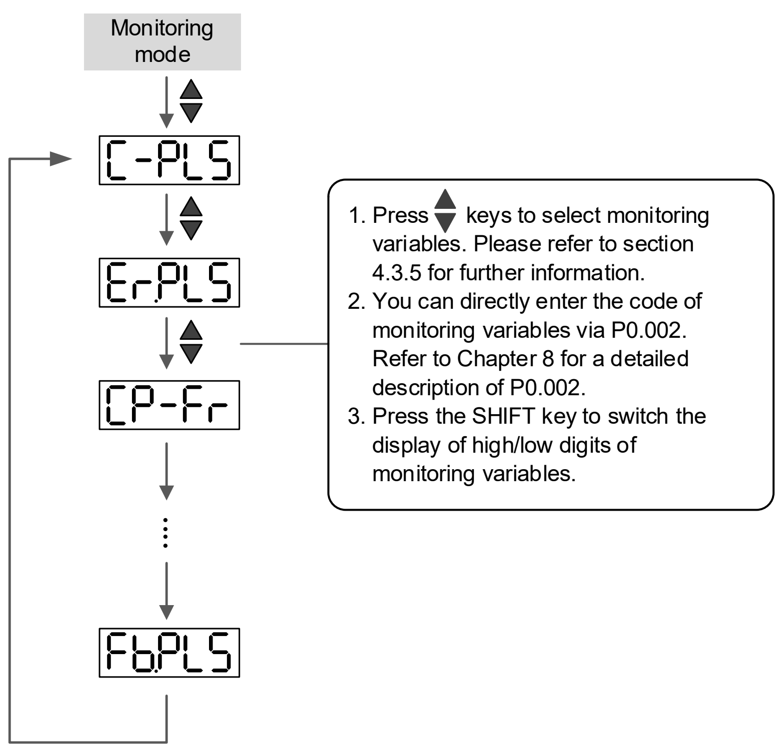
1) Display: 5-digit, 7-segment LED displays the monitoring values, parameters, and setting values.
2) MODE key: switches the display between Monitoring mode, Parameter mode, and Alarm mode. In Editing mode, press the MODE key to switch to Parameter mode.
3) UP key: changes monitoring code, parameter number, and value.
4) DOWN key: changes monitoring code, parameter number, and value.
5) SHIFT key: in Parameter mode, use this key to change the group number. In Editing mode, moving the flashing (selected) digit to the left lets you adjust the higher setting bit. In Monitor mode, this switches the display from high / low bytes in Monitor mode.
6) SET key: displays and stores the parameter value. In Monitor mode, pressing the SET key switches between decimal and hexadecimal display. In Parameter mode, pressing the SET key switches to Editing mode.
7) Charge LED: the Charge LED indicator is on when the circuit is powered and when hazardous voltages remain on the drive after power is turned off.

4.2 - Parameter setting procedure

4.2.1 - Switching modes



4.2.2 - Monitoring Mode



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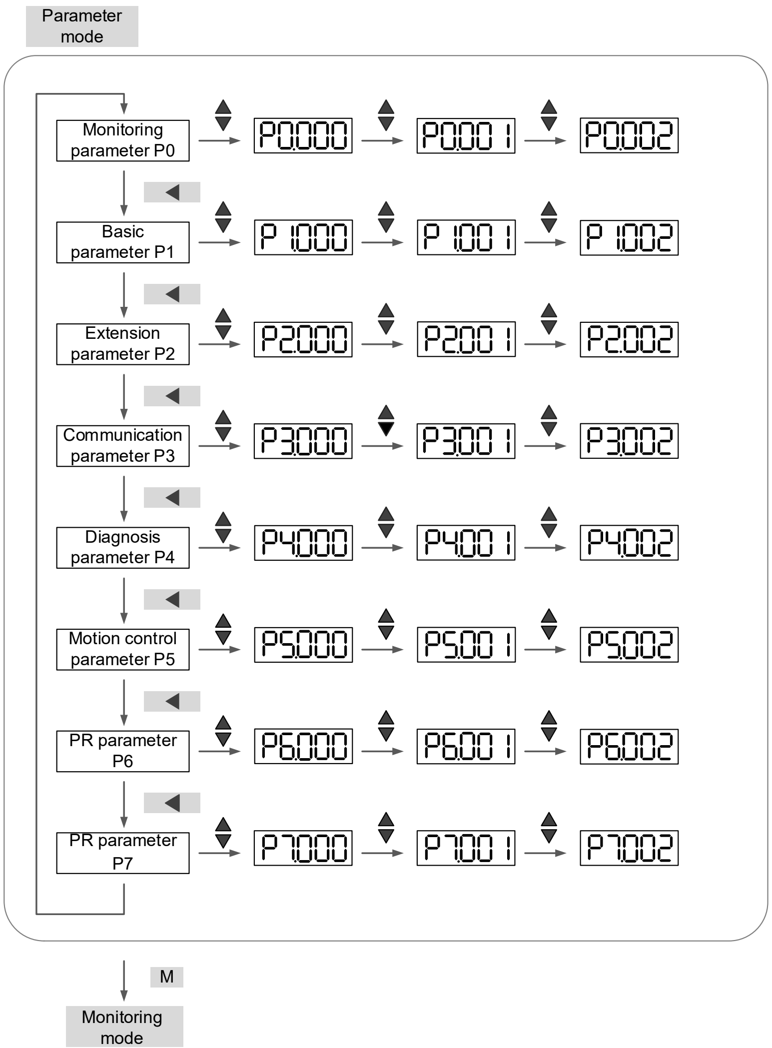
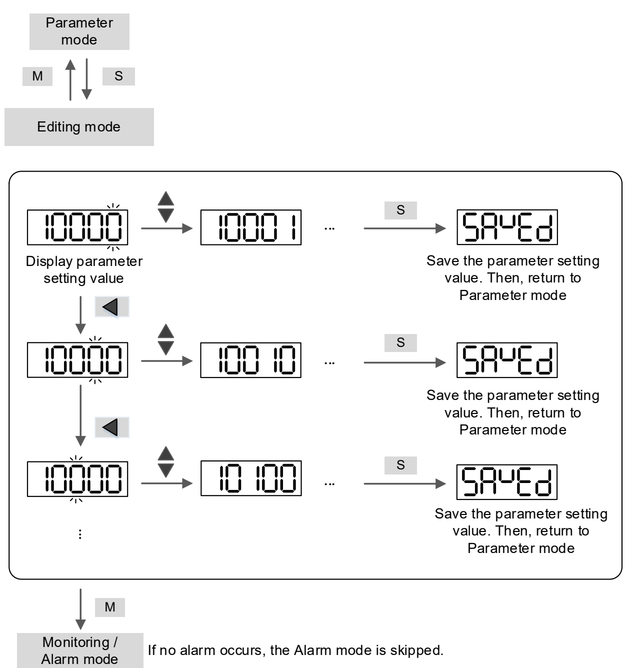
4.2.3 - Parameter Mode



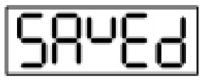
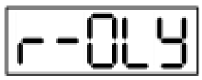
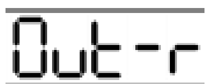
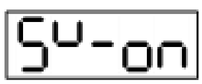
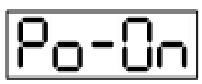
4.2.4 - Editing Mode



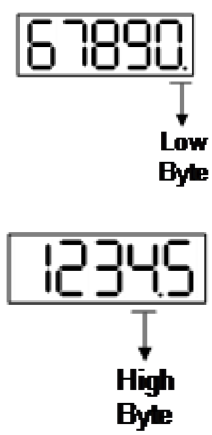
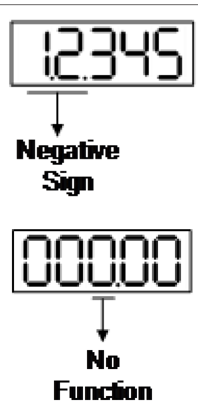
4.3 - Status Display

4.3.1 - Save the setting display

When you complete the parameter setting, press the SET key to save the parameters. The display shows the status for one second.

Displayed Symbol	Description
	Correctly saved the setting value (Saved).
	Read-only and write-protected parameter (Read-only).
	Entered the wrong password or did not enter a password (Locked).
	Entered an incorrect setting value or the reserved setting value (Out of Range).
	You cannot enter a value when in Servo On state (Servo On).
	Changes to the parameter take effect after cycling the power to the servo drive (Power On).

4.3.2 - Display the Decimal Point

Displayed Symbol	Description
	High byte / low byte indication: this indicates the current high byte or low byte when the data is displayed in decimal (32 bits). (Note: When in Hex format low byte will indicated by L0000 and high byte by h0000)
	Negative sign: the two decimal points on the left represents the negative sign when the data is displayed in decimal format, (16 or 32 bits). In hexadecimal format, it only shows positive values.

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4.3.3 - Alarm Messages

Displayed Symbol	Description
AL.nnn	When an alarm occurs, the servo drive shows 'AL' as the alarm symbol and 'nnn' as the alarm code. For detailed information, please refer to Chapter 8 P0.001 Parameter Description or Chapter 11 Troubleshooting.

4.3.4 - Positive and Negative Sign Setting

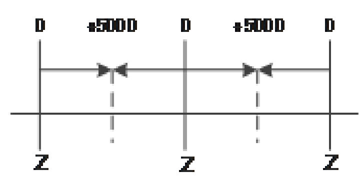
Displayed Symbol	Description
02468	In Editing mode, press the UP and DOWN keys to change the displayed value. Use the SHIFT key to change the selected value (the selected value is flashing.)
24680	Press the SHIFT key in editing mode for two seconds to switch between the positive (+) and negative (-) sign. If the parameter value is out of range after switching the positive or negative sign, then the value automatically resets to the original value.

4.3.5 - Monitoring Display

When you apply power to the drive, the display shows the monitoring symbol for one second, and then enters Monitoring mode. In Monitoring mode, use the UP and DOWN keys to change the monitoring variable. Or you can directly change the setting of P0.002 to specify the monitoring code. When power cycled, the monitoring code is set to the value of P0.002. Scrolling through the codes on the keypad will allow you to monitor codes 0-31. For example, if P0.002 = 85, then on every power cycle the display will monitor the "Ecam Alignment Deviation percentage" but you can quickly scroll through the 1st 31 codes with the keypad. Scrolling through the codes will not change the value of P0.002, so on power cycle the display will revert back to showing the value of 85 (Ecam Alignment Deviation percentage). PUU stands for Pulse User Units and is determined by the E-Gear ratio (P1.044 and P1.045).

See the details in the table below:

Parameter P0.002 setting	Displayed Symbol	Description	Unit
0	FbPUU	Motor feedback pulse number (after the scaling of E-Gear ratio) (user unit)	[user unit]
1	C-PUU	Input the number of pulses command (after the scaling of E-Gear ratio) (user unit)	[user unit]
2	ErPUU	The deviation between control command pulse and feedback pulse number (user unit)	[user unit]
3	FbPLS	Motor feedback pulse number (encoder unit) (1.28 million pulse/rev)	[pulse]
4	C-PLS	Input the number of pulses command (before the scaling of E-Gear ratio) (encoder unit)	[pulse]
5	ErPLS	Error pulse number (after the scaling of E-Gear ratio) (encoder unit)	[pulse]
6	CP-Fr	Input frequency of pulse command	[kpps]

Parameter P0.002 setting	Displayed Symbol	Description	Unit
7	SPEEd	Motor speed	[rpm]
8	CSPd 1	Speed command	[Volt]
9	CSPd2	Speed command	[rpm]
10	C-tq 1	Torque command	[Volt]
11	C-tq2	Torque command	[%]
12	AUG-L	Average torque	[%]
13	PE-L	Peak torque	[%]
14	U buS	Main circuit voltage	[Volt]
15	J-L	Load / Motor inertia ratio (note: if it shows 13.0, it means the actual inertia is 13)	[1 times]
16	IGbt.t	IGBT temperature	[°C]
17	rSn.Fr	Resonance frequency (low byte is the first resonance and high byte is the second one)	[Hz]
18	d IFF.2	The absolute pulse number of encoder Z phase equals the homing value, 0. It is +5000 or -5000 pulses when the motor rotates in the forward or reverse direction. 	-
19*	MAP 1	Mapping parameter #1: shows the content of parameter P0.025 (specify the mapping target by P0.035)	-
20*	MAP2	Mapping parameter #2: shows the content of parameter P0.026 (specify the mapping target by P0.036)	-
21*	MAP3	Mapping parameter #3: shows the content of parameter P0.027 (specify the mapping target by P0.037)	-

** - See section 8.4.11 on page 8–259 for special considerations concerning MAP and Monitoring settings.*

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Parameter P0.002 setting	Displayed Symbol	Description	Unit
22*	nnAP4	Mapping parameter #4: shows the content of parameter P0.028 (specify the mapping target by P0.038)	-
23*	UAr- 1	Monitoring variable #1: shows the content of parameter P0.009 (specify the monitoring variable code by P0.017)	-
24*	UAr-2	Monitoring variable #2: shows the content of parameter P0.010 (specify the monitoring variable code by P0.018)	-
25*	UAr-3	Monitoring variable #3: shows the content of parameter P0.011(specify the monitoring variable code by P0.019)	-
26*	UAr-4	Monitoring variable #4: shows the content of parameter P0.012 (specify the monitoring variable code by P0.020)	-
27–31		Reserved	-
** - See section 8.4.11 on page 8–259 for special considerations concerning MAP and Monitoring settings.*			

The following table shows the drive display of 16-bit and 32-bit value:

Example	Bits	Description
0 1234 (Decimal)	16	If the value is 1234, it displays 01234 (in decimal format).
1234 (Hex)		If the value is 0x1234, it displays 1234 (in hexadecimal format; the first digit does not show).
1234.5 (Dec high) 67890. (Dec low)	32	If the value is 1234567890, the display of the high byte is 1234.5 and displays 67890 as the low byte (in decimal format).
h 1234 (Hex high) L5678 (Hex low)		If the value is 0x12345678, the display of the high byte is h1234 and displays L5678 as the low byte (in hexadecimal format).

The following table shows the drive display for the negative sign:

Example	Description
1.2.345	If the value is -12345, it displays as 1.2.345 (only in decimal format; there is no positive or negative sign for hexadecimal format display).

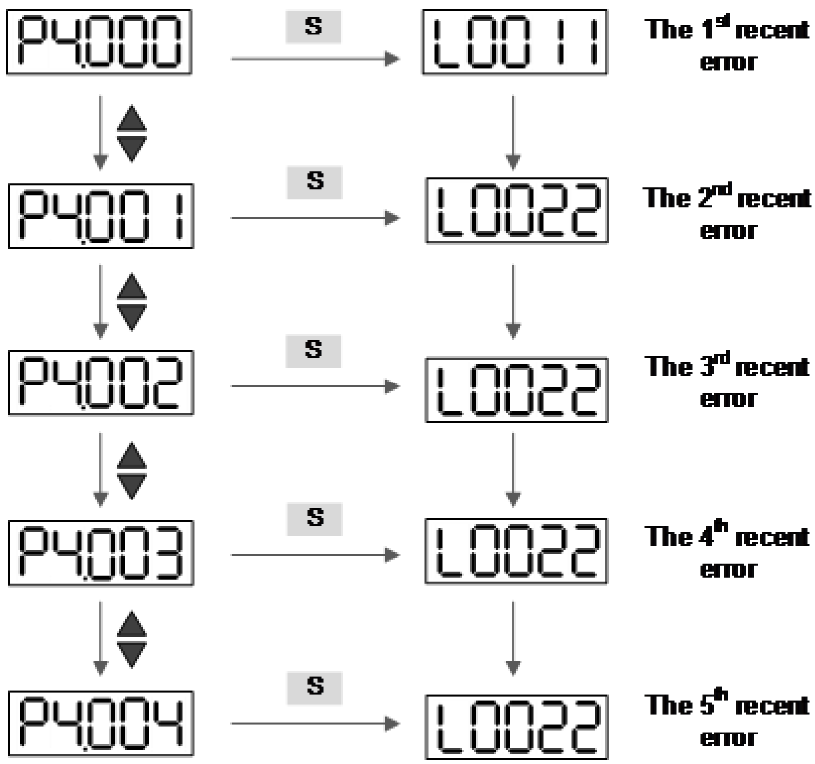
Notes:

1) Dec means the value is displayed in decimal format; Hex represents hexadecimal format.
2) The display is applicable in both Monitoring mode and Editing mode.
3) When all monitoring variables are 32 bits, you can switch the high / low bit and the display (Dec / Hex). As described in Chapter 8, each parameter only supports one display method and cannot be switched.

4.4 - General functions

4.4.1 - Operation of fault record display

In Parameter mode, select P4.000 – P4.004 and press the SET key to show the corresponding fault record.

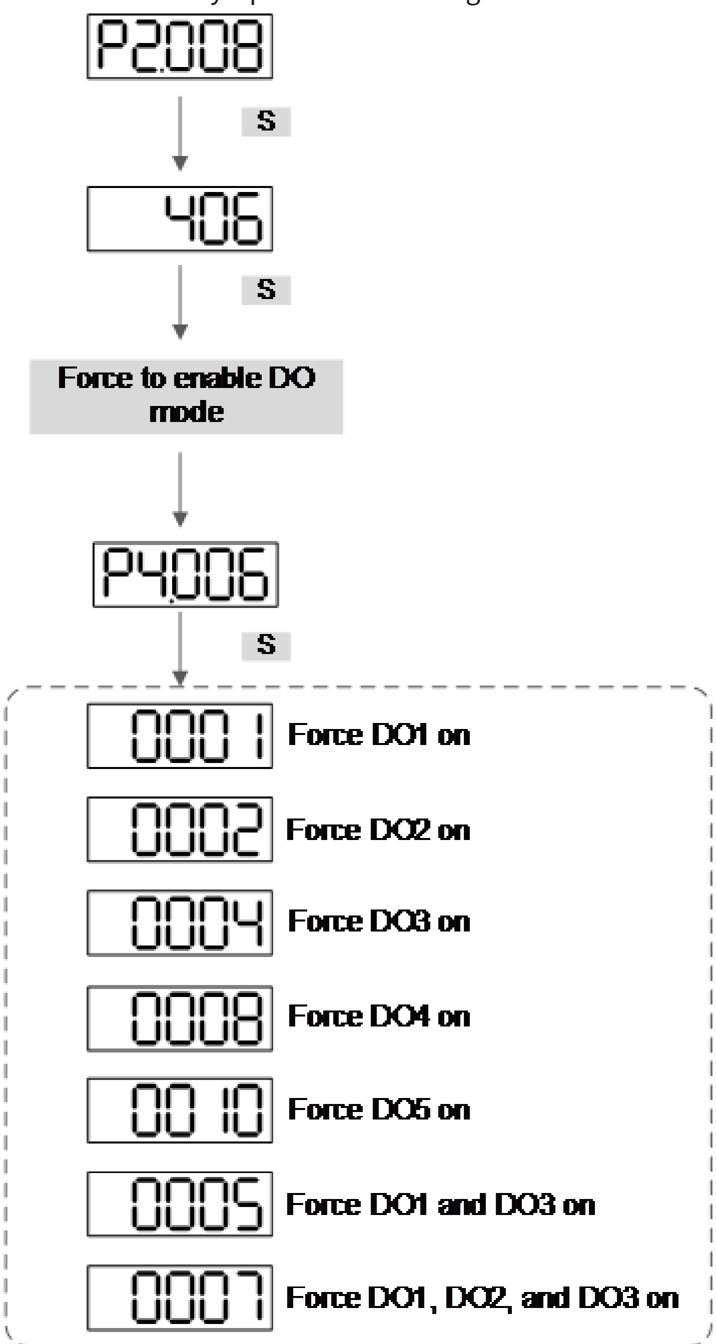


4.4.2 - Force DO on

You can switch to the Diagnosis mode by the following steps. Set P2.008 to 406 and enable the function to force DO1-DO6 on. Then, set the DO via hexadecimal method with P4.006. When the parameter value is 2, it forces DO2 on. When the value is A (binary 1010), it forces DO2 and DO4 on. No data is retained in this mode. The mode returns to the normal DO mode after cycling the power. You can also set P2.008 to 400 to switch to the normal DO mode. If you want to force one DO but not have to force all to 0, please refer to P4.006. This non-diagnostic method will allow you to trigger an output using communications.

Setting P2.008 to 406 will clear the contents of P4.006 which means turning on DO Force will initially force all digital outputs to low or closed.

Digital output NO and NC configurations do not remain in effect during DO forces. All DO become a Normally Open contact during the time P2.008 = 406.

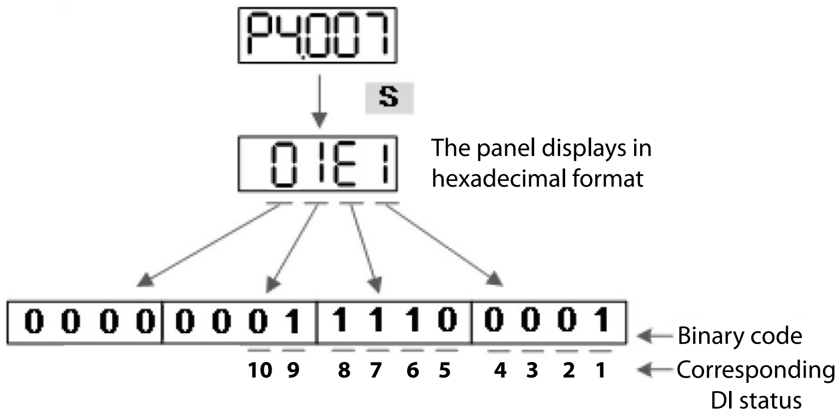


4.4.3 - Digital input diagnostic mode

You can switch to the Diagnostic mode by the following steps. P4.007 -> set -> 0000 -> set. This will set the drive display to monitoring mode to DI status (di-St). When DI1 – DI10 are triggered by an external signal, the display shows the corresponding input status displayed in hex. When it shows 9, then DI 1 and DI 4 are on. Entering P4.007 grabs a snapshot of the inputs and will not update in real time after entering into the parameter in edit mode. Pressing the Set key again will then set the display in Monitoring Mode to di-St (Digital Input Status). You can also see the inputs change in real time by setting P000.2 = 39.

For example, if it shows 01E1, E is in hexadecimal format, and is 1110 in binary format.

Then, DI6 – DI8 are ON for the second nibble.



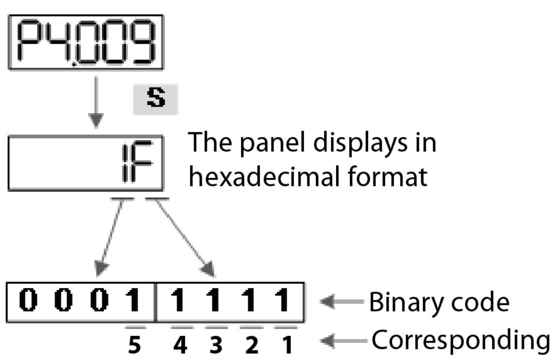
(Display in hexadecimal format)

4.4.4 - Digital output diagnostic mode

You can switch to the Diagnosis mode by the following steps. Entering P4.009 will only take a snapshot of the digital output status. If you want to see the digital outputs change in real time than you must set P0.002 = 40 to see the output change in monitoring mode. The output signals DO1 – DO6 are triggered and the corresponding signal appears on the display, displayed by bit. When it shows 1, it means the DO is on.

For example, if it shows 1F, F is in hexadecimal format, it is 1111 in binary format.

Then, DO1 – DO4 are on.



(Display in hexadecimal format)

4.5 - Testing

This section is divided into two parts. The first part introduces testing without load. And the second part describes testing when running the servo motor with load. To avoid danger, please operate the servo motor without a load first.

4.5.1 - Testing without load

Please remove the load from the servo motor, including coupling on the shaft and accessories, to avoid any damage to servo drive or machine. This prevents the disassembled parts of the motor shaft from falling off and possibly causing personnel injury or equipment damage during operation. Please run the motor without a load first to see if the servo motor can run during normal operation.

CAUTION! CHECK IF THE MOTOR CAN OPERATE NORMALLY WITHOUT A LOAD FIRST, THEN OPERATE THE MOTOR WITH A LOAD. FAILURE TO VERIFY THE OPERATIONAL STATUS OF THE MOTOR BEFORE OPERATING WITH LOAD COULD RESULT IN DAMAGE TO THE EQUIPMENT.

Check the following items before operation:

Test before running the servo drive (without power)

- *Check for any obvious visible damage.*
- *The wires at the wiring terminal should be isolated.*
- *Make sure the wiring is correct to avoid damage or any abnormal operation.*
- *Check for and remove any electrically conductive objects, including metal (such as screws) or flammable objects inside or near the servo drive.*
- *Ensure that control switch is in OFF or safe state.*
- *Do not place the servo drive or external regenerative resistor on flammable objects.*
- *Ensure the electromagnetic brake works and circuit breakers and disconnects are working normally.*
- *If there is electronic interference with any peripheral devices, please reduce electromagnetic interference from the devices.*
- *Please make sure the external voltage level of the servo drive is correct.*

Test while running the servo drive (with power)

- *The encoder cable should be protected from excessive mechanical tension or stress. When the motor is running, please make sure the cable is not worn or stretched.*
- *Please contact AutomationDirect if the servo motor vibrates or makes unusual noise during operation. Note that it is normal to hear a little bit of noise in brake motors when the brake is off.*
- *Make sure the setting for the parameters are correct. Different machinery and applications may require different servo behavior. Please adjust the parameters according to the characteristics of each machine.*
- *Only change parameters when the servo drive is in the Servo Off status, or you may cause the servo drive to malfunction.*
- *Check if the power indicator and LED display work properly.*

4.5.2 - Apply power to SureServo2 servo drive

Please follow the instructions below.

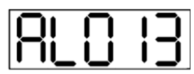
1) Make sure the wiring between the motor and servo drive is correct:
   a) U, V, W, and FG have to connect to the red, white, black, and green wires respectively. If the wiring is incorrect, the motor will not work properly. Please refer to Section 3.1.2 for wiring.
   b) The encoder cable for the motor is correctly connected to CN2: if you only want to use the JOG function then connecting CN1 and CN3 is not necessary. Please refer to Section 3.6 for the wiring for CN2. Please refer to section 4.5.3 for more information on JOG.

Caution! Do not connect the line power (R, S, T) to the output terminal (U, V, W) of servo drive, or you will damage the servo drive.

2) Connect the power circuit for the servo drive:
   Please refer to Section 3.1.3 for power wiring.
3) Turn on the power:
   Apply power, including to the control circuit (L1c, L2c) and main circuit (R, S, T).

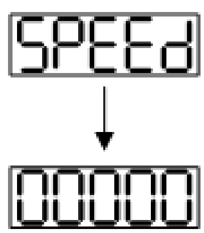
Please see “4.5.4 - Trial run without load (Speed mode)” on page 4–17 for a complete list of parameters that will need to be changed to test run a drive without an IO hooked up.

When the power is on, the display of the servo drive shows AL013 (motor override):



The default digital inputs (DI6 – DI8) are the signal for reverse inhibit limit or negative limit (NL), forward inhibit limit or positive limit (PL), and motor override (OVRD). If DI6 – DI8 is not used, you must change the values of P2.015 – P2.017, which you can set to 0 (disable the DI function) or some other value for a different function. DI6-DI8 are defaulted to be normally closed which is the best practice for end of travel limits and emergency stops. The onboard STO connector is a safer way to ensure removal of power to the motor in the event of an emergency.

If the servo drive status displays P0.002 setting as the motor speed (07), then the screen display shows:

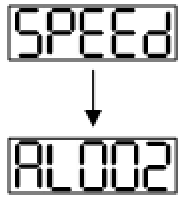


No Display

When the drive display displays no text, please check if the control circuit power is undervoltage.

Overvoltage warning:

When an overvoltage warning occurs the screen displays AL002:



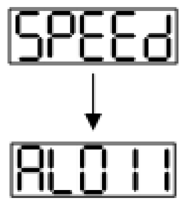
This means the voltage input from the main circuit is higher than the rated range or a power input error has occurred (incorrect power system).

Corrective action:

1) Use the voltmeter to measure the input voltage from the main circuit, and ensure it is within the rated range.
2) Use the voltmeter to check if the power system complies with the specifications.

Encoder error warning:

When an encoder error occurs the screen displays AL011:



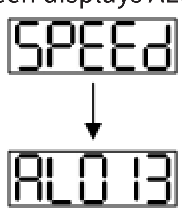
Check that the motor encoder is securely connected, and the wiring is correct.

Corrective action:

1) Make sure the wiring is following the instructions in the user manual.
2) Check the encoder connector.
3) Check for loose wiring.
4) Check for damage to the encoder.

Motor Override warning:

In the case of an motor override the screen displays AL013:



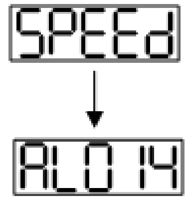
Please check if any of the digital inputs DI1 – DI10 are set to motor override (OVRD).

Corrective action:

1) If you do not want to set the motor override (OVRD) as one of the digital inputs, make sure no other digital input is set to motor override (OVRD) for DI1 – DI19 (make sure that none of the parameters, P2.010 – P2.017 and P2.036, are set to x21).
2) If the motor override (OVRD) function is needed and DI is set as normally closed (function code: 0x0021), please make sure that DI is always normally closed. If not, please set DI as normally open (function code: 0x0121).

Negative limit error warning:

When when a negative limit error occurs the screen displays AL014:



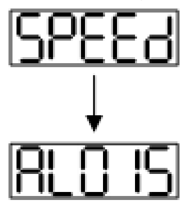
Please check if any of the digital inputs are set to negative limit (NL) and that DI is on.

Corrective action:

1) If you do not want to set the negative limit (NL) as one of the digital inputs, make sure no other digital input is set to negative limit (NL) for DI1 – DI9 (make sure that none of the parameters, P2.010 – P2.017 and P2.036 iare set to 22).
2) If the negative limit (NL) function is needed and DI is set as normally closed (function code: 0x0022), please make sure that DI is always normally closed. If not, please set DI as normally open (function code: 0x0122).

Positive limit error warning:

When a positive limit error occurs the screen displays AL015:



Please check if any of the digital inputs DI1–DI19 are set to positive limit (PL) and that DI is on.

Corrective action:

1) If you do not want to set the positive limit (PL) as one of the digital inputs, make sure no other digital input is set to positive limit (PL) for DI1 – DI9 (make sure that none of the parameters, P2.010 – P2.017 and P2.036 are set to 23).
2) If the positive limit (PL) function is needed and DI is set as normally closed (function code: 0x0023), please make sure DI is always normally closed. If not, please set DI as normally open (function code: 0x0123).

Overcurrent warning.

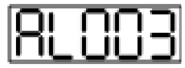
When an overcurrent event occurs the screen displays AL001:

Corrective action:

1) Check the connection between the motor and servo drive.
2) Check if the conducting wire is short circuited. Fix the short circuit and avoid any metal conductors being exposed.

Undervoltage warning.

When voltage is low but still sufficient to power the display, the screen displays AL003:



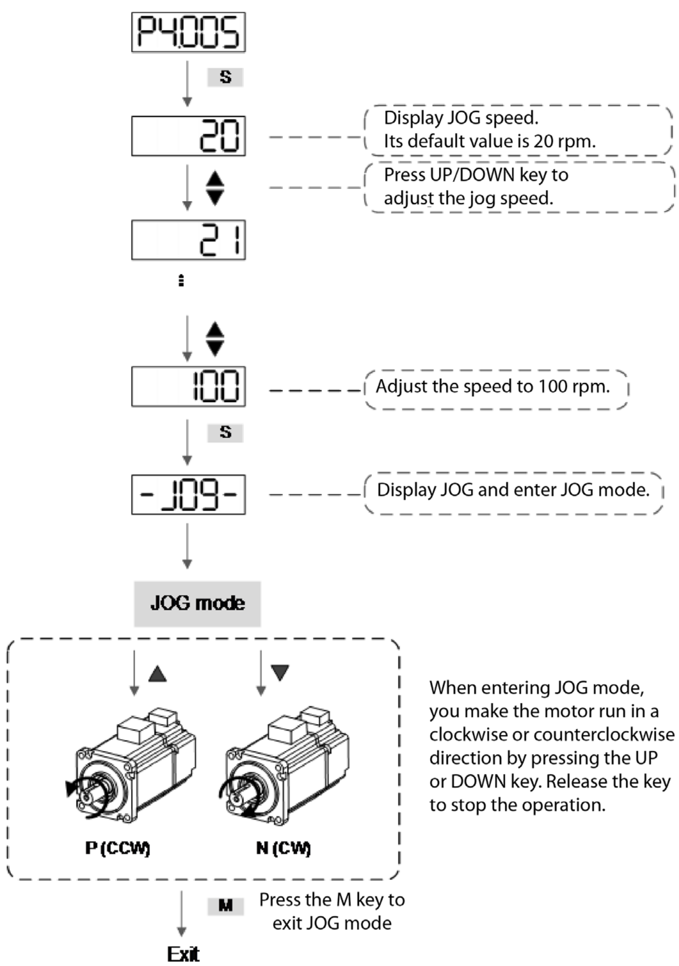
Corrective action:

1) Check if the main circuit wiring is correct.
2) Use a voltmeter to make sure that the main circuit voltage is normal.
3) Use a voltmeter to make sure that the power system complies with the specification.

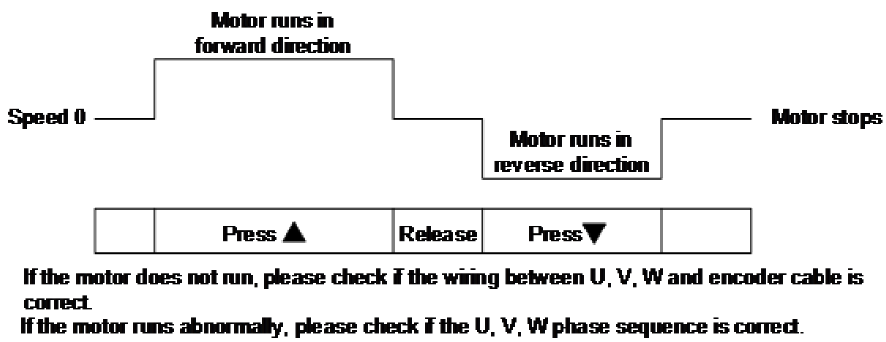
4.5.3 - JOG trial run without load

It is easy to test the motor and servo drive using a JOG trial run without load since no extra wiring is needed. For safety reasons, it is recommended to set JOG at a low speed. Follow the steps below:

1) JOG is available only when the servo drive is in the Servo On state. The drive can be forced into the Servo On state by setting P2.030 to 1 or with the host controller.
2) Set P4.005 to JOG speed (unit: rpm). Press the S key to display the JOG speed. The default is 20 rpm. Press the ▲ or ▼ key to adjust the JOG speed.
3) Press the ▲ or ▼ key to JOG. In the following example, the speed is set to 100 rpm.
4) To exit JOG mode press the M key. Be sure to set P2.030 back to 0 to exit the forced Servo On state.



The following shows the JOG timing diagram:



4.5.4 - Trial run without load (Speed mode)

Before starting the trial run without load, firmly secure the motor base to avoid any danger caused by force generated by the motor during speed changes.

Step 1:

Set the control mode of the servo drive to Speed mode. Set P1.001 to 2 for Speed mode. Then cycle the power to the servo drive.

Step 2:

In Speed mode, the following table lists the recommended digital input settings for the trial run:

Digital Input	Parameter value	Symbol	Function Description	CN1 Pin No.
DI1	P2.010 = 101	SON	Servo is activated	DI1- = 9
DI2	P2.011 = 109	TRQLM	Torque limit	DI2- = 10
DI3	P2.012 = 114	SPD0	Speed selection	DI3- = 34
DI4	P2.013 = 115	SPD1	Speed selection	DI4- = 8
DI5	P2.014 = 102	ARST	Alarm reset	DI5- = 33
DI6	P2.015 = 0	-	DI disabled	-
DI7	P2.016 = 0	-	DI disabled	-
DI8	P2.017 = 0	-	DI disabled	-
DI9	P2.036 = 0	-	DI disabled	-
DI10	P2.037 = 0	-	DI disabled	-
VDI11	P2.038 = 0	-	DI disabled	-
VDI12	P2.039 = 0	-	DI disabled	-
VDI13	P2.040 = 0	-	DI disabled	-

This table shows the settings that disable the negative limit (DI6), positive limit (DI7), and motor override (DI8) functions. Thus, parameter P2.015 – P2.017 and P2.036 – P2.040 are set to 0 (disabled). When configuring the digital input for the servo drive, please refer to the DI code descriptions.

The default setting includes the negative limit, positive limit, and motor override functions; therefore, if any alarm occurs after you complete the settings, please cycle the power to the servo drive or set DI5 to ON to clear the error. Please refer to Section 4.5.

The speed command selection is determined by SPD0 and SPD1. See the following table:

Speed Command No.	DI Signal for CN1		Command Source	Content	Range
	SPD1	SPD0			
S0	0	0	External analog command	Voltage difference between V-REF and GND	-10V to +10V
S1	0	1	Internal register (parameters)	P1.009	-60000 – 60000
S2	1	0		P1.010	-60000 – 60000
S3	1	1		P1.011	-60000 – 60000

0: means the switch is open (off).

1: means the switch is closed (on).

The parameter setting range is from -60000 to 60000. Setting speed = Setting range x unit (0.1 rpm). For example: P1.009 = +10000; Setting speed = +10000 x 0.1 rpm = +1000 rpm.

Test Values:

Command setting for the speed register:

Parameter	Setting
P1.009	100
P1.010	25
P1.011	100

Motor's running direction:

Input Command	Rotation Direction
+	CCW (forward direction)
-	CW (reverse direction)

Step 3:

1) Switch on DI1 to put the drive in the Servo On state.
2) Both speed commands: DI3 (SPD0) and DI4 (SPD1) are off. This means that it executes the S0 command. The motor rotates according to the analog voltage command.
3) When DI3 (SPD0) is on, that means it executes the S1 command (1000 rpm). The rotation speed is 3000 rpm.
4) When DI4 (SPD1) is on, that means it executes the S2 command (100 rpm). The rotation speed is 100 rpm.
5) When both DI3 (SPD0) and DI4 (SPD1) are on, that means it executes the S3 command (-1000 rpm). The rotation speed is -1000 rpm.
6) You can repeatedly execute steps 3, 4, and 5.
7) If you want to stop the motor, switch off DI1 (Servo Off).

4.5.5 - Trial run without load (Position mode)

Before starting the trial run without load, firmly secure the motor base to avoid any danger caused by the force generated by the motor during speed changes.

Step 1:

Set the control mode of the servo drive to Position mode. Set P1.001 to 1 for Position mode. Then cycle the power to the servo drive.

Step 2:

In Position mode, the following table lists the digital input settings for the trial run:

Digital Input	Parameter value	Symbol	Function Description	CN1 Pin No.
DI1	P2.010 = 101	SON	Servo is activated	DI1- = 9
DI2	P2.011 = 108	CTRG	Command triggered	DI2- = 10
DI3	P2.012 = 111	POS0	Position selection	DI3- = 34
DI4	P2.013 = 112	POS1	Position selection	DI4- = 8
DI5	P2.014 = 102	ARST	Alarm reset	DI5- = 33
DI6	P2.015 = 0	-	DI disabled	-
DI7	P2.016 = 0	-	DI disabled	-
DI8	P2.017 = 0	-	DI disabled	-
DI9	P2.036 = 0	-	DI disabled	-
DI10	P2.037 = 0	-	DI disabled	-
VDI11	P2.038 = 0	-	DI disabled	-
VDI12	P2.039 = 0	-	DI disabled	-
VDI13	P2.040 = 0	-	DI disabled	-

The above table shows the settings that disable the negative limit (DI6), positive limit (DI7), and motor override (DI8) functions. Thus, parameter P2.015 – P2.017 and P2.036 – P2.041 are set to 0 (disabled); you can program the digital input of the servo drive. When programming the digital input, please refer to the DI code descriptions.

The default setting includes the negative limit, positive limit, and motor override functions; therefore, if any alarm occurs after you complete the settings, please cycle the power to the servo drive or set DI5 to ON to clear the alarm. Please refer to Section 4.5.

Refer to Section 3.10.2 for the wiring for Position (PR) control mode. Please see the table below for the 99 sets for PR and the position command (POS0 – POS6):

Position Command	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0	CTRG	Corresponding Parameters
Homing	0	0	0	0	0	0	0	↑	P6.000 P6.001
PR1	0	0	0	0	0	0	1	↑	P6.002 P6.003
~									~
PR50	0	1	1	0	0	1	0	↑	P6.098 P6.099
PR51	0	1	1	0	0	1	1	↑	P7.000 P7.001
~									~
PR99	1	1	0	0	0	1	0	↑	P7.098 P7.099

0: means the switch is open (off).

1: means the switch is closed (on).

You can set the 99 sets of PR (P6.000 – P7.099), which you can also set for absolute position commands. Refer to chapter 7 for more detail on using PR mode.

Wiring Parameters DI/DO Codes Monitoring Alarms

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Chapter 5: Tuning

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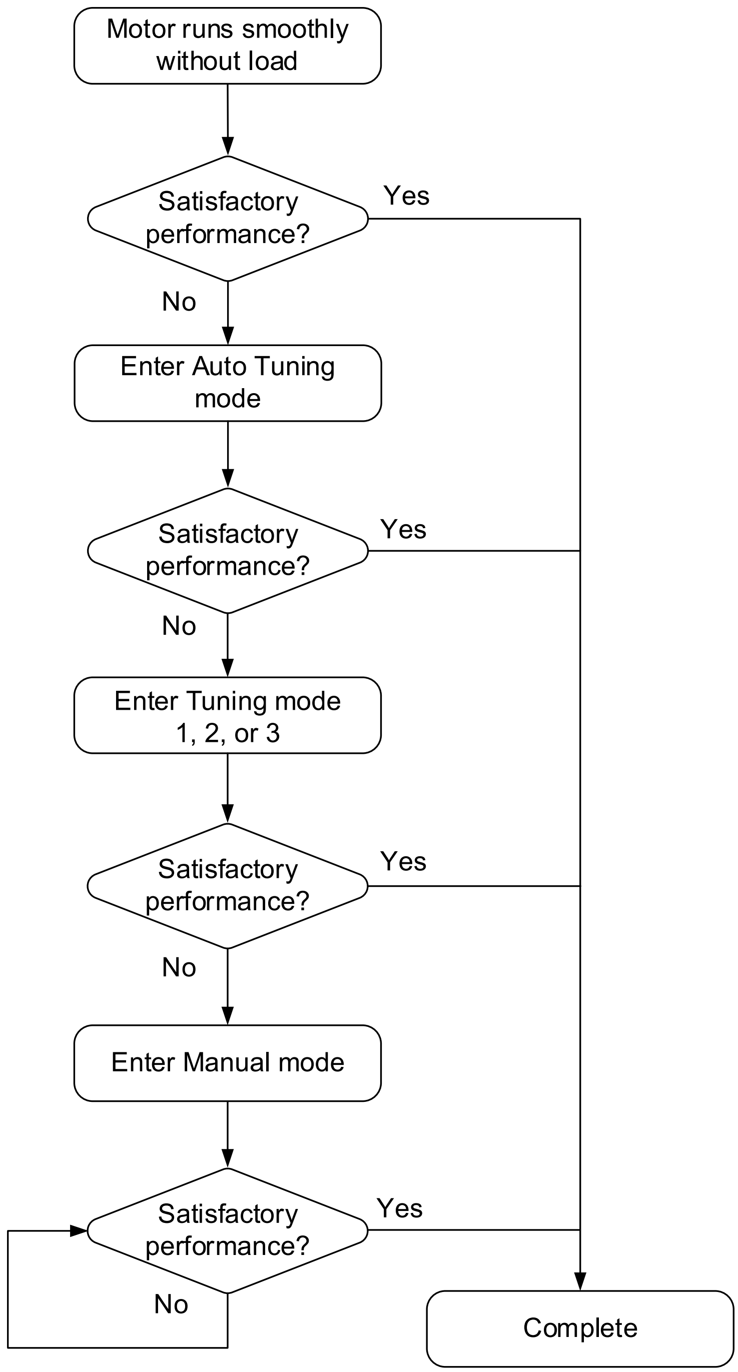
Introduction

This chapter contains information about the auto tuning procedure and the three tuning modes. Advanced users can also tune the servo system using the manual mode.

5.1 - Tuning procedure and the applied mode

5.1.1 - Flow chart for the tuning procedure

You can tune the servo drive by following the flow chart below. First, start from the Auto Tuning mode. If you are not satisfied with the system's performance, you can use Tuning modes 1, 2, 3 or Manual mode for tuning the servo system.



5.1.2 - Tuning Modes

P2.032 Setting Value	Adjustment Mode	Inertia Estimation	Parameter	
			Manually Set	Auto Tuning
0	Manual mode	Value of P1.037	P1.037, P2.000, P2.004, P2.006, P2.023, P2.024, P2.025, P2.043, P2.044, P2.045, P2.046, P2.049, P2.089, P2.098, P2.099, P2.101, P2.102	N/A
1	Gain adjustment mode 1	Real-time estimation	P2.031	P1.037, P2.000, P2.004, P2.006, P2.023, P2.024, P2.025, P2.043, P2.044, P2.045, P2.046, P2.049, P2.089, P2.098, P2.099, P2.101, P2.102
2	Gain adjustment mode 2	Value of P1.037	P1.037 P2.031	P2.000, P2.004, P2.006, P2.023, P2.024, P2.025, P2.043, P2.044, P2.045, P2.046, P2.049, P2.089, P2.098, P2.099, P2.101, P2.102
3	Gain adjustment mode 3	Value of P1.037	P1.037 P2.031 P2.089	P2.000, P2.004, P2.006, P2.023, P2.024, P2.025, P2.043, P2.044, P2.045, P2.046, P2.049, P2.098, P2.099, P2.101, P2.102
4	Gain adjustment mode 4	Restore default gain settings	-	-

Note: *Please refer to the parameters list in Section 5.3 Auto tuning.*

5.2 - Auto tuning

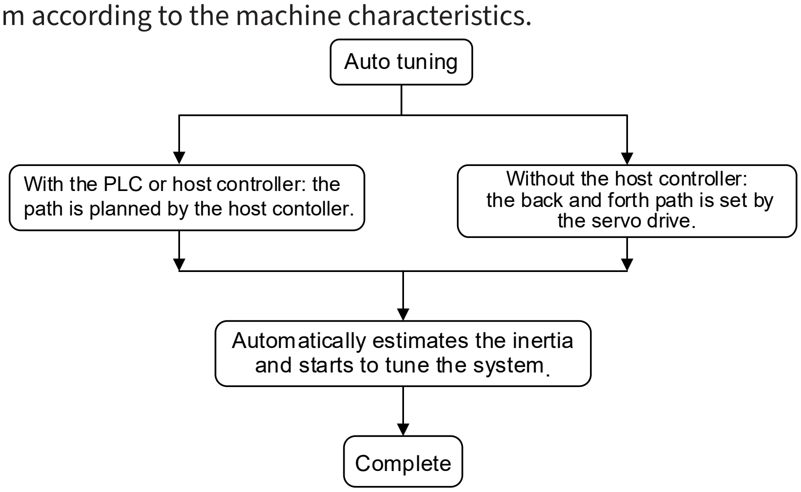
The Auto Tuning function provided by the servo drive enables the system to perform real-time machine inertia estimation and upload the corresponding tuning parameters to the servo drive. You can start auto tuning with SureServo2 Pro (software) or at the drive panel. In general, Auto Tuning works best when the speed is set to at least 200 RPMs (500 preferred) during the tuning process. An inertia ratio of more than 50:1 can very easily cause the auto tuning algorithms to not succeed. It is highly recommended to add some sort of gear reduction between the motor and the load in order to reduce high inertia mismatches. The following table lists the parameters that change according to the results of auto tuning.

Gain Related Parameters	
Parameter #	**Function**
P1.037	Inertia ratio and load weight ratio of servo motor
P2.000	Position control gain
P2.004	Speed control gain
P2.006	Speed integral compensation
P2.031	Level of frequency response
P2.032	Gain adjustment mode
P2.089	Command response gain
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-
-	-

Filter and Resonance Suppression Parameters	
Parameter #	**Function**
P1.025	Low-frequency vibration suppression (1)
P1.026	Low-frequency vibration suppression gain (1)
P1.027	Low-frequency vibration suppression (2)
P1.028	Low-frequency vibration suppression gain (2)
P2.023	Notch filter frequency (1)
P2.024	Notch filter attenuation level (1)
P2.025	Low-pass filter of resonance suppression
P2.043	Notch filter frequency (2)
P2.044	Notch filter attenuation level (2)
P2.045	Notch filter frequency (3)
P2.046	Notch filter attenuation level (3)
P2.049	Speed detection and jitter suppression
P2.098	Notch filter frequency (4)
P2.099	Notch filter attenuation level (4)
P2.101	Notch filter frequency (5)
P2.102	Notch filter attenuation level (5)

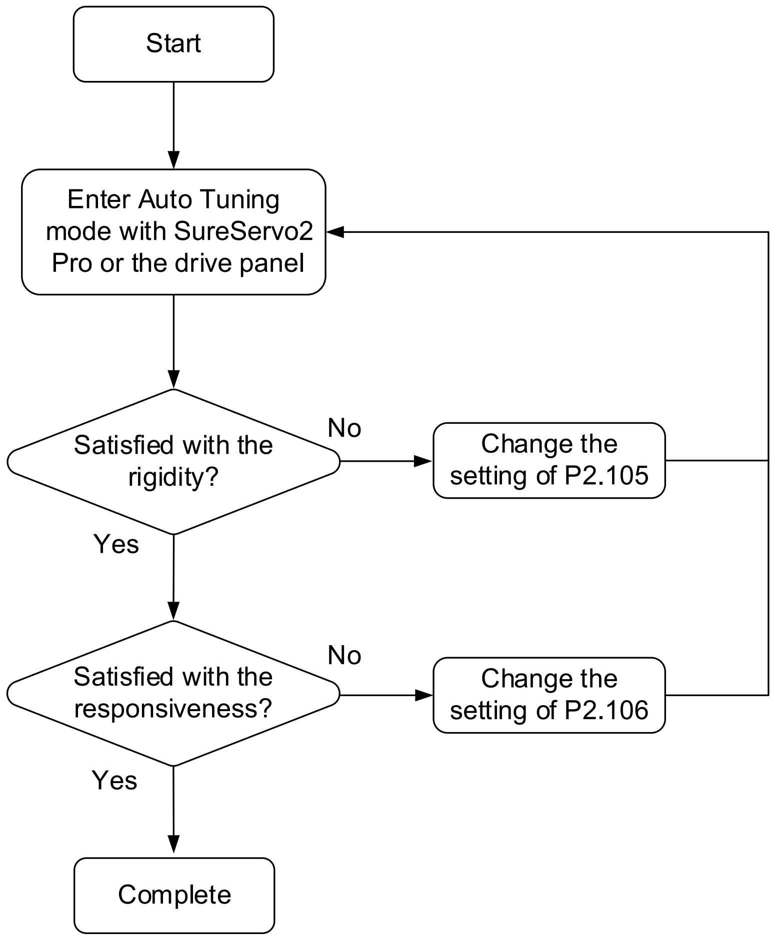
5.2.1 - Flow chart for auto tuning

You can perform the auto tuning using the drive keypad or SureServo2 Pro software. The Auto Tuning function in the SureServo2 servo drive helps you to find the most suitable parameters for your system according to the machine characteristics.



Note: *when the running distance is configured by the host controller, make sure the delay time is added to the operation time. Otherwise, AL08C (Auto-tuning function - Pause time is too short) occurs and the servo drive cannot complete auto tuning.*

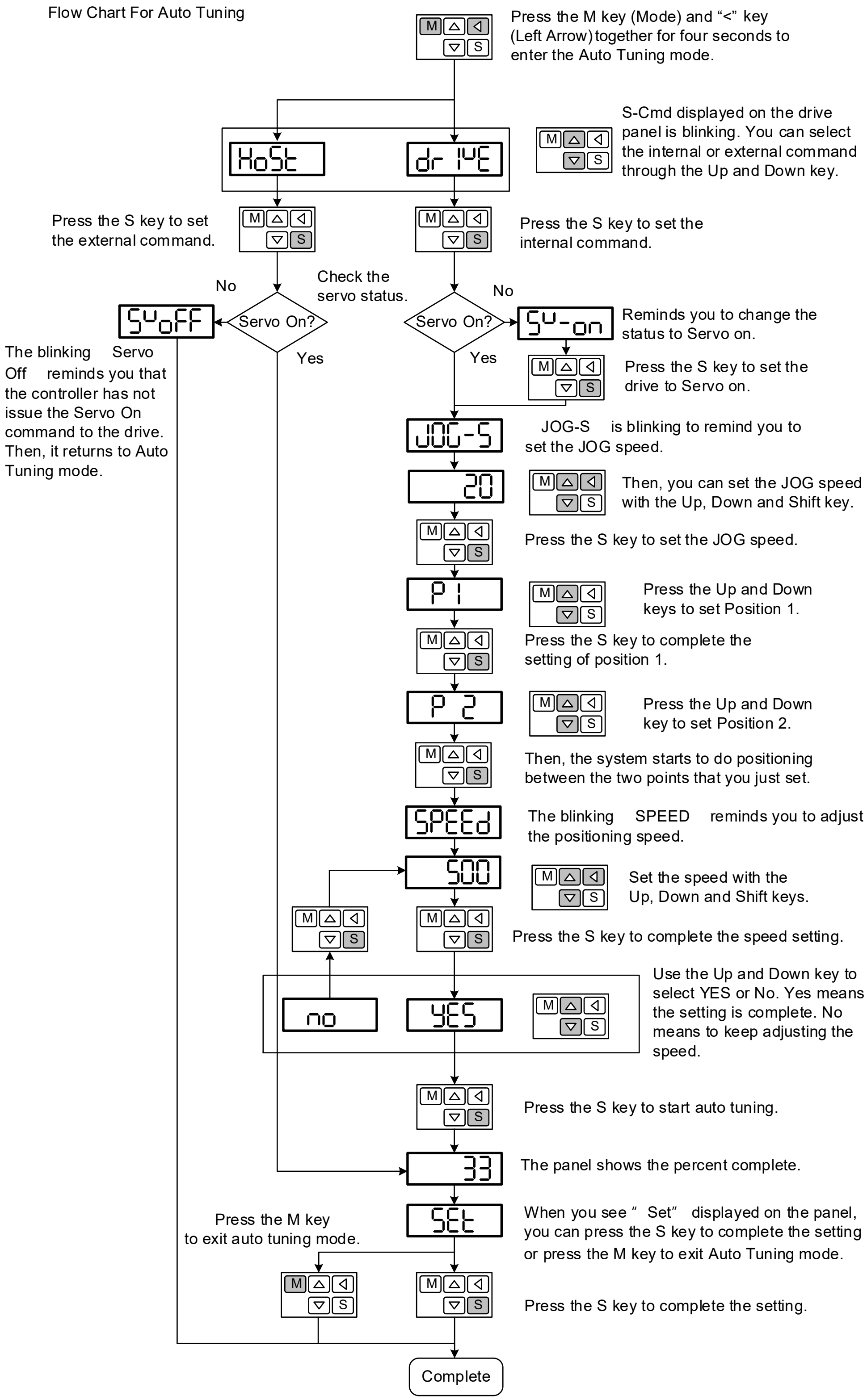
You can use P2.105 (Auto-tuning Adjustment Bandwidth Level) and P2.106 (Auto-tuning Adjustment Overshoot Level) to adjust the responsiveness and rigidity in Auto Tuning mode. See the flow chart below.



5.2.2 - Auto tuning through the drive keypad

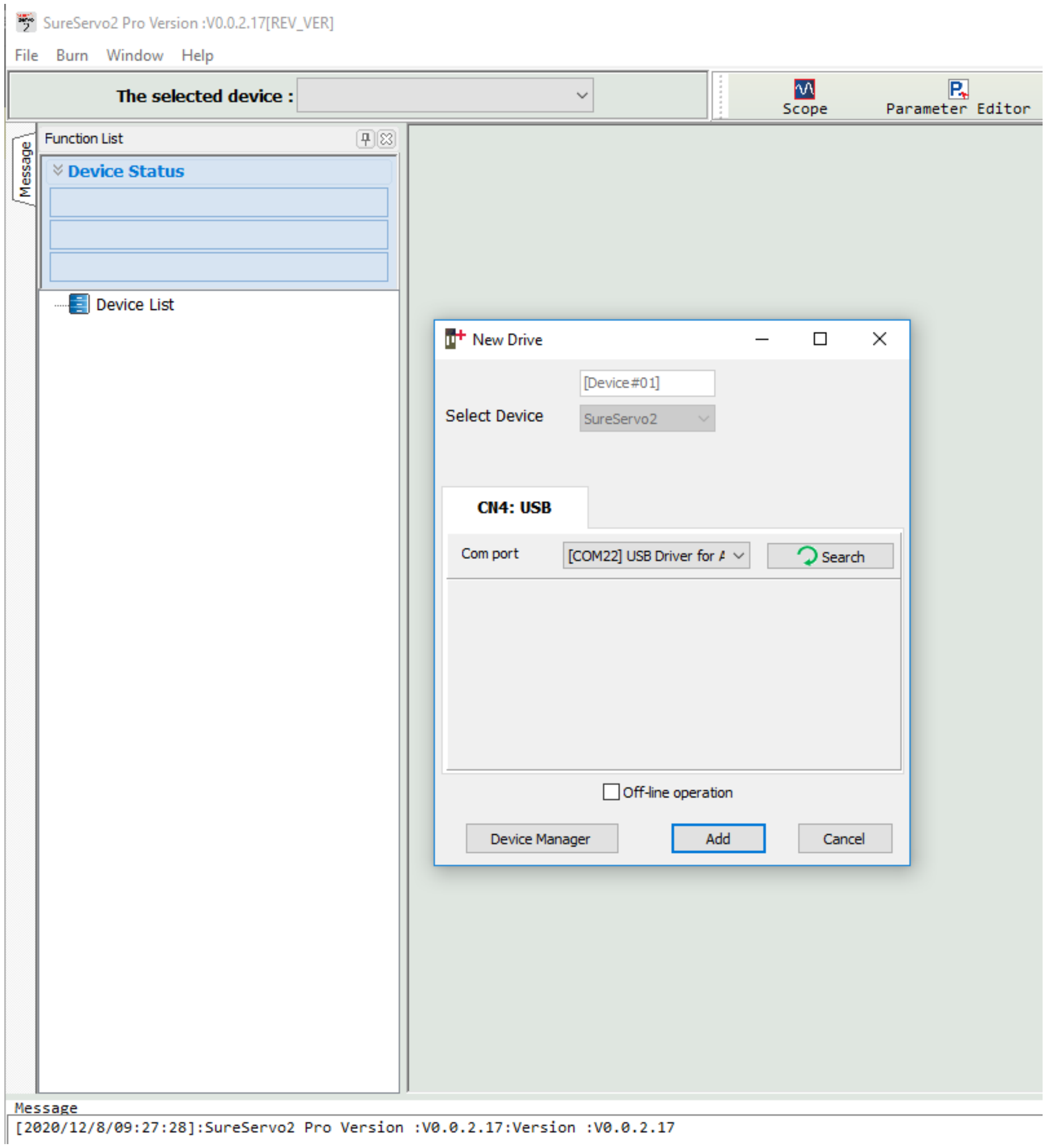
With the tuning procedure below, you can complete auto tuning with the drive keypad (Drive method). Make sure the motor override, positive and negative limit switches work properly before you start to tune the system. Drive must be clear of any faults or warnings.

Flow Chart For Auto Tuning



5.2.3 - Auto tuning with SureServo2 (software)

Instead of using the drive keypad, you can use SureServo2 Pro to complete auto tuning. Please go to go2adc.com/sureservo2 to download SureServo2 Pro for free. Install the software and open the executable file (.exe). You will see the screen shown below.



Make sure the servo drive, servo motor and power are all properly connected. Then click Add to connect to the servo drive with SureServo2.

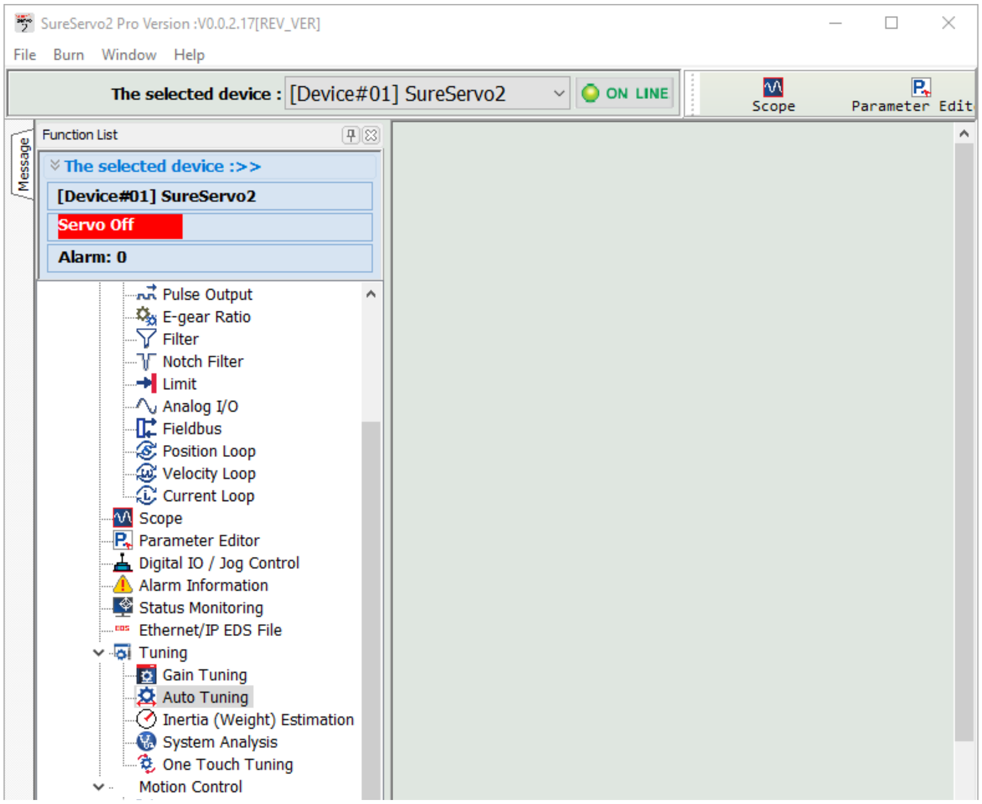
There are two types of auto-tuning procedure, one uses a host controller such as a PLC and one using the servo drive keypad. Both procedures are described below.

Auto-tuning with host controller

The host controller sends the commands to drive the motor.

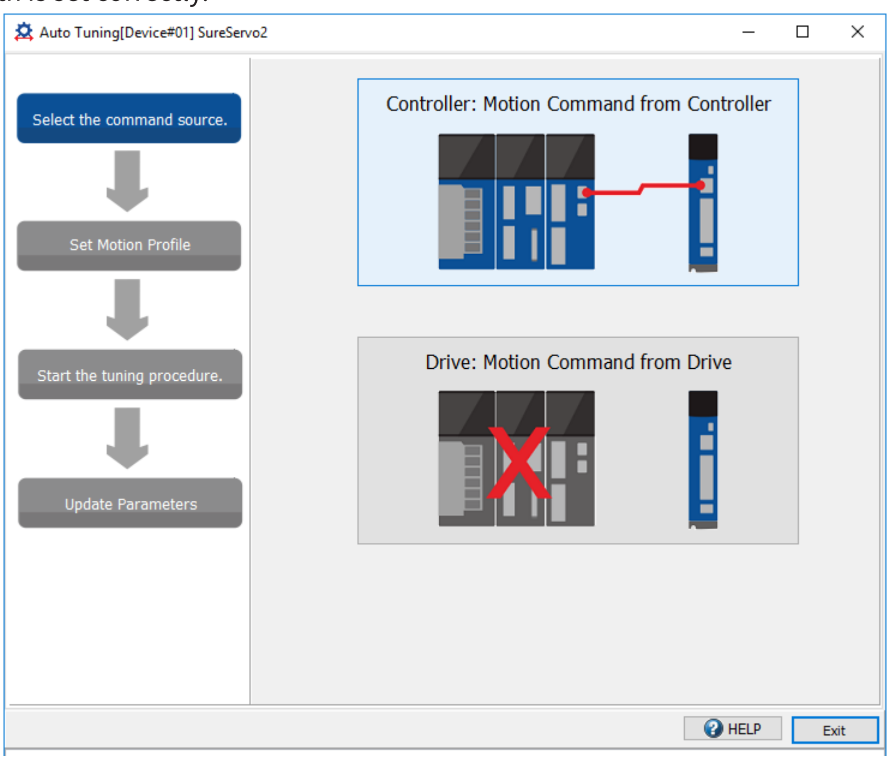
Step 1:

When the computer is connected to the controller, the program window appears as below. Click **Auto Tuning** in the Function List tree view.



Step 2:

Click **Controller: Motion Command From Controller** and make sure the motion/machining path is set correctly.

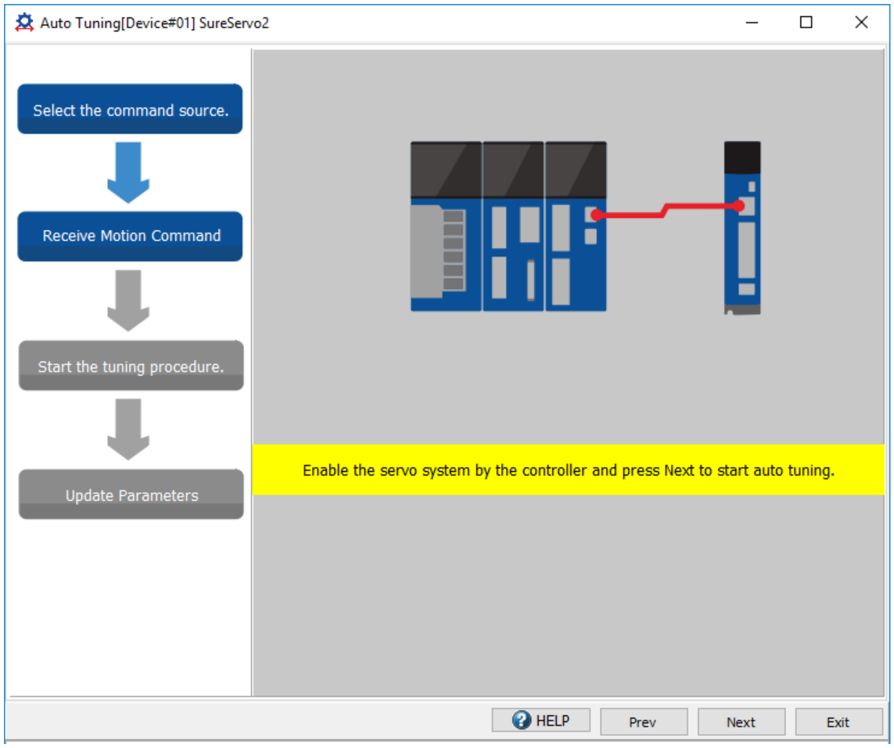


Suggestions: you should set the motor to operate at least one cycle in both forward and backward directions. It should reach the positions (in both forward and backward directions) in 1000 ms or less with the running speed not less than 500 rpm.

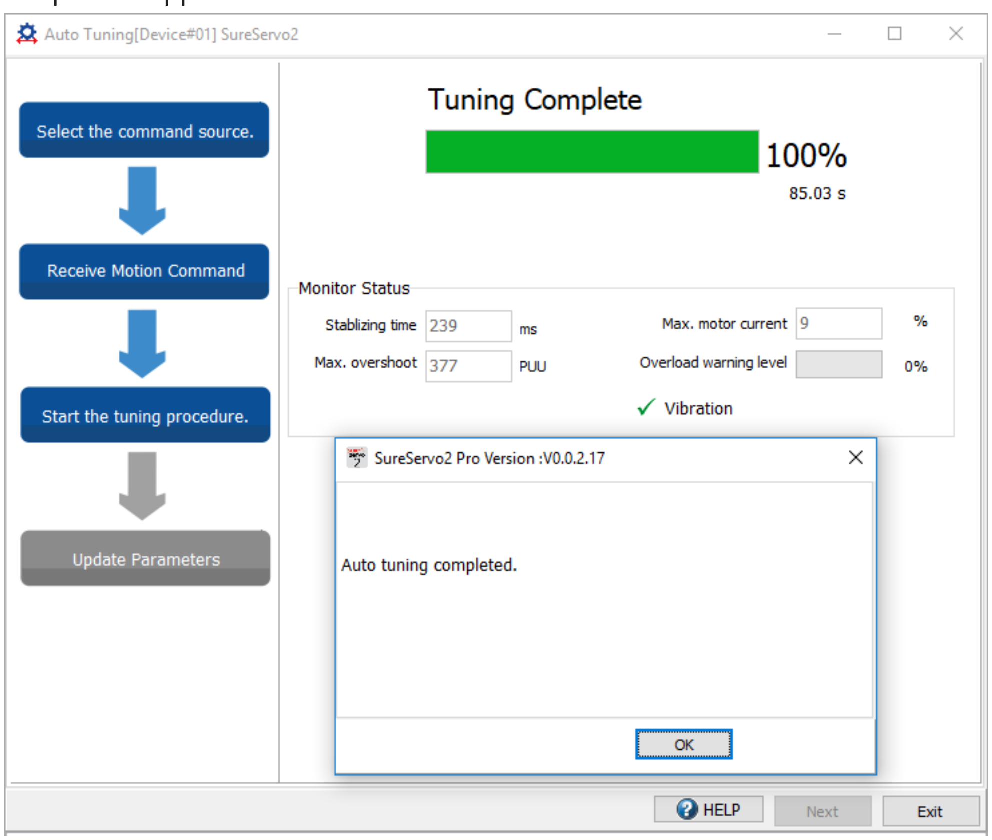
Step 3:

Enable the servo (Servo ON), then repeatedly start and run the motor with the path you just set. Before running the motor, make sure no one is standing close to the machinery.

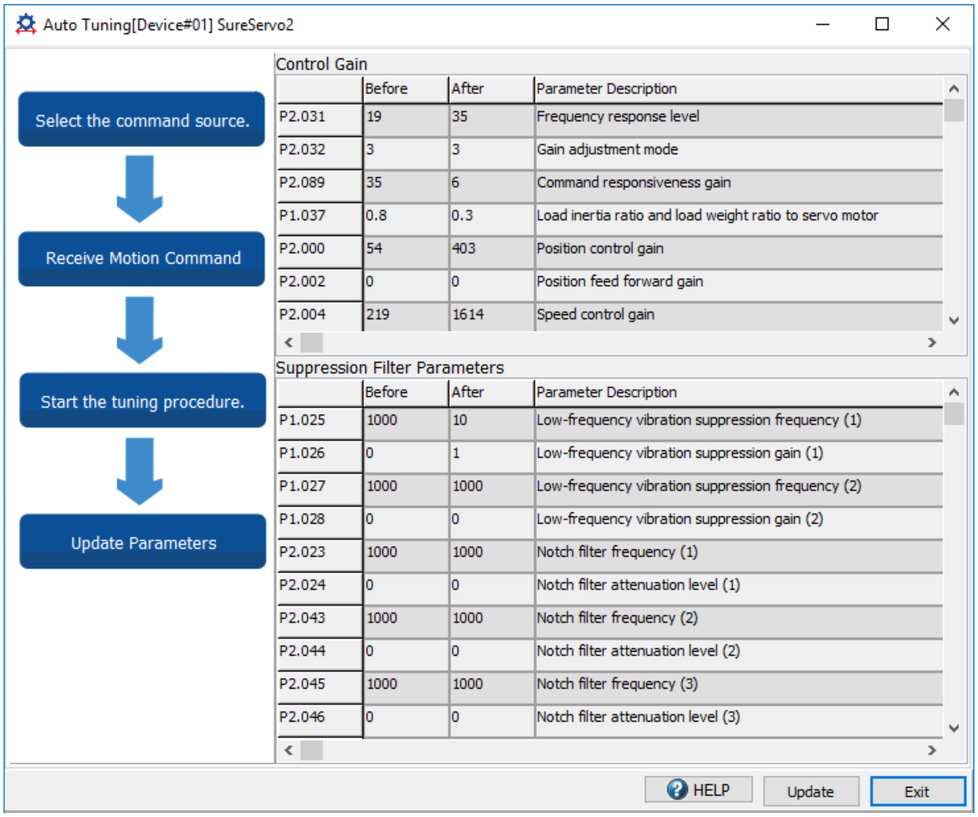
Then, click **Next**.



Wait until the tuning progress bar reaches 100%, after which a window with “Auto tuning completed” appears. Click **OK** to continue.



The screen shows a table comparing the parameters before and after being changed by auto tuning.



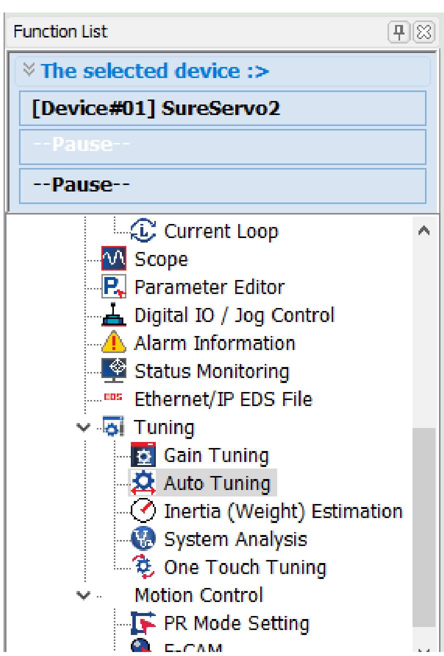
Click **Update** to save the new tuning parameters and complete auto tuning.

Auto-tuning with servo drive

The servo drive sends the commands to drive the motor.

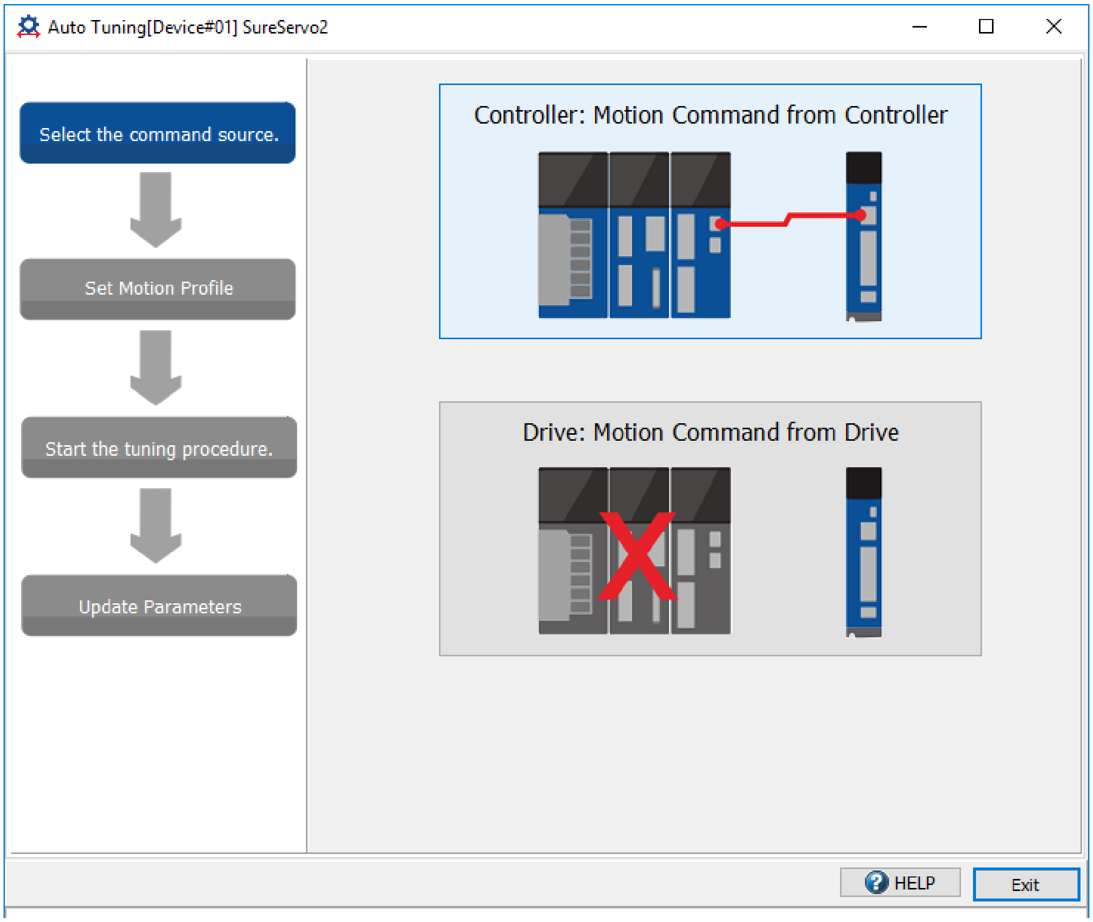
Step 1:

When the computer is connected to the servo drive, the program window appears as below. Click **Auto Tuning** in the Function List tree view.



Step 2:

Click **Drive: Motion Command From Drive** to start the Auto Tuning procedure.



Please follow the steps below to set the motor running path on the screen below:

1) Set the system to Servo On state.
2) Set the acceleration/deceleration time and jog speed. The default setting for acceleration/deceleration time is 200 ms. Set the jog speed to no less than 500 rpm. The Jog speed in this field is also the tuning speed. Then click Download.
3) After you set the motor's jog definition parameters, you can use the Left or Right button to jog the motor to position 1 and 2 (example: jog to the pick point and the place point on a pick and place application). Click on the **Left** or **Right** buttons to jog the motor into the machine's starting position and click the **Position 1** button. If the motor is connected to a belt or there is no "machine starting position", simply click **Position 1**. Next, use the **Left** and **Right** buttons to move to the machine's end-of-move position and press the **Position 2** button. If there is no defined end-of-move position, simply move the motor some distance from position 1 so the Auto Tune feature can properly function. Then, click **Start Moving** to run between two positions. The motor moves to position 1 and 2 in the forward and backward directions.

Before running the motor, make sure no one is standing close to the machinery.

After ensuring the motor is cycling back and forth between position 1 and position 2, press **Next** to start the Auto Tuning process.

Note: *If AL007 (Position Deviation) appears when you attempt to jog the motor, you will need to increase the ACC/DEC time and/or decrease the Jog Speed. Press the Prev button to return to the previous screen and restart the procedure (this will re-Enable the servo).*

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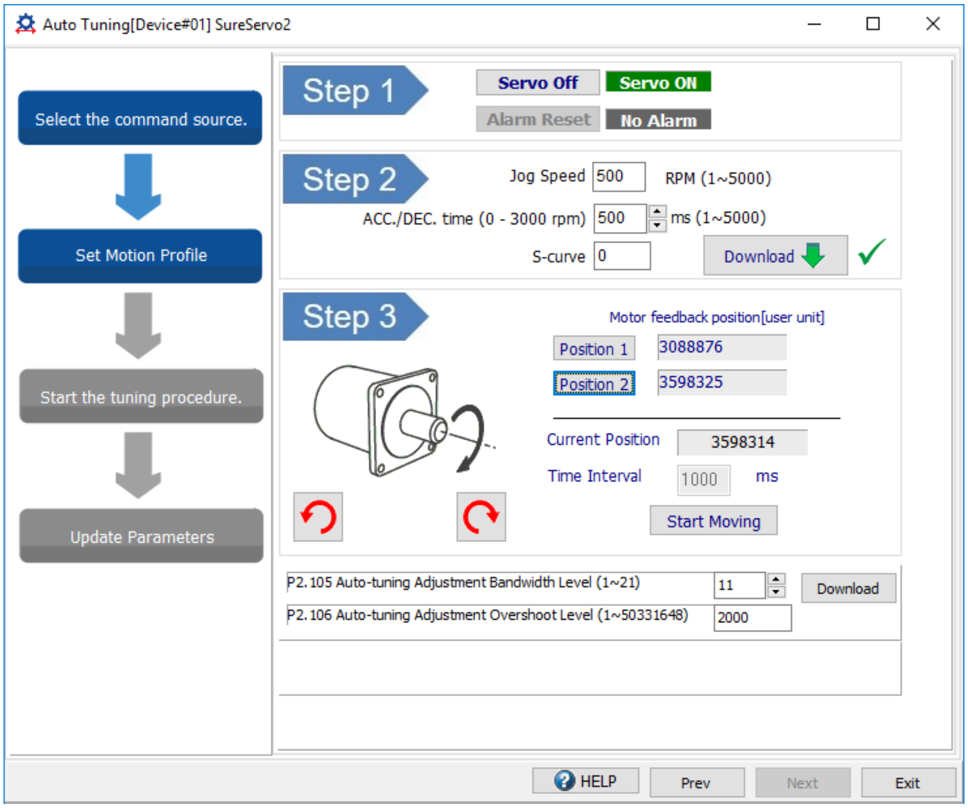
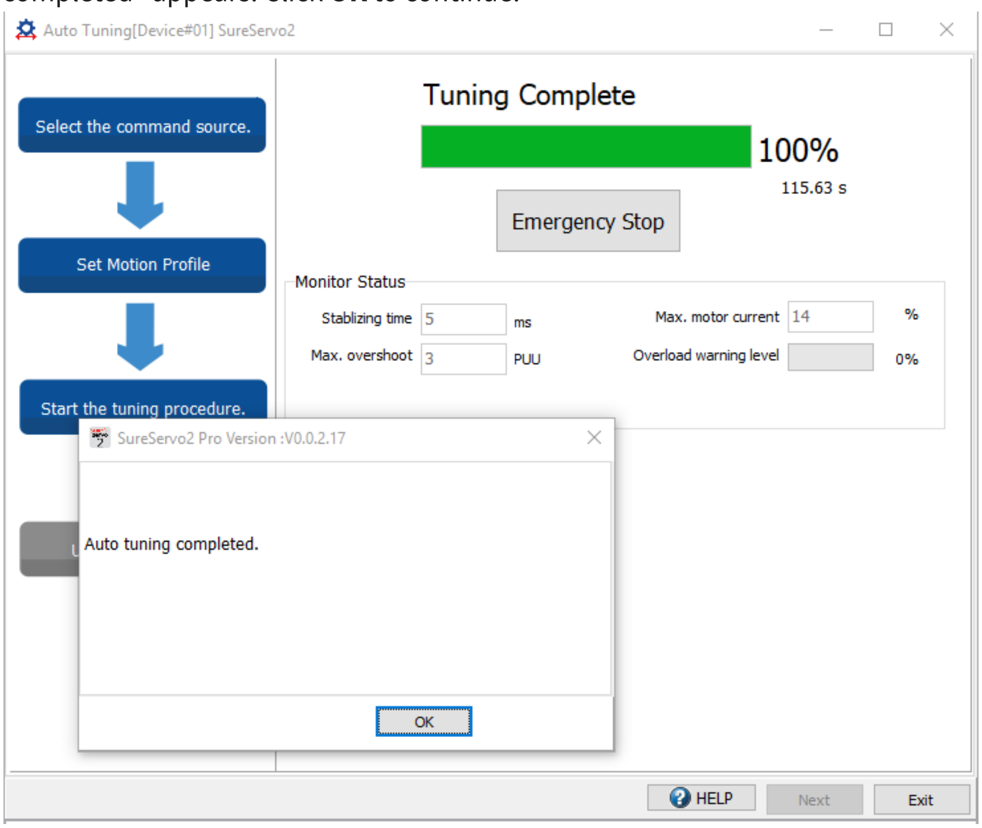
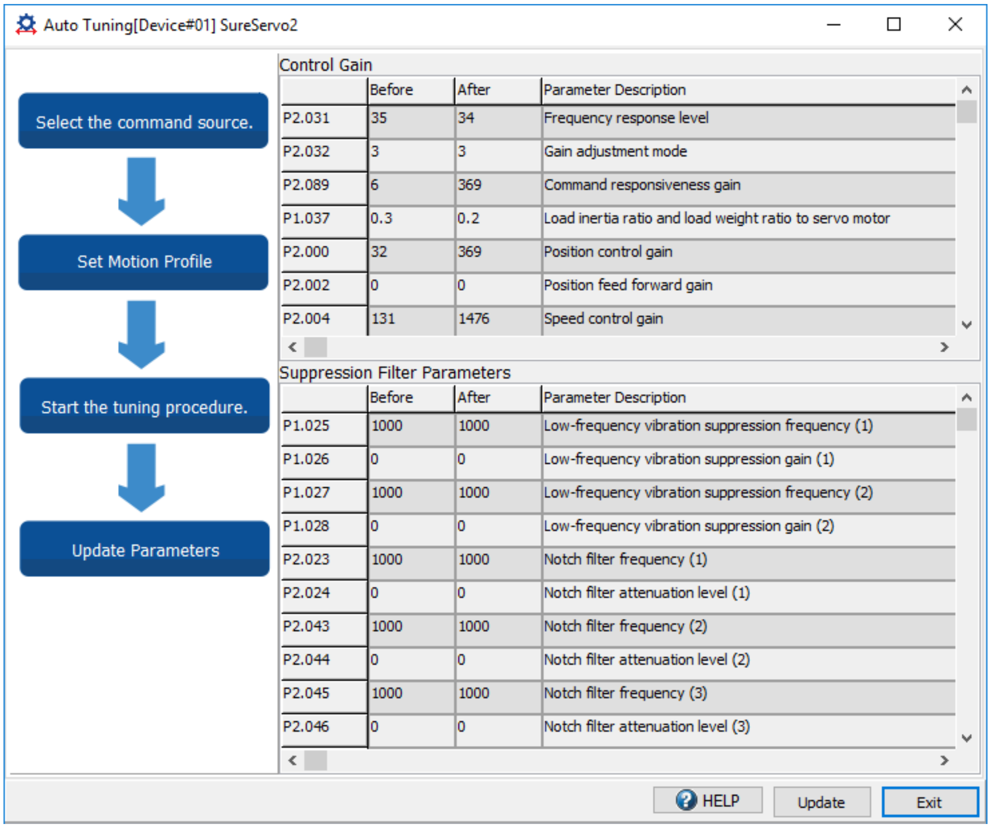


Step 3:

Wait until the tuning progress bar reaches 100%, after which a window with “Auto tuning completed” appears. Click **OK** to continue.



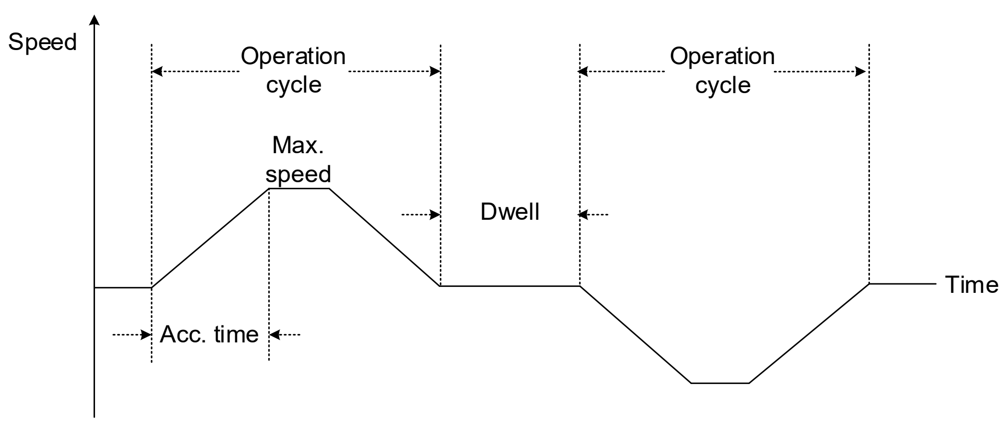
The screen shows a table comparing the parameters before and after being changed by auto tuning.



Please click **Update** to complete auto tuning or **Exit** to discard the new settings.

5.2.4 - *Alarms related to auto tuning*

In Auto Tuning mode, it is vital that you program the command path, including the operation cycle (such as acceleration, constant speed and deceleration) and dwell time. See the figure below. When any of the settings are incorrect, the servo drive stops and displays an alarm. Please check the alarm causes and take corrective action.

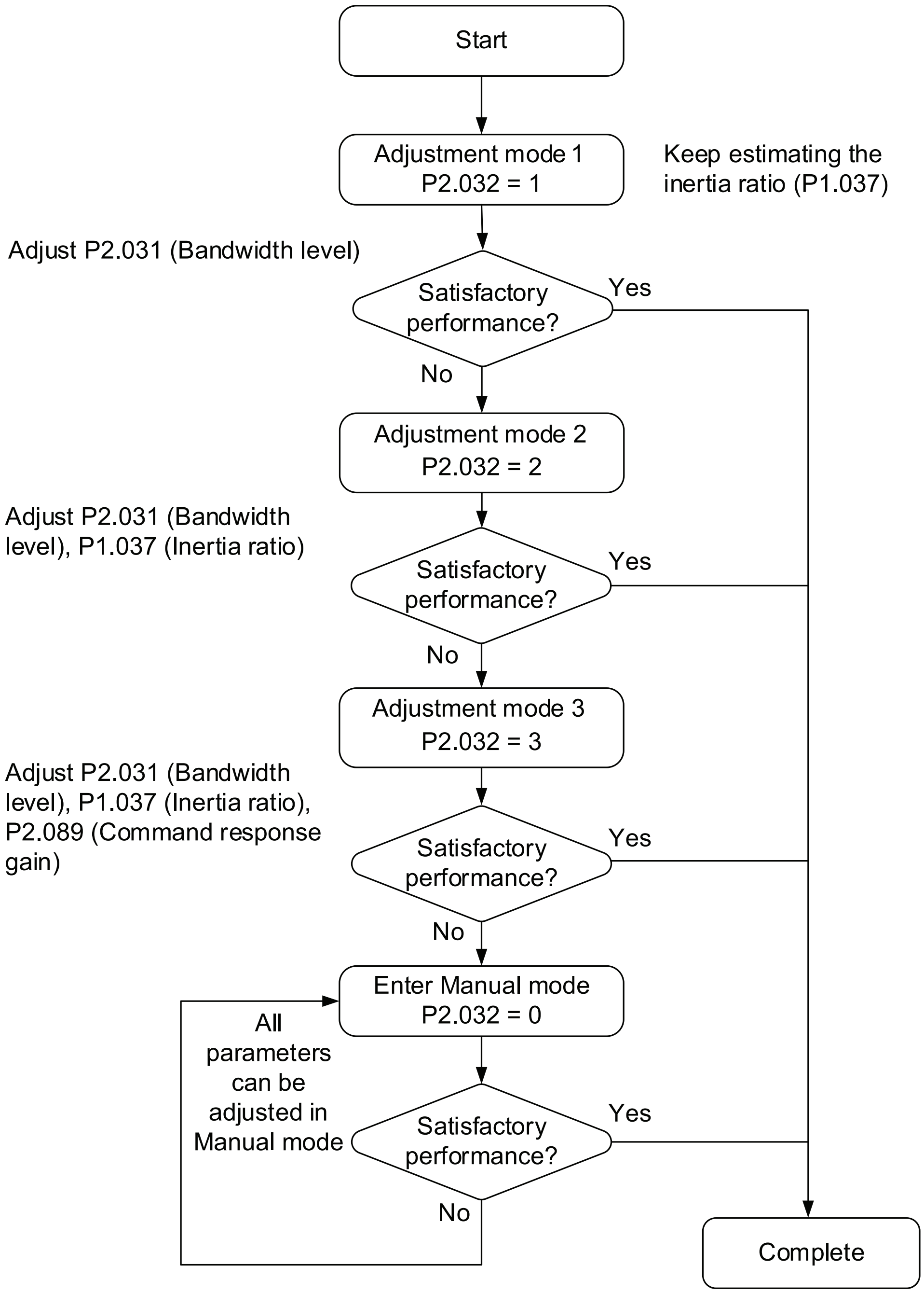


Display	*Alarm name*
AL007	Excessive Position Deviation
AL08A	Auto-tuning function - Command error
AL08B	Auto-tuning function - Inertia estimation error
AL08C	Auto-tuning function - Pause time is too short

5.3 - Tuning mode

Apart from the Auto Tuning function described above, there are three other tuning modes you can use to fine tune the system. You can then easily complete tuning by increasing or decreasing the frequency response bandwidth level (P2.031). Please follow the tuning procedure in Section 5.1.

5.3.1 - Flow chart of Tuning mode



5.3.2 - Gain Adjustment mode 1

In this mode, the servo drive continues to estimate the system's inertia and updates the value of parameter P1.037.

P2.032 Setting Value	Adjustment Mode	Inertia Estimation	Parameter	
			Manual Tuning	Auto Tuning
1	Gain adjustment mode 1	Real-time estimation	P2.031	P1.037, P2.000, P2.004, P2.006, P2.023, P2.024, P2.025, P2.043, P2.044, P2.045, P2.046, P2.049, P2.089, P2.098, P2.099, P2.101, P2.102

Requirements for inertia estimation:

1) Motor speed increases from 0 rpm to 3000 rpm within 1.5 seconds.
2) It is suggested to set the speed to 500 rpm or higher. The lowest speed should be no less than 200 rpm.
3) The load inertia should be less than 50 times the motor inertia.
4) The change in the external force or inertia ratio cannot be too great.

5.3.3 - Gain Adjustment mode 2

When gain adjustment mode 1 cannot meet your need, you can try gain adjustment mode 2 to tune the servo system. In gain adjustment mode 2, the system does not automatically estimate the inertia. You must set the correct mechanical inertia in parameter P1.037.

P2.032 Setting Value	Adjustment Mode	Inertia Estimation	Parameter	
			Manual Tuning	Auto Tuning
2	Gain adjustment mode 2	Value of P1.037	P1.037 P2.031	P2.000, P2.004, P2.006, P2.023, P2.024, P2.025, P2.043, P2.044, P2.045, P2.046, P2.049, P2.089, P2.098, P2.099, P2.101, P2.102

Inertia estimation is applicable to most applications. However, when the machine does not comply with the requirements for inertia estimation, you have to set the correct inertia ratio in parameter P1.037.

5.3.4 - Gain Adjustment mode 3

If your need cannot be met by gain adjustment mode 1 or 2, please select gain adjustment mode 3. Parameter P2.089 (Command Response Gain) is available in this mode. You can increase the gain value to shorten the response and settling time for the position command. However, if you set the parameter value too high, it might cause overshoot and machinery vibration. This function is only available when changing the command, such as the acceleration / deceleration application.

P2.032 Setting Value	Adjustment Mode	Inertia Estimation	Parameter	
			Manual Tuning	Auto Tuning
3	Gain adjustment mode 3	Value of P1.037	P1.037 P2.031 P2.089	P2.000, P2.004, P2.006, P2.023, P2.024, P2.025, P2.043, P2.044, P2.045, P2.046, P2.049, P2.098, P2.099, P2.101, P2.102

5.3.5 - Setting the Frequency Response Bandwidth (Stiffness)

You can use parameter P2.031 (frequency response bandwidth level) to tune the servo system in an easier and user-friendly way. With a fixed inertia ratio, when increasing the bandwidth level (P2.031), the servo's bandwidth increases as well. If resonance occurs, please lower the parameter value by one or two bandwidth levels (you should adjust the bandwidth level according to the actual situation). For instance, if the value of P2.031 is 30, you can reduce the bandwidth level to 28. When adjusting the value of this parameter, the servo system automatically adjusts the corresponding parameters, such as P2.000 and P2.004.

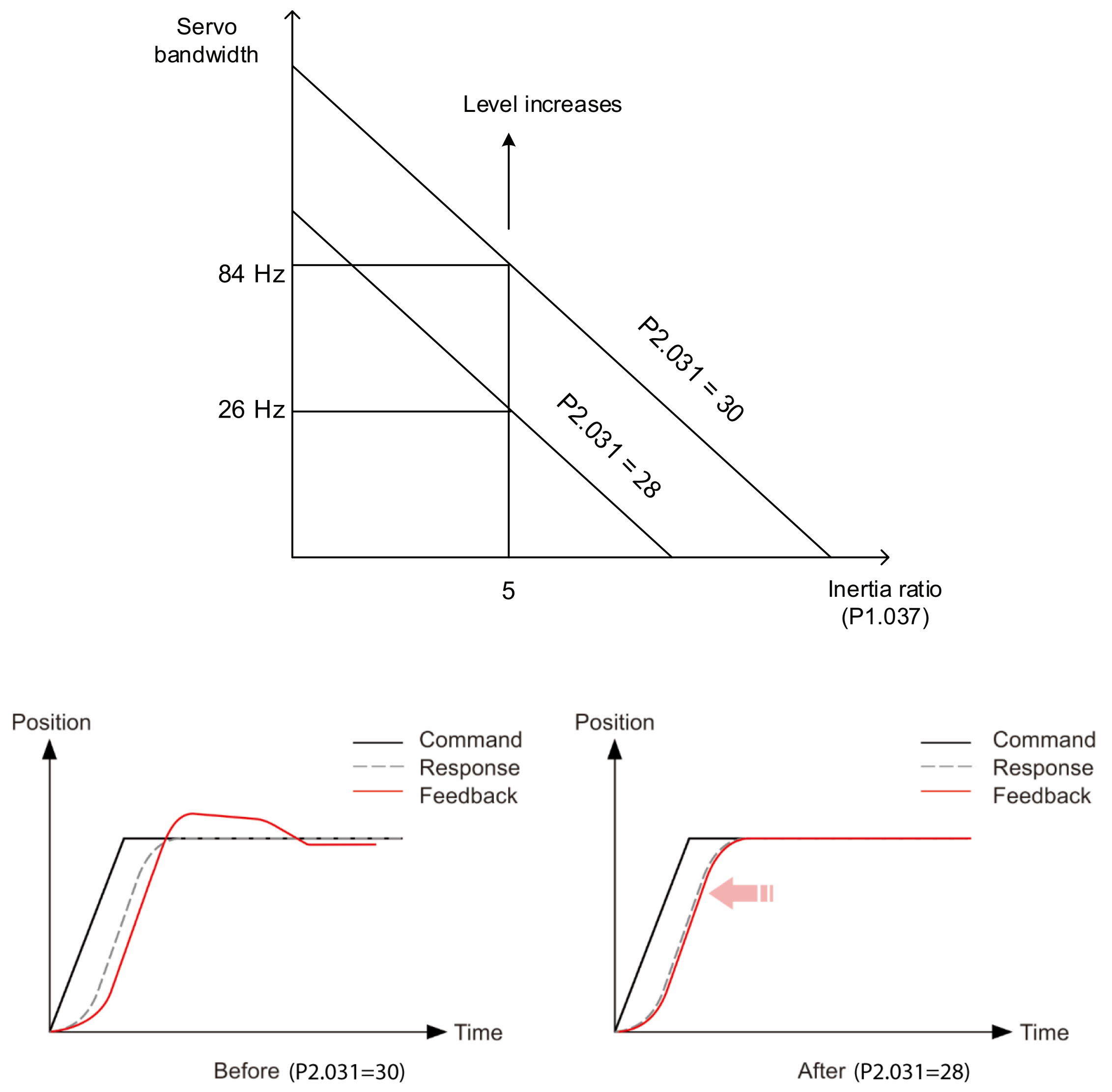


Figure 5-1 Adjust the bandwidth level

5.3.6 - Gain response

You can use parameter P2.089 (Command responsiveness gain) to adjust the response. Increasing the gain can minimize the deviation between the position command and command response in intermittent duty zone. When adjusting the value of P2.089, please enable the function for two degrees of freedom (two dimensional control)(set P2.094 to 0x1000).

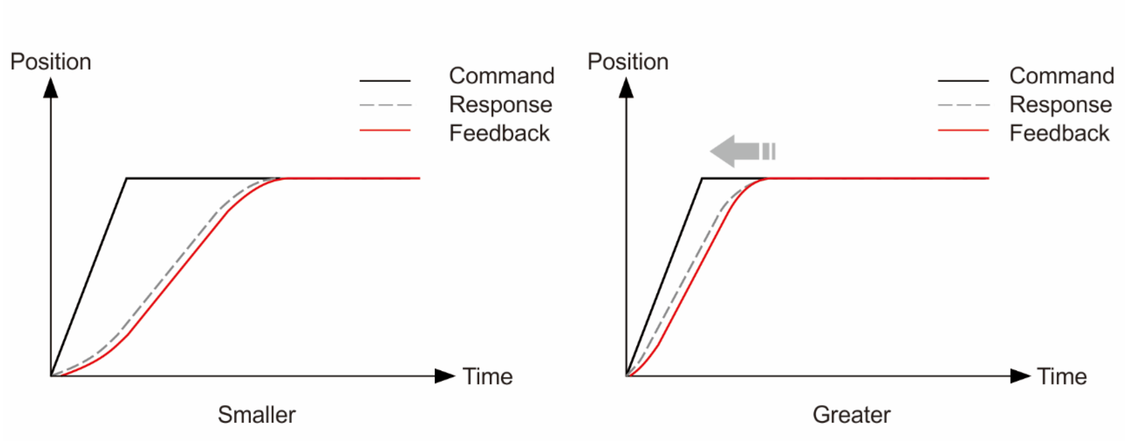


Figure 5-2 Adjust the gain response

5.4 - Tuning in Manual mode

The selection of the position and speed response frequency should be determined by the machinery stiffness and the application. Generally, for applications or machines that require high speed and high precision, higher frequency response bandwidth is required. However, increasing the response bandwidth might cause resonance. Thus, machinery with higher stiffness is used to solve this problem. When the resonance frequency is unknown, you can gradually increase the gain parameter values to increase the frequency resonance bandwidth. Then, decrease the gain parameter values until you hear the sound of the resonance. The following are the descriptions of the gain adjustment parameters.

Position control gain (KPP, parameter P2.000)

This parameter determines the response of the position loop. The bigger the KPP value, the higher the response frequency of the position loop. This lowers following error and position error, and shortens the settling time. However, if you set the value too high, it can cause the machinery to vibrate or cause overshoot when positioning. The calculation of position loop frequency response is as follows:

$$\text{Frequency response bandwidth of position loop (Hz)} = \frac{\text{KPP}}{2\pi}$$

Speed control gain (KVP, parameter P2.004)

This parameter determines the response of speed loop. The bigger the KVP value, the higher the response frequency of the speed loop and the lower the following error. However, if you set the value too high, it could cause machinery resonance. The response frequency of the speed loop must be 4–6 times higher than the response frequency of the position loop; otherwise, the machinery might vibrate or it might cause overshoot when positioning. The calculation of speed loop frequency response is as follows:

$$\text{Frequency response bandwidth of speed loop}$$
$$\text{fv} = \left(\frac{\text{KVP}}{2\pi}\right) \times \left[\frac{(1 + \text{P1} - 37/10)}{(1 + \text{JL/JM})}\right] \text{Hz}$$

JM: Motor Inertia; JL: Load Inertia; P1.037: 0.1 (times)

When P1.037 (auto estimation or manually set value) is equal to the real inertia ratio (JL / JM), the real speed loop frequency response is:

$$\text{fv} = \left(\frac{\text{KVP}}{2\pi}\right) \text{Hz}$$

Speed integral compensation (KVI, parameter P2.006)

The higher the KVI value, the better the elimination of the deviation. However, if you set the value too high, it can cause the machinery to vibrate. It is suggested that you set the value as follows:

$$\text{KVI (P2.006)} \leq 1.5 \times \text{Speed loop frequency response}$$

Low-pass filter for resonance suppression (NLP, parameter P2.025)

A high inertial value ratio reduces the frequency response of the speed loop. Therefore, you must increase the KVP value to maintain the response frequency. Increasing KVP value might cause machinery resonance. Please use this parameter to eliminate the noise from resonance. The higher the value, the better the capability for reducing high-frequency noise. However, if you set the value too high, it can cause instability in the speed loop and overshoot in positioning. It is suggested that you set the value as follows:

$$\text{NLP (P2.025)} \leq \frac{10000}{6 \times \text{Speed loop frequency response (Hz)}}$$

Anti-interference gain (DST, parameter P2.026)

Use this parameter to increase the ability to resist external force and eliminate overshoot during acceleration / deceleration. The default value is 0. Adjusting this value in Manual mode is not suggested unless it is for fine-tuning.

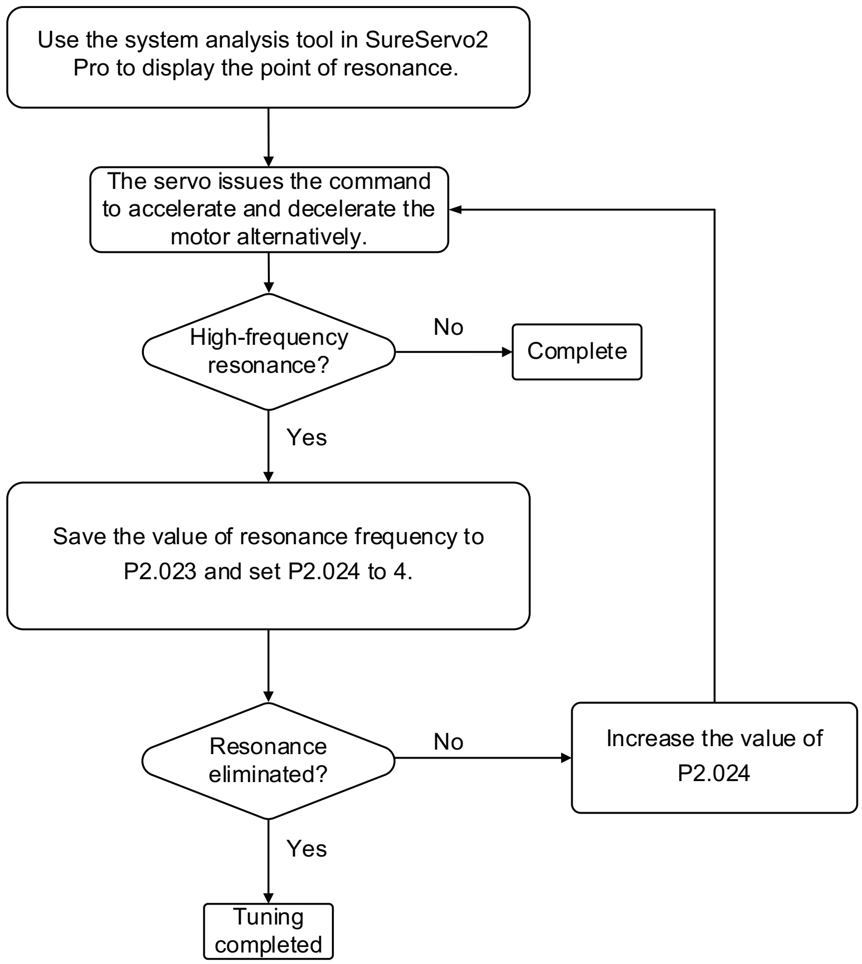
Position feed forward gain (PFG, parameter P2.002)

This parameter can reduce the position error and shorten the settling time. However, if you set the value too high, it might cause overshoot in positioning. If the setting of the e-gear ratio is larger than 10, it might cause noise as well.

5.5 - Mechanical resonance suppression

Five sets of notch filters are provided to suppress mechanical resonance. You can set all five to the auto resonance suppression parameter (P2.047) with manual adjustment.

Please see the following flowchart for manual adjustment.



Chapter 6

Chapter 6: Operation Mode

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Introduction

This chapter describes the operation of each control mode, including gain adjustment and filters. For position control, you can use an external pulse source or commands from the internal registers. For Speed mode and Torque mode, apart from the commands from the internal registers, you can also control the servo drive by the analog voltage input. In addition to Single mode, Dual mode is also available for meeting the application requirements.

6.1 - Selecting the operation mode

This servo drive provides three basic operation modes: Position, Speed, and Torque. The available communication modes are serial Modbus, Modbus TCP (optional card), and Ethernet/IP (optional card). For basic operation mode, you can choose from Single mode, Dual mode, and Multi-mode. The following table lists all the available control modes in P1.001.

Mode		Short Name	Code	Description
Single mode	Position mode (Terminal block input)	PT	00	The servo drive receives the Position command by high speed pulses and commands the motor to run to the target position. The Position command is communicated through the terminal block and the signal type is pulse and direction, CW/CCW pulses, or A/B Quadrature. Analog positioning mode is also available in PT mode. The motor position is commanded by an analog signal (potentiometer or 0-10V input). No pulse train is required. See P1.064 for more details.
	Position mode (Register input)	PR	01	The servo drive receives the Position command and commands the motor to run to the target position. Position commands are issued from the internal registers (99 sets in total). You can select the register number with DI signals or through communication.
	Speed mode	S	02	The servo drive receives the Speed command and commands the motor to run at the target speed. The Speed command is issued from the internal registers (3 sets in total) or by analog voltage (-10V to +10V) which is communicated through the terminal block. You select the command with DI signals.
	Speed mode (No analog input)	Sz	04	The servo drive receives the Speed command from internal registers that can be populated via communications, through SureServo2 Pro, or the keypad. These values command the motor to run at the target speed.The Speed command can only be issued from the internal registers (3 sets in total) instead of through the analog input. You select the command with DI signals.
	Torque mode	T	03	The servo drive receives the Torque command and commands the motor to run with the target torque. The Torque commands can be issued from the internal registers (3 sets in total) as well as by analog voltage (-10V to +10V) which is communicated through the terminal block. You select the command with DI signals.
	Torque mode (No analog input)	Tz	05	The servo drive receives the Torque command from internal registers that can be populated via communications, SureServo2 Pro, or the keypad. These values command the motor to run at the target torque. The Torque command can only be issued from the internal registers (3 sets in total). You select the command with DI signals.

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Mode	Short Name	Code	Description
Dual mode	PT-S	06	You can switch PT and S mode with DI signals.
	PT-T	07	You can switch PT and T mode with DI signals.
	PR-S	08	You can switch PR and S mode with DI signals.
	PR-T	09	You can switch PR and T mode with DI signals.
	S-T	0A	You can switch S and T mode with DI signals.
	-	0B	Reserved
	Communication	0C	Ethernet/IP mode
			PT-PR
	PT-PR	0D	You can switch PT and PR mode with DI signals.
Multi-mode	PT-PR-S	0E	You can switch PT, PR, and S mode with DI signals.
	PT-PR-T	0F	You can switch PT, PR, and T mode with DI signals.

Here are the steps to switch the operation mode:

1) Switch the servo drive to Servo Off status. You can do this by setting DI.SON to OFF.
2) Set P1.001 and refer to the code listed above for the mode selection.
3) After setting the parameter, cycle the power to the servo drive.
4) The following sections describe the operation of each mode, including the mode structure, command source, selection and processing of the command, and gain adjustment.

6.2 - Position mode

Two input modes for position control are available on the SureServo2: external pulses from **T**erminals (P**T** mode = **T**erminals) and internal position **R**egister (P**R** mode = **R**egisters). In PT mode, the SureServo2 can accept pulse input signals: Pulse and Direction, Clockwise/Counterclockwise, and Quadrature (AB phase). See P1.000 for details. The SureServo2 can receive pulse commands of up to 4 Mpps (MHz).

You can also accomplish position control using the internal **R**egister (P**R** mode) without the external high speed pulse command. The SureServo2 provides 99 command registers with two input modes. You can set the 99 registers first before switching the drive to Servo On status and then set DI.POS0 – DI.POS6 of CN1 to call the registers. Or, you can directly set the register values through communication.

6.2.1 - Position command in PT mode

The PT Position command is the pulse input from the **T**erminal block. There are three pulse types - Pulse and Direction, Clockwise/CounterClockwise (CW/CCW), and Quadrature (A/B); and each type has positive and negative logic that you can set in parameter P1.000. Please refer to Chapter 8 for more details.

Parameter	Function
P1.000	External pulse input type

6.2.2 - Position command in PR mode

You select the P**R** command source with (P6.000, P6.001) – (P7.098, P7.099), which are the 99 built-in command **R**egisters. Then, you trigger the Position command with DI.CTRG (0x08). See the following table for more detail.

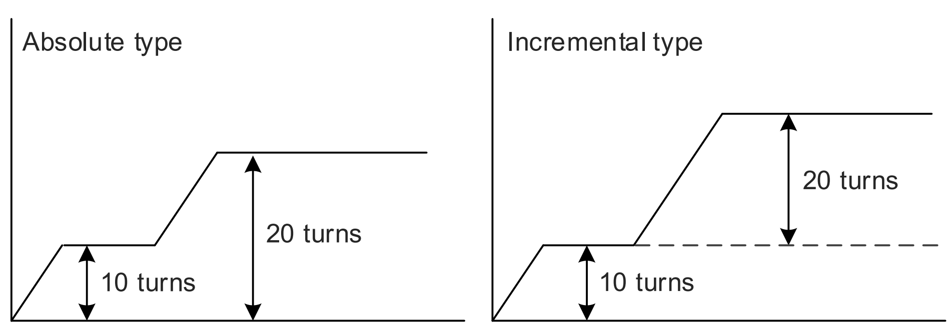
Position Command	*POS6 DI-0x1E*	*POS5 DI-0x1C*	*POS4 DI-0x1B*	*POS3 DI-0x1A*	*POS2 DI-0x13*	*POS1 DI-0x12*	*POS0 DI-0x11*	*CTRG DI-0x08*	*Setting Parameter*
Homing	0	0	0	0	0	0	0	↑	P6.000 P6.001
PR1	0	0	0	0	0	0	1	↑	P6.002 P6.003
~									~
PR49	0	1	1	0	0	1	0	↑	P6.098 P6.099
PR50	0	1	1	0	0	1	1	↑	P7.000 P7.001
~									~
PR99	1	1	0	0	0	1	1	↑	P7.098 P7.099

State of POS0 – POS6: 0 signifies that DI is off; 1 signifies that DI is on. See section 8.4.9 for information on Digital Input functions.

CTRG↑: this signifies the moment that DI is switched from off to on.

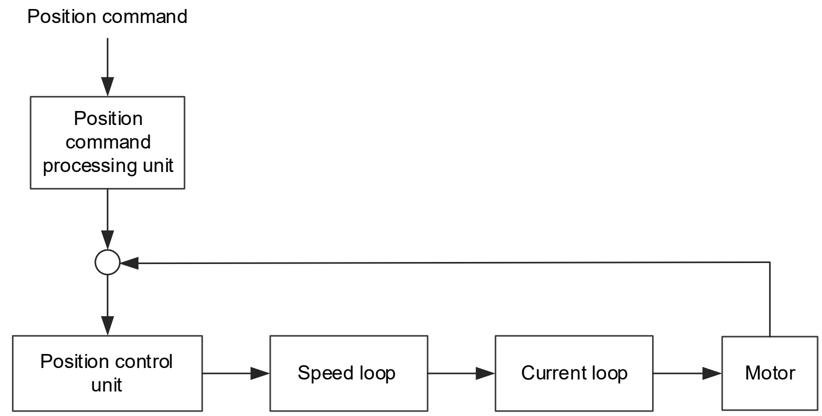
Note: *Instead of selecting the Path and triggering the command by DIs, PR mode can also be initiated by communication. See P5.007 (Modbus/ModTCP) and P5.112 (EtherNet/IP).*

There are many applications for both absolute type and incremental type registers. For example, assume the Position command PR1 is 10 turns and PR2 is 20 turns. The PR1 command is issued first and the motor moves 10 turns. When the PR statement is set for an Absolute type move, the motor will move another 10 turns (it will be at "20" revolutions). If the PR statement was set for Incremental type moves, the motor would rotate an additional 20 turns. The following diagram shows the difference between absolute and incremental positioning. Each set of PR command registers contains the target distance for the move, whether the move is Incremental or Absolute, and several other advanced features. See Chapter 7 for more details. SureServo2 PRO software simplifies setting up the PR command registers.

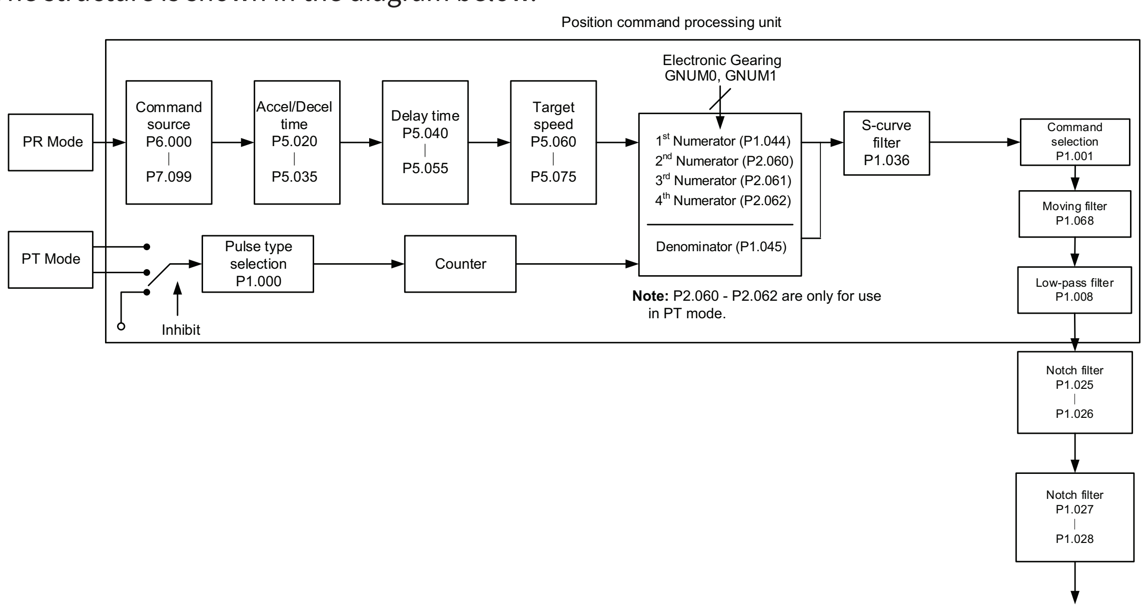


6.2.3 - Control structure of Position mode

The basic control structure is shown in the following flow chart:



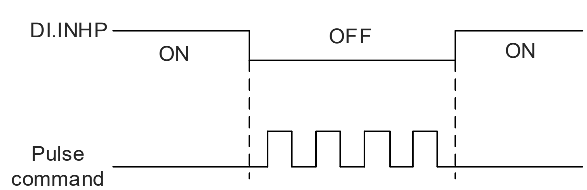
For better control, the pulse signals are processed by the Position Command processing unit. The structure is shown in the diagram below.



The upper path of the above diagram is the PR mode and the lower one is the PT mode that you can select with P1.001. You can set E-Gear ratio in both modes to adjust the positioning resolution. In addition, you can use either an S-curve or low-pass filter to smooth the command (described below).

The Pulse Command Input Inhibit (INHP) function

In PT mode, when DI.INHP is on, the servo drive stops receiving external pulse commands and the motor stops running. As this function is only supported by DI 8, setting 0x45 (DI.INHP) to P2.017 (DI 8) is required. This feature is useful when the servo needs to follow an encoder, but also needs to be started and stopped.



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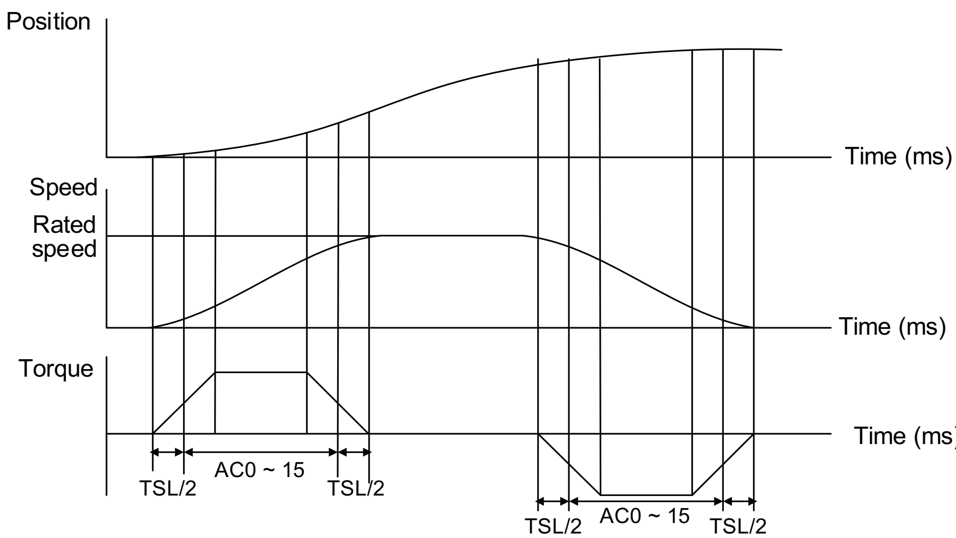
6.2.4 - S-curve filter (Position)

The S-curve filter smoothes the motion command in PR mode. This filter softens the speed and acceleration curves and reduces jerk, resulting in a smoother mechanical operation. If the load inertia increases, the motor operation is influenced by friction and inertia when the motor starts or stops rotating. Setting a larger acceleration / deceleration constant for the S-curve (TSL) and for the acceleration / deceleration time in P5.020 – P5.035 can increase the smoothness of operation. When the Position command source is pulse, the speed and angular acceleration are continuous, and the S-curve filter is not necessary.



Position and S-curve speed and time setting

Relevant parameters: please refer to Chapter 8 for detailed descriptions.

Parameter	Function
P1.036	S-curve acceleration / deceleration constant
P5.020 – P5.035	Acceleration / deceleration time (Number #0 – 15)

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6.2.5 - Electronic gear ratio (E-Gear ratio)

The resolution of SureServo2 system is 24 bits, which means that the drive generates 16,777,216 pulses per motor rotation. The drive output to the motor always operates in 24-bit for optimum control. The input pulse per revolution resolution can be changed with electronic gearing so the host controller does not need to send 16,777,216 pulses for every rotation.

If you leave the numerator (P1.044) of the gear ratio at the default value of 16,777,216 then just changing the denominator (P1.045) will give you the number of PUU (pulse user units) you need for 1 revolution. EX: If P1.045= 15000 and P1.044 is default then 15000 pulses will result in 1 shaft rotation.

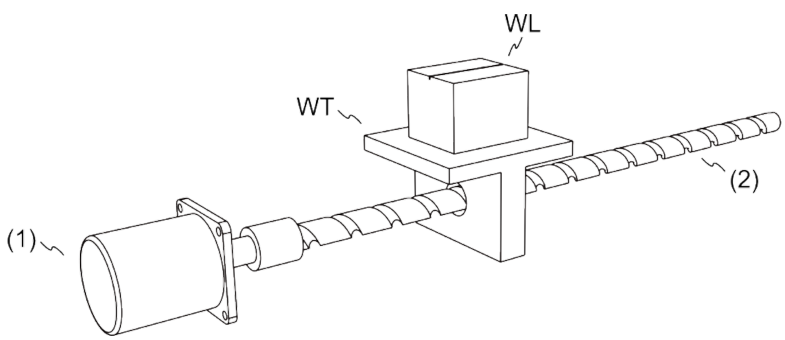
Example 1:

If the E-Gear ratio is 1, the drive will require 16,777,216 input pulses per one motor rotation and send 16,777,216 pulses to the motor to complete this rotation.

Example 2:

If the E-Gear ratio is 0.5 (1/2), then the drive will require 8,388,608 (16,777,216 divided by 2) input pulses per one motor rotation, but the drive still sends 16,777,216 pulses to the motor. In this E_Gear ratio every one pulse from the command controller (PLC) corresponds to two pulses to the motor.

A large E-Gear ratio might create a sharp corner in the profile and lead to a high jerk. To solve this problem, you can apply an S-curve acceleration / deceleration filter, or a low-pass filter to reduce the jerk.



(1) Motor (2) Ball screw pitch: 3mm (equals 3000μm)
WL: Workpiece; WT: platform

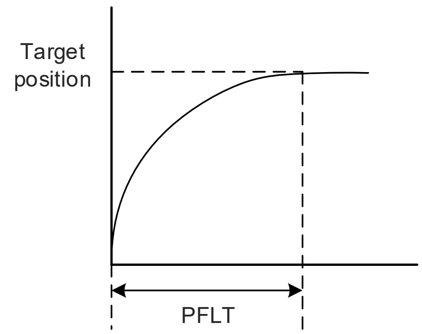
	Gear Ratio	Moving distance per 1 pulse command
Electronic gear is not applied	= 1 / 1	$= \dfrac{3000\,\frac{\mu m}{rev}}{16777216\,\frac{Pulse}{rev}} \times \dfrac{1}{1} = \dfrac{3000}{16777216}$ $\left(\text{Unit}: \dfrac{\mu m}{Pulse}\right)$
Electronic gear is applied	= 16777216 / 3000	$= \dfrac{3000\,\frac{\mu m}{rev}}{16777216\,\frac{Pulse}{rev}} \times \dfrac{16777216}{3000} = 1$ $\left(\text{Unit}: \dfrac{\mu m}{Pulse}\right)$

Relevant parameters: please refer to Chapter 8 for detailed descriptions.

Parameters	Function
P1.044	E-Gear ratio (Numerator) (N1) (Default=16777216)
P1.045	E-Gear ratio (Denominator) (M) (Default=100000)

The default E-Gear settings (16,777,216 / 100,000) result in 1 motor revolution for every 100,000 input pulses.

6.2.6 - Low-pass filter

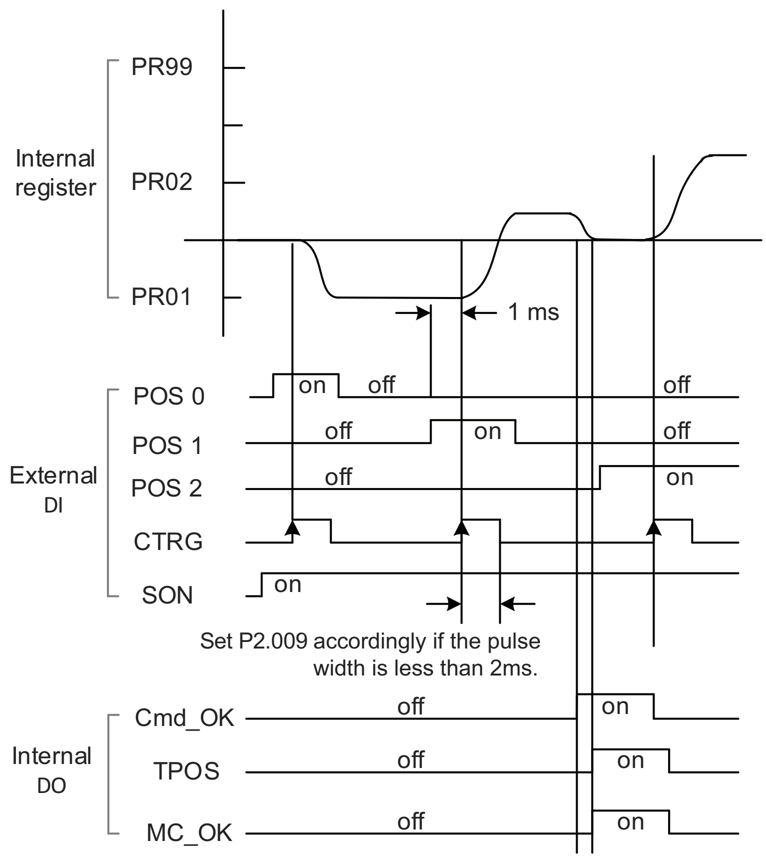


Relevant parameters: please refer to Chapter 8 for detailed descriptions.

Parameter	***Function***
P1.008	Position command smoothing constant (Low-pass filter)

6.2.7 - Timing diagram of PR mode (internal indexing)

In PR mode (**P**osition command from internal **R**egisters), the Position command is issued with DI signals (POS0 – POS6 to select the target position, and CTRG for the Command Trigger. Please refer to Section 6.2.2 for information about the DI signal and its selected register. The timing diagrams are shown below.



Note: *Cmd_OK is on when the PR command completes; TPOS is on when the error is smaller than value set by P1.054; MC_OK is on when Cmd_OK and TPOS are both on.*

6.2.8 - Gain adjustment for the position loop

There are two types of gain adjustment for the position loop: auto and manual.

- *Auto adjustment:*
  The SureServo2 servo drive provides an Auto Tuning function that allows you to easily complete the gain adjustment. Please refer to Chapter 5 Tuning for a detailed description.
- *Manual adjustment:*
  Before setting the position control loop, you have to manually set the speed control PID (P2.004 and P2.006) since a speed loop is included in the position loop. Then set the position loop gain (P2.000) and position feed forward gain (P2.002).

Description of the proportional gain and feed forward gain:

1) Proportional gain: a larger gain increases the response bandwidth of position loop.
2) Feed forward gain: reduces the deviation of phase delay.

Please note that the position loop bandwidth should not be larger than the speed loop bandwidth.

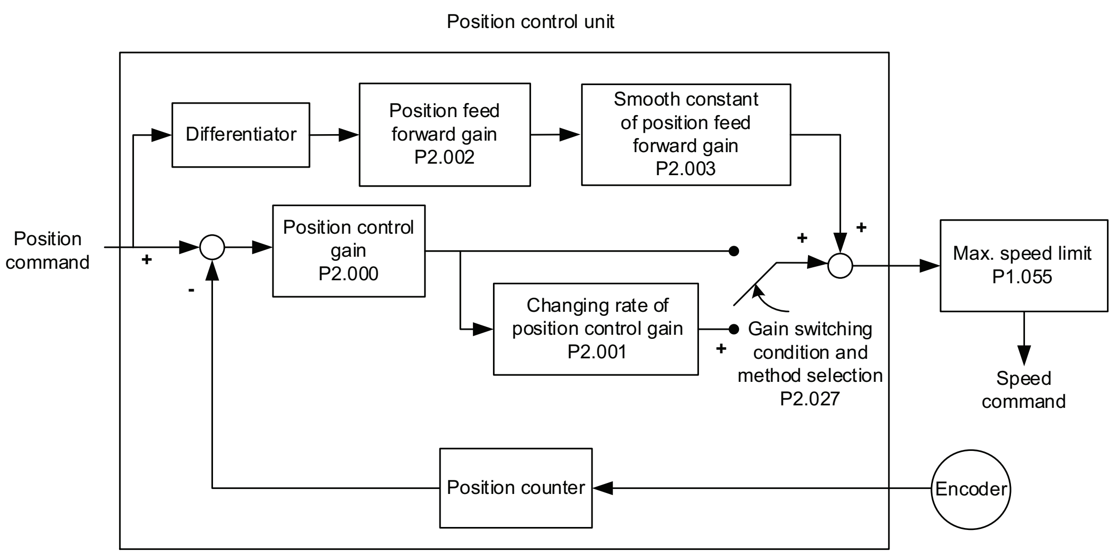
Calculation: $fp \leq \frac{fv}{4}$ (fv: response bandwidth of speed loop (Hz); fp: response bandwidth of position loop (Hz).)

Position Loop Gain setting (P2.000): KPP = $2 \times \pi \times fp$

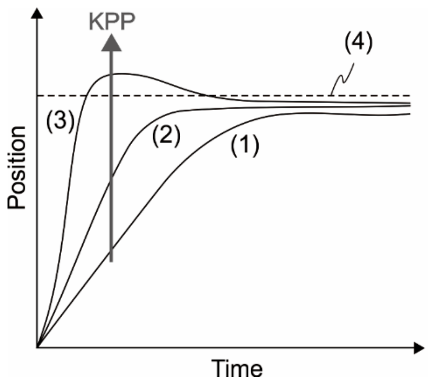
Example: if the desired position bandwidth is 20Hz, then adjust KPP (P2.000) to 125.
($2 \times \pi \times 20Hz = 125$)

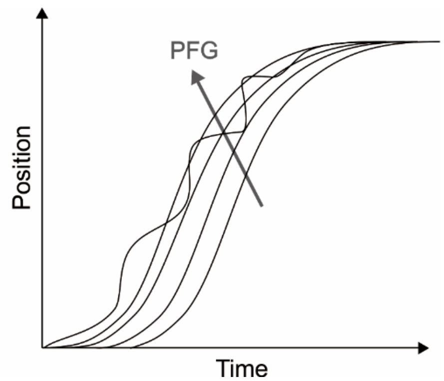
Relevant parameters: please refer to Chapter 8 for detailed descriptions.

Parameter	Function
P2.000	Position control gain
P2.002	Position feed forward gain



When you set the value of KPP (Position Control Gain: P2.000) too high, the bandwidth for the position loop is increased and the phase margin is reduced. Meanwhile, the motor rotates and vibrates in the forward and reverse directions. In this case, you should decrease KPP until the rotor stops vibrating. When the external torque is too high, a too-low value for KPP cannot meet the demand of reducing position error. In this case, increasing ***Position Feed Forward Gain***, PFG (Position Feed Forward Gain: P2.002), can effectively reduce the following error.





The actual position curve changes from (1) to (3) with the increase in the KPP value. (4) stands for the Position command.

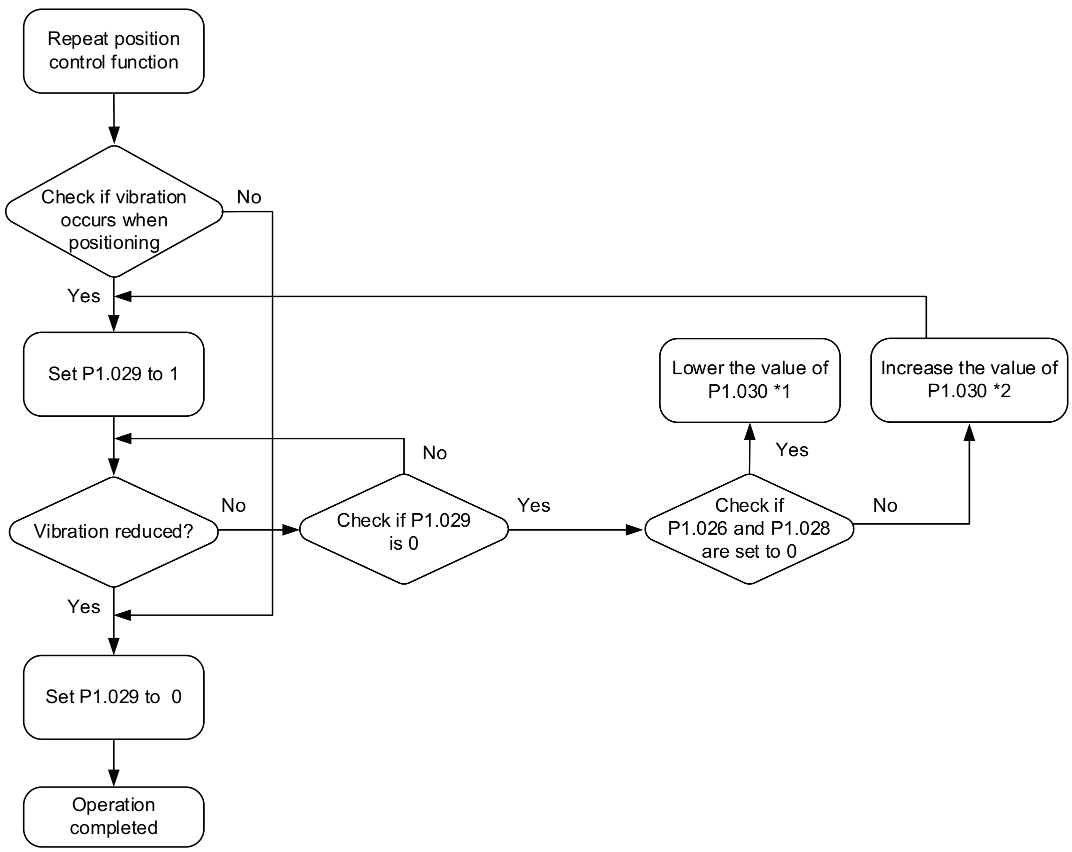
6.2.9 - Low-frequency vibration suppression in Position mode

If the machine is too flexible, vibration persists even when the motor stops after executing the Positioning command. The low-frequency vibration suppression (LFVS) function can reduce the machine vibration. The suppression range is between 1.0 Hz and 100.0 HZ. Both auto and manual functions are available.

Auto Low-frequency Vibration Suppression Mode (P1.029)

If you have difficulty finding the resonance frequency, you can enable the Auto LFVS function (P1.029), which searches for the specific resonance frequency. If you set P1.029 to 1, the system disables any existing LFVS and starts to search the vibration frequency. When the detected resonance frequency remains at the same level, it automatically sets Auto LFVS P1.029 to 0 and sets LFVS Frequency (1) P1.025 to the first frequency and sets LFVS Gain (1) P1.026 to 1. It sets LFVS Frequency (2) P1.027 to the second frequency and then sets LFVS Gain (2) P1.028 to 1. If Auto LFVS P1.029 is automatically reset to 0, but the low-frequency vibration persists, please check that the P1.026 or P1.028 gains are enabled. If the values of P1.026 and P1.028 are both 0, it means no frequency is detected. Please lower the LFVS detection value in P1.030 and set P1.029 to 1 to search the vibration frequency again. Please note that when you set the detection level too low, it might detect noise as low-frequency vibration.

The diagram of the basic control structure is shown in the following flowchart:



Notes:

1) When the gain values of P1.026 and P1.028 are 0, it means that the vibration frequency cannot be found, probably because the detection level is set too high so that the low-frequency vibration is not detected.
2) When the gain values of P1.026 or P1.028 are greater than 0 and the vibration is not reduced, it is probably because the detection level is set too low, and the system detects noise or other frequency as low-frequency vibration.

3) When the auto suppression procedure completes, but the vibration persists, you can manually set LFVS frequencies P1.025 or P1.027 to suppress the vibration if you have identified the problematic low frequency.
4) Physically lowering the inertia ratio of the motor to the machine's power transmission can reduce resonance along with stiffer couplings.

Relevant parameters: please refer to Chapter 8 for detailed descriptions.

Parameter	***Function***
P1.029	Auto low-frequency vibration suppression mode
P1.030	Low-frequency vibration detection level

P1.030 sets the detection range for the magnitude of low-frequency vibration. When the frequency is not detected, it is probably because you set the value of P1.030 too high and it exceeds the vibration range. In this case, it is suggested that you decrease the value of P1.030. Please note that if the value is too small, the system might detect noise as the resonance vibration frequency. You can also use the software Scope in SureServo2 Pro to observe the range of position error (pulse) between the upper and lower magnitude of the curve to adjust the value of P1.030.

Manual Setting

There are two sets of low-frequency vibration suppression: one is parameters P1.025 – P1.026 (LFVS frequency 1) and the other is parameters P1.027 – P1.028 (LFVS frequency 2). You can use these two sets of low-frequency vibration suppression parameters to reduce two different frequency vibrations. Use parameters P1.025 and P1.027 to suppress the low-frequency vibration. The function works only when the low-frequency vibration setting is close to the real vibration frequency. Use gain parameters P1.026 and P1.028 to set the response after frequency filtering. The bigger the values of P1.026 and P1.028, the better the response. However, if you set the values too high, the motor might not operate smoothly. The default values of parameters P1.026 and P1.028 are 0, which means the two filters are disabled by default.

Relevant parameters: please refer to Chapter 8 for detailed descriptions.

Parameter	***Function***
P1.025	Low-frequency vibration suppression frequency (1)
P1.026	Low-frequency vibration suppression gain (1)
P1.027	Low-frequency vibration suppression frequency (2)
P1.028	Low-frequency vibration suppression gain (2)

6.3 - Speed mode

This servo drive includes two types of command inputs: analog and internal register (parameters). The Analog command controls the motor speed by scaled external voltage input. The command register input controls the speed in two ways. The first is to set different speed values in three command registers and then switch the speed by using Digital Inputs SPD0 and SPD1 from CN1. The second is to change the value in the registers by communication. In order to deal with the problem of non-continuous speed when switching registers, you can use the S-curve acceleration / deceleration filter. In a closed-loop system, the servo drive uses gain adjustment, the integrated PI controller, and the two modes (Manual and Auto).

You can use Manual mode to manually set the parameters. In this mode, all auto or auxiliary function are disabled. The gain adjustment function provides different modes for you to estimate load inertia and tune the bandwidth as well as the responsiveness. In addition, the parameter values you set are regarded as the default values. It is a very good idea to apply a torque limit when in speed mode to ensure the torque of the motor does not exceed a safe value of the application. See “6.6.1 - Applying the speed limit” on page 6–31.

6.3.1 - Selecting the Speed command source

There are two types of Speed command sources: analog voltage and internal speed registers (parameters). There are 2 Speed control modes in P1.001:

Mode	***P1.001 Setting***	***Description***
S	02	Speed Mode (velocity command = analog input or from internal speed registers)
Sz	04	Speed-Zero Mode (velocity command = 0 or from internal speed registers)

You can select the source by using DI signals from CN1. See the following table for the command source selection:

<table>
<tr><th rowspan="2">Speed Command</th><th colspan="2">CN1 DI Signal</th><th rowspan="2" colspan="3">Command Source</th><th rowspan="2">Content</th><th rowspan="2">Range</th></tr>
<tr><th>SPD1</th><th>SPD0</th></tr>
<tr><td rowspan="2">S0</td><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">Mode</td><td>S</td><td>External analog signal</td><td>Voltage difference between V-REF and GND</td><td>-10V to +10V</td></tr>
<tr><td>Sz</td><td>N/A</td><td>Speed command is 0</td><td>0</td></tr>
<tr><td>S1</td><td>0</td><td>1</td><td rowspan="3" colspan="3">Register parameters</td><td>P1.009 Speed 1</td><td>-60000 – 60000</td></tr>
<tr><td>S2</td><td>1</td><td>0</td><td>P1.010 Speed 2</td><td>-60000 – 60000</td></tr>
<tr><td>S3</td><td>1</td><td>1</td><td>P1.011 Speed 3</td><td>-60000 – 60000</td></tr>
</table>

Status of SPD0 – SPD1:

0 means that DI is off; 1 means that DI is on.

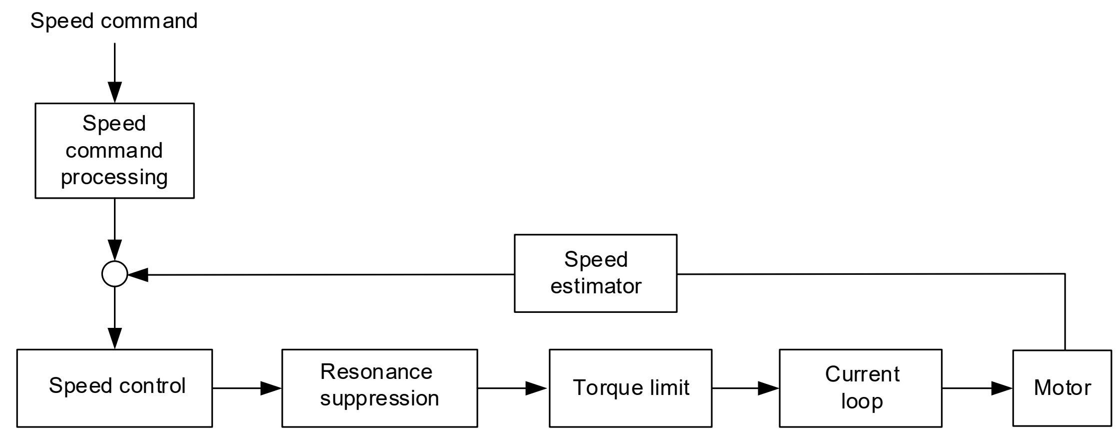
- *When both SPD0 and SPD1 are 0:*
    - *Sz mode: the analog velocity command is void. Thus, if the Speed command using analog voltage type is not required, you can use Sz mode to address the problem of zero drift in the voltage.*
    - *S mode: the voltage command is the voltage deviation between V-REF and GND. The range of the input voltage is between -10V and +10V and you can adjust the scaling by changing the “Maximum Rotation Speed for Analog Speed Command” (P1.040).*
- *When either SPD0 or SPD1 is not 0, the Speed command comes from the internal registers. The command is activated once the status of SPD0 – SPD1 is changed. There is no need to use CTRG for triggering.*

- *The parameter setting range (internal registers) is -60000 – 60000.*
  Setting value = setting range x unit (0.1 rpm). For example, if P1.009 = +30000, then rotation speed = +30000 x 0.1 rpm = +3000 rpm

Use the Speed command registers in Speed mode (S or Sz) to set the command speed. Use the Speed command registers in Torque mode (T or Tz) to set the speed limit. See section "6.6.2 - Applying the torque limit" for detailed explanations on limiting the torque in speed mode.

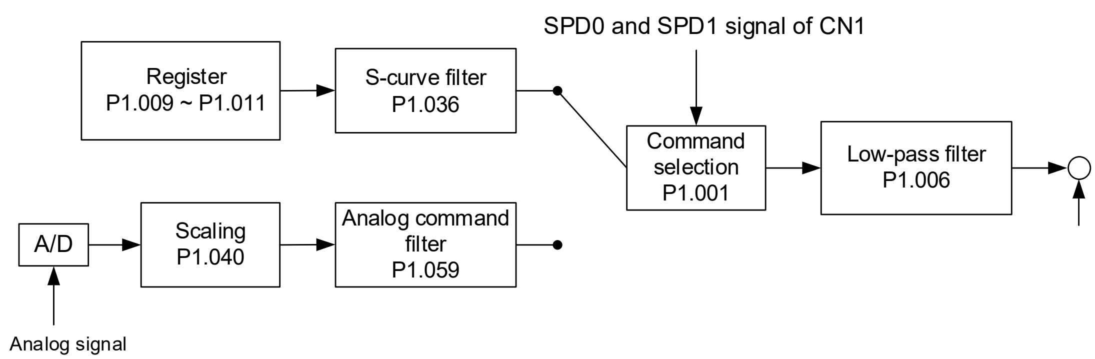
6.3.2 - Control structure of Speed mode

The diagram of the basic control structure is shown in the following flowchart:



The Speed Command processing unit selects the command source (see Section 6.3.1), including the scaling parameter (P1.040) for rotation speed and S-curve parameter for smoothing the speed. The Speed Control unit manages the gain parameters for the servo drive and calculates the current command for servo motor in real-time. The Resonance Suppression unit suppresses the resonance of the machine.

The following diagram introduces the function of the Speed Command unit. Its structure is shown below.



Control in the upper path is from the Speed control registers while the lower path command signal is from the external analog voltage. The command is selected according to the status of SPD0, SPD1 and P1.001 (S or Sz). In this condition, the S-curve and low-pass filters are applied to achieve a smoother response.

6.3.3 - Smooth Speed command

<u>S-curve filter</u>

During the process of acceleration or deceleration, the S-curve filter uses the three-stage acceleration curve and creates a smoother motion trajectory. It avoids jerk (rapid change of acceleration), resonance, and noise caused by abrupt speed variation. You can use the acceleration time constant P1.034 (TACC) to adjust the slope of the change in acceleration; the S-curve deceleration constant P1.035 (TDEC) adjusts the slope of the change in deceleration; and the S-curve acceleration / deceleration constant P1.036 (TSL) improves the status of motor activating and stopping. This can also calculate the total time for executing the command.

Note: *The S-Curve acceleration/deceleration constant P1.036 (TSL) must be greater than 0 for TACC and TDEC to take effect.*

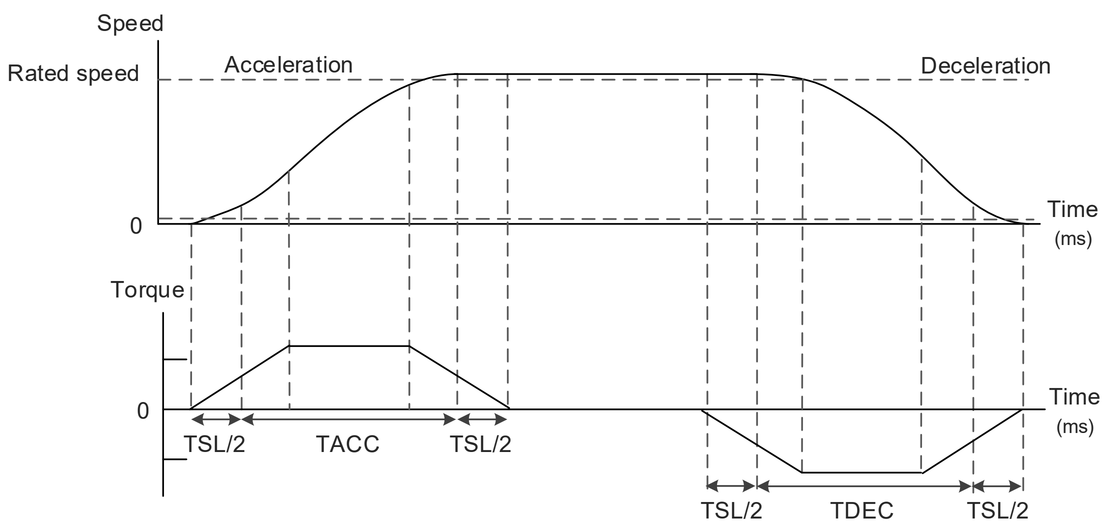


Figure 6-1 S-curve and time setting

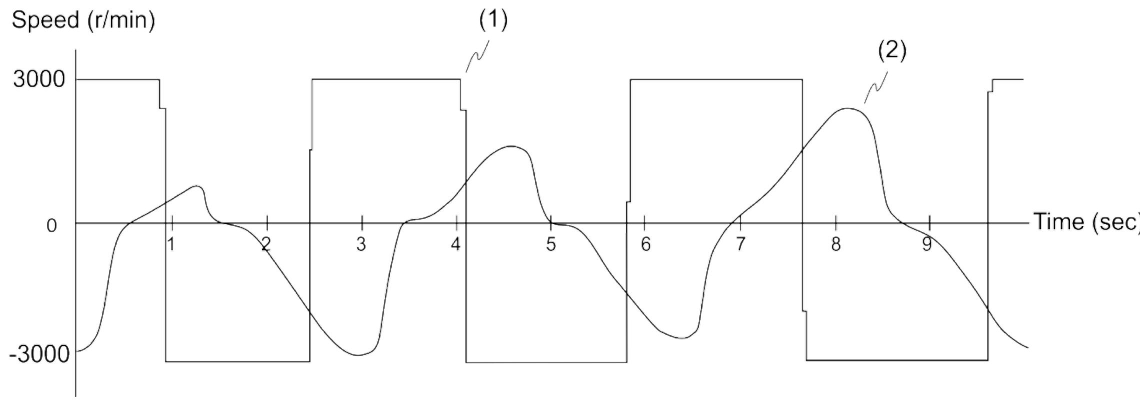
Note: *The graph is from 0 to Rated Speed (not 0 to commanded speed). The Calculated acceleration or deceleration time from 0 - rated speed will not be the same as the time from 0 - any commanded value less than Rated speed.*

Relevant parameters: refer to Chapter 8 for more information.

Parameter	***Function***
P1.034	Acceleration constant (TACC)
P1.035	Deceleration constant (TDEC)
P1.036	S-curve acceleration / deceleration constant (TSL)

Analog Speed command filter

The Analog Speed Command filter helps to stabilize the motor operation when the analog input signal (speed) changes rapidly.



(1) Analog Speed command (2) Motor torque

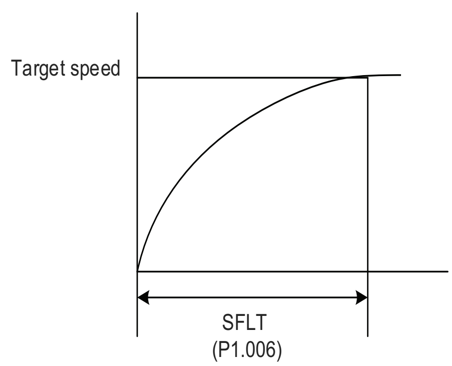
The Analog Speed Command filter smooths the analog input signal. Its time program is the same as the S-curve filter at normal speed. Also, the speed and acceleration curves are both continuous. The above graph shows the curve of the Speed command and the motor torque when you apply the Analog Speed Command filter. In the diagram above, the slopes of the Speed command in acceleration / deceleration are different. You can adjust the time setting (P1.034, P1.035, and P1.036) according to the actual application to improve the performance.

Low-pass filter for commands

You usually use the low-pass filter to remove unwanted high-frequency response or noise so that the speed change is smoother.

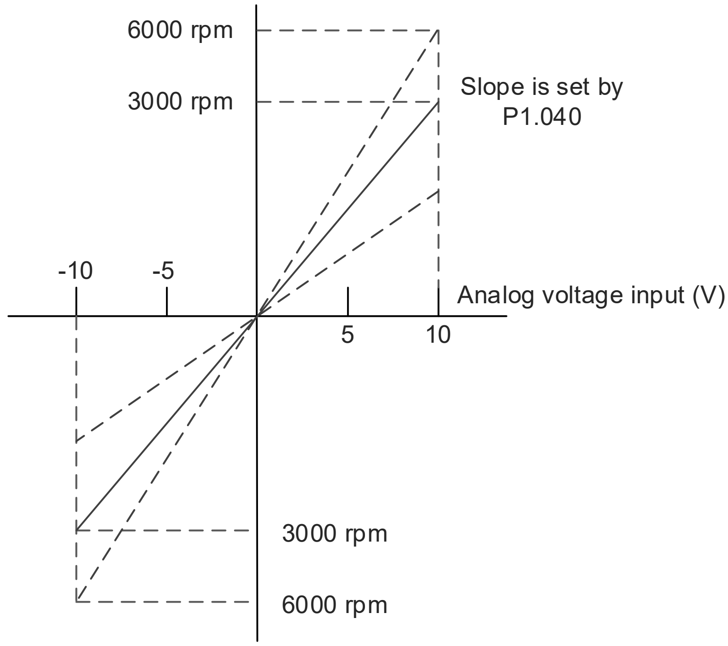
Relevant parameters: refer to Chapter 8 for more information.

Parameter	***Function***
P1.006	Speed command smoothing constant (Low-pass filter)



6.3.4 - Scaling of the analog command

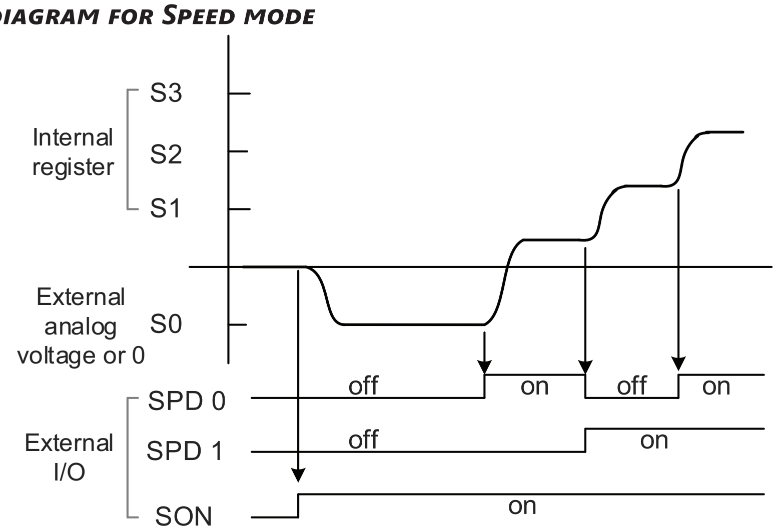
In Analog mode, you control the motor Speed command by the analog voltage difference between V_REF and GND. Use parameter P1.040 (maximum rotation speed for the analog Speed command) to adjust the slope of the speed change and its range.



Relevant parameters: refer to Chapter 8 for more information.

Parameter	Function
P1.040	Maximum rotation speed for the analog Speed command

6.3.5 - Timing diagram for Speed mode

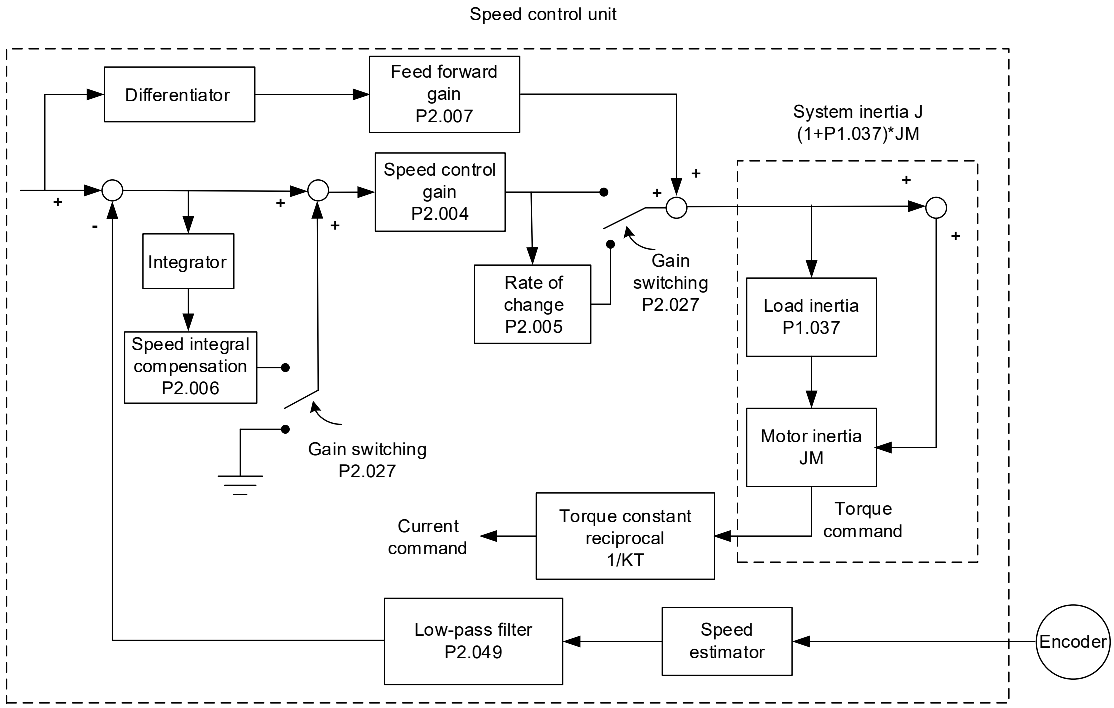


Notes:

1) “Off” means that the contact is open while “On” means that the contact is closed.
2) In Servo On state, the command is selected by the state of SPD0 – SPD1.
3) When in Sz mode (P1.001=4), the Speed command S0 = 0rpm; when in S mode (P1.001=2), the Speed command S1 is the external analog voltage input.

6.3.6 - Gain adjustment of the speed loop

The structure of the speed control unit appears in the following diagram:



In the Speed Control unit, you can adjust different types of gain. You can adjust the gain manually or use the three gain adjustment modes provided.

Manual: you set values for all the parameter settings. Auto and auxiliary functions are disabled.

For the other Gain Adjustment modes: please refer to Chapter 5 Auto tuning.

Manual mode

When you set Gain Adjustment Mode P2.032 to 0 (manual mode), you must set the Speed Loop gain (P2.004), Integral Compensation (P2.006), and Feed Forward gain (P2.007).

Speed Loop gain: the higher the gain, the larger the bandwidth for the speed loop response.

Integral Compensation gain: increasing this gain increases the low frequency rigidity and reduces the steady-state error. However, the phase margin is smaller. If you set this gain too high, you reduce the system stability.

Feed Forward gain: reduce the deviation of the phase delay.

Relevant parameters: refer to Chapter 8 for more information.

Parameter	Function
P2.004	Speed control gain (KVP)
P2.006	Speed integral compensation (KVI)
P2.007	Speed feed forward gain (KVF)

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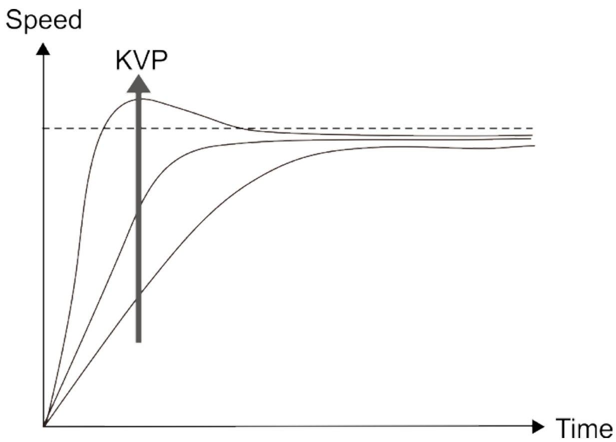
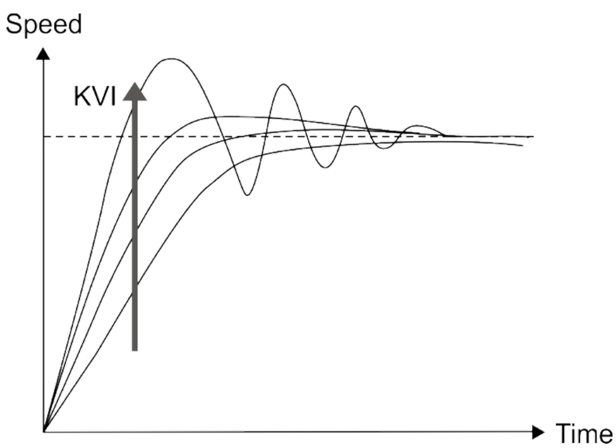
Theoretically, a step response can be used to explain proportional gain (KVP – P2.004), integral gain (KVI – P2.006), and feed forward gain (KVF – P2.007). Here, the frequency domain and time domain are used to illustrate the basic principle.

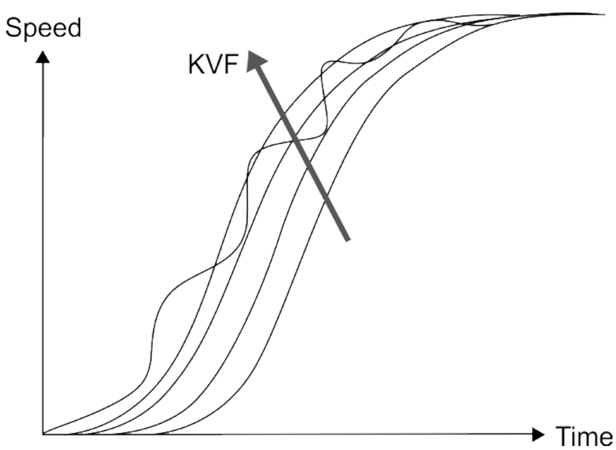
Frequency domain



The higher the KVP value, the larger the bandwidth. The time of the speed increase will also be shorter. However, if the value is set too high, the phase margin is too small. The effect is not as good as KVI for the steady-state error but is better for the effect for the following error.



The higher the KVI value, the larger the low frequency gain. It shortens the time for the steady-state error to reduce to zero. However, it does not significantly reduce the following error.



The closer the KVF value is to 1, the more complete the forward compensation. The following error becomes very small. But a KVF value that is set too high also causes vibration.

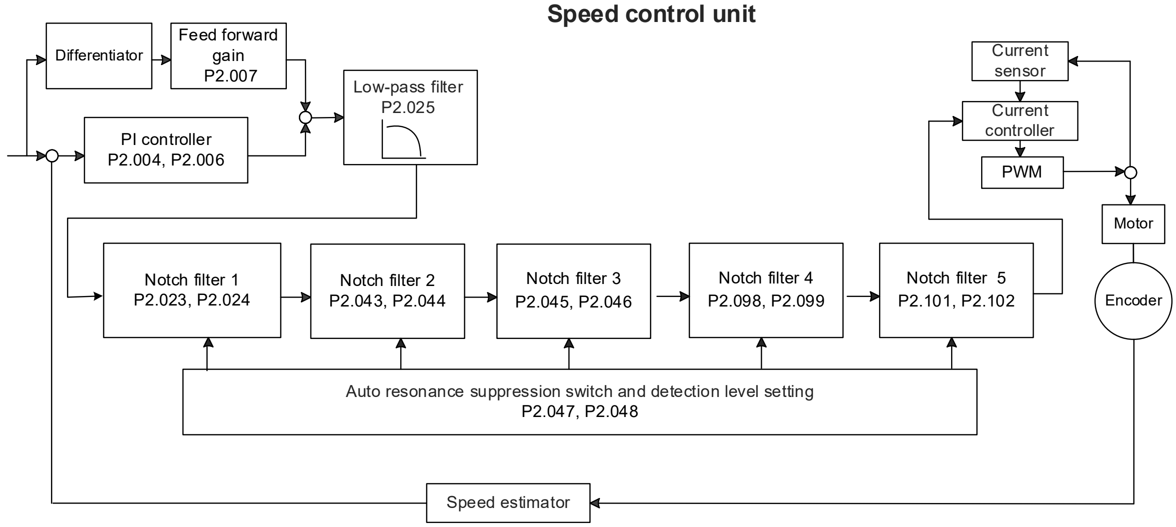
6.3.7 - Resonance Suppression unit

When resonance occurs, it is probably because the stiffness of the control system is too high or the response is too fast. Eliminating these two factors can improve the situation. In addition, you can use the low-pass filter (parameter P2.025) and Notch filter (parameters P2.023, P2.024, P2.043 – P2.046, P2.095 – P2.103) to suppress the resonance if you want the control parameters to remain unchanged. Each Notch filter consists of a Notch filter frequency (Hz) and a Notch filter attenuation level (-dB)

Relevant parameters: refer to Chapter 8 for more information.

Parameter	Function
P2.023	Notch filter frequency (1)
P2.024	Notch filter attenuation level (1)
P2.043	Notch filter frequency (2)
P2.044	Notch filter attenuation level (2)
P2.045	Notch filter frequency (3)
P2.046	Notch filter attenuation level (3)
P2.095	Notch filter bandwidth (1)
P2.096	Notch filter bandwidth (2)
P2.097	Notch filter bandwidth (3)
P2.098	Notch filter frequency (4)
P2.099	Notch filter attenuation level (4)
P2.100	Notch filter bandwidth (4)
P2.101	Notch filter frequency (5)
P2.102	Notch filter attenuation level (5)
P2.103	Notch filter bandwidth (5)
P2.025	Resonance suppression low-pass filter

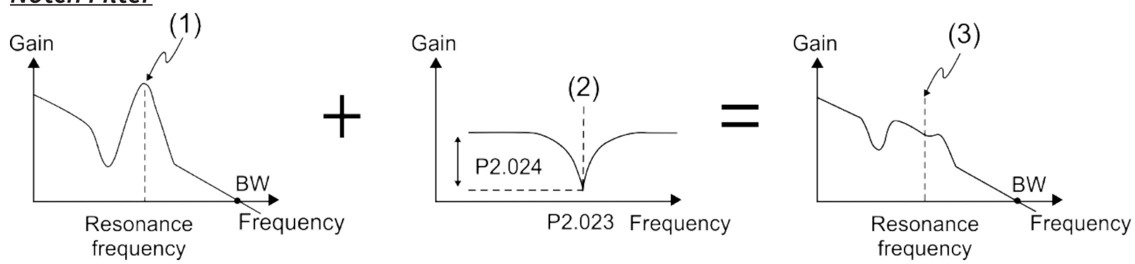
Speed control unit



SureServo2 provides two types of resonance suppression: one is the Notch filter and the other is the low-pass filter. See the following diagrams for the results of using these filters.

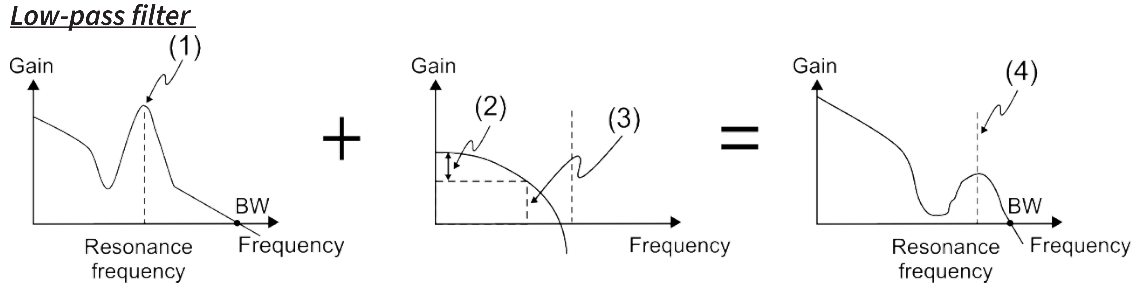
System open-loop gain with resonance:

Notch Filter



(1) Point of resonance (2) Notch filter (3) Point of resonance suppressed by the Notch filter

Low-pass filter

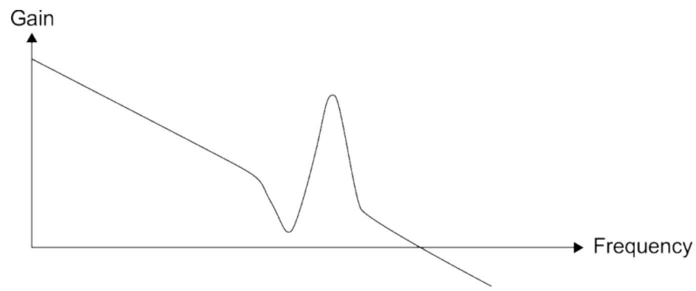


(1) Point of resonance (2) Attenuation rate (-3 dB)
(3) Low-pass filter (Cutoff frequency of low-pass filter = 1000 / P2.025 Hz)
(4) Resonance point suppressed by the low-pass filter

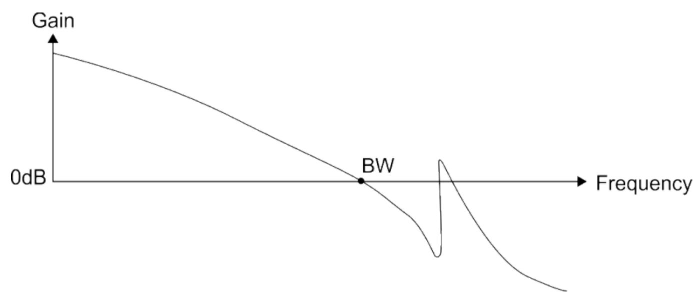
To conclude from these two examples, if you increase the value of the low pass filter P2.025 from 0, the bandwidth (BW) becomes smaller. Although it solves the problem of resonance, it also reduces the response bandwidth and phase margin, and thus the system becomes unstable.

If you know the resonance frequency, you can suppress the resonance by using the Notch filter, which is better than using the low-pass filter in this condition. If the resonance frequency drifts significantly with time or due to some other cause, using the Notch filter is not suggested.

The following figure shows the system open-loop gain with resonance suppression.



When the value of P2.025 (Low-pass Filter) is increased from 0, BW becomes smaller. Although it solves the problem of the resonance frequency, the response bandwidth and phase margin are reduced. Also, the system becomes unstable.



If you know the resonance frequency, the Notch filter can eliminate the resonance directly. The frequency range of the notch filter is 50 – 5000 Hz and the suppression strength is 0 – 32 dB. If the frequency does not meet the Notch filter conditions, then using the low-pass filter to reduce the resonance is suggested.

6.4 - Torque mode

Torque Control mode (T or Tz) is suitable for torque control applications, such as printing machines and winding machines. There are two kinds of command sources: analog input and internal torque register (parameters). The analog command input uses a scaled external voltage to control the torque of the motor while the register mode uses the internal parameters (P1.012 – P1.014) for the Torque command. t is a very good idea to apply a speed limit when in torque mode to ensure the velocity of the motor does not exceed a safe value of the application. See “6.6.1 - Applying the speed limit” on page 6–31.

Mode	P1.001 Setting	Description
T	3	Torque Mode (torque command = analog input or from internal torque registers)
Tz	5	Torque-Zero Mode (torque command = 0 or from internal torque registers)

6.4.1 - Selecting the Torque command source

External analog voltage and internal parameters are the two Torque command sources. You select the command source with CN1’s DI signal. See the table below for more detail.

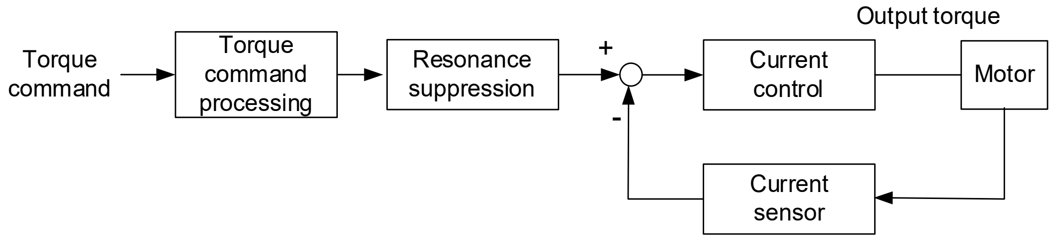
<table>
<tr><th rowspan="2">Torque Command</th><th colspan="2">DI signal of CN1</th><th rowspan="2" colspan="3">Command Source</th><th rowspan="2">Content</th><th rowspan="2">Range</th></tr>
<tr><th>TCM1</th><th>TCM0</th></tr>
<tr><td rowspan="2">T0</td><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">Mode</td><td>T</td><td>External analog command</td><td>Voltage difference between T-REF and GND</td><td>-10V to +10V</td></tr>
<tr><td>Tz</td><td>N/A</td><td>Torque command is 0</td><td>0</td></tr>
<tr><td>T1</td><td>0</td><td>1</td><td rowspan="3" colspan="3">Parameters</td><td>P1.012 Torque 1</td><td>-300% – 300%</td></tr>
<tr><td>T2</td><td>1</td><td>0</td><td>P1.013 Torque 2</td><td>-300% – 300%</td></tr>
<tr><td>T3</td><td>1</td><td>1</td><td>P1.014 Torque 3</td><td>-300% – 300%</td></tr>
</table>

- *State of TCM0 – TCM1: 0 means that the circuit is open (DI is off); 1 means that the circuit is closed (DI is on).*
- *When TCM0 and TCM1 are 0:*
    - *Tz mode: analog torque command is void. If there is no need to use the analog voltage for the Torque command, then Tz mode is applicable and can avoid the problem of zero voltage drift.*
    - *T mode: the command is the voltage difference between T-REF and GND. Its input voltage range is -10V to +10V, which means you can adjust the corresponding torque (P1.041).*
- *When either one of TCM0 or TCM1 is not 0, the internal parameters become the source for the Torque command. The command is executed after TCM0 – TCM1 are changed. There is no need to use CTRG for triggering.*

You can use the Torque command in Torque mode (T or Tz) and Speed mode (S or Sz). When in Speed mode, the torque registers are torque limits. See section “6.6.1 - Applying the speed limit” for detailed explanations on limiting the speed in torque mode.

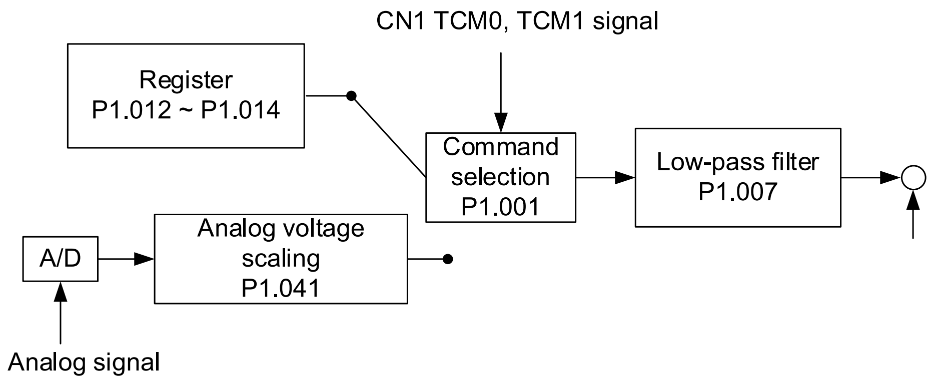
6.4.2 - Control structure of Torque mode

The following diagram shows the basic control structure of Torque mode:



Use the Torque Command unit to specify the Torque command source (mentioned in Section 6.4.1), including the scaling of the analog voltage (P1.041) and the S-curve setting. The current control unit manages the gain parameters for the servo drive and calculates the current for servo motor in real-time; you can only set this by commands.

The structure of Torque Command unit is as the follows:



Control in the upper path is from the torque registers while the lower path control is from the external analog voltage. You select the command according to the status of digital inputs TCM0, TCM1, and Control Mode P1.001 (T or Tz).

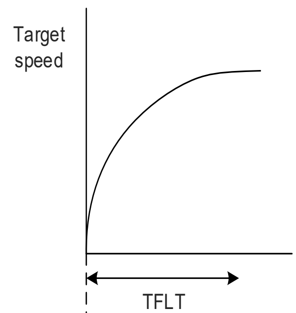
You can adjust the torque with the analog voltage scaling (P1.041) and you can smooth the response with the low-pass filter (P1.007).

6.4.3 - Smooth Torque command

Relevant parameters: refer to Chapter 8 for more information.

Setting the torque command low pass filter to 0ms disables the filter. Setting P1.007 to any other value smooths the torque command transition.

Parameter	Function
P1.007	Torque command smoothing constant (Low-pass filter)

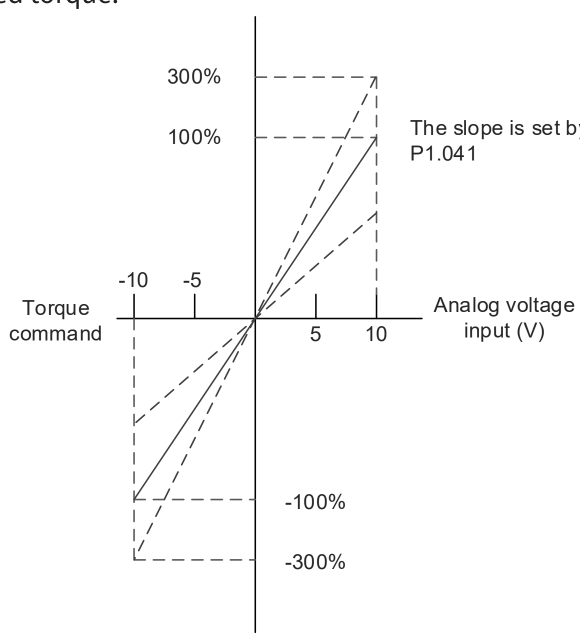


6.4.4 - Scaling of the analog command

The Torque command is controlled by the analog voltage difference between T_REF and GND. You can adjust the torque slope and its range with parameter P1.041 (Maximum output for analog Torque command). This parameter is entered in percent.

For example:

1) If you set P1.041 to 100 and the external input voltage is 10V, the Torque command is 100% of the rated torque.
2) If you set P1.041 to 300 and the external input voltage is 10V, the Torque command is 300% of the rated torque.



Relevant parameters: refer to Chapter 8 for more information.

Parameter	Function
P1.041	Maximum output for analog Torque command

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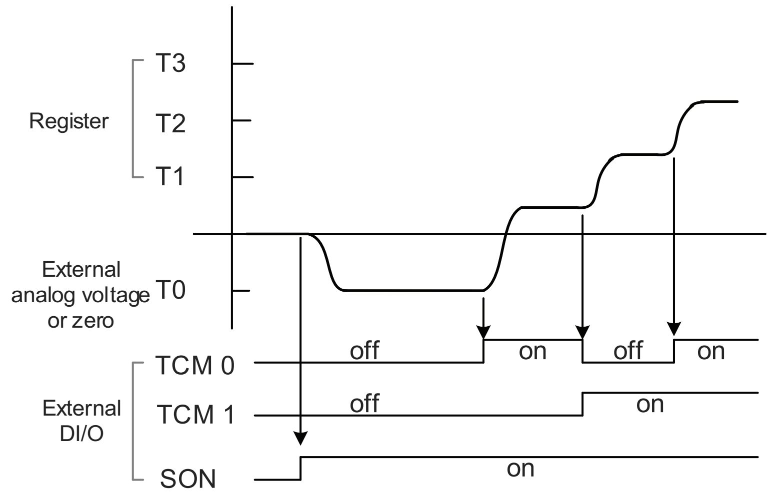
6.4.5 - Timing diagram in Torque mode



Notes:

1) “Off” signifies the contact is open while “On” signifies the contact is closed.
2) When in Tz mode, the Torque command T0 = 0; when in T mode, the Torque command T0 is the external analog voltage input.
3) In Servo On state, the command is selected according to the state of TCM0 – TCM1.

6.5 - Dual mode

Apart from single modes for position, speed, and torque control, there are eight dual / multiple modes also provided for operation (See Section 6.1).

Mode	Short Name	P1.001 Control Setting	Description
Dual mode	PT-S	06	PT and S can be switched with DI signal, DI.S-P (0x18).
	PT-T	07	PT and T can be switched with DI signal, DI.T-P (0x20).
	PR-S	08	PR and S can be switched with DI signal, DI-S-P (0x18).
	PR-T	09	PR and T can be switched with DI signal, DI.T-P (0x20).
	S-T	0A	S and T can be switched with DI signal, DI.S-T (0x19).
	PT-PR	0D	PT and PR can be switched with DI signal, DI.PT-PR (0x2B).
Multiple mode	PT-PR-S	0E	PT, PR, and S can be switched with DI signal, S_P and PT_PR.
	PT-PR-T	0F	PT, PR, and T can be switched with DI signal, T_P and PT_PR.

Sz and Tz (Speed and Torque Modes with a 0 selection and no analog input) dual mode is not supported. To avoid occupying too many digital inputs in dual mode, Speed and Torque modes can use the external analog voltage as the command source instead of the Speed and Torque parameters to reduce the use of DI points (SPD0, SPD1 or TCM0, TCM1). In addition, Position mode can use the pulse input to reduce the use of DI points (POS0, POS1, POS2, POS3, POS4, POS5, and POS6). Also, PR mode can be executed with communications (saving even more DI points). See P5.007 for more details. Please refer to Section 3.4.2 for the table of DI/O default value in each mode.

If you want to change the settings, the DI/O signals in correspondence with the PINs are defined as above in Section 3.4.2.

6.5.1 - Speed / Position dual mode (PT-S, PR-S, PT-PR)

P**T**-S and P**R**-S are available in Speed / Position dual mode. The command source for P**T**-S comes from the external **T**erminals (pulses) while the source for P**R**-S comes from the internal **R**egisters (P6.000 – P7.099). You can control the Speed command with the external analog voltage or the internal parameters (P1.009 – P1.011). The switch for Speed / Position mode is controlled by DI.S-P (0x18) signal. The switch for PT and PR for Position mode is controlled by DI.PT-PR (0x2B). Thus, you select both Position and Speed commands in PR-S mode with the DI signal. The timing diagram is shown below.

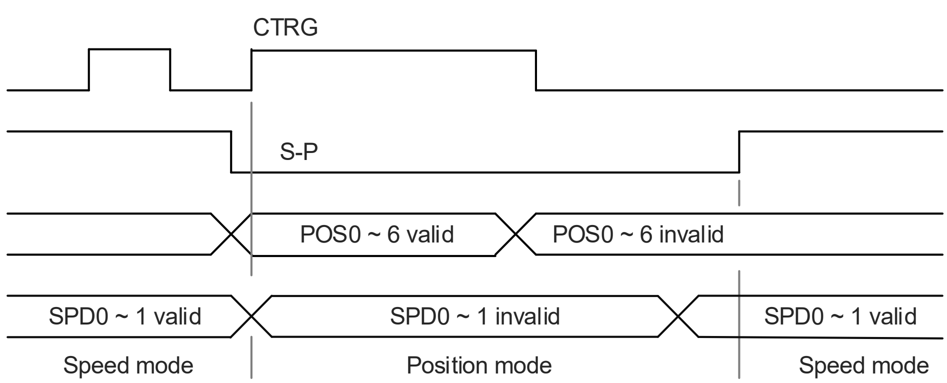


Figure 6-2 Speed / Position dual mode (PR-S)

In Speed mode (DI.S-P is on), you select the Speed command with DI.SPD0 and DI.SPD1. DI.CTRG is not applicable. When switching to Position mode (DI.S-P is off), since the Position command has not been issued (it waits for the *rising edge* of DI.CTRG), the motor stops. The Position command is controlled by DI.POS0–DI.POS6 and triggered by the rising edge of DI.CTRG. When DI.S-P is on, it returns to Speed mode. Please refer to the introduction of single mode for the DI signal and the selected commands for each mode.

6.5.2 - Speed / Torque dual mode (S-T)

Speed / Torque dual mode includes only the S-T mode. You control the Speed command with the external analog voltage and the internal parameters (P1.009 – P1.011), which you select with DI.SPD0 – DI.SPD1. Similarly, the source of the Torque command can be the external analog voltage or the internal parameters (P1.012 – P1.014), and is selected by DI.TCM0 – DI.TCM1. The switch between Speed and Torque mode is controlled by DI.S-T (0x19) signal. The timing diagram is shown below.

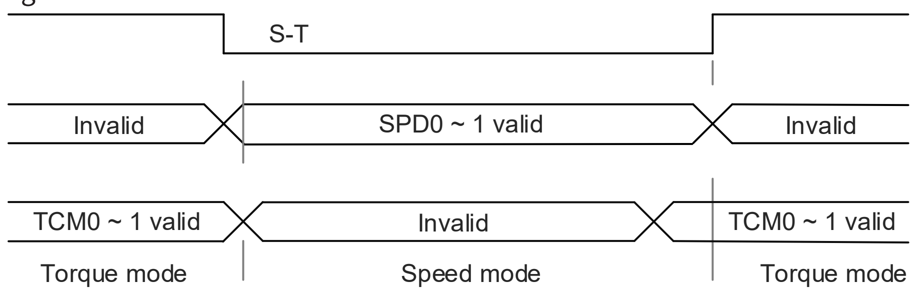


Figure 6-3 Speed / Torque dual mode

In Torque mode (DI.S-T is on), you select the Torque command with DI.TCM0 and DI.TCM1. When switching to Speed mode (DI.S-T is off), you select the Speed command with DI.SPD0 and DI.SPD1. The motor operates according to the Speed command. When DI.S-T is ON, it returns to the Torque mode. Please refer to the introduction of single mode for the DI signal and the selected commands for each mode.

6.5.3 - Torque / Position dual mode (PT-T, PR-T)

Torque / Position dual mode includes PT-T and PR-T. The command source for PT-T comes from the external pulse while the source for PR-T comes from internal parameters (P6.000 – P7.099). You control the Torque command with the external analog voltage or the internal parameters (P1.012 – P1.014). The switch between Torque and Position mode is controlled by DI.T-P (0x20) signal. You select PT and PR in Position mode with DI.PT-PR (0x2B). Thus, you select both Position and Torque commands in PR-T mode with the DI signal. The timing diagram is shown below.

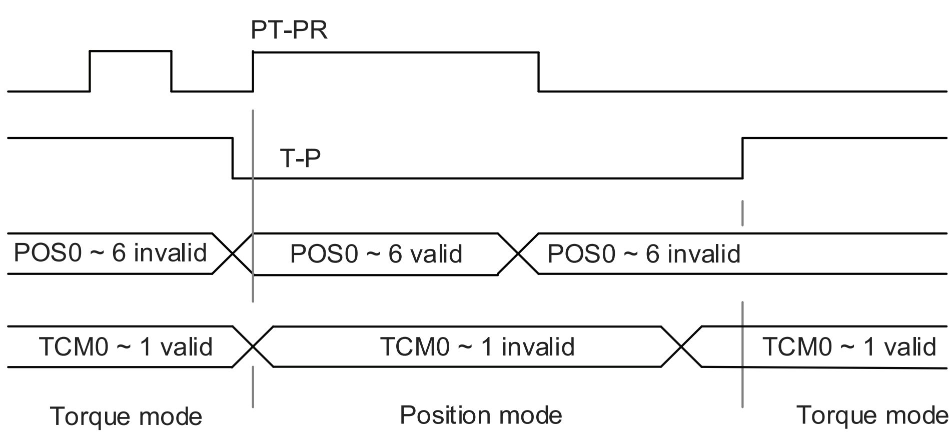


Figure 6-4 Torque / Position dual mode

In Torque mode (DI.T-P is on), you select the Torque command with DI.TCM0 and DI.TCM1. DI.CTRG is not applicable. When switching to Position mode (DI.T-P is off), since the Position command has not been issued (it waits for the rising edge of DI.CTRG), the motor stops.
The Position command is determined by DI.POS0 – DI.POS6 and triggered by rising edge of DI.CTRG. When DI.T-P is on, it returns to Torque mode. Please refer to the introduction of single mode for the DI signal and the selected commands for each mode.

6.6 - Others

6.6.1 - Applying the speed limit

The maximum speed in each mode (Position, Speed, Torque) is determined by the internal parameter P1.055 – Maximum Speed Limit (rpm). You use the same method for the Speed Limit and Speed commands. You can use either the external analog voltage or the internal parameters (P1.009 – P1.011). Please refer to Section 6.3.1 for descriptions.

If you are using the external analog voltage in Torque mode, the DI signals are available and you can set SPD0–SPD1 for the motor speed limit value (internal parameters). If not, you can use the analog voltage input for the Speed Limit command. When you set P1.002.X (disable / enable speed limit function) to 1, you enable the Speed Limit function.

Example Speed limit settings and behavior In Torque mode

When P1.001=3:

- *P1.041 is valid for limiting max torque when using analog torque control.*
- *P1.012 - P1.014 are valid torque selections and override the analog torque setting when TCM0 and TCM1 are not 0.*
- *P1.002.Y (enable torque limit) is not valid.*
- *DI.SPDLM [0x10] =1 will also enable speed limit. Speed limit is enabled in torque mode when P1.002.X=1 OR DI.SPDLM=1.*

When P1.002.X=1 , Enable speed limit:

- *P1.040 is valid for speed limitation when using analog torque control and SPD0 and SPD1 are 0.*
- *P1.009 - P1.011 are valid speed limits when properly selected with SPD0 and SPD1 and are not 0. Speed limit P1.040 is no longer valid.*

When P1.002.X =0, Disable speed limit:

- *P1.040 and P1.009 - P1.011 are not valid speed limits.*

6.6.2 - Applying the torque limit

The method for using the Torque Limit command and Torque command are the same. You can use either the external analog voltage or the internal parameters (P1.012 – P1.014). Please refer to Section 6.4.1 for descriptions.

You can use the torque limit in Position mode (PT, PR) or Speed mode (S) to limit the motor torque output. When you execute the command in Position mode using the external pulse or execute the command in Speed mode using the external analog voltage, DI signals are available and you can set TCM0 – TCM1 to determine the Torque Limit command (internal parameters). If there is not enough DI signal available, you can execute the Torque Limit command using the analog voltage. When you set the Torque Limit function (P1.002.Y) to 1, you enable the Torque Limit function. P1.041 determines the torque limit for the analog input and TCM0-TCM1 determine the limit when using DI selections.

Example Torque limit settings and behavior In Speed mode

When P1.001 =2:

- *P1.040 is valid for speed limitation when using analog speed control.*
- *P1.009 - P1.011 are valid speed selection when properly selected with SPD0 and SPD1 and are not 0. Speed limit P1.040 is no longer valid*
- *P1.002.X (enable speed limit) is not valid*
- *DI.TRQLM [0x09] =1 will also enable torque limit. Torque limit is enabled in speed mode when P1.002.Y=1 OR DI.TRQLM=1*

When P1.002.Y =1, Enable torque limit:

- *P1.041 is valid for limiting max torque when using analog torque control.*
- *P1.012 - P1.014 are valid torque setting and override the analog torque setting when TCM0 and TCM1 are not 0.*

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When P1.002.Y=0, Disable torque limit:

- *P1.041 and P1.012 - P1.014 are not valid torque limits.*

6.6.3 - Analog monitoring

You can externally monitor drive conditions with analog outputs. Two ±8V analog channels are provided by the servo drive and located on terminals 15 and 16 of CN1. P0.003 can set the two analog outputs to monitor motor speed (command or actual), motor torque (command or actual), pulse command frequency, DC bus voltage, or the outputs can be set as a generic analog voltage output (equal to P1.101 and P1.102). The analog output resolution is 10-bit. Please refer to Chapter 8 for more information about the relevant parameters.

Parameter	***Function***
P0.003	Analog output monitoring
P1.003	Analog and Encoder pulse output polarity
P1.004	MON1 analog monitor output proportion
P1.005	MON2 analog monitor output proportion
P1.101	Analog monitor output voltage 1
P1.102	Analog monitor output voltage 2

Example:

Specify a motor speed of 1000 rpm, which corresponds to analog voltage output of 8V with the maximum speed of 5000 rpm. The setting is as follows:

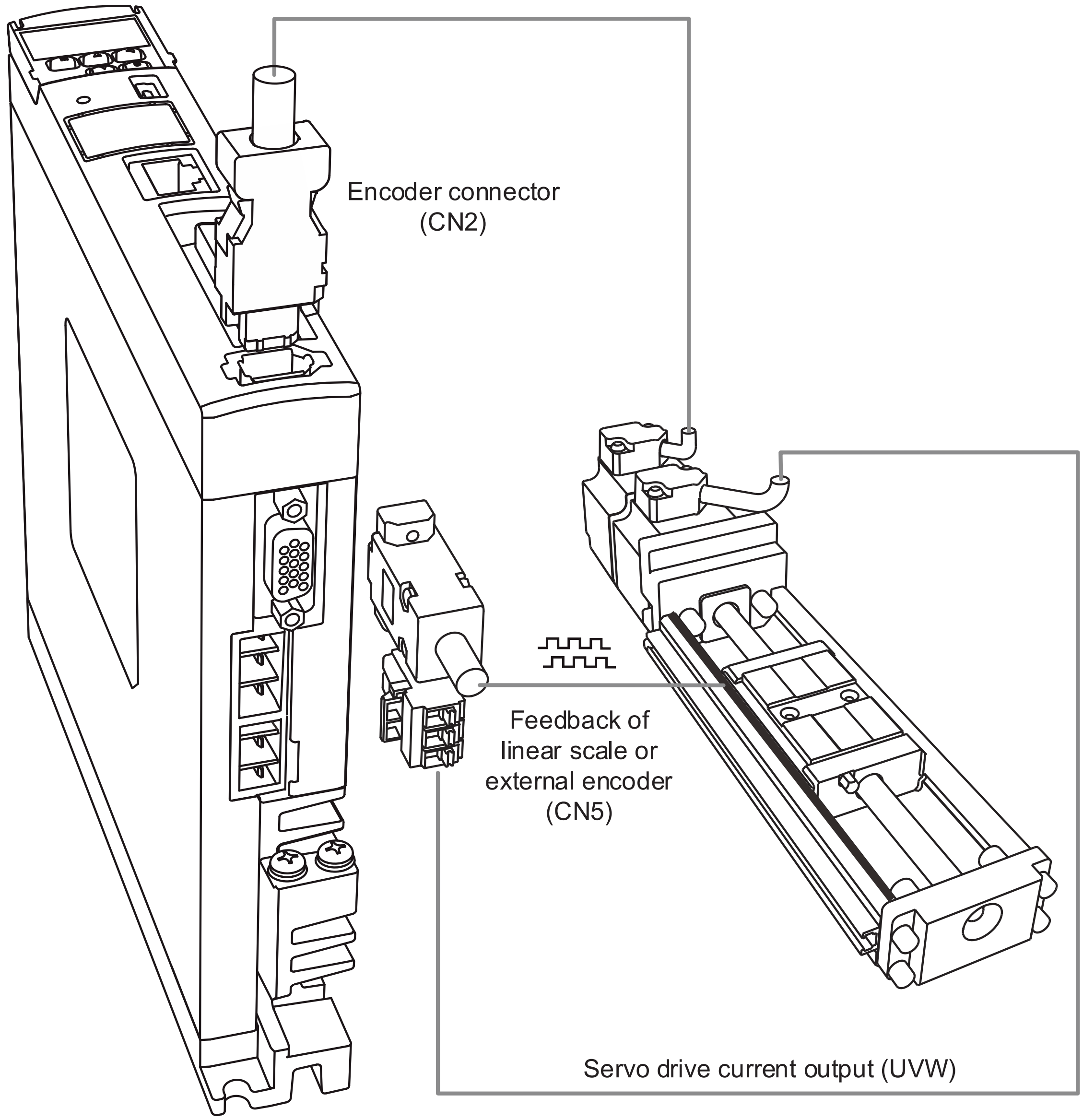
$$\text{P1.004} = \frac{\text{Required speed}}{\text{Maximum speed}} \times 100\% = \frac{1000\text{ rpm}}{5000\text{ rpm}} \times 100\% = 20\%$$

You can calculate the corresponding voltage output for the current motor speed with the formula below.

Motor speed	***Mon1 Analog monitoring output***
300 rpm	$\text{MON1} = 8\text{V} \times \frac{\text{Current speed}}{(\text{Maximum speed} \times \frac{\text{P1.004}}{100})} \times 100\% = 8\text{V} \times \frac{300\text{ rpm}}{5000\text{ rpm} \times \frac{20}{100}} \times 100\% = 2.4\text{V}$
900 rpm	$\text{MON1} = 8\text{V} \times \frac{\text{Current speed}}{(\text{Maximum speed} \times \frac{\text{P1.004}}{100})} \times 100\% = 8\text{V} \times \frac{900\text{ rpm}}{5000\text{ rpm} \times \frac{20}{100}} \times 100\% = 7.2\text{V}$

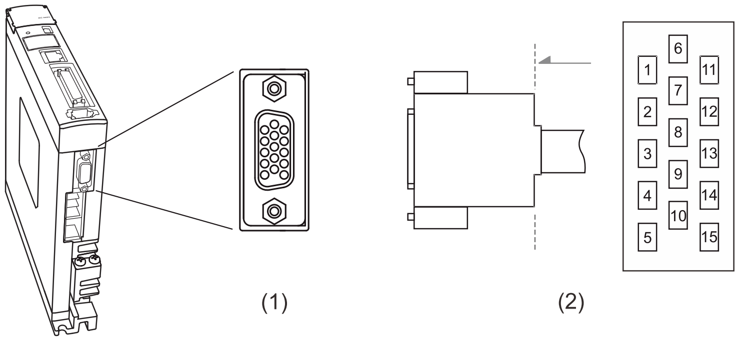
6.7 - Full-Closed Loop Control System

The auxiliary encoder (CN5) returns the actual position of the machine end to the servo drive in the full-closed loop system, which improves the conditions of lead screw backlash, flexibility or stretching of couplings or belts, and thermal expansion, linearity, and sliding end of the transmission system, achieving high-precision positioning.



6.7.1 - Hardware configuration

The CN5 connector is for connecting to the auxiliary encoder (A, B, and Z) and forms a full-closed loop with the servo system. If the Z pulse input for CN5 is not wired, then the full-closed loop function will not work. If there is not a Z pulse available, then wire Z to +5VDC and /Z to 0VDC.



(1) CN5 connector (female); (2) CN5 connector (male)

NOTE: This only supports AB phase signal and an encoder of 5V. The maximum single-phase (Phase A or Phase B) pulse frequency for the encoder cannot exceed 1MHz.

NOTE: Use ZL-HD15M-CBL-DB15F cable + ZL-RTB-DB15 ZIPLink breakout board, or use ZL-HD15M-CBL-2P cable (HD15 to flying leads).

WARNING: Do not use a standard VGA HD15 cable. The typical VGA cable does not include a connection on pin 8.

Pin Assignment:

Pin Number	Color	Signal	Function
1	Black/White	Opt_/Z	/Z pulse input
2	Blue/White	Opt_/B	/B phase input
3	Blue	Opt_B	B phase input
4	Green	Opt_A	A phase input
5	Green/White	Opt_/A	/A phase input
6	Yellow Yellow/Black	GND	Encoder grounding
7	Red/White	GND	Encoder grounding
8	Red	+5V	Encoder power
9	Black	Opt_Z	Z pulse input
10	Orange	Reserved	Reserved
11	Orange/White	Reserved	Reserved
12	Brown	Reserved	Reserved
13	Brown/White	Reserved	Reserved
14	Purple	Reserved	Reserved
15	Purple/White	Reserved	Reserved

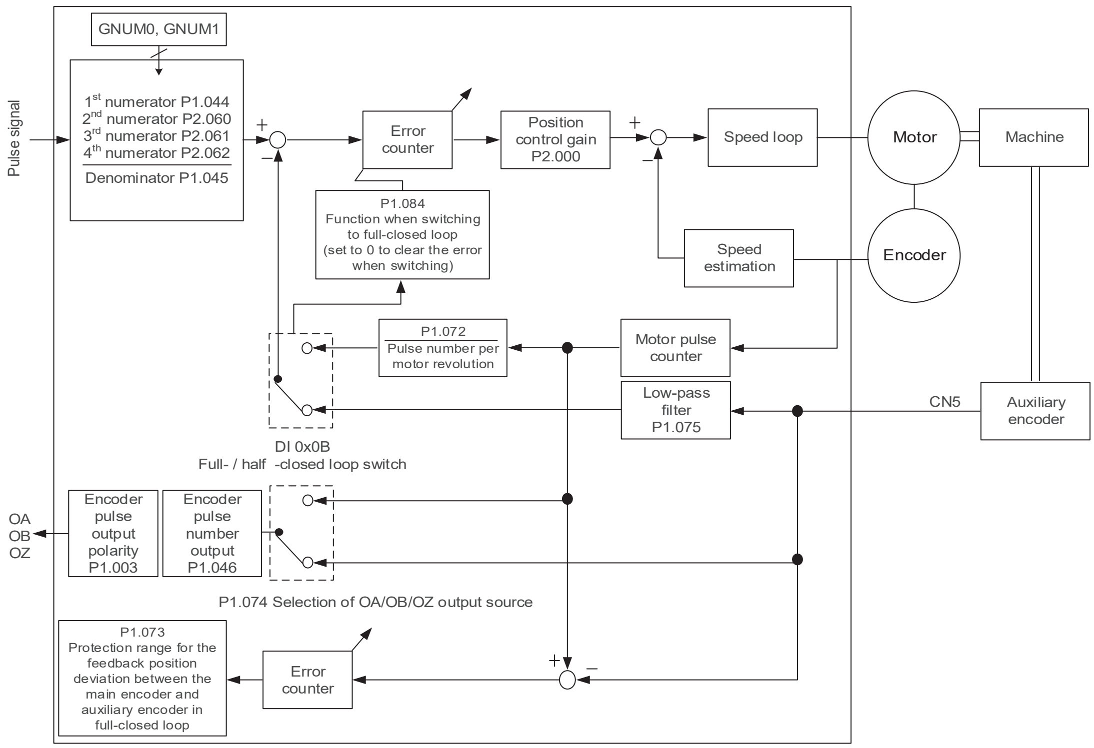
Specifications and Wiring Descriptions for the CN5 Signals:

Signal Type	A,B,Z Phase Signal
Operating voltage	5V
Signal format	Differential
Encoder power (5V) output	≤ 300mA
Max. pulse frequency	Single-phase pulse frequency: 4MHz

6.7.2 - Control structure

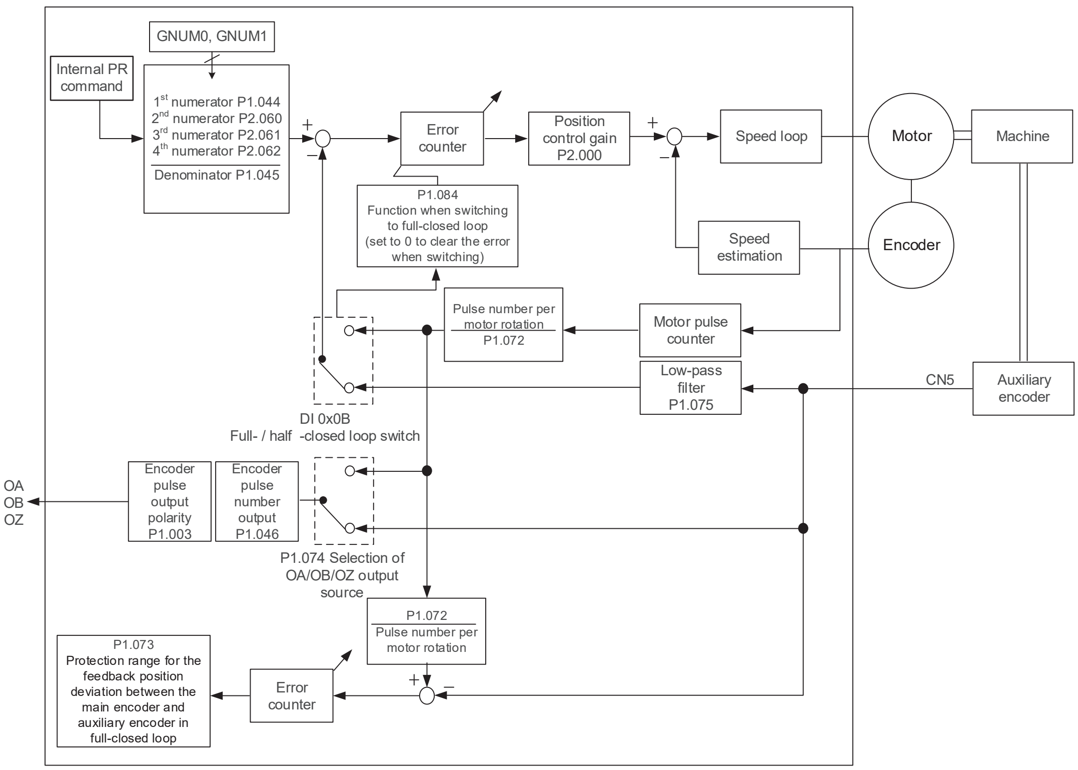
Full closed Loop Control Structure in PT Mode

When the servo is in full-closed loop control in PT mode, if the E-Gear ratio is set to $\frac{1}{1}$, one pulse from the command corresponds to one quadruple-frequency pulse from the auxiliary encoder. If the E-Gear ratio is set to $\frac{2}{1}$, one pulse from the command corresponds to two quadruple-frequency pulses from the auxiliary encoder.

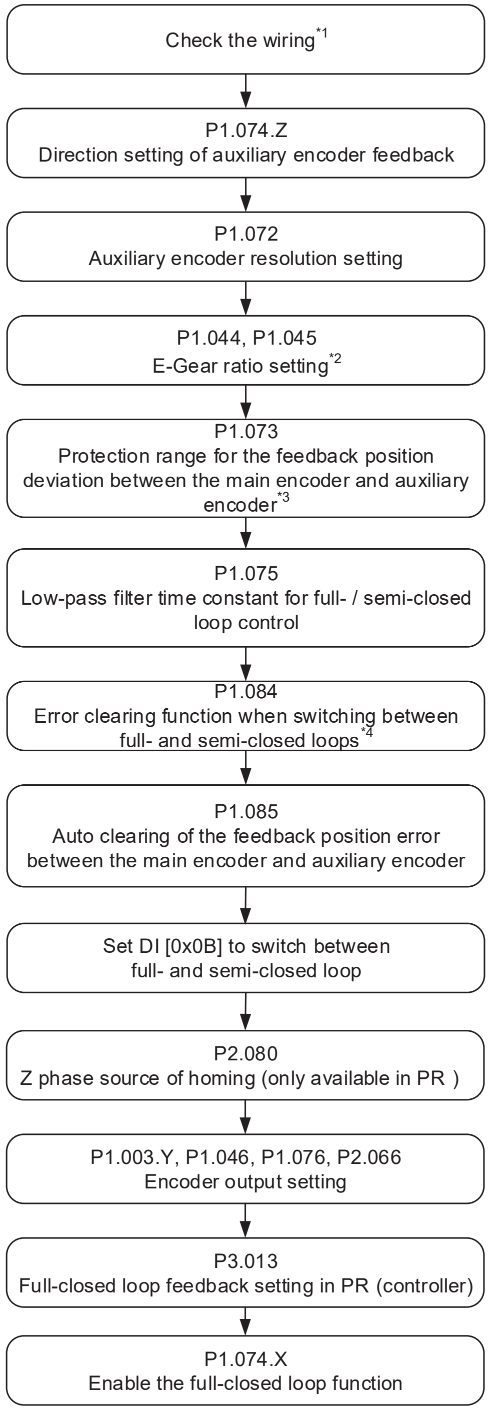


Full-closed Loop Control Structure in PR Mode

The servo is in full-closed loop control in PR mode (P1.001=1), full-closed loop function is enabled (P1.074.X=1), and full-closed loop to half-closed loop selection (DI [0x0B]) is set to OFF. When the servo is in full-closed loop control in PR mode, the E-Gear ratio should be set to $\frac{1}{1}$ for ease of use. With this setting, one PUU position command from the PR path corresponds to one quadruple-frequency pulse from the auxiliary encoder. If the E-Gear ratio is set to $\frac{2}{1}$, one PUU position command from the PR path corresponds to two quadruple-frequency pulses from the auxiliary encoder.



6.7.3 - Steps for setting the full-closed loop function



Notes:

1 - The auxiliary encoder (A, B, Z) is connected to the CN5 on the servo drive to form a full-closed loop. You can monitor whether the drive receives the feedback position from the auxiliary encoder with P5.017 or LED display.

2 - Set the E-Gear ratio to 1:1 to make PUU calculations easy.

3 - When setting the full-closed loop function for the first time, setting P1.073 too high can cause the auxiliary encoder to disconnect or trigger inverse direction causing motor continuous operation.

4 - This parameter is not available in PR mode. In PR mode, the error is automatically cleared when the system switches between full- and half-closed loops.

6.7.4 - Auxiliary encoder direction setting

P1.074	**Full-closed loop control for secondary or auxiliary encoder**		**Hex Address**	**Dec Address**
			0194H 0195H	40405 40406
Default:	0x0000	Control mode:	PT / PR (full-closed loop)	
Unit:	-	Setting range:	0000h–F132h	
Format:	HEX	Data size:	16-bit	

Settings:

0002

U Z Y X

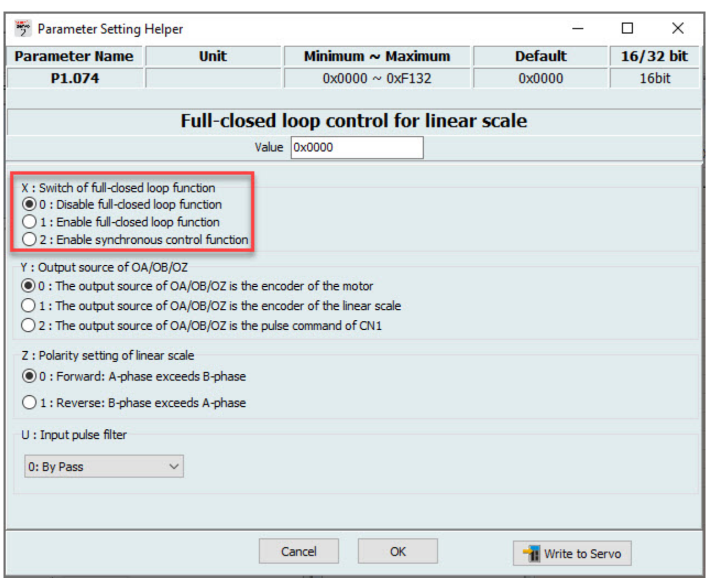
X	Full-closed loop control switch	Z	Positive / negative direction selection of auxiliary encoder feedback
Y	Source for OA / OB / OZ output	U	Auxiliary encoder filter function

- *X: full-closed loop*
  - *0: disable full-closed loop function*
  - *1: enable full-closed loop function*
- *Z: positive / negative direction selection of auxiliary encoder feedback*
  - *0: positive direction when A phase leads B phase of auxiliary encoder*
  - *1: positive direction when B phase leads A phase of auxiliary encoder*

Before using the full-closed loop control function, check if the feedback pulse of the auxiliary encoder increases or decreases in the same direction as the motor encoder. If the directions for the two feedback pulses are inverse, change the setting value of P1.074.Z to reverse the direction for the signal of the auxiliary encoder.

Here are the steps for checking the directions.

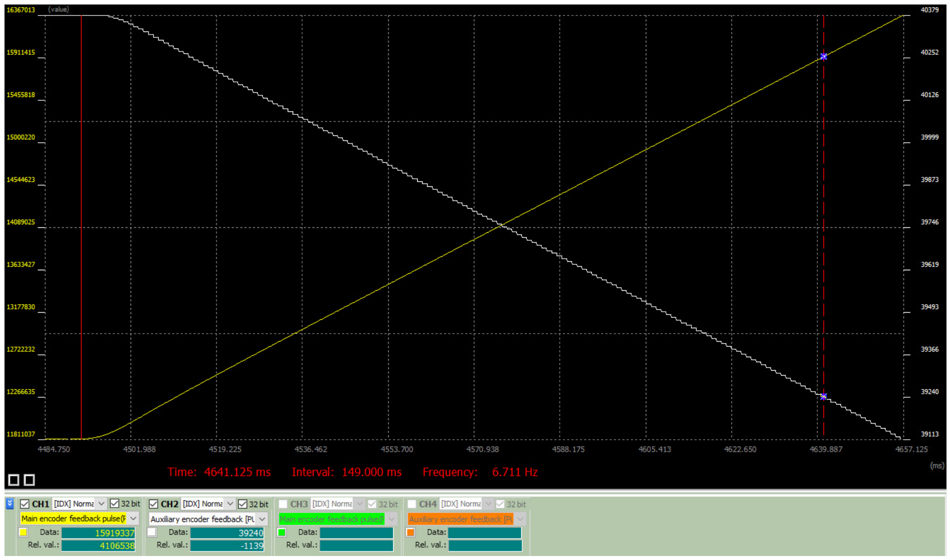
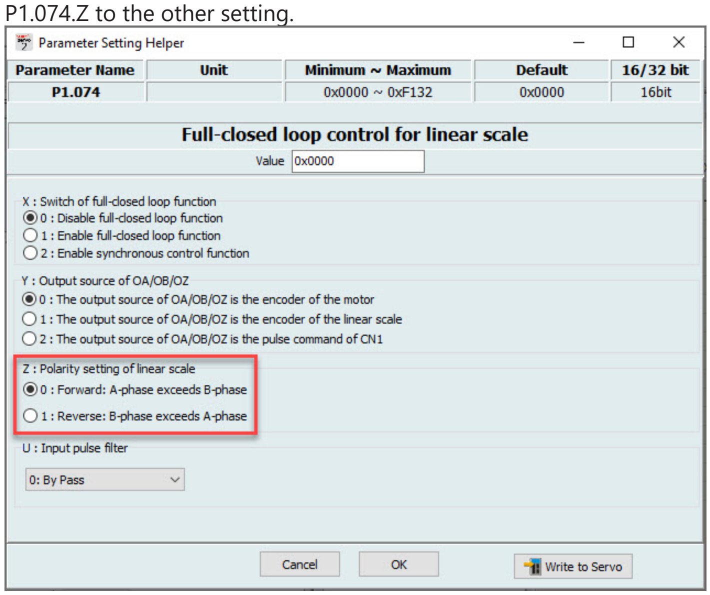
Step	Action
1	Disable the full-closed loop function by setting P1.074.X to 0.



<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>2</td><td>Open the software scope, select Main encoder feedback pulse [Pulse] for CH1 and Auxiliary encoder feedback [Pulse] for CH2, and then click Start to start the scope.

Use the JOG function to operate the motor in a single direction at a low speed. If you get two pulse signals which are in inverse directions (shown as follows), go on to Step 3 to adjust the parameter.

If the motor direction output control (P1.001.Z) is set to 1 then the trace will always have a negative slope when running in the forward direction when a scope channel is set to “Main encoder feedback pulse [pulse]”. Use “Feedback position [PUU]” if you have P1.001.Z=1.


</td></tr>
<tr><td>3</td><td>If the two pulse signals are in the inverse direction due to the previous setting of P1.074.Z. Switch P1.074.Z to the other setting.

</td></tr>
</table>

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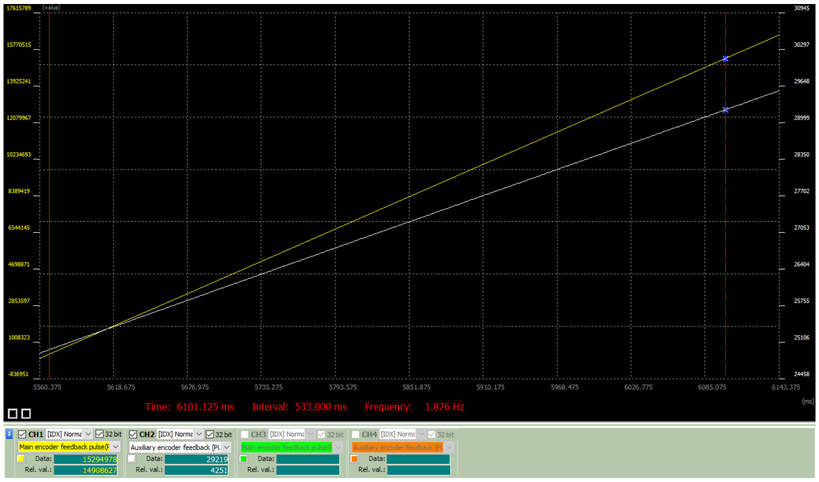
Step	Action
4	Go back to Step 2 to ensure the feedback pulses of the motor encoder and auxiliary encoder increase or decrease in the same direction. 

6.7.5 - Auxiliary encoder resolution setting

P1.072	Resolution of auxiliary encoder for full-closed loop control		Hex Address	Dec Address
			0190H 0191H	40401 40402
Default:	5000	Control mode:	PT / PR (full-closed loop)	
Unit:	pulse / rev	Setting range:	200–1280000	
Format:	DEC	Data size:	32-bit	

Settings:

A/B pulse count from the auxiliary encoder that equates to one revolution of the motor shaft. The 4x value needs to be entered here.

There are two methods for calculating the corresponding pulse number of the auxiliary encoder per motor revolution. One method calculates the theoretical value from hand calculations. The other calculates the actual value with the software scope of SureServo2 Pro. If the resolution of auxiliary encoder for full-closed loop control (P1.072) is incorrectly set, the position error between the auxiliary encoder feedback and the motor encoder accumulates during long-term operation, triggering AL040.

The encoder must be a line driver output AB Quadrature encoder with a Z pulse. If there is no Z pulse and one is not needed then the Z and Z/ signals need to be tied to +5V and 0V respectively to avoid an alarm.

Method 1: Calculating the Theoretical Value

To calculate the theoretical value for a machine using a screw transmission with an external encoder for full-closed loop control, the pitch and all gear ratios must be known as well as the resolution of the auxiliary encoder. The calculation will determine the corresponding number of pulses from the auxiliary encoder that equal one motor revolution. When the specifications of the screw and auxiliary encoder are known, you can calculate the value of P1.072.

Example 1:

If the screw pitch is 5mm (one revolution will translate to 5mm of linear travel) and the resolution of the auxiliary encoder is 0.5 µm between pulses, the calculation is as follows.

$$\frac{5\ mm}{0.5\ \mu m} = \frac{5000\ \mu m}{0.5\ \mu m} = 10000\ pulse = \ \mathrm{P1.072}$$

When the motor turns one revolution, the auxiliary encoder should produce 10,000 pulses.

Example 2:

Using a roll-on encoder that directly tracks a conveyor belt. The encoder is sold as a 1024ppr encoder. The drive will use the 4x multiplier of the AB quadrature signals so the true pulse count is 4096 ppr of the encoder for positioning calculations. For this example, the encoder wheel circumference is 317.6 mm.

$$\text{So } \frac{317.6\,mm}{4096\,pulses} = 0.0775\,mm/pulse$$

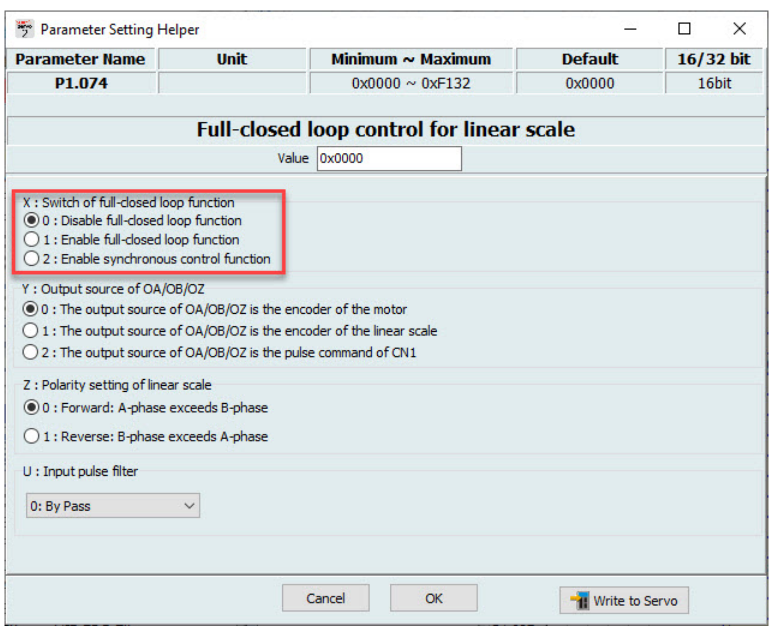
This means for every 0.0775 mm the conveyor travels, the aux encoder will output one pulse. If the distance the conveyor moves for one motor revolution is 375.23 mm then we can now calculate what to put into P1.072.

