IRONHORSE ACM SERIES AC DRIVE USER MANUAL

IH_ACM_UMW

Warnings and Trademarks

~ WARNING ~

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WARNINGS

⚠ *WARNING: READ THIS MANUAL THOROUGHLY BEFORE USING ACM 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 ACM 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
– ANALOG OUTPUT: AO
– DIGITAL OUTPUT: A1/C1/B1 (RELAY 1), A2/C2 (RELAY 2)
– 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 ACM 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 ACM AC DRIVE WITH GFCI (GROUND FAULT CIRCUIT INTERRUPT).*

ACM Drives User 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_ACM_UMW
Issue:	First Edition
Issue Date:	03/23/2026

Publication History		
Issue	*Date*	*Description of Changes*
First Edition	03/23/2026	Original Issue

IRONHORSE ACM SERIES AC DRIVE USER MANUAL TABLE OF CONTENTS

CONTENTS

CHAPTER 1: GETTING STARTED

USER MANUAL OVERVIEW

OVERVIEW OF THIS PUBLICATION

This user manual describes the installation, configuration, accessories, and methods of operation of the IronHorse ACM 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 ACM 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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On the Web: www.automationdirect.com

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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 AC drives. 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; Heavy load (HD) or Normal load (ND)

The load (also called torque) requirement has a direct effect on which drive to select. Normal load (ND) (also called Variable Torque (VT)) applications are generally easier to start; typically fans and pumps. Most other applications outside fans and pumps fall into the Heavy load (HD) (also called Constant Torque (CT)) category (machine control, conveyors, etc.). If you are unsure of the application, assume Heavy load (HD). This will provide the most robust performance from the drive.

ACM drives are specified by Heavy load (HD) rating.

PARTS LOCATOR

The illustrations below show part names and locations. Details may vary between frame sizes.

Din rail joint

Drive Body

Keypad

Speed Frequency
Potentiometer Dial

Control terminal block

Front Cover
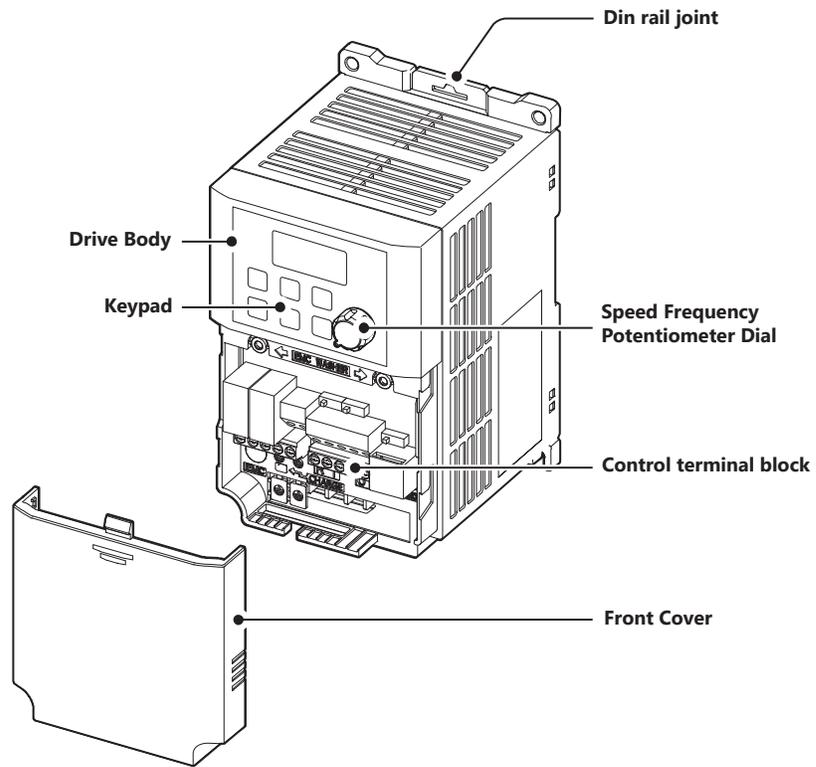
CONTINUOUS RATED CURRENT DERATING

DERATING BY CARRIER FREQUENCY

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

Frame A Drives:
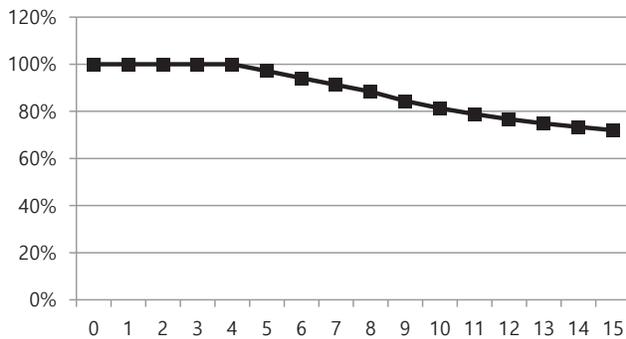
Frame B/C Drives:
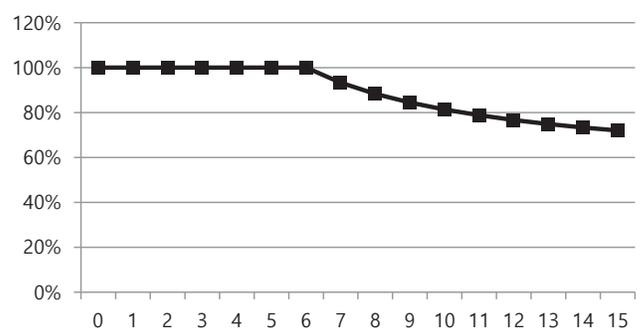
Derating by Carrier Frequency					
120V (Frame B/C)		**230V (Frame A)**		**230V (Frame B/C)**	
Carrier Frequency (kHz)	*Constant Rated Current (%)*	*Carrier Frequency (kHz)*	*Constant Rated Current (%)*	*Carrier Frequency (kHz)*	*Constant Rated Current (%)*
1-6	100	1-4	100	1-6	100
8	88	8	88	8	88
12	77	12	77	12	77
15	72	15	72	15	72

The 0.1–0.25 hp products can be operated at a maximum of 50 °C. However, the lifespan of the product may be reduced when operating continuously with a full load when the ambient temperature exceeds 40 °C (35 °C when an optional vent cover is installed).

If the ambient temperature is high, and if the maximum carrier frequency for continuous full load conditions (4 kHz for A Frame 0.1–0.25 hp products, 6 kHz for B/C Frame 0.5–3.0 hp products) is exceeded, a protective feature may be activated to limit the carrier frequency (to 4 kHz / 6 kHz) to prevent damages to the product.

The protective feature will be deactivated and the user-configured carrier frequency will be used again when the internal temperature becomes low enough for reliable operation. Before operating the product with a high carrier frequency, refer to the table above to ensure that the carrier frequency is appropriately set for reliable operation at continuous full load conditions(%).

DERATING BY INPUT VOLTAGE

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

120V Drives:
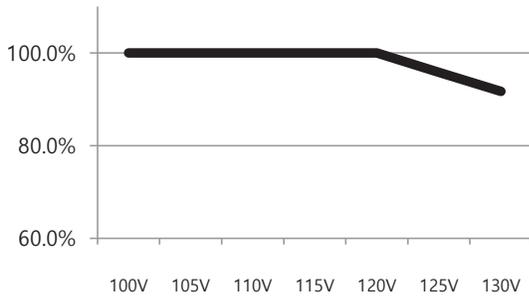
Voltage Class	Input Voltage (V)	Derating
120V	100	100%
	105	100%
	110	100%
	120	100%
	125	95.8%
	130	90%

230V Drives:
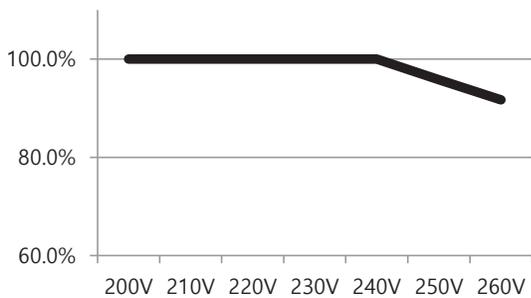
Voltage Class	Input Voltage (V)	Derating
230V	200	100%
	210	100%
	220	100%
	230	100%
	240	100%
	250	95.8%
	264	90%

DERATING BY AMBIENT TEMPERATURE AND INSTALLATION TYPE

The constant-rated current of the AC drive is limited based on the ambient temperature and installation type. Refer to the following graph.
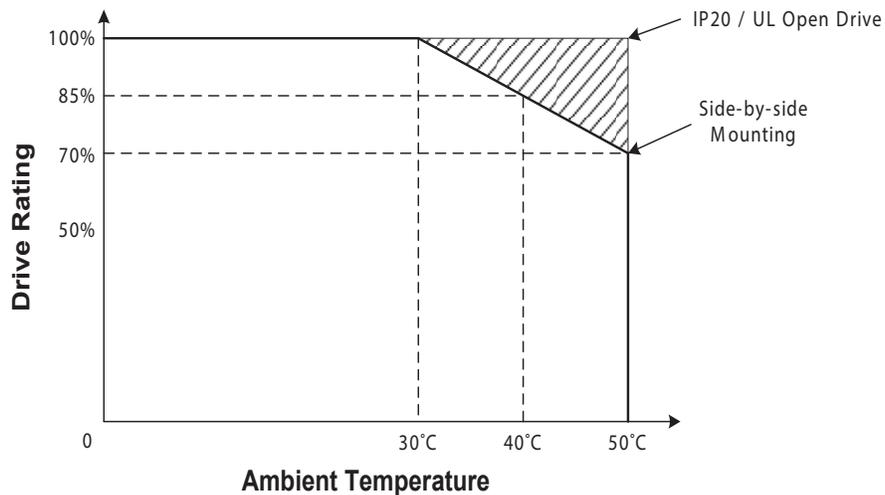
IRONHORSE ACM SERIES AC DRIVE ENVIRONMENTAL INFORMATION

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 during transport.*
- *Hi-capacity drives are very heavy and bulky. Use an appropriate transport method that is suitable for the weight.*

NOTE: 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 ACM Series AC Drives	
Installation Location	Mount the drive on a wall or inside a panel. Not suitable for use in direct sunlight.
Cooling	Forced fan cooling structure
Ambient Temperature	Heavy load (HD): -10 to +50 °C (14 to 122 °F)
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 2in (5cm) from the surface of the drive.

IronHorse ACM Series AC Drive Specifications

120V Class – (Model Specifications)

ACM 120 VAC Class Specifications			
Part Number	**ACM-10P2**	**ACM-10P5**	**ACM-11P0**
Drawing Link	PDF	PDF	PDF
Frame Size	B	B	C
Applied Motor *Max Motor Output* **hp**	0.25	0.5	1.0
Applied Motor *Max Motor Output* **kW**	0.2	0.4	0.75
Output Rating *Rated Capacity (kVA)*	0.6	0.95	1.9
Output Rating *Rated Current (A)*	1.4	2.4	4.2
Output Rating *Output Frequency*	0–400 Hz		
Output Rating *Output Voltage*	3-phase 200–240 VAC		
Input Rating *Input Voltage*	1-phase 100–120 VAC (-15% to +10%)		
Input Rating *Input Frequency*	50–60 Hz (±5%)		
Input Rating *Rated Current (A)*	3.7	7.4	13.9
Weight (lb [kg])	2.2 [1]	2.2 [1]	3 [1.36]
Cooling Method	Forced fan		

- *All specifications are for Heavy Load duty (Constant Torque).*
- *The standard motor capacity is based on a standard 4-pole motor.*
- *The standard used for 120V series drives is based on a 110V supply voltage.*
- *The rated output current is limited based on the carrier frequency set at Cn.4.*
- *The output voltage becomes 15~17% lower during no-load operations to protect the drive from the impact of the motor starting/stopping.*
- *For single phase power input, an input line reactor is recommended. See accessories for the specific line reactor for each drive model.*

230V Class – (Model Specifications)

ACM 230 VAC Class Specifications							
Part Number			**ACM-20P1**	**ACM-20P2**	**ACM-20P5**	**ACM-21P0**	**ACM-22P0**	**ACM-23P0**
Drawing Link			PDF	PDF	PDF	PDF	PDF	PDF
Frame Size			A	A	B	B	C	C
Applied Motor	*Max Motor Output*	*hp*	0.125	0.25	0.5	1.0	2.0	3.0
		kW	0.1	0.2	0.4	0.75	1.5	2.2
Output Rating	*Rated Capacity (kVA)*		0.3	0.6	0.95	1.9	3.0	4.5
	Rated Current (A)		0.8	1.4	2.4	4.2	7.5	11.0
	Output Frequency		0–400 Hz					
	Output Voltage		3-phase 200–240 VAC					
Input Rating	*Input Voltage*		200–240 VAC (-15% to +10%)					
	Input Frequency	*1-phase*	50–60 Hz (±5%)					
		3-phase	60 Hz (±5%)					
	Rated Current (A)		1.0	1.8	3.7	7.1	13.6	18.7
Weight (lb [kg])			1.46 [0.66]	1.46 [0.66]	2.2 [1.0]	2.2 [1.0]	3.2 [1.45]	3.2 [1.45]
Cooling Method			Natural cooling		Forced fan			

- *All specifications are for Heavy Load duty (Constant Torque).*
- *The standard motor capacity is based on a standard 4-pole motor.*
- *The standard used for 230V series drives is based on a 220V supply voltage.*
- *The rated output current is limited based on the carrier frequency set at Cn.4.*
- *The output voltage becomes 15~17% lower during no-load operations to protect the drive from the impact of the motor starting/stopping.*
- *For single phase power input, an input line reactor is recommended. See accessories for the specific line reactor for each drive model.*

SPECIFICATIONS APPLICABLE TO ALL ACM SERIES MODELS

IronHorse ACM Series General Specifications (All Models)			
Control Characteristics	**Control Method**	V/F control, Slip Compensation, Simple Sensorless Vector	
	Frequency Settings Power Resolution	Digital command: 0.01 Hz Analog command: 0.06 Hz (60 Hz standard)	
	Frequency Accuracy	1% of maximum output frequency	
	V/F Pattern	Linear, square reduction, user V/F	
	Overload Capacity	Heavy load (HD) rated current: 150% for 1 minute	
	Torque Boost	Manual torque boost, automatic torque boost	
Operation Characteristics	**Operation Type**	Select key pad, terminal strip, or communication operation	
	Frequency Setting Signal	Analog type: 0–10V, 0–20 mA, or Potentiometer Keypad: Up/Down arrows or integrated dial	
	Main Functions	• PID control • 3-wire operation • Frequency limit • Second motor function • Anti-forward and reverse direction rotation • Speed search • Up-down operation • DC braking • Frequency jump • Slip compensation • Automatic restart • Energy saving operation • Dwell operation • Jog operation	
	Input — **Multi-function Digital Inputs (5) P1–P5**	Select PNP (Source) or NPN (Sink) mode. Functions can be set according to In.65–In.69 codes and parameter settings. • Forward direction operation • Reset • Emergency Stop • Multi-step speed frequency-high/med/low • DC braking during stop • Frequency increase • 3-wire • Select acc/dec/stop • Reverse run • External trip • Jog operation • Multi-step acc/dec-high/med/low • Second motor selection • Frequency reduction • Fix analog command frequency • Transition from PID to general operation	
	Analog Inputs (2) VR, V1, I2	Set various drive control parameters to follow the analog input. • Voltage: 0–10V • Current: 4–20 mA • Potentiometer: 1–5 kΩ	
	Output — **Mutli-function Relay Outputs (2) A, B, C**	Functions can be set according to parameters OU.31 and OU.32	Less than 250VAC, 1A Less than 30VDC 1A (N.O., N.C.)
	Analog Output (1) AO	0–10 VDC: Select frequency, output current, output voltage, DC terminal voltage and others	
	Communication	RJ45 connector for RS-485 communication, communication to software, or remote keypad.	

IronHorse ACM Series General Specifications (All Models)		
Protection Function Characteristics	**Trip**	• Motor overheat trip • Motor overload trip • Output open-phase trip • External signal trip • AC drive overload trip • Command loss trip • Over current trip • AC drive overheat • Over voltage trip • Ground trip • COM (communication) trip • Fan trip • Low voltage trip
	Alarm	Overload alarm
	Instantaneous Blackout	• Less than 15ms: must be within the rated input voltage and rated output range • More than 15ms: auto-restart operation
IP Rating		IP20
Agency Approvals		UL, CE

RECEIVING AND INSPECTION

DRIVE PACKAGE CONTENTS

After receiving the ACM 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 ACM 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

ACM - 2 0P5

Applicable Motor Capacity (HD) with 1-phase rated input
0P1: 0.125 hp
0P2: 0.25 hp
0P5: 0.5 hp
1P0: 1.0 hp
2P0: 2.0 hp
3P0: 3.0 hp

Input Voltage
1: 120 VAC
2: 230 VAC

Series Name
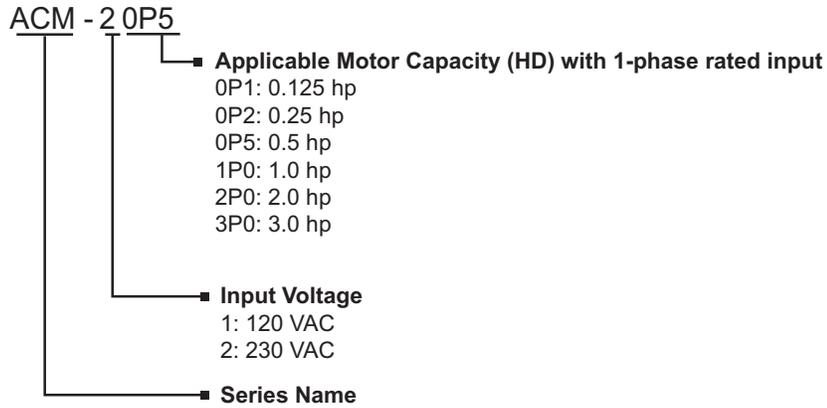
NAMEPLATE INFORMATION
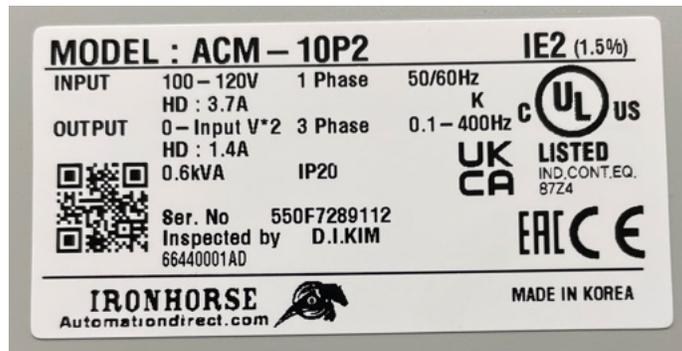
CHAPTER 2: INSTALLATION AND WIRING

DRIVE MODELS BY FRAME SIZE

ACM Series Drive Models by Frame Size	
Frame	*Drive*
A	ACM-20P1, ACM-20P2
B	ACM-10P2, ACM-10P5, ACM-20P5, ACM-21P0
C	ACM-11P0, ACM-22P0, ACM-23P0

INSTALLATION

Install the AC drive in a properly sized panel. 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.

WARNING: 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 drive. 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.

Power source — Input side — Output side

Circuit breaker OR Motor circuit breaker — Magnetic contactor (Optional) — AC reactor (Optional) — Motor
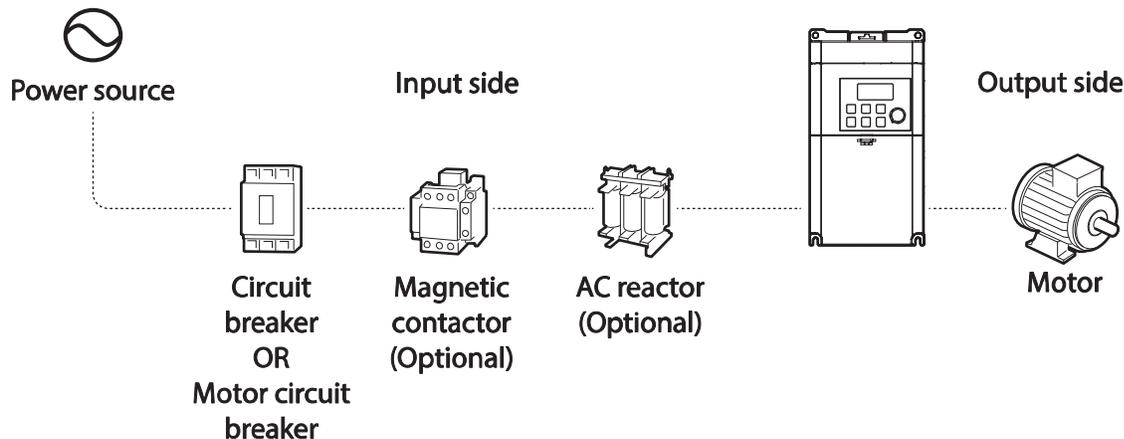
INSTALLATION CONSIDERATIONS

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

When selecting an installation location, consider the following points:

- *The location must be free from vibration, and the drive must be installed on a wall that can support the drive's weight*
- *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.*
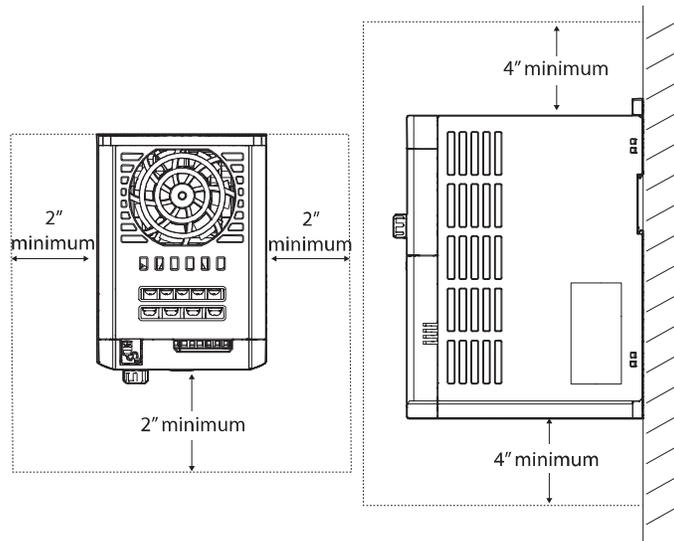
Ensure sufficient air circulation is provided around the drive when it is installed. If the drive is to be installed inside a panel, enclosure, or cabinet rack, carefully consider the position of the drive's cooling fan and the ventilation louver. Cooling fans must be positioned to efficiently transfer the heat generated by the operation of the drive.
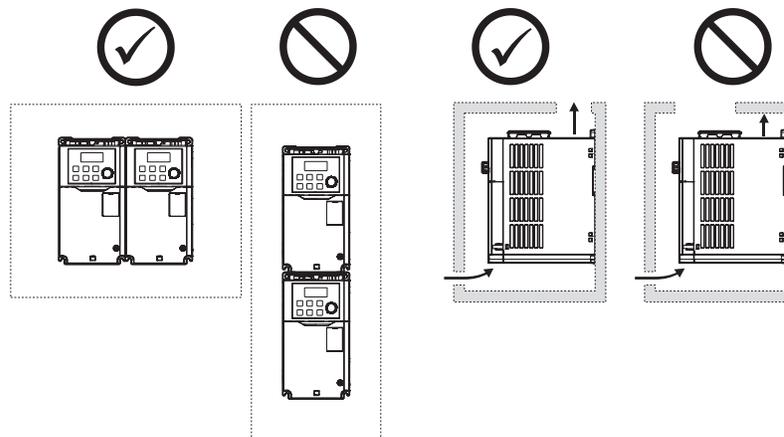
If you are installing multiple drives in one location, arrange them side-by-side. Keep drives at least 0.1 inch apart.
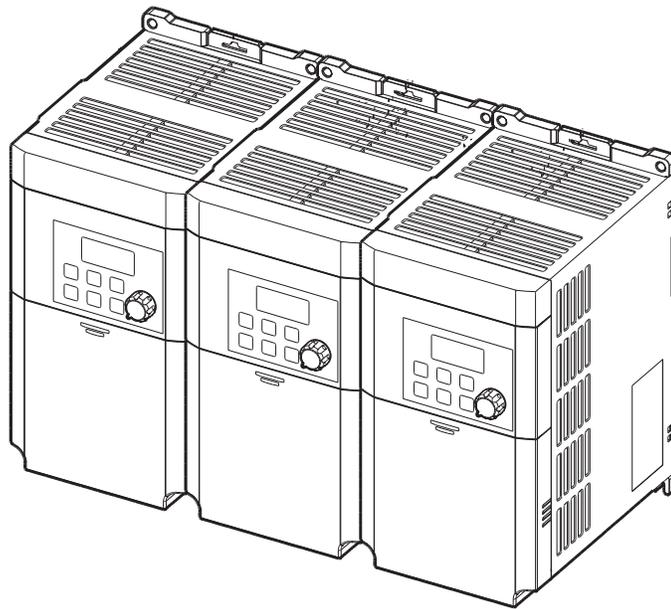
If you are installing multiple drives of different ratings, provide sufficient clearance to meet the clearance specifications of the larger drive.
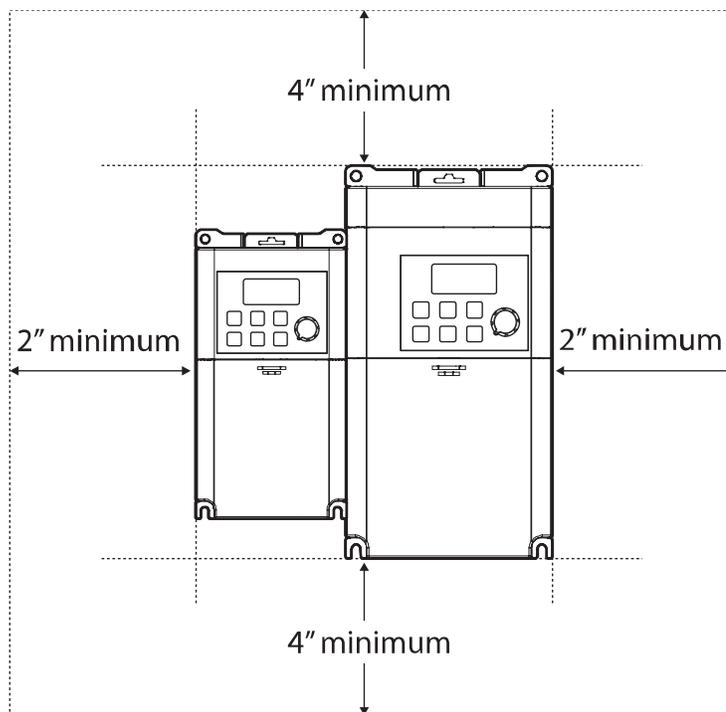
Dimensions

See our website: www.AutomationDirect.com for complete engineering drawings and 3D models.
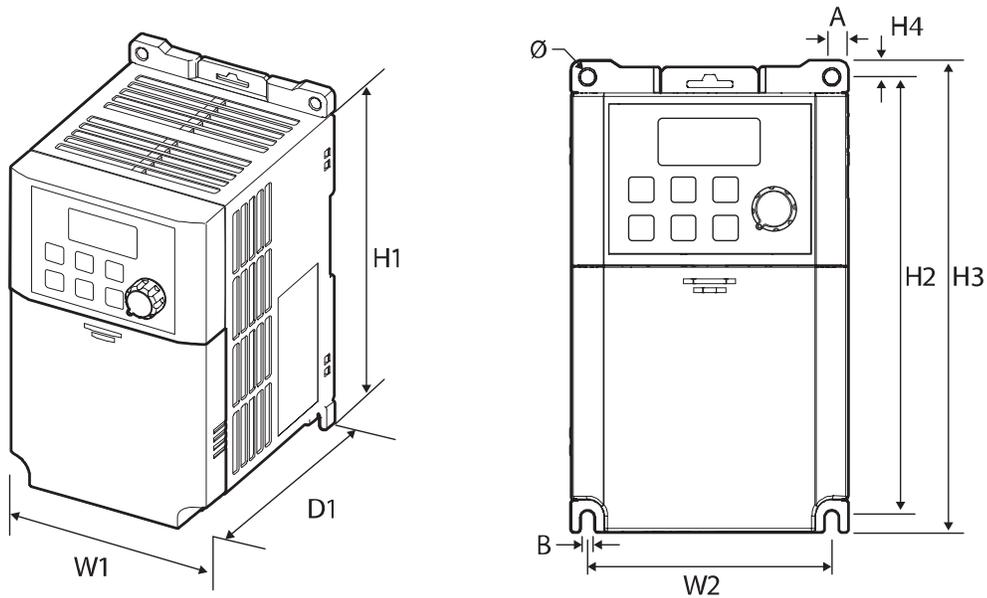
Dimensions											
Frame	Part no	W1	W2	H1	H2	H3	H4	D1	A	B	Ø	Drawings
A	ACM-20P1	85 [3.34]	75 [2.95]	135 [5.33]	135.5 [5.33]	145 [5.70]	5 [0.20]	100 [3.93]	5 [0.20]	4.5 [0.18]	4.5 [0.18]	PDF
	ACM-20P2											PDF
B	ACM-10P2	85 [3.34]	75 [2.95]	153 [6.02]	153.5 [6.04]	163 [6.42]	5 [0.20]	123 [4.84]	5 [0.20]	4.5 [0.18]	4.5 [0.18]	PDF
	ACM-10P5											PDF
	ACM-20P5											PDF
	ACM-21P0											PDF
C	ACM-11P0	100 [3.94]	90 [3.54]	180 [7.08]	180.5 [7.10]	190 [7.48]	5 [0.20]	140 [5.51]	5 [0.20]	4.5 [0.18]	4.5 [0.18]	PDF
	ACM-22P0											PDF
	ACM-23P0											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. Fully tighten the mounting bolts after the drive has been mounted.*
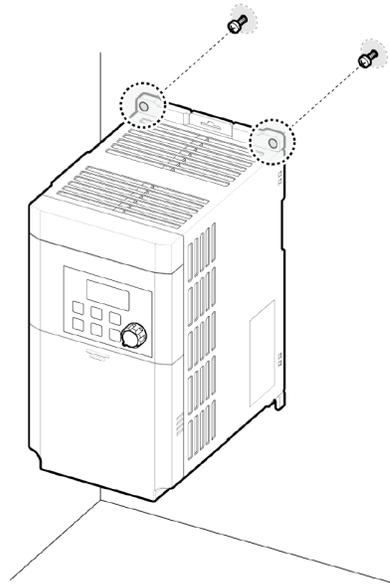
- *Mount the drive on the wall or inside a panel using the two lower bolts, and then fully tighten the mounting bolts. Ensure that the drive is placed flat on the mounting surface, and that the installation surface can securely support the weight of the drive.*
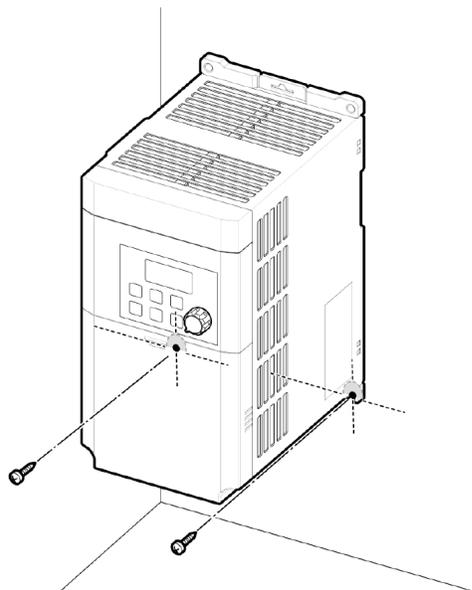
CAUTION: FAILURE TO OBSERVE THE PRECAUTIONS BELOW MAY DAMAGE THE DRIVE OR CAUSE INJURY.
• DO NOT TRANSPORT THE DRIVE BY LIFTING WITH THE DRIVE'S PLASTIC SURFACES. ALWAYS SUPPORT THE DRIVE USING THE METAL FRAMES WHEN MOVING IT.
• HI-CAPACITY DRIVES ARE VERY HEAVY AND BULKY. USE AN APPROPRIATE TRANSPORT 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.
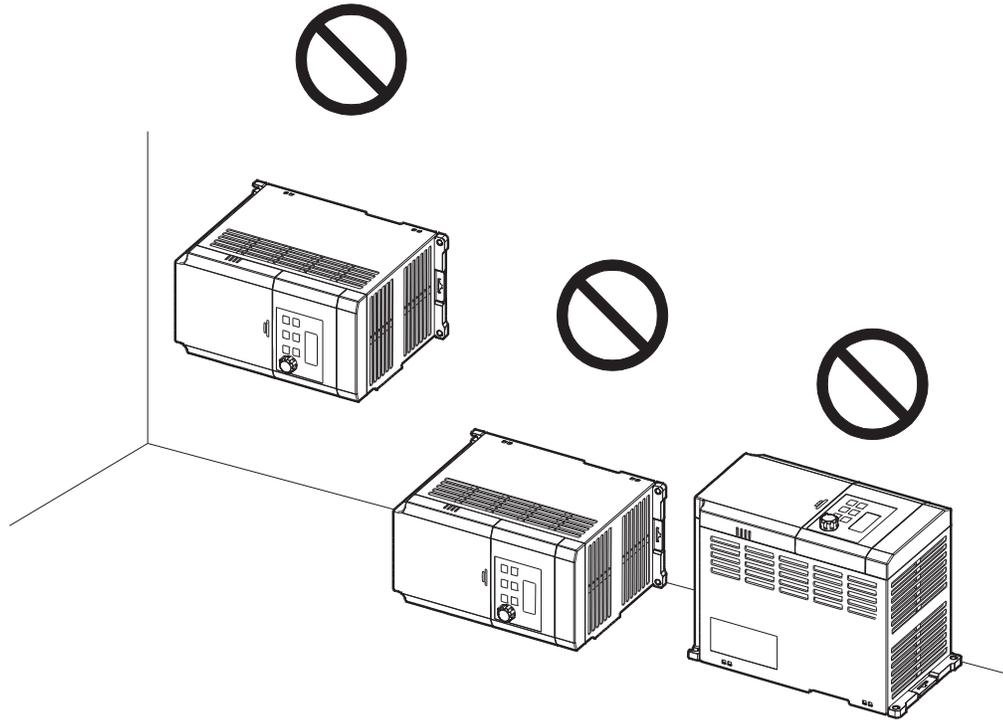
REMOVING FRONT COVER

The front cover must be removed to install cables.

Slide the front cover downward while pressing and holding the upper-center part of the cover. Remove the cover by lifting it upward from the bottom and moving it away from the front of the drive.
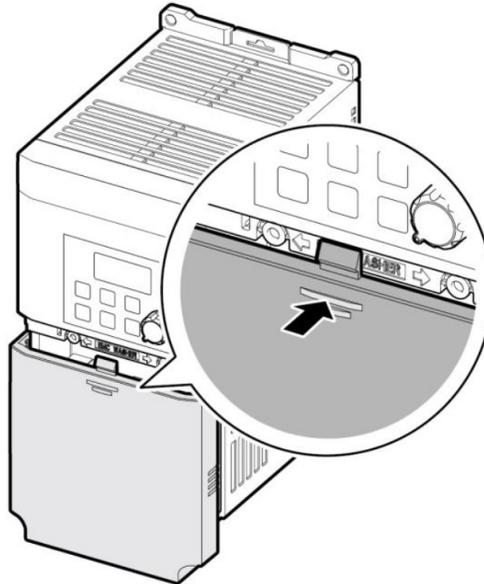
NOTE:To connect a remote keypad, remove the plastic knock-out from the bottom of the front cover (right side). Then connect the signal cable to the RJ-45 port on the control board.

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.

> ⚠️ *CAUTION: READ THE FOLLOWING INFORMATION CAREFULLY BEFORE MAKING ANY WIRING CONNECTIONS TO THE DRIVE.*

- *Install the drive before making any 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 power supply system for the ACM drive is a grounded system. Only use a grounded power supply system for the ACM drive. Do not use a TT, TN, IT, or corner grounded system with the drive.*
- *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 °C for power terminal wiring.*
- *Use copper cables rated at 300V, 75 °C 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.*

DISABLING EMC FILTER FOR POWER SOURCES WITH ASYMETRICAL GROUND

An EMC filter prevents electromagnetic interference by reducing radio emissions from the drive. EMC filter use is not always recommended, as it increases leakage current. If a drive uses a power source with an asymmetrical grounding connection, the EMC filter MUST be turned off. The 230 VAC ACM models have a built-in EMC Filter.

Asymmetric Ground / Corner Grounded TN Systems	
1) Grounding at a corner of a triangle configuration	2) Ground at a midpoint in a polygonal configuration
R(L1) S(L2) T(L3)	R(L1) S(L2) T(L3)
3) No stable neutral grounding in a three-phase autotransformer configuration L N	4) End of single-phase is gorunded R(L1) — R(L1) S(L2) — S(L2) T(L3) — T(L3)
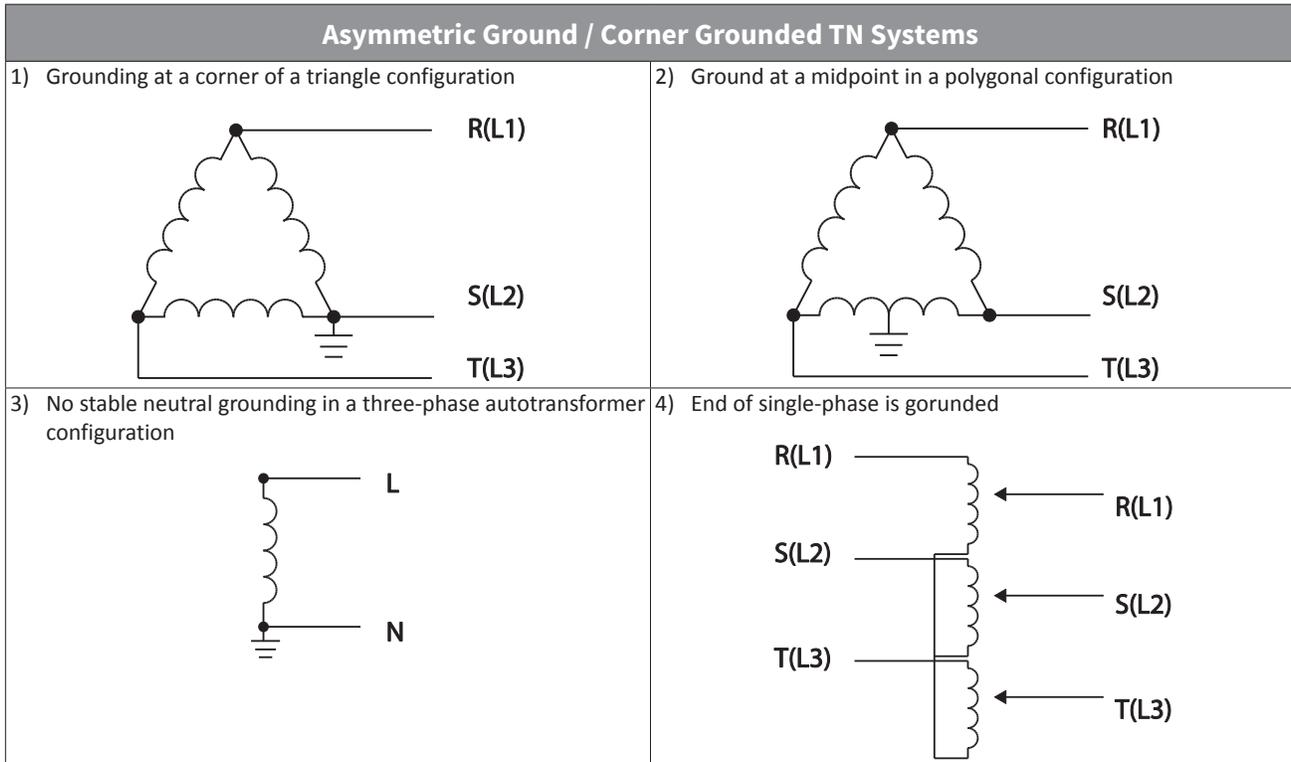
⚠️ **WARNING:** *DO NOT ACTIVATE THE EMC FILTER IF THE DRIVE USES A POWER SOURCE WITH AN ASYMMETRICAL GROUNDING STRUCTURE, FOR EXAMPLE A GROUNDED DELTA CONNECTION. PERSONAL INJURY OR DEATH BY ELECTRIC SHOCK MAY RESULT.*

⚠️ **WARNING:** *WAIT AT LEAST 10 MINUTES BEFORE OPENING THE COVERS AND EXPOSING THE TERMINAL CONNECTIONS. BEFORE STARTING WORK ON THE DRIVE, TEST THE CONNECTIONS TO ENSURE ALL DC VOLTAGE HAS BEEN FULLY DISCHARGED. PERSONAL INJURY OR DEATH BY ELECTRIC SHOCK MAY RESULT IF VOLTAGE HAS NOT BEEN FULLY DISCHARGED.*

Before using the drive, determine if the power supply has an asymmetrical grounding connection. If so, disable the EMC filter on the ACM drive. Check the location of the EMC filter on/off screw and attach a plastic washer to the screw under the control terminal block.
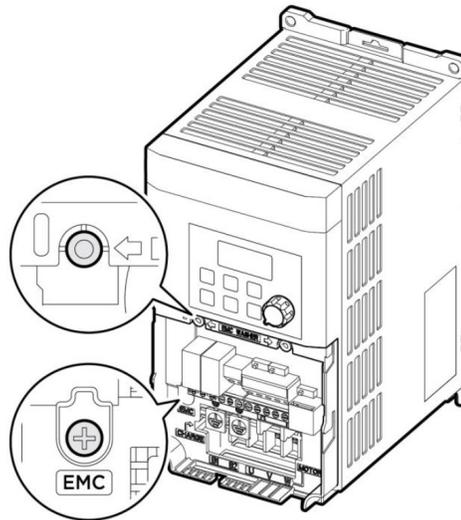
CABLE SELECTION

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.

