IronHorse ACN Series AC Drive User Manual

IH_ACN_UMW

Warnings and Trademarks

~ WARNING ~

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Warnings

Warning: Read this manual thoroughly before using ACN Series AC Motor Drives.

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

Warning: There are highly sensitive MOS components on the printed circuit boards, and these components are especially sensitive to static electricity. To avoid damage to these components, do not touch these components or the circuit boards with metal objects or your bare hands.

Warning: A charge may still remain in the DC-link capacitor with hazardous voltages, even if the power has been turned off. To avoid personal injury, do not remove the cover of the AC drive until all Display lights on the digital keypad are off. The Red Charge LED above the motor terminals indicates a voltage of >50VDC is present. Ensure this LED is off before service. Please note that there are live components exposed within the AC drive. Do not touch these live parts.

Warning: Ground the ACN Series AC Drive using the ground terminal. The grounding method must comply with the laws of the country where the AC drive is to be installed. Refer to the wiring diagrams in Chapter 2.

Warning: The AC drive may be destroyed beyond repair if incorrect cables are connected to the input/output terminals. Never connect the AC drive output terminals U, V, and W directly to the AC main circuit power supply.

Warning: Do not operate the drive with wet hands. Doing so may result in electric shock.

Warning: Check the information about the protection level for the circuits and devices. The following connection terminals and devices are the Protective Class 0. It means that the circuit protection level depends on the basic insulation. If the basic insulation has failed, it may cause accidental electric shock. When installing or wiring the connection terminals and devices, take the same protective action as with the power wire.

- *Multi-function Input: P1-P5, CM*
- *Analog Frequency Input: VR, V1, I2, TI*
- *Safety Function: SA, SB, SC*
- *Analog Output: AO*
- *Digital Output: Q1, EG, 24, A1/C1/B1 (Relay 1)*
- *Communications: S+/S-/SG*
- *Fan*

The protection level of this equipment (drive) is the Protective Class I.

Caution: Do not modify the interior workings of the drive. Doing so will void the warranty.

- *The drive is designed for 3-phase motor operation. Do not use the drive to operate a single phase motor.*
- *Do not place heavy objects on top of electric cables. Doing so may damage the cable and result in an electric shock.*
- *Do not operate Disconnect Switch when motor is operating.*

Maximum allowed prospective short-circuit current at the input power connection is defined in IEC 60439-1 as 100 kA. Depending on the selected MCCB, the ACN Series is suitable for use in circuits capable of delivering a maximum of 100 kA RMS symmetrical amperes at the drive's maximum rated voltage. See Appendix A- Fuse/Circuit breaker for more information

It is not recommended to use the IronHorse ACN AC drive with GFCI (Ground Fault Circuit Interrupt).

ACN Series Drives Manual Revision History

Please include the Manual Number and the Manual Issue, both shown below, when communicating with Technical Support regarding this publication.

Manual Number: ***IH_ACN_UMW***

Issue: ***Second Edition***

Issue Date: ***07/19/2024***

Publication History		
Issue	***Date***	***Description of Changes***
First Edition	07/28/2021	Original Issue
1st Ed., Rev A	11/09/2021	Ch 1: Updated Spec tables to reflect Input Current Rating applying to both 1 and 3 phase
1st Ed., Rev B	12/17/2021	Warnings: Removed unnecessary warning Ch 2: Removed ground system page (Did not apply)
1st Ed., Rev C	12/21/2021	Ch 2: Re-inserted correct ground system information
1st Ed., Rev D	05/23/2022	Warnings: Removed unnecessary warning
1st Ed., Rev E	09/13/2022	Ch 6 and Appendix D: Updated ambient temperature information
1st Ed., Rev F	09/26/2022	Warnings, Ch 2, Ch4, Ch6: Updated references to generic "relay" to "Relay 1" Ch2: Updated wiring diagram
1st Ed., Rev G	12/15/2022	Ch4: Added dr.94 and dr.95 table (Set Password and Lock Drive)
1st Ed., Rev H	05/02/2023	Ch4: Added details to Ad.79
1st Ed., Rev I	07/27/2023	AppxC: Changed descriptions for Control Supervisor Object, Item 6
1st Ed., Rev J	09/06/2023	Ch4: Corrected settings for Ad.71 parameter
1st Ed., Rev K	05/14/2024	Warnings: Added GFCI Warning Ch2: Added System Wiring Diagram
2nd Edition	07/19/2024	Chapter 7 removed to help file. Info on VFD suite added to Appendix A.

ACN AC Drive User Manual Table of Contents

ACN User Manual TOC

Chapter 1: Getting Started

Chapter 1

Table of Contents

User Manual Overview

Overview of this Publication

This user manual describes the installation, configuration, accessories, and methods of operation of the *IronHorse* ACN Series Variable Frequency AC Drives.

Who Should Read This Manual

This manual contains important information for those who will install, maintain, and/or operate any of the *IronHorse* ACN Series AC Drives.

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:

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Englewood, CO 80112-5776
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Special Symbols

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

WARNING: 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).

Purpose of AC Drives

AC drives are generally known by many different names: Adjustable Frequency Drives (AFD), Variable Frequency Drives (VFD), and Inverters. Drives are used primarily to vary the speed of three phase AC induction motors, and they also provide non-emergency start and stop control, acceleration and deceleration, and overload protection. By gradually accelerating the motor, drives can reduce the amount of motor startup inrush current.

AC drives function by converting incoming AC power to DC, which is then synthesized back into three phase output power. The voltage and frequency of this synthesized output power is directly varied by the drive, where the frequency determines the speed of the three phase AC induction motor.

Selecting the Proper Drive Rating

Determine Motor Full-Load Amperage (FLA)

Motor FLA is located on the nameplate of the motor.
NOTE: FLA of motors that have been rewound may be higher than stated.

Determine Motor Overload Requirements

Many applications experience temporary overload conditions due to starting requirements or impact loading. Most AC drives are designed to operate at 150% overload for 60 seconds. If the application requires an overload greater than 150% or longer than 60 seconds, the AC drive must be oversized.

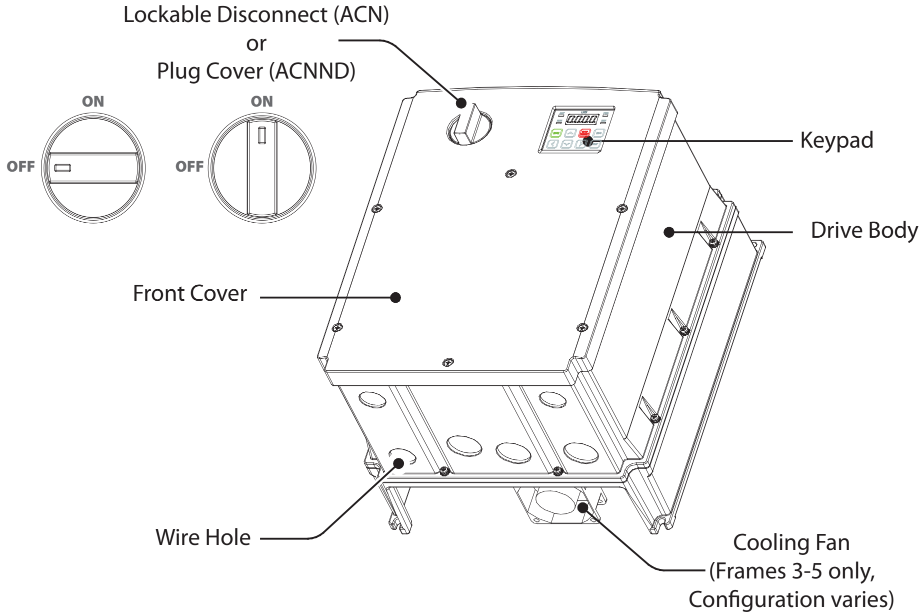
NOTE: Applications that require replacement of existing motor starters with AC drives may require up to 600% overload.

Determine Application Type; Constant Torque or Variable Torque

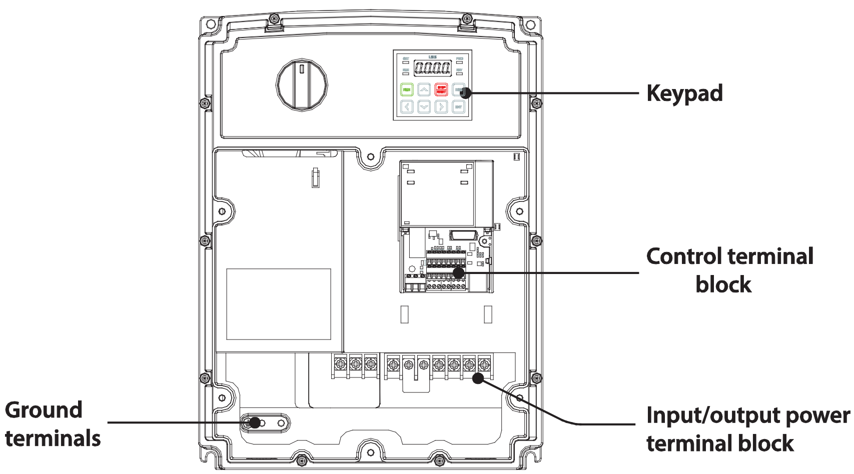
This torque requirement has a direct effect on which drive to select. Variable Torque applications are generally easier to start; typically fans and pumps. Most other applications outside fans and pumps fall into the Constant Torque category (machine control, conveyors, etc.). If you are unsure of the application, assume Constant Torque. ACN drives are specified with constant torque ratings only.

Parts Locater

The illustrations below show part names and locations. Details may vary between product groups.



Front Cover Removed



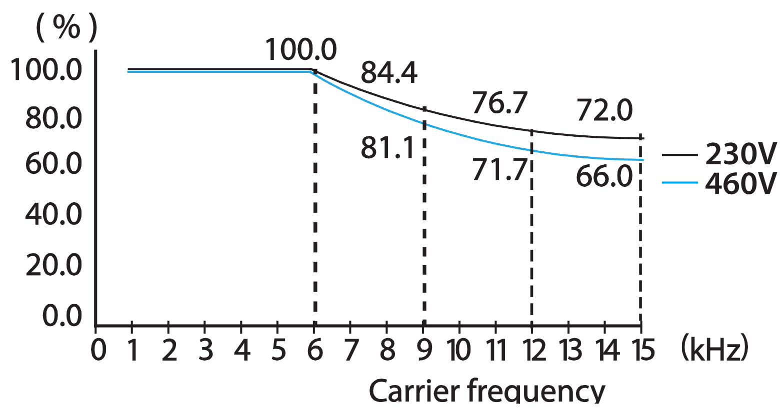
NOTE: The ACN version of the drive is equipped with a disconnect switch that allows lockout of the input power to the drive. This switch can be used for power isolation to perform maintenance and other duties to the motor and associated equipment. See Chapter 6 for disconnect operation.

Continuous Rated Current Derating

Derating by Carrier Frequency

The continuous rated current of the drive is limited based on the carrier frequency. Refer to the following graph.

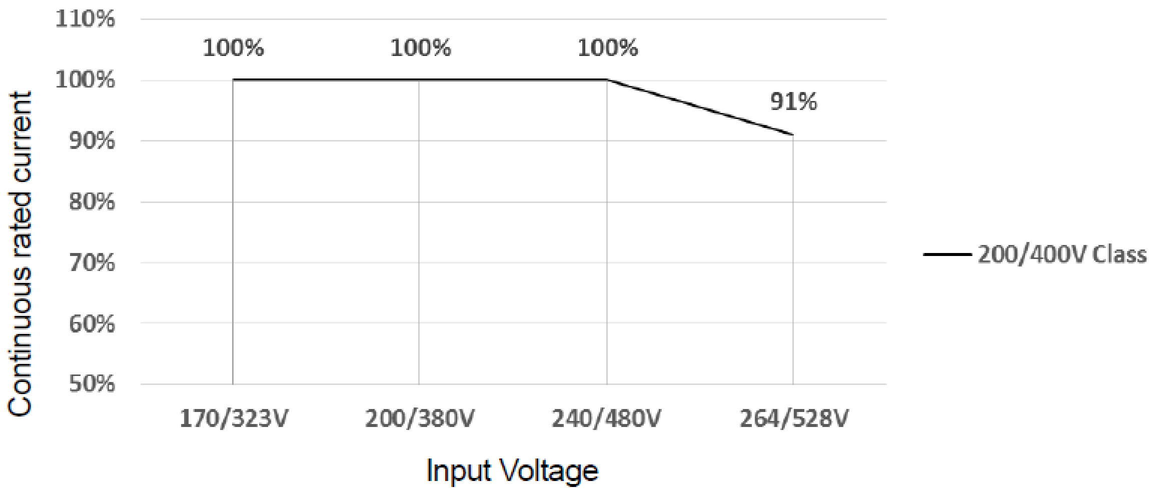
Continuous rated current (constant torque)



Derating by Carrier Frequency			
230V		***460V***	
Carrier Frequency (kHz)	***Constant Rated Current (%)***	***Carrier Frequency (kHz)***	***Constant Rated Current (%)***
1-6	100	1-6	100
9	84.4	9	81.1
12	76.7	12	71.7
15	72.0	15	66.0

Derating by Input Voltage

The continuous rated current of the drive is limited based on the input voltage. Refer to the following graphs.



Heat Emission

The following graph shows the drive's heat emission characteristics (by product capacity). Heat emission data is based on operations with default carrier frequency settings, under normal operating conditions. For detailed information on carrier frequency, "Operational Noise Settings (carrier frequency settings)" on page 4–171.

Watt Loss and Efficiency

IronHorse ACN Watt Loss and Efficiency							
Model Number ACN(ND)-xxxx	Voltage	Rated Power (kW)	Efficiency (%)	Total Losses (W)	Internal Losses (W)	External (Heat) Losses (W)	Heat Losses (Kcal)
20P5	230	0.4	96.6	21.6	12.6	9	7.7
21P0	230	0.8	96.7	42.4	12.6	29.8	25.6
22P0	230	1.5	96.9	76.5	16.8	59.7	51.3
23P0	230	2.2	97	110	16.8	93.2	80.2
25P0	230	4	97.3	188	18.9	169.1	145.4
27P5	230	5.5	97.5	247.5	38.7	208.8	179.6
2010	230	7.5	97.5	337.5	38.7	298.8	257
2015	230	11	97.8	462	38.7	423.3	364
2020	230	15	98	600	38.7	561.3	482.7
40P5	460	0.4	96.7	21.2	12.6	8.6	7.4
41P0	460	0.8	96.7	42.4	12.6	29.8	25.6
42P0	460	1.5	96.9	76.5	16.8	59.7	51.3
43P0	460	2.2	97	110	16.8	93.2	80.2
45P0	460	4	97.3	188	21	167	143.6
47P5	460	5.5	97.4	253	43	210	180.6
4010	460	7.5	97.5	337.5	43	294.5	253.3
4015	460	11	97.5	495	43	452	388.7
4020	460	15	97.5	675	43	632	543.5
4025	460	18.5	97.6	814	43	771	663.1
4030	460	22	97.7	946	43	903	776.6
This watt loss and efficiency data were measured under the following test conditions: • *Operation at 60Hz and room temperature* • *100% load* • *Carrier Frequency (Default value)*							

IronHorse ACN Series AC Drive Environmental Information

Storage and Transportation

AC drives should be kept in the shipping cartons or crates until they are installed to maintain the warranty coverage. Should they not be installed within three months of delivery, please store them as described below.

- *Store in a clean and dry location free from direct sunlight and corrosive fumes.*
- *Store within environmental conditions shown below in the "Environmental Conditions" table.*
- *DO NOT store in an area with rapid changes in temperature , to avoid condensation and frost.*
- *DO NOT place directly on the ground.*
- *Do not transport the drive by lifting with the drive's covers or plastic surfaces. The drive may tip over if covers break, causing injuries or damage to the product. Always support the drive using the metal frames when moving it.*
- *Hi-capacity drives are very heavy and bulky. Use an appropriate transport method that is suitable for the weight.*

If the drive is stored or is otherwise unused for more than a year, the drive's internal DC link capacitors should be recharged before use. Otherwise, the capacitors may be damaged when the drive starts to operate. We recommend recharging the capacitors of any unused drive at least once per year.

Environmental Conditions

Environmental Conditions for IronHorse ACN Series AC Drives	
Installation Location	IEC60529 standard IP66; NEMA standard 4X for indoor use. Not suitable for use in direct sunlight.
Cooling	Forced fan cooling structure Forced cooling type: 0.4-15 kW 230V/0.4-22 kW 460V (excluding some models)
Ambient Temperature	-10 to 40°C (14 to 104°F); No ice or frost should be present.
Storage Temperature*	-20° to 65°C (-4 to 149°F)
Relative Humidity	Max 90% (to avoid condensation)
Air Pressure	70 to 106 kPa
Pollution Level	Pollution level 3 environment: Prevent contact with corrosive gases, inflammable gases, oil stains, dust, and other pollutants.
Altitude	No higher than 3280ft (1,000m). From 1000 to 4000m, the rated input voltage and rated output current of the drive must be derated by 1% for every 100m.
Vibration	Less than 9.8 m/sec^2 (1G)
Installation Orientation	Max allowed offset angle = 0 degrees. (Vertical orientation only). Do not install the drive on the floor or mount it sideways against a wall. The drive MUST be installed vertically, on a wall or inside a panel, with its rear flat on the mounting surface.
** The ambient temperature is the temperature measured at a point 2" (5 cm) from the surface of the drive.*	

IronHorse ACN Series AC Drive Specifications

230V Class – (Model Specifications)

ACN 230V Class Constant Torque Specifications; Frame Sizes 1~2								
Model Name: ACN(ND)-xxxx			**20P5**	**21P0**	**22P0**	**23P0**	**25P0**
Frame Size			1		2		
Applied Motor	***Max Motor Output - 3ph input***	***hp***	0.5	1.0	2.0	3.0	5.4
		kW	0.4	0.75	1.5	2.2	4.0
	Max Motor Output – 1ph input	***hp***	1/6	0.5	1.0	1.5	2.0
		kW	0.1	0.4	0.7	1.1	1.5
Output Rating	***Rated Capacity–3ph input***	***kVA***	1.0	1.9	3.0	4.2	6.5
	Rated Current–3ph input	***A***	2.5	5.0	8.0	11.0	17.0
	Rated Current–1ph input	***A***	1.5	2.8	4.6	6.1	9.3
	Output Frequency	***Hz***	0-400 Hz (IM Sensorless: 0-120 Hz)				
	Output Voltage	***V***	3-phase 200-240 V				
Input Rating	***Working Voltage–3ph input***	***V***	3-phase 200-240 VAC (-15% to +10%)				
	Working Voltage–1ph input	***V***	1-phase 240VAC (-5% to +10%)				
	Input Frequency–3ph input	***Hz***	50-60 Hz (±5%)				
	Input Frequency–1ph input	***Hz***	60Hz (±5%)				
	Rated Current–1 or 3ph input	***A***	2.2	4.9	8.4	11.8	18.5
Weight (lb [kg])			7.9 [3.6]	7.9 [3.6]	11.5 [5.2]	11.9 [5.4]	12.13 [5.5]
Cooling Method			Forced Fan–Internal				

- *All specifications are for Constant Torque applications.*
- *The standard motor capacity is based on a standard 4-pole motor.*
- *The standard used for 230V drives is based on a 220V supply voltage.*
- *The rated output current is limited based on the carrier frequency set at Cn.04.*
- *The output voltage becomes 20~40% lower during no-load operations to protect the drive from the impact of the motor closing and opening (0.5~5HP models only).*

230V Class – (Model Specifications)

ACN 230V Class Constant Torque Specifications; Frame Sizes 3~5							
Model Name: ACN(ND)-xxxx			27P5	2010	2015	2020
Frame Size			3		4	5
Applied Motor	**Max Motor Output - 3ph input**	**hp**	7.5	10	15	20
		kW	5.5	7.5	11	15
	Max Motor Output – 1ph input	**hp**	3.0	5.0	7.5	10
		kW	2.2	3.7	5.6	7.5
Output Rating	**Rated Capacity–3ph input**	**kVA**	9.1	12.2	17.5	22.9
	Rated Current–3ph input	**A**	24.0	32.0	46.0	60.0
	Rated Current–1ph input	**A**	13.0	18.0	26.0	33.0
	Output Frequency	**Hz**	0-400 Hz (IM Sensorless: 0-120 Hz)			
	Output Voltage	**V**	3-phase 200-240 V			
Input Rating	**Working Voltage–3ph input**	**V**	3-phase 200-240 VAC (-15% to +10%)			
	Working Voltage–1ph input	**V**	1-phase 240VAC (-5% to +10%)			
	Input Frequency–3ph input	**Hz**	50-60 Hz (±5%)			
	Input Frequency–1ph input	**Hz**	60Hz (±5%)			
	Rated Current–1 or 3ph input	**A**	25.8	34.9	50.8	66.7
Weight (lb [kg])			19.4 [8.8]	19.4 [8.8]	20.7 [9.4]	26.2 [11.9]
Cooling Method			Forced Fan–Internal & Single External		Forced Fan-Internal & Dual External	

- *All specifications are for Constant Torque applications.*
- *The standard motor capacity is based on a standard 4-pole motor.*
- *The standard used for 230V drives is based on a 220V supply voltage.*
- *The rated output current is limited based on the carrier frequency set at Cn.04.*
- *The output voltage becomes 20~40% lower during no-load operations to protect the drive from the impact of the motor closing and opening (0.5~5HP models only).*

460V Class – (Model Specifications)

<table>
<tr><th colspan="8">ACN 460V Class Constant Torque Specifications; Frame Sizes 1~2</th></tr>
<tr><th colspan="3">Model Name: ACN(ND)-xxxx</th><th>40P5</th><th>41P0</th><th>42P0</th><th>43P0</th><th>45P0</th></tr>
<tr><td colspan="3">Frame Size</td><td colspan="2">1</td><td colspan="3">2</td></tr>
<tr><td rowspan="4">Applied Motor</td><td rowspan="2">Max Motor Output - 3ph input</td><td>hp</td><td>0.5</td><td>1.0</td><td>2.0</td><td>3.0</td><td>5.4</td></tr>
<tr><td>kW</td><td>0.4</td><td>0.75</td><td>1.5</td><td>2.2</td><td>4.0</td></tr>
<tr><td rowspan="2">Max Motor Output – 1ph input</td><td>hp</td><td>1/6</td><td>0.5</td><td>0.8</td><td>1.0</td><td>2.0</td></tr>
<tr><td>kW</td><td>0.1</td><td>0.4</td><td>0.6</td><td>0.7</td><td>1.5</td></tr>
<tr><td rowspan="5">Output Rating</td><td>Rated Capacity–3ph input</td><td>kVA</td><td>1.0</td><td>1.9</td><td>3.0</td><td>4.2</td><td>6.5</td></tr>
<tr><td>Rated Current–3ph input</td><td>A</td><td>1.3</td><td>2.5</td><td>4.0</td><td>5.5</td><td>9.0</td></tr>
<tr><td>Rated Current–1ph input</td><td>A</td><td>0.8</td><td>1.5</td><td>2.3</td><td>3.1</td><td>5.4</td></tr>
<tr><td>Output Frequency</td><td>Hz</td><td colspan="5">0-400 Hz (IM Sensorless: 0-120 Hz)</td></tr>
<tr><td>Output Voltage</td><td>V</td><td colspan="5">3-phase 380-480 V</td></tr>
<tr><td rowspan="5">Input Rating</td><td>Working Voltage–3ph input</td><td>V</td><td colspan="5">380-480 VAC (-15% to +10%)</td></tr>
<tr><td>Working Voltage–1ph input</td><td>V</td><td colspan="5">480VAC(-5% to +10%)</td></tr>
<tr><td>Input Frequency–3ph input</td><td>Hz</td><td colspan="5">50-60 Hz (±5%)</td></tr>
<tr><td>Input Frequency–1ph input</td><td>Hz</td><td colspan="5">60Hz (±5%)</td></tr>
<tr><td>Rated Current–1 or 3ph input</td><td>A</td><td>1.1</td><td>2.4</td><td>4.2</td><td>5.9</td><td>9.8</td></tr>
<tr><td colspan="3">Weight (lb [kg])</td><td>8.2 [3.7]</td><td>8.2 [3.7]</td><td>11.7 [5.3]</td><td>12.1 [5.5]</td><td>12.3 [5.6]</td></tr>
<tr><td colspan="3">Weight–Non EMC Filter Type (lb [kg])</td><td>7.9 [3.6]</td><td>7.9 [3.6]</td><td>11.5 [5.2]</td><td>11.9 [5.4]</td><td>12.13 [5.5]</td></tr>
<tr><td colspan="3">Cooling Method</td><td colspan="5">Forced Fan–Internal</td></tr>
</table>

- *All specifications are for Constant Torque applications.*
- *The standard motor capacity is based on a standard 4-pole motor.*
- *The standard used for 460V drives is based on a 440V supply voltage.*
- *The rated output current is limited based on the carrier frequency set at Cn.04.*
- *The output voltage becomes 20~40% lower during no-load operations to protect the drive from the impact of the motor closing and opening (0.5~5HP models only).*

460V Class – (Model Specifications)

ACN 460V Class Constant Torque Specifications; Frame Sizes 3~5								
Model Name: ACN(ND)-xxxx			**47P5**	**4010**	**4015**	**4020**	**4025**	**4030**
Frame Size			3		4		5	
Applied Motor	***Max Motor Output - 3ph input***	***hp***	7.5	10	15	20	25	30
		kW	5.5	7.5	11	15	18.5	22
	Max Motor Output – 1ph input	***hp***	3.0	5.0	7.5	10.0	10.0	15.0
		kW	2.2	3.7	5.6	7.5	7.5	11.2
Output Rating	***Rated Capacity–3ph input***	***kVA***	9.1	12.2	18.3	22.9	29.7	34.3
	Rated Current–3ph input	***A***	12.0	16.0	24.0	30.0	39.0	45.0
	Rated Current–1ph input	***A***	7.1	9.5	15.0	18.0	23.0	27.0
	Output Frequency	***Hz***	0-400 Hz (IM Sensorless: 0-120 Hz)					
	Output Voltage	***V***	3-phase 380-480 V					
Input Rating	***Working Voltage–3ph input***	***V***	3-phase 380-480 VAC (-15% to +10%)					
	Working Voltage–1ph input	***V***	1-phase 480VAC (-5% to +10%)					
	Input Frequency–3ph input	***Hz***	50-60 Hz (±5%)					
	Input Frequency–1ph input	***Hz***	60Hz (±5%)					
	Rated Current–1 or 3ph input	***A***	12.9	17.5	26.5	33.4	43.6	50.7
Weight (lb [kg])			19.4 [8.8]	19.6 [8.9]	21.2 [9.6]	21.6 [9.8]	27.3 [12.4]	27.3 [12.4]
Weight–Non EMC Filter Type (lb [kg])			18.9 [8.6]	19.2 [8.7]	20.7 [9.4]	21.2 [9.6]	26.9 [12.2]	26.9 [12.2]
Cooling Method			Forced Fan–Internal & Single External		Forced Fan-Internal & Dual External			

- *All specifications are for Constant Torque applications.*
- *The standard motor capacity is based on a standard 4-pole motor.*
- *The standard used for 460V drives is based on a 440V supply voltage.*
- *The rated output current is limited based on the carrier frequency set at Cn.04.*

Specifications Applicable to All ACN Series Models

IronHorse ACN Series General Specifications (All Models)		
Control Characteristics	Control Method	V/F, Slip Compensation, Sensorless Vector (IM or PM), Torque
	Applicable Motor	AC Induction Motor(IM), AC Permanent Magnet Motor(PM)
	Frequency Settings Power Resolution	Digital command: 0.01 Hz; Analog command: 0.06 Hz (60 Hz standard)
	Starting Torque	150% / 3Hz (V/F) 150% / 0.1 Hz (IM Sensorless) 100% / 3Hz (PM Sensorless
	Speed Regulation	± 3% of max freq (V/F) ± 0.3% of max freq (IM Sensorless) ± 1% of max freq (PM Sensorless)
	Speed Control Range	40:1 (V/F) 100:1 (IM Sensorless) 20:1 (PM Sensorless)
	Torque Mode Accuracy	± 10%
	Torque Mode Limits	± 180%
	V/F Pattern	Linear, square reduction, user V/F
	Overload Capacity	Constant Torque rated current: 150% for 1 minute; 200% for 4 sec
	Torque Boost	Manual torque boost, automatic torque boost
Operation Characteristics	Operation Command Signal	Keypad, Digital, Serial Communication
	Frequency Setting Signal	Analog type: -10~10 V, 0~10 V, 4~20 mA Digital type: keypad, pulse train input Serial Communication
	Main Functions	• PID control • 3-wire operation • Frequency limit • Second function • Anti-forward and reverse direction rotation • Commercial transition • Speed search • Power braking • Leakage reduction • Up-down operation • DC braking • Frequency jump • Slip compensation • Automatic restart • Automatic tuning • Energy buffering • Flux braking • Fire mode • Programmable User Sequence
	Digital Inputs	Five (5) - 24VDC NPN or PNP, includes 1 configurable 32kHz frequency input
	Digital Outputs	Two (2) - (1)-26VDC,100mA, configurable as 32kHz Pulse Output ; (1) Relay-250VAC/30VDC, 1A
	Analog Inputs	Two (2) - (1) voltage or potentiometer, (1) selectable Voltage or Current
	Analog Outputs	One (1) - selectable voltage (0-10 V) or current (0-20 mA)
	Safe Torque Off	SA and SB inputs- 24VDC

IronHorse ACN Series General Specifications (All Models)		
Function Characteristics	***Trip***	• External signal trip • ARM short circuit current trip • Overheat trip • Input imaging trip • Ground trip • Motor overheat trip • I/O board link trip • No motor trip • Parameter writing trip • Emergency stop trip • Command loss trip • External memory error • CPU watchdog trip • Motor normal load trip • Temperature sensor trip • Inverter overheat • Option trip • Output imaging trip • Inverter overload trip • Fan trip • Pre-PID operation failure • External break trip • Low voltage trip during operation • Low voltage trip • Safety A (B) trip • Analog input error • Motor overload trip
	Alarm	Command loss trip alarm, overload alarm, normal load alarm, drive overload alarm, fan operation alarm, resistance braking rate alarm, number of corrections on rotor tuning error
	PCB Conformal Coating	IEC 60721-3-3(3C2), IEC 60068-2-43, IEC 60068-2-60
Accessory	***Communication Card***	EtherNet/IP and Modbus TCP (ACN-ETH)
	IO Extension	3 DI, 2 DO, 2 AI, 1 AO (ACN-EIO)
Agency Approvals		UL, CE, TÜV NORD (SIL 2)

Receiving and Inspection

Drive Package Contents

After receiving the ACN Series AC drive, please check the following:

1) Make sure that the package includes the product insert.
2) Carefully follow the unpacking instructions contained in this chapter of this user manual when unpacking your AC drive.
3) Please inspect the unit after unpacking to assure it was not damaged during shipment. Make sure that the part number printed on the package corresponds with the part number indicated on the nameplate.
4) Make sure that the part number indicated on the nameplate corresponds with the part number of your order.
5) Make sure that the voltage for the wiring lies within the range as indicated on the nameplate. Please install the AC drive according to this manual.
6) Before applying the power, please make sure that all the devices, including power, motor, control board, and digital keypad are connected correctly.
7) When wiring the AC drive, please make sure that the wiring of input terminals and output terminals are correct to prevent drive damage.
8) When executing a trial run, please begin with a low speed, and then gradually increase the speed until the desired speed is reached.

The ACN series AC drive should be kept in the shipping carton or crate before installation. In order to retain the warranty coverage, the drive should be stored properly when it is not to be used for an extended period of time. Refer to the preceding "Environmental Information" section for proper storage conditions.

Model Number Explanation

ACN- 2 0P5

- **Applicable Motor Capacity with 3-Phase Input**

0P5: 0.5 hp	010: 10 hp
1P0: 1.0 hp	015: 15 hp
2P0: 2.0 hp	020: 20 hp
3P0: 3.0 hp	025: 25 hp
5P0: 5.0 hp	030: 30 hp
7P5: 7.5 hp	

- **Input Voltage**
  2: 230VAC
  4: 460VAC
- **Series Name**

Nameplate Information

MODEL : ACN-2020

QR Code

INPUT: 3PH 200-240V 50/60Hz 66.7A

SHORT CIRCUIT CURRENT: 100KA

OUTPUT: 3PH 200-240V 60.0A 22.9kVA 15.0kW/20.0 HP

FREQUENCY RANGE : 0-400Hz

IRONHORSE®
Automationdirect.com

CHAPTER 2: INSTALLATION AND WIRING

CHAPTER

2

TABLE OF CONTENTS

Drive Models by Frame Size

ACN Series Drive Models by Frame Size	
Frame	***Drive***
1	ACN(ND)-20P5; ACN(ND)-21P0; ACN(ND)-40P5; ACN(ND)-41P0
2	ACN(ND)-22P0; ACN(ND)-23P0; ACN(ND)-25P0; ACN(ND)-42P0; ACN(ND)-43P0; ACN(ND)-45P0
3	ACN(ND)-27P5; ACN(ND)-2010; ACN(ND)-47P5; ACN(ND)-4010
4	ACN(ND)-2015; ACN(ND)-4015; ACN(ND)-4020
5	ACN(ND)-2020; ACN(ND)-4025; ACN(ND)-4030

Installation

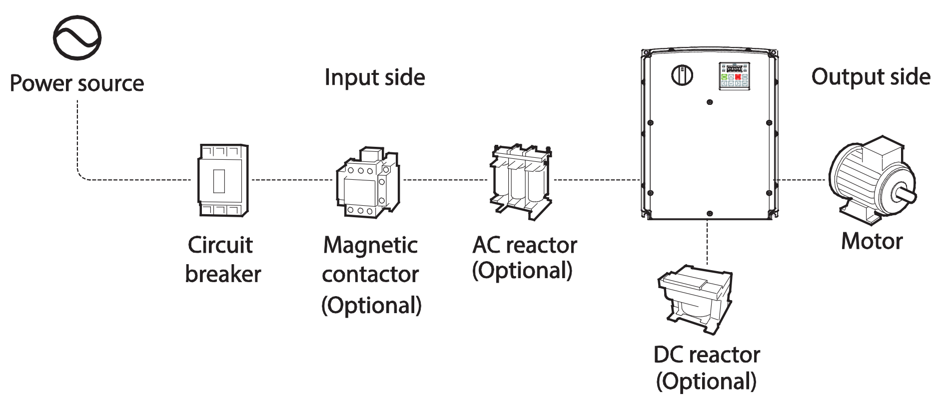
Install the AC drive in the proper IP66/NEMA4X rated environment. Provide proper spacing to allow the dissipation of heat produced by the drive and any other installed electrical and electronic equipment. Ventilation or air conditioning may also be required, depending upon the application.

Failure to observe these precautions may damage the drive and void the warranty. Improper installation of the AC drive will greatly reduce its life. Observe the following precautions when installing the drive:

- *Do not mount the AC drive near heat-radiating elements or in direct sunlight.*
- *Do not install the AC drive in a place subjected to high temperature, high humidity, excessive vibration, corrosive gases or liquids, or airborne dust or metallic particles.*
- *Mount the AC drive securely on a flat, rigid, non-flammable surface.*
- *Mount the AC drive vertically and do not restrict the air flow to the heat sink fins.*
- *Prevent fiber particles, scraps of paper, shredded wood saw dust, metal particles, etc., from adhering to the heat sink.*
- *Install covers and circuit breakers before operating the inverter. Drawings in this manual are shown with covers or circuit breakers removed to show a more detailed view of the installation arrangements.*
- *Operate the product according to the instructions in this manual.*

Basic Configuration Diagram

The reference diagram below shows a typical system configuration showing the drive and peripheral devices.



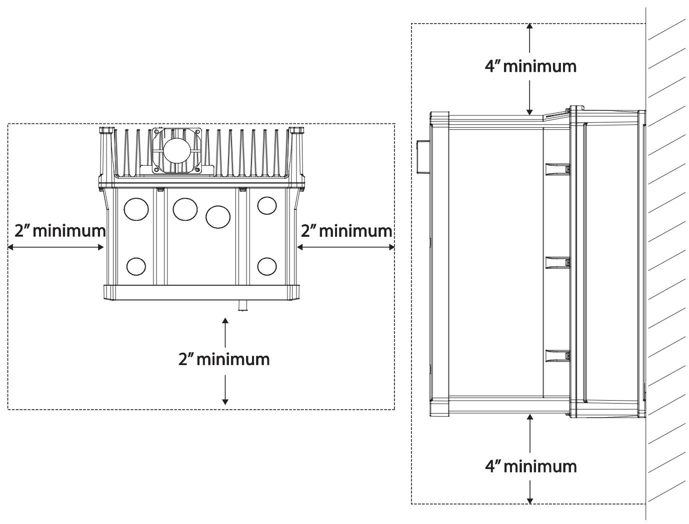
Installation Considerations

Drives are composed of various precision, electronic devices, and therefore the installation environment can significantly impact the lifespan and reliability of the product. See the environmental conditions table in Chapter 1 for information on the ideal operation and installation conditions for the drive.

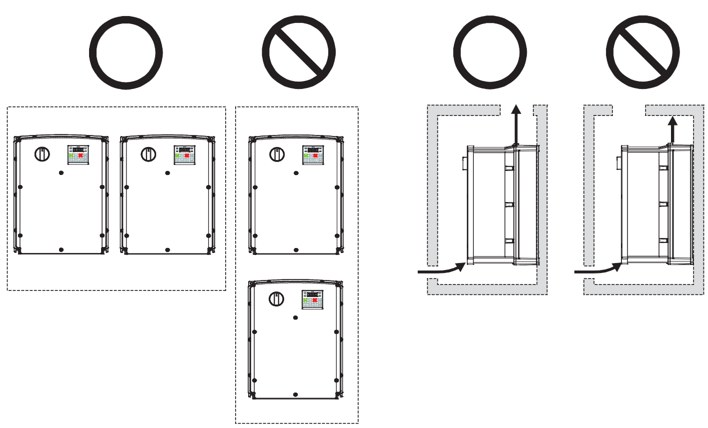
Minimum Clearances and Air Flow

The drive can become very hot during operation. Install the drive on a surface that is fire-resistant or flame-retardant and with sufficient clearance around the drive to allow air to circulate. The following illustrations show the required installation clearances. Do not allow the ambient temperature to exceed the allowable range while operating the drive.

If you are installing multiple drives of different ratings, provide sufficient clearance to meet the clearance specifications of the larger drive.

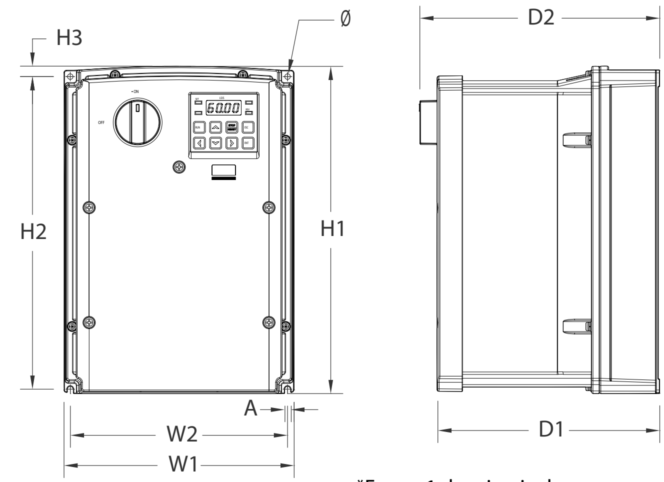


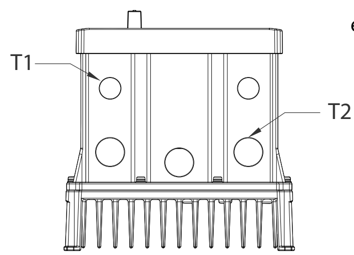
Ensure sufficient air circulation is provided around the drive when it is installed. If the drive is to be installed inside a panel, enclosure, or cabinet rack, carefully consider the position of the drive's cooling fan and the ventilation louver. Cooling fans must be positioned to efficiently transfer the heat generated by the operation of the drive.



Dimensions

See our website: www.AutomationDirect.com for complete engineering drawings and 3D models.





*Frame 1 drawing is shown as an example for dimension references only. See specific links below for exact Frame drawings

Dimensions												
Frame	Part no	W1	W2	H1	H2	H3	D1	D2	A	Ø	T1	T2	Drawings
1	ACN(ND)-20P5	180 (7.09)	170 (6.69)	256.6 (1010)	245 (9.65)	8.2 (0.32)	174.2 (6.86)	188.2 (7.41)	4.5 (0.18)	4.5 (0.18)	22.3 (0.88)	-	PDF
	ACN(ND)-21P0												PDF
	ACN(ND)-40P5												PDF
	ACN(ND)-41P0												PDF
2	ACN(ND)-22P0	220 (8.66)	204 (8.03)	258.8 (10.19)	241 (9.49)	11.8 (0.46)	201 (7.91)	215 (8.46)	5.5 (0.22)	5.5 (0.22)	22.3 (0.88)	28.6 (1.13)	PDF
	ACN(ND)-23P0												PDF
	ACN(ND)-25P0												PDF
	ACN(ND)-42P0												PDF
	ACN(ND)-43P0												PDF
	ACN(ND)-45P0												PDF
3	ACN(ND)-27P5	250 (9.84)	232 (9.13)	328 (12.91)	308 (12.13)	11 (0.43)	227.2 (8.94)	241.2 (9.50)	6 (0.24)	6 (0.24)	22.3 (0.88)	28.6 (1.13)	PDF
	ACN(ND)-2010												PDF
	ACN(ND)-47P5												PDF
	ACN(ND)-4010												PDF
4	ACN(ND)-2015	260 (10.24)	229 (9.02)	399.6 (15.73)	377 (14.84)	14.6 (0.57)	245.4 (9.66)	259.6 (10.22)	6 (0.24)	-	22.3 (0.88)	34.9 (1.37)	PDF
	ACN(ND)-4015												PDF
	ACN(ND)-4020												PDF
5	ACN(ND)-2020	300 (11.81)	270.8 (10.66)	460 (18.11)	436.5 (17.19)	15.5 (0.61)	250 (9.84)	264 (10.39)	6 (0.24)	-	22.3 (0.88)	44.5 (1.75)	PDF
	ACN(ND)-4025												PDF
	ACN(ND)-4030												PDF

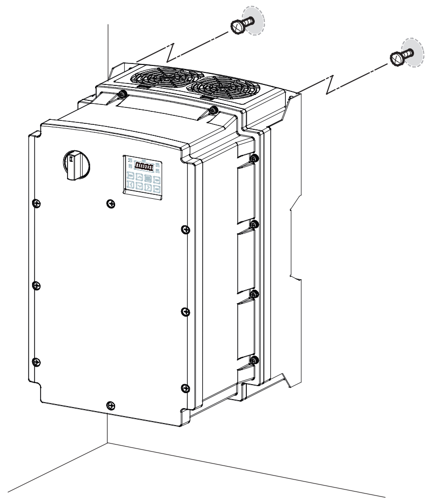
Units: mm (in)

Mounting the Drive

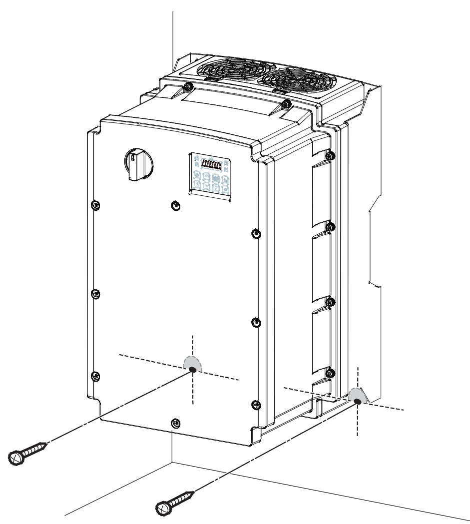
Mount the drive on a wall or inside a panel following the procedures below. Before installation, ensure that there is sufficient space to meet the clearance specifications, and that there are no obstacles impeding the cooling fan's air flow. The drive must be installed on a wall that can support the drive's weight. The location must be free from vibration, which can adversely affect the operation of the drive.

Select a wall or panel suitable to support the installation. Refer to the dimensions drawings and check the drive's mounting bracket dimensions.

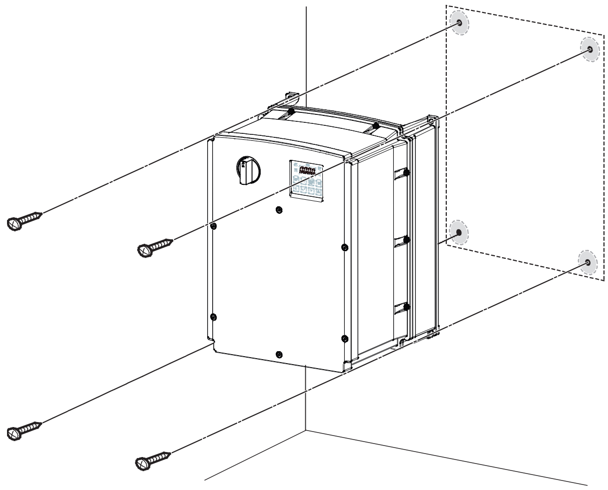
- *Use a level to draw a horizontal line on the mounting surface, and then carefully mark the fixing points.*
- *Drill the two upper mounting bolt holes, and then install the mounting bolts into the top holes of the drive. Do not fully tighten the bolts at this time.*



- *Mount the drive on the wall or inside a panel using the two upper bolts, and then fully tighten the mounting bolts. Ensure that the drive is placed flat on the mounting surface, and that the installation surface can securely support the weight of the drive.*

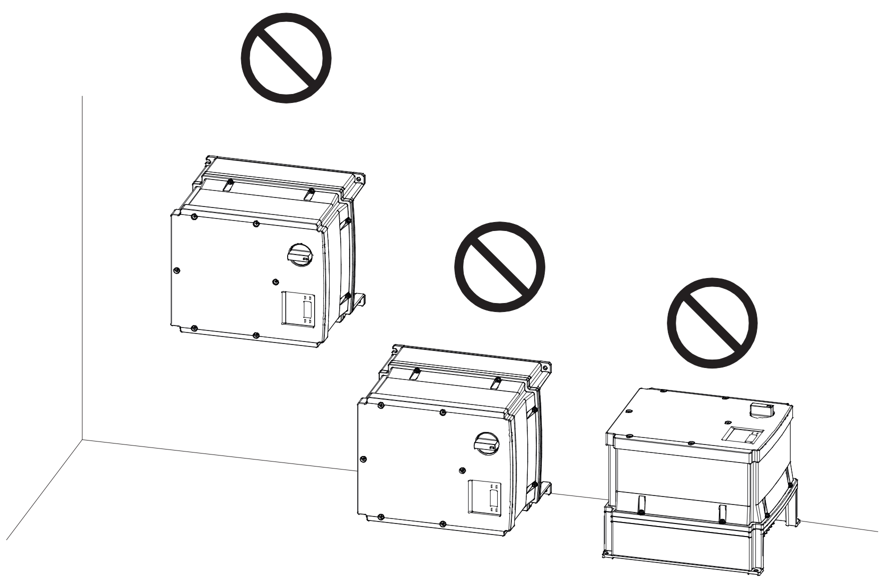


The quantity and dimensions of the mounting brackets vary based on frame size.



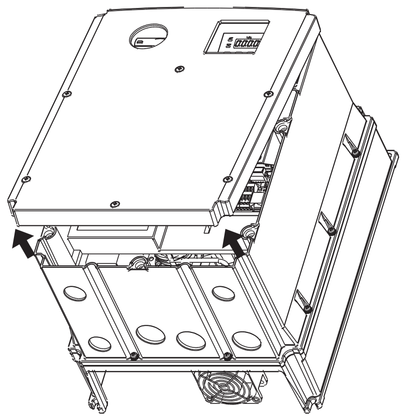
CAUTION: FAILURE TO OBSERVE THESE PRECAUTIONS MAY DAMAGE THE DRIVE OR CAUSE INJURY.

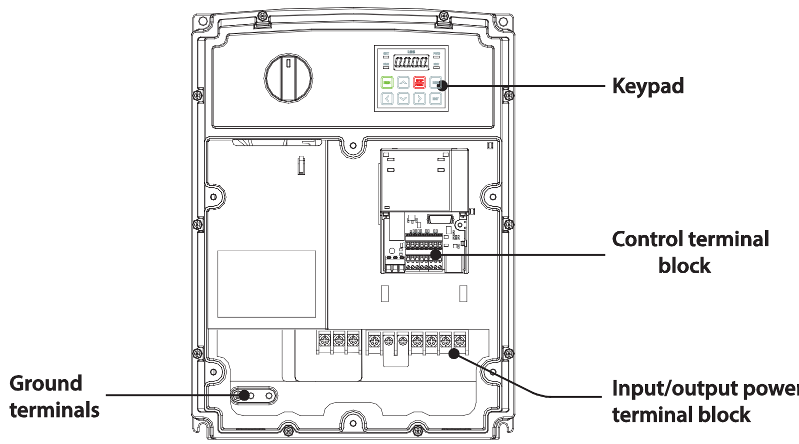
- *Caution: Do not transport the drive by lifting with the drive's covers or plastic surfaces. The drive may tip over if covers break, causing injuries or damage to the product. Always support the drive using the metal frames when moving it.*
- *Hi-capacity drives are very heavy and bulky. Use an appropriate transport method that is suitable for the weight.*
- *Do not install the drive on the floor or mount it sideways against a wall. The drive MUST be installed vertically, on a wall or inside a panel, with its rear face flat against the mounting surface.*



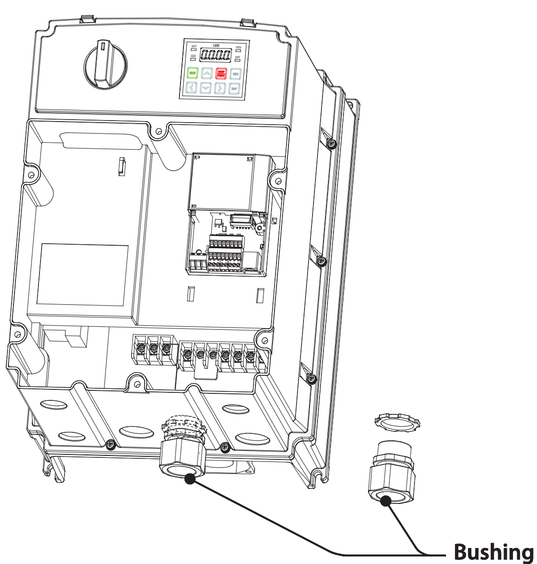
Removing Front Cover

The front cover must be removed to install cables. Loosen the bolt that secures the front cover, then remove the cover by lifting it from the bottom and moving it away from the front of the drive.





Install a bushing in every wiring hole prior to installing power and/or I/O cables. Use bushings that are NEMA 4X (IP66) or more.



NOTE: To connect an LCD keypad, remove the plastic knock-out from the bottom of the front cover (right side) or from the control terminal cover. Then connect the signal cable to the RJ-45 port on the control board.

Cable Wiring

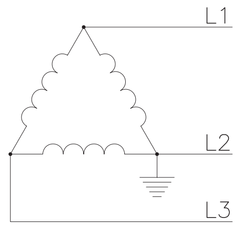
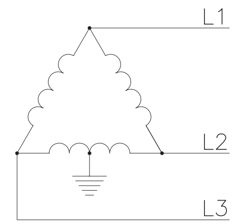
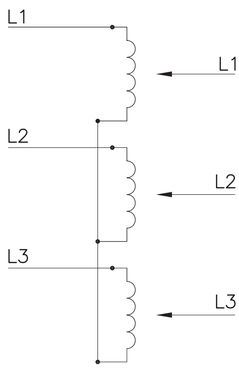
Open the front cover, remove the cable guides and control terminal cover, and then install the ground connection as specified. Complete the cable connections by connecting an appropriately rated cable to the terminals on the power and control terminal blocks.

Read the following information carefully before carrying out wiring connections to the drive.

- *Install the drive before carrying out wiring connections.*
- *Ensure that no small metal debris, such as wire cut-offs, remain inside the drive. Metal debris in the drive may cause drive failure.*
- *Tighten terminal screws to their specified torque. Loose terminal block screws may allow the cables to disconnect and cause short circuit or drive failure.*
- *Do not place heavy objects on top of electric cables. Heavy objects may damage the cable and result in electric shock.*
- *The ACN drive series does NOT contain an EMF filter and therefore has no ground reference on the input. The drive can be used with any TT,TN,IT or corner grounded systems.*
- *The equipment may generate direct current in the protective ground wire. When installing the residual current device (RCD) or residual current monitoring (RCM), only Type B RCDs and RCMs can be used.*
- *Use cables with the largest cross-sectional area, appropriate for power terminal wiring, to ensure that voltage drop does not exceed 2%.*
- *Use copper cables rated at 600V, 75° for power terminal wiring.*
- *Use copper cables rated at 300V, 75° for control terminal wiring.*
- *Separate control circuit wires from the main circuits and other high voltage circuits (230V relay sequence circuit).*
- *Check for short circuits or wiring failure in the control circuit. They could cause system failure or device malfunction.*
- *Use shielded cables when wiring the control circuit. Failure to do so may cause malfunction due to interference. If a ground is needed, use STP (Shielded Twisted Pair) cables.*
- *If you need to re-wire the terminals due to wiring-related faults, ensure that the drive keypad display is turned off and the charge lamp under the front cover is off before working on wiring connections. The drive may hold a high voltage electric charge long after the power supply has been turned off.*

Floating Ground System

The power supply system for this drive is an ugrounded system. The drive does not contain an input EMF filter. Therefore, an Asymmetric/Corner grounded power system can be safely used with the drive.

Asymmetric Ground / Corner Grounded TN Systems	
1) Grounding at a Corner of a Triangle Configuration 	2) Grounding at a Midpoint in a Polygonal Configuration 
3) No Stable Neutral Grounding in a Three-Phase Autotransformer Configuration 	

Cable Selection

When you install power and signal cables in the terminal blocks, only use cables that meet the required specification for the safe and reliable operation of the product. Refer to the following information to assist you with cable selection.

Read the following information carefully before carrying out wiring connections to the drive.

- *Wherever possible use cables with the largest cross-sectional area for mains power wiring to ensure that voltage drop does not exceed 2%.*
- *Use copper cables rated for 600V, 75° for power terminal wiring.*
- *Use copper cables rated for 300V, 75° for control terminal wiring.*
- *Utilize shielded VFD cable or Output line reactors/dVdT filters for any motor cable length over 100 feet.*
- *Ensure that the total cable length does not exceed 665ft (202m). For drives ≤ 5 HP capacity, ensure that the total cable length does not exceed 165ft (50m).*

Ground Cable and Power Cable Specifications

<table>
<tr><th colspan="6">Ground Cable and Power Cable Specifications</th></tr>
<tr><th colspan="2" rowspan="2">Load (kW)</th><th colspan="2">Ground</th><th colspan="2">Power I/O
R/S/T & U/V/W</th></tr>
<tr><th>mm²</th><th>AWG</th><th>mm²</th><th>AWG</th></tr>
<tr><td rowspan="10">3–Phase 230V</td><td>0.4</td><td rowspan="6">4</td><td rowspan="6">12</td><td rowspan="4">2</td><td rowspan="4">14</td></tr>
<tr><td>0.75</td></tr>
<tr><td>1.5</td></tr>
<tr><td>2.2</td></tr>
<tr><td>3.7</td><td rowspan="2">3.5</td><td rowspan="2">12</td></tr>
<tr><td>4</td></tr>
<tr><td>5.5</td><td rowspan="2">5.5</td><td rowspan="2">10</td><td rowspan="2">6</td><td rowspan="2">10</td></tr>
<tr><td>7.5</td></tr>
<tr><td>11</td><td rowspan="2">14</td><td rowspan="2">6</td><td>10</td><td>8</td></tr>
<tr><td>15</td><td>16</td><td>6</td></tr>
<tr><td rowspan="12">3–Phase 460V</td><td>0.4</td><td rowspan="6">4</td><td rowspan="6">12</td><td rowspan="6">2</td><td rowspan="6">14</td></tr>
<tr><td>0.75</td></tr>
<tr><td>1.5</td></tr>
<tr><td>2.2</td></tr>
<tr><td>3.7</td></tr>
<tr><td>4</td></tr>
<tr><td>5.5</td><td rowspan="2">4</td><td rowspan="2">12</td><td>25</td><td>14</td></tr>
<tr><td>7.5</td><td rowspan="2">4</td><td rowspan="2">12</td></tr>
<tr><td>11</td><td rowspan="2">8</td><td rowspan="2">8</td></tr>
<tr><td>15</td><td>6</td><td>10</td></tr>
<tr><td>18.5</td><td rowspan="2">14</td><td rowspan="2">6</td><td rowspan="2">10</td><td rowspan="2">8</td></tr>
<tr><td>22</td></tr>
</table>

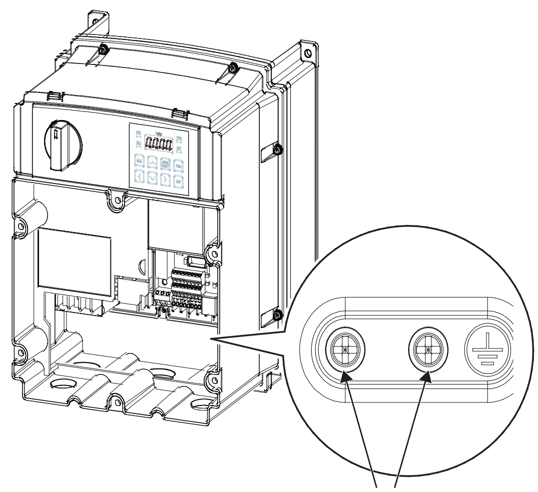
Control (signal) Cable Specifications

Control (signal) Cable Specifications				
Terminals	Signal Cable			
	Without Crimp Terminal Connectors (Bare wire)		With Crimp Terminal Connectors (Bootlace Ferrule)	
	mm^2	AWG	mm^2	AWG
P1–P5/ CM/VR/V1/I2/AO/Q1/ EG/24/ SA,SB,SC/S+,S-,SG	0.75	18	0.5	20
A1/B1/C1 (Relay 1)	1.0	17	1.5	15

Ground Connection

Remove the front cover(s), cable guide, and the control terminal cover. Locate the ground terminal and connect an appropriately rated ground cable to the terminals.

Connect the other ends of the ground cable to the supply earth (ground) terminal.



NOTE: 230V products require Class 3 grounding. Resistance to ground must be < 100Ω. 460V products require Special Class 3 grounding. Resistance to ground must be < 10Ω.

WARNING: Install ground connections for the drive and the motor by following the correct specifications to ensure safe and accurate operation. Using the drive and the motor without the specified grounding connections may result in electric shock.

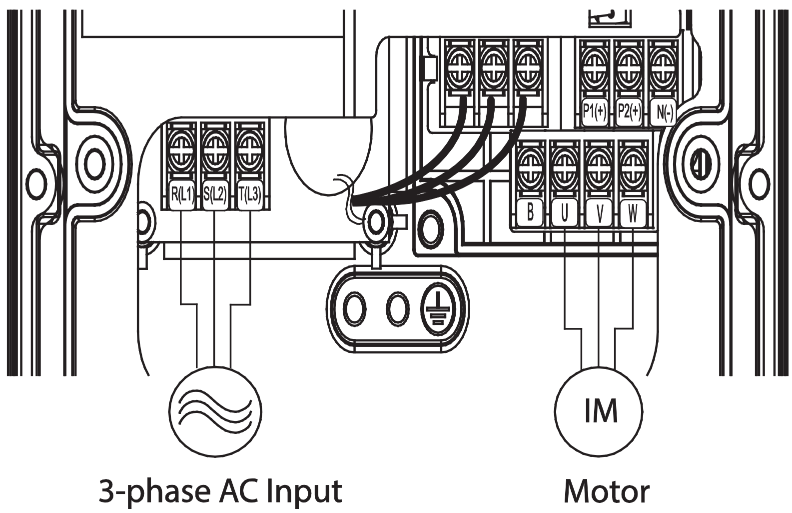
Power Terminal Wiring

The following drawings show the terminal layouts on the power terminal blocks. Refer to them to understand the function and location of each terminal before making wiring connections. Ensure that the cables selected meet or exceed the specifications in the cable selection table before installing them.

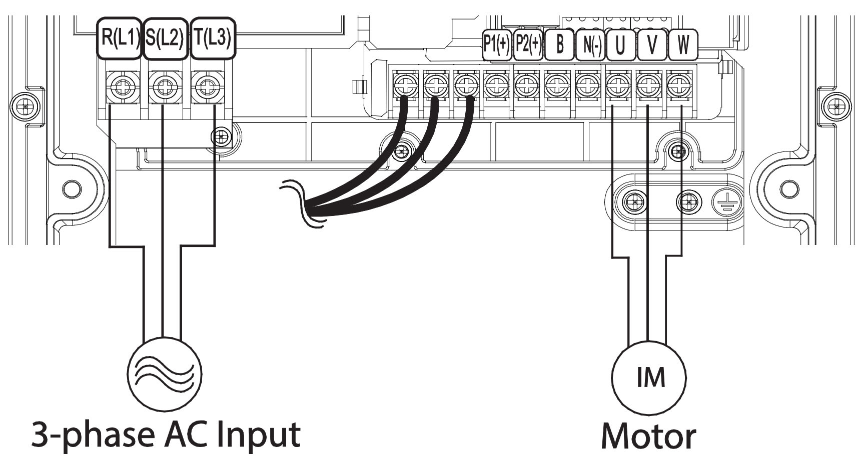
Read the following information carefully before carrying out wiring connections to the drive.

- *Apply rated torques to the terminal screws. Loose screws may cause short circuits and malfunctions. Tightening the screw too much may damage the terminals and cause short circuits and malfunctions.*
- *Use copper wires only with 600V, 75°C rating for the power terminal wiring, and 300V, 75°C rating for the control terminal wiring.*
- *Do not connect two wires to one terminal when wiring the power.*
- *Power supply wirings must be connected to the R, S, and T terminals. Connecting them to the U, V, W terminals causes internal damages to the drive. Motor should be connected to the U, V, and W Terminals. Arrangement of the phase sequence is not necessary.*

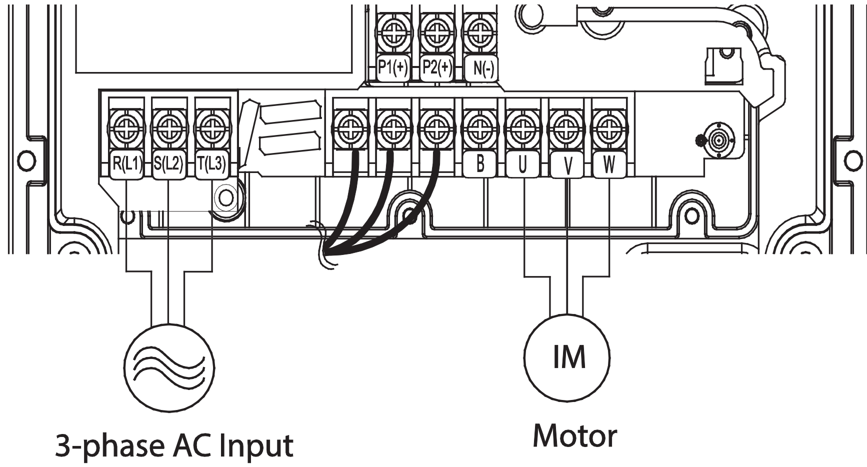
0.5 – 1 HP (3-phase)



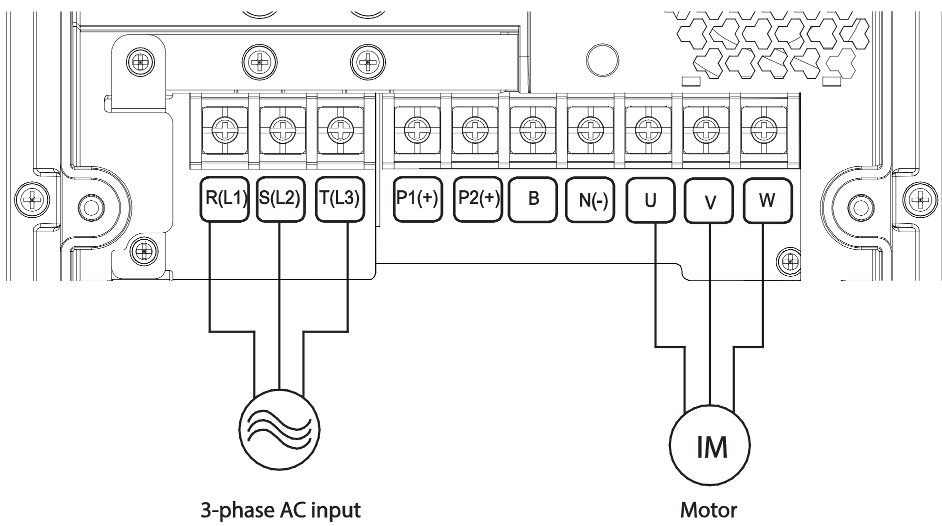
2.0 – 3.0 HP (3-phase)



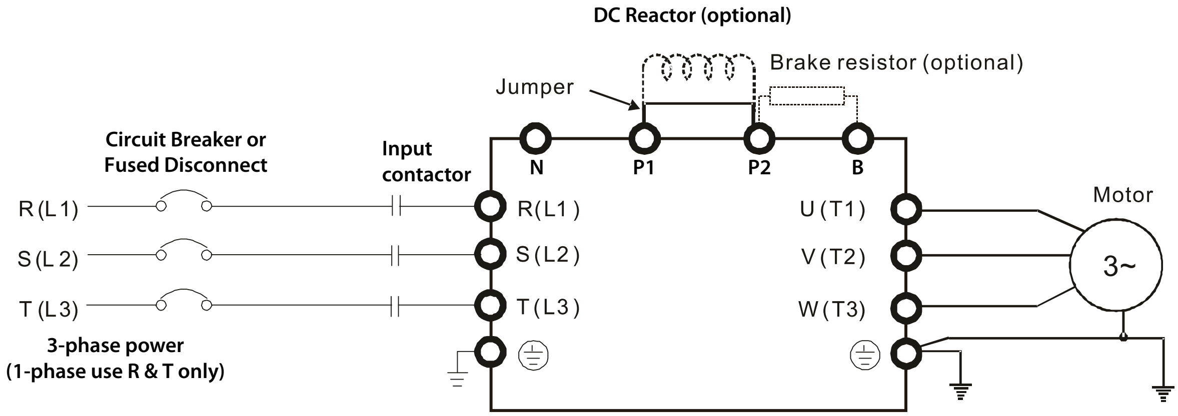
5 HP (3-phase)



7.5 – 30 HP (3-phase)



Main Circuit Wiring Diagram (all frames)

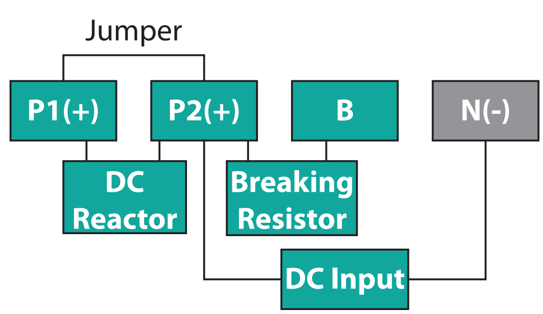


Power Terminal Labels and Descriptions

Power Terminal Labels and Descriptions		
Terminal Labels	**Name**	**Description**
R(L1)/S(L2)/T(L3)	AC power input terminal	Mains supply AC power connections (Use R and T only for single phase input power)
P2(+)/N(-)	DC input terminal	DC voltage terminals
P1(+)/P2(+)	DC reactor terminal	DC reactor wiring connection. (Remove the short-bar when you use the DC reactor)
P2(+)/B	Brake resistor terminals	Brake resistor wiring connection
U/V/W	Motor output terminals	3-phase AC motor wiring connections

Terminals for Connecting DC Reactor, External Brake Resistor, and DC Circuit

- *Terminals P1 and P2 are used to connect an optional DC reactor or choke to improve power factor. From the factory, these terminals are connected with a short-circuit jumper. Remove this jumper before connecting a DC reactor.*
- *Tighten the jumper if a DC reactor is not connected and P2 & B or P1 & N terminals are used for common DC bus or brake resistors. This will prevent the AC motor drive from losing power and damage to the terminals. If the jumper is missing due to wiring, refer to the recommended main circuit terminal wire to short-circuit the P1 and P2 terminals.*
- *Install an external brake resistor for applications in frequent deceleration to stop, short deceleration time (such as high frequency operation and heavy load operation), too low braking torque, or increased braking torque.*
- *For ACN series drives, the external brake resistor should be connected to the B and P2 terminals. See appendix accessories for recommended braking resistor sizes.*
- *P2 and N are connected for common DC bus.*
- *Please refer to the DURApulse Drives Dynamic Braking User Manual for more information on ADC braking resistors. (Available for free download at http://www.automationdirect.com/static/manuals/index.html.)*



Wiring Guidelines

- *Do not use 3 core cables to connect a remotely located motor with the drive.*
- *When operating brake resistor, the motor may vibrate under the Flux braking operation. In this case, please turn off the Flux braking (Pr.50).*
- *Ensure that the total cable length does not exceed 665ft (202m). For drives < = 5 HP capacity, ensure that the total cable length does not exceed 165ft (50m).*
- *Long cable runs can cause reduced motor torque in low frequency applications due to voltage drop. Long cable runs also increase a circuit's susceptibility to stray capacitance and may trigger over-current protection devices or result in malfunction of equipment connected to the drive.*
- *Voltage drop is calculated by using the following formula:*
  Voltage Drop (V) = [√3 X cable resistance (mΩ/m) X cable length (m) X current(A)] / 1000
- *Use cables with the largest possible cross-sectional area to ensure that voltage drop is minimized over long cable runs. Lowering the carrier frequency and installing a micro surge filter may also help to reduce voltage drop.*
- *Use cables with the largest possible cross-sectional area to ensure that voltage drop is minimized over long cable runs. Lowering the carrier frequency and installing a micro surge filter may also help to reduce voltage drop.*

Distance	<165ft (50m)	<330ft (100m)	>330ft (100m)
Allowed Carrier Frequency	<15 kHz	<5kHz	<2.5kHz

Warning: Do not connect power to the drive until installation has been fully completed and the drive is ready to be operated. Doing so may result in electric shock.

Read the following information carefully before carrying out wiring connections to the drive.

- *Power supply cables must be connected to the R, S, and T terminals. For single phase input power, use only the R and T terminals. Connecting power cables to other terminals will damage the drive.*
- *Use insulated ring lugs when connecting cables to R/S/T and U/V/W terminals.*
- *The drive's power terminal connections can cause harmonics that may interfere with other communication devices located near to the drive. To reduce interference the installation of noise filters or line filters may be required.*
- *To avoid circuit interruption or damaging connected equipment, do not install phase-advanced condensers, surge protection, magnetic contactors or electronic noise filters on the output side of the drive.*

Motor Operation Precautions

- *When using the ACN AC drive to operate a standard 3-phase induction motor, notice that the energy loss is greater than for an drive duty motor.*
- *Avoid running a standard induction motor at low speed, which may cause the motor temperature to exceed the motor rating due to limited airflow produced by the motor's fan.*
- *When the standard motor operates at low speed, the output load must be decreased.*
- *If 100% output torque is desired at low speed, it may be necessary to use a special "drive-duty" rated motor.*

Single Phase Input Utility Wiring and Operation

Ironhorse ACN is a three-phase standard variable frequency drive(VFD). When applying single-phase power to a three-phase VFD, there are several constraints that need to be considered. Standard Pulse-Width-Modulated (PWM) VFDs use a 6-pulse diode rectifier. The 6-pulse rectification results in 360 Hz DC bus ripple when used with a three-phase 60 Hz supply.

However, under single-phase use, the DC bus ripple becomes 120 Hz and the VFDs DC bus circuit is subject to higher stress in order to deliver equivalent power.

Additionally, input currents and harmonics increase beyond those encountered with three phase input. Input current distortion of 90% THD and greater can be expected under single-phase input, compared to approximately 40% with three-phase input as indicated in Figure 2. Therefore, single-phase use requires the three-phase VFD power rating be reduced (derated) to avoid over stressing the rectifier and DC link components.

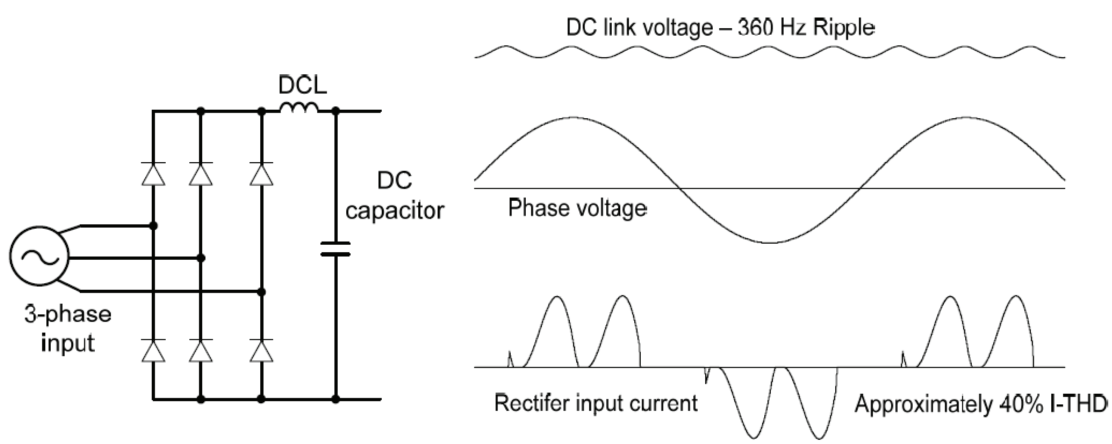


Figure-1 Typical Three-Phase Configuration

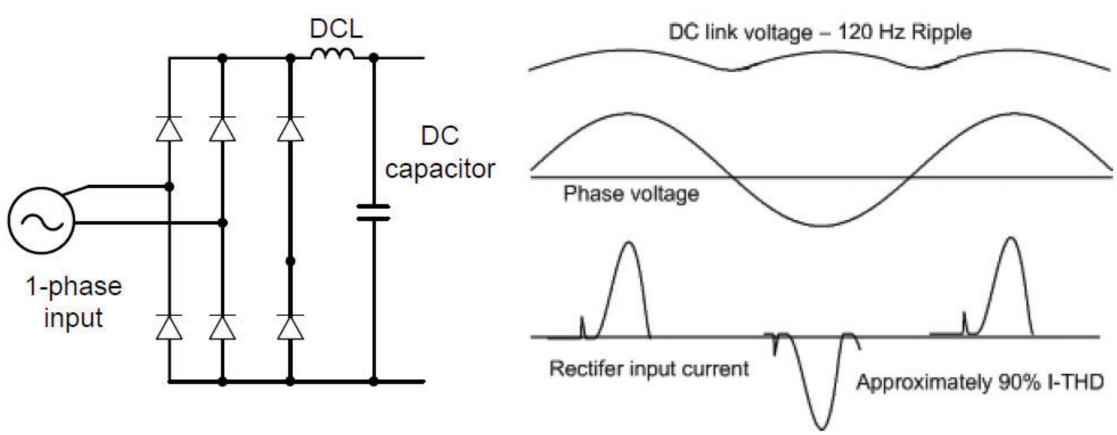


Figure-2 Typical Single-Phase Configuration

Power (HP), Input Current and Output Current

When using a three-phase VFD with single-phase input, derating the drive's output current and horsepower will be necessary because of the increase in DC bus ripple voltage and current. In addition, the input current through the remaining two phases on the diode bridge converter will approximately double, creating another derating consideration for the VFD. Input current harmonic distortion will increase beyond that with a three-phase supply making the overall input power factor low. Input current distortion over 100% is likely under single-phase conditions without a reactor. Therefore, it is required to install a line reactor on the drive input power. When using a motor that is selected by the three-phase drive rating criteria when using single phase input, it may result in poor performance, premature drive failure. The selected drive of single-phase current ratings must meet or exceed the motor current rating.

NOTE: For Single Phase Power input, an Input Line Reactor is required. See Accessories appendix for the specific line reactor for each drive model.

Input Frequency and Voltage Tolerance

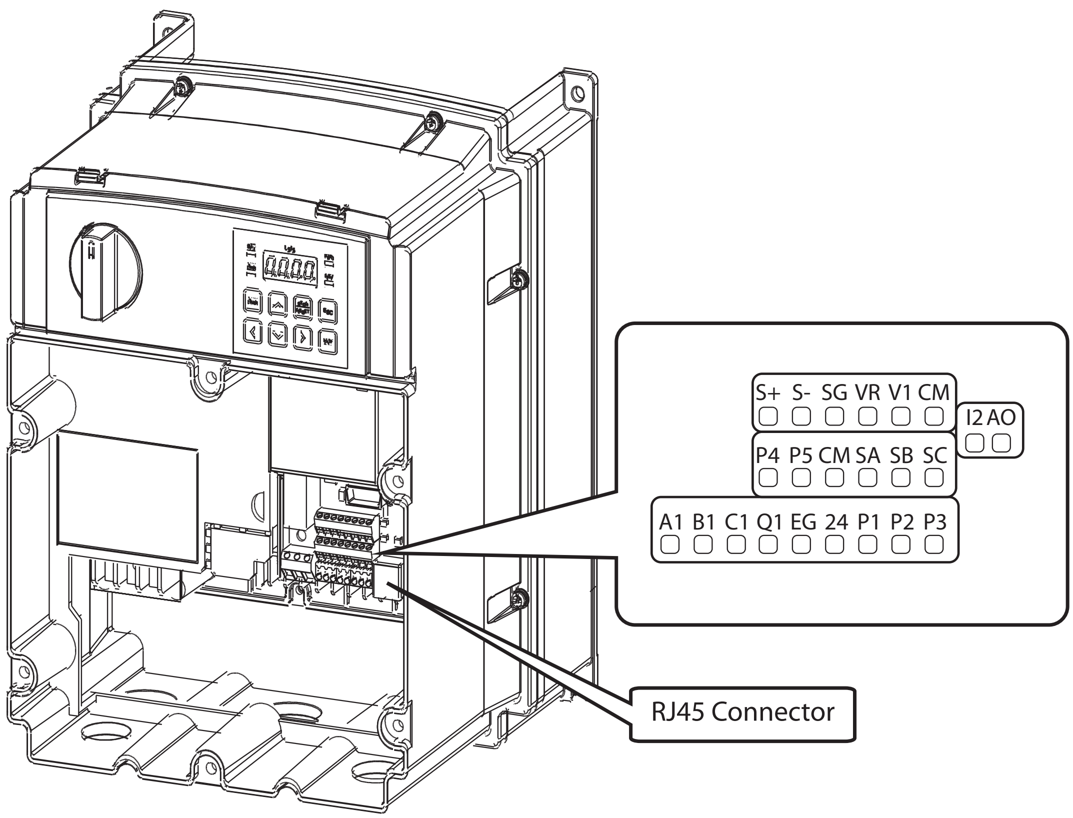
The single-phase current ratings are valid for 60Hz input only. The AC supply voltage must be within the required voltage range of 240/480Vac +10% to –5% to maximize motor power production. Standard product with three-phase voltage input has an allowable range of +10% to –15%. Therefore, a stricter input voltage tolerance of +10 to –5% applies when using the drive with a single-phase supply. The average bus voltage with single-phase input is lower than the equivalent of a three-phase input. Therefore, the maximum output voltage (motor voltage) will be lower with a single-phase input. The minimum input voltage must be no less than 228Vac for 230 volt models and 456Vac for 460 volt models, to ensure motor voltage production of 207Vac and 415Vac, respectively. Thus, if full motor torque must be developed near base speed (full power) it will be necessary to maintain a rigid incoming line voltage so that adequate motor voltage can be produced. Operating a motor at reduced speed (reduced power), or using a motor with a base voltage that is lower than the incoming AC supply rating (ex. 208Vac motor with a 240Vac supply), will also minimize the effect of voltage deprivation. (240VAC Input ▸ 208V motor, 480VAC Input ▸ 460V motor)

Protection

Protection for output current like OCT or IOLT is based on 3-phase input ratings which is larger than single-phase input. User should set the parameters that are relative to motor information (bA.11~ba.16), overload trip (Pr.17~Pr.22) and E-thermal functions (Pr.40~Pr.43).

Control Terminal Wiring

The following drawings show the layout of the control wiring terminals and control board switches. Refer to them before making control terminal wiring connections. Ensure that the cables selected meet or exceed the specifications in the control cable selection table before installing them.

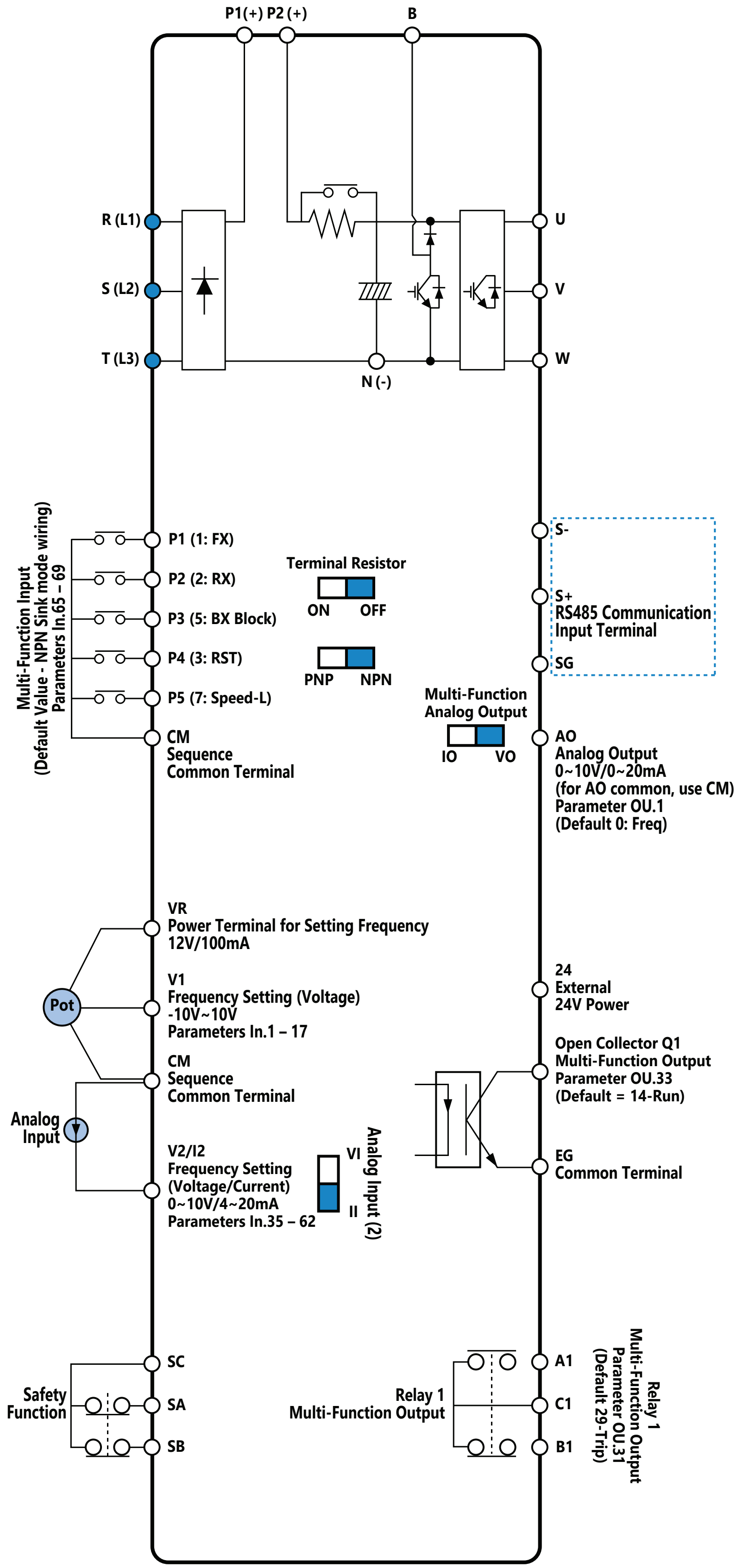


Control Board Switches

Control Board Switches	
Switch	***Description***
SW1	NPN/PNP mode selection switch
SW2	Analog voltage/current input terminal selection switch
SW3	Analog voltage/current output terminal selection switch
SW4	Terminating resistor selection switch

Connector

Connector	
Name	***Description***
RJ45 Connector	Connect to LCD Keypad or Smart Copier



NOTE: Default is marked in blue.

Input Terminal Labels and Descriptions

Input Terminal Labels and Descriptions			
Function	**Label**	**Name**	**Description**
Multi-function digital input terminal configuration	P1–P5	Multi-function Input 1-5	Configurable for multi-function input terminals. Factory default terminals and setup are as follows: • P1: Fx • P2: Rx • P3: BX • P4: RST • P5: Speed-L Use NPN/PNP dip switch to set terminal Sink/Source configuration NPN (Sink) : Px-CM, internal 24V (22~27V) • On = 0V (CM) • Off = 22V~27V (Internal 24V) PNP (Source) : Px-24V-CM, using external source • On : ≥ 9V • Off : ≤ 1.5V
	CM	Common Sequence	Common terminal for analog and digital terminal inputs and outputs.
Analog input configuration	VR	Potentiometer frequency reference input	Used to setup or modify a frequency reference via analog voltage or current input. • Maximum Voltage Output: 12V • Maximum Current Output: 100mA • Potentiometer: 1–5kΩ
	V1	Voltage input for frequency reference input	Used to setup or modify a frequency reference via analog voltage input terminal. • Unipolar: 0–10V (12V Max.) • Bipolar: -10–10V (±12V Max.)
	I2	Voltage/ current input for frequency reference input	Used to setup or modify a frequency reference via analog voltage or current input terminals. Switch between voltage (V2) and current (I2) modes using a control board switch (SW2). V2 Mode: • Unipolar: 0–10V (12V Max.) I2 Mode • Input current: 4–20mA • Maximum Input current: 24mA • Input resistance: 249Ω
	P5 (TI)	Pulse input for frequency reference input (pulse train)	Setup or modify frequency references using pulse inputs from 0 to 32kHz. • Low Level: 0–2.5V • High Level: 3.5–12V (Pulse input TI and Multi-function terminal P5 share the same terminal. Sel the In.69 P5 Define to 54(TI).)
Safety functionality configuration	SA	Safety input A	Used to block the drive output in an emergency. Conditions: • Normal Operation: Both the SA and SB terminals are connected to the SC terminal. • Output Block: One or both of the SA and SB terminals open connection with the SC terminal.
	SB	Safety input B	
	SC	Safety input power source	DC 24V, < 25mA

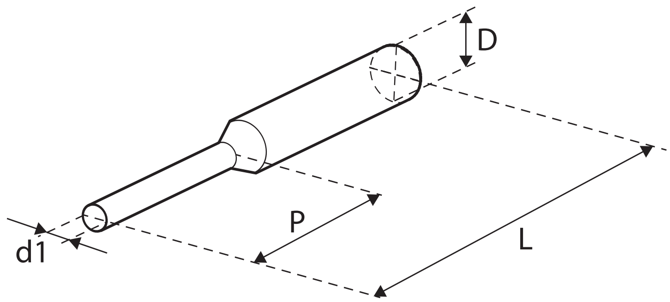
Output/Communication Terminal Labels and Descriptions

<table>
<tr><th colspan="4">Output/Communication Terminal Labels and Descriptions</th></tr>
<tr><th>Function</th><th>Label</th><th>Name</th><th>Description</th></tr>
<tr><td rowspan="2">Analog output</td><td>AO</td><td>Voltage/ Current Output</td><td>Configurable Analog Output to send drive output information to external devices: output frequency, output current, output voltage, or a DC voltage.
Operate switch (SW3) to select the signal output type (voltage or current) at the AO terminal. Use terminal CM for common connection.
Output Signal Specifications:
• Output voltage: 0–10V
• Maximum output voltage/current: 12V/10mA
• Output current: 0–20mA
• Maximum output current: 24mA
• Factory default output: Frequency</td></tr>
<tr><td>Q1 (TO)</td><td>Pulse Output</td><td>Configurable pulse signals to external devices to provide a single output value from the drive: output frequency, output current, output voltage, or DC voltage.
Output Signal Specifications:
• Output frequency: 0–32kHz
• Output voltage: 0–12V
• Factory default output: Frequency
(Pulse output TO and Multi-function output Q1 share the same terminal. Sel the OU.33-Q1 Define to 38(TO).)
• Duty cycle 50% (0.01Hz) ~ 55% (60Hz)

Connect a pulse between ACN drives as follows:<table><tr><th>ACN Drive #1
Output Terminal</th><th></th><th>ACN Drive #2
Input Terminal</th></tr><tr><td>Q1</td><td>➔</td><td>P5</td></tr><tr><td>EG</td><td>➔</td><td>CM</td></tr></table></td></tr>
<tr><td rowspan="4">Digital output</td><td>Q1</td><td>Multi-function Output (open collector)</td><td>DC 26V, 100mA or less
Factory default output: Run</td></tr>
<tr><td>EG</td><td>Common</td><td>Common ground contact for an open collector (with external power source)</td></tr>
<tr><td>24</td><td>External 24V power source</td><td>Maximum output current: 150mA</td></tr>
<tr><td>A1/C1/B1 (Relay 1)</td><td>Multi Function Output (Relay)</td><td>Configurable Relay 1 output signal via Parameter OU.31.
• Contact Rating: AC 250V <1A, DC 30V < 1A
• Signal ON operation: A1-C1 contact closed, B1-C1 contact open
• Signal OFF operation: B1-C1 contact closed, A1-C1 contact open</td></tr>
<tr><td rowspan="2">Communication</td><td>S+/S-/SG</td><td>RS-485 signal line</td><td>Used to send or receive RS-485 signals. Use the Terminating Resistor dip switch to set the end of line resistor in a communicaton network.</td></tr>
<tr><td>N/A</td><td>RJ45 Connector</td><td>Serial Connection to LCD keypad or PC software</td></tr>
</table>

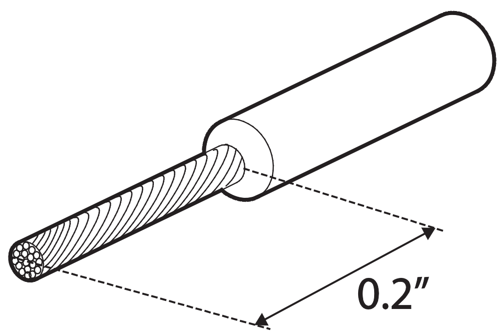
Pre-insulated Crimp Terminal Connectors (Bootlace Ferrule)

Use pre-insulated crimp terminal connectors to increase reliability of the control terminal wiring. Use this drawing and table to determine the crimp terminals to fit various cable sizes.



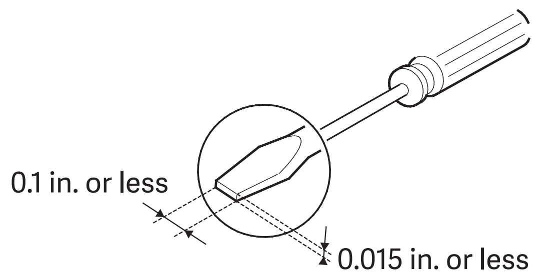
Cable Spec		Dimensions (mm)			
AWG	mm²	L*	P	d1	D
26	0.25	10.4	6.0	1.1	2.5
		12.4	8.0		
22	0.50	12.0	6.0	1.3	3.2
20	0.75	12.0	6.0	1.5	3.4
** If the length (L) of the crimp terminals exceeds 0.5″ (12.7mm) after wiring, the control terminal cover may not close fully*					

To connect cables to the control terminals without using crimp terminals, refer to this drawing showing the correct length of exposed conductor at the end of the control cable.



NOTE: Please read these general wiring recommendations:

- *While making wiring connections at the control terminals, ensure that the total cable length does not exceed 165ft (50m).*
- *Ensure that the length of any safety related wiring does not exceed 100ft (30m).*
- *Ensure that the cable length between an LCD keypad and the drive does not exceed 10ft (3.04 m). Cable connections longer than 10ft (3.04 m) may cause signal errors.*
- *Use ferrite material to protect signal cables from electro-magnetic interference.*
- *Take care when supporting cables using cable ties, to apply the cable ties no closer than 6 inches from the drive. This provides sufficient access to fully close the front cover.*
- *When making control terminal cable connections, use a small flat-tip screw driver (0.1 in wide (2.5 mm) and 0.015 in thick (0.4 mm) at the tip).*



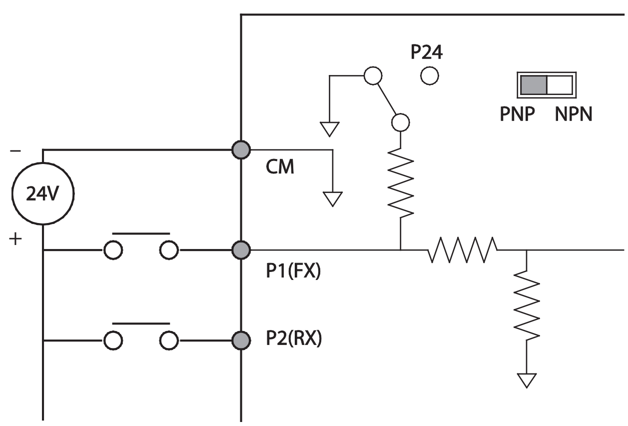
WARNING: SA,SB, SC ARE SHORTED AND HAVE 24V VOLTAGE ACROSS THEM. DO NOT CONNECT POWER TO THE DRIVE UNTIL INSTALLATION HAS BEEN FULLY COMPLETED AND THE DRIVE IS READY TO BE OPERATED. DOING SO MAY RESULT IN ELECTRIC SHOCK.

PNP/NPN Mode Wiring and Selection

The drive supports both PNP (Source) and NPN (Sink) modes for sequence inputs at the terminal. Select an appropriate mode to suit requirements using the PNP/NPN selection switch (SW1) on the control board. Refer to the following information for detailed applications.

PNP Mode (Source)

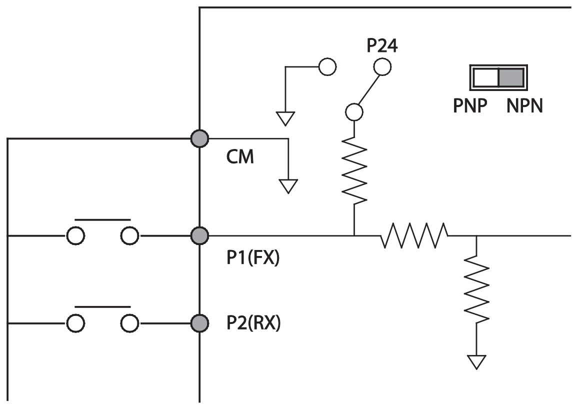
Select PNP using the PNP/NPN selection switch (SW1). Note that the factory default setting is NPN mode. CM is the common ground terminal for all analog inputs at the terminal, and P24 is 24V internal source. If you are using an external 24V source, build a circuit that connects the external source (-) and the CM terminal.



PNP Mode (Source)

NPN Mode (Sink)

Select NPN using the PNP/NPN selection switch (SW1). Note that the factory default setting is NPN mode. CM is is the common ground terminal for all analog inputs at the terminal, and P24 is 24V internal source.

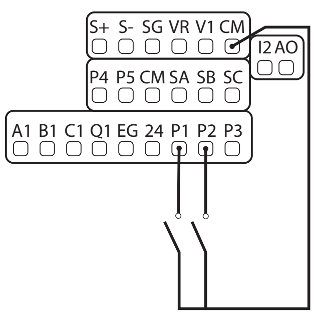


NPN Mode (Sink)

Run Command Wiring

Use one of the following examples to wire the run command for the drive in either 2-wire or 3-wire mode.

2-Wire Control



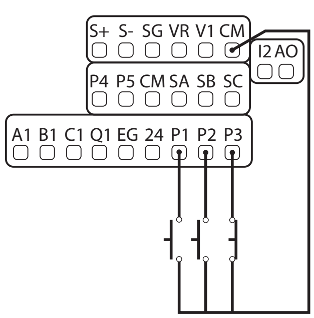
2-wire control consists of maintained run signals. This can be accomplished via toggle switches, relays, jumpers, etc. Default parameters support this operation.

P1=Forward Run (Fx)

P2=Reverse Run (Rx)

CM=Common

3-Wire Control



3-Wire control consists of momentary push buttons to run and stop the VFD. The Forward and Reverse buttons are Normally Open while the Stop button is Normally Closed. Set parameter In.67=14 if using P3 (like below) for the Stop button.

P1 = Forward Run (Fx)

P2 = Reverse Run (Rx)

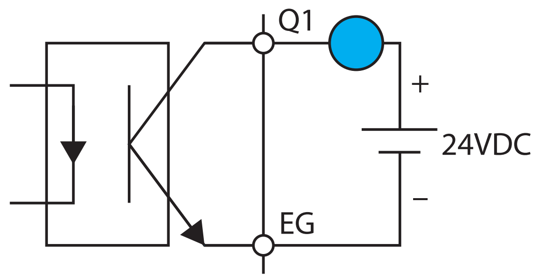
P3 = Stop (3-Wire)

CM = CommonFrequency Reference Wiring

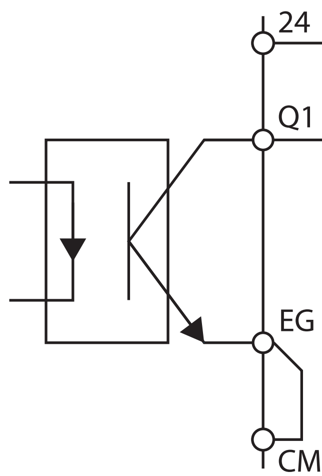
Digital Output Wiring

Output Wiring using External Power

Ensure device current does not exceed 100mA.



Output Wiring using Internal Drive Power

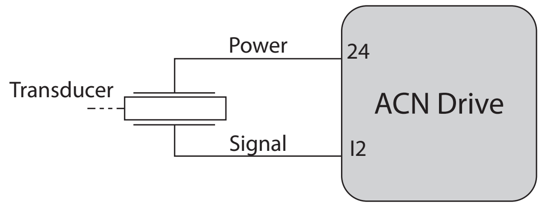


Analog Wiring

This section demonstrates how to wire up a 4-20mA or 0-10VDC source to the ACN VFDs. This document focuses on transducer, speed POT, and PLC connection sources but can be applied to any 4-20mA or 0-10VDC device.

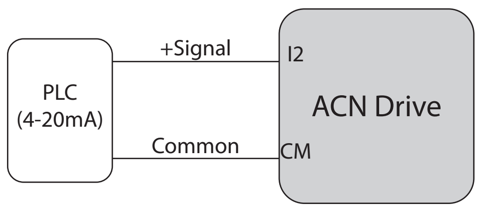
4-20mA Analog Input Wiring

Transducer (4-20mA): Transducers are typically 4-20mA devices which require a 24VDC power source. For 2-wire transducers connect to the 24VDC and 4-20mA input terminals listed below. Connect the positive lead of the device to the 24V terminal and the signal lead to the analog input terminal (I2).



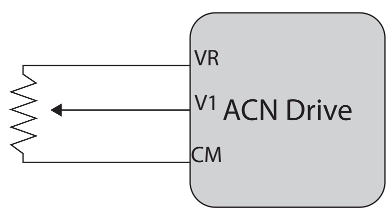
NOTE: Verify that SW2 dip switch on the terminal board to 'II' (down) for 4-20mA signal.

PLC (4-20mA): The wiring for connecting a PLC's 4-20mA output to the analog input of a VFD differs slightly from the transducer wiring discussed above. The positive (signal) lead is wired to the corresponding analog input while the negative (common) lead is wired to the drives common. Reference the figure below.

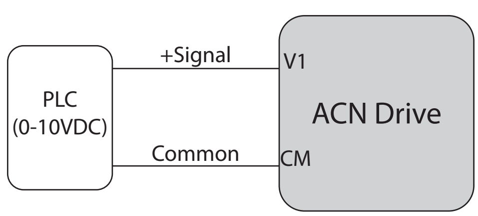


0-10VDC Analog Input Wiring

Speed POT/Rheostat (0-10VDC): Speed potentiometers have three wires which must be connected to properly vary a 0-10VDC signal. The required terminal connections will vary slightly depending on the drive series. Reference the figure below. The wiper of the speed POT should always be connected to the analog input.

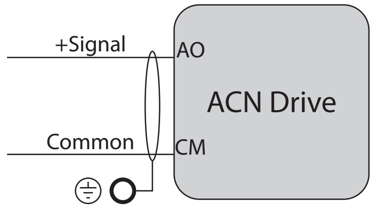


PLC (0-10VDC): The wiring for connecting a PLC's 0-10VDC output to the analog input of a VFD differs slightly from the speed POT wiring discussed above. The positive (signal) lead is wired to the corresponding analog input while the negative (common) lead is wired to the drives common. Reference the figure below.



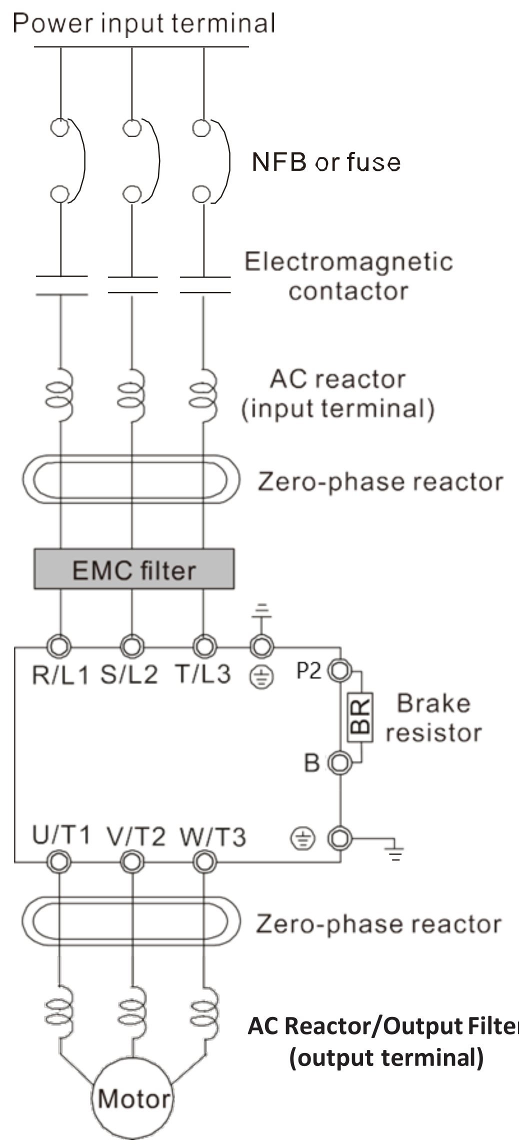
AO Wiring

Wire the drive analog out as follows:



System Wiring Diagram

System Wiring Components	
Component	**Function**
Power input terminal	Supply power according to the rated power specifications indicated in the manual
NFB or fuse	There may be a large inrush current during power on. Select a suitable NFB (Non Fuse Breaker or Circuit Breaker) or Fuse
Electromagnetic contactor	Switching the power ON/OFF on the primary side of the electromagnetic contactor can turn the drive ON/OFF, but frequent switching can cause machine failure. Do not switch ON/OFF more than once an hour. Do not use the electromagnetic contactor as the power switch for the drive; doing so shortens the life of the drive.
AC reactor (input terminal)	When the main power supply capacity is greater than 500 kVA, or when it switches into the phase capacitor, the instantaneous peak voltage and current generated may destroy the internal circuit of the drive.It is recommended that you install an input side AC reactor in the drive. This also improves the power factor and reduces power harmonics. The wiring distance should be within 10 m.
Zero phase reactor	Used to reduce radiated interference, especially in environments with audio devices, and reduce input and output side interference. The effective range is AM band to 10 MHz.
EMC filter	Can be used to reduce electromagnetic interference.
Brake module and Brake resistor (BR)	Used to shorten the deceleration time of the motor.
AC reactor or Filter (output terminal)	The motor cable length affects the size of the reflected wave on the motor end. For motor distances greater than 100 feet, the VTF series dV/dT filter is recommended.



Re-assembling the Cover

Re-assemble the cover after completing the wiring and basic configurations.

Post-Installation Checklist

After completing the installation, check the items in the following table to ensure that the drive has been safely and correctly installed.

Post-Installation Checklist	
Items	***Checkpoint***
Installation Location/Power I/O Verification	Is the installation location appropriate?
	Does the environment meet the drive's operating conditions?
	Does the power source match the drive's rated input?
	Is the drive's rated output sufficient to supply the equipment? (Degraded performance will result in certain circumstances.)
Power Terminal Wiring	Is a circuit breaker installed on the input side of the drive?
	Is the circuit breaker correctly rated?
	Are the power source cables correctly connected to the R/S/T terminals of the drive? (Caution: connecting the power source to the U/V/W terminals may damage the drive.)
	Are the motor output cables connected in the correct phase rotation (U/V/W)? (Caution: motors will rotate in reverse direction if three phase cables are not wired in the correct rotation.)
	Are the cables used in the power terminal connections correctly rated?
	Is the drive grounded correctly?
	Are the power terminal screws and the ground terminal screws tightened to their specified torques?
	Are the overload protection circuits installed correctly on the motors (if multiple motors are run using one drive)?
	Is the drive separated from the power source by a magnetic contactor (if a braking resistor is in use)?
	Are advanced-phase capacitors, surge protection and electromagnetic interference filters installed correctly? (These devices MUST not be installed on the output side of the drive.)
	If motor distance is greater than 100 feet from the drive, is VFD cable and/or line reactor/filter used?
	Is total motor cable length less than 165ft (5HP or less) or 665 feet (7.5HP or greater)?
Control Terminal Wiring	Are STP (shielded twisted pair) cables used for control terminal wiring?
	Is the shielding of the STP wiring properly grounded?
	If 3-wire operation is required, are the multi-function input terminals defined prior to the installation of the control wiring connections?
	Are the control cables properly wired?
	Are the control terminal screws tightened to their specified torques?
	Is the total cable length of all control wiring < 165ft (100m)?
	Is the total length of safety wiring < 100ft (30m)?
Miscellaneous	Are optional cards connected correctly?
	Is there any debris left inside the drive?
	Are any cables contacting adjacent terminals, creating a potential short circuit risk?
	Are the control terminal connections separated from the power terminal connections?
	Have the capacitors been replaced if they have been in use for > 2 years?
	Have the fans been replaced if they have been in use for > 3 years?
	Has a fuse been installed for the power source?
	Are the connections to the motor separated from other connections?

NOTE: STP (Shielded Twisted Pair) cable has a highly conductive, shielded screen around twisted cable pairs. STP cables protect conductors from electromagnetic interference.

Test Run

After the post-installation checklist has been completed, follow the instructions below to test the drive (This requires use of the keypad. See Chapter 3 for instructions on keypad operation).

1) Turn on the power supply to the drive. Ensure that the keypad display light is on.

2) Select the command source with parameter drv (operation group menu).

3) Set a frequency reference, and then check the following:

   a) If V1 is selected as the frequency reference source, does the reference change according to the input voltage at VR?

   b) If V2 is selected as the frequency reference source, is the voltage/current selector switch (SW2) set to voltage, and does the reference change according to the input voltage?

   c) If I2 is selected as the frequency reference source, is the voltage/current selector switch (SW2) set to current, and does the reference change according to the input current?

4) Set the acceleration and deceleration time using parameters ACC and DEC in the operation menu.

5) Start the motor and check the following:

   a) Ensure that the motor rotates in the correct direction (refer to the note below).

   b) Ensure that the motor accelerates and decelerates according to the set times, and that the motor speed reaches the frequency reference.

NOTE: If the forward command (Fx) is on, the motor should rotate counterclockwise when viewed from the load side of the motor. If the motor rotates in the reverse direction, switch the cables at the U and V terminals.

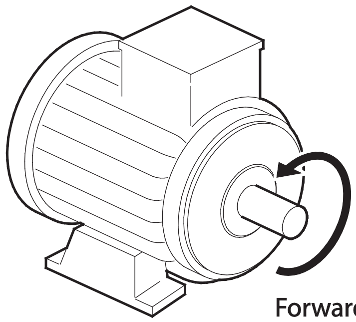
Verifying the Motor Rotation

1) On the keypad, set the drv (Drive Command reference source) parameter in the Operation group to 0 (Keypad).

2) Set a frequency reference to a low value (10Hz).

3) Press the [RUN] key. Motor starts forward operation.

4) Observe the motor's rotation from the load side and ensure that the motor rotates counterclockwise (forward).
If the motor rotates in the reverse direction, two of the U/V/W terminals need to be switched.



CAUTION: Read the following information before operating your drive:

- *Check the parameter settings before running the drive. Parameter settings may have to be adjusted depending on the load.*
- *To avoid damaging the drive, do not supply the drive with an input voltage that exceeds the rated voltage for the equipment.*
- *Before running the motor at maximum speed, confirm the motor's rated capacity. As drives can be used to easily increase motor speed, use caution to ensure that motor speeds do not accidentally exceed the motor's rated capacity.*

Chapter 3: Keypad Operation and Quick Start

Chapter 3

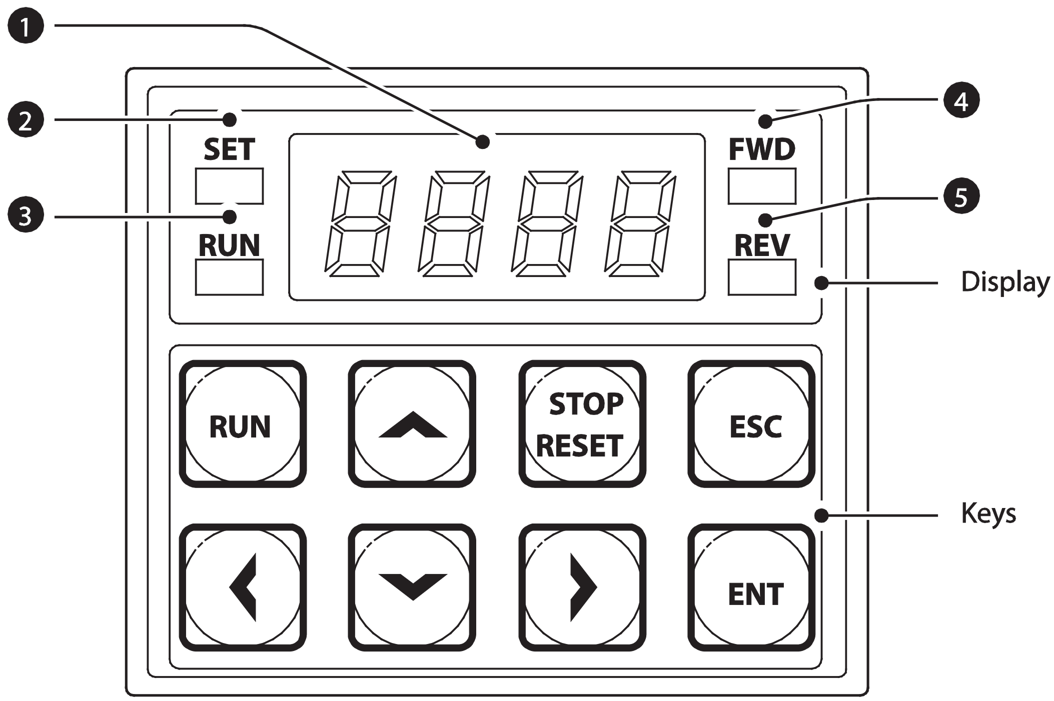
Table of Contents

Learning to Perform Basic Operations

This chapter describes the keypad layout and functions. It also introduces parameter groups and the parameters, required to perform basic operations. The chapter also outlines the basic operation of the drive before advancing to more complex applications. Examples are provided to demonstrate how the drive actually operates.

About the Keypad

The keypad is composed of two main components – the display and the operation (input) keys. Refer to the following illustration to identify part names and functions.



About the Display

The following table lists display part names and their functions.

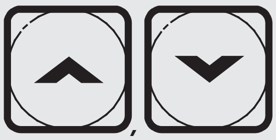
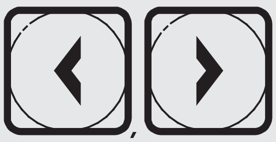
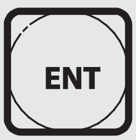
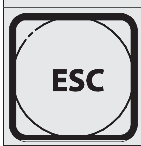
No.	Name	Function
1	7-Segment Display	Displays current operational status and parameter information.
2	SET Indicator	LED flashes during parameter configuration and when the ESC key operates as the multi-function key.
3	RUN Indicator	LED turns on (steady) during an operation, and flashes during acceleration or deceleration.
4	FWD Indicator	LED turns on (steady) during forward operation.
5	REV Indicator	LED turns on (steady) during reverse operation.

The table below lists the way that the keypad displays characters (letters and numbers).

	0		A		K		U
	1		B		L		V
	2		C		M		W
	3		D		N		X
	4		E		O		Y
	5		F		P		Z
	6		G		Q	-	-
	7		H		R	-	-
	8		I		S	-	-
	9		J		T	-	-

Operation Keys

The following table lists the names and functions of the keypad’s operation keys.

Key	Name	Description
	[RUN] key	Used to run the drive (inputs a RUN command).
	[STOP/RESET] key	STOP: stops the drive. RESET: resets the drive following fault or failure condition.
	Up Arrow key,Down Arrow key	Switch between codes, or to increase or decrease parameter values.
	[◄] key, [►] key	Switch between groups, or to move the cursor during parameter setup or modification.
	[ENT] key	Used to select, confirm, or save a parameter value.
	[ESC] key	A configurable multi-function key used to configure different functions, such as: Jog operation, Remote/Local mode switching, Cancellation of an input during parameter setup

Caution: Install a separate emergency stop switch in the circuit. The [STOP/RESET] key on the keypad works only when the drive has been configured to accept an input from the keypad.

Control Menu

The ACN control menu uses the following Parameter Groups for configuration. Groups with an asterisk only display when certain parameters/options are configured. See description for details.

Group	Display	Description
Operation	-	Configures basic parameters for drive operation. These include reference frequencies and acceleration or deceleration times. This group is only available on the Drive LED keypad.
Drive	dr	Configures parameters for basic operations. These include jog operation, motor capacity evaluation, torque boost, and other keypad related parameters.
Basic	bA	Configures basic parameters, including motor-related parameters and multi-step frequencies.
Advanced	Ad	Configure acceleration or deceleration patterns and to setup frequency limits.
Control	Cn	Configures sensorless vector related features.
Input Terminal	In	Configures input terminal–related features, including digital multi–functional inputs and analog inputs.
Output Terminal	OU	Configures output terminal related features such as relays and analog outputs.
Communication	Cm	Configures communication features for RS-485 or other communication options.
Application	AP	Configures PID control related sequences and operations.
Extension IO*	A0*	Configures extension IO card
Protection	Pr	Configures motor or drive protection features.
Motor 2 (Secondary Motor)**	m2	Configures secondary motor related features.
User Sequence***	US	Used to implement simple sequences with various function blocks.
User Sequence Function***	UF	

**Displays when ACN-EIO is installed*
***The secondary motor (M2) group displays when one of the multi-function input terminals (In.65–In.69) has been set to 26 (Secondary motor).*
****Group displays when AP.2 =1 or CM.95=1*

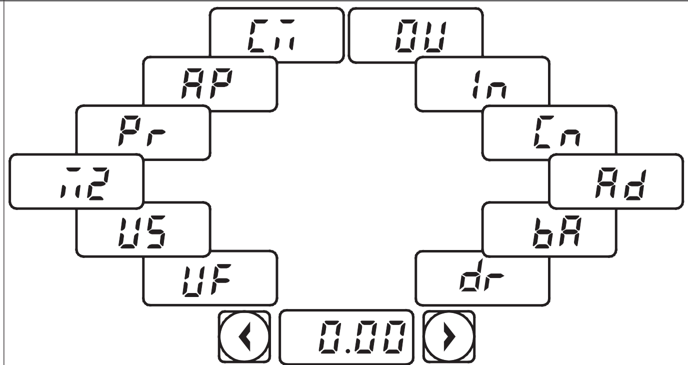
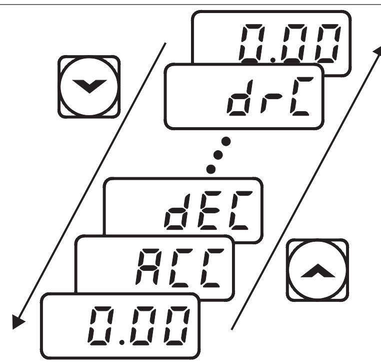
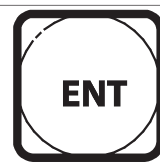
Learning to Use the Keypad

The keypad enables movement between parameter group and parameter numbers. It also enables users to select and configure functions. At the parameter number level, you can set parameter values and configure specific functions. See Chapter 4: AC Drive Parameters for detailed information.

Confirm the correct values (or the correct range of the values), and then follow the examples below to configure the drive with the keypad.

Parameter Group and Number Selection

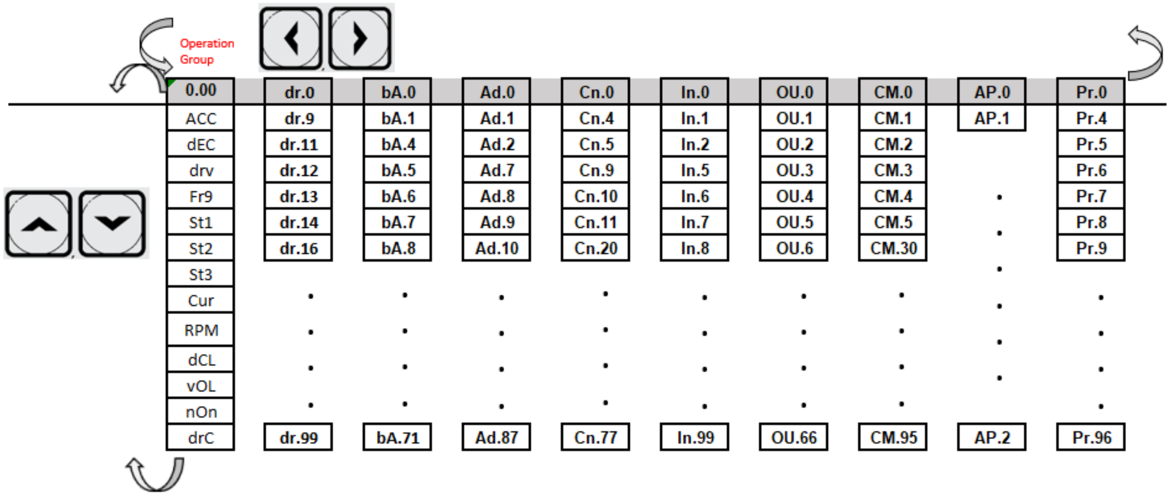
Follow the examples below to learn how to switch between parameter groups and parameter numbers.

<table>
<tr><th>Step</th><th>Instruction</th><th>Keypad Display</th></tr>
<tr><td>1</td><td>Move to the parameter group you want using the Left Arrow and Right Arrow keys.</td><td>
</td></tr>
<tr><td>2</td><td>The operation group, shown here, scrolls through a group of 14 parameters. When other parameter groups are selected, the arrows scroll through the available numbers of each parameter group (dr.0, dr.2, dr.9, etc).</td><td>
</td></tr>
<tr><td>3</td><td>Press the [ENT] key to save the change.</td><td>
</td></tr>
</table>

NOTE: Certain parameter groups and numbers have "parameter dependencies". These parameters will only display when other parameters are configured to the applicable settings. See the Chapter 4: AC Drive Parameters for all parameter dependencies.