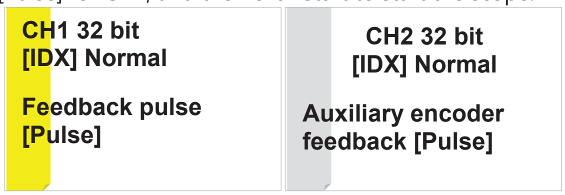
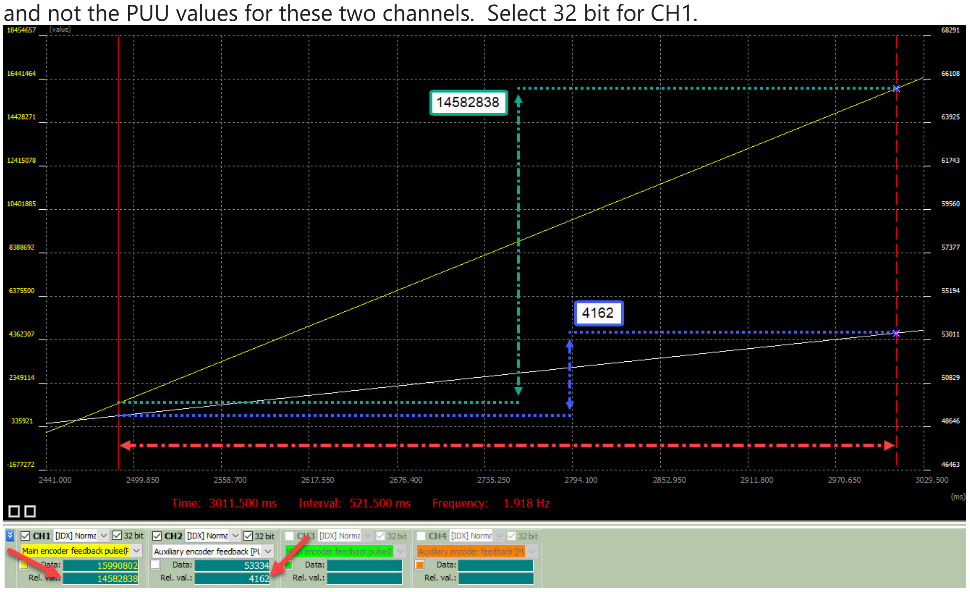
$$\frac{375.23\,mm/\textbf{motor revolution}}{0.0775\,mm/pulse} = 4841.70\ pulses$$

of the aux encoder per 1 motor rev revolution. Only integer values are allowed so P1.072 = 4842.

Method 2: Measuring the Actual Value with Motor Pulse Number (Short Distance)

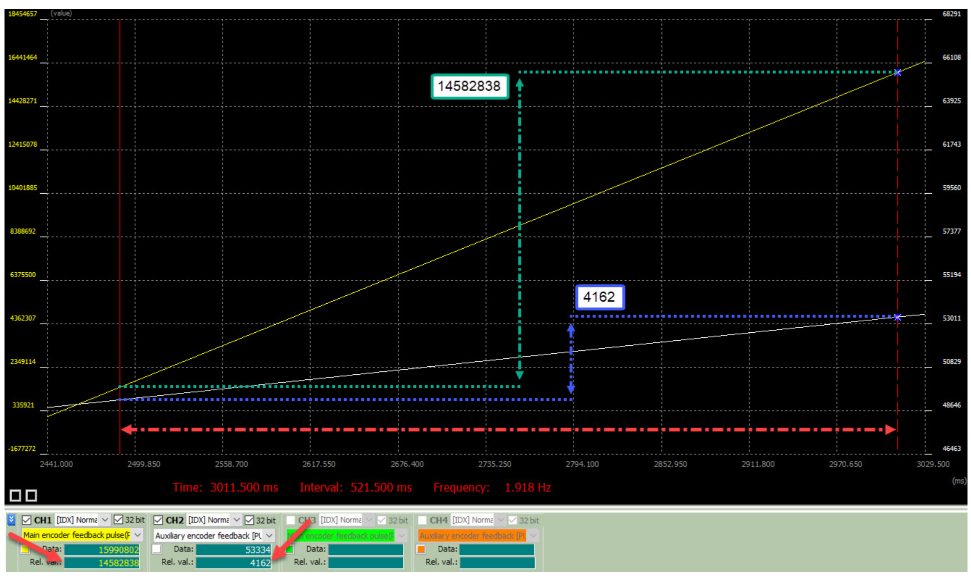
Calculating theoretical values is infeasible if the system does not use screws for transmission or the system consists of complex mechanical parts. In this case, use the JOG function to operate the motor in a single direction at low speed in the non full-closed loop mode, and calculate the value of P1.072 by using the software scope to monitor the feedback pulse number of the motor encoder and auxiliary encoder.

Step	*Action*
1	Disable the full-closed loop function by setting P1.074.X to 0. 

Step	Action
2	Open the software scope, select Feedback pulse [Pulse] for CH1 and Auxiliary encoder feedback [Pulse] for CH2, and then click Start to start the scope. 
3	Use the JOG function to operate the motor in a single direction at low speed, and observe the feedback pulse number from the two channels as shown in the following figure. Ensure that no slip is occurring on the auxiliary encoder during motion. Be sure you are reading the Pulse values and not the PUU values for these two channels. Select 32 bit for CH1. 
4	Use the two cursors to find the relative values (Rel. val.) of the two channels. Here you can see the motor moved 14582838 pulses. The auxiliary encoder traveled 4162 pulses in the same distance. According to the following formula, when the motor runs one revolution, the auxiliary encoder outputs 4788 pulses. This is not far off from the hand calculations of 4852 performed in the previous step. $\left\lvert\frac{\text{Auxiliary encoder (linear scale) pulse number} \times 16777216}{\text{Motor encoder pulse number}}\right\rvert = \frac{4162 \times 16777216}{14582838} \approx 4788$

Method 3: Measuring the Actual Value with Motor PUU Number (Long Distance)

If more accuracy is needed than provided by Method 2, then the auxiliary encoder should be allowed to travel a long distance before performing the calculations. Instead of using the JOG function from Method 2, you can use a PR path INC move that will move the motor a set number of exact rotations.

Step	Action
1	Enable full-closed loop function by setting P1.074.X to 1. You must also disable the full-closed/half-closed loop switching by assigning a DI to 0x0B and setting to ON so the drive is still in half-closed loop. Set P1.072 to an easy number such at 5000 and P1.044=1 and P1.045=1. This will cause the motor to have 5000 PUU per revolution for PR commands. If you have a more accurate number from Method 2, you can use that number instead. Configure a PR path to perform an incremental move of x10 or x100 the value entered in P1.074. In this example the PR path will move 100 exact revolutions of the motor by issuing a position command of 500000 (x100).
2	Open the software scope, select the following: CH1: Command Position [PUU] (32 bit) CH2: Auxiliary encoder feedback [Pulse] (32 bit) Then click Start to start the scope.
3	Run the PR path to have the motor run exactly 10 or 100 revolutions as was determined in step 1. Observe the Auxiliary encoder feedback [Pulse] number (Ref. value) with the first and second cursor placed at the zero speed zone at the beginning and end of the position move. 
4	Use the two cursors to find the relative values (Rel. val.) of the two channels. Here you can see the motor moved 500000 PUU which is 100 motor revolutions. The auxiliary encoder traveled 478073 pulses from start to stop. Since we know the move was exactly 100 motor revolutions then we just need to divide the aux encoder count by 100. The new more accurate value of P1.072 is 4781.

Method 1 resulted in 4852 pulses. This method is useful for calculating the value when all known ratios of the power transmission are known.

Method 2 resulted in 4788 pulses. This method is useful when the mechanics are unknown or hard to calculate and only a short position move is possible for the machine to perform.

Method 3 resulted in 4781 pulses. This method is useful when the mechanics are unknown or hard to calculate and a long position move is possible. Method 3 is the most accurate.

6.7.6 - Troubleshooting the full-closed loop function

Below are some helpful monitoring variables for troubleshooting the full-closed loop function. These can be monitored like any other monitoring variable using the LED display (P0.002), status monitoring registers (P0.009-P0.013), the status monitoring window, or using any of the channels in the Scope window. These codes can be found in section 8.4.11.

Variable	Code	Description
Feedback Position (PUU)	000	• Current feedback position of the motor encoder. Unit: (PUU). • When full-closed loop function is on (P1.074.X=1) the Feedback Position is referencing the PUU value set up in P1.044, P1.045, and P1.072. It does not matter if DI [0x0B] is set to full-closed or half-closed loop. • When in P1.074.X=1 and P3.013=1, this monitoring variable will show the feedback pulses of the auxiliary encoder, code 029. • When full-closed loop function is off (P1.074.X=0) the Feedback Position is referencing the PUU value set up in P1.044 and P1.045. Feedback Position will not reference P1.072.
Command Position (PUU)	001	• Current coordinate of the Position command. Unit: (PUU). • PT mode: number of pulse commands received by the drive. • PR mode: absolute coordinates of the Position command.
Auxiliary Encoder Feedback (PUU)	029	• Pulse counts directly from the auxiliary encoder (CN5). Unit: (PUU) • Same as code 048 but will get reset during homing routine.
Auxiliary Encoder CNT	048	• Pulse counts directly from the auxiliary encoder (CN5). Unit: (PUU) • Same as code 029 but will NOT get reset during homing routine or SV_OFF. Requires a power cycle to reset this value.
Main/Auxiliary Encoder Poistion Error (PUU)	031	• Feedback position deviation between the Command Position (Code 001) and auxiliary encoder CNT (Code 048). • This will show the accumulated error of the Auxiliary Encoder Feedback (Code 029) and/or Feedback Position (Code 000) compared to the Command Position (Code 001).
Auxiliary Encoder Position Error (PUU)	030	• Feedback position deviation between the Command Position (Code 001) and auxiliary encoder CNT (Code 048). • This will show the instantaneous error of the Auxiliary Encoder Feedback (Code 029) and/or Feedback Position (Code 000) compared to the Command Position (Code 001).
Main/Aux Encoder Deviation	115	• This variable is used for P1.073 and P1.085 fault protection. Like Code 031 but gets reset after the P1.085 number of motor revolutions has elapsed. • When using full closed loop, this variable will display the deviation between main encoder and auxiliary encoder. It will reset to zero once the number of motor revolutions entered in P1.085 have elapsed. If this value reaches the value entered in P1.073 before the P1.085 number of motor revolutions has been reached, then AL040 will occur. • A homing routine will not reset this value to 0. Setting SV_OFF will reset this value to 0.

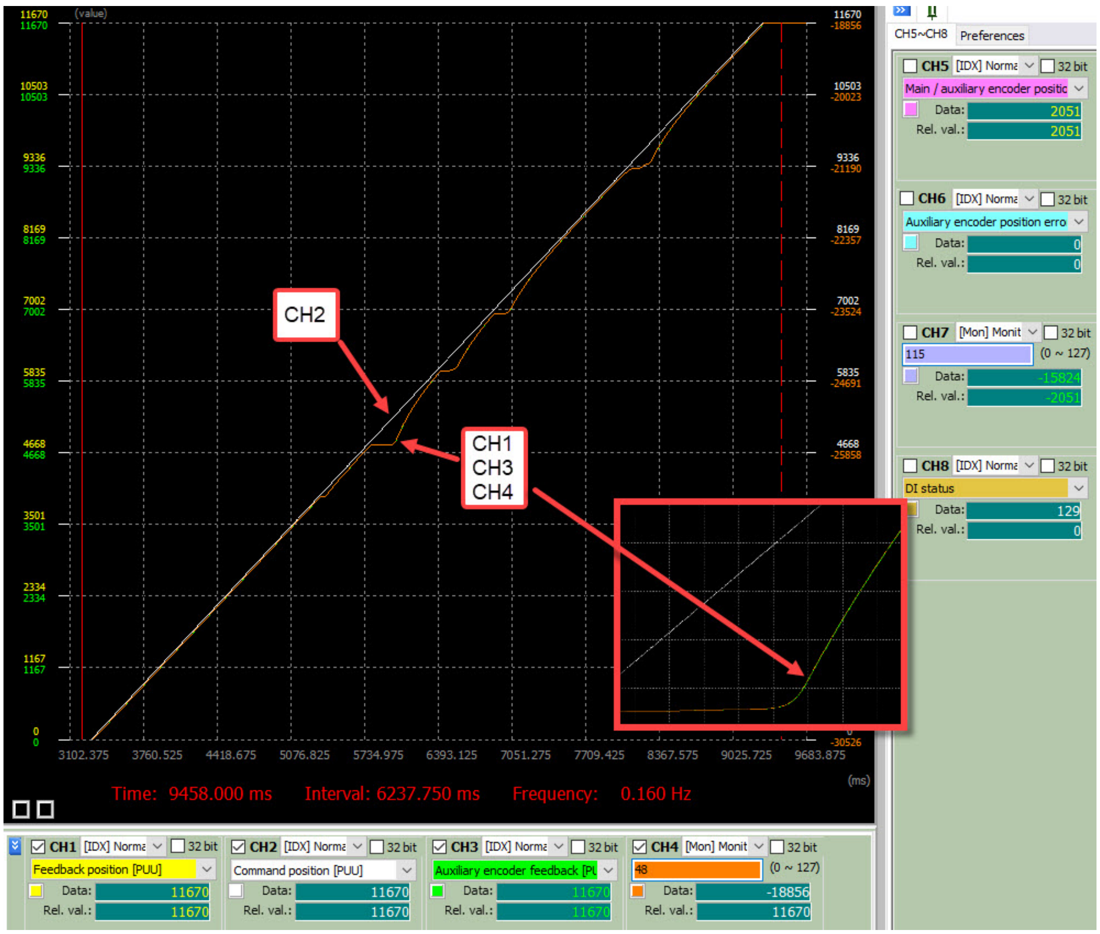
Example Trace:

Demonstration of traces below during a position move in full-closed loop mode.

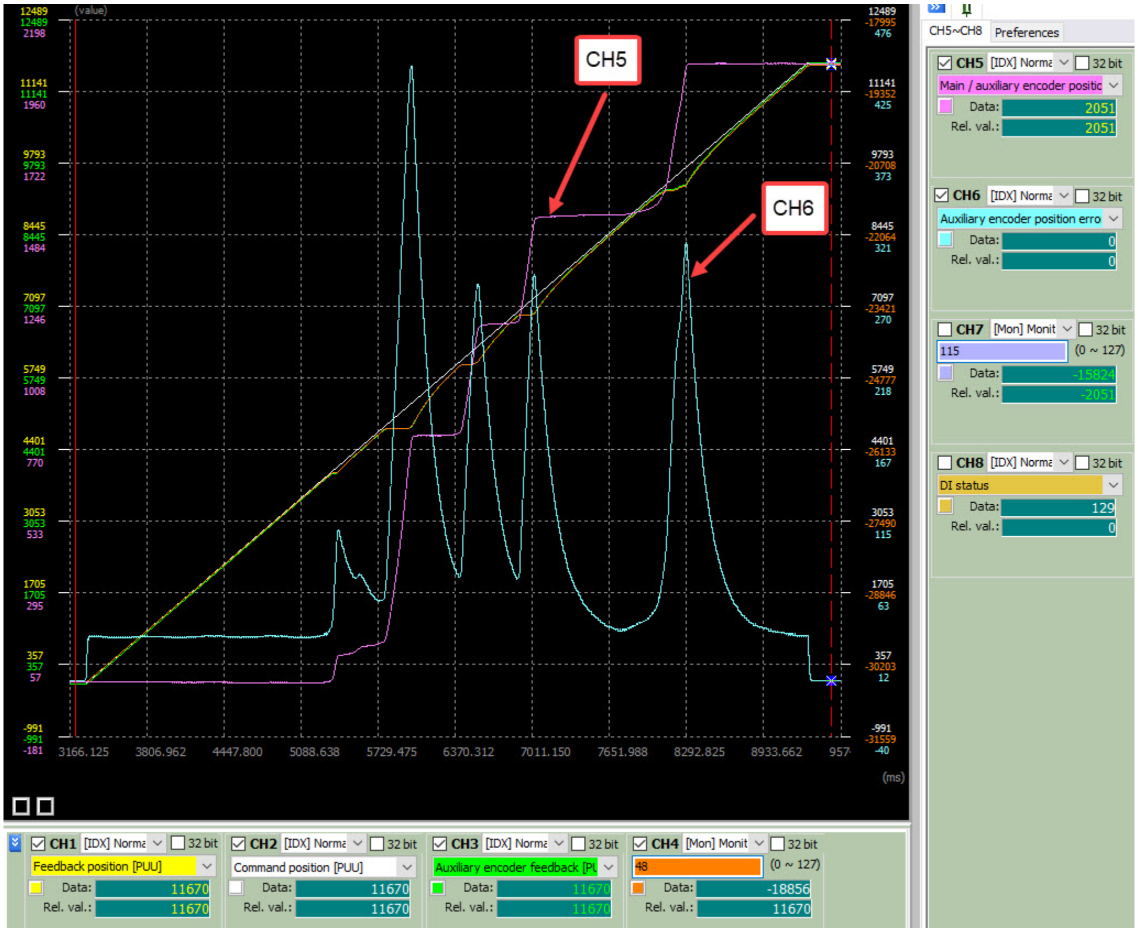
Parameter settings:

- *P1.072.X = 1*
- *P3.013.X = 1*
- *DI [0x0B] = Off*

In the below full-closed loop Scope capture you can see the Commanded position is linear and does not change (CH2). The encoder slips at several points along the move. Channels 1, 2, and 4 all show this and the traces are nearly identical.



In the same full-closed loop Scope capture below, with channel 5 and channel 6 turned on you can see how the Main/Auxiliary Encoder Position Error (CH 5) shows the accumulated error and the Auxiliary Encoder Position Error (CH 6) is showing the deviation at one moment in time.



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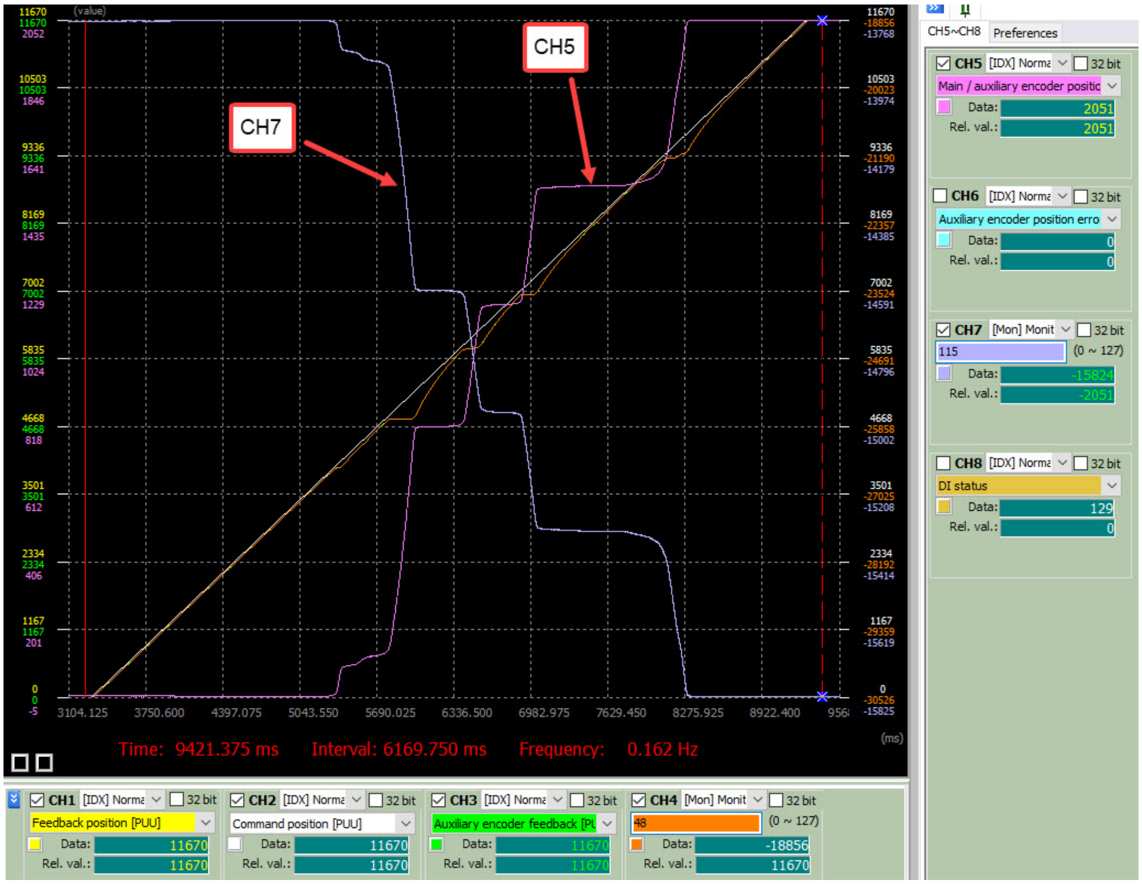
Again, in the same full-closed loop Scope capture below, with channel 5 and channel 7 turned on you can see how the Main/Auxiliary Encoder Position Error (CH 5) shows the accumulated error and the Main/Aux Encoder Deviation (CH 7) shows a similar trace in the opposite direction. Channel 7 shows the value that is monitored by P1.073. Once this absolute value reaches the value set in P1.073 then AL040 will occur. Positive or negative movement of this value just depends on the direction of travel during the deviation. The absolute value is all that P1.073 monitors. CH 5 gets reset during homing but CH 7 does not–a power cycle is required to reset CH 7.



6.7.7 - E-Gear settings

When the servo is in full-closed loop control, set both P1.044 and P1.045 to 1, this will make the value of P1.072 equal the motor PUU for one revolution when P1.074.X= 1.

6.7.8 - Protection range for feedback position error

P1.073	**Error protection range for full-closed loop control**		**Hex Address**	**Dec Address**
			0192H 0193H	40403 40404
Default:	30000	Control mode:	PT / PR (full-closed loop)	
Unit:	Pulse or PUU (based on the feedback of full-closed loop)	Setting range:	1 to (2^{31}-1)	
Format:	DEC	Data size:	32-bit	

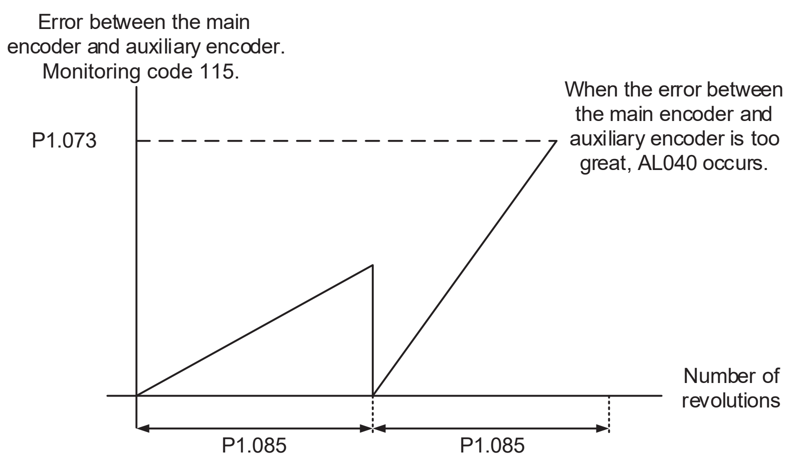
Settings:

Stopping the motor may be necessary when the deviation between the auxiliary encoder and the motor encoder feedback position is excessive due to a loose connector, an encoder failure, or other mechanical problems. This deviation can be monitored using monitoring variable code 115 in P0.001 or in the SureServo2 Pro Scope.

This parameter works in conjunction with P1.085. After the number of motor revolutions has occurred as defined in P1.085 the accumulated error measured in monitoring code [115] gets reset to 0.

When the deviation is greater than the value of P1.073, AL040 (excessive deviation of full closed-loop position control) occurs. To completely avoid this alarm, set P1.073 high and P1.085=1.

$$\text{P1.073} < (\text{Main encoder feedback} \times \frac{P1.072}{16777216}) - \text{Auxiliary encoder feedback}$$



6.7.9 - Setting low-pass filter time constant

P1.075	**Low-pass filter time constant for full- and half-closed loop control**		**Hex Address**	**Dec Address**
			0196H 0197H	40407 40408
Default:	100	Control mode:	PT / PR (full-closed loop)	
Unit:	ms	Setting range:	0–1000	
Format:	DEC	Data size:	16-bit	

Settings:

When the stiffness of the mechanical system between full-closed and half-closed loops is insufficient, set the proper time constant to enhance the stability of the system. In other words, this filter temporarily blends full-closed loop and half-closed loop feedback to establish a stable start and stop position, and after stabilizing, the full-closed loop effect is in 100% control. When the stiffness is sufficient, set to disable.

A half-closed loop is referring to the encoder on the back of the servo motor being the feedback device for the drive to close the velocity and position loop. For a fully-closed loop system, this is referring to the motor's encoder being used to close the velocity loop and an external encoder connected to CN5 to close the position loop.

Set the value to 0 to disable the low-pass filter (bypass) function.

If the stiffness of the mechanical system is high, decrease the value of P1.075, or set the value to 0 to disable. If the stiffness of the mechanical system is low, increase the value of P1.075.

When an extremely flexible mechanism is using full-closed loop control and when the motor starts turning, the external encoder might get some unstable feedback due to the flexible structure. So increasing the low pass filter (P1.075) can decrease the unstable level of the feedback.

This parameter will mitigate any fluctuations seen in the external encoder when in full-closed loop control when starting and stopping. The servo will partially act as a half-closed loop system and use the servo motor's encoder to reduce instability of the load, and after the motion of the load is stabilized, the full-closed loop function is turned back on. This filter blends the two encoder feedback signals during feedback instability.

6.7.10 - Setting error clearing function

P1.084	***Error clearing function when switching between full- and half-closed loops***	***Hex Address***	***Dec Address***
		01A8H 01A9H	40425 40426
Default:	0x0000	Control mode:	PT (full-closed loop)
Unit:	-	Setting range:	0x0000 – 0x0001
Format:	HEX	Data size:	16-bit

Settings:

This parameter is not available in PR mode. In PR mode, the error is automatically cleared when the systems switches between full- and half-closed loops.

0002

U Z Y X

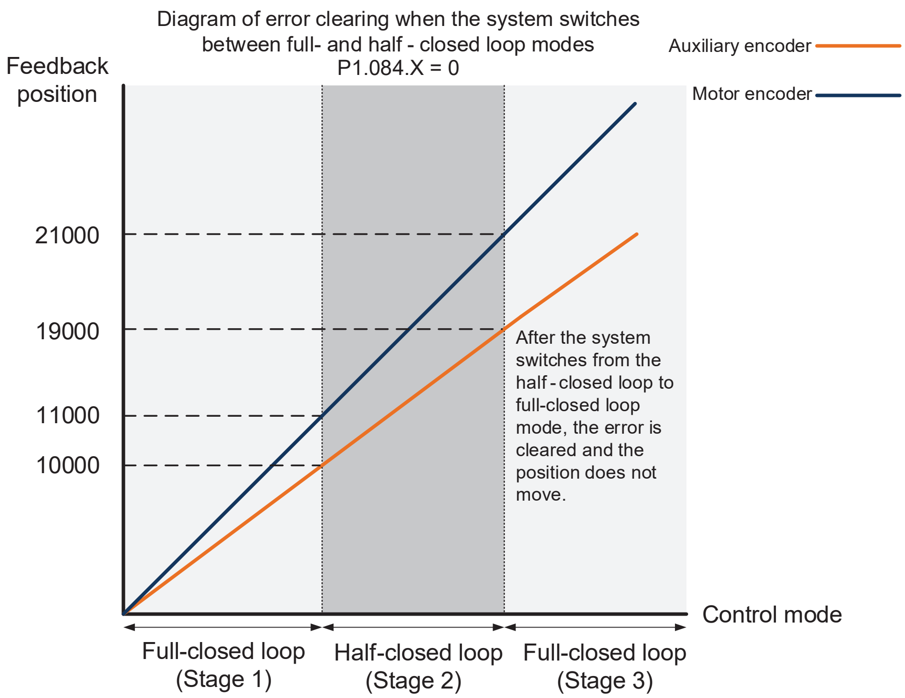
X	Error clearing function when the system switches from half-closed loop to full-closed loop	Z	Reserved
Y	Reserved	U	Reserved

- *X: Error clearing function when the system switches from half-closed loop to full-closed loop*
  - *0: clear the error when switching.*
    When the system is in half-closed loop, the command refers to the motor encoder and the position does not move after the system switches to full-closed loop.
  - *1: no clearing of the error when switching.*
    When the system is in half-closed loop control, the command refers to the motor encoder. After the system switches to full-closed loop, the command issued in half-closed loop becomes the full-closed loop command, and thus the position moves.

Note: Use DI [0x0B] to switch between full- and half-closed loop modes (P1.074.X must equal 1).

Examples:

Error Cleaning Enabled (P1.084.X=0)



Stage 1: full-closed loop control (feedback position of the auxiliary encoder)

If the servo drive issued a position command of 10,000 PUU and the feedback position of the auxiliary encoder is 10,000 PUU, the final feedback position of the motor encoder is 11,000 PUU due to the backlash and sliding of the mechanical parts.

Stage 2: half-closed loop control (feedback position of the motor encoder)

Use DI [0x0B] to switch the control mode from full-closed loop to half-closed loop, and then issue the position command of 10,000 PUU again. In half-closed loop control, since the command refers to the position of the motor encoder, the feedback position of the motor encoder is 21,000 PUU, but the feedback position of the auxiliary encoder is 19,000 PUU. In this mode, there is an error of 1,000 PUU between the auxiliary encoder (19,000 PUU) and the position command (20,000 PUU).

Stage 3: full-closed loop control (feedback position of the auxiliary encoder)

When you set P1.084 to 0, the error will be cleared. Thus, after using DI [0x0B] to switch the control mode from half-closed loop to full-closed loop, the feedback position of the auxiliary encoder is not corrected.

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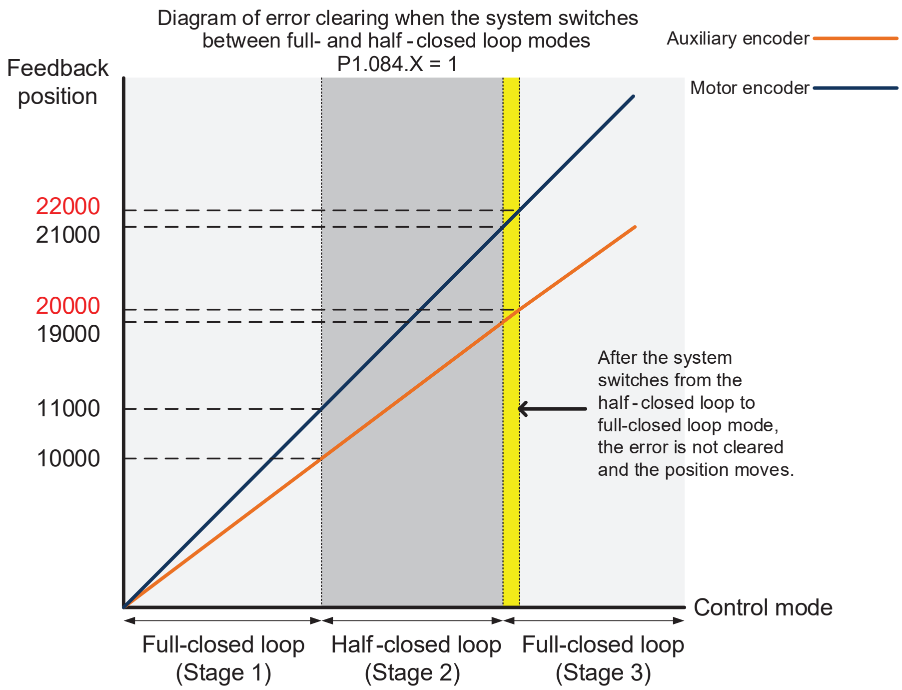
Error Clearing Disabled (P1.084.X=1)



Stage 1: full-closed loop control

If the servo drive issued a position command of 10,000 PUU and the feedback position of the auxiliary encoder is 10,000 PUU, the final feedback position of the motor encoder is 11,000 PUU due to the backlash and sliding of the mechanical parts.

Stage 2: half-closed loop control

Use DI [0x0B] to switch the control mode from full-closed loop to half-closed loop, and then issue the position command of 10,000 PUU again. In half-closed loop control, since the command refers to the position of the motor encoder, the feedback position of the motor encoder is 21,000 PUU, but the feedback position of the auxiliary encoder is 19,000 PUU. In this mode, there is an error of 1,000 PUU between the auxiliary encoder (19,000 PUU) and the position command (20,000 PUU).

Stage 3: full-closed loop control

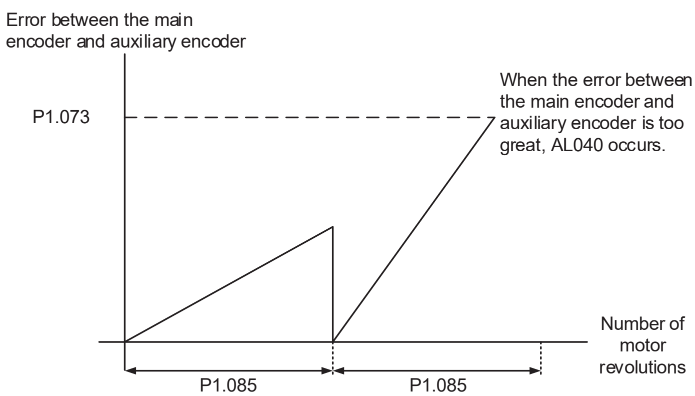
When you set P1.084 to 1, the error will not be cleared. Thus, after using DI [0x0B] to switch the control mode from half-closed loop to full-closed loop, the feedback position of the auxiliary encoder is corrected and the motor moves to the corresponding position (yellow area as shown in the above figure). The previous half-closed loop command becomes the full-closed loop command and refers to the auxiliary encoder to move the mechanical part to the position corresponding to the actual command. The final feedback position of the auxiliary encoder is 20,000 PUU.

6.7.11 - Auto clearing feedback position error

P1.085	Auto clearing position deviation between motor and auxiliary encoder		Hex Address	Dec Address
			01AAH 01ABH	40427 40428
Default:	0	Control mode:	PT/PR (full-closed loop)	
Unit:	rev	Setting range:	0–32767	
Format:	DEC	Data size:	16-bit	

Settings:

This parameter sets the upper limit of the feedback position error between the main encoder and auxiliary encoder. When the number of motor revolutions is greater than or equal to this parameter value, the system automatically clears the error. When set to 0 the parameter is disabled. The deviation value will not reset regardless of the number of motor revolutions. Once the deviation reaches P1.073 then an AL040 will occur.



6.7.12 - Set DI [0x0B] to Switch Between Loop Modes

DI [0x0B] is effective only when the full-closed loop function is enabled (P1.074.X = 1). When the full-closed loop function is disabled (in P1.074.X), the PUU setting of P1.072 is ignored.

DI [0x0B] must be OFF for a full-closed loop feedback from the aux encoder.

Example 1 illustrates the half-closed loop mode when the full-closed loop function is enabled (P1.074.X=1). Example 2 illustrates the half-closed loop function which is normally used in servo applications (P1.074.X=0).

The PUU value of P1.072 is effective when the full-closed loop function is enabled (P1.074.X=1) whether DI [0x0B] is ON or OFF.

Example 1:

Enable the full-closed loop function (P1.074.X = **1**), set DI [0x0B] to ON, E-Gear ratio to 1:1, and P1.072 = 5000.

To have the motor run a cycle when the full-closed loop function is enabled, the position command has to be 5000.

Example 2:

Disable the full-closed loop function (P1.074.X = **0**), set DI [0x0B] to ON, E-Gear ratio to 1:1, and P1.072 = 5000.

To have the motor run a cycle when the full-closed loop function is disabled, the position command has to be 16777216 because the DI [0x0B] setting is ignored and the setting of P1.072 is ignored.

Value: 0x0B			
DI Name	***Description***	***Triggering Method***	***Control Mode***
FHS	Switch between full- and half-closed loop modes.	Level triggered	PT / PR full-closed loop

6.7.13 - Z pulse source of homing

P2.080	***Z pulse source of homing***		***Hex Address***	***Dec Address***
			02A0H 02A1H	40671 40672
Default:	0x0000	Control mode:	PR (full-closed loop)	
Unit:	–	Setting range:	0x0000 – 0x0011	
Format:	HEX	Data size:	16-bit	

Settings:

When you execute homing and have the servo look for the Z pulse, use this parameter to set either the Z pulse of the motor or the Z pulse of the auxiliary encoder as the homing origin. Select the auxiliary encoder to achieve higher positioning precision. Note this is only available in PR mode.

X	Z pulse source of full-closed loop homing	Z	Reserved
Y	Z pulse source of half-closed loop homing	U	Reserved

- *X: Z pulse source of full-closed loop homing*
  - *0: auxiliary encoder*
  - *1: motor*
- *Y: Z pulse source of half-closed loop homing*
  - *0: motor*
  - *1: auxiliary encoder*

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6.7.14 - Encoder output settings

P1.003	**Analog and Encoder Pulse Output Polarity**		**Hex Address**	**Dec Address**
			0106H 0107H	40263 40264
Default:	0x0000	Control mode:	All	
Unit:	-	Setting range:	0–13	
Format:	HEX	Data size:	16-bit	
Related Parameters	P0.003, P1.004, P1.005			

Settings:

0002

U Z Y X

X	Polarity of monitor analog output	Y	Polarity of encoder pulse output	UZ	Reserved

- *X: polarity of monitor analog output*
  The MON1 and MON2 analog output terminals have a max output of ±8V. This equals an 8-volt swing about the center of the GND reference. The X nibble does not slide the center point of the analog output but can invert the MON1 or MON2 output signal. A (+) means normal polarity and (-) means inverted polarity. P1.004 and P1.005 can adjust the proportional output.
  - *0: MON1(+), MON2(+)*
  - *1: MON1(+), MON2(-)*
  - *2: MON1(-), MON2(+)*
  - *3: MON1(-), MON2(-)*
- *Y: polarity of encoder pulse output*
  - *0: pulse output in forward direction*
  - *1: pulse output in reverse direction*
- *UZ: reserved*

P1.046▲	**Encoder Pulse Number Output**		**Hex Address**	**Dec Address**
			015CH 015DH	40349 40350
Default:	2500	Control mode:	All	
Unit:	Pulse	Setting range:	20–536870912	
Format:	DEC	Data size:	32-bit	
Related Parameters	P1.074, P1.076, P1.097			

Settings:

The number of single-phase pulse outputs per revolution for **OA and OB terminals**; the maximum output frequency of the hardware is 19.8 MHz.

Notes:

The following circumstances may result in exceeding the maximum allowable output pulse frequency of the drive, causing AL018:

1) Encoder error
2) The motor speed is faster than P1.076
3) Source= Motor Encoder: If P1.074.Y = 0 and P1.097 = 0, motor speed (rpm)/60 x P1.046 x 4 > 19.8×10^6
   Source= Auxiliary Encoder: if P1.074.Y = 1 and P1.097 = 1, motor speed (µm/s)*1000/16777216 x P1.046 > 19.8×10^6

P1.076▲	Maximum speed for encoder output (OA, OB)		Hex Address	Dec Address
			0198H 0199H	40409 40410
Default:	5500	Control mode:	All	
Unit:	rpm	Setting range:	0–6000	
Format:	DEC	Data size:	16-bit	

Settings:

Input the actual maximum speed of the motor or the maximum speed of the application. When you set the value to 0, the smoothing function is disabled.

The setting of P1.076 and P1.046 should follow the two requirements below:

- *P1.076 > motor speed*
- $\frac{\text{Motor speed}}{60} \times \text{P1.046} \times 4 < 19.8 \times 10^6$

P2.066	Special bit register 2		Hex Address	Dec Address
			0284H 0285H	40645 40646
Default:	0x0000	Control mode:	PT / PR / S / Sz	
Unit:	-	Setting range:	0x0000–0x182F	
Format:	HEX	Data size:	16-bit	

Settings:

Bit	7	6	5	4	3	2	1	0
Bit	15	14	13	12	11	10	9	8

- *Bit 0–1, Bit 3, Bit 7–8, Bit 10–11, Bit 13–15: reserved*
- *Bit 2: cancel low-voltage error latch function.*
  - *0: enable the low-voltage error AL003 latch function; the error is not cleared automatically.*
  - *1: disable the low-voltage error AL003 latch function; the error is cleared automatically.*
- *Bit 4: disable AL044 detection (servo function overload warning).*
  - *0: enable AL044 detection.*
  - *1: disable AL044 detection.*
- *Bit 5: enable AL041 disconnection detection of linear encoder (only when the full-closed loop control function is activated).*
  - *0: enable AL041 detection.*
  - *1: disable AL041 detection.*
- *Bit 6: RST power error (AL022) latch*
  - *0: disable the latch; RST power error (AL022) is cleared automatically.*
  - *1: enable the latch; RST power error(AL022) is not cleared automatically.*
- *Bit 9: set AL003 Low-voltage as a warning or an alarm.*
  - *0: set AL003 as WARN.*
  - *1: set AL003 as ALM.*
- *Bit 12: set AL022 (RST power error) as ALM or WARN*
  - *0: set AL022 as WARN.*
  - *1: set AL022 as ALM.*

6.7.15 - Full-closed loop feedback source for the controller

P3.013	Full-closed Loop Feedback Source for the Controller		Hex Address	Dec Address
			031AH 031BH	40794 40795
Default:	0x0000	Control mode:	PR (full-closed loop)	
Unit:	-	Setting range:	0x0000 – 0x0022	
Format:	HEX	Data size:	16-bit	

Settings:

0002

U Z Y X

X	Encoder feedback source in full-closed loop control	Y	Z pulse offset source in full-closed loop mode (motor/auxiliary encoder)

- *X: encoder feedback source in full-closed loop control.*
  - *0: feedback pulse number from the motor*
  - *1: feedback pulse number from the auxiliary encoder*
  - *2: in half-closed loop control, the feedback pulse is from the motor; in full-closed loop control, the feedback pulse is from the auxiliary encoder*
- *Y: Z pulse offset source in full-closed loop mode (motor/auxiliary encoder)*
  - *0: motor*
  - *1: auxiliary encoder*
  - *2: in half-closed loop control, the motor's Z pulse offset is used; in full-closed loop control, the auxiliary encoder's Z pulse offset is used.*

Note: This parameter setting is different from P1.074.Y (switch between motor encoder and auxiliary encoder). This parameter only modifies the feedback signal source uploaded to the controller. Set P3.013 to 0x0022 to avoid misoperation when the motor is in the Servo On state.

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6.7.16 - Troubleshooting full-closed loop alarms

AL040 Excessive Deviation of Full Closed-Loop Position Control	
Trigger condition and causes	Condition: excessive deviation of full closed-loop position control. Cause: 1) The setting value of P1.073 is too low. 2) The connector may be loose or there is a problem when the connector connects to the mechanical parts. 3) The input value for P1.072 can only be an integer. However, when the motor runs a cycle, if the number of A/B pulses in a full-closed loop is not an integer, the position error between the motor encoder and the auxiliary encoder accumulates. Thus, you need to set P1.085 to avoid triggering AL040.
Checking methods and corrective actions	1) Check the value for P1.073. If the value is too low, please set a higher value. 2) Make sure the connector is firmly connected and there is no problem in connecting the mechanical load. 3) Check if the value of P1.085 is set properly.
How to clear the alarm?	DI.ARST

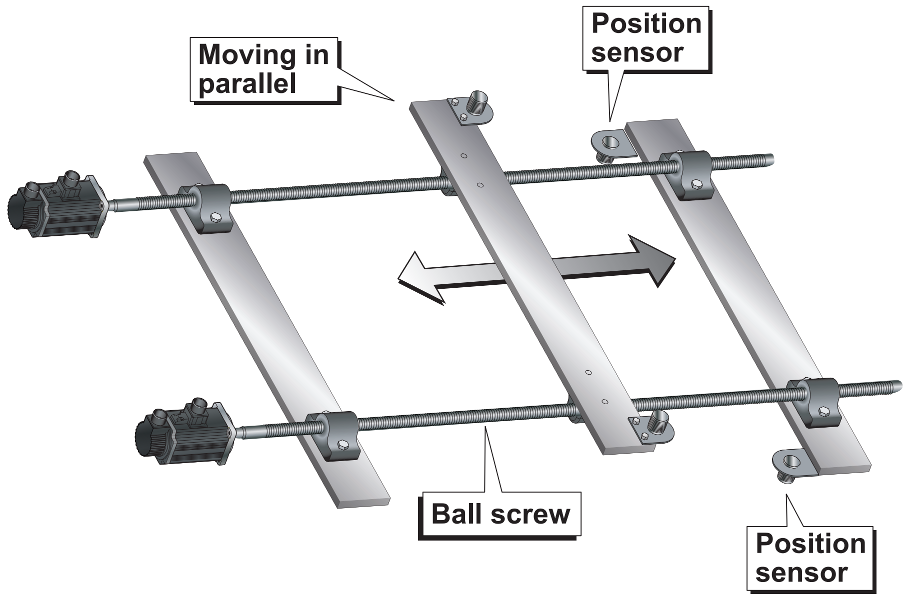
AL041 CN5 Encoder is Disconnected	
Trigger condition and causes	CN5 communication is cut off.
Checking methods and corrective actions	1) Check the communication circuit of CN5. 2) When CN5 is not in use, ensure P1.074.X is set to 0.
How to clear the alarm?	DI.ARST

6.8 - Gantry Mode

This section explains the gantry setting and how gantry works when it is used on SureServo2. The Gantry function allows both motors to watch the other's position and if they get too far out of alignment then both drives will fault out and stop.

6.8.1 - How does gantry mode work?

When two axes control a platform, they must move with the same speed as significant speed deviation between the two axes could damage the mechanism. Synchronizing the motion of the two axes is the top priority. See the example below:



The built-in gantry control function for SureServo2 drives allows the controller to synchronize motion automatically. If position devation exceeds the permitted range, an AL081 alarm will occur and the system will stop working. In this application, an open-loop control is used by the host controller and the servo system; the function of the host controller is to send position commands. The host controller is in charge of the alignment and homing control of two axes. If using the Z pulse as the homing origin, the host controller requires the capability to respond to the fast Z pulse signal of 66μs from the drive.

If misalignment of two axes does not occur or is not possible on the user's mechanism, then the positioning or homing function is not needed. Otherwise, positioning or homing is required before gantry mode is enabled because after the machine is moving the alignment between the two axes cannot occur.

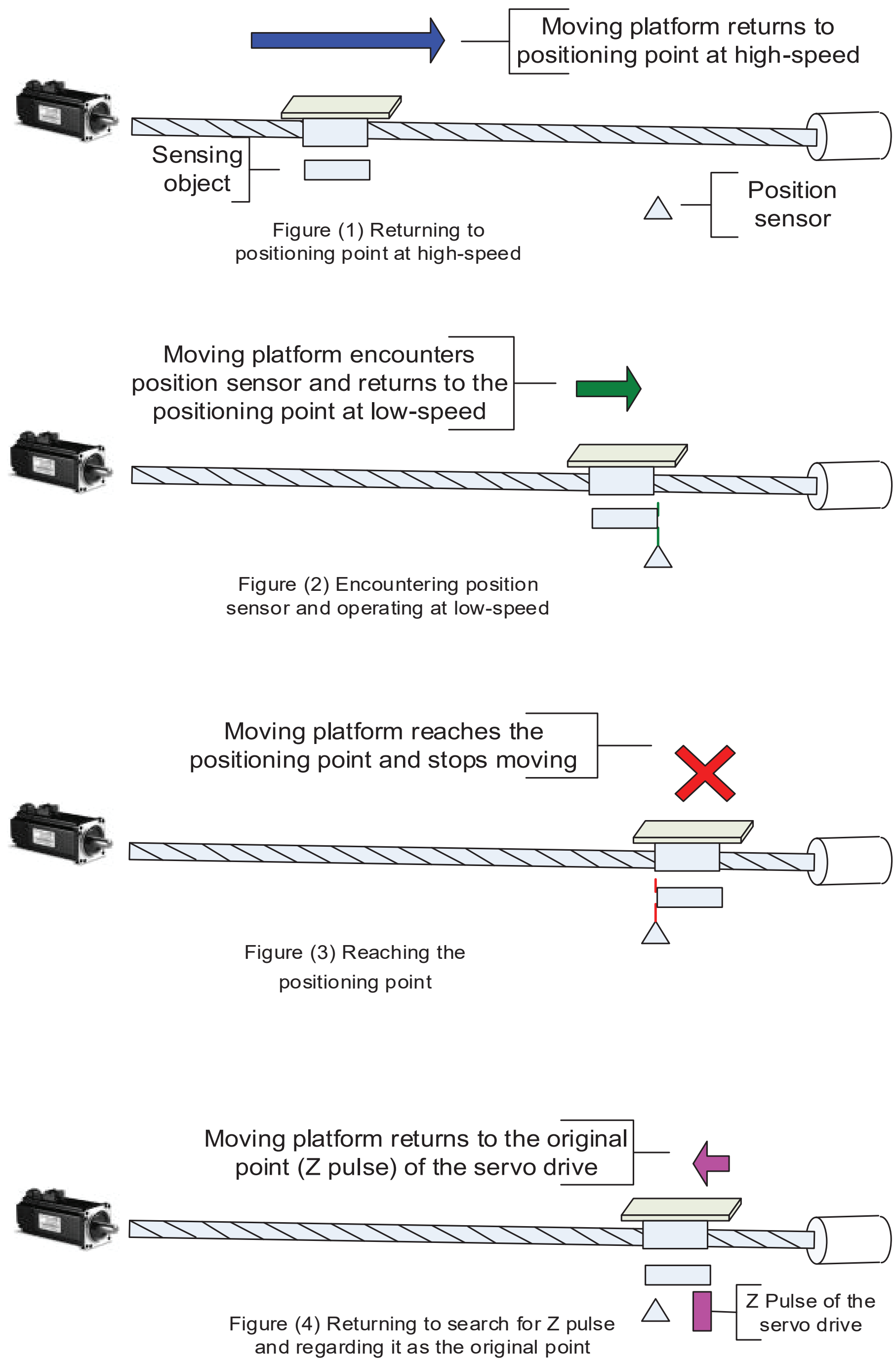
Gantry mode can be used in two ways. The simplest way is just to monitor the position deviation between the two axes and if the position difference is greater than the preset limit then an alarm will activate and the axes will stop. This is the easiest protection method in a difficult to tune system.

The second and more difficult method is to use the synchronous control bandwidth which blends the error of the two axes speed loops together so they sync to each other. Applying this method can cause the individual tuning of each drive to perform different and resonate.

6.8.2 - Positioning and Homing of Gantry

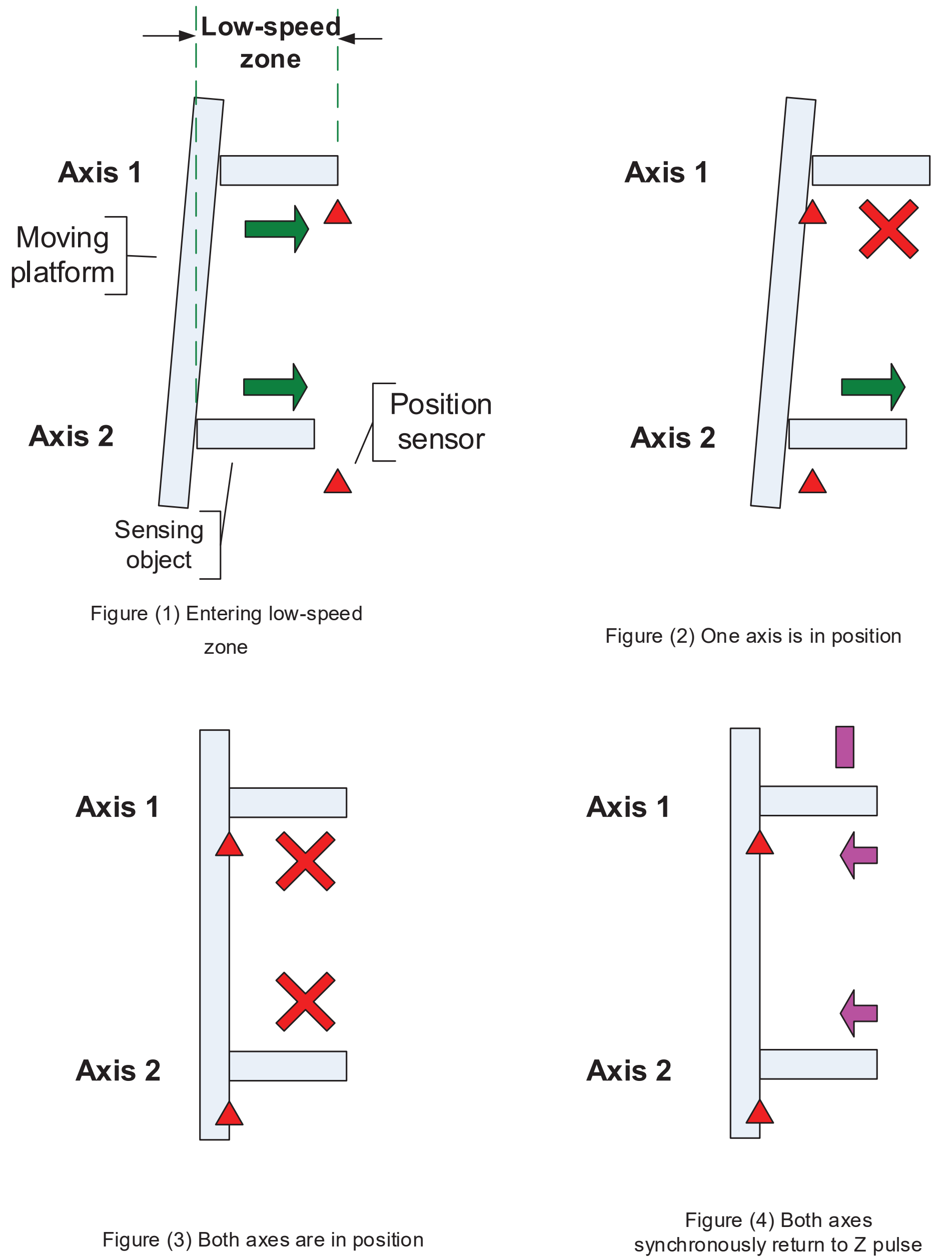
Homing and proper alignment of the two axes by the host controller must be done before using the Gantry function. It is up to the user to create a proper homing or position routine that aligns the two axes. Homing is completed by a position sensor installed on the side of each axis. This position sensor must be precisely installed since it is this sensor that ensures the gantry axes are aligned correctly. Adjust the length and running speed of the sensor according to system requirements. The illustration “Returning to Positioning Point and Homing Origin” on page 6–60 shows the positioning control; after positioning is finished, this point can be regarded as the homing origin (shown in figure (3)). Or, as shown in figure (4), the nearest Z pulse can also be the homing origin (either moving forward or backward to look for Z). The homing method will vary depending on the application.

After alignment, the host controller should then take control of both axes simultaneously to home the gantry and look for just one of the axes Z pulse signals or home sensors.



Returning to Positioning Point and Homing Origin

The figure below demonstrates the gantry misalignment before positioning. If position deviation between two axes exists, one of the axes will arrive at the low-speed zone earlier than the other. When any of the axes reaches the low-speed zone, the entire system will operate at low speed. Due to the deviation, the axis entering the low-speed zone first will reach the positioning point earlier. In figure 1 below, Axis 1 reaches the positioning point first and stops and waits for Axis 2 to arrive. After both axes reach the positioning point, both axes can then move forward (or backward) at the same time and look for Z pulse as the homing origin. The positioning point can also be regarded as homing origin as needed for different applications and demands.



System Positioning and Homing

6.8.3 - Motion Following

When gantry alignment is complete and the axes have returned to the home origin, the host controller sends the same position commands (pulses) to each drive so the two axes are synchronized. The drive must be operated in PT mode. The host controller is responsible for all acceleration/deceleration times.

6.8.4 - Servo System Wiring

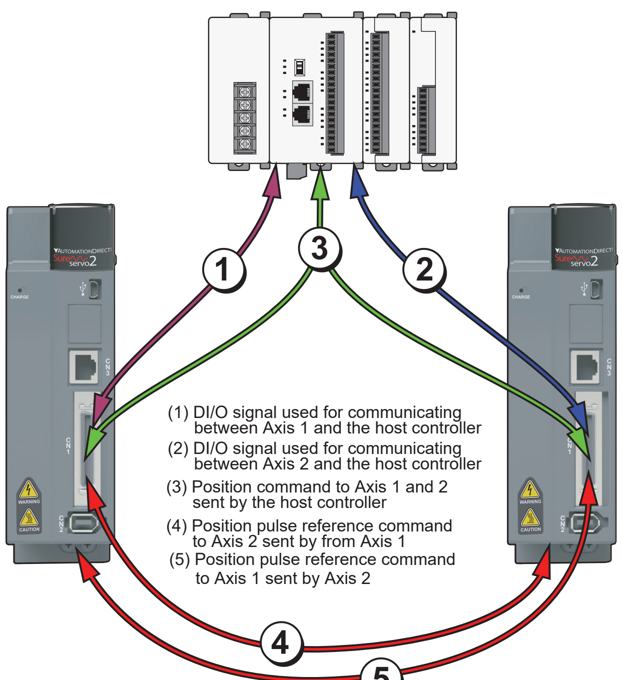
The System Connection Diagram (below) shows the basic connections of the entire system. Users may apply different applications according to actual needs. The "System Wiring Diagram" on page 6–64 shows detailed wiring.

DI Signal

- *SON (0x01): Servo On.*
- *CCLR (0x04): Pulse Clear.*
- *ARST (0x02): Alarm Reset.*
- *GTRY (0x0A): Gantry Stop (Pause); when this input is activated it changes P1.074.X (synchronous control function) from 2 (enable) to 0 (disable) so the two axes can be driven separately and not result in an AL081 alarm.*
- *EMGS (0x21): Emergency Stop; external switch. Make sure that both axes can synchronously receive this signal.*
- *INHP (0x45): Pulse Input Inhibit; when this signal is on, any input pulse signal will not be* admitted. Please note that this signal can only be used on DI8.

DO Signal

- *TPOS (0x105): Reach the Target Position, a reference for the host controller.*
- *SRDY (0x101): System Ready, waiting for the start-up command.*
- *SON (0x102): Servo on; servo system is able to receive commands from the host controller.*



System Connection Diagram

Pulse signal of position command

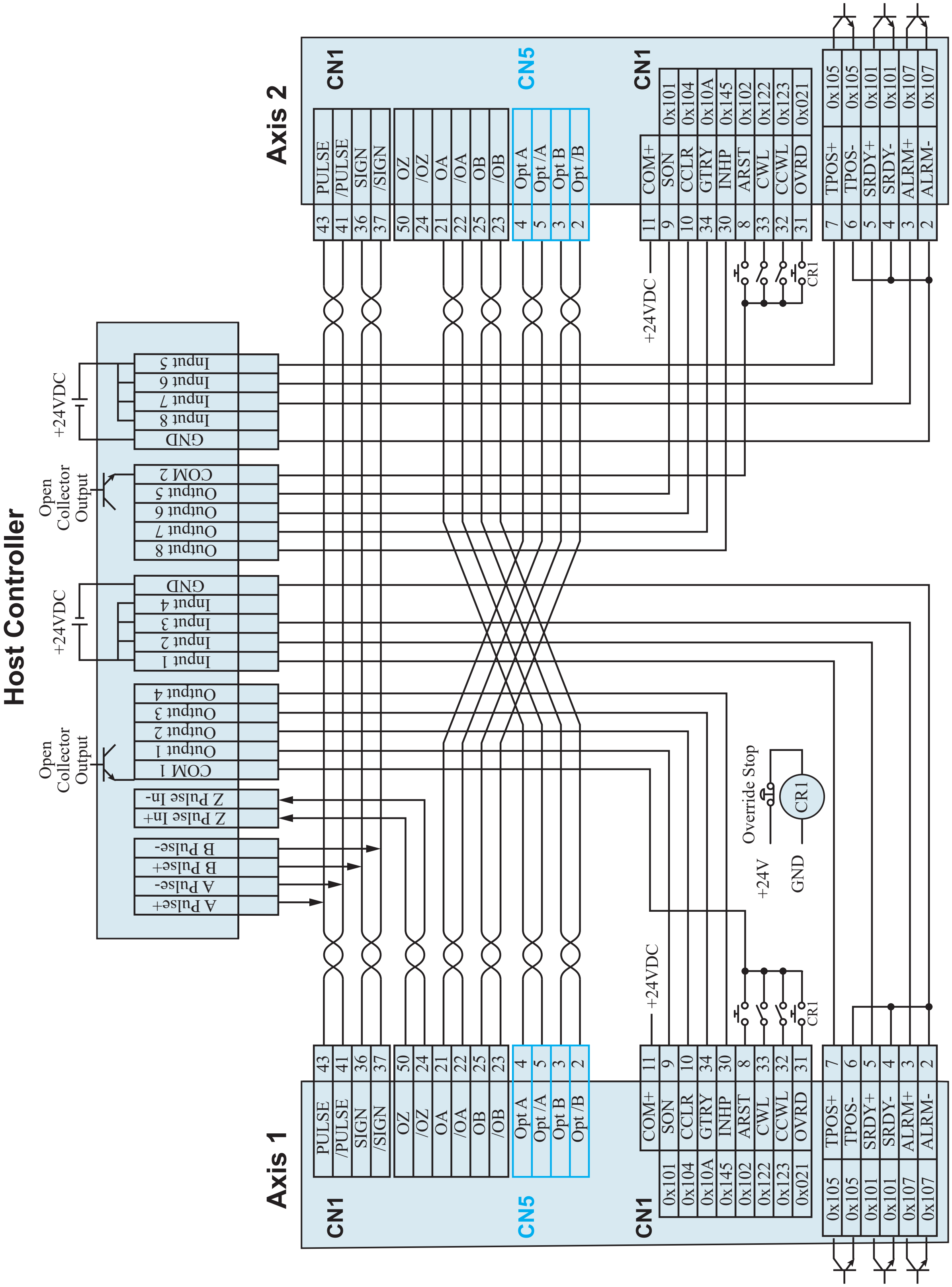
The pulse signal from the host controller should be directly parallel-connected and fed to both axes simultaneously. If a parallel connection is not used, then two separated high speed pulse output channels can be used if they are electronically locked together to provide the exact same pulse train profile move. If using open collector, please carefully apply the wire and the power to avoid short circuit. If Z pulse is used as the homing origin, then the Z pulse from only one of the axes should be sent back to the host controller.

The pulse signal communication between two axes

On Axis 1, CN1 will send pulse signals OA, /OA, OB, and /OB to OptA, /OptA, OptB, and /OptB of CN5 on Axis 2. On Axis 2, pulse signals OA, /OA, OB, and /OB from CN1 have to be sent back to CN5 of Axis 1, received by OptA, /OptA, OptB, and /OptB. This wiring is specially designed for use with Gantry mode. For ease of wiring to the CN5 connector use ZL-HD15M-CBL-DB15F cable + ZL-RTB-DB15 ZIPLink breakout board, or use ZL-HD15M-CBL-2P cable (HD15 to flying leads). See section 3.9 for cable pinout and wire color.

A detailed reference for wiring

The “System Wiring Diagram” on page 6–64 is the detailed wiring reference. This reference is for the wiring of the servo system only. Direct signal input to the host controller such as position sensor is not included in this diagram.



System Wiring Diagram

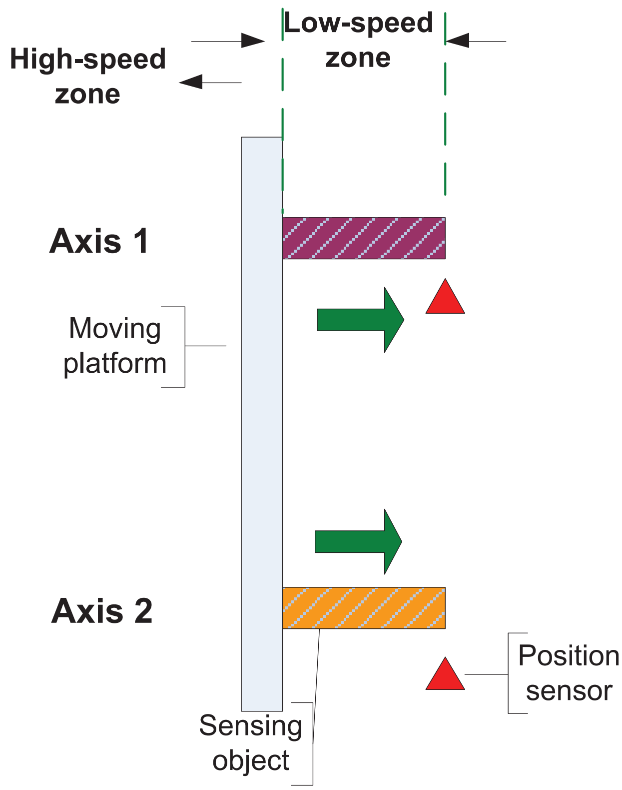
6.8.5 - Sequential Logic Control of Positioning and Homing

For gantry control, the positioning and homing control logic has to be completed by the host controller. The control sequence of a host controller and how it works is explained in previous sections. Detailed timing diagrams are shown on the following pages. Users can decide whether to use either the positioning point or Z pulse as the homing origin.

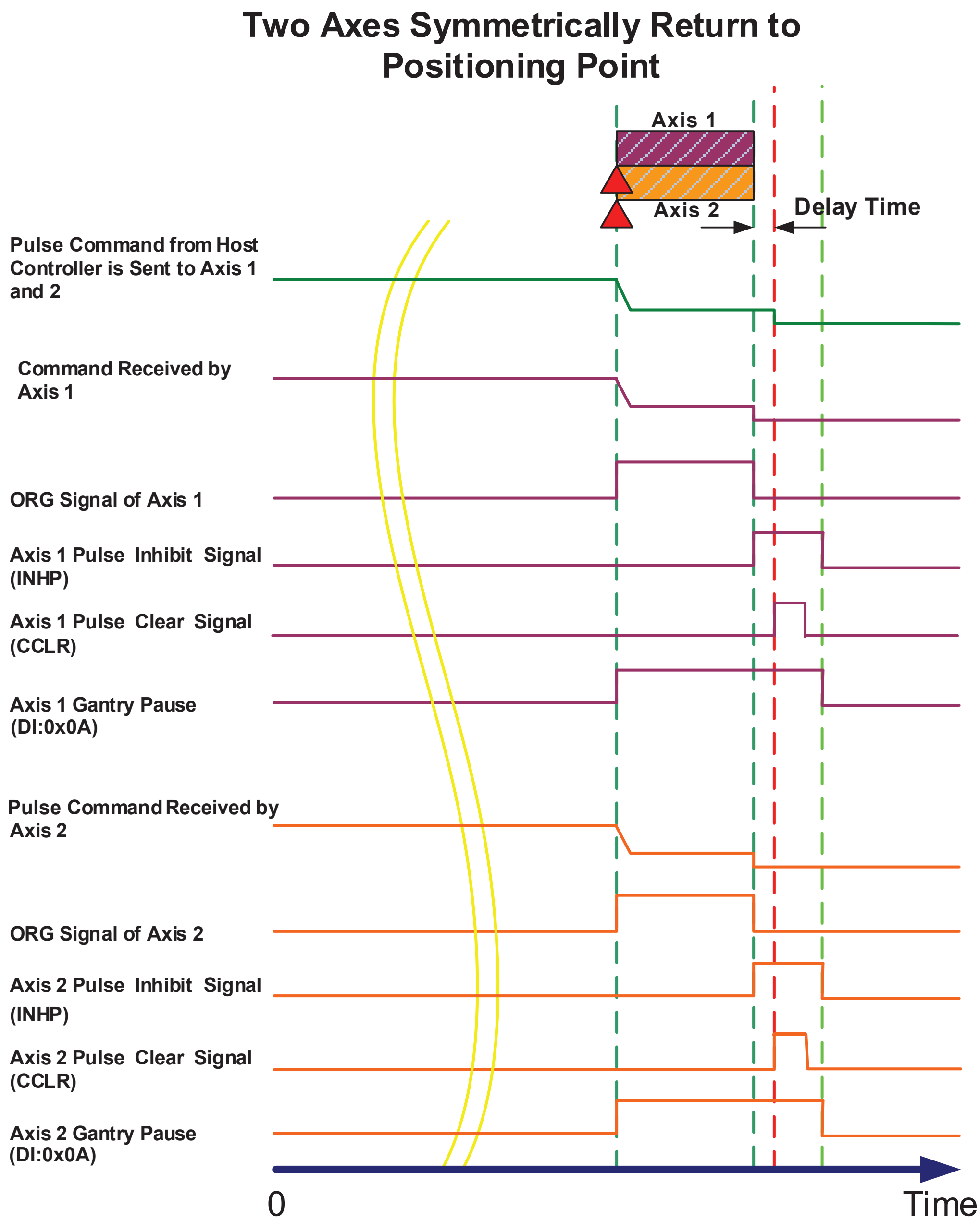
The homing example below has the host controller sending parallel pulses to each drive with the Gantry Pause DI activated so that Gantry mode is temporarily suppressed. This allows each axis to home individually if this method is desired.

Two axes symmetrically return to positioning point

If no abnormality occurs when gantry is working, two axes will be in symmetry when performing homing as shown below.

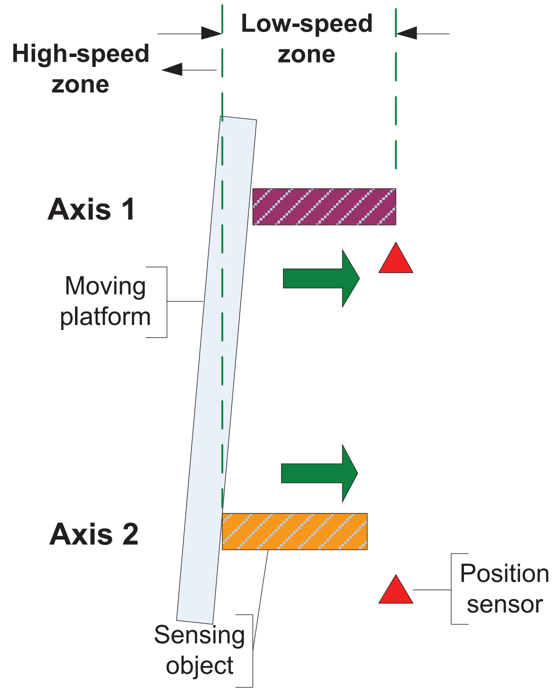


The timing diagram of two axes symmetrically return to positioning point



Two axes return to positioning point asymmetrically

As shown below, if any unexpected problem occurs during the operation that results in asymmetry of two axes, the position of two axes can be corrected by homing.



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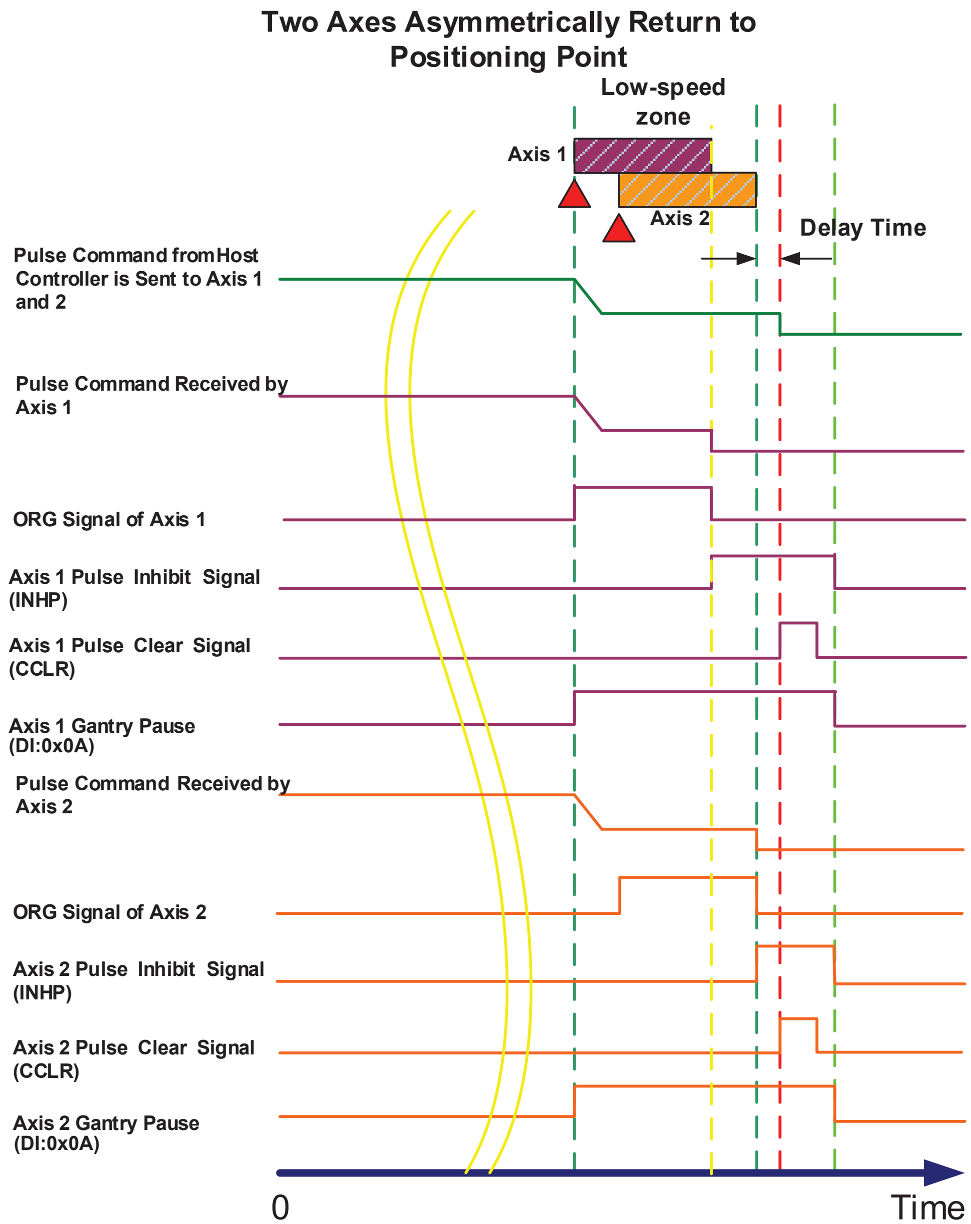
Timing diagram of two axes return to positioning point asymmetrically

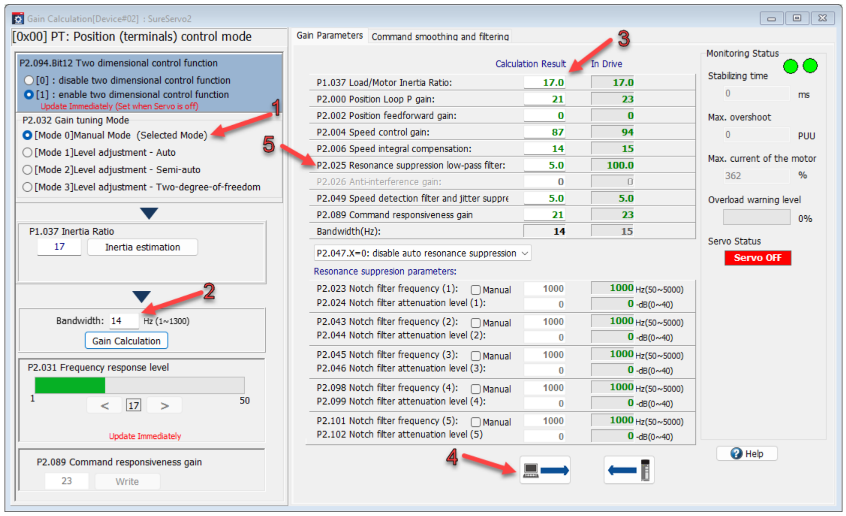


6.8.6 - Steps for Adjusting the Servo When Using Gantry Control

The following steps are about the gantry setting and parameter adjusting.

Note: Before configuring for gantry synchronous mode Set P2.025=100 and P2.057=0. This will reduce the risk of unintended position correction and motor resonance.

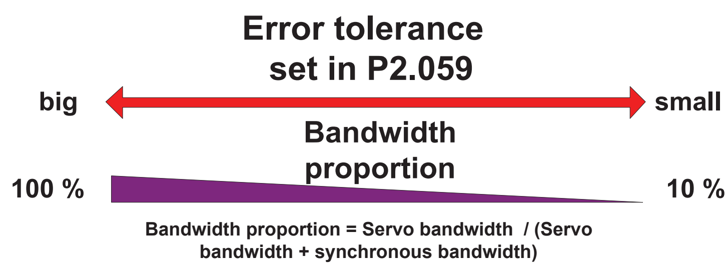
Step	Action
1	***Check the wiring.*** Please refer to section "6.8.4 - Servo System Wiring" on page 6–62 and make sure the wiring is correct.
2	***Tune each axis individually.*** This should be done if it is possible to decouple the two axes' moving platforms from each other. This will give you a better starting point for tuning when the complete gantry mechanism is attached. Ensure P1.074.X=0 to deactivate gantry mode. Open the Auto Tuning window and perform the proper tuning needed while ensuring emergency stop switches are working and the motion profile and speed is adequate for the tuning.
3	***Set up the inertia ratio of the system.*** Pause the gantry function (DI=0x0A activated). Check that all emergency stop and positive/negative limits are working properly. Open the Gain Calculation window in SureServo2 Pro and set P2.032=1 this will allow the drive to estimate the inertia value real time. Set P0.002=15, this will allow you to see the real time inertia on the front display of the drive. Let the host controller issue a position command to both axes to make the gantry mechanism move back and forth with low speed to make sure the mechanism is working fine. Then, gradually speed up the gantry to the speed you will likely be using in the final application. The gantry should be moving back and forth in the desired tuning profile. Once the inertia value has stabilized, enter this value in P1.037. Change P2.032, Gain Tuning Mode, to 2 so the inertia will not change. The inertia ratio is the calculation basis for servo motors' operation; this value must be correct. Both sides of the same gantry mechanism will have slightly different inertias. After setting both axes to Mode 2 for P2.032, take note of the Bandwidth in each Gain Calculation window. For Synchronous control to work both BW values must be the same. Lower the higher BW value to match the lower BW value in the other Axis. *Note: Add both drives to the device list and connect SureServo2 Pro to each drive with a separate USB connection to easily monitor and configure each drive.* *WARNING: NEVER AUTO TUNE (FROM THE DRIVE COMMAND OR A HOST CONTROLLER COMMAND) OR USE THE INERTIA ESTIMATION WINDOW FOR EITHER MOTOR INDEPENDENTLY WHEN ATTACHED TO THE MECHANICAL GANTRY. THIS CAN CAUSE MECHANICAL DAMAGE BECAUSE THE TWO MOTORS WILL NOT STAY SYNCHRONIZED* ***(Steps on next page)***

Step	Action
3	***(Continued from previous page)*** To manually lower the BW of the higher axis, perform the following in the image below: *1) Change P2.032 to Mode 0 in the Gain Calculations window and click confirm if not already in Mode 0.* *2) Enter the lower bandwidth value from the other drive and click the Gain Calculation button.* *3) The new values will populated in the Calculation Result column.* *4) Click the Transfer from PC to Drive button to download the Gain parameters to the drive and also to populate them into the Parameter Editor window.* *5) P2.025 will automatically drop to a low value. For Gantry Synchronous control this should be high during commissioning the system and lowered according to the application. In the Parameter Editor window, set this back to a high number and download to the drive.* *6) Set P2.032 back to Mode 2 and click Confirm.* 
4	***Output pulse setting for monitoring.*** For gantry synchronization, the controller's monitoring pulse receiving speed (which is CN5's capability of pulse receiving) needs to be set. The limit is calculated as below. $\frac{MotorSpeed}{60} \times P1.046 \times 4 < 8 \times 10^6$ <u>*Calculation Example:*</u> The pulse command from the host controller at maximum speed is 50000 pulse/s. And the E-gear ratio is 20 times. When the encoder completes a full rotation, the feedback pulse is 1280000 (without going through the E-gear). (Pulse command * E-gear ratio) / Actual pulse number * 60 sec. = Motor speed per minute (RPM), (50000 * 20) / 1280000 * 60 = 46.875 RPM = the maximum motor speed set by the control command Based on the above formula, the permitted maximum setting value of P1.046 (Pulse Number of Encoder Output) can be decided. Improper gain adjusting on a controller might lead to speed overshoot when the motor is operating; meanwhile, the motor speed might exceed the maximum speed set by the command; therefore, the overshoot level should be taken into consideration. For instance, if a margin of 10% is reserved, it has to be increased depending on the circumstances when using special mechanism. $(46.875 * 110\%) / 60 * (P1.046) * 4 < 8 * 10^6$ Two servos' setting of P1.046 has to be the same; this is the output resolution of the motor. The higher the resolution is, the better control of the gantry will be. But, if it exceeds the controllable range, accuracy would be affected when calculating the deviation between two axes. After setting up P1.046, please set up P1.072 (Resolution of Auxiliary encoder): (P1.072) = (P1.046) * 4, both settings of the two servos should be the same.

Step	Action
5	***Set up the permitted deviation value of synchronization.*** Set P2.059 for the max permitted deviation between the two servos. This is the maximum PUU count that the two servos can be off from each other. When the deviation exceeds the range, AL081 will occur. Thus, be sure to consider the position displacement deviation of two axes that the actual mechanism can tolerate. If the set deviation value goes beyond the actual mechanism's tolerance, the mechanical system may be damaged. For instance, the pitch of the ball screw is 10 mm, P1.046 = 60000 and P1.072= 240000. If P2.059 is set to 30000 pulse, the deviation of two axes can be calculated as: $\frac{30000}{240000} \times 10 = 1.25 \text{ mm}$ When the deviation of two axes is over 1.25 mm, the alarm will occur.

Step	Action	
6	***Check if motor feedback and auxiliary pulses are incrementing correctly.*** Open the Scope in the SureServo2 Pro software. Both servos can be connected in the same instance of SureServo2 Pro by right clicking on "Device List" and selecting "Add Device". This way you can see the scope trace of both motors at the same time in two different scope windows. Ensure P1.074.X=0 for this step.	
	A	At the bottom of the scope, select [IDX] Normal and 32-bit on CH1, and select Auxiliary encoder feedback [Pulse], which is the feedback pulse input from the other drive. This is monitoring the auxiliary encoder port (CN5) in the servo drive. This would be a 32-bit value (monitoring the moving direction of the other servo motor).
	B	Select [IDX] Normal and 32-bit on CH2, and select Feedback Position [PUU]. This is the feedback position of the motor (monitoring the moving direction of the servo drive that connected to the scope).
	C	Let the host controller issue position command to make the two motors move at the same time and then monitor the variation in the SV2-PRO scope. If CH1 is increasing and CH2 is decreasing then the CN5 pulses are not moving in the correct direction. To fix the direction of CH2 to match CH1, the value of P1.074.Z must be changed to the other direction.
	D	If the setting is correct, the signals will be incrementing in the same direction.
	E	Then, connect the PC scope to the other servo drive (if both were not connected to earlier) and make sure the direction of feedback pulse is correct.
7	***Activate the synchronous control.*** Disable both drives, set to SV_OFF. Activate the synchronous control via P1.074X to 2, the synchronous control of gantry function will be activated. Ensure DI.0x0A=OFF.	
8	***Trial Runs***	
	A	Keep the Gantry mode either deactivated (P1.074.X=0) or paused (DI.0x04=On) while conducting trail runs.
	B	After setting the Synchronous Control Bandwidth (P2.057) to a proper value (adjust from small to large), let host controller issue position commands and observe the position deviation and synchronization of two axes via the SV2 scope. Select CH1, [Mon], and 32-bit and then enter 071; this would be the position deviation between both axes and the unit is pulse (using P2.059 as a basis). If the deviation of two axes exceeds the setting value, alarm AL081 will occur. There is no chance that the loading, tuning, and inertia conditions of two axes are exactly identical, so the acceleration/deceleration times will cause a noticeable position deviation during acceleration and deceleration positions.
	C	When conducting trial runs, be sure to adjust the parameters to proper values; the individual axis bandwidth settings of the two controllers has to be identical so as to avoid alignment deviation due to their different response time. When executing the acceleration/deceleration command from the host controller, the position deviation has to be within the setting range of P2.059; otherwise, the alarm will occur.

<table>
<tr><th>Step</th><th colspan="2">Action</th></tr>
<tr><td>9</td><td colspan="2">Synchronizing test and parameters adjustment</td></tr>
<tr><td></td><td>A</td><td>Be sure to complete the steps described above. Then, use parallel pulses to control the gantry mechanism between two motors, and then start testing the gantry.</td></tr>
<tr><td></td><td>B</td><td>Please do Step 3 mentioned above again if the inertia has changed due to mechanical changes. Re-estimate the system inertia; otherwise, the system setting will not be accurate and unable to work properly. If the mechanism is not symmetric, inertia ratio of two axes will be different.</td></tr>
<tr><td></td><td>C</td><td>The system must be protected by a proper value in P2.059 to avoid any errors that could cause mis-alignment of the gantry mechanics.</td></tr>
<tr><td></td><td>D</td><td>The bandwidth settings of both servo drive and gantry synchronous control bandwidth has to be identical. The bandwidth of the servo drive can be calculated and set in the Gain Tuning window via SureServo2 Pro; Gantry bandwidth can be set via P2.057 (Synchronous Control Bandwidth). See figure below:



<table>
<tr><td>Servo bandwidth</td><td>100%</td><td>90%</td><td>80%</td><td>70%</td><td>60%</td><td>50%</td><td>40%</td><td>30%</td><td>20%</td><td>10%</td></tr>
<tr><td>Synchronous bandwidth</td><td>0%</td><td>10%</td><td>20%</td><td>30%</td><td>40%</td><td>50%</td><td>60%</td><td>70%</td><td>80%</td><td>90%</td></tr>
</table>

Regarding the synchronous bandwidth, P2.057 is the only related parameter that needs to be set. The system will automatically calculate the value of P2.054~P2.056 (the related parameters of synchronous control). When the bandwidth setting of synchronous control is wider (higher) than the bandwidth of servo drive, the synchronous following between the two motors is tighter. However, the following error for the host controller command pulses will be relatively worse. Please note that when <u>Bandwidth of synchronous control</u> + <u>Bandwidth of the servo drive</u> is greater than the <u>Permitted bandwidth of the system</u>, it is easier to cause resonance in the motor.

Bandwidth proportion example 1:
Drive 1 and 2 BW = 14
Synchronous BW (P2.057) = 80

$$Bandwidth\ proportion: \frac{14}{14+80} = 14.8\%$$

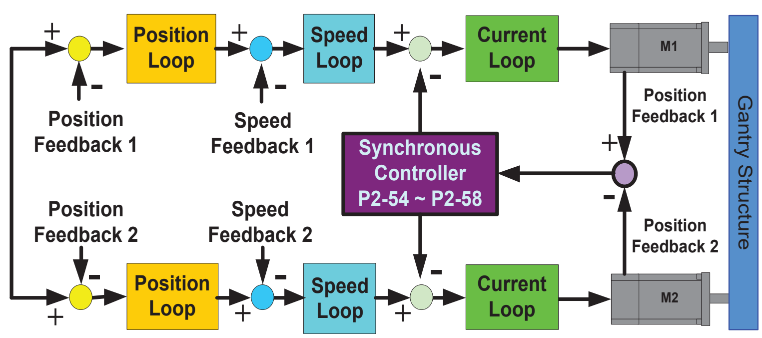
According to the scale above the synchronous feedback setting are more dominant.

(Step 9D continues on next page)</td></tr>
</table>

<table>
<tr><th>Step</th><th colspan="2">Action</th></tr>
<tr><td>9 (cont'd)</td><td colspan="2">Synchronizing test and parameters adjustment (continued)</td></tr>
<tr><td></td><td>D (cont'd)</td><td>Bandwidth proportion example 2:
Drive 1 and 2 BW = 14
Synchronous BW (P2.057) = 20

$$Bandwidth\ proportion: \frac{14}{14+20} = 41.2\%$$
According to the scale above the servo feedback settings are slightly more dominant than the synchronous feedback setting.

If bandwidth cannot be increased to achieve better following, please try to increase the value of P2.055 (Synchronous speed integral compensation). However, if the value of P2.055 is set too high, system vibration will occur. When deciding the bandwidth, be sure that the setting value of P2.025 (Resonance suppression lowpass filter) is much bigger than the bandwidth setting; otherwise, the result might not be satisfactory, and the system might become unstable. When adjusting the bandwidth of the synchronous control, start from small to large. The synchronous control of the gantry is shown below. The synchronous controller affects the speed loop of the cascade below and is directly added to or subtracted from the individual drive's speed loop component.

The synchronous control of the gantry is shown below:

</td></tr>
</table>

Chapter 7: Motion Control

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Introduction

This chapter introduces internal motion commands in the SureServo2 drive in PR mode. In this mode, commands are generated based on the internal commands of the servo drive. Various motion commands are available, including homing, speed, position, parameter writing, arithmetic operation, and jump. Other motion control functions such as high-speed position capture (Capture), high-speed position compare (Compare), and E-Cam are also available. This chapter contains detailed description of each command type.

7.1 - PR mode description

In PR mode, the servo drive automatically generates the motion commands. Apart from the basic arithmetic operation commands, the drive saves all parameter settings in the parameter file in the servo drive. Thus changing parameter values simultaneously changes the PR commands. The drive provides 100 path setting sets, which include the homing method, Position command, Speed command, Jump command, Write command, Index Positioning command, and arithmetic operation commands.

Except for arithmetic operations, the properties and corresponding data for each PR path are set by parameters. You can find information for all PR parameters in the descriptions of Group 6 and 7 in Chapter 8. For example, PR#1 path is defined by two parameters: P6.002 and P6.003. P6.002 specifies the properties for PR#1, such as the PR command type, whether to interrupt and whether to auto-execute. The next PR. P6.003 is subject to change based on the properties set in P6.002. If P6.002 is set to a Speed command, then P6.003 specifies the target speed. When P6.002 is set to a Jump command, then P6.003 specifies the target PR. The parameters for the PR#2 path are P6.004 and P6.005 and they work the same way as P6.002 and P6.003. The same is true for the rest of PR paths. See Figure 7-1.

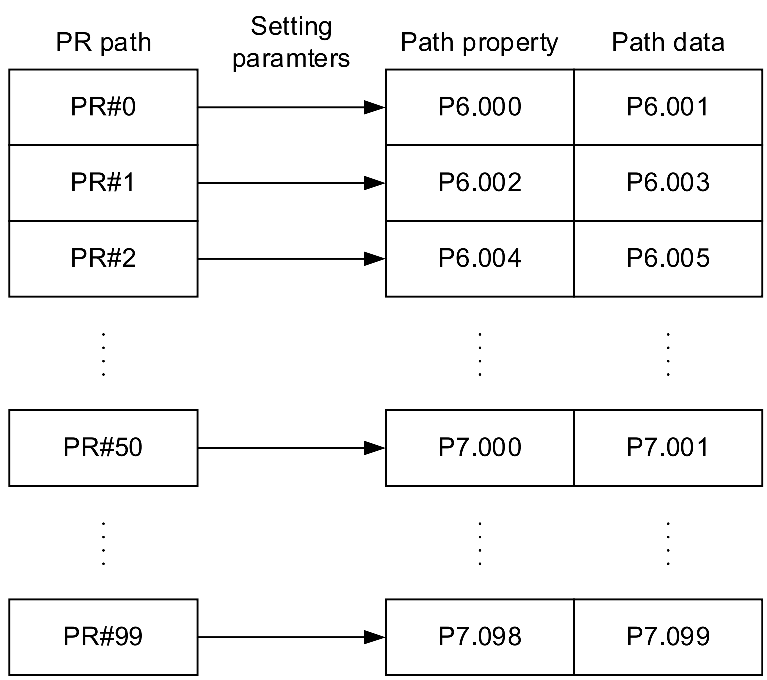


Figure 7-1 Setting parameters for each PR path

In the SureServo2 Pro software, when you select the PR to be edited in PR mode, the corresponding parameters appear at the top of the window. See Figure 7-2. If you select PR#1, P6.002 and P6.003 appear at the top in the editing section (see P6.002 and P6.003 in Table 7-1 for example). The PR property and its data content differ in accordance with the motion command type. The small green box in the top left of the screen contains the current value for P5.007 (command and status of the current PR path). For more information about Motion Control mode, please refer to Section 7.1.3.

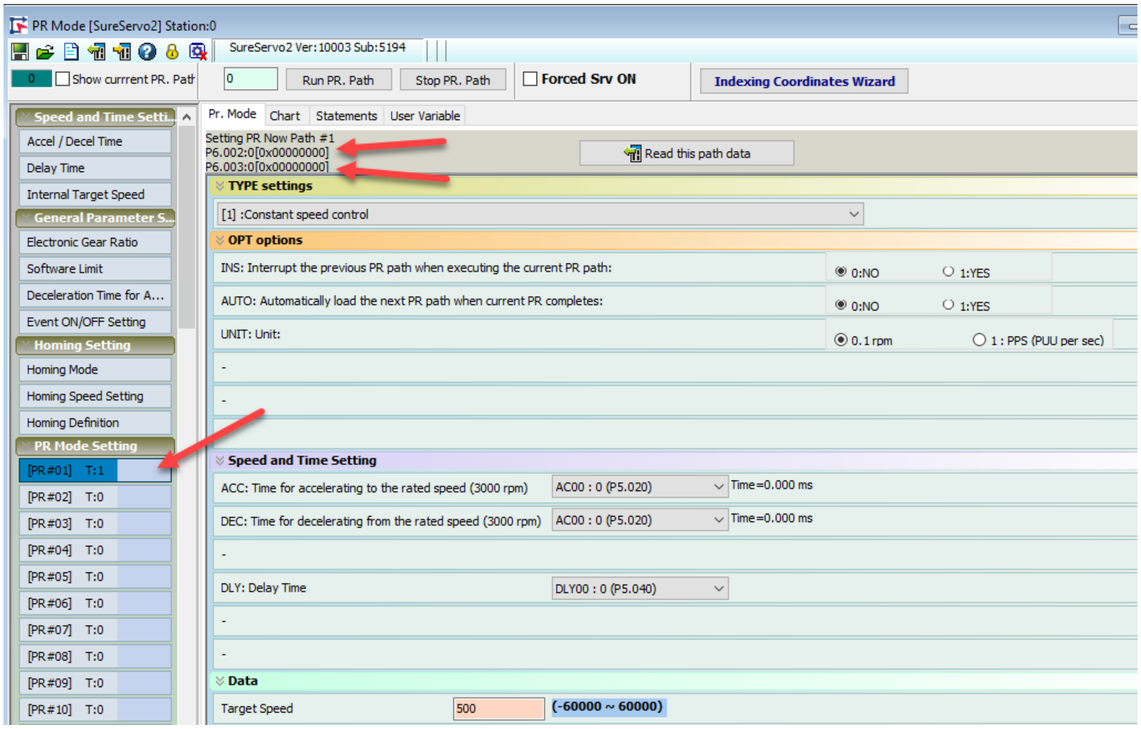


Figure 7-2 PR mode interface in SureServo2 Pro

Table 7-1 Example of PR#1 property and data content

BIT / ***PR#1***	***31–28***	***27–24***	***23–20***	***19–16***	***15–12***	***11–8***	***7–4***	***3–0***
P6.002								TYPE
P6.003	Data content (32-bit)							

TYPE: Control command mode

TYPE No.	***Command Mode***
1	SPEED: speed control
2	SINGLE: positioning control; stop once positioning is completed.
3	AUTO: positioning control; execute the next PR path once positioning is completed.
7	JUMP: jump to the specified path.
8	WRITE: write a constant, parameter value, data array, or monitoring variable to another parameter or data array..
0xA	INDEX: index positioning control
0xB	STATEMENT: statement / arithmetic operations

SureServo2 Pro software provides an editing interface for PR programming (see Figure 7-3). It is easier to set PR paths in SureServo2 Pro, where you can set the options for command triggering, command types and other properties. In the Chart tab you can view the sequence flow in a graphical manner.

Note: You must set the arithmetic operations statements in the software, you cannot enter arithmetic operations or statements using the keypad.

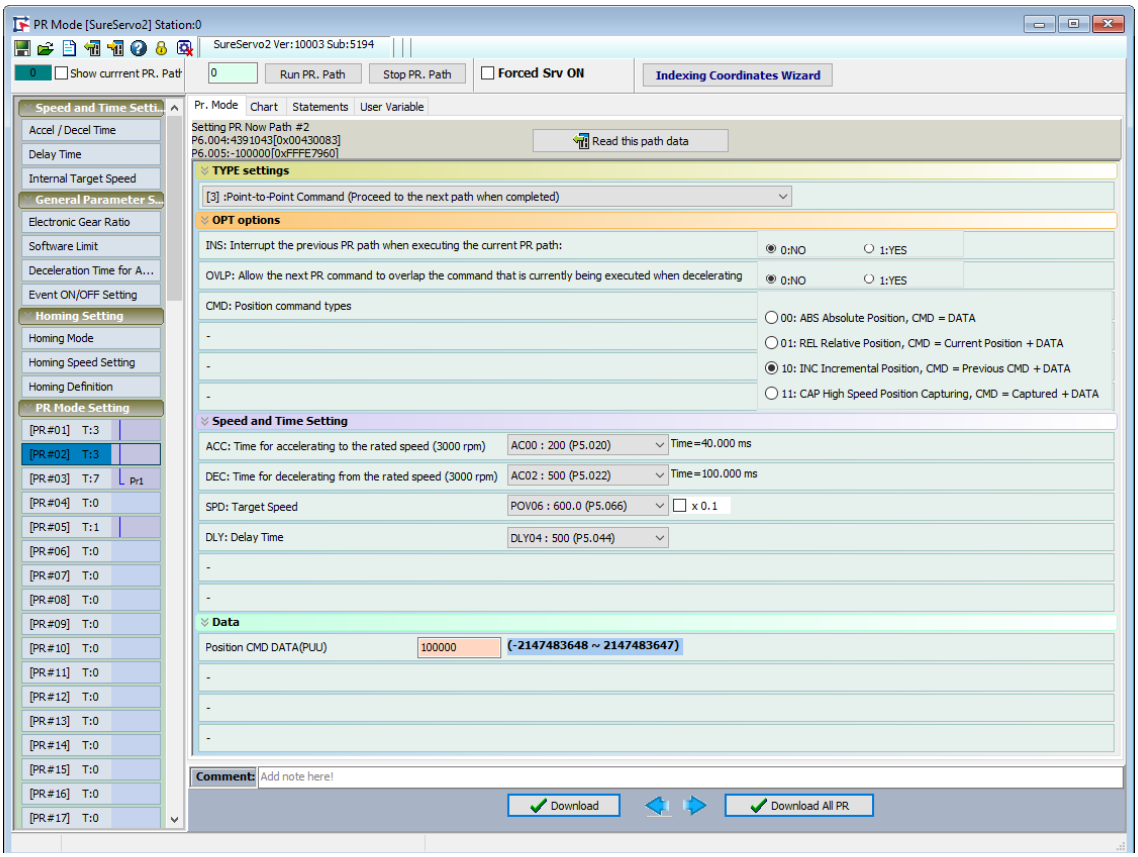


Figure 7-3 PR display in SureServo2 Pro

7.1.1 - Shared PR parameters

The SureServo2 drive provides 16 acceleration / deceleration time settings (P5.020–P5.035), 16 delay time settings (P5.040–P5.055), and 16 target speed settings (P5.060–P5.075) for you to set the PR paths (as shown in Figure 7-4). The Internal Target Speed or POV (Position Option Velocity) registers are only used for point-to-point and index positioning moves. If you change a parameter that is used by multiple PR paths, then all PR paths using this parameter are changed as well. Please be aware of this when setting PR paths so as to avoid any danger or damage to the machine. For example, if multiple PR commands use the target speed setting from P5.060, when you change the value of P5.060, those PR commands' target speed are also changed.

SureServo2 Pro also provides a user-friendly interface for this shared PR parameter function (see Figure 7-5). In this data window, the acceleration / deceleration time is set based on the length of time for the motor to accelerate from 0 to 3000rpm or to decelerate from 3000rpm to 0. For instance, if acceleration time is set to 50ms then it will take 50ms to reach 3000rpms. If target speed for the motion command is 1500rpm, then the acceleration time to reach 1500rpm is 25ms even though the acceleration time is set to 50ms. The acceleration / deceleration time is a fixed slope, and the slope does not change when you change target speed parameter values.

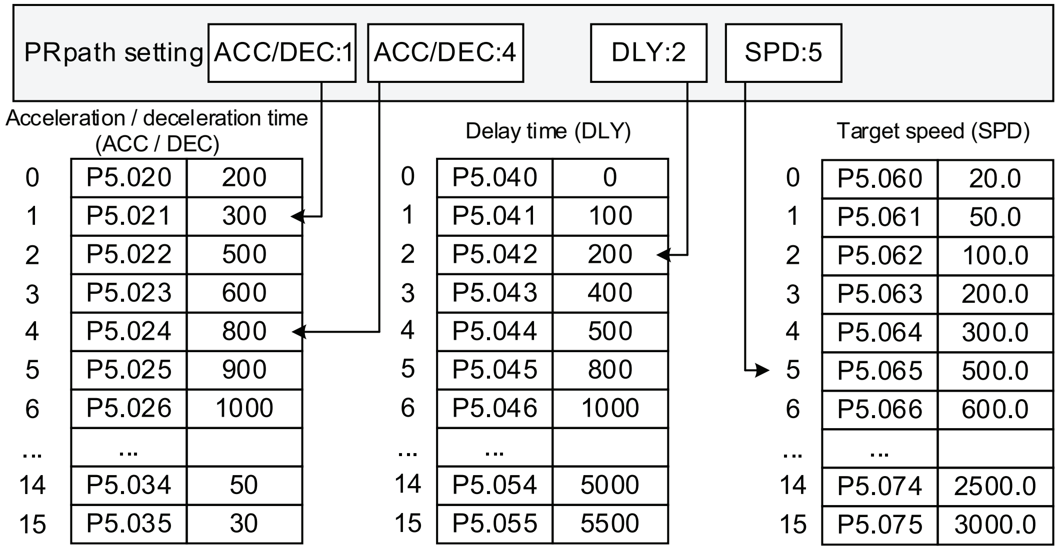


Figure 7-4 Shared parameter data for PR paths

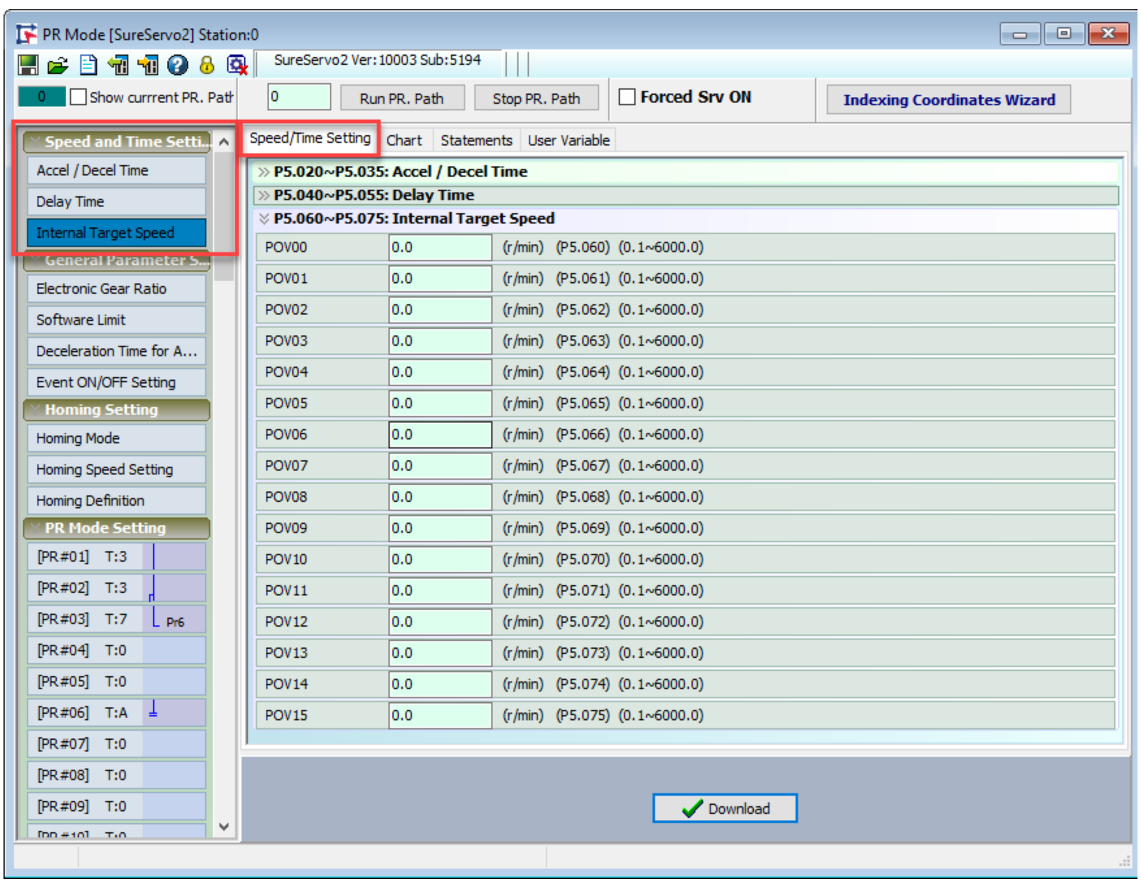


Figure 7-5 SureServo2 Pro interface for shared PR parameter data

7.1.2 - Monitoring variables of PR mode

PR mode provides four monitoring variables for the servo command and feedback: command position (PUU), PR command end register, feedback position (PUU), and position error (PUU). PUU stands for Pulse User Units and is determined by the E-Gear ratio (P1.044 and P1.045). These can be monitored in P0.002 and are described below:

1) PR command end register: monitoring variable code 064 (40h). The target position of the PR command, simplified as **Cmd_E** (Command End). When a command is triggered, the servo drive calculates the target position and then updates the PR command end register.
2) Command position (PUU): monitoring variable code 001. The target position of the motion command generated per scan cycle during servo operation (updated every 1ms), simplified as **Cmd_O** (Command Operation).
3) Position error (PUU): monitoring variable code 002. The deviation between the command position (PUU) and the feedback position (PUU), simplified as **Err_PUU** (Error PUU).
4) Feedback position (PUU): monitoring variable code 000. The feedback position (coordinates) for the motor, simplified as **Fb_PUU** (Feedback PUU).

How these four monitoring variables work is shown in Figure 7-6 After the servo issues a Position command, the servo sets the position of Cmd_E once the target position data is acquired. The motor operates to the target position based on the PR path setting. Cmd_O calculates the amount of command deviation in each fixed cycle and sends it to the servo drive, where it is treated as a dynamic command. Fb_PUU is motor's feedback position and Err_PUU is the deviation of Cmd_O minus Fb_PUU.

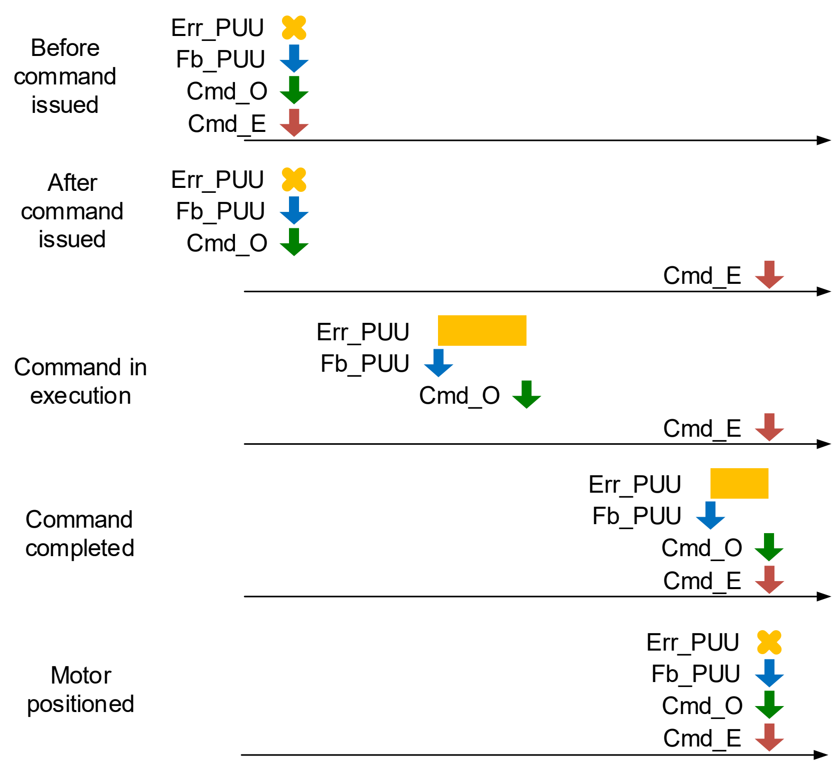


Figure 7-6 Timing diagram for PR mode monitoring variables

The detailed command behavior of each stage is illustrated in Figure 7-7. Cmd_E is the endpoint specified by the command; it is set when the PR path is triggered. Fb_PUU is the feedback position, that is motor's actual position. Divide this motion command into slices and take one of them as an example. Cmd_O is the target of this command section and Err_PUU is the deviation between the target position and the feedback position.

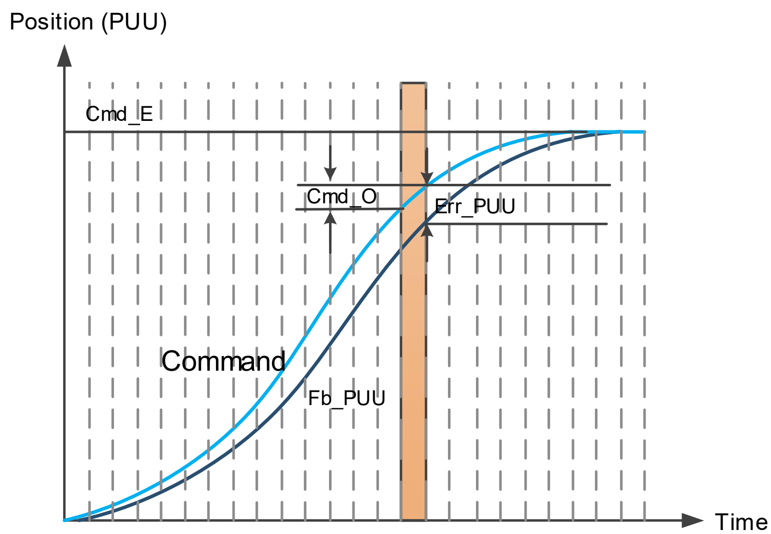


Figure 7-7 Monitoring variables status when executing a command in PR mode

You can use the digital inputs (DI) to trigger PR paths and digital outputs (DO) to monitor PR paths (refer to section 8.4.9 and 8.4.10 for DI and DO function descriptions). When you trigger the motion command with DI.CTRG [0x08], the servo drive operates based on the command from the internal registers. See section 7.1.5 for all the trigger methods for the PR paths. Once the execution is completed, DO.Cmd_OK [0x15] is set to on. When the position deviation (pulse number) becomes smaller than the set amount in P1.054, DO.TPOS [0x05] (Motor reaches the target position) is set to on. When both DO.TPOS and DO.Cmd_OK signals are on the servo outputs the MC_OK [0x17] signal to signify that it has completed this PR path. The operation is as shown in Figure 7-8. If you have set a delay time in this PR and the position deviation (pulse number) is smaller than the value of P1.054, DO.TPOS [0x05] is set to on.

When the delay time is over, DO.Cmd_OK [0x15] (PR position command complete) is set to on. After both of the above mentioned DO signals are on, DO.MC_OK [0x17] (Servo procedure complete) is set to on to signify it has completed this PR path, as shown in Figure 7-9.

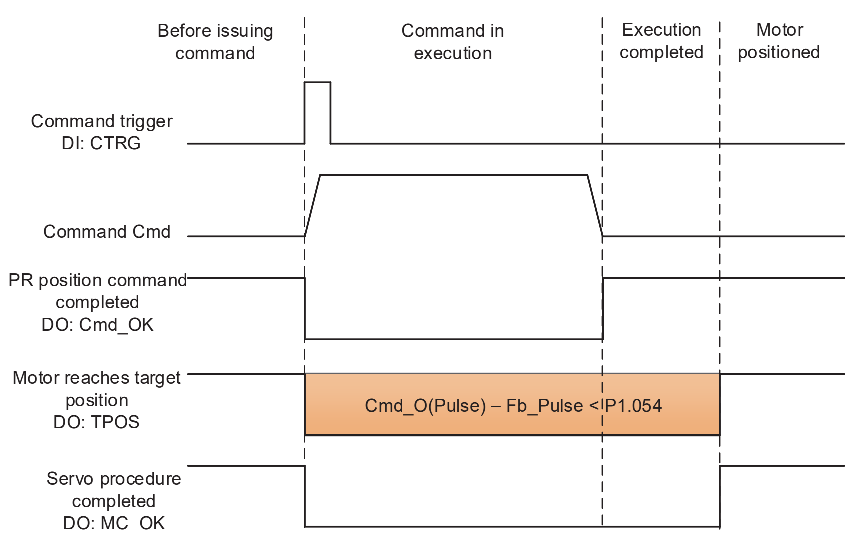


Figure 7-8 Operation of DI signals in PR mode

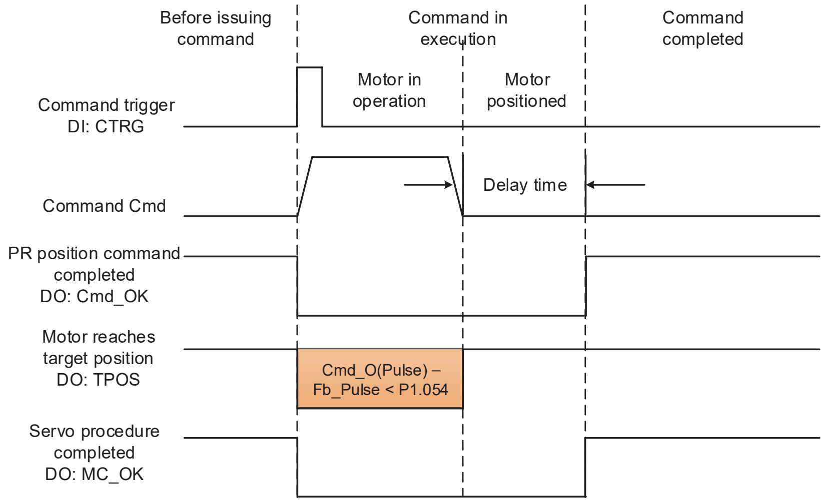


Figure 7-9 Operation of DO signals in PR mode

7.1.3 - Motion Control commands

The SureServo2 drive provides 100 path sets that can include homing methods, speed, position, path jumping, parameter writing, index positioning, and arithmetic operations. The following sections detail each command type.

Homing methods

The SureServo2 provides 11 homing methods in PR mode. They include home sensor (Origin Sensor = DI.ORG 0x24), limit sensor, and torque-level (collision point). Sub-selections such as whether to refer to the Z pulse and the limit signal as the trigger are available, with more than 30 combinations possible. The homing method is specified by P5.004 and the homing definition is determined by P6.000. Bit function bit is listed below.

P5.004	***Homing Methods***		***Address: 0508H 0509H***
Default:	0x0	Control mode:	PR
Unit:	-	Setting range:	0 – 0x128
Format:	HEX	Data size:	16-bit

Settings:

0000

U Z Y X

X	Homing method	Z	Limit setting
Y	Z pulse setting	U	Reserved

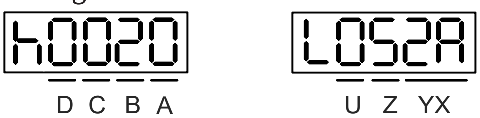
Definition of each setting value:

<table>
<tr><th>U</th><th>Z</th><th>Y</th><th>X</th></tr>
<tr><td>Reserved</td><td>Limit setting</td><td>Z pulse setting</td><td>Homing method</td></tr>
<tr><td rowspan="13">-</td><td>0 – 1</td><td>0 – 2</td><td>0 – A</td></tr>
<tr><td>-</td><td rowspan="2">Y = 0: return to Z pulse
Y = 1: go forward to Z pulse
Y = 2: do not look for Z pulse</td><td>X = 0: homing in forward direction and define PL (Positive Limit Sensor) as homing origin</td></tr>
<tr><td>-</td><td>X = 1: homing in reverse direction and define NL (Negative Limit Sensor) as homing origin</td></tr>
<tr><td rowspan="9">When limit sensor triggered:
Z = 0: show error
Z = 1: reverse direction</td><td rowspan="7">Y = 0: return to Z pulse
Y = 1: go forward to Z pulse
Y = 2: do not look for Z pulse</td><td>X = 2: homing in forward direction, DI.ORG: OFF→ON as homing origin</td></tr>
<tr><td>X = 3: homing in reverse direction, DI.ORG: OFF→ON as homing origin</td></tr>
<tr><td>X = 4: look for Z pulse in forward direction and define it as homing origin</td></tr>
<tr><td>X = 5: look for Z pulse in reverse direction and define it as homing origin</td></tr>
<tr><td>X = 6: homing in forward direction, DI.ORG: ON→OFF as homing origin</td></tr>
<tr><td>X = 7: homing in reverse direction, DI.ORG: ON→OFF as homing origin</td></tr>
<tr><td>X = 8: define current position as the origin</td></tr>
<tr><td rowspan="2">Y = 0: return to Z pulse
Y = 1: do not look for Z pulse</td><td>X = 9: look for the collision point in forward direction and define it as the origin</td></tr>
<tr><td>X = A: look for the collision point in reverse direction and define it as the origin</td></tr>
</table>

P6.000	***Homing Definition***		***Address: 0600H 0601H***
Default:	0x00000000	Control mode:	PR
Unit:	-	Setting range:	0x00000000 – 0x00000063
Format:	HEX	Data size:	32-bit

Settings:

Homing definition:



A	DEC2: deceleration time selection of second homing velocity	***YX***	PATH: path type
B	DLY: select 0 – F for delay time	***Z***	ACC: select 0 – F for acceleration time
C	N/A	***U***	DEC1: deceleration time selection of first homing velocity
D	BOOT	**-**	-

- *YX: PATH: path type*
  0x0: stop: homing complete and stop.
  0x1 – 0x63: auto: homing complete and execute the specified path (Path#1 – Path#99).
- *Z: ACC: select 0 – F for acceleration time*
  0 – F: corresponds to P5.020 – P5.035
- *U: DEC1: deceleration time selection of first homing velocity*
  0 – F: corresponds to P5.020 – P5.035
- *A: DEC2: deceleration time selection of second homing velocity*
  0 – F: corresponds to P5.020 – P5.035
- *B: DLY: select 0 – F for delay time*
  0 – F: corresponds to P5.040 – P5.055
- *D: BOOT: when the drive is powered on decide whether to initiate the homing routine or not.*
  0: do not execute homing
  1: execute homing automatically (servo must be enabled, SON, before homing will occur)

Apart from the above definitions, the related settings for homing also include:

1) P5.004 homing methods.
2) P5.005 – P5.006 speed setting of searching for the origin.
3) P6.001: Origin Definition (ORG_DEF) is the coordinate of the origin and may not be 0.

Notes:

1) After the origin is found (sensor or Z), it has to decelerate to a stop. The stop position exceeds the origin by a short distance. The motor will decel to another PUU value but the origin definition value (P6.001) was assigned at the Z pulse.
   If returning to the origin is not needed, set PATH to 0;
   If returning to the origin is needed, set PATH to a non-zero value and have that PATH execute an absolute move to the Origin Definition entered in P6.001.
   Example:
   Upon completion of P6.000 = 0x1, automatically execute Path#1.
   Set from absolute position (ABS) to 0 as the route of Path#1 (set P6.002 & P6.003).
2) If the origin is found (sensor or Z), and you want it to move an offset S and define the coordinate as P after moving, then PATH = non-zero and set ORG_DEF = P - S, and this absolute Position command = P.

The PR Homing mode includes the function for setting the origin offset. You can define any point on the coordinate axis as the reference origin, which does not have to be 0. Once you define the reference origin, the system can create the coordinate system for the motion axis. See Figure 7-10. The coordinate for the reference origin is 2000 (P6.001 = 2000). The motor passes by the reference origin and then stops at coordinate 1477. From the coordinate system that it created, the system automatically calculates the position of 0 point. As soon as the PR motion command is issued, the motor moves to the specified position.

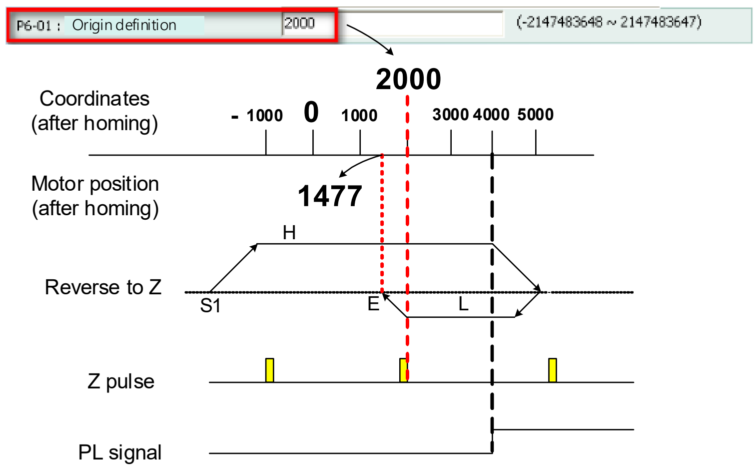


Figure 7-10 Origin Definition

P6.001	***Origin Definition***		***Address: 0602H 0603H***
Default:	0	Control mode:	PR
Unit:	-	Setting range:	-2147483648 – 2147483647
Format:	DEC	Data size:	32-bit

Settings:

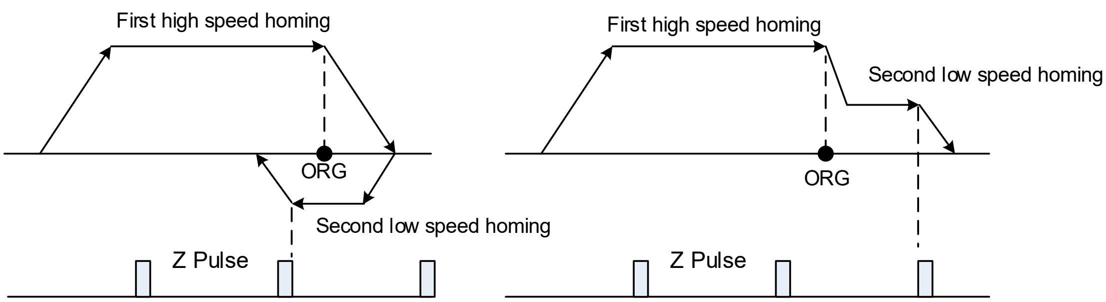
Origin definition (Home definition). This is the axis coordinate value (offset) that you want for this axis to be at the origin sensor. For example, if you use the rising edge of the Z pulse as the home origin, you can make that point on the coordinate system 3000 instead of 0 by entering 3000 in P6.001. In this example the Home Origin is 3000 instead of 0.

The homing procedure goes through two stages: high speed and low speed. Homing starts in high speed, seeking the reference point (such as the limit switch and ORG signal). Once the servo detects the reference point, the motor runs at low speed to find the reference point accurately (such as the Z pulse). The speeds for the two stages are defined by P5.005 and P5.006.

P5.005	High Speed Homing (First Speed Setting)			Address: 050AH 050BH
Operation interface:	Panel / software	Communication	Control mode:	PR
Default:	100.0	1000	Data size:	32-bit
Unit:	1 rpm	0.1 rpm		
Setting range:	0.1 – 2000.0	1 – 20000		
Format:	DEC	DEC	-	-
Example:	1.5 = 1.5 rpm	15 = 1.5 rpm	-	-

Settings:

The first speed setting for high speed homing.



P5.006	Low Speed Homing (Second Speed Setting)			Address: 050CH 050DH
Operation interface:	Panel / software	Communication	Control mode:	PR
Default:	20.0	200	Data size:	32-bit
Unit:	1 rpm	0.1 rpm		
Setting range:	0.1 – 500.0	1 – 5000		
Format:	DEC	DEC	-	-
Example:	1.5 = 1.5 rpm	150 = 1.5 rpm	-	-

Settings:

The second speed setting for low speed homing.

You can set the homing parameters in the PR mode homing screen in SureServo2 Pro, including the homing methods, homing definition, and homing speed (see Figure 7-11).

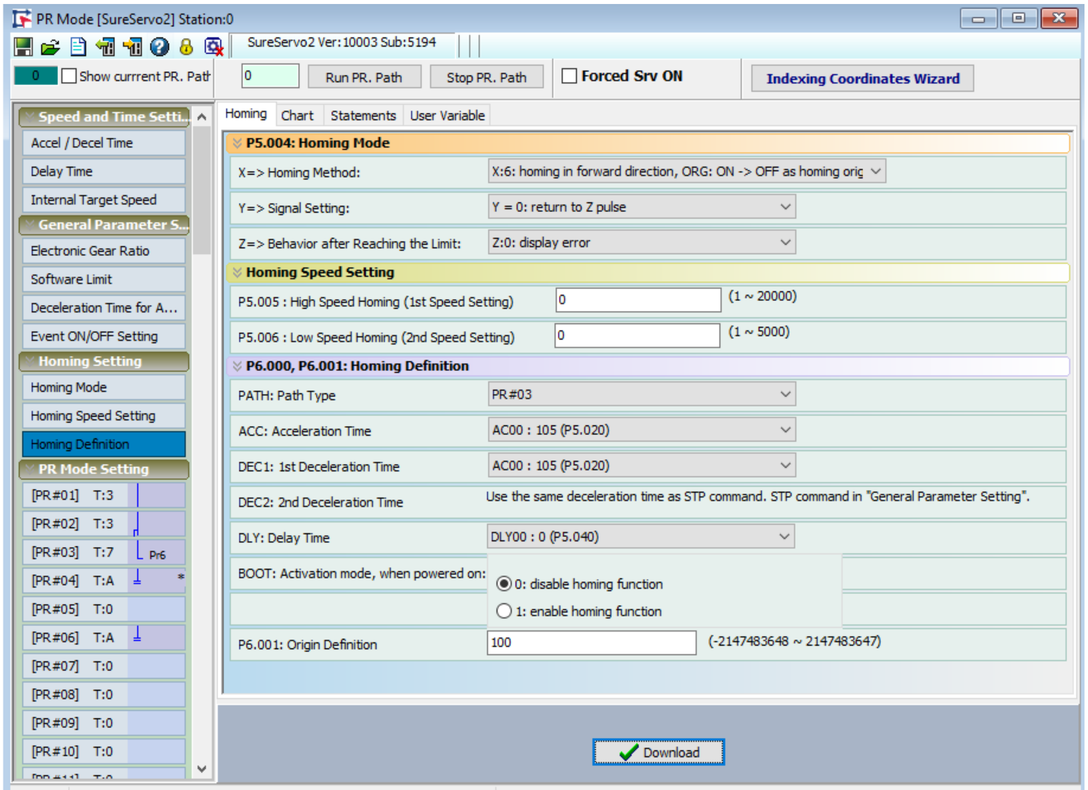
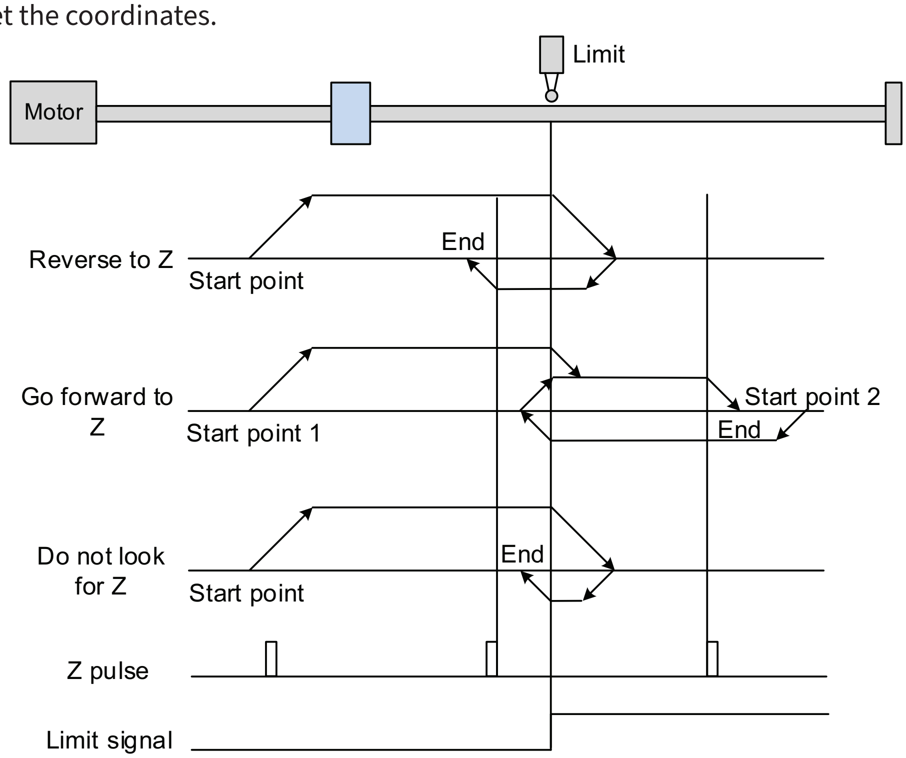


Figure 7-11 Homing screen in SureServo2 Pro

The following describes the homing methods supported by the SureServo2 drive. They can be categorized into six types based on their reference points.

1) **Referencing the limit:** this homing method uses the positive or negative limit as the reference point. When the limit is detected, you can choose to look for the Z pulse and use it as the homing reference point. Changing the starting position does not change the homing result. The drive always looks for the setting reference point so as to correctly reset the coordinates.



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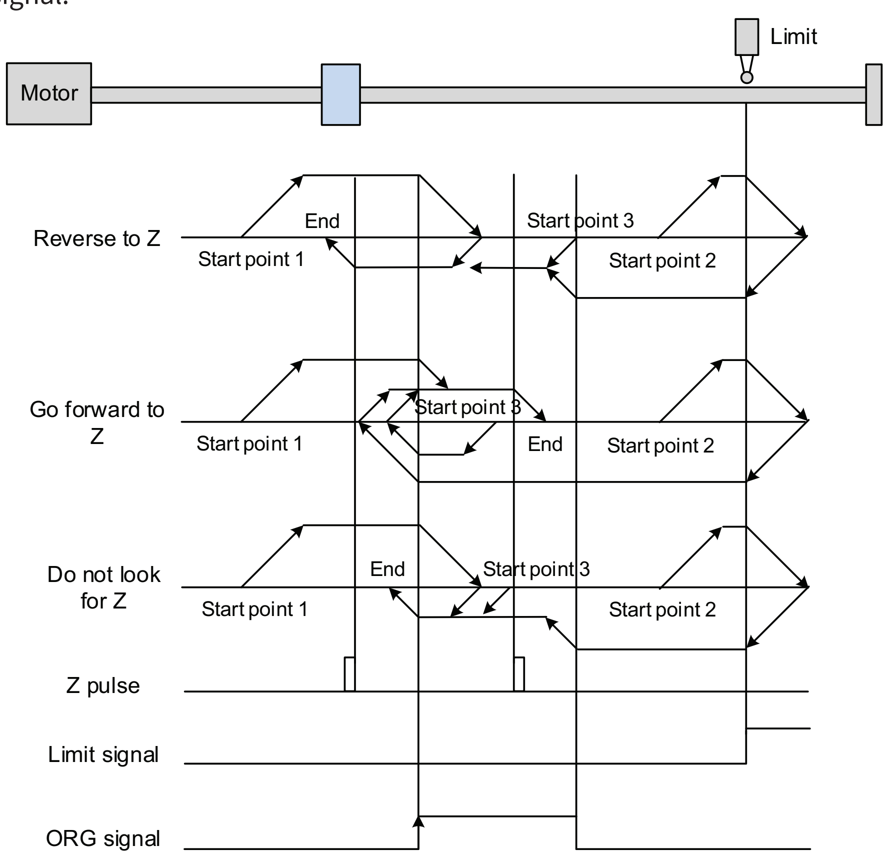
In the example above (looking for the Z pulse), the servo motor operates at high speed (first speed value) and then decelerates once it reaches the limit (rising-edge triggers the signal). Then the motor switches to low speed (second speed value) to look for the Z pulse. When the motor finds the Z pulse, it decelerates and stops, completing the homing procedure.

If you set the motor to look for the Z pulse and the limit signal remains un-triggered (low, Start point 1), the servo motor operates at high speed (first speed setting) and then decelerates once it reaches the limit (rising-edge triggers the signal). Then the motor switches to low speed (second speed setting) to look for the Z pulse. When the motor finds the Z pulse, it decelerates and stops, completing the homing procedure. The motor will decel to another PUU value but the origin definition value (P6.001) was assigned at the Z pulse. If the setting is to look for the Z pulse and the limit signal is triggered (high, Start point 2), the servo motor returns to look for the falling-edge trigger signal at low speed (second speed setting). Once it is found, the servo motor starts to look for the Z pulse and decelerates to stop when it finds the Z pulse., completing the homing. In conclusion, the set origin is at the same position after homing with the same condition regardless of the location of the starting point.

If you set the motor to not look for the Z pulse, the servo motor first operates at high speed (first speed setting) and then decelerates to a stop once rising-edge limit signal is triggered. Then the motor changes to low speed (second speed setting) to look for rising-edge signal. Once it finds the rising-edge signal, the motor decelerates to a stop, completing the homing.

2) **Referencing the rising-edge signal of the home sensor:** This method uses the rising-edge of the home sensor (ORG) signal as the reference point. You have the option of using the Z pulse as the reference point of the origin when the home sensor detects the signal.



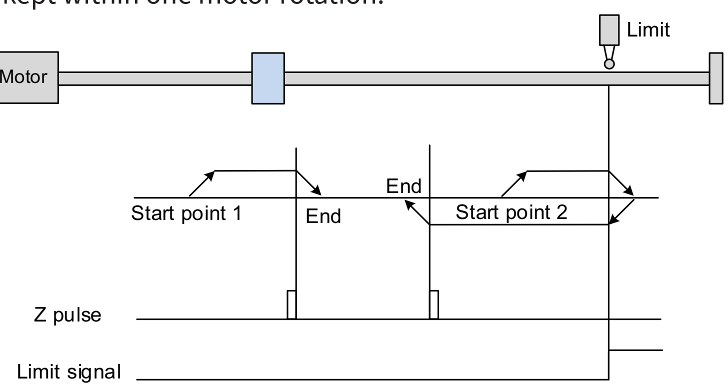
The figure above shows an example of reversing to look for the Z pulse. If the home sensor signal (DI.ORG sensor) for the start position is untriggered (low, Start point 1), the servo motor operates at high speed (first speed setting) until it reaches the rising-edge of ORG signal. Then it decelerates, switching to low speed (second speed setting) and reverses to look for the Z pulse. When the motor finds the Z pulse, it decelerates to a stop, completing the homing.

If the ORG signal at the start point is untriggered and the current position is relatively closer to the limit switch (Start point 2), then the servo motor operates at high speed (first speed setting). You can choose whether to show an error (P5.004.Z=0) or reverse the running direction (P5.004.Z=1) when it reaches the limit switch. If you choose to reverse the rotation direction, the servo motor keeps rotating in reverse direction. Once the motor reaches the limit switch, it changes to low speed (second speed setting) and operates until the ORG signal switches to low. Next, it starts to look for the Z pulse. When the motor finds the Z pulse, it decelerates to a stop, completing the homing.

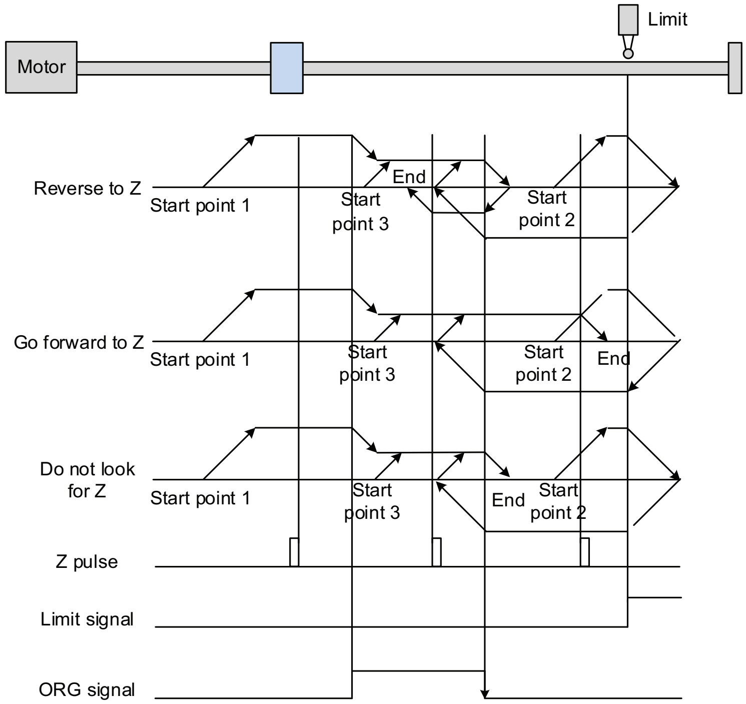
If the ORG signal is triggered (high, Start point 3), the motor reverses with low speed (second speed setting) and after the ORG signal switches to low, the motor returns to look for the Z pulse. Once the Z pulse is found, homing is complete.

If you set the server motor to look for the Z pulse, or not to look for the Z pulse in the forward direction (this is similar to the first method mentioned above, going in the reverse direction or not to look for the pulse Z), please refer to the timing diagram above.

3) **Referencing the Z pulse:** This method uses the Z pulse as the reference origin. One Z pulse is generated per rotation of the motor. This method is only suitable when the operation is kept within one motor rotation.



4) **Referencing the falling-edge of the ORG signal:** This method uses the falling-edge signal of the home sensor as the reference origin. You can choose whether or not to use Z pulse as the reference origin after the ORG signal is detected.



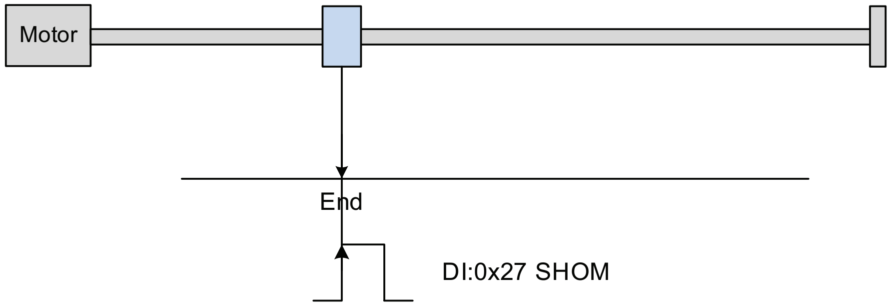
See the above example of looking for the Z pulse. If ORG signal is un-triggered at the start point (low, Start point 1), the servo motor runs at high speed (first speed setting) until reaching the rising edge of the ORG signal. Then it decelerates and switches to low speed until the ORG signal is off (low). Next, it reverses to look for the Z pulse and decelerates to a stop once it finds the Z pulse, completing the homing.

If ORG signal is un-triggered at the start point and is closer to the limit switch (Start point 2), the motor runs at high speed (first speed setting). You can set whether to show an error or reverse the running direction when it reaches the limit switch. If you set it to reverse direction, the motor operates in reverse to reach the ORG signal. Once it reaches the ORG signal, it decelerates and runs at low speed (second speed setting) until it reaches the falling edge of ORG signal. Then it reverses to look for Z pulse. When found, the servo decelerates to a stop, completing the homing.

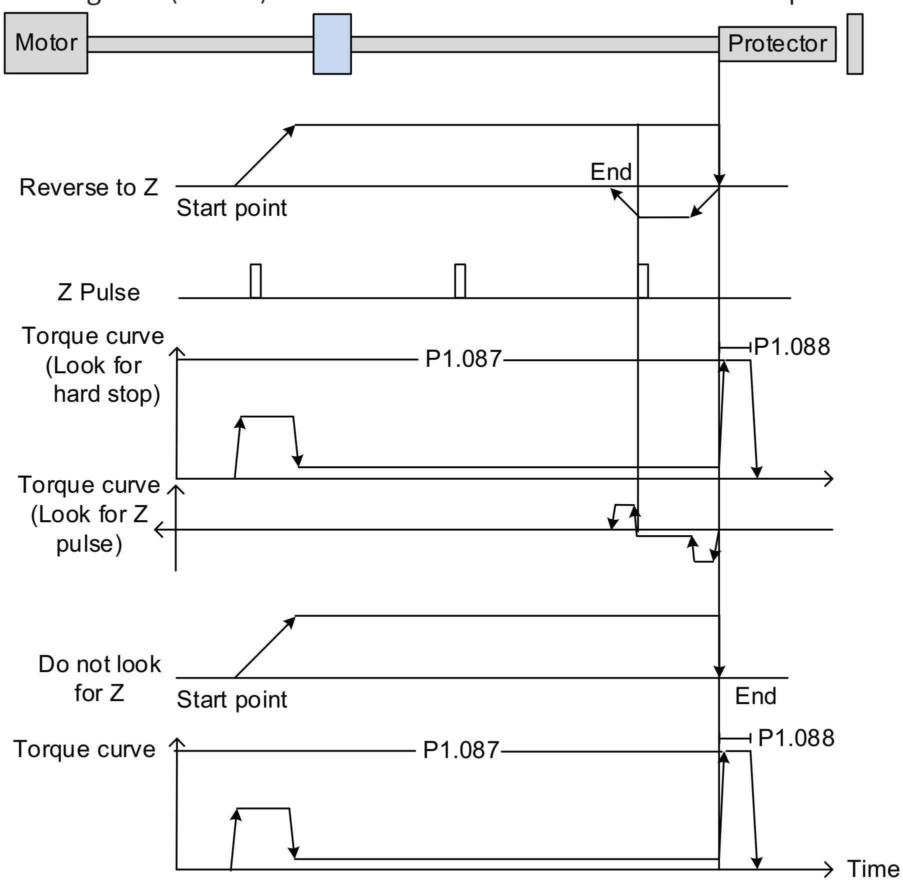
If the ORG signal is triggered at the start point (high, Start point 3), the servo motor operates at low speed (second speed setting) in the forward direction until the ORG signal switches to low. Finally, the motor reverses to look for the Z pulse and decelerates to a stop, completing the homing.

If you set it to look for the Z pulse or to not to look for the Z pulse in the forward direction, which is similar to the first setting mentioned above (going in the reverse direction or not to look for the Z pulse), please refer to the timing diagram above.

5) **Referencing the current position as the origin:** This method uses the motor's current position as the reference origin. As long as the homing procedure is triggered and the motor remains still, then coordinate positioning is completed.



6) **Referencing the torque limit:** This method uses the motor's stop position as the origin by referring to a mechanical limit on the machine, the torque level setting (P1.087), and the retaining time (P1.088). You can also choose whether to use the Z pulse as the origin.



In the figure above that uses looking for the Z pulse, the motor runs at the high speed (first speed setting). Then the servo outputs a greater current to resist the external force once the motor touches the collision protector. When the motor torque reaches the set limit (P1.087) and the output duration is longer than the time setting (P1.088), the motor runs in the reverse direction to look for the Z pulse at low speed (second speed setting). Once the motor finds the Z pulse, it decelerates to a stop, completing the homing.

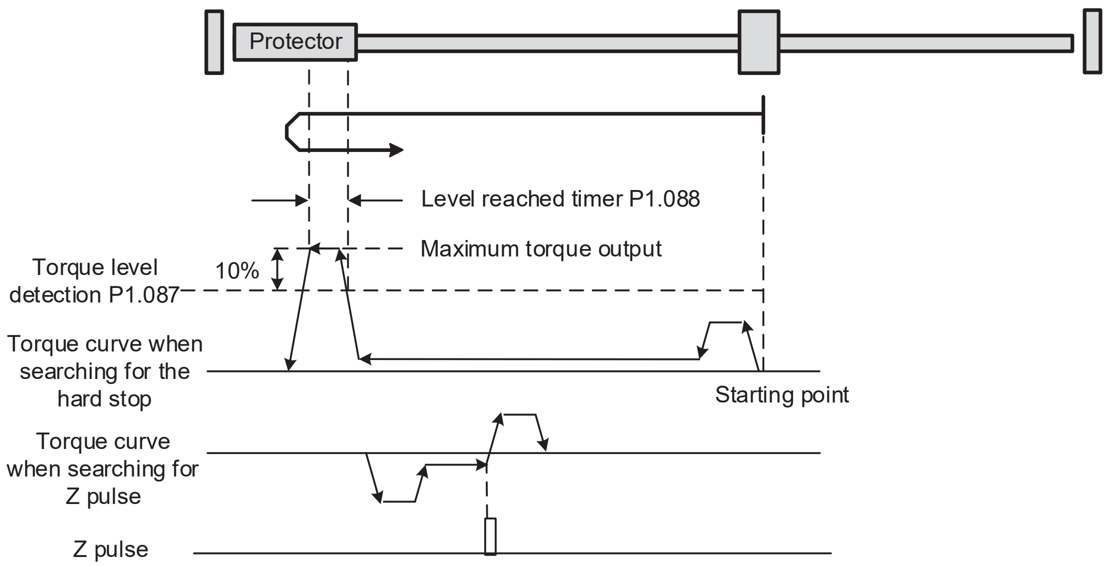
If you set it not to look for the Z pulse, the servo motor runs at high speed (first speed setting) until it touches the collision protector. Then the servo outputs a greater current to resist the external force. When the motor torque reaches the set limit (P1.087) and the output duration is longer than the time setting (P1.088), the motor stops, completing the homing.

The following table lists the parameters for the torque limit (P1.087) and the torque limit time (P1.088):

P1.087	***Torque Limit (Torque Level)***		***Address: 01AEH 01AFH***
Default:	1	Control mode:	PR
Unit:	%	Setting range:	1 – 300
Format:	DEC	Data size:	16-bit

Settings:

The Torque limit is only for Torque limit homing mode. As shown in the following diagram, when the homing command is triggered, the motor runs in one direction until it reaches the collision protector. After reaching the collision protector, the servo drive outputs a larger motor current to counter the external force from the collision protector. The servo drive uses the motor current and the Torque limit time to determine homing, and then it runs in the opposite direction to find the Z pulse.



Note: The actual maximum torque output of the motor is 10% greater than the detected torque level (P1.087). For example, set P1.087 to 50%, then the maximum torque output of the motor is 60%.

P1.088	Torque limit time		Address: 01B0H 01B1H
Default:	2000	Control mode:	PR
Unit:	millisecond	Setting range:	2 – 2000
Format:	DEC	Data size:	16-bit

Settings:

Set the Torque limit time for Torque limit homing mode. Please refer to P1.087 for the timing diagram of Torque limit homing mode.

PR Monitoring Variables

As mentioned in Section 7.1.2, the PR mode provides four monitoring variables for you to monitor the servo commands and feedback status. These are Command position PUU (Cmd_O), PR command end register (Cmd_E), Feedback position PUU (Fb_PUU), and Position error PUU (Err_PUU). Before homing completes, the command end register (Cmd_E) cannot be calculated because the coordinate system can only be created after homing is completed, and the target position remains unknown after the Homing command is issued. This is why the status of each monitoring variables is different during homing. In Homing command's default setting, the contents of Cmd_E and Cmd_O are identical. After it finds the reference origin in the coordinate system, it sets the content of Cmd_E to the coordinate of the reference origin. However, once it finds the reference origin, it still requires some distance for motor to decelerate to a stop. Meanwhile, Cmd_O continues to issue commands. If no other PR commands are issued after homing (other than the Position command), the contents of the final command position (Cmd_O) and command end position (Cmd_E) will be different. See Figure 7-12.

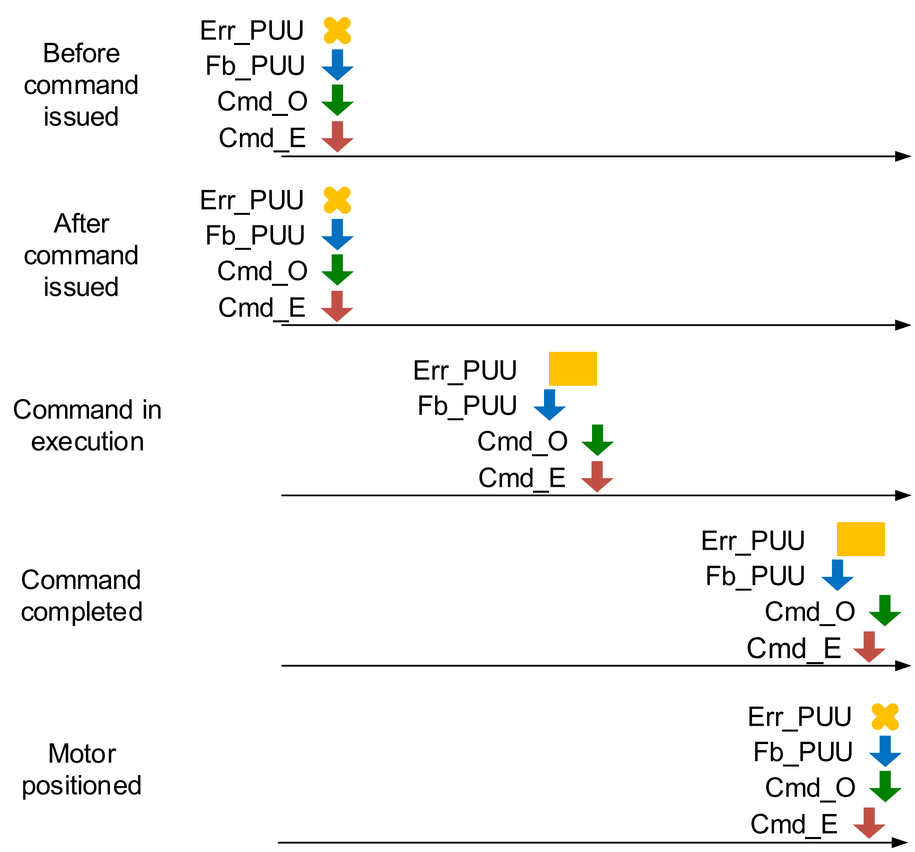


Figure 7-12 Homing mode and monitoring variables

Constant Speed Control

The PR mode provides a speed control function. The following parameters are available for PR speed setting: acceleration / deceleration time, delay time, and target speed. You can easily set the Speed command in the PR mode screen in SureServo2 Pro. See Figure 7-13.

INS (or Insert) is an interrupt command that interrupts the previous motion command. Please refer to Section 7.1.6 for more details. AUTO is a command that automatically loads the next PR path. It executes the next PR path when the current PR path completes. In addition, you can set the target speed with two unit options, which are 0.1 rpm and 1 PPS ranging from -6000 rpm–6000 rpm. You select the ACC/DEC acceleration / deceleration time with the shared PR parameters. The software calculates and displays the required duration for accelerating from 0 to the target speed. DLY is the delay time that is determined by the shared PR parameters. In Constant Speed Control the Delay starts counting after the Target Speed has been reached and only if the AUTO selection is on. If the PR path is not set up to automatically proceed to the next path then the Delay does not apply.

See Figure 7-14 for the effects of the parameters for the PR mode speed control. Table 7-2 shows the bit function when speed control is in operation.

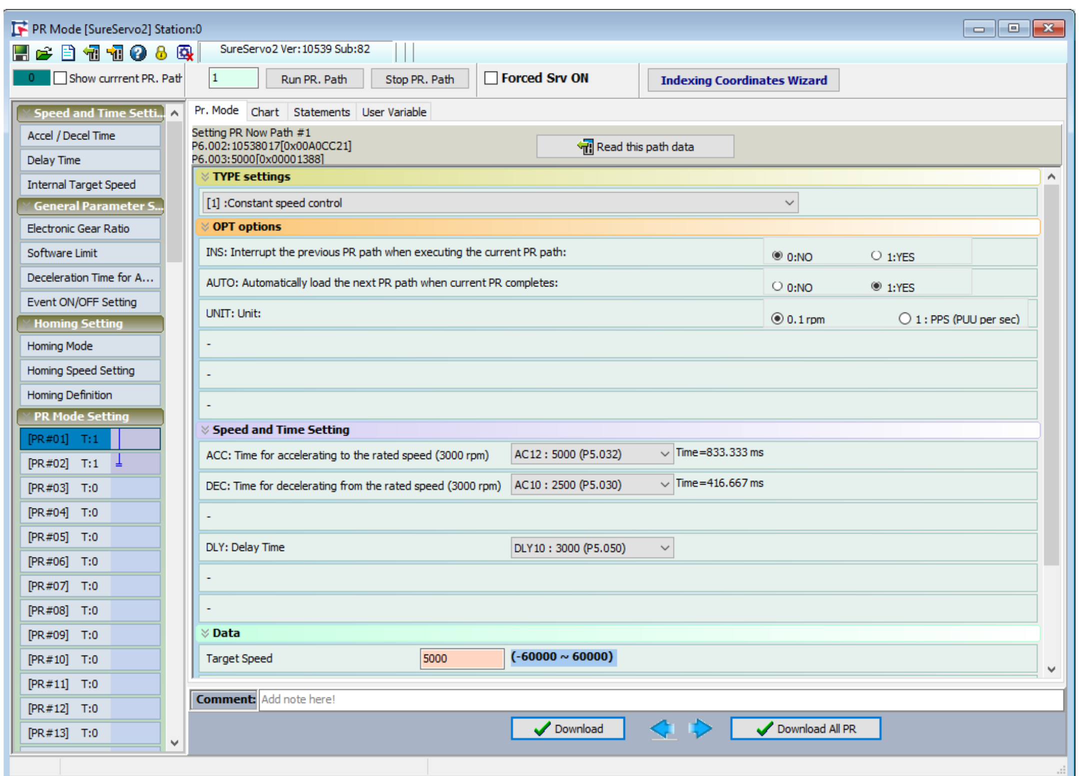


Figure 7-13 PR mode Speed screen in SureServo2 Pro

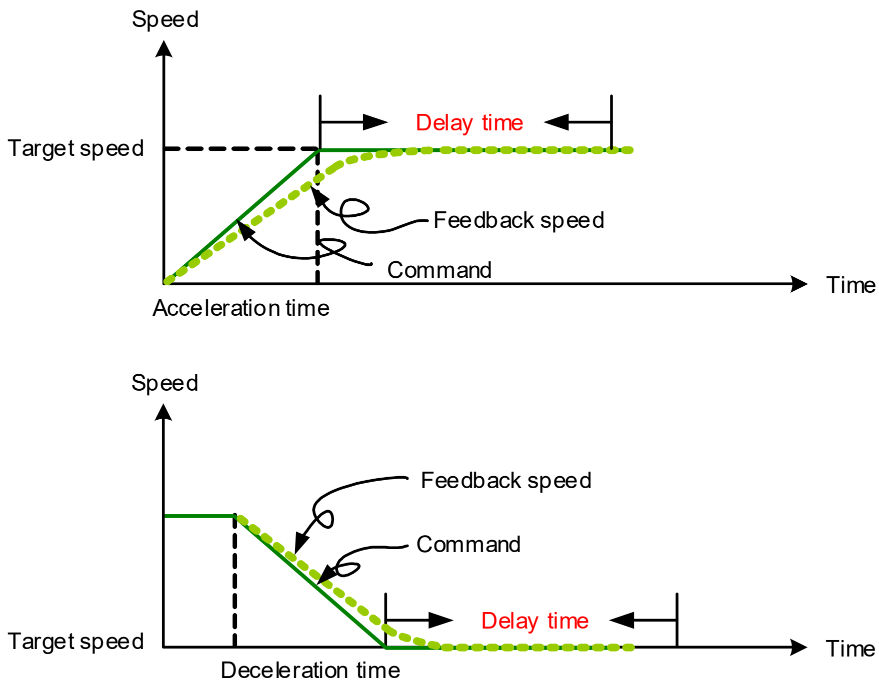


Figure 7-14 Parameters for PR mode speed control

Table 7-2 Bit function of PR speed control

PR Parameters	D	C	B	A	U	Z	Y	X
Command Type	-	-	DLY	-	DEC	ACC	OPT	1
Data Content	Target speed [0.1 rpm / PPS]							

Notes:

1) Y OPT: option

BIT	3	2	1	0
Command Type	-	UNIT	AUTO	INS

INS: Interrupt command that interrupts the previous motion command.
AUTO: automatically load the next PR command when the current one is completed.
UNIT: speed unit selection; 0 signifies 0.1 rpm and 1 signifies PPS.

2) Z, U: ACC / DEC: acceleration / deceleration time, set by P5.020 – P5.035.
3) B: DLY: delay time, set by P5.040 – P5.055.

Point-to-Point Command

PR mode includes a position control function. The Position command is user-defined and its unit is PUU. There are two command types: Mode 2 and Mode 3. In Mode 2 (Point-to-Point Command) the command signifies that it stops once the command is completed. In Mode 3 (Point-to-Point Command & proceed to next path) the command signifies that the next PR path is automatically executed. You use the same method to set the value for these modes in SureServo2 Pro. See Figure 7-15.

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In Figure 7-15, INS stands for the interrupt command that interrupts the previous motion command. OVLP stands for the overlap command that allows the next PR command to overlap the command that is currently being executed when decelerating. If you apply this this function, setting the delay time to 0 is suggested (please refer to Section 7.1.6). ACC / DEC is the acceleration / deceleration time determined by the shared PR parameters. The software calculates and displays the required time to accelerate from 0 to the target speed. SPD is the target speed specified by the shared PR parameters. You can choose whether it is multiplied by 0.1. DLY is the delay time specified by the shared PR parameters and it is defined by the command; in other words, once the target position is reached, the delay time starts counting.

The Position command for PR mode is illustrated in Figure 7-16. Table 7-3 lists the bit functions of position control.

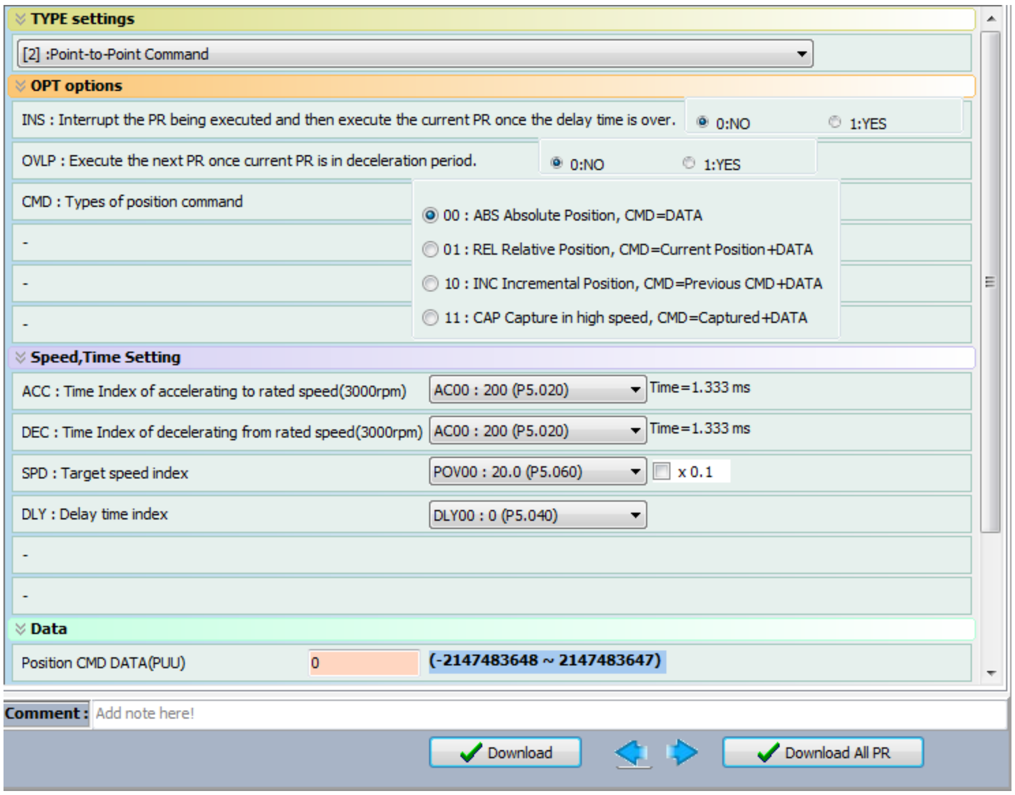

Figure 7-15 PR mode position interface of SureServo2 Pro

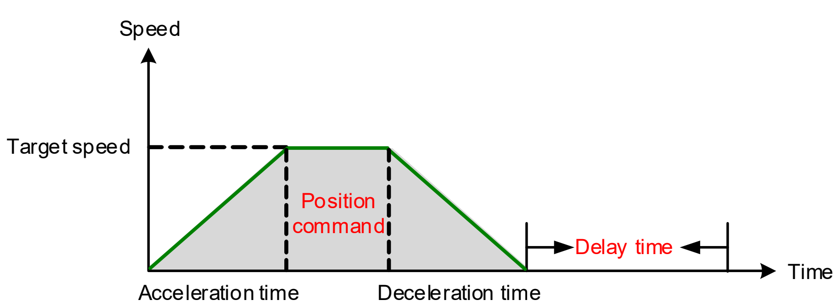

Figure 7-16 Parameters for PR mode position setting

There are four types of position commands for the PR mode. You can choose the position command according to the application requirements. The functions of each type are described in the examples below. Please note that the condition in these examples is that a position command is still being executed and another type of command is inserted. To see how the position commands are combined, please see Figure 7-17.

1) ***Absolute Position Command*** (ABS): when executed, the target position value equals the absolute command value. In the figure, an ABS command with the value of 60000 PUU is inserted in the previous PR path with setting target position of 60000 PUU on the coordinate axis.
2) ***Relative Position Command*** (REL): when executed, the target position value is the motor's current position value plus the position command value. In the figure, a REL command with the value on 60000 PUU is inserted in the previous PR path. The target position is the motor's current position (20000 PUU) plus the relative position command (60000 PUU), which equals 80000 PUU in the coordinate system. The target position specified by the original command is overwritten. When using REL or INC in a PR path as an interrupt (I) then they behave the same way. They both act as a REL command. See Figure 7-49 for this behavior.
3) ***Incremental Command*** (INC): when executed, the target position is the previous target position value plus the current position command value. In the example below, an INC command with the value of 60000 PUU is inserted in the previous PR path. The target position is the previous target position value 30000 PUU plus the relative position command 60000 PUU, which equals 90000 PUU. The previous destination specified by the previous command is combined to define the new one. When using REL or INC in a PR path as an interrupt (I) then they behave the same way. They both act as a REL command. See Figure 7-49 for this behavior.
4) ***High-Speed Position Capturing Command*** (CAP): when executed, the target position is the last position acquired by the Capture function plus the position command value. Please refer to Section 7.2.2 for more on the high-speed position capturing function. In the following example, a high-speed capturing command with the value of 60000 PUU is inserted in the previous PR path. The target position value is the captured position value of 10000 PUU plus the relative command of 60000 PUU, which equals 70000 PUU. The target position specified by the original command is omitted.

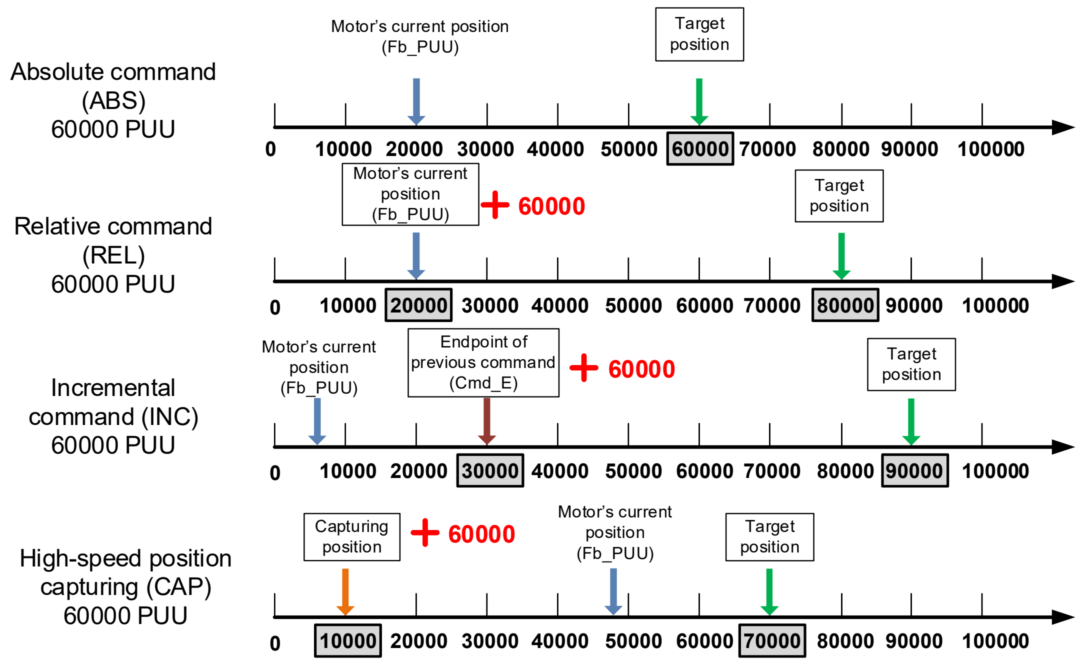

Figure 7-17 Four types of position command

Table 7-3 Bit functions of parameters of PR mode Position control

PR Parameters	D	C	B	A	U	Z	Y	X
Command Type	-	-	DLY	SPD	DEC	ACC	OPT	2 or 3
Data content	Target position [PUU]							

Notes:

1) Y: OPT: option

BIT / Command Type	3	2	1	0	Description
Command Type	CMD		OVLP	INS	-
Data Content	0	0	-	-	ABS (absolute positioning)
	0	1			REL (relative positioning)
	1	0			INC (incremental positioning)
	1	1			CAP (high-speed position capturing)

INS: Interrupt command interrupts the previous motion command.
OVLP: allow overlapping of the next command
CMD: Position command selection

2) Z, U: ACC / DEC: acceleration / deceleration time, set by P5.020 – P5.035.
3) A: SPD: internal target speed number, set by P5.060 – P5.075.
4) B: DLY: delay time, set by P5.040 – P5.055.

Jump to the Specific Path

PR mode includes a Jump command. It can call any PR paths or form PR paths into a loop, as shown in Figure 7-18. You can specify the PR path number to jump to in the PR mode screen in SureServo2 Pro (see Figure 7-19). INS stands for the interrupt command that interrupts the previous motion command. You can find more information in Section 7.1.6. DLY is the delay time determined by shared PR parameters. Once a Jump command is issued, the servo drive starts counting the delay time then jumps to the specific path. Available target PR numbers are PR#00 – PR#99. Table 7-4 shows the functions of each bit when executing a Jump command.

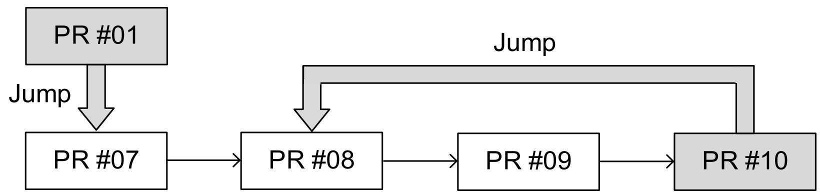

Figure 7-18 Jump command in PR mode

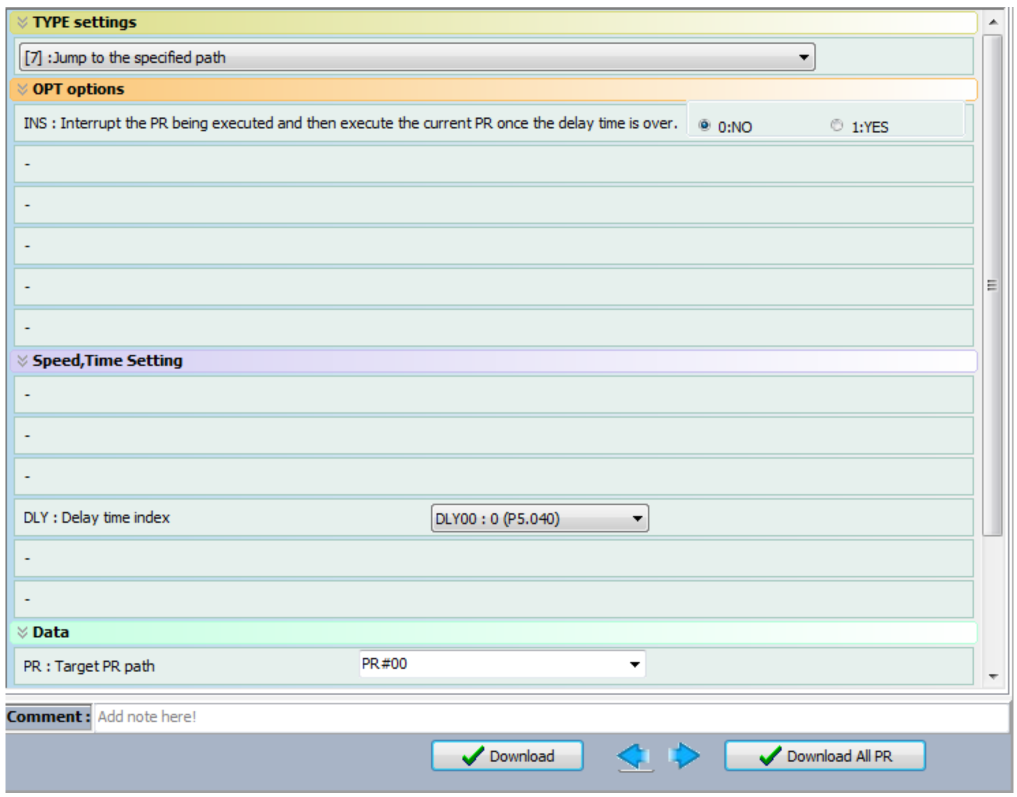

Figure 7-19 Using PR mode Jump command in SureServo2 Pro

Table 7-4 Bit function of PR Jump command

PR Parameters	D	C	B	A	U	Z	Y	X
Command Type	-	-	DLY	-	-	-	OPT	7
Data Content	Jump to target PR path (0 – 99)							

Notes:

1) Y: OPT: option

BIT	3	2	1	0
Command Type	-	-	-	INS

INS: Interrupt command; interrupts the previous motion command.

2) B: DLY: delay time, which is set in P5.040 – P5.055.

Write command

PR mode includes a Write command. It can write constants, parameters, data array elements, and monitoring variables to the specified parameters or to data array elements. You can write a parameter to a specified path in the PR mode screen in SureServo2 Pro (see Figure 7-20). INS is an interrupt command, which interrupts the previous motion command. Refer to Section 7.1.6 for more details. AUTO command automatically loads and executes the next PR once the current PR completes. ROM command writes parameters to both RAM and EEPROM at the same time. Writing to non-volatile memory function is also available; however, frequent writes shortens the life of the EEPROM. DLY is the delay time selected by shared PR parameters. Once the write command is issued the write happens immediately and the delay is applied after the data is written. Table 7-5 shows the functions of each bit when executing a Write command.

Writing Target	Data Source
Parameter	Constant
Data array	Parameter
-	Data array
-	Monitoring variables

Wiring
Parameters
DI/DO Codes
Monitoring
Alarms

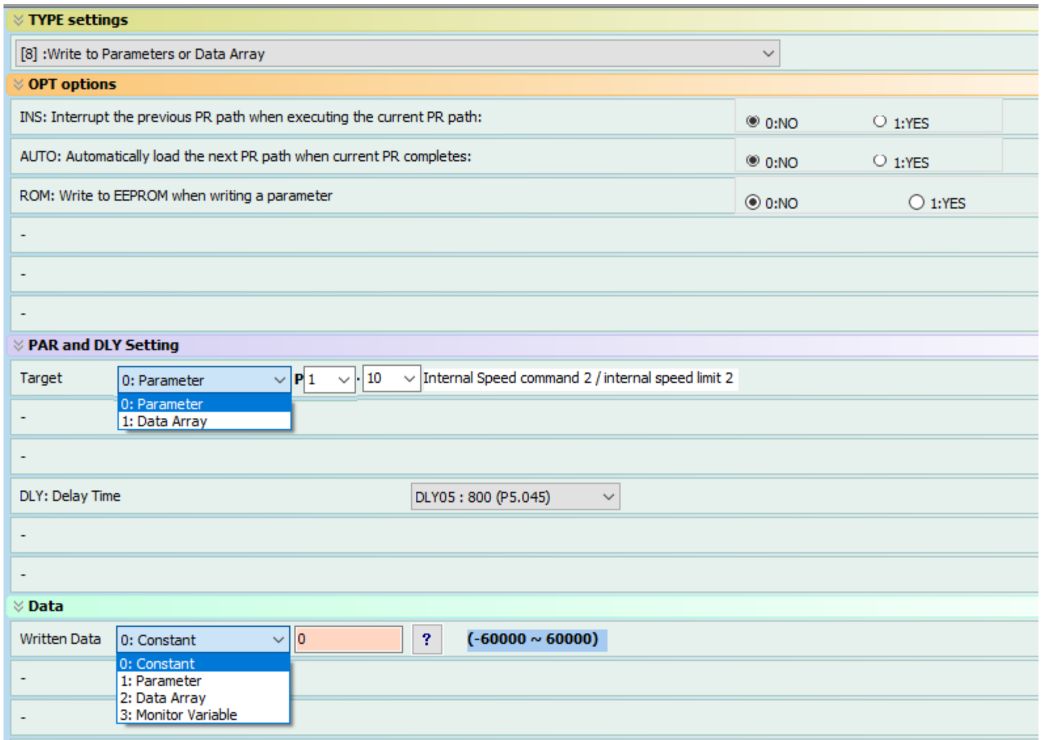

Figure 7-20 Using PR Write command in SureServo2 Pro

Table 7-5 Bit function for PR Write command

PR Parameters	***D***	***C***	***B***	***A***	***U***	***Z***	***Y***	***X***
Command Type	0	SOUR_ DEST	DLY	DESTINATION			OPT	8
Data Content	SOURCE							

Notes:

1) Y: OPT: option

BIT	***3***	***2***	***1***	***0***
Command Type	-	ROM	AUTO	INS

INS: Interrupt command interrupts the previous motion command.
AUTO: once the current PR is completed, automatically load the next command.
ROM: write data to RAM and EEPROM at the same time. This function is only available when the writing Target is a Parameter, it is not available when the writing Target is a Data Array.

2) B: DLY: delay time, which is set in P5.040 – P5.055.

Wiring
Parameters
DI/DO Codes
Monitoring
Alarms

Wiring
Parameters
DI/DO Codes
Monitoring
Alarms

3) C: SOUR_DEST: data source and data format to be written.

BIT	***3***	***2***	***1***	***0***	***Description***	
Command Type	SOUR		-	DEST	Data source	Writing target
Data Content	0	0	0	0	Constant	Parameter
	0	1		0	Parameter	Parameter
	1	0		0	Data array	Parameter
	1	1		0	Monitoring variable	Parameter
	0	0		1	Constant	Data array
	0	1		1	Parameter	Data array
	1	0		1	Data array	Data array
	1	1		1	Monitoring variable	Data array

4) Z, U, A: DESTINATION: destination

	A	***U***	***Z***
Target: Parameter	Parameter group	Parameter number	
Target: Data array	Data array number		

5) SOURCE: data source setting

	D	***C***	***B***	***A***	***U***	***Z***	***Y***	***X***
Data Source: Constant	Constant data							
Data source: Parameter	-					Parameter group	Parameter number	
Data source: Data array	-					Data array number		
Data source: Monitoring variable	-						Monitoring variable number	

Index Position command

PR mode includes an Index Position command, which creates an index coordinate system. The system must have completed the homing routine before indexing can occur. This command positions the motor within the indexing coordinates. Unlike other feedback positions in global coordinate system, index positioning is able to divide the total moving distance of one index into the number of paths required by the application (see Figure 7-21). Please refer to Chapter 10 for absolute position or if position counter overflows occur due to index positioning command. You can start the index positioning in the **Rotary Axis Position Setting Wizard** in the PR screen in SureServo2 Pro (see Figure 7-22). As shown in the example, the start PR path is set to 1, the Path Size (number of index locations) is set to 8, and total moving distance (Indexing Coordinate Scale) is 100000 PUU. When you click **OK**, the software automatically writes position command 0 PUU to PR#01, 12500 PUU to PR#02, 25000 PUU to PR#03, and so on up to PR#08. When the index position reaches 100000 PUU, it automatically returns to 0 PUU. The index path parameters will automatically populate PR1-PRn. If you want to leave open spaces in between each indexed PR path you can enter a value of how many empty PR registers you need by using “Set the interval between two paths” option if you want to have other actions occur after the index moves.

In addition, you can modify each individual index position in each PR path as needed, as shown in Figure 7-23. INS stands for the interrupt command that interrupts the previous motion command (see Section 7.1.6.). OVLP stands for the overlap command that allows the next PR command to overlap the current one during deceleration. If you use OVLP, setting the delay time to 0 is recommended (refer to Section 7.1.6). DIR sets the rotation direction with options of forward (always runs forward), backward (always runs backward), and shortest distance. The movement is illustrated in Figure 7-24. S_LOW is the speed unit with options of 0.1 rpm or 0.01 rpm. AUTO automatically loads and executes the next PR path when current PR completes. ACC / DEC is the acceleration / deceleration time setting determined by shared PR parameters. SPD is the target speed set by the PR shared parameters. DLY is the delay time defined by the command from controller; meaning that when motor reaches the target position, the servo drive starts counting the delay time. Position command is the target position of each index segment. Please note that the setting range must be smaller than the total index moving distance (P2.052). Table 7-6 shows the bit function for the Index Position command. If you use the index function, please execute homing in order to create the coordinate system so that the origin of the motor’s feedback position and that of the motor’s index position can be identical. If you do not execute homing, AL237 occurs.

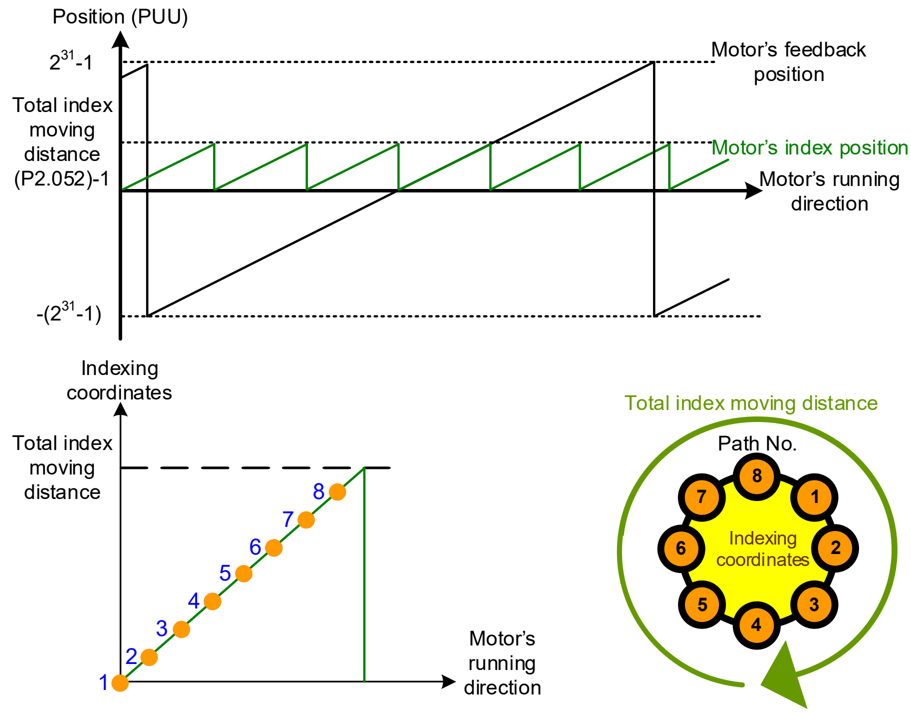

Figure 7-21 PR mode indexing coordinates

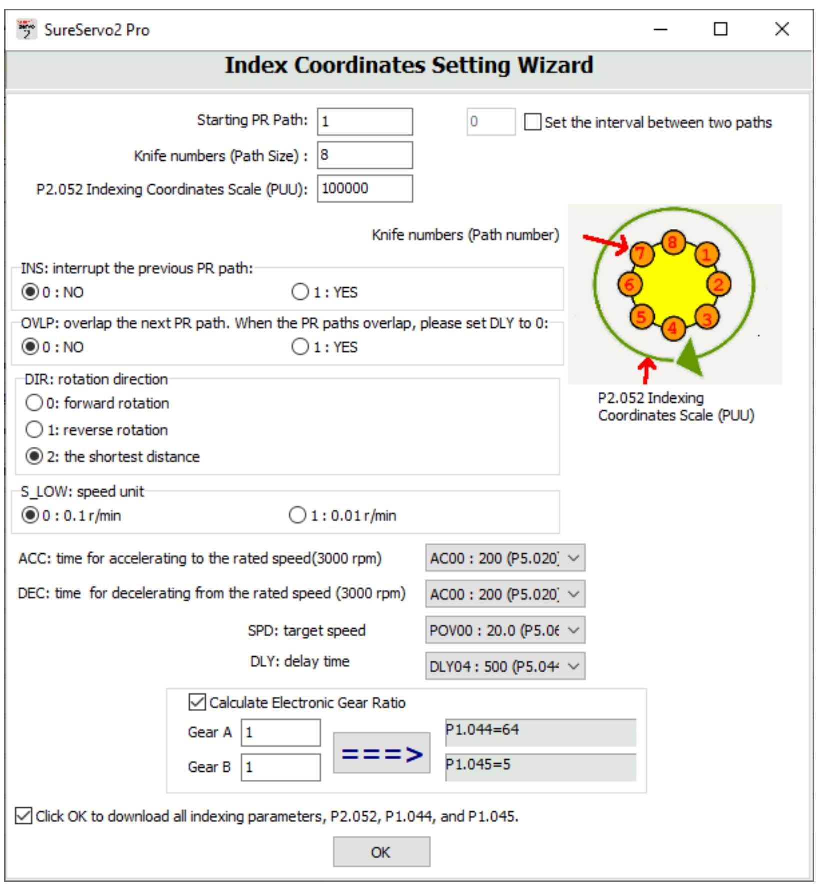

Figure 7-22 Indexing Coordinates Setting Wizard in PR mode

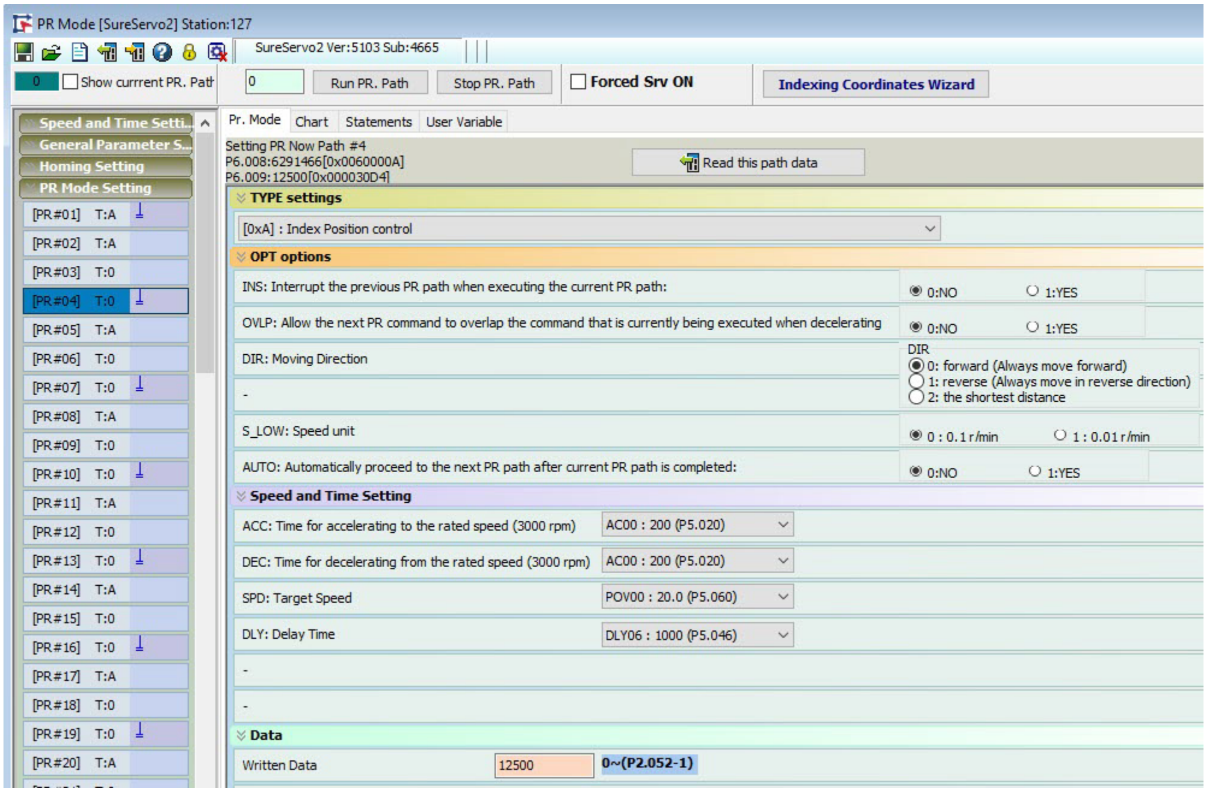

Figure 7-23 PR mode Index Position screen in SureServo2 Pro

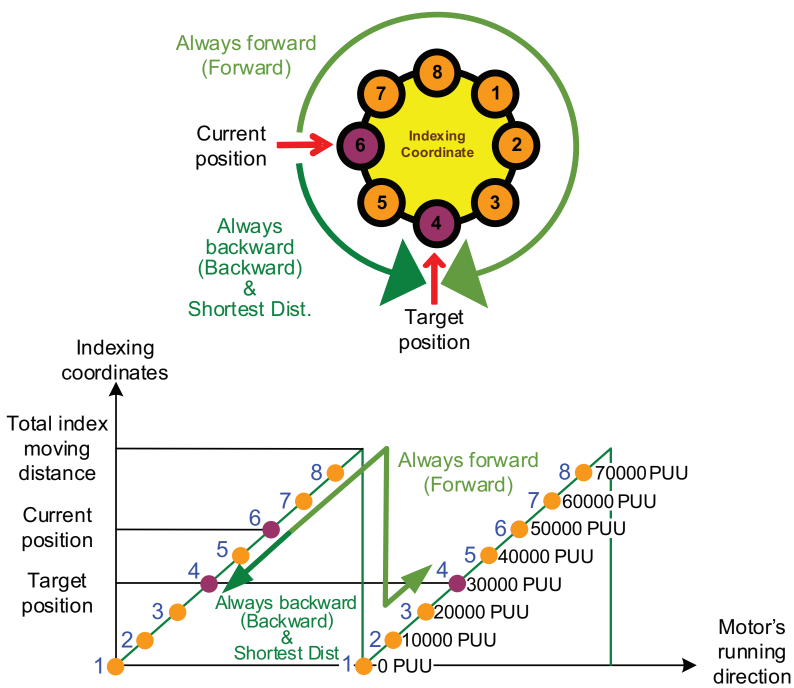

Figure 7-24 Motor's operation direction and indexing coordinates

Table 7-6 Bit function for the Index Position command

PR Parameters \ BIT	D	C	B	A	U	Z	Y	X
Command Type	-	OPT2	DLY	SPD	DEC	ACC	OPT	0xA
Data Content	Index Position command [PUU](0 – P2.052-1)							

Notes:

1) Y: OPT: option

BIT	3	2	1	0	Description
Command Type	DIR		OVLP	INS	-
Data Content	0	0	-	-	Always goes forward (Forward)
	0	1			Always goes backward (Backward)
	1	0			Shortest distance
	1	1			-

INS: Interrupt command interrupts the previous motion command.
OVLP: allow overlapping of the next command

2) C: OPT2: Option 2

BIT	3	2	1	0
Command Type	-	AUTO	-	S_LOW

S_LOW: speed unit options, 0 stands for 0.1 rpm and 1 for 0.01 rpm.
AUTO: automatically load the next PR command when the current one is completed.

3) Z, U: ACC / DEC: acceleration / deceleration time set by P5.020 – P5.035.
4) A: SPD: delay time, set by P5.060 – P5.075.
5) B: DLY: delay time, set by P5.040 – P5.055.

Statement (Arithmetic operations)

PR mode has arithmetic operations commands, including addition, subtraction, multiplication, division, OR, AND, MOD (obtain remainder), and logic conditions. The available operands are user variables, parameters, data arrays, monitoring variables, and constants. Among them, the user variable is the register only for arithmetic operations. There are 64 sets of user variables with a data size of 32-bits. The data size of a constant is also 32-bits. The user variable index number is selected in the Value column [3] of the Expressions block. This is not the data value, only the index number. In order to assign a data value to a User[*] index you must write an expression (equation) to populate it. Below is an expression that assigns a value of 111 plus the data value stored in array element 500 into User Index 1. When the PR path containing this expression is executed the values of 111+Array Element 500 data will be populated into User[1].

Expressions

	Type	Value	=	Type	Value	Opr	Type	Value	Hex
1	User[*]	1	=	Constant	111	+	Arr[*]	500	

After all arithmetic operation commands are executed, you can set a jump condition in the path so that execution jumps to different PR path and then continue or stop once the operation is done. A Statement Type in a PR path can execute expressions and procedures in the same PR execution cycle with the Expression being evaluated before the Procedure, or the PR path can execute either just an Expression or a Procedure. Multiple Expressions can be entered but only one Procedure (condition). The Statement section is the result of the equations entered in the Expression and the Procedure section.

The arithmetic operation commands support negative numbers operations but not floating point operations. Negative numbers are calculated by “two’s compliment”. Figure 7-25 is the Arithmetic Operations screen in SureServo2 Pro. **<u>Expressions, Procedures, and Statements must be created in SureServo2 Pro. Do not use the keypad or communication channels to enter arithmetic operations.</u>** Once you complete the arithmetic operation, click **Download All PR** to write all PR paths to the servo drive.

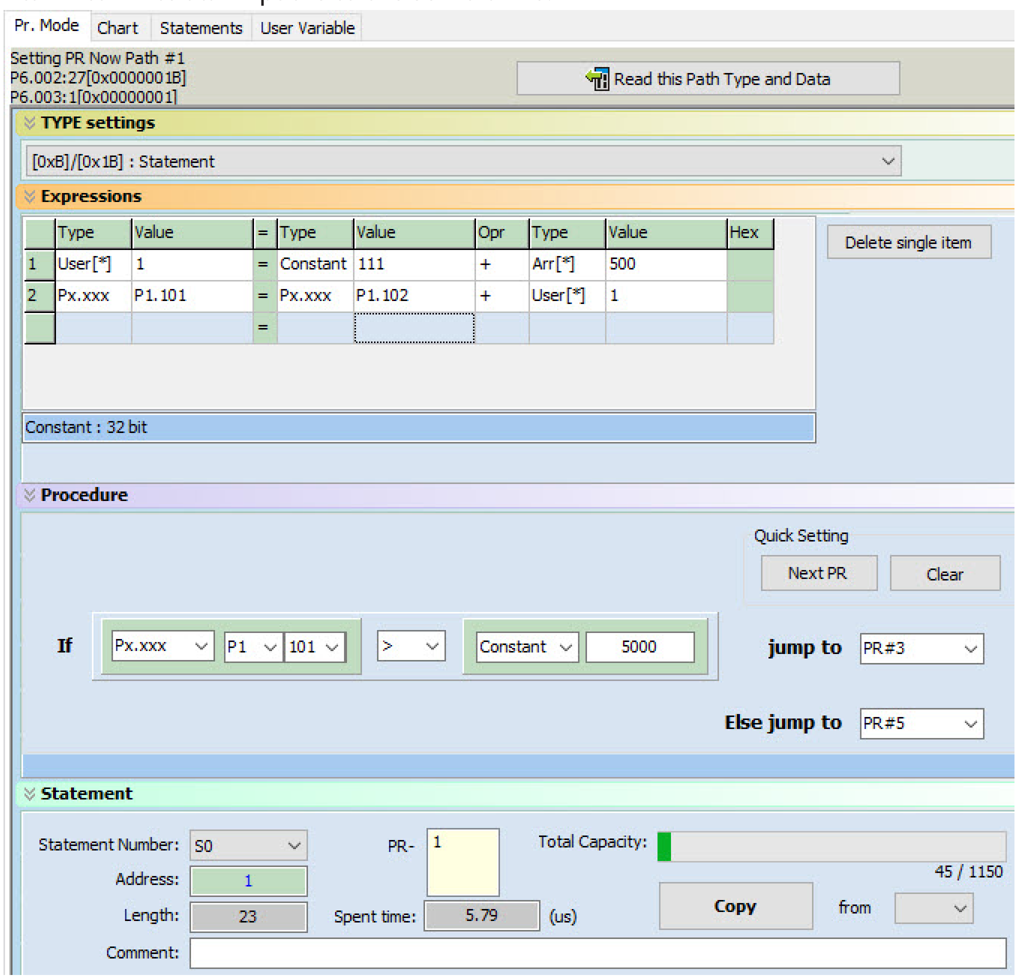

Figure 7-25 PR Arithmetic Operations screen in SureServo2 Pro

1) Expressions Section: supports addition, subtraction, multiplication, division, AND, OR, and MOD operation as well as logical operations for multiple data. Table 7-7 shows the supported operators and calculation data with data format in DEC and HEX.
After all expressions have been evaluated the Statement Path now evaluates the Procedure condition.

Table 7-7 Description of each field in the Expression section

<table>
<tr><th>Data to be Written</th><th>=</th><th>Calculation Data</th><th>Operator</th><th>Calculation Data</th></tr>
<tr><td rowspan="2">User variable
(User[0-63])</td><td rowspan="5"></td><td>User variable
(User[0-63])</td><td rowspan="5">Addition (+)
Subtraction (-)
Multiplication (*)
Division (/)
Modulus (%)
And (&)
Or (|)</td><td rowspan="2">User variable
(User[0-63])</td></tr>
<tr><td>Constant
(Constant)</td></tr>
<tr><td>Parameter
(PX.XXX)</td><td>Data array
(Arr[0-799])</td><td>Constant
(Constant)</td></tr>
<tr><td rowspan="2">Data array
(Arr[0-799])</td><td>Parameter
(PX.XXX)</td><td rowspan="2">Data array
(Arr[0-799])</td></tr>
<tr><td>Monitoring variable
(Mon[*])</td></tr>
</table>

2) Procedure Section: uses the IF statement to determine whether the user-defined condition is fulfilled. If true, jump to the next specified PR path; if false, jump to the other specified PR path. If you click **Next PR** in **Quick Setting**, the software automatically inputs the condition and then jumps to the next PR path. If you leave this section blank, then the PR procedure will stop once the basic operation is done. See Table 7-8 for data formats and operators.

Table 7-8 Field description for the Procedure setting section

<table>
<tr><th>Data Format</th><th>Operator</th><th>Data Format</th></tr>
<tr><td>User variable
(User[0-63])</td><td rowspan="5">Greater than (>)
Greater than or equal to(≥)
Less than (<)
Less than or equal to (≤)
Equal to (=)
Not equal to (≠)</td><td rowspan="2">User variable
(User[0-63])</td></tr>
<tr><td>Constant
(Constant)</td></tr>
<tr><td>Data array
(Arr[0-799])</td><td>Constant
(Constant)</td></tr>
<tr><td>Parameter
(PX.XXX)</td><td rowspan="2">Data array
(Arr[0-799])</td></tr>
<tr><td>Monitoring variable
(Mon[*])</td></tr>
</table>

3) Statement Section: this section includes statements and memory capacity. Statements save the data from the expression and procedure sections. Data in the expression and procedure sections of the same statement always remain identical and can be shared by multiple PR paths. If data in those two sections are different, then the data is saved to another statement. The time required to execute the statement is shown in the **Spend Time** field. **Total Capacity** shows the servo drive memory capacity; basic operations cannot be performed if there is no memory space available. The **Statements** tab is shown in Figure 7-26. The upper section displays all the statements and the lower section displays the operations in each statement and the values.

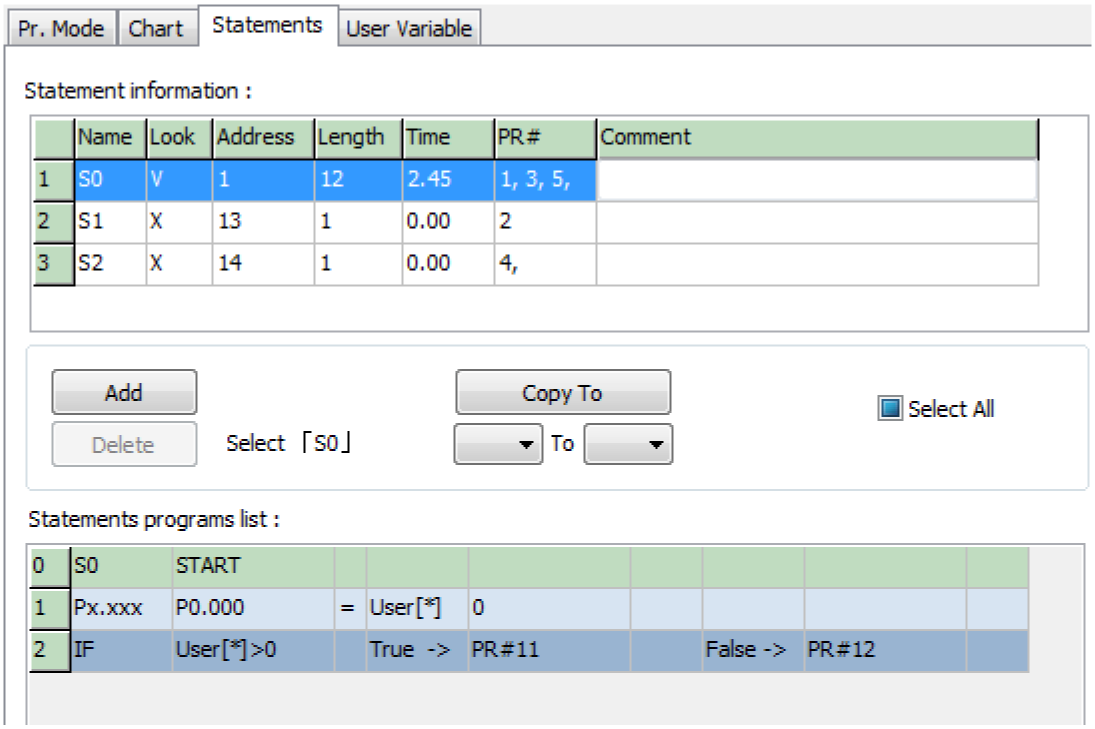

Figure 7-26 Statements tab in SureServo2 Pro

7.1.4 - Overview of the PR procedure

In PR mode, there are seven types of commands. To understand how the PR procedure works, SureServo2 Pro presents the execution order and calling sequence of all PR procedures. First, symbols and contents in the PR figure are shown. This includes five parts: PR path number, execution type, command type, next PR command, and command data. See Figure 7-27.

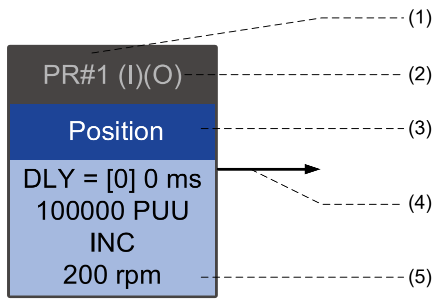

Figure 7-27 PR display

1) Number: the PR number, ranging from PR#0 to PR#99 (100 sets of PR paths).
2) Command execution (property): (B) Execute homing when power on; (O) Command overlap; (R) write data to EEPROM; (I) command interrupt.
3) Command type: there are six types of PR procedure commands: homing, speed, position, writing, jumping, and arithmetic operations. The color displayed in this section depends on the command type.
4) Next procedure command: if followed by a PR command, the arrow points to the specified PR path.
5) Command information: displays the details of this PR path. The color depends on the information types.

The following sections illustrate each command type and its presentation.

Homing methods

In the display of homing methods, PR#0 is always the homing procedure, which is marked as “Homing”. See Figure 7-28.

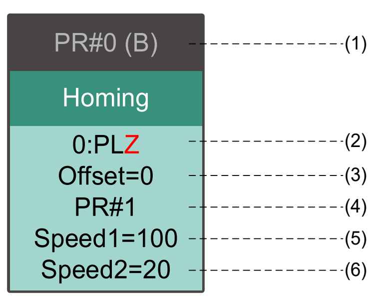

Figure 7-28 Homing methods display

1) Activation mode (Boot): to execute homing when the drive is in Servo On state, it displays (B); if homing is not required, then no information is displayed.

2) Method Selection: homing methods and Z pulse setting are shown in the table below. F signifies running forward; R signifies running in reverse; ORG signifies origin; CUR signifies current position; BUMP represents the collision point.

Homing methods	***Y = 0: reverse to look for Z pulse*** ***Y = 1: go forward to look for Z pulse***	***Y = 2: do not look for Z pulse***
X = 0: homing in forward direction with PL as the homing origin	0: PLZ	0: PL
X = 1: homing in reverse direction with NL as the homing origin	1: NLZ	1: NL
X = 2: homing in forward direction with ORG (when it switches from off to on state) as the homing origin	2: F_ORGZ	2: F_ORG
X = 3: homing in reverse direction with ORG (when it switches from off to on state) as the homing origin	3: R_ORGZ	3: R_ORG
X = 4: look for the Z pulse in forward direction with it as the homing origin	4: F_Z	
X = 5: look for the Z pulse in reverse direction with it as the homing origin	5: R_Z	
X = 6: homing in forward direction with ORG (when it switches from on to off state) as the homing origin	6: F_ORGZ	6: F_ORG
X = 7: homing in reverse direction with ORG (when it switches from on to off state) as the homing origin	7: R_ORGZ	7: R_ORG
X = 8: use the current point as the origin	8: CUR	
X = 9: look for collision point in forward direction and use it as the origin	9: F_BUMPZ	9: F_BUMP
X = A: look for collision point in reverse direction and use it as the origin	A: R_BUMPZ	A: R_BUMP

3) Offset: origin offset, P6.001
4) Path: next PR path to be executed after homing
5) Homing at high speed: first homing speed, P5.005.
6) Homing at low speed: second homing speed, P5.006.

Speed command

You can use the Speed command in any PR paths (PR#1 – PR#99). It is marked as “Speed”. See Figure 7-29.

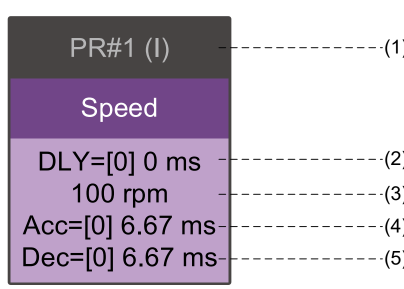

Figure 7-29 Speed command display

1) Command execution type: a Speed command can interrupt (INS) the previous PR path. If the Interrupt function is enabled, it displays (I); if not, no information is displayed.
2) Delay time (DLY): determined by shared PR parameters. It is defined by a command from the controller; the servo drive starts counting the delay time once it reaches the target speed.
3) Target speed: the set target speed.
4) Acceleration time (ACC): determined by shared PR parameters; length of time to reach the target speed from stopped.
5) Deceleration time (DEC): determined by shared PR parameters; length of time to decelerate from target speed to stopped.

Position command

You can use the Position command in any PR paths (PR#1 – PR#99). It is marked as “Position”, and includes the options to “Stop once position control completed” and “Load the next path once position control completed”. The only difference is that “Load the next path once position control completed” shows an arrow pointing to the next PR. See Figure 7-30.

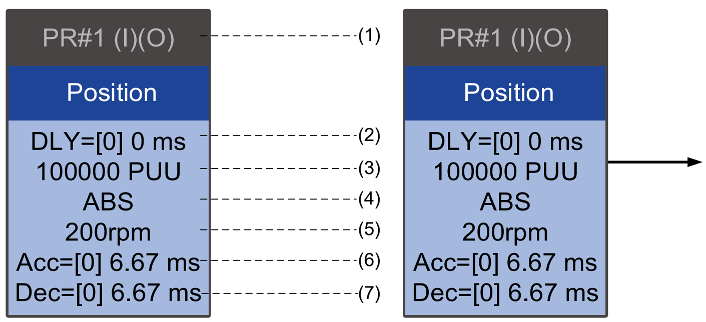

Figure 7-30 Position command display

1) Command execution type: a Position command can interrupt (INS) the previous PR path. If the Interrupt function is enabled, it displays (I); if not, no information is displayed. The Position command can overlap (OVLP) the next PR path. If delay time is set to 0 when this function is enabled, it displays (O). If the Overlap function is not used, no information is displayed.
2) Delay time (DLY): determined by shared PR parameters. It is defined by a command from the controller. The servo drive starts counting the delay time once it reaches the target position.
3) Target position: the set target position.
4) Position command type: “ABS” means an absolute positioning command ; “REL” means relative positioning; “INC” means incremental positioning; “CAP” means high speed position capture.
5) Target speed: determined by shared PR parameters.
6) Acceleration time (ACC): determined by shared PR parameters; the length of time to reach the target speed from stopped.
7) Deceleration time (DEC): determined by shared PR parameters; the length of time to decelerate from target speed to stopped.

Jump command

You can use the Jump command in any PR paths (PR#1–PR#99). It is marked as “Jump” and followed by an arrow pointing to the next PR path. See Figure 7-31.

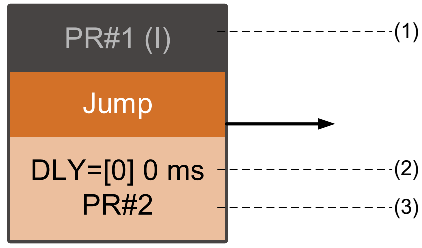

Figure 7-31 Jump command display

1) Command execution type: the Jump command can interrupt (INS) the previous PR path. If the Interrupt function is enabled, it displays (I); if not, no information is displayed.
2) Delay time (DLY): determined by shared PR parameters.
3) Target PR number: the target PR number.

Write command

You can use the Write command in any PR paths (PR#1 – PR#99). It is marked as “Write”. See Figure 7-32.

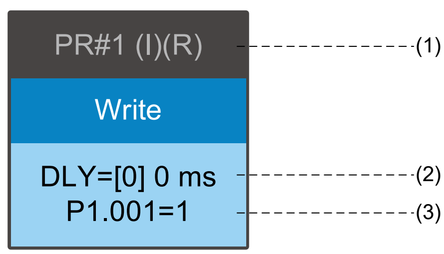

Figure 7-32 Write command display

1) Command execution type: a write command can interrupt (INS) the previous PR path. If the Interrupt function is enabled, it displays (I); if not, no information is displayed. You can determine whether to write the data to EEPROM. If writing data to EEPROM is required, it shows (R); if not, no information is displayed.
2) Delay time (DLY): determined by shared PR parameters.
3) Writing target and data source: the corresponding target and data sources are shown in the table below. Please note that constants can be written in DEC or HEX format.

Writing Target	***Data Source***
Parameter (PX.XXX)	Constant
Data array (Arr[#])	Parameter (PX.XXX)
-	Data array (Arr[#])
-	Monitoring variable (Mon[#])

Index position command

You can use the Indexing Position command in any PR paths (PR#1–PR#99). The number of PR paths is determined by the index number. It is marked as "Index Position". See Figure 7-33.

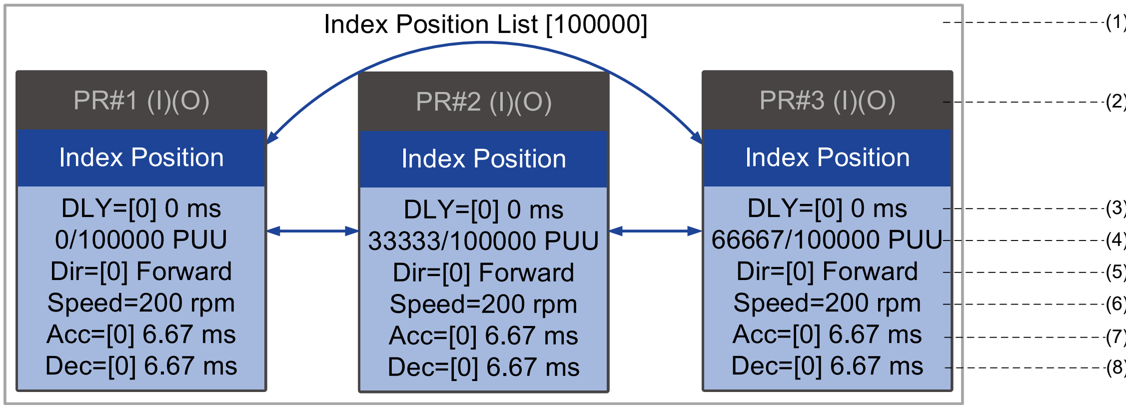

Figure 7-33 Indexing Position command display

1) Indexing Position command section: the number of the index position. It shows the total moving distance at the top using double arrows to show that the motor can run reciprocally between each target position in each PR path.
2) Command execution type: an Index Position command can interrupt (INS) the previous PR path. If the Interrupt function is enabled, it displays (I); if not, no information is displayed. The Index Position command can overlap (OVLP) the next PR path. If delay time is set to 0 when this function is enabled, it displays (O). If the Overlap function is not used, no information is displayed.
3) Delay time (DLY): determined by shared PR parameters. It is defined by a command from the controller. The servo drive starts counting the delay time once it reaches the target position.
4) Position command: the numerator is the position of this PR path; the denominator is the total moving distance of this indexing Position command, which is set by P2.052.
5) Rotation direction (Dir): available options are "Rotation forward (Forward)", "Rotation in reverse (Reverse)" and "Rotation with the shortest distance (Shortest)".
6) Target speed: determined by shared PR parameters.
7) Acceleration time (ACC): determined by shared PR parameters; the length of time to reach the target speed from stopped.
8) Deceleration time (DEC): determined by shared PR parameters; the length of time to decelerate from target speed to stopped.

Statement (Arithmetic operation)

You can use arithmetic operations and statements in any PR paths (PR#1 – PR#99). It is marked as “Statement”. When the condition is fulfilled, an arrow pointing to the next PR path appears with a solid line; if the condition is unfulfilled, an arrow pointing to the next PR appears with a dotted line; Or you can choose to execute the next PR path and stop once the execution is completed. See Figure 7-34.

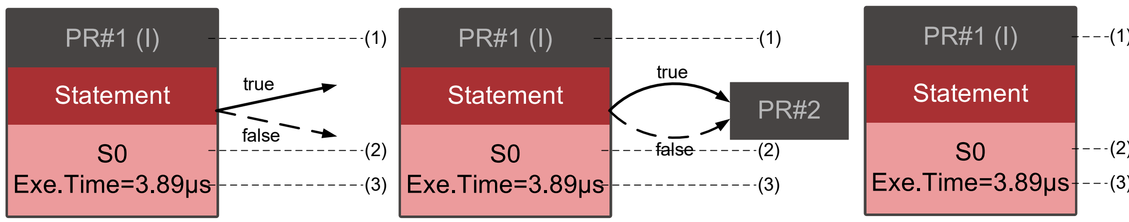

Figure 7-34 Arithmetic operation display

1) Command execution type: an arithmetic operation command can interrupt (INS) the previous PR path. If the Interrupt function is enabled, it displays (I); if not, no information is displayed.
2) Statement number: displays the statement number used in the PR path.
3) Execution time (Exe. Time): the time required to execute the arithmetic operation.

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7.1.5 - Trigger methods for the PR command

There are seven types of PR triggering methods. They are DI-triggered, Event-triggered, P5.007-triggered (for Modbus/ModTCP and EtherNet/IP Explicit communication), P5.122-triggered (for EtherNet/IP *Implicit* communications), Capture-triggered (high-speed position capturing), Compare-triggered (high-speed position comparing), and E-Cam-triggered. You can choose the most suitable triggering method according to the applications and requirements.

Digital input (DI) triggering

You can choose the PR path to be executed by using the internal registers (Position command Bit0 – Bit6) and use a command to trigger the selected PR path. Bits 0–6 are used to create a binary number that calls the PR path. Before using DI-triggering commands, you must define the 8 sets of DI functions, which are [0x11]POS0, [0x12]POS1, [0x13]POS2, [0x1A]POS3, [0x1B]POS4, [0x1C]POS5, [0x1E]POS6, and [0x08]CTRG (refer to section 8.4.9). You can also set this in the Digital IO / Jog Control window of SureServo2 Pro, as shown in Figure 7-35.

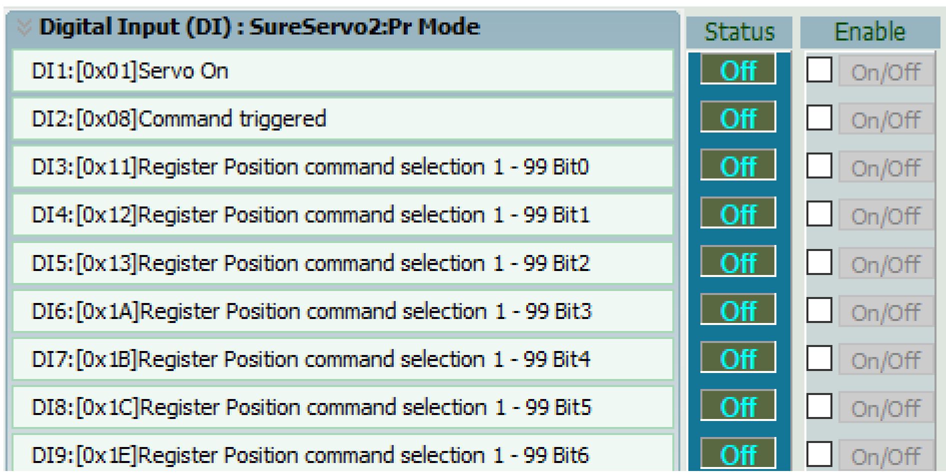

Figure 7-35 I/O screen in SureServo2 Pro

Select the PR number to be executed based on the on / off status of DI.POS0–6 and use DI.CTRG to trigger the specified PR path. See Figure 7-35 for an example.

Table 7-9 Use DI to select the PR path to be triggered

Position Command	POS 6	POS 5	POS 4	POS 3	POS 2	POS 1	POS 0	CTRG	Parameter
Homing	0	0	0	0	0	0	0	↑	P6.000 P6.001
PR#1	0	0	0	0	0	0	1	↑	P6.002 P6.003
~									
PR#50	0	1	1	0	0	1	0	↑	P6.098 P6.099
PR#51	0	1	1	0	0	1	1	↑	P7.000 P7.001
~									
PR#99	1	1	0	0	0	1	1	↑	P7.098 P7.099

In addition, there are two sets of DI for special functions: [0x27] Enable Homing and [0x46] motor stop. If the former is triggered, the servo drive executes the homing routine based on the homing setting. If the latter is triggered, the servo drive stops the motor. You can use the I/O screen in SureServo2 Pro to set these functions, as shown in Figure 7-36.

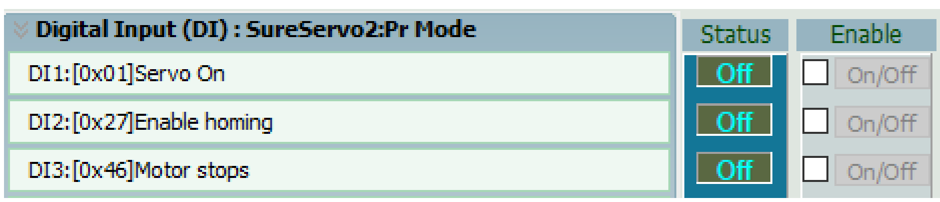

Figure 7-36 I/O screen in SureServo2 Pro

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Event triggering

You can use Event-triggered commands 1 – 4 to execute the specified PR path. You can select two types of Event triggering: rising-edge trigger and falling-edge trigger. Parameters P5.098 (rising edge events) and P5.099 (falling edge events) are used to configure what events trigger what PR paths. The range of PR path numbers that you can specify is from 51 – 63 (see example in Figure 7-37). Before using the Event-trigger for PR command, you must define the DI functions, which are [0x39] Event-trigger command 1, [0x3A] Event-trigger command 2, [0x3B] Event-trigger command 3, and [0x3C] Event-trigger command 4 (see section 8.4.9). You can use SureServo2 Pro to set the I/O triggering as shown in Figure 7-38.

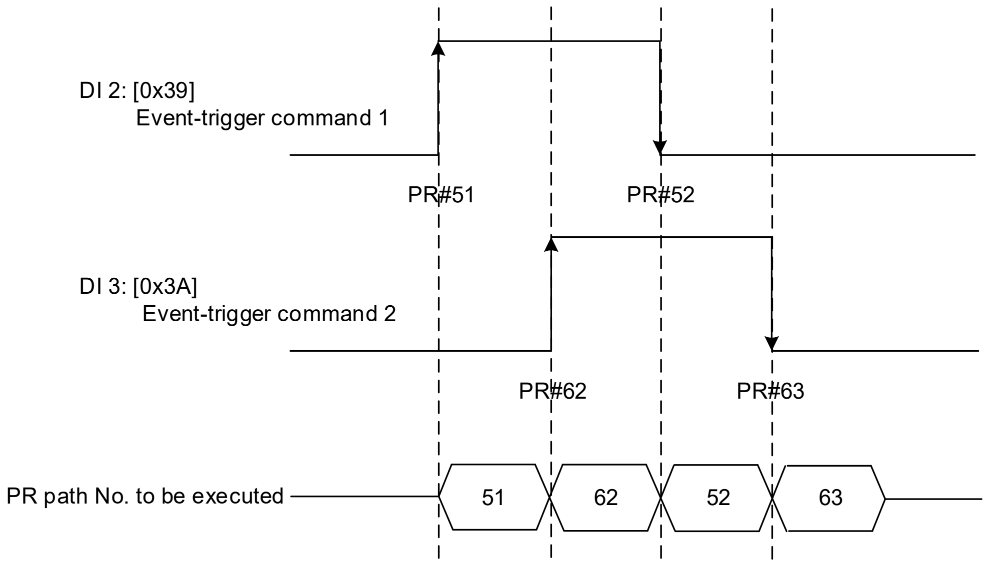

Figure 7-37 Example of Event triggering timing diagram

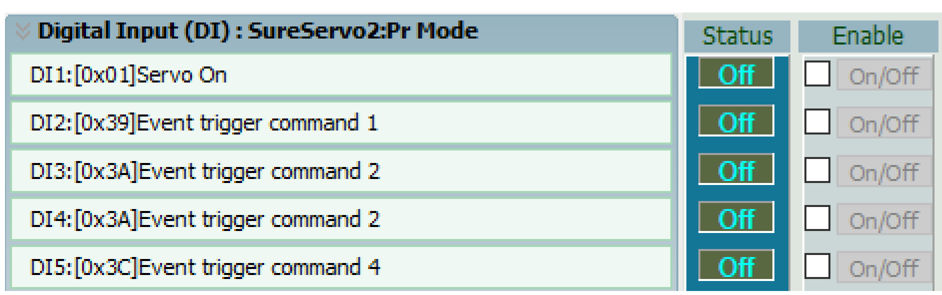

Figure 7-38 I/O screen in SureServo2 Pro

You can set the rising-edge trigger for the desired PR path with P5.098 while you can set the falling-edge trigger with P5.099. Please refer to Chapter 8 for more details. You can also set the Event trigger of PR in SureServo2 Pro (see Figure 7-39).

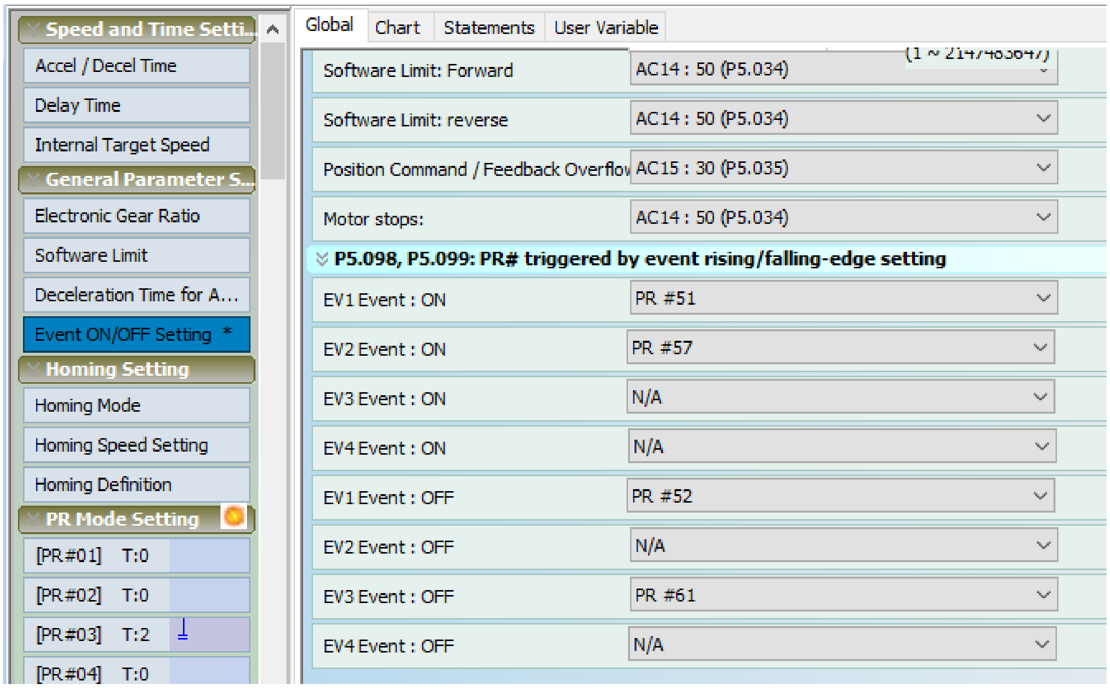

Figure 7-39 Event On/Off screen in SureServo2 Pro

PR command trigger register (P5.007)

You can write the PR number to be executed in P5.007 to make the servo drive execute the specified PR path. If you write 0 to the PR Command Trigger register, the servo drive executes homing. If you write 1 – 99 to the PR Command Trigger register, the servo drive executes the specified PR path. If you write 1000, the servo drive stops executing PR commands. You can find more information in the description of P5.007 in Chapter 8.

