IronHorse ACG Series AC Drive User Manual

IH_ACG_UMW

Warnings and Trademarks

~ WARNING ~

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Warnings

Warning: Read this manual thoroughly before using ACG 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 ACG 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. This 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*
- *SAnalog Output: AO*
- *Digital Output: A1/B1/C1 (Relay1), A2/C2 (Relay2)*
- *Communications: S+/S-*
- *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 ACG 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 ACG AC drive with GFCI (Ground Fault Circuit Interrupt).

ACG Series Drives Manual Revision History

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

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Issue: ***First Edition***

Issue Date: ***07/02/2024***

Publication History		
Issue	***Date***	***Description of Changes***
First Edition	07/02/2024	Original Issue

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Chapter 1: Getting Started

Chapter 1

Table of Contents

User Manual Overview

Overview of this Publication

This user manual describes the installation, configuration, accessories, and methods of operation of the *IronHorse* ACG 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* ACG 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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Special Symbols

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

WARNING: When you see the "exclamation mark" icon in the left-hand margin, the paragraph to its immediate right will be a warning. This information could prevent injury, loss of property, or even death (in extreme cases).

Purpose of AC Drives

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

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

Selecting the Proper Drive Rating

Determine Motor Full-Load Amperage (FLA)

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

Determine Motor Overload Requirements

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

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

Determine Application Type; Heavy load (HD) or Normal load (ND)

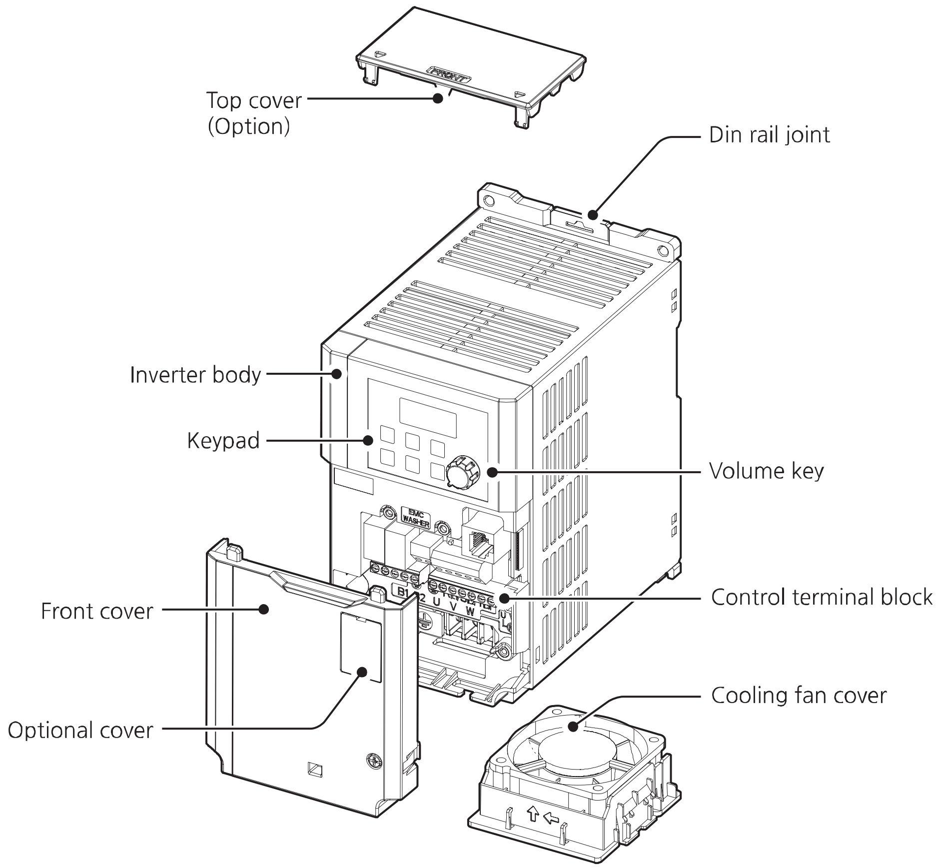
The load (also called torque) requirement has a direct effect on which drive to select. Normal load (ND) (also called Variable Torque (VT)) applications are generally easier to start; typically fans and pumps. Most other applications outside fans and pumps fall into the Heavy load (HD) (also called Constant 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.

ACG drives are specified by Heavy load (HD) rating. Normal load (ND) ratings are also listed on the nameplate and specification tables.

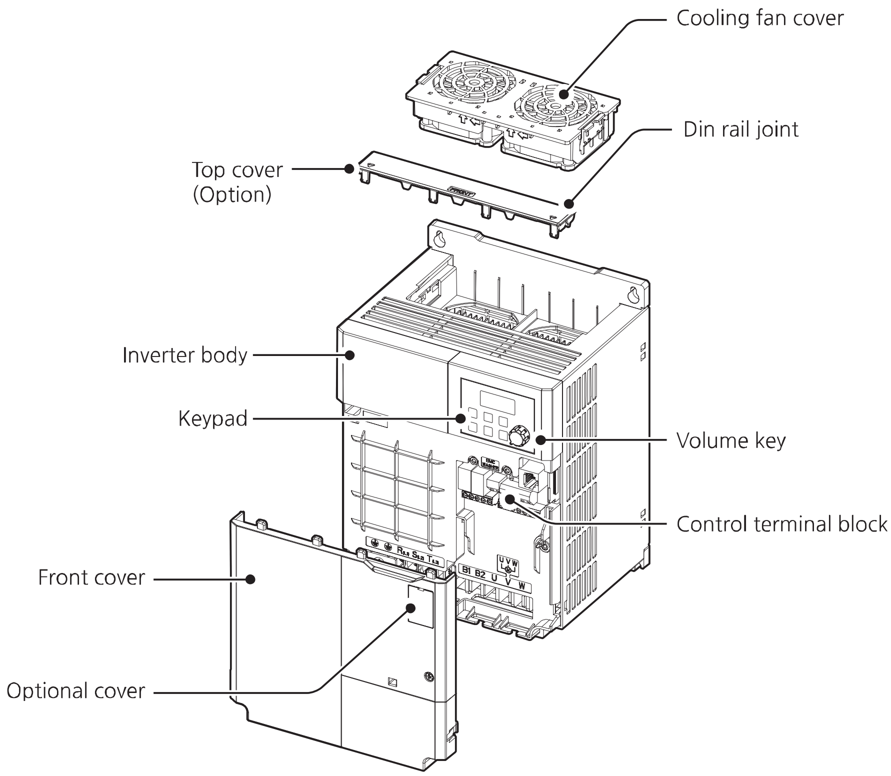
Parts Locater

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

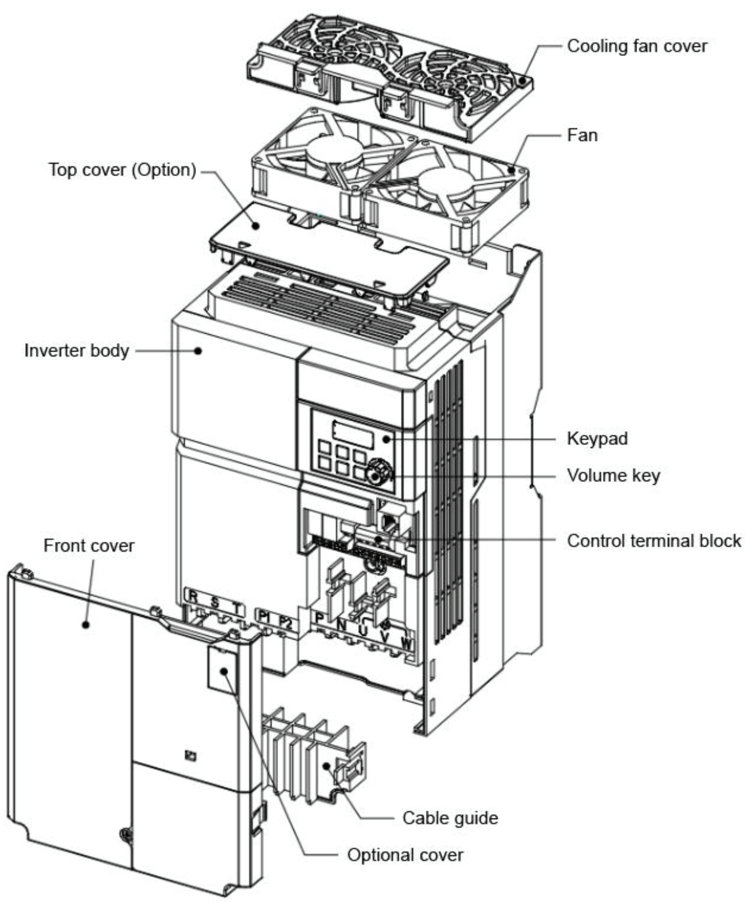
0.5–5 hp Drives:



7–10 hp Drives:



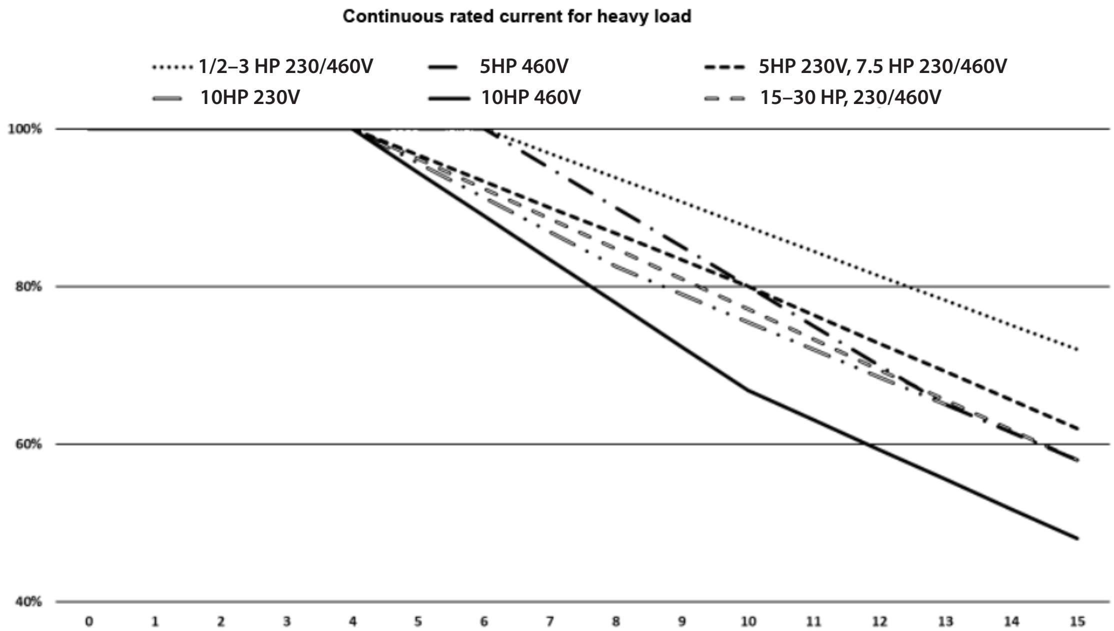
15–30 hp Drives:



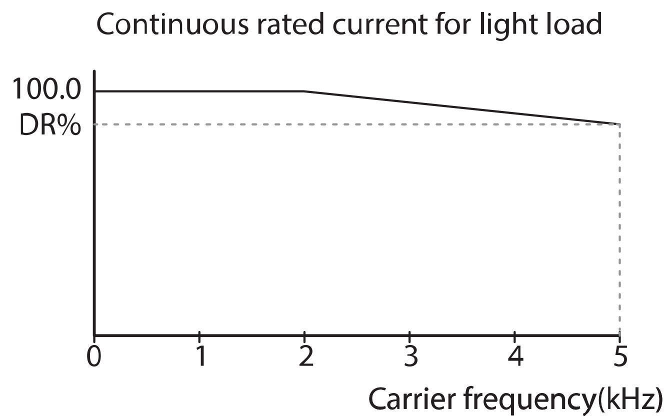
Continuous Rated Current Derating

Derating by Carrier Frequency

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



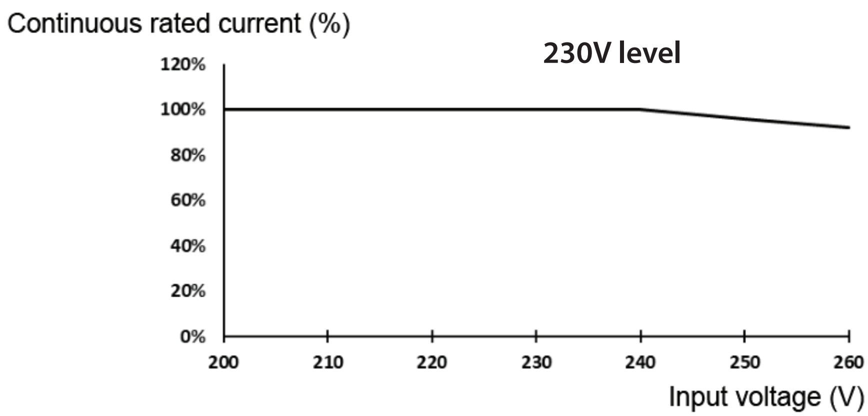
Derating by Carrier Frequency										
Carrier Frequency (kHz)	***Constant Rated Current (%)***									
	0.5–3.0 hp		***5.0 hp***		***7.5 hp***		***10 hp***		***15–30 hp***	
	230V	***460V***	***230V***	***460V***	***230V***	***460V***	***230V***	***460V***	***230V***	***460V***
1–4	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
6	100%	100%	93%	100%	93%	93%	91%	89%	92%	92%
9	91%	91%	83%	85%	83%	83%	79%	72%	81%	81%
12	81%	81%	73%	70%	73%	73%	69%	59%	69%	69%
15	72%	72%	62%	58%	62%	62%	58%	48%	58%	58%

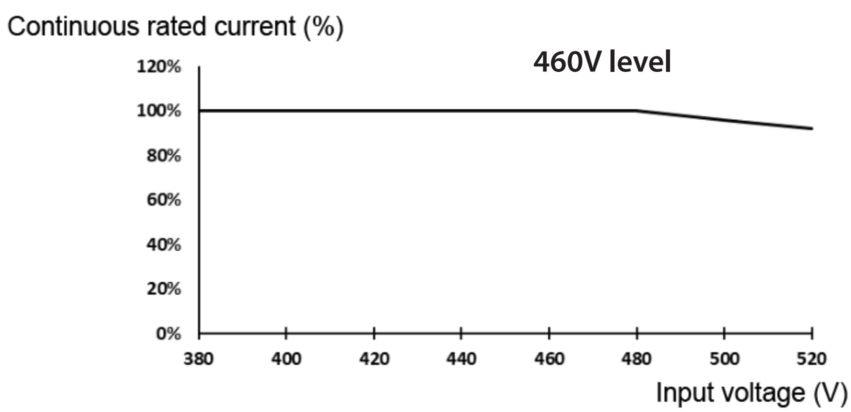


Capacity (hp)	*230V DR (%)*	*460V DR (%)*
0.5	88	74
1.0	88	86
2.0	88	84
3.0	94	85
5.0	96	93
7.5	85	81
10	85	77
15–30	80	80

Derating by Input Voltage

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

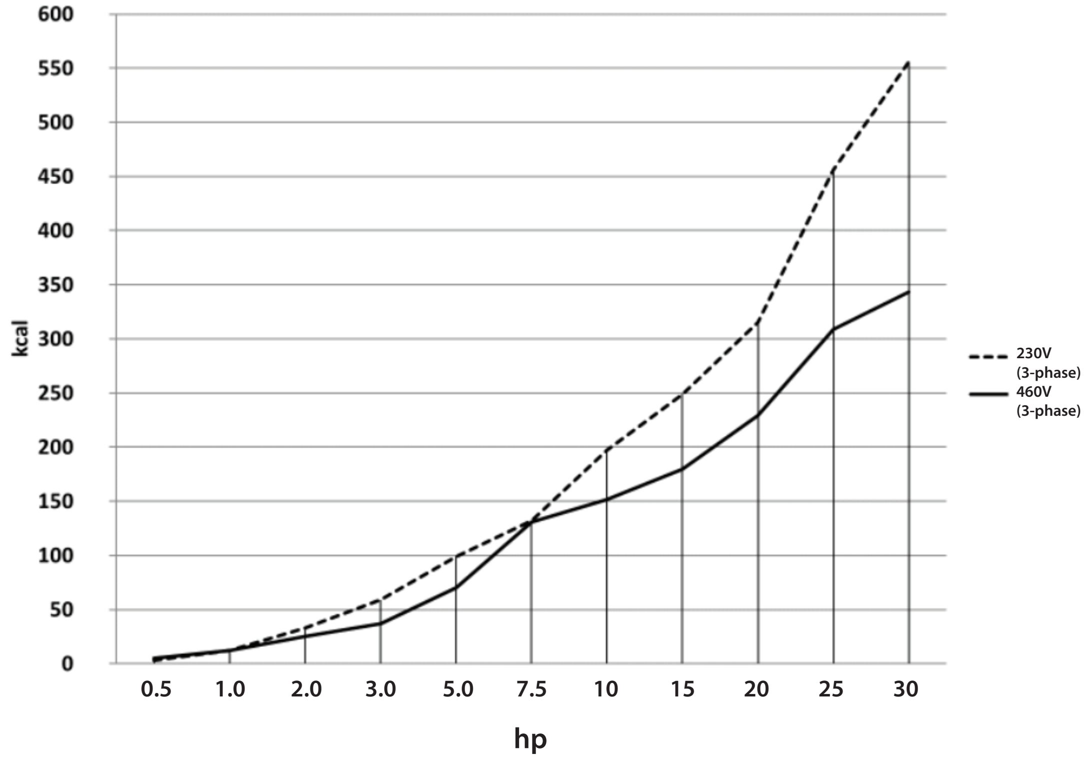




Voltage Class	*Input Voltage (V)*	*Derating*
230V	200	100%
	210	100%
	220	100%
	230	100%
	240	100%
	250	96%
	260	92%
	264	91%
460V	380	100%
	400	100%
	420	100%
	440	100%
	460	100%
	480	100%
	490	98%
	500	96%
	510	94%
	520	92%
	528	91%

Heat Emission

The following graph shows the drive's heat emission characteristics (by product capacity). Heat emission data is based on operations with default carrier frequency settings, under normal operating conditions. For detailed information on carrier frequency see "Operational Noise Settings (carrier frequency settings)" on page 4–118.



IronHorse ACG 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.*

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 ACG 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
Operating Ambient Temperature*	Heavy load (HD): -10 to 50°C (14 to 122°F) Normal load (ND): -10 to 40°C (14 to 104°F)
Storage Temperature	-20° to 65°C (-4 to 149°F)
Relative Humidity	Less than 95% (to avoid condensation)
Air Pressure	70 to 106 kPa
Pollution Level	Pollution level 3 environment: Prevent contact with corrosive gases, flammable gases, oil stains, dust, and other pollutants.
Altitude	No higher than 3280ft (1,000m). From 1000 to 4000m, the rated input voltage and rated output current of the drive must be derated by 1% for every 100m.
Vibration	Less than 9.8 m/sec^2 (1G)
Installation Orientation	Max allowed offset angle = 0 degrees. (Vertical orientation only). Do not install the drive on the floor or mount it sideways against a wall. The drive MUST be installed vertically, on a wall or inside a panel, with its rear flat on the mounting surface.
** The ambient temperature is the temperature measured at a point 2" (5 cm) from the surface of the drive.*	

IronHorse ACG Series AC Drive Specifications

230V Class – (Model Specifications)

ACG 230V Class Specifications; Frame Sizes A–C								
Model Name: ACG-xxxx				20P5	21P0	22P0	23P0	25P0
Frame Size				A	A	B	B	C
Applied Motor	Heavy load (HD)		hp	0.5	1.0	2.0	3.0	5.0
			kW	0.4	0.75	1.5	2.2	4.0
	Normal load (ND)		hp	1.0	2.0	3.0	5.0	7.5
			kW	0.75	1.5	2.2	4.0	5.5
Output Rating	Rated Capacity	HD	kVA	1.0	1.9	3.0	4.2	6.5
		ND	kVA	1.2	2.3	3.7	4.6	6.9
	Rated Current–3ph input	HD	A	2.5	5.0	8.0	11.0	17.0
		ND	A	3.1	6.0	9.6	12.0	18.0
	Rated Current –1ph input (60Hz)	HD	A	1.5	2.8	4.6	6.1	9.3
		ND	A	2.0	3.6	5.9	6.7	9.8
	Rated Current –1ph input (50Hz)	HD	A	1.5	2.7	4.5	5.9	9.1
		ND	A	1.9	3.5	5.7	6.5	9.5
	Output Frequency		Hz	0-400 Hz (IM Sensorless: 0-120 Hz)				
	Output Voltage		V	3-phase 200-240 VAC				
Input Rating	Input Voltage–3ph input		V	3-phase 200-240 VAC (-15% to +10%)				
	Input Voltage–1ph input		V	1-phase 240 VAC (-5% to +10%)				
	Input Frequency–3ph input		Hz	50-60 Hz (±5%)				
	Input Frequency–1ph input		Hz	60Hz (±5%)				
	Rated Current –1 or 3ph input	HD	A	2.2	4.9	8.4	11.8	18.5
		ND	A	3.0	6.3	10.3	13.1	19.4
IE2 Efficiency - Relative Power Loss (%)				1.5	1.4	1.6	1.7	2.0
Weight (lb [kg])				2.29 [1.04]	2.34 [1.06]	3.0 [1.36]	3.09 [1.4]	4.17 [1.89]
Cooling Method				Forced Fan–Internal				

- *The standard motor capacity is based on a standard 4-pole motor.*
- *The standard used for 230V drives is based on a 220V supply voltage.*
- *The rated output current is limited based on the carrier frequency set at Cn.04.*
- *The output voltage becomes 20~40% lower during no-load operations to protect the drive from the impact of the motor closing and opening (0.5~5HP models only).*
- *For Single Phase Power input, an input line reactor is required. See "Appendix A: Accessories" for the specific line reactor compatible with each drive model.*

230V Class – (Model Specifications)

ACG 230V Class Specifications; Frame Sizes D–E							
Model Name: ACG-xxxx				**27P5**	**2010**	**2015**	**2020**
Frame Size				D	D	E	E
Applied Motor	***Heavy load (HD)***		***hp***	7.5	10	15	20
			kW	5.5	7.5	11	15
	Normal load (ND)		***hp***	10	15	20	25
			kW	7.5	11	15	18.5
Output Rating	***Rated Capacity***	***HD***	***kVA***	9.1	12.2	17.9	22.9
		ND	***kVA***	11.4	15.2	21.3	26.7
	Rated Current–3ph input	***HD***	***A***	24.0	32.0	47	60
		ND	***A***	30.0	40.0	56	70
	Rated Current –1ph input (60Hz)	***HD***	***A***	12.8	17.4	26.8	34
		ND	***A***	16.3	22.0	31	38
	Rated Current –1ph input (50Hz)	***HD***	***A***	12.4	16.9	26	33.1
		ND	***A***	15.8	21.3	30	36.9
	Output Frequency		***Hz***	0-400 Hz (IM Sensorless: 0-120 Hz)			
	Output Voltage		***V***	3-phase 200-240 VAC			
Input Rating	***Input Voltage–3ph input***		***V***	3-phase 200-240 VAC (-15% to +10%)			
	Input Voltage–1ph input		***V***	1-phase 240 VAC (-5% to +10%)			
	Input Frequency–3ph input		***Hz***	50-60 Hz (±5%)			
	Input Frequency–1ph input		***Hz***	60Hz (±5%)			
	Rated Current –1 or 3ph input	***HD***	***A***	25.8	34.9	53.2	68.4
		ND	***A***	32.7	44.2	63.8	79.8
IE2 Efficiency - Relative Power Loss (%)				1.9	1.9	1.4	1.4
Weight (lb [kg])				6.79 [3.08]	7.08 [3.21]	10.7 [4.84]	16.8 [7.6]
Cooling Method				Forced Fan–Internal			

- *The standard motor capacity is based on a standard 4-pole motor.*
- *The standard used for 230V drives is based on a 220V supply voltage.*
- *The rated output current is limited based on the carrier frequency set at Cn.04.*
- *The output voltage becomes 20~40% lower during no-load operations to protect the drive from the impact of the motor closing and opening (0.5~5HP models only).*
- *For Single Phase Power input, an input line reactor is required. See "Appendix A: Accessories" for the specific line reactor compatible with each drive model.*
- *DC Link terminals (P1/P2) are only available on 15hp and larger models.*

460V Class – (Model Specifications)

<table>
<tr><th colspan="9">ACG 460V Class Specifications; Frame Sizes A–C</th></tr>
<tr><th colspan="4">Model Name: ACG-xxxx</th><th>40P5</th><th>41P0</th><th>42P0</th><th>43P0</th><th>45P0</th></tr>
<tr><td colspan="4">Frame Size</td><td>A</td><td>A</td><td>B</td><td>B</td><td>C</td></tr>
<tr><td rowspan="4">Applied Motor</td><td colspan="2" rowspan="2">Heavy load (HD)</td><td>hp</td><td>0.5</td><td>1.0</td><td>2.0</td><td>3.0</td><td>5.0</td></tr>
<tr><td>kW</td><td>0.4</td><td>0.75</td><td>1.5</td><td>2.2</td><td>4.0</td></tr>
<tr><td colspan="2" rowspan="2">Normal load (ND)</td><td>hp</td><td>1.0</td><td>2.0</td><td>3.0</td><td>5.0</td><td>7.5</td></tr>
<tr><td>kW</td><td>0.75</td><td>1.5</td><td>2.2</td><td>4.0</td><td>5.5</td></tr>
<tr><td rowspan="10">Output Rating</td><td rowspan="2">Rated Capacity</td><td>HD</td><td>kVA</td><td>1.0</td><td>1.9</td><td>3.0</td><td>4.2</td><td>6.9</td></tr>
<tr><td>ND</td><td>kVA</td><td>1.5</td><td>2.4</td><td>3.9</td><td>5.3</td><td>7.6</td></tr>
<tr><td rowspan="2">Rated Current–3ph input</td><td>HD</td><td>A</td><td>1.3</td><td>2.5</td><td>4.0</td><td>5.5</td><td>9.0</td></tr>
<tr><td>ND</td><td>A</td><td>2.0</td><td>3.1</td><td>5.1</td><td>6.9</td><td>10.0</td></tr>
<tr><td rowspan="2">Rated Current –1ph input (60Hz)</td><td>HD</td><td>A</td><td>0.7</td><td>1.4</td><td>2.1</td><td>2.8</td><td>4.9</td></tr>
<tr><td>ND</td><td>A</td><td>1.3</td><td>1.9</td><td>2.8</td><td>3.6</td><td>5.4</td></tr>
<tr><td rowspan="2">Rated Current –1ph input (50Hz)</td><td>HD</td><td>A</td><td>0.7</td><td>1.4</td><td>2.0</td><td>2.7</td><td>4.8</td></tr>
<tr><td>ND</td><td>A</td><td>1.3</td><td>1.8</td><td>2.7</td><td>3.5</td><td>5.2</td></tr>
<tr><td colspan="2">Output Frequency</td><td>Hz</td><td colspan="5">0-400 Hz (IM Sensorless: 0-120 Hz)</td></tr>
<tr><td colspan="2">Output Voltage</td><td>V</td><td colspan="5">3-phase 380-480 VAC</td></tr>
<tr><td rowspan="6">Input Rating</td><td colspan="2">Input Voltage–3ph input</td><td>V</td><td colspan="5">380-480 VAC (-15% to +10%)</td></tr>
<tr><td colspan="2">Input Voltage–1ph input</td><td>V</td><td colspan="5">480 VAC (-5% to +10%)</td></tr>
<tr><td colspan="2">Input Frequency–3ph input</td><td>Hz</td><td colspan="5">50-60 Hz (±5%)</td></tr>
<tr><td colspan="2">Input Frequency–1ph input</td><td>Hz</td><td colspan="5">60Hz (±5%)</td></tr>
<tr><td rowspan="2">Rated Current –1 or 3ph input</td><td>HD</td><td>A</td><td>1.1</td><td>2.4</td><td>4.2</td><td>5.9</td><td>9.8</td></tr>
<tr><td>ND</td><td>A</td><td>2.0</td><td>3.3</td><td>5.5</td><td>7.5</td><td>10.8</td></tr>
<tr><td colspan="4">IE2 Efficiency - Relative Power Loss (%)</td><td>1.6</td><td>1.3</td><td>1.3</td><td>1.3</td><td>1.4</td></tr>
<tr><td colspan="4">Weight (lb [kg])</td><td>2.25 [1.02]</td><td>2.34 [1.06]</td><td>3.09 [1.4]</td><td>3.13 [1.42]</td><td>4.23 [1.92]</td></tr>
<tr><td colspan="4">Cooling Method</td><td colspan="5">Forced Fan–Internal</td></tr>
</table>

- *The standard motor capacity is based on a standard 4-pole motor.*
- *The standard used for 460V drives is based on a 440V supply voltage.*
- *The rated output current is limited based on the carrier frequency set at Cn.04.*
- *The output voltage becomes 20~40% lower during no-load operations to protect the drive from the impact of the motor closing and opening (0.5~5HP models only).*
- *For Single Phase Power input, an input line reactor is required. See "Appendix A: Accessories" for the specific line reactor compatible with each drive model.*

460V Class – (Model Specifications)

ACG 460V Class Specifications; Frame Sizes D–F									
Model Name: ACG-xxxx				47P5	4010	4015	4020	4025	4030
Frame Size				D	D	E	E	F	F
Applied Motor	Heavy load (HD)		hp	7.5	10	15	20	25	30
			kW	5.5	7.5	11	15	18.5	22
	Normal load (ND)		hp	10	15	20	25	30	40
			kW	7.5	11	15	18.5	22	30
Output Rating	Rated Capacity	HD	kVA	9.1	12.2	18.3	23.6	29.7	34.3
		ND	kVA	12.2	17.5	23.6	29.0	34.3	46.5
	Rated Current–3ph input	HD	A	12.0	16.0	24	31	39	45
		ND	A	16.0	23.0	31	38	45	61
	Rated Current –1ph input (60Hz)	HD	A	6.4	8.7	15	18	23	27
		ND	A	8.7	12.6	18	23	27	35
	Rated Current –1ph input (50Hz)	HD	A	6.2	8.5	14.6	17.4	22.3	26.2
		ND	A	8.4	12.2	17.4	22.2	26.1	33.8
	Output Frequency		Hz	0-400 Hz (IM Sensorless: 0-120 Hz)					
	Output Voltage		V	3-phase 380-480 VAC					
Input Rating	Input Voltage–3ph input		V	380-480 VAC (-15% to +10%)					
	Input Voltage–1ph input		V	480 VAC (-5% to +10%)					
	Input Frequency–3ph input		Hz	50-60 Hz (±5%)					
	Input Frequency–1ph input		Hz	60Hz (±5%)					
	Rated Current –1 or 3ph input	HD	A	12.9	17.5	27.2	35.3	44.5	51.9
		ND	A	17.5	25.4	35.3	43.3	51.9	70.8
IE2 Efficiency - Relative Power Loss (%)				1.3	1.4	0.9	1.0	0.9	0.9
Weight (lb [kg])				6.79 [3.08]	6.88 [3.12]	10.8 [4.89]	10.8 [4.91]	16.8 [7.63]	16.9 [7.65]
Cooling Method				Forced Fan–Internal					