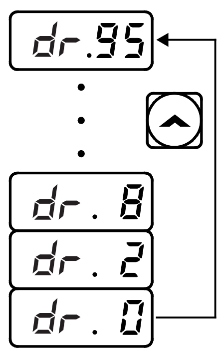
As an example, if Ad.24 (Frequency Limit) is set to 0 (No), the next codes, Ad.25 (Freq Limit Lo) and Ad.26 (Freq Limit Hi), will not be displayed. If you set code Ad.24 to 1 (Yes) and enable the frequency limit feature, codes Ad.25 and 26 will appear to allow the maximum and minimum frequency limitations to be set up.

Parameter Structure and Navigation



Navigating Directly to Parameter Numbers using the Jump Code

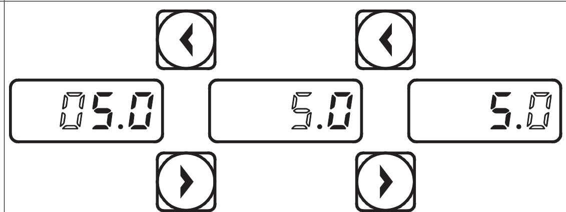
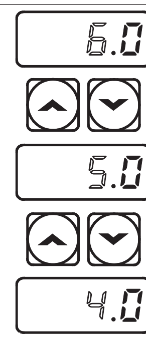
An alternative to using the up/down arrows to navigate to the parameter number is to use the parameter "Jump Code". Parameter number zero (xx.0) is the jump code for each group. The following example details navigating directly to dr.95 using the parameter dr.0 (jump code parameter):



1) Ensure that you are currently at the first code of the Drive group (dr.0).
2) Press the [ENT] key. (Number '9' will flash.)
3) Press theDown Arrow key to display '5.'
4) Press the Left Arrow key to move to the 10s' place. The cursor will move to the left and '05' will be displayed. This time, the number '0' will be flashing.
5) Press the Up Arrow key to increase the number from '0' to '9.'
6) Press the [ENT] key. Code dr.95 is displayed.

Setting Parameter Values

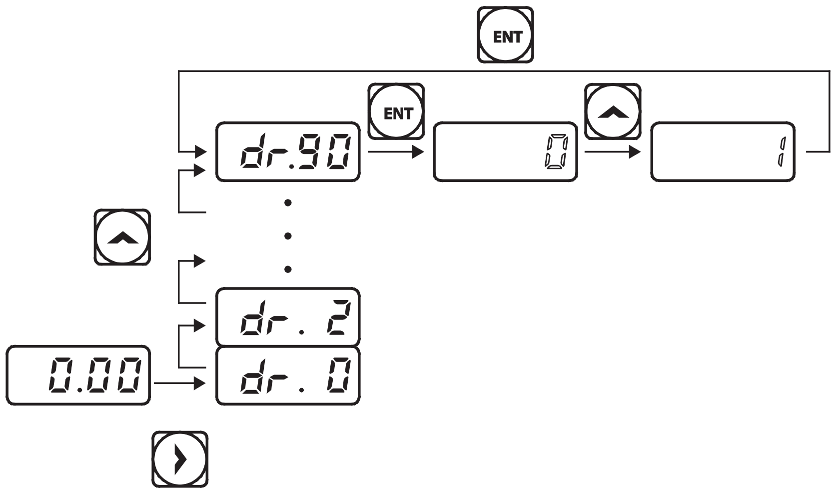
After navigating to the specific parameter number, follow the instructions below to set the parameter values. Setting the parameter value will change the drive functionality by configuring speed references, features, alarm limits, etc.

Step	Instruction	Keypad Display
1	Navigate to a specific parameter group and number, and then press the [ENT] key. The first number on the right side of the display will flash.	
2	Press the Left Arrow or Right Arrow key to move the cursor to the number that you would like to modify.	
3	Press the Up Arrow or Down Arrow key to adjust the value, and then press the [ENT] key to confirm it. The selected value will flash on the display. NOTE: If a number is listed with **rd** (i.e., rd 3), this indicates the value is “reserved” and can not be selected. If a number is listed with nO (i.e n0 5) the value selection is not allowed. Other parameters may need to be modified first, before the selection is allowed.	
4	Press the [ENT] key again to save the change.	-

NOTE: A flashing number on the display indicates that the keypad is waiting for an input from the user. Changes will be saved when the [ENT] key is pressed while the number is flashing. The setting change will be canceled if you press any other key. Each parameter’s values have default features and ranges specified. Refer to Chapter 4: AC Drive Parameters for information about the features and ranges before setting or modifying parameter values.

Configuring the [ESC] Key

The [ESC] key is a multi-functional key that can be configured to carry out a number of different functions. Refer to “Local/Remote Mode Switching” on page 4–82 for more information about the other functions of the [ESC] key. The following example shows how to configure the [ESC] key to perform a jog operation.



1) Ensure that you are currently at the first code of the Operation group, and that code 0.00 (Command Frequency) is displayed.

2) Press theRight Arrow key. You have moved to the initial code of the Drive group (dr.0).

3) Press the Up Arrow orDown Arrow key to select code 90 (ESC key configuration), and then press the [ENT] key. Parameter dr.90 currently has an initial parameter value of, 0 (adjust to the initial position).

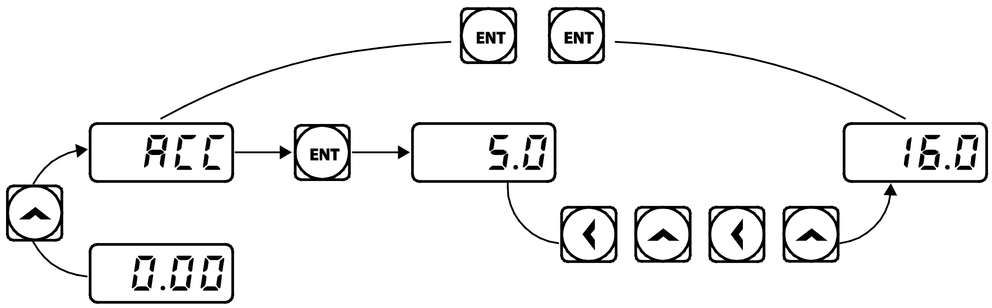
4) Press the Up Arrow key to modify the value to 1 (Jog key) and then press the [ENT] key. The new parameter value will flash.

5) Press the [ENT] key again to save changes.

NOTE:
- *If the code dr.90 (ESC key configuration) is set to 1 (JOG Key) or 2 (Local/Remote), the SET indicator will flash when the [ESC] key is pressed.*
- *The factory default setting for code dr.90 is 0 (move to the initial position). You can navigate back to the initial position (code 0.00 of the Operation group) immediately, by pressing the [ESC] key while configuring any parameters in any groups.*

Actual Application Examples

Acceleration Time Configuration

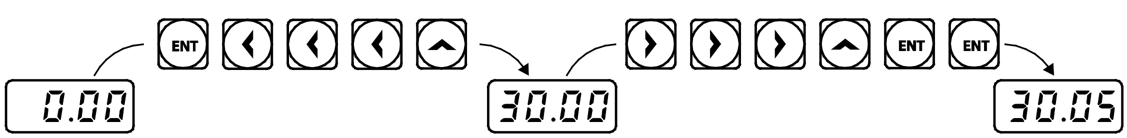


The following is an example demonstrating how to modify the ACC (Acceleration time) parameter value (from 5.0 to 16.0) from the Operation group.

1) Ensure that the first parameter of the Operation group is selected, and parameter 0.00 (Command Frequency) is displayed.
2) Press the Up Arrow key. The display will change to the second parameter in the Operation group, ACC (Acceleration Time).
3) Press the [ENT] key. The number '5.0' will be displayed, with '0' flashing. This indicates that the current acceleration time is set to 5.0 seconds. The flashing value is ready to be modified by using the keypad.
4) Press the Left Arrow key to change the first place value. '5' will be flashing now. This indicates the flashing value, '5' is ready to be modified.
5) Press the Up Arrow key to change the number '5' into '6', the first place value of the target number '16.
6) Press the Left Arrow key to move to the 10s, place value. The number in the 10s position, '0' in '06' will start to flash.
7) Press the Up Arrow key to change the number from '0' to '1', to match the 10s place value of the target number'16,' and then press the [ENT] key. Both digits will flash on the display.
8) Press the [ENT] key once again to save changes. 'ACC' will be displayed. The change to the acceleration time parameter has been completed.

Frequency Reference Configuration

The following is an example to demonstrate configuring a frequency reference of 30.05 (Hz) from the first parameter in the Operation group (0.00).



1) Ensure that the first parameter of the Operation group is selected. 0.00 (Command Frequency) is displayed.
2) Press the [ENT] key. The value, 0.00 will be displayed with the '0' in the 1/100s place value flashing.
3) Press the Left Arrow key 3 times to move to the 10s place value. The '0' at the 10s place value will start to flash.
4) Press the Up Arrow key to change it to '3,' the 10s place value of the target frequency, '30.05.'
5) Press theRight Arrow key 3 times. The '0' at the 1/100s place position will flash.

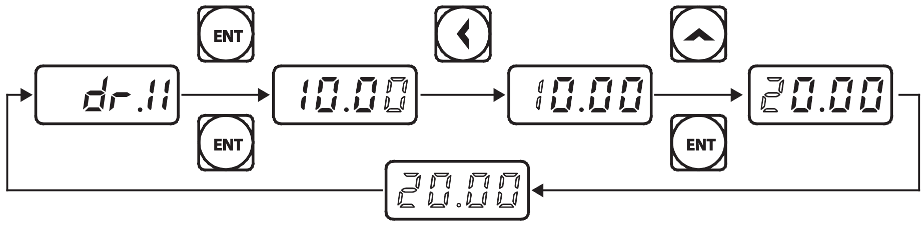
6) Press the Up Arrow key to change it to '5,' the 1/100 place value of the target frequency, '30.05,' and then press the [ENT] key. The parameter value will flash on the display.

7) Press the [ENT] key once again to save changes. Flashing stops. The frequency reference has been configured to 30.05 Hz.

Note: A flashing number on the display indicates that the keypad is waiting for an input from the user. Changes are saved when the [ENT] key is pressed while the value is flashing. Changes will be canceled if any other key is pressed. The ACN drive keypad display can show up to 4 digits. However, 5-digit figures can be used and are accessed by pressing the Left or Right arrow key, to allow keypad input.

Jog Frequency Configuration

The following example demonstrates how to configure Jog Frequency by modifying Drive Group parameter 11 (dr. 11) from 10.00(Hz) to 20.00(Hz). You can configure the parameters in any other group in exactly the same way.

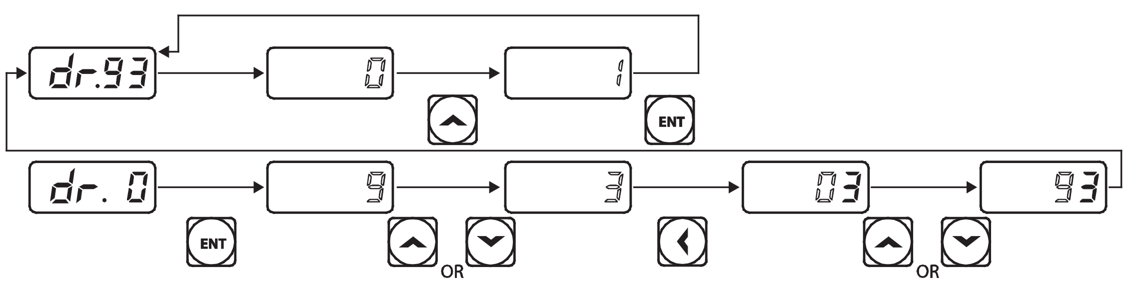


1) Go to Parameter dr.11 (Jog Frequency).
2) Press the [ENT] key. The current Jog Frequency value (10.00) for parameter dr.11 is displayed.
3) Press the Left Arrow key 3 times to move to the 10s place value. Number ‘1’ at the 10s place position will flash.
4) Press the Up Arrow key to change the value to ‘2,’ to match the 10s place value of the target value’20.00,’ and then press the [ENT] key. All parameter digits will flash on the display.
5) Press the [ENT] key once again to save the changes. Parameter dr.11 will be displayed. The parameter change has been completed.

Initializing All Parameters (Reset to Defaults)

To reset the drive parameters to factory default settings, utilize dr.93, (Drive Group Parameter 93- parameter initialization). Once executed, all parameters will be set back to original settings.

Note: This can be helpful when parameter dependencies are preventing certain parameters from displaying.

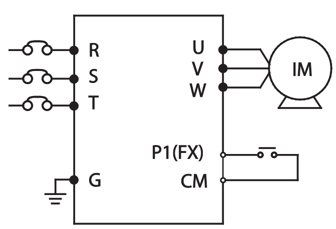


1) Go to parameter dr. 0.
2) Use the Jump Code or press the Down Arrow key to display dr.93.
3) Press the [ENT] key. The current parameter value for code dr.93 is set to 0 (Do not initialize).
4) Press the Up Arrow key to change the value to 1 (All Grp), and then press the [ENT] key. The parameter value will flash.
5) Press the [ENT] key once again. Parameter initialization begins. Parameter initialization is complete when code dr.93 reappears on the display.

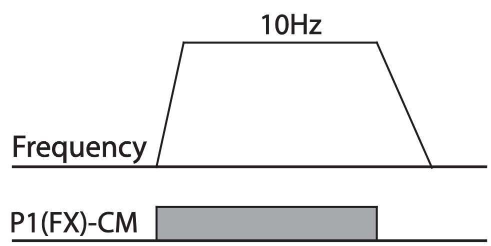
NOTE: Following parameter initialization, all parameters are reset to factory default values. Ensure that parameters are reconfigured before running the drive again after an initialization.

Frequency Setting (Keypad) and Operation (via Terminal Input)

1) Turn on the drive.
2) Ensure that the first parameter of the Operation group (Command Frequency) is selected (0.00 is displayed). Then press the [ENT] key. The first digit on the right will flash.
3) Press the Left Arrow key 3 times to go to the 10s place position. The number ‘0’ at the 10s place position will flash.
4) Press the Up Arrow key to change it to 1, and then press the [ENT] key. The parameter value (10.00) will flash.
5) Press the [ENT] key once again to save changes. A change of reference frequency to 10.00 Hz has been completed.
6) Refer to the wiring diagram at the bottom of the table, and close the switch between the P1 (FX) and CM terminals. The RUN indicator light flashes and the FWD indicator light comes on steady. The current acceleration frequency is displayed.
7) When the frequency reference is reached (10Hz), open the switch between the P1 (FX) and CM terminals. The RUN indicator light flashes again and the current deceleration frequency is displayed. When the frequency reaches 0Hz, the RUN and FWD indicator lights turn off, and the frequency reference (10.00Hz) is displayed again.



Wiring Diagram

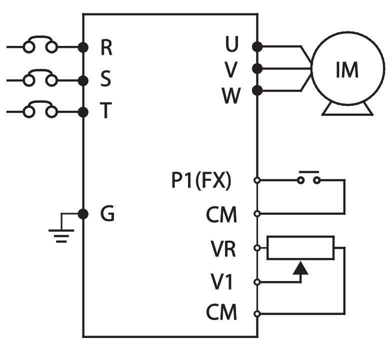


Operation Pattern

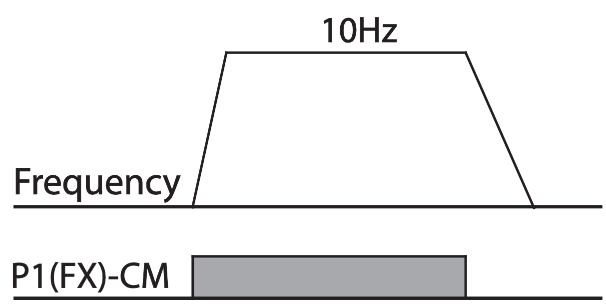
NOTE: The instructions in the table are based on the factory default parameter settings. The drive may not work correctly if the default parameter settings are changed after the drive is purchased. In such cases, initialize all parameters to reset the values to factory default parameter settings before following the instructions in the table (refer to Initializing All Parameters (Reset to Defaults) on page 3–12*).*

Frequency Setting (Potentiometer) and Operation (Terminal Input)

1) Turn on the drive.
2) Ensure that the first parameter of the Operation group (Command Frequency) is selected (0.00 is displayed). Then press the [ENT] key. The first digit on the right will flash.
3) Press the Up Arrow key 4 times to go to the Frq (Frequency reference source) parameter.
4) Press the [ENT] key. The Frq parameter in the Operation group is currently set to 0 (keypad).
5) Press the Up Arrow key to change the parameter value to 2 (Potentiometer), and then press the [ENT] key. The new parameter value will flash.
6) Press the [ENT] key once again. The Frq parameter will be displayed again. The frequency input has been configured for the potentiometer.
7) Press theDown Arrow key 4 times. Returns to the first parameter of the Operation group (0.00).From here frequency setting values can be monitored.
8) Adjust the potentiometer to increase or decrease the frequency reference to 10Hz.
9) Refer to the wiring diagram at the bottom of the table, and close the switch between the P1 (FX) and CM terminals. The RUN indicator light flashes and the FWD indicator light comes on steady. The current acceleration frequency is displayed.
10) When the frequency reference is reached (10Hz), open the switch between the P1 (FX) and CM terminals. The RUN indicator light flashes again and the current deceleration frequency is displayed. When the frequency reaches 0Hz, the RUN and FWD indicators turn off, and the frequency reference (10.00Hz) is displayed again.



Wiring Diagram

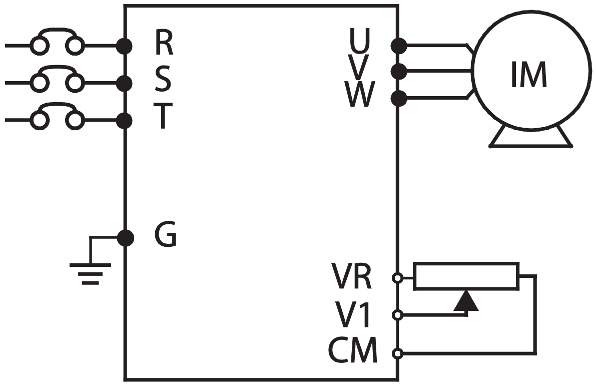


Operation Pattern

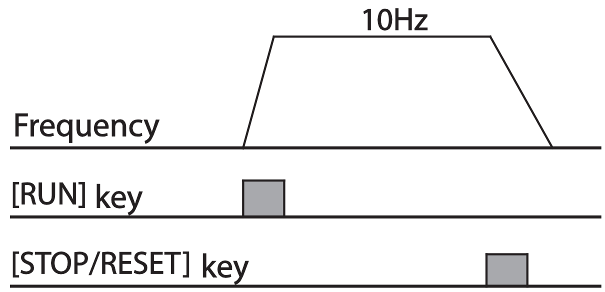
NOTE: The instructions in the table are based on the factory default parameter settings. The drive may not work correctly if the default parameter settings are changed after the drive is purchased. In such cases, initialize all parameters to reset the factory default parameter settings before following the instructions in the table (refer to Initializing All Parameters (Reset to Defaults) on page 3–12*).*

Frequency Setting (Potentiometer) and Operation (Keypad)

1) Turn on the drive.
2) Ensure that the first parameter of the Operation group (Command Frequency) is selected (0.00 is displayed). Then press the [ENT] key. The first digit on the right will flash.
3) Press the Up Arrow key 3 times to go to the drv parameter.
4) Press the [ENT] key.
5) The drv parameter in the Operation group is currently set to 1 (Fx/Rx-1 input terminal).
6) Press theDown Arrow key to change the parameter value to 0 (Keypad), and then press the [ENT] key.
7) The new parameter value will flash.
8) Press the [ENT] key once again.
9) The drv parameter is displayed again. The frequency input has been configured for the keypad.
10) Press the Up Arrow key.
11) To move to the Frq (Frequency reference source) parameter.
12) Press the [ENT] key.
13) The Frq parameter in the Operation group is set to 0 (Keypad).
14) Press the Up Arrow key to change it to 2 (Potentiometer), and then press the [ENT] key.
15) The new parameter value will flash.
16) Press the [ENT] key once again.
17) The Frq parameter is displayed again. The frequency input has been configured for potentiometer.
18) Press theDown Arrow key 4 times.
19) Returns to the first parameter of the Operation group (0.00). From here frequency setting values can be monitored.
20) Adjust the potentiometer to increase or decrease the frequency reference to 10Hz.
21) Press the [RUN] key on the keypad.
22) The RUN indicator light flashes and the FWD indicator light comes on steady. The current acceleration frequency is displayed.
23) When the frequency reaches the reference (10Hz), press the [STOP/RESET] key on the keypad.
24) The RUN indicator light flashes again and the current deceleration frequency is displayed. When the frequency reaches 0Hz, the RUN and FWD indicator lights turn off, and the frequency reference (10.00Hz) is displayed again.



Wiring Diagram



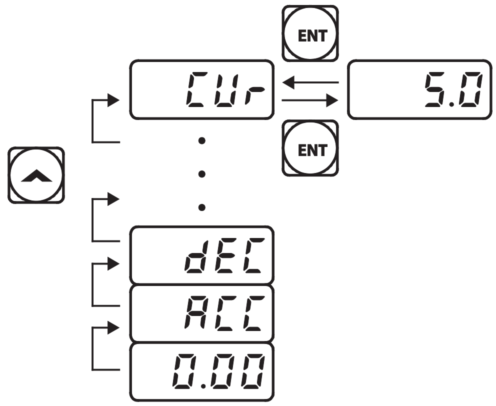
Operation Pattern

NOTE: The instructions in the table are based on the factory default parameter settings. The drive may not work correctly if the default parameter settings are changed after the drive is purchased. In such cases, initialize all parameters to reset the factory default parameter settings before following the instructions in the table (refer to Initializing All Parameters (Reset to Defaults) on page 3–12*).*

Monitoring the Operation

Output Current Monitoring

The following example demonstrates how to monitor the output current in the Operation group using the keypad.

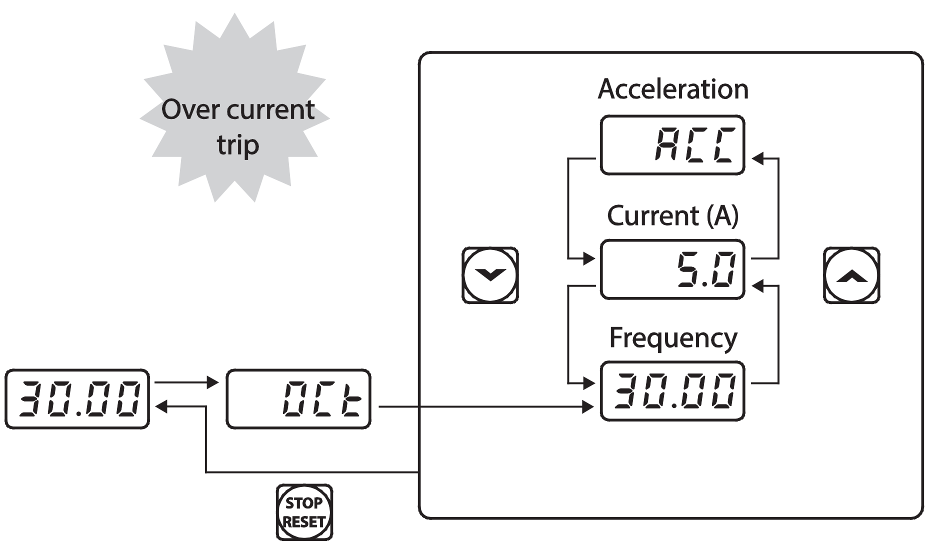


1) Ensure that the first code of the Operation group is selected, and 0.00 (Command Frequency) is displayed.
2) Press the Up Arrow orDown Arrow key to move to the Cur parameter.
3) Press the [ENT] key. The output current (5.0A) is displayed.
4) Press the [ENT] key again. Returns to the Cur parameter.

NOTE: You can use the DCL (DC link voltage monitor) and vOL (output voltage monitor) parameters in the Operation group in exactly the same way as shown in the example above, to monitor each function's relevant values.

Fault Trip Monitoring

The following example demonstrates how to monitor fault trip conditions in the Operation group using the keypad.



1) Refer to the example keypad display. An over current trip fault has occurred.
2) Press the [ENT] key, and then the Up Arrow key. The operation frequency at the time of the fault (30.00Hz) is displayed.

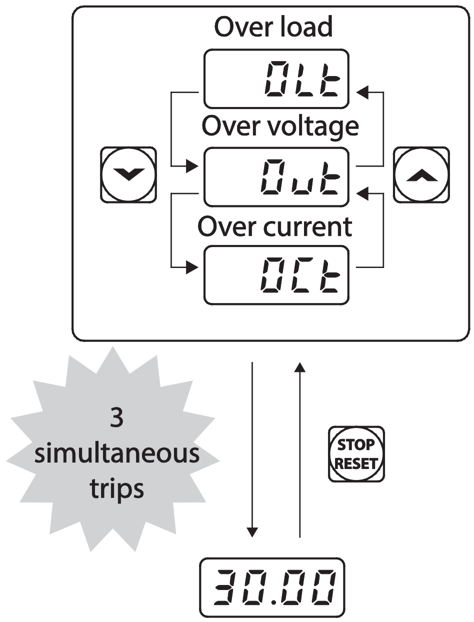
3) Press the Up Arrow key. The output current at the time of the fault (5.0A) is displayed.

4) Press the Up Arrow key. The operation status at the time of the fault is displayed. ACC on the display indicates that the fault occurred during acceleration.

5) Press the [STOP/RESET] key. The drive resets and the fault condition is cleared. The frequency reference is displayed on the keypad.

NOTE:

- *If multiple fault trips occur at the same time, a maximum of 3 fault trip records can be retrieved as shown in the following example:*



- *If a warning condition occurs while running at a specified frequency, the current frequency and the signal will be displayed alternately, at 1 second intervals. Refer to* “Fault Trips” on page 6–8 *for more details.*

Chapter 4: AC Drive Parameters

Chapter 4

TABLE OF CONTENTS

AC Drive Parameters

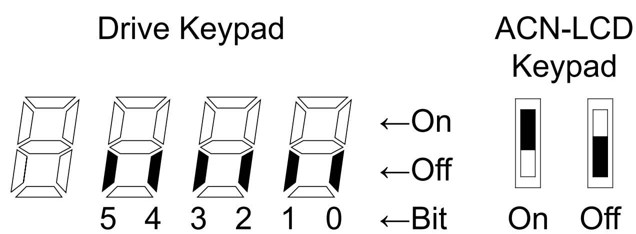
This chapter covers all the parameters available for use with the Ironhorse ACN series drives. The "Parameter Summary" section provides a table of all the parameters with basic information. The "Parameter Details" section provides explanation about each parameter and how they interact with other parameters.

Set the parameters required according to the following chapter. If a set value input is out of range or not allowed, the following messages can be shown on the keypad display. In these cases, the parameter value will not be accepted with the [ENT] key.

- ***rd**: Set value not allocated (reserved)*
- ***OL**: Set value repetition (multi–function input, PID reference, PID feedback related)*
- ***no**: Set value not allowed (select value, V2, I2)*

Bit Selection

Bit level selections are displayed as follows:



Use the left/right arrows to move bits. Use up/down arrows to toggle bits on/off.

Parameter Table Format Explanation

The ACN drive has 14 parameter groups containing over 700 parameters. The LCD keypad allows for 2 additional parameter menus.

Parameter Group								
Pr. Code	Name	Setting Range	Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.

Table Legend

- ***Code** – Parameter display group and number shown on the drive keypad*
- ***Name** – Parameter description*
- ***Setting Range** – Range of parameter settings, including units if applicable*
- ***Initial Value** – Parameter default setting*
- ***Run R/W***
  - » *♦R/W – Parameter Write–enabled during Operation (Run mode)*
  - » *R/W – Parameter Write–enabled when stopped*
  - » *Parameter Read Only*
- ***Parameter Dependency** – Indicates a parameter is available only when this criteria is met. If blank, the parameter has no additional dependency.*
- ***Compatible Control Mode** – Indicates a parameter is available in these control modes only. Control mode is set by Parameter dr.9.*
  - » *"v" – v/f (dr.9 =0)*
  - » *"s" – slip compensation (dr.9 = 2)*
  - » *"i" – IM Sensorless (dr.9 = 4)*
  - » *"p" – PM Sensorless (dr.9 = 6)*
- ***Comm. Addresses** – Hexadecimal and Modbus decimal parameter address for serial communications.*
- ***Ref.** – Page reference and link to parameter details.*

Parameter Group Summary			
Parameter Group Display Code		Description	Parameter Pr. Group Dependency
Drive Keypad LED (Built in)	Remote LCD (optional)		
			
"use up/down arrows at 0.0. (No code)"	n/a	Operation	
dr	DRV	Drive	
bA	BAS	Basic	
Ad	ADV	Advanced	
Cn	CON	Control	
In	IN	Inputs	
OU	OUT	Outputs	
CM	COM	Communication	
AP	APP	Application	
AO*	APO*	Optional I/O Card	*ACN–EIO card is installed
Pr	PRT	Protection	
M2*	M2*	2nd Motor	* In.65–69–> any one of these parameters is set to 26
US*	USS*	User Sequence	*AP.2 =1 or CM.95=1 (P2P Master)
UF*	USF*	User Sequence Function	*AP.2 =1 or CM.95=1 (P2P Master)
n/a	CNF	Configuration	LCD only
n/a	TRP	Trip	LCD only

Operation Parameter Group

The Operation group is used only on the standard drive keypad. It will not be displayed on an LCD keypad (ACN–LCD). If the LCD keypad is connected, the corresponding functions will be found in the Drive parameter group.

See "Table Legend" on page 4–3 for details on each column in the table below.

Pr. Code	Name	Setting Range	Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
0.00	Target frequency	0–Maximum frequency(Hz)	0.00	♦R/W	–	v, s, i, p	0h1F00	3–5
ACC	Acceleration time	0.0–600.0s	20.0	♦R/W	–	v, s, i, p	0h1F01	4–87
dEC	Deceleration time	0.0–600.0s	30.0	♦R/W	–	v, s, i, p	0h1F02	4–87
drv	Command source	0: Keypad 1: Fx/Rx–1 (Fwd Run/ Rev Run) 2: Fx/Rx–2 (Run/ Direction) 3: Int 485 4: Field Bus[1] 5: UserSeqLink	1: Fx/Rx–1 (Fwd Run/ Rev Run)	R/W	–	v, s, i, p	0h1F03	4–79
Frq	Frequency reference source	0: Keypad–1 1: Keypad–2 2: V1 4: V2 5: I2 6: Int 485 8: Field Bus 12: Pulse 13: V3 15: V4 16: I4	0: Keypad–1	R/W	–	v, s, i, p	0h1F04	4–68
St1	Multi–step speed frequency 1	0.00–Maximum frequency(Hz)	10.00	♦R/W	–	v, s, i, p	0h1F05	4–77
St2	Multi–step speed frequency 2	0.00–Maximum frequency(Hz)	20.00	♦R/W	–	v, s, i, p	0h1F06	4–77
St3	Multi–step speed frequency 3	0.00–Maximum frequency(Hz)	30.00	♦R/W	–	v, s, i, p	0h1F07	4–77
CUr	Output current	–	–	Read Only	–	v, s, i, p	0h1F08	3–17
Rpm	Motor revolutions per minute	–	–	Read Only	–	v, s, i, p	0h1F09	–
dCL	Drive direct current voltage	–	–	Read Only	–	v, s, i, p	0h1F0A	3–17
vOL	Drive output voltage	–	–	Read Only	–	v, s, i, p	0h1F0B	3–17
nOn	Out of order signal	–	–	–	–	v, s, i, p	0h1F0C	–

Operation Parameter Group									
Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
drC	Select rotation direction	F	Forward run	F	♦R/W	–	v, s, i, p	0h1F0D	–
		r	Reverse run						

DRIVE Parameter Group (dr, DRV)

The drive parameter group is labeled as follows:

- *dr – standard LED kepyad*
- *DRV– optional LCD keypad*

See "Table Legend" on page 4–3 for details on each column in the table below.

Drive Parameter Group (dr, DRV)								
Pr. Code	**Name**	**Setting Range**	**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
dr.0	Jump Code	1–99	9	♦R/W	–	v, s, i, p	–	3–5
dr.1	Target (CMD) frequency	Start frequency – Maximum frequency (Hz)	0.00	♦R/W	LCD only. +	v, s, i, p	0h1101	3–10
dr.2	Torque command	–180–180%	0.0	♦R/W	dr.9=4	i	0h1102	4–162
dr.3	Acceleration time	0.0–600.0s	20.0	♦R/W	LCD only. +	v, s, i, p	0h1103	4–87
dr.4	Deceleration time	0.0–600.0s	30.0	♦R/W	LCD only. +	v, s, i, p	0h1104	4–87
dr.6	Command source	0 Keypad 1 Fx/Rx–1 (Fwd Run/Rev Run) 2 Fx/Rx–2 (Run/Direction) 3 Int 485 4 Field Bus 5 UserSeqLink	1: Fx/Rx–1 (Fwd Run/ Rev Run)	R/W	LCD only. +	v, s, i, p	0h1106	4–79
dr.7	Frequency reference source	0 Keypad–1 1 Keypad–2 2 V1 4 V2 5 I2 6 Int 485 8 Field Bus 9 UserSeqLink 12 Pulse 13 V3 15 V4 16 I4	0: Keypad–1	R/W	LCD only. +	v, s, i, p	0h1107	4–68

\+ *View this parameter in the Operation menu group if LCD is not installed*
\# *View this parameter in CNF menu on ACN-LCD keypad*

<table>
<tr><th colspan="10">Drive Parameter Group (dr, DRV)</th></tr>
<tr><th>Pr. Code</th><th>Name</th><th colspan="2">Setting Range</th><th>Initial Value</th><th>Run R/W</th><th>Parameter Dependency</th><th>Compatible Control Mode</th><th>Comm. Address (Hex)</th><th>Ref.</th></tr>
<tr><td rowspan="12">dr.8</td><td rowspan="12">Torque reference setting</td><td>0</td><td>Keypad–1</td><td rowspan="12">0: Keypad–1</td><td rowspan="12">R/W</td><td rowspan="12">dr.9=4</td><td rowspan="12">i</td><td rowspan="12">0h1108</td><td rowspan="12">4–162</td></tr>
<tr><td>1</td><td>Keypad–2</td></tr>
<tr><td>2</td><td>V1</td></tr>
<tr><td>4</td><td>V2</td></tr>
<tr><td>5</td><td>I2</td></tr>
<tr><td>6</td><td>Int 485</td></tr>
<tr><td>8</td><td>FieldBus (Ethernet)</td></tr>
<tr><td>9</td><td>UserSeqLink</td></tr>
<tr><td>12</td><td>Pulse</td></tr>
<tr><td>13</td><td>V3</td></tr>
<tr><td>15</td><td>V4</td></tr>
<tr><td>16</td><td>I4</td></tr>
<tr><td rowspan="4">dr.9</td><td rowspan="4">Control mode</td><td>0</td><td>V/F</td><td rowspan="4">0: V/F</td><td rowspan="4">R/W</td><td rowspan="4">–</td><td rowspan="4">v, s, i, p</td><td rowspan="4">0h1109</td><td rowspan="4">4–93
4–137
4–147</td></tr>
<tr><td>2</td><td>Slip Compen</td></tr>
<tr><td>4</td><td>IM Sensorless</td></tr>
<tr><td>6</td><td>PM Sensorless</td></tr>
<tr><td rowspan="2">dr.10</td><td rowspan="2">Torque Control</td><td>0</td><td>No</td><td rowspan="2">0: No</td><td rowspan="2">R/W</td><td rowspan="2">dr.9=4</td><td rowspan="2">i</td><td rowspan="2">0h110A</td><td rowspan="2">4–162</td></tr>
<tr><td>1</td><td>Yes</td></tr>
<tr><td>dr.11</td><td>Jog frequency</td><td colspan="2">0.00, Start frequency–Maximum frequency(Hz)</td><td>10.00</td><td>♦R/W</td><td>–</td><td>v, s, i, p</td><td>0h110B</td><td>4–128</td></tr>
<tr><td>dr.12</td><td>Jog run acceleration time</td><td colspan="2">0.0–600.0s</td><td>20.0</td><td>♦R/W</td><td>–</td><td>v, s, i, p</td><td>0h110C</td><td>4–128</td></tr>
<tr><td>dr.13</td><td>Jog run deceleration time</td><td colspan="2">0.0–600.0s</td><td>30.0</td><td>♦R/W</td><td>–</td><td>v, s, i, p</td><td>0h110D</td><td>4–128</td></tr>
<tr><td rowspan="16">dr.14</td><td rowspan="16">Motor capacity</td><td>0</td><td>0.2kW</td><td rowspan="16">Varies by Drive capacity</td><td rowspan="16">R/W</td><td rowspan="16">–</td><td rowspan="16">v, s, i, p</td><td rowspan="16">0h110E</td><td rowspan="16">4–145</td></tr>
<tr><td>1</td><td>0.4kW</td></tr>
<tr><td>2</td><td>0.75kW</td></tr>
<tr><td>3</td><td>1.1kW</td></tr>
<tr><td>4</td><td>1.5kW</td></tr>
<tr><td>5</td><td>2.2kW</td></tr>
<tr><td>6</td><td>3.0kW</td></tr>
<tr><td>7</td><td>3.7kW</td></tr>
<tr><td>8</td><td>4.0kW</td></tr>
<tr><td>9</td><td>5.5kW</td></tr>
<tr><td>10</td><td>7.5kW</td></tr>
<tr><td>11</td><td>11.0kW</td></tr>
<tr><td>12</td><td>15.0kW</td></tr>
<tr><td>13</td><td>18.5kW</td></tr>
<tr><td>14</td><td>22.0kW</td></tr>
<tr><td>15</td><td>30.0kW</td></tr>
<tr><td colspan="10">+ View this parameter in the Operation menu group if LCD is not installed
View this parameter in CNF menu on ACN-LCD keypad</td></tr>
</table>

Drive Parameter Group (dr, DRV)									
Pr. Code	**Name**	**Setting Range**		**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
dr.15	Torque boost options	0	Manual	0: Manual	R/W	–	v, s	0h110F	–
		1	Auto1						
		2	Auto2						
dr.16	Forward Torque boost	0.0–15.0%		2.0	R/W	–	v, s	0h1110	4–96
dr.17	Reverse Torque boost	0.0–15.0%		2.0	R/W	–	v, s	0h1111	4–96
dr.18	Base frequency	30.00–400.00 Hz [V/F, Slip Compen] 40.00–120.00 Hz [IM Sensorless] 30.00–180.00 Hz [PM Sensorless]		60.00	R/W	–	v, s, i, p	0h1112	4–93
dr.19	Start frequency	0.01–10.00Hz		0.50	R/W	–	v, s, i, p	0h1113	4–93
dr.20	Maximum frequency	40.00–400.00 Hz [V/F, Slip Compen] 40.00–120.00 Hz [IM Sensorless] 40.00–180.00 Hz [PM Sensorless]		60.00	R/W	–	v, s, i, p	0h1114	4–101
dr.21	Select speed unit	0	Hz Display	0: Hz Display	♦R/W	LCD Only	v, s, i, p	0h1115	4–77
		1	Rpm Display						
dr.22	(+)Torque gain	50.0 – 150.0%		100.0	♦R/W	dR.10=1	i	0h1116	4–162
dr.23	(–)Torque gain	50.0 – 150.0%		80.0	♦R/W	dR.10=1	i	0h1117	4–162
dr.24	(–)Torque gain 0	50.0 – 150.0%		80.0	♦R/W	dR.10=1	i	0h1118	4–162
dr.25	(–)Torque offset	0.0 – 100.0%		40.0	♦R/W	dR.10=1	i	0h1119	4–162
+ View this parameter in the Operation menu group if LCD is not installed *# View this parameter in CNF menu on ACN-LCD keypad*									

Drive Parameter Group (dr, DRV)									
Pr. Code	**Name**	**Setting Range**		**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
dr.80	Select ranges at power input	Select ranges drive displays at power input		0: Run frequency	♦R/W	LED keypad only #	v, s, i, p	0h1150	–
		0	Run frequency						
		1	Acceleration time						
		2	Deceleration time						
		3	Command source						
		4	Frequency reference source						
		5	Multi–step speed frequency1						
		6	Multi–step speed frequency2						
		7	Multi–step speed frequency3						
		8	Output current						
		9	Motor RPM						
		10	Drive DC voltage						
		11	User select signal (dr.81)						
		12	Currently out of order						
		13	Select run direction						
		14	Output current2						
		15	Motor RPM2						
		16	Drive DC voltage2						
		17	User select signal2 (dr.81)						
dr.81	Select monitor code	Monitors user selected code		0: Output voltage	♦R/W	LED keypad only #	v, s, i, p	0h1151	–
		0	Output voltage(V)						
		1	Output electric power (kW)						
		2	Torque (kg f*m)						
dr.89	Display changed parameter	0	View All	0: View All	♦R/W	LED keypad only #	v, s, i, p	0h03E3	4–178
		1	View Changed						
dr.90	[ESC] key functions	0	Move to initial position	0: None	R/W	LED keypad only #	v, s, i, p	0h115A	3–9 4–82 4–130
		1	JOG Key						
		2	Local/Remote						
dr.91	Smart copy	0	None	0: None	R/W	LED keypad only #	v, s, i, p	0h115B	–
		1	Not Supported						
		3	Not Supported						

+ View this parameter in the Operation menu group if LCD is not installed
 # View this parameter in CNF menu on ACN-LCD keypad

Drive Parameter Group (dr, DRV)									
Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
dr.93	Parameter initialization	0	No	0: No	R/W	LED keypad only #	v, s, i, p	0h115D	4–175
		1	All Grp						
		2	dr Grp						
		3	bA Grp						
		4	Ad Grp						
		5	Cn Grp						
		6	In Grp						
		7	OU Grp						
		8	CM Grp						
		9	AP Grp						
		11	APO Grp						
		12	Pr Grp						
		13	M2 Grp						
		14	US Grp						
		15	UF Grp						
		16	SPS Grp (Operation)						
dr.94	Password registration	0–9999		–	♦R/W	LED keypad only #	v, s, i, p	0h115E	4–176
dr.95	Parameter lock settings	0–9999		–	♦R/W	LED keypad only #	v, s, i, p	0h115F	4–177
dr.97	Software version	–		–	Read Only	LED keypad only #	v, s, i, p	0h1161	–
dr.98	Display I/O board version	–		–	Read Only	–	v, s, i, p	0h1162	–
dr.99	Display I/O board H/W version	1	Standard IO	1: Standard IO	Read Only	–	v, s, i, p	0h1163	–

+ View this parameter in the Operation menu group if LCD is not installed
 # View this parameter in CNF menu on ACN-LCD keypad

BASIC Parameter group (bA, BAS)

The BASIC parameter group is labeled as follows:

- *bA – standard LED kepyad*
- *BAS– optional LCD keypad*

See "Table Legend" on page 4–3 for details on each column in the table below.

BASIC Parameter group (bA, BAS)									
Pr. Code	**Name**	**Setting Range**		**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
bA.0	Jump Code	1–99		20	♦R/W	–	v, s, i, p	–	3–5
bA.1	Auxiliary reference source	0	None	0: None	R/W	–	v, s, i, p	0h1201	4–125
		1	V1						
		3	V2						
		4	I2						
		6	Pulse						
		7	V3						
		9	V4						
		10	I4						
bA.2	Auxiliary command calculation type	0	M+(G*A)	0: M+(G*A)	R/W	bA.1≠0	v, s, i, p	0h1202	4–125
		1	Mx (G*A)						
		2	M/(G*A)						
		3	M+[M*(G*A)]						
		4	M+G*2(A–50%)						
		5	Mx[G*2(A–50%)						
		6	M/[G*2(A–50%)]						
		7	M+M*G*2 (A–50%)						
bA.3	Auxiliary command gain	–200.0–200.0%		100.0	♦R/W	bA.1≠0	v, s, i, p	0h1203	4–125
bA.4	2nd command source	0	Keypad	1: Fx/Rx–1 (Fwd Run/ Rev Run)	R/W	–	v, s, i, p	0h1204	4–103
		1	Fx/Rx–1 (Fwd Run/Rev Run)						
		2	Fx/Rx–2 (Run/Direction)						
		3	Int 485						
		4	FieldBus (Ethernet)						

BASIC Parameter group (bA, BAS)									
Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
bA.5	2nd frequency source	0	Keypad–1	0: Keypad–1	♦R/W	–	v, s, i, p	0h1205	4–103
		1	Keypad–2						
		2	V1						
		4	V2						
		5	I2						
		6	Int 485						
		8	FieldBus (Ethernet)						
		9	UserSeqLink						
		12	Pulse						
		13	V3						
		15	V4						
		16	I4						
bA.6	2nd Torque command source	0	Keypad–1	0: Keypad–1	♦R/W	–	i	0h1206	–
		1	Keypad–2						
		2	V1						
		4	V2						
		5	I2						
		6	Int 485						
		8	FieldBus (Ethernet)						
		9	UserSeqLink						
		12	Pulse						
		13	V3						
		15	V4						
		16	I4						
bA.7	V/F pattern options	0	Linear	0: Linear	R/W	–	v, s	0h1207	4–93
		1	Square						
		2	User V/F						
		3	Square 2						
bA.8	Acc/dec standard frequency	0	Max Freq	0: Max Freq	R/W	–	v, s, i, p	0h1208	4–87
		1	Delta Freq						
bA.9	Time scale settings	0	0.01 sec	1: 0.1 sec	R/W	–	v, s, i, p	0h1209	4–87
		1	0.1 sec						
		2	1 sec						
bA.10	Input power frequency	0	60Hz	0: 60Hz	R/W	–	v, s, i, p	0h120A	4–175
		1	50Hz						
bA.11	Number of motor poles	2–48		Dependent on motor setting	R/W	–	v, s, i, p	0h120B	4–137
bA.12	Rated slip speed	0–3000(Rpm)		Dependent on motor setting	R/W	dr.9≠6 not PM sensorless	v, s, i	0h120C	4–137
bA.13	Motor rated current	1.0–1000.0A		Dependent on motor setting	R/W	–	v, s, i, p	0h120D	4–137

BASIC Parameter group (bA, BAS)								
Pr. Code	**Name**	**Setting Range**	**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
bA.14	Motor no load current	0.0–1000.0A	Dependent on motor setting	R/W	dr.9≠6 not PM sensorless	v, s, i	0h120E	4–137
bA.15	Motor rated voltage	170–480V	Dependent on motor setting	R/W	–	v, s, i, p	0h120F	4–97
bA.16	Motor efficiency	64–100%	Dependent on motor setting	R/W	–	v, s, i, p	0h1210	4–137
bA.17	Load inertia rate	0–8	0	R/W	–	v, s, i, p	0h1211	4–137
bA.18	Trim power display	70–130%	100	♦R/W	–	v, s, i, p	0h1212	–
bA.19	Input power voltage	230V : 170–240V 460V : 320–480V	220 380	♦R/W	–	v, s, i, p	0h1213	4–175
bA.20	Auto Tuning	0 None 1 All (Rotation type) 2 ALL (Static type) 3 Rs+Lsigma (Rotation type) 6 Tr (Static type) 7 All PM	0: None	R/W	–	i, p	–	4–145
bA.21	Stator resistance	Dependent on motor setting	Dependent on motor setting	R/W	–	i, p	–	4–145
bA.22	Leakage inductance	–	Dependent on motor setting	R/W	dr.9≠6 not PM sensorless	i	–	4–145
bA.23	Stator inductance	–	Dependent on motor setting	R/W	dr.9≠6 not PM sensorless	i	–	4–145
bA.24	Rotor time constant	25–5000(ms)	Dependent on motor setting	R/W	dr.9=4 IM Sensorless	i	–	4–145
bA.25	Stator inductance scale	50 – 150%	100	R/W	dr.9=4 IM Sensorless	i	–	–
bA.26	Rotor time constant scale	50 – 150%	100	R/W	dr.9=4 IM Sensorless	i	–	–
bA.28	D–axis inductance	Settings vary depending on the motor specifications.	0	R/W	dr.9=6 PM Sensorless	p	–	–
bA.29	Q–axis inductance	Settings vary depending on the motor specifications.	0	R/W	dr.9=6 PM Sensorless	p	–	–
bA.30	Flux reference	Settings vary depending on the motor specifications.	0.147	R/W	dr.9=6 PM Sensorless	p	–	–
bA.31	Regeneration inductance scale	70 – 100%	80	R/W	dr.9=4 IM Sensorless	i	–	–
bA.32	Q–axis inductance scale	50–150%	100	R/W	dr.9=6 PM Sensorless	p	–	–

BASIC Parameter group (bA, BAS)								
Pr. Code	Name	Setting Range	Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
bA.34	PM auto tuning level	20.0–50.0%	33	R/W	dr.9=6 PM Sensorless	p	–	–
bA.35	PM auto tuning frequency	80.0–150.0%	150	R/W	dr.9=6 PM Sensorless	p	–	–
bA.41	User frequency1	0.00–Maximum frequency(Hz)	15.00	R/W	bA.7 or m2.25=2	v, s	0h1229	4–95
bA.42	User voltage1	0–100%	25	R/W	bA.7 or m2.25=2	v, s	0h122A	4–95
bA.43	User frequency2	0.00–0.00– Maximum frequency(Hz)	30.00	R/W	bA.7 or m2.25=2	v, s	0h122B	4–95
bA.44	User voltage2	0–100%	50	R/W	bA.7 or m2.25=2	v, s	0h122C	4–95
bA.45	User frequency3	0.00–Maximum frequency(Hz)	45.00	R/W	bA.7 or m2.25=2	v, s	0h122D	4–95
bA.46	User voltage3	0–100%	75	R/W	bA.7 or m2.25=2	v, s	0h122E	4–95
bA.47	User frequency4	0.00–Maximum frequency(Hz)	Maximum frequency	R/W	bA.7 or m2.25=2	v, s	0h122F	4–95
bA.48	User voltage4	0–100%	100	R/W	bA.7 or m2.25=2	v, s	0h1230	4–95
bA.50	Multi–step speed frequency1	0.00–Maximum frequency(Hz)	10.00	♦R/W	LCD Only	v, s, i, p	0h1232	4–77
bA.51	Multi–step speed frequency2	0.00–Maximum frequency(Hz)	20.00	♦R/W	LCD Only	v, s, i, p	0h1233	4–77
bA.52	Multi–step speed frequency3	0.00–Maximum frequency(Hz)	30.00	♦R/W	LCD Only	v, s, i, p	0h1234	4–77
bA.53	Multi–step speed frequency4	0.00–Maximum frequency(Hz)	40.00	♦R/W	In.65–71= Spd–L/M/H	v, s, i, p	0h1235	4–77
bA.54	Multi–step speed frequency5	0.00–Maximum frequency(Hz)	50.00	♦R/W	In.65–71= Spd–L/M/H	v, s, i, p	0h1236	4–77
bA.55	Multi–step speed frequency6	0.00–Maximum frequency(Hz)	Maximum frequency	♦R/W	In.65–71= Spd–L/M/H	v, s, i, p	0h1237	4–77
bA.56	Multi–step speed frequency7	0.00–Maximum frequency(Hz)	Maximum frequency	♦R/W	In.65–71= Spd–L/M/H	v, s, i, p	0h1238	4–77
bA.70	Multi–step acceleration time1	0.0–600.0s	20.0	♦R/W	–	v, s, i, p	0h1246	4–88
bA.71	Multi–step deceleration time1	0.0–600.0s	20.0	♦R/W	–	v, s, i, p	0h1247	4–88
bA.72	Multi–step acceleration time2	0.0–600.0s	30.0	♦R/W	In.65–71= Xcel–L/M/H	v, s, i, p	0h1248	4–88

BASIC Parameter group (bA, BAS)								
Pr. Code	Name	Setting Range	Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
bA.73	Multi–step deceleration time2	0.0–600.0s	30.0	♦R/W	In.65–71= Xcel–L/M/H	v, s, i, p	0h1249	4–88
bA.74	Multi–step acceleration time3	0.0–600.0s	40.0	♦R/W	In.65–71= Xcel–L/M/H	v, s, i, p	0h124A	4–88
bA.75	Multi–step deceleration time3	0.0–600.0s	40.0	♦R/W	In.65–71= Xcel–L/M/H	v, s, i, p	0h124B	4–88
bA.76	Multi–step acceleration time4	0.0–600.0s	50.0	♦R/W	In.65–71= Xcel–L/M/H	v, s, i, p	0h124C	4–88
bA.77	Multi–step deceleration time4	0.0–600.0s	50.0	♦R/W	In.65–71= Xcel–L/M/H	v, s, i, p	0h124D	4–88
bA.78	Multi–step acceleration time5	0.0–600.0s	40.0	♦R/W	In.65–71= Xcel–L/M/H	v, s, i, p	0h124E	4–88
bA.79	Multi–step deceleration time5	0.0–600.0s	40.0	♦R/W	In.65–71= Xcel–L/M/H	v, s, i, p	0h124F	4–88
bA.80	Multi–step acceleration time6	0.0–600.0s	30.0	♦R/W	In.65–71= Xcel–L/M/H	v, s, i, p	0h1250	4–88
bA.81	Multi–step deceleration time6	0.0–600.0s	30.0	♦R/W	In.65–71= Xcel–L/M/H	v, s, i, p	0h1251	4–88
bA.82	Multi–step acceleration time7	0.0–600.0s	20.0	♦R/W	In.65–71= Xcel–L/M/H	v, s, i, p	0h1252	4–88
bA.83	Multi–step deceleration time7	0.0–600.0s	20.0	♦R/W	In.65–71= Xcel–L/M/H	v, s, i, p	0h1253	4–88

ADVANCED Parameter group (Ad, ADV)

The ADVANCED parameter group is labeled as follows:

- *Ad – standard LED kepyad*
- *ADV– optional LCD keypad*

See "Table Legend" on page 4–3 for details on each column in the table below.

ADVANCED Parameter Group (Ad, ADV)									
Pr. Code	**Name**	**Setting Range**		**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
Ad.0	Jump Code	1–99		24	♦R/W	–	v, s, i, p	–	3–5
Ad.1	Acceleration pattern	0	Linear	0: Linear	R/W	–	v, s, i, p	0h1301	4–91
		1	S–curve						
Ad.2	Deceleration pattern	0	Linear	0: Linear	R/W	–	v, s, i, p	0h1302	4–91
		1	S–curve						
Ad.3	S–curve acceleration start point gradient	1–100%		40	R/W	Ad.1=1	v, s, i, p	0h1303	4–91
Ad.4	S–curve acceleration end point gradient	1–100%		40	R/W	Ad.1=1	v, s, i, p	0h1304	4–91
Ad.5	S–curve deceleration start point gradient	1–100%		40	R/W	Ad.2=1	v, s, i, p	0h1305	4–91
Ad.6	S–curve deceleration end point gradient	1–100%		40	R/W	Ad.2=1	v, s, i, p	0h1306	4–91
Ad.7	Start Mode	0	Acc	0: Acc	R/W	–	v, s, i, p	0h1307	4–97
		1	DC–Start						
Ad.8	Stop Mode	0	Dec	0: Dec	R/W	–	v, s, i, p	0h1308	4–98
		1	DC–Brake			dr.9≠6			
		2	Free–Run			–			
		4	Power Braking			dr.9≠6			
Ad.9	Selection of prohibited rotation direction	0	None	0: None	R/W	–	v, s, i, p	0h1309	4–84
		1	Forward Prev						
		2	Reverse Prev						
Ad.10	Starting with power on	0	No	0: No	♦R/W	–	v, s, i, p	0h130A	4–85
		1	Yes						
Ad.12	DC braking time at startup	0.00–60.00s		0.00	R/W	Ad.7=1	v, s, i, p	0h130C	4–97
Ad.13	Amount of applied DC	0–200%		50	R/W	–	v, s, i, p	0h130D	4–97
Ad.14	Output blocking time before DC braking	0.00– 60.00s		0.10	R/W	Ad.8=1	v, s, i, p	0h130E	4–98
Ad.15	DC braking time	0.00– 60.00s		1.00	R/W	Ad.8=1	v, s, i, p	0h130F	4–98
Ad.16	DC braking rate	0–200%		50	R/W	Ad.8=1	v, s, i, p	0h1310	4–98
Ad.17	DC braking frequency	Start frequency–60 Hz		5.00	R/W	Ad.8=1	v, s, i, p	0h1311	4–98
Ad.20	Dwell frequency on acceleration	Start frequency–Maximum frequency(Hz)		5.00	R/W	–	v, s, i, p	0h1314	4–135

ADVANCED Parameter Group (Ad, ADV)								
Pr. Code	**Name**	**Setting Range**	**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
Ad.21	Dwell operation time on acceleration	0.0–60.0s	0.0	R/W	–	v, s, i, p	0h1315	4–135
Ad.22	Dwell frequency on deceleration	Start frequency–Maximum frequency(Hz)	5.00	R/W	–	v, s, i, p	0h1316	4–135
Ad.23	Dwell operation time on deceleration	0.0–60.0s	0.0	R/W	–	v, s, i, p	0h1317	4–135
Ad.24	Frequency limit	0 No 1 Yes	0: No	R/W	–	v, s, i, p	0h1318	4–101
Ad.25	Frequency lower limit value	0.00–Upper limit frequency(Hz)	0.50	♦R/W	Ad.24=1	v, s, i, p	0h1319	4–101
Ad.26	Frequency upper limit value	Lower limit frequency–Maximum frequency(Hz)	maximum frequency	R/W	Ad.24=1	v, s, i, p	0h131A	4–101
Ad.27	Frequency jump	0 No 1 Yes	0: No	R/W	–	v, s, i, p	0h131B	4–102
Ad.28	Jump frequency lower limit1	0.00–Jump frequency upper limit1Hz	10.00	♦R/W	Ad.27=1	v, s, i, p	0h131C	4–102
Ad.29	Jump frequency upper limit1	Jump frequency lower limit1–Maximum frequency(Hz)	15.00	♦R/W	Ad.27=1	v, s, i, p	0h131D	4–102
Ad.30	Jump frequency lower limit2	0.00–Jump frequency upper limit2Hz	20.00	♦R/W	Ad.27=1	v, s, i, p	0h131E	4–102
Ad.31	Jump frequency upper limit2	Jump frequency lower limit2–Maximum frequency(Hz)	25.00	♦R/W	Ad.27=1	v, s, i, p	0h131F	4–102
Ad.32	Jump frequency lower limit3	0.00–Jump frequency upper limit3Hz	30.00	♦R/W	Ad.27=1	v, s, i, p	0h1320	4–102
Ad.33	Jump frequency upper limit3	Jump frequency lower limit3–Maximum frequency(Hz)	35.00	♦R/W	Ad.27=1	v, s, i, p	0h1321	4–102
Ad.41	Brake release current	0.0–180.0%	50.0	♦R/W	OU.31 or OU.33 = 35	v, s, i, p	0h1329	4–182
Ad.42	Brake release delay time	0.00–10.00s	1.00	R/W	OU.31 or OU.33 = 35	v, s, i, p	0h132A	4–182
Ad.44	Brake release Forward frequency	0.00–Maximum frequency(Hz)	1.00	R/W	OU.31 or OU.33 = 35	v, s, i, p	0h132C	4–182
Ad.45	Brake release Reverse frequency	0.00–Maximum frequency(Hz)	1.00	R/W	OU.31 or OU.33 = 35	v, s, i, p	0h132D	4–182
Ad.46	Brake engage delay time	0.00–10.00s	1.00	R/W	OU.31 or OU.33 = 35	v, s, i, p	0h132E	4–182
Ad.47	Brake engage frequency	0.00–Maximum frequency(Hz)	2.00	R/W	OU.31 or OU.33 = 35	v, s, i, p	0h132F	4–182
Ad.50	Energy saving operation	0 None 1 Manual 2 Auto	0: None	R/W	–	v, s	0h1332	4–166
Ad.51	Energy saving level	0–30%	0	♦R/W	Ad.50≠0	v, s	0h1333	4–166
Ad.60	Acc/Dec time switch frequency	0.00–Maximum frequency(Hz)	0.00	R/W	–	v, s, i, p	0h133C	4–89

ADVANCED Parameter Group (Ad, ADV)

Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
Ad.61	Rotation count speed gain	0.1–6000.0%		100.0	♦R/W	–	v, s, i, p	0h133D	–
Ad.62	Rotation count speed scale	0	x 1	0: x 1	♦R/W	–	v, s, i, p	0h133E	–
		1	x 0.1						
		2	x 0.01						
		3	x 0.001						
		4	x 0.0001						
Ad.63	Rotation count speed unit	0	Rpm	0: rpm	♦R/W	–	v, s, i, p	0h133F	–
		1	mpm						
Ad.64	Cooling fan control	0	During Run	0: During Run	♦R/W	–	v, s, i, p	0h1340	4–175
		1	Always ON						
		2	Temp Control						
Ad.65	Up/down operation frequency save	0	No	0: No	♦R/W	–	v, s, i, p	0h1341	4–131
		1	Yes						
Ad.66	Output contact On/Off control options	0	None	0: None	R/W	–	v, s, i, p	0h1342	4–183
		1	V1						
		3	V2						
		4	I2						
		6	Pulse						
		7	V3						
		9	V4						
		10	I4						
Ad.67	Output contact On level	Output contact off level–100.00%		90.00	R/W	–	v, s, i, p	0h1343	4–183
Ad.68	Output contact Off level	–100.00–output contact on level (%)		10.00	R/W	–	v, s, i, p	0h1344	4–183
Ad.70	Safe operation selection	0	Always Enable	0: Always Enable	R/W	–	v, s, i, p	0h1346	4–134
		1	DI Dependent						
Ad.71	Safe operation stop options	0	Free–Run	0: Free–Run	R/W	Ad.70=1	v, s, i, p	0h1347	4–134
		1	Q–Stop						
		2	Q–Stop Resume						
Ad.72	Safe operation deceleration time	0.0–600.0s		5.0	♦R/W	Ad.70=1	v, s, i, p	0h1348	4–134
Ad.74	Selection of regeneration evasion function for press	0	No	0: No	R/W	dr.9≠6	v, s, i	0h134A	4–183
		1	Yes						
Ad.75	Voltage level of regeneration evasion motion for press	230V : 300–400V		350	R/W	dr.9≠6	v, s, i	0h134B	4–183
		460V : 600–800V		700					
Ad.76	Compensation frequency limit of regeneration evasion for press	0.00– 10.00Hz		1.00	R/W	Ad.74=1	v, s, i	0h134C	4–183

ADVANCED Parameter Group (Ad, ADV)									
Pr. Code	**Name**	**Setting Range**		**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
Ad.77	Regeneration evasion for press P gain	0.0– 100.0%		50.0	♦R/W	Ad.74=1	v, s, i	0h134D	4–183
Ad.78	Regeneration evasion for press I gain	20–30000(ms)		500	♦R/W	Ad.74=1	v, s, i	0h134E	4–183
Ad.79	Dynamic Brake (DB) Unit turn on voltage level	230V: 350–400V		390V	R/W	–	v, s, i, p	0h134F	4–205
		460V: 600–800V		780V					
Ad.80	Fire mode selection	0	None	0: None	R/W	–	v, s, i, p	0h1350	4–122
		1	Fire Mode						
		2	Fire Mode Test						
Ad.81	Fire mode frequency	0.00–60.00(Hz]		60.00	R/W	Ad.80=1	v, s, i, p	0h1351	4–122
Ad.82	Fire mode direction	0	Forward	0:	R/W	Ad.80=1	v, s, i, p	0h1352	4–122
		1	Reverse	Forward					
Ad.83	Fire Mode Count	Can not be modified		–	Read Only	Ad.80=1	v, s, i, p	–	4–122
Ad.85	Up–down mode selection	0	U/D Normal	0: U/D Normal	R/W	–	v, s, i, p	0h1355	4–131
		1	U/D Step						
		2	U/D Step+ Norm						
Ad.86	Up–down step frequency	0–maxFreq		0	♦R/W	–	v, s, i, p	0h1356	4–131
Ad.87	Overmodulation mode selection	0	No	0: No	R/W	–	v, s	0h1357	
		1	Yes						

CONTROL Parameter Group (Cn, CON)

The CONTROL parameter group is labeled as follows:

- *Cn – standard LED kepyad*
- *CON – optional LCD keypad*

See "Table Legend" on page 4–3 for details on each column in the table below.

CONTROL Parameter Group (Cn, CON)									
Pr. Code	**Name**	**Setting Range**		**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
Cn.0	Jump Code	1–99		4	♦R/W	–	v, s, i, p	–	3–5
Cn.4	Carrier frequency	Heavy Duty	V/F: 1.0–15.0 (kHz) IM: 2.0–15.0 (kHz) PM: 2.0–10.0 kHz	3.0	R/W	–	v, s, i, p	0h1404	4–171
Cn.5	Switching mode	0	Normal PWM	0: Normal PWM	R/W	–	v, s, i	0h1405	4–171
		1	Lowleakage PWM						
Cn.9	Initial excitation time	0.00–60.00s		1.00	R/W	dr.9≠6	i	0h1409	4–149
Cn.10	Initial excitation amount	100.0–300.0%		100.0	R/W	dr.9≠6	i	0h140A	4–149
Cn.11	Continued operation duration	0.00–60.00s		0.00	R/W	–	i	0h140B	4–149
Cn.12	PM S/L speed controller proportional gain1	0–5000		100	R/W	dr.9=6 PM Sensorless	p	0h140C	4–153
Cn.13	PM S/L speed controller integral gain1	0–5000		150	R/W	dr.9=6 PM Sensorless	p	0h140D	4–153
Cn.15	PM S/L speed controller proportional gain2	0–5000		100	R/W	dr.9=6 PM Sensorless	p	0h140F	4–153
Cn.16	PM S/L speed controller integral gain2	0–9999		150	R/W	dr.9=6 PM Sensorless	p	0h1410	4–153
Cn.20	Sensorless 2nd gain display setting	0	No	0: No	♦R/W	dr.9≠6	i	0h1414	4–149
		1	Yes						
Cn.21	ASR Sensorless speed controller proportional gain1	0–5000%		Dependent on motor setting	♦R/W	dr.9≠6	i	0h1415	4–149
Cn.22	ASR Sensorless speed controller integral gain1	10–9999(ms)		Dependent on motor setting	♦R/W	dr.9≠6	i	0h1416	4–149
Cn.23	ASR Sensorless speed controller proportional gain2	1.0–1000.0%		Dependent on motor setting	♦R/W	Cn.20=1	i	0h1417	4–149

CONTROL Parameter Group (Cn, CON)								
Pr. Code	**Name**	**Setting Range**	**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
Cn.24	ASR Sensorless speed controller integral gain2	1.0–1000.0%	Dependent on motor setting	♦R/W	dr.9= 4 IM Sensorless& Cn.20=1	i	0h1418	4–149
Cn.25	ASR Sensorless speed controller integral gain 0	10–9999(ms)	Dependent on motor setting	♦R/W	dr.9= 4 IM Sensorless& Cn.20=1	i	0h1419	4–149
Cn.26	Flux estimator proportional gain	10–200%	Dependent on motor setting	♦R/W	dr.9= 4 IM Sensorless& Cn.20=1	i	0h141A	4–149
Cn.27	Flux estimator integral gain	10–200%	Dependent on motor setting	♦R/W	dr.9= 4 IM Sensorless& Cn.20=1	i	0h141B	4–149
Cn.28	Speed estimator proportional gain	0–32767	Dependent on motor setting	♦R/W	dr.9= 4 IM Sensorless& Cn.20=1	i	0h141C	4–149
Cn.29	Speed estimator integral gain1	100–1000	Dependent on motor setting	♦R/W	dr.9= 4 IM Sensorless& Cn.20=1	i	0h141D	4–149
Cn.30	Speed estimator integral gain2	100–10000	Dependent on motor setting	♦R/W	dr.9= 4 IM Sensorless& Cn.20=1	i	0h141E	4–149
Cn.31	ACR Sensorless current controller proportional gain	10–1000	Dependent on motor setting	♦R/W	dr.9= 4 IM Sensorless& Cn.20=1	i	0h141F	4–149
Cn.32	ACR Sensorless current controller integral gain	10 –1000	Dependent on motor setting	♦R/W	dr.9= 4 IM Sensorless& Cn.20=1	i	0h1420	4–149
Cn.33	PM D–axis back–EMF estimation gain %	0–300.0%	100.0	R/W	dr.9=6 PM Sensorless	p	0h1421	4–153
Cn.34	PM Q–axis back–EMF estimation gain %	0–300.0%	100.0	R/W	dr.9=6 PM Sensorless	p	0h1422	4–153
Cn.35	Initial pole position detection retry number	0–10	2	R/W	dr.9=6 PM Sensorless	p	0h1423	4–153
Cn.36	Initial pole position detection pulse interval	1–100	20	R/W	dr.9=6 PM Sensorless	p	0h1424	4–153
Cn.37	Initial pole position detection current level %	10–100	15	R/W	dr.9=6 PM Sensorless	p	0h1425	4–153

CONTROL Parameter Group (Cn, CON)									
Pr. Code	**Name**	**Setting Range**		**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
Cn.38	Initial pole position detection voltage level %	100–4000		500	R/W	dr.9=6 PM Sensorless	p	0h1426	4–153
Cn.39	PM dead time range %	50.0–100.0		100.0	R/W	dr.9=6 PM Sensorless	p	0h1427	4–153
Cn.40	PM dead time voltage %	50.0–100.0		100.0	R/W	dr.9=6 PM Sensorless	p	0h1428	4–153
Cn.41	Speed estimator P gain1	0–32000		100	R/W	dr.9=6 PM Sensorless	p	0h1429	4–153
Cn.42	Speed estimator I gain1	0–32000		10	R/W	dr.9=6 PM Sensorless	p	0h142A	4–153
Cn.43	Speed estimator P gain2	0–32000		300	R/W	dr.9=6 PM Sensorless	p	0h142B	4–153
Cn.44	Speed estimator I gain2	0–32000		30	R/W	dr.9=6 PM Sensorless	p	0h142C	4–153
Cn.45	Speed estimator feed forward high speed rate %	0–100%		30.0	R/W	dr.9=6 PM Sensorless	p	0h142D	4–153
Cn.46	Initial pole position detection options	0	None	1: Angle Detect	R/W	dr.9=6 PM Sensorless	p	0h142E	4–153
		1	Angle Detect						
		2	Align						
Cn.48	Current controller P gain	0–10000		1200	♦R/W	dr.9=6 PM Sensorless	p	1430	4–153
Cn.49	Current controller I gain	0–10000		120	♦R/W	dr.9=6 PM Sensorless	p	1431	4–153
Cn.50	Voltage controller limit	0–100.0%		10.0	R/W	dr.9=6 PM Sensorless	p	0h1432	4–153
Cn.51	Voltage controller I gain	0–1000.0%		10.0	R/W	dr.9=6 PM Sensorless	p	0h1433	4–153
Cn.52	Torque controller output filter	0–2000(ms)		0	R/W	–	i, p	0h1434	4–149

CONTROL Parameter Group (Cn, CON)									
Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
Cn.53	Torque limit setting options	0	Keypad–1	0: Keypad–1	R/W	–	i, p	0h1435	4–149
		1	Keypad–2						
		2	V1						
		4	V2						
		5	I2						
		6	Int 485						
		8	FieldBus (Ethernet)						
		9	UserSeqLink						
		12	Pulse						
		13	V3						
		15	V4						
		16	I4						
Cn.54	Positive–direction reverse torque limit	0.0–200.0%		150	♦R/W	dr.9= 4 or 6 IM or PM Sensorless	i, p	0h1436	4–149
Cn.55	Positive–direction regeneration torque limit	0.0–200.0%		150	♦R/W	dr.9= 4 or 6 IM or PM Sensorless	i, p	0h1437	4–149
Cn.56	Negative–direction regeneration torque limit	0.0–200.0%		150	♦R/W	dr.9= 4 or 6 IM or PM Sensorless	i, p	0h1438	4–149
Cn.57	Negative–direction reverse torque limit	0.0–200.0%		150	♦R/W	dr.9= 4 or 6 IM or PM Sensorless	i, p	0h1439	4–149
Cn.62	Speed limit Setting	0	Keypad–1	0: Keypad–1	R/W	dr.9=4 IM Sensorless	i, p	0h143E	4–162
		1	Keypad–2						
		2	V1						
		4	V2						
		5	I2						
		6	Int 485						
		7	FieldBus (Ethernet)						
		8	UserSeqLink						
		9	V3						
		11	V4						
		12	I4						
Cn.63	Positive–direction speed limit	0.00– Maximum frequency (Hz)		60.00	♦R/W	dr.9=4 IM Sensorless	i, p	0h143F	4–162
Cn.64	Negative–direction speed limit	0.00– Maximum frequency (Hz)		60.00	♦R/W	dr.9=4 IM Sensorless	i, p	0h1440	4–162
Cn.65	Speed limit operation gain	100–5000%		500	♦R/W	dr.9=4 IM Sensorless	i, p	0h1441	4–162

CONTROL Parameter Group (Cn, CON)									
Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
Cn.69	PM speed search current	10–100		15	♦R/W	dr.9=6 PM Sensorless	p		4–167
Cn.70	Speed search mode selection	0	Flying Start–1	0: Flying Start–1	R/W	–	v, s	0h1446	4–167
		1	Flying Start–2				v, s, i		
		2	Flying Start–3				p		
Cn.71	Speed search operation selection	bit	0000– 1111	0000	R/W	–	v, s, i, p	0h1447	4–167
		0001	Selection of speed search on acceleration						
		0010	When starting on initialization after fault trip						
		0100	When restarting after instantaneous power interruption						
		1000	When starting with power on						
Cn.72	Speed search reference current	80–200%		150	♦R/W	Cn.70=0	v, s, i, p	0h1448	4–167
Cn.73	Speed search proportional gain	0–9999		Flying Start–1 : 100	♦R/W	Cn.71. any bit set to 1	v, s, i	0h1449	4–167
				Flying Start–2 : 1200					
Cn.74	Speed search integral gain	0–9999		Flying Start–1 : 200	♦R/W	Cn.71. any bit set to 1	v, s, i	0h144A	4–167
				Flying Start–2 : 1000					
Cn.75	Output blocking time before speed search	0.0–60.0s		1.0	R/W	Cn.71. any bit set to 1	v, s, i, p	0h144B	4–167
Cn.76	Speed search Estimator gain	50–150%		100	♦R/W	Cn.71. any bit set to 1	v, s, i	0h144C	–
Cn.77	Energy buffering selection	0	No	0: No	R/W	–	v, s, i, p	0h144D	4–160
		1	KEB–1						
		2	KEB–2						
Cn.78	Energy buffering start level	110.0–200.0%		130.0	R/W	Cn.77≠0	v, s, i, p	0h144E	4–160
Cn.79	Energy buffering stop level	Cn.78–210.0%		135.0	R/W	Cn.77≠0	v, s, i, p	0h144F	4–160
Cn.80	Energy buffering P gain	0–20000		1500	♦R/W	Cn.77≠0	v, s, i, p	0h1450	4–160

CONTROL Parameter Group (Cn, CON)								
Pr. Code	**Name**	**Setting Range**	**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
Cn.81	Energy buffering I gain	1–20000	500	♦R/W	Cn.77≠0	v, s, i, p	0h1451	4–160
Cn.82	Energy buffering Slip gain	0–2000.0%	30.0	♦R/W	Cn.77≠0	v, s, i	0h1452	4–160
Cn.83	Energy buffering acceleration time	0.0–600.0s	10.0	♦R/W	Cn.77≠0	v, s, i, p	0h1453	4–160
Cn.85	Flux estimator proportional gain1	100–700	370	♦R/W	Cn.20=1	i	0h1455	4–149
Cn.86	Flux estimator proportional gain2	0–100	0	♦R/W	Cn.20=1	i	0h1456	4–149
Cn.87	Flux estimator proportional gain3	0–500	100	♦R/W	Cn.20=1	i	0h1457	4–149
Cn.88	Flux estimator integral gain1	0–200	50	♦R/W	Cn.20=1	i	0h1458	4–149
Cn.89	Flux estimator integral gain2	0–200	50	♦R/W	Cn.20=1	i	0h1459	4–149
Cn.90	Flux estimator integral gain3	0–200	50	♦R/W	Cn.20=1	i	0h145A	4–149
Cn.91	Sensorless voltage compensation1	0–60	Dependent on motor setting	♦R/W	Cn.20=1	i	0h145B	4–149
Cn.92	Sensorless voltage compensation2	0–60	Dependent on motor setting	♦R/W	Cn.20=1	i	0h145C	4–149
Cn.93	Sensorless voltage compensation3	0–60	Dependent on motor setting	♦R/W	Cn.20=1	i	0h145D	4–149
Cn.94	Sensorless field weakening start frequency	80.0–110.0%	100.0	R/W	Cn.20=1	i	0h145E	4–147
Cn.95	Sensorless gain switching frequency	0.00–8.00 Hz	2.00	R/W	Cn.20=1	i	0h145F	4–147

INPUT Parameter Group (In, IN)

The INPUT parameter group is labeled as follows:

- *In – standard LED kepyad*
- *IN– optional LCD keypad*

See "Table Legend" on page 4–3 for details on each column in the table below.

INPUT Parameter Group (In, IN)									
Pr. Code	**Name**	**Setting Range**		**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
In.0	Jump Code	1–99		65	♦R/W	–	v, s, i, p	–	3–5
In.1	Frequency for maximum analog input	Start frequency–Maximum frequency(Hz)		Maximum frequency	♦R/W	–	v, s, i, p	0h1501	4–69
In.2	Torque at maximum analog input	0.0–200.0%		100.0	♦R/W	–	i	0h1502	4–164
In.5	V1 input voltage display	–12.00–12.00V		0.00	Read Only	–	v, s, i, p	0h1505	4–69
In.6	V1 input polarity selection	0	Unipolar	0: Unipolar	R/W	–	v, s, i, p	0h1506	4–69
		1	Bipolar						
In.7	Time constant of V1 input filter	0–10000(ms)		10	♦R/W	–	v, s, i, p	0h1507	4–69
In.8	V1 Minimum input voltage	0.00–10.00V		0.00	♦R/W	–	v, s, i, p	0h1508	4–69
In.9	V1 output at Minimum voltage (%)	0.00–100.00%		0.00	♦R/W	–	v, s, i, p	0h1509	4–69
In.10	V1 Maximum input voltage	0.00–12.00V		10.00	♦R/W	–	v, s, i, p	0h150A	4–69
In.11	V1 output at Maximum voltage (%)	0.00–100.00%		100.00	♦R/W	–	v, s, i, p	0h150B	4–69
In.12	V1 Minimum input voltage	–10.00– 0.00V		0.00	♦R/W	In.6=1	v, s, i, p	0h150C	4–72
In.13	V1output at Minimum voltage (%)	–100.00–0.00%		0.00	♦R/W	In.6=1	v, s, i, p	0h150D	4–72
In.14	V1 Maximum input voltage	–12.00– 0.00V		–10.00	♦R/W	In.6=1	v, s, i, p	0h150E	4–72
In.15	V1 output at Maximum voltage (%)	–100.00–0.00%		–100.00	♦R/W	In.6=1	v, s, i, p	0h150F	4–72
In.16	V1 rotation direction change	0	No	0: No	♦R/W	–	v, s, i, p	0h1510	4–69
		1	Yes						
In.17	V1 quantization level	0.00, 0.04–10.00%		0.04	R/W	–	v, s, i, p	0h1511	4–69
In.35	V2 input voltage display	0.00–12.00V		0.00	Read Only	Analog Input Dipswitch =V	v, s, i, p	0h1523	4–74
In.37	V2 input filter time constant	0–10000(ms)		10	♦R/W	Analog Input Dipswitch =V	v, s, i, p	0h1525	4–74
In.38	V2 Minimum input voltage	0.00–10.00V		0.00	♦R/W	Analog Input Dipswitch =V	i, p	0h1526	4–74

INPUT Parameter Group (In, IN)									
Pr. Code	**Name**	**Setting Range**		**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
In.39	V2 output at Minimum voltage (%)	0.00–100.00%		0.00	♦R/W	Analog Input Dipswitch =V	v, s, i, p	0h1527	4–74
In.40	V2 Maximum input voltage	0.00–10.00V		10	♦R/W	Analog Input Dipswitch =V	i, p	0h1528	4–74
In.41	V2 output at Maximum voltage (%)	0.00–100.00%		100.00	♦R/W	Analog Input Dipswitch =V	v, s, i, p	0h1529	4–74
In.46	V2 rotation direction change	0	No	0: No	♦R/W	Analog Input Dipswitch =V	v, s, i, p	0h152E	4–74
		1	Yes						
In.47	V2 quantization level	0.0045, 0.04– 10.00%		0.04	♦R/W	Analog Input Dipswitch =V	v, s, i, p	0h152F	4–74
In.50	I2 input current display	0–24 mA		0.00	Read Only	Analog Input Dipswitch =I	v, s, i, p	0h1532	4–73
In.52	I2 input filter time constant	0–10000ms		100	♦R/W	Analog Input Dipswitch =I	v, s, i, p	0h1534	4–73
In.53	I2 minimum input current	0.00–20.00 mA		4.00	♦R/W	Analog Input Dipswitch =I	v, s, i, p	0h1535	4–73
In.54	I2 output at Minimum current (%)	0.00–100.00%		0.00	♦R/W	Analog Input Dipswitch =I	v, s, i, p	0h1536	4–73
In.55	I2 maximum input current	0.00–24.00mA		20.00	♦R/W	Analog Input Dipswitch =I	v, s, i, p	0h1537	4–73
In.56	I2 output at Maximum current (%)	0.00–100.00%		100.00	♦R/W	Analog Input Dipswitch =I	v, s, i, p	0h1538	4–73
In.61	Changing rotation direction of I2	0	No	0: No	♦R/W	Analog Input Dipswitch =I	v, s, i, p	0h153D	4–73
		1	Yes						
In.62	I2 quantization level	0.0045, 0.04–10.00%		0.04	♦R/W	Analog Input Dipswitch =I	v, s, i, p	0h153E	4–73

INPUT Parameter Group (In, IN)									
Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
In.65	P1 terminal function setting	0	None	1: Fx	R/W	–	v, s, i, p	0h1541	
		1	Fx						4–79
		2	Rx						
		3	RST						4–208
		4	External Trip						4–203
		5	BX						4–208
		6	JOG						4–128
		7	Speed–L						4–77
		8	Speed–M						
		9	Speed–H						
		11	XCEL–L						4–88
		12	XCEL–M						
		13	RUN Enable						4–134
		14	3–Wire						4–133
		15	2nd Source						4–103
		16	Exchange						4–173
		17	Up (Speed)						4–131
		18	Down (Speed)						
		20	U/D Clear						
		21	Analog Hold						4–76
		22	I–Term Clear						4–138
		23	PID Openloop						
		24	P Gain2						
		25	XCEL Stop						4–93
		26	2nd Motor						4–172
		34	Pre Excite						4–93
		38	Timer In						4–181
		40	dis Aux Ref						4–125
		46	FWD JOG						4–130
		47	REV JOG						4–130
		49	XCEL–H						4–88
		50	User Seq						4–107
		51	Fire Mode						4–122
		52	KEB–1 Select						4–160
		54	TI (In.69 Only)						
In.66	P2 terminal function setting	See In.65 for Setting Range		2: Rx	R/W	–	v, s, i, p	0h1542	See In.65
In.67	P3 terminal function setting	See In.65 for Setting Range		5: BX	R/W	–	v, s, i, p	0h1543	See In.65
In.68	P4 terminal function setting	See In.65 for Setting Range		3: RST	R/W	–	v, s, i, p	0h1544	See In.65
In.69	P5 terminal function setting	See In.65 for Setting Range		7: Speed–L	R/W	–	v, s, i, p	0h1545	See In.65

INPUT Parameter Group (In, IN)								
Pr. Code	**Name**	**Setting Range**	**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
In.72	P8 terminal function setting (Ext IO)	See In.65 for Setting Range	0: None				0h1548	
In.73	P9 terminal function setting (Ext IO)	See In.65 for Setting Range	0: None				0h1549	
In.74	P10 terminal function setting (Ext IO)	See In.65 for Setting Range	0: None				0h154A	
In.84	Multi–function input terminal On filter selection	Bit Value: 0 Disable 1 Enable Bit Assignment: 0 P1 1 P2 2 P3 3 P4 4 P5 8 P8 (Ext IO card) 9 P9 (Ext IO card) 10 P10 (Ext IO card)	1 1111	♦R/W	–	v, s, i, p	0h1554	4–104
In.85	Multi–function input terminal On filter	0–10000(ms)	10	♦R/W	–	v, s, i, p	0h1555	4–104
In.86	Multi–function input terminal Off filter	0–10000(ms)	3	♦R/W	–	v, s, i, p	0h1556	4–104
In.87	Multi–function input contact selection	Bit Value: 0 Norm Open(A) 1 Norm Closed(B) Bit Assignment: 0 P1 1 P2 2 P3 3 P4 4 P5 8 P8 (Ext IO card) 9 P9 (Ext IO card) 10 P10 (Ext IO card)	0 0000	R/W	–	v, s, i, p	0h1557	4–104
In.89	Multi–step command delay time	1–5000(ms)	1	R/W	–	v, s, i, p	0h1559	4–77

INPUT Parameter Group (In, IN)									
Pr. Code	**Name**	**Setting Range**		**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
In.90	Multi–function input terminal status	Bit Value:		0 0000	Read Only	–	v, s, i, p	0h155A	4–104
		0	Off						
		1	On						
		Bit Assignment:							
		0	P1						
		1	P2						
		2	P3						
		3	P4						
		4	P5						
		8	P8 (Ext IO card)						
		9	P9 (Ext IO card)						
		10	P10 (Ext IO card)						
In.91	Pulse input amount display	0.00–50.00kHz		0.00	Read Only	–	v, s, i, p	0h155B	4–75
In.92	TI input filter time constant	0–9999(ms)		10	♦R/W	–	v, s, i, p	0h155C	4–75
In.93	TI Minimum input pulse	0.00–32.00kHz		0.00	♦R/W	–	v, s, i, p	0h155D	4–75
In.94	TI output at Minimum pulse (%)	0.00–100.00%		0.00	♦R/W	–	v, s, i, p	0h155E	4–75
In.95	TI Maximum input pulse	0.00–32.00kHz		32.00	♦R/W	–	v, s, i, p	0h155F	4–75
In.96	TI Output at Maximum pulse (%)	0–100%		100.00	♦R/W	–	v, s, i, p	0h1560	4–75
In.97	TI rotation direction change	0	No	0: No	♦R/W	–	v, s, i, p	0h1561	4–75
		1	Yes						
In.98	TI quantization level	0.0045, 0.04–10.00%		0.04	♦R/W	–	v, s, i, p	0h1562	4–75
In.99	"SW1(NPN/PNP) SW2(V1/V2) status"	Bit	00–11	00	Read Only	–	v, s, i, p	0h1563	–
		00	V2, NPN						
		01	V2, PNP						
		10	I2, NPN						
		11	I2, PNP						

OUTPUT Parameter Group (OU, OUT)

The OUTPUT parameter group is labeled as follows:

- *OU – standard LED keypad*
- *OUT– optional LCD keypad*

See "Table Legend" on page 4–3 for details on each column in the table below.

OUTPUT Parameter Group (OU, OUT)									
Pr. Code	**Name**	**Setting Range**		**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
OU.0	Jump Code	1–99		30	♦R/W	–	v, s, i, p	–	3–5
OU.1	Analog output 1 Mode	0	Frequency	0: Frequency	♦R/W	–	v, s, i, p	0h1601	4–184
		1	Output Current						
		2	Output Voltage						
		3	DCLink Voltage						
		4	Torque						
		5	Output Power						
		6	Idse						
		7	Iqse						
		8	Target Freq						
		9	Ramp Freq						
		10	Speed Fdb						
		12	PID Ref Value						
		13	PID Fdb Value						
		14	PID Output						
		15	Constant						
OU.2	Analog output 1 gain	–1000.0–1000.0%		100.0	♦R/W	–	v, s, i, p	0h1602	4–184
OU.3	Analog output 1 bias	–100.0–100.0%		0.0	♦R/W	–	v, s, i, p	0h1603	4–184
OU.4	Analog output 1 filter	0–10000(ms)		5	♦R/W	–	v, s, i, p	0h1604	4–184
OU.5	Analog constant output 1	0.0–100.0%		0.0	♦R/W	–	v, s, i, p	0h1605	4–184
OU.6	Analog output 1 monitor	0.0–1000.0%		0.0	Read Only	–	v, s, i, p	0h1606	4–184
OU.30	Fault output item	bit	000–111	010	♦R/W	–	v, s, i, p	0h161E	4–191
		001	Low voltage						
		010	Any faults other than low voltage						
		100	Automatic restart final failure						

OUTPUT Parameter Group (OU, OUT)									
Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
OU.31	Multi–function Output Relay 1 Setting (A1, B1, C1 terminals)	0	None	29: Trip	♦R/W	–	v, s, i, p	0h161F	4–188
		1	FDT–1						
		2	FDT–2						
		3	FDT–3						
		4	FDT–4						
		5	Over Load						
		6	IOL						
		7	Under Load						
		8	Fan Warning						
		9	Stall						
		10	Over Voltage						
		11	Low Voltage						
		12	Over Heat						
		13	Lost Command						
		14	Run						
		15	Stop						
		16	Steady						
		17	Drive Line						
		18	Comm Line						
		19	Speed Search						
		22	Ready						
		28	Timer Out						
		29	Trip						
		31	DB Warn%ED						
		34	On/Off Control						
		35	BR Control						
		38	Fire Mode						
		39*	TO (OU.33 Only)						
		40	KEB Operating						
OU.33	Multi–function output Q1 setting	See OU.31 values		14: Run	♦R/W	–	v, s, i, p	0h1621	4–188
OU.34	Multi–function relay 3 setting	See OU.31 values		0: None	♦R/W		v, s, i, p	0h1622	4–188
OU.35	Multi–function relay 4 setting	See OU.31 values		0: None	♦R/W		v, s, i, p	0h1623	4–188
OU.41	Multi–function output monitor	Bit	00 0000 – 11 1111	00	Read Only	–	–	0h1629	4–188
		0	Relay 1						
		1	Q1						
		4	Relay 3 (Ext IO card)						
		5	Relay 4 (Ext IO card)						
OU.50	Multi–function output On delay	0.00–100.00s		0.00	♦R/W	–	v, s, i, p	0h1632	4–192
OU.51	Multi–function output Off delay	0.00–100.00s		0.00	♦R/W	–	v, s, i, p	0h1633	4–192

OUTPUT Parameter Group (OU, OUT)									
Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
OU.52	Multi–function output contact selection	Bit Value:		00	R/W	–	v, s, i, p	0h1634	4–192
		0 = A Contact (NO)							
		1 = B Contact (NC)							
		Bit	00 0000 – 11 1111						
		0	Relay 1						
		1	Q1						
		4	Relay 3 (Ext IO)						
		5	Relay 4 (Ext IO)						
OU.53	Fault output On delay	0.00–100.00s		0.00	♦R/W	–	v, s, i, p	0h1635	4–191
OU.54	Fault output Off delay	0.00–100.00s		0.00	♦R/W	–	v, s, i, p	0h1636	4–191
OU.55	Timer On delay	0.00–100.00s		0.00	♦R/W	–	v, s, i, p	0h1637	4–181
OU.56	Timer Off delay	0.00–100.00s		0.00	♦R/W	–	v, s, i, p	0h1638	4–181
OU.57	Detected frequency	0.00–Maximum frequency(Hz)		30.00	♦R/W	–	v, s, i, p	0h1639	4–188
OU.58	Detected frequency band	0.00–Maximum frequency(Hz)		10.00	♦R/W	–	v, s, i, p	0h163A	4–188
OU.61	TO/Q1 Pulse output gain	0	Frequency	0: Frequency	♦R/W	–	v, s, i, p	0h163D	4–186
		1	Output Current						
		2	Output Voltage						
		3	DCLink Voltage						
		4	Torque						
		5	Output Power						
		6	Idse						
		7	Iqse						
		8	Target Freq						
		9	Ramp Freq						
		10	Speed Fdb						
		12	PID Ref Value						
		13	PID Fdb Value						
		14	PID Output						
		15	Constant						
OU.62	Pulse output gain	–1000.0–1000.0%		100.0	♦R/W	–	v, s, i, p	0h163E	4–186
OU.63	Pulse output bias	–100.0–100.0%		0.0	♦R/W	–	v, s, i, p	0h163F	4–186
OU.64	Pulse output filter	0–10000(ms)		5	♦R/W	–	v, s, i, p	0h1640	4–186
OU.65	Pulse output constant output 2	0.0–100.0%		0.0	♦R/W	–	v, s, i, p	0h1641	4–186
OU.66	Pulse output monitor	0.0–1000.0%		0.0	Read Only	–	v, s, i, p	0h1642	4–186

COMMUNICATION Parameter Group (Cm, COM)

The COMMUNICATION parameter group is labeled as follows:

- *Cm – standard LED keypad*
- *COM– optional LCD keypad*

See "Table Legend" on page 4–3 for details on each column in the table below.

COMMUNICATION Parameter Group (Cm, COM)

Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
CM.0	Jump Code	1–99		20	♦R/W	–	v, s, i, p	–	3–5
CM.1	Built–in communication drive ID	1–250		1	♦R/W	CM.95=0 or 3	v, s, i, p	0h1701	5–7
CM.2	Built–in communication protocol	0	ModBus RTU	0: ModBus RTU	♦R/W	CM.95=0 or 3	v, s, i, p	0h1702	5–7
		2	Not Supported						
CM.3	Built–in communication speed	0	1200 bps	3: 9600 bps	♦R/W	CM.95=0 or 3	v, s, i, p	0h1703	5–7
		1	2400 bps						
		2	4800 bps						
		3	9600 bps						
		4	19200 bps						
		5	38400 bps						
		6	56 Kbps						
		7	115 Kbps						
CM.4	Built–in communication frame setting	0	D8/PN/S1	0: D8/ PN/S1	♦R/W	CM.95=0 or 3	v, s, i, p	0h1704	5–7
		1	D8/PN/S2						
		2	D8/PE/S1						
		3	D8/PO/S1						
CM.5	Transmission delay after reception	0–1000(ms)		5ms	♦R/W	CM.95=0 or 3	v, s, i, p	0h1705	5–7
CM.6	Ethernet Module (Fbus) S/W version	–		0.00	♦R/W	ACN–ETH Installed	v, s, i, p	0h1706	–
CM.9	Ethernet Module (Fbus) LED status	–		–	Read Only	ACN–ETH Installed	v, s, i, p	0h1709	–
CM.10	Opt Parameter 1 (IP address 1st octet)	0–255		192	R/W	ACN–ETH Installed	v, s, i, p	0h170A	–
CM.11	Opt Parameter 2 (IP address 2nd octet)	0–255		192	R/W	ACN–ETH Installed	v, s, i, p	0h170B	–
CM.12	Opt Parameter 3 (IP address 3rd octet)	0–255		168	R/W	ACN–ETH Installed	v, s, i, p	0h170C	–
CM.13	Opt Parameter 4 (IP address 4th octet)	0–255		3	R/W	ACN–ETH Installed	v, s, i, p	0h170D	–

**CM.29 and CM.49 must be configured to the same value for proper EtherNet/IP communication.*
***If ACN-ETH card is used in EtherNet/IP mode, value is read-only and set according to the CM.29 or CM.49 value.*

COMMUNICATION Parameter Group (Cm, COM)									
Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
CM.14	Opt Parameter 5 (IP Mask 1st octet)	0–255		255	R/W	ACN–ETH Installed	v, s, i, p	0h170E	–
CM.15	Opt Parameter 6 (IP Mask 2nd octet)	0–255		255	R/W	ACN–ETH Installed	v, s, i, p	0h170F	–
CM.16	Opt Parameter 7 (IP Mask 3rd octet)	0–255		255	R/W	ACN–ETH Installed	v, s, i, p	0h1710	–
CM.17	Opt Parameter 8 (IP Mask 4th octet)	0–255		0	R/W	ACN–ETH Installed	v, s, i, p	0h1711	–
CM.18	Opt Parameter 9 (IP Gateway 1st octet)	0–255		255	R/W	ACN–ETH Installed	v, s, i, p	0h1712	–
CM.19	Opt Parameter 10 (IP Gateway 2nd octet)	0–255		255	R/W	ACN–ETH Installed	v, s, i, p	0h1713	–
CM.20	Opt Parameter 11 (IP Gateway 3rd octet)	0–255		255	R/W	ACN–ETH Installed	v, s, i, p	0h1714	–
CM.21	Opt Parameter 12 (IP Gateway 4th octet)	0–255		1	R/W	ACN–ETH Installed	v, s, i, p	0h1715	–
CM.22	OptParameter13 – Eth Comm Rate	0	Automatic	0	R/W	ACN–ETH Installed	v, s, i, p	0h1716	–
		1	100 MB						
		2	10 MB						
CM.29*	In Instance	0	70	0: 70	R/W	ACN–ETH Installed	v, s, i, p (EtherNet/IP Only)	0h171D	–
		1	71						
		2	110						
		3	111						
		4	141						
		5	142						
		6	143						
		7	144						
		8	145						
		9	146						
		10	147						
		11	148						
CM.30	Number of output parameters	0–8		3	R/W**	–	v, s, i, p	0h171E	–
CM.31	Output Communication Address–1	0000–FFFF Hex		000A	♦R/W	–	v, s, i, p	0h171F	5–12

**CM.29 and CM.49 must be configured to the same value for proper EtherNet/IP communication.*
***If ACN-ETH card is used in EtherNet/IP mode, value is read-only and set according to the CM.29 or CM.49 value.*

COMMUNICATION Parameter Group (Cm, COM)									
Pr. Code	**Name**	**Setting Range**		**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
CM.32	Output Communication Address–2	0000–FFFF Hex		000E	♦R/W	–	v, s, i, p	0h1720	5–12
CM.33	Output Communication Address–3	0000–FFFF Hex		000F	♦R/W	–	v, s, i, p	0h1721	5–12
CM.34	Output Communication Address–4	0000–FFFF Hex		0000	♦R/W	–	v, s, i, p	0h1722	5–12
CM.35	Output Communication Address–5	0000–FFFF Hex		0000	♦R/W	–	v, s, i, p	0h1723	5–12
CM.36	Output Communication Address–6	0000–FFFF Hex		0000	♦R/W	–	v, s, i, p	0h1724	5–12
CM.37	Output Communication Address–7	0000–FFFF Hex		0000	♦R/W	–	v, s, i, p	0h1725	5–12
CM.38	Output Communication Address–8	0000–FFFF Hex		0000	♦R/W	–	v, s, i, p	0h1726	5–12
CM.49*	Out Instance	0	20	0: 20	–	ACN–ETH Installed	v, s, i, p (EtherNet/IP Only)	0h1731	5–12
		1	21						
		2	100						
		3	101						
		4	121						
		5	122						
		6	123						
		7	124						
		8	125						
		9	126						
		10	127						
		11	128						
CM.50	Number of input parameters	0–8		2	R/W**	–	v, s, i, p	0h1732	–
CM.51	Input Communication address1	0000–FFFF Hex		0005	R/W	–	v, s, i, p	0h1733	5–12
CM.52	Input Communication address2	0000–FFFF Hex		0006	R/W	–	v, s, i, p	0h1734	5–12
CM.53	Input Communication address3	0000–FFFF Hex		0000	R/W	–	v, s, i, p	0h1735	5–12
CM.54	Input Communication address4	0000–FFFF Hex		0000	R/W	–	v, s, i, p	0h1736	5–12

**CM.29 and CM.49 must be configured to the same value for proper EtherNet/IP communication.*
***If ACN-ETH card is used in EtherNet/IP mode, value is read-only and set according to the CM.29 or CM.49 value.*

COMMUNICATION Parameter Group (Cm, COM)									
Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
CM.55	Input Communication address5	0000–FFFF Hex		0000	R/W	–	v, s, i, p	0h1737	5–12
CM.56	Input Communication address6	0000–FFFF Hex		0000	R/W	–	v, s, i, p	0h1738	5–12
CM.57	Input Communication address7	0000–FFFF Hex		0000	R/W	–	v, s, i, p	0h1739	5–12
CM.58	Input Communication address8	0000–FFFF Hex		0000	R/W	–	v, s, i, p	0h173A	5–12
CM.68	Field bus data swap	0	No	0	R/W	–	v, s, i, p	0h1744	5–12
		1	Not Supported						

**CM.29 and CM.49 must be configured to the same value for proper EtherNet/IP communication.*
***If ACN-ETH card is used in EtherNet/IP mode, value is read-only and set according to the CM.29 or CM.49 value.*

COMMUNICATION Parameter Group (Cm, COM)									
Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
CM.70	Communication multi–function virtual input 1	0	None	0: None	♦R/W	–	v, s, i, p	0h1746	–
		1	Fx						
		2	Rx						
		3	RST						
		4	External Trip						
		5	BX						
		6	JOG						
		7	Speed–L						
		8	Speed–M						
		9	Speed–H						
		11	XCEL–L						
		12	XCEL–M						
		13	RUN Enable						
		14	3–Wire						
		15	2nd Source						
		16	Exchange						
		17	Up						
		18	Down						
		20	U/D Clear						
		21	Analog Hold						
		22	I–Term Clear						
		23	PID Openloop						
		24	P Gain2						
		25	XCEL Stop						
		26	2nd Motor						
		34	Pre Excite						
		38	Timer In						
		40	dis Aux Ref						
		46	FWD JOG						
		47	REV JOG						
		49	XCEL–H						
		50	User Seq						
		51	Fire Mode						
		52	KEB–1 Select						
		54	TI						
CM.71	Communication multi–function virtual input 2	See CM.70 for Values		0: None	♦R/W	–	v, s, i, p	0h1747	–
CM.73	Communication multi–function virtual input 4	See CM.70 for Values		0: None	♦R/W	–	v, s, i, p	0h1749	–

**CM.29 and CM.49 must be configured to the same value for proper EtherNet/IP communication.*
***If ACN-ETH card is used in EtherNet/IP mode, value is read-only and set according to the CM.29 or CM.49 value.*

COMMUNICATION Parameter Group (Cm, COM)									
Pr. Code	**Name**	**Setting Range**		**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
CM.74	Communication multi–function virtual input 5	See CM.70 for Values		0: None	♦R/W	–	v, s, i, p	0h174A	–
CM.75	Communication multi–function virtual input 6	See CM.70 for Values		0: None	♦R/W	–	v, s, i, p	0h174B	–
CM.76	Communication multi–function virtual input 7	See CM.70 for Values		0: None	♦R/W	–	v, s, i, p	0h174C	–
CM.77	Communication multi–function virtual input 8	See CM.70 for Values		0: None	♦R/W	–	v, s, i, p	0h174D	–
CM.86	Communication multi– function input monitoring	–		0	Read Only	–	v, s, i, p	0h1756	5–10
CM.90	Selection of data frame communication monitor	0	Int485	0	♦R/W	–	v, s, i, p	0h175A	–
		1	Keypad						
CM.91	Data frame Rev count	0–65535		0	♦R/W	–	v, s, i, p	0h175B	–
CM.92	Data frame Err count	0–65535		0	♦R/W	–	v, s, i, p	0h175C	–
CM.93	NAK frame count	0–65535		0	♦R/W	–	v, s, i, p	0h175D	–
CM.94	Communication data Save	0	No	0: No	Read Only	ACN–ETH Installed	v, s, i, p	–	5–9
		1	Yes						
CM.95	P2P communication selection	0	Disable All	0: Disable All	R/W	–	v, s, i, p	0h1760	4–105
		1	P2P Master						
		2	P2P Slave						
		3	M–KPD Ready						
CM.96	DO setting selection (P2P Out Select)	Bit	000–111 (See 4–3 for bit settings)	000: No	♦R/W	CM.95 = 2	v, s, i, p	–	4–105
		001	Analog output						
		010	Multi–function relay						
		100	Multi–function output						

**CM.29 and CM.49 must be configured to the same value for proper EtherNet/IP communication.*
***If ACN-ETH card is used in EtherNet/IP mode, value is read-only and set according to the CM.29 or CM.49 value.*

APPLICATION Parameter Group (AP , APP)

The APPLICATION parameter group is labeled as follows:

- *AP – standard LED kepyad*
- *APP– optional LCD keypad*

See "Table Legend" on page 4–3 for details on each column in the table below.

APPLICATION Parameter Group (AP , APP)									
Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
AP.0	Jump Code	1–99		20	♦R/W	–	v, s, i, p	–	3–5
AP.1	Application function selection	0	None	0: None	R/W	–	v, s, i, p	0h1801	4–138
		1	–						
		2	Proc PID						
AP.2	Enable user sequence	0	No	0: No	R/W	–	v, s, i, p	–	4–107
		1	Yes						
AP.16	PID output monitor	(%)		0.00	Read Only	AP.1 = 2	v, s, i, p	0h1810	4–138
AP.17	PID reference monitor	(%)		50.00	Read Only	AP.1 = 2	v, s, i, p	0h1811	4–138
AP.18	PID feedback monitor	(%)		0.00	Read Only	AP.1 = 2	v, s, i, p	0h1812	4–138
AP.19	PID reference setting	–100.00–100.00%		50.00	♦R/W	AP.1 = 2	v, s, i, p	0h1813	4–138
AP.20	PID reference source	0	Keypad	0: Keypad	R/W	AP.1 = 2	v, s, i, p	0h1814	4–138
		1	V1						
		3	V2						
		4	I2						
		5	Int 485						
		7	FieldBus (Ethernet)						
		8	UserSeqLink						
		11	Pulse						
		12	V3						
		14	V4						
		15	I4						
AP.21	PID feedback source	0	V1	0: V1	R/W	AP.1 = 2	v, s, i, p	0h1815	4–138
		2	V2						
		3	I2						
		4	Int 485						
		6	FieldBus (Ethernet)						
		7	UserSeqLink						
		10	Pulse						
		11	V3						
		13	V4						
		14	I4						
AP.22	PID controller proportional gain	0.0–1000.0%		50.0	♦R/W	AP.1 = 2	v, s, i, p	0h1816	4–138

APPLICATION Parameter Group (AP , APP)									
Pr. Code	**Name**	**Setting Range**		**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
AP.23	PID controller integral time	0.0–200.0s		10.0	♦R/W	AP.1 = 2	v, s, i, p	0h1817	4–138
AP.24	PID controller differentiation time	0–1000(ms)		0	♦R/W	AP.1 = 2	v, s, i, p	0h1818	4–138
AP.25	PID controller feed–forward compensation gain	0.0–1000.0%		0.0	♦R/W	AP.1 = 2	v, s, i, p	0h1819	4–138
AP.26	Proportional gain scale	0.0–100.0%		100.0	R/W	AP.1 = 2	v, s, i, p	0h181A	4–138
AP.27	PID output filter	0–10000(ms)		0	♦R/W	AP.1 = 2	v, s, i, p	0h181B	4–138
AP.28	PID Mode	0	Process PID	0	R/W	AP.1 = 2	v, s, i, p	0h181C	4–138
		1	Normal PID						
AP.29	PID upper limit frequency	PID lower limit frequency–300.00Hz		60.00	♦R/W	AP.1 = 2	v, s, i, p	0h181D	4–138
AP.30	PID lower limit frequency	–300.00 –PID upper limit frequency(Hz)		–60.00	♦R/W	AP.1 = 2	v, s, i, p	0h181E	4–138
AP.31	PID output inverse	0	No	0: No	R/W	AP.1 = 2	v, s, i, p	0h181F	4–138
		1	Yes						
AP.32	PID output scale	0.1–1000.0%		100.0	R/W	AP.1 = 2	v, s, i, p	0h1820	4–138
AP.34	PID controller motion frequency	0.00–Maximum frequency(Hz)		0.00	R/W	AP.1 = 2	v, s, i, p	0h1822	4–138
AP.35	PID controller motion level	0.0–100.0%		0.0	R/W	AP.1 = 2	v, s, i, p	0h1823	4–138
AP.36	PID controller motion delay time	0–9999s		600	♦R/W	AP.1 = 2	v, s, i, p	0h1824	4–138
AP.37	PID sleep mode delay time	0.0–999.9s		60.0	♦R/W	AP.1 = 2	v, s, i, p	0h1825	4–138
AP.38	PID sleep mode frequency	0.00–Maximum frequency(Hz)		0.00	♦R/W	AP.1 = 2	v, s, i, p	0h1826	4–138
AP.39	PID wake–up level	0–100%		35	♦R/W	AP.1 = 2	v, s, i, p	0h1827	4–138
AP.40	PID wake–up mode setting	0	Below Level	0: Below Level	♦R/W	AP.1 = 2	v, s, i, p	0h1828	4–138
		1	Above Level						
		2	Beyond Level						

APPLICATION Parameter Group (AP , APP)									
Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
AP.42	PID controller unit selection	0	%	0:%	♦R/W	AP.1 = 2	v, s, i, p	0h182A	4–138
		1	Bar						
		2	mBar						
		3	Pa						
		4	kPa						
		5	Hz						
		6	rpm						
		7	V						
		8	I						
		9	kW						
		10	HP						
		11	°C						
		12	°F						
		13	CUST						
		14	PSI						
		15	inWC						
		16	gl/m						
AP.43	PID unit gain	0.00–300.00%		100.00	♦R/W	AP.1 = 2	v, s, i, p	0h182B	4–138
AP.44	PID unit scale	0	x100	2: x 1	♦R/W	AP.1 = 2	v, s, i, p	0h182C	4–138
		1	x10						
		2	x 1						
		3	x 0.1						
		4	x 0.01						
AP.45	PID 2nd proportional gain	0.0–1000.0%		100.0	R/W	AP.1 = 2	v, s, i, p	0h182D	4–138

Extension IO Parameter Group (AO , APO)

The Extension IO parameter group is labeled as follows:

- *AO – standard LED kepyad*
- *APO– optional LCD keypad*

See "Table Legend" on page 4–3 for details on each column in the table below.

NOTE: The Extension IO parameter group is available only when the ACN-EIO module is installed.

Extension IO Parameter Group (AO , APO)									
Pr. Code	**Name**	**Setting Range**		**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
AO.0	Jump Code	1–99		0	♦R/W	–	v, s, i, p	–	3–5
AO.1	V3 input voltage display	–12.00–12.00V		0.00	Read Only	–	v, s, i, p	0h1A01	–
AO.2	V3 input polarity selection	0	Unipolar	0: Unipolar	R/W	–	v, s, i, p	0h1A02	–
		1	Bipolar						
AO.3	Time constant of V3 input filter	0–10000(ms)		100	♦R/W	–	v, s, i, p	0h1A03	–
AO.4	V3 Minimum input voltage	0.00–10.00V		0.00	♦R/W	–	v, s, i, p	0h1A04	–
AO.5	V3 output at Minimum voltage (%)	0.00–100.00%		0.00	♦R/W	–	v, s, i, p	0h1A05	–
AO.6	V3 Maximum input voltage	0.00–12.00V		10.00	♦R/W	–	v, s, i, p	0h1A06	–
AO.7	V3 output at Maximum voltage (%)	0.00–100.00%		100.00	♦R/W	–	v, s, i, p	0h1A07	–
AO.8	V3 rotation direction change	0	No	0: No	♦R/W	–	v, s, i, p	0h1A08	–
		1	Yes						
AO.9	V3 quantization level	0.00 , 0.04–10.00%		0.04	R/W	–	v, s, i, p	0h1A09	–
AO.10	V3 Minimum input voltage	–10.00–0.00V		0.00	♦R/W	AO.2 = 1	v, s, i, p	0h1A0A	–
AO.11	V3 output at Minimum voltage (%)	–100.00–0.00%		0.00	♦R/W	AO.2 = 1	v, s, i, p	0h1A0B	–
AO.12	V3 Maximum input voltage	–12.00–0.00V		–10.00	♦R/W	AO.2 = 1	v, s, i, p	0h1A0C	–
AO.13	V3 output at Maximum voltage (%)	–100.00–0.00%		–100.00	♦R/W	AO.2 = 1	v, s, i, p	0h1A0D	–
AO.14	V4 input voltage display	0.00–12.00V		0.00	Read Only	SW2= V (I4 input)	v, s, i, p	0h1A0E	–
AO.15	Time constant of V4 input filter	0–10000(ms)		100	♦R/W	SW2= V (I4 input)	v, s, i, p	0h1A0F	–
AO.16	V4 Minimum input voltage	0.00–10.00V		0.00	♦R/W	SW2= V (I4 input)	–	0h1A10	–
AO.17	V4 output at Minimum voltage (%)	0.00–100.00%		0.00	♦R/W	SW2= V (I4 input)	v, s, i, p	0h1A11	–

<table>
<tr><th colspan="10">Extension IO Parameter Group (AO , APO)</th></tr>
<tr><th>Pr. Code</th><th>Name</th><th colspan="2">Setting Range</th><th>Initial Value</th><th>Run R/W</th><th>Parameter Dependency</th><th>Compatible Control Mode</th><th>Comm. Address (Hex)</th><th>Ref.</th></tr>
<tr><td>AO.18</td><td>V4 Maximum input voltage</td><td colspan="2">0.00–10.00V</td><td>10</td><td>♦R/W</td><td>SW2= V (I4 input)</td><td>–</td><td>0h1A12</td><td>–</td></tr>
<tr><td>AO.19</td><td>V4 output at Maximum voltage (%)</td><td colspan="2">0.00–100.00%</td><td>100.00</td><td>♦R/W</td><td>SW2= V (I4 input)</td><td>v, s, i, p</td><td>0h1A13</td><td>–</td></tr>
<tr><td rowspan="2">AO.20</td><td rowspan="2">V4 rotation direction change</td><td>0</td><td>No</td><td rowspan="2">0: No</td><td rowspan="2">♦R/W</td><td rowspan="2">SW2= V (I4 input)</td><td rowspan="2">v, s, i, p</td><td rowspan="2">0h1A14</td><td rowspan="2">–</td></tr>
<tr><td>1</td><td>Yes</td></tr>
<tr><td>AO.21</td><td>V4 quantization level</td><td colspan="2">0.0050, 0.04–10.00%</td><td>0.04</td><td>♦R/W</td><td>SW2= V (I4 input)</td><td>v, s, i, p</td><td>0h1A15</td><td>–</td></tr>
<tr><td>AO.22</td><td>I4 input current display</td><td colspan="2">0–24mA</td><td>0.00</td><td>Read Only</td><td>SW2= i (I4 input)</td><td>v, s, i, p</td><td>0h1A16</td><td>–</td></tr>
<tr><td>AO.23</td><td>I4 input filter time constant</td><td colspan="2">0–10000(ms)</td><td>100</td><td>♦R/W</td><td>SW2= i (I4 input)</td><td>v, s, i, p</td><td>0h1A17</td><td>–</td></tr>
<tr><td>AO.24</td><td>I4 minimum input current</td><td colspan="2">0.00–20.00mA</td><td>4.00</td><td>♦R/W</td><td>SW2= i (I4 input)</td><td>v, s, i, p</td><td>0h1A18</td><td>–</td></tr>
<tr><td>AO.25</td><td>I4 output at Minimum current (%)</td><td colspan="2">0.00–100.00%</td><td>0.00</td><td>♦R/W</td><td>SW2= i (I4 input)</td><td>v, s, i, p</td><td>0h1A19</td><td>–</td></tr>
<tr><td>AO.26</td><td>I4 maximum input current</td><td colspan="2">0.00–24.00mA</td><td>20.00</td><td>♦R/W</td><td>SW2= i (I4 input)</td><td>v, s, i, p</td><td>0h1A1A</td><td>–</td></tr>
<tr><td>AO.27</td><td>I4 output at Maximum current (%)</td><td colspan="2">0.00–100.00%</td><td>100.00</td><td>♦R/W</td><td>SW2= i (I4 input)</td><td>v, s, i, p</td><td>0h1A1B</td><td>–</td></tr>
<tr><td rowspan="2">AO.28</td><td rowspan="2">Changing rotation direction of I4</td><td>0</td><td>No</td><td rowspan="2">0: No</td><td rowspan="2">♦R/W</td><td rowspan="2">SW2= i (I4 input)</td><td rowspan="2">v, s, i, p</td><td rowspan="2">0h1A1C</td><td rowspan="2">–</td></tr>
<tr><td>1</td><td>Yes</td></tr>
<tr><td>AO.29</td><td>I4 quantization level</td><td colspan="2">0.00* , 0.04–10.00%</td><td>0.04</td><td>♦R/W</td><td>SW2= i (I4 input)</td><td>v, s, i, p</td><td>0h1A1D</td><td>–</td></tr>
<tr><td rowspan="15">AO.30</td><td rowspan="15">Analog output 3 item</td><td>0</td><td>Frequency</td><td rowspan="15">0: Frequency</td><td rowspan="15">♦R/W</td><td rowspan="15">–</td><td rowspan="15">v, s, i, p</td><td rowspan="15">0h1A1E</td><td rowspan="15">–</td></tr>
<tr><td>1</td><td>Output Current</td></tr>
<tr><td>2</td><td>Output Voltage</td></tr>
<tr><td>3</td><td>DCLink Voltage</td></tr>
<tr><td>4</td><td>Torque</td></tr>
<tr><td>5</td><td>Output Power</td></tr>
<tr><td>6</td><td>Idse</td></tr>
<tr><td>7</td><td>Idr.</td></tr>
<tr><td>8</td><td>Target Freq</td></tr>
<tr><td>9</td><td>Ramp Freq</td></tr>
<tr><td>10</td><td>Speed Fdb</td></tr>
<tr><td>12</td><td>PID Ref Value</td></tr>
<tr><td>13</td><td>PID Fdb Value</td></tr>
<tr><td>14</td><td>PID Output</td></tr>
<tr><td>15</td><td>Constant</td></tr>
<tr><td>AO.31</td><td>Analog output 3 gain</td><td colspan="2">–1000.0–1000.0%</td><td>100.0</td><td>♦R/W</td><td>–</td><td>v, s, i, p</td><td>0h1A1F</td><td>–</td></tr>
<tr><td>AO.32</td><td>Analog output 3 bias</td><td colspan="2">–100.0–100.0%</td><td>0.0</td><td>♦R/W</td><td>–</td><td>v, s, i, p</td><td>0h1A20</td><td>–</td></tr>
</table>

Extension IO Parameter Group (AO , APO)									
Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
AO.33	Analog output 3 filter	0–10000(ms)		5	♦R/W	–	v, s, i, p	0h1A21	–
AO.34	Analog constant output 3	0.0–100.0%		0.0	♦R/W	–	v, s, i, p	0h1A22	–
AO.35	Analog output 3 monitor	0.0–1000.0%		0.0	Read Only	–	v, s, i, p	0h1A23	–
AO.36	Ext IO Switch	00	NPN, V	01	Read Only	–	v, s, i, p	0h1A24	–
		01	NPN, I						
		10	PNP, V						
		11	PNP, I						
AO.37	Ext I/O SW Ver	–		1.00	Read Only	–	v, s, i, p	0h1A25	–

PROTECTION Parameter Group (Pr, PRT)

The PROTECTION parameter group is labeled as follows:

- *Pr – standard LED kepyad*
- *PRT– optional LCD keypad*

See "Table Legend" on page 4–3 for details on each column in the table below.