Special trigger method

You can use High-speed position capturing (Capture), High-speed position comparing (Compare), and the E-Cam function to trigger the specified PR path. When the capturing completes, you can set Bit3 of P5.039.X to trigger or not trigger PR#50, or set Bit12 of P5.059 to trigger or not trigger PR#45 once the last data is compared. If the E-Cam disengagement setting is 2, 4, or 6, use P5.088.BA to write the PR path number. Please refer to Section 7.2 for Capture, Compare, and E-Cam functions.

Triggering method	*Setting bit*	*Trigger PR path*
High-speed position capturing (Capture)	P5.039.X Bit3	PR#50
High-speed position comparing (Compare)	P5.059.U Bit0	PR#45
E-Cam	P5.088.BA	User-defined

7.1.6 - PR Procedure Execution Flow

The SureServo2 drive updates the command status every 1ms. Figure 7-40 illustrates the PR procedure execution flow and how the servo drive deals with PR commands. Once a PR procedure is triggered, it goes through three phases, which are PR queue, PR executor, and motion command generator.

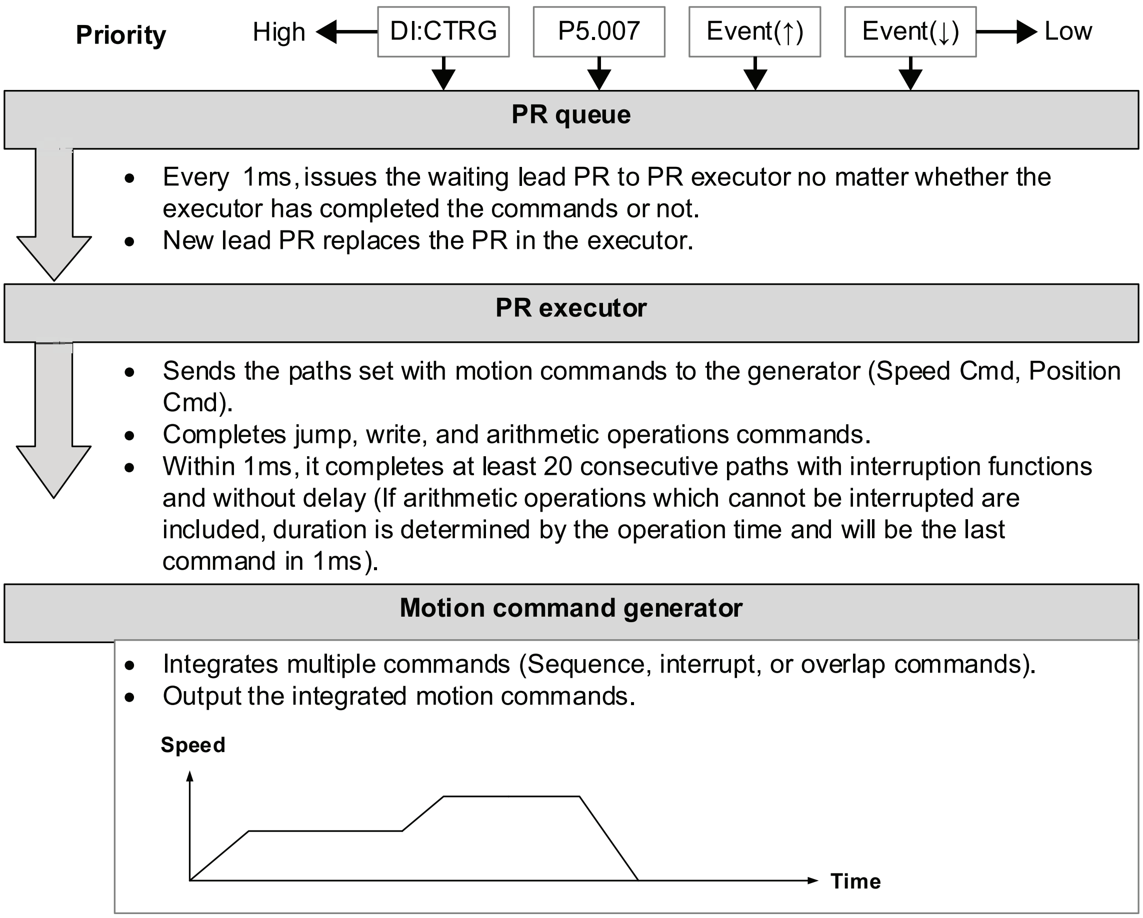

Figure 7-40 PR execution flow in the SureServo2 drive

- *Trigger mechanism*
  The trigger mechanism is as mentioned in Section 7.1.5. There are three trigger methods. A PR procedure is executed as long as a trigger signal is activated. When two different trigger methods are used for one PR procedure within the same millisecond, the priority is as follows: DI trigger (DI.CTRG) > PR command trigger register (P5.007) > Rising-edge event trigger (Event ↑) > Falling-edge event trigger (Event↓). Within this millisecond, commands with higher priority are executed first and then the lower priority commands are arranged in the next ms. If three trigger commands are generated in the same millisecond, the third is not added to the PR queue.

- *PR queue*
  The triggered PR path is the lead PR. The PR group it leads goes into the PR queue to wait for prioritization. In each millisecond, the servo drive sends the lead PR and the PR group it leads to the PR executor no matter whether a PR path is being executed. Therefore, as long as a PR path is triggered, the PR queue collects it and sends it to the executor.

- *PR executor*
  Once the PR executor receives the lead PR and its PR group, the PR group in execution is replaced immediately. If a PR group includes motion commands, such as Speed commands and Position commands, then the PR executor sends them to the motion command generator. PR paths with Write or Jump commands are completed at the moment when the PR executor reads the command, and thus they do not enter the motion command generator. The arithmetic operations commands are executed when entering the PR executor; however, the execution time varies with the computing duration and the next command cannot interrupt during computing. The PR executor can consecutively complete at least 20 PR paths with interrupt commands (INS) (without delay times) within 1ms. If there is a PR path that it has not completed within 1ms, and a new PR group is sent to the executor by the queue, the new PR group then replaces the previous PR group. In other words, instead of executing the PR group that hasn't been completed, the executor starts executing the new PR group. However, if a new PR group hasn't been sent to the executor yet, the executor continues to execute the unfinished PR path.

- *Motion command generator*
  Motion commands include the Speed and Position commands. The PR executor sends this type of command to the motion command generator. This generator has a buffer for temporarily storing the next motion command and all motion commands are integrated here. Motion commands can be executed as soon as they enter the generator. If another motion command (with interrupt setting) also enters the generator, it is integrated with the current command in the generator and the integration is based on the motion command settings. The settings include whether multiple motion commands are sequence commands, and whether it is set with the Overlap or Interrupt function. All integration varies with each PR path setting.

Sequence command

The configurable commands in PR path are the motion commands, which are the Position and Speed commands. A sequence command is a motion command without an Overlap or Interrupt function. The following command start to be executed only after the delay set in the previous command. Regarding Position commands, the delay time starts to count after the target position is reached. For Speed command, the delay time counting starts after the target speed is reached.

- *Position command followed by a Position command*
  When the PR executor receives two consecutive Position commands, if they do not have Interrupt or Overlap functions, the PR executor issues the first Position command to the motion command generator, and the generator starts the first part of position control. After the first Position command completes, if no delay time is set, the PR executor issues the second Position command for the generator to start the second part of position control (see Figure 7-41).
  If the first Position command includes a delay, the PR executor starts counting the delay time right after the motor reaches the target position. Then it issues the second Position command to the generator for the second part of position control as shown in Figure 7-42).

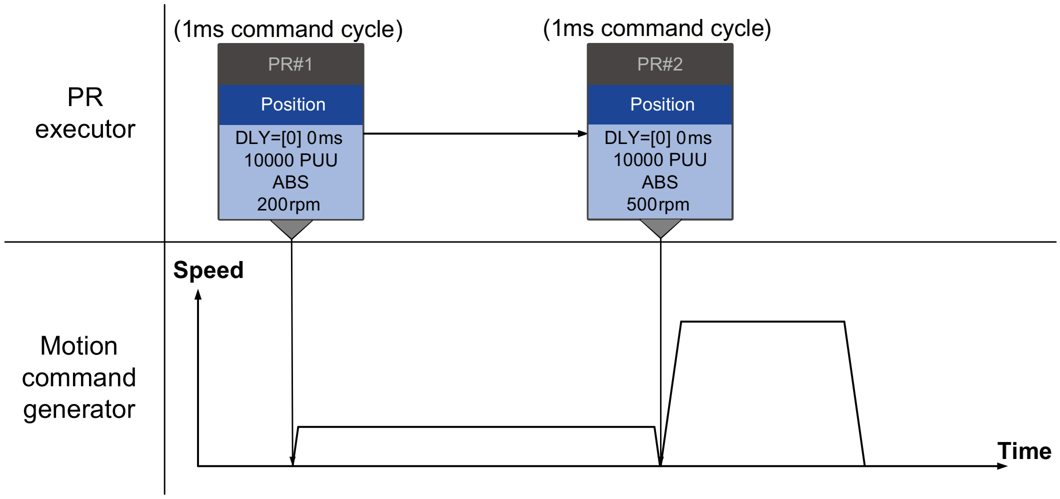

Figure 7-41 Position command without delay

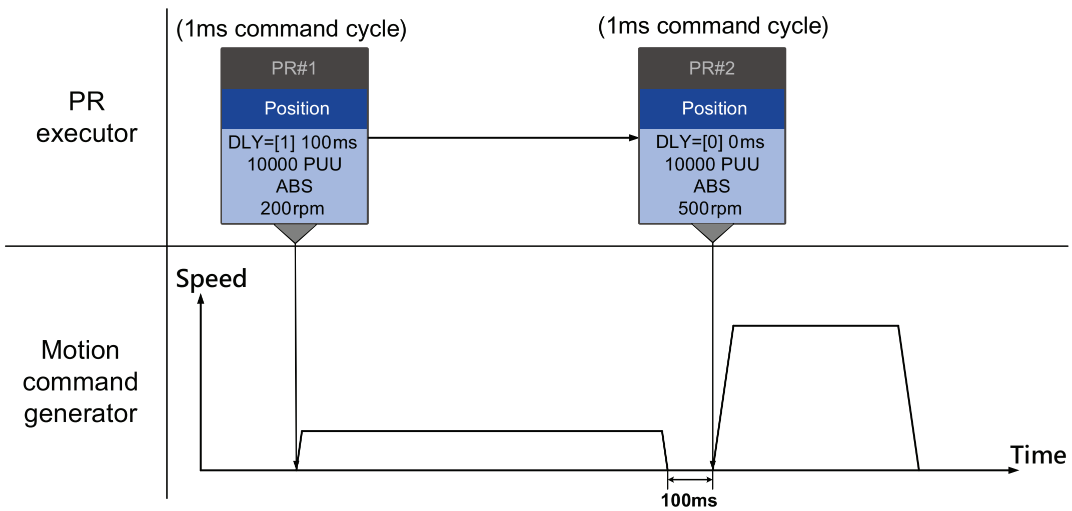

Figure 7-42 Position command with delay

- *Speed command followed by a Speed command*
  When the PR executor receives two consecutive Speed commands, if they do not have Interrupt or Overlap functions, the PR executor issues the first Speed command to the motion command generator, and the generator starts the first part of speed control. After the first Speed command completes, if no delay time is set, the PR executor issues the second Speed command to the generator to start the second part of speed control (see Figure 7-43).
  If the first Speed command includes a delay, the PR executor starts counting the delay time right after the motor reaches the target speed. Then it issues the second Speed command to the generator for the second part of speed control as shown in Figure 7-44.

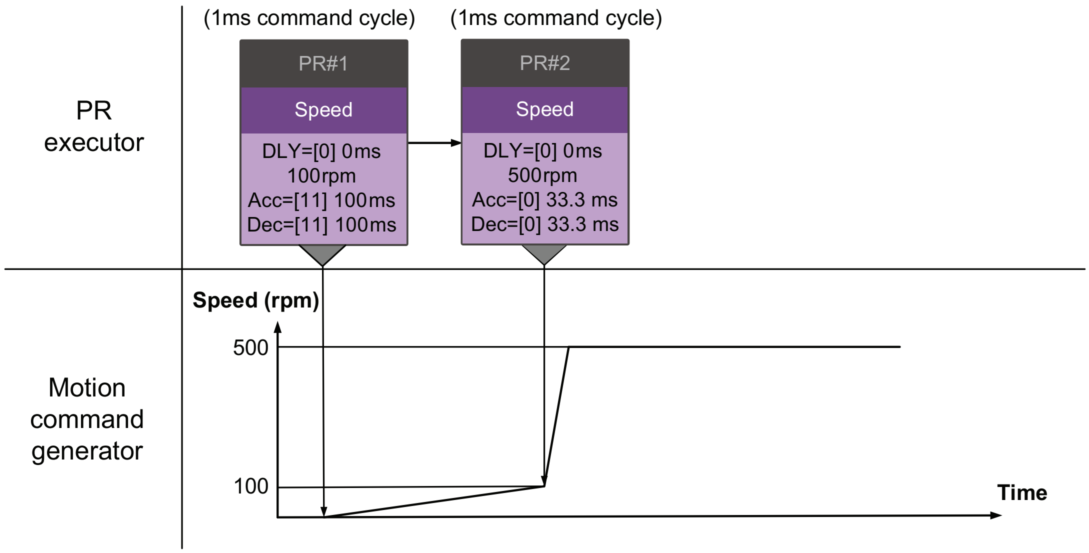

Figure 7-43 Speed command without delay

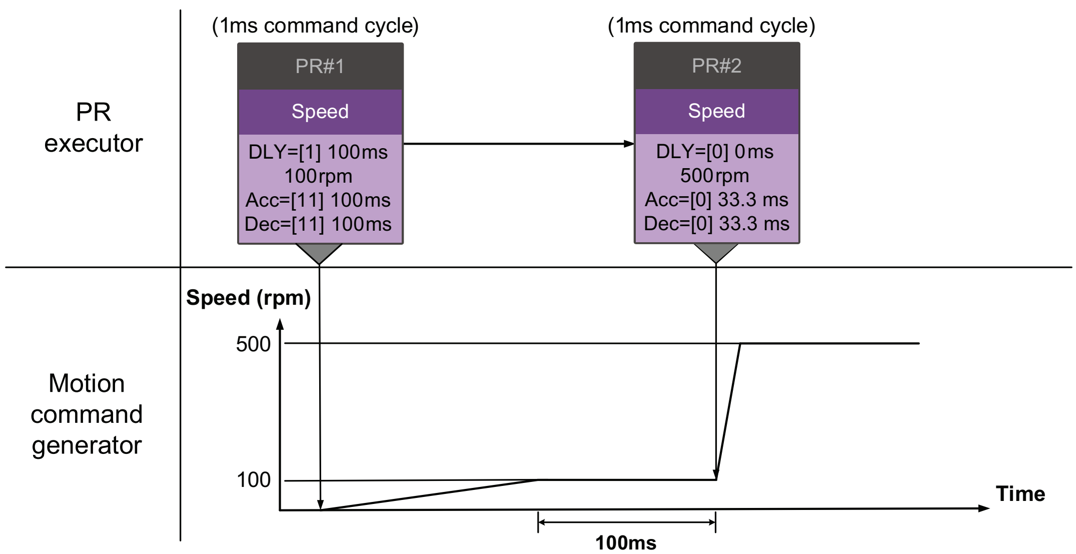

Figure 7-44 Speed command with delay

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- *Multiple commands*
  The PR queue updates commands every millisecond. For a motion command, the PR queue sends the next command to the generator only after the previous command completes. Jump or Write commands are executed in the PR queue immediately.
  As shown in Figure 7-45, in the first millisecond, the PR queue receives a Position command and it sends this command to the motion command generator, causing the generator to execute the command. In the second millisecond, the PR queue receives a Write command and executes it immediately. In the third millisecond, the PR queue receives a Jump command and executes it immediately as well. The Write and Jump commands are not sent to the motion command generator since the PR queue and the generator can execute commands independently. In the fourth millisecond, the PR queue receives a Position command. After the first Position command is completed, the PR executor sends it to the generator and the generator starts executing it immediately.

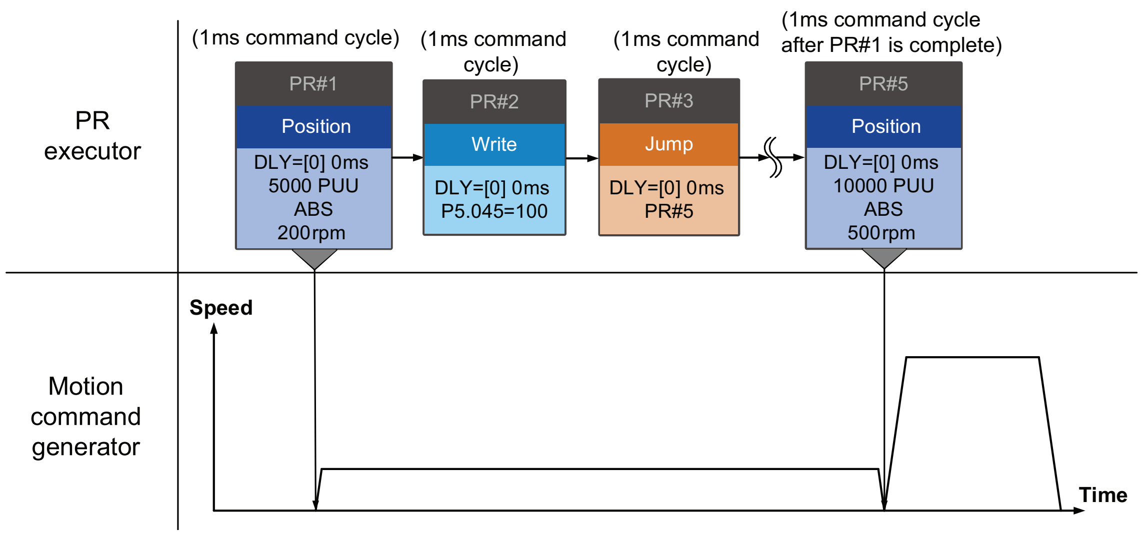


Figure 7-45 Sequence command – Multiple commands

Command interruption

Interruption (INS) causes a command in execution to be replaced or integrated. The results of the interruption differ based on the command types. The next command replaces the previous command. There are two types of interruption: internal and external, as shown in Figure 7-46.

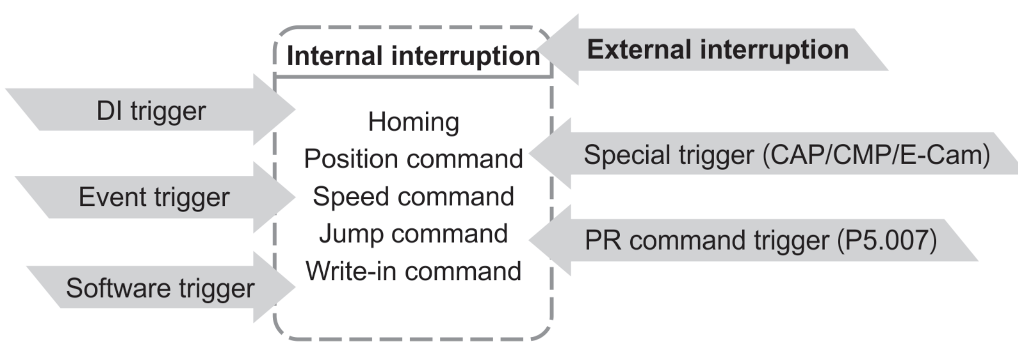


Figure 7-46 Internal and external interruption

Internal Interruption

For a series of PR paths, if one PR path includes an AUTO function (auto-execute the next path), the system reads the next path after reading the current path. If the current path includes a delay, the next path is read after delay time is over. Meanwhile, if the next path includes an Interrupt function (which has a higher execution priority) the servo drive immediately executes the interrupt command. It replaces the un-executed part in the previous path with the next or integrates the commands in the execution of the previous path.

- *Position command ► Position command (I) ► Position command*
  When the PR executor receives three consecutive Position commands with an interrupt in the second command, the executor treats the first and the second Position commands as one PR group. Since the first Position command is not executed, the executor replaces the first command with the second. It only sends the second command to the motion command generator for execution. After the second command is completed, the executor sends the third command to the generator (see Figure 7-47).
  If the first command includes a delay, then the PR executor sends the first command to the generator and then starts counting the delay time. After the delay is over, the PR executor then sends the second command and the generator starts the second part of position control. While the first command is still being executed, it is integrated with the second command. The integration is slightly different from what is described in Section 7.1.3. Please refer to the note below. Once the second command is completed, the executor sends the third command to the generator for execution (see Figure 7-48).

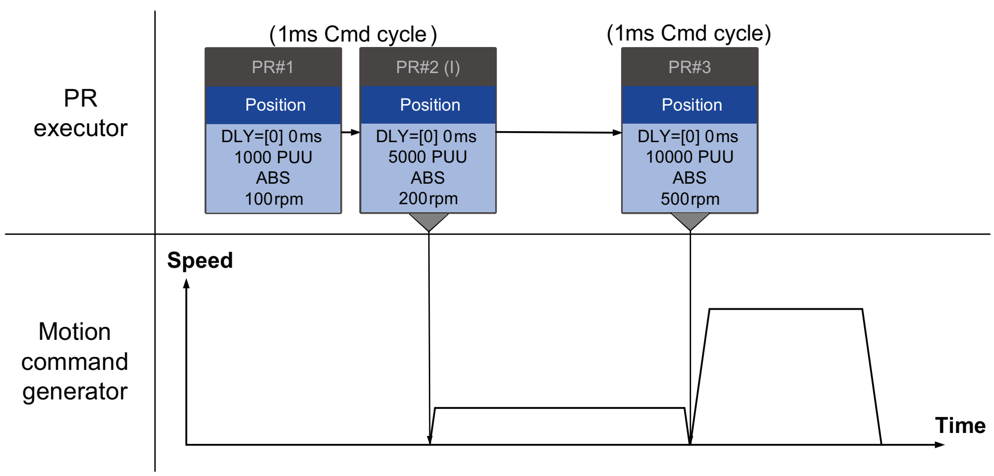


Figure 7-47 Position command without delay

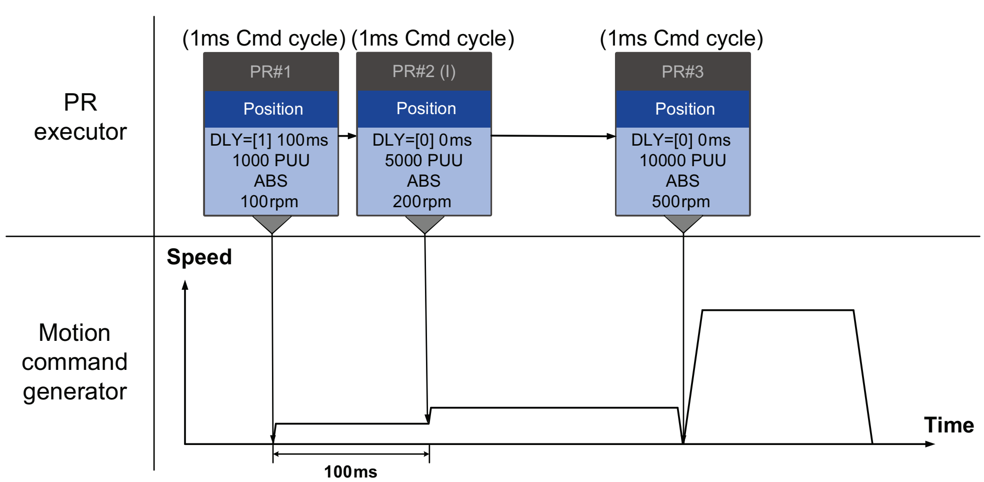


Figure 7-48 Position command with delay

NOTE: *The integration for internal interrupt position command is slightly different from what is described in Section 7.1.3. The way REL and INC commands work is the identical. The target position is the previous target position plus the current position. See the example below. The rest of the integration method is the same as mentioned in Section 7.1.3.*

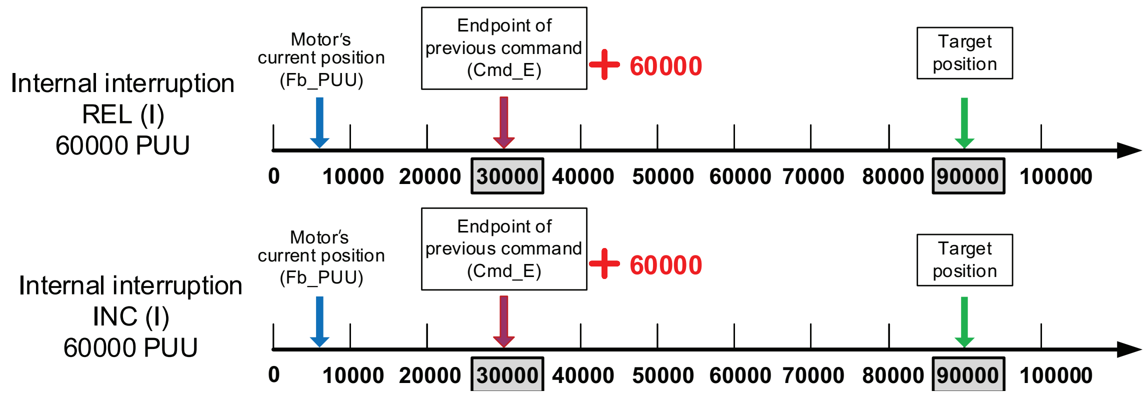


Figure 7-49 Example of relative and incremental position command for internal interruption

- *Speed command ► Speed command (I) ► Speed command*
  When the PR executor receives three consecutive Speed commands with an interrupt in the second command, the executor treats the first and the second as one PR group. Since the first Speed command is not executed, the executor replaces the first command with the second. It only sends the second command to the motion command generator for execution. After the second command is completed, the executor sends the third command to the generator (see Figure 7-50).
  If the first command includes a delay, then the PR executor sends the first command to the generator and then starts counting the delay time. After the delay is over, it then sends the second command and the generator starts the second part of speed control. While the first command is still being executed, it is integrated with the second command. Once the second command is completed, the executor sends the third to the generator for execution (see Figure 7-51).

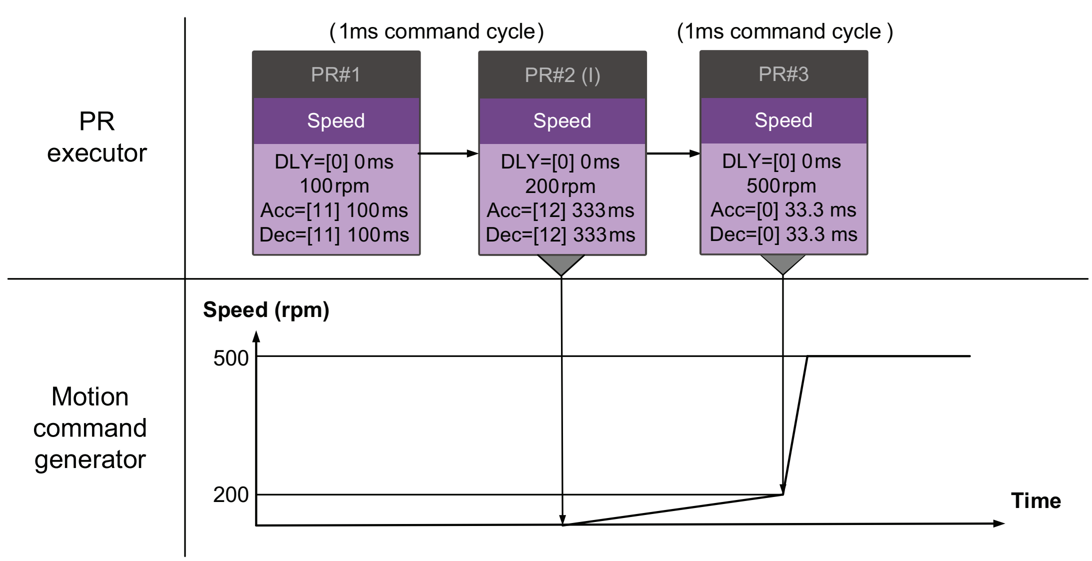


Figure 7-50 Speed command without delay

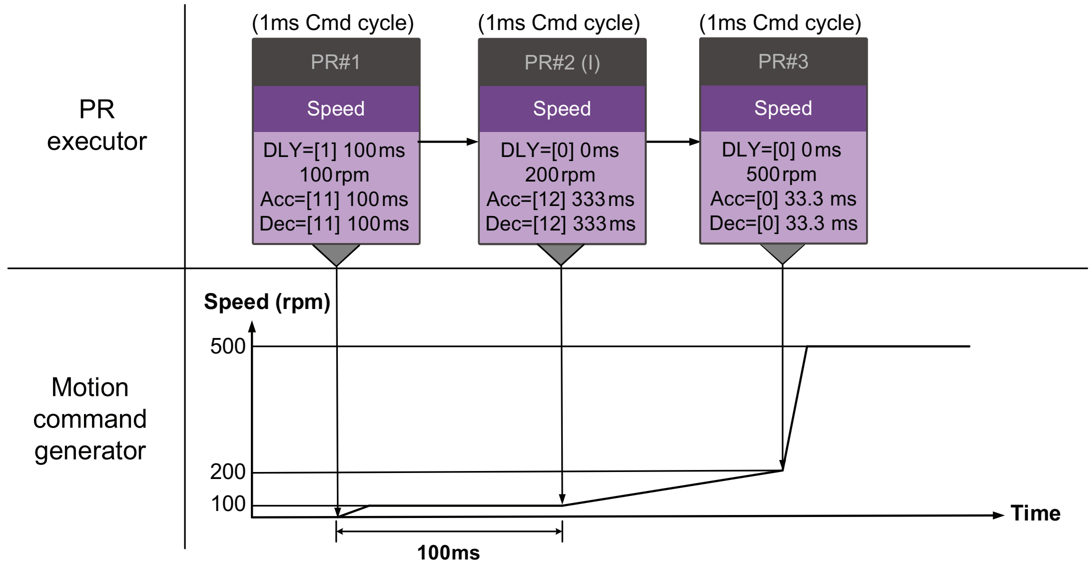


Figure 7-51 Speed command with delay

- *Multiple interrupt commands*
  The PR queue updates once every 1ms. If all PR paths include an Interrupt function, the queue can read at least 20 PR paths in 1ms, and these paths are called a PR group.
  If this PR group has multiple motion commands, the PR queue only sends the last command it receives to the motion command generator for execution. Therefore, in a PR group, only one PR path with motion command is executed. The latter motion command directly replaces the former, whereas Jump and Write commands are executed as soon as they are received by the PR queue (see Figure 7-52).
  If one of the PR paths includes a delay, the PR queue schedules all paths on the basis of this PR path. The prior path(s) including a delay becomes as the first PR group, and what follows is the second PR group. Thus, this PR procedure can execute up to two PR paths with motion commands, as shown in Figure 7-53.

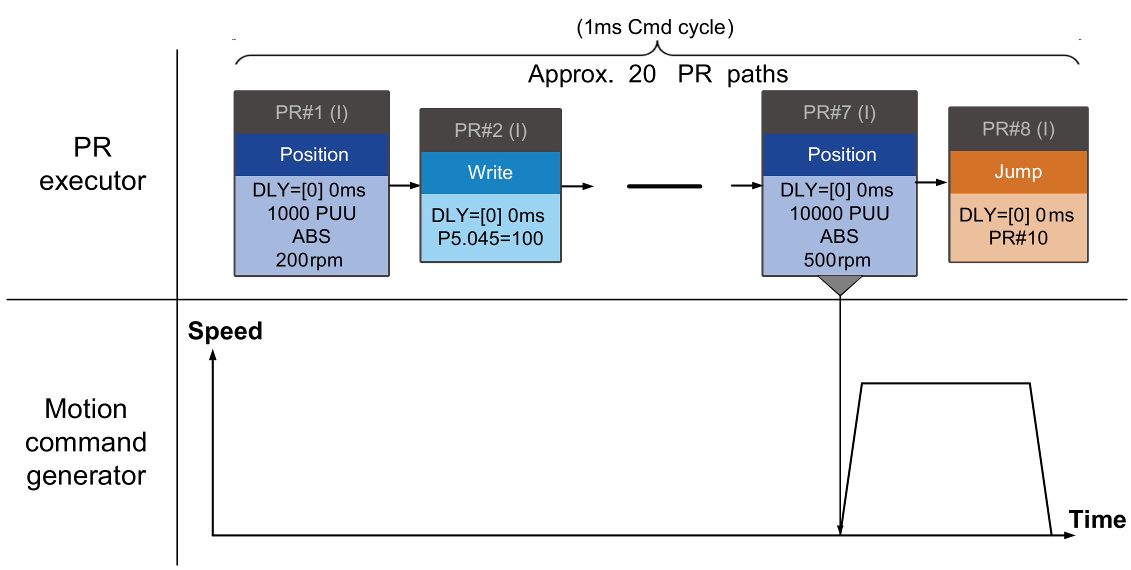


Figure 7-52 Multiple commands without delay

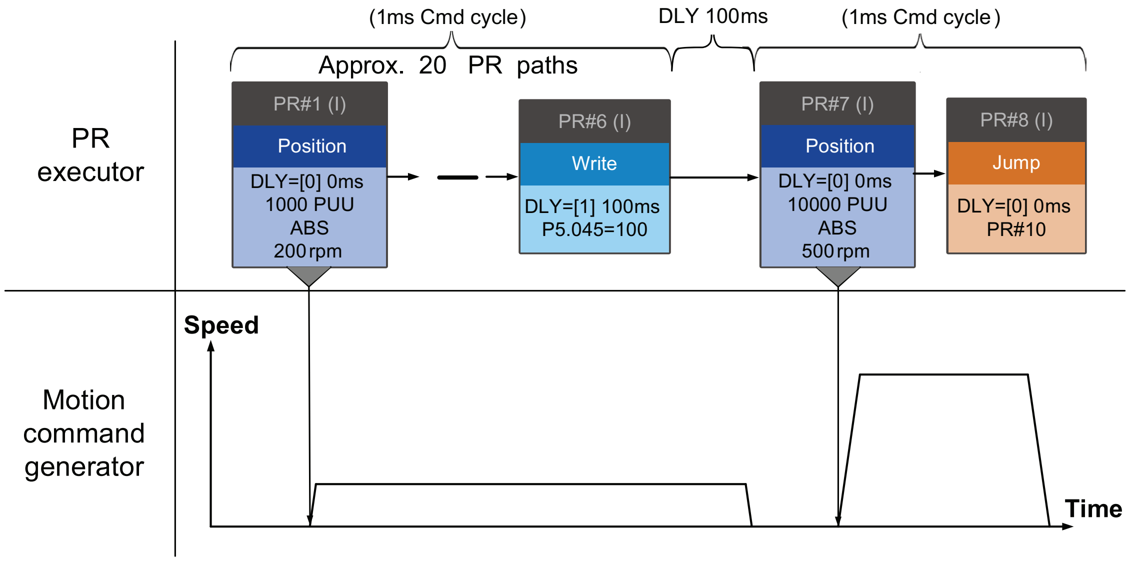


Figure 7-53 Multiple commands with delay

External Interruption

If an external interruption is encountered, it uses the PR Command trigger method to execute another PR path (refer to Section 7.1.5 for PR trigger methods). When the PR queue receives a PR path with an Interrupt function, it sends this path to the motion command generator immediately and changes the path in execution. Note that a delay does not change the result of an external interruption. That is, once the PR queue receives an external interruption command, the motion commands in the latter part are executed by the generator and integrated with the previous commands. The external interruption is as shown in Figure Figure 7-54.

If a PR path with external interruption enters the PR executor, the executor sends this Position command immediately to the generator so that the motor can run in accordance with the interruption. The motor uses the settings that integrate with the former motion commands when running. The methods of integration are described in Section 7.1.3. Similarly, an external interruption affects Speed and Position commands the same way and the same is true for multiple commands. See Figure 7-55 for an example.

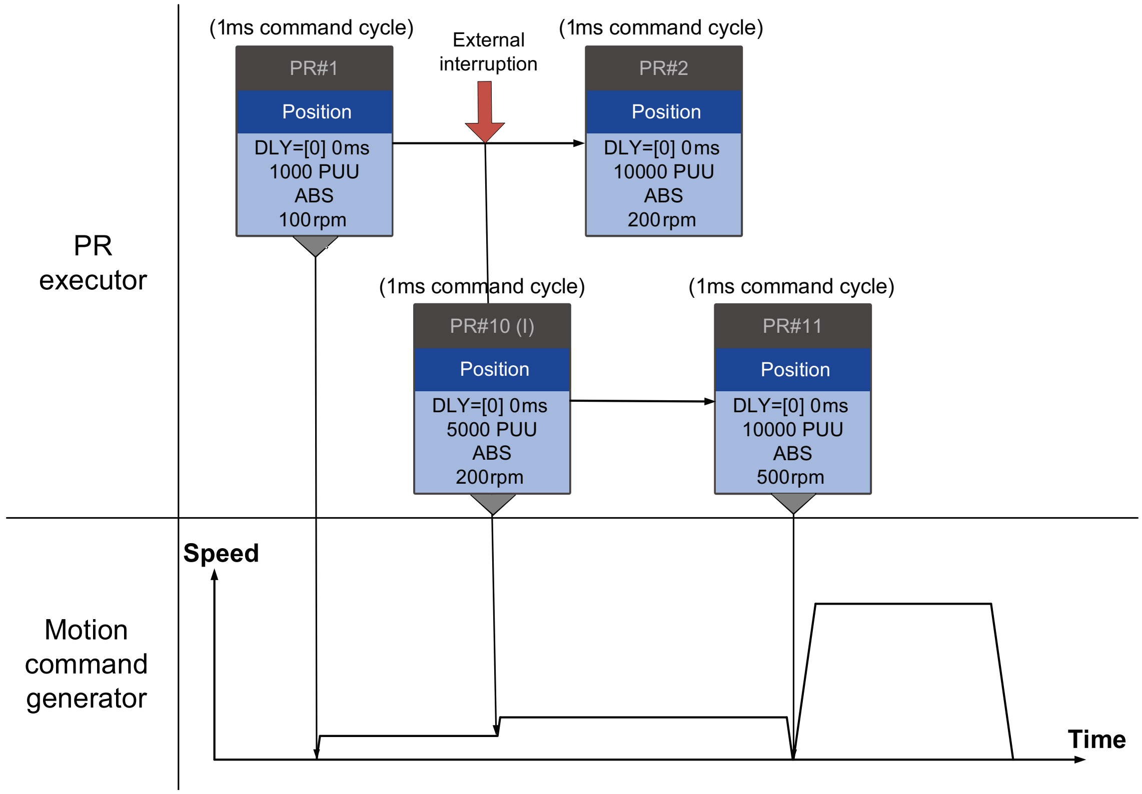


Figure 7-54 External interruption – Position command

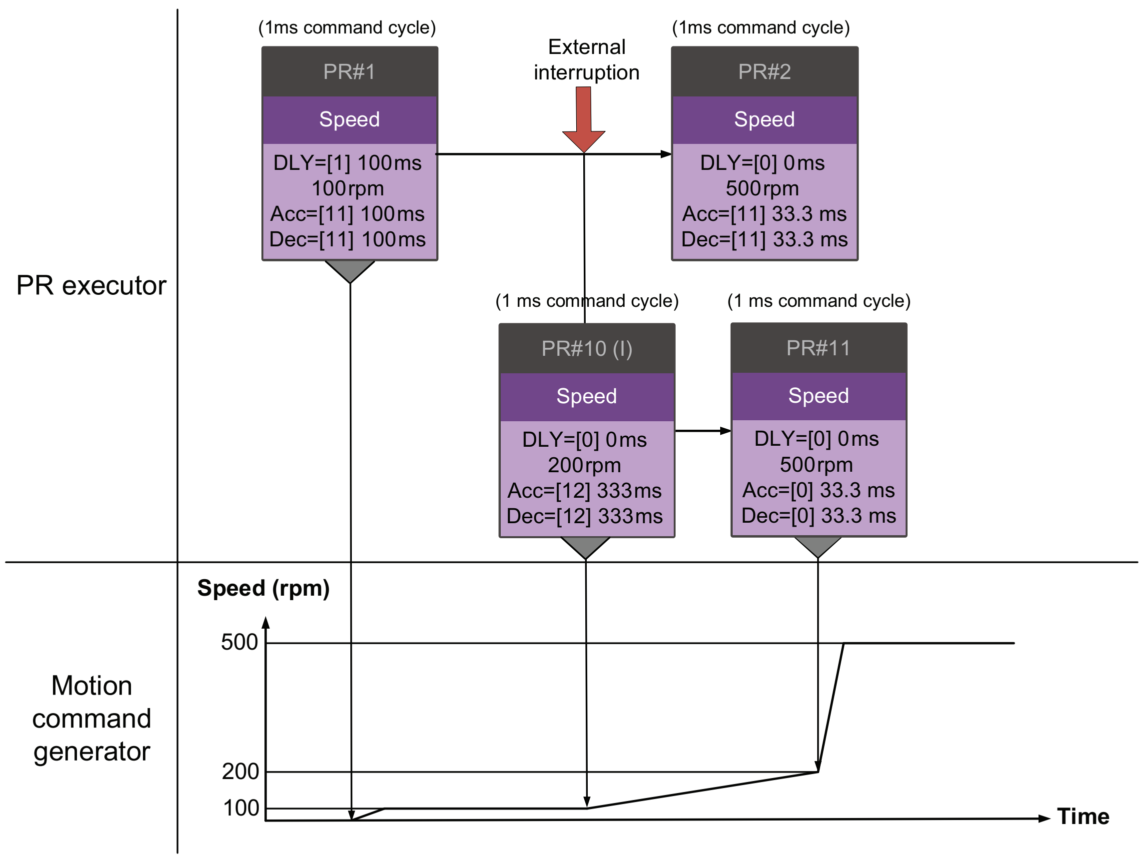


Figure 7-55 External interruption – Speed command

Overlap command

If the previous position command includes an Overlap function; it allows the next command to be executed while the previous motion is decelerating, thus achieving a continuous motion. This is also referred to as a blended move or a blended motion. When you use an Overlap command, the delay time is still effective. The delay time starts to count from the command's start point; however, in order to have the commands transition smoothly, setting the delay time of the previous command to 0 is suggested. In addition, if deceleration time of the previous command is identical to acceleration time of the next, the transition between commands can be very smooth, avoiding discontinuous speed during transition (see Figure 7-56 and Figure 7-57).

An Interrupt command has a higher priority than an Overlap command. Thus, when you set an Overlap function in the current Position command, and the next motion command includes an Interrupt function, only the command with the Interrupt function is executed.

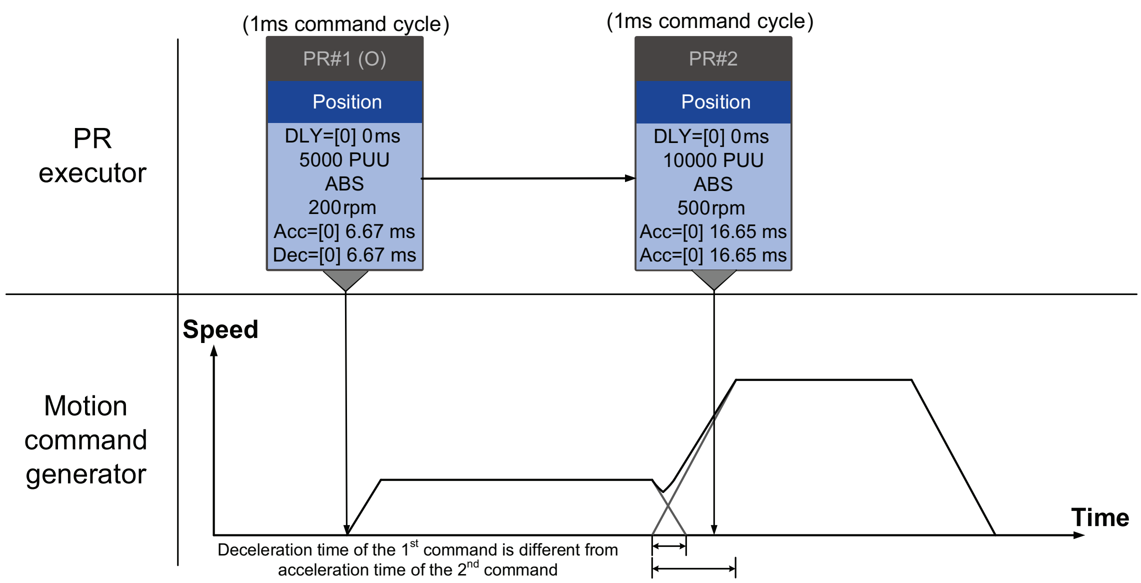


Figure 7-56 Overlap command - Acceleration and deceleration time are different

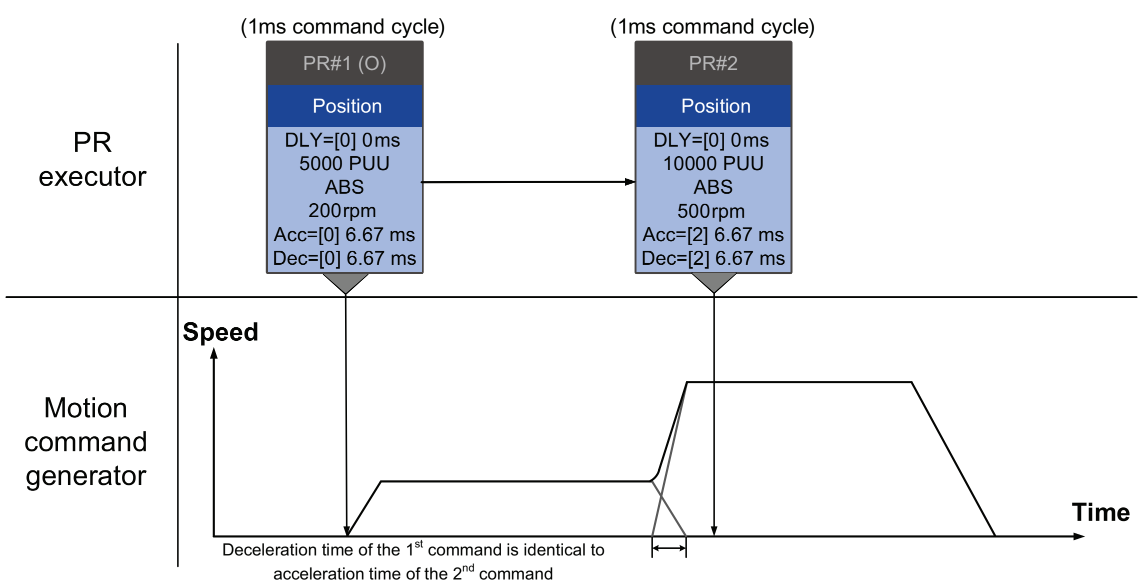


Figure 7-57 Overlap command - Acceleration and deceleration time are identical

Arithmetic operations (Statement)

You can regard arithmetic operation commands as combinations of Write commands and Jump commands. Thus, the execution priority is the same as these two types of commands, which are executed by PR executor. Arithmetic operation commands can interrupt the previous command but cannot be interrupted by the following command. This ensures that all arithmetic operations are completed before the PR paths enter the PR queue. In other words, for a series of PR paths with both arithmetic operations and Interrupt functions, only the arithmetic operations commands of this PR path are executed in the first ms. The rest are sent to the PR queue in the next ms.

Therefore, the jump target PR number specified by the path with arithmetic operations is executed in the next ms (see Figure 7-58). If you have entered the triggering parameter in the Statement section, such as PR command trigger register (P5.007) (which has the highest execution priority and is processed as an external interruption) after the arithmetic operations are done, the path specified by PR command trigger register is executed in the next ms. The logic condition commands are not executed (see Figure 7-59).

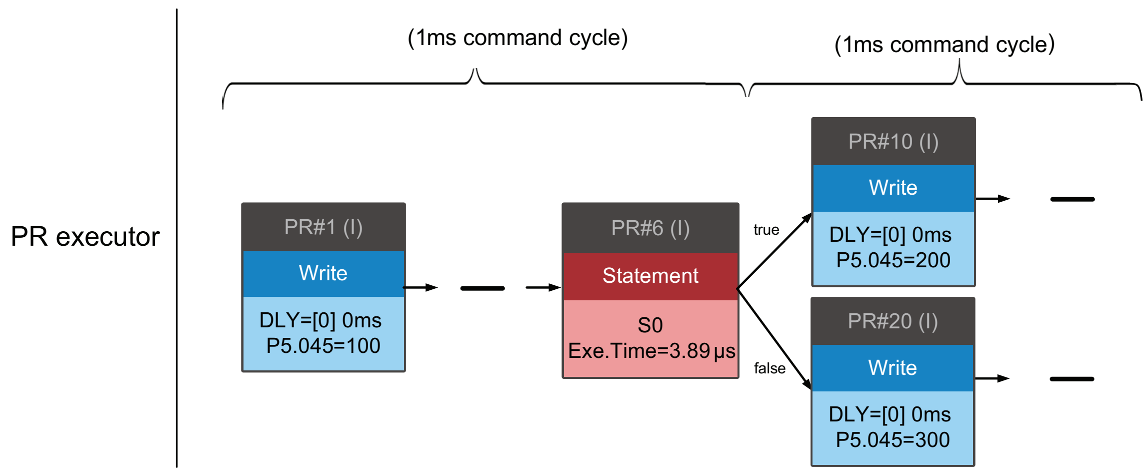


Figure 7-58 Multiple commands with arithmetic operations

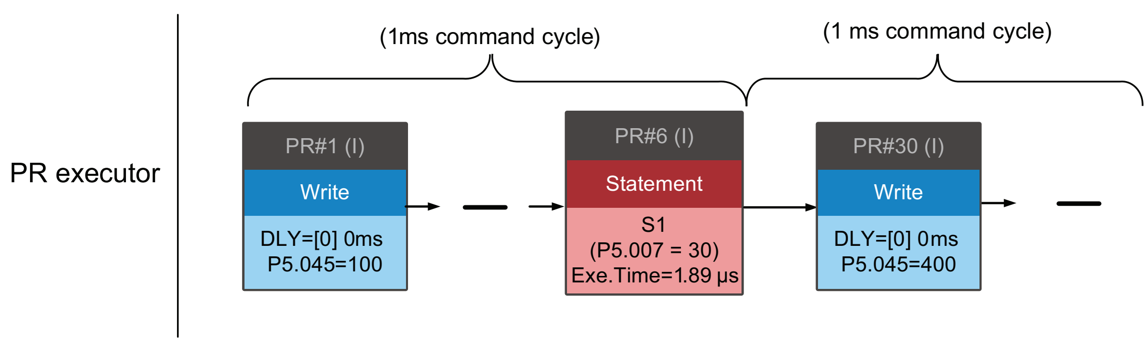


Figure 7-59 Writing trigger command in Statement section

7.2 - Application of Motion Control

Applications of motion control in the SureServo2 drive include high-speed position capture (Capture), high-speed position comparing (Compare), and E-Cam. High-speed position capturing uses digital input (DI7) to capture the motor's feedback position instantly and store this position in the data array. For high-speed position comparing, it writes the specified motor position to the data array and outputs a high-speed digital signal (DO4) once the motor feedback position reaches this specified position. The purpose of E-Cam is to create an E-Cam curve according to the correlation between the Master and the Slave, and then store the curve in the data array. The Slave axis refers to the Master axis position and moves to the position specified by the E-Cam. You can find more details about the setting and how it works in the following sections.

7.2.1 - Data Array

The data array can store up to 800 32-bit sets of data (0–799). You can use it to store the high-speed capture data and high-speed compare data as well as the E-Cam curves. You have to segment the space for these three functions as their individual spaces are not defined by default. This prevents overwriting or accidentally changing any data. You can set P2.008 to 30 and then 35 or use SureServo2 Pro to write the data to EEPROM; otherwise, the data is not saved after you turn the power off. SureServo2 Pro includes a user-friendly screen for reading and writing the data array. See the following figure.

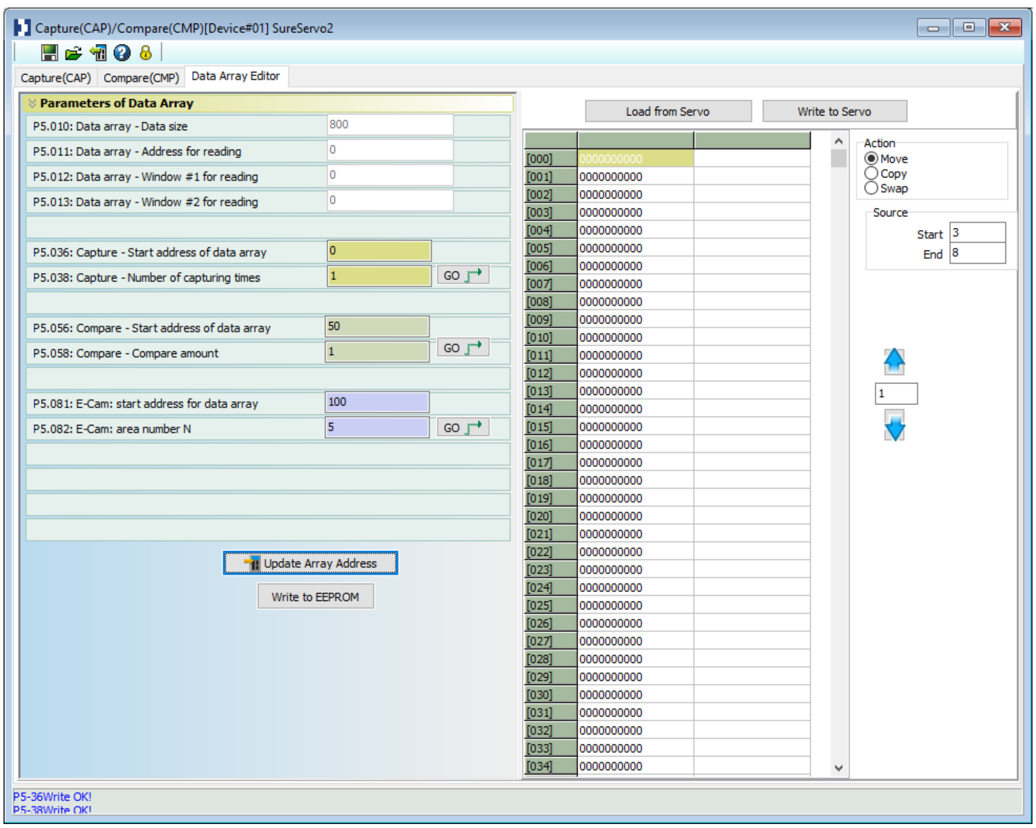


Figure 7-60 Data Array screen in SureServo2 Pro

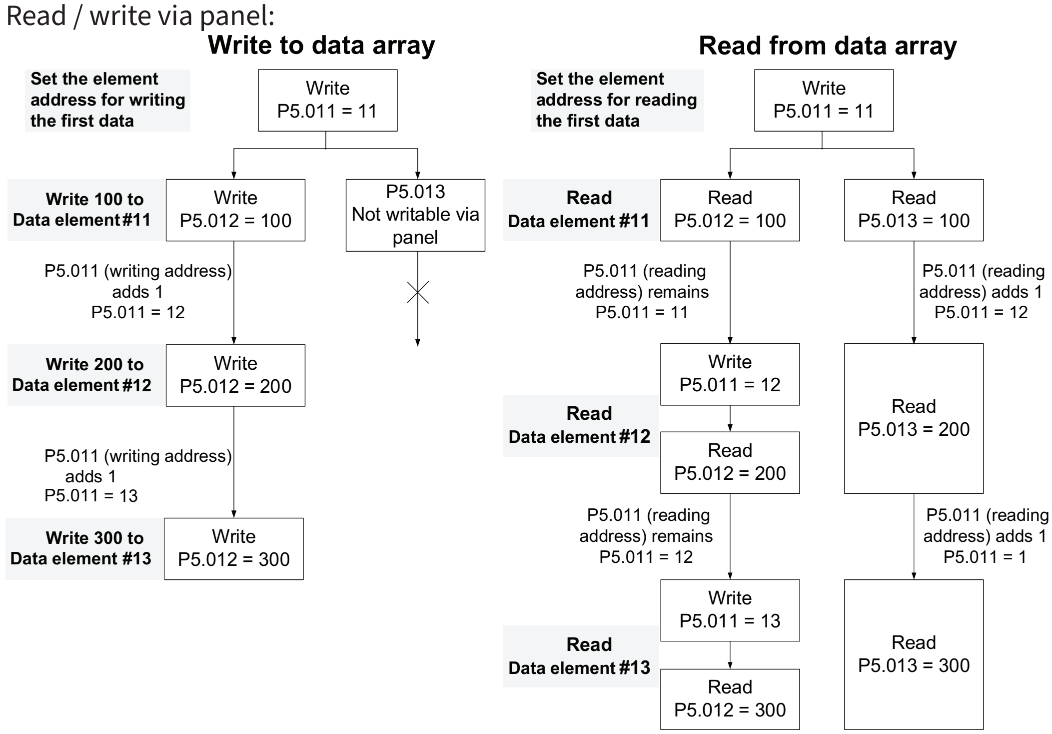
You can use the panel, communication, or SureServo2 Pro to read data from, or write data to, the data array. The first parameter group for reading and writing the data array is P5.011, P5.012, and P5.013. P5.011 specifies the address for reading and writing the value of the elements for the data array. P5.012 and P5.013 are for reading and writing the actual data contents to the element address in the data array. You can use both to read and write, but the behaviors after reading and writing differ. Please refer to Table 7-10. The second parameter group for reading and writing the data array is P5.011 and P5.100–P5.103. P5.100 reads data from or writes data to the data array element address set by P5.011. P5.101 reads data from or writes data to the data array element address following the address set by P5.011. P5.102 and P5.103 work the same way. If the address value accumulates and exceeds the maximum of 799, the returned address is 0. You can find more details in Table 7-11.

Table 7-10 Group 1 – reading / writing the data array

Parameter	***Description***		
P5.011 Address for reading / writing	Specify the address of the first element for reading from or writing to the data array		
Data Values for Reading / Writing	***by***	***Behavior After Reading***	***Behavior After Writing***
P5.012 Data Value #1 for reading / writing	Panel	Value of P5.011 does not increment 1	Value of P5.011 increments 1
	Communication / SureServo2 Pro	Value of P5.011 increments 1	Value of P5.011 increments 1
P5.013 Data Value #2 for reading / writing	Panel	Value of P5.011 increments 1	Cannot be written with the drive panel
	Communication / SureServo2 Pro	Value of P5.011 increments 1	Value of P5.011 increments 1

Example: when using the drive panel or communication for reading from or writing to the data array, input values to the data array address in sequence as follows: Data array #11 = 100, Data array #12 = 200, Data array #13 = 300. Then the data is read in sequence.

1) Read / write via panel:



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2) Read and write using communication:
   Reading and writing using communication requires Modbus RTU, MODTCP, or EtherNet/IP (Explicit only) communications. You can use the communication command 0x10 to write consecutively, 0x06 to write single data, and 0x03 to read consecutive data. First, use a consecutive writing command to write 100 to Data element #11, 200 to Data element #12, and 300 to Data element #13. When reading, use a single data writing command to set the start address as Data element #11, then use a consecutive reading command to read P5.011–P5.013 (Data element #11 and #12). This reads two values, so P5.011 is incremented by 2 and then it reads Data element #13.

Writing to Data Array									
Packet	Modbus Function Code	Start Address	Data Size	P5.011		P5.012		P5.013	
				Low byte	High byte	Low byte	High byte	Low byte	High byte
1	0x10	P5.011	6 words	11	0	100	0	200	0
2	0x10	P5.011	6 words	13	0	300	0	0	0

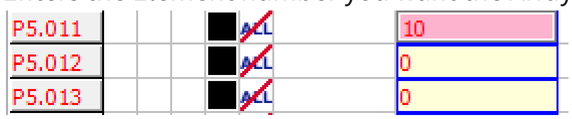
Reading Data Array									
Packet	Modbus Function Code	Start Address	Data size	P5.011		P5.012		P5.013	
				Low-byte	High-byte	Low byte	High byte	Low byte	High byte
4	0x06	P5.011	-	11	0	-	-	-	-
5	0x03	P5.011	6 words	11	0	100	0	200	0
6	0x03	P5.011	6 words	13	0	300	0	0	0

Table 7-11 Group 2 – reading and writing the data array

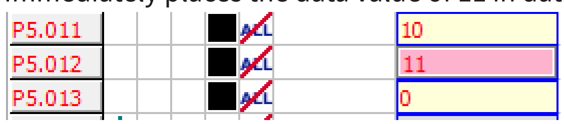
Parameter	***Description***	***Example 1***		***Example 2***	
P5.011 Read / write address	Specify the address for reading from or writing to the data array	200		797	
Parameter	***Description***	***Example 1***		***Example 2***	
		Address	***Content***	***Address***	***Content***
P5.100 Data value #3 for reading / writing	Read from or write to the address specified by P5.011.	200	1234	797	5678
P5.101 Data element - Data Value #4 for reading / writing	Read from or write to the first address following the address specified by P5.011.	201	2345	798	6789
P5.102 Data element - Data Value #5 for reading / writing	Read from or write to the second address following the address specified by P5.011.	202	3456	799	7890
P5.103 Data element - Data Value #6 for reading / writing	Read from or write to the third address following the address specified by P5.011.	203	4567	x	0

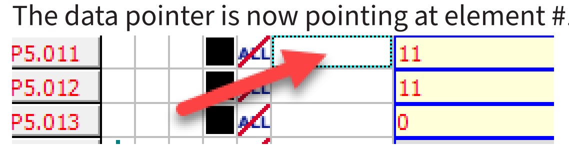
Data Array Intro Example

Set P2.008 to 30 and then 35 or use SureServo2 Pro to write the data to EEPROM; otherwise, the data is not saved after you turn the power off. This is only needed if you want to retain the data array after a power cycle. The below method uses the SureServo2 Pro Parameter Editor to read and write data to the array.

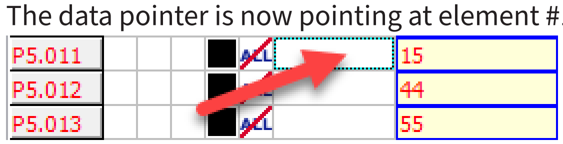
1) P5.010 = 10 -> Enter
   a) Enters the Element number you want the Array to start at with P5.011.
   b) 

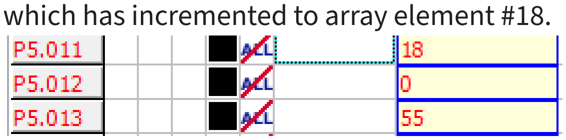
Group 1 Data Element Value 1 and 2 (P5.012, P5.013) can be written to the array starting at the P5.011 address and the element address will auto increment 1 address value.

2) P5.012 = 11 -> Enter
   a) Immediately places the data value of 11 in data array element #10.
   b) 

3) Click in the “Read Parameter” box for P5.011 to read the new value of the array pointer.
   a) The data pointer is now pointing at element #11.
   b) 

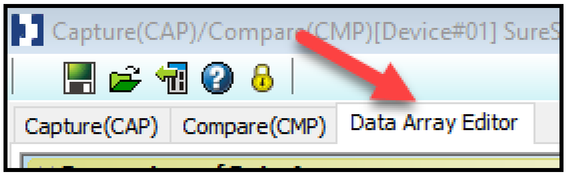
4) P5.012 = 22 -> Enter, P5.012 = 33 -> Enter, P5.012 = 44 -> Enter.
   a) Immediately places the data value of:
      i) 22 in data array element #11
      ii) 33 in data array element #12
      iii) 44 in data array element #13
5) Click in the “Read Parameter” box for P5.011 to read the new value of the array pointer.
   a) The data pointer is now pointing at element #14.
   b) 

6) P5.013 = 55 -> Enter (Not P5.012) then Click in the “Read Parameter” box for P5.011 to read the new value of the array pointer.
   a) Immediately places the data value of 55 in data array element #14
   b) The data pointer is now pointing at element #15.
   c) 

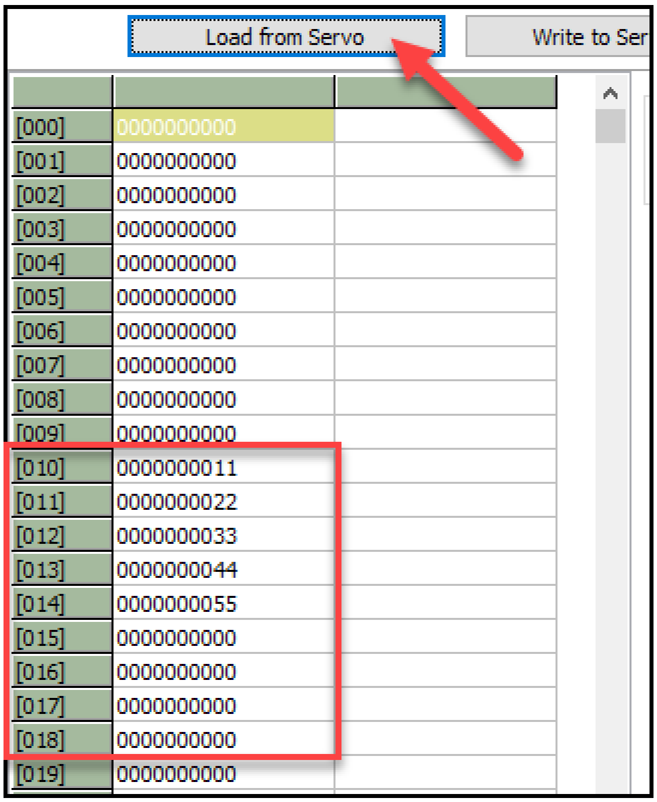
7) Click in the “Read Parameter” box for P5.012 three times.
   a) This will execute 3 reads from P5.012. Each read will increment the array data pointer which has incremented to array element #18.
   b) 

8) To verify what is in the data array, open the "High Speed Position Capture/Compare" window and select the "Data Array Editor". Click "Load from Servo" to update the array in SV2-PRO. You can now see the values you manually entered.

a) 



b)



c)

9) The method above walks the user through the understanding of how data is written into different block of the 800 element data array. Group 1 uses P5.012 and P5.013. Group 2 behaves the same using P5.100, P5.101, P5.102, and P5.103. This method is designed for keypad entry or PLC communication population. If you were to actually use SM-PRO you can just enter it in the "High Speed Position Capture/Compare" window and type in the values into the Data Array click "Write to Servo". SureServo2 Pro does not allow csv import of data arrays.

Group 2 Data Element Values 3, 4, 5, and 6 (P5.100, P5.101, P5.102, and P5.103) can be written to the array starting at the P5.011 address but the element address will NOT auto increment. Instead, they are written as follows:

- *Data in P5.100 -> written to array element value of P5.011*
- *Data in P5.101 -> written to array element value of P5.011 +1*
- *Data in P5.102 -> written to array element value of P5.011 +2*
- *Data in P5.103 -> written to array element value of P5.011 +3*

7.2.2 - High-speed position capturing function (Capture)

The high-speed position capturing function (CAP) uses the external-triggered high speed digital input DI7 (with execution time of only 5μs) to capture the position data of the motion axis and store it in the data array for further motion control. As the Capture function is executed by the hardware, there is no lag in the software, and it is able to capture the motion axis' position accurately. While the Capture function is enabled, DI7 is automatically defined as the Capture signal. DI7 cannot be user defined through the software as the Capture Signal. Whatever function DI7 was previously defined as gets overwritten once the Capture function is enabled. Once the Capture function is disabled, DI7 is automatically reset to Disable (0x00), DI7 will not revert back to the previously user defined value. High Speed Capture is only available in PR Mode.

The flow chart for high-speed position capturing is shown in Figure 7-61. The relevant parameters are defined as follows. P5.036 stores the start position for capturing in the data array; if it is not set, the default start position is #0. P5.038 sets the capturing amount. The amount has to be greater than 0, otherwise the Capture function is not executed. P1.019.X enables the cycle mode. When the last data is captured, the capturing amount is reset to 0 (P5.038 = 0), and the next cycle starts automatically to capture the set capturing amount. However, the start capturing position is still determined by P5.036; that is, the captured data in previous cycle is replaced by the data captured in the next cycle. P5.039 enables and disables the Capture function and other settings. See the following table for more information. To avoid capturing multiple false position data, you can use P1.020 to set the masking range for capturing to avoid false triggers due to EMI noise or a double bounce of the capture trigger DI7. This prevents the same position data being captured repeatedly because capturing more than once is not allowed in the masked area. You can set the Capture function in SureServo2 Pro, as shown in Figure 7-62.

P5.039	Bit	Function	Description
X	0	Enable Capture function	When P5.038 > 0 and bit 0 = 1, the capturing starts and DO.CAP_OK is off. Each time a position is captured, value of P5.038 is decremented by 1. When P5.038 = 0, it means the capturing is finished, DO.CAP_OK is on, and bit 0 is reset to 0. If bit 0 is already 1, the written value must not be 1; you must write 0 to disable the Capture function.
	1	Reset position when first data is captured	If bit 1 = 1, after the first data is captured, set Capture axis' position to the value of P5.076.
	2	Enable Compare function after first data is captured. The Compare Function is only supported in the Capture Trigger.	If bit 2 = 1, when the first data is captured, the Compare function is enabled. Activate Compare Bit P5.059.X bit 0 = 1 and P5.058 (Remaining Counts) resets to the previous value. If the Compare function is already enabled, then this bit function is ignored.
	3	Execute PR#50 after the last data is captured	If bit 3 = 1, execute PR#50 once all data are captured.
Y	-	Source of Capture axis	0: disabled 1: auxiliary encoder (CN5) 2: pulse command (CN1) 3: main motor encoder (CN2)
Z	-	Trigger logic	0: NO (normally open) 1: NC (normally closed)
U	-	Minimum trigger interval (ms)	-

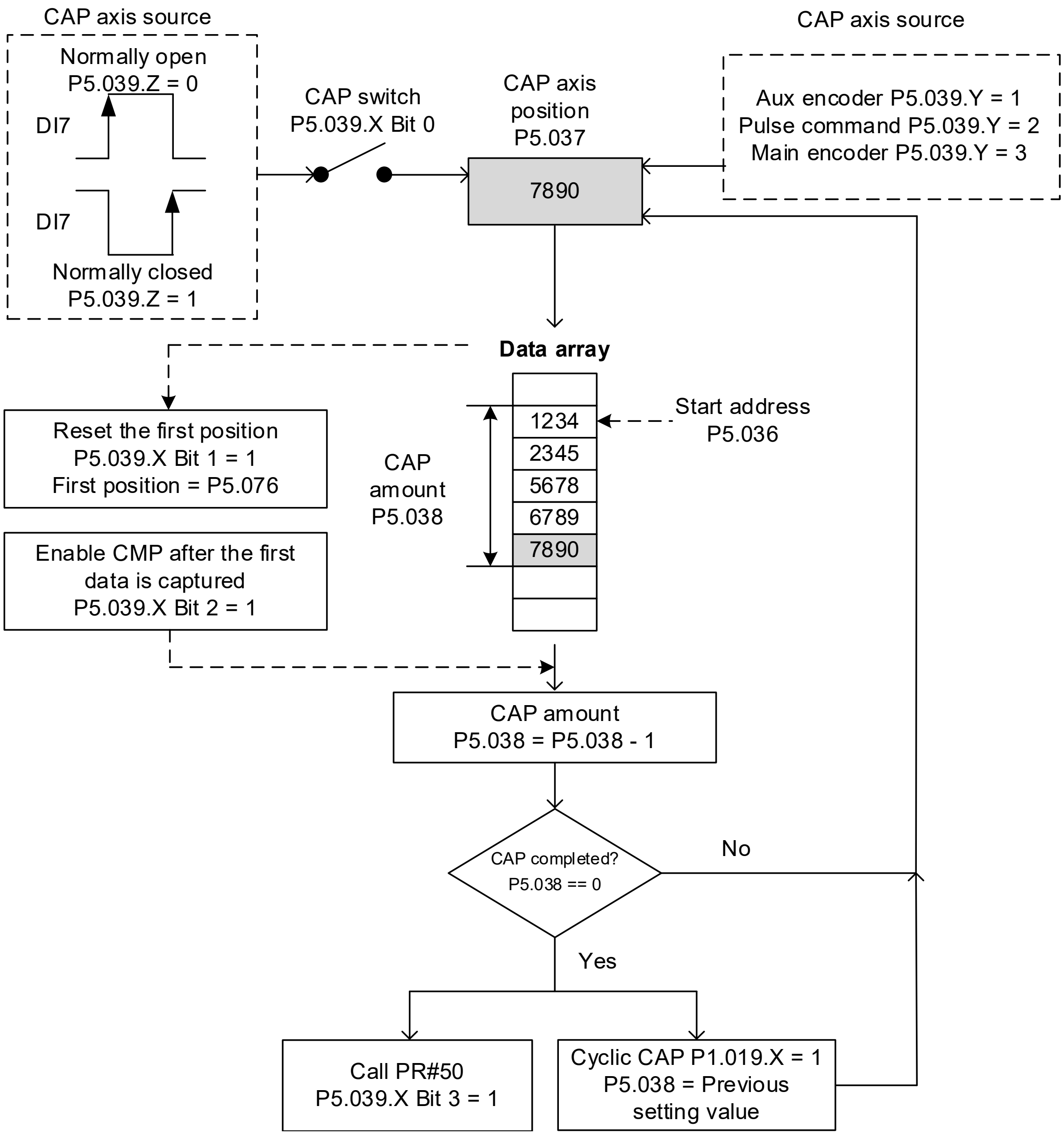


Figure 7-61 Flow chart for high-speed position capturing

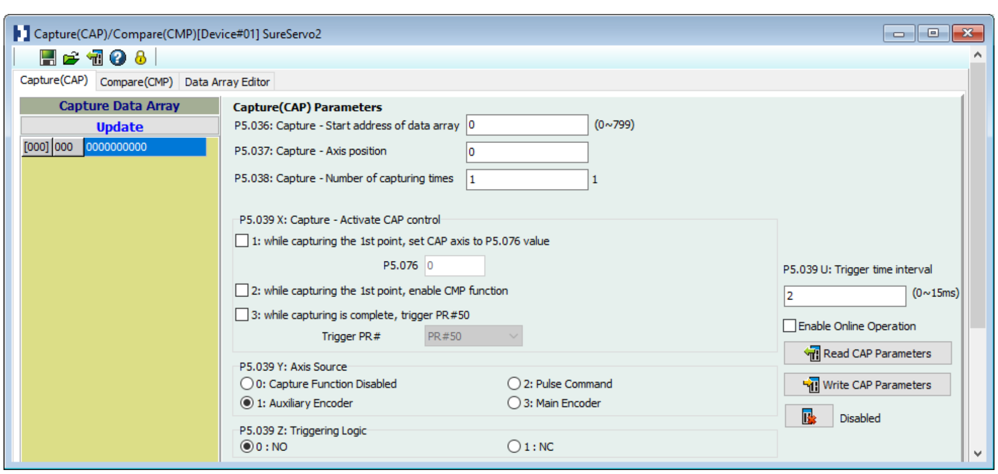


Figure 7-62 Capture Function screen in SureServo2 Pro

Walk Through Capture Example Intro

Use PR path programming to use the motion commands with the Capture function. Use Write commands to set the high-speed position Capture function, as well as to execute motion commands once the Capture cycle is completed. See the example in Figure 7-63.

1) Reset the drive to defaults (P2.008=10), cycle power and set limit switch inputs and OVRD stop as needed.
2) Set P1.001 = 1 (PR Mode).
3) Set Homing Mode to P5.0004.X = 8 (Define Current Position as the Origin) Since the motor's encoder is configured to be the capture axis (PR#6 below), the Capture Axis position (P5.037) is reset to 0 during the homing routine.
4) Configure the PR paths:
   - *PR#1 confirms that the Capture function is disabled (P5.039.X Bit 0 = 0).*
   - *PR#2 sets the start position of data array to #000.*
   - *PR#3 sets the capturing amount to 3.*
   - *PR#4 sets the capturing axis' position to 0 for the first capture point.*
   - *PR#5 sets the cyclic capture mode with delay time of 1 second to ensure that the next PR path can be executed with the Capture function.*
   - *PR#6:*
     - i) Enables the Capture function
     - ii) Resets the first point to the value of P5.076
     - iii) Once the data is captured the drive proceeds to path PR#50
     - iv) Selects the motor's encoder as the capturing axis
     - v) Uses 'normally open' contact as the trigger logic
     - vi) And sets a trigger interval of 2ms
   - *PR#7 sets the Speed command to 50 rpm.*
   - *PR#50 sets the move command (50000 PUU) per the last captured position once the CAP is completed.*
   - *PR#51 resets speed to 50 rpm.*

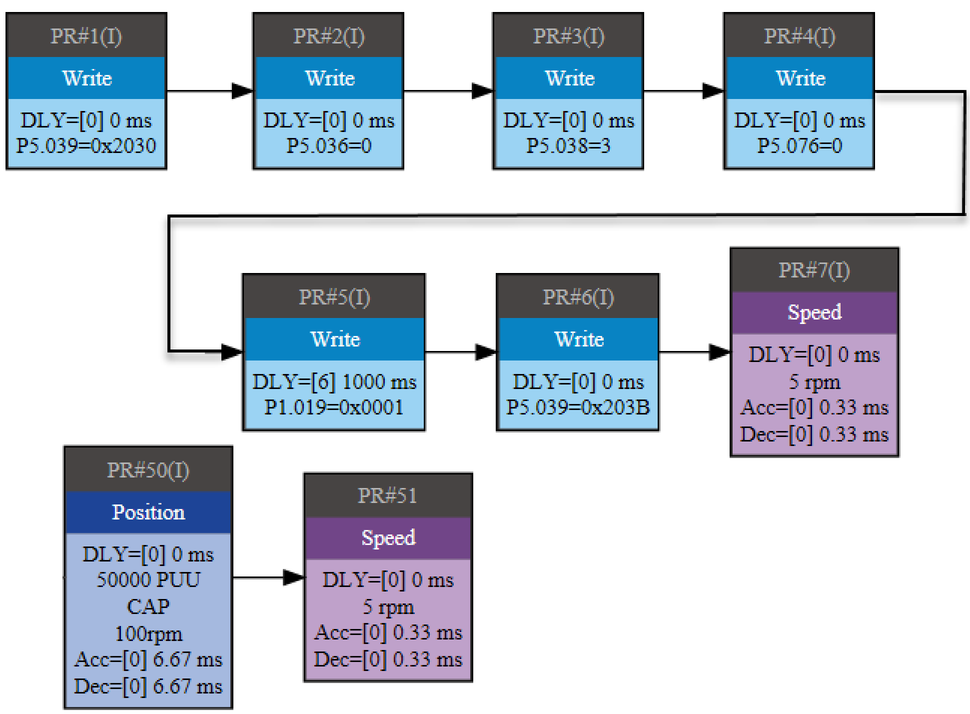


Figure 7-63 PR path with application of high-speed capture function

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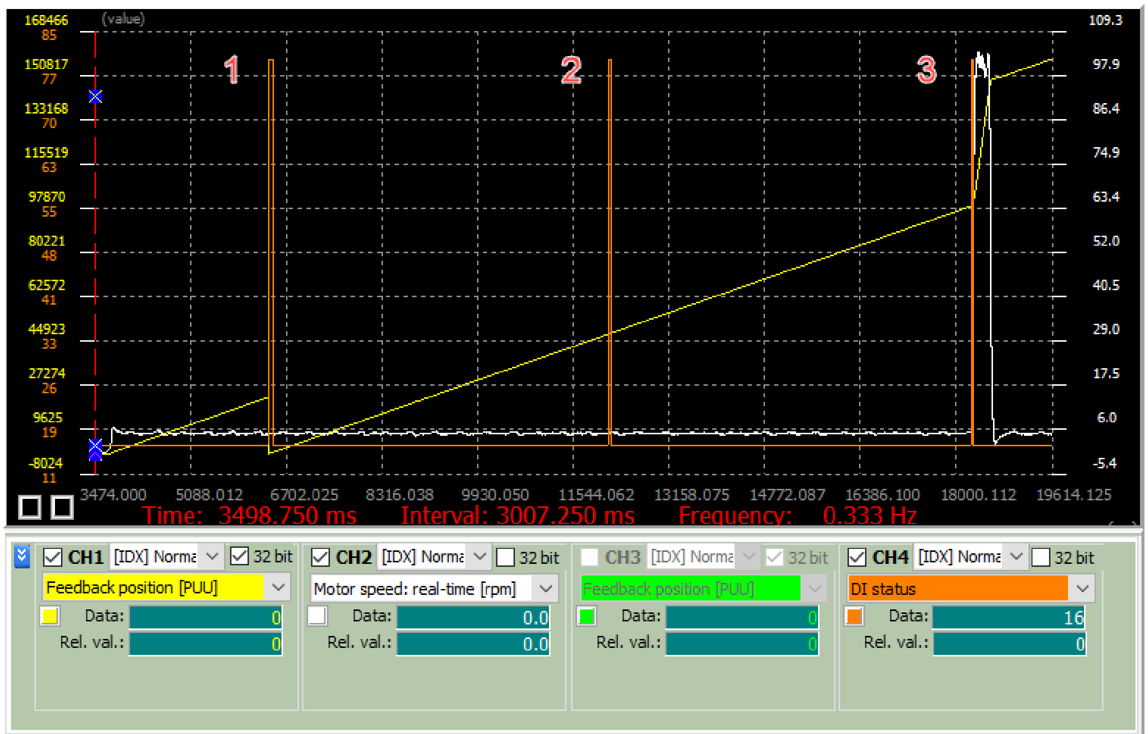
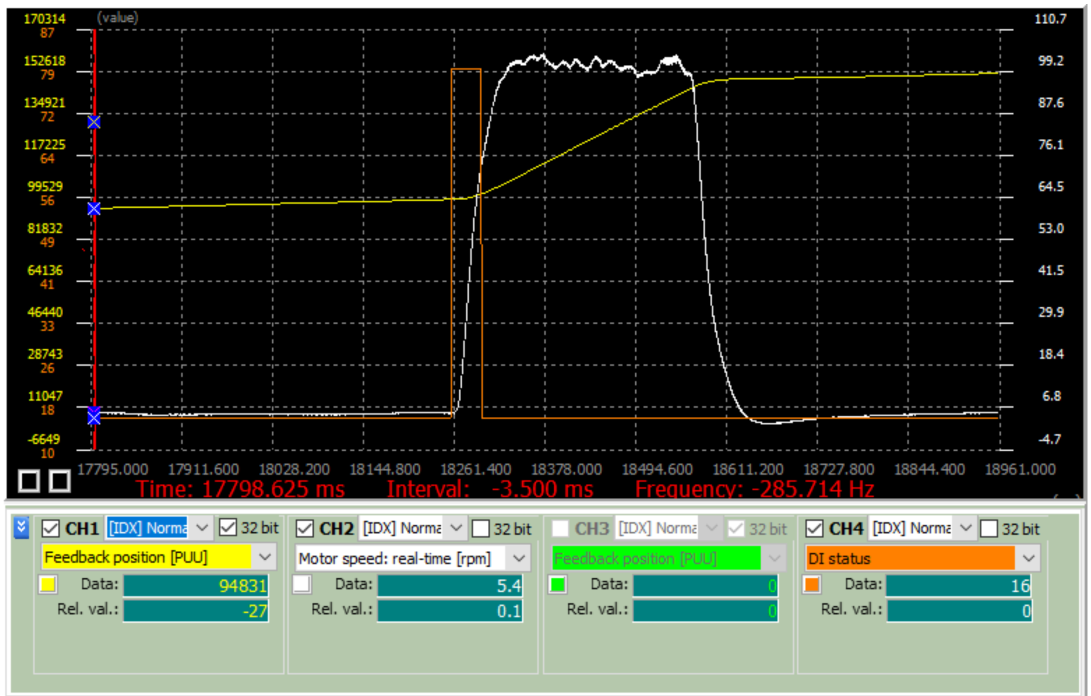
5) Set up the Scope in SureServo2 Pro to easily visualize what is happening.
   a) CH1 = Feedback Position (PUU)
      i) Be sure to check the 32 bit box. One revolution is 100,000 PUU. If left at 16 bit then the scope Y axis will roll over at 65535 total pulses. This will cause CH3 to be void since the 16 bits of CH3 will be used for the CH1 32 bit value.
   b) CH2 = Motor speed: real time (rpm). Uncheck the 32 bit box.
   c) CH4 = DI status.
6) Enable the servo.
7) Run PR path #0 from the PR Mode Editor window to home the axis.
8) Click Run on the Scope window.
9) Run PR path #1 from the PR Mode Editor window to run the PR path registers.
10) Trigger DI7 3 times within the scopes time capture limit.
11) Stop the scope and stop the PR path.

You should have a scope capture like the one below after you adjust your channel axis min and maxes.

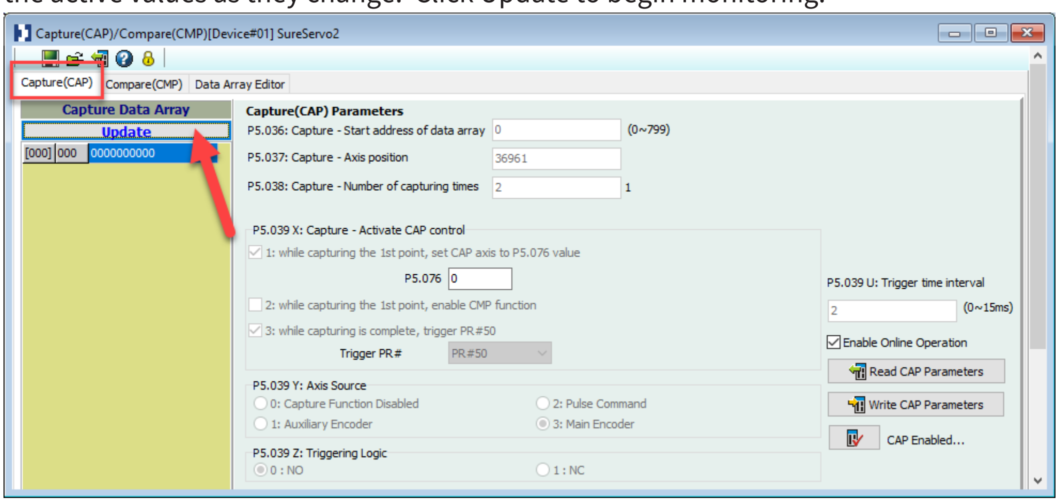


The above scope capture shows three input pulses from DI7. DI status is 80 decimal (50 hex) which represents DI5 (Set to disabled in this example) and DI7 are on. On the first pulse, the Position of the capture axis is reset to 0. This was configured by P5.039.X bit 1=1 that defines after the first data is captured, set Capture axis' position to the value of P5.076.

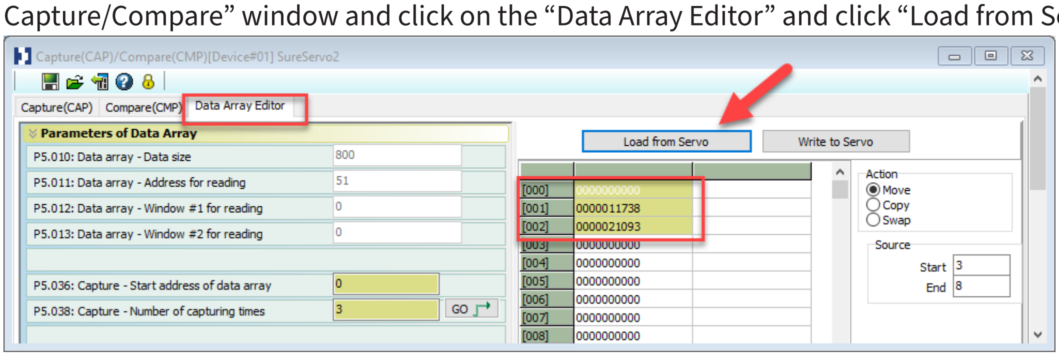
Since P5.038 = 3 (three data points for capture cycle) on the 3rd pulse the capture path is called (PR#50). Below you can see a zoomed in view of the third pulse. The scope shows the motor speed jump to 100 rpm for 50,000 PUU then returns to 5 rpm.



To view the captured data in SV2-PRO, open the "High Speed Position Capture/Compare" window and click on the "Capture (CAP)" tab during operation. Here you can view several of the active values as they change. Click Update to begin monitoring.



To view the actual values as they appear in the Data Array, open the "High Speed Position Capture/Compare" window and click on the "Data Array Editor" and click "Load from Servo".



From Figure 7-64, you see that after DI7 is triggered, the capturing axis is reset to 0 and the data stored in data element #000. P5.039.X bit1 = 1 tells the Capture event to reset the position after the first data point is captured. P5.076=0 defines that 0 will be the first data value written. When DI7 is triggered the second and third time, the position data is written to the data array element #001 and #002. Once the first capture cycle is completed, DO: [0x16]CAP_OK is set to on which then calls path PR#50 (high speed position capture command) and then proceeds to path PR#51 (motion with fixed speed). PR#50 is automatically called because P5.039.X Bit3 = 1. Then, the servo drive continues executing the next Capture cycle and sets DO: CAP_OK is set to off and the capturing amount is then set to 3 since P5.038 = 3. When DI7 is triggered for the fourth time, the capture axis' position is not reset according to the value in P5.076; the position data of the capturing axis is written to #000 again. Therefore, the data written in the previous cycle is replaced. At the moment DI7 is triggered the fifth and sixth time, the position of the capturing axis is stored in data array #101 and #102. As soon as the second capture cycle is finished, DO: [0x16]CAP_OK is set to on and then calls PR#50 (high-speed position capture command) and then PR#51 (motion with fixed speed).

When using Cyclic Capture mode (P1.019.X = 1), the Reset function is only valid for the first cycle. Executing the PR path is valid for every cycle; in other words, every time a cycle ends, PR#50 is executed. The first position data captured in every cycle is written to the data element number set by P5.036, and then the other data is written to sequential elements. So, position data written in the previous cycle is always replaced by the position data of the next cycle.

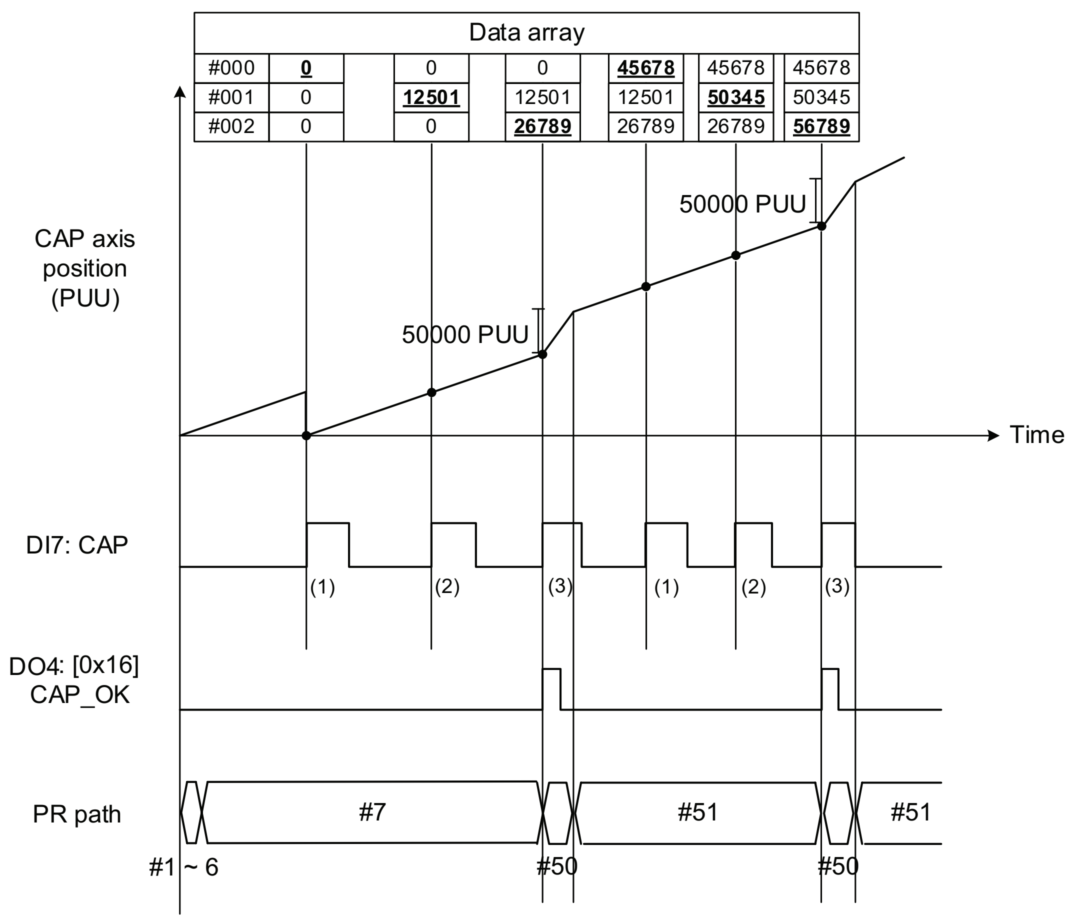


Figure 7-64 Application example for high-speed capturing function

7.2.3 - High-speed position comparing function (Compare)

The purpose of high-speed position comparing (CMP) is to compare the instant position of the motion axis with the value saved in the data array. When the compare condition is fulfilled (DO4 with execution time of only 5μs), a high-speed digital signal is sent immediately for user application motion control. Since this function is carried out by the hardware, there is no lag in the software and the position compare is more accurate on high speed motion axes. When the Compare function is enabled, the servo drive takes control of DO4, which cannot be user-defined, it is automatically defined when the Compare function is active.

As shown in Figure 7-65 Flow chart for the high-speed Compare function, P5.056 stores the start position of the data array for comparing (default is #50 in the data array). You must write the position data to be compared to the data array before comparing. P5.058 is the data size to be compared and must be greater than 0 or the function is invalid. P5.059 is the switch of the Compare function and for other settings. You can find more information in the table below. Please note that when the comparing source is the encoder output terminals of CN1, the pulse resolution of the comparing axis is set by P1.046 (numerator) and P1.097 (denominator) with default value of 2500 and 0 respectively; that is, the moving distance of the comparing axis is 10000 PUU per rotation of motor. The comparing position in the data array can be shifted using P1.023 (non-volatile) and P1.024 (volatile). You can reset P1.024 to 0 after the shift, and you can enable this function with P1.019.Z. You can also set the Compare function through SureServo2 Pro, as shown in Figure 7-66.

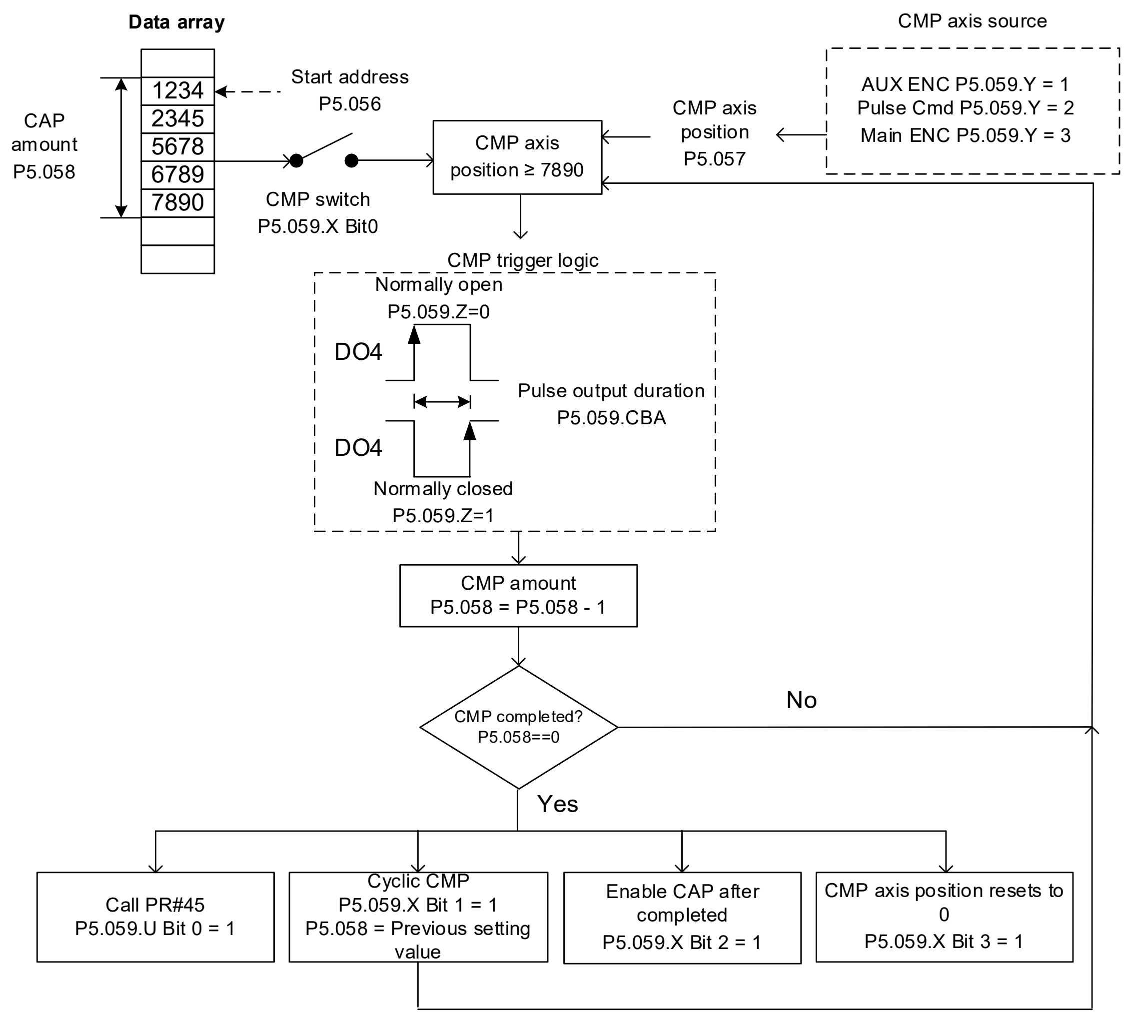


Figure 7-65 Flow chart for the high-speed position Compare function

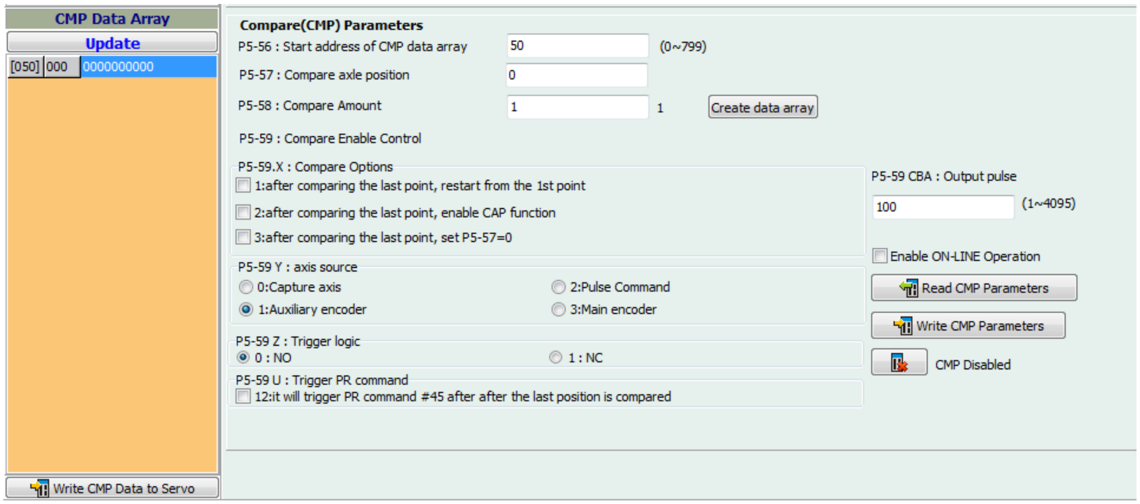


Figure 7-66 Compare Function screen in SureServo2 Pro

P5.059	Bit	Function	Description
X	0	Enable high-speed position compare function	When P5.058 is greater than 0 and bit 0 is set to 1, the comparing starts. The value of P5.058 decreases 1 every time a point in data array is compared. When P5.058 reaches 0, bit 0 is automatically cleared to 0. If bit 0 is 1, the new value to be written cannot be 1; you can only write 0 to disable the Compare function.
	1	Cycle mode	If bit 1 is set to 1 and all compare procedures are completed, P5.058 resets to the setting value and then the compare procedure starts again.
	2	Enable Capture function after data compared	If bit 2 is 1, after all comparing is done, enable the Capture function (Set P5.039.X bit 0 to 1, and set the previous value to P5.038 as the data size to be captured); if Capture function has been enabled, then this function is invalid.
	3	Reset position for the comparing axis to 0	If bit 3 is 1, set P5.057 to 0 once comparing is completed, the position for the comparing axis is reset to 0.
Y	-	Source setting of comparing axis	0: capturing axis 1: auxiliary encoder (CN5) 2: pulse command (CN1) 3: motor encoder (CN2) If capturing axis is selected, the source of the capturing axis (P5.039.Y) cannot be changed. If the motor encoder is selected, the pulse resolution is determined by P1.046 (Encoder pulse number output setting) and P1.097.
Z	-	Trigger logic	0: NO (normally open); 1 : NC (normally closed)
U	-	Trigger PR path	If bit 0 is set to 1, PR#45 is triggered once the last data is compared.
CBA	-	Pulse output duration (ms)	-

Walk Through Compare Example Intro

Use PR path programming to use motion commands with the Compare function. You can use Write commands to edit the contents of the data array and set the high-speed position Compare function, as well as executing a motion command. As shown in Figure 7-67, you set the numerator (P1.046) and denominator (P1.097) for the encoder's pulse output (the default is based on the comparing axis runs of 10000 pulses per rotation of the motor).

1) Reset the drive to defaults (P2.008=10), cycle power and set limit switch inputs and OVRD stop as needed.
2) Set P1.001 = 1 (PR Mode).
3) Set Homing Mode to P5.0004.X = 8 (Define Current Position as the Origin) Since the motor's encoder is configured to be the capture axis (PR#6 below), the Capture Axis position (P5.037) is reset to 0 during the homing routine.
4) Configure the PR paths:
   - *PR#1-3 uses write commands to populate values into data array #50 - 52.*
   - *PR#4 confirms that the Compare function is disabled (P5.059.X Bit 0 = 0), Compare axis source is the motor's encoder (P5.059.Y=3) and the output pulse width is 100mSec.*
   - *PR#5 sets the start position to #50.*
   - *PR#6 sets the comparing data array size to 3*
   - *PR#7 resets the compare axis position to 0 and sets a delay of 1 ms to ensure that the PR path using the Compare function can be executed.*
   - *PR#8.*
     i) Enables the Compare function in Cycle mode which resets the comparing axis to 0 on the first pulse of each cycle
     ii) Selects CN2 (motor encoder) as the capturing axis source
     iii) Selects the motor's encoder as the capturing axis
     iv) Uses 'normally closed' contact as the trigger logic
     v) Sets a (DO4) pulse output duration of 100 ms
     vi) After the comparison is complete execute PR#45
   - *PR#9 initiates a Speed command of 50 rpm.*
   - *PR#45 initiates an Incremental command of 50000 (5000.0) PUU which is equivalent to a half turn of the motor*
   - *PR#46 resets the Speed command setting at 50rpm.*

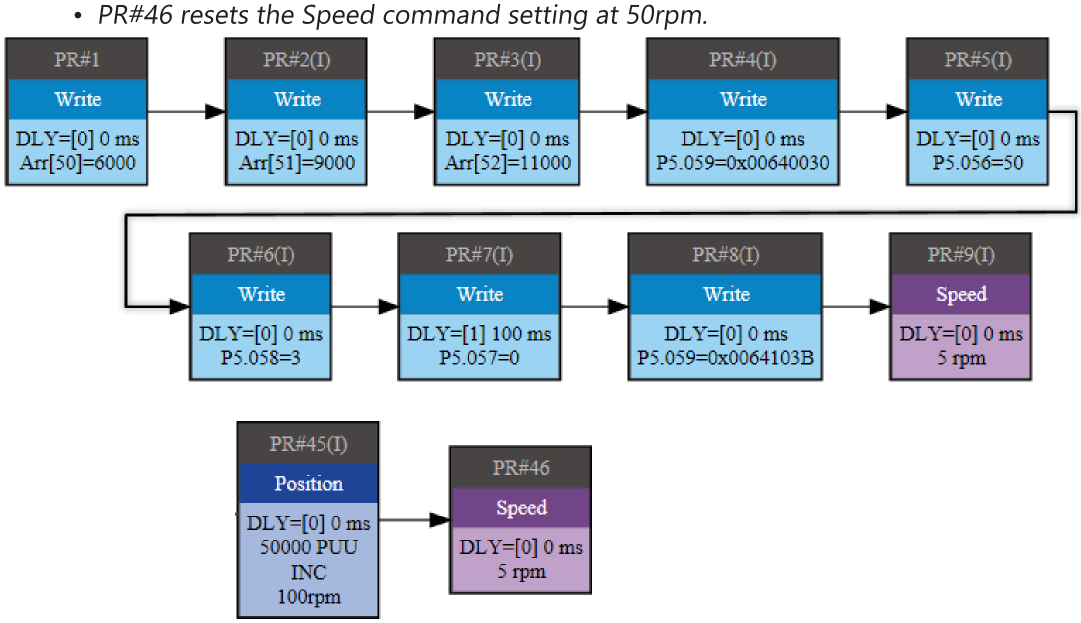
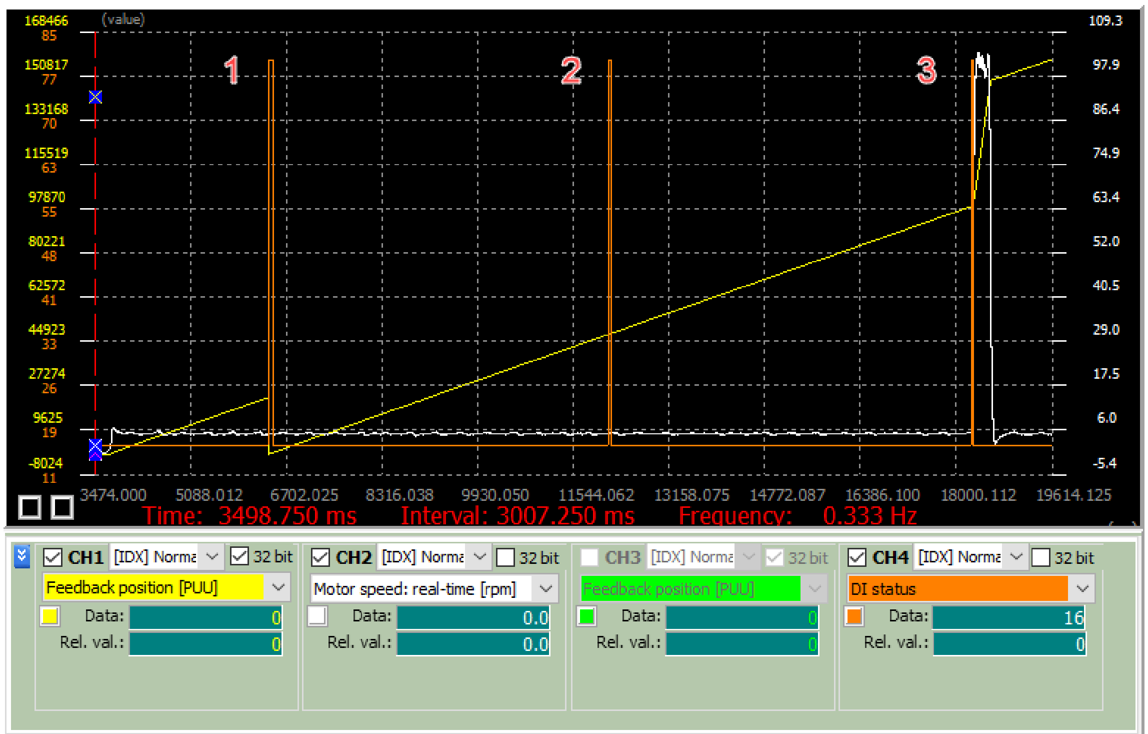


Figure 7-67 PR path using the Compare function

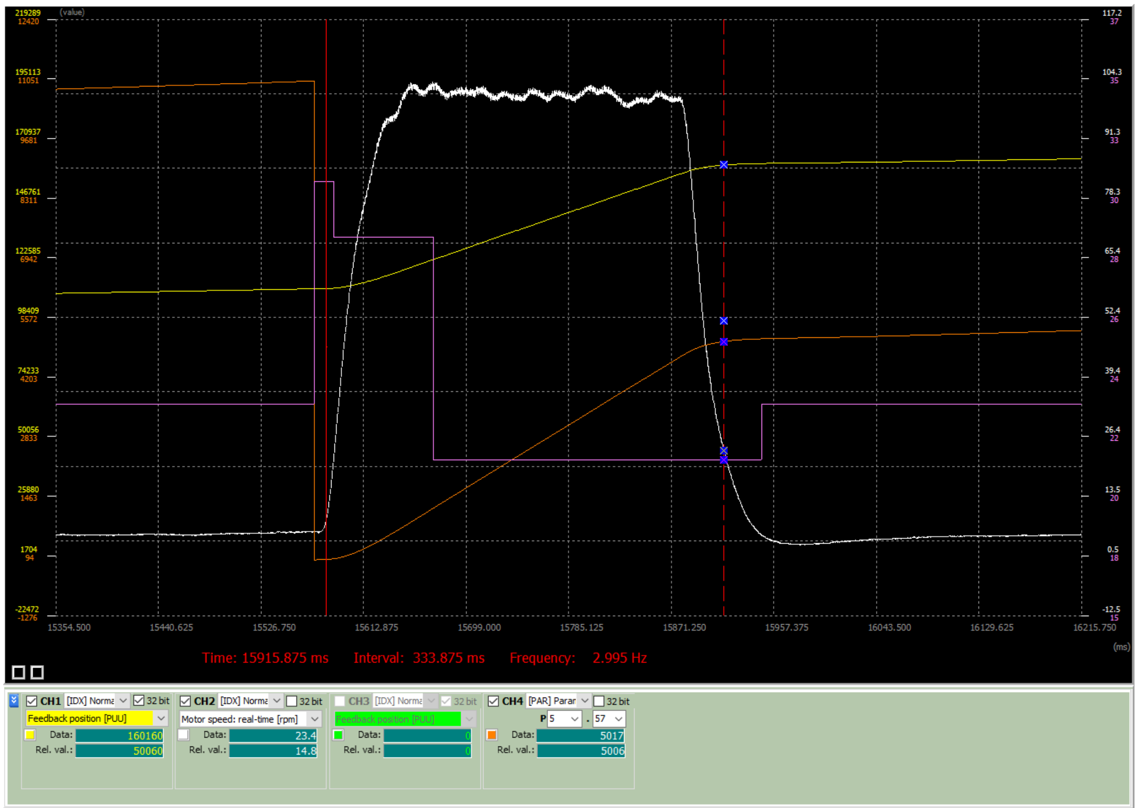
5) Set up the Scope in SureServo2 Pro to easily visualize what is happening.
   a) CH1 = Feedback Position (PUU)
      i) Be sure to check the 32 bit box. One revolution is 100,000 PUU. If left at 16 bit then the scope Y axis will roll over at 65535 total pulses. This will cause CH3 to be void since the 16 bits of CH3 will be used for the CH1 32 bit value.
   b) CH2 = Motor speed: real time (rpm)
   c) CH4 = P5.057 (compare axis position)
   d) CH5 = DO status
6) Enable the servo
7) Run PR path #0 from the PR Mode Editor window to home the axis.
8) Click Run on the Scope window.
9) Run PR path #1 from the PR Mode Editor window to run the PR path registers.
10) DO4 will pulse every time the compare axis is equal to the next element in the array. On the third pulse the compare axis position will reset to 0 and call PR45.
11) Stop the scope after three DO4 pulses.

You should have a scope capture like the one below after you adjust your channel axis min and maxes.

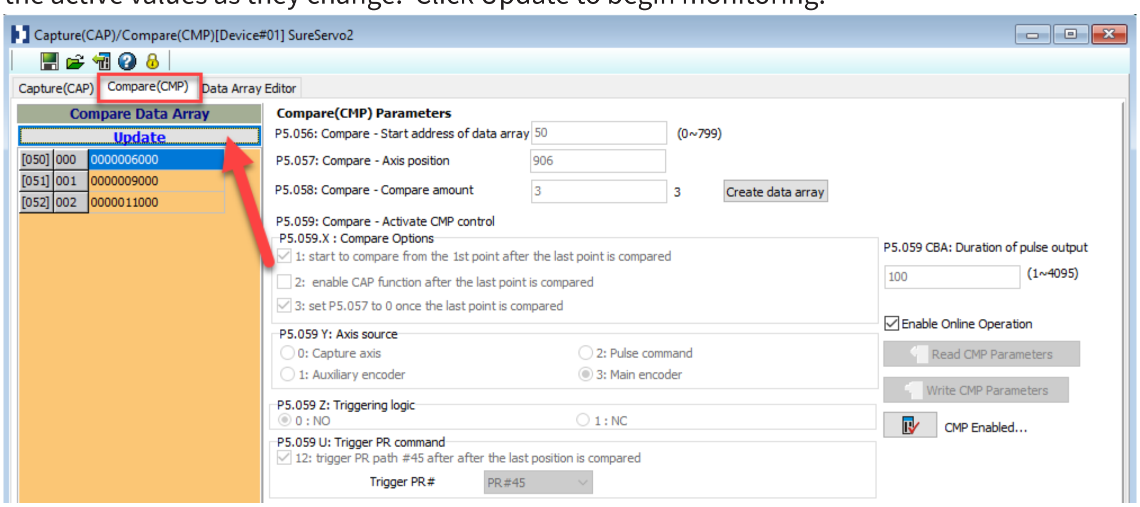


The above scope capture shows 3 DO4 pulses and on the 3 one the compare axis is reset to 0 then the position move 50,000 PUU as a speed of 100 rpm. On the first pulse, the Position of the compare axis is reset to 0. This was configured by P5.059.X bit 3=1 that defines after the compare is complete, set the compare axis' position to 0.

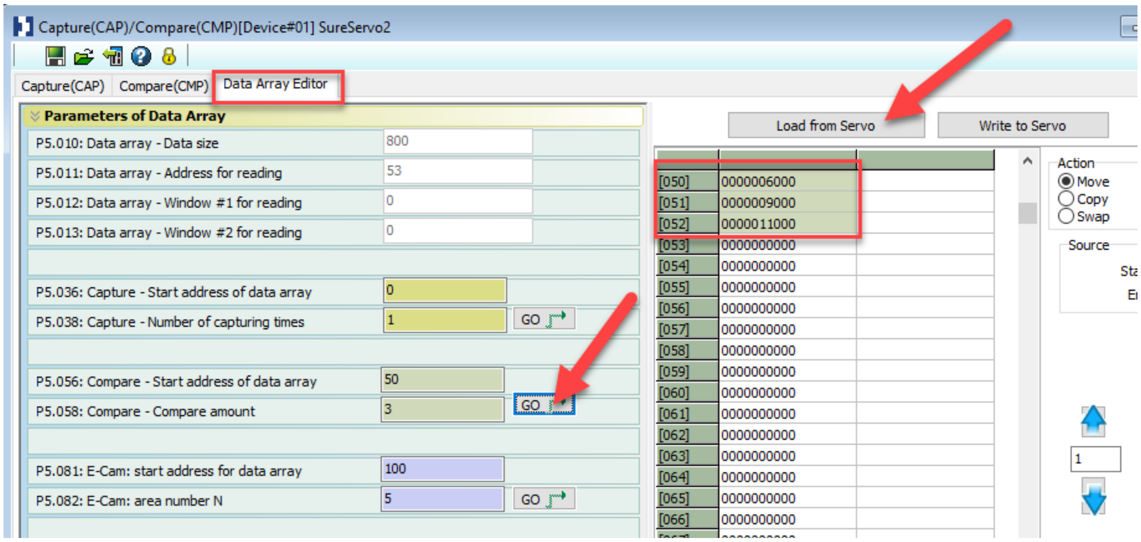
Below you can see a zoomed in view of the third pulse. The scope shows the motor speed jump to 100 rpm for 50,000 PUU then returns to 5 rpm. The capture axis gets reset to 0 but the motors actual encoder feedback pulses continue to increase.



To view the compare data in SV2-PRO, open the "High Speed Position Capture/Compare" window and click on the "Compare (CMP)" tab during operation. Here you can view several of the active values as they change. Click Update to begin monitoring.



To view the actual values as they appear in the Data Array, open the "High Speed Position Capture/Compare" window and click on the "Data Array Editor" and click "Load from Servo".



Looking at another example of three data points or 20000, 30000, 40000. From Figure 7-68, you see that when the comparing axis runs to 20000 pulses, it is identical to the contents of data array #50 and the first DO4 pulse is set. When the comparing axis runs to 30000 pulses, it is identical to the contents of data array #51 and the second DO4 pulse is set. While comparing axis runs to 40000 pulses, it is identical to the contents of data array #52 and the third DO4 pulse is set. Once the first cycle completes, the comparing axis resets to 0 and executes PR#45 (Incremental command 50000 (5000.0) PUU), which is equivalent to a half turn of the motor. Therefore, the comparing axis outputs 5000 pulses, and after the position command completes, it executes the Speed command. Then the next comparing cycle starts. This is the same as the first cycle, and the comparing axis outputs DO4 signal at 20000, 30000, and 40000 pulses respectively and then it resets to 0 and executes PR#45.

Data array

#50	**20000**	20000	20000	**20000**	20000	20000
#51	30000	**30000**	30000	30000	**30000**	30000
#52	40000	40000	**40000**	40000	40000	**40000**

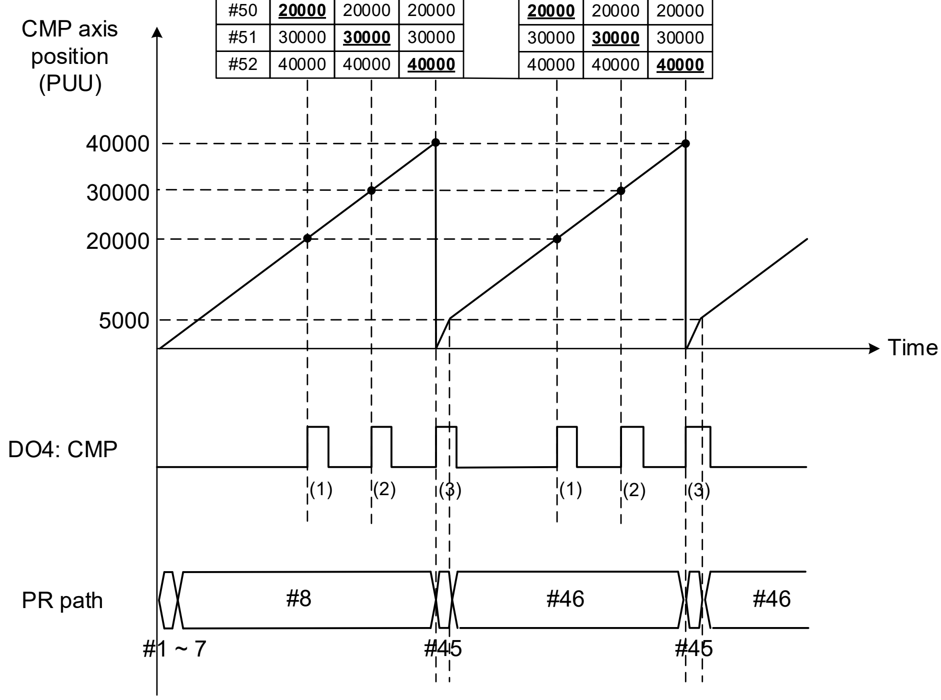
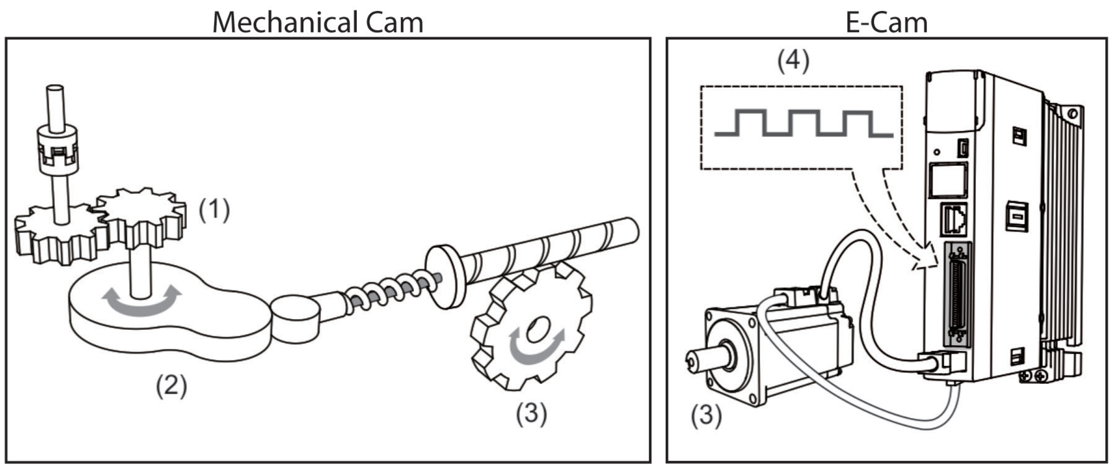


Figure 7-68 Timing of the Compare function

7.3 - E-Cam

The E-Cam system uses the mathematical formula to plan the relative following motion path based on the master-slave operation, which can replace the actual mechanical cams and overcome the limitation of the mechanical cam shapes. You can use the E-Cam function as long as it is a master-slave application and their positions can translate into a mathematical formula. The mechanical cam and E-Cam are shown in Figure 7-69.



(1) Master axis input; (2) Mechanical cam; (3) Slave axis output; (4) E-Cam master axis input

Figure 7-69 Mechanical cam and E-Cam

The E-Cam function is only available in PR mode (P1.001 = 1). The slave axis operates based on the cam curve; the positions of the master and slave correspond to a mathematical function. The master axis sends pulses to the slave axis so the slave axis runs according to the corresponding E-Cam curve, as shown in Figure 7-70. P5.088.X can enable or disable the E-Cam function. When this function is enabled, the servo drive determines the clutch engagement and disengagement timings. Figure 7-71 introduces the E-Cam parameters with a mechanical cam illustration. See the detailed settings in the following section.

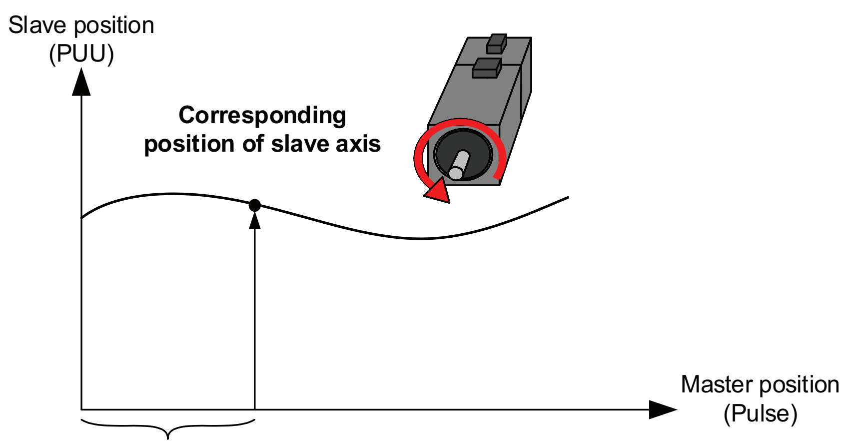
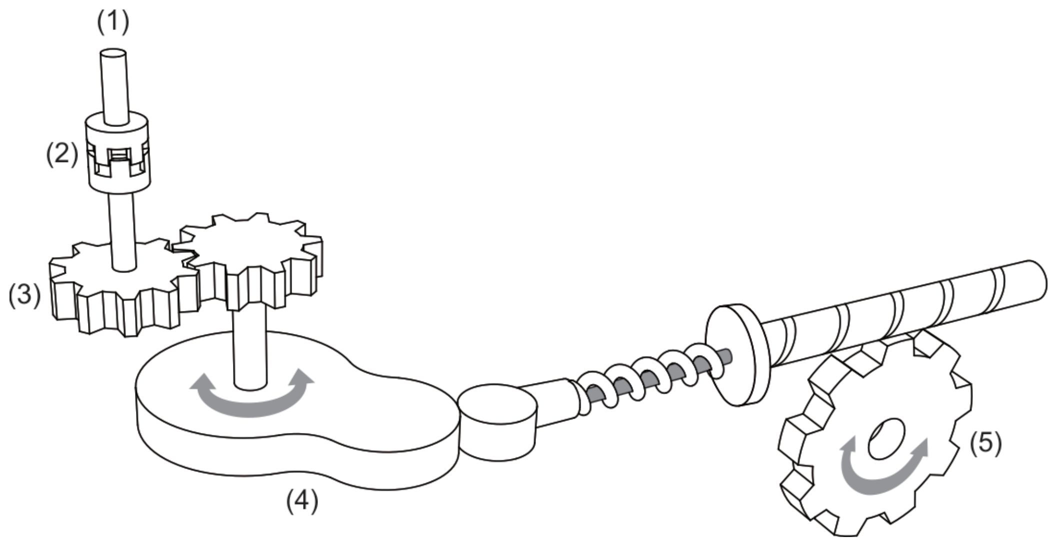


Figure 7-70 E-Cam curve

Wiring
Parameters
DI/DO Codes
Monitoring
Alarms



(1) Master axis: P5.088.Y: command source that acts as the master axis
(2) Clutch: P5.088.UZ, P5.087, and P5.089: engagement and disengagement timing control
(3) E-Gear of master axis: P5.083 and P5.084: command pulse resolution
(4) E-Cam curve: P5.081, P5.082, and P5.085: position correlations of master and slave axes; P5.019: scaling
(5) E-Gear of slave axis: P1.044 and P1.045: output signal resolution

Figure 7-71 Use E-Cam servo parameters to simulate mechanical cams

7.3.1 - Source signal for the master axis

When using the E-Cam function, you must specify the signal source for the master axis signaling, which can be an external encoder, PLC, or another servo drive to name a few. The SureServo2 servo drives support seven source types for the master axis. You can use P5.088.Y to select the master axis signal source and monitor the master axis position with P5.086.

1) Capture axis: when P5.088.Y = 0, it uses the source set in P5.039.Y (Capture function source) as the master axis signal source. You can read the value of P5.037 to display the axis position of Capture pulse source.
2) Encoder: when P5.088.Y = 1, it uses CN5 external encoder signals as the master axis signal source. You can read the value of P5.017 to acquire the master axis position.
3) Pulse input: when P5.088.Y = 2, it uses pulses input through CN1 as the master axis signal source. You can read the value of P5.018 to acquire the master axis position.
4) PR command: when P5.088.Y = 3, it uses the PR motion control command as the master axis signal source.
5) Time axis (1ms): when P5.088.Y = 4, it uses the pulse signal generated per millisecond from the servo drive as the master axis signal source.
6) P5.088.Y = 5 is Reserved.
7) Analog speed channel: when P5.088.Y = 6, it uses the analog speed command as the master axis signal source; 10V corresponds to the frequency of 1 M pulse/s.

SureServo2 provides two sets of DO, [0x18] CAM_AREA1 and [0x1A] CAM_AREA2, which specify the current E-Cam operation position (in respect of the master axis). The first set is set by P5.090 and P5.091; the second set is set by P2.078 and P2.079, as shown in Figure 7-72. For detailed settings, refer to Chapter 8.

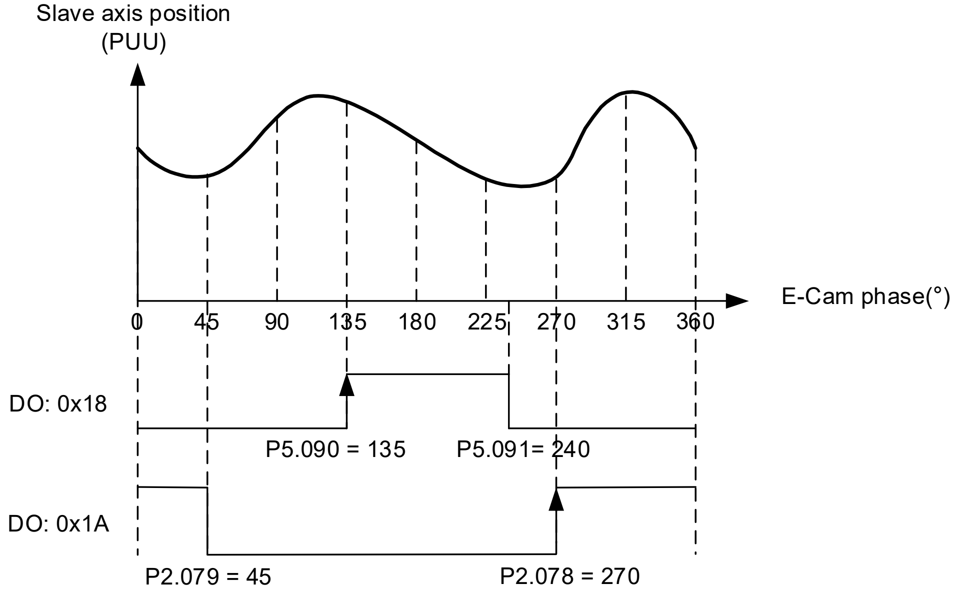


Figure 7-72 DO is on when the clutch engages

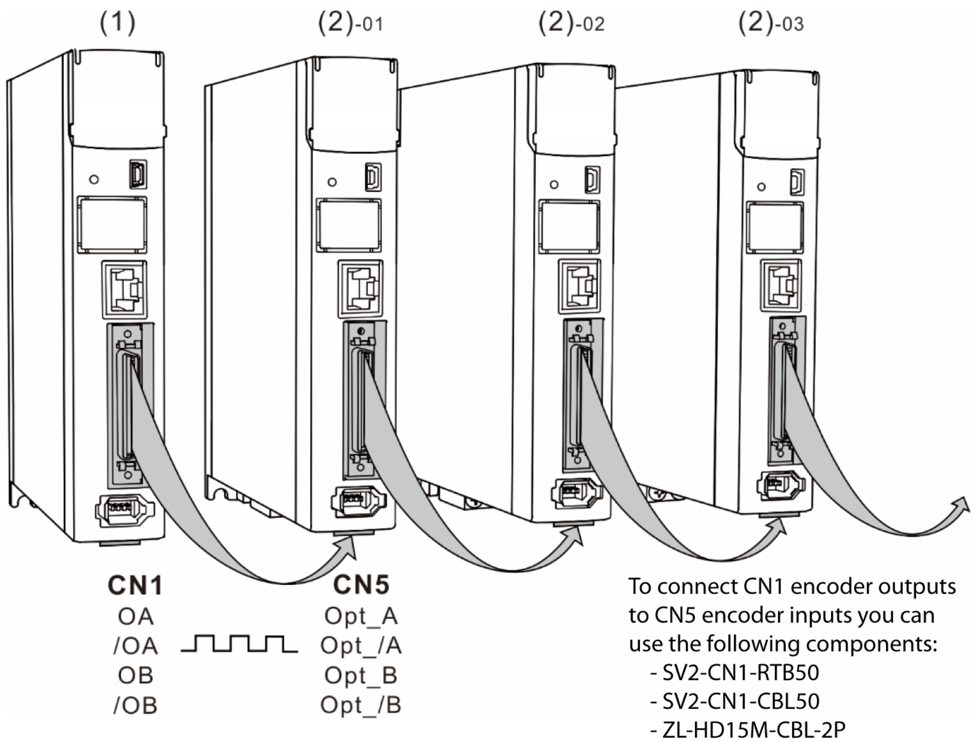
To get the data for the master axis, use four monitoring variables, which are Accumulative pulse of master axis, Incremental pulse of master axis, Pulse of master axis (lead pulse), and Position of master axis. The following is the detail description for the four monitoring variables.

1) Accumulative pulse of master axis: monitoring variable code 059(3Bh); the accumulative pulse number of the E-Cam master axis. Same as P5.086.
2) Incremental pulse of master axis: monitoring variable code 060(3Ch); the incremental pulse number of the E-Cam master axis generated per 1ms.
3) Pulse of master axis (lead pulse): monitoring variable code 061(3Dh); when the clutch is engaged, the master axis disengagement pulse number (P5.089) decrements to 0 and then the clutch disengages; when the clutch is disengaged, the master axis lead pulse number (P5.087 or P5.092) decrements to 0 and then the clutch engages.
4) Position of master axis: monitoring variable code 062(3Eh); the position of the E-Cam master axis.

Pulse Bypass Function

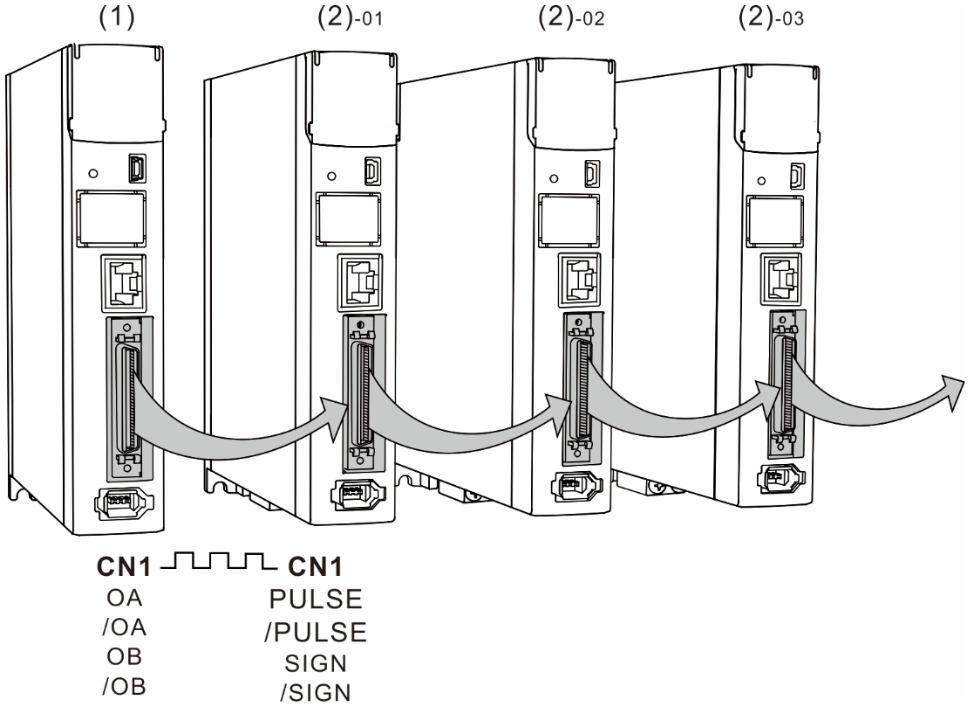
When using the E-Cam and pulse bypass functions, the servo drive can receive pulse signals and send these signals to the next servo axis, so multiple slave axes can refer to the same master axis signals. In addition, signals transmitted through the servo drives are not attenuated because the servo drive amplifies the signals to the strength they should have during output. For example, if the signal input is 4.5V, it becomes 5V when output. Since there is electrical resistance in the wire, take the signal attenuation into account and use twisted-pair shielded wires. If the signals transmitted to the servo drive are attenuated to the level that the servo cannot identify, use a cable with thicker gauge or a shorter signal cable. If not considering the signal delay caused by cables, the delay time of each servo drive is 50ns.

On the SureServo2 servo drives, the pulse output pins are OA, /OA, OB, and /OB of CN1 only; pulses can be input through CN1 or CN5 to the servo drive. Use P1.074.Y to set the output signal source for the servo drive. If selecting CN5 as the pulse input channel, as shown in Figure 7-73, then you must set P1.074.Y to 1 for each slave axis (servo drive) to have CN5 receive pulses. If selecting CN1 as the pulse input channel, as shown in Figure 7-74, then you must set P1.074.Y to 2 for each slave axis (servo drive) to have CN1 receive pulses.



(1) Master axis; (2) Slave axes 1, 2, and 3.

Figure 7-73 Pulse bypass function: CN1 output / CN5 input



(1) Master axis; (2) Slave axes 1, 2, and 3.

Figure 7-74 Pulse bypass function: CN1 output / CN1 input

7.3.2 - Clutch engagement and disengagement

When the E-Cam function is enabled, the E-Cam clutch status determines whether the slave axis operates based on the signals sent from the master axis. While cams are engaged, the slave axis operates according to the received master axis pulses and the E-Cam curve; when cams are disengaged, the slave axis does not operate according to the E-Cam curve even if it receives the master axis pulses. The clutch engagement and disengagement timings are described as follows. Note that if the drive is not in PR mode, then E-Cam will not engage.

Clutch engagement condition

After the E-Cam function is enabled, the slave axis operates according to the master axis signals and E-Cam curve only when the clutch is engaged as shown in Figure 7-75. The timing for clutch engagement can be specified with P5.088.Z. The SureServo2 provides three condition options for clutch engagement timing:

1) Engage immediately (P5.088.Z = 0): the clutch engages immediately as soon as the E-Cam function is enabled. The slave axis operates according to the E-Cam curve and the master axis signals.
2) Engagement control with DI (P5.088.Z = 1): trigger DI.CAM[0x36] to have the clutch engaged. When this DI is triggered, the clutch remains engaged until the disengagement condition is met.
3) Engagement control with high-speed capturing (P5.088.Z = 2): when the master axis source is the Capture axis and the first position data is captured and the clutch is engaged immediately. The Capture signal is triggered by DI7. Different from triggering DI.CAM[0x36] for clutch engagement, the high-speed capturing function only takes 5 μs to have the clutch engaged using the DI7, making the system timing control more precise. When the Capture function is engaged, DI7 automatically changes functions to the Capture trigger.

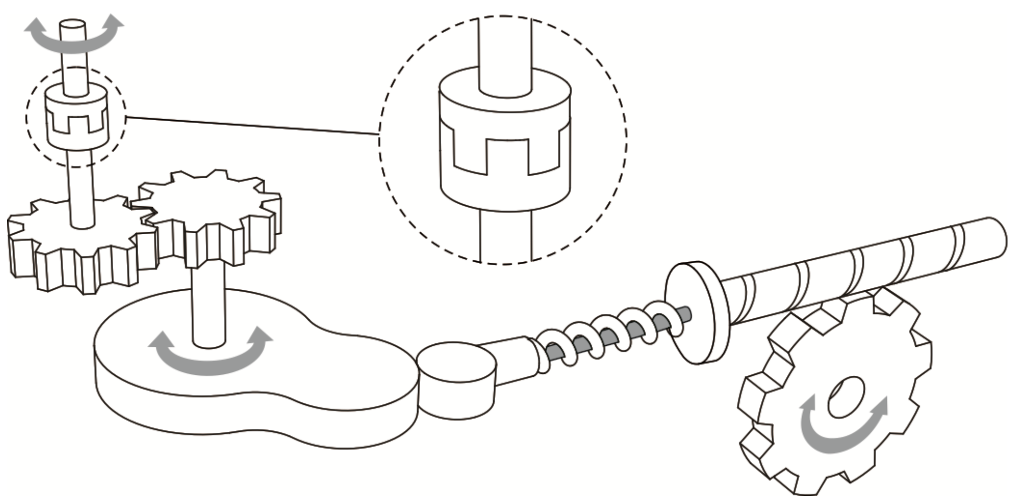


Figure 7-75 Clutch engagement

In addition, you can use P5.087 to set the initial lead pulse of the master axis before engagement. That is, once the engagement condition is met, the master axis needs to reach the set lead pulse number first and then the clutch is engaged as shown in Figure 7-76.

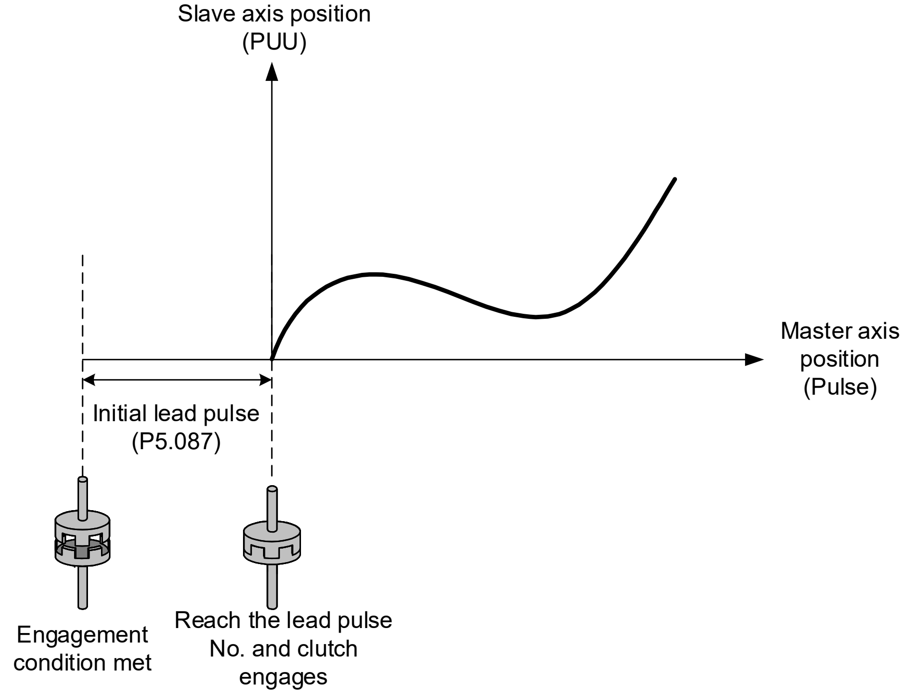


Figure 7-76 Initial lead pulse before clutch engagement

Clutch disengagement condition

When the E-Cam function is enabled and the clutch is engaged, the slave axis operates based on the E-Cam curve and master axis signals. When the slave axis completes the motion, you can directly disable the E-Cam function or disengage the clutch to stop the slave axis motion. While the clutch is disengaged, the slave remains stationary regardless of the master axis motion as shown in Figure 7-77.

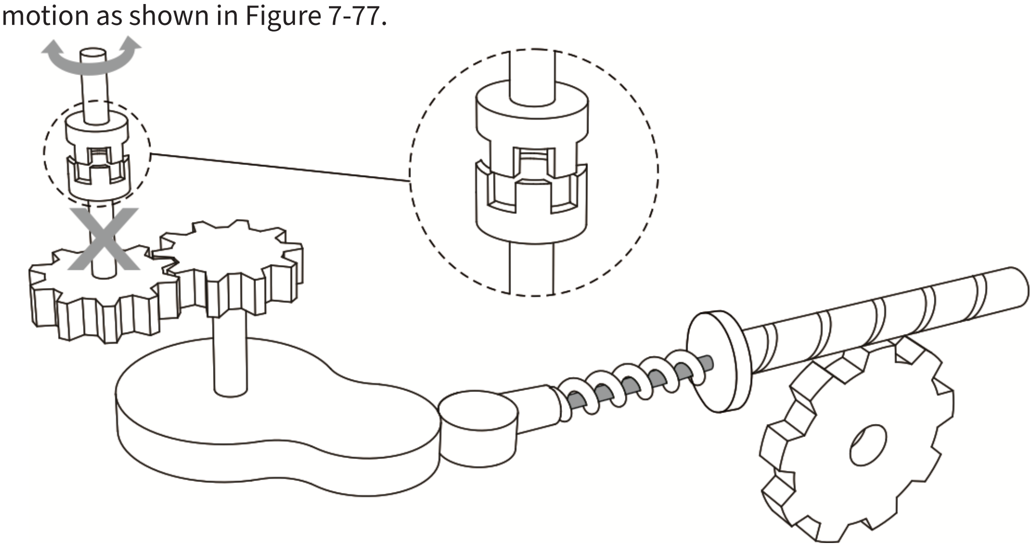


Figure 7-77Clutch disengagement

You can use P5.088.U to select the disengagement condition depending on the applications. The drive provides five condition options for clutch disengagement timing.

1) Remain engaged (P5.088.U = 0): the clutch remains engaged unless the E-Cam function is disabled.
2) Disengagement control with DI (P5.088.U = 1): switch the DI.CAM[0x36] to off to have the clutch disengaged. When this DI remains off, the clutch remains disengaged and the E-Cam system is in stop state.
3) Immediate stop after disengagement (P5.088.U = 2): when the clutch is engaged and the pulse number of the master axis reaches the value set in P5.089, the clutch disengages, the slave axis stops immediately, and the E-Cam system is in stop state as shown in Figure 7-78. This function is suitable for applications that require the slave axis to accurately stop at the specified position.

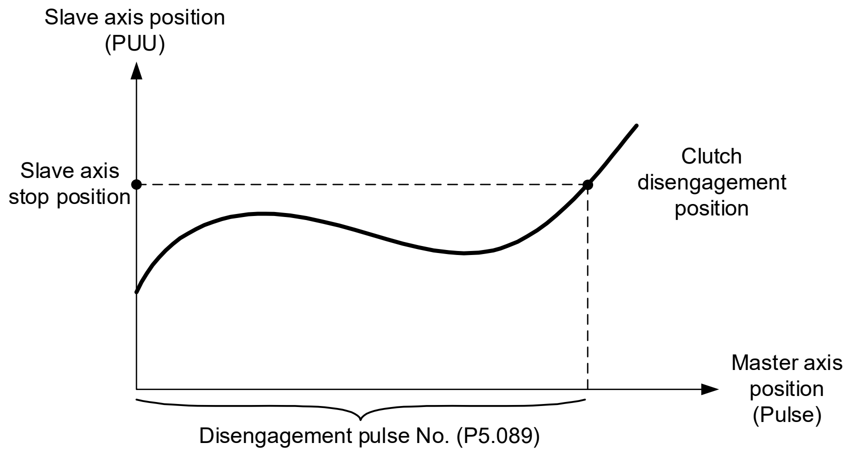


Figure 7-78 Disengagement timing: slave axis stops right after clutch disengagement

4) Decelerate to stop after disengagement (P5.088.U = 6): when the clutch is engaged and the pulse number of the master axis reaches the value set in P5.089, the clutch disengages, the slave axis decelerates to stop, and the E-Cam system is in stop state as shown in Figure 7-79. This function is suitable for applications that require the slave axis to slowly decelerate to stop.

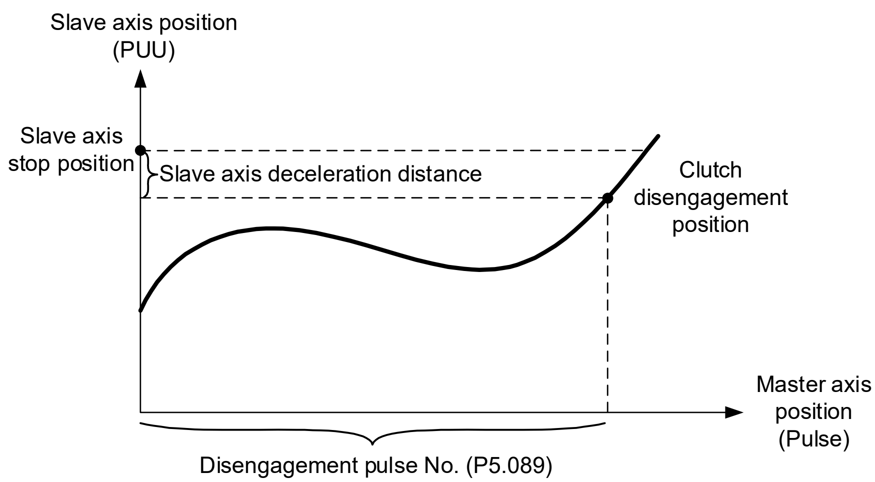


Figure 7-79 Disengagement timing: slave axis decelerates to stop after clutch disengagement

5) Enter cyclic mode after disengagement (P5.088.U = 4): when the clutch is engaged and the pulse number of the master axis reaches the value set in P5.089, the clutch disengages and the master and slave axes enter the cyclic mode. Then, the E-Cam system goes into the pre-engage state and waits for the master axis pulse to reach the number set in P5.092. Next, the clutch re-engages and operation of the next cycle starts. See Figure 7-80.

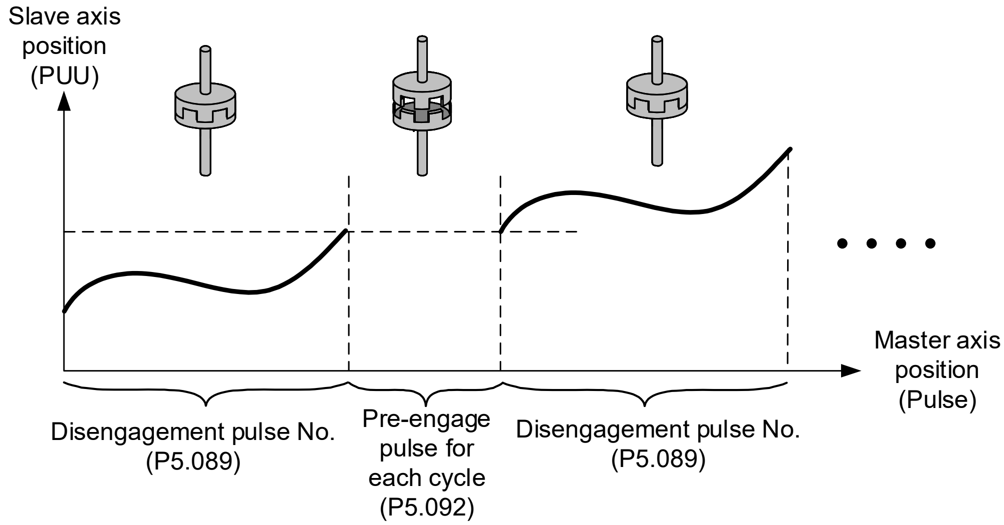


Figure 7-80 Disengagement timing: cyclic mode

NOTE: The "pre-engage pulse for each cycle" and the "initial lead pulse" are different. The "initial lead pulse" is valid only for the first engagement whereas the "pre-engage pulse for each cycle" is effective before each engagement cycle. You can see how these two work together in Figure 7-81.

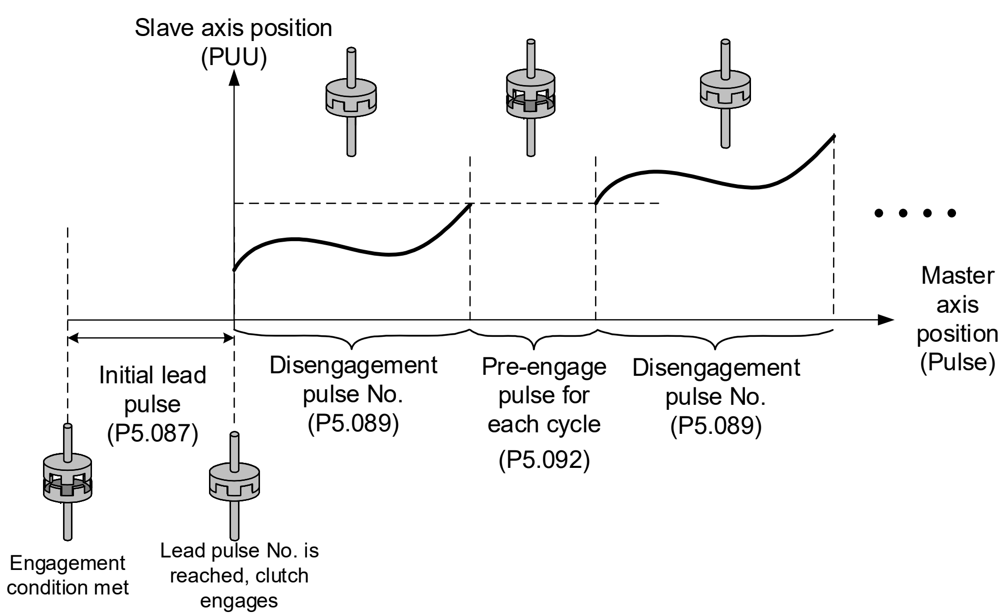


Figure 7-81 "Initial lead pulse" and "Pre-engage pulse for each cycle"

There are three available options for how the E-cam behaves after the clutch disengagement condition has been met (choose one of the following): “Immediate stop after disengagement”, “Decelerate to stop after disengagement”, or “Enter cyclic mode after disengagement”. If you select the disengagement options such as “Disengagement control with DI”, “Immediate stop after disengagement”, or “Decelerate to stop after disengagement” (P5.088.U = 1, 2, or 6), you can activate the function for disabling the E-Cam after clutch disengagement (P5.088.U = 8). This is the same as setting P5.088.X to 0; however, you cannot set it individually; you need to use one of the three options (P5.088.U = 1, 2, or 6) when setting P5.088.U to 8. You can stop the slave axis by disengaging the clutch or disabling the E-Cam. Regardless of the current state of the E-Cam system (stop, engaged, or disabled), you need to enable the E-Cam function to operate it. When the clutch is disengaged, although the slave axis is stopped, the slave axis continues to monitor the signals sent from the master axis as the E-Cam system remains operating. Settings for clutch disengagement timing and disabling E-Cam function are as follows:

P5.088.U value	***Clutch disengagement condition***	***System status after disengagement***
0	Condition 0: remains engaged unless E-cam function is disabled	-
1	Condition 1: DI.CAM Off. Disengages when DI (DI: 0x36) is off	0: stop
2	Condition 2: disengages when the master axis pulse number reaches the setting value of P5.089, and the slave axis stops immediately (sign indicates the direction)	0: stop
4	Condition 4: disengages when the master axis pulse number reaches the setting value of P5.089 and the master and slave axes enters the cyclic mode. When the pre-engaged pulse number for each cycle (P5.092) is reached, the clutch re-engages	2: pre-engage
6	Condition 6: disengages when the master axis pulse number reaches the setting value of P5.089, and the slave axis decelerates to stop	0: stop

NOTE: For the system status after disengagement, refer to the following sections.

You can choose one of the three disengagement conditions for the PR path after the clutch disengagement, which are “2: Immediate stop after disengagement”, “6: Decelerate to stop after disengagement”, and “4: Enter cyclic mode after disengagement” (P5.088.U = 2, 6, or 4). Write the PR number in hexadecimal to P5.088.BA. If this value is 0, it means no PR path is executed after the disengagement. In addition, if you use the setting “Enter cyclic mode after disengagement (P5.088.U = 4)” and specify the following PR path, as the E-Cam function does not have an interruption setting, the slave axis carries on to the next cycle until the motion set in the PR path is complete.

E-Cam system status

The E-Cam system has three states once the E-Cam is enabled, Stop, Engage, and Pre-engage. When the E-Cam function is enabled, you can use P5.088.D to promptly monitor the system's current status. The following section explains each state, as shown in Figure 7-82.

1) Stop state (P5.088.D = 0): the clutch is disengaged and the system continues to check the engagement condition (P5.088.Z). If the engagement condition is met and the initial lead pulse (P5.087) is not set, the clutch engages. If you have set the initial lead pulse, the system enters the Pre-engage state. When the E-Cam function is disabled, the system is also in the stop state.
2) Engage state (P5.088.D = 1): the clutch is engaged and the system continues to check the disengagement condition (P5.088.U). If one of the three disengagement conditions, "Disengagement control with DI", "Immediate stop after disengagement, or "Decelerate to stop after disengagement" (P5.088.U = 1, 2, or 6) is met, the system is stopped. If the condition "Enter cyclic mode after disengagement (P5.088.U = 4)" is met, the system enters the Pre-engage state.
3) Pre-engage state (P5.088.D = 2): the clutch is disengaged. If pulses from the master axis reach the initial lead pulse number or the pre-engaged pulse number for each cycle, the clutch engages and the system enters the Engage state.

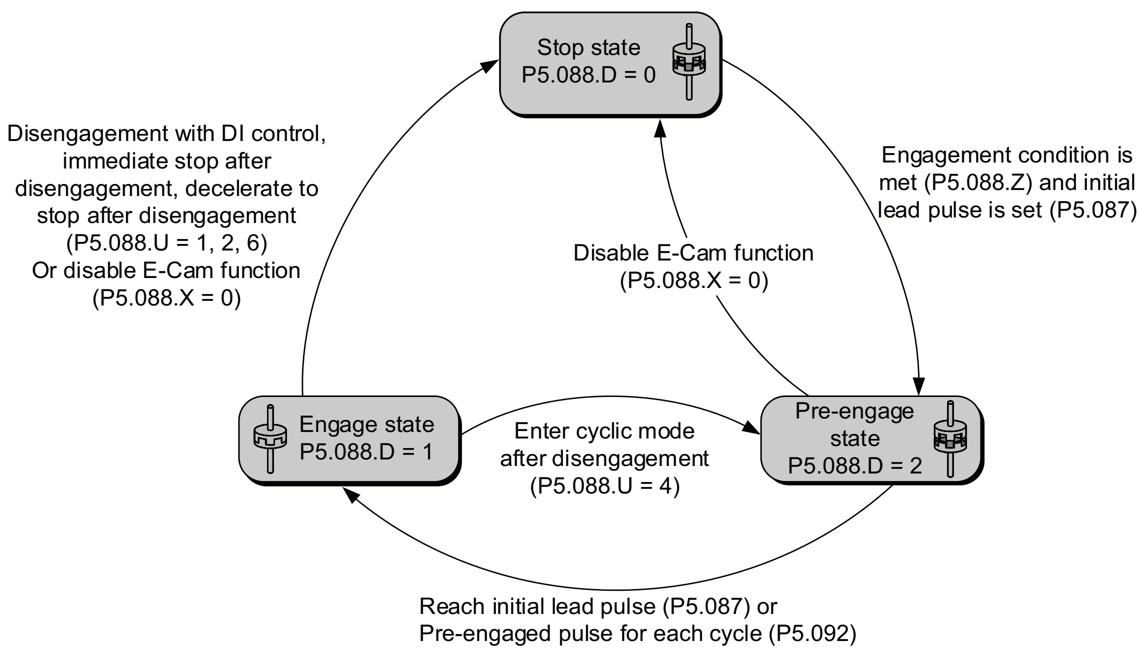
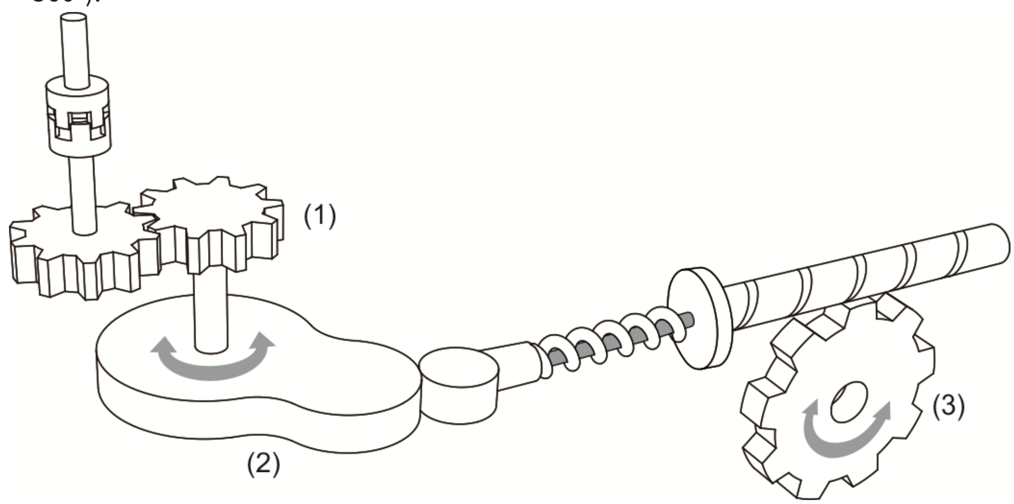


Figure 7-82 E-Cam system status

7.3.3 - E-Cam gears and curve scaling

In the E-Cam system, two sets of electronic gearing can determine the E-Cam motion, which are electronic gearing of the master axis and electronic gearing of the slave axis. The electronic gearing of the slave axis determines the motion ratio of all motion commands and is determined by P1.044 and P1.045. Changing this electronic gearing ratio will change the E-Cam motion and motion commands in PT and PR modes as well. Therefore, if you need to change the E-Cam curve scaling, changing P1.044 and P1.045 is not suggested. Use P5.019 to scale this electronic gear ratio.

The electronic gearing of the master axis is only for the E-Cam system and can change the pulse command resolution of the master axis. The Master axis E-Gear parameters are P5.083 and P5.084. When the slave axis receives the pulse number defined by P5.084 from the master axis, E-Cam rotates the number of cycles defined by P5.083 (one cycle of E-Cam = rotate from 0° – 360°).



(1) Electronic gearing of master axis: P5.083 and P5.084 for command pulse resolution. This is how many pulses you want to have for one E-Cam cycle.

(2) Electronic gearing curve: P5.019 for scaling

(3) Electronic gearing of slave axis: P1.044 and P1.045 for output signal resolution

Figure 7-83 E-Cam gear ratio

The following example illustrates how the command resolution is adjusted: assume that the original master axis pulse number for one cycle is 10000 pulses as shown in Figure 7-84. If this master axis E-Gear ratio becomes larger (P5.084 increases or P5.083 decreases), then the master axis pulse unit corresponds to a narrower E-Cam phase, making the master axis pulse command resolution higher. When the master axis E-Gear ratio becomes smaller (P5.084 decreases or P5.083 increases), the master axis pulse unit corresponds to a wider E-Cam phase, making the master axis pulse command resolution lower. In common applications, P5.083 is set to 1 and P5.084 is for specifying the required master axis pulse number for the E-Cam to operate one cycle. If the required master axis pulse number has decimal places, you can adjust the value of P5.083. For example, when the required master axis pulse for operating one cycle is 517.5, you can set P5.083 to 2 and P5.084 to 1035.

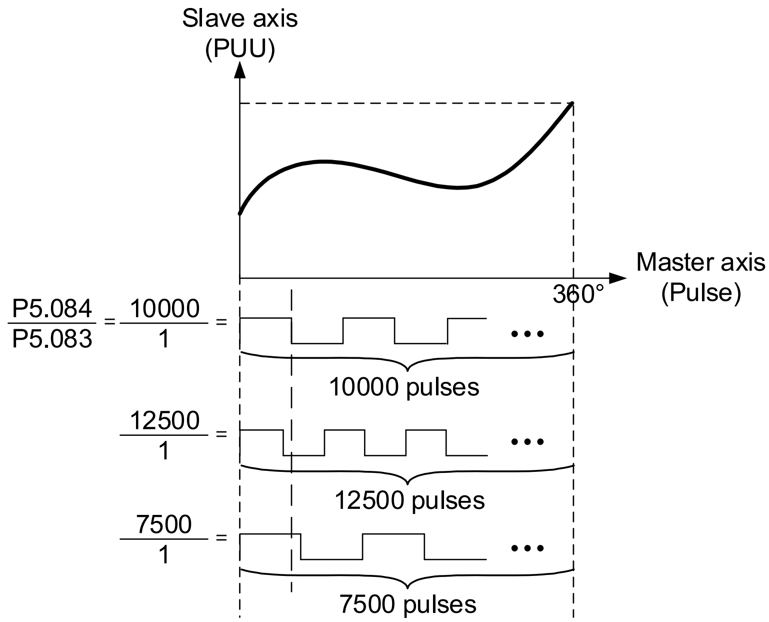


Figure 7-84 E-gear ratio for E-Cam

To change the slave axis motion path proportionally in E-Cam applications, it is suggested to use P5.019 to scale the E-Cam curve. This parameter is only effective to the E-Cam system and does not affect other motions in the servo system. As shown in Figure 7-85, if P5.019 = 2, the output curve of the slave axis is two times of the original. If P5.019 = 0.5, the output curve of the slave axis is 0.5 times of the original. If P5.019 = -1, the positive and negative outputs of the slave axis are reversed.

P5.088.X Bit 2 can specify the effective timing for the E-Cam curve scaling with the options of taking effect immediately and after clutch re-engagement. For example, after adjusting the cutting length in flying shear applications, you can use this parameter to determine when to make the modified E-Cam curve scaling take effect. If the clutch is set to remain engaged and modifying the cutting length is required, set P5.088.X Bit 2 to 1 (modified E-Cam curve scaling is effective immediately).

WARNING: Do not modify P5.088 during cutting, or the machine might be damaged.

If you set P5.088.X Bit 2 to 0 to have the modified E-Cam curve scaling take effect upon the next engagement, then the cutting length changes upon the next clutch engagement. For details about flying shear applications, refer to Section 7.3.8.

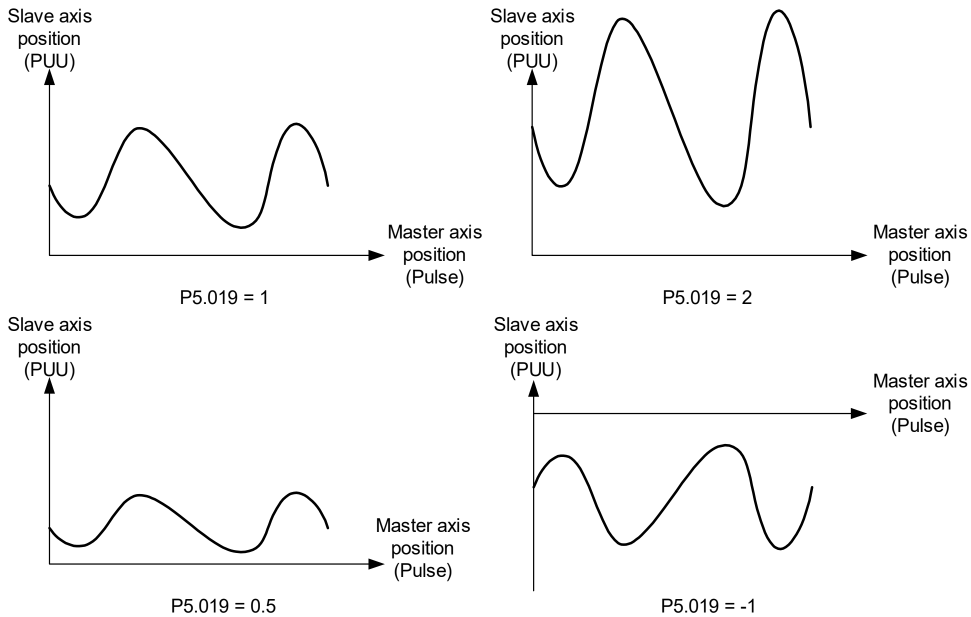
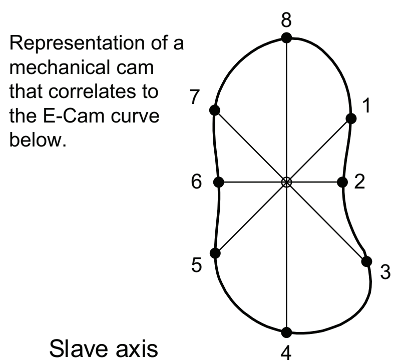


Figure 7-85 E-Cam curve scaling

7.3.4 - E-Cam curve

E-Cam curve is created by the mathematic function based on positions of the master and slave axes. There are various ways to create the table. You can use other 3rd party mathematic tools (software) or use the tabulation interface for industry-specific applications provided in SureServo2 Pro in the E-CAM editor window. Regardless of the tabulation methods, the software coverts the mathematic function into position data and stores them in the data array. To enter an E-Cam table made from 3rd party software, right-click on the Cam table in the E-Cam Editor window in SureServo2 Pro and select "Import Points". One E-Cam curve can have up to 721 sets of data (divided 720 times). It means the highest resolution is 0.5 degrees. As long as the total point number is within the data array's maximum 800, the array can store multiple E-Cam curves. The slave axis curve between two data points will be interpolated with a cubic curve to smooth the motion at each point.

See Figure 7-86 for example. If using E-Cams to replace mechanical cams, divide the mechanical cam into several segments. The more the segments, the higher the precision. In this example, the cam is divided into 8 segments, and each interval is 45 degrees (this is for reference only; you need to delicately segment the cam in the actual application, or the path will be distorted). Then, enter the distance between the cam shaft and the points (1 – 8) on the cam edge to the data array. The start point 0 degree and the last point 360 degrees are identical but you must enter both of the two points to the data array so the E-Cam can completely go around the mechanical cam for one cycle. Therefore, you need to enter 9 sets of data to complete the E-Cam curve table.



Point	Data array	
1	#50	30000
2	#51	20000
3	#52	40000
4	#53	45000
5	#54	30000
6	#55	20000
7	#56	20000
8	#57	50000
1	#58	30000

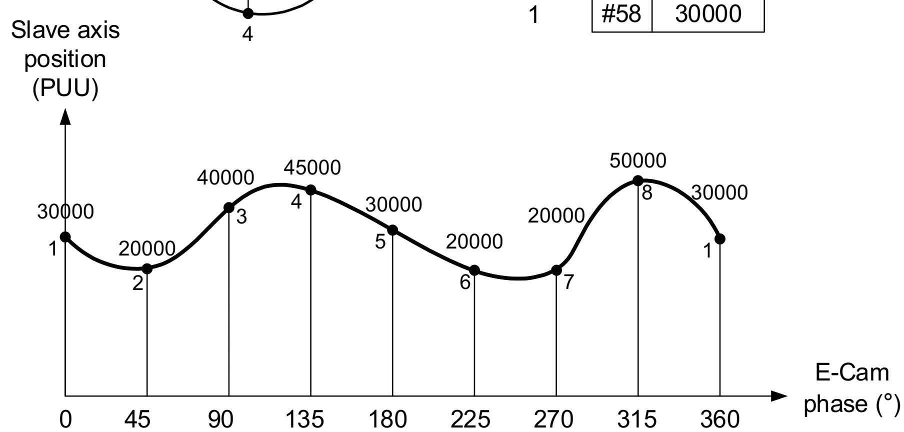


Figure 7-86 Example of creating E-Cam curve table

You can use SureServo2 Pro to create the E-Cam curve. Click **E-CAM** in the software function list and the E-CAM Editor appears, as shown in Figure 7-87.

In the first page of the editing window, select the method to create the E-Cam curve table. There are seven options, [Manual], [Speed Fitting], [Rotary Shear - W/O Sync. Zone], [Rotary Shear - Fixed Sync. Zone], [Rotary Shear - Adjustable Sync. Zone], [Cubic Curve], and [Rotary Shear - Printing Machine].

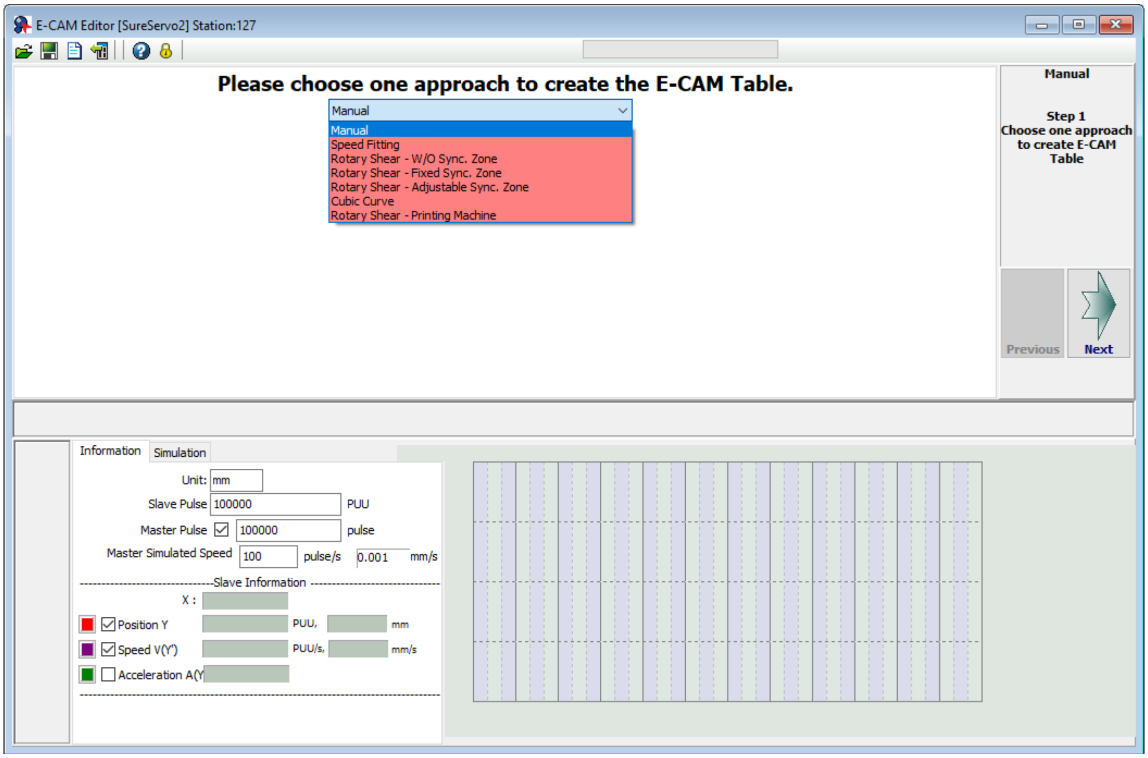


Figure 7-87 SureServo2 Pro E-Cam setting interface

Manual

When you use other software to create the table, the software presents the final results with position data and then imports these data to the table to complete the E-Cam curve. As the example shown in Figure 7-86, the mechanical cams can be replaced by E-Cams. It creates the E-Cam curve by using the angles of the mechanical cams corresponding to the distances between the cam shaft and edge, which is to establish the correlation of the angles and slave axis positions. The setting interface for manually creating E-Cam tables in SureServo2 Pro is shown in Figure 7-88. The following illustrates the steps to manually create the table:

1) Set the E-Cam segment number: an E-Cam can be divided into up to 720 segments (721 points). For a 360-degree cycle, every 0.5 degrees corresponds to a slave axis position. The more the points, the higher the resolution and the more delicate the curve. Appropriately allocate the resources for the curve resolution and data array to set the E-Cam segment number.
2) Create curve table: after setting the E-Cam segment number, click Create Table, and the software equally segments the 360-degree E-Cam and automatically fills in the angle data to the table. When you set n points for the E-Cam segment number, the table has n+1 columns.

3) Fill in the slave axis positions: fill in the corresponding position in PUU for each segment. Click Draw. The software automatically generates a simulated E-Cam curve and cam position, speed, and acceleration curve. When manually creating the table, pay more attention to the speed continuation of the slave axis to avoid machine vibration or motor overload caused by speed discontinuation.
4) Download E-Cam curve: once the E-Cam curve is confirmed, click Download Table to write the E-Cam curve to the data array. If you click Write Table Data to EEPROM, the data array is written to EEPROM and is non-volatile.

NOTE: Unless you write to EEPROM, the E-Cam table is cleared on a power cycle and the E-Cam will not run without an E-Cam table.

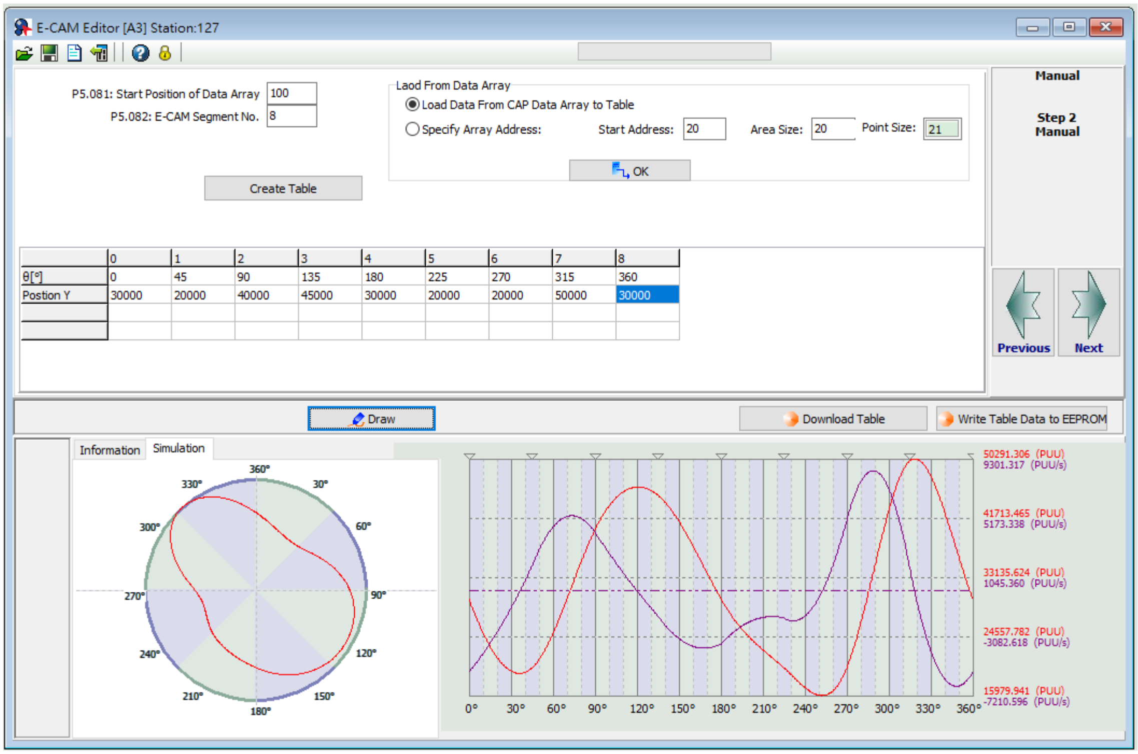


Figure 7-88 SureServo2 Pro Manual setting interface for creating E-Cam table

When using a third-party software (such as Excel) to create the table, save all position data as a text file (.txt) and use the Space, Tab, Enter keys, vertical bar "|", or a comma "," to separate the position data of each point.

If you start the E-CAM Editor in SureServo2 Pro and choose to manually create the table, first specify the number of E-Cam segments (P5.082), and click **Create Table**, then the table displays the E-Cam phase corresponding to the E-Cam segments. Right-click the table, select **Import points**, and then click **Browse** after the window for importing point data appears. Open the text file that has been saved, and select the separator you use in the saved file for **Separate symbol**. Then, click **OK** to complete loading the text file. Next, click **Draw** to have the software generate the E-Cam curve based on the E-Cam positions. You can also export the position data as a text file.

Right-click the table, and select **Batch change the values**, including increment, decrement, addition (+), deduction (-), multiplication (*), division (/), copy, and exchange functions for users to change the E-Cam curve quickly. There are also functions for inserting and deleting single position data on the right-click menu. The setting interface for creating E-Cam tables with a third-party software in SureServo2 Pro is shown in Figure 7-89.

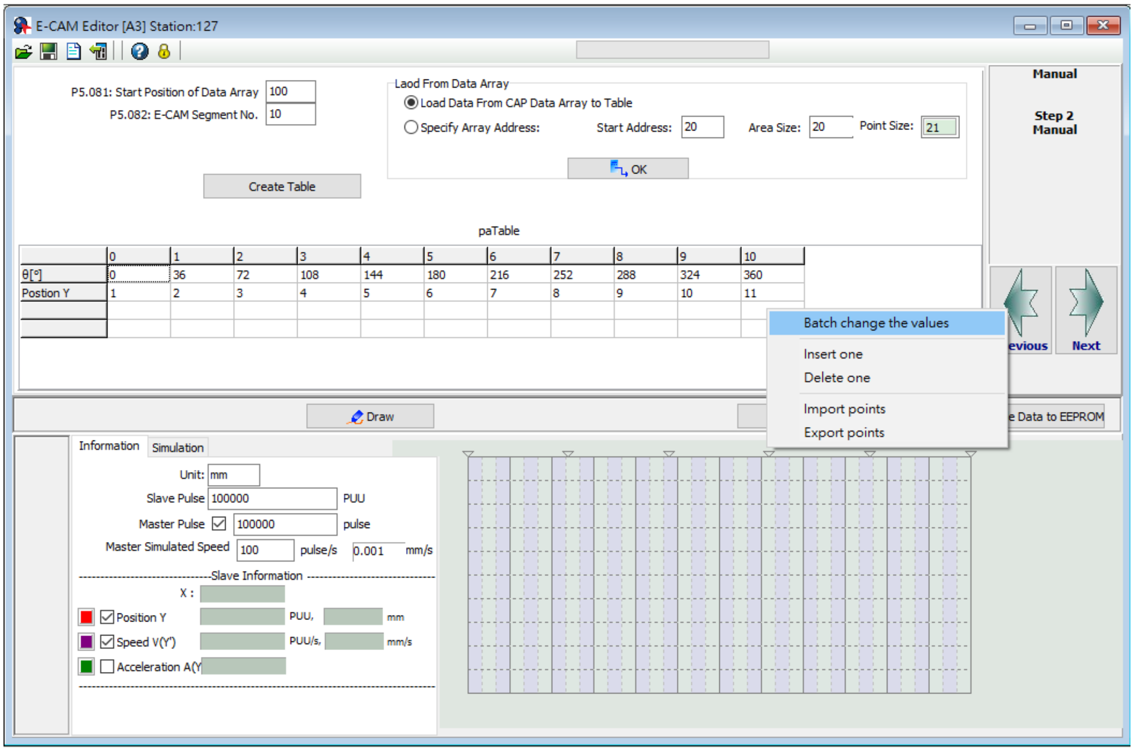


Figure 7-89 Use third-party software to create E-Cam curves

Speed Fitting

When the application requires the motions of both the master and slave axes to keep the same speed or have the same correspondence relations, you can use the speed fitting method to create the E-Cam curve. With this method, the E-Cam cycle is divided into five zones, which are the waiting, acceleration, synchronous speed, deceleration, and stop zones as shown in Figure 7-90. You can adjust the proportion of each zone as needed. All five zones added up must equal 100%. This is 100% of the 360 degree Cam profile.

This E-Cam curve is designed based on the positions. It plans the corresponding speed of the master and slave axes based on the relationship between the position change and speed within a given time. The setting interface for creating E-Cam curves with the speed fitting method in SureServo2 Pro is shown in Figure 7-91. Steps to create the table with the speed fitting method are as follows:

1) Plan the E-Cam curve: determine the proportions of the waiting, acceleration, synchronous speed, deceleration, and stop zones within an E-Cam cycle.
2) Set the total moving distance (lead): set the total moving distance of the slave axis within one cycle in the unit of PUU.
3) Set the S-curve: set smoothness at the transition points of the position curve. The higher the value, the smoother the motor acceleration or deceleration, and the longer the operation cycle. The S-curve setting value is usually the same or smaller than the stop zone point number. See section 6.2.4 for more on S-curve settings.
4) Download E-Cam curve: once the E-Cam curve is confirmed, click Download Table to write the E-Cam curve to the data array. If you click Write Table Data to EEPROM, the data array is written to EEPROM and is non-volatile.

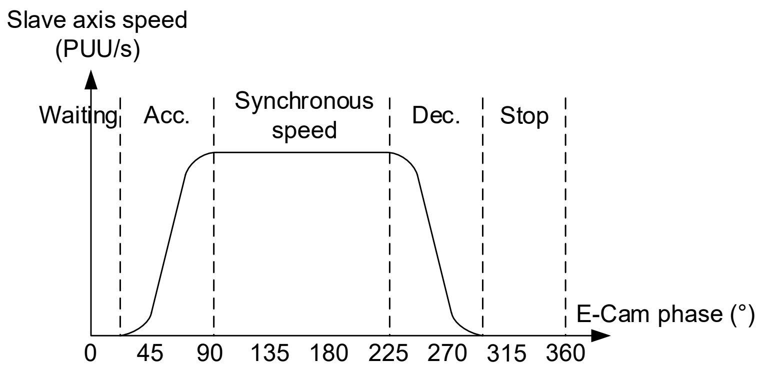


Figure 7-90 Speed fitting zone definition

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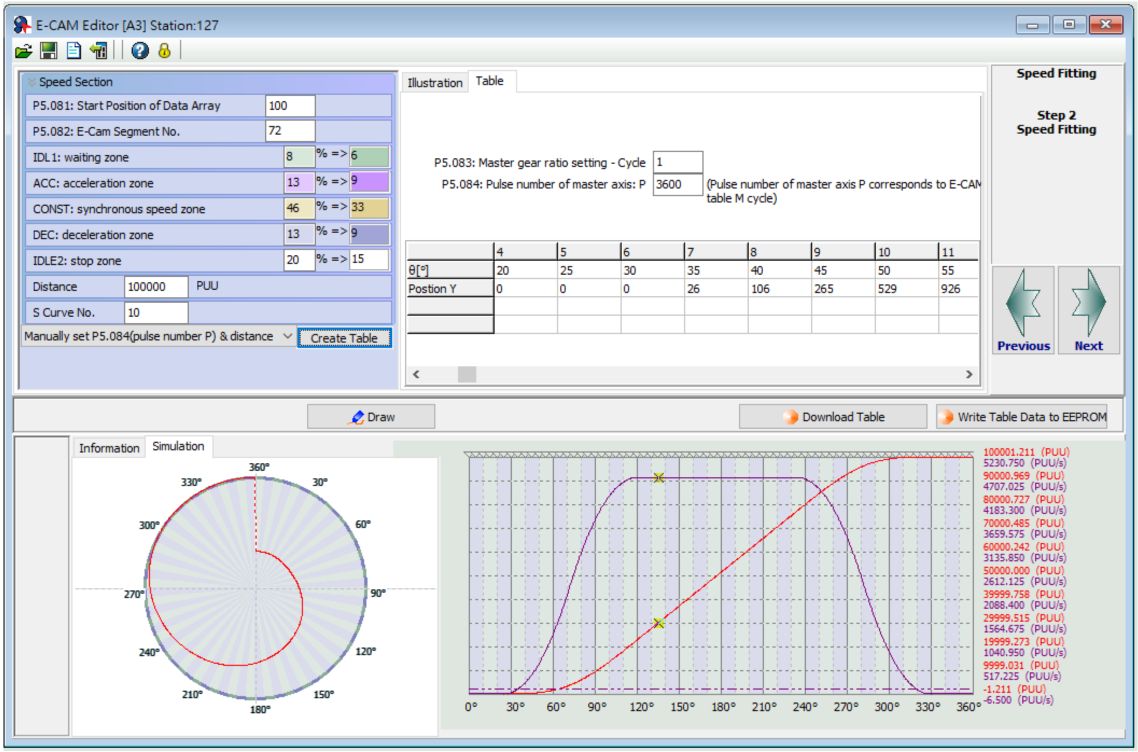

Figure 7-91 SureServo2 Pro Speed fitting setting interface for creating E-Cam table

Cubic Curve

If the master and slave axes operate only based on the corresponding positions, such as the point-to-point relation, you can use the cubic curve method to create an E-Cam curve. If using the cubic curve method to create the table, simply enter the E-Cam phase and the corresponding slave axis positions to have the tabulation tool automatically connect the points and optimize the curve. In some applications, you might need a point-to-point cam motion trajectory such as a constant line or curve, then you can use the cubic curve method to modify the curve, and set the start angle N1 (the angle departing from the start point) and the end angle N2 (the angle arriving at the target point) as needed, as shown in Figure 7-92. There are three types of curves for creating the table:

1) Constant speed: a constant-speed linear trajectory connecting two sets of cam point data; the start and end angles are unadjustable.
2) Uniform acceleration: a uniform incremental or decremental curve in single direction. Only the start angle is adjustable.
3) Cubic curve: the start and end angles are both adjustable. Changing the angles also changes the speed when departing from the start point and arriving at the target point. Note that improper angle setting leads to drastic speed change which causes machine vibration.

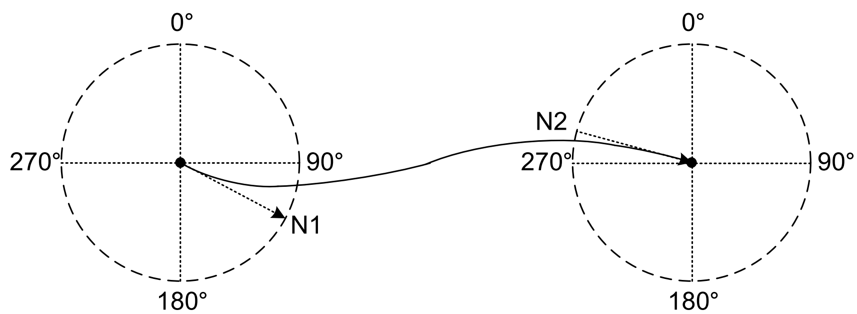

Figure 7-92 Start angle and end angle

Figure 7-93 is the cubic curve setting interface for creating E-Cam tables in SureServo2 Pro. The steps to create the table with the cubic curve method are as follows:

1) Set the E-Cam curve: set the E-Cam phase, slave axis position, curve type, start and end angles in Cubic Data. You can drag the transition points in the cubic curve simulation to change the corresponding data of each point. When you drag, insert, or delete the transition points, the corresponding cubic data contents are promptly changed. However, if you directly enter or select the desired content in the cubic data, you must click Create Cubic Curve to change the cubic curve simulation.
2) E-Cam table setting: when completing the transition point setting, set the sampling angle and click Convert to E-Cam table, so the software will fill in the sampling data to the E-Cam table. The more the sampling points, the more accurate the cam shapes. If the setting value for the slave axis is too small, vibration might occur because the decimal value is rounded off. Use P5.019, E-Cam curve scaling, to keep decimals in the table to reduce zigzags of the curve and generate an E-Cam with higher precision.
3) Download E-Cam curve: make sure the E-Cam curve is correct and click Download Table to write the E-Cam curve to the data array. If you click Write Table Data to EEPROM, the data array is written to EEPROM and is non-volatile.

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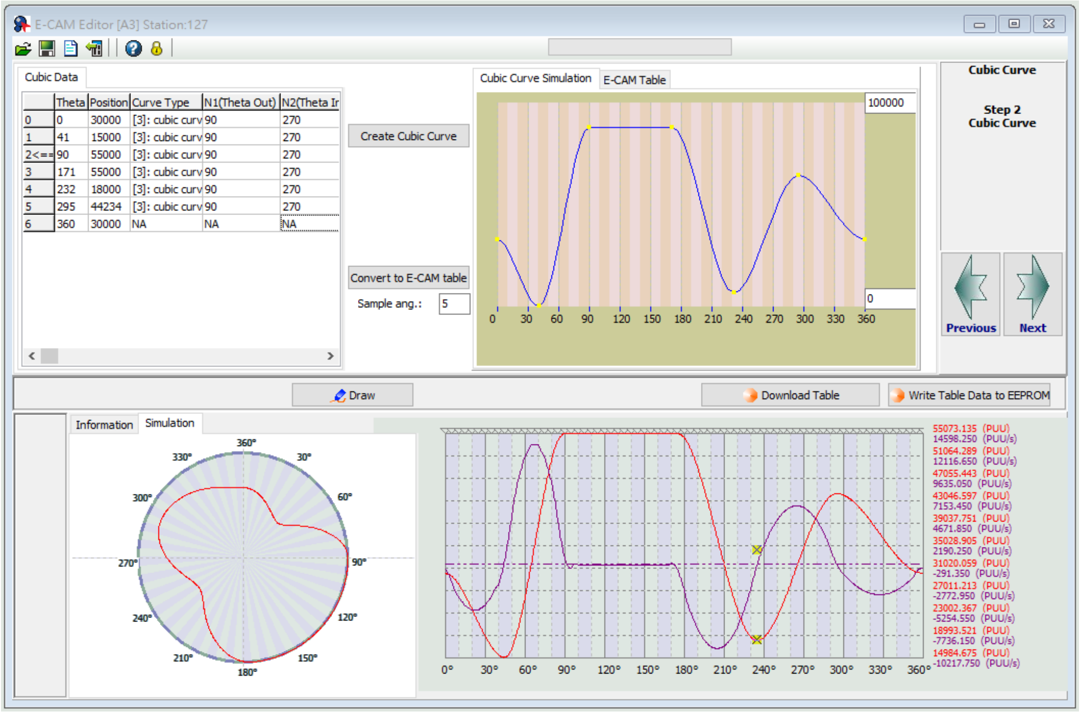

Figure 7-93 SureServo2 Pro Cubic curve setting interface for creating E-Cam table

Create E-Cam table for rotary shear applications

For rotary shear applications, SureServo2 Pro provides three methods for creating rotary shear curves, [Rotary Shear - W/O Syn. Speed Zone], [Rotary Shear - Fixed Sync. Zone], and [Rotary Shear - Adjustable Sync. Zone]. The only difference between these methods is the synchronous speed zone for the master and slave axes, which is adjusted based on the types of the machining cutter and motion. [Rotary Shear - Printing Machine] is for creating curves for printing machines. In addition, you can also use macro #7 to create E-Cam curves for the rotary shear. For detailed settings, refer to Section 7.3.7. For more informatoin on Macros, refer to section 7.3.9.

7.3.5 - E-Cam curve and PR command overlapping

When the E-Cam curve is operating, if you trigger a PR path of incremental position command, the E-Cam command is overlapped with the PR command. As shown in the upper part of Figure 7-94, the moving direction of the slave axis is the same as that set in the incremental position command. When the slave axis is moving at 300 rpm and you trigger an incremental position command with the target speed of 200 rpm in the same direction, the slave axis overlaps the PR incremental position command with the E-Cam command and completes the 5000 PUU incremental position command at the target speed of 500 rpm. As shown in the lower part of Figure 7-94, the moving direction of the slave axis is opposite to that set in the incremental position command. When the slave axis is moving at 300 rpm and you trigger an incremental position command with the target speed of 200 rpm in the reverse direction, the slave axis executes the E-Cam command at the target speed of 100 rpm. Then, it resumes the original speed after the incremental position command of -5000 PUU is executed completely.

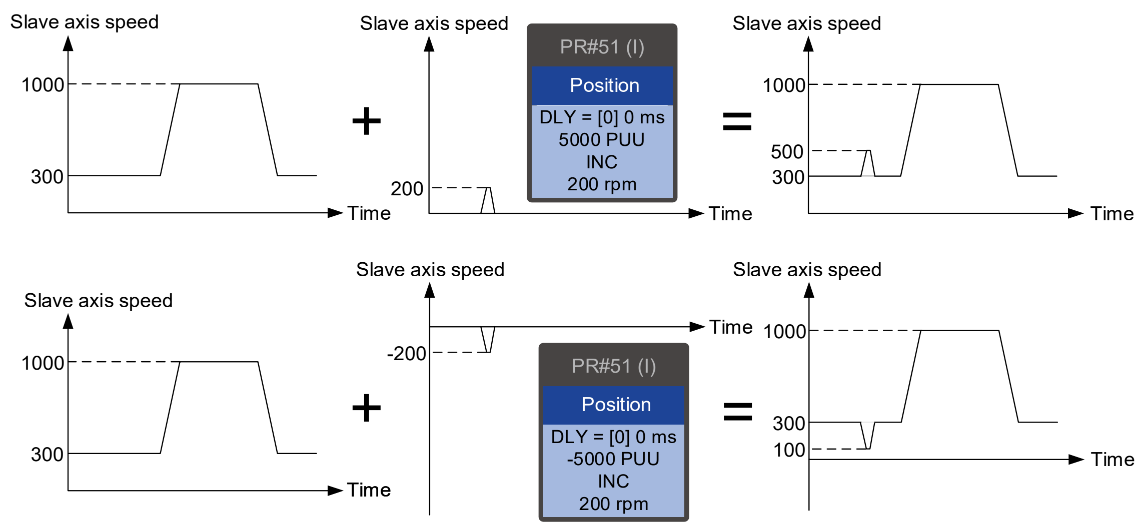

Figure 7-94 Overlapping of E-Cam command and PR incremental position command

To change the E-Cam phase when E-Cam is operating, use the PR incremental position command. Both the phase alignment function and macro for the rotary shear, which align the E-Cam phase, are completed by this command overlapping method. For more about this function, refer to Sections 7.3.7 and 7.3.9.

Take the triple-axis synchronous printing machine shown in Figure 7-95 for example. The material feeder is the master axis sending pulse signals to have the three slave axes operate based on the same E-Cam curve. The pulse bypass feature in P1.074.U allows for a pulse train to come in to one drive and be repeated back out on CN1 (OA, /OA, OB, /OB). Generally, the E-Cam phases of the three axes must be consistent. If inconsistent, use the command overlapping function to correct the E-Cam phase. To shift the phase in the forward direction, set the forward incremental command. To shift the phase in the reverse direction, set the reverse incremental command.

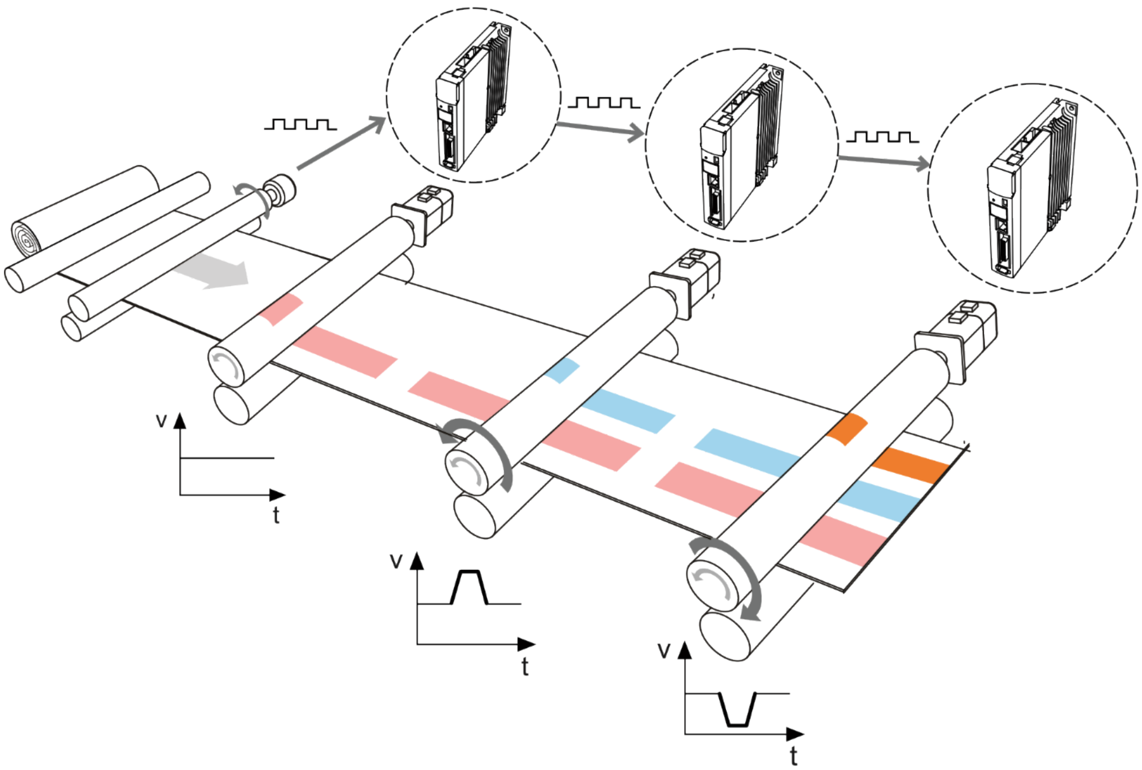

Figure 7-95 E-Cam phase alignment function

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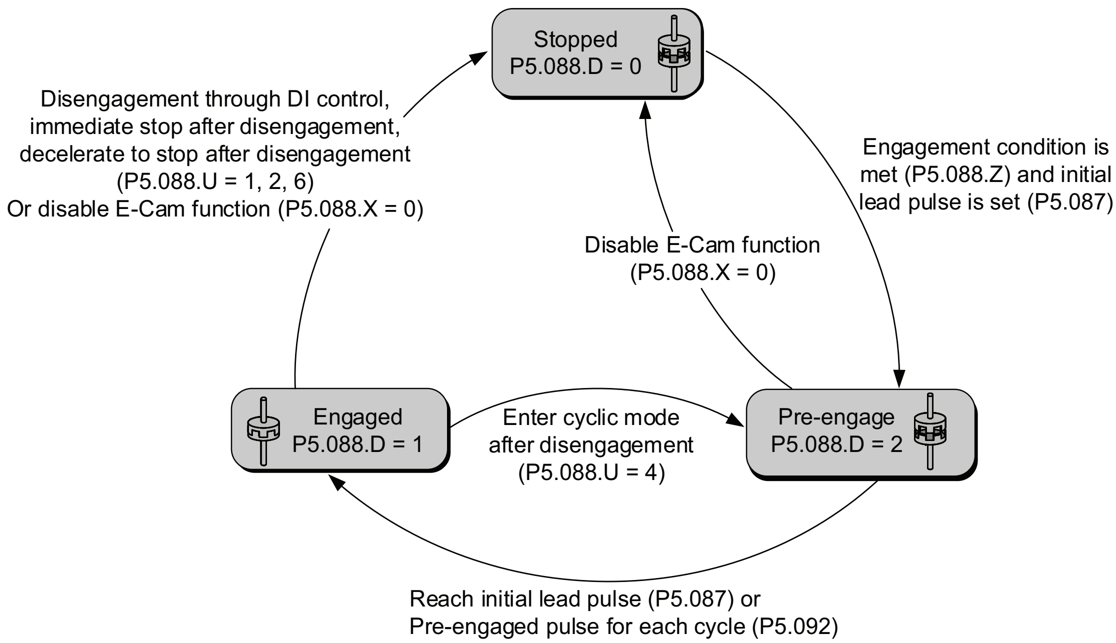
7.3.6 - Troubleshooting for E-Cam

If the E-Cam cannot operate normally, follow these steps to troubleshoot:

1) Servo drive control mode: make sure the control mode is PR mode and the system is in the Servo On state.
2) Pulse source of master axis: check the setting of P5.088.Y for the source of the master axis. Use P5.086 or monitoring variable 059 to read the pulse count of the master axis. If selecting CN1 as the input connector, use P5.018 to monitor the pulse count; if selecting CN5 as the input connector, use P5.017 to monitor the pulse count. Please note that this method is only applicable to the external input. When applying E-Cam function, it is suggested to use signal input externally as the source of the master axis; virtual signal which generates from the servo drive is for testing purposes only.
3) E-Cam curve: read the E-Cam curve data in the data array by opening the High Speed Position window and selecting the Data Array Editor tab, then click Load from Servo. Make sure the E-Cam curve is correct and check the settings for P5.081 (the start address of the E-Cam data array) and P5.082 (E-Cam segment number). The total number of points of E-Cam is the value of P5.082+1. If incorrect, the system is unable to carry out the setting of every point on the E-Cam curve. If the data is not written to EEPROM, then the data is lost on power cycle.
4) E-Cam gear ratio and scaling of E-Cam curve: check the master axis E-Gear ratio (P5.084 / 5.083) and the slave axis E-Gear ratio (P1.044 / P1.045). Check the E-Cam curve scaling (P5.019). If the proportion is set too small, the motor operation is too subtle to be monitored even when E-Cam is operating. In this case, use the scope in the SureServo2 Pro to see if the motor is slightly rotating.
5) Clutch status: read P5.088.D to obtain the current status of the clutch.
   If P5.088.D = 0, it means the clutch is disengaged. Check the engagement setting (P5.088.Z). If P5.088.D = 1, it means the clutch is engaged and the slave axis operates based on the pulses from the master axis. If the disengagement condition is determined by the DI (P5.088.U = 1), check the timing for triggering the DI to on and off. If the disengagement condition is set to “Immediate stop after disengagement” (P5.088.U = 2) or “Decelerate to stop after disengagement” (P5.088.U = 6), check the pulse number of disengaging time (P5.089).
6) When E-Cam is enabled (P5.088.X = 1), the pulse number count from the master axis can be accessed by P5.086. Its value must be an increasing value. If the value is not increasing, please reverse the pulse direction (not the motor’s operating direction). Value of P5.086 has to be an increasing value; otherwise, E-Cam axis will not be able to operate based on the E-Cam curve.

7) If P5.088.D = 2, it means the clutch is in the pre-engage status. Check the setting for the initial lead pulse before engaged (P5.087). The clutch engages only when receiving the set number of pulses in the forward direction from the master axis. If the received pulses are in the reverse direction, modify the setting according to the master axis pulse source:
   a) Master axis pulse source: change the encoder output polarity for the servo drive (P1.003).
   b) Master axis pulse input from CN5: change the auxiliary encoder feedback direction (P1.074.Z).
   c) Master axis pulse input from CN1: directly modify the wirings by exchanging the wirings for the A and B phase signals.



7.3.7 - Rotary Shear

The rotary shear system is a system that combines the material feeder and cutter; the cutter cuts simultaneously when materials are fed as shown in Figure 7-96. Similar systems are widely used in different applications, such as cutting machines, printing machines, and packing machines. In this example, the material feeder is the master axis in the E-Cam system. When the master axis operates, it simultaneously sends pulse commands to the slave axis (cutter).

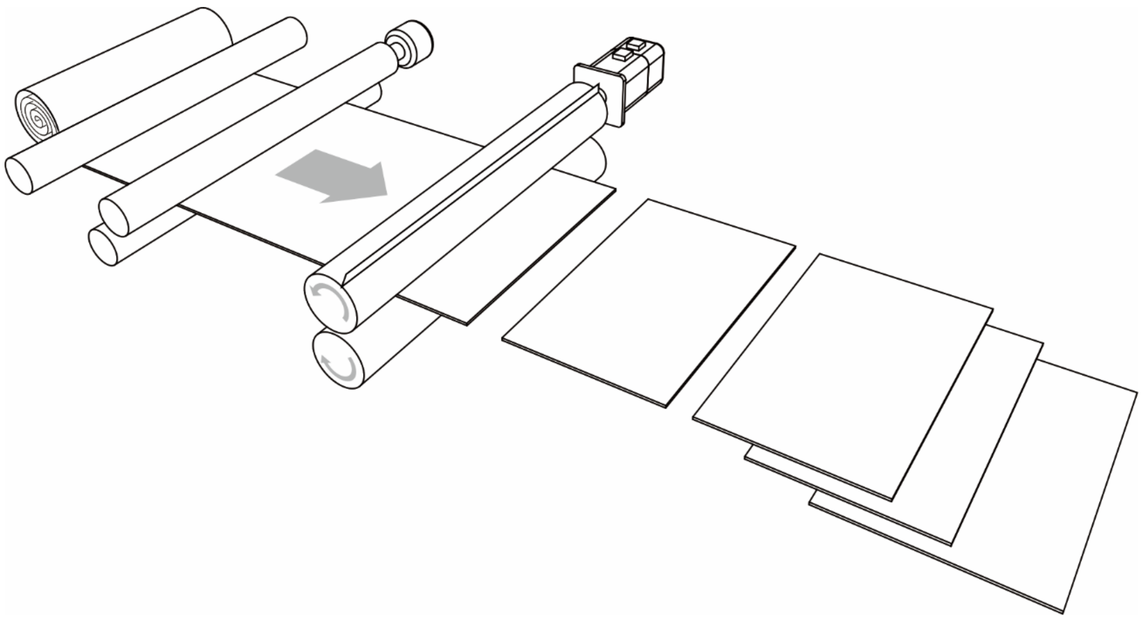
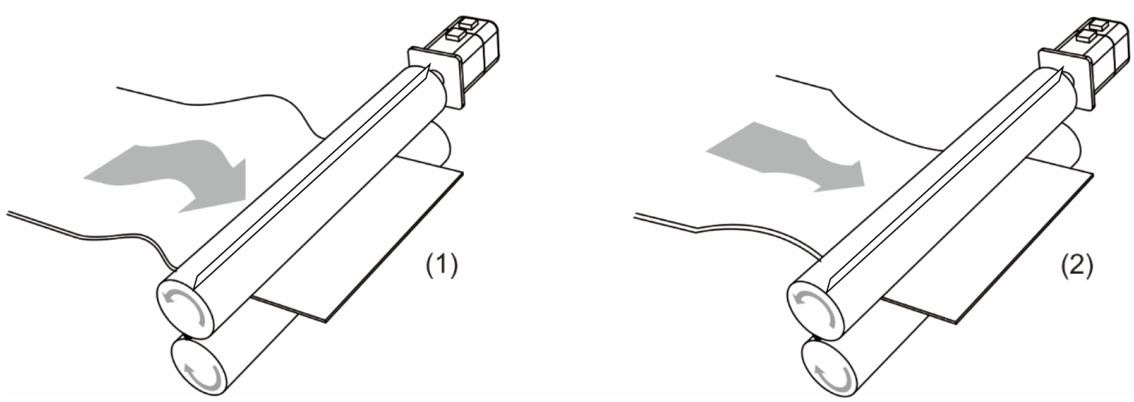


Figure 7-96 Rotary shear system - cutting machine

Apart from the requirement for calculating the correct cutting length, the operation speeds of both the material feeder and cutter have to be the same during cutting. This stage in the E-Cam curve is called the synchronous speed zone. During cutting, if the material feeder runs too fast, the material might be crushed or piled in front of the cutters, as shown in Figure 7-97 option (1).

If the feeder runs too slow, the cutter might over-stretch the material, causing the distortion of the material as shown in Figure 7-97 option (2).



(1) Material feeder runs too fast; (2) Material feeder runs too slow

Figure 7-97 Inconsistent speed in synchronous speed zone for cutting machine operation

E-Cam curve

In the E-Cam curve for the rotary shear system, apart from the requirement that the cutter cuts at the right position, it is important that the master axis and slave axis run at the same speed, which means the relative speed is zero, so the the materials are not over-stretched when cutting. In terms of cutters, wider cutters require larger synchronous speed zone (as shown in Figure 7-98). These wider cutters can be heat sealers or jaw/crimp cutters. The proportion of this zone is determined by the cutting length instead of the cutter width, as shown in Figure 7-99.

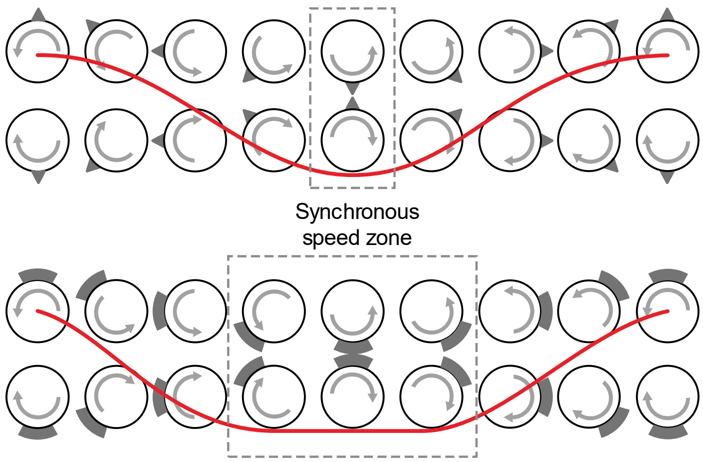


Figure 7-98 Cutter type and synchronous speed zone

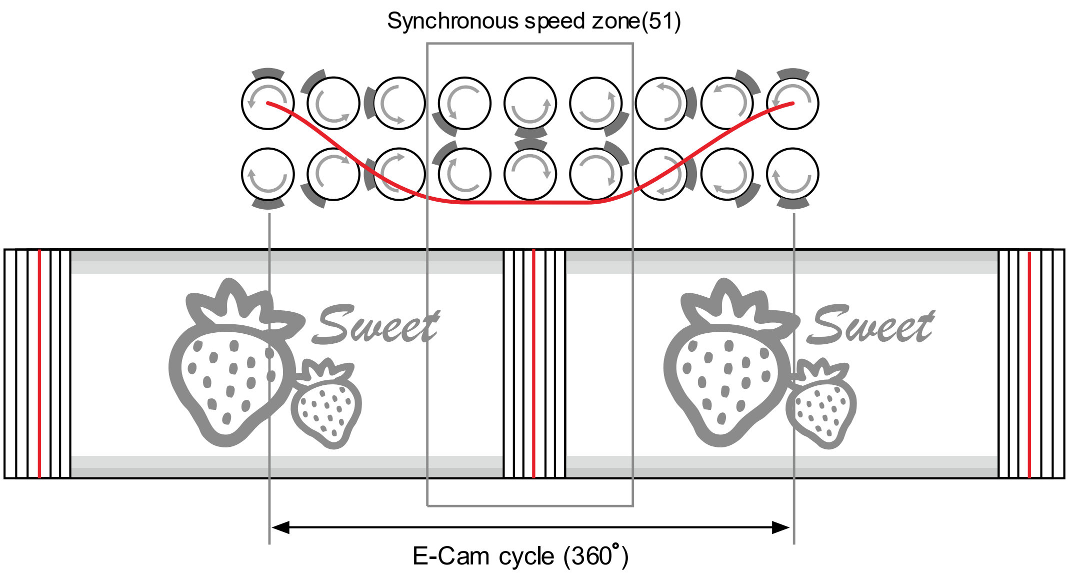
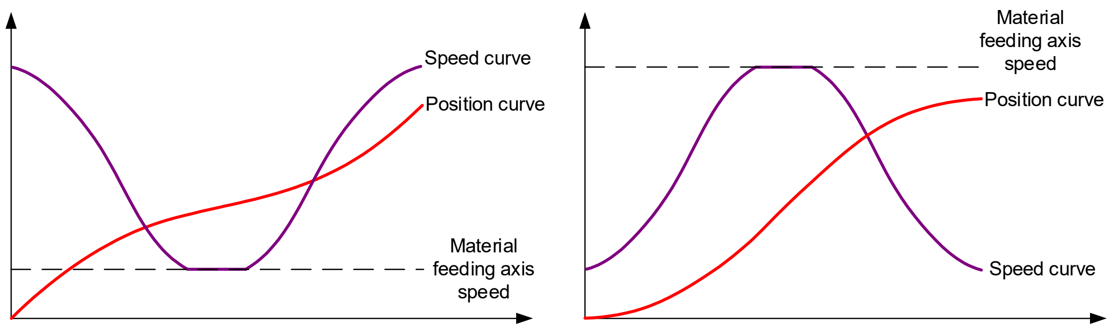


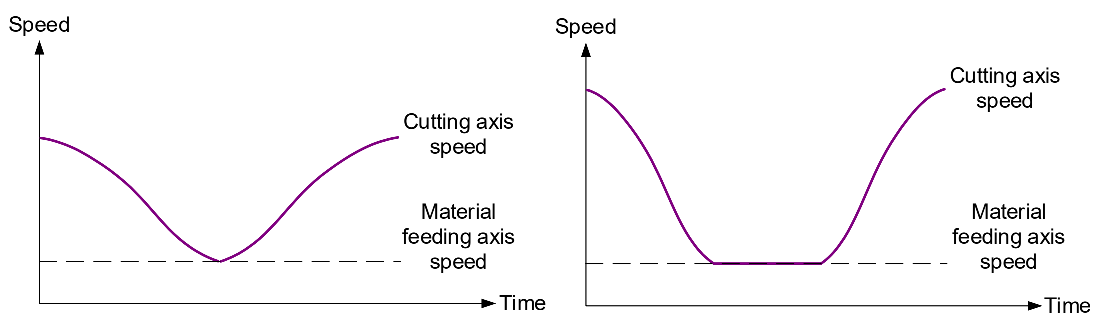
Figure 7-99 Definition of synchronous speed zone

For E-Cam curves used in the rotary shear applications, apart from the requirements of synchronous speed and fixed length, the speed has to be stable. The arc length between cutter ends (Figure 7-103) and the cutting length proportion will determine the speed variation. The larger the value, the greater the variation. If each arc length between cutters is longer than the cutting length, the motor speed is faster than the master axis before entering the synchronous speed zone. So, the motor needs to decelerate to the master axis speed, as shown in Figure 7-100 (a). If the arc length between cutters is shorter than the cutting length, the motor speed is slower than the master axis before entering the synchronous speed zone. Therefore, the motor needs to accelerate to the master axis speed, as shown in Figure 7-100 (b).



(a) Arc length between cutter ends > cutting length
(b) Arc length between cutter ends < cutting length
Figure 7-100 Correlations between the cutting length, speed, and arc length between cutter ends

You can adjust the cutting length by changing the cutter rotation speed. However, the larger the synchronous speed zone, the less flexibility to adjust the cutting length. As shown in Figure 7-101, the cutting length is the same, meaning the rotation distances of the pointed cutter and wide blade cutter are the same (measure of the speed curve area). When you use a wide blade cutter, the non-synchronous speed zone is larger and requires an abrupt acceleration or deceleration, which may easily make the motor reach the maximum torque limit. When the cutter cannot cut the material with a shorter length due to the cutter speed or the maximum current limit, increase the cutter number to shorten the operation distance per cutting, making the cutter slower and the current output lower.

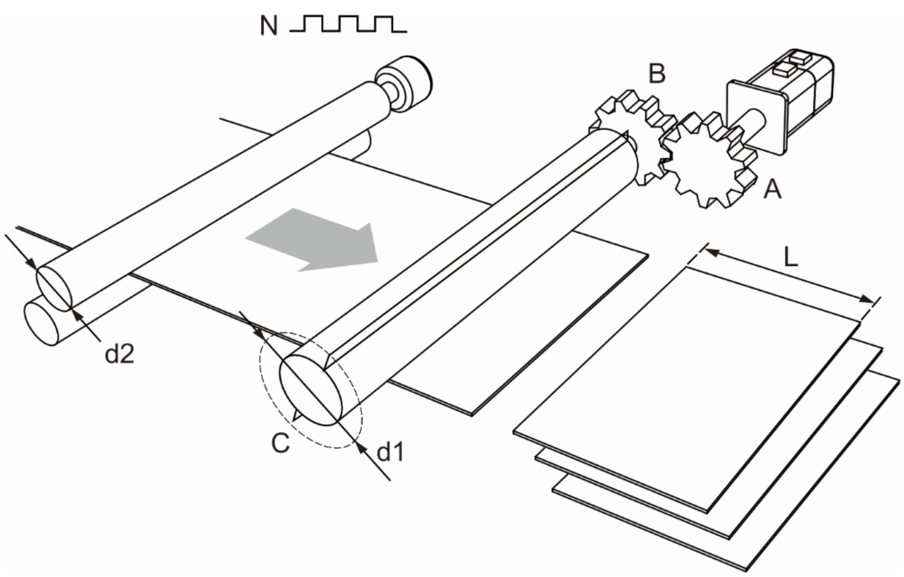


(a) Pointed cutter (small synchronous speed zone)
(b) Wide blade cutter (large synchronous speed zone)
Figure 7-101 Size of the synchronous speed zone and motor speed

To avoid drastic speed change during operation, when plotting the system, take the arc length between cutter ends, cutting length, and the synchronous speed zone into consideration. The synchronous speed zone is fixed based on the machining requirements for the materials; whereas the cutting length is determined by the acceleration and deceleration zones. Therefore, in addition to the cutter diameter, the cutter number can determine the speed and alleviate the speed variation caused by the acceleration or deceleration of the motor, which makes the system operation smoother. You can also use a lower power motor to have a more cost-effective servo system.

Create an E-Cam curve

You can plot the E-Cam curve for the rotary shear system through SureServo2 Pro or macros (see section 7.3.9)of the servo drive. There are four methods available to create E-Cam curves for rotary shear applications. [Rotary Shear - W/O Sync. Zone], [Rotary Shear - Fixed Sync. zone], and [Rotary Shear - Adjustable Sync. Zone] are designed for common rotary shear applications. The differences among the three are whether there is a synchronous speed zone and whether this zone is adjustable. [Rotary Shear - Printing Machine] is specially designed for creating curves for printing machines. Two macros provided by the servo drive are available for creating E-Cam curves. Macro #6 can create E-Cam curves with fixed synchronous speed zone and Macro #7 can create E-Cam curves with adjustable synchronous speed zone for rotary shear applications. The required setting parameters and the rotary shear mechanical structure are shown in Figure 7-102.



N: pulse number per encoder revolution
A: gear teeth number of the motor
B: gear teeth number of the cutter
L: cutting length
C: number of cutters
d1: cutter diameter
d2: encoder roller diameter

Figure 7-102 Example application of a rotary shear

Create E-Cam curves without synchronous speed zone

This kind of E-Cam curve is only suitable for applications using pointed cutters and can only be created by SureServo2 Pro. The setting interface is shown in Figure 7-104. The specification settings labeled in Figure 7-102 for the rotary shear are as follows:

1) Gear teeth ratio: set the gear teeth number of the motor (A) and gear teeth number of the cutter (B).
2) Number of cutters (C): set the cutter number based on the rotary shear mechanism.
3) Cutter diameter (d1): set the cutter diameter based on the rotary shear mechanism. The cutter radius is the distance from the cutter shaft center to the cutter end; the cutter diameter is two times of the cutter radius. This value does not change with the cutter number and the software will calculate the circumference drawn by the cutter end.
4) Encoder roller diameter (d2) and encoder pulse number (N): set the diameter and pulse per encoder revolution. The command resolution can be calculated with these two values.
   If you know the master axis gear ratio, entering the encoder diameter and pulse number are not required. You can simply input the values for P5.083 and P5.084.
5) PUU number per motor revolution: set the PUU number per motor revolution (slave axis) after being calculated with the E-Gear ratio (P1.044 / P1.045).
6) Cutting length (L): set the material cutting length. To avoid generating an unsuitable rotary shear curve, the software automatically limits the cutting length by referring to the ratio (R) of the cutting length (L) and the arc length between cutter ends (a); R = L / a; R = 0.3 – 3.

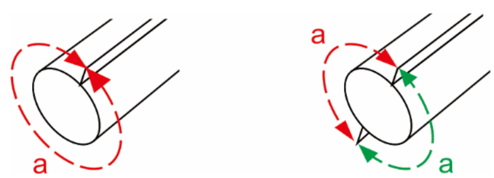


Figure 7-103 Arc length between cutter ends

7) Speed compensation (Vc): in some rotary shear applications, the speeds of the master and cutter axis are different during cutting; so you can use speed compensation to change the speed of the cutter axis. In the cutting zone, if the speed compensation value is positive, the cutter axis speed is faster than the master axis; if the speed compensation value is negative, the cutter axis speed is slower than the master axis.