⚠️ *CAUTION: READ THE FOLLOWING INFORMATION CAREFULLY BEFORE MAKING ANY 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 °C for power terminal wiring.*
- *Use copper cables rated for 300V, 75 °C 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

Ground Cable and Power Cable Specifications					
Voltage Rating	**Load (hp)**	**Ground**		**Power I/O R/S/T and U/V/W**	
		mm²	**AWG**	**mm²**	**AWG**
1-phase 120V	0.25	4	12	2.5	14
	0.5			2.5	14
	1			4	12
1-phase 230V	0.125	4	12	2.5	14
	0.25				
	0.5				
	1				
	2			4	12
	3				

CONTROL (SIGNAL) CABLE SPECIFICATIONS

Control (Signal) Cable Specifications				
Terminals	**Signal Cable**			
	Without Crimp Terminal Connectors (Bare Wire)		**With Crimp Terminal Connectors (Bootlace Ferrule)**	
	mm²	**AWG**	**mm²**	**AWG**
24, P1– P5, CM, VR, V1, I2, A0	0.8	18	0.5	20
A1/B1/C1/ A2/C2	1.0	17	1.5	15

Ground Connection

Remove the front 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.
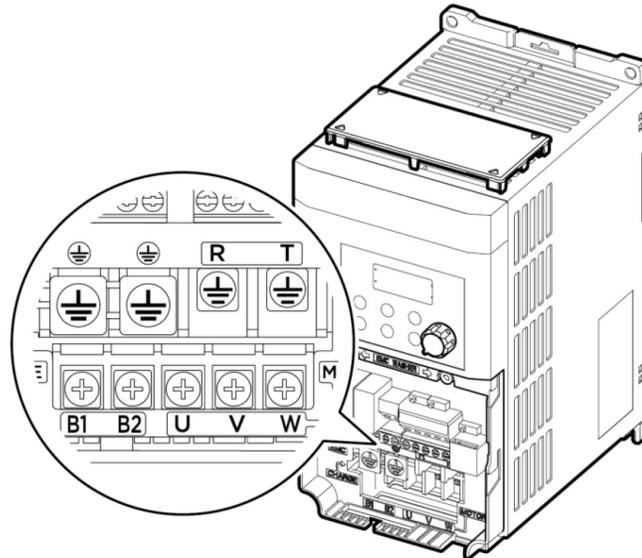
NOTE: 120V and 230V products require Class 3 grounding. Resistance to ground must be < 100Ω.

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.

⚠️ *CAUTION: READ THE FOLLOWING INFORMATION CAREFULLY BEFORE MAKING ANY 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 and T terminals. Connecting them to the U, V, W terminals causes internal damage to the drive. Motor should be connected to the U, V, and W Terminals. Arrangement of the phase sequence is not necessary.*

A FRAME:

- *230V: 0.125–0.25 hp*
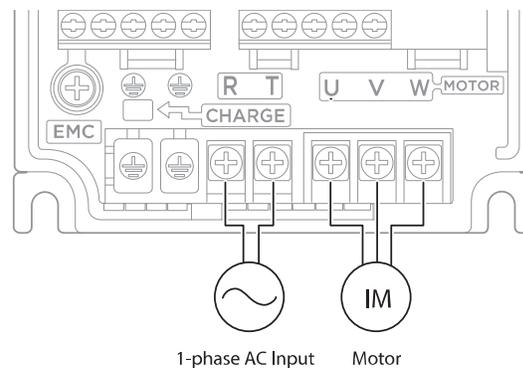
B FRAME:

- *120V: 0.25–0.5 hp*
- *230V: 0.5–1.0 hp*
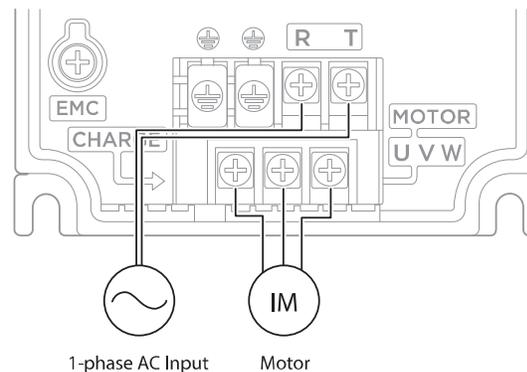
C FRAME:

- *120V: 1.0 hp*
- *230V: 2.0–3.0 hp*
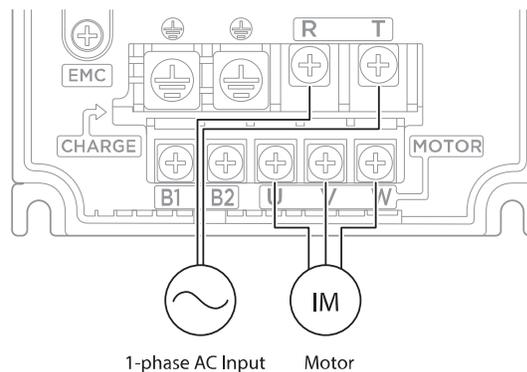
Main Circuit Wiring Diagram

120V: 0.25 to 0.5 hp, 230V: 0.125–1.0 hp drives (Frame A, B)
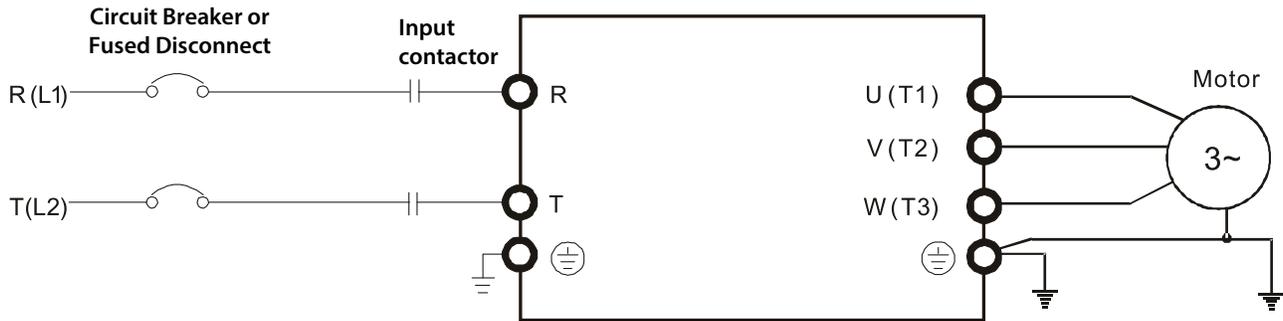
120V: 1.0 hp, 230V: 2.0–3.0 hp drives (Frame C)
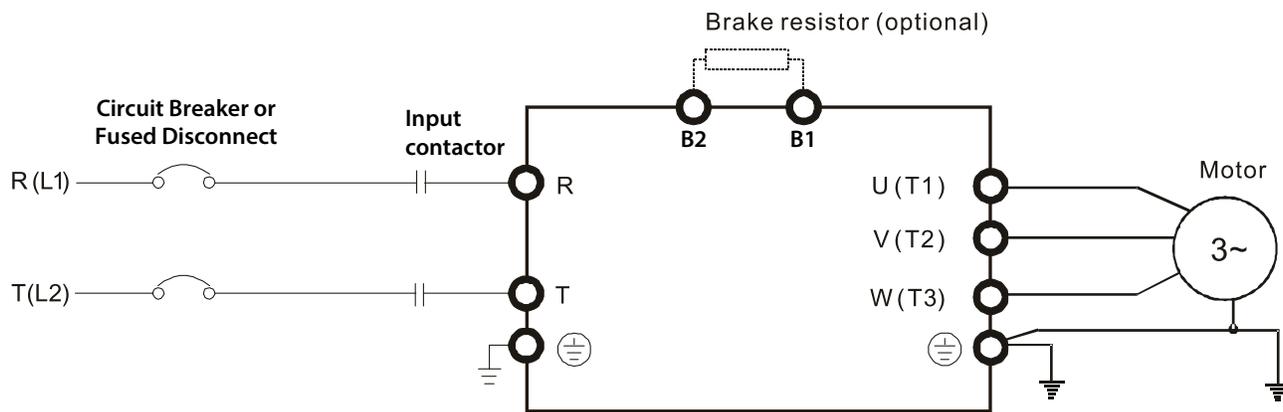
Power Terminal Labels and Descriptions

Power Terminal Labels and Descriptions		
Terminal Labels	Name	Description
R(L1)/T(L2)	AC power input terminal	Mains supply AC power connections
B1/B2 (120V: 1.0 hp, 230V: 2.0–3.0 hp only)	Brake resistor terminals	Brake resistor wiring connection
U/V/W	Motor output terminals	3-phase AC motor wiring connections

Terminals for Connecting External Brake Resistor

- 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 ACM series drives, the external brake resistor should be connected to the B1 and B2 terminals for C Frame size drives (120V: 1.0 hp, 230V: 2.0-3.0 hp). See appendix accessories for recommended braking resistor sizes.

WIRING GUIDELINES

- *Do not use 3 core cables to connect a remotely located motor with the drive.*
- *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.*

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

⚠️ *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.*

⚠️ *CAUTION: READ THE FOLLOWING INFORMATION CAREFULLY BEFORE MAKING ANY WIRING CONNECTIONS TO THE DRIVE.*

- *Power supply cables must be connected to the R and T terminals and output wiring to the motor must be connected to the U, V, and W terminals. Connecting power cables to other terminals will damage the drive.*
- *Use insulated ring lugs when connecting cables to R/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.*
- *Verify any advanced-phase capacitors, surge protection, or electromagnetic interference filters are installed correctly before powering on the drive.*
- *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

- *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, use AC motors in the High performance drive duty category at automationdirect.com.*

Single Phase Input Utility Wiring and Operation

Ironhorse ACM is a single-phase standard variable frequency drive (VFD) and 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 below.
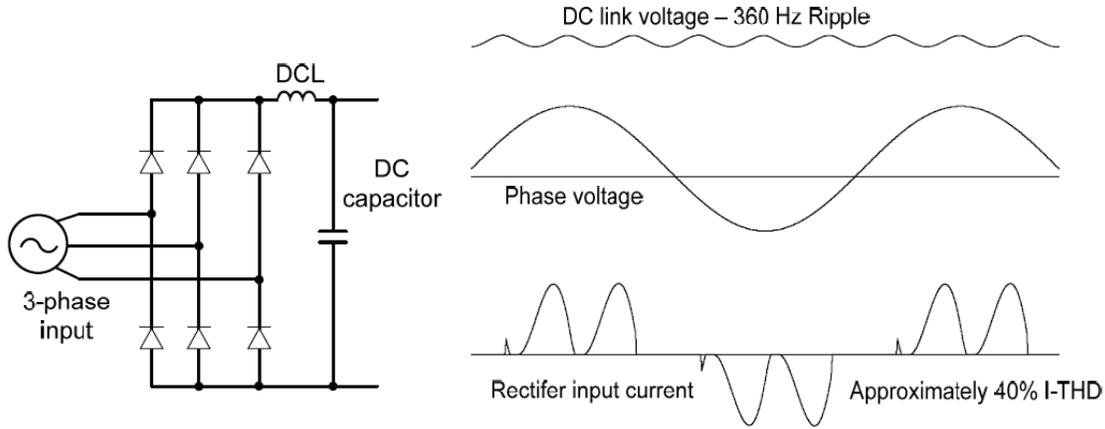
Figure-1 Typical Three-Phase Configuration
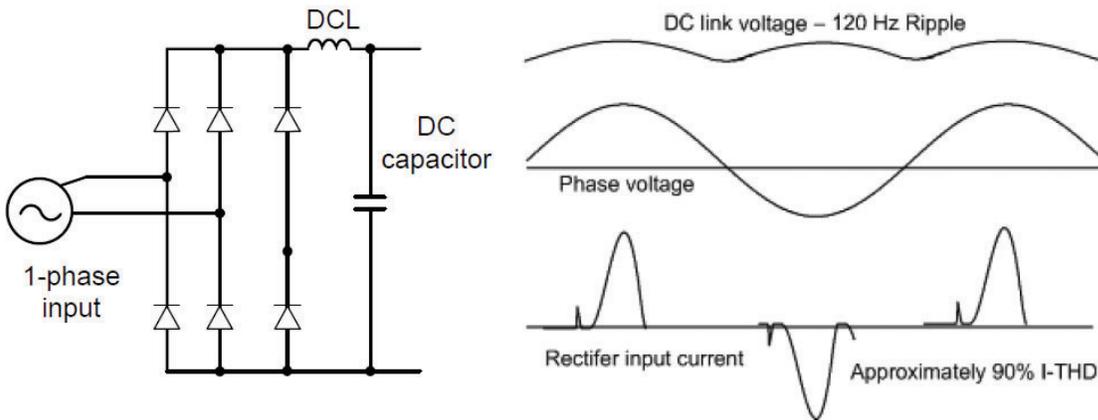
Figure-2 Typical Single-Phase Configuration

Power (HP), Input Current and Output Current

Input current distortion over 100% is likely under single-phase conditions without a reactor. Therefore, it is recommended 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 recommended. See Accessories appendix for the specific line reactor for each drive model.

Control Terminal Wiring

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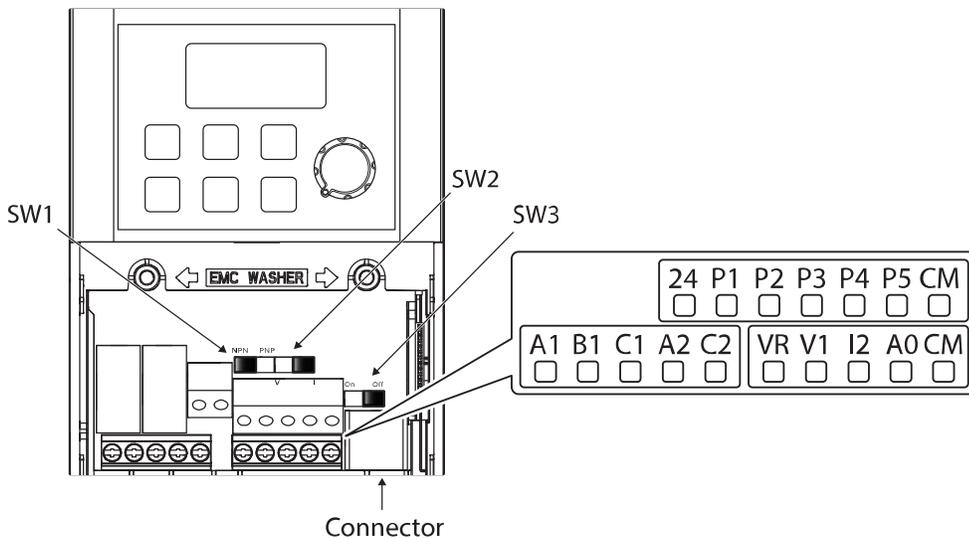
Control Board Switches

Control Board Switches	
Switch	**Description**
SW1	NPN/PNP mode selection switch
SW2	Analog volage/current input terminal I2 selection switch
SW3	Terminating Resistor selection switch

Connector

Connector	
Name	**Description**
RJ45 Connector	Connection to software, remote keypad, or RS-485 communication.

Full I/O Wiring Diagram

Multi-function input

(In.65=0) FX — P1

(In.66=1) RX — P2

(In.67=2) E-stop Trip — P3

SW1
NPN PNP

(In.68=3) RST — P4

(In.69=4) JOG — P5

CM

Analog input

VR

V1

SW2
V   I
Analog input

CM

I2

SW3
ON   OFF
Terminating resistor

RJ45
Remote/
485Com

AO Analog output
Default: Frequency (OU.1=0)

P24 24 V Power

C2 Relay output 2
A2 Default: Run (OU.32=12)

C1 Relay output 1
A1 Default: Trip (OU.31=17)
B1

RJ-45 Port / RS-485
Remote Keypad or
Software Connection
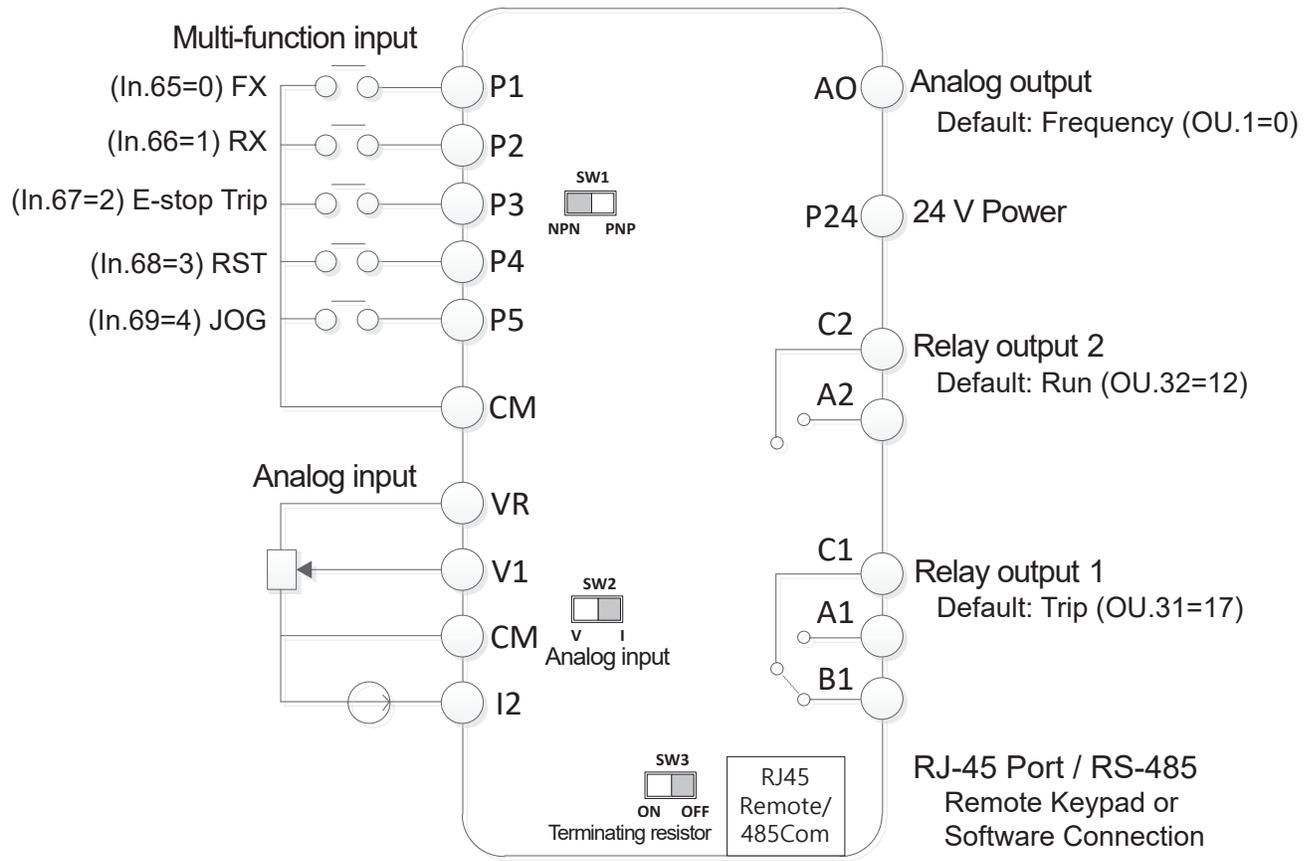
INPUT TERMINAL LABELS AND DESCRIPTIONS

Input Terminal Labels and Descriptions			
Function	**Label**	**Name**	**Description**
Multi-function terminal configuration	P1–P5	Mutli-function Input 1–5	Configurable for multi-function input terminals. Factory default terminals and setup are as follows: • P1: FX, Fwd Run (In.65=0) • P2: RX, Rev Run (In.66=1) • P3: Emergency Stop Trip (In.67=2) • P4: RST, Reset (In.68=3) • P5: JOG (In.69=4)
	CM	Common Sequence	Common terminal for terminal inputs and outputs
Analog input configuration	VR	Terminal for frequency reference setting	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	Frequency setting (voltage) terminal	Used to setup or modify a frequency reference via analog voltage input terminal (In.7–In.11). • Unipolar: 0–10V (12V Max.)
	I2	Current or voltage input for frequency reference input terminal	Used to setup or modify a frequency reference via the I2 terminal (In.52–In.56). • Input current: 4–20mA • Input voltage: 0-10V (12V Max.) • Maximum Input current: 20mA

OUTPUT/COMMUNICATION TERMINAL LABELS AND DESCRIPTIONS

Output/Communication Terminal Labels and Descriptions			
Function	**Label**	**Name**	**Description**
Analog output	AO	Voltage output terminal	Used to send drive output information to external devices: output frequency, output current, output voltage, or a DC voltage (OU.1). • Output voltage: 0–10V • Maximum output voltage/current: 10V/10mA • Factory default output: 0:Frequency
Digital relay outputs	24	24V internal power source	Maximum output current: 50mA
	A1/C1/B1	Relay output 1	Activates based on multi-function parameter setting (250VAC <1A, 30VDC < 1A)(OU.31). • A1/C1: Normally Open • B1/C1: Normally Closed • Default OU.31=17 (Drive Fault Trip)
	A2/C2	Relay output 2	Activates based on multi-function parameter setting (250VAC <1A, 30VDC < 1A)(OU.32). • A2/C2: Normally Open • Default: OU.32=12 (Drive Run)
Communication	RJ45	RJ45 connector	Connection to RS-485 communication, software, or keypad.

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.
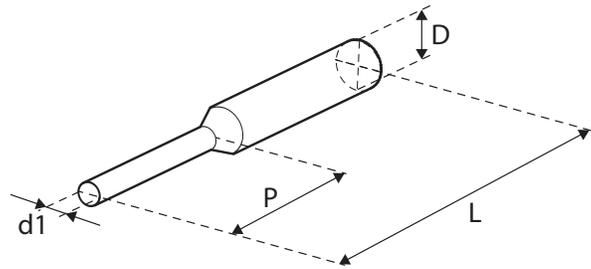
Cable Spec		Dimensions (mm)			
AWG	mm²	L*	P	d1	D
26	0.25	10.4	6.0	1.1	2.5
		12.4	8.0		
22	0.50	12.0	6.0	1.3	3.2
20	0.75	12.0	6.0	1.5	3.4

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.

0.2"
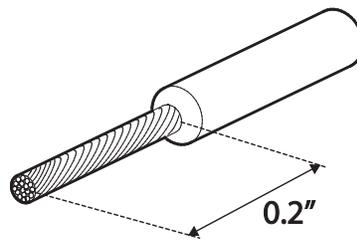
📋 NOTE: *Please read these general wiring recommendations.*

- *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 (30.5m).*
- *Ensure that the cable length between a remote 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 (0.1in wide (2.5mm) and 0.015in thick (0.4mm) at the tip).*

0.1 in. or less

0.015 in. or less
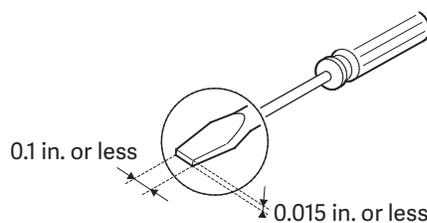
TERMINAL SCREW SPECIFICATION

Terminal Screw Specifications			
Drive Input Voltage	*Drive hp*	*Terminal Size*	*Terminal Torque (Kgf•cm [N•m])*
1-phase 120V	0.25	R/T, U/V/W: M3	R/T, U/V/W: 5.0 [0.5]
	0.5		
	1	R/T: M4 U/V/W: M3.5	R/T: 8.0 [0.8] U/V/W: 5.0 [0.5]
1-phase 230V	0.125	R/T, U/V/W: M3	R/T, U/V/W: 5.0 [0.5]
	0.25		
	0.5	R/T, U/V/W: M3	R/T, U/V/W: 5.0 [0.5]
	1		
	2	R/T: M4 U/V/W: M3.5	R/T: 8.0 [0.8] U/V/W: 5.0 [0.5]
	3		

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.
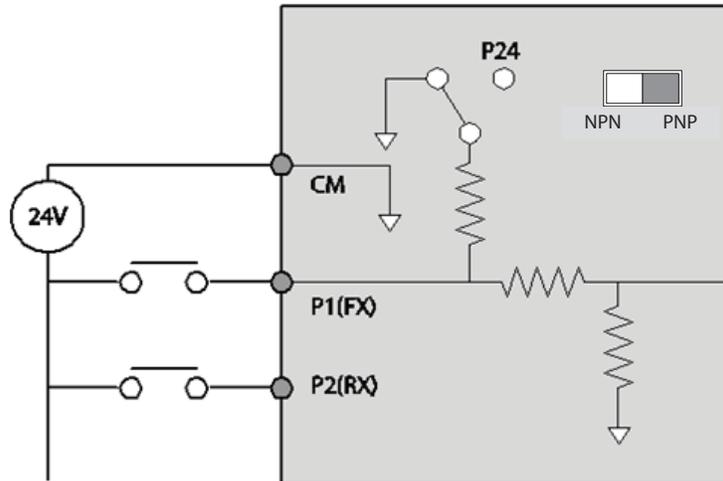
NPN Mode (Sink)

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 P24 is 24V internal source.
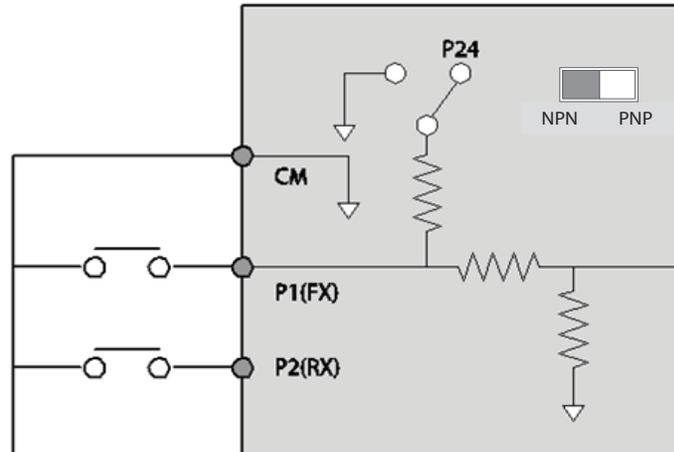
RUN COMMAND WIRING

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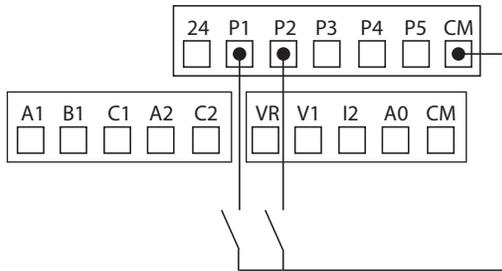
2-wire control consists of maintained run signals. This can be accomplished via toggle switches, relays, jumpers, etc. Default parameters support this operation.

drv=2 (FX/RX-2)
P1(In.65=0) FX (1=Run, 0=Stop)
P2 (In.66=1) RX (1=Reverse, 0=Forward)
CM=Common

3-WIRE CONTROL
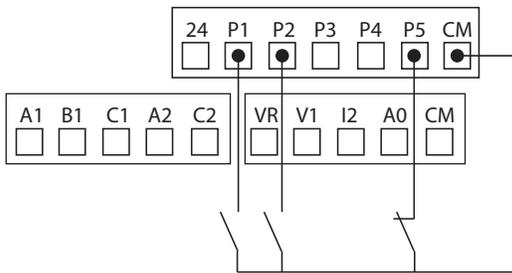
3-Wire control consists of momentary push buttons to run and stop the VFD. The Forward and Reverse buttons are Normally Open while the Stop button is Normally Closed. Set parameter In.69=17 if using P5 (like below) for the Stop button.

drv=1 (FX/RX-1)
P1(In.65=0) FX (FWD Run, FX))
P2 (In.66=1) RX (REV Run, RX)
P5 (In.69=17) (3-Wire Stop)
CM=Common

RELAY OUTPUT WIRING

OUTPUT WIRING USING EXTERNAL POWER

Ensure device current does not exceed 1A.

Relay 1
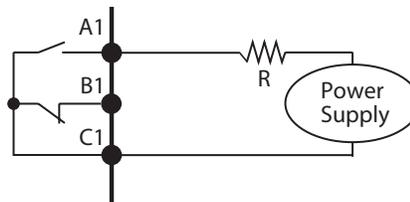
Relay 2
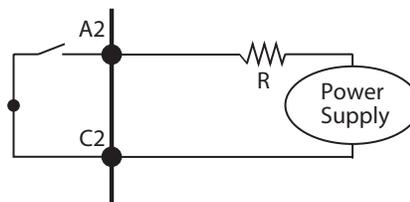
ANALOG WIRING

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

4-20 mA ANALOG INPUT WIRING

Transducer (4–20 mA):

Transducers are typically 4–20 mA devices which require a 24 VDC power source. For 2-wire transducers connect to the 24 VDC and 4–20 mA 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).
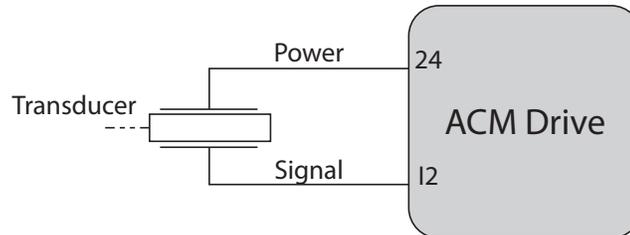
PLC (4–20 mA):

The wiring for connecting a PLC's 4–20 mA 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.
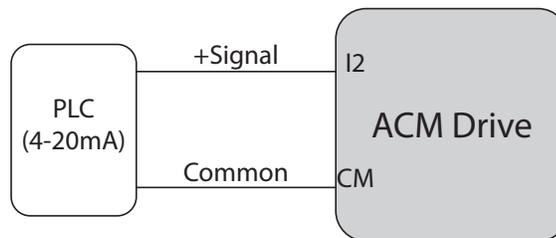
0-10 VDC ANALOG INPUT WIRING

Speed POT/Rheostat (0–10 VDC):

Speed potentiometers have three wires which must be connected to properly vary a 0–10 VDC 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.
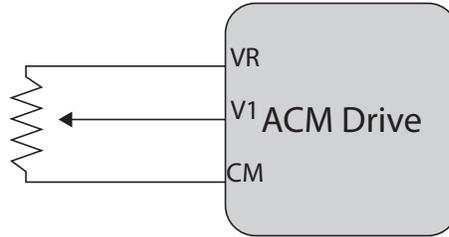
PLC (0–10 VDC):

The wiring for connecting a PLC's 0–10 VDC 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.
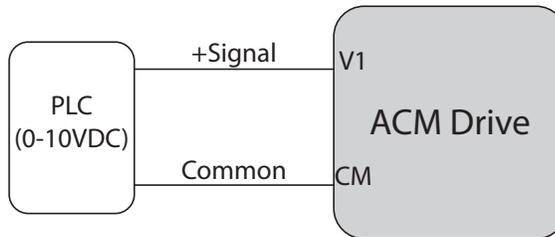
AO WIRING

Wire the drive analog out as follows:

System Wiring Diagram

Power input terminal

NFB or fuse

Electromagnetic contactor

AC reactor (input terminal)

Zero-phase reactor

EMC filter

R/L1   T/L3

BR   Brake resistor

U/T1 V/T2 W/T3

Zero-phase reactor

AC Reactor/Output Filter (output terminal)

Motor
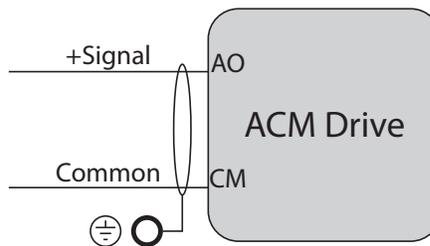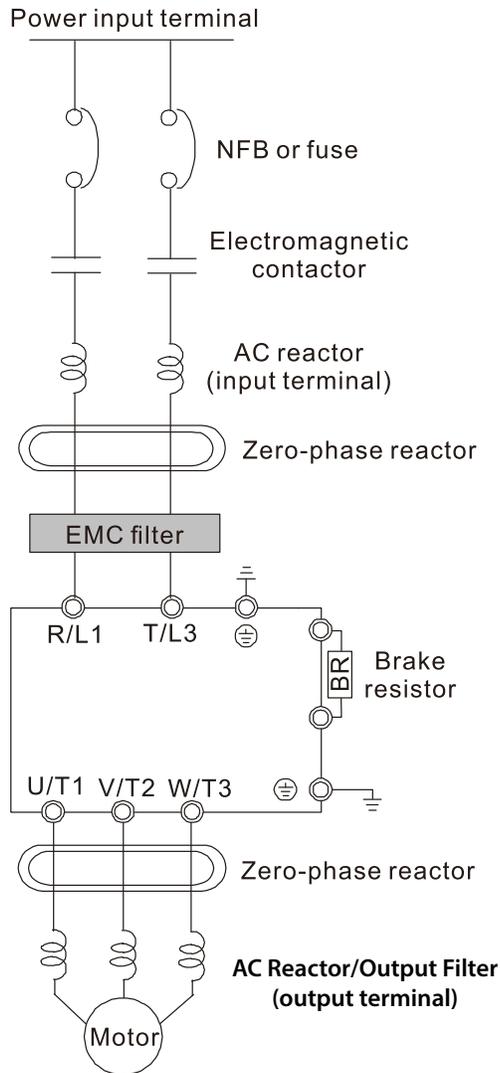
| System Wiring Components ||
Component	*Function*
Power input terminal	Supply power according to the rated power specifications indicated in the manual
NFB or fuse	There may be a large inrush current during power on. Select a suitable NFB (non-fuse breaker or circuit breaker) or Fuse.
Electromagnetic 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 500kVA, 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 10m.
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 10MHz.
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/ Output 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/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 665ft (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 (50m)?
	Is the total length of safety wiring < 100ft (30.5m)?
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 I2 is selected as the frequency reference source and configured for current, is selector switch SW2 set to current and does the reference change according to the input current?

   c) If I2 is selected as the frequency reference source and configured for voltage, is selector switch SW2 set to voltage and does the reference change according to the input voltage at VR?

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 (Command 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.*

Forward operation
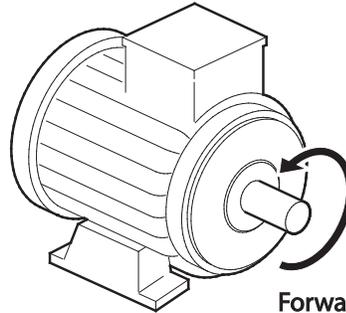
⚠ *CAUTION: READ THE FOLLOWING INFORMATION BEFORE OPERATING YOUR DRIVE:*

- *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

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

ACM Series Keypad Display Components		
Number	**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	0	*A*	A	*K*	K	*U*	U
1	1	*b*	B	*L*	L	*u*	V
2	2	*C*	C	*m*	M	*w*	W
3	3	*d*	D	*n*	N	*x*	X
4	4	*E*	E	*0*	O	*y*	Y
5	5	*F*	F	*P*	P	*z*	Z
6	6	*G*	G	*q*	Q	-	-
7	7	*H*	H	*r*	R	-	-
8	8	*I*	I	*S*	S	-	-
9	9	*J*	J	*t*	T	-	-

OPERATION KEYS

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

Key	Name	Description
RUN	[RUN] key	Used to run the drive (inputs a RUN command).
STOP RESET	[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.
MODE SHIFT	[MODE/SHIFT] key	Moves between groups or moves to the digit on the left when setting the parameter. Press the MODE/SHIFT key once again on the maximum number of digits to move to the minimum number of digits.
ENT	[ENTER] key	Switches from the selected state of parameter to the input state. Edits parameter and applies change. Accesses the operation information screen during failure on the failure screen.
Potentiometer dial (MIN MAX)	Potentiometer dial	Used to set the operation frequency when Pr. Code frq=4 (V0).
MODE SHIFT + ∨	ESC	Use the MODE/SHIFT key plus either arrow key to escape and make no change.

⚠️ *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 ACM 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.

Groups, except the Operation group, are not displayed on the group list and not accessible as factory default to prevent parameter input error. To display and access all groups, go to the OGr code in the Operation group and set the parameter to 1.

ACM Series Parameter Groups		
Group	*Display*	*Description*
Operation	-	Configures basic parameters for drive operation. These include reference frequencies, motor capacity 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, 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 functions such as carrier frequency or speed search.
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.
Application	AP	Configures PID control related sequences and operations.
Protection	Pr	Configures motor or drive protection features.
Motor 2 (Secondary Motor)*	m2	Configures secondary motor related features.
Configuration	CF	Configuration such as Parameter Initialization and password lock/unlock.

* The secondary motor (M2) group displays when one of the multi-function input terminals (In.65–In.69) has been set to 12 (Secondary motor).

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.

Step	Instruction	Keypad Display
ACM Series Keypad Parameter Selection		
1	Move to the parameter group you want using the MODE key. Press the MODE key for longer than 1 second to move in the opposite direction.	
2	Move up and down through the codes using the Up and Down arrow keys until you locate the code that you require.	
3	Press the **[ENT]** key to save the change.	

NOTE: *Certain parameter groups and numbers have "parameter dependencies". These parameters will only display when other parameters are configured to the applicable settings. See 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.

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 Ad.12 using the parameter Ad.0 (jump code parameter):
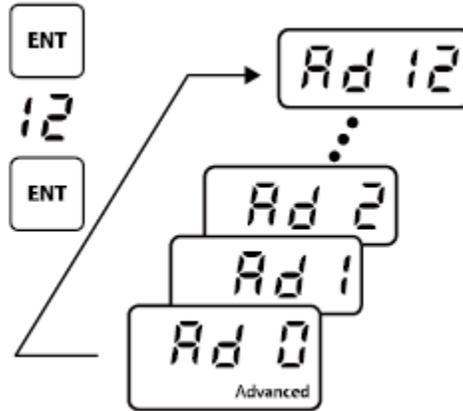
ACM Series Keypad Jump Code Navigation		
Step	*Instruction*	*Keypad Display*
1	Ad 0, the initial code of the Advanced (Ad) goup is displayed. Press the [ENT] key.	*Ad 0*
2	The code most often used for the group will be displayed as default. For example, "24" is displayed as a default code of the Ad group. The first digit will be flashing. This indicates the flashing value is ready to be modified. Press the down arrow key to set the first digit to "2".	*24*
3	Press the [MODE] key. The cursor will move to the left and the tenth digit will be flashing. Press the down arrow key to change "2" to "1".	*22*
4	The code destination "12" will be displayed. Press the [ENT] key.	*12*
5	The 12th code of the Advanced (Ad) group will be displayed.	*Ad 12*

NOTE: This example applies to all groups except the Operation group.

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
	ACM Series Keypad Setting Parameter Value	
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.	5.0
2	Move to the desired place value to edit using the [MODE] key (hold longer than 1 second to move left), then press the Up Arrow or Down Arrow key to adjust the value. Then press the [ENT] key to confirm it.	6.0 ⌃⌄ 5.0 ⌃⌄ 4.0
3	The parameter value will flash on the display. Press the [ENT] key	4.0
4	Press the [ENT] key again to save the change.	4.0
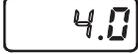
NOTE: *A flashing number on the display indicates that the keypad is waiting for an input from the user. Changes will be saved when the [ENT] key is pressed while the number is flashing. The setting change will be canceled if you press any other key.*

ACTUAL APPLICATION EXAMPLES

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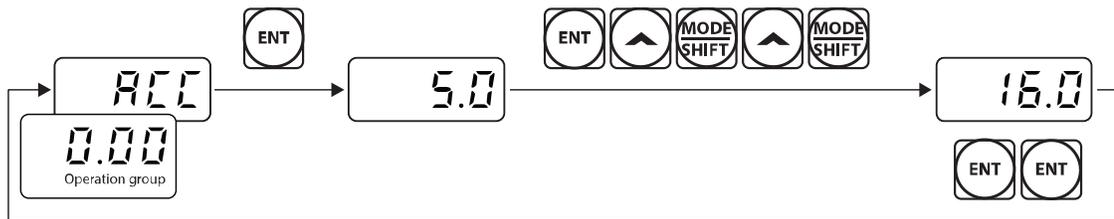
The following is an example demonstrating how to modify the ACC (Acceleration time) parameter value (from 5.0 to 16.0) from the Operation group.

ACM Series Keypad Setting Example		
Step	**Instruction**	**Keypad Display**
1	Select the first code of the Operation group to display code 0.00 (Command Frequency).	0.00
2	Press the Up arrow key. The display will change to the second code in the Operation group, the acceleration time (ACC) code.	ACC
3	Press the [ENT] key. The number 5.0 will be displayed with the "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.	5.0
4	Press the [MODE] key to change the place value.	5.0
5	To make the target value "16.0", press the Up arrow key to change the ones place value to "6".	6.0
6	Press the [MODE] key for more than one second to move to the tens' place value. "0" in the tens place from "06.0" will flash.	06.0
7	To make the target value "16.0", press the Up arrow key to change the tens place value to "1", then press the [ENT] key. The selected value will flash on the display.	16.0
8	Press the [ENT] key again to save the changes. "ACC" will be displayed. The change to the acceleration time setup has been completed.	ACC

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).
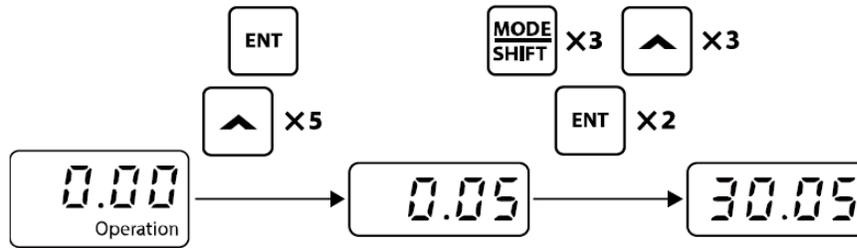
ACM Series Keypad Frequency Setting Example		
Step	**Instruction**	**Keypad Display**
1	The initial code of the Operation group is displayed. Press the [ENT] key.	*00.0*
2	The digit in the second decimal place becomes editable. Press the up arrow key until the digit in the second decimal place reaches "5".	*0.00*
3	Press the [MODE] key.	*0.05*
4	The cursor is moved to the left. Press the [MODE] key.	*0.05*
5	Press the [MODE] key.	*0.05*
6	Press the up arrow key to set the first digit to "3".	*00.05*
7	Press the [ENT] key. "30.05" will flash.	*30.05*
8	Press the [ENT] key. The value will stop flashing. This indicates that the frequency reference is set to "30.05".	*30.05*

NOTE: The ACM drive keypad display can show up to 4 digits. However, 5-digit figures can be used and are accessed by pressing the [MODE] key, to allow keypad input.