PROTECTION Parameter Group (Pr, PRT)									
Pr. Code	**Name**	**Setting Range**		**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
Pr.0	Jump Code	1–99		40	♦R/W	–	v, s, i, p	–	3–5
Pr.4	Load level setting	1	Heavy Duty	1: Heavy Duty	Read Only	–	v, s, i, p	0h1B04	4–198
Pr.5	Input/output open–phase protection	bit	00–11	00	R/W	–	v, s, i, p	0h1B05	4–202
		01	Output open phase						
		10	Input open phase						
Pr.6	Input voltage range during open–phase	1–100V		15	R/W	–	v, s, i, p	0h1B06	4–202
Pr.7	Deceleration time at fault trip	0.0–600.0s		3.0	♦R/W	–	v, s, i, p	0h1B07	4–204
Pr.8	Selection of startup on trip reset	0	No	0: No	♦R/W	–	v, s, i, p	0h1B08	4–170
		1	Yes						
Pr.9	Number of automatic restarts	0–10		0	♦R/W	–	v, s, i, p	0h1B09	4–170
Pr.10	Automatic restart delay time	0.0–60.0s		1.0	♦R/W	Pr.9>0	v, s, i, p	0h1B0A	4–170
Pr.12	Motion at speed command loss	0	None	0: None	♦R/W	–	v, s, i, p	0h1B0C	4–204
		1	Free–Run						
		2	Dec						
		3	Hold Input						
		4	Hold Output						
		5	Lost Preset						
Pr.13	Time to decide speed command loss	0.1–120s		1.0	♦R/W	Pr.12>0	v, s, i, p	0h1B0D	4–204
Pr.14	Operation frequency at speed command loss	Start frequency– Maximum frequency(Hz)		0.00	♦R/W	Pr.12>0	v, s, i, p	0h1B0E	4–204
Pr.15	Analog input loss decision level	0	Half x1	0: Half x1	♦R/W	Pr.12>0	v, s, i, p	0h1B0F	4–204
		1	Below x1						
Pr.17	Overload warning selection	0	No	0: No	♦R/W	–	v, s, i, p	0h1B11	4–198
		1	Yes						
Pr.18	Overload alarm level	30–180%		150	♦R/W	–	v, s, i, p	0h1B12	4–198
Pr.19	Overload warning time	0.0–30.0s		10.0	♦R/W	–	v, s, i, p	0h1B13	4–198

PROTECTION Parameter Group (Pr, PRT)									
Pr. Code	**Name**	**Setting Range**		**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
Pr.20	Motion at overload fault	0	None	1: Free–Run	♦R/W	–	v, s, i, p	0h1B14	4–198
		1	Free–Run						
		2	Dec						
Pr.21	Overload fault level	30–200%		180	♦R/W	–	v, s, i, p	0h1B15	4–198
Pr.22	Overload fault time	0.0–60.0s		60.0	♦R/W	–	v, s, i, p	0h1B16	4–198
Pr.25	Underload warning selection	0	No	0: No	♦R/W	–	v, s, i, p	0h1B19	4–207
		1	Yes						
Pr.26	Underload warning time	0.0–600.0s		10.0	♦R/W	–	v, s, i, p	0h1B1A	4–207
Pr.27	Underload fault selection	0	None	0: None	♦R/W	–	v, s, i, p	0h1B1B	4–207
		1	Free–Run						
		2	Dec						
Pr.28	Underload fault time	0.0–600.0s		30.0	♦R/W	–	v, s, i, p	0h1B1C	4–207
Pr.29	Underload lower limit level	10–30%		30	♦R/W	–	v, s, i, p	0h1B1D	4–207
Pr.30	Underload upper limit level	30–100%		30	♦R/W	–	v, s, i, p	0h1B1E	4–207
Pr.31	No motor motion at detection	0	None	0: None	♦R/W	–	v, s, i, p	0h1B1F	4–209
		1	Free–Run						
Pr.32	No motor detection current level	1–100%		5	♦R/W	–	v, s, i	0h1B20	4–209
Pr.33	No motor detection delay	0.1–10.0s		3.0	♦R/W	–	v, s, i	0h1B21	4–209
Pr.40	Electronic thermal fault selection	0	None	0: None	♦R/W	–	v, s, i, p	0h1B28	4–196
		1	Free–Run						
		2	Dec						
Pr.41	Motor cooling fan type	0	Self–cool	0: Self–cool	♦R/W	–	v, s, i, p	0h1B29	4–196
		1	Forced–cool						
Pr.42	Electronic thermal 1 minute rating	120–200%		150	♦R/W	–	v, s, i, p	0h1B2A	4–196
Pr.43	Electronic thermal continuous rating	50–150%		120	♦R/W	–	v, s, i, p	0h1B2B	4–196
Pr.45	BX trip mode	0	Free–Run	0	R/W	–	v, s, i, p	0h1B2D	–
		1	Dec						

PROTECTION Parameter Group (Pr, PRT)									
Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
Pr.50	Stall prevention motion and flux braking	bit	00000–11111	0 0000	R/W	dr.9≠6	v, s	0h1B32	4–199
		00001	Accelerating (Mode 1)						
		10001	Accelerating (Mode 2)						
		00010	At constant speed (Mode 1)						
		10010	At constant speed (Mode 2)						
		00100 or 10100	At deceleration						
		01000 or 11000	FluxBraking						
Pr.51	Stall frequency1	Start frequency – Stall frequency2 (Hz)		60.00	♦R/W	dr.9≠6	v, s	0h1B33	4–199
Pr.52	Stall level1	30–250%		180	R/W	dr.9≠6	v, s	0h1B34	4–199
Pr.53	Stall frequency2	Stall frequency1 – Stall frequency3 (Hz)		60.00	♦R/W	dr.9≠6	v, s	0h1B35	4–199
Pr.54	Stall level2	30–250%		180	R/W	dr.9≠6	v, s	0h1B36	4–199
Pr.55	Stall frequency3	Stall frequency2 – Stall frequency4 (Hz)		60.00	♦R/W	dr.9≠6	v, s	0h1B37	4–199
Pr.56	Stall level3	30–250%		180	R/W	dr.9≠6	v, s	0h1B38	4–199
Pr.57	Stall frequency4	Stall frequency3 – Maximum frequency (Hz)		60.00	♦R/W	dr.9≠6	v, s	0h1B39	4–199
Pr.58	Stall level4	30–250%		180	R/W	dr.9≠6	v, s	0h1B3A	4–199
Pr.59	Flux braking gain	0 – 150%		0	♦R/W	–	v, s, i	0h1B3B	–
Pr.66	DB resistor warning level	0–30%		0	♦R/W	–	v, s, i, p	0h1B42	4–205
Pr.73	Speed deviation trip	0	No	0: No	♦R/W	–	v, s, i, p	0h1B49	–
		1	Yes						
Pr.74	Speed deviation band	1 – 20		5	♦R/W	Pr.73=1	v, s, i, p	0h1B4A	–
Pr.75	Speed deviation time	0 – 120		60	♦R/W	Pr.73=1	v, s, i, p	0h1B4B	–
Pr.79	Cooling fan fault selection	0	Trip	1: Warning	♦R/W	–	v, s, i, p	0h1B4F	4–207
		1	Warning						
Pr.80	Motion selection at option trip	0	None	1: Free–Run	♦R/W	–	v, s, i, p	0h1B50	4–208
		1	Free–Run						
		2	Dec						
Pr.81	Low voltage fault decision delay time	0.0–60.0s		0.0	R/W	–	v, s, i, p	0h1B51	

PROTECTION Parameter Group (Pr, PRT)									
Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
Pr.82	Low Voltage2 Trip Selection	Bit	00–11	00	R/W	–	v, s, i, p	0h1B52	4–210
		00	No						
		01	LV2, no history						
		10	No						
		11	LV2, save history						
Pr.90	Warning information	–		–	Read Only	–	–	–	–
Pr.91	Fault history 1	–		–	Read Only	–	v, s, i, p	0h1B5B	4–211
Pr.92	Fault history 2	–		–	Read Only	–	v, s, i, p	0h1B5C	4–211
Pr.93	Fault history 3	–		–	Read Only	–	v, s	0h1B5D	4–211
Pr.94	Fault history 4	–		–	Read Only	–	v, s	0h1B5E	4–211
Pr.95	Fault history 5	–		–	Read Only	–	v, s	0h1B5F	4–211
Pr.96	Fault history deletion	0	No	0: No	♦R/W	–	v, s	0h1B60	4–211
		1	Yes						

2nd MOTOR Parameter Group (m2, M2)

The M2 parameter group is labeled as follows:

- *m2 – standard LED kepyad*
- *M2– optional LCD keypad*

See "Table Legend" on page 4–3 for details on each column in the table below.

NOTE: The 2nd Motor parameter group is only available when any one input configuration parameter (In.65 - In.69) is set to 26.

2nd MOTOR Parameter Group (m2, M2)									
Pr. Code	**Name**	**Setting Range**		**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
m2.0	Jump Code	1–99		14	♦R/W	–	v, s, i	–	3–5
m2.4	Acceleration time	0.0–600.0s		20.0	♦R/W	–	v, s, i	0h1C04	4–172
m2.5	Deceleration time	0.0–600.0s		30.0	♦R/W	–	v, s, i	0h1C05	4–172
m2.6	Motor capacity	0	0.2 kW	–	R/W	–	v, s, i	0h1C06	4–172
		1	0.4 kW						
		2	0.75 kW						
		3	1.1 kW						
		4	1.5 kW						
		5	2.2 kW						
		6	3.0 kW						
		7	3.7 kW						
		8	4.0 kW						
		9	5.5 kW						
		10	7.5 kW						
		11	11.0 kW						
		12	15.0 kW						
		13	18.5 kW						
		14	22.0 kW						
		15	30.0 kW						
m2.7	Base frequency	30.00–400.00Hz		60.00	R/W	–	v, s, i	0h1C07	4–172
m2.8	Control mode	0	V/F	0: V/F	R/W	–	v, s, i	0h1C08	4–172
		2	Slip Compen						
		4	IM Sensorless						
		6	PM Sensorless (Not Supported)						
m2.10	Number of motor poles	2–48		Dependent on motor settings	R/W	–	v, s, i	0h1C0A	4–172
m2.11	Rated slip speed	0–3000(rpm)		Dependent on motor settings	R/W	–	v, s, i	0h1C0B	4–172
m2.12	Motor rated current	1.0–1000.0A		Dependent on motor settings	R/W	–	v, s, i	0h1C0C	4–172

2nd MOTOR Parameter Group (m2, M2)									
Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
m2.13	Motor no–load current	0.5–1000.0A		Dependent on motor settings	R/W	–	v, s, i	0h1C0D	4–172
m2.14	Motor rated voltage	170–480V		Dependent on motor settings	R/W	–	v, s, i	0h1C0E	4–172
m2.15	Motor efficiency	64–100%		Dependent on motor settings	R/W	–	v, s, i	0h1C0F	4–172
m2.16	Load inertia rate	0–8		Dependent on motor settings	R/W	–	v, s, i	0h1C10	4–172
m2.17	Stator resistance	Dependent on motor settings		Dependent on motor settings	R/W	–	v, s, i	–	4–172
m2.18	Leakage inductance	–		Dependent on motor settings	R/W	–	v, s, i	–	4–172
m2.19	Stator inductance	–		Dependent on motor settings	R/W	–	v, s, i	–	4–172
m2.20	Rotor time constant	25–5000(ms)		Dependent on motor settings	R/W	M2.08=4 IM Sensorless	v, s, i	–	4–172
m2.25	V/F pattern	0	Linear	0: Linear	R/W	–	v, s, i	0h1C19	4–172
		1	Square						
		2	User V/F						
m2.26	Forward Torque boost	0.0–15.0%		2.0	R/W	–	v, s, i	0h1C1A	4–172
m2.27	Reverse Torque boost	0.0–15.0%		2.0	R/W	–	v, s, i	0h1C1B	4–172
m2.28	Stall prevention level	30–150%		150	R/W	–	v, s, i	0h1C1C	4–172
m2.29	Electronic thermal 1 minute rating	100–200%		150	R/W	–	v, s, i	0h1C1D	4–172
m2.30	Electronic thermal continuous rating	50–150%		100	R/W	–	v, s, i	0h1C1E	4–172
m2.40	Rotation count speed gain	0–6000.0%		100.0	♦R/W	–	v, s, i	0h1C28	–
m2.41	Rotation count speed scale	0	x 1	0: x 1	♦R/W	–	v, s, i	0h1C29	–
		1	x 0.1						
		2	x 0.01						
		3	x 0.001						
		4	x 0.0001						
m2.42	Rotation count speed unit	0	Rpm	0: rpm	♦R/W	–	v, s, i	0h1C2A	–
		1	mpm						

USER SEQUENCE Parameter Group (US, USS)

The USER SEQUENCE parameter group is labeled as follows:

- *US – standard LED kepyad*
- *USS– optional LCD keypad*

See "Table Legend" on page 4–3 for details on each column in the table below.

NOTE: User Sequence parameter group is only available when AP.2=1 or Cm.95=1

USER SEQUENCE Parameter Group (US, USS)									
Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
US.0	Jump code	1–99		31	♦R/W	–	v, s, i, p	–	3–5
US.1	User sequence operation command	0	Stop	0: Stop	R/W	–	v, s, i, p	0h1D01	4–107
		1	Run						
		2	Digital In Run						
US.2	User sequence operation loop time	0	0.01s	1: 0.02s	R/W	–	v, s, i, p	0h1D02	4–107
		1	0.02s						
		2	0.05s						
		3	0.1s						
		4	0.5s						
		5	1s						
US.11	Output address link1	0–0xFFFF		0	R/W	–	v, s, i, p	0h1D0B	4–107
US.12	Output address link2	0–0xFFFF		0	R/W	–	v, s, i, p	0h1D0C	4–107
US.13	Output address link3	0–0xFFFF		0	R/W	–	v, s, i, p	0h1D0D	4–107
US.14	Output address link4	0–0xFFFF		0	R/W	–	v, s, i, p	0h1D0E	4–107
US.15	Output address link5	0–0xFFFF		0	R/W	–	v, s, i, p	0h1D0F	4–107
US.16	Output address link6	0–0xFFFF		0	R/W	–	v, s, i, p	0h1D10	4–107
US.17	Output address link7	0–0xFFFF		0	R/W	–	v, s, i, p	0h1D11	4–107
US.18	Output address link8	0–0xFFFF		0	R/W	–	v, s, i, p	0h1D12	4–107
US.19	Output address link9	0–0xFFFF		0	R/W	–	v, s, i, p	0h1D13	4–107
US.20	Output address link10	0–0xFFFF		0	R/W	–	v, s, i, p	0h1D14	4–107
US.21	Output address link11	0–0xFFFF		0	R/W	–	v, s, i, p	0h1D15	4–107
US.22	Output address link12	0–0xFFFF		0	R/W	–	v, s, i, p	0h1D16	4–107
US.23	Output address link13	0–0xFFFF		0	R/W	–	v, s, i, p	0h1D17	4–107
US.24	Output address link14	0–0xFFFF		0	R/W	–	v, s, i, p	0h1D18	4–107

USER SEQUENCE Parameter Group (US, USS)								
Pr. Code	**Name**	**Setting Range**	**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
US.25	Output address link15	0–0xFFFF	0	R/W	–	v, s, i, p	0h1D19	4–107
US.26	Output address link16	0–0xFFFF	0	R/W	–	v, s, i, p	0h1D1A	4–107
US.27	Output address link17	0–0xFFFF	0	R/W	–	v, s, i, p	0h1D1B	4–107
US.28	Output address link18	0–0xFFFF	0	R/W	–	v, s, i, p	0h1D1C	4–107
US.31	Void Constant setting1	–9999–9999	0	R/W	–	v, s, i, p	0h1D1F	4–107
US.32	Void Constant setting2	–9999–9999	0	R/W	–	v, s, i, p	0h1D20	4–107
US.33	Void Constant setting3	–9999–9999	0	R/W	–	v, s, i, p	0h1D21	4–107
US.34	Void Constant setting4	–9999–9999	0	R/W	–	v, s, i, p	0h1D22	4–107
US.35	Void Constant setting5	–9999–9999	0	R/W	–	v, s, i, p	0h1D23	4–107
US.36	Void Constant setting6	–9999–9999	0	R/W	–	v, s, i, p	0h1D24	4–107
US.37	Void Constant setting7	–9999–9999	0	R/W	–	v, s, i, p	0h1D25	4–107
US.38	Void Constant setting8	–9999–9999	0	R/W	–	v, s, i, p	0h1D26	4–107
US.39	Void Constant setting9	–9999–9999	0	R/W	–	v, s, i, p	0h1D27	4–107
US.40	Void Constant setting10	–9999–9999	0	R/W	–	v, s, i, p	0h1D28	4–107
US.41	Void Constant setting11	–9999–9999	0	R/W	–	v, s, i, p	0h1D29	4–107
US.42	Void Constant setting12	–9999–9999	0	R/W	–	v, s, i, p	0h1D2A	4–107
US.43	Void Constant setting13	–9999–9999	0	R/W	–	v, s, i, p	0h1D2B	4–107
US.44	Void Constant setting14	–9999–9999	0	R/W	–	v, s, i, p	0h1D2C	4–107
US.45	Void Constant setting15	–9999–9999	0	R/W	–	v, s, i, p	0h1D2D	4–107
US.46	Void Constant setting16	–9999–9999	0	R/W	–	v, s, i, p	0h1D2E	4–107
US.47	Void Constant setting17	–9999–9999	0	R/W	–	v, s, i, p	0h1D2F	4–107
US.48	Void Constant setting18	–9999–9999	0	R/W	–	v, s, i, p	0h1D30	4–107
US.49	Void Constant setting19	–9999–9999	0	R/W	–	v, s, i, p	0h1D31	4–107
US.50	Void Constant setting20	–9999–9999	0	R/W	–	v, s, i, p	0h1D32	4–107
US.51	Void Constant setting21	–9999–9999	0	R/W	–	v, s, i, p	0h1D33	4–107

USER SEQUENCE Parameter Group (US, USS)								
Pr. Code	Name	Setting Range	Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
US.52	Void Constant setting22	–9999–9999	0	R/W	–	v, s, i, p	0h1D34	4–107
US.53	Void Constant setting23	–9999–9999	0	R/W	–	v, s, i, p	0h1D35	4–107
US.54	Void Constant setting24	–9999–9999	0	R/W	–	v, s, i, p	0h1D36	4–107
US.55	Void Constant setting25	–9999–9999	0	R/W	–	v, s, i, p	0h1D37	4–107
US.56	Void Constant setting26	–9999–9999	0	R/W	–	v, s, i, p	0h1D38	4–107
US.57	Void Constant setting27	–9999–9999	0	R/W	–	v, s, i, p	0h1D39	4–107
US.58	Void Constant setting28	–9999–9999	0	R/W	–	v, s, i, p	0h1D3A	4–107
US.59	Void Constant setting29	–9999–9999	0	R/W	–	v, s, i, p	0h1D3B	4–107
US.60	Void Constant setting30	–9999–9999	0	R/W	–	v, s, i, p	0h1D3C	4–107
US.80	Analog input 1	0–12, 000	–	Read Only	CM.95=1 P2P master	v, s, i, p	0h1D50	4–107
US.81	Analog input2	–12, 000–12, 000	–	Read Only	CM.95=1 P2P master	v, s, i, p	0h1D51	4–107
US.82	Digital input	0–0x7F	–	Read Only	CM.95=1 P2P master	v, s, i, p	0h1D52	4–107
US.85	Analog output	0–10, 000	0	R/W	CM.95=1 P2P master	v, s, i, p	0h1D55	4–107
US.89	Digital output	0–0x03	0	R/W	CM.95=1 P2P master	v, s, i, p	0h1D58	4–107

USER SEQUENCE FUNCTION Parameter Group (UF , USF)

The USER SEQUENCE FUNCTION parameter group is labeled as follows:

- *UF – standard LED kepyad*
- *USF– optional LCD keypad*

See "Table Legend" on page 4–3 for details on each column in the table below.

NOTE: User Sequence Function parameter group is only available when AP.2=1 or Cm.95=1

USER SEQUENCE FUNCTION Parameter Group (UF , USF)									
Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
UF.0	Jump code	1–99		41	♦R/W	–	v, s, i, p	–	3–5
UF.1	User function1	0	NOP	0: NOP	R/W	–	v, s, i, p	0h1E01	4–107
		1	ADD						
		2	SUB						
		3	ADDSUB						
		4	MIN						
		5	MAX						
		6	ABS						
		7	NEGATE						
		8	MPYDIV						
		9	REMAINDER						
		10	COMPARE–GT						
		11	COMPARE–GEQ						
		12	COMPARE–EQUAL						
		13	COMPARE–NEQUAL						
		14	TIMER						
		15	LIMIT						
		16	AND						
		17	OR						
		18	XOR						
		19	ANDOR						
		20	SWITCH						
		21	BITTEST						
		22	BITSET						
		23	BITCLEAR						
		24	LOWPASSFILTER						
		25	PI_CONTORL						
		26	PI_PROCESS						
		27	UPCOUNT						
		28	DOWNCOUNT						
UF.2	User function input1–A	0–0xFFFF		0	R/W	–	v, s, i, p	0h1E02	4–107
UF.3	User function input1–B	0–0xFFFF		0	R/W	–	v, s, i, p	0h1E03	4–107

USER SEQUENCE FUNCTION Parameter Group (UF , USF)								
Pr. Code	Name	Setting Range	Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
UF.4	User function input1–C	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E04	4–107
UF.5	User function output1	–32767–32767	0	Read Only	–	v, s, i, p	0h1E05	4–107
UF.6	User function 2	See UF.1 for Values	0: NOP	R/W	–	v, s, i, p	0h1E06	4–107
UF.7	User function input2–A	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E07	4–107
UF.8	User function input2–B	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E08	4–107
UF.9	User function input2–C	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E09	4–107
UF.10	User function output2	–32767–32767	0	Read Only	–	v, s, i, p	0h1E0A	4–107
UF.11	User function3	See UF.1 for Values	0: NOP	R/W	–	v, s, i, p	0h1E0B	4–107
UF.12	User function input3–A	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E0C	4–107
UF.13	User function input3–B	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E0D	4–107
UF.14	User function input3–C	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E0E	4–107
UF.15	User function output3	–32767–32767	0	Read Only	–	v, s, i, p	0h1E0F	4–107
UF.16	User function4	See UF.1 for Values	0: NOP	R/W	–	v, s, i, p	0h1E10	4–107
UF.17	User function input4–A	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E11	4–107
UF.18	User function input4–B	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E12	4–107
UF.19	User function input4–C	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E13	4–107
UF.20	User function output4	–32767–32767	0	Read Only	–	v, s, i, p	0h1E14	4–107
UF.21	User function5	See UF.1 for Values	0: NOP	R/W	–	v, s, i, p	0h1E15	4–107
UF.22	User function input5–A	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E16	4–107
UF.23	User function input5–B	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E17	4–107
UF.24	User function input5–C	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E18	4–107
UF.25	User function output5	–32767–32767	0	Read Only	–	v, s, i, p	0h1E19	4–107
UF.26	User function6	See UF.1 for Values	0: NOP	R/W	–	v, s, i, p	0h1E1A	4–107
UF.27	User function input6–A	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E1B	4–107
UF.28	User function input6–B	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E1C	4–107
UF.29	User function input6–C	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E1D	4–107
UF.30	User function output6	–32767–32767	0	Read Only	–	v, s, i, p	0h1E1E	4–107

USER SEQUENCE FUNCTION Parameter Group (UF , USF)								
Pr. Code	**Name**	**Setting Range**	**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
UF.31	User function7	See UF.1 for Values	0: NOP	R/W	–	v, s, i, p	0h1E1F	4–107
UF.32	User function input7–A	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E20	4–107
UF.33	User function input7–B	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E21	4–107
UF.34	User function input7–C	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E22	4–107
UF.35	User function output7	–32767–32767	0	Read Only	–	v, s, i, p	0h1E23	4–107
UF.36	User function8	See UF.1 for Values	0: NOP	R/W	–	v, s, i, p	0h1E24	4–107
UF.37	User function input8–A	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E25	4–107
UF.38	User function input8–B	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E26	4–107
UF.39	User function input8–C	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E27	4–107
UF.40	User function output8	–32767–32767	0	Read Only	–	v, s, i, p	0h1E28	4–107
UF.41	User function9	See UF.1 for Values	0: NOP	R/W	–	v, s, i, p	0h1E29	4–107
UF.42	User function input9–A	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E2A	4–107
UF.43	User function input9–B	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E2B	4–107
UF.44	User function input9–C	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E2C	4–107
UF.45	User function output9	–32767–32767	0	Read Only	–	v, s, i, p	0h1E2D	4–107
UF.46	User function10	See UF.1 for Values	0: NOP	R/W	–	v, s, i, p	0h1E2E	4–107
UF.47	User function input10–A	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E2F	4–107
UF.48	User function input10–B	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E30	4–107
UF.49	User function input10–C	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E31	4–107
UF.50	User function output10	–32767–32767	0	Read Only	–	v, s, i, p	0h1E32	4–107
UF.51	User function11	See UF.1 for Values	0: NOP	R/W	–	v, s, i, p	0h1E33	4–107
UF.52	User function input11–A	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E34	4–107
UF.53	User function input11–B	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E35	4–107
UF.54	User function input11–C	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E36	4–107
UF.55	User function output11	–32767–32767	0	Read Only	–	v, s, i, p	0h1E37	4–107
UF.56	User function12	See UF.1 for Values	0: NOP	R/W	–	v, s, i, p	0h1E38	4–107
UF.57	User function input12–A	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E39	4–107

USER SEQUENCE FUNCTION Parameter Group (UF , USF)								
Pr. Code	Name	Setting Range	Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
UF.58	User function input12–B	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E3A	4–107
UF.59	User function input12–C	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E3B	4–107
UF.60	User function output12	–32767–32767	0	Read Only	–	v, s, i, p	0h1E3C	4–107
UF.61	User function13	See UF.1 for Values	0: NOP	R/W	–	v, s, i, p	0h1E3D	4–107
UF.62	User function input13–A	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E3E	4–107
UF.63	User function input13–B	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E3F	4–107
UF.64	User function input13–C	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E40	4–107
UF.65	User function output13	–32767–32767	0	Read Only	–	v, s, i, p	0h1E41	4–107
UF.66	User function14	See UF.1 for Values	0: NOP	R/W	–	v, s, i, p	0h1E42	4–107
UF.67	User function input14–A	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E43	4–107
UF.68	User function input14–B	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E44	4–107
UF.69	User function input14–C	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E45	4–107
UF.70	User function output14	–32767–32767	0	Read Only	–	v, s, i, p	0h1E46	4–107
UF.71	User function15	See UF.1 for Values	0: NOP	R/W	–	v, s, i, p	0h1E47	4–107
UF.72	User function input15–A	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E48	4–107
UF.73	User function input15–B	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E49	4–107
UF.74	User function input15–C	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E4A	4–107
UF.75	User function output15	–32767–32767	0	Read Only	–	v, s, i, p	0h1E4B	4–107
UF.76	User function 16	See UF.1 for Values	0: NOP	R/W	–	v, s, i, p	0h1E4C	4–107
UF.77	User function input16–A	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E4D	4–107
UF.78	User function input16–B	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E4E	4–107
UF.79	User function input16–C	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E4F	4–107
UF.80	User function output16	–32767–32767	0	Read Only	–	v, s, i, p	0h1E50	4–107
UF.81	User function 17	See UF.1 for Values	0: NOP	R/W	–	v, s, i, p	0h1E51	4–107
UF.82	User function input17–A	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E52	4–107
UF.83	User function input17–B	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E53	4–107
UF.84	User function input17–C	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E54	4–107

USER SEQUENCE FUNCTION Parameter Group (UF , USF)								
Pr. Code	Name	Setting Range	Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
UF.85	User function output17	–32767–32767	0	Read Only	–	v, s, i, p	0h1E55	4–107
UF.86	User function 18	See UF.1 for Values	0: NOP	R/W	–	v, s, i, p	0h1E56	4–107
UF.87	User function input18–A	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E57	4–107
UF.88	User function input18–B	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E58	4–107
UF.89	User function input18–C	0–0xFFFF	0	R/W	–	v, s, i, p	0h1E59	4–107
UF.90	User function output18	–32767–32767	0	Read Only	–	v, s, i, p	0h1E5A	4–107

Trip Mode (TRP Last-x)

The Trip Mode menu is only available on the LCD keypad. It will display only when there are active faults or fault history. It is labeled as follows:

- *n/a – standard LED kepyad*
- *TRP– optional LCD keypad*

See "Table Legend" on page 4–3 for details on each column in the table below.

Trip Mode (TRP Last-x)					
Pr. Code	**Name**	**Setting Range**		**Initial Value**	**Compatible Control Mode**
00	Trip type display	-		-	v, s, i, p
01	Frequency reference at trip	-		-	v, s, i, p
02	Output current at trip	-		-	v, s, i, p
03	Acceleration/Deceleration state at trip	-		-	v, s, i, p
04	DC section state	-		-	v, s, i, p
05	NTC temperature	-		-	v, s, i, p
06	Input terminal state	-		0000 0000	v, s, i, p
07	Output terminal state	-		000	v, s, i, p
08	Trip time after Power on	-		0/00/00 00:00	v, s, i, p
09	Trip time after operation start	-		0/00/00 00:00	v, s, i, p
10	Delete trip history	0	No		v, s, i, p
		1	Yes		

Config Mode (CNF)

The Config menu is only available on the LCD keypad. Config Mode menu is labeled as follows:

- *n/a – standard LED kepyad*
- *CNF. optional LCD keypad*

See "Table Legend" on page 4–3 for details on each column in the table below.

Config Mode (CNF)						
Pr. Code	**Name**	**Setting Range**		**Initial Value**	**Compatible Control Mode**	**Ref.**
0	Jump code	1-99		42	v, s, i, p	3–5
1	Keypad language selection	0 : English		0: English	v, s, i, p	4–192
2	LCD contrast adjustment	-		-	v, s, i, p	4–180
3	Multi keypad ID	3-99		3	v, s, i, p	4–106
10	Inverter (Drive) S/W version	-		-	v, s, i, p	4–180
11	LCD keypad S/W version	-		-	v, s, i, p	4–180
12	LCD keypad title version	-		-	v, s, i, p	4–180
20	Status window display item	0	Frequency	0: Frequency	v, s, i, p	4–193
		1	Speed			
		2	Output Current			
		3	Output Voltage			
		4	Output Power			
		5	WHour Counter			
		6	DCLink Voltage			
		7	DI State			
		8	DO State			
		9	V1 Monitor(V)			
		10	V1 Monitor(%)			
		13	V2 Monitor(V)			
		14	V2 Monitor(%)			
		15	I2 Monitor(mA)			
		16	I2 Monitor(%)			
		17	PID Output			
		18	PID Ref Value			
		19	PID Fdb Value			
		20	Torque			
		21	Torque Limit			
		23	Speed Limit			
		24	Load Speed			
		25	Temperature			
21	Monitor mode display item1	See code 20 for values		0: Frequency	v, s, i, p	4–193
22	Monitor mode display item2	See code 20 for values		2: Output Current	v, s, i, p	4–193
23	Monitor mode display item3	See code 20 for values		3: Output Voltage	v, s, i, p	4–193
24	Monitor mode initialization	0	No	0: No	v, s, i, p	4–193
		1	Yes			

Config Mode (CNF)						
Pr. Code	Name	Setting Range		Initial Value	Compatible Control Mode	Ref.
30	Option slot 1 type display	0	None	0: None	v, s, i, p	4–180
		6	Ethernet			
		9	CANopen			
31	Option slot 2 type display	See code 30 for values		0: None	v, s, i, p	4–180
32	Option slot 3 type display	See code 30 for values		0: None	v, s, i, p	4–180
40	Parameter initialization	0	No		v, s, i, p	4–175
		1	All Grp			
		2	DRV Grp			
		3	BAS Grp			
		4	ADV Grp			
		5	CON Grp			
		6	IN Grp			
		7	OUT Grp			
		8	COM Grp			
		9	APP Grp			
		11	APO Grp			
		12	PRT Grp			
		13	M2 Grp			
		14	USS Grp			
		15	USF Grp			
41	Display changed Parameter	0	View All	0: View All	v, s, i, p	4–178
		1	View Changed			
42	Multi key item	0	None	0: None	v, s, i, p	4–178
		1	JOG Key			
		2	Local/Remote			
		3	UserGrp SelKey			
		4	Multi KPD			
43	Macro function item	0	None	0: None	v, s, i, p	
44	Trip history deletion	0	No	0: No	v, s, i, p	4–180
		1	Yes			
45	User registration code deletion	0	No	0: No	v, s, i, p	4–178
		1	Yes			
46	Read parameters	0	No	0: No	v, s, i, p	4–175
		1	Yes			
47	Write parameters	0	No	0: No	v, s, i, p	4–175
		1	Yes			
48	Save parameters	0	No	0: No	v, s, i, p	4–175
		1	Yes			
50	Hide parameter mode	0-9999		Un-locked	v, s, i, p	4–176
51	Password for hiding parameter mode	0-9999		Password	v, s, i, p	4–176
52	Lock parameter edit	0-9999		Unlocked	v, s, i, p	4–176

Config Mode (CNF)						
Pr. Code	**Name**	**Setting Range**		**Initial Value**	**Compatible Control Mode**	**Ref.**
53	Password for locking parameter edit	0-9999		Password	v, s, i, p	4–176
60	Additional title update	0	No	0:No	v, s, i, p	4–180
		1	Yes			
61	Simple parameter setting	0	No	1:Yes	v, s, i, p	4–178
		1	Yes			
62	Power consumption initialization	0	No	0:No	v, s, i, p	4–180
		1	Yes			
70	Accumulated drive motion time	00000DAY 00:00		-	v, s, i, p	4–195
71	Accumulated drive operation time	00000DAY 00:00		-	v, s, i, p	4–195
72	Accumulated drive operation time initialization	0	No	0:No	v, s, i, p	4–195
		1	Yes			
74	Accumulated cooling fan operation time	00000DAY 00:00		-	v, s, i, p	4–195
75	Reset of accumulated cooling fan operation time	0	No	0:No	v, s, i, p	4–195
		1	Yes			
76	CPU Fan Time	00000DAY 00:00		–	v, s, i, p	
77	CPU Fan Time Reset	0	No	0: No	v, s, i, p	
		1	Yes			

IronHorse® ACN Drive Operation and Parameter Details

This section describes in detail the function of each parameter, parameter interaction, and how to configure drive functionality via parameters. There are 3 main sections:

1) Learning Basic Features
2) Learning Advanced Features
3) Learning Protection Features

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
x	x	x	x	x	x	x

Chart Key

- *Group = Parameter Group, designated by one of the following:*
  - » *2 letter group abbreviation*
  - » *Operation (initial parameter group on Drive LED with no 2 letter designation)*
  - » *CNF (group available in optional LCD display only)*
- *Code = Parameter number, or full parameter group/code designation, i.e. dr.1*
- *Name = Parameter Description*
- *LCD Display = Parameter description seen on optional ACN-LCD display*
- *Parameter Setting = Applicable parameter setting value and function*
- *Setting Range = Full Range of parameter settings*
- *Unit = Engineering unit*

NOTE: Parameters can be restored to their default values using dr.93.

Learning Basic Features

This section describes the basic features of the ACN drive. Check the reference page in the table to see the detailed description for each of the advanced features.

Basic Tasks	Description	Ref.
Frequency reference source configuration for the keypad	Configures the drive to allow you to setup or modify frequency reference using the Keypad.	4–68
Frequency reference source configuration for the terminal block (input voltage)	Configures the drive to allow input voltages at the terminal block (V1, V2) and to setup or modify a frequency reference.	4–69 4–74
Frequency reference source configuration for the terminal block (input current)	Configures the drive to allow input currents at the terminal block (I2) and to setup or modify a frequency reference.	4–73
Frequency reference source configuration for the terminal block (input pulse)	Configures the drive to allow input pulse at the terminal block P5(TI) and to setup or modify a frequency reference.	4–75
Frequency reference source configuration for RS–485 communication	Configures the drive to allow communication signals from upper level controllers, such as PLCs or PCs, and to setup or modify a frequency reference.	4–76
Frequency control using analog inputs	Enables the user to hold a frequency using analog inputs at terminals.	4–76
Motor operation display options	Configures the display of motor operation values. Motor operation is displayed either in frequency (Hz) or speed (rpm).	4–77
Multi–step speed (frequency) configuration	Configures multi–step frequency operations by receiving an input at the terminals defined for each step frequency.	4–77
Command source configuration for keypad buttons	Configures the drive to allow the manual operation of the [FWD], [REV] and [Stop] keys.	4–79
Command source configuration for terminal block inputs (2-wire)	Configures the drive to accept inputs at the FX/RX terminals.	4–80
Command source configuration for RS–485 communication	Configures the drive to accept communication signals from upper level controllers, such as PLCs or PCs.	4–81
Local/remote switching via the [ESC] key	Configures the drive to switch between local and remote operation modes when the [ESC] key is pressed. When the drive is operated using remote inputs (any input other than one from the keypad), this configuration can be used to perform maintenance on the drive, without losing or altering saved parameter settings. It can also be used to override remotes and use the keypad immediately in emergencies.	4–82
Motor rotation control	Configures the drive to limit a motor's rotation direction.	4–84
Automatic start–up at power–on	Configures the drive to start operating at power–on. With this configuration, the drive begins to run and the motor accelerates as soon as power is supplied to the drive. To use automatic start–up configuration, the operation command terminals at the terminal block must be turned on.	4–85
Automatic restart after reset of a fault trip condition	Configures the drive to start operating when the drive is reset following a fault trip. In this configuration, the drive starts to run and the motor accelerates as soon as the drive is reset following a fault trip condition. For automatic start–up configuration to work, the operation command terminals at the terminal block must be turned on.	4–86
Acc/Dec time configuration based on the Max. Frequency	Configures the acceleration and deceleration times for a motor based on a defined maximum frequency.	4–87
Acc/Dec time configuration based on the frequency reference	Configures acceleration and deceleration times for a motor based on a defined frequency reference.	4–88
Multi–stage Acc/Dec time configuration using the multi–function terminal	Configures multi–stage acceleration and deceleration times for a motor based on defined parameters for the multi–function terminals.	4–88
Acc/Dec time transition speed (frequency) configuration	Enables modification of acceleration and deceleration gradients without configuring the multi–functional terminals.	4–89
Acc/Dec pattern configuration	Enables modification of the acceleration and deceleration gradient patterns. Basic patterns to choose from include linear and S–curve patterns.	4–91
Acc/Dec stop command	Stops the current acceleration or deceleration and controls motor operation at a constant speed. Multi–function terminals must be configured for this command .	4–93

Basic Tasks	Description	Ref.
Linear V/F pattern operation	Configures the drive to run a motor at a constant torque. To maintain the required torque, the operating frequency may vary during operation.	4–93
Square reduction V/F pattern operation	Configures the drive to run the motor at a square reduction V/F pattern. Fans and pumps are appropriate loads for square reduction V/F operation.	4–94
User V/F pattern configuration	Enables the user to configure a V/F pattern to match the characteristics of a motor. This configuration is for special–purpose motor applications to achieve optimal performance.	4–95
Manual torque boost	Manual configuration of the drive to produce a momentary torque boost. This configuration is for loads that require a large amount of starting torque, such as elevators or lifts.	4–96
Automatic torque boost	Automatic configuration of the drive that provides “auto tuning” that produces a momentary torque boost. This configuration is for loads that require a large amount of starting torque, such as elevators or lifts.	4–96
Output voltage adjustment	Adjusts the output voltage to the motor when the power supply to the drive differs from the motor’s rated input voltage.	4–97
Accelerating start	Accelerating start is the general way to start motor operation. The typical application configures the motor to accelerate to a target frequency in response to a run command, however there may be other start or acceleration conditions defined.	4–97
Start after DC braking	Configures the drive to perform DC braking before the motor starts rotating again. This configuration is used when the motor will be rotating before the voltage is supplied from the drive.	4–97
Deceleration stop	Deceleration stop is the typical method used to stop a motor. The motor decelerates to 0Hz and stops on a stop command, however there may be other stop or deceleration conditions defined.	4–98
Stopping by DC braking	Configures the drive to apply DC braking during motor deceleration. The frequency at which DC braking occurs must be defined and during deceleration, when the motor reaches the defined frequency, DC braking is applied.	4–99
Free–run stop	Configures the drive to stop output to the motor using a stop command. The motor will free–run until it slows down and stops.	4–100
Power braking	Configures the drive to provide optimal, motor deceleration, without tripping over–voltage protection.	4–100
Start/maximum frequency configuration	Configures the frequency reference limits by defining a start frequency and a maximum frequency.	4–101
Upper/lower frequency limit configuration	Configures the frequency reference limits by defining an upper limit and a lower limit.	4–101
Frequency jump	Configures the drive to avoid running a motor in mechanically resonating frequencies.	4–102
2nd Operation Configuration	Used to configure the 2nd operation mode and switch between the operation modes according to your requirements.	4–103
Multi–function input terminal control configuration	Enables the user to improve the responsiveness of the multi–function input terminals.	4–104
P2P communication configuration	Configures the drive to share input and output devices with other drives.	4–105
Multi–keypad configuration	Enables the user to monitor multiple drives with one monitoring device.	4–106
User sequence configuration	Enables the user to implement simple sequences using various function blocks.	4–107

Setting Frequency Reference

The ACN drive provides several methods to setup and modify a frequency reference for an operation. The keypad, analog inputs [for example voltage (V1, V2) and current (I2) signals], or RS–485 (digital signals from higher–level controllers, such as PC or PLC) can be used. If UserSeqLink is selected, the common area can be linked with user sequence output and can be used as frequency reference.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	Ref Freq Src	0	Keypad–1	0–12	–
				1	Keypad–2		
				2	V1		
				4	V2		
				5	I2		
				6	Int 485		
				8	Field Bus		
				9	UserSeqLink		
				12	Pulse		

Keypad as the Source (Keypad–1 setting)

You can modify frequency reference by using the keypad and apply changes by pressing the [ENT] key. To use the keypad as a frequency reference input source, go to the Frq (Frequency reference source) code in the Operation group and change the parameter value to 0 (Keypad–1). Input the frequency reference for an operation at the 0.00(Command Frequency) code in the Operation group.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	Freq Ref Src	0	Keypad–1	0–12	–
	0.00	Frequency reference	–	0.00		Min to Max Frq*	Hz
You cannot set a frequency reference that exceeds the Max. Frequency, as configured with dr.20.							

Keypad as the Source (Keypad–2 setting)

You can use the Up Arrow and Down Arrow keys to modify a frequency reference. To use this as a second option, set the keypad as the source of the frequency reference, by going to the Frq (Frequency reference source) code in the Operation group and change the parameter value to 1 (Keypad–2). This allows frequency reference values to be increased or decreased by pressing the Up Arrow and Down Arrow keys.

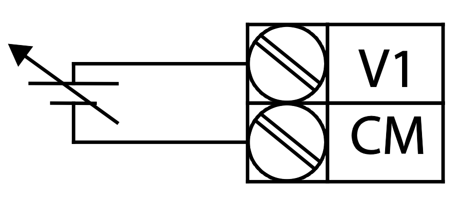
Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	Freq Ref Src	1	Keypad–2	0–12	–
	0.00	Frequency reference	–	0.00		Min to Max Frq*	Hz
You cannot set a frequency reference that exceeds the Max. Frequency, as configured with dr.20.							

V1 Terminal as the Source

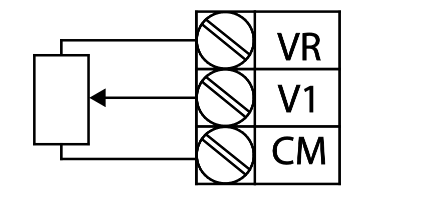
You can set and modify a frequency reference by setting voltage inputs when using the V1 terminal. Use voltage inputs ranging from 0 to 10V (unipolar) for forward only operation. Use voltage inputs ranging from –10 to +10V (bipolar) for both directions, where negative voltage inputs are used reverse operations.

Setting a Frequency Reference for 0–10V Input

Set In.6 (V1 Polarity) to 0 (unipolar). Use a voltage output from an external source or use the voltage output from the VR terminal to provide inputs to V1. Refer to the diagrams below for the wiring required for each application.



External source application



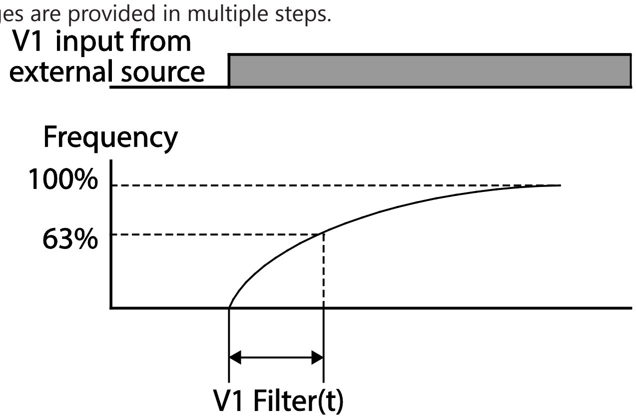
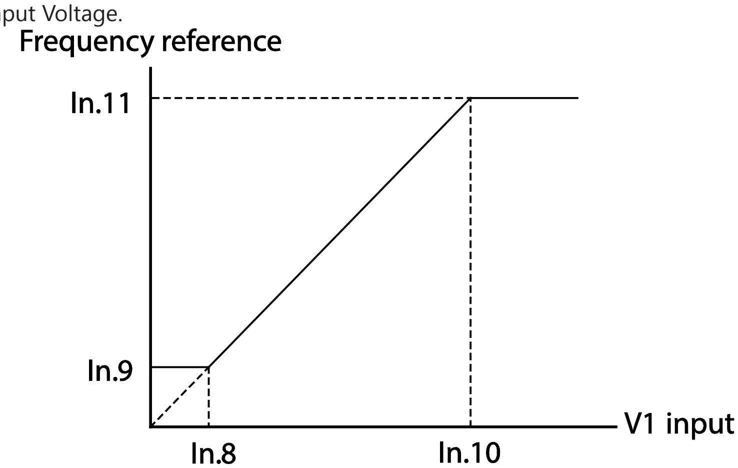
Internal source (VR) application

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
Operation	Frq	Frequency reference source	Freq Ref Src	2 V1	0–12	–
In	01	Frequency at maximum analog input	Freq at 100%	Maximum frequency	0.00–Max. Frequency	Hz
	05	V1 input monitor	V1 Monitor V	0.00	0.00–12.00	V
	06	V1 polarity options	V1 Polarity	0 Unipolar	0–1	–
	07	V1 input filter time constant	V1 Filter	10	0–10000	ms
	08	V1 minimum input voltage	V1 volt x1	0.00	0.00–10.00	V
	09	V1 output at minimum voltage (%)	V1 Perc y1	0.00	0.00–100.00	%
	10	V1 maximum input voltage	V1 Volt x2	10.00	0 .00– 12.00	V
	11	V1 output at maximum voltage (%)	V1 Perc y2	100.00	0–100	%
	16	Rotation direction options	V1 Inverting	0 No	0–1	–
	17	V1 Quantizing level	V1 Quantizing	0.04	0.00*, 0.04–10.00	%

Quantizing is disabled if '0' is selected.

0–10V Input Voltage Setting Details

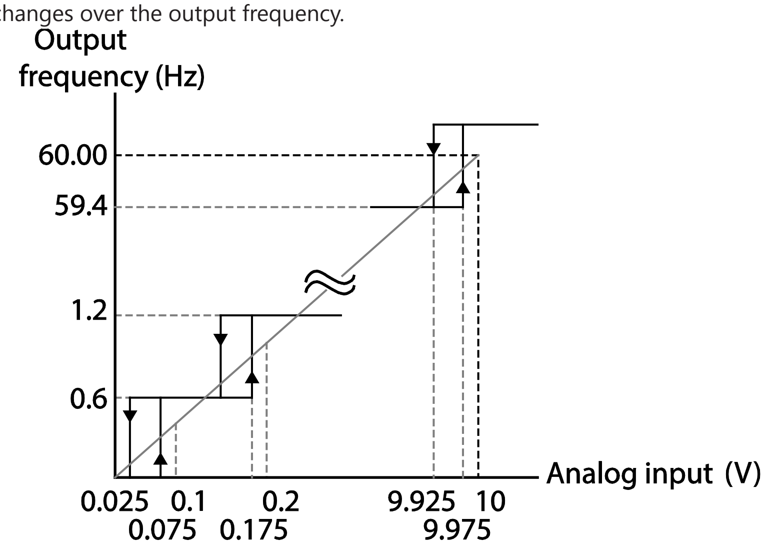
Pr. Code	Description
In.1 Freq at 100%	Configures the frequency reference at the maximum input voltage when a potentiometer is connected to the control terminal block. A frequency set with code In.1 becomes the maximum frequency only if the value set in code In.11 (or In.15) is 100%. Set code In.1 to 40.00 and use default values for codes In.2–In.16. Motor will run at 40.00 Hz when a 10V input is provided at V1. Set code In.11 to 50.00 and use default values for codes In.1–In.16. Motor will run at 30.00 Hz (50% of the default maximum frequency–60Hz) when a 10V input is provided at V1.
In.5 V1 MonitorV	Configures the drive to monitor the input voltage at V1.

Pr. Code	Description
In.7 V1 Filter	V1 Filter may be used when there are large variations between reference frequencies. Variations can be mitigated by increasing the time constant, but this will require an increased response time. The value t (time) indicates the time required for the frequency to reach 63% of the reference, when external input voltages are provided in multiple steps. 
In.8 V1 Volt x1– *In.11 V1 Perc y2*	These parameters are used to configure the gradient level and offset values of the Output Frequency, based on the Input Voltage. 
In.16 V1 Inverting	Inverts the direction of rotation. Set this code to 1 (Yes) if you need the motor to run in the opposite direction from the current rotation.

<table>
<tr><th>Pr. Code</th><th>Description</th></tr>
<tr><td>In.17 V1 Quantizing</td><td>
Quantizing may be used when the noise level is high in the analog input (V1 terminal) signal.
Quantizing is useful when you are operating a noise–sensitive system, because it suppresses any signal noise. However, quantizing will diminish system sensitivity (resultant power of the output frequency will decrease based on the analog input).
You can also turn on the low–pass filter using code In.7 to reduce the noise, but increasing the value will reduce responsiveness and may cause pulsations (ripples) in the output frequency.

Parameter values for quantizing refer to a percentage based on the maximum input. Therefore, if the value is set to 1% of the analog maximum input (60Hz), the output frequency will increase or decrease by 0.6 Hz per 0.1 V difference.

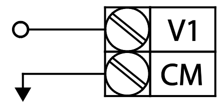
When the analog input is increased, an increase to the input equal to 75% of the set value will change the output frequency, and then the frequency will increase according to the set value. Likewise, when the analog input decreases, a decrease in the input equal to 75% of the set value will make an initial change to the output frequency.

As a result, the output frequency will be different at acceleration and deceleration, mitigating the effect of analog input changes over the output frequency.


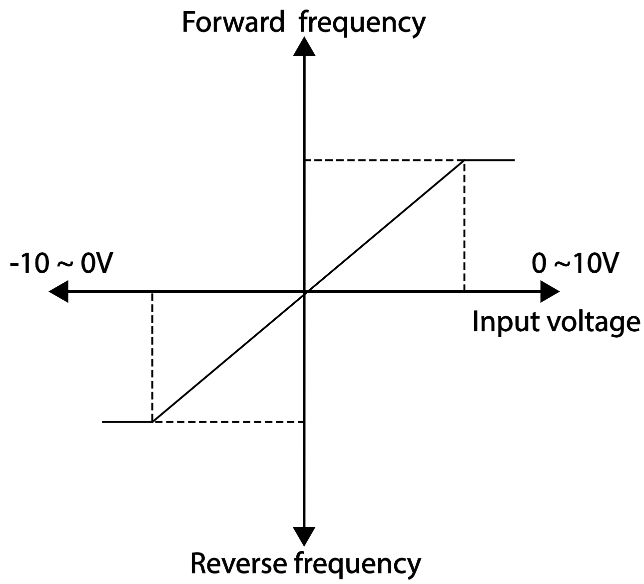
</td></tr>
</table>

Setting a Frequency Reference for –10–10V Input

Set the Frq (Frequency reference source) code in the Operation group to 2 (V1), and then set In.6 (V1 Polarity) to 1 (bipolar). Use the output voltage from an external source to provide input to V1.



V1 terminal wiring



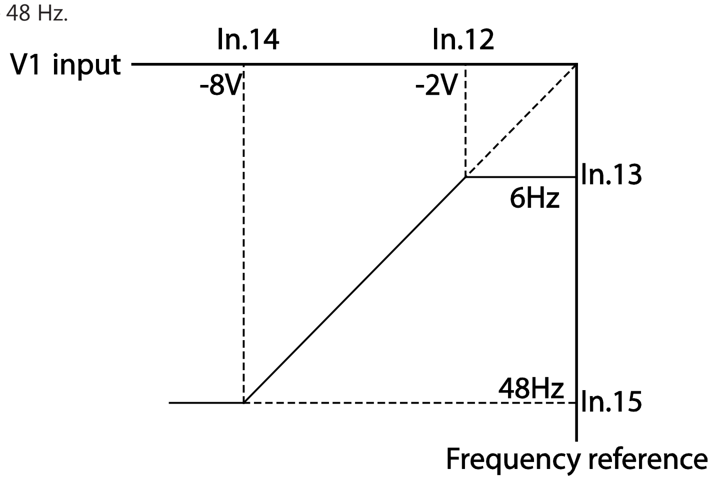
Bipolar input voltage and output frequency

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	Freq Ref Src	2	V1	0–12	–
In	01	Frequency at maximum analog input	Freq at 100%	60.00		0– Max Frequency	Hz
	05	V1 input monitor	V1 Monitor	0.00		0.00–12.00V	V
	06	V1 polarity options	V1 Polarity	1	Bipolar	0–1	–
	12	V1 minimum input voltage	V1– volt x1	0.00		10.00–0.00V	V
	13	V1 output at minimum voltage (%)	V1– Perc y1	0.00		–100.00–0.00%	%
	14	V1maximum input voltage	V1– Volt x2	–10.00		–12.00 –0.00V	V
	15	V1 output at maximum voltage (%)	V1– Perc y2	–100.00		–100.00–0.00%	%

Rotational Directions for Different Voltage Inputs

Command / Voltage Input	Input voltage	
	0–10V	–10–0V
FWD	Forward	Reverse
REV	Reverse	Forward

–10–10V Voltage Input Setting Details

Pr. Code	Description
In.12 V1– volt x1– In.15 V1– Perc y2	Sets the gradient level and off–set value of the output frequency in relation to the input voltage. These codes are displayed only when In.6 is set to 1 (bipolar). As an example, if the minimum input voltage (at V1) is set to –2 (V) with 10% output ratio, and the maximum voltage is set to –8 (V) with 80% output ratio respectively, the output frequency will vary within the range of 6 – 48 Hz.  [In.12 V1–volt X1–In.15 V1 Perc y] For details about the 0–+10V analog inputs, Refer to "In.8 V1 Volt x1–" on page 4–70.

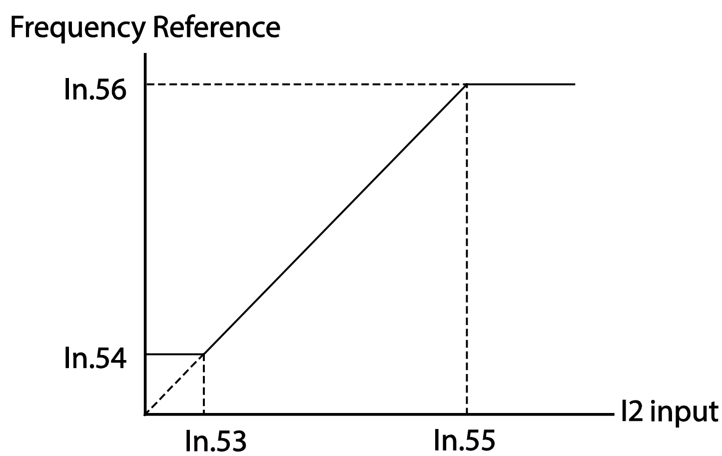
Setting a Reference Frequency using Input Current (I2)

You can set and modify a frequency reference using input current at the I2 terminal after selecting current input at SW 2. Set the Frq (Frequency reference source) code in the Operation group to 5 (I2) and apply 4–20 mA input current to I2.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
Operation	Frq	Frequency reference source	Freq Ref Src	5 I2	0–12	–
In	01	Frequency at maximum analog input	Freq at 100%	60.00	0– Maximum Frequency	Hz
	50	I2 input monitor	I2 Monitor	0.00	0.00–24.00	mA
	52	I2 input filter time constant	I2 Filter	10	0–10000	ms
	53	I2 minimum input current	I2 Curr x1	4.00	0.00–20.00	mA
	54	I2 output at minimum current (%)	I2 Perc y1	0.00	0–100	%
	55	I2 maximum input current	I2 Curr x2	20.00	0.00–24.00	mA
	56	I2 output at maximum current (%)	I2 Perc y2	100.00	0.00–100.00	%
	61	I2 rotation direction options	I2 Inverting	0 No	0–1	–
	62	I2 Quantizing level	I2 Quantizing	0.04	0*, 0.04–10.00	%

**Quantizing is disabled if '0' is selected.*

Input Current (I2) Setting Details

Pr. Code	Description
In.1 Freq at 100%	Configures the frequency reference for operation at the maximum current (when In.56 is set to 100%). If In.1 is set to 40.00Hz, and default settings are used for In.53–56, 20mA input current (max) to I2 will produce a frequency reference of 40.00 Hz. If In.56 is set to 50.00 (%), and default settings are used for In.1 (60Hz) and In.53–55, 20mA input current (max) to I2 will produce a frequency reference of 30.00 Hz (50% of 60Hz).
In.50 I2 Monitor	Used to monitor input current at I2.
In.52 I2 Filter	Configures the time for the operation frequency to reach 63% of target frequency based on the input current at I2.
In.53 I2 Curr x1–In.56 I2 Perc y2	Configures the gradient level and off–set value of the output frequency.  [Gradient and off–set configuration based on output frequency]

Setting a Frequency Reference with Input Voltage (Terminal I2)

Set and modify a frequency reference using input voltage at I2 (V2) terminal by setting SW2 to V2. Set the Frq (Frequency reference source) code in the Operation group to 4 (V2) and apply 0–12V input voltage to I2 (=V2, Analog current/voltage input terminal). Parameters In.35–47 will not be displayed when I2 is set to receive current input (Frq code parameter is set to 5).

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	Freq Ref Src	4	V2	0–12	–
In	35	V2 input display	V2 Monitor	0.00		0.00–12.00	V
	37	V2 input filter time constant	V2 Filter	10		0–10000	ms
	38	Minimum V2 input voltage	V2 Volt x1	0.00		0.00–10.00	V
	39	Output% at minimum V2 voltage	V2 Perc y1	0.00		0.00–100.00	%
	40	Maximum V2 input voltage	V2 Volt x2	10.00		0.00–10.00	V
	41	Output% at maximum V2 voltage	V2 Perc y2	100.00		0.00–100.00	%
	46	Invert V2 rotational direction	V2 Inverting	0	No	0–1	–
	47	V2 quantizing level	V2 Quantizing	0.04		0.00*, 0.04–10.00	%

**Quantizing is disabled if '0' is selected.*

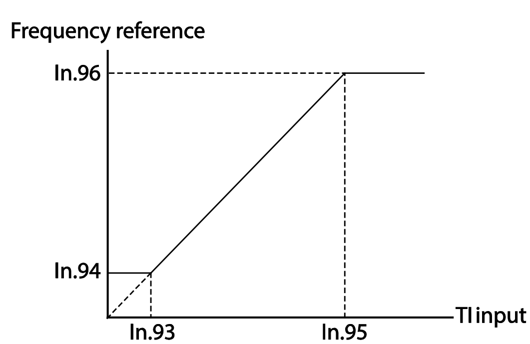
Setting a Frequency with TI Pulse Input

Set a frequency reference by setting the Frq (Frequency reference source) code in Operation group to 12 (Pulse). Set the In.69 P5 Define to 54(TI) and providing 0–32.00 kHz pulse frequency to P5.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	Freq Ref Src	12	Pulse	0–12	–
	69	P5 terminal function setting	P5 Define	54	TI	0–54	–
	01	Frequency at maximum analog input	Freq at 100%	60.00		0.00–Maximum frequency	Hz
	91	Pulse input display	Pulse Monitor	0.00		0.00–50.00	kHz
	92	TI input filter time constant	TI Filter	10		0–9999	ms
	93	TI input minimum pulse	TI Pls x1	0.00		0.00–32.00	kHz
In	94	Output% at TI minimum pulse	TI Perc y1	0.00		0.00–100.00	%
	95	TI Input maximum pulse	TI Pls x2	32.00		0.00–32.00	kHz
	96	Output% at TI maximum pulse	TI Perc y2	100.00		0.00–100.00	%
	97	Invert TI direction of rotation	TI Inverting	0	No	0–1	–
	98	TI quantizing level	TI Quantizing	0.04		0.00*, 0.04–10.00	%

**Quantizing is disabled if ‘0’ is selected.*

<u>TI Pulse Input Setting Details</u>

Pr. Code	Description
In.69 P5 Define	Pulse input TI and Multi–function terminal P5 share the same terminal. Set the In.69 P5 Define to 54(TI).
In.1 Freq at 100%	Configures the frequency reference at the maximum pulse input. The frequency reference is based on 100% of the value set with In.96. If In.1 Max Frequency is set to 40.00 and codes In.93–96 are set at default, 32kHz input to TI yields a frequency reference of 40.00 Hz. If In.96 is set to 50.00 and In.1 Max Freq is set to 60hz. (In.93–95 are set at default), 32kHz input to the TI terminal yields a frequency reference of 30.00 Hz.
In.91 Pulse Monitor	Displays the pulse frequency supplied at TI.
In.92 TI Filter	Sets the time for the pulse input at TI to reach 63% of its nominal frequency (when the pulse frequency is supplied in multiple steps).
In.93 TI Pls x1– In.96 TI Perc y2	Configures the gradient level and offset values for the output frequency. 
In.97 TI Inverting– In.98 TI Quantizing	Identical to In.16–17. Refer to "In.16 V1 Inverting" on page 4–70.

Setting a Frequency Reference via RS–485 Communication

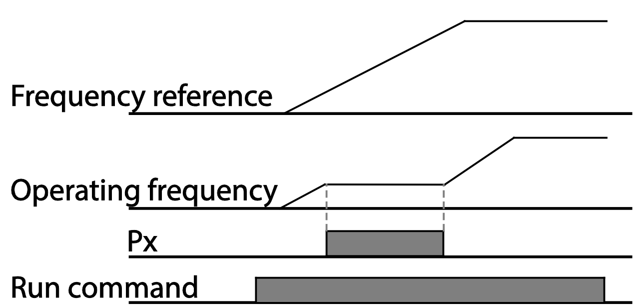
Control the drive with upper–level controllers, such as PCs or PLCs, via RS–485 communication. Set the Frq (Frequency reference source) code in the Operation group to 6 (Int 485) and use the RS–485 signal input terminals (S+/S–/SG) for communication. Refer to "Serial RS-485 Communication Features" on page 5–2.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	Freq Ref Src	6	Int 485	0–12	–
CM	01	Integrated RS–485 communication drive ID	Int485 St ID	–	1	1–250	–
	02	Integrated communication protocol	Int485 Proto	0	ModBus RTU	0–2	–
				1	Reserved		
				2	Not supported		
	03	Integrated communication speed	Int485 BaudR	3	9600 bps	0–7	–
	04	Integrated communication frame configuration	Int485 Mode	0	D8/PN/S1	0–3	–
				1	D8/PN/S2		
				2	D8/PE/S1		
				3	D8/PO/S1		

Frequency Hold by Analog Input

If you set a frequency reference via analog input at the control terminal block, you can hold the operation frequency of the drive by assigning a multi–function input as the analog frequency hold terminal. The operation frequency will be fixed upon an analog input signal.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	Freq Ref Src	0	Keypad–1	0–12	–
				1	Keypad–2		
				2	V1		
				4	V2		
				5	I2		
				6	Int 485		
				8	Field Bus		
				12	Pulse		
In	65–69	Px terminal configuration	Px Define(Px: P1–P5)	21	Analog Hold	0–54	–



Changing the Displayed Units (Hz↔Rpm)

You can change the units used to display the operational speed of the drive by setting dr.21 (Speed unit selection) to 0 (Hz) or 1 (Rpm). This function is available only with the LCD keypad.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
dr	21	Speed unit selection	Hz/Rpm Sel	0	Hz Display	0–1	–
				1	Rpm Display		

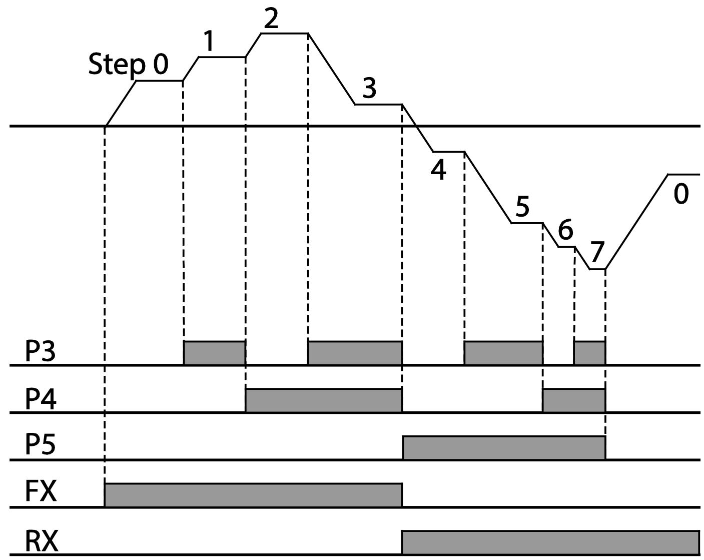
Setting Multi–step Frequency

Multi–step operations can be carried out by assigning different speeds (or frequencies) to the Px terminals. Step 0 uses the frequency reference source set with the Frq code in the Operation group. Px terminal parameter values 7 (Speed–L), 8 (Speed–M) and 9 (Speed–H) are recognized as binary commands and work in combination with Fx or Rx run commands. The drive operates according to the frequencies set with St.1–3 (multi–step frequency 1–3) , bA.53–56 (multi–step frequency 4–7) and the binary command combinations.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	St1–St3	Multi–step frequency 1–3	Step Freq – 1–3	–		0–Maximum frequency	Hz
bA	53–56	Multi–step frequency 4–7	Step Freq – 4–7	–		0–Maximum frequency	Hz
In	65–69	Px terminal configuration	Px Define (Px: P1–P5)	7	Speed–L	0–54	–
				8	Speed–M		–
				9	Speed–H		–
	89	Multi–step command delay time	InCheck Time	1		1–5000	ms

Multi–step Frequency Setting Details

Pr. Code	Description
Operation group St1–St3 Step Freq – 1–3	Configure multi–step frequency1–3. If an LCD keypad is in use, bA.50–52 is used instead of St1–St3 (multi–step frequency 1–3).
bA.53–56 Step Freq – 4–7	Configure multi–step frequency 4–7.

Pr. Code	Description
In.65–69 Px Define	Choose the terminals to setup as multi–step inputs, and then set the relevant codes (In.65–69) to 7(Speed–L), 8(Speed–M), or 9(Speed–H). Provided that terminals P3, P4 and P5 have been set to Speed–L, Speed–M and Speed–H respectively, the following multi–step operation will be available.  [An example of a multi–step operation] <table><tr><td>Speed</td><td>Fx/Rx</td><td>P5</td><td>P4</td><td>P3</td></tr><tr><td>0</td><td>X</td><td>–</td><td>–</td><td>–</td></tr><tr><td>1</td><td>X</td><td>–</td><td>–</td><td>X</td></tr><tr><td>2</td><td>X</td><td>–</td><td>X</td><td>–</td></tr><tr><td>3</td><td>X</td><td>–</td><td>X</td><td>X</td></tr><tr><td>4</td><td>X</td><td>X</td><td>–</td><td>–</td></tr><tr><td>5</td><td>X</td><td>X</td><td>–</td><td>X</td></tr><tr><td>6</td><td>X</td><td>X</td><td>X</td><td>–</td></tr><tr><td>7</td><td>X</td><td>X</td><td>X</td><td>X</td></tr></table>
In.89 InCheck Time	Set a time interval for the drive to check for additional terminal block inputs after receiving an input signal. After adjusting In.89 to 100ms and an input signal is received at P5, the drive will search for inputs at other terminals for 100ms, before proceeding to accelerate or decelerate based on P5's configuration.

Command Source Configuration

Various devices can be selected as command input devices for the ACN drive. Input devices available to select include keypad, multi–function input terminal, RS–485 communication and field bus adapter.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	drv	Command Source	Cmd Source*	0	Keypad	0–5	–
				1	Fx/Rx–1 (Fwd Run/Rev Run)		
				2	Fx/Rx–2 (Run/ Direction)		
				3	Int 485		
				4	Field Bus		
				5	UserSeqLink		
Displayed under DRV–06 on the LCD keypad.							

The Keypad as a Command Input Device

The keypad can be selected as a command input device to send command signals to the drive. This is configured by setting the drv (command source) code to 0 (Keypad). Press the [RUN] key on the keypad to start an operation, and the [STOP/RESET] key to end it.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	drv	Command source	Cmd Source*	0	Keypad	0–5	–
Displayed under DRV–06 on the LCD keypad.							

Terminal Block as a Command Input Device (Fwd/Rev Run Commands, 2-wire)

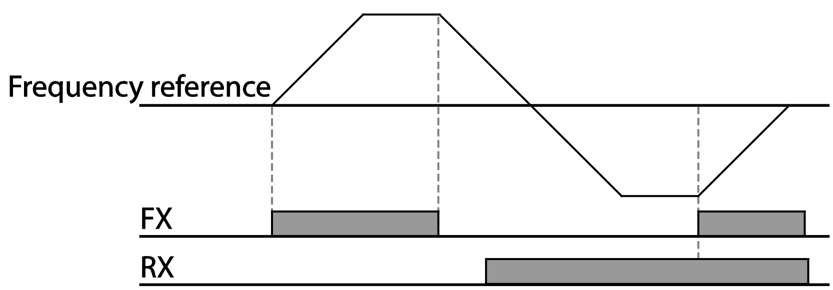
Multi–function terminals can be selected as a command input device. This is configured by setting the drv (command source) code in the Operation group to 1(Fx/Rx). Select 2 terminals for the forward and reverse operations, and then set the relevant codes (2 of the 5 multi–function terminal codes, In.65–69 for P1–P5) to 1(Fx) and 2(Rx) respectively. This application enables both terminals to be turned on or off at the same time, constituting a stop command that will cause the drive to stop operation.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	drv	Command source	Cmd Source*	1	Fx/Rx–1 (Fwd Run/Rev Run)	0–5	–
In	65–69	Px terminal configuration	Px Define(Px: P1– P5)	1	Fx	0–54	–
				2	Rx		

**Displayed under DRV–06 on the LCD keypad.*

<u>Fwd/Rev Command by Multi–function Terminal – Setting Details</u>

Pr. Code	Description
Operation group drv–Cmd Source	Set to 1(Fx/Rx–1 (Fwd Run/Rev Run)).
In.65–69 Px Define	Assign a terminal for forward (Fx) operation. Assign a terminal for reverse (Rx) operation.



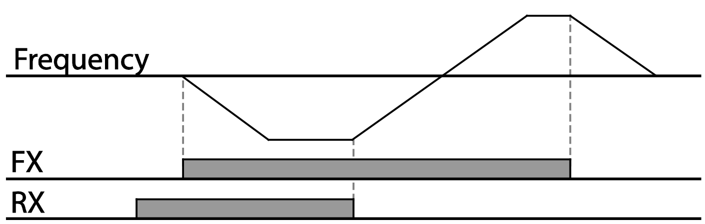
Terminal Block as a Command Input Device (Run and Rotation Direction Commands, 2-wire)

Multi–function terminals can be selected as a command input device. This is configured by setting the drv (command source) code in the Operation group to 2(Fx/Rx–2 (Run/Direction)). Select 2 terminals for run and rotation direction commands, and then select the relevant codes (2 of the 5 multi–function terminal codes, In.65–69 for P1–P5) to 1(Fx) and 2(Rx) respectively. This application uses an Fx input as a run command, and an Rx input to change a motor's rotation direction (On–Rx, Off–Fx).

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	Drv	Command source	Cmd Source*	2	Fx/Rx–2 (Run/ Direction)	0–5	–
In	65–69	Px terminal configuration	Px Define (Px: P1 – P5)	1	Fx	0–54	–
				2	Rx		
**Displayed under DRV–06 on the LCD keypad.*							

Run Command and Fwd/Rev Change Command Using Multi–function Terminal – Setting Details

Pr. Code	Description
Operation group drv Cmd Source	Set to 2(Fx/Rx–2 (Run/Direction)).
In.65–69 Px Define	Assign a terminal for run command (Fx). Assign a terminal for changing rotation direction (Rx).



RS–485 Communication as a Command Input Device

Internal RS–485 communication can be selected as a command input device by setting the drv (command source) code in the Operation group to 3(Int 485). This configuration uses upper level controllers such as PCs or PLCs to control the drive by transmitting and receiving signals via the S+, S–, and Sg terminals at the terminal block. For more details, refer to "Serial RS-485 Communication Features" on page 5–2.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	drv	Command source	Cmd Source*	3	Int 485	0–5	–
CM	01	Integrated communication drive ID	Int485 St ID	1		1–250	–
	02	Integrated communication protocol	Int485 Proto	0	ModBus RTU	0–2	–
	03	Integrated communication speed	Int485 BaudR	3	9600 bps	0–7	–
	04	Integrated communication frame setup	Int485 Mode	0	D8 / PN / S1	0–3	–
**Displayed under DRV–06 on the LCD keypad.*							

Local/Remote Mode Switching

Local/remote switching is useful for checking the operation of the drive or to perform an inspection while retaining all parameter values. Also, in an emergency, it can also be used to override control and operate the system manually using the keypad.

The [ESC] key is a programmable key that can be configured to carry out multiple functions. For more details, refer "Configuring the [ESC] Key" on page 3–9.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
dr	90	[ESC] key functions	–	2	Local/Remote	0–2	–
Operation	drv	Command source	Cmd Source*	1	Fx/Rx–1 (Fwd Run/ Rev Run)	0–5	–
Displayed under DRV–06 on the LCD keypad.							

Local/Remote Mode Switching Setting Details

Pr. Code	Description
dr.90 [ESC] key functions	Set dr.90 to 2(Local/Remote) to perform local/remote switching using the [ESC] key. Once the value is set, the drive will automatically begin operating in remote mode. Changing from local to remote will not alter any previously configured parameter values and the operation of the drive will not change. Press the [ESC] key to switch the operation mode back to "local." The SET light will flash, and the drive will operate using the [RUN] key on the keypad. Press the [ESC] key again to switch the operation mode back to "remote." The SET light will turn off and the drive will operate according to the previous drv code configuration.

NOTE:
Local/Remote Operation

- *Full control of the drive is available with the keypad during local operation (local operation).*
- *During local operation, jog commands will only work if one of the P1-P5 multi-function terminals (codes In.65-69) is set to 13(RUN Enable) and the relevant terminal is turned on.*
- *During remote operation (remote operation), the drive will operate according to the previously set frequency reference source and the command received from the input device.*
- *If Ad.10 (power-on run) is set to 0(No), the drive will NOT operate on power-on even when the following terminals are turned on:*
  - *-Fwd/Rev run (Fx/Rx) terminal*
  - *-Fwd/Rev jog terminal (Fwd jog/Rev Jog)*
  - *-Pre-Excitation terminal*
- *To operate the drive manually with the keypad, switch to local mode. Use caution when switching back to remote operation mode as the drive will stop operating. If Ad.10 (power-on run) is set to 0(No), a command through the input terminals will work ONLY AFTER all the terminals listed above have been turned off and then turned on again.*
- *If the drive has been reset to clear a fault trip during an operation, the drive will switch to local operation mode at power-on, and full control of the drive will be with the keypad. The drive will stop operating when operation mode is switched from "local" to "remote". In this case, a run command through an input terminal will work ONLY AFTER all the input terminals have been turned off.*

Drive Operation During Local/Remote Switching
Switching operation mode from "remote" to "local" while the drive is running will cause the drive to stop operating. Switching operation mode from "local" to "remote" however, will cause the drive to operate based on the command source:

- *Analog commands via terminal input: the drive will continue to run without interruption based on the command at the terminal block. If a reverse operation (Rx) signal is ON at the terminal block at startup, the drive will operate in the reverse direction even if it was running in the forward direction in local operation mode before the reset.*
- *Digital source commands: all command sources except terminal block command sources (which are analog sources) are digital command sources that include the keypad, LCD keypad, and communication sources. The drive stops operation when switching to remote operation mode, and then starts operation when the next command is given.*

WARNING: USE LOCAL/REMOTE OPERATION MODE SWITCHING ONLY WHEN IT IS NECESSARY. IMPROPER MODE SWITCHING MAY RESULT IN INTERRUPTION OF THE DRIVE'S OPERATION.

Forward or Reverse Run Prevention

The rotation direction of motors can be configured to run in only one direction. Pressing the [REV] key on the LCD keypad when direction prevention is configured, will cause the motor to decelerate to 0Hz and stop. The drive will remain on.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Ad	09	Run prevention options	Run Prevent	0	None	0–2	–
				1	Forward Prev		
				2	Reverse Prev		

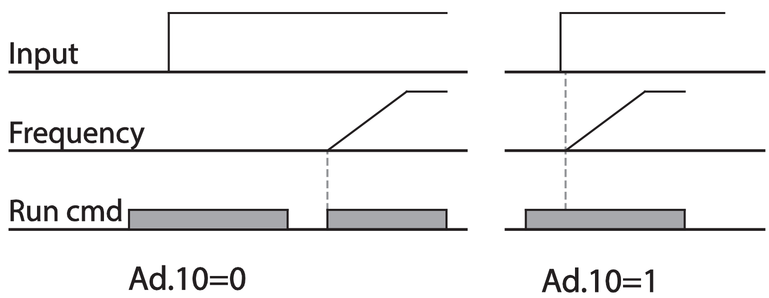
Forward/Reverse Run Prevention Setting Details

Pr. Code	Description		
Ad.9 Run Prevent	Choose a direction to prevent.		
	Setting		Description
	0	None	Do not set run prevention.
	1	Forward Prev	Set forward run prevention.
	2	Reverse Prev	Set reverse run prevention.

Power–on Run

A power–on command can be setup to start an drive operation after powering up, based on terminal block operation commands (if they have been configured). To enable power–on run set the drv (command source) code to 1(Fx/Rx–1 (Fwd Run/Rev Run)) or 2 (Fx/Rx–2 (Run/Direction)) in the Operation group.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	drv	Command source	Cmd Source*	1, 2	Fx/Rx–1 (Fwd Run/Rev Run) or Fx/Rx–2 (Run/ Direction)	0–5	–
Ad	10	Power–on run	Power–on Run	1	Yes	0–1	–
Displayed under DRV–06 on the LCD keypad.							



NOTE:
- *A fault trip may be triggered if the drive starts operation while a motor's load (fan-type load) is in free-run state. To prevent this from happening, set parameter Cn.71 (speed search options), Bit 4 = 1. The drive will perform a speed search at the beginning of the operation.*
- *If the speed search is not enabled, the drive will begin its operation in a normal V/F pattern and accelerate the motor. If the drive has been turned on without power-on run enabled, the terminal block command must first be turned off, and then turned on again to begin the drive's operation.*

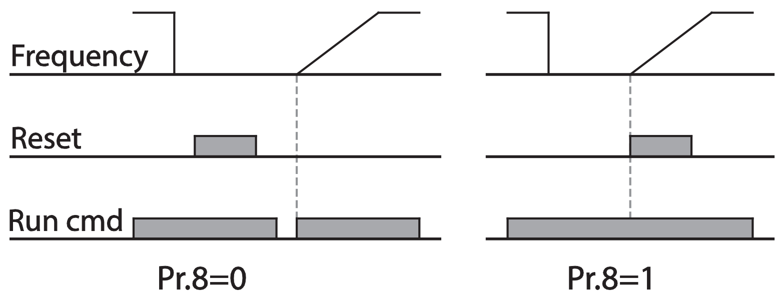
CAUTION: Use caution when operating the drive with Power–on Run enabled as the motor will begin rotating when the drive starts up.

Reset and Restart

Reset and restart operations can be setup for drive operation following a fault trip, based on the terminal block operation command (if it is configured). When a fault trip occurs, the drive cuts off the output and the motor will free–run. Another fault trip may be triggered if the drive begins its operation while motor load is in a free–run state.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	drv	Command source	Cmd Source*	1 2	Fx/Rx–1 (Fwd Run/Rev Run) or Fx/Rx–2 (Run/Direction)	0–5	–
Pr	08	Reset restart setup	RST Restart	1	Yes	0–1	–
	09	No. of auto restart	Retry Number	0	–	0–10	–
	10	Auto restart delay time	Retry Delay	1.0	–	0–60	sec

**Displayed under DRV–06 in an LCD keypad.*



NOTE:
- *To prevent a repeat fault trip from occurring, set Cn.71 (speed search options) bit 2 = 1. The drive will perform a speed search at the beginning of the operation.*
- *If the speed search is not enabled, the drive will start its operation in a normal V/F pattern and accelerate the motor. If the drive has been turned on without 'reset and restart' enabled, the terminal block command must be first turned off, and then turned on again to begin the drive's operation.*

CAUTION: Use caution when operating the drive with Power–on Run enabled as the motor will begin rotating when the drive starts up..

Setting Acceleration and Deceleration Times

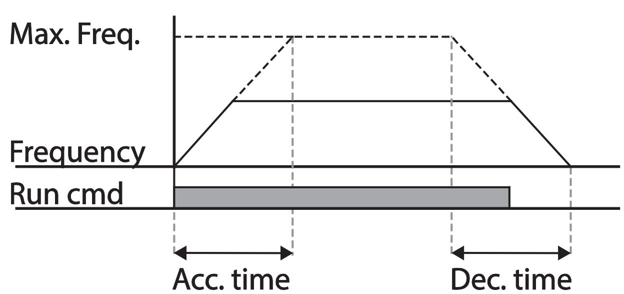
Acc/Dec Time Based on Maximum Frequency

Acc/Dec time values can be set based on maximum frequency, not on drive operation frequency. To set Acc/Dec time values based on maximum frequency, set bA.8 (Acc/Dec reference), = 0 (Max Freq).

Acceleration time set at the ACC (Acceleration time) code in the Operation group (dr.3 in an LCD keypad) refers to the time required for the drive to reach the maximum frequency from a stopped (0Hz) state. Likewise, the value set at the dEC (deceleration time) parameter in the Operation group (dr.4 in an LCD keypad) refers to the time required to return to a stopped state (0Hz) from the maximum frequency.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	ACC	Acceleration time	Acc Time	20.0		0.0–600.0	sec
	dEC	Deceleration time	Dec Time	30.0		0.0–600.0	sec
	20	Maximum frequency	Max Freq	60.00		40.00–400.00	Hz
bA	08	Acc/Dec reference frequency	Ramp T Mode	0	Max Freq	0–1	–
	09	Time scale	Time scale	1	0.1sec	0–2	–

Acc/Dec Time Based on Maximum Frequency – Setting Details

<table>
<tr><th>Pr. Code</th><th>Description</th></tr>
<tr><td>bA.8
Ramp T Mode</td><td>Set the parameter value to 0 (Max Freq) to setup Acc/Dec time based on maximum frequency.
<table><tr><td colspan="2">Configuration</td><td>Description</td></tr><tr><td>0</td><td>Max Freq</td><td>Set the Acc/Dec time based on maximum frequency.</td></tr><tr><td>1</td><td>Delta Freq</td><td>Set the Acc/Dec time based on operating frequency.</td></tr></table>
If, for example, maximum frequency is 60.00Hz, the Acc/Dec times are set to 5 seconds, and the frequency reference for operation is set at 30Hz (half of 60Hz), the time required to reach 30Hz therefore is 2.5 seconds (half of 5 seconds).

</td></tr>
<tr><td>bA.9 Time scale</td><td>Use the time scale for all time–related values. It is particularly useful when a more accurate Acc/Dec times are required because of load characteristics, or when the maximum time range needs to be extended.
<table><tr><td colspan="2">Configuration</td><td>Description</td></tr><tr><td>0</td><td>0.01sec</td><td>Sets 0.01 second as the minimum unit.</td></tr><tr><td>1</td><td>0.1sec</td><td>Sets 0.1 second as the minimum unit.</td></tr><tr><td>2</td><td>1sec</td><td>Sets 1 second as the minimum unit.</td></tr></table></td></tr>
</table>

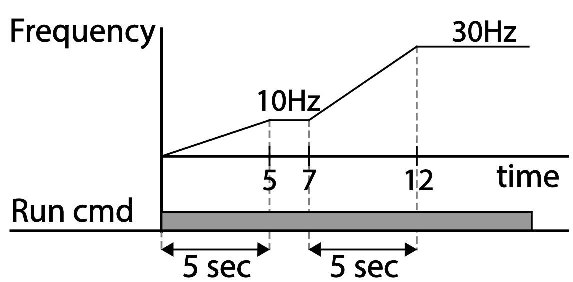
CAUTION: Note that the range of maximum time values may change automatically when the units are changed. If for example, the acceleration time is set at 6000 seconds, a time scale change from 1 second to 0.01 second will result in a modified acceleration time of 60.00 seconds.

Acc/Dec Time Based on Operation Frequency

Acc/Dec times can be set based on the time required to reach the next step frequency from the existing operation frequency. To set the Acc/Dec time values based on the existing operation frequency, set bA. 08 (acc/dec reference),= 1 (Delta Freq).

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	ACC	Acceleration time	Acc Time	20.0		0.0–600.0	sec
	dEC	Deceleration time	Dec Time	30.0		0.0–600.0	sec
bA	08	Acc/Dec reference	Ramp T Mode	1	Delta Freq	0–1	–

Acc/Dec Time Based on Operation Frequency – Setting Details

<table>
<tr><th>Pr. Code</th><th>Description</th></tr>
<tr><td>bA.8
Ramp T Mode</td><td>Set the parameter value to 1 (Delta Freq) to set Acc/Dec times based on Maximum frequency.
<table>
<tr><td colspan="2">Configuration</td><td>Description</td></tr>
<tr><td>0</td><td>Max Freq</td><td>Set the Acc/Dec time based on Maximum frequency</td></tr>
<tr><td>1</td><td>Delta Freq</td><td>Set the Acc/Dec time based on Operation Frequency</td></tr>
</table>


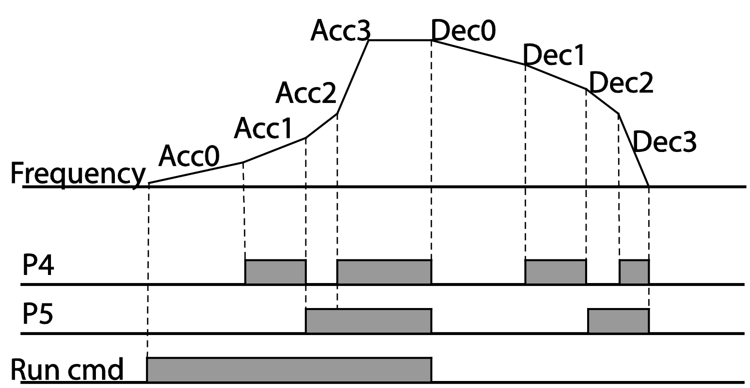
If Acc/Dec times are set to 5 seconds, and multiple frequency references are used in the operation in 2 steps, at 10Hz and 30 Hz, each acceleration stage will take 5 seconds (refer to the graph below).</td></tr>
</table>

Multi–step Acc/Dec Time Configuration

Acc/Dec times can be configured via a multi–function terminal by setting the ACC (acceleration time) and dEC (deceleration time) codes in the Operation group.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	ACC	Acceleration time	Acc Time	20.0		0.0–600.0	sec
	dEC	Deceleration time	Dec Time	30.0		0.0–600.0	sec
bA	70–82	Multi–step acceleration time1–7	Acc Time 1–7	x.xx		0.0–600.0	sec
	71–83	Multi–step deceleration time1–7	Dec Time 1–7	x.xx		0.0–600.0	sec
In	65–69	Px terminal configuration	Px Define (Px: P1–P5)	11	XCEL–L	0–54	–
				12	XCEL–M		
				49	XCEL–H		
	89	Multi–step command delay time	In Check Time	1		1–5000	ms

Acc/Dec Time Setup via Multi–function Terminals – Setting Details

<table>
<tr><th>Pr. Code</th><th colspan="3">Description</th></tr>
<tr><td>bA. 70–82 Acc Time 1–7</td><td colspan="3">Set multi–step acceleration time1–7.</td></tr>
<tr><td>bA.71–83 Dec Time 1–7</td><td colspan="3">Set multi–step deceleration time1–7.</td></tr>
<tr><td rowspan="11">In.65–69
Px Define (P1–P5)</td><td colspan="3">Choose and configure the terminals to use for multi–step Acc/Dec time inputs.</td></tr>
<tr><td colspan="2">Configuration</td><td>Description</td></tr>
<tr><td>11</td><td>XCEL–L</td><td>Acc/Dec command–L</td></tr>
<tr><td>12</td><td>XCEL–M</td><td>Acc/Dec command–M</td></tr>
<tr><td>49</td><td>XCEL–H</td><td>Acc/Dec command–H</td></tr>
<tr><td colspan="3">Acc/Dec commands are recognized as binary code inputs and will control the acceleration and deceleration based on parameter values set with bA.70–82 and bA.71–83.
If, for example, the P4 and P5 terminals are set as XCEL–L and XCEL-M respectively, the following operation will be available.
</td></tr>
<tr><td>Acc/Dec time</td><td>P5</td><td>P4</td></tr>
<tr><td>0</td><td>–</td><td>–</td></tr>
<tr><td>1</td><td>–</td><td>X</td></tr>
<tr><td>2</td><td>X</td><td>–</td></tr>
<tr><td>3</td><td>X</td><td>X</td></tr>
<tr><td>In.89 In Check Time</td><td colspan="3">Set the time for the drive to check for other terminal block inputs. If In.89 is set to 100ms and a signal is supplied to the P4 terminal, the drive searches for other inputs over the next 100ms. When the time expires, the Acc/Dec time will be set based on the input received at P4.</td></tr>
</table>

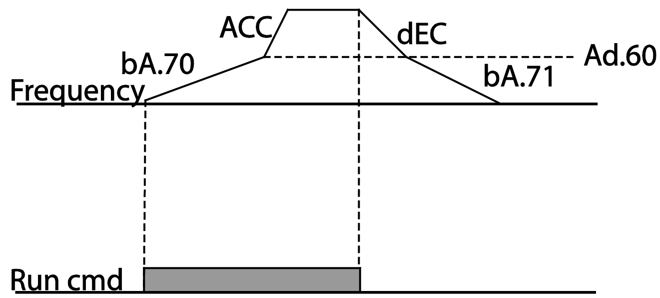
Configuring Acc/Dec Time Switch Frequency

You can switch between two different sets of Acc/Dec times (Acc/Dec gradients) by configuring the switch frequency without configuring the multi–function terminals.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
Operation	ACC	Acceleration time	Acc Time	10.0	0.0–600.0	sec
	dEC	Deceleration time	Dec Time	10.0	0.0–600.0	sec
bA	70	Multi–step acceleration time1	Acc Time–1	20.0	0.0–600.0	sec
	71	Multi–step deceleration time1	Dec Time–1	20.0	0.0–600.0	sec
Ad	60	Acc/Dec time switch frequency	Xcel Change Frq	30.00	0–Maximum frequency	Hz

Acc/Dec Time Switch Frequency Setting Details

Pr. Code	Description
Ad.60 ***Xcel Change Fr***	After the Acc/Dec switch frequency has been set, Acc/Dec gradients configured at bA.70 and 71 will be used when the drive's operation frequency is at or below the switch frequency. If the operation frequency exceeds the switch frequency, the configured gradient level, configured for the ACC and dEC codes, will be used. If you configure the P1–P5 multi–function input terminals for multi–step Acc/Dec gradients (XCEL–L, XCEL–M, XCEL–H), the drive will operate based on the Acc/Dec inputs at the terminals instead of the Acc/Dec switch frequency configurations.



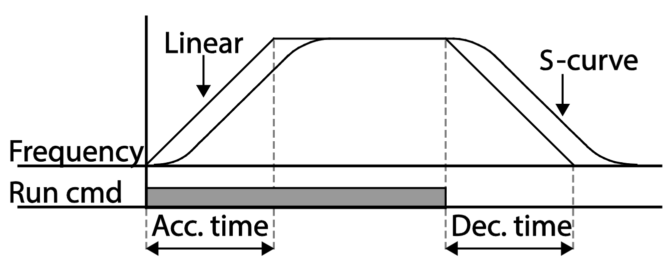
Acc/Dec Pattern Configuration

Acc/Dec gradient level patterns can be configured to enhance and smooth the drive's acceleration and deceleration curves. Linear pattern features a linear increase or decrease to the output frequency, at a fixed rate. For an S–curve pattern a smoother and more gradual increase or decrease of output frequency, ideal for lift–type loads or elevator doors, etc. S–curve gradient level can be adjusted using codes Ad. 03–06 in the Advanced group.

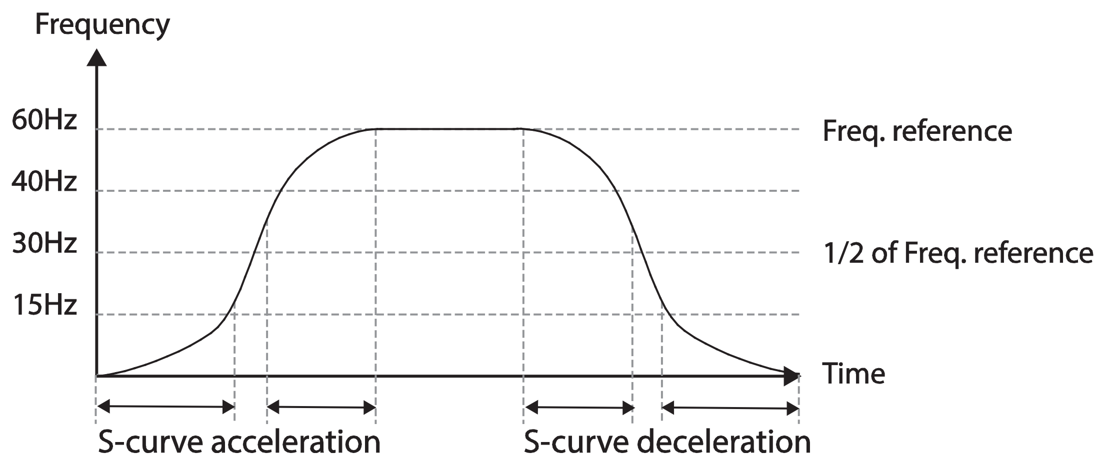
Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
bA	08	Acc/Dec reference	Ramp T mode	0	Max Freq	0–1	–
Ad	01	Acceleration pattern	Acc Pattern	0	Linear	0–1	–
	02	Deceleration pattern	Dec Pattern	1	S–curve		–
	03	S–curve Acc start gradient	Acc S Start	40		1–100	%
	04	S–curve Acc end gradient	Acc S End	40		1–100	%
	05	S–curve Dec start gradient	Dec S Start	40		1–100	%
	06	S–curve Dec end gradient	Dec S End	40		1–100	%

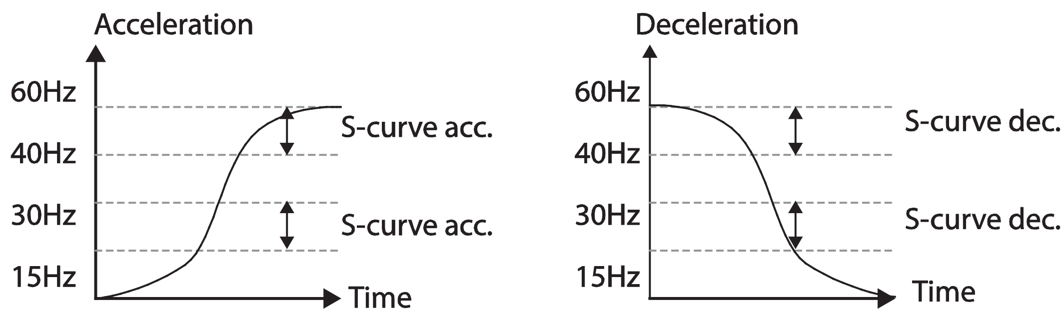
Acc/Dec Pattern Setting Details

Pr. Code	Description
Ad.3 Acc S Start	Sets the gradient level as acceleration starts when using an S–curve, Acc/Dec pattern. Ad. 03 defines S–curve gradient level as a percentage, up to half of total acceleration. If the frequency reference and maximum frequency are set at 60Hz and Ad.3 is set to 50%, Ad. 03 configures acceleration up to 30Hz (half of 60Hz).The drive will operate S–curve acceleration in the 0–15 Hz frequency range (50% of 30Hz). Linear acceleration will be applied to the remaining acceleration within the 15–30 Hz frequency range.
Ad.4 Acc S End	Sets the gradient level as acceleration ends when using an S–curve Acc/Dec pattern. Ad. 03 defines S–curve gradient level as a percentage, above half of total acceleration. If the frequency reference and the maximum frequency are set at 60Hz and Ad.4 is set to 50%, setting Ad. 04 configures acceleration to increase from 30Hz (half of 60Hz) to 60Hz (end of acceleration). Linear acceleration will be applied within the 30–45 Hz frequency range. The drive will perform an S–curve acceleration for the remaining acceleration in the 45–60 Hz frequency range.
Ad.5 Dec S Start – Ad.6 Dec S End	Sets the rate of S–curve deceleration. Configuration for codes Ad.5 and Ad.6 may be performed the same way as configuring codes Ad.3 and Ad.4.



Acceleration / deceleration pattern configuration





Acceleration / deceleration S–curve pattern configuration

NOTE:
The Actual Acc/Dec time during an S-curve application:

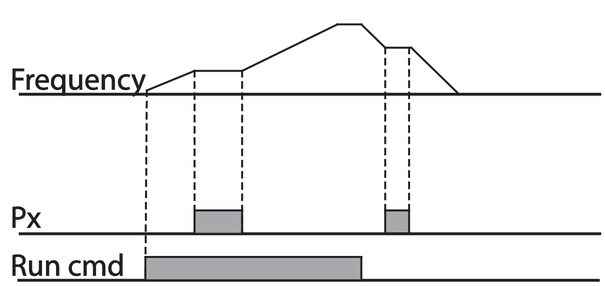
- *Actual acceleration time = user-configured acceleration time + user-configured acceleration time x starting gradient level/2 + user-configured acceleration time x ending gradient level/2.*
- *Actual deceleration time = user-configured deceleration time + user-configured deceleration time x starting gradient level/2 + user-configured deceleration time x ending gradient level/2*

CAUTION: Note that actual Acc/Dec times become greater than user defined Acc/Dec times when S–curve Acc/Dec patterns are in use.

Stopping the Acc/Dec Operation

Configure the multi–function input terminals to stop acceleration or deceleration and operate the drive at a fixed frequency.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
In	65–69	Px terminal configuration	Px Define(Px: P1– P5)	25	XCEL Stop	0–54	–



V/F (Voltage/Frequency) Control

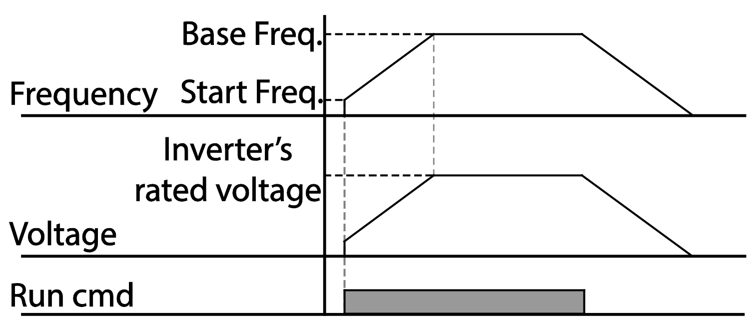
Configure the drive's output voltages, gradient levels and output patterns to achieve a target output frequency with V/F control. The amount of torque boost used during low frequency operations can also be adjusted.

Linear V/F Pattern Operation

A linear V/F pattern configures the drive to increase or decrease the output voltage at a fixed rate for different operation frequencies based on V/F characteristics. A linear V/F pattern is particularly useful when a constant torque load is applied.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
dr	09	Control mode	Control Mode	0	V/F	0–4	–
	18	Base frequency	Base Freq	60.00		30.00–400.00	Hz
	19	Start frequency	Start Freq	0.50		0.01–10.00	Hz
bA	07	V/F pattern	V/F Pattern	0	Linear	0–3	–
In	65–67	Px terminal configuration	Px terminal configuration	34	Pre Excitation	0–54	–

Linear V/F Pattern Setting Details

Pr. Code	Description
dr.18 Base Freq	Sets the base frequency. A base frequency is the drive's output frequency when running at its rated voltage. Refer to the motor's rating plate to set this parameter value.
dr.19 Start Freq	Sets the start frequency. A start frequency is a frequency at which the drive starts voltage output. The drive does not produce output voltage while the frequency reference is lower than the set frequency. However, if a deceleration stop is made while operating above the start frequency, output voltage will continue until the operation frequency reaches a full–stop (0Hz). 

Pre Excitation in V/F Mode

Pre-excitation allows current to flow to the stator coil to energize the motor flux before the start command. Cn.09 and Cn.10 control pre-exciation and are automatically active in Sensorless Vector control mode. The Pre-excitation of the motor can be configured in V/F mode with the use of the mulitfunction input parameter. Set any MF input In.65-69 to 34- Pre-Excite. When the bit is energized, Cn.9 and Cn.10 parameters will be used. See sensorless vector control mode for more information on pre-excitation.

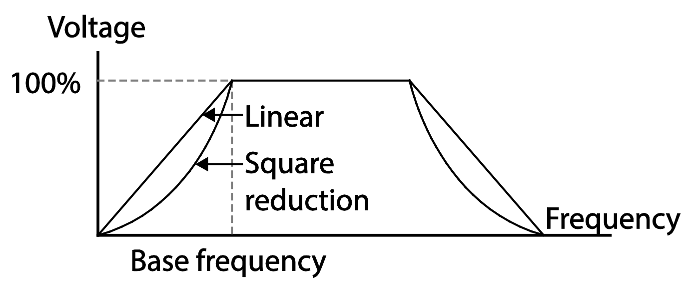
Square Reduction V/F pattern Operation

Square reduction V/F pattern is ideal for loads such as fans and pumps. It provides non–linear acceleration and deceleration patterns to sustain torque throughout the whole frequency range.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
bA	07	V/F pattern	V/F Pattern	1	Square	0–3	–
				3	Square2		

Square Reduction V/F pattern Operation – Setting Details

Pr. Code	Description		
bA.7 V/F Pattern	Sets the parameter value to 1(Square) or 3(Square2) according to the load's start characteristics.		
	Setting		Function
	1	Square	The drive produces output voltage proportional to 1.5 square of the operation frequency.
	3	Square2	The drive produces output voltage proportional to 2 square of the operation frequency. This setup is ideal for variable torque loads such as fans or pumps.



User V/F Pattern Operation

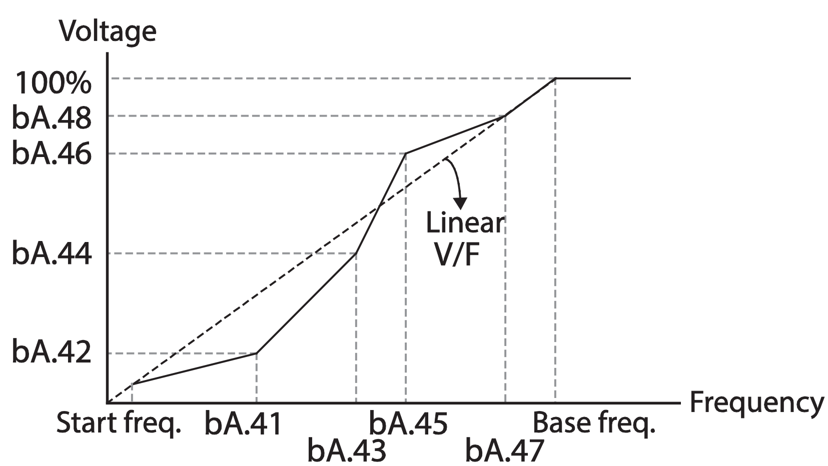
The ACN drive allows the configuration of user–defined V/F patterns to suit the load characteristics of special motors.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
bA	07	V/F pattern	V/F Pattern	2	User V/F	0–3	–
	41	User Frequency1	User Freq 1	15.00		0–Maximum frequency	Hz
	42	User Voltage1	User Volt 1	25		0–100	%
	43	User Frequency2	User Freq 2	30.00		0–Maximum frequency	Hz
	44	User Voltage2	User Volt 2	50		0–100	%
	45	User Frequency3	User Freq 3	45.00		0–Maximum frequency	Hz
	46	User Voltage3	User Volt 3	75		0–100	%
	47	User Frequency4	User Freq 4	Maximum frequency		0–Maximum frequency	Hz
	48	User Voltage4	User Volt 4	100		0–100%	%

<u>*User V/F pattern Setting Details*</u>

Pr. Code	Description
bA.41 User Freq 1– bA.48 User Volt 4	Set the parameter values to assign arbitrary frequencies (User Freq 1–4) for start and maximum frequencies. Voltages can also be set to correspond with each frequency, and for each user voltage (User Volt 1–4).

The 100% output voltage in the figure below is based on the parameter settings of bA.15 (motor rated voltage). If bA.15 is set to 0 it will be based on the input voltage.



CAUTION: When a normal induction motor is in use, care must be taken not to configure the output pattern away from a linear V/F pattern. Non–linear V/F patterns may cause insufficient motor torque or motor overheating due to over–excitation.
When a user V/F pattern is in use, forward torque boost (dr.16) and reverse torque boost (dr.17) do not operate.

Torque Boost

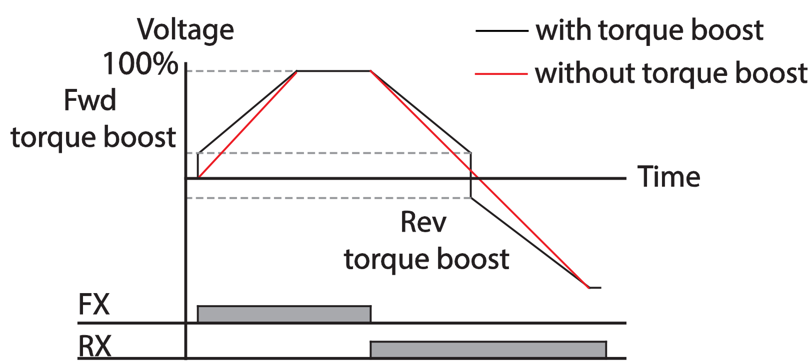
Manual Torque Boost

Manual torque boost enables users to adjust output voltage during low speed operation or motor start. Increase low speed torque or improve motor starting properties by manually increasing output voltage. Configure manual torque boost while running loads that require high starting torque, such as lift–type loads.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
dr	15	Torque boost options	Torque Boost	0	Manual	0–1	–
	16	Forward torque boost	Fwd Boost	2.0		0.0–15.0	%
	17	Reverse torque boost	Rev Boost	2.0		0.0–15.0	%

Manual Torque Boost Setting Details

Pr. Code	Description
dr.16 Fwd Boost	Set torque boost for forward operation.
dr.17 Rev Boost	Set torque boost for reverse operation.



CAUTION: Excessive torque boost will result in over–excitation and motor overheating

Auto Torque Boost–1

Auto torque boost enables the drive to automatically calculate the amount of output voltage required for torque boost based on the entered motor parameters. Because auto torque boost requires motor–related parameters such as stator resistance, inductance, and no–load current, auto tuning (bA.20) has to be performed before auto torque boost can be configured ("Auto Tuning" on page 4–145). Similarly to manual torque boost, configure auto torque boost while running a load that requires high starting torque, such as lift–type loads.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
dr	15	Torque boost mode	Torque Boost	1	Auto1	0–2	–
bA	20	Auto tuning	Auto Tuning	3	Rs+Lsigma	0–6	–

Auto Torque Boost–2

In V/F operation, this adjusts the output voltage if operation is unavailable due to a low output voltage. It is used when operation is unavailable, due to a lack of starting torque, by providing a voltage boost to the output voltage via the torque current.

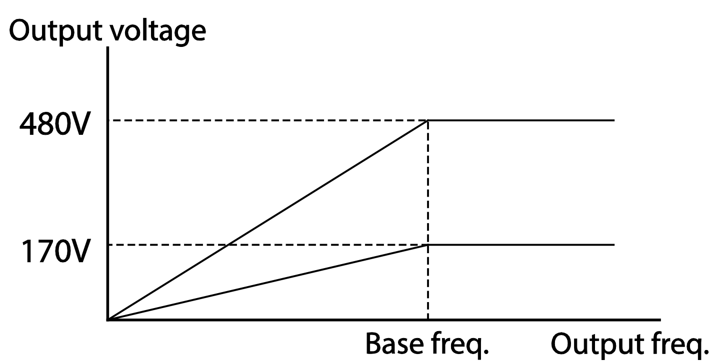
Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
dr	15	Torque boost mode	Torque Boost	2	Auto2	0–2	–

Output Voltage Setting

Output voltage settings are required when a motor's rated voltage differs from the input voltage to the drive. Set bA.15 to configure the motor's rated operating voltage. The set voltage becomes the output voltage of the drive's base frequency. When the drive operates above the base frequency, and when the motor's voltage rating is lower than the input voltage at the drive, the drive adjusts the voltage and supplies the motor with the voltage set at bA.15 (motor rated voltage). If the motor's rated voltage is higher than the input voltage at the drive, the drive will supply the drive input voltage to the motor.

If bA.15 (motor rated voltage) is set to 0, the drive corrects the output voltage based on the input voltage in the stopped condition. If the frequency is higher than the base frequency, when the input voltage is lower than the parameter setting, the input voltage will be the drive output voltage.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
bA	15	Motor rated voltage	Rated Volt	0	0, 170–480	V



Start Mode Setting

Select the start mode to use when the operation command is input with the motor in the stopped condition.

Acceleration Start

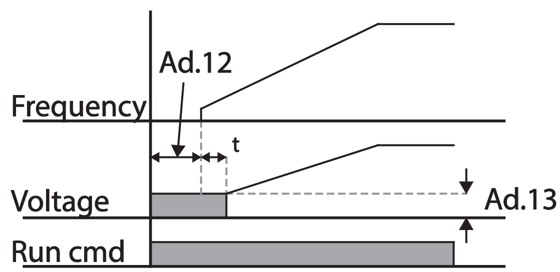
Acceleration start is a general acceleration mode. If there are no extra settings applied, the motor accelerates directly to the frequency reference when the command is input.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Ad	07	Start mode	Start mode	0	Acc	0–1	–

Start After DC Braking

This start mode supplies a DC voltage for a set amount of time to provide DC braking before the drive starts to accelerate a motor. If the motor continues to rotate due to its inertia, DC braking will stop the motor, allowing the motor to accelerate from a stopped condition. DC braking can also be used with a mechanical brake connected to a motor shaft when a constant torque load is applied, if a constant torque is required after the mechanical brake is released.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Ad	07	Start mode	Start Mode	1	DC–Start	0–1	–
	12	Start DC braking time	DC–Start Time	0.00		0.00–60.00	sec
	13	DC Injection Level	DC Inj Level	50		0–200	%



CAUTION: The amount of DC braking required is based on the motor's rated current. Do not use DC braking resistance values that can cause current draw to exceed the rated current of the drive. If the DC braking resistance is too high or brake time is too long, the motor may overheat or be damaged.

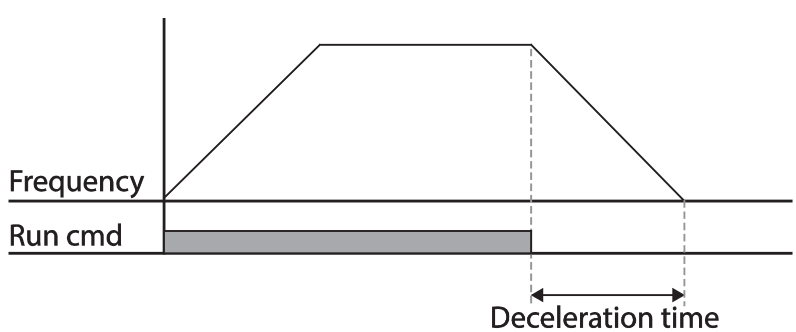
Stop Mode Setting

Select a stop mode to stop the drive operation.

Deceleration Stop

Deceleration stop is a general stop mode. If there are no extra settings applied, the motor decelerates down to 0Hz and stops, as shown in the figure below.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Ad	08	Stop mode	Stop Mode	0	Dec	0–4	–



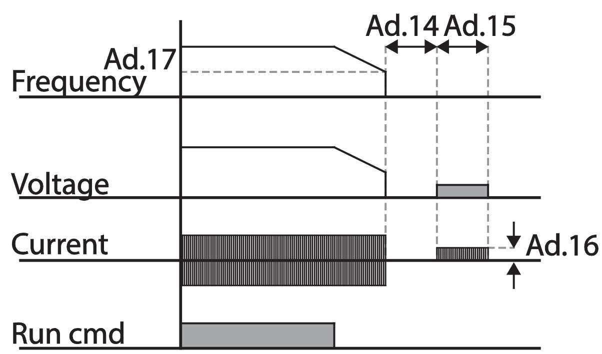
Stop After DC Braking

When the operation frequency reaches the set value during deceleration (DC braking frequency), the drive stops the motor by supplying DC power to the motor. With a stop command input, the drive begins decelerating the motor. When the frequency reaches the DC braking frequency set at Ad.17, the drive supplies DC voltage to the motor and stops it.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Ad	08	Stop mode	Stop Mode	0	Dec	0–4	–
	14	Output block time before braking	DC–Block Time	0.10		0.00–60.00	sec
	15	DC braking time	DC–Brake Time	1.00		0–60	sec
	16	DC braking amount	DC–Brake Level	50		0–200	%
	17	DC braking frequency	DC–Brake Freq	5.00		0.00–60.00	Hz

DC Braking After Stop Setting Details

Pr. Code	Description
Ad.14 DC–Block Time	Set the time to block the drive output before DC braking. If the inertia of the load is great, or if DC braking frequency (Ad.17) is set too high, a fault trip may occur due to overcurrent conditions when the drive supplies DC voltage to the motor. Prevent overcurrent fault trips by adjusting the output block time before DC braking.
Ad.15 DC–Brake Time	Set the time duration for the DC voltage supply to the motor.
Ad.16 DC–Brake Level	Set the amount of DC braking to apply. The parameter setting is based on the rated current of the motor.
Ad.17 DC–Brake Freq	Set the frequency to start DC braking. When the frequency is reached, the drive starts deceleration. If the dwell frequency is set lower than the DC braking frequency, dwell operation will not work and DC braking will start instead.

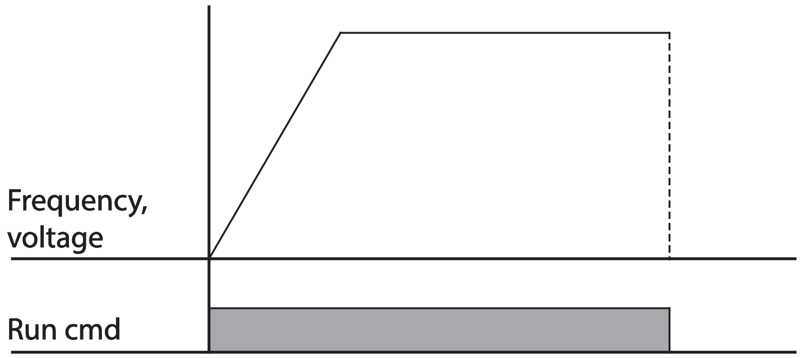


CAUTION: Note that the motor can overheat or be damaged if excessive amount of DC braking is applied to the motor, or DC braking time is set too long.
DC braking is configured based on the motor's rated current. To prevent overheating or damaging motors, do not set the current value higher than the drive's rated current.

Free Run Stop

When the Operation command is off, the drive output turns off, and the load stops due to residual inertia.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Ad	08	Stop Method	Stop Mode	2	Free–Run	0–4	–



CAUTION: Note that when there is high inertia on the output side and the motor is operating at high speed, the load's inertia will cause the motor to continue rotating even if the drive output is blocked.

Power Braking

When the drive's DC voltage rises above a specified level due to motor regenerated energy, a control is made to either adjust the deceleration gradient level or reaccelerate the motor in order to reduce the regenerated energy. Power braking can be used when short deceleration times are needed without brake resistors, or when optimum deceleration is needed without causing an over voltage fault trip.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Ad	08	Stop mode	Stop Mode	4	Power Braking	0–4	–

CAUTION:
- *To prevent overheating or damaging the motor, do not apply power braking to the loads that require frequent deceleration.*
- *Stall prevention and power braking only operate during deceleration, and power braking takes priority over stall prevention. In other words, when both Pr.50 (stall prevention and flux braking) and Ad.8 (power braking) are set, power braking will take precedence and operate.*
- *Note that if deceleration time is too short or inertia of the load is too great, an overvoltage fault trip may occur.*
- *Note that if a free run stop is used, the actual deceleration time can be longer than the pre–set deceleration time.*

Frequency Limit

Operation frequency can be limited by setting maximum frequency, start frequency, upper limit frequency and lower limit frequency.

Frequency Limit Using Maximum Frequency and Start Frequency

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
dr	19	Start frequency	Start Freq	0.50	0.01–10.00	Hz
	20	Maximum frequency	Max Freq	60.00	40.00–400.00	Hz

Frequency Limit Using Maximum Frequency and Start Frequency – Setting Details

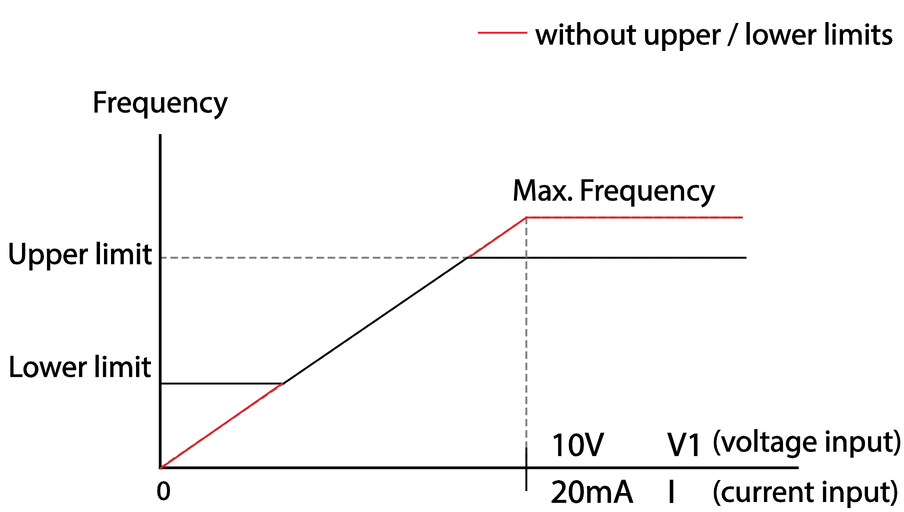
Pr. Code	Description
dr.19 Start Freq	Set the lower limit value for speed unit parameters that are expressed in Hz or rpm. If an input frequency is lower than the start frequency, the parameter value will be 0.00.
dr.20 Max Freq	Set an upper limit frequency to all speed unit parameters that are expressed in Hz or rpm, except for the base frequency (dr.18). Frequency cannot be set higher than the upper limit frequency.

Frequency Limit Using Upper and Lower Limit Frequency Values

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
Ad	24	Frequency limit	Freq Limit	0 No	0–1	–
	25	Frequency lower limit value	Freq Limit Lo	0.50	0.0–maximum frequency	Hz
	26	Frequency upper limit value	Freq Limit Hi	Maximum frequency	minimum–maximum frequency	Hz

Frequency Limit Using Upper and Lower Limit Frequencies – Setting Details

Pr. Code	Description
Ad.24 Freq Limit	The initial setting is 0(No). Changing the setting to 1(Yes) allows the setting of frequencies between the lower limit frequency (Ad.25) and the upper limit frequency (Ad.26). When the setting is 0(No), codes Ad.25 and Ad.26 are not visible.
Ad.25 Freq Limit Lo, Ad.26 Freq Limit Hi	Set upper and lower frequency limits. All frequency selections are restricted to frequencies from within the upper and lower limits. This restriction also applies when you in input a frequency reference using the keypad.