- *The standard motor capacity is based on a standard 4-pole motor.*
- *The standard used for 460V drives is based on a 440V supply voltage.*
- *The rated output current is limited based on the carrier frequency set at Cn.04.*
- *The output voltage becomes 20~40% lower during no-load operations to protect the drive from the impact of the motor closing and opening (0.5~5HP models only).*
- *For Single Phase Power input, an input line reactor is required. See "Appendix A: Accessories" for the specific line reactor compatible with each drive model.*
- *DC Link terminals (P1/P2) are only available on 15hp and larger models.*

Specifications Applicable to All ACG Series Models

<table>
<tr><th colspan="5">IronHorse ACG Series General Specifications (All Models)</th></tr>
<tr><td rowspan="6">Control Characteristics</td><td colspan="2">Control Method</td><td colspan="2">V/F control, Slip Compensation, Sensorless Vector</td></tr>
<tr><td colspan="2">Frequency Settings Power Resolution</td><td colspan="2">Digital command: 0.01 Hz
Analog command: 0.06 Hz (60Hz standard)</td></tr>
<tr><td colspan="2">Frequency Accuracy</td><td colspan="2">1% of maximum output frequency</td></tr>
<tr><td colspan="2">V/F Pattern</td><td colspan="2">Linear, square reduction, user V/F</td></tr>
<tr><td colspan="2">Overload Capacity</td><td colspan="2">Heavy load (HD) rated current: 150% for 1 minute
Normal load (ND) rate current: 120% for 1 minute</td></tr>
<tr><td colspan="2">Torque Boost</td><td colspan="2">Manual torque boost, automatic torque boost</td></tr>
<tr><td rowspan="11">Operation Characteristics</td><td colspan="2">Operation Type</td><td colspan="2">Select key pad, terminal strip, or communication operation</td></tr>
<tr><td colspan="2">Frequency Setting Signal</td><td colspan="2">Analog type: -10~10 V, 0~10 V, 4~20 mA, or Potentiometer
Keypad: Up/Down arrows or integrated dial</td></tr>
<tr><td colspan="2">Main Functions</td><td colspan="2">• PID control
• 3-wire operation
• Frequency limit
• Second motor function
• Anti-forward and reverse direction rotation
• Commercial transition
• Speed search
• Power braking
• Up-down operation
• DC braking
• Frequency jump
• Slip compensation
• Automatic restart
• Automatic tuning
• Energy buffering
• Flux braking
• Fire mode</td></tr>
<tr><td rowspan="3">Input</td><td rowspan="2">Multi-function Digital Inputs (5) P1-P5</td><td colspan="2">Select PNP (Source) or NPN (Sink) mode. Functions can be set according to In.65–In.69 codes and parameter settings.</td></tr>
<tr><td colspan="2">• 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</td></tr>
<tr><td>Analog Input (2) VR, V1, I2</td><td colspan="2">Set various drive control parameters to follow the analog input.
• Voltage: -10 to 10V, 0–10V
• Current: 4–20 mA
• Potentiometer: 1–5kΩ</td></tr>
<tr><td rowspan="2">Output</td><td>Multi-function relay outputs (2) A, B, C</td><td>Functions can be set according to parameters OU.31 and OU.33</td><td>Less than (N.O., N.C.) 250VAC, 1A
Less than 30VDC 1A</td></tr>
<tr><td>Analog Output (1) AO</td><td colspan="2">0–12 VDC: Select frequency, output current, output voltage, DC terminal voltage and others</td></tr>
<tr><td rowspan="2">Communication</td><td>Serial (S+, S-)</td><td colspan="2">RS-485 Modbus serial network or software</td></tr>
<tr><td>RJ45 Connector</td><td colspan="2">Comunication to software, remote keypad, or communication option card</td></tr>
</table>

IronHorse ACG Series General Specifications (All Models)		
Protection Function Characteristics	***Trip***	• Overcurrent trip • External signal trip • ARM short circuit current trip • Overheat trip • In phase open trip • Ground trip • Motor overheat trip • I/O board link trip • No motor trip • Parameter writing trip • Emergency stop trip • Command loss trip • External memory error • CPU watchdog trip • Motor light load trip • Overvoltage trip • Temperature sensor trip • Drive overheat • Option trip • Out phase open trip • Drive overload trip • Fan trip • Pre-PID operation failure • External break trip • Low voltage trip during operation • Low voltage trip • Analog input error • Motor overload trip • Over-torque trip • Under-torque trip
	Alarm	Command loss trip alarm, overload alarm, light load alarm, drive overload alarm, fan operation alarm, resistance braking rate alarm, number of corrections on rotor tuning error, drive pre-overheat alarm, over-torque alarm, under-torque alarm
	Instantaneous Blackout	• Heavy load less than 15ms (Normal load less than 8ms): must be within the rated input voltage and rated output range • Heavy load more than 15ms (Normal load more than 8ms): auto-restart operation
Accessory	***Communication Card Option***	EtherNet/IP and Modbus TCP (ACG-ET2)
Agency Approvals		UL, CE

Receiving and Inspection

Drive Package Contents

After receiving the ACG 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.

In the case of missing inserts, unit damage, or mis-matching nameplates, please contact AutomationDirect technical support.

The ACG 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

ACG - 2 0P5

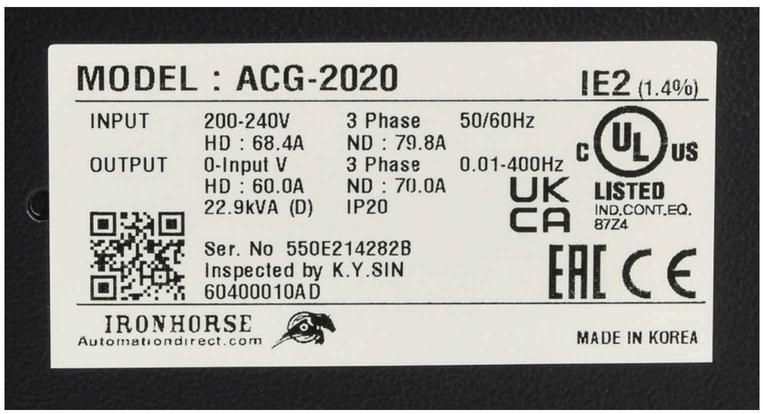
Applicable Motor Capacity (HD) with 3-Phase Input

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

Input Voltage
2: 230 VAC
4: 460 VAC

Series Name

Nameplate Information



Chapter 2

2

Chapter 2: Installation and Wiring

Table of Contents

Drive Models by Frame Size

ACG Series Drive Models by Frame Size	
Frame	**Drive**
A	ACG-20P5, ACG-21P0, ACG-40P5, ACG-41P0
B	ACG-22P0, ACG-23P0, ACG-42P0, ACG-43P0
C	ACG-25P0, ACG-45P0
D	ACG-27P5, ACG-2010, ACG-47P5, ACG-4010
E	ACG-2015, ACG-2020, ACG-4015, ACG-4020
F	ACG-4025, ACG-4030

Installation

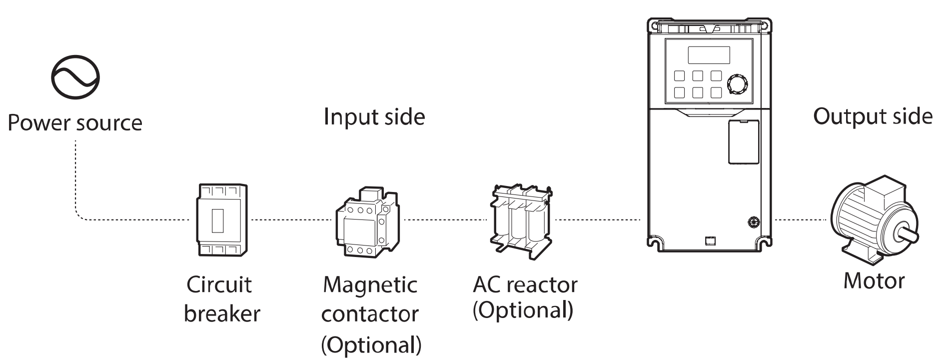
Install the AC drive in a properly sized panel. Provide proper spacing to allow the dissipation of heat produced by the drive and any other installed electrical and electronic equipment. Ventilation or air conditioning may also be required, depending upon the application.

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.



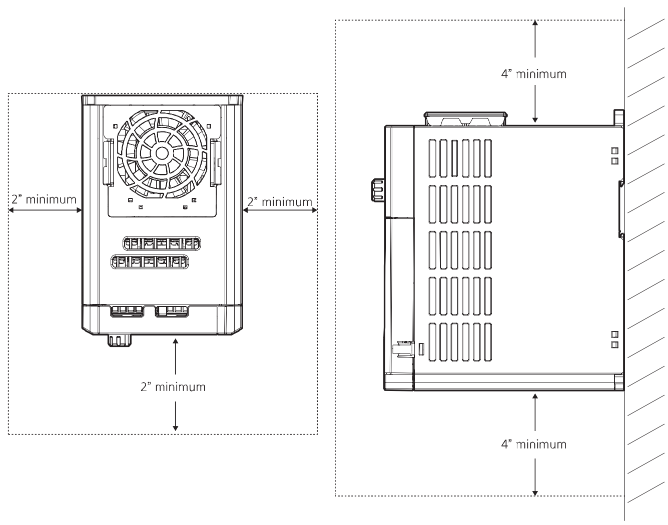
Installation Considerations

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

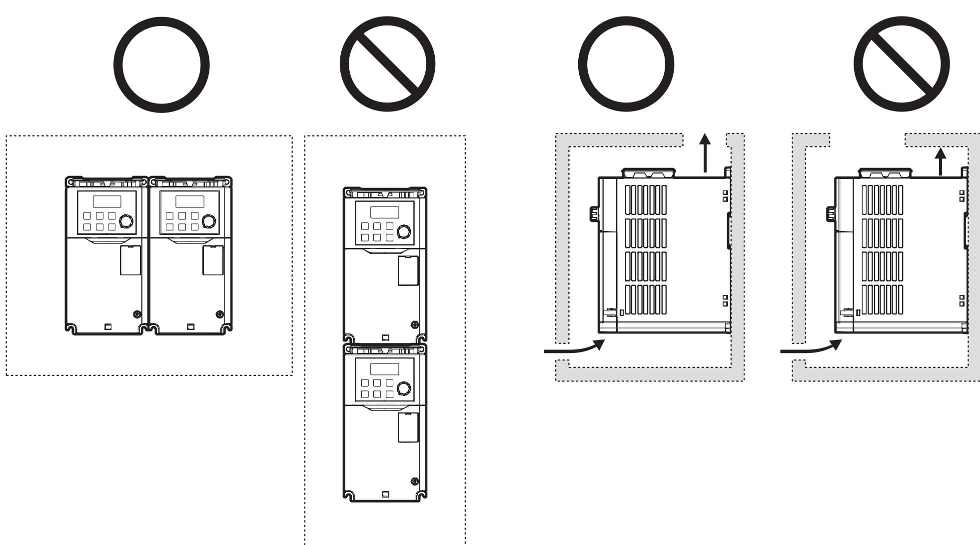
When selecting an installation location, consider the following points:

- *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.*

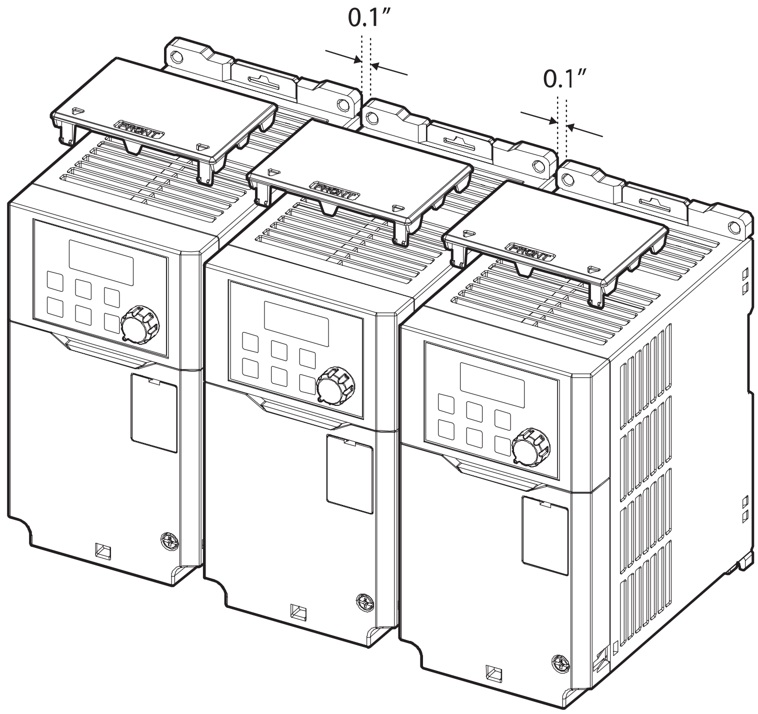


Bottom View *Side View*

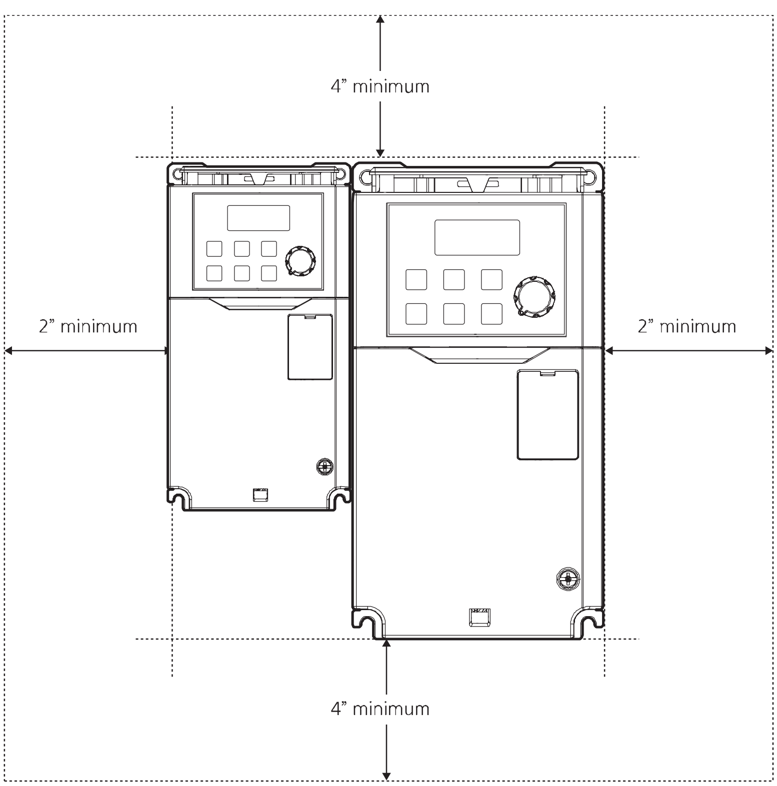
Ensure sufficient air circulation is provided around the drive when it is installed. If the drive is to be installed inside a panel, enclosure, or cabinet rack, carefully consider the position of the drive's cooling fan and the ventilation louver. Cooling fans must be positioned to efficiently transfer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



If you are installing multiple drives in one location, arrange them side-by-side and remove the top covers. The top covers MUST be removed for side-by-side installations. Use a flat-head screwdriver to remove the top covers.

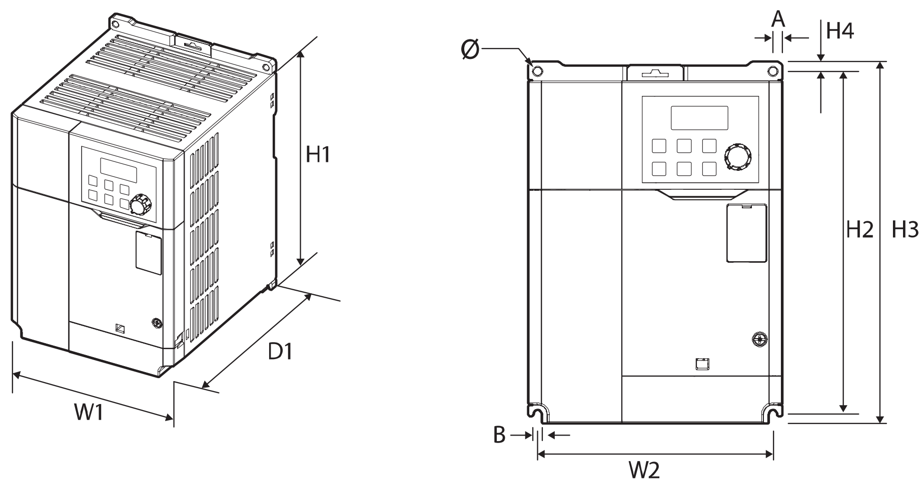


If you are installing multiple drives of different ratings, provide sufficient clearance to meet the clearance specifications of the larger drive.



Dimensions

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



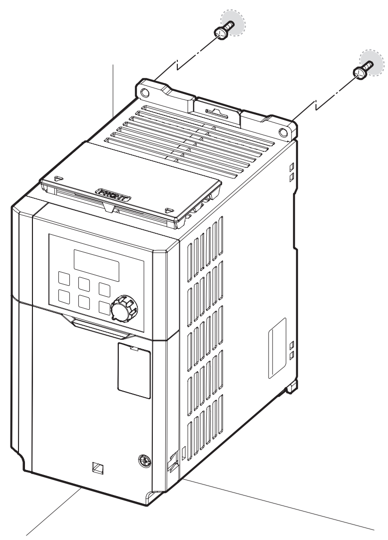
Dimensions												
Frame	**Part no**	**W1**	**W2**	**H1**	**H2**	**H3**	**H4**	**D1**	**A**	**B**	**Ø**	**Drawings**
A	ACG-20P5	86.2 (3.39)	76.2 (3.00)	154 (6.06)	154 (6.06)	164 (6.46)	5 (0.20)	131.5 (5.18)	5 (0.2)	4.5 (0.18)	4.5 (0.18)	PDF
	ACG-21P0											PDF
	ACG-40P5											PDF
	ACG-41P0											PDF
B	ACG-22P0	101 (3.98)	90 (3.54)	167 (6.57)	167 (6.57)	177 (6.97)	5 (0.2)	150.5 (5.93)	5.5 (0.22)	4.5 (0.18)	4.5 (0.18)	PDF
	ACG-23P0											PDF
	ACG-42P0											PDF
	ACG-43P0											PDF
C	ACG-25P0	135 (5.31)	125 (4.92)	183 (7.2)	183 (7.2)	193 (7.6)	5 (0.2)	150.5 (5.93)	5 (0.2)	4.5 (0.18)	4.5 (0.18)	PDF
	ACG-45P0											PDF
D	ACG-27P5	180 (7.09)	Top: 162 (6.38) Bottom: 170 (6.70)	220 (8.66)	229.5 (9.04)	240 (9.45)	5.5 (0.22)	144 (5.67)	Top: 9 (0.35) Bottom: 5 (0.20)	4.5 (0.18)	Φ-1: 4.5 (0.18) Φ-2: 9 (0.35)	PDF
	ACG-2010											PDF
	ACG-47P5											PDF
	ACG-4010											PDF
E	ACG-2015	180 (7.09)	157 (6.18)	290 (11.4)	273.7 (10.8)	290 (11.4)	11.3 (0.44)	173 (6.81)	8.5 (0.33)	4.5 (0.18)	Φ-1 : 4.5(0.18) Φ-2 : 8.5(0.33)	PDF
	ACG-2020											PDF
	ACG-4015											PDF
	ACG-4020											PDF
F	ACG-4025	220 (8.66)	193.8 (7.63)	345 (13.6)	331 (13)	345 (13.6)	8 (0.31)	187 (7.36)	10.1 (0.4)	5.5 (0.22)	Φ-1: 5.5 (0.22) Φ-2: 1 (0.43)	PDF
	ACG-4030											PDF
Units: mm (in)												

Mounting the Drive

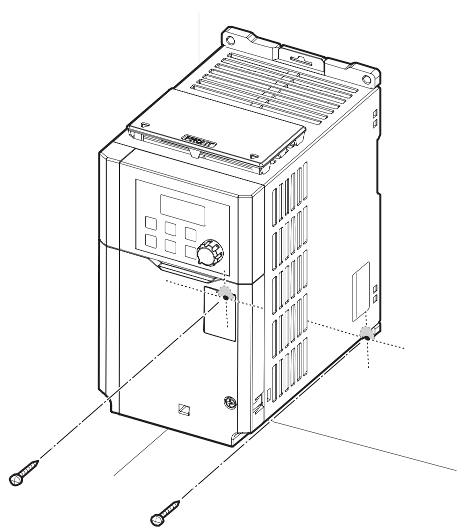
Mount the drive on a wall or inside a panel following the procedures below. Before installation, ensure that there is sufficient space to meet the clearance specifications, and that there are no obstacles impeding the cooling fan's air flow. The drive must be installed on a wall that can support the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

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

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

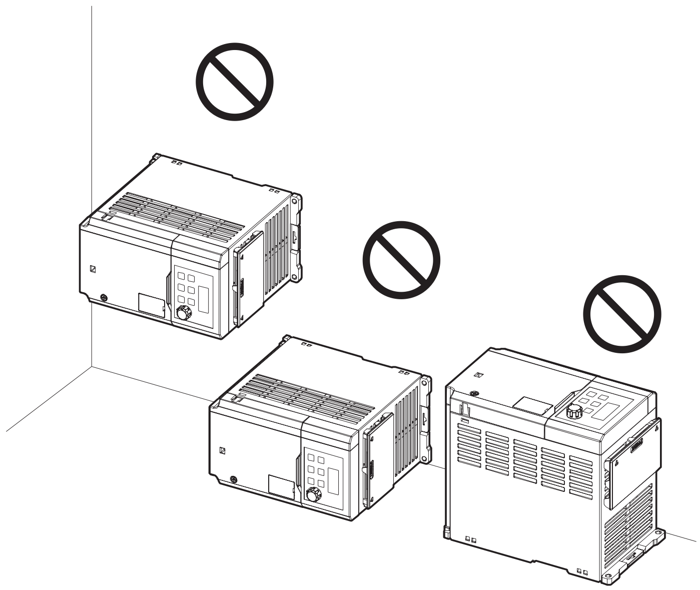


- *Mount the drive on the wall or inside a panel using the two lower bolts, and then fully tighten the mounting bolts. Ensure that the drive is placed flat on the mounting surface, and that the installation surface can securely support the weight of the drive.*



Caution: Failure to observe these precautions may damage the drive or cause injury.

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

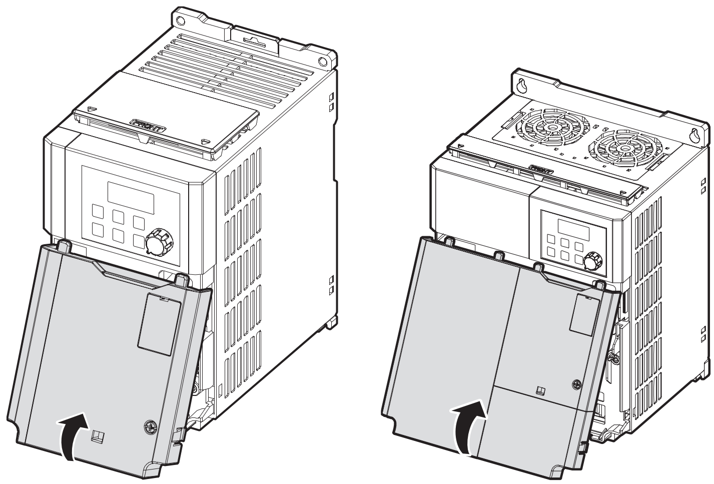


Removing Front Cover

The front cover must be removed to install cables. The procedure to do so varies slightly depending on your drive model.

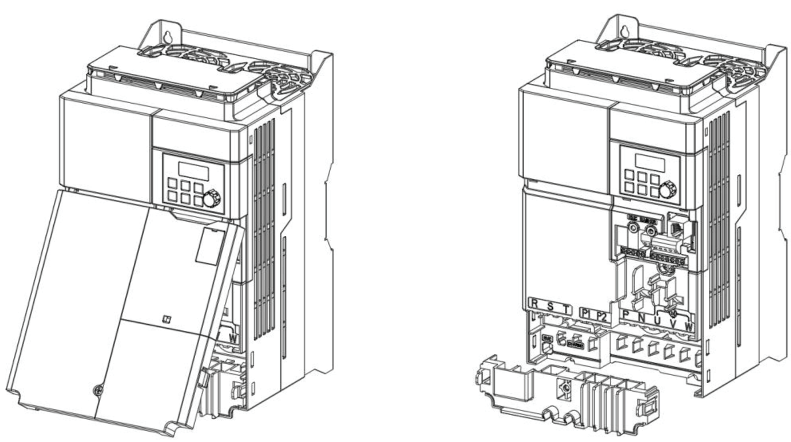
1/2 to 10 hp Drives

Loosen the bolt that secures the front cover. Push and hold the latch on the right side of the cover, then remove the cover by lifting it from the bottom and moving it away from the front of the drive.



15 to 30 hp Drives

Loosen the bolt that secures the front cover, and then pull the cover outward to remove it. Then, loosen the hook (or bolt) that secures the cable rack and pull the rack outward to remove it.



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

Cable Wiring

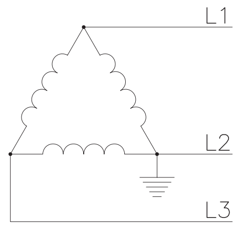
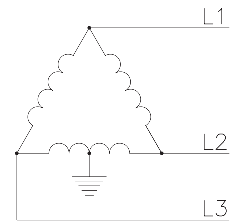
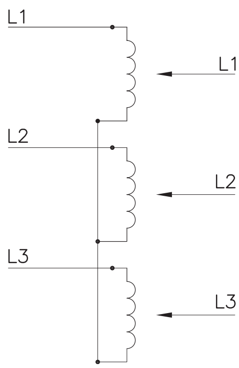
Open the front cover, remove the cable guides and control terminal cover, and then install the ground connection as specified. Complete the cable connections by connecting an appropriately rated cable to the terminals on the power and control terminal blocks.