In Step 7, you can cancel setting the parameter by pressing any key except the [ENT] key while '30.05' is flashing.

FREQUENCY SETTING

The following example demonstrates how to configure Frequency Jump (Ad.27) value (from 0 to 1) from the Advanced group. You can configure the parameters in any other group in exactly the same way.
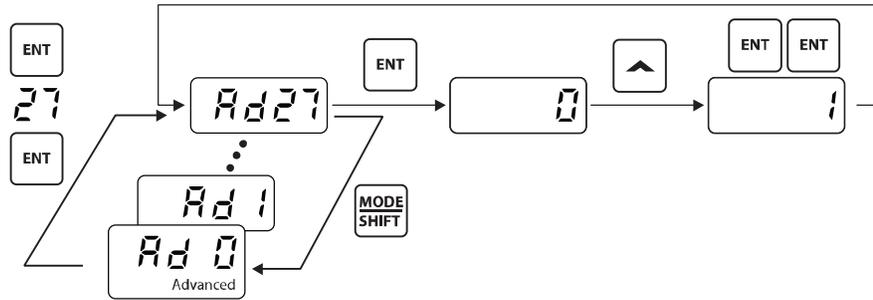
ACM Series Keypad Frequency Setting Example		
Step	**Instruction**	**Keypad Display**
1	Ad.0 will be the initially displayed code of the Advanced group. Press the [ENT] key.	Ad 0
2	The value "24" will be displayed. Press the Up arrow key until the first digit reaches "7".	24
3	The value of "27" will be displayed. Press the [ENT] key.	27
4	Ad.27 will be displayed. Press the [ENT] key.	Ad27
5	"0' will be displayed. Press the Up arrow key to set the value to "1".	0
6	Press the [ENT] key.	1
7	The value "1" will flash and then Ad.27 will be displayed.	Ad27

INITIALIZING ALL PARAMETERS (RESET TO DEFAULTS)

To reset the drive parameters to factory default settings, utilize CF.93, (Configuration Group Parameter 93-parameter initialization). Once executed, all parameters will be set back to original settings.
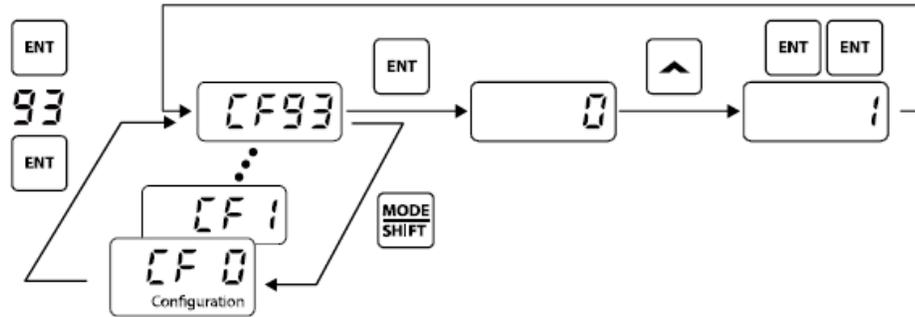
ACM Series Keypad Frequency Setting Example		
Step	*Instruction*	*Keypad Display*
1	Go to CF.0 in the Configuration group.	CF 0
2	Press the [ENT] key. The current parameter value "1" will be displayed.	1
3	To make the target value "93", press the Up arrow key to change the ones place value to "3".	3
4	Press the [MODE] key to move to the tens place value.	03
5	Press the Up or Down arrow key to change the tens place value to "9".	93
6	Press the [ENT] key. Code CF.93 will be displayed.	CF93
7	Press the [ENT] key again. The current parameter value for code CF.93 is set to 0 (do not initialize).	0
8	Press the Up arrow key to change the value to 1 (All Grp) and then press the [ENT] key. The parameter value will flash.	1
9	Press the [ENT] key again. Parameter initialization begins. Parameter initialization is complete when code CF.93 reappears on the display.	CF93

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 (POTENTIOMETER) AND OPERATION (VIA TERMINAL INPUT)

Step	Instruction	Keypad Display
1	Turn on the drive.	–
2	Select code 0.00 (Command Frequency) in the Operation group.	0.00
3	Press the Up arrow key 4 times. Move to the Frq (Frequency reference source) code.	Frq
4	Press the [ENT] key. The Frq code in the Operation group is currently set to 0 (keypad).	0
5	Press the Up arrow key three times to change the parameter value to 3. Press the [ENT] key. The parameter value will flash.	3
6	Press the [ENT] key once again while "3" flashes. The Frq code will be displayed again. The frequency input has been configured for the potentiometer. Press the down arrow key four times to return to monitor the frequency setting values. Adjust the potentiometer to increase or decrease the frequency reference to 10.00 Hz.	Frq
7	The run indicator light next to the drive display will flash and the FWD indicator will be steady. The current acceleration frequency is displayed. When the frequency reference reaches 10 Hz the display and LEDs will appear as shown in the image to the right. Turn off the switch located between the P1 (FX) terminal and CM terminal.	10.00
8	The run indicator next to the drive will flash again and the current deceleration frequency will display. When frequency reference reaches 0 Hz, the RUN and FWD LEDs turn off and the frequency reference (10.00 Hz) is displayed again.	10.00

[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)).*

FREQUENCY SETTING (POTENTIOMETER) AND OPERATION (KEYPAD)

	ACM Series Keypad Frequency Setting Example	
Step	*Instruction*	*Keypad Display*
1	Turn on the drive.	–
2	Ensure that "0.00" is displayed, then press the up arrow key three times.	*0.00*
3	The display should read drv (Command source). Press the [ENT] key.	*dr v*
4	Command source is set to 1 (drive terminal). Press the down arrow key.	*1*
5	With the code value set to "0", press the [ENT] key. Once "0" is flashing, press the [ENT] key again.	*0*
6	The display should show drv, indicating the frequency setting has changed to use the [RUN] key of the keypad. Press the down arrow key.	*drv*
7	Set the display to Frq (Frequency reference source). Press the [ENT] key.	*Frq*
8	Frequency reference source should be at 0 (Keypad). Press the up arrow key two times.	*0*
9	Frequency reference source should now display "2" (Built-in Potentiometer). Press the [ENT] key. When the "2" flashes, press the [ENT] key again to confirm.	*2*
10	The display should show Frq again. Press the down arrow key four times to return to monitor the frequency setting values. Adjust the potentiometer to increase or decrease the frequency reference to 10.00 Hz.	*Frq*
11	Press the [RUN] key. The RUN LED on the drive display will flash, the FWD LED will be steady. The current acceleration frequency is displayed. When the frequency reference reaches (10 Hz), the display and LED appear as shown in the image to the right. Press the [STOP/RST] key.	*10.00*
12	The RUN LED next to the drive display will flash again and the current deceleration frequency is displayed. When frequency reference reaches 0 Hz, the RUN and FWD LEDs turn off, and the frequency reference (10.00 Hz) is displayed again.	*10.00*
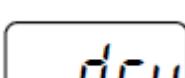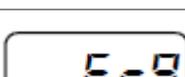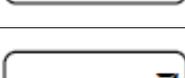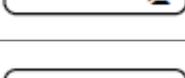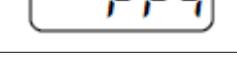
[Wiring Diagram]   [Operation Pattern]

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)).

MONITORING THE OPERATION

OUTPUT CURRENT MONITORING

The following example demonstrates how to monitor the output current in the Operation group using the keypad.
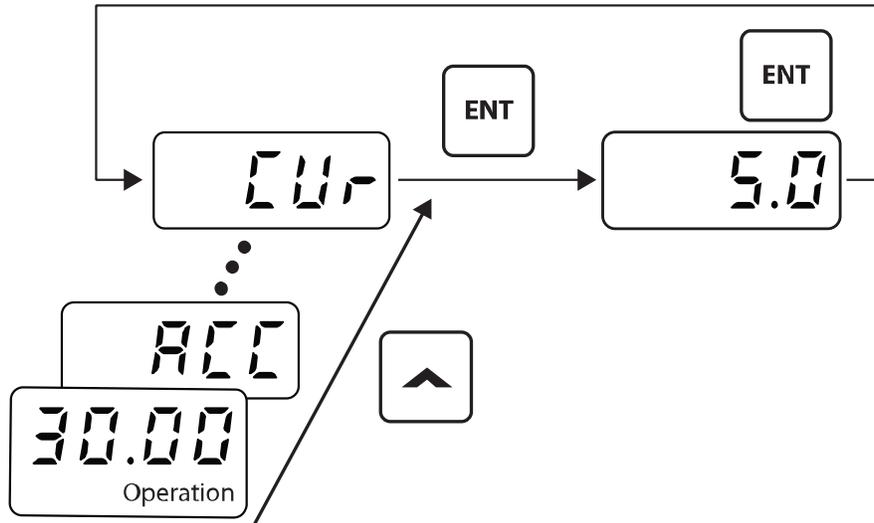
ACM Series Output Current Monitoring		
Step	*Instruction*	*Keypad Display*
1	Select the first code of the Operation group and make sure code 30.00 (Command Frequency) is displayed. Press the up or down arrow key until CUr is displayed.	30.00
2	With CUr (Output current) displayed, press the [ENT] key.	CUr
3	The drive output current of 5.0 A will display. Press the [ENT] key.	5.0
4	The cursor will move to the left. Press the [MODE] key.	CUr

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.

USER SELECTABLE MONITORING

The vOL (output voltage monitor) is configured by parameter dr.81. This parameter can be changed in order to display a user selected value of output voltage, power, torque, or analog V1/I2 feedback.

FAULT TRIP MONITORING

The following example demonstrates how to monitor fault trip conditions in the Operation group using the keypad.
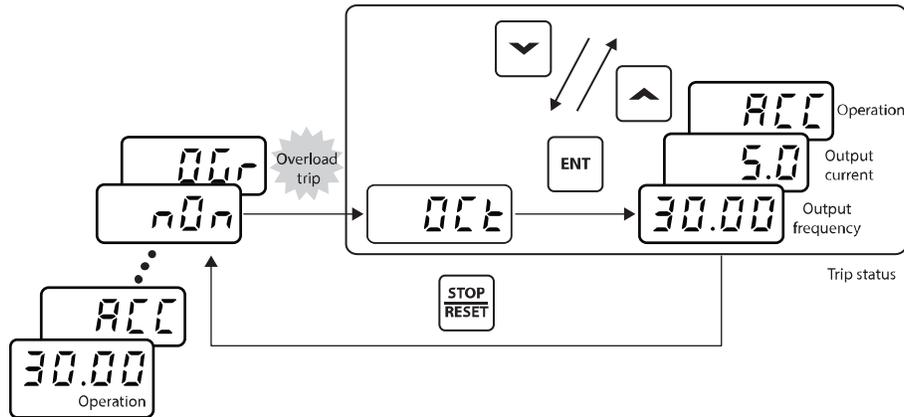
ACM Series Fault Trip Monitoring		
Step	*Instruction*	*Keypad Display*
1	When an over current trip fault occurs the OCt code displays. Press the [ENT] key and then press the up or down arrow key.	OCt
2	The operation frequency at the time of the fault (30.00 Hz) displays. Press the up arrow key.	30.00
3	The output current at the time of the fault (5.0 A) displays. Press the up arrow key.	5.0
4	The operation status at the time of the fault displays. ACC on the display indicates that the fault occured during acceleration. Press the [STOP/RESET] key.	ACC
5	The fault condition is cleared and the nOn code displays.	nOn

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:
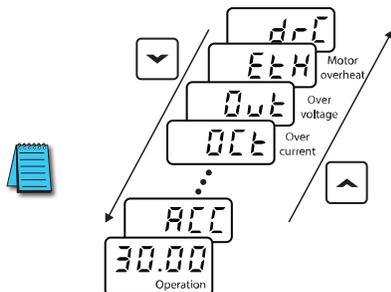
If a warning condition occurs while running at a specified frequency, the current frequency and the signal will be displayed alternately, at 1 second intervals. Refer to "Fault Trips" in chapter 6 for more details.

CHAPTER 4: AC DRIVE PARAMETERS

AC DRIVE PARAMETERS

This chapter covers all the parameters available for use with the Ironhorse ACM series drives. The "Parameter Summary" section provides a table of all the parameters with basic information. The subsequent chapter sections provide explanations 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, V0, I2)

BIT SELECTION

Bit level selections are displayed as follows:

Drive Keypad

←On
←Off
3 2 1 0 ←Bit
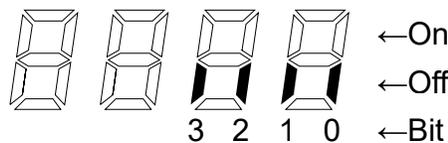
Use the left/right arrows to move bits. Use up/down arrows to toggle bits on/off.

PARAMETER TABLE FORMAT EXPLANATION

The ACM drive has 12 parameter groups containing over 400 parameters.

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=1)
  » "i" – Simple Sensorless (dr.9=2)

- **Comm. Address** – Hexadecimal parameter address for serial communications.
- **Ref.** – Page reference and link to parameter details.

Parameter Group Summary		
Parameter Group Display Code		
Drive Keypad LED	**Description**	**Parameter Pr. Group Dependency**
n/a	Operation (SPS)	
Ad	Expanded	
AP	Application	
bA	Basic	
CF	Configuration	
CM	Communication	
Cn	Control	
dr	Drive	
In	Inputs	
M2*	2nd Motor	* In.65–In.69–> any one of these parameters is set to 26
OU	Outputs	
Pr	Protection	

OPERATION PARAMETER GROUP

The Operation Group is accessed by pressing the up or down arrow on the keypad. The other parameter groups are accessed by pressing the Mode key.

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

		Operation Parameter Group							
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	0h1F00	–
ACC	Acceleration time	0.0–6000.0s		5.0	♦R/W	–	v, s, i	0h1F01	4–53
dEC	Deceleration time	0.0–6000.0s		10.0	♦R/W	–	v, s, i	0h1F02	4–53
drv	Command source	0	Keypad	1: Fx/Rx–1 (Fwd Run/ Rev Run)	R/W	–	v, s, i	0h1F03	4–46
		1	Fx/Rx–1 (Fwd Run/Rev Run)						
		2	Fx/Rx–2 (Run/ Direction)						
		3	RS-485 Comm						
Frq	Frequency reference source	0	Keypad–1: Change+Enter	0: Keypad–1	R/W	–	v, s, i	0h1F04	4–35
		1	Keypad–2: Instant change						
		2	V0: Built-in Potentiometer dial						
		3	V1: Voltage analog input						
		4	I2: Current Analog Input						
		5	I2: Voltage Analog input						
		6	V0 + I2 (current)						
		7	V0 + I2 (voltage)						
		8	V0 + V1						
		9	RS-485 Comm						
		10	Up-down Operation						
		11	V1 + I2 (voltage)						

		Operation Parameter Group							
Pr. Code	**Name**	**Setting Range**		**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
MkW	Frequency reference source	0.1	1/10 hp (0.1 kW)	–	R/W	–	v, s, i	0h1F05	4–35
		0.2	¼ hp (0.2 kW)						
		0.4	½ hp (0.4 kW)						
		0.75	1 hp (0.75 kW)						
		1.1	1.5 hp (1.1 kW)						
		1.5	2 hp (1.5 kW)						
		2.2	3 hp (2.2 kW)						
MrC	Rated motor current	0.1-150.0 (A)		-	R/W	–	v, s, i	0h1F06	–
MbF	Base frequency	30.00-400.00 (Hz)		60.00	R/W	–	v, s, i	0h1F07	–
FrM	Maximum frequency	40.00-400.00 (Hz)		60.00	R/W	–	v, s, i	0h1F08	4–53
IOv	Output voltage setting	0, 170~264 (V)		0	R/W	–	v, s, i	0h1F09	4–63
Ftb	Forward boost	0.0-20.0 (%)		4.0	R/W	–	v, s, i	0h1F0A	4–61
rtb	Reverse boost	0.0-20.0 (%)		4.0	R/W	–	v, s, i	0h1F0B	4–61
CUr	Output Current	–		–	Read Only	–	v, s, i	0h1F0C	4–104
rPM	Motor RPM	–		–	Read Only	–	v, s, i	0h1F0D	–
dCL	Drive DC voltage	–		-	Read Only	–	v, s, i	0h1F0E	–
vOL, POr, tOr, v1M, I2M	User Selectable signal	vOL – Output voltage POr- Output power tOr- Output torque v1M – Analog V1 terminal input value I2M – Analog I1 terminal input value		vOL	Read Only	dr.81	v,s,i	-	4–105
nOn	Current fault	–		-	Read Only	-	v,s,i	0h1F10	4–107
OGr	Open Hidden groups	0 – Hide groups except operation group 1 – Enable all groups		-	R/W	-	v,s,i	0h1F11	–

DRIVE Parameter Group (dr)

The DRIVE parameter group is labeled using dr.

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.
dr.0	Jump Code	0–81		9	♦R/W	–	v, s, i	–	Chapter 3
dr.9	Control mode	0	V/F	1: Slip Compen	R/W	–	v, s, i	0h1109	4–78 4–79 4–95
		1	Slip Compen						
		2	Simple sensorless control						
dr.11	Jog frequency	0.00- Maximum frequency(Hz)		10.00	♦R/W	–	v, s, i	0h110B	4–73
dr.15	Torque boost options	0 – Manual torque boost 1- Automatic torque boost		0	R/W	–	v, s, i	0h110F	4–61
dr.19	Starting frequency	0.10-10.00 (Hz)		0.50	R/W	–	v, s, i	0h1113	4–65
dr.20	Rotation direction	F	Forward Run	F: Forward	♦R/W	drv=0, Note1	v, s, i	0h1114	–
		r	Reverse Run						
dr.26	Automatic torque boost filter gain	1-1000		2	♦R/W	dr.15=1	v, s, i	0h111A	4–62
dr.27	Automatic torque boost monitoring gain	0.0-300.0%		120.0%	♦R/W	dr.15=1	v, s, i	0h111B	4–62
dr.28	Automatic torque boost regeneration gain	0.0-300.0%		120.0%	♦R/W	dr.15=1	v, s, i	0h111C	4–62
dr.81	Select monitor code	Select monitor code to display in Operation group		0: vOL	♦R/W		v, s, i	0h1151	–
		0	vOL (Output Voltage)						
		1	POr (Output Power)						
		2	tOr (Output Torque)						
		3	v1M (V1 terminal input)						
		4	I2M (I2 terminal input)						
dr.85	Read Parameters	0 – No 1 – Yes		0 : No	R/W	Note 2	v, s, i	-	–
dr.86	Write Parameters	0	No	0: No	R/W	Note 2	v, s, i	-	–
		1	Yes						
dr.91	Reserved	–		–	–	–	–	–	–

Note 1: dr.20 setting is applied only when drv (Command source) is set to 0. You can still display and set the dr.20 setting when drv (Command source) is set to other than 0.
Note 2: Displayed when remote keypad is connected to the drive.

BASIC Parameter group (bA)

The BASIC parameter group is labeled using bA.

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.
		BASIC Parameter group (bA)							
bA.0	Jump Code	0-83		19	♦R/W	–	v, s, i	–	Chapter 3
bA.4	2nd command source	0	Keypad	1: Fx/Rx–1 (Fwd Run/ Rev Run)	R/W	–	v, s, i	0h1204	4–91
		1	Fx/Rx–1 (Fwd Run/Rev Run)						
		2	Fx/Rx–2 (Run/Direction)						
		3	RS-485 Communication						
bA.5	2nd frequency source	0	Keypad–1	0: Keypad–1	R/W	–	v, s, i	0h1205	4–91
		1	Keypad–2						
		2	V0: 0-5 (V)						
		3	V1: 0-10 (V)						
		4	I2: 0-20 mA (I)						
		5	I2: 0-10 (V)						
		6	Volume + I2 (I)						
		7	Volume + I2 (V)						
		8	Volume + V1						
		9	RS-485 Communication						
		10	Up-down operation						
bA.7	V/F pattern options	0	Linear	0: Linear	R/W	–	v, s, i	0h1207	4–58
		1	Square						
		2	User V/F						
bA.8	Time scale settings	0	0.01 – 600.0 sec	1: 0.1-6000.0 sec	♦R/W	–	v, s, i	0h1208	4–53
		1	0.1 – 6000.0 sec						
		2	1 – 60000 sec						
bA.9	Acc/dec standard frequency	0	Max Frequency (FrM)	0: Max Frequency (FrM)	R/W	–	v, s, i	0h1209	4–53
		1	Delta Frequency						
bA.11	Number of motor poles	2–12		Dependent on motor setting	R/W	–	v, s, i	0h120B	4–104
bA.12	Rated motor slip current	0–10 (Hz)		Dependent on motor setting	R/W	–	v, s, i	0h120C	–
bA.14	Motor no load current	0.0–100.0A		Dependent on motor setting	R/W	–	v, s, i	0h120E	–
bA.15	Motor efficiency	50–100%		Dependent on motor setting	R/W	–	v, s, i	0h120F	4–78

BASIC Parameter group (bA)							
Pr. Code	**Name**	**Setting Range**	**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
bA.16	Load inertia rate	0 : Less than 10 times motor inertia 1: 10 times motor inertia 2: More then 10 times motor inertia	0	R/W	–	v, s, i	0h1210	4–78
bA.19	Input power voltage	120V: 85-132 V 230V: 170-240 V	120V: 110 230V: 220	♦R/W	–	v, s, i	0h1213	4–91
bA.25	Slip Gain	0.0-150%	100.0%	♦R/W	–	v, s, i	0h1219	–
bA.41	User frequency1	0.00–Maximum frequency(Hz)	15.00	R/W	bA.7 or m2.25=2	v, s, i	0h1229	4–60
bA.42	User voltage1	0–100%	25	R/W	bA.7 or m2.25=2	v, s, i	0h122A	4–60
bA.43	User frequency2	0.00–0.00– Maximum frequency(Hz)	30.00	R/W	bA.7 or m2.25=2	v, s, i	0h122B	4–60
bA.44	User voltage2	0–100%	50	R/W	bA.7 or m2.25=2	v, s, i	0h122C	4–60
bA.45	User frequency3	0.00–Maximum frequency(Hz)	45.00	R/W	bA.7 or m2.25=2	v, s, i	0h122D	4–60
bA.46	User voltage3	0–100%	75	R/W	bA.7 or m2.25=2	v, s, i	0h122E	4–60
bA.47	User frequency4	0.00–Maximum frequency(Hz)	60.00	R/W	bA.7 or m2.25=2	v, s, i	0h122F	4–60
bA.48	User voltage4	0–100%	100	R/W	bA.7 or m2.25=2	v, s, i	0h1230	4–60
bA.50	Multi-step speed frequency1	0.00–Maximum frequency(Hz)	10.00	♦R/W	In.65–69= Spd–L/M/H	v, s, i	0h1232	4–44
bA.51	Multi-step speed frequency2	0.00–Maximum frequency(Hz)	20.00	♦R/W	In.65–69= Spd–L/M/H	v, s, i	0h1233	4–44
bA.52	Multi-step speed frequency3	0.00–Maximum frequency(Hz)	30.00	♦R/W	In.65–69= Spd–L/M/H	v, s, i	0h1234	4–44
bA.53	Multi–step speed frequency4	0.00–Maximum frequency(Hz)	30.00	♦R/W	In.65–69= Spd–L/M/H	v, s, i	0h1235	4–44
bA.54	Multi–step speed frequency5	0.00–Maximum frequency(Hz)	25.00	♦R/W	In.65–69= Spd–L/M/H	v, s, i	0h1236	4–44
bA.55	Multi–step speed frequency6	0.00–Maximum frequency(Hz)	20.00	♦R/W	In.65–69= Spd–L/M/H	v, s, i	0h1237	4–44
bA.56	Multi–step speed frequency7	0.00–Maximum frequency(Hz)	15.00	♦R/W	In.65–69= Spd–L/M/H	v, s, i	0h1238	4–44
bA.70	Multi–step acceleration time1	0.0–6000.0s	2.0	♦R/W	In.65–69= Xcel–L/M/H	v, s, i	0h1246	4–54

BASIC Parameter group (bA)								
Pr. Code	Name	Setting Range	Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
bA.71	Multi–step deceleration time1	0.0–6000.0s	2.0	♦R/W	In.65–69= Xcel–L/M/H	v, s, i	0h1247	4–54
bA.72	Multi–step acceleration time2	0.0–6000.0s	3.0	♦R/W	In.65–69= Xcel–L/M/H	v, s, i	0h1248	4–54
bA.73	Multi–step deceleration time2	0.0–6000.0s	3.0	♦R/W	In.65–69= Xcel–L/M/H	v, s, i	0h1249	4–54
bA.74	Multi–step acceleration time3	0.0–6000.0s	4.0	♦R/W	In.65–69= Xcel–L/M/H	v, s, i	0h124A	4–54
bA.75	Multi–step deceleration time3	0.0–6000.0s	4.0	♦R/W	In.65–69= Xcel–L/M/H	v, s, i	0h124B	4–54
bA.76	Multi–step acceleration time4	0.0–6000.0s	5.0	♦R/W	In.65–69= Xcel–L/M/H	v, s, i	0h124C	4–54
bA.77	Multi–step deceleration time4	0.0–6000.0s	5.0	♦R/W	In.65–69= Xcel–L/M/H	v, s, i	0h124D	4–54
bA.78	Multi–step acceleration time5	0.0–6000.0s	4.0	♦R/W	In.65–69= Xcel–L/M/H	v, s, i	0h124E	4–54
bA.79	Multi–step deceleration time5	0.0–6000.0s	4.0	♦R/W	In.65–69= Xcel–L/M/H	v, s, i	0h124F	4–54
bA.80	Multi–step acceleration time6	0.0–6000.0s	3.0	♦R/W	In.65–69= Xcel–L/M/H	v, s, i	0h1250	4–54
bA.81	Multi–step deceleration time6	0.0–6000.0s	3.0	♦R/W	In.65–69= Xcel–L/M/H	v, s, i	0h1251	4–54
bA.82	Multi–step acceleration time7	0.0–6000.0s	2.0	♦R/W	In.65–69= Xcel–L/M/H	v, s, i	0h1252	4–54
bA.83	Multi–step deceleration time7	0.0–6000.0s	2.0	♦R/W	In.65–69= Xcel–L/M/H	v, s, i	0h1253	4–54

ADVANCED PARAMETER GROUP (AD)

The ADVANCED parameter group is labeled using Ad.

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

ADVANCED Parameter Group (Ad)

Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
Ad.0	Jump Code	0-79		24	♦R/W	–	v, s, i	–	Chapter 3
Ad.1	Acceleration pattern	0	Linear	0: Linear	R/W	–	v, s, i	0h1301	4–56
		1	S–curve						
Ad.2	Deceleration pattern	0	Linear	0: Linear	R/W	–	v, s, i	0h1302	4–56
		1	S–curve						
Ad.3	S–curve acceleration start point gradient	1–100%		40	R/W	-	v, s, i	0h1303	4–56
Ad.4	S–curve acceleration end point gradient	1–100%		40	R/W	-	v, s, i	0h1304	4–56
Ad.8	Stop Mode	0	Dec	0: Dec	R/W	–	v, s, i	0h1308	4–64
		1	DC–Brake						
		2	Free–Run						
Ad.9	Selection of prohibited rotation direction	0	None	0: None	R/W	–	v, s, i	0h1309	4–50
		1	Forward Prevent						
		2	Reverse Prevent						
Ad.10	Starting with power on	0	No	0: No	♦R/W	–	v, s, i	0h130A	4–51
		1	Yes						
Ad.12	DC braking time at startup	0.00–60.00s		0.00	R/W		v, s, i	0h130C	4–71
Ad.13	Amount of applied DC	0–200 (%)		50	R/W	–	v, s, i	0h130D	4–71
Ad.14	Output blocking time before DC braking	0.00– 60.00s		0.00	R/W	Ad.8=1	v, s, i	0h130E	4–70
Ad.15	DC braking time	0.00– 60.00s		1.00	R/W	Ad.8=1	v, s, i	0h130F	4–71
Ad.16	DC braking rate	0–200 (%)		50	R/W	Ad.8=1	v, s, i	0h1310	4–71
Ad.17	DC braking frequency	Start frequency–60 Hz		5.00	R/W	Ad.8=1	v, s, i	0h1311	4–71
Ad.20	Dwell frequency on acceleration	Start frequency– Maximum frequency(Hz)		5.00	R/W	–	v, s, i	0h1314	4–77

ADVANCED Parameter Group (Ad)								
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	0.0–10.0s		0.0	R/W	–	v, s, i	0h1315	4–77
Ad.24	Frequency limit	0	No	0: No	R/W	–	v, s, i	0h1318	4–65
		1	Yes						
Ad.25	Frequency lower limit value	Starting frequency –Upper limit frequency (Hz)		0.50	R/W	Ad.24=1	v, s, i	0h1319	4–65
Ad.26	Frequency upper limit value	0.00 – Maximum frequency (Hz)		60.00	R/W	Ad.24=1	v, s, i	0h131A	4–65
Ad.27	Frequency jump	0	No	0: No	R/W	–	v, s, i	0h131B	4–66
		1	Yes						
Ad.28	Jump frequency lower limit1	Starting frequency –Jump frequency upper limit1 (Hz)		10.00	R/W	Ad.27=1	v, s, i	0h131C	4–66
Ad.29	Jump frequency upper limit1	Jump frequency lower limit1–Maximum frequency (Hz)		15.00	R/W	Ad.27=1	v, s, i	0h131D	4–66
Ad.30	Jump frequency lower limit2	Starting frequency –Jump frequency upper limit2 (Hz)		20.00	R/W	Ad.27=1	v, s, i	0h131E	4–66
Ad.31	Jump frequency upper limit2	Jump frequency lower limit2–Maximum frequency(Hz)		25.00	R/W	Ad.27=1	v, s, i	0h131F	4–66
Ad.32	Jump frequency lower limit3	Starting frequency –Jump frequency upper limit3 (Hz)		30.00	R/W	Ad.27=1	v, s, i	0h1320	4–66
Ad.33	Jump frequency upper limit3	Jump frequency lower limit3–Maximum frequency (Hz)		35.00	R/W	Ad.27=1	v, s, i	0h1321	4–66
Ad.41	Brake release current	0.0–180.0%		50.0	♦R/W	OU.31 or OU.32 = 19	v, s, i	0h1329	4–95
Ad.42	Brake release delay time	0.00–10.00s		1.00	R/W	OU.31 or OU.32 = 19	v, s, i	0h132A	4–95
Ad.44	Brake release Forward frequency	0.00–Maximum frequency(Hz)		1.00	R/W	OU.31 or OU.32 = 19	v, s, i	0h132C	4–95
Ad.45	Brake release Reverse frequency	0.00–Maximum frequency(Hz)		1.00	R/W	OU.31 or OU.32 = 19	v, s, i	0h132D	4–95
Ad.46	Brake engage delay time	0.00–10.00s		1.00	R/W	OU.31 or OU.32 = 19	v, s, i	0h132E	4–95
Ad.47	Brake engage frequency	0.00–Maximum frequency(Hz)		2.00	R/W	OU.31 or OU.32 = 19	v, s, i	0h132F	4–95
Ad.51	Energy saving level	0–30%		0	♦R/W		v, s, i	0h1333	4–85

ADVANCED Parameter Group (Ad)								
Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
Ad.63	Motor RPM display gain	1-1000%		100	♦R/W	–	v, s, i	0h133F	4–104
Ad.64	Up-down frequency save	0.00-Maximum Frequency (Hz)		0.00	♦R/W	Ad.65=1	v, s, i	0h1340	4–74
Ad.65	Up/down operation frequency save selection	0	No	0: No	R/W	–	v, s, i	0h1341	4–74
		1	Yes						
Ad.66	Up-down operation mode selection	0	Maximum/ minimum frequency reference	0: Maximum/ minimum frequency reference	R/W	–	v, s, i	0h1342	4–74
		1	Increase or decrease based on step frequency (Ad.67)						
		2	Mixed function of 0 and 1						
Ad.67	Up-down operation step frequency	0.00-Maximum frequency (Hz)		0.00	R/W	–	v, s, i	0h1343	4–74
Ad.68	Cooling Fan control	0	During Run	0:During Run	♦R/W	–	v, s, i	0h1344	4–67
		1	Always On						
		2	Temp Control						
Ad.79	Dynamic Brake (DB) Unit turn on voltage level	120V: 300–400V		390V	R/W	–	v, s, i	0h134F	–
		230V: 300–400V		390V					

CONTROL PARAMETER GROUP (CN)

The CONTROL parameter group is labeled using Cn.

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.
Cn.0	Jump Code	0–74		4	♦R/W	–	v, s, i	–	Chapter 3
Cn.4	Carrier frequency	1.0–15.0 (kHz)		3.0	♦R/W	–	v, s, i	0h1404	4–89
Cn.71	Speed search operation selection	bit	0000– 1111	0000	R/W	–	v, s, i	0h1447	4–85
		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%		100	♦R/W	-	v, s, i	0h1448	4–85
Cn.73	Speed search proportional gain	0–9999		500	♦R/W	-	v, s, i	0h1449	4–85
Cn.74	Speed search integral gain	0–9999		1000	♦R/W	-	v, s, i	0h144A	4–85

INPUT Parameter Group (In)

The INPUT parameter group is labeled using In.

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.
In.0	Jump Code	0–90	65	♦R/W	–	v, s, i	–	Chapter 3
In.7	Time constant of V1 input filter	0–9999(ms)	10	♦R/W	–	v, s, i	0h1507	4–37
In.8	V1 Minimum input voltage	0.00–V1 Maximum input voltage [V]	0.00	♦R/W	–	v, s, i	0h1508	4–37
In.9	Frequency at minimum V1 input voltage	0.00–Maximum Frequency (Hz)	0.00	♦R/W	–	v, s, i	0h1509	4–37
In.10	V1 Maximum input voltage	V1 Minimum input voltage–10.00V	10.00	♦R/W	–	v, s, i	0h150A	4–37
In.11	Frequency at V1 maximum input voltage	0.00–Maximum Frequency (Hz)	60.00	♦R/W	–	v, s, i	0h150B	4–37
In.37	V0 input filter time constant	0–9999 (ms)	10	♦R/W	–	v, s, i	0h1525	4–39
In.38	V0 Minimum input voltage	0.00–V0 Maximum input voltage (V)	0.00	♦R/W	–	v, s, i	0h1526	4–39
In.39	Frequency at V0 minimum input voltage	0.00–Maximum Frequency (Hz)	0.00	♦R/W	–	v, s, i	0h1527	4–39
In.40	V0 Maximum input voltage	V0 Minimum input voltage–5.00V	5	♦R/W	-	v, s, i	0h1528	4–39
In.41	Frequency at V0 Maximum input voltage	0.00–Maximum Frequency (Hz)	60.00	♦R/W	-	v, s, i	0h1529	4–39
In.52	I2 input filter time constant	0–9999ms	10	♦R/W	-	v, s, i	0h1534	4–39
In.53	I2 minimum input current	0.00–I maximum input current mA	4.00	♦R/W	-	v, s, i	0h1535	4–39
In.54	Frequency at I2 minimum input current	0.00–Maximum Frequency (Hz)	0.00	♦R/W	-	v, s, i	0h1536	4–39
In.55	I2 maximum input current	In.53 – 20.00mA	20.00	♦R/W	-	v, s, i	0h1537	4–39
In.56	Frequency at I2 maximum input current	0.00–Maximum Frequency (Hz)	60.00	♦R/W	-	v, s, i	0h1538	4–39
In.57	V input filter time constant	0-9999 (ms)	10	♦R/W	-	v, s, i	0h1539	4–40

INPUT Parameter Group (In)								
Pr. Code	Name	Setting Range	Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
In.58	V minimum input voltage	0.00 – V maximum input voltage	0.00	♦R/W	-	v, s, i	0h153A	4–40
In.59	Frequency at V minimum input voltage	0.00 – Maximum Frequency (Hz)	0.00	♦R/W	-	v, s, i	0h153B	4–40
In.60	V maximum input voltage	In.58 – 10.00 V	10.00	♦R/W	-	v, s, i	0h153C	4–40
In.61	Frequency at V maximum input voltage	0.00 – Maximum Frequency (Hz)	60.00	♦R/W		v, s, i	0h153D	4–40
In.65	P1 terminal function setting	0 Fx 1 Rx 2 Emergency Stop (EST) 3 RST 4 JOG 5 Speed–L 6 Speed–M 7 Speed–H 8 XCEL–L 9 XCEL–M 10 XCEL–H 11 DC Braking 12 2nd Motor 15 Up (Speed) 16 Down (Speed) 17 3-wire 18 External Trip (EtA) 19 External Trip (EtB) 21 PID operation 22 2nd source 23 Fix analog command 24 XCEL Stop 25 U/D Init Frequency 26 Jog Forward (JOG-FX) 27 Jog Reverse (JOG-RX)	0: Fx	R/W	–	v, s, i	0h1541	4–47 – – 4–73 4–44 4–54 4–71 4–90 4–74 4–49 4–114 4–80 4–91 4–44 4–57 4–74 4–74

INPUT Parameter Group (In)								
Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
In.66	P2 terminal function setting	See In.65 for Setting Range		1: Rx	R/W	–	v, s, i	0h1542	See In.65
In.67	P3 terminal function setting	See In.65 for Setting Range		2: EST	R/W	–	v, s, i	0h1543	See In.65
In.68	P4 terminal function setting	See In.65 for Setting Range		3: RST	R/W	–	v, s, i	0h1544	See In.65
In.69	P5 terminal function setting	See In.65 for Setting Range		4: JOG	R/W	–	v, s, i	0h1545	See In.65
In.70	PNP/NPN selection switch	0	PNP	-	Read Only	–	v, s, i	0h1546	–
		1	NPN						
In.85	Multi–function input terminal filter time constant	1–15 s		4	♦R/W	–	v, s, i	0h1555	4–68
In.87	Multi–function input contact selection	Bit Value:		0 0000	R/W	–	v, s, i	0h1557	4–68
		0	Normally Closed (A contact)						
		1	Normally Open (B contact						
		Bit Assignment:							
		0	P1						
		1	P2						
		2	P3						
		3	P4						
		4	P5						
In.90	Multi–function input terminal monitor status	Bit Value:		0 0000	Read Only	–	v, s, i	0h155A	4–68
		0	Off						
		1	On						
		Bit Assignment:							
		0	P1						
		1	P2						
		2	P3						
		3	P4						
		4	P5						

OUTPUT Parameter Group (OU)

The OUTPUT parameter group is labeled using OU.

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.
		OUTPUT Parameter Group (OU)							
OU.0	Jump Code	0–58		30	♦R/W	–	v, s, i	–	Chapter 3
OU.1	Analog output 1 Mode	0	Frequency	0: Frequency	♦R/W	–	v, s, i	0h1601	4–96
		1	Output Current						
		2	Output Voltage						
		3	DCLink Voltage						
OU.2	Analog output 1 level adjustment	10–200%		100	♦R/W	–	v, s, i	0h1602	4–96
OU.30	Fault output item	bit	000–111	010	♦R/W	–	v, s, i	0h161E	4–97
		001	Low voltage						
		010	Any faults other than low voltage						
		100	Automatic restart final failure						
OU.31	Multi–function Output Relay1 Setting (A1, B1, C1 terminals)	0	FDT–1	17: Fault output setting	♦R/W	–	v, s, i	0h161F	4–97
		1	FDT–2						
		2	FDT–3						
		3	FDT–4						
		4	FDT–5						
		5	Over Load						
		6	IOL						
		7	STALL (Motor Stall)						
		8	Over voltage (Ovt)						
		9	Low voltage (Lvt)						
		10	Fan Overheat (OHt)						
		11	Lost Command						
		12	Run						
		13	Stop						
		14	At Constant Speed						
		15	Speed Search						
		16	Ready						
		17	Fault output setting						
		18	Abnormal Fan						
		19	Brake Signal						
OU.32	Multi–function Output Relay2 setting (A2,C2 terminals)	See OU.31 values		12: Run	♦R/W	–	v, s, i	0h1620	4–97
OU.41	Multi–function output monitor	Monitor status of Relay1 and Relay2		00	Read Only	–	v, s, i	0h1629	4–106

OUTPUT Parameter Group (OU)								
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: 0 = A Contact (NO) 1 = B Contact (NC)	00	R/W	–	v, s, i	0h1634	–
OU.57	Detected frequency (FDT)	0.00–Maximum frequency(Hz)	30.00	♦R/W	–	v, s, i	0h1639	–
OU.58	Detected frequency band (FDT)	0.00–Maximum frequency(Hz)	10.00	♦R/W	–	v, s, i	0h163A	–

COMMUNICATION PARAMETER GROUP (CM)

The COMMUNICATION parameter group is labeled using CM.