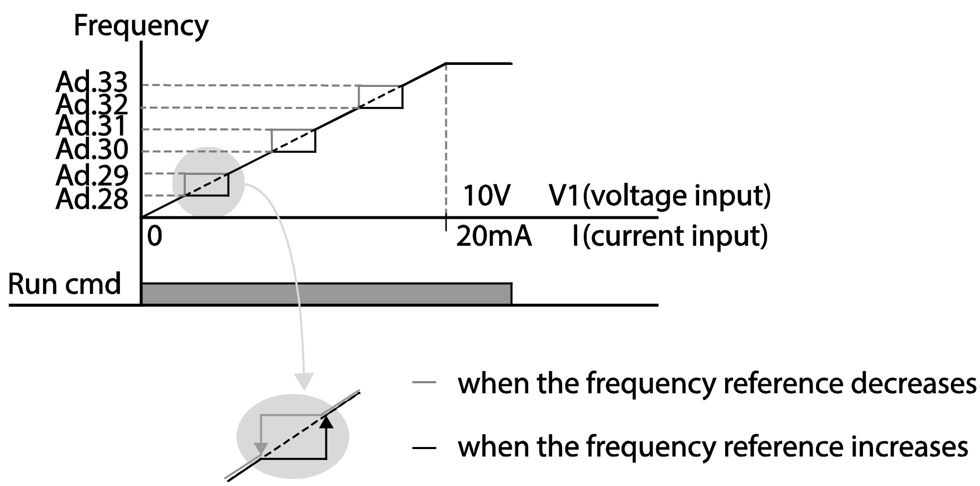


Frequency Jump

Use frequency jump to avoid mechanical resonance frequencies. Jump through frequency bands when a motor accelerates and decelerates. Operation frequencies cannot be set within the pre–set frequency jump band.

When a frequency setting is increased, while the frequency parameter setting value (voltage, current, RS–485 communication, keypad setting, etc.) is within a jump frequency band, the frequency will be maintained at the lower limit value of the frequency band. Then, the frequency will increase when the frequency parameter setting exceeds the range of frequencies used by the frequency jump band.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Ad	27	Frequency jump	Jump Freq	0	No	0–1	–
	28	Jump frequency lower limit1	Jump Lo 1	10.00		0.00–Jump frequency upper limit 1	Hz
	29	Jump frequency upper limit1	Jump Hi 1	15.00		Jump frequency lower limit 1–Maximum frequency	Hz
	30	Jump frequency lower limit 2	Jump Lo 2	20.00		0.00–Jump frequency upper limit 2	Hz
	31	Jump frequency upper limit 2	Jump Hi 2	25.00		Jump frequency lower limit 2–Maximum frequency	Hz
	32	Jump frequency lower limit 3	Jump Lo 3	30.00		0.00–Jump frequency upper limit 3	Hz
	33	Jump frequency upper limit 3	Jump Hi 3	35.00		Jump frequency lower limit 3–Maximum frequency	Hz



2nd Operation Mode Setting

Apply two types of operation modes and switch between them as required. For both the first and second command source, set the frequency after shifting operation commands to the multi–function input terminal. Mode switching can be used to stop remote control during an operation using the communication option and to switch operation mode to operate via the local panel, or to operate the drive from another remote control location.

Select one of the multi–function terminals from codes In. 65–69 and set the parameter value to 15 (2nd Source).

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	drv	Command source	Cmd Source*	1	Fx/Rx–1 (Fwd Run/Rev Run)	0–5	–
	Frq	Frequency reference source	Freq Ref Src	2	V1	0–12	–
bA	04	2nd Command source	Cmd 2nd Src	0	Keypad	0–4	–
	05	2nd Frequency reference source	Freq 2nd Src	0	Keypad–1	0–12	–
In	65–69	Px terminal configuration	Px Define (Px: P1–P5)	15	2nd Source	0–54	–
Displayed under DRV–06 in an LCD keypad.							

<u>*2nd Operation Mode Setting Details*</u>

Pr. Code	Description
bA.4 Cmd 2nd Src ***bA.5 Freq 2nd Src***	If signals are provided to the multi–function terminal set as the 2nd command source (2nd Source), the operation can be performed using the set values from bA.4–05 instead of the set values from the drv and Frq codes in the Operation group. The 2nd command source settings cannot be changed while operating with the 1st command source (Main Source).

CAUTION:
- *When setting the multi–function terminal to the 2nd command source (2nd Source) and input (On) the signal, operation state is changed because the frequency setting and the Operation command will be changed to the 2nd command. Before shifting input to the multi–function terminal, ensure that the 2nd command is correctly set. Note that if the deceleration time is too short or inertia of the load is too high, an overvoltage fault trip may occur.*
- *Depending on the parameter settings, the drive may stop operating when you switch the command modes.*

Multi–function Input Terminal Control

Filter time constants and the type of multi–function input terminals can be configured to improve the response of input terminals

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
In	85	Multi–function input terminal On filter	DI On Delay	10	0–10000	ms
	86	Multi–function input terminal Off filter	DI Off Delay	3	0–10000	ms
	87	Multi–function input terminal selection	DI NC/NO Sel	0 0000*	–	–
	90	Multi–function input terminal status	DI Status	0 0000*	–	–

**See "Bit Selection" on page 4–3 for details*

Multi–function Input Terminal Control Setting Details

Pr. Code	Description
In.84 DI Delay Sel	Select whether or not to activate the time values set at In.85 and In.86. If deactivated, the time values are set to the default values at In.85 and In.86. If activated, the set time values at In.85 and In.86 are set to the corresponding terminals. See "Bit Selection" on page 4–3 for details
In.85 DI On Delay, In.86 DI Off Delay	If the input terminal's state is not changed during the set time, when the terminal receives an input, it is recognized as On or Off.
In.87 DI NC/NO Sel	Select terminal contact types for each input terminal. The position of the indicator light corresponds to the segment that is on as shown in the table below. With the bottom segment on, it indicates that the terminal is configured as a A terminal (Normally Open) contact. With the top segment on, it indicates that the terminal is configured as a B terminal (Normally Closed) contact. Terminals are numbered P1–P5, from right to left. See "Bit Selection" on page 4–3 for details
In.90 DI Status	Display the configuration of each contact. When a segment is configured as Normally Open (A) terminal using In.87, the On condition is indicated by the top segment turning on. The Off condition is indicated when the bottom segment is turned on. When contacts are configured as Normally Closed (B) terminals, the segment lights behave conversely. Terminals are numbered P1–P5, from right to left. See "Bit Selection" on page 4–3 for details. If using Extension IO card, use the Left arrow key on the keypad to display the status of P8, P9 and P10.

P2P Setting

The P2P function is used to share input and output devices between multiple drives. To enable P2P setting, RS–485 communication must be turned on.

Drives connected through P2P communication are designated as either a master or slaves. The Master drive controls the input and output of slave drives. Slave drives provide input and output actions. When using the multi–function output, a slave drive can select to use either the master drive's output or its own output. When using P2P communication, first designate the slave drive and then the master drive. If the master drive is designated first, connected drives may interpret the condition as a loss of communication.

Master Parameter

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
CM	95	P2P Communication selection	Int 485 Func	1	P2P Master	0–3	–
US	80	Analog input1	P2P In V1	0		0–12, 000	%
	81	Analog input2	P2P In I2	0		–12, 000–12, 000	%
	82	Digital input	P2P In DI	0		0–0x7F	bit
	85	Analog output	P2P Out AO1	0		0–10, 000	%
	88	Digital output	P2P Out DO	0		0–0x03	bit

Slave Parameter

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
CM	95	P2P Communication selection	Int 485 Func	2	P2P Slave	0–3	–
	96	DO setting (P2P Out) selection	P2P OUT Sel	0	No	0–2	bit

P2P Setting Details

Pr. Code	Description
CM.95 Int 485 Func	Set master drive to 1(P2P Master), slave drive to 2(P2P Slave).
US.80–82 P2P Input Data	Input data sent from the slave drive.
US.85, 88 P2P Output Data	Output data transmitted to the slave drive.

CAUTION: Set the user sequence functions to use P2P features.

Multi–keypad Setting

Use multi–keypad settings to control more than one drive with one keypad. To use this function, first configure RS–485 communication.

The group of drives to be controlled by the keypad will include a master drive. The master drive monitors the other drives, and slave drive responds to the master drive's input. When using multi–function output, a slave drive can select to use either the master drive's output or its own output. When using the multi keypad, first designate the slave drive and then the master drive. If the master drive is designated first, connected drives may interpret the condition as a loss of communication.

Master Parameter

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
CM	95	P2P Communication selection	Int 485 Func	3	KPD–Ready	0–3	–
CNF	03	Multi–keypad ID	Multi KPD ID	3		3–99	–
	42	Multi–function key selection	Multi Key Sel	4	Multi KPD	0–4	–

Slave Parameter

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
CM	01	Station ID	Int485 St ID	3		3–99	–
	95	P2P communication options	Int 485 Func	3	KPD–Ready	0–3	–

Multi–keypad Setting Details

Pr. Code	Description
CM.01 Int485 St ID	Prevents conflict by designating a unique identification value to an drive. Values can be selected from numbers between 3–99.
CM.95 Int 485 Func	Set the value to 3(KPD–Ready) for both master and slave drive
CNF.03 Multi KPD ID	Select an drive to monitor from the group of drives.
CNF.42 Multi key Sel	Select a multi–function key type 4(Multi KPD)

CAUTION:

- *The multi–keypad feature will not work when the multi–keypad ID (CNF.03 Multi–KPD ID) setting is identical to the RS–485 communication station ID (CM.1 Int485 st ID) setting.*
- *The master/slave setting cannot be changed while the drive is operating in slave mode.*

User Sequence Setting

User Sequence allows custom programming to provide advanced control of the ACN series drive and the surrounding equipment. It can be used to provide simple diagnostics such as counting the number of times an input is received, or for more advanced control such as command frequency changes based on timers or other conditions. User Sequence creates a simple sequence from a combination of different function blocks. The sequence can comprise of a maximum of 18 steps using 29 function blocks and 30 void parameters.

User sequence can be programmed in 2 ways:

1) **Drive Keypad**: Entering the values in each parameter via the drive keypad.
2) **Using VFD Suite software**: See Chapter 7 for more information on User Sequence Windows based programming.

1 Loop refers to a single execution of a user configured sequence that contains a maximum of 18 steps. Users can select a Loop Time of between 10–1,000ms.

The codes for user sequences configuration can be found in the US group (for user sequence settings) and the UF group (for function block settings).

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
AP	02	User sequence activation	User Seq En	0	0–1	–
US	01	User sequence operation command	User Seq Con	0	0–2	–
	02	User sequence operation time	User Loop Time	0	0–5	–
	11–28	Output address link1–18	Link UserOut1–18	0	0–0xFFFF	–
	31–60	Input value setting1–30	Void Para1–30	0	–9999–9999	–
	80	Analog input 1	P2P In V1(–10–10 V)	0	0–12, 000	%
	81	Analog input 2	P2P In I2	0	–12, 000	%
	82	Digital input	P2P In D	0	–12, 000	bit
	85	Analog output	P2P Out AO1	0	0–0x7F	%
	89	Digital output	P2P Out DO	0	0–0x03	bit

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
UF	01	User function 1	User Func1	0	0–28	–
	02	User function input 1–A	User Input 1–A	0	0–0xFFFF	–
	03	User function input 1–B	User Input 1–B	0	0–0xFFFF	–
	04	User function input 1–C	User Input 1–C	0	0–0xFFFF	–
	05	User function output 1	User Output 1	0	–32767–32767	–
	06	User function 2	User Func2	0	0–28	–
	07	User function input 2–A	User Input 2–A	0	0–0xFFFF	–
	08	User function input 2–B	User Input 2–B	0	0–0xFFFF	–
	09	User function input 2–C	User Input 2–C	0	0–0xFFFF	–
	10	User function output 2	User Output 2	0	–32767–32767	–
	11	User function 3	User Func3	0	0–28	–
	12	User function input 3–A	User Input 3–A	0	0–0xFFFF	–
	13	User function input 3–B	User Input 3–B	0	0–0xFFFF	–
	14	User function input 3–C	User Input 3–C	0	0–0xFFFF	–
	15	User function output 3	User Output 3	0	–32767–32767	–
	16	User function 4	User Func4	0	0–28	–
	17	User function input 4–A	User Input 4–A	0	0–0xFFFF	–
	18	User function input 4–B	User Input 4–B	0	0–0xFFFF	–

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
UF	19	User function input 4–C	User Input 4–C	0	0–0xFFFF	–
	20	User function output 4	User Output 4	0	–32767–32767	–
	21	User function 5	User Func5	0	0–28	–
	22	User function input 5–A	User Input 5–A	0	0–0xFFFF	–
	23	User function input 5–B	User Input 5–B	0	0–0xFFFF	–
	24	User function input 5–C	User Input 5–C	0	0–0xFFFF	–
	25	User function output 5	User Output 5	0	–32767–32767	–
	26	User function 6	User Func6	0	0–28	–
	27	User function input 6–A	User Input 6–A	0	0–0xFFFF	–
	28	User function input 6–B	User Input 6–B	0	0–0xFFFF	–
	29	User function input 6–C	User Input 6–C	0	0–0xFFFF	–
	30	User function output 6	User Output 6	0	–32767–32767	–
	31	User function 7	User Func7	0	0–28	–
	32	User function input 7–A	User Input 7–A	0	0–0xFFFF	–
	33	User function input 7–B	User Input 7–B	0	0–0xFFFF	–
	34	User function input 7–C	User Input 7–C	0	0–0xFFFF	–
	35	User function output 7	User Output 7	0	–32767–32767	–
	36	User function 8	User Func8	0	0–28	–
	37	User function input 8–A	User Input 8–A	0	0–0xFFFF	–
	38	User function input8–B	User Input 8–B	0	0–0xFFFF	–
	39	User function input 8–C	User Input 8–C	0	0–0xFFFF	–
	40	User function output 8	User Output 8	0	–32767–32767	–
	41	User function 9	User Func9	0	0–28	–
	42	User function input 9–A	User Input 9–A	0	0–0xFFFF	–
	43	User function input 9–B	User Input 9–B	0	0–0xFFFF	–
	44	User function input 9–C	User Input 9–C	0	0–0xFFFF	–
	45	User function output 9	User Output 9	0	–32767–32767	–
	46	User function 10	User Func10	0	0–28	–
	47	User function input 10–A	User Input 10–A	0	0–0xFFFF	–
	48	User function input 10–B	User Input 10–B	0	0–0xFFFF	–
	49	User function input 10–C	User Input 10–C	0	0–0xFFFF	–
	50	User function output 10	User Output 10	0	–32767–32767	–
	51	User function 11	User Func11	0	0–28	–
	52	User function input 11–A	User Input 11–A	0	0–0xFFFF	–
	53	User function input 11–B	User Input 11–B	0	0–0xFFFF	–
	54	User function input 11–C	User Input 11–C	0	0–0xFFFF	–
	55	User function output 11	User Output 11	0	–32767–32767	–
	56	User function 12	User Func12	0	0–28	–
	57	User function input 12–A	User Input 12–A	0	0–0xFFFF	–
	58	User function input 12–B	User Input 12–B	0	0–0xFFFF	–
	59	User function input 12–C	User Input 12–C	0	0–0xFFFF	–
	60	User function output 12	User Output 12	0	–32767–32767	–
	61	User function 13	User Func13	0	0–28	–
	62	User function input 13–A	User Input 13–A	0	0–0xFFFF	–

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
UF	63	User function input 13–B	User Input 13–B	0	0–0xFFFF	–
	64	User function input 13–C	User Input 13–C	0	0–0xFFFF	–
	65	User function output 13	User Output 13	0	–32767–32767	–
	66	User function 14	User Func14	0	0–28	–
	67	User function input 14–A	User Input 14–A	0	0–0xFFFF	–
	68	User function input14–B	User Input 14–B	0	0–0xFFFF	–
	69	User function input 14–C	User Input 14–C	0	0–0xFFFF	–
	70	User function output14	User Output 14	0	–32767–32767	–
	71	User function 15	User Func15	0	0–28	–
	72	User function input 15–A	User Input 15–A	0	0–0xFFFF	–
	73	User function input 15–B	User Input 15–B	0	0–0xFFFF	–
	74	User function input 15–C	User Input 15–C	0	0–0xFFFF	–
	75	User function output 15	User Output 15	0	–32767–32767	–
	76	User function 16	User Func16	0	0–28	–
	77	User function input 16–A	User Input 16–A	0	0–0xFFFF	–
	78	User function input 16–B	User Input 16–B	0	0–0xFFFF	–
	79	User function input 16–C	User Input 16–C	0	0–0xFFFF	–
	80	User function output 16	User Output 16	0	–32767–32767	–
	81	User function 17	User Func17	0	0–28	–
	82	User function input 17–A	User Input 17–A	0	0–0xFFFF	–
	83	User function input 17–B	User Input 17–B	0	0–0xFFFF	–
	84	User function input 17–C	User Input 17–C	0	0–0xFFFF	–
	85	User function output 17	User Output 17	0	–32767–32767	–
	86	User function 18	User Func18	0	0–28	–
	87	User function input 18–A	User Input 18–A	0	0–0xFFFF	–
	88	User function input 18–B	User Input 18–B	0	0–0xFFFF	–
	89	User function input 18–C	User Input 18–C	0	0–0xFFFF	–
	90	User function output 18	User Output 18	0	–32767–32767	–

User Sequence Setting Details

Pr. Code	Description
AP.2 User Seq En	Set AP.2 = 1 to enable the user sequence. This allows parameter groups US and UF to be displayed for programming.
US.1 User Seq Con	Controls the the User sequence run and stop mode. 0= Stop 1= Run 2= Digital Input Run- (status of digital input determines program run or stop). Digital input must be set to 5=UserSeq) To program and adjust the user sequence, this parameter must be set to 0 (Stop)

Pr. Code	Description
US.2 User Loop Time	The user sequence loop time determines the time interval that the user sequence programming will be executed. User sequence loop time can be set as follows: 0= 0.01s 1= 0.02s 2= 0.05s 3 =0.1s 4 =0.5s 5 =1s
US.11–28 Link UserOut1–18	Set parameters to connect 18 Function Blocks. If the input value is 0x0000, an output value cannot be used. To use the output value in step 1 for the frequency reference (Cmd Frequency), input the communication address(0x1101) of the Cmd frequency as the Link UserOut1 parameter.
US.31–60 Void Para1–30	Set 30 void parameters. Use when a constant value parameter input is needed in the user function block.
UF.1–90	Set user defined functions for the 18 function blocks. If the function block setting is invalid, the output of the User Output@ is –1. All the outputs from the User Output@ are read only, and can be used with the user output link@ (Link UserOut@) of the US group.

Programming

- *User sequence is composed of function blocks and links.*
- *One or more values are inputted into a function block, the function block completes the preset operation, and then outputs a value.*
- *Inputs of function block can be linked by inputting communication addresses of parameters or constant values.*
- *Output Links determine where to output the result of the operation. Outputs can be used as input of other function blocks.*
- *Function block can be used many times in one loop.*

Programming Rules

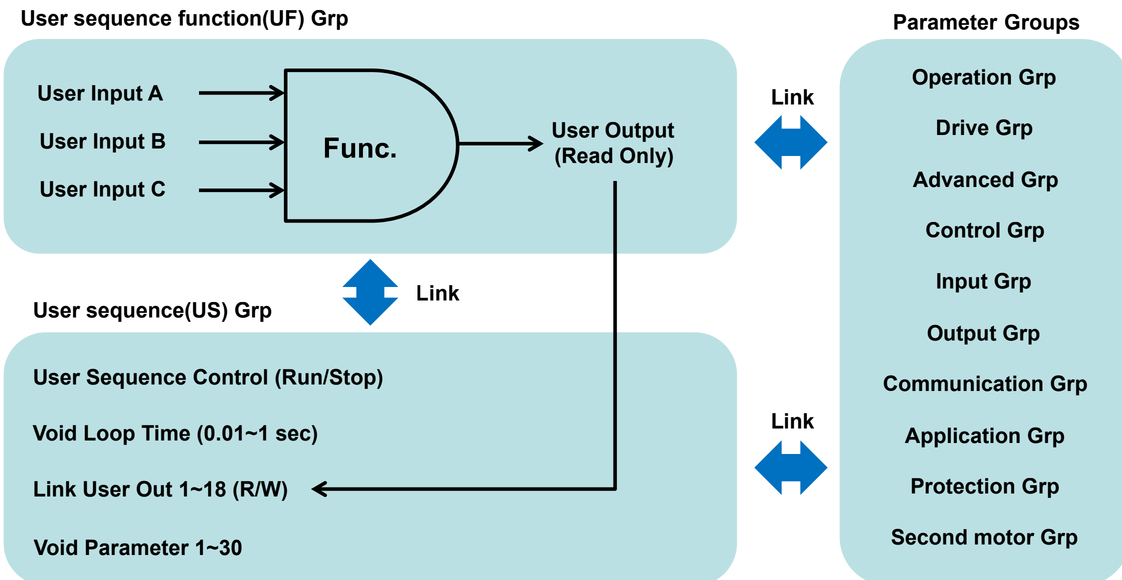
- *Parameters cannot be adjusted during User Sequence Run Mode (Ap.2). To adjust parameters, the operation must be stopped.*
- *All the outputs from the User Output@ are read only, and can be used with the user output link@(Link UserOut@) of the USS group.*
- *Function blocks can be used many times in one loop.*
- *Set parameter's address at Link UserOut@ to connect 18 function blocks. If the input value is 0x0000, an output value cannot be used.*
- *Void parameter can be set between -9999~9999.*
- *It the function block setting is invalid, the output of the User Output@ is -1*

Execution Rules

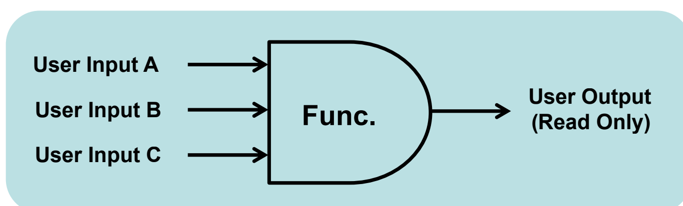
- *1 Loop refers to a single execution of a user configured sequence that contains a maximum of 18 steps.*
- *Users can select a loop time of between 10~1000ms at US.2.*
- *Output value of function block is between maximum and minimum value and can limit the output using limit function.*
- *If the scale of linked two parameter is different each other, scale is not changed automatically*

Activation

- *In order to activate the user sequence function, set AP.2 = 1.*
- *After user sequence is activated, US and UF parameter groups appear.*



Understanding of FB (Function Block)

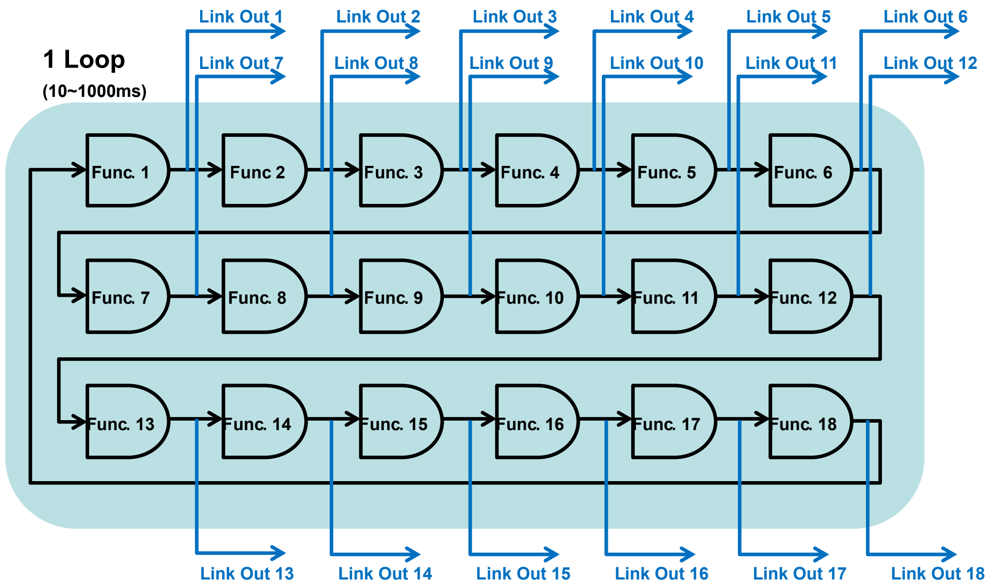


Each function block consists of 1-3 inputs and 1 output

Type	Description
User Func @*	Choose the function to perform in the function block.
User Input @-A	Communication address of the function's first input parameter.
User Input @-B	Communication address of the function's second input parameter.
User Input @-C	Communication address of the function's third input parameter.
User Output @	Output value (Read Only) after performing the function block.
**@ is the step number (1–18)*	

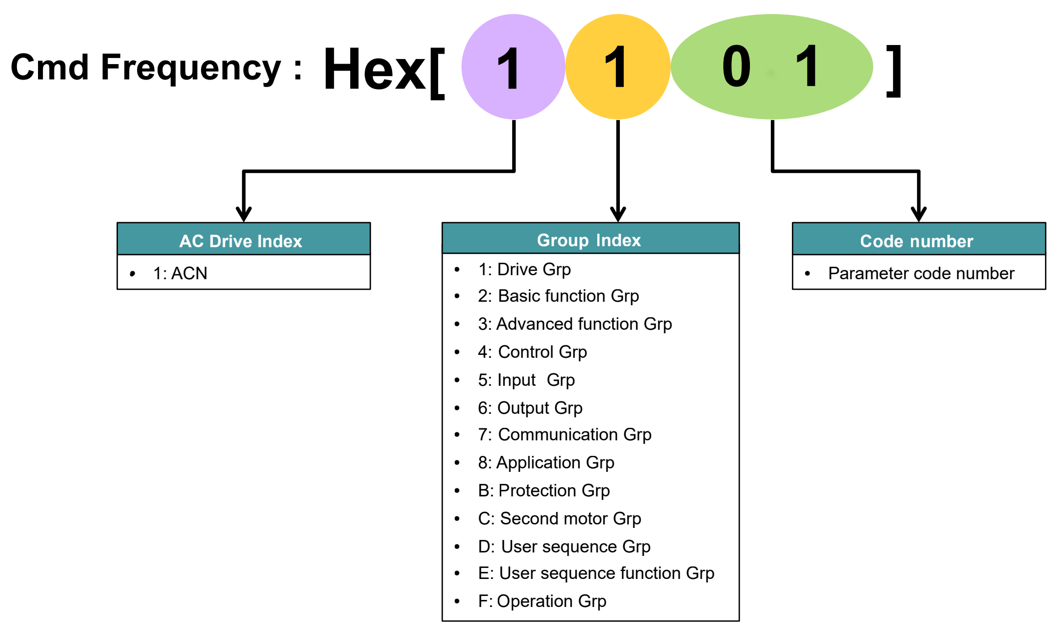
1 Loop Sequence

- *The sequence can comprise of a maximum of 18 steps using 29 function blocks and 30 void parameters.*
- *1 Loop refers to a single execution of a user configured sequence that contains a maximum of 18 steps. Users can select a loop time of between 10~1000ms.*



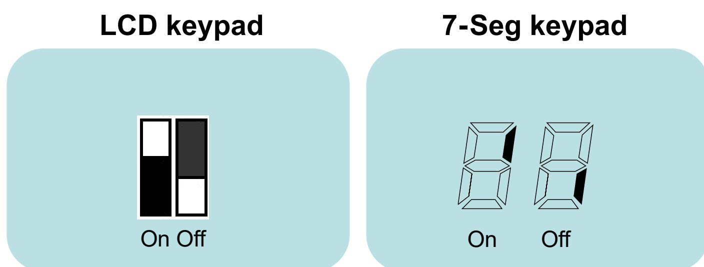
Communication Address

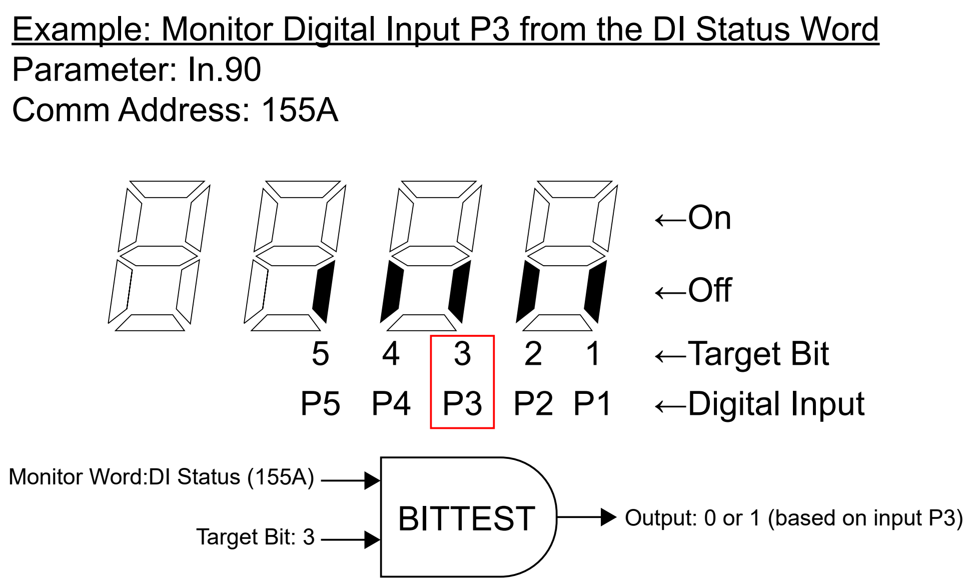
- *Input/Output links are connected by the communication address.*
- *Communication address is hexadecimal. The constituting principle is as follows.*



Data Format Type

- *Integer Type*
  - *Output range is -9999~9999.*
  - *Function block: Functions except for AND/OR/XOR/ANDOR/BITSET/BITCLEAR.*
- *Binary digit type*
  - *This type is expressed as 0 or 1, each is Off(False) or On(True).*
  - *To use a digital input/output individual bit in the program, the BITTEST/BITSET/BITCLEAR function block is required as the first programming step to separate the bit value from the word. See example below.*
  - *Function block: AND/OR/XOR/ANDOR/BITSET/BITCLEAR*
  - *Results of this type is expressed as below, There are any problem in calculating with other functions except for SWITCH function. If you input binary digit type parameters to SWITCH function, because of the error, the output is -1.*





Digital Input/Output Programming Addresses

The Digital Input/Output status information can be used in function blocks for monitor and control. The following tables show the addresses for the digital I/O.

To use a digital input/output individual bit in the program, the BITTEST/BITSET/BITCLEAR function block is required as the first programming step to separate the bit value from the word. See example above.

Communication multi-functional input (0385h) control			Word Value example
Target Bit	**Word Value**	**Description**	
B16	2^{15}=32,768	Reserved	• No input = 0 • Virtual DI 1 input = 1 • Virtual DI 1+DI 2 input = 1+2 = 3 • Virtual DI 1+DI 3 input = 1+4 = 5
B15	2^{14}=16,384	Reserved	
B14	2^{13}=8,192	Reserved	
B13	2^{12}=4,096	Reserved	
B12	2^{11}=2,048	Reserved	
B11	2^{10}=1,024	Reserved	
B10	2^{9}=512	Reserved	
B9	2^{8}=256	Reserved	
B8	2^{7}=128	Virtual DI 8 (CM.77)	
B7	2^{6}=64	Virtual DI 7 (CM.76)	
B6	2^{5}=32	Virtual DI 6 (CM.75)	
B5	2^{4}=16	Virtual DI 5 (CM.74)	
B4	2^{3}=8	Virtual DI 4 (CM.73)	
B3	2^{2}=4	Virtual DI 3 (CM.72)	
B2	2^{1}=2	Virtual DI 2 (CM.71)	
B1	2^{0}=1	Virtual DI 1 (CM.70)	

Digital output(0386h) control			Word Value example
Target Bit	**Word Value**	**Description**	
B16	2^{15}=32,768	Reserved	• No output =0 • Relay1 output = 1 • Relay1+Q1 output = 1+2 = 3
B15	2^{14}=16,384	Reserved	
B14	2^{13}=8,192	Reserved	
B13	2^{12}=4,096	Reserved	
B12	2^{11}=2,048	Reserved	
B11	2^{10}=1,024	Reserved	
B10	2^{9}=512	Reserved	
B9	2^{8}=256	Reserved	
B8	2^{7}=128	Reserved	
B7	2^{6}=64	Reserved	
B6	2^{5}=32	Multi_Func Output 4(ExtIO-R4)	
B5	2^{4}=16	Multi_Func Output 3(ExtIO-R3)	
B4	2^{3}=8	Reserved	
B3	2^{2}=4	Reserved	
B2	2^{1}=2	Multi-func. output 1(Q1)	
B1	2^{0}=1	Multi-func. Relay 1(A1, B1, C1 terminals)	

Target Bit	Word Value	Description	Monitoring Word Value example
Digital Input (DI) Status, In.90(155Ah)			
B11	2^{10}=1,024	P10 terminal Setting	
B10	2^{9}=512	P9 terminal Setting	
B9	2^{8}=256	P8 terminal Setting	
B8	2^{7}=128	Reserved	
B7	2^{6}=64	Reserved	
B6	2^{5}=32	Reserved	
B5	2^{4}=16	P5 terminal Setting	
B4	2^{3}=8	P4 terminal Setting	• No input =0 • P1 input = 1 • P1+P2 input = 1+2 = 3 • Relay1 output = 1 • Relay1+Q1 output = 1+2 = 3
B3	2^{2}=4	P3 terminal Setting	
B2	2^{1}=2	P2 terminal Setting	
B1	2^{0}=1	P1 terminal Setting	
Digital Output (DO) Status, OU.41 (1629h)			
B6	2^{5}=32	Multi-Func Relay 4 (Ext IO- R3)	
B5	2^{4}=16	Multi-Func Relay 3 (Ext IO-R4)	
B4	2^{3}=8	Reserved	
B3	2^{2}=4	Reserved	
B2	2^{1}=2	Multi-functional output 1 (Q1)	
B1	2^{0}=1	Multi-functional Relay 1(A1, B1, C1 terminals)	

Operation Status Monitoring Addresses

The drive operation status information can be used in function blocks. The following table shows the addresses for monitoring. If monitoring an individual bit, the BIT TEST function block must be used. Reference the "Target Bit" column. If monitoring the full Status Word in a compare block, reference the Monitoring Value example column. Interaction between varies bits will change the value of the status word.

Operation status(000E) monitoring			Monitoring value example
Target Bit	Word Value	Description	
B16	2^{15}=32,768	0: Remote, 1: Local	
B15	2^{14}=16,384	1: Frequency command source by communication	
B14	2^{13}=8,192	1: Operation command source by communication	
B13	2^{12}=4,096	REV operation command	
B12	2^{11}=2,048	FWD operation command	
B11	2^{10}=1,024	Brake release signal	
B10	2^{9}=512	Jog mode	• Stopped(B0)= 1 • FWD accelerating(B2+B5+B12)= 2+16+2048= 2066 • FWD decelerating(B2+B6+B12)= 2+32+2048= 2082 • FWD stopping(B2+B9)= 2+256= 258 • FWD speed reached(B2+B7+B12)= 2+64+2048= 2114
B9	2^{8}=256	Stopping	
B8	2^{7}=128	DC braking	
B7	2^{6}=64	Speed reached	
B6	2^{5}=32	Decelerating	
B5	2^{4}=16	Accelerating	
B4	2^{3}=8	Fault(Trip)	
B3	2^{2}=4	Run in REV direction	
B2	2^{1}=2	Run in FWD direction	
B1	2^{0}=1	Stopped	

ACN Major parameter communication addresses

The following are common address values that are used in function block programming.

Address (Hex)	Parameter	Unit	Scale
0005	Commanded Freq	Hz	0.01
1101	Target Freq.	Hz	0.01
1103	Acc Time	Sec	0.1
1104	Dec Time	Sec	0.1
1505	Analog Input 1	%	0.01
1606	Analog Output 1	%	0.1
155A	Multi-func. Input Status	Bit	-
0385	Virtual Multi-func. Input	Bit	-
1629	Multi-func. Output Status	Bit	-
1404	Carrier Freq.	kHz	0.1
0009	Output Current	A	0.1
000A	Output Freq.	Hz	0.01
000B	Output Volt.	V	1
000C	DC-link Volt.	V	1
000D	Output Power	kW	0.1
000E	Operation Status	-	-
000F	Fault Info.	-	-

ACN User Sequence Void Constant Parameters

If a constant value is needed in any user sequence program function block, utilize the Void constant parameters Us.31- US.60. Program these addresses into function blocks with the Hex Address. Note the constant values are decimal.

ACN User Sequence Void Constant Parameters			
Address (Hex)	**Code**	**Name**	**Range (decimal)**
0h1D1F	US.31	Void constant setting1	-9999-9999
0h1D20	US.32	Void constant setting2	-9999-9999
0h1D21	US.33	Void constant setting3	-9999-9999
0h1D22	US.34	Void constant setting4	-9999-9999
0h1D23	US.35	Void constant setting5	-9999-9999
0h1D24	US.36	Void constant setting6	-9999-9999
0h1D25	US.37	Void constant setting7	-9999-9999
0h1D26	US.38	Void constant setting8	-9999-9999
0h1D27	US.39	Void constant setting9	-9999-9999
0h1D28	US.40	Void constant setting10	-9999-9999
0h1D29	US.41	Void constant setting11	-9999-9999
0h1D2A	US.42	Void constant setting12	-9999-9999
0h1D2B	US.43	Void constant setting13	-9999-9999
0h1D2C	US.44	Void constant setting14	-9999-9999
0h1D2D	US.45	Void constant setting15	-9999-9999
0h1D2E	US.46	Void constant setting16	-9999-9999
0h1D2F	US.47	Void constant setting17	-9999-9999

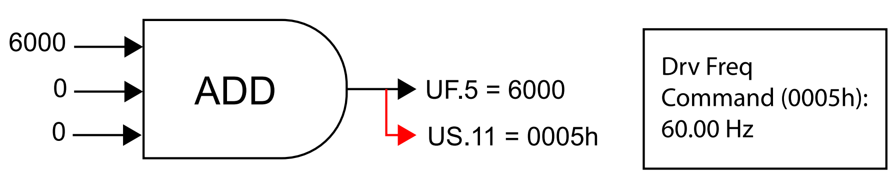
ACN User Sequence Void Constant Parameters			
Address (Hex)	**Code**	**Name**	**Range (decimal)**
0h1D30	US.48	Void constant setting18	-9999-9999
0h1D31	US.49	Void constant setting19	-9999-9999
0h1D32	US.50	Void constant setting20	-9999-9999
0h1D33	US.51	Void constant setting21	-9999-9999
0h1D34	US.52	Void constant setting22	-9999-9999
0h1D35	US.53	Void constant setting23	-9999-9999
0h1D36	US.54	Void constant setting24	-9999-9999
0h1D37	US.55	Void constant setting25	-9999-9999
0h1D38	US.56	Void constant setting26	-9999-9999
0h1D39	US.57	Void constant setting27	-9999-9999
0h1D3A	US.58	Void constant setting28	-9999-9999
0h1D3B	US.59	Void constant setting29	-9999-9999
0h1D3C	US.60	Void constant setting30	-9999-9999

ACN User Sequence Function Block Output Parameters

The output values of the 18 function blocks are read only addresses. These values can be read or monitored using the Hex address. The FB output values can be transferred to a different location by using the Output Address Link Parameters, which are linked automatically to the User Function Output value.

For example, if it is desired for the User function 1 ouput to be the Command frequency to the drive, program as follows:

Code	Address	Name	Setting
dr.7	***0h1107***	Freq Ref Source	9-Usr Seq
US.32	***0h1D20***	Void constant2	6000
US.33	***0h1D21***	Void constant3	0
UF.1	***0h1E02***	UF 1	1:ADD
UF.2	***0h1E02***	UF input 1-A	1D20h
UF.3	***0h1E03***	UF input 1-B	1D21h
UF.4	***0h1E04***	UF input 1-C	1D21h
UF.5	***0h1E05***	UF output1	-
US.11	***0h1D0B***	Output address link1	0005h



Function Block Output Addresses (Read Only)					Function Block Output Link Parameters			
Address (Hex)	Code	Name	Setting Range (Decimal)		Address (Hex)	Code	Name	Range (Hex)
0h1E05	UF.5	User function output1	-32767-32767	→	***0h1D0B***	US.11	Output address link1	0–0xFFFF
0h1E0A	UF.10	User function output2	-32767-32767	→	***0h1D0C***	US.12	Output address link2	0–0xFFFF
0h1E0F	UF.15	User function output3	-32767-32767	→	***0h1D0D***	US.13	Output address link3	0–0xFFFF
0h1E14	UF.20	User function output4	-32767-32767	→	***0h1D0E***	US.14	Output address link4	0–0xFFFF
0h1E19	UF.25	User function output5	-32767-32767	→	***0h1D0F***	US.15	Output address link5	0–0xFFFF
0h1E1E	UF.30	User function output6	-32767-32767	→	***0h1D10***	US.16	Output address link6	0–0xFFFF
0h1E23	UF.35	User function output7	-32767-32767	→	***0h1D11***	US.17	Output address link7	0–0xFFFF
0h1E28	UF.40	User function output8	-32767-32767	→	***0h1D12***	US.18	Output address link8	0–0xFFFF
0h1E2D	UF.45	User function output9	-32767-32767	→	***0h1D13***	US.19	Output address link9	0–0xFFFF
0h1E32	UF.50	User function output10	-32767-32767	→	***0h1D14***	US.20	Output address link10	0–0xFFFF
0h1E37	UF.55	User function output11	-32767-32767	→	***0h1D15***	US.21	Output address link11	0–0xFFFF
0h1E3C	UF.60	User function output12	-32767-32767	→	***0h1D16***	US.22	Output address link12	0–0xFFFF
0h1E41	UF.65	User function output13	-32767-32767	→	***0h1D17***	US.23	Output address link13	0–0xFFFF
0h1E46	UF.70	User function output14	-32767-32767	→	***0h1D18***	US.24	Output address link14	0–0xFFFF
0h1E4B	UF.75	User function output15	-32767-32767	→	***0h1D19***	US.25	Output address link15	0–0xFFFF
0h1E50	UF.80	User function output16	-32767-32767	→	***0h1D1A***	US.26	Output address link16	0–0xFFFF
0h1E55	UF.85	User function output17	-32767-32767	→	***0h1D1B***	US.27	Output address link17	0–0xFFFF
0h1E5A	UF.90	User function output18	-32767-32767	→	***0h1D1C***	US.28	Output address link18	0–0xFFFF

User Function Block Programming - Operation Explanation

The following table explains the operation of each programming block. For program examples, refer to the support resources section on the drive item page on the webstore.

Number	Type	Description
0	NOP	No Operation.
1	ADD	Addition operation, (A + B) + C If the C parameter is 0x0000, it will be recognized as 0.
2	SUB	Subtraction operation, (A – B) – C If the C parameter is 0x0000, it will be recognized as 0.
3	ADDSUB	Addition and subtraction compound operation, (A + B) – C If the C parameter is 0x0000, it will be recognized as 0.
4	MIN	Output the smallest value of the input values, MIN(A, B, C). If the C parameter is 0x0000, operate only with A, B.
5	MAX	Output the largest value of the input values, MAX(A, B, C). If the C parameter is 0x0000, operate only with A, B.
6	ABS	Output the absolute value of the A parameter, | A |. This operation does not use the B, or C parameter.
7	NEGATE	Output the negative value of the A parameter, –(A). This operation does not use the B, or C parameter.
8	REMAINDER	Remainder operation of A and B, A % B This operation does not use the C parameter.
9	MPYDIV	Multiplication, division compound operation, (A x B)/C. If the C parameter is 0x0000, output the multiplication operation of (A x B).

<table>
<tr><th>Number</th><th>Type</th><th>Description</th></tr>
<tr><td>10</td><td>COMPARE–GT
(greater than)</td><td>Comparison operation: if (A > B) the output is C; if (A </=B) the output is 0.
If the condition is met, the output parameter is C. If the condition is not met, the output is 0(False). If the C parameter is 0x0000 and if the condition is met, the output is 1(True).</td></tr>
<tr><td>11</td><td>COMPARE–GTEQ
(greater than or equal to)</td><td>Comparison operation; if (A >/= B) output is C; if (A<B) the output is 0.
If the condition is met, the output parameter is C. If the condition is not met, the output is 0(False). If the C parameter is 0x0000 and if the condition is met, the output is 1(True).</td></tr>
<tr><td>12</td><td>COMPARE–EQUAL</td><td>Comparison operation, if(A == B) then the output is C. For all other values the output is 0.
If the condition is met, the output parameter is C. If the condition is not met, the output is 0(False). If the C parameter is 0x0000 and if the condition is met, the output is 1(True).</td></tr>
<tr><td>13</td><td>COMPARE–NEQUAL</td><td>Comparison operation, if(A != B) then the output is C. For all other values the output is 0.
If the condition is met, the output parameter is C. If the condition is not met, the output is 0(False). If the C parameter is 0x0000 and if the condition is met, the output is 1(True).</td></tr>
<tr><td>14</td><td>TIMER</td><td>Adds 1 each time a user sequence completes a loop.
A: Max Loop, B: Timer Run/Stop, C: Choose output mode.
If input of B is 1, timer stops (output is 0). If input is 0, timer runs.
If input of C is 1, output the current timer value.
If input of C is 0, output 1 when timer value exceeds A(Max) value.
If the C parameter is 0x0000, C will be recognized as 0.
Timer overflow Initializes the timer value to 0.</td></tr>
<tr><td>15</td><td>LIMIT</td><td>Sets a limit for the A parameter.
If input to A is between B and C, output the input to A.
If input to A is larger than B, output B. If input of A is smaller than C, output C.
B parameter must be greater than or equal to the C parameter.</td></tr>
<tr><td>16</td><td>AND</td><td>Output the AND operation, (A and B) and C.
If the C parameter is 0x0000, operate only with A, B.</td></tr>
<tr><td>17</td><td>OR</td><td>Output the OR operation, (A | B) | C.
If the C parameter is 0x0000, operate only with A, B.</td></tr>
<tr><td>18</td><td>XOR</td><td>Output the XOR operation, (A ^ B) ^ C.
If the C parameter is 0x0000, operate only with A, B.</td></tr>
<tr><td>19</td><td>AND/OR</td><td>Output the AND/OR operation, (A and B) | C.
If the C parameter is 0x0000, operate only with A, B.</td></tr>
<tr><td>20</td><td>SWITCH</td><td>Output a value after selecting one of two inputs, if (A) then B otherwise C.
If the input at A is 1, the output will be B. If the input at A is 0, the output parameter will be C.</td></tr>
<tr><td>21</td><td>BITTEST</td><td>Test the B bit of the A parameter, BITTEST(A, B).
If the B bit of the A input is 1, the output is 1. If it is 0, then the output is 0. The input value of B must be between 0–16. If the value is higher than 16, it will be recognized as 16. If input at B is 0, the output is always 0.</td></tr>
<tr><td>22</td><td>BITSET</td><td>Set the B bit of the A parameter, BITSET(A, B). Output the changed value after setting the B bit to input at A.
The input value of B must be between 0–16. If the value is higher than 16, it will be recognized as 16. If the input at B is 0, the output is always 0. This operation does not use the C parameter.</td></tr>
<tr><td>23</td><td>BITCLEAR</td><td>Clear the B bit of the A parameter, BITCLEAR(A, B). Output the changed value after clearing the B bit to input at A.
The input value of B must be between 0–16. If the value is higher than 16, it will be recognized as 16. If the input at B is 0, the output is always 0. This operation does not use the C parameter.</td></tr>
<tr><td>24</td><td>LOWPASSFILTER</td><td>Output the input at A as the B filter gains time constant, B x US.2 (US Loop Time.
In the above formula, set the time when the output of A reaches 63.3%
C stands for the filter operation. If it is 0, the operation is started.</td></tr>
<tr><td>25</td><td>PI_CONTROL</td><td>P, I gain = A, B parameter input, then output as C.
Conditions for PI_PROCESS output: C = 0: Const PI,
C = 1: PI_PROCESS–B >= PI_PROCESS–OUT >= 0,
C = 2: PI_PROCESS–B >= PI_PROCESS–OUT >= –(PI_PROCESS–B),
P gain = A/100, I gain = 1/(Bx Loop Time),
If there is an error with PI settings, output –1.</td></tr>
<tr><td>26</td><td>PI_PROCESS</td><td>A is an input error, B is an output limit, C is the value of Const PI output.
Range of C is 0–32, 767.</td></tr>
</table>

Number	Type	Description
27	UPCOUNT	Upcounts the pulses and then output the value– UPCOUNT(A, B, C). After receiving a trigger input (A), outputs are upcounted by C conditions. If the B inputs is 1, do not operate and display 0. If the B inputs is 0, operate. If the C parameter is 0, upcount when the input at A changes from 0 to 1. If the C parameter is 1, upcount when the input at A is changed from 1 to 0. If the C parameter is 2, upcount whenever the input at A changes. Output range is: 0–32767
28	DOWNCOUNT	Downcounts the pulses and then output the value– DOWNCOUNT(A, B, C). After receiving a trigger input (A), outputs are downcounted by C conditions. If the B input is 1, do not operate and display the initial value of C. If the B input is 0, operate. Downcounts when the A parameter changes from 0 to 1.

NOTE: The Pl process block (Pl_PROCESS Block) must be used after the PI control block (PI_CONTROL Block) for proper Pl control operation. Pl control operation cannot be performed if there is another block between the two blocks, or if the blocks are placed in an incorrect order.
For Programming Examples, see the support resources section on the drive item page on the webstore.

Fire Mode Operation

This function is used to allow the drive to ignore minor faults during emergency situations, such as fire, and provides continuous operation to fire pumps.

When turned on, Fire mode forces the drive to ignore all minor fault trips and repeat a Reset and Restart for major fault trips, regardless of the restart trial count limit. The retry delay time set at PR. 10 (Retry Delay) still applies while the drive performs a Reset and Restart.

Fire Mode Parameter Settings

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Ad	80	Fire Mode selection	Fire Mode Sel	1	Fire Mode	0–2	–
	81	Fire Mode frequency	Fire Mode Freq	0–60		0–60	–
	82	Fire Mode run direction	Fire Mode Dir	0–1		0–1	–
	83	Fire Mode operation count	Fire Mode Cnt	Not configurable		–	–
In	65–69	Px terminal configuration	Px Define (Px: P1– P5)	51	Fire Mode	0–54	–

The drive runs in Fire mode when Ad. 80 (Fire Mode Sel) is set to ‘2 (Fire Mode)’, and the multi–function terminal (In. 65–69) configured for Fire mode (51: Fire Mode) is turned on. The Fire mode count increases by 1 at Ad. 83 (Fire Mode Count) each time a Fire mode operation is run.

CAUTION: Fire mode operation may result in drive malfunction. Note that Fire mode operation voids the product warranty – the drive is covered by the product warranty only when the Fire mode count is ‘0.’

Fire Mode Function Setting Details

Pr. Code	Description	Details
Ad.81 Fire Mode frequency	Fire mode frequency reference	The frequency set at Ad. 81 (Fire mode frequency) is used for the drive operation in Fire mode. The Fire mode frequency takes priority over the Jog frequency, Multi–step frequencies, and the keypad input frequency.
dr.3 Acc Time / dr.4 Dec Time	Fire mode Acc/Dec times	When Fire mode operation is turned on, the drive accelerates for the time set at dr.3 (Acc Time), and then decelerates based on the deceleration time set at dr.4 (Dec Time). It stops when the Px terminal input is turned off (Fire mode operation is turned off).
Pr.10 Retry Delay	Fault trip process	Some fault trips are ignored during Fire mode operation. The fault trip history is saved, but trip outputs are disabled even when they are configured at the multi–function output terminals. • Fault trips that are ignored in Fire mode • BX, External Trip, Low Voltage Trip, Drive Overheat, Drive Overload, Overload, Electrical Thermal Trip, Input/Output Open Phase, Motor Overload, Fan Trip, No Motor Trips, and other minor fault trips. For the following fault trips, the drive performs a Reset and Restart until the trip conditions are released. The retry delay time set at PR. 10 (Retry Delay) applies while the drive performs a Reset and Restart. • Fault trips that force a Reset Restart in Fire mode • Over Voltage, Over Current1(OC1), Ground Fault Trip The drive stops operating when the following fault trips occur: • Fault trips that stop drive operation in Fire mode • H/W Diag, Over Current 2 (Arm–Short)

Improvement of output voltage drop

Improvement of the output voltage drop enables the output voltage operation command when the input voltage and overload settings are low to gain more output voltage and decrease the output current.

Parameter Setting for Improvement of Output Voltage Drop

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Ad	87	Overmodulation mode selection	OVM Mod Sel	0	No	0–1	–

Pr. Code	Description	Details
Ad.87 OVM Mode Sel	Overmodulation mode selection	Setting Ad.87 (Overmodulation mode selection) as "No" limits command voltage to linear output range. Setting Ad.87 (Overmodulation mode selection) as "Yes" allows for the output of overmodulation area, which extends the range of the command voltage. The output voltage command area will be enlarged for more output voltage.

CAUTION:

- *Getting out of the linear range may cause waveform distortion.*
- *When the input voltage is higher than the motor-rated voltage, the motor output voltage may be higher than the rated voltage.*
- *The current value may vary quickly during a high-speed operation, but the current change amount will not increase by much.*
- *The compensation of the output voltage is less than the motor-rated voltage set in the parameter settings.*
- *Overmodulation mode does not operate when the input voltage is higher than the output voltage.*

Learning Advanced Features

This section describes the advanced features of the ACN drive. Check the reference page in the table to see the detailed description for each of the advanced features.

Advanced Tasks	Description	Ref.
Auxiliary frequency operation	Use the main and auxiliary frequencies in the predefined formulas to create various operating conditions. Auxiliary frequency operation is ideal for Draw Operation* as this feature enables fine–tuning of operation speeds.	4–125
Jog operation	Jog operation is a kind of a manual operation. The drive operates to a set of parameter settings predefined for Jog operation, while the Jog command button is pressed.	4–128
Up–down operation	Uses the upper and lower limit value switch output signals (i.e. signals from a flow meter) as Acc/Dec commands to motors.	4–131
3–wire operation	3–wire operation is used to latch an input signal. This configuration is used to operate the drive by a push button.	4–133
Safety operation mode	This safety feature allows the drive's operation only after a signal is input to the multi–function terminal designated for the safety operation mode. This feature is useful when extra care is needed in operating the drive using the multi–purpose terminals.	4–134
Dwell operation	Use this feature for the lift–type loads such as elevators, when the torque needs to be maintained while the brakes are applied or released.	4–135
Slip compensation	This feature ensures that the motor rotates at a constant speed, by compensating for the motor slip as a load increases.	4–137
PID control	PID control provides constant automated control of flow, pressure, and temperature by adjusting the output frequency of the drive.	4–138
Auto–tuning	Used to automatically measure the motor control parameters to optimize the drive's control mode performance.	4–145
Sensorless vector control	An efficient mode to control magnetic flux and torque without special sensors. Efficiency is achieved through the high torque characteristics at low current when compared with the V/F control mode.	4–147
Energy buffering operation	Used to maintain the DC link voltage for as long as possible by controlling the drive output frequency during power interruptions, thus to delay a low voltage fault trip.	4–160
Torque Control	Used to operate induction motors with a torque command.	4–162
Energy saving operation	Used to save energy by reducing the voltage supplied to motors during low–load and no–load conditions.	4–166
Speed search operation	Used to prevent fault trips when the drive voltage is output while the motor is idling or free–running.	4–167
Auto restart operation	Auto restart configuration is used to automatically restart the drive when a trip condition is released, after the drive stops operating due to activation of protective devices (fault trips).	4–170
Second motor operation	Used to switch equipment operation by connecting two motors to one drive. Configure and operate the second motor using the terminal input defined for the second motor operation.	4–172
Commercial power source switch operation	Used to switch the power source to the motor from the drive output to a commercial power source, or vice versa.	4–173
Cooling fan control	Used to control the cooling fan of the drive.	4–174
Multi-function IO Timer settings	Set the timer value and control the On/Off state of the multi–function output and relay.	4–181
Brake control	Used to control the On/Off operation of the load's electronic braking system.	4–182
Multi–function output On/Off control	Set standard values and turn On/Off the output relays or multi–function output terminals according to the analog input value.	4–183
Regeneration prevention for press operation.	Used during a press operation to avoid motor regeneration, by increasing the motor operation speed.	4–183
**Draw operation is an openloop tension control. This feature allows a constant tension to be applied to the material that is drawn by a motor–driven device, by fine–tuning the motor speed using operation frequencies that are proportional to a ratio of the main frequency reference.*		

Operating with Auxiliary References

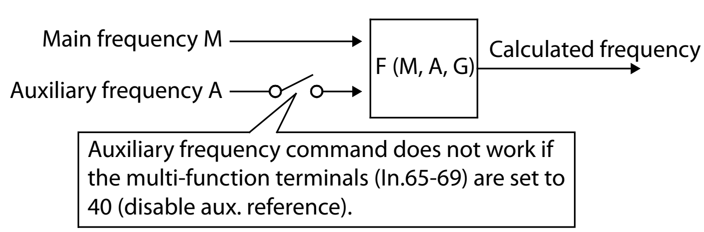
Frequency references can be configured with various calculated conditions that use the main and auxiliary frequency references simultaneously. The main frequency reference is used as the operating frequency, while auxiliary references are used to modify and fine–tune the main reference.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	Freq Ref Src	0	Keypad–1	0–12	–
bA	01	Auxiliary frequency reference source	Aux Ref Src	1	V1	0–4	–
	02	Auxiliary frequency reference calculation type	Aux Calc Type	0	M+(G*A)	0–7	–
	03	Auxiliary frequency reference gain	Aux Ref Gain	0.0	–	–200.0–200.0	%
In	65– 69	Px terminal configuration	Px Define	40	dis Aux Ref	–	–

The table above lists the available calculated conditions for the main and auxiliary frequency references. Refer to the table to see how the calculations apply to an example where the Frq code has been set to 0(Keypad–1), and the drive is operating at a main reference frequency of 30.00 Hz. Signals at –10 – +10V are received at terminal V1, with the reference gain set at 5%. In this example, the resulting frequency reference is fine–tuned within the range of 27.00–33.00 Hz [Codes In.1–16 must be set to the default values, and In.6 (V1 Polarity), set to 1 (Bipolar)].

Auxiliary Reference Setting Details

Pr. Code	Description		
bA.1 Aux Ref Src	Set the input type to be used for the auxiliary frequency reference		
	Configuration		Description
	0	None	Auxiliary frequency reference is disabled.
	1	V1	Sets the V1 (voltage) terminal at the control terminal block as the source of auxiliary frequency reference.
	3	V2	Sets the V2 (voltage) terminal at the control terminal block as the source of auxiliary frequency reference (SW2 must be set to "voltage").
	4	I2	Sets the I2 (current) terminal at the control terminal block as the source of auxiliary frequency reference (SW2 must be set to "current").
	5	Pulse	Sets the TI (pulse) terminal at the control terminal block as the source of auxiliary frequency reference.
bA.2 Aux Calc Type	Set the auxiliary reference gain with bA.3 (Aux Ref Gain) to configure the auxiliary reference and set the percentage to be reflected when calculating the main reference. Note that items 4–7 below may result in either plus (+) or minus (–) references (forward or reverse operation) even when unipolar analog inputs are used.		
	Configuration		Formula for frequency reference
	0	M+(G*A)	Main reference+(bA.3xbA.1xIn.1)
	1	M*(G*A)	x(bA.3xbA.1)
	2	M/(G*A)	Main reference/(bA.3xbA.1)
	3	M+{M*(G*A)}	Main reference+{Main reference x(bA.3xbA.1)}
	4	M+G*2*(A–50)	Main reference+bA.3x2x(bA.1–50)x In.1
	5	M*{G*2*(A–50)}	Main reference x{bA.3x2x(bA.1–50)}
	6	M/{G*2*(A–50)}	Main reference/{bA.3x2x(bA.1–50)}
	7	M+M*G*2*(A–50)	Main reference+Main reference x bA.3x2x(bA.1–50)
	M: Main frequency reference (Hz or rpm) G: Auxiliary reference gain (%) A: Auxiliary frequency reference (Hz or rpm) or gain (%)		
bA.3 Aux Ref Gain	Adjust the size of the input (bA.1 Aux Ref Src) configured for auxiliary frequency.		
In.65–69 Px Define	Set one of the multi–function input terminals to 40(dis Aux Ref) and turn it on to disable the auxiliary frequency reference. The drive will operate using the main frequency reference only.		



Auxiliary Reference Operation Ex #1

Keypad Frequency Setting is Main Frequency and V1 Analog Voltage is Auxiliary Frequency

- *Main frequency: Keypad (operation frequency 30Hz)*
- *Maximum frequency setting (dr.20): 400Hz*
- *Auxiliary frequency setting (bA.1): V1[Display by percentage(%) or auxiliary frequency (Hz) depending on the operation setting condition]*
- *Auxiliary reference gain setting (bA.3): 50%*
- *In.1–32: Factory default*

Example: an input voltage of 6V is supplied to V1, and the frequency corresponding to 10V is 60Hz. The table below shows the auxiliary frequency A as 36Hz[=60Hz X (6V/10V)] or 60%[= 100% X (6V/10V)].

Setting*		Calculating final command frequency**
0	M[Hz]+(G%*A[Hz])	30Hz(M)+(50%(G)x36Hz(A))=48Hz
1	M[Hz]*(G%*A%)	30Hz(M)x(50%(G)x60%(A))=9Hz
2	M[Hz]/(G%*A%)	30Hz(M)/(50%(G)x60%(A))=100Hz
3	M[Hz]+{M[Hz]*(G%*A%)}	30Hz(M)+{30[Hz]x(50%(G)x60%(A))}=39Hz
4	M[Hz]+G%*2*(A%–50%)[Hz]	30Hz(M)+50%(G)x2x(60%(A)–50%)x60Hz=36Hz
5	M[HZ]*{G%*2*(A%–50%)}	30Hz(M)x{50%(G)x2x(60%(A)–50%)}=3Hz
6	M[HZ]/{G%*2*(A%–50%)}	30Hz(M)/{50%(G)x2x(60%–50%)}=300Hz
7	M[HZ]+M[HZ]*G%*2*(A%–50%)	30Hz(M)+30Hz(M)x50%(G)x2x(60%(A)–50%)=33Hz
**M: main frequency reference (Hz or rpm)/G: auxiliary reference gain (%)/A: auxiliary frequency reference (Hz or rpm) or gain (%). **If the frequency setting is changed to rpm, it is converted to rpm instead of Hz.*		

Auxiliary Reference Operation Ex #2

Keypad Frequency Setting is Main Frequency and I2 Analog Voltage is Auxiliary Frequency

- *Main frequency: Keypad (Operation frequency 30Hz)*
- *Maximum frequency setting (dr.20): 400Hz*
- *Auxiliary frequency setting (bA.1): I2 [Display by percentage(%) or auxiliary frequency(Hz) depending on the operation setting condition]*
- *Auxiliary reference gain setting (bA.3): 50%*
- *In.1–32: Factory default*

Example: an input current of 10.4 mA is applied to I2, with the frequency corresponding to 20mA of 60Hz. The table below shows auxiliary frequency A as 24Hz(=60[Hz] X {(10.4[mA]–4[mA])/(20[mA] – 4[mA])} or 40%(=100% X {(10.4[mA] – 4[mA])/(20[mA] – 4[mA])}.

Setting*		Calculating final command frequency**
0	M[Hz]+(G%*A[Hz])	30Hz(M)+(50%(G)x24Hz(A))=42Hz
1	M[Hz]*(G%*A%)	30Hz(M)x(50%(G)x40%(A))=6Hz
2	M[Hz]/(G%*A%)	30Hz(M)/(50%(G)x40%(A))=150Hz
3	M[Hz]+{M[Hz]*(G%*A%)}	30Hz(M)+{30[Hz]x(50%(G)x40%(A))}=36Hz
4	M[Hz]+G%*2*(A%–50%)[Hz]	30Hz(M)+50%(G)x2x(40%(A)–50%)x60Hz=24Hz
5	M[HZ]*{G%*2*(A%–50%)	30Hz(M)x{50%(G)x2x(40%(A)–50%)} = –3Hz(Reverse)
6	M[HZ]/{G%*2*(A%–50%)}	30Hz(M)/{50%(G)x2x(60%–40%)} = –300Hz(Reverse)
7	M[HZ]+M[HZ]*G%*2*(A%–50%)	30Hz(M)+30Hz(M)x50%(G)x2x (40%(A)–50%)=27Hz
**M: main frequency reference (Hz or rpm)/G: auxiliary reference gain (%)/A: auxiliary frequency reference Hz or rpm) or gain (%). **If the frequency setting is changed to rpm, it is converted to rpm instead of Hz.*		

Auxiliary Reference Operation Ex #3

V1 is Main Frequency and I2 is Auxiliary Frequency

- *Main frequency: V1 (frequency command setting to 5V and is set to 30Hz)*
- *Maximum frequency setting (dr.20): 400Hz*
- *Auxiliary frequency (bA.1): I2[Display by percentage (%) or auxiliary frequency (Hz) depending on the operation setting condition]*
- *Auxiliary reference gain (bA.3): 50%*
- *In.1–32: Factory default*

Example: an input current of 10.4 mA is applied to I2, with the frequency corresponding to 20mA of 60Hz. The table below shows auxiliary frequency Aas 24Hz(=60[Hz]x{(10.4[mA]–4[mA])/(20[mA]–4[mA])} or 40%(=100% x {(10.4[mA] – 4[mA]) /(20 [mA] – 4[mA])}.

Setting*		Calculating final command frequency**
0	M[Hz]+(G%*A[Hz])	30Hz(M)+(50%(G)x24Hz(A))=42Hz
1	M[Hz]*(G%*A%)	30Hz(M)x(50%(G)x40%(A))=6Hz
2	M[Hz]/(G%*A%)	30Hz(M)/(50%(G)x40%(A))=150Hz
3	M[Hz]+{M[Hz]*(G%*A%)}	30Hz(M)+{30[Hz]x(50%(G)x40%(A))}=36Hz
4	M[Hz]+G%*2*(A%–50%)[Hz]	30Hz(M)+50%(G)x2x(40%(A)–50%)x60Hz=24Hz
5	M[HZ]*{G%*2*(A%–50%)}	30Hz(M)x{50%(G)x2x(40%(A)–50%)}=–3Hz(Reverse)
6	M[HZ]/{G%*2*(A%–50%)}	30Hz(M)/{50%(G)x2x(60%–40%)}=–300Hz(Reverse)
7	M[HZ]+M[HZ]*G%*2*(A%–50%)	30Hz(M)+30Hz(M)x50%(G)x2x(40%(A)–50%)=27Hz

**M: main frequency reference (Hz or rpm)/G: auxiliary reference gain (%)/A: auxiliary frequency reference (Hz or rpm) or gain (%).*
***If the frequency setting is changed to rpm, it is converted to rpm instead of Hz.,*

NOTE: When the maximum frequency value is high, output frequency deviation may result due to analog input variation and deviations in the calculations.

Jog operation

The jog operation allows for a temporary control of the drive. You can enter a jog operation command using the multi–function terminals or by using the [ESC] key on the keypad.

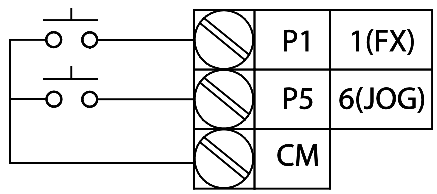
The jog operation is the second highest priority operation, after the dwell operation. If a jog operation is requested while operating the multi–step, up–down, or 3–wire operation modes, the jog operation overrides all other operation modes.

Jog Operation 1–Forward Jog by Multi–function Terminal

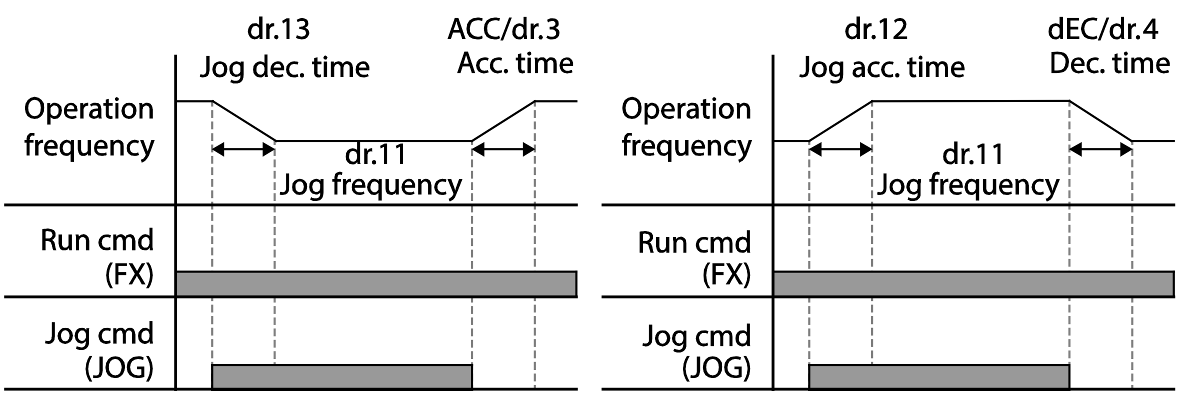
The jog operation is available in either forward or reverse direction, using the keypad or multi–function terminal inputs. The table below lists parameter setting for a forward jog operation using the multi–function terminal inputs.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
dr	11	Jog frequency	JOG Frequency	10.00	0.50–Maximum frequency	Hz
	12	Jog operation acceleration time	JOG Acc Time	20.00	0.00–600.00	sec
	13	Jog operation deceleration time	JOG Dec Time	30.00	0.00–600.00	sec
In	65–69	Px terminal configuration	Px Define(Px: P1–P5)	6 JOG	0–54	–

__Forward Jog Description Details__

Pr. Code	Description
In.65–69 Px Define	Select the jog frequency from P1– P5 and then select 6. Jog from In.65–69.  Terminal settings for jog operation
dr.11 JOG Frequency	Set the operation frequency.
dr.12 JOG Acc Time	Set the acceleration speed.
dr.13 JOG Dec Time	Set the deceleration speed.

If a signal is entered at the jog terminal while an FX operation command is on, the operation frequency changes to the jog frequency and the jog operation begins.

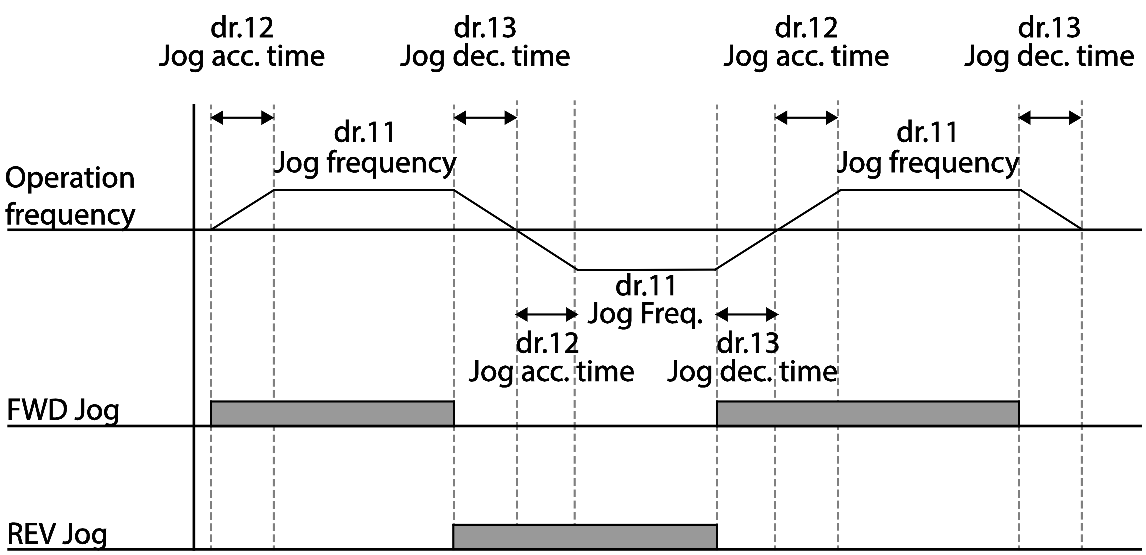


Operation frequency > Jog frequency   Operation frequency < Jog frequency

Jog Operation 2–Fwd/Rev Jog by Multi–function Terminal

For jog operation 1, an operation command must be entered to start operation, but while using jog operation 2, a terminal that is set for a forward or reverse jog also starts an operation. The priorities for frequency, Acc/Dec time and terminal block input during operation in relation to other operating modes (Dwell, 3–wire, up/down, etc.) are identical to jog operation 1. If a different operation command is entered during a jog operation, it is ignored and the operation maintains the jog frequency.

Pr. Group	Pr. Code	Name	LCD Display	Parameter setting		Setting Range	Unit
dr	11	Jog frequency	JOG Frequency	10.00		0.50–Maximum frequency	Hz
	12	Jog operation acceleration time	JOG Acc Time	20.00		0.00–600.00	sec
	13	Operation deceleration time	JOG Dec Time	30.00		0.00–600.00	sec
In	65–69	Px terminal configuration	Px Define(Px: P1–P5)	46	FWD JOG	0–54	–
				47	REV JOG		

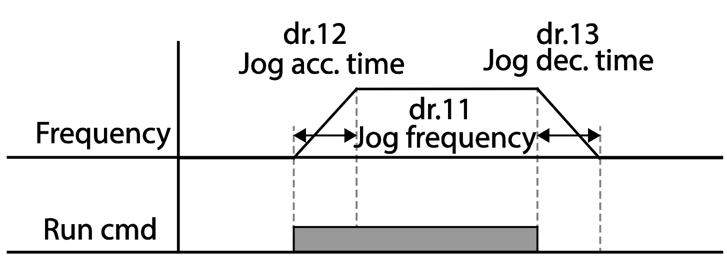


Jog Operation by Keypad

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Dr	90	[ESC] key functions	–	1	JOG Key	–	–
	06	Command source	Cmd Source*	0	Keypad	–	–

**Displayed under DRV–06 on the LCD keypad.*

Set dr.90 to 1(JOG Key) and set the drv code in the Operation group to 0(Keypad). When the [ESC] key is pressed, the SET display light flashes and the jog operation is ready to start. Pressing the [RUN] key starts the operation and the drive accelerates or decelerates to the designated jog frequency. Releasing the [RUN] key stops the jog operation. Set the Acc/Dec time for the jog operation frequency at dr.12 and dr.13.

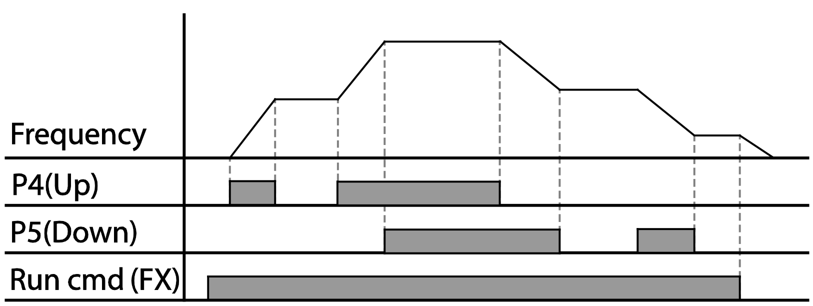
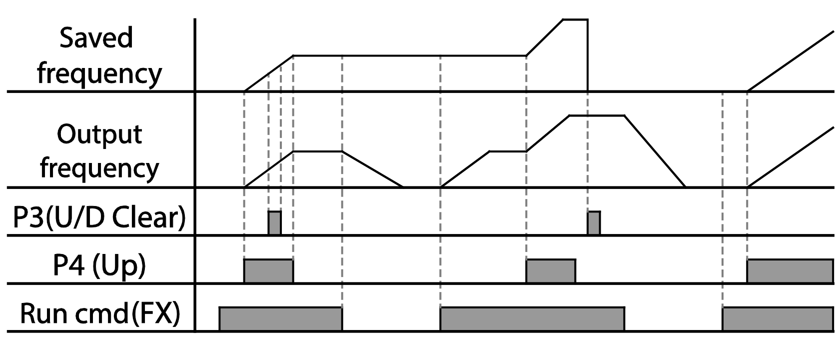


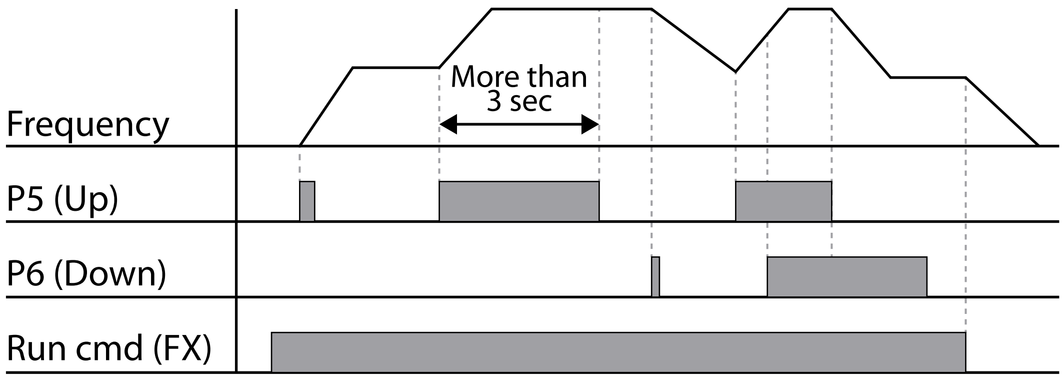
Up–down Operation

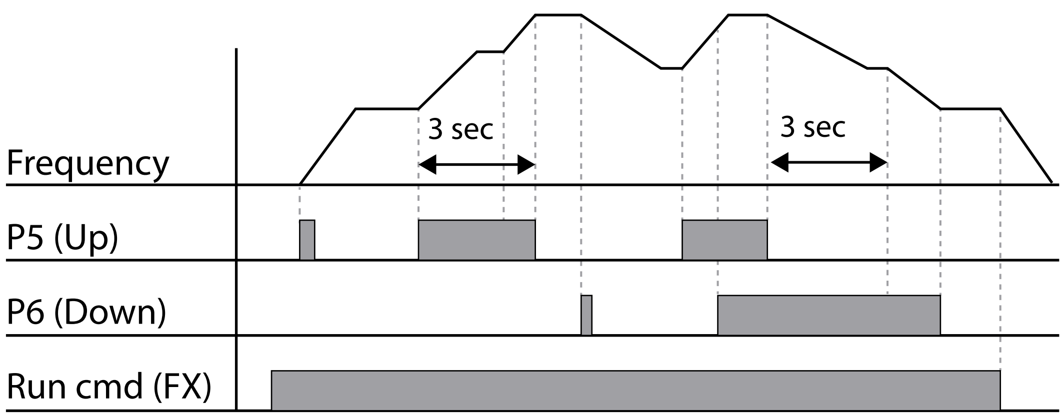
The Acc/Dec time can be controlled through input at the multi–function terminal block. Similar to a flowmeter, the up–down operation can be applied easily to a system that uses the upper–lower limit switch signals for Acc/Dec commands.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Ad	65	Up–down operation frequency save	U/D Save Mode	1	Yes	0–1	–
	85	Up–down mode selection	U/D Mode Sel	0	U/D Normal	0–2	–
				1	U/D Step		
				2	U/D Step+ Norm		
	86	Up–down step frequency	U/D Step Freq	0–maxFreq		0–Maximum Frequency	Hz
In	65–69	Px terminal configuration	Px Define(Px: P1–P5)	17	Up	0–54	–
				18	Down		
				20	U/D Clear		

Up–down Operation Setting Details

Pr. Code	Description
In.65–69 Px Define	Select two terminals for up–down operation and set them to 17 (Up) and 18 (Down), respectively. With the operation command input, acceleration begins when the Up terminal signal is on. Acceleration stops and constant speed operation begins when the signal is off. During operation, deceleration begins when the Down signal is on. Deceleration stops and constant speed operation begins when both Up and Down signals are entered at the same time. 
Ad.65 U/D Save Mode	During a constant speed operation, the operating frequency is saved automatically in the following conditions: the operation command (Fx or Rx) is off, a fault trip occurs, or the power is off. When the operation command is turned on again, or when the drive regains the power source or resumes to a normal operation from a fault trip, it resumes operation at the saved frequency. To delete the saved frequency, use the multi–function terminal block. Set one of the multi–function terminals to 20 (U/D Clear) and apply signals to it during constant speed operation. The saved frequency and the up–down operation configuration will be deleted. 

<table>
<tr><th>Pr. Code</th><th colspan="3">Description</th></tr>
<tr><td rowspan="6">Ad.85 U/D Mode Sel</td><td colspan="3">Select up-down operation mode.</td></tr>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>U/D Normal</td><td>Pressing the Up button increases the frequency to the maximum setting at a preset acceleration time. Pressing the Down button decreases the frequency to a preset deceleration speed, regardless of stop mode.</td></tr>
<tr><td>1</td><td>U/D Step</td><td>Accelerate or decelerate according to the step frequency set in Ad.86 on the ascending edge of the multi-function input set for up-down operation mode.</td></tr>
<tr><td>2</td><td>U/D Step+Norm</td><td>Accelerate or decelerate according to the step frequency set in Ad.86 on the ascending edge of the multi-function input set for up-down operation mode. If acceleration or deceleration is activated more than 3 seconds, the operation settings will change to up-down normal mode.</td></tr>
<tr><td colspan="3">

U/D Step


U/D Step+Norm</td></tr>
<tr><td>Ad.86 U/D Step Freq</td><td colspan="3">Set the frequency value to increase or decrease based on the up or down input.</td></tr>
</table>

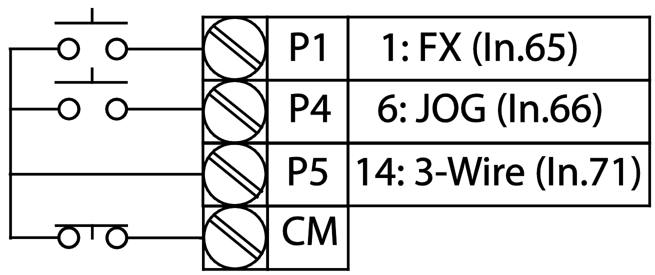
3–Wire Operation

The 3–wire operation latches the signal input (the signal stays on after the button is released), and is used when operating the drive with a push button.

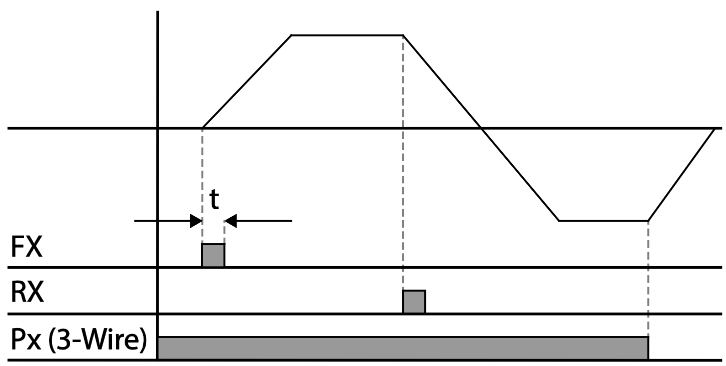
Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	drv	Command source	Cmd Source*	1	Fx/Rx – 1	–	–
In	65–69	Px terminal configuration	Px Define(Px: P1–P5)	14	3–Wire	0–54	–

**Displayed under DRV–06 on an LCD keypad.*

To enable the 3–wire operation, the following circuit sequence is necessary. The minimum input time (t) for 3–wire operation is 1ms, and the operation stops when both forward and reverse operation commands are entered at the same time.



Terminal connections for 3–wire operation



3–wire operation

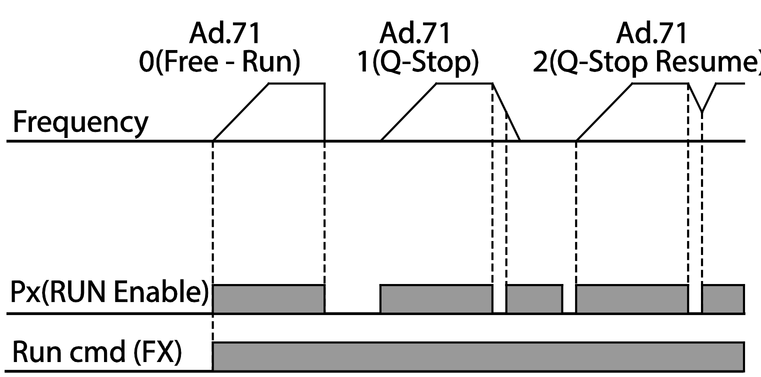
Safe Operation Mode

When the multi–function terminals are configured to operate in safe mode, operation commands can be entered in the Safe operation mode only. Safe operation mode is used to safely and carefully control the drive through the multi–function terminals.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Ad	70	Safe operation selection	Run En Mode	1	DI Dependent	–	–
	71	Safe operation stop mode	Run Dis Stop	0	Free–Run	0–2	–
	72	Safe operation deceleration time	Q–Stop Time	5.0		0.0–600.0	sec
In	65–69	Px terminal configuration	Px Define(Px: P1–P5)	13	RUN Enable	0–54	–

__Safe Operation Mode Setting Details__

Pr. Code	Description		
In.65–69 Px Define	From the multi–function terminals, select a terminal to operate in safe operation mode and set it to 13 (RUN Enable).		
Ad.70 Run En Mode	Setting		Function
	0	Always Enable	Enables safe operation mode.
	1	DI Dependent	Recognizes the operation command from a multi–function input terminal.
Ad.71 Run Dis Stop	Set the operation of the drive when the multi–function input terminal in safe operation mode is off.		
	Setting		Function
	0	Free–Run	Blocks the drive output when the multi–function terminal is off.
	1	Q–Stop	The deceleration time (Q–Stop Time) used in safe operation mode. It stops after deceleration and then the operation can resume only when the operation command is entered again. The operation will not begin if only the multi–function terminal is on.
	2	Q–Stop Resume	The drive decelerates to the deceleration time (Q–Stop Time) in safe operation mode. It stops after deceleration. Then if the multi–function terminal is on, the operation resumes as soon as the operation command is entered again.
Ad.72 Q–Stop Time	Sets the deceleration time when Ad.71 (Run Dis Stop) is set to 1 (Q–Stop) or 2 (Q–Stop Resume).		



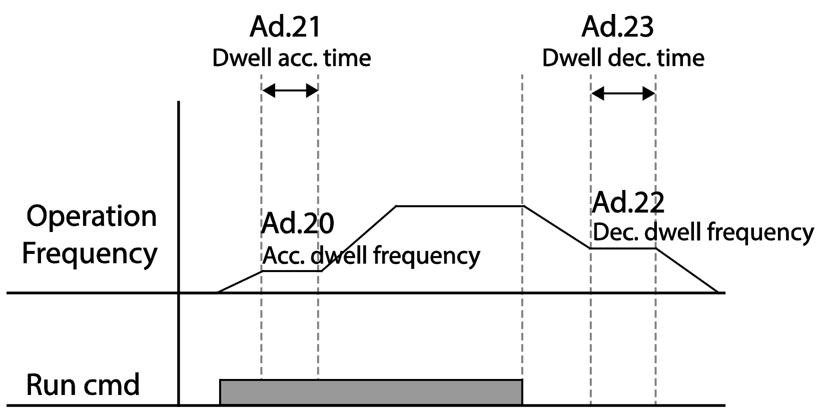
Dwell Operation

The dwell operation is used to maintain torque during the application and release of the brakes on lift–type loads. Drive dwell operation is based on the Acc/Dec dwell frequency and the dwell time set by the user. The following points also affect dwell operation:

- *Acceleration Dwell Operation: When an operation command runs, acceleration continues until the acceleration dwell frequency and constant speed is reached within the acceleration dwell operation time (Acc Dwell Time). After the Acc Dwell Time has passed, acceleration is carried out based on the acceleration time and the operation speed that was originally set.*
- *Deceleration Dwell Operation: When a stop command is run, deceleration continues until the deceleration dwell frequency and constant speed is reached within the deceleration dwell operation time (Dec Dwell Freq). After the set time has passed, deceleration is carried out based on the deceleration time that was originally set, then the operation stops.*

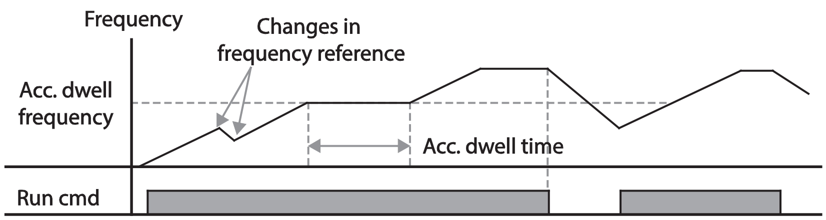
When dr.9 (Control Mode) is set to 0 (V/F), the drive can be used for operations with dwell frequency before opening the mechanical brake of lift–type loads, such as an elevator.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
Ad	20	Dwell frequency during acceleration	Acc Dwell Freq	5.00	Start frequency – Maximum frequency	Hz
	21	Operation time during acceleration	Acc Dwell Time	0.0	0.0–10.0	s
	22	Dwell frequency during deceleration	Dec Dwell Freq	5.00	Start frequency – Maximum frequency	Hz
	23	Operation time during deceleration	Dec Dwell Time	0.0	0 .0–60.0	s



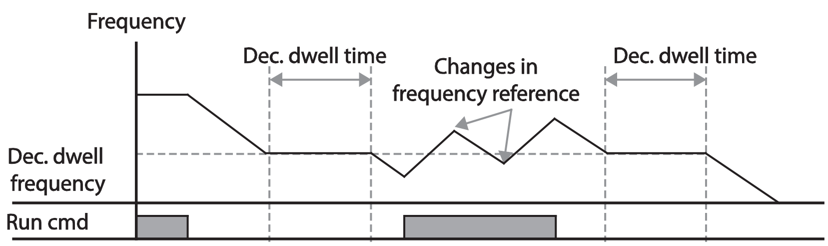
NOTE: Dwell operation does not work when:

- *Dwell operation time is set to 0 sec or dwell frequency is set to 0 Hz.*
- *Re-acceleration is attempted from stop or during deceleration, as only the first acceleration dwell operation command is valid.*



Acceleration dwell operation

Although deceleration dwell operation is carried out whenever stop commands are entered and the deceleration dwell frequency is passed through, it does not work during a deceleration by simple frequency change (which is not a deceleration due to a stop operation), or during external brake control applications.



Deceleration dwell operation

CAUTION: When a dwell operation is carried out for a lift – type load before its mechanical brake is released, motors can be damaged or their lifecyle reduced due to overflow current in the motor.

Slip Compensation Operation

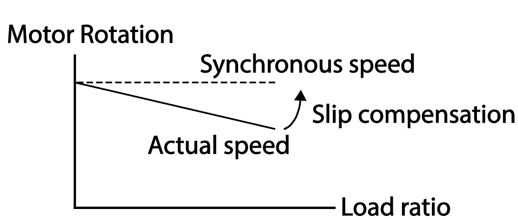
Slip refers to the variation between the setting frequency (synchronous speed) and motor rotation speed. As the load increases there can be variations between the setting frequency and motor rotation speed. Slip compensation is used for loads that require compensation of these speed variations.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
dr	09	Control mode	Control Mode	2	Slip Compen	–	–
	14	Motor capacity	Motor Capacity	2	0.75 kW (0.75 kW based)	0–15	–
bA	11	Number of motor poles	Pole Number	4		2–48	–
	12	Rated slip speed	Rated Slip	90 (0.75 kW based)		0–3000	rpm
	13	Rated motor current	Rated Curr	3.6 (0.75 kW based)		1.0–1000.0	A
	14	Motor no–load current	Noload Curr	1.6 (0.75 kW based)		0.5–1000.0	A
	16	Motor efficiency	Efficiency	72 (0.75 kW based)		64–100	%
	17	Load inertia rate	Inertia Rate	0 (0.75 kW based)		0–8	–

Slip Compensation Operation Setting Details

<table>
<tr><th>Pr. Code</th><th colspan="2">Description</th></tr>
<tr><td>dr.9 Control Mode</td><td colspan="2">Set dr.9 to 2 (Slip Compen) to carry out the slip compensation operation.</td></tr>
<tr><td>dr.14 Motor Capacity</td><td colspan="2">Set the capacity of the motor connected to the drive.</td></tr>
<tr><td>bA.11 Pole Number</td><td colspan="2">Enter the number of poles from the motor rating plate.</td></tr>
<tr><td>bA.12 Rated Slip</td><td colspan="2">Enter the rated slip in rpm. (Slip rpm = Synchronous RPM - Nameplate RPM)

For example, a 4 pole motor with nameplate of 1725 RPM.
Slip RPM = 1800 - 1725 = 75 RPM
ba.12 = 75</td></tr>
<tr><td>bA.13 Rated Curr</td><td colspan="2">Enter the rated current from the motor rating plate.</td></tr>
<tr><td>bA.14 Noload Curr</td><td colspan="2">Enter the measured current when the load on the motor axis is removed and when the motor is operated at the rated frequency. If no–load current is difficult to measure, enter a current equivalent to 30–50% of the rated motor current.</td></tr>
<tr><td>bA.16 Efficiency</td><td colspan="2">Enter the efficiency from the motor rating place.</td></tr>
<tr><td rowspan="6">bA.17 Inertia Rate</td><td colspan="2">Select load inertia based on motor inertia.</td></tr>
<tr><td>Setting</td><td>Function</td></tr>
<tr><td>0</td><td>Less than 10 times motor inertia</td></tr>
<tr><td>1</td><td>10 times motor inertia</td></tr>
<tr><td>2–8</td><td>More than 10 times motor inertia</td></tr>
<tr><td colspan="2">$$f_s = f_r - \frac{Rpm \times P}{120}$$
f(s)=Rated slip frequency
f(r)=Rated frequency
rpm=Number of the rated motor rotations
P=Number of motor poles</td></tr>
</table>



PID Control

PiD control is one of the most common auto–control methods. It uses a combination of proportional, integral, and differential (PID) control that provides more effective control for automated systems. The functions of PID control that can be applied to the drive operation are as follows:

Purpose	Function
Speed control	Controls speed by using feedback about the existing speed level of the equipment or machinery to be controlled. Control maintains consistent speed or operates at the target speed.
Pressure control	Controls pressure by using feedback about the existing pressure level of the equipment or machinery to be controlled. Control maintains consistent pressure or operates at the target pressure.
Flow control	Controls flow by using feedback about the amount of existing flow in the equipment or machinery to be controlled. Control maintains consistent flow or operates at a target flow.
Temperature control	Controls temperature by using feedback about the existing temperature level of the equipment or machinery to be controlled. Control maintains a consistent temperature or operates at a target temperature.

PID Basic Operation

PID operates by controlling the output frequency of the drive, through automated system process control to maintain speed, pressure, flow, temperature and tension.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
AP	01	Application function selection	App Mode	2	Proc PID	0–2	–
	16	PID output monitor	PID Output	–		–	–
	17	PID reference monitor	PID Ref Value	–		–	–
	18	PID feedback monitor	PID Fdb Value	–		–	–
	19	PID reference setting	PID Ref Set	50.00		–100.00–100.00	%
	20	PID reference source	PID Ref Source	0	Keypad	0–11	–
	21	PID feedback source	PID F/B Source	0	V1	0–10	–
	22	PID controller proportional gain	PID P–Gain	50.0		0.0–1000.0	%
	23	PID controller integral time	PID I–Time	10.0		0.0–200.0	sec
	24	PID controller differential time	PID D–Time	0		0–1000	msec
	25	PID controller feed–forward compensation gain	PID F–Gain	0.0		0–1000	%
	26	Proportional gain scale	P Gain Scale	100.0		0.0–100.0	%
	27	PID output filter	PID Out LPF	0		0–10000	ms
	28	PID mode	PID mode	0	Process PID	0–1	
	29	PID maximum frequency	PID Limit Hi	60.00		–300.00–300.00	Hz
	30	PID minimum frequency	PID Limit Lo	0.5		–300.00–300.00	Hz
	31	PID output reverse	PID Out Inv	0	No	0–1	–
	32	PID output scale	PID Out Scale	100.0		0.1–1000.0	%
	34	PID controller motion frequency	Pre–PID Freq	0.00		0–Maximum frequency	Hz
	35	PID controller motion level	Pre–PID Exit	0.0		0.0–100.0	%
	36	PID controller motion delay time	Pre–PID Delay	600		0–9999	sec
	37	PID sleep mode delay time	PID Sleep DT	60.0		0–999.9	sec
	38	PID sleep mode frequency	PID Sleep Freq	0.00		0–Maximum frequency	Hz
	39	PID wake–up level	PID WakeUp Lev	35		0–100	%

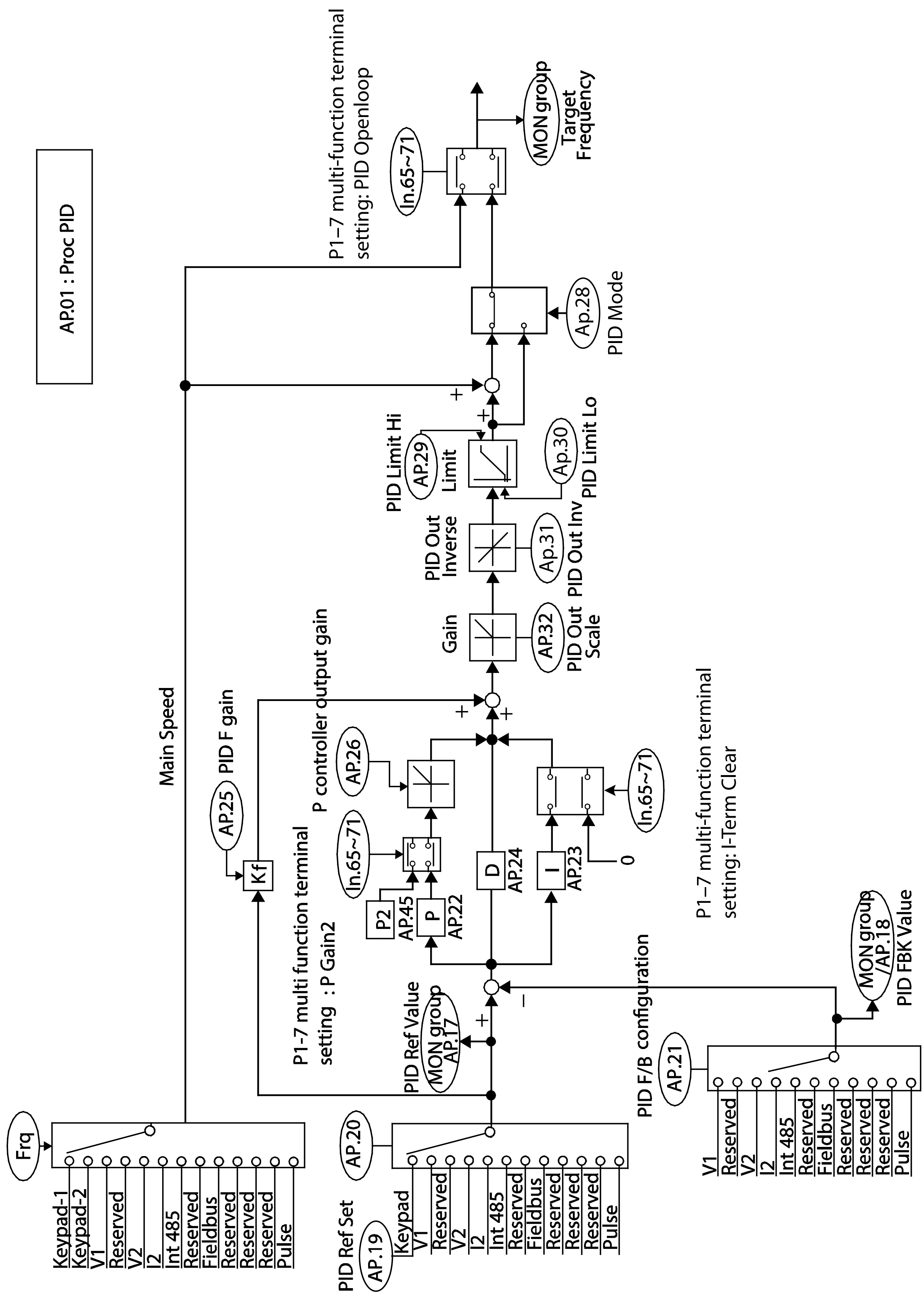
Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
AP	40	PID wake–up mode selection	PID WakeUp Mod	0	Below Level	0–2	–
	42	PID controller unit selection	PID Unit Sel	0	%	0–12	–
	43	PID unit gain	PID Unit Gain	100.0		0–300	%
	44	PID unit scale	PID Unit Scale	2	x 1	0–4	–
	45	PID 2nd proportional gain	PID P2–Gain	100.00		0–1000	%
In	65–69	Px terminal configuration	Px Define (Px: P1–P5)	22	I–Term Clear	0–54	–
				23	PID Openloop		
				24	P Gain2		

PID Basic Operation Setting Details

<table>
<tr><th>Pr. Code</th><th colspan="3">Description</th></tr>
<tr><td>AP.1 App Mode</td><td colspan="3">Set the code to 2 (Proc PID) to select functions for the process PID.</td></tr>
<tr><td>AP.16 PID Output</td><td colspan="3">Displays the existing output value of the PID controller. The unit, gain, and scale that were set at AP. 42–44 are applied on the display.</td></tr>
<tr><td>AP.17 PID Ref Value</td><td colspan="3">Displays the existing reference value set for the PID controller. The unit, gain, and scale that were set at AP. 42–44 are applied on the display.</td></tr>
<tr><td>AP.18 PID Fdb Value</td><td colspan="3">Displays the input value of the PID controller that is included in the latest feedback. The unit, gain, and scale that were set at AP. 42–44 are applied on the display.</td></tr>
<tr><td>AP.19 PID Ref Set</td><td colspan="3">When AP.20 (PID control reference source) is set to 0 (Keypad), the reference value can be entered. If the reference source is set to any other value, the setting values for AP.19 are void.</td></tr>
<tr><td rowspan="12">AP.20 PID Ref Source</td><td colspan="3">Selects the reference input for the PID control. If the V1 terminal is set to PID feedback source (PID F/B Source), the V1 terminal cannot be set to the PID reference source (PID Ref Source). To set V1 as a reference source, change the feedback source.</td></tr>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>Keypad</td><td>Keypad</td></tr>
<tr><td>1</td><td>V1</td><td>–10–10V input voltage terminal</td></tr>
<tr><td>3</td><td>V2</td><td rowspan="2">I2 analog input terminal
[When analog voltage/current input terminal selection switch (SW2) at the terminal block is set to I (current), input 4–20 mA current. If it is set to V (voltage), input 0–10V voltage]</td></tr>
<tr><td>4</td><td>I2</td></tr>
<tr><td>5</td><td>Int. 485</td><td>RS–485 input terminal</td></tr>
<tr><td>7</td><td>FieldBus (Ethernet)</td><td>Communication command via a communication option card</td></tr>
<tr><td>9</td><td>UserSeqLink</td><td>Link the common area with the user sequence output.</td></tr>
<tr><td>11</td><td>Pulse</td><td>TI Pulse input terminal (0–32 kHz Pulse input)</td></tr>
<tr><td colspan="3">When using the keypad, the PID reference setting can be displayed at AP.17. When using the LDC keypad, the PID reference setting can be monitored from the config mode (CNF) –06–08, set to 17 (PID Ref Value).</td></tr>
<tr style="display:none"><td colspan="3"></td></tr>
<tr><td>AP.21 PID F/B Source</td><td colspan="3">Selects feedback input for PID control. Items can be selected as reference input, except the keypad input (Keypad–1 and Keypad–2). Feedback cannot be set to an input item that is identical to the item selected as the reference. For example, when Ap.20 (Ref Source) is set to 1 (V1), for AP. 21 (PID F/B Source), an input other than the V1 terminal must be selected. When using the LCD keypad, the volume of feedback can be monitored using a code from the config mode (CNF) –06–08, by setting it to 18 (PID Fbk Value).</td></tr>
<tr><td>AP.22 PID P–Gain,
AP.26 P Gain Scale</td><td colspan="3">Sets the output ratio for differences (errors) between reference and feedback. If the Pgain is set to 50%, then 50% of the error is output. The setting range for Pgain is 0.0–1, 000%. For ratios below 0.1%, use AP.26 (P Gain Scale).</td></tr>
<tr><td>AP.23 PID I– Time</td><td colspan="3">Sets the time to output accumulated errors. When the error is 100%, the time taken for 100% output is set. When the integral time (PID I–Time) is set to 1 second, 100% output occurs after 1 second of the error remaining at 100%. Differences in a normal state can be reduced by PID I Time. When the multi–function terminal block is set to 21(I–Term Clear) and is turned on, all of the accumulated errors are deleted.</td></tr>
<tr><td>AP.24 PID D–Time</td><td colspan="3">Sets the output volume for the rate of change in errors. If the differential time (PID D–Time) is set to 1ms and the rate of change in errors per sec is 100%, output occurs at 1% per 10ms.</td></tr>
<tr><td>AP.25 PID F–Gain</td><td colspan="3">Sets the ratio that adds the target to the PID output. Adjusting this value leads to a faster response.</td></tr>
<tr><td>AP.27 PID Out LPF</td><td colspan="3">Used when the output of the PID controller changes too fast or the entire system is unstable, due to severe oscillation. In general, a lower value (default value=0) is used to speed up response time, but in some cases a higher value increases stability. The higher the value, the more stable the PID controller output is, but the slower the response time.</td></tr>
<tr><td>AP.28 PID Mode</td><td colspan="3">By default, parameter AP.28 is set to "Proc PID". This adds the main frequency reference based on the setting in frq/DRV07. This is more commonly suited for industrial applications that may be running a PID loop with a trim input.
If you are running a fan or pump application with a PID loop it is recommended to set this to "Normal PID". Reference the function block diagram for more info.</td></tr>
<tr><td>AP.29 PID Limit Hi,
AP.30 PID Limit Lo</td><td colspan="3">Limits the output of the controller.</td></tr>
<tr><td>AP.32 PID Out Scale</td><td colspan="3">Adjusts the volume of the controller output.</td></tr>
</table>

<table>
<tr><th>Pr. Code</th><th colspan="3">Description</th></tr>
<tr><td rowspan="15">AP.42 PID Unit Sel</td><td colspan="3">Sets the unit of the control variable (available only on the LCD keypad).</td></tr>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>%</td><td>Displays a percentage without a physical quantity given.</td></tr>
<tr><td>1</td><td>Bar</td><td rowspan="4">Various units of pressure can be selected.</td></tr>
<tr><td>2</td><td>mBar</td></tr>
<tr><td>3</td><td>Pa</td></tr>
<tr><td>4</td><td>kPa</td></tr>
<tr><td>5</td><td>Hz</td><td rowspan="2">Displays the drive output frequency or the motor rotation speed.</td></tr>
<tr><td>6</td><td>rpm</td></tr>
<tr><td>7</td><td>V</td><td rowspan="4">Displays in voltage/current/power/horsepower.</td></tr>
<tr><td>8</td><td>I</td></tr>
<tr><td>9</td><td>kW</td></tr>
<tr><td>10</td><td>HP</td></tr>
<tr><td>11</td><td>°C</td><td rowspan="2">Displays in Celsius or Fahrenheit.</td></tr>
<tr><td>12</td><td>°F</td></tr>
<tr><td>AP.43 PID Unit Gain,
AP.44 PID Unit Scale</td><td colspan="3">Adjusts the size to fit the unit selected at AP.41 PID Unit Sel.</td></tr>
<tr><td>AP.45 PID P2–Gain</td><td colspan="3">The PID controller’s gain can be adjusted using the multi–function terminal. When a terminal is selected from In.65–69 and set to 24 (P Gain2), and if the selected terminal is entered, the gain set in AP.22 and AP.23 can be switched to the gain set in AP.45.</td></tr>
</table>

NOTE: When the PID switch operation (switching from PID operation to general operation) enters the multi-function input, % values are converted to [Hz] values. The normal PID output, PID OUT, is unipolar, and is limited by AP.29 (PID Limit Hi) and AP.30 (PID Limit Lo). A calculation of 100.0% is based on the dr.20 (Max Freq) parameter setting.



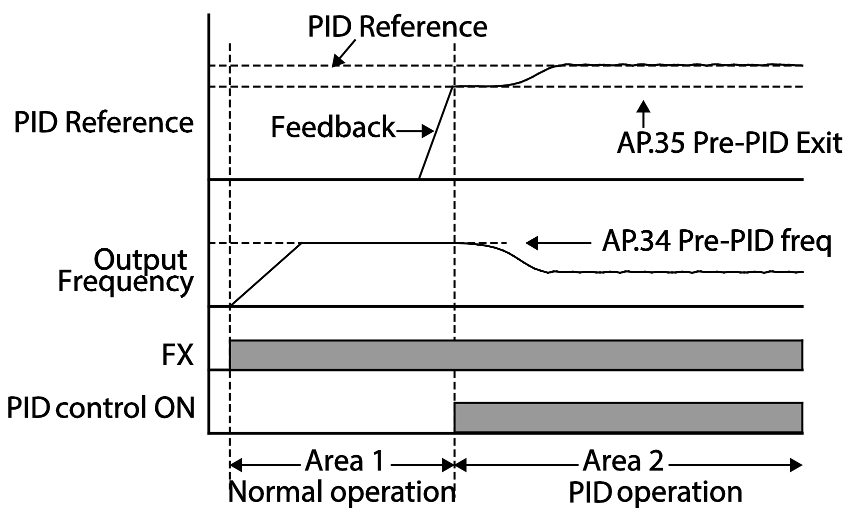
PID control block diagram

Pre–PID Operation

When an operation command is entered that does not include PID control, general acceleration occurs until the set frequency is reached. When the controlled variables increase to a particular point, the PID operation begins.

Pre–PID Operation Setting Details

Pr. Code	Description
AP.34 Pre–PID Freq	When general acceleration is required, the frequency up to general acceleration is entered. If Pre–PID Freq is set to 30Hz, the general operation continues until the control variable (PID feedback variable) set at AP. 35 is exceeded.
AP.35 Pre–PID Exit, AP.36 Pre–PID Delay	When the feedback variable of the PID controller is higher than the value set at AP. 35, the PID control operation begins. However, when a value is set for AP.36 (Pre–PID Delay) and a feedback variable less than the value set at AP.35 is maintained for a set amount of time, the “pre–PID Fail” fault trip will occur and the output will be blocked.

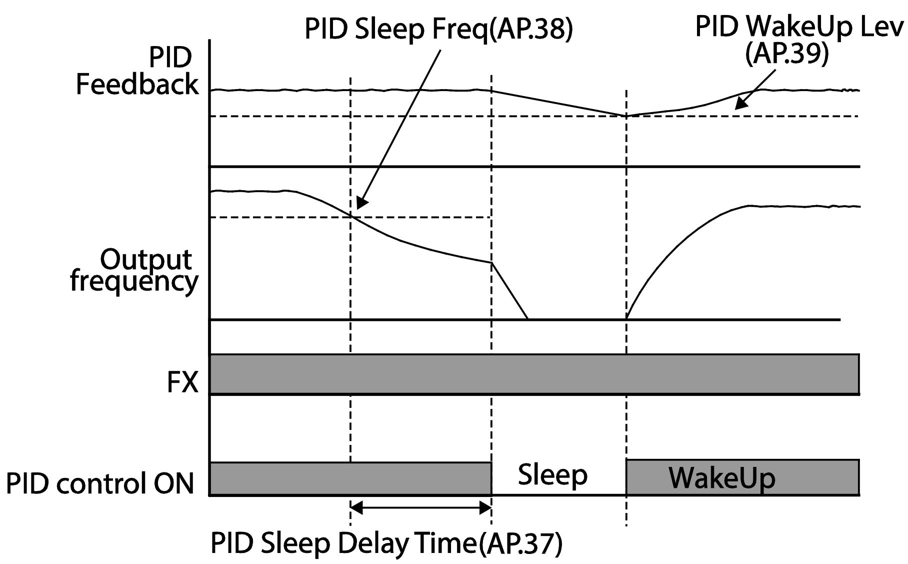


PID Operation Sleep Mode

If the operation continues at a frequency lower than the set condition for PID operation, the PID operation sleep mode starts. When PID operation sleep mode starts, the operation will stop until the feedback exceeds the parameter value set at AP.39 (PID WakeUp Lev).

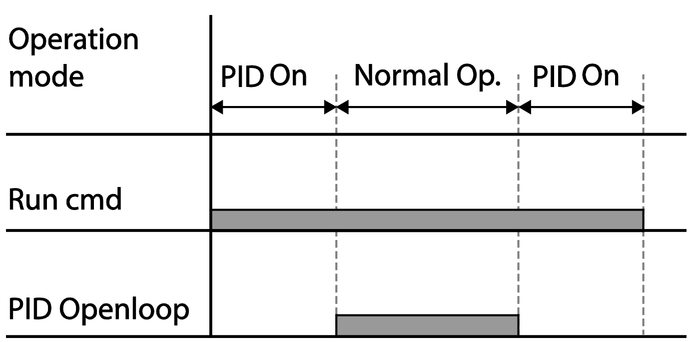
PID Operation Sleep Mode Setting Details

Pr. Code	Description
AP.37 PID Sleep DT, AP.38 PID Sleep Freq	If an operation frequency lower than the value set at AP.38 is maintained for the time set at AP.37, the operation stops and the PID operation sleep mode starts.
AP.39 PID WakeUp Lev, AP.40 PID WakeUp Mod	Starts the PID operation when in PID operation sleep mode. If AP. 40 is set to 0 (Below Level), the PID operation starts when the feedback variable is less than the value set as the AP. 39 parameter setting. If AP. 40 is set to 1 (Above Level), the operation starts when the feedback variable is higher than the value set at AP. 39. If AP. 40 is set to 2 (Beyond Level), the operation starts when the difference between the reference value and the feedback variable is greater than the value set at AP. 39.



PID Switching (PID Openloop)

When one of the multi–function terminals (In. 65–69) is set to 23 (PID Openloop) and is turned on, the PID operation stops and is switched to general operation. When the terminal turns off, the PID operation starts again.



Auto Tuning

The motor parameters can be measured automatically and can be used for auto torque boost or sensorless vector control.

Example – Auto Tuning Based on 1HP (0.75kW), 230V Motor

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
dr	14	Motor capacity	Motor Capacity	1	0.75 kW	0–15	–
bA	11	Motor pole number	Pole Number	4		2–48	–
	12	Rated slip speed	Rated Slip	40		0–3000	rpm
	13	Rated motor current	Rated Curr	3.6		1.0–1000.0	A
	14	Motor no–load current	Noload curr	1.6		0.5–1000.0	A
	15	Motor rated voltage	Rated Volt	220		170–480	V
	16	Motor efficiency	Efficiency	72		64–100	%
	20	Auto tuning	Auto Tuning	0	None	–	–
	21	Stator resistance	Rs	26.00		Depends on the motor setting	Ω
	22	Leakage inductance	Lsigma	179.4		Depends on the motor setting	mH
	23	Stator inductance	Ls	1544		Depends on the motor setting	mH
	24	Rotor time constant	Tr	145		25–5000	ms

Auto Tuning Default Parameter Setting

Motor Capacity kW (HP)		Rated Current (A)	No–load Current (A)	Rated Slip Frequency(Hz)	Stator Resistance(Ω)	Leakage Inductance (mH)
230V	0.2 (0.25)	1.1	0.8	3.33	14.0	40.4
	0.4 (0.5)	2.4	1.4	3.33	6.70	26.9
	0.75 (1.0)	3.4	1.7	3.00	2.600	17.94
	1.5 (2.0)	6.4	2.6	2.67	1.170	9.29
	2.2 (3.0)	8.6	3.3	2.33	0.840	6.63
	3.7 (5.0)	13.8	5.0	2.33	0.500	4.48
	5.5 (7.5)	21.0	7.1	1.50	0.314	3.19
	7.5 (10)	28.2	9.3	1.33	0.169	2.844
	11 (14.75)	40.0	12.4	1.00	0.120	1.488
	15 (20)	53.6	15.5	1.00	0.084	1.118
	18.5 (24.8)	65.6	19.0	1.00	0.068	0.819
	22 (29.5)	76.8	21.5	1.00	0.056	0.948
**When dr.9 (Control Mode) is set to 6 (PM Sensorless), auto tuning will configure the rated current and the stator resistor values by default.*						

Motor Capacity kW (HP)		Rated Current (A)	No–load Current (A)	Rated Slip Frequency(Hz)	Stator Resistance(Ω)	Leakage Inductance (mH)
460V	0.2 (0.25)	0.7	0.5	3.33	28.00	121.2
	0.4 (0.5)	1.4	0.8	3.33	14.0	80.8
	0.75 (1.0)	2.0	1.0	3.00	7.81	53.9
	1.5 (2.0)	3.7	1.5	2.67	3.52	27.9
	2.2 (3.0)	5.0	1.9	2.33	2.520	19.95
	3.7 (5.0)	8.0	2.9	2.33	1.500	13.45
	5.5 (7.5)	12.1	4.1	1.50	0.940	9.62
	7.5 (10)	16.3	5.4	1.33	0.520	8.53
	11 (14.75)	23.2	7.2	1.00	0.360	4.48
	15 (20)	31.0	9.0	1.00	0.250	3.38
	18.5 (24.8)	38.0	11.0	1.00	0.168	2.457
	22 (29.5)	44.5	12.5	1.00	0.168	2.844
**When dr.9 (Control Mode) is set to 6 (PM Sensorless), auto tuning will configure the rated current and the stator resistor values by default.*						

Auto Tuning Parameter Setting Details

Pr. Code	Description		
bA.20 Auto Tuning	Select an auto tuning type and run it. Select one of the options and then press the [ENT] key to run the auto tuning.		
	Setting		Function
	0	None	Auto tuning function is not enabled. Also, if you select one of the auto tuning options and run it, the parameter value will revert back to "0" when the auto tuning is complete.
	1	All (rotating type)	Measures all motor parameters, including stator resistance (Rs), stator inductance (Lsigma), no–load current (Noload Curr), rotor time constant (Tr), etc., while the motor is rotating. As the motor is rotating while the parameters are being measured, if the load is connected to the motor spindle, the parameters may not be measured accurately. For accurate measurements, remove the load attached to the motor spindle. However, note that the rotor time constant (Tr) must be measured in a stopped position.
	2	All (static type)	Measures all parameters while the motor is in the stopped position. Measures stator resistance (Rs), stator inductance (Lsigma), no–load current (Noload Curr), rotor time constant (Tr), etc., while the motor is in the stopped position. As the motor is not rotating while the parameters are measured, the measurements are not affected when the load is connected to the motor spindle. However, when measuring parameters, do not rotate the motor spindle on the load side.
	3	Rs+Lsigma (rotating type)	Measures parameters while the motor is rotating. The measured motor parameters are used for auto torque boost or sensorless vector control.
	6	Tr (static type)	Measures the rotor time constant (Tr) with the motor in the stopped position and Control Mode (dr.9) is set to IM Sensorless.
	7	All (PM)	When dr.9 (Control Mode) is set to 6 (PM Sensorless), the motor parameters are measured in the stopped position. Check the motor's rating plate for motor specifications, such as the base frequency (dr.18), rated voltage (bA.15), pole number (bA.11). Then, perform auto tuning by setting bA.20 to 7 [All (PM)]. The auto tuning operation will configure the bA.21 (Rs), bA.28 [Ld (PM)], bA.29 [Lq (PM)], and bA.30 (PM Flux Ref) parameters.

Pr. Code	Description
bA.14 Noload Curr, bA.21 Rs–bA.24 Tr	Displays motor parameters measured by auto tuning. For parameters that are not included in the auto tuning measurement list, the default setting will be displayed.