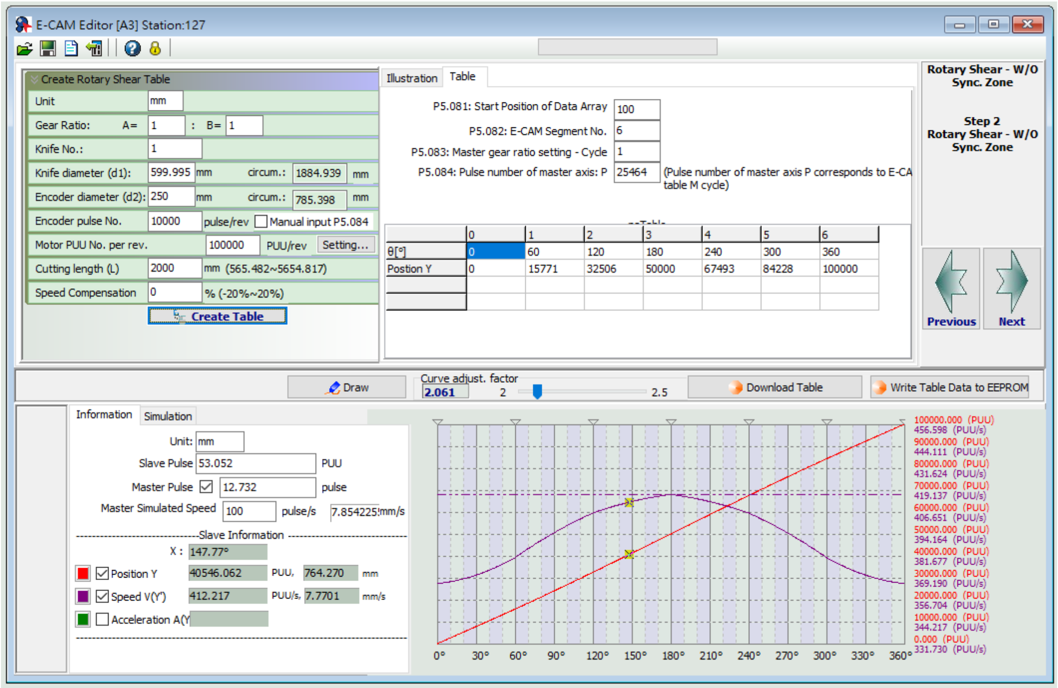


Figure 7-104 SureServo2 Pro setting interface for [Rotary Shear - W/O Sync. Zone]

Create E-Cam curve with fixed synchronous speed zone

This method allows you to create a rotary shear curve with fixed synchronous speed zone, which range is fixed to 51°. You can use SureServo2 Pro to create the table, which parameter setting is similar to the curve for rotary shears without synchronous speed zone, as shown in Figure 7-105. The software automatically limits the cutting length by referring to the ratio (R) of the cutting length (L) and the arc length between cutter ends (a); R = L / a; R = 0.07 - 2.5.

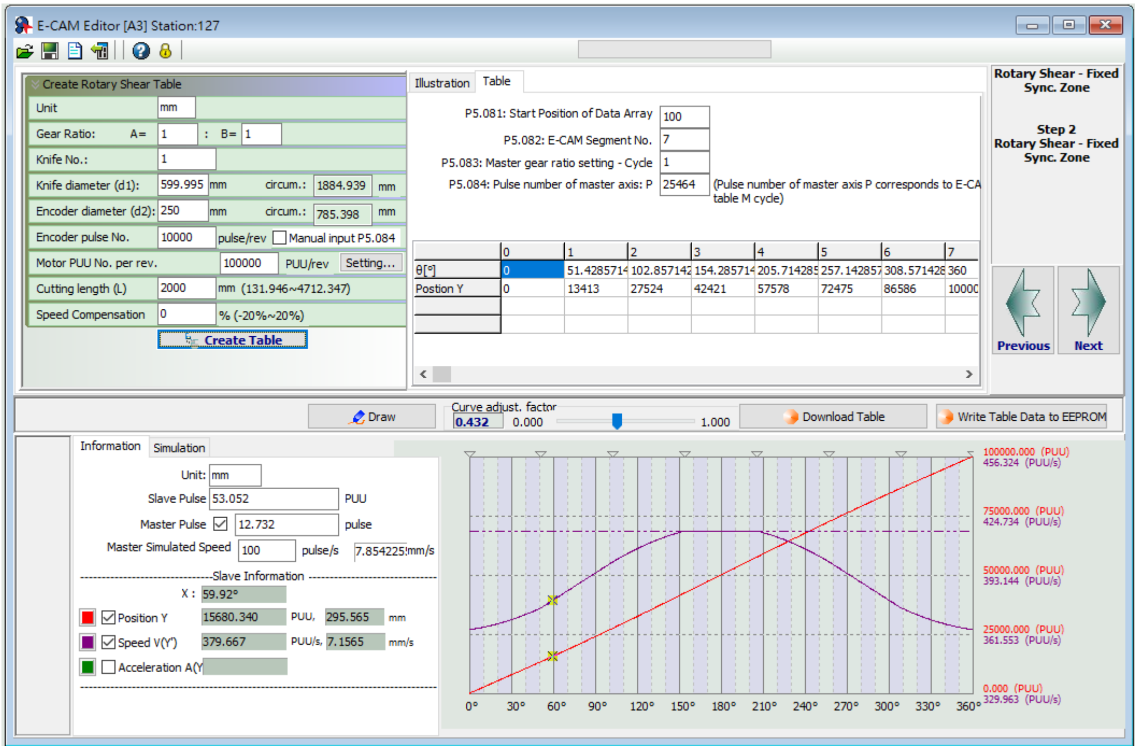


Figure 7-105 SureServo2 Pro setting interface for [Rotary Shear- Fixed Sync. Zone]

Create E-Cam curve with adjustable synchronous speed zone

This table creation method is for generating an E-Cam curve with adjustable synchronous speed zone. Use SureServo2 Pro to create the table. The parameter setting for the rotary shear curve is similar to the setting of that without the synchronous speed zone, as shown in Figure 7-106. The software automatically limits the cutting length by referring to the ratio (R) of the cutting length (L) and the arc length between cutter ends (a); R = L / a.

1.88 > R × Speed compensation (V_C).

The difference from the rotary shear curves without the synchronous speed zone is you can plot the acceleration, synchronous speed, and S-curve zones for the curves with adjustable synchronous speed zone. If the deceleration zone size is the same as the acceleration zone, the software defines the remaining part as the waiting zone.

Figure 7-106 SureServo2 Pro setting interface for [Rotary Shear - Adjustable Sync. Zone]

You can use Macro #7 of the servo drive to create the table with the same method. The advantage of using the macro to create an E-Cam curve is that when changing the cutting length is required, you can create a new curve simply by modifying the parameters. It is very friendly for those applications that require frequent modification of the cutting length. The setting steps are as follows:

1) Set the start position for the data array: use P5.081 to specify the data array start position for E-Cam and use P5.085 to set the E-Cam's segment number for clutch engagement. When using Macro #7, the range for the number of allowed E-Cam segments (P5.082) is 30–72. It is suggested to set number of segments to 72 for the optimal resolution of 5°.
2) Set the system E-Gear ratio: set the system E-Gear ratio with P1.044 and P1.045.

3) Set the E-Cam's gear ratio and curve scaling: set the pulse number required for the cutting length, which is P5.083 = 1 and P5.084 =

$$\frac{\text{Pulse number per turn of the master axis encoder } N}{\pi\ x \text{ master axis encoder diameter } d2 \text{ (mm)}}\ x \text{ Cutting Length L (mm)}$$

Use P5.019 to specify the E-Cam curve scaling.

4) Set the parameters for the E-Cam curve zones: specify the size of the waiting, acceleration, synchronous speed, and S-curve zones.
   - *P5.093.DCBA sets the S-curve level (S) with the range of 1 - 4; the calculation for the corresponding angle (S°) is as follows.*
   - *P5.093.UZYX sets the angle (W) of the waiting zone with the range of -1° to 170° in hexadecimal. If you enter -1 (0xFFFF), it means the cutter speed is 0 in the waiting zone and the angle for the waiting zone is calculated by the servo drive.*
   - *P5.094 sets the angle (Y) of the synchronous speed zone with the range of 0° - 330° in decimal format.*
   - *The acceleration zone is automatically calculated by the servo drive, as shown in the following formula:*

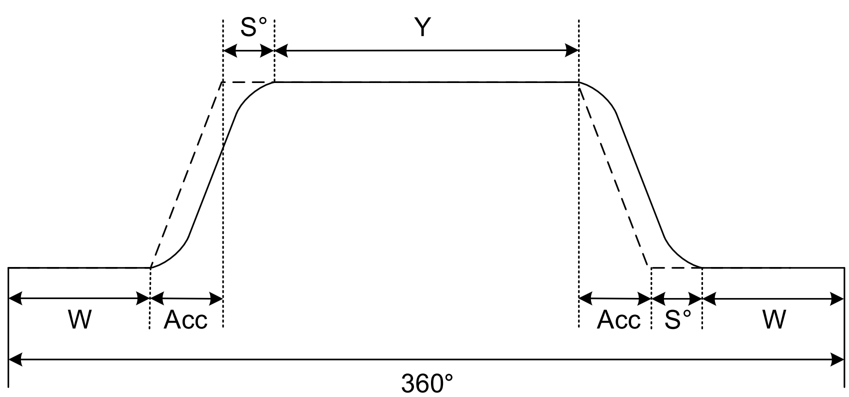
$$S° = \frac{2^S \text{ x } 360°}{\text{E – Cam total segment number } P5.082}$$

$$360° = 2W + 2Acc + 2S° + Y$$

As the synchronous speed zone is adjustable, there are limitations when using Macro #7 to create the waiting zone of the E-Cam curve. The conditions are as follows:

$$\hat{W} \text{ (minimum waiting zone)} = 180° + \frac{360°}{P5.082} - \frac{360°}{R} + \frac{Y}{2}$$

If the waiting zone (W) < minimum waiting zone (Ŵ), the error 0xF07A occurs, and you must increase the waiting zone or decrease the synchronous speed zone. If the waiting zone (W) = minimum waiting zone (Ŵ), the cutter speed is 0 at the waiting zone. If the waiting zone (W) > minimum waiting zone (Ŵ), the cutter axis speed is greater than 0 at the waiting zone.



5) Set the parameters for creating the E-Cam curve table (refer to Figure 7-102):
   - *P5.095.DCBA = Motor gear teeth number (A) cutter number (C) in decimal format.*

- *P5.095.UZYX = Cutter gear teeth number (B) in decimal format. For example, if the motor gear teeth number A = 10, cutter number C = 1, and cutter gear teeth number B = 1, then P5.095 = 0x000A0001 (HEX), but since the parameter only accepts decimal format, you need to set P5.095 to 655361 (DEC); P5.096 =*

$$\frac{\text{Cutting length } L \text{ (mm)}}{\pi \text{ x cutter diameter } d1 \text{ (mm)}} \text{ x Cutter number } C \text{ x Speed compensation } V_c \text{ x } 1000000$$

If Vc = 1, there is no speed compensation. If Vc = 0.9, the speed of the cutter axis in the synchronous speed zone is 0.9 times of the master axis speed. If Vc = 1.1, the speed of the cutter axis in the synchronous speed zone is 1.1 times of the master axis speed.

6) Enable Macro #7: write 0x0007 to P5.097 to enable Macro #7. Read P5.097 and if it returns 0x1007, it means using macro for table creation is successful. If any of the following failure codes shows, modify the setting according to the description.

Failure Code	***Description***
0xF071	When the clutch is engaged, the E-Cam table cannot be created.
0xF072	Degree of synchronous area of P5.094 exceeds the range (0 - 330).
0xF073	S-curve level of P5.093.DCBA (HEX) exceeds the range (1 - 4).
0xF074	Degree of waiting zone of P5.093.UZYX (HEX) exceeds the range (-1 to 170).
0xF075	Data of P5.096 exceeds the range (50000 - 5000000).
0xF076	E-Cam segment number of P5.082 exceeds the range (30 - 72).
0xF077	P5.081 data array start position exceeds the array length.
0xF078	The set values of P1.044 and P1.045 for the E-Gear ratio is too high. Decrease the values of P1.044 and P1.045, but maintain the same ratio, for example: adjust 167772160 : 1000000 to 16777216 : 100000.
0xF079	Acceleration degree is too small. Decrease the value for the waiting zone, synchronous speed zone, or S-curve level.
0xF07A	Waiting zone < minimum waiting zone. Increase the value for the waiting zone or decrease the value for the synchronous speed zone.

The following method helps you to test the maximum border condition and create the E-Cam curve successfully when using the HMI or controller to create the E-Cam table.
If the ratio (R) of the cutting length (L) and the arc length between cutter ends (a) is 0.05 - 1.09 (R = 0.05 - 1.09), and the E-Cam segment number P5.082 = 72, follow the parameter setting procedure to create the table with Macro #7.

1) Set the waiting zone (W) and synchronous speed zone (Y) based on the S-curve level:

S-curve Level (S)	***Range of Waiting Zone (W) and Synchronous Speed Zone (Y)***
1	0° ≤ W ≤ 75°; 0° ≤ Y ≤ 150°
	0° ≤ 2W+Y ≤ 300°
2	0° ≤ W ≤ 70°; 0° ≤ Y ≤ 150°
	0° ≤ 2W+Y ≤ 290°
3	0° ≤ W ≤ 55°; 0° ≤ Y ≤ 110°
	0° ≤ 2W+Y ≤ 220°
4	0° ≤ W ≤ 25°; 0° ≤ Y ≤ 30°
	0° ≤ 2W+Y ≤ 80°

2) Write the corresponding parameters:
   - *P5.093.DCBA = S-curve level (S)*
   - *P5.093.UZYX = Angle of the waiting zone (W) set in hexadecimal.*
   - *P5.094 = Synchronous speed zone (Y); other parameter settings for curve table creation are the same as Step 5 mentioned above. Set P5.097 to 7 to enable Macro #7.*

If the ratio (R) of the cutting length (L) and the arc length between cutter ends (a) is 1.1 - 5 (R = 1.1 - 5), and the E-Cam segment number P5.082 = 72, follow the parameter setting procedure to create the table with Macro #7.

1) Set the S-curve level: use macro parameter P5.093.DCBA to set the S-curve level (S) with the range of 1 - 4.
2) Set the synchronous speed zone: use macro parameter P5.094 to set the angle of the synchronous speed zone (Y). Its angle must be greater than 0. As shown in the following formula, when the synchronous speed zone (Y_{Max}) is less than 0 degree, decrease the S-curve level.

$$Y_{Max} = \frac{360}{R} - 5 \text{ x } (3+2^{s+1}) \geq 0$$

3) Set the waiting zone: use macro parameter P5.093.UZYX in hexadecimal to set the angle of the waiting zone (W). The calculation is as follows.

$$W\ (Hex) = 180 - \frac{180}{R} - \frac{5 \text{ x } (2^{s+1} - 1)}{2}$$

When cutting, if the cutter speed is faster than the material feeder, it means the speed compensation (V_c) is greater than 1. Proceed to Step 4 and re-plan the synchronous speed and waiting zones based on the speed compensation requirements. If the cutter is slower than the material feeder, it means the speed compensation is equal to or less than 1. Proceed to Step 6, set the mechanism related parameters, and enable Macro #7 to complete the E-Cam curve creation.

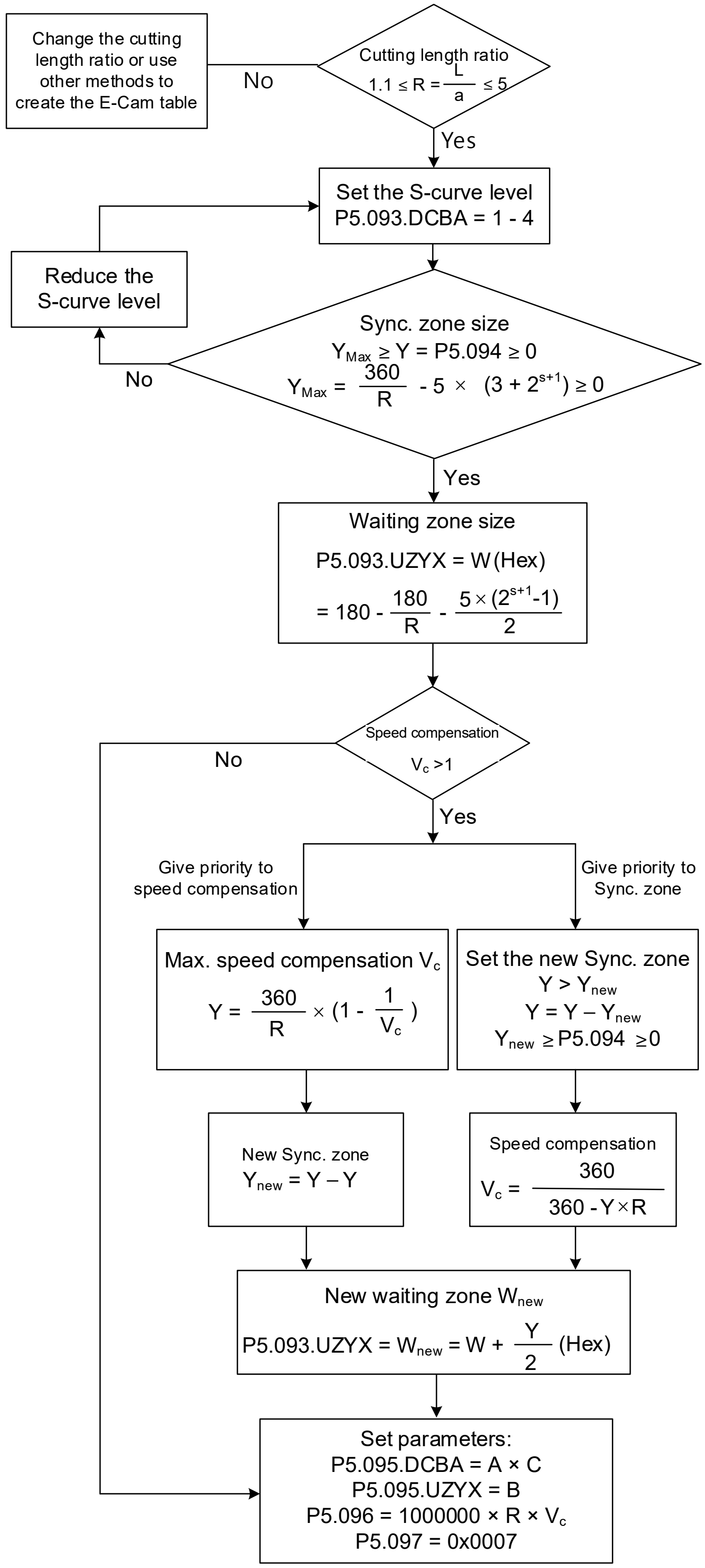
4) Taking adjusting the cutter speed as the priority, set the required maximum speed compensation and use this compensation value to re-calculate the Sync zone (Y_{new}) and the Waiting zone (W_{new}). Taking the Sync zone size as the priority, set the Sync zone (Y_{new}) and use the size of this Sync zone to re-calculate the speed compensation value and the Waiting zone (W_{new}). Refer to the following formulas to calculate the synchronous speed zone and speed compensation value.

Priority	***Calculation 1***	***Calculation 2***
Adjust cutter speed	Use the speed compensation (V_c) to calculate the variation of the Sync zone (ΔY): $\Delta Y = \frac{360}{R} \text{ x } (1 - \frac{1}{V_c})$	New Sync zone size (Y_{new}): $Y_{new} = Y - \Delta Y$
Sync zone size	Use the new Sync zone size (Ynew) to calculate the variation of the Sync zone (ΔY): $Y > Y_{new}$ $\Delta Y = Y - Y_{new}$ Y_{new} P5.094 0	Speed compensation (V_c): $V_c = \frac{360}{360 - \Delta Y \text{ x } R}$

5) Set the new waiting zone size: use the macro parameter P5.093.UZYX in hexadecimal to set the re-calculated waiting zone angle (W_{new}), as shown in the following formula.

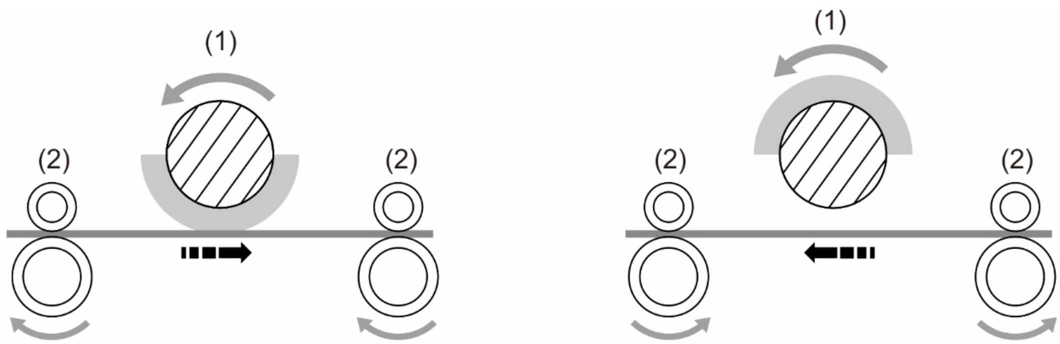
$$W_{new} = W + \frac{\Delta Y}{2}$$

6) Set the parameters related to the mechanism and enable Macro #7: use the macro parameter P5.095.DCBA in hexadecimal to set the motor gear number (A) Cutter number (C). Use the macro parameter P5.095.UZYX in hexadecimal to set the cutter gear number (B). Set P5.096 to 1000000 Ratio of the cutting length and arc length between two cutter ends (R) Speed compensation (V_C). Set P5.097 = 0x0007 to enable Macro #7 to complete the E-Cam curve for the adjustable synchronous speed zone.



Create E-Cam curve for periodic intermittent printer

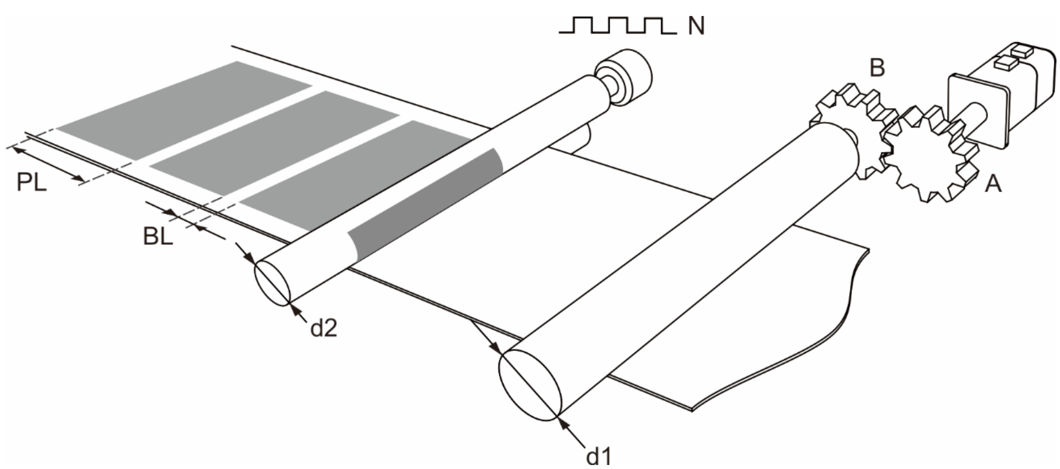
Use this type of E-Cam curve when the printing material length is limited and full print cannot be carried out. This type of curve helps to save the material, decreasing the interval between each print pattern by retracting the material when the printing plate detaches from the material. In the case of paper printing, the printing axis rotates at a fixed speed in a single direction. When the printing plate and paper come into contact, the paper and printing axis starts printing with the same linear speed, as shown in Figure 7-107 (a). Once the printing motion stops and during the interval when the printing plate and paper are separated, the drive roll starts to decelerate and move in the opposite direction until reaching the specified zone, as shown in Figure 7-107 (b). Afterwards, the drive roll resumes operation in the printing direction. When the printing plate and paper come into contact again, the paper and printing axis resume a synchronous relation and make the next print. Regarding the E-Cam curve for intermittent printing machines, the parameters that you must set and the corresponding relation with the printing machine mechanical structure are shown in Figure 7-108.



a) Printing motion b) Retraction motion

1) Printing axis; (2) Drive roll

Figure 7-107 Intermittent printing machine

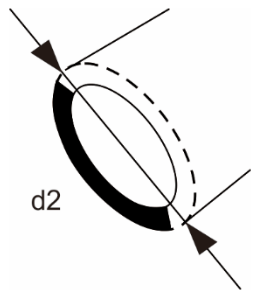


N: number of pulses per printing axis revolution
A: number of gear teeth on motor; B: number of gear teeth on material feeder
PL: print length; BL: blank length
d1: drive roll diameter; d2: printing axis diameter

Figure 7-108 Printing machine mechanical structure

You can create the E-Cam curve table for intermittent printer by using the SureServo2 Pro software. Figure 7-109 shows the user setting interface. The printer specification settings are as follows.

1) Gear ratio: set the number of motor gear teeth (A) and number of material feeder gear teeth (B).
2) Print length (PL) and blank length (BL): set the print length and blank length.
3) Drive roll diameter (d1): set the drive roll diameter for conveying the material.
4) Printing axis diameter (d2) and printing axis pulse number (N): set the diameter of master printing axis and number of pulses per revolution.



5) Number of PUU per motor revolution: set the number of PUU per motor revolution of the drive roll after E-Gear ratio conversion (P1.044 / P1.045).

The ratio of printing axis circumference to printing zone length ($R = \frac{\pi \text{ x } d2}{PL + BL}$) must exceed 1 when using E-Cam curves for intermittent printing machines in order to save the material. Calculate the synchronous speed zone angle with the formula $Y = \frac{PL}{\pi \text{ x } d2} \text{ x } 360°$. You can also adjust the waiting zone angle and S-curve angle in the advanced settings. Increase the angle for the synchronous speed zone to increase the zone size. This ensures the printing axis and drive roll are in the uniform operation speed and stable during printing motions to achieve higher quality printing.

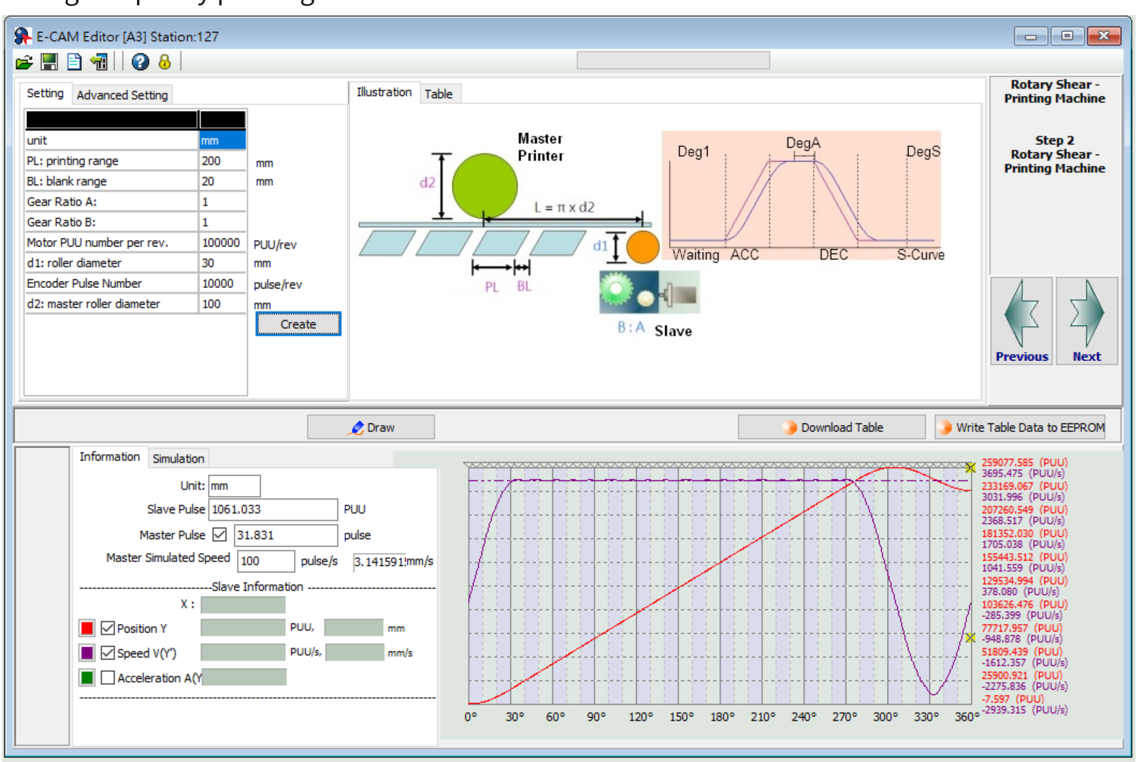


Figure 7-109 SureServo2 Pro rotary shear - intermittent printing machine setting interface

E-Cam phase alignment

The E-Cam phase alignment function is another compensation method provided by the servo drive. You need to first set the phase for the E-Cam phase alignment and the compensation detection position for the external sensor. In each cycle, everytime the E-Cam operates to the detection position of the external sensor, the servo drive starts comparing the actual phase with the correct phase and then calculates the deviation of the slave axis. Then, the servo drive writes this deviation amount to the PR program for immediate or later compensation (user-defined), which is completed with the E-Cam and PR command overlapping function introduced in Section 7.3.5. The compensation mechanism for the E-Cam phase alignment is shown in Figure 7-110.

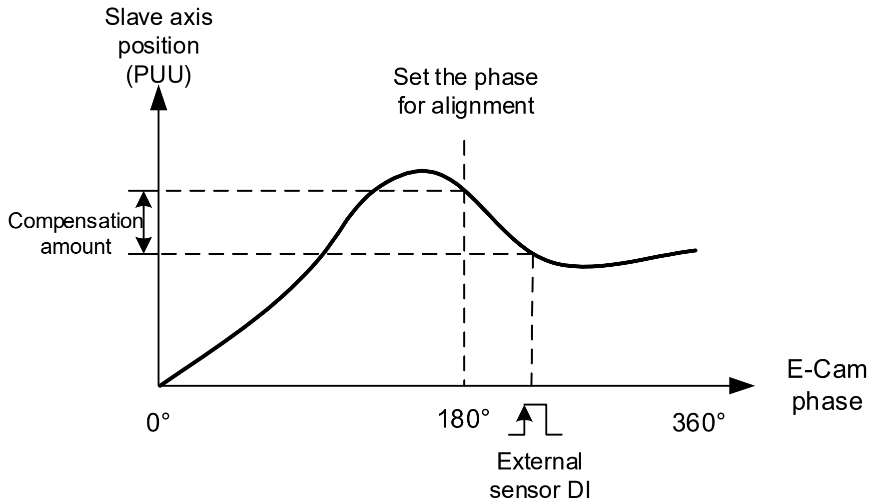


Figure 7-110 Compensation mechanism for phase alignment

E-Cam phase alignment setting steps

When using the E-Cam phase alignment compensation, set the parameters for the DI (digital input), phase alignment position, and compensation level. The flow chart is shown in Figure 7-112. The steps to set the E-Cam phase alignment function are as follows.

1) Presetting: create and download the E-Cam curve to the servo drive. Set the E-Gear ratio, including the system E-Gear ratio (P1.044 and P1.045), E-Cam gear ratio (P5.083 and P5.084), and E-Cam curve scaling (P5.019). Complete the settings relevant to the E-Cam, including the start address of the data array (P5.081), E-Cam total segment number (P5.082), and the E-Cam segment number for engagement (P5.085).
2) DI relevant settings: connect the external sensor with the DI point. Define this DI as [0x35]ALGN. Since both the DI and the sensor have delay, the captured phase position might also delay. Use P2.074 to set the delay time compensation of the DI as follows:

$$P2.074 = P2.009\ \text{(DI filter time)} + \text{Sensor delay time}$$

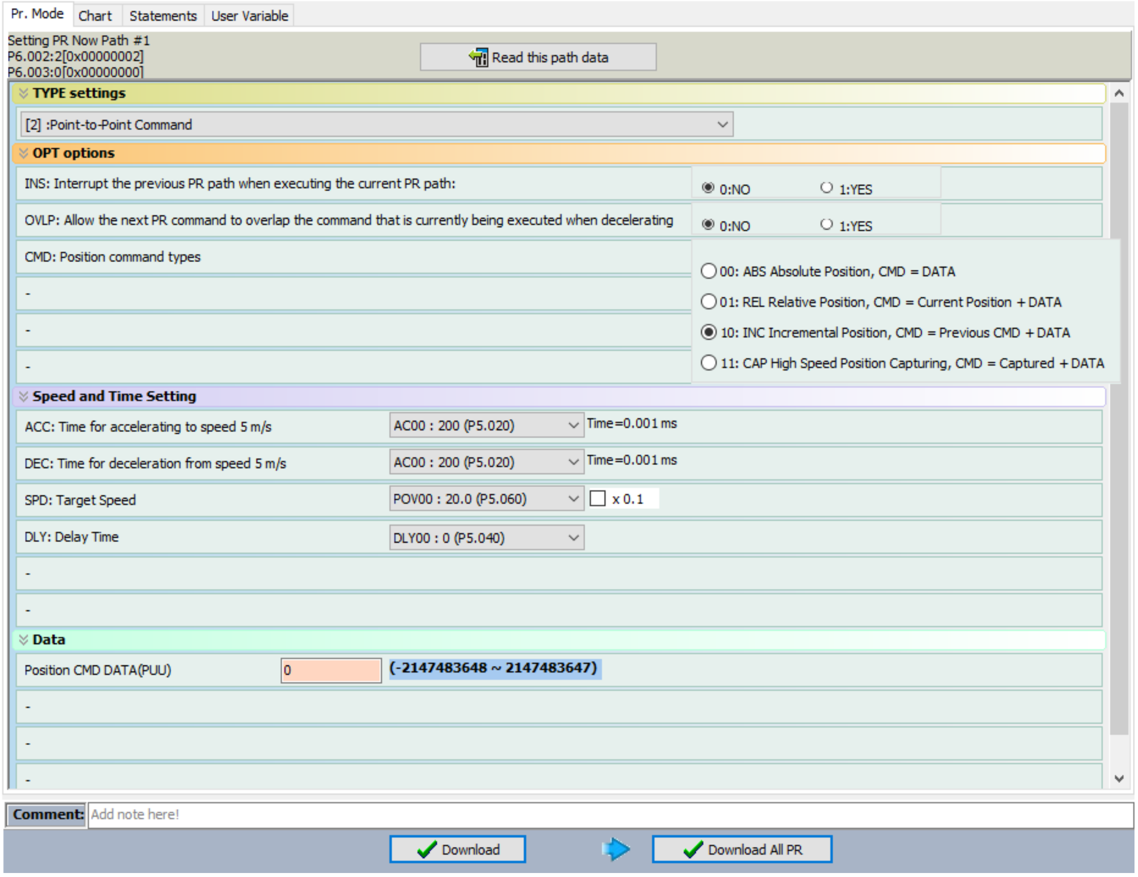
To prevent mistakenly triggering the DI, set P2.073.DC in hexadecimal to specify the masking zone proportion (%). The master axis pulse must exceed the masking area before the next phase alignment starts. This function is only applicable to the applications with forward direction pulse input.
The formula is as follows:

$$\text{Masking zone (pulse)} = \frac{P5.084}{P5.083}\ \text{x}\ P2.073.DC(\%)$$

3) E-Cam phase alignment setting: P2.075 sets the alignment position for E-Cam phase alignment. The unit is the pulse number of the master axis, which corresponds to the specified E-Cam phase after conversion. For example, if the pulse number per E-Cam curve cycle is 36000, then P5.083 = 1 and P5.084 = 36000. If you set P2.075 to 18000, then upon the DI receives the signal, the system starts comparing the slave axis actual position and the set E-Cam position of 180° and then calculates the required compensation value. If you set P2.075 to 10000, when the DI receives the signal, the system starts comparing the slave axis actual position and the set E-Cam position of 100° and then calculates the required compensation value. Use the monitoring variable 063(3Fh) to monitor the slave axis actual position.
4) Filter setting: to keep the operation smooth and decrease the position deviation caused by the noise of the external sensor, when the distances between each mark read by the sensor are equal, you can use the filter to improve the stability of the phase alignment. P2.073.YX specifies the filter range (%) in hexadecimal. If the deviation is smaller than this set value, the filter function is effective. If the deviation is greater than this value, it means the deviation is greater and requires immediate compensation. P2.076.Y specifies the filter intensity. Use the monitoring variable 085(55h) to monitor the E-Cam phase deviation in percentage, which unit is 0.1%. If this value is 10, it means the deviation is 1%, which is 3.6°.
5) Compensation direction setting: P2.076.UZ specifies the allowable forward alignment rate in hexadecimal. Set it to 0% to perform the alignment always in the reverse direction; set 50% to align the phase with the shortest path; set 100% to perform the alignment always in the forward direction. When you select “always forward” or “always reverse” for the alignment, you must set the maximum correction rate to avoid excessive compensation. Generally, using the shortest path for alignment is recommended. If the application has set the reverse inhibit condition and the deviation is sometimes positive and sometimes negative, use with P1.022.U the reverse inhibit function.
6) Maximum correction rate setting: when the alignment deviation is too great, the compensation amount might thus be great which causes motor vibration or even overload. P2.073.UZ in hexadecimal sets the maximum correction rate and gradually compensates the deviation in stages to alleviate the motor vibration, but it requires longer time to complete the alignment compensation. The formula for maximum correction amount per time is as follows:

$$\text{Max. correction rate per time (pulse)} = \frac{P5.084}{P5.083} \text{ x } P2.073.\text{UZ}(\%)$$

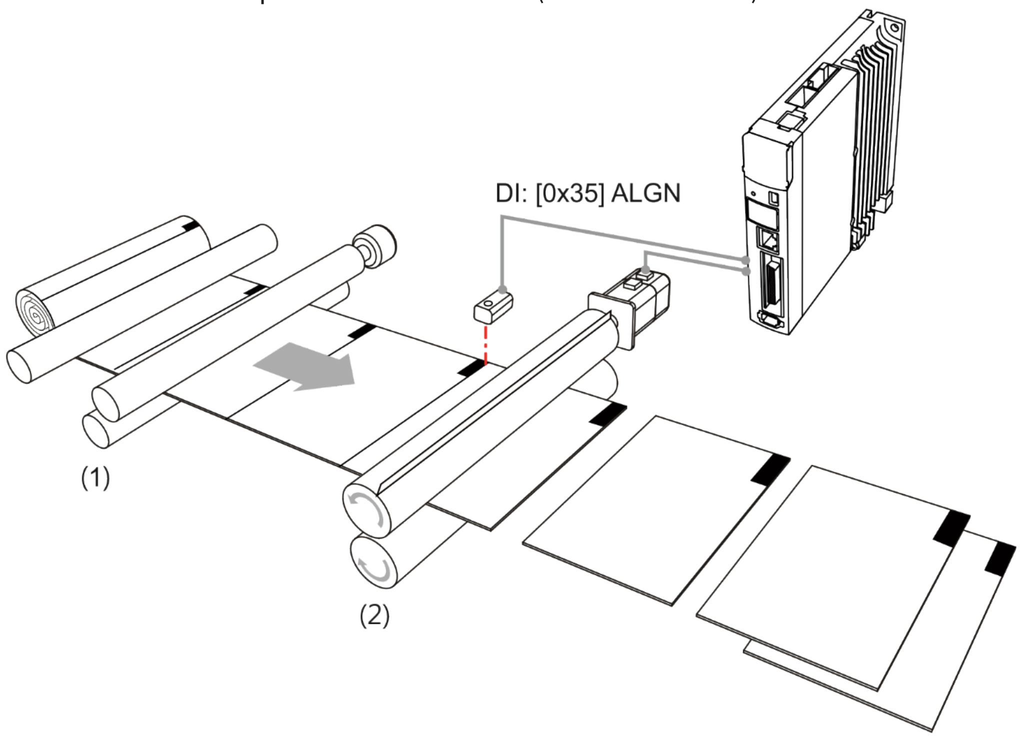
7) PR path setting: the compensation amount for the slave axis is stored in the PR number specified by P2.073.BA. When the slave axis requires compensation, the system can trigger this PR path at the proper timing. When using the E-Cam phase alignment function, set the following for the specified PR: [Point-to-Point Command], [INC Incremental position], [OVLP: allow the next PR command to overlap the command that is currently executed when decelerating], and the appropriate speed and acceleration. Setting the position command is not required because it is automatically set by the E-Cam phase alignment function.



8) E-Cam phase alignment setting: it is set by P2.076.X. P2.076.X Bit 0 enables or disables the alignment function. After this function is enabled, it starts operating as soon as the servo drive receives the DI signal. P2.076.X Bit 1 sets whether to immediately trigger the PR command and calls this PR command when the clutch disengages (P5.088.BA). P2.076.X Bit 2 selects the phase alignment method depending on whether the mark is on the compensated motion axis.

If the mark is on the non-compensation motion axis and when E-Cam phase alignment is operating, the following mark position is unchanged. If the mark is on the compensation motion axis and when E-Cam phase alignment is operating, the following mark position is changed, as shown in Figure 7-111.

A) Mark on the non-compensation motion axis (P2.076.X Bit 2 = 0)



B) Mark on the compensation motion axis (P2.076.X Bit 2 = 1)

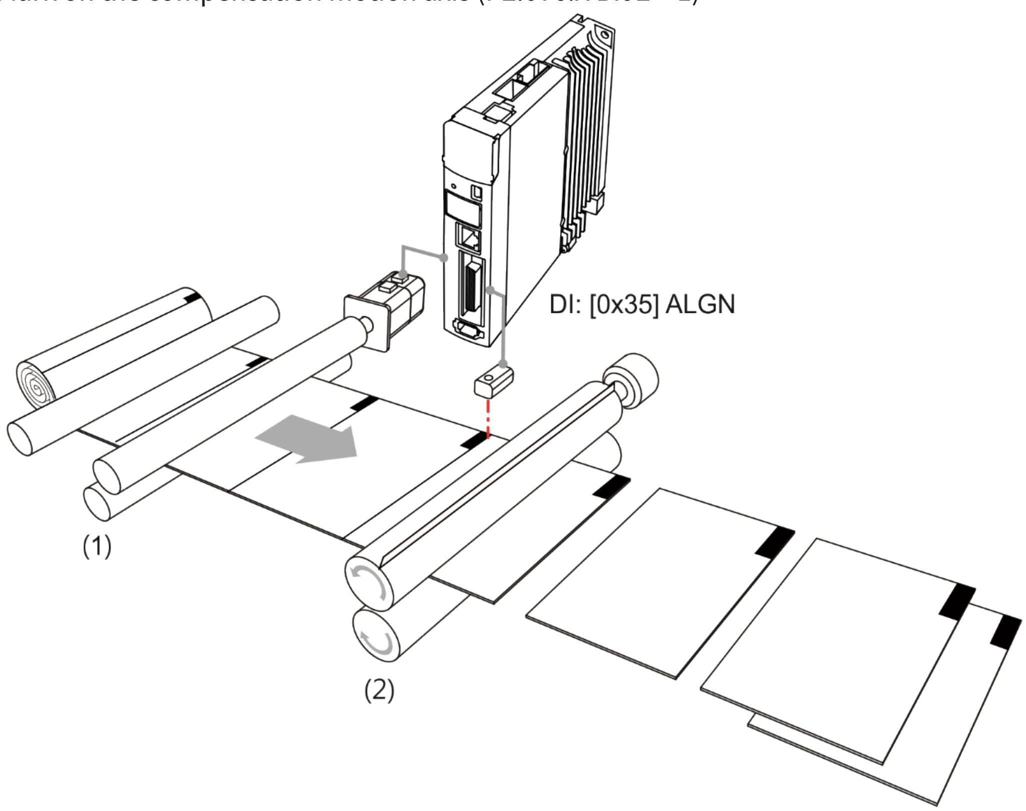
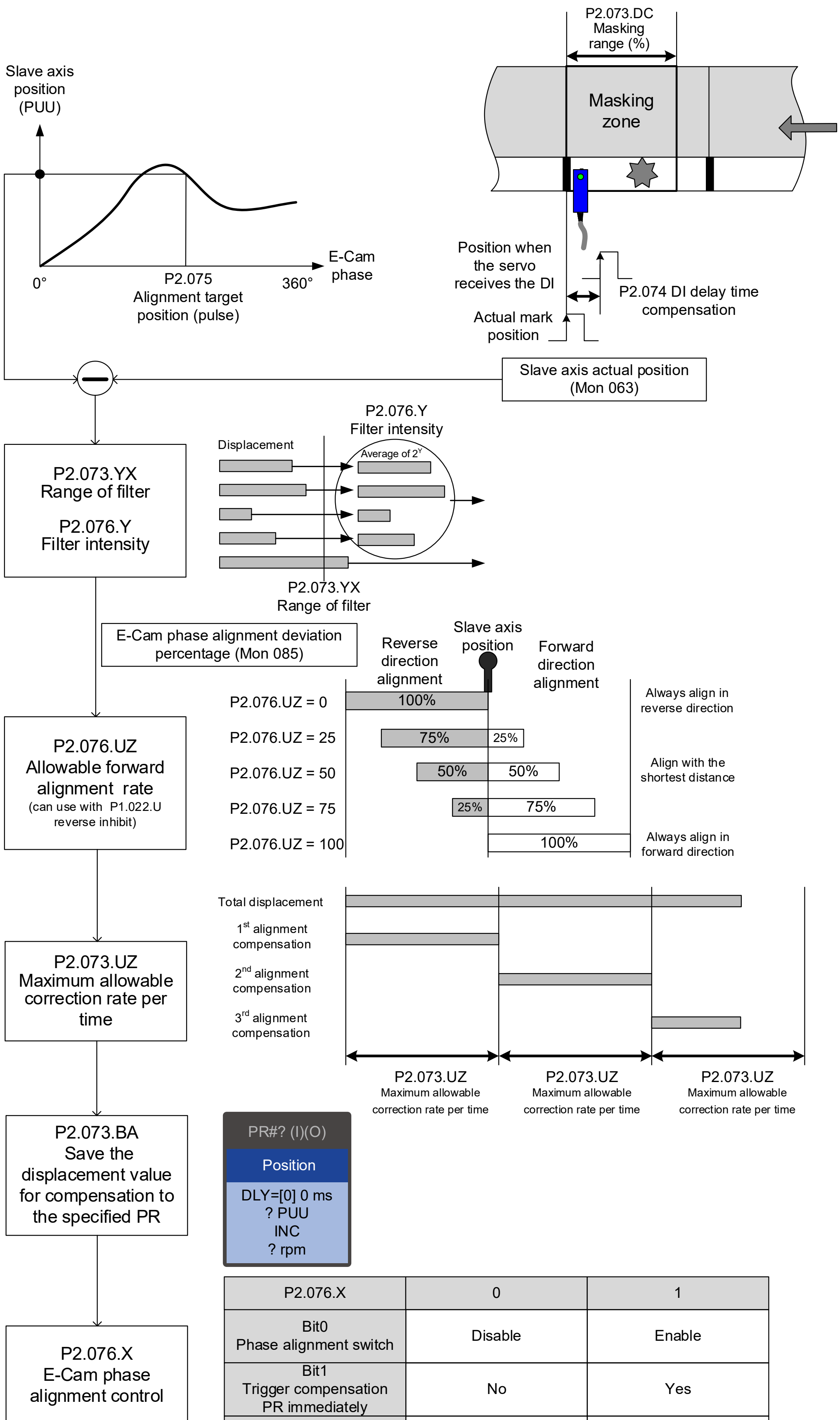


Figure 7-111 E-Cam phase alignment



P2.076.X	0	1
Bit0 Phase alignment switch	Disable	Enable
Bit1 Trigger compensation PR immediately	No	Yes
Bit2 Position of the mark	Alignment mark is on the non-compensation motion axis	Alignment mark is on the compensation motion axis

Figure 7-112 Phase alignment setting procedure

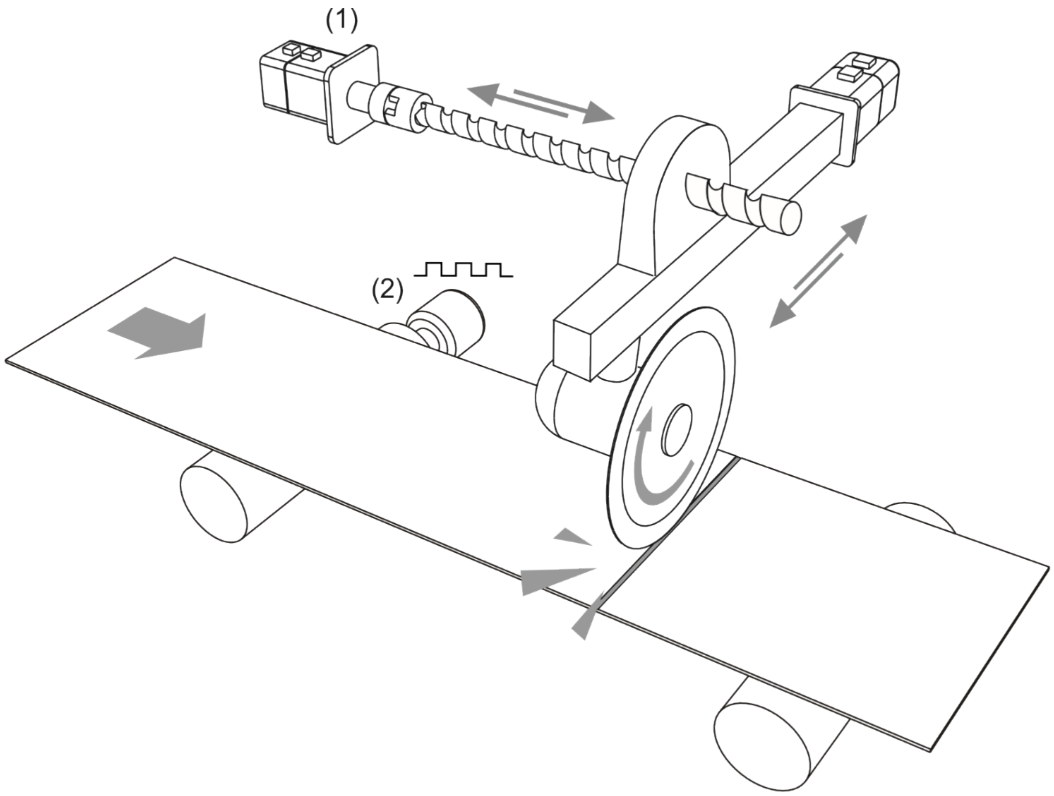
Differences between positioning with synchronous Capture axis and E-Cam phase alignment

The synchronous Capture axis (not currently available with SureServo2) and E-Cam phase alignment are both commonly used compensation approaches for the rotary shear system. In real applications, you can use these two together. The feature differences of the two are as follows.

Item	Synchronous Capture axis	E-Cam phase alignment
Correction method	Corrects master axis pulses.	Uses the PR incremental position command to correct the slave axis position.
Digital input (DI)	High-speed DI7 (CAP) only.	Uses DI.ALGN most of the time. Uses Macro #E if using high-speed DI7 (CAP) is required.
Marking position	On the non-compensation motion axis.	On any of the axes (compensation or non-compensation).
Equal space marking	Available.	Available and can be used with the filter.
Random marking	Not available.	When using the high-speed DI7 (CAP) with Macro #E, using the filter is not suggested. Keep the distance between the sensor and cutter within the cutting length per cut.

7.3.8 - Flying Shear

The flying shear system is a dynamic cutting system of which feeder continues to operate. Therefore, the cutting and feeding axes have to be synchronous during cutting. The synchronous speed duration should allow the cutter to finish cutting and return to the right position to avoid damaging the cutter or materials, as shown in Figure 7-113. Common applications include cutting machines, filling machines, and labeling machines. Different from rotary shear, the compensation methods using synchronous Capture axis and phase alignment are not applicable to flying shear applications. This avoids machine damage caused by the compensation in the synchronous area.



(1) Cutting axis (slave axis); (2) Material feeder (master axis)

Figure 7-113 Flying shear system

The application of flying shear is divided into two types according to the clutch engagement time. The first type is fully engaged. Its E-Cam curve includes the acceleration zone, synchronous speed zone, deceleration zone, and reset zone. The slave axis is completely controlled by the E-Cam system. The second type is partially engaged: the E-Cam operation is triggered by the signal, and the E-Cam curve has no reset zone. After one cycle of E-Cam operation, the clutch disengages and uses the PR command to reset. Then, the E-Cam waits for the next trigger signal. As shown in Figure 7-114 using a cutting machine as an example, the material feeder is the master axis and the cutting axis is the slave axis. The feeder maintains at a constant speed, and the cutting axis operates according to the E-Cam curve or PR command.

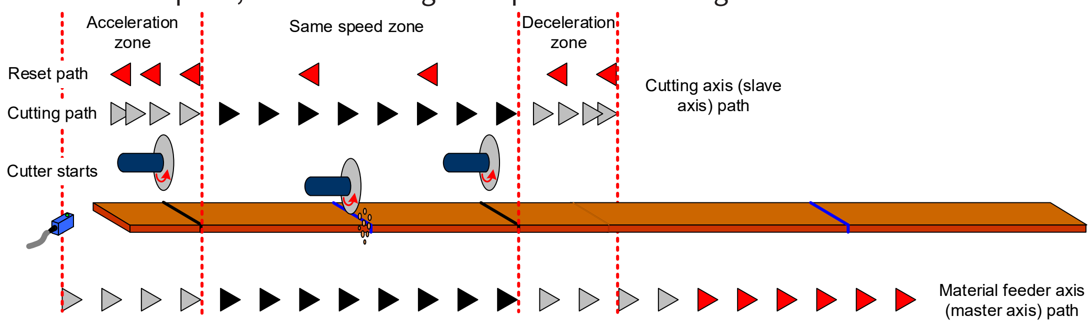


Figure 7-114 Cutting path and operation cycle of the cutting machine

Fully engaged

The fully engaged E-Cam application is suitable for cutting operations without marks. Its E-Cam curve includes the acceleration zone, synchronous speed zone, deceleration zone, and reset zone. The master axis operates at a constant speed. The slave axis operates according to the E-Cam curve and the cutting is complete in the synchronous speed zone. In each cycle, the slave axis starts from the acceleration zone. To avoid wasting materials in the first cycle, set the initial lead pulse before engaged (P5.087). The setting value is the total pulse number of the synchronous speed zone, deceleration zone, and reset zone. If the cutting sensor and material are not aligned during the first cutting, you need to add the offset pulse number of the sensor.

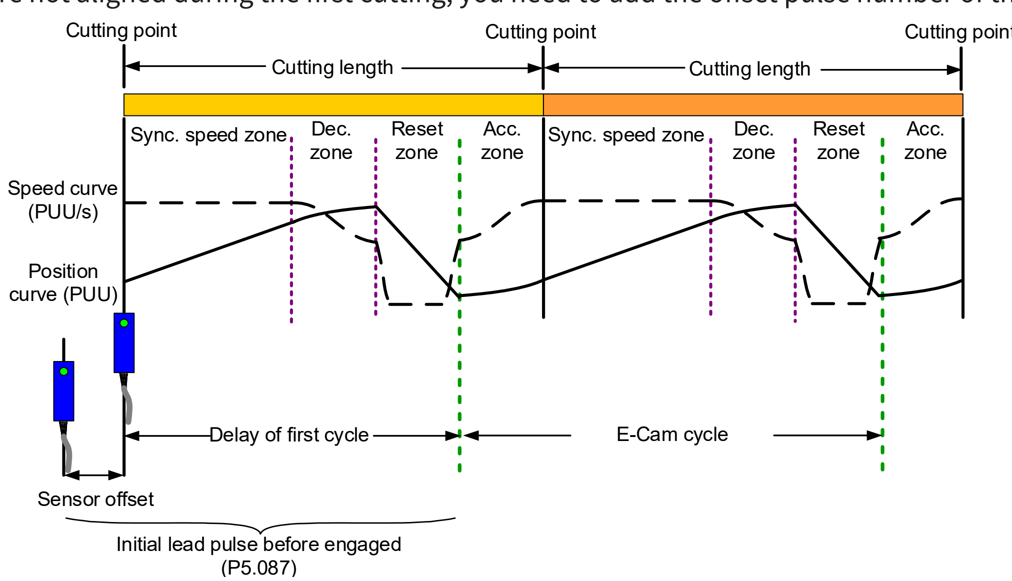
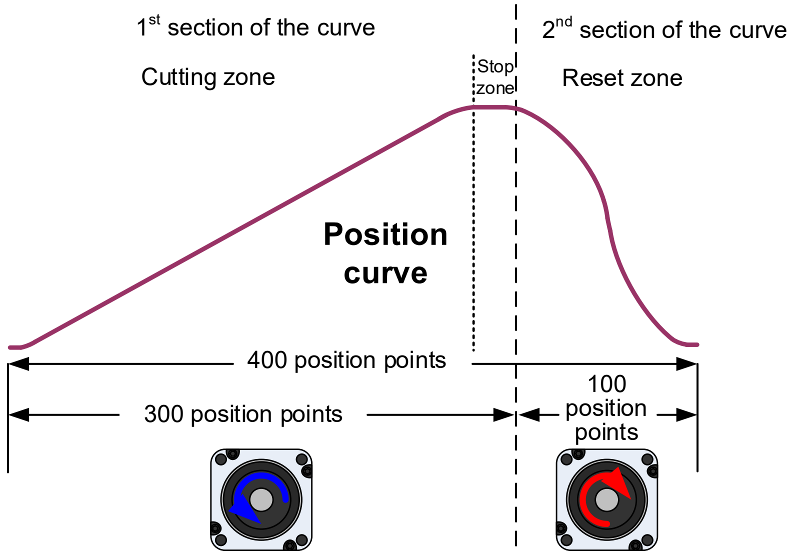


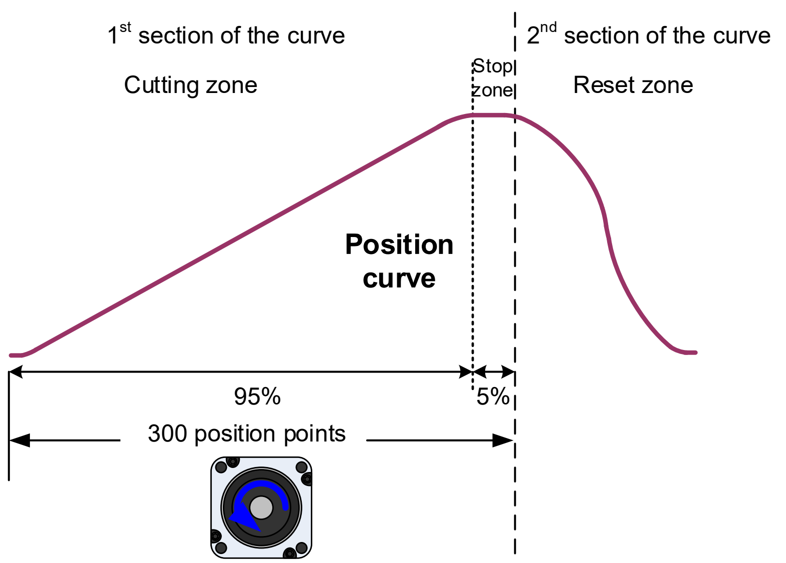
Figure 7-115 Fully engaged E-Cam cycle of the cutting machine

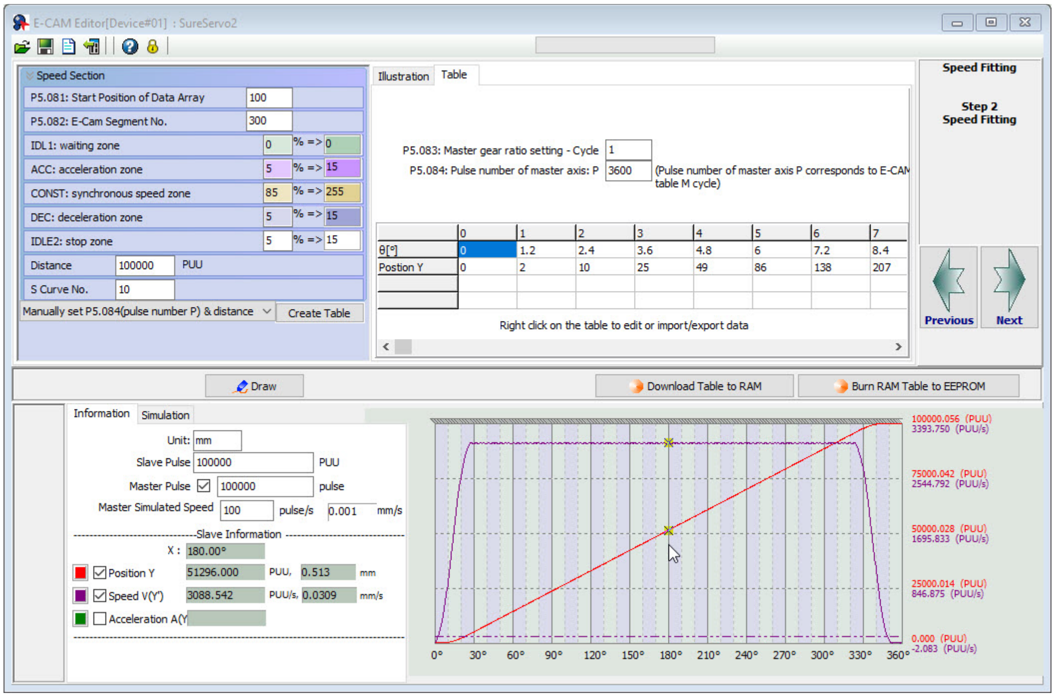
You can use the “Speed Fitting Creation” in SureServo2 Pro to create the E-Cam curve. However, this method can only generate E-Cam curves with single operation direction. You need to create the curves for the cutting zone and reset zone respectively. Then, combine the two curves with the “Manually create a table” function. The operation steps are as follows:

1) Curve planning: segment the cutting zone, stop zone, and reset zone. Because the cutting zone is in the first segment of the curve, there will be more position points plotted in the first segment to ensure the flying shear can complete the cutting in the cutting zone. In the following example, the cutting zone and stop zone are segmented as the first section of the curve with 300 position points. The second section of the curve is the reset zone with 100 position points. So, the curve is composed of 400 position points.

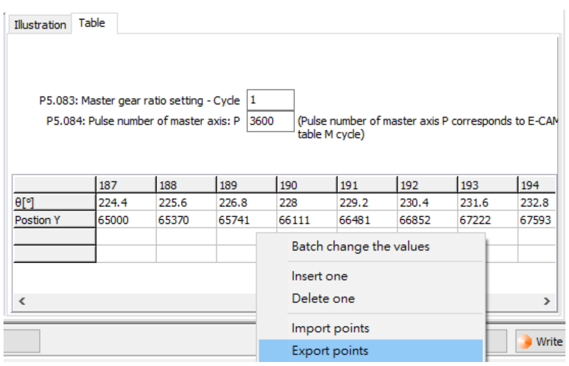


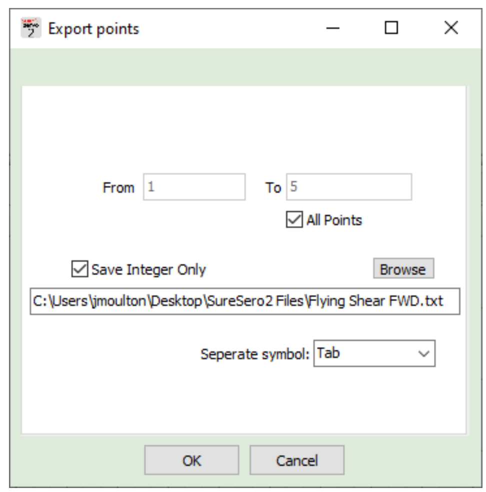
2) Plan and create the first section of the E-Cam curve: this section has a total of 300 position points including the cutting zone and stop zone, so set the E-Cam total segment number N (P5.082) to 300. This example sets the cutting zone to 95% (including acceleration zone of 5%, synchronous speed zone of 85%, and deceleration zone of 5%) which is 285 position points. The stop zone is 5%, which is 15 position points. After setting the required lead distance of the slave axis, click **Create Table**.



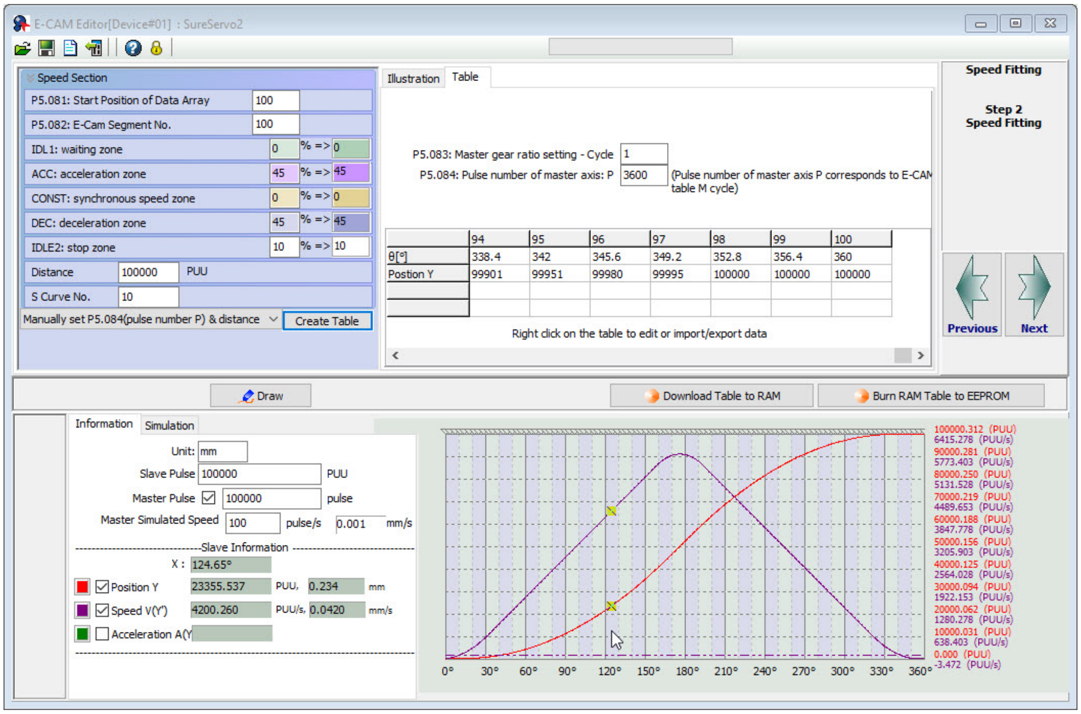


3) Export the curve data of the first section: right-click on the table, select **Export points** and a window appears. Select the check box for **All points** and specify the saving location, then click **OK** to save. And empty .txt file may need to be created first for some Windows versions.

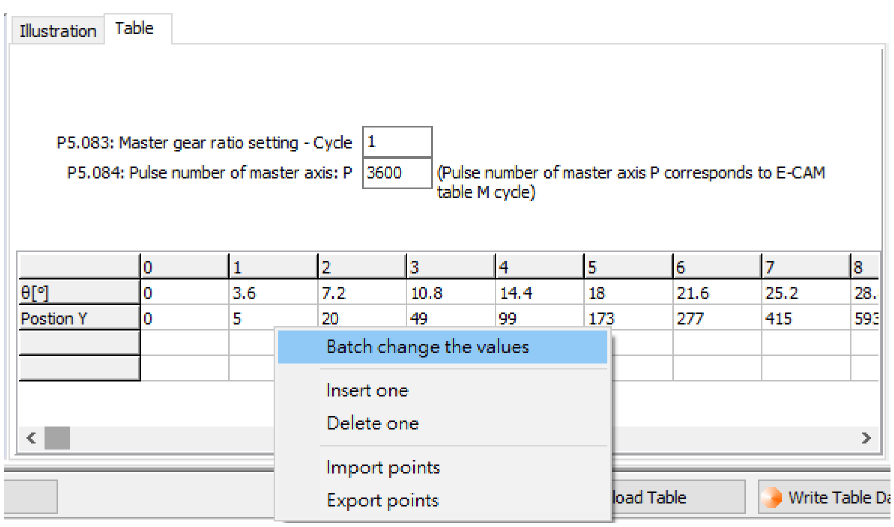




4) Plan and create the second section of the E-Cam curve: the reset zone has 100 position points in total. You must set the E-Cam total segment number N (P5.082) to 100. Since the curves created by this function are all in forward direction, you must first create a curve, and then reverse it to complete the curve for the reset zone.



After creating the forward direction E-Cam curve, right-click on the table, select **Batch change the values**, and fill in 0 to 100 in the pop-up window. Select "*" (multiplication), fill in "-1", and select the check box for **Don't close, continue the next operation**, then the curve direction reverses from forward to backward. Then, select "+" (plus), fill in "100000" for the lead distance of 100,000 PUU, so that the initial value of this curve section smoothly coincides with the final value of the previous curve section. Click **OK**, then click on **Draw** to complete the reversed direction of the curve.



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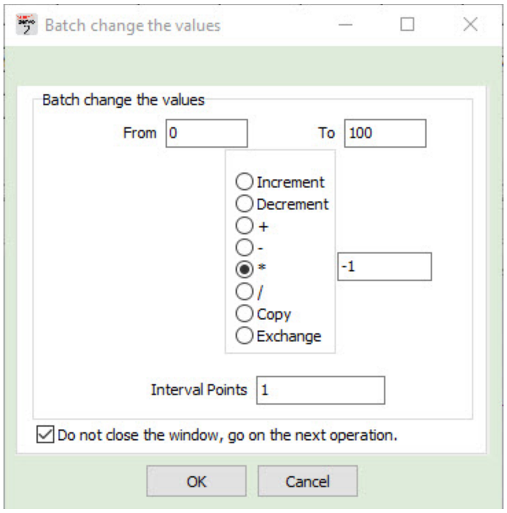
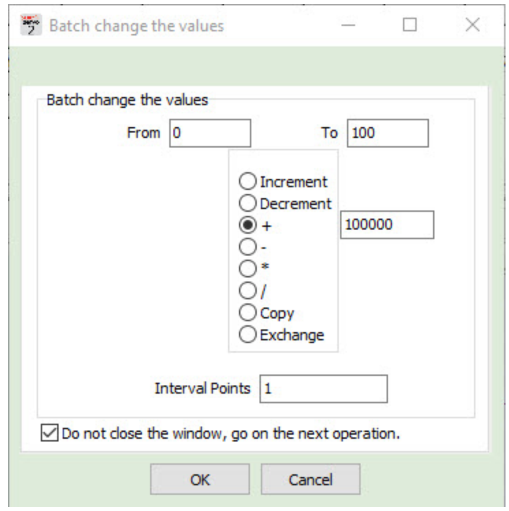
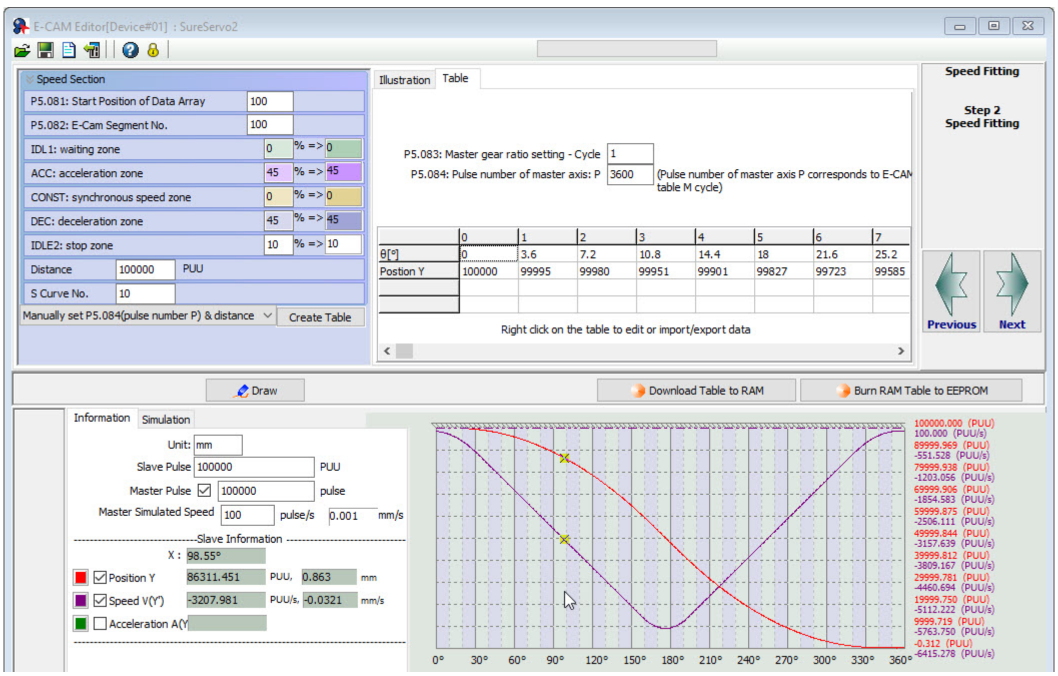
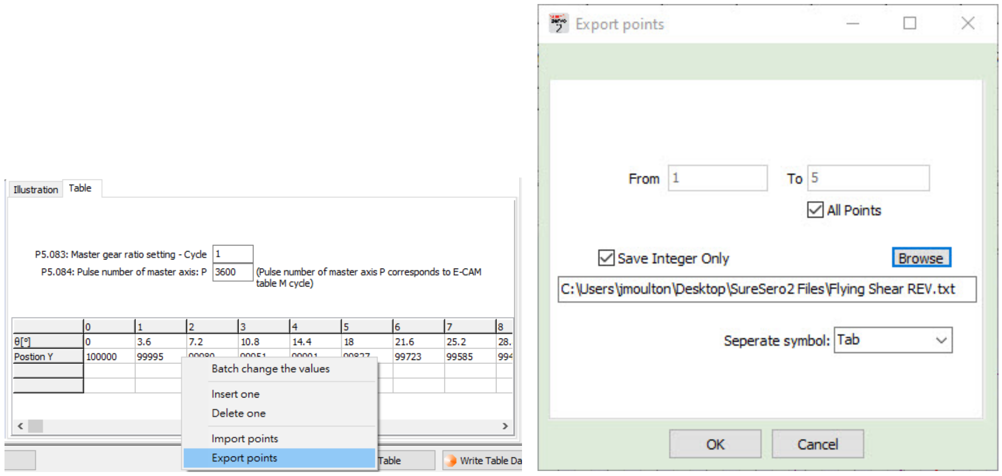

Batch change the values
Batch change the values
From 0
To 100
Increment
Decrement
+
-
*
/
Copy
Exchange
-1
Interval Points 1
Do not close the window, go on the next operation.
OK
Cancel

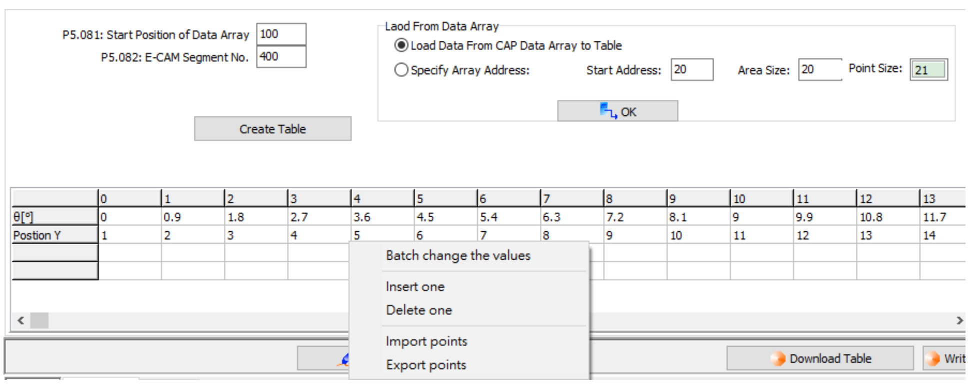

Batch change the values
Batch change the values
From 0
To 100
Increment
Decrement
+
100000
-
*
/
Copy
Exchange
Interval Points 1
Do not close the window, go on the next operation.
OK
Cancel

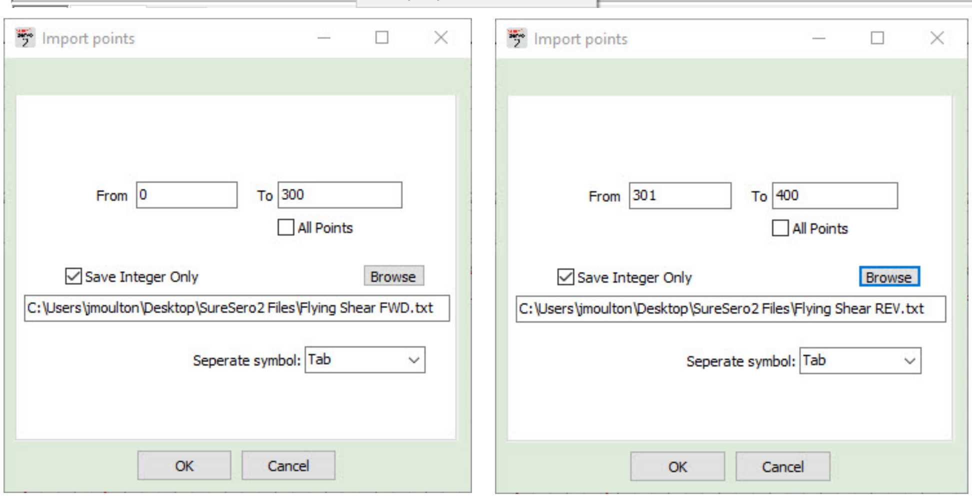

E-CAM Editor[Device#01] : SureServo2
Speed Section
P5.081: Start Position of Data Array 100
P5.082: E-Cam Segment No. 100
IDL1: waiting zone 0 % => 0
ACC: acceleration zone 45 % => 45
CONST: synchronous speed zone 0 % => 0
DEC: deceleration zone 45 % => 45
IDLE2: stop zone 10 % => 10
Distance 100000 PUU
S Curve No. 10
Manually set P5.084(pulse number P) & distance
Create Table
Illustration
Table
P5.083: Master gear ratio setting - Cycle 1
P5.084: Pulse number of master axis: P 3600
(Pulse number of master axis P corresponds to E-CAM table M cycle)
Right click on the table to edit or import/export data
Speed Fitting
Step 2
Speed Fitting
Previous
Next
Draw
Download Table to RAM
Burn RAM Table to EEPROM
Information
Simulation
Unit: mm
Slave Pulse 100000 PUU
Master Pulse 100000 pulse
Master Simulated Speed 100 pulse/s 0.001 mm/s
Slave Information
X : 98.55°
Position Y 86311.451 PUU, 0.863 mm
Speed V(Y') -3207.981 PUU/s, -0.0321 mm/s
Acceleration A(Y'')

5) Export the curve data of the second section: right-click on the table, select **Export points** and a window appears. Select the check box for **All points** and specify the save location, then click **OK** to save. Ensure the file path also has the correct file name at the end of the path (for example: ...\retractzone.txt).



6) Combine E-Cam curves: go back to the previous screen and use "Manually create a table". The E-cam curve has a total of 400 position points, so you need to set the E-Cam total segment number N (P5.082) to 400. Click **Create Table** and a table of 400 position points is generated. Right-click on the table, select **Import points**, fill in "1" to "300" in the pop-up window, select the first section of the curve, then click **OK**. Click **Draw** to see the imported points. Follow the same steps as previous, but fill in "301" to "400" in the pop-up window, select the second section of the curve, then click **Draw** to complete the E-Cam curve of the fully engaged mode. Save the .ecd file to preserve the CAM table that was just created.





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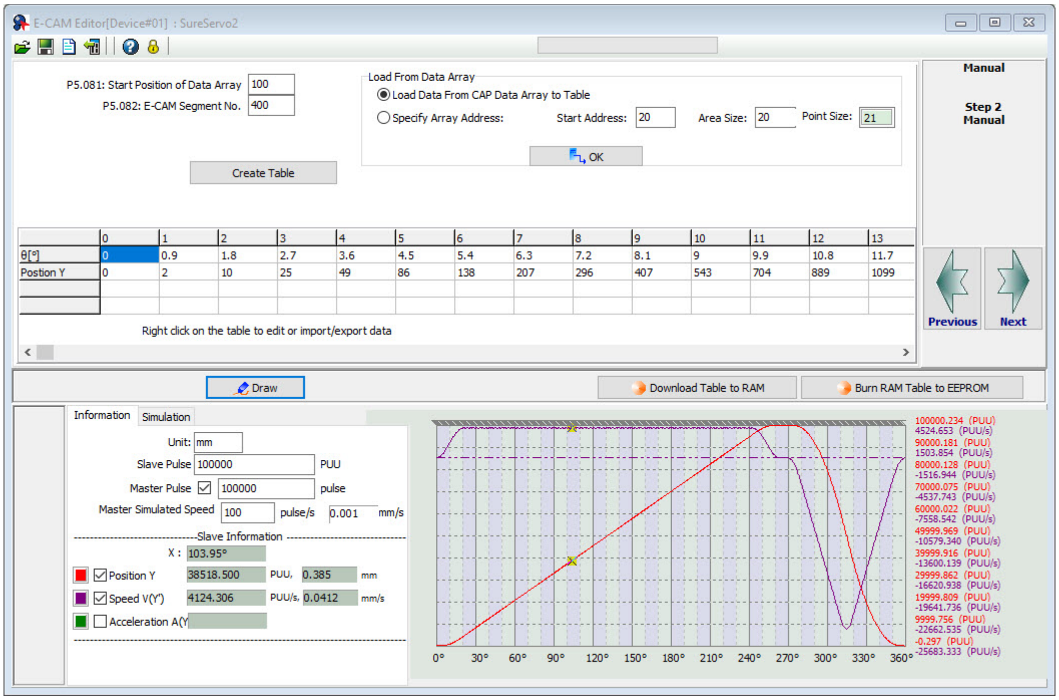
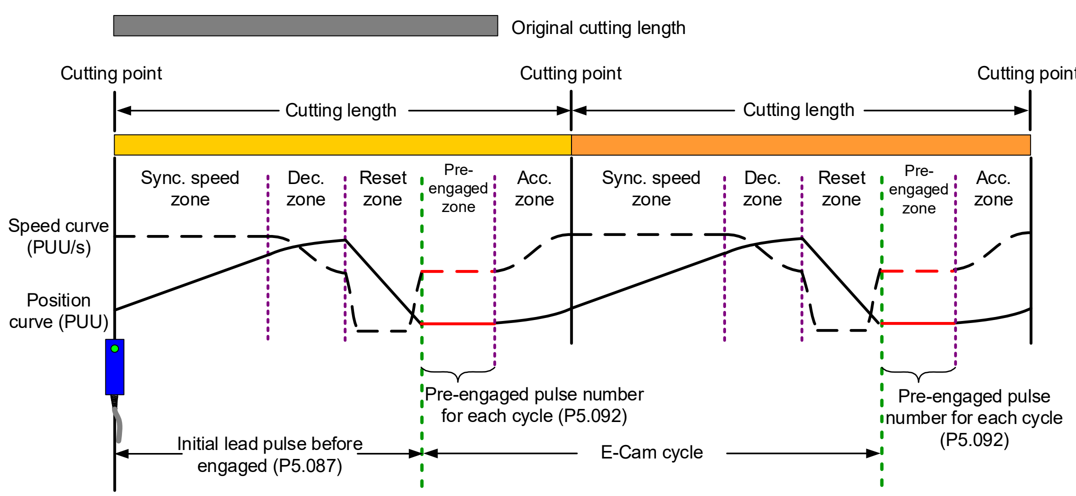


The operation of the fully engaged mode is based on the E-Cam curve. The E-Cam curve is more complex and more difficult to create, so if the cutting length changes, you can only modify the cutting length by setting the pre-engaged pulse number for each cycle (P5.092) or adjust the E-Cam gear ratio (P5.084 / P5.083) and curve scaling (P5.019).

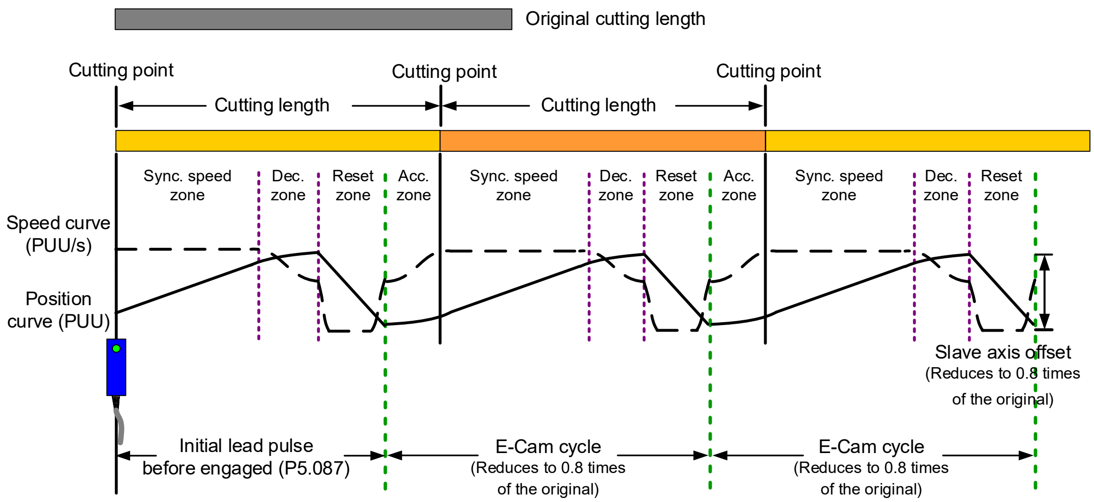
Cutting length is greater than the E-Cam curve operating length

Select to enter cyclic mode after disengaging (P5.088.U = 4) and set the pre-engaged pulse number for each cycle (P5.092). When the E-Cam enters the pre-engaged status, the material feeder continues operating, but the cutting axis stops. The cutting axis resumes operation until the pre-engaged pulse number for each cycle is met. The greater the pre-engaged pulse number for each cycle, the longer the cutting length.



Cutting length is less than the E-Cam curve operating length

Reduce the E-Cam master axis pulse number and slave axis moving distance proportionally. For example, if you reduce the master axis pulse number for each cycle (P5.084 / P5.083) to 0.8 times of the original, the moving distance of the slave axis should also reduce 0.8 times. You can use the E-Cam curve scaling (P5.019) to reduce the setting by 0.8 times to shorten the cutting length. However, this method also reduces the synchronous speed zone, so make sure that the cutting action can be completed in the synchronous speed zone. This method is not recommended for applications when the cutting length is greater than the E-Cam curve operating length. Because when you increase the moving distance of the slave axis, the machine may not have sufficient distance to complete the slave axis motion which can lead to collision.



Partially engaged

This is applicable for cutting operations with or without marks. For the cutting operation with marks, use the Capture function to have the E-Cam engaged. For the cutting without marks, use the Compare function to generate virtual marks for the Capture function to capture the position data. The E-Cam curve includes the acceleration zone, synchronous speed zone, and deceleration zone. After the E-Cam curve (acceleration, synchronous speed, deceleration zones) is executed, the clutch disengages. The reset zone is completed with a PR command and then it waits for the next trigger signal to have the clutch engaged. With this method, you can create an E-Cam curve with a larger synchronous speed zone based on the maximum moving distance of the cutter. This is suitable for applications with the cutting length smaller than the waiting zone. For applications with the cutting length greater than the maximum moving distance of the cutter, disengage the E-Cam and have the material feeder continue to operate, and then the E-Cam re-engages when the servo receives the trigger signal.

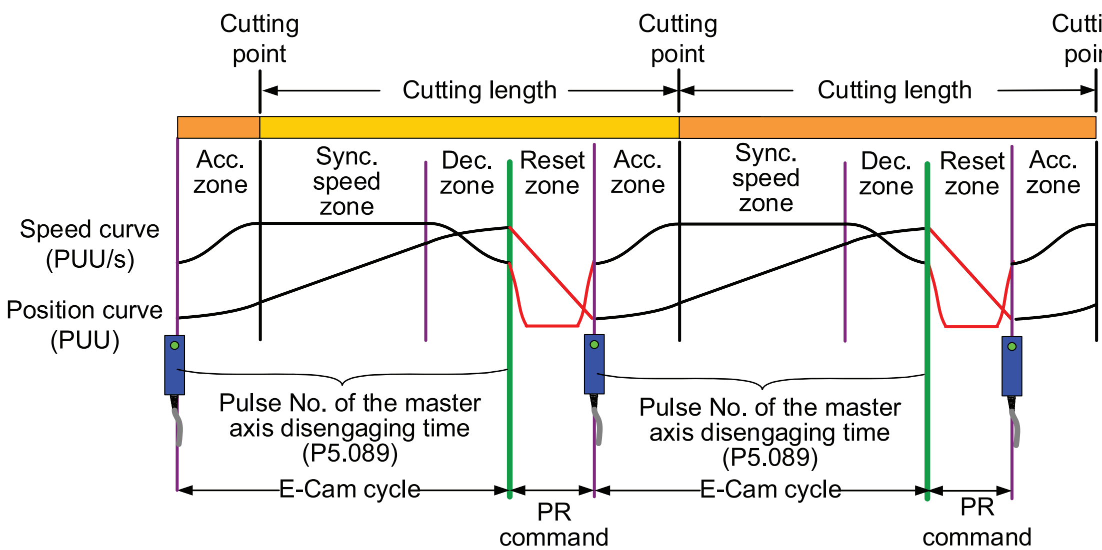
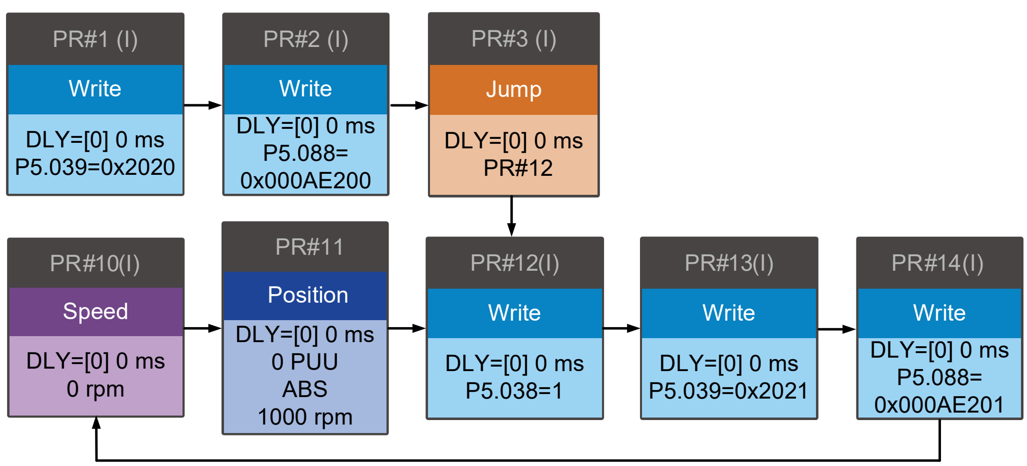


Figure 7-116 E-Cam cycle of the partially engaged cutting machine

After creating an E-Cam curve based on the maximum moving distance of the cutting axis, set the master pulse number of disengaging time (P5.089) according to the cutting length. After reaching the disengaging pulse number or receving the cutting complete signal, the clutch disengages and continues with a zero-speed PR speed command to stop the cutter. Then, it uses another PR position command to return the cutter to the initial position, as shown in Figure 7-117. The setting methods are as follows:

1) Master axis signal source: set P5.088.Y to 0; it means the source of the master axis is the capturing axis. In the Capture function, this capturing axis refers to the setting of P5.039.Y for the signal source of the master axis.
2) Engagement condition: set P5.088.Z to 2; it means the clutch engages as soon as the first data is captured and the signal is input through DI7 to the servo drive.
3) Disengagement condition: set P5.088.U to E; it means the clutch disengages when the master axis pulse number reaches the pulse number set in P5.089, the slave axis decelerates to stop, and the E-Cam function is disabled.
4) To set the subsequent PR procedure after the clutch disengages, set the PR number to be executed in P5.088.BA in hexadecimal.
5) Set the PR procedures:
   - *Procedure 1: set the PR commands for execution when the cutting machine is activated. PR#1 confirms the Capture function is disabled. PR#2 confirms the E-Cam function is disabled. PR#3 jumps to PR#12. PR#12 sets the capturing amount to 1. PR#13 enables the Capture function. PR#14 enables the E-Cam function.*
   - *Procedure 2: set the subsequent PR commands after the clutch disengages. PR#10 sets the zero-speed command to stop the cutting axis. PR#11 sets the position command to return the cutting axis to the initial position.*



Note: P5.088.BA causes a jump PR#10(A) when disengaging.

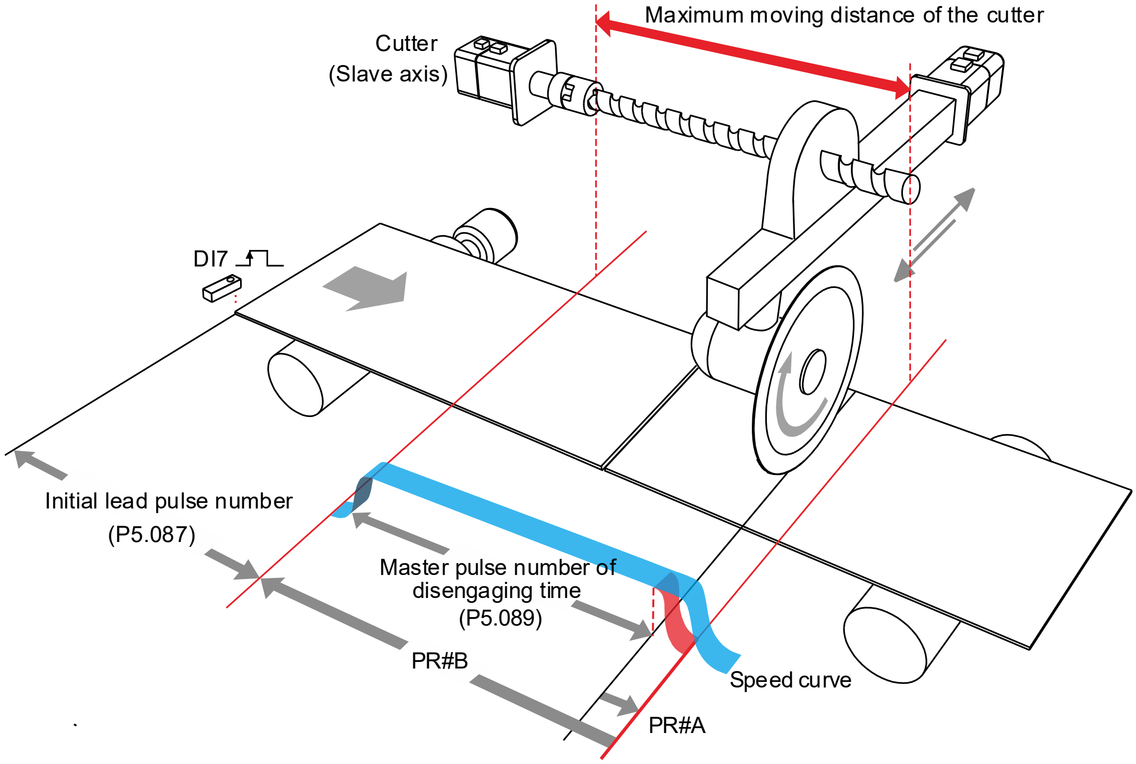


Figure 7-117 Operation of partially engaged cutting axis

7.3.9 - Macro

In real applications, the macro commands cater to different needs during E-Cam operation, such as the requirements for stopping and resuming the operation after an alarm occurs, the phase alignment at the initial operation stage, or phase modification and pausing the cycle during operation. You can use the following macros to complete the tasks. Use P5.097 to enable the macro. Input the values for P5.093 - P5.096 based on the macro requirements.

Macro	Function	Application Requirement
Macro #5	Sets the pulse number for the master axis gear ratio (P5.084) and the pulse number for disengagement (P5.089) as the same.	The cams disengage after one cycle.
Macro #8	When the clutch engages, the E-Cam curve scaling (P5.019) takes effect one time.	Prompt change in scaling.
Macro #C	When the clutch engages, sets the master axis pulse phase when the motor remains unmoved.	Precise control of the clutch engagement position.
Macro #D	When the slave axis position is not in the corresponding E-Cam curve, calculates the position correction amount and writes this amount to the PR incremental position command.	Slave axis position offset correction for E-Cam cycles.
Macro #E	Uses high-speed DI7 to perform E-Cam phase alignment, calculates the compensation amount, and writes this amount to the PR incremental position command.	Non-cyclic marking function.
Macro #F	When the master axis stops and the clutch disengages, moves the slave axis to the specified position and then back to the original position.	Evacuating the damaged material due to mis-cutting.
Macro #10	Carries on the operation after the slave axis stops for one cycle.	Empty pack prevention mechanism.

Macro #C - change the engagement position and operate in forward direction until the disengagement condition is met

When the clutch is engaged, this macro immediately changes the master axis position and automatically calculates the remaining pulse number in the cycle. When the E-Cam cycle is complete, the clutch disengages based on the set disengagement condition (P5.088.U).
This macro can be used for setting the initial engagement position for the master axis and you can select any of the master axis position to engage. The precision level is higher when you use Macro #C than using P5.085 to select the section from the E-Cam table for engagement. When using this macro, the master axis should stay stationary. Wait for the macro to complete before operating the master axis. The operation is shown in Figure 7-118.

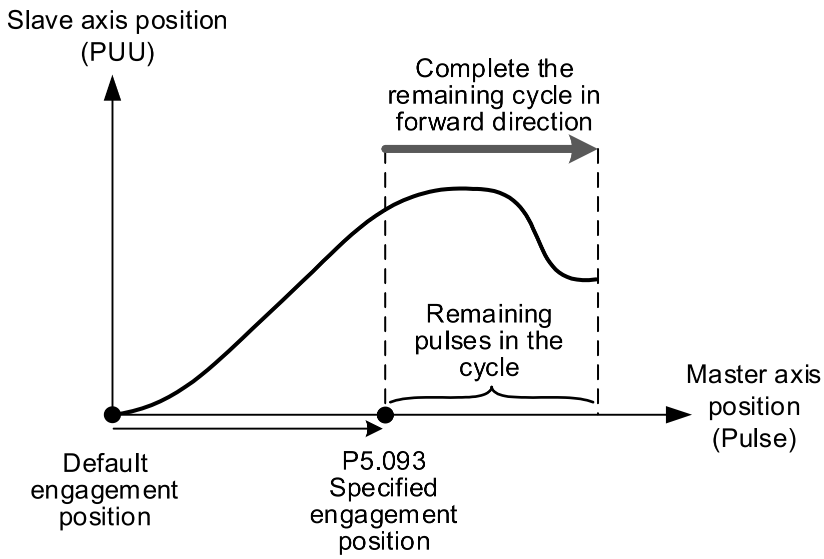


Figure 7-118 Macro #C operation

Setting steps:

1) The E-Cams engage and the master axis stops.
2) Set the disengagement condition (P5.088.U).
3) Set the engagement position: use P5.093 to write the master axis engagement position (pulse) in hexadecimal and use monitoring variable 062(3Eh) to monitor the current master axis position. The specified range for the new engagement master axis position is:

$$0 \leq \text{P5.093 (Pulse)} < \frac{P5.084}{P5.083}$$

4) Enable Macro #C: set P5.097 = 0x000C to enable Macro #C. Read P5.097 and if it returns 0x100C, it means the macro execution is successful. If any of the following failure codes shows, modify the setting according to the description.

Failure Code	Description
0xF0C1	When executing this macro command, the clutch is not in the engaged status.
0xF0C2	The engagement position specified in P5.093 exceeds the range (must be ≥ 0).
0xF0C3	The engagement position specified in P5.093 exceeds the range (must be < (P5.084/P5.083)).

Macro #D - calculate the deviation between the current slave axis position and index coordinate for PR positioning

When the slave axis position is not at the E-Cam curve corresponding position, this macro finds the slave axis position corresponding to the master axis position. Next, it calculates the deviation between this value and the current motor position, and writes the deviation to the PR incremental position command. You can trigger the specified PR and move the motor of the slave axis to the position corresponding to the master axis position. This macro is suitable for the cyclic motion which starts from the same point. In other words, the mechanism returns to the start point each cycle; and the slave axis moving distance is the same as the total index moving distance. You can monitor the index coordinate in PUU with monitoring variable 091(5Bh). The operation is shown in Figure 7-119.

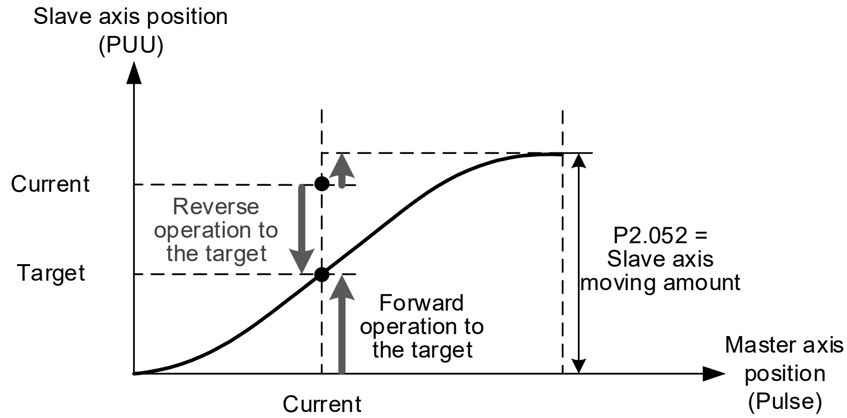
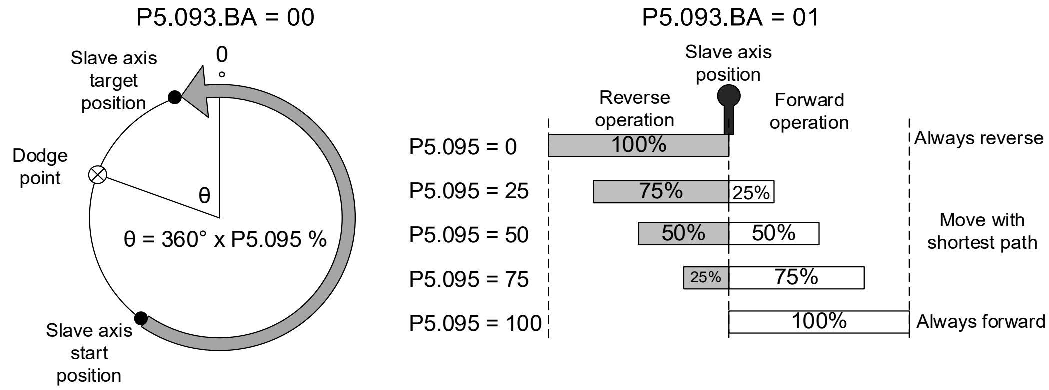


Figure 7-119 Macro #D operation

Setting steps:

1) Set P5.088.X Bit1 to 1 to keep the clutch engaged when Servo Off and engage the E-Cam.
2) Set the total index moving distance to equal the moving distance of the slave axis per cycle (P2.052 = slave axis moving distance ECAM_H).
3) Set the E-Cam scaling to 1 (P5.019 = 1).
4) Set the initial engagement position: align the start point of 0 degree in the E-Cam curve table with the index coordinate origin.
5) Set the PR number to save the deviation: specify PR#1 - 99 in hexadecimal.
   Set P5.093.YX = 0x01 - 0x63, and set this PR as an incremental position command.
6) Select the direction control type: set P5.093.BA = 00 to use the dodge point for controlling the forward and reverse directions. Set P5.093.BA = 01 to use the allowable forward rate for controlling the forward and reverse directions.
7) Set the reverse inhibit function: set P5.093.CD = 0 to disable the reverse inhibit function.
   Set P5.093.CD = 1 to enable the reverse inhibit function.
8) Set the dodge point or allowable forward rate: if using the dodge point for direction control, set P5.095 to 0 - 100% for the dodge position. If using the allowable forward rate for direction control, set P5.095 to 0 - 100% as the allowable forward rate. Refer to the following figure.



9) Enable Macro #D: set P5.097 = 0x000D to enable Macro #D. Read P5.097 and if it returns 0x100D, it means the macro execution is successful. If any of the following failure codes shows, modify the setting according to the description.

Failure Code	***Description***
0xF0D1	When executing this macro command, the clutch is not in the engaged status.
0xF0D2	PR number specified by P5.093.YX exceeds the range (0x01 - 0x63).
0xF0D3	P5.095 the dodge point or allowable forward rate exceeds the range (0 - 100%).
0xF0D5	Position correction value does not exist. This macro command might be triggered twice.
0xF0D6	E-Cam did not remain engaged when servo is off, so when servo switches to the on state again, E-Cam is not engaged.
0xF0D7	Slave axis moving distance does not equal the total index moving distance (ECAM_H ≠ P2.052).
0xF0D8	E-Cam curve scaling does not equal 1 (P5.019 ≠ 1).
0xF0D9	P5.093.BA forward / reverse direction setting exceeds the range (00 - 01).
0xF0DA	P5.093.DC reverse inhibit setting exceeds the range (00 - 01).
0xF0DB	The reverse inhibit function has failed. Do not use macro command #D and #10 consecutively.

Macro #E - PR positioning using E-Cam correction amount

When the clutch engages, this macro sets the master axis engagement position (pulse) and calculates the required correction amount for the slave axis to complete positioning for one time. Next, it writes this correction amount to the PR incremental position command to execute.

You can trigger this PR command to have the slave axis operate to the corresponding target position at the proper time. In actual applications, you can connect the external sensor to the servo drive DI, and use an event trigger to enable Macro #E. Then, the macro calculates the correction amount and writes this value to the specified PR program. This macro is suitable for applications with random markings. The operation is shown in Figure 7-120.

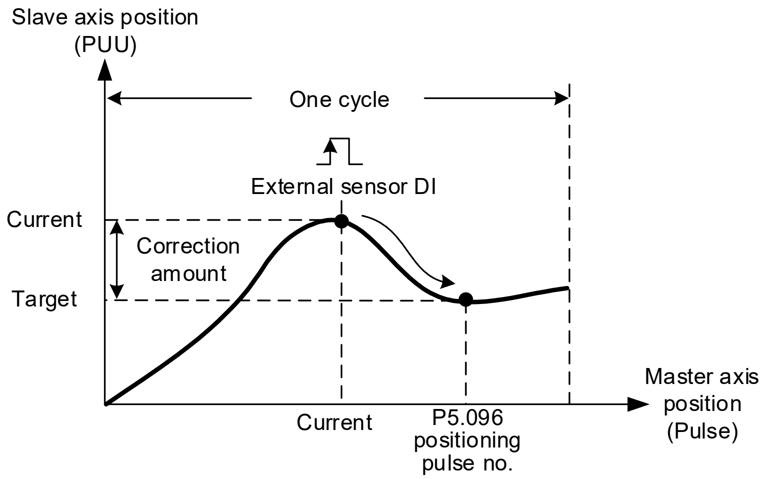
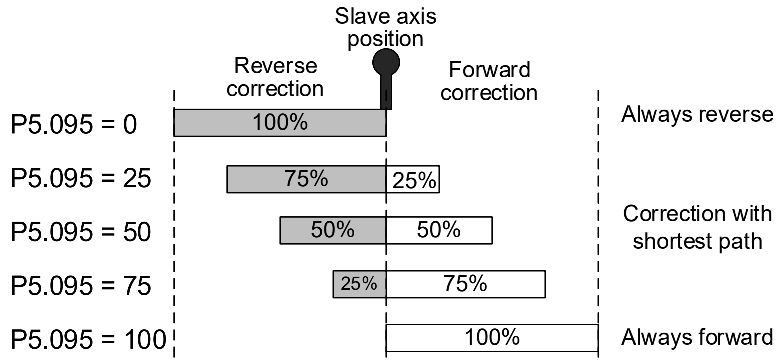


Figure 7-120 Operation of Macro #E

Setting steps:

1) Engage the clutch.
2) Set the PR number to save the correction amount: specify PR#1 - 99 in hexadecimal. Set P5.093.YX = 0x01 - 0x63, and set this PR as an incremental position command.
3) Set the maximum correction rate: specify the maximum correction rate of 0 - 100% in hexadecimal. When P5.093.UZ = 0x00 - 0x64%, it limits the correctable range to avoid over-correction per time and causing machine vibration.
4) Set the PR trigger timing: set P5.093.A to 1 to immediately trigger the PR command for correction. Set P5.093.A to 0 to manually trigger the PR command.
5) Set the mark position: set P5.093.B to 0 to mark on other motion axis and the following mark positions are not changed when positioning. Set P5.093.B to 1 to mark on the motion axis for compensation, but this changes the following mark positions when positioning.
6) Set the triggering method: set P5.093.C to 0 to use the general DI with event triggering. Set P5.093.C to 1 to use the high speed DI7 with Capture function as the triggering method; meanwhile, set the pulse source of the master axis (P5.088.Y = 0) as the Capture axis. When the last position data is captured, execute PR#50 (P5.039.X Bit3 = 1) to perform the compensation. This is suitable for high precision applications.
7) Set the compensation for the DI time delay: set P5.094 as -25000 to 25000 (µs) to compensate the delay time for the sensor and the signal transmission.
8) Set the allowable forward rate: set P5.095 to 0 - 100% to specify the allowable forward rotation rate.



9) Set the positioning pulse number: use P5.096 to set the pulse number (position) of the master axis for positioning. The setting range is as follows:

$$0 \leq \text{P5.096 (Pulse)} < \frac{P5.084}{P5.083}$$

10) Enable Macro #E: set P5.097 = 0x000E to enable Macro #E. Read P5.097 and if it returns 0x100E, it means the macro execution is successful. If any of the following failure codes shows, modify the setting according to the description.

Failure Code	***Description***
0xF0E1	When executing this macro command, the clutch is not in the engaged status.
0xF0E2	PR number specified by P5.093.YX exceeds the range (0x01 - 0x63).
0xF0E3	P5.093.UZ maximum correctable rate exceeds the range (0x00 - 0x64%).
0xF0E4	P5.094 DI delay time compensation exceeds the range (-25000 to 25000 µs).
0xF0E5	P5.095 allowable forward rate exceeds the range (0 - 100%).
0xF0E6	P5.096\ pulse number (position) of the master axis for positioning exceeds the range (0 ≤ P5.096).
0xF0E7	P5.093 setting value exceeds the range (0x0000 - 0x0111).
0xF0E8	When using DI7 with the Capture function for triggering (P5.093.C = 1), the Capture axis has to be the source pulse of the master axis (P5.088.Y = 0).
0xF0E9	When using DI7 with the Capture function for triggering (P5.093.C = 1), execute PR#50 (P5.039.X Bit3 = 1) for compensation after the last data is captured.

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Macro #F - Use the deviation between the current slave axis position and the target position for PR positioning

When the master axis stops but the E-Cams remain engaged, this macro can move the slave axis to the specified position and then return it to the original position. The specified position is specified with the master axis pulse number. After Macro #F is triggered, the servo calculates the required moving amount for the slave axis to move to the specified position and writes this moving amount to the two PR incremental position commands (onward and return trips). Trigger the onward trip PR command, and the slave axis moves to the target position. Trigger the return PR command, and the slave axis returns to the original position. This macro is suitable for applications that require moving the slave axis while the system or the master axis is stopped. The operation is shown in Figure 7-121.

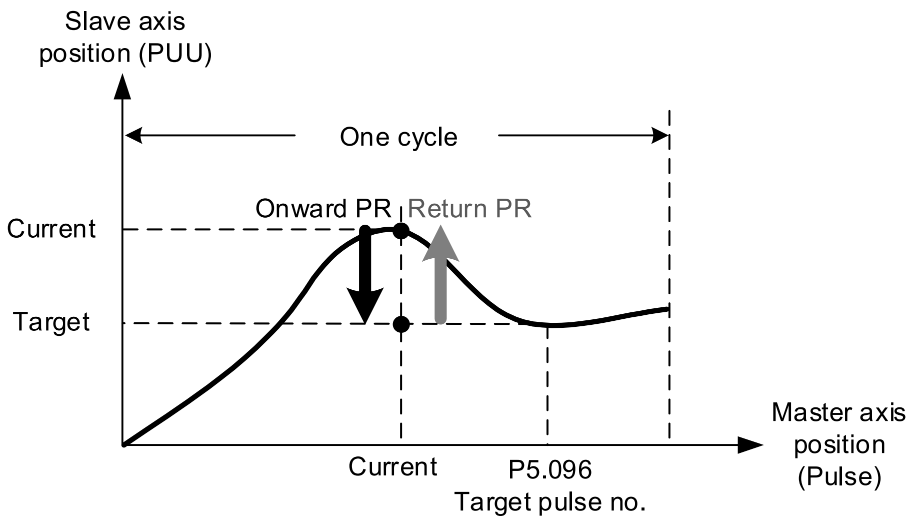
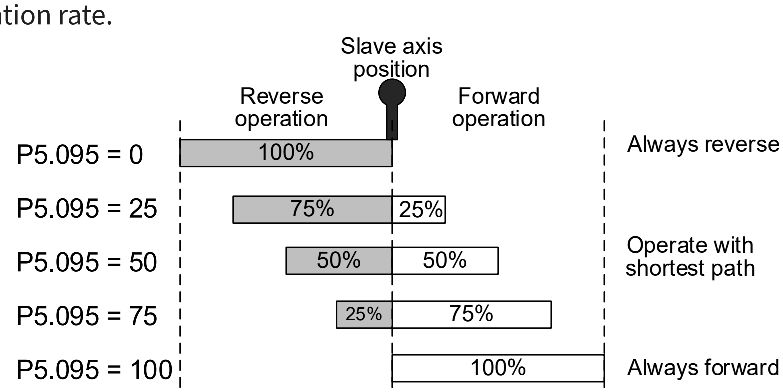


Figure 7-121 Macro #F operation

Setting steps:

1) The master axis stops and the clutch is engaged.
2) Set the onward and return trip PR numbers: specify any of the PR from PR#1 - 99 in hexadecimal as the onward trip PR command. Set P5.093.YX = 0x01 - 0x63 and set this PR as the incremental position command. Set any of the PR from PR#1 - 99 as the return trip PR command. Set P5.093.UZ = 0x01 - 0x63 and set this PR as the incremental position command. Do not use the same PR number at the same time.
3) Set the allowable forward rate: set P5.095 to 0 - 100% to specify the allowable forward rotation rate.



4) Set the target pulse number: use P5.096 to specify the master axis pulse number of the target position, which range is as follows:

$$0 \leq \text{P5.096 (Pulse)} < \frac{P5.084}{P5.083}$$

5) Enable Macro #F: set P5.097 = 0x000F to enable Macro #F. Read P5.097 and if it returns 0x100F, it means the macro execution is successful. If any of the following failure codes shows, modify the setting according to the description.

Failure Code	***Description***
0xF0F1	When executing this macro command, the clutch is not in the engaged status.
0xF0F2	PR number of onward trip specified by P5.093.YX exceeds the range (0x01 - 0x63).
0xF0F3	PR number of return trip specified by P5.093.UZ exceeds the range (0x01 - 0x63).
0xF0F5	P5.095 allowable forward rate exceeds the range (0 - 100%).
0xF0F6	P5.096 master axis pulse number of the target position exceeds the range (0 ≤ P5.096).

Macro #10 - the slave axis immediately pauses for one cycle

When the clutch is engaged and the slave axis operates in forward direction, this macro can stop one cycle of the slave axis operation and then the operation resumes. To stop for multiple cycles, consecutively trigger Macro #10 for a number of times. The servo drive records the number of times Macro #10 is triggered and the slave axis will stop for the number of cycles accordingly. When using this macro, use P1.022 PR special filter and set P1.022.YX acceleration time limit (the required time for the motor to accelerate from 0 to 3000 rpm, that range is 10–1270 ms).

If the acceleration or deceleration time is shorter than the acceleration time limit, then the filter takes effect and smooths the acceleration or deceleration process, preventing the command from changing too drastically and machine vibration. The following error caused by the smooth command will be compensated after the command changes become moderate, so the final position does not deviate. This macro is usually used for the empty pack prevention function on the packing machine. The operation is shown in Figure 7-122.

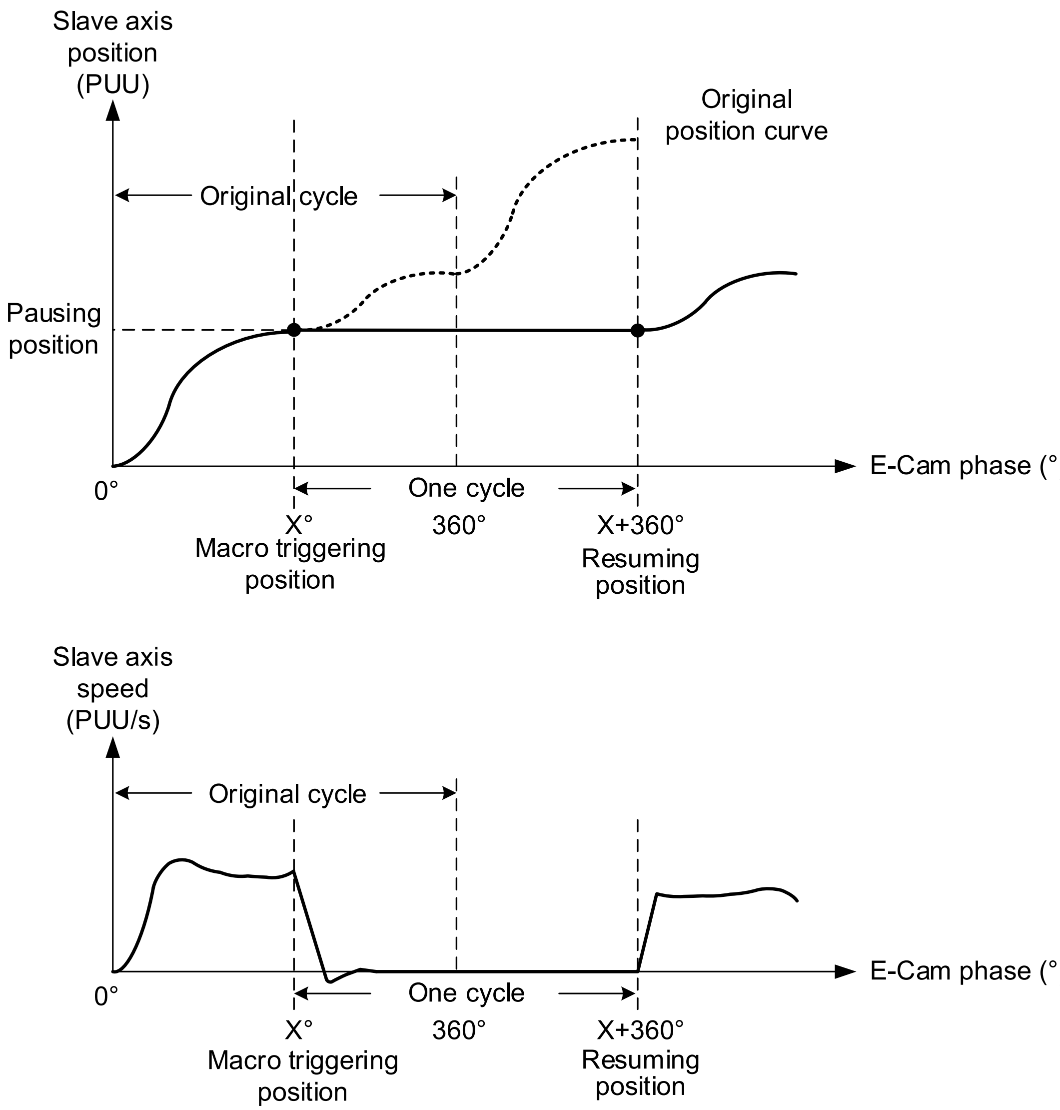


Figure 7-122 Macro #10 operation

Setting steps:

1) Engage the clutch.
2) Set P1.022.YX the acceleration time limit. If the reverse inhibit is required, set P1.022.U.
3) Enable Macro #10: set P5.097 = 0x0010 to enable Macro #10. Read P5.097 and if it returns 0x1010, it means the macro execution is successful. If any of the following failure codes shows, modify the setting according to the description.

Failure Code	*Description*
0xF101	When executing this macro command, the clutch is not in the engaged status.
0xF102	Set P5.093 to 0.
0xF103	The slave axis must operate in forward direction. Check the E-Cam curve and P5.019 E-Cam curve scaling.
0xF104	Accumulated pause distance exceeds 2^{31}. Do not execute this macro command consecutively.

NOTE: *This function is accumulative. If the command is triggered for N times consecutively, it pauses the E-Cam for N cycles. Note that the accumulated pause distance cannot exceed the range. When the pause cycle is complete, the slave axis continues to operate and the accumulated pause distance is cleared to 0.*

7.3.10 - Auxiliary function

Following error compensation

There are two factors causing the following error. The first is the servo error, which is generated by the position loop and can be eliminated by the position integral compensation (P2.053).

The second is the command processing delay, which is the delay caused by the filter or command. For the general point-to-point motion, the servo waits for the positioning complete signal and then proceed to the next command. This does not generate too much following error and affect the motion. However, for E-Cam applications, you must reduce the following error, or the E-Cam phase can deviate, and thus reducing the machining precision.

To enable the following error compensation function, set P1.036 to 1. Meanwhile, set P1.008 (Position command smoothing constant) to 0ms. Enable the position command moving filter (P1.068) and set the value to less than 10ms. Set the position integral compensation (P2.053) to less than 50. If you are not satisfied with the performance in the acceleration or deceleration stage, adjust the command response gain (P2.089) to reduce the following error. To have better performance in the synchronous speed zone, set the additional compensation time (P1.017) to compensate the deviation. The formula is as follows.

Compensation distance = P1.017 (additional compensation time) current motor speed

Excluding the following error caused by the machine, if the error is proportional to the speed (for example: 100 rpm with an error of 0.01%; 1000 rpm with an error of 0.1%), it could be caused by the electrical delay. In this case, use P1.018 and P1.021 to compensate the E-Cam phase. The compensation mechanism is as follows.

Compensation amount (pulse) = P1.018 (compensation time) x [Master axis pulse frequency (Kpps) – P1.021 (Minimum frequency of pulse compensation for the E-Cam master axis)]

The master axis pulse frequency can be monitored with monitoring variable 060(3Ch), which value has to be greater than the minimum compensation frequency.

Virtual master axis

During E-Cam operation, if there is a following error in the slave axis, use the virtual master axis to correct the cam phase. Virtual master axis operation is as shown in Figure 7-123.

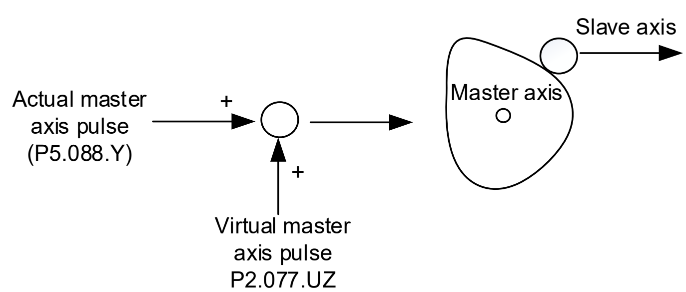


Figure 7-123 Virtual master axis operation

Use P2.077 to set the virtual master axis function. P2.077.X can mask the actual master axis pulses and determine how the virtual master axis pulses are generated, as shown in the following table.

<table>
<tr><th>X</th><th>Function</th><th>Actual Master Axis Pulse</th><th>Virtual Master Axis Pulse</th><th>Description</th></tr>
<tr><td>0</td><td>Function disabled</td><td>Receive actual master axis pulse</td><td rowspan="2">Disable</td><td>Slave axis operates based on the actual master axis pulses.</td></tr>
<tr><td>1</td><td>Mask the master axis pulses</td><td rowspan="5">Masked</td><td>Slave axis stops operating, but the masked master axis pulse number continues to be stored in the internal variable.</td></tr>
<tr><td>2</td><td>Continuous forward running</td><td rowspan="4">Enable</td><td rowspan="2">Command source is the virtual pulse frequency set in P2.077.UZ (unit: Kpps). This virtual pulse function continues to operate. To stop it, set X to 1.</td></tr>
<tr><td>3</td><td>Continuous reverse running</td></tr>
<tr><td>4</td><td>Forward JOG</td><td rowspan="2">Command source is the virtual pulse number set in P2.077.UZ (unit: pulse). This function only refers to the pulse number set in P2.077.UZ.</td></tr>
<tr><td>5</td><td>Reverse JOG</td></tr>
<tr><td>6 - 8</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>9</td><td>Master axis pulse masked</td><td rowspan="5">Receive actual master axis pulse</td><td>Disable</td><td>Slave axis operates based on the actual master axis pulses. The master axis pulse number continues to be stored in the internal variable.</td></tr>
<tr><td>A</td><td>Continuous forward running</td><td rowspan="4">Enable</td><td rowspan="2">Command source is the frequency transmitted by the actual master axis (P5.088 Y) plus the virtual pulse frequency in Kpps set by P2.077.UZ. This virtual pulse function continues to operate. To stop it, set X to 9.</td></tr>
<tr><td>B</td><td>Continuous reverse running</td></tr>
<tr><td>C</td><td>Forward JOG</td><td rowspan="2">Command source is the pulse transmitted by the actual master axis (P5.088.Y) plus the virtual pulse number in pulses set by P2.077.UZ. This function is often used for dynamic adjustment.</td></tr>
<tr><td>D</td><td>Reverse JOG</td></tr>
</table>

P2.077.Y sets whether to write the pulse number of the virtual master axis to P5.087 (initial lead pulse before engaged).

- *When the setting of P2.077.Y is changed from 0 to 1, write the pulse number of the virtual master axis to P5.087.*
- *When the setting of P2.077.Y is changed from 0 to 2, write the pulse number of the virtual master axis to P5.087 and store in EEPROM as non-volatile data.*
- *When the setting of P2.077.Y is changed from 0 to 7, write the pulse number of the virtual master axis plus the pulse number of one cycle to P5.087 and store in EEPROM as non-volatile data. The value written to P5.087 has to be positive. When the pulse number of the virtual master axis is negative, the system automatically makes it a positive number by adding the master axis pulses of one or multiple cycles and then write this value to P5.087.*
- *The virtual master pulse number set in P2.077.UZ is hexadecimal. If selecting continuous forward or reverse operation, the unit is Kpps. If selecting jog operation in forward or reverse direction, the unit is pulse.*

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Chapter 8: Parameters

Chapter 8

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INTRODUCTION

This chapter introduces the parameter settings of the servo drive, as well as the descriptions for digital input (DI) and digital output (DO). You can control the drive functions with these parameters through communications and/or DI/O.

All parameters consume two 16-bit registers. Some parameters only need the low word since the value range does not require the high word. Parameters that require both the low word and high word will populate all 32 bits.

8.1 - Parameter definitions

The servo drive parameters are divided into eight groups. The first character after the start code P is the group character and the following three characters are the parameter indicator. The communication address is the combination of the group number and the three-digit number, expressed in hexadecimal. The parameter groups are:

- *Group 0: Monitoring parameters* *(Example: P0.xxx)*
- *Group 1: Basic parameters* *(Example: P1.xxx)*
- *Group 2: Extension parameters* *(Example: P2.xxx)*
- *Group 3: Communication parameters* *(Example: P3.xxx)*
- *Group 4: Diagnosis parameters* *(Example: P4.xxx)*
- *Group 5: Motion control parameters* *(Example: P5.xxx)*
- *Group 6: PR parameters* *(Example: P6.xxx)*
- *Group 7: PR parameters* *(Example: P7.xxx)*

Control mode description:

PT: Position control (command input through terminal block)

PR: Position control (command sent from internal register)

S: Speed control

T: Torque control

Special symbol description:

Icon of Parameter Property	***Description***
★	Read-only parameter. Can only read the value of the parameter. For example, P0.000, P0.010, P4.000, etc.
▲	Parameter cannot be changed when servo is in Servo On status. For example, P1.000 and P1.046.
●	Parameter changes become valid after cycling the power. For example, P1.000 and P3.000.
■	Parameter resets to its default value after cycling the power. For example, P2.031.

8.2 - Parameter Summaries

8.2.1 - P0.xxx Monitoring Parameters

P0.xxx Parameters						
Param. No.	**Function**	**Range**	**Run Read/ Write**	**Address**	**Default**	**User**
P0.000	Firmware version	n/a	Read	0000H 0001H	Factory setting	
P0.001	Current drive alarm code	0X0000: alarm clear (same as DI.ARST). 0x0001–0xFFFF: displays the alarm code (not writable)	Read/Write■	0002H 0003H	–	
P0.002	LED Display Definition	-300 to +127	Read/Write	0004H 0005H	0	
P0.003	Analog output monitoring	0–77	Read/Write	0006H 0007H	0x0000	
P0.004	Reserved	–	–	–	–	
P0.005	Reserved	–	–	–	–	
P0.006	Reserved	–	–	–	–	
P0.007	Reserved	–	–	–	–	
P0.008	Total servo drive operation time	0–FFFFFFFF hours	Read	0010H 0011H	0	
P0.009	Status monitoring register 1	–	Read■	0012H 0013H	0	
P0.010	Status monitoring register 2	–	Read■	0014H 0015H	0	
P0.011	Status monitoring register 3	–	Read■	0016H 0017H	0	
P0.012	Status monitoring register 4	–	Read■	0018H 0019H	0	
P0.013	Status monitoring register 5	–	Read■	001AH 001BH	0	
P0.014	Reserved	–	–	–	–	
P0.015	Reserved	–	–	–	–	
P0.016	Reserved	–	–	–	–	
P0.017	Select content displayed by status monitoring register 1	0–127	Read/Write	0022H 0023H	0	
P0.018	Select content displayed by status monitoring register 2	0–127	Read/Write	0024H 0025H	0	
P0.019	Select content displayed by status monitoring register 3	0–127	Read/Write	0026H 0027H	0	
P0.020	Select content displayed by status monitoring register 4	0–127	Read/Write	0028H 0029H	0	
P0.021	Select content displayed by status monitoring register 5	0–127	Read/Write	002AH 002BH	0	
P0.022	Reserved	–	–	–	–	
P0.023	Reserved	–	–	–	–	
P0.024	Reserved	–	–	–	–	
▲=Cannot change while Servo On, ●=Cycle power to enable value, ■=Resets to default on power cycle						

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P0.xxx Parameters (continued)						
Param. No.	***Function***	***Range***	***Run Read/ Write***	***Address***	***Default***	***User***
P0.025	Mapping parameter #1	Determined by the corresponding parameter P0.035	Read/Write■	0032H 0033H	–	
P0.026	Mapping parameter #2	Determined by the corresponding parameter P0.036	Read/Write■	0034H 0035H	–	
P0.027	Mapping parameter #3	Determined by the corresponding parameter P0.037	Read/Write■	0036H 0037H	–	
P0.028	Mapping parameter #4	Determined by the corresponding parameter P0.038	Read/Write■	0038H 0039H	–	
P0.029	Mapping parameter #5	Determined by the corresponding parameter P0.039	Read/Write■	003AH 003BH	–	
P0.030	Mapping parameter #6	Determined by the corresponding parameter P0.040	Read/Write■	003CH 003DH	–	
P0.031	Mapping parameter #7	Determined by the corresponding parameter P0.041	Read/Write■	003EH 003FH	–	
P0.032	Mapping parameter #8	Determined by the corresponding parameter P0.042	Read/Write■	0040H 0041H	–	
P0.033	Reserved	–	–	–	–	
P0.034	Reserved	–	–	–	–	
P0.035	Target setting for mapping parameter P0.025	Determined by the communication address of the parameter group	Read/Write	0046H 0047H	–	
P0.036	Target setting for mapping parameter P0.026	Determined by the communication address of the parameter group	Read/Write	0048H 0049H	–	
P0.037	Target setting for mapping parameter P0.027	Determined by the communication address of the parameter group	Read/Write	004AH 004BH	–	
P0.038	Target setting for mapping parameter P0.028	Determined by the communication address of the parameter group	Read/Write	004CH 004DH	–	
P0.039	Target setting for mapping parameter P0.029	Determined by the communication address of the parameter group	Read/Write	004EH 004FH	–	
P0.040	Target setting for mapping parameter P0.030	Determined by the communication address of the parameter group	Read/Write	0050H 0051H	–	
P0.041	Target setting for mapping parameter P0.031	Determined by the communication address of the parameter group	Read/Write	0052H 0053H	–	
▲=Cannot change while Servo On, ●=Cycle power to enable value, ■=Resets to default on power cycle						

P0.xxx Parameters (continued)						
Param. No.	**Function**	**Range**	**Run Read/ Write**	**Address**	**Default**	**User**
P0.042	Target setting for mapping parameter P0.032	Determined by the communication address of the parameter group	Read/Write	0054H 0055H	–	
P0.043	Reserved	–	–	–	–	
P0.044	Reserved	–	–	–	–	
P0.045	Reserved	–	–	–	–	
P0.046	Commonly used DO function status	0x00–0xFF	Read■	005CH 005DH	0x0000	
P0.049	Update encoder absolute position registers	0x00–0x02	Read/Write	0062H 0063H	0x0000	
P0.050	Absolute coordinate system status	0x00–0x1F	Read■	0064H 0065H	0x0000	
P0.051	Encoder absolute position - Number of turns	-32786 to +32767 rev	Read■	0066H 0067H	0	
P0.052	Encoder absolute position - Pulse number or PUU within single turn	0–16777216-1 (pulse) -2147483648 to +2147483647 (PUU)	Read■	0068H 0069H	0	
P0.053	General range compare DO output - Filter time	0x0000–0x000F ms	Read/Write	006AH 006BH	0x0000	
P0.054	General range compare DO - first lower limit	-2147483648 to +2147483647	Read/Write	006CH 006DH	0	
P0.055	General range compare DO - first upper limit	-2147483648 to +2147483647	Read/Write	006EH 006FH	0	
P0.056	General range compare DO - second lower limit	-2147483648 to +2147483647	Read/Write	0071H 0072H	0	
P0.057	General range compare DO - second upper limit	-2147483648 to +2147483647	Read/Write	0073H 0074H	0	
P0.058	General range compare DO - third lower limit	-2147483648 to +2147483647	Read/Write	0075H 0076H	0	
P0.059	General range compare DO - third upper limit	-2147483648 to +2147483647	Read/Write	0077H 0078H	0	
P0.060	General range compare DO - fourth lower limit	-2147483648 to +2147483647	Read/Write	0079H 007AH	0	
P0.061	General range compare DO - fourth upper limit	-2147483648 to +2147483647	Read/Write	007BH 007CH	0	
P0.062	Reserved	–	–	–	–	
P0.063	Duration of DC Bus voltage exceeding 400V	0x00000000 to 0x7FFFFFFF ms	Read■	007EH 007FH	0	
P0.064	Reserved	–	–	–	–	
P0.065	Reserved	–	–	–	–	
P0.066	Reserved	–	–	–	–	
P0.067	Reserved	–	–	–	–	
P0.068	Reserved	–	–	–	–	
▲=Cannot change while Servo On, ●=Cycle power to enable value, ■=Resets to default on power cycle						

8.2.2 - P1.xxx Basic Parameters

P1.xxx Parameters						
Param. No.	**Function**	**Range**	**Run Read/ Write**	**Address**	**Default**	**User**
P1.000	External pulse input type	0x0000–0x11F2	Read/Write	0100H 0101H	0x1042	
P1.001	Input for control mode and control command	0x0000–0x111F P (pulse) or S (rpm) or T (N·m)	Read/Write ●	0102H 0103H	0x0000	
P1.002	Speed and torque limits	00–11	Read/Write ▲	0104H 0105H	0x0000	
P1.003	Analog and Encoder pulse output polarity	0–13	Read/Write	0106H 0107H	0x0000	
P1.004	MON1 analog monitor output proportion	0–100 % (full scale)	Read/Write	0108H 0109H	100	
P1.005	MON2 analog monitor output proportion	0–100 % (full scale)	Read/Write	010AH 010BH	100	
P1.006	Speed command smoothing constant (low-pass filter)	0–1000 ms	Read/Write	010CH 010DH	0	
P1.007	Torque command smoothing constant (low-pass filter)	0–1000 ms	Read/Write	010EH 010FH	0	
P1.008	Position command smoothing constant (low-pass filter)	0–1000 m	Read/Write	0110H 0111H	0	
P1.009	Internal Speed command 1 / internal speed limit 1	-60000 to +60000 (0.1 rpm)	Read/Write	0112H 0113H	1000	
P1.010	Internal Speed command 2 / internal speed limit 2	-60000 to +60000 (0.1 rpm)	Read/Write	0114H 0115H	1000	
P1.011	Internal Speed command 3 / internal speed limit 3	-60000 to +60000 (0.1 rpm)	Read/Write	0116H 0117H	1000	
P1.012	Internal Torque command 1 / internal torque limit 1	-400 to +400 %	Read/Write	0118H 0119H	100	
P1.013	Internal Torque command 2 / internal torque limit 2	-400 to +400 %	Read/Write	011AH 011BH	100	
P1.014	Internal Torque command 3 / internal torque limit 3	-400 to +400 %	Read/Write	011CH 011DH	100	
P1.015	Reserved	–	–	–	–	
P1.016	Reserved	–	–	–	–	
P1.017	Additional compensation time for the following error	-25.000 to +25.000	Read/Write	0122H 0123H	0	
P1.018	E-Cam: compensation time for the pulse of E-Cam master axis	-25.000 to +25.000	Read/Write	0124H 0125H	0	
P1.019	Capture / Compare additional function settings	0x0000–0x0101	Read/Write	0126H 0127H	0x0000	
P1.020	Capture - Masking range	0–100000000 pulse unit of capture source	Read/write	0128H 0129H	0	
▲=Cannot change while Servo On, ●=Cycle power to enable value, ■=Resets to default on power cycle						

P1.xxx Parameters (continued)						
Param. No.	**Function**	**Range**	**Run Read/ Write**	**Address**	**Default**	**User**
P1.021	E-Cam: minimum frequency of pulse compensation for the E-Cam master axis	0 to +30000	Read/Write	012AH 012BH	0	
P1.022	PR command special filter	0x0000 to 0x107F	Read/Write	012CH 012DH	0x0000	
P1.023	Compare - Data translation (non-volatile)	-10000000 to +100000000 pulse unit of compare source	Read/Write	012EH 012FH	0	
P1.024	Compare - Data translation (reset automatically)	-32768 to +32767 pulse unit of compare source	Read/Write■	0130H 0131H	0	
P1.025	Low-frequency vibration suppression frequency (1)	10–1000 0.1 Hz	Read/Write	0132H 0133H	1000	
P1.026	Low-frequency vibration suppression gain (1)	0–9	Read/Write	0134H 0135H	0	
P1.027	Low-frequency vibration suppression frequency (2)	10–1000 0.1 Hz	Read/Write	0136H 0137H	1000	
P1.028	Low-frequency vibration suppression gain (2)	0–9	Read/Write	0138H 0139H	0	
P1.029	Auto low-frequency vibration suppression mode	0–1	Read/Write	013AH 013BH	0	
P1.030	Low-frequency vibration detection level	1–8000 pulse	Read/Write	013CH 013DH	800	
P1.031	Reserved	–	–	–	–	
P1.032	Motor stop mode	0–20	Read/Write	0140H 0141H	0x0000	
P1.033	Reserved	–	–	–	–	
P1.034	Acceleration time constant (TACC)	1–65500 ms	Read/Write	0144H 0145H	200	
P1.035	Deceleration time constant (TDEC)	1–65500 ms	Read/Write	0146H 0147H	200	
P1.036	S-curve acceleration / deceleration time constant (TSL)	0–65500 ms	Read/Write	0148H 0149H	0	
P1.037	Load inertia ratio to servo motor	Panel/Software: 0.0–200.0 (1 times)	Read/Write	014AH 014BH	6.0	
		Communication: 0–2000 (0.1 times)			60	
P1.038	Zero speed range	Panel/Software: 0.0–200.0 (1 rpm)	Read/Write	014CH 014DH	10.0	
		Communication: 0–2000 (0.1 rpm)			100	
P1.039	Target speed detection level	0–30000 rpm	Read/Write	014EH 014FH	3000	
P1.040	Maximum rotation speed for analog Speed command	0–50000 rpm	Read/Write	0150H 0151H	3000	
▲=Cannot change while Servo On, ●=Cycle power to enable value, ■=Resets to default on power cycle						

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P1.xxx Parameters (continued)						
Param. No.	**Function**	**Range**	**Run Read/ Write**	**Address**	**Default**	**User**
P1.041	Maximum output for analog Torque command	-1000 to +1000 %	Read/Write	0152H 0153H	100	
P1.042	Delay time for releasing the magnetic brake	0–1000 ms	Read/Write	0154H 0155H	0	
P1.043	Delay time for engaging the magnetic brake	-1000 to +1000 ms	Read/Write	0156H 0157H	0	
P1.044	E-Gear ratio (Numerator) (N1)	1 to (2^{29}-1) pulse	Read/Write	0158H 0159H	16777216	
P1.045	E-Gear ratio (Denominator) (M)	1 to (2^{31}-1) pulse	Read/Write	015AH 015BH	100000	
P1.046	Encoder pulse number output	20–536870912 pulse	Read/Write▲	015CH 015DH	2500	
P1.047	Speed reached (DO. SP_OK) range	0–300 rpm	Read/Write	015EH 015FH	10	
P1.048	Motion reached (DO.MC_ OK) operation selection	0x0000 - 0x0011	Read/Write	0160H 0161H	0x0000	
P1.049	Accumulated time to reach desired speed	0 - 65535 ms	Read/Write	0162H 0163H	0	
P1.050	Reserved	–	–	–	–	
P1.051	Reserved	–	–	–	–	
P1.052	Regenerative resistor value	See parameter details	Read/Write	0168H 0169H	Determined by the model.	
P1.053	Regenerative resistor watts	0 - 15000 Watt	Read/Write	016AH 016BH	Determined by the model.	
P1.054	Pulse range for position reached	0 - 16777216 pulse	Read/Write	016CH 016DH	167772	
P1.055	Maximum speed limit	0 to maximum speed rpm	Read/Write	016EH 016FH	Rated speed	
P1.056	Motor output overload warning level	0 - 120 %	Read/Write	0170H 0171H	120	
P1.057	Motor hard stop (torque percentage)	0 - 300 %	Read/Write	0172H 0173H	0	
P1.058	Motor hard stop (protection time)	1 - 1000 ms	Read/Write	0174H 0175H	1	
P1.059	Speed command - moving filter	Panel/software: 0.0–4.0 (1 ms)	Read/Write	0176H 0177H	0.0	
		Communication: 0–40 (0.1 ms)			0	
P1.060	Reserved	–	–	–	–	
P1.061	Reserved	–	–	–	–	
P1.062	Percentage of friction compensation	0 - 100 %	Read/Write	017CH 017DH	0	
P1.063	Constant of friction compensation	1 - 1000 ms	Read/Write	017EH 017FH	1	
P1.064	Analog position command: activation control	0x0000 - 0x0011	Read/Write	0180H 0181H	0x0000	
▲=Cannot change while Servo On, ●=Cycle power to enable value, ■=Resets to default on power cycle						

P1.xxx Parameters (continued)						
Param. No.	**Function**	**Range**	**Run Read/ Write**	**Address**	**Default**	**User**
P1.065	Smooth constant of analog Position command	1–1000 (10 ms)	Read/Write	0182H 0183H	1	
P1.066	Maximum rotation number of analog Position command	Panel/software: 0.0–200.0 (1 rev)	Read/Write	0184H 0185H	1.0	
		Communication: 0–2000 (0.1 rev)			10	
P1.067	Reserved	–	–	–	–	
P1.068	Position command - moving filter	0–100 ms	Read/Write	0188H 0189H	4	
P1.069	Reserved	–	–	–	–	
P1.070	Reserved	–	–	–	–	
P1.071	Reserved	–	–	–	–	
P1.072	Resolution of auxiliary encoder for full-closed loop and Gantry control	200–1280000 pulse/ rev	Read/Write	0190H 0191H	5000	
P1.073	Error protection range for full-closed loop control	1 to (2^{31}-1) pulse	Read/Write	0192H 0193H	30000	
P1.074	Full-closed loop control for auxiliary encoder	0000h - F132h	Read/Write	0194H 0195H	0x0000	
P1.075	Low-pass filter time constant for full- / half-closed loop control	0–1000 ms	Read/Write	0196H 0197H	100	
P1.076	Maximum speed for encoder output (OA, OB)	0–6000 rpm	Read/Write▲	0198H 0199H	5500	
P1.077	Reserved	–	–	–	–	
P1.078	Reserved	–	–	–	–	
P1.079	Reserved	–	–	–	–	
P1.080	Reserved	–	–	–	–	
P1.081	Second set of maximum rotation speed for analog Speed command	0–50000 rpm/10V	Read/Write	01A2H 01A3H	Motor rated speed	
P1.082	Filter switching time between P1.040 and P1.081	0–1000 ms (0: disable this function)	Read/Write	01A4H 01A5H	0	
P1.083	Abnormal analog input voltage level	0–12000 mV (0: disable this function)	Read/Write	01A6H 01A7H	0	
P1.084	Error clearing function when switching between full- and half-closed loops	0x0000–0x0001	Read/Write▲	01A8H 01A9H	0	
P1.085	Auto clearing position deviation between motor and auxiliary encoder	0–32767	Read/Write	01AAH 01ABH	0	
P1.086	Reserved	–	–	–	–	
P1.087	Torque homing - torque level detection	1–300 %	Read/Write	01AEH 01AFH	1	
P1.088	Torque homing - level reached timer	2–2000 ms	Read/Write	01B0H 01B1H	2000	
▲=Cannot change while Servo On, ●=Cycle power to enable value, ■=Resets to default on power cycle						

P1.xxx Parameters (continued)						
Param. No.	***Function***	***Range***	***Run Read/ Write***	***Address***	***Default***	***User***
P1.089	First set of vibration elimination - anti-resonance frequency	10–4000 (0.1 Hz)	Read/Write	01B2H 01B3H	4000	
P1.090	First set of vibration elimination - resonance frequency	10–4000 (0.1 Hz)	Read/Write	01B4H 01B5H	4000	
P1.091	First set of vibration elimination - resonance difference	10–4000 (0.1 dB)	Read/Write	01B6H 01B7H	10	
P1.092	Second set of vibration elimination - anti-resonance frequency	10–4000 (0.1 Hz)	Read/Write	01B8H 01B9H	4000	
P1.093	Second set of vibration elimination - resonance frequency	10–4000 (0.1 Hz)	Read/Write	01BAH 01BBH	4000	
P1.094	Second set of vibration elimination - resonance difference	10–4000 (0.1 dB)	Read/Write	01BCH 01BDH	10	
P1.095	Reserved	–	–	–	–	
P1.096	Reserved	–	–	–	–	
P1.097	Encoder output denominator (OA, OB)	0–160000	Read/Write▲	01C2H 01C3H	0	
P1.098	Disconnection detection protection (UVW) response time	0, 100–800 ms	Read/Write	01C4H 01C5H	0	
P1.099	Reserved	–	–	–	–	
P1.100	Reserved	–	–	–	–	
P1.101	Analog monitor output voltage 1	-10000 to 10000 mV	Read/Write■	01CAH 01CBH	0	
P1.102	Analog monitor output voltage 2	-10000 to 10000 mV	Read/Write■	01CCH 01CDH	0	
P1.103	Reserved	–	–	–	–	
P1.104	Reserved	–	–	–	–	
P1.105	Reserved	–	–	–	–	
P1.106	Reserved	–	–	–	–	
P1.107	Reserved	–	–	–	–	
P1.108	Reserved	–	–	–	–	
P1.109	Reserved	–	–	–	–	
P1.110	Reserved	–	–	–	–	
P1.111	Overspeed protection level	0–66000 (rotary, rpm)	Read/Write	01DEH 01DFH	Max. motor speed x 1.1	
▲=Cannot change while Servo On, ●=Cycle power to enable value, ■=Resets to default on power cycle						

8.2.3 - P2.xxx Extension Parameters

P2.xxx Parameters						
Param. No.	**Function**	**Range**	**Run Read/ Write**	**Address**	**Default**	**User**
P2.000	Position control gain	0–2047 rad/s	Read/Write	0200H 0201H	35	
P2.001	Position control gain rate of change	10–500 %	Read/Write	0202H 0203H	100	
P2.002	Position feed forward gain	0–100 %	Read/Write	0204H 0205H	50	
P2.003	Position feed forward gain smoothing constant	2–100 ms	Read/Write	0206H 0207H	5	
P2.004	Speed control gain	0–8191 rad/s	Read/Write	0208H 0209H	500	
P2.005	Speed control gain rate of change	10–500 %	Read/Write	020AH 020BH	100	
P2.006	Speed integral compensation	0–1023 rad/s	Read/Write	020CH 020DH	100	
P2.007	Speed feed forward gain	0–100 %	Read/Write	020EH 020FH	0	
P2.008	Special parameter write-in function	0–65535	Read/Write	0210H 0211H	0	
P2.009	DI response filter time	0–20 ms	Read/Write	0212H 0213H	2	
P2.010	DI1 functional planning	0–0x015F (last two codes are DI codes)	Read/Write	0214H 0215H	0x0101	
P2.011	DI2 functional planning	0–0x015F (last two codes are DI codes)	Read/Write	0216H 0217H	0x0104	
P2.012	DI3 functional planning	0–0x015F (last two codes are DI codes)	Read/Write	0218H 0219H	0x0116	
P2.013	DI4 functional planning	0–0x015F (last two codes are DI codes)	Read/Write	021AH 021BH	0x0117	
P2.014	DI5 functional planning	0–0x015F (last two codes are DI codes)	Read/Write	021CH 021DH	0x0102	
P2.015	DI6 functional planning	0–0x015F (last two codes are DI codes)	Read/Write	021EH 021FH	0x0022	
P2.016	DI7 functional planning	0–0x015F (last two codes are DI codes)	Read/Write	0220H 0221H	0x0023	
P2.017	DI8 functional planning	0–0x015F (last two codes are DI codes)	Read/Write	0222H 0223H	0x0021	
P2.018	DO1 functional planning	0–0x013F (last two codes are DO codes)	Read/Write	0224H 0225H	0x0101	
P2.019	DO2 functional planning	0–0x013F (last two codes are DO codes)	Read/Write	0226H 0227H	0x0103	
P2.020	DO3 functional planning	0–0x013F (last two codes are DO codes)	Read/Write	0228H 0229H	0x0109	
P2.021	DO4 functional planning	0–0x013F (last two codes are DO codes)	Read/Write	022AH 022BH	0x0105	
▲=Cannot change while Servo On, ●=Cycle power to enable value, ■=Resets to default on power cycle						

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P2.xxx Parameters (continued)						
Param. No.	**Function**	**Range**	**Run Read/ Write**	**Address**	**Default**	**User**
P2.022	DO5 functional planning	0–0x013F (last two codes are DO codes)	Read/Write	022CH 022DH	0x0007	
P2.023	Notch filter frequency (1)	50–5000 Hz	Read/Write	022EH 022FH	1000	
P2.024	Notch filter attenuation level (1)	0–40 -dB	Read/Write	0230H 0231H	0	
P2.025	Resonance suppression low-pass filter	Panel/software: 0.0–100.0 (1 ms)	Read/Write	0232H 0233H	1.0	
		Communication: 0–1000 (0.1 ms)			10	
P2.026	Anti-interference gain	0–1023 rad/s	Read/Write	0234H 0235H	0	
P2.027	Gain switching condition and method selection	0x0000 - 0x0018	Read/Write	0236H 0237H	0x0000	
P2.028	Gain switching time constant	0–1000 ms	Read/Write	0238H 0239H	10	
P2.029	Gain switching condition	0–50331648 pulse; Kpps; rpm	Read/Write	023AH 023BH	16777216	
P2.030	Auxiliary function	-8 to +8	Read/Write■	023CH 023DH	0	
P2.031	Frequency response bandwidth level	1–50	Read/Write	023EH 023FH	19	
P2.032	Gain adjustment mode	0–4	Read/Write	0240H 0241H	0x0001	
P2.033	Reserved	–	–	–	–	
P2.034	Speed command error warning	1–30000 rpm	Read/Write	0244H 0245H	5000	
P2.035	Excessive deviation of Position command warning	1–1677721600 pulse	Read/Write	0246H 0247H	50331648	
P2.036	DI9 functional planning	0–0x015F (last two codes are DI codes)	Read/Write	0248H 0249H	0x0000	
P2.037	DI10 functional planning	0–0x015F (last two codes are DI codes)	Read/Write	024AH 024BH	0x0000	
P2.038	VDI11 functional planning	0–0x015F (last two codes are DI codes)	Read/Write	024CH 024DH	0x0000	
P2.039	VDI12 functional planning	0–0x015F (last two codes are DI codes)	Read/Write	024EH 024FH	0x0000	
P2.040	VDI13 functional planning	0–0x015F (last two codes are DI codes)	Read/Write	0250H 0251H	0x0000	
P2.041	DO6 functional planning	0–0x013F (last two codes are DO codes)	Read/Write	0252H 0253H	0x0000	
P2.042	Reserved	–	–	–	–	
P2.043	Notch filter frequency (2)	50–5000 Hz	Read/Write	0256H 0257H	1000	
P2.044	Notch filter attenuation level (2)	0–40 -dB	Read/Write	0258H 0259H	0	
▲=Cannot change while Servo On, ●=Cycle power to enable value, ■=Resets to default on power cycle						

P2.xxx Parameters (continued)						
Param. No.	**Function**	**Range**	**Run Read/ Write**	**Address**	**Default**	**User**
P2.045	Notch filter frequency (3)	50–5000 Hz	Read/Write	025AH 025BH	1000	
P2.046	Notch filter attenuation level (3)	0–40 -dB	Read/Write	025CH 025DH	0	
P2.047	Auto resonance suppression mode	0x0000–0x01F2	Read/Write	025EH 025FH	0x0001	
P2.048	Auto resonance detection level	0–1000	Read/Write	0260H 0261H	100	
P2.049	Speed detection filter and jitter suppression	Panel/software: 0.0–100.0 (1 ms)	Read/Write	0262H 0263H	1.0	
		Communication: 0–1000 (0.1 ms)			10	
P2.050	Pulse Clear mode	0–1	Read/Write	0264H 0265H	0x0000	
P2.051	Reserved	–	–	–	–	
P2.052	Indexing coordinates scale	0–1000000000 PUU	Read/Write▲	0268H 0269H	1000000000	
P2.053	Position integral compensation	0–1023 rad/s	Read/Write	026AH 026BH	0	
P2.054	Synchronous speed control gain	0–8191 rad/s	Read/Write▲	026CH 026DH	0	
P2.055	Synchronous speed integral compensation	0–1023 rad/s	Read/Write▲	026EH 026FH	0	
P2.056	Synchronous position integral compensation	0–1023 rad/s	Read/Write▲	0270H 0271H	0	
P2.057	Synchronous control bandwidth	0–1023 Hz	Read/Write▲	0272H 0273H	0	
P2.058	Synchronous speed error low-pass filter	0–1000 0.1 ms	Read/Write	0274H 0275H	0	
P2.059	Max deviation between axes of gantry	-32768–32767	Read/Write	0276H 0277H	0	
P2.060	E-Gear ratio (numerator) (N2)	1 to (2^{29}-1) pulse	Read/Write	0278H 0279H	16777216	
P2.061	E-Gear ratio (numerator) (N3)	1 to (2^{29}-1) pulse	Read/Write	027AH 027BH	16777216	
P2.062	E-Gear ratio (numerator) (N4)	1 to (2^{29}-1) pulse	Read/Write	027CH 027DH	16777216	
P2.063	Reserved	–	–	–	–	
P2.064	Reserved	–	–	–	–	
P2.065	Special bit register	0–0xFFFF	Read/Write	0282H 0283H	0x0100	
P2.066	Special bit register 2	0x0000–0x182F	Read/Write	0284H 0285H	0x0020	
P2.067	Reserved	–	–	–	–	
P2.068	Following error compensation switch	0x00000000–0x00002101	Read/Write	0288H 0289H	0x00000000	
P2.069	Absolute encoder	0–1	Read/Write●	028AH 028BH	0x0000	
P2.070	Read data selection	0x00–0x07	Read/Write	028CH 028DH	0x0000	
▲=Cannot change while Servo On, ●=Cycle power to enable value, ■=Resets to default on power cycle						

P2.xxx Parameters (continued)						
Param. No.	***Function***	***Range***	***Run Read/ Write***	***Address***	***Default***	***User***
P2.071	Absolute position homing	0–1	Read/Write■	028EH 028FH	0x0	
P2.072	Reserved	–	–	–	–	
P2.073	Reserved	–	–	–	–	
P2.074	Reserved	–	–	–	–	
P2.075	Reserved	–	–	–	–	
P2.076	Reserved	–	–	–	–	
P2.077	Reserved	–	–	–	–	
P2.078	E-Cam: DO.CAM_ AREA#2 rising-edge phase	0–360 degree	Read/Write	029CH 029DH	270	
P2.079	E-Cam: DO.CAM_ AREA#2 falling-edge phase	0–360 degree	Read/Write	029EH 029FH	360	
P2.080	Z pulse souce of homing	0x0000–0x0011	Read/Write	02A0H 02A1H	0x0000	
P2.081	Reserved	–	–	–	–	
P2.082	Reserved	–	–	–	–	
P2.083	Reserved	–	–	–	–	
P2.084	Reserved	–	–	–	–	
P2.085	Reserved	–	–	–	–	
P2.086	Reserved	–	–	–	–	
P2.087	Reserved	–	–	–	–	
P2.088	Reserved	–	–	–	–	
P2.089	Command response gain	1–2000 rad/s	Read/Write	02B2H 02B3H	25	
P2.090	Reserved	–	–	–	–	
P2.091	Reserved	–	–	–	–	
P2.092	Reserved	–	–	–	–	
P2.093	Reserved	–	–	–	–	
P2.094	Special bit register 3	0x0000–0xF3A6	Read/Write▲	02BCH 02BDH	0x1000	
P2.095	Notch filter bandwidth (1)	1–10	Read/Write	02BEH 02BFH	5	
P2.096	Notch filter bandwidth (2)	1–10	Read/Write	02C0H 02C1H	5	
P2.097	Notch filter bandwidth (3)	1–10	Read/Write	02C2H 02C3H	5	
P2.098	Notch filter frequency (4)	50–5000 Hz	Read/Write	02C4H 02C5H	1000	
P2.099	Notch filter attenuation level (4)	0–40 -dB	Read/Write	02C6H 02C7H	0	
P2.100	Notch filter bandwidth (4)	1–10	Read/Write	02C8H 02C9H	5	
P2.101	Notch filter frequency (5)	50–5000 Hz	Read/Write	02CAH 02CBH	1000	
P2.102	Notch filter attenuation level (5)	0–40 -dB	Read/Write	02CCH 02CDH	0	
▲=Cannot change while Servo On, ●=Cycle power to enable value, ■=Resets to default on power cycle						

P2.xxx Parameters (continued)						
Param. No.	**Function**	**Range**	**Run Read/ Write**	**Address**	**Default**	**User**
P2.103	Notch filter bandwidth (5)	1–10	Read/Write	02CEH 02CFH	5	
P2.104	P/PI torque switching command condition	1–800 %	Read/Write	02D0H 02D1H	200	
P2.105	Auto-tuning Adjustment Bandwidth Level	1–21	Read/Write	02D2H 02D3H	11	
P2.106	Auto-tuning Adjustment Overshoot Level	1–50331648 pulse number	Read/Write	02D4H 02D5H	2000	
P2.107	Reserved	–	–	–	–	
P2.108	Reserved	–	–	–	–	
P2.109	Reserved	–	–	–	–	
P2.110	Reserved	–	–	–	–	
P2.111	Reserved	–	–	–	–	
P2.112	Special bit register 4	0x0000–0x001F	Read/Write▲	02E0H 02E1H	0x0008	
▲=Cannot change while Servo On, ●=Cycle power to enable value, ■=Resets to default on power cycle						

8.2.4 - P3.xxx Communication Parameters

P3.xxx Parameters						
Param. No.	**Function**	**Range**	**Run Read/ Write**	**Address**	**Default**	**User**
P3.000	Address	0x0001–0x007F	Read/Write●	0300H 0301H	0x007F	
P3.001	Transmission speed	0x000–0x3405	Read/Write●	0302H 0303H	0x0203	
P3.002	Communication protocol	0x0000–0x0008	Read/Write	0304H 0305H	0x0006	
P3.003	Communication error handling	0x0000–0x0001	Read/Write	0306H 0307H	0x0000	
P3.004	Communication timeout	0–20 seconds	Read/Write	0308H 0309H	0	
P3.005	Reserved	–	–	–	–	
P3.006	Digital input (DI) control switch	0x0000–0x1FFF	Read/Write	030CH 030DH	0x0000	
P3.007	Communication response delay time	0–1000 (0.5 ms)	Read/Write	030EH 030FH	0	
P3.008	Reserved	–	–	–	–	
P3.009	Reserved	–	–	–	–	
P3.010	Reserved	–	–	–	–	
P3.011	Reserved	–	–	–	–	
P3.012	Reserved	–	–	–	–	
P3.013	Full-closed loop feedback source for the controller	0x0000–0x0022	Read/Write	031AH 031BH	0x0000	
P3.014	Reserved	–	–	–	–	
▲=Cannot change while Servo On, ●=Cycle power to enable value, ■=Resets to default on power cycle						

P3.xxx Parameters (continued)						
Param. No.	**Function**	**Range**	**Run Read/ Write**	**Address**	**Default**	**User**
P3.015	Reserved	–	–	–	–	
P3.016	Reserved	–	–	–	–	
P3.017	Reserved	–	–	–	–	
P3.018	Reserved	–	–	–	–	
P3.019	Reserved	–	–	–	–	
P3.020	Reserved	–	–	–	–	
P3.021	Reserved	–	–	–	–	
P3.022	Reserved	–	–	–	–	
P3.023	Reserved	–	–	–	–	
P3.024	Reserved	–	–	–	–	
P3.025	Reserved	–	–	–	–	
P3.026	Reserved	–	–	–	–	
P3.027	Reserved	–	–	–	–	
P3.028	Reserved	–	–	–	–	
P3.029	Reserved	–	–	–	–	
P3.030	Reserved	–	–	–	–	
P3.031	Reserved	–	–	–	–	
P3.032	Reserved	–	–	–	–	
P3.033	Reserved	–	–	–	–	
P3.034	Reserved	–	–	–	–	
P3.035	Reserved	–	–	–	–	
P3.036	Reserved	–	–	–	–	
P3.037	Reserved	–	–	–	–	
P3.038	Reserved	–	–	–	–	
P3.039	Reserved	–	–	–	–	
P3.040	Reserved	–	–	–	–	
P3.041	Reserved	–	–	–	–	
P3.042	Reserved	–	–	–	–	
P3.043	Reserved	–	–	–	–	
P3.044	Reserved	–	–	–	–	
P3.045*	Communication card type	-32768–32767	Read	035AH 035BH	0	
P3.046*	Communication card firmware version	0x0000–0xFFFF	Read	035CH 035DH	0x0000	
P3.047*	Communication product code	-32768–32767	Read	035EH 035FH	0	
P3.048*	Communication card error status	-32768–32767	Read	0360H 0361H	0	
P3.049*	IP configuration	-32768–32767	Read/Write■	0362H 0363H	0	
P3.050*	IP address 1	-32768–32767	Read/Write■	0364H 0365H	192	
P3.051*	IP address 2	-32768–32767	Read/Write■	0366H 0367H	168	
P3.052*	IP address 3	-32768–32767	Read/Write■	0368H 0369H	1	
▲=Cannot change while Servo On, ●=Cycle power to enable value, ■=Resets to default on power cycle						

P3.xxx Parameters (continued)						
Param. No.	**Function**	**Range**	**Run Read/ Write**	**Address**	**Default**	**User**
P3.053*	IP address 4	-32768–32767	Read/Write■	036AH 036BH	10	
P3.054*	Net mask 1	-32768–32767	Read/Write■	036CH 036DH	255	
P3.055*	Net mask 2	-32768–32767	Read/Write■	036EH 036FH	255	
P3.056*	Net mask 3	-32768–32767	Read/Write■	0370H 0371H	255	
P3.057*	Net mask 4	-32768–32767	Read/Write■	0372H 0373H	0	
P3.058*	Gateway 1	-32768–32767	Read/Write■	0374H 0375H	0	
P3.059*	Gateway 2	-32768–32767	Read/Write■	0376H 0377H	0	
P3.060*	Gateway 3	-32768–32767	Read/Write■	0378H 0379H	0	
P3.061*	Gateway 4	-32768–32767	Read/Write■	037AH 037BH	0	
P3.062	Reserved	–	–	–	–	
P3.063	Reserved	–	–	–	–	
P3.064	Return to factory setting	-32768–32767	Read/Write■	0380H 0381H	0	
P3.065	Setting of communication card	-32768–32767	Read/Write■	0382H 0383H	0	
P3.066	Reserved	–	–	–	–	
P3.067	PLC connection timeout	1–600	Read/Write	0386H 0387H	30	
P3.068	Ethernet timeout detection of servo drive	0–1	Read/Write	0388H 0389H	1	
P3.069	Ethernet timeout handle of servo drive	0–4	Read/Write	038AH 038BH	1	

** If the servo drive sets the Ethernet card parameters to zero at drive power-up, ensure the following:*
- *The Ethernet card is properly seated onto the drive*
- *The Ethernet card ground wire is properly attached to the card and to ground*
- *The Ethernet card Firmware Update switch is set to the "Normal" position*

▲=Cannot change while Servo On, ●=Cycle power to enable value, ■=Resets to default on power cycle

8.2.5 - P4.xxx Diagnosis Parameters

P4.xxx Parameters						
Param. No.	**Function**	**Range**	**Run Read/ Write**	**Address**	**Default**	**User**
P4.000	Fault record (N)	–	Read	0400H 0401H	0x00000000	
P4.001	Fault record (N-1)	–	Read	0402H 0403H	0x00000000	
P4.002	Fault record (N-2)	–	Read	0404H 0405H	0x00000000	
P4.003	Fault record (N-3)	–	Read	0406H 0407H	0x00000000	

▲=Cannot change while Servo On, ●=Cycle power to enable value, ■=Resets to default on power cycle

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P4.xxx Parameters (continued)						
Param. No.	***Function***	***Range***	***Run Read/ Write***	***Address***	***Default***	***User***
P4.004	Fault record (N-4)	–	Read	0408H 0409H	0x00000000	
P4.005	Servo motor JOG control	0–5000 rpm	Read/Write	040AH 040BH	20	
P4.006	Digital output register (readable and writable)	0–0xFFFF	Read/Write■	040CH 040DH	0x0000	
P4.007	Multi-function for digital input	0–3FFF	Read/Write■	040EH 040FH	0x0	
P4.008	Input status of servo drive panel (read-only)	–	Read	0410H 0411H	–	
P4.009	Digital output status (read-only)	0–0x1F	Read	0412H 0413H	–	
P4.010	Reserved	–	–	–	–	
P4.011	Reserved	–	–	–	–	
P4.012	Reserved	–	–	–	–	
P4.013	Reserved	–	–	–	–	
P4.014	Reserved	–	–	–	–	
P4.015	Reserved	–	–	–	–	
P4.016	Reserved	–	–	–	–	
P4.017	Reserved	–	–	–	–	
P4.018	Reserved	–	–	–	–	
P4.019	Reserved	–	–	–	–	
P4.020	Reserved	–	–	–	–	
P4.021	Reserved	–	–	–	–	
P4.022	Analog speed input offset	-5000 to +5000 mV	Read/Write	042CH 042DH	0	
P4.023	Analog torque input offset	-5000 to +5000 mV	Read/Write	042EH 042FH	0	
P4.024	Level of undervoltage error	40–380 V (rms)	Read	0430H 0431H	160	
▲=Cannot change while Servo On, ●=Cycle power to enable value, ■=Resets to default on power cycle						

8.2.6 - P5.xxx Motion Control Parameters

P5.xxx Parameters						
Param. No.	**Function**	**Range**	**Run Read/ Write**	**Address**	**Default**	**User**
P5.000	Firmware subversion	–	Read ■	0500H 0501H	Factory setting	
P5.001	Reserved	–	–	–	–	
P5.002	Reserved	–	–	–	–	
P5.003	Deceleration time for auto-protection	0x00000000–0xFFFFFFFF	Read/Write	0506H 0507H	0xEEEFEEFF	
P5.004	Homing methods	0–0x12A	Read/Write	0508H 0509H	0x0000	
P5.005	High speed homing (first speed setting)	Panel/software: 0.1–2000.0 (1rpm)	Read/Write	050AH 050BH	100.0	
		Communication: 1–20000 (0.1rpm)			1000	
P5.006	Low speed homing (second speed setting)	Panel/software: 0.1–500.0 (1rpm)	Read/Write	050CH 050DH	20.0	
		Communication: 1–5000 (0.1rpm)			200	
P5.007	Trigger Position command (PR mode only)	0–1000	Read/Write	050EH 050FH	0	
		Readback: 0–20099				
P5.008	Forward software limit	-2147483648 to +2147483647 PUU	Read/Write	0510H 0511H	2147483647	
P5.009	Reverse software limit	-2147483648 to +2147483647 PUU	Read/Write	0512H 0513H	-2147483648	
P5.010	Data array - data size	–	Read ■	0514H 0515H	–	
P5.011	Data array - address for reading and writing	0 to (value set by P5.010 minus 1)	Read/Write ■	0516H 0517H	0	
P5.012	Data array - Element Value #1 for reading and writing	-2147483648 to +2147483647	Read/Write ■	0518H 0519H	0	
P5.013	Data array - Element Value #2 for reading and writing	-2147483648 to +2147483647	Read/Write ■	051AH 051BH	0	
P5.014	Reserved	–	–	–	–	
P5.015	PATH#1 - PATH#2 volatile setting	0x0000–0x0011	Read/Write	051EH 051FH	0x0000	
P5.016	Axis position - CN2	-2147483648 to +2147483647 PUU	Read/Write ■	0520H 0521H	0	
P5.017	Axis position - CN5	-2147483648 to +2147483647 pulse number	Read/Write	0522H 0523H	0	
P5.018	Axis position - pulse command	-2147483648 to +2147483647 pulse number	Read/Write	0524H 0525H	0	

▲=Cannot change while Servo On, ●=Cycle power to enable value, ■=Resets to default on power cycle

P5.xxx Parameters (continued)						
Param. No.	***Function***	***Range***	***Run Read/ Write***	***Address***	***Default***	***User***
P5.019	E-Cam curve scaling	-2147.000000 to +2147.000000 (0.000001 times, or $1/10^6$)	Read/Write	0526H 0527H	1.000000	
P5.020	Acceleration / deceleration time (Number #0)	1–65500 ms	Read/Write	0528H 0529H	200	
P5.021	Acceleration / deceleration time (Number #1)	1–65500 ms	Read/Write	052AH 052BH	300	
P5.022	Acceleration / deceleration time (Number #2)	1–65500 ms	Read/Write	052CH 052DH	500	
P5.023	Acceleration / deceleration time (Number #3)	1–65500 ms	Read/Write	052EH 052FH	600	
P5.024	Acceleration / deceleration time (Number #4)	1–65500 ms	Read/Write	0530H 0531H	800	
P5.025	Acceleration / deceleration time (Number #5)	1–65500 ms	Read/Write	0532H 0533H	900	
P5.026	Acceleration / deceleration time (Number #6)	1–65500 ms	Read/Write	0534H 0535H	1000	
P5.027	Acceleration / deceleration time (Number #7)	1–65500 ms	Read/Write	0536H 0537H	1200	
P5.028	Acceleration / deceleration time (Number #8)	1–65500 ms	Read/Write	0538H 0539H	1500	
P5.029	Acceleration / deceleration time (Number #9)	1–65500 ms	Read/Write	053AH 053BH	2000	
P5.030	Acceleration / deceleration time (Number #10)	1–65500 ms	Read/Write	053CH 053DH	2500	
P5.031	Acceleration / deceleration time (Number #11)	1–65500 ms	Read/Write	053EH 053FH	3000	
P5.032	Acceleration / deceleration time (Number #12)	1–65500 ms	Read/Write	0540H 0541H	5000	
P5.033	Acceleration / deceleration time (Number #13)	1–65500 ms	Read/Write	0542H 0543H	8000	
P5.034	Acceleration / deceleration time (Number #14)	1–1500 ms	Read/Write	0544H 0545H	50	
P5.035	Acceleration / deceleration time (Number #15)	1–1200 ms	Read/Write	0546H 0547H	30	
▲=Cannot change while Servo On, ●=Cycle power to enable value, ■=Resets to default on power cycle						

P5.xxx Parameters (continued)						
Param. No.	**Function**	**Range**	**Run Read/ Write**	**Address**	**Default**	**User**
P5.036	Capture - start address of data array	0 to (value set by P5.010 minus 1)	Read/Write	0548H 0549H	0	
P5.037	Capture - axis position	-2147483648 to +2147483647 pulse unit of capture source	Read/Write ■	054AH 054BH	0	
P5.038	Number of times to Capture	1 to (value set by P5.010 minus value set by P5.036)	Read/Write ■	054CH 054DH	1	
P5.039	Capture - activate CAP control	0x0000–0xF13F	Read/Write ■	054EH 054FH	0x2010	
P5.040	Delay time after position reached (Number #0)	0–32767 ms	Read/Write	0550H 0551H	0	
P5.041	Delay time after position reached (Number #1)	0–32767 ms	Read/Write	0552H 0553H	100	
P5.042	Delay time after position reached (Number #2)	0–32767 ms	Read/Write	0554H 0555H	200	
P5.043	Delay time after position reached (Number #3)	0–32767 ms	Read/Write	0556H 0557H	400	
P5.044	Delay time after position reached (Number #4)	0–32767 ms	Read/Write	0558H 0559H	500	
P5.045	Delay time after position reached (Number #5)	0–32767 ms	Read/Write	055AH 055BH	800	
P5.046	Delay time after position reached (Number #6)	0–32767 ms	Read/Write	055CH 055DH	1000	
P5.047	Delay time after position reached (Number #7)	0–32767 ms	Read/Write	055EH 055FH	1500	
P5.048	Delay time after position reached (Number #8)	0–32767 ms	Read/Write	0560H 0561H	2000	
P5.049	Delay time after position reached (Number #9)	0–32767 ms	Read/Write	0562H 0563H	2500	
P5.050	Delay time after position reached (Number #10)	0–32767 ms	Read/Write	0564H 0565H	3000	
P5.051	Delay time after position reached (Number #11)	0–32767 ms	Read/Write	0566H 0567H	3500	
P5.052	Delay time after position reached (Number #12)	0–32767 ms	Read/Write	0568H 0569H	4000	
P5.053	Delay time after position reached (Number #13)	0–32767 ms	Read/Write	056AH 056BH	4500	
▲=Cannot change while Servo On, ●=Cycle power to enable value, ■=Resets to default on power cycle						

P5.xxx Parameters (continued)						
Param. No.	**Function**	**Range**	**Run Read/ Write**	**Address**	**Default**	**User**
P5.054	Delay time after position reached (Number #14)	0–32767 ms	Read/Write	056CH 056DH	5000	
P5.055	Delay time after position reached (Number #15)	0–32767 ms	Read/Write	056EH 056FH	5500	
P5.056	Compare - start address of data array	0 to (value set by P5.010 minus 1)	Read/Write	0570H 0571H	50	
P5.057	Compare - axis position	-2147483648 to +2147483647 pulse unit of compare source	Read/Write ■	0572H 0573H	0	
P5.058	Remaining Counts	1 to (value set by P5.010 minus value set by P5.056)	Read/Write ■	0574H 0575H	1	
P5.059	Compare - activate CMP control	0x00010000–0x0FFF313F	Read/Write ■	0576H 0577H	0x00640010	
P5.060	Target speed setting #0	Panel/software: 0.0–6000.0 (1 rpm)	Read/Write	0578H 0579H	20.0	
		Communication: 0–60000 (0.1 rpm)			200	
P5.061	Target speed setting #1	Panel/software: 0.0–6000.0 (1 rpm)	Read/Write	057AH 057BH	50.0	
		Communication: 0–60000 (0.1 rpm)			500	
P5.062	Target speed setting #2	Panel/software: 0.0–6000.0 (1 rpm)	Read/Write	057CH 057DH	100.0	
		Communication: 0–60000 (0.1 rpm)			1000	
P5.063	Target speed setting #3	Panel/software: 0.0–6000.0 (1 rpm)	Read/Write	057EH 057FH	200.0	
		Communication: 0–60000 (0.1 rpm)			2000	
P5.064	Target speed setting #4	Panel/software: 0.0–6000.0 (1 rpm)	Read/Write	0580H 0581H	300.0	
		Communication: 0–60000 (0.1 rpm)			3000	
P5.065	Target speed setting #5	Panel/software: 0.0–6000.0 (1 rpm)	Read/Write	0582H 0583H	500.0	
		Communication: 0–60000 (0.1 rpm)			5000	
P5.066	Target speed setting #6	Panel/software: 0.0–6000.0 (1 rpm)	Read/Write	0584H 0585H	600.0	
		Communication: 0–60000 (0.1 rpm)			6000	
P5.067	Target speed setting #7	Panel/software: 0.0–6000.0 (1 rpm)	Read/Write	0586H 0587H	800.0	
		Communication: 0–60000 (0.1 rpm)			8000	
▲=Cannot change while Servo On, ●=Cycle power to enable value, ■=Resets to default on power cycle						

P5.xxx Parameters (continued)						
Param. No.	**Function**	**Range**	**Run Read/ Write**	**Address**	**Default**	**User**
P5.068	Target speed setting #8	Panel/software: 0.0–6000.0 (1 rpm) Communication: 0–60000 (0.1 rpm)	Read/Write	0588H 0589H	1000.0 10000	
P5.069	Target speed setting #9	Panel/software: 0.0–6000.0 (1 rpm) Communication: 0–60000 (0.1 rpm)	Read/Write	058AH 058BH	1300.0 13000	
P5.070	Target speed setting #10	Panel/software: 0.0–6000.0 (1 rpm) Communication: 0–60000 (0.1 rpm)	Read/Write	058CH 058DH	1500.0 15000	
P5.071	Target speed setting #11	Panel/software: 0.0–6000.0 (1 rpm) Communication: 0–60000 (0.1 rpm)	Read/Write	058EH 058FH	1800.0 18000	
P5.072	Target speed setting #12	Panel/software: 0.0–6000.0 (1 rpm) Communication: 0–60000 (0.1 rpm)	Read/Write	0590H 0591H	2000.0 20000	
P5.073	Target speed setting #13	Panel/software: 0.0–6000.0 (1 rpm) Communication: 0–60000 (0.1 rpm)	Read/Write	0592H 0593H	2300.0 23000	
P5.074	Target speed setting #14	Panel/software: 0.0–6000.0 (1 rpm) Communication: 0–60000 (0.1 rpm)	Read/Write	0594H 0595H	2500.0 25000	
P5.075	Target speed setting #15	Panel/software: 0.0–6000.0 (1 rpm) Communication: 0–60000 (0.1 rpm)	Read/Write	0596H 0597H	3000.0 30000	
P5.076	Capture - reset position after first data	-1073741824 to +1073741823 pulse unit of capture source	Read/Write	0598H 0599H	0	
P5.077	Reserved	–	–	–	–	
P5.078	Reserved	–	–	–	–	
P5.079	Reserved	–	–	–	–	
P5.080	Reserved	–	–	–	–	
P5.081	E-Cam: start address for data array	0 to (800 minus value set by P5.082)	Read/Write	05A2H 05A3H	100	
P5.082	E-Cam: total segment number N	5–720	Read/Write	05A4H 05A5H	5	
P5.083	E-Cam: master gear ratio setting - cycle number (M)	1–32767	Read/Write	05A6H 05A7H	1	
P5.084	E-Cam: master gear ratio setting - pulse number (P)	10–1073741823	Read/Write	05A8H 05A9H	3600	
▲=Cannot change while Servo On, ●=Cycle power to enable value, ■=Resets to default on power cycle						

P5.xxx Parameters (continued)						
Param. No.	**Function**	**Range**	**Run Read/ Write**	**Address**	**Default**	**User**
P5.085	E-Cam: engaged segment number	0 to (value set by P5.082 minus 1)	Read/Write	05AAH 05ABH	0	
P5.086	E-Cam: master axis position	-2147483648 to +2147483647 pulse unit of master axis	Read/Write ■	05ACH 05ADH	0	
P5.087	E-Cam: initial lead pulse before engaged	-1073741824 to +1073741823 pulse unit of master axis	Read/Write	05AEH 05AFH	0	
P5.088	E-Cam: activate E-Cam control	0x0–0x203FF257	Read/Write ■	05B0H 05B1H	0x00000000	
P5.089	E-Cam: pulse number of disengaging time	-1073741824 to +1073741823 pulse unit of master axis	Read/Write	05B2H 05B3H	0	
P5.090	E-Cam: DO.CAM_ AREA#1 rising-edge phase	0–360 degree	Read/Write	05B4H 05B5H	270	
P5.091	E-Cam: DO.CAM_ AREA#1 falling-edge phase	0–360 degree	Read/Write	05B6H 05B7H	360	
P5.092	E-Cam: pre-engaged pulse number for each cycle	-2147483648 to +2147483647 pulse unit of master axis	Read/Write	05B8H 05B9H	0	
P5.093	Motion control macro command: command parameter #4	0x00000000–0xFFFFFFFF	Read/Write	05BAH 05BBH	0	
P5.094	Motion control macro command: command parameter #3	-2147483648 to +2147483647	Read/Write	05BCH 05BDH	0	
P5.095	Motion control macro command: command parameter #2	-2147483648 to +2147483647	Read/Write	05BEH 05BFH	0	
P5.096	Motion control macro command: command parameter #1	-2147483648 to +2147483647	Read/Write	05C0H 05C1H	0	
P5.097	Motion control macro command: issue command / execution result	0–0x099F	Read/Write ■	05C2H 05C3H	0	
P5.098	PR# triggered by event rising-edge	0x0000–0xDDDD	Read/Write	05C4H 05C5H	0x0000	
P5.099	PR# triggered by event falling-edge	0x0000–0xDDDD	Read/Write	05C6H 05C7H	0x0000	
P5.100	Data array - Element Value #3 for reading and writing	-2147483648 to +2147483647	Read/Write ■	05C8H 05C9H	0	
▲=Cannot change while Servo On, ●=Cycle power to enable value, ■=Resets to default on power cycle						

P5.xxx Parameters (continued)						
Param. No.	**Function**	**Range**	**Run Read/ Write**	**Address**	**Default**	**User**
P5.101	Data array - Element Value #4 for reading and writing	-2147483648 to +2147483647	Read/Write ■	05CAH 05CBH	0	
P5.102	Data array - Element Value #5 for reading and writing	-2147483648 to +2147483647	Read/Write ■	05CCH 05CDH	0	
P5.103	Data array - Element Value #6 for reading and writing	-2147483648 to +2147483647	Read/Write ■	05CEH 05CFH	0	
P5.112	PATH_Target	0–99	Read/Write	05E0H 05E1H	0	
P5.113	PATH_Type	0–7	Read/Write	05E2H 05E3H	0	
P5.114	PATH_Options1	0–0x12A	Read/Write	05E4H 05E5H	0	
P5.115	PATH_Options2	0–99	Read/Write	05E6H 05E7H	0	
P5.116	PATH_Acc	0–15	Read/Write	05E8H 05E9H	0	
P5.117	PATH_Dec	0–15	Read/Write	05EAH 05EBH	0	
P5.118	PATH_Data1	-2147483648 – 2147482647	Read/Write	05ECH 05EDH	0	
P5.119	PATH_Data2	-2147483648 – 2147483647	Read/Write	05EEH 05EFH	0	
P5.120	PATH_Delay	0–15	Read/Write	05F0H 05F1H	0	
P5.121	PATH_Save	0–2	Read/Write	05F2H 05F3H	0	
P5.122	PATH_Trigger	0–2	Read/Write	05F4H 05F5H	0	
P5.123	PATH_Status	0–2147483647	Read	05F6H 05F7H	0	
▲=Cannot change while Servo On, ●=Cycle power to enable value, ■=Resets to default on power cycle						

8.2.7 - P6.xxx PR Parameters

P6.xxx Parameters						
Param. No.	**Function**	**Range**	**Run Read/ Write**	**Address**	**Default**	**User**
P6.000	Homing definition	0x00000000– 0xFFFFFF6F	Read/Write	0600H 0601H	0x00000000	
P6.001	Origin definition	-2147483648 to +2147483647	Read/Write	0602H 0603H	0	
P6.002	PATH#1 definition	0x00000000– 0xFFFFFFFF	Read/Write	0604H 0605H	0x00000000	
P6.003	PATH#1 data	-2147483648 to +2147483647	Read/Write	0606H 0607H	0	
▲=Cannot change while Servo On, ●=Cycle power to enable value, ■=Resets to default on power cycle						

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P6.xxx Parameters (continued)						
Param. No.	**Function**	**Range**	**Run Read/ Write**	**Address**	**Default**	**User**
P6.004	PATH#2 definition	0x00000000–0xFFFFFFFF	Read/Write	0608H 0609H	0x00000000	
P6.005	PATH#2 data	-2147483648 to +2147483647	Read/Write	060AH 060BH	0	
P6.006	PATH#3 definition	0x00000000–0xFFFFFFFF	Read/Write	060CH 060DH	0x00000000	
P6.007	PATH#3 data	-2147483648 to +2147483647	Read/Write	060EH 060FH	0	
P6.008	PATH#4 definition	0x00000000–0xFFFFFFFF	Read/Write	0610H 0611H	0x00000000	
P6.009	PATH#4 data	-2147483648 to +2147483647	Read/Write	0612H 0613H	0	
P6.010	PATH#5 definition	0x00000000–0xFFFFFFFF	Read/Write	0614H 0615H	0x00000000	
P6.011	PATH#5 data	-2147483648 to +2147483647	Read/Write	0616H 0617H	0	
P6.012	PATH#6 definition	0x00000000–0xFFFFFFFF	Read/Write	0618H 0619H	0x00000000	
P6.013	PATH#6 data	-2147483648 to +2147483647	Read/Write	061AH 061BH	0	
P6.014	PATH#7 definition	0x00000000–0xFFFFFFFF	Read/Write	061CH 061DH	0x00000000	
P6.015	PATH#7 data	-2147483648 to +2147483647	Read/Write	061DH 061FH	0	
P6.016	PATH#8 definition	0x00000000–0xFFFFFFFF	Read/Write	0620H 0621H	0x00000000	
P6.017	PATH#8 data	-2147483648 to +2147483647	Read/Write	0622H 0623H	0	
P6.018	PATH#9 definition	0x00000000–0xFFFFFFFF	Read/Write	0624H 0625H	0x00000000	
P6.019	PATH#9 data	-2147483648 to +2147483647	Read/Write	0626H 0627H	0	
P6.020	PATH#10 definition	0x00000000–0xFFFFFFFF	Read/Write	0628H 0629H	0x00000000	
P6.021	PATH#10 data	-2147483648 to +2147483647	Read/Write	062AH 062BH	0	
P6.022	PATH#11 definition	0x00000000–0xFFFFFFFF	Read/Write	062CH 062DH	0x00000000	
P6.023	PATH#11 data	-2147483648 to +2147483647	Read/Write	062EH 062FH	0	
P6.024	PATH#12 definition	0x00000000–0xFFFFFFFF	Read/Write	0630H 0631H	0x00000000	
P6.025	PATH#12 data	-2147483648 to +2147483647	Read/Write	0632H 0633H	0	
P6.026	PATH#13 definition	0x00000000–0xFFFFFFFF	Read/Write	0634H 0635H	0x00000000	
P6.027	PATH#13 data	-2147483648 to +2147483647	Read/Write	0636H 0637H	0	
P6.028	PATH#14 definition	0x00000000–0xFFFFFFFF	Read/Write	0634H 0635H	0x00000000	
▲=Cannot change while Servo On, ●=Cycle power to enable value, ■=Resets to default on power cycle						

P6.xxx Parameters (continued)						
Param. No.	**Function**	**Range**	**Run Read/ Write**	**Address**	**Default**	**User**
P6.029	PATH#14 data	-2147483648 to +2147483647	Read/Write	063AH 063BH	0	
P6.030	PATH#15 definition	0x00000000– 0xFFFFFFFF	Read/Write	063CH 063DH	0x00000000	
P6.031	PATH#15 data	-2147483648 to +2147483647	Read/Write	063EH 063FH	0	
P6.032	PATH#16 definition	0x00000000– 0xFFFFFFFF	Read/Write	0640H 0641H	0x00000000	
P6.033	PATH#16 data	-2147483648 to +2147483647	Read/Write	0642H 0643H	0	
P6.034	PATH#17 definition	0x00000000– 0xFFFFFFFF	Read/Write	0644H 0645H	0x00000000	
P6.035	PATH#17 data	-2147483648 to +2147483647	Read/Write	0646H 0647H	0	
P6.036	PATH#18 definition	0x00000000– 0xFFFFFFFF	Read/Write	0648H 0649H	0x00000000	
P6.037	PATH#18 data	-2147483648 to +2147483647	Read/Write	064AH 064BH	0	
P6.038	PATH#19 definition	0x00000000– 0xFFFFFFFF	Read/Write	064CH 064DH	0x00000000	
P6.039	PATH#19 data	-2147483648 to +2147483647	Read/Write	064EH 064FH	0	
P6.040	PATH#20 definition	0x00000000– 0xFFFFFFFF	Read/Write	0650H 0651H	0x00000000	
P6.041	PATH#20 data	-2147483648 to +2147483647	Read/Write	0652H 0653H	0	
P6.042	PATH#21 definition	0x00000000– 0xFFFFFFFF	Read/Write	0654H 0655H	0x00000000	
P6.043	PATH#21 data	-2147483648 to +2147483647	Read/Write	0656H 0657H	0	
P6.044	PATH#22 definition	0x00000000– 0xFFFFFFFF	Read/Write	0658H 0659H	0x00000000	
P6.045	PATH#22 data	-2147483648 to +2147483647	Read/Write	065AH 065BH	0	
P6.046	PATH#23 definition	0x00000000– 0xFFFFFFFF	Read/Write	065CH 065DH	0x00000000	
P6.047	PATH#23 data	-2147483648 to +2147483647	Read/Write	065EH 065FH	0	
P6.048	PATH#24 definition	0x00000000– 0xFFFFFFFF	Read/Write	0660H 0661H	0x00000000	
P6.049	PATH#24 data	-2147483648 to +2147483647	Read/Write	0662H 0663H	0	
P6.050	PATH#25 definition	0x00000000– 0xFFFFFFFF	Read/Write	0664H 0665H	0x00000000	
P6.051	PATH#25 data	-2147483648 to +2147483647	Read/Write	0666H 0667H	0	
P6.052	PATH#26 definition	0x00000000– 0xFFFFFFFF	Read/Write	0668H 0669H	0x00000000	
P6.053	PATH#26 data	-2147483648 to +2147483647	Read/Write	066AH 066BH	0	
▲=Cannot change while Servo On, ●=Cycle power to enable value, ■=Resets to default on power cycle						

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P6.xxx Parameters (continued)						
Param. No.	**Function**	**Range**	**Run Read/ Write**	**Address**	**Default**	**User**
P6.054	PATH#27 definition	0x00000000–0xFFFFFFFF	Read/Write	066CH 066DH	0x00000000	
P6.055	PATH#27 data	-2147483648 to +2147483647	Read/Write	066EH 066FH	0	
P6.056	PATH#28 definition	0x00000000–0xFFFFFFFF	Read/Write	0670H 0671H	0x00000000	
P6.057	PATH#28 data	-2147483648 to +2147483647	Read/Write	0672H 0673H	0	
P6.058	PATH#29 definition	0x00000000–0xFFFFFFFF	Read/Write	0674H 0675H	0x00000000	
P6.059	PATH#29 data	-2147483648 to +2147483647	Read/Write	0676H 0677H	0	
P6.060	PATH#30 definition	0x00000000–0xFFFFFFFF	Read/Write	0678H 0679H	0x00000000	
P6.061	PATH#30 data	-2147483648 to +2147483647	Read/Write	067AH 067BH	0	
P6.062	PATH#31 definition	0x00000000–0xFFFFFFFF	Read/Write	067CH 067DH	0x00000000	
P6.063	PATH#31 data	-2147483648 to +2147483647	Read/Write	067EH 067FH	0	
P6.064	PATH#32 definition	0x00000000–0xFFFFFFFF	Read/Write	0680H 0681H	0x00000000	
P6.065	PATH#32 data	-2147483648 to +2147483647	Read/Write	0682H 0683H	0	
P6.066	PATH#33 definition	0x00000000–0xFFFFFFFF	Read/Write	0684H 0685H	0x00000000	
P6.067	PATH#33 data	-2147483648 to +2147483647	Read/Write	0686H 0687H	0	
P6.068	PATH#34 definition	0x00000000–0xFFFFFFFF	Read/Write	0688H 0689H	0x00000000	
P6.069	PATH#34 data	-2147483648 to +2147483647	Read/Write	068AH 068BH	0	
P6.070	PATH#35 definition	0x00000000–0xFFFFFFFF	Read/Write	068CH 068CH	0x00000000	
P6.071	PATH#35 data	-2147483648 to +2147483647	Read/Write	068EH 068FH	0	
P6.072	PATH#36 definition	0x00000000–0xFFFFFFFF	Read/Write	0690H 0691H	0x00000000	
P6.073	PATH#36 data	-2147483648 to +2147483647	Read/Write	0692H 0693H	0	
P6.074	PATH#37 definition	0x00000000–0xFFFFFFFF	Read/Write	0694H 0695H	0x00000000	
P6.075	PATH#37 data	-2147483648 to +2147483647	Read/Write	0696H 0697H	0	
P6.076	PATH#38 definition	0x00000000–0xFFFFFFFF	Read/Write	0698H 0699H	0x00000000	
P6.077	PATH#38 data	-2147483648 to +2147483647	Read/Write	069AH 069BH	0	
P6.078	PATH#39 definition	0x00000000–0xFFFFFFFF	Read/Write	069CH 069DH	0x00000000	
▲=Cannot change while Servo On, ●=Cycle power to enable value, ■=Resets to default on power cycle						

P6.xxx Parameters (continued)						
Param. No.	**Function**	**Range**	**Run Read/ Write**	**Address**	**Default**	**User**
P6.079	PATH#39 data	-2147483648 to +2147483647	Read/Write	069EH 069FH	0	
P6.080	PATH#40 definition	0x00000000– 0xFFFFFFFF	Read/Write	06A0H 06A1H	0x00000000	
P6.081	PATH#40 data	-2147483648 to +2147483647	Read/Write	06A2H 06A3H	0	
P6.082	PATH#41 definition	0x00000000– 0xFFFFFFFF	Read/Write	06A4H 06A5H	0x00000000	
P6.083	PATH#41 data	-2147483648 to +2147483647	Read/Write	06A6H 06A7H	0	
P6.084	PATH#42 definition	0x00000000– 0xFFFFFFFF	Read/Write	06A8H 06A9H	0x00000000	
P6.085	PATH#42 data	-2147483648 to +2147483647	Read/Write	06AAH 06ABH	0	
P6.086	PATH#43 definition	0x00000000– 0xFFFFFFFF	Read/Write	06ACH 06ADH	0x00000000	
P6.087	PATH#43 data	-2147483648 to +2147483647	Read/Write	06AEH 06AFH	0	
P6.088	PATH#44 definition	0x00000000– 0xFFFFFFFF	Read/Write	06B0H 06B1H	0x00000000	
P6.089	PATH#44 data	-2147483648 to +2147483647	Read/Write	06B2H 06B3H	0	
P6.090	PATH#45 definition	0x00000000– 0xFFFFFFFF	Read/Write	06B4H 06B5H	0x00000000	
P6.091	PATH#45 data	-2147483648 to +2147483647	Read/Write	06B6H 06B7H	0	
P6.092	PATH#46 definition	0x00000000– 0xFFFFFFFF	Read/Write	06B8H 06B9H	0x00000000	
P6.093	PATH#46 data	-2147483648 to +2147483647	Read/Write	06BAH 06BBH	0	
P6.094	PATH#47 definition	0x00000000– 0xFFFFFFFF	Read/Write	06BCH 06BDH	0x00000000	
P6.095	PATH#47 data	-2147483648 to +2147483647	Read/Write	06BEH 06BFH	0	
P6.096	PATH#48 definition	0x00000000– 0xFFFFFFFF	Read/Write	06C0H 06C1H	0x00000000	
P6.097	PATH#48 data	-2147483648 to +2147483647	Read/Write	06C2H 06C3H	0	
P6.098	PATH#49 definition	0x00000000– 0xFFFFFFFF	Read/Write	06C4H 06C5H	0x00000000	
P6.099	PATH#49 data	-2147483648 to +2147483647	Read/Write	0602H 0603H	0	
▲=Cannot change while Servo On, ●=Cycle power to enable value, ■=Resets to default on power cycle						

8.2.8 - P7.xxx Additional PR Parameters

P7.xxx Parameters						
Param. No.	**Function**	**Range**	**Run Read/ Write**	**Address**	**Default**	**User**
▲=Cannot change while Servo On, ●=Cycle power to enable value, ■=Resets to default on power cycle						

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P7.xxx Parameters (continued)						
Param. No.	***Function***	***Range***	***Run Read/ Write***	***Address***	***Default***	***User***
P7.000	PATH#50 definition	0x00000000–0xFFFFFFFF	Read/Write	0700H 0701H	0x00000000	
P7.001	PATH#50 data	-2147483648 to +2147483647	Read/Write	0702H 0703H	0	
P7.002	PATH#51 definition	0x00000000–0xFFFFFFFF	Read/Write	0704H 0705H	0x00000000	
P7.003	PATH#51 data	-2147483648 to +2147483647	Read/Write	0706H 0707H	0	
P7.004	PATH#52 definition	0x00000000–0xFFFFFFFF	Read/Write	0708H 0709H	0x00000000	
P7.005	PATH#52 data	-2147483648 to +2147483647	Read/Write	070AH 070BH	0	
P7.006	PATH#53 definition	0x00000000–0xFFFFFFFF	Read/Write	070CH 070DH	0x00000000	
P7.007	PATH#53 data	-2147483648 to +2147483647	Read/Write	070EH 070FH	0	
P7.008	PATH#54 definition	0x00000000–0xFFFFFFFF	Read/Write	0710H 0711H	0x00000000	
P7.009	PATH#54 data	-2147483648 to +2147483647	Read/Write	0712H 0713H	0	
P7.010	PATH#55 definition	0x00000000–0xFFFFFFFF	Read/Write	0714H 0715H	0x00000000	
P7.011	PATH#55 data	-2147483648 to +2147483647	Read/Write	0716H 0717H	0	
P7.012	PATH#56 definition	0x00000000–0xFFFFFFFF	Read/Write	0718H 0719H	0x00000000	
P7.013	PATH#56 data	-2147483648 to +2147483647	Read/Write	071AH 071BH	0	
P7.014	PATH#57 definition	0x00000000–0xFFFFFFFF	Read/Write	071CH 071DH	0x00000000	
P7.015	PATH#57 data	-2147483648 to +2147483647	Read/Write	071EH 071FH	0	
P7.016	PATH#58 definition	0x00000000–0xFFFFFFFF	Read/Write	0720H 0721H	0x00000000	
P7.017	PATH#58 data	-2147483648 to +2147483647	Read/Write	0722H 0723H	0	
P7.018	PATH#59 definition	0x00000000–0xFFFFFFFF	Read/Write	0724H 0725H	0x00000000	
P7.019	PATH#59 data	-2147483648 to +2147483647	Read/Write	0726H 0727H	0	
P7.020	PATH#60 definition	0x00000000–0xFFFFFFFF	Read/Write	0728H 0729H	0x00000000	
P7.021	PATH#60 data	-2147483648 to +2147483647	Read/Write	072AH 072BH	0	
P7.022	PATH#61 definition	0x00000000–0xFFFFFFFF	Read/Write	072CH 072DH	0x00000000	
P7.023	PATH#61 data	-2147483648 to +2147483647	Read/Write	072EH 072FH	0	
P7.024	PATH#62 definition	0x00000000–0xFFFFFFFF	Read/Write	0730H 0731H	0x00000000	
▲=Cannot change while Servo On, ●=Cycle power to enable value, ■=Resets to default on power cycle						

P7.xxx Parameters (continued)						
Param. No.	**Function**	**Range**	**Run Read/ Write**	**Address**	**Default**	**User**
P7.025	PATH#62 data	-2147483648 to +2147483647	Read/Write	0732H 0733H	0	
P7.026	PATH#63 definition	0x00000000– 0xFFFFFFFF	Read/Write	0734H 0735H	0x00000000	
P7.027	PATH#63 data	-2147483648 to +2147483647	Read/Write	0736H 0737H	0	
P7.028	PATH#64 definition	0x00000000– 0xFFFFFFFF	Read/Write	0738H 0739H	0x00000000	
P7.029	PATH#64 data	-2147483648 to +2147483647	Read/Write	073AH 073BH	0	
P7.030	PATH#65 definition	0x00000000– 0xFFFFFFFF	Read/Write	073CH 073DH	0x00000000	
P7.031	PATH#65 data	-2147483648 to +2147483647	Read/Write	073EH 073FH	0	
P7.032	PATH#66 definition	0x00000000– 0xFFFFFFFF	Read/Write	0740H 0741H	0x00000000	
P7.033	PATH#66 data	-2147483648 to +2147483647	Read/Write	0742H 0743H	0	
P7.034	PATH#67 definition	0x00000000– 0xFFFFFFFF	Read/Write	0744H 0745H	0x00000000	
P7.035	PATH#67 data	-2147483648 to +2147483647	Read/Write	0746H 0747H	0	
P7.036	PATH#68 definition	0x00000000– 0xFFFFFFFF	Read/Write	0748H 0749H	0x00000000	
P7.037	PATH#68 data	-2147483648 to +2147483647	Read/Write	074AH 074BH	0	
P7.038	PATH#69 definition	0x00000000– 0xFFFFFFFF	Read/Write	074CH 074DH	0x00000000	
P7.039	PATH#69 data	-2147483648 to +2147483647	Read/Write	074EH 074FH	0	
P7.040	PATH#70 definition	0x00000000– 0xFFFFFFFF	Read/Write	0750H 0751H	0x00000000	
P7.041	PATH#70 data	-2147483648 to +2147483647	Read/Write	0752H 0753H	0	
P7.042	PATH#71 definition	0x00000000– 0xFFFFFFFF	Read/Write	0754H 0755H	0x00000000	
P7.043	PATH#71 data	-2147483648 to +2147483647	Read/Write	0756H 0757H	0	
P7.044	PATH#72 definition	0x00000000– 0xFFFFFFFF	Read/Write	0758H 0759H	0x00000000	
P7.045	PATH#72 data	-2147483648 to +2147483647	Read/Write	075AH 075BH	0	
P7.046	PATH#73 definition	0x00000000– 0xFFFFFFFF	Read/Write	075CH 075DH	0x00000000	
P7.047	PATH#73 data	-2147483648 to +2147483647	Read/Write	075EH 075FH	0	
P7.048	PATH#74 definition	0x00000000– 0xFFFFFFFF	Read/Write	0760H 0761H	0x00000000	
P7.049	PATH#74 data	-2147483648 to +2147483647	Read/Write	0762H 0763H	0	
▲=Cannot change while Servo On, ●=Cycle power to enable value, ■=Resets to default on power cycle						

P7.xxx Parameters (continued)						
Param. No.	**Function**	**Range**	**Run Read/ Write**	**Address**	**Default**	**User**
P7.050	PATH#75 definition	0x00000000–0xFFFFFFFF	Read/Write	0764H 0765H	0x00000000	
P7.051	PATH#75 data	-2147483648 to +2147483647	Read/Write	0766H 0767H	0	
P7.052	PATH#76 definition	0x00000000–0xFFFFFFFF	Read/Write	0768H 0769H	0x00000000	
P7.053	PATH#76 data	-2147483648 to +2147483647	Read/Write	076AH 076BH	0	
P7.054	PATH#77 definition	0x00000000–0xFFFFFFFF	Read/Write	076CH 076DH	0x00000000	
P7.055	PATH#77 data	-2147483648 to +2147483647	Read/Write	076EH 076FH	0	
P7.056	PATH#78 definition	0x00000000–0xFFFFFFFF	Read/Write	0770H 0771H	0x00000000	
P7.057	PATH#78 data	-2147483648 to +2147483647	Read/Write	0772H 0773H	0	
P7.058	PATH#79 definition	0x00000000–0xFFFFFFFF	Read/Write	0774H 0775H	0x00000000	
P7.059	PATH#79 data	-2147483648 to +2147483647	Read/Write	0776H 0777H	0	
P7.060	PATH#80 definition	0x00000000–0xFFFFFFFF	Read/Write	0778H 0779H	0x00000000	
P7.061	PATH#80 data	-2147483648 to +2147483647	Read/Write	077AH 077BH	0	
P7.062	PATH#81 definition	0x00000000–0xFFFFFFFF	Read/Write	077CH 077DH	0x00000000	
P7.063	PATH#81 data	-2147483648 to +2147483647	Read/Write	077EH 077FH	0	
P7.064	PATH#82 definition	0x00000000–0xFFFFFFFF	Read/Write	0780H 0781H	0x00000000	
P7.065	PATH#82 data	-2147483648 to +2147483647	Read/Write	0782H 0783H	0	
P7.066	PATH#83 definition	0x00000000–0xFFFFFFFF	Read/Write	0784H 0785H	0x00000000	
P7.067	PATH#83 data	-2147483648 to +2147483647	Read/Write	0786H 0787H	0	
P7.068	PATH#84 definition	0x00000000–0xFFFFFFFF	Read/Write	0788H 0789H	0x00000000	
P7.069	PATH#84 data	-2147483648 to +2147483647	Read/Write	078AH 078BH	0	
P7.070	PATH#85 definition	0x00000000–0xFFFFFFFF	Read/Write	078CH 078DH	0x00000000	
P7.071	PATH#85 data	-2147483648 to +2147483647	Read/Write	078EH 078FH	0	
P7.072	PATH#86 definition	0x00000000–0xFFFFFFFF	Read/Write	0790H 0791H	0x00000000	
P7.073	PATH#86 data	-2147483648 to +2147483647	Read/Write	0792H 0793H	0	
P7.074	PATH#87 definition	0x00000000–0xFFFFFFFF	Read/Write	0794H 0795H	0x00000000	
▲=Cannot change while Servo On, ●=Cycle power to enable value, ■=Resets to default on power cycle						

P7.xxx Parameters (continued)						
Param. No.	**Function**	**Range**	**Run Read/ Write**	**Address**	**Default**	**User**
P7.075	PATH#87 data	-2147483648 to +2147483647	Read/Write	0796H 0797H	0	
P7.076	PATH#88 definition	0x00000000– 0xFFFFFFFF	Read/Write	0798H 0799H	0x00000000	
P7.077	PATH#88 data	-2147483648 to +2147483647	Read/Write	079AH 079BH	0	
P7.078	PATH#89 definition	0x00000000– 0xFFFFFFFF	Read/Write	079CH 079DH	0x00000000	
P7.079	PATH#89 data	-2147483648 to +2147483647	Read/Write	079EH 079FH	0	
P7.080	PATH#90 definition	0x00000000– 0xFFFFFFFF	Read/Write	07A0H 07A1H	0x00000000	
P7.081	PATH#90 data	-2147483648 to +2147483647	Read/Write	07A2H 07A3H	0	
P7.082	PATH#91 definition	0x00000000– 0xFFFFFFFF	Read/Write	07A4H 07A5H	0x00000000	
P7.083	PATH#91 data	-2147483648 to +2147483647	Read/Write	07A6H 07A7H	0	
P7.084	PATH#92 definition	0x00000000– 0xFFFFFFFF	Read/Write	07A8H 07A9H	0x00000000	
P7.085	PATH#92 data	-2147483648 to +2147483647	Read/Write	07AAH 07ABH	0	
P7.086	PATH#93 definition	0x00000000– 0xFFFFFFFF	Read/Write	07ACH 07ADH	0x00000000	
P7.087	PATH#93 data	-2147483648 to +2147483647	Read/Write	07AEH 07AFH	0	
P7.088	PATH#94 definition	0x00000000– 0xFFFFFFFF	Read/Write	07B0H 07B1H	0x00000000	
P7.089	PATH#94 data	-2147483648 to +2147483647	Read/Write	07B2H 07B3H	0	
P7.090	PATH#95 definition	0x00000000– 0xFFFFFFFF	Read/Write	07B4H 07B5H	0x00000000	
P7.091	PATH#95 data	-2147483648 to +2147483647	Read/Write	07B6H 07B7H	0	
P7.092	PATH#96 definition	0x00000000– 0xFFFFFFFF	Read/Write	07B8H 07B9H	0x00000000	
P7.093	PATH#96 data	-2147483648 to +2147483647	Read/Write	07BAH 07BBH	0	
P7.094	PATH#97 definition	0x00000000– 0xFFFFFFFF	Read/Write	07BCH 07BDH	0x00000000	
P7.095	PATH#97 data	-2147483648 to +2147483647	Read/Write	07BEH 07BFH	0	
P7.096	PATH#98 definition	0x00000000– 0xFFFFFFFF	Read/Write	07C0H 07C1H	0x00000000	
P7.097	PATH#98 data	-2147483648 to +2147483647	Read/Write	07C3H 07C4H	0	
P7.098	PATH#99 definition	0x00000000– 0xFFFFFFFF	Read/Write	07C4H 07C5H	0x00000000	
P7.099	PATH#99 data	-2147483648 to +2147483647	Read/Write	07C6H 07C7H	0	
▲=Cannot change while Servo On, ●=Cycle power to enable value, ■=Resets to default on power cycle						

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8.3 - Common Parameter Groups

8.3.1 - Monitor and general output parameters

Parameter No.	Function	Default Value	Unit	Control Mode			
				PT	PR	S	T
P0.000★	Firmware version	Factory setting	-	O	O	O	O
P0.001■	Current drive alarm code (Seven-segment display)	-	-	O	O	O	O
P0.002	LED Display Definition	00	-	O	O	O	O
P0.003	Analog output monitoring	00	-	O	O	O	O
P0.008★	Total servo drive operation time	0	hour	-	-	-	-
P0.009★	Status monitoring register 1	-	-	O	O	O	O
P0.010★	Status monitoring register 2	-	-	O	O	O	O
P0.011★	Status monitoring register 3	-	-	O	O	O	O
P0.012★	Status monitoring register 4	-	-	O	O	O	O
P0.013★	Status monitoring register 5	-	-	O	O	O	O
P0.017	Select content displayed by status monitoring register 1	0	-	-	-	-	-
P0.018	Select content displayed by status monitoring register 2	0	-	-	-	-	-
P0.019	Select content displayed by status monitoring register 3	0	-	-	-	-	-
P0.020	Select content displayed by status monitoring register 4	0	-	-	-	-	-
P0.021	Select content displayed by status monitoring register 5	0	-	-	-	-	-
P0.025	Mapping parameter #1	-	-	O	O	O	O
P0.026	Mapping parameter #2	-	-	O	O	O	O
P0.027	Mapping parameter #3	-	-	O	O	O	O
P0.028	Mapping parameter #4	-	-	O	O	O	O
P0.029	Mapping parameter #5	-	-	O	O	O	O
P0.030	Mapping parameter #6	-	-	O	O	O	O
P0.031	Mapping parameter #7	-	-	O	O	O	O
P0.032	Mapping parameter #8	-	-	O	O	O	O
P0.035	Target setting for mapping parameter P0.025	-	-	O	O	O	O
P0.036	Target setting for mapping parameter P0.026	-	-	O	O	O	O
P0.037	Target setting for mapping parameter P0.027	-	-	O	O	O	O
P0.038	Target setting for mapping parameter P0.028	-	-	O	O	O	O
P0.039	Target setting for mapping parameter P0.029	-	-	O	O	O	O
P0.040	Target setting for mapping parameter P0.030	-	-	O	O	O	O
P0.041	Target setting for mapping parameter P0.031	-	-	O	O	O	O
P0.042	Target setting for mapping parameter P0.032	-	-	O	O	O	O

Parameter No.	Function	Default Value	Unit	Control Mode			
				PT	PR	S	T
P0.046★	Commonly Used DO Function Status	0	-	O	O	O	O
P1.101	Analog monitor output voltage 1	0	mV	O	O	O	O
P1.102	Analog monitor output voltage 2	0	mV	O	O	O	O

- ★ *Read-only parameter. Can only read the value of the parameter. For example, P0.000, P0.010, P4.000, etc.*
- ▲ *Parameter cannot be changed when servo is in Servo On status. For example, P1.000 and P1.046.*
- ● *Parameter changes become valid after cycling the power. For example, P1.001 and P3.000.*
- ■ *Parameter resets to its default value after cycling the power. For example, P2.031.*

8.3.2 - Filter and resonance suppression parameters

Parameter No.	Function	Default Value	Unit	Control Mode			
				PT	PR	S	T
P1.006	Speed command smoothing constant (Low-pass filter)	0	ms	-	-	O	-
P1.007	Torque command smoothing constant (Low-pass filter)	0	ms	-	-	-	O
P1.008	Position command smoothing constant (Low-pass filter)	0	10ms	O	O	-	-
P1.025	Low-frequency vibration suppression frequency (1)	1000	0.1 Hz	O	O	-	-
P1.026	Low-frequency vibration suppression gain (1)	0	-	O	O	-	-
P1.027	Low-frequency vibration suppression frequency (2)	1000	0.1 Hz	O	O	-	-
P1.028	Low-frequency vibration suppression gain (2)	0	-	O	O	-	-
P1.029	Auto low-frequency vibration suppression mode	0	-	O	O	-	-
P1.030	Low-frequency vibration detection level	500	pulse	O	O	-	-
P1.034	S-curve acceleration constant	200	ms	-	-	O	-
P1.035	S-curve deceleration constant	200	ms	-	-	O	-
P1.036	S-curve acceleration / deceleration constant	0	ms	-	O	O	-
P1.062	Percentage of friction compensation	0	%	O	O	O	O
P1.063	Constant of friction compensation	1	ms	O	O	O	O
P1.068	Position command - Moving filter	4	ms	O	O	-	-
P1.075	Low-pass filter time constant for full- and half-closed loop control	100	ms	O	O	-	-
P1.089	Set 1: Vibration elimination - Anti-resonance frequency	4000	0.1 Hz	O	O	-	-

Parameter No.	Function	Default Value	Unit	Control Mode			
				PT	PR	S	T
P1.090	Set 1: Vibration elimination - Resonance frequency	4000	0.1 Hz	O	O	-	-
P1.091	Set 1: Vibration elimination - Resonance difference	10	0.1 dB	O	O	-	-
P1.092	Set 2: Vibration elimination - Anti-resonance frequency	4000	0.1 Hz	O	O	-	-
P1.093	Set 2: Vibration elimination - Resonance frequency	4000	0.1 Hz	O	O	-	-
P1.094	Set 2: Vibration elimination - Resonance difference	10	0.1 dB	O	O	-	-
P2.023	Notch filter frequency (1)	1000	Hz	O	O	O	O
P2.024	Notch filter attenuation level (1)	0	-dB	O	O	O	O
P2.043	Notch filter frequency (2)	1000	Hz	O	O	O	O
P2.044	Notch filter attenuation level (2)	0	-dB	O	O	O	O
P2.045	Notch filter frequency (3)	1000	Hz	O	O	O	O
P2.046	Notch filter attenuation level (3)	0	-dB	O	O	O	O
P2.047	Auto resonance suppression mode	1	-	O	O	O	O
P2.048	Auto resonance detection level	100	-	O	O	O	O
P2.025	Resonance suppression low-pass filter	1.0 (panel/software)	1 ms (panel/software)	O	O	O	O
		10 (communication)	0.1 ms (communication)				
P2.049	Speed detection filter and jitter suppression	0	-	O	O	O	O
P2.095	Notch filter bandwidth (1)	5	-	O	O	O	O
P2.096	Notch filter bandwidth (2)	5	-	O	O	O	O
P2.097	Notch filter bandwidth (3)	5	-	O	O	O	O
P2.098	Notch filter frequency (4)	1000	Hz	O	O	O	O
P2.099	Notch filter attenuation level (4)	0	-dB	O	O	O	O
P2.100	Notch filter bandwidth (4)	5	-	O	O	O	O
P2.101	Notch filter frequency (5)	1000	Hz	O	O	O	O
P2.102	Notch filter attenuation level (5)	0	-dB	O	O	O	O
P2.103	Notch filter bandwidth (5)	5	-	O	O	O	O

8.3.3 - Gain and switching parameters

Parameter No.	Function	Default Value	Unit	Control Mode PT	PR	S	T
P1.037	Load inertia ratio and load weight ratio to servo motor	6.0 (panel / software) 60 (communication)	1 times (panel / software) 0.1 times (communication)	O	O	O	O
P2.000	Position control gain	35	rad/s	O	O	-	-
P2.001	Position control gain rate of change	100	%	O	O	-	-
P2.002	Position feed forward gain	50	%	O	O	-	-
P2.003	Position feed forward gain smoothing constant	5	ms	O	O	-	-
P2.004	Speed control gain	500	rad/s	O	O	O	O
P2.005	Speed control gain rate of change	100	%	O	O	O	O
P2.006	Speed integral compensation	100	rad/s	O	O	O	O
P2.007	Speed feed forward gain	0	%	O	O	O	O
P2.026	Anti-interference gain	0	rad/s	O	O	O	O
P2.027	Gain switching condition and method selection	0	-	O	O	O	O
P2.028	Gain switching time constant	10	10 ms	O	O	O	O
P2.029	Gain switching condition	16777216	pulse kpps rpm	O	O	O	O
P2.031	Frequency response bandwidth level	19	Hz	O	O	O	O
P2.032	Gain adjustment mode	1	-	O	O	O	O
P2.053	Position integral compensation	0	rad/s	O	O	O	O
P2.089	Command responsiveness gain	25	rad/s	O	O	-	-
P2.094▲	Special bit register 3	0x1000	-	O	O	O	-
P2.104	P/PI torque switching command condition	200	%	O	O	O	-
P2.105	Auto-tuning Adjustment Bandwidth Level	11	-	O	O	-	-
P2.106	Auto-tuning Adjustment Overshoot Level	2000	-	O	O	-	-
P2.112▲	Special bit register 4	0x0008	-	O	O	O	-

- ★ *Read-only parameter. Can only read the value of the parameter. For example, P0.000, P0.010, P4.000, etc.*
- ▲ *Parameter cannot be changed when servo is in Servo On status. For example, P1.000 and P1.046.*
- ● *Parameter changes become valid after cycling the power. For example, P1.001 and P3.000.*
- ■ *Parameter resets to its default value after cycling the power. For example, P2.031.*

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8.3.4 - Position control parameters

Parameter No.	Function	Default Value	Unit	Control Mode			
				PT	PR	S	T
P1.001●	Input for control mode and control command	0	pulse rpm N-M	O	O	O	O
P1.002▲	Speed and torque limits	0	-	O	O	O	O
P1.003	Analog and Encoder pulse output polarity	0	-	O	O	O	O
P1.012–P1.014	Internal torque limits 1–3	100	%	O	O	O	-
P1.044▲	E-Gear ratio (Numerator) (N1)	16777216	pulse	O	O	-	-
P1.045▲	E-Gear ratio (Denominator) (M)	100000	pulse	O	O	-	-
P1.046▲	Encoder pulse number output	2500	pulse	O	O	O	O
P1.055	Maximum speed limit	Rated speed of the model	rpm	O	O	O	O
P1.097▲	Encoder output denominator	0	-	O	O	O	O
P5.003	Deceleration time for auto-protection	EEEFEEFF	-	O	O	O	O
P5.020–P5.035	Acceleration / deceleration times	200–30	ms	O	-	-	-
P5.016	Axis position - Motor encoder	0	PUU	O	O	O	O
P5.017	Axis position - Auxiliary encoder	0	pulse	O	O	O	O
P5.018	Axis position - Pulse command	0	pulse	O	O	O	O

8.3.5 - Position control parameters - External pulse control command (PT mode)

Parameter No.	Function	Default Value	Unit	Control Mode			
				PT	PR	S	T
P1.000▲	External pulse input type	0x1042	-	O	-	-	-
P2.060	E-Gear ratio (Numerator) (N2)	16777216	pulse	O	O	-	-
P2.061	E-Gear ratio (Numerator) (N3)	16777216	pulse	O	O	-	-
P2.062	E-Gear ratio (Numerator) (N4)	16777216	pulse	O	O	-	-

8.3.6 - Position control parameters - Internal register control command (PR mode)

Parameter No.	Function	Default Value	Unit	Control Mode			
				PT	PR	S	T
P5.008	Forward software limit	$+2^{31}$	PUU	-	O	-	-
P5.009	Reverse software limit	-2^{31}	PUU	-	O	-	-
P6.002–P7.099	Internal Position commands 1–99	0	-	-	O	-	-
P5.060–P5.075	Internal Position commands control the movement speeds from 0–15	20–3000 (panel / software)	1 rpm (panel / software)	-	O	-	-
		200–30000 (communication)	0.1 rpm (communication)				
P5.004	Homing methods	0	-	-	O	-	-
P5.005	High speed homing (first speed setting)	1000 (communication)	0.1 rpm (communication)	-	O	-	-
				-	O	-	-
P5.006	Low speed homing (second speed setting)	200 (communication)	0.1 rpm (communication)	-	O	-	-
				-	O	-	-
P5.007	Trigger Position command (PR mode only)	0	-	-	O	-	-
P5.040–P5.055	Delay times after position reached	0–5500	ms	-	O	-	-
P5.098	PR# triggered by event rising-edge	0	-	-	O	-	-
P5.099	PR# triggered by event falling-edge	0	-	-	O	-	-
P5.015	PATH#1–PATH#2 Volatile setting	0x0	-	-	O	-	-
P5.112–P5.123	PR registers for EtherNet/IP Implicit comms	-	-	-	O	-	-

- ★ *Read-only parameter. Can only read the value of the parameter. For example, P0.000, P0.010, P4.000, etc.*
- ▲ *Parameter cannot be changed when servo is in Servo On status. For example, P1.000 and P1.046.*
- ● *Parameter changes become valid after cycling the power. For example, P1.001 and P3.000.*
- ■ *Parameter resets to its default value after cycling the power. For example, P2.031.*

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8.3.7 - Speed control parameters

Parameter No.	Function	Default Value	Unit	Control Mode			
				PT	PR	S	T
P1.001●	Input for control mode and control command	0	pulse rpm N-M	O	O	O	O
P1.002▲	Speed and torque limits	0	-	O	O	O	O
P1.003	Analog and Encoder pulse output polarity	0	-	O	O	O	O
P1.046▲	Encoder pulse number output	2500	pulse	O	O	O	O
P1.055	Maximum speed limit	motor's rated speed	rpm	O	O	O	O
P1.009–P1.011	Internal Speed commands 1–3	1000–3000	0.1 rpm	-	-	O	O
P1.012–P1.014	Internal torque limits 1–3	100	%	O	O	O	O
P1.040	Maximum rotation speed for analog Speed command	3000	rpm	-	-	O	O
P1.041	Maximum output for analog Torque command	100	%	O	O	O	O
P1.076	Maximum speed for encoder output (OA, OB)	5500	rpm	O	O	O	O
P1.081	Second set of maximum rotation speed for analog Speed command	motor's rated speed	rpm			O	O

8.3.8 - Torque control parameters

Parameter No.	Function	Default Value	Unit	Control Mode			
				PT	PR	S	T
P1.001●	Input for control mode and control command	0	pulse rpm N-M	O	O	O	O
P1.002▲	Speed and torque limits	0	-	O	O	O	O
P1.003	Analog and Encoder pulse output polarity	0	-	O	O	O	O
P1.046▲	Encoder pulse number output	2500	pulse	O	O	O	O
P1.055	Maximum speed limit	motor's rated speed	rpm	O	O	O	O
P1.009–P1.011	Internal speed limits 1–3	1000–3000	0.1 rpm	-	-	O	O
P1.012–P1.014	Internal Torque commands 1–3	100	%	O	O	O	O
P1.040	Maximum rotation speed for analog Speed command	3000	rpm	-	-	O	O

Parameter No.	Function	Default Value	Unit	Control Mode			
				PT	PR	S	T
P1.041▲	Maximum output for analog Torque command	100	%	O	O	O	O

8.3.9 - Planning of digital input / output pin and output parameters

NOTE: For more detailed descriptions of DI and DO settings, please refer to section 8.4.9.