Read the following information carefully before 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 ACG drive is a grounded system. Only use a grounded power supply system for the ACG 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° for power terminal wiring.*
- *Use copper cables rated at 300V, 75° for control terminal wiring.*
- *Separate control circuit wires from the main circuits and other high voltage circuits (230V relay sequence circuit).*
- *Check for short circuits or wiring failure in the control circuit. They could cause system failure or device malfunction.*
- *Use shielded cables when wiring the control circuit. Failure to do so may cause malfunction due to interference. If a ground is needed, use STP (Shielded Twisted Pair) cables.*
- *If you need to re-wire the terminals due to wiring-related faults, ensure that the drive keypad display is turned off and the charge lamp under the front cover is off before working on wiring connections. The drive may hold a high voltage electric charge long after the power supply has been turned off.*

Floating Ground System

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

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

Cable Selection

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

Read the following information carefully before 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° for power terminal wiring.*
- *Use copper cables rated for 300V, 75° for control terminal wiring.*
- *Utilize shielded VFD cable or Output line reactors/dVdT filters for any motor cable length over 100 feet.*
- *Ensure that the total cable length does not exceed 665ft (202m). For drives ≤ 5 HP capacity, ensure that the total cable length does not exceed 165ft (50m).*

Ground Cable and Power Cable Specifications

<table>
<tr><th colspan="6">Ground Cable and Power Cable Specifications</th></tr>
<tr><th colspan="2" rowspan="2">Load (hp)</th><th colspan="2">Ground</th><th colspan="2">Power I/O
R/S/T & U/V/W</th></tr>
<tr><th>mm²</th><th>AWG</th><th>mm²</th><th>AWG</th></tr>
<tr><td rowspan="9">3–Phase 230V</td><td>0.5</td><td rowspan="5">4</td><td rowspan="5">12</td><td rowspan="4">2.5</td><td rowspan="4">14</td></tr>
<tr><td>1</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td></tr>
<tr><td>5</td><td>4</td><td>12</td></tr>
<tr><td>7.5</td><td rowspan="2">6</td><td rowspan="2">10</td><td>6</td><td>10</td></tr>
<tr><td>10</td><td>10</td><td>8</td></tr>
<tr><td>15</td><td rowspan="2">16</td><td rowspan="2">6</td><td>16</td><td>6</td></tr>
<tr><td>20</td><td>25</td><td>4</td></tr>
<tr><td rowspan="11">3–Phase 460V</td><td>0.5</td><td rowspan="5">2.5</td><td rowspan="5">14</td><td rowspan="5">2.5</td><td rowspan="5">14</td></tr>
<tr><td>1</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td></tr>
<tr><td>5</td></tr>
<tr><td>7.5</td><td rowspan="2">4</td><td rowspan="2">12</td><td>4/2.5</td><td>12/14</td></tr>
<tr><td>10</td><td>4</td><td>12</td></tr>
<tr><td>15</td><td rowspan="2">10</td><td rowspan="2">8</td><td>6</td><td>10</td></tr>
<tr><td>20</td><td rowspan="2">16/10</td><td rowspan="2">6/8</td></tr>
<tr><td>25</td><td rowspan="2">16</td><td rowspan="2">6</td></tr>
<tr><td>30</td><td>25/16</td><td>4/6</td></tr>
</table>

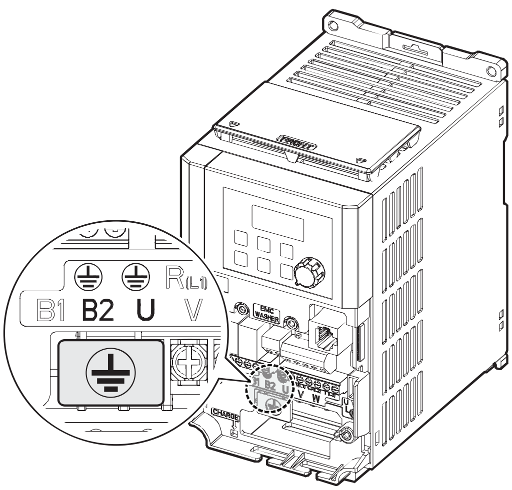
Control (signal) Cable Specifications

Control (signal) Cable Specifications				
Terminals	***Signal Cable***			
	Without Crimp Terminal Connectors (Bare wire)		***With Crimp Terminal Connectors (Bootlace Ferrule)***	
	mm²	***AWG***	***mm²***	***AWG***
24/P1, P1–P5, CM	0.8	18	0.5	20
A1/B1/C1/A2/C3/VR/V1 I2/AO/CM/Q1/EG/S+/S-	0.8	18	0.5	20

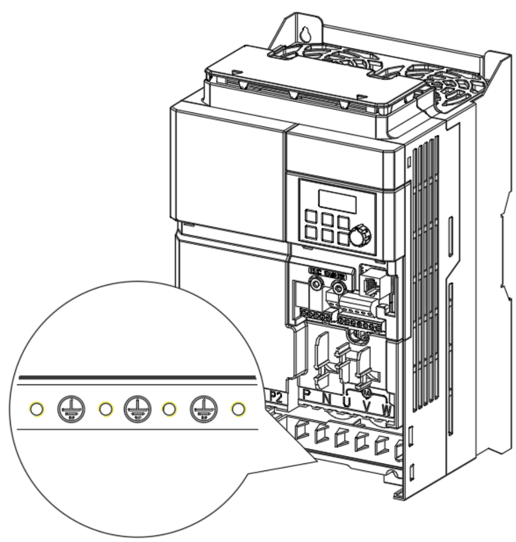
Ground Connection

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

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



0.5 – 10 hp Drives



15 – 30 hp Drives

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

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

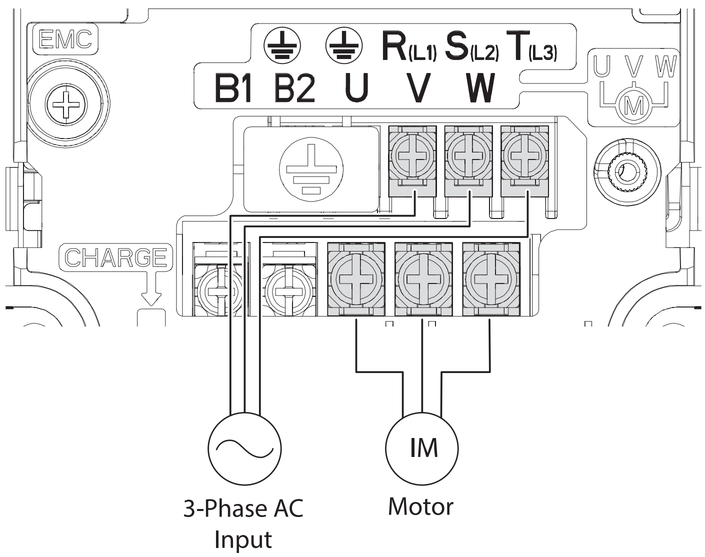
Power Terminal Wiring

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

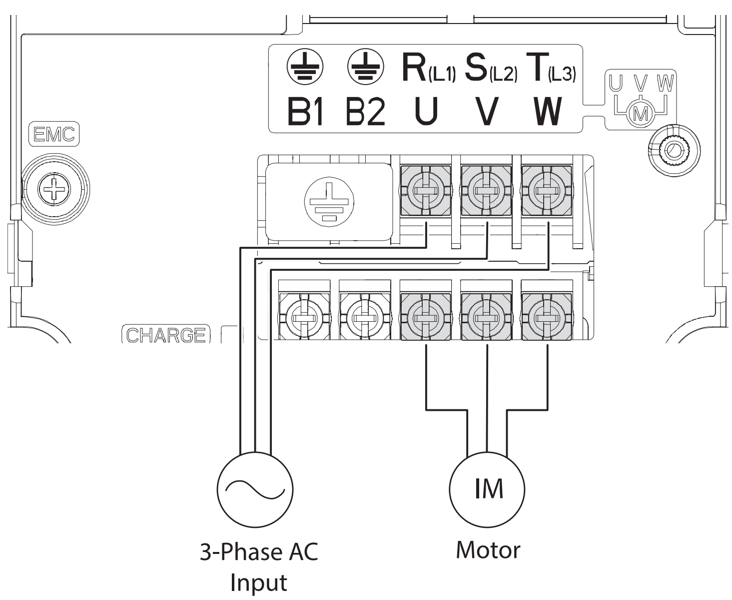
Read the following information carefully before making any wiring connections to the drive.

- *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, S, 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.*

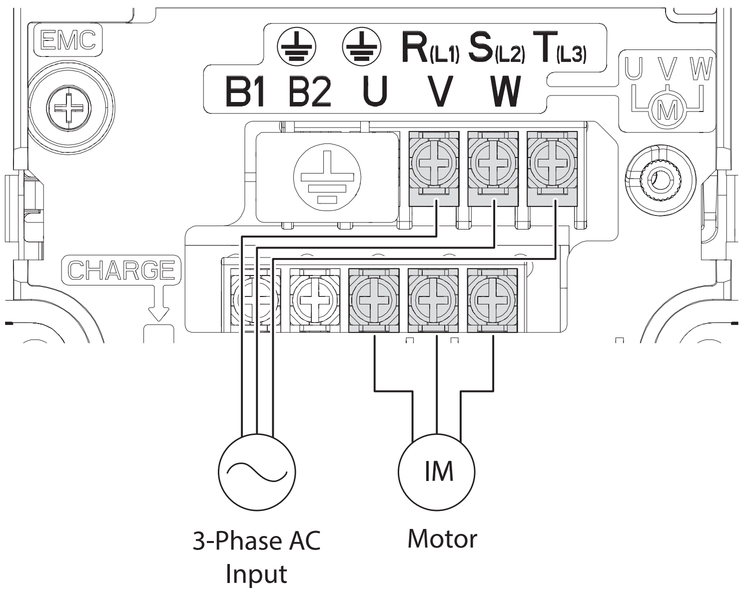
0.5 – 1 HP (3-phase)



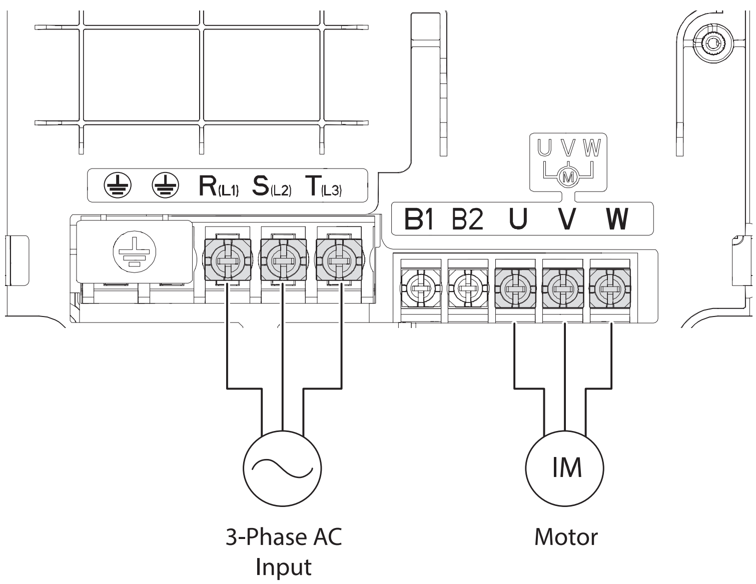
2.0 – 3.0 HP (3-phase)



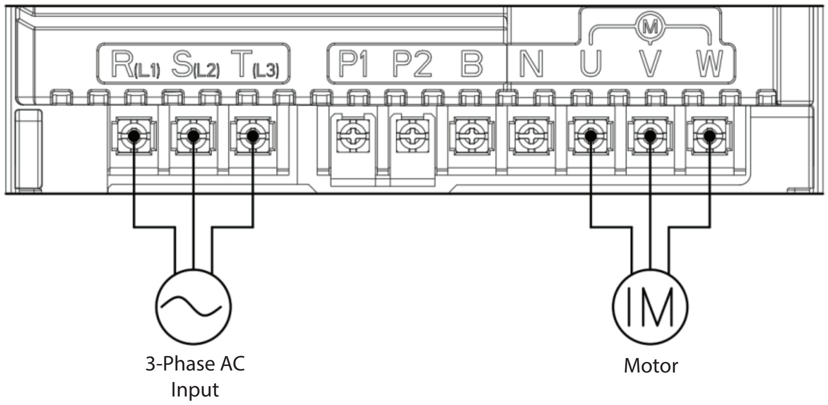
5 HP (3-phase)



7.5 – 10 HP (3-phase)

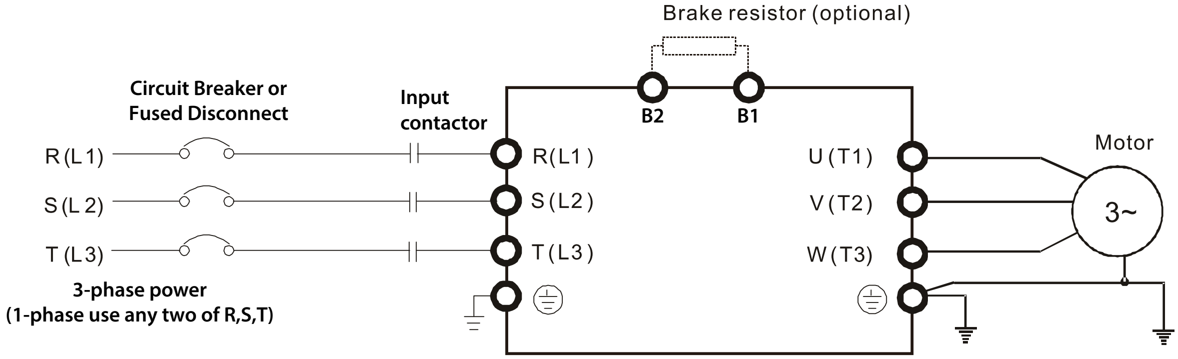


15 – 30 HP (3-phase)

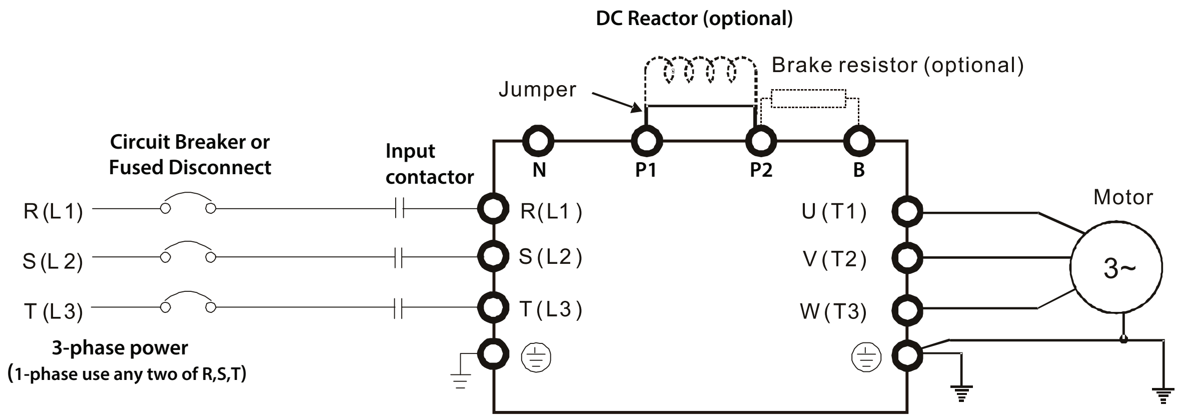


Main Circuit Wiring Diagram (all frames)

0.5 to 10 hp Drives



15 to 30 hp Drives



Power Terminal Labels and Descriptions

Power Terminal Labels and Descriptions		
Terminal Labels	**Name**	**Description**
R(L1)/S(L2)/T(L3)	AC power input terminal	Mains supply AC power connections (*For single phase input*, any two of the R,S,T terminals may be used)
P2(+)/N(-)	DC input terminal	DC voltage terminals for 15–30 hp drives only.
P1(+)/P2(+)	DC reactor terminal	DC reactor wiring connection for 15-30 hp drives. (Remove the short-bar when you use the DC reactor)
B1/B2 *(0.5 to 10 hp)* ***P2(+)/B*** *(15 to 30 hp)*	Brake resistor terminals	Brake resistor wiring connection
U/V/W	Motor output terminals	3-phase AC motor wiring connections

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

- *Terminals P1 and P2 are used to connect an optional DC reactor or choke to improve power factor. From the factory, these terminals are connected with a short-circuit jumper. Remove this jumper before connecting a DC reactor.*
- *Tighten the jumper if a DC reactor is not connected and P2 & B or P1 & N terminals are used for common DC bus or brake resistors. This will prevent the AC motor drive from losing power and damage to the terminals. If the jumper is missing due to wiring, refer to the recommended main circuit terminal wire to short-circuit the P1 and P2 terminals.*
- *Install an external brake resistor for applications in frequent deceleration to stop, short deceleration time (such as high frequency operation and heavy load operation), too low braking torque, or increased braking torque.*
- *For ACG series drives, the external brake resistor should be connected to the B1 and B2 terminals for 1/2 to 10 hp drives, and the B1 and P2 terminals for 15 to 30 hp drives. See appendix accessories for recommended braking resistor sizes.*
- *P2 and N are connected for common DC bus for 15 to 30 hp drives.*
- *Please refer to the DURApulse Drives Dynamic Braking User Manual for more information on ADC braking resistors. (Available for free download at* http://www.automationdirect.com/static/manuals/index.html*.)*

Wiring Guidelines

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

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

WARNING: DO NOT CONNECT POWER TO THE DRIVE UNTIL INSTALLATION HAS BEEN FULLY COMPLETED AND THE DRIVE IS READY TO BE OPERATED. DOING SO MAY RESULT IN ELECTRIC SHOCK.

READ THE FOLLOWING INFORMATION CAREFULLY BEFORE MAKING ANY WIRING CONNECTIONS TO THE DRIVE.

- *Power supply cables must be connected to the R, S, 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/S/T and U/V/W terminals.*
- *The drive's power terminal connections can cause harmonics that may interfere with other communication devices located near to the drive. To reduce interference the installation of noise filters or line filters may be required.*
- *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 ACG is a three-phase standard variable frequency drive (VFD). When applying single-phase power to a three-phase VFD, there are several constraints that need to be considered. Standard Pulse-Width-Modulated (PWM) VFDs use a 6-pulse diode rectifier. The 6-pulse rectification results in 360 Hz DC bus ripple when used with a three-phase 60 Hz supply.

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

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

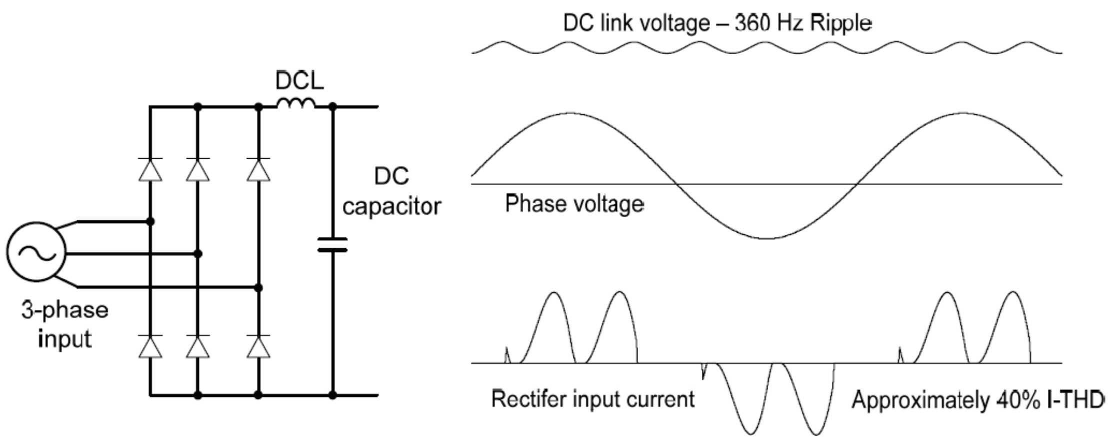


Figure-1 Typical Three-Phase Configuration

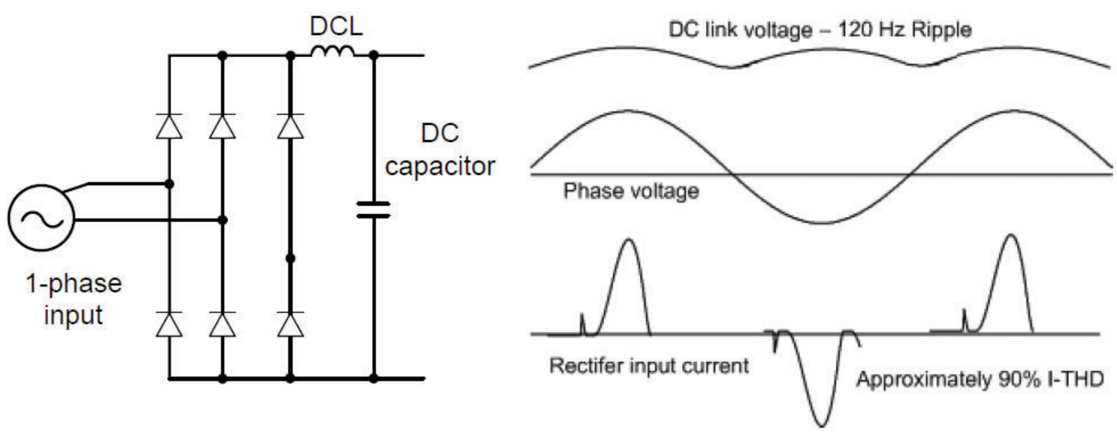


Figure-2 Typical Single-Phase Configuration

Power (HP), Input Current and Output Current

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

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

Input Frequency and Voltage Tolerance

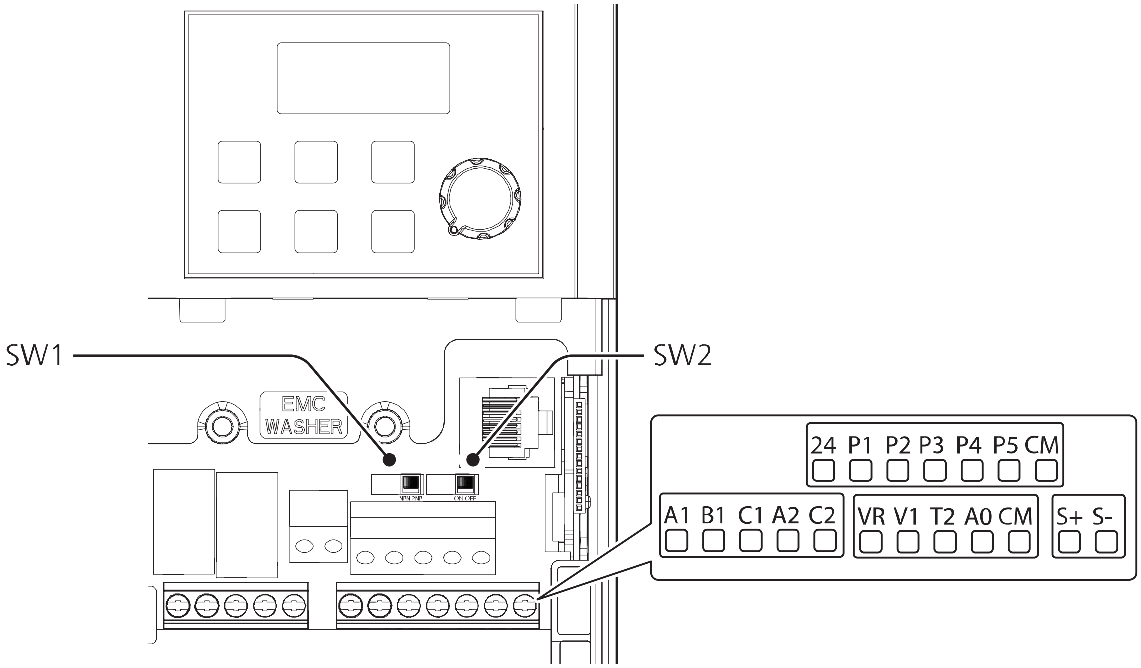
The single-phase current ratings are valid for 60Hz input only. The AC supply voltage must be within the required voltage range of 240/480Vac +10% to –5% to maximize motor power production. Standard product with three-phase voltage input has an allowable range of +10% to –15%. Therefore, a stricter input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

Protection

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

Control Terminal Wiring

The following drawings show the layout of the control wiring terminals and control board switches. Refer to 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.



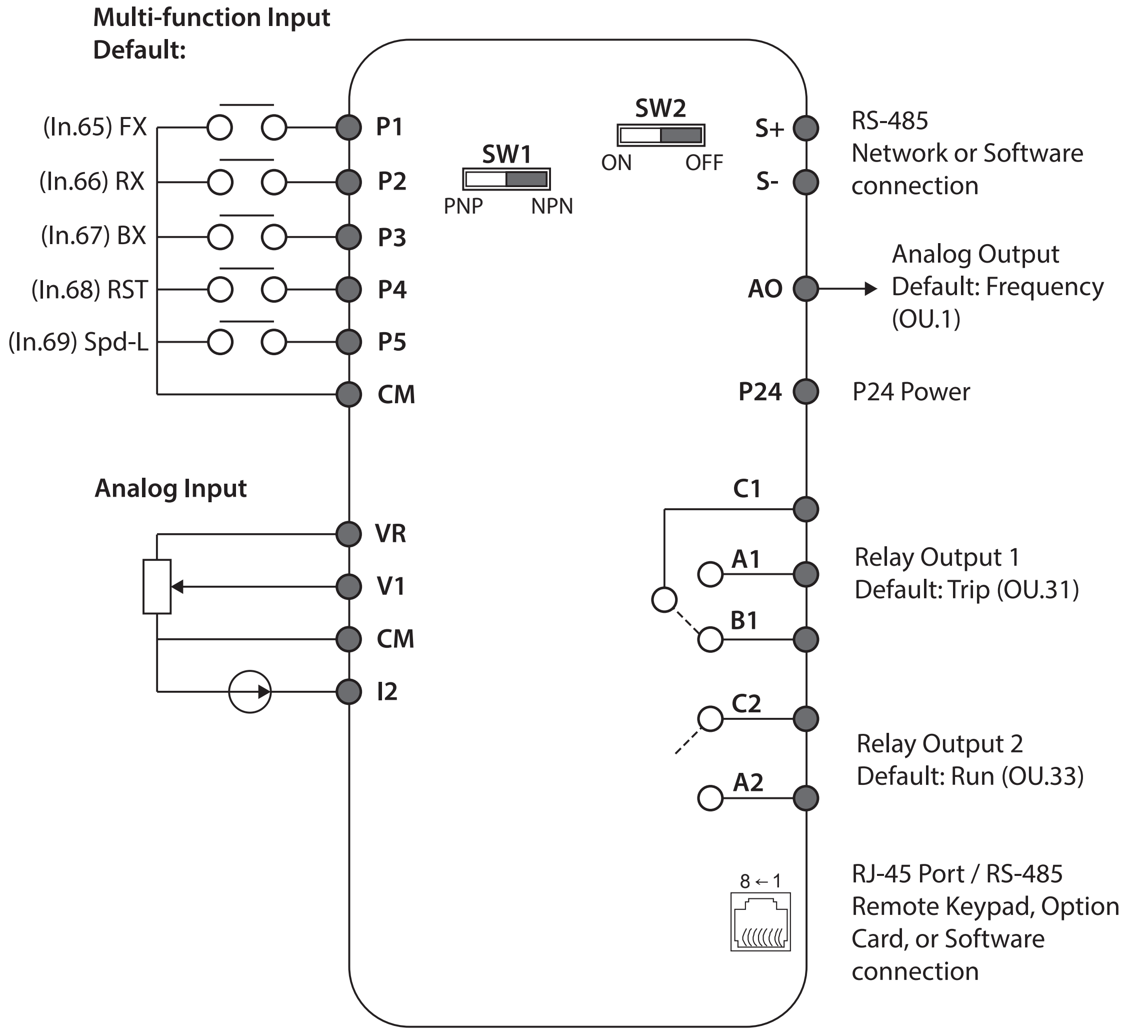
Control Board Switches

Control Board Switches	
Switch	***Description***
SW1	NPN/PNP mode selection switch
SW2	Terminating Resistor selection switch

Connector

Connector	
Name	***Description***
RJ45 Connector	Connection to software, remote keypad, or ACG-ET2 communication module.

Full I/O Wiring Diagram



Input Terminal Labels and Descriptions

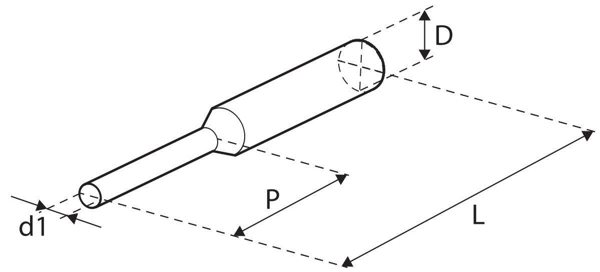
Input Terminal Labels and Descriptions			
Function	**Label**	**Name**	**Description**
Multi-function terminal configuration	P1–P5	Multi-function Input 1-5	Configurable for multi-function input terminals. Factory default terminals and setup are as follows: • P1: FX, Fwd Run (In.65) • P2: RX, Rev Run (In.66) • P3: BX, Block (In.67) • P4: RST, Reset (In.68) • P5: Speed-L (In.69)
	CM	Common Sequence	Common terminal for terminal input, RS-485 communication, and analog 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.1–In.17). • Unipolar: 0–10V (12V Max.) • Bipolar: -10–10V (±12V Max.)
	I2	Current input for frequency reference input Terminal	Used to setup or modify a frequency reference via the I2 terminal (In.50–In.62). • Input current: 4–20mA • Maximum Input current: 20mA • Input resistance: 249Ω

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: 12V/10mA • Factory default output: Frequency
Digital Relay Outputs	24	24V internal power source	Maximum output current: 100mA
	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=29 (Drive Trip)
	A2/C2	Relay output 2	Activates based on multi-function parameter setting (250VAC <1A, 30VDC < 1A)(OU.33). • A2/C2: Normally Open • Default: OU.33=14 (Drive Run)
Communication	S+/S-	RS-485 signal input terminal	Used to send or receive RS-485 signals.
	RJ45	RJ45 Connector	Connection to Software, Remote keypad, or ACG-ET2 communication module.

Pre-insulated Crimp Terminal Connectors (Bootlace Ferrule)

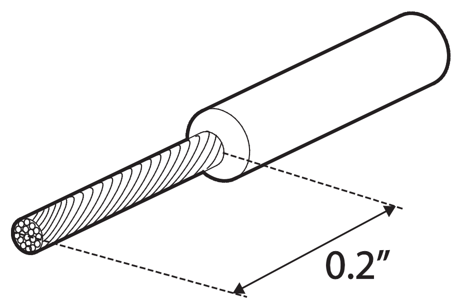
Use pre-insulated crimp terminal connectors to increase reliability of the control terminal wiring. Use this drawing and table to determine the crimp terminals to fit various cable sizes.



Cable Spec		Dimensions (mm)			
AWG	mm²	L*	P	d1	D
22	0.50	12.0	6.0	1.3	3.2
20	0.75	12.0	6.0	1.5	3.4
18	1.0	12.0	6.0	1.7	3.6

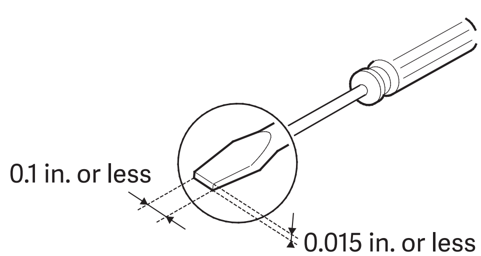
** If the length (L) of the crimp terminals exceeds 0.5″ (12.7mm) after wiring, the control terminal cover may not close fully*

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



NOTE: Please read these general wiring recommendations:

- *While making wiring connections at the control terminals, ensure that the total cable length does not exceed 165ft (50m).*
- *Ensure that the length of any safety related wiring does not exceed 100ft (30m).*
- *Ensure that the cable length between 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 (0.1 in wide (2.5 mm) and 0.015 in thick (0.4 mm) at the tip).*



Terminal Screw Specification

Drive		Terminal Screw Specifications	
Input Voltage	hp	Size	Torque (Kgf·cm [Nm])
3-phase 230V	1/2	R/S/T, U/V/W: M3	R/S/T, U/V/W: 5.1 [0.5]
	1		
	2	R/S/T, U/V/W: M4	R/S/T, U/V/W: 12.1 [1.2]
	3		
	5		R/S/T, U/V/W: 18.4 [1.8]
	7.5		R/S/T: 14.3 [1.4] U/V/W: 15.0 [1.5]
	10		
	15	R/S/T, U/V/W: M5	R/S/T, U/V/W: 25.34 [2.5]
	20		
	25	R/S/T, U/V/W: M6	R/S/T, U/V/W: 5.1 [0.5]
	30		
3-phase 460V	1/2	R/S/T, U/V/W: M3.5	R/S/T, U/V/W: 10.3 [1.0]
	1		
	2		
	3		
	5	R/S/T, U/V/W: M4	R/S/T, U/V/W: 18.4 [1.8]
	7.5		R/S/T: 14.3 [1.4] U/V/W: 18.4 [1.8]
	10		
	15	R/S/T, U/V/W: M5	R/S/T, U/V/W: 25.34 [2.5]
	20		
	25		
	30		

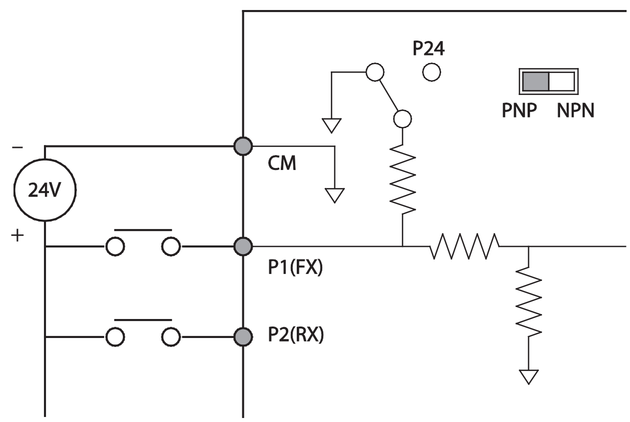
WARNING: SA,SB, SC ARE SHORTED AND HAVE 24V VOLTAGE ACROSS THEM. DO NOT CONNECT POWER TO THE DRIVE UNTIL INSTALLATION HAS BEEN FULLY COMPLETED AND THE DRIVE IS READY TO BE OPERATED. DOING SO MAY RESULT IN ELECTRIC SHOCK.