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

COMMUNICATION Parameter Group (CM)								
Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
CM.0	Jump Code	0-58		31	♦R/W	–	v, s, i	–	Chapter 3
CM.1	Built–in communication drive ID	1–250		1	♦R/W	–	v, s, i	0h1701	4–43
CM.2	Built–in communication protocol	0	ModBus RTU	0: ModBus RTU	♦R/W	–	v, s, i	0h1702	4–43
		1	Not supported						
CM.3	Built–in communication speed	0	1200 bps	3: 9600 bps	♦R/W	–	v, s, i	0h1703	4–43
		1	2400 bps						
		2	4800 bps						
		3	9600 bps						
		4	19200 bps						
		5	38400 bps						
CM.4	Built–in communication frame setting	0	D8/PN/S1	0: D8/PN/S1	♦R/W	–	v, s, i	0h1704	Chapter 5
		1	D8/PN/S2						
		2	D8/PE/S1						
		3	D8/PO/S1						
CM.5	Transmission delay after reception	2–100(ms)		5ms	♦R/W	–	v, s, i	0h1705	Chapter 5
CM.31	Read Address registration 1	0000–A4FF Hex		000A	♦R/W	–	v, s, i	0h171F	Chapter 5
CM.32	Read Address registration 2	0000–A4FF Hex		000E	♦R/W	–	v, s, i	0h1720	Chapter 5
CM.33	Read Address registration 3	0000–A4FF Hex		000F	♦R/W	–	v, s, i	0h1721	Chapter 5
CM.34	Read Address registration 4	0000–A4FF Hex		0000	♦R/W	–	v, s, i	0h1722	Chapter 5
CM.35	Read Address registration 5	0000–A4FF Hex		0000	♦R/W	–	v, s, i	0h1723	Chapter 5
CM.36	Read Address registration 6	0000–A4FF Hex		0000	♦R/W	–	v, s, i	0h1724	Chapter 5
CM.37	Read Address registration 7	0000–A4FF Hex		0000	♦R/W	–	v, s, i	0h1725	Chapter 5

COMMUNICATION Parameter Group (CM)								
Pr. Code	Name	Setting Range	Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
CM.38	Read Address registration 8	0000–A4FF Hex	0000	♦R/W	–	v, s, i	0h1726	Chapter 5
CM.51	Write address registration 1	0000–A4FF Hex	0005	R/W	–	v, s, i	0h1733	Chapter 5
CM.52	Write address registration 2	0000–A4FF Hex	0006	R/W	–	v, s, i	0h1734	Chapter 5
CM.53	Write address registration 3	0000–A4FF Hex	0000	R/W	–	v, s, i	0h1735	Chapter 5
CM.54	Write address registration 4	0000–A4FF Hex	0000	R/W	–	v, s, i	0h1736	Chapter 5
CM.55	Write address registration 5	0000–A4FF Hex	0000	R/W	–	v, s, i	0h1737	Chapter 5
CM.56	Write address registration 6	0000–A4FF Hex	0000	R/W	–	v, s, i	0h1738	Chapter 5
CM.57	Write address registration 7	0000–A4FF Hex	0000	R/W	–	v, s, i	0h1739	Chapter 5
CM.58	Write address registration 8	0000–A4FF Hex	0000	R/W	–	v, s, i	0h173A	Chapter 5

APPLICATION PARAMETER GROUP (AP)

The APPLICATION parameter group is labeled using AP.

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.
AP.0	Jump Code	0-71		20	♦R/W	–	v, s, i	–	Chapter 3
AP.1	PID control setting	0	No	0: No	R/W	–	v, s, i	0h1801	4–80
		1	Yes						
AP.2	PID control unit selection	0	Frequency (Hz)	0: Frequency (Hz)	R/W	AP.1 = 1	v, s, i	0h1802	4–80
		1	Percentage (%)						
AP.18	PID feedback monitor	AP.2 = 0	0.00-400.00 Hz	-	Read Only	AP.1 = 1	v, s, i	0h1812	4–80
		AP.2=1	0.0-100.0%						
AP.19	PID reference setting	AP.2 = 0	0.00-Maximum frequency (Hz)	0.00	♦R/W	AP.1 = 1	v, s, i	0h1813	4–80
		AP.2=1	0.0-100.0%						
AP.20	PID reference source	0	Keypad 1	0: Keypad	R/W	AP.1 = 1	v, s, i	0h1814	4–80
		1	Keypad 2						
		2	V1: 0-10 V						
		3	I2: 0-20 mA						
		4	I2: 0-10 V						
		5	RS-485 Communication						
AP.21	PID feedback source	0	I2: 0-20 mA	2: V1	R/W	AP.1 = 1	v, s, i	0h1815	4–80
		1	I2: 0-10 V						
		2	V1: 0-10 V						
		3	RS-485 Communication						
AP.22	PID controller proportional gain	0.0–999.0%		300.0	♦R/W	AP.1 = 1	v, s, i	0h1816	4–80
AP.23	PID controller integral time	0.10–32.00s		1.0	♦R/W	AP.1 = 1	v, s, i	0h1817	4–80
AP.24	PID controller differentiation time	0.00–30.00 (s)		0.00	♦R/W	AP.1 = 1	v, s, i	0h1818	4–80
AP.28	PID Mode	0	Normal PID	0	R/W	AP.1 = 1	v, s, i	0h181C	4–80
		1	Process PID						
AP.29	PID upper limit frequency	PID lower limit frequency– Maximum frequency [Hz]		60.00	♦R/W	AP.1 = 1	v, s, i	0h181D	4–80

APPLICATION Parameter Group (AP)								
Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
AP.30	PID lower limit frequency	Starting frequency –PID upper limit frequency(Hz)		0.50	♦R/W	AP.1 = 1	v, s, i	0h181E	4–80
AP.37	PID sleep mode delay time	0.0–2000.0s		60.0	R/W	AP.1 = 1	v, s, i	0h1825	4–80
AP.38	PID sleep mode frequency	0.00–Maximum frequency(Hz)		0.00	♦R/W	AP.1 = 1	v, s, i	0h1826	4–80
AP.39	PID wake–up level	0.0–100.0%		35.0	♦R/W	AP.1 = 1	v, s, i	0h1827	4–80
AP.70	Draw operation mode selection	0	Don't use draw operation	0: Don't use	R/W	-	v, s, i	0h1846	4–101
		1	V1 input draw operation						
		2	V0 input draw operation						
		3	I2 (0-20mA) input draw operation						
		4	I2 (0-10V) input draw operation						
AP.71	Draw Percentage	0.0–100.0%		0.0	♦R/W	-	v, s, i	0h1847	4–101

PROTECTION PARAMETER GROUP (PR)

The PROTECTION parameter group is labeled using Pr.

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.
Pr.0	Jump Code	0–96		40	♦R/W	–	v, s, i	–	Chapter 3
Pr.5	Output open–phase protection	0	No	0	♦R/W	–	v, s, i	0h1905	4–113
		1	Yes						
Pr.8	Selection of startup on trip reset	0	No	0: No	♦R/W	–	v, s, i	0h1908	4–52
		1	Yes						
Pr.9	Number of automatic restarts	0–10		0	♦R/W	–	v, s, i	0h1909	4–52
Pr.10	Automatic restart delay time	0.0–60.0s		1.0	♦R/W	-	v, s, i	0h190A	4–52
Pr.12	Motion at speed command loss	0	Hold Output	0: Hold Output	♦R/W	–	v, s, i	0h190C	4–115
		1	Free–Run						
		2	Dec						
Pr.13	Time to decide speed command loss	0.1–120s		1.0	♦R/W	-	v, s, i	0h190D	4–115
Pr.15	Analog input loss decision level	0	Not operating	0: Not operating	♦R/W	-	v, s, i	0h190F	4–115
		1	Half of the set value						
		2	Under the set value						
Pr.18	Overload alarm level	30–150%		150	♦R/W	OU.31 or OU.32 = 5	v, s, i	0h1912	4–111
Pr.19	Overload warning time	0.0–30.0s		10.0	♦R/W	–	v, s, i	0h1913	4–111
Pr.20	Motion at overload fault	0	None	1: Free-Run	♦R/W	–	v, s, i	0h1914	4–111
		1	Free-Run						
Pr.21	Overload fault level	30–200%		180	♦R/W	Pr.20=1	v, s, i	0h1915	4–111
Pr.22	Overload fault time	0.0–60.0s		60.0	♦R/W	Pr.20=1	v, s, i	0h1916	4–111
Pr.40	Electronic thermal fault selection	0	No	0: No	♦R/W	–	v, s, i	0h1928	4–109
		1	Yes						
Pr.41	Motor cooling fan type	0	Self-cool	0: Self–cool	♦R/W	Pr.40=1	v, s, i	0h1929	4–109
		1	Forced-cool						
Pr.42	Electronic thermal 1 minute rating	Electronic thermal continuous operation level–200%		150	♦R/W	Pr.40=1	v, s, i	0h192A	4–109
Pr.43	Electronic thermal continuous rating	50–Electronic thermal 1 minute level [%]		100	♦R/W	Pr.40=1	v, s, i	0h192B	4–109

PROTECTION Parameter Group (Pr)									
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	0000–1111	000	R/W	–	v, s, i	0h1932	4–112
		001	Accelerating						
		010	At constant speed						
		100	At deceleration						
Pr.52	Stall prevention level	30–200%		150	R/W	–	v, s, i	0h1934	4–112
Pr.53	Voltage limit when using stall prevention during deceleration	0	No	0: No	♦R/W	Pr.50=1 or 2	v, s, i	0h1935	4–94
		1	Yes						
Pr.65	Dynamic Brake resistor warning level limit setting (Note 1)	0	Use DB resistor without limit level	1: Use Pr.66	♦R/W	–	v, s, i	0h1941	4–117
		1	Use DB resistor during the time set to Pr.66						
Pr.66	Dynamic Brake resistor warning level (Note 1)	0-30%		10	♦R/W	Pr.65=1	v, s, i	0h1942	4–117
Pr.79	Cooling fan fault selection	0	Run continuously	1: Stop	♦R/W	–	v, s, i	0h194F	4–103
		1	Stop operation						
Pr.80	Initial charging circuit trip protection	0	Disable ROT function	1: Enable ROT	R/W	–	v, s, i	0h1950	4–118
		1	Enable ROT function						
Pr.91	Fault history 1	–		nOn	Read Only	–	v, s, i	0h195B	4–107
Pr.92	Fault history 2	–		nOn	Read Only	–	v, s, i	0h195C	4–107
Pr.93	Fault history 3	–		nOn	Read Only	–	v, s, i	0h195D	4–107
Pr.94	Fault history 4	–		nOn	Read Only	–	v, s, i	0h195E	4–107
Pr.95	Fault history 5	–		nOn	Read Only	–	v, s, i	0h195F	4–107
Pr.96	Fault history deletion	0	No	0: No	♦R/W	–	v, s, i	0h1960	4–107
		1	Yes						

Note 1: Brake resistor terminals are available on Frame C drives only. Functionality does not apply to Frame A/B drives.

2ND MOTOR PARAMETER GROUP (M2)

The M2 parameter group is labeled using M2. 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 12.

Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
M2.0	Jump Code	0-30		12	♦R/W	–	v, s, i	–	Chapter 3
M2.4	Acceleration time	0.0–6000.0s		5.0	♦R/W	–	v, s, i	0h1A04	4–90
M2.5	Deceleration time	0.0–6000.0s		10.0	♦R/W	–	v, s, i	0h1A05	4–90
M2.7	Base frequency	30.00–400.00Hz		60.00	R/W	–	v, s, i	0h1A07	4–90
M2.12	Motor rated current	1.0–100.0A		Dependent on motor settings	R/W	–	v, s, i	0h1A0C	4–90
M2.25	V/F pattern	0	Linear	0: Linear	R/W	–	v, s, i	0h1A19	4–90
		1	Square						
		2	User V/F						
M2.26	Forward Torque boost	0.0–15.0%		4.0	R/W	–	v, s, i	0h1A1A	4–90
M2.27	Reverse Torque boost	0.0–15.0%		4.0	R/W	–	v, s, i	0h1A1B	4–90
M2.28	Stall prevention level	30–150%		150	R/W	–	v, s, i	0h1A1C	4–90
M2.29	Electronic thermal 1 minute rating	2nd motor electronic thermal continuous operation level –200%		150	♦R/W	–	v, s, i	0h1A1D	4–90
M2.30	Electronic thermal continuous rating	50–Electronic thermal 1 minute rating		100	♦R/W	–	v, s, i	0h1A1E	4–90

CONFIG MODE GROUP (CF)

The CF parameter group is labeled using CF.

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.
CF.0	Jump Code	0-30		12	♦R/W	–	v, s, i	–	Chapter 3
CF.1	Display setting after power on	Information displayed after power is on		0: Command frequency	♦R/W	–	v, s, i	0h1B01	4–105
		0	Command frequency						
		1	Acceleration time						
		2	Deceleration time						
		3	Command Source						
		4	Frequency Setting Method						
		5	Motor selection						
		6	Rated Motor Current						
		7	Base frequency						
		8	Maximum frequency						
		9	Output voltage adjustment						
		10	Forward boost						
		11	Reverse boost						
		12	Output Current						
		13	Motor RPM						
		14	Drive DC voltage						
		15	User Select signal (dr.81)						
		16	Reserved						
		17	Open Hidden groups						
CF.2	reserved	-		-	-	-	-	-	–
CF.79	Software version	Drive software version		-	Read Only	-	v, s, i	0h1B4F	–
CF.80	I/O board version	Drive I/O board version		-	Read only	-	v, s, i	0h1B50	–

Config Mode Parameter Group (CF)									
Pr. Code	**Name**	**Setting Range**		**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
CF.93	Parameter Initialization	0	No	0: No	R/W	-	v, s, i	0h1B5D	4–92
		1	All group						
		2	Operation group						
		3	dr group						
		4	bA group						
		5	Ad group						
		6	Cn group						
		7	In group						
		8	OU group						
		9	CM group						
		10	AP group						
		11	Pr group						
		12	M2 group						
		13	CF group						
CF.94	Password Registration	0000-FFFF		0000	♦R/W	-	v, s, i	0h1B5E	4–93
CF.95	Parameter lock	UL (Unlock)	Unlock parameter	UL	♦R/W	-	v, s, i	0h1B5F	4–93
		L (Lock)	Lock parameter						

IRONHORSE® ACM CONTROL BLOCK DIAGRAMS

V/F CONTROL

Setting Frequency with 1 Source

Final frequency reference

Multi-function input
In65-69
P1-P5

① Select JOG.
② Select JOG_FX.
③ Select JOG_RX.

※P4, P5, In68, and In69 are available only for models equipped with advanced I/O.

Multi-function input
In65-69
P1-P5

Set the multi-step speed (0–7).

1st frequency reference

Multi-function input
In65-69
P1-P5

Set the 2nd frequency reference.

1st frequency reference

2nd frequency reference

Multi-step frequency

Jog frequency

SETTING FREQUENCY WITH 2 SOURCES

Multi-step frequency command

Multi-step frequency set

Basic	
bA50	
bA51	
bA52	
bA53	
bA54	
bA55	
bA56	

Multi-step operation setting at multi-function terminal

Input Terminal	
In65–69	5, 6, 7

Digital input filter

Input Terminal	
In85	

P1 P2 P3 P4 P5

1st frequency reference

1st frequency reference source

Operation	
Frq	

0	Keypad1
1	Keypad2
2	V0: 0-5 [V]
3	V1: 0-10 [V]
4	I2 (I) : 0-20 [mA]
5	I2 (V) : 0-10 [V]
6	V0 + I2 (I)
7	V0 + I2 (V)
8	V0 + V1
9	RS-485 communication
10	Up-down operation

Analog input scale

Input Terminal	
In8-11,38-41, 53-56,58-61	

Analog input filter

Input Terminal	
In7,37, 52,57	

Keypad or remote loader key

V0 0-5 [V]

V1 0-10 [V]

I2 (I) 0-20 [mA]

I2 (V) 0-10 [V]

Digital Volume

RS-485 communication

2nd frequency reference

2nd frequency reference source

Operation	
Frq	

0	Keypad1
1	Keypad2
2	V0: 0-5 [V]
3	V1: 0-10 [V]
4	I2 (I): 0-20 [mA]
5	I2 (V): 0-10 [V]
6	V0 + I2(I)
7	V0 + I2(V)
8	V0 + V1
9	RS-485 communication

Analog input scale

Input Terminal	
In8-11,38-41, 53-56,58-61	

Analog input filter

Input Terminal	
In7,37, 52,57	

Keypad or remote loader key

Volume 0-5 [V]

V1 0-10 [V]

I2 (I) 0-20 [mA]

I2 (V) 0-10 [V]

RS-485 communication

※ P4, P5, In68, and In69 are available only for models equipped with advanced I/O

SETTING RUN COMMAND

Run cmd

Forward and reverse run

Advanced	
Ad09	
0	Do not set run prevention
1	Set forward run prevention
2	Set reverse run

Run cmd source

Operation	
drv	

0
1
2
3

0
1,2
3

※ P4–5, In68–69, RS-485 communication is available only for models equipped with advanced

Command by

3-wire operation

Input Terminal	
In65–69	

17

Command by communication

Multi-function terminal Fx/Rx run cmd selection

Input Terminal	
In65–69	

0,1

Digital input filter

Input Terminal	
In85	

P1
P2
P3
P4
P5

CONTROLLING ACC/DEC AND V/F VOLTAGE

IRONHORSE® ACM 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	Parameter Setting	Setting Range	Unit
In	In.7	V1 input filter time constant	10	0–9999	ms

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)*
- *Code = Parameter number, or full parameter group/code designation, i.e. dr.1*
- *Name = Parameter Description*
- *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 CF.93.*

LEARNING BASIC FEATURES

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

Basic Tasks	Description	Ref.
Setting Frequency Reference	Configures the drive to allow you to setup or modify frequency reference using the Keypad.	4–35
Setting V1 Terminal as the source	Configures the drive to allow input voltages at the terminal block (V1, V0) and to setup or modify a frequency reference.	4–37
Configuring frequency reference source for the I2 terminal	Configures the drive to allow input currents or voltages at the terminal block (I2) and to setup or modify a frequency reference.	4–38
Setting a frequency reference via 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.	4–43
Frequency setting via Up-Down control	Configures the drive to modify the frequency with Up-Down inputs from the terminal block.	4–43
Frequency control using analog inputs	Enables the user to hold a frequency using analog inputs at terminals.	4–44
Multi–step speed (frequency) configuration	Configures multi–step frequency operations by receiving an input at the terminals defined for each step frequency.	4–44
Command source configuration for keypad buttons	Configures the drive to start operation with the [RUN] key on the keypad and stop with the [STOP/RESET] keys.	4–46
Command source configuration for terminal block inputs (2-wire and 3-wire)	Configures the drive to accept inputs at the FX/RX terminals.	4–47
Command source configuration for RS–485 communication	Configures the drive to accept communication signals from upper level controllers, such as PLCs or PCs.	4–50
Motor rotation control	Configures the drive to limit a motor's rotation direction.	4–50
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.	4–51
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.	4–52
Acc/Dec time configuration based on the Max. Frequency	Configures the acceleration and deceleration times for a motor based on a defined maximum frequency.	4–53
Acc/Dec time configuration based on the frequency reference	Configures acceleration and deceleration times for a motor based on a defined frequency reference.	4–54
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.	4–54
Acc/Dec pattern configuration	Enables modification of the acceleration and deceleration gradient patterns. Basic patterns to choose from include linear and S–curve patterns.	4–56
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.	4–57
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.	4–58
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.	4–59
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.	4–60

Basic Tasks	Description	Ref.
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.	4–61
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.	4–62
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.	4–63
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.	4–64
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.	4–64
Start/maximum frequency configuration	Configures the frequency reference limits by defining a start frequency and a maximum frequency.	4–65
Upper/lower frequency limit configuration	Configures the frequency reference limits by defining an upper limit and a lower limit.	4–65
Frequency jump	Configures the drive to avoid running a motor in mechanically resonating frequencies.	4–66
Cooling fan control	Enables the control of the drive's cooling fan.	4–67
Multi-function input terminal control	Filter time constants and the type of multi-function input terminals can be configured to improve the response of intput terminals.	4–68

SETTING FREQUENCY REFERENCE

The ACM drive provides several methods to setup and modify a frequency reference for an operation. The keypad, analog inputs [for example voltage (V1) and current/voltage (I2) signals], or RS-485.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	0	Keypad–1: Change+Enter	0–11	–
			1	Keypad–2: Up/Down buttons		
			2	V0: Built-in Potentiometer Dial		
			3	V1: Analog Voltage Input		
			4	I2: Analog Current Input		
			5	I2: Analog Voltage Input		
			6	V0 + I2 (Current Input)		
			7	V0 + I2 (Voltage Input)		
			8	V0 + V1		
			9	RS-485 communication		
			11	V1 + I2 (Current Input)		

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	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	0	Keypad–1	0–11	–
	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 FrM.						

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	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	1	Keypad–2	0–11	–
	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 FrM.						

BUILT-IN POTENTIOMETER DIAL (V0) AS THE SOURCE

You can modify the frequency reference by using the built-in potentiometer dial. Go to the Frq (Frequency reference source) code in the Operation group and change the parameter value to 2, and then rotate the built-in potentiometer dial. You can monitor the parameter setting of the frequency reference at the 0.00 (command frequency) code in the Operation group.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	2	V0	0–11	–
In	In.37	Time constant of V0 input filter	10		0–9999	ms
	In.38	V0 minimum input voltage	0.00		0.00–In.40	V
	In.39	Frequency when V0 input is at minimum voltage	0.00		0.00-Max frequency	Hz
	In.40	V0 maximum input voltage	5.00		In.38–5.00	V
	In.41	Frequency when V0 input is at maximum voltage	60.00		0.00–Max frequency	Hz

Setting 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 for forward only operation.

Setting a Frequency Reference for 0–10V Input

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.
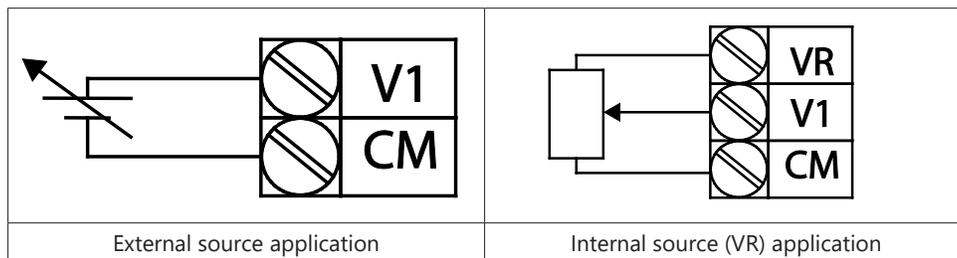
External source application	Internal source (VR) application
V1 / CM	VR / V1 / CM

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	3	V1	0–11	–
In	In.7	V1 input filter time constant	10		0–9999	ms
	In.8	V1 minimum input voltage	0.00		0.00–In.10	V
	In.9	Frequency when V1 input is at minimum voltage	0.00		0.00–Max frequency	Hz
	In.10	V1 maximum input voltage	10.00		In.8– 10.00	V
	In.11	Frequency when V1 input is at minimum voltage	60.00		0–Max frequency	Hz

0–10V Input Voltage Setting Details

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. V1 input from external source Frequency 100% 63% V1 Filter(t)

Pr. Code	Description
In.8 V1 minimum input voltage **In.9 Frequency when V1 input is at minimum voltage** **In.10 maximum input voltage** **In.11 Frequency when V1 input is at minimum voltage**	These parameters are used to configure the gradient level and offset values of the Output Frequency, based on the Input Voltage.

CONFIGURING FREQUENCY REFERENCE SOURCE FOR THE I2 TERMINAL

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 4 (I2) and apply 0–20 mA input current to I2 and CM terminals.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	4	I2	0–11	–
In	In.52	I2 input filter time constant	10		0–9999	ms
	In.53	I2 minimum input current	4.00		0.00–In.55	mA
	In.54	Frequency when I2 input is a minimum current	0.00		0–Max frequency	Hz
	In.55	I2 maximum input current	20.00		In.55–20.00	mA
	In.56	Frequency when I2 input is a maximum current	60.00		0.00–Max frequency	Hz

SETTING A REFERENCE FREQUENCY USING VOLTAGE CURRENT (I2)

You can set and modify a frequency reference using input voltage at the I2 terminal after selecting voltage input at SW 2. Set the Frq (Frequency reference source) code in the Operation group to 5 (I2) and apply 0-10 V input voltage to I2 and CM terminals.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	5	I2	0–11	–
In	In.57	V (I2) input filter time constant	10		0–9999	ms
	In.58	V (I2) minimum input voltage	0.00		0.00–In.60	V
	In.59	Frequency when V (I2) input is a minimum voltage	0.00		0–Max frequency	Hz
	In.60	V (I2) maximum input voltage	10.00		In.58–10.00	V
	In.61	Frequency when V (I2) input is a maximum voltage	60.00		0.00–Max frequency	Hz

Setting a Reference Frequency using the Built-in Potentiometer (V0) and I2 (Current) Terminal

You can set and modify a frequency reference using input current at the I2 terminal with the built-in potentiometer (V0) as an auxiliary reference source with override feature. Select current input at SW 2 switch. Set the Frq (Frequency reference source) code in the Operation group to 6 (V0 + I2).

Override allows the total frequency reference to be set with the main reference value and the auxiliary reference value simultaneously. The main reference provides a quick response and auxiliary reference may be used to provide some more accuracy to the total frequency reference. The built-in potentiometer (V0) uses 0-5 V for the auxiliary reference and the I2 terminal uses 0-20 mA for the main reference.

Example: When the built-in potentiometer (V0) voltage is 2.5 V (2.5 Hz) and I2 current is 12 mA (30Hz), the drive output frequency becomes 32.5 Hz.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	6	V0 + I2	0–11	–
In	In.37	Time constant of V0 input filter	10		0–9999	ms
	In.38	V0 minimum input voltage	0.00		0.00–In.40	V
	In.39	Frequency when V0 input is at minimum voltage	0.00		0.00-Max frequency	Hz
	In.40	V0 maximum input voltage	5.00		In.38–5.00	V
	In.41	Frequency when V0 input is at maximum voltage	5.00		0.00–Max frequency	Hz
	In.52	I2 input filter time constant	10		0–9999	ms
	In.53	I2 minimum input current	0.00		0.00–In.55	mA
	In.54	Frequency when I2 input is a minimum current	0.00		0–Max frequency	Hz
	In.55	I2 maximum input current	20.00		In.55–20.00	mA
	In.56	Frequency when I2 input is a maximum current	60.00		0.00–Max frequency	Hz

Setting a Reference Frequency using the Built-in Potentiometer (V0) and I2 (Voltage) Terminal

You can set and modify a frequency reference using input voltage at the I2 terminal with the built-in potentiometer (V0) as an auxiliary reference source with override feature. Select voltage input at SW 2 switch. Set the Frq (Frequency reference source) code in the Operation group to 7 (V0 + I2).

Override allows the total frequency reference to be set with the main reference value and the auxiliary reference value simultaneously. The main reference provides a quick response and auxiliary reference may be used to provide some more accuracy to the total frequency reference. The built-in potentiometer (V0) uses 0-5 V for the auxiliary reference and the I2 terminal uses 0-10 V for the main reference.

Example: When the built-in potentiometer (V0) voltage is 2.5 V (2.5 Hz) and I2 voltage is 5 V (30Hz), the drive output frequency becomes 32.5 Hz.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	7	V0 + I2	0–11	–
In	In.37	Time constant of V0 input filter	10		0–9999	ms
	In.38	V0 minimum input voltage	0.00		0.00–In.40	V
	In.39	Frequency when V0 input is at minimum voltage	0.00		0.00-Max frequency	Hz
	In.40	V0 maximum input voltage	5.00		In.38–5.00	V
	In.41	Frequency when V0 input is at maximum voltage	60.00		0.00–Max frequency	Hz
	In.57	V (I2) input filter time constant	10		0–9999	ms
	In.58	V (I2) minimum input voltage	4.00		0.00–In.60	V
	In.59	Frequency when V (I2) input is a minimum voltage	0.00		0–Max frequency	Hz
	In.60	V (I2) maximum input voltage	10.00		In.58–10.00	V
	In.61	Frequency when V (I2) input is a maximum voltage	5.00		0.00–Max frequency	Hz

Setting a Reference Frequency using the Built-in Potentiometer (V0) and V1 Terminal

You can set and modify a frequency reference using input voltage at the V1 terminal with the built-in potentiometer (V0) as an auxiliary reference source with override feature. Set the Frq (Frequency reference source) code in the Operation group to 8 (V0 + V1).

Override allows the total frequency reference to be set with the main reference value and the auxiliary reference value simultaneously. The main reference provides a quick response and auxiliary reference may be used to provide some more accuracy to the total frequency reference. The built-in potentiometer (V0) uses 0-5 V for the auxiliary reference and the V1 terminal uses 0-10 V for the main reference.

Example: When the built-in potentiometer (V0) voltage is 2.5V (2.5 Hz) and V1 voltage is 5V (30Hz), the drive output frequency becomes 32.5 Hz.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	8	V0 + V1	0–11	–
In	In.7	V1 input filter time constant	10		0–9999	ms
	In.8	V1 minimum input voltage	0.00		0.00–In.10	V
	In.9	Frequency when V1 input is at minimum voltage	0.00		0.00–Max frequency	Hz
	In.10	V1 maximum input voltage	10.00		In.8– 10.00	V
	In.11	Frequency when V1 input is at minimum voltage	60.00		0–Max frequency	Hz
	In.37	Time constant of V0 input filter	10		0–9999	ms
	In.38	V0 minimum input voltage	0.00		0.00–In.40	V
	In.39	Frequency when V0 input is at minimum voltage	0.00		0.00-Max frequency	Hz
	In.40	V0 maximum input voltage	5.00		In.38–5.00	V
	In.41	Frequency when V0 input is at maximum voltage	60.00		0.00–Max frequency	Hz

SETTING A REFERENCE FREQUENCY USING THE V1 AND I2 TERMINALS

You can set and modify a frequency reference using input voltage at the V1 terminal with the I2 terminal as an auxiliary reference source with override feature. Set the Frq (Frequency reference source) code in the Operation group to 11 (V1 + I2).

Override allows the total frequency reference to be set with the main reference value and the auxiliary reference value simultaneously. The main reference provides a quick response and auxiliary reference may be used to provide some more accuracy to the total frequency reference. The I2 terminal uses 0-20 mA for the auxiliary reference and the V1 terminal uses 0-10 V for the main reference.

Example: When V1 voltage is 2.5 V (2.5 Hz) and I2 current is 12 mA (30Hz), the drive output frequency becomes 32.5 Hz.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	11	V1+ I2	0–11	–
In	In.7	V1 input filter time constant	10		0–9999	ms
	In.8	V1 minimum input voltage	0.00		0.00–In.10	V
	In.9	Frequency when V1 input is at minimum voltage	0.00		0.00–Max frequency	Hz
	In.10	V1 maximum input voltage	10.00		In.8– 10.00	V
	In.11	Frequency when V1 input is at minimum voltage	5.00		0–Max frequency	Hz
	In.52	I2 input filter time constant	10		0–9999	ms
	In.53	I2 minimum input current	4.00		0.00–In.55	mA
	In.54	Frequency when I2 input is a minimum current	0.00		0–Max frequency	Hz
	In.55	I2 maximum input current	20.00		In.55–20.00	mA
	In.56	Frequency when I2 input is a maximum current	60.00		0.00–Max frequency	Hz

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 9 (RS-485 Communication) and use the RS–485 signal inputs located in the communication port. Refer to Chapter 5.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	9	RS-485 Communication	0–11	–
CM	CM.1	Integrated RS–485 communication drive ID	–	1	1–250	–
	CM.2	Integrated communication protocol	0	ModBus RTU	0–1	–
			1	Reserved		
	CM.3	Integrated communication speed	3	9600 bps	0–5	–

SETTING FREQUENCY VIA UP-DOWN CONTROL

You can set and modify a frequency reference using the input terminals when configured for Up-down operation. Set the Frq (Frequency reference source) code in the Operation group to 10 (Up-down operation) and configure In.65-In.69. Refer to Up–down Operation on page 4–74.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	10	Up-down operation	0–11	–
In	65	P1 setting	0	FX	0-27	–
	66	P2 setting	1	RX	0-27	–
	67	P3 setting	2	EST	0-27	–
	68	P4 setting	15	Up-down increase frequency	0-27	-
	69	P5 setting	16	Up-down decrease frequency	0-27	-
Ad	64	Up-down operation frequency save	0.00		0.00-Maximum frequency (Hz)	Hz
	65	Up-down operation frequency save operation	0		0-1	-
	66	Up-down operation mode selection	1 (Step frequency based on In.67)		0-3	-
	67	Up-down operation step frequency	Set to your desired frequency step		0.0-Max frequency	Hz

FREQUENCY CONTROL USING ANALOG INPUTS

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	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	2	V0	0–11	–
			3	V1		
			4	I2 (Current)		
			5	I2 (Voltage)		
			6	V0 + I2 (Current)		
			7	V0 + I2 (Voltage)		
			8	V0 + V1		
In	In.65–In.69	Px terminal configuration	23	Analog Hold	0–27	–
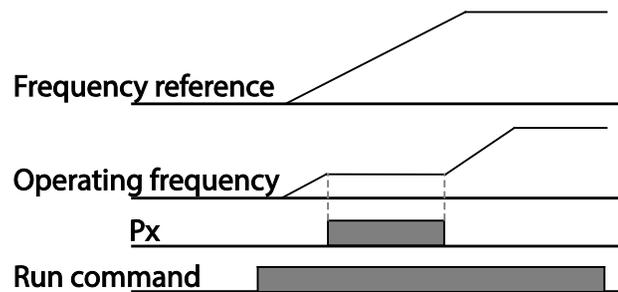
SETTING MULTI–STEP FREQUENCY

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 5 (Speed–L), 6 (Speed–M) and 7 (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 bA.50–bA.56 (multi–step frequency 1–7) and the binary command combinations.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	0		0-11	-
bA	bA.50 bA.51 bA.52 bA.53 bA.54 bA.55 bA.56	Multi–step frequency 1–7	–		0–Maximum frequency	Hz
In	In.67–In.69*	Px terminal configuration	5	Speed–L	0–27	–
			6	Speed–M		–
			7	Speed–H		–

* It is possible to configur this option in In.65 and In.66, but it is assumed those parameters will be used for 2-wire control.

Multi–step Frequency Setting Details

Pr. Code	Description
bA.50–bA.56 **Step Freq – 1–7**	Configure multi–step frequency 1–7.
In.65–In.69 Px Define	Choose the P1–P5 terminals to setup as multi–step inputs, and then set the relevant codes (In.65–69) to 5(Speed–L), 6(Speed–M), or 7(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] See table below.

Speed	Fx/Rx	P5	P4	P3
0	X	–	–	–
1	X	–	–	X
2	X	–	X	–
3	X	–	X	X
4	X	X	–	–
5	X	X	–	X
6	X	X	X	–
7	X	X	X	X

COMMAND SOURCE CONFIGURATION

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

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	drv	Command Source	0	Keypad	0-3	-
			1	Fx/Rx-1		
			2	Fx/Rx-2		
			3	RS-485 Communication		

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. When you use the keypad as a command input device, you can set motor rotation direction with dr.20.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	drv	Command source	0	Keypad	0–4	–
dr	20	Rotation direction selection	F	Forward	-	-
			r	Reverse		

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 0(Fx) and 1(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	Parameter Setting		Setting Range	Unit
Operation	drv	Command source	1	Fx/Rx–1	0–3	–
In	In.65–In.69	Px terminal configuration	0	Fx	0–27	–
			1	Rx		

Fwd/Rev Command by Multi–function Terminal – Setting Details

Pr. Code	Description
Operation group drv–Cmd Source	Set to 1(Fx/Rx–1).
In.65–In.69 Px Define	Assign a terminal for forward (Fx) operation. Assign a terminal for reverse (Rx) operation.
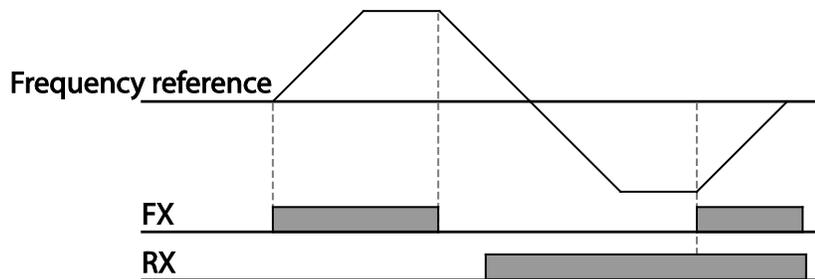
TERMINAL BLOCK AS A COMMAND INPUT DEVICE (RUN AND ROTATION DIRECTION COMMANDS, 2-WIRE)

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 0(Fx) and 1(Rx) respectively. This application uses an Fx input as a run command, and an Rx input to change a motor's rotation direction (On–Reverse, Off–Forward).

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	drv	Command source	2	Fx/Rx–2	0–3	–
In	In.65–In.69	Px terminal configuration	0	Fx	0–27	–
			1	Rx		

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).
In.65–In.69 Px Define	Assign a terminal for run command (Fx). Assign a terminal for changing rotation direction (Rx).
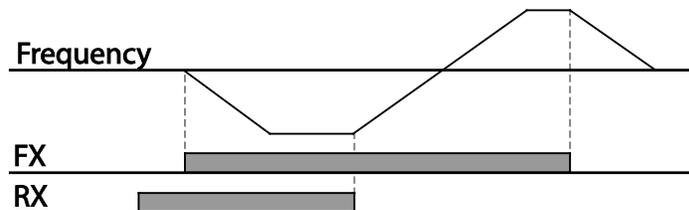
Terminal Block as Command Input Device (Run/Stop, 3–Wire Operation)

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	Parameter Setting		Setting Range	Unit
Operation	drv	Command source	1	Fx/Rx – 1	–	–
In	In.65–In.69	Px terminal configuration	17	3–Wire	0–27	–

To enable the 3–wire operation, the following circuit sequence is necessary. The minimum input time (t) for 3–wire operation is 50 ms, and the operation stops when both forward and reverse operation commands are entered at the same time.
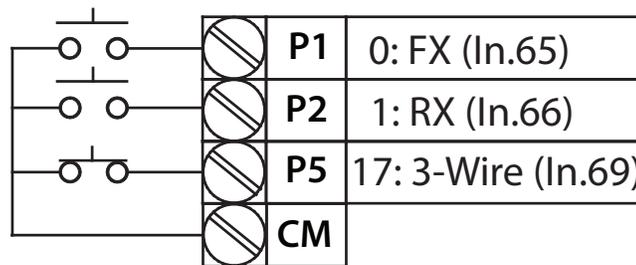
Terminal connections for 3–wire operation
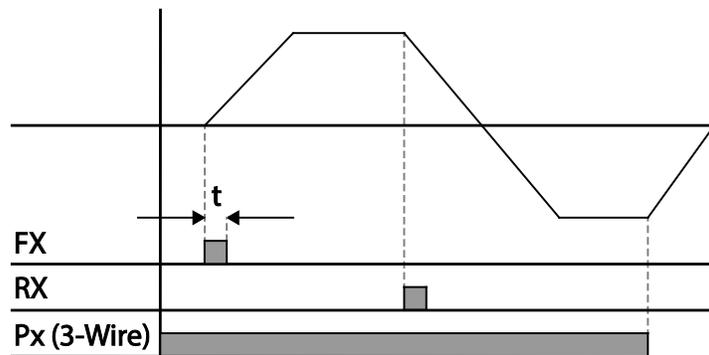
3–wire operation

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(RS-485 Communication). This configuration uses upper level controllers such as PCs or PLCs to control the drive by transmitting and receiving signals via Pin 1, Pin 7 and Pin 8 of the communication port. For more details, refer to Chapter 5.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	drv	Command source	3	RS-485 Communication	0–3	–
CM	CM.1	Integrated communication drive ID	1		1–250	–
	CM.2	Integrated communication protocol	0	ModBus RTU	0–1	–
	CM.3	Integrated communication speed	3	9600 bps	0–4	–

MOTOR ROTATION CONTROL (FOWARD/REVERSE RUN PREVENTION)

The rotation direction of motors can be configured to run in only one direction. Setting Ad.9 parameter prevents Parameter dr.20 from changing direction.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Ad	Ad.9	Run prevention options	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	No prevention for Forward or Reverse.
	1	Forward Prev	Set forward run prevention.
	2	Reverse Prev	Set reverse run prevention.

AUTOMATIC STARTUP AT POWER ON

A power–on run command can be setup to start a drive operation after powering up, based on terminal block operation command being ON. 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	Parameter Setting		Setting Range	Unit
Operation	drv	Command source	1, 2	Fx/Rx–1 or Fx/Rx–2	0–3	–
Ad	Ad.10	Power–on run	1	Yes	0–1	–

Ad.10=0   Ad.10=1
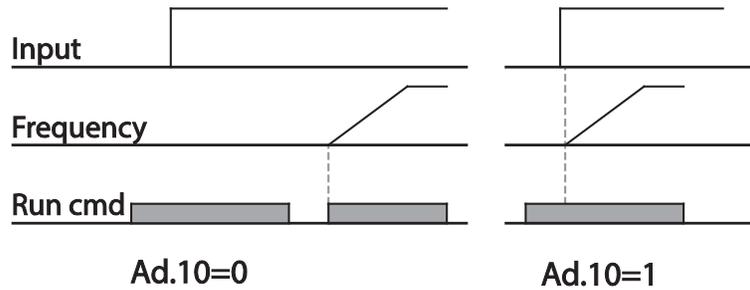
> ⚠ WARNING: USE CAUTION WHEN OPERATING THE DRIVE WITH POWER-ON RUN ENABLED AS THE MOTOR WILL BEGIN ROTATING WHEN THE DRIVE STARTS UP. UNEXPECTED MOTOR ROTATION CAN CAUSE INJURY OR EQUIPMENT DAMAGE. ENSURE AREA IS CLEAR AND SAFETY GUARDS ARE IN PLACE BEFORE APPLYING POWER.