Parameter No.	Function	Default Value	Unit	Control Mode			
				PT	PR	S	T
P0.053	Extensive range compare DO output - Filter time	0	ms	O	O	O	O
P0.054	General range compare DO output - First lower limit	0	-	O	O	O	O
P0.055	General range compare DO output - First upper limit	0	-	O	O	O	O
P2.009	Response filter time of DI	2	ms	O	O	O	O
P2.010	DI1 functional planning	101	-	O	O	O	O
P2.011	DI2 functional planning	104	-	O	O	O	O
P2.012	DI3 functional planning	116	-	O	O	O	O
P2.013	DI4 functional planning	117	-	O	O	O	O
P2.014	DI5 functional planning	102	-	O	O	O	O
P2.015	DI6 functional planning	022	-	O	O	O	O
P2.016	DI7 functional planning	023	-	O	O	O	O
P2.017	DI8 functional planning	021	-	O	O	O	O
P2.018	DO1 functional planning	101	-	O	O	O	O
P2.019	DO2 functional planning	103	-	O	O	O	O
P2.020	DO3 functional planning	109	-	O	O	O	O
P2.021	DO4 functional planning	105	-	O	O	O	O
P2.022	DO5 functional planning	7	-	O	O	O	O
P2.036	DI9 functional planning	0	-	O	O	O	O
P2.037	DI10 functional planning	0	-	O	O	O	O
P2.038	VDI11 functional planning	0	-	O	O	O	O
P2.039	VDI12 functional planning	0	-	O	O	O	O
P2.040	VDI13 functional planning	0	-	O	O	O	O
P2.041	DO6 functional planning	0	-	O	O	O	O

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Parameter No.	Function	Default Value	Unit	Control Mode			
				PT	PR	S	T
P1.038	Zero speed range	10.0 (panel / software) 100 (communication)	1 rpm (panel / software) 0.1 rpm (communication)	O	O	O	O
P1.039	Target speed detection level	3000	rpm	O	O	O	O
P1.042	Enable delay time for magnetic brake	0	ms	O	O	O	O
P1.043	Disable delay time for magnetic brake	0	ms	O	O	O	O
P1.047	Speed reached (DO. SP_OK) range	10	rpm	-	O	-	O
P1.054	Pulse range for position reached	167772	pulse	O	-	-	O
P1.056	Motor output overload warning level	120	%	O	O	O	O

- ★ *Read-only parameter. Can only read the value of the parameter. For example, P0.000, P0.010, P4.000, etc.*
- ▲ *Parameter cannot be changed when servo is in Servo On status. For example, P1.000 and P1.046.*
- ● *Parameter changes become valid after cycling the power. For example, P1.001 and P3.000.*
- ■ *Parameter resets to its default value after cycling the power. For example, P2.031.*

8.3.10 - Communication parameters

Parameter No.	Function	Default Value	Unit	Control Mode			
				PT	PR	S	T
P3.000●	RS-485 Address	0x7F	-	O	O	O	O
P3.001●	Transmission speed	0x0203	Bps	O	O	O	O
P3.002	Communication protocol	6	-	O	O	O	O
P3.003	Communication error handling	0	-	O	O	O	O
P3.004	Communication timeout	0	sec	O	O	O	O
P3.005	Communication mechanism	0	-	O	O	O	O
P3.006	Digital input (DI) control switch	0	-	O	O	O	O
P3.007	Communication response delay time	0	1ms	O	O	O	O

8.3.11 - Diagnosis parameters

Parameter No.	Function	Default Value	Unit	Control Mode			
				PT	PR	S	T
P4.000★	Fault record (N)	0	-	O	O	O	O
P4.001★	Fault record (N-1)	0	-	O	O	O	O
P4.002★	Fault record (N-2)	0	-	O	O	O	O
P4.003★	Fault record (N-3)	0	-	O	O	O	O
P4.004★	Fault record (N-4)	0	-	O	O	O	O
P4.005	Servo motor JOG control	20	rpm	O	O	O	O
P4.006▲■	Digital output register (readable and writable)	0	-	O	O	O	O
P4.007	Multi-function for digital input	0	-	O	O	O	O
P4.008★	Input status of servo drive panel (read-only)	-	-	O	O	O	O
P4.009★	Digital output status (read-only)	-	-	O	O	O	O
P4.022	Analog speed input offset	0	mV	O	O	O	O
P4.023	Analog torque input offset	0	mV	O	O	O	O

- ★ *Read-only parameter. Can only read the value of the parameter. For example, P0.000, P0.010, P4.000, etc.*
- ▲ *Parameter cannot be changed when servo is in Servo On status. For example, P1.000 and P1.046.*
- ● *Parameter changes become valid after cycling the power. For example, P1.001 and P3.000.*
- ■ *Parameter resets to its default value after cycling the power. For example, P2.031.*

8.4 - Detailed Parameter descriptions

8.4.1 - P0.xxx Monitoring parameters

P0.000★	Firmware Version		Hex Address	Dec Address
			0000H 0001H	40001 40002
Default:	Factory setting	Control mode:	All	
Unit:	-	Setting range:	-	
Format:	DEC	Data size:	16-bit	

Settings:

Displays the firmware version of the servo drive. The servo drive firmware can be upgraded with a SV2-PGM-USB15 (or -USB30) cable and SureServo2 Pro software. See the SureServo2 Pro software help file for firmware upgrade instructions. The Firmware Subversion is located in P5.000.

P0.001■	Current Drive Alarm Code (Seven-segment display)		Hex Address	Dec Address
			0002H 0003H	40003 40004
Default:	-	Control mode:	All	
Unit:	-	Setting range:	0X0000: alarm clear (same as DI.ARST). 0x0001 - 0xFFFF: displays the alarm code (not writable).	
Format:	HEX	Data size:	16-bit	

Settings:

For the list of alarms, please refer to Section 11.1 Alarm list. Most alarms can be reset by either cycling power to the drive or using a digital input set to Alarm Reset (DI.ARST) to reset the alarm after the issue causing the alarm has been corrected. Refer to section 11.2 on page 11–11 for causes and corrective actions for each alarm code. See P4.000–P4.004 for the last 5 alarm codes stored in the drive.

P0.002	LED Display Definition		Hex Address	Dec Address
			0004H 0005H	40005 40006
Default:	0	Control mode:	All	
Unit:	-	Setting range:	-300 to +127	
Format:	DEC	Data size:	16-bit	

Settings:

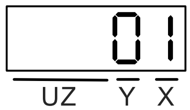
The front panel LED can display some types of drive information. See the chart in section 8.4.11 for a list of all the parameters that the LED can be set to display. Enter one of these codes into P0.002 and the LED will display that information if the keypad is not being used to enter values in Parameter Mode and if there are no active errors.

There is a common subset of monitoring variables that you can scroll through using the keypad up/down arrows when the display is in monitoring mode (variables 0-25). When changing the visible display variable through the keypad, the value is not updated in P0.002. This means the displayed variable will not be the same after a power cycle. The code entered into P0.002 determines what will be displayed on a power cycle. For the list of monitoring variables, please refer to section 8.4.11 on page 8–259 for monitoring variables descriptions. See also section 4.3.5 for keypad operation and use.

More monitoring variables can be actively monitored through communications using P0.009 - P0.013.

P0.003	Analog Output Monitoring		Hex Address	Dec Address
			0006H 0007H	40007 40008
Default:	0x0000	Control mode:	All	
Unit:	-	Setting range:	0–77	
Format:	HEX	Data size:	16-bit	

Settings:



- *X: MON***2**
- *Y: MON***1**
- *UZ: reserved*

MON1 and MON2 value	Description	MON1 and MON2 value	Description
0	Motor speed (±8 volts / Maximum speed)	4	Torque command (±8 volts / Maximum Torque command)
1	Motor torque (±8 volts / Maximum torque)	5	VBUS voltage (±8 volts / 450V)
2	Pulse command frequency (+8 volts / 4.5 Mpps)	6	Analog output voltage is the user defined value of P1.101
3	Speed command (±8 volts / Maximum Speed command)	7	Analog output voltage is the user defined value of P1.102

NOTE: *Please refer to parameters P1.004 and P1.005 for the proportional setting for the analog voltage output.*

For example: when you set P0.003 to 01 (MON1 is the analog output of motor speed; MON2 is the analog output of motor torque):

- *MON1 output voltage =* $8 \times \dfrac{\text{Motor Speed}}{(\text{Maximum speed} \times \frac{P1.004}{100})}$ (Unit: volts)
- *MON2 output voltage =* $8 \times \dfrac{\text{Motor Torque}}{(\text{Maximum torque} \times \frac{P1.005}{100})}$ (Unit: NM)

P0.004–P0.007	Reserved

P0.008 ★	Total Servo Drive Operation Time		Hex Address	Dec Address
			0010H 0011H	40017 40018
Default:	0	Control mode:	All	
Unit:	Hour	Setting range:	0–FFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Displays the total servo drive operation time. The unit is in hours and durations of less than 1 hour are not recorded. The recorded hours are saved when the servo powers off.

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DCBA	Servo on time	UZYX	Servo power applied time
h	High word	L	Low word

P0.009★■	***Status Monitoring Register 1***		***Hex Address***	***Dec Address***
			0012H 0013H	40019 40020
Default:	0	Control mode:	All	
Unit:	-	Setting range:	-	
Format:	DEC*	Data size:	32-bit	
*If the source register data is not DEC then it will be converted to decimal.				

Settings:

Set the value to be monitored in P0.017 through SureServo2 Pro, the drive panel, or communication. Please refer to P0.002 for codes that define the available monitoring values. See section 8.4.11 on page 8–259 for more information. To get the status, the communication port must read the communication address.

Where to Define the Value/Code (from table in section 8.4.11)	***Where to Read the Monitored Data***
P0.017	P0.009
P0.018	P0.010
P0.019	P0.011
P0.020	P0.012
P0.021	P0.013

For example, if you set P0.017 to 3, when accessing P0.009, the register will take a snapshot and displays the total number of feedback pulses of the motor encoder. If accessing the data through MODBUS communication, it reads two 16-bit values (0012H and 0013H) as a single 32-bit value. (0013H : 0012H) = (Hi-word : Low-word). Set P0.002 to 23 and the panel displays VAR-1 as the value of P0.009.

When accessing parameter P0.009 - P0.013, the value displayed is the value read at the moment the register was accessed. It is not a real time display or value.

P0.010★■	***Status Monitoring Register 2***		***Hex Address***	***Dec Address***
			0014H 0015H	40021 40022
Default:	-	Control mode:	All	
Unit:	-	Setting range:	-	
Format:	DEC*	Data size:	32-bit	
*If the source register data is not DEC then it will be converted to decimal.				

Settings:

Set the value to be monitored in P0.018. Behavior is the same as P0.009.

P0.011 ★■	Status Monitoring Register 3		Hex Address	Dec Address
			0016H 0017H	40023 40024
Default:	-	Control mode:	All	
Unit:	-	Setting range:	-	
Format:	DEC*	Data size:	32-bit	
*If the source register data is not DEC then it will be converted to decimal.				

Settings:

Set the value to be monitored in P0.019. Behavior is the same as P0.009.

P0.012 ★■	Status Monitoring Register 4		Hex Address	Dec Address
			0018H 0019H	40025 40026
Default:	-	Control mode:	All	
Unit:	-	Setting range:	-	
Format:	DEC*	Data size:	32-bit	
*If the source register data is not DEC then it will be converted to decimal.				

Settings:

Set the value to be monitored in P0.020. Behavior is the same as P0.009.

P0.013 ★■	Status Monitoring Register 5		Hex Address	Dec Address
			001AH 001BH	40027 40028
Default:	-	Control mode:	All	
Unit:	-	Setting range:	-	
Format:	DEC*	Data size:	32-bit	
*If the source register data is not DEC then it will be converted to decimal.				

Settings:

Set the value to be monitored in P0.021. Behavior is the same as P0.009.

P0.014–P0.016	Reserved

P0.017	Select Content Displayed by Status Monitoring Register 1		Hex Address	Dec Address
			0022H 0023H	40035 40036
Default:	0	Control mode:	All	
Unit:	-	Setting range:	0–127	
Format:	DEC	Data size:	16-bit	

Settings:

Please refer to section 8.4.11 for the available values.

For example, if you set P0.017 to 07, then reading P0.009 displays the motor speed (rpm).

P0.018	Select Content Displayed by Status Monitoring Register 2	Hex Address	Dec Address
		0024H 0025H	40037 40038

Default:	0	Control mode:	All
Unit:	-	Setting range:	0–127
Format:	DEC	Data size:	16-bit

Settings:

Please refer to section 8.4.11 for the available values.

P0.019	Select Content Displayed by Status Monitoring Register 3	Hex Address	Dec Address
		0026H 0027H	40039 40040

Default:	0	Control mode:	All
Unit:	-	Setting range:	0–127
Format:	DEC	Data size:	16-bit

Settings:

Please refer to section 8.4.11 for the available values.

P0.020	Select Content Displayed by Status Monitoring Register 4	Hex Address	Dec Address
		0028H 0029H	40041 40042

Default:	0	Control mode:	All
Unit:	-	Setting range:	0–127
Format:	DEC	Data size:	16-bit

Settings:

Please refer to section 8.4.11 for the available values.

P0.021	Select Content Displayed by Status Monitoring Register 5	Hex Address	Dec Address
		002AH 002BH	40043 40044

Default:	0	Control mode:	All
Unit:	-	Setting range:	0–127
Format:	DEC	Data size:	16-bit

Settings:

Please refer to section 8.4.11 for the available values.

P0.022–P0.024	Reserved

P0.025■	Mapping Parameter (data for read/write) #1		Hex Address	Dec Address
			0032H 0033H	40051 40052
Default:	-	Control mode:	All	
Unit:	-	Setting range:	Determined by the corresponding parameter P0.035	
Format:	HEX	Data size:	32-bit	

Settings:

You can easily read and write many parameters that are scattered around by assigning them to the mapping parameters, placing them in one contiguous group for reading and writing. This is also known as Block Transfer. You can use P0.035 to specify the mapping parameter number through SureServo2 Pro, the keypad, or communication. The value of the parameter that is specified by P0.035 is shown in P0.025. Please refer to P0.035 for its settings. The Status Monitoring window in SureServo2 Pro is the easiest way to configure Mapping parameters (Block Transfer).

Block Transfer Parameters (32bit Registers)	
Where to Specify the Data Parameter Numbers to Map from/to	Where to Load/ Retrieve
P0.035	P0.025
P0.036	P0.026
P0.037	P0.027
P0.038	P0.028
P0.039	P0.029
P0.040	P0.030
P0.041	P0.031
P0.042	P0.032

P0.026■	Mapping Parameter #2		Hex Address	Dec Address
			0034H 0035H	40053 40054
Default:	-	Control mode:	All	
Unit:	-	Setting range:	Determined by the corresponding parameter P0.036	
Format:	HEX	Data size:	32-bit	

Settings:

This setting is the same as P0.025, except its mapping target is set in P0.036.

P0.027■	Mapping Parameter #3		Hex Address	Dec Address
			0036H 0037H	40055 40056
Default:	-	Control mode:	All	
Unit:	-	Setting range:	Determined by the corresponding parameter P0.037	
Format:	HEX	Data size:	32-bit	

Settings:

This setting is the same as P0.025, except its mapping target is set in P0.037.

P0.028■	Mapping Parameter #4		Hex Address	Dec Address
			0038H 0039H	40057 40058
Default:	-	Control mode:	All	
Unit:	-	Setting range:	Determined by the corresponding parameter P0.038	
Format:	HEX	Data size:	32-bit	

Settings:

This setting is the same as P0.025, except its mapping target is set in P0.038.

P0.029■	Mapping Parameter #5		Hex Address	Dec Address
			003AH 003BH	40059 40060
Default:	-	Control mode:	All	
Unit:	-	Setting range:	Determined by the corresponding parameter P0.039	
Format:	HEX	Data size:	32-bit	

Settings:

This setting is the same as P0.025, except its mapping target is set in P0.039.

P0.030■	Mapping Parameter #6		Hex Address	Dec Address
			003CH 003DH	40061 40062
Default:	-	Control mode:	All	
Unit:	-	Setting range:	Determined by the corresponding parameter P0.040	
Format:	HEX	Data size:	32-bit	

Settings:

This setting is the same as P0.025, except its mapping target is set in P0.040.

P0.031■	Mapping Parameter #7		Hex Address	Dec Address
			003EH 003FH	40063 40064
Default:	-	Control mode:	All	
Unit:	-	Setting range:	Determined by the corresponding parameter P0.041	
Format:	HEX	Data size:	32-bit	

Settings:

This setting is the same as P0.025, except its mapping target is set in P0.041.

P0.032■	Mapping Parameter #8		Hex Address	Dec Address
			0040H 0041H	40065 40066
Default:	-	Control mode:	All	
Unit:	-	Setting range:	Determined by the corresponding parameter P0.042	
Format:	HEX	Data size:	32-bit	

Settings:

This setting is the same as P0.025, except its mapping target is set in P0.042.

P0.033–P0.034	Reserved

P0.035	Target Setting (pointer) for Mapping Parameter P0.025		Hex Address	Dec Address
			0046H 0047H	40071 40072
Default:	-	Control mode:	All	
Unit:	-	Setting range:	Determined by the communication address of the parameter group	
Format:	HEX	Data size:	32-bit	

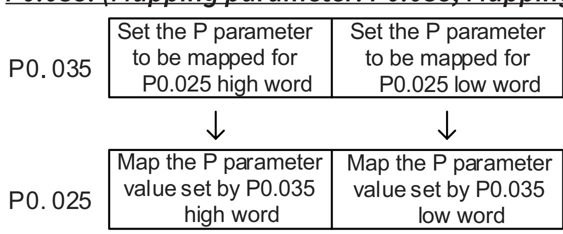
Settings:

The formats of the high-word parameter (PH) and the low-word parameter (PL) are:

BA	Hexadecimal code for the parameter index	YX	Hexadecimal code for the parameter index
C	Hexadecimal code for the parameter group	Z	Hexadecimal code for the parameter group
D	N/A	U	N/A
h	High-word	L	Low-word

Select the data block to access the parameter corresponding to register 1. The mapping value is 32 bits and can map to two 16-bit parameters or one 32-bit parameter. When writing to two different 16-bit parameters in one mapped parameter, you can't just write to one of the parameters (words). Both parameters (words) will always be written to. You cannot have a 16-bit read only and a 16-bit read/write parameter in the mapping pointers unless you only read the values. Writing to the mapping parameter will cause an error.

P0.035: (Mapping parameter: P0.035; Mapping content: P0.025)



When PH does not equal PL, it indicates that the content of P0.025 includes two 16-bit parameters. When PH = PL = P, it indicates that P0.025 has one 32-bit parameter.

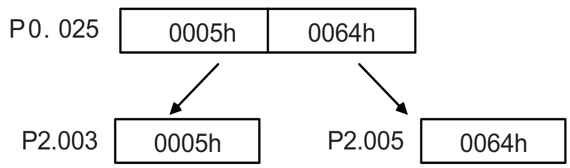
Example:

Target: Set P2.003 to 5 in the mapping parameter and set P2.005 to 100.

Setting: Set the P0.035 high word to 0203 (P2.003) and low word to 0205 (P2.005).

Thus, P0.035 = 0x02030205.

Write: In the mapping content, set P0.025 to 0x00050064, and the values of P2.003 and P2.005 are:



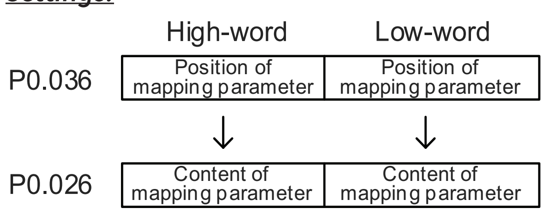
Example:

Target: Set P6.010 to 0x00050064 in the mapping parameter.
Setting: Set both the high bit and low bit of P0.035 to 060A (P6.010).
Thus, P6.010 = 0x060A060A.

Write: In the mapping content, set P0.025 to 0x00050064 and P6.010 changes immediately.

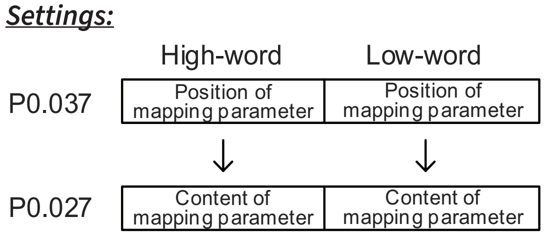
P0.036	***Target Setting (pointer) for Mapping Parameter P0.026***		***Hex Address***	***Dec Address***
			0048H 0049H	40073 40074
Default:	-	Control mode:	All	
Unit:	-	Setting range:	Determined by the communication address of the parameter group	
Format:	HEX	Data size:	32-bit	

Settings:



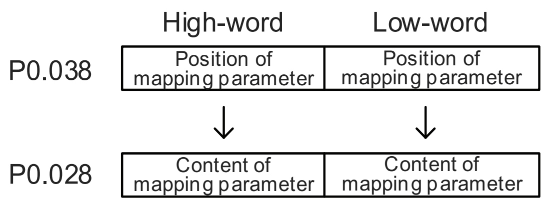
P0.037	***Target Setting (pointer) for Mapping Parameter P0.027***		***Hex Address***	***Dec Address***
			004AH 004BH	40075 40076
Default:	-	Control mode:	All	
Unit:	-	Setting range:	Determined by the communication address of the parameter group	
Format:	HEX	Data size:	32-bit	

Settings:



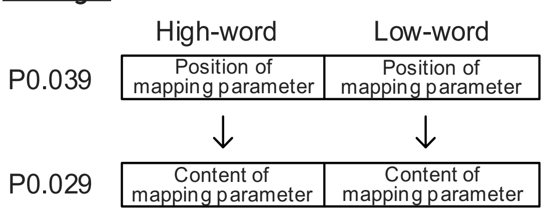
P0.038	Target Setting (pointer) for Mapping Parameter P0.028		Hex Address	Dec Address
			004CH 004DH	40077 40078
Default:	-	Control mode:	All	
Unit:	-	Setting range:	Determined by the communication address of the parameter group	
Format:	HEX	Data size:	32-bit	

Settings:



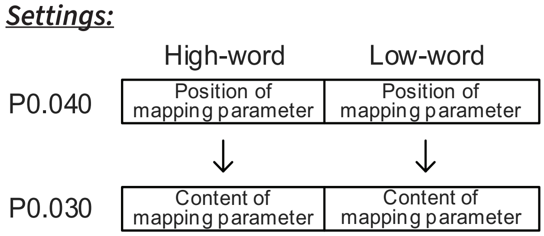
P0.039	Target Setting (pointer) for Mapping Parameter P0.029		Hex Address	Dec Address
			004EH 004FH	40079 40080
Default:	-	Control mode:	All	
Unit:	-	Setting range:	Determined by the communication address of the parameter group	
Format:	HEX	Data size:	32-bit	

Settings:



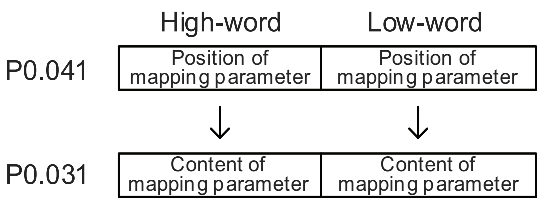
P0.040	Target Setting (pointer) for Mapping Parameter P0.030		Hex Address	Dec Address
			0050H 0051H	40081 40082
Default:	-	Control mode:	All	
Unit:	-	Setting range:	Determined by the communication address of the parameter group	
Format:	HEX	Data size:	32-bit	

Settings:



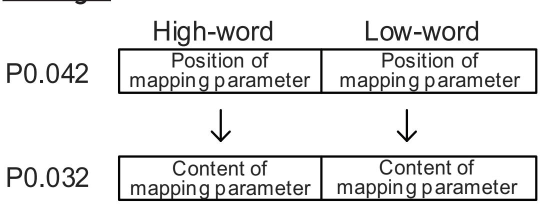
P0.041	***Target Setting (pointer) for Mapping Parameter P0.031***		***Hex Address***	***Dec Address***
			0052H 0053H	40083 40084
Default:	-	Control mode:	All	
Unit:	-	Setting range:	Determined by the communication address of the parameter group	
Format:	HEX	Data size:	32-bit	

Settings:



P0.042	***Target Setting (pointer) for Mapping Parameter P0.032***		***Hex Address***	***Dec Address***
			0054H 0055H	40085 40085
Default:	-	Control mode:	All	
Unit:	-	Setting range:	Determined by the communication address of the parameter group	
Format:	HEX	Data size:	32-bit	

Settings:



P0.043–P0.045	***Reserved***

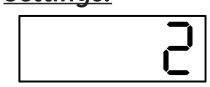
P0.046 ★■	Commonly Used DO Function Status		Hex Address	Dec Address
			005CH 005DH	40093 40094
Default:	0x0000	Control mode:	All	
Unit:	-	Setting range:	0x00–0xFF	
Format:	HEX	Data size:	16-bit	

Settings:

Bit	Function	Bit	Function
0	SRDY (servo ready)	8	HOME (homing completed)
1	SON (servo activated)	9	OLW (early warning for motor overload)
2	ZSPD (zero speed)	10	WARN (This is on when servo warning, CW, CCW, OVRD, undervoltage, communication error, etc. occurs.)
3	TSPD (target speed reached)	11	Reserved
4	TPOS (target position reached)	12	Reserved
5	TQL (torque limit activated)	13	Reserved
6	ALRM (servo alarm)	14	Reserved
7	BRKR (magnetic brake control output)	15	Reserved

P0.049■	Update Encoder Absolute Position Registers		Hex Address	Dec Address
			0062H 0063H	40099 40100
Default:	0x0000	Control mode:	All	
Unit:	-	Setting range:	0x00–0x02	
Format:	HEX	Data size:	16-bit	

Settings:



X

- *X: command processing*
  - *0: N/A*
  - *1: update the encoder data of P0.050–P0.052*
  - *2: update P0.050–P0.052 and clear the position error. When the command takes effect, the motor's current position is set to the terminal point of the Position command.*

P0.050 ★■	Absolute Coordinate System Status		Hex Address	Dec Address
			0064H 0065H	40101 40102
Default:	0x0000	Control mode:	All	
Unit:	-	Setting range:	0x00–0x1F	
Format:	HEX	Data size:	16-bit	

Settings:

- *Bit 0: 1 means the absolute position is lost; 0 means normal.*
- *Bit 1: 1 means the battery voltage is under 3.1 V; 0 means normal.*
- *Bit 2: 1 means the absolute multiple turns is overflowing; 0 means normal.*
- *Bit 3: 1 means the PUU is overflowing; 0 means normal.*
- *Bit 4: 1 means the absolute coordinate has not been set; 0 means normal.*
- *Bit 5–Bit 15: reserved (0).*

P0.051 ★■	Encoder Absolute Position - Number of Turns		Hex Address	Dec Address
			0066H 0067H	40103 40104
Default:	0	Control mode:	All	
Unit:	Rev	Setting range:	-32768 to +32767	
Format:	DEC	Data size:	32-bit	

Settings:

- *When you set P2.070 [Bit 1=1] to read the pulse number, this parameter displays the number of turns of the encoder (absolute position).*
- *When you set P2.070 [Bit 1=0] to read the PUU number, this parameter becomes invalid and displays 0.*

P0.052 ★■	Encoder Absolute Position - Pulse Number Or PUU Within Single Turn		Hex Address	Dec Address
			0068H 0069H	40105 40106
Default:	0	Control mode:	All	
Unit:	Pulse or PUU	Setting range:	0–16777216-1 (pulse) -2147483648 to +2147483647 (PUU)	
Format:	DEC	Data size:	32-bit	

Settings:

- *When you set bit 1 of P2.070 to 1 to read the pulse number, this parameter displays the encoder pulse number of the absolute position within a single turn.*
- *When you set bit 1 of P2.070 to 0 to read the PUU number, this parameter displays the motor's absolute position in PUU.*

P0.053	General Range Compare DO Output - Filter Time		Hex Address	Dec Address
			006AH 006BH	40107 40108
Default:	0x0000	Control mode:	All	
Unit:	ms	Setting range:	0x0000–0x000F	
Format:	HEX	Data size:	16-bit	

Settings:

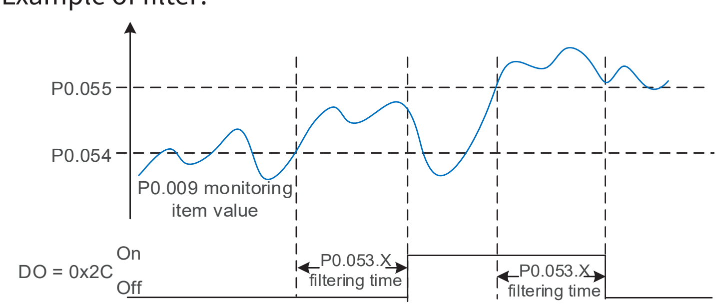
0002

U Z Y X

- *X: filter time*
- *Y–U: reserved*

Note: The minimum filter time is 1ms (set value 0 = 1ms; 1 = 2ms; 2 = 3ms; ...; F = 16ms).

Example of filter:



P0.054	**General Range Compare Digital Output - First Lower Limit**		**Hex Address**	**Dec Address**
			006CH 006DH	40109 40110
Default:	0	Control mode:	All	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Before using this function, set a digital output function (DOx) to [0x2C]. Set the lower and upper range for the range compare window. Set the variable to be monitored by the window using P0.017. When the value of the monitored variable of P0.009 is between the lower and upper range set by P0.054 and P0.055, and remains in this window for the period of time set by P0.053.X, this digital output status is on. Once the value falls outside this window for the same period of time the digital output will turn off.

P0.055	**General Range Compare Digital Output - First Upper Limit**		**Hex Address**	**Dec Address**
			006EH 006FH	40111 40112
Default:	0	Control mode:	All	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

This parameter sets the upper limit while P0.054 sets the lower limit. See the P0.054 settings for details.

P0.056	**General Range Compare Digital Output - Second Lower Limit**		**Hex Address**	**Dec Address**
			0071H 0072H	40113 40114
Default:	0	Control mode:	All	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Before using this function, set the digital output function to [0x2D] (second set of general range comparison) and the monitoring items of P0.018. When the monitoring item value of P0.010 is within the range set by P0.056 and P0.057, and after the filtering time set by P0.053.Y, this digital output status is on.

P0.057	**General Range Compare Digital Output - Second Upper Limit**		**Hex Address**	**Dec Address**
			0073H 0074H	40115 40116
Default:	0	Control mode:	All	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

This parameter sets the upper limit while P0.056 sets the lower limit. See the P0.056 settings for details.

P0.058	General Range Compare Digital Output - Third Lower Limit		Hex Address	Dec Address
			0075H 0076H	40117 40118
Default:	0	Control mode:	All	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Before using this function, set the digital output function to [0x2E] (third set of general range comparison) and the monitoring items of P0.019. When the monitoring item value of P0.011 is within the range set by P0.058 and P0.059, and after the filtering time set by P0.053.Z, this digital output status is on.

P0.059	General Range Compare Digital Output - Third Upper Limit		Hex Address	Dec Address
			0077H 0078H	40119 40120
Default:	0	Control mode:	All	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

This parameter sets the upper limit while P0.058 sets the lower limit. See the P0.058 settings for details.

P0.060	General Range Compare Digital Output - Fourth Lower Limit		Hex Address	Dec Address
			0079H 007AH	40121 40122
Default:	0	Control mode:	All	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Before using this function, set the digital output function to [0x2F] (fourth set of general range comparison) and the monitoring items of P0.020. When the monitoring item value of P0.012 is within the range set by P0.060 and P0.061, and after the filtering time set by P0.053.U, this digital output status is on.

P0.061	General Range Compare Digital Output - Fourth Upper Limit		Hex Address	Dec Address
			007BH 007CH	40123 40124
Default:	0	Control mode:	All	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

This parameter sets the upper limit while P0.060 sets the lower limit. See the P0.060 settings for details.

P0.062	Reserved

P0.063	**Duration of DC Bus Voltage Exceeding 400V**		**Hex Address**	**Dec Address**
			007EH 007FH	40127 40128
Default:	0	Control mode:	All	
Unit:	ms	Setting range:	0x00000000–0x7FFFFFFF	
Format:	DEC	Data size:	32-bit	

Settings:

Records the total time during which the DC bus voltage of the servo drive exceeded 400V for SV2A-2xxx drives (230V) and 800V for SV2A-4xxx drives (460V).

P0.064–P0.068	**Reserved**

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8.4.2 - P1.xxx Basic parameters

P1.000▲	***External Pulse Input Type***		**Hex Address**	**Dec Address**
			0100H 0101H	40257 40258
Default:	0x1042	Control mode:	PT	
Unit:	-	Setting range:	0x0000–0x11F2	
Format:	HEX	Data size:	16-bit	

Settings:

0020

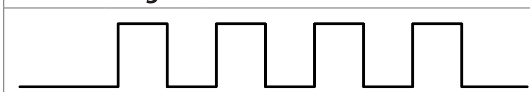
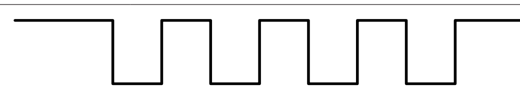
U Z Y X

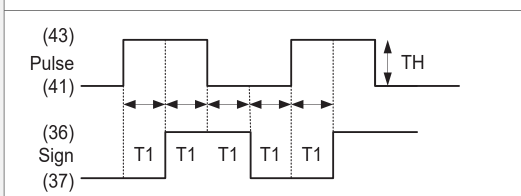
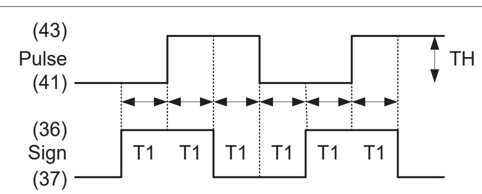
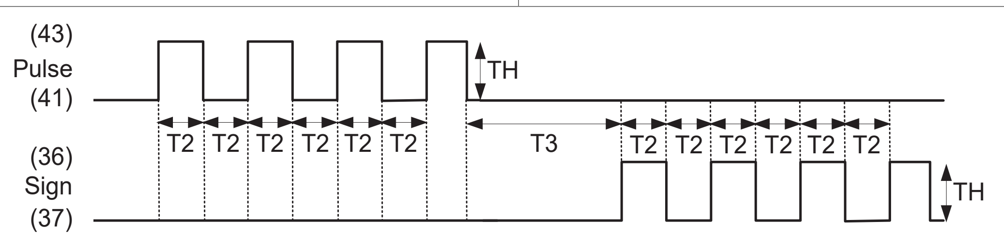
X	Command source	Z	Logic type	UY	Filter width

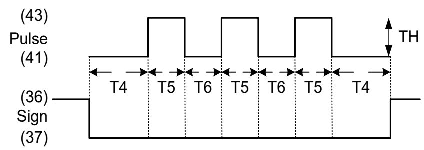
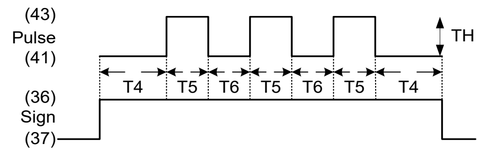
- *X: command source*
  - *0: AB phase pulse (4x)*
  - *1: clockwise and counterclockwise pulse*
  - *2: pulse + direction*
  - *Others: reserved*
- *Z: logic type*
  - *0: positive logic*
  - *1: negative logic*

Digital circuits use 0 and 1 to represent the low and high voltage levels. In positive logic, 1 represents high voltage and 0 represents low voltage; in negative logic, 1 represents low voltage and 0 represents high voltage.

For example:

Positive LLogic	***Negative Logic***
	

Logic Type	***Pulse Type***	***Pulse Input***	
		Forward	***Reverse***
Z = 0		Pulse phase lead	Pulse phase lag
	X = 0		
	X = 1		

Logic Type	Pulse Type	Pulse Input	
		Forward	**Reverse**
		Sign = low	Sign = high
Z = 0	X = 2		

Pulse Specification	Maximum Input Frequency	Minimum Allowed Time Width					
		T1	**T2**	**T3**	**T4**	**T5**	**T6**
Differential signal	4 Mpps (MHz)	62.5 ns	125ns	250ns	200ns	125ns	125ns
Open-collector	200 Kpps (kHz)	1.25 µs	2.5 µs	5µs	5µs	2.5 µs	2.5 µs

Pulse Specification	Maximum Input Frequency	Voltage	Forward Current
Differential signal	4 Mpps (MHz)	5V	< 25mA
Open-collector	200 Kpps (kHz)	24V (maximum)*	< 25mA
** If using 24V signals, do not apply 24V to SIGN and PULSE directly. Use Pull-Hi_S and Pull-Hi_P terminals to avoid damage to the drive's PT mode control circuit.*			

UY: filter width setting

If the input pulse frequency is too high, causing a pulse width smaller than the filter width, then this pulse gets filtered out as noise. Therefore, set the filter width smaller than the actual pulse width. You should set the filter width to 4 times smaller than the actual pulse width.

Y value	U = 0 Unit: µs (kHz)	U = 1 Unit: µs (kHz)
0	No filter function	No filter function
1	2 (250)	0.2 (2500)
2	3 (166)	0.3 (1666)
3	4 (125)	0.4 (1250)
4	5 (100)	0.5 (1000)
5	6 (83)	0.6 (833)
6	7 (71)	0.7 (714)
7	8 (62)	0.8 (625)
8	9 (55)	0.9 (555)
9	10 (50)	1 (500)
A	11 (45)	1.1 (454)
B	12 (41)	1.2 (416)
C	13 (38)	1.3 (384)
D	14 (35)	1.4 (357)
E	15 (33)	1.5 (333)

Example 1:

When U is set to 0 and Y is set to 4 this means there is a filter width setting of 5 µs. 5 µs is 1/2 the width of the full period. 1/100kH = 10 µs. This should be used on input pulse frequencies 4 times slower (4 times longer pulse width). Which means the input pulse width should be at least 20µs wide.

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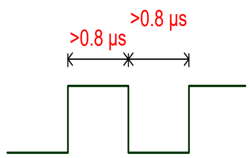
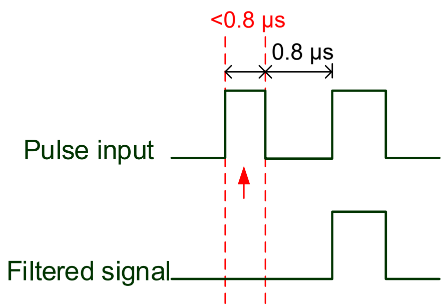
Example 2:

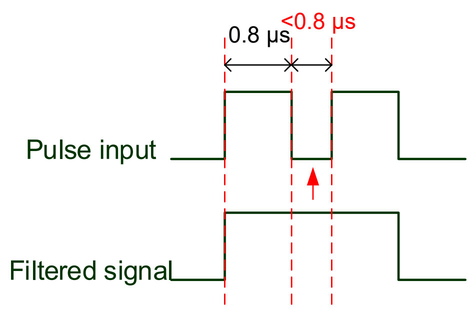
When U is set to 1 and Y is set to 1 (and filter width is therefore 0.2 µs), and when the high and low duty width of the command pulse are both larger than 0.8 µs (which means the width is 4 times 0.2 µs), then the pulse command is not filtered out.



When the high or low duty width of the pulse is smaller than the filter width, then it is filtered out.



If this first pulse width is shorter than 0.8 µs, it may be filtered, and thus two input pulses will be regarded as one pulse. If this pulse width is shorter than 0.2 µs, it will be filtered.



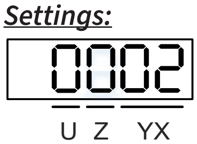
If this low level pulse width is shorter than 0.8 µs, it may be filtered, and thus two input pulses will be regarded as one pulse. If this low level pulse width is shorter than 0.2 µs, it will be filtered.

If you use a 125ns (4 Mpps) input pulse, set the filter value Y to 0 to disable the filter function.

NOTE: *When the high-speed pulse specification of the signal is 4 Mpps and the value of the filter is 0, then the pulse is not filtered. This pulse frequency can only be used with Differential Line Driver which is naturally less susceptible to external EMI noise interference.*

P1.001●	***Input for Control Mode and control command***		***Hex Address***	***Dec Address***
			0102H 0103H	40259 40260
Default:	0x0000	Control mode:	All	
Unit:	P (pulse); S (rpm); T (N-M)	Setting range:	0x0000–0x111F	
Format:	HEX	Data size:	16-bit	

Settings:



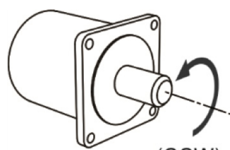
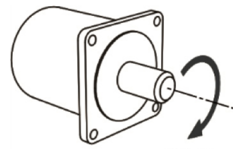
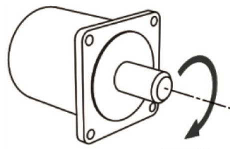
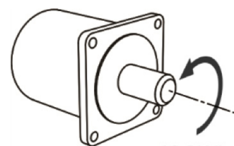
YX	Control mode setting	Z	Direction control	U	DIO value control

- *YX: control mode setting*

Mode	PT	PR	S	T	Sz	Tz
00	▲					
01		▲				
02			▲			
03				▲		
04					▲	
05						▲
Dual Mode						
06	▲		▲			
07	▲			▲		
08		▲	▲			
09		▲		▲		
0A			▲	▲		
Multi-mode						
0E	▲	▲	▲			
0F	▲	▲		▲		

  - *PT: Position (terminals) control mode; the command source is from the external pulse and the external analog voltage.*
  - *PR: Position (registers) control mode; the command source is from the 100 sets of internal registers which you can select with DI.POS0–DI.POS6. Multiple homing methods are also available.*
  - *S: Speed control mode; the command source is from the external analog voltage and the internal register which you can select with DI.SPD0 and DI.SPD1.*
  - *T: Torque control mode; the command source is from the external analog voltage and the internal register which you can select with DI.TCM0 and DI.TCM1.*
  - *Sz: Speed control mode; the command source is from the zero speed and the internal speed register which you can select with DI.SPD0 and DI.SPD1.*
  - *Tz: Torque control mode; the command source is from the zero torque and the internal torque register which you can select with DI.TCM0 and DI.TCM1.*
- *Dual mode: you can switch the mode with external DI. For example, you can use DI.S-P to switch the dual mode of PT/S (control mode setting: 06). Please refer to section 8.4.9 for further information.*
- *Multi-mode: you can switch the mode with external DI. For example, you can use DI.S-P and PT-PR to switch the multi-mode for PT/PR/S (control mode setting: 12). Please refer to section 8.4.9 for further information.*

- *Z: Definition of forward and reverse direction control*

	Z = 0	***Z = 1***
Forward direction	 (CCW)	 (CW)
Reverse direction	 (CW)	 (CCW)

- *U: DIO value control (volatile)*
    - *0: when switching modes, DIO settings (P2.010–P2.022) remain the same.*
    - *1: when switching modes, DIO settings (P2.010–P2.022) are reset to the default for each mode. This parameter nibble (U) is volatile and reset to 0 after power cycle. Refer to section 3.4.2 for DI/DO default setting for each mode.*

P1.002▲	***Speed and Torque Limits***		***Hex Address***	***Dec Address***
			0104H 0105H	40261 40262
Default:	0x0000	Control mode:	All	
Unit:	-	Setting range:	00–11	
Format:	HEX	Data size:	16-bit	

Settings:

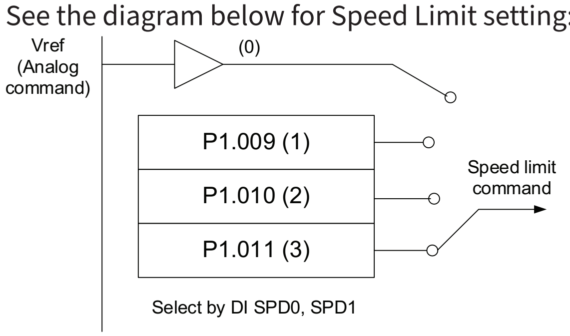
0000

U Z Y X

X	Disable / enable Speed Limit function	Y	Disable / enable Torque Limit function	UZ	Reserved

- *X: disable / enable Speed Limit function*
    - *0: disable Speed Limit function*
    - *1: enable Speed Limit function (only available in torque modes)*

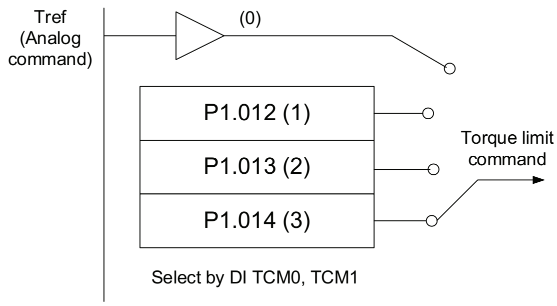
See the diagram below for Speed Limit setting:



P1.040 and P1.081 allow you to scale the analog input and DI (0x0F) allows you to switch between the two scaling values. Refer to section 6.6.1 and 6.6.2 for details on applying the speed and torque limits.

- *Y: disable / enable Torque Limit function*
  - *0: disable Torque Limit function*
  - *1: enable Torque Limit function (only available in Speed and Position modes)*

See the diagram below for Torque Limit setting:



When using the Torque Limit function, you can set this parameter to 10 to limit the torque permanently without occupying a DI setting. Alternatively, you can enable or disable the limit function through DI.TRQLM, which is more flexible, but the setting then occupies a DI setting. P1.041 determines the torque limit for the analog input and P1.012, P1.013, and P1.014 determine the limit when using TCM0-TCM1 DI selections. You can enable the Torque Limit function by either P1.002 or DI (0x09).

UZ: reserved

P1.003	***Analog and Encoder Pulse Output Polarity***		***Hex Address***	***Dec Address***
			0106H 0107H	40263 40264
Default:	0x0000	Control mode:	All	
Unit:	-	Setting range:	0–13	
Format:	HEX	Data size:	16-bit	
Related Parameters	P0.003, P1.004, P1.005			

Settings:

0002

U Z Y X

X	Polarity of monitor analog output	Y	Polarity of encoder pulse output	UZ	Reserved

- *X: polarity of monitor analog output*
  The MON1 and MON2 analog output terminals have a max output of ±8V. This equals an 8 volt swing about the center of the GND reference. The X nibble does not slide the center point of the analog output but can invert the MON1 or MON2 output signal. A (+) means normal polarity and (-) means inverted polarity. P1.004 and P1.005 can adjust the proportional output.
  - *0: MON1(+), MON2(+)*
  - *1: MON1(+), MON2(-)*
  - *2: MON1(-), MON2(+)*
  - *3: MON1(-), MON2(-)*
- *Y: polarity of encoder pulse output*
  - *0: pulse output in forward direction*
  - *1: pulse output in reverse direction*
- *UZ: reserved*

P1.004	**MON1 Analog Monitor Output Proportion**		Hex Address	Dec Address
			0108H 0109H	40265 40266
Default:	100	Control mode:	All	
Unit:	% (full scale)	Setting range:	0–100	
Format:	DEC	Data size:	16-bit	
Related Parameters	P0.003, P1.003, P1.005			

Settings:

Please refer to P0.003 for the definition of the analog output function setting.

Example 1:

If the requirement is for the motor to run at 1000 rpm, which corresponds to 8V, and its maximum speed is 5000 rpm, the setting is:

$$\text{P1.004} = \frac{\text{Required speed}}{\text{Maximum speed}} \times 100\% = \frac{1000 \text{ rpm}}{5000 \text{ rpm}} \times 100\% = 20\%$$

Refer to the following example for the motor's current speed and relative voltage output:

Motor Speed	MON1 Analog Monitor Output
300 rpm	$\text{MON1} = 8\text{V} \times \frac{\text{Current speed}}{(\text{Maximum speed} \times \frac{\text{P1.004}}{100})} \times 100\% = 8\text{V} \times \frac{300 \text{ rpm}}{5000 \text{ rpm} \times \frac{20}{100}} \times 100\% = 2.4\text{V}$
900 rpm	$\text{MON1} = 8\text{V} \times \frac{\text{Current speed}}{(\text{Maximum speed} \times \frac{\text{P1.004}}{100})} \times 100\% = 8\text{V} \times \frac{900 \text{ rpm}}{5000 \text{ rpm} \times \frac{20}{100}} \times 100\% = 7.2\text{V}$

P1.005	**MON2 Analog Monitor Output Proportion**		Hex Address	Dec Address
			010AH 010BH	40267 40268
Default:	100	Control mode:	All	
Unit:	% (full scale)	Setting range:	0–100	
Format:	DEC	Data size:	16-bit	

Settings:

Please refer to P0.004 for the analog output setting.

P1.006	**Speed Command Smoothing Constant (Low-pass filter)**		Hex Address	Dec Address
			010CH 010DH	40269 40270
Default:	0	Control mode:	S / Sz	
Unit:	ms	Setting range:	0–1000	
Format:	DEC	Data size:	16-bit	
Related Parameters	P1.036, P1.059			

Settings:

- *0: disable this function.*
- *The acceleration to the target speed is immediately started but the acceleration to the target speed is given an S-curve towards the end of the acceleration over the time frame entered in P1.006 (0-1000 milliseconds).*

P1.007	Torque Command Smoothing Constant (Low-pass filter)	Hex Address	Dec Address
		010EH 010FH	40271 40272
Default:	0	Control mode:	T / Tz
Unit:	ms	Setting range:	0–1000
Format:	DEC	Data size:	16-bit

Settings:

- *0: disable this function.*
- *The acceleration to the target torque is immediately started but the acceleration to the target torque is given an S-curve towards the end of the acceleration over the time frame entered in P1.007 (0-1000 milliseconds).*

P1.008	Position Command Smoothing Constant (Low-pass filter)	Hex Address	Dec Address
		0110H 0111H	40273 40274
Default:	0	Control mode:	PT / PR
Unit:	10ms	Setting range:	0–1000
Format:	DEC	Data size:	16-bit
Example:	11 = 110 ms		

Settings:

- *0: disable this function.*
- *The acceleration to the target position is immediately started but the acceleration to the target position is given an S-curve towards the end of the acceleration over the time frame entered in P1.008 (0-1000 milliseconds).*
- *Should be set to 0 if using E-Cam function.*

P1.009	Internal Speed Command 1 / Internal Speed Limit 1	Hex Address	Dec Address
		0112H 0113H	40275 40276
Default:	1000	Control mode:	S / Sz: internal Speed command 1 (S1) T / Tz: internal speed limit 1
Unit:	0.1 rpm	Setting range:	-60000 to +60000
Format:	DEC	Data size:	32-bit
Example:	Internal Speed command: 120 = 12 rpm Internal speed limit: positive and negative values are identical. Please refer to the following descriptions.		

Settings:

- *Internal Speed command 1: first internal Speed command.*
- *Internal speed limit 1: first internal speed limit.*
- *Using DI.SPD0 and DI.SPD1 will allow selecting S1, S2, or S3.*

In Torque Mode, the Speed limits are only valid if DI.SPDLM or P1.002:X = 1. See section “6.6 - Others” on page 6–31 for more details.

Example of internal speed limit:

Speed Limit Value Of P1.009	Valid Speed Range	Speed Limit In Forward Direction	Speed Limit In Reverse Direction
1000	-100 to +100 rpm	100 rpm	-100 rpm
-1000			

P1.010	Internal Speed Command 2 / Internal Speed Limit 2		Hex Address	Dec Address
			0114H 0115H	40277 40278
Default:	2000	Control mode:	S / Sz: internal Speed command 2 (S2) T / Tz: internal speed limit 2	
Unit:	0.1 rpm	Setting range:	-60000 to +60000	
Format:	DEC	Data size:	32-bit	
Example:	Internal Speed command: 120 = 12 rpm Internal speed limit: positive and negative values are identical. Please refer to the following descriptions.			

Settings:

- *Internal Speed command 2: second internal Speed command.*
- *Internal speed limit 2: second internal speed limit.*
- *Using DI.SPD0 and DI.SPD1 will allow selecting S1, S2, or S3.*

Example of internal speed limit:

Speed Limit Value Of P1.010	Valid Speed Range	Speed Limit In Forward Direction	Speed Limit In Reverse Direction
1000	-100 to +100 rpm	100 rpm	-100 rpm
-1000			

P1.011	Internal Speed command 3 / internal speed limit 3		Hex Address	Dec Address
			0116H 0117H	40279 40280
Default:	3000	Control mode:	S / Sz: internal Speed command 3 (S3) T / Tz: internal speed limit 3	
Unit:	0.1 rpm	Setting range:	-60000 to +60000	
Format:	DEC	Data size:	32-bit	
Example:	Internal Speed command: 120 = 12 rpm Internal speed limit: positive and negative values are identical. Please refer to the following descriptions.			

Settings:

- *Internal Speed command 3: third internal Speed command.*
- *Internal speed limit 3: third internal speed limit.*
- *Using DI.SPD0 and DI.SPD1 will allow selecting S1, S2, or S3.*

Example of internal speed limit:

Speed Limit Value Of P1.011	Valid Speed Range	Speed Limit In Forward Direction	Speed Limit In Reverse Direction
1000	-100 to +100 rpm	100 rpm	-100 rpm
-1000			

P1.012	Internal Torque Command 1 / Internal Torque Limit 1		Hex Address	Dec Address
			0118H 0119H	40281 40282
Default:	100	Control mode:	T / Tz: internal Torque command 1 (T1) PT / PR / S / Sz: internal torque limit 1	
Unit:	%	Setting range:	-400 to +400	
Format:	DEC	Data size:	16-bit	
Example:	Internal Torque command: 30 = 30% Internal torque limit: positive and negative values are identical. Please refer to the following descriptions.			

Settings:

The torque percentage relates directly to the motor's nameplate continuous torque rating. Example: For an SVL-204N, the nameplate torque is 1.27 Nm. Setting the torque limit to 50% will result in a max torque output of 0.635 Nm for this motor.

- *Internal Torque command 1: first internal Torque command.*
- *Internal torque limit 1: first internal torque limit.*
- *Using DI.TCM0 and DI.TCM1 will allow selecting of T1, T2, or T3.*

In Speed Mode, the Torque limits are only valid if DI.TRQLM or P1.002:Y=1. See section "6.6 - Others" on page 6–31 for more details.

Example of internal torque limit:

Torque Limit Value Of P1.012	Valid Torque Range	Torque Limit In Forward Direction	Torque Limit In Reverse Direction
30	-30 to +30%	30%	-30%
-30			

P1.013	Internal Torque Command 2 / Internal Torque Limit 2		Hex Address	Dec Address
			011AH 011BH	40283 40284
Default:	100	Control mode:	T / Tz: internal Torque command 2 (T2) PT / PR / S / Sz: internal torque limit 2	
Unit:	%	Setting range:	-400 to +400	
Format:	DEC	Data size:	16-bit	
Example:	Internal Torque command: 30 = 30% Internal torque limit: positive and negative values are identical. Please refer to the following descriptions.			

Settings:

- *Internal Torque command 2: second internal Torque command.*
- *Internal torque limit 2: second internal torque limit.*
- *Using DI.TCM0 and DI.TCM1 will allow selecting of T1, T2, or T3.*

Example of internal torque limit:

Torque Limit Value Of P1.013	Valid Torque Range	Torque Limit In Forward Direction	Torque Limit In Reverse Direction
30	-30 to +30%	30%	-30%
-30			

P1.014	Internal Torque Command 3 / Internal Torque Limit 3		Hex Address	Dec Address
			011CH 011DH	40285 40286
Default:	100	Control mode:	T / Tz: internal Torque command 3 (T3) PT / PR / S / Sz: internal torque limit 3	
Unit:	%	Setting range:	-400 to +400	
Format:	DEC	Data size:	16-bit	
Example:	Internal Torque command: 30 = 30% Internal torque limit: positive and negative values are identical. Please refer to the following descriptions.			

Settings:

- *Internal Torque command 3: third internal Torque command.*
- *Internal torque limit 3: third internal torque limit.*
- *Using DI.TCM0 and DI.TCM1 will allow selecting of T1, T2, or T3.*

Example of internal torque limit:

Torque Limit Value Of P1.014	Valid Torque Range	Torque Limit In Forward Direction	Torque Limit In Reverse Direction
30	-30 to +30%	30%	-30%
-30			

P1.015 – P1.016	Reserved

NOTE: *The setting value of this parameter is accumulative, which is not affected by the current error amount.*

P1.017	Additional Compensation Time for the Following Error		Hex Address	Dec Address
			0122H 0123H	40291 40292
Default:	0	Control mode:	PR	
Unit:	ms (minimum scale is μs)	Setting range:	-25.000 to +25.000	
Format:	DEC	Data size:	16-bit	

Settings:

When the following error compensation function is enabled (P1.036=1), the servo calculates the compensation amount according to the command and adjusts the position error (PUU) close to 0. If this is unable to accomplish by setting the position feed forward gain (P2.002) and position integral compensation (P2.053), set the additional compensation time to compensate the error amount.

Additional compensation distance = P1.017 x motor speed

NOTE: *Enable the following error compensation function (P1.036=1) to use the additional compensation function.*

P1.018	E-Cam: Compensation Time for the Pulse of E-Cam Master Axis	Hex Address	Dec Address
		0124H 0125H	40293 40294

Default:	0	Control mode:	PR
Unit:	ms (minimum scale is μs)	Setting range:	-25.000 to +25.000
Format:	DEC	Data size:	16-bit

Settings:

During the operation of the E-Cam, if the mechanical factor is excluded but the following error still exists which may be error caused by the electrical delay, set the compensation pulse number of the master axis to correct the E-Cam phase. If the compensation time is set to 0, it is not compensated.

- *Compensation pulse = P1.018 x (pulse frequency of the E-cam master axis (Kpps) - P1.021 (minimum frequency of pulse compensation for the E-cam master axis))*

NOTE: *Monitor the pulse frequency of the E-cam master axis (Kpps) with the monitoring variable 060 (3Ch).*

P1.019	Capture / Compare Additional Function Settings	Hex Address	Dec Address
		0126H 0127H	40295 40296

Default:	0x0000	Control mode:	ALL
Unit:	-	Setting range:	0x0000–0x0101
Format:	HEX	Data size:	16-bit

Settings:

0000

U Z Y X

X	Additional function for Capture	Z	Additional Function for Compare
Y	Reserved	U	Reserved

- *X: additional function for Capture*

Bit	3	2	1	0

Bit	Function	Description
0	Cycle mode	Set this bit to 0 to disable this function. Set this bit to 1 to enable this function. If enabled, the E-Cam alignment correction is conducted when DI.ALGN is on.
1–3	Reserved	-

- *Z: additional function for Compare*

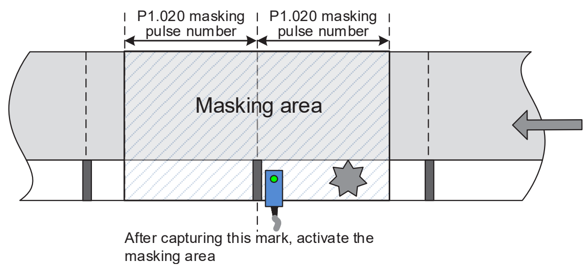
Bit	3	2	1	0

Bit	Function	Description
0	P1.024 is reset to 0 automatically	Set this bit to 0 to disable this function. Set this bit to 1, and P1.024 is reset to 0 automatically, but it only takes effect once.
1–3	Reserved	-

P1.020	Capture - Masking Range		Hex Address	Dec Address
			0128H 0129H	40297 40298
Default:	0	Control mode:	ALL	
Unit:	PUU of capture source	Setting range:	0–100000000	
Format:	DEC	Data size:	32-bit	

Settings:

When the Capture function is enabled and set to capture multiple points (P5.038 > 1), the system stops receiving the DI captured signal within this range once the data is captured. The DI captured signal received within this range is not recognized as valid. Use this function to keep the drive from seeing noise as a valid trigger within the masking range. The masking range is defined as the position of the captured data plus and minus the PUU value entered in P1.020 (CAP_DATA-P1.020, CAP_DATA+P1.020). This can also be used as a debounce filter for the Capture trigger DI7.



P1.021	E-Cam: Minimum Frequency of Pulse Compensation for the E-Cam Master Axis		Hex Address	Dec Address
			012AH 012BH	40299 40300
Default:	0	Control mode:	PR	
Unit:	Kpps	Setting range:	0 to +30000	
Format:	DEC	Data size:	16-bit	

Settings:

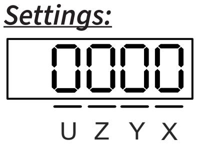
During the operation of the E-Cam, if the mechanical factor is excluded but the following error still exists which may be error caused by the electrical delay, set the compensation pulse number of the master axis to correct the E-Cam phase.

- *Compensation pulse = P1.018 (compensation time for the pulse of the E-Cam master axis) x (pulse frequency of the E-Cam master axis (Kpps) - P1.021)*

NOTE: *Monitor the pulse frequency of the E-cam master axis (Kpps) with the monitoring variable 060 (3Ch). The pulse frequency of the E-Cam master axis (Kpps) must be greater than P1.021 to be compensated.*

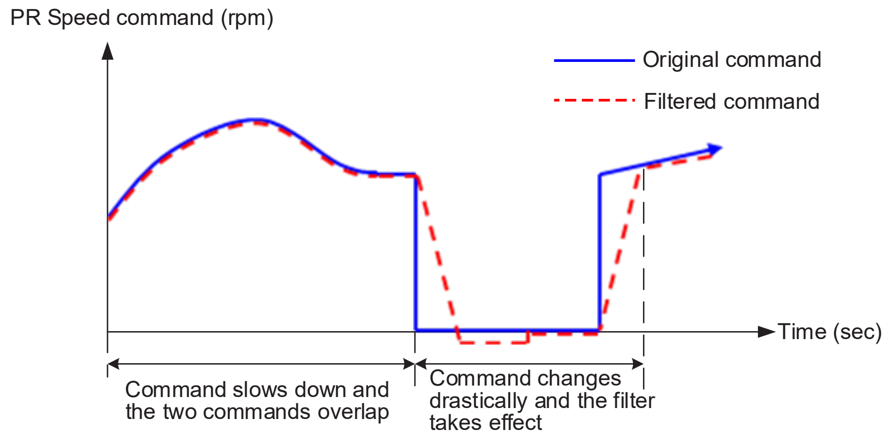
P1.022	PR Command Special Filter		Hex Address	Dec Address
			012CH 012DH	40301 40302
Default:	0x0000	Control mode:	PR	
Unit:	-	Setting range:	0x0000–0x107F	
Format:	HEX	Data size:	16-bit	

Settings:



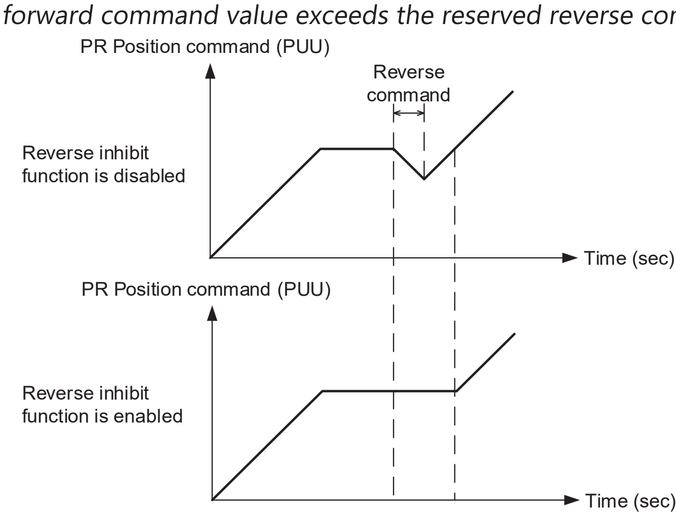
XY	Acceleration / deceleration time limit (0–1270 ms)	Z	Reserved
U	Reverse inhibit	-	-

- *YX: acceleration / deceleration time limit (0–1270 ms)*
  If the PR command changes too drastically it causes mechanical vibration. Set the acceleration / deceleration time limit (the time required for the motor to accelerate from 0 to 3,000 rpm) with this function. If the acceleration / deceleration time of the command is shorter than this limit, the filter takes effect to smooth the acceleration / deceleration which prevents the command from changing too drastically and causing mechanical vibration. When the filter is functioning, the lag caused by the smooth command is automatically compensated after the command is smoothed, so the final position is not deviated.
  Example:
  Set YX to 12 and the acceleration / deceleration time limit as 180ms (data format is HEX and unit is 10ms). If the acceleration / deceleration time of the PR command is longer than 180ms, the filter does not take effect.



NOTE: *If the command does not slow down, the internal position lag accumulates and triggers AL404.*

- *Z: reserved*
- *U: reverse inhibit*
  When the reverse inhibit function is enabled, the reverse command is inhibited. The reverse command is reserved in the servo drive and the forward command outputs after the received forward command value exceeds the reserved reverse command value.



Wiring
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P1.023	Compare - Data Translation (non-volatile)		Hex Address	Dec Address
			012EH 012FH	40303 40304
Default:	0	Control mode:	ALL	
Unit:	Pulse unit of compare source	Setting range:	-10000000 to +100000000	
Format:	DEC	Data size:	32-bit	

Settings:

When using the Compare function, you can add the translation value to the data array to be used as the actual comparison data:

CMP_DATA = DATA_ARRAY[*] + P1.023 + P1.024

For example:

If the data array for comparison is DATA_ARRAY[100] = 2000 and P1.023 = 40,

Then the actual comparison value = 2000 + 40 = 2040.

Notes:

1) This parameter is non-volatile.
2) P1.024: after the value takes effect, if P1.019.Z [Bit 0 = 1], then it automatically resets.
3) You can display CMP_DATA with the monitoring variable V25h (037).

P1.024■	Compare - Data Translation (reset automatically)		Hex Address	Dec Address
			0130H 0131H	40305 40306
Default:	0	Control mode:	ALL	
Unit:	Pulse unit of compare source	Setting range:	-32768 to +32767	
Format:	DEC	Data size:	16-bit	

Settings:

When using the Compare function, you can add the translation value to the data array to be used as the actual comparison data:

CMP_DATA = DATA_ARRAY[*] + P1.023 + P1.024

Notes:

1) This parameter is volatile.
2) After the parameter takes effect, if P1.019.Z [Bit 0 = 1], then it automatically resets.
3) You can display CMP_DATA with the monitoring variable V25h (037).

P1.025	Low-frequency Vibration Suppression Frequency (1)		Hex Address	Dec Address
			0132H 0133H	40307 40308
Default:	1000	Control mode:	PT / PR	
Unit:	0.1 Hz	Setting range:	10–1000	
Format:	DEC	Data size:	16-bit	
Example:	150 = 15Hz			
Related Parameters	P1.068, section 6.2.9			

Settings:

Sets the first low-frequency vibration suppression frequency. When you set P1.026 to 0, the first low-frequency vibration suppression filter is disabled.

P1.026	Low-Frequency Vibration Suppression Gain (1)		Hex Address	Dec Address
			0134H 0135H	40309 40310
Default:	0	Control mode:	PT / PR	
Unit:	-	Setting range:	0–9	
Format:	DEC	Data size:	16-bit	

Settings:

To set the gain of the first low-frequency vibration suppression, increase the value to improve the position response. If you set the value too high, the motor may not operate smoothly. The suggested value is 1. Set P1.026 to 0 to disable the first low-frequency vibration suppression filter.

P1.027	Low-frequency Vibration Suppression Frequency (2)		Hex Address	Dec Address
			0136H 0137H	40311 40312
Default:	1000	Control mode:	PT / PR	
Unit:	0.1 Hz	Setting range:	10–1000	
Format:	DEC	Data size:	16-bit	
Example:	150 = 15 Hz			

Settings:

Sets the second low-frequency vibration suppression frequency. Set P1.028 to 0 to disable the second low-frequency vibration suppression filter.

P1.028	Low-Frequency Vibration Suppression Gain (2)		Hex Address	Dec Address
			0138H 0139H	40313 40314
Default:	0	Control mode:	PT / PR	
Unit:	-	Setting range:	0–9	
Format:	DEC	Data size:	16-bit	

Settings:

To set the gain of the second low-frequency vibration suppression, increase the value to improve the position response. If you set the value too high, the motor may not operate smoothly. The suggested value is 1. Set P1.028 to 0 to disable the second low-frequency vibration suppression filter.

P1.029	Auto Low-Frequency Vibration Suppression Mode		Hex Address	Dec Address
			013AH 013BH	40315 40316
Default:	0	Control mode:	PT / PR	
Unit:		Setting range:	0–1	
Format:	DEC	Data size:	16-bit	

Settings:

- *0: Disable the automatic low-frequency vibration detection function.*
- *1: Enables the automatic low-frequency vibration suppression mode. After vibration suppression has been completed. The value resets to 0 automatically.*

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Auto mode setting description:

When the value is 1, vibration suppression is in automatic mode. When the vibration cannot be detected or the vibration frequency is stable, the system resets the parameter to 0 and automatically saves the vibration suppression frequency to P1.025. This mode is not used during the Auto Tuning process.

P1.030	***Low-Frequency Vibration Detection Level***		***Hex Address***	***Dec Address***
			013CH 013DH	40317 40318
Default:	800	Control mode:	PT / PR	
Unit:	Pulse	Setting range:	1–8000	
Format:	DEC	Data size:	16-bit	

Settings:

When enabling automatic vibration suppression (P1.029 = 1), the system automatically finds the detection level. The lower the value, the more sensitive the detection, but the system may also misjudge noise or treat other low-frequency vibrations as frequencies to be suppressed. If the value is high, the system is less likely to misjudge, but if the vibration of the machine is small, the system may not properly detect low-frequency vibrations.

P1.031	***Reserved***

P1.032	***Motor Stop Mode***		***Hex Address***	***Dec Address***
			0140H 0141H	40321 40322
Default:	0x0000	Control mode:	All	
Unit:	-	Setting range:	0–20	
Format:	HEX	Data size:	16-bit	
Related Parameters	P1.038, P1.042, P1.043, DO.BRKR			

Settings:

0000

U Z Y X

X	Reserved	Y	Dynamic brake operation options	UZ	Reserved

- *Y: options for using the dynamic brake when the servo is in Servo Off state or an alarm (including OVRD) occurs*
  - *0: use dynamic brake*
  - *1: motor runs freely*
  - *2: use dynamic brake first. Then let the motor run freely once the speed is slower than the value of P1.038*

When the motor reaches PL (CCWL) or NL (CWL), please refer to P5.003 for setting the deceleration time. If you set the deceleraton time to 1 ms, the motor stops instantly.

P1.033	***Reserved***

P1.034	Acceleration Time Constant (TACC)		Hex Address	Dec Address
			0144H 0145H	40325 40326
Default:	200	Control mode:	S / Sz	
Unit:	ms	Setting range:	1–65500	
Format:	DEC	Data size:	16-bit	

Settings:

Acceleration constant:

P1.034 represents the acceleration time for the Speed command from zero to the motor's rated speed (not 0 to commanded speed). You can set each ramp individually. When using an internal command, if you set P1.036 to 0, acceleration / deceleration follows a trapezoid-curve; when using an analog command, P1.036 must be larger than 0 so that the acceleration / deceleration doesn't create too much jerk.

P1.034 is used for Speed Mode and for PT (high speed pulse input) Mode. See P5.020–P5.035 for 16 Acceleration/Deceleration ramp values that can be used in PR Mode.

P1.035	Deceleration Time Constant (TDEC)		Hex Address	Dec Address
			0146H 0147H	40327 40328
Default:	200	Control mode:	S / Sz	
Unit:	ms	Setting range:	1–65500	
Format:	DEC	Data size:	16-bit	

Settings:

Deceleration constant:

P1.035 represents the deceleration time for the Speed command from the rated speed to zero (not commanded speed to 0). You can set each ramp individually. When using an internal command, if you set P1.036 to 0, acceleration / deceleration follows a trapezoid-curve; when using an analog command, P1.036 must be larger than 0 so that the acceleration / deceleration doesn't create too much jerk.

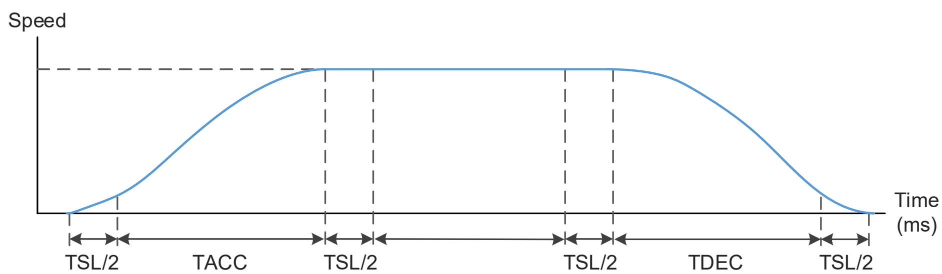
P1.034 is used for Speed Mode and for PT (high speed pulse input) Mode. See P5.020–P5.035 for 16 Acceleration/Deceleration ramp values that can be used in PR Mode.

P1.036	S-curve Acceleration / Deceleration Time Constant (TSL)			Hex Address	Dec Address
				0148H 0149H	40329 40330
Default:	0	Control mode:	PR / S / Sz		
Unit:	ms	Setting range:	0–65500		
Format:	DEC	Data size:	16-bit		

Settings:

- *0: disable this function.*

Acceleration / deceleration timing diagram of the S-curve constant.



- *P1.034: set the acceleration time for the trapezoid-curve.*
- *P1.035: set the deceleration time for the trapezoid-curve.*
- *P1.036: set the smoothing time for the S-curve acceleration / deceleration.*

You can set P1.034, P1.035, and P1.036 individually. If you set P1.036 to 0, the acceleration / deceleration follows a trapezoid-curve. See section 6.3.3 for more information on the S-curve filter.

NOTE: *The graph is from 0 to Rated Speed (not 0 to commanded speed). The Calculated acceleration or deceleration time from 0-rated speed will not be the same as the time from 0-any commanded value less than Rated speed.*

Please note the following error compensation:

	P1.036 = 0	P1.036 = 1	P1.036 > 1
Smoothing function for S-curve	Disable	Disable	Enable
Following error compensation function	Disable	Enable	Determine by P2.068.X

P1.037	Load Inertia Ratio To Servo Motor			Hex Address	Dec Address
				014AH 014BH	40331 40332
Operation interface:	Panel / software	Communication	Control mode:	All	
Default:	6.0	60	Data size:	16-bit	
Unit:	1 times	0.1 times	-	-	
Setting range:	0.0–200.0	0–2000			
Format:	One decimal	DEC	-	-	
Example:	1.5 = 1.5 times	15 = 1.5 times	-	-	

Settings:

- *Inertia ratio to servo motor: (J_load / J_motor)*
- *J_motor: rotor inertia of the servo motor*
- *J_load: total equivalent inertia of external mechanical load*

P1.038	***Zero Speed Range***			***Hex Address***	***Dec Address***
				014CH 014DH	40333 40334
Operation interface:	Panel / software	Communication	Control mode:	All	
Default:	10.0	100	Data size:	16-bit	
Unit:	1 rpm	0.1 rpm	-	-	
Setting range:	0.0–200.0	0–2000	-	-	
Format:	One decimal	DEC	-	-	
Example:	1.5 = 1.5 rpm	15 = 1.5 rpm	-	-	

Settings:

Sets the range for the zero-speed signal (ZSPD). When the forward / reverse speed of the motor is slower than this value, the zero-speed signal is triggered and the digital output is enabled if the DOx is set to DO.ZSPD.

P1.039	***Target Speed Detection Level***		***Hex Address***	***Dec Address***
			014EH 014FH	40335 40336
Default:	3000	Control mode:	ALL	
Unit:	rpm	Setting range:	0–30000	
Format:	DEC	Data size:	16-bit	

Settings:

When the target speed is reached, DO (TSPD) is enabled. When the forward / reverse speed of the motor is faster than this value, the target speed signal is triggered and the digital output is enabled.

P1.040	***Maximum Rotation Speed for Analog Speed Command***		***Hex Address***	***Dec Address***
			0150H 0151H	40337 40338
Default:	3000	Control mode:	S/T	
Unit:	rpm	Setting range:	0–50000	
Format:	DEC	Data size:	32-bit	

Settings:

P1.081 is a duplicate of this parameter and you can switch between these two parameters using DI(0x0F).

Maximum rotation speed for analog Speed command:

Speed mode:

$$\text{Speed control command} = \frac{\text{Input voltage} \times \text{Setting}}{10}$$

Set the rotation speed corresponding to 10V (maximum voltage) for the analog Speed command. If the value is 2000 and the external voltage input is 5V, then the speed control command is 1000 rpm.

$$\text{Speed control command} = \frac{5\text{V} \times 2000 \text{ rpm}}{10} = 1000 \text{ rpm}$$

Torque mode:

$$\text{Speed limit command} = \frac{\text{Input voltage} \times \text{Setting}}{10}$$

Set the rotation speed limit corresponding to 10V (maximum voltage) for the analog speed limit. If the value is 2000 and the external voltage input is 5V, then the

speed limit command = $\frac{5\text{V} \times 2000 \text{ rpm}}{10}$ = 1000 rpm

P1.041▲	Maximum Output for Analog Torque Command		Hex Address	Dec Address
			0152H 0153H	40339 40340
Default:	100	Control mode:	All	
Unit:	%	Setting range:	-1000 to +1000	
Format:	DEC	Data size:	16-bit	

Settings:

Maximum output for analog Torque command:

Torque mode:

Torque control command = (Unit: %)

Set the torque corresponding to 10V (maximum voltage) for the analog Torque command.

If the external voltage input is 10V, then the torque control command is 100% of the rated torque. If the external voltage input is 5V, then the torque control command is 50% of the rated torque.

- *When the external analog input is 10V, the torque control command =* $\frac{10V \times 100}{10}$ *= 100%*
- *When the external analog input is 5V, the torque control command =* $\frac{5V \times 100}{10}$ *= 50%*

Example:

If P1.041 = 10

- *When the external analog input is 10V, the torque control command =* $\frac{10V \times 10}{10}$ *= 10%*
- *When the external analog input is 5V, the torque control command =* $\frac{5V \times 10}{10}$ *= 5%*

Speed, PT, and PR modes:

Torque limit command = $\frac{\text{Input voltage} \times \text{Setting}}{10}$ (Unit: %)

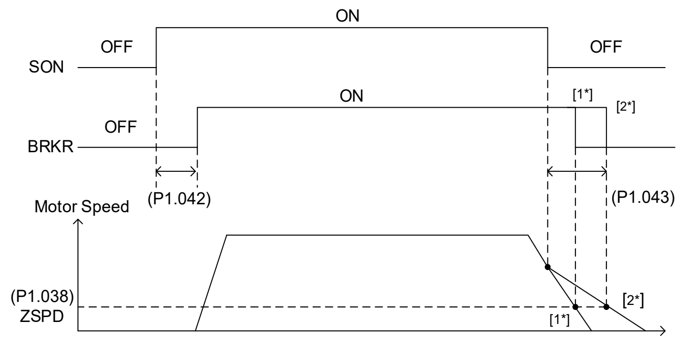
Set the torque limit corresponding to 10V (maximum voltage) for the analog torque limit.

Torque limit command = $\frac{10V \times 100}{10}$ = 100%

P1.042	Delay Time for Releasing the Magnetic Brake		Hex Address	Dec Address
			0154H 0155H	40341 40342
Default:	0	Control mode:	All	
Unit:	ms	Setting range:	0–1000	
Format:	DEC	Data size:	16-bit	
Related Parameters	P1.032, P1.038, P1.043, DO.BRKR			

Settings:

Set the delay time from Servo On status to the activation of the magnetic brake signal (DO:0x08, BRKR). Refer to “2.9 - The Use of Braking” on page 2–19 for more details.



P1.043	Delay Time For Engaging The Magnetic Brake		Hex Address	Dec Address
			0156H 0157H	40343 40344
Default:	0	Control mode:	All	
Unit:	ms	Setting range:	-1000 to +1000	
Format:	DEC	Data size:	16-bit	
Related Parameters	P1.032, P1.038, P1.042, DO. BRKR			

Settings:

Set the delay time from Servo Off status to the deactivation of the magnetic brake signal (DO:0x08, BRKR). For the detailed diagram, please refer to P1.042.

Notes:

1) If the delay time specified in P1.038 has not passed yet and the motor speed is slower than the value of P1.038, the magnetic brake signal (BRKR) is deactivated.
2) If the delay time specified in P1.038 has passed and the motor speed is faster than the value of P1.038, the magnetic brake signal (BRKR) is deactivated.
3) If P1.043 is a negative value and the servo is off due to an alarm (except for AL022) or motor override, this setting does not function. This is equivalent to setting the delay time to 0.

P1.044▲	E-Gear Ratio (Numerator) (N1)		Hex Address	Dec Address
			0158H 0159H	40345 40346
Default:	16777216	Control mode:	PT / PR	
Unit:	Pulse	Setting range:	1 to (2^{29}-1)	
Format:	DEC	Data size:	32-bit	

Settings:

For the E-Gear ratio setting, please refer to Section 6.2.5. Please refer to P2.060–P2.062 for multiple E-Gear ratio (numerator) settings. P2.060-P2.062 are only valid in PT mode.

For most applications the numerator does not need to be changed since adjusting the denominator will usually work. One example of needing to change the numerator is if the Pulse command needs to be 20,000 pulses/rev and uses a 3:1 gear box on the motor. This means the motor needs to turn 3 rotations for the mechanism to move 1 cycle. P1.045 would need to be 20000/3, but this will not work since P1.045 needs to be an integer. Instead, you set P1.044 = 3*16777216 and P1.045 = 20000 to solve this.

NOTE: *Do not change the E-Gear ratio in the Servo On state as the ratio will take effect immediately.*

In communication mode, if you cycle the power to the drive, the E-Gear ratio is set to the default value of the communication protocol. Resetting to the default value results in the reconstruction of the absolute coordinate system, so you must re-do the homing procedure.

P1.045▲	***E-Gear Ratio (Denominator) (M)***		***Hex Address***	***Dec Address***
			015AH 015BH	40347 40348
Default:	100000	Control mode:	PT / PR	
Unit:	Pulse	Setting range:	1 to (2^{31}-1)	
Format:	DEC	Data size:	32-bit	

Settings:

If the setting is incorrect, the servo motor is prone to sudden unintended acceleration. Please follow the instructions below.

Setting of pulse input:

Command pulse input range: 1 / 4<Nx / M < 262144.

Nx = (P1.044, P2.060, P2.061, or P2.062). M=P1.045. For the E-Gear ratio setting, please refer to Section 6.2.5.

NOTE: *Do not change the E-Gear ratio in the Servo On state as the ratio will take effect immediately.*

In direct communication mode, if you cycle the power to the drive, the E-Gear ratio is set to the default value of the communication protocol. Resetting to the default value results in the reconstruction of the absolute coordinate system, so you must re-do the homing procedure.

P1.046▲	***Encoder Pulse Number Output Numerator***		***Hex Address***	***Dec Address***
			015CH 015DH	40349 40350
Default:	2500	Control mode:	All	
Unit:	Pulse	Setting range:	20–536870912	
Format:	DEC	Data size:	32-bit	
Related Parameters	P1.074, P1.076, P1.097			

Settings:

The number of single-phase pulse outputs per revolution for **OA and OB terminals**; the maximum output frequency of the hardware is 19.8 MHz.

Notes:

The following circumstances may result in exceeding the maximum allowable output pulse frequency of the drive, causing AL018:

1) Encoder error
2) The motor speed is faster than P1.076

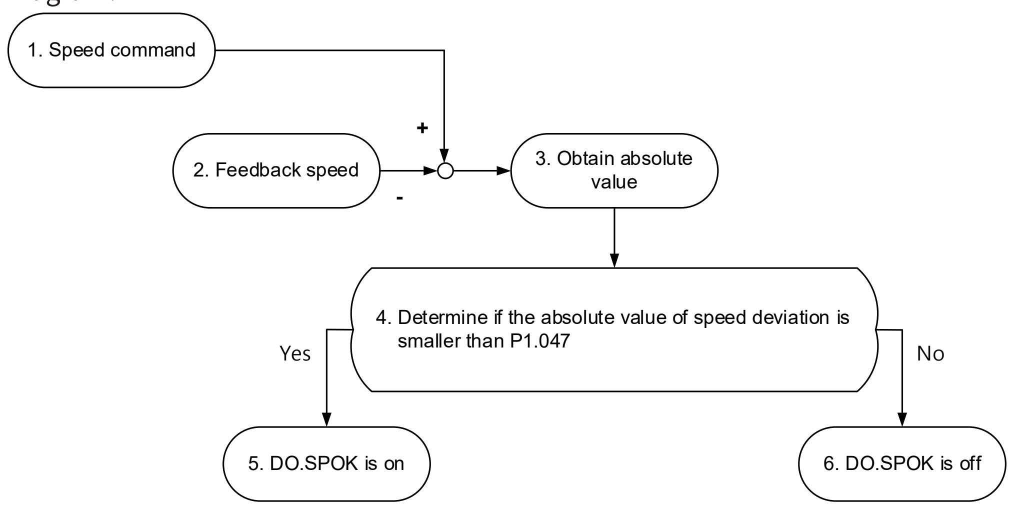
3) Source= Motor Encoder: If P1.074.Y = 0 and P1.097 = 0, motor speed (rpm)/60 x P1.046 x 4 > 19.8 x 10^6
Source= Auxiliary Encoder: if P1.074.Y = 1 and P1.097 = 1, motor speed (um/s)*1000/ 16777216 x P1.046 > 19.8 x 10^6

P1.047	***Speed Reached (DO.SP_OK) Range***		***Hex Address***	***Dec Address***
			015EH 015FH	40351 40352
Default:	10	Control mode:	S / Sz	
Unit:	rpm	Setting range:	0–300	
Format:	DEC	Data size:	16-bit	

Settings:

When the deviation between the Speed command and the motor feedback speed is less than this parameter, the digital output DO.SP_OK (DO code 0x19) is on.

Diagram:

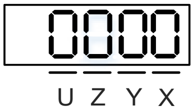


- *Speed command: command that you input without acceleration / deceleration, not the command from the front end speed circuit. The source is the user entered target speed setting.*
- *Feedback speed: the actual speed of the motor which has been filtered for low jitter and a more stable reading.*
- *Obtain the absolute value.*
- *Determine whether the absolute value of the speed deviation is smaller than the parameter value: If you set the parameter to 0, the output is always off. If the absolute value is smaller than the parameter, the DO output is on, otherwise it is off.*

P1.048	***Motion Reached (DO.MC_OK) Operation Selection***		***Hex Address***	***Dec Address***
			0160H 0161H	40353 40354
Default:	0x0000	Control mode:	PR	
Unit:	-	Setting range:	0x0000–0x0011	
Format:	HEX	Data size:	16-bit	

Settings:

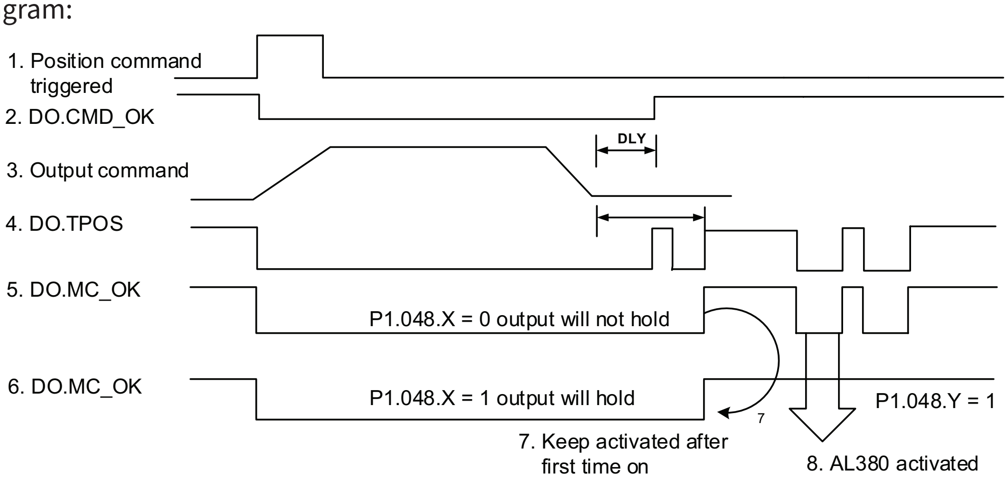
Control selection of digital output DO.MC_OK (DO code: 0x17).



X	DO output hold option	Y	Position deviation alarm AL380 option	UZ	Reserved

- *X: DO output hold option*
  - *0: output status is not retained*
  - *1: output status is retained*
- *Y: position deviation alarm AL380 option*
  - *0: AL380 not functioning*
  - *1: AL380 functioning*

Diagram:



Description:

- *Command triggered: new PR command is effective. Output command (3) starts and clears signals 2, 4, 5, and 6 simultaneously. Command triggering source: DI.CTRG, DI.EV1/EV2, P5.007 (triggered through software), etc.*
- *DO.CMD_OK: command 3 is completed and it can set the delay time (DLY).*
- *Command output: output the profile of the Position command based on the acceleration / deceleration setting.*
- *DO.TPOS: position error of the servo drive is within the range set in P1.054.*
- *DO.MC_OK: Position command output and servo positioning completed, which indicate that DO.CMD_OK and DO.TPOS are both on.*
- *DO.MC_OK (retains digital output status): same as 5, except that once this DO is on, its status is kept regardless of the signal 4 status.*
- *Can only select one of signal 5 or signal 6 to output, and the choice is specified in P1.048.X.*
- *Position deviation: when number 7 occurs, if signal 4 (or 5) is off, it means the position has deviated and AL380 can be triggered. This alarm may be set with P1.048.Y.*

P1.049	***Accumulated Time to Reach Desired Speed***		***Hex Address***	***Dec Address***
			0162H 0163H	40355 40356
Default:	0	Control mode:	S / Sz	
Unit:	ms	Setting range:	0–65535	
Format:	DEC	Data size:	16-bit	

Settings:

In Speed mode, when the deviation between the Speed command and the motor feedback speed is less than the range in P1.047 and the difference reaches the time in P1.049, the digital output DO.SP_OK (DO code 0x19) is on. If the difference exceeds the range set in P1.047 at any time, the system recalculates the duration.

P1.050–P1.051	***Reserved***

P1.052	***Regenerative Resistor Value***			***Hex Address***	***Dec Address***
				0168H 0169H	40361 40362
Default:	Determined by the model. Please refer to the following table.	Control mode:	All		
Unit:	Ohm	Setting range:	Please refer to the note below.		
Format:	DEC	Data size:	16-bit		

Settings:

Model	***Default (Ω)***	***Setting Range***
1.5 kW or below	100	20–750
2kW	30	10–750
3kW–15kW	20	10–750

For drives up to and including 3kW, the drives include a built in resistor. For heat dissipation reasons the Wattage of the actual resistor is decreased in P1.053 vs. what is actually printed on the resistor. If the resistor was externally mounted with good airflow then the full Watt value of the resistor can be entered in P1.053. For further drive and resistor protection the drive's firmware uses half that value (P1.053/2) for energy regeneration calculations. Once the DC bus goes higher than 370VDC then the regen resistor is in use for regen purposes. See section 2.8 for more detail.

Please refer to the instructions for P1.053 for the setting to use when connecting the regenerative resistor through a different method.

NOTE: *Setting range for 220V.*

P1.053	***Regenerative Resistor Watts***			***Hex Address***	***Dec Address***
				016AH 016BH	40363 40364
Default:	Determined by the model. Please refer to the following table.	Control mode:	All		
Unit:	Watt	Setting range:	0–15000		
Format:	DEC	Data size:	16-bit		

Settings:

Model	***Default (Watt)***
1.5 kW or below	100
2kW	30
3kW	20
5.5 kW to 15kW	0

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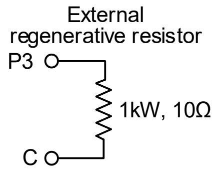
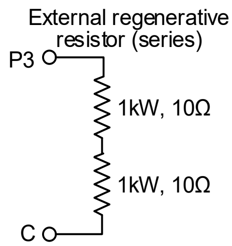
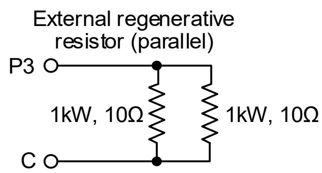
Setting the parameter value when connecting the regenerative resistor with different methods:

External Regenerative Resistor	***Setting***
	Setting: P1.052 = 10 (Ω) P1.053 = 1000 (W)
	Setting: P1.052 = 20 (Ω) P1.053 = 2000 (W)
	Setting: P1.052 = 5 (Ω) P1.053 = 2000 (W)

P1.054	***Pulse Range for Position Reached***		***Hex Address***	***Dec Address***
			016CH 016DH	40365 40366
Default:	167772	Control mode:	PT / PR	
Unit:	Pulse	Setting range:	0–16777216	
Format:	DEC	Data size:	32-bit	

Settings:

- *In Position (PT) mode, when the deviation pulse number is smaller than the range of P1.054, DO.TPOS is on.*
- *In Position Register (PR) mode, when the deviation between the target position and the actual motor position is smaller than the range of P1.054, DO.TPOS is on. For example, if P1.054 = 167772 and the deviation is less than 167772 pulses, which equals 0.01 turns (167772/16777216 = 0.01), then DO.TPOS is on.*

P1.055	***Maximum Speed Limit***		***Hex Address***	***Dec Address***
			016EH 016FH	40367 40368
Default:	Same as the rated speed of each model	Control mode:	All	
Unit:	rpm	Setting range:	0 to maximum speed	
Format:	DEC	Data size:	16-bit	

Settings:

Sets the absolute maximum global speed of the servo motor. The default is the rated speed. Refer to Appendix A for the maximum speed of each motor.

P1.056	Motor Output Overload Warning Level		Hex Address	Dec Address
			0170H 0171H	40369 40370
Default:	120	Control mode:	All	
Unit:	%	Setting range:	0–120	
Format:	DEC	Data size:	16-bit	

Settings:

When the value is 0–100 and the servo motor continuously outputs load that is higher than the setting (P1.056), the pre-warning for overload (DO is set to 0x10, OLW) occurs. If the value is over 100, this function is disabled.

P1.057	Motor Hard Stop (torque percentage)		Hex Address	Dec Address
			0172H 0173H	40371 40372
Default:	0	Control mode:	All	
Unit:	%	Setting range:	0–300	
Format:	DEC	Data size:	16-bit	

Settings:

Set the protection level as a percentage of rated torque. Works with P1.058. Set the value to 0 to disable the function. Set the value to 1 or above to enable the function.

P1.058	Motor Hard Stop (protection time)		Hex Address	Dec Address
			0174H 0175H	40373 40374
Default:	1	Control mode:	All	
Unit:	ms	Setting range:	1–1000	
Format:	DEC	Data size:	16-bit	

Settings:

Set the protection time: when the motor reaches the protection level and exceeds the protection time, AL030 occurs.

NOTE: *This function is only suitable for non-contactable uses, such as applications where the actuator is not designed to impact or press down on the product (please set P1.037 correctly).*

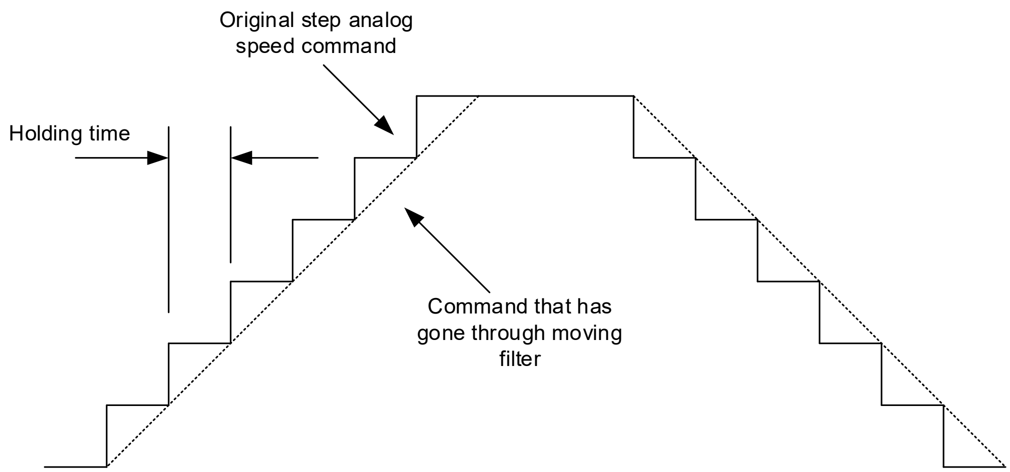
P1.059	Speed Command - Moving Filter		Hex Address	Dec Address
			0176H 0177H	40375 40376
Operation interface:	Panel / software	Communication	Control mode:	S
Default:	0.0	0	Data size:	16-bit
Unit:	1 ms	0.1 ms	-	-
Format:	One decimal	DEC	-	-
Setting range:	0.0–4.0	0–40	-	-
Example:	1.5 = 1.5 ms	15 = 1.5 ms	-	-

Settings:

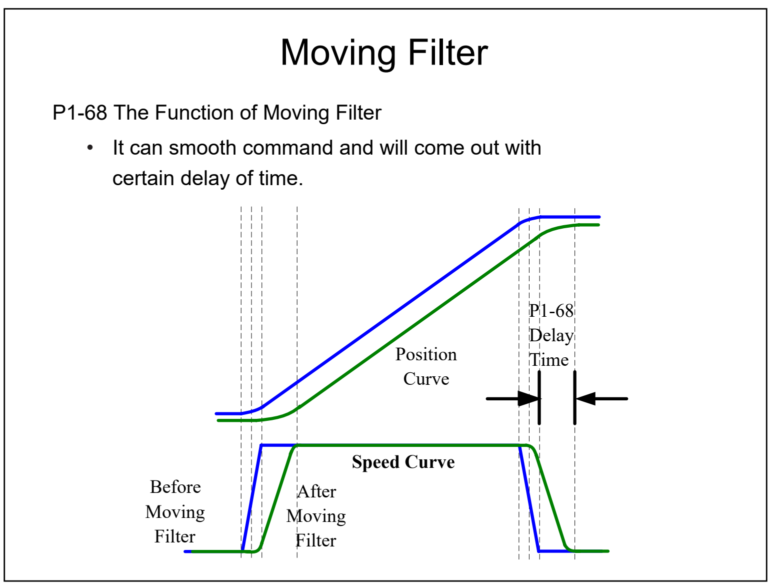
- *0: disable moving filter*

P1.006 is the low-pass filter and P1.059 is the moving filter. The difference between them is that the moving filter can smooth the command at the beginning and end of the acceleration and at the beginning and end of the deceleration ramp, while the low-pass filter can only smooth the command at the end of the acceleration and deceleration ramp. .

Therefore, if the speed loop receives the command from the controller for the position control loop, then the low-pass filter is recommended but it also slightly delays the command. If the setting is only for the speed control, then use the moving filter for better smoothing.



The delay time for a moving filter is the same as the value set in the parameter. If P1.068 is assigned to 100ms, the response will delay 100ms.



If there are commands for step function: 1→3→5→7→5→3→1, the step command difference for each step is 2.

The Moving Filter function averages the commands in a fixed range. For example, if averaging three commands each time:

- ***(1→3→5)****→7→5→3→1 = average of 3*
- *1→****(3→5→7)****→5→3→1 = average of 5*
- *1→3→****(5→7→5)****→3→1 = average of 5.7*
- *1→3→5→****(7→5→3)****→1 = average of 5*
- *1→3→5→7→****(5→3→1)*** *= average of 5*

Commands after Moving Filter: 3→5→5.7→5→3. One step command difference becomes 0.7 instead of 2, and smoothing the commands is accomplished.

P1.060–P1.061	Reserved

P1.062	Percentage of Friction Compensation		Hex Address	Dec Address
			017CH 017DH	40381 40382
Default:	0	Control mode:	PT / PR / S / Sz	
Unit:	%	Setting range:	0–100	
Format:	DEC	Data size:	16-bit	

Settings:

The level of friction compensation. For the percentage of rated torque, set the value to 0 to disable the function; set the value to 1 or above to enable the function. This function can be applied when the position error is too much while the motor begins to rotate as it overcomes the maximum static friction.

P1.063	Constant of Friction Compensation		Hex Address	Dec Address
			017EH 017FH	40383 40384
Default:	***1***	Control mode:	PT / PR / S / Sz	
Unit:	***ms***	Setting range:	1–1000	
Format:	***DEC***	Data size:	16-bit	

Settings:

Set the smoothing constant of friction compensation.

P1.064	Analog Position Command: Activation Control		Hex Address	Dec Address
			0180H 0181H	40385 40386
Default:	0x0000	Control mode:	PT	
Unit:	–	Setting range:	0x0000–0x0011	
Format:	HEX	Data size:	16-bit	

Settings:

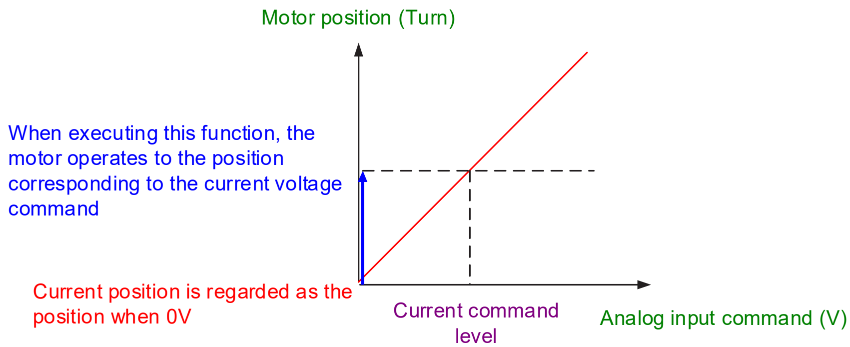
0000

U Z Y X

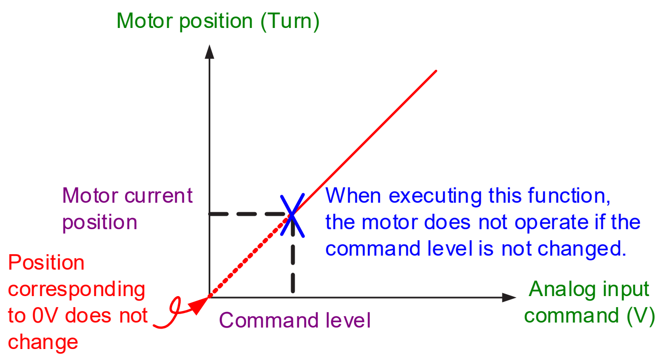
X	Setting for position command issued by the analog signal	Y	Initial position setting	UZ	Reserved

- *X: Setting for position command issued by the analog signal*
  - *0: disable*
  - *1: enable*
- *Y: Initial position setting*

- *0: After the servo is on, the motor regards the current position as the position when the voltage is 0V. Then the motor operates to the corresponding position according to the analog input command.*



- *1: After the servo is on, if the command level is not changed, the motor does not operate. The position the motor stops at is the position corresponding to the current command level.*



P1.065	***Smooth Constant of Analog Position Command***		***Hex Address***	***Dec Address***
			0182H 0183H	40387 40388
Default:	1	Control mode:	PT	
Unit:	10ms	Setting range:	1–1000	
Format:	DEC	Data size:	16-bit	

Settings:

The smooth constant of analog Position command is only effective for analog Position command.

P1.066	Maximum Rotation Number of Analog Position Command			Hex Address	Dec Address
				0184H 0185H	40389 40390
Operation Interface:	Panel / software	Communication	Control mode:	PT	
Default:	1.0	10	Data size:	16-bit	
Unit:	1 rev	0.1 rev	–		
Format:	One decimal	DEC			
Setting Range:	0.0–200.0	0–2000			
Example:	1.5 = 1.5 rev	15 = 1.5 rev			

Settings:

Rotation number setting when inputting the maximum voltage (10V) to the analog Position command. If the setting on the panel is 3.0 and the external voltage input is 10V, then the Position command is +3 revolutions. If the input is +5V, then the Position command is +1.5 revolutions. If the input is -10V, then the Position command is -3 cycles. Position control command = Input voltage x Set value / 10. It is highly recommended to keep the analog input at 0V when changing P1.066 or enabling the drive if P1.064.Y=0. If you want to change the direction of rotation of the motor without respect to the established analog input then use P1.001.Z to change the definition of forward being CW or CCW.

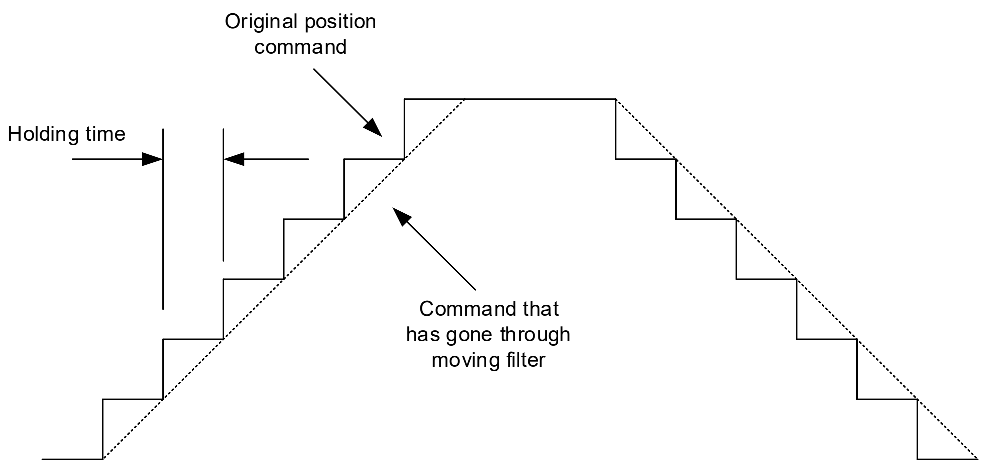
P1.067	Reserved

P1.068	Position Command - Moving Filter	Hex Address	Dec Address
		0188H 0189H	40393 40394
Default:	4	Control mode:	PT / PR
Unit:	ms	Setting range:	0–100
Format:	DEC	Data size:	16-bit

Settings:

- *0: disable this function*

The moving filter activates the smoothing function at the beginning and end of the step, but it also delays the command.



P1.069–P1.071	Reserved

P1.072	**Resolution of auxiliary encoder for full-closed loop and gantry control**		**Hex Address** 0190H 0191H	**Dec Address** 40401 40402
Default:	5000	Control mode:	PT / PR (full-closed loop)	
Unit:	pulse / rev	Setting range:	200–1280000	
Format:	DEC	Data size:	32-bit	

Settings:

A/B pulse count from the auxiliary encoder that equates to one revolution of the motor shaft. The 4x value needs to be entered here.

There are two methods for calculating the corresponding pulse number of the auxiliary encoder per motor revolution. One method calculates the theoretical value from hand calculations. The other calculates the actual value with the software scope of SureServo2 Pro. If the resolution of auxiliary encoder for full-closed loop control (P1.072) is incorrectly set, the position error between the auxiliary encoder feedback and the motor encoder accumulates during long-term operation, triggering AL040.

The encoder must be a line driver output AB Quadrature encoder with a Z pulse. If using the full-closed loop function and if there is no Z pulse and one is not needed, then the Z and Z/ signals need to be tied to +5V and 0V respectively to avoid an alarm. A Z pulse is not required to be connected for the gantry control function.

P1.073	**Error protection range for full-closed loop control**		**Hex Address** 0192H 0193H	**Dec Address** 40403 40404
Default:	30000	Control mode:	PT / PR (full-closed loop)	
Unit:	Pulse or PUU (based on the feedback of full-closed loop)	Setting range:	1 to (2^{31}-1)	
Format:	DEC	Data size:	32-bit	

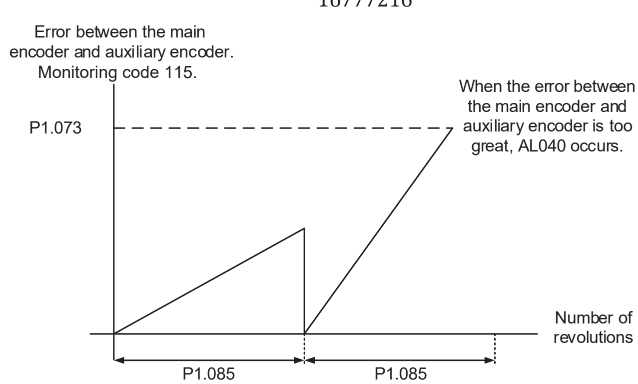
Settings:

Stopping the motor may be necessary when the deviation between the auxiliary encoder and the motor encoder feedback position is excessive due to a loose connector, an encoder failure, or other mechanical problems. This deviation can be monitored using monitoring variable code 115 in P0.001 or in the SureServo2 Pro Scope.

This parameter works in conjunction with P1.085. After the number of motor revolutions has occurred as defined in P1.085 the accumulated error measured in monitoring code [115] gets reset to 0.

When the deviation is greater than the value of P1.073, AL040 (excessive deviation of full closed-loop position control) occurs. To completely avoid this alarm, set P1.073 high and P1.085=1.

$$\text{P1.073} < (\text{Main encoder feedback} \times \frac{P1.072}{16777216}) - \text{Auxiliary encoder feedback}$$



P1.074	Full-closed loop control for secondary or auxiliary encoder		Hex Address	Dec Address
			0194H 0195H	40405 40406
Default:	0x0000	Control mode:	PT / PR (full-closed loop)	
Unit:	-	Setting range:	0000h–F132h	
Format:	HEX	Data size:	16-bit	

Settings:

0002

U Z Y X

X	Full-closed loop control switch	Z	Positive / negative direction selection of auxiliary encoder feedback
Y	Source for OA / OB / OZ output	U	Auxiliary encoder filter function

- *X: full-closed loop/Gantry function switch*
  - *0: disable full-closed loop/Gantry function switch*
  - *1: enable full-closed loop function*
  - *2: enable synchronous gantry control function*
- *Y: input source for CN1 outputs OA/OB/OZ*
  - *0: motor encoder is the source*
  - *1: CN5 auxiliary encoder is the source*
  - *2: CN1 pulse command is the source*
  - *3: reserved*
- *Z: positive / negative direction selection of auxiliary encoder feedback*
  - *0: positive direction when A phase leads B phase of auxiliary encoder*
  - *1: positive direction when B phase leads A phase of auxiliary encoder*
- *U: auxiliary encoder filter function*
  - *0: bypass (relays pulse signal coming into the drive back out on CN1 OA, /OA, OB, /OB)*
  - *1: 6.66 MHz*
  - *2: 1.66 MHz*
  - *3: 833 kHz*
  - *4: 416 kHz*
  - *5–F: reserved*

P1.075	Low-pass filter time constant for full- and half-closed loop control		Hex Address	Dec Address
			0196H 0197H	40407 40408
Default:	100	Control mode:	PT / PR (full-closed loop)	
Unit:	ms	Setting range:	0–1000	
Format:	DEC	Data size:	16-bit	

Settings:

When the stiffness of the mechanical system between full-closed and half-closed loops is insufficient, set the proper time constant to enhance the stability of the system. In other words, this filter temporarily blends full-closed loop and half-closed loop feedback to establish a stable start and stop position, and after stabilizing, the full-closed loop effect is in 100% control. When the stiffness is sufficient, set to disable.

A half-closed loop is referring to the encoder on the back of the servo motor being the feedback device for the drive to close the velocity and position loop. For a fully-closed loop system, this is referring to the motor's encoder being used to close the velocity loop and an external encoder connected to CN5 to close the position loop.

Set the value to 0 to disable the low-pass filter (bypass) function.

If the stiffness of the mechanical system is high, decrease the value of P1.075, or set the value to 0 to disable. If the stiffness of the mechanical system is low, increase the value of P1.075.

When an extremely flexible mechanism is using full-closed loop control and when the motor starts turning, the external encoder might get some unstable feedback due to the flexible structure. So increasing the low pass filter (P1.075) can decrease the unstable level of the feedback.

This parameter will mitigate any fluctuations seen in the external encoder when in full-closed loop control when starting and stopping . The servo will partially act as a half-closed loop system and use the servo motor's encoder to reduce instability of the load, and after the motion of the load is stabilized, the full-closed loop function is turned back on. This filter blends the two encoder feedback signals during feedback instability

P1.076▲	***Maximum speed for encoder output (OA, OB)***		***Hex Address***	***Dec Address***
			0198H 0199H	40409 40410
Default:	5500	Control mode:	All	
Unit:	rpm	Setting range:	0–6000	
Format:	DEC	Data size:	16-bit	

Settings:

Input the actual maximum speed of the motor or the maximum speed of the application.

When you set the value to 0, the smoothing function is disabled.

The setting of P1.076 and P1.046 should follow the two requirements below:

- *P1.076 > motor speed*
- $\frac{\text{Motor speed}}{60} \times \text{P1.046} \times 4 < 19.8 \times 10^{6}$

P1.077–P1.080	***Reserved***

P1.081	***Second set of maximum rotation speed for analog Speed command***		***Hex Address***	***Dec Address***
			01A2H 01A3H	40419 40420
Default:	Motor rated speed	Control mode:	S / T	
Unit:	rpm / 10V	Setting range:	0–50000	
Format:	DEC	Data size:	32-bit	

Settings:

This is the same parameter is P1.040. Please refer to the description of P1.040, Maximum rotation speed for analog speed command. Switch between P1.040 and P1.081 using DI(0x0F).

P1.082	Filter switching time between P1.040 and P1.081		Hex Address	Dec Address
			01A4H 01A5H	40421 40422
Default:	0	Control mode:	S / T	
Unit:	ms	Setting range:	0–1000 (0: disable this function)	
Format:	DEC	Data size:	16-bit	

Settings:

- *0: disable filter switching time*

P1.083	Abnormal analog input voltage level		Hex Address	Dec Address
			01A6H 01A7H	40423 40424
Default:	0	Control mode:	S	
Unit:	mV	Setting range:	0–12000 (0: disable this function)	
Format:	DEC	Data size:	16-bit	

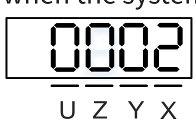
Settings:

When the analog input voltage is higher than P1.083 for more than 50ms, AL042 (analog input voltage is too high) occurs. The comparison value for this parameter is the original analog input voltage (in millivolts) which has not been changed by an offset value through P4.022 (analog speed input offset).

P1.084	Error clearing function when switching between full- and half-closed loops		Hex Address	Dec Address
			01A8H 01A9H	40425 40426
Default:	0x0000	Control mode:	PT (full-closed loop)	
Unit:	-	Setting range:	0x0000 – 0x0001	
Format:	HEX	Data size:	16-bit	

Settings:

This parameter is not available in PR mode. In PR mode, the error is automatically cleared when the systems switches between full- and half-closed loops.



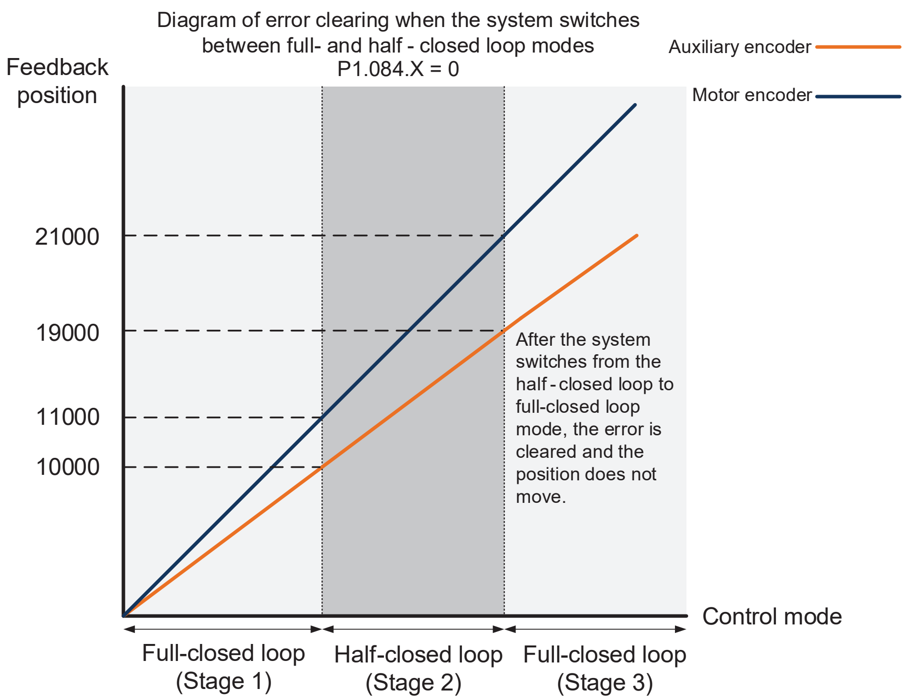
X	Error clearing function when the system switches from half-closed loop to full-closed loop	Z	Reserved
Y	Reserved	U	Reserved

- *X: Error clearing function when the system switches from half-closed loop to full-closed loop*
  - *0: clear the error when switching.*
    When the system is in half-closed loop, the command refers to the motor encoder and the position does not move after the system switches to full-closed loop.
  - *1: no clearing of the error when switching.*
    When the system is in half-closed loop control, the command refers to the motor encoder. After the system switches to full-closed loop, the command issued in half-closed loop becomes the full-closed loop command, and thus the position moves.

Note: Use DI [0x0B] to switch between full- and half-closed loop modes (P1.074.X must equal 1).

Examples:

Error Cleaning Enabled (P1.084.X=0)



Stage 1: full-closed loop control (feedback position of the auxiliary encoder)

If the servo drive issued a position command of 10,000 PUU and the feedback position of the auxiliary encoder is 10,000 PUU, the final feedback position of the motor encoder is 11,000 PUU due to the backlash and sliding of the mechanical parts.

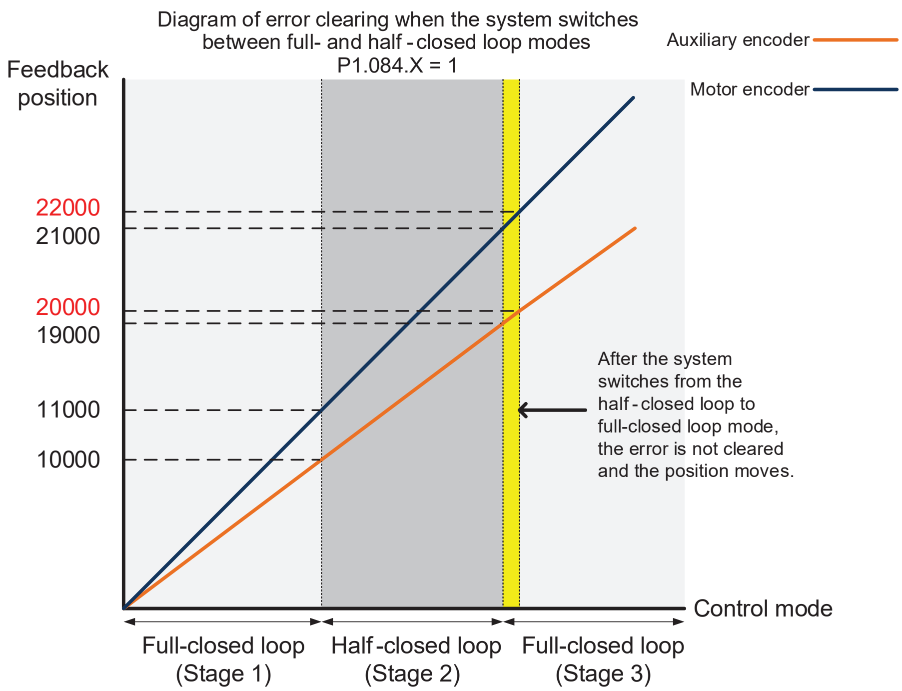
Stage 2: half-closed loop control (feedback position of the motor encoder)

Use DI [0x0B] to switch the control mode from full-closed loop to half-closed loop, and then issue the position command of 10,000 PUU again. In half-closed loop control, since the command refers to the position of the motor encoder, the feedback position of the motor encoder is 21,000 PUU, but the feedback position of the auxiliary encoder is 19,000 PUU. In this mode, there is an error of 1,000 PUU between the auxiliary encoder (19,000 PUU) and the position command (20,000 PUU).

Stage 3: full-closed loop control (feedback position of the auxiliary encoder)

When you set P1.084 to 0, the error will be cleared. Thus, after using DI [0x0B] to switch the control mode from half-closed loop to full-closed loop, the feedback position of the auxiliary encoder is not corrected.

Error Clearing Disabled (P1.084.X=1)



Stage 1: full-closed loop control

If the servo drive issued a position command of 10,000 PUU and the feedback position of the auxiliary encoder is 10,000 PUU, the final feedback position of the motor encoder is 11,000 PUU due to the backlash and sliding of the mechanical parts.

Stage 2: half-closed loop control

Use DI [0x0B] to switch the control mode from full-closed loop to half-closed loop, and then issue the position command of 10,000 PUU again. In half-closed loop control, since the command refers to the position of the motor encoder, the feedback position of the motor encoder is 21,000 PUU, but the feedback position of the auxiliary encoder is 19,000 PUU. In this mode, there is an error of 1,000 PUU between the auxiliary encoder (19,000 PUU) and the position command (20,000 PUU).

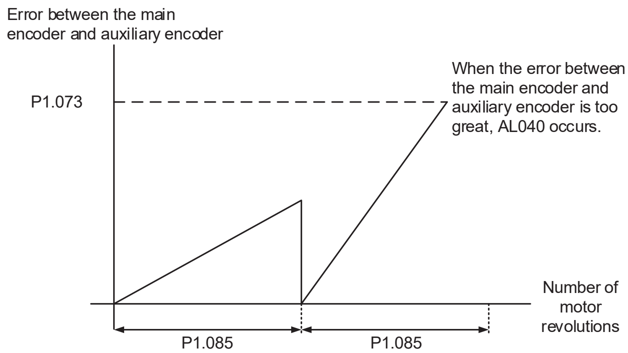
Stage 3: full-closed loop control

When you set P1.084 to 1, the error will not be cleared. Thus, after using DI [0x0B] to switch the control mode from half-closed loop to full-closed loop, the feedback position of the auxiliary encoder is corrected and the motor moves to the corresponding position (yellow area as shown in the above figure). The previous half-closed loop command becomes the full-closed loop command and refers to the auxiliary encoder to move the mechanical part to the position corresponding to the actual command. The final feedback position of the auxiliary encoder is 20,000 PUU.

P1.085	Auto clearing position deviation between motor and auxiliary encoder		Hex Address	Dec Address
			01AAH 01ABH	40427 40428
Default:	0	Control mode:	PT/PR (full-closed loop)	
Unit:	rev	Setting range:	0–32767	
Format:	DEC	Data size:	16-bit	

Settings:

This parameter sets the upper limit of the feedback position error between the main encoder and auxiliary encoder. When the number of motor revolutions is greater than or equal to this parameter value, the system automatically clears the error. When set to 0 the parameter is disabled. The deviation value will not reset regardless of the number of motor revolutions. Once the deviation reaches P1.073 then an AL040 will occur.

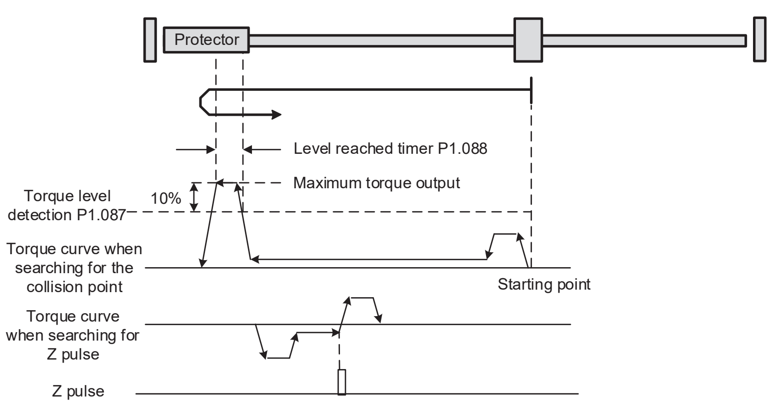


P1.086	Reserved

P1.087	Torque homing - torque level detection		Hex Address	Dec Address
			01AEH 01AFH	40431 40432
Default:	1	Control mode:	PR	
Unit:	%	Setting range:	1–300	
Format:	DEC	Data size:	16-bit	

Settings:

This setting is only for the torque homing mode. As shown in the following figure, after homing is triggered, the motor runs in one direction and reaches the protector. The servo drive then outputs a larger motor current in order to counter the external force. The servo drive uses P1.087 and P1.088 as the conditions for homing. Since the hard stops are not always the same, it is recommended to return to find the Z pulse as the origin.



P1.088	**Torque homing - level reached timer**		**Hex Address**	**Dec Address**
			01B0H 01B1H	40433 40434
Default:	2000	Control mode:	PR	
Unit:	ms	Setting range:	2–2000	
Format:	DEC	Data size:	16-bit	

Settings:

The setting of the torque level reached timer for the torque homing mode. If the motor torque output continues to exceed the level set by P1.087 and the duration exceeds this setting, the homing is complete. Refer to P1.087 for the timing diagram of torque homing mode.

P1.089	**First set of vibration elimination - Anti-resonance frequency**		**Hex Address**	**Dec Address**
			01B2H 01B3H	40435 40436
Default:	4000	Control mode:	PT / PR	
Unit:	0.1 Hz	Setting range:	10–4000	
Format:	DEC	Data size:	16-bit	

Settings:

Anti-resonance frequency for the first set of low frequency vibration elimination.

Use this function in flexible machines with low rigidity. The definition of a flexible machine is one for which when the target position is reached, due to lack of rigidity the machine vibrates and needs more time to become stable. SureServo2 provides two sets of vibration elimination. The first set is P1.089–P1.091, and the second set is P1.092–P1.094. The vibration elimination setting must be obtained through the system analysis window, and is needed to enable the low-frequency analysis options. For details, please refer to the SureServo2 Pro software instructions.

Vibration elimination takes effect only when you enable the two dimensional control function P2.094 [Bit 12]. After enabling the vibration elimination function, turn on the first set of vibration elimination with P2.094 [Bit 8] and the second set with P2.094 [Bit 9].

Example:

- *Set P2.094=0x1100 to enable the first set (bit 12=1, and bit 8=1. Binary=0001 0001 0000 0000)*
- *Set P2.094=0x1200 to enable the second set (bit 12=1, and bit 9=1. Binary=0001 0010 0000 0000).*
- *Set P2.094=0x1300 to enable the first and second set (bit 12, bit 9, and bit 8=1. Binary=0001 0011 0000 0000).*

NOTE: *See P2.094 for the definition of other special bits in P2.094.*

P1.090	**First set of vibration elimination - Resonance frequency**		**Hex Address**	**Dec Address**
			01B4H 01B5H	40437 40438
Default:	4000	Control mode:	PT / PR	
Unit:	0.1 Hz	Setting range:	10–4000	
Format:	DEC	Data size:	16-bit	

Settings:

Anti-resonance frequency for the first set of low frequency vibration elimination.

P1.091	First set of vibration elimination - Resonance difference	Hex Address	Dec Address
		01B6H 01B7H	40439 40440
Default:	10	Control mode:	PT / PR
Unit:	0.1 dB	Setting range:	10–4000
Format:	DEC	Data size:	16-bit

Settings:

Attenuation rate for the first set of low frequency vibration elimination.

P1.092	Second set of vibration elimination - Anti-resonance frequency	Hex Address	Dec Address
		01B8H 01B9H	40441 40442
Default:	4000	Control mode:	PT / PR
Unit:	0.1 Hz	Setting range:	10–4000
Format:	DEC	Data size:	16-bit

Settings:

Setting method is the same as for the first set of vibration elimination P1.089.

P1.093	Second set of vibration elimination - Resonance frequency	Hex Address	Dec Address
		01BAH 01BBH	40443 40444
Default:	4000	Control mode:	PT / PR
Unit:	0.1 Hz	Setting range:	10–4000
Format:	DEC	Data size:	16-bit

Settings:

Anti-resonance frequency for the second set of low frequency vibration elimination.

P1.094	Second set of vibration elimination - Resonance difference	Hex Address	Dec Address
		01BCH 01BDH	40445 40446
Default:	10	Control mode:	PT / PR
Unit:	0.1 dB	Setting range:	10–4000
Format:	DEC	Data size:	16-bit

Settings:

Attenuation rate for the second set of low frequency vibration elimination.

P1.095–P1.096	Reserved

P1.097▲	Encoder pulse number output denominator	Hex Address	Dec Address
		01C2H 01C3H	40451 40452
Default:	0	Control mode:	All
Unit:	-	Setting range:	0–160000
Format:	DEC	Data size:	32-bit
Related Parameters	P1.074.Y = which input (CN2, CN5, etc.) is the source for the encoder output P1.046 = the encoder output pulses/rev (Numerator)		

Settings:

1) When P1.074.Y = 0 (CN2 motor encoder is the source):

a) When P1.097 = 0, OA / OB pulse output refers to the value of P1.046. (Refer to Example 1.)
b) When P1.097 ≠ 0, OA / OB pulse output refers to the values of P1.046 and P1.097. (Refer to Example 2.)

2) When P1.074.Y = 1 (CN5 encoder is the source) or 2 (CN1 pulse command is the source):
a) When P1.097 = 0, OA / OB pulse output does not refer to the value of P1.046, but outputs according to the ratio of 1:1 instead.
b) When P1.097 ≠ 0, OA / OB pulse output refers to the values of P1.046 and P1.097. (Refer to Example 2.)

Example 1 (the value must be multiplied by 4 times the frequency):
When P1.097 = 0 and P1.046 = 2500,
OA / OB output is P1.046 multiplied by 4 times the frequency, which is 10,000 pulses.

Example 2 (the calculated value does not need to be multiplied by 4 times the frequency):
When P1.097 = 7 and P1.046 = 2500,
OA / OB output = 2500 / 7

NOTE: *The motor outputs 2,500 pulses per seven revolutions.*

P1.098	***Disconnection detection protection (UVW) response time***		***Hex Address***	***Dec Address***
			01C4H 01C5H	40453 40454
Default:	0	Control mode:	All	
Unit:	ms	Setting range:	0, 100–800	
Format:	DEC	Data size:	16-bit	

Settings:

When the motor disconnection detection protection (UVW) function is enabled (P2.065 [bit 9] = 1), this parameter indicates the response time of the detection mode. Set P1.098 to 0 to use the servo's default response time.

When P1.098 is not set to 0, the range should be between 100–800 for the detection response time.

Notes:

1) If it is necessary to shorten the response time, it is recommended that you use this parameter.
2) When the servo is on and has not started running, it is recommended that you set this parameter if you need to detect disconnection.

P1.099–P1.100	***Reserved***

P1.101■	Analog monitor output voltage 1		Hex Address	Dec Address
			01CAH 01CBH	40459 40460
Default:	0	Control mode:	ALL	
Unit:	mV	Setting range:	-10000 to +10000	
Format:	DEC	Data size:	16-bit	

Settings:

When you select 6 for the monitor source for P0.003 [YX], then the analog monitor output voltage refers to the voltage value of P1.101. You can write a fixed analog value in this register for precise control of external equipment such as a VFD or continuously write to this register to dynamically change the analog output.

P1.102■	Analog monitor output voltage 2		Hex Address	Dec Address
			01CCH 01CDH	40461 40462
Default:	0	Control mode:	ALL	
Unit:	mV	Setting range:	-10000 to +10000	
Format:	DEC	Data size:	16-bit	

Settings:

When you select 7 for the monitor source of P0.003 [YX], then the analog monitor output voltage refers to the voltage value of P1.102.

P1.103–P1.110	Reserved

P1.111■	Overspeed protection level		Hex Address	Dec Address
			01DEH 01DFH	40479 40480
Default:	Maximum motor speed x 1.1	Control mode:	ALL	
Unit:	rpm	Setting range:	0–66000	
Format:	DEC	Data size:	32-bit	

Settings:

This function is to protect the motor from overspeeding, which can be applied to all control modes. When the filtered motor speed exceeds this set speed, AL056 is triggered.

8.4.3 - P2.xxx Extension parameters

***NOTE:** Most applications can be tuned with the servo's Auto Tuning feature. The 3.1MHz bandwidth will help solve many problem applications. For further Auto Tuning help or for instructions on how to Manually Tune the drive, please see Chapter 5: Tuning.*

P2.000	Position control gain		Hex Address	Dec Address
			0200H 0201H	40513 40514
Default:	35	Control mode:	PT / PR	
Unit:	rad/s	Setting range:	0–2047	
Format:	DEC	Data size:	16-bit	

Settings:

Increasing the value of the position control gain can enhance the position response and reduce the position errors. If you set the value too high, it may cause vibration and noise.

P2.001	Position control gain rate of change		Hex Address	Dec Address
			0202H 0203H	40515 40516
Default:	100	Control mode:	PT / PR	
Unit:	%	Setting range:	10–500	
Format:	DEC	Data size:	16-bit	

Settings:

Adjust the rate of change of position control gain according to the gain switching condition.

P2.002	Position feed forward gain		Hex Address	Dec Address
			0204H 0205H	40517 40518
Default:	50	Control mode:	PT / PR	
Unit:	%	Setting range:	0–100	
Format:	DEC	Data size:	16-bit	

Settings:

If the position control command changes position smoothly, increasing the gain value can reduce position following errors. If it does not change smoothly, decreasing the gain value can reduce mechanical vibration. This gain parameter is disabled when the two dimensional control function is on (P2.094 [Bit 12] = 1).

P2.003	Position feed forward gain smoothing constant		Hex Address	Dec Address
			0206H 0207H	40519 40520
Default:	5	Control mode:	PT / PR	
Unit:	ms	Setting range:	2–100	
Format:	DEC	Data size:	16-bit	

Settings:

If the position control command changes position smoothly, decreasing the smoothing constant value can reduce the position following errors. If it does not change smoothly, increasing the smoothing constant value can reduce mechanical vibration.

P2.004	***Speed control gain***		***Hex Address***	***Dec Address***
			0208H 0209H	40521 40522
Default:	500	Control mode:	All	
Unit:	rad/s	Setting range:	0–8191	
Format:	DEC	Data size:	16-bit	

Settings:

Increasing the speed control gain can enhance the speed response. If you set the value too high, it may cause vibration and noise.

P2.005	***Speed control gain rate of change***		***Hex Address***	***Dec Address***
			020AH 020BH	40523 40524
Default:	100	Control mode:	All	
Unit:	%	Setting range:	10–500	
Format:	DEC	Data size:	16-bit	

Settings:

Adjust the rate of change for the speed control gain according to the gain switching condition.

P2.006	***Speed integral compensation***		***Hex Address***	***Dec Address***
			020CH 020DH	40525 40526
Default:	100	Control mode:	All	
Unit:	rad/s	Setting range:	0–1023	
Format:	DEC	Data size:	16-bit	

Settings:

Increasing the value of the integral speed control can enhance speed response and reduce the deviation in speed control. If you set the value too high, it may cause vibration and noise.

P2.007	***Speed feed forward gain***		***Hex Address***	***Dec Address***
			020EH 020FH	40527 40528
Default:	0	Control mode:	All	
Unit:	%	Setting range:	0–100	
Format:	DEC	Data size:	16-bit	

Settings:

If the speed control command changes speed smoothly, increasing the gain value can reduce the speed following error. If it does not change smoothly, decreasing the gain value can reduce mechanical vibration.

P2.008■	***Special parameter write-in function***		***Hex Address***	***Dec Address***
			0210H 0211H	40529 40530
Default:	0	Control mode:	All	
Unit:	-	Setting range:	0–65535	
Format:	DEC	Data size:	16-bit	

Settings:

Special parameter write-in function:

Code	Function
10	Reset to Factory Defaults (power cycle the drive after reset to defaults is finished). Be sure that both the L1/L2 control power is removed and the USB power. A power cycle will not be valid if one or the other is still supplying power.
30, 35	Write 30 then 35 to Save Compare, Capture, and E-Cam data table to EEPROM.
400	Return Digital Outputs to normal DO mode. Set P2.008=400 to exit Force mode.
406	Put Digital Outputs in Force mode (see Section 4.4.2 and P4.006).

NOTE: *Other parameters that contain special functions and/or bit adjustments:*
-P2.030 Auxiliary function (force Servo ON, enable disable EEPROM writes, save to EEPROM),
-P2.065 Special bit register (pulse/encoder/UVW error detection, ZCLAMP, pulse inhibit, friction compensation)
-P2.066 Special bit register 2 (low voltage latch and warning, overload warning detection, linear encoder disconnect error)
-P2.094 Special bit register 3 (2D control, vibration elimination, alarm enables: brake R temp, AL007, AL016).

P2.009	**DI response filter time**		**Hex Address**	**Dec Address**
			0212H 0213H	40531 40532
Default:	2	Control mode:	All	
Unit:	ms	Setting range:	0–20	
Format:	DEC	Data size:	16-bit	

Settings:

When environmental interference (or EMI) is high, increasing this value can enhance the control stability. If you set the value too high, it impacts the response time.

P2.010	**DI1 functional planning**		**Hex Address**	**Dec Address**
			0214H 0215H	40533 40534
Default:	0x0101	Control mode:	All	
Unit:	-	Setting range:	0–0x015F (last two digits are DI codes)	
Format:	HEX	Data size:	16-bit	

Settings:

0002

U Z YX

- *YX: input function selection*
  Please refer to section 8.4.9
- *Z: input contact: A or B contact*
  - *0: set this input contact to be normally closed (B contact)*
  - *1: set this input contact to be normally open (A contact)*
- *U: not in use*

Wiring
Parameters
DI/DO Codes
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Alarms

When these parameters are modified, please re-start the servo drive to ensure it functions normally. Use P3.006 to change the source for the digital signal, either through an external terminal block or communication parameter P4.007. See section 8.4.9 for information on Digital Input functions. All digital inputs have a max input frequency of 1kHz. This does not include Pulse or Sign inputs.

NOTE: *Some DIs and DOs can have their actions changed by certain advanced features. Be careful when using the COMPARE functions. They will supersede the actions/definitions of DI7 and DO4. It is highly recommended to set the affected DI and DO definitions to 0 (disabled) if using the above features.*

P2.011	***DI2 functional planning***		***Hex Address***	***Dec Address***
			0216H 0217H	40535 40535
Default:	0x0104	Control mode:	All	
Unit:	-	Setting range:	0–0x015F (last two codes are DI codes)	
Format:	HEX	Data size:	16-bit	

Settings:

Please refer to the description of P2.010.

P2.012	***DI3 functional planning***		***Hex Address***	***Dec Address***
			0218H 0219H	40537 40538
Default:	0x0116	Control mode:	All	
Unit:	-	Setting range:	0–0x015F (last two codes are DI codes)	
Format:	HEX	Data size:	16-bit	

Settings:

Please refer to the description of P2.010.

P2.013	***DI4 functional planning***		***Hex Address***	***Dec Address***
			021AH 021BH	40539 40540
Default:	0x0117	Control mode:	All	
Unit:	-	Setting range:	0–0x015F (last two codes are DI codes)	
Format:	HEX	Data size:	16-bit	

Settings:

Please refer to the description of P2.010.

NOTE: *DI4 functional planning will be overwritten to DI.ABSQ automatically, if using the Absolute Encoder function (DI.ABSE is on). See ABSE (0x1D) and ABSQ in section 8.4.9.*

P2.014	DI5 functional planning		Hex Address	Dec Address
			021CH 021DH	40541 40542
Default:	0x0102	Control mode:	All	
Unit:	-	Setting range:	0–0x015F (last two codes are DI codes)	
Format:	HEX	Data size:	16-bit	

Settings:

Please refer to the description of P2.010.

P2.015	DI6 functional planning		Hex Address	Dec Address
			021EH 021FH	40543 40544
Default:	0x0022	Control mode:	All	
Unit:	-	Setting range:	0–0x015F (last two codes are DI codes)	
Format:	HEX	Data size:	16-bit	

Settings:

Please refer to the description of P2.010.

P2.016	DI7 functional planning		Hex Address	Dec Address
			0220H 0221H	40545 40546
Default:	0x0023	Control mode:	All	
Unit:	-	Setting range:	0–0x015F (last two codes are DI codes)	
Format:	HEX	Data size:	16-bit	

Settings:

Please refer to the description of P2.010.

NOTE: *When P5.039.X (bit 0) = 1, the Capture feature is enabled and DI7 is automatically assigned as the High Speed Capture input. When Capture is disabled P2.016 is assigned 0x0100. This reassignment is not stored in the EEPROM therefore a power cycle will revert P2.016 back to the original assignment.*

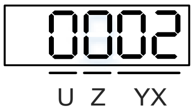
P2.017	DI8 functional planning		Hex Address	Dec Address
			0222H 0223H	40547 40548
Default:	0x0021	Control mode:	All	
Unit:	-	Setting range:	0–0x015F (last two digits are DI codes)	
Format:	HEX	Data size:	16-bit	

Settings:

Please refer to the description of P2.010. DI8 is the only input allowed for DI.INHP (inhibit pulse) assignment due to the high speed input feature of this input.

P2.018	DO1 functional planning		Hex Address	Dec Address
			0224H 0225H	40549 40550
Default:	0x0101	Control mode:	All	
Unit:	-	Setting range:	0–0x013F (last two digits are DO codes)	
Format:	HEX	Data size:	16-bit	

Settings:



- *YX: output function selection*
  Please refer to section "8.4.10 - Digital output (DO) Function Assignments" on page 8–252.
- *Z: output contact: A or B contact*
  - *0: set this output contact to be normally closed (B contact)*
  - *1: set this output contact to be normally open (A contact)*
- *U: not in use*

When these parameters are modified, please re-start the servo drive to ensure it functions normally.

***NOTE:** Several DO functions have their status available in P0.046. Use that register for status feedback (with communications) without consuming physical DO terminals.*

***NOTE:** Some DIs and DOs can have their actions changed by certain advanced features. Be careful when using the COMPARE functions. They will supersede the actions/definitions of DI7 and DO4. It is highly recommended to set the affected DI and DO definitions to 0 (disabled) if using the above features.*

P2.019	DO2 functional planning		Hex Address	Dec Address
			0226H 0227H	40551 40552
Default:	0x0103	Control mode:	All	
Unit:	-	Setting range:	0–0x013F (last two codes are DO code)	
Format:	HEX	Data size:	16-bit	

Settings:

Please refer to the description of P2.018. See section 8.4.9 and 8.4.10 for more information.

***NOTE:** DO2 functional planning will be automatically overwritten to DO.ABSR, if using the Absolute Encoder function (DI.ABSE is on). See ABSE (0x1D) and ABSR in section 8.4.9 and 8.4.10.*

P2.020	DO3 functional planning			Hex Address	Dec Address
				0228H 0229H	40553 40554
Default:	0x0109	Control mode:	All		
Unit:	-	Setting range:	0–0x013F (last two codes are DO code)		
Format:	HEX	Data size:	16-bit		

Settings:

Please refer to the description of P2.018. See section 8.4.9 and 8.4.10 for more information.

NOTE: *DDO3 functional planning will be automatically overwritten to DO.ABSD, if using the Absolute Encoder function (DI.ABSE is on). See ABSE (0x1D) and ABSD in section 8.4.9 and 8.4.10.*

P2.021	DO4 functional planning			Hex Address	Dec Address
				022AH 022BH	40555 40556
Default:	0x0105	Control mode:	All		
Unit:	-	Setting range:	0–0x013F (last two codes are DO code)		
Format:	HEX	Data size:	16-bit		

Settings:

Please refer to the description of P2.018.

NOTE: *When P5.039.X (bit 0) =1, the Capture feature is enabled and DO4 is automatically assigned as the High Speed Compare Output. When Compare is disabled P2.021 is assigned 0x0100 automatically. This reassignment is not stored in the EEPROM therefore a power cycle will revert P2.021 back to the original assignment.*

P2.022	DO5 functional planning			Hex Address	Dec Address
				022CH 022DH	40557 40558
Default:	0x0007	Control mode:	All		
Unit:	-	Setting range:	0–0x013F (last two codes are DO code)		
Format:	HEX	Data size:	16-bit		

Settings:

Please refer to the description of P2.018 (P2.041 is DO6).

P2.023	Notch filter frequency (1)			Hex Address	Dec Address
				022EH 022FH	40559 40560
Default:	1000	Control mode:	All		
Unit:	Hz	Setting range:	50–5000		
Format:	DEC	Data size:	16-bit		

Settings:

The first resonance frequency setting. Set P2.024 to 0 to disable this function. P2.043 and P2.044 are the second Notch filter parameters.

P2.024	***Notch filter attenuation level (1)***	***Hex Address***	***Dec Address***
		0230H 0231H	40561 40562
Default:	0	Control mode:	All
Unit:	-dB	Setting range:	0–40
Format:	DEC	Data size:	16-bit

Settings:

This is the first Notch filter attenuation level. For example, an attenuation level of 5 indicates -5 dB. Set this parameter to 0 to disable the Notch filter function.

P2.025	***Resonance suppression low-pass filter***		***Hex Address***	***Dec Address***
			0232H 0233H	40563 40564
Operation interface:	Panel / software	Communication	Control mode:	All
Default:	1.0	10	Data size:	16-bit
Unit:	1 ms	0.1 ms	-	-
Setting range:	0.0–100.0	0–1000	-	-
Format:	One decimal	DEC	-	-
Example:	1.5 = 1.5 ms	15 = 1.5 ms	-	-

Settings:

Set the time constant for the low-pass filter for resonance suppression. Set this parameter to 0 to disable the low-pass filter.

P2.026	***Anti-interference gain***	***Hex Address***	***Dec Address***
		0234H 0235H	40565 40566
Default:	0	Control mode:	All
Unit:	rad/s	Setting range:	0–1023
Format:	DEC	Data size:	16-bit

Settings:

Increasing this parameter can increase the damping of the speed loop and reduce the speed loop response. Setting the value of P2.026 to equal P2.006 is recommended. Please see the following for setting P2.026:

- *In Speed mode, increase the value of this parameter to reduce speed overshoot.*
- *In Position mode, decrease the value of this parameter to reduce position overshoot.*

NOTE: *This gain parameter is disabled when the two dimensional control function is on (P2.094 [Bit 12] = 1).*

P2.027	Gain switching condition and method selection	Hex Address	Dec Address
		0236H 0237H	40567 40568
Default:	0x0000	Control mode:	All
Unit:	-	Setting range:	0000h–0x0018
Format:	HEX	Data size:	16-bit

Settings:

0002

U Z Y X

UZ	Reserved	Y	Gain switching method	X	Gain switching condition

- *X: gain switching condition (determines the conditions when the gain switching will occur)*

X	Function	Control Mode
0	Disable gain switching function	-
1	Signal of gain switching (GAINUP) is on	All
2	In position control mode, position error is larger than P2.029	P
3	Frequency of Position command is larger than P2.029	P
4	Rotation speed of servo motor is faster than P2.029	All
5	Signal of gain switching (GAINUP) is off	All
6	In position control mode, position error is smaller than P2.029	P
7	Frequency of Position command is smaller than P2.029	P
8	Rotation speed of servo motor is slower than P2.029	All

- Y: gain switching method (after the condition in X is met, this setting determines what changes occur for gain switching)
  - *0: gain rate switching*
  - *1: integrator switching (P controller switches to PI controller)*

<table>
<tr><th>Value</th><th>Control Mode P</th><th>Control Mode S</th><th>Gain switching</th></tr>
<tr><td rowspan="2">0</td><td>P2.000 x 100%
P2.004 x 100%</td><td>P2.004 x 100%</td><td>Before switching</td></tr>
<tr><td>P2.000 x P2.001
P2.004 x P2.005</td><td>P2.004 x P2.005</td><td>After switching</td></tr>
<tr><td rowspan="2">1</td><td colspan="2">P2.006 x 0%; P2.026 x 0%</td><td>Before switching</td></tr>
<tr><td colspan="2">P2.006 x 100%; P2.026 x 100%</td><td>After switching</td></tr>
</table>

- *UZ: not in use*

P2.028	Gain switching time constant	Hex Address	Dec Address
		0238H 0239H	40569 40570
Default:	10	Control mode:	All
Unit:	ms	Setting range:	0–1000
Format:	DEC	Data size:	16-bit
Example:	15 = 150 ms		

Settings:

Controls the smoothing gain. Set this parameter to 0 to disable this function.

P2.029	***Gain switching condition***			***Hex Address***	***Dec Address***
				023AH 023BH	40571 40572
Default:	16777216	Control mode:	All		
Unit:	pulse; kpps; rpm	Setting range:	0–50331648		
Format:	DEC	Data size:	32-bit		

Settings:

You determine the gain switching (pulse error, kpps, rpm) by the selection of gain switching condition (P2.027).

P2.030■	***Auxiliary function***			***Hex Address***	***Dec Address***
				023CH 023DH	40573 40574
Default:	0	Control mode:	All		
Unit:	-	Setting range:	-8 to +8		
Format:	DEC	Data size:	16-bit		

Settings:

Value	***Function***
0	Disable all functions described below
1	Switch servo to Servo On state
2–4	(Reserved)
5	Disable writing to the non-volatile EEPROM (parameter changes are saved in RAM only). This setting does not retain its value after powering off. When there is no need to save the data, this setting can avoid continually writing the parameters into EEPROM and shortening the lifetime of the EEPROM. Y**ou must set this parameter when using communication control.** When using communication control, always have the PLC set P2.030=5 after drive configuration is complete. Even though the EEPROM can handle millions of writes, constantly writing a new velocity (if the drive is in Speed mode) or a new position (if using PR mode) could eventually cause EEPROM failure after several years.
8	Back up all current parameter values to EEPROM, so that the values are retained after cycling the power. The panel displays 'to.rom' during execution. This feature can also be executed when servo is in the Servo On state.
-1, -5	Disable the functions of 1 and 5.
7, -2 to -4, -7, -8	(Reserved)

NOTE: *Please set the value to 0 during normal operation. The value returns to 0 automatically after cycling the power.*

NOTE: *Other parameters that contain special functions and/or bit adjustments: P2.008 Special parameter write-in function (factory reset, write to capture/compare/CAM table to EEPROM, force DOs), P2.065 Special bit register (Pulse/encoder/UVW error detection, ZCLAMP, pulse inhibit, friction compensation), P2.066 Special bit register 2 (low voltage latch and warning, overload warning detection, linear encoder disconnect error), P2.094 Special bit register 3 (2D control, vibration elimination, alarm enables: brake R temp, AL007, AL016).*

P2.031	Frequency response bandwidth level			Hex Address	Dec Address
				023EH 023FH	40575 40576
Default:	19	Control mode:	All		
Unit:	-	Setting range:	1–50		
Format:	DEC	Data size:	16-bit		

Settings:

In gain adjustment mode (P2.032), adjust the servo bandwidth with the bandwidth response level parameter (P2.031). When you increase the bandwidth response level (P2.031), the servo bandwidth increases as well. Refer to Chapter 5 for adjustment details.

P2.032	Gain adjustment mode			Hex Address	Dec Address
				0240H 0241H	40577 40578
Default:	0x0001	Control mode:	All		
Unit:	-	Setting range:	0–4		
Format:	HEX	Data size:	16-bit		

Settings:

The servo drive provides three gain adjustment modes for fine tuning. You only need to increase or decrease the frequency response level (P2.031) to tune the system. Recommendations for tuning the system are in Section 5.1.

Value	Adjustment Mode	Inertia Estimation	Parameter	
			Manual	Auto
0	Manual	Fixed set value of P1.037	P1.037, P2.000, P2.004, P2.006, P2.023, P2.024, P2.025, P2.043, P2.044, P2.045, P2.046, P2.049, P2.089, P2.098, P2.099, P2.101, P2.102	N/A
1	Gain adjustment mode 1	Real-time estimation	P2.031	P1.037, P2.000, P2.004, P2.006, P2.023, P2.024, P2.025, P2.043, P2.044, P2.045, P2.046, P2.049, P2.089, P2.098, P2.099, P2.101, P2.102
2	Gain adjustment mode 2	Fixed set value of P1.037	P1.037 P2.031	P2.000, P2.004, P2.006, P2.023, P2.024, P2.025, P2.043, P2.044, P2.045, P2.046, P2.049, P2.089, P2.098, P2.099, P2.101, P2.102
3	Gain adjustment mode 3 (only two dimensional control function is enabled)	Fixed set value of P1.037	P1.037 P2.031 P2.089	P2.000, P2.004, P2.006, P2.023, P2.024, P2.025, P2.043, P2.044, P2.045, P2.046, P2.049, P2.098, P2.099, P2.101, P2.102
4	Gain adjustment mode 4	Reset to gain default value		

NOTE: *When the two dimensional control function is turned off (P2.094 [Bit 12] = 0), the effect of gain adjustment mode 3 is equivalent to gain adjustment mode 2, so setting P2.089 (Command Response Gain) is invalid in that scenario.*

P2.033	Reserved

P2.034	Speed command error warning		Hex Address	Dec Address
			0244H 0245H	40581 40582
Default:	5000	Control mode:	S / Sz	
Unit:	rpm	Setting range:	1–30000	
Format:	DEC	Data size:	16-bit	

Settings:

In Speed mode, this parameter sets the acceptable difference between the command speed and the feedback speed. If the difference is greater than this value, AL007 occurs.

P2.035	Excessive deviation of Position command warning		Hex Address	Dec Address
			0246H 0247H	40583 40584
Default:	50331648	Control mode:	PT / PR	
Unit:	pulse	Setting range:	1–1677721600	
Format:	DEC	Data size:	32-bit	

Settings:

In Position mode, this parameter sets the acceptable difference between the command position and the feedback position. If the difference is greater than this value, AL009 occurs.

P2.036	DI9 functional planning		Hex Address	Dec Address
			0248H 0249H	40585 40586
Default:	0x0100	Control mode:	All	
Unit:	-	Setting range:	0–0x015F (last two codes are DI codes)	
Format:	HEX	Data size:	16-bit	

Settings:

Please refer to the description of P2.010.

P2.037	DI10 functional planning		Hex Address	Dec Address
			024AH 024BH	40587 40588
Default:	0x0100	Control mode:	All	
Unit:	-	Setting range:	0–0x015F (last two codes are DI codes)	
Format:	HEX	Data size:	16-bit	

Settings:

Please refer to the description of P2.010.

P2.038	VDI11 functional planning		Hex Address	Dec Address
			024CH 024DH	40589 40590
Default:	0x0000	Control mode:	All	
Unit:	-	Setting range:	0–0x015F (last two codes are DI codes)	
Format:	HEX	Data size:	16-bit	

Settings:

Please refer to the description of P2.010. Virtual digital inputs are useful when triggering communication or when physical DI points are insufficient. You can set the DI to be used as soon as power is on when the contact would be normally closed for virtual digital input, such as Servo On. P3.006 and P4.007 settings are valid for virtual DIs (VDIs) as well as physical DIs.

P2.039	VDI12 functional planning		Hex Address	Dec Address
			024EH 024FH	40591 40592
Default:	0x0000	Control mode:	All	
Unit:	-	Setting range:	0–0x015F (last two codes are DI codes)	
Format:	HEX	Data size:	16-bit	

Settings:

Please refer to the description of P2.038.

P2.040	VDI13 functional planning		Hex Address	Dec Address
			0250H 0251H	40593 40594
Default:	0x0000	Control mode:	All	
Unit:	-	Setting range:	0–0x015F (last two codes are DI codes)	
Format:	HEX	Data size:	16-bit	

Settings:

Please refer to the description of P2.038.

P2.041	DO6 functional planning		Hex Address	Dec Address
			0252H 0253H	40595 40596
Default:	0x0000	Control mode:	All	
Unit:	-	Setting range:	0–0x013F (last two codes are DO code)	
Format:	HEX	Data size:	16-bit	

Settings:

Please refer to the description of P2.018.

P2.042	Reserved

P2.043	Notch filter frequency (2)		Hex Address	Dec Address
			0256H 0257H	40599 40600
Default:	1000	Control mode:	All	
Unit:	Hz	Setting range:	50–5000	
Format:	DEC	Data size:	16-bit	

Settings:

The second setting for resonance frequency. This function is disabled if P2.044 is 0.

P2.044	Notch filter attenuation level (2)		Hex Address	Dec Address
			0258H 0259H	40601 40602
Default:	0	Control mode:	All	
Unit:	-dB	Setting range:	0–40	
Format:	DEC	Data size:	16-bit	

Settings:

The second Notch filter attenuation level. A value of 5 indicates -5 dB. Set this parameter to 0 to disable the Notch filter.

P2.045	Notch filter frequency (3)		Hex Address	Dec Address
			025AH 025BH	40603 40604
Default:	1000	Control mode:	All	
Unit:	Hz	Setting range:	50–5000	
Format:	DEC	Data size:	16-bit	

Settings:

The third setting for resonance frequency. This function is disabled if P2.046 is 0.

P2.046	Notch filter attenuation level (3)		Hex Address	Dec Address
			025CH 025DH	40605 40606
Default:	0	Control mode:	All	
Unit:	-dB	Setting range:	0–40	
Format:	DEC	Data size:	16-bit	

Settings:

The third Notch filter attenuation level. A value of 5 indicates -5dB. Set this parameter to 0 to disable the Notch filter.

P2.047	Auto resonance suppression mode		Hex Address	Dec Address
			025EH 025FH	40607 40608
Default:	0x0001	Control mode:	All	
Unit:	-	Setting range:	0x0000–0x01F2	
Format:	DEC	Data size:	16-bit	

Settings:

0000
U Z Y X

X	Auto resonance suppression function	Z	Fixed resonance suppression parameter
Y	Fixed resonance suppression parameter	U	Reserved

- *X: auto resonance suppression function*
  - *0: disable auto resonance suppression. After the function is disabled, the existing resonance suppression parameter values do not change.*
  - *1: auto resonance suppression mode 1; when the servo determines it is stable(see Note 2 below), the servo stores the resonance suppression points in EEPROM (non-volatile memory for parameters), and disables the auto resonance suppression function (X = 0). Before the servo is stable, if you cycle power on the servo drive, the found resonance suppression points are lost and will not be saved.* ***The servo searches for the resonance suppression points again****.*
    If you switch the setting of X from 1 to 0, the known resonance suppression points will be stored in EEPROM.
    If you keep the setting of X as 1, the known resonance suppression points will not be cleared, but they are not written to EEPROM yet. They are written to EEPROM when the servo determines it is stable.
  - *2: auto resonance suppression mode 2; when the servo determines it is stable(see Note 2 below), the servo stores the resonance suppression points in EEPROM (non-volatile memory for parameters).* ***In this mode, the searching cycle continues until the 5 sets of resonance suppression parameters are set****, then the auto resonance suppression function is disabled (X = 0). Before the servo is stable, if you cycle power on the servo drive, the resonance suppression points that are not yet stored in EEPROM are lost and will not be saved. The resonance suppression points that are stored in EEPROM will not be affected.*
    If you switch the setting of X from 2 to 0, the known resonance suppression points will be stored in EEPROM.
    If you keep the setting of X as 2, the known resonance suppression points will not be cleared, but they are not written to EEPROM yet. They are written to EEPROM when the servo determines it is stable.

NOTE:
1: If you switch the setting of X from 0 to 1 or 2, the unfixed Notch filter is automatically cleared, the frequency is set to 1,000 Hz, and the suppression level is set to 0 dB.

2: The servo determines it is stable according to the following conditions: resonances have been suppressed, no other interference that affects the operation is found, and the motor speed is maintained at above 10 rpm for 3 minutes.

- *Y: fixed resonance suppression parameter (Notch Filters 1–4)*
  In auto resonance suppression, set the Notch filters to use manual resonance suppression.

Bit	3	2	1	0

Bit	Function	Description
0	Notch 1 auto / manual setting	0: auto resonance suppression 1: manually set the first set of resonance suppression parameters
1	Notch 2 auto / manual setting	0: auto resonance suppression 1: manually set the second set of resonance suppression parameters
2	Notch 3 auto / manual setting	0: auto resonance suppression 1: manually set the third set of resonance suppression parameters
3	Notch 4 auto / manual setting	0: auto resonance suppression 1: manually set the fourth set of resonance suppression parameters

- *Z: fixed resonance suppression parameter (Notch Filter 5)*
  In auto resonance suppression, set the Notch filters to use manual resonance suppression.

Bit	3	2	1	0

Bit	Function	Description
0	Notch 5 auto / manual setting	0: auto resonance suppression 1: manually set the fifth set of resonance suppression parameters

Example: if P2.047 = 0x0021 (Z=0000, Y=0010, X=0001), and the auto resonance suppression function is enabled, the servo searches for the point of resonance and suppresses it. When you set Y to 2, you manually set the second set of resonance suppression parameters. Then, if the servo finds 2 resonance points, it writes data for the 1st point to the 1st set of resonance suppression parameters and the data for the 2nd point to the 3rd set of resonance suppression parameters. That is, it skips the 2nd set of parameters (the ones set to “manual”).

P2.048	***Auto resonance detection level***			***Hex Address***	***Dec Address***
				0260H 0261H	40609 40610
Default:	100	Control mode:	All		
Unit:	-	Setting range:	1–1000		
Format:	DEC	Data size:	16-bit		

Settings:

The smaller this parameter value, the more sensitive the drive is to detecting resonance. If P2.048 is larger, the resonance sensitivity is lower. If P2.048 is smaller, the resonance sensitivity is higher.

P2.049	Speed detection filter and jitter suppression			Hex Address	Dec Address
				0262H 0263H	40611 40612
Operation interface:	Panel / software	Communication	Control mode:	All	
Default:	1.0	10	Data size:	16-bit	
Unit:	1 ms	0.1 ms	-	-	
Setting range:	0.0–100.0	0–1000	-	-	
Format:	One decimal	DEC	-	-	
Example:	1.5 = 1.5 ms	15 = 1.5 ms	-	-	

Settings:

Set the filter for speed estimation. Adjusting this parameter can improve the extent of the speed jitter, but when the value is too high, the phase margin affecting the speed loop decreases which makes the system unstable.

P2.050	Pulse Clear mode		Hex Address	Dec Address
			0264H 0265H	40613 40614
Default:	0x0000	Control mode:	PT	
Unit:	-	Setting range:	0–1	
Format:	HEX	Data size:	16-bit	

Settings:

Please refer to section 8.4.9 for digital input. Set digital input (DI) as CCLR to enable the Pulse Clear function. If this DI is on, the accumulated position error is reset to 0. P2.050 only determines if DI.CCLR is edge triggered or level triggered.

- *0: DI.CCLR is rising-edge triggered.*
- *1: DI.CCLR is action-level triggered.*

P2.051	Reserved

***NOTE:** In SureServo1 (prior servo family) P2-51 allowed the drive to be enabled on power up. To do this with SureServo2, you must assign function "Servo ON" to a DI or VDI input and configure it to be a "B" contact (normally closed).*

P2.052▲	Indexing coordinates scale		Hex Address	Dec Address
			0268H 0269H	40617 40618
Default:	1000000000	Control mode:	All	
Unit:	PUU	Setting range:	0–1000000000	
Format:	DEC	Data size:	32-bit	

Settings:

This value is the total PUU moved to cause one full 360 degree rotation of the index table when using the index coordinate wizard. Set the scale of the indexing coordinates, indexing command position, and indexing feedback position. If the value is too small, it may cause errors in the indexing coordinates. The ranges of values for P2.052 are:

- *P2.052 > 1.05 x Maximum motor speed (rpm) x* $\frac{16777216}{60000} \times \frac{P1.045}{P1.044}$

P2.053	Position integral compensation		Hex Address	Dec Address
			026AH 026BH	40619 40620
Default:	0	Control mode:	All	
Unit:	rad/s	Setting range:	0–1023	
Format:	DEC	Data size:	16-bit	

Settings:

Increase the position control integral to reduce position steady-state errors. If the value is too high, it may cause position overshoot and noise.

P2.054▲	Synchronous speed control gain		Hex Address	Dec Address
			026CH 026DH	40621 40622
Default:	0	Control mode:	PT	
Unit:	rad/s	Setting range:	0–8191	
Format:	DEC	Data size:	16-bit	

Settings:

Increase the synchronous speed control to enhance the speed following between two motors. If the value is too high, it may cause vibration and noise. This parameter is only for use in Gantry mode (P2.074.X=2). See section “6.8 - Gantry Mode” for more information on the Gantry function.

P2.055▲	Synchronous speed integral compensation		Hex Address	Dec Address
			026EH 026FH	40623 40624
Default:	0	Control mode:	PT	
Unit:	rad/s	Setting range:	0–1023	
Format:	DEC	Data size:	16-bit	

Settings:

Increase the synchronous speed integral compensation to enhance the speed following and reduce the speed errors between two motors. If the value is too high, it may cause vibration and noise. This parameter is only for use in Gantry mode (P2.074.X=2). See section “6.8 - Gantry Mode” for more information on the Gantry function.

P2.056▲	Synchronous position integral compensation		Hex Address	Dec Address
			0270H 0271H	40625 40626
Default:	0	Control mode:	PT	
Unit:	rad/s	Setting range:	0–1023	
Format:	DEC	Data size:	16-bit	

Settings:

Increase synchronous speed integral compensation to enhance the speed following and reduce the speed error between two motors. If the value is too high, it may cause vibration and noise. It is recommended that you set this value to the same value as P2.006 (Speed Integral Compensation). This parameter is only for use in Gantry mode (P2.074.X=2). See section “6.8 - Gantry Mode” for more information on the Gantry function.

P2.057▲	Synchronous control bandwidth			Hex Address	Dec Address
				0272H 0273H	40627 40628
Default:	0	Control mode:	PT		
Unit:	Hz	Setting range:	0–1023		
Format:	DEC	Data size:	16-bit		

Settings:

If you are unsure about setting P2.054–P2.056, set the value of synchronous control bandwidth instead so that the value corresponds to P2.054–P2.056. Refer to Chapter 5 for more detailed Tuning information. This parameter is only for use in Gantry mode (P2.074.X=2). See section “6.8 - Gantry Mode” for more information on the Gantry function.

1) When the synchronous control bandwidth is greater than the servo bandwidth, the synchronous following is better.
2) When the servo bandwidth is greater than the synchronous control bandwidth, the single-axis motion following is better.

When the servo bandwidth plus the synchronous control bandwidth (P2.057) is greater than the system’s allowable bandwidth, however, it causes system resonance.

NOTE: *When increasing the bandwidth of both speed loop and synchronous control, the response of P2.025 (Resonance suppression low-pass filter) must be faster than the setting of both bandwidths. Therefore, decrease P2.025 as needed.*

P2.058	Synchronous speed error low-pass filter			Hex Address	Dec Address
				0274H 0275H	40629 40630
Default:	0	Control mode:	PT		
Unit:	0.1 ms	Setting range:	0–1000		
Format:	DEC	Data size:	16-bit		
Example:	15 = 1.5 ms				

Settings:

When the synchronous control is affected by low resonance, meaning that audible noise (less sharp and rough sound) is generated, use low-pass filter suppression. This filter must be faster than the synchronous control bandwidth. This parameter is only for use in Gantry mode (P2.074.X=2). See section “6.8 - Gantry Mode” for more information on the Gantry function.

P2.059	Maximum deviation between axes of gantry			Hex Address	Dec Address
				0276H 0277H	40631 40632
Default:	0	Control mode:	PT		
Unit:	PUU	Setting range:	-32768–32767		
Format:	DEC	Data size:	16-bit		

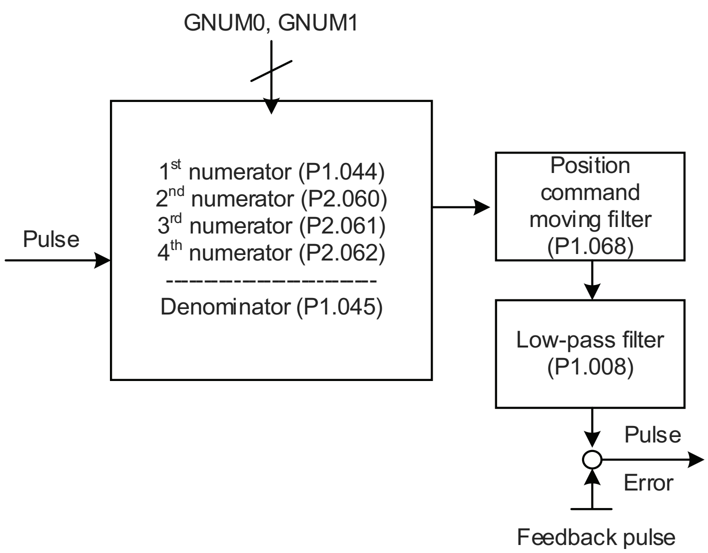
Settings:

Set P2.059 for the max permitted deviation between the two servos. This is the maximum PUU count that the two servos can be off from each other. When the deviation exceeds the range, AL081 will occur. This parameter is only for use in Gantry mode (P2.074.X=2). See section “6.8 - Gantry Mode” for more information on the Gantry function.

P2.060	**E-Gear ratio (Numerator) (N2)**		**Hex Address**	**Dec Address**
			0278H 0279H	40633 40634
Default:	16777216	Control mode:	PT	
Unit:	pulse	Setting range:	1 to (2^{29}-1)	
Format:	DEC	Data size:	32-bit	

Settings:

The numerator of the E-Gear ratio can be selected with DI.GNUM0 and DI.GNUM1 (please refer to section 8.4.9). If DI.GNUM0 and DI.GNUM1 are not both defined, P1.044 (E-Gear ratio numerator N1) is the default numerator of the E-Gear ratio. Please be aware that switching DI.GNUM0 and DI.GNUM1 when the servo is moving can cause mechanical damage if the gear ratio changes too drastically. Changing the E-Gear ratio in the Servo On state using DI.GNUM0 and DI.GNUM1 will cause the electronic gearing to take affect immediately.



P2.061	**E-Gear ratio (Numerator) (N3)**		**Hex Address**	**Dec Address**
			027AH 027BH	40635 40636
Default:	16777216	Control mode:	PT	
Unit:	pulse	Setting range:	1 to (2^{29}-1)	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P2.060.

P2.062	**E-Gear ratio (Numerator) (N4)**		**Hex Address**	**Dec Address**
			027CH 027DH	40637 40638
Default:	16777216	Control mode:	PT	
Unit:	pulse	Setting range:	1 to (2^{29}-1)	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P2.060.

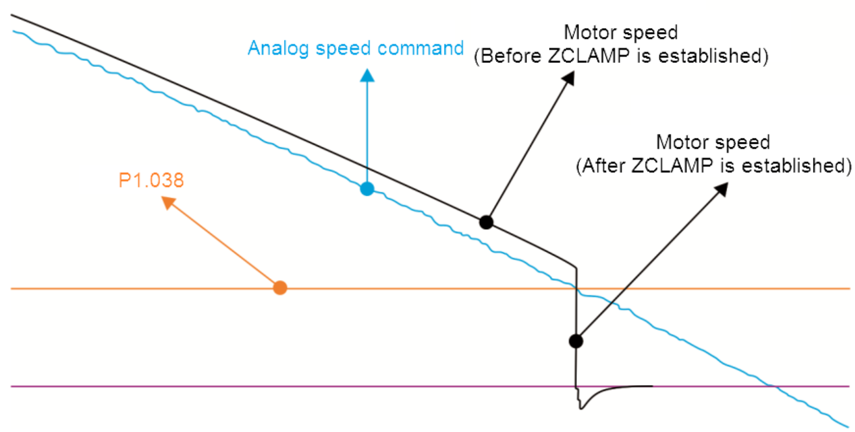
P2.063–P2.064	**Reserved**

P2.065	**Special bit register**			**Hex Address**	**Dec Address**
				0282H 0283H	40643 40644
Default:	0100	Control mode:	PT / PR / S / Sz		
Unit:	-	Setting range:	0–0xFFFF		
Format:	-	Data size:	-		

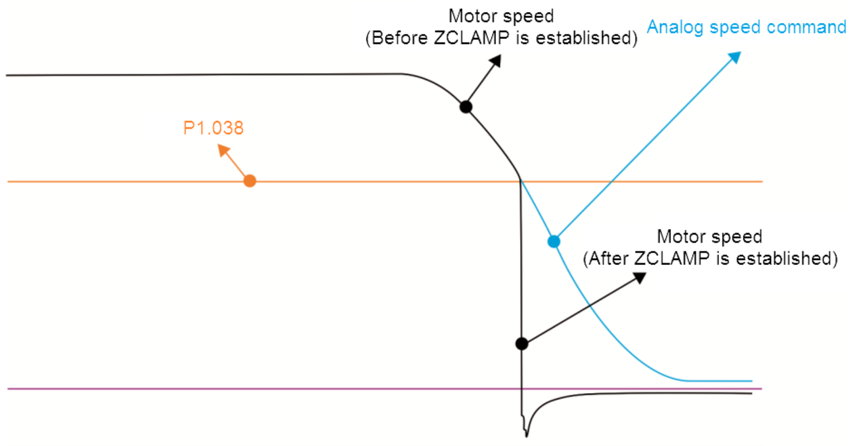
Settings:

Bit	7	6	5	4	3	2	1	0
Bit	15	14	13	12	11	10	9	8

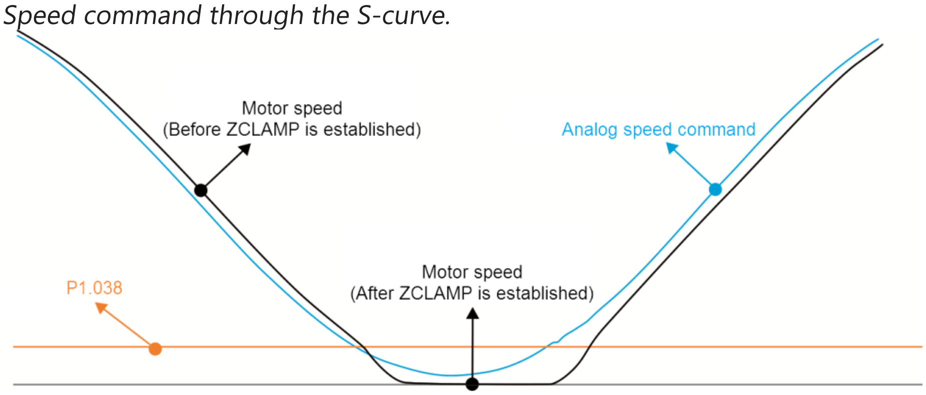
- *Bit 0–Bit 4, Bit 7, Bit 12, and Bit 14: reserved, please set to 0.*
- *Bit 5: switch for AL003 (Undervoltage) and AL022 (RST power error) in Servo Off status.*
  - *0: when the servo is off, disable the detection for AL003 (Undervoltage) and AL022 (RST power error).*
  - *1: when the servo is off, enable the detection for AL003 (Undervoltage) and AL022 (RST power error).*
- *Bit 6: in PT mode, set the pulse error (pulse frequency is too high) protection function.*
  - *0: enable the pulse error protection function.*
  - *1: disable the pulse error protection function.*
- *Bit 8: U, V, W wiring error detection function.*
  - *1: enable the U, V, W wiring error detection function.*
- *Bit 9: U, V, W wiring cut-off detection function.*
  - *1: enable the U, V, W wiring cut-off detection function. See P1.098 for response time settings.*
- *Bit 10: ZCLAMP function selection. The ZCLAMP function is enabled when the following conditions are met. Condition 1: Speed mode; Condition 2: DI.ZCLAMP is on; Condition 3: motor speed is slower than the value of P1.038 (Zero Speed Range).*
  - *Bit10=0 and the command source is analog voltage: The ZCLAMP function uses the analog Speed command without acceleration / deceleration to determine if this function should be enabled. The motor is clamped at the position where ZCLAMP conditions are met.*

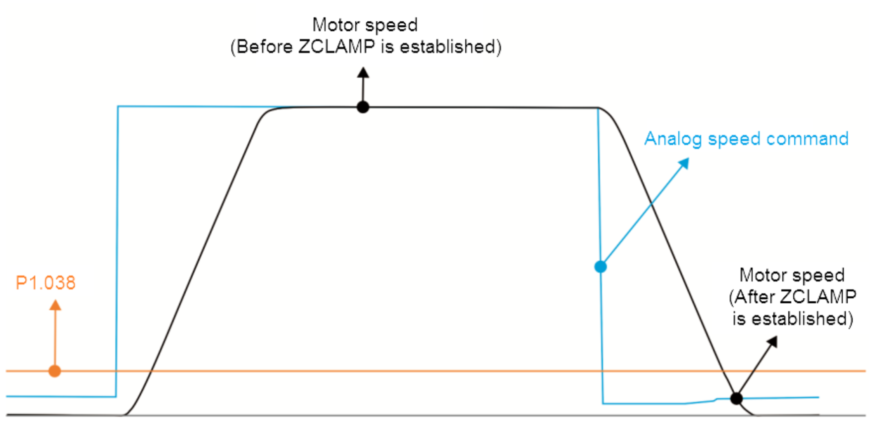


- *<u>Bit10=0 and the command source is internal registers:</u> ZCLAMP function uses the register speed command with acceleration / deceleration to determine if this function should be enabled. The motor is clamped at the position where ZCLAMP conditions are met.*

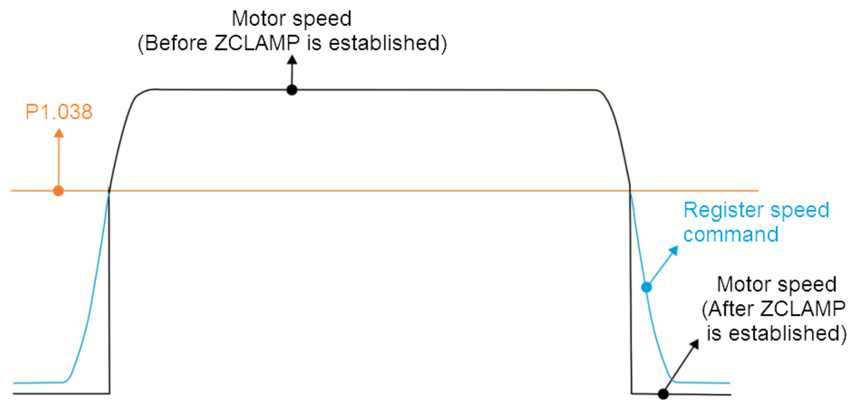


- *<u>Bit10=1 and the command source is analog voltage:</u> ZCLAMP function uses the analog Speed command without acceleration / deceleration to determine if this function is enabled. When ZCLAMP conditions are met, the motor speed decelerates to 0 rpm by S-curve deceleration. If ZCLAMP conditions are not met, the motor follows the analog Speed command through the S-curve.*





- *Bit10=1 and the command source is internal registers:* ZCLAMP function uses the register Speed command with acceleration / deceleration to determine if this function should be enabled. When ZCLAMP conditions are met, the motor speed is set to 0 rpm.



- *Bit 11: enable pulse inhibit function.*
  - *0: disable NL / PL pulse inhibit function. In PT mode, the external Position pulse command is input to the servo drive under any condition.*
  - *1: enable NL / PL pulse inhibit function. In PT mode, if NL (Reverse Inhibit Limit Digital Input) exists, the external NL pulse is not input to the servo drive and the PL Pulse command is accepted. In PT mode, if PL (Forward Inhibit Limit Digital Input) exists, the external PL pulse is not input to the servo drive and the NL pulse command is accepted. Bit11=1 allows the motor to reverse off of an overtravel sensor (but not go further in the direction of the overtravel).*
- *Bit 13: Encoder output error detection function*
  - *0: enable encoder output error (AL018, Abnormal encoder error signal alarm) detection function.*
  - *1: disable encoder output error (AL018, Abnormal encoder error signal alarm) detection function.*
- *Bit 15: Friction compensation mode selection*
  - *0: if the speed is slower than the value of P1.038 (Zero Speed Range), the friction compensation P1.062 remains unchanged.*
  - *1: if the speed is slower than the value of P1.038(Zero Speed Range), the friction compensation P1.062 becomes 0.*

***NOTE:** Other parameters that contain special functions and/or bit adjustments:*
-P2.008 Special parameter write-in function (factory reset, write to capture/compare/CAM table to EEPROM, force DOs)
-P2.030 Auxiliary function (force Servo ON, enable/disable EEPROM writes, save to EEPROM)
-P2.066 Special bit register 2 (low voltage latch and warning, overload warning detection, linear encoder disconnect error)
-P2.094 Special bit register 3 (2D control, vibration elimination, alarm enables: brake R temp, AL007, AL016).

Wiring
Parameters
DI/DO Codes
Monitoring
Alarms

P2.066	**Special bit register 2**			**Hex Address**	**Dec Address**
				0284H 0285H	40645 40646
Default:	0x0000	Control mode:	PT / PR / S / Sz		
Unit:	-	Setting range:	0x0000–0x182F		
Format:	HEX	Data size:	16-bit		

Settings:

Bit	7	6	5	4	3	2	1	0
Bit	15	14	13	12	11	10	9	8

- *Bit 0–1, Bit 3, Bit 7–8, Bit 10–11, Bit 13–15: reserved*
- *Bit 2: cancel low-voltage error latch function.*
  - *0: enable the low-voltage error AL003 latch function; the error is not cleared automatically.*
  - *1: disable the low-voltage error AL003 latch function; the error is cleared automatically.*
- *Bit 4: disable AL044 detection (servo function overload warning).*
  - *0: enable AL044 detection.*
  - *1: disable AL044 detection.*
- *Bit 5: enable AL041 disconnection detection of linear encoder (only when the full-closed loop control function is activated).*
  - *0: enable AL041 detection.*
  - *1: disable AL041 detection.*
- *Bit 6: RST power error (AL022) latch*
  - *0: disable the latch; RST power error (AL022) is cleared automatically.*
  - *1: enable the latch; RST power error (AL022) is not cleared automatically.*
- *Bit 9: set AL003 Low-voltage as a warning or an alarm.*
  - *0: set AL003 as WARN.*
  - *1: set AL003 as ALM.*
- *Bit 12: set AL022 (RST power error) as ALM or WARN*
  - *0: WARN.*
  - *1: ALM.*

***NOTE:** When the full-closed loop function is enabled the detection for AL041 (CN5 is disconnected) is disabled by default (P2.066 [Bit 5] = 0). It is strongly recommended that you enable this function when the servo is in the full-closed loop mode.*

***NOTE:** Other parameters that contain special functions and/or bit adjustments:*
-P2.008 Special parameter write-in function (factory reset, write to capture/compare/CAM table to EEPROM, force DOs)
-P2.030 Auxiliary function (force Servo ON, enable/disable EEPROM writes, save to EEPROM)
-P2.065 Special bit register (pulse/encoder/UVW error detection, ZCLAMP, pulse inhibit, friction compensation)
-P2.094 Special bit register 3 (2D control, vibration elimination, alarm enables: brake R temp, AL007, AL016).

P2.067	**Reserved**

P2.068	Following error compensation switch		Hex Address	Dec Address
			0288H 0289H	40649 40650
Default:	0x00000000	Control mode:	All	
Unit:	-	Setting range:	0x00000000–0x00002101	
Format:	HEX	Data size:	32-bit	

Settings:

h0000 L0020

D C B A U Z Y X

#	High Word	#	Low Word
A	Reserved	X	Following error compensation switch
B	Reserved	Y	Reserved
C	Reserved	Z	DI.STP triggering method
D	Reserved	U	Speed unit in Speed mode

- *X: following error compensation switch for S-Curve accel and decel (functions under the condition of P1.036 > 1)*
  - *0: disable following error compensation.*
  - *1: enable following error compensation.*
- *Y: reserved*
- *Z: DI.STP triggering method*
  - *0: DI.STP is rising-edge triggered.*
  - *1: DI.STP is level triggered.*
- *U: reserved*

P2.069●	Absolute encoder		Hex Address	Dec Address
			028AH 028BH	40651 40652
Default:	0x0000	Control mode:	All	
Unit:	-	Setting range:	0–1	
Format:	HEX	Data size:	16-bit	

Settings:

0000

U Z Y X

X	Set up operation mode	Z	Index coordinates function setting when overflow occurs
Y	Y: Pulse command setting when absolute position is lost	U	Reserved

- *X: set up operation mode*
  - *0: Incremental coordinate system. Absolute moves can still be performed in PR mode but the absolute position will not be tracked when the motor moves during a power off state even if a battery is installed.*
  - *1: Absolute coordinate system is to be used (encoder battery required).*
- *Y: Pulse command setting when absolute position is lost*
  - *0: when AL060 or AL06A occurs, the system cannot accept a pulse command.*
  - *1: when AL060 or AL06A occurs, the system can accept a pulse command.*

- *Z: rotary position function when an overflow occurs*
  - *0: rotary axis position is lost when an overflow occurs.*
  - *1: rotary axis position is not affected by overflow, but the absolute position is not retained (AL289 and AL062 do not function).*
- *U: reserved*

NOTE: *Changes to this setting are effective only after power is cycled to the servo drive.*

P2.070	***Read data selection***			***Hex Address***	***Dec Address***
				028CH 028DH	40653 40654
Default:	0x0000	Control mode:	All		
Unit:	-	Setting range:	0x00–0x07		
Format:	HEX	Data size:	16-bit		

Settings:

Bit	7	6	5	4	3	2	1	0
Bit	15	14	13	12	11	10	9	8

- *Bit 0: Reserved*
- *Bit 1: communication data unit setting*
  - *0: PUU (P0.051 is invalid when Bit1=0)*
  - *1: Pulse*
- *Bit 2: overflow warning setting*
  - *0: overflow warning, including AL289 (PUU) and AL062 (pulse)*
  - *1: no overflow warning*
- *Bit 3–Bit15: reserved; set to 0*

P2.071■	***Absolute position homing***			***Hex Address***	***Dec Address***
				028EH 028FH	40655 40656
Default:	0x0	Control mode:	All		
Unit:	-	Setting range:	0–1		
Format:	HEX	Data size:	16-bit		

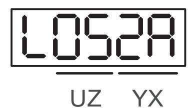
Settings:

When P2.071 is 1, the current absolute position of the encoder is the home position. Clearing this function is enabled by setting P2.008 to 271 or by setting P2.069.x = 1 (set the encoder system to absolute).

P2.072	***Reserved***

P2.073■	E-Cam phase alignment - operation		Hex Address	Dec Address
			0292H 0293H	40659 40660
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0x5F3F6F5F	
Format:	HEX	Data size:	32-bit	

Settings:



BA	PR number	YX	Range of filter (0–95%)
DC	Masking range (0–95%)	UZ	Maximum allowable collection rate (0–100%)
h	High bit	L	Low bit

- *YX: range of filter (0–95%)*
  When DI.ALGN is triggered, the E-Cam phase alignment function is enabled. The system detects the current E-Cam position. When the difference between the current E-Cam position and its previous alignment position is less than the parameter's range as a percentage, the filter function is enabled. Otherwise, the system uses the new position to do the alignment.

YX	Description
00	Filter disabled
01–5F	If |Error| ≤ (1–YX)%, then the filter is enabled

NOTE: *Using the filter allows the alignment to be more stable and reduces any position errors caused by DI noise, so the operation can be smoother.*

- *UZ: maximum allowable correction rate (0–100%)*
  When phase alignment isenabled, the limitation of the maximum allowable correction rate (C) is defined as |C| ≤ (P5.084/P5.083) x P2.073.UZ%

NOTE: *When the alignment error is too large, correcting this error once may cause motor vibration or overloading. Using this parameter can divide the phase alignment into several stages to smooth the process, but it may need more time to complete the phase alignment.*

- *BA: PR number (PR#0–PR#99)*
  After each alignment, any shortage of pulse numbers from the slave axis is stored in a specified PR. This PR can compensate for the slave position at the appropriate timing point. If BA is set to 0, any shortage of pulse numbers is not stored in PR.

NOTE: *The format of this parameter is HEX. Thus, to set PR#11, write 0B to BA.*

- *DC: masking range (0–95%)*
  When DI.ALGN is triggered, the next alignment action is allowed only after the increasing pulses of the master axis are greater than the masking distance (M).
  M ≤ (P5.084/P5.083) x P2.073.DC%

NOTE: *This masking function only allows forward pulse input and does not work for reverse pulse input.*

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P2.074■	**E-Cam phase alignment - DI delay time**		**Hex Address**	**Dec Address**
			0294H 0295H	40661 40662
Default:	0.000	Control mode:	PR	
Unit:	ms (minimum scale is μs)	Setting range:	-25.000 to +25.000	
Format:	DEC	Data size:	16-bit	

Settings:

This parameter offsets the alignment target to resolve DI and sensor delays. The setting works as follows:

P2.074 = P2.009 (DI response filter time) + sensor's delay time

P2.075■	**E-Cam phase alignment - target position**		**Hex Address**	**Dec Address**
			0296H 0297H	40663 40664
Default:	0	Control mode:	PR	
Unit:	Pulse unit of master axis	Setting range:	0 to (P5.084/P5.083)-1	
Format:	DEC	Data size:	32-bit	

Settings:

Set the alignment target position for E-Cam; unit: pulse unit of master axis.

NOTE: *When the input value is within the setting range, but changes in the value of P5.084 or P5.083 cause the value to exceed the range, this parameter is automatically reset to 0.*

P2.076■	**E-Cam phase alignment - control switch**		**Hex Address**	**Dec Address**
			0298H 0299H	40665 40666
Default:	0x0000	Control mode:	PR	
Unit:	-	Setting range:	0x0000–0x6FF7	
Format:	HEX	Data size:	16-bit	

Settings:

0002

UZ Y X

X	E-Cam alignment control	UZ	Pulse data when master axis performs continous forward/reverse running or JOG function
Y	Filter intensity (0–F)	-	-

- *X: E-Cam alignment control*

Bit	3	2	1	0

Bit	Function	Description
0	Enable alignment	Set this bit to 0 to disable this function. Set this bit to 1 to enable this function. If enabled, the E-Cam phase alignment is executed when DI.ALGN is on.
1	Trigger PR immediately	The E-Cam displacement value is stored in the PR data location specified by P2.073.BA. Set this bit to 1 to trigger this PR command immediately. Set this bit to 0 and it does not tirgger this PR command imemediately. Use the PR command (P5.088.BA) when E-Cam disengages to execute phase alignment.
2	Position of the mark	Set this bit to 0 if the mark is on a non-compensated motion axis, as the position of the mark is not affected when aligning. Set this bit to 1 if the mark is on a compensated motion axis, as the position of the mark is affected when aligning.
3	Reserved	-

- *Y: filter intensity (0–F)*
  Indicates average of $2^{(value)}$. Set to 0 to disable the filter. When the value of Y increases, the correction is slower which can avoid large amounts of correction during E-Cam adjustment. This can also avoid disturbances caused by sensor noise for a smoother operation. Setting P2.076.Y too high causes the alignment to not work properly. The recommended value is 3.
  Example:
  When the filter intensity is set to 3, the actual filter intensity is 2^3=8, which means that after capturing 8 times of error values, the 8 values are averaged for the correction value of the alignment.
- *UZ: alignment forward direction allowable rate (0–100%)*

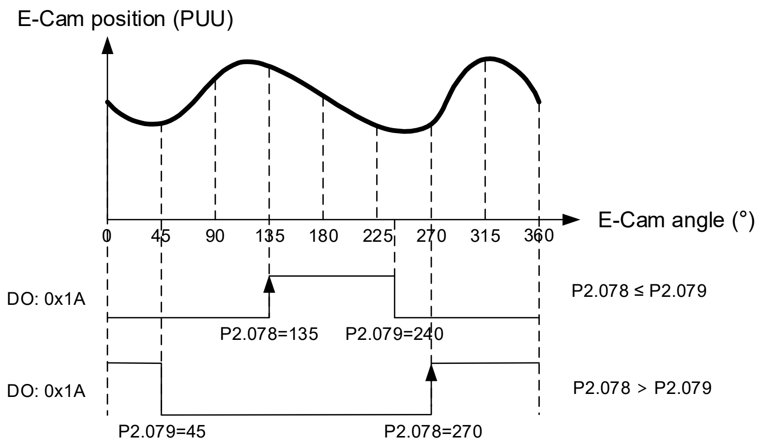
Setting Value	Alignment Direction
0	Backward alignment only
30	Forward 30%, backward 70%
50	Alignment with the shortest distance
80	Forward 80%, backward 20%
≥100	Forward alignment only

P2.077	Reserved

P2.078	E-Cam: DO.CAM_Area#2 rising-edge phase		Hex Address	Dec Address
			029CH 029DH	40669 40670
Default:	270	Control mode:	PR	
Unit:	degree	Setting range:	0–360	
Format:	DEC	Data size:	16-bit	

Settings:

The relationship between DO.CAM_Area2 and the parameter values is shown below. When E-Cam is not engaged, this signal is always off. P5.090 and P5.091 represent a second window that can be used for a different DO (0x18).



P2.079	E-Cam: DO.CAM_Area#2 falling-edge phase		Hex Address	Dec Address
			029EH 029FH	40671 40672
Default:	360	Control mode:	PR	
Unit:	degree	Setting range:	0–360	
Format:	DEC	Data size:	16-bit	

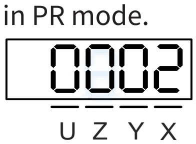
Settings:

Please refer to P2.078 for the relationship between DO.CAM_Area2 and its parameters.

P2.080	Z pulse source of homing		Hex Address	Dec Address
			02A0H 02A1H	40671 40672
Default:	0x0000	Control mode:	PR (full-closed loop)	
Unit:	–	Setting range:	0x0000 – 0x0011	
Format:	HEX	Data size:	16-bit	

Settings:

When you execute homing and have the servo look for the Z pulse, use this parameter to set either the Z pulse of the motor or the Z pulse of the auxiliary encoder as the homing origin. Select the auxiliary encoder to achieve higher positioning precision. Note this is only available in PR mode.



X	Z pulse source of full-closed loop homing	Z	Reserved
Y	Z pulse source of half-closed loop homing	U	Reserved

- *X: Z pulse source of full-closed loop homing*
  - *0: auxiliary encoder*
  - *1: motor*
- *Y: Z pulse source of half-closed loop homing*
  - *0: motor*
  - *1: auxiliary encoder*

P2.081 - P2.088	Reserved

P2.089	Command responsiveness gain		Hex Address	Dec Address
			02B2H 02B3H	40691 40692
Default:	25	Control mode:	PT / PR	
Unit:	rad/s	Setting range:	1 - 2000	
Format:	DEC	Data size:	16-bit	

Settings:

Increasing this gain speeds up the responsiveness of the Position command and shortens the tuning time, but when the gain is too large, it causes position overshoot which leads to machine jitter.

NOTE: *Enable the two dimensional control function (P2.094 [Bit 12] = 1) before adjusting this parameter.*

P2.090 - P2.093	Reserved

P2.094	Special bit register 3		Hex Address	Dec Address
			02BCH 02BDH	40701 40702
Default:	0x1010	Control mode:	PT / PR / S / Sz	
Unit:	-	Setting range:	0x0000 - 0xF3A6	
Format:	HEX	Data size:	16-bit	

Settings:

Bit	7	6	5	4	3	2	1	0
Bit	15	14	13	12	11	10	9	8

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Bit	Function	Description
Bit 15–13	Reserved	-
Bit 12	Two dimensional control function	0: disable two dimensional control function 1: enable two dimensional control function If P2.094 Bit12 is off then Gain Adjustment Mode 3 is equal to Gain Adjustment Mode 2 (P2.032). Two dimensional control just allows you to adjust P2.094 and P2.031 separately.
Bit 11–10	Reserved	-
Bit 9	Second set of vibration elimination	0: disable second set of vibration elimination 1: enable second set of vibration elimination (P1.092–P1.094) Vibration elimination takes effect only when the two dimensional control function P2.094 [Bit 12] is enabled.
Bit 8	First set of vibration elimination	0: disable first set of vibration elimination 1: enable first set of vibration elimination (P1.089–P1.091) Vibration elimination takes effect only when the two dimensional control function P2.094 [Bit 12] is enabled.
Bit 7	Switch for brake resistor temperature protection after AL086 is triggered	Switch for the brake resistor temperature protection when the input voltage is too high. 0: disable 1: enable
Bit 6	Switch for AL007 (Excessive devation of speed command) detection in Position mode	Switch for AL007 detection in Position mode (PT and PR). 0: disable AL007 detection (default) 1: enabled AL007 detection
Bit 5	Cancel AL016 IGBT overheat alarm	0: enable AL016 IGBT overheat alarm 1: disable AL016 IGBT overheat alarm
Bit 4	Reserved	Bit 4 should not be adjusted by the customer and should remain at the default value of 1.
Bit 3–0	Reserved	-

***NOTE:** Other parameters that contain special functions and/or bit adjustments:*
-P2.008 Special parameter write-in function (factory reset, write to capture/compare/CAM table to EEPROM, force DOs)
-P2.030 Auxiliary function (force Servo ON, enable/disable EEPROM writes, save to EEPROM)
-P2.065 Special bit register (pulse/encoder/UVW error detection, ZCLAMP, pulse inhibit, friction compensation)
-P2.066 Special bit register 2 (low voltage latch and warning, overload warning detection, auxiliary encoder disconnect error).

P2.095	Notch filter bandwidth (1)			Hex Address	Dec Address
				02BEH 02BFH	40703 40704
Default:	5	Control mode:	All		
Unit:	-	Setting range:	1 - 10		
Format:	DEC	Data size:	16-bit		

Settings:

The first value of resonance width. This function is disabled if P2.024 (Notch filter frequency (1)) is 0. P2.023, P2.024, and P2.095 are the first set of Notch filter parameters. Refer to Chapter 5: Tuning for more detailed information on using Notch filters.

P2.096	Notch filter bandwidth (2)		Hex Address	Dec Address
			02COH 02C1H	40705 40706
Default:	5	Control mode:	All	
Unit:	-	Setting range:	1 - 10	
Format:	DEC	Data size:	16-bit	

Settings:

The second value of resonance width. This function is disabled if P2.044 (Notch filter attenuation level (2)) is 0. P2.043, P2.044,

and P2.096 are the second set of Notch filter parameters.

P2.097	Notch filter bandwidth (3)		Hex Address	Dec Address
			02C2H 02C3H	40707 40708
Default:	5	Control mode:	All	
Unit:	-	Setting range:	1 - 10	
Format:	DEC	Data size:	16-bit	

Settings:

The third value of resonance width. This function is disabled if P2.046 (Notch filter attenuation level (3)) is 0. P2.045, P2.046, and P2.097 are the third set of Notch filter parameters.

P2.098	Notch filter frequency (4)		Hex Address	Dec Address
			02C4H 02C5H	40709 40710
Default:	1000	Control mode:	All	
Unit:	Hz	Setting range:	50 - 5000	
Format:	DEC	Data size:	16-bit	

Settings:

The fourth value of resonance frequency. This function is disabled if you set P2.099 to 0. P2.098, P2.099, and P2.100 are the fourth set of Notch filter parameters.

P2.099	Notch filter attenuation level (4)		Hex Address	Dec Address
			02C6H 02C7H	40711 40712
Default:	0	Control mode:	All	
Unit:	-dB	Setting range:	0 - 40	
Format:	DEC	Data size:	16-bit	

Settings:

The fourth Notch filter attenuation level. The Notch filter is disabled if you set this parameter to 0. For example, if you set the attenuation level to 5, then the value is -5 dB

P2.100	Notch filter bandwidth (4)		Hex Address	Dec Address
			02C8H 02C9H	40713 40714
Default:	5	Control mode:	All	
Unit:	-	Setting range:	1 - 10	
Format:	DEC	Data size:	16-bit	

Settings:

The fourth value of resonance width. This function is disabled if you set P2.099 to 0. P2.098, P2.099, and P2.100 are the fourth set of Notch filter parameters.

P2.101	Notch filter frequency (5)		Hex Address	Dec Address
			02CAH 02CBH	40715 40716
Default:	1000	Control mode:	All	
Unit:	Hz	Setting range:	50 - 5000	
Format:	DEC	Data size:	16-bit	

Settings:

The fifth value of resonance frequency. This function is disabled if you set P2.102 to 0. P2.101, P2.102, and P2.103 are the fifth set of Notch filter parameters.

P2.102	Notch filter attenuation level (5)		Hex Address	Dec Address
			02CCH 02CDH	40717 40718
Default:	0	Control mode:	All	
Unit:	-db	Setting range:	0 - 40	
Format:	DEC	Data size:	16-bit	

Settings:

The fifth Notch filter attenuation level. The Notch filter function is disabled if you set this parameter to 0. For example, if you set the attenuation level to 5, then the value is -5dB.

P2.103	Notch filter bandwidth (5)		Hex Address	Dec Address
			02CEH 02CFH	40719 40720
Default:	5	Control mode:	All	
Unit:	-	Setting range:	1 - 10	
Format:	DEC	Data size:	16-bit	

Settings:

The fifth value of resonance width. This function is disabled if you set P2.102 to 0. P2.101, P2.102, and P2.103 are the fifth set of Notch filter parameters.

P2.104	P/PI torque switching command condition		Hex Address	Dec Address
			02D0H 02D1H	40721 40722
Default:	200	Control mode:	PT / PR / S / Sz	
Unit:	[%]	Setting range:	1 - 800	
Format:	DEC	Data size:	16-bit	

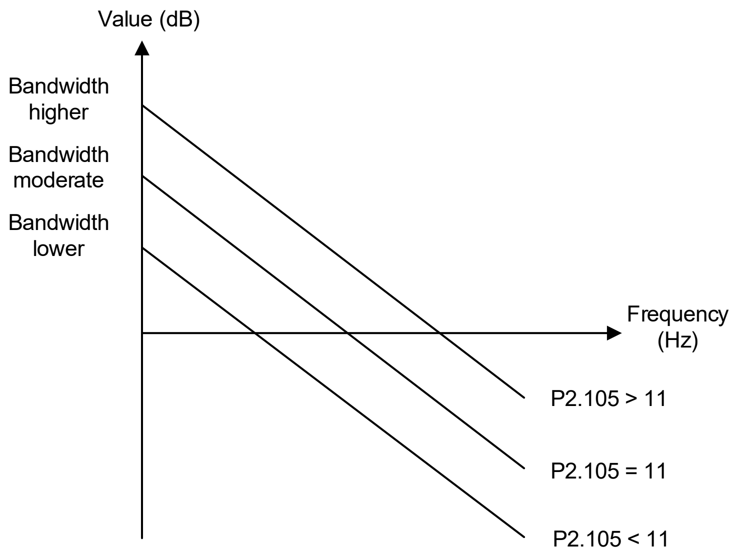
Settings:

When the Torque command exceeds P2.104, the speed controller gain is switched from PI to P in order to reduce response overshoot.

P2.105	***Auto-tuning Adjustment Bandwidth Level***		***Hex Address***	***Dec Address***
			02D2H 02D3H	40723 40724
Default:	11	Control mode:	PT / PR	
Unit:	-	Setting range:	1 - 21	
Format:	DEC	Data size:	16-bit	

Settings:

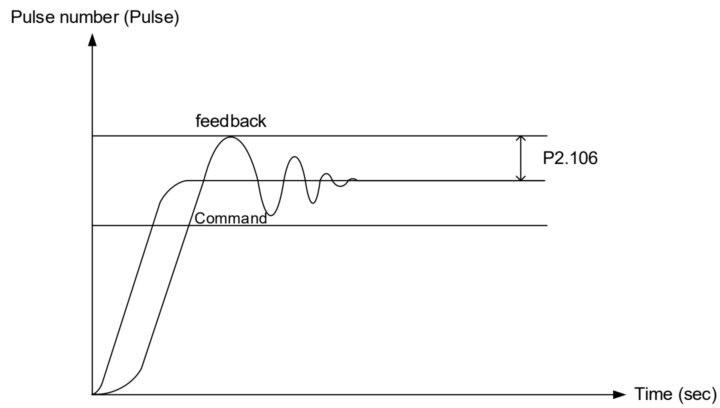
Use this parameter to adjust the bandwidth when auto-tuning. If the value is larger, the bandwidth after auto-tuning is higher, but if the bandwidth margin is insufficient, it may cause machine jitter. If the value is too low, the bandwidth after auto-tuning is lower, but the response is slower. Refer to section “5.2 - Auto tuning” on page 5–4 for more detailed information on using P2.105 and P2.106.



P2.106	***Auto-tuning Adjustment Overshoot Level***		***Hex Address***	***Dec Address***
			02D4H 02D5H	40725 40726
Default:	2000	Control mode:	PT / PR	
Unit:	Pulse number	Setting range:	1 - 50331648	
Format:	DEC	Data size:	32-bit	

Settings:

Use this parameter to adjust the maximum allowable overshoot when auto-tuning. The overshoot range is set for either the user or the machine. If the value is larger, the maximum overshoot allowed by auto-tuning is greater, but the response is faster. If the value is smaller, the maximum overshoot allowed by auto-tuning is smaller, but the response is slower.



P2.107 - P2.111	Reserved

P2.112	Special bit register		Hex Address	Dec Address
			02E0H 02E1H	40737 40738
Default:	0x000C	Control mode:	PT / PR / S / Sz	
Unit:	-	Setting range:	0x0000 - 0x001F	
Format:	HEX	Data size:	16-bit	

Settings:

Bit	7	6	5	4	3	2	1	0
Bit	15	14	13	12	11	10	9	8

Bit	Function	Description
Bit 15–4	Reserved	-
Bit 3	Auto gain adjustment mode	0: reserved 1: cycle adjustment
Bit 2	Reserved	-
Bit 1	Enable AL089	0: disable AL089 1: enable AL089
Bit 0	Reserved	-

8.4.4 - P3.xxx Communication parameters

P3.000	**Address**		**Hex Address**	**Dec Address**
			0300H 0301H	40769 40770
Default:	0x7F	Control mode:	All	
Unit:	-	Setting range:	0x01–0x7F	
Format:	HEX	Data size:	16-bit	

Settings:

0020

U Z YX

YX	Communication address setting	UZ	Reserved

When using RS-485 to communicate, every address must be unique. Setting more than one drive to the same address (or leaving more than drive as default) will cause abnormal communication. P3.000 represents the absolute address of the servo drive in the communication network. It is applicable to RS-485 and when connected to SureServo2 Pro. In SV2-PRO this is the Station Number (SN). This address is also used in ModTCP communication. The ModTCP PLC message must be configured with the same Station/Unit Number as P3.000.

P3.001	**Transmission speed**		**Hex Address**	**Dec Address**
			0302H 0303H	40771 40772
Default:	0x0203	Control mode:	All	
Unit:	-	Setting range:	0x000–0x3405	
Format:	HEX	Data size:	16-bit	

Settings:

0000

U Z Y X

Transmission speed is divided into U, Z, Y, and X (hexadecimal):

	U	**Z**	**Y**	**X**
Communication port	-	-	-	RS-485
Range	0	0–2	0	0–5

- *Definition of X value*

0: 4800	1: 9600	2: 19200
3: 38400	4: 57600	5: 115200

Notes:

1) U, Y, and Z are for future comms use.
2) The communication speed of USB is set at 1.0 Mbit/s and it cannot be changed.

P3.002	Communication protocol			Hex Address	Dec Address
				0304H 0305H	40773 40774
Default:	0x6	Control mode:	All		
Unit:	-	Setting range:	0–8		
Format:	HEX	Data size:	16-bit		

Settings:

0: 7, N, 2 (MODBUS, ASCII)	1: 7, E, 1 (MODBUS, ASCII)	2: 7, O, 1 (MODBUS, ASCII)
3: 8, N, 2 (MODBUS, ASCII)	4: 8, E, 1 (MODBUS, ASCII)	5: 8, O, 1 (MODBUS, ASCII)
6: 8, N, 2 (MODBUS, RTU)	7: 8, E, 1 (MODBUS, RTU)	8: 8, O, 1 (MODBUS, RTU)

ASCII (American Standard Code for Information Interchange). Uses 10-bit protocol string for 7 data bits, plus start, stop, and parity bits. Parity bits are Even, Odd, or None.

Example: 7N2 = (1 start + 7 data + 0 parity + 2 stop) bits

RTU (Remote Terminal Unit). Uses 11-bit protocol string for 8 data bits, plus start, stop, and parity bits.

Example: 8E1 = (1 start + 8 data + 1 parity + 1 stop) bits

P3.003	Communication error handling			Hex Address	Dec Address
				0306H 0307H	40775 40776
Default:	0x0	Control mode:	All		
Unit:	-	Setting range:	0–1		
Format:	HEX	Data size:	16-bit		

Settings:

- *0: display warning and let motor continue operating.*
- *1: display warning and let motor decelerate to a stop. Deceleration time is set in P5.003.B.*

P3.004	Communication timeout			Hex Address	Dec Address
				0308H 0309H	40777 40778
Default:	0x0	Control mode:	All		
Unit:	sec	Setting range:	0–20		
Format:	DEC	Data size:	16-bit		

Settings:

If the value is not 0, enable communication timeout immediately. To disable this function, set the value to 0.

P3.005	Reserved

P3.006	Digital input (DI) control switch		Hex Address	Dec Address
			030CH 030DH	40781 40782
Default:	0x0	Control mode:	All	
Unit:	-	Setting range:	0x0000–0x1FFF	
Format:	HEX	Data size:	16-bit	

Settings:

Source of the DI that controls the switch. Each bit of this parameter determines one input source of DI signal:

- *Bit0–Bit9 correspond to DI1–DI10.*

Bit10–Bit12 correspond to VDI11–VDI13.
The setting of bit is as follows:

- *0: DI status is controlled by the external hardware.*
- *1: DI status is controlled by P4.007.*

For more information on DI, please see:

- *DI1–DI8: P2.010–P2.017*
- *DI9–DI10: P2.036–P2.037*
- *VDI11–VDI13: P2.038–P2.040*

***NOTE:** When using the "Digital IO/Jog Control" window in SureServo2 Pro, the Enable check boxes directly control the bits of P3.006. Toggling the "On/Off" button to the right of the check box will directly control the bits of P4.007.*

P3.007	Communication response delay time		Hex Address	Dec Address
			030EH 030FH	40783 40784
Default:	0	Control mode:	All	
Unit:	0.5 ms	Setting range:	0–1000	
Format:	DEC	Data size:	16-bit	

Settings:

Delay the time of communication response from servo drive to controller.

P3.008–P3.012	Reserved

P3.013	Full-closed Loop Feedback Source for the Controller		Hex Address	Dec Address
			031AH 031BH	40794 40795
Default:	0x0000	Control mode:	PR (full-closed loop)	
Unit:	-	Setting range:	0x0000 – 0x0022	
Format:	HEX	Data size:	16-bit	

Settings:

X	Encoder feedback source in full-closed loop control	Y	Z pulse offset source in full-closed loop mode (motor/auxiliary encoder)

- *X: encoder feedback source in full-closed loop control.*

- *0: feedback pulse number from the motor*
- *1: feedback pulse number from the auxiliary encoder*
- *2: in half-closed loop control, the feedback pulse is from the motor; in full-closed loop control, the feedback pulse is from the auxiliary encoder*

- *Y: Z pulse offset source in full-closed loop mode (motor/auxiliary encoder)*
  - *0: motor*
  - *1: auxiliary encoder*
  - *2: in half-closed loop control, the motor's Z pulse offset is used; in full-closed loop control, the auxiliary encoder's Z pulse offset is used.*

Note: This parameter setting is different from P1.074.Y (switch between motor encoder and auxiliary encoder). This parameter only modifies the feedback signal source uploaded to the controller. Set P3.013 to 0x0022 to avoid misoperation when the motor is in the Servo On state.

P3.014–P3.044	**Reserved**

NOTE: *If the servo drive sets the Ethernet card parameters to zero at drive power-up, ensure the following:*
1) The Ethernet card is properly seated onto the drive.
2) The Ethernet card ground wire is properly attached to the card and to ground.
3) The Ethernet card Firmware Update switch is set to the "Normal" position.

P3.045 ★	**Communication card type**		**Hex Address**	**Dec Address**
			035AH 035BH	40859 40860
Default:	0	Control mode:	All	
Unit:	-	Setting range:	-32768 to +32767	
Format:	DEC	Data size:	16-bit	

Settings:

The hardware version of the communication card. This Read Only value will be set by the communication card at power-up.

Setting	Description
4	Modbus TCP
5	EtherNet/IP

P3.046	**Communication card firmware version**		**Hex Address**	**Dec Address**
			035CH 035DH	40861 40862
Default:	0x0000	Control mode:	All	
Unit:	-	Setting range:	0x0000–0xFFFF	
Format:	HEX	Data size:	16-bit	

Settings:

Current firmware version of the ethernet card.

The Ethernet card firmware is updated through a standard Ethernet cable. The Ethernet card has a built-in webserver that facilitates the update process.

See Chapter 9 for more details.

P3.047★	Communication product code		Hex Address	Dec Address
			035EH 035FH	40863 40864
Default:	0	Control mode:	All	
Unit:	-	Setting range:	-32768 to +32767	
Format:	DEC	Data size:	16-bit	

Settings:

The protocol version of the communication card. This read only value will be set by the communication card at power-up.

Setting	Description
1	Modbus TCP
2	EtherNet/IP

P3.048	Communication card error status		Hex Address	Dec Address
			0360H 0361H	40865 40866
Default:	0	Control mode:	All	
Unit:	-	Setting range:	-32768 to +32767	
Format:	DEC	Data size:	16-bit	

Settings:

Error Code	Description
0	No error
75	Incorrect factory parameters default setting.
80	Ethernet connection error.
81	Communication timeout between Communication card and Servo.
83	Reset Communication card to default setting.
86	IP address setting error (IP is not assigned or IP is dupicated)
89	Communication card cannot communicate with SV2.

P3.049	IP Configuration		Hex Address	Dec Address
			0362H 0363H	40867 40868
Default:	0	Control mode:	All	
Unit:	-	Setting range:	-32768 to +32767	
Format:	DEC	Data size:	16-bit	

Settings:

Determines whether the system uses a manually configured IP address or DHCP.

Setting	Description
0	Use a Static IP address (user defined in P3.049–P3.061)
1	Use DHCP for IP addresses

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NOTE: *When Ethernet card parameters are changed, the new values must be "saved" from the drive parameters to the card. See P3.065.*

NOTE: *If the servo drive sets the Ethernet card parameters to zero at drive power-up, ensure the following:*
1) The Ethernet card is properly seated onto the drive.
2) The Ethernet card ground wire is properly attached to the card and to ground.
3) The Ethernet card Firmware Update switch is set to the "Normal" position.

NOTE: *SureServo2 / PLC ModTCP communication requires that the Station ID (typically a serial communication setting) be configured correctly in both the PLC ModTCP message and SureServo2 P3.000.*

P3.050	**IP address 1**		**Hex Address**	**Dec Address**
			0364H 0365H	40869 40870
Default:	192	Control mode:	All	
Unit:	-	Setting range:	1 to 255	
Format:	DEC	Data size:	8-bit	

Settings:
Configures the first set of digits of the IP address when manual IP addressing is used.

P3.051	**IP address 2**		**Hex Address**	**Dec Address**
			0366H 0367H	40871 40872
Default:	168	Control mode:	All	
Unit:	-	Setting range:	1 to 255	
Format:	DEC	Data size:	8-bit	

Settings:
Configures the second set of digits of the IP address when manual IP addressing is used.

P3.052	**IP address 3**		**Hex Address**	**Dec Address**
			0368H 0369H	40873 40874
Default:	1	Control mode:	All	
Unit:	-	Setting range:	1 to 255	
Format:	DEC	Data size:	8-bit	

Settings:
Configures the third set of digits of the IP address when manual IP addressing is used.

P3.053	**IP address 4**		**Hex Address**	**Dec Address**
			036AH 036BH	40875 40876
Default:	10	Control mode:	All	
Unit:	-	Setting range:	1 to 255	
Format:	DEC	Data size:	8-bit	

Settings:
Configures the fourth set of digits of the IP address when manual IP addressing is used.

P3.054	Net mask 1		Hex Address	Dec Address
			036CH 036DH	40877 40878
Default:	255	Control mode:	All	
Unit:	-	Setting range:	0 to 255	
Format:	DEC	Data size:	8-bit	

Settings:

Configures the first set of digits of the subnet mask when manual IP addressing is used.

P3.055	Net mask 2		Hex Address	Dec Address
			036EH 036FH	40879 40880
Default:	255	Control mode:	All	
Unit:	-	Setting range:	0 to 255	
Format:	DEC	Data size:	8-bit	

Settings:

Configures the second set of digits of the subnet mask when manual IP addressing is used.

P3.056	Net mask 3		Hex Address	Dec Address
			0370H 0371H	40881 40882
Default:	255	Control mode:	All	
Unit:	-	Setting range:	0 to 255	
Format:	DEC	Data size:	8-bit	

Settings:

Configures the third set of digits of the subnet mask when manual IP addressing is used.

P3.057	Net mask 4		Hex Address	Dec Address
			0372H 0373H	40883 40884
Default:	0	Control mode:	All	
Unit:	-	Setting range:	0 to 255	
Format:	DEC	Data size:	8-bit	

Settings:

Configures the fourth set of digits of the subnet mask when manual IP addressing is used.

P3.058	Gateway 1		Hex Address	Dec Address
			0374H 0375H	40885 40886
Default:	0	Control mode:	All	
Unit:	-	Setting range:	0 to 255	
Format:	DEC	Data size:	8-bit	

Settings:

Configures the first set of digits of the gateway when manual IP addressing is used.

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P3.059	Gateway 2		Hex Address	Dec Address
			0376H 0377H	40887 40888
Default:	0	Control mode:	All	
Unit:	-	Setting range:	0 to 255	
Format:	DEC	Data size:	8-bit	

Settings:

Configures the second set of digits of the gateway when manual IP addressing is used.

P3.060	Gateway 3		Hex Address	Dec Address
			0378H 0379H	40889 40890
Default:	0	Control mode:	All	
Unit:	-	Setting range:	0 to 255	
Format:	DEC	Data size:	8-bit	

Settings:

Configures the third set of digits of the gateway when manual IP addressing is used.

P3.061	Gateway 4		Hex Address	Dec Address
			037AH 037BH	40891 40892
Default:	0	Control mode:	All	
Unit:	-	Setting range:	0 to 255	
Format:	DEC	Data size:	8-bit	

Settings:

Configures the fourth set of digits of the gateway when manual IP addressing is used.

P3.062–P3.063	Reserved

P3.064	Communication Card Factory Setting (Reset)		Hex Address	Dec Address
			0380H 0381H	40897 40898
Default:	0	Control mode:	All	
Unit:	-	Setting range:	-32768 to +32767	
Format:	DEC	Data size:	16-bit	

Settings:

Resets the system to factory defaults.

Setting	Description
1	Reset to factory defaults

P3.065	Setting of Communication Card (save parameters to card)		Hex Address	Dec Address
			0382H 0383H	40899 40900
Default:	0	Control mode:	All	
Unit:	-	Setting range:	-32768 to +32767	
Format:	DEC	Data size:	16-bit	

Settings:

Saves the configured parameters to the communication card.