PNP/NPN Mode Wiring and Selection

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

PNP Mode (Source)

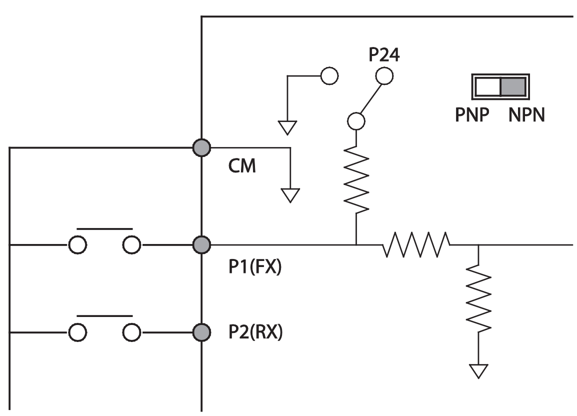
Select PNP using the PNP/NPN selection switch (SW1). Note that the factory default setting is NPN mode. CM is the common ground terminal for all analog inputs at the terminal, and P24 is 24V internal source. If you are using an external 24V source, build a circuit that connects the external source (-)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



PNP Mode (Source)

NPN Mode (Sink)

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

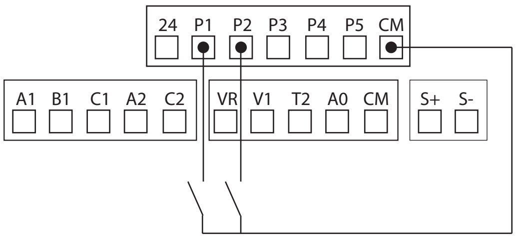


NPN Mode (Sink)

Run Command Wiring

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

2-Wire Control



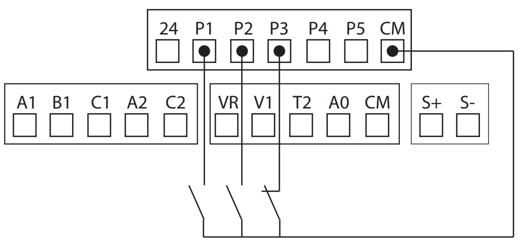
2-wire control consists of maintained run signals. This can be accomplished via toggle switches, relays, jumpers, etc. Default parameters support this operation.

P1=Forward Run (Fx)

P2=Reverse Run (Rx)

CM=Common

3-Wire Control



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

P1 = Forward Run (Fx)

P2 = Reverse Run (Rx)

P3 = Stop (3-Wire)

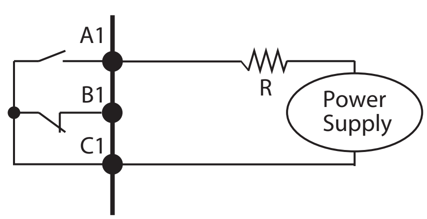
CM = CommonFrequency Reference Wiring

Relay Output Wiring

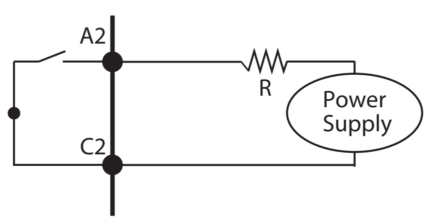
Output Wiring using External Power

Ensure device current does not exceed 1A.

Relay 1



Relay 2

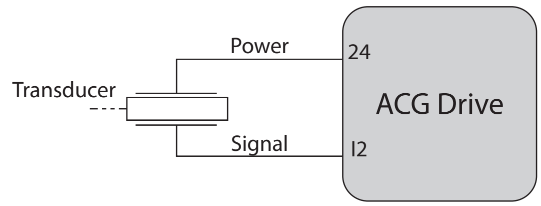


Analog Wiring

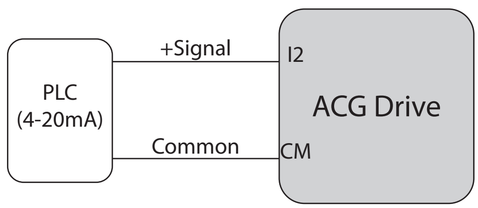
This section demonstrates how to wire up a 4-20mA or 0-10VDC source to the ACG VFDs. This document focuses on transducer, speed POT, and PLC connection sources but can be applied to any 4-20mA or 0-10VDC device.

4-20mA Analog Input Wiring

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

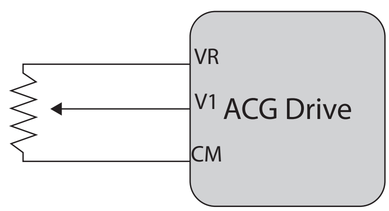


PLC (4-20mA): The wiring for connecting a PLC's 4-20mA output to the analog input of a VFD differs slightly from the transducer wiring discussed above. The positive (signal) lead is wired to the corresponding analog input while the negative (common) lead is wired to the drives common. Reference the figure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

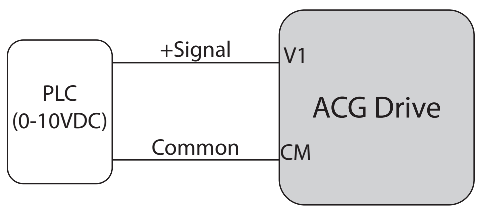


0-10VDC Analog Input Wiring

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

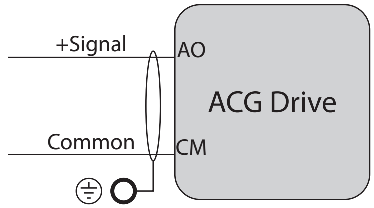


PLC (0-10VDC): The wiring for connecting a PLC's 0-10VDC output to the analog input of a VFD differs slightly from the speed POT wiring discussed above. The positive (signal) lead is wired to the corresponding analog input while the negative (common) lead is wired to the drives common. Reference the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

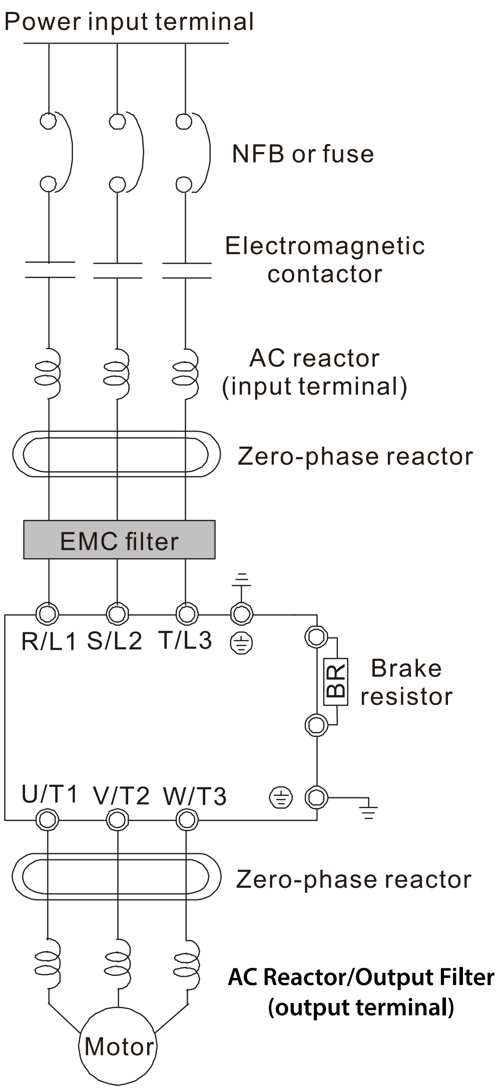


AO Wiring

Wire the drive analog out as follows:



System Wiring Diagram



System Wiring Components	
Component	***Function***
Power input terminal	Supply power according to the rated power specifications indicated in the manual
NFB or fuse	There may be a large inrush current during power on. Select a suitable NFB (non-fuse breaker or circuit breaker) or Fuse.
Electromagnetic contactor	Switching the power ON/OFF on the primary side of the electromagnetic contactor can turn the drive ON/OFF, but frequent switching can cause machine failure. Do not switch ON/OFF more than once an hour. Do not use the electromagnetic contactor as the power switch for the drive; doing so shortens the life of the drive.
AC reactor (input terminal)	When the main power supply capacity is greater than 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/S/T terminals of the drive? (Caution: connecting the power source to the U/V/W terminals may damage the drive.)
	Are the motor output cables connected in the correct phase rotation (U/V/W)? (Caution: motors will rotate in reverse direction if three phase cables are not wired in the correct rotation.)
	Are the cables used in the power terminal connections correctly rated?
	Is the drive grounded correctly?
	Are the power terminal screws and the ground terminal screws tightened to their specified torques?
	Are the overload protection circuits installed correctly on the motors (if multiple motors are run using one drive)?
	Is the drive separated from the power source by a magnetic contactor (if a braking resistor is in use)?
	Are advanced-phase capacitors, surge protection, and electromagnetic interference filters installed correctly? (These devices MUST not be installed on the output side of the drive.)
	If motor distance is greater than 100 feet from the drive, is VFD cable and/or line reactor/filter used?
	Is total motor cable length less than 165ft (5HP or less) or 665 feet (7.5HP or greater)?
Control Terminal Wiring	Are STP (shielded twisted pair) cables used for control terminal wiring?
	Is the shielding of the STP wiring properly grounded?
	If 3-wire operation is required, are the multi-function input terminals defined prior to the installation of the control wiring connections?
	Are the control cables properly wired?
	Are the control terminal screws tightened to their specified torques?
	Is the total cable length of all control wiring < 165ft (100m)?
	Is the total length of safety wiring < 100ft (30m)?
Miscellaneous	Are optional cards connected correctly?
	Is there any debris left inside the drive?
	Are any cables contacting adjacent terminals, creating a potential short circuit risk?
	Are the control terminal connections separated from the power terminal connections?
	Have the capacitors been replaced if they have been in use for > 2 years?
	Have the fans been replaced if they have been in use for > 3 years?
	Has a fuse been installed for the power source?
	Are the connections to the motor separated from other connections?

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

Test Run

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

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

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

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

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

   b) If I2 is selected as the frequency reference source, does the reference change according to the input current?

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

5) Start the motor and check the following:

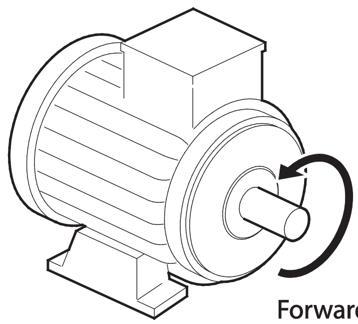
   a) Ensure that the motor rotates in the correct direction (refer to the note below).

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

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

Verifying the Motor Rotation

1) On the keypad, set the Frq (Drive Command reference source) parameter in the Operation group to 0 (Keypad).
2) Set a frequency reference to a low value (10Hz).
3) Press the [RUN] key. Motor starts forward operation.
4) Observe the motor's rotation from the load side and ensure that the motor rotates counterclockwise (forward).
   If the motor rotates in the reverse direction, two of the U/V/W terminals need to be switched.



CAUTION: Read the following information before operating your drive:

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

Chapter 3: Keypad Operation and Quick Start

Chapter
3

Table of Contents

Learning to Perform Basic Operations

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

About the Keypad

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

About the Display

The following table lists display part names and their functions.

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

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

0	0	A	A	K	K	U	U
1	1	b	B	L	L	v	V
2	2	C	C	M	M	W	W
3	3	d	D	n	N	X	X
4	4	E	E	O	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.
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 ACG control menu uses the following Parameter Groups for configuration. Groups with an asterisk only display when certain parameters/options are configured. See description for details.

Group	Display	Description
Operation	-	Configures basic parameters for drive operation. These include reference frequencies and acceleration or deceleration times. This group is only available on the Drive LED keypad.
Drive	dr	Configures parameters for basic operations. These include jog operation, motor capacity evaluation, torque boost, and other keypad related parameters.
Basic	bA	Configures basic parameters, including motor-related parameters and multi-step frequencies.
Advanced	Ad	Configure acceleration or deceleration patterns and to setup frequency limits.
Control	Cn	Configures sensorless vector related features.
Input Terminal	In	Configures input terminal–related features, including digital multi–functional inputs and analog inputs.
Output Terminal	OU	Configures output terminal related features such as relays and analog outputs.
Communication	Cm	Configures communication features for RS-485 or other communication options.
Application	AP	Configures PID control related sequences and operations.
Protection	Pr	Configures motor or drive protection features.
Motor 2 (Secondary Motor)*	m2	Configures secondary motor related features.
**The secondary motor (M2) group displays when one of the multi-function input terminals (In.65–In.69) has been set to 26 (Secondary motor).*		

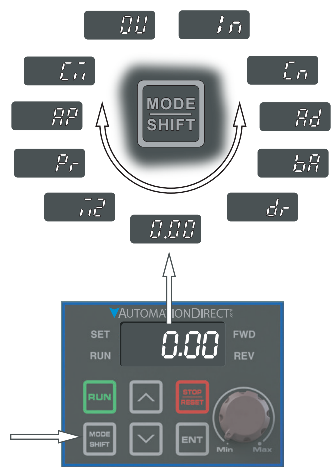
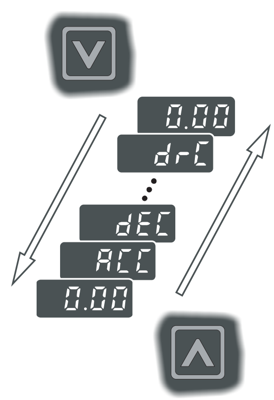
Learning to Use the Keypad

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.

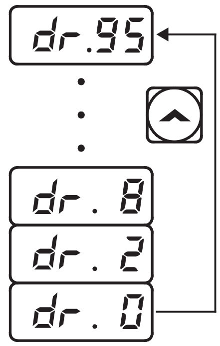
Step	Instruction	Keypad Display
1	Move to the parameter group you want using the MODE key. Press the MODE key for longer than 1 second to move in the opposite direction.	
2	Move up and down through the codes using the Up and Down arrow keys until you locate the code that you require.	
3	Press the [ENT]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

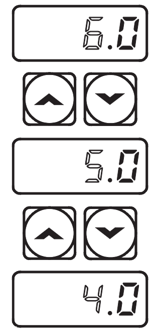
An alternative to using the up/down arrows to navigate to the parameter number is to use the parameter "Jump Code". Parameter number zero (xx.0) is the jump code for each group. The following example details navigating directly to dr.95 using the parameter dr.0 (jump code parameter):



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

Setting Parameter Values

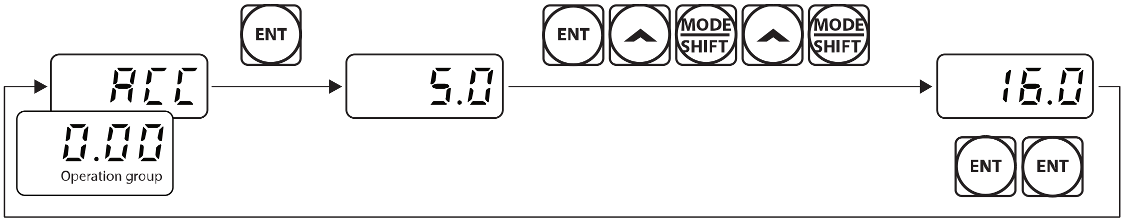
After navigating to the specific parameter number, follow the instructions below to set the parameter values. Setting the parameter value will change the drive functionality by configuring speed references, features, alarm limits, etc.

Step	Instruction	Keypad Display
1	Navigate to a specific parameter group and number, and then press the [ENT] key. The first number on the right side of the display will flash.	
2	Move to the place value to edit using the [MODE] key, then press the Up Arrow or Down Arrow key to adjust the value. Then press the [ENT] key to confirm it. Press the [MODE] key for longer than 1 second to move to the left place value. The selected value will flash on the display.	
3	Press the [ENT] key again to save the change.	-

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

Actual Application Examples

Acceleration Time Configuration

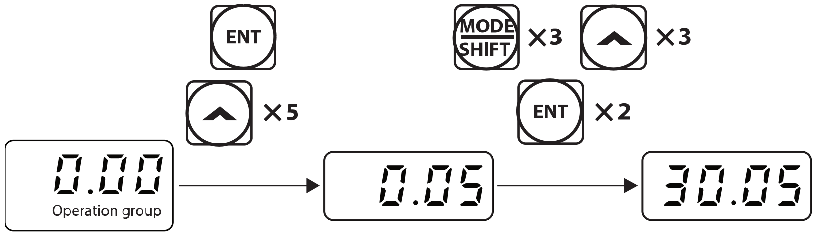


The following is an example demonstrating how to modify the ACC (Acceleration time) parameter value (from 5.0 to 16.0) from the Operation group.

Step	Action	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 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 cceleration 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).

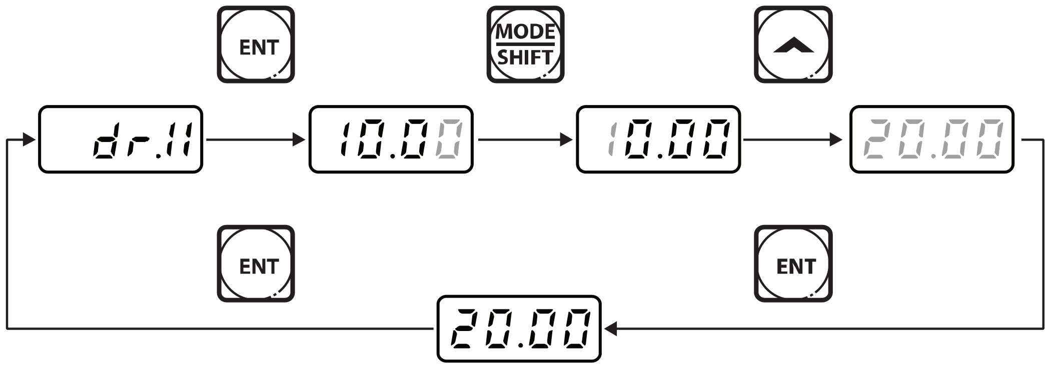


Step	Action	Keypad Display
1	Select the first code of the Operation group to display code 0.00 (Command Frequency).	0.00
2	Press the [ENT] key. The default value “0.00” will be displayed and “0” in the second decimal place will flash.	0.00
3	Press the [MODE] key 3 times to move to the tens place value. “0” in the tens place will flash.	00.00
4	To make the target value “30.05”, press the Up arrow key to change the tens place value to “3”.	30.00
5	Press the [MODE] key 2 times. The “0” key in the second decimal place will flash.	30.00
6	To make the target value “30.05”, press the Up arrow key to change the second decimal place value to “5”, and then press the [ENT] key. The selected value will flash on the display.	30.05
7	Press the [ENT] key again to save the changes. Flashing stops. The frequency reference has been configured to 30.05 Hz.	30.05

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

Jog Frequency Configuration

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

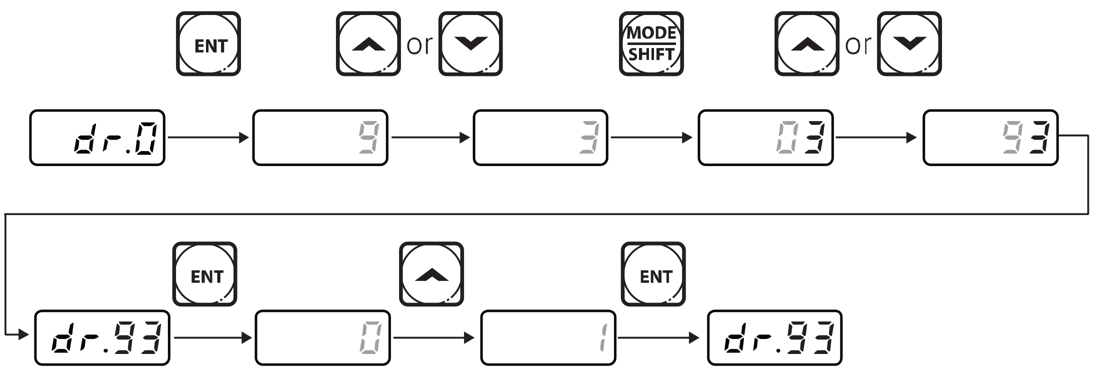


Step	Action	Keypad Display
1	Go to dr.11 in the Drive group.	dr.11
2	Press the [ENT] key. The current Jog Frequency value (10.00) for code dr.11 is displayed.	10.00
3	Press the [MODE] key 3 times to move to the tens place value. “1” in the tens place will flash.	10.00
4	To make the target value “20.00”, press the Up arrow key to change the tens place value to “2”, and then press the [ENT] key. The selected value will flash on the display.	20.00
5	Press the [ENT] key again to save the changes. Code dr.11 will be displayed. The parameter change has been completed.	dr.11

Initializing All Parameters (Reset to Defaults)

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

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

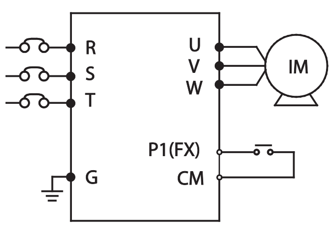


Step	Action	Keypad Display
1	Go to dr.0 in the Drive group.	dr.0
2	Press the [ENT] key. The current parameter value “9” will be displayed.	9
3	To make the target value “93”, press the Down arrow key to change the ones place value to “3”.	3
4	Press the [MODE] key to move to the tens place value.	03
5	Press the Up or Down arrow key to change the tens place value to “9”.	93
6	Press the [ENT] key. Code dr.93 will be displayed.	dr.93
7	Press the [ENT] key again. The current parameter value for code dr.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 initilization is complete when code dr.93 reappears on the display.	dr.93

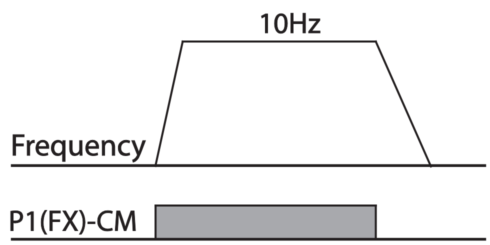
NOTE: Following parameter initialization, all parameters are reset to factory default values. Ensure that parameters are reconfigured before running the drive again after an initialization.

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

Step	Action	Keypad Display
1	Turn on the drive.	–
2	Select code 0.00 (Command Frequency) in the Operation group and press the [ENT] key.	0.00
3	Press the [MODE] key 3 times to move to the tens place value. “0” in the tens place will flash.	00.00
4	Press the Up arrow key to change the value to 10.00, and then press the [ENT] key. The selected value will flash on the display.	10.00
5	Press the [ENT] key again to save the changes. The reference frequency has been changed.	10.00
6	Refer to the wiring diagram at the bottom of the table, and turn on the switch between the P1 (FX) and CM terminals. The RUN indicator light flashes and the FWD indicator light comes on steady. The current acceleration frequency is displayed.	SET RUN 10.00 FWD REV
7	When the frequency reference is reached (10 Hz), open the switch between the P1 (FX) and CM terminals. The RUN indicator light flashes again and the current deceleration frequency is displayed. When the frequency reaches 0 Hz, the RUN and FWD indicator lights turn off, and the frequency reference 10.00 is displayed again.	SET RUN 10.00 FWD REV



Wiring Diagram

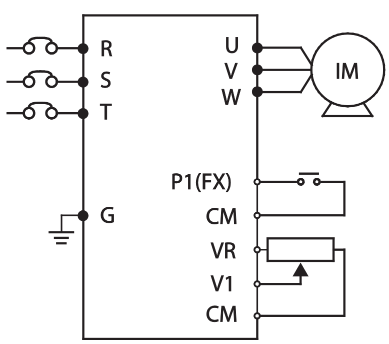


Operation Pattern

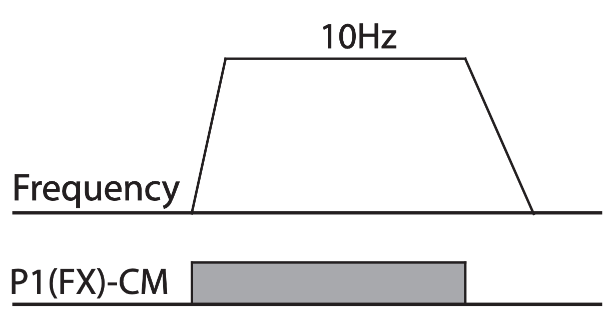
NOTE: The instructions in the table are based on the factory default parameter settings. The drive may not work correctly if the default parameter settings are changed after the drive is purchased. In such cases, initialize all parameters to reset the values to factory default parameter settings before following the instructions in the table (refer to Initializing All Parameters (Reset to Defaults) on page 3–11*).*

Frequency Setting (Potentiometer) and Operation (Terminal Input)

Step	Action	Keypad Display
1	Turn on the drive.	–
2	Select code 0.00 (Command Frequency) in the Operation group and press the [ENT] key.	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 to change the parameter value to 2 (V1-Set frequency input to potentiometer) and then press the [ENT] key. The parameter value will flash.	2
6	Press the [ENT] key once again. The Frq code will be displayed again. The frequency input has been configured for the potentiometer.	Frq
7	Press the Down arrow key 4 times. Move to the first code of the Operation group (0.00). From here frequency setting values can be monitored.	0.00
8	Adjust the potentiometer to increase or decrease the frequency reference to 10 Hz.	–
9	Refer to the wiring diagram at the bottom of the table, and turn on the switch between P1 (FX) and CM terminals. The RUN indicator light will flash and the FWD indicator light comes on steady. The current acceleration frequency is displayed.	SET RUN 10.00 FWD REV
10	When the frequency reference is reached (10 Hz), open the switch between the P1 (FX) and CM terminals. The RUN indicator light flashes again and the current deceleration frequency is displayed. When the frequency reaches 0 Hz, the RUN and FWD indicator lights turn off, and the frequency reference 10.00 is displayed again.	SET RUN 10.00 FWD REV



Wiring Diagram

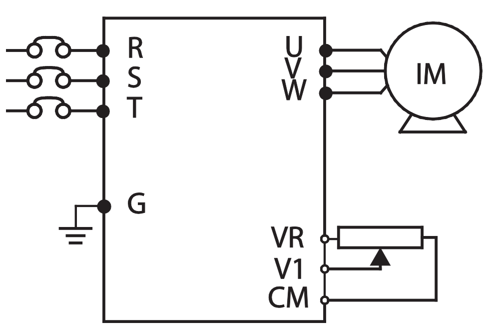


Operation Pattern

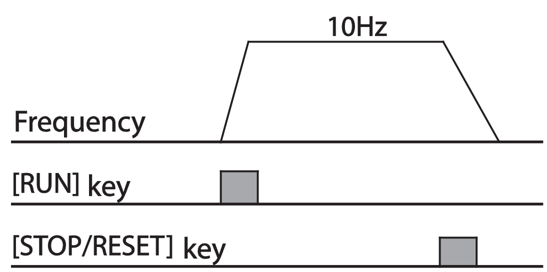
NOTE: The instructions in the table are based on the factory default parameter settings. The drive may not work correctly if the default parameter settings are changed after the drive is purchased. In such cases, initialize all parameters to reset the factory default parameter settings before following the instructions in the table (refer to Initializing All Parameters (Reset to Defaults) on page 3–11*).*

Frequency Setting (Potentiometer) and Operation with the Keypad

Step	Action	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 3 times to move to the drv (command source) parameter.	drv
4	Press the [ENT] key. The drv code in the Operation group is currently set to 1 (FX/RX1 operation command set from the terminal block).	1
5	Press the Down arrow key to change the parameter value to 0 (Keypad), and then press the [ENT] key. The parameter value will flash.	0
6	Press the [ENT] key again. The drv code is displayed again. The fequency input has been configured for the keypad.	drv
7	Press the Up arrow key one time. Move to the Frq (Frequency reference source) code.	Frq
8	Press the [ENT] key. The Frq code in the Operations group is currently set to 0 (keypad).	0
9	Press the Up arrow key to change the parameter value to 4 (V0-Set frequency input to (internal) potentiometer), and then press the [ENT] key.	4
10	Press the [ENT] key once again. The Frq code will be displayed again. The frequency input has been configured for the potentiometer.	Frq
11	Press the Down arrow key 4 times. Move to the first code of the Operation group (0.00). From here, frequency setting values can be monitored.	0.00
12	Adjust the internal potentiometer to increase or decrease the frequency reference to 10 Hz.	–
13	Press the [RUN] key. The RUN indicator light flashes and the FWD indicator light comes on steady. The current acceleration frequency is displayed.	SET RUN 10.00 FWD REV
14	When the frequency reaches the references (10 Hz), press the [STOP/RESET] key on the keypad. The RUN indicator light flashes again and the current deceleration frequency is displayed. When the frequency reaches 0 Hz, the RUN and FWD indicator lights turn off, and the frequency reference, 10.00, is displayed again.	SET RUN 10.00 FWD REV



Wiring Diagram



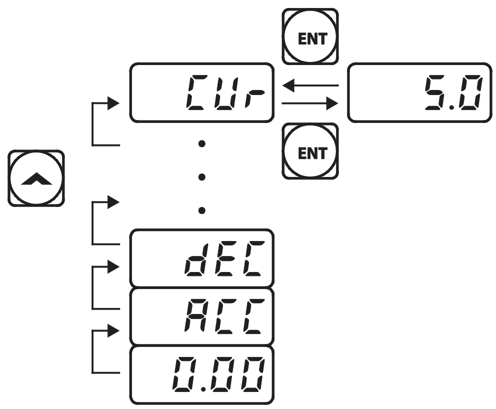
Operation Pattern

NOTE: The instructions in the table are based on the factory default parameter settings. The drive may not work correctly if the default parameter settings are changed after the drive is purchased. In such cases, initialize all parameters to reset the factory default parameter settings before following the instructions in the table (refer to Initializing All Parameters (Reset to Defaults) on page 3–11*).*

Monitoring the Operation

Output Current Monitoring

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



Step	Action	Keypad Display
1	Select code 0.00 (Command Frequency) in the Operation group.	0.00
2	Press the Up or Down arrow key to move to the Cur code.	CUr
3	Press the [ENT] key. The output current of (5.0 A) is displayed.	5.0
4	Press the [ENT] key again. Returns to the Cur code.	CUr

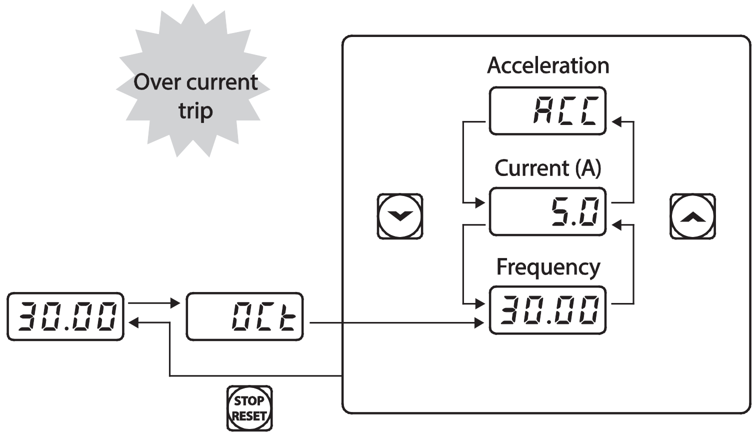
NOTE: You can use the dCL (DC link voltage monitor) and vOL (output voltage monitor) parameters in the Operation group in exactly the same way as shown in the example above, to monitor each function's relevant values.