AUTOMATIC RESTART AFTER RESET (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	Parameter Setting		Setting Range	Unit
Operation	drv	Command source	1, 2	Fx/Rx–1 or Fx/Rx–2	0–3	–
Pr	Pr.8	Reset restart setup	1	Yes	0–1	–
	Pr.9	No. of auto restart	0	–	0–10	–
	Pr.10	Auto restart delay time	1.0	–	0–60	sec

Pr.8=0   Pr.8=1
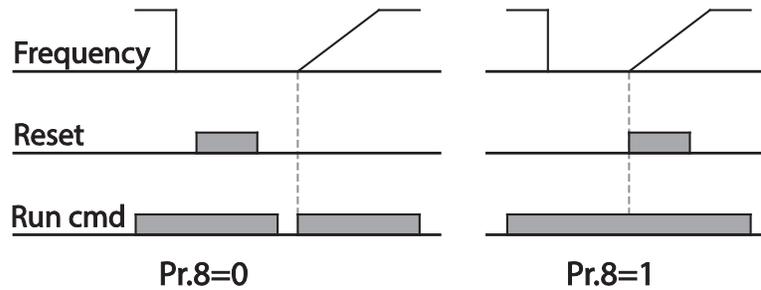
NOTE:
- *To prevent a repeat fault trip from occurring, set Cn.71 (speed search options) bit 2 = 1. The drive will perform a speed search at the beginning of the operation.*
- *If the speed search is not enabled, the drive will start its operation in a normal V/F pattern and accelerate the motor. If 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 AUTOMATIC RESTART AFTER RESET ENABLED AS THE MOTOR WILL BEGIN ROTATING AS SOON AS THE DRIVE IS RESET FROM THE TERMINAL BLOCK OR KEYPAD AFTER A TRIP OCCURS.

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.9 (Acc/Dec reference), = 0 (Max Freq).

Acceleration time set at the ACC (Acceleration time) code in the Operation group 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 refers to the time required to return to a stopped state (0Hz) from the maximum frequency.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	ACC	Acceleration time	5.0		0.0–6000.0	sec
	dEC	Deceleration time	10.0		0.0–6000.0	sec
	FrM	Maximum frequency	60.00		40.00–400.00	Hz
bA	bA.9	Acc/Dec reference frequency	0	Max Freq	0–1	–
	bA.8	Time scale	1	0.1sec	0–2	–

Acc/Dec Time Based on Maximum Frequency – Setting Details

Pr. Code	Description
bA.9 Ramp T Mode	Set the parameter value to 0 (Max Freq) to setup Acc/Dec time based on maximum frequency. | Configuration		Description
---	---	---
0	Max Freq	Set the Acc/Dec time based on maximum frequency.
1	Delta Freq	Set the Acc/Dec time based on operating frequency.	 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).
bA.8 Time scale	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. | Configuration		Description
---	---	---
0	0.01sec	Sets 0.01 second as the minimum unit.
1	0.1sec	Sets 0.1 second as the minimum unit.
2	1sec	Sets 1 second as the minimum unit.	

⚠️ *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 60000 SECONDS, A TIME SCALE CHANGE FROM 1 SECOND TO 0.01 SECOND WILL RESULT IN A MODIFIED ACCELERATION TIME OF 600.00 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.09 (acc/dec reference),= 1 (Delta Freq).

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	ACC	Acceleration time	5.0		0.0–6000.0	sec
	dEC	Deceleration time	10.0		0.0–6000.0	sec
bA	bA.9	Acc/Dec reference	1	Delta Freq	0–1	–

Acc/Dec Time Based on Operation Frequency – Setting Details

Pr. Code	Description
bA.9 **Ramp T Mode**	Set the parameter value to 1 (Delta Freq) to set Acc/Dec times based on Maximum frequency. <table><tr><td>**Configuration**</td><td></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).

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	Parameter Setting		Setting Range	Unit
Operation	ACC	Acceleration time	5.0		0.0–6000.0	sec
	dEC	Deceleration time	10.0		0.0–6000.0	sec
bA	bA.70–bA.83	Multi–step acceleration and deceleration time 1–7	0.0		0.0–6000.0	sec
In	In.65–In.69	Px terminal configuration	8	XCEL–L	0–27	–
			9	XCEL–M		
			10	XCEL–H		

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

Pr. Code	Description
bA.70, bA.72, bA.74, bA.76, bA.78, bA.80, bA.82 **Acc Time 1–7**	Set multi–step acceleration time 1–7.
bA.71, bA.73, bA.75, bA.77, bA.79, bA.81, bA.83 **Dec Time 1–7**	Set multi–step deceleration time 1–7.
In.65–In.69 **Px Define (P1–P5)**	Choose and configure the terminals to use for multi–step Acc/Dec time inputs.

Configuration		Description
8	XCEL–L	Acc/Dec command–L
9	XCEL–M	Acc/Dec command–M
10	XCEL–H	Acc/Dec command–H

Acc/Dec commands are recognized as binary code inputs and will control the acceleration and deceleration based on parameter values set with bA.70–bA.83.
If, for example, the P3, P4 and P5 terminals are set as XCEL-L, XCEL–M and XCEL-H respectively, the following operation will be available.

Acc/Dec time	P5	P4	P3
0	–	–	-
1	–	–	X
2	–	X	-
3	–	X	X
4	X	–	-
5	X	–	X
6	X	X	-
7	X	X	X

ACC/DEC PATTERN CONFIGURATION

Acc/Dec gradient level patterns can be configured to enhance and smooth drive 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.1–Ad.4 in the Advanced group.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
bA	bA.9	Acc/Dec reference	0	Max Freq	0–1	–
Ad	Ad.1	Acceleration pattern	0	Linear	0–1	–
	Ad.2	Deceleration pattern	1	S–curve		–
	Ad.3	S–curve start gradient	40		1–100	%
	Ad.4	S–curve end gradient	40		1–100	%

Acc/Dec Pattern Setting Details

Pr. Code	Description
Ad.3 S Start	Sets the gradient level as acceleration or deceleration starts when using an S–curve, Acc/Dec pattern. Ad.3 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.3 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 or deceleration within the 15–30 Hz frequency range.
Ad.4 S End	Sets the gradient level as acceleration or deceleration ends when using an S–curve Acc/Dec pattern. Ad.3 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.4 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.
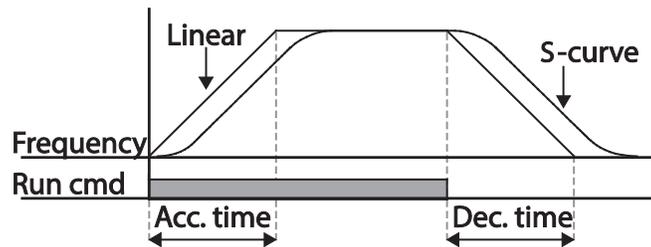
Acceleration / deceleration pattern configuration
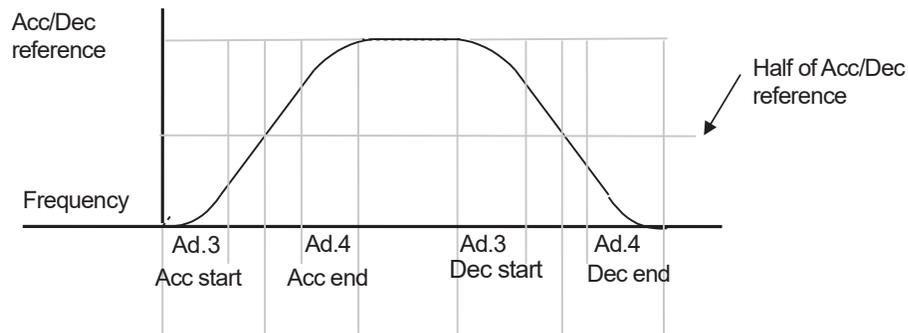
NOTE:
The Actual Acc/Dec time during an S-curve application:

Acceleration time when the S-curve pattern is set:

$$= ACC + ACC \times \frac{(Ad.3/100\%)}{2} + ACC \times \frac{(Ad.4/100\%)}{2}$$

Deceleration time when the S-curve pattern is set:

$$= dEC + dEC \times \frac{(Ad.3/100\%)}{2} + dEC \times \frac{(Ad.4/100\%)}{2}$$

⚠️ 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	Parameter Setting		Setting Range	Unit
In	In.65–In.69	Px terminal configuration	24	XCEL Stop	0–27	–
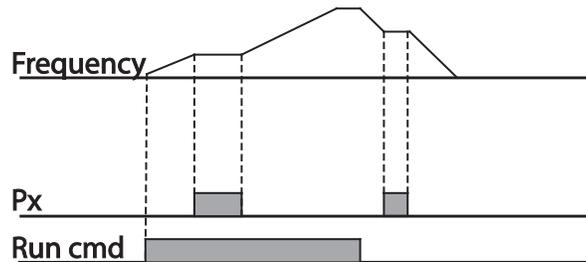
V/F (Voltage/Frequency) Control

Configure drive 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	Parameter Setting		Setting Range	Unit
Operation	MbF	Base frequency	60.00		30-400.00	Hz
dr	dr.9	Control Mode	0	V/F	0-1	-
	dr.19	Start frequency	0.50		0.01–10.00	Hz
bA	bA.7	V/F pattern	0	Linear	0–2	–

Linear V/F Pattern Setting Details

Pr. Code	Description
MbF 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).

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	Parameter Setting		Setting Range	Unit
bA	bA.7	V/F pattern	1	Square	0–2	–

Square Reduction V/F pattern Operation – Setting Details

Pr. Code	Description		
bA.7 V/F Pattern	Sets the parameter value to 1(Square) according to the load's start characteristics.		
	Setting	Function	
	1	Square	The drive produces output voltage proportional to 2 square of the operation frequency.
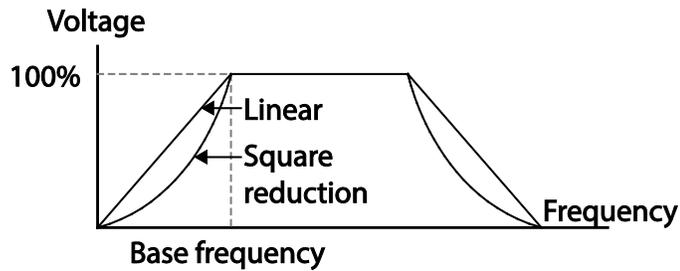
USER V/F PATTERN OPERATION

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

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
bA	bA.7	V/F pattern	2	User V/F	0–2	–
	bA.41	User Frequency1	15.00		0–Maximum frequency	Hz
	bA.42	User Voltage1	25		0–100	%
	bA.43	User Frequency2	30.00		0–Maximum frequency	Hz
	bA.44	User Voltage2	50		0–100	%
	bA.45	User Frequency3	45.00		0–Maximum frequency	Hz
	bA.46	User Voltage3	75		0–100	%
	bA.47	User Frequency4	60.00		0–Maximum frequency	Hz
	bA.48	User Voltage4	100		0–100%	%

User V/F pattern Setting Details

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 IOv (motor rated voltage). If IOv is set to 0 it will be based on the input voltage.
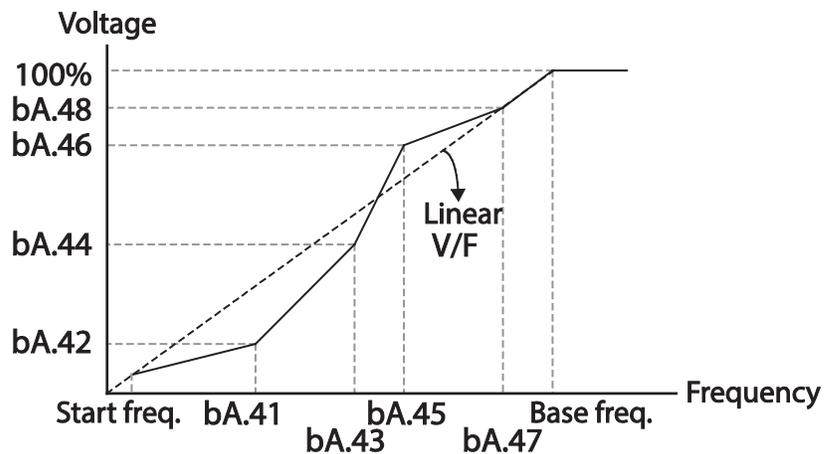
CAUTION: WHEN A NORMAL INDUCTION MOTOR IS IN USE, CARE MUST BE TAKEN NOT TO CONFIGURE THE OUTPUT PATTERN AWAY FROM A LINEAR V/F PATTERN. NON–LINEAR V/F PATTERNS MAY CAUSE INSUFFICIENT MOTOR TORQUE OR MOTOR OVERHEATING DUE TO OVER–EXCITATION.
WHEN A USER V/F PATTERN IS IN USE, FORWARD TORQUE BOOST (DR.16) 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	Parameter Setting		Setting Range	Unit
dr	dr.15	Torque boost options	0	Manual	0–1	–
Operation Group	Ftb	Forward torque boost	4.0		0.0–20.0	%
	rtb	Reverse torque boost	4.0		0.0–20.0	%

Manual Torque Boost Setting Details

Pr. Code	Description
Ftb Fwd Boost	Set torque boost for forward operation.
rtb Rev Boost	Set torque boost for reverse operation.
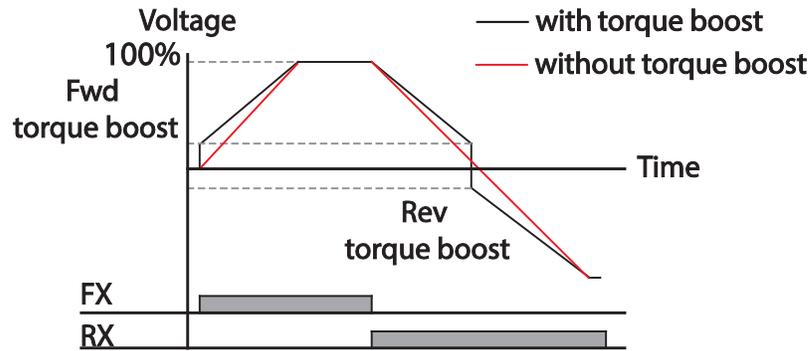
CAUTION: Excessive torque boost will result in over–excitation and motor overheating

AUTOMATIC TORQUE BOOST

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	Parameter Setting		Setting Range	Unit
dr	dr.15	Torque boost mode	1	Auto	0–1	–
	dr.26	Auto torque boost filter gain	2		1–1000	–
	dr.27	Auto torque boost motoring voltage gain	120.0		0.0–300.0	%
	dr.28	Auto torque boost regeneration voltage gain	120.0		0.0–300.0	%
Operation Group	Ftb	Forward torque boost	4.0		0.0–20.0	%
	rtb	Reverse torque boost	4.0		0.0–20.0	%

You can use the parameter value displayed on the motor's rating plate without motor parameter tuning. Use after entering the value recorded on the motor's rating plate in MbF (base frequency), bA.12 (motor's rated slip frequency), MrC (motor's rated current), and bA.14 (motor's no load current). If you do not use the value displayed on the motor's rating plate, each parameter value is set to the initial value and some features may be limited.

In V/F operation, this adjusts the output voltage if operation is unavailable due to a low output voltage. Use when it cannot be started due to the lack of the starting torque as a method to output voltage by adding the voltage boost quantity calculated by using torque current on the manual torque boost quantity (Ftb, rtb). If the run direction is forward, Ftb forward torque boost quantity is applied. If the direction is reverse, rtb reverse torque boost quantity is applied. As the values to adjust the amount of compensation according to the load, dr.27 and dr.28 automatic torque boost voltage gain can be adjusted and used when there is a lack of starting torque or when excessive current is flowing.

If automatic torque boost is selected (dr.15=1), parameter codes dr.26, dr.27, and dr.28 are enabled and the drive outputs voltage according to the torque boost quantity. Auto torque boost is disabled if dr.9 (Control mode) is set to 1 (Slip compensation control).

OUTPUT VOLTAGE ADJUSTMENT

Output voltage settings are required when a motor's rated voltage differs from the input voltage to the drive. Set IOv 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 IOv (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 IOv (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	Parameter Setting	Setting Range	Unit
Operation	IOv	Motor rated voltage	0	0, 170–264	V
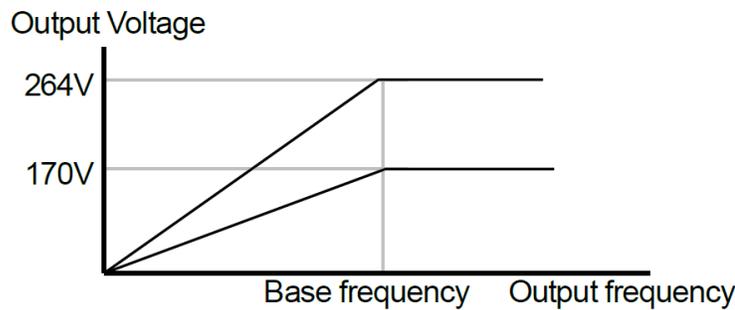
STOP MODE SETTING

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	Parameter Setting		Setting Range	Unit
Ad	Ad.8	Stop mode	0	Dec	0–2	–
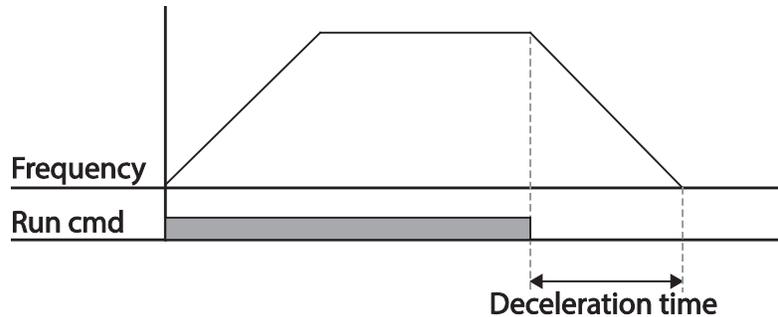
FREE RUN STOP

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

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Ad	Ad.8	Stop Method	2	Free–Run	0–2	–
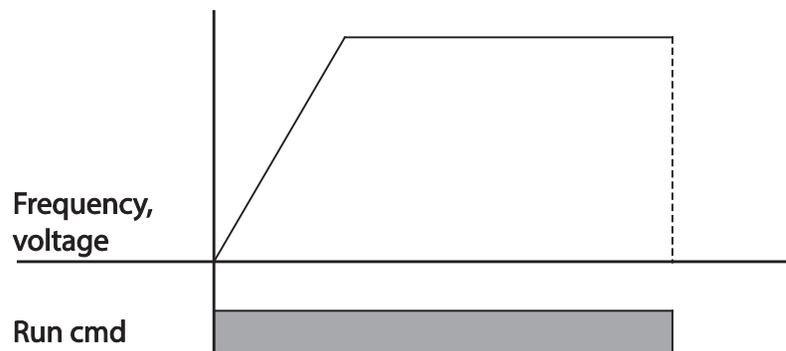
⚠️ CAUTION: NOTE THAT WHEN THERE IS HIGH INERTIA ON THE OUTPUT SIDE AND THE MOTOR IS OPERATING AT HIGH SPEED, THE LOAD'S INERTIA WILL CAUSE THE MOTOR TO CONTINUE ROTATING EVEN IF THE DRIVE OUTPUT IS BLOCKED.

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	Parameter Setting	Setting Range	Unit
dr	dr.19	Start frequency	0.50	0.10–10.00	Hz
Operation Group	FrM	Maximum frequency	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. If an input frequency is lower than the start frequency, the parameter value will be 0.00.
FrM Max Freq	Set an upper limit frequency to all speed unit parameters that are expressed in Hz, except for the base frequency (MbF). Frequency cannot be set higher than the upper limit frequency.

FREQUENCY LIMIT USING UPPER AND LOWER LIMIT FREQUENCY VALUES

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
	Ad.24	Frequency limit	1	Yes	0–1	–
Ad	Ad.25	Frequency lower limit value	0.50		Starting frequency–Ad.26	Hz
	Ad.26	Frequency upper limit value	60.00		0.00–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.
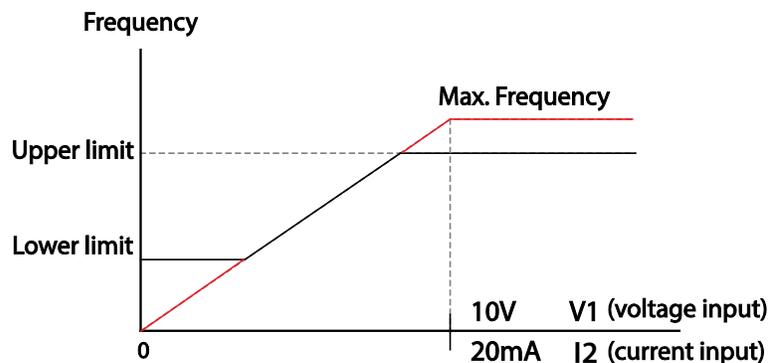
FREQUENCY JUMP

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	Parameter Setting		Setting Range	Unit
Ad	Ad.27	Frequency jump	1	Yes	0–1	–
	Ad.28	Jump frequency lower limit1	10.00		Starting Frequency–Jump frequency upper limit 1	Hz
	Ad.29	Jump frequency upper limit1	15.00		Jump frequency lower limit 1–Maximum frequency	Hz
	Ad.30	Jump frequency lower limit 2	20.00		Starting Frequency–Jump frequency upper limit 2	Hz
	Ad.31	Jump frequency upper limit 2	25.00		Jump frequency lower limit 2–Maximum frequency	Hz
	Ad.32	Jump frequency lower limit 3	30.00		Starting Frequency–Jump frequency upper limit 3	Hz
	Ad.33	Jump frequency upper limit 3	35.00		Jump frequency lower limit 3–Maximum frequency	Hz

— when the frequency reference decreases

— when the frequency reference increases
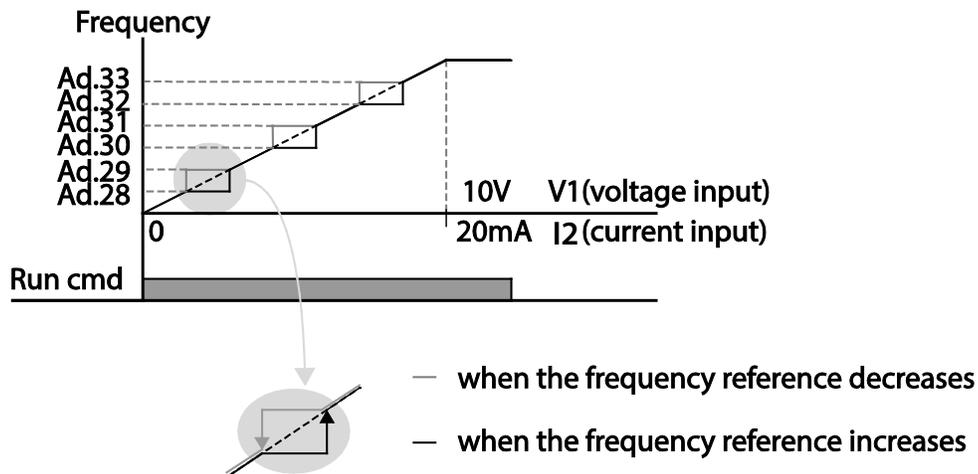
COOLING FAN CONTROL

The drive's heatsink fan can be configured to run in different situations, such as load stops and starts frequently, or noise free environment is required. Ad.68 is used to control the fan operation and should be set to a correct setting to extend the fan's life.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Ad	Ad.68	Cooling fan control	0	During Run	0–2	–

Cooling Fan Control Setting Details

Pr. Code	Description		
	Configuration		**Function**
Ad.68 Fan Control	0	During Run	Cooling fan runs when power is supplied to the drive and operation command is on. The cooling fan is stopped when power is supplied to the drive and operation command is off. When the drive's heat sink temperature is higher then the set value, the fan operates automatically regardless of operation command status.
	1	Always On	Cooling fan runs constantly if power is supplied to the drive.
	2	Temperature Control	Cooling fan runs when power is supplied to the drive and operation command is on, while the heat sink temperature is equal to or greater then set temperature.

NOTE: Despite setting Ad.68 to 0 (During Run), if the heat sink temperature reaches a set level, the cooling fan may run as a protection function.

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	Parameter Setting	Setting Range	Unit
In	In.85	Multi–function input terminal filter	4	1–15	ms
	In.87	Multi–function input terminal selection	0 0000*	–	–
	In.90	Multi–function input terminal status	0 0000*	–	–
See "Bit Selection" on page 4–3 for details					

Multi–function Input Terminal Control Setting Details

Pr. Code	Description
In.85 DI 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.
	<table><tr><td>Items</td><td>B contact status</td><td>A contact status</td></tr><tr><td>Keypad</td><td></td><td></td></tr></table>
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. If using Extension IO card, use the Left arrow key on the keypad to display the status of P8, P9 and P10.
	<table><tr><td>Items</td><td>Bit ON when A contact is set</td><td>Bit OFF when A contact is set</td></tr><tr><td>Keypad</td><td></td><td></td></tr></table>

LEARNING ADVANCED FEATURES

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

Advanced Tasks	Description	Ref.
DC Braking	Use the drive to supply DC power to the motor for braking when the operation frequency reaches the set value during deceleration.	4–70
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.	4–73
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.	4–74
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.	4–77
Slip compensation	This feature ensures that the motor rotates at a constant speed, by compensating for the motor slip as a load increases.	4–78
Simple 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.	4–79
PID control	PID control provides constant automated control of flow, pressure, and temperature by adjusting the output frequency of the drive.	4–79
Energy saving operation	Used to save energy by reducing the voltage supplied to motors during low–load and no– load conditions.	4–85
Speed search operation	Used to prevent fault trips when the drive voltage is output while the motor is idling or free-running.	4–85
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).	4–88
Operational Noise Settings	Used to set carrier frequency settings to adjust motor operational noise.	4–89
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.	4–90
Second operation mode settings	Use to apply two types of operation modes and switch between them as needed.	4–91
Input voltage settings	Set the drive input power voltage. Aslo automatically changes the low voltage fault trip level.	4–91
Parameter initialization	Used to reset parameter settings to factory default on all or selected groups.	4–92
Parameter lock	Used to prevent unauthorized modification of parameter settings.	4–93
Voltage trip prevention during deceleration	Uses regenerative brake force to prevent over voltage trips when the drive decelerates or stops.	4–94
Brake control	Used to control the On/Off operation of the electronic brake load system.	4–95
Analog output	Enable an analog output terminal.	4–96
Digital output	Enable digital multi-function output relay settings.	4–97
Draw operation	Use to apply a constant tension to the material that is drawn by a motor-driven device by fine-tuning the motor speed.	4–101
Operation mode when cooling fan is abnormal	Used to enable the drive to continue operation during a cooling fan fault.	4–103
Operation state monitor	The drive output current can be monitored at the CUr code in the Operation group.	4–104
I/O terminal block state monitor	Monitor the input and output terminal block state.	4–106

Advanced Tasks	Description	Ref.
Fault state monitor	Use the nOn code to display a fault type when a trip occurs during operation.	4–107

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.

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	Parameter Setting		Setting Range	Unit
Ad	Ad.8	Stop mode	1	DC Braking Stop	0–2	–
	Ad.14	Output block time before braking	0.00		0.00–60.00	sec
	Ad.15	DC braking time	1.0		0.0–60.0	sec
	Ad.16	DC braking amount	50		0–200	%
	Ad.17	DC braking frequency	5.00		Start Frequency–60.00	Hz
bA	bA.16	Inertia Rate	0		0-2	-

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. The maximum value of the DC braking rate is limited by the drive rated current. Maximum Value of Dc-Brake Level = Rated Current of Drive/Rated Current of Motor x 100%.
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.
bA.16 **Inertia Rate**	When the inertia of the load is great and DC braking frequency is set too high, modify the inertia rate (bA.16). The DC braking controller's controller gain will be changed based on the set value of bA.16.
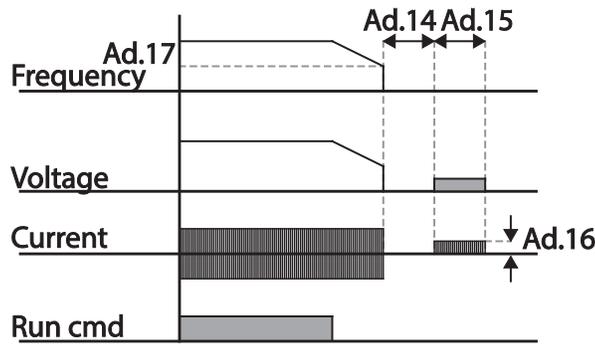
⚠️ CAUTION: *NOTE THAT THE MOTOR CAN OVERHEAT OR BE DAMAGED IF EXCESSIVE AMOUNT OF DC BRAKING IS APPLIED TO THE MOTOR, OR DC BRAKING TIME IS SET TOO LONG.*
DC BRAKING IS CONFIGURED BASED ON THE MOTOR'S RATED CURRENT. TO PREVENT OVERHEATING OR DAMAGING MOTORS, DO NOT SET THE CURRENT VALUE HIGHER THAN THE DRIVE'S RATED CURRENT.

DC BRAKING AFTER START

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. DC Braking after start is disabled if Ad.12 or Ad.13 is set to 0.

Pr. Group	Pr. Code	Name	Parameter Setting	Setting Range	Unit
Ad	Ad.12	Start DC braking time	0.0	0.0–60.0	sec
	Ad.13	DC Braking Amount at Start	50	0–200	%
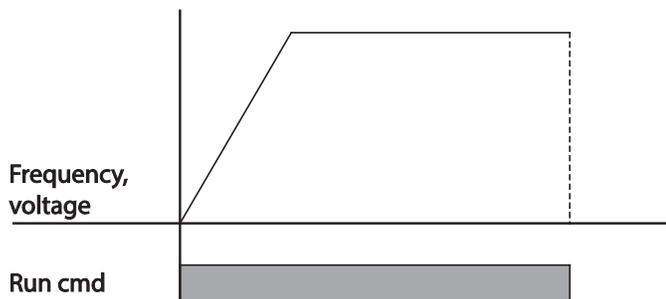
⚠️ CAUTION: *NOTE THAT WHEN THERE IS HIGH INERTIA ON THE OUTPUT SIDE AND THE MOTOR IS OPERATING AT HIGH SPEED, THE LOAD'S INERTIA WILL CAUSE THE MOTOR TO CONTINUE ROTATING EVEN IF THE DRIVE OUTPUT IS BLOCKED.*

DC DURING STOP

This stop mode applies DC braking during a stop command. Select a terminal to use as the DC braking during a stop from the multi-function input terminal (P1–P5). Ad.13 must be set based on the rated current of the motor (MrC).

Pr. Group	Pr. Code	Name	Parameter Setting	Setting Range	Unit

					0–Rated Current of Drive/Rated Current of Motor x 100%	%
Ad	Ad.13	DC Injection Level		50	0–Rated Current of Drive/Rated Current of Motor x 100%	%
In	In.65-In.69	Px Input terminal	11	DC Braking during stop command	0-27	-
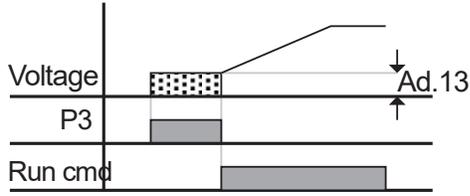
JOG OPERATION

The jog operation allows for a temporary control of the drive. You can enter a jog operation command using the multi–function terminals.

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

For jog operation 1, a forward or reverse operation command and a jog command must be entered to start jog operation. Direction is determined by forward/reverse command. 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	Parameter Setting		Setting Range	Unit
dr	dr.11	Jog frequency	10.00		0.00–Maximum frequency	Hz
In	In.65–In.69	Px terminal configuration	4	JOG	0–52	–
Operation Group	ACC	Acceleration time	5.0	0.00–6000.0	sec	
	dEC	Deceleration time	10.0	0.00–6000.0	sec	

Forward Jog Description Details

Pr. Code	Description
In.65–69 Px Define	Enable the jog command feature by setting any input P1-P5 to a value of 4: Jog. Terminal settings for jog operation
dr.11 JOG Frequency	Set the operation frequency.
Operation group Acc Time	Set the acceleration speed.
Operation group Dec Time	Set the deceleration speed.
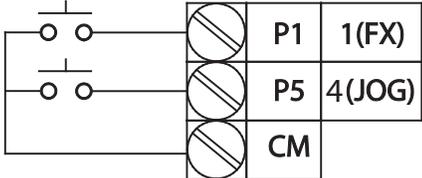
If a signal is entered at the jog terminal while an FX operation command is on, the operation frequency changes to the jog frequency and the jog operation begins.
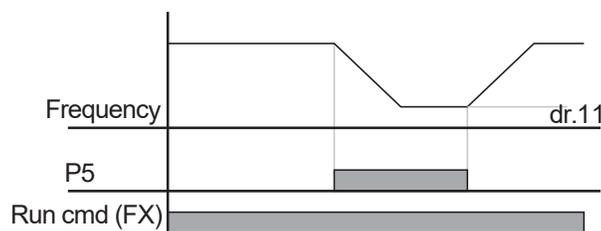
Jog Operation 2–Fwd/Rev Jog by Multi–function Terminal

For jog operation 2, separate input signals are used to determine Jog forward or Jog reverse. A separate run signal is not required. 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.
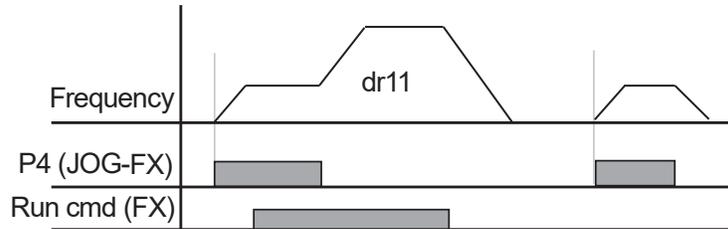
Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
dr	dr.11	Jog frequency	10.00		0.00–Maximum frequency	Hz
In	In.65–In.69	Px terminal configuraiton	26	FWD JOG	0–27	–
			27	REV JOG		
Operation Group	ACC	Acceleration time	5.0		0.00–6000.0	sec
	dEC	Deceleration time	10.0		0.00–6000.0	sec

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	Parameter Setting		Setting Range	Unit
Ad	Ad.64	Up–down operation frequency	0.0		0.00 – Maximum Frequency	Hz
	Ad.65	Up–down operation frequency save options	1	Yes	0–1	–
	Ad.66	Up-down mode selection	0		0-2	-
	Ad.67	Up-down step frequency	0.00		0.00 - Maximum frequency	-
Operation group	Frq	Frequency reference Source	10	Up-down operation	0–11	–
In	In.65–In.69	Px terminal configuration	15	Up	0–27	–
			16	Down		
			25	U/D Save		

If there is a multi-function terminal set to U/D Enable among the multi-function terminal blocks, the command frequency source can be changed depending on the U/D Enable terminal status. For example, when the U/D Enable signal is off, even if up-down signal is entered for the up-down operation while operating according to the analog voltage input V1, the drive will operate according to the analog voltage input V1. If the up-down switchover (U/D Enable) signal is entered, the operation will follow the up-down operation terminal input and the analog voltage input V1 will not be used for the drive operation until the up-down switchover (U/D Enable) signal is disabled. If none of the multi-function terminal blocks have a multi-function terminal set to U/D Enable, the frequency will change only according to the up-down signal. In this case, the parameter will not be changed by keypad/analog input.

Up–down Operation Setting Details

Pr. Code	Description
In.65–In.69 Px Define	Select three terminals for up-down operation and set them to 15 (Up), 16 (Down) and 16 (U/D Clear), respectively.
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 save frequency, use the multi–function terminal block. Set one of the multi–function terminals to 25 (U/D Save) and apply signals to it during constant speed operation. The frequency and the up–down operation configuration will be saved.

Pr. Code	Description
Ad.66 U/D Mode Sel	Select up-down operation mode.

Setting		Function
0	Maximum/Minimum frequency reference	If the Up terminal signal is on, the frequency reaches up to the maximum value for the set acceleration time. It reaches up to the upper limit when the upper limit has been set. If the Down terminal signal is on, the frequency decelerates to the value for the set deceleration time, regardless of the stop mode. It decelerates to the lower limit when the lower limit has been set.
1	U/D Step	The motor accelerates by as much as the step frequency set by the Ad.67 at the multi-function input's positive edge that has been set as the Up terminal signal. The motor decelerates by as much as the step frequency set at the Ad.67 at the multi-function input's positive edge that has been set as the Down signal. The frequency is saved at the falling edge when the Up/down signal is specified. In this case, when the stop command is supplied while the multi-function input set as the Up or Down signal has been set, the previous edge value is saved continuously and the current frequency is not saved, even when the multi-function input is not set during a stop. The acc/dec time is identical to the time when 0 is set.
2	U/D Step+Min/Max	The motor accelerates by as much as the step frequency set by the Ad.67 at the multi-function input's positive edge that has been set as the Up terminal signal. The motor operation is identical to when 0 is set when the function is activated for more than 3 seconds. The motor decelerates by as much as the step frequency set at the Ad.67 at the multi-function input's positive edge that has been set as the Down signal. The motor operation is identical to when 0 is set when the function is activated for more than 3 seconds, and the acc/dec time is identical to the time when 0 is set.

U/D - Max/Min

U/D Step

U/D Step + Max/Min

Pr. Code	Description
Ad.67 U/D Step Freq	Set the frequency value to increase or decrease based on the up or down input.

⚠️ *CAUTION: The signal is void when the input is supplied again before it increases 1 step frequency by the Up or Down signal. The frequency deactivation is saved.*

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 acceleration dwell frequency and the dwell time set by the user. The following points also affect dwell operation:

- *Dwell Operation: A rated slip frequency that supplies the rated torque to the motor before opening the mechanical brake of lift-type loads. The rated slip frequency is different from the rated frequency converted from the rated RPM on the motor rating plate.*

Pr. Group	Pr. Code	Name	Parameter Setting	Setting Range	Unit
Ad	Ad.20	Dwell frequency	5.00	Start frequency – Maximum frequency	Hz
	Ad.21	Operation time	0.0	0.0–10.0	sec
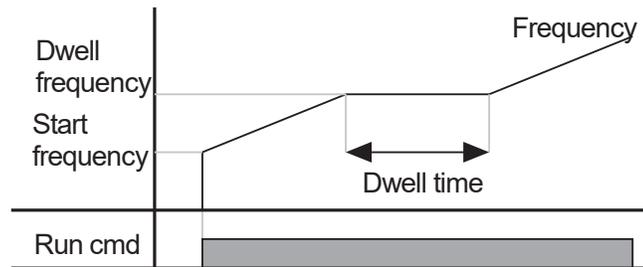
NOTE: Dwell operation does not work when:
- *Dwell operation time is set to 0 sec or dwell frequency is set to 0 Hz.*
- *Re-acceleration is attempted from stop or during deceleration, as only the first acceleration dwell operation command is valid.*
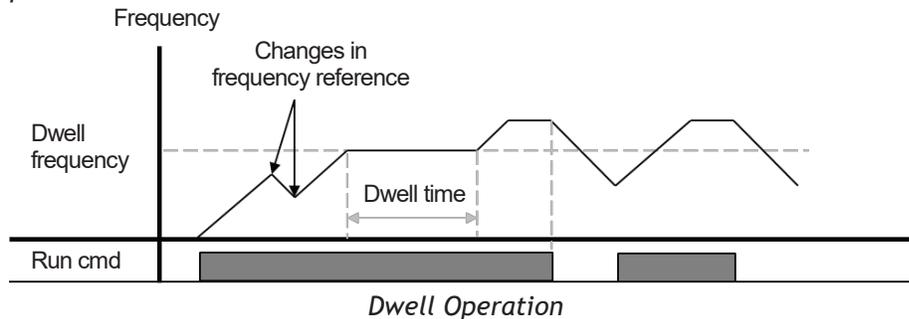
Dwell Operation

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 LIFECYCLE 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	Parameter Setting		Setting Range	Unit
dr	dr.9	Control mode	1	Slip Compen	0-2	–
Operation group	MkW	Motor capacity	Based on motor rating		0.1-2.2	–
	MrC	Motor rated current	Based on motor rating		0.1-150.0	-
	bA.11	Number of motor poles	4		2–12	–
	bA.12	Rated slip frequency	Based on motor rating		0.00-10.00	Hz
bA	bA.14	Motor no–load current	Based on motor rating		0.1–100.0	A
	bA.15	Motor efficiency	Based on motor rating		50–100	%
	bA.16	Load inertia rate	0	Less than 10 times motor inertia	0–2	–

Slip Compensation Operation Setting Details

Pr. Code	Description
dr.9 Control Mode	Set dr.9 to 1 (Slip Compen) to carry out the slip compensation operation.
MkW Motor Capacity	Set the capacity of the motor connected to the drive.
MrC Rated Curr	Enter the rated current from the motor rating plate.
bA.11 Pole Number	Enter the number of poles from the motor rating plate.
bA.12 Rated Slip	Enter the number of rated rotations from the motor rating plate. $$f_s = f_r - \frac{Rpm \times P}{120}$$ Where: • fs = rated slip frequency • fr = rated frequency • Rpm = number of rated motor rotations • P = number of motor poles
bA.13 Rated Curr	Enter the rated current from the motor rating plate.
bA.14 Motor no-load current	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 40 % of the rated motor current.
bA.15 Motor Efficiency	Enter the efficiency from the motor rating plate.
bA.16 Load inertia rate	Select the load inertia based on the motor inertia.
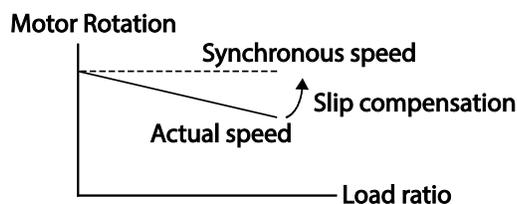
Simple Sensorless Vector Control for Induction Motors

Simple sensorless control automatically increases the starting torque when high starting torque is required. It also compensates for the slip of the motor so that it can rotate at a constant speed. Manual torque boost is disabled if the dr.9(Control mode) code is set to 2(Simple sensorless control).

Pr. Group	Pr. Code	Name	Parameter Setting	Setting Range	Unit
dr	dr.9	Control mode	2: Simple Sensorless control	–	–

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.