Setting	Description
1	Write/save drive parameters to the ethernet card

P3.066	Reserved

P3.067	Communication Card TCP Connection Timeout		Hex Address	Dec Address
			0386H 0387H	40903 40904
Default:	30	Control mode:	All	
Unit:	ms	Setting range:	1–600	
Format:	DEC	Data size:	16-bit	

Settings:

Ethernet timeout detection in msec. This is for both SV2-CM-ENETIP Ethernet/IP & SV2-CM-MODTCP ModTCP cards.

P3.068	Ethernet Timeout Detection of Servo Drive		Hex Address	Dec Address
			0388H 0389H	40905 40906
Default:	1	Control mode:	All	
Unit:	-	Setting range:	0–1	
Format:	DEC	Data size:	16-bit	

Settings:

Timeout detected between external controller (PLC, etc.) and ethernet card.

Setting	Description
0	Enable. Use alarm function definition from P3.069
1	Disable

P3.069	Ethernet Timeout Handle of Servo Drive			Hex Address	Dec Address
				038AH 038BH	40907 40908
Default:	1	Control mode:	All		
Unit:	-	Setting range:	0–4		
Format:	DEC	Data size:	16-bit		

Settings:

P3.069 - Ethernet timeout function.

Setting	Description
0	Warn (AL180) and continue operation
1	Fault and ramp to stop (P5.003.C as deceleration stop). (Keep Servo State ON)
2	Fault and coast to stop (Servo State OFF)
3	No warning and continue operation
4	Fault and ramp to stop (P5.003.C as deceleration stop). (Servo State OFF). Reset by DI.ARST.

NOTE: *Settings #1 and #2 will resume operation immediately when communication is restored. This may be hard to troubleshoot if comms are intermittent. (Motor stops briefly, restarts, and Warning disappears). Setting #4 will stop the drive and require a reset once the timeout occurs.*

8.4.5 - P4.xxx Diagnosis parameters

P4.000 ★	Fault record (N)		Hex Address	Dec Address
			0400H 0401H	41025 41026
Default:	0x0	Control mode:	All	
Unit:	-	Setting range:	-	
Format:	HEX	Data size:	32-bit	

Settings:

- *The last abnormal status record.*
- *Low word (LXXXX): the alarm number.*
- *High word (HYYYY): future use.*

P4.000-P4.004 will save the last 5 alarm codes. P4.000 is not necessarily the current alarm, but is the most recent alarm in the alarm history. See P0.001 for the drive's active alarm code.

P4.001 ★	Fault record (N-1)		Hex Address	Dec Address
			0402H 0403H	41027 41028
Default:	0x0	Control mode:	All	
Unit:	-	Setting range:	-	
Format:	HEX	Data size:	32-bit	

Settings:

- *The second to last abnormal status record.*
- *Low word (LXXXX): the alarm number.*
- *High word (hYYYY): future use.*

P4.002 ★	Fault record (N-2)		Hex Address	Dec Address
			0404H 0405H	41029 41030
Default:	0x0	Control mode:	All	
Unit:	-	Setting range:	-	
Format:	HEX	Data size:	32-bit	

Settings:

- *The third to last abnormal status record.*
- *Low word (LXXXX): the alarm number.*
- *High word (hYYYY): future use.*

P4.003 ★	Fault record (N-3)		Hex Address	Dec Address
			0406H 0407H	41031 41032
Default:	0x0	Control mode:	All	
Unit:	-	Setting range:	-	
Format:	HEX	Data size:	32-bit	

Settings:

- *The fourth to last abnormal status record.*
- *Low word (LXXXX): the alarm number.*
- *High word (hYYYY): future use.*

P4.004 ★	Fault record (N-4)		Hex Address	Dec Address
			0408H 0409H	41033 41034
Default:	0x0	Control mode:	All	
Unit:	-	Setting range:	-	
Format:	HEX	Data size:	32-bit	

Settings:

- *The fifth to last abnormal status record.*
- *Low word (LXXXX): the alarm number.*
- *High word (hYYYY): future use.*

P4.005	Servo motor JOG control		Hex Address	Dec Address
			040AH 040BH	41035 41036
Default:	20	Control mode:	All	
Unit:	rpm	Setting range:	0–5000	
Format:	DEC	Data size:	16-bit	

Settings:

The control methods are as follows:

- *Operation test:*
  First turn SV_ON. After the JOG speed is set by P4.005, the panel displays the JOG symbol. Pressing the UP key controls JOG operation in the positive direction; pressing the DOWN key controls JOG operation in the negative direction. Stop pressing to stop the JOG operation. If there is any error in this setting, then the motor cannot operate. The maximum JOG speed is the maximum speed of the servo motor.
- *DI control:*
  If you set the DI to JOGU and JOGD (refer to section 8.4.9), then the JOG operation in the positive or negative direction is controlled with this DI. P1.034 and P1.035 can be used to control the acceleration and deceleration when using DI jog function JOGU and JOGD.

Communication control:

Write the following values to the parameter via serial communications:

- *First enter 1–5000 to set the velocity in rpm.*
- *Then write:*
  4998: JOG operation in positive direction
  4999: JOG operation in negative direction
  0: Stop Command

NOTE: *When using communication to write values, and the write frequency is high, please set P2.030 to 5.*

P4.006▲■	Digital output register (readable and writable)		Hex Address	Dec Address
			040CH 040DH	41037 41038
Default:	0x0	Control mode:	All	
Unit:	-	Setting range:	0–0xFFFF	
Format:	HEX	Data size:	16-bit	

Settings:

bit 00: corresponds to DO code = 0x30	bit 08: corresponds to DO code = 0x38
bit 01: corresponds to DO code = 0x31	bit 09: corresponds to DO code = 0x39
bit 02: corresponds to DO code = 0x32	bit 10: corresponds to DO code = 0x3A
bit 03: corresponds to DO code = 0x33	bit 11: corresponds to DO code = 0x3B
bit 04: corresponds to DO code = 0x34	bit 12: corresponds to DO code = 0x3C
bit 05: corresponds to DO code = 0x35	bit 13: corresponds to DO code = 0x3D
bit 06: corresponds to DO code = 0x36	bit 14: corresponds to DO code = 0x3E
bit 07: corresponds to DO code = 0x37	bit 15: corresponds to DO code = 0x3F

P4.006 can be used to force DO on in two different ways. A diagnostic or non-diagnostic method.

Diagnostic Method:

Setting P2.008=406 first will cause all DO assignments to become null and switch to off so you can individually trigger each output to verify functionality of the output. See section “4.4.2 - Force DO on” on page 4–10 for info on forcing DOs for diagnostic purposes.

Non-Diagnostic Method:

Do not set P2.008=406. Assigning 0x30 - 0x3F functions to any DO# will allow you to write directly into P4.006 via communications or SureServo2 Pro. If you set P2.018 to 0x0030, then the output of DO#1 is now controlled by the value of bit 0 in P4.006.

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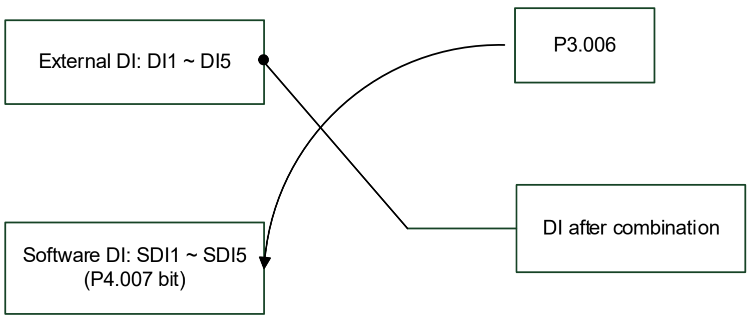
P4.007■	**Multi-function for digital input**		**Hex Address**	**Dec Address**
			040EH 040FH	41039 41040
Default:	0x0	Control mode:	All	
Unit:	-	Setting range:	0–3FFF	
Format:	HEX	Data size:	16-bit	

Settings:

The source of the DI input signal can be the external terminal (DI1–DI10) or the software (SDI1–SDI10 corresponding to Bit 0–8 of P4.007), which is determined by P3.006. If the corresponding bit of P3.006 is 1, which means the source is the software SDI (P4.007); if the corresponding bit is 0, then the source is the hardware DI. See the figure below:



Read parameters: shows the DI status after combining external DI and software DI.

Write parameters: writes the software SDI status. This function is the same whether using the panel or communication to set the parameter.

For example: if the value of P4.007 is 0x0011 then DI1 and DI5 are ON only if P3.006 is also setting these bits to 1. Please refer to P2.010–P2.014 for more information on digital input pins (DI1–DI8).

NOTE: *When using the "Digital IO/Jog Control" window in SureServo2 Pro, the Enable check boxes directly control the bits of P3.006. Toggling the "On/Off" button to the right of the check box will directly control the bits of P4.007.*

P4.008★	**Input status of servo drive panel (read-only)**		**Hex Address**	**Dec Address**
			0410H 0411H	41041 41042
Default:	-	Control mode:	All	
Unit:	-	Setting range:	Read-only	
Format:	HEX	Data size:	16-bit	

Settings:

Use this communication parameter to read and check that the five keys (MODE, UP, DOWN, SHIFT, and SET) can function normally.

P4.009★	**Digital output status (read-only)**		**Hex Address**	**Dec Address**
			0412H 0413H	41043 41044
Default:	-	Control mode:	All	
Unit:	-	Setting range:	0–0x1F	
Format:	HEX	Data size:	16-bit	

Settings:

There is no difference whether reading by panel or through communication.

P4.010 - P4.021	Reserved

P4.022	Analog speed input offset	Hex Address	Dec Address
		042CH 042DH	41069 41070
Default:	0	Control mode:	S
Unit:	mV	Setting range:	-5000 to +5000
Format:	DEC	Data size:	16-bit

Settings:

Manually adjust the offset.

P4.023	Analog torque input offset	Hex Address	Dec Address
		042EH 042FH	41071 41072
Default:	0	Control mode:	T
Unit:	mV	Setting range:	-5000 to +5000
Format:	DEC	Data size:	16-bit

Settings:

Manually adjust the offset.

P4.024★	Level of undervoltage error	Hex Address	Dec Address
		0430H 0431H	41073 41074
Default:	160	Control mode:	All
Unit:	V (rms)	Setting range:	40–380
Format:	DEC	Data size:	16-bit

Settings:

When the voltage of the DC BUS is lower than P4.024* $\sqrt{2}$, the undervoltage alarm occurs. The drive will auto detect the input voltage type, 110V, 230V, or 480V (model dependent), and assign the correct voltage to this parameter.

8.4.6 - P5.xxx Motion control parameters

P5.000★■	Firmware subversion		Hex Address	Dec Address
			0500H 0501H	41281 41282
Default:	Factory setting	Control mode:	All	
Unit:	-	Setting range:	-	
Format:	DEC	Data size:	32-bit	

Settings:

The low byte is the subversion of the firmware. The Firmware main version is located in P0.000

P5.001–P5.002	Reserved

P5.003	Deceleration time for auto-protection		Hex Address	Dec Address
			0506H 0507H	41287 41288
Default:	0xEEEFEEFF	Control mode:	All	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

The parameter setting is divided into D, C, B, A, U, Z, Y, X (hexadecimal), including:

Deceleration time when activating the auto-protection function: OVF (DO.0x11, Position command / feedback overflows), CTO (communication timeout AL020), SPL, SNL, PL, NL

Deceleration time for stop command: STP

Digit	D	C	B	A	U	Z	Y	X
Function	STP	PFQS	CTO	OVF	SNL	SPL	NL	PL
Range	0–F	0–F	0–F	0–F	0–F	0–F	0–F	0–F

Use 0–F to index the deceleration time of P5.020–P5.035. For example: if you set X to A, then the deceleration time of PL is determined by P5.030.

P5.004	Homing methods		Hex Address	Dec Address
			0508H 0509H	41289 41290
Default:	0x0	Control mode:	PR	
Unit:	-	Setting range:	0–0x128	
Format:	HEX	Data size:	16-bit	

Settings:

0000

U Z Y X

X	Homing method	Z	Limit setting
Y	Z pulse setting	U	Reserved

NOTE: *More Homing information can be found in section 7.1.3. It is highly recommended to use the Homing Setting screen of the PR Mode Window in SureServo2 Pro to configure Homing settings.*

Definition of each setting value:

<table>
<tr><th>U</th><th>Z</th><th>Y</th><th>X</th></tr>
<tr><td>Reserved</td><td>Limit setting</td><td>Z pulse setting</td><td>Homing method</td></tr>
<tr><td rowspan="12">-</td><td>0–1</td><td>0–2</td><td>0–A</td></tr>
<tr><td>Not available</td><td rowspan="4">Y = 0: return to Z pulse
Y = 1: go forward to Z pulse
Y = 2: do not look for Z pulse</td><td>X = 0: homing in forward direction and define PL as homing origin</td></tr>
<tr><td>Not available</td><td>X = 1: homing in reverse direction and define NL as homing origin</td></tr>
<tr><td rowspan="6">When the end of travel limit sensor is triggered during homing:
Z=0: show error and stop homing routine
Z=1: reverse direction and continue homing routine</td><td>X = 2: homing in forward direction, ORG: OFF→ON as homing origin</td></tr>
<tr><td>X = 3: homing in reverse direction, ORG: OFF→ON as homing origin</td></tr>
<tr><td rowspan="2">Not available</td><td>X = 4: look for Z pulse in forward direction and define it as homing origin</td></tr>
<tr><td>X = 5: look for Z pulse in reverse direction and define it as homing origin</td></tr>
<tr><td rowspan="2">Y = 0: return to Z pulse
Y = 1: go forward to Z pulse
Y = 2: do not look for Z pulse</td><td>X = 6: homing in forward direction, ORG: ON→OFF as homing origin</td></tr>
<tr><td>X = 7: homing in reverse direction, ORG: ON→OFF as homing origin</td></tr>
<tr><td>Not available</td><td>Not available</td><td>X = 8: define current position as the origin</td></tr>
<tr><td rowspan="2">When the end of travel limit sensor is triggered during homing:
Z=0: show error and stop homing routine
Z=1: reverse direction and continue homing routine</td><td rowspan="2">Y = 0: return to Z pulse
Y = 1: not available
Y = 2: do not look for Z pulse</td><td>X = 9: look for the collision point in forward direction and define it as the origin</td></tr>
<tr><td>X = A: look for the collision point in reverse direction and define it as the origin</td></tr>
</table>

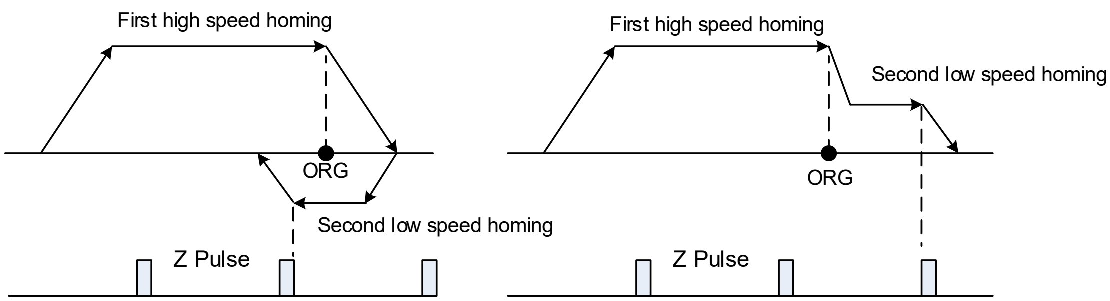
NOTE: *If homing to a hard stop (X = 9 or A), see P1.087 Torque homing - Torque level detection and P1.088 Torque Homing - level reached timer.*

NOTE: *If Homing in FWD direction to the PL (Positive Limit), don't choose "go forward to Z Pulse" after finding the home sensor (the motor can't keep going forward when it is on the PL overtravel sensor).*
If Homing in REV direction to the NL (Negative Limit), don't choose "go forward to Z Pulse" after finding the home sensor (the motor can't keep going forward when it is on the NL overtravel sensor).

P5.005	High speed homing (first speed setting)		Hex Address	Dec Address
			050AH 050BH	41291 41292
Default:	1000	Control mode:	PR (set with P5.004)	
Unit:	0.1 rpm	Setting range:	1–20000	
Format:	DEC	Data size:	32-bit	
Example:	15 = 1.5 rpm			

Settings:

The first speed setting for high speed homing. The left image is for P5.004.Y=0 (Find ORG and Return to find Z). The right image is P5.004.Y=1 (Find ORG and Keep going to find Z).



P5.006	Low speed homing (second speed setting)		Hex Address	Dec Address
			050CH 050DH	41293 41294
Default:	200	Control mode:	PR (set with P5.004)	
Unit:	0.1 rpm	Setting range:	1–5000	
Format:	DEC	Data size:	32-bit	
Example:	150 = 1.5 rpm			

Settings:

The second speed setting for low speed homing.

P5.007■	Trigger Position command (PR mode only)		Hex Address	Dec Address
			050EH 050FH	41295 41296
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	0–1000*	
Format:	DEC	Data size:	16-bit	
** Register "Read back" range = 0–20099*				

Settings:

- *Set P5.007 to 0 to start homing*
- *Set P5.007 to 1–99 to execute the specified PR procedure, which is the same as using DI.CTRG+POSn. You cannot set P5.007 to 100–999 as the value exceeds the valid range*
  Example:
  To trigger PR#2

Method 1	Trigger by DI: Register Position command selection 1–64 Bit1 (DI:0x12) + Trigger command (DI:0x08)
Method 2	By P5.007: Set P5.007 to 2 to start executing PR#2

- *Write 1000 to execute stop command which is the same as DI.STOP.*
  When reading P5.007, if the command is incomplete, the drive reads the current command (1–99). If the command is completed, the drive reads the current command +10000. If the command is completed, DO.TPOS is on, and motor position is reached, the drive reads the current command +20000. Commands triggered by DI are also applicable.
  Example:
  If the value read is 3, it means PR#3 is incomplete. If the value read is 10003, it means PR#3 completed, but the motor has not reached the target position yet. If the value read is 20003, it means PR#3 completed and the motor reached the target position.

NOTE: *Do not use P5.007 with Ethernet/IP Implicit Messaging. This parameter requires bidirectional writing (to send the command and read back status in the same register). Use P5.112 and P5.122 to trigger PR moves with Ethernet/IP Implicit Messaging.*

P5.008	**Forward software limit**		**Hex Address**	**Dec Address**
			0510H 0511H	41297 41298
Default:	2147483647	Control mode:	PR	
Unit:	PUU	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

In PR mode, if the motor rotates in the forward direction and its feedback position exceeds the value of P5.008, AL283 occurs. Manual jog operation will allow the motor to move past the software limits.

P5.009	**Reverse software limit**		**Hex Address**	**Dec Address**
			0512H 0513H	41299 41300
Default:	2147483647	Control mode:	PR	
Unit:	PUU	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

In PR mode, if the motor rotates in the reverse direction and its feedback position exceeds the value of P5.009, AL285 occurs. Manual jog operation will allow the motor to move past the software limits.

P5.010★■	**Data array - Data size**		**Hex Address**	**Dec Address**
			0514H 0515H	41301 41302
Default:	-	Control mode:	All	
Unit:	-	Setting range:	Read-only	
Format:	DEC	Data size:	16-bit	

Settings:

Data size (N x 32 bits) means size N of data array.

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P5.011■	Data array - Address for reading and writing		Hex Address	Dec Address
			0516H 0517H	41303 41304
Default:	0	Control mode:	All	
Unit:	-	Setting range:	0 to (value set by P5.010 minus 1)	
Format:	DEC	Data size:	16-bit	

Settings:

Specify the address in the data array when reading and writing data. Please refer to Chapter 7 for detailed instructions.

P5.012■	Data array–Element Value #1 for reading and writing		Hex Address	Dec Address
			0518H 0519H	41305 41306
Default:	0	Control mode:	All	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Data value #1: when reading the parameter using the panel, the value set by P5.011 does not add 1, but reading or writing by other methods adds 1. Please refer to Chapter 7 Data array for detailed instructions.

P5.013■	Data array–Element Value #2 for reading and writing		Hex Address	Dec Address
			051AH 051BH	41307 41308
Default:	0	Control mode:	All	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

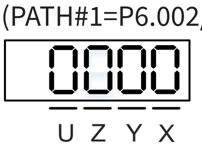
Data value #2: when reading and writing the parameter with the panel or through communication, the value set by P5.011 adds 1, but the panel is write-protected. Please refer to Chapter 7 Data array for detailed instructions.

P5.014	Reserved

P5.015■	PATH#1–PATH#2 Volatile setting		Hex Address	Dec Address
			051EH 051FH	41311 41312
Default:	0x0	Control mode:	PR	
Unit:	-	Setting range:	0x0–0x0011	
Format:	HEX	Data size:	16-bit	

Settings:

This parameter allows you to write data to the target continuously through communication. (PATH#1=P6.002/P6.003, PATH#2=P6.004/P6.005)



X	PATH#1 Volatile setting	UZ	Reserved
Y	PATH#2 Volatile setting		Reserved

- *X: PATH#1 Volatile setting*
  - *0: non-volatile*
  - *1: volatile*
- *Y: PATH#2 Volatile setting*
  - *0: non-volatile*
  - *1: volatile*

P5.016■	***Axis position–Motor encoder***			***Hex Address***	***Dec Address***
				0520H 0521H	41313 41314
Default:	0	Control mode:	All		
Unit:	PUU	Setting range:	-2147483648 to +2147483647		
Format:	DEC	Data size:	32-bit		

Settings:

- *Read: feedback position of the motor encoder, which is the monitoring variable 000 (00h) + offset value.*
- *Write: you can write any value to the parameter, and it will neither change monitoring variable 000 (00h) nor affect the positioning coordinate system. It is only for observation when adjusting the offset value.*

P5.017	***Axis position–Auxiliary encoder (CN5)***			***Hex Address***	***Dec Address***
				0522H 0523H	41315 41316
Default:	0	Control mode:	All		
Unit:	Pulse number	Setting range:	-2147483648 to +2147483647		
Format:	DEC	Data size:	32-bit		

Settings:

Pulse count from the auxiliary encoder (linear scale).

P5.018	***Axis position–Pulse command***			***Hex Address***	***Dec Address***
				0524H 0525H	41317 41318
Default:	0	Control mode:	All		
Unit:	Pulse number	Setting range:	-2147483648 to +2147483647		
Format:	DEC	Data size:	32-bit		

Settings:

Pulse count from the pulse command.

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P5.019	E-Cam curve scaling		Hex Address	Dec Address
			0526H 0527H	41319 41320
Default:	1.000000	Control mode:	PR	
Unit:	0.000001 times, which is 1 / (10^6)	Setting range:	-2147.000000 to +2147.000000	
Format:	DEC	Data size:	32-bit	
Example:	1.100000 = 1.1 times			

Settings:

Use this parameter to magnify or reduce the magnitude of the E-Cam table without changing its value.

Example: if the data in the table is 0, 10, 20, 30, 40, 20, then setting P5.019=2.000000 will cause the E-Cam table to run values 0, 20, 40, 60, 80.

This enables the operation of E-Cam change amplitutde with the same pulse frequency of the master axis.

Magnification enlarges the path within the same time envelope and therfore proportionally increases the speed.

Notes:

This parameter can be set at any time, but the time when it becomes effective is determined by P5.088.X[Bit2].

P5.020	Acceleration / deceleration time (Number #0)		Hex Address	Dec Address
			0528H 0529H	41321 41322
Default:	200	Control mode:	PR	
Unit:	ms	Setting range:	1–65500	
Format:	DEC	Data size:	16-bit	

Settings:

The duration of acceleration and deceleration in PR mode, which is the length of time to accelerate from 0 to 3000 rpm. These accel/decel times are used in the PR mode paths in parameters 6.01 through 7.99.

P5.021	Acceleration / deceleration time (Number #1)		Hex Address	Dec Address
			052AH 052BH	41323 41324
Default:	300	Control mode:	PR	
Unit:	ms	Setting range:	1–65500	
Format:	DEC	Data size:	16-bit	

Settings:

Please refer to P5.020 for the acceleration / deceleration time in PR mode.

P5.022	Acceleration / deceleration time (Number #2)		Hex Address	Dec Address
			052CH 052DH	41325 41326
Default:	500	Control mode:	PR	
Unit:	ms	Setting range:	1–65500	
Format:	DEC	Data size:	16-bit	

Settings:

Please refer to P5.020 for the acceleration / deceleration time in PR mode.

P5.023	Acceleration / deceleration time (Number #3)		Hex Address	Dec Address
			052EH 052FH	41327 41328
Default:	600	Control mode:	PR	
Unit:	ms	Setting range:	1–65500	
Format:	DEC	Data size:	16-bit	

Settings:

Please refer to P5.020 for the acceleration / deceleration time in PR mode.

P5.024	Acceleration / deceleration time (Number #4)		Hex Address	Dec Address
			0530H 0531H	41329 41330
Default:	800	Control mode:	PR	
Unit:	ms	Setting range:	1–65500	
Format:	DEC	Data size:	16-bit	

Settings:

Please refer to P5.020 for the acceleration / deceleration time in PR mode.

P5.025	Acceleration / deceleration time (Number #5)		Hex Address	Dec Address
			0532H 0533H	41331 41332
Default:	900	Control mode:	PR	
Unit:	ms	Setting range:	1–65500	
Format:	DEC	Data size:	16-bit	

Settings:

Please refer to P5.020 for the acceleration / deceleration time in PR mode.

P5.026	Acceleration / deceleration time (Number #6)		Hex Address	Dec Address
			0534H 0535H	41333 41334
Default:	1000	Control mode:	PR	
Unit:	ms	Setting range:	1–65500	
Format:	DEC	Data size:	16-bit	

Settings:

Please refer to P5.020 for the acceleration / deceleration time in PR mode.

P5.027	Acceleration / deceleration time (Number #7)		Hex Address	Dec Address
			0536H 0537H	41335 41336
Default:	1200	Control mode:	PR	
Unit:	ms	Setting range:	1–65500	
Format:	DEC	Data size:	16-bit	

Settings:

Please refer to P5.020 for the acceleration / deceleration time in PR mode.

P5.028	**Acceleration / deceleration time (Number #8)**		**Hex Address**	**Dec Address**
			0538H 0539H	41337 41338
Default:	1500	Control mode:	PR	
Unit:	ms	Setting range:	1–65500	
Format:	DEC	Data size:	16-bit	

Settings:

Please refer to P5.020 for the acceleration / deceleration time in PR mode.

P5.029	**Acceleration / deceleration time (Number #9)**		**Hex Address**	**Dec Address**
			053AH 053BH	41339 41340
Default:	2000	Control mode:	PR	
Unit:	ms	Setting range:	1–65500	
Format:	DEC	Data size:	16-bit	

Settings:

Please refer to P5.020 for the acceleration / deceleration time in PR mode.

P5.030	**Acceleration / deceleration time (Number #10)**		**Hex Address**	**Dec Address**
			053CH 053DH	41341 41342
Default:	2500	Control mode:	PR	
Unit:	ms	Setting range:	1–65500	
Format:	DEC	Data size:	16-bit	

Settings:

Please refer to P5.020 for the acceleration / deceleration time in PR mode.

P5.031	**Acceleration / deceleration time (Number #11)**		**Hex Address**	**Dec Address**
			053EH 053FH	41343 41344
Default:	3000	Control mode:	PR	
Unit:	ms	Setting range:	1–65500	
Format:	DEC	Data size:	16-bit	

Settings:

Please refer to P5.020 for the acceleration / deceleration time in PR mode.

P5.032	**Acceleration / deceleration time (Number #12)**		**Hex Address**	**Dec Address**
			0540H 0541H	41345 41346
Default:	5000	Control mode:	PR	
Unit:	ms	Setting range:	1–65500	
Format:	DEC	Data size:	16-bit	

Settings:

Please refer to P5.020 for the acceleration / deceleration time in PR mode.

P5.033	**Acceleration / deceleration time (Number #13)**		**Hex Address**	**Dec Address**
			0542H 0543H	41347 41348
Default:	8000	Control mode:	PR	
Unit:	ms	Setting range:	1–65500	
Format:	DEC	Data size:	16-bit	

Settings:

Please refer to P5.020 for the acceleration / deceleration time in PR mode.

P5.034	**Acceleration / deceleration time (Number #14)**		**Hex Address**	**Dec Address**
			0544H 0545H	41349 41350
Default:	50	Control mode:	PR	
Unit:	ms	Setting range:	1–1500	
Format:	DEC	Data size:	16-bit	

Settings:

This parameter is for the deceleration time for auto protection, and the default value of this is small (shorter deceleration time).

P5.035	**Acceleration / deceleration time (Number #15)**		**Hex Address**	**Dec Address**
			0546H 0547H	41351 41352
Default:	30	Control mode:	PR	
Unit:	ms	Setting range:	1–1200	
Format:	DEC	Data size:	16-bit	

Settings:

This parameter is for the deceleration time for auto protection, and the default value of this is small (shorter deceleration time).

P5.036	**Capture - Start address of data array**		**Hex Address**	**Dec Address**
			0548H 0549H	41353 41354
Default:	0	Control mode:	All	
Unit:	-	Setting range:	0 to (value set by P5.010 minus 1)	
Format:	DEC	Data size:	16-bit	

Settings:

The first data point is Captured, it is saved at this address for the data array. Please note that this parameter is only writable when Capture is disabled (P5.039, X bit 0 = 0).

P5.037■	Capture - Axis position		Hex Address	Dec Address
			054AH 054BH	41355 41356
Default:	0	Control mode:	All	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Displays the axis position of Capture pulse source. Please note that this parameter is only writable when Capture stops (please refer to P5.039). If the source is the main encoder, this parameter is write-protected and the Capture axis position is the feedback position of the motor (monitoring variable 00h).

P5.038■	Number of Times to Capture		Hex Address	Dec Address
			054CH 054DH	41357 41358
Default:	1	Control mode:	All	
Unit:	-	Setting range:	1 to (value set by P5.010 minus value set by P5.036)	
Format:	DEC	Data size:	16-bit	

Settings:

When Capture stops, this parameter indicates the number of data elements in the array expected to be captured (readable and writable). When Capture activates, this parameter indicates the remaining number of data elements to be captured (read-only); each time an element is captured, the value of P5.038 decrements by one until the value is 0. Once P5.038 reaches 0 it indicates that the Capture Cycle is complete.

NOTE: *The total number of data elements from Compare, Capture, and E-Cam cannot exceed 800.*

P5.039■	Capture - Activate CAP control		Hex Address	Dec Address
			054EH 054FH	41359 41360
Default:	0x2010	Control mode:	All	
Unit:	-	Setting range:	0x0000–0xF13F	
Format:	HEX	Data size:	16-bit	

Settings:

0000

U Z Y X

X	Capture setting	Z	Triggering logic
Y	Axis source of Capture	U	Trigger minimum interval

- *X: Capture setting*

bit	3	2	1	0
X function	Execute PR when finishing capturing	After capturing the first data, activate Compare	Reset position after first data	Activate Capture
Description	Execute PR#50 when finishing Capture. This will not execute when in cycle mode (P1.019.X=1)	Invalid when Compare is activated	After capturing the first data, reset the position coordinate	Start capturing when set to 1; after finishing capturing, this bit is cleared automatically. Before enabling this bit when using a sequential path group, be sure to add a 1ms delay prior to the path that sets this bit.

- *Y: axis source of Capture*
  - *0: Capture is disabled*
  - *1: AUX ENC (CN5)*
  - *2: Pulse command (CN1)*
  - *3: Main encoder (CN2)*

NOTE: *When the source of Compare is the Capture axis, the source Y of Capture cannot be changed.*

- *Z: triggering logic*
  - *0: NO (normally open). Use this option when needing to detect a black mark on a white background.*
  - *1: NC (normally closed). Use this option when needing to detect a white mark on a black background.*
- *U: trigger minimum interval (unit: ms)*

NOTE: *When P5.039.X (bit 0) = 1, the Capture feature is enabled and DI7 is automatically assigned as the High Speed Capture input. Please refer to Chapter 7 for detailed instructions.*

P5.040	Delay time after position reached (Number #0)		Hex Address	Dec Address
			0550H 0551H	41361 41362
Default:	0	Control mode:	PR	
Unit:	ms	Setting range:	0–32767	
Format:	DEC	Data size:	16-bit	

Settings:

The first delay time of PR mode.

P5.041	Delay time after position reached (Number #1)		Hex Address	Dec Address
			0552H 0553H	41363 41364
Default:	100	Control mode:	PR	
Unit:	ms	Setting range:	0–32767	
Format:	DEC	Data size:	16-bit	

Settings:

The second delay time of PR mode.

P5.042	Delay time after position reached (Number #2)		Hex Address	Dec Address
			0554H 0555H	41365 41366
Default:	200	Control mode:	PR	
Unit:	ms	Setting range:	0–32767	
Format:	DEC	Data size:	16-bit	

Settings:

The third delay time of PR mode.

P5.043	Delay time after position reached (Number #3)		Hex Address	Dec Address
			0556H 0557H	41367 41368
Default:	400	Control mode:	PR	
Unit:	ms	Setting range:	0–32767	
Format:	DEC	Data size:	16-bit	

Settings:

The fourth delay time of PR mode.

P5.044	Delay time after position reached (Number #4)		Hex Address	Dec Address
			0558H 0559H	41369 41370
Default:	500	Control mode:	PR	
Unit:	ms	Setting range:	0–32767	
Format:	DEC	Data size:	16-bit	

Settings:

The fifth delay time of PR mode.

P5.045	Delay time after position reached (Number #5)		Hex Address	Dec Address
			055AH 055BH	41371 41372
Default:	800	Control mode:	PR	
Unit:	ms	Setting range:	0–32767	
Format:	DEC	Data size:	16-bit	

Settings:

The sixth delay time of PR mode.

P5.046	Delay time after position reached (Number #6)		Hex Address	Dec Address
			055CH 055DH	41373 41374
Default:	1000	Control mode:	PR	
Unit:	ms	Setting range:	0–32767	
Format:	DEC	Data size:	16-bit	

Settings:

The seventh delay time of PR mode.

P5.047	Delay time after position reached (Number #7)		Hex Address	Dec Address
			055EH 055FH	41375 41376
Default:	1500	Control mode:	PR	
Unit:	ms	Setting range:	0–32767	
Format:	DEC	Data size:	16-bit	

Settings:

The eighth delay time of PR mode.

P5.048	Delay time after position reached (Number #8)		Hex Address	Dec Address
			0560H 0561H	41377 41378
Default:	2000	Control mode:	PR	
Unit:	ms	Setting range:	0–32767	
Format:	DEC	Data size:	16-bit	

Settings:

The ninth delay time of PR mode.

P5.049	Delay time after position reached (Number #9)		Hex Address	Dec Address
			0562H 0563H	41379 41380
Default:	2500	Control mode:	PR	
Unit:	ms	Setting range:	0–32767	
Format:	DEC	Data size:	16-bit	

Settings:

The tenth delay time of PR mode.

P5.050	Delay time after position reached (Number #10)		Hex Address	Dec Address
			0564H 0565H	41381 41382
Default:	3000	Control mode:	PR	
Unit:	ms	Setting range:	0–32767	
Format:	DEC	Data size:	16-bit	

Settings:

The eleventh delay time of PR mode.

P5.051	Delay time after position reached (Number #11)		Hex Address	Dec Address
			0566H 0567H	41383 41384
Default:	3500	Control mode:	PR	
Unit:	ms	Setting range:	0–32767	
Format:	DEC	Data size:	16-bit	

Settings:

The twelfth delay time of PR mode.

P5.052	Delay time after position reached (Number #12)		Hex Address	Dec Address
			0568H 0569H	41385 41386
Default:	4000	Control mode:	PR	
Unit:	ms	Setting range:	0–32767	
Format:	DEC	Data size:	16-bit	

Settings:

The thirteenth delay time of PR mode.

P5.053	Delay time after position reached (Number #13)		Hex Address	Dec Address
			056AH 056BH	41387 41388
Default:	4500	Control mode:	PR	
Unit:	ms	Setting range:	0–32767	
Format:	DEC	Data size:	16-bit	

Settings:

The fourteenth delay time of PR mode.

P5.054	Delay time after position reached (Number #14)		Hex Address	Dec Address
			056CH 056DH	41389 41390
Default:	5000	Control mode:	PR	
Unit:	ms	Setting range:	0–32767	
Format:	DEC	Data size:	16-bit	

Settings:

The fifteenth delay time of PR mode.

P5.055	Delay time after position reached (Number #15)		Hex Address	Dec Address
			056EH 056FH	41391 41392
Default:	5500	Control mode:	PR	
Unit:	ms	Setting range:	0–32767	
Format:	DEC	Data size:	16-bit	

Settings:

The sixteenth delay time of PR mode.

P5.056	Compare - Start address of data array		Hex Address	Dec Address
			0570H 0571H	41393 41394
Default:	50	Control mode:	All	
Unit:	-	Setting range:	0 to (value of P5.010 minus 1)	
Format:	DEC	Data size:	16-bit	

Settings:

The address of data array where the first Compare data is saved. Please note that this parameter is only writable when Compare stops (please refer to P5.059).

P5.057■	Compare - Axis position		Hex Address	Dec Address
			0572H 0573H	41395 41396
Default:	0	Control mode:	All	
Unit:	Pulse from Compare axis	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Displays the axis position of the Compare pulse source. Please note that this parameter is only writable when Compare stops (please refer to P5.059).

Notes:

1) This parameter is write-protected when the source of Compare axis is the Capture axis (P5.059.Y = 0).
2) When the Compare axis source is the Main Encoder, P5.057 is also write-protected. The pulse resolution is determined by P1.046. When you set P5.059.Y to the Main Encoder, this parameter is set to the feedback position of the motor (monitoring variable 00h). When the motor feedback position is redefined due to homing or Capture, the value will be different from the parameter value. In this case, set P5.059.Y to 0, then set P5.059.Y to 3, to reset the parameter to the motor feedback position.

P5.058■	Compare - Remaining Counts		Hex Address	Dec Address
			0574H 0575H	41397 41398
Default:	1	Control mode:	All	
Unit:	-	Setting range:	1 to (value set by P5.010 minus value set by P5.056)	
Format:	DEC	Data size:	16-bit	

Settings:

When Compare is not in operation, the parameter indicates the number of data elements in the array expected to be compared (readable and writable). When Compare is in operation, this parameter indicates the remaining number of data elements to be compared. Each time it compares one data element, the value of P5.058 decrements by one until the value is 0 indicating that comparing is completed (read-only).

P5.059■	Compare - Activate CMP control		Hex Address	Dec Address
			0576H 0577H	41399 41400
Default:	0x00640010	Control mode:	All	
Unit:	-	Setting range:	0x00010000–0x0FFF313F	
Format:	HEX	Data size:	32-bit	

Settings:

h052A   L0020

D CBA   U Z Y X

h	High Word	L	Low Word
CBA	Duration of pulse output (unit: 1 ms)	X	Compare setting
D	N/A	Y	Compare axis source
-	-	Z	Triggering logic
-	-	U	Trigger PR

- *X: Compare setting*

bit	3	2	1	0
X function	Compare axis position returns to 0	After finishing comparing, activate Capture	Cycle mode	Activate Compare
Description	As soon as the last data is compared, Compare axis position (P5.057) returns to 0	Invalid when Capture is activated	Does not stop	Start comparing when set to 1; after finishing comparing, this bit is cleared automatically

- *Y: Compare axis source*
  - *0: when selecting Capture axes, the source of CAP cannot be changed*
  - *1: AUX ENC (CN5)*
  - *2: Pulse command (CN1)*
  - *3: Main encoder (CN2)*

NOTE: *When the source of Compare is Capture axis, the source Y of Capture cannot be changed.*

- *Z: triggering logic*
  - *0: NO (normally open)*
  - *1: NC (normally closed)*
- *U: trigger PR*

bit	3	2	1	0
U function	-	-	-	Trigger PR
Description	-	-	-	When you set this bit to 1, PR#45 is triggered after the last compare is completed

- *CBA: duration of pulse output (unit: 1 ms). Ensure the next position value to be captured is outside the pulse width value here. If DO4 is still active high when the next position in the array is met then the drive will not acknowledge that position for comparison.*

NOTE: *Please refer to Chapter 7 for detailed instructions.*

P5.060	Target speed setting #0			Hex Address	Dec Address
				0578H 0579H	41401 41402
Operation interface:	Panel / software	Communication	Control mode:	PR	
Default:	20.0	200	Data size:	16-bit	
Unit:	1 rpm	0.1 rpm			
Setting range:	0.0–6000.0	0–60000			
Format:	DEC		-	-	
Example:	15 = 15 rpm	150 = 15 rpm	-	-	

Settings:

First target speed of PR mode. Used in Point to point moves and Index position moves.

P5.061	Target speed setting #1			Hex Address	Dec Address
				057AH 057BH	41403 41404
Operation interface:	Panel / software	Communication	Control mode:	PR	
Default:	50.0	500	Data size:	16-bit	
Unit:	1 rpm	0.1 rpm			
Setting range:	0.0–6000.0	0–60000			
Format:	DEC		-	-	
Example:	1 = 1 rpm	10 = 1 rpm	-	-	

Settings:

Second target speed of PR mode.

P5.062	Target speed setting #2			Hex Address	Dec Address
				057CH 057DH	41405 41406
Operation interface:	Panel / software	Communication	Control mode:	PR	
Default:	100.0	1000	Data size:	16-bit	
Unit:	1 rpm	0.1 rpm			
Setting range:	0.0–6000.0	0–60000			
Format:	DEC		-	-	
Example:	1 = 1 rpm	10 = 1 rpm	-	-	

Settings:

Third target speed of PR mode.

P5.063	***Target speed setting #3***			**Hex Address**	**Dec Address**
				057EH 057FH	41407 41408
Operation interface:	Panel / software	Communication	Control mode:	PR	
Default:	200.0	2000	Data size:	16-bit	
Unit:	1 rpm	0.1 rpm			
Setting range:	0.0–6000.0	0–60000			
Format:	DEC		-	-	
Example:	1 = 1 rpm	10 = 1 rpm	-	-	

Settings:

Fourth target speed of PR mode.

P5.064	***Target speed setting #4***			**Hex Address**	**Dec Address**
				0580H 0581H	41409 41410
Operation interface:	Panel / software	Communication	Control mode:	PR	
Default:	300.0	3000	Data size:	16-bit	
Unit:	1 rpm	0.1 rpm			
Setting range:	0.0–6000.0	0–60000			
Format:	DEC		-	-	
Example:	1 = 1 rpm	10 = 1 rpm	-	-	

Settings:

Fifth target speed of PR mode.

P5.065	***Target speed setting #5***			**Hex Address**	**Dec Address**
				0582H 0583H	41411 41412
Operation interface:	Panel / software	Communication	Control mode:	PR	
Default:	500.0	5000	Data size:	16-bit	
Unit:	1 rpm	0.1 rpm			
Setting range:	0.0–6000.0	0–60000			
Format:	DEC		-	-	
Example:	1 = 1 rpm	10 = 1 rpm	-	-	

Settings:

Sixth target speed of PR mode.

P5.066	Target speed setting #6			Hex Address	Dec Address
				0584H 0585H	41413 41414
Operation interface:	Panel / software	Communication	Control mode:	PR	
Default:	600.0	6000	Data size:	16-bit	
Unit:	1 rpm	0.1 rpm			
Setting range:	0.0–6000.0	0–60000			
Format:	DEC		-	-	
Example:	1 = 1 rpm	10 = 1 rpm	-	-	

Settings:

Seventh target speed of PR mode.

P5.067	Target speed setting #7			Hex Address	Dec Address
				0586H 0587H	41415 41416
Operation interface:	Panel / software	Communication	Control mode:	PR	
Default:	800.0	8000	Data size:	16-bit	
Unit:	1 rpm	0.1 rpm			
Setting range:	0.0–6000.0	0–60000			
Format:	DEC		-	-	
Example:	1 = 1 rpm	10 = 1 rpm	-	-	

Settings:

Eighth target speed of PR mode.

P5.068	Target speed setting #8			Hex Address	Dec Address
				0588H 0589H	41417 41418
Operation interface:	Panel / software	Communication	Control mode:	PR	
Default:	1000.0	10000	Data size:	16-bit	
Unit:	1 rpm	0.1 rpm			
Setting range:	0.0–6000.0	0–60000			
Format:	DEC		-	-	
Example:	1 = 1 rpm	10 = 1 rpm	-	-	

Settings:

Ninth target speed of PR mode.

P5.069	***Target speed setting #9***			***Hex Address***	***Dec Address***
				058AH 058BH	41419 41420
Operation interface:	Panel / software	Communication	Control mode:	PR	
Default:	1300.0	13000	Data size:	16-bit	
Unit:	1 rpm	0.1 rpm			
Setting range:	0.0–6000.0	0–60000			
Format:	DEC		-	-	
Example:	1 = 1 rpm	10 = 1 rpm	-	-	

Settings:

Tenth target speed of PR mode.

P5.070	***Target speed setting #10***			***Hex Address***	***Dec Address***
				058CH 058DH	41421 41422
Operation interface:	Panel / software	Communication	Control mode:	PR	
Default:	1500.0	15000	Data size:	16-bit	
Unit:	1 rpm	0.1 rpm			
Setting range:	0.0–6000.0	0–60000			
Format:	DEC		-	-	
Example:	1 = 1 rpm	10 = 1 rpm	-	-	

Settings:

Eleventh target speed of PR mode.

P5.071	***Target speed setting #11***			***Hex Address***	***Dec Address***
				058EH 058FH	41423 41424
Operation interface:	Panel / software	Communication	Control mode:	PR	
Default:	1800.0	18000	Data size:	16-bit	
Unit:	1 rpm	0.1 rpm			
Setting range:	0.0–6000.0	0–60000			
Format:	DEC		-	-	
Example:	1 = 1 rpm	10 = 1 rpm	-	-	

Settings:

Twelfth target speed of PR mode.

P5.072	Target speed setting #12			Hex Address	Dec Address
				0590H 0591H	41425 41426
Operation interface:	Panel / software	Communication	Control mode:	PR	
Default:	2000.0	20000	Data size:	16-bit	
Unit:	1 rpm	0.1 rpm			
Setting range:	0.0–6000.0	0–60000			
Format:	DEC		-	-	
Example:	1 = 1 rpm	10 = 1 rpm	-	-	

Settings:

Thirteenth target speed of PR mode.

P5.073	Target speed setting #13			Hex Address	Dec Address
				0592H 0593H	41427 41428
Operation interface:	Panel / software	Communication	Control mode:	PR	
Default:	2300.0	23000	Data size:	16-bit	
Unit:	1 rpm	0.1 rpm			
Setting range:	0.0–6000.0	0–60000			
Format:	DEC		-	-	
Example:	1 = 1 rpm	10 = 1 rpm	-	-	

Settings:

Fourteenth target speed of PR mode.

P5.074	Target speed setting #14			Hex Address	Dec Address
				0594H 0595H	41429 41430
Operation interface:	Panel / software	Communication	Control mode:	PR	
Default:	2500.0	25000	Data size:	16-bit	
Unit:	1 rpm	0.1 rpm			
Setting range:	0.0–6000.0	0–60000			
Format:	DEC		-	-	
Example:	1 = 1 rpm	10 = 1 rpm	-	-	

Settings:

Fifteenth target speed of PR mode.

Wiring Parameters DI/DO Codes Monitoring Alarms

P5.075	Target speed setting #15			Hex Address	Dec Address
				0596H 0597H	41431 41432
Operation interface:	Panel / software	Communication	Control mode:	PR	
Default:	3000.0	30000	Data size:	16-bit	
Unit:	1 rpm	0.1 rpm			
Setting range:	0.0–6000.0	0–60000			
Format:	DEC		-	-	
Example:	1 = 1 rpm	10 = 1 rpm	-	-	

Settings:

Sixteenth target speed of PR mode.

P5.076	Capture - Reset position after first data		Hex Address	Dec Address
			0598H 0599H	41433 41434
Default:	0	Control mode:	All	
Unit:	Unit from Capture source	Setting range:	-1073741824 to +1073741823	
Format:	DEC	Data size:	32-bit	

Settings:

If the position reset function is enabled (P5.039.X [Bit1] = 1), after the first position data is captured, the servo resets the coordinates of the first point, which is defined by this parameter.

P5.077 – P5.080	Reserved

P5.081	E-Cam: start address for data array		Hex Address	Dec Address
			05A2H 05A3H	41443 41444
Default:	100	Control mode:	PR	
Unit:	-	Setting range:	0 to (800 minus value set by P5.082)	
Format:	DEC	Data size:	16-bit	

Settings:

The first piece of data in the E-Cam table is saved at the address of the data array. This parameter can be set at any time, but will be effective only when status changes from pre-engaged to engaged.

P5.082	E-Cam: total segment number N		Hex Address	Dec Address
			05A4H 05A5H	41445 41446
Default:	5	Control mode:	PR	
Unit:	-	Setting range:	5–720	
Format:	DEC	Data size:	16-bit	

Settings:

Indicates that the E-Cam curve is divided into N segments, and the table includes N+1 data. This parameter is only writable when E-Cam stops (please refer to P5.088.X [Bit0] = 0). Its range must be smaller than or equal to P5.010 minus P5.081, and P5.082 x P5.084 must be smaller than or equal to 2147483647. The number of segments in P5.082 will equal 360 degrees if P5.083=1.

P5.083	E-Cam: Master gear ratio setting - Cycle number (M)		Hex Address	Dec Address
			05A6H 05A7H	41447 41448
Default:	1	Control mode:	PR	
Unit:	-	Setting range:	1–32767	
Format:	DEC	Data size:	16-bit	

Settings:

When receiving the pulse number defined by P5.084 from the master axis, E-Cam rotates the number of cycles defined by P5.083. If P5.083 = 1 (one cycle of the E-Cam table is completed in one 360° cam cycle). If P5.083 = 2 (two cycles of the E-Cam table are completed in one 360° cam cycle. This parameter is only writable when E-Cam stops (P5.088.X [Bit0] = 0).

P5.084	E-Cam: Master gear ratio setting - Pulse number (P)		Hex Address	Dec Address
			05A8H 05A9H	41449 41450
Default:	3600	Control mode:	PR	
Unit:	-	Setting range:	10–1073741823	
Format:	DEC	Data size:	32-bit	

Settings:

When receiving the pulse number defined by P5.084 from the master axis, E-Cam rotates the number of cycles defined by P5.083. If P5.083 = 1 (one cycle of the E-Cam table is completed in one 360° Cam cycle). This parameter can be modified at any time. Its range must be the value of P5.082 x P5.083 smaller than or equal to P5.084, and P5.082 x P5.084 must be smaller than or equal to 2147483647.

P5.085	E-Cam: engaged segment number		Hex Address	Dec Address
			05AAH 05ABH	41451 41452
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	0 to (setting value of P5.082 minus 1)	
Format:	DEC	Data size:	16-bit	

Settings:

The segment number of the E-Cam table when the E-Cam is engaged.

P5.086■	**E-Cam: Master axis position**		**Hex Address**	**Dec Address**
			05ACH 05ADH	41453 41454
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Position counter of the E-Cam Master. This parameter is only writable when E-Cam stops (please refer to P5.088.X [Bit0] =0). P5.086 allows the master axis position to be set and monitored from here and can be written in before E-Cam has engaged. Since the moving distance of master axis remains unchanged, changing the value of P5.086 will not change the position of slave axis.

P5.087	**E-Cam: Lead pulse before engaged**		**Hex Address**	**Dec Address**
			05AEH 05AFH	41455 41456
Default:	0	Control mode:	PR	
Unit:	Unit from master axis	Setting range:	-1073741824 to +1073741823	
Format:	DEC	Data size:	32-bit	

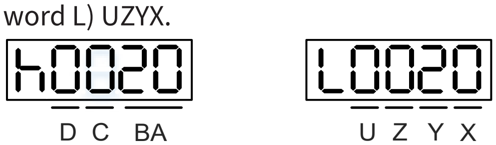
Settings:

When the condition to engage E-Cam (P5.088.Z) is met, the pulse number from the master axis has to exceed the value of this parameter for the E-Cam to fully engage. During this lead pulse period the drive is in a pre-engage state P5.088.D=2.

P5.088■	**E-Cam: activate E-Cam control**		**Hex Address**	**Dec Address**
			05B0H 05B1H	41457 41458
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x0–0x203FF257	
Format:	HEX	Data size:	32-bit	

Settings:

See section 7.3.1 for more information. Format of this parameter: (High word h) DCBA : (Low word L) UZYX.



BA	PR path to execute	X	Activation setting of E-Cam function
C	Reserved	Y	Command source for the master axis
D	E-Cam status display	Z	Engaging condition
-	-	U	Disengaging condition

Definition as follows:

- *X: E-Cam command*
  Description of each bit:

Bit	Function	Description
0	E-Cam activation	0: E-Cam is disabled 1: E-Cam is enabled (relevant parameters cannot be modified once E-Cam is enabled), therefore set this bit after all other E-CAM settings have been configured.
1	E-Cam does not disengage when servo is off	0: when the servo is stopped by alarm or servo is off, the clutch disengages 1: when the servo stops because of alarm or servo is off, the clutch can remain engaged. When the servo switches to on again, E-Cam can operate directly. It can return to the correct E-Cam position by macro #D.
2	P5.019 is effective immediately	0: P5.019 is effective after next engagement 1: P5.019 is effective immediately
3	Reserved	-

- *Y: command source signal of master axis*
  - *0: capture axis*
  - *1: auxiliary encoder (CN5)*
  - *2: pulse command (CN1)*
  - *3: PR command*
  - *4: time axis (1 ms)*
  - *5: reserved*
  - *6: analog channel 1 (Virtual axis, Unit: 1M pulse/s per 10V)*
- *Z: engaging time*
  - *0: immediately*
  - *1: trigger DI.CAM*
  - *2: Capture Trigger (DI7)*
- *U: disengaging condition (2, 4, and 6 cannot be selected at the same time)*

P5.088.U value	Clutch disengagement condition	System status after disengagement
0	Condition 0: remains engaged unless E-cam function is disabled	-
1	Condition 1: DI.CAM Off. Disengages when DI (DI: 0x36) is off	0: stop
2	Condition 2: disengages when the master axis pulse number reaches the setting value of P5.089, and the slave axis stops immediately (sign indicates the direction). If P5.088.Z bit 0=1 then the E-Cam will re-engage immediately.	0: stop
4	Condition 4: disengages when the master axis pulse number reaches the setting value of P5.089 and the master and slave axes enters the cyclic mode. When the pre-engaged pulse number for each cycle (P5.092) is reached, the clutch re-engages	2: pre-engage
6	Condition 6: disengages when the master axis pulse number reaches the setting value of P5.089, and the slave axis decelerates to stop	0: stop
8	Condition 8: set other disengagement conditions first, and the E-Cam function is disabled after the clutch disengages	-

- *BA: auto execute the specified PR path*
  When disengaging condition (P5.088.U = 2, 4, 6) is met, a PR 00–3F (hexadecimal; 00 means no action) is executed automatically. If the PR path is still running and the E-Cam is disabled then the PR path set is still executed.

Wiring Parameters DI/DO Codes Monitoring Alarms

- *C: reserved*
- *D: display engage status (Read-only)*
  - *0: stop status*
  - *1: engage status*
  - *2: pre-engage status*

P5.089	***E-Cam: data of disengaging time***		***Hex Address***	***Dec Address***
			05B2H 05B3H	41459 41460
Default:	0	Control mode:	PR	
Unit:	Unit for by master axis	Setting range:	-1073741824 to +1073741823	
Format:	DEC	Data size:	32-bit	

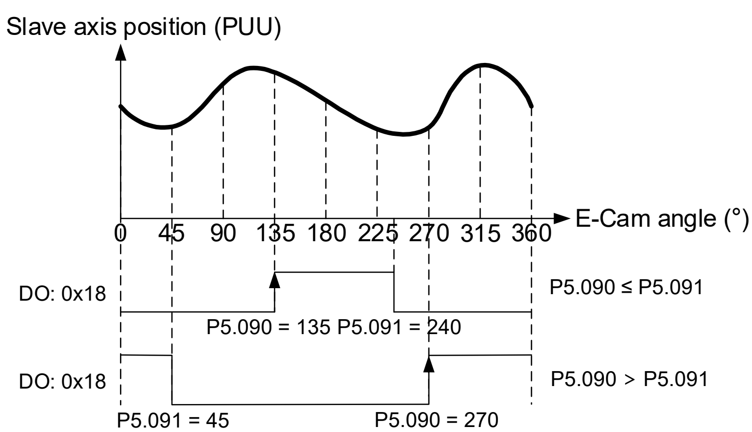
Settings:

When the pulse number of the master axis reaches the value set by P5.089, the clutch disengages based on the disengage timing setting (P5.088.U).

P5.090	***E-Cam: DO.CAM_Area rising-edge phase***		***Hex Address***	***Dec Address***
			05B4H 05B5H	41461 41462
Default:	270	Control mode:	PR	
Unit:	Degree	Setting range:	0–360	
Format:	DEC	Data size:	16-bit	

Settings:

See the correlation between DO.CAM_Area and parameters in the figure below.
When E-Cam is disengaged, DO.CAM_Area is always off. P2.078 and P2.079 represent a second window that can be used for a different DO (0x1A).



P5.091	***E-Cam: DO.CAM_Area falling-edge phase***		***Hex Address***	***Dec Address***
			05B6H 05B7H	41463 41464
Default:	360	Control mode:	PR	
Unit:	Degree	Setting range:	0–360	
Format:	DEC	Data size:	16-bit	

Settings:

Please refer to P5.090 for the correlation between DO.CAM_Area and parameters.

P5.092	E-Cam: pre-engaged length for each cycle		Hex Address	Dec Address
			05B8H 05B9H	41465 41466
Default:	0	Control mode:	PR	
Unit:	Unit from master axis	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

This parameter goes with the selection of P5.088.U = 4 (E-Cam disengages if it exceeds the moving distance): after disengaging, it does not enter stop status, but instead enters pre-engaged status. The lead pulse is determined by this parameter. The pulse number from the master axis has to exceed the value of this parameter for the E-Cam to engage again.

P5.093	Motion control macro command: command parameter #4		Hex Address	Dec Address
			05BAH 05BBH	41467 41468
Default:	0	Control mode:	All	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Before executing the macro command, you must set the relevant parameter #4 in advance. The function of the parameter is determined by the macro command. Not every macro command requires this parameter.

P5.094	Motion control macro command: command parameter #3		Hex Address	Dec Address
			05BCH 05BDH	41469 41470
Default:	0	Control mode:	All	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Before executing the macro command, you must set the relevant parameter #3 in advance. The function of the parameter is determined by the macro command. Not every macro command requires this parameter.

P5.095	Motion control macro command: command parameter #2		Hex Address	Dec Address
			05BEH 05BFH	41471 41472
Default:	0	Control mode:	All	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Before executing the macro command, you must set the relevant parameter #2 in advance. The function of the parameter is determined by the macro command. Not every macro command requires this parameter.

P5.096	Motion control macro command: command parameter #1		Hex Address	Dec Address
			05C0H 05C1H	41473 41474
Default:	0	Control mode:	All	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Before executing the macro command, you must set the relevant parameter #1 in advance. The function of the parameter is determined by the macro command. Not every macro command requires this parameter.

P5.097■	Motion control macro command: issue command / execution result		Hex Address	Dec Address
			05C2H 05C3H	41475 41476
Default:	0	Control mode:	All	
Unit:	-	Setting range:	0–0x099F	
Format:	HEX	Data size:	16-bit	

Settings:

- *Write: used to issue macro command (0CBAh).*
- *Read: used to examine the execution result of macro command. If successful, the result is returned to 1CBAh.*

If the command issues 0001, 1001h is returned if successful; and Fxxxh if unsuccessful (depending on the command description). If you execute a command that is not supported, the failure code F001h is returned.

The command codes are listed in the following table:

Macro 3 Command code 0003h	Motion parameter protection: password setting, protection activation.
Macro parameters	P5.093 = parameter write-protected level (0–1) (0: no protection, 1: enable protection) P5.094 = protection level of data array (-1 to 7) -1: parameter groups 5, 6, 7, and data array are readable 0: password protection of all data array 1: password protection of data array #100–#799 2: password protection of data array #200–#799 3: password protection of data array #300–#799 4: password protection of data array #400–#799 5: password protection of data array #500–#799 6: password protection of data array #600–#799 7: no password protection of data array P5.095 = set new password (1–16777215) P5.096 = confirm new password (1–16777215) **Note:** P5.095 must equal to P5.096 to be successfully set and the password must be set within the allowable range.
This function can only be executed prior to activating the parameter protection function. When the protection function has been activated, the failure code is returned if this function is executed repeatedly.	
Failure code F031h	Protection function has been activated and cannot be set repeatedly
Failure code F032h	Wrong password: P5.095 does not equal to P5.096
Failure code F033h	Password value exceeds the allowable range (1–16777215)
Failure code F034h	Protection level P5.094 exceeds the allowable range (-1 to 7)
Failure code F035h	Protection level P5.093 exceeds the allowable range (0–1)
Success code 1003h	-

Macro 4 Command code 0004h	Parameter and data array protection: unlock protection
Macro parameters	P5.096 = enter password (1–16777215)

This function can only be executed when the parameter protection function has been activated.
When the protection function has been unlocked, the failure code is returned if this function is executed repeatedly. If the wrong password is entered, failure code Ennn is returned where nnn indicates the remaining attempts to enter the password. The number decrements by one after each failed attempt. When the number displays 0, it indicates the maximum number of failed password attempts has been reached and it is locked. You can only reset all parameters (P2.008=10) to unlock.

Failure code F041h	Protection function is unlocked and cannot be unlocked repeatedly
Failure code F043h	Password value exceeds the allowable range (1–16777215)
Failure code F044h	Exceeded maximum failed password attempts: locked. Can only be unlocked by resetting the parameter (P2.008 = 10), but this also resets all parameters to the default values.
Failure code Ennnh	Incorrect password setting: failed to unlock nnn: remaining attempts to enter the password. The number decrements by one after each failed attempt. When the number displays 0, it is locked and does not allow further attempts.
Success code 1004h	-

Macro 6 Command code 0006h	Build up the E-Cam table: rotary shear, including synchronous area (7 areas)
General parameters	P5.081 = Address of table (data array) P5.082 = 7 (This macro is fixed to 7 areas, 8 points) P1.044 and P1.045 = E-Gear ratio (must be set up in advance)
Macro parameters	P5.094 = A (deceleration ratio: numerator) x C (cutting count) P5.095 = B (deceleration ratio: denominator) P5.096 = 1000000 x R x V **Notes:** 1) R (cutting ratio) = L (target cutting length) / ℓ (perimeter of cutter). Allowable cutting ratio: (0.3–2.5) times 2) V (speed factor) = target cutting speed / speed of delivered product 3) V = 1.0: when cutting, the speed of cutter is same as the delivered product 4) V = 1.1: when cutting, the speed of cutter is 10% faster than the delivered product 5) V = 0.9: when cutting, the speed of cutter is 10% slower than the delivered product

This macro calculates the data for the E-Cam table according to the above parameters, and stores them in the data array specified by P5.081. Parameters listed above are relevant to the E-Cam table calculation. Please correctly set up the parameters prior to execution.
After this macro is executed, if the above parameters have been modified, the E-Cam table must be recreated and you must execute this macro again. Data in E-Cam table is changed after executing this macro; thus, do not execute the macro when E-Cam is in engaged status.
In E-Cam applications, parameters (such as P5.083 and P5.084) that are irrelevant to this macro are not listed here. Set up the parameters according to the actual application. Please refer to sections about E-Cam in Chapter 7. After executing this macro, the E-Cam table is not saved to EEPROM automatically.

Failure code F061h	When creating the table, E-Cam is in engaged status. To issue this command, E-Cam needs to disengage first.
Failure code F062h	Value of P5.094 exceeds the range: (1–65535)
Failure code F063h	Value of P5.095 exceeds the range: (1–65535)
Failure code F064h	Value of P5.096 exceeds the range: (300000–2500000)
Failure code F065h	Address specified by P5.081 is too long and the space of data array is insufficient.
Failure code F066h	Value of P5.082 must be set to 7. Otherwise the command cannot be executed.
Failure code F067h	Data calculation error. Please decrease the value of P1.044 and P1.045, but maintain the same proportions.

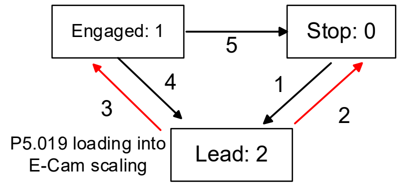
Macro 7 Command code 0007h	Build up the E-Cam table: rotary shear (multi-dimensional control)
General parameters	P5.081 = address of table (data array) P5.082 = N (30–72) (area number of E-Cam) P1.044 and P1.045 = E-Gear ratio (must be set up in advance).
Macro parameters	P5.093.H16 (high 16-bit) = S P5.093.L16 (low 16-bit) = W Note: S (curve level) = 1–4 levels; W (degree of waiting area) = -1 to +170 degrees (W = -1 is available in firmware version V1.038 (sub29) or later versions) P5.094 = Y (degree of synchronous area) = 0–330 degrees P5.095.H16 (high 16-bit) = A x C P5.095.L16 (low 16-bit) = B **Notes:** 1) A (deceleration ratio: numerator), C (cutting count) 2) B (deceleration ratio: denominator) 3) P5.096 = 1000000 x R x V
	Notes: R (cutting ratio) = L (target cutting length) / ℓ (length of cutter) 1) Allowable cutting ratio: (0.05–5.0) times 2) V (speed factor) = target cutting speed / speed of delivered product 3) V = 1.0: when cutting, the speed of cutter is same as the delivered product 4) V = 1.1: when cutting, the speed of cutter is 10% faster than the delivered product 5) V = 0.9: when cutting, the speed of cutter is 10% slower than the delivered product **Notes:** 1) W′ = 180 + 360/N–360/R + Y/2 2) P5.093.L16 < W′, E-Cam table is in error (failure code F07Ah) 3) P5.093.L16 = W′, initial speed is 0 in E-Cam table P5.093.L16 > W′, initial speed > 0 in E-Cam table

This macro calculates the data for the E-Cam table according to the above parameters, and stores them in the data array specified by P5.081. Parameters listed above are relevant to the E-Cam table calculation. Please correctly set up the parameters prior to execution. After this macro is executed, if the above parameters have been modified, the E-Cam table must be recreated and you must execute this macro again. Data in E-Cam table is changed after executing this macro; thus, do not execute when E-Cam is in engaged status. In E-Cam applications, parameters (such as P5.083 and P5.084) that are irrelevant to this macro are not listed here. Set up the parameters according to the actual application. Please refer to sections about E-Cam. After executing this macro, the E-Cam table is not saved to EEPROM automatically.

Failure code F071h	When creating the table, E-Cam is in engaged status. To issue this command, E-Cam must disengage first.
Failure code F072h	Degree of synchronous area of P5.094 exceeds the range: (0–330)
Failure code F073h	Curve level of P5.093.H16 exceeds the range: (1–4)
Failure code F074h	Degree of waiting area of P5.093.L16 exceeds the range: (0–170)
Failure code F075h	Value of P5.096 exceeds the range: (50000–5000000)
Failure code F076h	Area number of E-Cam of P5.082 exceeds the range: (30–72)
Failure code F077h	Address specified by P5.081 is too long and the space of data array is insufficient.
Failure code F078h	Data calculation error. Please decrease the setting value of P1.044 and P1.045, but maintain the same proportions.
Failure code F079h	Acceleration degree is too small; please decrease the value for waiting area (W), synchronous area (Y), or curve level (S).
Failure code F07Ah	Waiting area is too small; please increase the value for waiting area (W) or decrease the value for synchronous area (Y).

Macro 8 Command code 0008h	E-Cam curve scaling (P5.019) is effective immediately.
Macro parameters	N/A

This macro can be triggered when E-Cam is engaged, and P5.019 becomes effective immediately.
Normally, E-Cam scaling is only loaded into the system by P5.019 at the point when E-Cam engages (see below: transition 3). It cannot be changed in the engaged condition. E-Cam scaling can only be changed after one E-Cam cycle to ensure that the E-Cam can return to the original position without accumulative error.



If necessary in the application, there are two ways to change the setting of E-Cam curve scaling immediately:
1) P5.088.X2 = 1: when E-Cam is engaged, set up this bit at the same time, this causes each change in P5.019 to be enabled immediately.
2) Use macro #8: each time that this macro command is triggered, the function of P5.019 is enabled immediately. However, if the value of P5.019 is changed and this macro is not triggered, then the function of P5.019 is not enabled immediately. This macro command has to be triggered again to enable the function of P5.019.

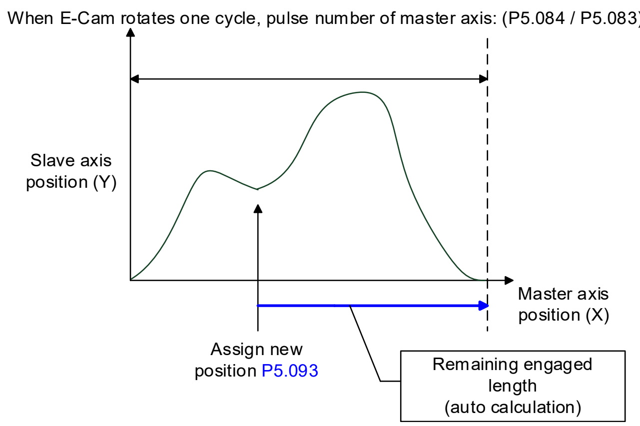
Failure code	N/A

Macro 12 Command code 000Ch	Change position X where E-Cam is engaged: E-Cam disengages after rotating one cycle in the forward direction.
General parameters	N/A
Macro parameters	P5.093 = new engaged position X, Unit: pulse number of master axis. Monitoring variable 062(3Eh): displays the current engaged position (X) of master axis.

This macro command can change the engaged position immediately even when E-Cam is engaged. It automatically calculates the remaining engaged length so that E-Cam disengages after rotating one cycle (360°) in the forward direction. However, you must set P5.088.U to 2, 4, or 6; otherwise, E-Cam does not disengage.

E-Cam disengages when an alarm occurs or power supply is cut off. If you want E-Cam to re-engage at the last disengaged position and continue its remaining cycle, it is recommended that you record the last disengaged position (X) and then resume the operation of this macro command. Please note that when E-Cam is disengaged, the servo position might shift slightly, causing position error when E-Cam re-engages.

The engaged direction is in the forward direction (master axis operates in forward direction):

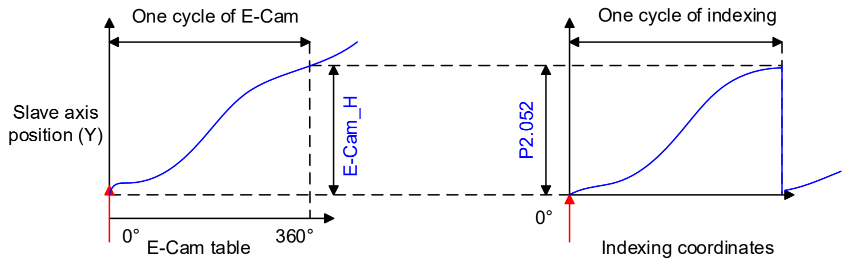


Note: when using this macro command, it is recommended that you execute the macro command before operating the master axis.

Failure code F0C1h	When executing this macro command, E-Cam is not in engaged status. Engaged position can only be modified when E-Cam is engaged.
Failure code F0C2h	Value of P5.093 is in error. The value cannot be less than 0.
Failure code F0C3h	Value of P5.093 is in error. The value has to be less than the value of (P5.084 / P5.083).
Macro 13 Command code 000Dh	Calculate the error between E-Cam and indexing coordinates for PR positioning.
General parameters	N/A
Macro parameters	P5.093.Low_Word = DCBA : UZYX (8 digits, HEX) YX (PR number) = 0–0X3F (invalid when value is 0) Value of UZ has to be set to 0 BA (function of P5.095): 0 (use avoid point); 1 (use allowable forward rate) DC (inhibit reverse rotation): 0 (invalid), 1 (inhibit reverse rotation) P5.095: avoid point (cannot pass this point) = 0–100 (%) of E-Cam cycle or allowable forward rate 0–100 (%)
Monitoring variable 091(5Bh): displays the current indexing coordinate position (PUU).	
When E-Cam is engaged and the motor is stopped due to Servo Off or an alarm, it causes position error between the actual position and the E-Cam position. After changing back to Servo On, you can use this macro command to calculate the correction value and write the value into the specified PR for incremental positioning, so that the motor can return to the correct E-Cam position.	

When using this macro command:

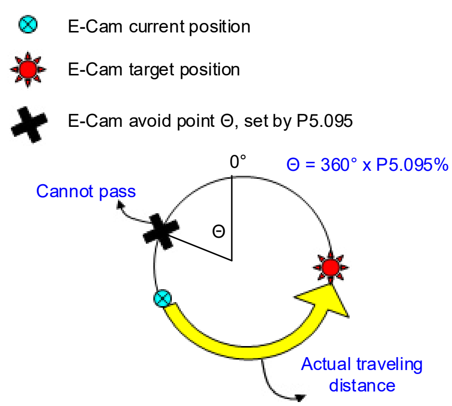
1) Set P5.088.X1 to 1 to keep E-Cam engaged when Servo Off and continue to calculate E-Cam position.
2) Height of indexing coordinate and E-Cam coordinate should be the same: P2.052 = ECAM_H (moving distance when E-Cam operates one cycle).
3) E-Cam table scaling P5.019 must be 1.0 time.
4) When E-Cam is engaged for the first time, 0 degrees in the E-Cam table should point to 0 degrees in the indexing coordinate. You can achieve this alignment by executing homing.
5) You can only use this macro command for a periodic cycle and when each cycle starts from the same position.



Notes:

1) ECAM_H (height of E-Cam table) = E-Cam table (last point minus first point)
2) Indexing coordinate = remainder of (absolute coordinate / P2.052)
3) Use PR command via incremental positioning control

Due to the cyclic operation of E-Cam, the motor travels to the specified position either in the forward or reverse direction. However, the moving distance is usually different between them. Thus, you can use the position of the avoid point to determine whether to operate in the forward or reverse direction.
***Avoid point:** the point that cannot be passed when executing macro PR positioning. Please see below for details.



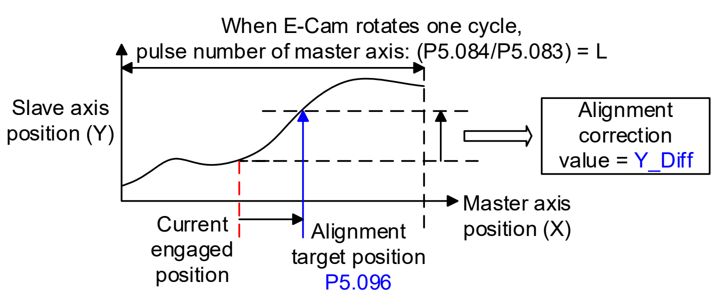
(Continued)

Failure code F0D1h	When executing this macro command, E-Cam is not in engaged status. E-Cam should be engaged.
Failure code F0D2h	P5.093.YX (PR number) exceeds the range: 1–0x3F
Failure code F0D3h	P5.095 (allowable forward rate) exceeds the range: 0–100 (%)
Failure code F0D5h	Position correction value does not exist. This macro command might be triggered twice.
Failure code F0D6h	When servo switches to on state again, E-Cam is not engaged.
Failure code F0D7h	Height (Y axis) of E-Cam table does not equal to the value of P2.052.
Failure code F0D8h	E-Cam table scaling does not equal to 1.
Failure code F0D9h	Values of P5.093.BA and P5.095 exceed the range: 0–1.
Failure code F0DAh	P5.093.DC (reverse inhibit) exceeds the range: 0–1.
Failure code F0DBh	The reverse inhibit function has failed. Do not use macro command #D and #10h consecutively.

Macro 14 Command code 000Eh	Perform E-Cam alignment immediately and write the correction value into the specified PR.
Macro parameters	P5.093 = DCBA : UZYX (8 digits, HEX) YX (PR number) = 0–0x3F (invalid when value is 0). UZ (maximum allowable correction rate) = 0–0x64 (%) A (trigger specified PR directly) = 1: on, 0: off DCB = must be set to 0. P5.094 (DI delay time compensation) = -25000 to +25000 (unit: usec). P5.095 (allowable forward rate) = 0–100 (%) P5.096 (target position of alignment X) (unit: pulse number of master axis) = 0 to (P5.084/P5.083) - 1.

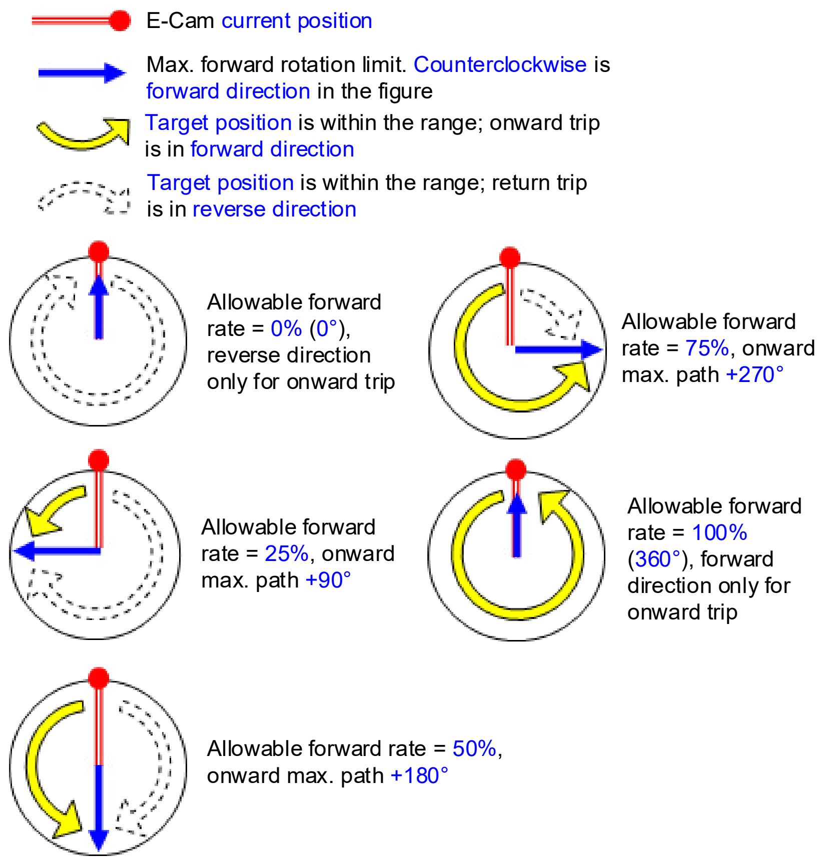
Monitoring variable 062(3Eh): displays the current engaged position (X) of master axis.

This macro command can move the engaged position to the **alignment target position X** when E-Cam is engaged, and then write the **alignment correction value** into the specified PR.
You can use this macro command: during E-Cam operation (E-Cam is engaged), if you want to quickly align the E-Cam position with the mechanical referral point, you can use the sensor to trigger DI.EVx to execute this macro command.
After E-Cam alignment completes, the engaged position moves to the new position. The excessive or insufficient moving distance after E-Cam operates one cycle is called the **alignment correction value** which is written into the PR specified by P5.093.YX. You can use the PR incremental command to execute this alignment correction so that the E-Cam slave axis position remains and offset the phase of E-Cam to align with the referral position of the machine. For some applications when PR is not needed, set P5.093.YX to 0. Please note that PR can only be executed when triggered by the host controller. This macro command is only for setting the value.



*P5.093.UZ is able to limit the maximum correction rate. The alignment target position ★ will be different from P5.096.
☐☐|Alignment target position ★ - Current engaged position | / L <= P5.093.UZ %
*DI time delay compensation can be set by P5.094 to correct the error caused by different speed of motion.
Due to cyclic operation, when E-Cam moves from current position to the target position, it can either rotate in the forward or reverse direction. However, the moving distance is usually different between them. Thus, you can use the allowable forward rate to determine whether to operate in the forward or reverse rotation.
(Continued)

*__Allowable forward rate:__ the allowable maximum proportion of the **forward path**. Please see below for details.

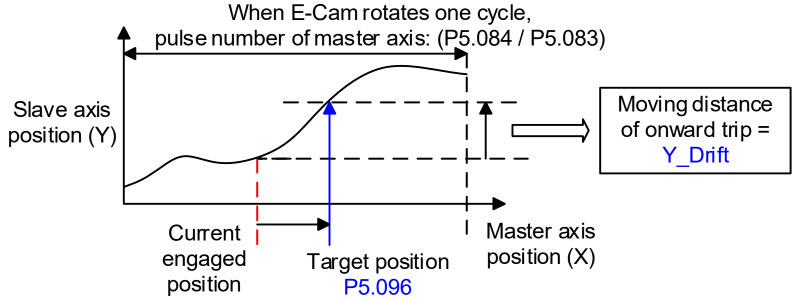


Failure code F0E1h	When executing this macro command, E-Cam is not in engaged status. E-Cam has to be engaged to execute the alignment correction.
Failure code F0E2h	P5.093.YX (PR number) exceeds the range: 0–0x3F
Failure code F0E3h	P5.093.UZ (maximum alignment correction rate) exceeds the range: 0–0x64 (%)
Failure code F0E4h	P5.094 (DI delay time compensation) exceeds the range: -10000 to +10000
Failure code F0E5h	P5.095 (allowable forward rate) exceeds the range: 0–100 (%)
Failure code F0E6h	P5.096 (alignment target position) exceeds the range: 0 to (P5.084/P5.083) - 1

Macro 15 Command code 000Fh	Calculate the moving distance between current and target position of E-Cam for PR positioning.
General parameters	N/A
Macro parameters	P5.093.Low_Word = UZYX (4 digits, HEX) YX (PR number of onward trip) = 0–0X3F (invalid when value is 0). UX (PR number of return trip) = 0–0X3F (invalid when value is 0). P5.093.Hi_Word = must be set to 0. P5.095 (allowable forward rate) = 0–100 (%) P5.096 (target position X) (unit: pulse number of master axis) = 0 to (P5.084 / P5.083) - 1.
Monitoring variable 062(3Eh): displays the current engaged position (X) of master axis.	
When E-Cam is engaged, this macro command calculates the moving distance between the **current** and **target engaged position (X)** and writes the value into the specified PR. You can use this macro command: during E-Cam operation, if you want to move the slave axis to the specified position when the master axis stops but is still in engaged status. This macro command can calculate the correct **moving distance** (Y_Drift) **of the onward trip** for the PR incremental command.	

(Continued)

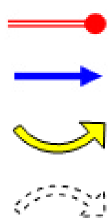
When the master axis resumes operation, use another PR for the **moving distance of the return trip** (-Y_ Drift) to return to the original position **(moving distance of onward trip + moving distance of return trip = 0)**. E-Cam position remains the same.



Note: regardless of onward trip or return trip, use the PR command through incremental positioning control.

Due to cyclic operation, when E-Cam moves from current position to the target position, it can either rotate in the forward or reverse direction. However, the moving distance is usually different between them. Thus, you can use the allowable forward rate to determine whether to operate in forward or reverse rotation.

***Allowable forward rate:** the allowable maximum proportion of **forward path**. Please see below for details.

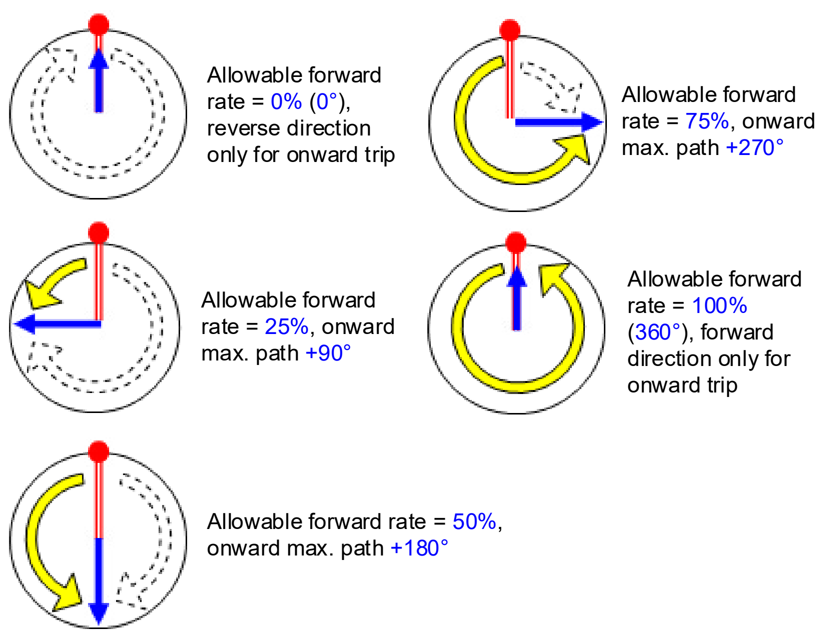


E-Cam current position

Max. forward rotation limit. Counterclockwise is forward direction in the figure

Target position is within the range; onward trip is in forward direction

Target position is within the range; return trip is in reverse direction



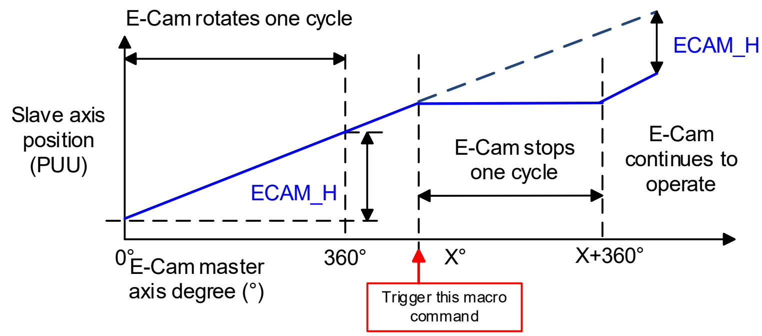
Failure code F0F1h	When executing this macro command, E-Cam is not in engaged status. Engaged position can only be modified when E-Cam is engaged.
Failure code F0F2h	P5.093.YX (PR number of onward trip) exceeds the range: 0–0x3F
Failure code F0F3h	P5.093.UZ (PR number of return trip) exceeds the range: 0–0x3F
Failure code F0F5h	P5.095 (allowable forward rate) exceeds the range: 0–100 (%)
Failure code F0F6h	P5.096 (target position) exceeds the range: 0 to (P5.084/P5.083) - 1

Macro 16 Command code 0010h	E-Cam pauses for one cycle and resumes operation at next cycle.
General parameters	N/A
Macro parameters	P5.093 must be set to 0.

After E-Cam is engaged, this macro command can pause the slave axis for one distance cycle regardless of the current E-Cam degree. The following conditions have to be met when using this macro command:

1) E-Cam must be in the engaged status.
2) E-Cam must be the forward operation curve (including straight line) so it can pause.

As shown in the figure below, by triggering this macro command, E-Cam pauses for one cycle regardless of the degree (X) of E-Cam's current location.



Notes:

1) ECAM_H (E-Cam pause distance) = E-Cam table (Last point minus first point) x P5.019 (effective scaling).
2) This function is accumulative. If the command is triggered for N times consecutively, it pauses the E-Cam for N cycles. Please note that the **accumulated pause distance** cannot exceed (2^31), otherwise the macro command is disabled.
3) When E-Cam resumes operation, the **accumulated pause distance** is cleared to 0.

Failure code F101h	When executing this macro command, E-Cam is not in the engaged status. E-Cam should be engaged.
Failure code F102h	Value of P5.093 is incorrect: must be set to 0.
Failure code F103h	E-Cam must operate in the forward direction. Please check the E-Cam table and make sure P5.019 > 0.
Failure code F104h	Accumulated pause distance exceeds 2^31. Do not execute this macro command consecutively.

P5.098	***PR# triggered by event rising-edge***		***Hex Address***	***Dec Address***
			05C4H 05C5H	41477 41478
Default:	0x0	Control mode:	PR	
Unit:	-	Setting range:	0x0000–0xDDDD	
Format:	HEX	Data size:	16-bit	

Settings:

Use this parameter to configure Digital Inputs (EV events) to trigger PR commands. Each EV nibble can be set to 0 - D (hex) that will point to PR#51 - PR#63. (1 = PR#51, 2 = PR#52, etc.)

- *Step 1: Define a Digital Input as an Event Trigger. Example: set P2.012 to 0x013A (DI3 = Event Trigger 2, normally open)*
- *Step 2: Configure which PR to initiate when the EV is triggered. Example: set P5.098 = 0x0090 (Y = 9 = PR#59 is triggered by EV2)*
- *Step 3: Configure PR#59 with the desired action.*

Every rising edge of DI3 will now trigger PR#59.

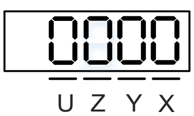
X	PR triggered by EV1 rising-edge	Z	PR triggered by EV3 rising-edge
Y	PR triggered by EV2 rising-edge	U	PR triggered by EV4 rising-edge

- *X: PR triggered when EV1 is on*
  - *0: no action*
  - *1–D: execute PR# 51–63*
- *Y: PR triggered when EV2 is on*
  - *0: no action*
  - *1–D: execute PR# 51–63*
- *Z: PR triggered when EV3 is on*
  - *0: no action*
  - *1–D: execute PR# 51–63*
- *U: PR triggered when EV4 is on*
  - *0: no action*
  - *1–D: execute PR# 51–63*

P5.099	**PR# triggered by event falling-edge**		***Hex Address***	***Dec Address***
			05C6H 05C7H	41479 41480
Default:	0x0	Control mode:	PR	
Unit:	-	Setting range:	0x0000–0xDDDD	
Format:	HEX	Data size:	16-bit	

Settings:

See P5.098 for details.



X	PR triggered by EV1 falling-edge	Z	PR triggered by EV3 falling-edge
Y	PR triggered by EV2 falling-edge	U	PR triggered by EV4 falling-edge

- *X: PR triggered when EV1 is off*
  - *0: no action*
  - *1–D: execute PR# 51–63*
- *Y: PR triggered when EV2 is off*
  - *0: no action*
  - *1–D: execute PR# 51–63*
- *Z: PR triggered when EV3 is off*
- *0: no action*
  - *1–D: execute PR# 51–63*
- *U: PR triggered when EV4 is off*
  - *0: no action*
  - *1–D: execute PR# 51–63*

P5.100■	Data array - Element Value #3 for reading / writing		Hex Address	Dec Address
			05C8H 05C9H	41481 41482
Default:	0	Control mode:	All	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Data value #3: when reading or writing the parameter by any method, the value set by P5.011 does not increase by 1. Please refer to Chapter 7 Data array for detailed instructions.

P5.101■	Data array - Element Value #4 for reading / writing		Hex Address	Dec Address
			05CAH 05CBH	41483 41484
Default:	0	Control mode:	All	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Data value #4: when reading or writing the parameter by any method, the value set by P5.011 does not increase by 1. Please refer to Chapter 7 Data array for detailed instructions.

P5.102■	Data array - Element Value #5 for reading / writing		Hex Address	Dec Address
			05CCH 05CDH	41485 41486
Default:	0	Control mode:	All	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Data value #5: when reading or writing the parameter by any method, the value set by P5.011 does not increase by 1. Please refer to Chapter 7 Data array for detailed instructions.

P5.103■	Data array - Element Value #6 for reading / writing		Hex Address	Dec Address
			05CEH 05CFH	41487 41488
Default:	0	Control mode:	All	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Data value #6: when reading or writing the parameter by any method, the value set by P5.011 does not increase by 1. Please refer to Chapter 7 Data array for detailed instructions.

Parameters P5.112–P5.123 were created to be able to command PR statements with Implicit Ethernet/IP communications. P5.007 can be used by Modbus (and ModTCP) to initiate PR moves, but P5.007 is bidirectional (the command is sent by a controller and the status is read back in the same register). Since Implicit communication is unidirectional, P5.112 is the PR# to be executed. P5.113–P5.119 will build all the path options just like you would in the PR Mode Setting Window in SureServo2 Pro. P5.123 is the status register of the move for Implicit messaging.

Hint- go to the PR Mode Setting window and build the path in a temporary location to view all the desired settings since the available options change depending on the Path type chosen.

Please reference P6.002 for more details on path configuration details.

P5.112	***PATH_Target***		***Hex Address***	***Dec Address***
			05DEH 05DFH	41505 41506
Default:	0	Control mode:	All	
Unit:	-	Setting range:	0–99	
Format:	DEC	Data size:	16-bit	

Settings:

This is the target Path that will be saved or executed when P5.121 (Path Save) or P5.122 (Path Trigger) are set to 1. A change in this value does not automatically trigger/save the PATH.

P5.113	***PATH_Type***		***Hex Address***	***Dec Address***
			05E2H 05E3H	41507 41508
Default:	0	Control mode:	All	
Unit:	-	Setting range:	0–7	
Format:	DEC	Data size:	16-bit	

Settings:

Configures the PATH type.

Path Type	***Value***
Homing	0
Speed	1
Position	2 (P5.115.Z will alter this mimic path type 3)
Jump	7

P5.114	PATH Options1 configuration		Hex Address	Dec Address
			05E4H 05E5H	41509 41510
Default:	0	Control mode:	All	
Unit:	-	Setting range:	0–0x12A	
Format:	DEC	Data size:	16-bit	

Settings:

Configure Options1 for PATH.

Value Set in P5.113	Setting Options
0 (Homing)	ZYX: hexdecimal digits to configure homing method (see P5.004 for ZYX values). This maps to P5.004 and overwrites P5.004. • X: Homing Method • Y: Signal Setting • Z: Behavior after reaching the limit
1 (Speed)	• 0: 0.1 rpm • 1: PPS (PUU per second)
2 (Position)	• 0: ABS Absolute position • 1: REL Relative position • 2: INC Incremental position • 3: CAP High speed position capturing
7 (Jump)	n/a

P5.115	PATH Options2 configuration		Hex Address	Dec Address
			05E6H 05E7H	41511 41512
Default:	0	Control mode:	All	
Unit:	-	Setting range:	0–99	
Format:	DEC	Data size:	16-bit	

Settings:

Configure Options2 for PATH.

Value Set in P5.113	Setting Options
0 (Homing)	• 0: Stop • 1–99: Target PATH index triggered after Homing
1 (Speed)	ZYX: hexdecimal digits to configure INS/AUTO • X = 1: INS • Z = 1: AUTO
2 (Position)	ZYX: hexdecimal digits to configure INS/OVLP/AUTO • X = 1: INS • Y = 1: OVLP • Z = 1: AUTO (this will make path proceed to the next path, simulates path type 3)
7 (Jump)	ZYX: hexdecimal digits to configure INS • X = 1: INS

P5.116	PATH_Acc		Hex Address	Dec Address
			05E8H 05E9H	41513 41514
Default:	0	Control mode:	All	
Unit:	-	Setting range:	0–15	
Format:	DEC	Data size:	16-bit	

Settings:

Set the acceleration for PATH.

Value Set in P5.113	Setting Options
0 (Homing)	0–15 (uses parameters P5.020–P5.035)
1 (Speed)	
2 (Position)	
7 (Jump)	n/a

P5.117	PATH_Dec		Hex Address	Dec Address
			05EAH 05EBH	41515 41516
Default:	0	Control mode:	All	
Unit:	-	Setting range:	0–15	
Format:	DEC	Data size:	16-bit	

Settings:

Set the deceleration for PATH.

Value Set in P5.113	Setting Options
0 (Homing)	0–15 (uses parameters P5.020–P5.035)
1 (Speed)	
2 (Position)	
7 (Jump)	n/a

P5.118	PATH_Data1		Hex Address	Dec Address
			05ECH 05EDH	41517 41518
Default:	0	Control mode:	All	
Unit:	-	Setting range:	-2147483648–2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Configure Data1 for PATH.

Value Set in P5.113	Setting Options
0 (Homing)	1–20000 (1st homing speed in rpm). Maps to P5.005 and overwrites P5.005.
1 (Speed)	-60000–60000/-2^{31}–2^{31-1}. Target speed in 0.1 rpm/PPS.
2 (Position)	0–15 Profile speed (0.1 rpm). Uses parameters P5.060 ~ P5.075.
7 (Jump)	0–99. Target PATH index to jump to.

P5.119	PATH_Data2		Hex Address	Dec Address
			05EEH 05EFH	41519 41520
Default:	0	Control mode:	All	
Unit:	-	Setting range:	-2147483648–2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Configure Data2 for PATH.

Value Set in P5.113	Setting Options
0 (Homing)	1–5000 (2nd homing speed in rpm). Maps to P5.006 and overwrites P5.006.
1 (Speed)	n/a
2 (Position)	-2147483648 to 2147483647 (Target position in PUU)
7 (Jump)	n/a

P5.120	Delay for PATH		Hex Address	Dec Address
			05F0H 05F1H	41521 41522
Default:	0	Control mode:	All	
Unit:	-	Setting range:	0–15	
Format:	DEC	Data size:	16-bit	

Settings:

Set the delay for PATH.

Value Set in P5.113	Setting Options
0 (Homing)	0–15 (uses parameters P5.040–P5.055)
1 (Speed)	
2 (Position)	
7 (Jump)	

P5.121	PATH_Save		Hex Address	Dec Address
			05F2H 05F3H	41523 41524
Default:	0	Control mode:	All	
Unit:	-	Setting range:	0–2	
Format:	DEC	Data size:	16-bit	

Settings:

Save the PATH related parameters (P5.112–P5.119) into Path index assigned in P5.xx1 with rising edge trigger.

- *0->1 rising edge to save to RAM*
- *0->2 rising edge to save to EEPROM*

P5.122	PATH_Trigger		Hex Address	Dec Address
			05F4H 05F5H	41525 41526
Default:	0	Control mode:	All	
Unit:	-	Setting range:	0–2	
Format:	DEC	Data size:	16-bit	

Settings:

Trigger PR motion of PATH index assigned in P5.112 with rising edge trigger 0 -> 1. Changing this parameter from 0 -> 2 will stop the current PATH motion.

NOTE: *The value of P5.122 must be set to 0 after each command. Changing P5.122 from a value of 1 to a value of 2 will NOT stop the current motion.*

P5.123★	PATH_Status		Hex Address	Dec Address
			05F6H 05F7H	41527 41528
Default:	0	Control mode:	All	
Unit:	-	Setting range:	0–2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Read-only status of PATH moves. Mirrors the read function of P5.007.

Example:

If PLC triggers PATH zz:

- *P5.123 = zz when Trigger is activated*
- *P5.123= X0000 + zz when save is complete*
- *P5.123= 10000 + zz when cmd is complete*
- *P5.123= 20000 + zz when motor reaches position.*

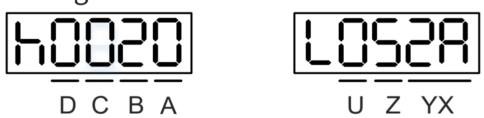
8.4.7 - P6.xxx PR parameters

P6.000	***Homing definition***			***Hex Address***	***Dec Address***
				0600H 0601H	41537 41538
Default:	0x00000000	Control mode:	PR		
Unit:	-	Setting range:	0x00000000–0xFFFFFF3F		
Format:	HEX	Data size:	32-bit		

NOTE: *Additional Homing information can be found in section 7.1.3.*
We highly recommended using the Homing Setting screen of the PR Mode Window in SureServo2 Pro to configure Homing settings.

Settings:

Homing definition:



A	DEC2: deceleration time selection of second homing	YX	PATH: path type
B	DLY: select 0–F for delay time	Z	ACC: select 0–F for acceleration time
C	N/A	U	DEC1: deceleration time selection of first homing
D	BOOT	-	-

- *YX: PATH: path type*
  - *0x0: stop: homing complete and stop.*
  - *0x1–0x63h: after homing is complete, execute the specified path (Path#1–Path#99).*
- *Z: ACC: select 0–F for acceleration time*
  - *0–F: corresponds to P5.020–P5.035*
- *U: DEC1: deceleration time selection of first homing velocity*
  - *0–F: corresponds to P5.020–P5.035*
- *A: DEC2: deceleration time selection of second homing velocity*
  - *0–F: corresponds to P5.020–P5.035*
- *B: DLY: select 0–F for delay time*
  - *0–F: corresponds to P5.040–P5.055*
- *D: BOOT: when the drive is powered on decide whether to initiate the homing routine or not.*
  - *0: do not execute homing*
  - *1: execute homing automatically (servo switches to Servo On status after applying power)*

Apart from the above definitions, the related settings for homing also include:

- *P5.004 homing methods.*
- *P5.005–P5.006 speed setting of searching for the origin.*
- *P6.001: ORG_DEF is the coordinate of the origin and may not be 0.*

Notes:

1) After the origin is found (sensor or Z), it has to decelerate to a stop. The stop position exceeds the origin by a short distance:
2) If returning to the origin is not needed, set PATH to 0;
3) If returning to the origin is needed, set PATH to a non-zero value and set have that PATH execute an absolute move to ORG_DEF.

Example:

1) Upon completion of P6.000 = 0x1, automatically execute Path#1.

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2) Set from absolute position (ABS) to 0 as the route of Path#1 (set P6.002 & P6.003).
3) If the origin is found (sensor or Z), and you want it to move an offset S and define the coordinate as P after moving, then PATH = non-zero and set ORG_DEF = P - S, and this absolute Position command = P.

<table>
<tr><th rowspan="2">P6.001</th><th rowspan="2" colspan="2">Origin definition</th><th>Hex Address</th><th>Dec Address</th></tr>
<tr><td>0602H
0603H</td><td>41539
41540</td></tr>
<tr><td>Default:</td><td>0</td><td>Control mode:</td><td colspan="2">PR</td></tr>
<tr><td>Unit:</td><td>-</td><td>Setting range:</td><td colspan="2">-2147483648 to +2147483647</td></tr>
<tr><td>Format:</td><td>DEC</td><td>Data size:</td><td colspan="2">32-bit</td></tr>
</table>

Settings:

Origin definition. After Homing is complete, the actual position of the motor encoder will be set to P6.001. No motion occurs - the motor position is simply redefined.

ALL P6 and P7 parameters use the same settings as P6.002 and P6.003 as shown below. Please refer to P6.002 and P6.003 for detailed information about all other P6 and P7 parameters.

<table>
<tr><th rowspan="2">P6.002</th><th rowspan="2" colspan="2">PATH#1 definition</th><th>Hex Address</th><th>Dec Address</th></tr>
<tr><td>0604H
0605H</td><td>41541
41542</td></tr>
<tr><td>Default:</td><td>0x00000000</td><td>Control mode:</td><td colspan="2">PR</td></tr>
<tr><td>Unit:</td><td>-</td><td>Setting range:</td><td colspan="2">0x00000000–0xFFFFFFFF</td></tr>
<tr><td>Format:</td><td>HEX</td><td>Data size:</td><td colspan="2">32-bit</td></tr>
</table>

Settings:

Format of this parameter: (High word h) DCBA : (Low word L) UZYX

A	SPD, Target speed index*1	X	TYPE, Path type
B	DLY, Delay time index	Y	OPT, Option
C	AUTO*1	Z	ACC, Acceleration time index*1
D	Reserved	U	DEC, Deceleration time index*1

Definitions are as follows:

- *YX*

<table>
<tr><th colspan="4">Y: OPT, Option</th><th rowspan="2">X: TYPE, Path type</th></tr>
<tr><th>BIT 3</th><th>BIT 2</th><th>BIT 1</th><th>BIT 0</th></tr>
<tr><td>-</td><td>UNIT</td><td>AUTO</td><td>INS</td><td>1: SPEED, constant speed control.</td></tr>
<tr><td colspan="2" rowspan="2">CMD</td><td rowspan="2">OVLP</td><td rowspan="2">INS</td><td>2: SINGLE, positioning control. It stops when finished.</td></tr>
<tr><td>3: AUTO, positioning control. It loads the next path automatically when finished.</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>INS</td><td>7: JUMP, jump to the specified path.</td></tr>
<tr><td>-</td><td>ROM</td><td>AUTO</td><td>INS</td><td>8: write specified parameter to specified path.</td></tr>
<tr><td colspan="2">DIR</td><td>OVLP</td><td>INS</td><td>A: indexing position control.</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>-</td><td>Statement / arithmetic operation</td></tr>
</table>

- *TYPE path type: when executing 1–3, it can be interrupted and stopped by DO.STP (stop) and software limits.*
- *INS: executing this path interrupts the previous path.*
- *OVLP: allows overlapping of the next path. Overlapping is not allowed in Speed mode. When overlapping in Position mode, DLY has no function.*
- *AUTO: once current PR path is finished, load the next path automatically.*
- *UNIT: speed unit selection; 0 signifies 0.1 rpm and 1 signifies PPS (PUU per sec).*
- *CMD: please refer to Chapter 7 PR command description.*
- *ROM: write data to RAM and EEPROM at the same time. This function is only available when the writing Target is a Parameter, it is not available when the writing Target is a Data Array.*
- *DIR: sets the rotation direction with options of forward (always runs forward), backward (always runs backward), and shortest distance.*
- *UZ*

U: DEC, Deceleration time	***Z: ACC, Acceleration time***	***Corresponding parameters***	***Default Value (ms)***
0	0	P5.020	200
1	1	P5.021	300
2	2	P5.022	500
3	3	P5.023	600
4	4	P5.024	800
5	5	P5.025	900
6	6	P5.026	1000
7	7	P5.027	1200
8	8	P5.028	1500
9	9	P5.029	2000
10	10	P5.030	2500
11	11	P5.031	3000
12	12	P5.032	5000
13	13	P5.033	8000
14	14	P5.034	50
15	15	P5.035	30

- *A: SPD, target speed index*

A	Corresponding parameters	Default Value (ms)
0	P5.060	20
1	P5.061	50
2	P5.062	100
3	P5.063	200
4	P5.064	300
5	P5.065	500
6	P5.066	600
7	P5.067	800
8	P5.068	1000
9	P5.069	1300
10	P5.070	1500
11	P5.071	1800
12	P5.072	2000
13	P5.073	2300
14	P5.074	2500
15	P5.075	3000

- *B: DLY, Delay time index*

B	Corresponding parameters	Default Value (ms)
0	P5.040	0
1	P5.041	100
2	P5.042	200
3	P5.043	400
4	P5.044	500
5	P5.045	800
6	P5.046	1000
7	P5.047	1500
8	P5.048	2000
9	P5.049	2500
10	P5.050	3000
11	P5.051	3500
12	P5.052	4000
13	P5.053	4500
14	P5.054	5000
15	P5.055	5500

- *C: AUTO: once current PR path is finished, load the next path automatically.*
  This function is only enabled when X = A indexing position control.
- *Description of each bit:*

Bit 2	AUTO	0: disable auto function 1: once current PR path is finished, load next path automatically
Bit 0–1	Reserved	-

NOTE: *The parameter format definition [C, A, U, Z] is different from the above table when the path type is [7]: write the specified parameter to the specified path, and [8]: statement / arithmetic operation. Please refer to Chapter 7 for detailed instructions.*

P6.003	PATH#1 data		Hex Address	Dec Address
			0606H 0607H	41543 41544
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

P6.002 defines the property of the target point; P6.003 defines the target position of P6.002 or the target path for the Jump command.

P6.004	PATH#2 definition		Hex Address	Dec Address
			0608H 0609H	41545 41546
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.005	PATH#2 data		Hex Address	Dec Address
			060AH 060BH	41547 41548
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.006	PATH#3 definition		Hex Address	Dec Address
			060CH 060DH	41549 41550
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.007	PATH#3 data		Hex Address	Dec Address
			060EH 060FH	41551 41552
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.008	PATH#4 definition		Hex Address	Dec Address
			0610H 0611H	41553 41554
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.009	PATH#4 data		Hex Address	Dec Address
			0612H 0613H	41555 41556
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.010	PATH#5 definition		Hex Address	Dec Address
			0614H 0615H	41557 41558
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.011	PATH#5 data		Hex Address	Dec Address
			0616H 0617H	41559 41560
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.012	PATH#6 definition		Hex Address	Dec Address
			0618H 0619H	41561 41562
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.013	PATH#6 data		Hex Address	Dec Address
			061AH 061BH	41563 41564
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.014	PATH#7 definition		Hex Address	Dec Address
			061CH 061DH	41565 41566
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.015	PATH#7 data		Hex Address	Dec Address
			061EH 061FH	41567 41568
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.016	PATH#8 definition		Hex Address	Dec Address
			0620H 0621H	41569 41570
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.017	PATH#8 data		Hex Address	Dec Address
			0622H 0623H	41571 41572
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.018	PATH#9 definition		Hex Address	Dec Address
			0624H 0625H	41573 41574
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.019	PATH#9 data		Hex Address	Dec Address
			0626H 0627H	41575 41576
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.020	PATH#10 definition		Hex Address	Dec Address
			0628H 0629H	41577 41578
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.021	PATH#10 data		Hex Address	Dec Address
			062AH 062BH	41579 41580
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.022	PATH#11 definition		Hex Address	Dec Address
			062CH 062DH	41581 41582
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.023	PATH#11 data			Hex Address	Dec Address
				062EH 062FH	41583 41584
Default:	0	Control mode:	PR		
Unit:	-	Setting range:	-2147483648 to +2147483647		
Format:	DEC	Data size:	32-bit		

Settings:

Please refer to the description of P6.003.

P6.024	PATH#12 definition			Hex Address	Dec Address
				0630H 0631H	41585 41586
Default:	0x00000000	Control mode:	PR		
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF		
Format:	HEX	Data size:	32-bit		

Settings:

Please refer to the description of P6.002.

P6.025	PATH#12 data			Hex Address	Dec Address
				0632H 0633H	41587 41588
Default:	0	Control mode:	PR		
Unit:	-	Setting range:	-2147483648 to +2147483647		
Format:	DEC	Data size:	32-bit		

Settings:

Please refer to the description of P6.003.

P6.026	PATH#13 definition			Hex Address	Dec Address
				0634H 0635H	41589 41590
Default:	0x00000000	Control mode:	PR		
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF		
Format:	HEX	Data size:	32-bit		

Settings:

Please refer to the description of P6.002.

P6.027	PATH#13 data			Hex Address	Dec Address
				0636H 0637H	41591 41592
Default:	0	Control mode:	PR		
Unit:	-	Setting range:	-2147483648 to +2147483647		
Format:	DEC	Data size:	32-bit		

Settings:

Please refer to the description of P6.003.

P6.028	PATH#14 definition		Hex Address	Dec Address
			0638H 0639H	41593 41594
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.029	PATH# 14 data		Hex Address	Dec Address
			063AH 063BH	41595 41596
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.030	PATH#15 definition		Hex Address	Dec Address
			063CH 063DH	41597 41598
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.031	PATH#15 data		Hex Address	Dec Address
			063EH 063FH	41599 41600
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.032	PATH#16 definition		Hex Address	Dec Address
			0640H 0641H	41601 41602
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.033	**PATH#16 data**			**Hex Address**	**Dec Address**
				0642H 0643H	41603 41604
Default:	0	Control mode:	PR		
Unit:	-	Setting range:	-2147483648 to +2147483647		
Format:	DEC	Data size:	32-bit		

Settings:

Please refer to the description of P6.003.

P6.034	**PATH#17 definition**			**Hex Address**	**Dec Address**
				0644H 0645H	41605 41606
Default:	0x00000000	Control mode:	PR		
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF		
Format:	HEX	Data size:	32-bit		

Settings:

Please refer to the description of P6.002.

P6.035	**PATH#17 data**			**Hex Address**	**Dec Address**
				0646H 0647H	41607 41608
Default:	0	Control mode:	PR		
Unit:	-	Setting range:	-2147483648 to +2147483647		
Format:	DEC	Data size:	32-bit		

Settings:

Please refer to the description of P6.003.

P6.036	**PATH#18 definition**			**Hex Address**	**Dec Address**
				0648H 0649H	41609 41610
Default:	0x00000000	Control mode:	PR		
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF		
Format:	HEX	Data size:	32-bit		

Settings:

Please refer to the description of P6.002.

P6.037	**PATH#18 data**			**Hex Address**	**Dec Address**
				064AH 064BH	41611 41612
Default:	0	Control mode:	PR		
Unit:	-	Setting range:	-2147483648 to +2147483647		
Format:	DEC	Data size:	32-bit		

Settings:

Please refer to the description of P6.003.

P6.038	**PATH#19 definition**		**Hex Address**	**Dec Address**
			064CH 064DH	41613 41614
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.039	**PATH#19 data**		**Hex Address**	**Dec Address**
			064EH 064FH	41615 41616
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.040	**PATH#20 definition**		**Hex Address**	**Dec Address**
			0650H 0651H	41617 41618
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.041	**PATH#20 data**		**Hex Address**	**Dec Address**
			0652H 0653H	41619 41620
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.042	**PATH#21 definition**		**Hex Address**	**Dec Address**
			0654H 0655H	41621 41622
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.043	PATH#21 data		Hex Address	Dec Address
			0656H 0657H	41623 41624
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.044	PATH#22 definition		Hex Address	Dec Address
			0658H 0659H	41625 41626
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.045	PATH#22 data		Hex Address	Dec Address
			065AH 065BH	41627 41628
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.046	PATH#23 definition		Hex Address	Dec Address
			065CH 065DH	41629 41630
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.047	PATH#23 data		Hex Address	Dec Address
			065EH 065FH	41631 41632
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.048	PATH#24 definition		Hex Address	Dec Address
			0660H 0661H	41633 41634
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.049	PATH#24 data		Hex Address	Dec Address
			0662H 0663H	41635 41636
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.050	PATH#25 definition		Hex Address	Dec Address
			0664H 0665H	41637 41638
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.051	PATH#25 data		Hex Address	Dec Address
			0666H 0667H	41639 41640
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.052	PATH#26 definition		Hex Address	Dec Address
			0668H 0669H	41641 41642
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.053	PATH#26 data		Hex Address	Dec Address
			066AH 066BH	41643 41644
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.054	PATH#27 definition		Hex Address	Dec Address
			066CH 066DH	41645 41646
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.055	PATH#27 data		Hex Address	Dec Address
			066EH 066FH	41647 41648
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.056	PATH#28 definition		Hex Address	Dec Address
			0670H 0671H	41649 41650
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.057	PATH#28 data		Hex Address	Dec Address
			0672H 0673H	41651 41652
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.058	**PATH#29 definition**		**Hex Address**	**Dec Address**
			0674H 0675H	41653 41654
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.059	**PATH#29 data**		**Hex Address**	**Dec Address**
			0676H 0677H	41655 41656
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.060	**PATH#30 definition**		**Hex Address**	**Dec Address**
			0678H 0679H	41657 41658
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.061	**PATH#30 data**		**Hex Address**	**Dec Address**
			067AH 067BH	41659 41660
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.062	**PATH#31 definition**		**Hex Address**	**Dec Address**
			067CH 067DH	41661 41662
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.063	PATH#31 data		Hex Address	Dec Address
			067EH 067FH	41663 41664
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.064	PATH#32 definition		Hex Address	Dec Address
			0680H 0681H	41665 41666
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.065	PATH#32 data		Hex Address	Dec Address
			0682H 0683H	41667 41668
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.066	PATH#33 definition		Hex Address	Dec Address
			0684H 0685H	41669 41670
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.067	PATH#33 data		Hex Address	Dec Address
			0686H 0687H	41671 41672
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.068	**PATH#34 definition**		**Hex Address**	**Dec Address**
			0688H 0689H	41673 41674
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.069	**PATH#34 data**		**Hex Address**	**Dec Address**
			068AH 068BH	41675 41676
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.070	**PATH#35 definition**		**Hex Address**	**Dec Address**
			068CH 068DH	41677 41678
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.071	**PATH#35 data**		**Hex Address**	**Dec Address**
			068EH 068FH	41679 41680
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.072	**PATH#36 definition**		**Hex Address**	**Dec Address**
			0690H 0691H	41681 41682
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.073	PATH#36 data		Hex Address	Dec Address
			0692H 0693H	41683 41684
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.074	PATH#37 definition		Hex Address	Dec Address
			0694H 0695H	41685 41686
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.075	PATH#37 data		Hex Address	Dec Address
			0696H 0697H	41687 41688
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.076	PATH#38 definition		Hex Address	Dec Address
			0698H 0699H	41689 41690
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.077	PATH#38 data		Hex Address	Dec Address
			069AH 069BH	41691 41692
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.078	PATH#39 definition		Hex Address	Dec Address
			069CH 069DH	41693 41694
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.079	PATH#39 data		Hex Address	Dec Address
			069EH 069FH	41695 41696
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.080	PATH#40 definition		Hex Address	Dec Address
			06A0H 06A1H	41697 41698
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.081	PATH#40 data		Hex Address	Dec Address
			06A2H 06A3H	41699 41700
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.082	PATH#41 definition		Hex Address	Dec Address
			06A4H 06A5H	41701 41702
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.083	PATH#41 data			Hex Address	Dec Address
				06A6H 06A7H	41703 41704
Default:	0	Control mode:	PR		
Unit:	-	Setting range:	-2147483648 to +2147483647		
Format:	DEC	Data size:	32-bit		

Settings:

Please refer to the description of P6.003.

P6.084	PATH#42 definition			Hex Address	Dec Address
				06A8H 06A9H	41705 41706
Default:	0x00000000	Control mode:	PR		
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF		
Format:	HEX	Data size:	32-bit		

Settings:

Please refer to the description of P6.002.

P6.085	PATH#42 data			Hex Address	Dec Address
				06AAH 06ABH	41707 41708
Default:	0	Control mode:	PR		
Unit:	-	Setting range:	-2147483648 to +2147483647		
Format:	DEC	Data size:	32-bit		

Settings:

Please refer to the description of P6.003.

P6.086	PATH#43 definition			Hex Address	Dec Address
				06ACH 06ADH	41709 41710
Default:	0x00000000	Control mode:	PR		
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF		
Format:	HEX	Data size:	32-bit		

Settings:

Please refer to the description of P6.002.

P6.087	PATH#43 data			Hex Address	Dec Address
				06AEH 06AFH	41711 41712
Default:	0	Control mode:	PR		
Unit:	-	Setting range:	-2147483648 to +2147483647		
Format:	DEC	Data size:	32-bit		

Settings:

Please refer to the description of P6.003.

P6.088	PATH# 44 definition			Hex Address	Dec Address
				06B0H 06B1H	41713 41714
Default:	0x00000000	Control mode:	PR		
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF		
Format:	HEX	Data size:	32-bit		

Settings:

Please refer to the description of P6.002.

P6.089	PATH#44 data			Hex Address	Dec Address
				06B2H 06B3H	41715 41716
Default:	0	Control mode:	PR		
Unit:	-	Setting range:	-2147483648 to +2147483647		
Format:	DEC	Data size:	32-bit		

Settings:

Please refer to the description of P6.003.

P6.090	PATH# 45 definition			Hex Address	Dec Address
				06B4H 06B5H	41717 41718
Default:	0x00000000	Control mode:	PR		
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF		
Format:	HEX	Data size:	32-bit		

Settings:

Please refer to the description of P6.002.

P6.091	PATH#45 data			Hex Address	Dec Address
				06B6H 06B7H	41719 41720
Default:	0	Control mode:	PR		
Unit:	-	Setting range:	-2147483648 to +2147483647		
Format:	DEC	Data size:	32-bit		

Settings:

Please refer to the description of P6.003.

P6.092	PATH#46 definition			Hex Address	Dec Address
				06B8H 06B9H	41721 41722
Default:	0x00000000	Control mode:	PR		
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF		
Format:	HEX	Data size:	32-bit		

Settings:

Please refer to the description of P6.002.

P6.093	PATH#46 data		Hex Address	Dec Address
			06BAH 06BBH	41723 41724
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.094	PATH#47 definition		Hex Address	Dec Address
			06BCH 06BDH	41725 41726
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.095	PATH#47 data		Hex Address	Dec Address
			06BEH 06BFH	41727 41728
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.096	PATH#48 definition		Hex Address	Dec Address
			06C0H 06C1H	41729 41730
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.097	PATH#48 data		Hex Address	Dec Address
			06C2H 06C3H	41731 41732
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P6.098	PATH#49 definition		Hex Address	Dec Address
			06C4H 06C5H	41733 41734
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P6.099	PATH#49 data		Hex Address	Dec Address
			06C6H 06C7H	41735 41736
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

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P7.000	PATH#50 definition			Hex Address	Dec Address
				0700H 0701H	41793 41794
Default:	0x00000000	Control mode:	PR		
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF		
Format:	HEX	Data size:	32-bit		

Settings:

Please refer to the description of P6.002.

P7.001	PATH#50 data			Hex Address	Dec Address
				0702H 0703H	41795 41796
Default:	0	Control mode:	PR		
Unit:	-	Setting range:	-2147483648 to +2147483647		
Format:	DEC	Data size:	32-bit		

Settings:

Please refer to the description of P6.003.

P7.002	PATH#51 definition			Hex Address	Dec Address
				0704H 0705H	41797 41798
Default:	0x00000000	Control mode:	PR		
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF		
Format:	HEX	Data size:	32-bit		

Settings:

Please refer to the description of P6.002. Note that P7.002 - P7.027 can be linked to Events. See P5.098 and P5.099

P7.003	PATH#51 data			Hex Address	Dec Address
				0706H 0707H	41799 41800
Default:	0	Control mode:	PR		
Unit:	-	Setting range:	-2147483648 to +2147483647		
Format:	DEC	Data size:	32-bit		

Settings:

Please refer to the description of P6.003.

P7.004	PATH#52 definition			Hex Address	Dec Address
				0708H 0709H	41801 41802
Default:	0x00000000	Control mode:	PR		
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF		
Format:	HEX	Data size:	32-bit		

Settings:

Please refer to the description of P6.002.

P7.005	PATH#52 data		Hex Address	Dec Address
			070AH 070BH	41803 41804
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.006	PATH#53 definition		Hex Address	Dec Address
			070CH 070DH	41805 41806
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.007	PATH#53 data		Hex Address	Dec Address
			070EH 070FH	41807 41808
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.008	PATH#54 definition		Hex Address	Dec Address
			0710H 0711H	41809 41810
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.009	PATH#54 data		Hex Address	Dec Address
			0712H 0713H	41811 41812
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.010	PATH#55 definition		Hex Address	Dec Address
			0714H 0715H	41813 41814
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.011	PATH#55 data		Hex Address	Dec Address
			0716H 0717H	41815 41816
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.012	PATH#56 definition		Hex Address	Dec Address
			0718H 0719H	41817 41818
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.013	PATH#56 data		Hex Address	Dec Address
			071AH 071BH	41819 41820
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.014	PATH#57 definition		Hex Address	Dec Address
			071CH 071DH	41821 41822
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.015	***PATH#57 data***		***Hex Address***	***Dec Address***
			071EH 071FH	41823 41824
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.016	***PATH#58 definition***		***Hex Address***	***Dec Address***
			0720H 0721H	41825 41826
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.017	***PATH#58 data***		***Hex Address***	***Dec Address***
			0722H 0723H	41827 41828
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.018	***PATH#59 definition***		***Hex Address***	***Dec Address***
			0724H 0725H	41829 41830
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.019	***PATH#59 data***		***Hex Address***	***Dec Address***
			0726H 0727H	41831 41832
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.020	PATH#60 definition		Hex Address	Dec Address
			0728H 0729H	41833 41834
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000to–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.021	PATH#60 data		Hex Address	Dec Address
			072AH 072BH	41835 41836
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.022	PATH#61 definition		Hex Address	Dec Address
			072CH 072DH	41837 41838
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.023	PATH#61 data		Hex Address	Dec Address
			072EH 072FH	41839 41840
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.024	PATH#62 definition		Hex Address	Dec Address
			0730H 0731H	41841 41842
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.025	PATH#62 data		Hex Address	Dec Address
			0732H 0733H	41843 41844
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.026	PATH#63 definition		Hex Address	Dec Address
			0734H 0735H	41845 41846
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.027	PATH#63 data		Hex Address	Dec Address
			0736H 0737H	41847 41848
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.028	PATH#64 definition		Hex Address	Dec Address
			0738H 0739H	41849 41850
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.029	PATH#64 data		Hex Address	Dec Address
			073AH 073BH	41851 41852
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.030	PATH#65 definition		Hex Address	Dec Address
			073CH 073DH	41853 41854
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.031	PATH#65 data		Hex Address	Dec Address
			073EH 073FH	41855 41856
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.032	PATH#66 definition		Hex Address	Dec Address
			0740H 0741H	41857 41858
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.033	PATH#66 data		Hex Address	Dec Address
			0742H 0743H	41859 41860
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.034	PATH#67 definition		Hex Address	Dec Address
			0744H 0745H	41861 41862
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.035	PATH#67 data		Hex Address	Dec Address
			0746H 0747H	41863 41864
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.036	PATH#68 definition		Hex Address	Dec Address
			0748H 0749H	41865 41866
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.037	PATH#68 data		Hex Address	Dec Address
			074AH 074BH	41867 41868
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.038	PATH#69 definition		Hex Address	Dec Address
			074CH 074DH	41869 41870
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.039	PATH#69 data		Hex Address	Dec Address
			074EH 074FH	41871 41872
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.040	PATH#70 definition			Hex Address	Dec Address
				0750H 0751H	41873 41874
Default:	0x00000000	Control mode:	PR		
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF		
Format:	HEX	Data size:	32-bit		

Settings:

Please refer to the description of P6.002.

P7.041	PATH#70 data			Hex Address	Dec Address
				0752H 0753H	41875 41876
Default:	0	Control mode:	PR		
Unit:	-	Setting range:	-2147483648 to +2147483647		
Format:	DEC	Data size:	32-bit		

Settings:

Please refer to the description of P6.003.

P7.042	PATH#71 definition			Hex Address	Dec Address
				0754H 0755H	41877 41878
Default:	0x00000000	Control mode:	PR		
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF		
Format:	HEX	Data size:	32-bit		

Settings:

Please refer to the description of P6.002.

P7.043	PATH#71 data			Hex Address	Dec Address
				0756H 0757H	41879 41880
Default:	0	Control mode:	PR		
Unit:	-	Setting range:	-2147483648 to +2147483647		
Format:	DEC	Data size:	32-bit		

Settings:

Please refer to the description of P6.003.

P7.044	PATH#72 definition			Hex Address	Dec Address
				0758H 0759H	41881 41882
Default:	0x00000000	Control mode:	PR		
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF		
Format:	HEX	Data size:	32-bit		

Settings:

Please refer to the description of P6.002.

P7.045	PATH#72 data		Hex Address	Dec Address
			075AH 075BH	41883 41884
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.046	PATH#73 definition		Hex Address	Dec Address
			075CH 075DH	41885 41886
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.047	PATH#73 data		Hex Address	Dec Address
			075EH 075FH	41887 41888
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.048	PATH#74 definition		Hex Address	Dec Address
			0760H 0761H	41889 41890
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.049	PATH#74 data		Hex Address	Dec Address
			0762H 0763H	41891 41892
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.050	PATH#75 definition		Hex Address	Dec Address
			0764H 0765H	41893 41894
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.051	PATH#75 data		Hex Address	Dec Address
			0766H 0767H	41895 41896
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.052	PATH#76 definition		Hex Address	Dec Address
			0768H 0769H	41897 41898
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.053	PATH#76 data		Hex Address	Dec Address
			076AH 076BH	41899 41900
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.054	PATH#77 definition		Hex Address	Dec Address
			076CH 076DH	41901 41902
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.055	PATH#77 data		Hex Address	Dec Address
			076EH 076FH	41903 41904
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.056	PATH#78 definition		Hex Address	Dec Address
			0770H 0771H	41905 41906
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.057	PATH#78 data		Hex Address	Dec Address
			0772H 0773H	41907 41908
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.058	PATH#79 definition		Hex Address	Dec Address
			0774H 0775H	41909 41910
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.059	PATH#79 data		Hex Address	Dec Address
			0776H 0777H	41911 41912
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.060	PATH#80 definition		Hex Address	Dec Address
			0778H 0779H	41913 41914
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.061	PATH#80 data		Hex Address	Dec Address
			077AH 077BH	41915 41916
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.062	PATH#81 definition		Hex Address	Dec Address
			077CH 077DH	41917 41918
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.063	PATH#81 data		Hex Address	Dec Address
			077EH 077FH	41919 41920
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.064	PATH#82 definition		Hex Address	Dec Address
			0780H 0781H	41921 41922
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.065	PATH#82 data		Hex Address	Dec Address
			0782H 0783H	41923 41924
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.066	PATH#83 definition		Hex Address	Dec Address
			0784H 0785H	41925 41926
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.067	PATH#83 data		Hex Address	Dec Address
			0786H 0787H	41927 41928
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.068	PATH#84 definition		Hex Address	Dec Address
			0788H 0789H	41929 41930
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.069	PATH#84 data		Hex Address	Dec Address
			078AH 078BH	41931 41932
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.070	PATH#85 definition		Hex Address	Dec Address
			078CH 078DH	41933 41934
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.071	PATH#85 data		Hex Address	Dec Address
			078EH 078FH	41935 41936
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.072	PATH#86 definition		Hex Address	Dec Address
			0790H 0791H	41937 41938
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.073	PATH#86 data		Hex Address	Dec Address
			0792H 0793H	41939 41940
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.074	PATH#87 definition		Hex Address	Dec Address
			0794H 0795H	41941 41942
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.075	PATH#87 data		Hex Address	Dec Address
			0796H 0797H	41943 41944
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.076	PATH#88 definition		Hex Address	Dec Address
			0798H 0799H	41945 41946
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.077	PATH#88 data		Hex Address	Dec Address
			079AH 079BH	41947 41948
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.078	PATH#89 definition		Hex Address	Dec Address
			079CH 079DH	41949 41950
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.079	PATH#89 data		Hex Address	Dec Address
			079EH 079FH	41951 41952
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.080	PATH#90 definition			Hex Address	Dec Address
				07A0H 07A1H	41953 41954
Default:	0x00000000	Control mode:	PR		
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF		
Format:	HEX	Data size:	32-bit		

Settings:

Please refer to the description of P6.002.

P7.081	PATH#90 data			Hex Address	Dec Address
				07A2H 07A3H	41955 41956
Default:	0	Control mode:	PR		
Unit:	-	Setting range:	-2147483648 to +2147483647		
Format:	DEC	Data size:	32-bit		

Settings:

Please refer to the description of P6.003.

P7.082	PATH#91 definition			Hex Address	Dec Address
				07A4H 07A5H	41957 41958
Default:	0x00000000	Control mode:	PR		
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF		
Format:	HEX	Data size:	32-bit		

Settings:

Please refer to the description of P6.002.

P7.083	PATH#91 data			Hex Address	Dec Address
				07A6H 07A7H	41959 41960
Default:	0	Control mode:	PR		
Unit:	-	Setting range:	-2147483648 to +2147483647		
Format:	DEC	Data size:	32-bit		

Settings:

Please refer to the description of P6.003.

P7.084	PATH#92 definition			Hex Address	Dec Address
				07A8H 07A9H	41961 41962
Default:	0x00000000	Control mode:	PR		
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF		
Format:	HEX	Data size:	32-bit		

Settings:

Please refer to the description of P6.002.

P7.085	PATH#92 data		Hex Address	Dec Address
			07AAH 07ABH	41963 41964
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.086	PATH#93 definition		Hex Address	Dec Address
			07ACH 07ADH	41965 41966
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.087	PATH#93 data		Hex Address	Dec Address
			07AEH 07AFH	41967 41968
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.088	PATH#94 definition		Hex Address	Dec Address
			07B0H 07B1H	41969 41970
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.089	PATH#94 data		Hex Address	Dec Address
			07B2H 07B3H	41971 41972
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.090	PATH#95 definition		Hex Address	Dec Address
			07B4H 07B5H	41973 41974
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.091	PATH#95 data		Hex Address	Dec Address
			07B4H 07B5H	41975 41976
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.092	PATH#96 definition		Hex Address	Dec Address
			07B8H 07B9H	41977 41978
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.093	PATH#96 data		Hex Address	Dec Address
			07BAH 07BBH	41979 41980
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.094	PATH#97 definition		Hex Address	Dec Address
			07BCH 07BDH	41981 41982
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.095	PATH#97 data		Hex Address	Dec Address
			07BEH 07BFH	41983 41984
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.096	PATH#98 definition		Hex Address	Dec Address
			07C0H 07C1H	41985 41986
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.097	PATH#98 data		Hex Address	Dec Address
			07C2H 07C3H	41987 41988
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

P7.098	PATH#99 definition		Hex Address	Dec Address
			07C4H 07C5H	41989 41990
Default:	0x00000000	Control mode:	PR	
Unit:	-	Setting range:	0x00000000–0xFFFFFFFF	
Format:	HEX	Data size:	32-bit	

Settings:

Please refer to the description of P6.002.

P7.099	PATH#99 data		Hex Address	Dec Address
			07C6H 07C7H	41991 41992
Default:	0	Control mode:	PR	
Unit:	-	Setting range:	-2147483648 to +2147483647	
Format:	DEC	Data size:	32-bit	

Settings:

Please refer to the description of P6.003.

8.4.9 - Digital Input (DI) Function Assignments

Table 8-1: Digital Input (DI) Descriptions (see P2.010–P2.017, P2.030–P2.040)

Value	Name	Description
0x01	SON	Servo on
0x02	ARST	Alarm reset
0x03	GAINUP	Gain switching
0x04	CCLR	Pulse clear
0x05	ZCLAMP	Enables a low-speed deadband for the motor speed. See P1.038. Also see P2.065 for more information.
0x06	CMDINV	Reverse direction of input command
0x08	CTRG	Command triggered
0x09	TRQLM	Torque limit (duplicates behavior of P1.002.Y)
0x0B	FHS	Switch between full- and half-closed loop modes while P1.074.X=1
0x0C	VPL	Latch function of analog Position command
0x0D	VPRS	Clear function of analog Position command
0x0E	FEC	Clear errors of the full closed-loop auxiliary encoder and motor encoder
0x0F	SPDKVC	Maximum analog Speed command switch (P1.040 and P1.081)
0x10	SPDLM	Speed limit (duplicates behavior of P1.002.X)
0x11	POS0	Register Position command selection 1 - 99 Bit0
0x12	POS1	Register Position command selection 1 - 99 Bit1
0x13	POS2	Register Position command selection 1 - 99 Bit2
0x1A	POS3	Register Position command selection 1 - 99 Bit3
0x1B	POS4	Register Position command selection 1 - 99 Bit4
0x1C	POS5	Register Position command selection 1 - 99 Bit5
0x1E	POS6	Register Position command selection 1 - 99 Bit6
0x1D	ABSE	Enable the setting and reading of absolute coordinate system
0x1F	ABSC	Set or clear the absolute coordinate system
0x14	SPD0	Register Speed command selection (1 - 4) Bit0
0x15	SPD1	Register Speed command selection (1 - 4) Bit1
0x16	TCM0	Register Torque command selection (1 - 4) Bit0
0x17	TCM1	Register Torque command selection (1 - 4) Bit1
0x18	S-P	Position / Speed modes selection
0x19	S-T	Torque / Speed modes selection
0x20	T-P	Torque / Position modes selection
0x21	OVRD	Motor override (level-based DI motor stop)
0x22	NL (CWL)	Reverse inhibit limit
0x23	PL (CCWL)	Forward inhibit limit
0x24	ORG	Homing origin
0x27	SHOM	Enable homing
0x2B	PT-PR	PT / PR modes selection
0x35	ALGN	Electronic cam phase alignment
0x36	CAM	E-Cam engaging control
0x37	JOGU	Motor JOGs in the forward direction
0x38	JOGD	Motor JOGs in the reverse direction
0x39	EV1	Event trigger command 1
0x3A	EV2	Event trigger command 2

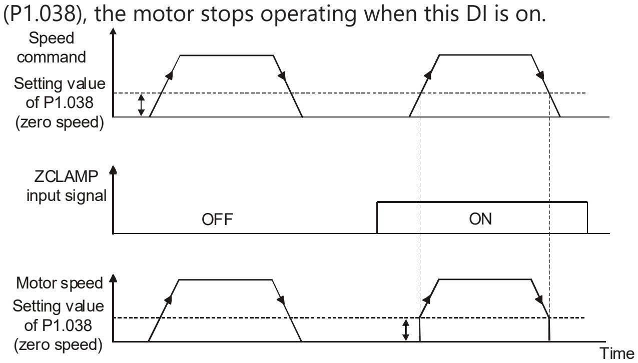
Value	Name	Description
0x3B	EV3	Event trigger command 3
0x3C	EV4	Event trigger command 4
0x43	GNUM0	E-Gear ratio (Numerator) selection 0
0x44	GNUM1	E-Gear ratio (Numerator) selection 1
0x45	INHP	External pulse inhibit (This can only be assigned to DI8. See P2.017.)
0x46	STP	Motor stops
0x47	PFQS	Use this DI to set the emergency stop for deceleration time

Value: 0x01			
DI Name	**Description**	**Triggering Method**	**Control Mode**
SON	When this DI is on, servo is activated (Servo On).	Level triggered	ALL

Value: 0x02			
DI Name	**Description**	**Triggering Method**	**Control Mode**
ARST	Alarm reset. After the alarm is cleared, the drive shows that the alarm is cleared when this DI is on.	Rising-edge triggered	ALL

Value: 0x03			
DI Name	**Description**	**Triggering Method**	**Control Mode**
GAINUP	In Speed and Position modes, when this DI is on (P2.027, Gain switching condition and method selection, set to 1), the gain switches to the original gain multiplied by the switching rate.	Level triggered	PT, PR, S

Value: 0x04			
DI Name	**Description**	**Triggering Method**	**Control Mode**
CCLR	Clear pulse counter and P2.050, Pulse Clear Mode (defines CCLR as rising-edge or level triggered). Set DI.CCLR to clear position pulse deviation (applicable to PT mode). When this DI is on, the accumulative pulse deviation of the drive is cleared to 0.	Rising-edge triggered, level triggered	PT, PR

Value: 0x05			
DI Name	**Description**	**Triggering Method**	**Control Mode**
ZCLAMP	When the speed is slower than the setting of zero speed (P1.038), the motor stops operating when this DI is on. 	Level triggered	S

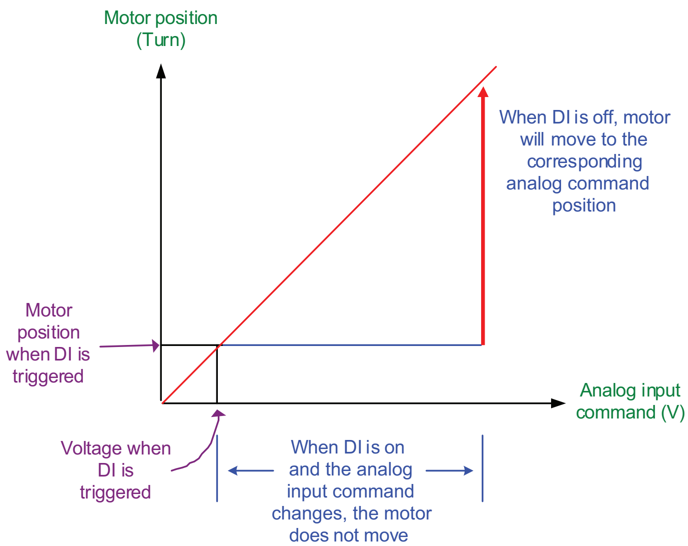
Value: 0x06			
DI Name	**Description**	**Triggering Method**	**Control Mode**
CMDINV	Command inversion. In Speed and Torque modes, input command is set to the reverse direction when this DI is on.	Level triggered	S, Sz, T

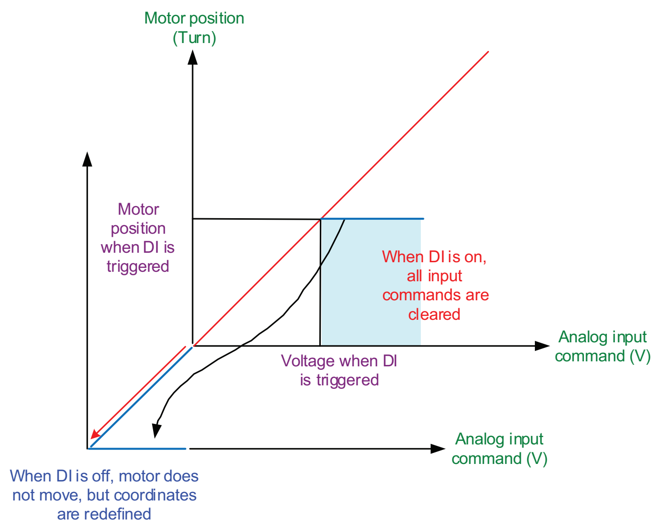
Value: 0x08			
DI Name	**Description**	**Triggering Method**	**Control Mode**
CTRG	Command trigger. In PR mode, after selecting the PR command (POS0–6), the motor operates according to the command issued by the register when this DI is on.	Rising-edge triggered	PR

Value: 0x09			
DI Name	**Description**	**Triggering Method**	**Control Mode**
TRQLM	Torque limit. In Speed and Position modes, motor torque is limited when this DI is on, and source of the torque limit command is the internal register or analog voltage. DI.TRQLM or P1.002:Y can be used to enable a torque limit. See definitions of DI.TCM0 and DI.TCM1 below. Also refer to “6.6 - Others” on page 6–31 for more details.	Level triggered	PT, PR, S

Value: 0x0A			
DI Name	**Description**	**Triggering Method**	**Control Mode**
GTRY	When the gantry synchronization function is enabled (P1.074=2), switch this DI ON to temporarily disable the monitoring function of the grantry synchronization. After receiving this DI, the servo stops calculating and monitoring the error between the two axes.	Rising-edge triggered	PT

Value: 0x0B			
DI Name	**Description**	**Triggering Method**	**Control Mode**
FHS	Switch between full- and semi-closed loop modes while P1.074.X=1..	Level triggered	PT, PR (Full-closed loop)

<table>
<tr><th colspan="4">Value: 0x0C</th></tr>
<tr><th>DI Name</th><th>Description</th><th>Triggering Method</th><th>Control Mode</th></tr>
<tr><td>VPL</td><td>Voltage/position latch for the Analog Position command. If this DI is on, position of the motor is held at the current position when the DI is triggered. While this DI is on, the motor does not move even when there is a change in the analog position command. When this DI is off, the motor completes the command that was changed during the time DI was on. See P1.064 for more details of Analog Positioning.

</td><td>Level triggered</td><td>PT</td></tr>
</table>

<table>
<tr><th colspan="4">Value: 0x0D</th></tr>
<tr><th>DI Name</th><th>Description</th><th>Triggering Method</th><th>Control Mode</th></tr>
<tr><td>VPRS</td><td>Clear function of analog Position command. If this DI is on, the position of the motor is held at the current position when DI is triggered. Despite the change in the analog command when DI is on, the motor remains at the current position even when the DI turns off. However, the position that the motor remains at corresponds to the new analog command. Thus, the analog input command redefines the coordinate system of the motor.

</td><td>Level triggered</td><td>PT</td></tr>
</table>

Value: 0x0E			
DI Name	**Description**	**Triggering Method**	**Control Mode**
FEC	Clear error of full-closed loop auxiliary encoder and motor encoder.	Rising-edge triggered	PT/PR full-closed loop

Value: 0x0F			
DI Name	**Description**	**Triggering Method**	**Control Mode**
SPDKVC	Maximum analog Speed command switch (P1.040 and P1.081)	Level triggered	S

Value: 0x10			
DI Name	**Description**	**Triggering Method**	**Control Mode**
SPDLM	Speed limit. In Torque mode, motor speed is limited when this DI is on, and the limited Speed command is the internal register or analog voltage command. DI.SPDLM or P1.002:X can be used to enable the speed limit. See definitions of SPD0 and SPD1 below. Also refer to “6.6 - Others” on page 6–31 for more details.	Level triggered	T

Value: 0x11, 0x12, 0x13, 0x1A, 0x1B, 0x1C, 0x1E			
DI Name	**Description**	**Triggering Method**	**Control Mode**
POS0 POS1 POS2 POS3 POS4 POS5 POS6	PR command selection (1–99). The decimal value of POS6 - POS0 corresponds to the triggered PR value. Example (on the last row): binary 1100011 = decimal 99 = PR99.	Level triggered	PR

Position command	POS 6	POS 5	POS 4	POS 3	POS 2	POS 1	POS 0	CTRG	Corresponding parameter
Homing	0	0	0	0	0	0	0	↑	P6.000 P6.001
PR 1	0	0	0	0	0	0	1	↑	P6.002 P6.003
-									
PR 50	0	1	1	0	0	1	0	↑	P6.098 P6.099
PR 51	0	1	1	0	0	1	1	↑	P7.000 P7.001
-									
PR 99	1	1	0	0	0	1	1	↑	P7.098 P7.099

Value: 0x1D			
DI Name	**Description**	**Triggering Method**	**Control Mode**
ABSE	When DI.ABSE is on, it is in absolute mode and can enable the functions of DI.ABSQ, DI.ABSC, DO.ABSR, and DO.ABSD at the same time. When DI.ABSE is on, the functions of DI4, DO2, and DO3 are no longer the ones assigned by the parameter. The DI4 function will be DI.ABSQ, DO2 will be DO.ABSR, and DO3 will be DO.ABSD. In addition, the DI point of DI.ABSC can be assigned by parameters.	Level triggered	All

Value: 0x1F			
DI Name	***Description***	***Triggering Method***	***Control Mode***
ABSC	Absolute encoder clear. When DI.ABSC is on, the number of turns stored in the absolute encoder are cleared. But this DI is only valid when DI.ABSE is on.	Rising-edge triggered	All

Value: when DI.ABSE is on, the DI.ABSQ from DI4 replaces the DI4 fnction from P2.013			
DI Name	***Description***	***Triggering Method***	***Control Mode***
ABSQ always input by DI4	During I/O transmission, the controller sends the handshaking signal. When DI.ABSQ is off, the controller issues the request; when DI.ABSQ is on, the controller has processed the ABSD signal. This DI is only valid when DI.ABSE is on.	Rising- and falling-edge triggered	All

<table>
<tr><th colspan="4">Value: 0x14, 0x15</th></tr>
<tr><th>DI Name</th><th>Description</th><th>Triggering Method</th><th>Control Mode</th></tr>
<tr><td>SPD0
SPD1</td><td>Register Speed command selection (0–3)
<table>
<tr><th rowspan="2">Speed Command Number</th><th colspan="2">DI signal of CN1</th><th rowspan="2" colspan="2">Command source</th><th rowspan="2">Content</th><th rowspan="2">Range</th></tr>
<tr><th>SPD1</th><th>SPD0</th></tr>
<tr><td rowspan="2">S0</td><td rowspan="2">0</td><td rowspan="2">0</td><td>Mode S</td><td>External analog signal</td><td>Voltage difference between V-REF and GND</td><td>-10V to +10V</td></tr>
<tr><td>Mode Sz</td><td>0Hz</td><td>Speed command is 0</td><td>0</td></tr>
<tr><td>S1</td><td>0</td><td>1</td><td rowspan="3" colspan="2">Register parameter</td><td>P1.009</td><td rowspan="3">+/- 6000 rpm (rotary)</td></tr>
<tr><td>S2</td><td>1</td><td>0</td><td>P1.010</td></tr>
<tr><td>S3</td><td>1</td><td>1</td><td>P1.011</td></tr>
</table>
In Torque Mode, SPD0 and SPD1 are only used as limits if DI.SPDLM=1 or P1.002.X=1. See “6.6 - Others” on page 6–31 for more details.</td><td>Level triggered</td><td>S</td></tr>
</table>

<table>
<tr><th colspan="4">Value: 0x16, 0x17</th></tr>
<tr><th>DI Name</th><th>Description</th><th>Triggering Method</th><th>Control Mode</th></tr>
<tr><td>TCM0
TCM1</td><td>Register Torque command selection (0–3)
<table>
<tr><th rowspan="2">Torque Command Number</th><th colspan="2">DI Signal of CN1</th><th rowspan="2" colspan="3">Command source</th><th rowspan="2">Content</th><th rowspan="2">Range</th></tr>
<tr><th>TCM1</th><th>TCM0</th></tr>
<tr><td rowspan="2">T0</td><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">Mode</td><td>T</td><td>External analog command</td><td>Voltage difference between T-REF and GND</td><td>-10V to +10V</td></tr>
<tr><td>Tz</td><td>N/A</td><td>Torque command is 0</td><td>0</td></tr>
<tr><td>T1</td><td>0</td><td>1</td><td rowspan="3" colspan="3">Register parameter</td><td>P1.012</td><td rowspan="3">+/- 400%</td></tr>
<tr><td>T2</td><td>1</td><td>0</td><td>P1.013</td></tr>
<tr><td>T3</td><td>1</td><td>1</td><td>P1.014</td></tr>
</table>
In Speed Mode, TCM0 and TCM1 are only used as limits if DI.TRQLM=1 or if P1.002:Y =1. See “6.6 - Others” on page 6–31 for more details.</td><td>Level triggered</td><td>T</td></tr>
</table>

Value: 0x18			
DI Name	**Description**	**Triggering Method**	**Control Mode**
S-P	In Position and Speed dual modes, if this DI is off, the drive is in Speed mode; if this DI is on, the drive is in Position mode. In PT / PR / S mode, PT and PR are selected with DI.PT-PR (0x2B).	Level triggered	Dual mode

Value: 0x19			
DI Name	**Description**	**Triggering Method**	**Control Mode**
S-T	In Speed and Torque dual modes, if this DI is off, the drive is in Speed mode; if this DI is on, the drive is in Torque mode.	Level triggered	Dual mode

Value: 0x20			
DI Name	**Description**	**Triggering Method**	**Control Mode**
T-P	In Position and Torque dual modes, if this DI is off, the drive is in Torque mode; if this DI is on, the drive is in Position mode. In PT / PR / T modes, PT and PR are selected with DI.PT-PR (0x2B).	Level triggered	Dual mode

Value: 0x21			
DI Name	**Description**	**Triggering Method**	**Control Mode**
OVRD	When this DI is active, the motor stops per P1.032, and triggers AL013. The motor will restart when the DI is inactive.	Level triggered	All

Value: 0x22			
DI Name	**Description**	**Triggering Method**	**Control Mode**
NL (CWL)	This DI is the Reverse inhibit limit (Reverse Overtravel). This DI triggers AL014 Reverse Limit Error.	Level triggered	All

Value: 0x23			
DI Name	**Description**	**Triggering Method**	**Control Mode**
PL (CCWL)	This DI is the Forward inhibit limit (Forward Overtravel). This DI triggers AL015 Forward Limit Error.	Level triggered	All

Value: 0x24			
DI Name	**Description**	**Triggering Method**	**Control Mode**
ORG	During homing, when this DI is triggered, the servo uses the position as the homing origin. Please refer to the setting of P5.004.	Rising- and falling-edge triggered	PR

Value: 0x27			
DI Name	**Description**	**Triggering Method**	**Control Mode**
SHOM	During homing, when this DI is on, it activates the function to search for the origin. Please refer to the setting of P5.004.	Rising-edge triggered	PR

Value: 0x2B			
DI Name	**Description**	**Triggering Method**	**Control Mode**
PT-PR	Use this DI to select the command source in PT-PR dual mode or PT-PR-S multiple mode. If this DI is off, the drive is in PT mode; if this DI is on, the drive is in PR mode.	Level triggered	Dual mode

Value: 0x35			
DI Name	**Description**	**Triggering Method**	**Control Mode**
ALGN	When E-Cam alignment function is enabled (P2.076.bit0 = 1 & P2.076.bit1 = 1), it executes alignment correction when this DI is on.	Rising-edge triggered	PR

Value: 0x36			
DI Name	**Description**	**Triggering Method**	**Control Mode**
CAM	E-Cam engaging control. Please refer to the setting of P5.088 U, Z value.	Rising- and falling-edge triggered	PR

Value: 0x37			
DI Name	**Description**	**Triggering Method**	**Control Mode**
JOGU	When this DI is on, the motor JOGs in the forward direction. P1.034 and P1.035 can be used to control acceleration and deceleration when using the DI jog function.	Level triggered	All

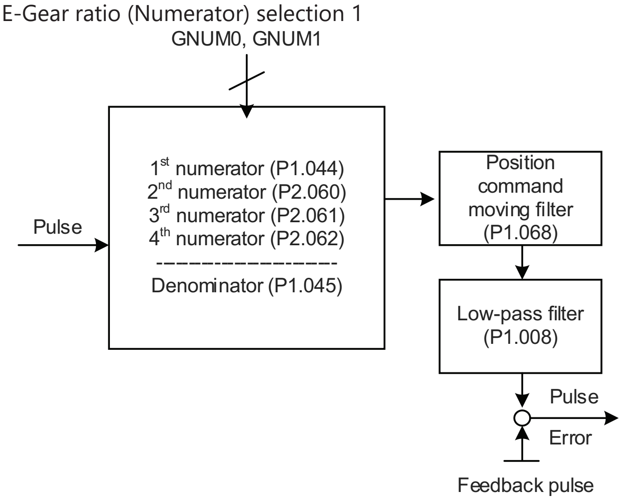
Value: 0x38			
DI Name	**Description**	**Triggering Method**	**Control Mode**
JOGD	When this DI is on, the motor JOGs in the reverse direction. P1.034 and P1.035 can be used to control acceleration and deceleration when using the DI jog function.	Level triggered	All

Value: 0x39			
DI Name	**Description**	**Triggering Method**	**Control Mode**
EV1	Event trigger command #1. Please refer to the setting of P5.098 and P5.099.	Rising- and falling-edge triggered	PR

Value: 0x3A			
DI Name	**Description**	**Triggering Method**	**Control Mode**
EV2	Event trigger command #2. Please refer to the setting of P5.098 and P5.099.	Rising- and falling-edge triggered	PR

Value: 0x3B			
DI Name	**Description**	**Triggering Method**	**Control Mode**
EV3	Event trigger command #3. Please refer to the setting of P5.098 and P5.099.	Rising- and falling-edge triggered	PR

Value: 0x3C			
DI Name	**Description**	**Triggering Method**	**Control Mode**
EV4	Event trigger command #4. Please refer to the setting of P5.098 and P5.099.	Rising- and falling-edge triggered	PR

<table>
<tr><th colspan="4">Value: 0x43, 0x44</th></tr>
<tr><th>DI Name</th><th>Description</th><th>Triggering Method</th><th>Control Mode</th></tr>
<tr><td>GNUM0
GNUM1</td><td>E-Gear ratio (Numerator) selection 0
E-Gear ratio (Numerator) selection 1


<table>
<tr><th>GNUM1</th><th>GNUM0</th><th>Numerator to Use</th></tr>
<tr><td>0</td><td>0</td><td>P1.044</td></tr>
<tr><td>0</td><td>1</td><td>P2.060</td></tr>
<tr><td>1</td><td>0</td><td>P2.061</td></tr>
<tr><td>1</td><td>1</td><td>P2.062</td></tr>
</table></td><td>Level triggered</td><td>PT</td></tr>
</table>

Value: 0x45			
DI Name	**Description**	**Triggering Method**	**Control Mode**
INHP	In Position mode, the external pulse input command will no longer command position moves when this DI is on. INHP only works when connected to the actual DI8 terminal. If DI8 is controlled via communication control or SV2-Pro2 the pulse inhibit will not work. **Note:** this function has to be set to DI8 to ensure immediate pulse inhibition.	Level triggered	PT

Value: 0x46			
DI Name	**Description**	**Triggering Method**	**Control Mode**
STP	Motor stops. This DI commands the motor to stop in PR mode. P2.068.Z defines DI.STP as rising edge triggered (default) or level triggered.	Rising-edge triggered	PR

Value: 0x47			
DI Name	**Description**	**Triggering Method**	**Control Mode**
PFQS	Use this DI to set an emergency stop. The motor decelerates to a controlled stop. The value for deceleration time is same as P5.003. If this DI is triggered, AL3CF occurs and the motor starts decelerating. When the speed reaches 0, AL3CF occurs and servo is switched to Servo Off. Please reset the alarm to switch the drive to the Servo On state.	Rising-edge triggered	PT, PR, T, S

NOTE: *When P2.010-P2.017, P2.036-P2.040 are set to 0, the input function is disabled.*

8.4.10 - Digital output (DO) Function Assignments

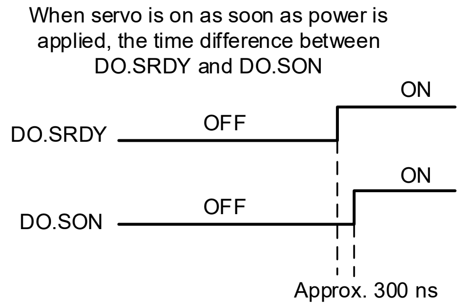
NOTE: *Several DO functions have their status available in P0.046. Since there are a limited number of physical outputs to tie the DO functions to, you can use that register for status feedback (with communications) without consuming physical DO terminals.*

Table 8-2: Digital Output (DO) Descriptions (see P2.018–P2.022, and P2.041)

Value	Name	Description
0x01	SRDY	Servo ready
0x02	SON	Servo On
0x03	ZSPD	Motor is at zero speed
0x04	TSPD	Motor reaches the target speed
0x05	TPOS	Motor reaches the target position
0x06	TQL	Torque limit activated
0x07	ALRM	Servo alarm
0x08	BRKR	Magnetic brake control
0x09	HOME	Homing is complete
0x0D	ABSW	Absolute type system error
0x0E	IDXD	Indexing coordinate is defined
0x10	OLW	Early warning for overload
0x11	WARN	Warning outputs
0x12	OVF	Position command overflows
0x13	SNL (SCWL)	Reverse software limit
0x14	SPL (SCCWL)	Forward software limit
0x15	Cmd_OK	PR command completed
0x16	CAP_OK	CAP procedure completed
0x17	MC_OK	Servo procedure completed
0x18	CAM_AREA1	Master position of the E-Cam is in the setting area
0x19	SP_OK	Speed reaches the target speed
0x1A	CAM_AREA2	Master position of the E-Cam is in the setting area 2
0x2C	Zon1	General range comparison 1
0x2D	Zon2	General range comparison 2
0x2E	Zon3	General range comparison 3
0x2F	Zon4	General range comparison 4
0x30	SPO_0	Output bit 00 of P4.006
0x31	SPO_1	Output bit 01 of P4.006
0x32	SPO_2	Output bit 02 of P4.006
0x33	SPO_3	Output bit 03 of P4.006
0x34	SPO_4	Output bit 04 of P4.006
0x35	SPO_5	Output bit 05 of P4.006
0x36	SPO_6	Output bit 06 of P4.006
0x37	SPO_7	Output bit 07 of P4.006
0x38	SPO_8	Output bit 08 of P4.006
0x39	SPO_9	Output bit 09 of P4.006
0x3A	SPO_A	Output bit 10 of P4.006
0x3B	SPO_B	Output bit 11 of P4.006
0x3C	SPO_C	Output bit 12 of P4.006
0x3D	SPO_D	Output bit 13 of P4.006
0x3E	SPO_E	Output bit 14 of P4.006

Value	Name	Description
0x3F	SPO_F	Output bit 15 of P4.006

Value: 0x01			
DO Name	Description	Triggering Method	Control Mode
SRDY	When the control and main circuit power is applied to the drive, this DO is on if no alarm occurs.	Level triggered	All

Value: 0x02			
DO Name	Description	Triggering Method	Control Mode
SON	When the servo is activated (Servo On), this DO is on if no alarm occurs. 	Level triggered	All

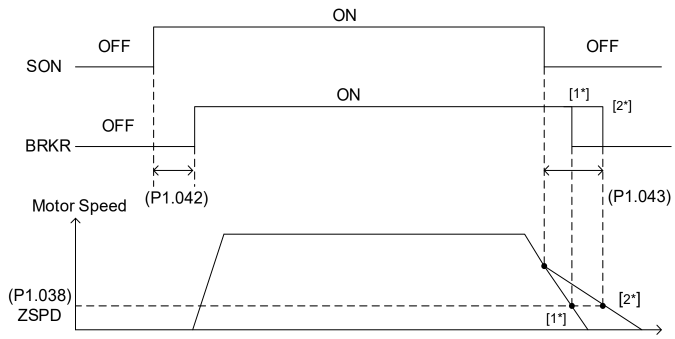
Value: 0x03			
DO Name	Description	Triggering Method	Control Mode
ZSPD	When the motor speed is slower than the value of the zero speed (P1.038), this DO is on.	Level triggered	All

Value: 0x04			
DO Name	Description	Triggering Method	Control Mode
TSPD	When the motor speed is faster than the target speed setting (P1.039), this DO is on.	Level triggered	All

Value: 0x05			
DO Name	Description	Triggering Method	Control Mode
TPOS	When the deviation pulse number is smaller than the position range setting (setting value of P1.054), this DO is on.	Level triggered	PT, PR

Value: 0x06			
DO Name	Description	Triggering Method	Control Mode
TQL	When the drive is in torque limit, this DO is on.	Level triggered	All (Except for T and Tz)

Value: 0x07			
DO Name	Description	Triggering Method	Control Mode
ALRM	When an alarm occurs, this DO is on (except for forward / reverse limit, communication error, and undervoltage). Read the current alarm in P0.001	Level triggered	All

Value: 0x08			
DO Name	***Description***	***Triggering Method***	***Control Mode***
BRKR	When the magnetic brake control signal is detected, please adjust the settings of parameters P1.042 and P1.043. This DO will normally turn off (engage the brake) when the motor speed drops below ZSPD. If SON is off and the speed has not dropped below ZSPD by the time set in P1.043, the brake will engage regardless of current speed.  1) If the delay time specified in P1.038 has not passed yet and the motor speed is slower than the value of P1.038, the magnetic brake signal (BRKR) is deactivated. 2) If the delay time specified in P1.038 has passed and the motor speed is faster than the value of P1.038, the magnetic brake signal (BRKR) is deactivated. 3) If P1.043 is a negative value and the servo is off due to an alarm (except for AL022) or emergency stop, this setting does not function. This is equivalent to setting the delay time to 0.	Level triggered	All

Value: 0x09			
DO Name	***Description***	***Triggering Method***	***Control Mode***
HOME	When homing is completed, the position coordinate system and position counter are defined and this DO turns on. When first applying power, this DO is off; when homing is completed, this DO is on. During operation, this DO is on until the position counter overflows (including commands or feedback). Then, this DO turns off. When the homing command is triggered, this DO turns off. After homing is completed, this DO turns on.	Level triggered	PR

Value: 0x0D			
DO Name	***Description***	***Triggering Method***	***Control Mode***
ABSW	When there are absolute encoder alarms, this DO is on.	-	All

Value: 0x0E			
DO Name	***Description***	***Triggering Method***	***Control Mode***
IDXD	Indexing coordinate is defined. When homing is completed, indexing coordinate is defined as well.	-	PR

Value: 0x10			
DO Name	**Description**	**Triggering Method**	**Control Mode**
OLW	Overload warning. This DO is on when the overload level setting is reached. **t_{OL}** = Overload allowable time of the servo x value for the overload warning level (P1.056). When the overload accumulative time exceeds **t_{OL}**, it sends the overload pre-warning DO (OLW). However, if the overload accumulative time exceeds the overload allowable time of the servo, it sets the overload error (DO.ALRM). For example: the value of the overload pre-warning is 60%. (P1.056 = 60) When the output average load of the servo drive is 200% and the output time exceeds 8 seconds, the overload alarm (AL006) occurs. **t_{OL}** = Duration of the output average load of the servo is 200% x overload warning level parameter = 8 sec x 60% = 4.8 sec Result: when the output average load of the servo drive is 200% for over **t_{OL}** = 4.8 seconds, this overload warning DO is on (DO code is set to 10). If the duration exceeds 8 seconds, then the overload alarm (AL006) occurs and sends the overload error (DO. ALRM).	Level triggered	All

Value: 0x11			
DO Name	**Description**	**Triggering Method**	**Control Mode**
WARN	Warning outputs (forward / reverse limit, communication error, and undervoltage). Read the current warning in P0.001.	Level triggered	All

Value: 0x12			
DO Name	**Description**	**Triggering Method**	**Control Mode**
OVF	Position command / feedback overflows.	Level triggered	PT, PR

Value: 0x13			
DO Name	**Description**	**Triggering Method**	**Control Mode**
SNL (SCWL)	Software limit (reverse limit).	Level triggered	PR

Value: 0x14			
DO Name	**Description**	**Triggering Method**	**Control Mode**
SPL (SCCWL)	Software limit (forward limit).	Level triggered	PR

Value: 0x15			
DO Name	**Description**	**Triggering Method**	**Control Mode**
Cmd_OK	When the Position command is completed this DO is on. When the Position command is executing, this DO is off; after the command completes, this DO is on. This DO only indicates that the processing of the command is completed, but the motor positioning may not be completed yet. Please refer to DO.TPOS.	Level triggered	PR

Value: 0x16			
DO Name	**Description**	**Triggering Method**	**Control Mode**
CAP_OK	Capture procedure is completed.	Level triggered	All

Value: 0x17			
DO Name	**Description**	**Triggering Method**	**Control Mode**
MC_OK	When DO.Cmd_OK and DO.TPOS are both on, then this DO is on. Please refer to P1.048.	Level triggered	PR

Value: 0x18			
DO Name	**Description**	**Triggering Method**	**Control Mode**
CAM_ AREA1	E-Cam area 1: the master axis phase is between the values of P5.090 and P5.091.	Level triggered	PR

Value: 0x19			
DO Name	**Description**	**Triggering Method**	**Control Mode**
SP_OK	Motor speed reaches the target speed: in Speed mode, when the deviation between the speed feedback and the command is smaller than the value of P1.047, this DO is on.	Level triggered	S, Sz

Value: 0x1A			
DO Name	**Description**	**Triggering Method**	**Control Mode**
CAM_ AREA2	E-Cam area 2: the master axis phase is between the values of P2.078 and P2.079.	Level triggered	PR

Value: 0x2C			
DO Name	**Description**	**Triggering Method**	**Control Mode**
Zon1	When the value of the item monitored by P0.009 ranges between the value of P0.054 and P0.055, then this DO is on.	-	All

Value: 0x2D			
DO Name	**Description**	**Triggering Method**	**Control Mode**
Zon2	Second set of general range comparison: when the value of the item monitored by P0.010 ranges between the values of P0.056 and P0.057, then this DO is on.	-	All

Value: 0x2E			
DO Name	**Description**	**Triggering Method**	**Control Mode**
Zon3	Third set of general range comparison: when the value of the item monitored by P0.011 ranges between the values of P0.058 and P0.059, then this DO is on.	-	All

Value: 0x2F			
DO Name	**Description**	**Triggering Method**	**Control Mode**
Zon4	Fourth set of general range comparison: when the value of the item monitored by P0.012 ranges between the values of P0.060 and P0.061, then this DO is on.	-	All

Value: 0x30			
DO Name	**Description**	**Triggering Method**	**Control Mode**
SPO_0	Output bit 00 of P4.006.	Level triggered	All

Value: 0x31			
DO Name	**Description**	**Triggering Method**	**Control Mode**
SPO_1	Output bit 01 of P4.006.	Level triggered	All

Value: 0x32			
DO Name	**Description**	**Triggering Method**	**Control Mode**
SPO_2	Output bit 02 of P4.006.	Level triggered	All

Value: 0x33			
DO Name	**Description**	**Triggering Method**	**Control Mode**
SPO_3	Output bit 03 of P4.006.	Level triggered	All

Value: 0x34			
DO Name	**Description**	**Triggering Method**	**Control Mode**
SPO_4	Output bit 04 of P4.006.	Level triggered	All

Value: 0x35			
DO Name	**Description**	**Triggering Method**	**Control Mode**
SPO_5	Output bit 05 of P4.006.	Level triggered	All

Value: 0x36			
DO Name	**Description**	**Triggering Method**	**Control Mode**
SPO_6	Output bit 06 of P4.006.	Level triggered	All

Value: 0x37			
DO Name	**Description**	**Triggering Method**	**Control Mode**
SPO_7	Output bit 07 of P4.006.	Level triggered	All

Value: 0x38			
DO Name	**Description**	**Triggering Method**	**Control Mode**
SPO_8	Output bit 08 of P4.006.	Level triggered	All

Value: 0x39			
DO Name	**Description**	**Triggering Method**	**Control Mode**
SPO_9	Output bit 09 of P4.006.	Level triggered	All

Value: 0x3A			
DO Name	**Description**	**Triggering Method**	**Control Mode**
SPO_A	Output bit 10 of P4.006.	Level triggered	All

Value: 0x3B			
DO Name	**Description**	**Triggering Method**	**Control Mode**
SPO_B	Output bit 11 of P4.006.	Level triggered	All

Value: 0x3C			
DO Name	**Description**	**Triggering Method**	**Control Mode**
SPO_C	Output bit 12 of P4.006.	Level triggered	All

Value: 0x3D			
DO Name	**Description**	**Triggering Method**	**Control Mode**
SPO_D	Output bit 13 of P4.006.	Level triggered	All

Value: 0x3E			
DO Name	**Description**	**Triggering Method**	**Control Mode**
SPO_E	Output bit 14 of P4.006.	Level triggered	All

Value: 0x3F			
DO Name	**Description**	**Triggering Method**	**Control Mode**
SPO_F	Output bit 15 of P4.006.	Level triggered	All

NOTE: *The output function is disabled when P2.018-P2.022 are set to 0.*

Value: when DI.ABSE is on, DO.ABSR triggered by DO2 will replace the DO2 assigned by P2.019			
DO Name	**Description**	**Triggering Method**	**Control Mode**
ABSR always output by DO2	When DO.ABSR is off, it indicates servo drive can receive request issued by DI.ABSQ; when DO.ABSR is on, it indicates after receiving the request, the data has been prepared and the ABSD data is valid so that the controller can access the ABSD data. This output is only valid when DI.ABSE is on.	Level triggered	All

Value: when DI.ABSE is on, DO.ABSD triggered by DO3 will replace the DO3 assigned by P2.020			
DO Name	**Description**	**Triggering Method**	**Control Mode**
ABSD always output by DO3	The DO for ABS data. The data is valid when DO.ABSR is on. This output is only valid when DI.ABSE is on.	Level triggered	All

8.4.11 - Monitoring variables descriptions

Table 8-3

Item	Description
Monitoring code	Each monitoring variable has a code, and you can use P0.002 to set the code and monitor the variable.
Format	Each monitoring variable is stored in the 32-bit format (long integer) of the servo drive.
Category	Basic variables / expansion variables: 1) Basic variables: variables (P0.002 = 0–26) within the cycle; in monitoring mode, you can display the variables by using the UP / DOWN keys on the panel. 2) Expansion variables: variables other than basic variables. (P0.002 = 27–127)
Monitoring method	Panel display / mapping: 1) Panel display: monitor with the panel 2) Mapping: monitor variables or parameters by mapping parameters (P0.009–P0.013, P0.017–P0.021)
Panel display	1) Use the MODE key to switch to the monitor mode and press the UP / DOWN keys to select the variable to monitor. 2) Input the variable code to monitor into P0.002 and start monitoring. Press the SHIFT key on the panel to switch between high and low digit display; Press the SET key on the panel to switch between decimal and hexadecimal display.
Mapping	1) Parameters that support monitoring variable mapping: for P0.009–P0.013, please refer to Section 8.3 Parameter descriptions. 2) You can read monitoring variables through communication using mapping parameters. 3) The value of the mapping parameter (P0.009–P0.013) is the content of the basic variables (17h, 18h, 19h, 1Ah). To monitor P0.009, set P0.017 to the value to read (please refer to P0.002). You can read the data specified by P0.017 through communication or the monitor panel (set P0.002 to 23). When the panel displays “VAR-1”, it indicates the content value of P0.009.

The property code of each monitoring variable is described in the following table:

Property	Description
B	BASE: basic variables, you can select with the UP / DOWN keys on the panel.
D1 D2	Decimal place displayed on panel: D1 indicates 1 decimal place, D2 indicates 2 decimal places.
Dec	Only decimal display is available on the panel, and you cannot switch to hexadecimal display by pressing the SET key.
Hex	Only hexadecimal display is available on the panel, and you cannot switch to decimal display by pressing the SET key.

Monitoring variables are described in the following table by the code sequence:

Code	Keypad Display	Variable Name / Property	Description
000 (00h)	Fb.PUU	Feedback position (PUU) B	Current feedback position of the motor encoder. Unit: Pulse of User Unit (PUU).
001 (01h)	C-PUU	Position command (PUU) B	Current coordinate of the Position command. Unit: Pulse of User Unit (PUU). PT mode: number of pulse commands received by the drive. PR mode: absolute coordinates of the Position command.
002 (02h)	Er.PUU	Position deviation (PUU) B	Deviation between the Position command and the feedback position. Unit: Pulse of User Unit (PUU).
003 (03h)	Fb.PLS	Feedback position (pulse) B	Current feedback position of the motor encoder. Unit: Encoder unit (pulse).
004 (04h)	C-PLS	Position command (pulse) B	Current coordinate of the Position command. Unit: Encoder unit (pulse). This is the command after passing E-Gear.
005 (05h)	Er.PLS	Position deviation (pulse) B	Deviation between the Position command and the feedback position. Unit: Encoder unit (pulse).
006 (06h)	CP-Fr	Pulse command frequency B	Frequency of the pulse command received by the drive. Unit: Kpps. Applicable to PT / PR mode.
007 (07h)	SPEEd	Speed feedback B,D1,Dec	Current motor speed. Unit: 0.1 rpm. A low-pass filter has been applied to this value to make it more stable for viewing.
008 (08h)	CSPd1	Speed command (analog) B,D2,Dec	Speed command from the analog channel. Unit: 0.01 Volt.
009 (09h)	CSPd2	Speed command (integrated) B	Integrated Speed command. Unit: 1 rpm. Source includes analog, register, or position loop.
010 (0Ah)	C-tq1	Torque command (analog) B,D2,Dec	Torque command from the analog channel. Unit: 0.01 Volt.
011 (0Bh)	C-tq2	Torque command (integrated) B	Integrated Torque command. Unit: percentage (%). Source includes analog, register, or speed loop.
012 (0Ch)	AUG-L	Average load rate B	Average load rate from the drive. Unit: percentage (%).
013 (0Dh)	PE-L	Peak load rate B	Maximum load rate from the drive. Unit: percentage (%).
014 (0Eh)	U buS	DC Bus voltage B	Rectified capacitor voltage. Unit: Volt.
015 (0Fh)	J-L	Load inertia ratio B,D1,Dec	Ratio of the load inertia to the motor inertia. Unit: 0.1 times. This variable will show the static value of P1.037. When P2.032 is set to 1 this variable will show the real time estimated inertia ratio seen by the drive.
016 (10h)	IGbt.t	IGBT temperature B	Temperature of IGBT. Unit: °C.

Code	Keypad Display	Variable Name / Property	Description
017 (11h)	rSnFr	Resonance frequency B,Dec	Resonance frequency of the system consists of two groups of frequencies: F1 and F2 When monitoring from the panel, press the SHF key to switch between F1 and F2: F2 displays zero decimal places, F1 displays 1 decimal place. When reading by communication (mapping parameter): Low word displays frequency F2. High word displays frequency F1.
018 (12h)	d IFF2	Z phase offset B,Dec	Offset value between motor position and Z phase, range: -5000 to +5000. Where it overlaps with Z phase, the value is 0; the greater the value, the greater the offset.
019 (13h)*	MAP 1	Mapping parameter content #1 B	Returns the value of P0.025 which is mapped by P0.035.
020 (14h)*	MAP2	Mapping parameter content #2 B	Returns the value of P0.026 which is mapped by P0.036.
021 (15h)*	MAP3	Mapping parameter content #3 B	Returns the value of P0.027 which is mapped by P0.037.
022 (16h)*	MAP4	Mapping parameter content #4 B	Returns the value of P0.028 which is mapped by P0.038.
023 (17h)*	UAr- 1	Mapping monitoring variable #1 B	Returns the value of P0.009 which is mapped by P0.017.
024 (18h)*	UAr-2	Mapping monitoring variable #2 B	Returns the value of P0.020 which is mapped by P0.018.
025 (19h)*	UAr-3	Mapping monitoring variable #3 B	Returns the value of P0.011 which is mapped by P0.019.
026 (1Ah)*	UAr-4	Mapping monitoring variable #4 B	Returns the value of P0.012 which is mapped by P0.020.
** For MAP/Monitoring Parameters (seetings 19-26) see the details at the end of this section.*			
028 (1Ch)		Alarm code Dec B	The alarm code (in decimal). The value being converted to the hexadecimal notation is identical to the alarm code displayed in P0.001 and the error code of communication models.
029 (1Dh)		Auxiliary encoder feedback (PUU) B	Position feedback from the auxiliary encoder.
030 (1Eh)		Auxiliary encoder position error (PUU) B	Postion difference between the position feedback and the command from the auxiliary encoder.
031 (1Fh)		Position error between main and auxiliary encoders (PUU) B	Feedback position difference between the main encoder and auxiliary encoder.
032 (20h)		Position error (PUU)	Difference between the filtered position command and the feedback position. Unit: Pulse of User User (PUU).

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Code	Keypad Display	Variable Name / Property	Description
033 (21h)		Position error (pulse)	Difference between the filtered position command and the feedback position. Unit: Pulse of User Unit (PUU)
035 (23h)	Set via P0.002	Indexing coordinate command	Current command for the indexing coordinates. Unit: Pulse of User Unit (PUU).
037 (25h)		Compare data of Compare	The actual Compare data is the Compare data plus a specified value: CMP_DATA = DATA_ARRAY[*] + P1.023 + P1.024.
039 (27h)		DI status (Integrated) Hex	Integrated DI status of the drive. Each bit corresponds to one DI channel. Source includes Hardware channel / P4.007, which is determined by P3.006.
040 (28h)		DO status (Hardware) Hex	Actual status from the DO hardware. Each bit corresponds to one DI channel.
041 (29h)		Status of select DO functions	Returns P0.046. Please refer to the description of this parameter.
042 (2Ah)		Index of the PR command in execution	Displays the index of the PR command being executed.
043 (2Bh)		CAP data capturing	The latest data captured by CAP hardware. Note: CAP can continuously capture multiple points.
048 (30h)		Auxiliary encoder CNT	Pulse counts from the auxiliary encoder (CN5).
049 (31h)		Pulse command CNT	Pulse counts from the pulse command (CN1).
050 (32h)		Speed command (integrated) D1,Dec	Integrated Speed command. Unit: 0.1 rpm. Source includes analog, register, or position loop.
051 (33h)		Speed feedback (immediate) D1,Dec	Current actual motor speed. Unit: 0.1 rpm.
053 (35h)		Torque command (integrated) D1,Dec	Integrated Torque command. Unit: 0.1%. Source includes analog, register, or speed loop.
054 (36h)		Torque feedback D1,Dec	Present actual motor torque of motor's nameplate continuous torque rating. Unit: 0.1%.
055 (37h)		Current feedback D2,Dec	Present actual motor amps. Unit: 0.01 ampere (Amp).
056 (38h)		DC Bus voltage D1,Dec	Rectified capacitor voltage. Unit: 0.1 Volt.
059 (3Bh)		Pulse of E-Cam master axis (accumulative)	Accumulative pulse number of the E-Cam master axis. Same as P5.086.
060 (3Ch)		Pulse of E-Cam master axis (incremental)	Incremental pulse number of the E-Cam master axis. The increment per ms.
061 (3Dh)		Pulse of E-Cam master axis (lead pulse)	The lead pulse of the E-Cam master axis which determines the engaging condition. When disengaged: lead pulse = P5.087 or P5.092; when the value is 0, E-Cam engages. When engaged: lead pulse = P5.089; when the value is 0, it disengages.
062 (3Eh)		Position of E-Cam master axis	Position of the E-Cam which corresponds to the master axis pulse, and can be used to find the phase of the E-Cam. Unit: same as the master axis pulse; when the incremental pulse number of the master axis is P, E-Cam rotates M cycles (P5.083=M, P5.084=P).

Code	Keypad Display	Variable Name / Property	Description
063 (3Fh)	Set via P0.002	Position of E-Cam slave axis	Position of the E-Cam slave axis and can be found from the E-Cam table. Unit: PUU
064 (40h)	Set via P0.002	Endpoint register of PR command	In PR mode, the endpoint of the Position command (Cmd_E).
065 (41h)		Output register of PR command	In PR mode, the accumulative output of the Position command.
067 (43h)		PR target speed	Target speed specified in the PR path. Unit: PPS (Pulse Per Second).
072 (48h)		Speed command (analog) B,D1,Dec	Speed command from the analog channel. Unit: 0.1 rpm.
081 (51h)		Capture synchronous axis Incremental pulse input	When Capture synchronous axis is enabled, the actual Mark distance can be measured by the received pulse number between two Captures.
084 (54h)		Capture synchronous axis Pulse number of synchronous deviation	When Capture synchronous axis is enabled, the accumulative deviation between the actual output pulse and the target pulse. This value is close to 0 if synchronization is reached.
085 (55h)		E-Cam alignment deviation percentage	The alignment error rate after filtering. Unit: 0.1% 10 indicates 1% and the angle conversion is 360º x 1% = 3.6º.
091 (5Bh)		Indexing coordinate feedback	Immediate feedback position of the indexing coordinates. Unit: Pulse of User Unit (PUU).
096 (60h)		Drive firmware version Dec	Includes 2 versions: DSP and CPLD When monitoring from the panel, press the SHF key to switch between DSP and CPLD: DSP displays zero decimal places, CPLD displays 1 decimal place. When reading by communication (mapping parameter): Low word returns the DSP version number. High word returns the CPLD version number.
111 (6Fh)		Error code of the servo drive	Error code from the servo drive: control loop of the servo only, not including the motion controller.
115 (73h)		Main / auxiliary encoder position deviation (pulse)	When using full closed loop, this variable will display the deviation between main encoder and auxiliary encoder.
116 (74h)		Deviation between position and Z phase of auxiliary encoder (pulse)	Deviation between the current position of the auxiliary encoder and the Z phase position of the auxiliary encoder.
120 (78h)		Communication error rate	When this value continues to increase, it indicates that there is communication interference. In an interference-free environment, this value should not increase.
123 (7Bh)		Value returned when monitoring by panel	Monitoring value displayed when returned to the monitoring panel.
-80		Encoder communication error rate	If this value is increasing, communication interference is present. This value should not increase in an interference-free environment.
-91		Overload (AL006) protection counter	Displays the motor load during operation. When the value of the overload counter reaches 100%, AL006 occurs.
-111		Regeneration error (AL005) protection counter	When the regeneration counter reaches 100%, AL005 occurs.
-124		Encoder temperature	Monitor the encoder temperature.

Code	Keypad Display	Variable Name / Property	Description
-178	Set via P0.002	Auxiliary encoder Z pulse data	Use the bit to check the Z pulse of the auxiliary encoder. • Bit0=Z pulase Note: Use the SV2-Pro scope function to monitor at the sampling rate of 16k/20k. This monitoring variable is only available on third-party incremental encoders.
-207	Set via P0.002	Regenerative Resistor power consumption	The power consumption (unit:%) of the regenerative resistor at the time when the energy of the servo drive capacitor is released to the regenerative resistor.

Map and Monitoring Parameters

When displaying MAP and Monitoring Parameters (settings 19 - 26) on the keypad display, there is a mathematical nuance to be aware of.

Each MAP/Monitoring Parameter has two Parameters' worth of data in it. Double-click on P0.035 in SureServo2 Pro to easily see how the two target parameters are defined for MAP#1.

- *If the High Word's Parameter value = 0 and the Low Word's Parameter value= 1, the keypad display will show 00001 in decimal (0x00000001 in hex). This is as expected.*
- *If the High Word's Parameter value = 1 and the Low Word's Parameter value = 0, the keypad display will show 65536 in decimal. This may not be expected, but it is the decimal conversion of hex 0x00010000. Pressing the "S" key on the keypad to display the value in Hex will show the Low word is 0000. Pressing the left arrow button to display the High word will show that it is 0001.*

To get the MAP/Monitoring parameters to display decimal values correctly on the keypad display, point the Low Word to the desired Parameter, then point the High Word Parameter to a value that will always be 0. A typical solution is to set an unused Delay Time (P5.040 - P5.055) or Target Speed Setting (P5.060 - P5.075) to zero and use that Parameter as the High Word. Make sure that the "unused" parameter is not actually used in the PR settings.

Chapter 9: Communications

Chapter 9

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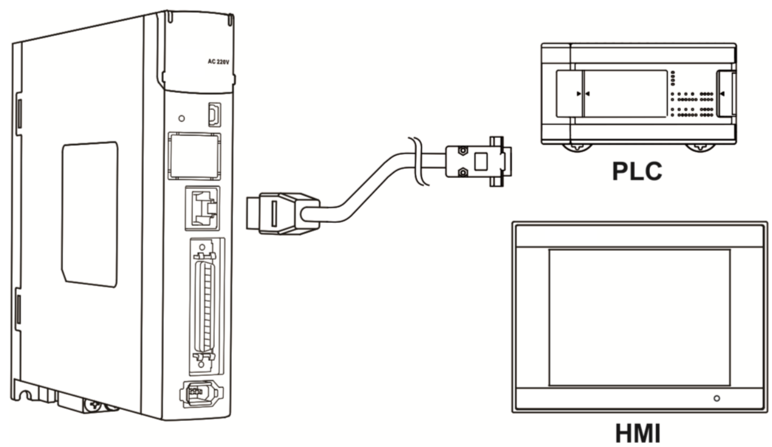
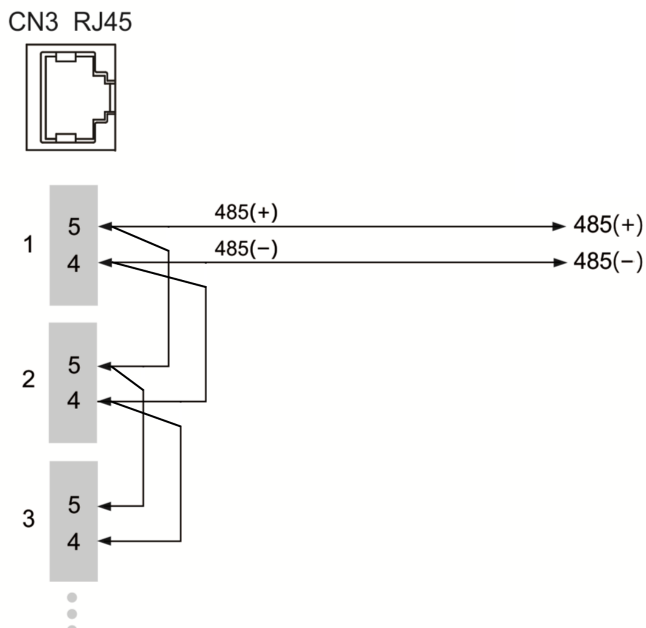
Introduction

This chapter describes the Modbus, Modbus TCP, and EtherNet/IP communications which you use for setting, reading, and writing general parameters.

9.1 - RS-485 Communication Interface (Hardware)

The SureServo2 series servo drive supports RS-485 serial communication that you can use to access and change the parameters of the servo system. See the following description of the wiring:





Notes:

1) The cable length can be up to 100 meters when the servo drive is installed in a quiet environment. If the transmission speed is over 38400 bps, however, a maximum 15 meter cable is recommended to ensure data transmission accuracy.
2) The numbers on the above figure represent the pin number of each connector.
3) When using RS-485 communication, you may connect up to 32 servo drives. You can install a repeater to connect more servo drives (the maximum is 127).
4) Please refer to Section 3.7, Wiring for CN3 pin assignment and the use of SV2-CN3-CON-2 and SV2-CN3-TR2 to create an RS485 network with minimal end-user wiring.

9.2 - RS-485 Communication Parameter Settings

The required parameters for a single servo drive connection are: P3.000 (Address setting), P3.001 (Transmission speed) and P3.002 (Communication protocol). P3.003 (Communication error handling), P3.004 (Communication timeout setting). P3.006 (Digital input (DI) control switch) and P3.007 (Communication delay time) are optional settings.

Please refer to Chapter 8 for detailed descriptions of the relevant parameters.

Parameter	*Function*
P3.000	Address setting
P3.001	Transmission speed
P3.002	Communication protocol
P3.003	Communication error handling
P3.004	Communication timeout

NOTE: It is highly recommended to set P2.030=5 before initiating control with communication. This will disable writing any changes to the servo EEPROM. While the EEPROM can be written to several millions of times, inadvertent messaging could reach that limit within a few years. Setting P2.030 =5 eliminates this potential.

9.3 - MODBUS Communication Protocol

There are two modes of MODBUS network communication: ASCII (American Standard Code for Information Interchange) and RTU (Remote Terminal Unit). You can set both communication protocols (ASCII and RTU) with the P3.002 parameter. The SureServo2 servo drive also supports these functions: accessing data (03H), writing one word (06H) and writing multiple words (10H).

For Modbus address details, see the Hex and Decimal addresses in the parameter details in Chapter 8. For AutomationDirect PLC programs that demonstrate Modbus PLC command and control with SureServo2, please see the SureServo2 support page at go2adc.com/sureservo2. Also, refer to the SureServo2 Modbus videos.

- *SureServo2 Modbus RTU Servo Modbus RTU Tutorial using the CLICK PLC and SureServo2*
- *SureServo2 Modbus TCP Servo Modbus TCP Tutorial using a Do-more PLC and SureServo2*

The Modbus protocol handles data structure and error checking automatically. For more information on the mechanics of the Modbus protocol, please download the free documentation from www.modbus.org.

9.4 - Setting and Accessing Communication Parameters

Please refer to Chapter 8 for the descriptions of the parameters that you can write or read through the communication interface.

The SureServo2 drive parameters are divided into eight groups: Group 0 (Monitoring parameters), Group 1 (Basic parameters), Group 2 (Extension parameters), Group 3 (Communication parameters), Group 4 (Diagnosis parameters), Group 5 (Motion control parameters) and Group 6 and Group 7 (PR parameters).

Setting parameters through communication:

You can set parameters through communication:

- *Group 0, except (P0.000 ~ P0.001), (P0.008 ~ P0.013) and (P0.046).*
- *Group 1*
- *Group 2*
- *Group 3*
- *Group 4, except (P4.000 ~ P4.004) and (P4.008 ~ P4.009).*
- *Group 5, except (P5.010), (P5.016) and (P5.076).*
- *Group 6*
- *Group 7*

Please note the following additional details:

- *P3.001: when changing to a new communication speed, the next data is written in the new transmission speed after the new speed is set.*
- *P3.002: when changing to a new communication protocol, the next data is written with the new communication protocol after the new protocol is set.*
- *P4.005: JOG control parameters. Please refer to Chapter 8 for detailed descriptions.*
- *P4.006: Force Digital Output (DO) contact control. You can use this parameter to test the DO contact. Set P4.006 to 1, 2, 4, 8, 16, and 32 to test DO1, DO2, DO3, DO4, DO5 and DO6 respectively. Then, set P4.006 to 0 to complete the test.*
- *P4.010: Calibration functions. First set P2.008 to 20 (14H in hexadecimal format) to enable this function.*
- *P4.011 ~ P4.021: these parameters are for adjusting the hardware offset. The parameters were adjusted before delivery, so changing these parameters is not recommended. If it is necessary, set P2.008 to 22 (16H in hexadecimal format) first.*

Accessing parameters through communication:

You can read the values from parameters through communication: Group 0 ~ Group 7.

NOTE: It is highly recommended to set P2.030=5 before initiating control with communication. This will disable writing any changes to the servo EEPROM. While the EEPROM can be written to several millions of times, inadvertent messaging could reach that limit within a few years. Setting P2.030 =5 eliminates this potential.

9.5 - Modbus TCP Communication Card Specifications and Installation

SV2-CM-MODTCP is an Ethernet communication module. In addition, with the MDI / MDI-X automatic detection function, there is no need for crossover cables when using the network cable. Refer to the following for more information about the SV2-CM-MODTCP module.

Features

- *Auto-detection for transmission speed of 10 / 100 Mbps*
- *MDI / MDI-X automatic detection*
- *Supports MODBUS TCP communication protocol*

NOTE: SureServo2 / PLC ModTCP communication requires that the Station ID (typically a serial communication setting) be configured correctly in both the PLC ModTCP message and SureServo2 P3.000.

9.5.1 - Functional Specifications

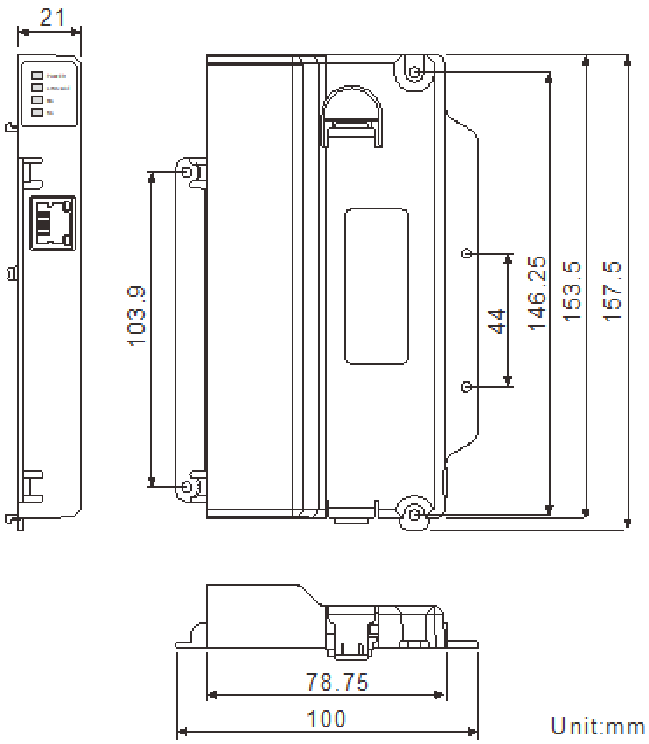
Network Interface	
Item	***Specification***
Interface	RJ45 with Auto MDI / MDIX
Number of ports	1
Transmission standard	IEEE802.3, IEEE802.3u
Transmission cable	Category 5e shielding 100M
Transmission speed	10/100 Mbps Auto-Defect
Network protocol	ICMP, IP, TCP, UDP, DHCP, Modbus TCP
Default IP Address	192.168.1.10
Default Subnet Mask	255.255.255.0

Modbus TCP Specifications		
General	***Device Type***	Server
	Maximum number of connections	4
	Maximum data length of a single connection	32 words

Environmental Specifications	
Item	***Specification***
Noise immunity	ESD (IEC 61800-5-1, IEC 6100-4-2) EFT (IEC 61800-5-1, IEC 6100-4-4) Surge test (IEC 61800-5-1, IEC 6100-4-5) Conducted susceptibility test (IEC 61800-5-1, IEC 6100-4-6)
Operating temperature	-10°C to 50°C (14°F to 122°F), humidity 90% RH
Storage temperature	-25°C to 70°C (-13°F to 158°F), humidity 95% RH
Vibration and impact resistance	IEC 61800-5-1, IEC 60068-2-6 / IEC 61800-5-1, IEC 60068-2-27

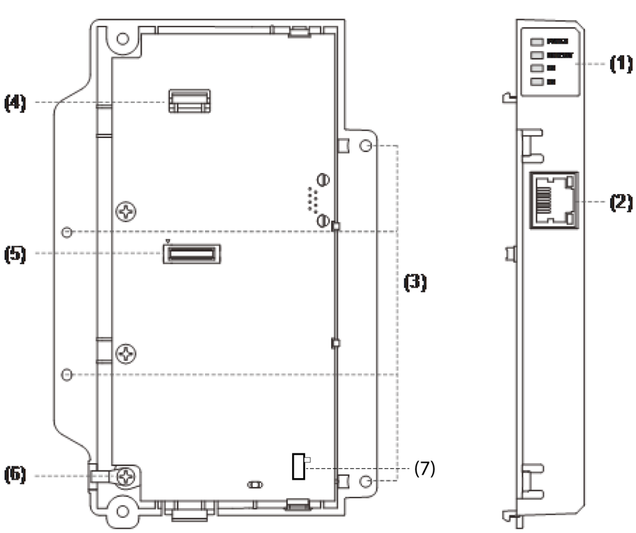
Electrical Specifications	
Item	***Specification***
Power supply voltage	5VDC
Power consumption	0.8 W
Insulation voltage	500VDC
Weight	Approx. 100g

9.5.2 - Modbus TCP Card Dimensions



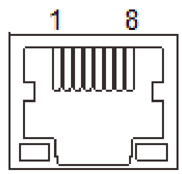
9.5.3 - Modbus TCP Card Parts

Item	Description
1	LED Indicator
2	Ethernet port (RJ45)
3	Servo drive screw fixing hole
4	Positioning hole
5	Servo drive connection port
6	PCB screw fixing hole
7	Firmware update switch



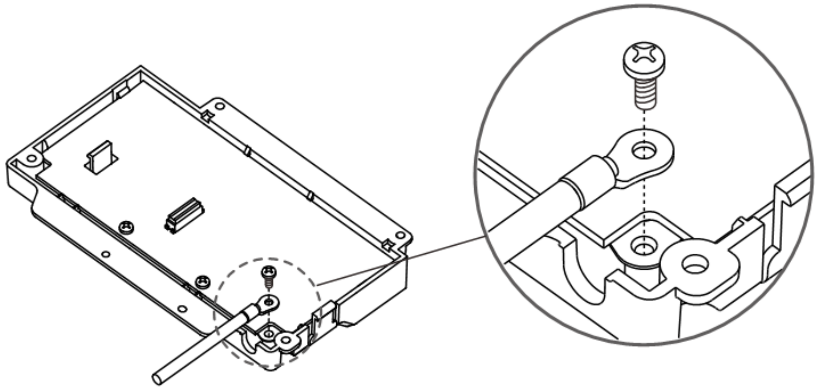
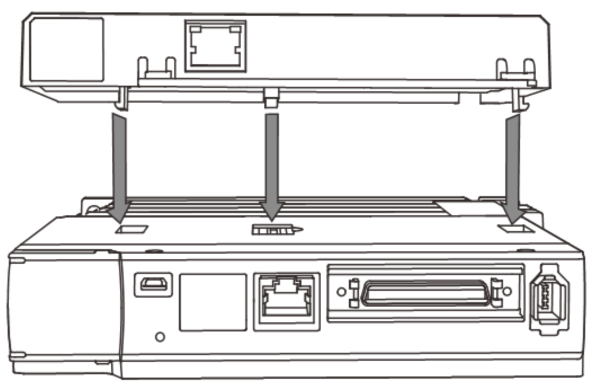
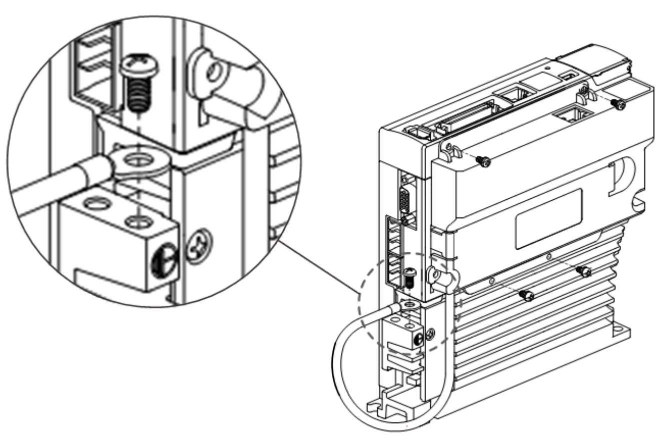
NOTE: Refer to Section 9.9 for the firmware update process.

9.5.4 - RJ45 Pin Assignment

RJ45 Connector	Pin No.	Signal	Description
	1	Tx+	Data transmission positive
	2	Tx-	Data transmission negative
	3	Rx+	Data reception positive
	4	--	N/C
	5	--	N/C
	6	Rx-	Data reception negative
	7	--	N/C
	8	--	N/C

9.5.5 - Installation

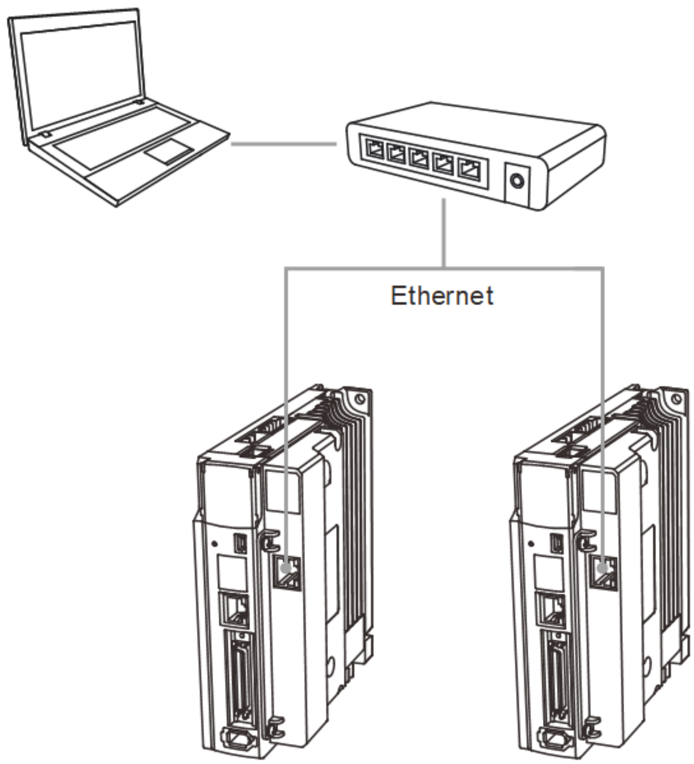
Follow the steps below to install the SV2-CM-MODTCP card in your SureServo2 drive.

Step	Description
1	Remove the screw from the ground terminal of the communication card to screw on the grounding wire that comes with the communication card. 
2	Ensure the firmware update switch is in the "Normal" position. For instructions on updating the firmware (normally not required), see Section 9.9.
3	Align the hooks of the communication card with the installation slot of the servo drive. Evenly press and insert the hooks into the slots to attach the communication card to the servo drive. Inserting the hooks by force may damage the communication card. 
4	Tighten the four screws with a torque of 6.5 Kg-cm (5.64 in-lbs) to secure the communication card. Connect the other end of the grounding wire to the ground terminal of the servo drive. 

9.5.6 - Network Configuration

Connect SV2-CM-MODTCP to an Ethernet hub with the CAT-5e twisted-pair cable.
SV2-CM-MODTCP has the Auto MDI / MDIX function, so the CAT-5e twisted-pair cable does not require crossover.

The network connection between the computer and the SV2-CM-MODTCP module is as follows:



9.5.7 - MODBUS Communication Standard

The following function codes are supported:

Function Code	Description
0x03	Read the register.
0x10	Write multiple data sets to the register.

NOTE: It is highly recommended to set P2.030=5 before initiating control with communication. This will disable writing any changes to the servo EEPROM. While the EEPROM can be written to several millions of times, inadvertent messaging could reach that limit within a few years. Setting P2.030 =5 eliminates this potential.

Troubleshooting:

If the servo drive sets the Ethernet card parameters to zero at drive power-up, ensure the following:

1) The Ethernet card is properly seated onto the drive.
2) The Ethernet card ground wire is properly attached to the card and to ground.
3) The Ethernet card Firmware Update switch is set to the “Normal” position.

NOTE: SureServo2 / PLC ModTCP communication requires that the Station ID (typically a serial communication setting) be configured correctly in both the PLC ModTCP message and SureServo2 P3.000.

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9.6 - EtherNet/IP Communication Card

EtherNet/IP (IP = Industrial Protocol) is an industrial Ethernet communication protocol managed by ODVA, Inc. (formerly Open DeviceNet Vendors Association, Inc.). EtherNet/IP is built on the TCP / IP communication protocol and is compatible with general IT networks.

The servo drive peripheral device that supports EtherNet/IP communication is the SV2-CM-ENETIP communication card. With the MDI / MDI-X automatic detection function, there is no need for crossover cables when using the network cable. Refer to the following for more information about the SV2-CM-ENETIP communication card.

Features

- *Auto-detection for transmission speed of 10 / 100 Mbps*
- *MDI / MDI-X automatic detection*
- *Supports MODBUS TCP communication protocol*
- *Supports EtherNet/IP Explicit Message*
- *Supports EtherNet/IP Implicit Message (or I/O Connections)*

9.6.1 - Functional Specifications

Network Interface	
Item	***Specification***
Interface	RJ45 with Auto MDI / MDIX
Number of ports	1
Transmission standard	IEEE802.3, IEEE802.3u
Transmission cable	Category 5e shielding 100 M
Transmission speed	10 / 100 Mbps Auto-Detect
Network protocol	ICMP, IP, TCP, UDP, DHCP, BOOTP, Modbus TCP, EtherNet/IP
Default IP Address	192.168.1.10
Default Subnet Mask	255.255.255.0

Modbus TCP Specifications		
General	***Device Type***	Server
	Maximum number of connections	4
	Maximum data length of a single connection	32 words (16 bits/word)

EtherNet/IP Specifications		
General	***Device Type***	Adapter
	Topology	Star
CIP network_ I/O Connection	***Maximum number of CIP connections (Number of communication connections)***	8 (Servers)
	Maximum number of TCP connections (Number of device connections)	8 (Servers)
	Requested Packet Interval (RPI) (Interval setting range)	5ms - 1000ms
	Maximum transmission speed	400pps
	Maximum data length of a single connection	500 bytes

EtherNet/IP Specifications (continued)		
CIP network_ Explicit Message	***Class 3 (Connected)***	8 (Servers), including the connections from UCMM
	UCMM (Unconnected; TCP connections)	8 (Servers), including the connections from Class 3
	CIP objects	Identity Object (0x01) Message Router Object (0x02) Assembly Object (0x04) Connection Manager Object (0x06) TCP/IP Interface Object (0xF5) Ethernet Link Object (0xF6) SV2 Data Object (0x300) User-defined objects are not supported For the object description, refer to Appendix A.

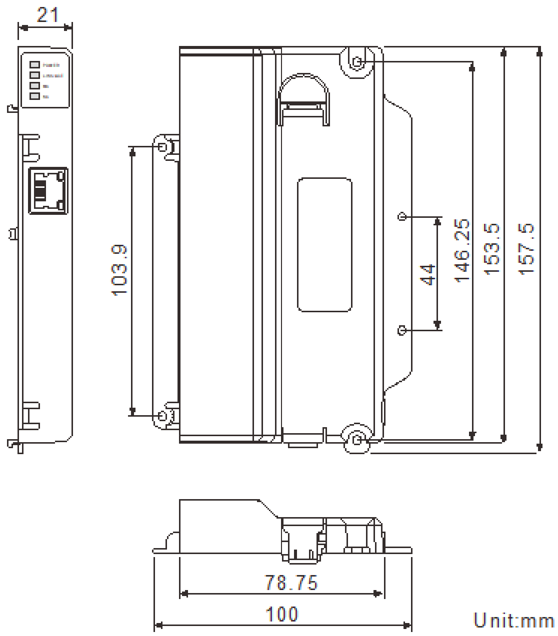
Environmental Specifications	
Item	***Specification***
Noise immunity	ESD (IEC 61800-5-1, IEC 6100-4-2) EFT (IEC 61800-5-1, IEC 6100-4-4) Surge test (IEC 61800-5-1, IEC 6100-4-5) Conducted susceptibility test (IEC 61800-5-1, IEC 6100-4-6)
Operating temperature	-10°C to 50°C (14°F to 122°F), humidity 90% RH
Storage temperature	-25°C to 70°C (-13°F to 158°F), humidity 95% RH
Vibration and impact resistance	IEC 61800-5-1, IEC 60068-2-6 / IEC 61800-5-1, IEC 60068-2-27

Electrical Specifications	
Item	***Specification***
Power supply voltage	5VDC
Power consumption	0.8 W
Insulation voltage	500VDC
Weight	Approx. 100g

9.6.2 - Glossary

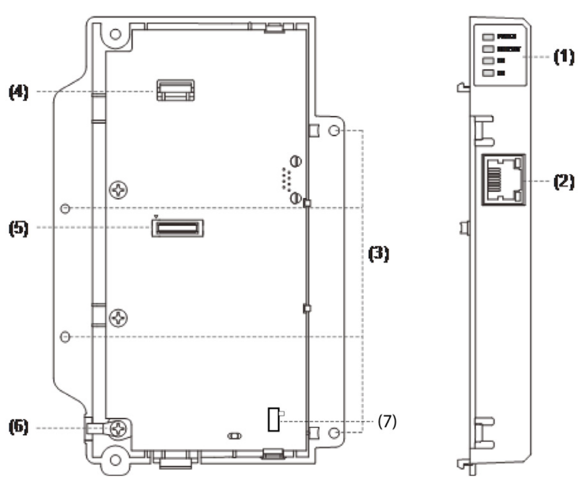
Term	Definition
ODVA	Open DeviceNet Vendor Association; EtherNet/IP is managed by ODVA.
EIP	EtherNet/IP; an industrial Ethernet communication protocol that provides interoperability between products of various providers. IP is the abbreviation for Industrial Protocol. The abbreviation “EIP” (EtherNet/IP) is used throughout this user manual.
I/O Connection	Also known as ‘Implicit Messaging’, ‘I/O Messaging’, and ‘Class 1 Connection.’ Transported via UDP, this communication is used for time-critical data exchange and real-time control applications.
Explicit Message	Data is exchanged between devices using separate request/response model and transported via TCP. Explicit Messaging is less efficient than an I/O Connection but offers more reliability and flexibility.
RPI	Requested Packet Interval; the time interval at which data will be exchanged between devices.
EDS	Electronic Data Sheets; EDS files are simple text files used by EtherNet/IP network configuration tools to help you identify EtherNet/IP products and easily commission them on a network.
Data Mapping	The size and format of data to be exchanged between devices.
EIP Scanner	The client device (PLC, controller) that initiates communication using an I/O connection.
EIP Adapter	The server device (servo drive) that is the target for communication using an I/O connection.
Cyclic	The controller sends commands to the communication card every communication cycle, and the communication card sends commands to the servo drive every communication cycle.
Acyclic	The controller sends commands to the communication card according to the request, and the communication card sends commands to the servo drive according to the actual processing sequence.

9.6.3 - EtherNet/IP Card Dimensions

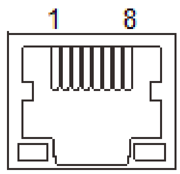


9.6.4 - EtherNet/IP Card Parts

Item	Description
1	LED Indicator
2	Ethernet port (RJ45)
3	Servo drive screw fixing hole
4	Positioning hole
5	Servo drive connection port
6	PCB screw fixing hole
7	Firmware update switch

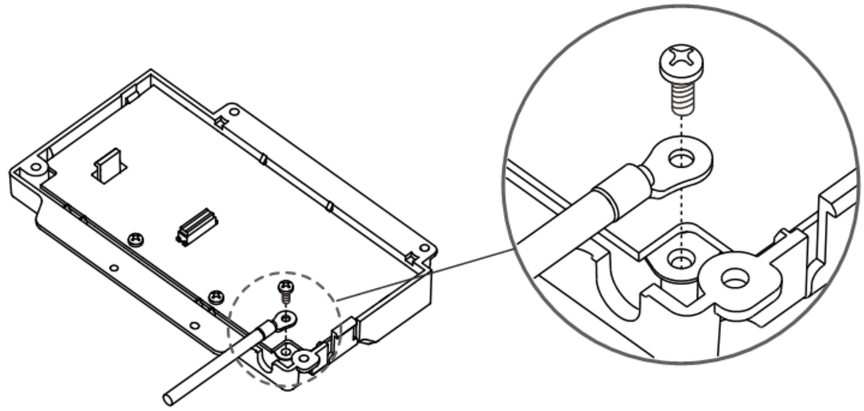
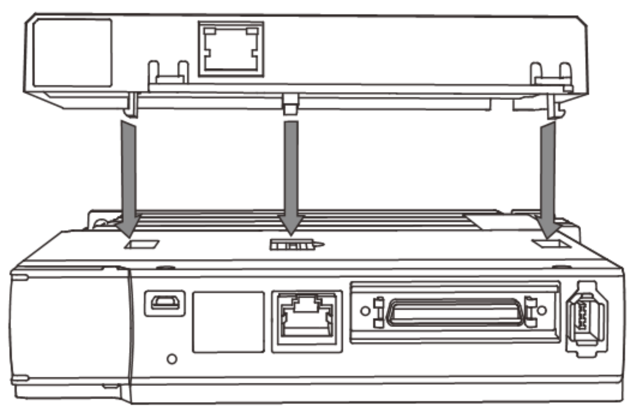
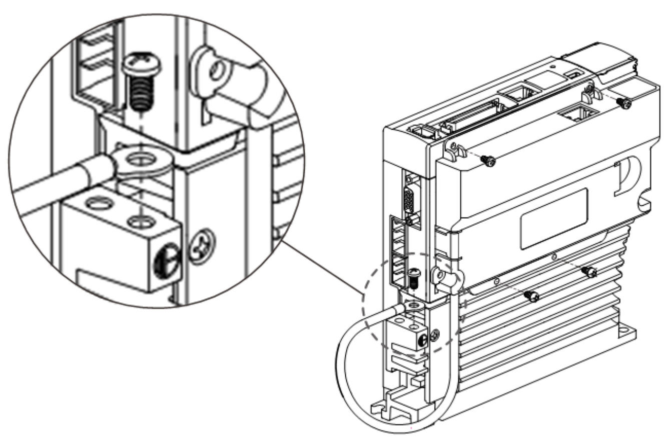


9.6.5 - RJ45 Pin Assignment

RJ45 Connector	Pin No.	Signal	Description
	1	Tx+	Data transmission positive
	2	Tx-	Data transmission negative
	3	Rx+	Data reception positive
	4	--	N/C
	5	--	N/C
	6	Rx-	Data reception negative
	7	--	N/C
	8	--	N/C

9.6.6 - EtherNet/IP Card Installation

Follow the steps below to install the SV2-CM-ENETIP card in your SureServo2 drive.

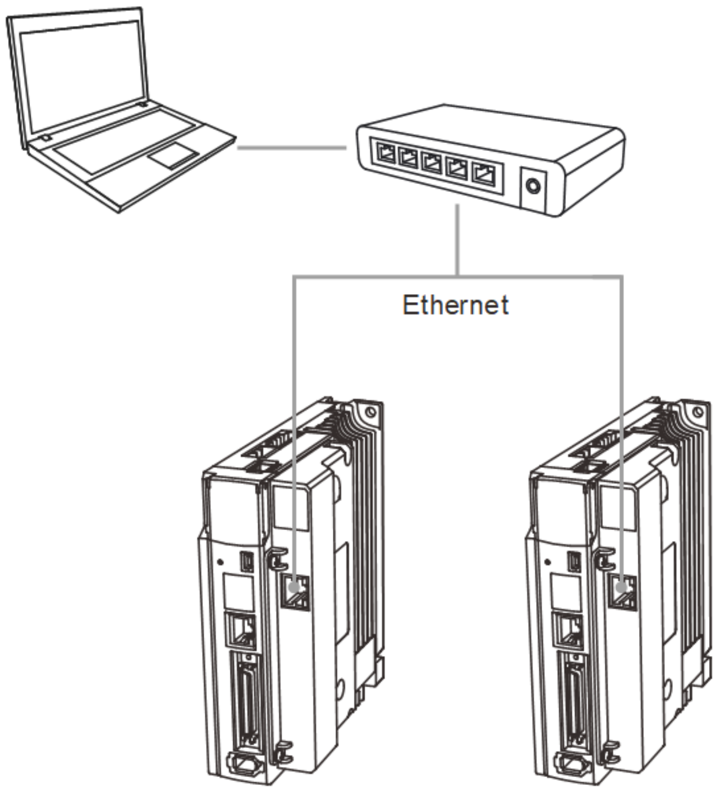
Step	Description
1	Remove the screw from the ground terminal of the communication card to screw on the grounding wire that comes with the communication card. 
2	Ensure the firmware update switch is in the “Normal” position. For instructions on updating the firmware (normally not required), see Section 9.9.
3	Align the hooks of the communication card with the installation slot of the servo drive. Evenly press and insert the hooks into the slots to attach the communication card to the servo drive. Inserting the hooks by force may damage the communication card. 
4	Tighten the four screws with a torque of 6.5 Kg-cm (5.64 in-lbs) to secure the communication card. Connect the other end of the grounding wire to the ground terminal of the servo drive. 

Wiring
Parameters
DI/DO Codes
Monitoring
Alarms

9.6.7 - Network Configuration

Connect SV2-CM-ENETIP to an Ethernet Switch with the CAT-5e twisted-pair cable.
SV2-CM-ENETIP has the Auto MDI / MDIX function, so the CAT-5e twisted-pair cable does not require crossover.

The network connection between the computer and the SV2-CM-ENETIP communication card is as follows:



9.6.8 - Explicit and Implicit (I/O Connection) Messaging

The EtherNet/IP interface of SV2 supports various servo drive control methods. The communication protocol provides two packet types for data exchange, which are Explicit Message and Implicit Message.

Explicit Message

You can use the controller to directly set the content value of the servo drive, but you need to first set the corresponding object class address for the SV2-CM-ENETIP communication card. The current object class address occupied by the servo drive is 0x300. Refer to the following sections for the supported setting methods and address list.

The Explicit Message corresponds to the parameter address as follows.

EIP communication data type:

Object class		Instance		Attribute
0x300	+	P. Group	+	P. Member

Since the SureServo2 Parameters are 32-bit and EtherNet/IP is basesd on 16-bit words, the Parameter Member value = the Parameter Number x 2.

NOTE: If your Explicit Message instruction targets an odd-numbered register, the PLC command will not be successful. Ensure that your target is a valid (even-numbered) address.

Example:

To write data to P6.004 (PR PATH #2), first refer to the corresponding communication address of this parameter in Chapter 8.

P6.004 = 0x0608

Group		Member
6 (0x06)	+	8 (0x08)

The format of Explicit Message is as follows:

Object class + Instance + Attribute = 0x300 + 0x06 + 0x08

Most all drive parameters can be addressed by Explicit Messaging. The configuration parameters in the drive are in the table below.

Once a configuration parameter has been changed, set P3.065 = 1 to “push” the new values to the Ethernet card.

Parameter Addresses for Setting SV2-CM-ENETIP					
Object	***Instance***	***Attribute***	***Parameter***	***Property***	***Function***
0x300	0x03	0x00	P3.000	RW	SV2 Communication Address
		0x5C	P3.046	R	SV2-CM-ENETIP Firmware Version
		0x5E	P3.047	R	SV2-CM-ENETIP Product Code
		0x60	P3.048	R	SV2-CM-ENETIP Error Code
		0x62	P3.049	RW	IP Configuration 0=Static 1=DHCP
		0x64	P3.050	RW	IP Address 1
		0x66	P3.051	RW	IP Address 2
		0x68	P3.052	RW	IP Address 3
		0x6A	P3.053	RW	IP Address 4
		0x6C	P3.054	RW	Net Mask 1
		0x6E	P3.055	RW	Net Mask 2
		0x70	P3.056	RW	Net Mask 3
		0x72	P3.057	RW	Net Mask 4
		0x74	P3.058	RW	Gateway 1
		0x76	P3.059	RW	Gateway 2
		0x78	P3.060	RW	Gateway 3
		0x7A	P3.061	RW	Gateway 4
		0x80	P3.064	RW	Return to Factory Setting
		0x82	P3.065	RW	Save parameters to the communication card
		0x86	P3.067	RW	SV2-CM-ENETIP Timeout, ms
		0x88	P3.068	RW	Ethernet Timeout Detection 0=Enable 1=Disable
		0x8A	P3.069	RW	Ethernet Timeout Function 0=Warn (AL180) & continue operation 1=Warn & ramp to stop (decel=P5.003.C) 2=Warn & coast to stop 3=No warning and continue operation 4=Fault and ramp to stop (P5.003.C as deceleration stop)

I/O Connection (or Implicit Message)

Use the controller to specify the read and write data addresses for the mapping register of the EIP communication card. Then use the mapping register to read and write fixed-size address data at once. The supported object class address and definition of the Implicit Message are shown in the following table.

I/O Message Connection No.	*Function*	*Object*	*Instance*	*Attribute*	*Length*	*Description*
Connection 1	Input	0x04	0x6B	0x03	32 words	Corresponds to the input data to the buffer register.
				0x04	1 word	Corresponds to the input length to the buffer register.
	Output		0x6A	0x03	32 words	Corresponds to the output data of the buffer register.
				0x04	1 word	Corresponds to the output length of the buffer register.
	Configuration		0x83	0x03	96 words	Corresponds to the set object address and data.
				0x04	1 word	Corresponds to the set object length.
Connection 1_ Listen only	Input		0x6B	0x03	32 words	Corresponds to the input buffer register.
				0x04	1 word	Corresponds to the input length to the buffer register.
	Output		0xC7	0x03	0 words	n/a
				0x04	0 words	n/a
	Configuration		0x83	0x03	96 words	Corresponds to the set object address and data.
				0x04	1 word	Corresponds to the set object length.

IN/OUT Register Address Setting

The structure for the 96-word address of the IN / OUT register is shown as follows.

Object	*Instance*	*Attribute*	*SV2-CM-ENETIP*	*Word*	*IN / OUT Corresponding Address*	*Description*
0x04	0x83	0x03	R	0 - 15	IN 1 - IN 16 corresponding address	Non-fixed input address; changeable address data (user-defined address). The default is 0xFFFF.
			R	16 - 47	IN 1 - IN 16 default values	The default value of input.
			RW	48 - 63	OUT 1 - OUT 16 corresponding address	Non-fixed output address; changeable address data (user-defined address). The default is 0xFFFF.
			RW	64 - 95	OUT 1 - OUT 16 default value	The default value of output.