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 PID feedback.

Fault Trip Monitoring

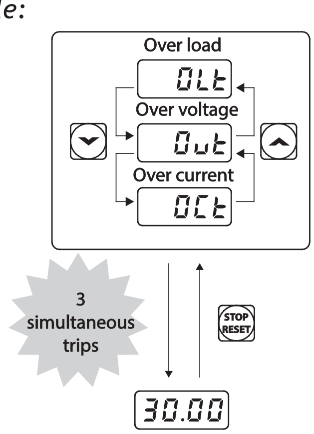
The following example demonstrates how to monitor fault trip conditions in the Operation group using the keypad.



Step	Action	Keypad Display
1	Refer to the example keypad display. An over current trip fault has occurred.	OCt
2	Press the [ENT] key, and then the Up Arrow key. The operation frequency at the time of the fault (30.00Hz) is displayed.	30.00
3	Press the Up Arrow key. The output current at the time of the fault (5.0A) is displayed.	5.0
4	Press the Up Arrow key. The operation status at the time of the fault is displayed. ACC on the display indicates that the fault occurred during acceleration.	ACC
5	Press the [STOP/RESET] key. The drive resets and the fault condition is cleared. The frequency reference is displayed on the keypad.	30.00

NOTE:

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



- *If a warning condition occurs while running at a specified frequency, the current frequency and the signal will be displayed alternately, at 1 second intervals. Refer to* “Fault Trips” on page 6–7 *for more details.*

Chapter 4: AC Drive Parameters

Chapter 4

Table of Contents

AC Drive Parameters

This chapter covers all the parameters available for use with the Ironhorse ACG 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.

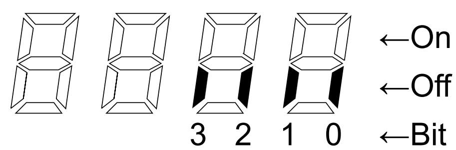
Set the parameters required according to the following chapter. If a set value input is out of range or not allowed, the following messages can be shown on the keypad display. In these cases, the parameter value will not be accepted with the [ENT] key.

- ***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



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

Parameter Table Format Explanation

The ACG 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 = 2)*
  - » *"i" – IM Sensorless (dr.9=4)*
- ***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)	
dr	Drive	
bA	Basic	
Ad	Advanced	
Cn	Control	
In	Inputs	
OU	Outputs	
CM	Communication	
AP	Application	
Pr	Protection	
M2*	2nd Motor	* In.65–In.69–> any one of these parameters is set to 26

Operation Parameter Group

The Operation Group (SPS) 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.

<table>
<tr><th colspan="10">Operation Parameter Group</th></tr>
<tr><th>Pr. Code</th><th>Name</th><th colspan="2">Setting Range</th><th>Initial Value</th><th>Run R/W</th><th>Parameter Dependency</th><th>Compatible Control Mode</th><th>Comm. Address (Hex)</th><th>Ref.</th></tr>
<tr><td>0.00</td><td>Target frequency</td><td colspan="2">0–Maximum frequency(Hz)</td><td>0.00</td><td>♦R/W</td><td>–</td><td>v, s, i</td><td>0h1D00</td><td>3–5</td></tr>
<tr><td>ACC</td><td>Acceleration time</td><td colspan="2">0.0–600.0s</td><td>5.0</td><td>♦R/W</td><td>–</td><td>v, s, i</td><td>0h1D01</td><td>4–62</td></tr>
<tr><td>dEC</td><td>Deceleration time</td><td colspan="2">0.0–600.0s</td><td>10.0</td><td>♦R/W</td><td>–</td><td>v, s, i</td><td>0h1D02</td><td>4–62</td></tr>
<tr><td rowspan="5">drv</td><td rowspan="5">Command source</td><td>0</td><td>Keypad</td><td rowspan="5">1: Fx/Rx–1 (Fwd Run/ Rev Run)</td><td rowspan="5">R/W</td><td rowspan="5">–</td><td rowspan="5">v, s, i</td><td rowspan="5">0h1D03</td><td rowspan="5">4–55</td></tr>
<tr><td>1</td><td>Fx/Rx–1 (Fwd Run/Rev Run)</td></tr>
<tr><td>2</td><td>Fx/Rx–2 (Run/ Direction)</td></tr>
<tr><td>3</td><td>Int 485</td></tr>
<tr><td>4</td><td>Fieldbus (Ethernet)[1]</td></tr>
<tr><td rowspan="7">Frq</td><td rowspan="7">Frequency reference source</td><td>0</td><td>Keypad–1: Change+Enter</td><td rowspan="7">0: Keypad–1</td><td rowspan="7">R/W</td><td rowspan="7">–</td><td rowspan="7">v, s, i</td><td rowspan="7">0h1D04</td><td rowspan="7">4–44</td></tr>
<tr><td>1</td><td>Keypad–2: Instant change</td></tr>
<tr><td>2</td><td>V1: Voltage Analog Input</td></tr>
<tr><td>4</td><td>V0: Built-in Potentiometer dial</td></tr>
<tr><td>5</td><td>I2: Current Analog Input</td></tr>
<tr><td>6</td><td>Int 485</td></tr>
<tr><td>8</td><td>Fieldbus (Ethernet)</td></tr>
<tr><td>St1</td><td>Multi–step speed frequency 1</td><td colspan="2">0.00–Maximum frequency(Hz)</td><td>10.00</td><td>♦R/W</td><td>–</td><td>v, s, i</td><td>0h1D05</td><td>4–53</td></tr>
<tr><td>St2</td><td>Multi–step speed frequency 2</td><td colspan="2">0.00–Maximum frequency(Hz)</td><td>20.00</td><td>♦R/W</td><td>–</td><td>v, s, i</td><td>0h1D06</td><td>4–53</td></tr>
<tr><td>St3</td><td>Multi–step speed frequency 3</td><td colspan="2">0.00–Maximum frequency(Hz)</td><td>30.00</td><td>♦R/W</td><td>–</td><td>v, s, i</td><td>0h1D07</td><td>4–53</td></tr>
<tr><td>CUr</td><td>Output current</td><td colspan="2">–</td><td>–</td><td>Read Only</td><td>–</td><td>v, s, i</td><td>0h1D08</td><td>3–15</td></tr>
<tr><td>Rpm</td><td>Motor revolutions per minute</td><td colspan="2">–</td><td>–</td><td>Read Only</td><td>–</td><td>v, s, i</td><td>0h1D09</td><td>–</td></tr>
<tr><td>dCL</td><td>Drive direct current voltage</td><td colspan="2">–</td><td>–</td><td>Read Only</td><td>–</td><td>v, s, i</td><td>0h1D0A</td><td>3–15</td></tr>
<tr><td>vOL</td><td>Drive output voltage (dr.81 User Selectable)</td><td colspan="2">–</td><td>–</td><td>Read Only</td><td>–</td><td>v, s, i</td><td>0h1D0B</td><td>3–15</td></tr>
<tr><td>nOn</td><td>Out of order signal</td><td colspan="2">–</td><td>–</td><td>–</td><td>–</td><td>v, s, i</td><td>0h1D0C</td><td>–</td></tr>
</table>

Operation Parameter Group									
Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
drC	Select rotation direction	F	Forward run	F	♦R/W	–	v, s, i	0h1D0D	–
		r	Reverse run						

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.

Drive Parameter Group (dr)									
Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
dr.0	Jump Code	1–99		9	♦R/W	–	v, s, i	–	3–6
dr.9	Control mode	0	V/F	0: V/F	R/W	–	v, s, i	0h1109	4–68 4–95 4–104
		2	Slip Compen						
		4	IM Sensorless						
dr.11	Jog frequency	0.00, Start frequency–Maximum frequency(Hz)		10.00	♦R/W	–	v, s, i	0h110B	4–88
dr.12	Jog run acceleration time	0.0–600.0s		20.0	♦R/W	–	v, s, i	0h110C	4–88
dr.13	Jog run deceleration time	0.0–600.0s		30.0	♦R/W	–	v, s, i	0h110D	4–88
dr.14	Motor capacity	0	0.2 kW (1/4 hp)	Varies by Drive capacity	R/W	–	v, s, i	0h110E	4–102
		1	0.4 kW (1/2 hp)						
		2	0.75 kW (1 hp)						
		3	1.1 kW (1.5 hp)						
		4	1.5 kW (2 hp)						
		5	2.2 kW (3 hp)						
		6	3.0 kW (4 hp)						
		7	3.7 kW (4 hp)						
		8	4.0 kW (5 hp)						
		9	5.5 kW (7.5 hp)						
		10	7.5 kW (10 hp)						
		11	11.0 kW (15 hp)						
		12	15.0 kW (20 hp)						
		13	18.5 kW (25 hp)						
		14	22.0 kW (30 hp)						
		15	30.0 kW (40 hp)						
dr.15	Torque boost options	0	Manual	0: Manual	R/W	–	v, s	0h110F	–
		1	Auto1						
dr.16	Forward Torque boost	0.0–15.0%		2.0	R/W	–	v, s	0h1110	4–71
dr.17	Reverse Torque boost	0.0–15.0%		2.0	R/W	–	v, s	0h1111	4–71
dr.18	Base frequency	40.00–400.00 Hz [V/F, Slip Compen] 40.00–120.00 Hz [IM Sensorless]		60.00	R/W	–	v, s, i	0h1112	4–68
dr.19	Start frequency	0.01–10.00Hz		0.50	R/W	–	v, s, i	0h1113	4–68
dr.20	Maximum frequency	40.00–400.00 Hz [V/F, Slip Compen] 40.00–120.00 Hz [IM Sensorless]		60.00	R/W	–	v, s, i	0h1114	4–78

Drive Parameter Group (dr)								
Pr. Code	**Name**	**Setting Range**	**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
dr.26	Auto torque boost filter gain	1–1000	2.0	♦R/W	dR.15=1	v, s	0h111A	4–72
dr.27	Auto torque boost monitoring gain	0.0–300.0%	50.0	♦R/W	dR.15=1	v, s	0h111B	4–72
dr.28	Auto torque boost regeneration	0.0–300.0%	50.0	♦R/W	dR.15=1	v, s	0h111C	4–72
dr.80	Select ranges at power input	Select ranges drive displays at power input 0 Run frequency 1 Acceleration time 2 Deceleration time 3 Command source 4 Frequency reference source 5 Multi–step speed frequency1 6 Multi–step speed frequency2 7 Multi–step speed frequency3 8 Output current 9 Motor RPM 10 Drive DC voltage 11 User select signal (dr.81) 12 Currently out of order 13 Select run direction 14 Output current2 15 Motor RPM2 16 Drive DC voltage2 17 User select signal2 (dr.81)	0: Run frequency	♦R/W		v, s, i	0h1150	–
dr.81	Select monitor code	User selected display value for Operation (SPS) Menu 0 Output voltage(V) 1 Output electric power (kW) 2 Torque (kg f*m) 3 PID feedback monitor	0: Output voltage	♦R/W		v, s, i	0h1151	3–15
dr.87	Drive Firmware (datafile) version					v, s, i	0h0301	
dr.89	Display changed parameter	0 View All 1 View Changed	0: View All	♦R/W		v, s, i	0h03E3	4–124
dr.90	Reserved	–	–	–	–	–	–	–

Drive Parameter Group (dr)									
Pr. Code	**Name**	**Setting Range**		**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
dr.91	Smart copy	0	None	0: None	R/W		v, s, i	0h115B	–
		1	SmartDownlaod						
		3	SmartUpLoadd						
		4	RemoteUpLoad						
		5	RemoteDownload						
dr.92	Parameter save	0	None	0: None	R/W		v, s, i	no address	4–123
		1	Parameter Save						
dr.93	Parameter initialization	0	No	0: No	R/W		v, s, i	0h115D	4–123
		1	All Grp						
		2	dr Grp						
		3	bA Grp						
		4	Ad Grp						
		5	Cn Grp						
		6	In Grp						
		7	OU Grp						
		8	CM Grp						
		9	AP Grp						
		12	Pr Grp						
		13	M2 Grp						
		14	Operation Grp						
dr.94	Password registration	0–9999		–	♦R/W		v, s, i	0h115E	4–124
dr.95	Parameter lock settings	0–9999		–	♦R/W		v, s, i	0h115F	4–124
dr.97	Software version	–		–	Read Only		v, s, i	0h1161	–
dr.98	Display I/O (Comm) board version	–		–	Read Only	–	v, s, i	0h1162	–

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.
bA.0	Jump Code	1–99		20	♦R/W	–	v, s, i	–	3–6
bA.1	Auxiliary reference source	0	None	0: None	R/W	–	v, s, i	0h1201	4–84
		1	V1: Analog Voltage Input						
		3	V0: Built-in Potentiometer dial						
		4	I2: Analog Current Input						
bA.2	Auxiliary command calculation type	0	M+(G*A)	0: M+(G*A)	R/W	bA.1≠0	v, s, i	0h1202	4–84
		1	Mx (G*A)						
		2	M/(G*A)						
		3	M+[M*(G*A)]						
		4	M+G*2(A–50%)						
		5	Mx[G*2(A–50%)						
		6	M/[G*2(A–50%)]						
		7	M+M*G*2 (A–50%)						
bA.3	Auxiliary command gain	–200.0–200.0%		100.0	♦R/W	bA.1≠0	v, s, i	0h1203	4–84
bA.4	2nd command source	0	Keypad	1: Fx/Rx–1 (Fwd Run/ Rev Run)	R/W	–	v, s, i	0h1204	4–80
		1	Fx/Rx–1 (Fwd Run/Rev Run)						
		2	Fx/Rx–2 (Run/Direction)						
		3	Int 485						
		4	Fieldbus (Ethernet)						
bA.5	2nd frequency source	0	Keypad–1	0: Keypad–1	♦R/W	–	v, s, i	0h1205	4–80
		1	Keypad–2						
		2	V1						
		4	V0						
		5	I2						
		6	Int 485						
		8	Fieldbus (Ethernet)						
bA.7	V/F pattern options	0	Linear	0: Linear	R/W	–	v, s	0h1207	4–68
		1	Square						
		2	User V/F						
		3	Square 2						
bA.8	Acc/dec standard frequency	0	Max Freq	0: Max Freq	R/W	–	v, s, i	0h1208	4–62
		1	Delta Freq						
bA.9	Time scale settings	0	0.01 sec	1: 0.1 sec	R/W	–	v, s, i	0h1209	4–62
		1	0.1 sec						
		2	1 sec						

BASIC Parameter group (bA)								
Pr. Code	**Name**	**Setting Range**	**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
bA.10	Input power frequency	0 60Hz 1 50Hz	0: 60Hz	R/W	–	v, s, i	0h120A	4–122
bA.11	Number of motor poles	2–48	Dependent on motor setting	R/W	–	v, s, i	0h120B	4–95
bA.12	Rated slip speed	0–3000(Rpm)	Dependent on motor setting	R/W	–	v, s, i	0h120C	4–95
bA.13	Motor rated current	1.0–1000.0A	Dependent on motor setting	R/W	–	v, s, i	0h120D	4–95
bA.14	Motor no load current	0.0–1000.0A	Dependent on motor setting	R/W	–	v, s, i	0h120E	4–95
bA.15	Motor rated voltage	0, 100–480V	0	R/W	–	v, s, i	0h120F	4–73
bA.16	Motor efficiency	64–100%	Dependent on motor setting	R/W	–	v, s, i	0h1210	4–95
bA.17	Load inertia rate	0–8	0	R/W	–	v, s, i	0h1211	4–95
bA.18	Trim power display	70–130%	100	♦R/W	–	v, s, i	0h1212	–
bA.19	Input power voltage	170–480V	220/380	♦R/W	–	v, s, i	0h1213	4–122
bA.20	Auto Tuning	0 None 1 All (Rotation type) 2 ALL (Static type) 3 Rs+Lsigma (Rotation type) 6 Tr (Static type)	0: None	R/W	–	i	–	4–102
bA.21	Stator resistance	Dependent on motor setting	Dependent on motor setting	R/W	–	i	–	4–102
bA.22	Leakage inductance	–	Dependent on motor setting	R/W	–	i	–	4–102
bA.23	Stator inductance	–	Dependent on motor setting	R/W	–	i	–	4–102
bA.24	Rotor time constant	25–5000(ms)	Dependent on motor setting	R/W	dr.9=4 IM Sensorless	i	–	4–102
bA.41	User frequency1	0.00–Maximum frequency(Hz)	15.00	R/W	bA.7 or m2.25=2	v, s	0h1229	4–70
bA.42	User voltage1	0–100%	25	R/W	bA.7 or m2.25=2	v, s	0h122A	4–70
bA.43	User frequency2	0.00–0.00– Maximum frequency(Hz)	30.00	R/W	bA.7 or m2.25=2	v, s	0h122B	4–70
bA.44	User voltage2	0–100%	50	R/W	bA.7 or m2.25=2	v, s	0h122C	4–70

BASIC Parameter group (bA)								
Pr. Code	Name	Setting Range	Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
bA.45	User frequency3	0.00–Maximum frequency(Hz)	45.00	R/W	bA.7 or m2.25=2	v, s	0h122D	4–70
bA.46	User voltage3	0–100%	75	R/W	bA.7 or m2.25=2	v, s	0h122E	4–70
bA.47	User frequency4	0.00–Maximum frequency(Hz)	Maximum frequency	R/W	bA.7 or m2.25=2	v, s	0h122F	4–70
bA.48	User voltage4	0–100%	100	R/W	bA.7 or m2.25=2	v, s	0h1230	4–70
bA.53	Multi–step speed frequency4	0.00–Maximum frequency(Hz)	40.00	♦R/W	In.65–69= Spd–L/M/H	v, s, i	0h1235	4–53
bA.54	Multi–step speed frequency5	0.00–Maximum frequency(Hz)	50.00	♦R/W	In.65–69= Spd–L/M/H	v, s, i	0h1236	4–53
bA.55	Multi–step speed frequency6	0.00–Maximum frequency(Hz)	Maximum frequency	♦R/W	In.65–69= Spd–L/M/H	v, s, i	0h1237	4–53
bA.56	Multi–step speed frequency7	0.00–Maximum frequency(Hz)	Maximum frequency	♦R/W	In.65–69= Spd–L/M/H	v, s, i	0h1238	4–53
bA.70	Multi–step acceleration time1	0.0–600.0s	20.0	♦R/W	–	v, s, i	0h1246	4–63
bA.71	Multi–step deceleration time1	0.0–600.0s	20.0	♦R/W	–	v, s, i	0h1247	4–63
bA.72	Multi–step acceleration time2	0.0–600.0s	30.0	♦R/W	In.65–69= Xcel–L/M/H	v, s, i	0h1248	4–63
bA.73	Multi–step deceleration time2	0.0–600.0s	30.0	♦R/W	In.65–69= Xcel–L/M/H	v, s, i	0h1249	4–63
bA.74	Multi–step acceleration time3	0.0–600.0s	40.0	♦R/W	In.65–69= Xcel–L/M/H	v, s, i	0h124A	4–63
bA.75	Multi–step deceleration time3	0.0–600.0s	40.0	♦R/W	In.65–69= Xcel–L/M/H	v, s, i	0h124B	4–63
bA.76	Multi–step acceleration time4	0.0–600.0s	50.0	♦R/W	In.65–69= Xcel–L/M/H	v, s, i	0h124C	4–63
bA.77	Multi–step deceleration time4	0.0–600.0s	50.0	♦R/W	In.65–69= Xcel–L/M/H	v, s, i	0h124D	4–63
bA.78	Multi–step acceleration time5	0.0–600.0s	40.0	♦R/W	In.65–69= Xcel–L/M/H	v, s, i	0h124E	4–63
bA.79	Multi–step deceleration time5	0.0–600.0s	40.0	♦R/W	In.65–69= Xcel–L/M/H	v, s, i	0h124F	4–63
bA.80	Multi–step acceleration time6	0.0–600.0s	30.0	♦R/W	In.65–69= Xcel–L/M/H	v, s, i	0h1250	4–63

BASIC Parameter group (bA)								
Pr. Code	Name	Setting Range	Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
bA.81	Multi–step deceleration time6	0.0–600.0s	30.0	♦R/W	In.65–69= Xcel–L/M/H	v, s, i	0h1251	4–63
bA.82	Multi–step acceleration time7	0.0–600.0s	20.0	♦R/W	In.65–69= Xcel–L/M/H	v, s, i	0h1252	4–63
bA.83	Multi–step deceleration time7	0.0–600.0s	20.0	♦R/W	In.65–69= Xcel–L/M/H	v, s, i	0h1253	4–63

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	1–99		24	♦R/W	–	v, s, i	–	3–6
Ad.1	Acceleration pattern	0	Linear	0: Linear	R/W	–	v, s, i	0h1301	4–66
		1	S–curve						
Ad.2	Deceleration pattern	0	Linear	0: Linear	R/W	–	v, s, i	0h1302	4–66
		1	S–curve						
Ad.3	S–curve acceleration start point gradient	1–100%		40	R/W	Ad.1=1	v, s, i	0h1303	4–66
Ad.4	S–curve acceleration end point gradient	1–100%		40	R/W	Ad.1=1	v, s, i	0h1304	4–66
Ad.5	S–curve deceleration start point gradient	1–100%		40	R/W	Ad.2=1	v, s, i	0h1305	4–66
Ad.6	S–curve deceleration end point gradient	1–100%		40	R/W	Ad.2=1	v, s, i	0h1306	4–66
Ad.7	Start Mode	0	Acc	0: Acc	R/W	–	v, s, i	0h1307	4–73
		1	DC–Start						
Ad.8	Stop Mode	0	Dec	0: Dec	R/W	–	v, s, i	0h1308	4–75
		1	DC–Brake						
		2	Free–Run						
		4	Power Braking						
Ad.9	Selection of prohibited rotation direction	0	None	0: None	R/W	–	v, s, i	0h1309	4–59
		1	Forward Prevent						
		2	Reverse Prevent						
Ad.10	Starting with power on	0	No	0: No	♦R/W	–	v, s, i	0h130A	4–60
		1	Yes						
Ad.12	DC braking time at startup	0.00–60.00s		0.00	R/W	Ad.7=1	v, s	0h130C	4–73
Ad.13	Amount of applied DC	0–Rated Current of Drive/ Rated Current of Motor x 100 (%)		50	R/W	–	v, s	0h130D	4–73
Ad.14	Output blocking time before DC braking	0.00– 60.00s		0.10	R/W	Ad.8=1	v, s, i	0h130E	4–75
Ad.15	DC braking time	0.00– 60.00s		1.00	R/W	Ad.8=1	v, s, i	0h130F	4–75
Ad.16	DC braking rate	0–Rated Current of Drive/ Rated Current of Motor x 100 (%)		50	R/W	Ad.8=1	v, s, i	0h1310	4–75
Ad.17	DC braking frequency	Start frequency–60 Hz		5.00	R/W	Ad.8=1	v, s, i	0h1311	4–75
Ad.20	Dwell frequency on acceleration	Start frequency–Maximum frequency(Hz)		5.00	R/W	–	v, s, i	0h1314	4–93

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	0.0–60.0s		0.0	R/W	–	v, s, i	0h1315	4–93
Ad.22	Dwell frequency on deceleration	Start frequency–Maximum frequency(Hz)		5.00	R/W	–	v, s, i	0h1316	4–93
Ad.23	Dwell operation time on deceleration	0.0–60.0s		0.0	R/W	–	v, s, i	0h1317	4–93
Ad.24	Frequency limit	0	No	0: No	R/W	–	v, s, i	0h1318	4–78
		1	Yes						
Ad.25	Frequency lower limit value	0.00–Upper limit frequency (Hz)		0.50	♦R/W	Ad.24=1	v, s, i	0h1319	4–78
Ad.26	Frequency upper limit value	Lower limit frequency–Maximum frequency (Hz)		maximum frequency	R/W	Ad.24=1	v, s, i	0h131A	4–78
Ad.27	Frequency jump	0	No	0: No	R/W	–	v, s, i	0h131B	4–79
		1	Yes						
Ad.28	Jump frequency lower limit1	0.00–Jump frequency upper limit1 (Hz)		10.00	♦R/W	Ad.27=1	v, s, i	0h131C	4–79
Ad.29	Jump frequency upper limit1	Jump frequency lower limit1–Maximum frequency (Hz)		15.00	♦R/W	Ad.27=1	v, s, i	0h131D	4–79
Ad.30	Jump frequency lower limit2	0.00–Jump frequency upper limit2 (Hz)		20.00	♦R/W	Ad.27=1	v, s, i	0h131E	4–79
Ad.31	Jump frequency upper limit2	Jump frequency lower limit2–Maximum frequency(Hz)		25.00	♦R/W	Ad.27=1	v, s, i	0h131F	4–79
Ad.32	Jump frequency lower limit3	0.00–Jump frequency upper limit3 (Hz)		30.00	♦R/W	Ad.27=1	v, s, i	0h1320	4–79
Ad.33	Jump frequency upper limit3	Jump frequency lower limit3–Maximum frequency (Hz)		35.00	♦R/W	Ad.27=1	v, s, i	0h1321	4–79
Ad.41	Brake release current	0.0–180.0%		50.0	♦R/W	OU.31 or OU.33 = 35	v, s, i	0h1329	4–126
Ad.42	Brake release delay time	0.00–10.00s		1.00	R/W	OU.31 or OU.33 = 35	v, s, i	0h132A	4–126
Ad.44	Brake release Forward frequency	0.00–Maximum frequency(Hz)		1.00	R/W	OU.31 or OU.33 = 35	v, s, i	0h132C	4–126
Ad.45	Brake release Reverse frequency	0.00–Maximum frequency(Hz)		1.00	R/W	OU.31 or OU.33 = 35	v, s, i	0h132D	4–126
Ad.46	Brake engage delay time	0.00–10.00s		1.00	R/W	OU.31 or OU.33 = 35	v, s, i	0h132E	4–126
Ad.47	Brake engage frequency	0.00–Maximum frequency(Hz)		2.00	R/W	OU.31 or OU.33 = 35	v, s, i	0h132F	4–126
Ad.50	Energy saving operation	0	None	0: None	R/W	–	v, s	0h1332	4–112
		1	Manual						
		2	Auto						
Ad.51	Energy saving level	0–30%		0	♦R/W	Ad.50≠0	v, s	0h1333	4–112
Ad.60	Acc/Dec time switch frequency	0.00–Maximum frequency(Hz)		0.00	R/W	–	v, s, i	0h133C	4–64

ADVANCED Parameter Group (Ad)								
Pr. Code	**Name**	**Setting Range**	**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
Ad.61	Rotation count speed gain (RPM display)	0.1–6000.0%	100.0	♦R/W	–	v, s, i	0h133D	4–137
Ad.62	Reserved	–	–	–	–	–	–	–
Ad.63	Reserved	–	–	–	–	–	–	–
Ad.64	Cooling fan control	0 During Run 1 Always ON 2 Temp Control	0: During Run	♦R/W	–	v, s, i	0h1340	4–122
Ad.65	Up/down operation frequency save	0 No 1 Yes	0: No	♦R/W	–	v, s, i	0h1341	4–89
Ad.66	Output contact On/ Off control options	0 None 1 V1 3 V0 4 I2	0: None	R/W	–	v, s, i	0h1342	4–127
Ad.67	Output contact On level	Output contact off level–100.00%	90.00	R/W	–	v, s, i	0h1343	4–127
Ad.68	Output contact Off level	–100.00–output contact on level (%)	10.00	R/W	–	v, s, i	0h1344	4–127
Ad.70	Safe operation selection	0 Always Enable 1 DI Dependent	0: Always Enable	R/W	–	v, s, i	0h1346	4–92
Ad.71	Safe operation stop options	0 Free–Run 1 Q–Stop 2 Q–Stop Resume	0: Free–Run	R/W	Ad.70=1	v, s, i	0h1347	4–92
Ad.72	Safe operation deceleration time	0.0–600.0s	5.0	♦R/W	Ad.70=1	v, s, i	0h1348	4–92
Ad.74	Selection of regeneration evasion function for press	0 No 1 Yes	0: No	R/W		v, s, i	0h134A	4–127
Ad.75	Voltage level of regeneration evasion motion for press	230V : 300–400V 460V : 600–800V	350 700	R/W		v, s, i	0h134B	4–127
Ad.76	Compensation frequency limit of regeneration evasion for press	0.00– 10.00Hz	1.00	R/W	Ad.74=1	v, s, i	0h134C	4–127
Ad.77	Regeneration evasion for press P gain	0.0– 100.0%	50.0	♦R/W	Ad.74=1	v, s, i	0h134D	4–127
Ad.78	Regeneration evasion for press I gain	20–30000(ms)	500	♦R/W	Ad.74=1	v, s, i	0h134E	4–127
Ad.79	Dynamic Brake (DB) Unit turn on voltage level	230V: 350–400V 460V: 600–800V	390V 780V	R/W	–	v, s, i	0h134F	4–147

ADVANCED Parameter Group (Ad)									
Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
Ad.80	Fire mode selection	0	None	0: None	R/W	–	v, s, i	0h1350	4–82
		1	Fire Mode						
		2	Fire Mode Test						
Ad.81	Fire mode frequency	Start frequency–Maximum frequency (Hz)		60.00	R/W	Ad.80≠0	v, s, i	0h1351	4–82
Ad.82	Fire mode direction	0	Forward	0: Forward	R/W	Ad.80≠0	v, s, i	0h1352	4–82
		1	Reverse						
Ad.83	Fire Mode Count	Can not be modified		–	Read Only	Ad.80≠0	v, s, i	–	4–82
Ad.85	Up–down mode selection	0	U/D Normal	0: U/D Normal	R/W	–	v, s, i	0h1355	4–89
		1	U/D Step						
		2	U/D Step+ Norm						
Ad.86	Up–down step frequency	0–maximum frequency (Hz)		0	♦R/W	–	v, s, i	0h1356	4–89

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.