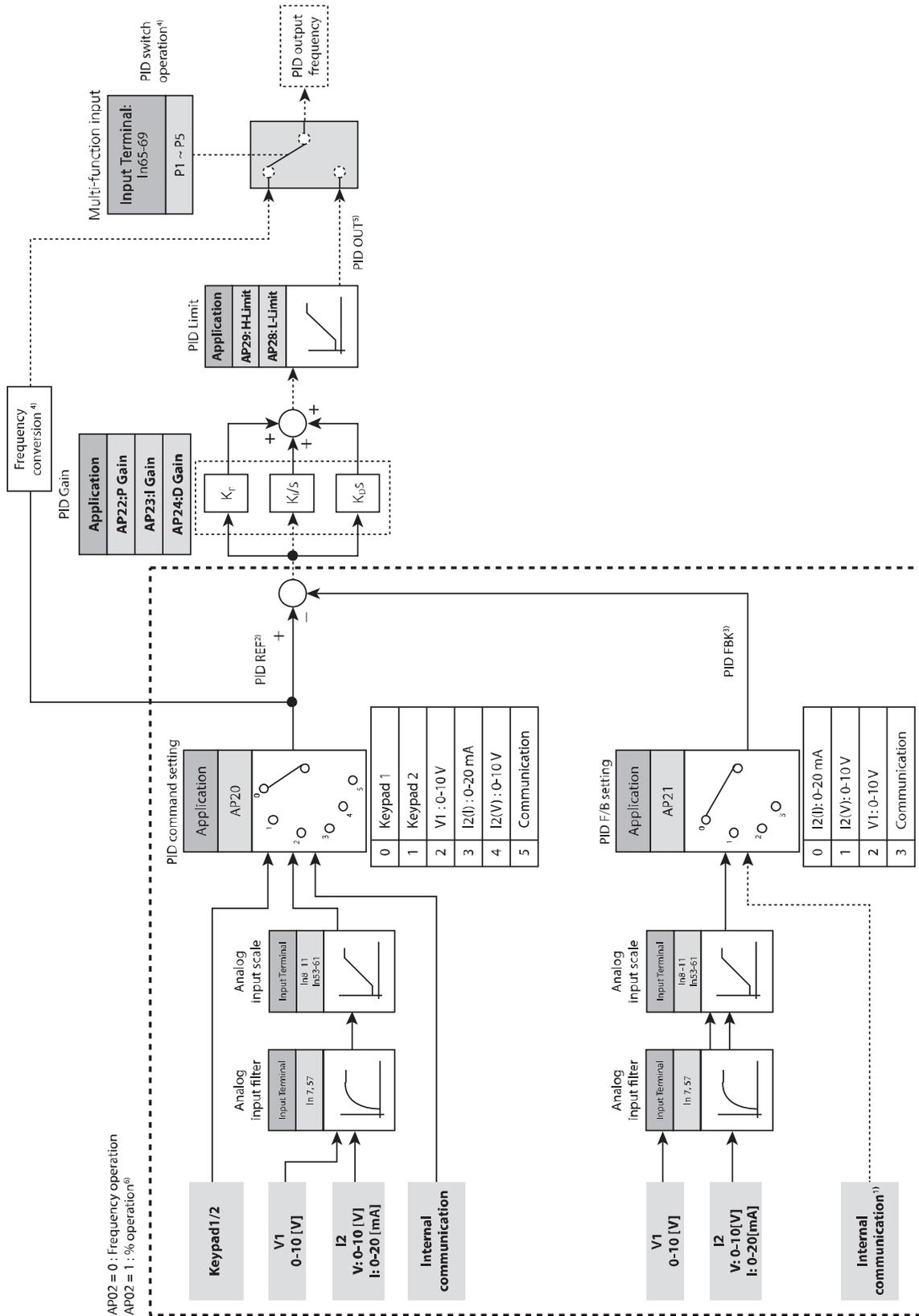| Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
AP	AP.1	Application function selection	1	Yes	0–1	–
	AP.2	PID control unit selection	0 – Hz		0 : Hz 1: %	-
	AP.18	PID feedback monitor	–		0.00-400 Hz 0.0-100.0 %	Hz %
	AP.19	PID reference setting	-		0.00-Max Frequency (Hz) 0–100.0 %	Hz %
	AP.20	PID reference source	0	Keypad	0–5	–
	AP.21	PID feedback source	0	I2 (0-20 mA)	0–3	–
	AP.22	PID controller proportional gain	300.0		0.0–999.0	%
	AP.23	PID controller integral time	1.00		0.10–32.00	sec
	AP.24	PID controller differential time	0.00		0.00–30.00	sec
	AP.28	PID mode	1	Proc PID	0–1	
	AP.29	PID maximum frequency	60.00		AP.30–Maximum Frequency	Hz
	AP.30	PID minimum frequency	0.50		Starting Frequency–AP.29	Hz
	AP.37	PID sleep mode delay time	60.0		0.0–2000.0	sec
	AP.38	PID sleep mode frequency	0.00		0.00–Maximum frequency	Hz
	AP.39	PID wake–up level	35.0		0.0–100.0	%
In	In.65–In.69	Px terminal configuration	21	PID to general operation	0–27	–

> 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 100.0% calculation of the PID OUT value is based on the FrM (MaxFreq) parameter setting.

PID Basic Operation Setting Details

Pr. Code	Description
AP.1 App Mode	Set the code to 1 to enable PID functionality.
AP.2 PID Unit Selection	Select Hz or % for the unit setting of the PID.
AP.18 PID Fdb Value	Displays the input value of the PID controller that is included in the latest feedback. The input is scaled to Hz or % based on AP.2.
AP.19 PID Ref Set	Reference value is scaled to unit set with AP.2. Reference value will change based on the reference source set in AP.20.
AP.20 PID Ref Source	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. **Setting** / **Function** 0 / Keypad 1 / Keypad 1 1 / Keypad 2 / Keypad 2 2 / V1 / 0-10 V input voltage terminal 3 / I2 / 0–20 mA input current terminal 4 / I2 / 0-10 V input voltage terminal 5 / RS-485 / Communication command via a RS-485 When using the keypad, the PID reference setting can be displayed at AP.19.
AP.21 PID F/B Source	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 2 (V1), for AP. 21 (PID F/B Source), an input other than the V1 terminal must be selected. **Setting** / **Function** 0 / I2: 0-20 mA input current terminal 1 / I2: 0-10 V input voltage terminal 2 / V1: 0-10 V input voltage terminal 3 / RS-485 Communication
AP.22 PID P–Gain	Sets the P gain as the output ratio to the error rate. If the P gain is set to 50%, 50% of the error is output. Higher input value leads to reaching the target control variable faster, but oscillation may occur at the controller when the value is too high.
AP.23 PID I– Time	Sets the time to output accumulated errors. When the error is 100%, the time taken for 100% output is set. When the integral 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 the integral time. Adjusting the value leads to a faster response, but oscillation may occur at the controller.
AP.24 PID D–Time	Sets the output volume for the rate of change in errors. ACM detects error every 1 ms. When the differential time is set to 1 ms and the rate of change in errors per sec is 100%, output occurs at 1% per 10 ms.
AP.28 PID Mode	By default, parameter AP.28 is set to "Normal PID". If you are running a fan or pump application with a PID loop it is recommended to use "Normal PID". Reference the function block diagram for more info. Setting AP.28 to "Proc PID" is more commonly suited for industrial applications that may be running a PID loop with a trim input.
AP.29 PID Limit Hi, AP.30 PID Limit Lo	Limits the output of the controller.

Normal PID Operation (AP.28=0)

Normal PID Control Block Diagram

Process PID Operation (AP.28=1)
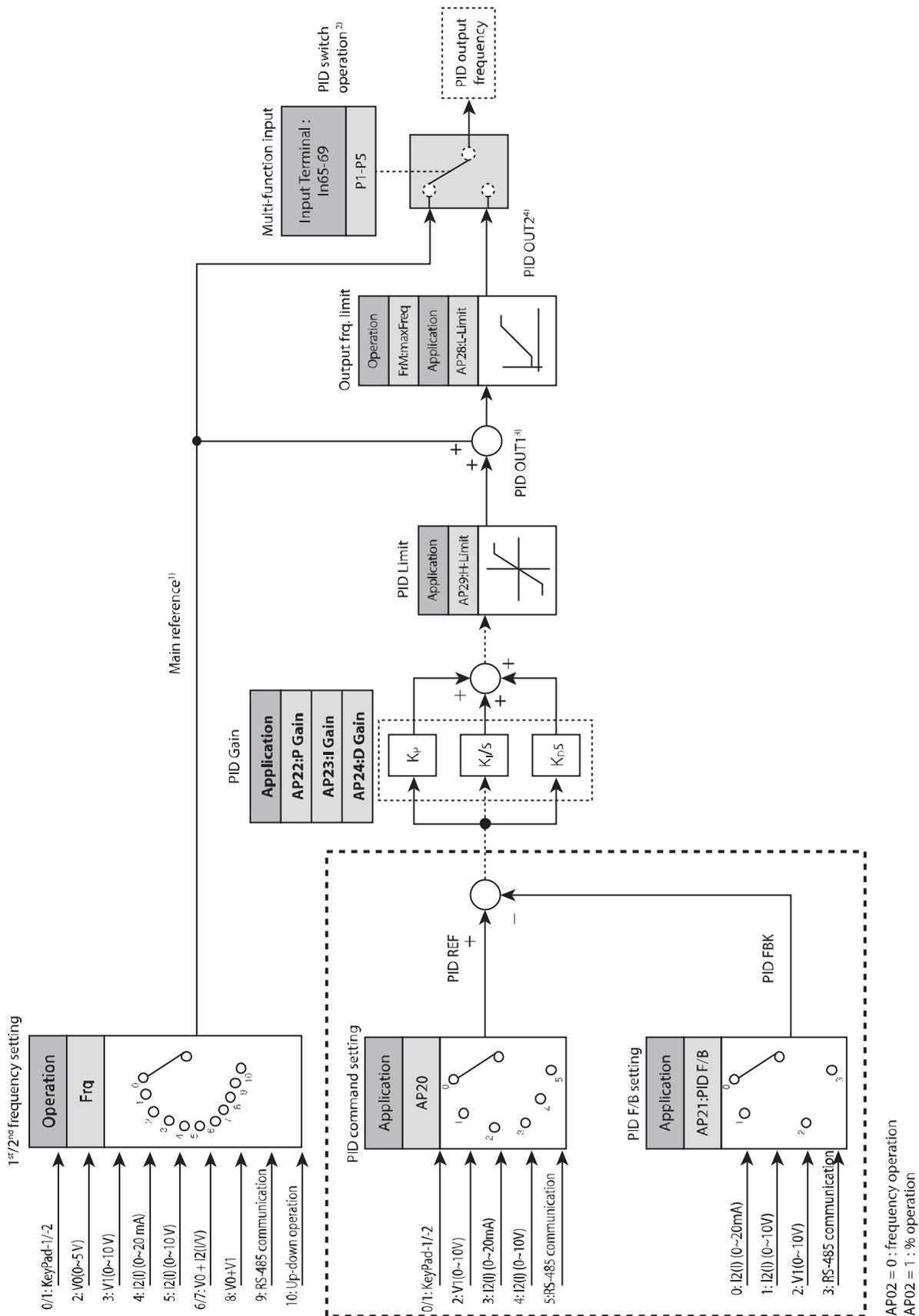
Process PID control block diagram

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	Starts the PID operation when the feedback variable is higher than the value set at AP.39.
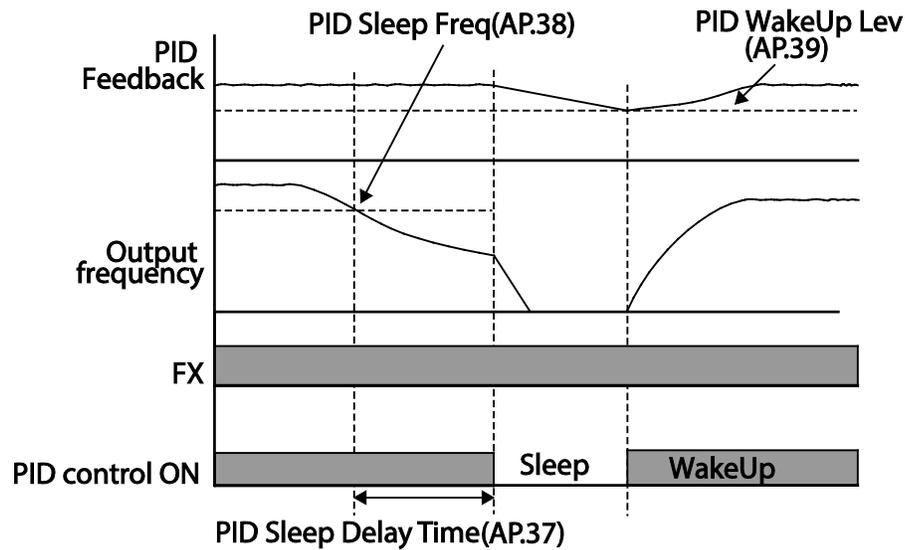
ENERGY SAVING OPERATION

You can set a reduced amount of output voltage at the Ad.51 code based on the maximum output voltage (IOv).

This operation is used to save energy by reducing the voltage supplied to motors during low-load and no-load conditions when a fan or pump is operating.

Pr. Group	Pr. Code	Name	Parameter Setting	Setting Range	Unit
Ad	Ad.51	Energy saving amount	30	0–30	%
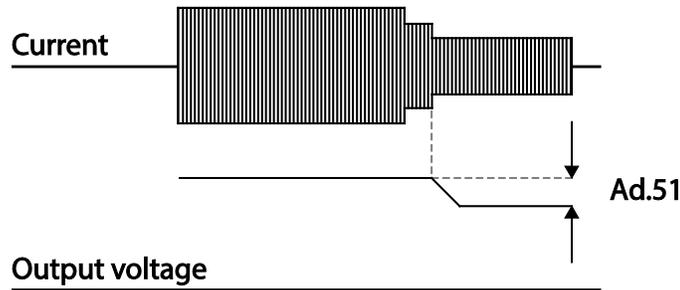
SPEED SEARCH OPERATION

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	Parameter Setting		Setting Range	Unit
Cn	Cn.71	Speed search operation selection	0000*		0000–1111	bit
	Cn.72	Speed search reference current	150		80–200	%
	Cn.73	Speed search proportional gain	500		0–9999	–
	Cn.74	Speed search integral gain	1000		0–9999	–
OU	OU.31	Multi–function Relay1 define	15	Speed Search	0-19	–
	OU.32	Multi–function Relay2 define				
See "Bit Selection" on page 4–3 for details						

Speed Search Operation Setting Details

Pr. Code	Description
Cn.71 Speed Search	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.

Type and Functions of Speed Search Setting

Setting				Function
bit4	bit3	bit2	bit1	
			X	Speed search for general acceleration
		X		Initialization after a fault trip
	X			Restart after instantaneous power interruption
X				Starting with power–on

- **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.72, 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.

Pr. Code	Description
Cn.72 SS Sup–Current	The amount of current flow is controlled during speed search operation based on the motor's rated current (MrC).
Cn.73 SS P–Gain, Cn.74 SS I-Gain	The P/I gain of the speed search controller can be adjusted. The P/I gain are adjusted according to the characteristics of a load.

NOTE:
- *If operated within the rated output, the ACM series drive is designed to withstand instantaneous power interruptions within 15 ms and maintain normal operation.*
- *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.*
- *The instantaneous power interruption specification is applied when the input voltage is 200-240 VAC for 230V models.*
- *The instantaneous power interruption specification is applied when the input voltage is 100-120 VAC for 120V models.*

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	Parameter Setting	Setting Range	Unit
Pr	Pr.9	Auto restart count	0	0–10	–
	Pr.10	Auto restart delay time	1.0	0.0–60.0	s
Cn	Cn.71	Speed search operation selection	0000*	0000–1111	bit
	Cn.72	Speed search reference current	150	80–200	%
	Cn.73	Speed search proportional gain	500	0–9999	–
	Cn.74	Speed search integral gain	1000	0–9999	–
See "Bit Selection" on page 4–3 for details					

Auto Restart Setting Details

Pr. Code	Description
Pr.9 Retry Number **Pr.10 Retry Delay**	When a fault trip occurs and the run command is on after the trip, the drive restarts automatically after the set time programmed at the Pr.10. At each restart, the drive counts the number of tries and subtracts it from the number set at the Pr.9, until the retry number count reaches 0. The retry number count returns to the original setting when you manually reset it using the drive terminal block or the [STOP/RESET] key, and when a trip does not occur within 30 seconds after an auto restart. If the drive stops due to low voltage, emergency stop (Bx), drive overheating, or hardware diagnosis, an auto restart is not activated. The drive starts acceleration automatically after the auto restart delay time set by the Pr.10 code. At auto restart, the acceleration options are identical to those of speed search operation. Codes Cn.71–Cn.74 can be set based on the load. Information about the speed search function can be found at "Speed Search Operation" on page 4–91.
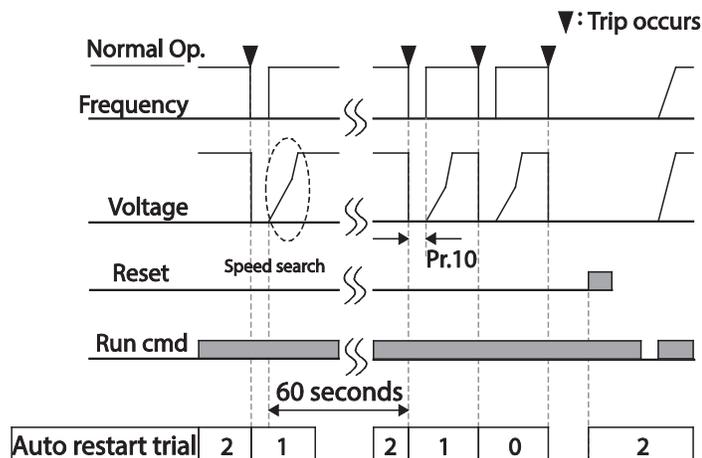
Example of auto restart with a setting of 2

⚠️ **WARNING:** 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. UNEXPECTED MOTOR ROTATION CAN CAUSE INJURY OR EQUIPMENT DAMAGE. ENSURE AREA IS CLEAR AND SAFETY GUARDS ARE IN PLACE BEFORE APPLYING POWER.

OPERATIONAL NOISE SETTINGS (CARRIER FREQUENCY SETTINGS)

Pr. Group	Pr. Code	Name	Parameter Setting	Setting Range	Unit
Cn	Cn.4	Carrier Frequency	3.0	1.0–15.0	kHz

Operational Noise Setting Details

Pr. Code	Description
Cn.4 Carrier Freq	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.

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	Parameter Setting		Setting Range	Unit
In	In.65– In.69	Px terminal configuration	12	2nd Motor	0–27	–

2nd Motor Operation Setting Details

Pr. Code	Description
In.65–In.69 Px Define	Set one of the the multi–function input terminals (P1–P5) to 12 (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 Electronic Thermal 1 minute rating) and M2.30 (M2 Electronic Thermal continuous rating) settings.

PARAMETER SETTING AT MULTI–FUNCTION TERMINAL INPUT ON A 2ND MOTOR

Pr. Code	Description
M2.4 Acc Time	Acceleration time
M2.5 Dec Time	Deceleration time
M2.7 Base Freq	Motor base frequency
M2.12 Rated Curr	Rated current
M2.25 V/F Patt	V/F pattern
M2.26 Fwd Boost	Forward torque boost
M2.27 Rev Boost	Reverse torque boost
M2.28 Stall Lev	Stall prevention level
M2.29 ETH 1min	Motor Elec. Thermal protection 1min rating
M2.30 ETH Cont	Motor Elec. Thermal protection continuous rating

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	Parameter Setting		Setting Range	Unit
In	In.67	Terminal P3 configuration	12	2nd Motor	–	–
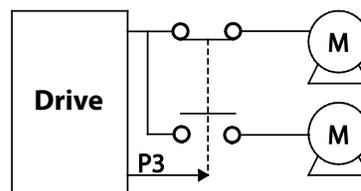
2ND OPERATION MODE SETTINGS

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–In.69 and set the parameter value to 22 (2nd Source).

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	drv	Command source	1	Fx/Rx–1 (Fwd Run/Rev Run)	0–3	–
	Frq	Frequency reference source	3	V1	0–10	–
bA	bA.4	2nd Command source	0	Keypad	0–3	–
	bA.5	2nd Frequency reference source	0	Keypad–1	0–10	–
In	In.65–In.69	Px terminal configuration	22	2nd Source	0–27	–

2nd Operation Mode Setting Details

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, bA.5 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.

INPUT VOLTAGE SETTINGS

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	Parameter Setting		Setting Range	Unit
bA	bA.19	Input power voltage	120V	110	85–132	V
			230V	220	170–240	

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	Parameter Setting		Setting Range	Unit
CF	CF.93	Parameter initialization	0	No	0–14	–

Parameter Initialization Setting Details

Pr. Code	Description		
	Setting		Function
	0	No	–
	1	Initialize all groups	Initialize all data. Select 1(All Grp) and press [PROG/ ENT] key to start initialization. On completion, CF.93 will be displayed.
CF.93	2	Initialize Operation group	Initialize data by groups. Select initialize group and press [PROG/ENT] key to start initialization. On completion, CF.93 will be displayed.
	3	Initialize dr group	
	4	Initialize bA group	
	5	Initialize Ad group	
	6	Initialize Cn group	
	7	Initialize In group	
	8	Initialize OU group	
	9	Initialize CM group	
	10	Initialize AP group	
	11	Initialize Pr group	
	12	Initialize M2 group	
	13	Initialize CF group	

PARAMETER LOCK AND PASSWORD REGISTRATION

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	Parameter Setting	Setting Range	Unit
CF	CF.94	Password registration	–	0000–FFFF	–
	CF.95	Parameter lock password	–	0000–FFFF	–

Pr. Code	Description	
CF.94 Password Registration	Setting the Password for first time. Follow the procedure below to register a password.	
	1	Press the [ENT] key twice on CF.94 code. '0000' will be displayed
	2	Set the desired password with the arrow keys.
	3	Press the [ENT] key when the password flashes. The display will return to CF.94.
CF.94 Password Change	To change the previously registered password, follow the steps below.	
	1	Press the [ENT] key on CF.94 code. 0000 will be displayed.
	2	Use the arrow keys to enter the current password.
	3	Press the [ENT] key. The value should remain on the display.
	4	Set the new password with the arrow keys.
	5	Press the [ENT] key twice. The display will return to CF.94.
CF.95 Locking the Drive	To lock the drive, follow the steps below.	
	1	Press the [ENT] key on CF.95 code. UL will be displayed. This means the drive is currently unlocked.
	2	Press the [ENT] key again to display 0000.
	3	Enter the password set in CF.94 using the arrow keys.
	4	Press the [ENT] key. L will be displayed. This means the drive is locked. (If no password has been registered, drive remains unlocked and displays UL.)
	5	Press the [ENT] key. CF.95 will be displayed.
CF.95 Unlocking the Drive	To unlock the drive, follow the steps below.	
	1	Press the [ENT] key on CF.95 code. L will be displayed. This means the drive is currently locked.
	2	Press the [ENT] key again to display 0000.
	3	Enter the password set in CF.94 using the arrow keys.
	4	Press the [ENT] key. UL will be displayed. This means the drive is unlocked.
	5	Press the [ENT] key. CF.95 will be displayed.

⚠️ CAUTION: IF THE PARAMETER VIEW LOCK AND PARAMETER LOCK FUNCTIONS ARE ENABLED, NO DRIVE OPERATION RELATED FUNCTION CHANGES CAN BE MADE. IT IS VERY IMPORTANT THAT YOU DOCUMENT THE PASSWORD.

VOLTAGE TRIP PREVENTION DURING DECELERATION

Voltage trip prevention during deceleration uses regenerative brake force to prevent over voltage trips when the drive decelerates or stops. To enable the over voltage trip during deceleration, set Pr.50, bit 2 to a value of 1. The stall prevention during deceleration is enabled only during deceleration.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Ad	Ad.8	Stop mode	0	DEC Stop	0–2	–
Pr	Pr.50	Stall Prevention Selection	1--	Prevent stall when decelerating	--1, -1-, 1--	-
	Pr.53	Voltage Limit during deceleration	0	No	0-1	-

BRAKE CONTROL

Brake control is used to control the On/Off operation of the electronic brake load system and is enabled only when the dr.9 code is set to 0 (V/F steady control).

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
dr	dr.9	Control Mode	0	V/F Control	0–2	–
	Ad.41	Brake release current	50.00		0.0-180.0	%
	Ad.42	Brake release delay time	1.00		0.00-10.00	sec
	Ad.44	Brake release forward frequency	1.00		0.00 – Max frequency	Hz
Ad	Ad.45	Brake release reverse frequency	1.00		0.00-Max frequency	Hz
	Ad.46	Brake engage delay time	1.00		0.00-10.00	Sec
	Ad.47	Brake engage frequency	2.00		0.00-Max frequency	Hz
OU	OU.31	Multi–function Relay1 define	19	Brake signal	0-19	-
	OU.32	Multi–function Relay2 define				

When brake control is activated, DC braking at drive start and dwell operation 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–Ad.45) in forward or in reverse direction. After reaching brake release frequency, if motor current reaches brake release current (Ad.41), the output relay for brake control sends a release signal. Once the signal has been sent, acceleration will begin after maintaining frequency for brake release delay time (Ad.42).*
- **Brake engage sequence:** *If a stop command is sent during operation, the motor decelerates. Once the output frequency reaches brake engage frequency (Ad.47), 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 (Ad.46) and will become 0 afterwards.*
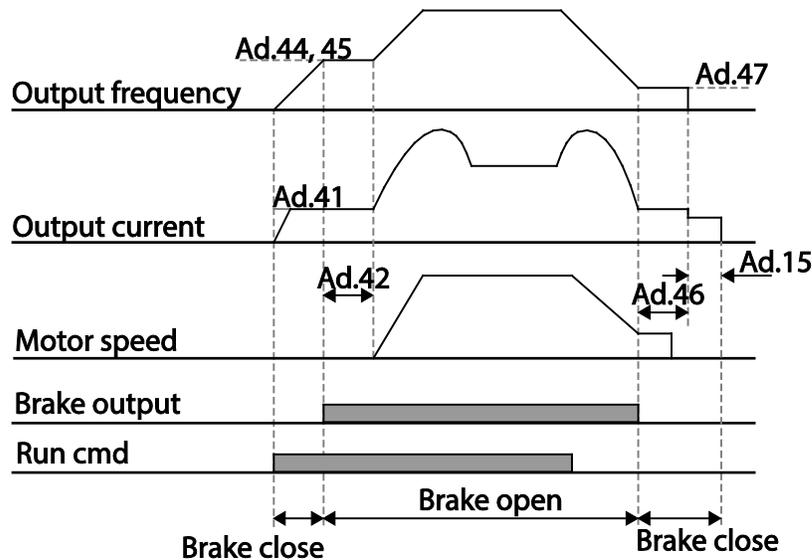
ANALOG OUTPUT

An analog output terminal provides output of 0–10V voltage.

VOLTAGE AND CURRENT ANALOG OUTPUT

An output type can be adjusted by selecting an output option at AO(Analog Output) terminal.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
OU	OU.1	Analog output1 define	0	Frequency	0–3	–
	OU.2	Analog output1 gain	100.0		10-200	%

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 FrM(Max Freq)
	1	Output Current	10V output is made from 150% of drive rated current.
	2	Output Voltage	Sets the outputs based on the drive output voltage. 10V output is 282 VAC.
	3	DC Link Volt	Outputs drive DC link voltage as a standard. Outputs 10V when the DC link voltage is 410Vdc.
OU.2 AO1 Gain	Adjusts the analog output value based on various meters when an analog output is used as the input to the meter.		

DIGITAL OUTPUT

MULTI–FUNCTION OUTPUT RELAY SETTINGS

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
OU	OU.30	Fault output item	010*		–	bit
	OU.31	Multi–function Relay1 define	29	Trip	0–19	–
	OU.32	Multi–function Relay2 define	14	Run	0–19	–
See "Bit Selection" on page 4–3 for details						

Multi–function Output Relay Setting Details

Pr. Code	Description
OU.31 Relay1	Set the Relay1 output multi-function selection. Reference the selection table below for setting options.
OU.32 Relay2	Set the Relay2 output multi-function selection. Reference the selection table below for setting options.

	Setting		Function
OU.31/ OU.32 Multi- function Output Relay Selections	0	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 (OU.58 FDT Band), FDT–1 output is as shown in the graph below.
	1	FDT-2	Outputs a signal when the user set frequency and detected frequency (OU.57 FDT Frequency) are equal, and fulfills FDT–1 condition at the same time. (Set frequency=detected frequency) & [FDT-1] When the OU.57, OU.58 codes are set to 30 Hz and 10 Hz respectively, FDT-2 output is as shown in the graph.

Pr. Code			Description
OU.31/ OU.32 Multi- function Selections (continued)	2	FDT-3	Outputs a signal when the Absolute value (output frequency–operation frequency) < detected frequency width/2. Detected frequency width is OU.58 FDT Band (10Hz). When detected frequency (OU.57 FDT Frequency) is set to 30Hz, FDT–3 output is as shown in the graph below.
	3	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 (OU.58 FDT Band). When detected frequency (OU.57 FDT Frequency) is set to 30Hz, FDT–4 output is as shown in the graph below.
	4	FDT-5	Outputs a signal to the B contact, in reverse to the FDT-4, in the following conditions: • In acceleration: Operation frequency ≥Detected frequency • In deceleration: Operation frequency>(Detected frequency– Detected frequency width/2) When the OU.57, OU.58 codes are set to 30 Hz and 10 Hz respectively, FDT-5 output is as shown in the graph.
	5	Overload	Outputs a signal at motor overload.
	6	IOL	Outputs a signal when a fault is triggered from drive overload protection.
	7	Motor Stall	Outputs a signal when motor is overloaded and stalled.
	8	Over voltage	Outputs a signal when the drive DC link voltage rises above the protective operation voltage.
	9	Low Voltage	Outputs a signal when the drive DC link voltage drops below the low voltage protective level.
	10	OHt	Outputs a signal when the drive cooling pin overheats.
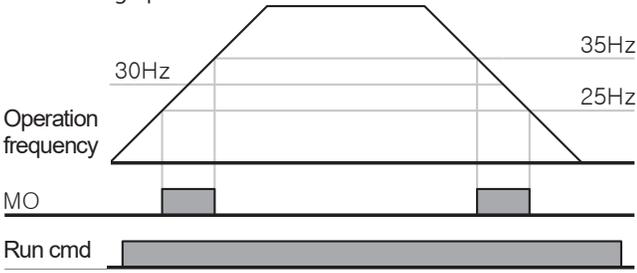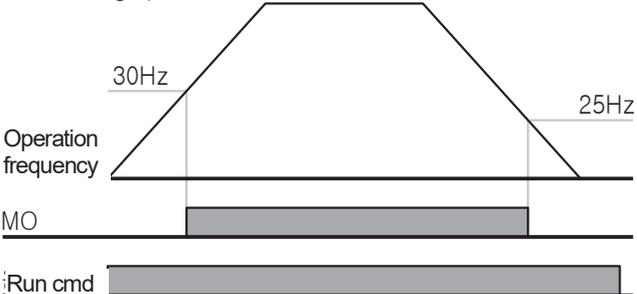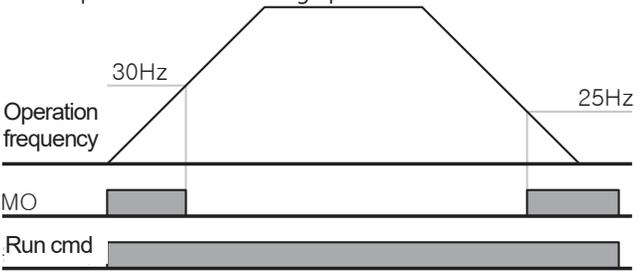
Pr. Code			Description
OU.31/ OU.32 Multi- function Selections (continued)	11	Lost command	Outputs a signal when there is a loss of analog input (V0, V1 ,I2 input) terminal and RS-485 communication command.
	12	RUN	Outputs a signal when operation command is entered and the drive outputs voltage. No signal output during DC braking. Operation frequency MO Run cmd
	13	Stop	Outputs a signal at operation command off, and when there is no drive output voltage.
	14	Steady	Outputs a signal in steady operation. Operation frequency MO Run cmd
	15	Speed search	Outputs a signal during drive speed search operation. For details, refer to "Speed Search Operation".
	16	Ready	Outputs signal when the drive is in stand by operation and ready to receive an external operation command.
	17	Trip output	Outputs a signal according to the OU.30 code settings. If the OU.31 code is set to 17, and the OU.30 is set to 2, the multi-function relay operates when a trip (except a low voltage trip) occurs.
	18	Cooling Fan Abnormal warning	Outputs a signal when the Pr.79 code is set to 0 (Continuous operation when cooling fan fault).
	19	Brake signal	Outputs a signal when the external brake signal is set.
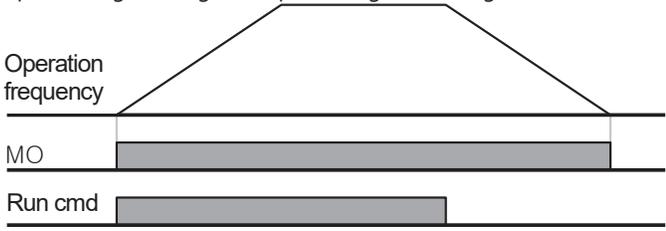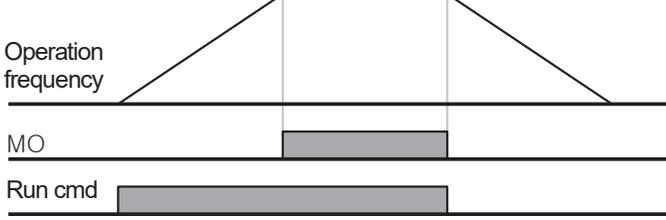
FAULT TRIP OUTPUT USING MULTI–FUNCTION OUTPUT RELAYS

The drive can output fault trip state using multi–function output Relay1 and Relay2.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
OU	OU.30	Fault trip output mode	010		–	bit
	OU.31	Multi–function Relay1 define	29	Trip	0–45	–
	OU.32	Multi–function Relay2 define	14	Run	0–45	–

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

Pr. Code	Description
OU.30 Trip Out Mode	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. After selecting the multi-function relay to use as the trip output, select 29 (Trip Mode) in OU.31, 33. If the trip occurs from the drive, the applicable multi-function relay will be activated. Activation status of multi-function relay can be set up as below depending on the trip type.

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.9)

Pr. Code	Description
OU.31 Relay1	Set the Relay1 output multi-function selection.
OU.32 Relay2	Set the Relay2 output multi-function selection.

DRAW OPERATION

Draw operation 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.

Pr. Group	Pr. Code	Name	Parameter Setting	Setting Range	Unit
AP	AP.70	Draw operation	-	0-4	-
	AP.71	Draw ratio	-	0.0-100.0	%

Multi–function Output On/Off Control Setting Details

Pr. Code	Description
AP.70 Draw operation	<table><tr><td>*Parameter setting*</td><td>*Function*</td></tr><tr><td>0</td><td>No draw operation</td></tr><tr><td>1</td><td>V1 (0–10 V) input draw operation</td></tr><tr><td>2</td><td>V0 (0–5 V) input draw operation</td></tr><tr><td>3</td><td>I2 (I) (0–20 mA) input draw operation</td></tr><tr><td>4</td><td>I2 (V) (0–10 V) input draw operation</td></tr></table> Set the AP.70 code to 1, 2, or 3. If the input value is higher than the analog input's median value that is determined by the parameter settings of In.8–11, In.38–41, In.53–56, and In.58–61, the value is applied to the output frequency as a positive value, as much as the ratio set by AP.71. If it is lower than the median value, it is applied as a negative value. **Example of Draw Operation** When the set frequency is 30 Hz, AP.70=1(V1: 0 –10 V), AP.71=10.0%, and In.7–In.11 are set to the factory default settings, the frequency converted to the draw operation is 27 Hz (V1=0 V)–33 Hz (V1=10 V). When the AP.70 code is set to 1 (V1), the frequency is calculated by the following formula: $$f'_{Ref} = f_{Ref} + \left\{ f_{ref} \times \frac{AP71}{100} \times \left(V_{in} - \frac{IN8 + IN10}{2} \right) \times \left(\frac{2}{IN10 - IN8} \right) \right\}$$

Draw Operation Control Diagram

CAUTION:
- *SET THE OPERATION COMMAND AT THE FRQ/BA.5 CODES AND OTHER FREQUENCIES AT THE AP.70 CODE (DRAW OPERATION).*
- *FOR EXAMPLE, THE DRAW OPERATION IS DISABLED IF FRQ=3 (V1) AND AP.70=1 (V1).*

OPERATION MODE WHEN COOLING FAN IS ABNORMAL

The operation of the drive when a cooling fan fault occurs can be set at Pr.79. Set Pr.79 to 0 for continuous operation during cooling fan fault and OU.31 or OU.32 can be used to output cooling fan fault status.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Pr	Pr.79	Cooling fan fault operation selection	1		0-1	-
OU	OU.31, OU.32	Multi-function relay outputs	18	Abnormal Cooling Fan	0-19	-

Abormal Cooling Fan Setting Details

Pr. Code	Description
Pr.79 Cooling Fan Fault Op	Pr.79=0: Sets continuous drive operation when a cooling fan fault occurs. The drive does not stop and keeps operating. A cooling fan fault signal can be output using the multi-function relay output terminals when OU.31 or OU.32 is set to 18 (Cooling fan warning signal). Pr.79=1: Set the drive operation to stop when a cooling fan fault occurs. The keypad segment displays FAn and the drive stops operation. A cooling fan fault signal can be output when OU.31 or OU.32 is set to 17 (Trip output).

⚠ CAUTION: IF YOU KEEP OPERATING THE DRIVE WHEN A COOLING FAN FAULT OCCURS, THE DRIVE COOLING PIN OVERHEATS AND THE COOLING PIN OVERHEAT PROTECTION MAY ACTIVATE. ALSO, THE LIFESPAN OF IMPORTANT COMPONENTS INSIDE THE DRIVE MAY BE SHORTENED BY THE RISE OF THE INTERNAL TEMPERATURE. OPERATE THE DRIVE AFTER FIXING THE COOLING FAN FAULT

OPERATION STATE MONITOR

OUTPUT CURRENT

The drive output current can be monitored at the CUr code in the *Operation* group.

Pr. Group	Pr. Code	Name	Parameter Setting	Setting Range	Unit
Operation	CUr	Output Current	-	-	A

MOTOR RPM

The motor RPM can be monitored by the rPM code in the Operation group.

Pr. Group	Pr. Code	Name	Parameter Setting	Setting Range	Unit
Operation	rPM	Motor RPM	-	-	Rpm
bA	bA.11	Number of motor poles	-	2-12	-
AP	AP.1	PID control selection	-	0-1	-
Ad	Ad.63	Motor RPM display gain	100	1-1000	%

Pr. Code	Description
rPM Motor RPM	When the dr.9 code is set to 0 (V/F control), the motor slip is not compensated and the drive output frequency (f) is converted to rPM by the following formula: $$rPM = \left(\frac{120 \times f}{bA.11}\right) \times \frac{Ad.63}{100\%}$$
AP.1 PID control selection	When the AP.1 code is set to 1 (PID control), the volume of feedback is displayed as a frequency.
Ad.63 RPM gain	Inputs the motor RPM display gain with the gear rate involved when the motor system RPM is monitored rather than the motor shaft RPM.

DRIVE DC VOLTAGE

Monitor the DC voltage of the drive's main circuit at the dCL code in the Operation group.

Pr. Group	Pr. Code	Name	Parameter Setting	Setting Range	Unit
Operation	dCL	Drive DC voltage	-	-	V

USER SELECT SIGNAL CODE OPTIONS

You can monitor an option set by the dr.81 code in the Drive group at vOL. If output power, torque, analog V1 terminal input, or analog I2 terminal input are selected, the *vOL* code display changes to POr, tOr, v1M, or I2M respectively.

Pr. Group	Pr. Code	Name	Parameter Setting	Setting Range	Unit
Operation	vOL	User Select Signal	-	-	V
dr	dr.81	Monitor code selection	-	0-4	-

Pr. Code	Description		
	Parameter Setting	Function	Output
	0	Output voltage (V)	vOL
	1	Output power (kW)	POr
dr.81 Monitor code	2	Torque (kgf*m)	tOr
	3	Analog V1 terminal input (V)	v1M
	4	Analog I2 terminal input (mA or V)	I2M

RANGE SELECTION AT POWER INPUT

An option set by the CF.1 code in the Configuration group is displayed when power is on. When the parameter is set for 12–15, output current, motor RPM, DC voltage, and user select signal are displayed.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
			0	Run frequency (0.00)		
			1	Acceleration time (ACC)		
			2	Deceleration time (dEC)		
			3	Command source (drv)		
			4	Frequency reference source (Frq)		
			5	Motor selection (MkW)		
			6	Motor rated current (MrC)		
			7	Base frequency (MbF)		
		Select ranges at power input	8	Maximum frequency (FrM)		
CF	CF.1		9	Output volage setting (IOv)	0-17	-
			10	Forward torque boost (Ftb)		
			11	Reverse torque boost (rtb)		
			12	Output current (Cur)		
			13	Motor RPM (rPM)		
			14	Drive DC voltage (dCL)		
			15	User select signal		
			16	Fault signal (nOn)		
			17	Open hidden group (OGr)		

I/O Terminal Block State Monitor

Input Terminal Block State Monitor

Monitor the current ON or OFF state of the input terminal block with the In.90 code in the Input Terminal group.