CAUTION:

- *Perform auto tuning ONLY after the motor has completely stopped running.*
- *Before you run auto tuning, check the motor pole number, rated slip, rated current, rated voltage and efficiency on the motor's rating plate and enter the data. The default parameter setting is used for values that are not entered.*
- *When measuring all parameters after selecting 2 (All – static type) at bA.20: compared with rotation type auto tuning where parameters are measured while the motor is rotating, parameter values measured with static auto tuning may be less accurate. Inaccuracy of the measured parameters may degrade the performance of sensorless operation. Therefore, run static type auto tuning by selecting 2 (All) only when the motor cannot be rotated (when gearing and belts cannot be separated easily, or when the motor cannot be separated mechanically from the load).*
- *In PM synchronous motor sensorless control mode, check the motor's rating plate and enter the motor specifications, such as the base frequency, pole number, rated current and voltage, and efficiency, before performing auto tuning and detecting other motor parameters by setting bA.20 (Auto Tuning) to 7 [All (PM)]. The detected parameter values may not be accurate if the motor's base specifications are not entered.*

Sensorless Vector Control for Induction Motors

Sensorless vector control is an operation to carry out vector control without the rotation speed feedback from the motor but with an estimation of the motor rotation speed calculated by the drive. Compared to V/F control, sensorless vector control can generate greater torque at a lower level of current.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
dr	09	Control mode	Control Mode	4: IM Sensorless	–	–
	14	Motor capacity	Motor Capacity	Depends on the motor capacity	0–15	–
	18	Base frequency	Base Freq	60	30–400	Hz
bA	11	Motor pole number	Pole Number	4	2–48	–
	12	Rated slip speed	Rated Slip	Depends on the motor capacity	0–3000	Hz
	13	Rated motor current	Rated Curr	Depends on the motor capacity	1–1000	A
	14	Motor no–load current	Noload curr	Depends on the motor capacity	0.5–1000	A
	15	Rated motor voltage	Rated Volt	220/380/440/480	170–480	V
	16	Motor efficiency	Efficiency	Depends on the motor capacity	64–100	%
	20	Auto tuning	Auto Tuning	1: All	–	–

**Cn.23–32 and Cn.85–95 can be displayed only when Cn.20 is set to 1 (Yes).*

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
Cn	09	Pre–Excite time	PreExTime	1.0	0.0–60.0	s
	10	Pre–Excite amount	Flux Force	100.0	100.0–300.0	%
	20	Sensorless second gain display setting	SL2 G View Sel	1: Yes	0–1	–
	21	Sensorless speed controller proportional gain1	ASR–SL P Gain1	Depends on the motor capacity	0–5000	%
	22	Sensorless speed controller integral gain 1	ASR–SL I Gain1	Depends on the motor capacity	10–9999	ms
	23*	Sensorless speed controller proportional gain 2	ASR–SL P Gain2	Depends on the motor capacity	1–1000	%
	24*	Sensorless speed controller integral gain 2	ASR–SL I Gain2	Depends on the motor capacity	1–1000	%
	25*	Sensorless speed controller integral gain 0	ASR–SL I Gain0	Depends on the motor capacity	10–9999	ms
	26*	Flux estimator proportional gain	Flux P Gain	Depends on the motor capacity	10–200	%
	27*	Flux estimator integral gain	Flux I Gain	Depends on the motor capacity	10–200	%
	28*	Speed estimator proportional gain	S–Est P Gain1	Depends on the motor capacity	0–32767	–
Cn	29*	Speed estimator integral gain1	S–Est I Gain1	Depends on the motor capacity	100–1000	–
	30*	Speed estimator integral gain2	S–Est I Gain2	Depends on the motor capacity	100–10000	–
	31*	Sensorless current controller proportional gain	ACR SL P Gain	75	10–1000	–
	32*	Sensorless current controller integral gain	ACR SL I Gain	120	10–1000	–
	52	Torque controller output filter	Torque Out LPF	0	0–2000	ms
	53	Torque limit setting	Torque Lmt Src	0: Keypad–1	0–12	–
	54	Forward direction retrograde torque limit	FWD +Trq Lmt	180.0	0.0–200.0	%
	55	Forward direction regenerative torque limit	FWD –Trq Lmt	180.0	0.0–200.0	%
	56	Reverse direction regenerative torque limit	REV +Trq Lmt	180.0	0.0–200.0	%
	57	Reverse direction retrograde torque limit	REV –Trq Lmt	180.0	0.0–200.0	%
	85*	Flux estimator proportional gain 1	Flux P Gain1	370	100–700	–
	86*	Flux estimator proportional gain 2	Flux P Gain2	0	0–100	–
	87*	Flux estimator proportional gain 3	Flux P Gain3	100	0–500	–
	88*	Flux estimator integral gain 1	Flux I Gain1	50	0–200	–
	89*	Flux estimator integral gain2	Flux I Gain2	50	0–200	–
	90*	Flux estimator integral gain 3	Flux I Gain3	50	0–200	–
	91*	Sensorless voltage compensation 1	SL Volt Comp1	30	0–60	–
	92*	Sensorless voltage compensation 2	SL Volt Comp2	20	0–60	–
	93*	Sensorless voltage compensation 3	SL Volt Comp3	20	0–60	–
	94*	Sensorless field weakening start frequency	SL FW Freq	95.0	80.0–110.0	%
	95*	Sensorless gain switching frequency	SL Fc Freq	2.00	0.00–8.00	Hz

**Cn.23–32 and Cn.85–95 can be displayed only when Cn.20 is set to 1 (Yes).*

CAUTION: For high–performance operation, the parameters of the motor connected to the drive output must be measured. Use auto tuning (bA.20 Auto Tuning) to measure the parameters before you run sensorless vector operation. To run high–performance sensorless vector control, the drive and the motor must have the same capacity. If the motor capacity is smaller than the drive capacity by more than two levels, control may be inaccurate. In that case, change the control mode to V/F control. When operating with sensorless vector control, do not connect multiple motors to the drive output.

Sensorless Vector Control Operation Setting for Induction Motors

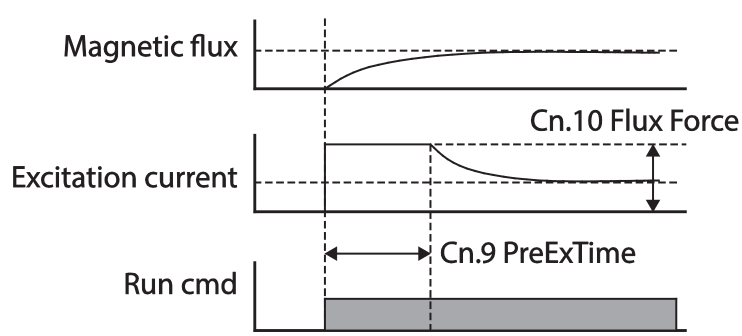
To run sensorless vector control operation, set dr.9 (Control Mode) to 4 (IM sensorless), select the capacity of the motor you will use at dr.14 (Motor Capacity), and select the appropriate codes to enter the rating plate information of the motor.

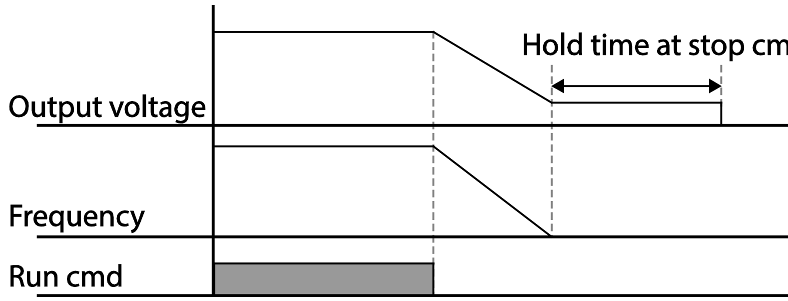
Pr. Code	Input (Motor Rating Plate Information)
dr.18 Base Freq	Base frequency
bA.11 Pole Number	Motor pole number
bA.12 Rated Slip	Rated slip
bA.13 Rated Curr	Rated current
bA.15 Rated Volt	Rated voltage
bA.16 Efficiency	Efficiency (when no information is on the rating plate, default values are used.)

After setting each code, set bA.20 (Auto tuning) to 1 (All – rotation type) or 2 (All – static type) and run auto tuning. Because rotation type auto tuning is more accurate than static type auto tuning, select 1 (All – rotation type) and run auto tuning if you can rotate the motor.

> *NOTE: Excitation Current*
> *A motor can be operated only after magnetic flux is generated by current flowing through a coil. The power supply used to generate the magnetic flux is called the excitation current. The stator coil that is used with the drive does not have a permanent magnetic flux, so the magnetic flux must be generated by supplying an excitation current to the coil before operating the motor.*

<u>Sensorless Vector Control Operation Setting Details for Induction Motors</u>

<table>
<tr><th>Pr. Code</th><th colspan="3">Description</th></tr>
<tr><td rowspan="4">Cn.20 SL2 G View Sel</td><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>No</td><td>Does not display sensorless (II) vector control gain code.</td></tr>
<tr><td>1</td><td>Yes</td><td>Allows the user to set various gains applied when the motor rotates faster than medium speed (approx. 1/2 of the base frequency) through sensorless (II) vector control.</td></tr>
<tr><td colspan="3">Codes available when setting to 1 (Yes): Cn.23 ASR–SL P Gain2/Cn.24 ASR–SL I Gain2/Cn.26 Flux P Gain/ Cn.27 Flux I Gain Gain3/Cn.28 S–Est P Gain1/Cn.29 S–Est I Gain1/Cn.30 S–Est I Gain1/Cn.31 ACR SL P Gain/ Cn.32 ACR SL I Gain</td></tr>
<tr><td>Cn.9 PreExTime</td><td colspan="3">Sets pre–excitation time. Pre–excitation is used to start the operation after performing excitation up to the motor’s rated flux.</td></tr>
<tr><td>Cn.10 Flux Force</td><td colspan="3">Allows for the reduction of the pre–excitation time. The motor flux increases up to the rated flux with the time constant as shown in the following figure. To reduce the time taken to reach the rated flux, a higher motor flux base value than the rated flux must be provided. When the magnetic flux reaches the rated flux, the provided motor flux base value is reduced.

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

Pr. Code	Description
Cn.11 Hold Time	Sets the zero–speed control time (hold time) in the stopped position. The output is blocked after zero–speed operation for a set period when the motor decelerates and is stopped by a stop command. 
Cn.21 ASR–SL P Gain1, Cn.22 ASR–SL I Gain1	Changes the speed PI controller gain during sensorless vector control. For a PI speed controller, P gain is a proportional gain for the speed deviation. If speed deviation becomes higher than the torque the output command increases accordingly. As the value increases, the faster the speed deviation decreases. The speed controller I gain is the integral gain for speed deviation. It is the time taken for the gain to reach the rated torque output command while a constant speed deviation continues. The lower the value becomes, the faster the speed deviation decreases. This setting applies to speed ranges from 3-30Hz
Cn.23 ASR–SL P Gain2, Cn.24 ASR–SL I Gain2	Appears only when 1 (Yes) is selected for Cn.20 (SL2 G view Sel). The speed controller gain can be increased to more than the medium speed for sensorless vector control. Cn.23 ASR–SL P Gain2 is set as a percentage of the low speed gain Cn.21 ASR–SL P Gain1 – if P Gain 2 is less than 100.0%, the responsiveness decreases. For example, if Cn.21 ASR–SL P Gain1 is 50.0% and Cn.23 ASR–SL P Gain2 is 50.0%, the actual middle speed or faster speed controller P gain is 25.0%. Cn.24 ASR–SL I Gain2 is also set as a percentage of the Cn.22 ASR–SL I Gain1. For I gain, the smaller the I gain 2 becomes, the slower the response time becomes. For example, if Cn.22 ASR–SL I Gain1 is 100ms and Cn.24 ASR–SL I Gain2 is 50.0%, the middle speed or faster speed controller I gain is 200 ms. The controller gain is set according to the default motor parameters and Acc/Dec time. This setting applies to speed ranges from above 30Hz
Cn.25	Integral gain to keep the output current from increasing up to overload current level (150%). This parameter only applies for drives of 4Kw(5HP) or less and to speed ranges from 0-3Hz.
Cn.26 Flux P Gain, Cn.27 Flux I Gain, Cn.85–87 Flux P Gain13, Cn.88–90 Flux I Gain1–3	Sensorless vector control requires the rotor flux estimator. For the adjustment of flux estimator gain, refer to "Sensorless Vector Control Operation Guide for Induction Motors" on page 4–152.
Cn.28 S–Est P Gain1, Cn.29 S–Est I Gain1, Cn.30 S–Est I Gain2	Speed estimator gain for sensorless vector control can be adjusted. To adjust speed estimator gain, refer to "Sensorless Vector Control Operation Guide for Induction Motors" on page 4–152.
Cn.31 ACR SL P Gain, Cn.32 ACR SL I Gain	Adjusts the P and I gains of the sensorless current controller. For the adjustment of sensorless current controller gain, refer to "Sensorless Vector Control Operation Guide for Induction Motors" on page 4–152.

<table>
<tr><th>Pr. Code</th><th colspan="3">Description</th></tr>
<tr><td rowspan="12">Cn.53 Torque Lmt Src</td><td colspan="3">Select a type of torque limit setting, using the keypad, terminal block analog input (V1 and I2) or communication power. When setting torque limit, adjust the torque size by limiting the speed controller output. Set the retrograde and regenerative limits for forward and reverse operation.</td></tr>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>Keypad–1</td><td rowspan="2">Sets the torque limit with the keypad.</td></tr>
<tr><td>1</td><td>Keypad–2</td></tr>
<tr><td>2</td><td>V1</td><td rowspan="3">Sets the torque limit with the analog input terminal of the terminal block.</td></tr>
<tr><td>4</td><td>V2</td></tr>
<tr><td>5</td><td>I2</td></tr>
<tr><td>6</td><td>Int 485</td><td>Sets the torque limit with the communication terminal of the terminal block.</td></tr>
<tr><td>8</td><td>FieldBus (Ethernet)</td><td>Sets the torque limit with the FieldBus (Ethernet) communication option.</td></tr>
<tr><td>9</td><td>UserSeqLink</td><td>This enters the torque reference by linking the common area with the user sequence output.</td></tr>
<tr><td>12</td><td>Pulse</td><td>Sets the torque limit with the pulse input of the terminal block.</td></tr>
<tr><td colspan="3">The torque limit can be set up to 200% of the rated motor torque.</td></tr>
<tr><td>Cn.54 FWD +Trq Lmt</td><td colspan="3">Sets the torque limit for forward retrograde (motoring) operation.</td></tr>
<tr><td>Cn.55 FWD –Trq Lmt</td><td colspan="3">Sets the torque limit for forward regenerative operation.</td></tr>
<tr><td>Cn.56 REV +Trq Lmt</td><td colspan="3">Sets the torque limit for reverse regenerative operation.</td></tr>
<tr><td>Cn.57 REV –Trq Lmt</td><td colspan="3">Sets the torque limit for reverse retrograde (motoring) operation.</td></tr>
<tr><td>In.2 Torque at 100%</td><td colspan="3">Sets the maximum torque. For example, if In.2 is set to 200% and an input voltage (V1) is used, the torque limit is 200% when 10V is entered. However, when the VI terminal is set up with the factory default setting and the torque limit setup uses a method other than the keypad, check the parameter settings in the monitor mode. In the Config Mode CNF.21–23 (only displayed when using LCD keypad), select 21(Torque limit).</td></tr>
<tr><td>Cn.91–93 SL Volt Comp1–3</td><td colspan="3">Adjust output voltage compensation values for sensorless vector control. For output voltage compensation, refer to "Sensorless Vector Control Operation Setting for Induction Motors" on page 4–149.</td></tr>
<tr><td>Cn.52 Torque Out LPF</td><td colspan="3">Sets the time constant for torque command by setting the torque controller output filter.</td></tr>
</table>

CAUTION: Adjust the controller gain according to the load's characteristics. However, the motor can overheat or the system may become unstable depending on the controller gain settings.

NOTE: Speed controller gain can improve the speed control waveform while monitoring the changes in speed. If speed deviation does not decrease quickly, increase the speed controller P gain or decrease I gain (time in ms). However, if the P gain is increased too high or I gain is decreased too low, severe vibration may occur. If oscillation occurs in the speed waveform, try to increase I gain (ms) or reduce P gain to adjust the waveform.

Sensorless Vector Control Operation Guide for Induction Motors

Problem	Relevant function code	Troubleshooting
The amount of starting torque is insufficient.	bA.24 Tr Cn.9 PreExTime Cn.10 Flux Force Cn.31 ACR SL P Gain Cn.54–57 Trq Lmt Cn.93 SL Volt Comp3	Set the value of Cn. 90 to be more than 3 times the value of bA.24 or increase the value of Cn.10 by increments of 50%. If the value of Cn.10 is high, an overcurrent trip at start can occur. In this case, reduce the value of Cn.31 by decrements of 10.
		Increase the value of Trq Lmt (Cn.54–57) by increments of 10%.
		Increase the value of Cn.93 by increments of 5.
The output frequency is higher than the base frequency during no–load operation at low speed (10Hz or lower).	Cn.91 SL Volt Comp1	Decrease the value of Cn.91 by decrements of 5.
The motor hunts or the amount of torque is not sufficient while the load is increasing at low speed (10Hz or lower).	Cn.4 Carrier Freq Cn.21 ASR–SL P Gain1 Cn.22 ASR–SL I Gain1 Cn.93 SL Volt Comp3	If the motor hunts at low speed, increase the value of Cn.22 by increments of 50m/s, and if hunting does not occur, increase the value of Cn.21 to find the optimal operating condition.
		If the amount of torque is insufficient, increase the value of Cn.93 by increments of 5.
		If the motor hunts or the amount of torque is insufficient in the 5–10 Hz range, decrease the value of Cn.4 by increments of 1kHz (if Cn.4 is set to exceed 3kHz).
The motor hunts or overcurrent trip occurs in regenerative load at low speed (10 Hz or lower).	Cn.92 SL Volt Comp2 Cn.93 SL Volt Comp3	Increase the value of Cn.92–93 by increments of 5 at the same time.
Over voltage trip occurs due to sudden acceleration/deceleration or sudden load fluctuation (with no brake resistor installed) at mid speed (30Hz or higher).	Cn.24 ASR–SL I Gain2	Decrease the value of Cn.2 by decrements of 5%.
Over current trip occurs due to sudden load fluctuation at high speed (50 Hz or higher).	Cn.54–57 Trq Lmt Cn.94 SL FW Freq	Decrease the value of Cn.54–57 by decrements of 10% (if the parameter setting is 150% or higher).
		Increase/decrease the value of Cn.94 by increments/decrements of 5% (set below 100%).
The motor hunts when the load increases from the base frequency or higher.	Cn.22 ASR–SL I Gain1 Cn.23 ASR–SL I Gain2	Increase the value of Cn.22 by increments of 50m/s or decrease the value of Cn.24 by decrements of 5%.
The motor hunts as the load increases.	Cn.28 S–Est P Gain1 Cn.29 S–Est I Gain1	At low speed (10Hz or lower), increase the value of Cn.29 by increments of 5.
		At mid speed (30 Hz or higher), increase the value of Cn.28 by increments of 500. If the parameter setting is too extreme, over current trip may occur at low speed.
The motor speed level decreases.	bA.20 Auto Tuning	Select 6. Tr (static type) from bA.20 and run tuning. Then Select 1 from bA.20 and run tuning.
**Hunting: Symptom of irregular vibration of the equipment.*		

Sensorless Vector Control for PM (Permanent–Magnet) Synchronous Motors

Sensorless vector control is an operation that carries out vector control without rotation speed feedback from the motor but, instead, with an estimation of the motor rotation speed calculated by the drive.

Pr. Grp	Pr. #	Name	LCD Display	Parameter Setting	Setting Range	Unit
dr	09	Control mode	Control Mode	6: PM Sensorless	–	–
	14	Motor capacity	Motor Capacity	Depends on the motor capacity	0–15	–
	18	Base frequency	Base Freq	Depends on the PM motor capacity	30–180	Hz
	20	Maximum frequency	Max Freq	Depends on the PM motor capacity	40–180	Hz
bA	11	Motor pole number	Pole Number	4	2–48	–
	13	Rated motor current	Rated Curr	Depends on the motor capacity	1–1000	A
	15	Motor–rated voltage	Rated Volt	220/380/440/480	170–480	V
	16	Motor efficiency	Efficiency	Depends on the motor capacity	64–100	%
	19	Motor input voltage	AC Input Volt	220/380	170–480	–
	20	Auto tuning	Auto Tuning	7	All (PM)	–
	32	Q–axis inductance scale	Lq (PM) Scale	100%	50–150	%
	34	Auto tuning level for Ld and Lq	Ld, Lq Tune Lev	33.3%	20.0–50.0	%
	35	Auto tuning frequency for Ld and Lq	Ld, Lq Tune Hz	100.0%	80.0–150.0	%
Cn	12	PM speed controller P gain 1	ASR P Gain 1	100	0–5000	–
	13	PM speed controller I gain 1	ASR I Gain 1	150	0–5000	–
	15	PM speed controller P gain 2	ASR P Gain 2	100	0–5000	–
	16	PM speed controller I gain 2	ASR I Gain 2	150	0–9999	–
	33	PM D–axis back–EMF estimated gain	PM EdGain Perc	100.0	0–300.0	%
	34	PM Q–axis back–EMF estimated gain	PM EqGain Perc	100.0	0–300.0	%
	35	Initial pole position estimation retry	PD Repeat Num	2	0–10	–
	36	Initial pole position estimation interval	Pulse Interval	20	1–100	ms
	37	Initial pole position estimation pulse current	Pulse Curr %	15	10–100	%
	38	Initial pole position estimation pulse voltage	Pulse Volt %	500	100–4000	–
	39	PM dead–time range	PMdeadBand Per	100.0	50.0–200.0	%
	40	PM dead–time voltage	PMdeadVolt Per	100.0	50.0–200.0	%
	41	PM speed estimator proportional gain	PM SpdEst Kp	100	0–32000	–
	42	PM speed estimator integral gain	PM SpdEst Ki	10	0–32000	–
	43	PM speed estimator proportional gain 2	PM SpdEst Kp 2	300	0–32000	–
	44	PM speed estimator integral gain 2	PM SpdEst Ki 2	30	0–32000	–
	45	Speed estimator feedforward high speed range	PM Flux FF %	300	0–1000	%
	46	Initial pole position estimation type	Init Angle Sel	1: Angle Detect	0–2	0–2
	48	Current controller P gain	ACR P Gain	1200	0–10000	–
	49	Current controller I gain	ACR I Gain	120	0–10000	–
	50	Voltage controller limit	V Con HR	10.0%	0–1000	%
	51	Voltage controller I gain	V Con Ki	10.0%	0–20000	%
	52	Torque controller output filter	Torque Out LPF	0	0–2000	msec
	53	Torque limit source	Torque Lmt Src	0	Keypad–1	0–12
	54	FWD reverse torque limit	FWD +Trq Lmt	180.0	0.0–200.0	%
	55	FWD regenerative torque limit	FWD –Trq Lmt	180.0	0.0–200.0	%
	56	REV regenerative torque limit	REV +Trq Lmt	180.0	0.0–200.0	%
	57	REV reverse torque limit	REV –Trq Lmt	180.0	0.0–200.0	%

CAUTION: For high–performance operation, the parameter values of the motor connected to the drive output must be estimated. Configure the motor–related Basic function group parameters by entering the motor specification values on the rating plate. Then, perform auto tuning by setting bA. 20 (Auto Tuning) to 7 [All (PM)] to automatically measure other parameters before operating a PM synchronous motor in sensorless vector control mode. For high–performance PM sensorless vector control, the drive and the motor must have the same capacity. The drive control may be inaccurate if the motor capacity and the drive capacity do not match. In sensorless vector control mode, do not connect multiple motors to the drive output.

Detecting the Initial Pole Position

Initial pole position detection is a process to match the rotor position calculated by the drive and the actual rotor position in a motor. In a permanent–magnet (PM) synchronous motor, rotor flux is generated from the permanent magnet attached to the rotor. Therefore, to run the motor in vector control mode, the exact rotor position (flux position) must be detected for accurate control of the torque generated by the motor.

At Cn. 46 (InitAngle Sel), select the type of initial pole position detection.

When Cn.46 is set to 0 (None), the motor is operated according to the pole position estimated by the drive's internal algorithm, instead of actually detecting the physical position of the rotor pole.

When Cn.46 is set to 1 (Angle Detect), the motor is operated according to the pole position detected by changes in the current. The voltage pulse input is used to detect the pole position and results in a small amount of noise at motor startup.

When Cn.46 is set to 2 (Alignment), the drive forcefully aligns the rotor position by supplying DC current for a certain period of time.

Pr. Group	Pr. Code	Name	LCD display	Setting		Setting range	Unit
Cn	35	Pole position detection retry count	PD Repeat Num	1		0–10	–
	36	Pole position detection interval	Pulse Interval	20		1–100	Ms
	37	Pole position detection pulse current	Pulse Curr %	15		10–100	%
	38	Pole position detection pulse voltage	Pulse Volt %	500		100–4000	%
	46	Pole position detection type	Init Angle Sel	0	None	0–2	–
				1	Angle Detect		
				2	Alignment		

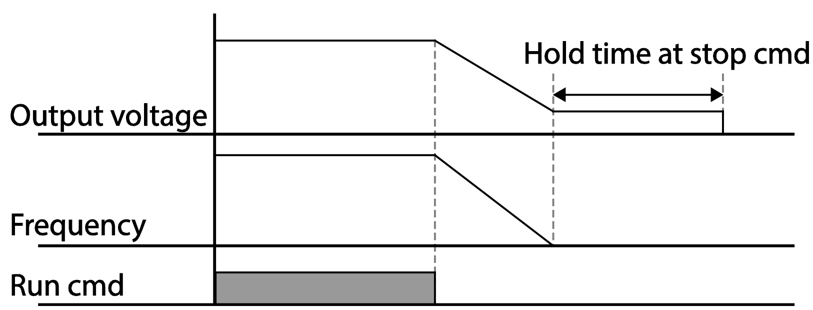
Sensorless Vector Control Mode Settings for PM Synchronous Motors

To operate a PM synchronous motor in sensorless vector control mode, set dr.9 (Control Mode) to 6 (PM Sensorless), select the motor capacity at dr.14 (Motor Capacity), and enter the appropriate codes in the Basic (bA) group with the motor specification values found on the motor's rating plate. If a specific motor capacity does not exist in the setting options, select a higher motor capacity that is closest to the actual motor capacity.

Pr. Code	Input Values (Motor's Rating Plate Information)
dr.18 Base Freq	Base frequency
dr.20 Max Freq	Maximum frequency
bA.11 Pole Number	Motor pole number
bA.13 Rated Curr	Rated current
bA.15 Rated Volt	Rate voltage
bA.16 Efficiency	Efficiency
bA.19 AC Input Volt	Input power voltage

After entering the codes, set bA.20 (Auto tuning) to 7 [All(PM)] and perform a static auto tuning operation. When auto tuning is complete, the bA.21 (Rs), bA.28 Ld (PM), bA. 29 Lq (PM), and bA. 30 (PM Flux Ref) parameters are automatically measured and saved.

<u>Sensorless Vector Control Operation Setting Details</u>

Pr. Code	Description
Cn.4 Carrier Freq	Sets the PWM interrupter cycle and sampling frequency cycle for a PM synchronous motor operation in sensorless vector control mode. The default carrier frequency is set at 5 kHz, and the setting range is 2–10 kHz.
Cn.11 Hold Time	Sets the zero–speed control time (hold time) in the stopped position. The output is blocked after zero–speed operation for a set period when the motor decelerates and is stopped by a stop command. 
Cn.12 ASR P Gain1, Cn.13 ASR I Gain1 Cn.15 ASR P Gain2 Cn.16 ASR I Gain2	Changes the speed PI controller gain during a PM synchronous motor operation in sensorless vector control mode. For a PI speed controller, P gain is a proportional gain for the speed deviation. If the speed deviation becomes greater than the torque, the output command will increase accordingly. The higher the value becomes, the faster the speed deviation will decrease. The speed controller I gain is the integral gain for speed deviation. It is the time taken for the gain to reach the rated torque output command while constant speed deviation continues. The lower the value becomes, the faster the speed deviation will decrease. As the motor inertia varies by motor, the gain values should be changed according to the motor speeds. Cn.12 and Cn. 13 set the low speed P/I controller gain values, while Cn.15 and Cn.16 set the high speed P/I controller gain values, so that an appropriate gain value can be used for different motor speeds.
Cn.33 PM EdGain Perc, Cn.34 PM EqGain Perc	To ensure that the back–EMF with rotor position information can be appropriately estimated during a PM synchronous motor operation in sensorless vector control mode, set these values as a percentage of the proportional gain, which is designed to have stable estimator polarity. Higher values result in faster responses, with higher chances of increased motor vibration. Excessively low values may result in motor startup failure due to slow response rate.

<table>
<tr><th>Pr. Code</th><th colspan="3">Description</th></tr>
<tr><td>Cn.41 PM SpdEst Kp,
Cn.42 PM SpdEst Ki
Cn.43 PM SpdEst Kp2
Cn.44 PM SpdEst Ki2</td><td colspan="3">Set these parameters to change the speed estimator gain during a PM synchronous motor operation in sensorless vector control mode.
If fault trips occur or excessive oscillation is observed at low speeds, decrease the value at Cn.41 in 10% decrements until the motor operates stably.
If ripples occur during normal operation, increase the value at Cn. 42.
The values at Cn.43 and Cn.44 are used for low speed operations in 200V motors.</td></tr>
<tr><td>Cn.39 PMdeadBand Per
Cn.40PMdeadVolt Per</td><td colspan="3">Sets the output compensation values during a PM synchronous motor operation in sensorless vector control mode.
If the motor fails to operate at low speeds at or below 5% of the rated motor speed, increase the values set at Cn.39 and Cn.40 by 10% increments. Decrease the values in 10% decrements if a clanking noise occurs at motor startup and motor stop.</td></tr>
<tr><td>Cn.45 PM Flux FF %</td><td colspan="3">Sets the high–speed portion of the feed forward rate against the back–EMF during a PM synchronous motor operation in sensorless vector control mode. Feed forwarding enhances operation of the speed estimator. Increase the value at Cn.45 in 10% increments to suppress motor oscillation under load. A fault trip may occur if this value is set too high.</td></tr>
<tr><td>Cn.48 ACR P–Gain
Cn.49 ACR I–Gain</td><td colspan="3">Sets the gain values for the PI current controller in a synchronous motor.
The P gain is the proportional gain for the current deviation. The current deviation decreases faster with higher values, as the deviation in voltage output command increases with increased deviation.
The I gain is the integral gain for the current deviation. Deviation in normal operation decreases with higher values.
However, the gain values are limited by the carrier frequency. A fault trip may occur due to interference if you set the gain values too high.</td></tr>
<tr><td rowspan="11">Cn.53 Torque Lmt Src</td><td colspan="3">Select a source for torque limit input: Keypad, terminal block analog input (V1 and I2), or input via network communication.
The torque limit value is used to adjust the torque reference size by limiting the speed controller output. The reverse and regenerative torque limits may be set for operations in the forward or reverse direction.</td></tr>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>Keypad–1</td><td rowspan="2">Sets the torque limit via the keypad.</td></tr>
<tr><td>1</td><td>Keypad–2</td></tr>
<tr><td>2</td><td>V1</td><td rowspan="3">Sets the torque limit via the analog input terminals of the terminal block.</td></tr>
<tr><td>4</td><td>V2</td></tr>
<tr><td>5</td><td>I2</td></tr>
<tr><td>6</td><td>Int 485</td><td>Sets the torque limit via the communication terminal of the terminal block.</td></tr>
<tr><td>8</td><td>FieldBus (Ethernet)</td><td>Sets the torque limit with the FieldBus (Ethernet) communication option.</td></tr>
<tr><td>9</td><td>UserSeqLink</td><td>Sets the torque limit with a user sequence output. The torque reference is received via the common area addresses.</td></tr>
<tr><td>12</td><td>Pulse</td><td>Sets the torque limit with the pulse input of the terminal block.</td></tr>
<tr><td></td><td colspan="3">The torque limit can be set up to 200% of the rated motor torque.</td></tr>
<tr><td>Cn.54 FWD +Trq Lmt</td><td colspan="3">Sets the reverse torque limit for forward operation.</td></tr>
<tr><td>Cn.55 FWD –Trq Lmt</td><td colspan="3">Sets the regenerative torque limit for forward operation.</td></tr>
<tr><td>Cn.56 REV +Trq Lmt</td><td colspan="3">Sets the regenerativese torque limit for reverse operation.</td></tr>
<tr><td>Cn.57 REV –Trq Lmt</td><td colspan="3">Sets the reverse torque limit for reverse operation.</td></tr>
<tr><td>In.2 Torque at 100%</td><td colspan="3">Sets the maximum torque. For example, if In.2 is set to 200% and an input voltage (V1) is used, the torque limit will be 200% when 10V is entered. However, when the V1 terminal is set to the factory default setting and the torque limit input source is any device other than the keypad, check the parameter settings in Monitor mode. Set CnF.21–23 (only displayed when an LCD keypad is used) to 21 (Torque limit).</td></tr>
<tr><td>Cn.52 Torque Out LPF</td><td colspan="3">Sets the time constant for torque command by setting the torque controller output filter.</td></tr>
</table>

CAUTION: ADJUST THE CONTROLLER GAIN ACCORDING TO THE LOAD'S CHARACTERISTICS. HOWEVER, THE MOTOR CAN OVERHEAT OR THE SYSTEM CAN BECOME UNSTABLE DEPENDING ON THE CONTROLLER GAIN SETTINGS.

NOTE: Speed controller gain can improve the speed control waveform while monitoring the changes in speed. If the speed deviation does not decrease fast enough, increase the speed controller P gain or decrease I gain (time in ms). However, if the P gain value is increased too much or the I gain value is decreased too much, severe vibrations may occur. If oscillation occurs in the speed waveform, try to increase the I gain (ms) or reduce the P gain to adjust the waveform.

Guidelines for Running a PM Synchronous Motor in Sensorless Vector Control Mode

Problem	Relevant function code	Troubleshooting
Starting torque is insufficient.	Cn.48 ACR P–Gain Cn.39 PMdeadBand Per Cn.40Note1) PMdeadVolt Per	If an overcurrent trip occurs at startup, try decreasing the value at Cn.48 in 10% decrements. Try increasing the value at Cn.39 or Cn.40 in 10% increments.
The motor hunts when starting up.	Cn.40 PMdeadVolt Per	Try decreasing the value at Cn.40 in 10% decrements.
The motor hunts with regenerative load at low speed (10Hz or lower), or an "OCT" fault trip occurs.	Cn.40 PMdeadVolt Per	Try increasing the value at Cn.40 in 10% increments.
The motor hunts* or the torque is not sufficient while the load is increasing at low speed (10Hz or lower).	Cn.4 Carrier Freq Cn.12 ASR P Gain 1 Cn.13 ASR I Gain 1	If the motor hunts at low speeds, try increasing the value at Cn.13 in 50 msec increments. If the motor does not hunt, try increasing the value at Cn.12 in 10% increments until the motor runs in an optimal operation condition.
		If the motor hunts and the torque is not sufficient at 5–10 Hz speed range, and if the carrier frequency at Cn.4 is set to more than 3 kHz, try decreasing the value in 1kHz decrements.
The motor hunts excessively during no–load operation when rated current is supplied to the motor.	Cn.12 ASR P Gain 1 Cn.13 ASR I Gain 1 Cn.15 ASR P Gain 2 Cn.16 ASR I Gain 2	Try decreasing the speed controller gains at Cn. 12–16 in 30% decrements.
The value at bA.30 (PM Flux Ref) becomes "0" after performing an auto tuning operation by setting bA. 20 to 7 [All (PM)].	bA.11 Pole Number bA.15 Rated Volt dr.18 Base Freq	Refer to the motor's rating plate and set the pole number at bA.11 (Pole Number), or enter a calculated pole number: Pole Number = (120 x BaseFreq/BaseRPM) Refer to the motor's rating plate and set the rated voltage and base frequency at bA.15 (Rated Volt) and dr.18 (Base Freq), and then run auto tuning again by setting bA.20 (Auto Tuning) to 7 [All (PM)].
Fault trips occur after a static auto tuning.	bA.21 Rs bA.28 Ld (PM) bA.29 Lq (PM) bA.30 PM Flux Ref	Motor operation may fail if a static PM auto tuning result is not accurate. Refer to the motor's rating plate and set the motor–related parameters again.
"OVT" occurs due to abrupt acceleration, deceleration, or massive load change while the motor is operated at mid–speed (above 30Hz). Note2)	Cn.16 ASR I Gain 2	Try decreasing the value at Cn.16 in 5% decrements.
Speed variation occurs during an operation at rated motor speed, or during an overloaded high speed operation.	Cn.45 PM Flux FF % Cn.50 V Con HR Cn.51 V Con Ki	If the motor is operated at the rated speed, try decreasing the value at Cn.50 in 5% increments. If the motor response is slow, try increasing the value at Cn.51 in 5% increments (or, try increasing the value at Cn.45 in 100% increments).
"OC1" fault trip or jerking occurs during a high speed operation.	Cn.41 PM SpdEst Kp Cn.42 PM SpdEst Ki	Try increasing the value at Cn. 41 in increments of 10 and the value at Cn.42 in increments of 1. Note that a fault trip may occur if the values at Cn. 41 and Cn.42 are set too high.
Jerking occurs during a low speed operation.	Cn.13 ASR I Gain 1	Try increasing the value at Cn.13 (low speed range speed controller I gain) to eliminate jerking.
A "clanking" noise is heard at the beginning of startup or during deceleration.	Cn.12 ASR P Gain 1 Cn.13 ASR I Gain 1 Cn.40 PMdeadVolt Per	Try increasing the values at Cn.12 and Cn.13 in 10% increments, or try decreasing the value at Cn.40 in 10% decrements.
The motor cannot reach the speed reference when it is operated at or above the rated speed, or when the acceleration is not responsive.	Cn.50 V Con HR Cn.51 V Con Ki	Try increasing the value at Cn.50 in 1% increments if the motor cannot reach the speed reference. Try increasing the value at Cn.51 in 10% increments if the motor acceleration is not responsive.
"OC1" trip occurs after an abrupt regenerative load (over 100%).	Cn.12 ASR P Gain 1 Cn.13 ASR I Gain 1	Try decreasing the values at Cn.12 and Cn.13 in 10% decrements.

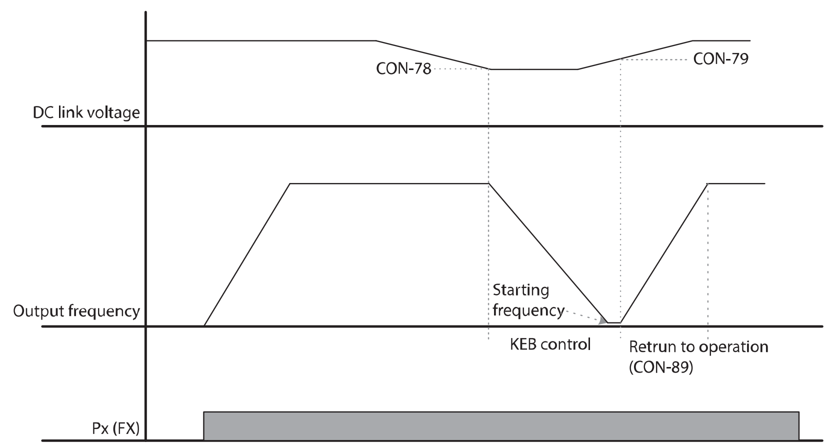
Problem	Relevant function code	Troubleshooting
The motor jerks during acceleration.	Cn.42 PM SpdEst Ki	Try increasing the speed estimator proportional gain at Cn.42 in increments of 5.
A massive current rises when the motor is stopped during a 20: 1 speed startup.	Cn.13 ASR I Gain 1	Try increasing the value at Cn. 13 in 10% increments.
An oscillation occurs when an abrupt load is applied to the motor during a low speed operation.	Cn.41 PM SpdEst Kp Cn.42 PM SpdEst Ki	Try increasing the values at Cn. 41 and Cn.42 in 10% increments.
During a PM speed search, the speed search stops at around 20% of the base frequency, and the motor is stopped and starts again after a massive current rises.	Cn.69 SS Pulse Curr	Try decreasing the value at Cn.69 in 5% decrements.
During a high–speed operation in PM control mode utilizing the kinetic energy buffering, a massive current rises at around 20% of the base frequency, the motor is stopped, and it fails to start.	Cn.78 KEB Start Lev Cn.79 KEB Stop Lev Cn.80 KEB P Gain Cn.81 KEB I Gain	Try increasing the values at Cn.78 and Cn.79 in 5% increments, or try doubling the gain values at Cn.80 and Cn. 81.
1. When the motor is overloaded, the maximum torque limit current is supplied to the motor at startup, and the motor fails to operate due to an drive overload fault trip. 2. Speed search fails when the a load exceeding the rated load is applied to the motor at each speed section, or a current equal to or exceeding 150% of the rated current is supplied to the motor.	bA.29 Lq (PM)	This happens when the Lq parameter value is decreasing due to certain causes, such as self–saturation. Try increasing the value (100%) at bA.32 in 5% increments.
A fault trip occurs when the motor tries to start up or accelerate from a free run at certain speed range.	Cn.71 Speed Search	During a PM synchronous motor operation in sensorless vector mode, the motor starts up after the initial pole position detection is made. To accelerate the motor in a free–run state, enable speed search at acceleration by setting bit 0 (0001) at Cn.71 (Speed Search).
During a low speed operation, the output speed search becomes unstable when a massive load exceeding the rated load is abruptly applied to the motor.	Cn.13 ASR I Gain 1 Cn.40 PMdeadVolt Per	The motor control may become unstable due to input voltage deviation during a low–speed operation with low voltage input. Try decreasing the values at Cn.31 and Cn.40 in 10% decrements.

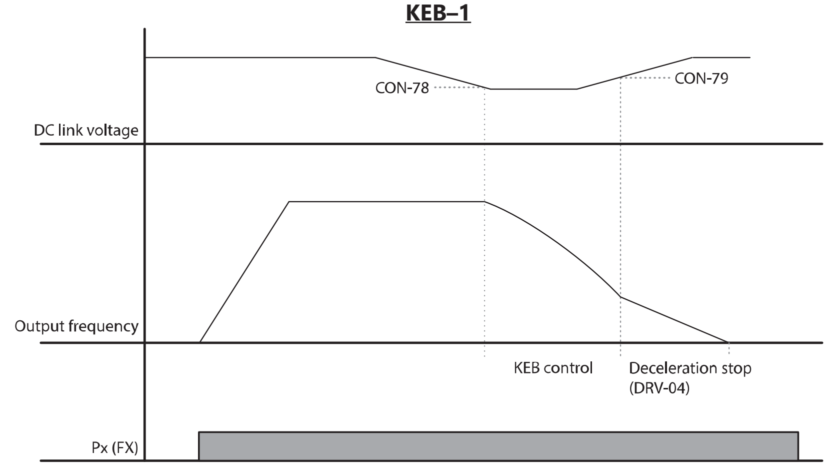
Kinetic Energy Buffering Operation

When the input power supply is disconnected, the drive's DC link voltage decreases, and a low voltage trip occurs blocking the output. A kinetic energy buffering operation uses regenerative energy generated by the motor during the blackout to maintain the DC link voltage. This extends the time for a low voltage trip to occur, after an instantaneous power interruption.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Cn	77	Kinetic energy buffering selection	KEB Select	0	None	0–2	–
				1	KEB–1		
				2	KEB–2		
	78	Kinetic energy buffering start level	KEB Start Lev	125.0		110.0–200.0	%
	79	Kinetic energy buffering stop level	KEB Stop Lev	130.0		Cn.78–210.0	%
	80	Energy buffering P gain	KEB P Gain	1000		0–20000	–
	81	Energy buffering I gain	KEB I Gain	500		1–20000	–
	82	Energy buffering Slip gain	KEB Slip Gain	30.0		0–2000.0%	–
	83	Energy buffering acceleration time	KEB Acc Time	10.0		0.0–600.0s	–
In	65 –69	Px terminal function setting	Px Define	52	KEB–1 Select	–	–

Kinetic Energy Buffering Operation Setting Details

<table>
<tr><th>Pr. Code</th><th colspan="3">Description</th></tr>
<tr><td rowspan="7">Cn.77 KEB Select</td><td colspan="3">Select the kinetic energy buffering operation when the input power is disconnected. If 1 or 2 is selected, it controls the drive's output frequency and charges the DC link (drive's DC part) with energy generated from the motor. Also, this function can be set using a terminal input. From the Px terminal function settings, select KEB–1 Select, and then turn on the terminal block to run the KEB–1 function. (If KEB–1 Select is selected, KEB–1 or KEB–2 cannot be set in Cn.77.)</td></tr>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>None</td><td>General deceleration is carried out until a low voltage trip occurs.</td></tr>
<tr><td>1</td><td>KEB–1</td><td>When the input power is blocked, it charges the DC link with regenerated energy. When the input power is restored, it restores normal operation from the energy buffering operation to the frequency reference operation. KEB Acc Time in Cn.89 is applied as the operation frequency acceleration time when restoring to the normal operation.</td></tr>
<tr><td>2</td><td>KEB–2</td><td>When the input power is blocked, it charges the DC link with regenerated energy. When the input power is restored, it changes from the energy buffering operation to the deceleration stop operation. The Dec Time in dr.4 is applied as the operation frequency deceleration time during the deceleration stop operation.</td></tr>
<tr><td colspan="3">

<u>KEB–1</u></td></tr>
<tr><td colspan="3">

<u>KEB–2</u></td></tr>
<tr><td>Cn.78 KEB Start Lev,
Cn.79 KEB Stop Lev</td><td colspan="3">Sets the start and stop points of the kinetic energy buffering operation. The set values must be based on the low voltage trip level as 100% and the stop level (Cn. 79) must be set higher than the start level (Cn.78).</td></tr>
<tr><td>Cn.80 KEB P Gain</td><td colspan="3">The controller P Gain is for maintaining the voltage of the DC power section during thekinetic energy buffering operation. Change the setting value when a low voltage trip occurs right after a power failure.</td></tr>
<tr><td>Cn.81 KEB I Gain</td><td colspan="3">The controller I Gain is for maintaining the voltage of the DC power section during the kinetic energy buffering operation. Sets the gain value to maintain the frequency during the kinetic energy buffering operation until the drive stops.</td></tr>
</table>

Pr. Code	Description
Cn.82 KEB Slip Gain	The slip gain is for preventing a low voltage trip due to load when the kinetic energy buffering operation start from blackout.
Cn.83 KEB Acc Time	Set the acceleration time of operation frequency when it restores normal operation from the kinetic energy buffering operation under the input power is restored.

CAUTION: Depending on the duration of Instantaneous power interruptions and the amount of load inertia, a low voltage trip may occur even during a kinetic energy buffering operation. Motors may vibrate during kinetic energy buffering operation for some loads except variable torque load (for example, fan or pump loads).

Torque Control

When the motor output torque is greater than the load, the speed of motor becomes too fast. To prevent this, set the speed limit. (The torque control function cannot be used while the speed limit function is running.)

The torque control function controls the motor to maintain the preset torque value. The motor rotation speed maintains the speed constantly when the output torque and load torque of the motor keep a balance. Therefore, the motor rotation speed is decided by the load when controlling the torque.

Torque control setting option

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Unit
dr	09	Control mode	Control Mode	4	IM Sensorless	–
	10	Torque control	Torque Control	1	Yes	–

Torque control setting option details

Pr. Group	Pr. Code	Name	Parameter Setting		Unit
dr	02	Cmd Torque	–	0.0	%
	08	Trq Ref Src	0	Keypad–1	–
	09	Control Mode	4	IM Sensorless	–
	10	Torque Control	1	Yes	–
	22	(+) Trq Gain	50–150		%
	23	(–) Trq Gain	50–150		%
	24	(–) Trq Gain0	50–150		%
	25	(–) Trq offset	0–100		%
bA	20	Auto Tuning	1	Yes	–
Cn	62	Speed LmtSrc	0	Keypad–1	–
	63	FWD Speed Lmt	–	60.00	Hz
	64	REV Speed Lmt	–	60.00	Hz
	65	Speed Lmt Gain	–	100	%
In	65–69	Px Define	35	Speed/Torque	–
OU	31–33	Relay1 or Q1	27	Torque Dect	–
OU	59	TD Level	–	100	%
OU	60	TD Band	–	5.0	%

NOTE:
To operate in torque control mode, basic operation conditions must be set. For more information, refer to "Sensorless Vector Control Operation Guide for Induction Motors" on page 4-152.

- *The torque control cannot be used in a low speed regeneration area or low load conditions.*
- *If you change the rotation direction while operating, an over current trip or low speed reverse direction error will be generated.*

Torque reference setting option

The torque reference can be set using the same method as the target frequency setting. If Torque Control Mode is selected, the target frequency is not used.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Unit
dr	02	Torque command	Cmd Torque	–180–180		%
	08	Torque reference setting	Trq Ref Src	0	Keypad–1	–
				1	Keypad–2	
				2	V1	
				4	V2	
				5	I2	
				6	Int 485	
				8	FieldBus (Ethernet)	
				9	UserSeqLink	
				12	Pulse	
Cn	62	Speed limit setting	Speed LmtSrc	0	Keypad–1	–
				1	Keypad–2	
				2	V1	
				4	V2	
				5	I2	
				6	Int 485	
				7	FieldBus (Ethernet)	
				8	UserSeqLink	
	63	Positive–direction speed limit	FWD Speed Lmt	0–Maximum frequency		Hz
	64	Negative–direction speed limit	REV Speed Lmt	0– Maximum frequency		Hz
	65	Speed limit operation gain	Speed Lmt Gain	100–5000		%
In	02	Torque at maximum analog input	Torque at 100%	–12.00–12.00		mA
CNF*	21	Monitor mode display 1	Monitor Line–1	1	Speed	–
	22	Monitor mode display 2	Monitor Line–2	2	Output Current	–
	23	Monitor mode display 3	Monitor Line–3	3	Output Voltage	–

**LCD keypad only*

Torque reference setting details

Pr. Code	Description		
dr.8	Select an input method to use as the torque reference.		
	Parameter Setting		Description
	0	Keypad–1	Sets the torque reference with the keypad.
	1	Keypad–2	
	2, 4, 5	V1, V2, I2	Sets the torque reference using the voltage or current input terminal of the terminal block.
	6	Int 485	Sets the torque reference with the communication terminal of the terminal block.
	8	FieldBus (Ethernet)	Input the torque reference using the drive's FieldBus (Ethernet) option.
	9	UserSeqLink	Enters torque reference by linking common area with the user sequence output.
	12	Pulse	Input the torque reference using the pulse input on the drive's terminal block.
Cn.2	The torque reference can be set up to 180% of the maximum rated motor torque.		
In.2	Sets the maximum torque. You can check the set maximum torque in Monitor (MON) mode.		
CNF.21–23	Select a parameter from the Config (CNF) mode and then select 19 (Torque Ref) (for monitoring)		

Speed limit details

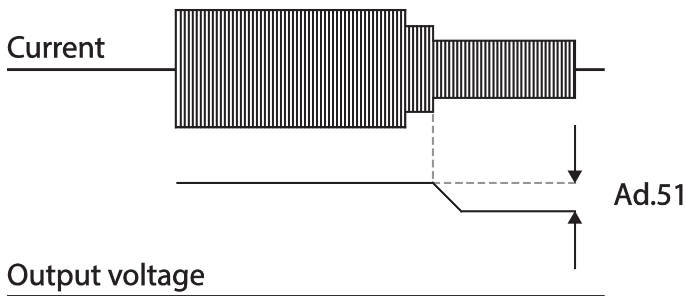
Pr. Code	Description		
Cn.62	Select a method for setting the speed limit value.		
	Parameter Setting		Description
	0	Keypad–1	Sets the speed limit value with the keypad.
	1	Keypad–2	
	2, 4, 5	V1, V2, I2	Sets the speed limit value using the same method as the frequency command. You can check the setting in Monitor (MON) mode.
	6	Int 485	
	7	FieldBus (Ethernet)	
	8	UserSeqLink	
Cn.63	Sets the positive–direction speed limit value.		
Cn.64	Sets the negative–direction speed limit value.		
Cn.65	Sets the decrease rate of the torque reference when the motor speed exceeds the speed limit value.		
CNF.21–23	Select a parameter from the Config (CNF) mode and then select 21 (Torque Bias) (for monitoring).		
In.65–69	Select a multi–functional input terminal to set as the (35 Speed/Torque). If you turn on the terminal while the operation is stopped, it operates in vector control (speed limit) mode.		

Energy Saving Operation

Manual Energy Saving Operation

If the drive output current is lower than the current which is set at bA.14 (Noload Curr), the output voltage must be reduced as low as the level set at Ad.51 (Energy Save). The voltage before the energy saving operation starts will become the base value of the percentage. Manual energy saving operation will not be carried out during acceleration and deceleration.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Ad	50	Energy saving operation	E–Save Mode	1	Manual	–	–
	51	Energy saving amount	Energy Save	30		0–30	%



Automatic Energy Saving Operation

The amount of energy saving can be automatically calculated based on the rated motor current (bA.13) and the no–load current (bA.14). From the calculations, the output voltage can be adjusted.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Ad	50	Energy saving operation	E–Save Mode	2	Auto	–	–

CAUTION: If operation frequency is changed or acceleration and /deceleration is carried out by a stop command during the energy saving operation, the actual Acc/Dec time may take longer than the set Acc/Dec time due to the time required to return to the gerneral operation from the energy saving operation.

Speed Search Operation

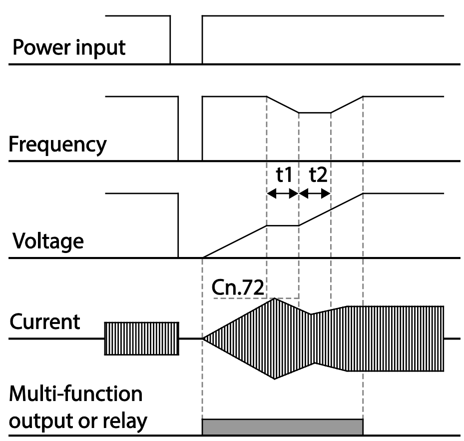
This operation is used to prevent fault trips that can occur while the drive output voltage is disconnected and the motor is idling. Because this feature estimates the motor rotation speed based on the drive output current, it does not give the exact speed.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Cn	69	PM speed search pulse current	SS Pulse Curr	15		10–100	%
	70	Speed search mode	SS Mode	0	Flying Start–1	0–2	–
				1	Flying Start–2		
				2	Flying Start–3		
	71	Speed search operation selection	Speed Search	0000*		0000–1111	bit
	72	Speed search reference current	SS Sup–Current	–	Below 75kW	80–200	%
	73	Speed search proportional gain	SS P–Gain	100		0–9999	–
	74	Speed search integral gain	SS I–Gain	200		0–9999	–
	75	Output block time before speed search	SS Block Time	1.0		0–60	sec
OU	31	Multi–function relay 1 item	Relay 1	19	Speed Search	0–40	–
	33	Multi–function output 1 item	Q1 Define				

**See "Bit Selection" on page 4–3 for details*

Speed Search Operation Setting Details

Pr. Code	Description		
Cn.69 SS Pulse Curr	Sets the speed search current based on the motor's rated current. This parameter is only displayed when dr.9 (Control Mode) is set to 6 (PM Sensorless).		
Cn.70 SS Mode	Select a speed search type.		
	Setting		Function
	0	Flying Start–1	The speed search is carried out as it controls the drive output current during idling below the Cn.72 (SS Sup–Current) parameter setting. If the direction of the idling motor and the direction of operation command at restart are the same, a stable speed search function can be performed at about 10Hz or lower. However, if the direction of the idling motor and the direction of operation command at restart are different, the speed search does not produce a satisfactory result because the direction of idling cannot be established. *Only available for dr.9 = 0 or2 (V/F or Slip comp mode)
	1	Flying Start–2	The speed search is carried out as it PI controls the ripple current which is generated by the counter electromotive force during no–load rotation. Because this mode establishes the direction of the idling motor (forward/ reverse), the speed search function is stable regardless of the direction of the idling motor and direction of operation command. However because the ripple current is used which is generated by the counter electromotive force at idle (the counter electromotive force is proportional to the idle speed), the idle frequency is not determined accurately and re–acceleration may start from zero speed when the speed search is performed for the idling motor at low speed (about 10 – 15 Hz, though it depends on motor characteristics). *Only available for dr.9 = 0,2,4 (V/F, Slip comp, or IM Sensorless mode)
	2	Flying Start–3	This speed search is available when operating a PM synchronous motor. It is used when dr.9 (Control Mode) is set to 6 (PM Sensorless).

<table>
<tr><th>Pr. Code</th><th colspan="5">Description</th></tr>
<tr><td rowspan="9">Cn.71 Speed Search</td><td colspan="5">Speed search can be selected from the following 4 options. If the top display segment is on it is enabled (On), and if the bottom segment is on it is disabled (Off). *See "Bit Selection" on page 4–3 for details</td></tr>
<tr><td colspan="5">Type and Functions of Speed Search Setting</td></tr>
<tr><td colspan="4">Setting</td><td rowspan="2">Function</td></tr>
<tr><td>bit4</td><td>bit3</td><td>bit2</td><td>bit1</td></tr>
<tr><td></td><td></td><td></td><td>X</td><td>Speed search for general acceleration</td></tr>
<tr><td></td><td></td><td>X</td><td></td><td>Initialization after a fault trip</td></tr>
<tr><td></td><td>X</td><td></td><td></td><td>Restart after instantaneous power interruption</td></tr>
<tr><td>X</td><td></td><td></td><td></td><td>Starting with power–on</td></tr>
<tr><td colspan="5">• Speed search for general acceleration: If bit 1 is set to 1 and the drive operation command runs, acceleration starts with speed search operation. When the motor is rotating under load, a fault trip may occur if the operation command is run for the drive to provide output voltage. The speed search function prevents such fault trip from occurring.
• Initialization after a fault trip: If Bit 2 is set to 1 and Pr.8 (RST Restart) is set to 1 (Yes), the speed search operation automatically accelerates the motor to the operation frequency used before the fault trip, when the [Reset] key is pressed (or the terminal block is initialized) after a fault trip.
• Automatic restart after reset of a fault trip: If bit 3 is set to 1, and if a low voltage trip occurs due to a power interruption but the power is restored before the internal power shuts down, the speed search operation accelerates the motor back to its frequency reference before the low voltage trip.
If an instantaneous power interruption occurs and the input power is disconnected, the drive generates a low voltage trip and blocks the output. When the input power returns, the operation frequency before the low voltage trip and the voltage is increased by the drive's inner PI control.
If the current increases above the value set at Cn.72, the voltage stops increasing and the frequency decreases (t1 zone). If the current decreases below the value set at Cn.27, the voltage increases again and the frequency stops decelerating (t2 zone). When the normal frequency and voltage are resumed, the speed search operation accelerates the motor back to its frequency reference before the fault trip.


• Starting with power–on: Set bit 4 to 1 and Ad.10 (Power–on Run) to 1 (Yes). If drive input power is supplied while the drive operation command is on, the speed search operation will accelerate the motor up to the frequency reference.</td></tr>
<tr><td>Cn.72 SS Sup–Current</td><td colspan="5">The amount of current flow is controlled during speed search operation based on the motor's rated current. If Cn.70 (SS mode) is set to 1 (Flying Start–2), this code is not visible.</td></tr>
<tr><td>Cn.73 SS P/I–Gain,
Cn.75 SS Block Time</td><td colspan="5">The P/I gain of the speed search controller can be adjusted. If Cn.70 (SS Mode) is set to 1 (Flying Start–2), different factory defaults based on motor capacity are used and defined in dr.14 (Motor Capacity).</td></tr>
</table>

NOTE:

- *If operated within the rated output, the ACN series drive is designed to withstand instantaneous power interruptions within 15 ms and maintain normal operation. Based on the rated heavy load current, safe operation during an instantaneous power interruption is guaranteed for 230V and 460V drives (whose rated input voltages of 200-230 VAC for 230V drives and 380-460 VAC for 460V drives.*
- *The DC voltage inside the drive may vary depending on the output load. If the power interruption time is longer than 15 ms, a low voltage trip may occur.*

CAUTION: When operating in sensorless mode while the starting load is in free–run, the speed search function (for general acceleration) must be set for smooth operation. If the speed search function is not set, an overcurrent trip or overload trip may occur.

Auto Restart Settings

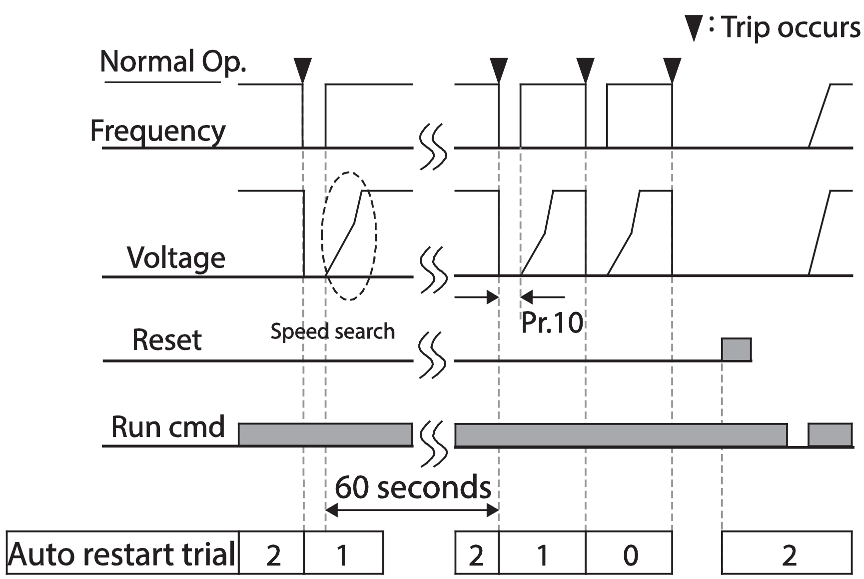
When drive operation stops due to a fault and a fault trip is activated, the drive automatically restarts based on the parameter settings.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Pr	08	Select start at trip reset	RST Restart	0	No	0–1	–
	09	Auto restart count	Retry Number	0		0–10	–
	10	Auto restart delay time	Retry Delay	1.0		0.0–60.0	s
Cn	71	Select speed search operation	Speed Search	–		0000*–1111	bit
	72	Speed search startup current	SS Sup–Current	150		80–200	%
	73	Speed search proportional gain	SS P–Gain	100		0–9999	–
	74	Speed search integral gain	SS I–Gain	200		0–9999	–
	75	Output block time before speed search.	SS Block Time	1.0		0.0–60.0	s

*See "Bit Selection" on page 4–3 for details

Auto Restart Setting Details

Pr. Code	Description
Pr.8 RST Restart, Pr.9 Retry Number, Pr.10 Retry Delay	Only operates when Pr.8 (RST Restart) is set to 1(Yes). The number of attempts to try the auto restart is set at Pr.9 (Auto Restart Count). If a fault trip occurs during operation, the drive automatically restarts after the set time programmed at Pr.10 (Retry Delay). At each restart, the drive counts the number of tries and subtracts it from the number set at Pr.9 until the retry number count reaches 0. After an auto restart, if a fault trip does not occur within 60 sec, it will increase the restart count number. The maximum count number is limited by the number set at Pr.9 (Auto Restart Count). If the drive stops due to low voltage, emergency stop (Bx), drive overheating, or hardware diagnosis, an auto restart is not activated. At auto restart, the acceleration options are identical to those of speed search operation. Codes Cn.72–75 can be set based on the load. Information about the speed search function can be found at "Speed Search Operation" on page 4–167.



Example of auto restart with a setting of 2

CAUTION: If the auto restart number is set, be careful when the drive resets from a fault trip. The motor may automatically Rotate on Power Up.

Operational Noise Settings (carrier frequency settings)

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Cn	04	Carrier Frequency	Carrier Freq	3.0		1.0–15.0	kHz
	05	Switching Mode	PWM* Mode	0	Normal PWM	0–1	–
**PWM: Pulse width modulation*							

Operational Noise Setting Details

<table>
<tr><th>Pr. Code</th><th colspan="3">Description</th></tr>
<tr><td>Cn.4 Carrier Freq</td><td colspan="3">Adjust motor operational noise by changing carrier frequency settings. Power transistors (IGBT) in the drive generate and supply high frequency switching voltage to the motor. The switching speed in this process refers to the carrier frequency. If the carrier frequency is set high, it reduces operational noise from the motor, and if the carrier frequency is set low, it increases operational noise from the motor.</td></tr>
<tr><td rowspan="8">Cn.5 PWM Mode</td><td colspan="3">The heat loss and leakage current from the drive can be reduced by changing the load rate option at Cn.5 (PWM Mode). Selecting 1 (LowLeakage PWM) reduces heat loss and leakage current, compared to when 0 (Normal PWM) is selected. However, it increases the motor noise. Low leakage PWM uses 2 phase PWM modulation mode, which helps minimize degradation and reduces switching loss by approximately 30%.</td></tr>
<tr><td rowspan="3">Item</td><td colspan="2">Carrier frequency</td></tr>
<tr><td>1.0kHz</td><td>15kHz</td></tr>
<tr><td>Low Leakage PWM</td><td>Normal PWM</td></tr>
<tr><td>Motor noise</td><td>▲</td><td>▼</td></tr>
<tr><td>Heat generation</td><td>▼</td><td>▲</td></tr>
<tr><td>Noise generation</td><td>▼</td><td>▲</td></tr>
<tr><td>Leakage current</td><td>▼</td><td>▲</td></tr>
</table>

2nd Motor Operation

The 2nd motor operation is used when a single drive switch operates two motors. Using the 2nd motor operation, a parameter for the 2nd motor is set. The 2nd motor is operated when a multi–function terminal input defined as a 2nd motor function is turned on.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
In	65– 69	Px terminal configuration	Px Define(Px: P1–P5)	26	2nd Motor	0–54	–

2nd Motor Operation Setting Details

Pr. Code	Description
In.65–69 Px Define	Set one of the the multi–function input terminals (P1–P5) to 26 (2nd Motor) to display M2 (2nd motor group) group. An input signal to a multi–function terminal set to 2nd motor will operate the motor according to the code settings listed below. However, if the drive is in operation, input signals to the multi–function terminals will not read as a 2nd motor parameter. Pr.50 (Stall Prevent) must be set first, before M2.28 (M2–Stall Lev) settings can be used. Also, Pr.40 (Electronic Thermal [ETH] Trip Sel) must be set first, before M2.29 (M2–ETH 1min) and M2.30 (M2.ETH Cont) settings.

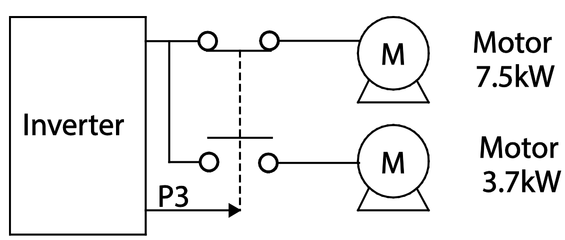
Parameter Setting at Multi–function Terminal Input on a 2nd Motor

Pr. Code	Description	Pr. Code	Description
M2.4 Acc Time	Acceleration time	***M2.16 Inertia Rt***	Load inertia rate
M2.5 Dec Time	Deceleration time	***M2.17 Rs***	Stator resistance
M2.6 Capacity	Motor capacity	***M2.18 Lsigma***	Leakage inductance
M2.7 Base Freq	Motor base frequency	***M2.19 Ls***	Stator inductance
M2.8 Ctrl Mode	Control mode*	***M2.20 Tr***	Rotor time constant
M2.10 Pole Num	Pole number	***M2.25 V/F Patt***	V/F pattern
M2.11 Rate Slip	Rated slip	***M2.26 Fwd Boost***	Forward torque boost
M2.12 Rated Curr	Rated current	***M2.27 Rev Boost***	Reverse torque boost
M2.13 Noload Curr	No–load current	***M2.28 Stall Lev***	Stall prevention level
M2.14 Rated Volt	Motor rated voltage	***M2.29 ETH 1min***	Motor Elec. Thermal protection 1min rating
M2.15 Efficiency	Motor efficiency	***M2.30 ETH Cont***	Motor Elec. Thermal protection continuous rating
**Control mode dr.9=6 is not supported.*			

Example – 2nd Motor Operation

Use the 2nd motor operation when switching operation between a 7.5 kW motor and a secondary 3.7 kW motor connected to terminal P3. Refer to the following settings.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
In	67	Terminal P3 configuration	P3 Define	26	2nd Motor	–	–
M2	06	Motor capacity	M2–Capacity	–	3.7kW	–	–
	08	Control mode	M2–Ctrl Mode	0	V/F	–	–



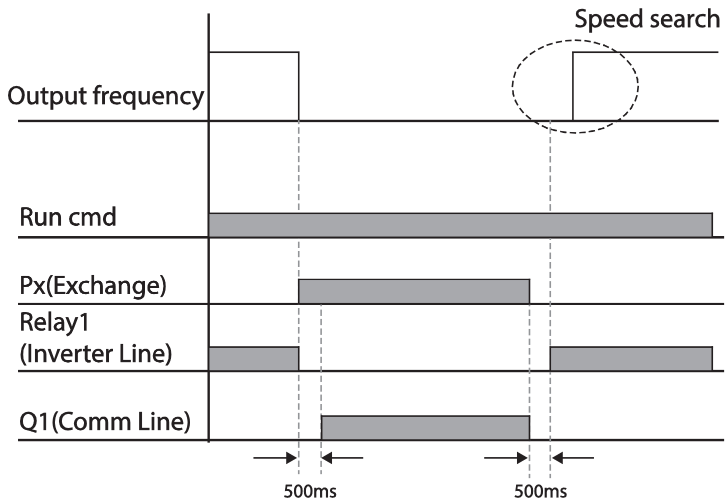
Supply Power Transition

Supply power transition is used to switch the power source for the motor connected to the drive from the drive output power to the main supply power source (commercial power source), or vice versa.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
In	65–69	Px terminal configuration	Px Define(Px: P1–P5)	16	Exchange	0–54	–
OU	31	Multi–function relay1 items	Relay1	17	Drive Line	–	–
	33	Multi–function output1 items	Q1 Define	18	Comm Line	–	–

Supply Power Transition Setting Details

Pr. Code	Description
In.65–69 Px Define	When the motor power source changes from drive output to main supply power, select a terminal to use and set the code value to 16 (Exchange). Power will be switched when the selected terminal is on. To reverse the transition, switch off the terminal.
OU.31 Relay 1 Define (A1, B1, C1 terminals), OU.33 Q1 Define	Set multi–function relay or multi–function output to 17 (Drive Line) or 18 (COMM line). Relay operation sequence is as follows.



Cooling Fan Control

This function turns the drive’s heat–sink cooling fan on and off. It is used in situations where the load stops and starts frequently, or noise free environment is required. The correct use of cooling fan control can extend the cooling fan’s life.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Ad	64	Cooling fan control	FAN Control	0	During Run	0–2	–

Cooling Fan Control Detail Settings

Pr. Code	Settings		Description
Ad.64 Fan Control	Settings		Description
	0	During Run	Cooling fan runs when the power is supplied to the drive and the operation command is on. The cooling fan stops when the power is supplied to the drive and the operation command is off. When the drive heat sink temperature is higher than its set value, the cooling fan operates automatically regardless of its operation status.
	1	Always On	Cooling fan runs constantly if the power is supplied to the drive.
	2	Temp Control	With power connected and the run operation command on, if the setting is in Temp Control, the cooling fan will not operate unless the temperature in the heat sink reaches the set temperature.

NOTE: Despite setting Ad.64 to 0(During Run), if the heat sink temperature reaches a set level by current input harmonic wave or noise, the cooling fan may run as a protection function.

Input Power Frequency and Voltage Settings

Select the frequency for drive input power. If the frequency changes from 60Hz to 50Hz, all other frequency (or RPM) settings including the maximum frequency, base frequency etc., will change to 50Hz. Likewise, changing the input power frequency setting from 50Hz to 60Hz will change all related function item settings from 50Hz to 60Hz.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
bA	10	Input power frequency	60/50 Hz Sel	0	60Hz	0–1	–
				1	50Hz		

Set Drive input power voltage at bA.19. Low voltage fault trip level changes automatically to the set voltage standard.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
bA	19	Input power voltage	AC Input Volt	230V	220	170–240	V
				460V	380	320–480	

Read, Write, and Save Parameters

For use with the optional ACN-LCD advanced keypad only, Use read, write and save function parameters on the drive to copy parameters from the drive to the LCD keypad or from the LCD keypad to the drive.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
CNF*	46	Parameter read	Parameter Read	1	Yes	–	–
	47	Parameter write	Parameter Write	1	Yes	–	–
	48	Parameter save	Parameter Save	1	Yes	–	–

**Available on ACN-LCD keypad only.*

Read, Write, and Save Parameter Setting Details

Pr. Code	Description
CNF.46 Parameter Read	Copies saved parameters from the drive to the keypad. Saved parameters on the keypad will be deleted and replaced with copied parameters.
CNF.47 Parameter Write	Copies saved parameters from the keypad to the drive. Saved parameters on the drive will be deleted and replaced with copied parameters. If an error occurs during parameter writing, previous saved data will be used. If there is no saved data on the Keypad, 'EEP Rom Empty' message will be displayed.
CNF.48 Parameter Save	As parameters set during communication transmission are saved to RAM, the setting values will be lost if the power goes off and on. When setting parameters during communication transmission, select 1 (Yes) from CNF.48 code to save the set parameter.

Parameter Initialization (Reset to Defaults)

User changes to parameters can be initialized (reset) to factory default settings on all or selected groups. However, during a fault trip situation or operation, parameters cannot be initialized.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
dr*	93	Parameter initialization	–	0	No	0–16	–
CNF**	40	Parameter initialization	Parameter Init	0	No	0–16	–

**For standard drive keypad*
***For ACN-LCD keypad*

Parameter Initialization Setting Details

Pr. Code	Description			
dr.93, CNF.40 Parameter Init	Setting		LCD Display	Function
	0	No	No	–
	1	Initialize all groups	All Grp	Initialize all data. Select 1(All Grp) and press [PROG/ENT] key to start initialization. On completion, 0(No) will be displayed.
	2	Initialize dr group	DRV Grp	Initialize data by groups. Select initialize group and press [PROG/ENT] key to start initialization. On completion, 0(No) will be displayed.
	3	Initialize bA group	BAS Grp	
	4	Initialize Ad group	ADV Grp	
	5	Initialize Cn group	CON Grp	
	6	Initialize In group	IN Grp	
	7	Initialize OU group	OUT Grp	
	8	Initialize CM group	COM Grp	
	9	Initialize AP group	APP Grp	
	11	Initialize APO group	APO Grp	
	12	Initialize Pr group	PRT Grp	
	13	Initialize M2 group	M2 Grp	
	14	Initialize USS group	USS Grp	
	15	Initialize USF group	USF Grp	
	16	Initialize OperationGroup	SPS Grp	

Parameter View Lock

For use with ACN-LCD keypad only, Use parameter view lock to hide parameters after registering and entering a user password.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
CNF*	50	Parameter view lock	View Lock Set	Unlocked	0–9999	–
	51	Parameter view lock password	View Lock Pw	Password	0–9999	–
**Available on ACN-LCD keypad only.*						

Parameter View Lock Setting Details

Pr. Code	Description	
CNF.51 View Lock Pw	Register a password to allow access to parameter view lock. Follow the steps below to register a password.	
	No	Procedure
	1	[PROG/ENT] key on CNF.51 code will show the previous password input window. If registration is made for the first time, enter 0. It is the factory default.
	2	If a password had been set, enter the saved password.
	3	If the entered password matches the saved password, a new window prompting the user to enter a new password will be displayed (the process will not progress to the next stage until the user enters a valid password).
	4	Register a new password.
	5	After registration, code CNF.53 will be displayed.
CNF.50 View Lock Set	To enable parameter view lock, enter a registered password. [Locked] sign will be displayed on the screen to indicate that parameter view lock is enabled. To disable parameter view lock, re–enter the password. The [locked] sign will disappear.	

Parameter Lock

Use parameter lock to prevent unauthorized modification of parameter settings. To enable parameter lock, register and enter a user password first.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
dr	94	Password registration	–	–	0–9999	–
	95	Parameter lock password	–	–	0–9999	–
CNF*	52	Parameter lock	Key Lock Set	Unlocked	0–9999	–
	53	Parameter lock password	Key Lock PW	Password	0–9999	–
**Available on ACN-LCD keypad only.*						

Pr. Code	Description	
dr.94 Password Registration	Setting the Password. Follow the procedures below to register a password.	
	No	Procedures
	1	Press the [PROG/ENT] key twice on dr.94 code.
	2	Set the desired password with the arrow keys.
	3	Press the [PROG/ENT] key twice. The display will return to dr.94.
	Changing the Password	
	No	Procedures
	1	Press the [PROG/ENT] key on dr.94 code. 0000 will be displayed.
	2	Use the arrow keys to enter the current password.
	3	Press the [PROG/ENT] key. The value should remain on the display.
	4	Set the new password with the arrow keys.
	5	Press the [PROG/ENT] key twice. The display will return to dr.94.
dr.95 Parameter Lock Password	Locking the Drive.	
	No	Procedure
	1	Press the [PROG/ENT] key on dr.95 code. UL will be displayed. This means the drive is currently unlocked.
	2	Press the [PROG/ENT] key again to display 0000.
	3	Enter the password using the arrow keys.
	4	Press the [PROG/ENT] key. L will be displayed. This means the drive is locked. (If no password has been registered, drive remains unlocked and displays UL.)
	Unlocking the Drive.	
	No	Procedure
	1	Press the [PROG/ENT] key on dr.95 code. L will be displayed. This means the drive is currently locked.
	2	Press the [PROG/ENT] key again to display 0000.
	3	Enter the password using the arrow keys.
	4	Press the [PROG/ENT] key. UL will be displayed. This means the drive is unlocked.

Parameter Lock Setting Details

Pr. Code	Description	
CNF.53 Key Lock Pw	Register a password to prohibit parameter modifications. Follow the procedures below to register a password.	
	No	Procedures
	1	Press the [PROG/ENT] key on CNF.53 code and the saved password input window will be displayed. If password registration is being made for the first time, enter 0. It is the factory default.
	2	If a saved password has been set, enter the saved password.
	3	If the entered password matches the saved password, then a new window to enter a new password will be displayed. (The process will not move to next stage until the user enters a valid password).
	4	Register a new password.
	5	After registration, Code CNF.51 will be displayed.
CNF.52 Key Lock Set	To enable parameter lock, enter the registered password. [Locked] sign will be displayed on the screen to indicate that prohibition is enabled. Once enabled, Pressing the [PROG/ENT] key on function code will not allow the display edit mode to run. To disable parameter modification prohibition, re–enter the password. The [Locked] sign will disapear.	

CAUTION: If parameter view lock and parameter lock functions are enabled, no drive operation related function changes can be made. It is very important that you memorize the password.

Changed Parameter Display

This feature displays all the parameters that are different from the factory defaults. Use this feature to track changed parameters.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
CNF*	41	Changed parameter display	Changed Para	0	View All	–	–
**Available on ACN-LCD keypad only.*							

Changed Parameter Display Setting Details

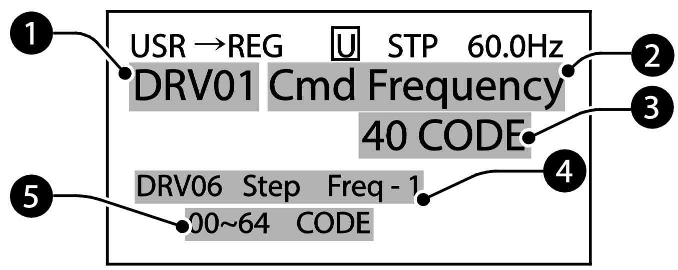
Pr. Code	Description		
CNF.41 Changed Para	Setting		Function
	0	View All	Display all parameters
	1	View Changed	Display changed parameters only

User Group

Create a user defined group and register user–selected parameters from the existing function groups. The user group can carry up to a maximum of 64 parameter registrations.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
CNF*	42	Multi–function key settings	Multi Key Sel	3	UserGrp SelKey	–	–
	45	Delete all user registered codes	UserGrp AllDel	0	No	–	–
**Available on ACN-LCD keypad only.*							

User Group Setting Details

<table>
<tr><th>Pr. Code</th><th colspan="2">Description</th></tr>
<tr><td rowspan="16">CNF.42 Multi–Key Sel</td><td colspan="2">Select 3(UserGrp SelKey) from the multi–function key setting options. If user group parameters are not registered, setting the multi–function key to the user group select key (UserGrp SelKey) will not display user group (USR Grp) item on the Keypad.</td></tr>
<tr><td colspan="2">Follow the procedures below to register parameters to a user group.</td></tr>
<tr><td>No</td><td>Procedure</td></tr>
<tr><td>1</td><td>Set CNF. 42 to 3(UserGrp SelKey). A “U” icon will be displayed at the top of the LCD display.</td></tr>
<tr><td>2</td><td>In the parameter mode (PAR Mode), move to the parameter you need to register and press the [MULTI] key. For example, if the [MULTI] key is pressed in the frequency reference in DRV 01 (Cmd Frequency), the screen below will be displayed.


1) Group name and code number of the parameter
2) Name of the parameter
3) Code number to be used in the user group. Pressing the [PROG/ENT] key on the code number (40 Code) will register DRV–01 as code 40 in the user group.
4) Existing parameter registered as the user group code 40
5) Setting range of the user group code. Entering 0 cancels the settings.</td></tr>
<tr><td>3</td><td>Set a code number (3) to use to register the parameter in the user group. Select code number and press [PROG/ENT] key.</td></tr>
<tr><td>4</td><td>Changing the value in (3) will also change the value in (4). If no code is registered, ‘Empty Code’ will be displayed. Entering 0 cancels the settings.</td></tr>
<tr><td>5</td><td>The registered parameters are listed in the user group in U&M mode. You can register one parameter multiple times if necessary. For example, a parameter can be registered as code 2, code 11, and more in the user group.</td></tr>
<tr><td colspan="2">Follow the procedures below to delete parameters in the user group.</td></tr>
<tr><td>No.</td><td>Settings</td></tr>
<tr><td>1</td><td>Set CNF. 42 to 3(UserGrp SelKey). A ‘U’ icon will be displayed at the top of the LCD display.</td></tr>
<tr><td>2</td><td>In the USR group in U&M mode, move the cursor to the code that is to be deleted.</td></tr>
<tr><td>3</td><td>Press the [MULTI] key.</td></tr>
<tr><td>4</td><td>Move to YES on the deletion confirmation screen, and press the [PROG/ENT] key.</td></tr>
<tr><td>5</td><td>Deletion completed.</td></tr>
<tr><td>CNF.25 UserGrp AllDel</td><td colspan="2">Set to 1(Yes) to delete all registered parameters in the user group.</td></tr>
</table>

Easy Start On

For use with the ACN-LCD advanced keypad only, run Easy Start On to easily setup the basic motor parameters required to operate a motor in a batch. Set CNF.61(Easy Start On) to 1(Yes) to activate the feature, initialize all parameters by setting CNF.40 (Parameter Init) to 1 (All Grp), and restart the drive to activate Easy Start On.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
CNF*	61	Parameter easy start settings	Easy Start On	1	Yes	–	–

**Available on ACN-LCD keypad only.*

Easy Start On Setting Details

Pr. Code	Description	
CNF.61 Easy Start On	Follow the procedures listed below to set parameter easy start.	
	No	Procedures
	1	Set CNF.61 (Easy Start On) to 1(Yes).
	2	Select 1(All Grp) in CNF.40 (Parameter Init) to initialize all parameters in the drive.
	3	Restarting the drive will activate the Easy Start On. Set the values in the following screens on the LCD keypad. To escape from the Easy Start On, press the [ESC] key. • Start Easy Set: Select Yes. • DRV.14 Motor Capacity: Set motor capacity. • BAS.11 Pole Number: Set motor pole number. • BAS.15 Rated Volt: Set motor rated voltage. • BAS.10 60/50Hz Sel: Set motor rated frequency. • BAS.19 AC Input Volt: Set input voltage. • DRV.06 Cmd Source: Set command source. • DRV.01 Cmd Frequency: Set operation frequency. When the settings are completed, the minimum parameter setting on the motor has been made. The LCD keypay will return to a monitoring display. Now the motor can be operated with the command source set at DRV–06.

Config(CNF) Mode

The config mode parameters are used to configure the LCD keypad related features.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
CNF*	2	LCD brightness/contrast adjustment	LCD Contrast	–	–	–
	10	Drive S/W version	Inv S/W Ver	x.xx	–	–
	11	Keypad S/W version	Keypad S/W Ver	x.xx	–	–
	12	Keypad title version	KPD Title Ver	x.xx	–	–
	30–32	Open slot type	Option–x Type	None	–	–
	44	Erase trip history	Erase All Trip	No	–	–
	60	Add title update	Add Title Up	No	–	–
	62	Initialize accumulated electric energy	WH Count Reset	No	–	–

**Available on the LCD keypad only.*

Config Mode Parameter Setting Details

Pr. Code	Description
CNF.2 LCD contrast	Adjusts LCD brightness/contrast on the LCD keypad.
CNF.10 Inv S/W Ver, CNF.11 Keypad S/W Ver	Check OS version in the drive and on the LCD keypad.
CNF.12 KPD title Ver	Checks title version on the LCD keypad.
CNF.30–32 Option–x type	Checks type of powerboard installed in 1–3 power slot
CNF.44 Erase all trip	Deletes stored trip history.
CNF.60 Add Title Up	When drive SW version is updated and more code is added, CNF.60 settings will add, display, and operate the added codes. Set CNF.60 to 1(Yes) and disconnect the LCD keypad from the drive. Reconnecting the LCD keypad to the drive updates titles.
CNF.62 WH Count Reset	Initialize accumulated electric energy consumption count.

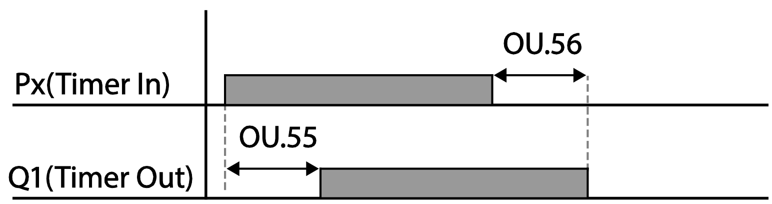
Multi-function IO Timer Settings

Set a multi–function input terminal to a timer and On/Off control the multi–function output and relay according to the timer settings.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
In	65–69	Px terminal configuration	Px Define(Px: P1–P5)	38	Timer In	0–54	–
OU	31	Multi–function relay1	Relay 1	28	Timer Out	–	–
	33	Multi–function output1	Q1 Define				
	55	Timer on delay	Timer on delay	3.00		0.00–100	sec
	56	Timer off delay	Timer off delay	1.00		0.00–100	sec

Timer Setting Details

Pr. Code	Description
In.65–69 Px Define	Choose one of the multi–function input terminals and change it to a timer terminal by setting it to 38 (Timer In).
OU.31 Relay1, OU.33 Q1 Define	Set multi–function output terminal or relay to be used as a timer to 28 (Timer out).
OU.55 TimerOn Delay, OU.56 TimerOff Delay	Input a signal (On) to the timer terminal to operate a timer output (Timer out) after the time set at OU.55 has passed. When the multi–function input terminal is off, multi–function output or relay turns off after the time set at OU.56.



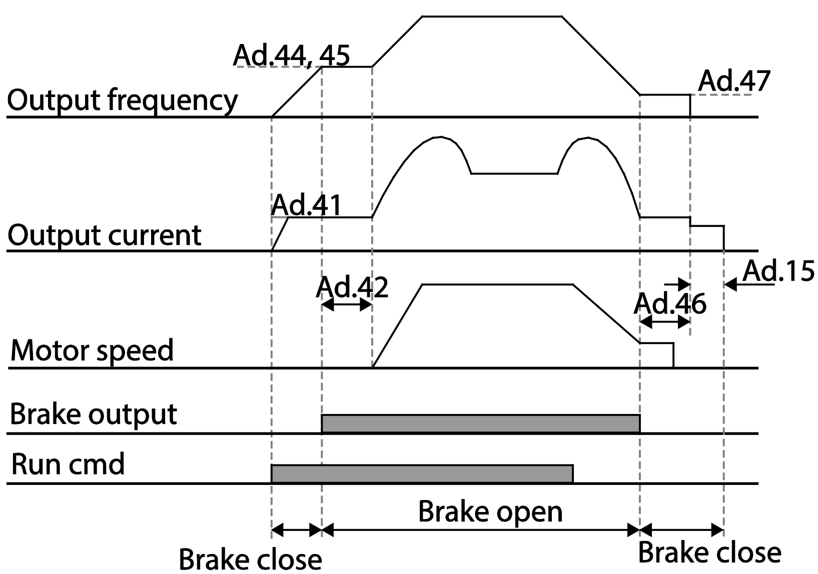
Brake Control

Brake control is used to control the On/Off operation of electronic brake load system.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
dr	09	Control mode	Control Mode	0	V/F	–	–
Ad	41	Brake open current	BR Rls Curr	50.0		0.0–180%	%
	42	Brake open delay time	BR Rls Dly	1.00		0.0–10.0	sec
	44	Brake open forward frequency	BR Rls Fwd Fr	1.00		0–Maximum frequency	Hz
	45	Brake open reverse frequency	BR Rls Rev Fr	1.00		0–Maximum frequency	Hz
	46	Brake close delay time	BR Eng Dly	1.00		0.00–10.00	sec
	47	Brake close frequency	BR Eng Fr	2.00		0–Maximum frequency	Hz
OU	31	Multi–function relay1 item	Relay 1	35	BR Control	–	–
	33	Multi–function output1 item	Q1 Define				

When brake control is activated, DC braking (Ad.12) at drive start and dwell operation (Ad.20–23) do not operate.

- *Brake release sequence: During motor stop state, if an operation command is entered, the drive accelerates up to brake release frequency (Ad.44– 45) in forward or in reverse direction. After reaching brake release frequency, if motor current reaches brake release current (BR Rls Curr), the output relay or multi function output terminal for brake control sends a release signal. Once the signal has been sent, acceleration will begin after maintaining frequency for brake release delay time (BR Rls Dly).*
- *Brake engage sequence: If a stop command is sent during operation, the motor decelerates. Once the output frequency reaches brake engage frequency (BR Eng Fr), the motor stops deceleration and sends out a brake engage signal to a preset output terminal. Frequency is maintained for the brake engage delay time (BR Eng Dly) and will become 0 afterwards. If DC braking time (Ad.15) and DC braking resistance (Ad.16) are set, drive output is blocked after DC braking. For DC braking, refer to "Stop After DC Braking" on page 4–99.*



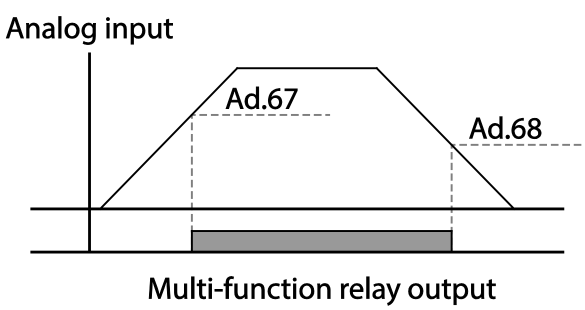
Multi–Function Output On/Off Control

Set reference values (on/off level) for analog input and control output relay or multi–function output terminal on/off status accordingly.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Ad	66	Output terminal on/off control mode	On/Off Ctrl Src	1	V1	–	–
	67	Output terminal on level	On–C Level	90.00		Output terminal off level– 100.00%	%
	68	Output terminal off level	Off–C Level	10.00		0.00–Output terminal on level	%
OU	31	Multi–function relay1 item	Relay 1	34	On/Off	–	–
	33	Multi–function output1 item	Q1 Define				

Multi–function Output On/Off Control Setting Details

Pr. Code	Description
Ad.66 On/Off Ctrl Src	Select analog input On/Off control.
Ad.67 On–C Level , Ad.68 Off–C Level	Set On/Off level at the output terminal.



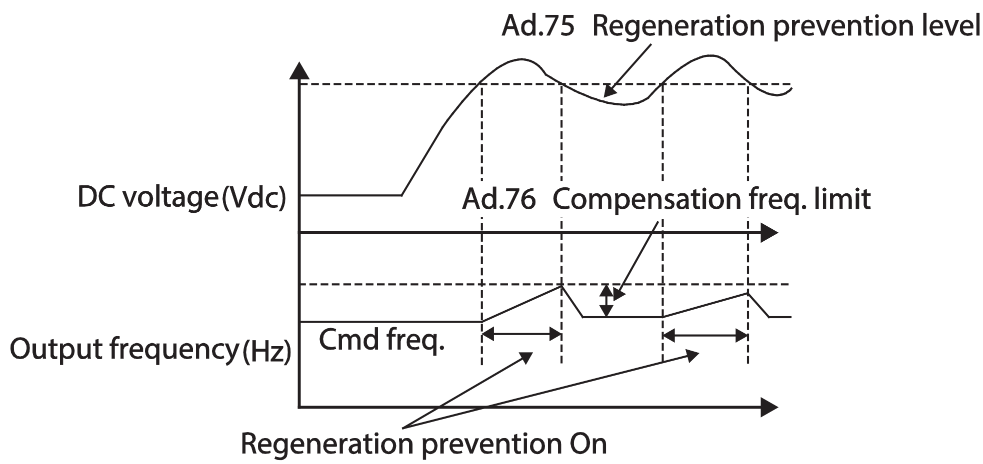
Press Regeneration Prevention

Press regeneration prevention is used during press operations to prevent braking during the regeneration process. If motor regeneration occurs during a press operation, motor operation speed automatically goes up to avoid the regeneration zone.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Ad	74	Select press regeneration prevention for press	RegenAvd Sel	0	No	0–1	–
	75	Press regeneration prevention operation voltage level	RegenAvd Level	350V		230V: 300–400V	VDC
				700V		460V: 600–800V	
	76	Press regeneration prevention compensation frequency limit	CompFreq Limit	1.00Hz		0.00– 10.00Hz	Hz
	77	Press regeneration prevention P gain	RegenAvd Pgain	50.0%		0 .0– 100.0%	%
	78	Press regeneration prevention I gain	RegenAvd Igain	500(ms)		20–30000ms	ms

Press Regeneration Prevention Setting Details

Pr. Code	Description
Ad.74 RegenAvd Sel	Frequent regeneration voltage from a press load during constant speed motor operation may force excessive work on the brake unit which may damage or shorten the brake life. To prevent this situation, select Ad.74 (RegenAvd Sel) to control DC link voltage and disable the brake unit operation.
Ad.75 RegenAvd Level	Set brake operation prevention level voltage when the DC link voltage goes up due to regeneration.
Ad.76 CompFreq Limit	Set alternative frequency width that can replace actual operation frequency during regeneration prevention.
Ad.77 RegenAvd Pgain, Ad.78 RegenAvd Igain	To prevent regeneration zone, set P gain/I gain in the DC link voltage supress PI controller.



NOTE: Press regeneration prevention does not operate during accelerations or decelerations, but it only operates during constant speed motor operation. When regeneration prevention is activated, output frequency may change within the range set at Ad.76 (CompFreq Limit).

Analog Output

An analog output terminal provides output of 0–10V voltage, 4–20 mA current, or 0–32 kHz pulse.

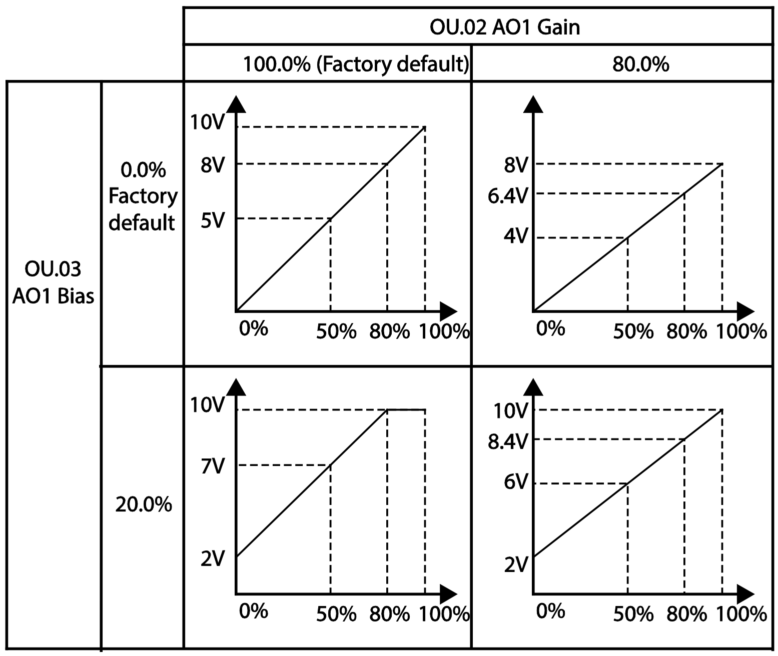
Voltage and Current Analog Output

An output type can be adjusted by selecting an output option at AO(Analog Output) terminal. Set the analog voltage/current output terminal setting switch (SW3) to change the output type (voltage/current).

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
OU	01	Analog output1	AO1 Mode	0	Frequency	0–15	–
	02	Analog output1 gain	AO1 Gain	100.0		–1000.0–1000.0	%
	03	Analog output1 bias	AO1 Bias	0.0		–100.0–100.0	%
	04	Analog output1 filter	AO1 Filter	5		0–10000	ms
	05	Analog constant output1	AO1 Const %	0.0		0.0–100.0	%
	06	Analog output1 monitor	AO1 Monitor	0.0		0.0–1000.0	%

Voltage and Current Analog Output Setting Details

Pr. Code	Description		
OU.1 AO1 Mode	Select a constant value for output. The following example for output voltage setting.		
	Setting		Function
	0	Frequency	Outputs operation frequency as a standard. 10V output is made from the frequency set at dr.20(Max Freq)
	1	Output Current	10V output is made from 200% of drive rated current.
	2	Output Voltage	Sets the outputs based on the drive output voltage. 10V output is made from a set voltage in bA.15 (Rated V). If 0V is set in bA.15, 230V/460V models output 10V based on the actual input voltages (240V and 480V respectively).
	3	DC Link Volt	Outputs drive DC link voltage as a standard. Outputs 10V when the DC link voltage is 410Vdc for 230V models, and 820Vdc for 460V models.
	4	Torque	Outputs the generated torque as a standard. Outputs 10V at 250% of motor rated torque.
	5	Ouput Power	Monitors output wattage. 200% of rated output is the maximum display voltage (10V).
	6	Iqse	Outputs the maximum voltage at 200% of no load current.
	7	Idr.	Outputs the maximum voltage at 250% of rated torque current $rated\ torque\ current = \sqrt{rated\ current^2 - no\ load\ current^2}$
	8	Target Freq	Outputs set frequency as a standard. Outputs 10V at the maximum frequency (dr.20).
	9	Ramp Freq	Outputs frequency calculated with Acc/Dec function as a standard. May vary with actual output frequency. Outputs 10V.
	12	PID Ref Value	Outputs command value of a PID controller as a standard. Outputs approximately 6.6 V at 100%.
	13	PID Fdk Value	Outputs feedback volume of a PID controller as a standard. Outputs approximately 6.6 V at 100%.
	14	PID Output	Outputs output value of a PID controller as a standard. Outputs approximately 10V at 100%.
	15	Constant	Outputs OU.5 (AO1 Const %) value as a standard.

Pr. Code	Description
OU.2 AO1 Gain, OU.3 AO1 Bias	Adjusts output value and offset. If frequency is selected as an output item, it will operate as shown below. $$AO1 = \frac{Frequency}{MaxFreq} \times AO1\ Gain + AO1\ Bias$$ The graph below illustrates the analog voltage output (AO1) changes depend on OU.2 (AO1 Gain) and OU.3 (AO1 Bias) values. Y–axis is analog output voltage (0–10V), and X–axis is % value of the output item. Example, if the maximum frequency set at dr.20 (Max Freq) is 60Hz and the present output frequency is 30Hz, then the x–axis value on the next graph is 50%. 
OU.4 AO1 Filter	Set filter time constant on analog output.
OU.5 A01 Const %	If analog output at OU.1 (AO1 Mode) is set to 15(Constant), the analog voltage output is dependent on the set parameter values (0–100%).
OU.6 AO1 Monitor	Monitors analog output value. Displays the maximum output voltage as a percentage (%) with 10V as the standard.

Analog Pulse Output

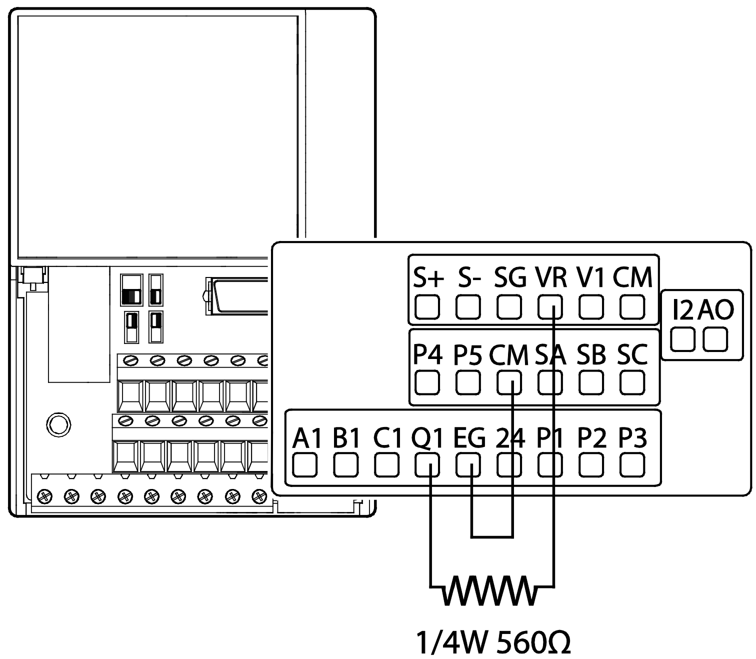
Output item selection and pulse size adjustment can be made for the Q1 terminal when configured as TO (Pulse Output).

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
OU	33	Multi–function output 1	Q1 define	39	TO	0–38	–
	61	Pulse output setting	TO Mode	0	Frequency	0–15	–
	62	Pulse output gain	TO Gain	100.0		–1000.0–1000.0	%
	63	Pulse output bias	TO Bias	0.0		–100.0–100.0	%
	64	Pulse output filter	TO Filter	5		0–10000	ms
	65	Pulse output constant output2	TO Const %	0.0		0.0–100.0	%
	66	Pulse output monitor	TO Monitor	0.0		0.0–1000.0	%

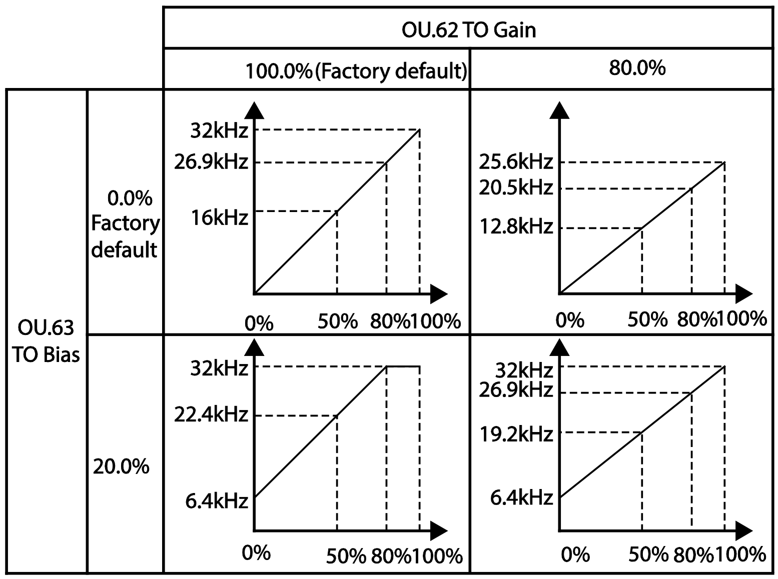
Analog Pulse Output Setting Details

<table>
<tr><th>Pr. Code</th><th>Description</th></tr>
<tr><td>OU.33 Q1 Define</td><td>
Pulse output TO and multi–function output Q1 share the same terminal. Set OU.33 to 32kHz pulse output and follow the instructions below to make wiring connections that configure the open collector output circuit.

1) Connect a 1/4W, 560Ω resistor between VR and Q1 terminals.
2) Connect EG and CM terminals.

When wiring the resistor, a resistance of 560Ω or less is recommended to stably provide 32kHz pulse output.


Connect a pulse between ACN drives as follows:
<table>
<tr><th>ACN Drive #1
Output Terminal</th><th></th><th>ACN Drive #2
Input Terminal</th></tr>
<tr><td>Q1</td><td>➔</td><td>P5</td></tr>
<tr><td>EG</td><td>➔</td><td>CM</td></tr>
</table>
</td></tr>
</table>

Pr. Code	Description
OU.62 TO Gain, OU.63 TO Bias	Adjusts output value and offset. If frequency is selected as an output, it will operate as shown below. $$TO = \frac{Frequency}{MaxFreq} \times TO\ Gain + TO\ Bias$$ The following graph illustrates that the pulse output (TO) changes depend on OU.62 (TO Gain) and OU.63 (TO Bias) values. The Y–axis is an analog output current(0–32kHz), and X–axis is % value on output item. For example, if the maximum frequency set with dr.20 (Max Freq) is 60Hz and present output frequency is 30Hz, then the x–axis value on the next graph is 50%. 
OU.64 TO Filter	Sets filter time constant on analog output.
OU.65 TO Const %	If analog output item is set to constant, the analog pulse output is dependent on the set parameter values.
OU.66 TO Monitor	Monitors analog output value. Displays the maximum output pulse (32kHz) as a percentage (%) of the standard.

Digital Output

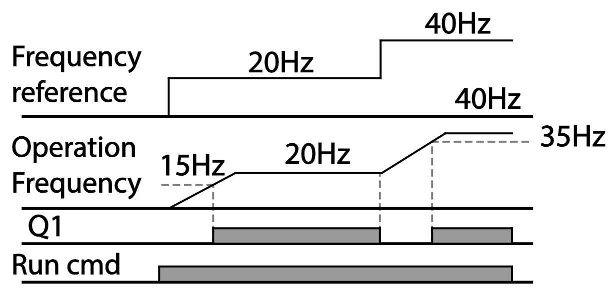
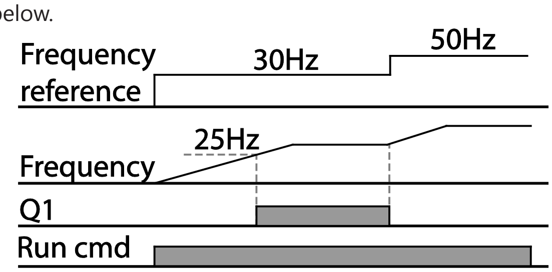
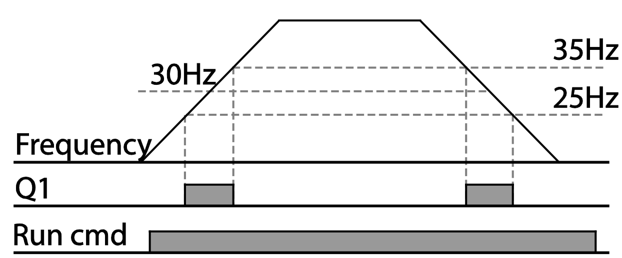
Multi–function Output Terminal and Relay Settings

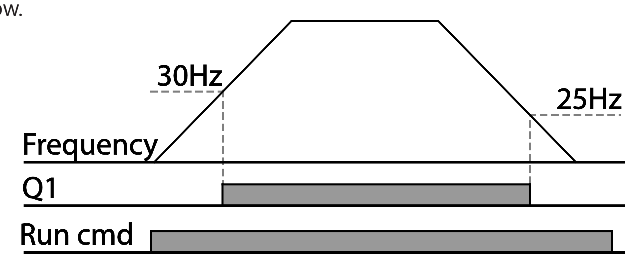
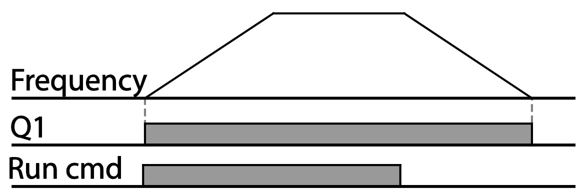
Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
OU	30	Fault output item	Trip Out Mode	010*		–	bit
	31	Multi–function relay1 setting	Relay 1	29	Trip	–	–
	33	Multi–function output1 setting	Q1 Define	14	Run	–	–
	34	Multi-function relay3 setting	Relay 3	00	None	–	–
	35	Multi-function relay4 setting	Relay 4	00	None	–	–
	41	Multi–function output monitor	DO Status	–		00– 11	bit
	57	Detection frequency	FDT Frequency	30.00		0.00–Maximum frequency	Hz
	58	Detection frequency band	FDT Band	10.00			

**See "Bit Selection" on page 4–3 for details*

Multi–function Output Terminal and Relay Setting Details

Pr. Code	Description
OU.31 Relay1	Set Relay1 output options (See Table Below).
OU.33 Q1 Define	Select output options for multi–function output terminal (Q1). Q1 is open collector TR output.
OU.34 ***OU.35***	Set Relay output options for extension IO card (See Table Below).
OU.57 FDT Freq ***OU.58 FDT Band***	Set output terminal and relay functions according to OU.57 FDT (Frequency), OU.58 (FDT Band) settings and fault trip conditions (see table below).

Digital Output OU.31, OU.33, OU.34, OU.35 Functions		
Setting		**Function**
0	None	No output signal.
1	FDT–1	Detects drive output frequency reaching the user set frequency. Outputs a signal when the absolute value (set frequency–output frequency) < detected frequency width/2. When detected frequency width is 10Hz, FDT–1 output is as shown in the graph below. 
2	FDT–2	Outputs a signal when the user set frequency and detected frequency (FDT Frequency) are equal, and fulfills FDT–1 condition at the same time. [Absolute value (set frequency–detected frequency) < detected frequency width/2]&[FDT–1] Detected frequency width is 10Hz. When the detected frequency is set to 30Hz, FDT–2 output is as shown in the graph below. 
3	FDT–3	Outputs a signal when the Absolute value (output frequency–operation frequency) < detected frequency width/2. Detected frequency width is 10Hz. When detected frequency is set to 30Hz, FDT–3 output is as shown in the graph below. 

Digital Output OU.31, OU.33, OU.34, OU.35 Functions		
Setting		Function
4	FDT–4	Output signal can be separately set for acceleration and deceleration conditions. • In acceleration: Operation frequency≥Detected frequency • In deceleration: Operation frequency>(Detected frequency–Detected frequency width/2) Detected frequency width is 10Hz. When detected frequency is set to 30Hz, FDT–4 output is as shown in the graph below. 
5	Overload	Outputs a signal at motor overload.
6	IOL	Outputs a signal when a fault is triggered from a protective function operation by drive overload inverse proportion.
7	Underload	Outputs a signal at load fault warning.
8	Fan Warning	Outputs a signal at fan fault warning.
9	Stall	Outputs a signal when a motor is overloaded and stalled.
10	Over voltage	Outputs a signal when the drive DC link voltage rises above the protective operation voltage.
11	Low Voltage	Outputs a signal when the drive DC link voltage drops below the low voltage protective level.
12	Over Heat	Outputs signal when the drive overheats.
13	Lost command	Outputs a signal when there is a loss of analog input terminal and RS–485 communication command at the terminal block. Outputs a signal when communication power and expansion an I/O power card is installed, and also outputs a signal when losing analog input and communication power commands.
14	RUN	Outputs a signal when operation command is entered and the drive outputs voltage. No signal output during DC braking. 
15	Stop	Outputs a signal at operation command off, and when there is no drive output voltage.
16	Steady	Outputs a signal in steady operation.
17	Drive line	Outputs a signal while the motor is driven by the drive line.
18	Comm line	Outputs a signal while the motor is driven by a commercial power source. For details, refer to "Supply Power Transition" on page 4–173.
19	Speed search	Outputs a signal during drive speed search operation. For details, refer to "Speed Search Operation" on page 4–167.
22	Ready	Outputs signal when the drive is in stand by operation and ready to receive an external operation command.
28	Timer Out	A timer function to operate terminal output after a certain time by using multi–function terminal block input. For more details, refer to "Multi-function IO Timer Settings" on page 4–181.
29	Trip	Outputs a signal after a fault trip Refer to "Multi–function Output On/Off Control Setting Details" on page 4–183.
31	DB Warn %ED	Refer to "Dynamic Braking" on page 4–205.
34	On/Off Control	Outputs a signal using an analog input value as a standard. Refer to "Multi–function Output On/Off Control Setting Details" on page 4–183.

Digital Output OU.31, OU.33, OU.34, OU.35 Functions		
Setting		Function
35	BR Control	Outputs a brake release signal. Refer to "Brake Control" on page 4–182.
40	KEB Operating	This outputs when the energy buffering operation is started because of low voltage of the drive's DC power section due to a power failure on the input power. (This outputs in the energy buffering state before the input power restoration regardless of KEB–1 and KEB–2 mode settings.)

Fault Trip Output using Multi–Function Output Terminal and Relay

The drive can output fault trip state using multi–function output terminal (Q1) and relay (Relay 1).

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
OU	30	Fault trip output mode	Trip Out Mode	010		–	bit
	31	Multi–function relay1	Relay 1	29	Trip	–	–
	33	Multi–function output1	Q1 Define	14	Run	–	–
	34	Multi-function relay3 setting	Relay 3	29	Trip	–	–
	35	Multi-function relay4 setting	Relay 4	29	Trip	–	–
	53	Fault trip output on delay	TripOut OnDly	0.00		0.00–100.00	sec
	54	Fault trip output off delay	TripOut OffDly	0.00		0.00–100.00	sec

Fault Trip Output by Multi–function Output Terminal and Relay – Setting Details

<table>
<tr><th>Pr. Code</th><th colspan="4">Description</th></tr>
<tr><td rowspan="6">OU.30 Trip Out Mode</td><td colspan="4">Fault trip relay operates based on the fault trip output settings.

When a fault trip occurs in the drive, the relevant terminal and relay will operate. Depending on the fault trip type, terminal and relay operation can be configured as shown in the table below. *See "Bit Selection" on page 4–3 for details.</td></tr>
<tr><td colspan="3">Setting</td><td rowspan="2">Function</td></tr>
<tr><td>bit3</td><td>bit2</td><td>bit1</td></tr>
<tr><td></td><td></td><td>X</td><td>Operates when low voltage fault trips occur</td></tr>
<tr><td></td><td>X</td><td></td><td>Operates when fault trips other than low voltage occur</td></tr>
<tr><td>X</td><td></td><td></td><td>Operates when auto restart fails (Pr.8 and Pr.9)</td></tr>
<tr><td>OU.31 Relay1
OU.33 Q1 Define
OU.34 Relay 3
OU.35 Relay 4</td><td colspan="4">Select fault trip output terminal/relay and select 29 (Trip Mode) at codes OU.31 and OU.33. Set OU.34 and OU.35 if extension IO module is installed.</td></tr>
<tr><td>OU.53 Trip Out On Dly,
OU.54 Trip Out Off Dly</td><td colspan="4">If a fault trip occurs, trip relay or multi–function output operates after the time delay set in OU.53. Terminal is off with the input initialized after the time delay set in OU.54.</td></tr>
</table>

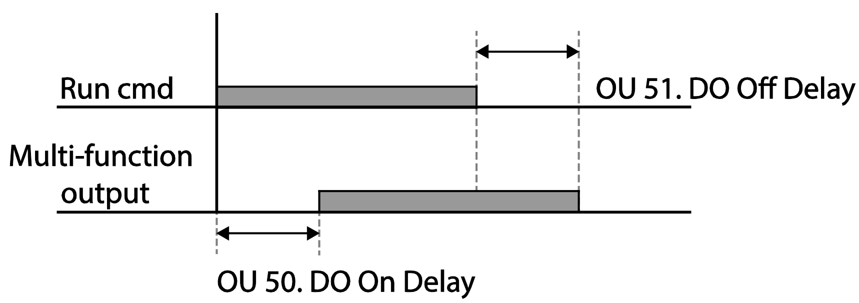
Multi–function Output Terminal Delay Time Settings

Set on–delay and off–delay times separately to control the output terminal and relay operation times. The delay time set at codes OU.50–51 applies to multi–function output terminal (Q1) and relay (Relay 1), except when the multi–function output function is in fault trip mode.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
OU	50	Multi–function output On delay	DO On Delay	0.00	0.00–100.00	s
	51	Multi–function output Off delay	DO Off Delay	0.00	0.00–100.00	s
	52	Select multi–function output terminal	DO NC/NO Sel	00*	00–11	bit
**See "Bit Selection" on page 4–3 for details*						

Output Terminal Delay Time Setting Details

Pr. Code	Description
OU.52 DO NC/NO Sel	Select terminal type for relay and multi–function output terminal. An additional three terminal type selection bits at the terminal block will be added when an expansion I/O is added. By setting the relevant bit to 0, it will operate A terminal (Normally Open), and setting it to 1 will operate B terminal (Normally Closed). Shown below in the table are Relay 1 and Q1 settings starting from the right bit.



Keypad Language Settings

Select the language to be displayed on the LCD keypad.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
CNF*	01	Select keypad language	Language Sel	0	English	–	–
				1	Korean		
**Available on ACN-LCD keypad only.*							

Operation State Monitor

The drive's operation condition can be monitored using the LCD keypad. If the monitoring option is selected in config (CNF) mode, a maximum of four items can be monitored simultaneously. Monitoring mode displays three different items on the LCD keypad, but only one item can be displayed in the status window at a time.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
CNF*	20	Display item condition display window	Anytime Para	0	Frequency	–	–
	21	Monitor mode display 1	Monitor Line–1	0	Frequency	–	Hz
	22	Monitor mode display 2	Monitor Line–2	2	Output Current	–	A
	23	Monitor mode display 3	Monitor Line–3	3	Output Voltage	–	V
	24	Monitor mode initialize	Mon Mode Init	0	No	–	–

*Available on ACN-LCD keypad only.

Operation State Monitor Setting Details

Pr. Code	Description		
CNF.20 AnyTime Para	Select items to display on the top–right side of the LCD keypad screen. Choose the parameter settings based on the information to be displayed. Codes CNF.20–23 share the same setting options as listed in the table below.		
	Setting		Function
	0	Frequency	On stop, displays the set frequency. During operation, displays the actual output frequency (Hz).
	1	Speed	On stop, displays the set speed (rpm). During operation, displays the actual operating speed (rpm).
	2	Output Current	Displays output current.
	3	Output Voltage	Displays output voltage.
	4	Output Power	Displays output power.
	5	WHour Counter	Displays drive power consumption.
	6	DCLink Voltage	Displays DC link voltage within the drive.
	7	DI Status	Displays input terminal status of the terminal block. Starting from the right, displays P1–P5.
	8	DO Status	Displays output terminal status of the terminal block. Starting from the right, Relay1, Relay2, and Q1.
	9	V1 MonitorV	Displays the input voltage value at terminal V1 (V).
	10	V1 Monitor%	Displays input voltage terminal V1 value as a percentage. If –10V, 0V, +10V is measured, –100%, 0%, 100% will be displayed.
	13	V2 MonitorV	Displays input voltage terminal V2 value (V).
	14	V2 Monitor%	Displays input voltage terminal V2 value as a percentage.
	15	I2 Monitor[mA]	Displays input current terminal I2 value (A).
	16	I2 Monitor%	Displays input current terminal I2 value as a percentage.
	17	PID Output	Displays output of PID controller.
	18	PID Ref Value	Displays reference value of PID controller.
	19	PID Fdb Value	Displays feedback volume of PID controller.
	20	Torque	If the torque reference command mode (DRV–08) is set to a value other than keypad (0 or 1), the torque reference value is displayed.
	21	Torque Limit	If torque limit setting (Cn.53) is set to a value other than keypad (0 or 1), the torque limit value is displayed.
	23	Spd Limit	If the speed limit setting (Cn.62) on torque control mode is set to a value other than keypad (0 or 1), the speed limit setting is displayed.
	24	Load Speed	Displays the speed of a load in the desired scale and unit. Displays the speed of a load that ADV–61 (Load Spd Gain) and ADV–62 (Load Spd Scale) are applied as rpm or mpm set at ADV–63 (Load Spd Unit).
CNF.21–23 Monitor Line–x	Select the items to be displayed in monitor mode. Monitor mode is the first displayed mode when the drive is powered on. A total of three items, from monitor line–1 to monitor line– 3, can be displayed simultaneously.		
CNF.24 Mon Mode Init	Selecting 1(Yes) initializes CNF.20–23.		