CONTROL Parameter Group (Cn)									
Pr. Code	**Name**	**Setting Range**		**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
Cn.0	Jump Code	1–99		4	♦R/W	–	v, s, i	–	3–6
Cn.4	Carrier frequency	Heavy load (HD)	V/F: 1.0–15.0 (kHz) IM: 2.0–15.0 (kHz)	3.0	R/W	–	v, s, i	0h1404	4–118
		Normal load (ND)	V/F: 1.0–5.0 (kHz) IM: 2.0–5.0 (kHz)	2.0					
Cn.5	Switching mode	0	Normal PWM	0: Normal PWM	R/W	–	v, s, i	0h1405	4–118
Cn.9	Initial excitation time	0.00–60.00s		1.00	R/W	–	i	0h1409	4–106
Cn.10	Initial excitation amount	100.0–300.0%		100.0	R/W	–	i	0h140A	4–106
Cn.11	Continued operation duration	0.00–60.00s		0.00	R/W	–	i	0h140B	4–106
Cn.21	Low-speed torque compensation gain	50–300%		Dependent on motor setting	R/W	–	i	0h1415	4–106
Cn.22	Output torque compensation gain	50–300%		Dependent on motor setting	R/W	–	i	0h1416	4–106
Cn.23	Speed deviation compensation gain	50–300%		Dependent on motor setting	R/W	–	i	0h1417	4–106
Cn.24	Main compensation of speed deviation	50–300%		Dependent on motor setting	R/W	–	i	0h1418	4–106
Cn.29	No load speed deviation compensation gain	0.50–2.00		1.06	♦R/W	–	i	0h141D	4–106
Cn.30	Speed response adjustment gain	2.0–10.0		4	♦R/W	–	i	0h141E	4–106

CONTROL Parameter Group (Cn)									
Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
Cn.53	Torque limit setting options	0	Keypad–1: Change+Enter	0: Keypad–1	R/W	–	i	0h1435	4–106
		1	Keypad–2: Instant change						
		2	V1: Voltage Analog Input						
		4	V0: Built-in Potentiometer dial						
		5	I2: Current Analog Input						
		6	Int 485						
		8	Fieldbus (Ethernet)						
Cn.54	Positive–direction reverse torque limit	0.0–300.0%		180	♦R/W	dr.9= 4	i	0h1436	4–106
Cn.55	Positive–direction regeneration torque limit	0.0–200.0%		180	♦R/W	dr.9= 4	i	0h1437	4–106
Cn.56	Negative–direction regeneration torque limit	0.0–200.0%		180	♦R/W	dr.9= 4	i	0h1438	4–106
Cn.57	Negative–direction reverse torque limit	0.0–300.0%		180	♦R/W	dr.9= 4	i	0h1439	4–106
Cn.70	Speed search mode selection	0	Flying Start–1	0: Flying Start–1	R/W	–	v, s, i	0h1446	4–113
		1	Flying Start–2						
Cn.71	Speed search operation selection	bit	0000– 1111	0000	R/W	–	v, s, i	0h1447	4–113
		0001	Selection of speed search on acceleration						
		0010	When starting on initialization after fault trip						
		0100	When restarting after instantaneous power interruption						
		1000	When starting with power on						
Cn.72	Speed search reference current	80–200%		150	♦R/W	Cn.70=0 and Cn.71 any bit set to 1	v, s, i	0h1448	4–113
Cn.73	Speed search proportional gain	0–9999		Flying Start–1 : 100	♦R/W	Cn.71. any bit set to 1	v, s, i	0h1449	4–113
				Flying Start–2 : 600					

CONTROL Parameter Group (Cn)								
Pr. Code	**Name**	**Setting Range**	**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
Cn.74	Speed search integral gain	0–9999	Flying Start–1 : 200 Flying Start–2 : 1000	♦R/W	Cn.71. any bit set to 1	v, s, i	0h144A	4–113
Cn.75	Output blocking time before speed search	0.0–60.0s	1.0	R/W	Cn.71. any bit set to 1	v, s, i	0h144B	4–113
Cn.76	Speed search Estimator gain	50–150%	100	♦R/W	Cn.71. any bit set to 1	v, s, i	0h144C	–
Cn.77	Energy buffering selection	0: No 1: KEB–1 2: KEB–2	0: No	R/W	–	v, s, i	0h144D	4–109
Cn.78	Energy buffering start level	110.0–200.0%	125.0	R/W	Cn.77≠0	v, s, i	0h144E	4–109
Cn.79	Energy buffering stop level	Cn.78–210.0%	130.0	R/W	Cn.77≠0	v, s, i	0h144F	4–109
Cn.80	Energy buffering P gain	0–20000	1000	♦R/W	Cn.77≠0	v, s, i	0h1450	4–109
Cn.81	Energy buffering I gain	1–20000	500	♦R/W	Cn.77≠0	v, s, i	0h1451	4–109
Cn.82	Energy buffering Slip gain	0–2000.0%	30.0	♦R/W	Cn.77≠0	v, s, i	0h1452	4–109
Cn.83	Energy buffering acceleration time	0.0–600.0s	10.0	♦R/W	Cn.77≠0	v, s, i	0h1453	4–109

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.

INPUT Parameter Group (In)									
Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
In.0	Jump Code	1–99		65	♦R/W	–	v, s, i	–	3–6
In.1	Frequency for maximum analog input	Start frequency–Maximum frequency(Hz)		Maximum frequency	♦R/W	–	v, s, i	0h1501	4–46
In.2	Torque at maximum analog input	0.0–200.0%		100.0	♦R/W	–		0h1502	4–105
In.5	V1 input voltage display	–12.00–12.00V		0.00	Read Only	–	v, s, i	0h1505	4–46
In.6	V1 input polarity selection	0	Unipolar	0: Unipolar	R/W	–	v, s, i	0h1506	4–46
		1	Bipolar						
In.7	Time constant of V1 input filter	0–10000(ms)		100	♦R/W	–	v, s, i	0h1507	4–46
In.8	V1 Minimum input voltage	0.00–10.00V		0.00	♦R/W	–	v, s, i	0h1508	4–46
In.9	V1 output at Minimum voltage (%)	0.00–100.00%		0.00	♦R/W	–	v, s, i	0h1509	4–46
In.10	V1 Maximum input voltage	0.00–12.00V		10.00	♦R/W	–	v, s, i	0h150A	4–46
In.11	V1 output at Maximum voltage (%)	0.00–100.00%		100.00	♦R/W	–	v, s, i	0h150B	4–46
In.12	V1 Minimum input voltage	–10.00– 0.00V		0.00	♦R/W	In.6=1	v, s, i	0h150C	4–49
In.13	V1 output at Minimum voltage (%)	–100.00–0.00%		0.00	♦R/W	In.6=1	v, s, i	0h150D	4–49
In.14	V1 Maximum input voltage	–12.00– 0.00V		–10.00	♦R/W	In.6=1	v, s, i	0h150E	4–49
In.15	V1 output at Maximum voltage (%)	–100.00–0.00%		–100.00	♦R/W	In.6=1	v, s, i	0h150F	4–49
In.16	V1 rotation direction change	0	No	0: No	♦R/W	–	v, s, i	0h1510	4–46
		1	Yes						
In.17	V1 quantization level	0.00, 0.04–10.00%		0.04	R/W	–	v, s, i	0h1511	4–46
In.35	V0 input voltage display	0.00–5.00V		0.00	Read Only		v, s, i	0h1523	4–45
In.37	V0 input filter time constant	0–10000(ms)		100	♦R/W		v, s, i	0h1525	4–45
In.38	V0 Minimum input voltage	0.00–5.00V		0.00	♦R/W		i	0h1526	4–45
In.39	V0 output at Minimum voltage (%)	0.00–100.00%		0.00	♦R/W		v, s, i	0h1527	4–45

INPUT Parameter Group (In)									
Pr. Code	**Name**	**Setting Range**		**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
In.40	V0 Maximum input voltage	0.00–5.00V		5	♦R/W		i	0h1528	4–45
In.41	V0 output at Maximum voltage (%)	0.00–100.00%		100.00	♦R/W		v, s, i	0h1529	4–45
In.46	V0 rotation direction change	0	No	0: No	♦R/W	Analog Input Dipswitch =V	v, s, i	0h152E	4–45
		1	Yes						
In.47	V0 quantization level	0.00, 0.04– 10.00%		0.04	♦R/W		v, s, i	0h152F	4–45
In.50	I2 input current display	0–24 mA		0.00	Read Only		v, s, i	0h1532	4–51
In.52	I2 input filter time constant	0–10000ms		100	♦R/W		v, s, i	0h1534	4–51
In.53	I2 minimum input current	0.00–20.00 mA		4.00	♦R/W		v, s, i	0h1535	4–51
In.54	I2 output at Minimum current (%)	0.00–100.00%		0.00	♦R/W		v, s, i	0h1536	4–51
In.55	I2 maximum input current	0.00–20.00mA		20.00	♦R/W		v, s, i	0h1537	4–51
In.56	I2 output at Maximum current (%)	0.00–100.00%		100.00	♦R/W		v, s, i	0h1538	4–51
In.61	Changing rotation direction of I2	0	No	0: No	♦R/W	Analog Input Dipswitch =I	v, s, i	0h153D	4–51
		1	Yes						
In.62	I2 quantization level	0.00, 0.04–10.00%		0.04	♦R/W		v, s, i	0h153E	4–51

INPUT Parameter Group (In)									
Pr. Code	**Name**	**Setting Range**		**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
In.65	P1 terminal function setting	0	None	1: Fx	R/W	–	v, s, i	0h1541	
		1	Fx						4–55
		2	Rx						
		3	RST						4–151
		4	External Trip						4–145
		5	BX (Block)						4–151
		6	JOG						4–88
		7	Speed–L						4–53
		8	Speed–M						
		9	Speed–H						
		11	XCEL–L						4–63
		12	XCEL–M						
		13	RUN Enable						4–92
		14	3–Wire						4–58
		15	2nd Source						4–80
		16	Exchange						4–120
		17	Up (Speed)						4–89
		18	Down (Speed)						
		20	U/D Clear						
		21	Analog Hold						4–52
		22	I–Term Clear						4–97
		23	PID Openloop						
		24	P Gain2						
		25	XCEL Stop						4–68
		26	2nd Motor						4–119
		27	U/D Enable						4–89
		33	Base Block						4–137
		34	Pre Excite						4–74
		38	Timer In						4–125
		40	dis Aux Ref						4–84
		46	FWD JOG						4–89
		47	REV JOG						4–89
		49	XCEL–H						4–63
		51	Fire Mode						4–82
		52	KEB–1 Select						4–109
In.66	P2 terminal function setting	See In.65 for Setting Range		2: Rx	R/W	–	v, s, i	0h1542	See In.65
In.67	P3 terminal function setting	See In.65 for Setting Range		5: BX (block)	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		7: Speed–L	R/W	–	v, s, i	0h1545	See In.65

INPUT Parameter Group (In)									
Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
In.84	Multi–function input terminal On filter selection	Bit Value:		1 1111	♦R/W	–	v, s, i	0h1554	4–81
		0	Disable						
		1	Enable						
		Bit Assignment:							
		0	P1						
		1	P2						
		2	P3						
		3	P4						
		4	P5						
In.85	Multi–function input terminal On filter	0–10000(ms)		10	♦R/W	–	v, s, i	0h1555	4–81
In.86	Multi–function input terminal Off filter	0–10000(ms)		3	♦R/W	–	v, s, i	0h1556	4–81
In.87	Multi–function input contact selection	Bit Value:		0 0000	R/W	–	v, s, i	0h1557	4–81
		0	Norm Open(A)						
		1	Norm Closed(B)						
		Bit Assignment:							
		0	P1						
		1	P2						
		2	P3						
		3	P4						
		4	P5						
In.88	Selects the NO/ NC operation command	0	NO	0	R/W		v, s, i	0h1558	
		1	NC						
In.89	Multi–step command delay time	1–5000(ms)		1	R/W	–	v, s, i	0h1559	4–53
In.90	Multi–function input terminal monitor status	Bit Value:		0 0000	Read Only	–	v, s, i	0h155A	4–81
		0	Off						
		1	On						
		Bit Assignment:							
		0	P1						
		1	P2						
		2	P3						
		3	P4						
		4	P5						
In.99	"SW1(NPN/PNP) status"	Bit	0–1	00	Read Only	–	v, s, i	0h1563	–
		00	NPN						
		01	PNP						

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.

OUTPUT Parameter Group (OU)									
Pr. Code	**Name**	**Setting Range**		**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
OU.0	Jump Code	1–99		30	♦R/W	–	v, s, i	–	3–6
OU.1	Analog output 1 Mode	0	Frequency	0: Frequency	♦R/W	–	v, s, i	0h1601	4–128
		1	Output Current						
		2	Output Voltage						
		3	DCLink Voltage						
		4	Torque						
		5	Output Power						
		6	Idse						
		7	Iqse						
		8	Target Freq						
		9	Ramp Freq						
		10	Speed Fdb						
		12	PID Ref Value						
		13	PID Fdb Value						
		14	PID Output						
		15	Constant						
OU.2	Analog output 1 gain	–1000.0–1000.0%		100.0	♦R/W	–	v, s, i	0h1602	4–128
OU.3	Analog output 1 bias	–100.0–100.0%		0.0	♦R/W	–	v, s, i	0h1603	4–128
OU.4	Analog output 1 filter	0–10000(ms)		5	♦R/W	–	v, s, i	0h1604	4–128
OU.5	Analog constant output 1	0.0–100.0%		0.0	♦R/W	–	v, s, i	0h1605	4–128
OU.6	Analog output 1 monitor	0.0–1000.0%		0.0	Read Only	–	v, s, i	0h1606	4–128
OU.30	Fault output item	bit	000–111	010	♦R/W	–	v, s, i	0h161E	4–135
		001	Low voltage						
		010	Any faults other than low voltage						
		100	Automatic restart final failure						

OUTPUT Parameter Group (OU)									
Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
OU.31	Multi–function Output Relay1 Setting (A1, B1, C1 terminals)	0	None	29: Trip	♦R/W	–	v, s, i	0h161F	4–131
		1	FDT–1						
		2	FDT–2						
		3	FDT–3						
		4	FDT–4						
		5	Over Load						
		6	IOL						
		7	Under Load						
		8	Fan Warning						
		9	Stall						
		10	Over Voltage						
		11	Low Voltage						
		12	Over Heat						
		13	Lost Command						
		14	Run						
		15	Stop						
		16	Steady						
		17	Drive Line						
		18	Comm Line						
		19	Speed Search						
		21	Regeneration						
		22	Ready						
		23	Zero Speed						
		28	Timer Out						
		29	Trip						
		31	DB Warn%ED						
		34	On/Off Control						
		35	BR Control						
		36	Reserved						
		37	Fan Exchange						
		38	Fire Mode						
		40	KEB Operating						
		41	Pre Overhead						
		42	Minor Fault						
		43	Torque Detect1						
		44	Torque Detect2						
		45	PID Sleep						
OU.33	Multi–function Output Relay2 setting (A2,C2 terminals)	See OU.31 values		14: Run	♦R/W	–	v, s, i	0h1621	4–131
OU.41	Multi–function output monitor	Monitor status of Relay1 and Relay2		00	Read Only	–	v, s, i	0h1629	4–131

OUTPUT Parameter Group (OU)									
Pr. Code	**Name**	**Setting Range**		**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
OU.50	Multi–function output On delay	0.00–100.00s		0.00	♦R/W	–	v, s, i	0h1632	4–136
OU.51	Multi–function output Off delay	0.00–100.00s		0.00	♦R/W	–	v, s, i	0h1633	4–136
OU.52	Multi–function output contact selection	Bit Value:		00	R/W	–	v, s, i	0h1634	4–136
		0 = A Contact (NO)							
		1 = B Contact (NC)							
OU.53	Fault output On delay	0.00–100.00s		0.00	♦R/W	–	v, s, i	0h1635	4–135
OU.54	Fault output Off delay	0.00–100.00s		0.00	♦R/W	–	v, s, i	0h1636	4–135
OU.55	Timer On delay	0.00–100.00s		0.00	♦R/W	–	v, s, i	0h1637	4–125
OU.56	Timer Off delay	0.00–100.00s		0.00	♦R/W	–	v, s, i	0h1638	4–125
OU.57	Detected frequency (FDT)	0.00–Maximum frequency(Hz)		30.00	♦R/W	–	v, s, i	0h1639	4–131
OU.58	Detected frequency band (FDT)	0.00–Maximum frequency(Hz)		10.00	♦R/W	–	v, s, i	0h163A	4–131
OU.67	Torque detection 1 operation setting	0	None	0:None	R/W	OU.31 or OU.33 = 43	v, s, i	0h1643	4–154
		1	OT CmdSpd Warn						
		2	OT Warning						
		3	OT CmdSpdTrip						
		4	OT Trip						
		5	UT CmdSpd Warn						
		6	UT Warning						
		7	UT CmdSpdTrip						
		8	UT Trip						
OU.68	Torque detection 1 level	0.0–200.0		100.0	♦R/W	OU.31 or OU.33 = 43	v, s, i	0h1644	4–154
OU.69	Torque detection 1 delay time	0–100		1.0	♦R/W	OU.31 or OU.33 = 43	v, s, i	0h1645	4–154
OU.70	Torque detection 2 operation setting	0	None	0:None	R/W	OU.31 or OU.33 = 44	v, s, i	0h1646	4–154
		1	OT CmdSpd Warn						
		2	OT Warning						
		3	OT CmdSpdTrip						
		4	OT Trip						
		5	UT CmdSpd Warn						
		6	UT Warning						
		7	UT CmdSpdTrip						
		8	UT Trip						
OU.71	Torque detection 2 level	0.0–200.0		100.0	♦R/W	OU.31 or OU.33 = 44	v, s, i	0h1647	4–154
OU.72	Torque detection 2 delay time	0–100		1.0	♦R/W	OU.31 or OU.33 = 44	v, s, i	0h1648	

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	1–99		20	♦R/W	–	v, s, i	–	3–6
CM.1	Built–in communication drive ID	1–250		1	♦R/W	–	v, s, i	0h1701	5–7
CM.2	Built–in communication protocol	0	ModBus RTU	0: ModBus RTU	♦R/W	–	v, s, i	0h1702	5–7
		2	Not supported						
CM.3	Built–in communication speed	0	1200 bps	3: 9600 bps	♦R/W	–	v, s, i	0h1703	5–7
		1	2400 bps						
		2	4800 bps						
		3	9600 bps						
		4	19200 bps						
		5	38400 bps						
		6	56 Kbps						
		7	115 Kbps						
CM.4	Built–in communication frame setting	0	D8/PN/S1	0: D8/ PN/S1	♦R/W	–	v, s, i	0h1704	5–7
		1	D8/PN/S2						
		2	D8/PE/S1						
		3	D8/PO/S1						
CM.5	Transmission delay after reception	0–1000(ms)		5ms	♦R/W	–	v, s, i	0h1705	5–7
CM.6	Ethernet Module (Fbus) S/W version	–		0.00	♦R/W	ACG–ET2 Installed	v, s, i	0h1706	–
CM.7	Communication option drive ID	0–255		1.00	♦R/W	ACG–ET2 Installed	v, s, i	0h1707	
CM.8	Ethernet Module (Fbus) communication speed	–		12Mbps	Read Only	ACG-ET2 Installed	v, s, i	0h1708	
CM.9	Ethernet Module (Fbus) LED status	–		–	Read Only	ACG–ET2 Installed	v, s, i	0h1709	–
CM.10	Opt Parameter 1 (IP address 1st octet)	0–255		192	R/W	ACG–ET2 Installed	v, s, i	0h170A	B–8
CM.11	Opt Parameter 2 (IP address 2nd octet)	0–255		168	R/W	ACG–ET2 Installed	v, s, i	0h170B	B–8
CM.12	Opt Parameter 3 (IP address 3rd octet)	0–255		1	R/W	ACG–ET2 Installed	v, s, i	0h170C	B–8

COMMUNICATION Parameter Group (CM)								
Pr. Code	Name	Setting Range	Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
CM.13	Opt Parameter 4 (IP address 4th octet)	0–255	101	R/W	ACG–ET2 Installed	v, s, i	0h170D	B–8
CM.14	Opt Parameter 5 (IP Mask 1st octet)	0–255	255	R/W	ACG–ET2 Installed	v, s, i	0h170E	B–8
CM.15	Opt Parameter 6 (IP Mask 2nd octet)	0–255	255	R/W	ACG–ET2 Installed	v, s, i	0h170F	B–8
CM.16	Opt Parameter 7 (IP Mask 3rd octet)	0–255	255	R/W	ACG–ET2 Installed	v, s, i	0h1710	B–8
CM.17	Opt Parameter 8 (IP Mask 4th octet)	0–255	0	R/W	ACG–ET2 Installed	v, s, i	0h1711	B–8
CM.18	Opt Parameter 9 (IP Gateway 1st octet)	0–255	192	R/W	ACG–ET2 Installed	v, s, i	0h1712	B–8
CM.19	Opt Parameter 10 (IP Gateway 2nd octet)	0–255	168	R/W	ACG–ET2 Installed	v, s, i	0h1713	B–8
CM.20	Opt Parameter 11 (IP Gateway 3rd octet)	0–255	1	R/W	ACG–ET2 Installed	v, s, i	0h1714	B–8
CM.21	Opt Parameter 12 (IP Gateway 4th octet)	0–255	10	R/W	ACG–ET2 Installed	v, s, i	0h1715	B–8
CM.22	Opt Parameter 13 (Network Comm Speed)	0	0	R/W	ACG–ET2 Installed	v, s, i	0h1716	B–8
CM.23	Opt Parameter 14 (CIP Input Instance)	0–11	1	R/W	ACG–ET2 Installed	v, s, i	0h1717	B–8
CM.24	Opt Parameter 15 (CIP Output Instance)	0–11	1	R/W	ACG–ET2 Installed	v, s, i	0h1718	B–8
CM.30	Number of output parameters	0–16	3	♦R/W	–	v, s, i	0h171E	–
CM.31	Output Communication Address–1	0000–FFFF Hex	000A	♦R/W	–	v, s, i	0h171F	5–10
CM.32	Output Communication Address–2	0000–FFFF Hex	000E	♦R/W	–	v, s, i	0h1720	5–10
CM.33	Output Communication Address–3	0000–FFFF Hex	000F	♦R/W	–	v, s, i	0h1721	5–10

COMMUNICATION Parameter Group (CM)								
Pr. Code	**Name**	**Setting Range**	**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
CM.34	Output Communication Address–4	0000–FFFF Hex	0000	♦R/W	–	v, s, i	0h1722	5–10
CM.35	Output Communication Address–5	0000–FFFF Hex	0000	♦R/W	–	v, s, i	0h1723	5–10
CM.36	Output Communication Address–6	0000–FFFF Hex	0000	♦R/W	–	v, s, i	0h1724	5–10
CM.37	Output Communication Address–7	0000–FFFF Hex	0000	♦R/W	–	v, s, i	0h1725	5–10
CM.38	Output Communication Address–8	0000–FFFF Hex	0000	♦R/W	–	v, s, i	0h1726	5–10
CM.39	Output Communication Address–9	0000–FFFF Hex	0000	♦R/W	–	v, s, i	0h1727	5–10
CM.40	Output Communication Address–10	0000–FFFF Hex	0000	♦R/W	–	v, s, i	0h1728	5–10
CM.41	Output Communication Address–11	0000–FFFF Hex	0000	♦R/W	–	v, s, i	0h1729	5–10
CM.42	Output Communication Address–12	0000–FFFF Hex	0000	♦R/W	–	v, s, i	0h172A	5–10
CM.43	Output Communication Address–13	0000–FFFF Hex	0000	♦R/W	–	v, s, i	0h172B	5–10
CM.44	Output Communication Address–14	0000–FFFF Hex	0000	♦R/W	–	v, s, i	0h172C	5–10
CM.45	Output Communication Address–15	0000–FFFF Hex	0000	♦R/W	–	v, s, i	0h172D	5–10
CM.46	Output Communication Address–16	0000–FFFF Hex	0000	♦R/W	–	v, s, i	0h172E	5–10
CM.50	Number of input parameters	0–16	2	♦R/W	–	v, s, i	0h1732	–
CM.51	Input Communication address 1	0000–FFFF Hex	0005	R/W	–	v, s, i	0h1733	5–10
CM.52	Input Communication address 2	0000–FFFF Hex	0006	R/W	–	v, s, i	0h1734	5–10
CM.53	Input Communication address 3	0000–FFFF Hex	0000	R/W	–	v, s, i	0h1735	5–10
CM.54	Input Communication address 4	0000–FFFF Hex	0000	R/W	–	v, s, i	0h1736	5–10

COMMUNICATION Parameter Group (CM)									
Pr. Code	**Name**	**Setting Range**		**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
CM.55	Input Communication address 5	0000–FFFF Hex		0000	R/W	–	v, s, i	0h1737	5–10
CM.56	Input Communication address 6	0000–FFFF Hex		0000	R/W	–	v, s, i	0h1738	5–10
CM.57	Input Communication address 7	0000–FFFF Hex		0000	R/W	–	v, s, i	0h1739	5–10
CM.58	Input Communication address 8	0000–FFFF Hex		0000	R/W	–	v, s, i	0h173A	5–10
CM.59	Input Communication address 9	0000–FFFF Hex		0000	R/W	–	v, s, i	0h173B	5–10
CM.60	Input Communication address 10	0000–FFFF Hex		0000	R/W	–	v, s, i	0h173C	5–10
CM.61	Input Communication address 11	0000–FFFF Hex		0000	R/W	–	v, s, i	0h173D	5–10
CM.62	Input Communication address 12	0000–FFFF Hex		0000	R/W	–	v, s, i	0h173E	5–10
CM.63	Input Communication address 13	0000–FFFF Hex		0000	R/W	–	v, s, i	0h173F	5–10
CM.64	Input Communication address 14	0000–FFFF Hex		0000	R/W	–	v, s, i	0h1740	5–10
CM.65	Input Communication address 15	0000–FFFF Hex		0000	R/W	–	v, s, i	0h1741	5–10
CM.66	Input Communication address 16	0000–FFFF Hex		0000	R/W	–	v, s, i	0h1742	5–10
CM.68	Fieldbus (Ethernet) data swap	0	No	0	R/W	–	v, s, i	0h1744	5–10
		1	Not Supported						

COMMUNICATION Parameter Group (CM)									
Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
CM.70	Communication multi–function input 1	0	None	0: None	♦R/W	–	v, s, i	0h1746	5–9
		1	Fx						
		2	Rx						
		3	RST						
		4	External Trip						
		5	BX						
		6	JOG						
		7	Speed–L						
		8	Speed–M						
		9	Speed–H						
		11	XCEL–L						
		12	XCEL–M						
		13	RUN Enable						
		14	3–Wire						
		15	2nd Source						
		16	Exchange						
		17	Up						
		18	Down						
		20	U/D Clear						
		21	Analog Hold						
		22	I–Term Clear						
		23	PID Openloop						
		24	P Gain2						
		25	XCEL Stop						
		26	2nd Motor						
		27	U/D Enable						
		33	Baseblock						
		34	Pre Excite						
		38	Timer In						
		40	dis Aux Ref						
		46	FWD JOG						
		47	REV JOG						
		49	XCEL–H						
		51	Fire Mode						
		52	KEB–1 Select						
CM.71	Communication multi–function input 2	See CM.70 for Values		0: None	♦R/W	–	v, s, i	0h1747	–
CM.72	Communication multi–function input 3	See CM.70 for Values		0: None	♦R/W	–	v, s, i	0h1748	–
CM.73	Communication multi–function input 4	See CM.70 for Values		0: None	♦R/W	–	v, s, i	0h1749	–

COMMUNICATION Parameter Group (CM)									
Pr. Code	**Name**	**Setting Range**		**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
CM.74	Communication multi–function input 5	See CM.70 for Values		0: None	♦R/W	–	v, s	0h174A	–
CM.75	Communication multi–function input 6	See CM.70 for Values		0: None	♦R/W	–	v, s, i	0h174B	–
CM.76	Communication multi–function input 7	See CM.70 for Values		0: None	♦R/W	–	v, s, i	0h174C	–
CM.77	Communication multi–function input 8	See CM.70 for Values		0: None	♦R/W	–	v, s, i	0h174D	–
CM.86	Communication multi–function input monitoring	–		0	Read Only	–	v, s, i	0h1756	5–9
CM.90	Selection of data frame communication monitor	0	Int485	0	♦R/W	–	v, s, i	0h175A	–
		1	Keypad						
CM.91	Data frame Rev count	0–65535		0	♦R/W	–	v, s, i	0h175B	–
CM.92	Data frame Err count	0–65535		0	♦R/W	–	v, s, i	0h175C	–
CM.93	NAK frame count	0–65535		0	♦R/W	–	v, s, i	0h175D	–
CM.94	Communication data Save	0	No	0: No	R/W	ACG–ET2 Installed	v, s, i	–	B–8
		1	Yes						

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.