Pr. Group	Pr. Code	Name	Parameter Setting	Setting Range	Unit
In	In.90	Input monitor block state signal	-	00000-11111	bits

When the input terminal P1, P3, and P4 are ON, the keypad segement is displayed as shown below:

Output Terminal Block State Monitor

Monitor the current ON or OFF state of the multi-function relay and the open collector output with the OU.41 code in the Output Terminal group.

Pr. Group	Pr. Code	Name	Parameter Setting	Setting Range	Unit
OU	OU.41	Output monitor block state signal	-	00-11	bits

When the multi-function relay 1 is ON and the open collector output (standard I/O) is OFF, the keypad segment is displayed as shown below:
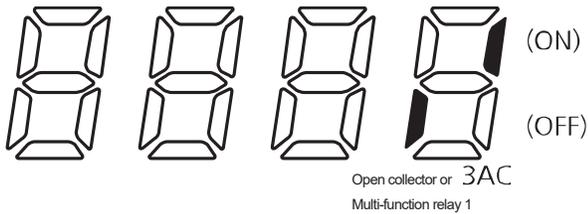
FAULT STATE MONITOR

CURRENT FAULT STATE MONITOR

The nOn *code in the* Operation group displays a fault type when a trip occurs during operation.

Pr. Group	Pr. Code	Name	Parameter Setting	Setting Range	Unit
Operation	nOn	Fault signal	-	-	-

When a trip occurs, you can view the information for the fault type and the drive operation state, fault type, frequency, current, and acceleration/deceleration information sequentially.

Item	Display Example	
Frequency	`30.00`	
Current	`5.0`	
Acceleration/Deceleration information	`ACC`	Trip occurred during acceleration
	`dEC`	Trip occurred during deceleration
	`Std`	Trip occurred during constant speed

FAULT HISTORY MONITOR

Information of the current fault trip can be monitored by the nOn code in the Operation group. Pr.91–Pr.95: saves information for up to 5 fault trips that occur during operation. Pr.96: Clears all information for the fault trips saved at the Pr.91–Pr.95 codes.

Pr. Group	Pr. Code	Name	Parameter Setting	Setting Range	Unit
Pr	Pr.91	Fault History 1	-	-	-
	Pr.92	Fault History 2	-	-	-
	Pr.93	Fault History 3	-	-	-
	Pr.94	Fault History 4	-	-	-
	Pr.95	Fault History 5	-	-	-
	Pr.96	Delete Fault History	-	0: No 1: Delete History	-

When you clear the fault status by using the [STOP/RESET] key or a multi-function input terminal, the information displayed by the Operation group is moved to the Pr.91 code. At this time, the previous fault information saved at the Pr.91 code is moved to the Pr.92 code automatically. Therefore, the most recent trip information is saved in the lowest fault history code. If multiple trips occur at the same time, the trip information is saved at a single code in a sequential order.

The following example details navigating to a different code after viewing a fault.

Next code
Pr93

Operation status during the fault trip

Current code
Pr92

ENT

EtH

ENT

ACC
5.0
30.00

Pr91

Previous code
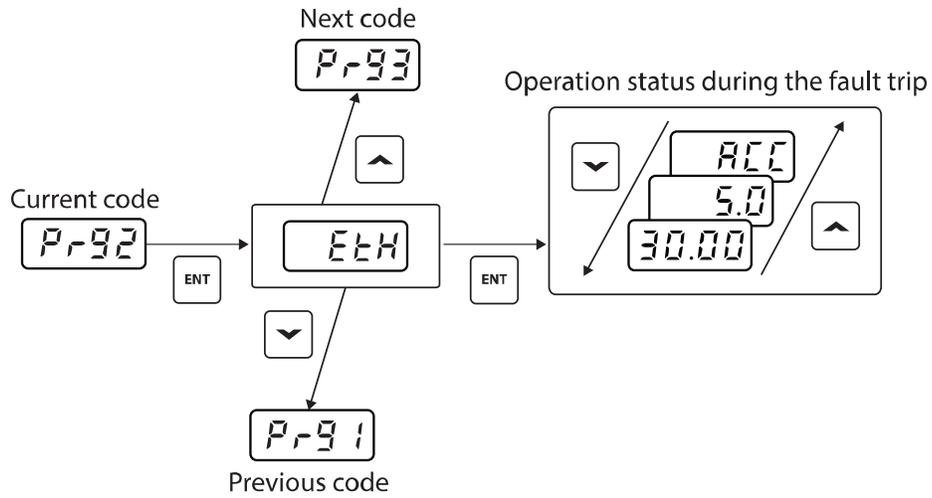
LEARNING PROTECTION FEATURES

Protection features provided by the ACM 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	Parameter Setting		Setting range	Unit
Pr	Pr.40	Electronic thermal prevention fault trip selection	1	Yes	0–1	–
	Pr.41	Motor cooling fan type	0	Self–cool	0-1	–
	Pr.42	Electronic thermal one minute rating	150		Pr.43–200	%
	Pr.43	Electronic thermal prevention continuous rating	100		50–Pr.42	%

Electronic Thermal (ETH) Prevention Function Setting Details

Pr. Code	Description
Pr.40 ETH Trip Sel	Electronic Thermal (ETH) can be selected to provide motor thermal protection.
	<table><tr><td>Setting</td><td>Function</td></tr><tr><td>0 No</td><td>The ETH function is not activated.</td></tr><tr><td>1 Yes</td><td>The drive output is blocked. The motor coasts to a halt (free–run).</td></tr></table>
Pr.41 Motor Cooling	Select the drive mode of the cooling fan, attached to the motor.
	<table><tr><td>Setting</td><td></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></table>
Pr.42 Electronic thermal one minute rating	The amount of input current that can be continuously supplied to the motor for 1 minute, based on the motor–rated current (MrC). This value cannot be lower than value set at Pr.43.
Pr.43 Electronic thermal prevention continuous rating	Sets the amount of current with the ETH function activated. Generally, the value is the rated current on the motor's nameplate. This value cannot be lower than value set at Pr.42 or more then 150%. The range below details the set values that can be used during continuous operation without the protection function.

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	Parameter Setting		Setting range	Unit
Pr	Pr.18	Overload warning level	150		30–150	%
	Pr.19	Overload warning time	10.0		0.0–30.0	s
	Pr.20	Motion at overload trip	1	Free–Run	0-1	–
	Pr.21	Overload trip level	180		30–200	%
	Pr.22	Overload trip time	60.0		0.0–60.0	s
OU	OU.31	Multi–function Relay1 define	5	Over Load	0-19	–
	OU.32	Multi–function Relay2 define				

Overload Early Warning and Trip Setting Details

Pr. Code	Description
Pr.18 OL Warn Level, Pr.19 OL Warn Time	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 (Relay1, Relay2) sends a warning signal. When Over Load is selected at OU.31 and OU.32, the multi– function relay outputs a signal. The signal output does not block the drive output.
Pr.20 OL Trip Select	Select the drive protective action in the event of an overload fault trip.
	Setting Function
	0 None No protective action is taken.
	1 Free–Run In the event of an overload fault, drive output is blocked and the motor will free–run due to inertia.
Pr.21 OL Trip Level, Pr.22 OL Trip Time	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 blocked and motor slows to a stop.
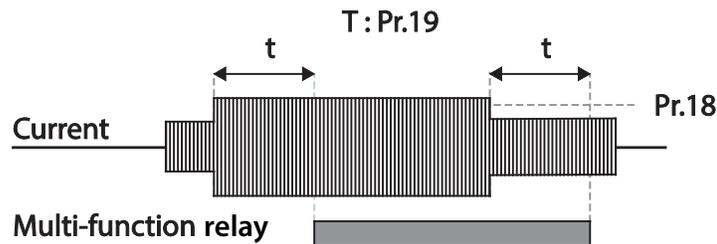
NOTE: Overload warnings notify of an overload before an overload fault trip occurs. The overload warning signal may not work in an overload fault trip situation, if the overload warn level (OL Warn Level) and the overload warn time (OL Warn Time) are set higher than the overload trip level (OL Trip Level) and overload trip time (OL Trip Time).

STALL PREVENTION

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.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting range	Unit
Pr	Pr.50	Stall prevention selection	000		000-111	bit
	Pr.52	Stall prevention level	150		30-200	%
OU	OU.31	Multi–function Relay1	7	Stall	0-19	–
	OU.32	Multi–function Relay2				
See "Bit Selection" on page 4–3 for details						

Stall Prevention Function 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 LED segment is on, the corresponding bit is set. When the bottom LED segment is on, the corresponding bit is off.. *See Bit Selection on page 4–3 for details.*

Configuration				Function
bit4	bit3	bit2	bit1	
			X	Stall protection during acceleration
		X		Stall protection while operating at a constant speed
	X			Stall protection during deceleration

Setting		Function
001	Stall protection during acceleration	If drive output current exceeds the preset stall level (Pr.52) during acceleration, the motor stops accelerating and starts decelerating. If the current level causes deceleration below the preset level while operating the stall protection function, the motor resumes acceleration.
010	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. During acceleration, the operation will follow the stall protection settings for acceleration.
100	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.

⚠️ 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

OUTPUT OPEN–PHASE PROTECTION

Open–phase output protection is 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	Parameter Setting	Setting range	Unit
Pr	Pr.5	Input/output open–phase protection	1	0-1	-
*See "Bit Selection" on page 4–3 for details					

Output Open–phase Protection Setting Details

Pr. Code	Description	
	Parameter Setting	Description
Pr.5 Phase Loss Chk	0	Set to disable output open-phase protection
	1	Set to use output open-phase protection

EXTERNAL TRIP SIGNAL

Set one of the multi–function input terminals to 18 or 19 (External Trip) to allow the drive to stop operation by using external signals.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting range	Unit
In	In.65–In.69	Px terminal setting options	18	External Trip A	0–27	–
			19	External Trip B		
	In.87	Multi–function input contact selection	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	5	4	3	2	1
	Terminal	P5	P4	P3	P2	P1

External Trip A terminal On ▢

External Trip B terminal On ▪

P1	FX In.65 = 0
P4	N.O In.68 = 18
P5	N.C In.69 = 19
CM	

Frequency

P4(A)

P5(B)

Run cmd
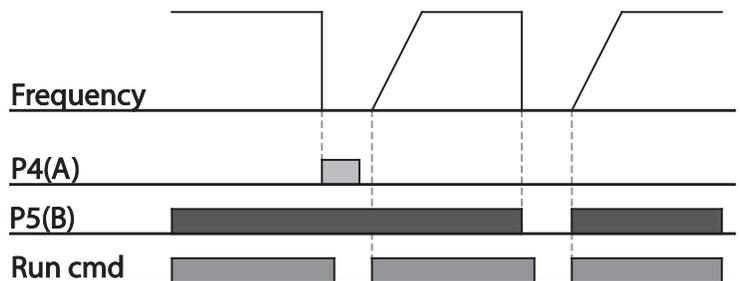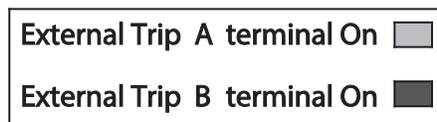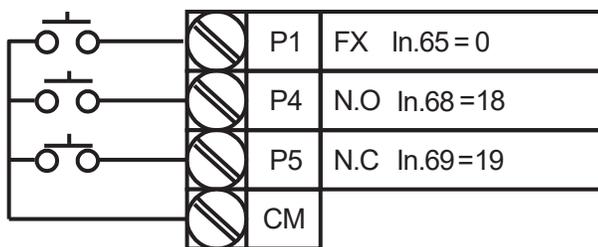
DRIVE OVERLOAD PROTECTION

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	Parameter Setting		Setting range	Unit
OU	OU.31	Multi–function Relay1	6	IOL	0-19	–
	OU.32	Multi–function Relay2				

SPEED COMMAND LOSS

When setting operation speed using an analog input, serial communications, 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	Parameter Setting		Setting range	Unit
Pr	Pr.12	Speed command loss operation mode	1	Free–Run	0-2	–
	Pr.13	Time to determine speed command loss	1.0		0.1–120.0	s
	Pr.15	Analog input loss decision level	0	Not Operating	0-2	–
OU	OU.31	Multi–function Relay1	11	Lost Command	0-19	–
	OU.32	Multi–function Relay2				

Speed Command Loss Setting Details

Pr. Code	Description
Pr.12 Lost Cmd Mode	In situations when speed commands are lost, the drive can be configured to operate in a specific mode:

	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 to a stop.

Pr. Code	Description
Pr.15 AI Lost Level	Configure the voltage and decision time for speed command loss when using analog input.

	Setting		Function
	0	None	Analog input command loss is not monitored.
	1	Below 1/2	When the input value is less than the half of the value set at the In. 8, In.38, and In.53.
	2	Below x1	When the input value is less than the value set at the In.8, In.38, and In.53.

Pr. Code	Description
Pr.13 Lost Cmd Time	Set the time to determine the loss of the speed command.

Set Pr.15 (Al Lost Level) to 2 (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:
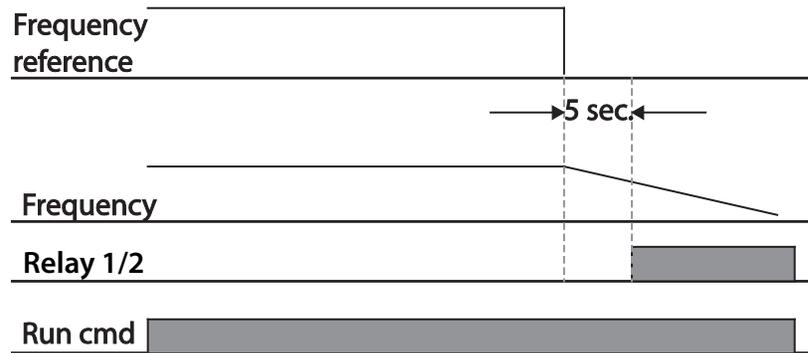
NOTE: If speed command is lost while using communication options or the integrated RS-485 communication, the protection function operates after the command loss decision time set at Pr.13 (Lost Cmd Time) is passed.

DYNAMIC BRAKING

DYNAMIC BRAKING (DB) RESISTOR CONFIGURATION

For Dynamic braking with external resistor, set the desired turn on level with Pr.65. Brake resistor terminals are available on Frame C drives only. Pr.65 and Pr.66 functionality does not apply to Frame A and B drives.

Pr.66 is for setup of a warning signal if the braking is being used too frequently.

Pr. Group	Pr. Code	Name	Parameter Setting	Setting range	Unit
Pr	Pr.65	Braking resistor warning level setting	1	0-1	-
	Pr.66	Braking resistor warning level	10	0–30	%

Dynamic Braking Resistor Setting Details

Pr. Code	Description
Pr.65 DB Warn Setting	<table><tr><td>*Parameter Setting*</td><td>*Description*</td></tr><tr><td>0</td><td>Use Braking resistor without level limit.</td></tr><tr><td>1</td><td>Use Braking resistor during time set at Pr.66.</td></tr></table>
Pr.66 DB Warn Level	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 second period has expired. An example of braking resistor set up is as follows: **Example 1** $$Pr.66 = \frac{T\_dec}{T\_acc + T\_steady + T\_dec + T\_stop} \times 100[\%]$$ **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
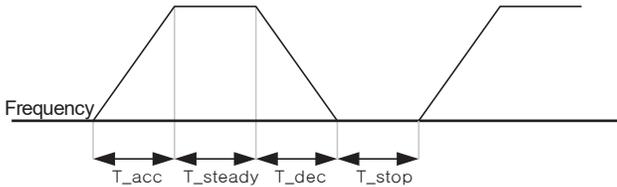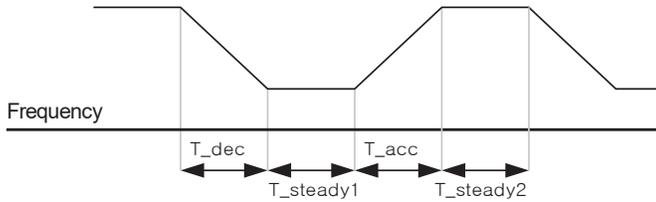
⚠️ *CAUTION: DO NOT SET THE BRAKING RESISTOR TO EXCEED THE RESISTOR'S POWER RATING. IF OVERLOADED, IT CAN OVERHEAT AND CAUSE A FIRE. WHEN USING A RESISTOR WITH A HEAT SENSOR, THE SENSOR OUTPUT CAN BE USED AS AN EXTERNAL TRIP SIGNAL FOR THE DRIVE'S MULTI–FUNCTION INPUT. MAXIMUM CONTINUOUS BRAKING TIME IS 15 SECONDS. EXCEEDING THE RESISTOR'S DUTY CYCLE RATING OR POWER RATING CAN CAUSE OVERHEATING AND FIRE. CONSULT THE RESISTOR SPECIFICATIONS FOR PROPER SIZING AND DUTY CYCLE LIMITS FOR YOUR APPLICATION*

INITIAL CHARGING CIRCUIT TRIP

The initial charging circuit limits the inrush current when supplying power to the drive, and it consists of a resistor and a relay.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting range	Unit
Pr	Pr.80	Initial charging circuit trip protection	1	Use ROT function	0-1	–

Under Load Trip and Warning Setting Details

Pr. Code	Description	
Pr.80 ROT Function	*Parameter Setting*	*Description*
	0	Do not use ROT function
	1	Use ROT function

CAUTION: THE INITIAL CHARGING CIRCUIT TRIP PROTECTION FUNCTION CAN BE USED ONLY WHEN INPUT POWER IS 0.4–2.2 KW, AND IT DOES NOT PROTECT TRIPS DUE TO A RELAY FUSION. THIS FUNCTION ACTIVATES AND PROTECTS THE DRIVE WHEN THE INPUT POWER IS UNSTABLE OR AN INITIAL CHARGING CIRCUIT TRIP OCCURS WHILE SUPPLYING POWER TO THE DRIVE. IF THE ROT CONTINUES TO OCCUR AFTER TURNING THE POWER OFF AND ON AGAIN, STOP USING THE DRIVE AND CONTACT AUTOMATIONDIRECT. THE DRIVE MAY BECOME DAMAGED IF YOU OPERATE THE DRIVE IN AN INITIAL CHARGING CIRCUIT TRIP STATUS.

FAULT/WARNING LIST

The following list shows the types of faults and warnings that can occur while using the ACM drive. For specific fault codes, details, and troubleshooting steps, refer to Chapter 6. Explanation of user controlled faults and warnings can be found in Learning Protection Features on page 4–109.

Category		Details
Major fault	**Latch type**	Over load (OLt)
		Over current (OCt)
		Over voltage (Ovt)
		Ground Trip (GFt)
		E-Thermal (EtH)
		Output Phase Open (OPO)
		Drive overload (IOL)
		Over Heat (OHt)
		NTC Open (ntC)
		Fan trip (FAn)
		External Trip A, B (EtA, Etb)
		Communication trip (COM)
		nbr (communication lost between Main DSP and IO cpu)
		IO board Trip (HOLd, ErrC)
	Level type	Low voltage fault trip (Lvt)
	Fatal	rOt
Warning		Command loss fault trip warning
		Overload warning
		Drive overload warning
		Braking resistor braking rate warning

NOTE: ACM drive warnings must be set to a multi-function output for monitoring as there are no drive codes for them. See OU.31 and OU.32 (Multi-function relay configuration) for setting warning outputs.

CHAPTER 5: SERIAL COMMUNICATIONS

TABLE OF CONTENTS

SERIAL RS-485 COMMUNICATION FEATURES

This chapter details how to control an ACM series drive with a PLC or a computer using the RS-485 serial communication features. The ACM series drive RJ45 connector with terminals S+ (Pin 1), S- (Pin8) 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.

COMMUNICATION STANDARDS

Following the RS-485 communication standards, ACM 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	ACM 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	RJ-45 connector (pin 1: S+, pin 8: S-, pin 7: SG)
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 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 ACM 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)*
- *LS Electric XGB.*

Other PLC-Drive connectivity is possible: Please refer to the chart below.

Typical ADC PLC to ACM Serial Communications Connectivity

Typical ADC PLC to ACM Serial Communications Connectivity Matrix*					
Recommended PLC Connectivity			**Communication**	**Direct Cable**	**ACM**
PLC	**Port #**	**Port Type**			**Terminals**
CLICK	3	3 screw terminals	RS-485	Q8304-1 cable	
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	Q8304-1 cable	
LS XEM-DN32HP, XEM-DP32HP, XEM-DN32H2, XEM-DP32H2, XEM-DP16H2, XEM-DH16H2 and XEM-DR14H2	RS-485	3 push-in terminals	RS-485	Q8304-1 cable	
P1-540 and P1-550	RS-485	4 screw terminals	RS-485	Q8304-1 cable	
P2-550 and P2-622	RS-485	3 screw terminals	RS-485	Q8304-1 cable	S+ S- SG
P3-530	RS-485	3 screw terminals	RS-485	Q8304-1 cable	
P3-550E	RS-485	3 screw terminals	RS-485	Q8304-1 cable	
Other PLC Connectivity			**Communication**	**Direct Cable**	
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	Q8304-1 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	Q8304-1 cable	
P3-SCM	4	4 screw terminals	RS-485	Q8304-1 cable	
Ethernet connectivity for EtherNet/IP or Modbus TCP communication is possible with an optional communication card ACM-ETH. Refer to Appendix C 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.
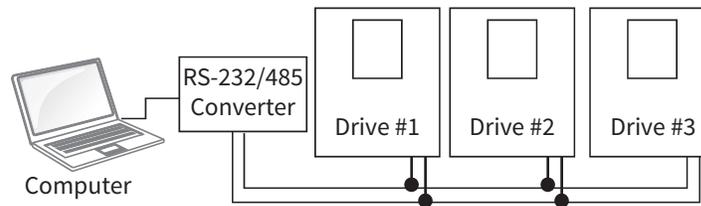
RS-232C to RS-485 Conversion

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**
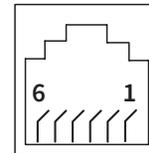
1: Signal Ground
2: CTS (input)
3: RXD (input)
4: TXD (output)
5: +5VDC in
6: Signal Ground

FA-ISOCON Wiring

RS-232 to RS-485 Conversion Wiring Schematic

120Ω Termination Resistor at both ends of network
[FA-ISOCON has a built-in terminating resistor controllable by switch settings]

FA-ISOCON
RS-232 to RS-485 converter with ANTE

Connect shield to signal ground at one end only

Termination Resistor dip switch can be used with the ACM Drive
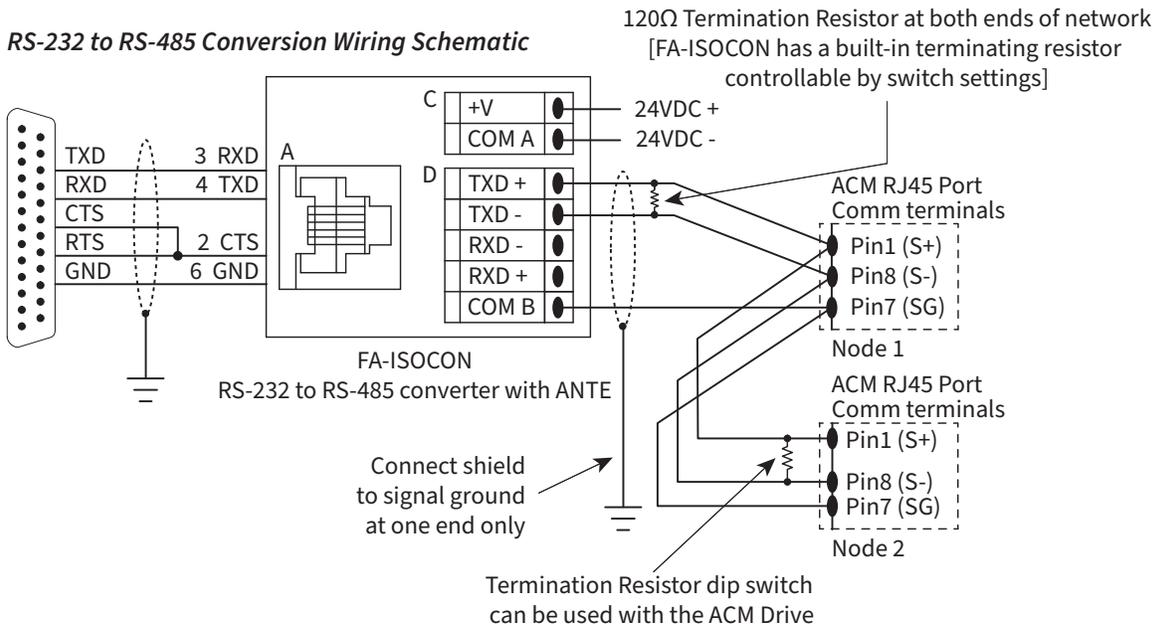
> NOTE: For information regarding configuration of AutomationDirect PLCs or other PLCs, please refer to the applicable PLC user manual for your application.

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.
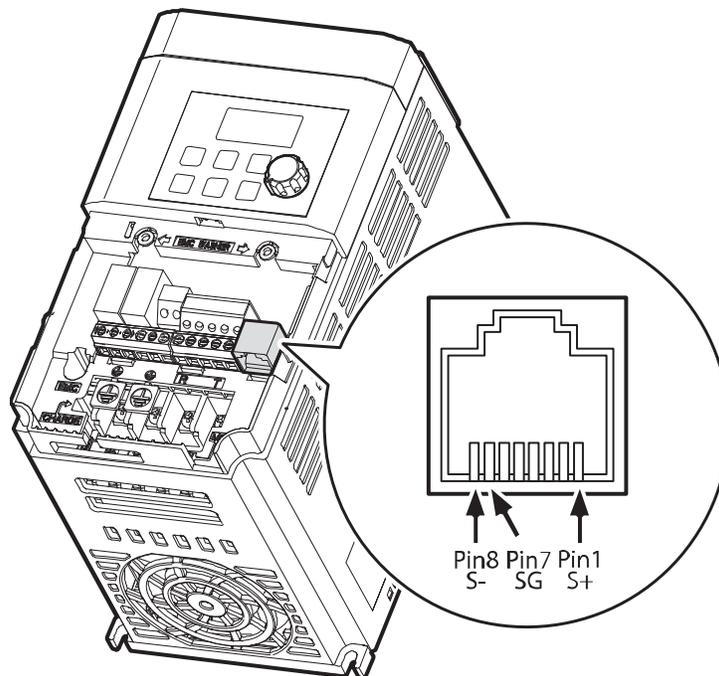
SERIAL COMMUNICATION TO VFD SUITE SOFTWARE

For instruction on serial communication to VFD Suite, see the VFD Suite manual.

ADC Part #
USB-485M

Connect Red Wire to Terminal 1
Connect Green Wire to Terminal 8

Ethernet
Patch cable
ADC Part #
C5E-STPGY-S3

ADC Part #
ZL-RTB-RJ45

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 Code	Name	Parameter Setting	Setting Range	Unit
CM	CM.1	Built-in communication drive ID	1		1-250	-
	CM.2	Built-in communication protocol	0	Modbus RTU	0, 1	-
	CM.3	Built-in communication speed	3	9600 bps	0-5	-
	CM.4	Built-in communication frame setting	0	D8/PN/S1	0-3	-
	CM.5	Transmission delay after reception	5		0-100	ms

Communication Parameters Setting Details

Communication Parameters Setting Details	
Parameter	**Description**
CM.1 Int485 St ID	Set the drive station ID between 1 and 250.
CM.2 Int485 Protocol	*Select one of the two built-in protocols: Modbus-RTU or LS INV 485.*
	Setting / *Function*
	0 / Modbus-RTU / Modbus-RTU compatible protocol
	1 / Not supported / –
CM.3 Int485 Baud Rate	*Set a communication setting speed up to 115,200 bps.*
	Setting / *Function*
	0 / 1,200 bps
	1 / 2,400 bps
	2 / 4,800 bps
	3 / 9,600 bps
	4 / 19,200 bps
	5 / 38,400 bps
CM.4 Int485 Mode	*Set a communication configuration. Set the data length, parity check method, and the number of stop bits.*
	Setting / *Function*
	0 / D8/PN/S1 / 8-bit data / no parity check / 1 stop bit
	1 / D8/PN/S2 / 8-bit data / no parity check / 2 stop bits
	2 / D8/PE/S1 / 8-bit data / even parity / 1 stop bit
	3 / D8/PO/S1 / 8-bit data / odd parity / 1 stop bit

Communication Parameters Setting Details	
Parameter	**Description**
CM.5 Response Delay	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.

SETTING OPERATION COMMAND AND FREQUENCY

Set the drv code of the operation group to 3 (RS-485 comm) and the Frq code of the operation group to 9 (RS-485 comm) in order to set the operation command and frequency of the common area parameters via communication.

Setting Operation Command and Frequency						
Parameter Group	**Parameter Number**	**Name**	**Parameter Setting**		**Setting Range**	**Unit**
Operation	drv	Command source	3	RS-485 comm	0-3	-
	Frq	Frequency setting method	9	RS-485 comm	0-11	-

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).

Saving Parameters Defined by Communication

If you turn off the drive after setting the common area parameters or keypad parameters via communication and operate the drive, the changes are lost and the values changed via communication revert to the previous setting values when you turn on the drive.

When editing data via each group parameter other than the common area parameter, the data change will be maintained when you turn on the drive.

Total Memory Map for Communication

Total Memory Map for Communication		
Item	**Memory Map**	**Details**
Parameter registration type area	0h0100-0h0107	CM.31–CM.38: Status Parameter 1–8
	0h0108-0h010F	CM.51– CM.58: Control Parameter 1–8
Drive communication common area	0h1F00	Operation Group
	0h1100	dr Group
	0h1200	bA Group
	0h1300	Ad Group
	0h1400	Cn Group
	0h1500	In Group
	0h1600	OU Group
	0h1700	CM Group
	0h1800	AP Group
	0h1900	Pr Group
	0h1A00	M2 Group
	0h1B00	CF 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	Parameter Setting	Setting Range	Unit
CM	CM.31-CM.38	Read address x	-	-	0000-A4FF	Hex
	CM.51-CM.58	Write address x	-	-	0000-A4FF	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
…
…
Data Hi
Data Lo
CRC Lo
CRC Hi

Number of Points (brackets Data Hi through Data Lo)

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
Data Lo
…
…
Data Hi
Data Lo
CRC Lo
CRC Hi

Number of Points

Function Code #06: Preset Single Register

Query Field Name
Station ID
Function(0x06)
Starting Address Hi
Starting Address Lo
Preset Data Hi
Preset Data Lo
CRC Lo
CRC Hi

Response Field Name
Station ID
Function(0x06)
Register Address Hi
Register Address Lo
Preset Data Hi
Preset Data Lo
CRC Lo
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 ADDRESS
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.1 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.1 Int485 St ID	Preset Multiple Register	Starting Address -1 (0x1103-1)	-	-

COMPATIBLE COMMON AREA PARAMETER

Comm. Address	Parameter	Scale	Unit	R/W	Assigned Content by Bit		
0h0001	Drive capacity	–	–	R	120V	0001	0.2 kW (0.25 hp)
						0002	0.4 kW (0.5 hp)
						0003	0.75 kW (1 hp)
					230V	0000	0.1 kW (0.125 hp)
						0001	0.2 kW (0.25 hp)
						0002	0.4 kW (0.5 hp)
						0003	0.75 kW (1 hp)
						0004	1.5 kW (2 hp)
						0005	2.2 kW (3 hp)
0h0002	Drive input voltage	–	–	R	0	230V level	
					3	110V level	
0h0003	Version	–	–	R	0h0010	Version 1.01	
0h0004	Reserved	–	–	R/W	–		
0h0005	Target frequency	0.01	Hz	R/W	Start frequency – Maximum frequency		

Comm. Address	Parameter	Scale	Unit	R/W	Assigned Content by Bit	
0h0006	Operation command (option)	–	–	R	B15, B14, B13	Reserved
					B12	0: Keypad-2, Keypad-2 Freq 1: Reserved
					B11	2: Multi-step speed 1 3: Multi-step speed 2 4: Multi-step speed 3
					B10	5: Multi-step speed 4 6: Multi-step speed 5 7: Multi-step speed 6
					B9	8: Multi-step speed 7 9: UP 10: Down 11: Up/Down zero 12: V0 13: V1 14: I2 (I) 15: I2 (V)
					B8	16: V0+I2(I) 17: V0+I2(V) 18:V0+I2(V) 19: Built-in 485
					B7	0: Terminal block 1: Keypad 3: Built-in 485
					B6	
				R/W	B5	Reserved
					B4	Emergency stop
					B3	Fault Reset
					B2	Reverse operation (R)
					B1	Forward operation (F)
					B0	Stop (S)
0h0007	Acceleration time	0.1	sec	R/W	–	
0h0008	Deceleration time	0.1	sec	R/W	–	
0h0009	Output current	0.1	A	R	–	
0h000A	Output frequency	0.01	Hz	R	–	
0h000B	Output voltage	1	V	R	–	
0h000C	DC link voltage	1	V	R	–	
0h000D	Output power	0.1	kW	R	–	
0h000E	Operation status	–	–	–	B15	Reserved
					B14	Reserved
					B13	Reserved
					B12	Reverse operation command
					B11	Forward operation command
					B10	Brake release signal
					B9	Reserved
					B8	Drive stopping
					B7	DC braking
					B6	Speed reached
					B5	Decelerating
					B4	Accelerating
					B3	Fault Trip
					B2	Operating in reverse direction
					B1	Operating in forward direction
					B0	Stopped

Comm. Address	Parameter	Scale	Unit	R/W	Assigned Content by Bit	
0h000F	Fault trip information	–	–	R	B15	LVT
					B14	IOLT
					B13	POT
					B12	FAN
					B11	EEP
					B10	EXT-B
					B9	Reserved
					B8	OLT
					B7	ETH
					B6	OHT
					B5	GFT
					B4	COL
					B3	EST
					B2	EXT-A
					B1	OVT
					B0	Reserved
0h0010	Input terminal information	–	–	R	B15–B5	Reserved
					B4	P5
					B3	P4
					B2	P3
					B1	P2
					B0	P1
0h0011	Output relay information	–	–	R	Others	Reserved
					B4	3ABC
0h0012	V1	-	V	R	V1 voltage input	
0h0013	V0	-	V	R	Potentiometer voltage input	
0h0014	I2	-	A	R	I2 current input	
0h0015	Motor rotation speed	1	Rpm	R	Displays existing motor rotation speed	
0h001A	Unit display	–	–	R	Not used	
0h001B	Display the number of poles for the selected motor	–	–	R	Display the number of poles for the selected motor	
0h001D	Fault trip information -B	-	-	R	B9	ROT
					B8	Reserved
					B7	Reserved
					B6	Reserved
					B5	NBR
					B4	OCT
					B3	REEP
					B2	NTC
					B1	Reserved
						COM

Comm. Address	Parameter	Scale	Unit	R/W	Assigned Content by Bit
0h001E	PID Feedback	0.1	%	R/W	When Feedback is set to communication in PID operation, the amount of feedback is written and read in 0.1% increments.

DRIVE PARAMETER MODBUS COMMUNICATION ADDRESSES

The following tables list the specific modbus addresses for all parameters in the ACM series drive.

Parameter	HEX	ModbusRTU Decimal	Parameter	HEX	ModbusRTU Decimal
Operation Group					
0.00	1F00	47936	IOv	1F09	47945
ACC	1F01	47937	Ftb	1F0A	47946
dEC	1F02	47938	rtb	1F0B	47947
drv	1F03	47939	CUr	1F0C	47948
Frq	1F04	47940	rPM	1F0D	47949
MkW	1F05	47941	dCL	1F0E	47950
MrC	1F06	47942	nOn	1F10	47952
MbF	1F07	47943	OGr	1F11	47953
FrM	1F08	47944			
Drive Group					
dr.9	1109	44361	dr.26	111A	44378
dr.11	110B	44363	dr.27	111B	44379
dr.15	110F	44367	dr.28	111C	44380
dr.19	1113	44371	dr.81	1151	44433
dr.20	1114	44372	dr.91	115B	44443
Basic Group					
bA.4	1204	44612	bA.51	1233	44659
bA.5	1205	44613	bA.52	1234	44660
bA.7	1207	44615	bA.53	1235	44661
bA.8	1208	44616	bA.54	1236	44662
bA.9	1209	44617	bA.55	1237	44663
bA.11	120B	44619	bA.56	1238	44664
bA.12	120C	44620	bA.70	1246	44678
bA.14	120E	44622	bA.71	1247	44679
bA.15	120F	44623	bA.72	1248	44680
bA.16	1210	44624	bA.73	1249	44681
bA.19	1213	44627	bA.74	124A	44682
bA.25	1219	44633	bA.75	124B	44683
bA.41	1229	44649	bA.76	124C	44684
bA.42	122A	44650	bA.77	124D	44685
bA.43	122B	44651	bA.78	124E	44686
bA.44	122C	44652	bA.79	124F	44687
bA.45	122D	44653	bA.80	1250	44688
bA.46	122E	44654	bA.81	1251	44689
bA.47	122F	44655	bA.82	1252	44690
bA.48	1230	44656	bA.83	1253	44691
bA.50	1232	44658			

Parameter	HEX	ModbusRTU Decimal	Parameter	HEX	ModbusRTU Decimal
Advanced Group					
Ad.1	1301	44865	Ad.29	131D	44893
Ad.2	1302	44866	Ad.30	131E	44894
Ad.3	1303	44867	Ad.31	131F	44895
Ad.4	1304	44868	Ad.32	1320	44896
Ad.8	1308	44872	Ad.33	1321	44897
Ad.9	1309	44873	Ad.41	1329	44905
Ad.10	130A	44874	Ad.42	132A	44906
Ad.12	130C	44876	Ad.44	132C	44908
Ad.13	130D	44877	Ad.45	132D	44909
Ad.14	130E	44878	Ad.46	132E	44910
Ad.15	130F	44879	Ad.47	132F	44911
Ad.16	1310	44880	Ad.51	1333	44915
Ad.17	1311	44881	Ad.63	133F	44927
Ad.20	1314	44884	Ad.64	1340	44928
Ad.21	1315	44885	Ad.65	1341	44929
Ad.24	1318	44888	Ad.66	1342	44930
Ad.25	1319	44889	Ad.67	1343	44931
Ad.26	131A	44890	Ad.68	1344	44932
Ad.27	131B	44891	Ad.79	134F	44943
Ad.28	131C	44892			
Control Group					
Cn.4	1404	45124	Cn.73	1449	45193
Cn.71	1447	45191	Cn.74	144A	45194
Cn.72	1448	45192			
Input Group					
In.7	1507	45383	In.57	1539	45433
In.8	1508	45384	In.58	153A	45434
In.9	1509	45385	In.59	153B	45435
In.10	150A	45386	In.60	153C	45436
In.11	150B	45387	In.61	153D	45437
In.37	1525	45413	In.65	1541	45441
In.38	1526	45414	In.66	1542	45442
In.39	1527	45415	In.67	1543	45443
In.40	1528	45416	In.68	1544	45444
In.41	1529	45417	In.69	1545	45445
In.52	1534	45428	In.70	1546	45446
In.53	1535	45429	In.85	1555	45461
In.54	1536	45430	In.87	1557	45463
In.55	1537	45431	In.90	155A	45466
In.56	1538	45432			

Parameter	HEX	ModbusRTU Decimal	Parameter	HEX	ModbusRTU Decimal
			Output Group		
OU.1	1601	45633	OU.41	1629	45673
OU.2	1602	45634	OU.52	1634	45684
OU.30	161E	45662	OU.57	1639	45689
OU.31	161F	45663	OU.58	163A	45690
OU.32	1620	45664			
			Communication Group		
CM.1	1701	45889	CM.37	1725	45925
CM.2	1702	45890	CM.38	1726	45926
CM.3	1703	45891	CM.51	1733	45939
CM.4	1704	45892	CM.52	1734	45940
CM.5	1705	45893	CM.53	1735	45941
CM.31	171F	45919	CM.54	1736	45942
CM.32	1720	45920	CM.55	1737	45943
CM.33	1721	45921	CM.56	1738	45944
CM.34	1722	45922	CM.57	1739	45945
CM.35	1723	45923	CM.58	173A	45946
CM.36	1724	45924			
			Application Group		
AP.1	1801	46145	AP.28	181C	46172
AP.2	1802	46146	AP.29	181D	46173
AP.18	1812	46162	AP.30	181E	46174
AP.19	1813	46163	AP.37	1825	46181
AP.20	1814	46164	AP.38	1826	46182
AP.21	1815	46165	AP.39	1827	46183
AP.22	1816	46166	AP.70	1846	46214
AP.23	1817	46167	AP.71	1847	46215
AP.24	1818	46168			
			Protection Group		
Pr.5	1905	46405	Pr.43	192B	46443
Pr.8	1908	46408	Pr.50	1932	46450
Pr.9	1909	46409	Pr.52	1934	46452
Pr.10	190A	46410	Pr.53	1935	46453
Pr.12	190C	46412	Pr.65	1941	46465
Pr.13	190D	46413	Pr.66	1942	46466
Pr.15	190F	46415	Pr.79	194F	46479
Pr.18	1912	46418	Pr.80	1950	46480
Pr.19	1913	46419	Pr.91	195B	46491
Pr.20	1914	46420	Pr.92	195C	46492
Pr.21	1915	46421	Pr.93	195D	46493
Pr.22	1916	46422	Pr.94	195E	46494
Pr.40	1928	46440	Pr.95	195F	46495
Pr.41	1929	46441	Pr.96	1960	46496

Parameter	HEX	ModbusRTU Decimal	Parameter	HEX	ModbusRTU Decimal
Pr.42	192A	46442			
2nd Motor Group					
M2.4	1A04	46660	*M2.26*	1A1A	46682
M2.5	1A05	46661	*M2.27*	1A1B	46683
M2.7	1A07	46663	*M2.28*	1A1C	46684
M2.12	1A0C	46668	*M2.29*	1A1D	46685
M2.25	1A19	46681	*M2.30*	1A1E	46686
Config Mode Group					
CF.1	1B01	46913	*CF.93*	1B5D	47005
CF.2	1B02	46914	*CF.94*	1B5E	47006
CF.79	1B4F	46991	*CF.95*	1B5F	47007
CF.80	1B50	46992			

CHAPTER 6: MAINTENANCE AND TROUBLESHOOTING

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 25 VDC.