IN/OUT Buffer Address Register Setting

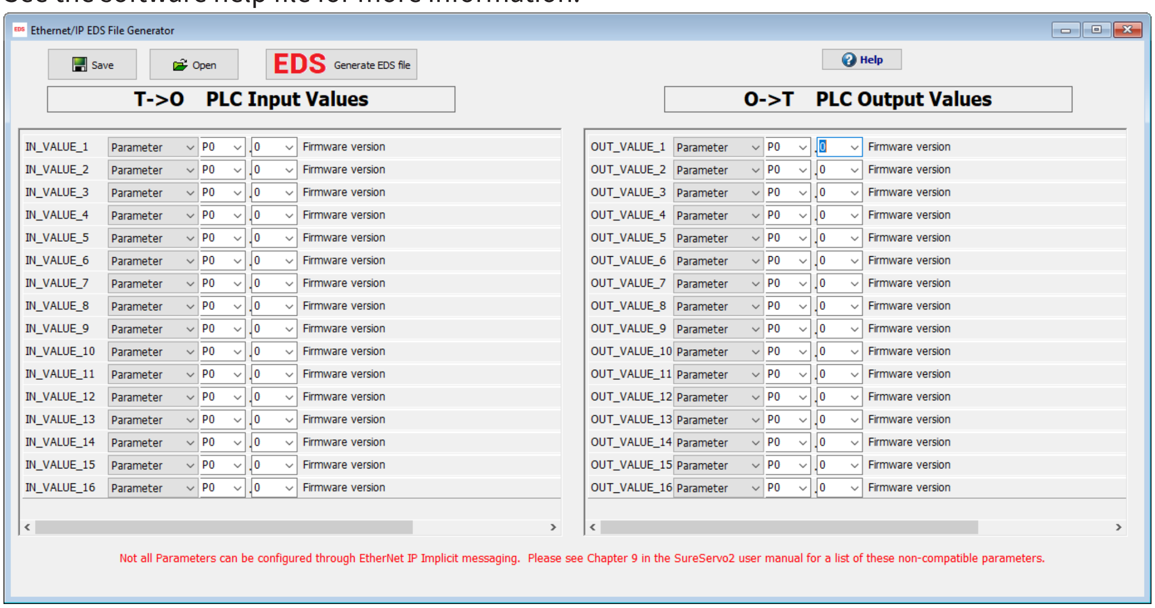
There are 16 sets of IN / OUT buffers available for dynamic mapping. Refer to the following for address planning.

The structure for the 32-word address of the IN / OUT register is shown as follows.

Object	*Instance*	*Attribute*	*SV2-CM-ENETIP*	*Word*	*IN / OUT Corresponding Address*	*Description*
0x04	0x6B	0x03	R	0 - 31	Return value of IN 1 - IN 16 corresponding address	The return value of the input address.
	0x6A		RW	0 - 31	Set value of OUT 1 - OUT 16 corresponding address	The set value written to the output address.

EDS Files - The Easy Way to Define PLC Handshaking for I/O Connections (Implicit Messaging)

PLCs and other EtherNet/IP enabled controllers often use an EDS file to define the Implicit Messaging interfacing and handshaking between the controller (scanner) and the EtherNet/IP adapter (in this case - the SureServo2 EtherNet/IP card). You typically import the EDS file (a very structured text file) into the PLC's software. Most devices have a fixed EDS file that pre-defines the data structure that will be passed between the PLC and the drive. Since the SureServo2 drive has a tremendous amount of flexibility (and the need to specify different values in different applications), there is a need to be able to customize the EDS file. The SureServo2 Pro software has a built-in EDS File Generator that will allow each application to custom-configure the input and output data that will be passed between the PLC and the drive. Open the SureServo2 Pro software, connect to your drive (or select "Offline Operation"), and double-click on the "EtherNet/IP EDS File" link. Enter the desired T->O and O->T parameters in the tables. Then press the "Generate EDS file" file to create your custom EDS file. See the software help file for more information.

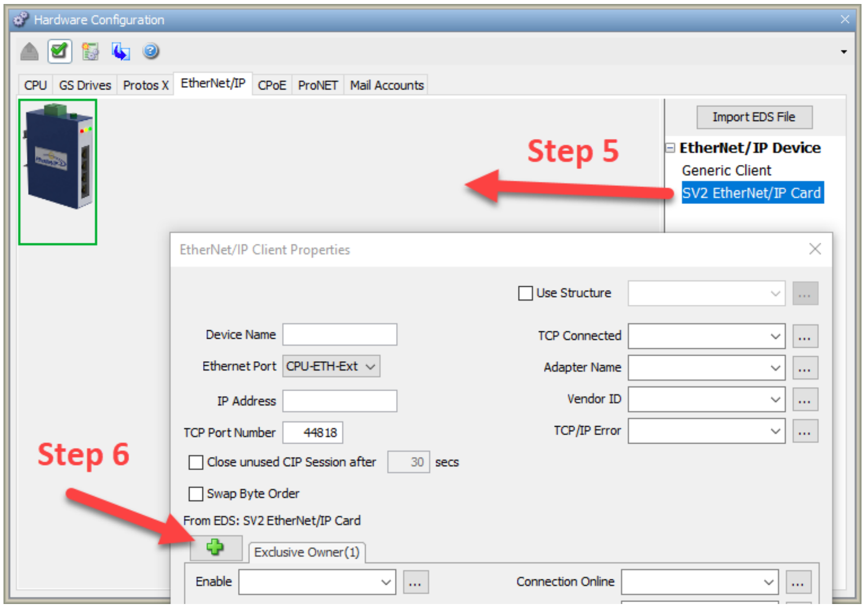


If your PLC supports EDS files, it will be able to import the EDS file into the PLC configuration software.

In the Productivity PLC software, these are the steps to import the SureServo2 EDS File:

1) Open Hardware Config
2) Select the CPU
3) Click on the Ethernet/IP tab

4) Click “Import EDS File” button
5) Choose the EDS file and press OK
6) Drag the EDS file into the Ethernet/IP window
7) Click the green “Plus” Sign and add an “Exclusive Owner” Message (that will use the EDS file).
8) Click “Show EDS Parameters” to view the Parameters you configured in the SureServo2 Pro EDS file.



Please view the SureServo2 Ethernet/IP Implicit Messaging video at AutomationDirect.com for a detailed walk-through on how to set up the Implicit Messaging feature with Productivity PLCs.

NOTE: Not all parameters can be configured through Implicit Messaging. Do not attempt to enter the following parameters in the O->T (PLC Output) values:
***P5.007 Trigger Position Command for PR Mode** (instead, use P5.112 Path Target and P5.122 Path Trigger to initiate PR Paths over Implicit Messaging)*

***P2.010-P2.022, P2.036-P2.041** Do not change DI or DO functional assignments over Implicit Messaging. If you must change the definition of DIs and DOs during operation with communication (not advised), do not use Implicit Messaging - use Explicit Messaging instead.*

P5.038 - Number of Times to Capture
Each time the Capture function activates, this parameter decrements by one. So this parameter should not be constantly written to by Implicit Messaging. If you need to write to P5.038, use Explicit Messaging.

NOTE: P5.088 Activate E-Cam Control can be used with Implicit Messaging. The PLC can write to the parameter with P5.088 in O->T and will be able to read back status with P5.088 in T->O.

NOTE: Always set P2.030=5 to disable writing any changes to the servo EEPROM. While the EEPROM can be written to several millions of times, inadvertent messaging could reach that limit within a few years. Always set P2.030 =5 before initiating communication control to the drive.

9.7 - *Communication Card Troubleshooting*

This section provides alarm descriptions for the error codes displayed on the SV2 panel and the corrective actions you can use for troubleshooting when the LED indicators of the SV2-CM-MODTCP and SV2-CM-ENETIP communication cards are on.

NOTE: If the servo drive sets the communication card parameters to zero at drive power-up, ensure the following:
1) The communication card is properly seated onto the drive.
2) The communication card ground wire is properly attached to the card and to ground.
3) The communication card Firmware Update switch is set to the “normal” position.

9.7.1 - *LED Indicators*

Indicator	LED Color	Description	Corrective Action
MS (Module Status) Indicator (Valid only for the ENETIP card, MS indicator means nothing for MODTCP card)	Flashing red / green	Self-test.	No action required.
	Steady red	Unrecoverable fault.	Malfunction of the hardware. Contact the distributor.
	Steady green	Parameter setting is configured.	No action required.
	Flashing red	Recoverable fault.	Check the parameter settings.
	Flashing green	Parameter setting has not been configured.	Set the parameters as described in the user manual.
	Steady off	No power.	Check if power is supplied to the servo drive.
NS (Network Status) Indicator (Valid only for the ENETIP card, NS indicator means nothing for MODTCP card)	Flashing red / green	Network status self-test.	No action required.
	Steady red	A duplicate IP address has been identified.	Check the IP address setting.
	Steady green	Network connection is established.	No action required.
	Flashing red	Communication timeout / disconnected / IP address is changed.	Check the communication setting.
	Flashing green	Network packet sending / receiving.	No action required.
	Steady off	Not connected to the network.	Check if the network cable is connected.
POWER indicator is OFF	n/a	No power is supplied to the servo drive.	Check if the servo drive is powered on and the power supply is normal.
		Ethernet card is not connected to the servo drive.	Check if the Ethernet card is firmly connected to the servo drive.
LINK indicator is OFF	n/a	The communication card is not connected to the controller.	Check if the network cable of the communication card is connected to the controller.
		RJ45 connector has poor contact.	Check if the RJ45 connector is firmly connected to the Ethernet communication port.

9.7.2 - SureServo2 Warning/Error Codes

The current Error Code is available in P3.048.

ID	Description	Corrective Actions
75	Manufacturing parameter read error.	Restore the default settings of the communication card. If the issue persists, contact AutomationDirect.
76	Internal parameter setting error.	1. Re-install the communication card or check that the wirings of the control circuit, RST circuit, and grounding meet the requirements for resisting interference. 2. Restore the default settings of the communication card. If the issue persists, contact the servo system distributor.
80	Ethernet connection error.	Make sure the Ethernet cable is firmly connected.
81	The communication between the communication card and SV2 has timed out.	Re-install the communication card or check that the wirings of the control circuit, RST circuit, and grounding meet the requirements for resisting interference.
83	Communication card resets to the default.	Troubleshooting is not required.
84	Modbus TCP exceeds the maximum number of communications.	Reduce the number of communications for the Modbus TCP controller.
85	EtherNet/IP exceeds the maximum number of communications.	Reduce the number of communications for the EtherNet/IP controller.
86	IP address error.	1. Make sure there is no IP address conflict onsite. Remove all other devices from the network to test for IP address conflicts. 2. Reset the IP address or ensure the normal operation of the DHCP/BOOTP Server.
89	Communication card cannot communicate with SV2.	Re-install the communication card or check that the wirings of the control circuit, RST circuit, and grounding meet the requirements for resisting interference.

9.7.3 - EtherNet/IP CIP Connection Status Code

Status Code	Status	Description
0x00	Success	The requested service is successfully executed.
0x01	Connection failure	The connection service failed.
0x04	Path segment error	The program node cannot identify the definition or syntax of a path segment. When this error occurs, the execution of the path program will be terminated.
0x05	Path destination unknown	The path is related to an object type, but the program node does not include or cannot identify the type or structure of the object. When this error occurs, the execution of the path program will be terminated.
0x08	Service not supported	The object type does not support the requested service or this service has not been defined.
0x0E	Attribute not settable	Received a request to modify an unchangeable attribute.
0x13	Not enough data	Received insufficient data to execute the command.
0x14	Attribute not supported	The requested attribute is not supported.
0x15	Too much data	Received more data than needed to execute the command.
0x20	Invalid parameter	The requested parameter is invalid. This status code indicates that the parameter does not meet the requirement definition or the requirement has been defined in the Application Object Specification.
0x26	Path size invalid	The size of the transmission path is not sufficient to route the request to the object or too much routing data is included.

9.8 - EtherNet/IP Services and Objects

9.8.1 - Supported Objects

Class Code	Description
0x01	Device identity object.
0x02	Message router object.
0x04	Assembly object.
0x06	Connection manager object.
0xF5	TCP/IP interface object.
0xF6	Ethernet link object.
0x300	Servo drive data object.

9.8.2 - Supported Data Types

Data Type	Description
BYTE	8-bit string.
WORD	16-bit string.
DWORD	32-bit string.
STRING[n]	A string composed of n bytes.
SHORT_STRING	A string composed of bytes (1-byte length indicator, 1-byte characters).
USINT	8-bit unsigned integer.
UINT	16-bit unsigned integer.
UDINT	32-bit unsigned integer.

9.8.3 - Identity Object (Clase Code: 0x01)

Instance Code:

0x01

Instance Attributes				
Attribute ID	**Access Rule**	**Name**	**Data Type**	**Description of attribute**
0x01	Get	Vendor ID	UINT	660
0x02	Get	Device Type	UINT	Communications adapter 12
0x03	Get	Product Code	UINT	Model code: 0x04302
0x04	Get	Revision	STRUCT of: USINT, USINT	Ethernet/IP version Major Revision, Minor Revision
0x05	Get	Status	WORD	Summary status of devices
0x06	Get	Serial Number	UDINT	32-bit serial number of device
0x07	Get	Product Name	SHORT_STRING	SV2-CM-ENETIP

Common Services				
Service code	**Implemented for**		**Service Name**	**Description of Service**
	Class	**Instance**		
0x01		✓	Get_Attribute_All	Returns the attribute content of multiple objects.
0x05		✓	Reset	Resets device setting.
0x0E	✓	✓	Get_Attribute_Single	Returns the attribute content of the specified object.

9.8.4 - Message Router Object (Class Code: 0x02)

Instance Code:

0x01

Instance Attributes:

None

Common Services				
Service code	Implemented for		Service Name	Description of Service
	Class	Instance		
0x0E		✓	Get_Attribute_Single	Returns the attribute content of the specified object.

9.8.5 - Assembly Object (Class Code: 0x04)

Instance Code				
Name	Function	Instance	Size	Description
Connection 1	Input	0x6B	32 words	Corresponds to the input buffer register.
	Output	0x6A	32 words	Corresponds to the output buffer register.
	Configuration	0x83	96 words	Corresponds to the set object.
Connection 1_ Listen only	Input	0x6B	32 words	Corresponds to the input buffer register.
	Output	0xC7	0 words	n/a
	Configuration	0x83	96 words	Corresponds to the set object.

Instance Attributes				
Attribute ID	Access rule	Name	Data Type	Description of Attribute
0x03	Get / Set	Data	ARRAY of BYTE	Instance Code = 0x6A (Get / Set) Others Get only
0x04	Get	Size	UINT	n/a

Common Services				
Service code	Implemented for		Service Name	Description of Service
	Class	Instance		
0x0E	✓	✓	Get_Attribute_Single	Returns the attribute content of the specified object.
0x10		✓	Set_Attribute_Single	Modifies the attribute.

9.8.6 - Connection Manager Object (Class code: 0x06)

Instance Code:

0x01

Instance Attributes:

None

Common Services				
Service code	Implemented for		Service Name	Description of Service
	Class	Instance		
0x0E	✓	✓	Get_Attribute_Single	Returns the attribute content of the specified object.
0x4E		✓	Forward_Close	Closes the connection.
0x54		✓	Forward_Open	Establishes the connection (maximum of 511 bytes per transmission).
0x5B		✓	Large_Forward_Open	n/a

9.8.7 - TCP/IP Interface Object (Class code: 0xF5)

Instance Code:

0x01

Instance Attributes				
Attribute ID	Access Rule	Name	Data Type	Description of Attribute
0x01	Get	Status	DWORD	Interface status
0x02	Get	Configuration Capability	DWORD	Interface capability flags
0x03	Get / Set	Configuration Control	DWORD	Interface control flags
0x04	Get	Path Size, Path	STRUCT of: UINT, Padded EPATH	Path size Path
0x05	Get / Set	Interface Configuration	STRUCT of: UDINT, UDINT, UDINT, UDINT, UDINT, STRING	IP Address Network Mask Gateway Address Name Server Name Server 2 Domain Name
0x06	Get / Set	Host Name	STRING	Host name

Additional Attributes			
Attribute	***Bits***	***Name***	***Description***
Status Instance	0-3	Interface Configuration Status	0 = The Interface Configuration attribute has not been configured. 1 = The Interface Configuration attribute contains valid configuration obtained from BOOTP, DHCP or non-volatile storage. 2 = The IP address member of the Interface Configuration attribute contains valid configuration, obtained from hardware settings (e.g.: pushwheel, thumbwheel, etc.) 3 - 15 = Reserved for future use.
Configuration Capability	2	DHCP Client	1 (TRUE) shall indicate the device is capable of obtaining its network configuration via DHCP.
	4	Configuration Settable	1 (TRUE) shall indicate the Interface Configuration attribute is settable.
Configuration Control	0-3	Startup Configuration	0 = The device shall use the interface configuration values previously stored in non-volatile memory. 1 = The device shall obtain its interface configuration values via BOOTP. 2 = The device shall obtain its interface configuration values via DHCP upon start-up. 3 - 15 = Reserved for future use.

Common Services				
Service code	***Implemented for***		***Service Name***	***Description of Service***
	Class	***Instance***		
0x0E	✓	✓	Get_Attribute_Single	Returns the attribute content of the specified object.
0x10		✓	Set_Attribute_Single	Modifies the attribute.

9.8.8 - EtherNet Link Object (Class code: 0xF6)

Instance Code:

0x01

Instance Attributes				
Attribute ID	***Access rule***	***Name***	***Data Type***	***Description of attribute***
0x01	Get	Interface Speed	UDINT	Interface speed currently in use Speed in Mbps (e.g., 0, 10, 100, 1000, etc.)
0x02	Get	Interface Flags	DWORD	Interface status flags
0x03	Get	Physical Address	USINT [6]	MAC address

Bits	Name	Description
0	Link Status	0 indicates an inactive link; 1 indicates an active link.
1	Half / Full Duplex	0 indicates the interface is running half duplex; 1 indicates full duplex.
2-4	Negotiation Status	Indicates the status of link auto-negotiation 0 = Auto-negotiation in progress. 1 = Auto-negotiation and speed detection failed. Using default values for speed and duplex. Defaults are 10 Mbps and half duplex. 2 = Auto negotiation failed but detected speed. Default is half duplex. 3 = Successfully negotiated speed and duplex. 4 = Auto-negotiation not attempted. Forced speed and duplex.

Common Services				
Service code	Implemented for		Service Name	Description of Service
	Class	Instance		
0x01		✓	Get_Attribute_All	Returns the attribute content of multiple objects.
0x0E		✓	Get_Attribute_Single	Returns the attribute content of the specified object.

9.8.9 - SV2 Data Object (Class code: 0x300)

Class Attributes and Instance Attributes:

Object class = 0x300

Instance = Parameter Group

Attribute = Parameter Member = Parameter Number x 2

Example:

P5.007 would be addressed as Instance 5, Attribute 14.

Instance and Attributes					
Instance	Attribute	Access rule	Name	Data Type	Description of attribute
0x00 - 0x07	0x00 - 0xFF	Get / Set*	SV2 Parameter.	UDINT, STRING	SV2 parameter data
0x10	0x00 - 0xFE	Get / Set	Monitor Parameter	UDINT, STRING	SV2 Monitor Parameter
0x32 - 0x34	0x00 – 0xFF	-	Reserved	-	Internal used
** Refer to the Parameters chapter to check if the parameter is read-only. It is not recommended to modify the attributes for read-only parameters.*					

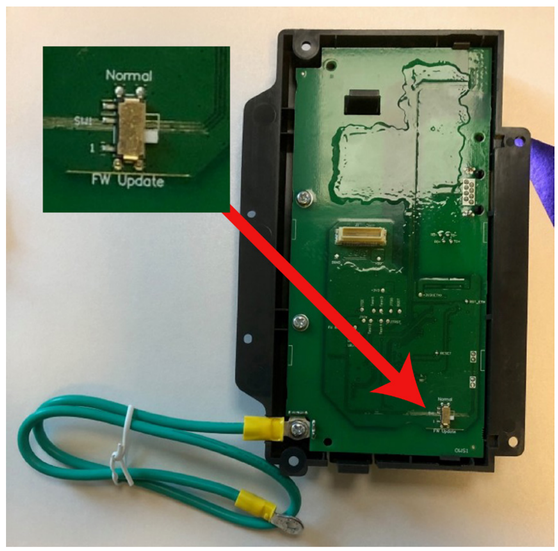
Common Services				
Service code	Implemented for		Service Name	Description of Service
	Class	Instance		
0x0E	✓	✓	Get_Attribute_Single	Returns the attribute content of the specified object.
0x10	✓	✓	Set_Attribute_Single	Modifies the attribute.

9.9 - Ethernet Card Firmware Update

NOTE: This procedure is only for the firmware located inside the Ethernet card. For servo drive firmware updates, SureServo2 Pro software and a SV2-PGM-USB15 (or -USB30) cable are required. See the SureServo2 Pro software help file for more information.

The ModTCP and the EtherNet/IP firmware update process is the same for both cards. The Ethernet cards have web servers built-in that will facilitate upgrading the firmware. An Ethernet cable attached to a PC is all that is required.

To determine if the Ethernet card firmware needs to be updated, compare the Ethernet card firmware version in P3.046 to the latest firmware file at the Ethernet card item page on Automationdirect.com.

<table>
<tr><th colspan="2">Ethernet Card Firmware Update Process</th></tr>
<tr><td>1</td><td>To updae firmware, first ensure the “FW Update” switch is in the “FW Update” position.


NOTE: The card will only allow firmware updates when the switch is set to “FW Update”. The switch must be returned to the “Normal” position after updating for typical servo communication and control.</td></tr>
<tr><td>2</td><td>Mount the card to the drive (see the card installation instructions if necessary).</td></tr>
<tr><td>3</td><td>Insert one end of an Ethernet cable into the RJ45 connector. Insert the other end into a switch or controller.</td></tr>
<tr><td>4</td><td>Turn on power to the drive. The POWER light should turn solid (no blinking). The LINK/ACT should turn on and blink several times while establishing connection to the switch or controller. This indicates the card is negotiating a connection.

NOTE: If the LINK/ACT light turns on solid when first powered up, cycle power to the switch. If the LINK/ACT light still does not blink after powering up the switch, unplug and replug the controller (PLC, etc.) from the switch. If the card’s LINK/ACT light still does not blink this may indicate that the switch in use is an older model that may not work with the drive. Replace the switch or run the ethernet cable from the card directly to the controller. The card will automatically negotiate the direct connection, so a cross-over cable is not needed.</td></tr>
</table>

<table>
<tr><th colspan="2">Ethernet Card Firmware Update Process, continued</th></tr>
<tr><td>5</td><td>Set your PC IP address to 192.168.1.xxx where xxx is a number of your choice excepting “3” (the communication card is hard-coded to 192.168.1.3).

If you don’t know how to manually set your PC’s IP address, follow the steps below:
<table>
<tr><th colspan="2">Manually Setting PC IP Address</th></tr>
<tr><td>1</td><td>In your PC’s search box, type “Network Status” and click on the Network Status app.</td></tr>
<tr><td>2</td><td>Select “Change Adapter Options”.</td></tr>
<tr><td>3</td><td>Double-click on the hard-wired ethernet connection to the servo.</td></tr>
<tr><td>4</td><td>Select “Properties”.</td></tr>
<tr><td>5</td><td>Double-click on “Internet Protocol Version 4 (TCP/IPv4).</td></tr>
<tr><td>6</td><td>Make sure “Use the Following IP Address” is selected, then enter 192.168.1.xxx where xxx is a number of your choice other than 3. Enter 255.255.255.0 for the subnet mask.</td></tr>
<tr><td>7</td><td>Click “Ok”.</td></tr>
</table></td></tr>
<tr><td>6</td><td>Using your web browser, go to http://192.168.1.3. This is the hard-coded address for the communication card when the “FW Update” switch is toggled on.

The communication card web server should display. If it does not, try connecting to the card with a direct ethernet connection from your PC to your card (don’t use a switch or hub). A standard ethernet cable will work (cross-over cable is not required).</td></tr>
<tr><td>7</td><td>Press “Choose File” and select the appropriate file for your card (*.web).</td></tr>
<tr><td>8</td><td>Press “Update”. After a few seconds, the Update Status should change to “Firmware Update Success”.</td></tr>
<tr><td>9</td><td>Once the update is complete, remove power from the drive, then remove the ethernet cable and uninstall the ethernet card.</td></tr>
<tr><td>10</td><td>Slide the “SW Update” switch on the card to the “Normal” position. The card will NOT communicate with other devices unless the switch is set correctly.</td></tr>
<tr><td>11</td><td>Re-install the communication card and reconnect the ethernet cable.</td></tr>
<tr><td>12</td><td>Apply power to the drive and ensure that the “Power” light is solid. Ensure that the LINK/ACT light blinks several times after the drive has powered up. See Step 4 if the card doesn’t establish communications.</td></tr>
</table>

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Chapter 10

Chapter 10: Absolute System

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Introduction

This chapter introduces the absolute servo system, including the wiring and installation of the absolute encoder, the steps to set up the system, and the procedures for initializing and operating the system for the first time.

Note:

A complete absolute servo system includes a SureServo2 servo drive, a motor, and a backup battery box. All SureServo2 motors have a serial communication encoder system installed though they can be used in an incremental or absolute coordinate setup. The backup battery supplies power to the encoder system on the motor so that the encoder continues to operate even when the power is off. The encoders on the SureServo2 motors have a small amount of local memory which allows the motor to record positional changes when the drive is not powered and a battery box is installed. In addition, the absolute encoder can continuously record the motor's actual position at any time, even when the motor shaft is rotated after the power is off.

Install the battery properly with the encoder cable. One battery box (SV2-BBOX-1) for one drive/motor system only. Do not try to connect multiple drives or motors to one battery backup box. Please use AutomationDirect's motor feedback encoder cable to connect to the battery box. See the following section for the specifications of the battery box and its accessories.

The standard voltage level of the battery is 3.6 V. If the battery level reaches a 3.1 V threshold then P0.050 Bit 1 will turn ON along with AL061 (P0.050 Bit 1=1 means the battery is under-voltage; 0=normal). When the voltage is under 2.7 V, the motor's position might be lost when operated under battery power alone. The shelf life of the battery is 10 years. When the drive is powered off and the motor encoder is continuously powered by the SV2-BBOX-1 battery the battery can sustain encoder position for 5 cumulative years. The SV2 motor encoders only have a current draw of 30µA.

10.1 - Battery Box (Absolute Type) and Wiring

10.1.1 - Specifications

Precautions

Please carefully read through the following safety precautions. Use batteries only in accordance with the specifications so as to avoid damage or dangerous conditions.

The installation location must be free of all water, corrosive and inflammable gas.

Correctly place the battery into the battery box to avoid short circuiting.

Do not short circuit the positive and negative electrodes of the battery, and do not install the battery in reverse direction.

Only use new batteries to avoid losing power or shortening the life of the batteries.

Please follow the instructions when wiring the battery box to avoid dangerous conditions.

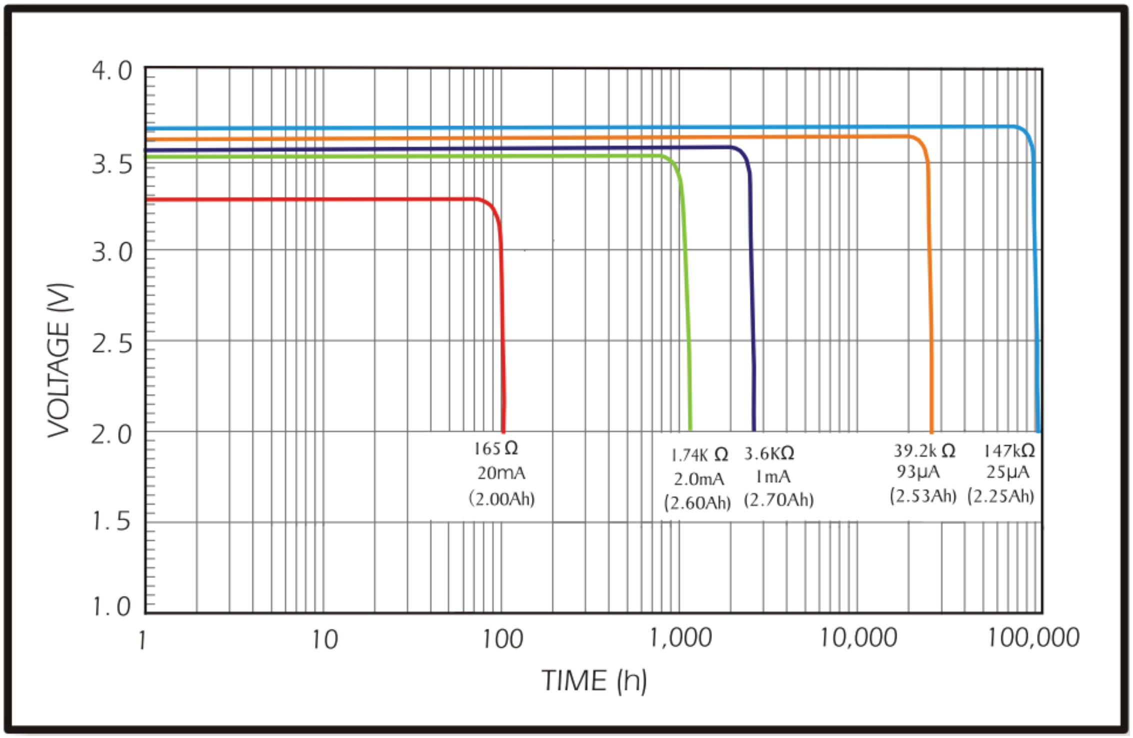
Do not place the battery in a high-temperature environment over 100°C, as this may cause a fire or an explosion.

The batteries are non-rechargeable. Do not charge the batteries as this might result in an explosion.

Do not directly weld on the surface of the battery.

Battery specifications

Item	Li/SOCl2 Cylindrical Battery
Type	ER14505
International Standard Size	AA
Standard Voltage	3.6 V
Standard Capacity	2700mAh
Maximum Continuous Discharge Current	100mA
Maximum Pulse Current	200mA
Dimensions (D X H)	14.5 x 50.5 mm
Weight	Approx. 19g
Operating Temperature	-40°C to +85°C



The figure above illustrates the discharge current curves measured in the constant current test. According to the five curves shown above, if the voltage of the battery keeps at 3V or higher, the expected battery life is as shown in the following table. Therefore, the lowest battery voltage level for an absolute encoder is set to 3.1 V.

For SureServo2 motors the battery mode current comsumption[2] is 45µA. Battery life expectancy is 58.33 months.

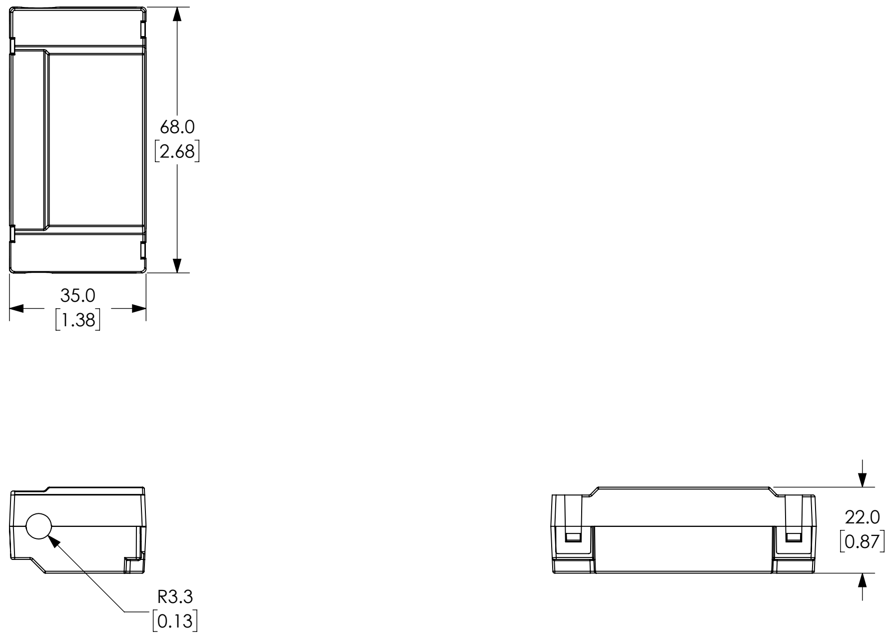
Notes:

1) The battery life expectancy is measured with a test using a servo drive, a motor, and a single battery.
2) The current consumption is nearly zero when the absolute origin coordinate is not established. Once the absolute origin coordinate is established, battery power consumption starts. To avoid battery power consumption when the machine is in transport, disconnect the servo drive and battery or do not establish the absolute origin coordinate.

10.1.2 - Battery Box Dimensions

Single battery box

Part number: SV2-BBOX-1



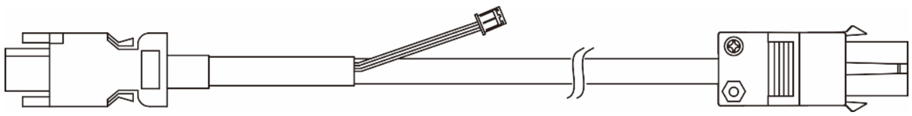
NOTE: SV2-BBOX-1 requires the use of SV2-BBOX-CBL (connectorized on both ends) if using SureServo2 factory encoder cables. Ensure the battery is plugged into the connector that is labeled J1 on the SV2-BBOX-1 circuit board and the encoder cable is plugged into the connector labeled J2 on the circuit board.

If you are constructing your own encoder cable, the SV2-BBOX-1 does come with a pigtail cable that can attach to custom encoder cables.

10.1.3 - Connection Cable for the Absolute Encoder

Quick connector

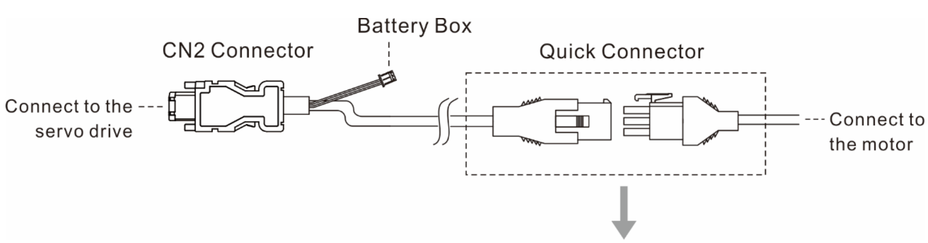
Part number: SV2C-E122-xxxN

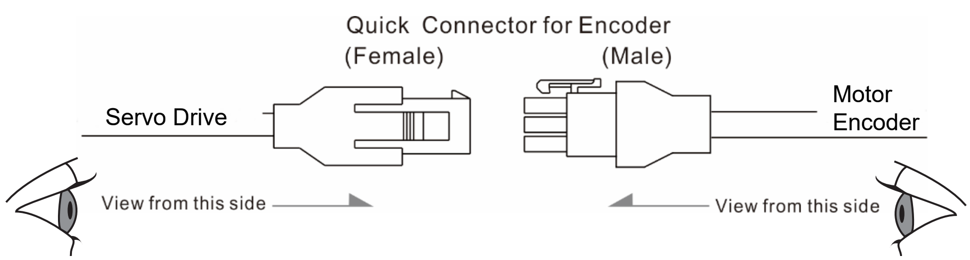


Model Name	*L*	
	mm	*inch*
SV2C-E122-03FN	3000 ± 100	118 ± 4
SV2C-E122-03NN		
SV2C-E122-05FN	5000 ± 100	197 ± 4
SV2C-E122-05NN		
SV2C-E122-10FN	10000 ± 100	394 ± 4
SV2C-E122-10NN		
SV2C-E122-20FN	20000 ± 100	787 ± 4
SV2C-E122-20NN		

Connection method:

NOTE: Please follow the instructions below when connecting the cable. Incorrect wiring may result in a battery explosion.



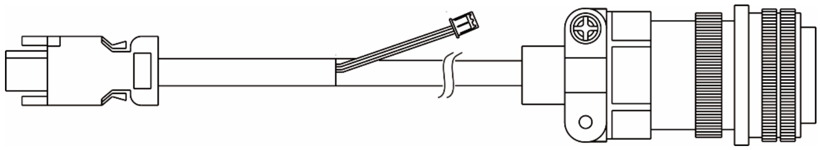


1 White T+	2 Red BAT+	3 N/C
4 White / Red T-	5 Black BAT-	6 N/C
7 Brown +5 VDC	8 Blue GND	9 Shield

3 N/C	2 Black BAT+	1 White T+
6 N/C	5 Red BAT-	4 White / Red T-
9 Shield	8 Blue GND	7 Brown +5 VDC

Military connector

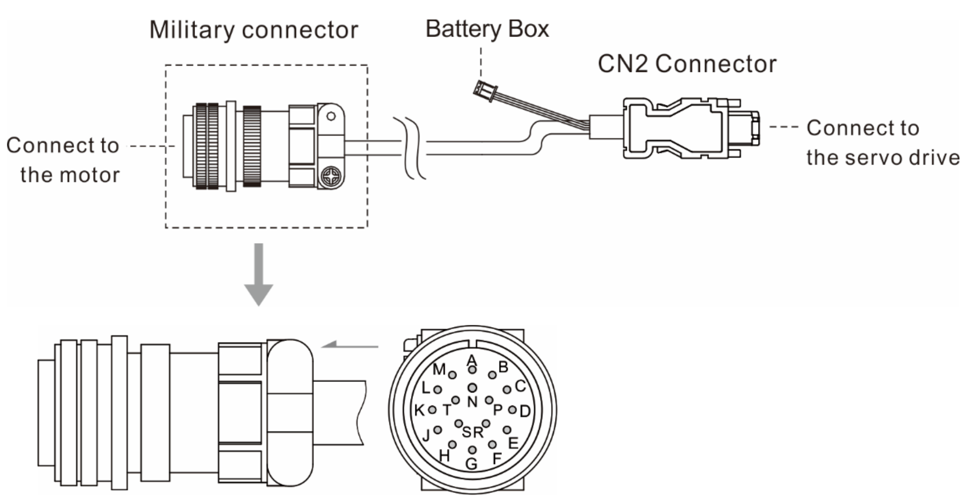
Part number: SV2C-E222-xxxN



Model name	L	
	mm	**inch**
SV2C-E222-03FN	3000 ± 100	118 ± 4
SV2C-E222-03NN		
SV2C-E222-05FN	5000 ± 100	197 ± 4
SV2C-E222-05NN		
SV2C-E222-10FN	10000 ± 100	394 ± 4
SV2C-E222-10NN		
SV2C-E222-20FN	20000 ± 100	787 ± 4
SV2C-E222-20NN		

Connection method:

NOTE: Please follow the instructions below when connecting the cable. Incorrect wiring may result in a battery explosion.

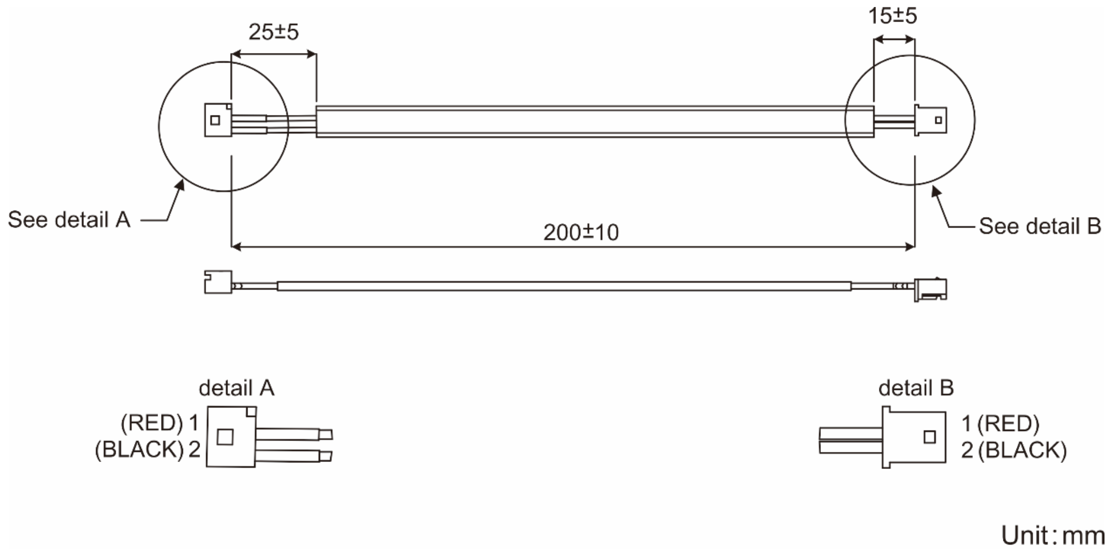


Pin No.	Terminal	Color
A	T+	White
B	T -	White / Red
C	BAT+	Red
D	BAT-	Black
S	+5 VDC	Brown
R	GND	Blue
L	BRAID SHIELD	–

10.1.4 - Battery Box Cable

Battery box cable.

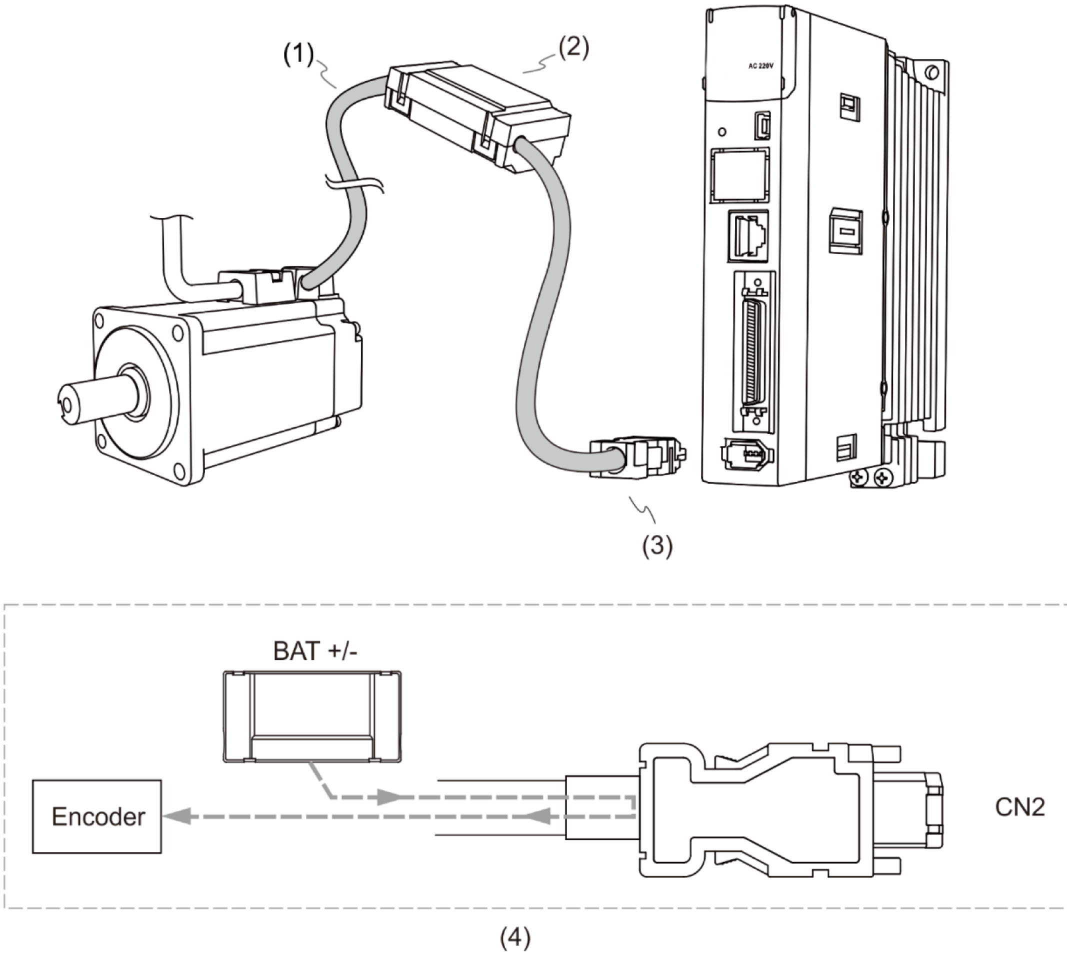
Part number: SV2-BBOX-CBL



10.2 - Installation

10.2.1 - Installing the battery box in the servo system

Standard Wiring



(1) Encoder cable; (2) Battery Box; (3) CN2 connector; (4) Battery box wiring

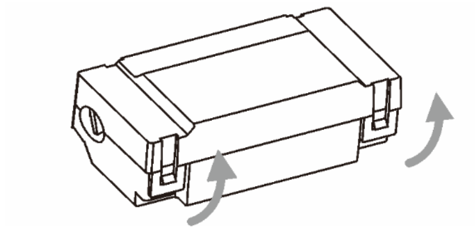
Pin assignment of CN2:

Encoder End			Servo Drive End		
Military Connector	**Quick Connector**	**Color**	**Pin No.**	**Symbol**	**Description**
A	1	White	5	T+	Serial communication signal (+)
B	4	White / Red	6	T-	Serial communication signal (-)
S	7	Brown	1	+5V	Power +5V
R	8	Blue	2	GND	Power ground
L	9	-	Case	Shielding	Shielding
C	2	Red	–	–	Battery +3.6 V
D	5	Black	–	–	Battery ground

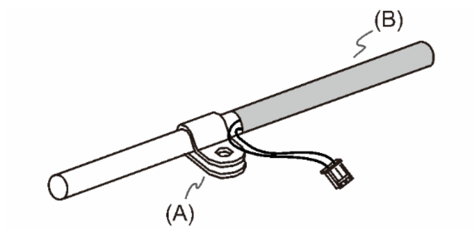
NOTE: When using the battery box, the battery supplies power directly to the encoder. Thus, connecting the encoder cable to the drive's CN2 port is not required to maintain position. This is useful if you want to maintain encoder position and need to disconnect it from the drive. Please refer to the wiring description in Section 3.6 Specifications of encoder connector for details.

10.2.2 - Installing and replacing a battery

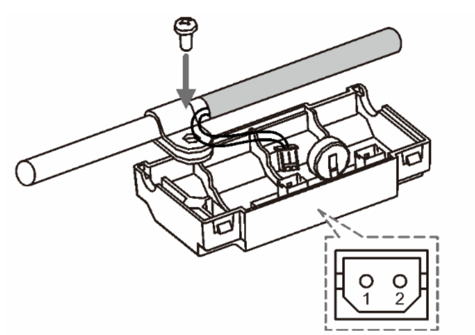
If you need to replace the battery and maintain absolute position you will need to purchase another SV2-BBOX-1 and use the new battery that comes with it.



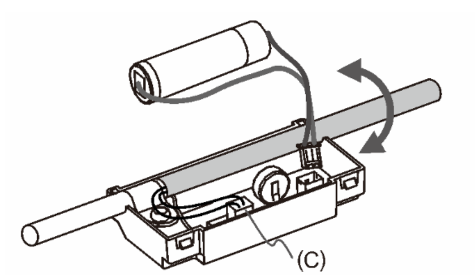
Step 1:
Loosen the hooks on both sides to open the lid of the battery box.



Step 2:
Attach the metal clip to the connection cable. Please note that the metal clip should be placed close to the heat shrink.
Metal clip; (B) Heat shrink

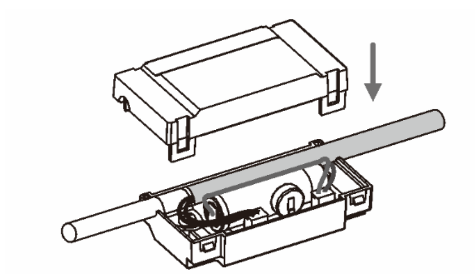


Step 3:
Plug in the connection cable and tighten the screw.



Step 4:
Install a new battery and connect it to the cable.
(C) Please replace the battery only when the main power to the servo drive is still on.

CAUTION: Do not remove the power cable, as the system might lose data.



Step 5:
Place the cable into the box and close the lid.

To avoid data loss, please replace the battery when any of the following circumstances occurs:

1) The servo drive shows alarm AL061, which means the voltage is too low. Please refer to Chapter 11 for more information.
2) When the voltage is under 2.9 V, the motor's position record might be lost if the motor is moved while solely under battery power, so you should perform the homing procedure after installing a new battery. You should replace the battery while the main power is connected to the servo drive.

10.3 - System Initialization and Operating Procedures

10.3.1 - System Initialization

When the absolute coordinates are lost, the servo drive provides three ways to establish the absolute origin coordinates: DI/DO, parameter setting, or the PR homing function. The following provides more details for each operation mode.

After the servo system resumes operation, the host controller can acquire the motor's current absolute position either with communication or SureServo2 Pro. AutomationDirect's absolute system provides two types of position value for the host controller: pulse and PUU.

AL060 occurs when you initialize the absolute system for the first time because the coordinate system has not been created. Clear the alarm by setting up the coordinate system. Insufficient encoder battery power or the failure of the main power supply when no battery is connected also causes loss of the coordinate system and the re-occurrence of AL060. In the absolute system, when the number of motor rotations exceeds the range -32768 to 32767, AL062 occurs. The number of motor rotations is being recorded in the drive's memory but there is no parameter to view this value. When the PUU position value goes outside the range -2147483648 to 2147483647, AL289 occurs.

Except for the alarms mentioned above, you can use P2.069 and P2.070 to set up AutomationDirect's absolute servo system. You can choose not to show AL062 and AL289 if the absolute coordinate system overflows when the number of rotations exceeds the range -32768 to 32767 or when the PUU exceeds the range -2147483648 to 2147483647 (32 bit register). For example, you might do this on a system that uses incremental commands to operate in a single direction.

P2.069.X Setting

- *X: Set up operation mode*
- *0: Incremental type system*
- *1: Absolute type system*

P2.071 setting:

1) Initialize the absolute coordinates. When the coordinate setting is complete, AL06A (or AL060) is automatically cleared. There are two ways for you to initialize the host controller coordinates: DI (please refer to Section 10.3.4) or setting parameters (please refer to Section 10.3.5).
2) When the system is powered on again, you can access the drive's absolute position with Modbus RTU, MODTCP, or EtherNet/IP communication (please refer to Section 9.3). Based on the setting of P2.070, the host controller can select the requested value, either the PUU (please refer to Section 10.3.3) or the pulse value of 16777216, within a single turn (please refer to Section 10.3.2).

10.3.2 - Pulse Number (P2.070 bit1=1)

When the motor is running in the clockwise direction, the shaft rotation number is expressed as a negative value. When the motor runs in the counterclockwise direction, the shaft rotation number is expressed as a positive value. The range of the number of rotations is between -32768 and +32767, and AL062 occurs once the number exceeds the range. To clear the alarm, you must re-initialize the coordinate system. If P2.070 has been set to ignore the AL062 alarm, then the system shows no error. If the system is operating in the counterclockwise direction and it reaches 32,767 turns, the value jumps to -32768 once it reaches the target position in the next shaft rotation, and the value keeps increasing to -32768, -32767, -32766, and so on. When the system is operating in the clockwise direction, the value jumps to 32767 in the next shaft rotation after reaching -32768.

In addition to the shaft rotation counter, there are 16,777,216 pulses (0 – 16777215) in one (shaft or encoder) rotation. Please pay attention to the motor's running direction. You can read the shaft rotation number and the pulse number with communication. Total pulse number = m (shaft rotation number(P0.051)) x 16777216 + pulse number(P0.052) (0 – 16777215). The conversions between pulse number and PUU are as follows:

When the rotation direction is defined as CCW in P1.001,

then the PUU number = pulse number $\times \frac{P1.045}{P1.044}$ + P6.001.

When the rotation direction is defined as CW in P1.001,

then the PUU number = (-1) × pulse number $\times \frac{P1.045}{P1.044}$ + P6.001.

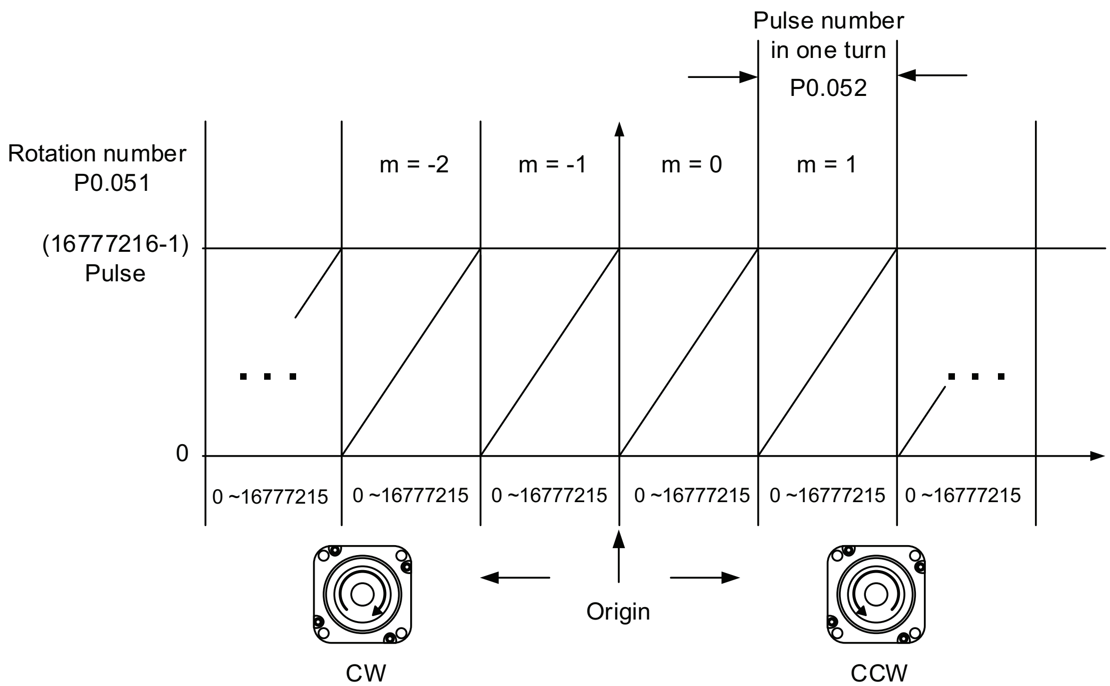


Figure 10-1 Absolute position for PUU number

10.3.3 - PUU Number (P2.070 bit1=0)

The PUU number is a 32-bit absolute value with positive and negative signs. When the motor is running in the forward direction, the PUU number increases; when it is running in the reverse direction, the PUU number decreases. The forward direction does not mean the motor is running clockwise; the direction is defined by P1.001.Z. The maximum range of the shaft rotation number is -32768 to +32767, the drive keeps track of this cycle count internally but it is not reported in any parameter. AL062 occurs when the number of rotations overflows the range. If the PUU number exceeds the range -2147483648 to 2147483647, the position counter overflows and AL289 occurs. Re-initialize the system to clear these alarms (AL062 or AL289). You can determine whether or not to show AL062 and AL289 when the position overflows through P2.070. When reaching the maximum PUU number in the forward direction, the value changes from 2147483647 to -2147483648, -2147483647, 2147483647, and so on. The value changes the other way when the motor operates in the reverse direction. See the following examples:

Example 1:

When P1.044 = 16777216 and P1.045 = 100000, the motor needs 100,000 PUU to run one shaft rotation. 2,147,483,647 ÷ 100,000 = 21,474.8, so once the motor runs over 21,474.8 (< 32,767) rotations in the forward direction, AL289 occurs.

Example 2:

When P1.044 = 16777216 and P1.045 = 10000, the motor needs 10,000 PUU to run one shaft rotation. 2,147,483,647 ÷ 10,000 = 214,748.3, so once the motor runs over 32,767 (< 214,748.3) rotations in the forward direction, AL062 occurs.

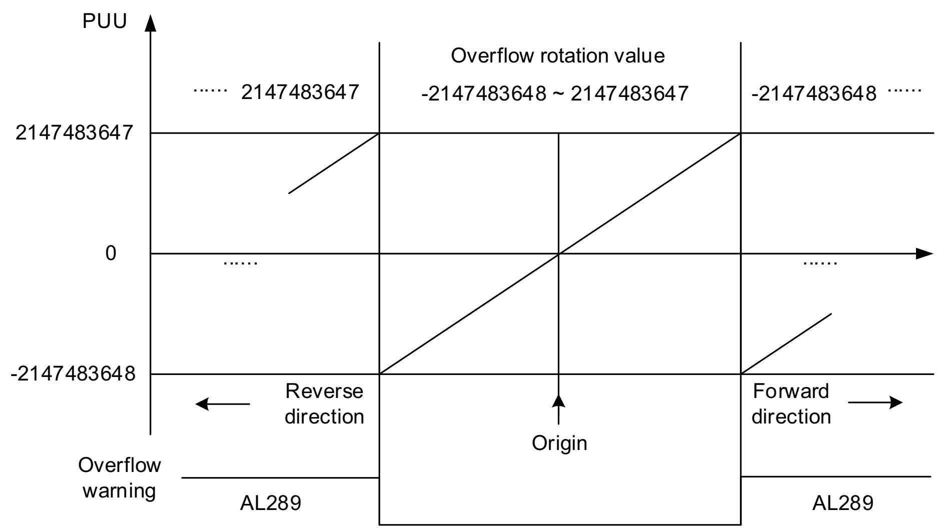


Figure 10-2 Absolute position for PUU number

NOTE: After initializing the absolute coordinate system, any change to P1.001.Z or E-Gear ratio (P1.044 and P1.045) changes the original setting of the absolute coordinate system. If the above parameters are changed, please re-initialize the coordinate system.

Wiring
Parameters
DI/DO Codes
Monitoring
Alarms

10.3.4 - Establishing the Absolute Origin Coordinates with DI/DO

When the servo system is controlled by the host controller, you can reset the absolute coordinate system with DI/DO. To initialize the coordinate system first set P2.069.X=1, then power cycle the drive for the setting to take affect, set DI.ABSE (***0x1D***) to on and switch DI.ABSC (***0x1F***) to ON. At that point, the pulse number is set to 0 and the PUU number is the value of P6.001. Please refer to the following diagram for detailed descriptions.

NOTE: (1), (2), and (3) represent the required delay time between triggering DI.ABSE and DI.ABSC to enable the function.

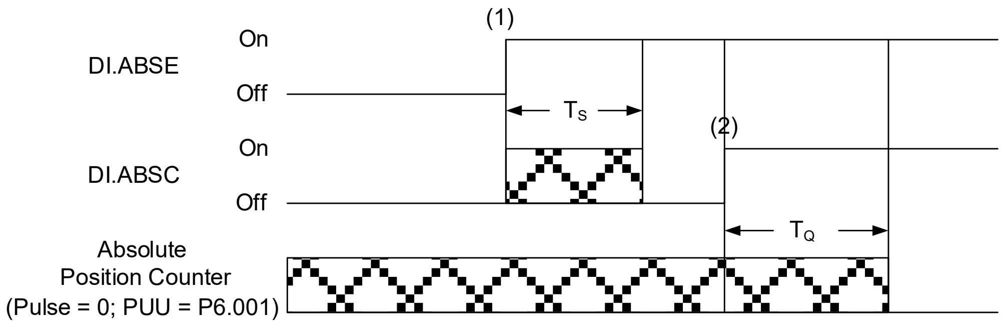


Figure 10-3 Timing diagram for initializing the absolute coordinate system with DI/DO

The following table describes the TS and TQ delay time after triggering DI.ABSE and DI. ABSC.

	$T_{S(ms)}$	$T_{Q(ms)}$
Min (T_S, T_Q)	Value of P2.009 + 2	
Max	P2.009 + 250	

Description:

1) When DI.ABSE turns on, it has to wait for TS ms before setting DI.ABSC on.
2) When DI.ABSC turns on and remains on for TQ ms, the pulse number is set to zero and the PUU number is set to the value of P6.001.

10.3.5 - Establishing the Absolute Origin Coordinates with Parameters

Set P2.069.X to 1 then power cycle. This must be done before P2.071 can be set to 1. This is to initialize the absolute coordinates and can be done through the panel or with communication. As soon as P2.071 is set to 1, the absolute coordinate system resets. Since the write-protect function of P2.071 is protected by P2.008, you must set P2.008 to 271 first. In other words, the sequence is: set P2.008 to 271, then set P2.071 to 1. At this point, the pulse number is set to 0 and the PUU number is the value of P6.001.

10.3.6 - Establishing the Absolute Origin Coordinates with the PR Homing Function

You can use the 11 homing modes in the PR mode to establish the absolute origin coordinates. For more details, refer to Section 7.1.3.1 Homing methods.

10.3.7 - Reading the Absolute Position with Communication

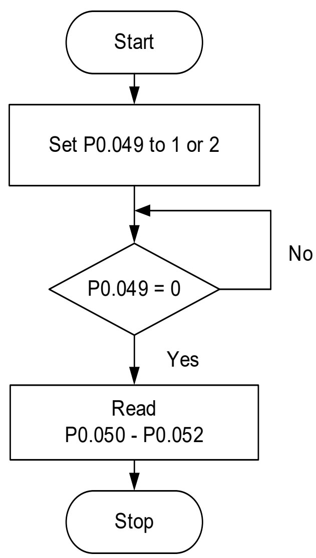
You can access the data of the absolute encoder through two communication methods: instant access or parameter access.

Instant access refers to reading the motor's feedback position as soon as power is sent to the servo. When you set the status monitoring register 1 to the motor's feedback pulse number (P0.017 = 0), you can access the motor's current position by reading P0.009.

Parameter access means the motor's position is temporarily stored in parameters. Once you set P0.049 with communication, the encoder's status, absolute position (shaft rotation number), and pulse number (or PUU) are stored in P0.050, P0.051, and P0.052 respectively. You can choose to read the pulse number or PUU by setting P2.070 Bit 1. Even when the motor is stopped, it still moves slightly forward and backward.

- *When you set P0.049 to 1, the encoder will perform a one-time read of the exact position where the motor stops without changing anything else.*
- *On the other hand, when you set P0.049 to 2, the encoder updates the motor's current position on the servo drive, which clears any position error.*
- *After all positions are updated in P0.050 – P0.052, P0.049 is automatically reset to 0. At that point, the controller can access the values of P0.050 – P0.052.*
- *P0.050 shows the status of the absolute encoder. When it shows absolute position lost or overflow, that indicates that the absolute position is invalid. You must re-do the homing procedure and re-initialize the absolute coordinates.*

For example, the motor's current position is 20000, but it varies between 19999 and 20001. If you send the command to read the motor's position when it stops at 20001, the motor's position is updated to 20001.



10.3.8 - Reading the absolute position with DI/DO

NOTE: Using DI/DO to read the absolute position is not recommended. It is an old method for communicating to devices that don't have more reliable communications such as RS485 or Ethernet. It is highly suggested to use RS485 or Ethernet for reading absolute position when in absolute mode.

Reading the absolute position via DI/DO is not recommended unless there is a specific need to do so. The DI/DO method mimics serial protocol. Using communications to read the position is recommended (Section 10.3.7).

- *Set P2.070 [Bit 0] to 0 so that you can read the value in PUU with DI/DO. See the following descriptions.*

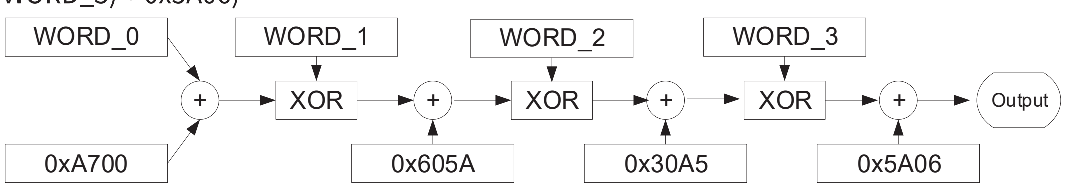
Bit	Description
Bit 79 – Bit 64	Checksum
Bit 63 – Bit 32	Encoder PUU -2,147,483,648 to 2,147,483,647
Bit 31 – Bit 16	0
Bit 15 – Bit 0	Encoder status (P0.050)

- *Set P2.070 [Bit 0] to 1 so that you can read the value in pulse with DI/DO. See the following descriptions.*

Bit	Description
Bit 79 – Bit 64	Checksum
Bit 63 – Bit 32	Pulse number of one encoder revolution 0 to 16,777,215 (=16,777,216-1)
Bit 31 – Bit 16	Number of encoder revolution -32,768 to 32,767
Bit 15 – Bit 0	Encoder status (P0.050)

Description:

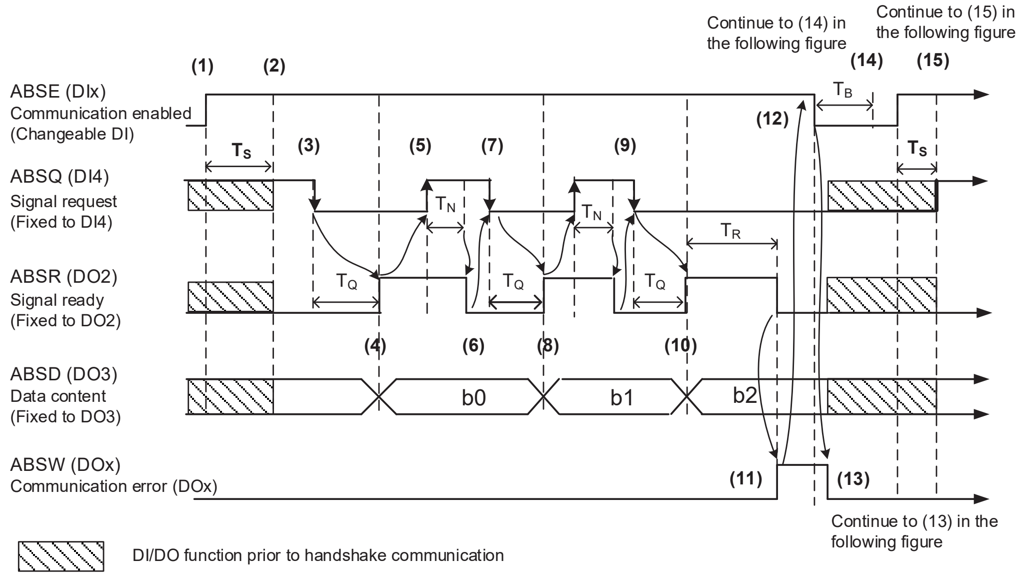
Checksum = (((((((WORD_0+0xA700) XOR WORD_1) + 0x605A) XOR WORD_2) + 0x30A5) XOR WORD_3) + 0x5A06)

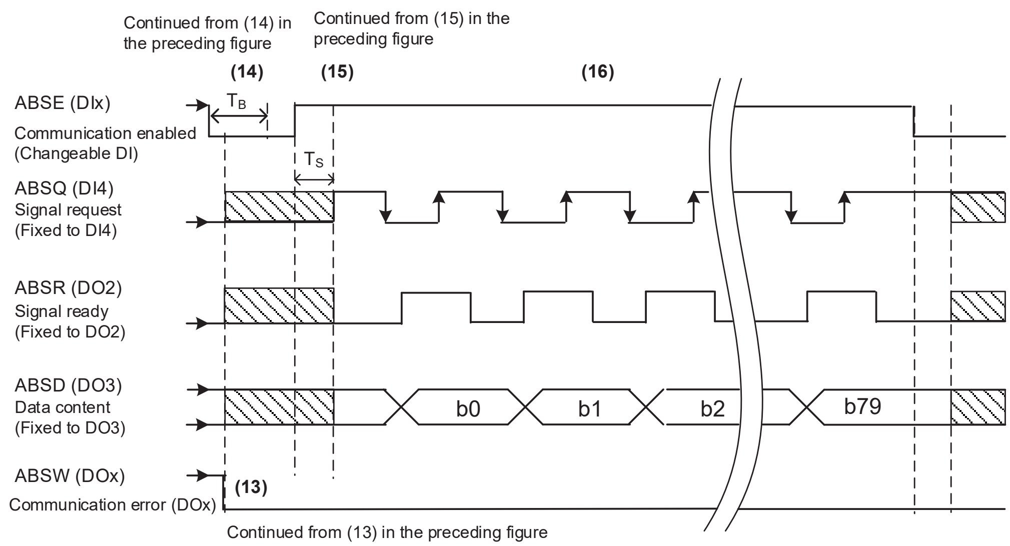


Notes:

1) This algorithm has no positive or negative sign.
2) 0xA700, 0x605A, 0x30A5, and 0x5A06 are constants in hexadecimal format.
3) WORD_0: encoder status (Bit 15–0)
   WORD_1: number of encoder revolution (Bit 31–16)
   WORD_2: encoder pulse number (Bit 47–32)
   WORD_3: encoder pulse number (Bit 63–48)

You can set P2.070 to read the position value in the unit of pulse or PUU with DI/DO. See the timing diagram below:





The following table describes the delay time when reading the absolute position with DI/DO.

	$T_{R(ms)}$	$T_{S(ms)}$	$T_{Q(ms)}$	$T_{N(ms)}$	$T_{B(ms)}$
Min.	–	P2.009 + 2			
Max.	200	P2.009 + 10			

Steps:

1) When the handshake communication starts, the ABSE signal is triggered.
2) After the T_S delay time (make sure the signal is on), the functions for DI4, DO2, and DO3 are switched to ABSQ, ABSR, and ABSD, respectively. If DI4 was in the high-level state before, it remains in the high-level state when switched to ABSQ (logic high-level signal). DI4, DO2, and DO3 are dual-function DI/DO, which means DI4, DO2, and DO3 share the same DI with ABSQ, ABSR, and ABSD. Pay special attention when switching functions or set the DI/DO to 0 to disable the dual-function of DI/DO.
3) If DI4 was in the high-level state and switched to ABSQ after the T_S delay time, when the controller

resets this signal to low level, the new signal is interpreted as the data access command.

4) After the T_Q time, the handshake data is ready and the absolute position is sent to ABSD. Now the servo drive turns on the ABSR signal and the controller can access the data.
If the controller still cannot detect the ABSR status while it is changing to high level after the maximum T_Q time, there may be a communication error.
5) Once the ABSR signal is set to high level, the controller accesses the data, and the ABSQ signal is set to high level to notify the servo drive that data was read.
6) When ABSQ is at high level, ABSR is set to low level after the T_N time in order to send the data for the next bit communication.
7) When ABSR is at low level, ABSQ is also set to low level and the servo drive needs to send the data for the next bit communication.
8) Repeat steps 3 and 4. Send the absolute position to ABSD for the next bit communication.
9) (Repeat steps 5 to 7. The controller has read and received the data.
10) The third bit data is ready.
11) After the T_R waiting time, if the controller has not read the data and turned on the ABSQ signal, the servo drive sends the ABSW signal (communication error) and stops the handshake communication.
12) When the controller receives the communication error signal, it sets ABSE to low level and prepares to restart the handshake communication.
13) ABSW resumes to low level after the servo drive receives the ABSE signal.
14) The controller resumes communication after the T_B time.
15) Repeat step 1.
16) If no error occurs, the controller completes 80 bits (0 - 79) of the handshake communication with the servo drive. DI4, DO2, and DO3 then resume their original functions.

10.4 - List of Absolute Parameters, DI/DO, and Alarms

Relevant parameters (please refer to Chapter 8 for detailed information):

Parameter	***Function***
P0.002	Drive status
P0.049	Update encoder absolute position
P0.050	Absolute coordinate system status
P0.051	Encoder absolute position - Multiple turns
P0.052	Encoder absolute position - Pulse number or PUU within single turn
P2.069	Absolute encoder
P2.070	Read data selection
P2.071	Absolute position homing

Relevant DI/DO (please refer to Chapter 8 for detailed information):

Setting Value	***DI Name***	***Setting Value***	***DO Name***
0x1D	ABSE	WHEN DI.ABSE is on, DI.ABSR triggered by DO2 replaced the DO2 assigned by P2.019	ABSR always output by DO2
When DI.ABSE is on, the DI.ABSQ from DI4 replaced the DI4 function from P2.013.	ABSQ always input by DI4	When DI.ABSE is on, DI.ABSD triggered by DO3 replaced the DO3 assigned by P2.012.	ABSD always output by DO3
0x1F	ABSC	0x0D	ABSW

Relevant alarms (please refer to Chapter 11 for detailed information):

Display	***Alarm name***
AL060	Absolute position is lost
AL061	Encoder undervoltage
AL062	Number of turns for the absolute encoder overflows
AL066	Number of turns for the absolute encoder overflows (servo drive)
AL072	Encoder overspeed
AL073	Encoder memory error
AL074	Absolute encoder single turn position error
AL075	Absolute encoder position error
AL077	Encoder computing error
AL079	Encoder parameter error
AL07B	Encoder memory busy
AL07C	Command to clear the absolute position is issued when the motor speed is over 200 rpm
AL07D	Servo drive power is cycled before AL07C is cleared
AL07E	Encoder clearing procedure error
AL289	Feedback position counter overflows

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Chapter

11

Chapter 11: Troubleshooting

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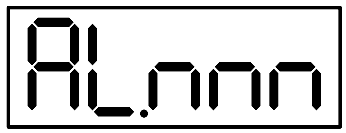
Introduction

This chapter provides alarm descriptions and the corrective actions you can use for troubleshooting.

There are four types of alarms: General, STO, Communication, and Motion control.

- *General type: alarms caused by hardware or encoder signal errors.*
- *STO type: alarms caused by STO errors.*
- *Communication type: alarms caused by serial/Ethernet Modbus or Ethernet/IP errors.*
- *Motion control type: alarms caused by motion control command (in PR mode) errors.*

AL.nnn is the alarm format on the 7-segment display.



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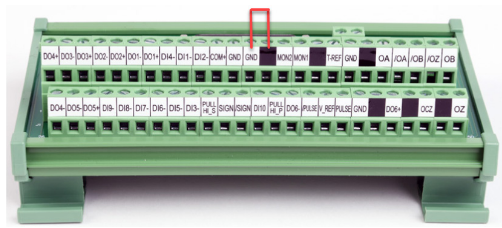
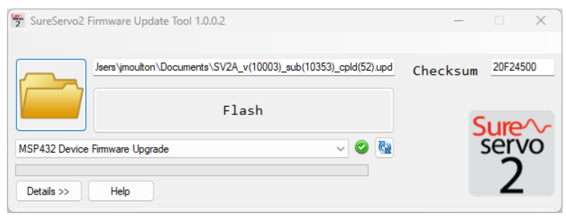
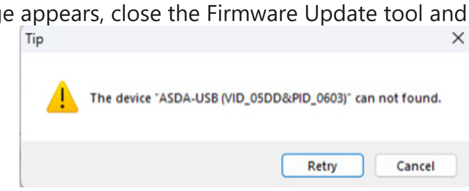
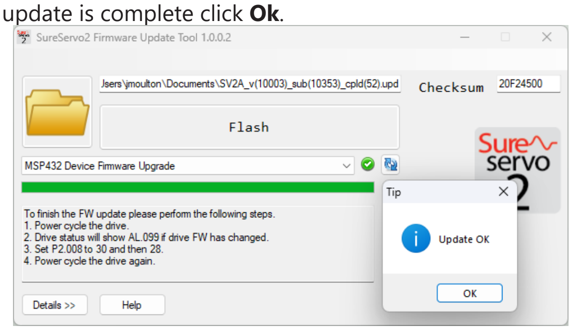
11.1 - How to Revive a Dead (Bricked) Drive

In the unlikely event that a drive is non-responsive, front panel does not light up and no communications are possible, the below procedure can revive an otherwise dead drive. Removing power from the drive during a firmware update is a common way to brick a drive.

Step	Action
1	Pins 13 and 14 need to be jumpered on CN1. No other wires should be connected. 
2	Use the latest SV2 software from the Automation Direct website. (https://www.automationdirect.com/support/software-downloads?itemcode=SV2-PRO)
3	Apply power to the drive, then open the Firmware update tool in SureServo2 Pro and open the latest FW file. The USB connection will be different than normally shown. Depending on the PCs drivers it could be similar to “MSP 432 Device Firmware Upgrade” or “TMS3200F28x7x USB Boot Loader”.
4	Click ‘Flash’  If the following message appears, close the Firmware Update tool and restart the procedure. 
5	After the firmware update is complete click **Ok**. 
6	Turn off power to the drive, then unplug the jumper and re-apply power to the drive.

11.2 - Alarm List

General Type:

Display	Alarm Name	Error Type		Servo State	
		ALM	WARN	ON	OFF
AL001	Overcurrent	○			○
AL002	Overvoltage	○			○
AL003	Undervoltage		○		○
AL004	Motor combination error	○			○
AL005	Regeneration error	○			○
AL006	Overload	○			○
AL007	Excessive deviation of speed command	○			○
AL008	Abnormal pulse command	○			○
AL009	Excessive deviation of position command	○			○
AL010	Voltage error duration regeneration	○		○	
AL011	Encoder error	○			○
AL012	Adjustment error	○			○
AL013	Motor Override		○		○
AL014	Reverse limit error		○	○	
AL015	Forward limit error		○	○	
AL016	IGBT overheat	○			○
AL017	Abnormal EEPROM	○			○
AL018	Abnormal encoder signal output	○			○
AL019	Serial communication error	○			○
AL020	Serial communication timeout		○	○	
AL022	RST leak phase		○		○
AL023	Early overload warning		○	○	
AL024	Encoder initial magnetic field error	○			○
AL025	Encoder internal error	○			○
AL026	Encoder unreliable internal data	○			○
AL027	Internal motor error	○			○
AL028	Encoder voltage error or encoder internal error	○			○
AL02A	Number of revolutions of the encoder is in error	○			○
AL02B	Motor data error	○			○

General alarms continued on next page

Display	Alarm Name	Error Type		Servo State	
		ALM	WARN	ON	OFF
AL02C	Servo drive overload	○		○	
AL030	Motor crash error	○			○
AL031	Motor power cable incorrect wiring or disconnection	○			○
AL032	Abnormal encoder vibration	○			○
AL034	Encoder internal communication error	○			○
AL035	Encoder temperature exceeds the protective range	○			○
AL036	Encoder alarm status error	○			○
AL040	Excessive deviation of full closed-loop position control	○			○
AL041	CN5 communication is disconnected	○			○
AL042	Analog input voltage is too high	○			○
AL044	Servo function overload warning		○	○	
AL045	E-Gear ratio value error	○			○
AL056	Excessive motor speed	○			○
AL057	Feedback pulse is lost	○			○
AL058	Excessive position deviation after initial magnetic field detection is complete	○			○
AL05C	Motor position feedback error	○			○
AL060	Absolute position lost		○	○	
AL061	Encoder undervoltage		○	○	
AL062	Mult-turn overflow in absolute encoder		○	○	
AL063	Linear scale (CN5) signal error		○	○	
AL064	Encoder vibration warning		○	○	
AL066	Number of turns for the absolute encoder overflows (servo drive)	○		○	
AL067	Encoder temperature warning		○	○	
AL068	Absolute data transmitted by I/O is in error		○	○	
AL06A	Absolute position is lost / Absolute position is not initialized		○	○	

General alarms continued on next page

Display	Alarm Name	Error Type		Servo State	
		ALM	WARN	ON	OFF
AL06B	The error between the servo drive internal coordinates and the encoder coordinates is too large		○	○	
AL06E	Encoder type is unidentifiable	○			○
AL06F	The absolute position is not established		○	○	
AL070	Encoder did not complete the command issued by servo drive		○	○	
AL071	Number of revolutions of the encoder is in error	○			○
AL072	Encoder overspeed	○			○
AL073	Encoder memory error	○			○
AL074	Absolute encoder single turn position error	○			○
AL075	Absolute encoder position error	○			○
AL077	Encoder computing error	○			○
AL079	Encoder parameter error	○			○
AL07A	Encoder Z phase position is lost	○			○
AL07B	Encoder memory busy	○			○
AL07C	Command to clear the absolute position is issued when the motor speed is over 200 rpm		○	○	
AL07D	Servo drive power is cycled before AL07C is cleared	○			○
AL07E	Encoder clearing procedure error	○			○
AL07F	Encoder version error	○			○
AL083	Servo drive outputs excessive current	○			○
AL085	Regeneration error	○			○
AL086	Regenerative Resistor Overload	○			○
AL088	Servo function overload warning	○			○
AL089	Current detection interference		○	○	
AL08A	Auto-tuning function - Command error		○	○	
AL08B	Auto-tuning function - Pause time is too short		○	○	

General alarms continued on next page

Display	Alarm Name	Error Type		Servo State	
		ALM	WARN	ON	OFF
AL08C	Auto-tuning function - Inertia estimation error		○	○	
AL095	Regenerative brake resistor disconnected		○	○	
AL099	DSP firmware update	○			○
AL09C	Parameter reset failed	○			○
AL219	Write Parameters: parameter cannot be written		○	○	
AL221	A non-existing mode is used		○	○	
AL21B	Memory stack is out of range		○	○	
AL22D	Absolute positioning is not allowed when E-Cam is engaged		○	○	
AL223	Some commands are not allowed to be used when the servo is in the ERROR or FAULT state		○	○	
AL239	The argument of the LOOP_CMD command is out of range		○	○	
AL23F	Parameter is written to a memory address that is out of range		○	○	
AL245	PR positioning timeout		○	○	
AL247	The MATT_ACC command called a math function that is out of range		○	○	
AL249	PR path number is out of range		○	○	
AL251	The argument of the MATH_POWR command is out of range		○	○	
AL255	The system object ID is out of range when the object is used		○	○	
AL257	The system object function block ID is out of range when a system object is used		○	○	
AL25B	Object argument format error		○	○	
AL25F	An error occured when the object dictionary was accessed		○	○	
AL35F	Emergency stop during acceleration		○	○	
AL422	Write-in failed caused by power supply cut-off	○			○

NOTE: If the servo drive shows an alarm that is not in this table, please contact Automation Direct.

STO type:

Display	Alarm Name	Error Type		Servo State	
		ALM	WARN	ON	OFF
AL500	STO function is enabled	○			○
AL501	STO_A lost (signal loss or signal error)	○			○
AL502	STO_B lost (signal loss or signal error)	○			○
AL503	STO self-diagnostic error	○			○
AL510	Internal parameter update program of the servo drive is abnormal		○	○	
AL520	Calculation program timeout	○			○
AL521	Vibration elimination parameter error	○			○
ALF21	Command error	○			○

NOTE: If the servo drive shows an alarm that is not in this table, please contact Automation Direct.

Communication type:

Display	Alarm Name	Error Type		Servo State	
		ALM	WARN	ON	OFF
AL131	CRC of EEPROM calculation error occurs when using PDO	○		○	
AL132	Parameter is write-prohibited when using PDO	○		○	
AL180	Detect the connection between PLC and comm. card (timeout detection based on P3.067)	○			○
AL185	HSSP command timeout or data checksum error	○			○
AL186	Comms Bus off	○		○	
AL201	Error occurs when loading data	○			○
AL301	Synchronization failure		○	○	
AL302	Synchronization signal for sent too soon		○	○	
AL303	Synchronization signal timeout		○	○	
AL304	Invalid IP command		○	○	
AL305	SYNC period error		○	○	
AL401	NMT reset command is received while the servo is on	○			○

NOTE: If the servo drive shows an alarm that is not in this table, please contact Automation Direct.

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Motion control type:

Display	Alarm Name	Error Type		Servo State	
		ALM	WARN	ON	OFF
AL207	Parameter group of PR Type 8 (Write) is out of range		○	○	
AL209	Parameter number of PR Type 8 (Write) is out of range		○	○	
AL211	Parameter format setting of Type 8 (Write) PR is in error		○	○	
AL213	Parameter setting of PR Type 8 (Write) is in error		○	○	
AL215	Write parameters: read-only		○	○	
AL217	Write parameters: parameter locked		○	○	
AL22D	Absolute positioning is not allowed when E-Cam is engaged	○		○	
AL231	Monitoring item for PR Write command is out of range		○	○	
AL235	Absolute positioning command error		○	○	
AL237	Indexing coordinate is undefined		○	○	
AL283	Software positive limit		○	○	
AL285	Software negative limit		○	○	
AL289	Feedback position counter overflows		○	○	
AL380	Position offset alarm for DO.MC_OK		○	○	
AL3CF	DI.PFQS input for quick stop and fault (Emergency Stop)		○		○
AL3F1	Absolute index coordinate undefined	○			○
AL400	Index coordinate error	○			○
AL404	Value of PR special filter setting is too high	○			○
AL555	System failure	○			○
AL809	PR arithmetic operation parameter error or secondary platform error	○			○

NOTE: If the servo drive shows an alarm that is not in this table, please contact Automation Direct.

11.3 - Causes and Corrective Actions

11.3.1 - General type

AL001 Overcurrent	
Trigger condition and causes	Condition: main circuit current is over 1.5 times of the maximum instantaneous current of the motor. Causes: 1) Motor has a short-circuit or fault to ground (frame). 2) Motor wiring is wrong. 3) IGBT is abnormal. 4) Parameter setting is wrong. 5) Control command setting is wrong.
Checking methods and corrective actions	1) Check the connection between the motor and servo drive and make sure that the wire is not short-circuited. Do not expose the metal part of the wiring. Check if you have followed the wiring sequence of the motor and servo drive as described in this manual. 2) If the temperature of the heat sink is abnormal, please contact AutomationDirect technical support. Check if the setting value is much greater than the default. It is suggested that you reset the servo drive to the factory default settings and then modify the settings one by one. 3) Check if the target Torque/Speed/Position commanded changes greatly. If so, please modify the rate of change in the command or enable the filter.
How to clear the alarm?	DI.ARST

AL002 Overvoltage	
Trigger condition and causes	Condition: main circuit voltage exceeds the rated value. Causes: 1) The input voltage of the main circuit is higher than the rated voltage. 2) Wrong power input (wrong power system). 3) Malfunction of the servo drive hardware. 4) Incorrect selection of the regenerative resistor or no connection to an external regenerative resistor. This will occur if the DC bus voltage is over 410V for over 1 second.
Checking methods and corrective actions	1) Use a voltmeter to check if the input voltage of the main circuit is within the rated range (refer to Appendix A Specifications). Use the right voltage source or connect the regulator in series. Use a voltmeter to check if the power system complies with the specifications. If not, use the right voltage source or connect the transformer in series. 2) Check if the input voltage of the main circuit is within the rated range. If the issue persists, please contact AutomationDirect technical support. 3) Check the connection for the regenerative resistor, re-calculate the value for the regenerative resistor, and correctly set the values of P1.052 and P1.053.
How to clear the alarm?	DI.ARST

AL003 Undervoltage	
Trigger condition and causes	Condition: 1) Main circuit voltage is below the rated value. By default, AL003 is defined as a warning. To define it as an alarm, set P2.066 [Bit 9]. 2) The DC Bus voltage is below P4.024 x √2 Causes: 1) The input voltage of main circuit is lower than the permissible rated value. 2) No power is supplied to the main circuit. 3) Wrong power input (wrong power system).
Checking methods and corrective actions	1) Check that the voltage wiring is correct and the input voltage for the main circuit is normal. 2) Cycle the servo drive power and use a voltmeter to check the main circuit voltage. 3) Use a voltmeter to check if the power system complies with the specifications. Check if using the right voltage source or the transformer is connected in series.
How to clear the alarm?	AL003 is cleared according to the setting of P2.066 [Bit2] 1) If P2.066 [Bit2] is set to 0, use DI.ARST to clear the alarm after the voltage is back in the normal range. 2) If P2.066 [Bit2] is set to 1, the alarm is automatically cleared once the voltage is back in the normal range.

AL004 Motor Combination Error	
Trigger condition and causes	Condition: wrong motor is used with the servo drive. Causes: 1) Motor combination error (the servo drive connects to the wrong motor.) 2) The encoder is loose. 3) The encoder is damaged.
Checking methods and corrective actions	1) Use the right motor. 2) Check and re-install the encoder connector. 3) If the encoder (motor) is not operating properly, please replace the motor.
How to clear the alarm?	Cycle power on the servo drive.

AL005 Regeneration Error	
Trigger condition and causes	Condition: an error occurs during regeneration. Causes: 1) You selected a wrong regeneration resistor or the external regeneration resistor is not connected. 2) P1.053 (regenerative resistor watts) is not set to 0 when the regenerative resistor is not connected 3) Parameter setting error (P1.052, P1.053).
Checking methods and corrective actions	1) Re-calculate the value for the regenerative resistor and reset the value of P1.052 and P1.053. If you cannot clear the alarm, please contact AutomationDirect technical support. 2) Set P1.053 to 0 if not using a regenerative resistor. 3) Correctly set the parameters for the regenerative resistor, (P1.052) and the regenerative resistor watts (P1.053).
How to clear the alarm?	DI.ARST

AL006 Overload	
Trigger condition and causes	Condition: overload of motor and servo drive. Causes: 1) The load is over the rated range and the servo drive is in a persistent overload condition. 2) The control system parameter is wrong. 3) Incorrect wiring of motor and encoder. 4) Encoder malfunction.
Checking methods and corrective actions	1) Set P0.002 to 11 to monitor the servo drive status. Check if the average torque [%] is continuously over 100%. If so, please increase the motor capacity or reduce the load. Refer to Load and operation time in Appendix A for more details. • Check if there is any mechanical vibration. • Acceleration/deceleration constant is set too high. 2) Check if the wiring of UVW and the encoder cables is correct. 3) Contact AutomationDirect technical support.
How to clear the alarm?	DI.ARST

AL007 Excessive Speed Deviation	
Trigger condition and causes	Condition: deviation from the Speed command and the feedback speed exceeds the allowable range (P2.034). Causes: 1) A drastic change in speed. 2) Incorrect setting for P2.034. 3) Incorrect wiring of the UVW and/or encoder cables.
Checking methods and corrective actions	1) Use the signal detector to check if the input analog voltage signal is normal. If not, adjust the signal changing rate or enable the filter function. 2) Check and make sure the value of P2.034 (over-speed warning) is correct. 3) Ensure correct wiring of the UVW and encoder cables.
How to clear the alarm?	DI.ARST

AL008 Abnormal Pulse Command	
Trigger condition and causes	Condition: the input frequency for the pulse command is over the allowable value for the hardware interface. Cause: the pulse command frequency is higher than the rated input frequency.
Checking methods and corrective actions	Use the scope to check if the input frequency is higher than the rated frequency. Correctly set the input pulse frequency.
How to clear the alarm?	DI.ARST

AL009 Excessive Position Command Deviation	
Trigger condition and causes	Condition: Deviation of position command and feedback exceeds the allowable range (P2.035). Causes: 1) The maximum position deviation is set too low. 2) Gain value is set too low. 3) Torque limit is set too low. 4) Excessive external load. 5) Improper setting for the E-gear ratio. 6) The power cables are loose. 7) Speed limit is set too low.
Checking methods and corrective actions	1) Check the value of the maximum deviation (P2.035 excessive position deviation warning condition). 2) Check if the gain value is appropriate for the application. 3) Check if the torque limit setting is appropriate for the application. 4) Check the external load. Reduce the external load or re-evaluate the motor capacity if necessary. 5) Check if the settings for P1.044 and P1.045 are appropriate for the application and set the correct values. 6) Check if the power cables are loose. 7) Check if the set value of P1.055 (Maximum speed limit) is too low.
How to clear the alarm?	DI.ARST

AL010 Voltage error during regeneration	
Trigger condition and causes	1) When the regenerative resistor is incorrectly selected or no external regenerative resistor is connected, the regenerative voltage remains at 400V for a period of time during regeneration. 2) P1.053 (Regenerative resistor watts) is not set to 0 when the regenerative resistor is not connected.
Checking methods and corrective actions	1) Check the connection for the regenerative resistor, re-calculate the value for the regenerative resistor, and correctly set the values of P1.052 and P1.053. If the issue persists, please contact AutomationDirect technical support. 2) Set P1.053 to 0 if not using a regenerative resistor.
How to clear the alarm?	DI.ARST

AL011 Encoder Error	
Trigger condition and causes	Condition: the encoder produces abnormal pulses. Causes: 1) Encoder wiring is wrong. 2) Encoder connector is loose. 3) Poor wiring of the encoder. 4) Connection to the encoder is cut off due to interference. 5) Encoder is damaged.
Checking methods and corrective actions	1) Check if the wiring follows the instructions in the user manual. If not, connect the wiring correctly. 2) Check if the CN2 connector and the encoder connector are loose. If so, reconnect the connectors. 3) Check both of the connections between the encoder and CN2 of the servo drive to see if there is any poor wiring or damaged wires. If so, please replace the connector and cable. 4) Please check the communication error status by setting P0.002 to -80. If the value continuously increases, it means there is interference. Please check the following: • Make sure the servo motor is well grounded. Please connect the ground of UVW connector (Green) to the heat sink of the servo drive. • Check if the connection for the encoder signal cable is normal. Make sure that you separate the encoder signal cable from the main power circuit cable to avoid interference. • Use shielded cable for the encoder. 5) If you took all corrective actions but the issue persists, please replace the motor.
How to clear the alarm?	Re-power on the servo drive.

AL012 Adjustment Error	
Trigger condition and causes	Condition: the calibration value exceeds the allowable value during electric calibration. Causes: 1) The analog input contact is not correctly set to zero. 2) The detection device is damaged.
Checking methods and corrective actions	Check if the voltage at the analog input contact is the same as the ground voltage. Reset the power supply. If the issue persists, please contact Automation Direct.
How to clear the alarm?	Remove the connection cable for CN1 and then execute auto calibration.

AL013 Motor Override	
Trigger condition and causes	The Motor Override input is active.
Checking methods and corrective actions	Check the digital input and make sure it is off.
How to clear the alarm?	DI.OVRD

AL014 Reverse Limit Error	
Trigger condition and causes	Condition: reverse limit switch is triggered. Causes: 1) Reverse limit switch is triggered. 2) Servo system is unstable.
Checking methods and corrective actions	1) Check the reverse limit switch and make sure it is off. 2) Check the parameter setting and the load inertia. If the setting is wrong, please modify the parameter value or re-estimate the motor capacity.
How to clear the alarm?	Reset the alarm or switch the servo drive off.

AL015 Forward Limit Error	
Trigger condition and causes	Condition: forward limit switch is activated. Causes: 1) Forward limit switch is activated. 2) Servo system is unstable.
Checking methods and corrective actions	1) Check the forward limit switch and make sure it is off. 2) Check the parameter setting and the load inertia. If the setting is wrong, please modify the parameter value or re-estimate the motor capacity.
How to clear the alarm?	Reset the alarm or switch the servo drive off.

AL016 IGBT Overheat	
Trigger condition and causes	Condition: temperature of IGBT is too high. Causes: 1) The load is over the rated range and the servo drive is in a persistent overload condition. 2) Motor has a short-circuit or fault to ground (frame).
Checking methods and corrective actions	1) Check if the motor is overloaded or over-current. Then try increasing the motor's capacity or reducing the load. 2) Check if the wiring of servo drive output is correct.
How to clear the alarm?	DI.ARST

AL017 Abnormal EEPROM	
Trigger condition and causes	Condition: error occurs when DSP accesses EEPROM. Causes: 1) Parameter writing error or the value exceeds the permissible range. This error occurs when parameters are restored to the default and servo drive type is incorrect. 2) Data in ROM is damaged or there is no data in ROM. This occurs when the system is in Servo On status. If this alarm occurs, please contact AutomationDirect technical support.
Checking methods and corrective actions	Press the SHIFT key on the panel and "EXGAB" is displayed. X = 1, 2, 3 G = Group No. of the parameter AB = Parameter No. in hexadecimal format If the panel displays E320A, this is parameter P2.010; if E3610 is displayed, this is P6.016. Please check the value for the displayed parameter. 1) Press the SHIFT key to display the parameter code. If this alarm occurs when power is supplied to the drive, it means a parameter value has exceeded the range. You can modify the value and then cycle the power. If the error occurs during normal operation, it means an error occurred when writing the parameter. 2) Press the SHIFT key on the panel and E100X is displayed. If this alarm occurs while parameters are being restored to the default, it means the servo model type setting is incorrect. Please correct it. 3) Press the SHIFT key on the panel and E0001 is displayed. If this alarm occurs while power is being supplied, it is usually because the data in ROM is damaged or there is no data in the ROM. Please contact AutomationDirect technical support.
How to clear the alarm?	If this alarm occurs when the drive is started, please reset the parameters and then cycle the power. If the alarm occurs during operation, please reset the alarm.

AL018 Abnormal Encoder Signal Output	
Trigger condition and causes	Condition: output frequency of the encoder is higher than the rated output frequency of the hardware. Causes: 1) Pulse resolution of the encoder is set too high. 2) There is interference or cable damage causing communication error. 3) Encoder error.
Checking methods and corrective actions	1) The setting of P1.076 and P1.046 should follow these requirements: P1.076 > motor speed and $\frac{\text{Motor speed}}{60} \times P1.046 \times 4 < 19.8 \times 10^6$ 2) Please check the communication error status by setting P0.002 to -80. If the value continuously increases, it means there is interference. Please check the following: • Make sure the servo motor is properly grounded and connect the UVW connector (color green) to the heat sink of the servo drive. • Check if the connection of encoder signal cable is normal. Make sure that you separate the encoder signal cable from the main power circuit cable to avoid interference. • Use shielded cable for the encoder. 3) Check the error log (P4.000—P4.005) and see if an alarm has occurred (AL011, AL024, AL025, and AL026). Use the checking methods and corrective actions to clear the alarm if any of them occurs. 4) If you do not need to use the OA/OB pulse, set P2.065 [Bit 13] to 1 to disable the detection function for encoder output error (AL018).
How to clear the alarm?	1) DI.ARST 2) Please contact Automation Direct technical support.

AL019 Serial Communication Error	
Trigger condition and causes	Condition: RS-485 communication error. Causes: 1) Improper setting of the communication parameters. 2) Incorrect communication address. 3) Incorrect communication value.
Checking methods and corrective actions	1) Check the values of the communication parameters. Then correctly set P3.003 and P3.004 or restore the value to default. 2) Check and correctly set the communication address. 3) Check and correctly set the accessing value.
How to clear the alarm?	DI.ARST

AL020 Serial Communication Timeout	
Trigger condition and causes	Condition: RS-485 communication error. Causes: 1) Improper setting of the timeout parameter (P5.003). 2) Servo drive has not received the communication command for a long time and has timed out (please refer to P5.003). 3) Improper setting for P3.004.
Checking methods and corrective actions	1) Check and make sure the value for the communication timeout parameter is correct. 2) Check if the communication cable is loose or broken and is correctly wired.
How to clear the alarm?	DI.ARST

AL022 RST Leak Phase	
Trigger condition and causes	Condition: RST power cable is loose or there is no power. The default setting of AL022 is a warning. To set AL022 as an alarm, you can set P2.066 [Bit 12]. Cause: RST leak phase.
Checking methods and corrective actions	Check if the RST power cable is loose or there is no power. For 3kW (or above) SureServo2 servo drives, the alarm occurs when one single phase is not connected to the power supply. Correctly connect the power to the servo drive. If the issue persists, please contact AutomationDirect technical support.
How to clear the alarm?	DI.ARST

AL023 Early Overload Warning	
Trigger condition and causes	Early overload warning
Checking methods and corrective actions	1) Check if your servo drive is overloaded and refer to the corrective actions for AL006 for troubleshooting. 2) Check if the value of P1.056 is set too low. If yes, please increase the value, which should be over 100 to disable the warning function.
How to clear the alarm?	DI.ARST

AL024 Encoder Initial Magnetic Field Error	
Trigger condition and causes	Condition: the magnetic field of the encoder U, V, W signal is in error. Cause: the initial magnetic field of the encoder is in error (Signal U, V, W of the encoder magnetic field is in error.)
Checking methods and corrective actions	1) Make sure the servo motor is properly grounded and connect the UVW connector (color green) to the heat sink of the servo drive. 2) Make sure the encoder cable is separated from the power supply or any high-current cables to avoid interference. 3) Use shielded cable for the encoder. 4) If using an external encoder, check the wiring noise interference. For the noise filter of the CN5 position feedback signal connector, refer to P1.074. If the issue persists, please contact AutomationDirect technical support.
How to clear the alarm?	Re-power on the servo drive.

AL025 Encoder Internal Error	
Trigger condition and causes	Condition: internal memory and counter of the encoder are in error. Causes: 1) Internal encoder error (internal memory and counter are in error). 2) When applying power, the motor rotates because of inertia of the machinery or other causes.
Checking methods and corrective actions	1) Check grounding and connections: • Make sure the servo motor is properly grounded and connect the UVW connector (color green) to the SureServo2 servo drive heat sink. • Make sure the encoder cable is separated from the power supply or any high-current cables to avoid interference. • Use shielded cable for the encoder. 2) Make sure the motor shaft does not move when power is turned on.
How to clear the alarm?	Cycle the power to the servo drive.

AL026 Encoder Unreliable Internal Data	
Trigger condition and causes	Condition: internal data error occurs three consecutive times. Causes: 1) External interference. 2) Malfunction of encoder hardware.
Checking methods and corrective actions	To correct the interference, check the following descriptions: 1) Make sure the servo motor is properly grounded and connect the UVW connector (color green) to the SureServo2 servo drive heat sink. 2) Make sure the encoder cable is separated from the power supply or any high-current cables to avoid interference. 3) Use shielded cable for the encoder. 4) Set P0.002 to -80 by using the panel to monitor the communication error status. If the value is greater than 0 and the value increases continuously, please check steps 1—3 again. If the value is 0, contact AutomationDirect technical support.
How to clear the alarm?	Re-power on the servo drive.

AL027 Internal Motor Error	
Trigger condition and causes	Condition: encoder reset error. Cause: encoder reset.
Checking methods and corrective actions	1) Check if the encoder cable is firmly connected. 2) Check if the power supply for the encoder is stable and make sure to use shielded cable. 3) Check if the operation temperature is over 95°C. Identify the cause for the high temperature and do not restart operation before the temperature falls back into the allowable range. There is no monitoring variable or parameter to read this temperature. If issue persists, please contact Automation Direct technical support.
How to clear the alarm?	Re-power on the servo drive.

AL028 Encoder Voltage Error or Encoder Internal Error	
Trigger condition and causes	Condition: servo drive charging circuit is not removed so the battery voltage is higher than the specification (>3.8 V) or the encoder signal is in error. Causes: 1) Voltage level of the battery is too high. 2) Internal encoder error.
Checking methods and corrective actions	1) Follow the testing procedure for over-voltage/over-current and troubleshoot. This automatically clears AL028. • Check the servo drive charging circuit. Avoid incorrect wiring; if Pin 1 (5V) of CN2 is connected to BAT+, it means the power (5V) of the servo drive is being charged to the battery. • Check if the battery is correctly installed (voltage > 3.8 V). 2) Check and remove the cause for the alarm. If the issue persists, please contact AutomationDirect technical support. • Make sure the servo motor is properly grounded and connect the UVW connector (color green) to the servo drive heat sink. • Make sure the encoder cable is separated from the power supply or any high-current cables to avoid interference. • Use shielded cable for the encoder. If issue persists, please contact AutomationDirect technical support.
How to clear the alarm?	Cycle power on the servo drive.

AL029 Gray Code Error	
Trigger condition and causes	Absolute position error.
Checking methods and corrective actions	Cycle the power to the servo drive to operate the motor. Then check if the alarm occurs again. If the issue persists, please replace the encoder.
How to clear the alarm?	Re-power on the servo drive.

AL02A Number of Revolutions of the Encoder is in Error	
Trigger condition and causes	Condition: the number of revolutions of the encoder is in error. Cause: the internal signal of the encoder is abnormal causing error in the number of revolutions.
Checking methods and corrective actions	Contact AutomationDirect for a new motor.
How to clear the alarm?	N/A

AL02B Motor Data Error	
Trigger condition and causes	Accessing the internal data of the motor is in error.
Checking methods and corrective actions	Send your servo motor back to AutomationDirect.
How to clear the alarm?	N/A

AL02C Servo drive overload	
Trigger condition and causes	1) The servo drive has exceeded the rated load for a continuous time. 2) The gain parameter of the control system or the motion profile setting is inappropriate. 3) Incorrect wiring of the motor and encoder. 4) Motor encoder is damaged or defective.
Checking methods and corrective actions	1) Check if the monitoring variable "motor current (ampere)" has exceeded the rated output current of the servo drive for a long period of time. a) Check if there is mechanical vibration and adjust the control gain parameter appropriately. b) If the acceleration/deceleration time setting is too short, reduce the acceleration/deceleration speed setting. 2) Check if the wirings of the motor power cable and the encoder are correct. 3) Run Autotune to properly set the system gains.
How to clear the alarm?	DI.ARST

AL030 Motor Collision Error	
Trigger condition and causes	Condition: when the motor hits the device, the torque reaches the value of P1.057 and lasts for the time set by P1.058. Causes: 1) Check if the function of motor crash protection (P1.057) is enabled. If so, please set P1.057 to 0. 2) Check if the value of P1.057 is set too low and the time set by P1.058 is too short. Please set P1.057 according to the actual torque. Incorrect values might inadvertently trigger the signal or lose the protection function.
Checking methods and corrective actions	Cycle power on the servo drive to operate the motor and check if the alarm occurs again. If the issue persists, please replace the encoder.
How to clear the alarm?	DI.ARST

AL031 Motor Power Cable Incorrect Wiring or Disconnection	
Trigger condition and causes	Condition: incorrect wiring or disconnection of the power cable U, V, W, and GND. Causes: Incorrect wiring or disconnection of motor power cable U, V, W. The switch for cut-off detection is set by P2.065 Bit 9, which default is set to disable. The switch for wiring error detection is set by P2.065 Bit 8, which is disabled by default.
Checking methods and corrective actions	Check if the motor power cable (U, V, W, GND) is firmly connected. Please connect wiring and ground properly by following the instructions in this user manual.
How to clear the alarm?	Cycle power on the servo drive.

AL032 Abnormal Encoder Vibration	
Trigger condition and causes	Condition: abnormal vibration occurred in the encoder. Cause: the internal signal or mechanical part of the encoder is abnormal causing the signal returned by the encoder to be in error.
Checking methods and corrective actions	Check if the motor vibration range is within 2.5 G. If the vibration is within the range, send your servo motor back to AutomationDirect.
How to clear the alarm?	DI.ARST or cycle power on the servo drive.

AL034 Encoder Internal Communication Error	
Trigger condition and causes	Condition: 1) Internal communication error for the absolute type encoder. 2) Internal error for the other type of encoder. Cause: encoder internal communication error.
Checking methods and corrective actions	1) Check the battery wiring. Then wire it again and cycle power on the system. 2) Check if the battery voltage is within the normal range. 3) Internal communication error for the encoder occurs. Please replace the motor.
How to clear the alarm?	Cycle power on the servo drive.

AL035 Encoder Temperature Exceeds the Protective Range	
Trigger condition and causes	Condition: encoder temperature is over the maximum of 105°C. Cause: encoder temperature is over 105°C. This is an estimated temperature. The encoder may trigger the temperature alarm slightly under or above this temperature.
Checking methods and corrective actions	Set P0.002 to -124 in order to read the temperature and check if it is below 105°C. If the encoder temperature is higher than 100°C, please improve the heat dissipation or reduce the operating load. If the temperature difference between the motor and the displayed temperature value is over 30°C, please send the motor back to the distributor.
How to clear the alarm?	After the temperature detector shows a temperature below 105°C, please cycle power on the servo drive.

AL036 Encoder Alarm Status Error	
Trigger condition and causes	Condition: abnormal state occurred in the encoder. Cause: the encoder sends out an alarm signal, but the alarm status of the encoder read by the servo drive shows no error.
Checking methods and corrective actions	1) Check if the motor is properly grounded. Make sure the power cable (green end) is grounded to the servo drive heat sink. 2) Check if the connection for the encoder signal cable is normal. Make sure the encoder signal cable is separated from the power supply or any high-current cables to avoid interference. 3) Use shielded cable for the encoder, pull out the shielded mesh, and ground it. 4) Check the motor speed and make sure it is within the rated range. If the issue persists, send your servo motor back to AutomationDirect.
How to clear the alarm?	DI.ARST or cycle power on the servo drive.

AL040 Excessive Deviation of Full Closed-Loop Position Control	
Trigger condition and causes	Condition: excessive deviation of full closed-loop position control. Cause: 1) The setting value of P1.073 is too low. 2) The connector may be loose or there is a problem when the connector connects to the mechanical parts. 3) The input value for P1.072 can only be an integer. However, when the motor runs a cycle, if the number of A/B pulses in a full-closed loop is not an integer, the position error between the motor encoder and the auxiliary encoder accumulates. Thus, you need to set P1.085 to avoid triggering AL040.
Checking methods and corrective actions	1) Check the value for P1.073. If the value is too low, please set a higher value. 2) Make sure the connector is firmly connected and there is no problem in connecting the mechanical load. 3) Check if the value of P1.085 is set properly.
How to clear the alarm?	DI.ARST

AL041 CN5 Encoder is Disconnected	
Trigger condition and causes	CN5 communication is cut off.
Checking methods and corrective actions	1) Check the communication circuit of CN5. 2) When CN5 is not in use, ensure P1.074.X is set to 0.
How to clear the alarm?	DI.ARST

AL042 Analog Input Voltage is Too High	
Trigger condition and causes	Analog input voltage for the speed command is higher than the level specified by P1.083.
Checking methods and corrective actions	Check if the voltage source for the speed command is correct. Check the setting value of P1.083 and set it to 0 when this function is not required.
How to clear the alarm?	DI.ARST

AL044 Servo Function Overload Warning	
Trigger condition and causes	Condition: when the motor controlling function of servo drive is overloaded, the motion control function is affected, causing PR or E-Cam operation to be in error. Cause: Servo function overload warning.
Checking methods and corrective actions	1) Check if the filter is enabled and see if enabling the filter is necessary. 2) Set P2.066 Bit4 to 1 to disable this alarm.
How to clear the alarm?	1) Disable the filter if it is not required, such as the low-pass filter (P1.006 – P1.008), moving filter (P1.068), low-frequency vibration suppression (P1.025 – P1.028), vibration elimination (P1.089 – P1.094), or Notch filter (5 sets), percentage of friction compensation (P1.062), and motor hard stop (torque percentage)(P1.057). 2) Set P2.066 Bit4 to 1 and cycle power on the servo drive.

Wiring Parameters DI/DO Codes Monitoring Alarms

AL045 E-Gear Ratio Value Error	
Trigger condition and causes	Condition: when the value of the E-Gear ratio exceeds the range (1/4–262144), this alarm occurs once power to the servo drive is cycled. Cause: when the servo drive is powered on, E-Gear ratio value is in error.
Checking methods and corrective actions	Check if the value for the E-gear ratio is within the allowable range (1/4–262144). Correct the value in P1.044, P1.045, or P2.00-P2.062 and then cycle power on the servo drive.
How to clear the alarm?	Cycle power on the servo drive after the value is corrected.

AL056 Excessive Motor Speed	
Trigger condition and causes	Condition: when the filtered motor speed exceeds the setting of P1.111, the servo drive immediately switches to the Servo Off state and displays this alarm. Cause: this alarm is to remind the user that the motor speed has reached the upper limit of the current setting (P1.111).
Checking methods and corrective actions	1) Check the reason for the high motor speed, such as the set value of P1.111 is too small, the bandwidth is not set properly, or the motor parameter setting does not match the motor specification. 2) Evaluate the motor speed and the condition of the mechanical parts. If allowable, increase the speed and then the set value of P1.111.
How to clear the alarm?	DI.ARST

AL057 Feedback Pulse is Lost	
Trigger condition and causes	Condition: when P2.081 is set to 1, the servo drive will detect if there is pulse leakage. When the pulse leakage exceeds the set value of P2.082, this alarm is triggered. Cause: 1) Pulse leakage occurs during motor operation. 2) The pulse signal is interfered by noise.
Checking methods and corrective actions	1) Check if pulse leakage has occurred to the motor encoder feedback due to noise interference. 2) If there is interference, check the following items: (a) Check if the motor is properly grounded. Make sure the power cable (green end) is grounded to the servo drive heat sink. (b) Use shielded cable for the feedback signal cable. Make sure the signal cable is separated from the power supply or any high-current cables to avoid interference. 3) If the encoder feedback type is a square-wave digital signal, check if the motor speed is too fast and exceeds the maximum limit of 20 MHz that the hardware can receive (the limit multiplied by 4 times the frequency). 4) In addition to eliminating the noise interference, if the encoder type is a square wave digital signal, you can also filter the noise by setting the applicable filter functions. When the main encoder signal source is CN5, set P1. 074.U. 5) Set the maximum speed limit of the motor with P1.055. 6) Check if P2.083 is set correctly.
How to clear the alarm?	Cycle power on the servo drive.

AL058 Excessive Position Deviation after Initial Magnetic Field Detection is Complete	
Trigger condition and causes	Condition: 1) After the initial magnetic field detection is complete, the servo system then attempts, but fails to reduce the existing position error. 2) If the controller issues commands when the servo system is not fully settled, the position error might thus be greater and cannot be reduced. Cause: the controller issues commands during initial magnetic field detection.
Checking methods and corrective actions	1) Check if the controller has issued a command immediately when it is powered on. Use the software scope and select [Command position] to monitor whether there is a command issued. If so, increase the delay time for the controller to issue the command after it is powered on. 2) If the controller time sequence cannot be modified due to surge interference or other factors when powered on, set P2.088 [Bit 4] to 1 to prohibit the servo from receiving controller commands during the initial magnetic field detection.
How to clear the alarm?	DI.ARST

AL05C Motor Position Feedback Error	
Trigger condition and causes	Condition: sudden jumps occur to the motor position feedback. Cause: 1) Encoder feedback is abnormal or the encoder is damaged. 2) Encoder feedback is interfered.
Checking methods and corrective actions	1) Check if the feedback signal is abnormal. Use the software scope and select Feedback position [PUU] as the input signal for the channel and sample at 16 kHz or 20 kHz, and then operate the motor manually to monitor whether the feedback value has discontinuous sudden jumps. 2) Check if the feedback signal is interfered, causing sudden jumps to the motor position feedback. 3) If the source of the main encoder is CN2, check if the communication error rate is increased due to interference. For example, check the communication error rate by setting P0.017 to -80 and monitor whether the value of P0.009 is not 0 and continuously increases.
How to clear the alarm?	Cycle power on the servo drive.

AL060 Absolute Position is Lost	
Trigger condition and causes	Condition: losing number of revolutions because of low battery voltage or loss of the power. Causes: 1) Voltage level of the battery is too low. 2) The battery is replaced when the main power of the servo drive is off. 3) The battery is not installed when the absolute function is enabled. 4) Poor connection or disconnection of the battery power circuit.
Checking methods and corrective actions	1) Check if the battery voltage is below 2.9V; execute homing after changing the battery. Please refer to Chapter 10 Absolute servo system for more details about initializing the absolute coordinate system. 2) Do not change or remove the battery when the SureServo2 servo drive's main power is off. To execute homing again, please refer to Chapter 10 for absolute coordinate initialization. 3) Please follow the instructions below: • Install the battery. • Check the connection between the battery power source and the servo drive. • Check the encoder wiring. 4) Connect or correct the wiring so that the battery power is supplied to the encoder and then execute homing again. • Check the encoder wiring. • Check the connection between the battery box and servo drive.
How to clear the alarm?	Connect or reconnect the wiring so that the battery power is supplied to the encoder and then re-establish the absolute origin coordinates. Refer to Chapter 10 for more information on the absolute servo system.

AL061 Encoder Undervoltage	
Trigger condition and causes	Condition: voltage level of the absolute encoder battery is lower than the allowable value (3.1V). Cause: voltage level of the battery is too low.
Checking methods and corrective actions	Measure the battery voltage and see if it is less than 3.1V. If the voltage is too low, replace the battery when the main power is on.
How to clear the alarm?	The alarm is cleared automatically.

AL062 Number of Turns for the Absolute Encoder Overflows	
Trigger condition and causes	Condition: the number of turns for the absolute encoder exceeds the range: -32768 to +32767. Cause: motor's rotation cycle exceeds the allowable range.
Checking methods and corrective actions	Check if the motor's number of turns while operating is within the range between -32768 and +32767. If not, please execute homing again.
How to clear the alarm?	Cycle power on the servo drive.

AL063 Linear Scale (CN5) Signal Error	
Trigger condition and causes	An error occurred to the linear scale original signal.
Checking methods and corrective actions	Check if the linear scale and read head are installed correctly, and then set DI.ARST to On or cycle power on the servo drive. If the issue persists and you have ensured the CN5 encoder is correct, send your servo motor back to AutomationDirect.
How to clear the alarm?	DI.ARST or cycle power on the servo drive.

AL064 Encoder Vibration Warning	
Trigger condition and causes	Condition: abnormal vibration occurred in the encoder. Cause: the internal signal or mechanical part of the encoder is abnormal, so the encoder returns a warning signal.
Checking methods and corrective actions	Check if the motor vibration range is within 2G. If the vibration is within the range, contact AutomationDirect.
How to clear the alarm?	DI.ARST or cycle power on the servo drive.

AL066 Number of Turns for the Absolute Encoder Overflows (Servo Drive)	
Trigger condition and causes	Condition: the number of turns for the encoder absolute position (P0.051) exceeds half the number of turns for the encoder resolution (-32768 to +32767 for a motor). Cause: motor’s rotation cycle exceeds the allowable range.
Checking methods and corrective actions	1) Check if the motor’s number of turns during operation is within the range specified above. If not, re-establish the absolute origin coordinates. 2) Make sure you have enabled the function for preventing rotary axis position loss when an overflow occurs. If it is disabled, set P2.069.Z to 1 to enable the function.
How to clear the alarm?	Re-establish the absolute origin coordinates.

AL067 Encoder Temperature Warning	
Trigger condition and causes	Condition: the encoder temperature is over 85°C (warning level), but still under 100°C, which is within the protective range. Cause: encoder temperature warning (85°C–100°C).
Checking methods and corrective actions	Set P0.002 to -124 and check if the encoder temperature is identical to the motor temperature. If the encoder temperature is too high, please improve the heat dissipation or reduce the operating load. If the temperature difference between the encoder and motor is over 30°C, please contact AutomationDirect technical support.
How to clear the alarm?	Cycle power on the servo drive.

AL068 Absolute data transmitted by I/O is in error	
Trigger condition and causes	Condition: the time sequence is wrong when the absolute position is read by DI/O. Cause: 1) Time sequence is wrong. 2) Reading timeout.
Checking methods and corrective actions	1) Correct the time sequence for reading the data with DI/O: a) DI.ABSQ switches to off after DO.ABSR is off. b) DI.ABSQ switches to on after DO.ABSR is on. 2) Check the duration from when DO.ABSR switches on to the time when DI.ABSQ switches on and see if this duration is over 200ms. When DO.ABSR switches on and after the bit data of absolute position is ready, it should read DO.ABSD within 200ms, switch DI.ABSQ on, and then inform the servo drive that data reading is complete.
How to clear the alarm?	Cycle power in the servo drive.

AL06A Absolute Position is Lost / Absolute Position is not Initialized	
Trigger condition and causes	There are two conditions that may cause the loss of absolute position. One is the absolute coordinates are not established. When the absolute origin coordinates are established, the origin is lost after power cycling of the servo drive. The other is an error occurred. After the absolute origin coordinates are established, AL06A still occurs after power cycling of the servo drive. **Coordinates are not established.** Condition: 1) The servo drive is used for the first time. 2) The battery is drained and the power supply of the servo drive is cut off. 3) When the servo is used with an absolute motor, the user issues an absolute position command after the first use or modification of the E-Gear ratio. Cause: 1) The servo drive is used for the first time, so the absolute origin coordinates are not established. 2) Retaining the absolute position requires power supply, so when the battery is drained and the power supply of the servo drive is cut off, the absolute position of the servo is lost. 3) After the E-Gear ratio is modified, the communication type coordinate system needs to be re-established. **An error occurred.** Condition: 1) The encoder cable is damaged, including the exterior and internal wiring. 2) There is a momentary power failure in the battery power supply. 3) The absolute motor is in error. 4) The battery box is used, and J1 and J2 are connected in reverse. 5) The voltage level of the battery is lower than 2.9V. Cause: 1) Power supply is unstable due to damage of the encoder cable. 2) The reason for the momentary power failure may be that the battery box connector is loose or excessive machine vibration. 3) The absolute encoder of this motor is in error. 4) If J1 and J2 are connected in reverse, the battery cannot charge the capacitor. The capacitor functions as a buffer to supply power when the power supply of the servo drive power is switched to the battery due to a main power failure.
Checking methods and corrective actions	1) Check if the absolute origin coordinates are established (refer to Section 10.3 for more information). 2) Avoid replacing the battery when the servo drive is powered off. It is suggested to replace the battery when the servo drive is powered on, so the absolute encoder has continuous power supply. 3) Re-establish the absolute origin coordinates. 4) Replace the encoder cable. Use the X-ray to check if the internal wiring is damaged. 5) Check if the wiring is loose. If the wiring is fine, replace the battery box for cross-testing. 6) Replace the servo motor. 7) Ensure J1 is connected to the battery and J2 is connected to the servo drive.
How to clear the alarm?	This alarm is cleared after you complete the initialization of the absolute position.

AL06B The Error Between the Servo Drive Internal Coordinates and the Encoder Coordinates is Too Large	
Trigger condition and causes	Condition: when the absolute motor is powered by the battery, the number of motor rotations exceeds half the number of revolutions of the resolution. Cause: the error between the servo drive internal coordinates and the encoder coordinates is too large.
Checking methods and corrective actions	The mechanical parts are not properly fastened when the machine is being transported causing rotation of the motor.
How to clear the alarm?	Re-establish the absolute origin coordinates.

AL06E Encoder Type is Unidentifiable	
Trigger condition and causes	The servo drive cannot identify the encoder type.
Checking methods and corrective actions	Check all encoder cable wiring and connections.
How to clear the alarm?	If encoder cabling and connectors are OK, replace the motor.

AL06F The Absolute Position is not Established	
Trigger condition and causes	Condition: the establishment of the absolute position has timed out. Cause: the process for establishing the absolute position of the servo drive is in error.
Checking methods and corrective actions	If the issue persists after you cycle power on the servo drive and re-establish the absolute origin coordinates, contact AutomationDirect.
How to clear the alarm?	Cycle power on the servo drive and re-establish the absolute origin coordinates.

AL070 Encoder Does Not Complete the Command Issued by Servo Drive	
Trigger condition and causes	Command is not completed when the barcode is written to the encoder.
Checking methods and corrective actions	Check if the wiring is correct and firmly connected. If not, please correctly connect the wiring again.
How to clear the alarm?	Cycle power on the servo drive.

AL071 Number of Revoluations of the Encoders is in Error	
Trigger condition and causes	Condition: the number of revolutions of the encoder is in error. Cause: the internal signal of the encoder is abnormal causing error in the number of revolutions of the encoder.
Checking methods and corrective actions	If you executed DI.ARST but the issue persists, contact AutomationDirect.
How to clear the alarm?	DI.ARST

AL072 Encoder Overspeed	
Trigger condition and causes	1) When encoder is powered by the servo drive: over 8800 rpm; 2) When encoder is powered by the battery: over 10000 rpm. 3) Voltage level of the battery is too low.
Checking methods and corrective actions	1) Check if the motor is well grounded; make sure the power cable is grounded to the heat sink of the servo drive. 2) Make sure the encoder cable is separated from the power supply or any high-current cable to avoid interference. 3) Use shielded cable for the encoder and pull out the shielded mesh and ground it. 4) Check the motor speed and make sure it is within the rated range. 5) Measure the battery voltage to see if it is below 3.1 V. 6) Check if the battery wiring has poor contact. If issue persists, please contact AutomationDirect technical support.
How to clear the alarm?	Cycle power on the servo drive.

AL073 Encoder Memory Error	
Trigger condition and causes	An error occurs when the encoder is reading data from, or writing data to EEPROM.
Checking methods and corrective actions	1) Check if the motor is well grounded; make sure the power cable is grounded to the servo drive heat sink. 2) Make sure the encoder cable is separated from the power supply or any high-current cables to avoid interference. 3) Use shielded cable for the encoder and pull out the shielded mesh and ground it. 4) Check the motor speed and make sure it is within the rated range. If the issue persists, please contact AutomationDirect technical support.
How to clear the alarm?	Cycle power on the servo drive.

AL074 Absolute Encoder Single Turn Position Error	
Trigger condition and causes	Absolute encoder single turn position error.
Checking methods and corrective actions	1) Check if the motor is well grounded; make sure the power cable is grounded to the servo drive heat sink. 2) Make sure the encoder cable is separated from the power supply or any high-current cables to avoid interference. 3) Use shielded cable for the encoder and pull out the shielded mesh and ground it. 4) Check the motor speed and make sure it is within the rated range. If the issue persists, please contact AutomationDirect technical support.
How to clear the alarm?	Cycle power on the servo drive.

AL075 Absolute Encoder Position Error	
Trigger condition and causes	Absolute encoder position error.
Checking methods and corrective actions	1) Check if the motor is well grounded; make sure the power cable is grounded to the heat sink of the servo drive. 2) Make sure the encoder cable is separated from the power supply or any high-current cables to avoid interference. 3) Use shielded cable for the encoder and pull out the shielded mesh and ground it. 4) Check the motor speed and make sure it is within the rated range. If the issue persists, please contact AutomationDirect technical support.
How to clear the alarm?	Cycle power on the servo drive.

AL077 Encoder Computing Error	
Trigger condition and causes	Encoder internal error (internal computing error).
Checking methods and corrective actions	1) Check if the motor is well grounded; make sure the power cable is grounded to the heat sink of the servo drive. 2) Make sure the encoder cable is separated from the power supply or any high-current cables to avoid interference. 3) Use shielded cable for the encoder and pull out the shielded mesh and ground it. 4) Check the motor speed and make sure it is within the rated range. If the issue persists, please contact AutomationDirect technical support.
How to clear the alarm?	Cycle power on the servo drive.

AL079 Encoder Parameter Error	
Trigger condition and causes	The encoder is not cycled after the parameter is written, so the parameter value is not updated.
Checking methods and corrective actions	Check if the parameter is written to the encoder. If so, please cycle power on the encoder to update the parameter.
How to clear the alarm?	Cycle power on the servo drive.

AL07A Encoder Z Phase Position is Lost	
Trigger condition and causes	Encoder Z phase position is in error.
Checking methods and corrective actions	Send your servo motor back to AutomationDirect.
How to clear the alarm?	N/A

AL07B Encoder Memory Busy	
Trigger condition and causes	Encoder memory is busy.
Checking methods and corrective actions	1) Check if the motor is well grounded; make sure the power cable is grounded to the heat sink of the servo drive. 2) Make sure the encoder cable is separated from the power supply or any high-current cables to avoid interference. 3) Use shielded cable for the encoder and pull out the shielded mesh and ground it. 4) Check the motor speed and make sure it is within the rated range. If the issue persists, please contact AutomationDirect technical support.
How to clear the alarm?	Cycle power on the servo drive.

AL07C Command to Clear The Absolute Position is Issued When the Motor Speed is Over 200 rpm	
Trigger condition and causes	The command to clear the absolute position is issued when the motor speed is over 200 rpm.
Checking methods and corrective actions	Check if a command to clear the absolute position is issued while motor speed is over 200 rpm. If so, follow the procedure for clearing the absolute position to clear this alarm. Do not issue a command to clear the absolute position when the motor speed is over 200 rpm.
How to clear the alarm?	Cycle power on the servo drive.

AL07D Servo Drive Power Is Cycled Before AL07C is Cleared	
Trigger condition and causes	AL07C occurs and is not cleared before the power is cycled on the servo drive, and the motor stops operating.
Checking methods and corrective actions	Use DI.ARST to clear the alarm. Once this alarm is cleared, AL07C occurs. Please follow the checking and troubleshoot methods to clear that alarm.
How to clear the alarm?	Cycle power on the servo drive.

AL07E Encoder Clearing Procedure Error	
Trigger condition and causes	The time to clear the encoder exceeds the limit.
Checking methods and corrective actions	If the issue persists, set P0.002 to -81 to check the communication quality with the encoder. If communication is normal, use DI.ARST to clear this alarm.
How to clear the alarm?	Cycle power on the servo drive.

AL07F Encoder Version Error	
Trigger condition and causes	The encoder version read by the servo drive is wrong.
Checking methods and corrective actions	N/A
How to clear the alarm?	Replace the motor immediately.

AL083 Servo Drive Outputs Excessive Current	
Trigger condition and causes	Condition: during general operation, this alarm occurs when the servo drive outputs current that is over the allowable level specified by the firmware. This alarm protects IGBT from overheating or burning out because of the high current. Causes: 1) UVW cable is short-circuited. 2) Motor wiring is wrong. 3) Interference on the analog signal GND for the servo drive.
Checking methods and corrective actions	1) Check the connection between the motor power cable and its connector. If metal wire is exposed or the wire is torn, the UVW cable can short-circuit. In this case, please replace the UVW cable and prevent the metal conductor from being exposed. 2) Refer to Chapter 3 *Wiring* and check the following: • If you do not use the AutomationDirect standard power cable, make sure the UVW wiring sequence is correct. • Make sure the UVW wiring between the servo drive and the motor is correctly connected. 3) Check if the analog signal GND is mistakenly connected to another ground signal (incorrect connection can cause interference). DO NOT use a common ground for the analog signal and GND. Follow the wiring instructions in Chapter 3.
How to clear the alarm?	DI.ARST

AL085 Regeneration Error	
Trigger condition and causes	Condition: regeneration control error. Cause: regenerative resistor is not operating, but the regenerative voltage remains at 400V for a period of time.
Checking methods and corrective actions	Check the connections for the regenerative resistor, re-calculate the value for the regenerative resistor, and reset the value of P1.052 and P1.053. If this does not clear the alarm, please contact AutomationDirect technical support.
How to clear the alarm?	DI.ARST

AL086 Regenerative Resistor Overload	
Trigger condition and causes	Condition: excessive energy in the capacitor of the servo drive is released to the regenerative resistor causing overload of the resistor. Cause: 1) Incorrect selection of the regenerative resistor or no connection to an external regenerative resistor. 2) Incorrect parameter settings for P1.052 and P1.053. 3) Other energy (such as interference) is input to the servo drive or the input voltage is higher than the allowable rated voltage. 4) Malfunction of the servo drive hardware.
Checking methods and corrective actions	1) Check the connection for the regenerative resistor and correctly set the values of P1.052 and P1.053. 2) Re-assess whether the regenerative energy exceeds the value of P1.053. If the regenerative energy exceeds the set value, replace the regenerative resistor with a regenerative resistor that has a higher capacity. 3) Use a voltmeter to measure if the input voltage from the power supply is within the allowable rated voltage (refer to Appendix A Specifications). If the input voltage exceeds the rated range, remove the interference source. 4) Measure the voltage between P3 and terminals. If it does not match the displayed DC Bus voltage when you enter monitoring code 14 to P0.002, the servo drive may be malfunctioning. Contact AutomationDirect. 5) If you took the above actions and the issue persists, use a scope with a differential carbon rod to measure whether the input voltage has high-frequency signal interference. If there is interference, remove the interference source, use the right voltage source, or connect the regulator in series.
How to clear the alarm?	DI.ARST

AL088 Servo Function Overload Warning	
Trigger condition and causes	Condition: too many motor control functions on the servo drive are enabled. Cause: Servo function overload warning.
Checking methods and corrective actions	If using a filter, see if using this filter is necessary.
How to clear the alarm?	Disable the filter if not required, such as low-pass filter (P1.006 — P1.008), moving filter (P1.068), low-frequency vibration suppression (P1.025 — P1.028), vibration elimination (elasticity compensation) (P1.089 — P1.094), or Notch filter (5 sets), percentage of friction compensation (P1.062), and motor hard stop - torque percentage (P1.057).

AL089 Current Detection Interference	
Trigger condition and causes	Condition: current detection interference. Cause: current detection in the servo drive is affected by an external interference source.
Checking methods and corrective actions	Check the environment around the servo drive to see if there is any interference source.
How to clear the alarm?	Remove or reposition the interference source. Set P2.112 [Bit 1] to 0 to disable AL089. If the issue persists, please contact AutomationDirect technical support.

AL08A Auto-tuning Function - Command Error	
Trigger condition and causes	Condition: no command is issued when the servo drive starts the auto-tuning procedure. Causes: 1) When the command source is the controller, neither the controller nor the position register issue the command. 2) When command source is the servo drive, position 1 and 2 specify the same position. 3) The signal cable is not connected or incorrectly connected so that the servo drive cannot receive the command.
Checking methods and corrective actions	1) Make sure a command is being issued. 2) Make sure the wiring between the controller and servo drive is correct.
How to clear the alarm?	DI.ARST

AL08B Auto-tuning Function - Pause Time is too Short	
Trigger condition and causes	Condition: the pause time is too short when the controller is the command source in the auto-tuning procedure. The auto-tuning algorithm requires a certain amount of time to perform the calculation. The tuning result is affected if the pause time is too short. Cause: pause time in the cycle is too short.
Checking methods and corrective actions	1) For a reciprocating motion between two points, pausing is required on the return, which has to be longer than 1 sec. 2) For rotation in a single direction, pause time is required when the motor rotates a certain number of cycles (> 2 cycles).
How to clear the alarm?	DI.ARST

AL08C Auto-tuning Function - Inertia Estimation Error	
Trigger condition and causes	Condition: inertia estimation error occurs when the servo drive starts the auto-tuning procedure. Causes: 1) Acceleration/deceleration time is too long. 2) Rotation speed is too slow. 3) Inertia of the machine is too large. 4) Inertia variation is too drastic.
Checking methods and corrective actions	1) The acceleration/deceleration time for the motor to rotate from 0 rpm to 3000 rpm must be within 1.5 sec. 2) The slowest speed must be no less than 200 rpm; above 500 rpm is suggested. 3) The load inertia must be no more than 50 times the motor inertia. 4) Avoid applications that require drastic variation in the inertia.
How to clear the alarm?	DI.ARST

AL095 Regenerative Braking Resistor Disconnected	
Trigger condition and causes	The value of P1.053 (wattage of regenerative resistor) is not 0 and the external regenerative resistor or the brake is not connected. Only servo drives of 5.5 kW or above that have built-in regenerative resistors show this alarm.
Checking methods and corrective actions	1) If the regenerative brake is required for dynamic braking, please connect the regenerative resistor. Once you connect the resistor, make sure that the value of P1.053 is correct. 2) If not using the regenerative brake, set P1.053 (wattage of regenerative resistor) to 0. If the issue persists, please contact AutomationDirect technical support.
How to clear the alarm?	DI.ARST

AL099 DSP Firmware Update	
Trigger condition and causes	EEPROM is not reset after DSP firmware is updated.
Checking methods and corrective actions	Check if the firmware is updated. Set P2.008 to 30 first and then set it to 28. Next, cycle power on the servo drive.
How to clear the alarm?	Set P2.008 to 30 and then 28. Cycle power on the servo drive.

AL09C Parameter Reset Failed	
Trigger condition and causes	Condition: the parameter reset process is not complete. Cause: an error occurred during the parameter reset process, so the reset procedure could not be completed.
Checking methods and corrective actions	Check if the power is cut off during the reset process. Check the power wiring and switch.
How to clear the alarm?	Set P2.008 to 30 and then 28. Cycle power on the servo drive.

AL219 Write Parameters: Parameter Cannot Be Written	
Trigger condition and causes	Condition: this parameter is write-protected. Cause: the parameter write-protected function is enabled.
Checking methods and corrective actions	Check if the parameter and data array protection function (P5.097) is enabled.
How to clear the alarm?	Disable the parameter and data array protection function or reset the parameters.

AL221 A Non-existing Mode is Used	
Trigger condition and causes	Condition: the drive is set for a non-existent Mode or a command was issued that is not valid in the current mode. Cause: incorrect use of firmware command.
Checking methods and corrective actions	Verify there is a proper setting in P1.001 and that any DI or communication commands that are being triggered are relevant to the current operating mode. If P1.001 is correct and this problem persists, record the steps that lead to this issue and contact AutomationDirect.
How to clear the alarm?	DI.ARST

AL223 Some Commands are Not Allowed to be Used When the Servo is in the ERROR or FAULT state	
Trigger condition and causes	Condition: the servo is in the ERROR or FAULT state when a specific command is used. Cause: incorrect use of firmware command.
Checking methods and corrective actions	Record the operation steps and contact AutomationDirect.
How to clear the alarm?	DI.ARST

AL21B Memory Stack is Out of Range	
Trigger condition and causes	Condition: when a tack control command is used, the memory address it out of range. Cause: incorrect use of the command of the firmware.
Checking methods and corrective actions	Record the operatoin steps and contact AutoamtionDirect.
How to clear the alarm?	DI.ARST

AL21D A Divisor in an Expression is Zero in the Program	
Trigger condition and causes	Condition: a divisor in an expression is zero in the program. Cause: programming error of the firmware.
Checking methods and corrective actions	Record the operation steps and contact AutomationDirect.
How to clear the alarm?	DI.ARST

AL239 The Argument of the LOOP_CMD Command is Out of Range	
Trigger condition and causes	Condition: when the LOOP_CMD command is used, the input argument it out of range. Cause: incorrect use of firmware command.
Checking methods and corrective actions	Record the operation steps and contact AutomationDirect.
How to clear the alarm?	DI.ARST

AL23F Parameter is Written to a Memory Address that is Out of Range	
Trigger condition and causes	Condition: when the command for writing the parameter is used, the parameter is written to the memory address that is out of range. Cause: incorrect use of firmware command.
Checking methods and corrective actions	Record the operation steps and contact AutomationDirect.
How to clear the alarm?	DI.ARST

AL245 PR Positioning Timeout	
Trigger condition and causes	Condition: PR positioning function is triggered. Cause: incorrect use of firmware command.
Checking methods and corrective actions	Check if the conditions for completing the PR commands are not set or not triggered, causing the PR command to register as incomplete.
How to clear the alarm?	DI.ARST or cycle power on the servo drive.

AL247 The MATT_ACC Command Called a Math Function that is Out of Range	
Trigger condition and causes	Condition: the function ID of the math function called by the MATH_ACC command is out of range. Cause: incorrect use of firmware command.
Checking methods and corrective actions	Record the operation steps and contact AutomationDirect.
How to clear the alarm?	DI.ARST

AL249 PR Path Number is Out of Range	
Trigger condition and causes	Condition: the number of the triggered PR path exceeds the upper limit. Cause: the number of the triggered PR path is higher than 99.
Checking methods and corrective actions	1) Check if the PR command jumps to a path exceeding the range. 2) Check if the PR command format is correct.
How to clear the alarm?	DI.ARST or cycle power on the servo drive.

AL251 The Argument of the MATH_POWER Command is Out of Range	
Trigger condition and causes	Condition: when the MATH_POWER command is used, the argument is not within the range of 0–10. Cause: incorrect use of firmware command.
Checking methods and corrective actions	Record the operation steps and contact AutomationDirect.
How to clear the alarm?	DI.ARST

AL255 The System Object ID is Out of Range when the Object is Used	
Trigger condition and causes	Condition: when the system object is used, the object ID is out of range. Cause: incorrect use of firmware command.
Checking methods and corrective actions	Record the operation steps and contact AutomationDirect.
How to clear the alarm?	DI.ARST

AL257 The System Object Function Block ID is Out of Range when a System Object is Used	
Trigger condition and causes	Condition: when the system object is used, the object function block ID is out of range. Cause: incorrect use of firmware command.
Checking methods and corrective actions	Record the operation steps and contact AutomationDirect.
How to clear the alarm?	DI.ARST

AL25B Object Argument Format Error	
Trigger condition and causes	Condition: when the system object is used, the argument format of the object is in error. Cause: incorrect use of firmware command.
Checking methods and corrective actions	Record the operation steps and contact AutomationDirect.
How to clear the alarm?	DI.ARST

AL25F An Error Occured when the Object Dictionary was Accessed	
Trigger condition and causes	Condition: when an object dictionary command is used, an error occurs because the value is out of range or the object dictionary does not exist. Cause: incorrect use of firmware command.
Checking methods and corrective actions	Record the operation steps and contact AutomationDirect.
How to clear the alarm?	DI.ARST

AL35F Emergency Stop During Acceleration	
Trigger condition and causes	The rising edge of DI(0x47) is triggered, and then the motor decelerates to 0 and triggers AL3CF.
Checking methods and corrective actions	Check if any of the parameters, P2.010–P2.017 and P2.036–P2.040, are set to DI9(0x47) and are triggered.
How to clear the alarm?	Cycle power on the servo drive.

AL422 Write-in Failed Caused by Power Supply Cut-off	
Trigger condition and causes	Condition: if P2.069.Z is set to 1 (prevent indexing coordinate overflow = yes) and the power supply is cut off, the motor fails to store the current position. Cause: 1) The load is over the trated range and the servo drive is in a continous overload condition. 2) After firmware update, the internal variables vary depending on the version. 3) The servo drive hardware EEPROM is abnormal. 4) The hardware of the servo drive is short-circuited. 5) AL520 occurred and cause malfunction of the servo drive.
Checking methods and corrective actions	Set P0.002 to 12 for monitoring if the average load rate (%) is continuously over 100%. If so, increase the motor capacity or reduce the load. Refer to Appendix A for graph of load and operating time.
How to clear the alarm?	Cycle power on the servo drive.

11.3.2 - STO type

AL500 STO Function Is Enabled	
Trigger condition and causes	Safe torque off function (STO) is enabled.
Checking methods and corrective actions	Safe torque off function (STO) is enabled. Please check why it is enabled.
How to clear the alarm?	1) Use DI.ARST or 0x6040.Fault Reset, or set P0.001 to 0. 2) If not using STO, plug the short circuit device into CN10 or wiring to short circuit the block. Follow the instructions in Section 3.11.3 for the STO wiring.

AL501 STO_A Loss (signal loss or signal error)	
Trigger condition and causes	Loss of STO_A signal or STO_A and STO_B signals are not synchronized for more than 1sec.
Checking methods and corrective actions	Make sure the wiring of STO_A is correct.
How to clear the alarm?	Cycle power on the servo drive.

AL502 STO_B Loss (signal loss or signal error)	
Trigger condition and causes	Loss of STO_B signal or STO_A and STO_B signals are not synchronized for more than 1 sec.
Checking methods and corrective actions	Make sure the wiring of STO_B is correct.
How to clear the alarm?	Cycle power on the servo drive.

AL503 STO Self-diagnostic Error	
Trigger condition and causes	An error occurs during STO self-diagnosis.
Checking methods and corrective actions	Make sure the wiring of STO_A and STO_B are correct.
How to clear the alarm?	If the wiring is correct, it might be that the STO circuit is causing the error.

AL510 Internal Parameter Update Program of the Servo Drive is Abnormal	
Trigger condition and causes	Internal parameter update program of the servo drive is abnormal.
Checking methods and corrective actions	If this alarm occurs when the motor parameter identification function is executed, cycle power on the servo drive and re-execute the motor parameter identification function.
How to clear the alarm?	N/A

AL520 Calculation Program Timeout	
Trigger condition and causes	Servo drive calculation program timeout.
Checking methods and corrective actions	1) Cycle power on the servo drive. 2) If the alarm persists, disable the vibration elimination function by setting [Bit 8] and [Bit 9] of P2.094 to 0.
How to clear the alarm?	N/A

AL521 Vibration Elimination Parameter Error	
Trigger condition and causes	Condition: the value for the vibration elimination parameter (elasticity compensation) is not appropriate. Causes: 1) The value of vibration suppression (elasticity compensation) is incorrect. 2) The Bode plot is in error due to other variables while the operation system is analyzing the program.
Checking methods and corrective actions	Perform system analysis again and correctly set the value for the vibration elimination parameter.
How to clear the alarm?	1) Perform system analysis again and correctly set the value for the vibration elimination parameter. 2) If the issue persists, please disable the vibration elimination function P2.094 [Bit 8] & [Bit 9].

ALF21 Command Error	
Trigger condition and causes	Condition: the use of the firmware commands does not comply with the specifications. Cause: servo status mode error. It could occur when servo is in motion status and reconnecting status at the same time.
Checking methods and corrective actions	Record the operation steps and contact AutomationDirect.
How to clear the alarm?	Cycle power on the servo drive.

11.3.3 - Communication Type:

AL131 CRC of EEPROM Calculation Error Occurs when Using PDO	
Trigger condition and causes	The data in ROM is damaged; all objects are automatically restored to default values.
Checking methods and corrective actions	Check if the specified object causes a CRC calculation error in EEPROM when PDO is being received or sent. Usually, this alarm is caused by an error in DSP.
How to clear the alarm?	NMT: reset node or 0x6040 (fault reset) or DI.ARST.

AL132 Parameter is Write-prohibited when Using PDO	
Trigger condition and causes	When using communication object to write data to the parameter, the parameter is currently write-prohibited.
Checking methods and corrective actions	Please refer to the specified parameter description to write data to the parameter.
How to clear the alarm?	NMT: reset node or 0x6040 (fault reset).

Wiring
Parameters
DI/DO Codes
Monitoring
Alarms

AL180 Detect the connection between the PLC and comm. card	
Trigger condition and causes	No data message received in the time duration specified in P3.067 on EtherNet/IP Explicit or Modbus TCP. This can be set as a Warning or an Alarm
Checking methods and corrective actions	1) Check if the communication is normal. 2) Check if the wiring is correctly connected.
How to clear the alarm?	NMT: reset node or 0x6040 (fault reset) or DI.ARST

AL185 HSSP command timeout or data checksum error	
Trigger condition and causes	Condition: internal communication is cut off. Cause: Abnormal communication hardware, (internal communication card packet fails for > 5s, or the received packet contains a CRC error 3x in a row)..
Checking methods and corrective actions	1) Check if the communication cable is intact and firmly connected. 2) Check the communication quality; it is suggested that you use common grounding and shielded cable. 3) For communication type models, check if the value of monitoring variable 120 increases constantly.
How to clear the alarm?	NMT: reset node or 0x6040 (fault reset) or DI.ARST (**NOTE:** This is an internal alarm and is not dependent on P3.065 or P3.067)

AL186 Communication Bus Off	
Trigger condition and causes	Transmission error in comms data.
Checking methods and corrective actions	1) Check if the cable is well connected and whether there is any noise inference. Replace the communication cable or eliminate the noise if necessary. 2) There are an excessive number of the slave stations, and the communication cycle is too short. Please lengthen the communication cycle.
How to clear the alarm?	NMT: reset node or 0x6040 (fault reset).

AL201 Error occurs when loading data	
Trigger condition and causes	Condition: an error has occurred when loading data from EEPROM. Cause: initialization error of comms data.
Checking methods and corrective actions	1) If the alarm is cleared after cycling power on the servo drive, it means the error occurs at the moment when reading the data. 2) If the issue persists after cycling power on the servo drive, it means the data in the EEPROM is damaged and you need to write the correct value again. See the following methods: • To write the default value, set P2.008 to 30 and then 28
How to clear the alarm?	DI.ARST

AL22D Absolute positioning is not allowed when E-Cam is engaged	
Trigger condition and causes	Condition: Absolute positioning is performed when the E-Cam is engaged. Cause: Absolute positioning is performed when the E-Cam is engaged.
Checking methods and corrective actions	Check if the E-Cam is engaged when the servo is performing absolute positioning.
How to clear the alarm?	DI.ARST

AL301 Synchronization failure	
Trigger condition and causes	Condition: the servo drive fails to synchronize with the controller in IP mode. Cause: synchronization failure.
Checking methods and corrective actions	1) Make sure the communication between the servo drive and the controller is good. 2) After eliminating any problems that you find, allow the controller to re-send the SYNC signal and ensure that it is sent successfully. 3) Modify the setting for P3.009 (setting the default value is suggested).
How to clear the alarm?	NMT: reset node or 0x6040 (fault reset).

AL302 Synchronization signal is sent too soon	
Trigger condition and causes	Condition: when using comms, the synchronization signal is received too soon. Cause: the synchronization signal is sent too soon.
Checking methods and corrective actions	1) Make sure the setting of synchronization cycle (0x1006) is identical to that of the controller. 2) Modify the setting of P3.009 (using the default value is suggested). 3) Ensure the correct time sequence of sending packets from the controller. A drift or delay in packet sending time causes synchronization failure.
How to clear the alarm?	NMT: reset node or 0x6040 (fault reset).

AL303 Synchronization signal timeout	
Trigger condition and causes	Condition: in IP mode, the synchronization with the controller failed. Cause: timeout of synchronization signal.
Checking methods and corrective actions	1) Make sure the communication quality is good. 2) Make sure the setting of synchronization cycle (0x1006) is identical to that of the controller. 3) Modify the setting of P3.009 (using default value is suggested). 4) Ensure the correct time sequence for sending packets from the controller. A drift or delay in packet sending time causes synchronization failure.
How to clear the alarm?	NMT: reset node or 0x6040 (fault reset).

AL304 Invalid IP command	
Trigger condition and causes	Condition: command cannot be sent when in IP mode. Cause: invalid IP command.
Checking methods and corrective actions	The computing time in IP mode takes too long. Please disable the USB monitoring function.
How to clear the alarm?	NMT: reset node or 0x6040 (fault reset).

AL305 SYNC period error	
Trigger condition and causes	Condition: Comms 301 Obj 0x1006 Data Error Cause: SYNC period error.
Checking methods and corrective actions	Check the value of 0x1006. If it is smaller than or equal to 0, the alarm occurs.
How to clear the alarm?	NMT: reset node or 0x6040 (fault reset).

AL401 NMT reset command is received while servo is on	
Trigger condition and causes	NMT reset command is received while servo drive is on.
Checking methods and corrective actions	Check if the NMT reset command is received while the servo drive is on. Use NMT.reset or 0x6040 (fault reset).
How to clear the alarm?	DI.ARST

11.3.4 - Motion control type:

AL207 Parameter group of PR Type 8 (Write) is out of range	
Trigger condition and causes	Condition: parameter group for PR Type 8 (Write), P_Group, is out of range. Cause: the group for PR Type 8 (Write) command source exceeds the range.
Checking methods and corrective actions	Writing parameter using PR procedure: the parameter group of command source exceeds the range. Please check the setting.
How to clear the alarm?	DI.ARST or set P0.001 to 0.

AL209 Parameter number of PR Type 8 (Write) is out of range	
Trigger condition and causes	Condition: parameter number for PR Type 8 (Write) is out of range. Cause: parameter number is out of range.
Checking methods and corrective actions	Writing parameter using PR procedure: parameter number of PR Type 8 (Write) is out of range. Please check the setting.
How to clear the alarm?	DI.ARST or set P0.001 to 0.

AL211 Parameter Format Setting of Type 8 (Write) PR is in Error	
Trigger condition and causes	Condition: parameter format setting of Type 8 (Write) PR command is in error. Cause: 1) Incorrect parameter format. 2) The SureServo2 Pro software version and the firmware version do not match.
Checking methods and corrective actions	1) Check if the parameter format is correct. 2) Check if you are using the latest version of the software. If you took the corrective actions but the issue persists, contact AutomationDirect.
How to clear the alarm?	DI.ARST

AL213 Parameter setting of PR Type 8 (Write) is in error	
Trigger condition and causes	Condition: when using PR Type 8 (Write) to write parameters, the parameter value is incorrect. Cause: parameter value of PR Type 8 (Write) is in error.
Checking methods and corrective actions	Make sure the parameter value is within the correct range.
How to clear the alarm?	DI.ARST or set P0.001 to 0.

AL215 Write parameters: read-only	
Trigger condition and causes	Condition: write parameters using PR procedure: the parameter is read-only. Cause: an error occurs when writing parameters with PR Type 8 (Write) command.
Checking methods and corrective actions	The specified parameter is read-only.
How to clear the alarm?	DI.ARST or set P0.001 to 0.

AL217 Write parameters: parameter locked	
Trigger condition and causes	Condition: write parameters using PR procedure: the parameter is write-protected when the servo drive is on or the parameter's value exceeds the range. Condition: an error occurs when writing parameters with PR Type 8 (Write) command.
Checking methods and corrective actions	Please write the parameters when the servo drive is off and make sure the parameter's value is within the range.
How to clear the alarm?	Modify the PR command and the parameter.

AL231 Monitoring item for PR Write command is out of range	
Trigger condition and causes	Condition: the value of the monitoring item for PR Type 8 (Write), Sys_Var, exceeds the range. Cause: the value for the monitoring item is out of range.
Checking methods and corrective actions	Please check the code range when writing the monitoring code and make sure it is within the allowable range.
How to clear the alarm?	Reset the alarm or set P0.001 to 0.

AL235 Absolute positioning command error	
Trigger condition and causes	Condition: execute a position command after the feedback position counter overflows. Cause: feedback position counter overflows.
Checking methods and corrective actions	Incremental system: When the motor keeps operating in one direction, this leads to overflow of the position feedback register (FB_PUU), and the coordinate system cannot display the correct position. Executing a positioning command after overflow results in an error. Please use the scope to check if the feedback position has overflowed and then execute the homing procedure. Absolute system: This error occurs when executing the absolute positioning command in the following situations: 1) Feedback position register (FB_PUU) overflows. 2) Setting for P1.001.Z changes, but homing has not been completed yet. 3) E-Gear ratio (P1.044 and P1.045) changes, but homing has not been completed yet. 4) The function to return to the original point is triggered, but homing has not been completed yet. 5) When AL060 or AL062 occurs, please use the scope to check if the feedback position has overflowed. Check steps 1—4 above and perform the homing procedure.
How to clear the alarm?	Incremental system: Perform homing procedure after using DI.ARST to clear the alarm. Absolute system: Establish the absolute origin position.

AL237 Indexing coordinate is undefined	
Trigger condition and causes	Condition: using the indexing function and execute positioning command before defining the start point of the indexing coordinate. Cause: The servo drive cannot identify this coordinate system.
Checking methods and corrective actions	Check if the indexing coordinate has been defined: 1) Perform the homing procedure before using the indexing function. 2) After alarm occurs, use DI.ARST or set P0.001 to 0 to clear the alarm. 3) This alarm is also cleared when you power on the servo.
How to clear the alarm?	DI.ARST or set P0.001 to 0.

AL283 Software positive limit	
Trigger condition and causes	Condition: the target position specified by the command exceeds the software positive limit. Cause: reaching the software positive limit.
Checking methods and corrective actions	When you enable the software positive limit function, this alarm is determined by the command instead of by the feedback position. The alarm may occur while the actual position is still within the allowable range. The software positive limit is determined by the Position command instead of the actual feedback position because the command is sent before the feedback is received. That is, the actual position may have not reached the limit when the limit protection has been triggered. To fix this, you can set a proper deceleration time to satisfy the application requirement. Please see description for P5.003.
How to clear the alarm?	The alarm is automatically cleared after the motor moves away from the limit.

AL285 Software negative limit	
Trigger condition and causes	Condition: target position specified by the command is less than the software negative limit. Cause: the software negative limit is triggered.
Checking methods and corrective actions	The software negative limit is determined by the Position command instead of the actual feedback position because the command is sent before the feedback is received. That is, the actual position may have not reached the limit when the limit protection has been triggered. To fix this, you can set a proper deceleration time for the application. Please refer to the description for P5.003.
How to clear the alarm?	The alarm is automatically cleared after the motor moves away from the limit.

AL289 Feedback position counter overflows	
Trigger condition and causes	Feedback position counter overflows.
Checking methods and corrective actions	1) Please set the gear ratio according to the total traveling distance of the absolute motor and the actual application requirements to avoid the feedback position counter overflow. 2) If P2.069.Z is set to 1 (prevent index coordinate overflow function), please set P2.070 bit 2 to 1.
How to clear the alarm?	DI.ARST

AL380 Position offset alarm for DO.MC_OK	
Trigger condition and causes	DO.MC_OK is on and then goes off.
Checking methods and corrective actions	Please refer to the description of P1.048. After DO.MC_OK is on, DO.MC_OK goes off because DO.TPOS turns off. There might be an external force causing the position deviation of the motor after positioning is completed. You can disable this alarm by setting P1.048.Y to 0.
How to clear the alarm?	DI.ARST or set P0.001 to 0.

AL3CF DI.PFQS input for quick stop and fault (Emergency Stop)	
Trigger condition and causes	After AL35F is triggered and the motor has decelerated to 0, this alarm occurs.
Checking methods and corrective actions	Check if any of the parameters, P2.010–P2.017 and P2.036–P2.040, are set to DI(0x47) and are triggered.
How to clear the alarm?	Cycle power on the servo drive.

AL3F1 Absolute index coordinate undefined	
Trigger condition and causes	Condition: in communication mode, an absolute positioning command is issued before absolute coordinate system is created. Causes: 1) The absolute coordinate system has not been created. 2) Overflow occurs since the motor keeps rotating in the same direction.
Checking methods and corrective actions	1) Create an absolute coordinate system. 2) Set the coordinate system origin again.
How to clear the alarm?	Set the origin again.

AL400 Index coordinate error	
Trigger condition and causes	Condition: P1.044 x P2.052 x 4 has to be less than 2^31. Cause: value of P2.052 is set too low and causes the index coordinate error.
Checking methods and corrective actions	Check if the value of P2.052 is within the allowable setting range. If the setting value is too low, an index coordinate error occurs. Please adjust the value of P2.052.
How to clear the alarm?	DI.ARST

AL404 Value of PR special filter setting is too high	
Trigger condition and causes	Condition: the value of the PR special filter (P1.022) is set too high so that the following error exceeds the range. Cause: following error of internal position exceeds the allowable range.
Checking methods and corrective actions	Check the setting of P1.022. If the value is too high, the following error exceeds the allowable range faster. Please adjust the value of P1.022.
How to clear the alarm?	DI.ARST

AL555 System failure	
Trigger condition and causes	DSP processing error.
Checking methods and corrective actions	If this alarm occurs, please contact AutomationDirect technical support without making any modification.
How to clear the alarm?	N/A

AL809 PR Arithmetic operation parmeter error or secondary platform error	
Trigger condition and causes	Condition: an error occurs when the servo drive decodes the motion command. Cause: The PR arithmetic operation parameters have to be compiled by the SureServo2 Pro software before being downloaded to the servo drive. Directly editing the PR arithmetic operation parameters through the panel or controller without recompiling the parameters in SureServo2 Pro triggers AL809.
Checking methods and corrective actions	1) Make sure you edit PR arithmetic operation parameters through SureServo2 Pro. Do not directly modify these parameters with the panel or controller. 2) If this alarm occurs when the servo is not in PR mode, please save the parameter file and contact the AutomationDirect technical support. 3) For advanced users: you can save the scope screenshot when the alarm occurs. Set P5.007 and P0.001 for the two channels to monitor the status and save the scope.
How to clear the alarm?	Cycle power on the servo drive.

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Appendix A

SureServo2 Specifications

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Introduction

This appendix covers specifications and dimensions for SureServo2 series drives and motors.

A.1 - Model Explanation

SV2 A - 2 04 0

Component Option
#: Drive
N: Motor without brake
B: Motor with brake

Rated Output Power

01: 100W	10: 1kW	45: 4.5 kW
02: 200W	15: 1.5 kW	55: 5.5 kW
04: 400W	20: 2kW	75: 7.5 kW
07: 750W	30: 3kW	B0: 11 kW
		F0: 15 kW

Nominal Input Voltage
2: 400W–2kW: 110/220 VAC 1-phase, 220VAC 3-phase
Over 2kW: 220VAC 3-phase
4: 400W–15kW: 460VAC 3-phase

Component Type
A: Drive
L: Low inertia motor
M: Medium inertia motor
H: High inertia motor

Series
SV2: SureServo2 AC servo

A.2 - SureServo2 Series Drive Specifications

230V SURESERVO2 DRIVE SPECIFICATIONS									
Model		**SV2A-2040**	**SV2A-2075**	**SV2A-2150**	**SV2A-2200**	**SV2A-2300**	**SV2A-2550**	**SV2A-2750**	**SV2A-2F00**
Power	**Power Rating**	400W	750W	1.5 kW	2kW	3kW	5.5 kW	7.5 kW	15kW
	Phase/Voltage	Single-phase / Three-phase 110VAC/220VAC				Three-phase 220VAC			
	Permissible Voltage	50/60 Hz, Single-phase / Three-phase 100–120VAC/200–230 VAC, -15% to 10%				50/60 Hz, Three-phase 200–230 VAC, -15% to 10%			
	Input Current 200–230 VAC 3-phase [Amps] rms	2.76	5.09	8.09	11.36	14.52	27.06	37.33	69.95
	Input Current 100–120 VAC 1-phase [Amps] rms	3.98	7.73	12.56	18.03	–	–	–	–
	Input Current 200–230 VAC 1-phase [Amps] rms	4.69	8.71	14.82	20.83	–	–	–	–
	Continuous Output Current [Amps] rms	2.60	5.10	8.33	13.40	17.92	41.33	49.04	78
	Max. Instantaneous Output Current [Amps] rms	8.56	15.43	20.16	40.57	55.93	91.44	127.46	162.04
	Main Circuit Inrush Current [Amps]	1.44	1.40	1.44	4.64	4.42	9.55	28.68	32.0
	Control Circuit Inrush Current [Amps]	37.0	37.40	39.80	32.40	36.40	32.80	40.0	37.0
	Short Circuit Current Rating (SCCR)	5000A (see section "2.5 - Specifications for the Circuit Breaker and Fuse" on page 2–6 for information on installing SureServo2 in panels requiring higher SCCR ratings)							
Cooling Method		Air Conv. Cooling	Fan Cooling						
Regenerative Resistor		Built-in					External (optional)		
Weight [kg (lb)]		0.92 (2)	1.3 (2.9)	1.3 (2.9)	2.7 (6)	2.7 (6)	4.9 (10.8)	7.2 (15.9)	13 (29)

460V SURESERVO2 DRIVE SPECIFICATIONS									
Model		SV2A-4040	SV2A-4075	SV2A-4150	SV2A-4200	SV2A-4300	SV2A-4550	SV2A-4750	SV2A-4F00
Power	Power Rating	400W	750W	1.5 kW	2kW	3kW	5.5 kW	7.5 kW	15kW
	Phase/Voltage	Three-phase 460V							
	Permissible Voltage	50/60 Hz, Three-phase 380–480 VAC, -10% to 10%							
	Input Current 460 VAC 3-phase [Amps] rms	1.49	2.31	4.98	6.29	9.92	16.83	23.06	36.65
	Continuous Output Current [Amps] rms	1.6	2.91	5.61	6.7	12.6	23.6	28.7	37.5
	Max. Instantaneous Output Current [Amps] rms	5.4	9.7	13.94	21.35	30.46	47.5	57.69	95.3
	Main Circuit Inrush Current [Amps]	5.6	5.6	5.6	12.5	12.5	12.5	12.5	12.5
	Control Circuit Inrush Current [Amps]	5	5	5	4.8	4.8	5.5	6	6
	Short Circuit Current Rating (SCCR)	5000A (see section "2.5 - Specifications for the Circuit Breaker and Fuse" on page 2–6 for information on installing SureServo2 in panels requiring higher SCCR ratings)							
Cooling Method		Fan Cooling							
Regenerative Resistor		Built-in			External (optional)				
Weight [kg (lb)]		5.96 [13.14]	5.96 [13.14]	5.96 [13.14]	9.71 [21.4]	9.71 [21.4]	12.14 [26.76]	12.14 [26.76]	15.01 [33.1]

GENERAL DRIVE SPECIFICATIONS (All Models)			
		Encoder Resolution	24-bit (16777216 p/rev)
		Main Circuit Control	SVPWM control
		Control Mode	Manual / Auto
Position Control Mode		**Pulse Type**	Pulse + Direction, CCW pulse + CW pulse, A phase + B phase
		Max. Input Pulse Frequency4	Pulse + Direction; CCW pulse + CW pulse; A phase + B phase: Line driver 4 Mpps; Open collector: 200 Kpps
		Command Source	External pulse / Register
		Smoothing Method	Low-pass and P-curve filter
		E-Gear Ratio	E-Gear ratio: N/M times, limited to (1/4 < N/M < 262144) N: 1 - 536870911 / M: 1 - 2147483647
		Torque Limit	Parameter settings
		Feed Forward Compensation	Parameter settings
Speed Control Mode	**Analog Command Input**	**Voltage Range**	±10VDC
		Resolution	15-bit
		Input Impedance	1MΩ
		Time Constant	25μs
		Speed Control Range[Note 1]	1 : 6000
		Command Source	External analog command / Register
		Smoothing Method	Low-pass and S-curve filter
		Torque Limit	Parameter settings / Analog input
		Bandwidth	Maximum 3.1 kHz (closed-loop)
		Speed Calibration Ratio[Note2]	±0.01% at 0% to 100% load fluctuation
			±0.01% at ±10% power fluctuation
			±0.01% at 0˚C to 50˚C ambient temperature fluctuation
Torque Control Mode	**Analog Command Input**	**Voltage Range**	±10VDC
		Input Impedance	1MΩ
		Time Constant	25μs
		Command Source	External analog command / Register
		Smoothing Method	Low-pass filter
		Speed Limit	Parameter settings / Analog input
		Analog Monitor Output	Monitor signal can be set by parameters (voltage output range: ±8V); resolution:10-bit

GENERAL DRIVE SPECIFICATIONS (All Models)		
Digital Input / Output	Input	Servo on, Fault reset, Gain switch, Pulse clear, Zero speed clamping, Command input reverse control, Internal position command trigger, Torque limit, Speed limit, Internal position command selection, Motor stop, Speed command selection, Speed / position mode switching, Speed / torque mode switching, Torque / position mode switching, PT / PR command switching, motor override, Forward / reverse limit, Original point, Forward / reverse operation torque limit, Homing activated, E-Cam engage, Forward / reverse JOG input, Event trigger, E-Gear N selection, Pulse input prohibition
	Output	A, B, Z line driver output
		Servo ready, Servo on, Zero speed detection, Target speed reached, Target position reached, Torque limiting, Servo alarm, Magnetic brake control, Homing completed, Early warning for overload, Servo warning, Position command overflows, Software limit (reverse direction), Software limit (forward direction), Internal position command completed, Capture procedure completed, Servo procedure completed, Master position area of E-Cam.
Protection Function		Overcurrent, Overvoltage, Undervoltage, Overheat, Regeneration error, Overload, Excessive speed deviation, Excessive position deviation, Encoder error, Adjustment error, Emergency stop, Forward / reverse limit error, Excessive deviation of full-closed loop control, Serial communication error, RST leak phase, Serial communication timeout, Short-circuit protection for terminals U, V, W and CN1, CN2, CN3
Communication Interface		RS-485 / USB / Optional EtherNet/IP or ModTCP
Environment	Installation Site	Indoors (avoid direct sunlight), no corrosive vapor (avoid fumes, flammable gases, and dust)
	Altitude	Altitude 1000m or lower above sea level
	Atmospheric Pressure	86kPa - 106kPa
	Operating Temperature	0˚C to 55˚C (If operating temperature is above 45˚C, forced cooling is required)
	Storage Temperature	-20˚C to 65˚C
	Humidity	0–90% RH (non-condensing)
	Vibrating	9.80665 m/s^2 (1 G) less than 20 Hz, 5.88 m/s^2 (0.6 G) 20 to 50 Hz
	IP Rating	IP20
	Power System	TN system[Note3,Note4]
	Approvals	IEC/EN 61800-5-1, UL 61800-5-1, TUV, CE

1 - Within the rated load, the speed ratio is: the minimum speed (smooth operation) / rated speed.
2 - Within the rated speed, the speed calibration ratio is: (rotational speed with no load - rotational speed with full load) / rated speed.
3 - TN system: the neutral point of the power system connects directly to the ground. The exposed metal components connect to the ground through the protective ground conductor.
4 - Use a single-phase three-wire power system for the single-phase power model.

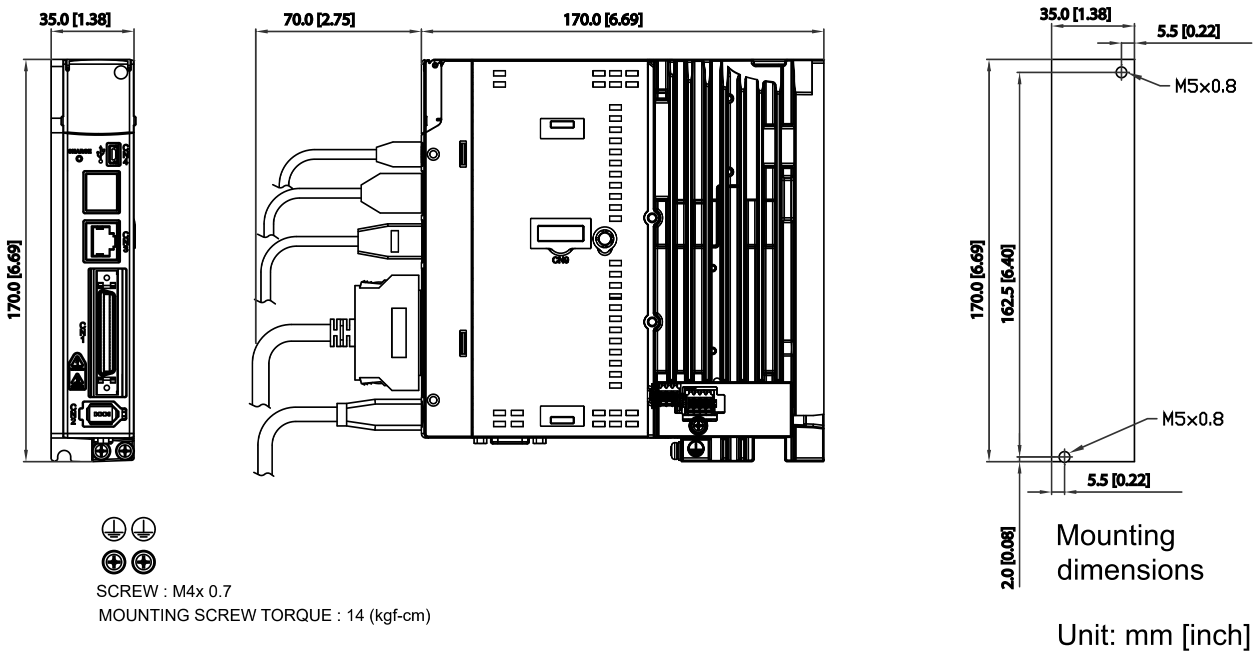
A.2.1 - Safety Specifications

The SureServo2 series servo drive conforms to the following safety specifications:

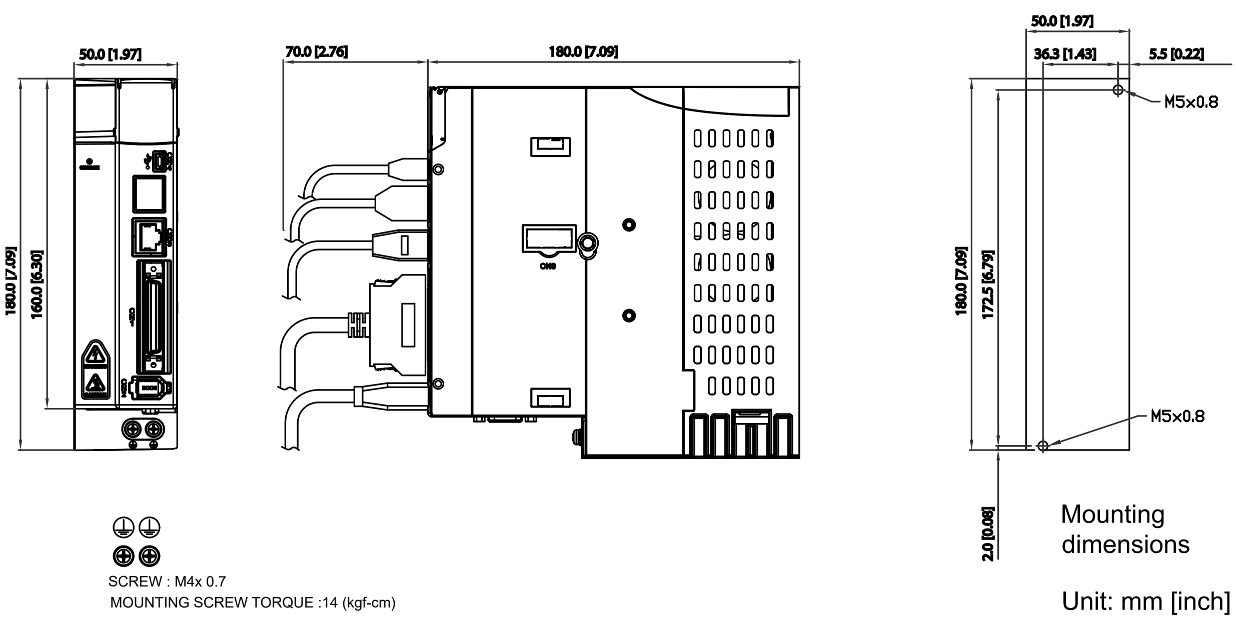
Item	Description	Standard	Safety Data
SFF	Safe failure fraction	IEC61508	Channel1: 80.08% Channel2: 68.91%
HFT (Type A subsystem)	Hardware fault tolerance	IEC61508	1
SIL	Safety integrity level	IEC61508	SIL2
		IEC62061	SILCL2
PFH	Probability of dangerous failure per hour (h^{-1})	IEC61508	9.56×10^{-10}
PFD_{av}	Average probability of failure on demand	IEC61508	4.18×10^{-6}
Category	Category	ISO13849-1	Category 3
PL	Performance level	ISO13849-1	d
$MTTF_d$	Mean time to dangerous failure	ISO13849-1	High
DC	Diagnostic coverage	ISO13849-1	Low

A.3 - SureServo2 Drive Dimensions

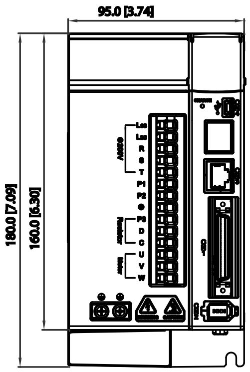
SV2A-2040

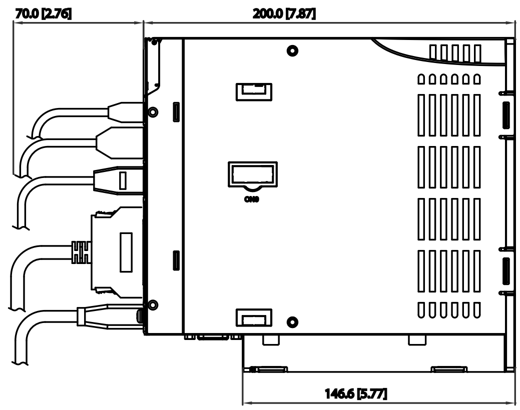


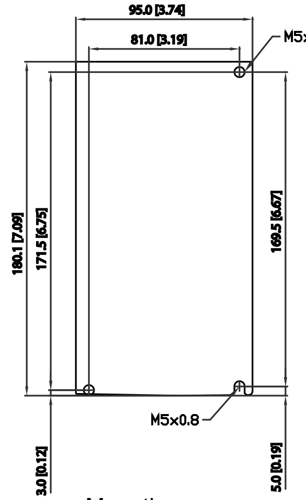
SV2A-2075, SV2A-2150



SV2A-2200, SV2A-2300





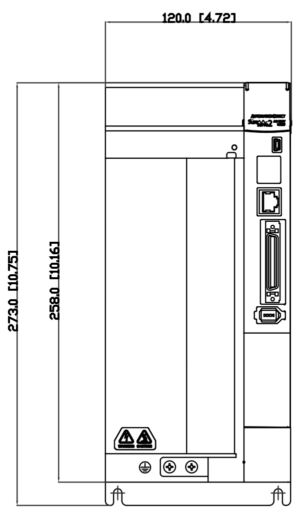


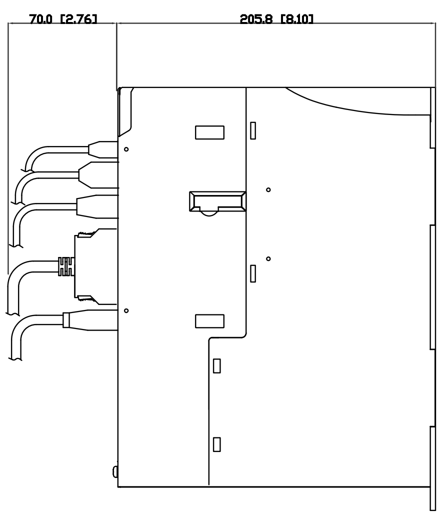
SCREW : M4x 0.7
MOUNTING SCREW TORQUE :14 (kgf-cm)

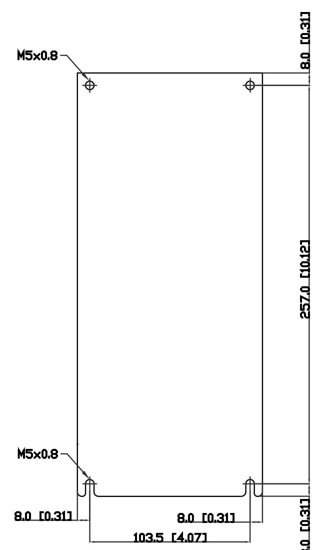
Mounting dimensions

Unit: mm [inch]

SV2A-2550







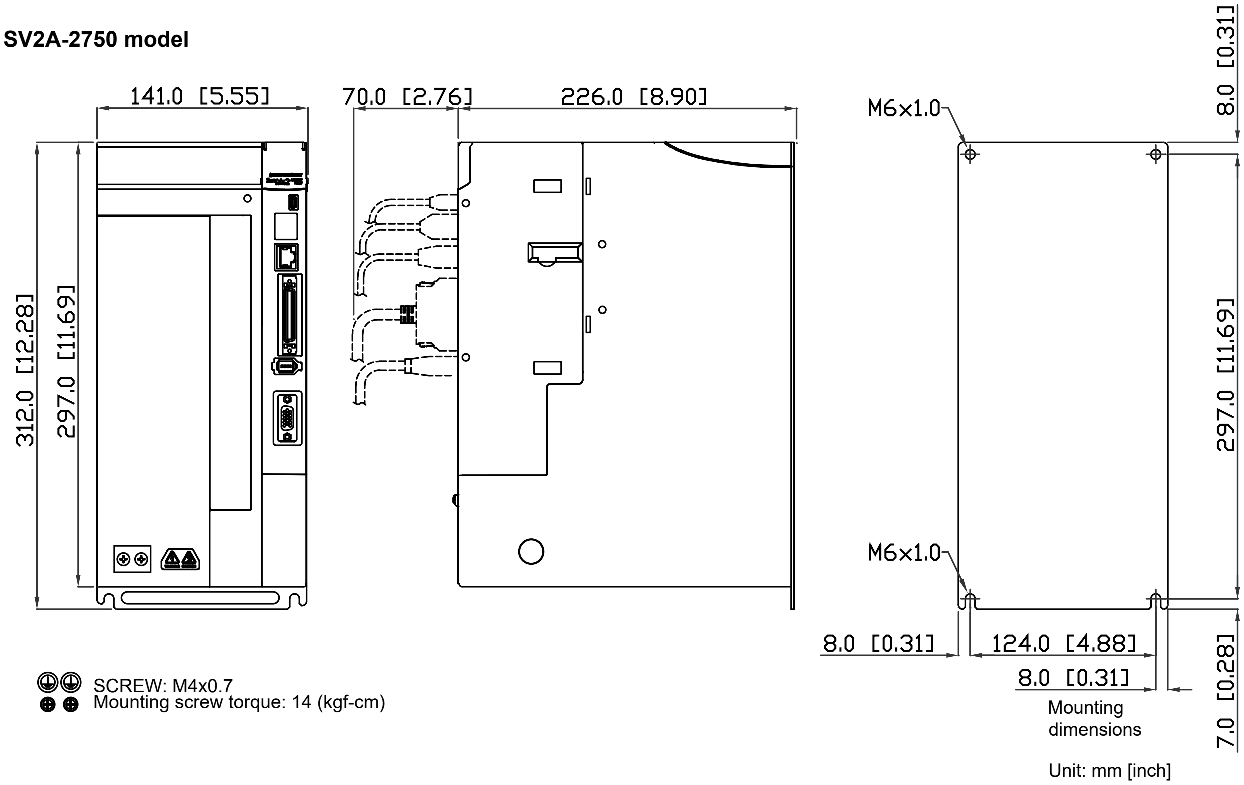
SCREW: M4x0.7
Mounting screw torque: 14 (kgf-cm)

Mounting dimensions

Unit: mm [inch]

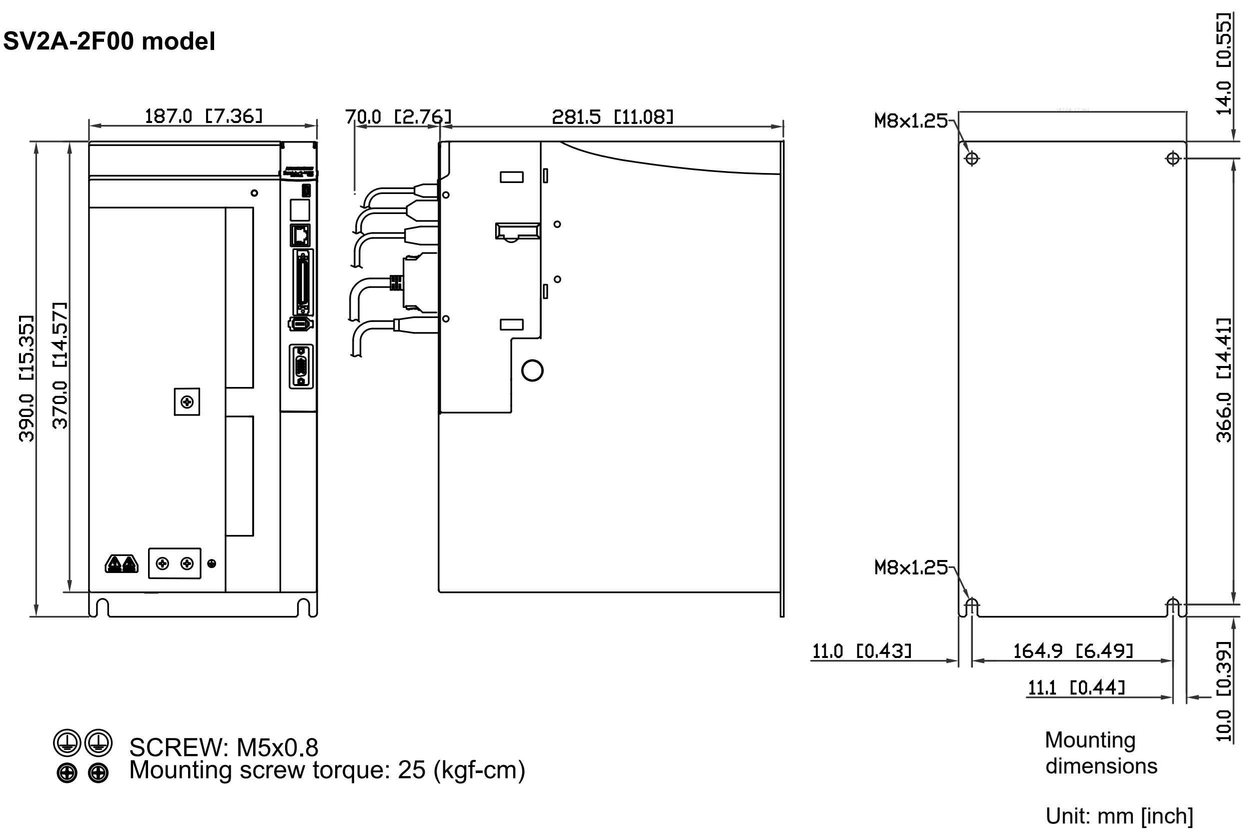
SV2A-2750

SV2A-2750 model

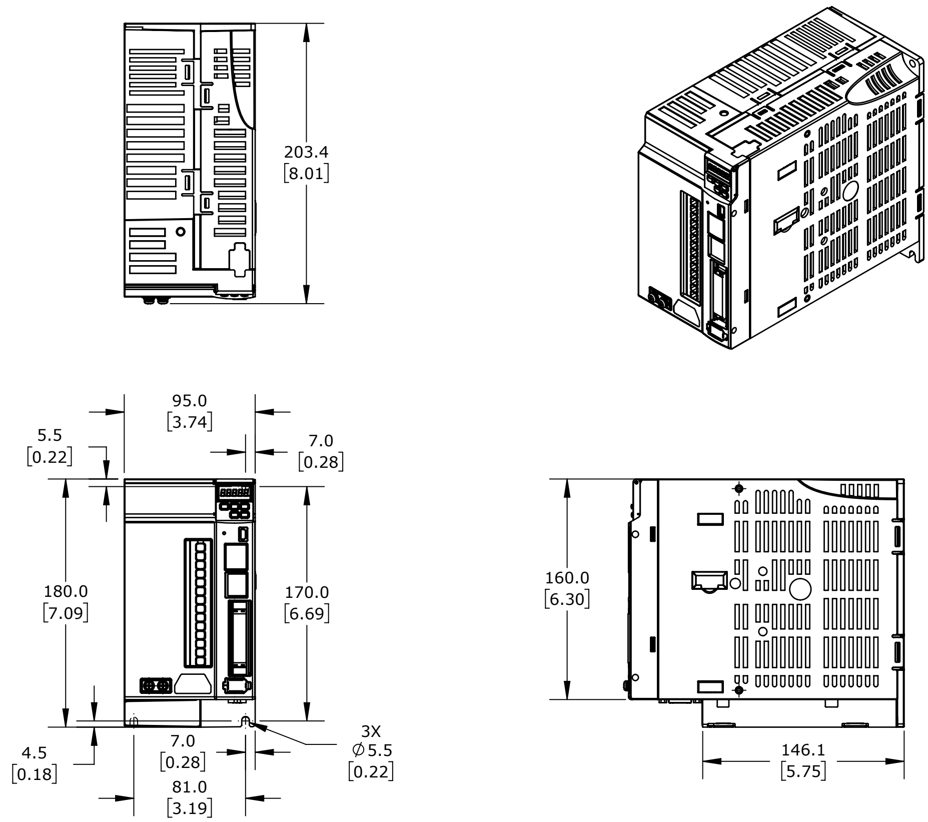


SV2A-2F00

SV2A-2F00 model

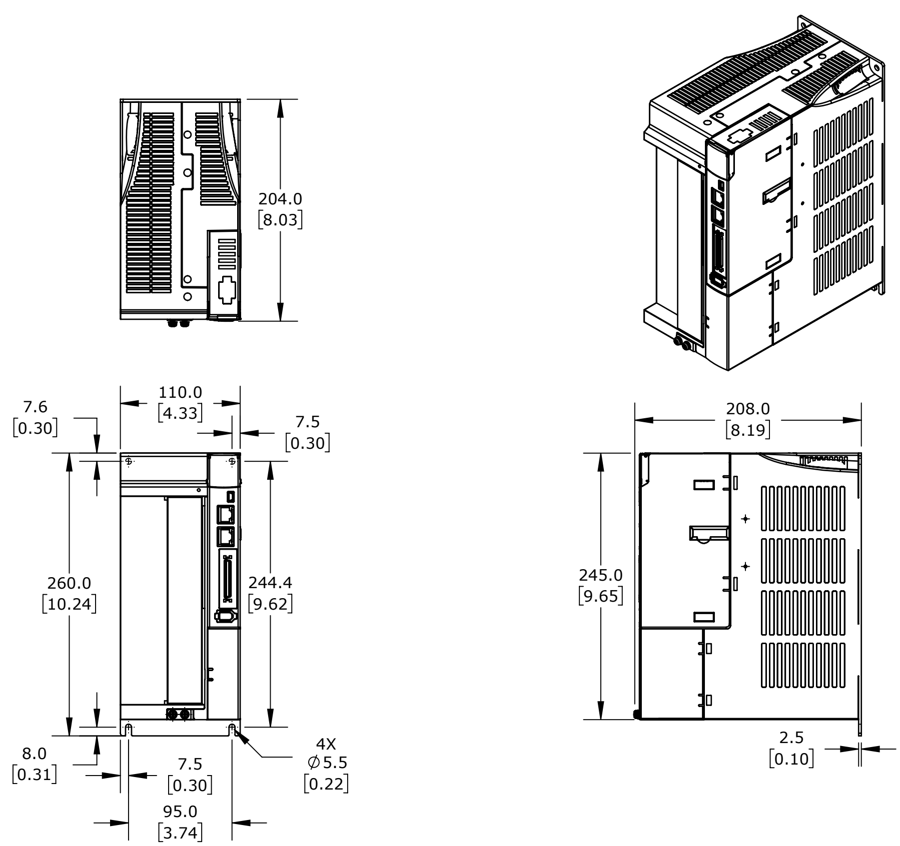


SV2A-4040, SV2A-4075, SV2A-4150

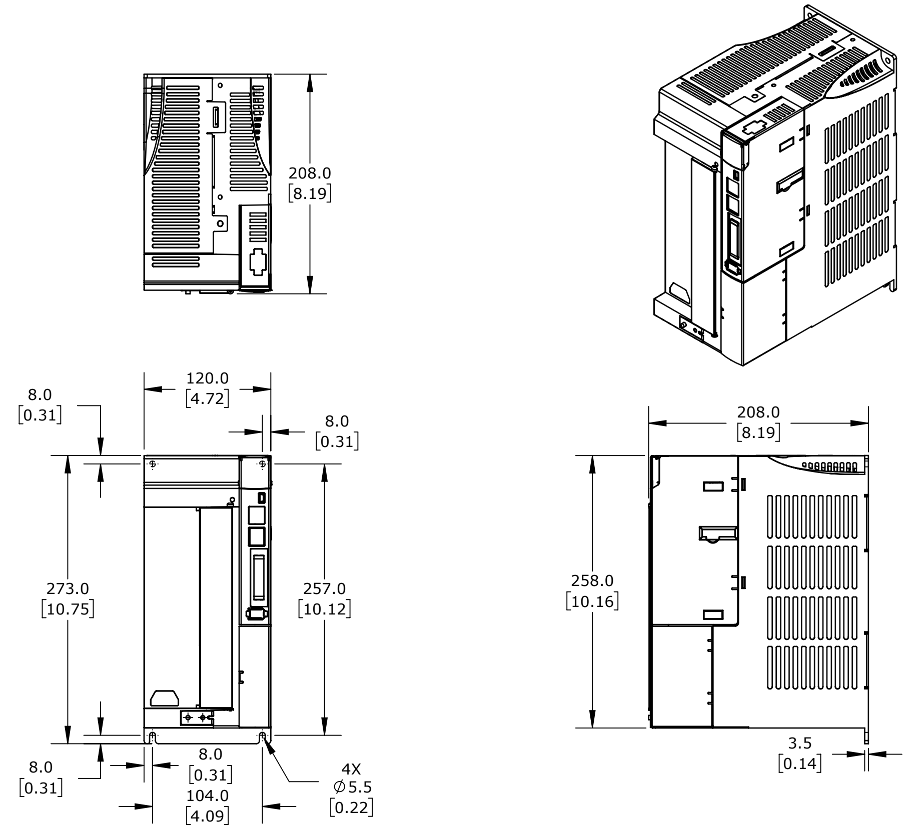


Units: **mm [inches]**

SV2A-4200, SV2A-4300

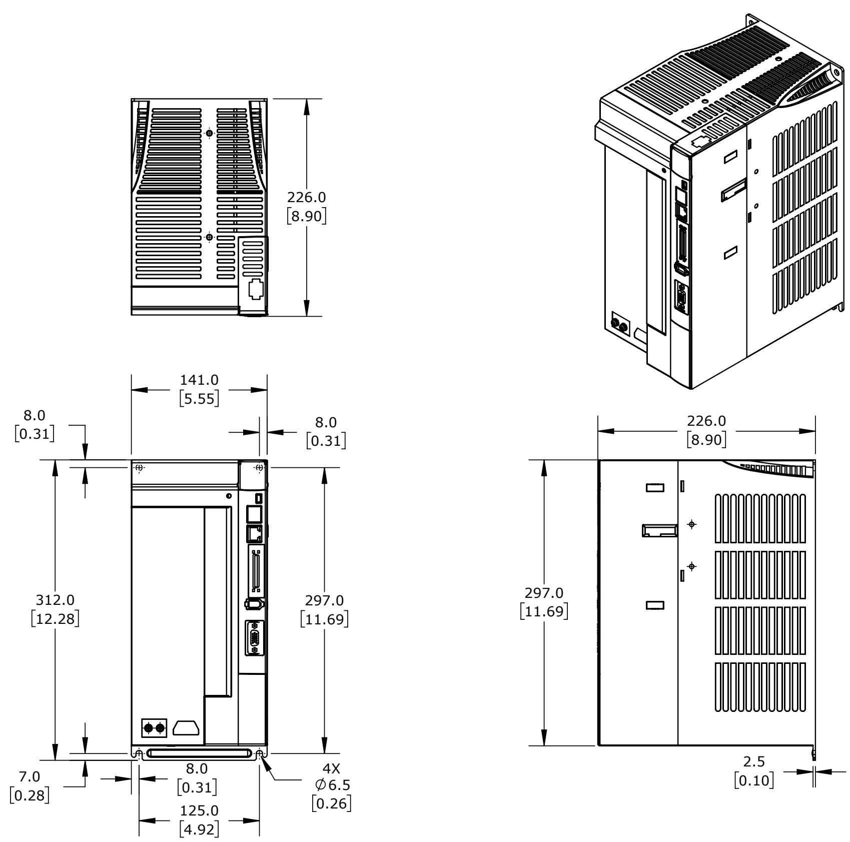


SV2A-4550

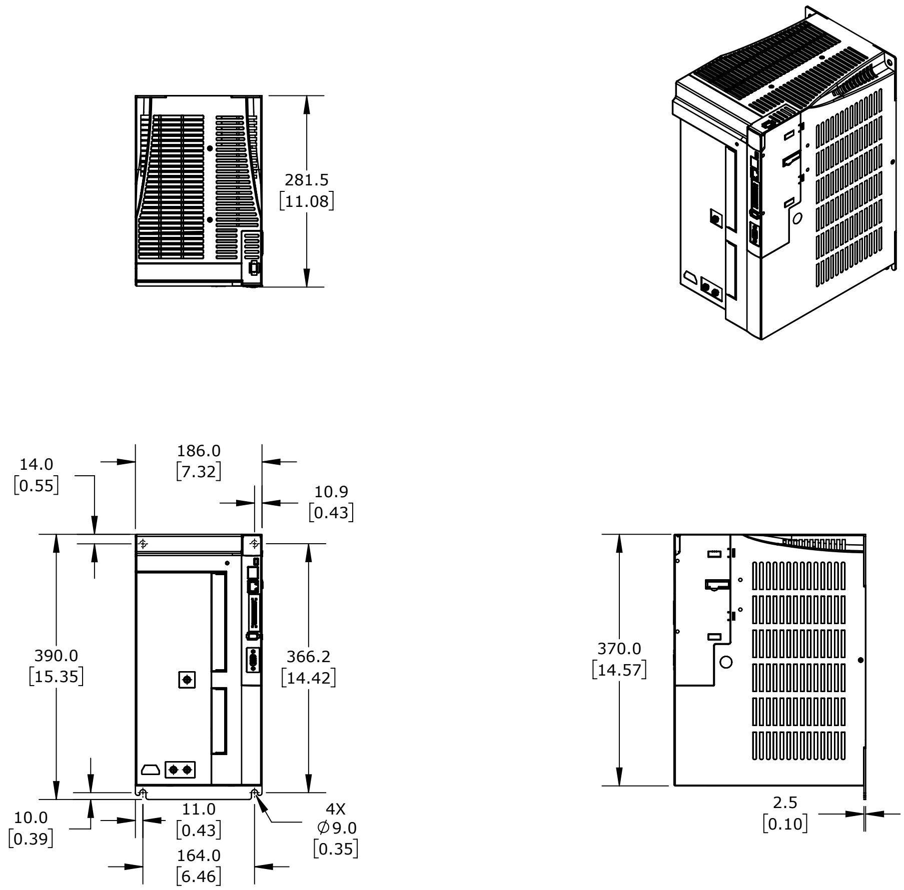


Units: **mm [inches]**

SV2A-4750



SV2A-4F00



Units: mm [inches]

A.4 - SureServo2 Motor Specifications

A.4.1 - SureServo2 230V Motor Specifications

230V Motor Specifications										
Model	**SV2L-201N**	**SV2L-201B**	**SV2L-202N**	**SV2L-202B**	**SV2L-204N**	**SV2L-204B**	**SV2L-207N**	**SV2L-207B**	**SV2L-210N**	**SV2L-210B**
Rated Power [kW]	0.1	0.1	0.2	0.2	0.4	0.4	0.75	0.75	1.0	1.0
Rated Torque [N·m]Note1	0.32	0.32	0.64	0.64	1.27	1.27	2.39	2.39	3.18	3.18
Max. Torque [N·m]	1.12	1.12	2.24	2.24	3.96	3.96	7.86	7.86	8.12	8.12
Rated Speed [rpm]	3000									
Max. Speed [rpm]	6000								5000	
Rated Current [Amps] rms	0.9	0.9	1.45	1.45	2.60	2.60	4.5	4.5	8.04	8.04
Max. Instantaneous Current [Amps] rms	3.3	3.3	5.4	5.4	8.56	8.56	15.41	15.41	20.16	20.16
Change of Rated Power [W/s]	16.3	14.90	16.4	14.60	35.8	33.60	37.8	34.40	38.2	30.40
Rotor Inertia [$x10^{-4}$ kg m^2]	0.0627	0.0689	0.25	0.28	0.45	0.48	1.51	1.66	2.65	3.33
Mechanical Time Constant [ms]	1.13	1.24	1.38	1.54	0.94	1.01	0.91	1.00	0.83	1.05
Torque Constant-KT [N-m/A]	0.356	0.356	0.441	0.441	0.488	0.488	0.531	0.531	0.396	0.396
Voltage Constant-KE [mV/rpm]	13.66	13.66	16.4	16.4	17.2	17.2	18.7	18.7	16.8	16.8
Armature Resistance [Ohm]	8,34	8,34	3,8	3,8	1.68	1.68	0.57	0.57	0.20	0.20
Armature Inductance [mH]	9.85	9.85	8.15	8.15	4.03	4.03	2.2	2.2	1.81	1.81
Electrical Time Constant [ms]	1.18	1.18	2.14	2.14	2.40	2.40	3.86	3.86	9.05	9.05
Insulation Class	Class A (UL), Class B (CE)									
Insulation Resistance	> 100MΩ, 500VDC									
Insulation Strength	1.8 kVAC, 1 second									
Weight [kg]	0.5	0.8	1.1	1.6	1.4	1.9	2.8	3.6	4.3	4.7
Max. Radial Loading [N] Note3	78	78	245	245	245	245	392	392	490	490
Max. Axial Loading [N]	54	54	74	74	74	74	147	147	98	98
Brake Holding Torque [N·m (min)]Note2	n/a	0.32	n/a	1.3	n/a	1.3	n/a	2.5	n/a	8
Brake Power Consumption (at 20°C) [W]		6.1		7.2		7.2		8		18.7
Brake Release Time [ms (max)]		20		20		20		20		10
Brake Pull-in Time [ms (max)]		35		50		50		60		70

1–The rated torque is the continuous permissible torque between the 0°C and 40°C operating temperature which is suitable for a servo motor mounted with the heat sink dimension shwon below. The heat sink should be attached to the motor's mounting surface. For operating temperatures above 40°C, see section A.4.4.

Motor Face Direction	Heat Sink Dimension
40mm, 60mm, and 80mm	250mm x 250mm x 6mm

2–The built-in servo motor brake is only for keeping the object in a stopped state. Do not use it for deceleration or as a dynamic brake.
3–Max radial force is specified at 5mm from the end of the shaft.

230V Motor Specifications								
Model	***SV2M-210N***	***SV2M-210B***	***SV2M-215N***	***SV2M-215B***	***SV2M-220N***	***SV2M-220B***	***SV2M-230N***	***SV2M-230B***
Rated Power [kW]	1.0	1.0	1.5	1.5	2.0	2.0	3.0	3.0
Rated Torque [N·m] Note1	4.77	4.77	7.16	7.16	9.55	9.55	17.55	17.55
Max. Torque [N·m]	14.32	14.32	14.88	14.88	24.54	24.54	48.29	48.29
Rated Speed [rpm]	2000						1700	
Max. Speed [rpm]	3000							
Rated Current [Amps] rms	5.66	5.66	8.33	8.33	12.1	12.1	17.9	17.9
Max. Instantaneous Current [Amps] rms	19.73	19.73	20.16	20.16	33.66	33.66	55.93	55.93
Change of Rated Power [W/s]	27.1	24.90	45.8	43.10	26.3	24.10	56.0	53.90
Rotor Inertia [x10^{-4} kg m^2]	8.41	9.14	11.2	11.9	34.7	37.8	55	57.1
Mechanical Time Constant [ms]	1.54	1.67	1.12	1.18	1.75	1.90	1.29	1.34
Torque Constant-KT [N-m/A]	0.843	0.843	0.860	0.860	0.789	0.789	0.980	0.980
Voltage Constant-KE [mV/rpm]	31.9	31.9	31.8	31.8	31.4	31.4	35	35
Armature Resistance [Ohm]	0.47	0.47	0.26	0.26	0.119	0.119	0.077	0.077
Armature Inductance [mH]	5.99	5.99	4.01	4.01	2.84	2.84	1.27	1.27
Electrical Time Constant [ms]	12.74	12.74	15.42	15.42	23.87	23.87	16.49	16.49
Insulation Class	Class A (UL), Class B (CE)							
Insulation Resistance	> 100MΩ, 500VDC							
Insulation Strength	1.8 kVAC, 1 second							
Weight [kg]	7.0	8.4	7.5	8.9	13.5	17.5	18.5	22.5
Max. Radial Loading [N] Note3	490				1176		1470	
Max. Axial Loading [N]	98				490			
Brake Holding Torque [N·m (min)] Note2	n/a	10	n/a	10	n/a	25	n/a	25
Brake Power Consumption (at 20°C) [W]		19		19		20.4		20.4
Brake Release Time [ms (max)]		10		10		10		10
Brake Pull-in Time [ms (max)]		70		70		70		70

1–The rated torque is the continuous permissible torque between the 0°C and 40°C operating temperature which is suitable for a servo motor mounted with the heat sink dimensions shown below. The heat sink should be attached to the motor's mounting surface. For operating temperatures above 40°C, see section A.4.4.

Motor Face Direction	***Heat Sink Dimension***
40mm, 60mm, and 80mm	250mm x 250mm x 6mm

2–The built-in servo motor brake is only for keeping the object in a stopped state. Do not use it for deceleration or as a dynamic brake.
3–Max radial force is specified at 5mm from the end of the shaft.

<table>
<tr><th colspan="7">230V Motor Specifications</th></tr>
<tr><th>Model</th><th>SV2H-245N</th><th>SV2H-245B</th><th>SV2H-255N</th><th>SV2H-255B</th><th>SV2H-275N</th><th>SV2H-275B</th></tr>
<tr><td>Rated Power [kW]</td><td>4.5</td><td>4.5</td><td>5.5</td><td>5.5</td><td>7.5</td><td>7.5</td></tr>
<tr><td>Rated Torque [N·m]Note1</td><td>28.65</td><td>28.65</td><td>35.01</td><td>35.01</td><td>47.74</td><td>47.74</td></tr>
<tr><td>Max. Torque [N·m]</td><td>71.62</td><td>71.62</td><td>87.53</td><td>87.53</td><td>119.36</td><td>119.36</td></tr>
<tr><td>Rated Speed [rpm]</td><td colspan="6">1500</td></tr>
<tr><td>Max. Speed [rpm]</td><td colspan="6">3000</td></tr>
<tr><td>Rated Current [Amps] rms</td><td>32.5</td><td>32.5</td><td>40.12</td><td>40.12</td><td>47.5</td><td>47.5</td></tr>
<tr><td>Max. Instantaneous Current [Amps] rms</td><td>91.4</td><td>91.4</td><td>108.0</td><td>108.0</td><td>127.46</td><td>127.46</td></tr>
<tr><td>Change of Rated Power [W/s]</td><td>105.6</td><td>101.8</td><td>122.8</td><td>119.3</td><td>159.7</td><td>156.6</td></tr>
<tr><td>Rotor Inertia [$x10^{-4}$ kg m^2]</td><td>77.75</td><td>80.65</td><td>99.78</td><td>102.70</td><td>142.7</td><td>145.55</td></tr>
<tr><td>Mechanical Time Constant [ms]</td><td>0.93</td><td>0.96</td><td>0.97</td><td>0.99</td><td>0.84</td><td>0.85</td></tr>
<tr><td>Torque Constant-KT [N·m/A]</td><td>0.878</td><td>0.878</td><td>0.873</td><td>0.873</td><td>1.005</td><td>1.005</td></tr>
<tr><td>Voltage Constant-KE [mV/rpm]</td><td>32.0</td><td>32.0</td><td>31.0</td><td>31.0</td><td>35.5</td><td>35.5</td></tr>
<tr><td>Armature Resistance [Ohm]</td><td>0.032</td><td>0.032</td><td>0.025</td><td>0.025</td><td>0.02</td><td>0.02</td></tr>
<tr><td>Armature Inductance [mH]</td><td>0.89</td><td>0.89</td><td>0.71</td><td>0.71</td><td>0.6</td><td>0.6</td></tr>
<tr><td>Electrical Time Constant [ms]</td><td>27.81</td><td>27.81</td><td>28.4</td><td>28.4</td><td>30.0</td><td>30.0</td></tr>
<tr><td>Insulation Class</td><td colspan="6">Class A (UL), Class B (CE)</td></tr>
<tr><td>Insulation Resistance</td><td colspan="6">> 100MΩ, 500VDC</td></tr>
<tr><td>Insulation Strength</td><td colspan="6">1.8 kVAC, 1 second</td></tr>
<tr><td>Weight [kg]</td><td>23.5</td><td>29</td><td>30.5</td><td>36</td><td>40.5</td><td>46</td></tr>
<tr><td>Max. Radial Loading [N] Note3</td><td colspan="2">1470</td><td colspan="4">1764</td></tr>
<tr><td>Max. Axial Loading [N]</td><td colspan="2">490</td><td colspan="4">588</td></tr>
<tr><td>Brake Holding Torque [N·m (min)]Note2</td><td rowspan="4">n/a</td><td>55.0</td><td rowspan="4">n/a</td><td>55.0</td><td rowspan="4">n/a</td><td>55.0</td></tr>
<tr><td>Brake Power Consumption (at 20°C) [W]</td><td>19.9</td><td>19.9</td><td>19.9</td></tr>
<tr><td>Brake Release Time [ms (max)]</td><td>10</td><td>10</td><td>10</td></tr>
<tr><td>Brake Pull-in Time [ms (max)]</td><td>70</td><td>70</td><td>70</td></tr>
</table>

1–The rated torque is the continuous permissible torque between the 0°C and 40°C operating temperature which is suitable for a servo motor mounted with the heat sink dimensions shown below. The heat sink should be attached to the motor's mounting surface. For operating temperatures above 40°C, see section A.4.4.

Motor Face Direction	Heat Sink Dimension
100mm	300mm x 300mm x 12mm
130mm	400mm x 400mm x 20mm
180mm	550mm x 550mm x 30mm

All made from aluminum.

2–The built-in servo motor brake is only for keeping the object in a stopped state. Do not use it for deceleration or as a dynamic brake.

3–Max radial force is specified at 5mm from the end of the shaft.

230V Motor Specifications (cont'd)				
Model	**SV2H-2B0N**	**SV2H-2B0B**	**SV2H-2F0N**	**SV2H-2F0B**
Rated Power [kW]	11	11	15	15
Rated Torque [N·m]Note1	70	70	95.4	95.4
Max. Torque [N·m]	175	175	224.0	224.0
Rated Speed [rpm]	1500			
Max. Speed [rpm]	2000			
Rated Current [Amps] rms	51.1	51.1	67	67
Max. Instantaneous Current [Amps] rms	129.5	129.5	162	162
Change of Rated Power [W/s]	145.0	141.4	201.8	197.1
Rotor Inertia [x10^{-4} kg m^2]	338	346.5	451	461.8
Mechanical Time Constant [ms]	1.38	1.41	1.22	1.25
Torque Constant-KT [N·m/A]	1.370	1.370	1.424	1.424
Voltage Constant-KE [mV/rpm]	49	49	50	50
Armature Resistance [Ohm]	0.0261	0.0261	0.0184	0.0184
Armature Inductance [mH]	0.65	0.65	0.48	0.48
Electrical Time Constant [ms]	24.9	24.9	26.09	26.09
Insulation Class	Class F (UL), Class F (CE)			
Insulation Resistance	> 100MΩ, 500VDC			
Insulation Strength	1.8 kVAC, 1 second			
Weight [kg]	56.4	68.4	75	87
Max. Radial Loading [N]Note3	3300			
Max. Axial Loading [N]	1100			
Brake Holding Torque [N·m (min)]Note2	n/a	115	n/a	115
Brake Power Consumption (at 20°C) [W]		28.8		28.8
Brake Release Time [ms (max)]		10		10
Brake Pull-in Time [ms (max)]		70		70

1–The rated torque is the continuous permissible torque between the 0°C and 40°C operating temperature which is suitable for a servo motor mounted with the heat sink dimensions shown below. The heat sink should be attached to the motor's mounting surface. For operating temperatures above 40°C, see section A.4.4.

Motor Face Direction	Heat Sink Dimension
100mm	300mm x 300mm x 12mm
130mm	400mm x 400mm x 20mm
180mm	550mm x 550mm x 30mm

All made from aluminum

2–The built-in servo motor brake is only for keeping the object in a stopped state. Do not use it for deceleration or as a dynamic brake.

3–Max radial force is specified at 5mm from the end of the shaft.

A.4.2 - SureServo2 460V Motor Specifications

460V Motor Specifications						
Model	**SV2L-404N**	**SV2L-404B**	**SV2L-407N**	**SV2L-407B**	**SV2L-410N**	**SV2L-410B**
Rated Power [kW]	0.4	0.4	0.75	0.75	1.0	1.0
Rated Torque [N·m]Note1	1.27	1.27	2.24	2.24	3.18	3.18
Max. Torque [N·m]	4.45	4.45	7.58	7.58	9.54	9.54
Rated Speed [rpm]	3000		3200		3000	
Max. Speed [rpm]	6000				5000	
Rated Current [Amps] rms	1.43	1.43	2.90	2.90	4.36	4.36
Max. Instantaneous Current [Amps] rms	5.25	5.25	9.70	9.70	13.74	13.74
Change of Rated Power [W/s]	35.8	33.6	33.2	30.2	38.2	30.40
Rotor Inertia [$x10^{-4}$ kg m^2]	0.45	0.48	1.51	1.66	2.65	3.33
Mechanical Time Constant [ms]	1.05	1.12	1.02	1.12	0.81	1.02
Torque Constant-KT [N-m/A]	0.888	0.888	0.772	0.772	0.729	0.729
Voltage Constant-KE [mV/rpm]	31.83	31.83	27.83	27.83	29.00	29.00
Armature Resistance [Ohm]	6.28	6.28	1.38	1.38	0.617	0.617
Armature Inductance [mH]	13.34	13.34	4.78	4.78	6.03	6.03
Electrical Time Constant [ms]	2.12	2.12	3.46	3.46	9.77	9.77
Insulation Class	Class A (UL), Class B (CE)					
Insulation Resistance	>100MΩ, 500VDC					
Insulation Strength	2.3 kVAC, 1 second					
Weight [kg]	1.4	1.9	2.8	3.6	4.3	4.7
Max. Radial Loading [N]Note3	245	245	392	392	490	490
Max. Axial Loading [N]	74	74	147	147	98	98
Brake Holding Torque [N·m (min)]Note2	n/a	1.3	n/a	2.5	n/a	8
Brake Power Consumption (at 20°C) [W]		7.2		8		18.7
Brake Release Time [ms (max)]		20		20		10
Brake Pull-in Time [ms (max)]		50		60		70

1–The rated torque is the continuous permissible torque between the 0°C and 40°C operating temperature which is suitable for a servo motor mounted with the heat sink dimensions shown below. The heat sink should be attached to the motor's mounting surface. For operating temperatures above 40°C, see section A.4.4.

Motor Face Direction	Heat Sink Dimension
40mm, 60mm, and 80mm	250mm x 250mm x 6mm

2–The built-in servo motor brake is only for keeping the object in a stopped state. Do not use it for deceleration or as a dynamic brake.
3–Max radial force is specified at 5mm from the end of the shaft.

460V Motor Specifications						
Model	**SV2M-410N**	**SV2M-410B**	**SV2L-415N**	**SV2L-415B**	**SV2L-420N**	**SV2L-420B**
Rated Power [kW]	1.0	1.0	1.5	1.5	2.0	2.0
Rated Torque [N·m]Note1	4.77	4.77	7.16	7.16	9.55	9.55
Max. Torque [N·m]	14.32	14.32	18.1	18.1	28.65	28.65
Rated Speed [rpm]	2000		2000			
Max. Speed [rpm]	3000		3000			
Rated Current [Amps] rms	3.6	3.6	5.1	5.1	6.7	6.7
Max. Instantaneous Current [Amps] rms	11.41	11.41	13.28	13.28	21.35	21.35
Change of Rated Power [W/s]	27.1	24.90	45.9	43.10	62.5	57.4
Rotor Inertia [$x10^{-4}$ kg m^2]	8.41	9.14	11.18	11.9	14.59	15.88
Mechanical Time Constant [ms]	1.85	2.01	1.26	1.34	1.11	1.21
Torque Constant-KT [N-m/A]	1.325	1.325	1.404	1.404	1.425	1.425
Voltage Constant-KE [mV/rpm]	53.20	53.20	55.00	55.00	55.00	55.00
Armature Resistance [Ohm]	1.477	1.477	0.83	0.83	0.57	0.57
Armature Inductance [mH]	17.79	17.79	11.67	11.67	8.29	8.29
Electrical Time Constant [ms]	12.04	12.04	14.06	14.06	14.54	14.54
Insulation Class	Class A (UL), Class B (CE)					
Insulation Resistance	> 100MΩ, 500VDC					
Insulation Strength	2.3 kVAC, 1 second					
Weight [kg]	7.0	8.4	7.5	8.9	7.8	9.2
Max. Radial Loading [N] Note3	490		490	490	490	490
Max. Axial Loading [N]	98		98	98	98	98
Brake Holding Torque [N·m (min)]Note2	n/a	10	n/a	10	n/a	10
Brake Power Consumption (at 20°C) [W]		19		19		19
Brake Release Time [ms (max)]		10		10		10
Brake Pull-in Time [ms (max)]		70		70		70

1–The rated torque is the continuous permissible torque between the 0°C and 40°C operating temperature which is suitable for a servo motor mounted with the heat sink dimensions shown below. The heat sink should be attached to the motor's mounting surface. For operating temperatures above 40°C, see section A.4.4.

Motor Face Direction	Heat Sink Dimension
40mm, 60mm, and 80mm	250mm x 250mm x 6mm

2–The built-in servo motor brake is only for keeping the object in a stopped state. Do not use it for deceleration or as a dynamic brake.
3–Max radial force is specified at 5mm from the end of the shaft.

460V Motor Specifications						
Model	**SV2H-430N**	**SV2H-430B**	**SV2H-445N**	**SV2H-445B**	**SV2H-455N**	**SV2H-455B**
Rated Power [kW]	3.0	3.0	4.5	4.5	5.5	5.5
Rated Torque [N·m]Note1	19.1	19.1	28.65	28.65	35	35
Max. Torque [N·m]	49.38	49.38	64.61	64.61	73.48	73.48
Rated Speed [rpm]	1500					
Max. Speed [rpm]	3000					
Rated Current [Amps] rms	12.2	12.2	21.9	21.9	23.6	23.6
Max. Instantaneous Current [Amps] rms	30.46	30.46	47.5	47.5	47.5	47.5
Change of Rated Power [W/s]	66.4	63.9	105.6	101.8	122.8	119.3
Rotor Inertia [x10^{-4} kg m^2]	54.95	57.1	77.75	80.65	99.78	102.7
Mechanical Time Constant [ms]	1.20	1.24	1.06	1.10	0.84	0.86
Torque Constant-KT [N·m/A]	1.566	1.566	1.308	1.308	1.483	1.483
Voltage Constant-KE [mV/rpm]	64.4	64.4	53.00	53.00	58.9	58.9
Armature Resistance [Ohm]	0.21	0.21	0.09	0.09	0.07	0.07
Armature Inductance [mH]	4.94	4.94	2.36	2.36	2.20	2.20
Electrical Time Constant [ms]	23.52	23.52	26.22	26.22	31.43	31.43
Insulation Class	Class A (UL), Class B (CE)					
Insulation Resistance	> 100MΩ, 500VDC					
Insulation Strength	1.8 kVAC, 1 second					
Weight [kg]	18.5	22.5	23.5	29	30.5	36
Max. Radial Loading [N] Note3	1470				1764	
Max. Axial Loading [N]	490				588	
Brake Holding Torque [N·m (min)]Note2	n/a	25	n/a	55	n/a	55
Brake Power Consumption (at 20°C) [W]		20.4		19.9		19.9
Brake Release Time [ms (max)]		10		10		10
Brake Pull-in Time [ms (max)]		70		70		70

1–The rated torque is the continuous permissible torque between the 0°C and 40°C operating temperature which is suitable for a servo motor mounted with the heat sink dimensions shown below. The heat sink should be attached to the motor's mounting surface. For operating temperatures above 40°C, see section A.4.4.

Motor Face Direction	Heat Sink Dimension
100mm	300mm x 300mm x 12mm
130mm	400mm x 400mm x 20mm
180mm	550mm x 550mm x 30mm

All made from aluminum

2–The built-in servo motor brake is only for keeping the object in a stopped state. Do not use it for deceleration or as a dynamic brake.

3–Max radial force is specified at 5mm from the end of the shaft.

460V Motor Specifications (cont'd)						
Model	**SV2H-475N**	**SV2H-475B**	**SV2H-4B0N**	**SV2H-4B0B**	**SV2H-4F0N**	**SV2H-4F0B**
Rated Power [kW]	7.5	7.5	11	11	15	15
Rated Torque [N·m]Note 1	47.74	47.74	70	70	95.4	95.4
Max. Torque [N·m]	93.71	93.71	175	175	224.0	224.0
Rated Speed [rpm]	1500		1500			
Max. Speed [rpm]	3000		2000			
Rated Current [Amps] rms	28.7	28.7	26.8	26.8	37.5	37.5
Max. Instantaneous Current [Amps] rms	57.69	57.69	67.7	67.7	95.3	95.3
Change of Rated Power [W/s]	159.7	156.6	145.0	141.4	201.8	197.1
Rotor Inertia [$x10^{-4}$ kg m^2]	142.7	145.5	338	346.5	451	461.8
Mechanical Time Constant [ms]	0.81	0.83	1.40	1.44	1.21	1.23
Torque Constant-KT [N·m/A]	1.663	1.663	2.612	2.612	2.544	2.544
Voltage Constant-KE [mV/rpm]	66.40	66.40	96.00	96.00	83.90	83.90
Armature Resistance [Ohm]	0.06	0.06	0.0994	0.0994	0.0545	0.0545
Armature Inductance [mH]	1.70	1.70	2.51	2.51	1.43	1.43
Electrical Time Constant [ms]	28.33	28.33	25.25	25.25	26.24	26.24
Insulation Class	Class A (UL), Class B (CE)		Class F (UL), Class F (CE)			
Insulation Resistance	> 100MΩ, 500VDC					
Insulation Strength	1.8 kVAC, 1 second					
Weight [kg]	40.5	46	56.4	68.4	75	87
Max. Radial Loading [N] Note 3	1764		3300			
Max. Axial Loading [N]	588		1100			
Brake Holding Torque [N·m (min)]Note 2	n/a	55	n/a	115	n/a	115
Brake Power Consumption (at 20°C) [W]		19.9		28.8		28.8
Brake Release Time [ms (max)]		10		10		10
Brake Pull-in Time [ms (max)]		70		70		70

1–The rated torque is the continuous permissible torque between the 0°C and 40°C operating temperature which is suitable for a servo motor mounted with the following heat sink dimensions (the heat sink should be attached to the motor's mounting surface):

Motor Face Dimension	Heat Sink Dimension
40mm, 60mm, and 80mm	250mm x 250mm x 6mm
100mm	300mm x 300mm x 12mm
130mm	400mm x 400mm x 20mm
180mm	550mm x 550mm x 30mm
220mm	650mm x 650mm x 35mm

2–The built-in servo motor brake is only for keeping the object in a stopped state. Do not use it for deceleration or as a dynamic brake.
3–Max radial force is specified at 5mm from the end of the shaft.

A.4.3 - SureServo2 Motor Environmental Specifications

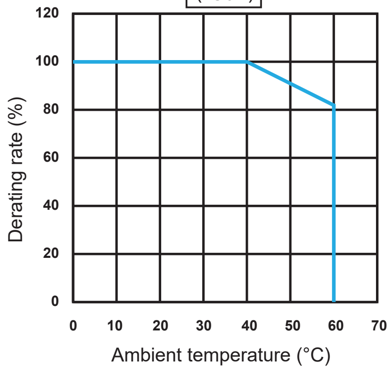
Model	All 230V and 460V SureServo2 Motors
Vibration Grade [μm]	V15
Operating Temperature [°C]	0–40 °C** (32–104 °F)
Storage Temperature [°C]	-10°C to 80°C (-14°F to 176°F)
Operating Humidity	20–90% relative humidity (non-condensing)
Storage Humidity	20–90% relative humidity (non-condensing)
Vibration Capacity	2.5 G
IP Rating	IP67* or IP65 (when using waterproof connectors) All SureServo2 motors are shipped with oil seals installed.
Encoder Resolution	24-bit (16777216 p/rev)
Agency Approvals	$_{C}UR_{US}$, CE

** SV2L-201x, SV2L-202x, SV2L-204x, SV2L-207x, SV2L-404x, and SV2L-407x are IP67 when using waterproof connectors. All other SureServo2 motors are IP65.*
*** For operating temperatures above 40°C, see section A.4.4.*

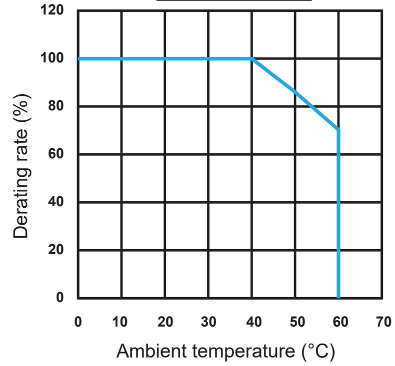
A.4.4 - SureServo2 Motor Temperature Derating

Refer to the below graphs for operating different motor sizes in environments from 40-60°C. The derated percent torque shown is continuous torque.