Load Speed Display Setting

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
ADV (M2)	61(40)	Rotation count speed gain	Load Spd Gain	–	100.0	1–6000.0%	–
	62(41)	Rotation count speed scale	Load Spd Scale	0	x 1	0–4	Hz
	63(42)	Rotation count speed unit	Load Spd Unit	2	rpm	0–1	A

Load Speed Display Setting Detail

Pr. Code	Description
ADV.61 (M2.40) Load Spd Gain	If monitoring item 24 Load Speed is selected and if the motor spindle and the load are connected with belt, the actual number of revolutions can be displayed by calculating the pulley ratio.
ADV.62 (M2.41) Load Spd Scale	Selects the decimal places that monitoring item 24 Load Speed displays (from x1–x0.0001).
ADV.63 (M2.42) Load Spd Unit	Selects the unit of monitoring item 24 Load Speed. Selects between RPM (Revolution Per Minute) and MPM (Meter Per Minute) for the unit. For example, if line speed is 300 [mpm] at 800 [rpm], set ADV61 (Load Spd Gain) to "37.5%" to display the line speed. Also, set ADV62 (Load Sped Scale) to "X 0.1" to display the value to the first decimal point. And set ADV63 (Load Spd Unit) to mpm. Now, the monitoring item 24 Load Speed is displayed on the keypad display as 300.0 mpm instead of 800 rpm.

NOTE: Drive power consumption
Values are calculated using voltage and current. Electric power is calculated every second and the results are accumulated. Setting CNF.62 (WH Count Reset) value to 1(Yes) will reset cumulated electric energy consumption. Power consumption is displayed as shown below:

- *Less than 1, 000 kW: Units are in kW, displayed in 999.9 kW format.*
- *1-99 MW: Units are in MW, displayed in 99.99 MWh format.*
- *100-999 MW: Units are in MW, displayed in 999.9 MWh format.*
- *More than 1, 000 MW: Units are in MW, displayed in 9, 999 MWh format and can be displayed up to 65, 535 MW. (Values exceeding 65, 535MW will reset the value to 0, and units will return to kW. It will be displayed in 999.9 kW format).*

Operation Time Monitor

Monitors drive and fan operation time.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
CNF*	70	Drive operation accumulated time	On–time	0/00/00 00: 00		–	min
	71	Drive operation accumulated time	Run–time	0/00/00 00: 00		–	min
	72	Drive operation accumulated time initialization	Time Reset	0	No	0–1	–
	74	Cooling fan operation accumulated time	Fan time	0/00/00 00: 00		–	min
	75	Cooling fan operation accumulated time initialization	Fan Time Reset	0	No	0–1	–

**Available on ACN-LCD keypad only.*

Operation Time Monitor Setting Details

Pr. Code	Description
CNF.70 On–time	Displays accumulated power supply time. Information is displayed in [YY/MM/DD Hr: Min (0/00/00 00: 00)] format.
CNF.71 Run–time	Displays accumulated time of voltage output by operation command input. Information is displayed in [YY/MM/DD Hr: Min (0/00/00 00: 00)] format.
CNF.72 Time Reset	Setting 1(Yes) will delete power supply accumulated time (On–time) and operation accumulated time (Run–time) and is displayed as 0/00/00 00: 00 format.
CNF.74 Fan time	Displays accumulated time of drive cooling fan operation. Information will be displayed in [YY/MM/DD Hr: Min (0/00/00 00: 00)] format.
CNF.75 Fan Time Reset	Setting 1(Yes) will delete cooling fan operation accumulated time(on–time) and operation accumulated time (Run–time) and will display it in 0/00/00 00: 00 format.

Learning Protection Features

Protection features provided by the ACN series drive are categorized into two types: protection from overheating damage to the motor, and protection against the drive malfunction.

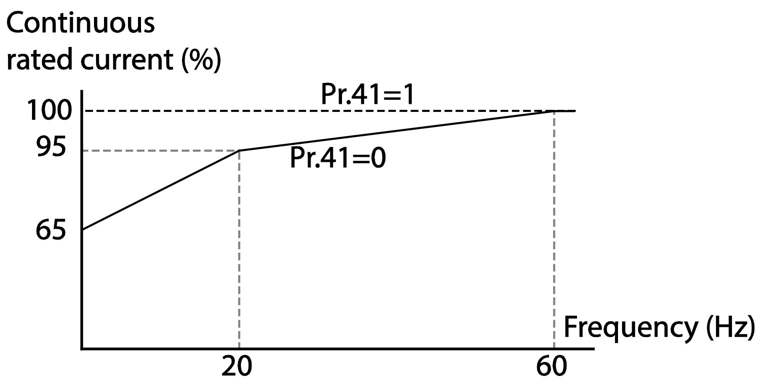
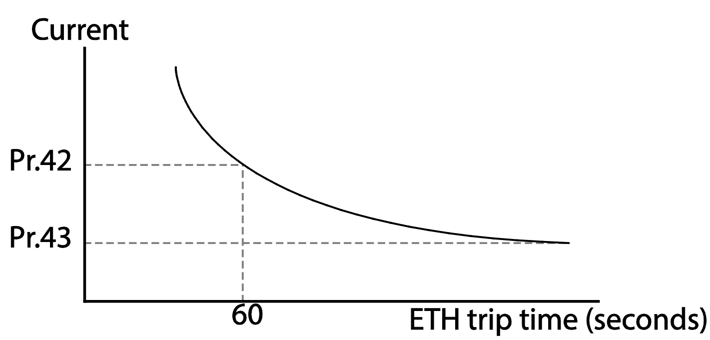
Motor Protection

Electronic Thermal Motor Overheating Prevention (ETH)

ETH is a protective function that uses the output current of the drive without a separate temperature sensor, to predict a rise in motor temperature to protect the motor based on its heat characteristics.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting range	Unit
Pr	40	Electronic thermal prevention fault trip selection	ETH Trip Sel	0	None	0–2	–
	41	Motor cooling fan type	Motor Cooling	0	Self–cool	–	–
	42	Electronic thermal one minute rating	ETH 1min	150		120–200	%
	43	Electronic thermal prevention continuous rating	ETH Cont	120		50–150	%

Electronic Thermal (ETH) Prevention Function Setting Details

<table>
<tr><th>Pr. Code</th><th colspan="3">Description</th></tr>
<tr><td rowspan="5">Pr.40 ETH Trip Sel</td><td colspan="3">ETH can be selected to provide motor thermal protection. The LCD screen displays “E–Thermal.”</td></tr>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>None</td><td>The ETH function is not activated.</td></tr>
<tr><td>1</td><td>Free–Run</td><td>The drive output is blocked. The motor coasts to a halt (free–run).</td></tr>
<tr><td>2</td><td>Dec</td><td>The drive decelerates the motor to a stop.</td></tr>
<tr><td rowspan="5">Pr.41 Motor Cooling</td><td colspan="3">Select the drive mode of the cooling fan, attached to the motor.</td></tr>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>Self–cool</td><td>As the cooling fan is connected to the motor axis, the cooling effect varies, based on motor speed. Most universal induction motors have this design.</td></tr>
<tr><td>1</td><td>Forced–cool</td><td>Additional power is supplied to operate the cooling fan. This provides extended operation at low speeds. Motors designed for drives typically have this design.</td></tr>
<tr><td colspan="3">
</td></tr>
<tr><td>Pr.42 ETH 1 min</td><td colspan="3">The amount of input current that can be continuously supplied to the motor for 1 minute, based on the motor–rated current (bA.13).</td></tr>
<tr><td>Pr.43 ETH Cont</td><td colspan="3">Sets the amount of current with the ETH function activated. The range below details the set values that can be used during continuous operation without the protection function.

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

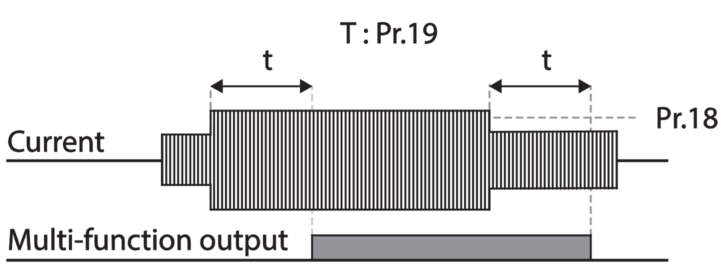
Overload Early Warning and Trip

A warning or fault ‘trip’ (cutoff) occurs when the motor reaches an overload state, based on the motor’s rated current. The amount of current for warnings and trips can be set separately.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting range	Unit
Pr	17	Overload warning selection	OL Warn Select	1	Yes	0–1	–
	18	Overload warning level	OL Warn Level	150		30–180	%
	19	Overload warning time	OL Warn Time	10.0		0–30	s
	20	Motion at overload trip	OL Trip Select	1	Free–Run	–	–
	21	Overload trip level	OL Trip Level	180		30–200	%
	22	Overload trip time	OL Trip Time	60.0		0–60.0	s
OU	31	Multi–function relay 1 item	Relay 1	5	Over Load	–	–
	33	Multi–function output 1 item	Q1 Define				

<u>*Overload Early Warning and Trip Setting Details*</u>

<table>
<tr><th>Pr. Coden</th><th colspan="3">Description</th></tr>
<tr><td>Pr.17 OL Warn Select</td><td colspan="3">If the overload reaches the warning level, the terminal block multi–function output terminal and relay are used to output a warning signal. If 1 (Yes) is selected, it will operate. If 0 (No) is selected, it will not operate.</td></tr>
<tr><td>Pr.18 OL Warn Level,
Pr.19 OL Warn Time</td><td colspan="3">When the input current to the motor is greater than the overload warning level (OL Warn Level) and continues at that level during the overload warning time (OL Warn Time), the multi–function output (Relay 1, Q1) sends a warning signal. When Over Load is selected at OU.31 and 33, the multi–function output terminal or relay outputs a signal. The the signal output does not block the drive output.</td></tr>
<tr><td rowspan="5">Pr.20 OL Trip Select</td><td colspan="3">Select the drive protective action in the event of an overload fault trip.</td></tr>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>None</td><td>No protective action is taken.</td></tr>
<tr><td>1</td><td>Free–Run</td><td>In the event of an overload fault, drive output is blocked and the motor will free–run due to inertia.</td></tr>
<tr><td>2</td><td>Dec</td><td>If a fault trip occurs, the motor decelerates and stops.</td></tr>
<tr><td>Pr.21 OL Trip Level,
Pr.22 OL Trip Time</td><td colspan="3">When the current supplied to the motor is greater than the preset value at the overload trip level (OL Trip Level) and continues to be supplied during the overload trip time (OL Trip Time), the drive output is either blocked according to the preset mode from Pr. 17 or slows to a stop after deceleration.</td></tr>
</table>



NOTE: Overload warnings warn of an overload before an overload fault trip occurs. The overload warning signal may not work in an overload fault trip situation, if the overload warn level (OL Warn Level) and the overload warn time (OL Warn Time) are set higher than the overload trip level (OL Trip Level) and overload trip time (OL Trip Time).

Stall Prevention and Flux Braking

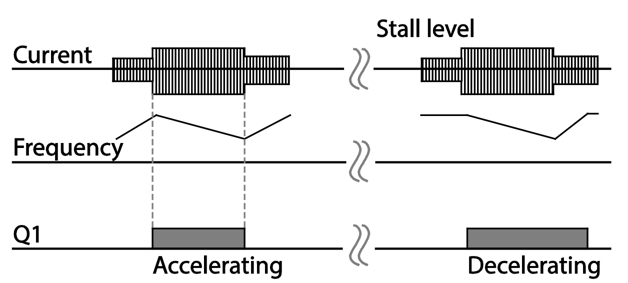
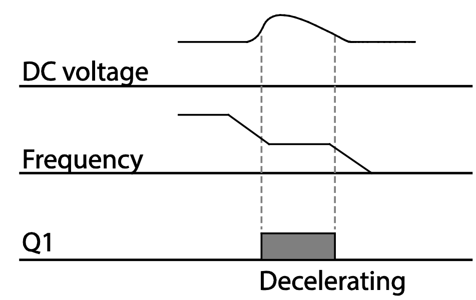
The stall prevention function is a protective function that prevents motor stall caused by overloads. If a motor stall occurs due to an overload, the drive operation frequency is adjusted automatically. When stall is caused by overload, high currents are induced in the motor may cause motor overheat or damage the motor and interrupt operation of the motor–driven devices.

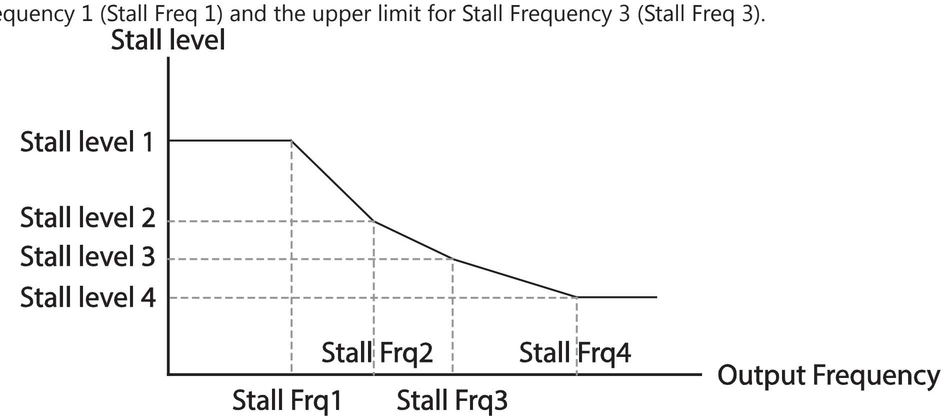
To protect the motor from overload faults, the drive output frequency is adjusted automatically, based on the size of load.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting range	Unit
Pr	50	Stall prevention and flux braking	Stall Prevent	0000*		–	bit
	51	Stall frequency 1	Stall Freq 1	60.00		Start frequency–Stall Freq 1	Hz
	52	Stall level 1	Stall Level 1	180		30–250	%
	53	Stall frequency 2	Stall Freq 2	60.00		Stall Freq 1–Stall Freq 3	Hz
	54	Stall level 2	Stall Level 2	180		30–250	%
	55	Stall frequency 3	Stall Freq 3	60.00		Stall Freq 2–Stall Freq 4	Hz
	56	Stall level 3	Stall Level 3	180		30–250	%
	57	Stall frequency 4	Stall Freq 4	60.00		Stall Freq 3–Maximum frequency	Hz
	58	Stall level 4	Stall Level 4	180		30–250	%
OU	31	Multi–function relay 1 item	Relay 1	9	Stall	–	–
	33	Multi–function output 1 item	Q1 Define				

**See "Bit Selection" on page 4–3 for details*

Stall Prevention Function and Flux Braking Setting Details

Pr. Code	Description		
Pr.50 Stall Prevent	Stall prevention can be configured for acceleration, deceleration, or while operating a motor at constant speed. When the top LCD segment is on, the corresponding bit is set. When the bottom LCD segment is on, the corresponding bit is off.. *See "Bit Selection" on page 4–3 for details		
	Setting		Function
	0001	Stall protection during acceleration	If drive output current exceeds the preset stall level (Pr.52, 54, 56, 58) during acceleration, the motor stops accelerating and starts decelerating. If current level stays above the stall level, the motor decelerates to the start frequency (dr.19). If the current level causes deceleration below the preset level while operating the stall protection function, the motor resumes acceleration.
	0010	Stall protection while operating at constant speed	Similar to stall protection function during acceleration, the output frequency automatically decelerates when the current level exceeds the preset stall level while operating at constant speed. When the load current decelerates below the preset level, it resumes acceleration.
	0100	Stall protection during deceleration	The drive decelerates and keeps the DC link voltage below a certain level to prevent an over voltage fault trip during deceleration. As a result, deceleration times can be longer than the set time depending on the load.
	1000	Flux braking during deceleration	When using flux braking, deceleration time may be reduced because regenerative energy is expended at the motor.
	1100	Stall protection and flux braking during deceleration	Stall protection and flux braking operate together during deceleration to achieve the shortest and most stable deceleration performance.
			

Pr. Code	Description
Pr.51 Stall Freq 1– Pr.58 Stall Level 4	Additional stall protection levels can be configured for different frequencies, based on the load type. As shown in the graph below, the stall level can be set above the base frequency. The lower and upper limits are set using numbers that correspond in ascending order. For example, the range for Stall Frequency 2 (Stall Freq 2) becomes the lower limit for Stall Frequency 1 (Stall Freq 1) and the upper limit for Stall Frequency 3 (Stall Freq 3). 

NOTE: Stall protection and flux braking operate together only during deceleration. Turn on the third and fourth bits of Pr.50 (Stall Prevention) to achieve the shortest and most stable deceleration performance without triggering an overvoltage fault trip for loads with high inertia and short deceleration times. Do not use this function when frequent deceleration of the load is required, as the motor can overheat and may be damaged easily.
When operating Brake resistor, the motor may vibrate under the Flux braking operation. In this case, please turn off the Flux braking (Pr.50).

CAUTION: Use caution when decelerating while using stall protection as depending on the load, the deceleration time can take longer than the time set. Acceleration stops when stall protection operates during acceleration. This may make the actual acceleration time longer than the preset acceleration time. When the motor is operating, Stall Level 1 applies and determines the operation of stall protection.

Drive and Sequence Protection

Open–phase Protection

Open–phase protection is used to prevent overcurrent levels induced at the drive inputs due to an open–phase within the input power supply. Open–phase output protection is also available. An open–phase at the connection between the motor and the drive output may cause the motor to stall, due to a lack of torque.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting	Setting range	Unit
Pr	05	Input/output open–phase protection	Phase Loss Chk	00*	–	bit
	06	Open–phase input voltage band	IPO V Band	40	1–100V	V
**See "Bit Selection" on page 4–3 for details*						

Input and Output Open–phase Protection Setting Details

<table>
<tr><th>Pr. Code</th><th colspan="3">Description</th></tr>
<tr><td rowspan="5">Pr.5 Phase Loss Chk,
Pr.6 IPO V Band</td><td colspan="3">When open–phase protection is operating, input and output configurations are displayed differently. When the top LCD segment is On, the corresponding bit is set to On. When the bottom LCD segment is On, the corresponding bit is set to Off. *See "Bit Selection" on page 4–3 for details</td></tr>
<tr><td colspan="2">Setting</td><td rowspan="2">Function</td></tr>
<tr><td>Bit 2</td><td>Bit 1</td></tr>
<tr><td></td><td>X</td><td>Output open–phase protection</td></tr>
<tr><td>X</td><td></td><td>Input open–phase protection</td></tr>
</table>

External Trip Signal

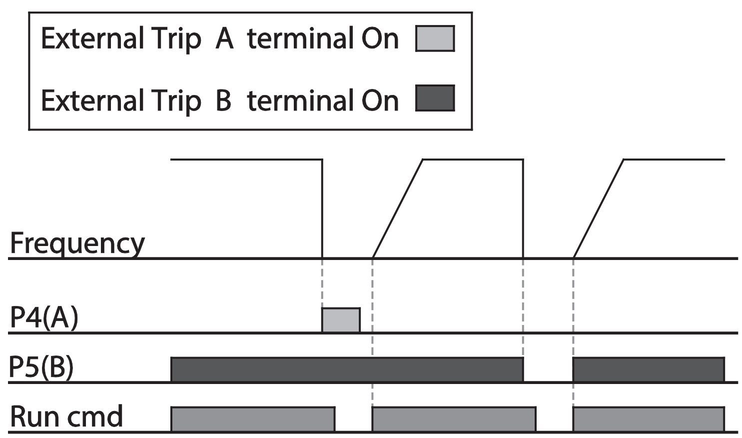
Set one of the multi–function input terminals to 4 (External Trip) to allow the drive to stop operation when abnormal operating conditions arise.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting range	Unit
In	65–69	Px terminal setting options	Px Define (Px: P1–P5)	4	External Trip	0–54	–
	87	Multi–function input contact selction	DI NC/NO Sel	00000*		–	bit

*See "Bit Selection" on page 4–3 for details

External Trip Signal Setting Details

Pr. Code	Description											
In.87 DI NC/NO Sel	Selects the type of input contact. If the mark of the switch is at the bottom (0), it operates as an A contact (Normally Open). If the mark is at the top (1), it operates as a B contact (Normally Closed). The corresponding terminals for each bit are as follows:											
	Bit	11	10	9	8	7	6	5	4	3	2	1
	Terminal							P5	P4	P3	P2	P1



Drive Overload Protection

When the drive input current exceeds the rated current, a protective function is activated to prevent damages to the drive based on inverse proportional characteristics.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting range	Unit
OU	31	Multi–function relay 1	Relay 1	6	IOL	–	–
	33	Multi–function output 1	Q1 Define				

NOTE: A warning signal output can be provided in advance by the multi-function output terminal before the drive overload protection function (IOLT) operates. When the overcurrent time reaches 60% of the allowed overcurrent (150%, 1 min), a warning signal output is provided (signal output at 150%, 36sec).

Speed Command Loss

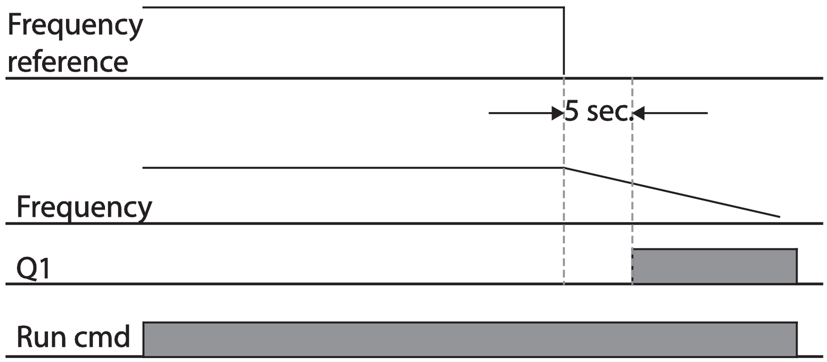
When setting operation speed using an analog input at the terminal block, communication options, or the keypad, speed command loss setting can be used to select the drive operation for situations when the speed command is lost due to the disconnection of signal cables.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting range	Unit
Pr	12	Speed command loss operation mode	Lost Cmd Mode	1	Free–Run	–	–
	13	Time to determine speed command loss	Lost Cmd Time	1.0		0.1–120	s
	14	Operation frequency at speed command loss	Lost Preset F	0.00		Start frequency–Max. frequency	Hz
	15	Analog input loss decision level	AI Lost Level	0	Half of x1	–	–
OU	31	Multi–function Relay 1	Relay 1	13	Lost Command	–	–
	33	Multi–function output 1	Q1 Define				

<u>Speed Command Loss Setting Details</u>

<table>
<tr><th>Pr. Code</th><th colspan="3">Description</th></tr>
<tr><td rowspan="8">Pr.12 Lost Cmd Mode</td><td colspan="3">In situations when speed commands are lost, the drive can be configured to operate in a specific mode:</td></tr>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>None</td><td>The speed command immediately becomes the operation frequency without any protection function.</td></tr>
<tr><td>1</td><td>Free–Run</td><td>The drive blocks output. The motor performs in free–run condition.</td></tr>
<tr><td>2</td><td>Dec</td><td>The motor decelerates and then stops at the time set at Pr.7 (Trip Dec Time).</td></tr>
<tr><td>3</td><td>Hold Input</td><td>The drive calculates the average input value for 10 seconds before the loss of the speed command and uses it as the speed reference.</td></tr>
<tr><td>4</td><td>Hold Output</td><td>The drive calculates the average output value for 10 seconds before the loss of the speed command and uses it as the speed reference.</td></tr>
<tr><td>5</td><td>Lost Preset</td><td>The drive operates at the frequency set at Pr. 14 (Lost Preset F).</td></tr>
<tr><td rowspan="4">Pr.15 AI Lost Level, Pr.13 Lst Cmd Time</td><td colspan="3">Configure the voltage and decision time for speed command loss when using analog input.</td></tr>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>Half of x1</td><td>Based on the values set at In.8 and In.12, protective operation starts when the input signal is reduced to half of the initial value of the analog input set using the speed command (Frq code of Operation group) and it continues for the time (speed loss decision time) set at Pr. 13 (Lost Cmd Time). For example, set the speed command to 2 (V1) at the Frq code in the Operation group, and In.6 (V1 Polarity) to 0 (Unipolar). When the voltage input drops to less than half of the value set at In.8 (V1 Volt x 1), the protective function is activated.</td></tr>
<tr><td>1</td><td>Below x1</td><td>The protective operation starts when the signal becomes smaller than the initial value of the analog input set by the speed command and it continues for the speed loss decision time set at Pr.13 (Lost Cmd Time). Codes In.8 and In.12 are used to set the standard values.</td></tr>
<tr><td>Pr.14 Lost Preset F</td><td colspan="3">In situations where speed commands are lost, set the operation mode (Pr.12 Lost Cmd Mode) to 5 (Lost Preset). This operates the protection function and sets the frequency so that the operation can continue.</td></tr>
</table>

Set Pr.15 (Al Lost Level) to 1 (Below x 1), Pr.12 (Lost Cmd Mode) to 2 (Dec), and Pr.13 (Lost Cmd Time) to 5 sec. Then it operates as follows:



NOTE: If speed command is lost while using communication options or the integrated RS-485 communication, the protection function operates after the command loss decision time set at Pr.13 (Lost Cmd Time) is passed.

Dynamic Braking

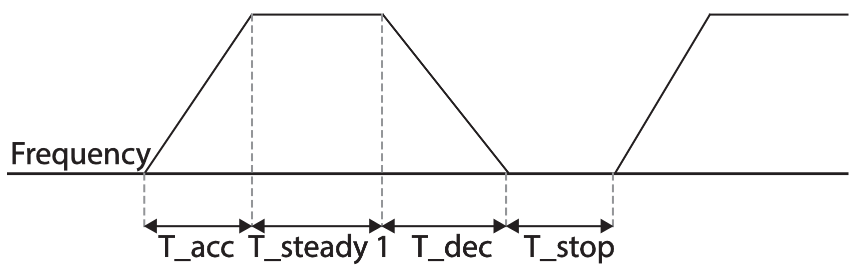
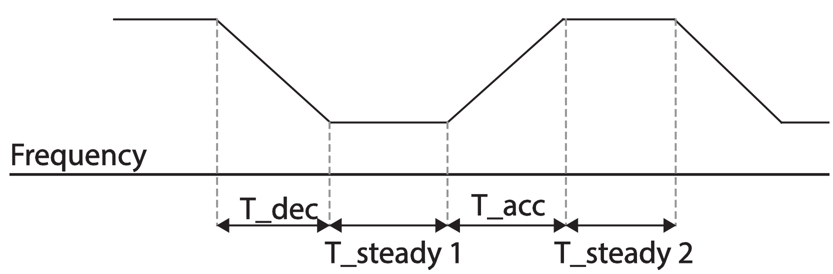
Dynamic Braking (DB) Resistor Configuration

For ACN series, the braking resistor circuit is integrated inside the drive. For Dynamic braking with external resistor, set the desired turn on level with AD.79. Ensure AD.74=0. Monitor the DC bus voltage on the main screen by dCL and check voltage on terminals P2/B to verify activation to brake resistor

Pr.66 is for setup of a warning signal if the braking is being used too frequently.

<table>
<tr><th>Pr. Group</th><th>Pr. Code</th><th>Name</th><th>LCD Display</th><th colspan="2">Parameter Setting</th><th>Setting range</th><th>Unit</th></tr>
<tr><td>Ad</td><td>79</td><td>Dynamic Braking (DB) Unit turn on voltage level</td><td>DB Turn on Lev</td><td colspan="2">230V: 390
460V: 780</td><td>230V: 350–400
460V: 600–800</td><td>V</td></tr>
<tr><td>Pr</td><td>66</td><td>Braking resistor configuration</td><td>DB Warn %ED</td><td colspan="2">10</td><td>0–30</td><td>%</td></tr>
<tr><td rowspan="2">OU</td><td>31</td><td>Multi–function relay 1 item</td><td>Relay 1</td><td rowspan="2">31</td><td rowspan="2">DB Warn %ED</td><td rowspan="2">–</td><td rowspan="2">–</td></tr>
<tr><td>33</td><td>Multi–function output 1 item</td><td>Q1 Define</td></tr>
</table>

Dynamic Breaking Resistor Setting Details

Pr. Code	Description
Pr.66 DB Warn %ED	Set braking resistor configuration (%ED: Duty cycle). Braking resistor configuration sets the rate at which the braking resistor operates for one operation cycle. The maximum time for continuous braking is 15 sec and the braking resistor signal is not output from the drive after the 15 sec period has expired. An example of braking resistor set up is as follows: $\%ED = \frac{T\_dec}{T\_acc + T\_steady + T\_dec + T\_stop} \times 100\%$  **Example 1** $\%ED = \frac{T\_dec}{T\_dec + T\_steady1 + T\_acc + T\_steady2} \times 100\%$  **Example 2** • T_acc: Acceleration time to set frequency • T_steady: Constant speed operation time at set frequency • T_dec: Deceleration time to a frequency lower than constant speed operation or the stop time from constant speed operation frequency • T_stop: Stop time until operation resumes

CAUTION: Do not set the braking resistor to exceed the resistor's power rating. If overloaded, it can overheat and cause a fire. When using a resistor with a heat sensor, the sensor output can be used as an external trip signal for the drive's multi–function input.

Under load Fault Trip and Warning

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting range	Unit
Pr	25	Under load warning selection	UL Warn Sel	1	Yes	0–1	–
	26	Under load warning time	UL Warn Time	10.0		0–600	sec
	27	Under load trip selection	UL Trip Sel	1	Free–Run	–	–
	28	Under load trip timer	UL Trip Time	30.0		0–600	sec
	29	Under load upper limit level	UL LF Level	30		10–100	%
	30	Under load lower limit level	UL BF Level	30		10–100	%

Under Load Trip and Warning Setting Details

Pr. Code	Description
Pr.27 UL Trip Sel	Sets the underload fault trip occurs. If set to 0(None), does not detect the underload fault trip. If set to 1 (Free–Run), the output is blocked in an underload fault trip situation. If set to 2 (Dec), the motor decelerates and stops when an underload trip occurs.
Pr.25 UL Warn Sel	Sets the underload warning options. Set to 1(Yes) and set the multi–function output terminals (at OU.31 and 33) to 7 (Underload). The warning signals are output when an underload condition arises.
Pr.26 UL Warn Time, Pr.28 UL Trip Time	The protection function operates when the underload level condition explained above is maintained for a set warning time or fault trip time. This function does not operate if energy–saving operation is activated at Ad.50 (E–Save Mode).
Pr.29 UL LF Level, Pr.30 UL BF Level	Setting Heavy Duty – Do not support Pr.29. – At Pr.30, the underload level is decided based on the motor's rated current.

Fan Fault Detection

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting range	Unit
Pr	79	Cooling fan fault selection	FAN Trip Mode	0		Trip	–
OU	31	Multi–function relay 1	Relay 1	8	FAN Warning	–	–
OU	33	Multi–function output 1	Q1 Define				

Fan Fault Detection Setting Details

Pr. Code	Description		
Pr.79 FAN Trip Mode	Set the cooling fan fault mode.		
	Setting		Function
	0	Trip	The drive output is blocked and the fan trip is displayed when a cooling fan error is detected.
	1	Warning	When OU.33 (Q1 Define) and OU.31 (Relay1) are set to 8 (FAN Warning), the fan error signal is output and the operation continues.
OU.33 Q1 Define, OU.31 Relay1 (A1, B1, C1 terminals)	When the code value is set to 8 (FAN Warning), the fan error signal is output and operation continues. However, when the drive inside temperature rises above a certain level, output is blocked due to activation of overheat protection.		

Low Voltage Fault Trip

When drive input power is lost and the internal DC link voltage drops below a certain voltage level, the drive stops output and a low voltage trip occurs.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting range	Unit
Pr	81	Low voltage trip decision delay time	LVT Delay	0.0		0–60	sec
OU	31	Multi–function relay 1	Relay 1	11	Low Voltage	–	–
	33	Multi–function output 1	Q1 Define				

Low Voltage Fault Trip Setting Details

Pr. Code	Description
Pr.81 LVT Delay	If the code value is set to 11 (Low Voltage), the drive stops the output first when a low voltage trip condition arises, then a fault trip occurs after the low voltage trip decision time is passed. The warning signal for a low voltage fault trip can be provided using the multi–function output or a relay. However, the low voltage trip delay time (LVT Delay time) does not apply to warning signals.

Output Block by Multi–Function Terminal

When the multi–function input terminal is set as the output block signal terminal and the signal is input to the terminal, then the operation stops.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting range	Unit
In	65–69	Px terminal setting options	Px Define(Px: P1–P5)	5	BX	0–54	–

Output Block by Multi–Function Terminal Setting Details

Pr. Code	Description
In.65–69 Px Define	When the operation of the multi–function input terminal is set to 5 (BX) and is turned on during operation, the drive blocks the output and 'BX' is displayed on the keypad display. While 'BX' is displayed on the keypad screen, the drive's operation information including the operation frequency and current at the time of BX signal can be monitored. The drive resumes operation when the BX terminal turns off and operation command is input.

Trip Status Reset

Restart the drive using the keypad or analog input terminal, to reset the trip status.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting range	Unit
In	65–69	Px terminal setting options	Px Define(Px: P1–P5)	3	RST	0–54	–

Trip Status Reset Setting Details

Pr. Code	Description
In.65–69 Px Define	Press [Stop/Reset] key on the keypad or use the multi–function input terminal to restart the drive. Set the multi–function input terminal to 3 (RST) and turn on the terminal to reset the trip status.

Drive Diagnosis State

Check the diagnosis of components or devices for drive to check if they need to be replaced.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting	Setting Range		Unit
Pr	89	CAP, FAN replacement warning	Drive State	–	Bit	00–10	Bit
					00	–	
					01	CAP Warning	
					10	FAN Warning	
**See "Bit Selection" on page 4–3 for details*							

Operation Mode on Option Card Trip

Option card trips may occur when an option card is used with the drive. Set the operation mode for the drive when a communication error occurs between the option card and the drive body, or when the option card is detached during operation.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting range	Unit
Pr	80	Operation mode on option card trip	Opt Trip Mode	0	None	0–3	–
				1	Free–Run		
				2	Dec		

Operation Mode on Option Trip Setting Details

Pr. Code	Description		
Pr.80 Opt Trip Mode	Setting		Function
	0	None	No operation
	1	Free–Run	The drive output is blocked and fault trip information is shown on the keypad.
	2	Dec	The motor decelerates to the value set at Pr.7 (Trip Dec Time).

No Motor Trip

If an operation command is run when the motor is disconnected from the drive output terminal, a ‘no motor trip’ occurs and a protective operation is performed by the system.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting		Setting range	Unit
Pr	31	Operation on no motor trip	No Motor Trip	0	None	–	–
	32	No motor trip current level	No Motor Level	5		1–100	%
	33	No motor detection time	No Motor Time	3.0		0.1–10	s

No Motor Trip Setting Details

Pr. Code	Description
Pr.32 No Motor Level, Pr.33 No Motor Time	If the output current value [based on the rated current (bA.13)] is lower than the value set at Pr.32 (No Motor Level), and if this continues for the time set at Pr.33 (No Motor Time), a ‘no motor trip’ occurs.

CAUTION: If bA.7 (V/F Pattern) is set to 1 (Square), set Pr.32 (No Motor Level) to a value lower than the factory default. Otherwise, ‘no motor trip’ due to a lack of output current will result when the ‘no motor trip’ operation is set.

Low voltage trip 2

If you set the Pr.82 (LV2 Selection) code to 1 (Yes), the trip notification is displayed when a low voltage trip occurs. In this case, even if the voltage of the DC Link bus is higher than the trip level, the LV2 trip will remain active. To reset the trip, reset the drive. The trip history will not be saved.

Pr. Group	Pr. Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
Pr	82	LV2 Selection	LV2 Enable	1: Yes	0/1	–

Fault/Warning List

The following list shows the types of faults and warnings that can occur while using the ACN drive. Please refer to "Learning Protection Features" on page 4–196 for details about faults and warnings. Further detail on faults and warnings are included in Chapter 6: Maintenance and Troubleshooting on page 6–1

Category		LCD Display	Details
Major fault	***Latch type***	Over Current1	Over current trip
		Over Voltage	Over voltage trip
		External Trip	Trip due to an external signal
		NTC Open	Temperature sensor fault trip
		Over Current2	ARM short current fault trip
		Option Trip–x*	Option fault trip*
		Over Heat	Over heat fault trip
		Out Phase Open	Output open–phase fault trip
		In Phase Open	Input open–phase fault trip
		Drive OLT	Drive overload fault trip
		Ground Trip	Ground fault trip
		Fan Trip	Fan fault trip
		E–Thermal	Motor overheat fault trip
		Pre–PID Fail	Pre–PID operation failure
		IO Board Trip	IO Board connection fault trip
		Ext–Brake	External brake fault trip
		No Motor Trip	No motor fault trip
		Low Voltage 2	Low voltage fault trip during operation
		ParaWrite Trip**	Write parameter fault trip
	Level type	Low Voltage	Low voltage fault trip
		BX	Emergency stop fault trip
		Lost Command	Command loss trip
		Safety A(B) Err	Safety A(B) contact trip
	Hardware damage	EEP Err	External memory error
		ADC Off Set	Analog input error
		Watch Dog–1	CPU Watch Dog fault trip
		Watch Dog–2	
Minor fault		Over Load	Motor overload fault trip
		Under load	Motor underload fault trip
Warning		Lost Command	Command loss fault trip warning
		Over Load	Overload warning
		Under Load	Under load warning
		Inverter OLT	Drive overload warning
		Fan Warning	Fan operation warning
		DB Warn %ED	Braking resistor braking rate warning
		Retry Tr Tune	Rotor time constant tuning error
		CAP Exchange	Capacitor replacement warning
		FAN Exchange	Fan replacement warning

** Applies only when an option board is used.*
*** Displayed on an ACN-LCD keypad only.*

Chapter 5: Serial Communications

Chapter 5

Table of Contents

Serial RS-485 Communication Features

This chapter details how to control an ACN series drive with a PLC or a computer using the RS-485 serial communication features. The ACN series drive terminals S+, S-, SG will accommodate an RS-485 connection, through which the drive can be controlled by a remote master device on an RS-485 network. RS-232 signals can be converted to RS-485 by using a separate converter.

The ACN AC drive communication address (station ID) is specified in parameter CM.01, and the remote master device can control each AC drive according to its individual communication address. The ACN drive serial communications utilizes the Modbus RTU protocol. The mode and serial network settings must be the same for all devices on a Modbus network. The Station IDs must all be unique. See "Setting Communication Parameters" on page 5–7 for more details.

NOTE: Ethernet connectivity for EtherNet/IP or Modbus TCP communication is possible with an optional communication card (ACN-ETH). Refer to Appendix C: Ethernet Module ACN-ETH for details

Communication Standards

Following the RS-485 communication standards, ACN series products exchange data with a PLC and computer. The RS-485 communication standards support the Multi-drop Link System and offer an interface that is strongly resistant to noise. Please refer to the following table for details about the communication standards.

Communication Standards	
Item	**Standard**
Communication method/ Transmission type	RS-485/Bus type, Multi-drop Link System
Drive type name	ACN Series
Number of connected drives/ Transmission distance	Maximum of 16 drives / Maximum1,200m (recommended distance: within 700m)
Recommended cable size	0.75mm², (18AWG), shielded type twisted-pair (STP) wire
Installation type	Dedicated terminals (S+/S-/SG) on the control terminal block
Power supply	Supplied by the drive - insulated power source from the drive's internal circuit
Communication speed	1,200/2,400/9,600/19,200/38,400/57,600/115,200 bps
Control procedure	Asynchronous communications system
Communication system	Half duplex system
Character system	Modbus-RTU: Binary
Stop bit length	1-bit/2-bit
Frame error check	2 bytes
Parity check	None/Even/Odd

Common Third-Party Modbus RTU Masters

- *Modbus Poll from www.modbustools.com*

AutomationDirect PLCs as Modbus Master

Serial Modbus-capable AutomationDirect PLCs can communicate with the ACN drive. Serial Modbus control is easier to accomplish from a PLC that has a built-in RS-485 port and supports dedicated Modbus messaging. [RS-232-only PLCs will require an RS-232/RS-485 converter (FA-ISOCON); and older PLCs may require programming to construct the Modbus strings.] We recommend PLCs with built-in RS-485 ports and dedicated Modbus serial commands: CLICK (with RS-485 ports), P1000, P2000, P3000, BRX/Do-more, DirectLogic (DL06, D2-260, or D2-262). Other PLC-Drive connectivity is possible: Please refer to the chart below

Typical ADC PLC to ACN Serial Communications Connectivity

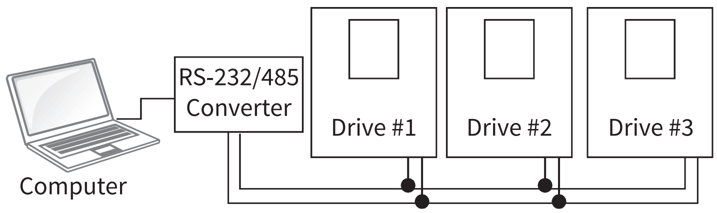
Typical ADC PLC to ACN Serial Communications Connectivity Matrix*					
Recommended PLC Connectivity			Communication	Direct Cable	ACN
PLC	Port #	Port Type			Terminals
CLICK	3	3 screw terminals	RS-485	L19954 cable	
D2-260	2	HD15	RS-485	D2-DSCBL-2	
D2-262	2	HD15	RS-485	D2-DSCBL-2	
DL06	2	HD15	RS-485	D2-DSCBL-2	
BRX/Do-more	RS-485	3 screw terminals	RS-485	L19954 cable	
Do-more H2-DM1	RS-232	RJ12	RS-232 to RS-485	FA-ISOCON with L19954 cable	
P1-550	RS-485	4 screw terminals	RS-485	L19954 cable	
P2-550	RS-485	3 screw terminals	RS-485	L19954 cable	
P3-530	RS-485	3 screw terminals	RS-485	L19954 cable	
P3-550	RS-485	3 screw terminals	RS-485	L19954 cable	S+ S- SG
P3-550E	RS-485	3 screw terminals	RS-485	L19954 cable	
Other PLC Connectivity			Communication	Direct Cable	
D2-250-1	2	HD15	RS-485	D2-DSCBL-2	
D4-450/D4-454	1	DB25	RS-232 to RS-485	FA-ISOCON with L19954 cable	
DL05	2	RJ12	RS-232 to RS-485	FA-ISOCON with L19954 cable	
DL06 + DCM	2	HD15	RS-485	D2-DSCBL-2	
Do-more H2-DM1 + H2-SERIO-4	3	5 screw terminals	RS-485	L19954 cable	
Do-more T1H-DM1	RS-232	RJ12	RS-232 to RS-485	FA-ISOCON with L19954 cable	
P2-SCM	4	4 screw terminals	RS-485	L19954 cable	
P3-SCM	4	4 screw terminals	RS-485	L19954 cable	

**Ethernet connectivity for EtherNet/IP or Modbus TCP communication is possible with an optional communication card ACN-ETH. Refer to Appendix C: Ethernet Module ACN-ETH for details*

RS-232C to RS-485 Conversion

In an RS-485 communication system, the PLC or computer is the master device and the drive is the slave device. When using a computer as the master, the RS-232 converter must be integrated with the computer, so that it can communicate with the drive through the RS-232/RS-485 converter. Specifications and performance of converters may vary depending on the manufacturer, but the basic functions are identical. Please refer to the converter manufacturer's user manual for details about features and specifications. RS-232 signals can be converted to RS-485 by using a separate converter (see the FA-ISOCON drawings below).

Connect the wires and configure the communication parameters on the drive by referring to the following illustration of the communication system configuration.



RS-232C to RS-485 Conversion

Many AutomationDirect PLCs have only RS-232C communication ports, and require an FA-ISOCON (RS-232C to RS-422/485 network adapter) in order to make an RS-485 connection.

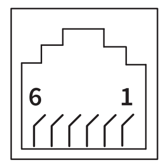
NOTE: If an FA-ISOCON module is used, set the module dipswitches as required. Refer to the FA-ISOCON manual for more detailed information.

FA-ISOCON Switch Settings:

- *S21–S23: OFF, ON, ON (19200 baud)*
- *S24–S27: OFF (Automatic Network Transmit Enable)*
- *Terminate: ON (end of run term resistors)*
- *Bias (2): ON (end of run bias resistors)*
- *1/2 DPX (2): ON (RS-485 TXD/RXD jumpers)*

Helpful Hint: Some applications require that the FA-ISOCON baud rate is set faster than the drive/network baud rate.

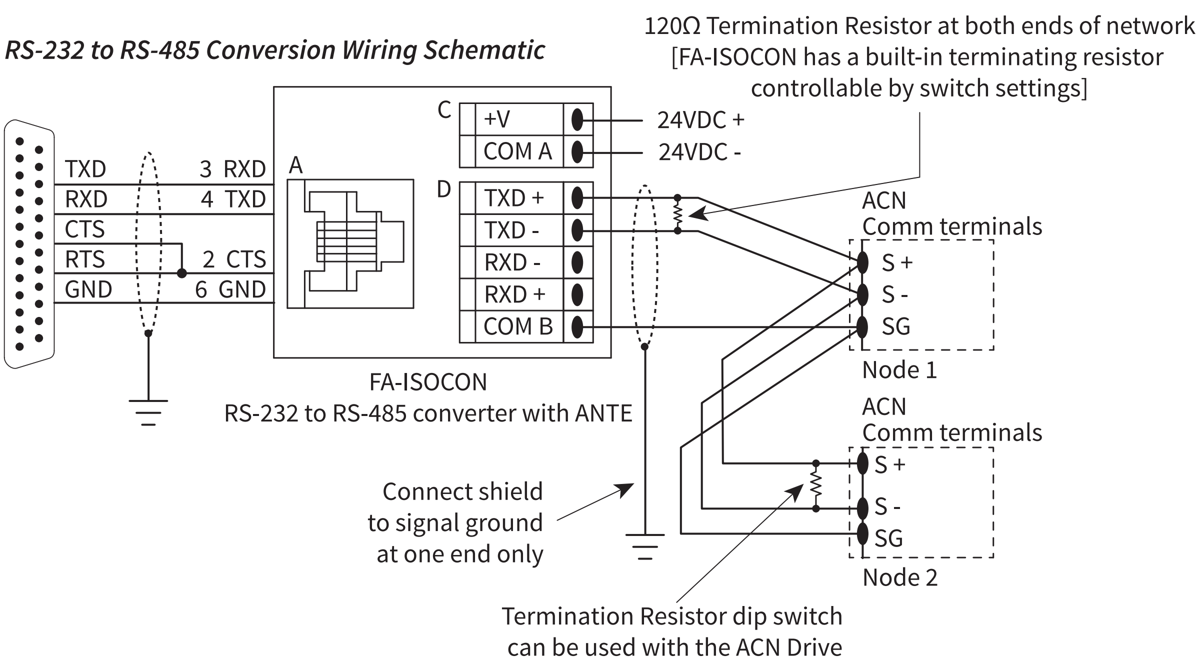
FA-ISOCON RJ-12 Serial Comm Port A
RS-232 Input Port



1: Signal Ground
2: CTS (input)
3: RXD (input)
4: TXD (output)
5: +5VDC in
6: Signal Ground

FA-ISOCON Wiring

RS-232 to RS-485 Conversion Wiring Schematic



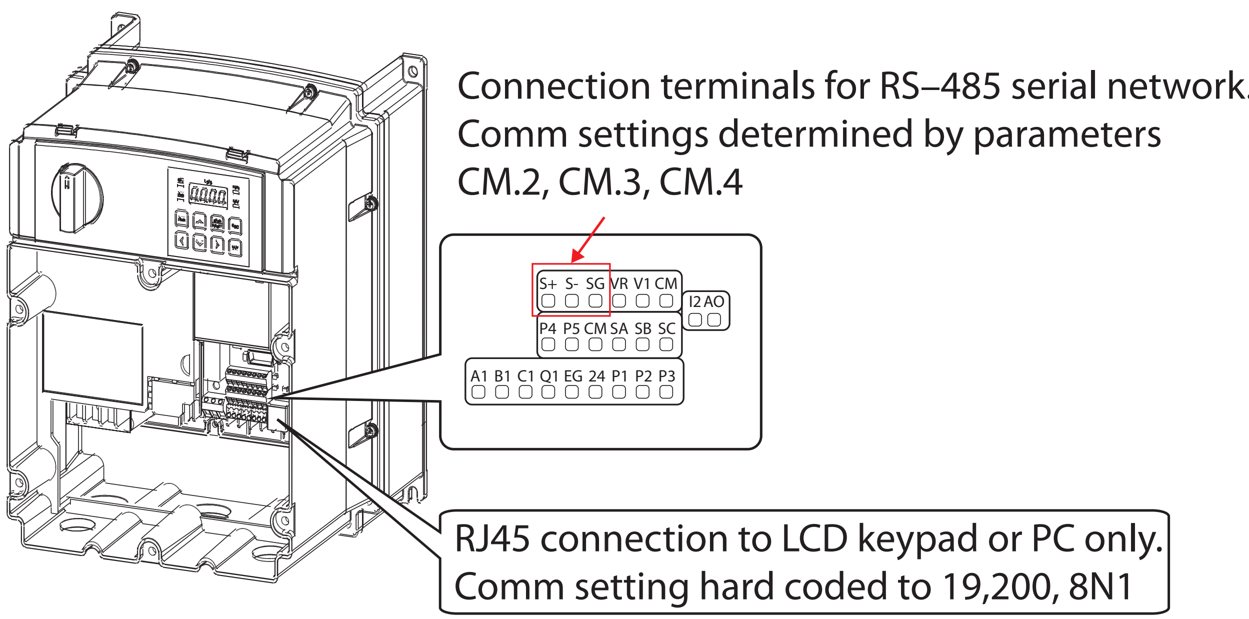
NOTE: For information regarding configuration of AutomationDirect PLCs or other PLCs, please refer to Appendix D: Safe Torque Off, or to the applicable PLC user manual for your application.

Communication Cable Connection

Make sure that the drive is turned off completely, and then connect the RS-485 communication cable to the S+/S-/SG terminals of the terminal block. The maximum number of drives you can connect is 16. For communication wiring, use shielded twisted pair (STP) cables. The maximum length of the communication cable is 1,200 meters, but it is recommended to use no more than 700 meters of communication cable to ensure stable communication. Please use a repeater to enhance the communication speed when using a communication cable longer than 1,200 meters or when using a large number of devices. A repeater is effective at reducing noise where smooth communication is required.

NOTE: Recommended RS-485 cable: Belden 9842, AutomationDirect L19954 series, or equivalent.

NOTE: RJ45 connector is for connection to LCD keypad or PC software only. Communication settings are fixed at 19,200bps, 8,N,1.



Serial Communication to VFD Suite Software

For instruction on serial communication to VFD Suite, see page A–44.

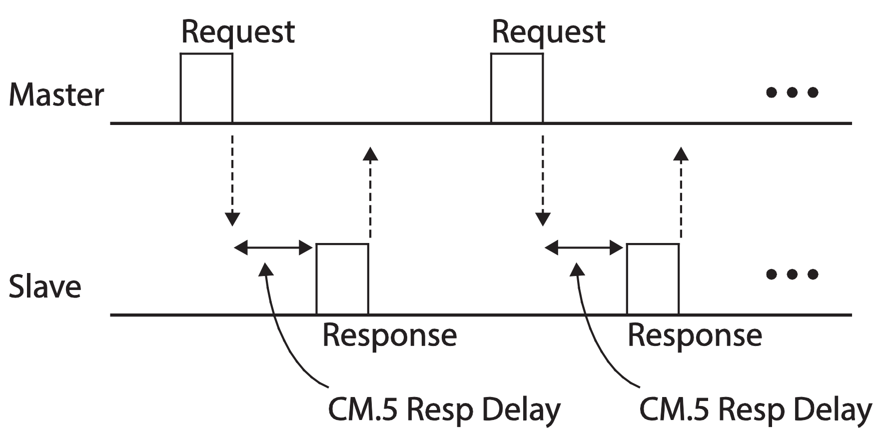
Setting Communication Parameters

Before proceeding with setting communication configurations, make sure that the communication cables are connected properly. Turn on the drive and set the communication parameters.

Setting Communication Parameters							
Parameter Group	Parameter Number	Name	LCD Display	Parameter Setting		Setting Range	Unit
CM	01	Built-in communication drive ID	Int485 St ID	1		1-250	-
	02	Built-in communication protocol	Int485 Proto	0	Modbus RTU	0	-
	03	Built-in communication speed	Int485 Baudr	3	9600 bps	0-7	-
	04	Built-in communication frame setting	Int485 Mode	0	D8/PN/S1	0-3	-
	05	Transmission delay after reception	Resp Delay	5		0-1000	ms

Communication Parameters Setting Details

Communication Parameters Setting Details			
Parameter	Description		
CM.01 Int485 St ID	Set the drive station ID between 1 and 250.		
CM.02 Int485 Proto	***Select one of the two built-in protocols: Modbus-RTU or LS INV 485.***		
	Setting		***Function***
	0	Modbus-RTU	Modbus-RTU compatible protocol
	2	Not supported	–

<table>
<tr><th colspan="4">Communication Parameters Setting Details</th></tr>
<tr><th>Parameter</th><th colspan="3">Description</th></tr>
<tr><td rowspan="10">CM.03 Int485 Baudr</td><td colspan="3">Set a communication setting speed up to 115,200 bps.</td></tr>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td colspan="2">0</td><td>1,200 bps</td></tr>
<tr><td colspan="2">1</td><td>2,400 bps</td></tr>
<tr><td colspan="2">2</td><td>4,800 bps</td></tr>
<tr><td colspan="2">3</td><td>9,600 bps</td></tr>
<tr><td colspan="2">4</td><td>19,200 bps</td></tr>
<tr><td colspan="2">5</td><td>38,400 bps</td></tr>
<tr><td colspan="2">6</td><td>56 Kbps</td></tr>
<tr><td colspan="2">7</td><td>115 Kbps</td></tr>
<tr><td rowspan="6">CM.04 Int485 Mode</td><td colspan="3">Set a communication configuration. Set the data length, parity check method, and the number of stop bits.</td></tr>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>D8/PN/S1</td><td>8-bit data / no parity check / 1 stop bit</td></tr>
<tr><td>1</td><td>D8/PN/S2</td><td>8-bit data / no parity check / 2 stop bits</td></tr>
<tr><td>2</td><td>D8/PE/S1</td><td>8-bit data / even parity / 1 stop bit</td></tr>
<tr><td>3</td><td>D8/PO/S1</td><td>8-bit data / odd parity / 1 stop bit</td></tr>
<tr><td>CM.05 Resp Delay</td><td colspan="3">Set the response time for the slave (drive) to react to the request from the master. Response time is used in a system where the slave device response is too fast for the master device to process. Set this code to an appropriate value for smooth master-slave communication.

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

Setting Operation Command and Frequency

To select the built-in RS-485 communication as the source of command, set the Frq code to 6 (Int485) and set the DrV code to 3 (Int485). Then, set common area parameters for the operation command and frequency via communication.

Setting Operation Command and Frequency							
Parameter Group	**Parameter Number**	**Name**	**LCD Display**	**Parameter Setting**		**Setting Range**	**Unit**
Pr	12	Speed command loss operation mode	Lost Cmd Mode	1	Free-Run	0-5	-
	13	Time to determine speed command loss	Lost Cmd Time	1.0		0.1-120	s
	14	Operation frequency at speed command loss	Lost Preset F	0.00		Start frequency–Maximum frequency	Hz
OU	31	Multi-function relay 1	Relay 1	13	Lost Command	0-35	-
	33	Multi-function output 1	Q1 Define				
Operation	DrV	Command source	Cmd Source (DrV.06 on LCD)	3	Int485	0-5	-
	Frq	Frequency setting method	Freq Ref Src (DrV.07 on LCD)	6	Int485	0-12	-

Command Loss Protective Operation

Set the following parameters to determine the drive action in the event of a communication loss.

Command Loss Protective Operation			
Parameter Group	**Description**		
Pr.12 Lost Cmd Mode, Pr.13 Lost Cmd Time	Select the drive function that will occur after the communication loss time is expired (set in Pr.13).		
	Setting		Function
	0	None	The speed command immediately becomes the operation frequency without any protection function.
	1	Free-Run	The drive blocks output. The motor performs in free-run condition.
	2	Dec	The motor decelerates and then stops at the time set at Pr.07 (Trip Dec Time).
	3	Hold Input	The drive calculates the average input value for 10 seconds before the loss of the speed command and uses it as the speed reference.
	4	Hold Output	The drive calculates the average output value for 10 seconds before the loss of the speed command and uses it as the speed reference.
	5	Lost Preset	The drive operates at the frequency set at Pr. 14 (Lost Preset F).

Setting Virtual Multi-Function Input

Multi-function input can be controlled using a communication address (0h0385). Set codes CM.70–77 to the functions to operate, and then set the bit relevant to the function to 1 at 0h0385 to operate it. Virtual multi-function operates independently from In.65-69 analog multi-function inputs and cannot be set redundantly. Virtual multi-function input can be monitored using CM.86 (Virt Dl Status). Before you configure the virtual multi-function inputs, set the DrV code according to the command source.

Setting Virtual Multi-Function Input							
Parameter Group	**Parameter Number**	**Name**	**LCD Display**	**Parameter Setting**		**Setting Range**	**Unit**
CM	70-77	Communication multi-function input x	Virtual DI x (x: 1-8)	0	None	0-49	-
	86	Communication multi-function input monitoring	Virt DI Status	-	-	-	-

Example: When sending the Forward and Reverse command by controlling virtual multi-function input in the common area via Int485, set the following:

1) *Set CMD= Fx/Rx-1*
   - » *For Forward motion: set CM.70 = FX and set address 0h0385 to 0h0001.*
   - » *For Reverse motion: Set CM.71 = Rx and set address 0h0385 to 0h0002.*

NOTE: The following are values and functions that are applied to address 0h0385

Values and functions that are applied to address 0h0385	
Setting	**Function**
0h0001	Forward operation (Fx)
0h0002	Reverse operation (Rx)
0h0000	Stop

Saving Parameters Defined by Communication

After changing settings in the common area parameters, it is best practice to complete the "Save Parameters" action to ensure all settings are recognized by the drive. This can be accomplished through comm address 0h03E0 or the LCD keypad parameter CNF.48.

If the drive is powered off after setting the common area parameters or keypad parameters via communication, the settings will be lost. Performing the "Save Parameters" operation immediately after setting common area parameters will prevent any data loss.

Set CNF-48 to 1 (Yes) to allow all the changes over comunication to be saved, so that the drive retains all the existing values even after the power has been turned off.

Setting address 0h03E0 to 0 and then setting it again to 1 via communication allows the existing parameter settings to be saved. However, setting address 0h03E0 to 1 and then setting it to 0 does not carry out the same function. Parameters defined by communication can only be saved using an LCD keypad.

Saving Parameters Defined by Communication							
Parameter Group	Parameter Number	Name	LCD Display	Parameter Setting		Setting Range	Unit
CNF (LCD keypad only)	48	Save parameters	Parameter Save	0	Yes	0-1	-
				1	No		

Total Memory Map for Communication

Total Memory Map for Communication		
Item	Memory Map	Details
Parameter registration type area	0h0100-0h01FF	Areas registered at CM.31–38 and CM.51–58
	0h0200-0h023F	Area registered for User Group
	0h0240-0h027F	Area registered for Macro Group
	0h0280-0h02FF	Reserved
Drive communication common area	0h0300-0h037F	Drive monitoring area
	0h0380-0h03DF	Drive control area
	0h03E0-0h03FF	Drive memory control area
	0h0400-0h0FFF	Reserved
	0h1100	dr Group
	0h1200	bA Group
	0h1300	Ad Group
	0h1400	Cn Group
	0h1500	In Group
	0h1600	OU Group
	0h1700	CM Group
	0h1800	AP Group
	0h1B00	Pr Group
	0h1C00	M2 Group

Parameter Group for Data Transmission

By defining a parameter group for data transmission, the communication addresses registered in the communication function group (CM) can be used in communication. Parameter group for data transmission may be defined to transmit multiple parameters at once, into the communication frame.

Parameter Group for Data Transmission							
Parameter Group	Parameter Number	Name	LCD Display	Parameter Setting		Setting Range	Unit
CM	31-38	Output communication address x	Para Status-x	-	-	0000-FFFF	Hex
	51-58	Input communication address x	Para Control-x	-	-	0000-FFFF	Hex

Currently Registered CM Group Parameter

Currently Registered CM Group Parameter		
Address	Parameter	Assigned content by bit
0h0100-0h0107	Status Parameter-1- Status Parameter-8	Parameter communication code value registered at CM.31-38 (Read-only)
0h0110-0h0117	Control Parameter-1- Control Parameter-8	Parameter communication code value registered at CM.51-58 (Read/Write access)

NOTE: When registering control parameters, register the operation speed (0h0380, 0h0381) and operation command (0h0006, 0h0382) parameters at the end of a parameter control frame. For example, when the parameter control frame has 5 parameter control items (Para Control - x), register the operation speed at Para Control-4 and the operation command to Para Control-5.

Communication Protocol

The built-in RS-485 communication supports Modbus-RTU protocol only.

Modbus-RTU Protocol

Function Code and Protocol (unit: byte)

In the following section, station ID is the value set at CM.01 (Int485 St ID), and starting address is the communication address. (starting address size is in bytes).

Function Code #03: Read Holding Register

Query Field Name
Station ID
Function(0x03)
Starting Address Hi
Starting Address Lo
Number of Points Hi
Number of Points Lo
CRC Lo
CRC Hi

Response Field Name	
Station ID	
Function(0x03)	
Byte Count	
Data Hi	
Data Lo	
…	Number of Points
…	
Data Hi	
Data Lo	
CRC Lo	
CRC Hi	

Function Code #04: Read Input Register

Query Field Name
Station ID
Function(0x04)
Starting Address Hi
Starting Address Lo
Number of Points Hi
Number of Points Lo
CRC Lo
CRC Hi

Response Field Name	
Station ID	
Function(0x04)	
Byte Count	
Data Hi	Number of Points
Data Lo	
...	
...	
Data Hi	
Data Lo	
CRC Lo	
CRC Hi	

Function Code #06: Preset Single Register

Query Field Name	Response Field Name
Station ID	Station ID
Function(0x06)	Function(0x06)
Starting Address Hi	Register Address Hi
Starting Address Lo	Register Address Lo
Preset Data Hi	Preset Data Hi
Preset Data Lo	Preset Data Lo
CRC Lo	CRC Lo
CRC Hi	CRC Hi

Function Code #16 (hex 0h10): Preset Multiple Register

Query Field Name
Station ID
Function(0x06)
Starting Address Hi
Starting Address Lo
Number of Register Hi
Number of Register Lo
Byte Count
Data Hi
Data Lo
...
...
Data Hi
Data Lo
CRC Lo
CRC Hi

Number of Points

Response Field Name
Station ID
Function(0x06)
Register Address Hi
Register Address Lo
Preset Data Hi
Preset Data Lo
CRC Lo
CRC Hi

Exception Code

Code
01: ILLEGAL FUNCTION
02: ILLEGAL DATA ADrESS
03: ILLEAL DATA VALUE
06: SLAVE DEVICE BUSY

Response

Field Name
Station ID
Function (The function value uses the top level bit for all query values.)
Exception Code
CRC Lo
CRC Hi

Example of Modbus-RTU Communication in Use

When the Acc time (Communication address 0x1103) is changed to 5.0 sec and the Dec time (Communication address 0x1104) is changed to 10.0 sec.

Frame Transmission from Master to Slave (Request)								
Item	Station ID	Function	Staring Address	Number of Register	Byte Count	Data 1	Data 2	CRC
Hex	0x01	0x10	0x1102	0x0002	0x04	0x0032	0x0064	0x1202
Description	CM.01 Int485 St ID	Preset Multiple Register	Starting Address -1 (0x1103-1)	-	-	50 (ACC time 5.0sec)	100 (DEC time 10.0sec)	-

Frame Transmission from Slave to Master (Response)					
Item	Station ID	Function	Staring Address	Number of Register	CRC
Hex	0x01	0x10	0x1102	0x0002	0xE534
Description	CM.01 Int485 St ID	Preset Multiple Register	Starting Address -1 (0x1103-1)	-	-

Drive Expansion Common Area Parameter

Monitoring Area Parameter (Read Only)

Monitoring Area Parameter (Read Only)							
Comm. Address			Parameter	Scale	Unit	Assigned Content by Bit	
Hex	Modbus RTU	Modbus TCP					
0h0300	***40768***	***40769***	Drive model	-	-	ACN: 0006h	
0h0301	***40769***	***40770***	Drive capacity	-	-	0.4 kW	1900h
						1.1 kW	4011h
						2.2 kW	4022h
						3.7 kW	4037h
						5.5 kW	4055h
						11kW	40B0h
						18.5 kW	4125h
						0.75 kW	3200h
						1.5 kW	4015h
						3.0 kW	4030h
						4.0 kW	4040h
						7.5 kW	4075h
						15kW	40F0h
						22kW	4160h
0h0302	***40770***	***40771***	Drive input voltage/power (Single phase, 3-phase)/cooling method	-	-	230V 3-phase forced cooling: 0231h	
						460V single phase self cooling: 0420h	
						230V single phase self cooling: 0220h	
						460V 3-phase self cooling: 0430h	
						230V 3-phase self cooling: 0230h	
						460V single phase forced cooling: 0421h	
						230V single phase forced cooling: 0221h	
						460V 3-phase forced cooling: 0431h	
0h0303	***40771***	***40772***	Drive S/W version	-	-	(Ex) 0h0100: Version 1.00	
						(Ex) 0h0101: Version 1.01	
0h0304	***40772***	***40773***	Reserved	-	-	-	

Monitoring Area Parameter (Read Only)								
Comm. Address			Parameter	Scale	Unit	Assigned Content by Bit		
Hex	Modbus RTU	Modbus TCP						
0h0305	***40773***	***40774***	Drive operation state	-	-	B12–B15	0	Normal state
							4	Warning occurred
							8	Fault occurred [operates according to Pr. 30 (Trip Out Mode) setting.]
						B8–B11	-	
						B4–B7	1	Speed searching
							2	Accelerating
							3	Operating at constant rate
							4	Decelerating
							5	Decelerating to stop
							6	H/W OCS
							7	S/W OCS
							8	Dwell operating
						B0–B3	0	Stopped
							1	Operating in forward direction
							2	Operating in reverse direction
							3	DC operating (0 speed control)
0h0306	***40774***	***40775***	Drive operation frequency command source	-	-	B8–B15	Operation command source	
							0	Keypad
							1	Communication option
							2	User Sequence
							3	Built-in RS 485
							4	Terminal block
						B0–B7	Frequency command source	
							0	Keypad speed
							1	Keypad torque
							2–4	Up/Down operation speed
							5	V1
							7	V2
							8	I2
							9	Pulse
							10	Built-in RS 485
							11	Communication option
							12	User Sequence
							13	Jog
							14	PID
							25-39	Multi-step speed frequency
0h0307	***40775***	***40776***	LCD keypad S/W version	-	-	(Ex.) 0h0100: Version 1.00		
0h0308	***40776***	***40777***	LCD keypad title version	-	-	(Ex.) 0h0101: Version 1.01		
0h0309 - 0h030F	***40777 - 40783***	***40778 - 40784***	Reserved	-	-	-		

Monitoring Area Parameter (Read Only)							
Comm. Address			Parameter	Scale	Unit	Assigned Content by Bit	
Hex	Modbus RTU	Modbus TCP					
0h0310	***40784***	***40785***	Output current	0.1	A	-	
0h0311	***40785***	***40786***	Output frequency	0.01	Hz	-	
0h0312	***40786***	***40787***	Output rpm	0	rpm	-	
0h0313	***40787***	***40788***	Motor feedback speed	0	rpm	-32768 rpm-32767 rpm (directional)	
0h0314	***40788***	***40789***	Output voltage	1	V	-	
0h0315	***40789***	***40790***	DC Link voltage	1	V	-	
0h0316	***40790***	***40791***	Output power	0.1	%	-	
0h0317	***40791***	***40792***	Output torque	0.1	%	-	
0h0318	***40792***	***40793***	PID reference	0.1	%	-	
0h0319	***40793***	***40794***	PID feedback	0.1	%	-	
0h031A	***40794***	***40795***	Display the number of poles for the first motor	-	-	Displays the number of poles for the first motor	
0h031B	***40795***	***40796***	Display the number of poles for the second motor	-	-	Displays the number of poles for the second motor	
0h031C	***40796***	***40797***	Display the number of poles for the selected motor	-	-	Displays the number of poles for the selected motor	
0h031D	***40797***	***40798***	Select Hz/rpm	-	-	0	Hz
						1	RPM
0h031E - 0h031F	***40798 - 40799***	***40799 - 40800***	Reserved	-	-	-	
0h0320	***40800***	***40801***	Digital input information	-	-	B5–B15	Reserved
						B4	P5(I/O board)
						B3	P4(I/O board)
						B2	P3(I/O board)
						B1	P2(I/O board)
						B0	P1(I/O board)
0h0321	***40801***	***40802***	Digital output information	-	-	B2–BI5	Reserved
						B1	Q1
						B0	Relay 1
0h0322	***40802***	***40803***	Virtual digital input information	-	-	B8–B15	Reserved
						B7	Virtual DI 8(CM.77)
						B6	Virtual DI 7(CM.76)
						B5	Virtual DI 6(CM.75)
						B4	Virtual DI 5(CM.74)
						B3	Virtual DI 4(CM.73)
						B2	Virtual DI 3(CM.72)
						B1	Virtual DI 2(CM.71)
						B0	Virtual DI 1(CM.70)

Monitoring Area Parameter (Read Only)							
Comm. Address			Parameter	Scale	Unit	Assigned Content by Bit	
Hex	Modbus RTU	Modbus TCP					
0h0323	***40803***	***40804***	Display the selected motor	-	-	0	First Motor
						1	Second Motor
0h0324	***40804***	***40805***	AI1	0.01	%	Analog input V1 (I/O board)	
0h0325	***40805***	***40806***	Reserved	0.01	%		
0h0326	***40806***	***40807***	AI3	0.01	%	Analog input V2 (I/O board)	
0h0327	***40807***	***40808***	AI4	0.01	%	Analog input I2 (I/O board)	
0h0328	***40808***	***40809***	AO1	0.01	%	Analog output 1 (I/O board)	
0h0329	***40809***	***40810***	Reserved	0.01	%	Not used	
0h032A	***40810***	***40811***	AO3	0.01	%	Analog output 3 (extension IO board)	
0h032B	***40811***	***40812***	Reserved	0.01	%	Reserved	
0h032C	***40812***	***40813***	Reserved	-	-	-	
0h032D	***40813***	***40814***	Drive module temperature	1	°C	-	
0h032E	***40814***	***40815***	Drive power consumption	1	kWh	-	
0h032F	***40815***	***40816***	Drive power consumption		MWh	-	
0h0330	***40816***	***40817***	Latch type trip information - 1	-	-	BI5	Fuse Open Trip
						BI4	Over Heat Trip
						BI3	Arm Short
						BI2	External Trip
						BI1	Overvoltage Trip
						BI0	Overcurrent Trip
						B9	NTC Trip
						B8	Reserved
						B7	Reserved
						B6	Input open-phase trip
						B5	Output open-phase trip
						B4	Ground Fault Trip
						B3	E-Thermal Trip
						B2	Drive Overload Trip
						B1	Underload Trip
						B0	Overload Trip

Monitoring Area Parameter (Read Only)							
Comm. Address			Parameter	Scale	Unit	Assigned Content by Bit	
Hex	Modbus RTU	Modbus TCP					
0h0331	***40817***	***40818***	Latch type trip information - 2	-	-	BI5	Reserved
						BI4	Reserved
						BI3	Safety B
						BI2	Safety A
						BI1	Reserved
						BI0	Bad option card
						B9	No motor trip
						B8	External brake trip
						B7	Bad contact at basic I/O board
						B6	Pre PID Fail
						B5	Error while writing parameter
						B4	Reserved
						B3	FAN Trip
						B2	Reserved
						B1	Reserved
						B0	Reserved
0h0332	***40818***	***40819***	Level type trip information	-	-	B4–B15	Reserved
						B3	Keypad Lost Command
						B2	Lost Command
						B1	LV
						B0	BX
0h0333	***40819***	***40820***	H/W Diagnosis Trip information	-	-	B6–B15	Reserved
						B5	Queue Full
						B4	Reserved
						B3	Watchdog-2 error
						B2	Watchdog-1 error
						B1	EEPROM error
						B0	ADC error
0h0334	***40820***	***40821***	Warning information	-	-	B10–B15	Reserved
						B9	Auto Tuning failed
						B8	Keypad lost
						B7	Encoder disconnection
						B6	Wrong installation of encoder
						B5	DB
						B4	FAN running
						B3	Lost command
						B2	Drive Overload
						B1	Underload
						B0	Overload
0h0335 - 0h033F	***40821 - 40831***	***40822 - 40832***	Reserved	-	-	-	
0h0340	***40832***	***40833***	On Time date	0	Day	Total number of days the drive has been powered on	

Monitoring Area Parameter (Read Only)							
Comm. Address			Parameter	Scale	Unit	Assigned Content by Bit	
Hex	Modbus RTU	Modbus TCP					
0h0341	***40833***	***40834***	On Time minute	0	Min	Total number of minutes excluding the total number of On Time days	
0h0342	***40834***	***40835***	Run Time date	0	Day	Total number of days the drive has driven the motor	
0h0343	***40835***	***40836***	Run Time minute	0	Min	Total number of minutes excluding the total number of Run Time days	
0h0344	***40836***	***40837***	Fan Time date	0	Day	Total number of days the heat sink fan has been running	
0h0345	***40837***	***40838***	Fan Time minute	0	Min	Total number of minutes excluding the total number of Fan Time days	
0h0346 - 0h0348	***40838 - 40840***	***40839 - 40841***	Reserved	-	-	-	
0h0349	***40841***	***40842***	Reserved	-	-	-	
0h034A	***40842***	***40843***	Option 1	-	-	0	None
						9	Not Supported
0h034B	***40843***	***40844***	Reserved	-	-	-	
0h034C	***40844***	***40845***	Reserved	-	-	-	

Control Area Parameter (Read/ Write)

Control Area Parameter (Read/ Write)							
Comm. Address			Parameter	Scale	Unit	Assigned Content by Bit	
Hex	Modbus RTU	Modbus TCP					
0h0380	***40896***	***40897***	Frequency command	0.01	Hz	Command frequency setting	
0h0381	***40897***	***40898***	RPM command	1	rpm	Command rpm setting	
0h0382	***40898***	***40899***	Operation command	-	-	B7	Reserved
						B6	Reserved
						B5	Reserved
						B4	Reserved
						B3	0 → 1: Free-run stop
						B2	0 → 1: Trip initialization
						B1	0: Reverse command
							1: Forward command
						B0	0 Stop command
							1 Run command
						Example: Forward operation command 0003h, Reverse operation command 0001h.	
0h0383	***40899***	***40900***	Acceleration time	0.1	s	Acceleration time setting	
0h0384	***40900***	***40901***	Deceleration time	0.1	s	Deceleration time setting	
0h0385	***40901***	***40902***	Virtual digital input control (0: Off, 1:On)	-	-	B8–B15	Reserved
						B7	Virtual DI 8(CM.77)
						B6	Virtual DI 7(CM.76)
						B5	Virtual DI 6(CM.75)
						B4	Virtual DI 5(CM.74)
						B3	Virtual DI 4(CM.73)
						B2	Virtual DI 3(CM.72)
						B1	Virtual DI 2(CM.71)
						B0	Virtual DI 1(CM.70)
0h0386	***40902***	***40903***	Digital output control (0:Off, 1:On)	-	-	B5–BI5	Reserved
						B4	Relay 4 (Ext I/O, OUT-35: None)
						B3	Relay 3 (Ext I/O, OUT-34: None)
						B2	Not Supported
						B1	Q1 (0.4~22kW, OUT-33: None)
						B0	Relay 1 (0.4~22kW, OUT-31: None)
0h0387	***40903***	***40904***	Reserved	-	-	Reserved	
0h0388	***40904***	***40905***	PID reference	0.1	%	PID reference command	
0h0389	***40905***	***40906***	PID feedback value	0.1	%	PID feedback value	
0h038A	***40906***	***40907***	Motor rated current	0.1	A	-	
0h038B	***40907***	***40908***	Motor rated voltage	1	A	-	
0h038C-0h038F	***40908 - 40911***	***40909 - 40912***	Reserved	-	-	-	

Control Area Parameter (Read/ Write)						
Comm. Address			Parameter	Scale	Unit	Assigned Content by Bit
Hex	Modbus RTU	Modbus TCP				
0h0390	***40912***	***40913***	Torque Ref	0.1	%	Torque command
0h0391	***40913***	***40914***	Fwd Pos Torque Limit	0.1	%	Forward motoring torque limit
0h0392	***40914***	***40915***	Fwd Neg Torque Limit	0.1	%	Forward regenerative torque limit
0h0393	***40915***	***40916***	Rev Pos Torque Limit	0.1	%	Reverse motoring torque limit
0h0394	***40916***	***40917***	Rev Neg Torque Limit	0.1	%	Reverse regenerative torque limit
0h0395	***40917***	***40918***	Torque Bias	0.1	%	Torque bias
0h0396 - 0h0399	***40918 - 40921***	***40919 - 40922***	Reserved	-	-	-
0h039A	***40922***	***40923***	Anytime Para	-	-	Set the CNF.20 value (displayed on LCD keypad only)
0h039B	***40923***	***40924***	Monitor Line-1	-	-	Set the CNF.21 value (displayed on LCD keypad only)
0h039C	***40924***	***40925***	Monitor Line-2	-	-	Set the CNF.22 value (displayed on LCD keypad only)
0h039D	***40925***	***40926***	Monitor Line-3	-	-	Set the CNF.23 value (displayed on LCD keypad only)

A frequency set via communication using the common area frequency address (0h0380) is not saved even when used with the parameter save function. To save a changed frequency to use after a power cycle, follow these steps:

2) *Set dr.07 to Keypad-1 and select a random target frequency.*
3) *Set the frequency via communication into the parameter area frequency address (0h1101).*
4) *Perform the parameter save (0h03E0: '1') before turning off the power. After the power cycle, the frequency set before turning off the power is displayed.*

Drive Memory Control Area Parameter (Read and Write)

- *♦R/W – Parameter Write–enabled during Operation (Run mode)*
- *R/W – Parameter Write–enabled when stopped*
- *Parameter Read Only*

Drive Memory Control Area Parameter (Read and Write)								
Comm. Address			Parameter	Scale	Unit	Changeable During Operation	Function	
Hex	Modbus RTU	Modbus TCP						
0h03E0	***40992***	***40993***	Save parameters	-	-	R/W	0	No
							1	Yes
0h03E1	***40993***	***40994***	Monitor mode initialization	-	-	♦R/W	0	No
							1	Yes

Drive Memory Control Area Parameter (Read and Write)								
Comm. Address			Parameter	Scale	Unit	Changeable During Operation	Function	
Hex	Modbus RTU	Modbus TCP						
0h03E2	***40994***	***40995***	Parameter initialization	-	-	R/W	0	No
							1	All Grp
							2	Drv Grp
							3	bA Grp
							4	Ad Grp
							5	Cn Grp
							6	In Grp
							7	OU Grp
							8	CM Grp
							9	AP Grp
							12	Pr Grp
							13	M2 Grp
							Setting is prohibited during fault trip interruptions.	
0h03E3	***40995***	***40996***	Display changed parameters	-	-	♦R/W	0	No
							1	Yes
0h03E4	***40996***	***40997***	Reserved	-	-	Read Only	-	
0h03E5	***40997***	***40998***	Delete all fault history	-	-	♦R/W	0	No
							1	Yes
0h03E6	***40998***	***40999***	Delete user-registrated codes	-	-	♦R/W	0	No
							1	Yes
0h03E7	***40999***	***41000***	Hide parameter mode	0	Hex	♦R/W	Write: 0-9999	
							Read	
							0	Unlock
							1	Lock
0h03E8	***41000***	***41001***	Lock parameter mode	0	Hex	♦R/W	Write: 0-9999	
							Read	
							0	Unlock
							1	Lock
0h03E9	***41001***	***41002***	Easy start on (easy parameter setup mode)	-	-	♦R/W	0	No
							1	Yes
0h03EA	***41002***	***41003***	Initializing power consumption	-	-	♦R/W	0	No
							1	Yes
0h03EB	***41003***	***41004***	Initialize drive operation accumulative time	-	-	♦R/W	0	No
							1	Yes
0h03EC	***41004***	***41005***	Initialize cooling fan accumulated operation time	-	-	♦R/W	0	No
							1	Yes

When setting parameters in the drive memory control area, the values are reflected to the drive operation and saved. Parameters set in other areas via communication are reflected to the drive operation, but are not saved. All set values are cleared following a drive power cycle and revert back to its previous values. When setting

parameters via communication, ensure that a parameter save is completed prior to shutting the drive down.

Whereas the drive may respond and operate to new parameters written via communications, some parameters set via communications are not retentive upon a power cycle UNLESS the new parameter values have been SAVED prior to the power cycle.

- *Parameter SET via Communications + NOT Saved + Power Cycle = Parameters reverts back to previous setting.*
- *Parameter SET via Communications + SAVED + Power Cycle = Parameters holds saved value.*

The addresses 0h03E7 and 0h03E8 are parameters for entering the password. When the password is entered, the condition will change from Lock to Unlock, and vice versa. When the same parameter value is entered continuously, the parameter is executed just once. Therefore, if the same value is entered again, change it to another value first and then re-enter the previous value. For example, if you want to enter 244 twice, enter it in the following order: 244 → 0 → 244.

NOTE: It may take longer to set the parameter values in the drive memory control area because all data is saved to the drive. Be careful as communication may be lost during parameter setup if parameter setup is continues for an extended period of time.

Drive Parameter Modbus Communication Addresses

The following tables list the specific modbus addresses for all parameters in the ACN series drive. Please note, the Modbus RTU addresses for serial use are different than the Modbus TCP addresses for use with the ACN-ETH communications option card. Hex Address 0000 is unavailable with Modbus RTU.

Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal	Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal
Drive Group							
dr.01	1101	44353	44354	***dr.20***	1114	44372	44373
dr.02	1102	44354	44355	***dr.21***	1115	44373	44374
dr.03	1103	44355	44356	***dr.22***	1116	44374	44375
dr.04	1104	44356	44357	***dr.23***	1117	44375	44376
dr.06	1106	44358	44359	***dr.24***	1118	44376	44377
dr.07	1107	44359	44360	***dr.25***	1119	44377	44378
dr.08	1108	44360	44361	***dr.80***	1150	44432	44433
dr.09	1109	44361	44362	***dr.81***	1151	44433	44434
dr.10	1110A	44362	44363	***dr.89***	1159	40995	40996
dr.11	110B	44363	44364	***dr.90***	115A	44442	44443
dr.12	110C	44364	44365	***dr.91***	115B	44443	44444
dr.13	110D	44365	44366	***dr.93***	115D	44445	44446
dr.14	110E	44366	44367	***dr.94***	115E	44446	44447
dr.15	110F	44367	44368	***dr.95***	115F	44447	44448
dr.16	1110	44368	44369	***dr.97***	1161	44449	44450
dr.17	1111	44369	44370	***dr.98***	1162	44450	44451
dr.18	1112	44370	44371	***dr.99***	1163	44451	44452
dr.19	1113	44371	44372				

Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal	Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal
Basic Group							
bA.1	1201	44609	44610	***bA.35***	-	-	-
bA.2	1202	44610	44611	***bA.41***	1229	44649	44650
bA.3	1203	44611	44612	***bA.42***	122A	44650	44651
bA.4	1204	44612	44613	***bA.43***	122B	44651	44652
bA.5	1205	44613	44614	***bA.44***	122C	44652	44653
bA.6	1206	44614	44615	***bA.45***	122D	44653	44654
bA.7	1207	44615	44616	***bA.46***	122E	44654	44655
bA.8	1208	44616	44617	***bA.47***	122F	44655	44656
bA.9	1209	44617	44618	***bA.48***	1230	44656	44657
bA.10	120A	44618	44619	***-***	-	40000	40001
bA.11	120B	44619	44620	***bA.50***	1232	44658	44659
bA.12	120C	44620	44621	***bA.51***	1233	44659	44660
bA.13	120D	44621	44622	***bA.52***	1234	44660	44661
bA.14	120E	44622	44623	***bA.53***	1235	44661	44662
bA.15	120F	44623	44624	***bA.54***	1236	44662	44663
bA.16	1210	44624	44625	***bA.55***	1237	44663	44664
bA.17	1211	44625	44626	***bA.56***	1238	44664	44665
bA.18	1212	44626	44627	***bA.70***	1246	44678	44679
bA.19	1213	44627	44628	***bA.71***	1247	44679	44680
bA.20	-	-	-	***bA.72***	1248	44680	44681
bA.21	-	-	-	***bA.73***	1249	44681	44682
bA.22	-	-	-	***bA.74***	124A	44682	44683
bA.23	-	-	-	***bA.75***	124B	44683	44684
bA.24	-	-	-	***bA.76***	124C	44684	44685
bA.25	-	-	-	***bA.77***	124D	44685	44686
bA.26	-	-	-	***bA.78***	124E	44686	44687
bA.28	-	-	-	***bA.79***	124F	44687	44688
bA.29	-	-	-	***bA.80***	1250	44688	44689
bA.30	-	-	-	***bA.81***	1251	44689	44690
bA.31	-	-	-	***bA.82***	1252	44690	44691
bA.32	-	-	-	***bA.83***	1253	44691	44692
bA.34	-	-	-				

Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal	Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal
Advanced Group							
Ad.1	1301	44865	44866	***Ad.44***	132C	44908	44909
Ad.2	1302	44866	44867	***Ad.45***	132D	44909	44910
Ad.3	1303	44867	44868	***Ad.46***	132E	44910	44911
Ad.4	1304	44868	44869	***Ad.47***	132F	44911	44912
Ad.5	1305	44869	44870	***Ad.50***	1332	44914	44915
Ad.6	1306	44870	44871	***Ad.51***	1333	44915	44916
Ad.7	1307	44871	44872	***Ad.60***	133C	44924	44925
Ad.8	1308	44872	44873	***Ad.61***	133D	44925	44926
Ad.9	1309	44873	44874	***Ad.62***	133E	44926	44927
Ad.10	130A	44874	44875	***Ad.63***	133F	44927	44928
Ad.12	130C	44876	44877	***Ad.64***	1340	44928	44929
Ad.13	130D	44877	44878	***Ad.65***	1341	44929	44930
Ad.14	130E	44878	44879	***Ad.66***	1342	44930	44931
Ad.15	130F	44879	44880	***Ad.67***	1343	44931	44932
Ad.16	1310	44880	44881	***Ad.68***	1344	44932	44933
Ad.17	1311	44881	44882	***Ad.70***	1346	44934	44935
Ad.20	1314	44884	44885	***Ad.71***	1347	44935	44936
Ad.21	1315	44885	44886	***Ad.72***	1348	44936	44937
Ad.22	1316	44886	44887	***Ad.74***	134A	44938	44939
Ad.23	1317	44887	44888	***Ad.75***	134B	44939	44940
Ad.24	1318	44888	44889	***Ad.76***	134C	44940	44941
Ad.25	1319	44889	44890	***Ad.77***	134D	44941	44942
Ad.26	131A	44890	44891	***Ad.78***	134E	44942	44943
Ad.27	131B	44891	44892	***Ad.79***	134F	44943	44944
Ad.28	131C	44892	44893	***Ad.80***	1350	44944	44945
Ad.29	131D	44893	44894	***Ad.81***	1351	44945	44946
Ad.30	131E	44894	44895	***Ad.82***	1352	44946	44947
Ad.31	131F	44895	44896	***Ad.83***	-	-	-
Ad.32	1320	44896	44897	***Ad.85***	1355	44949	44950
Ad.33	1321	44897	44898	***Ad.86***	1356	44950	44951
Ad.41	1329	44905	44906	***Ad.87***	1357	44951	44952
Ad.42	132A	44906	44907				

Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal	Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal
Control Group							
Cn.4	1404	45124	45125	***Cn.50***	1432	45170	45171
Cn.5	1405	45125	45126	***Cn.51***	1433	45171	45172
Cn.9	1409	45129	45130	***Cn.52***	1434	45172	45173
Cn.10	140A	45130	45131	***Cn.53***	1435	45173	45174
Cn.11	140B	45131	45132	***Cn.54***	1436	45174	45175
Cn.12	140C	45133	45134	***Cn.55***	1437	45175	45176
Cn.13	140D	45135	45136	***Cn.56***	1438	45176	45177
Cn.15	140F	45136	45137	***Cn.57***	1439	45177	45178
Cn.16	1410	45137	45138	***Cn.62***	143E	45182	45183
Cn.20	1414	45140	45141	***Cn.63***	143F	45183	45184
Cn.21	1415	45141	45142	***Cn.64***	1440	45184	45185
Cn.22	1416	45142	45143	***Cn.65***	1441	45185	45186
Cn.23	1417	45143	45144	***Cn.69***	-	-	-
Cn.24	1418	45144	45145	***Cn.70***	1446	45190	45191
Cn.25	1419	45145	45146	***Cn.71***	1447	45191	45192
Cn.26	141A	45146	45147	***Cn.72***	1448	45192	45193
Cn.27	141B	45147	45148	***Cn.73***	1449	45193	45194
Cn.28	141C	45148	45149	***Cn.74***	144A	45194	45195
Cn.29	141D	45149	45150	***Cn.75***	144B	45195	45196
Cn.30	141E	45150	45151	***Cn.76***	144C	45196	45197
Cn.31	141F	45151	45152	***Cn.77***	144D	45197	45198
Cn.32	1420	45152	45153	***Cn.78***	144E	45198	45199
Cn.33	1421	45153	45154	***Cn.79***	144F	45199	45200
Cn.34	1422	45154	45155	***Cn.80***	1450	45200	45201
Cn.35	1423	45155	45156	***Cn.81***	1451	45201	45202
Cn.36	1424	45156	45157	***Cn.82***	1452	45202	45203
Cn.37	1425	45157	45158	***Cn.83***	1453	45203	45204
Cn.38	1426	45158	45159	***Cn.85***	1455	45205	45206
Cn.39	1427	45159	45160	***Cn.86***	1456	45206	45207
Cn.40	1428	45160	45161	***Cn.87***	1457	45207	45208
Cn.41	1429	45161	45162	***Cn.88***	1458	45208	45209
Cn.42	142A	45162	45163	***Cn.89***	1459	45209	45210
Cn.43	142B	45163	45164	***Cn.90***	145A	45210	45211
Cn.44	142C	45164	45165	***Cn.91***	145B	45211	45212
Cn.45	142D	45165	45166	***Cn.92***	145C	45212	45213
Cn.46	142E	45166	45167	***Cn.93***	145D	45213	45214
Cn.48	1430	45168	45169	***Cn.94***	145E	45214	45215
Cn.49	1431	45169	45170	***Cn.95***	145F	45215	45216

Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal	Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal
Input Group							
In.1	1501	45377	45378	***In.54***	1536	45430	45431
In.2	1502	45378	45379	***In.55***	1537	45431	45432
In.5	1505	45381	45382	***In.56***	1538	45432	45433
In.6	1506	45382	45383	***In.61***	153D	45437	45438
In.7	1507	45383	45384	***In.62***	153E	45438	45439
In.8	1508	45384	45385	***In.65***	1541	45441	45442
In.9	1509	45385	45386	***In.66***	1542	45442	45443
In.10	150A	45386	45387	***In.67***	1543	45443	45444
In.11	150B	45387	45388	***In.68***	1544	45444	45445
In.12	150C	45388	45389	***In.69***	1545	45445	45446
In.13	150D	45389	45390	***In.84***	1554	45460	45461
In.14	150E	45390	45391	***In.85***	1555	45461	45462
In.15	150F	45391	45392	***In.86***	1556	45462	45463
In.16	1510	45392	45393	***In.87***	1557	45463	45464
In.17	1511	45393	45394	***In.89***	1559	45465	45466
In.35	1523	45411	45412	***In.90***	155A	45466	45467
In.37	1525	45413	45414	***In.91***	155B	45467	45468
In.38	1526	45414	45415	***In.92***	155C	45468	45469
In.39	1527	45415	45416	***In.93***	155D	45469	45470
In.40	1528	45416	45417	***In.94***	155E	45470	45471
In.41	1529	45417	45418	***In.95***	155F	45471	45472
In.46	152E	45422	45423	***In.96***	1560	45472	45473
In.47	152F	45423	45424	***In.97***	1561	45473	45474
In.50	1532	45426	45427	***In.98***	1562	45474	45475
In.52	1534	45428	45429	***In.99***	1563	45475	45476
In.53	1535	45429	45430				
Output Group							
OU.1	1601	45633	45634	***OU.52***	1634	45684	45685
OU.2	1602	45634	45635	***OU.53***	1635	45685	45686
OU.3	1603	45635	45636	***OU.54***	1636	45686	45687
OU.4	1604	45636	45637	***OU.55***	1637	45687	45688
OU.5	1605	45637	45638	***OU.56***	1638	45688	45689
OU.6	1606	45638	45639	***OU.57***	1639	45689	45690
OU.30	161E	45662	45663	***OU.58***	163A	45690	45691
OU.31	161F	45663	45664	***OU.61***	163D	45693	45694
OU.32	1620	45664	45665	***OU.62***	163E	45694	45695
OU.33	1621	45665	45666	***OU.63***	163F	45695	45696
OU.41	1629	45673	45674	***OU.64***	1640	45696	45697
OU.50	1632	45682	45683	***OU.65***	1641	45697	45698
OU.51	1633	45683	45684	***OU.66***	1642	45698	45699

Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal	Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal
Communication Group							
CM.1	1701	45889	45890	***CM.35***	1723	45923	45924
CM.2	1702	45890	45891	***CM.36***	1724	45924	45925
CM.3	1703	45891	45892	***CM.37***	1725	45925	45926
CM.4	1704	45892	45893	***CM.38***	1726	45926	45927
CM.5	1705	45893	45894	***CM.49***	1731	45937	45938
CM.6	1706	45894	45895	***CM.50***	1732	45938	45939
CM.7	1707	45895	45896	***CM.51***	1733	45939	45940
CM.8	1708	45896	45897	***CM.52***	1734	45940	45941
CM.9	1709	45897	45898	***CM.53***	1735	45941	45942
CM.10	170A	45898	45899	***CM.54***	1736	45942	45943
CM.11	170B	45899	45900	***CM.55***	1737	45943	45944
CM.12	170C	45900	45901	***CM.56***	1738	45944	45945
CM.13	170D	45901	45902	***CM.57***	1739	45945	45946
CM.14	170E	45902	45903	***CM.58***	173A	45946	45947
CM.15	170F	45903	45904	***CM.68***	1744	45956	45957
CM.16	1710	45904	45905	***CM.70***	1746	45958	45959
CM.17	1711	45905	45906	***CM.71***	1747	45959	45960
CM.18	1712	45906	45907	***CM.72***	1748	45960	45961
CM.19	1713	45907	45908	***CM.73***	1749	45961	45962
CM.20	1714	45908	45909	***CM.74***	174A	45962	45963
CM.21	1715	45909	45910	***CM.75***	174B	45963	45964
CM.22	1716	45910	45911	***CM.76***	174C	45964	45965
CM.23	1717	45911	45912	***CM.77***	174D	45965	45966
CM.24	1718	45912	45913	***CM.86***	1756	45974	45975
CM.25	1719	45913	45914	***CM.90***	175A	45978	45979
CM.29	171D	45917	45918	***CM.91***	175B	45979	45980
CM.30	171E	45918	45919	***CM.92***	175C	45980	45981
CM.31	171F	45919	45920	***CM.93***	175D	45981	45982
CM.32	1720	45920	45921	***CM.94***	-	-	-
CM.33	1721	45921	45922	***CM.95***	1760	45984	45985
CM.34	1722	45922	45923	***CM.96***	-	-	-

Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal	Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal
Application Group							
AP.1	1801	46145	46146	***AP.29***	181D	46173	46174
AP.2	-	46146	46147	***AP.30***	181E	46174	46175
AP.16	1810	46160	46161	***AP.31***	181F	46175	46176
AP.17	1811	46161	46162	***AP.32***	1820	46176	46177
AP.18	1812	46162	46163	***AP.34***	1822	46178	46179
AP.19	1813	46163	46164	***AP.35***	1823	46179	46180
AP.20	1814	46164	46165	***AP.36***	1824	46180	46181
AP.21	1815	46165	46166	***AP.37***	1825	46181	46182
AP.22	1816	46166	46167	***AP.38***	1826	46182	46183
AP.23	1817	46167	46168	***AP.39***	1827	46183	46184
AP.24	1818	46168	46169	***AP.40***	1828	46184	46185
AP.25	1819	46169	46170	***AP.42***	182A	46186	46187
AP.26	181A	46170	46171	***AP.43***	182B	46187	46188
AP.27	181B	46171	46172	***AP.44***	182C	46188	46189
AP.28	181C	46172	46173	***AP.45***	182D	46189	46190
Extension IO Group							
AO.1	1A01	46657	46658	***AO.20***	1A14	46676	46677
AO.2	1A02	46658	46659	***AO.21***	1A15	46677	46678
AO.3	1A03	46659	46660	***AO.22***	1A16	46678	46679
AO.4	1A04	46660	46661	***AO.23***	1A17	46679	46680
AO.5	1A05	46661	46662	***AO.24***	1A18	46680	46681
AO.6	1A06	46662	46663	***AO.25***	1A19	46681	46682
AO.7	1A07	46663	46664	***AO.26***	1A1A	46682	46683
AO.8	1A08	46664	46665	***AO.27***	1A1B	46683	46684
AO.9	1A09	46665	46666	***AO.28***	1A1C	46684	46685
AO.10	1A0A	46666	46667	***AO.29***	1A1D	46685	46686
AO.11	1A0B	46667	46668	***AO.30***	1A1E	46686	46687
AO.12	1A0C	46668	46669	***AO.31***	1A1F	46687	46688
AO.13	1A0D	46669	46670	***AO.32***	1A20	46688	46689
AO.14	1A0E	46670	46671	***AO.33***	1A21	46689	46690
AO.15	1A0F	46671	46672	***AO.34***	1A22	46690	46691
AO.16	1A10	46672	46673	***AO.35***	1A23	46691	46692
AO.17	1A11	46673	46674	***AO.36***	1A24	46692	46693
AO.18	1A12	46674	46675	***AO.37***	1A25	46693	46694
AO.19	1A13	46675	46676				

Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal	Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal
Protection Group							
Pr.4	1B04	46916	46917	***Pr.51***	1B33	46963	46964
Pr.5	1B05	46917	46918	***Pr.52***	1B34	46964	46965
Pr.6	1B06	46918	46919	***Pr.53***	1B35	46965	46966
Pr.7	1B07	46919	46920	***Pr.54***	1B36	46966	46967
Pr.8	1B08	46920	46921	***Pr.55***	1B37	46967	46968
Pr.9	1B09	46921	46922	***Pr.56***	1B38	46968	46969
Pr.10	1B0A	46922	46923	***Pr.57***	1B39	46969	46970
Pr.12	1B0C	46924	46925	***Pr.58***	1B3A	46970	46971
Pr.13	1B0D	46925	46926	***Pr.59***	1B3B	46971	46972
Pr.14	1B0E	46926	46927	***Pr.60***	1B3C	46972	46973
Pr.15	1B0F	46927	46928	***Pr.61***	1B3D	46973	46974
Pr.17	1B11	46929	46930	***Pr.62***	1B3E	46974	46975
Pr.18	1B12	46930	46931	***Pr.63***	1B3F	46975	46976
Pr.19	1B13	46931	46932	***Pr.66***	1B42	46978	46979
Pr.20	1B14	46932	46933	***Pr.73***	1B49	46946	46947
Pr.21	1B15	46933	46934	***Pr.74***	1B4A	46947	46948
Pr.22	1B16	46934	46935	***Pr.75***	1B4B	46948	46949
Pr.25	1B19	46937	46938	***Pr.79***	1B4F	46991	46992
Pr.26	1B1A	46938	46939	***Pr.80***	1B50	46992	46993
Pr.27	1B1B	46939	46940	***Pr.81***	1B51	46993	46994
Pr.28	1B1C	46940	46941	***Pr.82***	1B52	46994	46995
Pr.29	1B1D	46941	46942	***Pr.86***	1B56	46998	46999
Pr.30	1B1E	46942	46943	***Pr.87***	1B57	46999	47000
Pr.31	1B1F	46943	46944	***Pr.88***	1B58	47000	47001
Pr.32	1B20	46944	46945	***Pr.89***	1B59	47001	47002
Pr.33	1B21	46945	46946	***Pr.91***	1B5B	47003	47004
Pr.40	1B28	46952	46953	***Pr.92***	1B5C	47004	47005
Pr.41	1B29	46953	46954	***Pr.93***	1B5D	47005	47006
Pr.42	1B2A	46954	46955	***Pr.94***	1B5E	47006	47007
Pr.43	1B2B	46955	46956	***Pr.95***	1B5F	47007	47008
Pr.45	1B2D	46957	46958	***Pr.96***	1B60	47008	47009
Pr.50	1B32	46962	46963				

Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal	Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal
2nd Motor Group							
m2.4	1C04	47172	47173	***m2.18***	-	-	-
m2.5	1C05	47173	47174	***m2.19***	-	-	-
m2.6	1C06	47174	47175	***m2.20***	-	-	-
m2.7	1C07	47175	47176	***m2.25***	1C19	47193	47194
m2.8	1C08	47176	47177	***m2.26***	1C1A	47194	47195
m2.10	1C0A	47178	47179	***m2.27***	1C1B	47195	47196
m2.11	1C0B	47179	47180	***m2.28***	1C1C	47196	47197
m2.12	1C0C	47180	47181	***m2.29***	1C1D	47197	47198
m2.13	1C0D	47181	47182	***m2.30***	1C1E	47198	47199
m2.14	1C0E	47182	47183	***m2.40***	1C28	47208	47209
m2.15	1C0F	47183	47184	***m2.41***	1C29	47209	47210
m2.16	1C10	47184	47185	***m2.42***	1C2A	47210	47211
m2.17	-	-	-				
User Sequence Group							
US.1	1D01	47425	47426	***US.39***	1D27	47463	47464
US.2	1D02	47426	47427	***US.40***	1D28	47464	47465
US.11	1D0B	47435	47436	***US.41***	1D29	47465	47466
US.12	1D0C	47436	47437	***US.42***	1D2A	47466	47467
US.13	1D0D	47437	47438	***US.43***	1D2B	47467	47468
US.14	1D0E	47438	47439	***US.44***	1D2C	47468	47469
US.15	1D0F	47439	47440	***US.45***	1D2D	47469	47470
US.16	1D10	47440	47441	***US.46***	1D2E	47470	47471
US.17	1D11	47441	47442	***US.47***	1D2F	47471	47472
US.18	1D12	47442	47443	***US.48***	1D30	47472	47473
US.19	1D13	47443	47444	***US.49***	1D31	47473	47474
US.20	1D14	47444	47445	***US.50***	1D32	47474	47475
US.21	1D15	47445	47446	***US.51***	1D33	47475	47476
US.22	1D16	47446	47447	***US.52***	1D34	47476	47477
US.23	1D17	47447	47448	***US.53***	1D35	47477	47478
US.24	1D18	47448	47449	***US.54***	1D36	47478	47479
US.25	1D19	47449	47450	***US.55***	1D37	47479	47480
US.26	1D1A	47450	47451	***US.56***	1D38	47480	47481
US.27	1D1B	47451	47452	***US.57***	1D39	47481	47482
US.28	1D1C	47452	47453	***US.58***	1D3A	47482	47483
US.31	1D1F	47455	47456	***US.59***	1D3B	47483	47484
US.32	1D20	47456	47457	***US.60***	1D3C	47484	47485
US.33	1D21	47457	47458	***US.80***	1D50	47504	47505
US.34	1D22	47458	47459	***US.81***	1D51	47505	47506
US.35	1D23	47459	47460	***US.82***	1D52	47506	47507
US.36	1D24	47460	47461	***US.85***	1D55	47509	47510
US.37	1D25	47461	47462	***US.88***	1D58	47512	47513
US.38	1D26	47462	47463				

Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal	Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal
User Sequence Function Group							
UF.1	1E01	47681	47682	***UF.46***	1E2E	47726	47727
UF.2	1E02	47682	47683	***UF.47***	1E2F	47727	47728
UF.3	1E03	47683	47684	***UF.48***	1E30	47728	47729
UF.4	1E04	47684	47685	***UF.49***	1E31	47729	47730
UF.5	1E05	47685	47686	***UF.50***	1E32	47730	47731
UF.6	1E06	47686	47687	***UF.51***	1E33	47731	47732
UF.7	1E07	47687	47688	***UF.52***	1E34	47732	47733
UF.8	1E08	47688	47689	***UF.53***	1E35	47733	47734
UF.9	1E09	47689	47690	***UF.54***	1E36	47734	47735
UF.10	1E0A	47690	47691	***UF.55***	1E37	47735	47736
UF.11	1E0B	47691	47692	***UF.56***	1E38	47736	47737
UF.12	1E0C	47692	47693	***UF.57***	1E39	47737	47738
UF.13	1E0D	47693	47694	***UF.58***	1E3A	47738	47739
UF.14	1E0E	47694	47695	***UF.59***	1E3B	47739	47740
UF.15	1E0F	47695	47696	***UF.60***	1E3C	47740	47741
UF.16	1E10	47696	47697	***UF.61***	1E3D	47741	47742
UF.17	1E11	47697	47698	***UF.62***	1E3E	47742	47743
UF.18	1E12	47698	47699	***UF.63***	1E3F	47743	47744
UF.19	1E13	47699	47700	***UF.64***	1E40	47744	47745
UF.20	1E14	47700	47701	***UF.65***	1E41	47745	47746
UF.21	1E15	47701	47702	***UF.66***	1E42	47746	47747
UF.22	1E16	47702	47703	***UF.67***	1E43	47747	47748
UF.23	1E17	47703	47704	***UF.68***	1E44	47748	47749
UF.24	1E18	47704	47705	***UF.69***	1E45	47749	47750
UF.25	1E19	47705	47706	***UF.70***	1E46	47750	47751
UF.26	1E1A	47706	47707	***UF.71***	1E47	47751	47752
UF.27	1E1B	47707	47708	***UF.72***	1E48	47752	47753
UF.28	1E1C	47708	47709	***UF.73***	1E49	47753	47754
UF.29	1E1D	47709	47710	***UF.74***	1E4A	47754	47755
UF.30	1E1E	47710	47711	***UF.75***	1E4B	47755	47756
UF.31	1E1F	47711	47712	***UF.76***	1E4C	47756	47757
UF.32	1E20	47712	47713	***UF.77***	1E4D	47757	47758
UF.33	1E21	47713	47714	***UF.78***	1E4E	47758	47759
UF.34	1E22	47714	47715	***UF.79***	1E4F	47759	47760
UF.35	1E23	47715	47716	***UF.80***	1E50	47760	47761
UF.36	1E24	47716	47717	***UF.81***	1E51	47761	47762
UF.37	1E25	47717	47718	***UF.82***	1E52	47762	47763
UF.38	1E26	47718	47719	***UF.83***	1E53	47763	47764
UF.39	1E27	47719	47720	***UF.84***	1E54	47764	47765
UF.40	1E28	47720	47721	***UF.85***	1E55	47765	47766
UF.41	1E29	47721	47722	***UF.86***	1E56	47766	47767
UF.42	1E2A	47722	47723	***UF.87***	1E57	47767	47768
UF.43	1E2B	47723	47724	***UF.88***	1E58	47768	47769

Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal	Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal
UF.44	1E2C	47724	47725	***UF.89***	1E59	47769	47770
UF.45	1E2D	47725	47726	***UF.90***	1E5A	47770	47771
Operation Group							
0.00	1F00	47936	47937	***St3***	1F07	47943	47944
ACC	1F01	47937	47938	***Cur***	1F08	47944	47945
dEC	1F02	47938	47939	***RPM***	1F09	47945	47946
drv	1F03	47939	47940	***dCL***	1F0A	47946	47947
Fr9	1F04	47940	47941	***vOL***	1F0B	47947	47948
St1	1F05	47941	47942	***nOn***	1F0C	47948	47949
St2	1F06	47942	47943	***drC***	1F0D	47949	47950

Chapter 6: Maintenance and Troubleshooting

Chapter 6

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Operations Lockout

The ACN series drive is equipped with a lockable disconnect switch that can be used to isolate electrical power to the motor. This provides a convenient, local lockout point for personnel to safely perform work on the motor.

WARNING: Lockout disconnect switch should not be used to isolate power if the drive cover is removed or if internal drive access is needed. Input power remains present on the input terminals at all times.

Use the disconnect switch as follows:

NOTE: Before switching off the disconnect, ensure the drive is stopped.

Maintenance and Inspections

Modern AC drives are based on solid state electronics technology, including ICs, resistors, capacitors, transistors, cooling fans, relays, etc. These components have a limited life under normal operation. Preventive maintenance is required to operate the drive in its optimal condition, and to ensure a long life. We recommend that a qualified technician perform a regular inspection of the drive. Some items should be checked once a month, and some items should be checked yearly.

NOTE: All inspections should be accomplished with Safety in mind with due and required caution. Some of these Inspection items may require the Drive to be powered down, while others may require power to be applied. Proper safety precautions including the use of PPE are/may be required. Please review cautionary statements in each section

Monthly Inspection

Check the following items at least once a month.

1) *Make sure the motors are operating as expected.*
2) *Make sure the drive installation environment is normal.*
3) *Make sure the enclosure and drive cooling systems are operating as expected.*
4) *Check for irregular vibrations or sounds during operation.*
5) *Make sure the motors are not overheating during operation.*
6) *Check the input voltage to the drive and make sure the voltage is within the operating range. Check the voltage with a voltmeter.*

Annual Inspection

Check the following items once annually.

1) *Check the torque of the drive power and control terminal screws and tighten if necessary. They may loosen due to vibration or changing temperatures.*
2) *Make sure the conductors and insulators are not corroded or damaged.*
3) *Check the resistance of cable insulation with a megohmmeter.*
4) *Clean off any dust and dirt with a vacuum cleaner. Pay special attention to cleaning the ventilation ports and PCBs. Always keep these areas clean. Accumulation of dust and dirt in these areas can cause unforeseen failures.*
5) *Recharge the capacitors of any drive that is in storage or is otherwise unused.*

CAUTION: Do not run an insulation resistance test (Megger) on the control circuit as it may result in damage to the product.

Recharge Capacitors (for drives not in service)

Recharge the DC link before using any drive that has not been operated within a year:

1) *Disconnect the motor from the drive.*
2) *Apply input power to the drive for 2 hours.*

If the drive is stored or is otherwise unused for more than a year, the drive's internal DC link capacitors should be recharged before use. Otherwise, the capacitors may be damaged when the drive starts to operate. We recommend recharging the capacitors of any unused drive at least once per year.

CAUTION: Disconnect AC power and ensure that the internal capacitors have fully discharged before inspecting the drive! Wait at least two minutes after all display lamps have turned off.

- ☑ *Wait 5 seconds after a fault has been cleared before performing reset via keypad or input terminal.*
- ☑ *When the power is off after 5 minutes for ≤ 30HP models and 10 minutes for ≥ 40HP models, please confirm that the capacitors have fully discharged by measuring the voltage between + and -. The voltage between + and - should be less than 25VDC.*
- ☑ *Only qualified personnel can install, wire and maintain drives. Please take off any metal objects, such as watches and rings, before operation. And only insulated tools are allowed.*
- ☑ *Never reassemble internal components or wiring.*
- ☑ *Make sure that installation environment complies with regulations without abnormal noise, vibration and odor.*

Recommended Inspection Schedules

Before the check-up, always turn off the AC input power and remove the cover. Wait at least 10 minutes after all display lamps have gone out, and then confirm that the capacitors have fully discharged by measuring the voltage between DC+ and DC-. The voltage between DC+ and DC-should be less than 25VDC.

Ambient environment

Check Items	Methods and Criteria	Maintenance Period		
		Daily	Half Year	One Year
Check the ambient temperature, humidity, vibration and see if there are any dust, gas, oil or water drops	Visual inspection and measurement with equipment with standard specification	X		
If there are any dangerous objects	Visual inspection	X		

Voltage

Check Items	Methods and Criteria	Maintenance Period		
		Daily	Half Year	One Year
Check if the voltage of main circuit and control circuit is correct	Measure with multimeter with standard specification	X		

Digital Keypad Display

Check Items	Methods and Criteria	Maintenance Period		
		Daily	Half Year	One Year
Is the display clear for reading	Visual inspection	X		
Any missing characters	Visual inspection	X		

Mechanical parts

Check Items	Methods and Criteria	Maintenance Period		
		Daily	Half Year	One Year
If there is any abnormal sound or vibration	Visual and audible inspection	X		
If there are any loose screws	Tighten the screws	X		
If any part is deformed or damaged	Visual inspection	X		
If there is any color change due to overheating	Visual inspection	X		
If there is any dust or dirt	Visual inspection	X		

Main circuit

Check Items	Methods and Criteria	Maintenance Period		
		Daily	Half Year	One Year
If there are any loose or missing screws	Tighten or replace the screw	X		
If any drive or wiring insulation is deformed, cracked, damaged or has changed color due to overheating or aging	Visual inspection **NOTE: Ignore any color change of copper plate**		X	
If there is any dust or dirt	Visual inspection		X	

Terminals and wiring of main circuit

Check Items	Methods and Criteria	Maintenance Period		
		Daily	Half Year	One Year
If the terminal color or the placement has changed due to overheating	Visual inspection		X	
If the wiring insulation is damaged or there has been a color change	Visual inspection		X	
If there is any damage	Visual inspection	X		

DC capacity of main circuit

Check Items	Methods and Criteria	Maintenance Period		
		Daily	Half Year	One Year
If there is any liquid leaking, color change, crack or deformation	Visual inspection	X		
If the capacitor safety vent is bulging or inflated.	Visual inspection	X		
Measure static capacity when required (if drive overloads/faults during normal operation)	Measure with multimeter with standard specification	X		

Resistor of main circuit

Check Items	Methods and Criteria	Maintenance Period		
		Daily	Half Year	One Year
If there is any peculiar odor or insulation cracks due to overheating	Visual inspection, odor	X		
If there is any disconnection or discoloration	Visual inspection	X		
If the connection is damaged	Measure with a multimeter with standard specifications	X		

Transformer and reactor of main circuit

Check Items	Methods and Criteria	Maintenance Period		
		Daily	Half Year	One Year
If there is any abnormal vibration or peculiar odor	Visual, audible inspection and odor	X		

Magnetic contactor and relay of main circuit

Check Items	Methods and Criteria	Maintenance Period		
		Daily	Half Year	One Year
If there are any loose screws	Visual and audible inspection	X		
If the contact works correctly	Visual inspection	X		

Printed circuit board and connector of main circuit

Check Items	Methods and Criteria	Maintenance Period		
		Daily	Half Year	One Year
If there are any loose screws and connectors	Tighten the screws and press the connectors firmly in place		X	
If there is any peculiar odor and/or color change	Visual and odor inspection		X	
If there is any crack, damage, deformation or corrosion	Visual inspection		X	
If there is any liquid leakage or deformation in capacity	Visual inspection		X	

Cooling fan of cooling system

Check Items	Methods and Criteria	Maintenance Period		
		Daily	Half Year	One Year
If there is any abnormal sound or vibration	Visual, audible inspection and turn the fan with hand (turn off the power before operation) to see if it rotates smoothly	X		
If there is any loose screw	Tighten the screw	X		
If there is any color change due to overheating	Change the fan	X		

Ventilation channel of cooling system

Check Items	Methods and Criteria	Maintenance Period		
		Daily	Half Year	One Year
If there is any obstruction in the heat sink, air intake or air outlet	Visual inspection		X	

Please use a clean lint free cloth for cleaning and use a dust cleaner to remove dust when necessary.

Storage and Disposal

If you are not using the product for an extended period, store it in the following way:

- *Store the product in the same environmental conditions as specified for operation.*
- *When storing the product for a period longer than 3 months, store it between 10˚C and 30˚C, to prevent depletion of the electrolytic capacitor.*
- *Do not expose the drive to snow, rain, fog, or dust.*
- *Package the drive in a way that prevents contact with moisture. Keep the moisture level below 70% in the package by including a desiccant, such as silica gel.*

Troubleshooting

This chapter explains how to troubleshoot a problem when drive protective functions, fault trips, warning signals, or a fault occurs. If the drive does not work normally after following the suggested troubleshooting steps, please contact AutomationDirect customer support.

Trips and Warnings

When the drive detects a fault, it stops the operation (trips) or sends out a warning signal. When a trip or warning occurs, the keypad displays the information briefly. If the LCD keypad is used, detailed information is shown on the LCD display. Users can read the warning message at Pr.90. When more than two trips occur at roughly the same time, the keypad (basic keypad with 7-segment display) displays the higher priority fault trip information, while the LCD keypad shows the information for the fault trip that occurred first.