APPLICATION Parameter Group (AP)

Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
AP.0	Jump Code	1–99		20	♦R/W	–	v, s, i	–	3–6
AP.1	Application function selection	0	None	0: None	R/W	–	v, s, i	0h1801	4–97
		1	–						
		2	Proc PID						
AP.16	PID output monitor	(%)		0.00	Read Only	AP.1 = 2	v, s, i	0h1810	4–97
AP.17	PID reference monitor	(%)		50.00	Read Only	AP.1 = 2	v, s, i	0h1811	4–97
AP.18	PID feedback monitor	(%)		0.00	Read Only	AP.1 = 2	v, s, i	0h1812	4–97
AP.19	PID reference setting	–100.00–100.00%		50.00	♦R/W	AP.1 = 2	v, s, i	0h1813	4–97
AP.20	PID reference source	0	Keypad	0: Keypad	R/W	AP.1 = 2	v, s, i	0h1814	4–97
		1	V1						
		3	V0						
		4	I2						
		5	Int 485						
		7	Fieldbus (Ethernet)						
AP.21	PID feedback source	0	V1	0: V1	R/W	AP.1 = 2	v, s, i	0h1815	4–97
		2	V0						
		3	I2						
		4	Int 485						
		6	Fieldbus (Ethernet)						
AP.22	PID controller proportional gain	0.0–1000.0%		50.0	♦R/W	AP.1 = 2	v, s, i	0h1816	4–97
AP.23	PID controller integral time	0.0–200.0s		10.0	♦R/W	AP.1 = 2	v, s, i	0h1817	4–97
AP.24	PID controller differentiation time	0–1000(ms)		0	♦R/W	AP.1 = 2	v, s, i	0h1818	4–97
AP.25	PID controller feed–forward compensation gain	0.0–1000.0%		0.0	♦R/W	AP.1 = 2	v, s, i	0h1819	4–97
AP.26	Proportional gain scale	0.0–100.0%		100.0	R/W	AP.1 = 2	v, s, i	0h181A	4–97
AP.27	PID output filter	0–10000(ms)		0	♦R/W	AP.1 = 2	v, s, i	0h181B	4–97
AP.28	PID Mode	0	Process PID	0	R/W	AP.1 = 2	v, s, i	0h181C	4–97
		1	Normal PID						
AP.29	PID upper limit frequency	PID lower limit frequency–300.00Hz		60.00	♦R/W	AP.1 = 2	v, s, i	0h181D	4–97

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	–300.00 –PID upper limit frequency(Hz)		–60.00	♦R/W	AP.1 = 2	v, s, i	0h181E	4–97
AP.32	PID output scale	0.1–1000.0%		100.0	R/W	AP.1 = 2	v, s, i	0h1820	4–97
AP.33	PID output inverse	0	No	NO	R/W	AP.1 = 2	v, s, i	0h1821	
		1	Yes						
AP.34	PID controller motion frequency	0.00–Maximum frequency(Hz)		0.00	R/W	AP.1 = 2	v, s, i	0h1822	4–97
AP.35	PID controller motion level	0.0–100.0%		0.0	R/W	AP.1 = 2	v, s, i	0h1823	4–97
AP.36	PID controller motion delay time	0–9999s		600	♦R/W	AP.1 = 2	v, s, i	0h1824	4–97
AP.37	PID sleep mode delay time	0.0–999.9s		60.0	♦R/W	AP.1 = 2	v, s, i	0h1825	4–97
AP.38	PID sleep mode frequency	0.00–Maximum frequency(Hz)		0.00	♦R/W	AP.1 = 2	v, s, i	0h1826	4–97
AP.39	PID wake–up level	0–100%		35	♦R/W	AP.1 = 2	v, s, i	0h1827	4–97
AP.40	PID wake–up mode setting	0	Below Level	0: Below Level	♦R/W	AP.1 = 2	v, s, i	0h1828	4–97
		1	Above Level						
		2	Beyond Level						
AP.43	PID unit gain	0.00–300.00%		100.00	♦R/W	AP.1 = 2	v, s, i	0h182B	4–97
AP.44	PID unit scale	0	x100	2: x 1	♦R/W	AP.1 = 2	v, s, i	0h182C	4–97
		1	x10						
		2	x 1						
		3	x 0.1						
		4	x 0.01						
AP.45	PID 2nd proportional gain	0.0–1000.0%		100.0	R/W	AP.1 = 2	v, s, i	0h182D	4–97

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.

PROTECTION Parameter Group (Pr)									
Pr. Code	Name	Setting Range		Initial Value	Run R/W	Parameter Dependency	Compatible Control Mode	Comm. Address (Hex)	Ref.
Pr.0	Jump Code	1–99		40	♦R/W	–	v, s, i	–	3–6
Pr.4	Load level setting	0	Normal load (ND)	1: Heavy load (HD)	♦R/W	–	v, s, i	0h1B04	4–140
		1	Heavy load (HD)						
Pr.5	Input/output open–phase protection	bit	00–11	00	R/W	–	v, s, i	0h1B05	4–144
		01	Output open phase						
		10	Input open phase						
Pr.6	Input voltage range during open–phase	1–100V		15	R/W	–	v, s, i	0h1B06	4–144
Pr.7	Deceleration time at fault trip	0.0–600.0s		3.0	♦R/W	–	v, s, i	0h1B07	4–146
Pr.8	Selection of startup on trip reset	0	No	0: No	♦R/W	–	v, s, i	0h1B08	4–117
		1	Yes						
Pr.9	Number of automatic restarts	0–10		0	♦R/W	–	v, s, i	0h1B09	4–117
Pr.10	Automatic restart delay time	0.0–60.0s		1.0	♦R/W	Pr.9>0	v, s, i	0h1B0A	4–117
Pr.12	Motion at speed command loss	0	None	0: None	♦R/W	–	v, s, i	0h1B0C	4–146
		1	Free–Run						
		2	Dec						
		3	Hold Input						
		4	Hold Output						
		5	Lost Preset						
Pr.13	Time to decide speed command loss	0.1–120s		1.0	♦R/W	Pr.12>0	v, s, i	0h1B0D	4–146
Pr.14	Operation frequency at speed command loss	Start frequency– Maximum frequency(Hz)		0.00	♦R/W	Pr.12>0	v, s, i	0h1B0E	4–146
Pr.15	Analog input loss decision level	0	Half x1	0: Half x1	♦R/W	Pr.12>0	v, s, i	0h1B0F	4–146
		1	Below x1						
Pr.17	Overload warning selection	0	No	0: No	♦R/W	–	v, s, i	0h1B11	4–140
		1	Yes						
Pr.18	Overload alarm level	30–180%		150	♦R/W	–	v, s, i	0h1B12	4–140
Pr.19	Overload warning time	0.0–30.0s		10.0	♦R/W	–	v, s, i	0h1B13	4–140

PROTECTION Parameter Group (Pr)									
Pr. Code	**Name**	**Setting Range**		**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
Pr.20	Motion at overload fault	0	None	1: Free–Run	♦R/W	–	v, s, i	0h1B14	4–140
		1	Free–Run						
		2	Dec						
Pr.21	Overload fault level	30–200%		180	♦R/W	–	v, s, i	0h1B15	4–140
Pr.22	Overload fault time	0.0–60.0s		60.0	♦R/W	–	v, s, i	0h1B16	4–140
Pr.25	Underload warning selection	0	No	0: No	♦R/W	–	v, s, i	0h1B19	4–149
		1	Yes						
Pr.26	Underload warning time	0.0–600.0s		10.0	♦R/W	–	v, s, i	0h1B1A	4–149
Pr.27	Underload fault selection	0	None	0: None	♦R/W	–	v, s, i	0h1B1B	4–149
		1	Free–Run						
		2	Dec						
		3	Underload sleep						
Pr.28	Underload fault time	0.0–600.0s		30.0	♦R/W	–	v, s, i	0h1B1C	4–149
Pr.29	Underload lower limit level	10–100%		30	♦R/W	–	v, s, i	0h1B1D	4–149
Pr.30	Underload upper limit level	10–100%		30	♦R/W	–	v, s, i	0h1B1E	4–149
Pr.31	No motor motion at detection	0	None	0: None	♦R/W	–	v, s, i	0h1B1F	4–152
		1	Free–Run						
Pr.32	No motor detection current level	1–100%		5	♦R/W	–	v, s, i	0h1B20	4–152
Pr.33	No motor detection delay	0.1–10.0s		3.0	♦R/W	–	v, s, i	0h1B21	4–152
Pr.40	Electronic thermal fault selection	0	None	0: None	♦R/W	–	v, s, i	0h1B28	4–138
		1	Free–Run						
		2	Dec						
Pr.41	Motor cooling fan type	0	Self–cool	0: Self–cool	♦R/W	–	v, s, i	0h1B29	4–138
		1	Forced–cool						
Pr.42	Electronic thermal 1 minute rating	120–200%		150	♦R/W	–	v, s, i	0h1B2A	4–138
Pr.43	Electronic thermal continuous rating	50–150%		120	♦R/W	–	v, s, i	0h1B2B	4–138
Pr.45	BX (Block) trip mode	0	Free–Run	0	R/W	–	v, s, i	0h1B2D	–
		1	Decelerate						

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 0001 Accelerating 0010 At constant speed 0100 At deceleration 1000 FluxBraking	0000	R/W	–	v, s	0h1B32	4–141
Pr.51	Stall frequency1	Start frequency – Stall frequency2 (Hz)	60.00	♦R/W	–	v, s	0h1B33	4–141
Pr.52	Stall level1	30–250%	180	R/W	–	v, s	0h1B34	4–141
Pr.53	Stall frequency2	Stall frequency1 – Stall frequency3 (Hz)	60.00	♦R/W	–	v, s	0h1B35	4–141
Pr.54	Stall level2	30–250%	180	R/W	–	v, s	0h1B36	4–141
Pr.55	Stall frequency3	Stall frequency2 – Stall frequency4 (Hz)	60.00	♦R/W	–	v, s	0h1B37	4–141
Pr.56	Stall level3	30–250%	180	R/W	–	v, s	0h1B38	4–141
Pr.57	Stall frequency4	Stall frequency3 – Maximum frequency (Hz)	60.00	♦R/W	–	v, s	0h1B39	4–141
Pr.58	Stall level4	30–250%	180	R/W	–	v, s	0h1B3A	4–141
Pr.59	Flux braking gain	0 – 150%	0	♦R/W	–	v, s, i	0h1B3B	–
Pr.66	DB resistor warning level	0–30%	10	♦R/W	–	v, s, i	0h1B42	4–147
Pr.77	Preoverheat warning temperature	90–110	90	♦R/W	–	v, s, i	0h1B4D	
Pr.78	Preoverheat warning operation selection	0 None 1 Warning 2 Freerun 3 Decelerate	0	♦R/W	–	v, s, i	0h1B4E	
Pr.79	Cooling fan fault selection	0 Trip 1 Warning	1: Warning	♦R/W	–	v, s, i	0h1B4F	4–150
Pr.80	Motion selection at option trip	0 None 1 Free–Run 2 Decelerate	1: Free–Run	♦R/W	–	v, s, i	0h1B50	4–151
Pr.81	Low voltage fault decision delay time	0.0–60.0s	0.0	R/W	–	v, s, i	0h1B51	
Pr.82	Low Voltage2 Trip Selection	0 No 1 Yes	0	R/W	–	v, s, i	0h1B52	4–153
Pr.86	Accumulated percent of fan usage	0.0 - 100.0%	0	Read Only	–	v, s, i	0h1B56	
Pr.87	Fan exchange warning level	0.0 - 100.0%	90	♦R/W	–	v, s, i	0h1B57	
Pr.88	Fan reset time	0 = No; 1 = Yes	0	R/W	–	v, s, i	0h1B58	

PROTECTION Parameter Group (Pr)									
Pr. Code	**Name**	**Setting Range**		**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
Pr.89	FAN Status	Bit	00–01	00	Read Only	–	v, s, i	0h1B59	4–153
		00	None						
		01	Fan Exchange						
Pr.90[1]	Relay Open Trip Selection	–		–	Read Only	–	v, s, i	–	6–7
Pr.91	Fault history 1	–		–	Read Only	–	v, s, i	0h1B5B	6–7
Pr.92	Fault history 2	–		–	Read Only	–	v, s, i	0h1B5C	6–7
Pr.93	Fault history 3	–		–	Read Only	–	v, s, i	0h1B5D	6–7
Pr.94	Fault history 4	–		–	Read Only	–	v, s, i	0h1B5E	6–7
Pr.95	Fault history 5	–		–	Read Only	–	v, s, i	0h1B5F	6–7
Pr.96	Fault history deletion	0	No	0: No	♦R/W	–	v, s, i	0h1B60	6–7
		1	Yes						

1 - Pr.90 can only be used with 460 VAC 2–5 hp 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 26.

2nd MOTOR Parameter Group (M2)									
Pr. Code	**Name**	**Setting Range**		**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
M2.0	Jump Code	1–99		14	♦R/W	–	v, s, i	–	3–6
M2.4	Acceleration time	0.0–600.0s		20.0	♦R/W	–	v, s, i	0h1C04	4–119
M2.5	Deceleration time	0.0–600.0s		30.0	♦R/W	–	v, s, i	0h1C05	4–119
M2.6	Motor capacity	0	0.2 kW (1/4 hp)	–	R/W	–	v, s, i	0h1C06	4–119
		1	0.4 kW (1/2 hp)						
		2	0.75 kW (1 hp)						
		3	1.1 kW (1.5 hp)						
		4	1.5 kW (2 hp)						
		5	2.2 kW (3 hp)						
		6	3.0 kW (4 hp)						
		7	3.7 kW (4 hp)						
		8	4.0 kW (5 hp)						
		9	5.5 kW (7.5 hp)						
		10	7.5 kW (10 hp)						
		11	11.0 kW (15 hp)						
		12	15.0 kW (20 hp)						
		13	18.5 kW (25 hp)						
		14	22.0 kW (30 hp)						
		15	30.0 kW (40 hp)						
M2.7	Base frequency	30.00–400.00Hz		60.00	R/W	–	v, s, i	0h1C07	4–119
M2.8	Control mode	0	V/F	0: V/F	R/W	–	v, s, i	0h1C08	4–119
		2	Slip Compen						
		4	IM Sensorless						
M2.10	Number of motor poles	2–48		Dependent on motor settings	R/W	–	v, s, i	0h1C0A	4–119
M2.11	Rated slip speed	0–3000(rpm)		Dependent on motor settings	R/W	–	v, s, i	0h1C0B	4–119
M2.12	Motor rated current	1.0–1000.0A		Dependent on motor settings	R/W	–	v, s, i	0h1C0C	4–119
M2.13	Motor no–load current	0.5–1000.0A		Dependent on motor settings	R/W	–	v, s, i	0h1C0D	4–119
M2.14	Motor rated voltage	170–480V		Dependent on motor settings	R/W	–	v, s, i	0h1C0E	4–119

2nd MOTOR Parameter Group (M2)								
Pr. Code	**Name**	**Setting Range**	**Initial Value**	**Run R/W**	**Parameter Dependency**	**Compatible Control Mode**	**Comm. Address (Hex)**	**Ref.**
M2.15	Motor efficiency	64–100%	Dependent on motor settings	R/W	–	v, s, i	0h1C0F	4–119
M2.16	Load inertia rate	0–8	Dependent on motor settings	R/W	–	v, s, i	0h1C10	4–119
M2.17	Stator resistance	Dependent on motor settings	Dependent on motor settings	R/W	–	v, s, i	–	4–119
M2.18	Leakage inductance	–	Dependent on motor settings	R/W	–	v, s, i	–	4–119
M2.19	Stator inductance	–	Dependent on motor settings	R/W	–	v, s, i	–	4–119
M2.20	Rotor time constant	25–5000(ms)	Dependent on motor settings	R/W	M2.08=4 IM Sensorless	v, s, i	–	4–119
M2.25	V/F pattern	0: Linear 1: Square 2: User V/F	0: Linear	R/W	–	v, s, i	0h1C19	4–119
M2.26	Forward Torque boost	0.0–15.0%	2.0	R/W	–	v, s, i	0h1C1A	4–119
M2.27	Reverse Torque boost	0.0–15.0%	2.0	R/W	–	v, s, i	0h1C1B	4–119
M2.28	Stall prevention level	30–150%	150	R/W	–	v, s, i	0h1C1C	4–119
M2.29	Electronic thermal 1 minute rating	100–200%	150	R/W	–	v, s, i	0h1C1D	4–119
M2.30	Electronic thermal continuous rating	50–Electronic thermal 1 minute rating	100	R/W	–	v, s, i	0h1C1E	4–119
M2.31	Low-speed torque compensation gain	50–300%	Varies by Motor capacity	R/W	–	i	0h1C1F	
M2.32	Stator leakage inductance scale	50–300%	Varies by Motor capacity	R/W	–	i	0h1C20	
M2.33	Stator inductance scale	50–300%	Varies by Motor capacity	R/W	–	i	0h1C21	
M2.34	Rotor time constant scale	50–300%	Varies by Motor capacity	R/W	–	i	0h1C12	
M2.40	Rotation count speed gain (RPM Display)	0.1–6000.0%	100.0	♦R/W	–	v, s, i	0h1C28	4–137
M2.41	Reserved	–	–	–	–	–	–	–
M2.42	Reserved	–	–	–	–	–	–	–

IronHorse® ACG 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
x	x	x	x	x	x

Chart Key

- *Group = Parameter Group, designated by one of the following:*
  - » *2 letter group abbreviation*
  - » *Operation (initial parameter group on Drive LED with no 2 letter designation)*
- *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 dr.93.

Learning Basic Features

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

Basic Tasks	Description	Ref.
Frequency reference source configuration for the keypad	Configures the drive to allow you to setup or modify frequency reference using the Keypad.	4–45
Frequency reference source configuration for the terminal block (input voltage)	Configures the drive to allow input voltages at the terminal block (V1, V0) and to setup or modify a frequency reference.	4–46 4–45
Frequency reference source configuration for the terminal block (input current)	Configures the drive to allow input currents at the terminal block (I2) and to setup or modify a frequency reference.	4–51
Frequency reference source configuration for RS–485 communication	Configures the drive to allow communication signals from upper level controllers, such as PLCs or PCs, and to setup or modify a frequency reference.	4–52
Frequency control using analog inputs	Enables the user to hold a frequency using analog inputs at terminals.	4–52
Multi–step speed (frequency) configuration	Configures multi–step frequency operations by receiving an input at the terminals defined for each step frequency.	4–53
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..	4–55
Command source configuration for terminal block inputs (2-wire and 3-wire)	Configures the drive to accept inputs at the FX/RX terminals.	4–56
Command source configuration for RS–485 communication	Configures the drive to accept communication signals from upper level controllers, such as PLCs or PCs.	4–59
Motor rotation control	Configures the drive to limit a motor's rotation direction.	4–59
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.	4–60
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.	4–61
Acc/Dec time configuration based on the Max. Frequency	Configures the acceleration and deceleration times for a motor based on a defined maximum frequency.	4–62
Acc/Dec time configuration based on the frequency reference	Configures acceleration and deceleration times for a motor based on a defined frequency reference.	4–63
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.	4–63
Acc/Dec time transition speed (frequency) configuration	Enables modification of acceleration and deceleration gradients without configuring the multi–functional terminals.	4–64
Acc/Dec pattern configuration	Enables modification of the acceleration and deceleration gradient patterns. Basic patterns to choose from include linear and S–curve patterns.	4–66
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 .	4–68
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.	4–68
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.	4–69
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.	4–70
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.	4–71

Basic Tasks	Description	Ref.
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.	4–72
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.	4–73
Accelerating start	Accelerating start is the general way to start motor operation. The typical application configures the motor to accelerate to a target frequency in response to a run command, however there may be other start or acceleration conditions defined.	4–73
DC braking after Start	Configures the drive to perform DC braking before the motor starts rotating again. This configuration is used when the motor will be rotating before the voltage is supplied from the drive.	4–73
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.	4–75
Stopping by DC braking	Configures the drive to apply DC braking during motor deceleration. The frequency at which DC braking occurs must be defined and during deceleration, when the motor reaches the defined frequency, DC braking is applied.	4–76
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.	4–77
Power braking	Configures the drive to provide optimal, motor deceleration, without tripping over–voltage protection.	4–77
Start/maximum frequency configuration	Configures the frequency reference limits by defining a start frequency and a maximum frequency.	4–78
Upper/lower frequency limit configuration	Configures the frequency reference limits by defining an upper limit and a lower limit.	4–78
Frequency jump	Configures the drive to avoid running a motor in mechanically resonating frequencies.	4–79
2nd Operation Configuration	Used to configure the 2nd operation mode and switch between the operation modes according to your requirements.	4–80
Multi–function input terminal control configuration	Enables the user to improve the responsiveness of the multi–function input terminals.	4–81

Setting Frequency Reference

The ACG drive provides several methods to setup and modify a frequency reference for an operation. The keypad, analog inputs [for example voltage (V1) and current (I2) signals], or RS-485, and Fieldbus (Ethernet) option card can be used.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	0	Keypad–1: Change+Enter	0–8	–
			1	Keypad–2: Instant Change		
			2	V1: Analog Voltage Input		
			4	V0: Built-in Potentiometer Dial		
			5	I2: Analog Current Input		
			6	Int 485		
			8	Fieldbus (Ethernet)		

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	0–8	–
	0.00	Frequency reference	0.00		Min to Max Frq*	Hz

You cannot set a frequency reference that exceeds the Max. Frequency, as configured with dr.20.

Keypad as the Source (Keypad–2 setting)

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

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	1	Keypad–2	0–8	–
	0.00	Frequency reference	0.00		Min to Max Frq*	Hz

You cannot set a frequency reference that exceeds the Max. Frequency, as configured with dr.20.

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 4, 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	4	V0	0–8	–
In	In.1	Frequency at maximum analog input	60.00		0– Maximum Frequency	Hz
	In.35	V0 input voltage display	0.00		0.00–5.00	V
	In.37	Time constant of V0 input filter	100		0–10000	ms
	In.38	V0 minimum input voltage	0.00		0.00–5.00	V
	In.39	V0 output at minimum voltage (%)	0.00		0–100	%
	In.40	V0 maximum input voltage	5.00		0.00–5.00	V
	In.41	V0 output at maximum voltage (%)	100.00		0.00–100.00	%
	In.46	Changing rotation direction of V0	0	No	0–1	–
	In.47	V0 quantization level	0.04		0*, 0.04–10.00	%

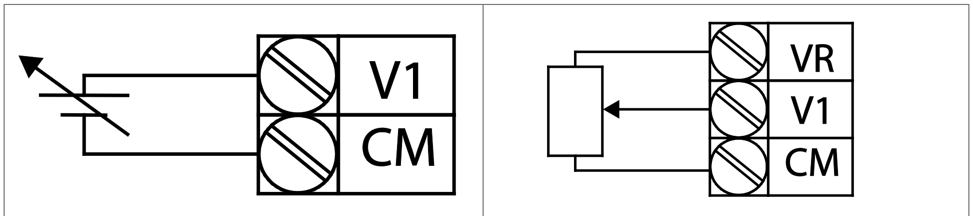
**Quantizing is disabled if '0' is selected.*

V1 Terminal as the Source

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

Setting a Frequency Reference for 0–10V Input

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



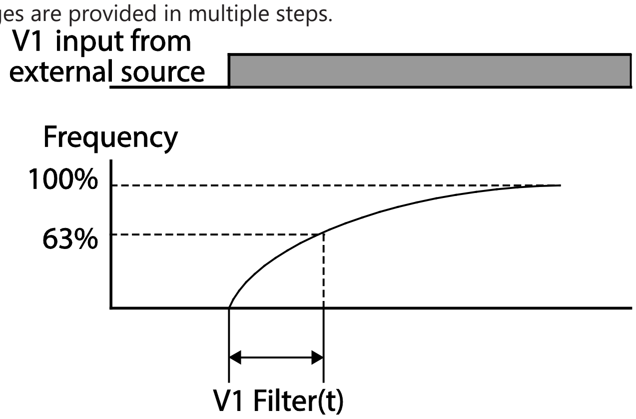
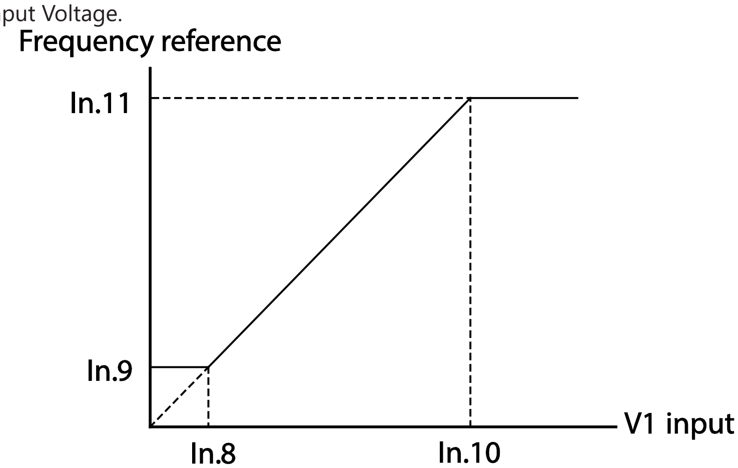
External source application	Internal source (VR) application

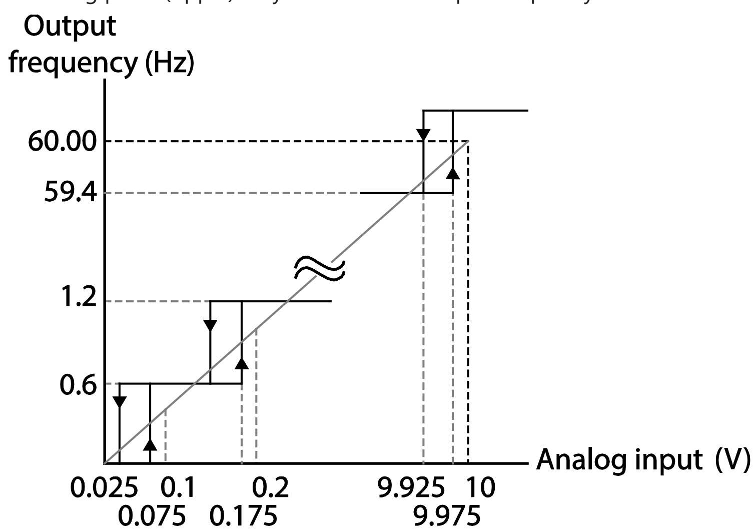
Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	2	V1	0–8	–
In	In.1	Frequency at maximum analog input	Maximum frequency		0.00– Max. Frequency	Hz
	In.5	V1 input monitor	0.00		0.00–12.00	V
	In.6	V1 polarity options	0	Unipolar	0–1	–
	In.7	V1 input filter time constant	100		0–10000	ms
	In.8	V1 minimum input voltage	0.00		0.00–10.00	V
	In.9	V1 output at minimum voltage (%)	0.00		0.00–100.00	%
	In.10	V1 maximum input voltage	10.00		0 .00– 12.00	V
	In.11	V1 output at maximum voltage (%)	100.00		0–100	%
	In.16	Rotation direction options	0	No	0–1	–
	In.17	V1 Quantizing level	0.04		0.00*, 0.04–10.00	%

Quantizing is disabled if '0' is selected.

0–10V Input Voltage Setting Details

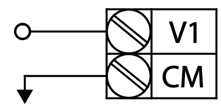
Pr. Code	Description
In.1 Freq at 100%	Configures the frequency reference at the maximum input voltage when a potentiometer is connected to the control terminal block. A frequency set with code In.1 becomes the maximum frequency only if the value set in code In.11 (or In.15) is 100%. Set code In.1 to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

Pr. Code	Description
In.7 V1 Filter	V1 Filter may be used when there are large variations between reference frequencies. Variations can be mitigated by increasing the time constant, but this will require an increased response time. The value t (time) indicates the time required for the frequency to reach 63% of the reference, when external input voltages are provided in multiple steps. 
In.8 V1 minimum input voltage ***In.9 V1 output at minimum voltage (%)*** ***In.10 maximum input voltage*** ***In.11 V1 output at maximum voltage (%)***	These parameters are used to configure the gradient level and offset values of the Output Frequency, based on the Input Voltage. 
In.16 V1 Inverting	Inverts the direction of rotation. Set this code to 1 (Yes) if you need the motor to run in the opposite direction from the current rotation.

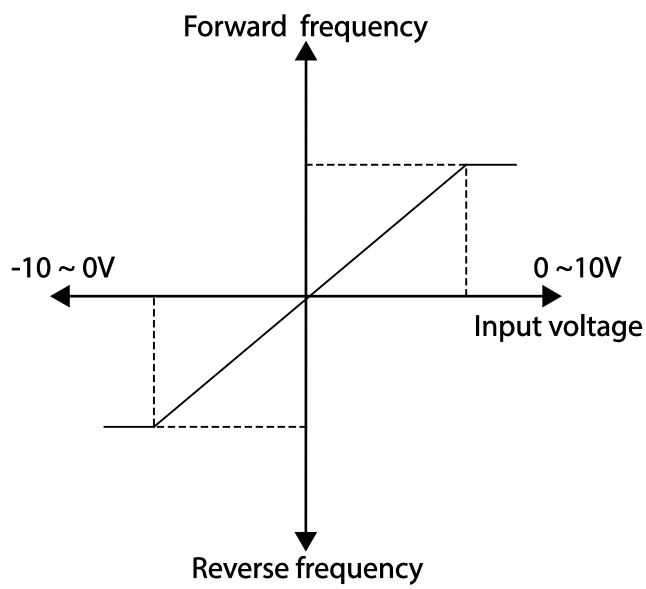
Pr. Code	Description
In.17 V1 Quantizing	Quantizing may be used when the noise level is high in the analog input (V1 terminal) signal. Quantizing is useful when you are operating a noise–sensitive system, because it suppresses any signal noise. However, quantizing will diminish system sensitivity (resultant power of the output frequency will decrease based on the analog input). You can also turn on the low–pass filter using code In.7 to reduce the noise, but increasing the value will reduce responsiveness and may cause pulsations (ripples) in the output frequency. Parameter values for quantizing refer to a percentage based on the maximum input. Therefore, if the value is set to 1% of the analog maximum input (60Hz), the output frequency will increase or decrease by 0.6 Hz per 0.1 V difference. To reduce the effect of the input signal changes (runout of height) on the operation frequency, the output frequency during increase or decrease of input signal value (height) is applied differently. When the input signal value increases, the output frequency starts changing if the height becomes equivalent to 3/4 of the quantizing value. From then on, the output frequency increases according to the quantizing value. On the other hand, when the input signal decrease, the output frequency starts decreasing if the height becomes equivalent to 1/4 of the quantizing value. Although the noise can be reduced using the low-pass filter (In.7), the response on the input signal takes long as the set value gets higher. Since it becomes difficult to control the frequency if the input signal is delayed, a period of long pulse (ripple) may occur on the output frequency. 