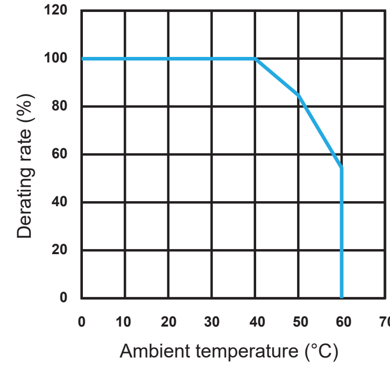
100W
(230V)



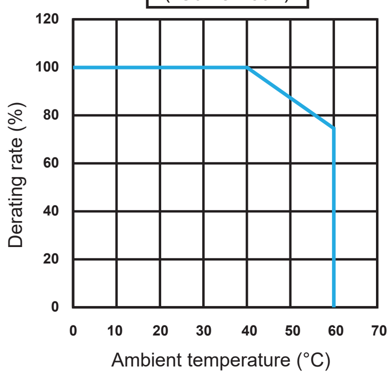
200-400W
(230V & 460V)



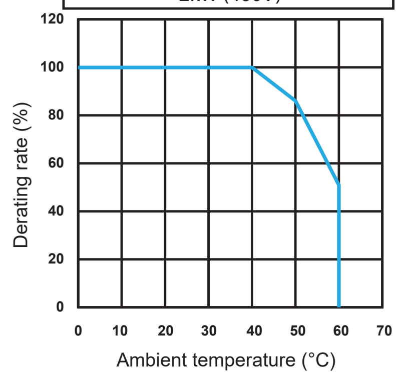
750W
(230V & 460V)



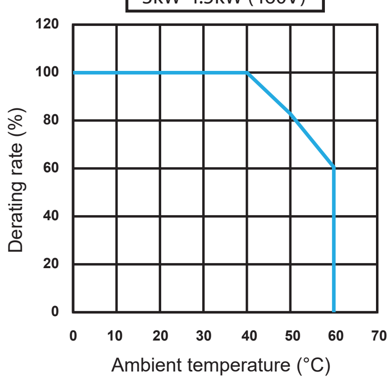
1kW Low Inertia
(230V & 460V)



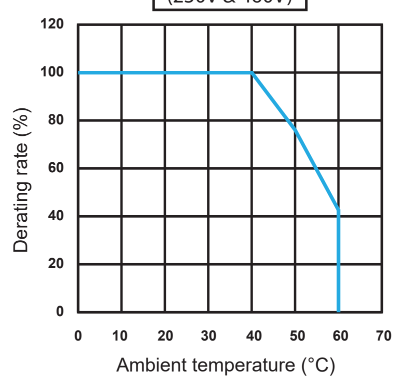
1kW Medium Inertia (230V & 460V)
1.5 kW (230V & 460V)
2kW (460V)



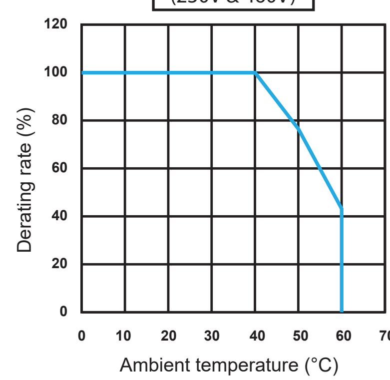
2kW-4.5kW (230V)
3kW-4.5kW (460V)



5.5kW, 7.5 kW
(230V & 460V)

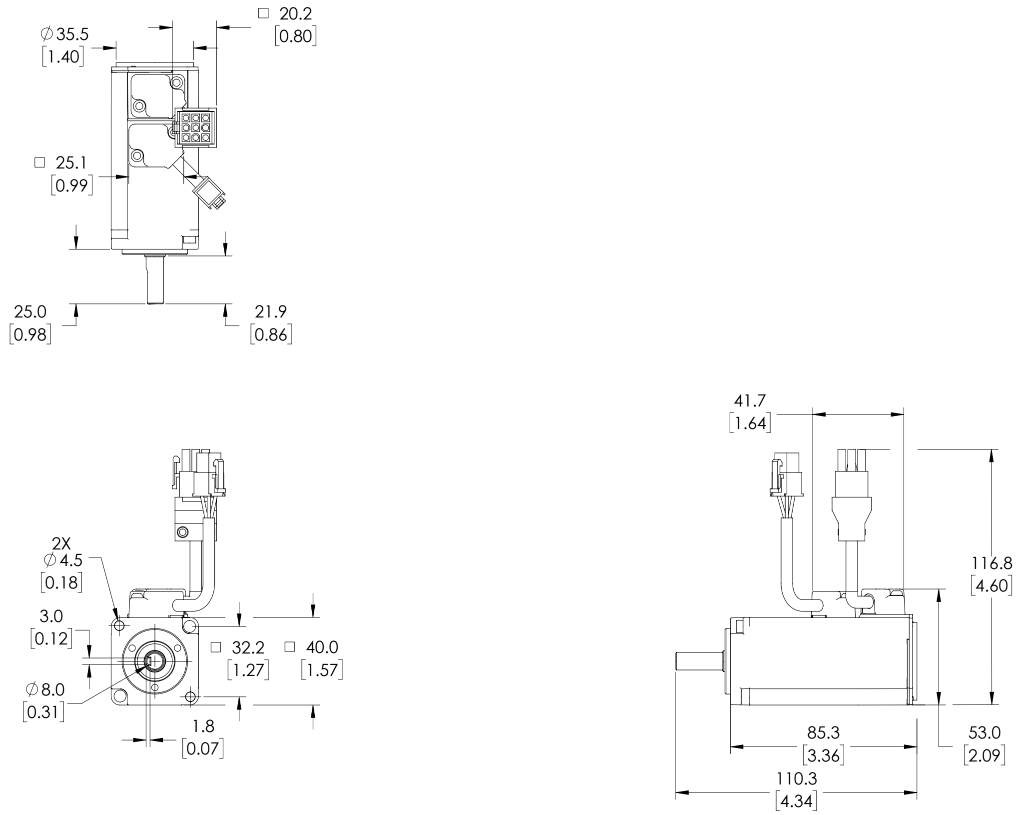


11kW-15kW
(230V & 460V)



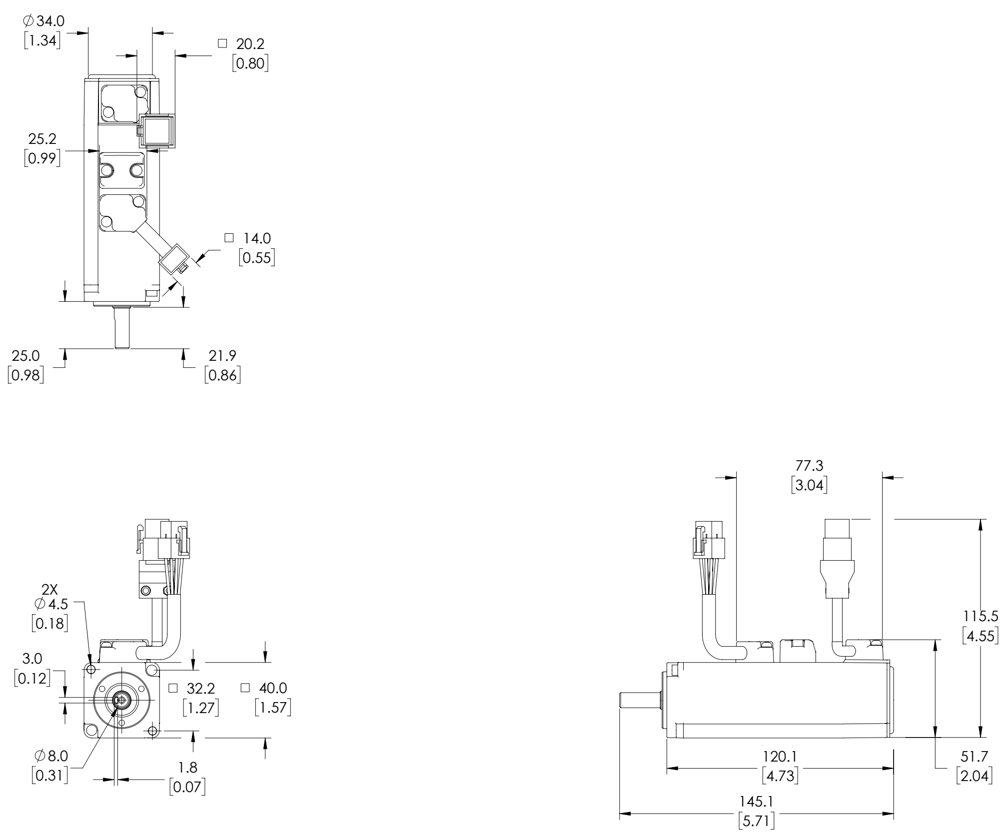
A.5 - SureServo2 Motor Dimensions

SV2L-201N

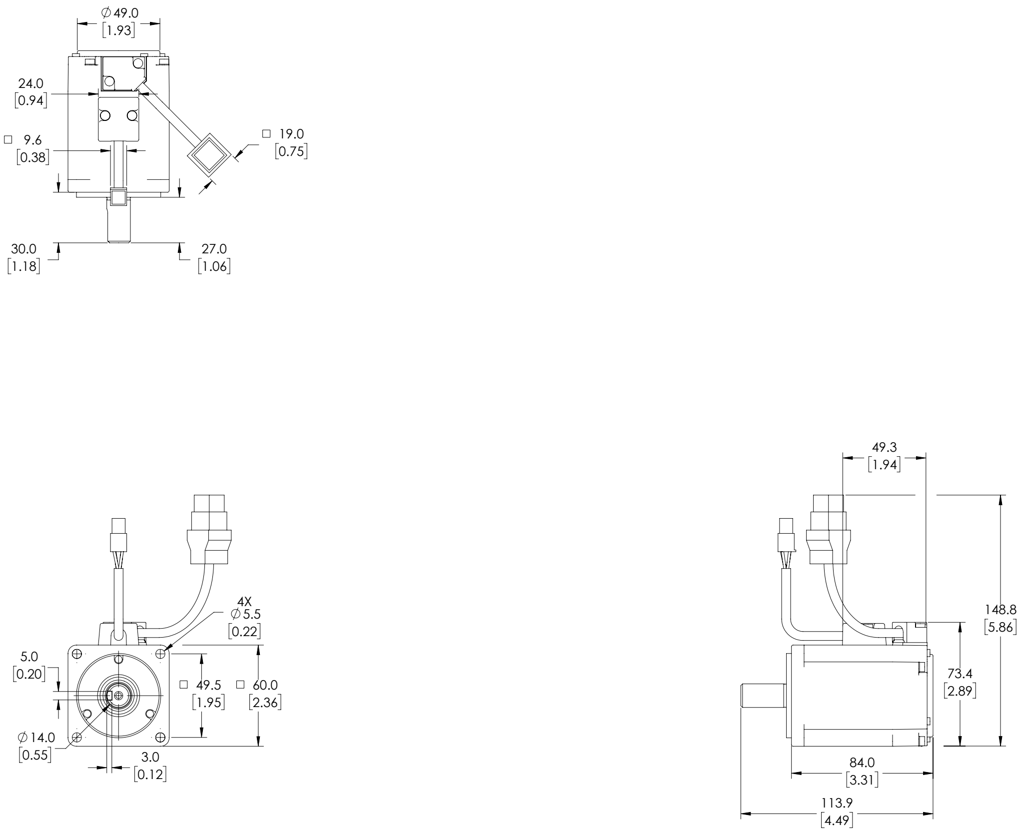


Units: **mm [inches]**

SV2L-201B

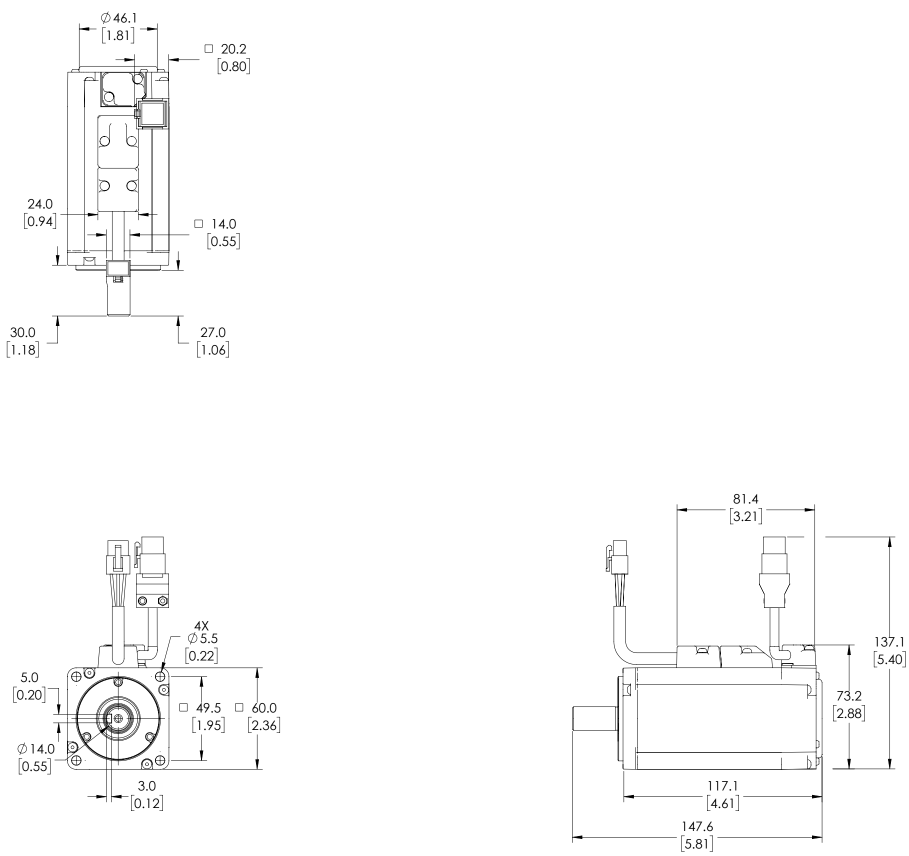


SV2L-202N

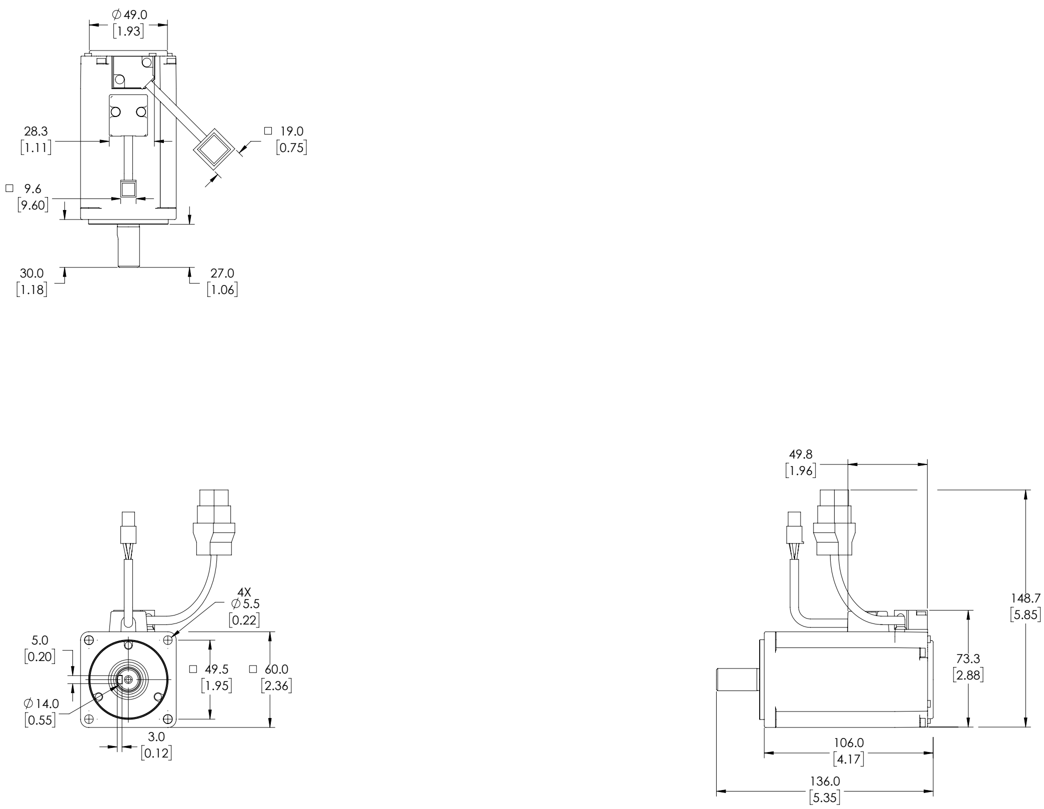


Units: mm [inches]

SV2L-202B

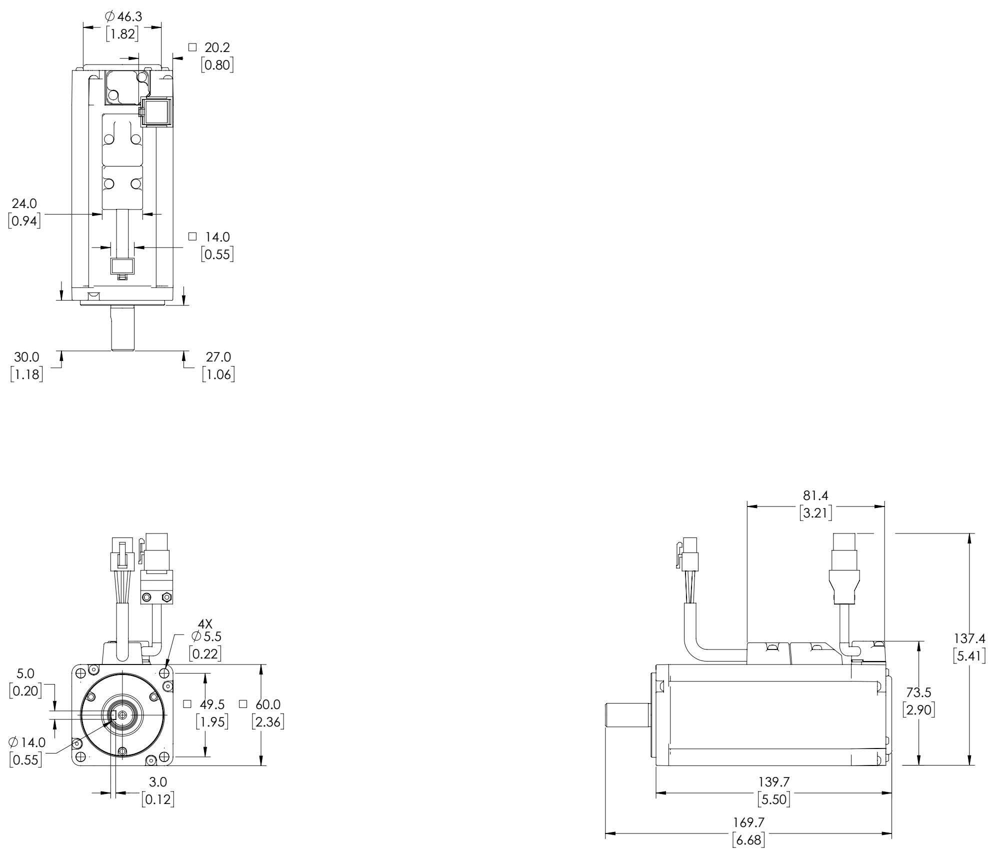


SV2L-204N

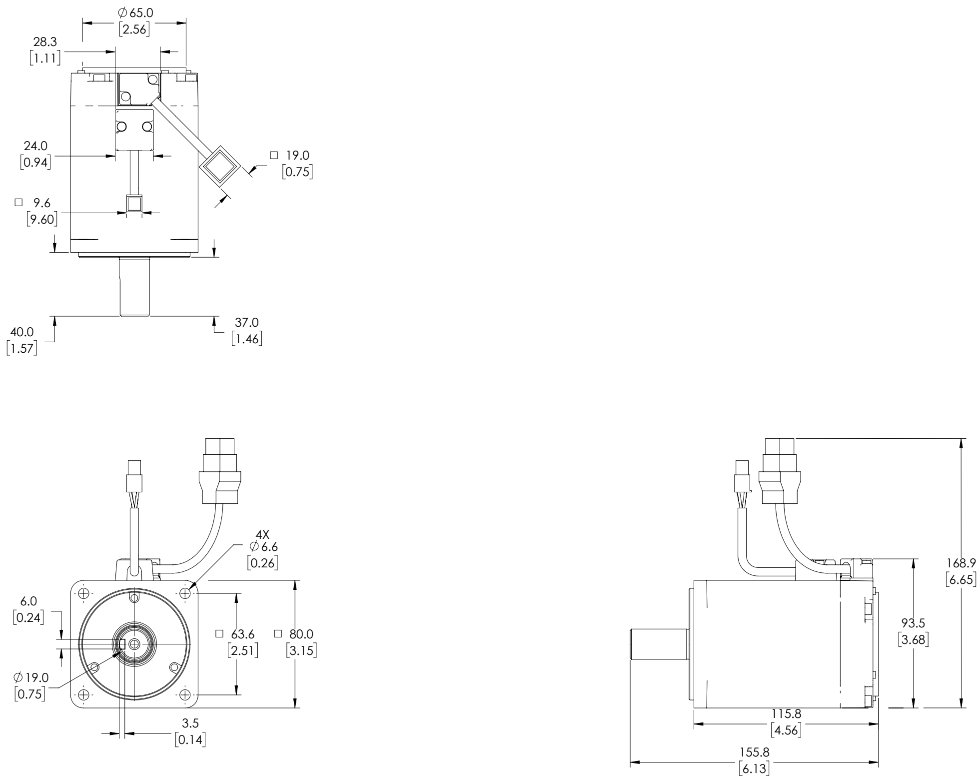


Units: **mm [inches]**

SV2L-204B

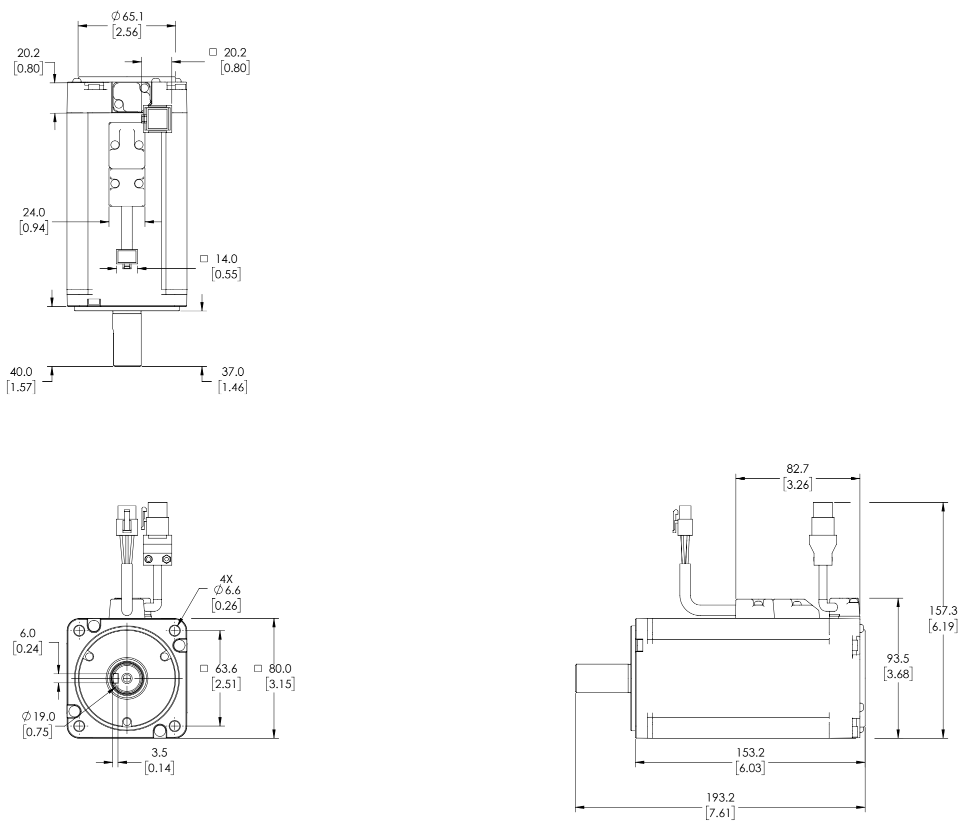


SV2L-207N



Units: mm [inches]

SV2L-207B



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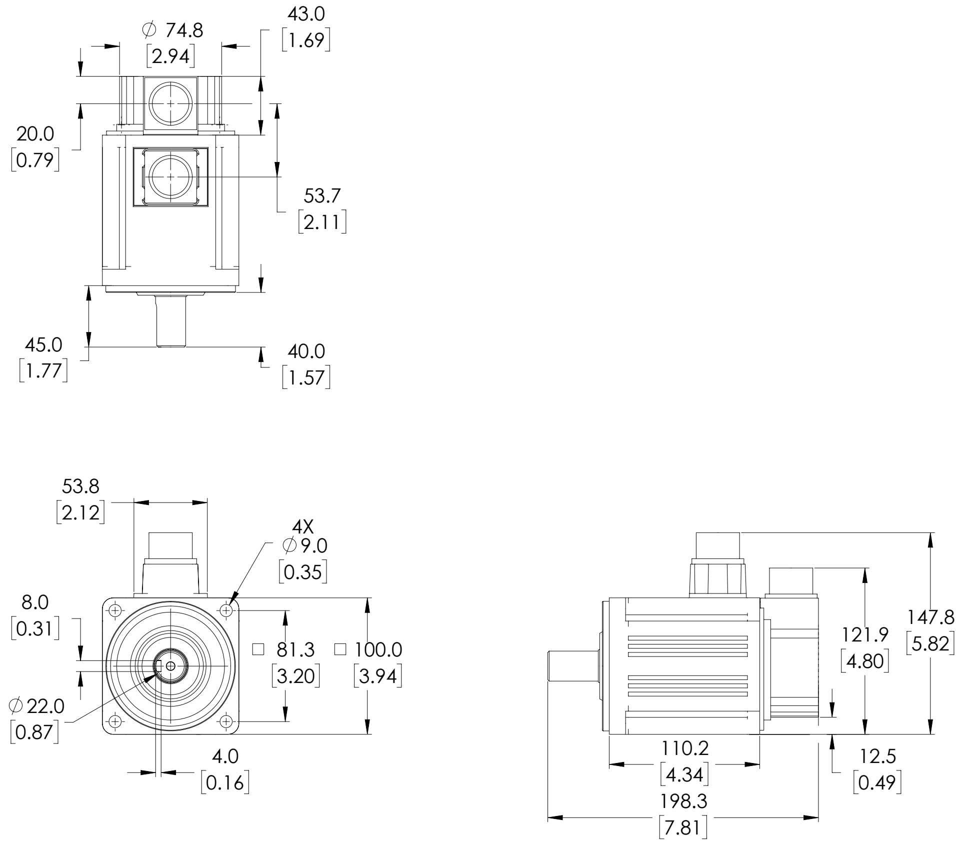
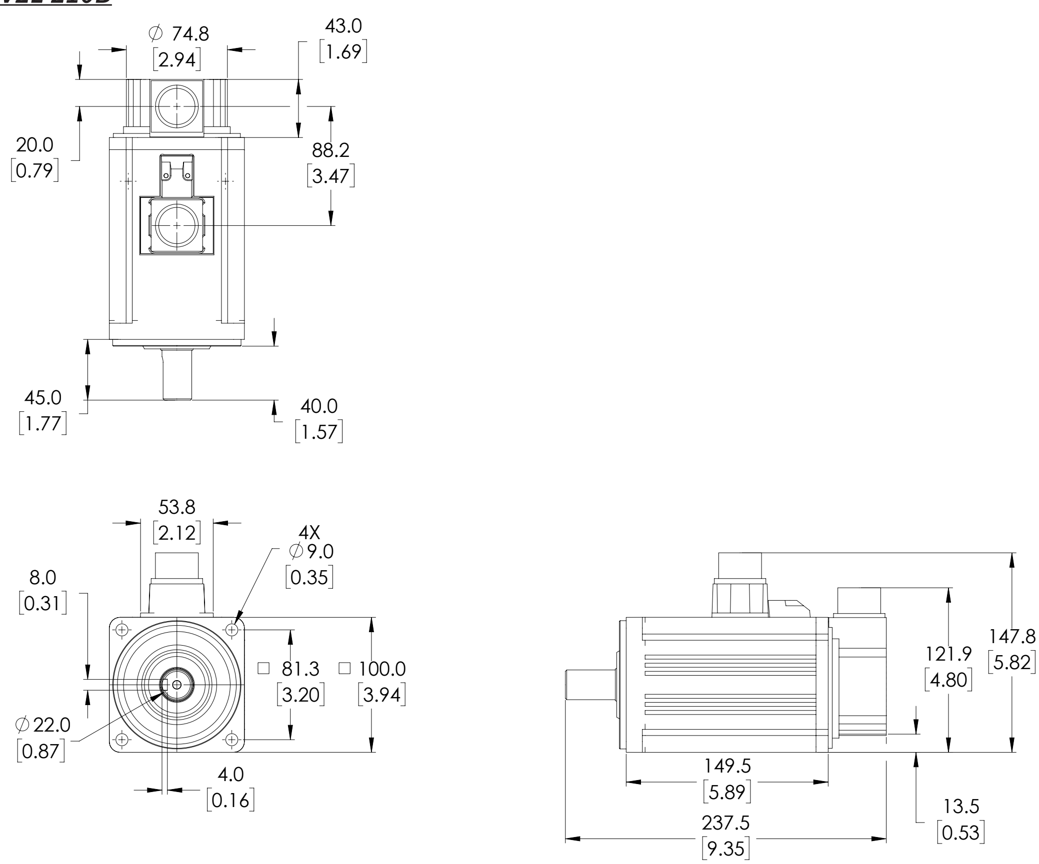


Units: **mm [inches]**

SV2L-210B



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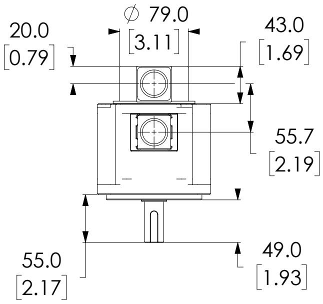
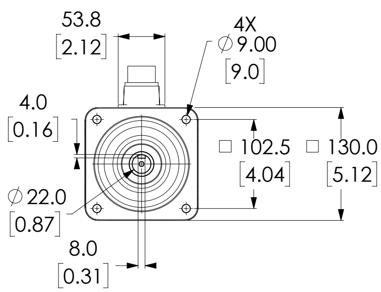
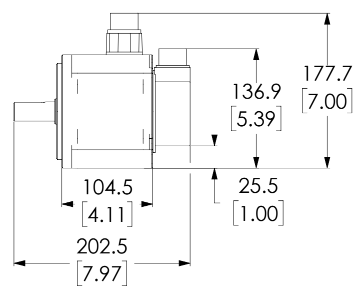
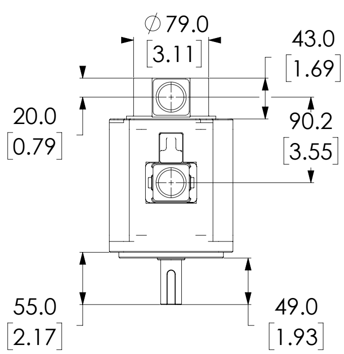


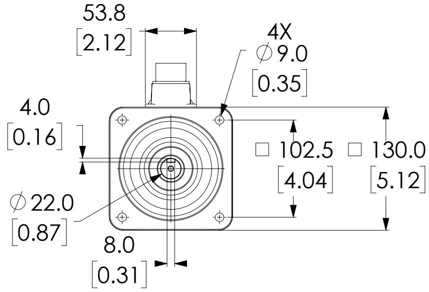


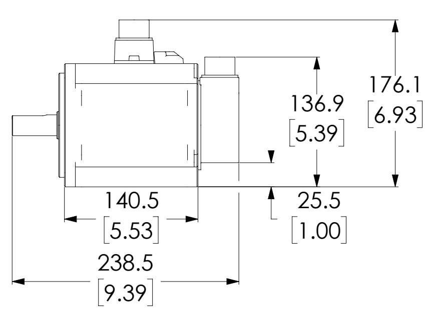


Units: mm [inches]

SV2M-210B







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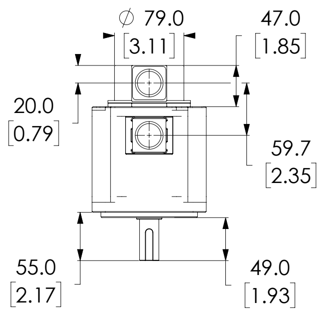
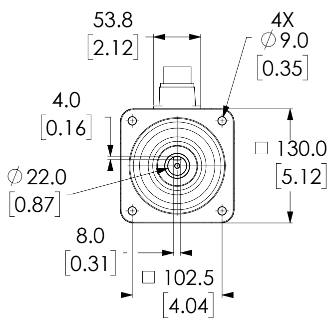
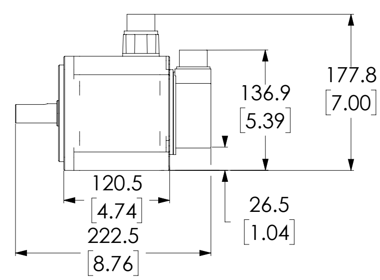
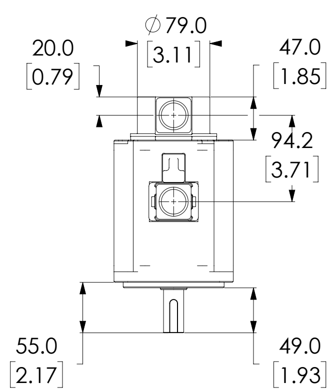


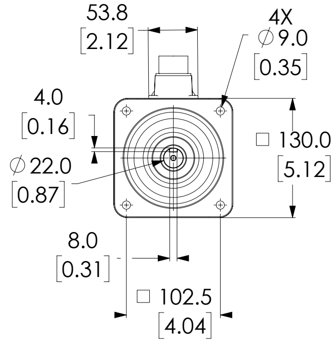


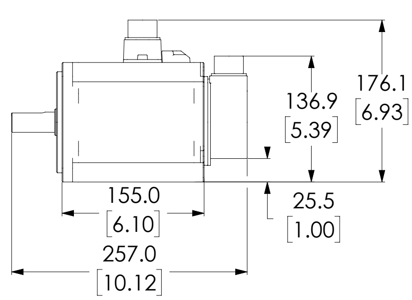


Units: **mm [inches]**

SV2M-215B







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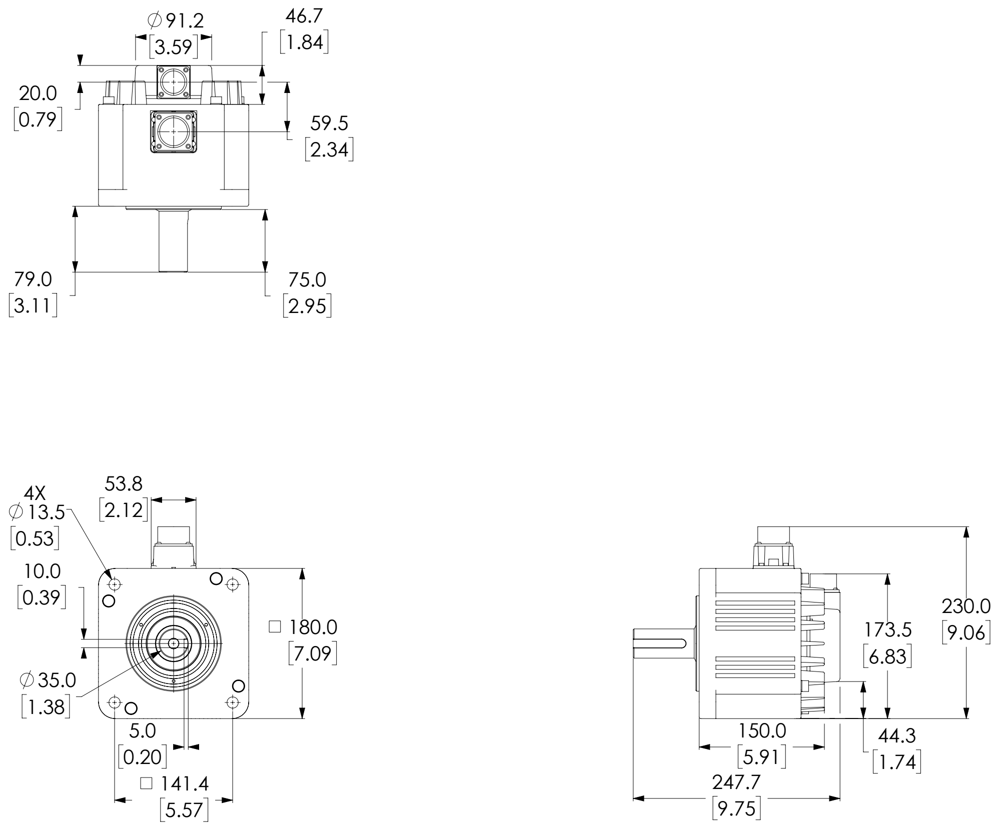
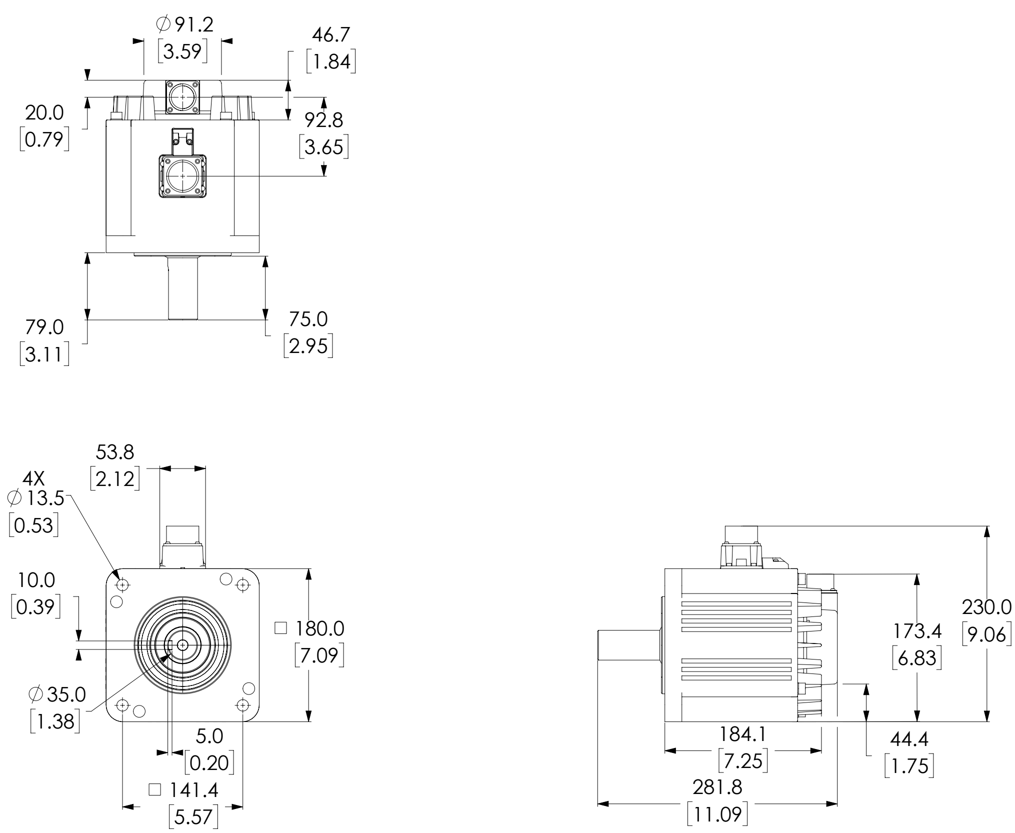


Units: **mm [inches]**

SV2M-220B



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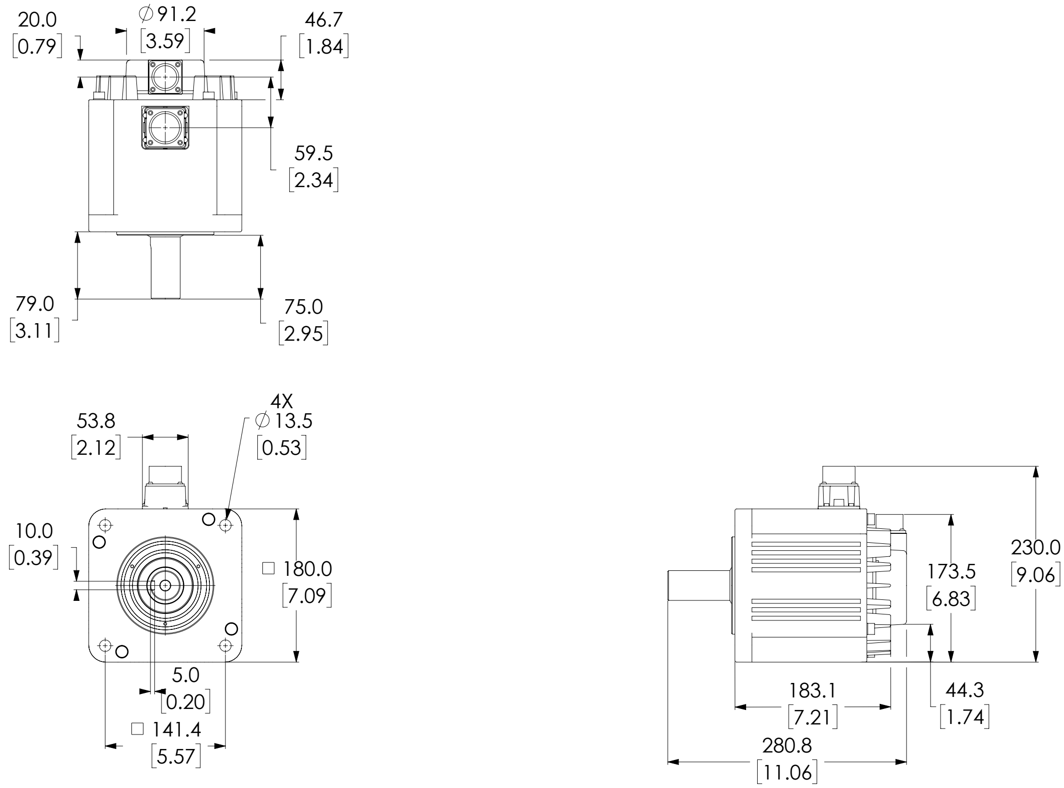
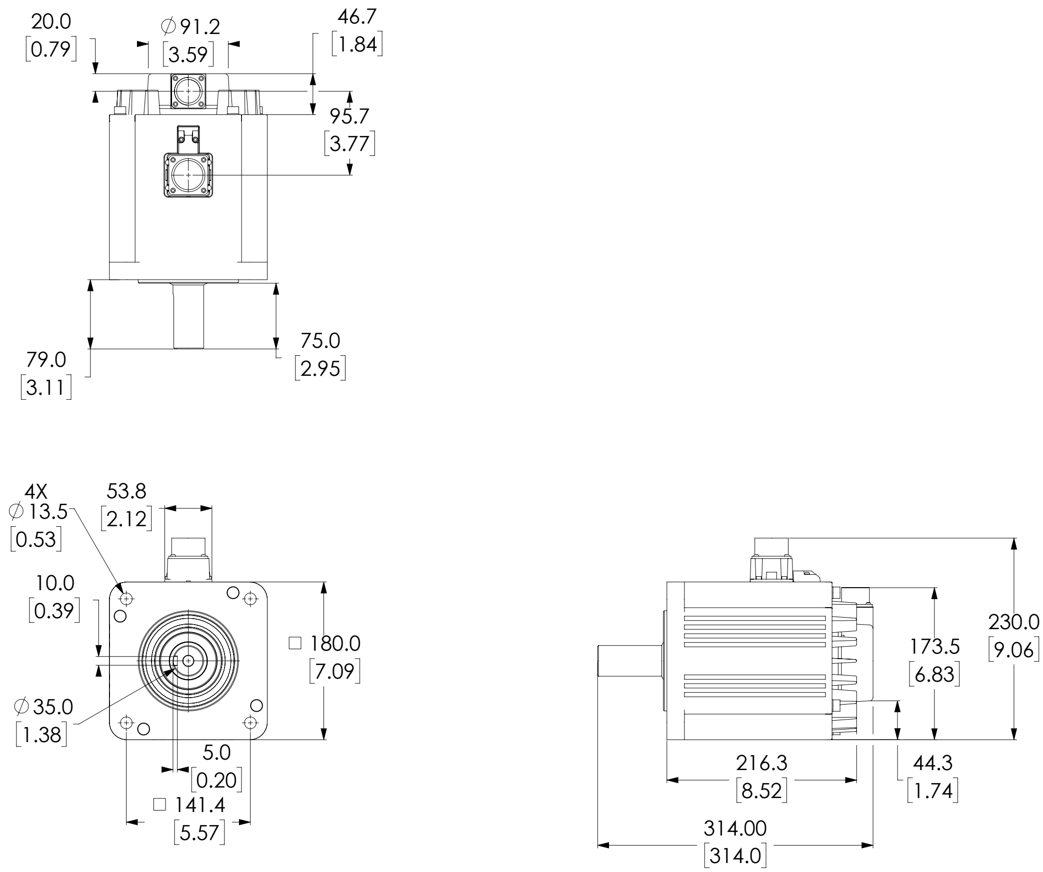
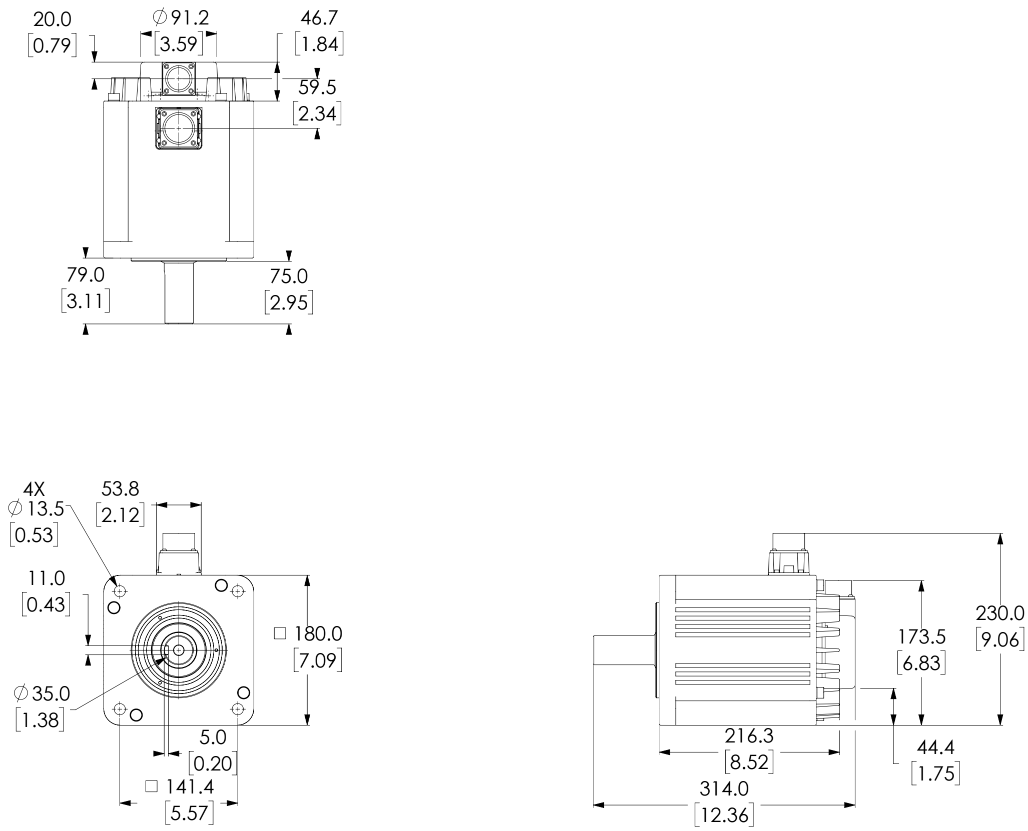


Units: **mm [inches]**

SV2M-230B

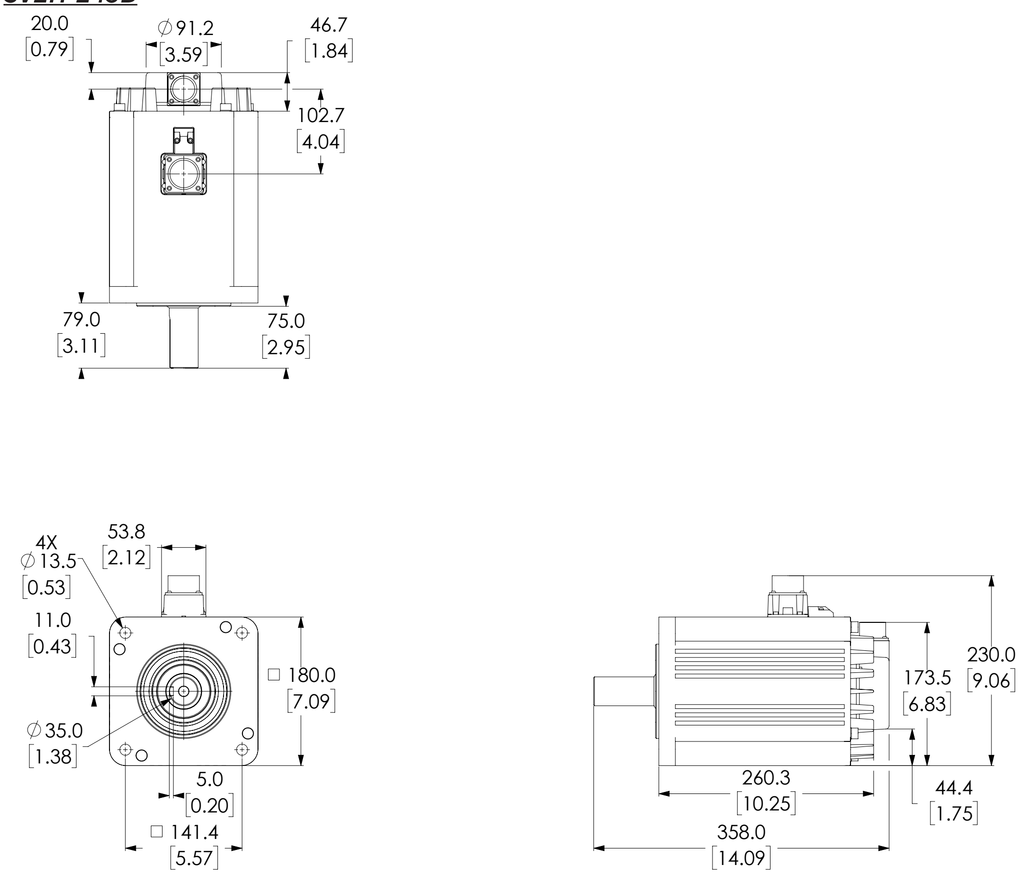


SV2H-245N



Units: **mm [inches]**

SV2H-245B



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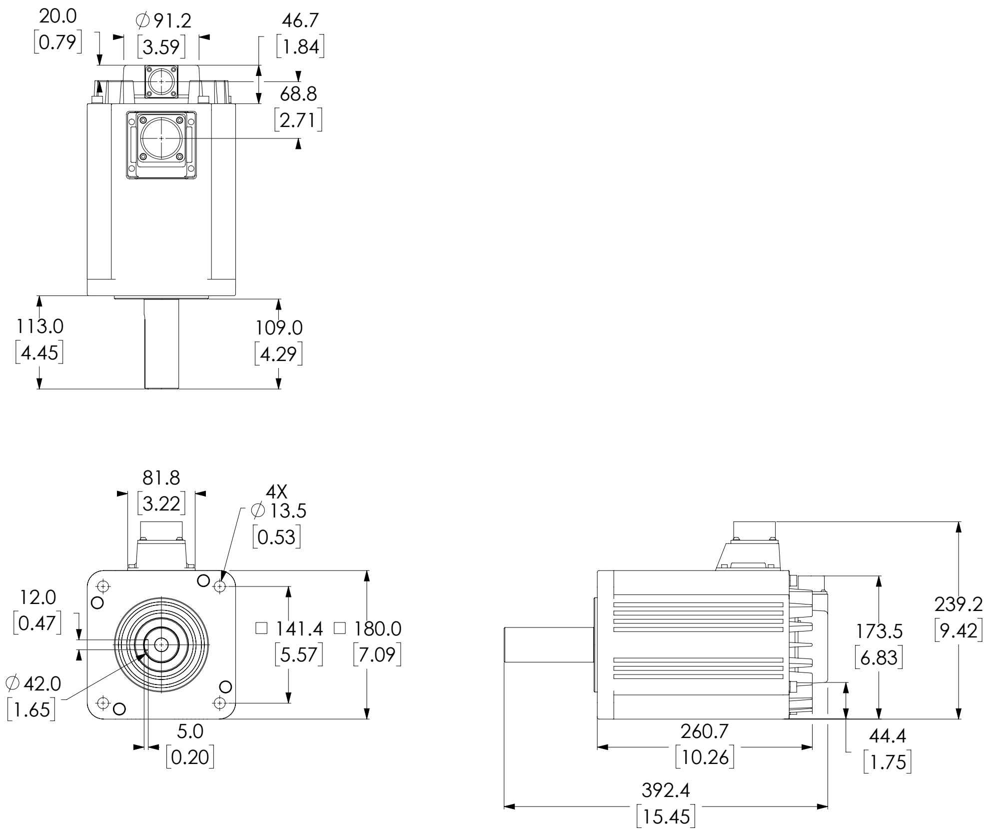
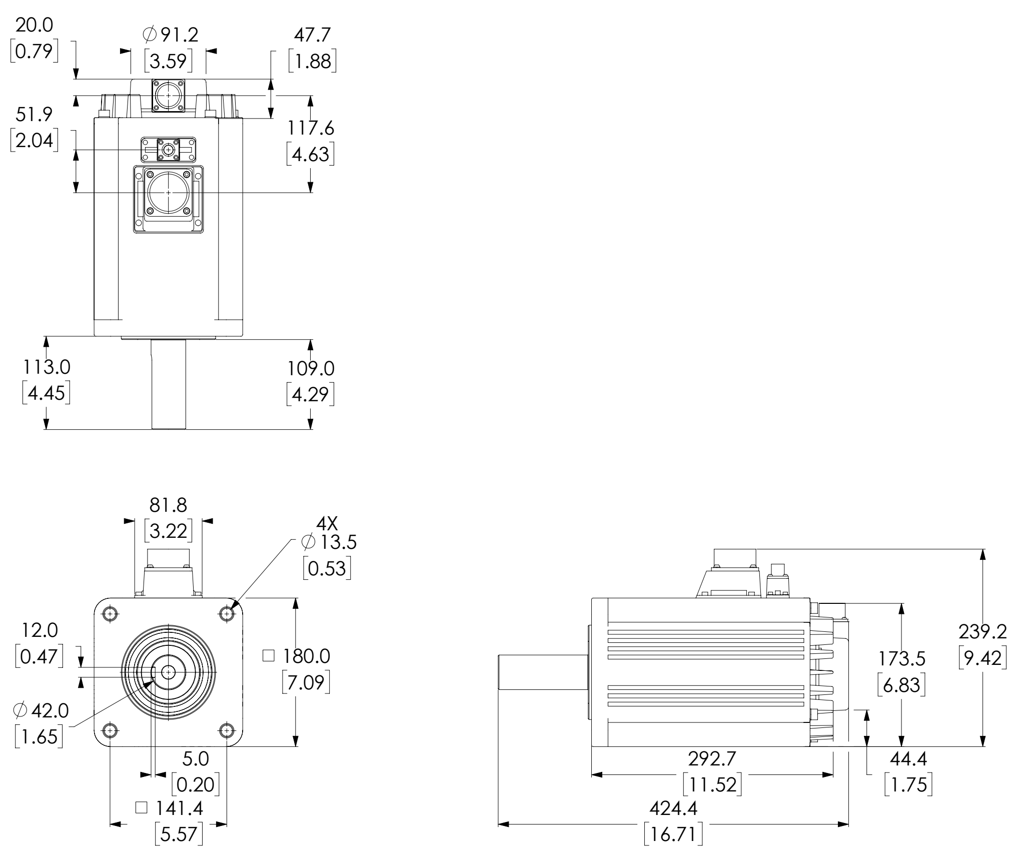


Units: **mm [inches]**

SV2H-255B



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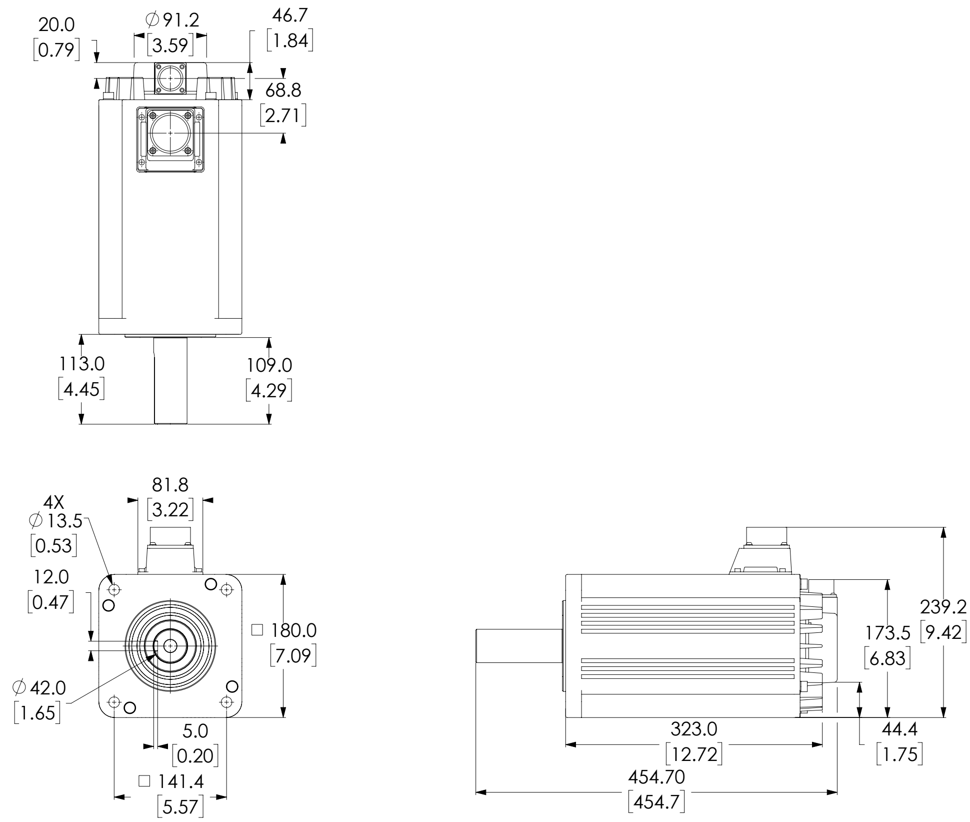

Units: **mm [inches]**

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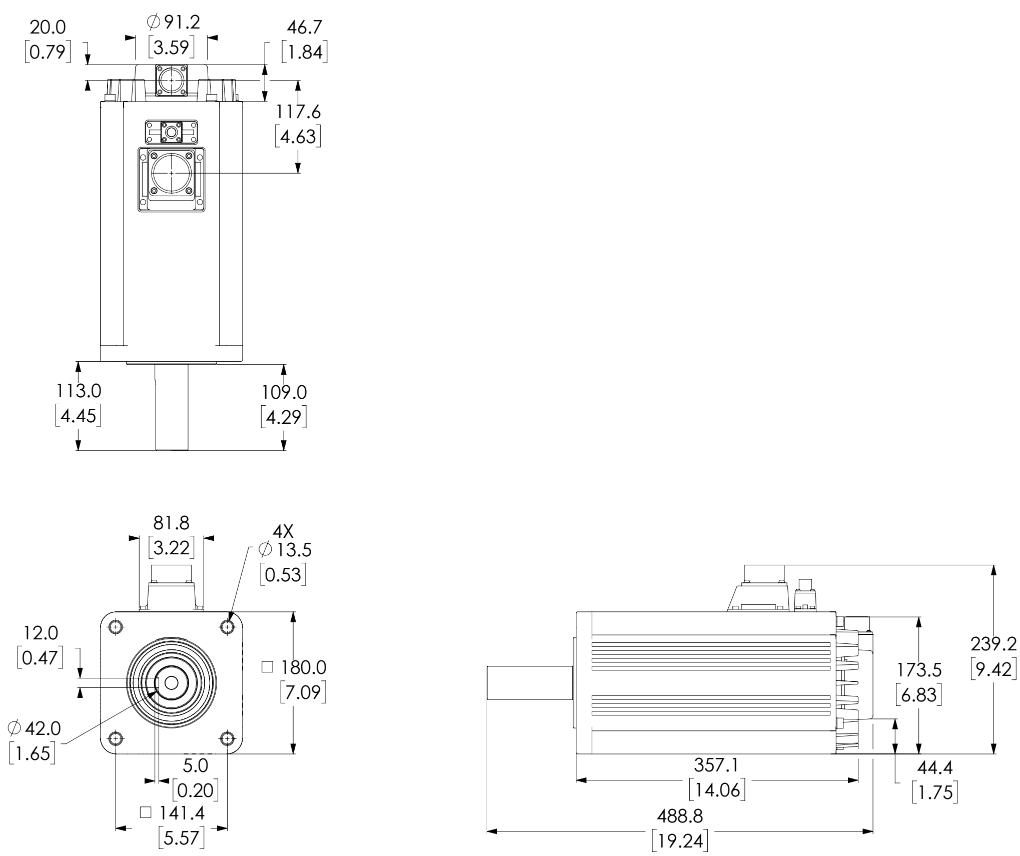

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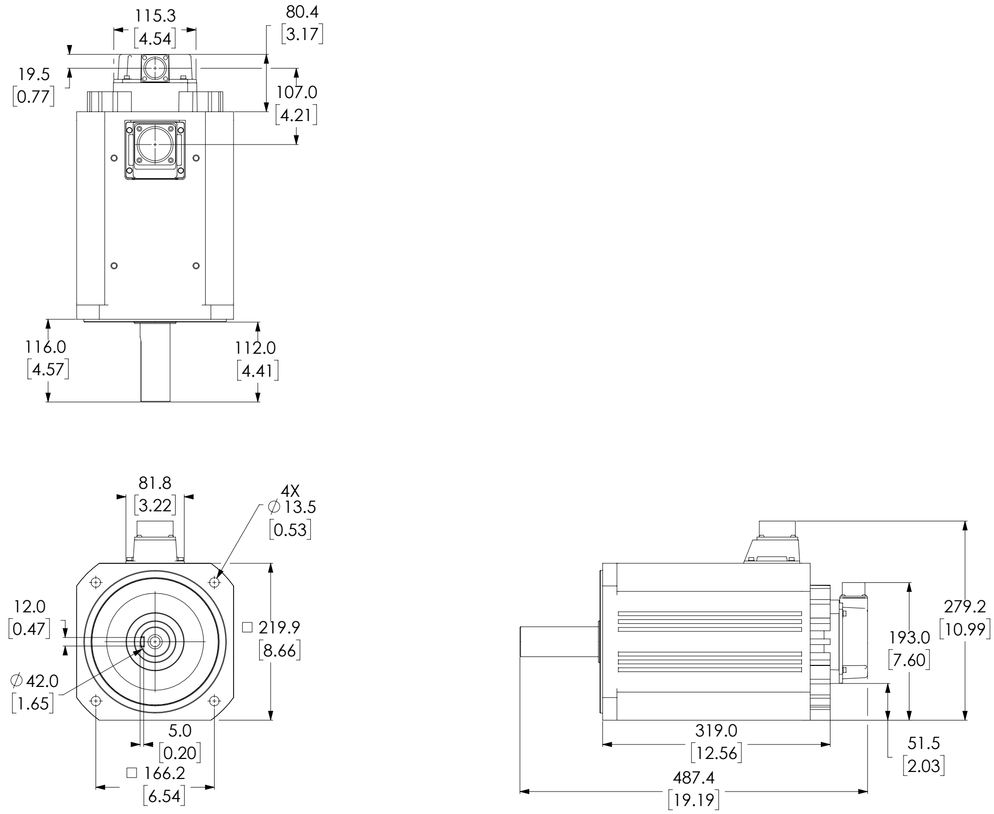
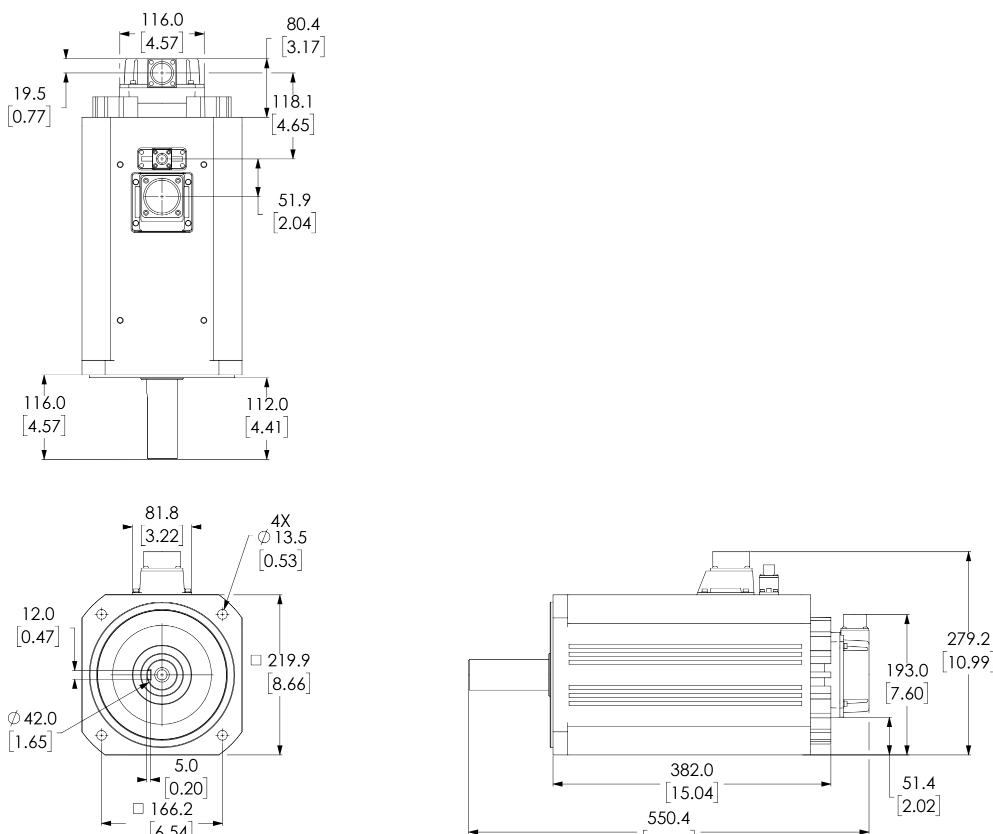
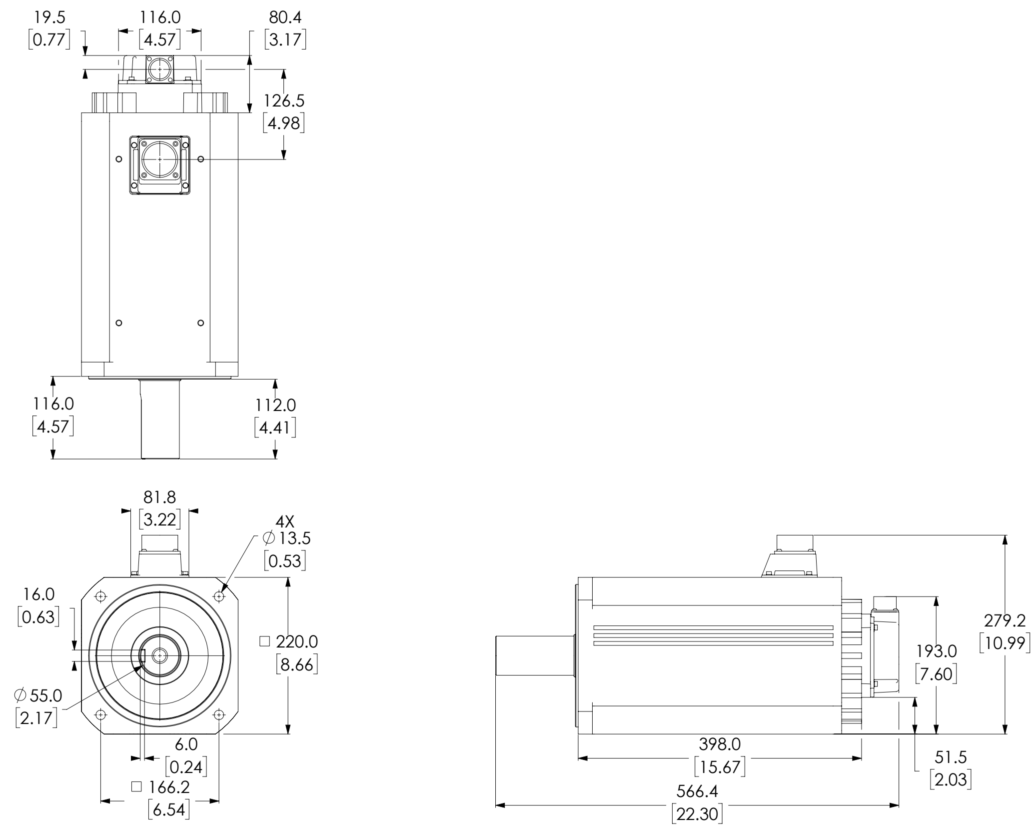


Units: **mm [inches]**

SV2H-2B0B

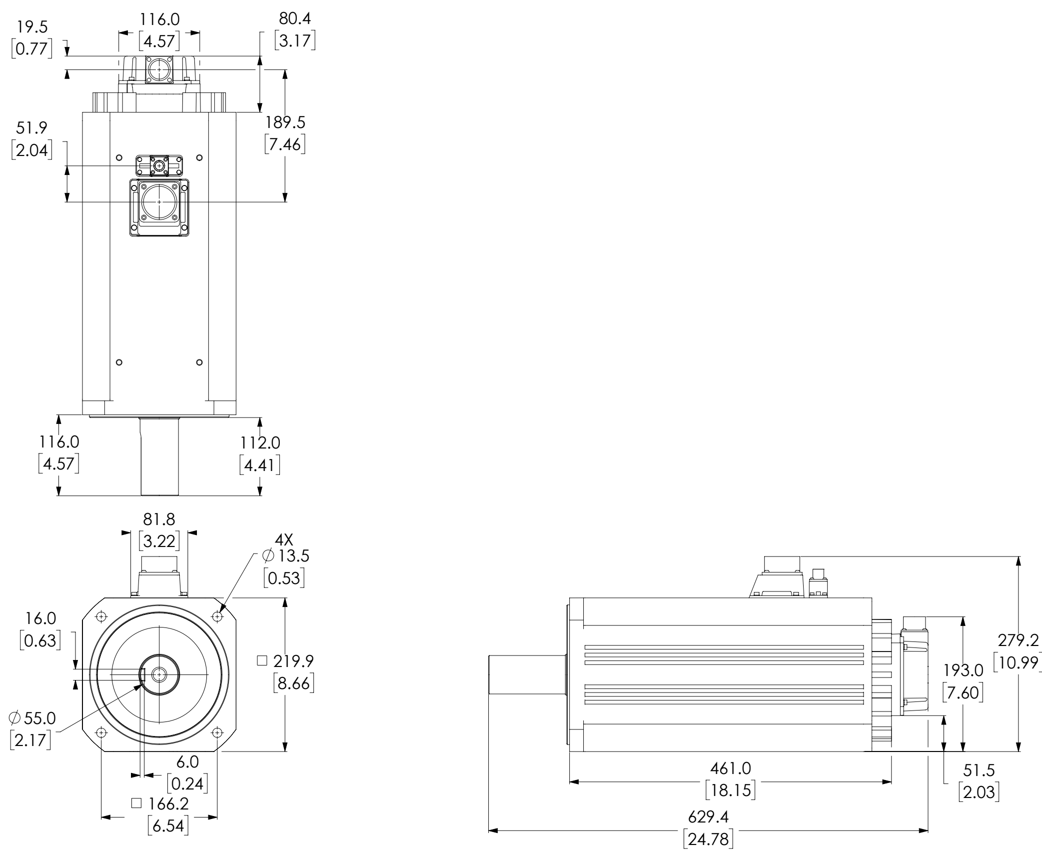


SV2H-2F0N

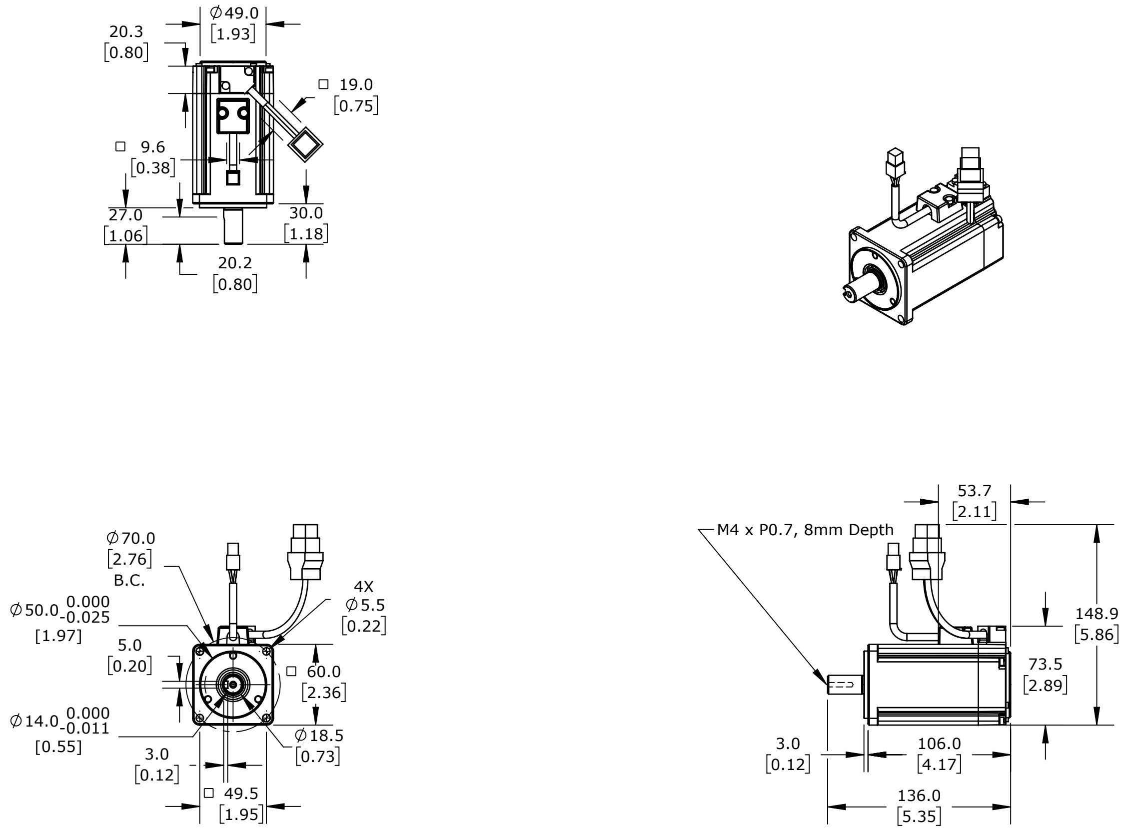


Units: **mm [inches]**

SV2H-2F0B

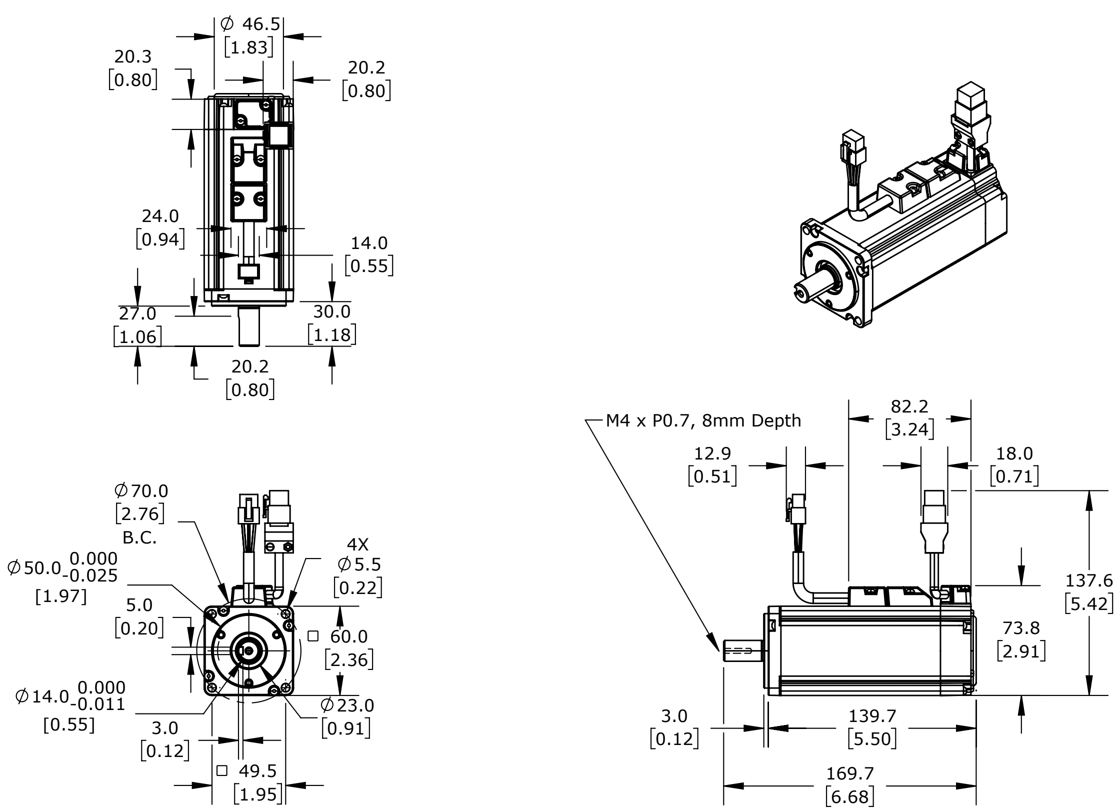


SV2L-404N

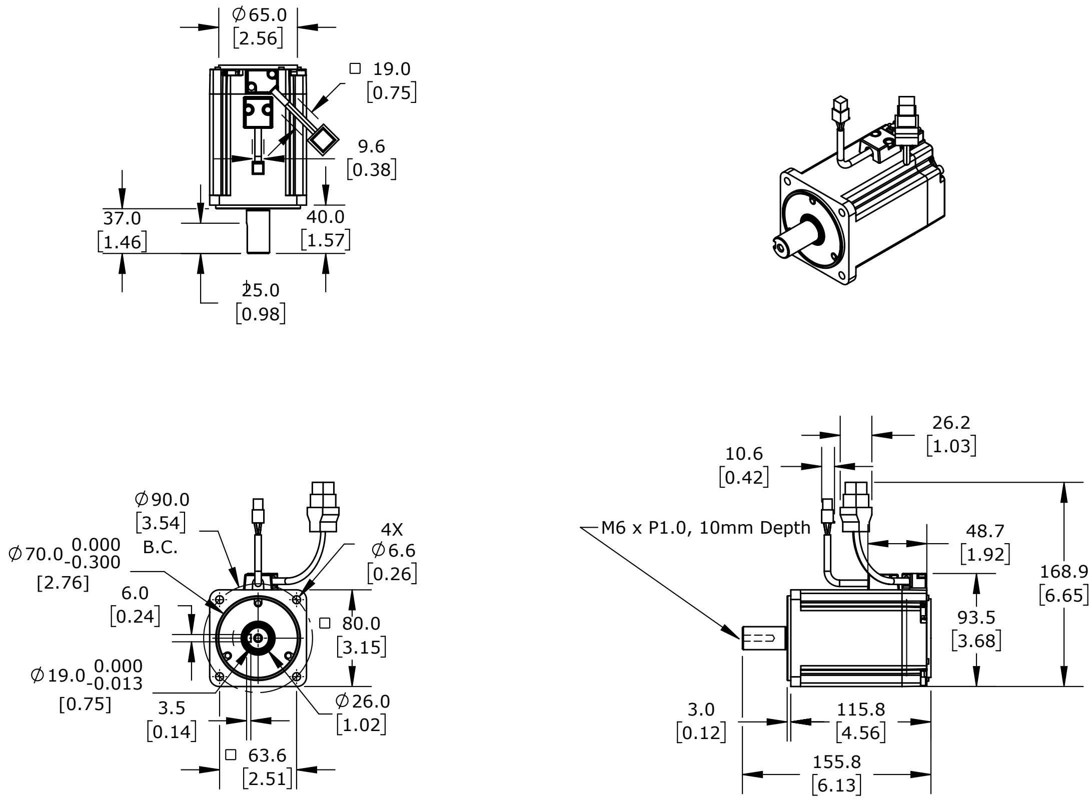


Units: **mm [inches]**

SV2L-404B

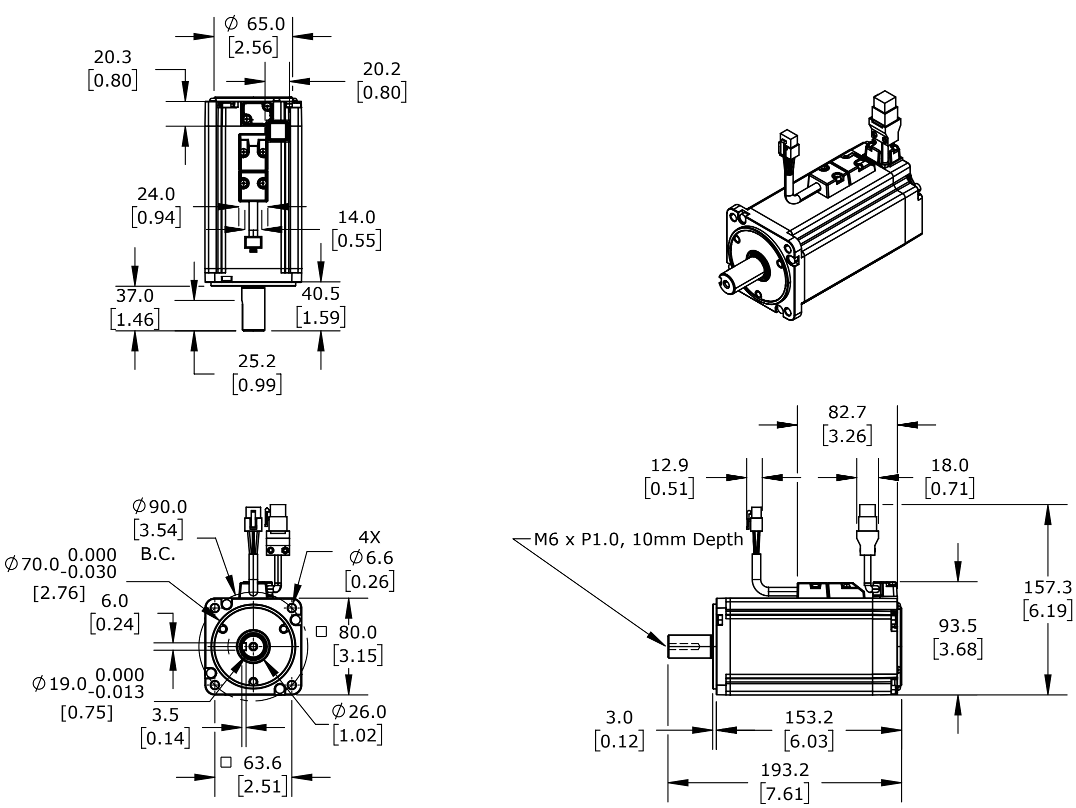


SV2L-407N

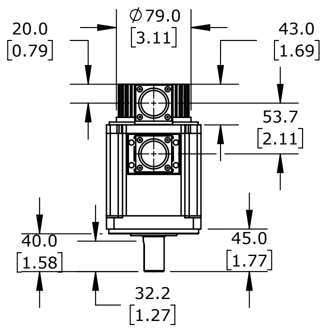


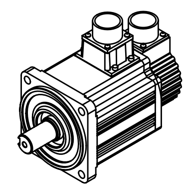
Units: **mm [inches]**

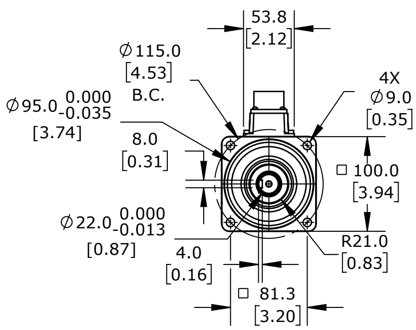
SV2L-407B

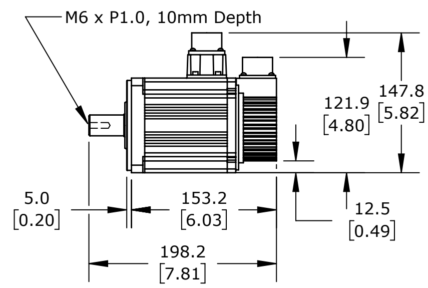


SV2L-410N



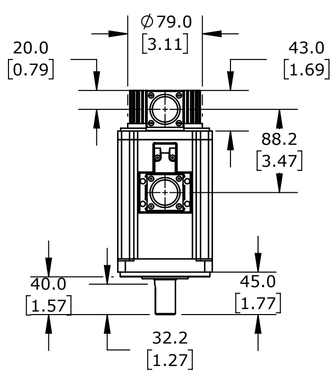


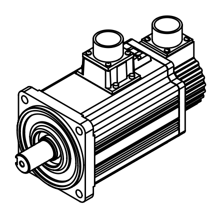


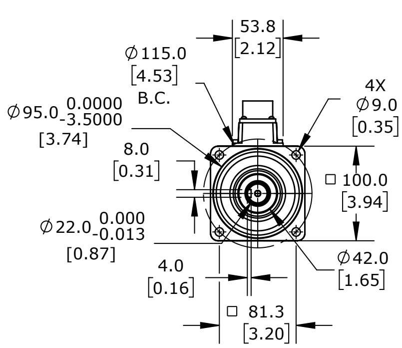


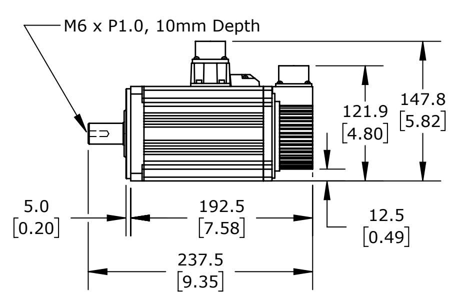
Units: **mm [inches]**

SV2L-410B

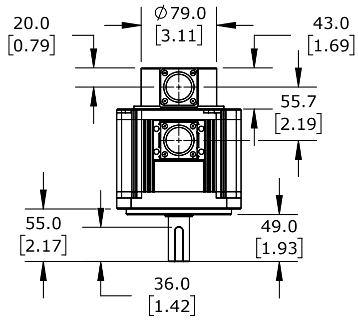


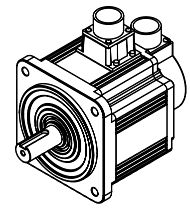


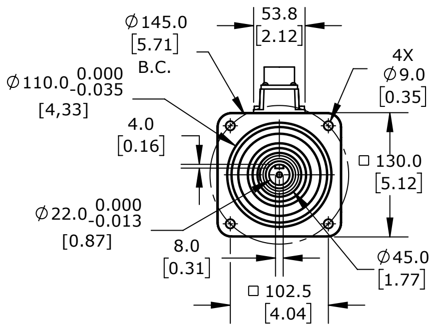


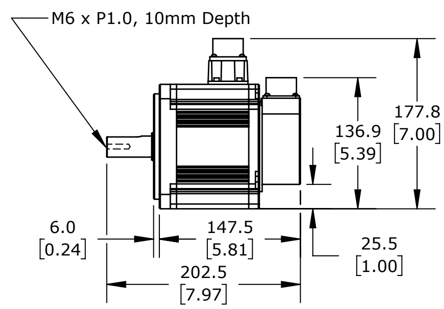


SV2M-410N









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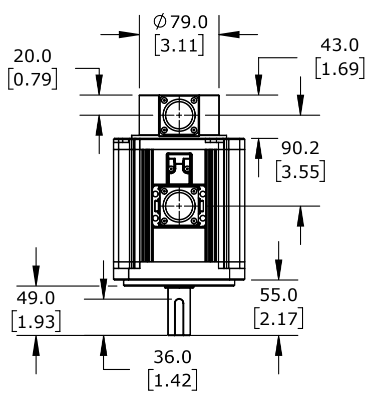

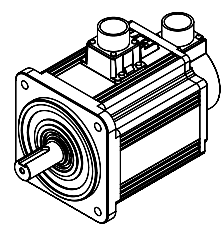

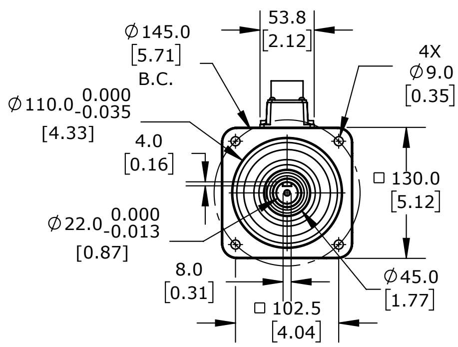

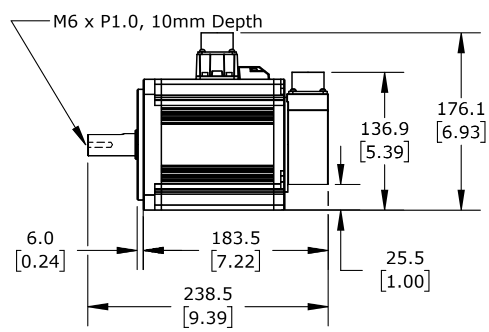

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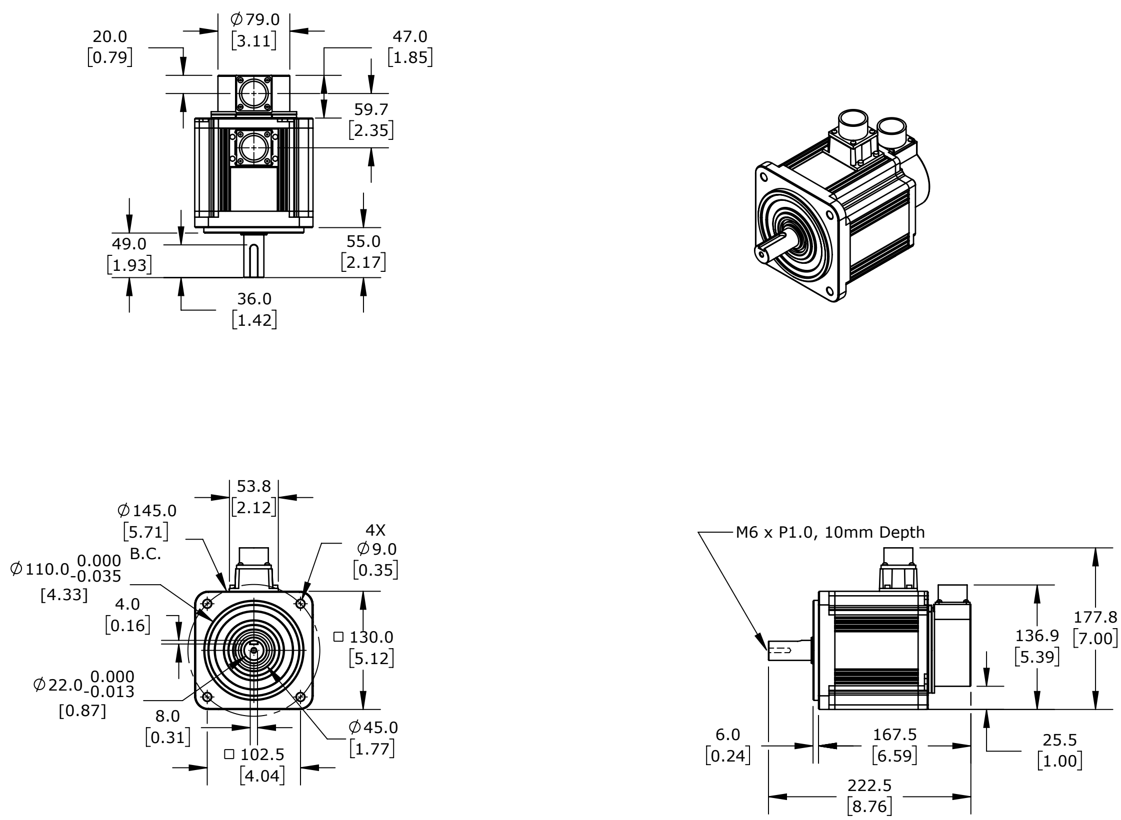

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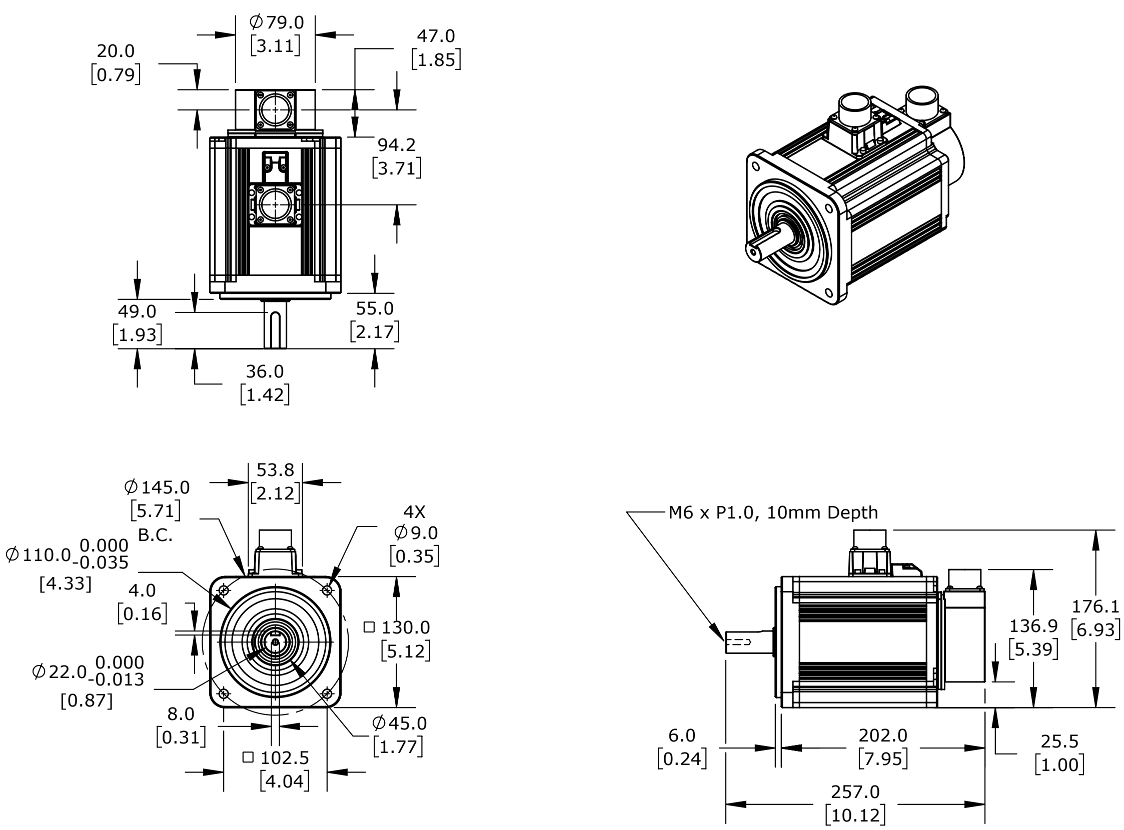

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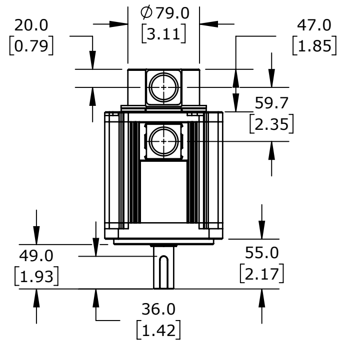
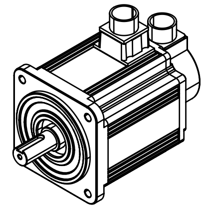
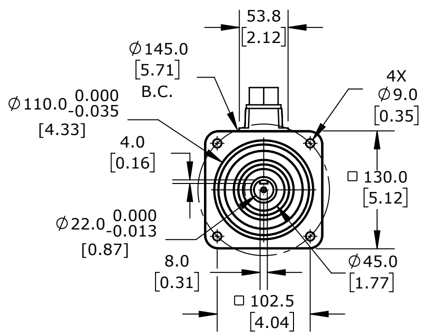
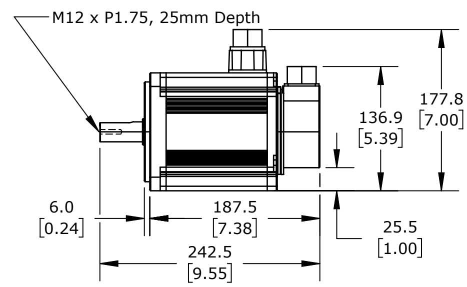


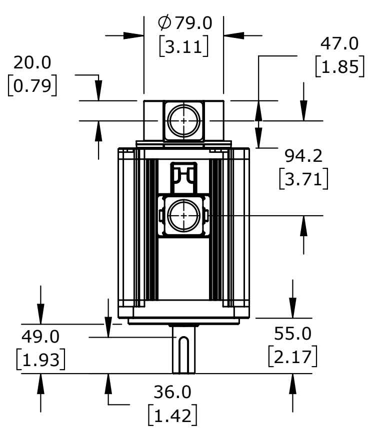


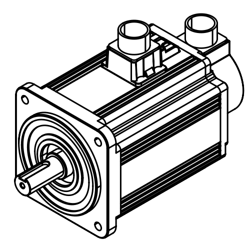


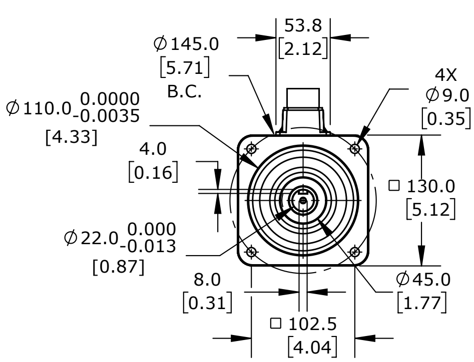


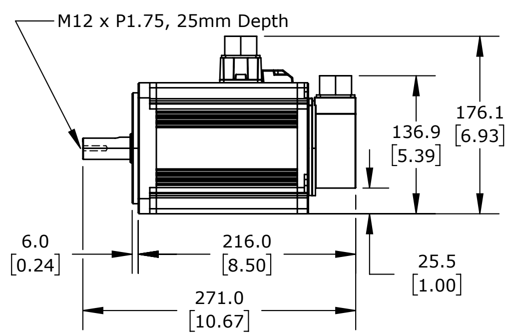
Units: **mm [inches]**

SV2L-420B









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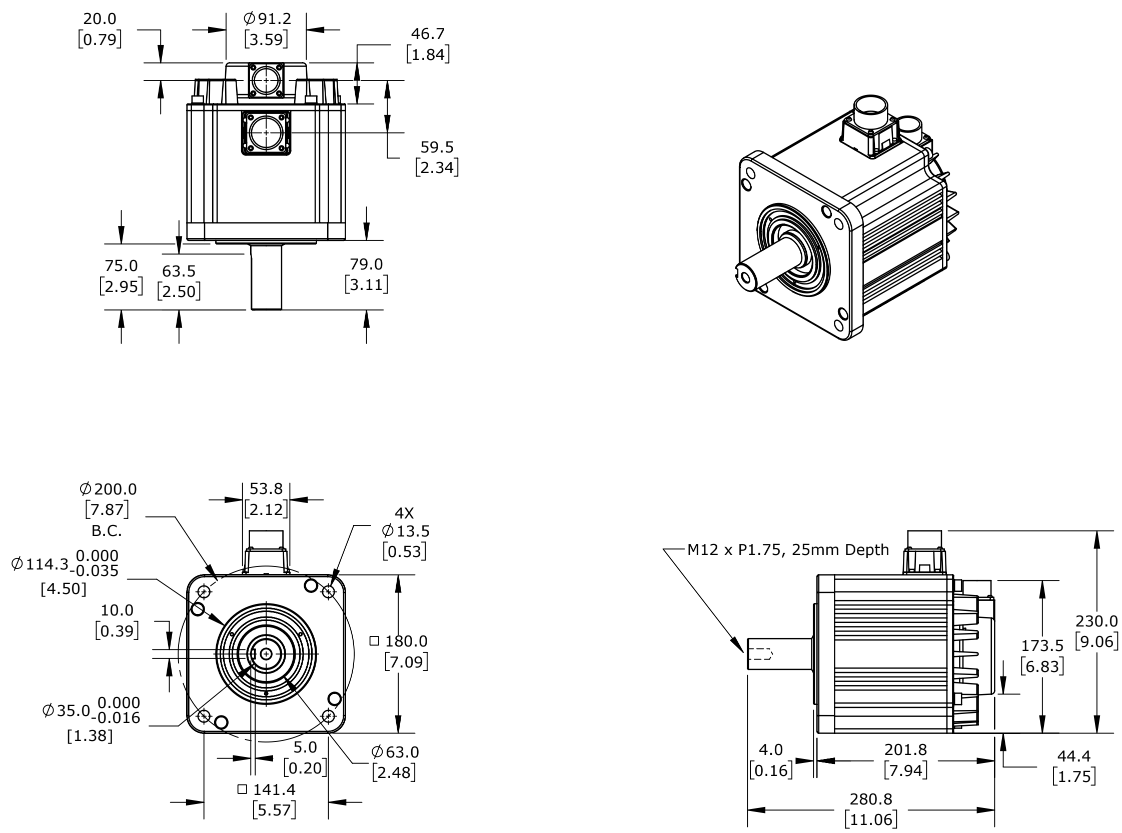

Units: **mm [inches]**

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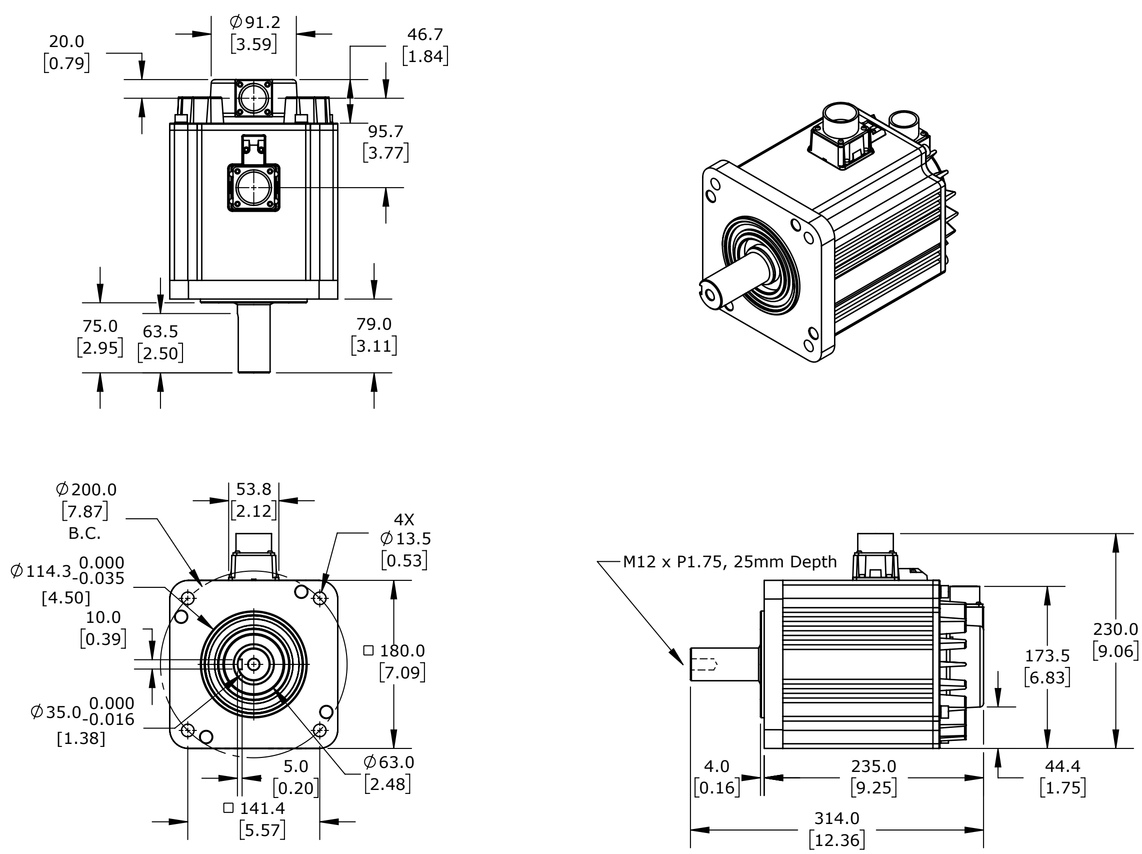

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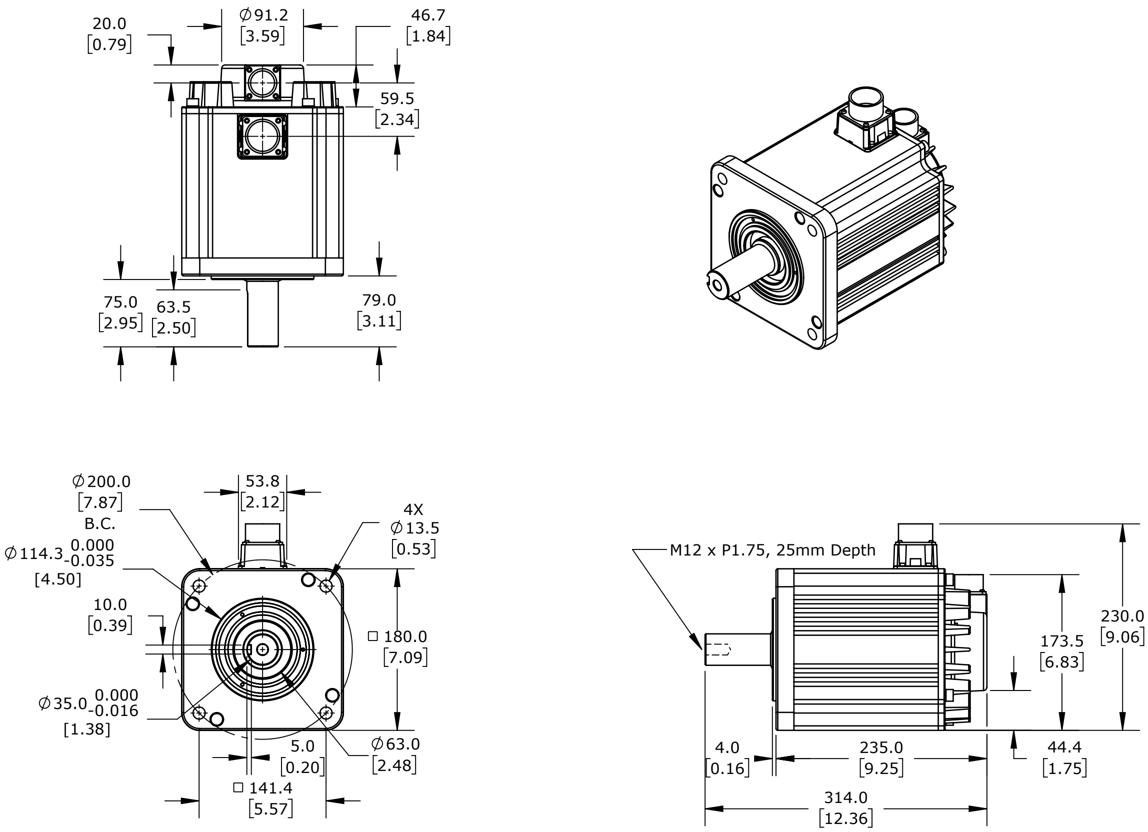

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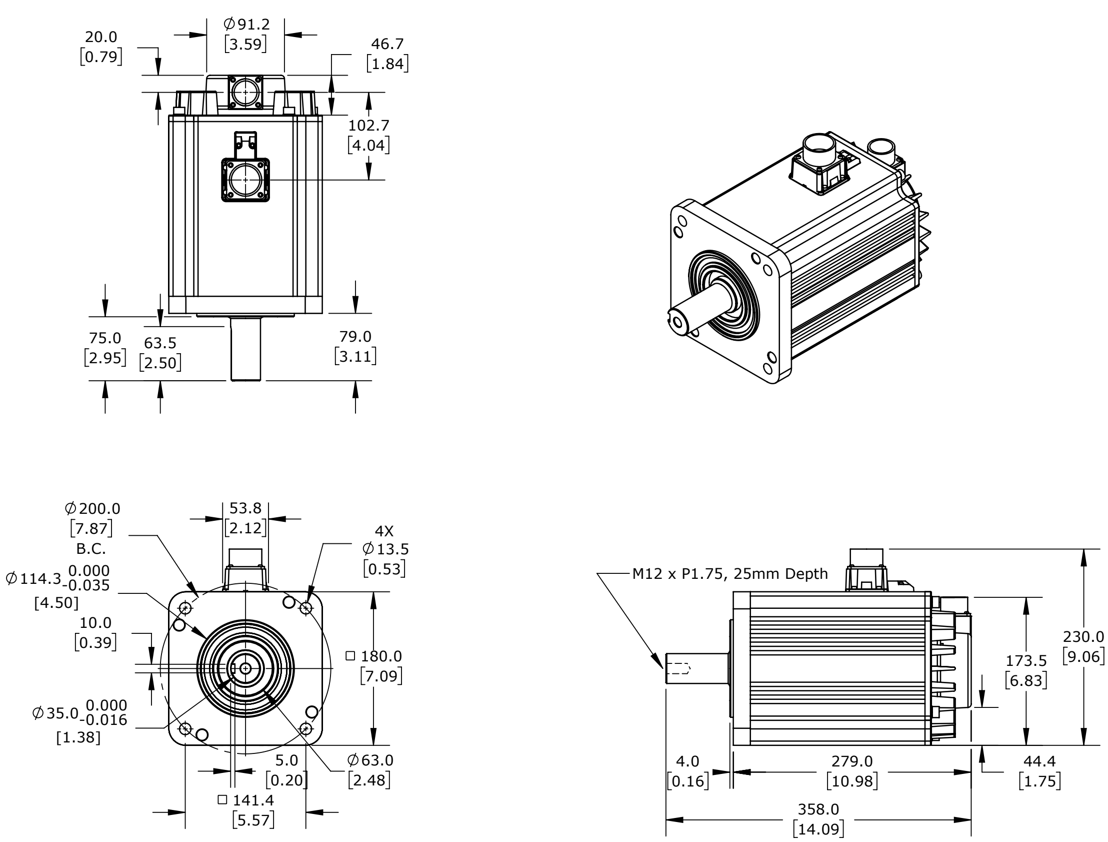

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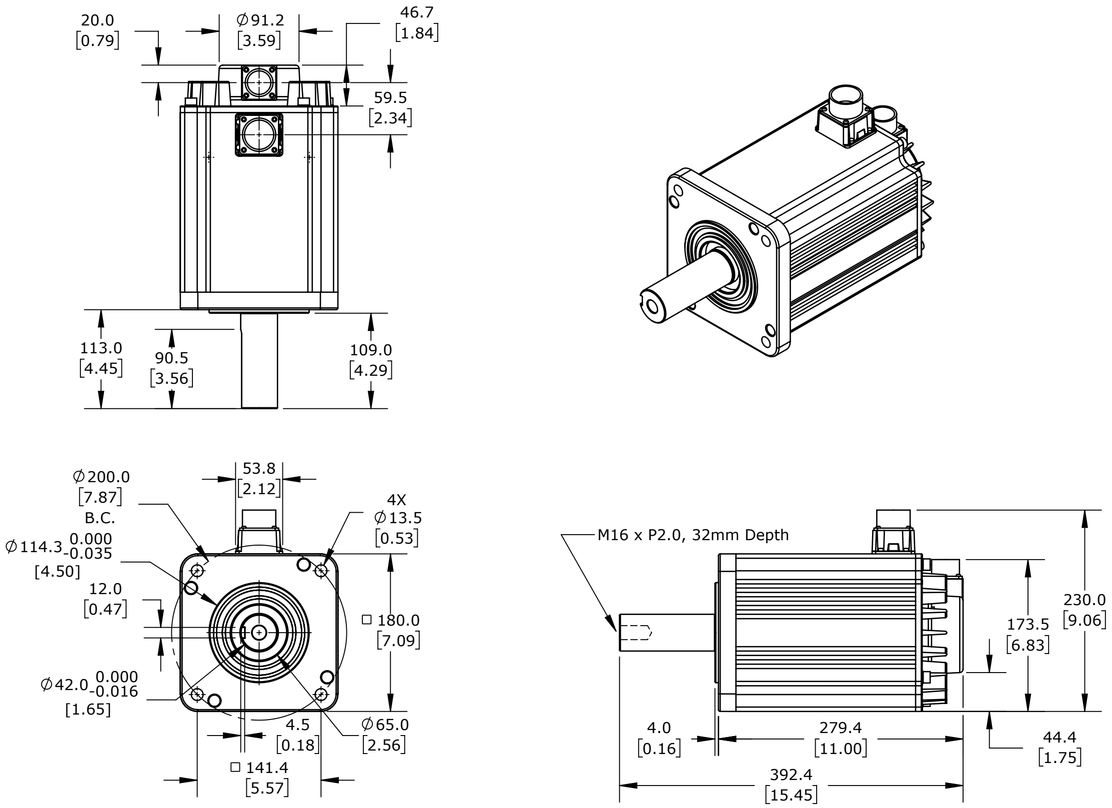

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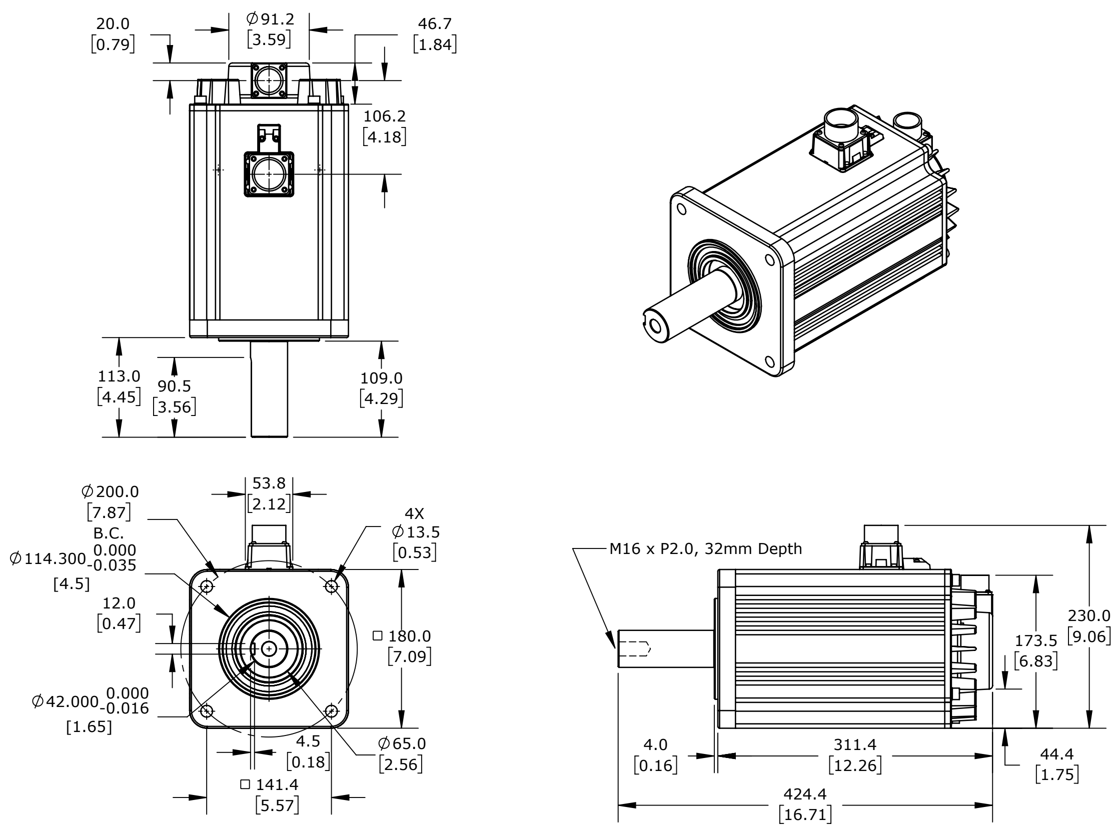

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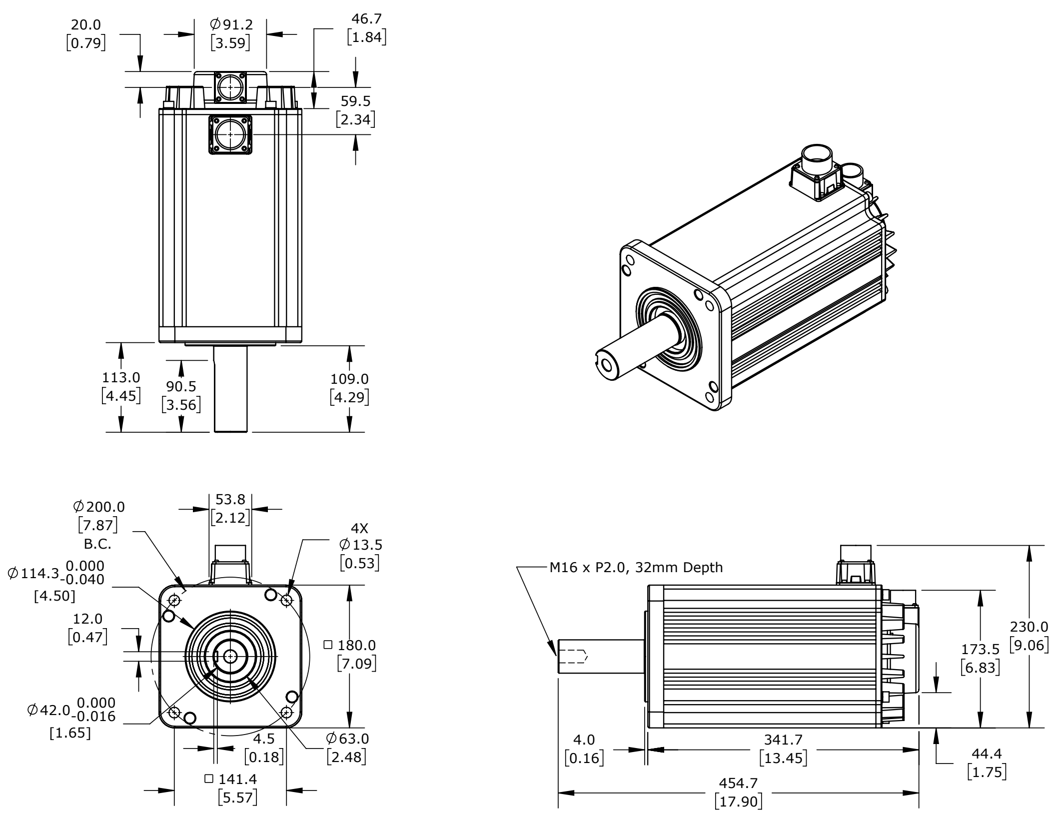

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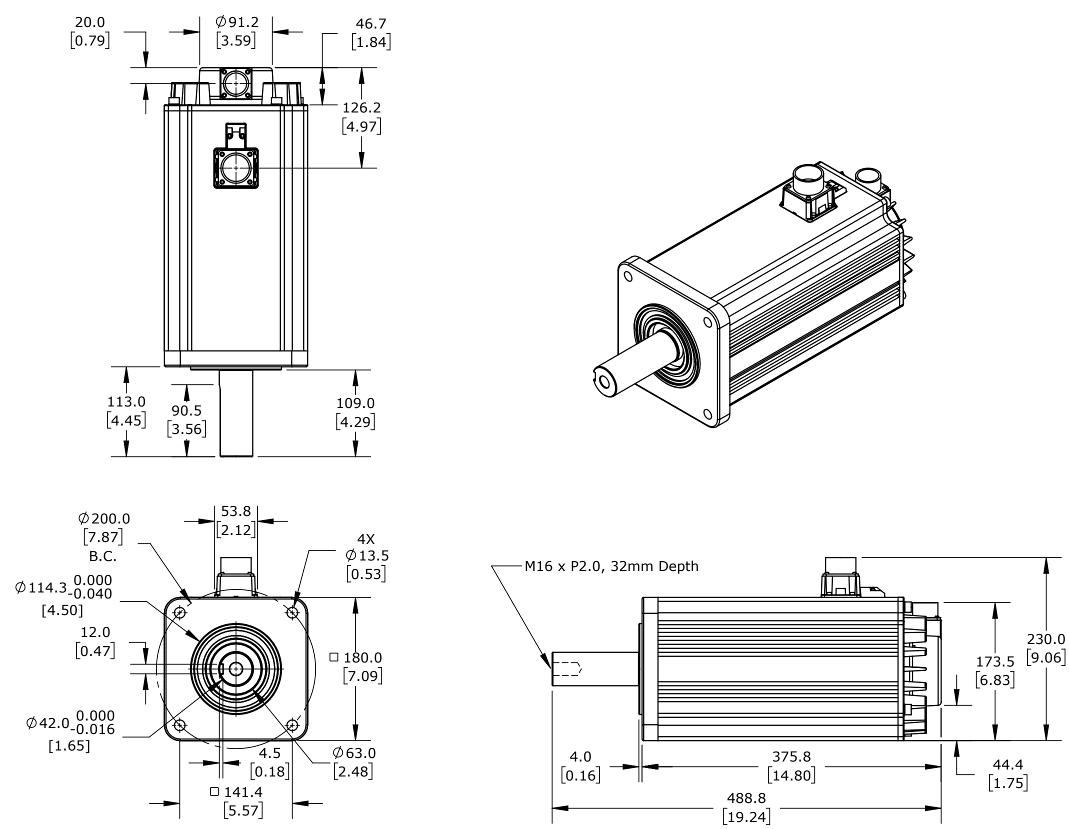
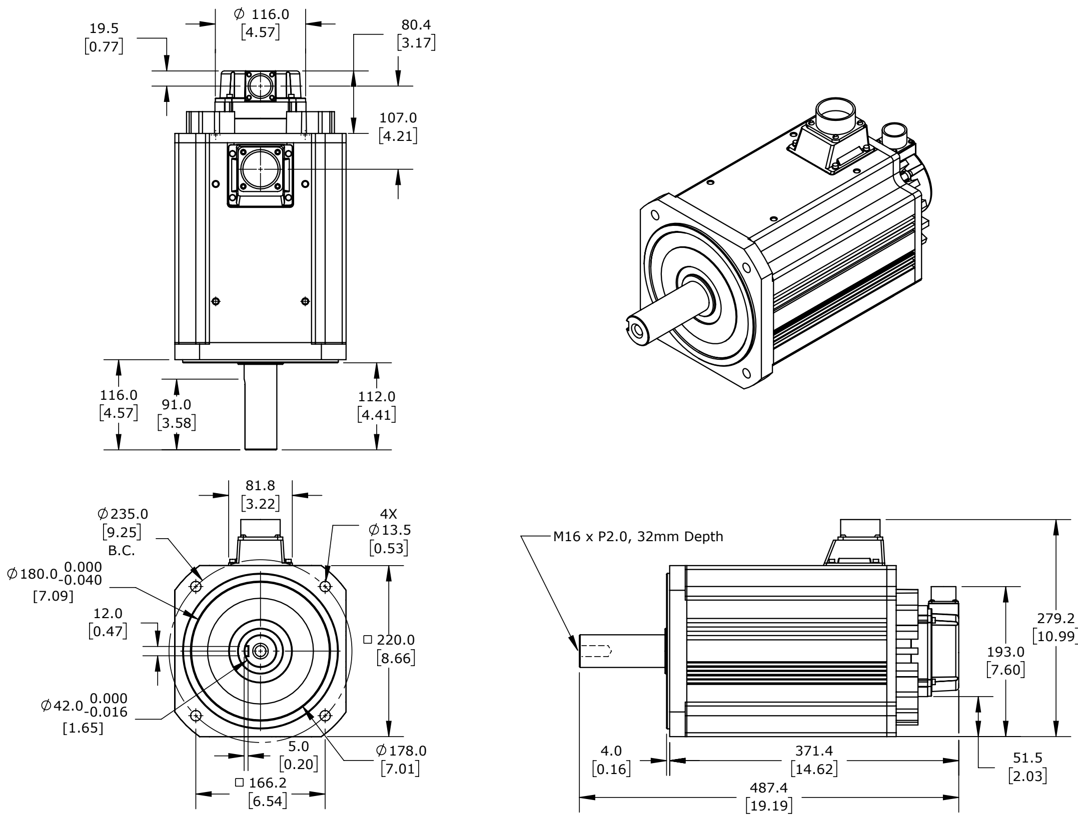
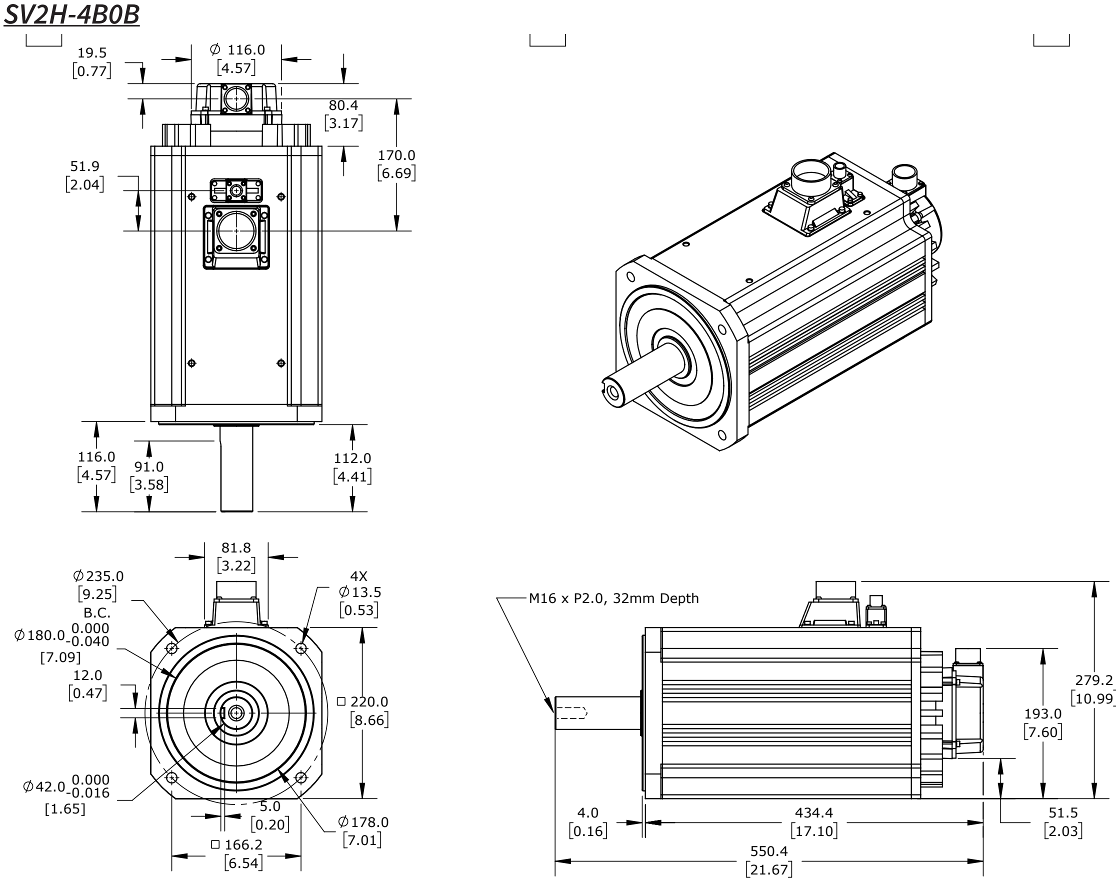


SV2H-4B0N

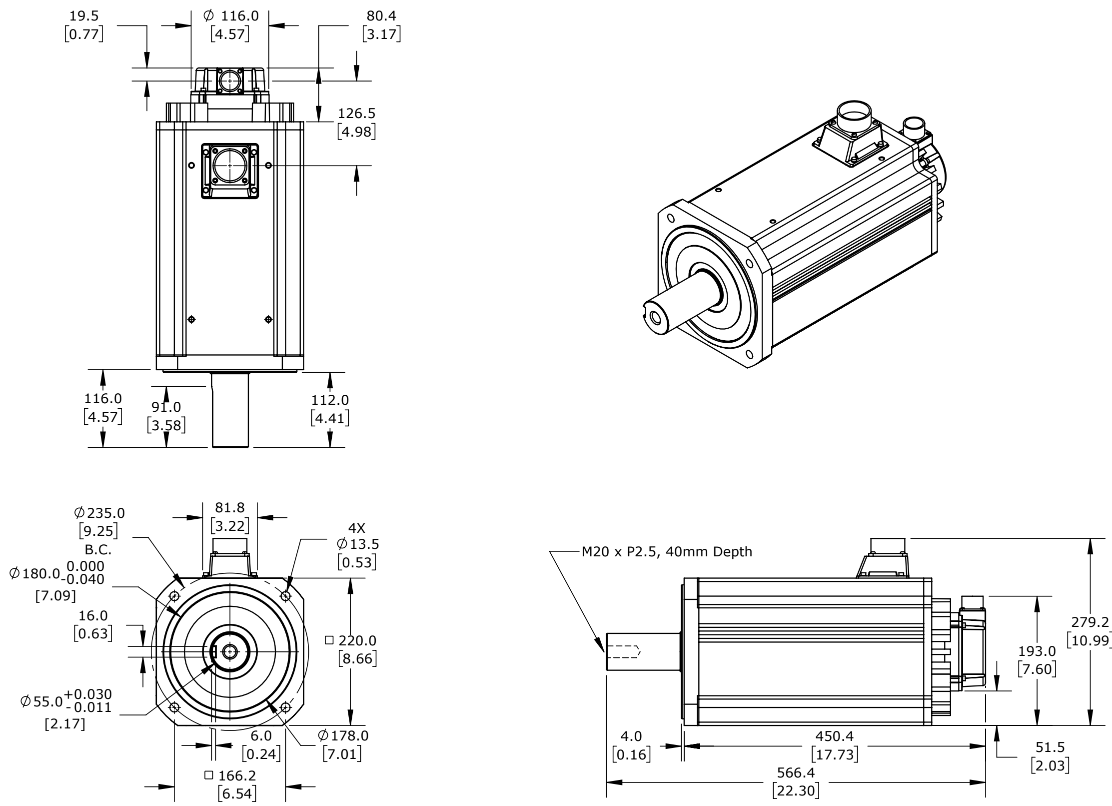


Units: **mm [inches]**

SV2H-4B0B

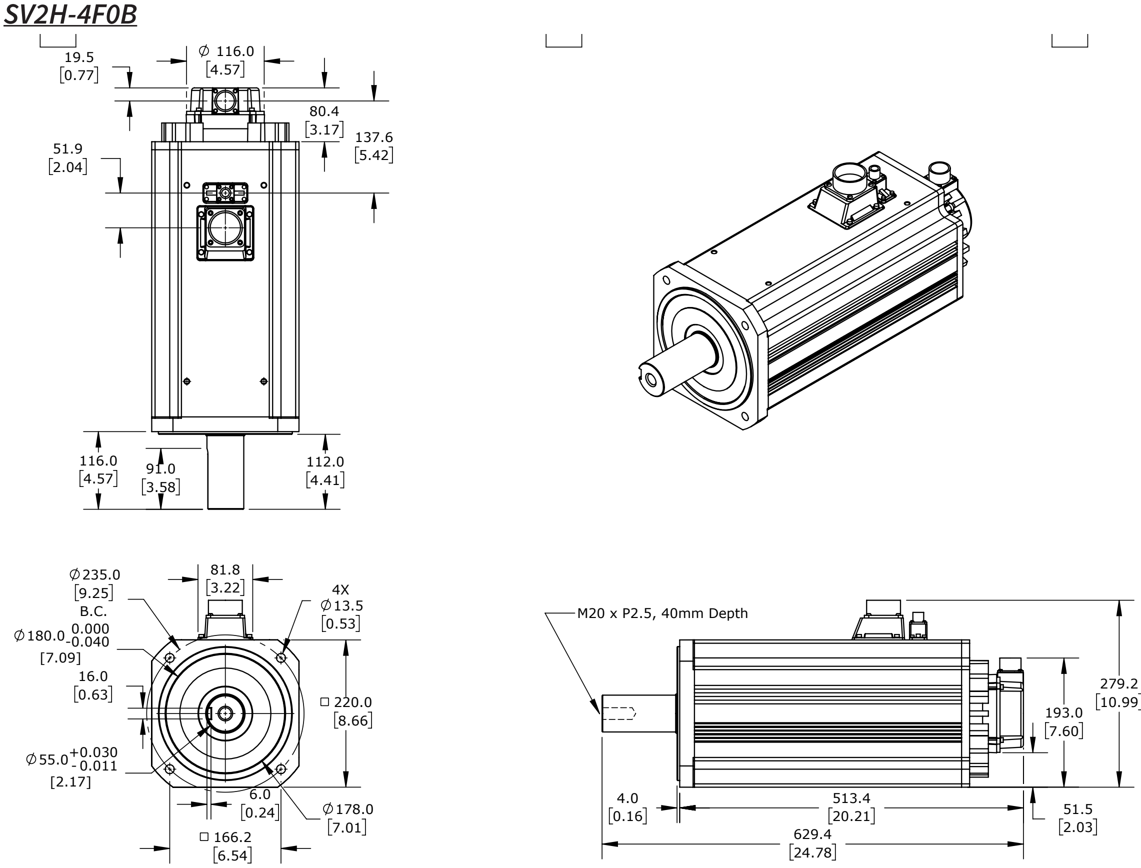


SV2H-4F0N



Units: **mm [inches]**

SV2H-4F0B



A.6 - Torque Features (T-N curves)

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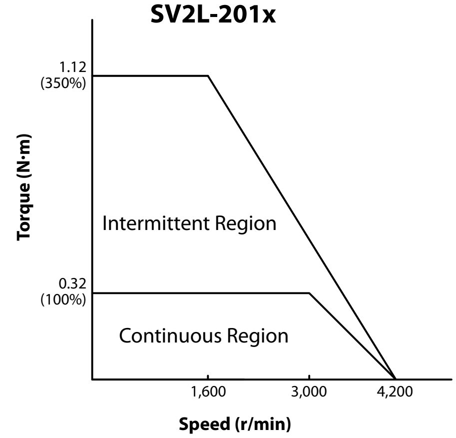

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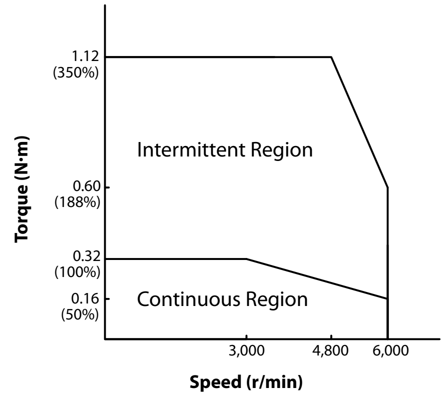

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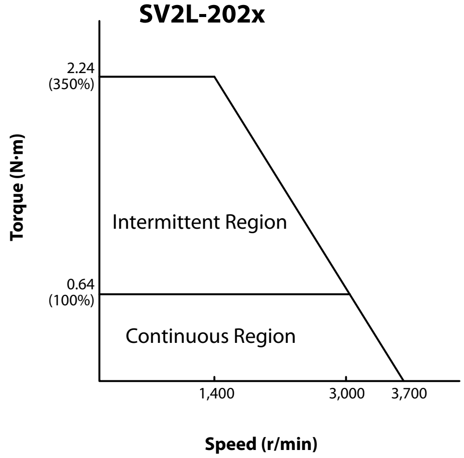

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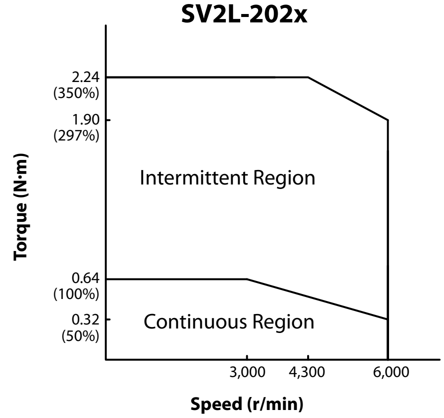

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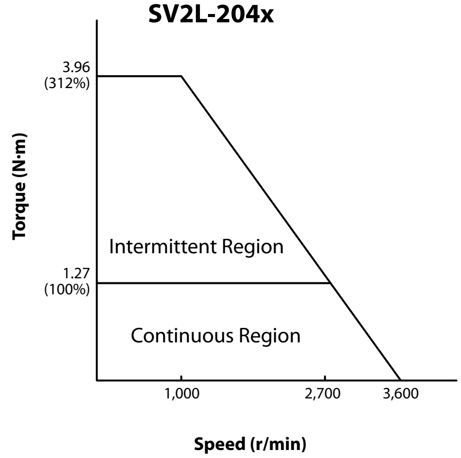

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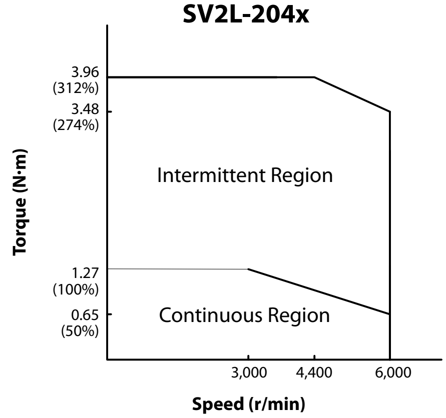

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120VAC	230VAC

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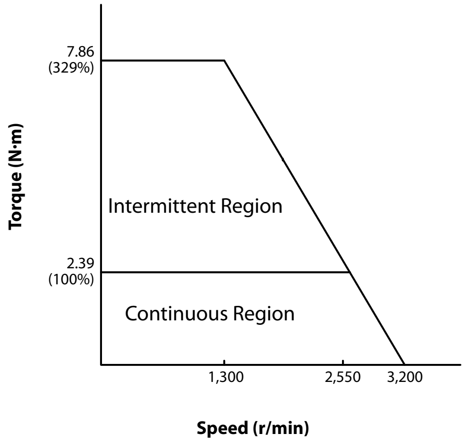

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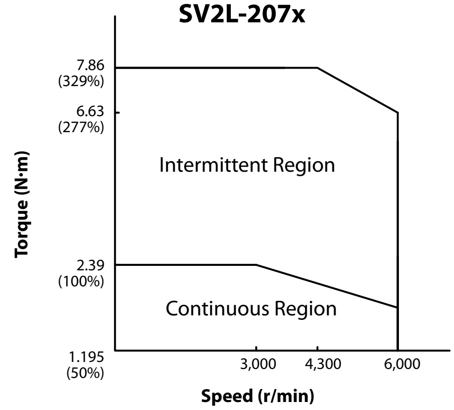

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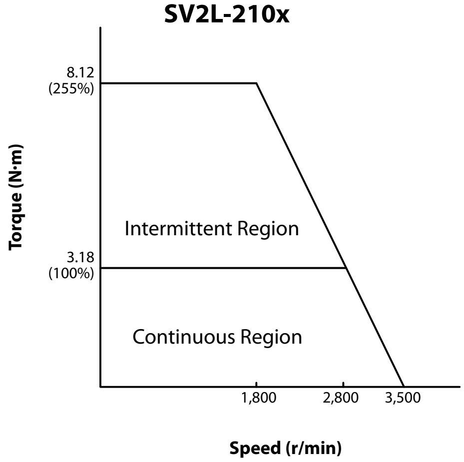

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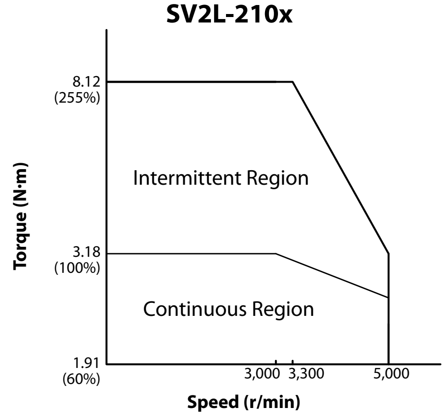

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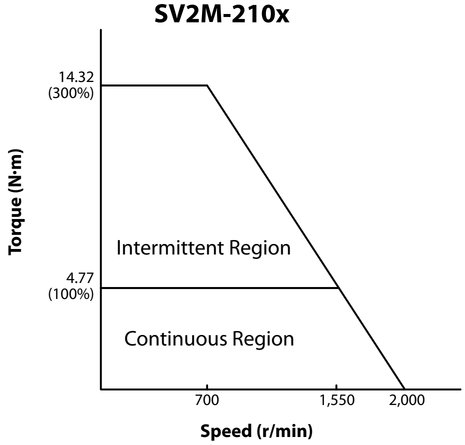

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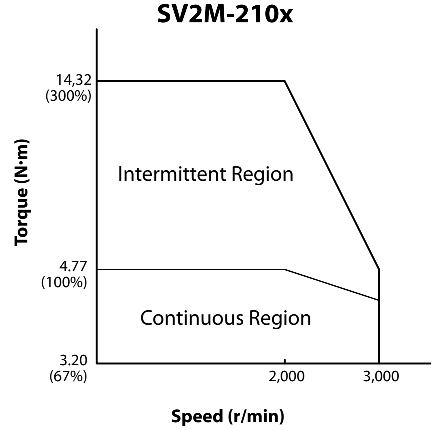
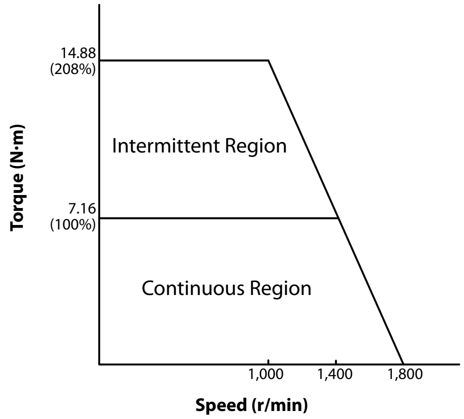


120VAC	*230VAC*

SV2M-215x (120VAC)



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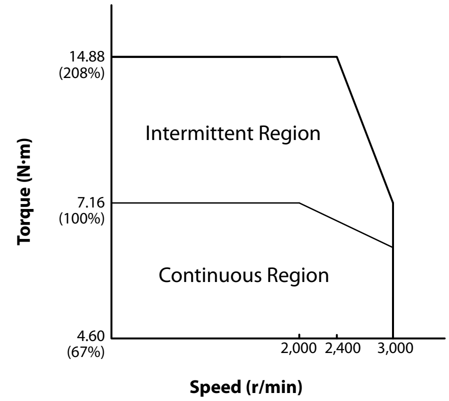

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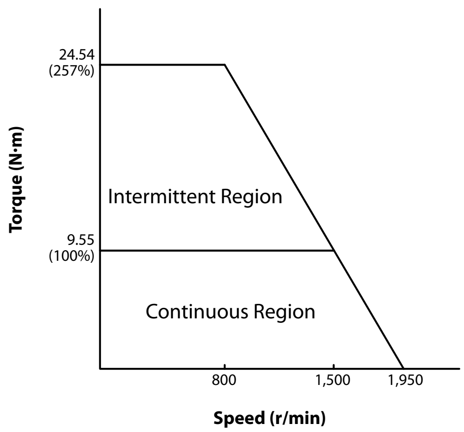

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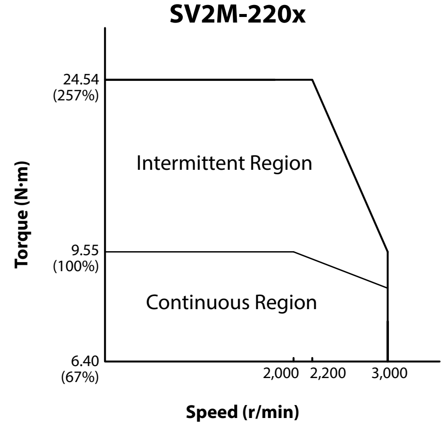
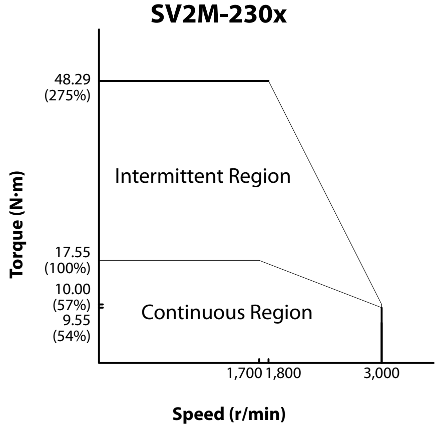


230VAC

SV2M-230x



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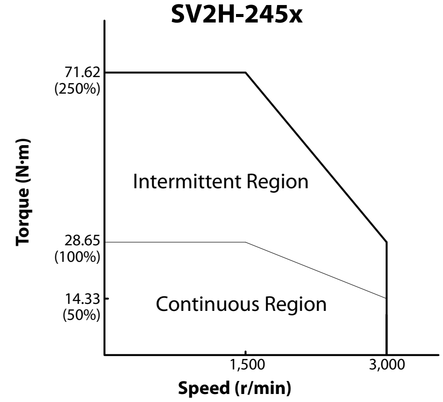

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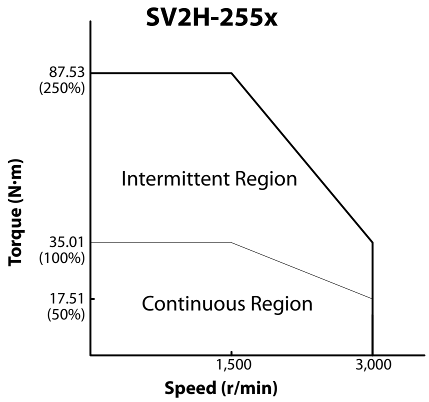
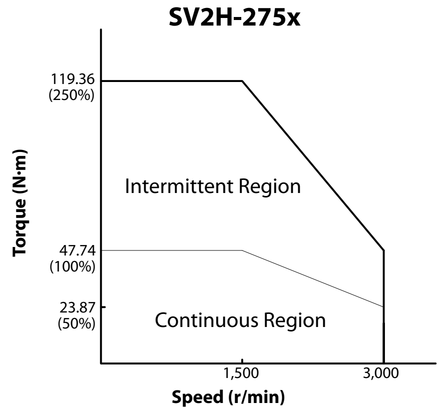
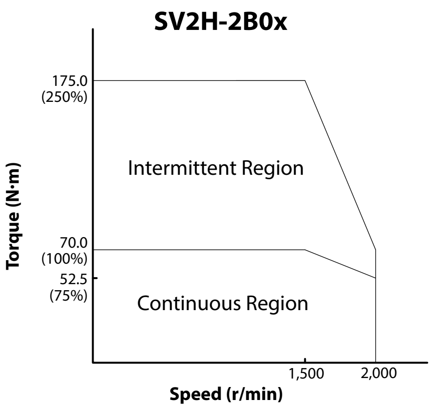
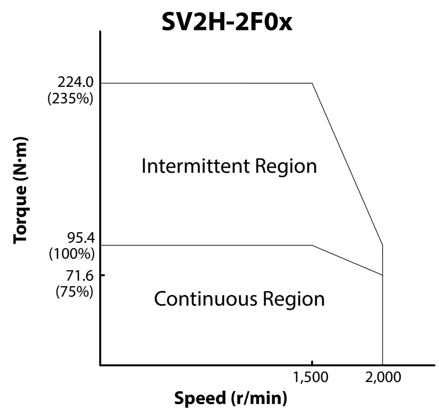
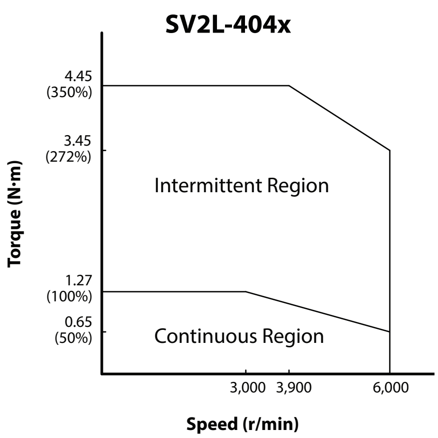


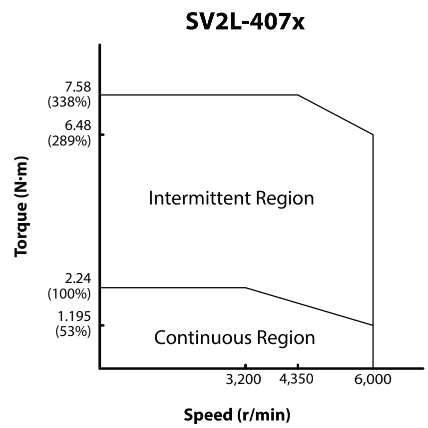






460VAC





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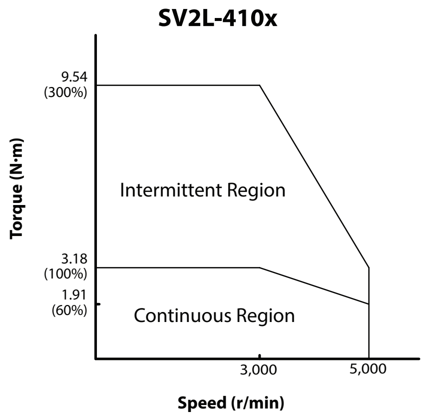
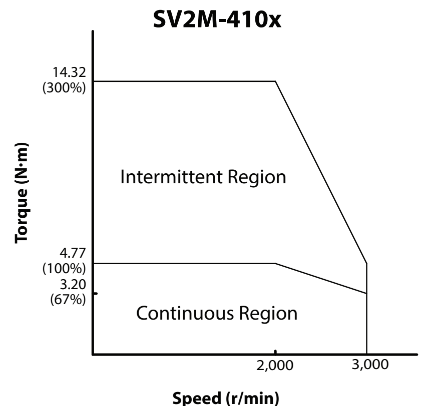
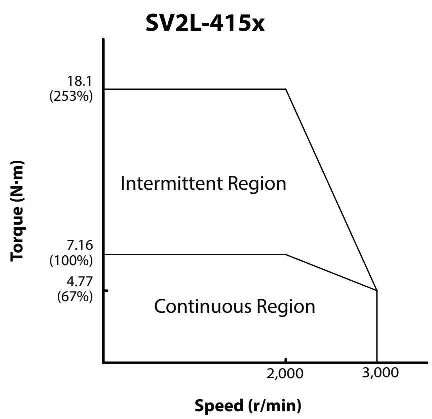
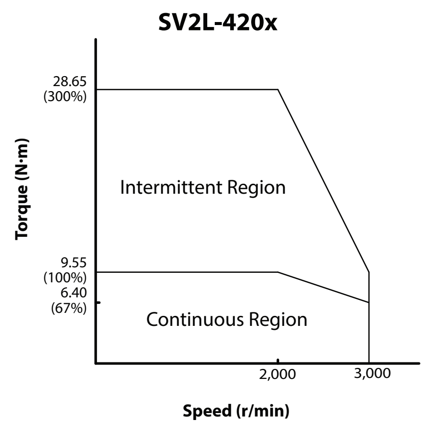
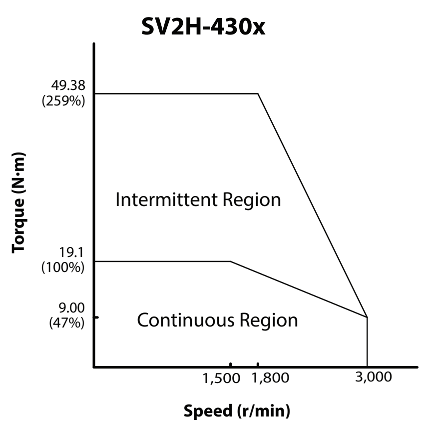
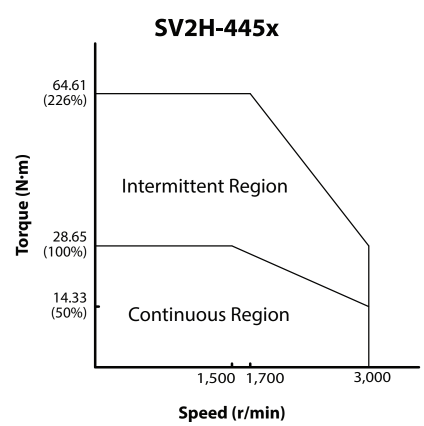

SV2L-410x
9.54 (300%)
3.18 (100%)
1.91 (60%)
Torque (N·m)
Intermittent Region
Continuous Region
3,000
5,000
Speed (r/min)


SV2M-410x
14.32 (300%)
4.77 (100%)
3.20 (67%)
Torque (N·m)
Intermittent Region
Continuous Region
2,000
3,000
Speed (r/min)


SV2L-415x
18.1 (253%)
7.16 (100%)
4.77 (67%)
Torque (N·m)
Intermittent Region
Continuous Region
2,000
3,000
Speed (r/min)

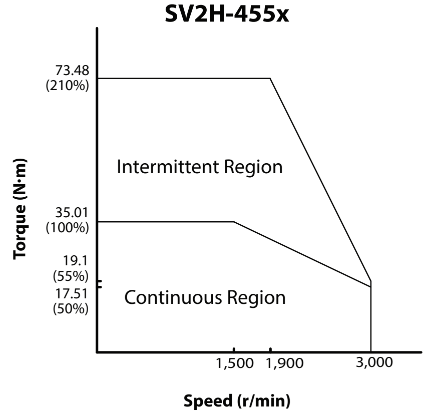

SV2L-420x
28.65 (300%)
9.55 (100%)
6.40 (67%)
Torque (N·m)
Intermittent Region
Continuous Region
2,000
3,000
Speed (r/min)


SV2H-430x
49.38 (259%)
19.1 (100%)
9.00 (47%)
Torque (N·m)
Intermittent Region
Continuous Region
1,500
1,800
3,000
Speed (r/min)

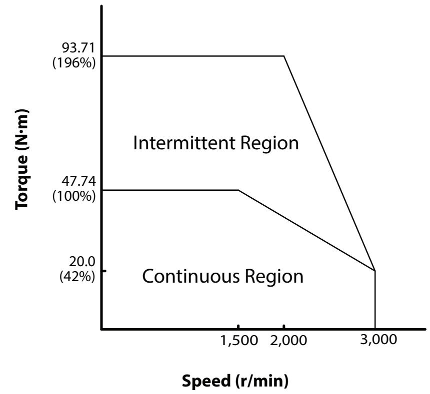

SV2H-445x
64.61 (226%)
28.65 (100%)
14.33 (50%)
Torque (N·m)
Intermittent Region
Continuous Region
1,500
1,700
3,000
Speed (r/min)

460VAC

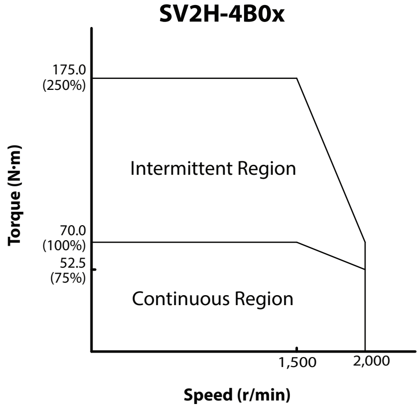
SV2H-455x



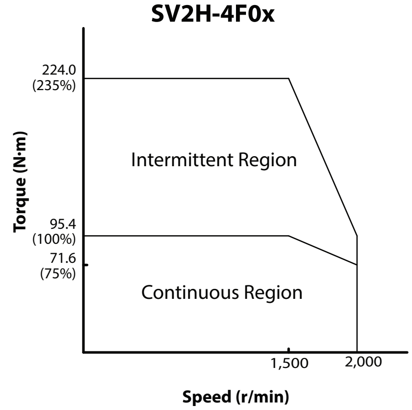
SV2H-475x



SV2H-4B0x



SV2H-4F0x



A.7 - Overload Features

Overload protection prevents the motor from overheating. Common causes of overloading include:

1) The motor's rated torque exceeds the rated range and the operation time is too long.
2) The inertia ratio is too high and the motor frequently accelerates and decelerates.
3) An incorrect connection between the power cable and the encoder wiring.
4) Incorrect servo gain setting causes resonance in the motor.
5) A brake equipped motor is operated without releasing the brake.

A.7.1 - Load and Operating Time

Low Inertia Motors (SV2L Series)

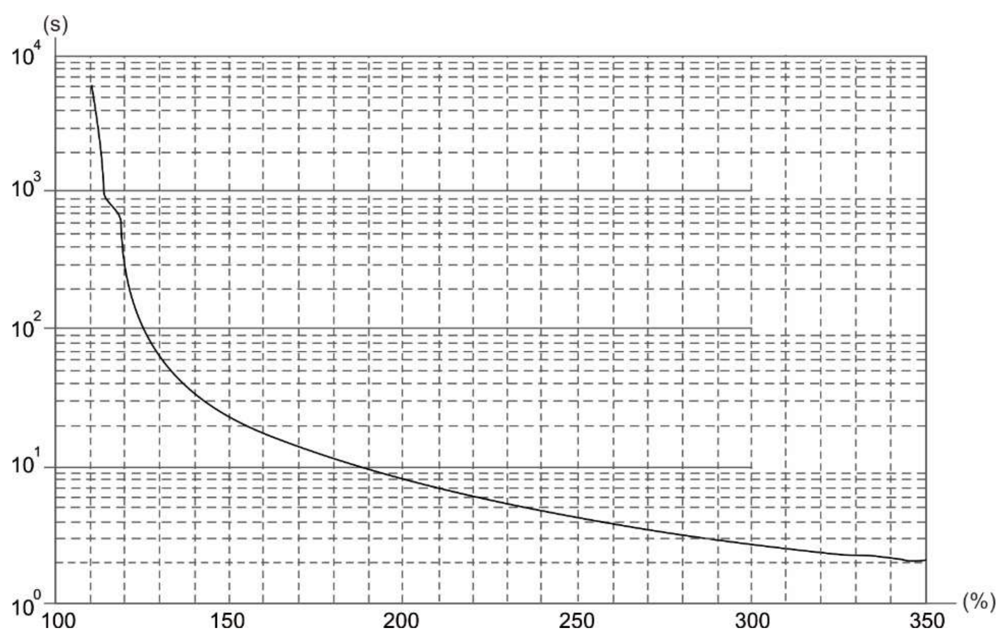
This graph applies to the following motors:

230V:

- *SV2L-201x*
- *SV2L-202x*
- *SV2L-204x*
- *SV2L-207x*
- *SV2L-210x*

460V:

- *SV2L-404x*
- *SV2L-407x*
- *SV2L-410x*



Load (%)	*Operating Time (Seconds)*
120	263.8
140	35.2
160	17.6
180	11.2
200	8
220	6.1
240	4.8
260	3.9
280	3.3
300	2.8
350	2.1

Medium and High Inertia Motors (SV2M Series, SV2H Series)

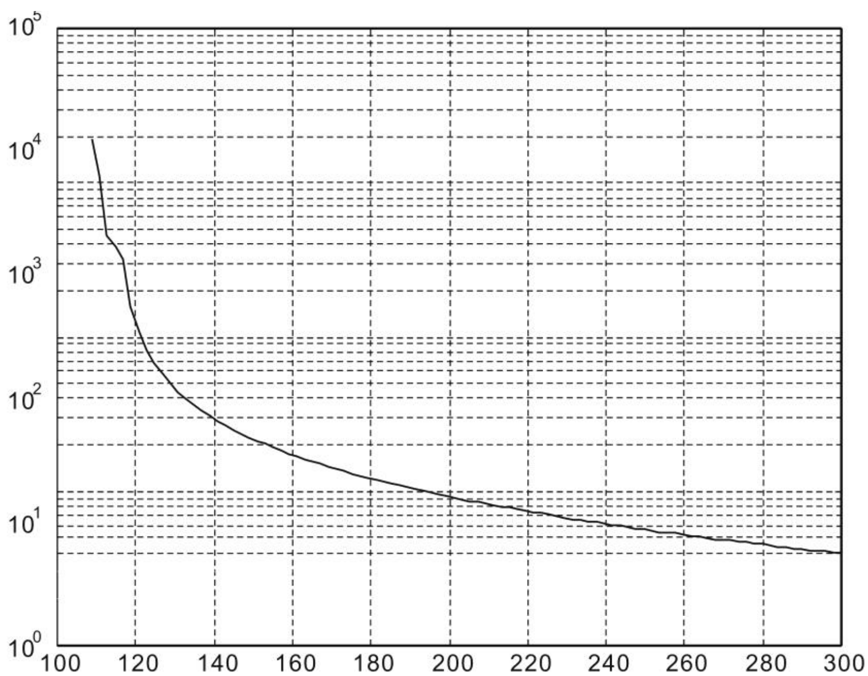
This graph applies to the following motors:

230V:

- *SV2M-210x*
- *SV2M-215x*
- *SV2M-220x*
- *SV2M-230x*
- *SV2H-245x*
- *SV2H-255x*
- *SV2H-275x*
- *SV2H-2B0x*
- *SV2H-2F0x*

460V:

- *SV2M-410x*
- *SV2M-415x*
- *SV2M-420x*
- *SV2H-430x*
- *SV2H-445x*
- *SV2H-455x*
- *SV2H-475x*
- *SV2H-4B0x*
- *SV2H-4F0x*



Load (%)	*Operating Time (Seconds)*
120	527.6
140	70.4
160	35.2
180	22.4
200	16
220	12.2
240	9.6
260	7.8
280	6.6
300	5.6

Appendix B

SureServo2 Accessories

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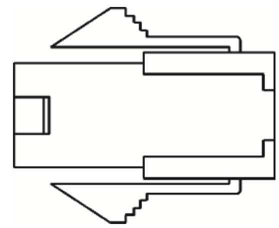
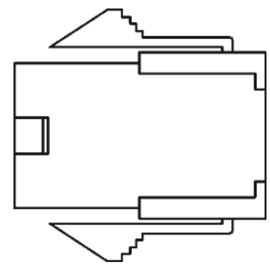
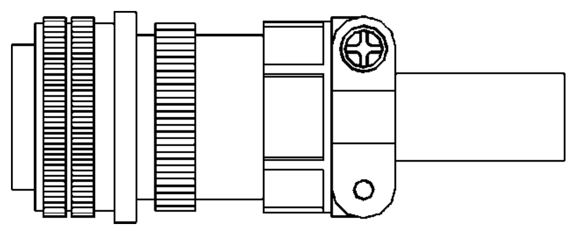
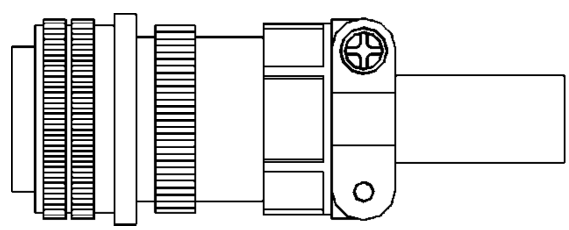
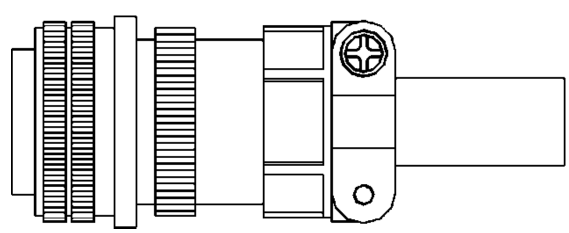
Introduction

This appendix details the accessories available for use with SureServo2 series drives and motors.

B.1 - Power Connector

The following power connectors are compatible with SureServo2 motors:

Power Connector	Non-AutomationDirect Part Number	Use With	Reference Drawing
SV2C-PA-CON	Molex 39-01-2041	Up to 750W motors without brake	
SV2C-PB-CON	Molex 39-01-2061	Up to 750W motors with brake	
SV2C-PC-CON	3106A20-18S-R	230VAC 1kW-1.5 kW and 460VAC 1kW-2kW SureServo2 motors	
SV2C-PD-CON	3106A24-11S-R	230VAC 2kW-4.5 kW and 460VAC 3kW-7.5 kW SureServo2 motors.	
SV2C-PF-CON	3106A32-17S-R	230VAC 5.5 kW-15kW and 460VAC 11kW-15kW SureServo2 motors	

B.2 - Power Cables

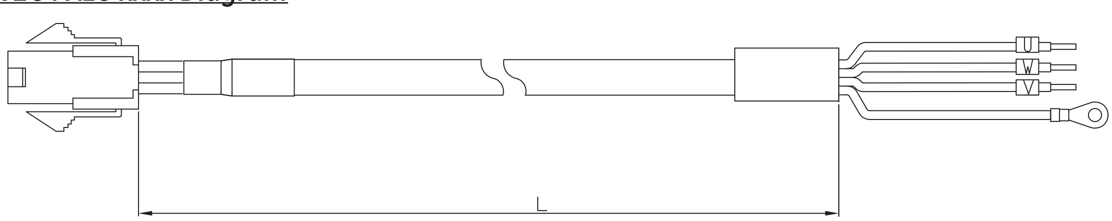
All the power cables described in this section are compatible with SureServo2 motors. For cable entry into a panel, do not dissasemble the connector/cable. Please use a Murrplastik KDL or KDP Cable Entry System to feed large connectors through an enclosure wall and retain a high IP rating. To find cables appropriate for your motor, determine the power rating of your motor and whether it has a built-in brake or not, then refer to the reference table below: SureServo2 power cables are not rated for long term use in oil environments.

Motor Type	Brake	Refer to
Up to 750W	N	B.2.1
	Y	B.2.2
SV2L-210N, SV2L-410N, SV2M-410N, SV2L-415N, SV2L-420N	N	B.2.3
SV2L-210B, SV2L-410B, SV2M-410B, SV2L-415B, SV2L-420B	Y	B.2.4
230V Medium Inertia 1kW and 1.5 kW	N	B.2.5
	Y	B.2.6
SV2M-220N, SV2M-230N, SV2H-430N	N	B.2.7
SV2M-220B, SV2M-230B, SV2H-430B.	Y	B.2.8
SV2H-245N, SV2H-445N, SV2H-455N, SV2H-475N	N	B.2.9
SV2H-245B, SV2H-445B, SV2H-455B, SV2H-475B	Y	B.2.10
230V 5.5 to 11 kW	Either	B.2.11
230V 15kW High Inertia Motors	Either	B.2.13
460V 11 to 15kW High Inertia Motors	Either	B.2.12
230V 5.5 to 15kW High Inertia Motors and 460V 11 to 15kW High Inertia Motors	Y	B.2.14

B.2.1 - Up to 750W Low Inertia Motors (no brake)

Cable Type	Part Number	Use With	Connector	Diameter (mm)	Gauge	L mm	L inch	Bend Radius (mm)
Non-flex Rated	SV2C-PA18-03NN	Up to 750W motors without brake	SV2C-PA-CON	8	18	3000 ± 50	118 ± 2	60.75
	SV2C-PA18-05NN					5000 ± 50	197 ± 2	
	SV2C-PA18-10NN					10000 ± 100	394 ± 4	
	SV2C-PA18-20NN					20000 ± 100	788 ± 4	
Flex Rated	SV2C-PA18-03FN					3000 ± 50	118 ± 2	
	SV2C-PA18-05FN					5000 ± 50	197 ± 2	
	SV2C-PA18-10FN					10000 ± 100	394 ± 4	
	SV2C-PA18-20FN					20000 ± 100	788 ± 4	

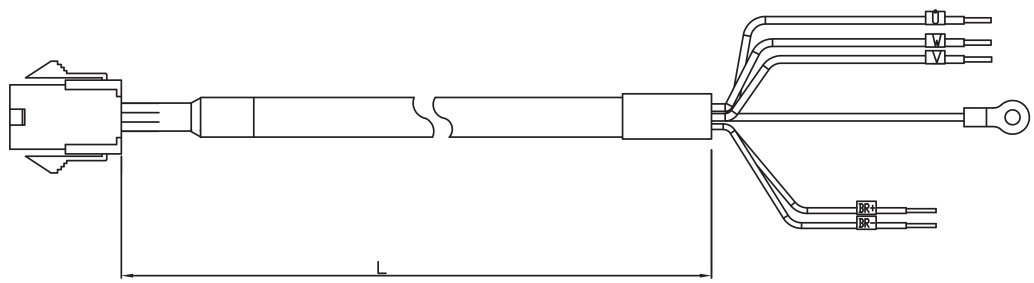
SV2C-PA18-xxxx Diagram



B.2.2 - Up to 750W Low Inertia Motors (with brake)

Cable Type	Part Number	Use With	Connector	Diameter (mm)	Gauge	L mm	L inch	Bend Radius (mm)
Non-flex Rated	SV2C-PB18-03NB	Up to 750W motors with brake	SV2C-PB-CON	9	18	3000 ± 50	118 ± 2	67.5
	SV2C-PB18-05NB					5000 ± 50	197 ± 2	
	SV2C-PB18-10NB					10000 ± 100	394 ± 4	
	SV2C-PB18-20NB					20000 ± 100	788 ± 4	
Flex Rated	SV2C-PB18-03FB					3000 ± 50	118 ± 2	
	SV2C-PB18-05FB					5000 ± 50	197 ± 2	
	SV2C-PB18-10FB					10000 ± 100	394 ± 4	
	SV2C-PB18-20FB					20000 ± 100	788 ± 4	

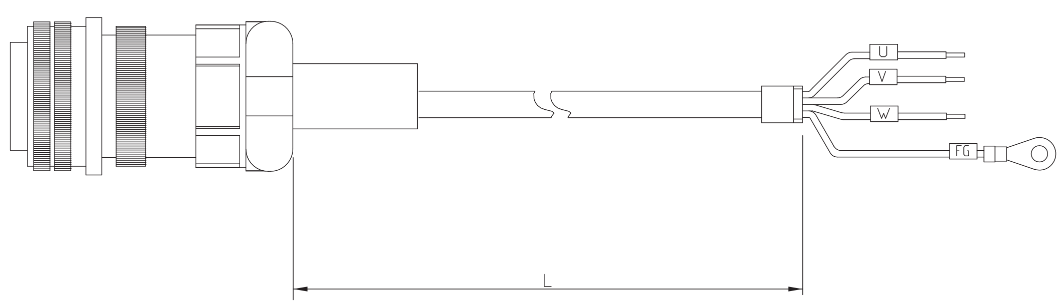
SV2C-PB18-xxxx Diagram



B.2.3 - For SV2L-210N, SV2L-410N, SV2M-410N, SV2L-415N, SV2L-420N

Cable Type	Part Number	Use With	Connector	Diameter (mm)	Gauge	L mm	L inch	Bend Radius (mm)
Non-flex Rated	SV2C-PC16-03NN	1kW low inertia motors without brake	SV2C-PC-CON	11	16	3000 ± 50	118 ± 2	82.5
	SV2C-PC16-05NN					5000 ± 50	197 ± 2	
	SV2C-PC16-10NN					10000 ± 100	394 ± 4	
	SV2C-PC16-20NN					20000 ± 100	788 ± 4	
Flex Rated	SV2C-PC16-03FN					3000 ± 50	118 ± 2	
	SV2C-PC16-05FN					5000 ± 50	197 ± 2	
	SV2C-PC16-10FN					10000 ± 100	394 ± 4	
	SV2C-PC16-20FN					20000 ± 100	788 ± 4	

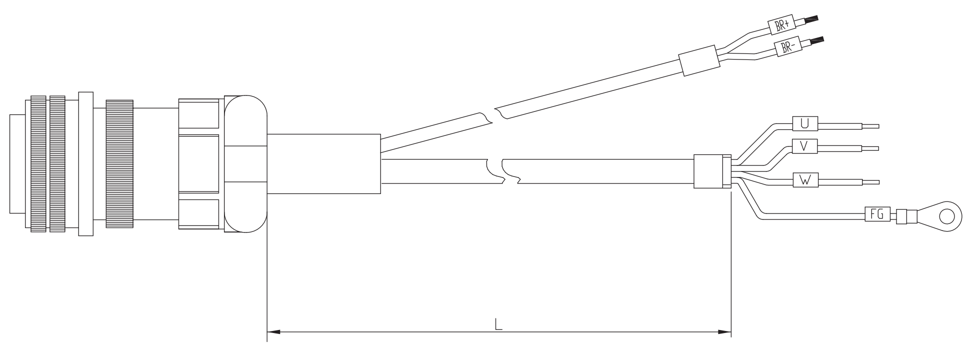
SV2C-PC16-xxxN Diagram



B.2.4 - For SV2L-210B, SV2L-410B, SV2M-410B, SV2L-415B, SV2L-420B

Cable Type	Part Number	Use With	Connector	Diameter (mm)	Gauge	L mm	L inch	Bend Radius (mm)
Non-flex Rated	SV2C-PC16-03NB	1kW low inertia motors with brake	SV2C-PC-CON	11	16	3000 ± 50	118 ± 2	82.5
	SV2C-PC16-05NB					5000 ± 50	197 ± 2	
	SV2C-PC16-10NB					10000 ± 100	394 ± 4	
	SV2C-PC16-20NB					20000 ± 100	788 ± 4	
Flex Rated	SV2C-PC16-03FB					3000 ± 50	118 ± 2	
	SV2C-PC16-05FB					5000 ± 50	197 ± 2	
	SV2C-PC16-10FB					10000 ± 100	394 ± 4	
	SV2C-PC16-20FB					20000 ± 100	788 ± 4	

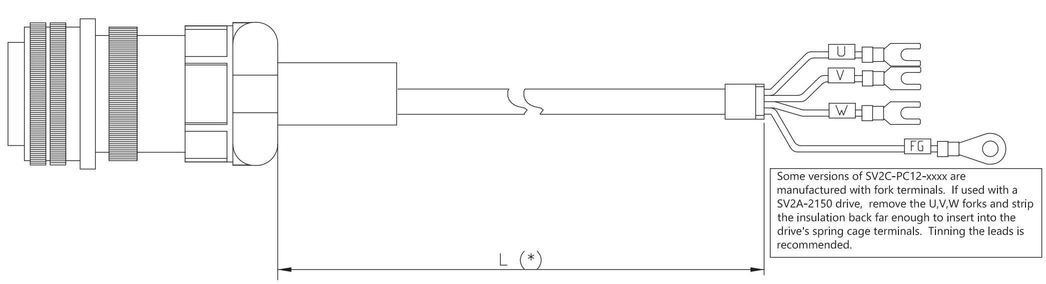
SV2C-PC16-xxxB Diagram



B.2.5 - 230V 1 and 1.5 kW Medium Inertia Motors (no brake)

Cable Type	Part Number	Use With	Connector	Diameter (mm)	Gauge	L mm	L inch	Bend Radius (mm)
Non-flex Rated	SV2C-PC12-03NN	1kW and 1.5 kW medium inertia motors without brake	SV2C-PC-CON	15	12	3000 ± 50	118 ± 2	108.75
	SV2C-PC12-05NN					5000 ± 50	197 ± 2	
	SV2C-PC12-10NN					10000 ± 100	394 ± 4	
	SV2C-PC12-20NN					20000 ± 100	788 ± 4	
Flex Rated	SV2C-PC12-03FN					3000 ± 50	118 ± 2	
	SV2C-PC12-05FN					5000 ± 50	197 ± 2	
	SV2C-PC12-10FN					10000 ± 100	394 ± 4	
	SV2C-PC12-20FN					20000 ± 100	788 ± 4	

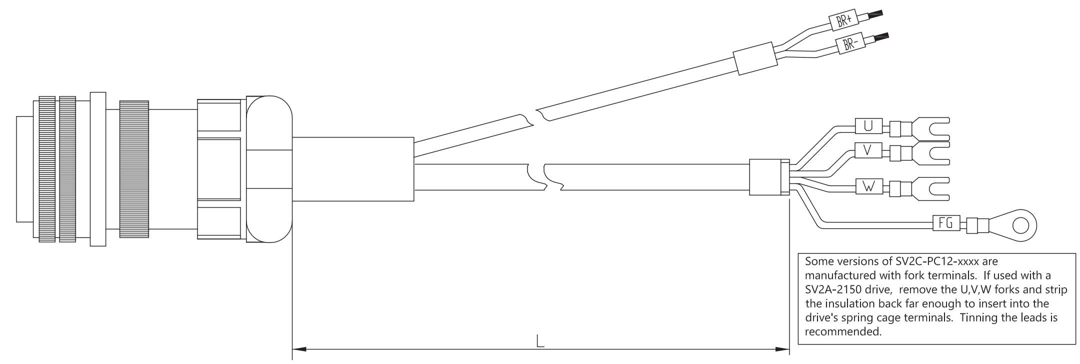
SV2C-PC12-xxxN Diagram



B.2.6 - 230V 1 and 1.5 kW Medium Inertia Motors (with brake)

Cable Type	Part Number	Use With	Connector	Diameter (mm)	Gauge	L		Bend Radius (mm)
						mm	inch	
Non-flex Rated	SV2C-PC12-03NB	1kW and 1.5 kW medium inertia motors with brake	SV2C-PC-CON	15	12	3000 ± 50	118 ± 2	108.75
	SV2C-PC12-05NB					5000 ± 50	197 ± 2	
	SV2C-PC12-10NB					10000 ± 100	394 ± 4	
	SV2C-PC12-20NB					20000 ± 100	788 ± 4	
Flex Rated	SV2C-PC12-03FB					3000 ± 50	118 ± 2	
	SV2C-PC12-05FB					5000 ± 50	197 ± 2	
	SV2C-PC12-10FB					10000 ± 100	394 ± 4	
	SV2C-PC12-20FB					20000 ± 100	788 ± 4	

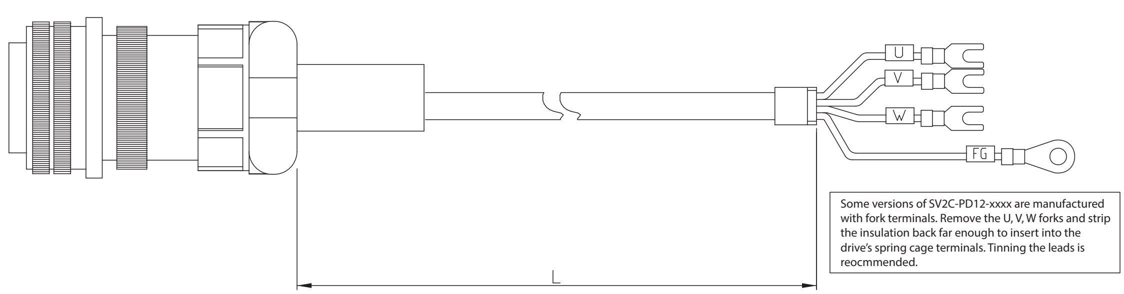
SV2C-PC12-xxxB Diagram



B.2.7 - For SV2M-220N, SV2M-230N, and SV2H-430N Motors

Cable Type	Part Number	Use With	Connector	Diameter (mm)	Gauge	L		Bend Radius (mm)
						mm	inch	
Non-flex Rated	SV2C-PD12-03NN	2kW and 3kW medium inertia motors without brake	SV2C-PD-CON	15	12	3000 ± 50	118 ± 2	108.75
	SV2C-PD12-05NN					5000 ± 50	197 ± 2	
	SV2C-PD12-10NN					10000 ± 100	394 ± 4	
	SV2C-PD12-20NN					20000 ± 100	788 ± 4	
Flex Rated	SV2C-PD12-03FN					3000 ± 50	118 ± 2	
	SV2C-PD12-05FN					5000 ± 50	197 ± 2	
	SV2C-PD12-10FN					10000 ± 100	394 ± 4	
	SV2C-PD12-20FN					20000 ± 100	788 ± 4	

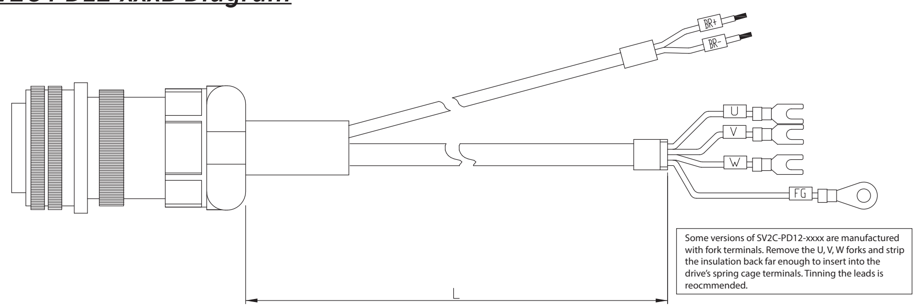
SV2C-PD12-xxxN Diagram



B.2.8 - For SV2M-220B, SV2M-230B, and SV2H-430B Motors

Cable Type	Part Number	Use With	Connector	Diameter (mm)	Gauge	L		Bend Radius (mm)
						mm	inch	
Non-flex Rated	SV2C-PD12-03NB	2kW and 3kW medium inertia motors with brake	SV2C-PD-CON	15	12	3000 ± 50	118 ± 2	108.75
	SV2C-PD12-05NB					5000 ± 50	197 ± 2	
	SV2C-PD12-10NB					10000 ± 100	394 ± 4	
	SV2C-PD12-20NB					20000 ± 100	788 ± 4	
Flex Rated	SV2C-PD12-03FB					3000 ± 50	118 ± 2	
	SV2C-PD12-05FB					5000 ± 50	197 ± 2	
	SV2C-PD12-10FB					10000 ± 100	394 ± 4	
	SV2C-PD12-20FB					20000 ± 100	788 ± 4	

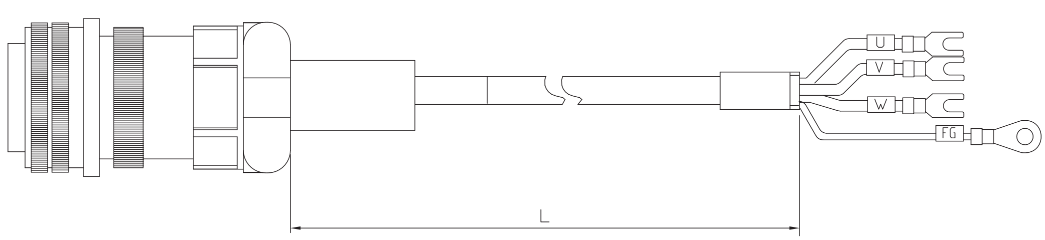
SV2C-PD12-xxxB Diagram



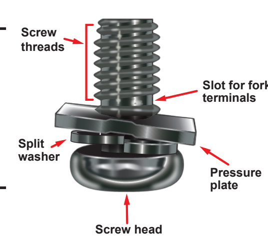
B.2.9 - For SV2H-245N, SV2H-445N, SV2H-455N, and SV2H-475N Motors

Cable Type	Part Number	Use With	Connector	Diameter (mm)	Gauge	L		Bend Radius (mm)
						mm	inch	
Non-flex Rated	SV2C-PD08-03NN	4.5 kW high inertia motors without brake	SV2C-PD-CON	22	8	3000 ± 50	118 ± 2	165
	SV2C-PD08-05NN					5000 ± 50	197 ± 2	
	SV2C-PD08-10NN					10000 ± 100	394 ± 4	
	SV2C-PD08-20NN					20000 ± 100	788 ± 4	
Flex Rated	SV2C-PD08-03FN					3000 ± 50	118 ± 2	
	SV2C-PD08-05FN					5000 ± 50	197 ± 2	
	SV2C-PD08-10FN					10000 ± 100	394 ± 4	
	SV2C-PD08-20FN					20000 ± 100	788 ± 4	

SV2C-PD08-xxxN Diagram



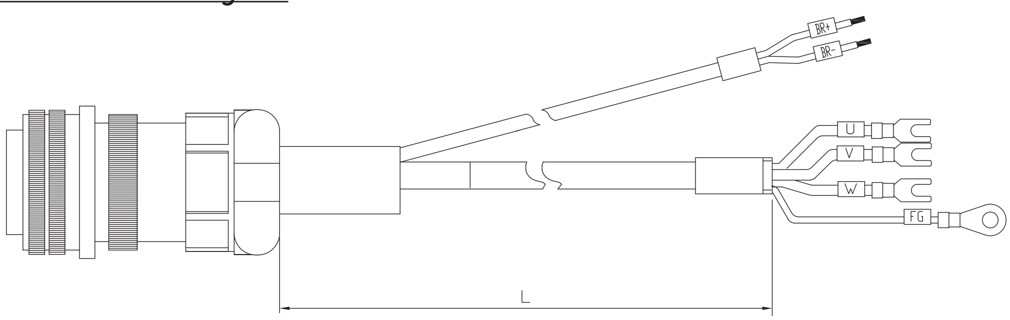
NOTE: The fork connectors on the PD08 motor power cables (for 4.5kW motors) may not fit around the threads of the 5.5kW drive's motor power screws. There is a small area between the screw threads and the screw head (beside the screw's pressure plate) where the threads taper off. Slide the fork terminals around the screw there (near the pressure plate).



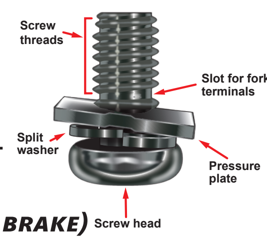
B.2.10 - For SV2H-245B, SV2H-445B, SV2H-455B, and SV2H-475B Motors

Cable Type	Part Number	Use With	Connector	Diameter (mm)	Gauge	L		Bend Radius (mm)
						mm	inch	
Non-flex Rated	SV2C-PD08-03NB	4.5 kW high inertia motors with brake	SV2C-PD-CON	22	8	3000 ± 50	118 ± 2	165
	SV2C-PD08-05NB					5000 ± 50	197 ± 2	
	SV2C-PD08-10NB					10000 ± 100	394 ± 4	
	SV2C-PD08-20NB					20000 ± 100	788 ± 4	
Flex Rated	SV2C-PD08-03FB					3000 ± 50	118 ± 2	
	SV2C-PD08-05FB					5000 ± 50	197 ± 2	
	SV2C-PD08-10FB					10000 ± 100	394 ± 4	
	SV2C-PD08-20FB					20000 ± 100	788 ± 4	

SV2C-PD08-xxxB Diagram



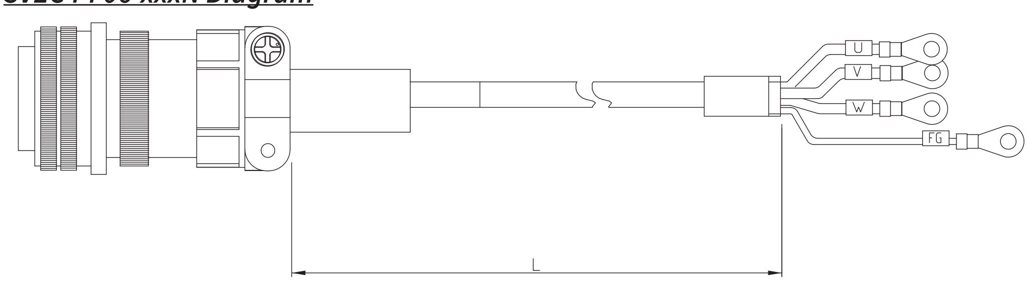
NOTE: The fork connectors on the PD08 motor power cables (for 4.5kW motors) may not fit around the threads of the 5.5kW drive's motor power screws. There is a small area between the screw threads and the screw head (beside the screw's pressure plate) where the threads taper off. Slide the fork terminals around the screw there (near the pressure plate).



B.2.11 - 230V 5.5 to 11 kW High Inertia Motors (with and without brake)

Cable Type	Part Number	Use With	Connector	Diameter (mm)	Gauge	L		Bend Radius (mm)
						mm	inch	
Non-flex Rated	SV2C-PF06-03NN	230V 5.5 to 11 kW high inertia motors (brake motors also require SV2C-B120-xxxB cable, see next page)	SV2C-PF-CON	27	6	3000 ± 50	118 ± 2	210
	SV2C-PF06-05NN					5000 ± 50	197 ± 2	
	SV2C-PF06-10NN					10000 ± 100	394 ± 4	
	SV2C-PF06-20NN					20000 ± 100	788 ± 4	
Flex Rated	SV2C-PF06-03FN					3000 ± 50	118 ± 2	
	SV2C-PF06-05FN					5000 ± 50	197 ± 2	
	SV2C-PF06-10FN					10000 ± 100	394 ± 4	
	SV2C-PF06-20FN					20000 ± 100	788 ± 4	

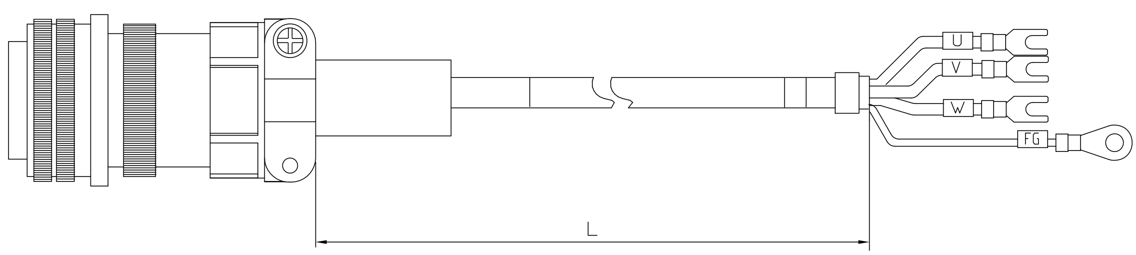
SV2C-PF06-xxxN Diagram



B.2.12 - 11 to 15 kW High Inertia Motors (460V, with and without brake)

Cable Type	Part Number	Use With	Connector	Diameter (mm)	Gauge	L mm	L inch	Bend Radius (mm)
Non-flex Rated	SV2C-PF08-03NN	11-15 kW 460V high inertia motors (brake motors also require SV2C-B120-xxxB cable, see below)	SV2C-PF-CON	22	8	3000 ± 50	118 ± 2	165
	SV2C-PF08-05NN					5000 ± 50	197 ± 2	
	SV2C-PF08-10NN					10000 ± 100	394 ± 4	
	SV2C-PF08-20NN					20000 ± 100	788 ± 4	
Flex Rated	SV2C-PF08-03FN					3000 ± 50	118 ± 2	
	SV2C-PF08-05FN					5000 ± 50	197 ± 2	
	SV2C-PF08-10FN					10000 ± 100	394 ± 4	
	SV2C-PF08-20FN					20000 ± 100	788 ± 4	

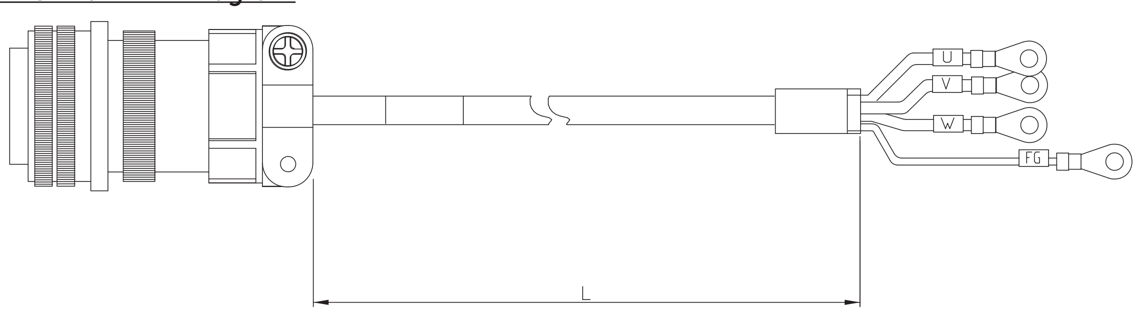
SV2C-PF08-xxxN Diagram



B.2.13 - 230V 15kW High Inertia Motors (with and without brake)

Cable Type	Part Number	Use With	Connector	Diameter (mm)	Gauge	L mm	L inch	Bend Radius (mm)
Non-flex Rated	SV2C-PF04-03NN	15kW high inertia motors (brake motors also require SV2C-B120-xxxB cable, see below)	SV2C-PF-CON	32	4	3000 ± 50	118 ± 2	240
	SV2C-PF04-05NN					5000 ± 50	197 ± 2	
	SV2C-PF04-10NN					10000 ± 100	394 ± 4	
	SV2C-PF04-20NN					20000 ± 100	788 ± 4	
Flex Rated	SV2C-PF04-03FN					3000 ± 50	118 ± 2	
	SV2C-PF04-05FN					5000 ± 50	197 ± 2	
	SV2C-PF04-10FN					10000 ± 100	394 ± 4	
	SV2C-PF04-20FN					20000 ± 100	788 ± 4	

SV2C-PF04-xxxN Diagram

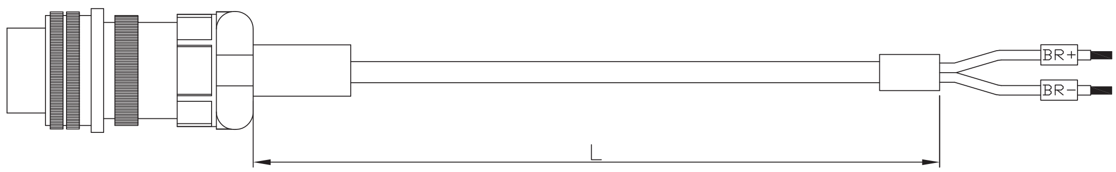


B.2.14 - 230V 5.5 to 15 kW High Inertia Motors and 460V 11 and 15kW High Inertia Motors (with brake)

The 5.5 to 15 kW high inertia motors use the same motor power cable as the non-brake versions plus the specialized brake cable detailed below.

Cable Type	**Part Number**	**Use With**	**Connector**	**Diameter (mm)**	**Gauge**	**L**		**Bend Radius (mm)**
						mm	**inch**	
Non-flex Rated	SV2C-B120-03NB	5.5 to 15 kW high inertia motors with brake	SV2C-B1-CON	5.5	20	3000 ± 50	118 ± 2	41.25
	SV2C-B120-05NB					5000 ± 50	197 ± 2	
	SV2C-B120-10NB					10000 ± 100	394 ± 4	
	SV2C-B120-20NB					20000 ± 100	788 ± 4	
Flex Rated	SV2C-B120-03FB					3000 ± 50	118 ± 2	
	SV2C-B120-05FB					5000 ± 50	197 ± 2	
	SV2C-B120-10FB					10000 ± 100	394 ± 4	
	SV2C-B120-20FB					20000 ± 100	788 ± 4	

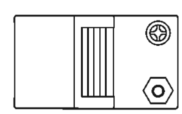
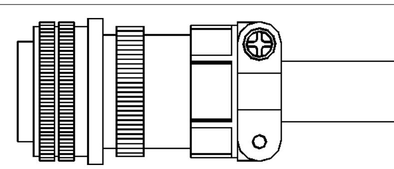
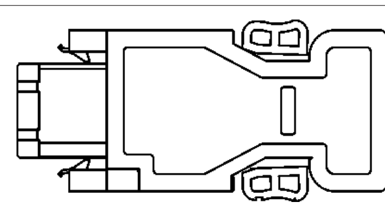
SV2C-B120-xxxB and SV2C-B1-CON Diagram



Note: Non-ADC part number is 3106A10SL-4S-R.

B.3 - Encoder Connector

The following encoder connectors are compatible with SureServo2 systems:

Encoder Connector	**Non-ADC Part Number**	**Use With**	**Reference Drawing**
SV2C-E1-CON motor cable connector	TE Connectivity 1-172161-9	Up to 750W motors	
SV2C-E2-CON motor connector	Apex WPS3106A20-29S-R	1kW to 15kW motors	
SV2C-E3-CON drive connector	Standard Firewire	All drives	

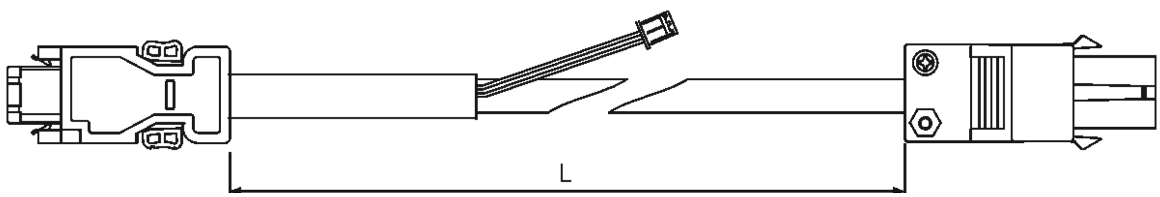
B.4 - Encoder Cables

SureServo2 encoder cables are not rated for long term use in oil environments.

B.4.1 - Up to 750W Motors

Cable Type	Part Number	Use With	Connector	Diameter (mm)	L mm	L inch	Bend Radius (mm)
Non-flex Rated	SV2C-E122-03NN	Up to 750W motors	SV2C-E1-CON	7	3000 ± 50	118 ± 2	52.5
	SV2C-E122-05NN				5000 ± 50	197 ± 2	
	SV2C-E122-10NN				10000 ± 100	394 ± 4	
	SV2C-E122-20NN				20000 ± 100	788 ± 4	
Flex Rated	SV2C-E122-03FN				3000 ± 50	118 ± 2	
	SV2C-E122-05FN				5000 ± 50	197 ± 2	
	SV2C-E122-10FN				10000 ± 100	394 ± 4	
	SV2C-E122-20FN				20000 ± 100	788 ± 4	

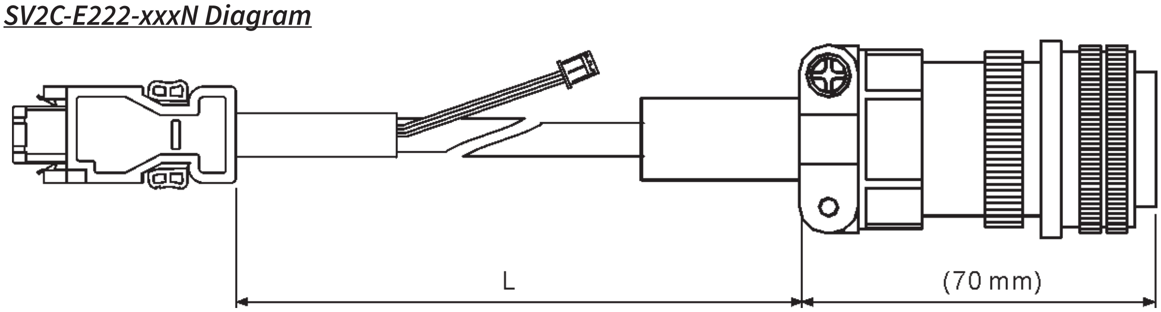
SV2C-E122-xxxN Diagram



B.4.2 - 1 to 15 kW Motors

Cable Type	Part Number	Use With	Connector	Diameter (mm)	L mm	L inch	Bend Radius (mm)
Non-flex Rated	SV2C-E222-03NN	1 to 15 kW motors	SV2C-E2-CON	7	3000 ± 50	118 ± 2	52.5
	SV2C-E222-05NN				5000 ± 50	197 ± 2	
	SV2C-E222-10NN				10000 ± 100	394 ± 4	
	SV2C-E222-20NN				20000 ± 100	788 ± 4	
Flex Rated	SV2C-E222-03FN				3000 ± 50	118 ± 2	
	SV2C-E222-05FN				5000 ± 50	197 ± 2	
	SV2C-E222-10FN				10000 ± 100	394 ± 4	
	SV2C-E222-20FN				20000 ± 100	788 ± 4	

SV2C-E222-xxxN Diagram

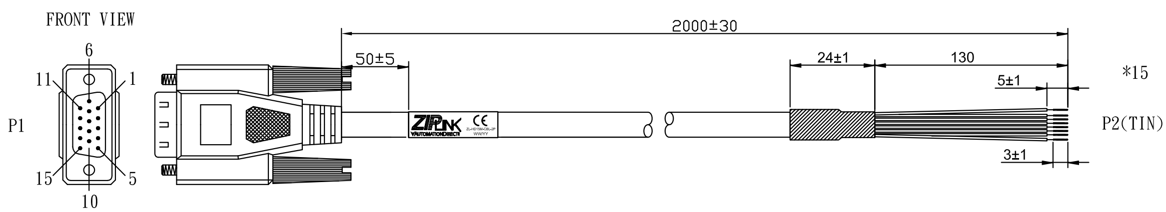


B.5 - Secondary Encoder Cables

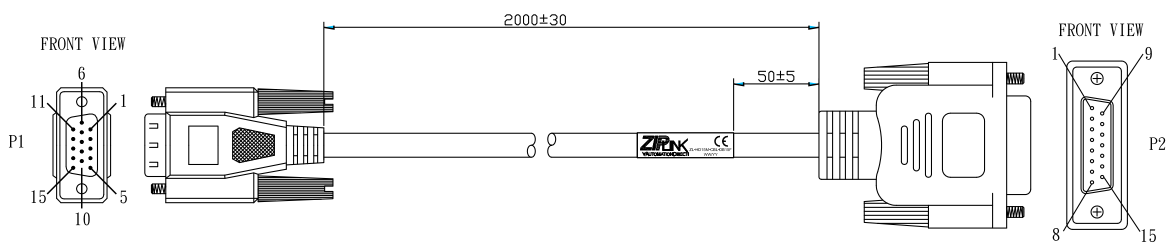
CN5 secondary encoder cables used to connect an external secondary encoder to the drive. Note that CN5 uses a wire not present in standard VGA cables (pin 8) - a standard VGA HD15 cable will not work, you must use one of these cables.

Cable Type	Part Number	Description	Use With	L	
				mm	inch
15-pin male to pigtail	ZL-HD15M-CBL-2P	ZIPLink communication cable, 15-pin D-sub HD15 male to pigtail, shielded, twisted pair.	All SureServo2 drives	2000 ± 30	78.74 ± 1.18
15-pin female to 15-pin male	ZL-HD15M-CBL-DB15F	ZIPLink communication cable, 15-pin female D-sub to 15-pin D-sub HD15 male, shielded, twisted pair. Use with ZL-RTB-DB15 breakout board.			

ZL-HD15M-CBL-2P Diagram



ZL-HD15M-CBL-DB15F Diagram



NOTE: Use with ZL-RTB-DB15 breakout board.

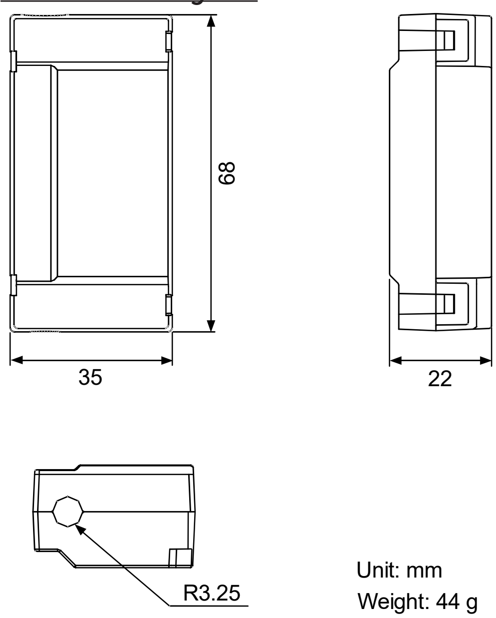
B.6 - External Battery

Encoders used with SureServo2 can be connected to an external battery box for power. This will allow the encoder to track position even when the servo power is off (results in an absolute positioning system). The BBOX mounts onto the encoder cable near the drive connector. Each encoder cable has a small mating connector that accepts the BBOX connector.

B.6.1 - Battery Box

Part Number	Type	Use With	Connector	Battery
SV2-BBOX-1	Single battery box	All SureServo2 drives	SV2-BBOX-CBL	(1) AA lithium battery included

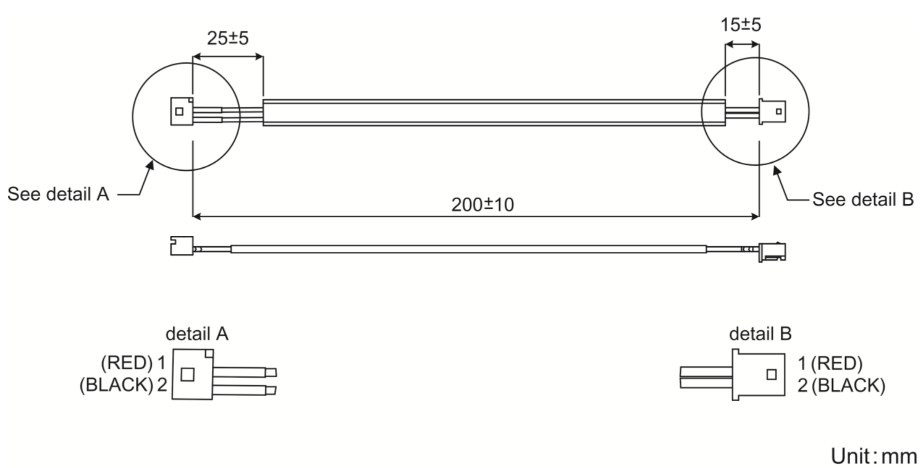
SV2-BBOX-1 Diagram



B.6.2 - Battery Box Cable

Optional. Use to mount the BBOX away from the encoder cable and drive if desired.

Part Number	Type	Use With	L	
			mm	inch
SV2-BBOX-CBL	Battery box connector cable	SV2-BBOX-1	200 ± 10	7.87 ± 0.39

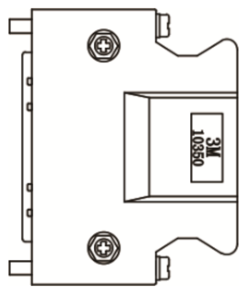


B.7 - I/O Connector

Use this solder-type connector to create a custom CN1 cable. Not recommended if more than a few wires are needed. See SV2-CN1-CBL50-x or SV2-CN1-LTB20.

Part Number	Type	Use With
SV2-CN1-CON	Optional I/O connector	All SureServo2 drives

<u>*SV2-CN1-CON Diagram*</u>

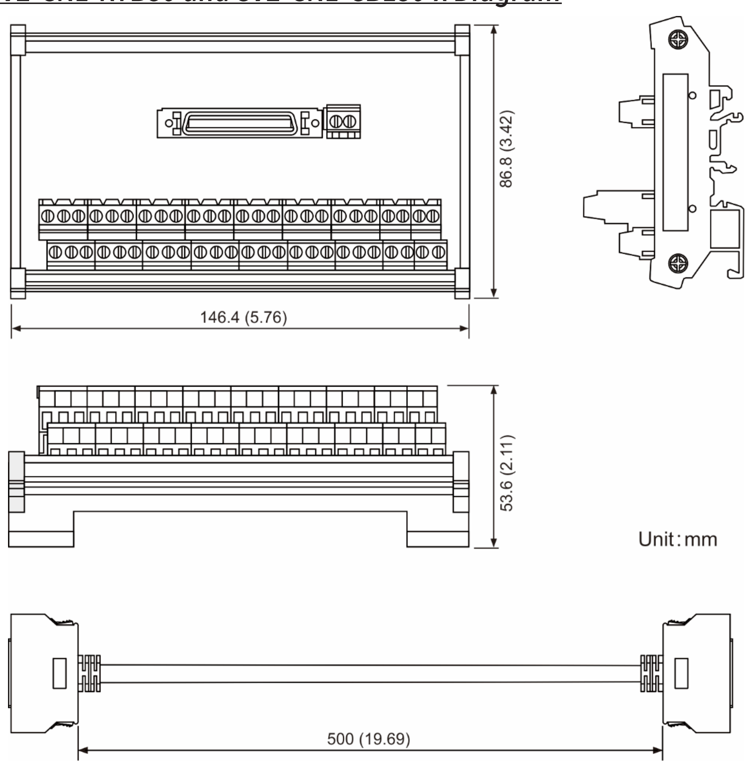


B.8 - Additional Terminal Options

B.8.1 - Terminal Block Module

Part Number	Type	Use With	L	
			mm	inch
SV2-CN1-RTB50	SureServo2 feedthrough module, 50-pole, DIN rail mount	All SureServo2 drives	–	–
SV2-CN1-CBL50	SureServo2 control cable with mating connectors		500	19.69
SV2-CN1-CBL50-1			1000	39.37
SV2-CN1-CBL50-2			2000	78.74

<u>*SV2-CN1-RTB50 and SV2-CN1-CBL50-x Diagram*</u>

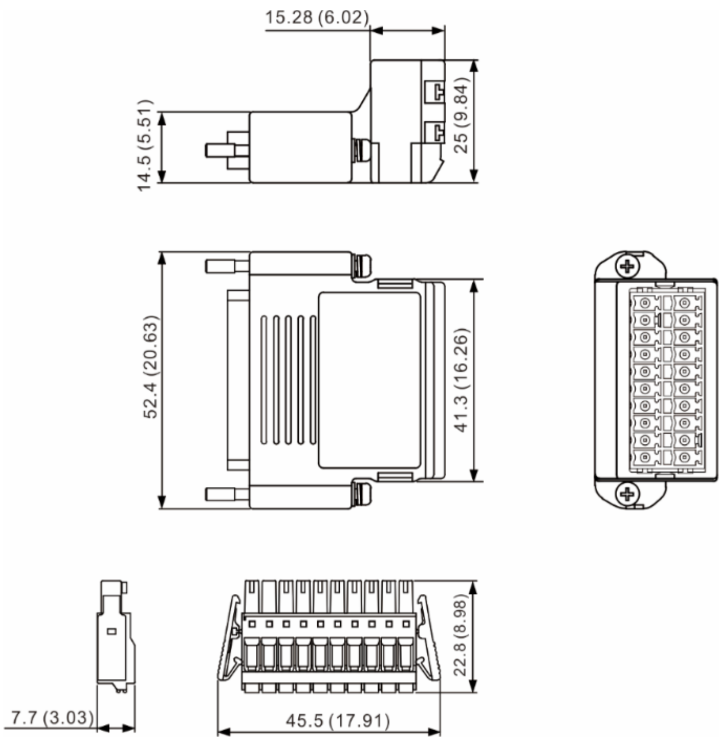


B.8.2 - Direct Mount Feedthrough Module

The SV2-CN1-LTB20 quick connector is designed for easy wiring and can be used with SureServo2 drives for applications that don't require too many I/O points. There are five digital inputs, four digital outputs, one Z phase open-collector output, and differential pulse command inputs.

Part Number	Type	Use With	L	
			mm	inch
SV2-CN1-LTB20	SureServo2 feedthrough module, 20-pole, direct mount.	All SureServo2 drives	–	–

SV2-CN1-LTB20

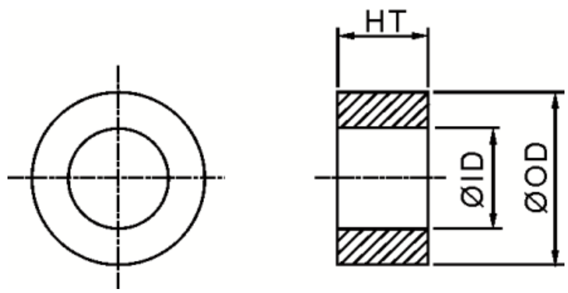


B.9 - Ferrite Ring

Toroids are used to mitigate high frequency noise/EMI. See Section 2.6 for installation and use.

Part Number	Type	Use With	Diameter (mm [inches])		Height (mm [inches])
			Inner	Outer	
SV2-TOR1	Toroid ring for EMI/RFI filtering	All SureServo2 drives	44.0 ± 0.6 [1.73 ± 0.02]	68.0 ± 0.6 [1.73 ± 0.02]	13.5 ± 0.5 [1.73 ± 0.0197]

SV2-TOR1 Diagram



B.10 - EMI Filters

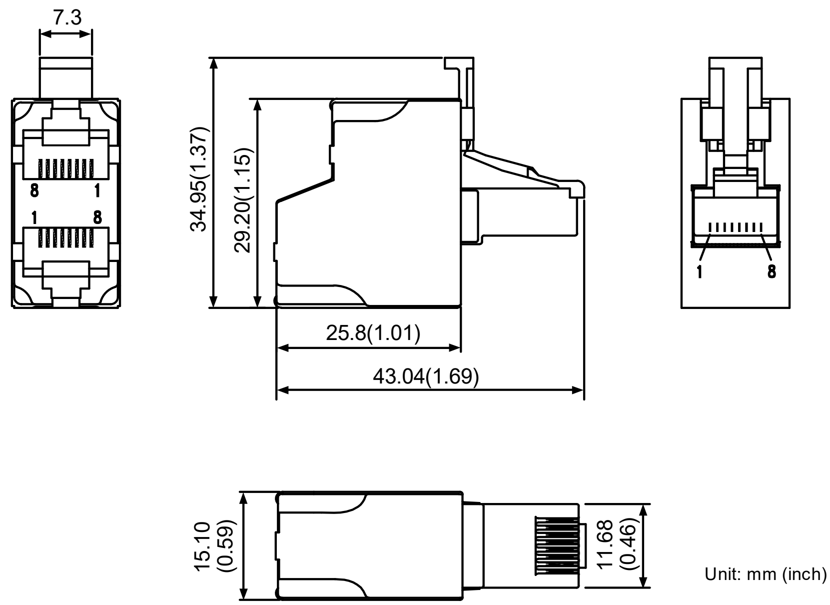
Servo drive model	Main Voltage Level	Drive Rated Input	Recommended Circuit Protection	GS Series Standard Performance EMI Filter	Roxburgh Good Performance EMI Filter	Roxburgh High Performance EMI Filter
SV2A-2040	100-120VAC 1-phase	3.98 A	8	EMF11AM21A	RES90F10	MIF10
	200-230VAC 1-phase	4.69 A	10	EMF11AM21A	RES90F10	MIF10
	200-230VAC 3-phase	2.76 A	5	EMF10AM23A	KMF306A	MIF310
SV2A-2075	100-120VAC 1-phase	7.73 A	15	EMF27AM21B	RES90F16	MIF16
	200-230VAC 1-phase	8.71 A	16	EMF27AM21B	RES90F16	MIF16
	200-230VAC 3-phase	5.09 A	10	EMF10AM23A	KMF310A	MIF310
SV2A-2150	100-120VAC 1-phase	12.56 A	20	EMF27AM21B	RES90S20	MIF23
	200-230VAC 1-phase	14.82 A	20	EMF27AM21B	RES90S20	MIF23
	200-230VAC 3-phase	8.09 A	15	EMF24AM23B	KMF318A	MIF316
SV2A-2200	100-120VAC 1-phase	18.03 A	30	EMF27AM21B	RES90S30	MIF330B
	200-230VAC 1-phase	20.83 A	30	EMF27AM21B	RES90S30	MIF330B
	200-230VAC 3-phase	11.36 A	20	EMF24AM23B	KMF325A	MIF323
SV2A-2300	200-230VAC 3-phase	14.52 A	30	EMF24AM23B	KMF336A	MIF330B
SV2A-2550	200-230VAC 3-phase	27.06 A	40	NA	KMF350A	MIF350
SV2A-2750	200-230VAC 3-phase	37.33 A	40	NA	KMF350A	MIF350
SV2A-2F00	200-230VAC 3-phase	69.95 A	70	NA	KMF3100A	MIF3100
SV2A-4040	460V 3-phase	1.5	3	EMF6A0M43A	KMF306A	MIF310
SV2A-4075	460V 3-phase	2.3	5	EMF6A0M43A	KMF306A	MIF310
SV2A-4150	460V 3-phase	5.0	7	EMF12AM43B	KMF310A	MIF310
SV2A-4200	460V 3-phase	6.3	10	EMF12AM43B	KMF318A	MIF316
SV2A-4300	460V 3-phase	9.9	15	EMF23AM43B	KMF325A	MIF323
SV2A-4550	460V 3-phase	16.8	25	NA	KMF336A	MIF330B
SV2A-4750	460V 3-phase	23.1	35	NA	KMF350A	MIF350
SV2A-4F00	460V 3-phase	36.7	50	NA	KMF370A	MIF375

B.11 - RS-485 Splitter

SureServo2 uses RJ45 connectors for CN3 (Modbus serial RS485). Use this 2-into-1 RJ45 adapter, standard RJ45 Ethernet cables, and an ZL-RTB-RJ45 breakout board to create an RS485 network with minimal customer wiring.

Part Number	Type	Use With
SV2-CN3-CON-2	SureServo2 splitter, (2) RS-485 (RJ45) to (1) RS-485 (RJ45)	All SureServo2 drives

SV2-CN3-CON-2 Diagram

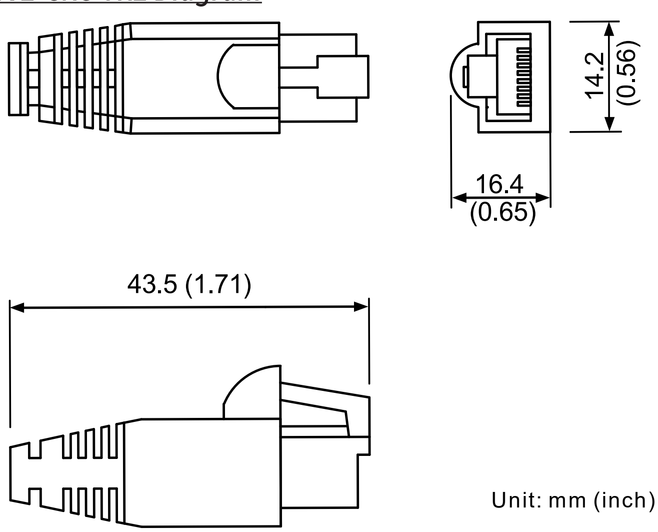


B.12 - RS-485 Terminating Resistor

Use this terminating resistor at the end of an RS485 network. Use this resistor combined with SV2-CN3-CON on the last drive on the network.

Part Number	Type	Use With
SV2-CN3-TR2	Terminating resistor, 120 ohm, RJ45 8P8C male.	All SureServo2 drives

SV2-CN3-TR2 Diagram

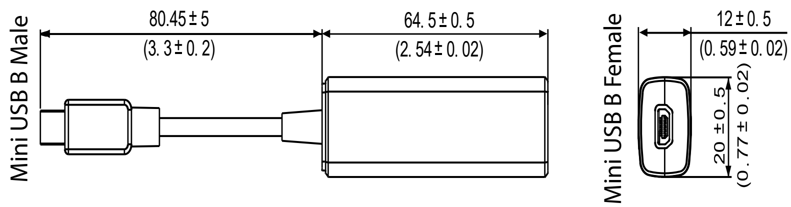


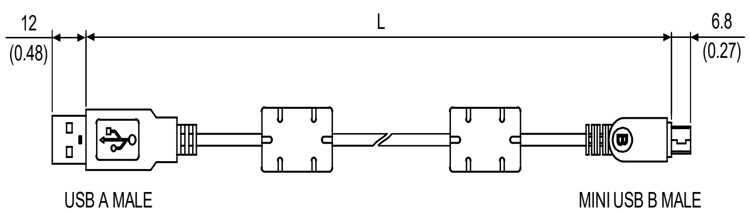
B.13 - USB Programming Cable

Each USB programming cable consists of two parts: a standard USB A to miniB USB cable, and a USB miniB filter/isolator. The filter/isolator is used in noisy environments to ensure consistent communication with the drive. The standard cable will allow a PC's USB port to power the servo CPU. The filter/isolator will isolate the USB power to the servo (only allows comms).

Part Number	Type	Use With	L	
			mm	inch
SV2-PGM-USB15	Programming cable, USB A to miniB-USB	All SureServo2 drives	1500 ± 100	59 ± 4
SV2-PGM-USB30			3000 ± 100	118 ± 4

SV2-PGM-USBxx Diagram





B.14 - Replacement Parts

B.14.1 - Connector Kit

Part Number	Type	Contents	Use With
SV2-CON-KIT	SureServo2 replacement connector kit	(1) SV2-CN10-STO STO connector (2) AC power connectors (1) Power resistor connector (1) Motor power connector (1) Wire insert tool	Up to 750W SureServo2 drives

SV2-CON-KIT

B.14.2 - STO (Safe Torque Off) Connector for CN10

Part Number	Type	Use With
SV2-CN10-STO	Replacement SureServo2 STO connector	For use with all SureServo2 drives

B.14.3 - Safety Specifications

The SureServo2 series servo drive conforms to the following safety specifications:

Item	Description	Standard	Safety Data
SFF	Safe failure fraction	IEC61508	Channel1: 80.08% Channel2: 68.91%
HFT (Type A subsystem)	Hardware fault tolerance	IEC61508	1
SIL	Safety integrity level	IEC61508	SIL2
		IEC62061	SILCL2
PFH	Probability of dangerous failure per hour (h^{-1})	IEC61508	$9.56x10^{-10}$
PFD_{av}	Average probability of failure on demand	IEC61508	$4.18x10^{-6}$
Category	Category	ISO13849-1	Category 3
PL	Performance level	ISO13849-1	d
$MTTF_d$	Mean time to dangerous failure	ISO13849-1	High
DC	Diagnostic coverage	ISO13849-1	Low