The fault conditions can be categorized as follows:

- ***Level**: When the fault is corrected, the trip or warning signal disappears and the fault is not saved in the fault history.*
- ***Latch**: When the fault is corrected and a reset input signal is provided, the trip or warning signal disappears.*
- ***Fatal**: When the fault is corrected, the fault trip or warning signal disappears only after the user turns off the drive, waits until the charge indicator light goes off, and turns the drive on again. If the the drive is still in a fault condition after powering it on again, please contact AutomationDirect customer support.*

Fault Trips

Protection Functions for Output Current and Input Voltage

Protection Functions for Output Current and Input Voltage			
Keypad Display	**LCD Display**	**Type**	**Description**
olt	Overload	Latch	Displayed when the motor overload trip is activated and the actual load level exceeds the set level. Operates when Pr.20 is set to a value other than 0.
ult	Underload	Latch	Displayed when the motor underload trip is activated and the actual load level is less than the set level. Operates when Pr.27 is set to a value other than 0.
oct	Overcurrent	Latch	Displayed when drive output current exceeds 200% of the rated current.
ovt	Overvoltage	Latch	Displayed when internal DC circuit voltage exceeds the specified value.
lvt	Low voltage	Level	Displayed when internal DC circuit voltage is less than the specified value.
lv2	Low voltage2	Latch	Displayed when internal DC circuit voltage is less than the specified value during drive operation.
gft	Ground Trip*	Latch	Displayed when a ground fault trip occurs on the output side of the drive and causes the current to exceed the specified value. The specified value varies depending on drive capacity. (Note: drives rated for 4.0kW or less do not support the ground fault trip (GFT) feature. Therefore, an overcurrent trip (OCT) or overvoltage trip (OVT) may occur when there is a low-resistance ground fault.)
eth	E-thermal	Latch	Displayed based on inverse time-limit thermal characteristics to prevent motor overheating. Operates when Pr.40 is set to a value other than 0.
pot	Out phase open	Latch	Displayed when a 3-phase drive output has one or more phases in an open circuit condition. Operates when bit 1 of Pr.5 is set to 1.
ipo	In phase open	Latch	Displayed when a 3-phase drive input has one or more phases in an open circuit condition. Operates only when bit 2 of Pr.5 is set to 1.
iol	Drive OLT	Latch	Displayed when the drive has been protected from overload and resultant overheating, based on inverse time-limit thermal characteristics. Allowable overload rates for the drive are 150% for 1 min and 200% for 4 sec. Protection is based on drive rated capacity, and may vary depending on the device's capacity.
nmt	No motor trip	Latch	Displayed when the motor is not connected during drive operation. Operates when Pr.31 is set to 1.
**ACN drives rated for 4.0kW or less do not support the ground fault trip (GFT) feature. Therefore, an over current trip (OCT) or over voltage trip (OVT) may occur when there is a low-resistance ground fault.*			

Protection Functions Using Abnormal Internal Circuit Conditions and External Signals

Protection Functions Using Abnormal Internal Circuit Conditions and External Signals			
Keypad Display	**LCD Display**	**Type**	**Description**
oht	Overheat	Latch	Displayed when the tempertature of the drive heat sink exceeds the specified value.
oc2	Overcurrent2	Latch	Displayed when the DC circuit in the drive detects a specified level of excessive, short circuit current.
trip	External trip	Latch	Displayed when an external fault signal is provided by the multi-function terminal. Set one of the multi-function input terminals at In.65-69 to 4 (External Trip) to enable external trip.
bx	BX	Level	Displayed when the drive output is blocked by a signal provided from the multi-function terminal. Set one of the multi-function input terminals at In.65-69 to 5 (BX) to enable input block function.
hwt	H/W-Diag	Fatal	Displayed when an error is detected in the memory (EEPROM), analog-digital converter output (ADC Off Set), or CPU watchdog (Watch Dog-1, Watch Dog-2). EEP Err: An error in reading/writing parameters due to keypad or memory (EEPROM) fault. ADC Off Set: An error in the current sensing circuit (U/V/W terminal, current sensor, etc.).
ntc	NTC Open	Latch	Displayed when an error is detected in the temperature sensor of the Insulated Gate Bipolar Transistor (IGBT).
fan	Fan Trip	Latch	Displayed when an error is detected in the cooling fan. Set Pr.79 to 0 to activate fan trip.
pid	Pre-PID Fail	Latch	Displayed when pre-PID is operating with functions set at AP.34–AP.36. A fault trip occurs when a controlled variable (PID feedback) is measured below the set value and the low feedback continues, as it is treated as a load fault.
xbr	Ext-Brake	Latch	Operates when the external brake signal is provided by the multi-function terminal. Occurs when the drive output starting current remains below the set value at Ad.41. Set either OU.31 or OU.32 to 35 (BR Control).
sfa ***sfb***	Safety A (B) Err	Latch	Displayed when at least one of the two safety input signals is off.

Protection Functions for Communications Options

Protection Functions for Communications Options			
Keypad Display	**LCD Display**	**Type**	**Description**
lor	Lost Command	Level	Displayed when a frequency or operation command error is detected during drive operation by controllers other than the keypad (e.g., using a terminal block and a communication mode). Activate by setting Pr.12 to any value other than 0.
iot ***hold***	IO Board Trip	Latch	Displayed when the I/O board or external communication card is not connected to the drive or there is a bad connection.
errc			Displayed when the “HOLd” error code continues for more than 5 seconds. (‘Errc’ -> ‘-rrc’ -> E-rc’ -> ‘Er-c’ -> ‘Err-’ -> ‘- -rc’ -> ‘Er- -’ -> ‘- - - -’-> ‘Errc’ -> ...)
par	ParaWrite Trip	Latch	Displayed when communication fails during parameter writing. Occurs when using an LCD keypad due to a control cable fault or a bad connection.
opt	Option Trip-1	Latch	Displayed when a communication error is detected between the drive and the communication board. Occurs when the communication option card is installed.

Warning Messages

Warning Messages		
Keypad Display	**LCD Display**	**Description**
olw	Overload	Displayed when the motor is overloaded. Operates when Pr.17 is set to 1. To operate, select 5. Set the Q1 Digital output terminal or Relay 1 (OU.31 or OU.33) to 5 (Over Load) to receive overload warning output signals.
ulw	Underload	Displayed when the motor is underloaded. Operates when Pr.25 is set to 1. Set the Q1 Digital output terminal or Relay 1 (OU.31 or OU.33) to 7 (Under Load) to receive underload warning output signals.
iolw	INV Overload	Displayed when the overload time equivalent to 60% of the drive overheat protection (drive IOLT) level, is accumulated. Set the Q1 Digital output terminal or Relay 1 (OU.31 or OU.33) to 6 (IOL) to receive drive overload warning output signals.
lcw	Lost Command	Lost command warning alarm occurs even with Pr.12 set to 0. The warning alarm occurs based on the condition set at Pr.13- 15. Set the digital output terminal or relay (OU.31 or OU.33) to 13 (Lost Command) to receive lost command warning output signals. If the communication settings and status are not suitable for P2P, a Lost Command alarm occurs.
fanw	Fan Warning	Displayed when an error is detected from the cooling fan while Pr.79 is set to 1. Set the Q1 Digital output terminal or Relay 1 (OU.31 or OU.33) to 8 (Fan Warning) to receive fan warning output signals.
dbw	DB Warn %ED	Displayed when the DB resistor usage rate exceeds the set value. Set the detection level at Pr.66.
trer	Retry Tr Tune	Tr tune error warning alarm is activated when Dr.9 is set to 4. The warning alarm occurs when the motor's rotor time constant (Tr) is either too low or too high.
slp	PID Sleep	When the PID operation enters sleep mode, a warning occurs.

Troubleshooting Fault Trips

When a fault trip or warning occurs due to a protection function, refer to the following table for possible causes and remedies.

Troubleshooting Fault Trips		
Type	**Cause**	**Remedy**
Over Load	The load is greater than the motor's rated capacity.	Ensure that the motor and drive have appropriate capacity ratings.
	The set value for the overload trip level (Pr.21) is too low.	Increase the set value for the overload trip level.
Under Load	There is a motor-load connection problem.	Replace the motor and drive with models with lower capacity.
	The set value for underload level (Pr.29, Pr.30) is less than the system's minimum load.	Reduce the set value for the underload level.
Over Current1	Acc/Dec time is too short, compared to load inertia (GD2).	Increase Acc/Dec time.
	The drive load is greater than the rated capacity.	Replace the drive with a model that has increased capacity.
	The drive supplied an output while the motor was idling.	Operate the drive after the motor has stopped or use the speed search function (Cn.60).
	The mechanical brake of the motor is operating too fast.	Check the mechanical brake.
Over Voltage	Deceleration time is too short for the load inertia (GD2).	Increase the deceleration time.
	A generative load occurs at the drive output.	Use the braking unit.
	The input voltage is too high.	Determine if the input voltage is above the specified value.
Low Voltage	The input voltage is too low.	Determine if the input voltage is below the specificed value.
	A load greater than the power capacity is connected to the system (e.g., a welder, direct motor connection, etc.)	Increase the power capacity.
	The magnetic contactor connected to the power source has a faulty connection.	Replace the magnetic contactor.
Low Voltage2	The input voltage has decreased during the operation.	Determine if the input voltage is above the specified value.
	An input phase-loss has occurred.	Check the input wiring.
	The power supply magnetic contactor is faulty.	Replace the magnetic contractor.
Ground Trip	A ground fault has occurred in the drive output wiring.	Check the output wiring.
	The motor insulation is damaged.	Replace the motor.
E-Thermal	The motor has overheated.	Reduce the load or operation frequency.
	The drive load is greater than the rated capacity.	Replace the drive with a model that has increased capacity.
	The set value for electronic thermal protection is too low.	Set an appropriate electronic thermal level.
	The drive has been operated at low speed for an extended duration.	Replace the motor with a model that supplies extra power to the cooling fan.
Output Phase Open	The magnetic contactor on the output side has a connection fault.	Check the magnetic contactor on the output side.
	The output wiring is faulty.	Check the output wiring.
Input Phase Open	The magnetic contactor on the input side has a connection fault.	Check the magnetic contactor on the input side.
	The input wiring is faulty.	Check the input wiring.
	The DC link capacitor needs to be replaced.	Replace the DC link capacitor. Contact AutomationDirect Customer Support.

Troubleshooting Fault Trips		
Type	**Cause**	**Remedy**
Drive OLT	The load is greater than the rated motor capacity.	Replace the motor and drive with models that have increased capacity.
	The torque boost level is too high.	Reduce the torque boost level.
Over Heat	There is a problem with the cooling system.	Determine if a foreign object is obstructing the air inlet, outlet, or vent.
	The drive cooling fan has been operated for an extended period.	Replace the cooling fan.
	The ambient temperature is too high.	Keep the ambient temperature below 40°C.
Over Current2	Output wiring is short-circuited.	Check the output wiring.
	There is a fault with the electronic semiconductor (IGBT).	Do not operate the drive. Contact AutomationDirect Customer Support.
NTC Open	The ambient temperature is too low.	Keep the ambient temperature above -10°C.
	There is a fault with the internal temperature sensor.	Contact AutomationDirect Customer Support.
FAN Trip / FAN Warning	A foreign object is obstructing the fan's air vent.	Remove the foreign object from the air inlet or outlet.
	The fan connector is not connected.	Connect the fan connector.
	The fan connector needs to be replaced.	Replace the fan connector.

Troubleshooting Other Faults

When a fault other than those identified as fault trips or warnings occurs, refer to the following table for possible causes and remedies.

Troubleshooting Other Faults		
Type	**Cause**	**Remedy**
Parameters cannot be set.	The drive is in operation (run mode).	Stop the drive to change to program mode and set the parameter.
	The parameter access is incorrect.	Check the correct parameter access level and set the parameter.
	The password is incorrect.	Check the password, disable the parameter lock and set the parameter.
	Low voltage is detected.	Check the power input to resolve the low voltage and set the parameter.
The motor does not rotate.	The frequency command source is set incorrectly.	Check the frequency command source setting.
	The operation command source is set incorrectly.	Check the operation command source setting.
	Power is not supplied to the terminal R/S/T.	Check the terminal connections R/S/T and U/V/W.
	The charge lamp is turned off.	Turn on the drive.
	The operation command is off.	Turn on the operation command (RUN).
	The motor is locked.	Unlock the motor or lower the load level.
	The load is too high.	Operate the motor independently.
	An emergency stop signal is input.	Reset the emergency stop signal.
	The wiring for the control circuit terminal is incorrect.	Check the wiring for the control circuit terminal.
	The input option for the frequency command is incorrect.	Check the input option for the frequency command.
	The input voltage or current for the frequency command is incorrect.	Check the input voltage or current for the frequency command.
	The PNP/NPN mode is selected incorrectly.	Check the PNP/NPN mode setting.
	The frequency command value is too low.	Check the frequency command and input a value above the minimum frequency.
	The [STOP/RESET] key is pressed.	Check that the stoppage is normal, if so resume operation normally.
	Motor torque is too low.	Change the operation modes in dr.9 (V/F, IM, and Sensorless). If the fault remains, replace the drive with a model with increased capacity.
The motor rotates in the opposite direction to the command.	The wiring for the motor output cable is incorrect.	Determine if the cable on the output side is wired correctly to the phase (U/V/W) of the motor.
	The signal connection between the control circuit terminal (forward/reverse rotation) of the drive and the forward/reverse rotation signal on the control panel side is incorrect.	Check the forward/reverse rotation wiring.
The motor only rotates in one direction.	Reverse rotation prevention is selected.	Remove the reverse rotation prevention.
	The reverse rotation signal is not provided, even when a 3-wire sequence is selected.	Check the input signal associated with the 3-wire operation and adjust as necessary.

Troubleshooting Other Faults		
Type	**Cause**	**Remedy**
The motor is overheating.	The load is too heavy.	Reduce the load.
The motor is overheating.	The load is too heavy.	Increase the Acc/Dec time.
The motor is overheating.	The load is too heavy.	Check the motor parameters and set the correct values.
The motor is overheating.	The load is too heavy.	Replace the motor and the drive with models with appropriate capacity for the load.
The motor is overheating.	The ambient temperature of the motor is too high.	Lower the ambient temperature of the motor.
The motor is overheating.	The phase-to-phase voltage of the motor is insufficient.	Use a motor that can withstand phase-to-phase voltages surges greater than the maximum surge voltage.
The motor is overheating.	The phase-to-phase voltage of the motor is insufficient.	Only use motors suitable for apllications with drives.
The motor is overheating.	The phase-to-phase voltage of the motor is insufficient.	Connect an AC reactor to the drive output (set the carrier frequency to 2 kHz).
The motor is overheating.	The motor fan has stopped or the fan is obstructed with debris.	Check the motor fan and remove any foreign objects.
The motor stops during acceleration or when connected to load.	The load is too high.	Reduce the load.
The motor stops during acceleration or when connected to load.	The load is too high.	Replace the motor and the drive with models with capacity appropriate for the load.
The motor does not accelerate or the acceleration time is too long.	The frequency command value is low.	Set an appropriate value.
The motor does not accelerate or the acceleration time is too long.	The load is too high.	Reduce the load and increase the acceleration time. Check the mechanical brake status.
The motor does not accelerate or the acceleration time is too long.	The acceleration time is too long.	Change the acceleration time.
The motor does not accelerate or the acceleration time is too long.	The combined values of the motor properties and the drive parameter are incorrect.	Change the motor related parameters.
The motor does not accelerate or the acceleration time is too long.	The stall prevention level during acceleration is low.	Change the stall prevention level.
The motor does not accelerate or the acceleration time is too long.	The stall prevention level during operation is low.	Change the stall prevention level.
The motor does not accelerate or the acceleration time is too long.	Starting torque is insufficient.	Change to vector control operation mode. If the fault is still not corrected, replace the drive with a model with increased capacity.
Motor speed varies during operation.	There is a high variance in load.	Replace the motor and drive with models with increased capacity.
Motor speed varies during operation.	The input voltage varies.	Reduce input voltage variation.
Motor speed varies during operation.	Motor speed variations occur at a specific frequency.	Adjust the output frequency to avoid a resonance area.
The motor rotation is different from the setting.	The V/F pattern is set incorrectly.	Set a V/F pattern that is suitable for the motor specification.
The motor deceleration time is too long even with Dynamic Braking (DB) resistor connected.	The deceleration time is set too long.	Change the setting accordingly.
The motor deceleration time is too long even with Dynamic Braking (DB) resistor connected.	The motor torque is insufficient.	If motor parameters are normal, it is likely to be a motor capacity fault. Replace the motor with a model with increased capacity.
The motor deceleration time is too long even with Dynamic Braking (DB) resistor connected.	The load is higher than the internal torque limit determined by the rated current of the drive.	Replace the drive with a model with increased capacity.
Operation is difficult in underload applications.	The carrier frequency is too high.	Reduce the carrier frequency.
Operation is difficult in underload applications.	Over-excitation has occurred due to an inaccurate V/F setting at low speed.	Reduce the torque boost value to avoid over-excitation.
While the drive is in operation, a control unit malfunctions or noise occurs.	Noise occurs due to switching inside the drive.	Change the carrier frequency to the minimum value.
While the drive is in operation, a control unit malfunctions or noise occurs.	Noise occurs due to switching inside the drive.	Install a micro surge filter in the drive output.

Troubleshooting Other Faults		
Type	**Cause**	**Remedy**
When the drive is operating, the earth leakage breaker is activated.	An earth leakage breaker will interrupt the supply if current flows to ground during drive operation.	Connect the drive to a ground terminal.
		Check that the ground resistance is less than 100Ω for 230V drives and less than 10Ω for 460V drives.
		Check the capacity of the earth leakage breaker and make the appropriate connection, based on the rated current of the drive.
		Lower the carrier frequency.
		Make the cable length between the drive and the motor as short as possible.
The motor vibrates severely and does not rotate normally.	Phase-to-phase voltage of 3-phase power source is not balanced.	Check the input voltage and balance the voltage.
		Check and test the motor's insulation.
The motor makes humming, or loud noises.	Resonance occurs between the motor's natural frequency and the carrier frequency.	Slightly increase or decrease the carrier frequency.
	Resonance occurs between the motor's natural frequency and the drive's output frequency.	Slightly increase or decrease the carrier frequency.
		Use the frequency jump function to avoid the frequency band where resonance occurs.
The motor vibrates/hunts.	The frequency input command is an external, analog command.	In situations of noise inflow on the analog input side that results in command interference, change the input filter time constant (In.7).
	The wiring length between the drive and the motor is too long.	Ensure that the total cable length between the drive and the motor is less than 200m (50m for motors rated 3.7 kW or lower).
The motor does not come to a complete stop when the drive output stops.	It is difficult to decelerate sufficiently, because DC braking is not operating normally.	Adjust the DC braking parameter.
		Increase the set value for the DC braking current.
		Increase the set value for the DC braking stopping time.
The output frequency does not increase to the frequency reference.	The frequency reference is within the jump frequency range.	Set the frequency reference higher than the jump frequency range.
	The frequency reference is exceeding the upper limit of the frequency command.	Set the upper limit of the frequency command higher than the frequency reference.
	Because the load is too heavy, the stall prevention function is working.	Replace the drive with a model with increased capacity.
The cooling fan does not rotate.	The control parameter for the cooling fan is set incorrectly.	Check the control parameter setting for the cooling fan.

Appendix A: Accessories

Appendix
A

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Fuses/Circuit Breakers

Protection devices are essential to prevent damage to your ACN drive and application equipment. Please use the fuse specification chart below to select fuses that are applicable to your ACN drive. Only use UL-certified 600V fuses which comply with your local regulations.

Drive	Drive Voltage	HP (CT)	Fuse Amps (Class H or RK5)	Suggested ADC Class RK5 Fuses	Circuit Breaker	
					Size	Model*
ACN(ND)-20P5	200-240	0.5	10	ECSR10	5	UTE10033C
ACN(ND)-21P0	200-240	1	10	ECSR10	10	
ACN(ND)-22P0	200-240	2	15	ECSR15	15	
ACN(ND)-23P0	200-240	3	20	ECSR20	20	
ACN(ND)-25P0	200-240	5	50	ECSR50	30	
ACN(ND)-27P5	200-240	7.5	50	ECSR50	50	UTE10053C
ACN(ND)-2010	200-240	10	63	ECSR60	60	UTE10063C
ACN(ND)-2015	200-240	15	80	ECSR80	100	UTE100103C
ACN(ND)-2020	200-240	20	100	ECSR100	125	
ACN(ND)-40P5	380-480	0.5	10	ECSR10	3	UTE10033C
ACN(ND)-41P0	380-480	1	10	ECSR10	5	
ACN(ND)-42P0	380-480	2	10	ECSR10	10	
ACN(ND)-43P0	380-480	3	15	ECSR15	10	
ACN(ND)-45P0	380-480	5	32	ECSR30	20	
ACN(ND)-47P5	380-480	7.5	32	ECSR30	30	
ACN(ND)-4010	380-480	10	35	ECSR35	30	
ACN(ND)-4015	380-480	15	50	ECSR50	50	UTE10053C
ACN(ND)-4020	380-480	20	63	ECSR60	60	UTE10063C
ACN(ND)-4025	380-480	25	70	ECSR70	75	UTE100103C
ACN(ND)-4030	380-480	30	100	ECSR100	100	

** Manufactured by LS Electric.*

Caution: Only use 600V Class H or RK5, UL listed input fuses and UL listed circuit breakers. See the table above for the current ratings for fuses and circuit breakers.

Maximum allowed prospective short-circuit current at the input power connection is defined in IEC 60439-1 as 100 kA. Depending on the selected MCCB, the ACN Series is suitable for use in circuits capable of delivering a maximum of 100 kA RMS symmetrical amperes at the drive's maximum rated voltage. The following table shows the recommended MCCB for RMS symmetrical amperes.

High Performance EMI Input Filters

The optional accessories listed in this chapter are available for use with the ACN drive. Selection of these accessories is application specific and may improve drive performance. Additional information regarding filter installation and operation is available in the AutomationDirect white paper, "Applied EMI/RFI Techniques Overview."

Drive	Drive Voltage	HP (CT)	Roxburgh Filters Chassis Type 1ph *1	Roxburgh High Performance Filters *2	Roxburgh Max Performance Filters *3
ACN(ND)-20P5	200-240	0.5	RES90F03	KMF306A	MIF310
ACN(ND)-21P0	200-240	1	RES90F10	KMF310A	MIF310
ACN(ND)-22P0	200-240	2	RES90F16	KMF318A	MIF316
ACN(ND)-23P0	200-240	3	RES90F16	KMF318A	MIF316
ACN(ND)-25P0	200-240	5	RES90S20	KMF325A	MIF323
ACN(ND)-27P5	200-240	7.5	–	KMF336A	MIF350
ACN(ND)-2010	200-240	10	–	KMF350A	MIF350
ACN(ND)-2015	200-240	15	–	KMF370A	MIF375
ACN(ND)-2020	200-240	20	–	KMF3100A	MIF3100
ACN(ND)-40P5	380-480	0.5	–	KMF306A	MIF310
ACN(ND)-41P0	380-480	1	–	KMF306A	MIF310
ACN(ND)-42P0	380-480	2	–	KMF306A	MIF310
ACN(ND)-43P0	380-480	3	–	KMF310A	MIF310
ACN(ND)-45P0	380-480	5	–	KMF318A	MIF316
ACN(ND)-47P5	380-480	7.5	–	KMF318A	MIF323
ACN(ND)-4010	380-480	10	–	KMF336A	MIF330B
ACN(ND)-4015	380-480	15	–	KMF336A	MIF350
ACN(ND)-4020	380-480	20	–	KMF350A	MIF350
ACN(ND)-4025	380-480	25	–	KMF350A	MIF350
ACN(ND)-4030	380-480	30	–	KMF370A	MIF375

**1 -EMI rating for motor cable length: C2 to 75Ft, C1 to 30ft*
**2 -EMI rating for motor cable length: C2 to 150Ft, C1 to 75ft*
**3 -EMI rating for motor cable length: C2 to 300Ft, C1 to 150ft*

EMI Filter Installation

Electrical equipment like the ACN drive, will generate electrical noise when in operation and may interfere with the normal operation of peripheral equipment. The use of an EMI filter will mitigate this type of power supply interference. Other measures may be required for reduction or mitigation of radiated emissions. Roxburgh EMI filters have been tested with the ACN family of drives and are recommended for the mitigation of interference and the highest performance When the ACN drive and Roxburgh EMI filter are installed and wired according to the user manual, the installation will conform to the following rules:

- *EN61000-6-4*
- *EN61800-3: 1996*
- *EN55011 (1991) Class A Group 1 (1st Environment, restricted distribution)*

General precaution

1) *Install the EMI filter and ACN drive on the same subpanel or metal plate.*
2) *Install the EMI filter as close as possible to the ACN drive.*
3) *Keep wiring between the EMI filter and ACN drive as short as possible.*

4) *The subpanel or metal plate used to support the EMI filter and ACN drive should be well grounded (minimal resistance to ground is typically less then 1Ω).*
5) *To insure that the EMI filter and ACN drive are adequately grounded, insure that both are securely attached to the subpanel or plate.*

Choose suitable motor cable and precautions

Proper installation and the the choice of good motor cable will positively affect the performance of the filter. When selecting motor cable, please observe the following precautions.

1) *Cable shielding (double shielding is best).*
2) *Ground the shield on both ends of the motor cable. Maintain minimum length and employ strong mechanical connection to ground.*
3) *Remove paint on the metal saddle, subpanel or plate to insure good contact to ground.*

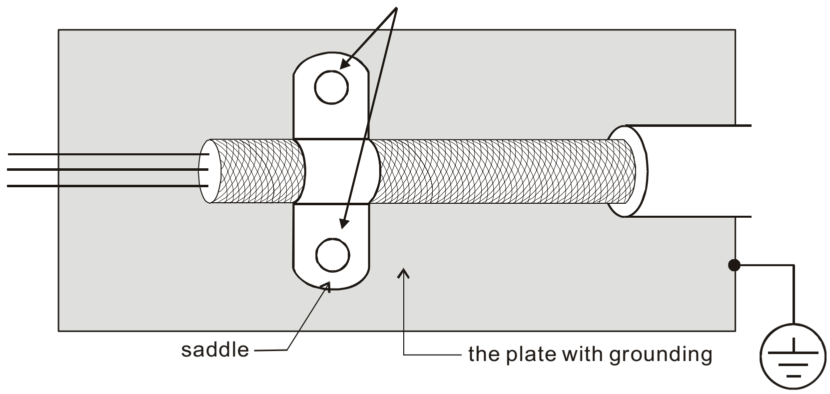


Figure 1

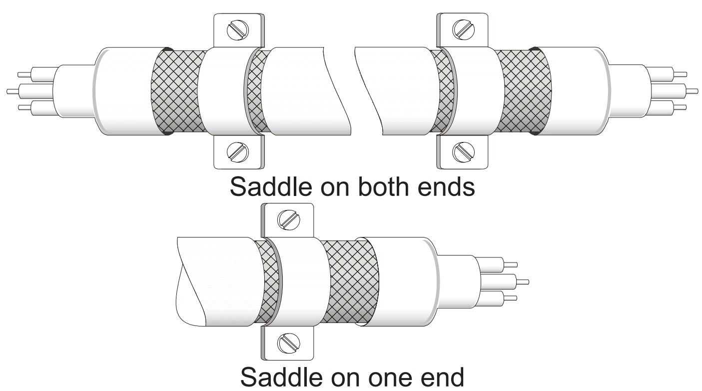


Figure 2

Reflective Wave Phenomenon

The drive section of a PWM drive like the ACN does not produce sinusoidal output voltage wave forms. Rather, the output voltage produced is a continuous train of width modulated pulses, sent to the motor terminals via the motor cable.

Peak pulse voltage at the ACN drive is equal to the drive DC bus voltage and contains steep rise and fall times, the result of the IGBT switching device used in the drive drive section.

Peak pulse voltage at the motor terminals may exceed the drive DC bus voltage and is dependent on the dynamics of the drive output voltage rise time, cable transmission line characteristics, cable length and motor impedance.

The voltage pulse train at the motor terminals experiences momentary transient over voltage as the IGBT transistors switch. The result being voltage levels at the motor terminals double that of the drive bus voltage.

Over voltage of this type has the potential to stress the motor insulation, damaging the motor.

Recommended Motor Cable Length

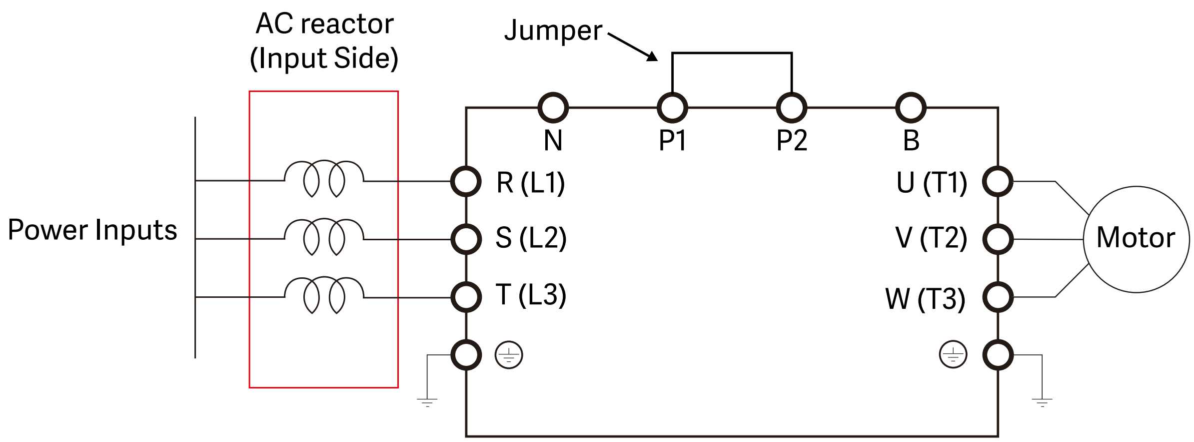
1) *Never connect phase lead capacitors or surge absorbers to the output terminals of the drive.*
2) *As cable length increases, capacitance between cables will increase and may result in leakage current and over current faults with the possibility of damage to the ACN drive.*
3) *If more than one motor is connected to the drive, the total cable length is the sum of the cable lengths from the ACN drive to each motor.*
4) *Should an overload relay malfunction occur, lower the ACN drive carrier frequency (Cn.4) or install an output reactor.*
5) *When operating an AC motor with a PWM drive like the ACN, the motor may experience reflective wave as described above. To prevent this situation, please observe the recommendations below:*
   a) Use a motor with enhanced insulation. (1000V, 1200V, 1600V, higher is better)
   b) Connect an output reactor (optional) on the drive output wiring.
   c) Keep motor cable length as short as possible. (65ft, 20m, or less)
   d) Where motor cable lengths will exceed 65ft (20m),

Line Reactors / Voltage Time Filters

Line Reactor

Installing an AC reactor on the input side of an AC motor drive can increase line impedance, improve the power factor, reduce input current, increase system capacity, and reduce interference generated from the motor drive. It also reduces momentary voltage surges or abnormal current spikes from the mains power, further protecting the drive. For example, when the main power capacity is higher than 500 kVA, or when using a phase-compensation capacitor, momentary voltage and current spikes may damage the AC motor drive's internal circuit. An AC reactor on the input side of the AC motor drive protects it by suppressing surges.

Install an AC input reactor in series between the main power and the three input phases R S T, as shown in the figure below:

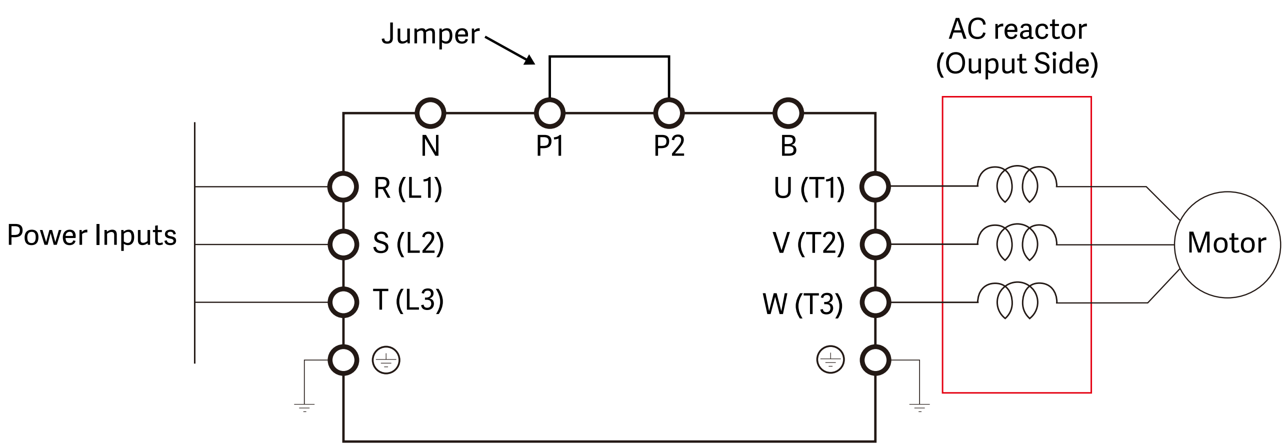


Load Reactor/Voltage Time Filter

When using drives in long wiring output application, ground fault (GFF), over-current (OC) and motor over-voltage (OV) often occur. GFF and OC cause errors due to the drive's self-protective mechanism; over-voltage damages motor insulation.

The excessive length of the output wires makes the grounded stray capacitance too large, increases the three-phase output common mode current, and the reflected wave of the long wires makes the motor dv / dt and the motor terminal voltage too high. Thus, installing a reactor on the drive's output side can increase the high-frequency impedance to reduce the dv / dt and terminal voltage to protect the motor. For AC Drive-to-Motor wiring distances over 100 feet, use of a VTF dV/dT output filter is recommended.

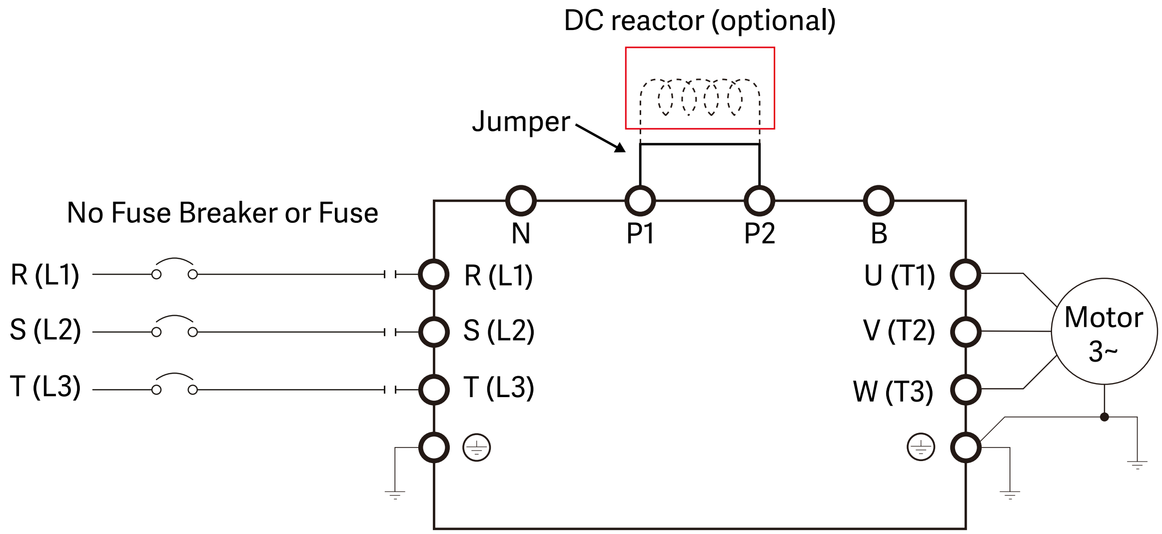
Install an AC output reactor or voltage time filter in series between the three output phases U V W and the motor, as shown in the figure below:



DC Reactor

A DC reactor can also increase line impedance, improve the power factor, reduce input current, increase system power, and reduce interference generated from the motor drive. A DC reactor stabilizes the DC bus voltage. Compared with an AC input reactor, a DC reactor is in smaller size, lower price, and lower voltage drop (lower power dissipation).

Install a DC reactor between terminals P1 and P2 Remove the jumper, as shown in the figure below, before installing a DC reactor.



When the ACN drive is connected directly to a large-capacity power transformer (600kVA or above) or when a power correction capacitor is switched on, excessive peak currents may occur in the input power circuit resulting in damage to the ACN drive.

To avoid this, install a line reactor in series with the ACN drive on the input side. The installation of a line reactor will reduce input current peaks and improve the output power efficiency.

Line (load) reactors installed on the output side protect the motor insulation against AC drive short circuits and IGBT reflective wave damage, and also allow the motor to run cooler by “smoothing” the motor current waveform. They are recommended for operating “non-drive-duty” motors, and for any motors where the length of wiring between the AC drive and motor is less than or equal to 100 feet. For AC drive-to-motor wiring distances over 100 feet, use of the VTF series output filter is recommended.

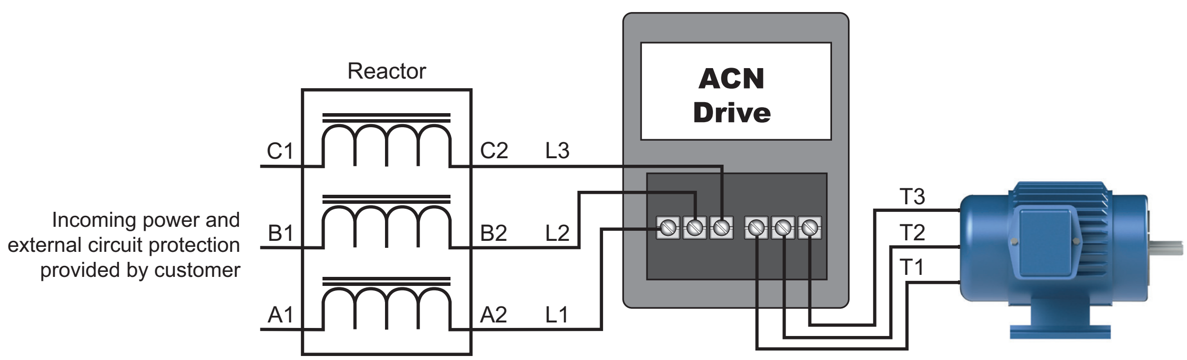
Line/Load Reactors and Output Filters Selection Charts

Drive	Voltage	HP	Input (Amps)	Output FLA 3ph (Amps)	AC Input Line Reactor		AC Output Load Reactor		AC dVdT Output Filter		DC reactor values Induct./ Current
					3ph	1ph	3ph	1ph	3ph	1ph	
ACN(ND)-20P5	200-240	0.5	2.2	5	LR2-20P5	LR2-20P2	LR2-20P5	LR2-20P2	VTF-246-CFG	VTF-46-DE	4/8.67
ACN(ND)-21P0		1	4.9	8	LR2-21P0	LR2-21P0	LR2-21P0	LR2-20P5	VTF-24-FH	VTF-246-CFG	
ACN(ND)-22P0		2	8.4	11	LR-23P0	LR-25P0	LR2-22P0	LR2-22P0	VTF-246-GJJ	VTF-24-FH	3/13.05
ACN(ND)-23P0		3	11.8	17	LR-23P0	LR-23P0	LR2-22P0	LR2-22P0	VTF-4-M	VTF-246-GJJ	1.33/18.45
ACN(ND)-25P0		5	18.5	24	LR-25P0	LR-2010	LR-25P0	LR2-22P0	VTF-46-LM	VTF-246-HKL	1.33/26.35
ACN(ND)-27P5		7.5	25.8	32	LR-2010	LR-2015	LR-27P5	LR-25P0	VTF-246-KMN	VTF-24-JL	1.60/32
ACN(ND)-2010		10	34.9	46	LR-2015	LR-2020	LR-2010	LR-25P0	VTF-246-LPQ	VTF-46-LM	1.25/43
ACN(ND)-2015		15	50.8	60	LR-2020	LR-2030	LR-2015	LR-2010	VTF-246-NRS	VTF-46-NP	0.95/61
ACN(ND)-2020		20	66.7	1.3	LR-2025	LR-2040	LR-2020	LR-2010	VTF-246-PSU	VTF-246-LPQ	0.70/75
ACN(ND)-40P5	380-480	0.5	1.1	2.5	LR2-40P5				VTF-46-DE		16/4.27
ACN(ND)-41P0		1	2.4	4	LR2-41P0				VTF-246-CFG		
ACN(ND)-42P0		2	4.2	5.5	LR2-42P0				VTF-246-DGH		12/6.41
ACN(ND)-43P0		3	5.9	9	LR2-43P0				VTF-24-FH		8/8.9
ACN(ND)-45P0		5	9.8	12	LR2-45P0				VTF-46-DE		5.4/13.2
ACN(ND)-47P5		7.5	12.9	16	LR2-47P5				VTF-46-DE		3.20/17
ACN(ND)-4010		10	17.5	24	LR-4010				VTF-24-JL		2.50/25
ACN(ND)-4015		15	26.5	30	LR-4015				VTF-246-KMN		1.90/32
ACN(ND)-4020		20	33.4	39	LR-4020				VTF-246-LPQ		1.40/41
ACN(ND)-4025		25	43.6	45	LR-4025				VTF-246-MQR		1.00/49
ACN(ND)-4030		30	50.7	27	LR-4030				VTF-246-MQR		0.70/64

Line Reactor Applications and Wiring Connections

Input Side of AC Drive

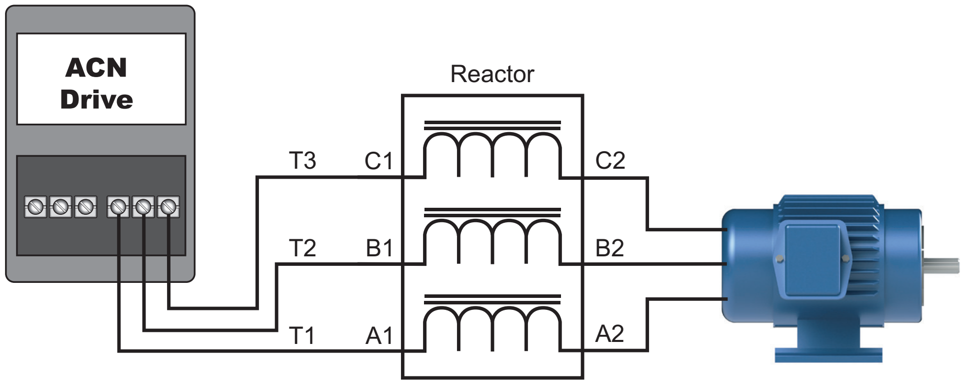
When installed on the input side of the ACN drive, a line reactor will reduce line notching, current peaks, voltage spikes and surges from the incoming line, as well as reduce the available short circuit current. A line reactor will also reduce harmonic distortion from the ACN drive onto the line. The line reactor is installed in front of the ACN drive as shown.



Please refer to "Chapter 2: Installation and Wiring" for detailed wiring information for the ACN drive.

Output Side of AC Drive

When installed on the output side of the ACN drive, line (load) reactors help to protect the ACN drive from short circuits at the load. Voltage and current waveforms from the ACN drive are enhanced, reducing motor overheating and noise emissions.

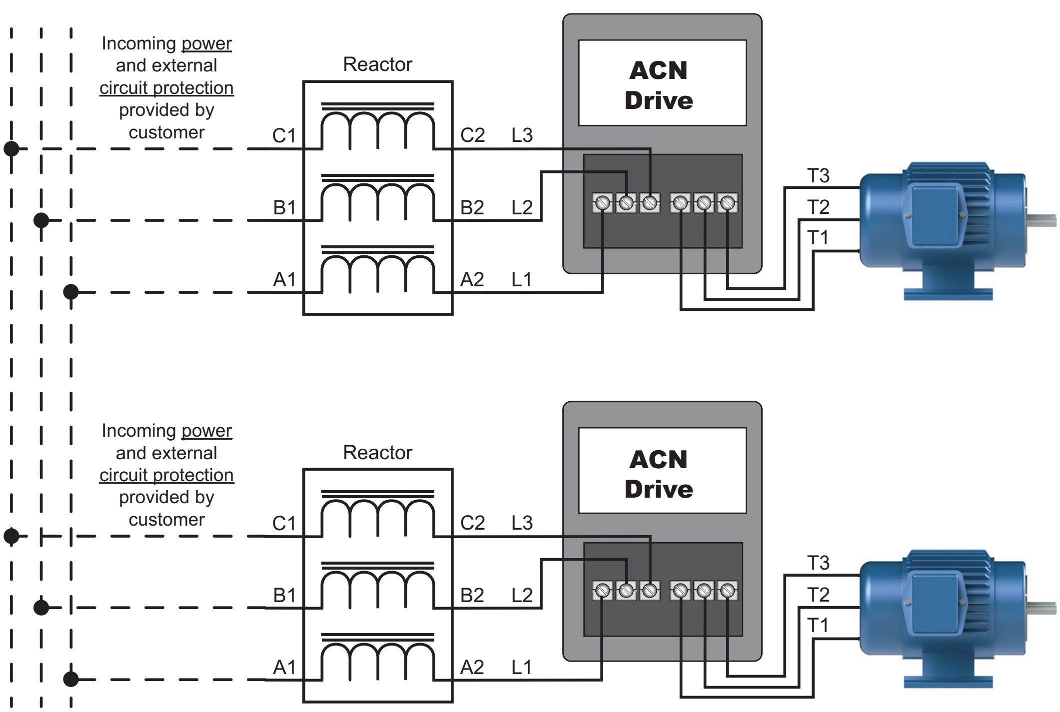


Please refer to "Chapter 2: Installation and Wiring" for detailed wiring information for the ACN drive.

Single phase line reactors should NOT be installed on the output side of an AC Drive. Use only three-phase reactors on drive outputs, and only for three-phase motors.

Multiple AC Drives

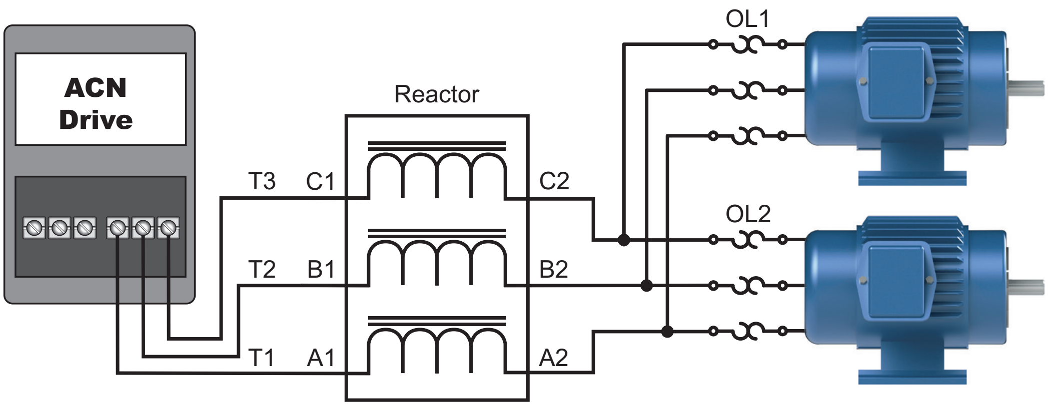
Individual line reactors are recommended when installing multiple ACN drives on the same power line. Individual line reactors eliminate cross-talk between multiple ACN drives and provide isolated protection for each ACN drive for its own specific load.



Please refer to "Chapter 2: Installation and Wiring" for detailed wiring information for the ACN drive.

Multiple Motors

A single output (load) reactor can be used with multiple motors on the same ACN drive, but only if the motors operate simultaneously. Size the reactor based upon the total horsepower of all the motors, and select a reactor with a current rating greater than the sum of the motor full-load currents. Overload relays are required for use in multi-motor applications. Additional Motor OL's should be interlocked with the ACN Drive control terminal; "BX" or "EXTERNAL Fault" input.

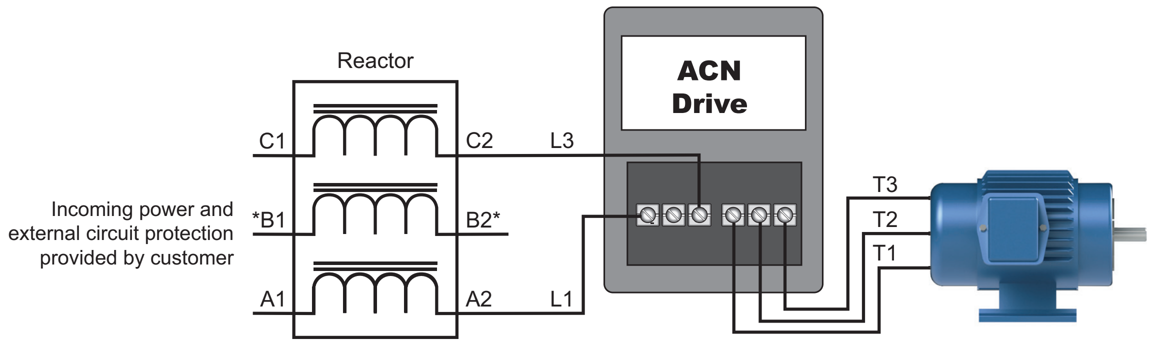


Please refer to "Chapter 2: Installation and Wiring" for detailed wiring information for the ACN drive.

A single reactor should be used with multiple motors ONLY when the motors will operate simultaneously from a single AC drive. OVERLOAD RELAYS are required for use in multiple motor applications.

Single-Phase Applications

Some three-phase line reactors are listed for use with single-phase input power. Follow the connection diagram shown below. Make sure that terminals B1 and B2, if present, are properly insulated before any connections are made. If a 3-phase reactor is used on the line side of a single-phase input drive application, ensure that the actual single-phase current does not exceed the Line Reactor's current rating (example: a 3-phase, 5hp line reactor and 3-phase 5hp drive will not handle enough current to power a 5hp motor on a single-phase supply - both the drive and the line reactor will have to be doubled). An input line reactor is strongly recommended for any single phase applications.



*LR series 1-phase reactors do not include a B-phase winding.

Please refer to "Chapter 2: Installation and Wiring" for detailed wiring information for the ACN drive.

Ensure that you properly insulate terminals B1 and B2 before making any connections to single-phase power.

Recommended Cable Length

Motor Leakage Current

If the cable length is too long, the stray capacitance between cables increases and may cause leakage current. This activates over-current protection, increases leakage current, or may affect the current display. In the worst case, it may damage the AC motor drive. If more than one motor is connected to one AC motor drive, the total wiring length should be the sum of the wiring length from AC motor drive to each motor.

For the 460V series AC motor drive, when you install an overload thermal relay between the drive and the motor to protect the motor from overheating, the connecting cable must be shorter than 50m. However, an overload thermal relay malfunction may still occur. To prevent the malfunction, install an output reactor (optional) to the drive or lower the carrier frequency setting.

Motor Surge Voltage

When a motor is driven by a PWM-type AC drive, the motor terminals experience surge voltages (dv/dt) due to power transistor conversion of the drive. For very long motor cable (especially for the 460V series), surge voltages (dv/dt) may damage the motor insulation and bearing. To prevent this, follow these rules:

A) Use a motor with enhanced insulation.

B) Reduce the cable length between the AC drive and motor to suggested values.

C) Connect an output reactor (optional) to the output terminals of the AC drive.

For drive models < 480V, use a motor with a rated voltage ≤ 500 VAC and an insulation level ≥ 1.35 kVp-p in accordance with IEC 60034-17. For the 575V drive model, use a motor with a rated voltage ≤ 600 VAC and an insulation level ≥ 1.79 kVp-p in accordance with IEC 60034-25.

Dynamic Braking

Dynamic braking resistors dissipate the regeneration energy of AC motors when they are being controlled to a stop faster than a coasting stop. GS series brake resistors can be used with ACN drives. All drives have the braking function built-in and do not require a separate dynamic braking unit. See "Terminals for Connecting DC Reactor, External Brake Resistor, and DC Circuit" on page 2–15 for brake wiring diagrams.

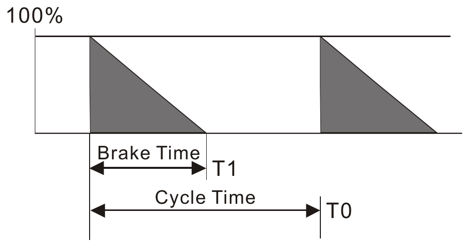
To avoid possible injury, please refer to Chapter 2 of this user manual for correct wiring of the brake resistors.

Braking Units

Voltage	Drive	HP	Drive Braking Capacity-Max Torque			150% Braking Torque @ 5% Duty Cycle Open Type Resistors		
			Minimum Resistor	Max Total Brake Current (A)	Peak Power (kW)	Qty	ADC Part Number	Total Brake Current (A)
230V	ACN(ND)-20P5	0.5	250.0	1.6	0.6	1	GS-BR-300W250	1.6
	ACN(ND)-21P0	1	150.0	2.6	1.0	1	GS-BR-400W150	2.6
	ACN(ND)-22P0	2	50.0	7.8	3.0	1	GS-BR-300W070	5.6
	ACN(ND)-23P0	3	43.0	9.1	3.5	1	GS-BR-1K5W043	9.1
	ACN(ND)-25P0	5	25.0	15.6	6.1	2	GS-BR-1K2W015	13.0
	ACN(ND)-27P5	7.5	18.0	21.7	8.5	1	GS-BR-1K0W020	19.5
	ACN(ND)-2010	10	14.0	27.9	10.9	1	GS-BR-1K2W015	26.0
	ACN(ND)-2015	15	8.6	45.3	17.7	1	GS-BR-1K5W012	32.5
	ACN(ND)-2020	20	8.0	48.8	19.0	2	GS-BR-1K2W015	52.0
460V	ACN(ND)-40P5	0.5	400.0	2.0	1.5	1	GS-BR-300W400	2.0
	ACN(ND)-41P0	1	400.0	2.0	1.5	1		2.0
	ACN(ND)-42P0	2	250.0	3.1	2.4	1		2.0
	ACN(ND)-43P0	3	180.0	4.3	3.4	2	GS-BR-200W360	4.3
	ACN(ND)-45P0	5	85.0	9.2	7.2	2	GS-BR-300W250	6.2
	ACN(ND)-47P5	7.5	75.0	10.4	8.1	1	GS-BR-1K0W075	10.4
	ACN(ND)-4010	10	49.0	15.9	12.4	1	GS-BR-1K5W043	18.1
	ACN(ND)-4015	15	40.0	19.5	15.2	1		18.1
	ACN(ND)-4020	20	22.0	35.5	27.7	2		36.3
	ACN(ND)-4025	25	20.0	39.0	30.4	2		36.3
	ACN(ND)-4030	30	20.0	39.0	30.4	2		36.3

Choosing and Installing a Braking Resistor

1) Select the resistance value, power and brake usage (ED %). Definition for Brake Usage ED%:



ED% = T1 / T0 x 100(%)

Explanation:
Brake usage ED (%) is the amount of time needed for the brake unit and brake resistor to dissipate heat generated by braking. When the brake resistor heats up, the resistance increases with temperature, and braking torque decreases accordingly.

For safety, install a thermal overload relay (O.L) between the brake unit and the brake resistor in conjunction with the magnetic contactor (MC) before the drive for additional protection. The thermal overload relay protects the brake resistor from damage due to frequent or continuous braking. Under such circumstances, turn off the power to prevent damage to the brake resistor and drive.

Note: Never use the thermal overload relay to disconnect the brake resistor.

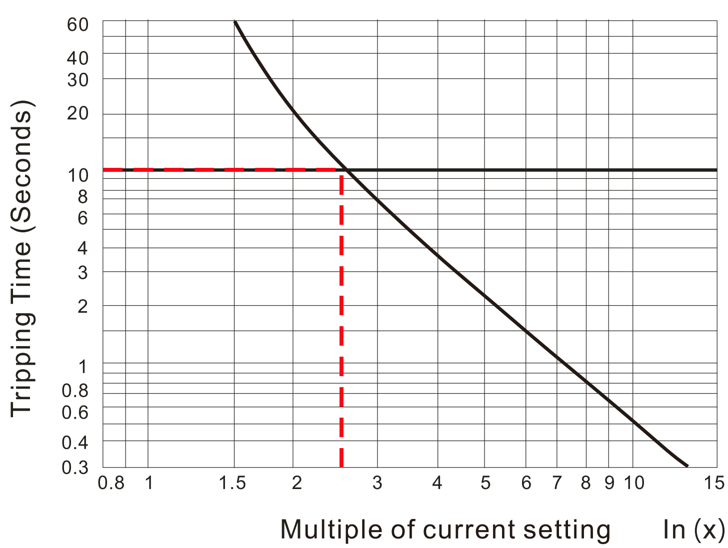
2) Any damage to the drive or other equipment caused by using brake resistors and brake modules that are not provided by AutomationDirect voids the warranty.

3) Consider environmental safety factors when installing the brake resistors. If you use the minimum resistance value, consult AutomationDirect for the power calculation.

4) Refer to the ADC Dynamic Braking unit User Manual for more detail on braking resistors (https://cdn.automationdirect.com/static/manuals/gs3dbm/gs-db_ump.pdf)

5) The selection tables are for 5% duty cycle. If the AC motor drive requires frequent braking, increase the Watts by two to three times.

6) Thermal Overload Relay (TOR):
Thermal overload relay selection is based on its overload capacity. A standard braking capacity of the ACN is 5% ED (Tripping time=10 s). As shown in the figure below, a 460V, 1kw ACAN required the thermal relay to take 260% overload capacity for 10 seconds (hot starting) and the braking current is 24A. In this case, select a thermal overload relay rated at 10A (10 * 260% = 26 A > 24 A). The property of each thermal relay may vary among different manufacturers. Carefully read the specification before using it.



ACN-232C IronHorse ACN 232 USB to RJ45 Port Cable

This cable is required for connecting to VFD suite software from a PC.

- *Standard: USB2.0*
- *Function: USB RS232 level signals converter for PC communication. VFD suite software to ACN drive.*
- *Cable Length: 1.8 meters*
- *Support OS: Win 8/10/Linux/Win CE*

RJ45 Pin Assignment	
Pin No.1 – NC	Pin No.2 – NC
Pin No.3 – RXD	Pin No.4 – TXD
Pin No.5 – NC	Pin No.6 – NC
Pin No.7 – GND	Pin No.8 – NC

ACN-LCD Remote LCD Keypad

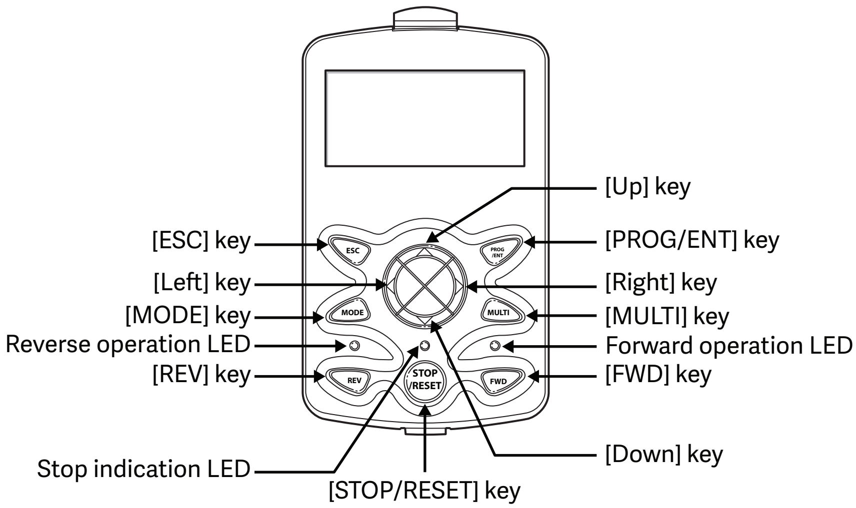
The Remote LCD keypad provides advanced functionality for use with the ACN series drives. The unit provides enhanced text descriptions of each parameter and enhanced failure status monitoring. The unit allows backup and download of drive parameters.

About the Keypad

A keypad is used to set drive parameters, monitor the drive's status, and operate the drive.

Key Functions

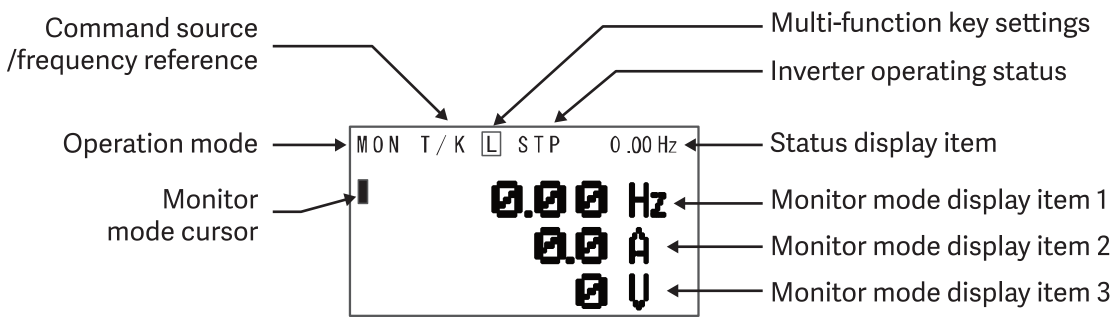
The following table lists the names and functions of the keypad's operation keys.



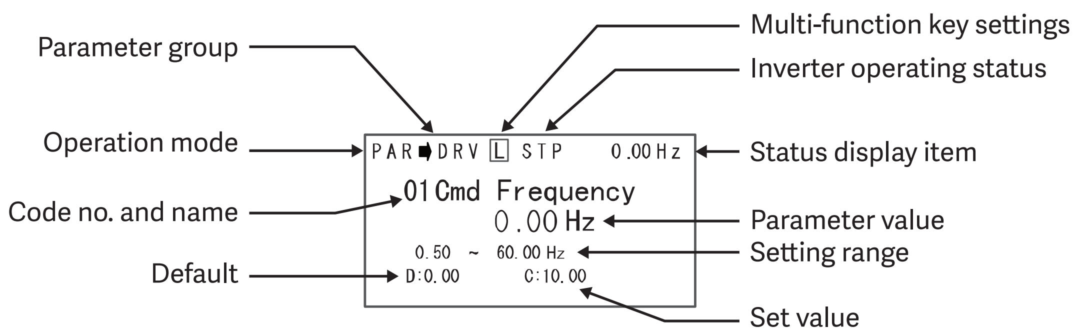
Key Name	Function Description
[MODE] key	Used to switch between modes.
[PROG/ENT] key	If this button is pressed once, the parameter can be edited at the status of the editable parameter code. If this button is pressed after modification, it will save the modified data.
[Up] key ***[Down] key***	Switch between codes, or increase and decrease parameter values.
[Left] key ***[Right] key***	Switch between groups or move the cursor during parameter setup or modification.
[MULTI] key	Used to perform special functions, such as User Code, Local/Remote toggle or Jog.
[ESC] key	If you press this key before pressing the [PROG / ENT] key, it will revert the parameter value to the previous value. If you press this key while editing the codes in any function group, the keypad will display the first code of the function group. If you press this key while moving through the modes, the keypad will display Monitor mode.
[FWD] key	Used to rotate the motor in the forward direction.
[REV] key	Used to rotate the motor in the reverse direction.
[STOP/RESET] key	Used to stop the operation and release a fault.

Display Items

Monitor Mode



Parameter Mode



Display Item List

The following table lists the items in the display.

Item	Description
Mode display items	Displays the current mode's display items. For more details, refer to "Menu Items" on page A–18 below.
Parameter group items	Displays the current parameter group's items. For more details, refer to "Menu Items" on page A–18 below.
Command source / frequency reference items	Displays the types of sequences and the number of steps during an auto sequence operation.
Status display items	Displays the output frequency, output voltage, and current. For more details, refer to "Monitor display items" on page A–17 below.
Monitor mode display items	Displays the current operation status. For more details, refer to "Monitor display items" on page A–17 below.

Monitor display items

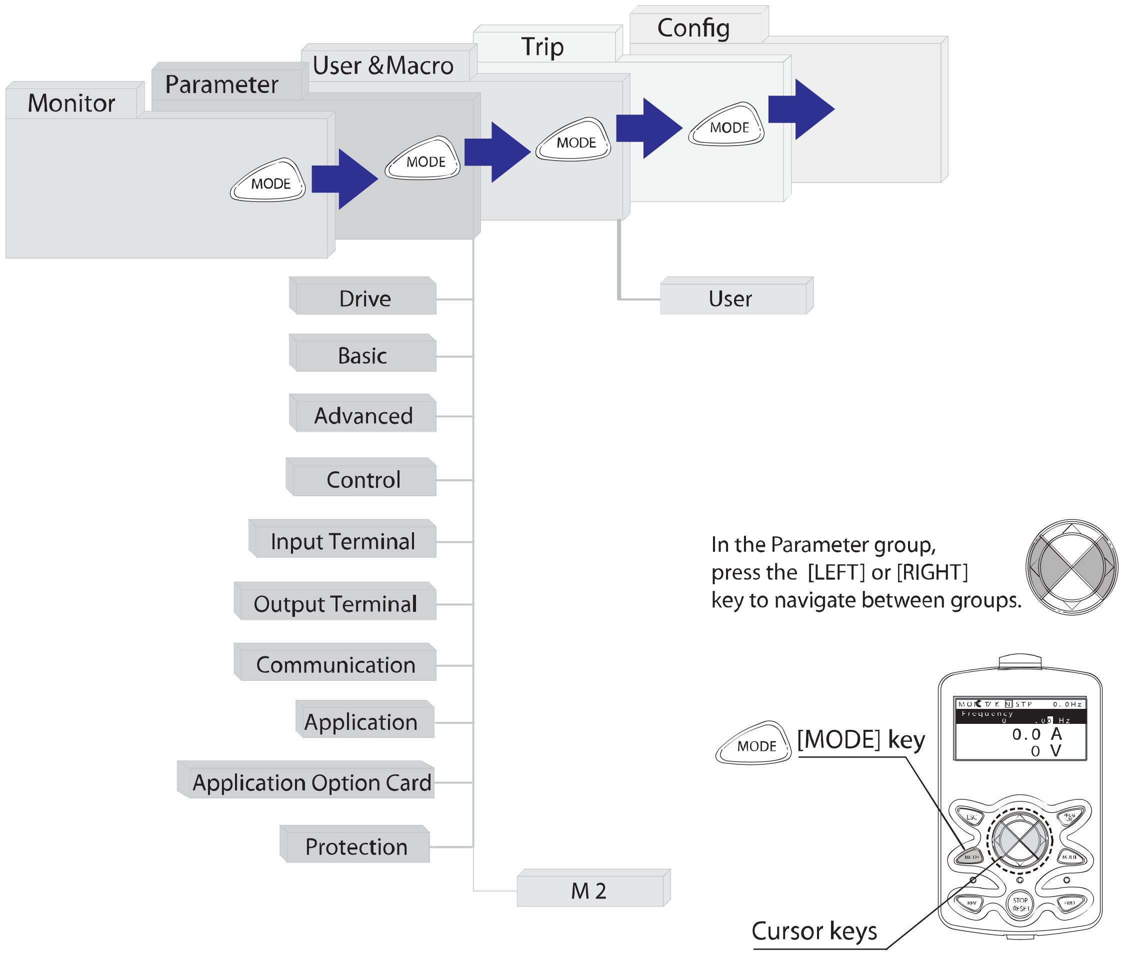
The following table lists display icons and their names and functions.

No	Function	Display	Description
1	Operation mode	MON	Monitor mode
		PAR	Parameter mode
		U&M	User-defined and Macro mode
		TRP	Trip mode
		CNF	Configuration mode
2	Command source	K	Keypad operation command
		O	FieldBus communication option operation command
		A	Application option operation command
		R	Built-in 485 operation command
		T	Terminal block operation command
3	Frequency reference	K	Keypad frequency command
		V	V1 input frequency command
		I	I1 input frequency command
		P	Pulse input frequency command
		U	Frequency command during UP operation (Up-Down operation)
		D	Frequency command during DOWN operation (Up-Down operation)
		S	Frequency command during STOP operation (Up-Down operation)
		O	FBus Option frequency command
		X	V2 and I2 frequency commands for sub-terminal block
		J	Jog frequency command
		R	Internal 485 frequency command
		1-9 A-F	Multi-step frequency command
4	Multi-function key settings	J – JOG key	Used to switch to Keypad JOG mode
		L, R – Local/Remote	Used to select local or remote operation
		U – User Group Select key	Used to register parameters as a user group in Parameter mode or delete parameters in the user group.
5	Drive operating status	STP	Motor stopped
		FWD	Operating in the forward direction
		REV	Operating in the reverse direction
		DC	DC output
		WAN	Warning
		STL	Stalling
		SPS	Speed Search
		OSS	Software over current controlled
		OSH	Hardware over current controlled
		TUN	Auto tuning

**OSS / OSH may cause overcurrent when the load is too large or when the acceleration/deceleration time is short. The drive monitors the output current so that an overcurrent trip does not occur and also performs overcurrent suppression. At this time, the output frequency is automatically changed to reduce the output current or the drive output is temporarily cut off to prevent overcurrent.*

Menu Items

The ACN series drive uses 5 modes to monitor or configure different functions. Each mode has its own function items suitable for the desired properties. The parameters in Parameter mode and User & Macro mode are divided into smaller groups of relevant functions.



Mode	Display	Description
Monitor mode	MON	Displays the drive's operation status information. You can monitor the frequency setting, operating frequency display, output current, voltage, etc.
Parameter mode	PAR	Used to configure the functions required to operate the drive. These functions are divided into 12 groups based on purpose and complexity.
User & Macro mode	U&M	Used to define User and Macro groups. These user-definable groups allow specific functions of the drive to be grouped and managed in separate groups. This mode will not be displayed when navigating through modes if no User groups or Macro groups have been defined.
Trip mode	TRP	Used to monitor the drive's fault trip information, including the previous fault trip history. When a fault trip occurs during drive operation, the operation frequency, output current, and output voltage of the drive at the time of the fault can be monitored. This mode will not be displayed if the drive is not at fault and a fault trip history does not exist.
Configuration mode	CNF	Used to configure the drive features that are not directly related to the operation of the drive. The settings you can configure in Configuration mode include keypad display language options, monitor mode environment settings, communication module display settings, and parameter duplication and initialization.

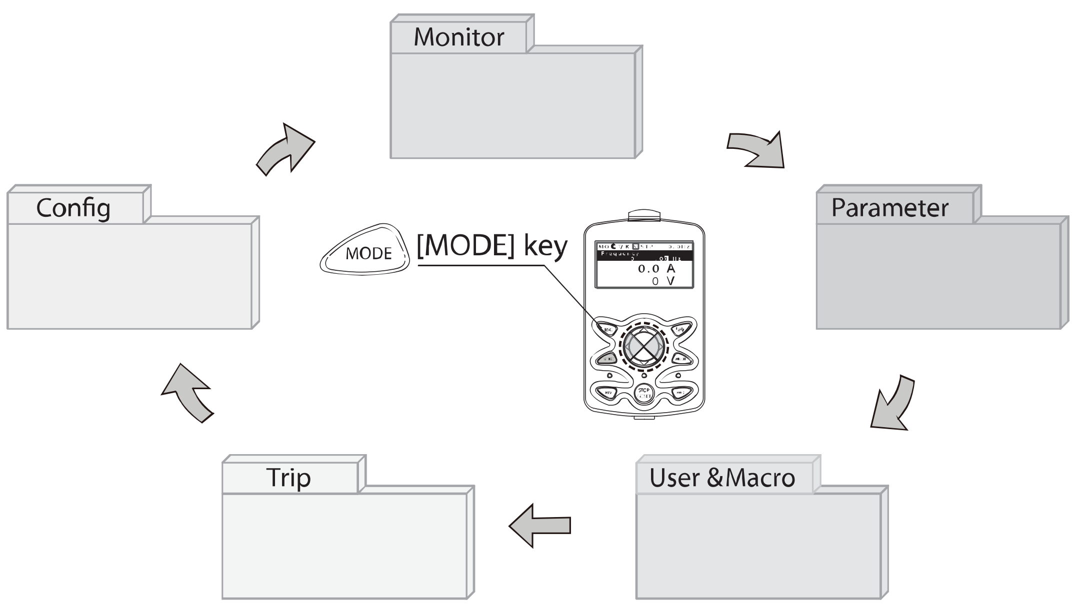
Parameter Mode

Mode	Display	Description
Drive group	DRV	Includes frequency/acceleration/deceleration time setting, operation command selection, etc.
Basic group	BAS	Configures basic operation parameters. These parameters include motor parameters and multi-step frequency parameters.
Advanced function group	ADV	Configures acceleration or deceleration, patterns, and frequency limits.
Control function group	CON	Configures functions related to sensorless and vector control.
Input terminal function group	IN	Configures input terminal–related features, including digital multi–functional inputs and analog inputs.
Output terminal function group	OUT	Configures the drive output terminal block-related features, including the relay and analog outputs.
Communication function group	COM	Configures the communication features for the RS-485, if one is installed.
Application function group	APP	Configures the features related to PID control and auto sequence operation.
Application option group	APO	Configures the encoder and PLC option module-related features if they are installed.
Protection group	PRT	Configures motor and drive protection features.
Motor 2 function group (Motor 2)	M2	Configures the secondary motor-related features. This group will be displayed when Motor #2 is selected from the multi-function input terminal functions.

User & Macro Mode

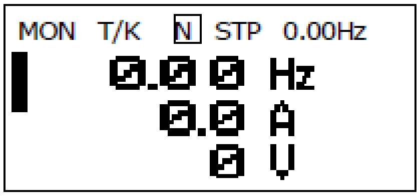
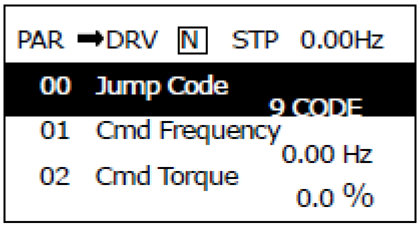
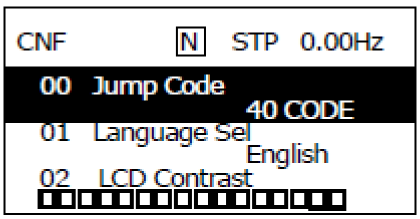
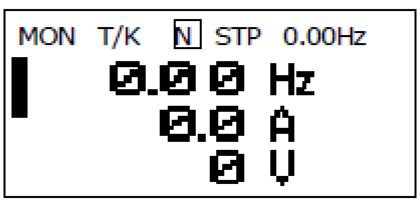
Group	Display	Description
User group	USR	Used to group frequently accessed function parameters. User parameter groups can be configured using the multi-function key on the keypad.

Navigating Modes



Mode Navigation at the Factory Default

You can change the display to navigate modes by using the [MODE] key. The User & Macro Mode and Trip Mode are not displayed when the drive is set to the factory default settings.

	Displays when the drive is powered on. This is the display of Monitor mode (MON). Press the [MODE] key.
	You are now in Parameter mode (PAR). Press the [MODE] key.
	You are now in Config mode (CNF). Press the [MODE] key.
	You are now in Monitor mode again.

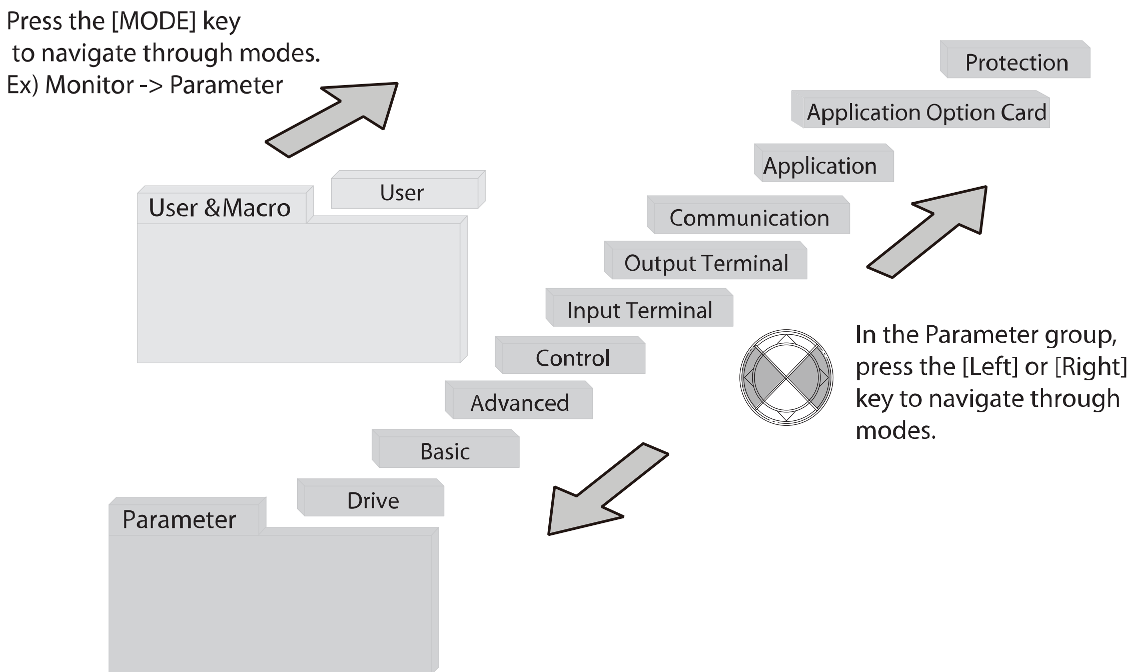
Mode Navigation with User/Macro Mode and Trip Mode

If you register a user code or set the macro function using the [MULTI] key, the User & Macro mode will be displayed, unlike the factory default settings during mode navigation. In addition, when a trip occurs during operation, Trip mode will be displayed. The trip information will also be saved in the trip mode history if you release the trip using the RESET function. The two modes for mode navigation are as follows.

MON T/K N STP 0.00Hz 0.00 Hz 0.0 A 0 V	Displays when the drive is powered on. This is the display of Monitor mode (MON). Press the [MODE] key.
PAR ➡DRV N STP 0.00Hz 00 Jump Code 9 CODE 01 Cmd Frequency 0.00 Hz 02 Cmd Torque 0.0 %	You are now in Parameter mode (PAR). Press the [MODE] key.
U&M ➡USR N STP 0.00Hz 00 Jump Code 9 CODE 01 Cmd Frequency 0.00 Hz 02 Cmd Torque 0.0 %	You are now in User & Macro mode (U&M). Press the [MODE] key.
TRP Last-1 00 Trip Name (1) External Trip 01 Output Freq 0.00 Hz 02 Output Current 0.0 A	You are now in Trip mode (TRP). Press the [MODE] key.
CNF N STP 0.00Hz 00 Jump Code 40 CODE 01 Language Sel English 03 LCD Contrast	You are now in Config mode (CNF). Press the [MODE] key.
MON T/K N STP 0.00Hz 0.00 Hz 0.0 A 0 V	You are now in Monitor mode again.

Navigating Modes and Parameters

You can navigate modes by using the [Left] or [Right] keys after navigating to the Parameter Mode or User & Macro Mode via the [Mode] key.



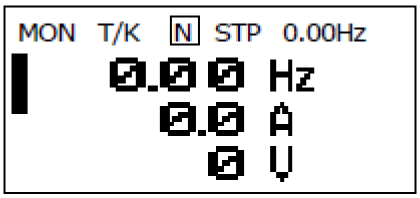
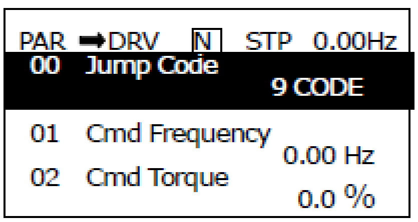
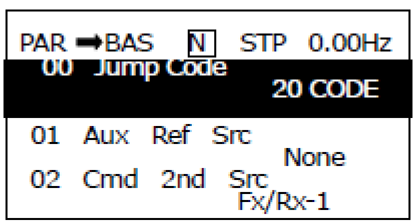
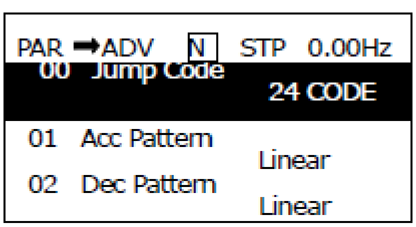
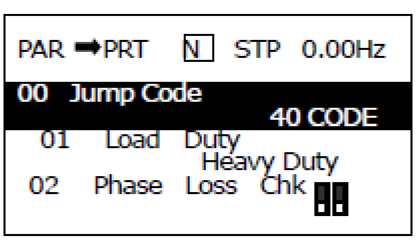
Group Navigation in Parameter mode

If you press the [Right] key in Parameter mode, the display will change as shown below. If you press the [Left] key, the display order will be reversed.

User/Macro mode must first be configured before it is available for use. Perform the following steps:

1) CNF.42 = 3 UserGrp SelKey
2) Navigate to any parameter. Press the "Multi" key to assign the parameter to the user group.
3) Choose the User Grp code number to register the parameter.
4) User Group is available in the Menu.

For more info, see "User Group" on page 4–178.

<table>
<tr><td>
</td><td>Displays when the drive is powered on. This is the display of Monitor mode (MON).
Press the [MODE] key.</td></tr>
<tr><td>
</td><td>You are now in Parameter mode (PAR).
The Drive Group (DRV) of Parameter mode is displayed.
Press the [Left] or [Right] keys to scroll through the registered parameters.</td></tr>
<tr><td>
</td><td>You are now in the Basic Function Group (BAS).
Press the [Right] key.</td></tr>
<tr><td>
</td><td>You are now in the Advanced Function Group (ADV).
Press the [Right] key 7 times.</td></tr>
<tr><td>
</td><td>The group sequence will change and the Protection Function Group (PRT) will be displayed.
Press the [Right] key.</td></tr>
</table>

PAR ➡DRV [N] STP 0.00Hz 00 Jump Code 9 CODE 01 Cmd Frequency 0.00 Hz 02 Cmd Torque 0.0 %	You are now in the Drive group (DRV) of the Parameter group again

Group Shift in User & Macro Mode

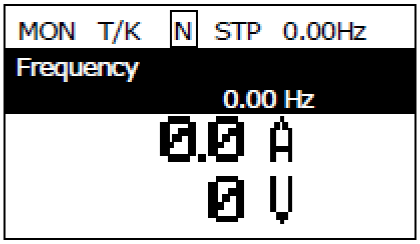
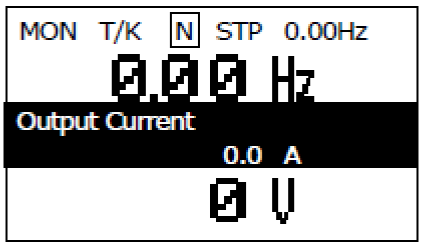
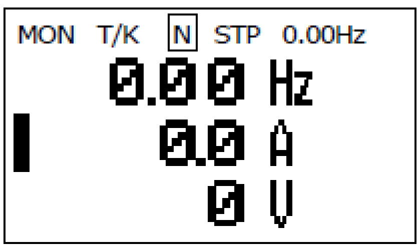
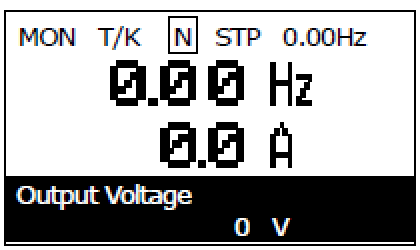
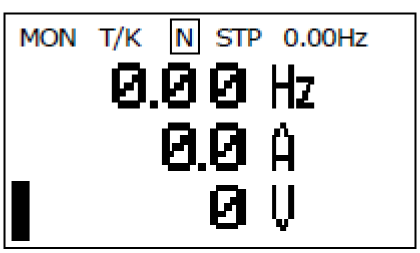
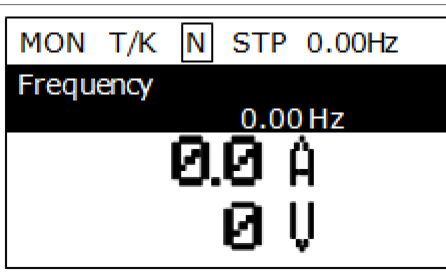
To navigate to User & Macro Mode, the user code should be registered or the macro function should be selected. If the user code is registered and the macro function is selected, you can navigate to the group as shown below.

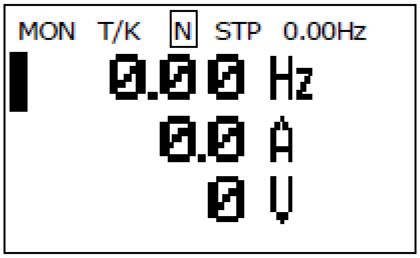
U&M ➡USR [U] STP 0.00Hz 00 Jump Code 9 CODE 01 Cmd Frequency 0.00 Hz 02 Acc Time 20.0 sec	Displays when the drive is powered on. This is the display of Monitor mode (MON). Press the [MODE] key twice.
U&M ➡MC1 [U] STP 0.00Hz 00 Jump Code 1 CODE 01 Acc Time 20.0 sec 02 Dec Time 30.0 sec	You are now in the User & Macro mode (U&M). The User Group (USR) is displayed. Press the [Right] key.

Navigating through Codes (Function Items)

Code Navigation in Monitor Mode

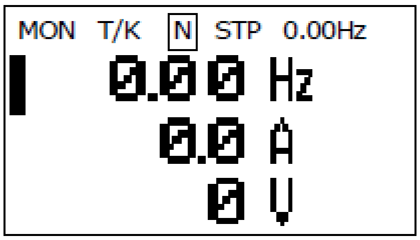
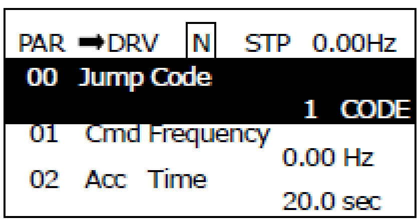
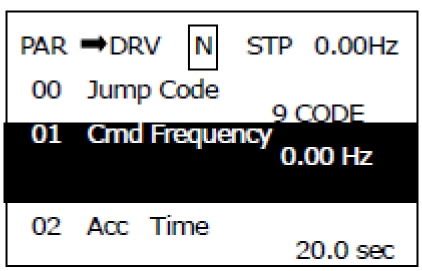
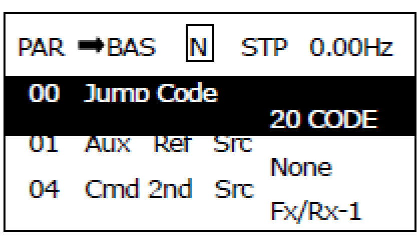
To display the frequency, output current, and output voltage, press the [Up] or [Down] keys to scroll through the items.

	Displays when the drive is powered on. This display is in Monitor mode. The cursor is located at the frequency item. Press the [Down] key.
	The second display item displays the output current. Do not press any key for approximately 2 seconds after navigation.
	The output current text has disappeared and the cursor has moved to the second display item. Press the [Down] key.
	The third display item displays the output voltage. Do not press any key for approximately 2 seconds after navigation.
	The output voltage text has disappeared and the cursor has moved to the third display item. Press the [Up] key twice.
	The first item displays the frequency.

	The frequency text has disappeared and the cursor has moved to the first display item.

Code Navigation (function items) in Other Modes and Groups

Using the [Up] and [Down] keys: The following example demonstrates how to navigate through the codes in the Drive (DRV) group and the Basic [BAS] group of Parameter mode. Code navigation in other modes is the same as follows.

	Displays when the drive is powered on. This display is in Monitor mode. Press the [Down] key.
	Displays the Drive (DRV) group of Parameter mode. If the DRV group is not displayed, press the [MODE] key until the DRV group appears, or press the [ESC] key.
	If you press the [Down] key, you will navigate to code No. 01 in the DRV group of Parameter mode. Press the [Right] key.
	You have moved to the Basic (BAS) group of Parameter mode. You can navigate through the codes using the [Up] or [Down] keys.

Code Navigation Using Jump Code

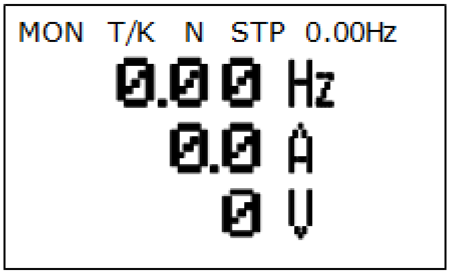
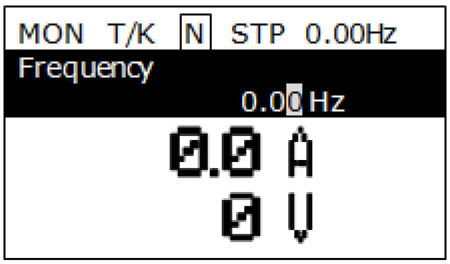
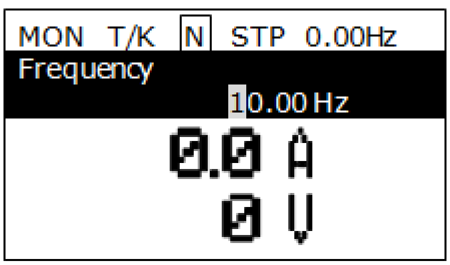
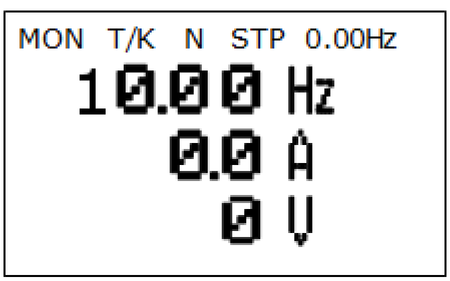
In the Parameter mode and User/Macro mode groups, you can use the Jump Code Entry item to move to a desired code. It is quicker to move to a large code number using the Jump Code Entry item rather than the [Up] and [Down] keys. The following example demonstrates how to move to code No. 09 of the Drive (DRV) group.

PAR ➡DRV N STP 0.00Hz 00 Jump Code 9 CODE 01 Cmd Frequency 0.00 Hz 02 Acc Time 20.0 sec	Ensure that code No. 00 is displayed in the initial display of the Drive (DRV) group of Parameter mode. Press the [PROG/ENT] key.
PAR ➡DRV N STP 0.00Hz 00 Jump Code 9 CODE 01 Cmd Frequency 0.00 Hz 02 Acc Time 20.0 sec	The cursor flashes and you can enter the code number.
PAR ➡DRV N STP 0.00Hz 00 Jump Code 9 CODE 1~99 CODE D:9 C:9	Press the [Up] key to enter 9 and then press the [PROG/ENT] key.
PAR ➡DRV N STP 0.00Hz 09 Control Mode V/F 10 Torque Control ----- No ----- 11 JOG Frequency 10.00 Hz	You have moved to code No. 09 of the DRV group.
PAR ➡DRV N STP 0.00Hz 00 Jump Code 9 CODE 01 Cmd Frequency 0.00 Hz 02 Acc Time 20.0 sec	Press the [ESC] key to move to code No. 00 of the DRV group.

Setting Parameters

Parameter Settings in Monitor Mode

You can set some parameters, such as the frequency, in Monitor mode. The following example demonstrates how to set the frequency.

	Ensure that the cursor is at the frequency item. Also, ensure that the frequency can be set to 09 in the Drive (DRV) group using the keypad. Press the [PROG/ENT] key.
	Detailed information of the item is displayed and the cursor flashes. Press the [Left] or [Right] keys to move the cursor to the desired location to set the frequency.
	Press the [Up] key to set the frequency to 10 Hz. Press the [PROG/ENT] key.
	The frequency reference is set to 10 Hz.

Parameter Settings in Other Modes and Groups

The following example demonstrates how to change the frequency of the Drive (DRV) group in Parameter mode. The frequency in the other modes or groups can be set as follows.

PAR ➡DRV N STP 0.00Hz 00 JumpCode 9 CODE 01 Cmd Frequency 0.00 Hz 02 Cmd Torque 0.0 %	This is the initial display in Parameter mode. Press the [Down] key.
PAR ➡DRV N STP 0.00Hz 00 JumpCode 9 CODE 01 Cmd Frequency 0.00 Hz 02 Cmd Torque 0.0 %	You have moved to the 01 frequency setting code. Press the [PROG/ENT] key.
PAR ➡DRV N STP 0.00Hz 01 Cmd Frequency 0.00 Hz 0.50 ~ 60.00 Hz D:0.00 C:0.00	The cursor flashes and you can enter the desired frequency. If the frequency reference is set to 10 Hz, press the [Left] or [Right] keys to move the cursor to the desired place.
PAR ➡DRV N STP 0.00Hz 01 Cmd Frequency 10.00 Hz 0.50 ~ 60.00 Hz D:0.00 C:0.00	Press the [Up] key to enter 10 Hz and then press the [PROG/ENT] key.
PAR ➡DRV N STP 0.00Hz 00 JumpCode 9 CODE 01 Cmd Frequency 10.00 Hz 02 Cmd Torque 0.0 %	The frequency reference is set to 10 Hz.

Monitoring Operating Status

Using Monitor Mode

Three items can be displayed in Monitor mode at a time. Also, some items, such as the frequency item, can be edited. You can select the displayed items in Configuration (CNF) mode.

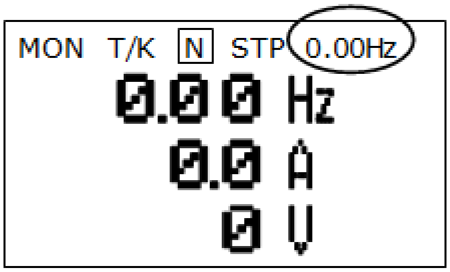
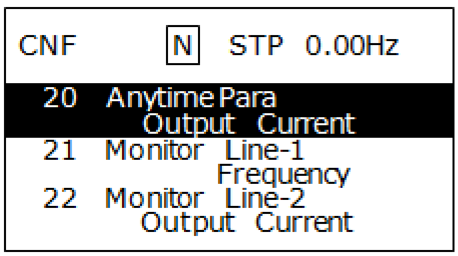
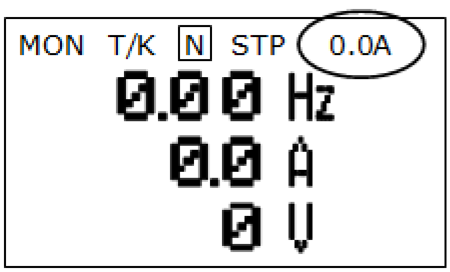
MON T/K N STP 0.00Hz 10.00 Hz 0.0 A 0 V	This is the initial display in Monitor mode. The frequency, current, and voltage are set as the default monitor items. The frequency reference is displayed when the drive operation has stopped, and the operating frequency is displayed when the drive is operating.
CNF N STP 0.00Hz 21 Monitor Line-1 Frequency 22 Monitor Line-2 Output Current 23 Monitor Line-3 Output Voltage	You can set the items to display in Monitor mode in sequence from 21 to 23 in Configuration (CNF) mode. Press the [Down] key to move to code No. 23
CNF N STP 0.00Hz 21 Monitor Line-1 Frequency 22 Monitor Line-2 Output Current 23 Monitor Line-3 Output Power	Change the code No. 23 item in Monitor mode to the output power.
MON T/K N STP 0.00Hz 0.00 Hz 0.0 A 0.00 kW	Ensure that the third displayed item in Monitor mode is changed to the output power.

Monitoring Items

Mode	Code	Function Display	Setting Range		Initial Value
CNF	20	Anytime Para	0	Frequency	0: Frequency
			1	Speed	
			2	Output Current	
			3	Output Voltage	
			4	Output Power	
			5	WHour Counter	
			6	DCLink Voltage	
			7	DI Status	
			8	DO Status	
			9	V1 Monitor (V)	
			10	V1 Monitor (%)	
			11	I1 Monitor (mA)	
			12	I1 Monitor (%)	
			13	V2 Monitor (V)	
			14	V2 Monitor (%)	
			15	I2 Monitor (mA)	
			16	I2 Monitor (%)	
			17	PID Output	
			18	PID Ref Value	
			19	PID Fdb Value	
			20	Torque	
			21	Torque Limit	
			22	Trq Bias Ref	
			23	Speed Limit	
			24	Load Speed	
			25	Temperature	
	21	Monitor Line-1	See CNF 20 Setting Range		0: Frequency
	22	Monitor Line-2	See CNF 20 Setting Range		2:Output Current
	23	Monitor Line-3	See CNF 20 Setting Range		3:Output Voltage

Using the Status Display

The items displayed on the right-top of the display are shown in other modes, including Monitor mode. If you register a desired variable in the display, you can monitor it at any time regardless of the mode navigation or change.

	This is the initial display of Monitor mode. When the drive settings are set to the factory default, the status item displays the frequency.
	Select the item to display in the status display in code 20 of Configuration (CNF) mode. Press the [PROG/ENT] key to change the item to the output current. The unit at the top of the display is changed from hertz (frequency) to amps (current).
	Ensure that the unit in the status display is changed to amps (current) in Monitor mode.

Monitoring Faults

Faults during Drive Operation

TRP current Over Voltage (01) 01 Output Freq 48.30 Hz 02 Output Current 33.3 A	If a fault trip occurs during drive operation, the drive enters Trip mode automatically and displays the type of fault trip that has occurred.
TRP Last-1 01 Output Freq 48.30 Hz 02 Output Current 33.3 A 03 Inverter State Stop	Press the [Down] key to view the information on the drive at the time of the fault, including the output frequency, current, and operating status.
MON T/K N STP 0.0A 0.00 Hz 0.0 A 0 V	When the drive is reset and the fault trip is released, the keypad display returns to the screen that was displayed before the fault trip occurred.

Multiple Faults at a Time during Drive Operation

TRP current **Over Voltage (02)** 01 Output Freq 48.30 Hz 02 Output Current 33.3 A	If multiple fault trips occur at the same time, the number of fault trips that occurred is displayed next to the fault trip type. Press the [PROG/ENT] key.
TRP current **00 Trip Name (2)** 0 Over Voltage 1 Externa Trip	The types of all the fault trips are displayed. Press the [PROG/ENT] key.
TRP current **Over Voltage (02)** 01 Output Freq 48.30 Hz 02 Output Current 33.3 A	The display mode that was shown before you checked the fault information is displayed.

Saving and Monitoring the Fault Trip History

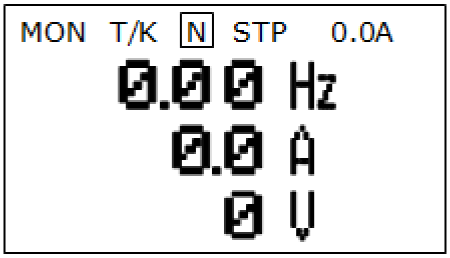
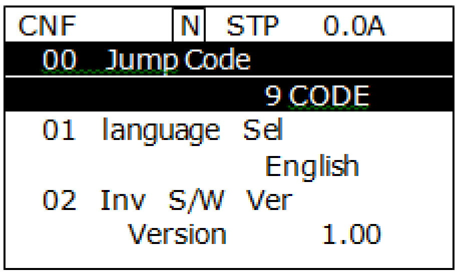
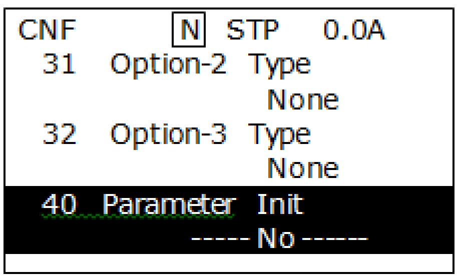
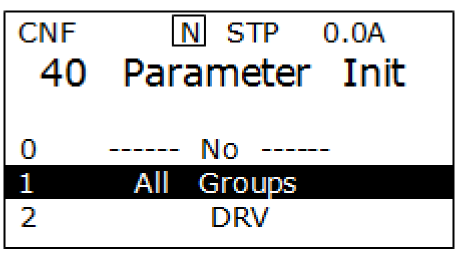
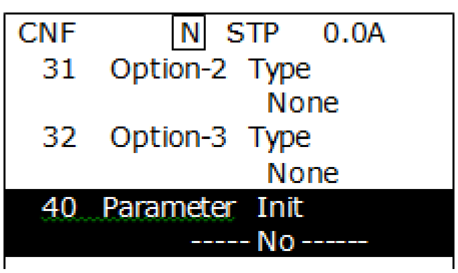
Previous fault trips can be saved in Trip mode. You can save up to 5 previous fault trips. Fault trips caused by resetting the drive, as well as low voltage faults caused by the drive being switched off, are also saved.

If there are more than 5 fault trips, the oldest 5 fault trips are automatically deleted.

TRP current Over Voltage (02) 01 Output Freq 48.30 Hz 02 Output Current 33.3 A	If a fault trip occurs during drive operation, the drive enters Trip mode and displays the type of fault trip that has occurred.
MON T/K N STP 0.0A 0.00 Hz 0.0 A 0 V	If you press the [STOP/RESET] key or an input is entered on the terminal, the fault trip is automatically saved and the display status that was displayed before the fault trip occurred is displayed. Press the [MODE] key to move to Trip mode.
TRP current 00 Trip Name (2) Over Voltage 01 Output Freq 48.30 Hz 02 Output Current 33.3 A	The most recent fault trip is saved in the Last-1 code. Press the [Right] key.
TRP current 00 Trip Name (1) External Trip 01 Output Freq 48.30 Hz 02 Output Current 33.3 A	The previous fault trips are saved in the Last-2 code. If another fault trip occurs, the previous fault trips saved in the Last-2 code move to the Last-3 code.

Initializing Parameters

You can initialize the changed parameters. In addition to initializing the entire parameter, you can also select the individual parameter mode to be initialized.

<table>
<tr><td>
</td><td>Monitor mode is displayed.</td></tr>
<tr><td>
</td><td>Press the [MODE] key to move to Configuration (CNF) mode.</td></tr>
<tr><td>
</td><td>Press the [Down] key to move to code No. 40.
Press the [PROG/ENT] key.</td></tr>
<tr><td>
</td><td>Of the parameter items to initialize, select All Groups and then press the [PROG/ENT] key.</td></tr>
<tr><td>
</td><td>The Parameter Initialization option is displayed again when the initialization is complete.</td></tr>
</table>

Parameter Lock (LCD)

Level 1

- *Set the password in CNF.51*
- *Enter the password in CNF.50*

This removes the entire Parameter Group from view – only able to view and change CNF and User Group (if there is one set)

Level 2

- *Set the password in CNF.52*
- *Enter the password in CNF.53*

This allows the user to view the Parameter Group, CNF and User Group but not change anything.

Level 3

- *Set the password in CNF.51*
- *Enter the password in CNF.50*
- *Set the password in CNF.52*
- *Enter the password in CNF.53*

This removes the Parameter Group, but can view only the CNF and User Groups (without changing).

NOTE: A locked parameter is outlined by a box when highlighted.

ACN-3MRC LCD Keypad Mount Kit and Cable

For mounting the ACN-LCD keypad in standard locations

ACN-LCDKM Remote LCD Keypad NEMA4X Mounting Kit and Cable

Installation Procedure

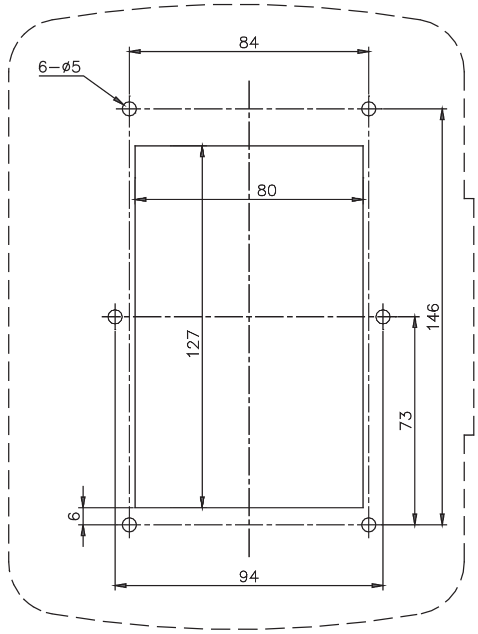
Mounting Option Assembly and Installation Procedure

DANGER! ELECTRICAL SHOCK HAZARD! Do not connect or disconnect wiring while the power is on. Failure to comply will result in death or serious injury

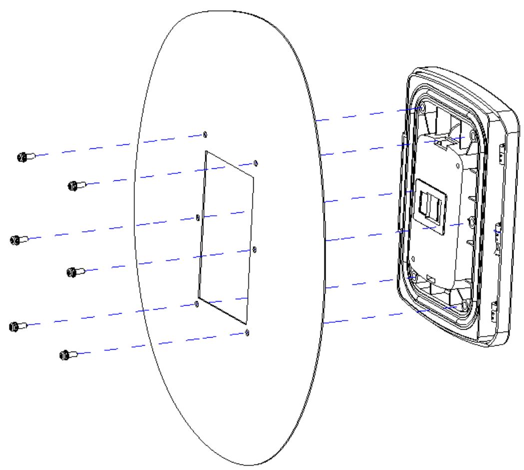
Wiring and periodic inspections should be performed at least 10 minutes after disconnecting the input power and after checking the DC link voltage is discharged with a meter (below DC 30V).

1) *Turn off power to the drive by completely removing power to the enclosure. Wait 10 minutes for capacitor discharge.*
2) *Unpack and verify the contents of the NEMA 4X Keypad Mounting Option.*

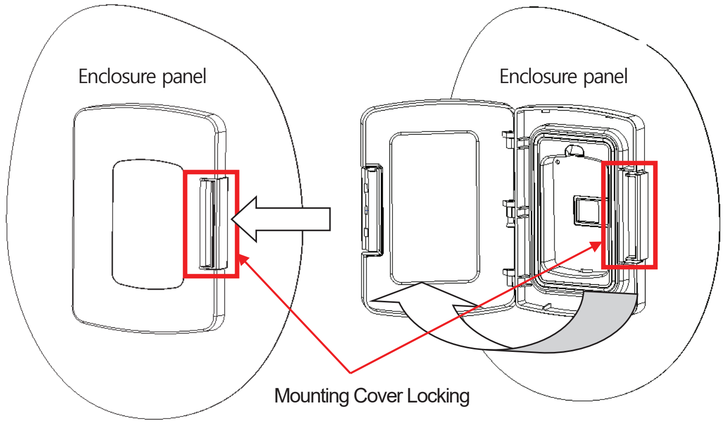
3) *Create the cutout at the desired location on the customer supplied panel. Measurements are listed in Centimeters(cm).*



4) *Complete installation by attaching the mounting option to the end-user panel according to Figure 2. Use the provided M6 screw and tighten to 15.0 (13.5~16.5) kgf·cm.*

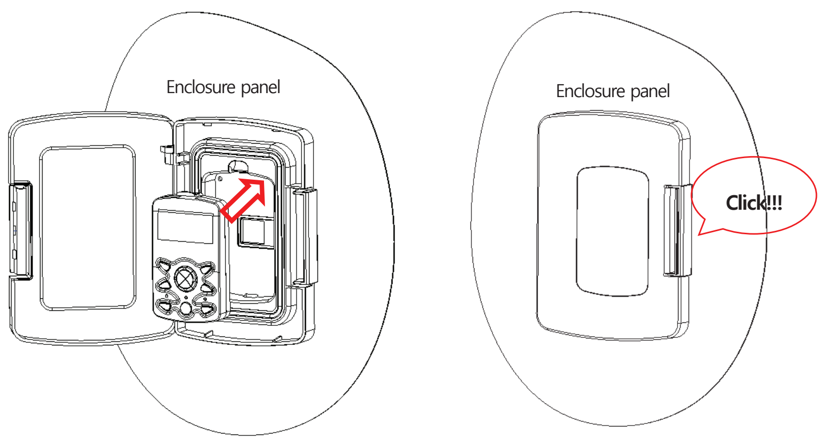


5) *Install the Keypad Mounting Option to the enclosure panel as show in Figure 3. Open the cover while pressing the cover handle inward.*



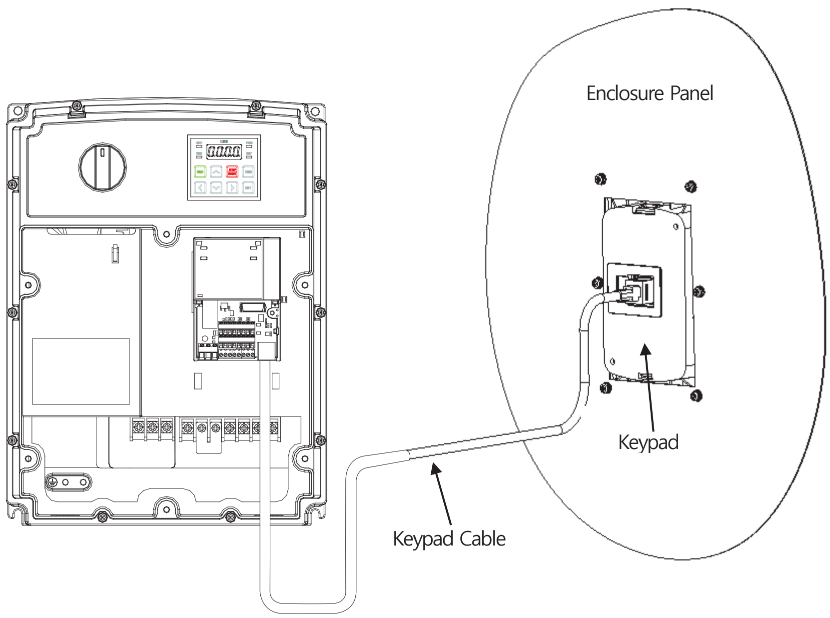
6) *Install the keypad in mounting option and close the cover as show in Figure 4.*

WARNING! : CLOSE THE COVER COMPLETELY UNTIL CLICK. IF YOU USE COVER IT IS NOT COMPLETELY CLOSED, KEYPAD CAN NOT BE PROTECTED FROM FOREIGN MATERIALS.



7) *Plug one end of the keypad cable (3m cable included) to the female connector on the backside of the keypad. Plug the other end of the keypad cable to the female connector on the front the drive. The location of the connector on the drive varies with drive size. Secure the loose cable to the enclosure and protect the cable from sharp edges or from being pinched in the enclosure door. Make sure that opening and closing the enclosure door does not strain the cable or connections.*

8) *Apply main power to the drive and verify the keypad functions properly. Refer to the drive manual supplied with the drive.*



Replacement Cooling Fans

Replacement cooling fans are available for the ACN series drives. Replace the fan if your drive is experiencing overheating issues. We also recommend replacing cooling fans on a 3-year interval.

Replacement Fan	Drive Compatibility
ACN-FAN-FR3	ACN series 7.5 to 10 hp AC drives
ACN-FAN-FR46	ACN series 15 to 30 hp AC drives

To replace the cooling fan in your ACN NEMA4X drive, please follow the steps below.

1) Remove all screws from the top cover.
2) Remove all screws from the drive housing.
3) Remove the top cover.
4) Remove wire and screw from the I/O board.
5) Detatch the I/O board and remove the wiring from underneath.
6) Lift up the drive housing and detach the inner fan wire from the main board.
7) Detach the wire from PCB BD.
8) Remove the seal.
9) Take off the sealing rubber chamber with connector and screw.
10) Remove the old fan(s).
11) Install replacement fan assembly.
12) Tighten fan screws, then run connector through seal.
13) Re-install the seal.
14) Attach fan connector to PCB BD.
15) Reattach inner fan wire to the main board.
16) Re-install drive housing.
17) Re-attach underside connector to I/O board, then re-install the I/O board.
18) Connect wiring to I/O board, and tighten I/O board mounting screw.
19) Replace top cover.
20) Replace and tighten drive housing and top cover screws.

VFD Suite

VFD Suite is the configuration software for the Automation Direct Ironhorse AC family of variable frequency drives, featuring the ACG IP20 series and the ACN Nema4X series. It is designed to allow connection of a personal computer to the drives and perform a variety of functions:

- *Create new drive configurations*
- *Upload/Download drive configurations*
- *Edit/Compare drive configurations*
- *Utilize Parameter Wizard for easy configuration*
- *Archive/Store multiple drive configurations on your PC*
- *Trend drive operation parameters*
- *Tune the drive PID loop*
- *View real time key operating parameters*
- *Start/Stop drive and switch directions, provided drive is set up for remote operation*
- *View drive faults*

VFD Suite includes a PDF help file for explanation of the software and features. VFD Suite can be downloaded for free from Automationdirect.com.

System Requirements

Category	Requirement
Windows	Windows 8/10/11
Processor	1 GHz or higher
RAM	1 GB (32-bit) or 2 GB (64-bit)
HDD	16 GB (32-bit) or 20 GB (64-bit)
Graphics	Graphic card supporting MS DirectX 9

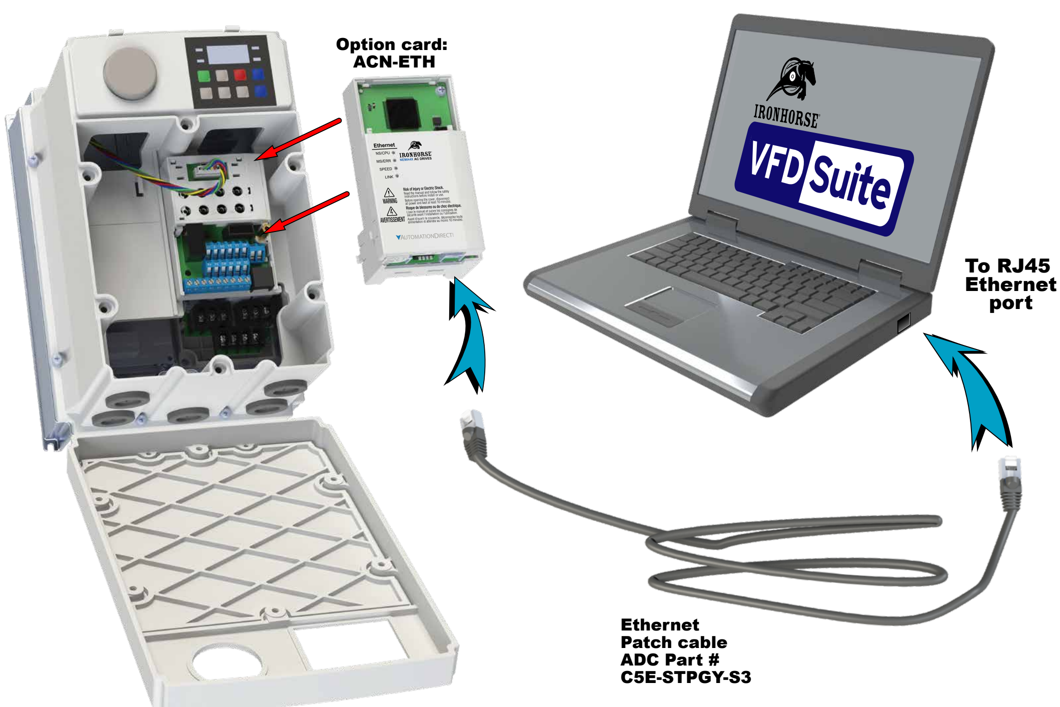
Connecting to VFD Suite

Set the network to connect with the drive.

Connecting to the ACN drive with VFD Suite can be accomplished in 2 ways:

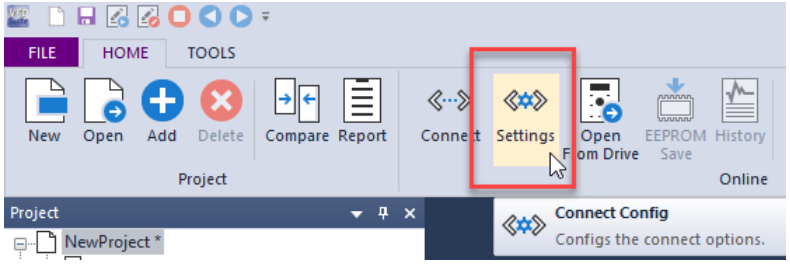
1) Serial communication (Modbus-RTU). Connection can be made to the RJ45 port directly with cable ACN-232C. Or the S+, S- terminals can be used with the USB-485 adapter. If connecting to a Windows 11 PC, you must use the USB-485 adapter.

2) Ethernet communication (Modbus TCP) via the optional ACN-ETH card

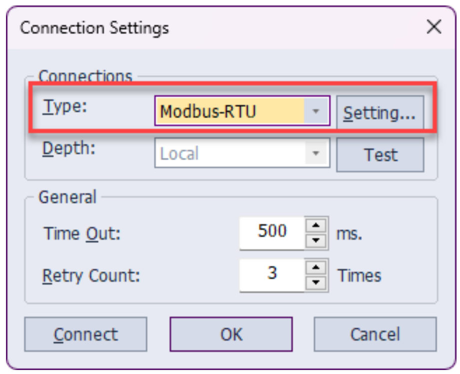


VFD Suite Serial Connection Setup

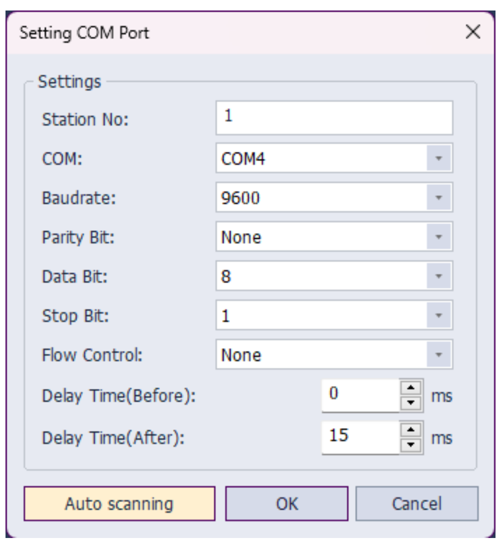
1) Select the menu HOME→Settings.



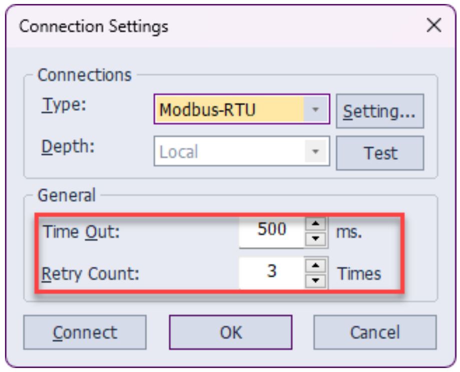
2) Choose Modbus-RTU for the communication type and press the Setting… button.



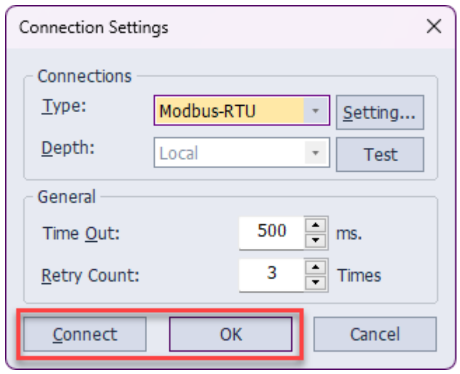
3) Enter in the COM Port settings. Pressing the Auto Scanning button will let VFD Suite try to automatically configure these settings. Press OK when done.



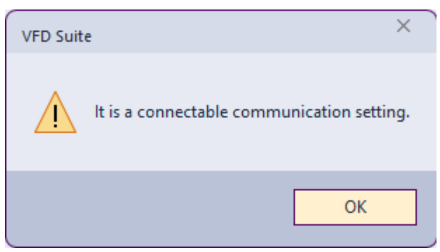
4) Enter the Time out value in milliseconds for setting the communication timeout value. Enter a value in to Retry Count to configure the number of communication attempts to try after communication failure.



5) Press Connect to attempt a connection to the drive over Modbus-RTU. Or Press OK to save connection setting without connecting to the drive.



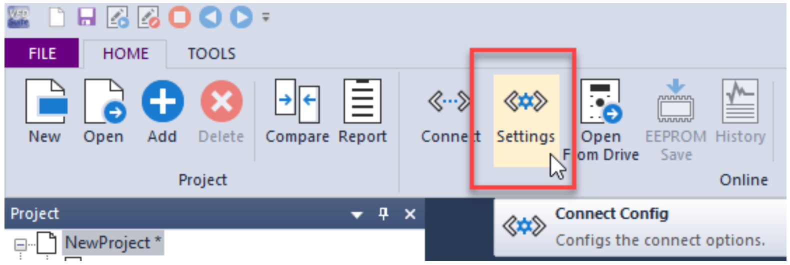
6) VFD Suite will display the below message when successfully connecting to the drive.



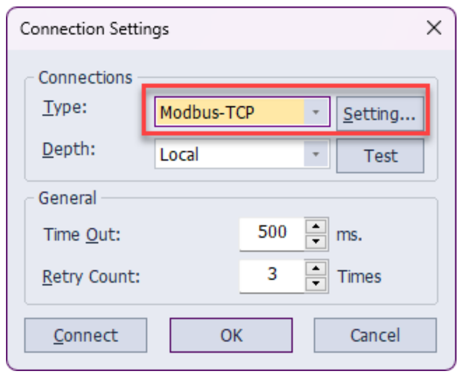
VFD Suite Ethernet Connection Setup

ACN-ETH has a default IP Address of 192.168.1.101 and a default Subnet mask of 255.255.255.0. The ACN-ETH must be set to Modbus-TCP mode with the protocol selection switch.

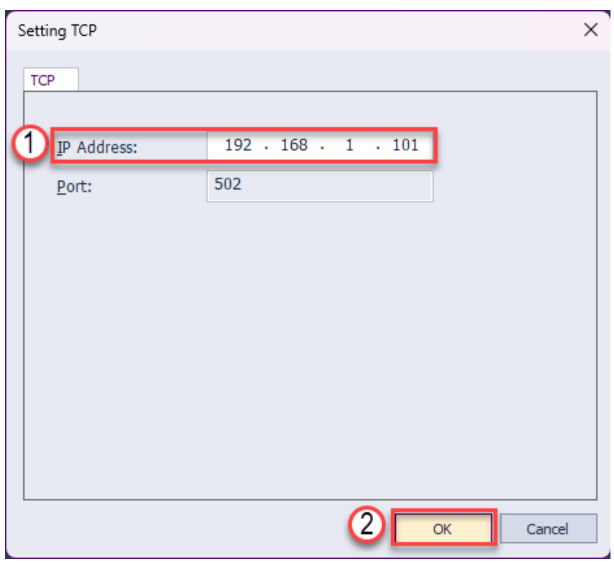
1) Select the menu HOME→Settings.