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

STORAGE

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.*
- *Do not leave drive in a humid or dusty environment.*

DISPOSAL

When disposing of the product, categorize it as general industrial waste. The product contains materials that can be recycled. Please consider the environment, energy, and resources and recycle unused products. The packing materials and all metal parts can be recycled. Although plastic can also be recycled, it can be incinerated under controlled conditions in some regions.

⚠️ *CAUTION: IF THE PRODUCT IS LEFT IN A PROLONGED STATE WITHOUT A FLOW OF CURRENT, THE CONDENSER WILL DETERIORATE DUE TO ITS CHARACTERISTICS. TO PREVENT THE DETERIORATION OF THE ELECTROLYTIC CAPACITOR, TURN ON THE DRIVE POWER AT LEAST ONCE A YEAR AND APPLY CURRENT FOR 30-60 SECONDS. RUN THE DEVICE UNDER NO-LOAD CONDITIONS.*

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. Users can read the warning message at Pr.91-95. When more than two trips occur at roughly the same time, the keypad displays the higher priority fault trip information.

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.*
- **nOn:** *Displays when no fault is present.*

FAULT TRIPS

PROTECTION FUNCTIONS FOR OUTPUT CURRENT AND INPUT VOLTAGE

Note: Reference chapter 3 for the LED display letter codes. The characters displayed on the drive LED display do not appear exactly as the letters in the "Keypad Display" column.

Protection Functions for Output Current and Input Voltage			
Keypad Display	**Name**	**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.
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.
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.
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.
opo	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.
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.
rot	Relay open trip	Latch	Displayed when the input power is unstable or an initial charging circuit trip occurs while supplying power to the drive. Can only occur in 0.5 – 3.0 hp drives (0.4 – 2.2 kW). There is a possibility of ROT trip when power is turned off within 1 second after LVT trip.

PROTECTION FUNCTIONS USING ABNORMAL INTERNAL CIRCUIT CONDITIONS AND EXTERNAL SIGNALS

Protection Functions Using Abnormal Internal Circuit Conditions and External Signals			
Keypad Display	**Name**	**Type**	**Description**
oht	Overheat	Latch	Displayed when the temperature of the drive heat sink exceeds the specified value.
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. The cooling fan trip can occur when it is overloaded, its connectors are disconnected, or its components break. When the problem is solved, the Fan Trip is cleared and the fan operates normally.
eta etb	EtA, Etb (External Trip A,B)	Latch	When the multi-function input terminal of the I/O is set to EtA or EtB, the input terminal is used as the signal. • EtA is displayed when the CM and short signal are generated when the multi-function input is NPN or P24 and the short signal is generated when multi-function input is PNP. • EtB is displayed when the CM and open signal are generated when multi-function input is NPN or P24 and open signal is generated when multi-function input is PNP.
com	COM (Communi-cation trip)	Latch	Displayed when communication between the Main DSP and the IO CPU is disconnected for more than 500 ms.
nbr	nbr	Latch	Displayed when the drive's output current is below the value set at Ad.41 during the external brake signal operation based on the multi-function terminal function setting. Set OU.31 or OU.32 to 19 (Brake signal setting).
hold	IO Board Trip	Latch	Displayed when supplying power to the drive and continuously displayed when communication is disconnected after supplying power.
errc	IO Board Trip	Latch	Displayed when communication is disconnected for more than 2 seconds after connected normally.

WARNING CODES

	Warning Codes	
Keypad Display	**Name**	**Description**
olw	Overload	Displayed when the motor is overloaded. Operates when Pr.17 is set to 1. To operate, select 5. Set the Digital output relay (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 Digital output relay (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 Digital output relay (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 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.
efan	Fan exchange	An alarm occurs when the value set at Pr.86 is less than the value set at Pr.87. To receive fan exchange output signals, set the digital output relay (OU.31 or OU.33) to 37 (Fan Exchange).
fanw	Fan Warning	Displayed when an error is detected from the cooling fan while Pr.79 is set to 1. Set the Digital output relay (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.
oh	Overheat pre alarm	When the user has set Pr.78 to 1: Warning, pre-overheating warning of drive occurs if the drive temperature exceeds the temperature set by the user in Pr.77.
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.

Type	Name	Cause	Remedy
OLT	**Over Load**	The load is greater than the motor's rated capacity.	Ensure that the motor and drive have appropriate capacity ratings. Verify motor nameplate FLA does not exceed drive rated output current. Refer to Chapter 1 for drive ratings.
		The set value for the overload trip level (Pr.21) is too low.	Increase the set value for the overload trip level.
OCT	**Over Current**	Acc/Dec time is too short, compared to load inertia (bA.16).	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.71).
		The mechanical brake of the motor is operating too fast.	Check the mechanical brake.
OVT	**Over Voltage**	Deceleration time is too short for the load inertia (bA.16).	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.
LVT	**Low Voltage**	The input voltage is too low.	Determine if the input voltage is below the specified 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.
GFT	**Ground Trip**	A ground fault has occurred in the drive output wiring.	Check the output wiring.
		The motor insulation is damaged.	Replace the motor.
ETH	**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 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.
OPO	**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.
IOL	**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.
OHT	**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 50°C.

Troubleshooting Fault Trips			
Type	Name	Cause	Remedy
NTC	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	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 needs to be replaced.	Replace the fan.
ROT	Relay Open Trip	The input power is unstable or an initial charging circuit trip occurs while supplying power to the drive.	Turn off and on the power again. If the problem continues, stop using the drive and contact AutomationDirect Customer Support

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/T.	Check the terminal connections R/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.
		Increase the Acc/Dec time.
		Check the motor parameters and set the correct values.
		Replace the motor and the drive with models with appropriate capacity for the load.
	The ambient temperature of the motor is too high.	Lower the ambient temperature of the motor.
	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.
		Only use motors suitable for applications with drives.
		Connect an AC reactor to the drive output (set the carrier frequency to 2 kHz).
	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.
		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 load is too high.	Reduce the load and increase the acceleration time. Check the mechanical brake status.
	The acceleration time is too long.	Change the acceleration time.
	The combined values of the motor properties and the drive parameter are incorrect.	Change the motor related parameters.
	The stall prevention level during acceleration is low.	Change the stall prevention level.
	The stall prevention level during operation is low.	Change the stall prevention level.
	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.
	The input voltage varies.	Reduce input voltage variation.
	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 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 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.
	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.
		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 ACM 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 100m.
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: ACCESSORIES

FUSES/CIRCUIT BREAKERS

Protection devices are essential to prevent damage to your ACM drive and application equipment. Please use the fuse specification chart below to select fuses that are applicable to your ACM drive. Only use UL-certified 600V fuses which comply with your local regulations.

Drive	Drive Voltage	HP (HD)	Fuse Amps (Class H or RK5)	Suggested ADC Class RK5 Fuses	Circuit Breaker	
					Size (A)	Model*
ACM-10P2	100-120	0.25	15	ECSR15	15	GCB100S-2FF15LL
ACM-10P5	100-120	0.5	20	ECSR20	15	GCB100S-2FF15LL
ACM-11P0	100-120	1	30	ECSR30	20	GCB100S-2FF20LL
ACM-20P1	200-240	0.125	5	ECSR5	15	GCB100S-2FF15LL
ACM-20P2	200-240	0.25	5	ECSR5	15	GCB100S-2FF15LL
ACM-20P5	200-240	0.5	10	ECSR10	15	GCB100S-2FF15LL
ACM-21P0	200-240	1	10	ECSR10	15	GCB100S-2FF15LL
ACM-22P0	200-240	2	15	ECSR15	15	GCB100S-2FF15LL
ACM-23P0	200-240	3	20	ECSR20	20	GCB100S-2FF20LL
* Gladiator molded case circuit breaker available at AutomationDirect.com						

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 ACM 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.

GLADIATOR MOLDED CASE CIRCUIT BREAKERS WILL PROVIDE THESE SHORT-CIRCUIT CURRENT RATINGS:
- 120 VAC DRIVES: 65 KA AT 60 HZ. 50 KA AT 50 HZ
- 230 VAC DRIVES: 65 KA AT 60 HZ. 50 KA AT 50 HZ

HIGH PERFORMANCE EMI INPUT FILTERS

The optional accessories listed in this chapter are available for use with the ACM 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 (HD)	Roxburgh Filters C2 Rated
ACM-10P2	100-120	0.25	MIF10
ACM-10P5	100-120	0.5	MIF16
ACM-11P0	100-120	1	MIF23
ACM-20P1	200-240	0.125	MIF06
ACM-20P2	200-240	0.25	MIF06
ACM-20P5	200-240	0.5	MIF10
ACM-21P0	200-240	1	MIF10
ACM-22P0	200-240	2	MIF16
ACM-23P0	200-240	3	MIF23
* All specs for the EMI filters can be found at www.automationdirect.com or by clicking the following link: *-MIF Series Filters*			

EMI FILTER INSTALLATION

Electrical equipment like the ACM 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 ACM family of drives and are recommended for the mitigation of interference and the highest performance When the ACM 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 ACM drive on the same subpanel or metal plate.*

2) *Install the EMI filter as close as possible to the ACM drive.*

3) *Keep wiring between the EMI filter and ACM drive as short as possible.*

4) *The subpanel or metal plate used to support the EMI filter and ACM drive should be well grounded (minimal resistance to ground is typically less than 1Ω).*

5) *To insure that the EMI filter and ACM 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.*
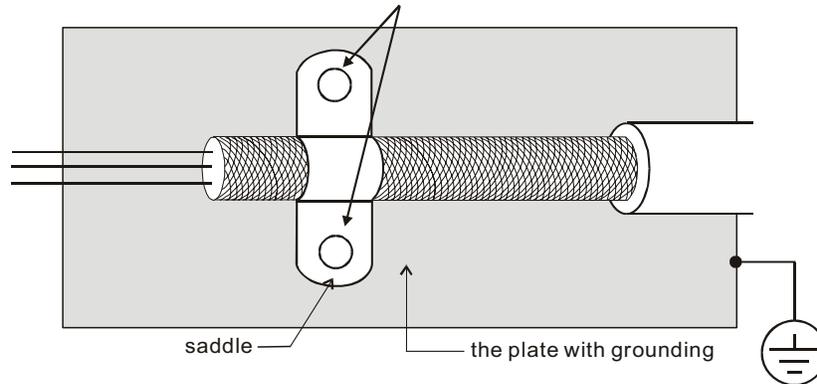

saddle   the plate with grounding

Figure 1

Saddle on both ends

Saddle on one end

Figure 2

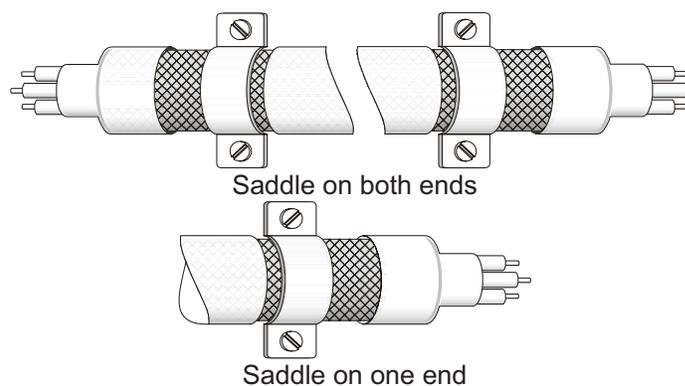### REFLECTIVE WAVE PHENOMENON

The drive section of a PWM drive like the ACM 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 ACM 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 ACM 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 ACM drive to each motor.*

4) *Should an overload relay malfunction occur, lower the ACM drive carrier frequency (Cn.4) or install an output reactor.*

5) *When operating an AC motor with a PWM drive like the ACM, 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 two input phases R & T, as shown in the figure below:
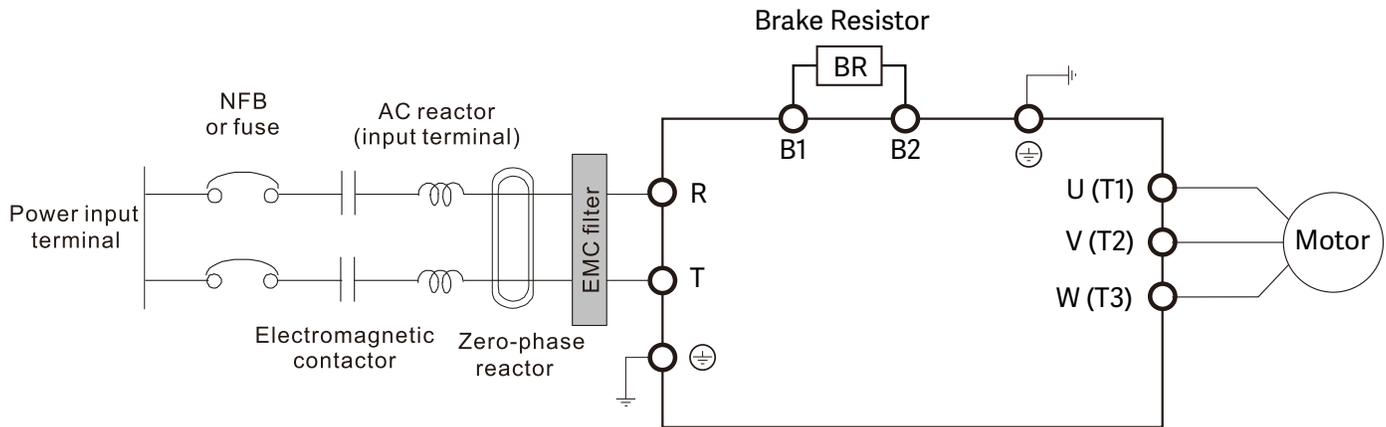
LOAD REACTOR/VOLTAGE TIME FILTER

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:
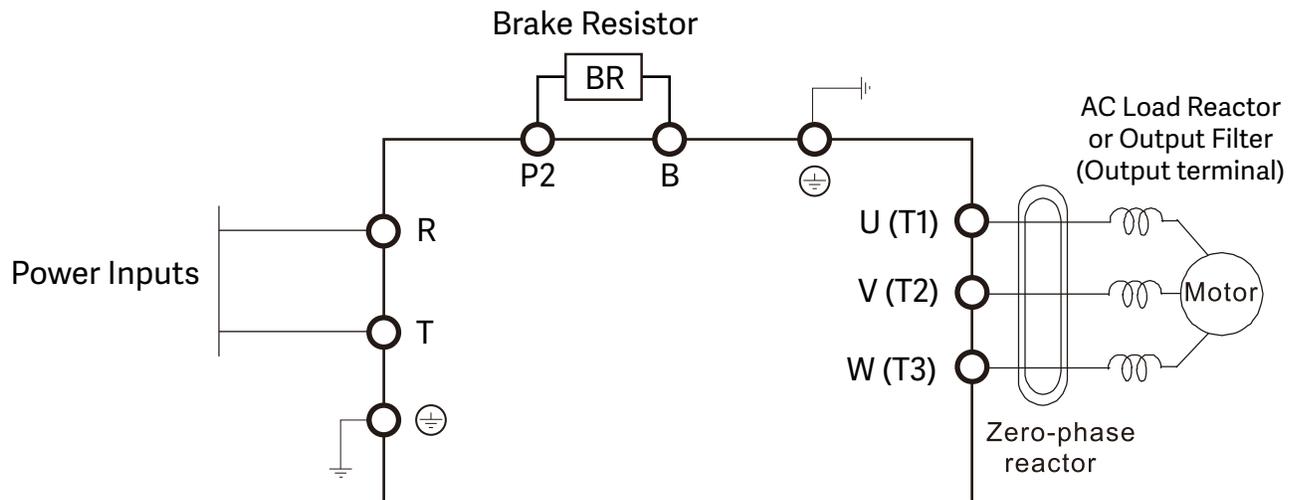
LINE/LOAD REACTORS AND OUTPUT FILTERS SELECTION CHARTS

Drive	Voltage	HP	Input (Amps)	Output FLA 3ph (Amps)	AC Input Line Reactor (LR2)*	AC Output Load Reactor (LR2)*	AC dVdT Output Filter*
ACM-10P2		0.25	3.7	1.4	LR2-10P2-1PH-A	LR2-20P2	VTF-46-DE
ACM-10P5	100–120	0.5	7.4	2.4	LR2-10P5-1PH-A	LR2-20P5	VTF-246-CFG
ACM-11P0		1	13.9	4.2	LR2-11P5-1PH	LR2-21P0	VTF-24-FH
ACM-20P1		0.125	1.0	0.8	LR2-20P5-1PH	LR2-20P2	VTF-46-DE
ACM-20P2		0.25	1.8	1.4	LR2-20P5-1PH	LR2-20P2	VTF-46-DE
ACM-20P5		0.5	3.7	2.4	LR2-20P5-1PH	LR2-20P5	VTF-246-CFG
ACM-21P0	200–240	1	7.1	4.2	LR2-21P5-1PH-A	LR2-21P0	VTF-24-FH
ACM-22P0		2	13.6	7.5	LR2-22P0-1PH	LR2-22P0	VTF-246-HKL
ACM-23P0		3	18.7	11.0	LR2-23P0-1PH	LR2-23P0	VTF-24-JL

Reactor sizing is based on rated HP NEMA motor load, not drive output amp load. Size the reactor based on the motor nameplate current. All specs for the LR2 and VTF can be found at www. automationdirect.com or by clicking the following links:
*-LR2 Line Reactors*
-VTF Output Filters

LINE REACTOR APPLICATIONS AND WIRING CONNECTIONS

INPUT SIDE OF AC DRIVE

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.
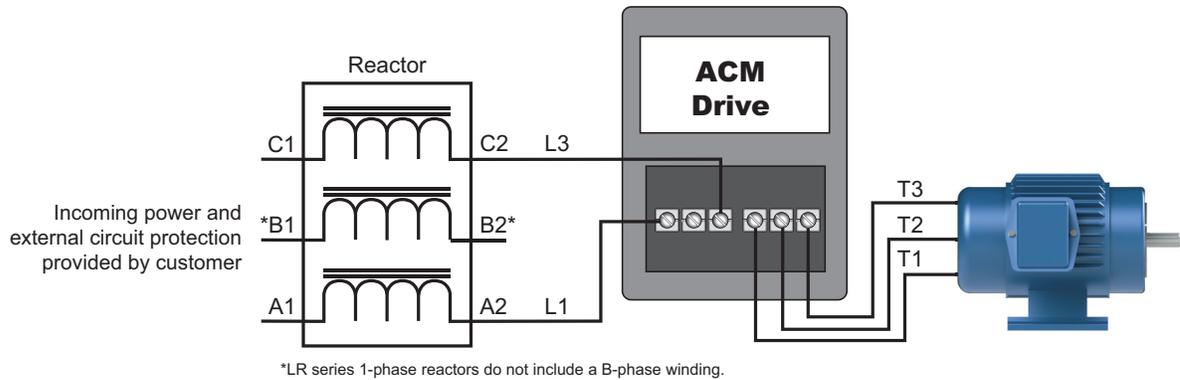
Please refer to Chapter 2 for detailed wiring information for the ACM drive.

⚠️ *ENSURE THAT YOU PROPERLY INSULATE TERMINALS B1 AND B2 BEFORE MAKING ANY CONNECTIONS TO SINGLE-PHASE POWER.*

OUTPUT SIDE OF AC DRIVE

When installed on the output side of the ACM drive, line (load) reactors help to protect the ACM drive from short circuits at the load. Voltage and current waveforms from the ACM drive are enhanced, reducing motor overheating and noise emissions.
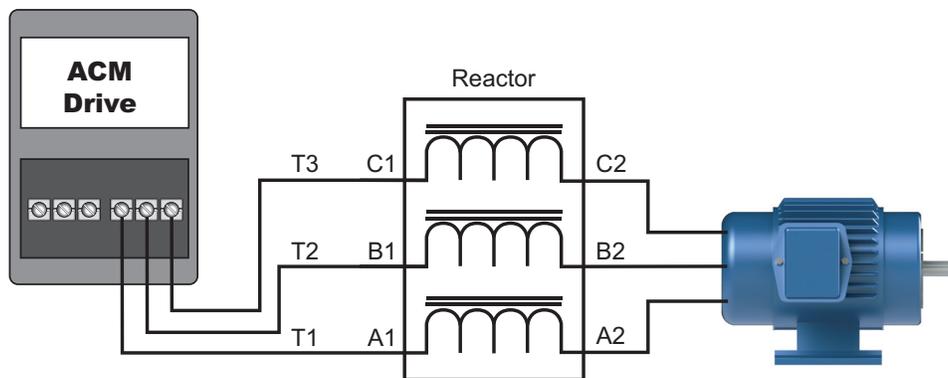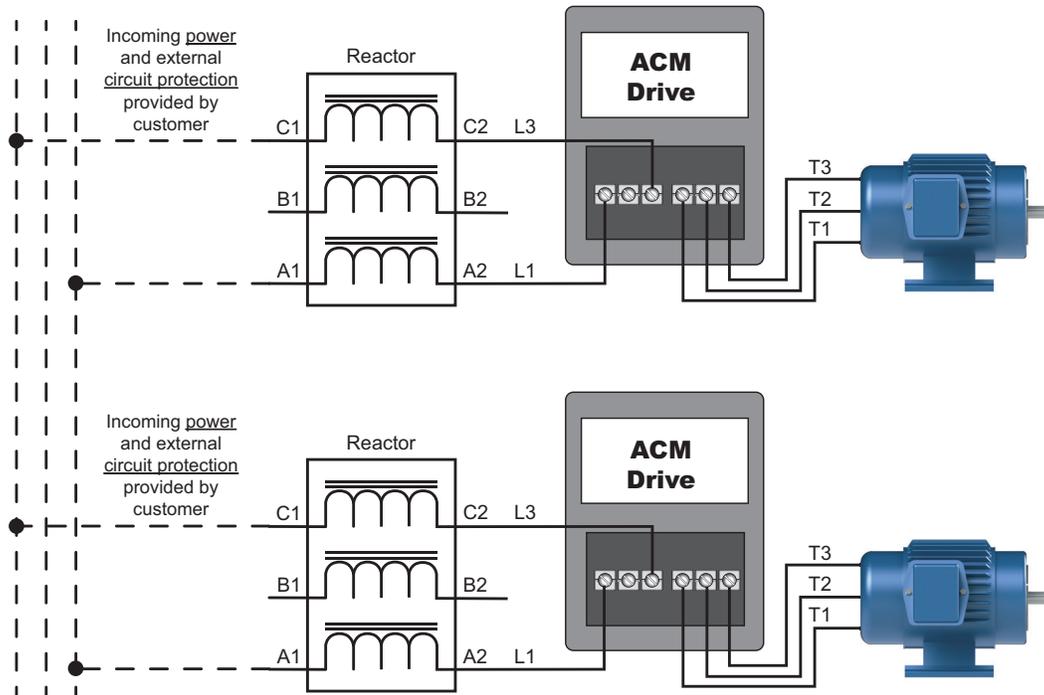

Please refer to Chapter 2 for detailed wiring information for the ACM drive.

📝 *All AC Drive outputs are only compatible with 3-phase load reactors and 3-phase AC motors.*

Multiple AC Drives

Individual line reactors are recommended when installing multiple ACM drives on the same power line. Individual line reactors eliminate cross-talk between multiple ACM drives and provide isolated protection for each ACM drive for its own specific load.
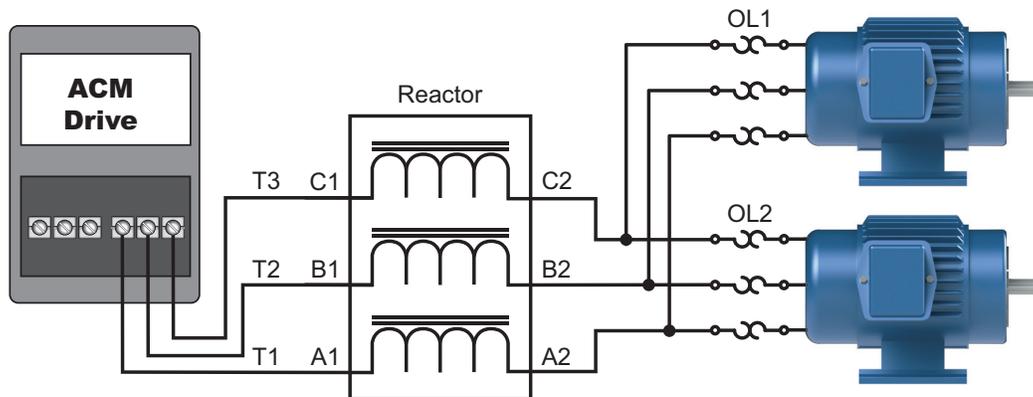

Please refer to Chapter 2 for detailed wiring information for the ACM drive.

MULTIPLE MOTORS

A single output (load) reactor can be used with multiple motors on the same ACM 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 ACM Drive control terminal; "EXTERNAL Fault" input.

Multiple motors only work with V/Hz mode.

Please refer to Chapter 2 for detailed wiring information for the ACM 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.

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.

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, 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.

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. Only ACM Frame C models (listed below) support dynamic braking with a built in dynamic braking function. See Chapter 2 for the drive dynamic braking wiring diagram. Compatible brake resistors offered at AutomationDirect are linked below.

⚠️ *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			Compatible Brake Resistors (150% Torque, 5% Duty Cycle)
			Minimum Resistor	Max Total Brake Current (A)	Peak Power (kW)	
120V	ACM-21P0	1	120.0	3	0.15	
230V	ACM-22P0	2	60	6	0.3	Click Here
	ACM-23P0	3	50	7	0.4	

CHOOSING AND INSTALLING A BRAKING RESISTOR

1) Select the resistance value, power and brake usage (ED %). Definition for Brake Usage ED%:

100%
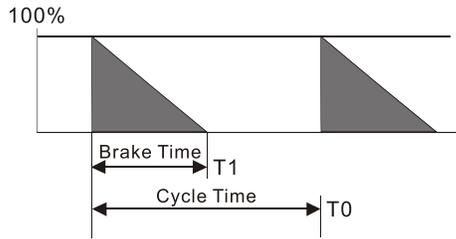
$$ED\% = T1 / T0 \times 100(\%)$$

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.

Brake Time → T1

Cycle Time → T0

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) The selection tables are for 5% duty cycle. If the AC motor drive requires frequent braking, increase the Watts by two to three times.

5) Thermal Overload Relay (TOR):
Thermal overload relay selection is based on its overload capacity. A standard braking capacity of the ACM 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.

Tripping Time (Seconds) vs. Multiple of current setting   In (x)
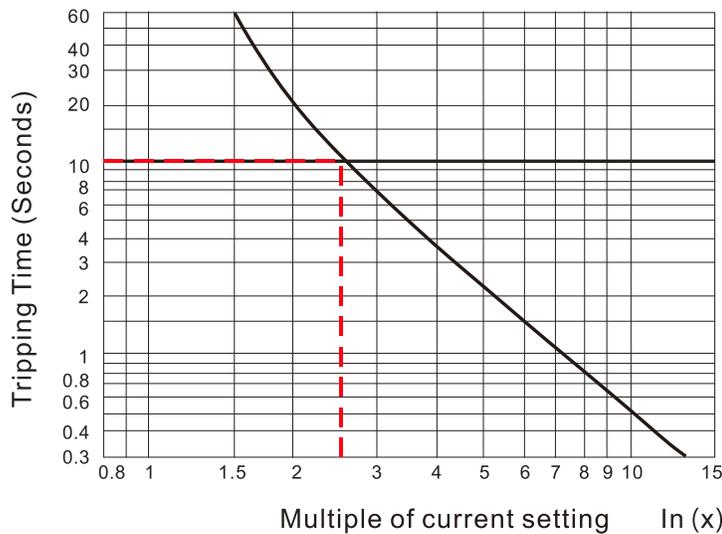
ACM-KPD

The Remote LED keypad provides access to the ACM series drive from outside of the panel while maintaining the same functionality as the built-in keypad.

ABOUT THE KEYPAD

A keypad is used to set drive parameters, monitor the drive's status, and operate the drive. The ACM-KPD accessory consists of a remote keypad and 3m cable.

KEY FUNCTIONS

The remote keypad supports the same functions as the built-in keypad. It can also be used to upload and download parameters to/from the same model drive using parameters dr.85 and dr.86.
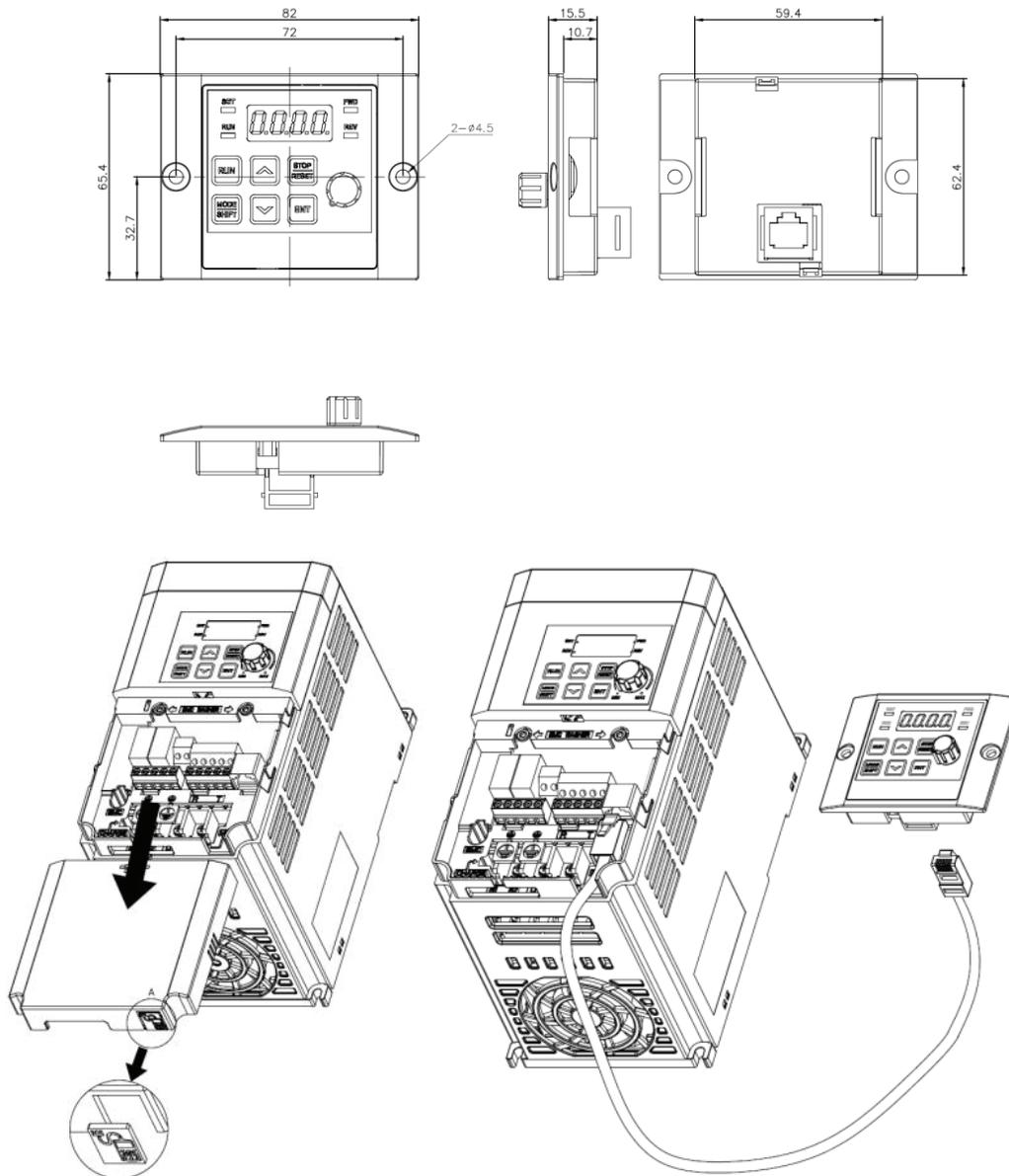
INSTALLATION

1) *Remove the remote keypad cable connection hole and then connect the cable of the remote keypad to the I/O RJ45 connector.*

2) *Connect the other end of the cable to the remote keypad.*

OPERATION

1) *When connecting the remote keypad, the keys and potentiometer on the drive keypad are ignored and replaced by the keys and potentiometer on the remote keypad.*
   - *Disconnect the remote keypad and 2 seconds later, the keys and potentiometer on the drive keypad will be functional again.*
   - *If the frequency reference source is set to V0 - Potentiometer, at the time of mounting and dismounting, the command frequency is instantly switched between the drive keypad potentiometer and the remote keypad potentiometer. Be careful that the motor does not rotate at an unintended frequency.*
   - *If communication between the drive and the remote keypad is not established, "E.vEr" is displayed on the remote keypad 7-Seg.*

2) *With the remote keypad connected to the drive, parameter settings saved in the drive can be copied to the remote keypad by setting the dr.85 to 1.*
   - *"R-UL" is displayed on the 7-Seg keypad during upload. When the save is complete, the text disappears and the main screen is displayed.*
   - *If there is an error such as communication error during upload, "FAIL" warning message will be displayed for 3 seconds and the operation to save the parameter on the remote keypad will fail.*

3) *With the remote keypad connected to the other drive of same series, parameter settings saved in the remote keypad can be copied to the drive by setting the dr.86 to 1.*
   - *"W-dL" is displayed on the 7-Seg keypad during saving. When the save is complete, the text disappears and the main screen is displayed.*
   - *If the model name of the drive is different or the version of the parameter code of the drive is different or if an error such as remote keypad communication error occurs, a warning message "FAIL" is displayed for 3 seconds and the parameter is set to drive will fail.*

⚠️ *CAUTION: ONLY UPLOAD AND DOWNLOAD PARAMETERS BETWEEN DRIVES OF THE SAME MODEL NUMBER.*

VFD Suite

VFD Suite is the configuration software for the Automation Direct Ironhorse AC family of variable frequency drives, featuring the ACM & 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.
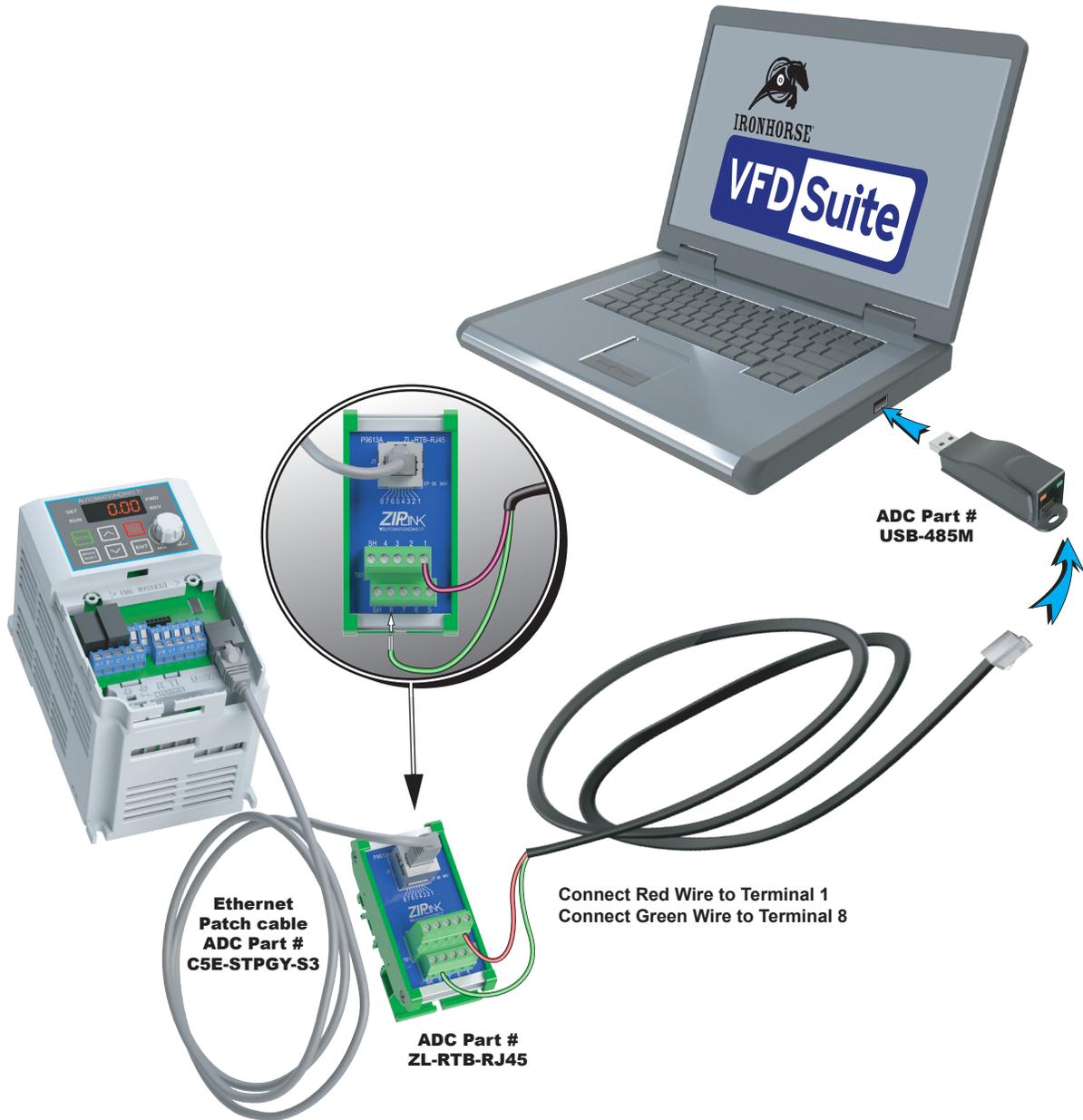
System Requirements

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

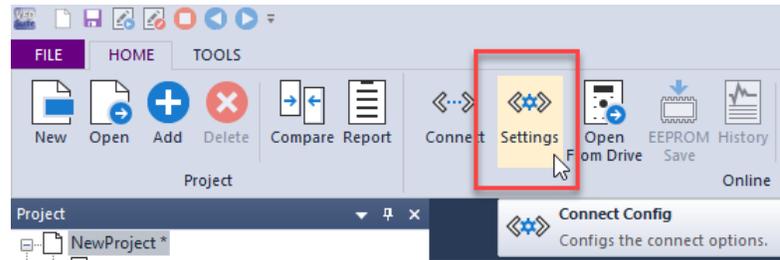## CONNECTING TO VFD SUITE

Set the network to connect with the drive.

Connecting to the ACM drive with VFD Suite can be accomplished in 2 ways:

1) Serial communication (Modbus-RTU) via Pin 1 (S+) and Pin 8 (S-) of the RJ45 port integrated in the drive, ZL-RTB-RJ45 adapter, and USB-485M adapter.
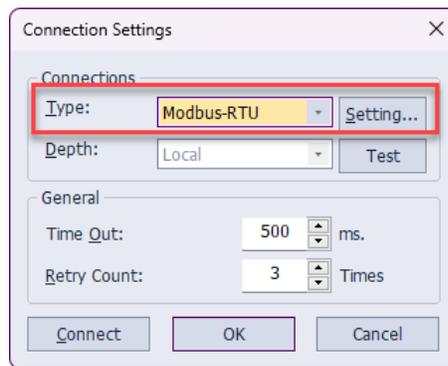

ADC Part #
USB-485M

Ethernet
Patch cable
ADC Part #
C5E-STPGY-S3

Connect Red Wire to Terminal 1
Connect Green Wire to Terminal 8

ADC Part #
ZL-RTB-RJ45

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.
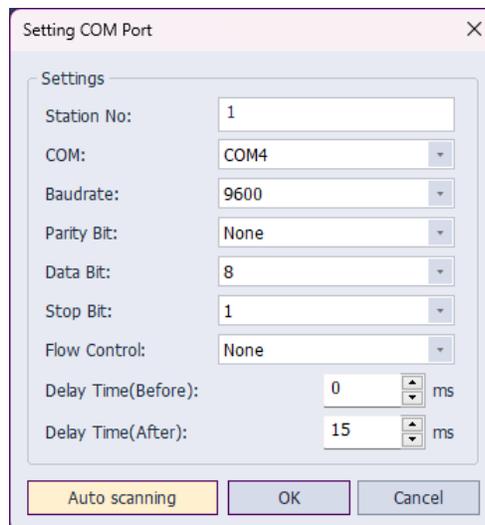
4) Enter the Time out value in milliseconds for setting the communication timeout value. Enter a value in to Retry Count to configure the number of communication attempts to try after communication failure.
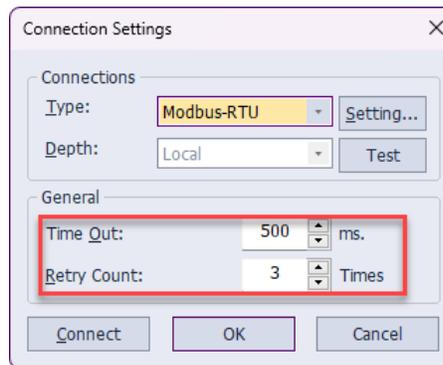
5) Press Connect to attempt a connection to the drive over Modbus-RTU. Or Press OK to save connection setting without connecting to the drive.
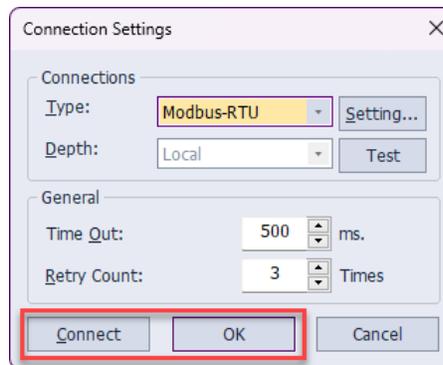
6) VFD Suite will display the below message when successfully connecting to the drive.