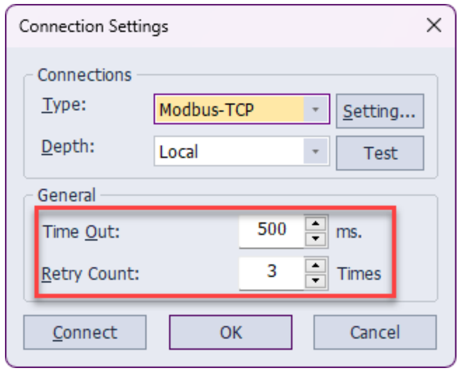
2) Choose Modbus-TCP for the communication type and press the Setting… button.



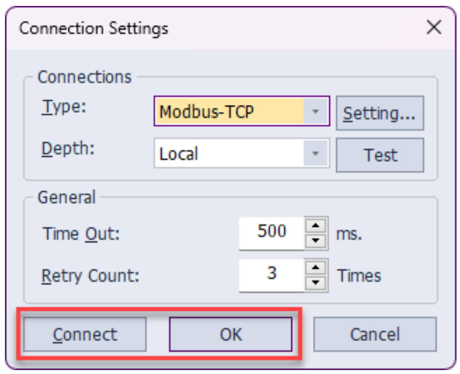
3) Enter in the IP address of the drive and press the OK button.



4) Enter the Time out value in milliseconds for setting the communication timeout value. Enter a value in to Retry Count to configure the number of communication attempts to try after communication failure.



5) Press Connect to attempt a connection to the drive over Modbus TCP. Or Press OK to save connection setting without connecting to the drive.



6) VFD Suite will display a connection status at the bottom of the screen when successful.

NOTE: FOR AN ETHERNET CONNECTION, THE PC MUST HAVE AN ETHERNET PORT CONFIGURED WITH AN IP ADDRESS AND SUBNET MASK IN THE SAME NETWORK RANGE AS THE DRIVE. PING CAN BE USED TO TEST THE CONNECTION BETWEEN THE PC AND THE DRIVE.

Appendix B: Optional I/O Card

Appendix B

Table of Contents

Basic Information

The ACN-EIO Extension IO option card provides additional discrete and analog IO points for any ACN(ND) series drives. This appendix explains specifications, installation, and features of the option card.

Characteristics

Additional terminals

- *Digital Input : 3ea*
- *Digital Output : 2ea(1FormC)*
- *Analog Input : 2ea*
- *Analog Output : 1ea*

Components

ACN Extension I/O consists of following items.

- *ACN Extension I/O : 1ea*
- *Installation Instructions : 1ea*
- *Brass supporter(M3xL17.3) : 1ea*
- *Brass supporter(M3xL23) : 1ea*
- *Screw(M3xL8) : 2ea*
- *Other parts*

Specifications

Input and Output Specification

Function		Label	Name	Description
INPUT	Multi-function terminal configuration	P8 ~ P10	Multi-function Input 8~10	Configurable for multi-function input terminals.
		CM	Common Sequence	Common terminal for analog terminal inputs and outputs.
	Analog input configuration	V3	Voltage input for frequency reference input	Used to setup or modify a frequency reference via analog voltage input terminal. • Unipolar: 0–10V (12V Max.) • Bipolar: -10–10V (±12V Max.)
		I4	Voltage/current input for frequency reference input	Used to setup or modify a frequency reference via analog voltage or current input terminals. Switch between voltage (V4) and current (I4) modes using a control board switch (SW2). V4 Mode: • Unipolar: 0–10V (12V Max.) I4 Mode • Input current: 4–20mA • Maximum Input current: 24mA • Input resistance: 249Ω
OUTPUT	Analog Output	AO3	Voltage/Current Output	Devices: output frequency, output current, output voltage, or a DC voltage. Operate switch (SW3) to select the signal output type (voltage or current) at the AO terminal. Output Signal Specifications: • Output voltage: 0–10V • Maximum output voltage/current: 12V/10mA • Output current: 0–20mA • Maximum output current: 24mA • Factory default output: Frequency
	Digital Output	CM	Common Sequence	Common terminal for analog terminal inputs and outputs.
		A3, C3, B4	Fault signal output	Sends out alarm signals when the drive's safety features are activated (AC 250V <1A, DC 30V < 1A). Fault condition: A3 and C3 contacts are connected (B3 and C3 open connection) Normal operation: B3 and C3 contacts are connected (A3 and C3 open connection)
		A4, C4, B4	Fault signal output	Sends out alarm signals when the drive's safety features are activated (AC 250V <1A, DC 30V < 1A). Fault condition: A4 and C3 contacts are connected (B4 and C4 open connection) Normal operation: B4 and C4 contacts are connected (A4 and C4 open connection)

Installation

Installation of ACN I/O Card

The following steps illustrate how to install the ACN-EIO or the ACN-ETH Option Card on the IronHorse ACN series drive.

NOTE: Ensure all control board cables are terminated BEFORE installing the option card. Once the option card is installed, there is no access to the control terminals.

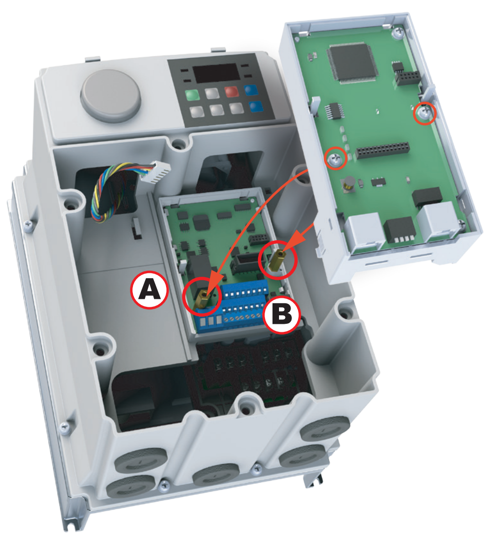
WARNING: Ensure all power is removed from the drive before installing or removing any Option Card. Failure to comply will damage the drive.

1) Loosen all front cover screws and remove the cover plate. Remove the face plate from the front of the Option card.

2) Remove keypad connector.

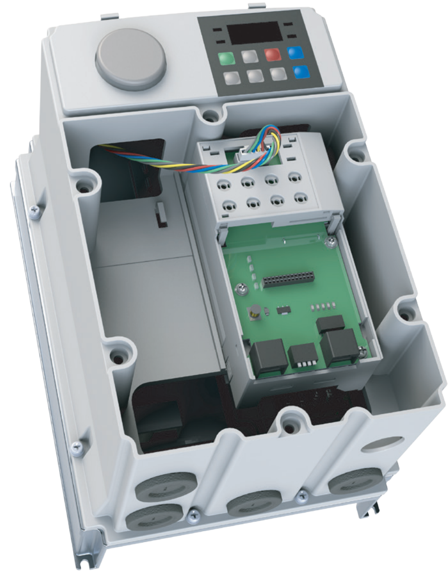
3) Remove the white keypad adapter PCB. It may be helpful to use a screwdriver to clear the plastic tabs (circled).

4) Once the keypad PCB adapter is removed, remove the existing bottom left screw (A) on the IO board. Keep this screw for later use. Fasten the included brass bar (M3xL23) to (A), and (M3xL17.3) to (B).

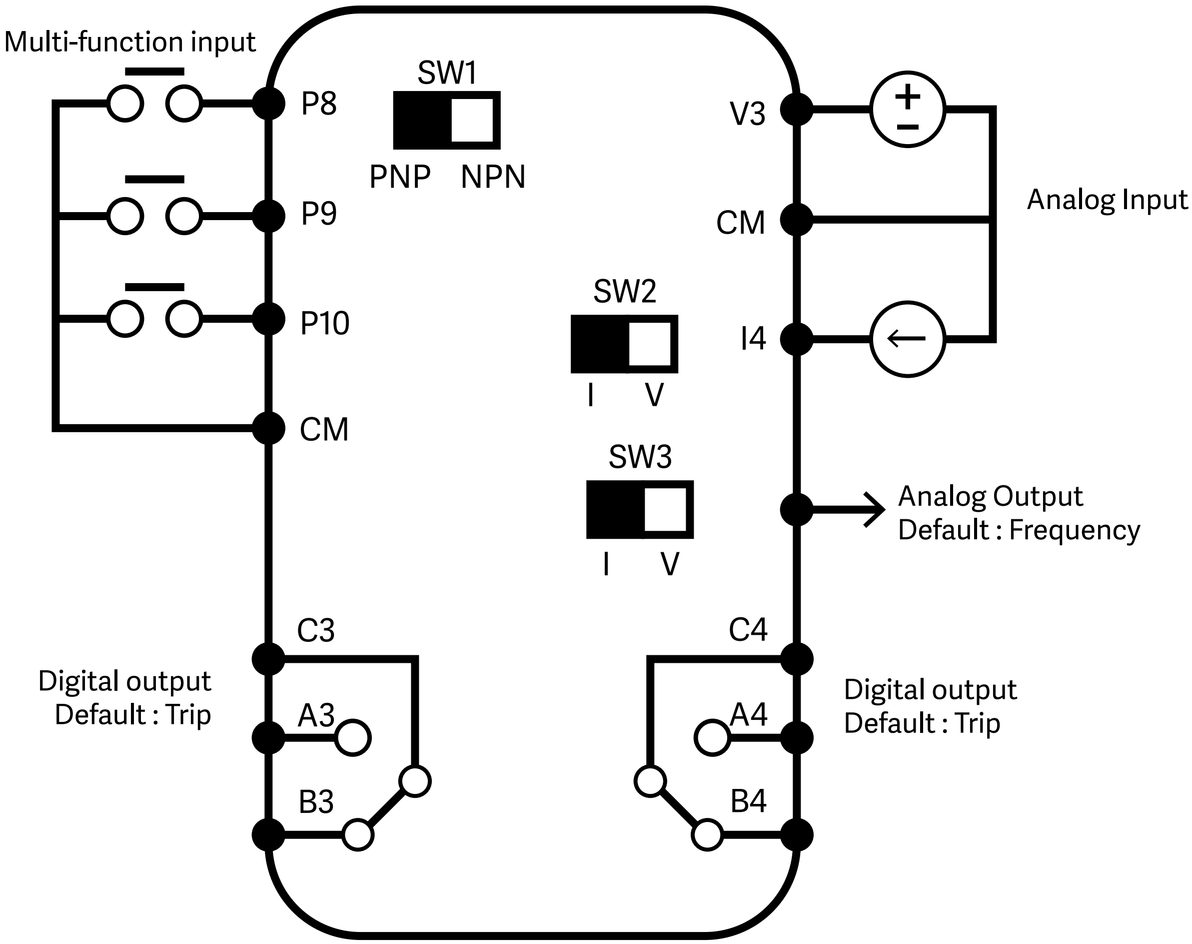


5) Install the Option Card and fasten the screws to the brass bars installed in the previous step.

6) Snap the keypad adapter PCB back into place on the Option Card and reconnect the keypad connector cable. Connect the field cables to the Option Card and install the Option Card cover (not shown). Re-install the drive front cover and tighten the screws.



Control Terminal Wiring

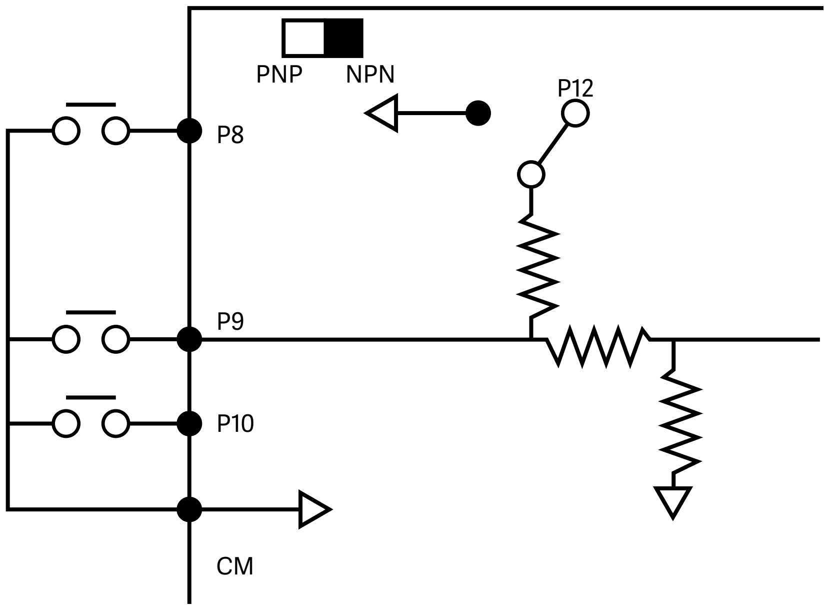


NPN(Sink)/PNP(Source) Mode Selection

The ACN Extension I/O supports both PNP (Source) and NPN (Sink) modes for sequence inputs at the terminal. Select an appropriate mode to suit requirements using the PNP/NPN selection switch (SW1) on the control board. Refer to the following information for detailed applications.

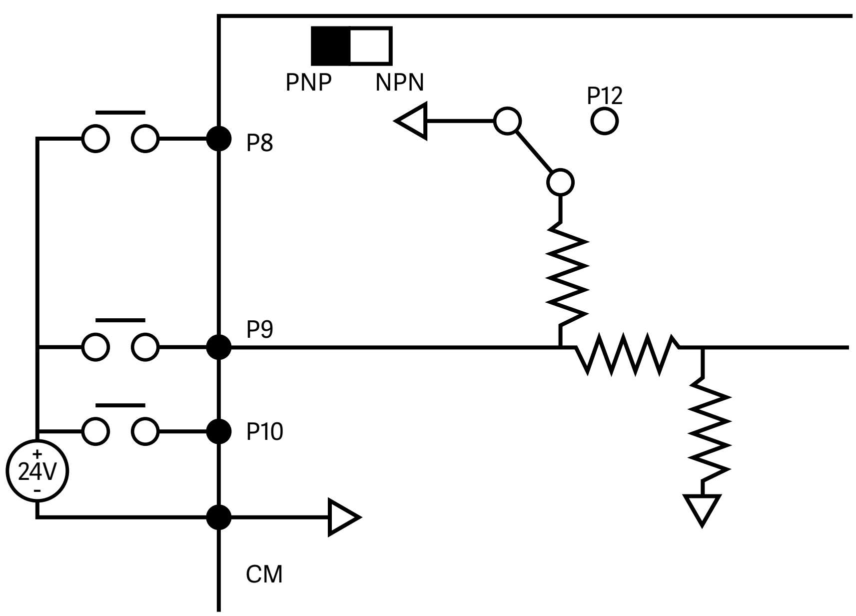
NPN Mode (Sink)

Select NPN using the PNP/NPN selection switch (SW1). Note that the factory default setting is NPN mode. CM is the common ground terminal for all analog inputs at the terminal, and P12 is 12V internal source.



PNP Mode (Source)

Select PNP using the PNP/NPN selection switch (SW1). Note that the factory default setting is NPN mode. CM is is the common ground terminal for all analog inputs at the terminal, and P12 is 12V internal source. If you are using an external Voltage source, build a circuit that connects the external source (-) and the CM terminal In case of PNP, you should apply more than 3V source for on-state and less than 2V for off-state.

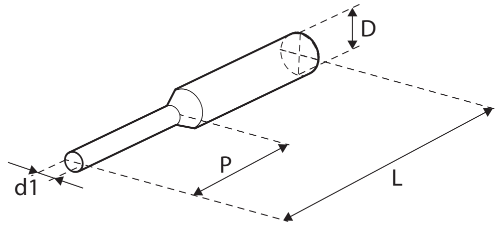


Signal (Control) Cable Specifications

Control (Signal) Cable Specifications				
Terminals	Signal Cable			
	Without Crimp Terminal Connectors (Bare wire)		With Crimp Terminal Connectors (Bootlace Ferrule)	
	mm^2	AWG	mm^2	AWG
P8~P10/CM/V3/I4/AO3	0.75	18	0.5	20
A3/B3/C3/A4/B4/C4	1.0	17	1.5	15

Pre-insulated Crimp Terminal Connectors (Bootlace Ferrule)

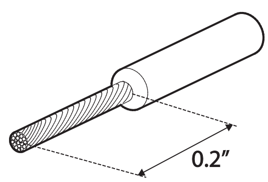
Use pre-insulated crimp terminal connectors to increase reliability of the control terminal wiring. Use this drawing and table to determine the crimp terminals to fit various cable sizes.



Cable Spec		Dimensions (mm)			
AWG	mm^2	L*	P	d1	D
26	0.25	10.4	6.0	1.1	2.5
		12.4	8.0		
22	0.50	12.0	6.0	1.3	3.2
20	0.75	12.0	6.0	1.5	3.4

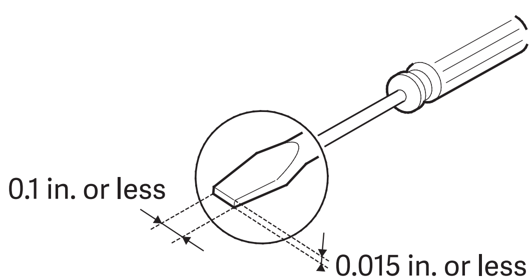
** If the length (L) of the crimp terminals exceeds 0.5 in. (12.7 mm) after wiring, the control terminal cover may not close fully.*

To connect cables to the control terminals without using crimp terminals, refer to this drawing showing the correct length of exposed conductor at the end of the control cable.



NOTE: Please read these general wiring recommendations:

- *While making wiring connections at the control terminals, ensure that the total cable length does not exceed 165ft (50m).*
- *Ensure that the length of any safety related wiring does not exceed 100ft (30m).*
- *Ensure that the cable length between an LCD keypad and the drive does not exceed 10ft (3.04 m). Cable connections longer than 10ft (3.04 m) may cause signal errors.*
- *Use ferrite material to protect signal cables from electro-magnetic interference.*
- *Take care when supporting cables using cable ties, to apply the cable ties no closer than 6 in. (15.24 cm) from the drive. This provides sufficient access to fully close the front cover.*
- *When making control terminal cable connections, use a small flat-tip screw driver (0.1 in wide (2.5 mm) and 0.015 in thick (0.4 mm) at the tip).*



Parameter Configuration

For P8, P9, P10 Digital Input configuration parameters, see In.72, 73,74 on Page 4–30.

For A3-C3, A4-C4 Digital Output Configuration parameters, see OU.34,35 on Page 4–33.

For V3, I4, AO3 Analog configuration, parameters, see group AO (APO), on Page 4–44. This parameter group is only available when the option card is installed.

Basic Features

Basic Function

Basic Function	Example
Frequency reference source configuration for the terminal block (input voltage)	Configures the drive to allow input voltages at the terminal block (V3, V4) and to setup or modify a frequency reference.
Frequency reference source configuration for the terminal block (input current)	Configures the drive to allow input currents at the terminal block (I4) and to setup or modify a frequency reference.
Multi-step speed (frequency) configuration	Configures multi-step frequency operations by receiving an input at the terminals defined for each step frequency.
Multi-stage Acc/Dec time configuration using the multi-function terminal	Configures multi-stage acceleration and deceleration times for a motor based on defined parameters for the multi-function terminals.
Command source configuration for terminal block inputs	Configures the drive to accept inputs at the FX/RX terminals.
Multi-function input terminal control configuration	Enables the user to improve the responsiveness of the multi-function input terminals.

Setting Frequency Reference

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	Ref Freq Src	0	KeyPad-1	0–16	-
				1	KeyPad-2		
				2	V1		
				4	V2		
				5	I2		
				6	Int 485		
				8	Field Bus		
				12	Pulse		
				13	V3		
				15	V4		
				16	I4		

V3 Terminal as the Source

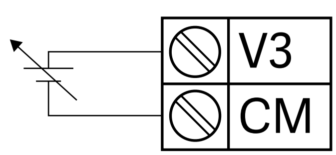
You can set and modify a frequency reference by setting voltage inputs when using the V3 terminal. Use voltage inputs ranging from 0 to 10V (unipolar) for forward only operation. Use voltage inputs ranging from -10 to +10V (bipolar) for both directions, where negative voltage inputs are used reverse operations

Setting a Frequency Reference for 0–10V Input

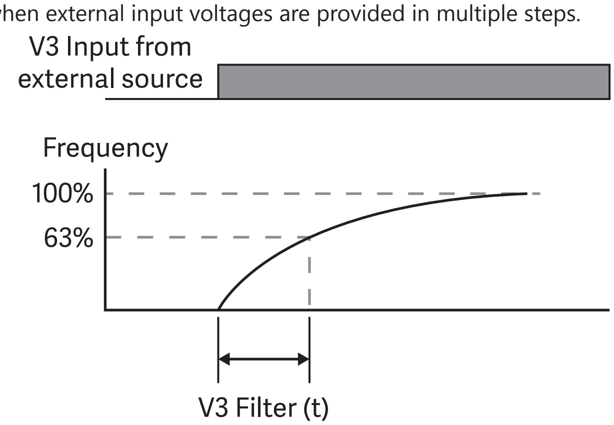
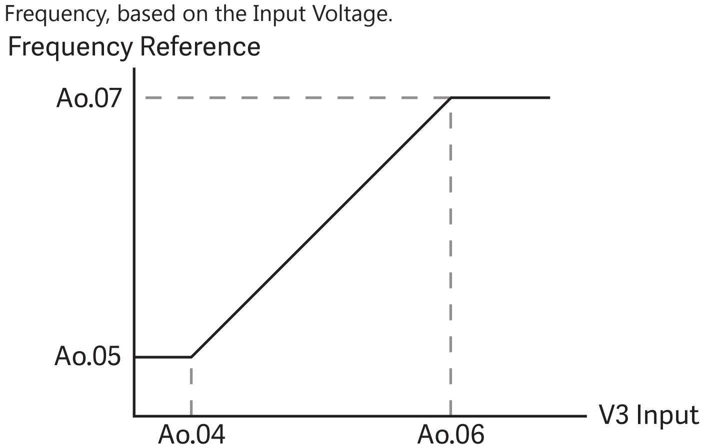
Set the Frq (Frequency reference source) code in the Operation group to 13 (V3), and then set code 02 (V3 Polarity) to 0 (unipolar) in the AO group . Use a voltage output from an external source or use the voltage output from the VR terminal (Standard I/O) to provide inputs to V3. Refer to the diagrams below for the wiring required for each application.

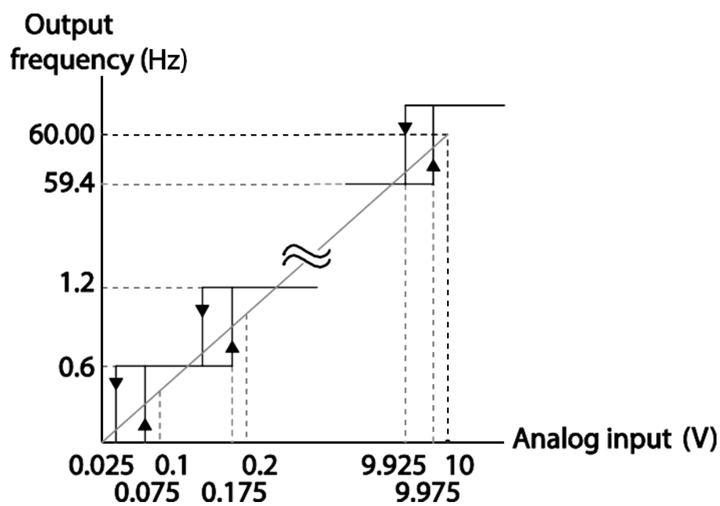
Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	Freq Ref Src	13	V3	0–16	-
In	1	Frequency at maximum analog input	Freq at 100%	Maximum frequency		0.00–Max. Frequency	Hz
Ao	1	V3 input monitor	V3 Monitor [V]	0.00		0.00–12.00	V
	2	V3 polarity options	V3 Polarity	0	Unipolar	0–1	-
	3	V3 input filter time constant	V3 Filter	10		0–10000	ms
	4	V3 minimum input voltage	V3 volt x1	0.00		0.00–10.00	V
	5	V3 output at minimum voltage (%)	V3 Perc y1	0.00		0.00–100.00	%
	6	V3 maximum input voltage	V3 Volt x2	10.00		0 .00– 12.00	V
	7	V3 output at maximum voltage (%)	V3 Perc y2	100.00		0–100	%
	8	Rotation direction options	V3 Inverting	0	No	0–1	-
	9	V3 Quantizing level	V3 Quantizing	0.04		0.00*, 0.04–10	%

**Quantizing is disabled if '0' is selected.*



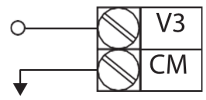
0–10V Input Voltage Setting Details

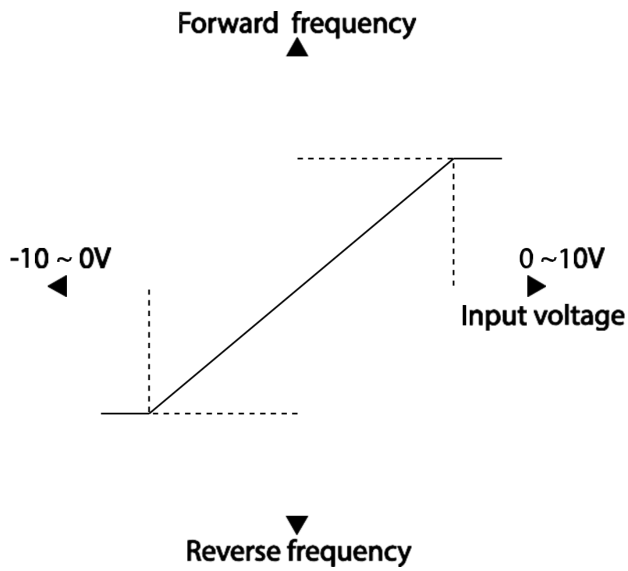
Code	Description
In.01 Freq at 100%	Configures the frequency reference at the maximum input voltage when a potentiometer is connected to the control terminal block. A frequency set with code In.01 becomes the maximum frequency only if the value set in code Ao.07 (or Ao.13) is 100(%). • Set code In.01 to 40.00 and use default values for codes Ao.01–Ao.09. Motor will run at 40.00Hz when a 10V input is provided at V3 • Set code Ao.07 to 50.00and use default values for codes In.01, Ao.01–Ao.09. Motor will run at 30.00Hz (50% of the default maximum frequency–60Hz)when a 10V input is provided at V3.
Ao.01 V3 Monitor[V]	Configures the drive to monitor the input voltage at V3.
Ao.03 V3 Filter	V3 Filter may be used when there are large variations between reference frequencies. Variations can be mitigated by increasing the time constant, but this will require an increased response time. The value t (time) indicates the time required for the frequency to reach 63% of the reference, when external input voltages are provided in multiple steps. 
Ao.04 V3 Volt x1– Ao.07 V3 Perc y2	These parameters are used to configure the gradient level and offset values of the Output Frequency, based on the Input Voltage. 
Ao.08 V3 Inverting	Inverts the direction of rotation. Set this code to 1 (Yes) if you need the motor to run in the opposite direction from the current rotation.

Code	Description
Ao.09.V3 Quantizing	Quantizing may be used when the noise level is high in the analog input (V3 terminal) signal. Quantizing is useful when you are operating a noise-sensitive system, because it suppresses any signal noise. However, quantizing will diminish system sensitivity (resultant power of the output frequency will decrease based on the analog input). You can also turn on the low-pass filter using code Ao.03 to reduce the noise, but increasing the value will reduce responsiveness and may cause pulsations (ripples) in the output frequency. Parameter values for quantizing refer to a percentage based on the maximum input. Therefore, if the value is set to 1% of the analog maximum input (60Hz), the output frequency will increase or decrease by 0.6Hz per 0.1V difference. When the analog input is increased, an increase to the input equal to 75% of the set value will change the output frequency, and then the frequency will increase according to the set value. Likewise, when the analog input decreases, a decrease in the input equal to 75% of the set value will make an initial change to the output frequency. As a result, the output frequency will be different at acceleration and deceleration, mitigating the effect of analog input changes over the output frequency. 

Setting a Frequency Reference for -10–10V Input

Set the Frq (Frequency reference source) code in the Operation group to 13 (V3), and then set code 02 (V3 Polarity) to 1 (bipolar) in the AO group (APO). Use the output voltage from an external source to provide input to V3.



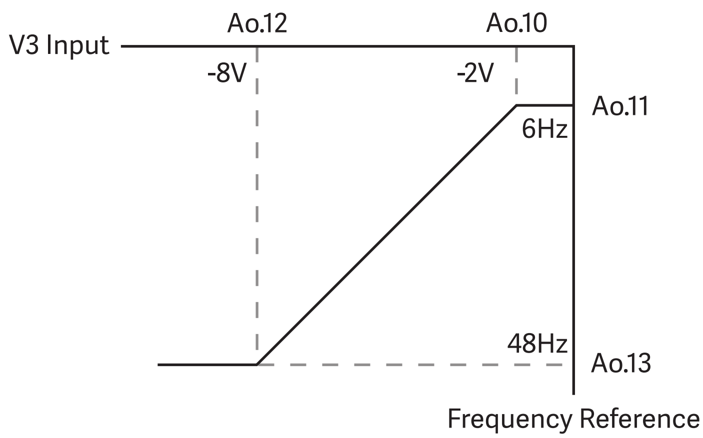


Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	Freq Ref Src	13	V3	0–16	-
In	1	Frequency at maximum analog input	Freq at 100%	60.00		0– Max Frequency	Hz
Ao	1	V3 input monitor	V3 Monitor	0.00		0.00–12.00V	V
	2	V3 polarity options	V3 Polarity	1	Bipolar	0–1	-
	10	V3 minimum input voltage	V3- volt x1	0.00		10.00–0.00V	V
	11	V3 output at minimum voltage (%)	V3- Perc y1	0.00		-100.00–0.00%	%
	12	V3maximum input voltage	V3- Volt x2	-10.00		-12.00 –0.00V	V
	13	V3 output at maximum voltage (%)	V3- Perc y2	-100.00		-100.00–0.00%	%

Rotational Directions for Different Voltage Inputs

Command / Voltage Input	Input voltage	
	0–10V	-10–0V
FWD	Forward	Reverse
REV	Reverse	Forward

-10–10V Voltage Input Setting Details

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>Ao.10 V3- volt x1–
Ao.13 V1- Perc y2</td><td>Sets the gradient level and offset value of the output frequency in relation to the input voltage. These codes are displayed only when Ao.02 is set to 1 (bipolar). As an example, if the minimum input voltage (at V3) is set to -2 (V) with 10% output ratio, and the maximum voltage is set to -8 (V) with 80% output ratio respectively, the output frequency will vary within the range of 6 - 48 Hz.


For details about the 0–+10V analog inputs, refer to the code descriptions Ao.10 V3 volt x1–Ao.13 V1 Perc y2.</td></tr>
</table>

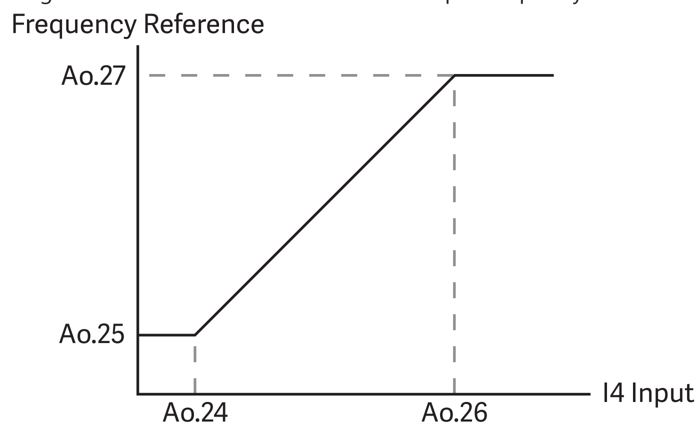
Setting a Reference Frequency using Input Current (I4)

You can set and modify a frequency reference using input current at the I4 terminal after selecting current input at SW 2. Set the Frq (Frequency reference source) code in the Operation group to 16 (I4) and apply 4–20mA input current to I4.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	Freq Ref Src	16	I4	0–16	-
In	1	Frequency at maximum analog input	Freq at 100%	60.00		0– Maximum Frequency	Hz
Ao	22	I4 input monitor	I4 Monitor	0.00		0.00–24.00	mA
	23	I4 input filter time constant	I4 Filter	10		0–10000	ms
	24	I4 minimum input current	I4 Curr x1	4.00		0.00–20.00	mA
	25	I4 output at minimum current (%)	I4 Perc y1	0.00		0–100	%
	26	I4 maximum input current	I4 Curr x2	20.00		0.00–24.00	mA
	27	I4 output at maximum current (%)	I4 Perc y2	100.00		0.00–100.00	%
	28	I4 rotation direction options	I4 Inverting	0	No	0–1	-
	29	I4 Quantizing level	I4 Quantizing	0.04		0*, 0.04–10.00	%

**Quantizing is disabled if ‘0’ is selected.*

Input Current (I4) Setting Details

Code	Description
In.01 Freq at 100%	Configures the frequency reference for operation at the maximum current (when Ao.27 is set to 100%). • If In.01 is set to 40.00Hz, and default settings are used for Ao.24–27, 20mA input current (max) to I4 will produce a frequency reference of 40.00Hz. • If Ao.27 is set to 50.00 (%), and default settings are used for In.01 (60Hz) and Ao.24–26, 20mA input current (max) to I4 will produce a frequency reference of 30.00Hz (50% of 60Hz).
Ao.22 I4 Monitor	Used to monitor input current at I4.
Ao.23 I4 Filter	Configures the time for the operation frequency to reach 63% of target frequency based on the input current at I4.
In.24 I4 Curr x1– In.27 I4 Perc y2	Configures the gradient level and offset value of the output frequency. 

Setting a Frequency Reference with Input Voltage (Terminal I4)

Set and modify a frequency reference using input voltage at I4 (V4) terminal by setting SW2 to V4. Set the Frq (Frequency reference source) code in the Operation group to 15 (V4) and apply 0–12V input voltage to I4 (=V4, Analog current/voltage input terminal). Codes Ao.14–21 will not be displayed when I4 is set to receive current input (Frq code parameter is set to 16).

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	Freq Ref Src	15	V4	0–16	-
	14	V4 input display	V4 Monitor	0.00		0.00–12.00	V
	15	V4 input filter time constant	V4 Filter	10		0–10000	ms
	16	Minimum V4 input voltage	V4 Volt x1	0.00		0.00–10.00	V
	17	Output% at minimum V4 voltage	V4 Perc y1	0.00		0.00–100.00	%
Ao	18	Maximum V4 input voltage	V4 Volt x2	10.00		0.00–10.00	V
	19	Output% at maximum V4 voltage	V4 Perc y2	100.00		0.00–100.00	%
	20	Invert V4 rotational direction	V4 Inverting	0	No	0–1	-
	21	V4 quantizing level	V4 Quantizing	0.04		0.00*, 0.04–10	%
**Quantizing is disabled if '0' is selected.*							

Analog Output

An analog output terminal provides output of 0–10V voltage, 4–20mA current.

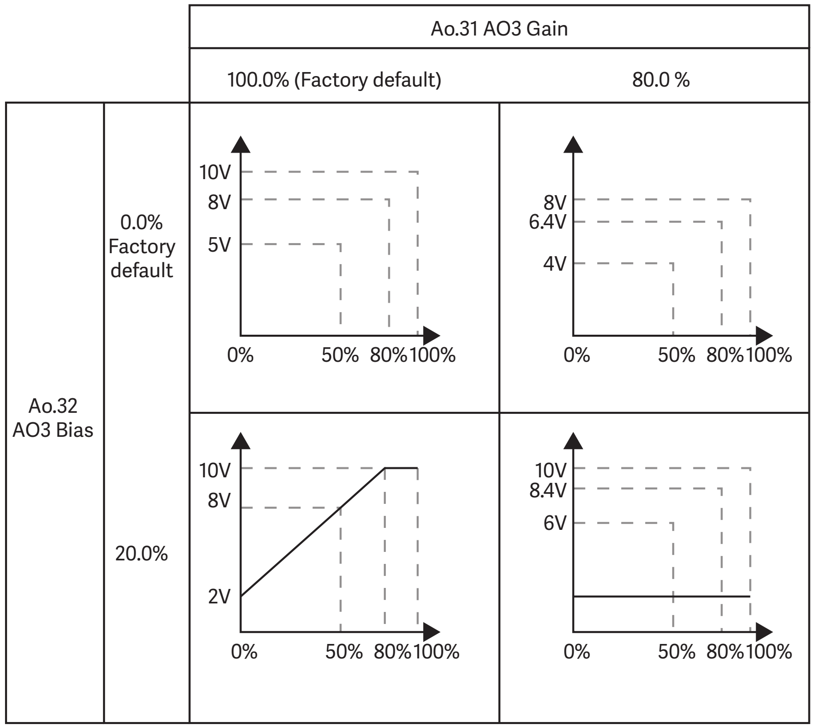
Voltage and Current Analog Output

An output size can be adjusted by selecting an output option at AO3(Analog Output3) terminal. Set the analog voltage/current output terminal setting switch (SW3) to change the output type (voltage/current).

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Ao	30	Analog output3	AO3 Mode	0	Frequency	0–15	-
	31	Analog output3 gain	AO3 Gain	100.0		-1000.0–1000.0	%
	32	Analog output3 bias	AO3 Bias	0.0		-100.0–100.0	%
	33	Analog output3 filter	AO3 Filter	5		0–10000	ms
	34	Analog constant output3	AO3 Const %	0.0		0.0–100.0	%
	35	Analog output3 monitor	AO3 Monitor	0.0		0.0–1000.0	%

Voltage and Current Analog Output Setting Details

Code	Description		
AO.30 AO3 Mode	Select a constant value for output. The following example for output voltage setting.		
	Setting		Function
	0	Frequency	Outputs operation frequency as a standard. 10V output is made from the frequency set at dr.20(Max Freq).
	1	Output Current	10V output is made from 200% of drive rated current (heavy load).
	2	Output Voltage	Sets the outputs based on the drive output voltage. 10V output is made from a set voltage in bA.15 (Rated V). If 0V is set in bA.15, 200V/400V models output 10V based on the actual input voltages (240V and 480V respectively).
	3	DC Link Volt	Outputs drive DC link voltage as a standard. Outputs 10V when the DC link voltage is 410Vdc for 200V models, and 820Vdc for 400V models.
	4	Torque	Outputs the generated torque as a standard. Outputs 10V at 250% of motor rated torque.
	5	Ouput Power	Monitors output wattage. 200% of rated output is the maximum display voltage (10V).
	6	Idse	Outputs the maximum voltage at 200% of no load current.
	7	Iqse	Outputs the maximum voltage at 250% of rated torque current. $\text{rated torque current} = \sqrt{\text{rated current}^2 - \text{no load current}^2}$
	8	Target Freq	Outputs set frequency as a standard. Outputs 10V at the maximum frequency (dr.20).
	9	Ramp Freq	Outputs frequency calculated with Acc/Dec function as a standard. May vary with actual output frequency. Outputs 10V.
	12	PID Ref Value	Outputs command value of a PID controller as a standard. Outputs approximately 6.6V at 100%.
	13	PID Fdk Value	Outputs feedback volume of a PID controller as a standard. Outputs approximately 6.6V at 100%.
	14	PID Output	Outputs output value of a PID controller as a standard. Outputs approximately 10V at 100%.
	15	Constant	Outputs OU.05 (AO1 Const %) value as a standard.

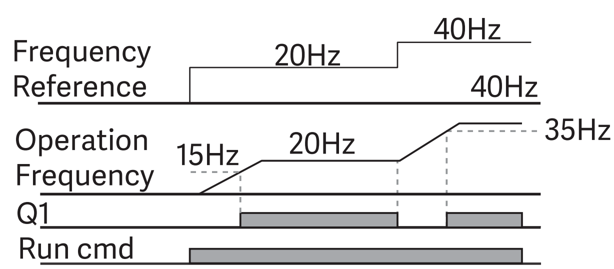
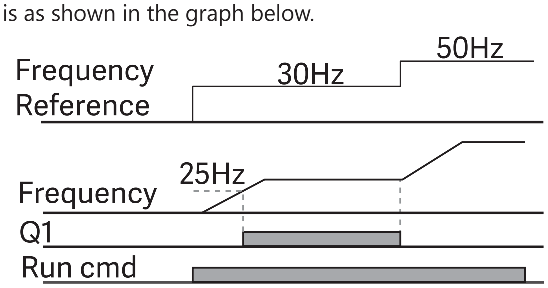
Code	Description
AO.31 AO3 Gain, AO.32 AO3 Bias	Adjusts output value and offset. If frequency is selected as an output item, it will operate as shown below. $$AO3 = \frac{Frequency}{MaxFreq} \text{ X } AO3\ Gain + AO3\ Bias$$ The graph below illustrates the analog voltage output (AO3) changes depend on Ao.31 (AO3 Gain) and Ao.32 (AO3 Bias) values. Y-axis is analog output voltage (0–10V), and X-axis is % value of the output item. Example, if the maximum frequency set at dr.20 (Max Freq) is 60Hz and the present output frequency is 30Hz, then the x-axis value on the next graph is 50%. 
AO.33 AO3 Filter	Set filter time constant on analog output.
AO.34 A013Const %	If analog output at AO.30 (AO3 Mode) is set to 15(Constant), the analog voltage output is dependent on the set parameter values (0–100%).
AO.35 AO3 Monitor	Monitors analog output value. Displays the maximum output voltage as a percentage (%) with 10V as the standard.

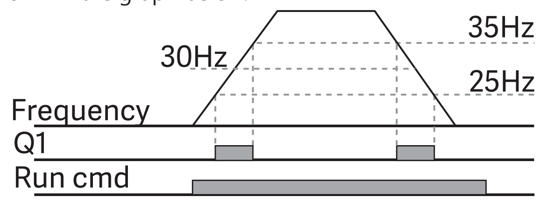
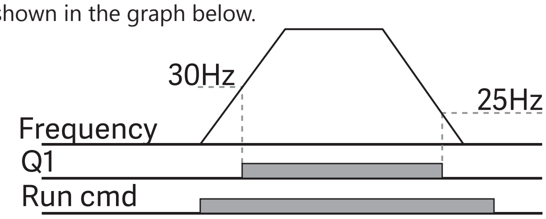
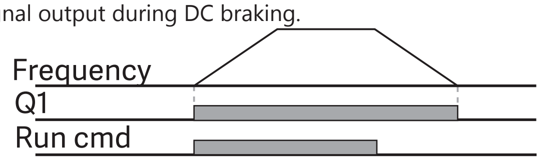
Digital Output

Multi-function Output Terminal and Relay Settings

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
OU	30	Fault output item	Trip Out Mode	010		-	bit
	34	Multi-function relay3 setting	Relay 3	29	Trip	-	-
	35	Multi-function relay4 setting	Relay 4	29	Trip	-	-
	41	Multi-function output monitor	DO Status	-		00– 11	bit
	57	Detection frequency	FDT Frequency	30.00		0.00–Maximum frequency	
	58	Detection frequency band	FDT Band	10.00			Hz
In	65– 74	Px terminal configuration	Px Define	16	Exchange	-	-

Multi-function Output Terminal and Relay Setting Details

Code	Description		
OU.34 Relay3	Set relay (Relay 3) output options.		
OU.35 Relay4	Set relay (Relay 4) output options.		
OU.41 DO Status	Set output terminal and relay functions according to OU.57 FDT (Frequency), OU.58 (FDT Band) settings and fault trip conditions.		
	Setting		Function
	0	None	No output signal.
	1	FDT-1	Detects drive output frequency reaching the user set frequency. Outputs a signal when the absolute value (set frequency–output frequency) < detected frequency width/2. When detected frequency width is 10Hz, FDT-1 output is as shown in the graph below. 
	2	FDT-2	Outputs a signal when the user set frequency and detected frequency (FDT Frequency) are equal, and fulfills FDT-1 condition at the same time. [Absolute value (set frequency-detected frequency) < detected frequency width/2]&[FDT-1] Detected frequency width is 10Hz. When the detected frequency is set to 30Hz, FDT-2 output is as shown in the graph below. 

Code	Description		
OU.41 DO Status	3	FDT-3	Outputs a signal when the Absolute value (output frequency–operation frequency) < detected frequency width/2. Detected frequency width is 10Hz. When detected frequency is set to 30Hz, FDT-3 output is as shown in the graph below. 
	4	FDT-4	Output signal can be separately set for acceleration and deceleration conditions. • In acceleration: Operation frequency ≥ Detected frequency • In deceleration: Operation frequency>(Detected frequency–Detected frequency width/2) Detected frequency width is 10Hz. When detected frequency is set to 30Hz, FDT-4 output is as shown in the graph below. 
	5	Overload	Outputs a signal at motor overload.
	6	IOL	Outputs a signal when a fault is triggered from a protective function operation by drive overload inverse proportion.
	7	Underload	Outputs a signal at load fault warning.
	8	Fan Warning	Outputs a signal at fan fault warning.
	9	Stall	Outputs a signal when a motor is overloaded and stalled.
	10	Over voltage	Outputs a signal when the drive DC link voltage rises above the protective operation voltage.
	11	Low Voltage	Outputs a signal when the drive DC link voltage drops below the low voltage protective level.
	12	Over Heat	Outputs signal when the drive overheats.
	13	Lost command	Outputs a signal when there is a loss of analog input terminal and RS-485 communication command at the terminal block. Outputs a signal when communication power and expansion an I/O power card is installed, and also outputs a signal when losing analog input and communication power commands.
	14	RUN	Outputs a signal when operation command is entered and the drive outputs voltage. No signal output during DC braking. 
	15	Stop	Outputs a signal at operation command off, and when there is no drive output voltage.
	16	Steady	Outputs a signal in steady operation.
	17	Drive line	Outputs a signal while the motor is driven by the drive line.
	18	Comm line	Outputs a signal while the motor is driven by a commercial power source..
	19	Speed search	Outputs a signal during drive speed search operation.
	22	Ready	Outputs signal when the drive is in stand by operation and ready to receive an external operation command.
	28	Timer Out	A timer function to operate terminal output after a certain time by using multi-function terminal block input..

Code	Description		
OU.41 DO Status	29	Trip	Outputs a signal after a fault trip
	31	DB Warn %ED	In case of exceeding DB resistor usage rate, the signal changes to on-state.
	34	On/Off Control	Outputs a signal using an analog input value as a standard.
	35	BR Control	Outputs a brake release signal.

Fault Trip Output using Multi-Function Output Terminal and Relay

The drive can output fault trip state using multi-function output terminal (Q1) and relay (Relay 3, 4).

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
OU	30	Fault trip output mode	Trip Out Mode	010		-	bit
	34	Multi-function relay3 setting	Relay 3	29	Trip	-	-
	35	Multi-function relay4 setting	Relay 4	29	Trip	-	-
	53	Fault trip output on delay	TripOut OnDly	0.00		0.00–100.00	sec
	54	Fault trip output off delay	TripOut OffDly	0.00		0.00–100.00	sec

Fault Trip Output by Multi-function Output Terminal and Relay - Setting Details

Code	Description			
OU.30 Trip Out Mode	Fault trip relay operates based on the fault trip output settings. Select fault trip output terminal/relay and select 29 (Trip Mode) at codes OU. 34, 35. When a fault trip occurs in the drive, the relevant terminal and relay will operate. Depending on the fault trip type, terminal and relay operation can be configured as shown in the table below.			
	Setting			Function
	bit3	bit2	bit1	
			X	Operates when low voltage fault trips occur
		X		Operates when fault trips other than low voltage occur
	X			Operates when auto restart fails (Pr. 08–09)
OU.34 Relay3	Set relay output (Relay 3).			
OU.35 Relay4	Set relay output (Relay 4).			
OU.53 TripOut On Dly ***OU.54 TripOut OffDly***	If a fault trip occurs, trip relay or multi-function output operates after the time delay set in OU.53. Terminal is off with the input initialized after the time delay set in OU.54.			

Multi-function Output Terminal Delay Time Settings

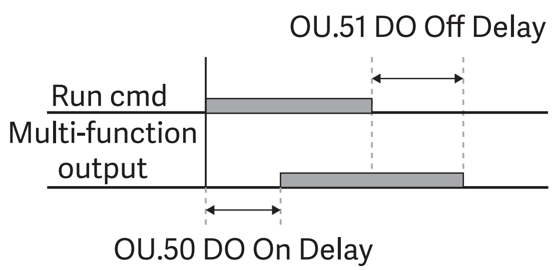
Set on-delay and off-delay times separately to control the output terminal and relay operation times. The delay time set at codes OU.50–51 applies to multi-function output terminal (Q1), relay (Relay 1, 3, 4), except when the multi-function output function is in fault trip mode.

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
OU	50	Multi-function output On delay	DO On Delay	0.00	0.00–100.00	s
	51	Multi-function output Off delay	DO Off Delay	0.00	0.00–100.00	s
	52	Select multi-function output terminal	DO NC/NO Sel	00*	00–11	bit

**On the 7-seg screen of multi-function output contact parameter, clicking of left/right key switches between extension I/O and built-in I/O*

Output Terminal Delay Time Setting Details

Code	Description
OU.52 DO NC/NO Sel	Select terminal type for relay and multi-function output terminal. An additional three terminal type selection bits at the terminal block will be added when an expansion I/O is added. By setting the relevant bit to 0, it will operate A terminal (Normally Open), and setting it to 1 will operate B terminal (Normally Closed). Shown below in the table are Relay 1 and Q1 settings starting from the right bit.



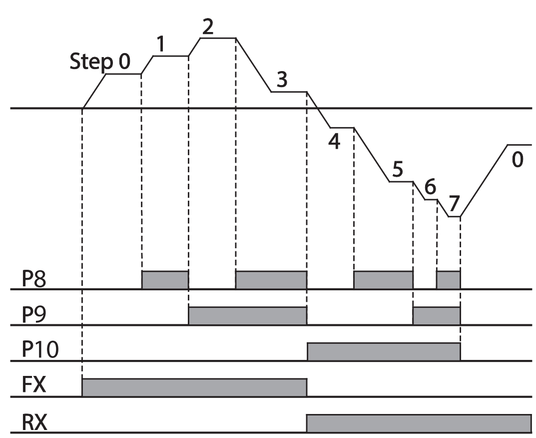
Setting Multi-step Frequency

Multi-step operations can be carried out by assigning different speeds (or frequencies) to the Px terminals. Step 0 uses the frequency reference source set with the Frq code in the Operation group. Px terminal parameter values 7 (Speed-L), 8 (Speed-M) and 9 (Speed-H) are recognized as binary commands and work in combination with Fx or Rx run commands. The drive operates according to the frequencies set with St.1–3 (multi-step frequency 1–3) , bA.53–56 (multi-step frequency 4–7) and the binary command combinations.

<table>
<tr><th>Group</th><th>Code</th><th>Name</th><th>LCD Display</th><th colspan="2">Parameter Setting</th><th>Setting Range</th><th>Unit</th></tr>
<tr><td>Operation</td><td>St1–St3</td><td>Multi-step frequency 1–3</td><td>Step Freq - 1–3</td><td colspan="2">-</td><td>0–Maximum frequency</td><td>Hz</td></tr>
<tr><td>bA</td><td>53–56</td><td>Multi-step frequency 4–7</td><td>Step Freq - 4–7</td><td colspan="2">-</td><td>0–Maximum frequency</td><td>Hz</td></tr>
<tr><td rowspan="4">In</td><td rowspan="3">72–74</td><td rowspan="3">Px terminal configuration</td><td rowspan="3">Px Define (Px: P8–P10)</td><td>7</td><td>Speed-L</td><td rowspan="3">0–54</td><td>-</td></tr>
<tr><td>8</td><td>Speed-M</td><td>-</td></tr>
<tr><td>9</td><td>Speed-H</td><td>-</td></tr>
<tr><td>89</td><td>Multi-step command delay time</td><td>InCheck Time</td><td colspan="2">1</td><td>1–5000</td><td>ms</td></tr>
</table>

Multi-step Frequency Setting Details

<table>
<tr><th>Code</th><th colspan="5">Description</th></tr>
<tr><td>Operation group St 1–St3 Step Freq - 1–3</td><td colspan="5">Configure multi-step frequency1–3. If an LCD keypad is in use, bA.50–52 is used instead of St1–St3 (multi-step frequency 1–3).</td></tr>
<tr><td>bA.53–56 Step Freq - 4–7</td><td colspan="5">Configure multi-step frequency 4–7.</td></tr>
<tr><td rowspan="10">In.72–74 Px Define</td><td colspan="5">Choose the terminals to setup as multi-step inputs, and then set the relevant codes (In.72–74) to 7(Speed-L), 8(Speed-M), or 9(Speed-H).

Provided that terminals P3, P4 and P5 have been set to Speed-L, Speed-M and Speed-H respectively, the following multi-step operation will be available.

</td></tr>
<tr><td>Speed</td><td>Fx/Rx</td><td>P5</td><td>P4</td><td>P3</td></tr>
<tr><td>0</td><td>X</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>1</td><td>X</td><td>-</td><td>-</td><td>X</td></tr>
<tr><td>2</td><td>X</td><td>-</td><td>X</td><td>-</td></tr>
<tr><td>3</td><td>X</td><td>-</td><td>X</td><td>X</td></tr>
<tr><td>4</td><td>X</td><td>X</td><td>-</td><td>-</td></tr>
<tr><td>5</td><td>X</td><td>X</td><td>-</td><td>X</td></tr>
<tr><td>6</td><td>X</td><td>X</td><td>X</td><td>-</td></tr>
<tr><td>7</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
</table>

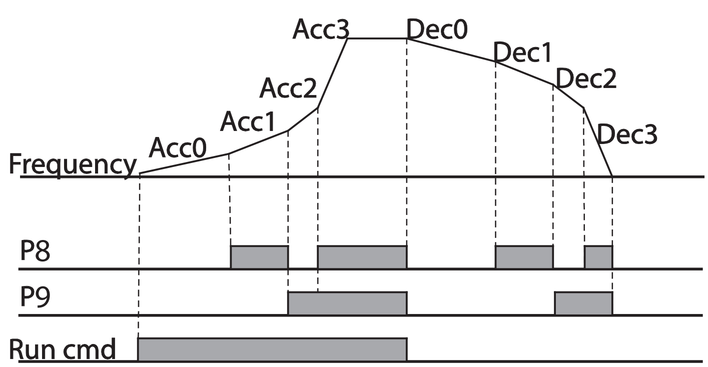
Code	Description
In.89 InCheck Time	Set a time interval for the drive to check for additional terminal block inputs after receiving an input signal. After adjusting In.89 to 100ms and an input signal is received at P8, the drive will search for inputs at other terminals for 100ms, before proceeding to accelerate or decelerate based on P8’s configuration.

Multi-step Acc/Dec Time Configuration

Acc/Dec times can be configured via a multi-function terminal by setting the ACC (acceleration time) and dEC (deceleration time) codes in the Operation group.

<table>
<tr><th>Group</th><th>Code</th><th>Name</th><th>LCD Display</th><th colspan="2">Parameter Setting</th><th>Setting Range</th><th>Unit</th></tr>
<tr><td rowspan="2">Operation</td><td>ACC</td><td>Acceleration time</td><td>Acc Time</td><td colspan="2">20.0</td><td>0.0–600.0</td><td>sec</td></tr>
<tr><td>dEC</td><td>Deceleration time</td><td>Dec Time</td><td colspan="2">30.0</td><td>0.0–600.0</td><td>sec</td></tr>
<tr><td rowspan="2">bA</td><td>70–82</td><td>Multi-step acceleration time1–7</td><td>Acc Time 1–7</td><td colspan="2">x.xx</td><td>0.0–600.0</td><td>sec</td></tr>
<tr><td>71–83</td><td>Multi-step deceleration time1–7</td><td>Dec Time 1–7</td><td colspan="2">x.xx</td><td>0.0–600.0</td><td>sec</td></tr>
<tr><td rowspan="4">In</td><td rowspan="3">72–74</td><td rowspan="3">Px terminal configuration</td><td rowspan="3">Px Define (Px: P8–P10)</td><td>11</td><td>XCEL-L</td><td rowspan="3">0–54</td><td rowspan="3">-</td></tr>
<tr><td>12</td><td>XCEL-M</td></tr>
<tr><td>49</td><td>XCEL-H</td></tr>
<tr><td>89</td><td>Multi-step command delay time</td><td>In Check Time</td><td colspan="2">1</td><td>1–5000</td><td>ms</td></tr>
</table>

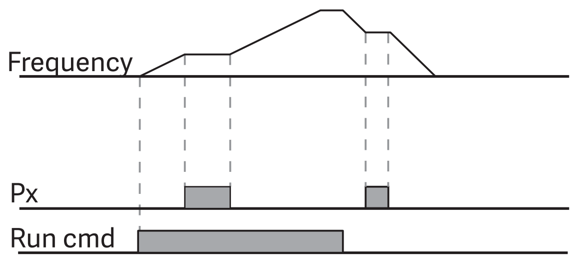
Acc/Dec Time Setup via Multi-function Terminals – Setting Details

<table>
<tr><th>Code</th><th colspan="3">Description</th></tr>
<tr><td>bA. 70–82 Acc Time 1–7</td><td colspan="3">Set multi-step acceleration time1–7.</td></tr>
<tr><td>bA.71–83 Dec Time 1–7</td><td colspan="3">Set multi-step deceleration time1–7.</td></tr>
<tr><td rowspan="12">In.72–74
Px Define (P8–P10)</td><td colspan="3">Choose and configure the terminals to use for multi-step Acc/Dec time inputs.</td></tr>
<tr><td>Configuration</td><td colspan="2">Description</td></tr>
<tr><td>11</td><td>XCEL-L</td><td>Acc/Dec command-L</td></tr>
<tr><td>12</td><td>XCEL-M</td><td>Acc/Dec command-M</td></tr>
<tr><td>49</td><td>XCEL-H</td><td>Acc/Dec command-H</td></tr>
<tr><td colspan="3">Acc/Dec commands are recognized as binary code inputs and will control the acceleration and deceleration based on parameter values set with bA.70–82 and bA.71–83.
If, for example, the P8 and P9 terminals are set as XCEL-L and XCEL respectively, the following operation will be available.

</td></tr>
<tr><td>Acc/Dec time</td><td>P5</td><td>P4</td></tr>
<tr><td>0</td><td>-</td><td>-</td></tr>
<tr><td>1</td><td>-</td><td>X</td></tr>
<tr><td>2</td><td>X</td><td>-</td></tr>
<tr><td>3</td><td>X</td><td>X</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td>In.89 In Check Time</td><td colspan="3">Set the time for the drive to check for other terminal block inputs. If In.89 is set to 100ms and a signal is supplied to the P8 terminal, the drive searches for other inputs over the next 100ms. When the time expires, the Acc/Dec time will be set based on the input received at P8.</td></tr>
</table>

Stopping the Acc/Dec Operation

Configure the multi-function input terminals to stop acceleration or deceleration and operate the drive at a fixed frequency.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
In	72–74	Px terminal configuration	Px Define(Px: P8– P10)	25	XCEL Stop	0–54	-

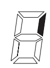
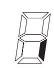
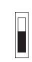
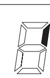
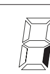
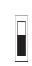


Multi-function Input Terminal Control

Filter time constants and the type of multi-function input terminals can be configured to improve the response of input terminals

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
In	85	Multi-function input terminal On filter	DI On Delay	10	0–10000	ms
	86	Multi-function input terminal Off filter	DI Off Delay	3	0–10000	ms
	87	Multi-function input terminal selection	DI NC/NO Sel	0 0000*	-	-
	90	Multi-function input terminal status	DI Status	0 0000*	-	-
**On the 7-seg screen of multi-function output contact parameter, clicking of left/right key switches between extension I/O and built-in I/O*						

Multi-function Input Terminal Control Setting Details

Code	Description		
In.85 DI On Delay, In.86 DI Off Delay	If the input terminal's state is not changed during the set time, when the terminal receives an input, it is recognized as On or Off.		
In.87 DI NC/NO Sel	Select terminal contact types for each input terminal. The position of the indicator light corresponds to the segment that is on as shown in the table below. With the bottom segment on, it indicates that the terminal is configured as a A terminal (Normally Open) contact. With the top segment on, it indicates that the terminal is configured as a B terminal (Normally Closed) contact. From right to left side, there are P1~P5 terminals. In case of installation of extension I/O, P8/P9/P10 terminals are added.		
	Source	B terminal status (Normally Closed)	A terminal status (Normally Open)
	Keypad		
	LCD keypad		
In.90 DI Status	Display the configuration of each contact. When a segment is configured as A terminal using dr.87, the On condition is indicated by the top segment turning on. The Off condition is indicated when the bottom segment is turned on. When contacts are configured as B terminals, the segment lights behave conversely. From right to left side, there are P1~P5 terminals. In case of installation of extension I/O, P8/P9/P10 terminals are added.		
	Source	A terminal setting (On)	A terminal setting (Off)
	Keypad		
	LCD keypad		

Appendix C: Ethernet Module ACN-ETH

Appendix
C

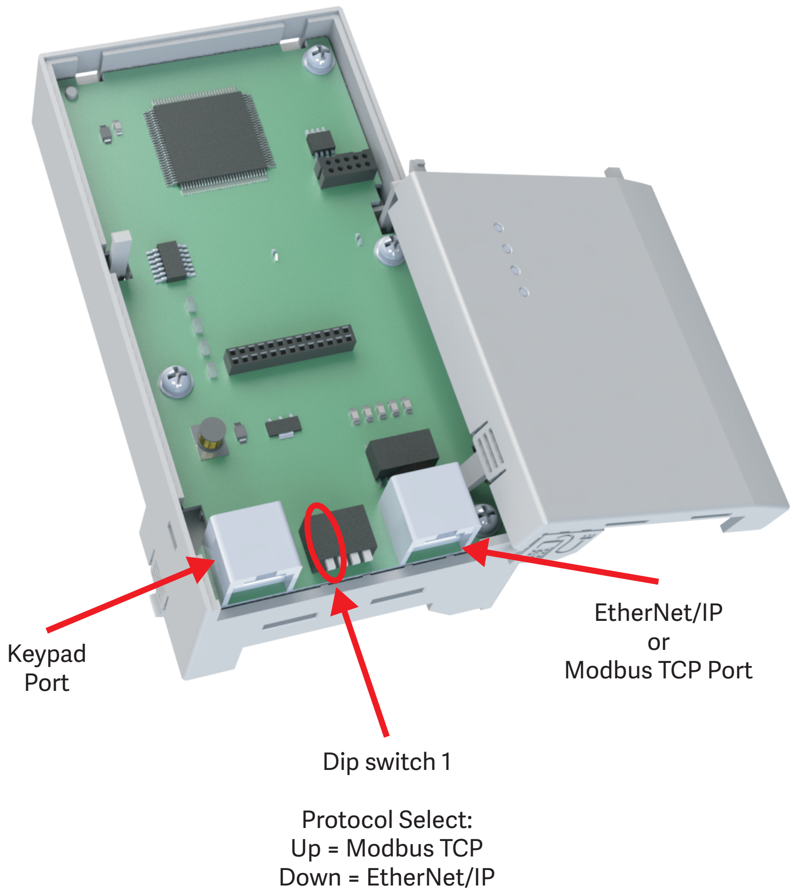
Table of Contents

Ethernet/Modbus Card Quick Start

Hardware

1) Install card with no power applied to the drive.

2) Protocol select: Set dip switch 1 to UP for Modbus TCP or DOWN for EtherNet/IP



Parameters

Pr. Code	Parameter Name	Range	Setting for ETH Control	Definition	Protocol
CM-10	Opt Parameter1	0 ~ 255	192	Set up the IP Address.	M/E
CM-11	Opt Parameter2	0 ~ 255	192		
CM-12	Opt Parameter3	0 ~ 255	168		
CM-13	Opt Parameter4	0 ~ 255	3		
CM-14	Opt Parameter5	0 ~ 255	255	Set up the Subnet Mask.	M/E
CM-15	Opt Parameter6	0 ~ 255	255		
CM-16	Opt Parameter7	0 ~ 255	255		
CM-17	Opt Parameter8	0 ~ 255	0		
CM-18	Opt Parameter9	0 ~ 255	255	Set up the Gateway Address.	M/E
CM-19	Opt Parameter10	0 ~ 255	255		
CM-20	Opt Parameter11	0 ~ 255	255		
CM-21	Opt Parameter12	0 ~ 255	3		
CM-22	Opt Parameter13	0~2	0 - Auto Speed Select	Set up the Ethernet communication rate.	M/E
CM-29	In Instance	0~11	0 - 70	CIP Input Instance.	E
CM-49	Out Instance	0~11	0 - 20	CIP Output Instance.	E
CM-94	Comm Update	0: No 1: Yes	1	Update communication relating to keypad parameters.	M/E
dr.06	Command source	4-FieldBus	0-5	Set for Run/Stop by ETH card.	M/E
dr.07	Frequency Reference Source	8-FieldBus	0 - 16	Set for Speed Control by ETH card.	M/E

After setting these parameters:

- ***Apply all changes by setting CM.94 = 1****: This parameter setting will return to '0' after being set.*
- ***If using LCD keypad, set CNF.48 = 1****: Makes the drive retain the parameter settings after a power loss.*

NOTE: If this step is not completed, the drive will NOT retain the communication parameters after a power cycle.

Introduction

ACN-ETH Module

The ACN-ETH is an option module for connecting any ACN series drive to an ethernet network. The module supports both the EtherNet/IP and Modbus TCP protocols.

Components

Product Contents:

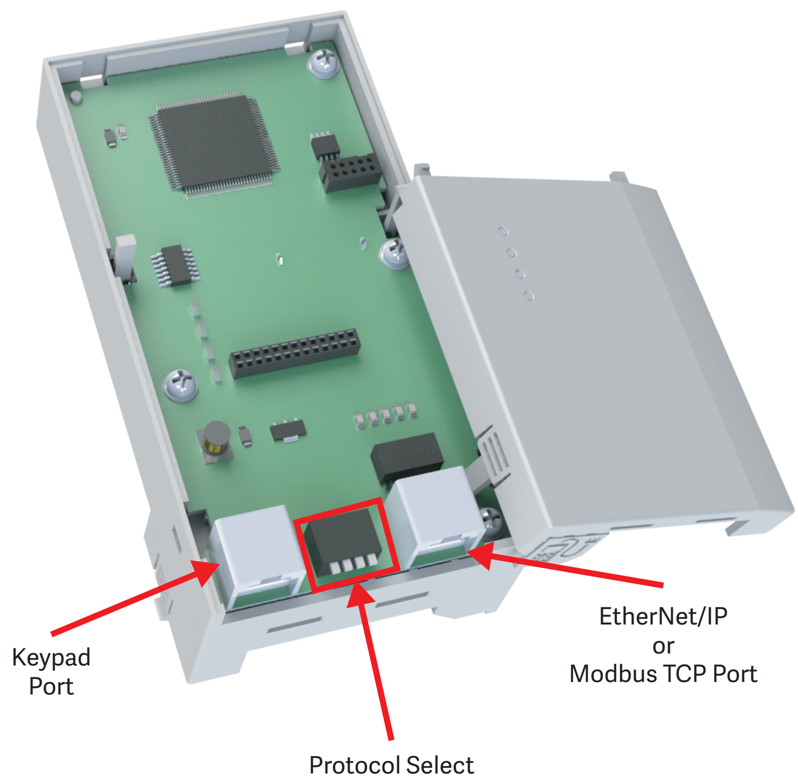
- *Ethernet Communication Module board (CENTACN): 1 ea*
- *Installation Instructions Insert: 1 ea*
- *Brass Bar(M3xL23): 1 ea*
- *Brass Bar(M3xL17.3): 1 ea*
- *Fixed Screw(M3xL8): 2 ea*

Ethernet Communication Module Features

Common Features

Transmission Speed	10Mbps, 100Mbps
Transmission Method	Baseband
Max. Extensible Distance between Nodes	100m (Node-Hub)
Max. Node Number	Hub connection
Auto-Negotiation	Supported
Max. Frame Size	1,500 bytes
Communication Zone Access Method	CSMA/CD
Frame Error Checking Method	CRC32
Recommended TCP Socket	2 Sockets

Layout of Ethernet Communication Module



Installation

The following steps illustrate how to install the ACN-EIO or the ACN-ETH Option Card on the IronHorse ACN series drive.

NOTE: Ensure all control board cables are terminated BEFORE installing the option card. Once the option card is installed, there is no access to the control terminals.

WARNING; Ensure all power is removed from the drive before installing or removing any Option Card. Failure to comply will damage the drive.

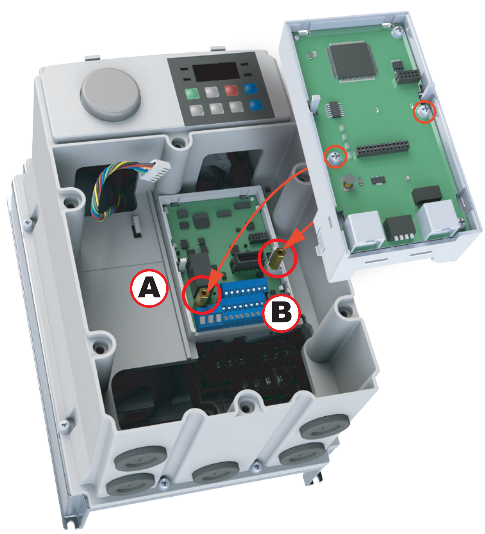
1) Loosen all front cover screws and remove the cover plate. Remove the face plate from the front of the Option card.

2) Remove keypad connector.

3) Remove the white keypad adapter PCB. It may be helpful to use a screwdriver to clear the plastic tabs

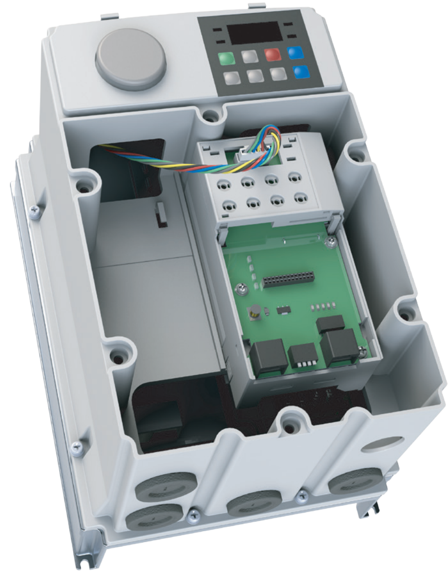
(circled).

4) Once the keypad PCB adapter is removed, remove the existing bottom left screw (A) on the IO board. Keep this screw for later use. Fasten the included brass bar (M3xL23) to (A), and (M3xL17.3) to (B).

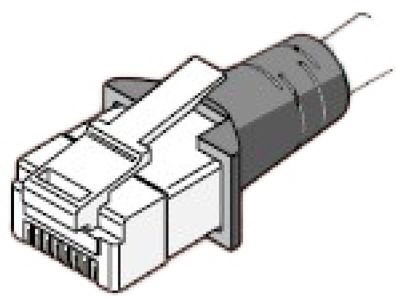


5) Install the Option Card and fasten the screws to the brass bars installed in the previous step.

6) Snap the keypad adapter PCB back into place on the Option Card and reconnect the keypad connector cable. Connect the field cables to the Option Card and install the Option Card cover (not shown). Re-install the drive front cover and tighten the screws.



Terminal Block of Ethernet communication Specifications

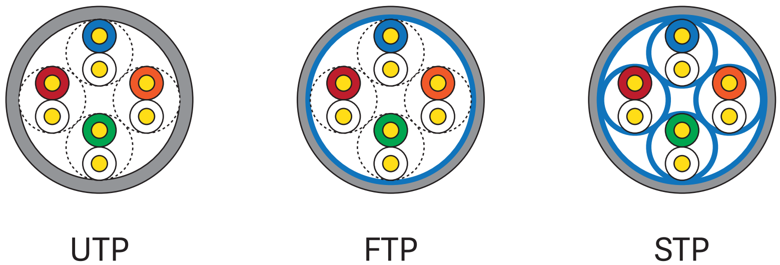


Pin No.	Signal	Description	Cable color
1	TX+	Transmitting data Plus	White / Yellow
2	TX-	Transmitting data Minus	Yellow
3	RX+	Receiving data Plus	White / Green
4	NONE	Not used	Blue
5	NONE	Not used	White / Blue
6	RX-	Receiving data Minus	Green
7	NONE	Not used	White / Brown
8	NONE	Not used	Brown
Make sure that cables connected to Pin1 and 2 are twisted together. Make sure that cables connected to Pin3 and 6 are twisted together.			

Network Cable Specification

Category 5 is used. Transmission speed of category 5 is 100MHz and available up to 100Mbps.

Classification	Detail	Used
UTP (U.UTP)	Unshielded twisted pair cable	Maximum 200MHz, Voice + Information (Data)+Low video signal
FTP (S.UTP)	Foil screened twisted pair cable	Maximum 100MHz Electromagnetic interruption (EMI) or electric stability considered, Voice+ Information (Data) + Low Video signal
STP (S.STP)	Shielded twisted pair cable	Maximum 500MHz, Voice +Information(Data)+Video signal, Replacement for 75Ω coaxial cable



Protocol Selection

The ACN Ethernet module can utilize either the Modbus TCP or EtherNet/IP protocol. Ensure the drive is powered off and use Switch 1 to select the protocol. Switch 2,3,4 are not used.

Switch State	Protocol
OFF (Switch at the upper position)	Modbus TCP
ON (Switch at the lower position	EtherNet/IP

If the option module is operating, the protocol will not be changed even if the switch selection is changed. The protocol is determined by the state of switch when the option module is turned on or the drive is initialized by 'Yes' execution of COM-94 Comm Update.

LED information

LED display feature

Four LEDs are located on the ACN Ethernet Communication Module. Each LED indicates different functions and displays the status of Ethernet Protocol.

Ethernet Line LED (EtherNet/IP and Modbus TCP are same)

LED	Color	Status	Function
SPEED	Green	ON	The communication speed is 100Mbps.
		OFF	The communication speed is 10Mbps.
LINK	Green	ON	The communication module is ready to communicate.
		OFF	Communication cable wiring has a fault, Link LED is turned Off. Check if wiring is correct.

Modbus TCP LED & Troubleshooting

LED	Color	Status	Function and Troubleshooting
CPU	Green	Flash	The CPU of Modbus TCP is operating normally when the power is well supplied to the communication module.
		OFF	Failure in power supply to the communication module. Re-install the module.
ERROR	Red	OFF	The communication module is normal without error.
		ON	IP address set to 0.0.0.0 or 255.255.255.255. Set to a different address.
		CPU and Flash	1. The communication is interrupted. Turn off the power and then reinstall the module. 2. The data from drive is not updated to Ethernet Module. Execute Comm. Update or cycle power.
		Flashing slower than CPU	IP address is conflicted in a network. Check if IP address is appropriate.

EtherNet/IP LED & Troubleshooting

LED	Color	Status	Function and Troubleshooting
NS	Green	ON	IO communicating normally. Class 1 connection is established.
		OFF	Client and TCP are not connected.
		Flash	UCMM communication is available by the registration after Client and TCP are connected.
	Red	ON	Displayed if an IP address clashes with the same IP address in a network. Check whether IP address is duplicated.
		OFF	Communication module is normal.
		Flash	Class 1 connection is disconnected abnormally. Check if the Network cable and connection state are correct.
MS	Green	ON	Communication module board is normal.
		OFF	Communication module has a problem.
	Red	ON	IP address set to 0.0.0.0 or 255.255.255.255. Please do not use the address IP Address because it can be only used for the specific case.
		OFF	Communication module is normal.
		Flash	1. The communication is interrupted. Turn off the power and then reinstall the module. 2. The data from drive is not updated to Ethernet Module. Execute Comm update or cycle power.

NOTE:

1. *When the module is initialized by the selection of EtherNet/IP, LED turns on and off in order as below.*

(MS LED(GREEN) -> NS LED(RED) -> MS LED(RED) -> NS LED(GREEN) -> NS LED(RED)-> NS LED(OFF)->MS LED(GREEN))

2. *When IP address is conflicted, please reset IP and execute Comm. Update.*
3. *Do not use Comm Update (CM.94 ► 1) when the drive is working or in cyclic communication.*

Keypad Parameter of Ethernet Communication

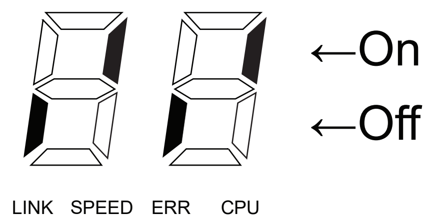
FBus S/W Ver (CM.06)

CM.06 automatically indicates the version of the communication module presently installed in the ACN.

FBus Led (CM.09)

Modbus TCP

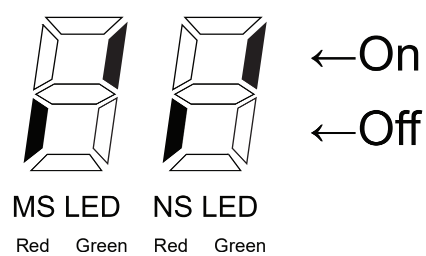
The On/off state of the 4 LEDs on the Ethernet module are displayed in parameter Cm.09.



LINK LED	SPEED LED	ERR LED	CPU LED
OFF	ON	OFF	ON

EtherNet/IP

The On/off state of the 4 LEDs on the Ethernet module are displayed in parameter Cm.09.



MS LED(Red)	MS LED(Green)	NS LED(Red)	NS LED(Green)
OFF	ON	OFF	ON

IP Address, Subnet Mask, Gateway (CM.10~21) Setting

Ethernet communication cards must have their own unique IP address. While the card addresses can be set for DHCP (IP address is set and can be changed by the network), we recommend using static IP addresses. Either method requires the IP addresses (and subnet masks) of the communication cards to be compatible with any other devices that connect to the drive. For an easy subnet mask calculator, please visit www.subnet-calculator.com.

The IP ver. supported by Ethernet Module is v4. All the addresses and maskes are expressed with (decimal).(decimal).(decimal).(decimal) and each decimal number is within 0~255. In Ethernet communication Module, decimal numbers can be entered in Opt Parameter directly. Each Opt Parameters has the value 0 through 255, which is implemented with each field of addresses divided with '.'.

Ex) To set up IP Address 196.168.10.131, enter the Opt Parameter as shown in the table below.

Code Number	Parameter Name	Opt Parameter
CM.10	Opt Para-1	196
CM.11	Opt Para-2	168
CM.12	Opt Para-3	10
CM.13	Opt Para-4	131

Ethernet Speed (CM.22)

Ethernet speed can be set up within the range of 0~2

Set Value	Speed
0	Set the speed automatically
1	100Mbps
2	10Mbps

Automatic speed setting function automatically sets up the highest speed in the network.

CIP Input Instance (CM.29)

This parameter is displayed when the protocol setting is EtherNet/IP. It sets up the data format of the drive status sent from the drive to the Client (Originator) during the I/O communication module of the CIP (Common Industrial Protocol). Refer to the Assembly Object of the EtherNet/IP.

Set Value	Input Instance Value	Data Size	Parameter Number
0	70	4	X
1	71	4	X
2	110	4	X
3	111	4	X
4	141	2	1
5	142	4	2
6	143	6	3
7	144	8	4
8	145	10	5
9	146	12	6
10	147	14	7
11	148	16	8

NOTE: For proper EtherNet/IP communications, CM.29 and CM.49 must be manually set to the same value.

CIP Output Instance(CM.49)

This parameter is displayed only when protocol is set to EtherNet/IP. It sets up the data format of the drive command sent from the Client (Originator) to control the drive during the I/O communication module of the CIP (Common Industrial Protocol). Refer to the Assembly Object of the EtherNet/IP.

Set Value	Output Instance Value	Data Size	Parameter Number
0	20	4	X
1	21	4	X
2	100	4	X
3	101	4	X
4	121	2	1
5	122	4	2
6	123	6	3
7	124	8	4
8	125	10	5
9	126	12	6
10	127	14	7
11	128	16	8

NOTE: Ensure Cm.29 and Cm.49 are set to the same value for communications to work properly.

Cm.29 & CM.49 Parameter Value	Cm.29 Input Instance		Cm.49 Output Instance
0	70	↔	20
1	71	↔	21
2	110	↔	100
3	111	↔	101
4	141	↔	121
5	142	↔	122
6	143	↔	123
7	144	↔	124
8	145	↔	125
9	146	↔	126
10	147	↔	127
11	148	↔	128

Number of Output Parameters (CM.30)

This parameter is not used in case of Modbus TCP. This parameter updates only when the value of the Input Instance (CM.29) is set to 4 or above and Comm Update(CM-94:YES) is initialized. CM.30 Para Status is read only and will display the number of parameters configured in CM.29.

Parameter Status (CM.31~CM.38)

These parameters can be utilized by Modbus TCP or EtherNet/IP. Enter the hex address of the desired drive parameter or common address. This is sent for the reference data of the Client (Originator) at the same number as that of the set parameters in the CM.31~CM.38.

Number of Input Parameters (CM.50)

This parameter is not used in case of Modbus TCP. This parameter updates only when the set value of the Output Instance (CM.49) is 4 or above and Comm Update(CM-94:YES) is initialized. CM.50 Para Ctrl Num is read only and will display the number of parameters configured in CM.49.

Parameter Control (CM.51~CM.58)

These parameters can be utilized by Modbus TCP or EtherNet/IP. Enter the hex address of the desired drive parameter or common address. This is used for the reference data of the Client (Originator) at the same number as that of the set parameters in the CM.51~CM.58.

Comm Update (CM.94)

When Communication settings parameters are changed, the value is not applied immediately. The Communication update parameter (CM.94) must be set to 1 to apply the change. After any Comm settings changes be sure to set CM.94=1. This action will restart Ethernet Communication. In addition, this action will prevent any data loss from a drive power loss.

Modbus TCP

Modbus TCP Frame Structure

MBAP Header(7 bytes)	PDU (5 bytes ~)

Generally, Ethernet uses Ethernet II Frame.

Header	Length	Description
Transaction Identifier	2 Bytes	It is increased by 1 each time as an unique transmitting number when Data Frame is sent from Client to Server.
Protocol Identifier	2 Bytes	Fixed as 0
Length	2 Bytes	It is Modbus Data Frame length which means the length by Byte from MBAP Header to Unit Identifier.
Unit Identifier	1 Bytes	When Modbus TCP and Modbus/RTU are connected by Gate, Slave number is written. When Modbus TCP is only used, it is fixed as 0xFF.

Protocol Data Unit (PDU): AS an actual Data of Modbus TCP, It is composed of Function Code and Data.

Function Code Description

Modbus TCP can be divided into Client and Server. Client gives the command and Server responds to the command. Generally, as Client, there are PLC, HMI and PC so on, and Server means drive.

Read Holding Register

This is a function for reading data from drive (Server).

NOTE: For Modbus TCP addresses, refer to "Drive Expansion Common Area Parameter" on page 5-16.

Frame configuration requiring to Server from Client

Required Frame	Length	Value
Function Code	1 Bytes	0x03
Comm. Address	2 Bytes	0x0000 ~ 0xFFFF
Required Data Number	2 Bytes	1~16

Frame configuration responding to Master from Server

Responded Frame	Length	Value
Function Code	1 Bytes	0x03
Comm. Address	1 Bytes	2 x Required Data Number
Required Data Number	Required Data Number x 2 Bytes	The required data number according to the number of communication address

Read Input Register

This is a function for reading data from Drive (Server).

Frame configuration requiring to Server from Client

Required Frame	Length	Value
Function Code	1 Bytes	0x04
Comm. Address	2 Bytes	0x0000 ~ 0xFFFF
Required Data Number	2 Bytes	1~16

Frame configuration responding to Master from Server

Required Frame	Length	Value
Function Code	1 Bytes	0x04
Comm. Address	1 Bytes	2 x Required Data Number
Required Data Number	Required Data Number x 2 Bytes	The required data number according to the number of communication address

Write Single Register

This is a function for modifying a data of Drive (Server).

Frame configuration requiring to Server from Client

Required Frame	Length	Value
Function Code	1 Bytes	0x06
Comm. Address	2 Bytes	0x0000 ~ 0xFFFF
Required Data Number	2 Bytes	0x0000 ~ 0xFFFF

Frame configuration responding to Master from Server

Required Frame	Length	Value
Function Code	1 Bytes	0x06
Comm. Address	2 Bytes	0x0000 ~ 0xFFFF
Required Data Number	2 Bytes	0x0000 ~ 0xFFFF

Write Multiple Register

This is a function for modifying the consecutive data of drive (Server) from 1 up to 16.

Frame configuration requiring to Server from Client

Required Frame	Length	Value
Function Code	1 bytes	0x10
Comm. Address	2 bytes	0x0000 ~ 0xFFFF
Modifying data number	2 bytes	1~16
Byte Count	1 bytes	2 X Number of data
Data value to be modified	Number of data x 2 bytes	Data for modifying

Frame configuration responding to Master from Server

Required Frame	Length	Value
Function Code	1 Bytes	0x10
Comm. Address	2 Bytes	0x0000 ~ 0xFFFF
Modifying Data number	2 Bytes	1~16

Except Frame

This is a responding frame from server in case of an error that happens when it sends the required frame from Client.

Exception Frame Structure

Error Frame	Length	Value
Error Code	1bytes	0x80 + Function Code that client requires
Exception Code	1bytes	0x0000 ~ 0xFFFF

Exception Code Type

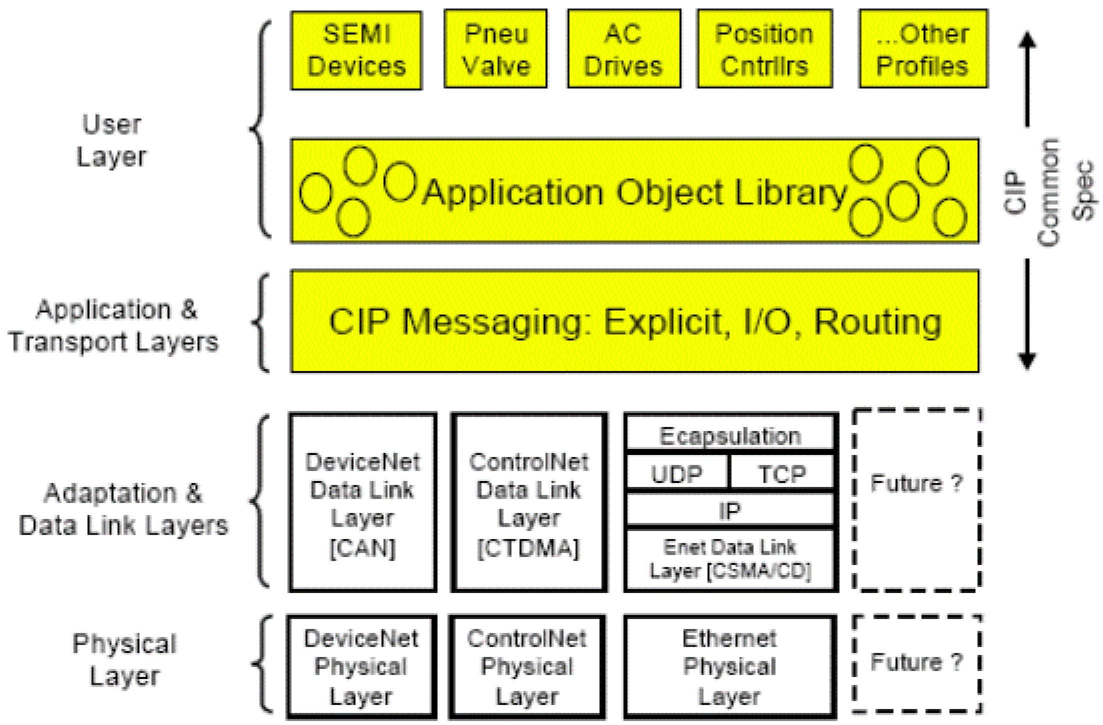
Type	Code	Description
ILLEGAL FUNCTION	0x01	In case non-supported Function is required.
ILLEGAL DATA ADDRESS	0x02	Unused address is required or to be modified.
ILLEGAL DATA VALUE	0x03	The modified data exceeds the permitted range when it needs to modify the data.
SLAVE DEVICE FAILURE	0x04	In case there is an error in server (Communication failure with drive, Initialization failure, Communication failure between drive and Data)
SLAVE DEVICE BUSY	0x06	In case the server can't respond due to other process (such as Drive parameter initialization or module initialization setting)
WRITE PERMITION ERROR	0x20	In case the value cannot be modified because the value is prohibited to modify.

EtherNet/IP

Basic Protocol Configuration

The EtherNet/IP is a protocol implemented with the CIP (Common Industrial Protocol), defined by the ODVA, by using TCP and UDP.

- *Originator: It is the device requesting connection, called Client. The device represents a PLC or a scanner.*
- *Target: It is the device responded to the connection, called Server. The device represents an Drive.*



Implicit Message

The Implicit Message is also called I/O Message, which is the data communicated between the Client (Originator) and Server (Target) at preset period by the Input Instance and Output Instance. The connection is a Class 1 Connection

Supported range

- *Transport Type*
  - » *Originator->Target: Point to Point*
  - » *Target->Originator: Multicast*
- *Transport Trigger: Cyclic*
- *Configuration Connection: 1*
- *Connection Tag: Not supported*
- *Priority*
  - » *Originator->Target: Scheduled*
  - » *Target->Originator: Scheduled*
  - » *Configuration Data: Not supported*

Input Instance

The data of the Drive status periodically sent from the Drive to PLC or a Client device.

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
70	0						Running1 (Fwd)		Faulted
	1								
	2	Speed Actual (Low Byte) – RPM unit (note 1)							
	3	Speed Actual (High Byte) – RPM unit							
71	0	At Reference	Ref From Net	Ctrl From Net	Ready	Running 2 (Rev)	Running1 (Fwd)	Warning	Faulted
	1	Drive State							
	2	Speed Actual (Low Byte) – RPM unit							
	3	Speed Actual (High Byte) – RPM unit							
110	0						Running1 (Fwd)		Faulted
	1								
	2	Speed Actual (Low Byte) – Hz unit (note 1)							
	3	Speed Actual (High Byte) – Hz unit							
111	0	At Reference	Ref From Net	Ctrl From Net	Ready	Running 2 (Rev)	Running1 (Fwd)	Warning	Faulted
	1	Drive State							
	2	Speed Actual (Low Byte) – Hz unit							
	3	Speed Actual (High Byte) – Hz unit							
141	0	Status Parameter - 1 data (Low Byte)							
	1	Status Parameter - 1 data (Hi Byte)							
142	0	Status Parameter - 1 data (Low Byte)							
	1	Status Parameter - 1 data (Hi Byte)							
	2	Status Parameter - 2 data (Low Byte)							
	3	Status Parameter - 2 data (Hi Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
143	0	Status Parameter - 1 data (Low Byte)							
	1	Status Parameter - 1 data (Hi Byte)							
	2	Status Parameter - 2 data (Low Byte)							
	3	Status Parameter - 2 data (Hi Byte)							
	4	Status Parameter - 3 data (Low Byte)							
	5	Status Parameter - 3 data (Hi Byte)							
144	0	Status Parameter - 1 data (Low Byte)							
	1	Status Parameter - 1 data (Hi Byte)							
	2	Status Parameter - 2 data (Low Byte)							
	3	Status Parameter - 2 data (Hi Byte)							
	4	Status Parameter - 3 data (Low Byte)							
	5	Status Parameter - 3 data (Hi Byte)							
	6	Status Parameter - 4 data (Low Byte)							
	7	Status Parameter - 4 data (Hi Byte)							
145	0	Status Parameter - 1 data (Low Byte)							
	1	Status Parameter - 1 data (Hi Byte)							
	2	Status Parameter - 2 data (Low Byte)							
	3	Status Parameter - 2 data (Hi Byte)							
	4	Status Parameter - 3 data (Low Byte)							
	5	Status Parameter - 3 data (Hi Byte)							
	6	Status Parameter - 4 data (Low Byte)							
	7	Status Parameter - 4 data (Hi Byte)							
	8	Status Parameter - 5 data (Low Byte)							
	9	Status Parameter - 5 data (Hi Byte)							
146	0	Status Parameter - 1 data (Low Byte)							
	1	Status Parameter - 1 data (Hi Byte)							
	2	Status Parameter - 2 data (Low Byte)							
	3	Status Parameter - 2 data (Hi Byte)							
	4	Status Parameter - 3 data (Low Byte)							
	5	Status Parameter - 3 data (Hi Byte)							
	6	Status Parameter - 4 data (Low Byte)							
	7	Status Parameter - 4 data (Hi Byte)							
	8	Status Parameter - 5 data (Low Byte)							
	9	Status Parameter - 5 data (Hi Byte)							
	10	Status Parameter - 6 data (Low Byte)							
	11	Status Parameter - 6 data (Hi Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
147	0	Status Parameter - 1 data (Low Byte)							
	1	Status Parameter - 1 data (Hi Byte)							
	2	Status Parameter - 2 data (Low Byte)							
	3	Status Parameter - 2 data (Hi Byte)							
	4	Status Parameter - 3 data (Low Byte)							
	5	Status Parameter - 3 data (Hi Byte)							
	6	Status Parameter - 4 data (Low Byte)							
	7	Status Parameter - 4 data (Hi Byte)							
	8	Status Parameter - 5 data (Low Byte)							
	9	Status Parameter - 5 data (Hi Byte)							
	10	Status Parameter - 6 data (Low Byte)							
	11	Status Parameter - 6 data (Hi Byte)							
	12	Status Parameter - 7 data (Low Byte)							
	13	Status Parameter - 7 data (Hi Byte)							
148	0	Status Parameter - 1 data (Low Byte)							
	1	Status Parameter - 1 data (Hi Byte)							
	2	Status Parameter - 2 data (Low Byte)							
	3	Status Parameter - 2 data (Hi Byte)							
	4	Status Parameter - 3 data (Low Byte)							
	5	Status Parameter - 3 data (Hi Byte)							
	6	Status Parameter - 4 data (Low Byte)							
	7	Status Parameter - 4 data (Hi Byte)							
	8	Status Parameter - 5 data (Low Byte)							
	9	Status Parameter - 5 data (Hi Byte)							
	10	Status Parameter - 6 data (Low Byte)							
	11	Status Parameter - 6 data (Hi Byte)							
	12	Status Parameter - 7 data (Low Byte)							
	13	Status Parameter - 7 data (Hi Byte)							
	14	Status Parameter - 8 data (Low Byte)							
	15	Status Parameter - 8 data (Hi Byte)							

The table below presents the description of the bit data for the 0, 1 byte of 70, 71, 110, 111.

Name	Description	Related Attribute	
		Class	Attr. ID
Faulted	Drive Error	0x29	10
Warning	Not Supported	0x29	11
Running1	Motor is running Forward	0x29	7
Running2	Motor is running Reverse	0x29	8
Ready	Motor is ready to running	0x29	9
Ctrl From Net	Run/Stop control	0x29	15
Ref From Net	Speed control	0x2A	29
At Reference	Reach at reference Speed	0x2A	3
Drive State	Current Motor State	0x29	6
Speed Actual	Speed Command	0x2A	7

Output Instance

The command data sent from PLC or a Client device to the Drive, on periodical frequency.

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
20	0						Fault Reset		Run Fwd
	1	0							
	2	Speed Reference (Low Byte) – RPM unit							
	3	Speed Reference (High Byte) – RPM unit							
21	0		NetRef (note2)	NetCtrl (note2)			Fault Reset	Run Rev	Run Fwd
	1	0							
	2	Speed Reference (Low Byte) – RPM unit							
	3	Speed Reference (High Byte) – RPM unit							
100	0						Fault Reset		Run Fwd
	1	0							
	2	Speed Reference (Low Byte) – Hz unit							
	3	Speed Reference (High Byte) – Hz unit							
101	0		NetRef	NetCtrl			Fault Reset	Run Rev	Run Fwd
	1	0							
	2	Speed Reference (Low Byte) – Hz unit							
	3	Speed Reference (High Byte) – Hz unit							
121	0	Control Parameter - 1 data (Low Byte)							
	1	Control Parameter - 1 data (Hi Byte)							
122	0	Control Parameter - 1 data (Low Byte)							
	1	Control Parameter - 1 data (Hi Byte)							
	2	Control Parameter - 2 data (Low Byte)							
	3	Control Parameter - 2 data (Hi Byte)							
123	0	Control Parameter - 1 data (Low Byte)							
	1	Control Parameter - 1 data (Hi Byte)							
	2	Control Parameter - 2 data (Low Byte)							
	3	Control Parameter - 2 data (Hi Byte)							
	4	Control Parameter - 3 data (Low Byte)							
	5	Control Parameter - 3 data (Hi Byte)							
124	0	Control Parameter - 1 data (Low Byte)							
	1	Control Parameter - 1 data (Hi Byte)							
	2	Control Parameter - 2 data (Low Byte)							
	3	Control Parameter - 2 data (Hi Byte)							
	4	Control Parameter - 3 data (Low Byte)							
	5	Control Parameter - 3 data (Hi Byte)							
	6	Control Parameter - 4 data (Low Byte)							
	7	Control Parameter - 4 data (Hi Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
125	0	Control Parameter - 1 data (Low Byte)							
	1	Control Parameter - 1 data (Hi Byte)							
	2	Control Parameter - 2 data (Low Byte)							
	3	Control Parameter - 2 data (Hi Byte)							
	4	Control Parameter - 3 data (Low Byte)							
	5	Control Parameter - 3 data (Hi Byte)							
	6	Control Parameter - 4 data (Low Byte)							
	7	Control Parameter - 4 data (Hi Byte)							
	8	Control Parameter - 5 data (Low Byte)							
	9	Control Parameter - 5 data (Hi Byte)							
126	0	Control Parameter - 1 data (Low Byte)							
	1	Control Parameter - 1 data (Hi Byte)							
	2	Control Parameter - 2 data (Low Byte)							
	3	Control Parameter - 2 data (Hi Byte)							
	4	Control Parameter - 3 data (Low Byte)							
	5	Control Parameter - 3 data (Hi Byte)							
	6	Control Parameter - 4 data (Low Byte)							
	7	Control Parameter - 4 data (Hi Byte)							
	8	Control Parameter - 5 data (Low Byte)							
	9	Control Parameter - 5 data (Hi Byte)							
	10	Control Parameter - 6 data (Low Byte)							
	11	Control Parameter - 6 data (Hi Byte)							
127	0	Control Parameter - 1 data (Low Byte)							
	1	Control Parameter - 1 data (Hi Byte)							
	2	Control Parameter - 2 data (Low Byte)							
	3	Control Parameter - 2 data (Hi Byte)							
	4	Control Parameter - 3 data (Low Byte)							
	5	Control Parameter - 3 data (Hi Byte)							
	6	Control Parameter - 4 data (Low Byte)							
	7	Control Parameter - 4 data (Hi Byte)							
	8	Control Parameter - 5 data (Low Byte)							
	9	Control Parameter - 5 data (Hi Byte)							
	10	Control Parameter - 6 data (Low Byte)							
	11	Control Parameter - 6 data (Hi Byte)							
	12	Control Parameter - 7 data (Low Byte)							
	13	Control Parameter - 7 data (Hi Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
128	0	Control Parameter - 1 data (Low Byte)							
	1	Control Parameter - 1 data (Hi Byte)							
	2	Control Parameter - 2 data (Low Byte)							
	3	Control Parameter - 2 data (Hi Byte)							
	4	Control Parameter - 3 data (Low Byte)							
	5	Control Parameter - 3 data (Hi Byte)							
	6	Control Parameter - 4 data (Low Byte)							
	7	Control Parameter - 4 data (Hi Byte)							
	8	Control Parameter - 5 data (Low Byte)							
	9	Control Parameter - 5 data (Hi Byte)							
	10	Control Parameter - 6 data (Low Byte)							
	11	Control Parameter - 6 data (Hi Byte)							
	12	Control Parameter - 7 data (Low Byte)							
	13	Control Parameter - 7 data (Hi Byte)							
	14	Control Parameter - 8 data (Low Byte)							
	15	Control Parameter - 8 data (Hi Byte)							

The table below presents the data description of the 0Byte of 20, 21, 100 and 101.

Name	Description	Related Attribute	
		Class	Attr. ID
Run Fwd note1)	Forward Run Command	0x29	3
Run Rev note1)	Reverse Run Command	0x29	4
Fault reset note1)	Fault Reset Command	0x29	12
NetRef note2)	Not used	0x2A	4
NetCtrl note2)	Not used	0x29	5
Speed Reference	Speed Command	0x2A	8

note1) refer to the Drive Run and Fault in the Control Supervisor Object (Class 0x29).

note2) the setting of the Reference Control and Run/Strop Control can be made only by the LCD Control Panel. Therefore, NetRef and NetCtrl are not used at the Instances 21 and 101.

Explicit Message

A non-periodic communication method used for reading or writing the attribute value of the Drive or EtherNet/IP. The UCMM method which can communicate data between Originator and Target without connection, and a periodic data communication method using Class 3 Connection are available.

Supported Object

Identity Object (Class 0x01, Instance 1)

Attribute ID	Access	Attribute Name	Data Length	Attribute Value
1	Get	Vendor ID	Word	259
2	Get	Device Type (AC Drive)	Word	2
3	Get	Product Code	Word	10*
4	Get	Low Byte - Major revision High Byte - Minor revision	Word	0x0102**
5	Get	Status	Word	See "Bit Status Definition" table below
6	Get	Serial Number	Double Word	Serial number is made by last four numbers of MAC ID. For example, if MAC ID is 00:0B:29:00:00:22, Serial number will be 0x29000022
7	Get	Product Name	12 Byte	ACN Ethernet
**Product code '6' means ACN AC drive. **The Upper and Lower byte represent the Major Revision and Minor Revision, respectively. For example, 0x0102 means 2.01. The version of the Ethernet communication is indicated in the Keypad CM. 6 FBus S/W Ver.*				

Bit Status Definition	
Bit	**Definition**
0	0: Device is not connected to Master. 1: Device is connected to Master.
1	Reserved
2	Configured (always '0')
3	Reserved
4 ***5*** ***6*** ***7***	0 : Unknown 2: in case of incorrect I/O connection. 3: in case of no previous I/O connection at all. 5: Major Fault 6: I/O in connection.
8	Minor Recoverable Fault (In case of Warning state of drive)
9	Minor Unrecoverable Fault (N/A)
10	Major Recoverable Fault (In case of H/W trip state of drive)
11	Major Unrecoverable Fault (In case of trip state except for H/W trip of drive)

Service Code	Definition	Support for Class	Support for Instance
0x0E	Get Attribute Single	No	Yes
0x05	Reset	No	Yes
0x10	Set Attribute Single	No	Yes

Motor Data Object (Class 0x28, Instance 1)

Attribute ID	Access	Attribute Name	Range	Definition
3	Get	Motor Type	0~10	0 : Non-standard motor
				1 : PM DC Motor
				2 : FC DC Motor
				3 : PM Synchronous Motor
				4 : FC Synchronous Motor
				5 : Switched Reluctance Motor
				6 : Wound Rotor Induction Motor
				7 : Squirrel Cage Induction Motor
				8 : Stepper Motor
				9 : Sinusoidal PM BL Motor
				10 : Trapezoidal PM BL Motor
6	Get/Set	Motor Rated Current	0.0~1000.0	[Get] Read Rated Current of bA-13. [Set] The setting value is reflected on Rated Current of bA-13 Scale: 0.1
7	Get/Set	Motor Rated Voltage	0~690	[Get] Read Rated Voltage of bA-15 [Set] The setting value is reflected on Rated Voltage of bA-15 Scale: 1

Service Code	Definition	Support for Class	Support for Instance
0x0E	Get Attribute Single	No	Yes
0x10	Set Attribute Single	No	Yes

Control Supervisor Object (Class 0x29, Instance 1)

Attribute ID	Access	Attribute Name	Range	Definition
3	Get / Set	Forward Run Cmd.	0	Stop Operation in normal direction (See "Drive Run Command" table below)
			1	
4	Get / Set	Reverse Run Cmd.	0	Stop Operation in reverse direction (See "Drive Run Command" table below)
			1	
5	N/A	Net Control	-	Can be set up as Drive parameter only.
6	Get	Drive State	0	Vendor specific
			1	Startup
			2	Not_Ready
			3	Ready
			4	Enabled
			5	Stopping
			6	Fault_Stop
			7	Faulted
7	Get	Running Forward	0	Stopping
			1	Operating in normal direction
8	Get	Running Reverse	0	Stopping
			1	Operating in reverse direction
9	Get	Drive Ready	0	Being reset or tripped
			1	Normal condition for Drive operation

Attribute ID	Access	Attribute Name	Range	Definition
10	Get	Drive Fault	0	Presently not tripped
			1	Presently being tripped.
12	Get / Set	Drive Fault Reset	0	Trip Reset after a trip. Reset can be done only when TRUE is inputted in FALSE status (See the Drive Fault Code Table below).
			1	
13	Get	Drive Fault Code		See the Drive Fault Code Table below
14	Get	Control From Net.	0	Provide operation reference through a source other than FieldBus communication.
			1	Provide operation reference through FieldBus communication source.

Drive Run Command			
Run1	**Run2**	**Trigger Event**	**Run Type**
0	0	Stope	NA
0→1	0	Run	Run1
0	0→1	Run	Run2
0→1	0→1	No Action	NA
1	1	No Action	NA
1→0	1	Run	Run2
1	1→0	Run	Run1
Run1 stands for the Forward Run Cmd. and Run 2 stands for the Reverse Run Cmd. In other words, the Option gives an operation reference to the Drive at the moment of change from 0(FALSE) to 1(TRUE). When the Forward Run Cmd. value has been read, it does not represent the present operation status of the Drive, but the operation command value of the Option.			

Drive Fault Codes			
Fault Code Number	**Description**		
0x0000	None		
0x1000	Ethermal	Out Phase Open	DriveOLT
	InPhaseOpen	ThermalTrip	UnderLoad
	ParaWriteTrip	IOBoardTrip	PrePIDFail
	OptionTrip1	OptionTrip2	OptionTrip3
	LostCommand	UNDEFINED	LostKeypad
0x2200	OverLoad		
0x2310	OverCurrent1		
0x2330	GFT		
0x2340	OverCurrent2		
0x3210	OverVoltage		
0x3220	LowVoltage		
0x2330	GroundTrip		
0x4000	NTCOpen		
0x4200	OverHeat		
0x5000	FuseOpen	HWDiag	
0x7000	FanTrip		
0x7120	No Motor Trip		
0x7300	EncorderTrip		
NOTE: If the Drive is tripped, the Drive Fault becomes TRUE.			

Drive Fault Codes		
Fault Code Number	**Description**	
0x8401	SpeedDevTrip	
0x8402	OverSpeed	
0x9000	ExternalTrip	BX
NOTE: If the Drive is tripped, the Drive Fault becomes TRUE.		

At 0 → 1 (FALSE → TRUE), the Drive Fault Reset gives TRIP RESET reference to Drive. Overwriting 1 (TRUE) on 1 (TRUE) does not generate RESET reference to the Drive trip. To send RESET reference from Option to Drive in 1 (TRUE) status, write 0 (FAULT) and then write 1(TRUE) again.

Service Code	Definition	Support for Class	Support for Instance
0x0E	Get Attribute Single	No	Yes
0x10	Set Attribute Single	No	Yes

<u>AC Drive Object (Class 0x2A, Instance 1)</u>

Attribute ID	Access	Attribute Name	Range	Definition
3	Get	At Reference	0	Means that the output frequency has not reached the set up frequency, yet.
			1	Means that the output frequency has reached the set up frequency.
4	Not supported	Net Reference	-	-
6	Get	Drive Mode *	0	Vendor Specific Mode
			1	Open Loop Speed(Frequency)
			2	Closed Loop Speed Control
			3	Torque Control
			4	Process Control (e.g. PI)
7	Get	Speed Actual	0~24000	Displayed present output frequency in [rpm] unit.
8	Get/Set	Speed Ref	0~24000	Give reference after converting the target frequency in [rpm] unit. For this, the DRV-07 Freq Ref Src must have been set up to FieldBus.
9	Get	Actual Current	0~111.0 A	Monitor present current by 0.1 A unit basis.
29	Get	Ref.From Network	0	The frequency reference source is not the FieldBus communication.
			1	The frequency reference source is the FieldBus communication.
100	Get	Actual Hz	0~400.00 Hz	Monitor present operating frequency by Hz unit.
101	Get/Set	Reference Hz	0~400.00 Hz	When the dr-07 Freq Ref Src is set to FieldBus, the reference frequency can be set up by communication.
102	Get/Set	Acceleration Time **	0~6000.0 sec	Set-up/monitor Drive acceleration time.
103	Get/Set	Deceleration Time ***	0~6000.0 sec	Set-up/monitor Drive deceleration time.
Related with dr-10 Torque Control and AP-01 App mode. If the dr-10 Torque Control is set to 'Yes,' Drive Mode becomes "Torque Control," and if AP-01 App mode is set to Proc PID, the Drive Mode becomes "Process Control (e.g.PI)." **dr-03: Acc Time value. * dr-04: Dec Time value.*				

Service Code	Definition	Support for Class	Support for Instance
0x0E	Get Attribute Single	No	Yes
0x10	Set Attribute Single	No	Yes

Class 0x64 (Drive Object) – Manufacture Profile

This is the object to access Keypad Parameters of the Drive.

Instance	Access	Attribute Number	Attribute Name	Attribute Value
1 (dr Group)	Get/Set	Refer to "Chapter 4: AC Drive Parameters"	ACN Keypad Title	Setting range of ACN Parameter
2 (bA Group)				
3 (Ad Group)				
4 (Cn Group)				
5 (In Group)				
6 (OU Group)				
7 (CM Group)				
8 (AP Group)				
9 (Reserved)				
10 (Reserved)				
11 (PRT Group)				
12 (M2 Group)				

Service Code	Definition	Support for Class	Support for Instance
0x0E	Get Attribute Single	No	Yes
0x10	Set Attribute Single	No	Yes

Lost Command

Drive Keypad Parameter

Code Number	Parameter Name	Default	Set Value	Description
Pr-12	Lost Cmd Mode	"None"	"None" "Free-Run" "Dec" "Hold Input" "Hold Output" "Lost Preset"	If Lost Command occurs, sets up the Drive action. (See "Lost Command Mode" table below)
Pr-13	Lost Cmd Time	1.0	0.1~120.0 sec	Sets up Lost Command occurrence time
Pr-14	Lost Preset F	0	0~600.00 Hz	Sets up speed of Lost Preset

Lost Command Mode	
Set Value	**Function**
"None"	Maintains the previous status.
"Free-Run"	Lost Command Trip occurs and Free Run stops.
"Dec"	Lost Command Trip occurs and stops by Trip deceleration time.
"Hold Input"	Lost Command Warning occurs and operates by the previous operation reference.
"Hold Output"	Lost Command Warning occurs and operates at the previous operation speed.
"Lost Preset"	Lost Command Warning occurs and operates at the speed set up in the Pr-14.

Modbus TCP Lost Command Status

If the Modbus TCP receives no data from Client for 100msec, the Option becomes Lost Command status, and after the time set up in the Pr-13, the Drive operates according to the settings in the Pr-12.

EtherNet/IP Lost Command Status

If there is no Implicit Message Connection (Class1 Connection) between the Originator (PLC or Client) and Target (Drive), the Option becomes Lost Command status, and after the time set up in the Pr-13, the Drive operates according to the settings in the Pr-12.

APPENDIX D: SAFE TORQUE OFF

APPENDIX

D

Table of Contents

Introduction

Introduction

The Safe Torque Off (STO) function turns off the power supplied to the motor through the hardware, so that the motor cannot produce torque. This method of removing power from the motor is considered an emergency power off, also known as "coast to stop." The Safe Torque Off function utilizes two independent hardware circuits to control the motor current drive signal, and thus turns off the inverter power module output in order to achieve the status of safe stop. In normal E-stop situations, both circuits will be opened (using a dual-channel safety relay, etc.).

ACN Series drives have built-in safety functions suitable for modern safety standards. The Safety input function meets EN ISO 13849-1 PLd and EN 61508 SIL2 (EN60204-1, stop category 0).

This feature is standard and enables compliance with current safety standards.

Terminal Configuration

Terminal		Size		Specification
Name	Description	mm^2	AWG	
SC	Safety Input Power	0.25~0.75 mm^2 (20~26AWG) Shield Type Twisted pair cable		DC 24V, Below 25mA
SA	Safety Input A			Short: Normal (SC-SA or SB) Open: Safety trip (SC-SA or SB)
SB	Safety Input B			

Safe Torque Off Terminal Function Description

Operation Conditions Description

To detect a safety situation, 24V power is not detected or external switch (Safety relay) is disconnected to signal both circuits. These two circuits are connected to the CPU, Gate Drive circuit, and serve to block the PWM Gate to shut off the drive output in a safety situation.

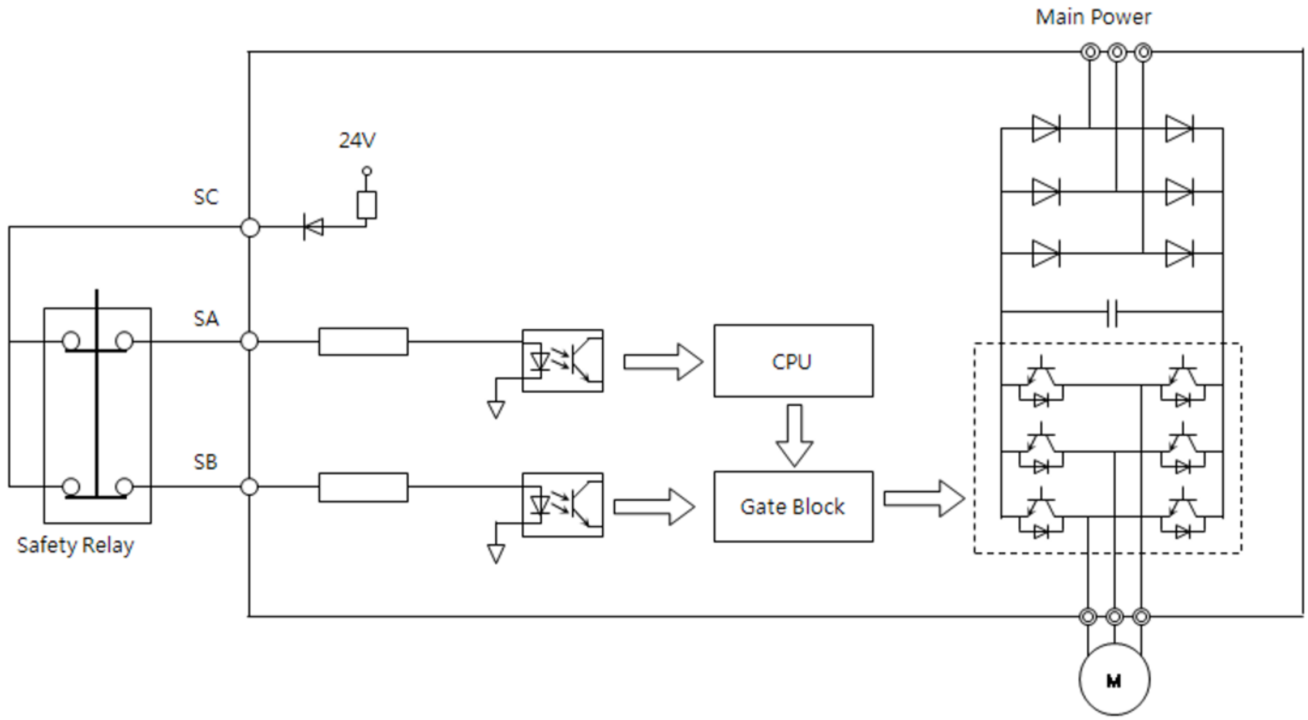
- *IGBT Drive IC Power Off: In a Safety situation, signals are transmitted to the CPU via the Safety A (SA) circuit, turning off the Gate Drive IC power to shut down the Gate.*
- *IGBT Drive Buffer IC Shutdown: In a Safety situation, turn the pin of the Gate Drive or Drive buffer IC high through the Safety B (SB) circuit to shut down the Gate.*

Status	SC-SA	SC-SB	Digital Output (Trip)
Short	Normal	Normal	Off (Low)
Open	Safety trip (Shut down)	Safety trip (Shut down)	On (High)

Wiring Diagrams

Internal Sto Circuit

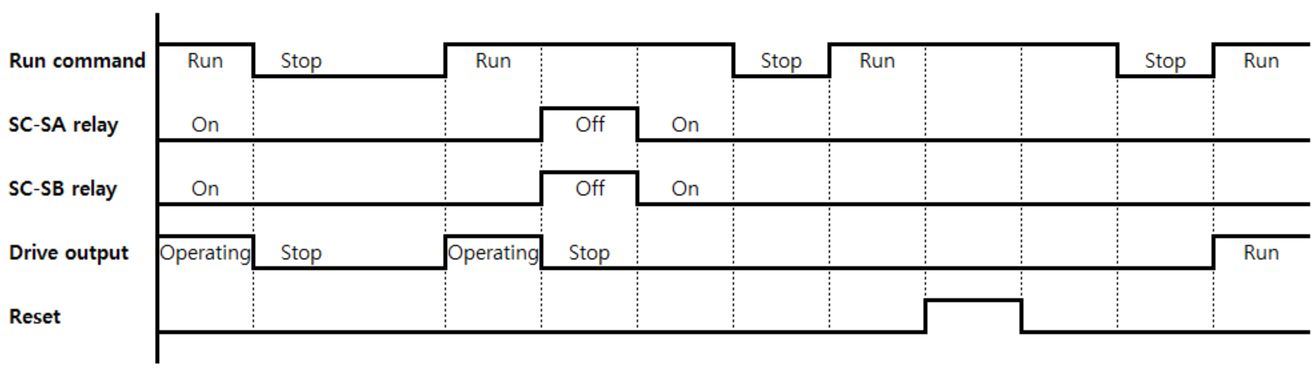
In the figure below, the factory setting for SC-SA and SC-SB is short circuit by a factory installed jumper.



Operating Sequence Description

Normal Operation Status

When the SC-SA and SC-SB = On (Short), the drive will execute "Operating" or "Stop" according to Run/Stop command.



Safe Function Failure Rate

Item	Definition	Performance
SFF	Safety Fraction	77%
Maximum Allowable SIL	Maximum Allowable Safety Integrity Level	SIL2
PFH	Average Frequency of Dangerous Failure	1.2x10^(-7) hour
SIL	Safety Integrity Level	SIL2

Safety Requirements Specification

Installation Considerations

The extremes of all environmental conditions (including electromagnetic) that are likely to be encountered by the PDS (SR) during storage, transport, testing, installation, commissioning, operation and maintenance.

Item	Description
Ambient Temperature	Heavy Duty: 14~104°F(-10–40°C)
Ambient Humidity	90% relative humidity (no condensation)
Storage Temperature	-4~149°F(-20~65°C)
Environmental Factors	An environment free from corrosive or flammable gases, oil residue or dust
Altitude/Vibration	Lower than 3,280ft (1,000m) above sea level/less than 1G (9.8m/sec^2)
Air Pressure	70~106kPa

Safe Function Performance

For each safety-related function (or group of simultaneously used safety functions), both a SIL capability and a maximum probability of dangerous random hardware failure.

Item	Definition	Performance
SIL	Safety Integrity Level	2
PFH	Average Frequency of Dangerous Failure	≥ 10^{-7} to < 10^{-6}
Category	Category	Category 0
PL	Performance Level	d
Note. The PFH is sometimes referred to as the frequency if dangerous failures, or dangerous failure rate, in units of dangerous failures per hour.		

The standard of Safety Integrity Level and Performance Level is as follows:

PL (ISO 13849-1)	PFH	SIL (IEC 61508, 62061)
a	≥ 10^(-5) to < 10^(-4)	-
b	≥ 3x10^(-6) to < 10^(-5)	1
d	≥ 10^(-6) to < 3x10^(-6)	1
d	≥ 10^(-7) to < 10^(-6)	2
e	≥ 10^(-8) to < 10^(-7)	3