Setting a Frequency Reference for –10–10V Input

Set the Frq (Frequency reference source) code in the Operation group to 2 (V1), and then set code 06 (V1 Polarity) to 1 (bipolar) in the Input Terminal group (IN). Use the voltage output of the external controller or use the VR terminal (frequency setting power terminal) of the control terminal to input voltage in the V1 terminal as the volume resistance.



V1 terminal wiring



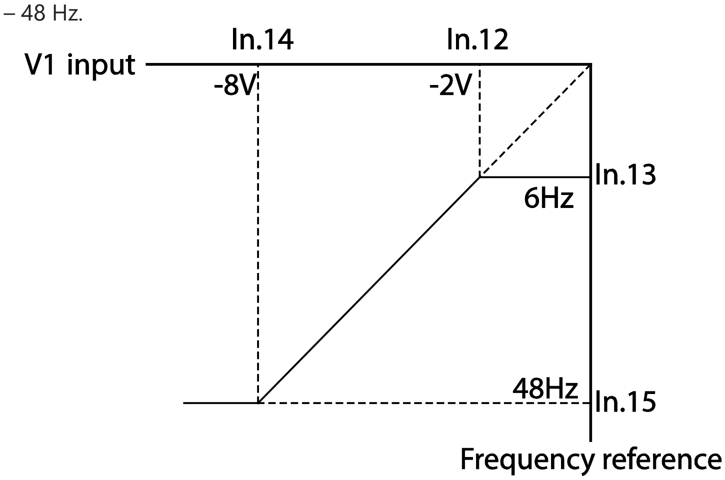
Bipolar input voltage and output frequency

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	2	V1	0–8	–
In	In.1	Frequency at maximum analog input	60.00		0– Max Frequency	Hz
	In.5	V1 input monitor	0.00		0.00–12.00V	V
	In.6	V1 polarity options	1	Bipolar	0–1	–
	In.12	V1 minimum input voltage	0.00		10.00–0.00V	V
	In.13	V1 output at minimum voltage (%)	0.00		–100.00–0.00%	%
	In.14	V1maximum input voltage	–10.00		–12.00 –0.00V	V
	In.15	V1 output at maximum voltage (%)	–100.00		–100.00–0.00%	%

Rotational Directions for Different Voltage Inputs

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

–10–10V Voltage Input Setting Details

Pr. Code	Description
In.12 V1 minimum input voltage ***In.13 V1 output at minimum voltage (%)*** ***In.14 V1 maximum input voltage*** ***In.15 V1 output at maximum voltage (%)***	Sets the gradient level and off–set value of the output frequency in relation to the input voltage. These codes are displayed only when In.6 is set to 1 (bipolar). As an example, if the minimum input voltage (at V1) is set to –2 (V) with 10% output ratio, and the maximum voltage is set to –8 (V) with 80% output ratio respectively, the output frequency will vary within the range of 6 – 48 Hz.  For details about the 0–+10V analog inputs, Refer to"In.8 V1 minimum input voltage" on page 4–47.

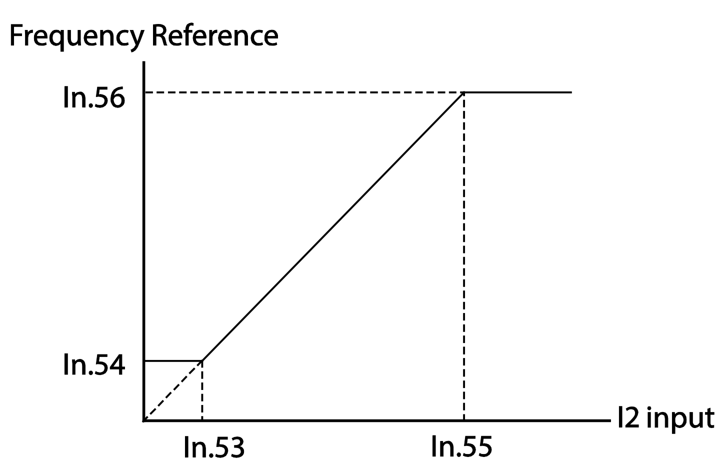
Setting a Reference Frequency using Input Current (I2)

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

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	5	I2	0–8	–
In	In.1	Frequency at maximum analog input	60.00		0– Maximum Frequency	Hz
	In.50	I2 input monitor	0.00		0.00–20.00	mA
	In.52	I2 input filter time constant	100		0–10000	ms
	In.53	I2 minimum input current	4.00		0.00–20.00	mA
	In.54	I2 output at minimum current (%)	0.00		0–100	%
	In.55	I2 maximum input current	20.00		0.00–20.00	mA
	In.56	I2 output at maximum current (%)	100.00		0.00–100.00	%
	In.61	I2 rotation direction options	0	No	0–1	–
	In.62	I2 Quantizing level	0.04		0*, 0.04–10.00	%

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

Input Current (I2) Setting Details

Pr. Code	Description
In.1 Freq at 100%	Configures the frequency reference for operation at the maximum current (when In.56 is set to 100%). If In.1 is set to 40.00Hz, and default settings are used for In.53–56, 20mA input current (max) to I2 will produce a frequency reference of 40.00 Hz. If In.56 is set to 50.00 (%), and default settings are used for In.1 (60Hz) and In.53–55, 20mA input current (max) to I2 will produce a frequency reference of 30.00 Hz (50% of 60Hz).
In.50 I2 Monitor	Used to monitor input current at I2.
In.52 I2 Filter	Configures the time for the operation frequency to reach 63% of target frequency based on the input current at I2.
In.53 I2 minimum input current In.54 I2 output at Minimum current (%) In.55 I2 maximum input current In.56 I2 output at maximum current (%)	Configures the gradient level and off–set value of the output frequency.  [Gradient and off–set configuration based on output frequency]

Setting a Frequency Reference via RS–485 Communication

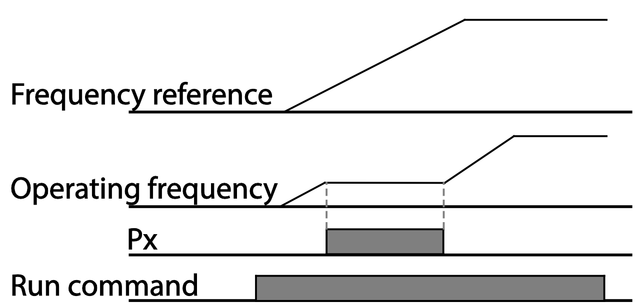
Control the drive with upper–level controllers, such as PCs or PLCs, via RS–485 communication. Set the Frq (Frequency reference source) code in the Operation group to 6 (Int 485) and use the RS–485 signal input terminals (S+/S–) for communication. Refer to "Serial RS-485 Communication Features" on page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

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	6	Int 485	0–8	–
CM	CM.1	Integrated RS–485 communication drive ID	–	1	1–250	–
	CM.2	Integrated communication protocol	0	ModBus RTU	0–2	–
			1	Reserved		
			2	Not supported		
	CM.3	Integrated communication speed	3	9600 bps	0–7	–
	CM.4	Integrated communication frame configuration	0	D8/PN/S1	0–3	–
			1	D8/PN/S2		
			2	D8/PE/S1		
			3	D8/PO/S1		

Frequency Hold by Analog Input

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

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	0	Keypad–1	0–8	–
			1	Keypad–2		
			2	V1		
			4	V0		
			5	I2		
			6	Int 485		
			8	Fieldbus (Ethernet)		
In	In.65–In.69	Px terminal configuration	21	Analog Hold	0–52	–



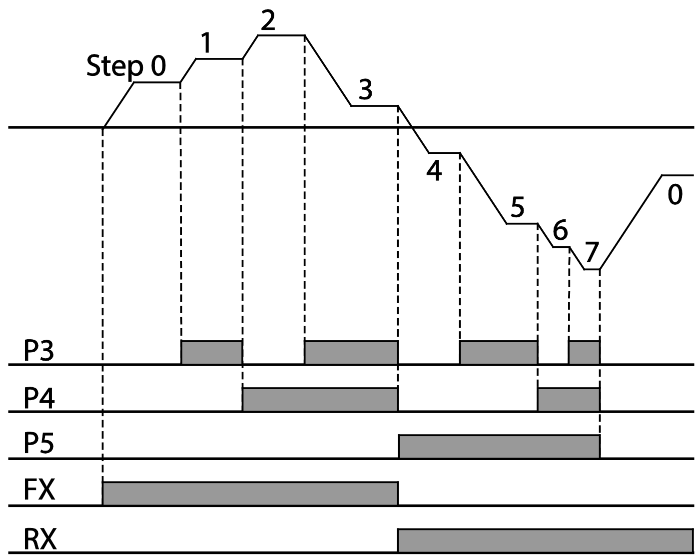
Setting Multi–step Frequency

Multi–step operations can be carried out by assigning different speeds (or frequencies) to the Px terminals. Step 0 uses the frequency reference source set with the Frq code in the Operation group. Px terminal parameter values 7 (Speed–L), 8 (Speed–M) and 9 (Speed–H) are recognized as binary commands and work in combination with Fx or Rx run commands. The drive operates according to the frequencies set with St1, St2, St3 (multi–step frequency 1–3) , bA.53–bA.56 (multi–step frequency 4–7) and the binary command combinations.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	St1 St2 St3	Multi–step frequency 1–3	–		0–Maximum frequency	Hz
bA	bA.53 bA.54 bA.55 bA.56	Multi–step frequency 4–7	–		0–Maximum frequency	Hz
In	In.65–In.69	Px terminal configuration	7	Speed–L	0–52	–
			8	Speed–M		–
			9	Speed–H		–
	In.89	Multi–step command delay time	1		1–5000	ms

Multi–step Frequency Setting Details

Pr. Code	Description
Operation group St1–St3	Configure multi–step frequency 1–3.
bA.53–bA.56 Step Freq – 4–7	Configure multi–step frequency 4–7.

Pr. Code	Description
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 7(Speed–L), 8(Speed–M), or 9(Speed–H). Provided that terminals P3, P4 and P5 have been set to Speed–L, Speed–M and Speed–H respectively, the following multi–step operation will be available.  [An example of a multi–step operation]

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

Pr. Code	Description
In.89 InCheck Time	Set a time interval for the drive to check for additional terminal block inputs after receiving an input signal. After adjusting In.89 to 100ms and an input signal is received at P5, the drive will search for inputs at other terminals for 100ms, before proceeding to accelerate or decelerate based on P5’s configuration.

Command Source Configuration

Various devices can be selected as command input devices for the ACG drive. Input devices available to select include keypad, multi–function input terminal, RS–485 communication and Fieldbus (Ethernet) adapter.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	drv	Command Source	0	Keypad	0–4	–
			1	Fx/Rx–1		
			2	Fx/Rx–2		
			3	Int 485		
			4	Fieldbus (Ethernet)		

The Keypad as a Command Input Device

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

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	drv	Command source	0	Keypad	0–4	–

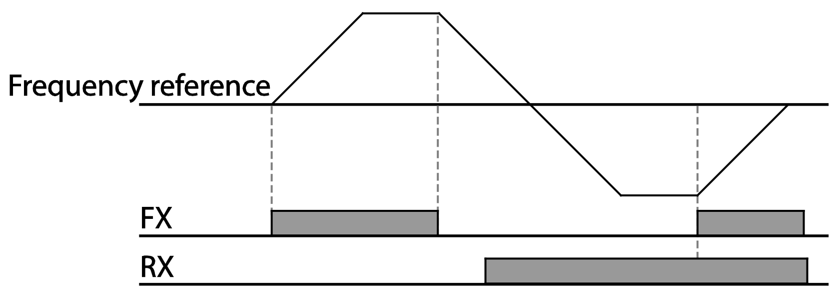
Terminal Block as a Command Input Device (Fwd/Rev Run Commands, 2-wire)

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

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	drv	Command source	1	Fx/Rx–1	0–4	–
In	In.65–In.69	Px terminal configuration	1	Fx	0–52	–
			2	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.



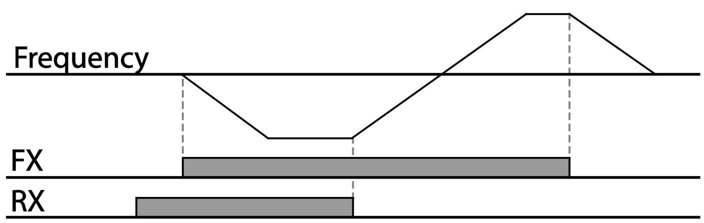
Terminal Block as a Command Input Device (Run and Rotation Direction Commands, 2-wire)

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 1(Fx) and 2(Rx) respectively. This application uses an Fx input as a run command, and an Rx input to change a motor's rotation direction (On–Reverse, Off–Forward).

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	Drv	Command source	2	Fx/Rx–2	0–4	–
In	In.65–In.69	Px terminal configuration	1	Fx	0–52	–
			2	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).

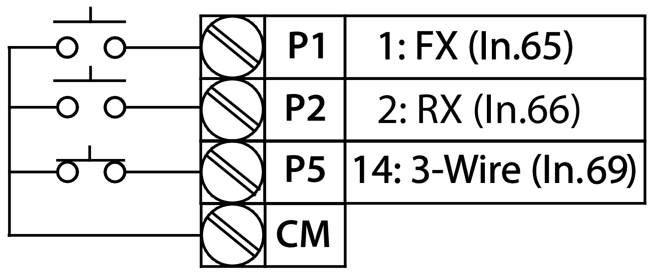


Terminal Block as Command Input Device (Run/Stop, 3–Wire Operation)

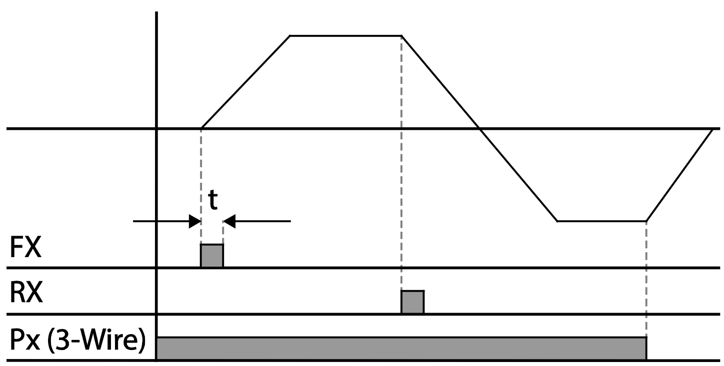
The 3–wire operation latches the signal input (the signal stays on after the button is released), and is used when operating the drive with a push button.

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	14	3–Wire	0–52	–

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



Terminal connections for 3–wire operation



3–wire operation

RS–485 Communication as a Command Input Device

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

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	drv	Command source	3	Int 485	0–4	–
CM	CM.1	Integrated communication drive ID	1		1–250	–
	CM.2	Integrated communication protocol	0	ModBus RTU	0–2	–
	CM.3	Integrated communication speed	3	9600 bps	0–7	–
	CM.4	Integrated communication frame setup	0	D8 / PN / S1	0–3	–

Forward or Reverse Run Prevention

The rotation direction of motors can be configured to run in only one direction. Setting Ad.9 parameter prevents Parameter drC (operation group) 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		

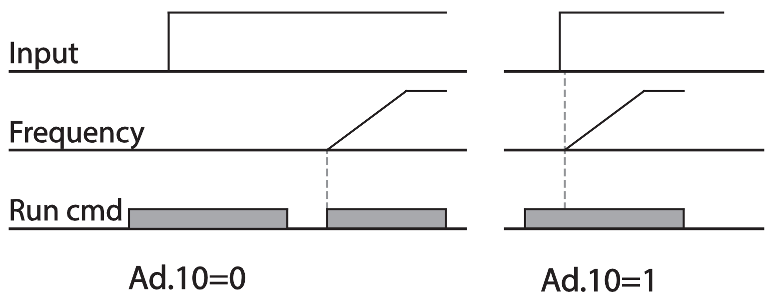
<u>Forward/Reverse Run Prevention Setting Details</u>

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.

Power–on Run

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	0–4	–
Ad	Ad.10	Power–on run	1	Yes	0–1	–



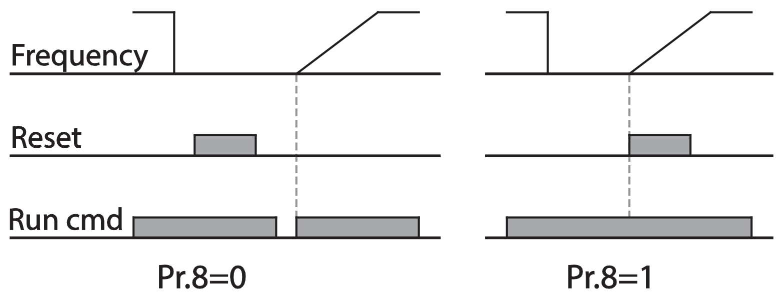
NOTE:
- *A fault trip may be triggered if the drive starts operation while a motor's load (fan-type load) is in free-run state. To prevent this from happening, set parameter Cn.71 (speed search options), Bit 4 = 1. The drive will perform a speed search at the beginning of the operation.*
- *If the speed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

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

Reset and Restart

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

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	drv	Command source	1 2	Fx/Rx–1 or Fx/Rx–2	0–4	–
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



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

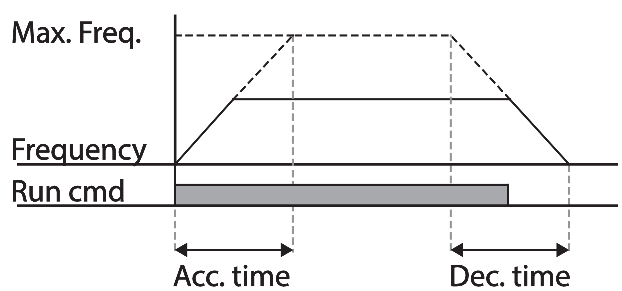
Acc/Dec Time Based on Maximum Frequency

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.8 (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.

<table>
<tr><th>Pr. Group</th><th>Pr. Code</th><th>Name</th><th colspan="2">Parameter Setting</th><th>Setting Range</th><th>Unit</th></tr>
<tr><td rowspan="2">Operation</td><td>ACC</td><td>Acceleration time</td><td colspan="2">5.0</td><td>0.0–600.0</td><td>sec</td></tr>
<tr><td>dEC</td><td>Deceleration time</td><td colspan="2">10.0</td><td>0.0–600.0</td><td>sec</td></tr>
<tr><td>dr</td><td>dr.20</td><td>Maximum frequency</td><td colspan="2">60.00</td><td>40.00–400.00</td><td>Hz</td></tr>
<tr><td rowspan="2">bA</td><td>bA.8</td><td>Acc/Dec reference frequency</td><td>0</td><td>Max Freq</td><td>0–1</td><td>–</td></tr>
<tr><td>bA.9</td><td>Time scale</td><td>1</td><td>0.1sec</td><td>0–2</td><td>–</td></tr>
</table>

Acc/Dec Time Based on Maximum Frequency – Setting Details

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


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

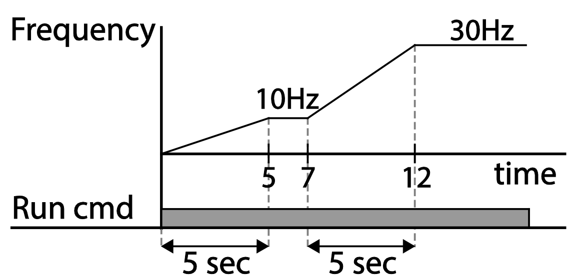
CAUTION: Note that the range of maximum time values may change automatically when the units are changed. If for example, the acceleration time is set at 6000 seconds, a time scale change from 1 second to 0.01 second will result in a modified acceleration time of 60.00 seconds.

Acc/Dec Time Based on Operation Frequency

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

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	ACC	Acceleration time	20.0		0.0–600.0	sec
	dEC	Deceleration time	30.0		0.0–600.0	sec
bA	bA.8	Acc/Dec reference	1	Delta Freq	0–1	–

Acc/Dec Time Based on Operation Frequency – Setting Details

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


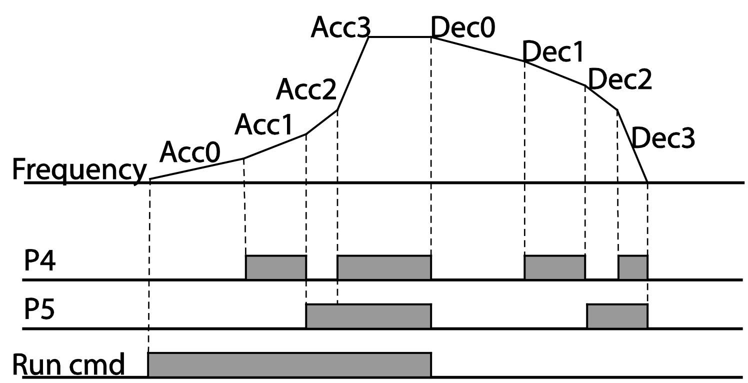
If Acc/Dec times are set to 5 seconds, and multiple frequency references are used in the operation in 2 steps, at 10Hz and 30 Hz, each acceleration stage will take 5 seconds (refer to the graph).</td></tr>
</table>

Multi–step Acc/Dec Time Configuration

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

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	ACC	Acceleration time	5.0		0.0–600.0	sec
	dEC	Deceleration time	10.0		0.0–600.0	sec
bA	bA.70–bA.83	Multi–step acceleration and deceleration time 1–7	0.0		0.0–600.0	sec
In	In.65–In.69	Px terminal configuration	11	XCEL–L	0–52	–
			12	XCEL–M		
			49	XCEL–H		
	In.89	Multi–step command delay time	1		1–5000	ms

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
	11	XCEL–L	Acc/Dec command–L
	12	XCEL–M	Acc/Dec command–M
	49	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 P4 and P5 terminals are set as XCEL–L and XCEL-M respectively, the following operation will be available.		
			
	Acc/Dec time	P5	P4
	0	–	–
	1	–	X
	2	X	–
	3	X	X
In.89 In Check Time	Set the time for the drive to check for other terminal block inputs. If In.89 is set to 100ms and a signal is supplied to the P4 terminal, the drive searches for other inputs over the next 100ms. When the time expires, the Acc/Dec time will be set based on the input received at P4.		

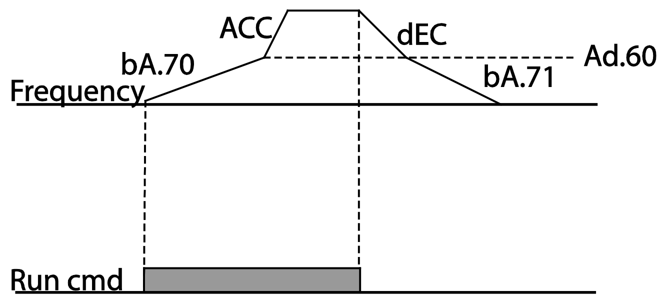
Configuring Acc/Dec Time Switch Frequency

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

Pr. Group	Pr. Code	Name	Parameter Setting	Setting Range	Unit
Operation	ACC	Acceleration time	5.0	0.0–600.0	sec
	dEC	Deceleration time	10.0	0.0–600.0	sec
bA	bA.70	Multi–step acceleration time 1	20.0	0.0–600.0	sec
	bA.71	Multi–step deceleration time 1	20.0	0.0–600.0	sec
Ad	Ad.60	Acc/Dec time switch frequency	30.00	0–Maximum frequency	Hz

Acc/Dec Time Switch Frequency Setting Details

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



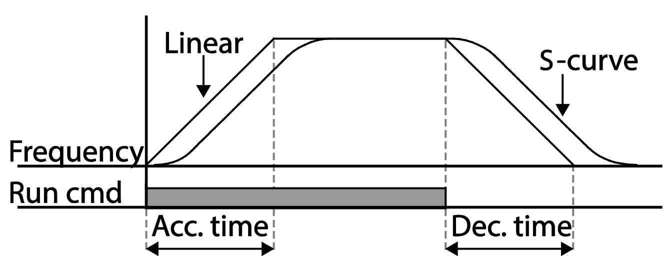
Acc/Dec Pattern Configuration

Acc/Dec gradient level patterns can be configured to enhance and smooth the drive's acceleration and deceleration curves. Linear pattern features a linear increase or decrease to the output frequency, at a fixed rate. For an S–curve pattern a smoother and more gradual increase or decrease of output frequency, ideal for lift–type loads or elevator doors, etc. S–curve gradient level can be adjusted using codes Ad.3–Ad.6 in the Advanced group.

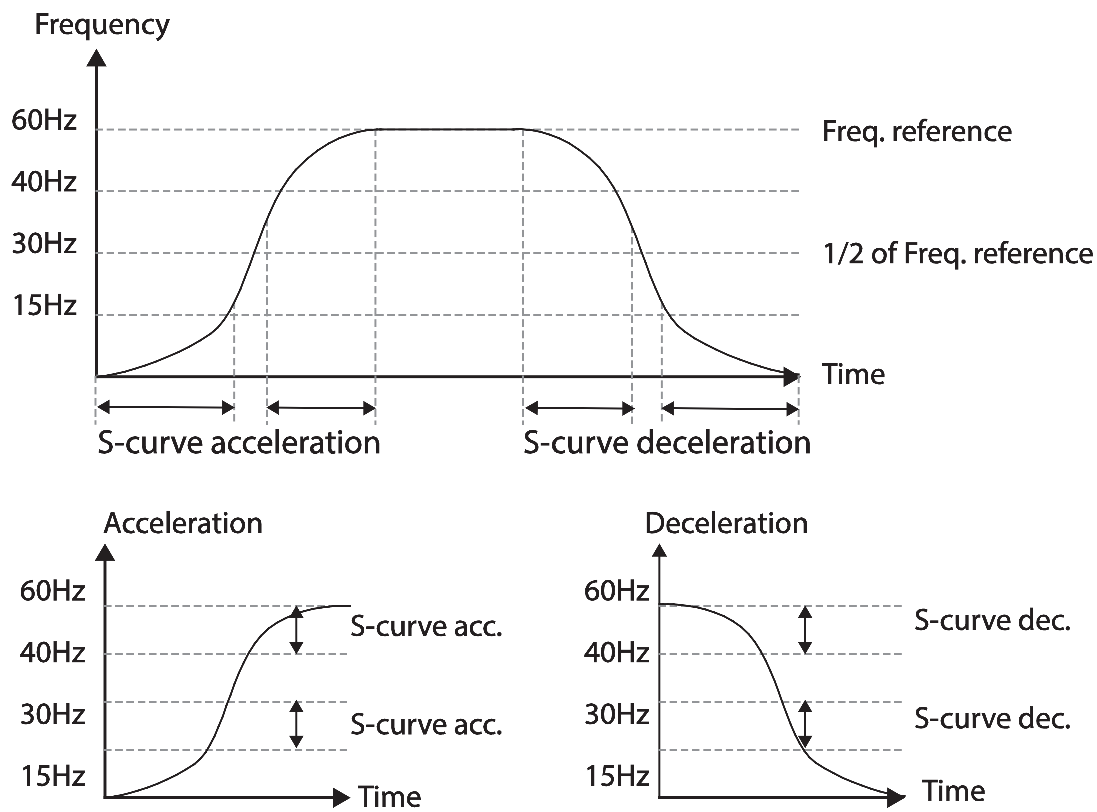
Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
bA	bA.8	Acc/Dec reference	0	Max Freq	0–1	–
Ad	Ad.1	Acceleration pattern	0	Linear	0–1	–
	Ad.2	Deceleration pattern	1	S–curve		–
	Ad.3	S–curve Acc start gradient	40		1–100	%
	Ad.4	S–curve Acc end gradient	40		1–100	%
	Ad.5	S–curve Dec start gradient	40		1–100	%
	Ad.6	S–curve Dec end gradient	40		1–100	%

Acc/Dec Pattern Setting Details

Pr. Code	Description
Ad.3 Acc S Start	Sets the gradient level as acceleration starts when using an S–curve, Acc/Dec pattern. Ad.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 within the 15–30 Hz frequency range.
Ad.4 Acc S End	Sets the gradient level as acceleration ends when using an S–curve Acc/Dec pattern. Ad.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.
Ad.5 Dec S Start – Ad.6 Dec S End	Sets the rate of S–curve deceleration. Configuration for codes Ad.5 and Ad.6 may be performed the same way as configuring codes Ad.3 and Ad.4.



Acceleration / deceleration pattern configuration



Acceleration / deceleration S–curve pattern configuration

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

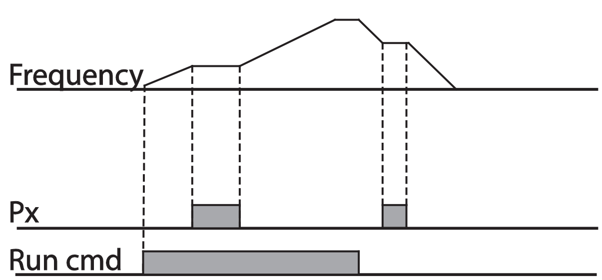
- *Actual acceleration time = user-configured acceleration time + user-configured acceleration time x starting gradient level/2 + user-configured acceleration time x ending gradient level/2.*
- *Actual deceleration time = user-configured deceleration time + user-configured deceleration time x starting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

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

Stopping the Acc/Dec Operation

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

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
In	In.65–In.69	Px terminal configuration	25	XCEL Stop	0–52	–



V/F (Voltage/Frequency) Control

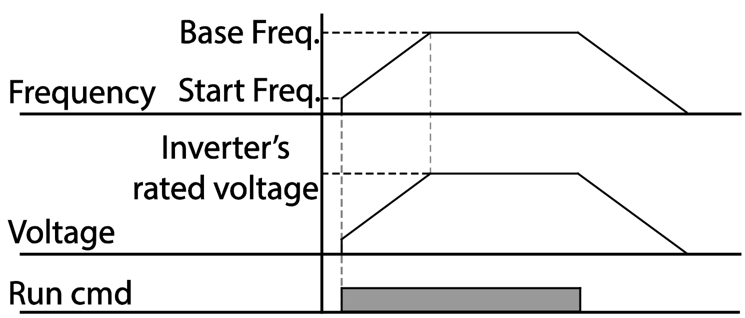
Configure the drive's output voltages, gradient levels and output patterns to achieve a target output frequency with V/F control. The amount of torque boost used during low frequency operations can also be adjusted.

Linear V/F Pattern Operation

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

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
dr	dr.9	Control mode	0	V/F	0–4	–
	dr.18	Base frequency	60.00		30.00–400.00	Hz
	dr.19	Start frequency	0.50		0.01–10.00	Hz
bA	bA.7	V/F pattern	0	Linear	0–3	–

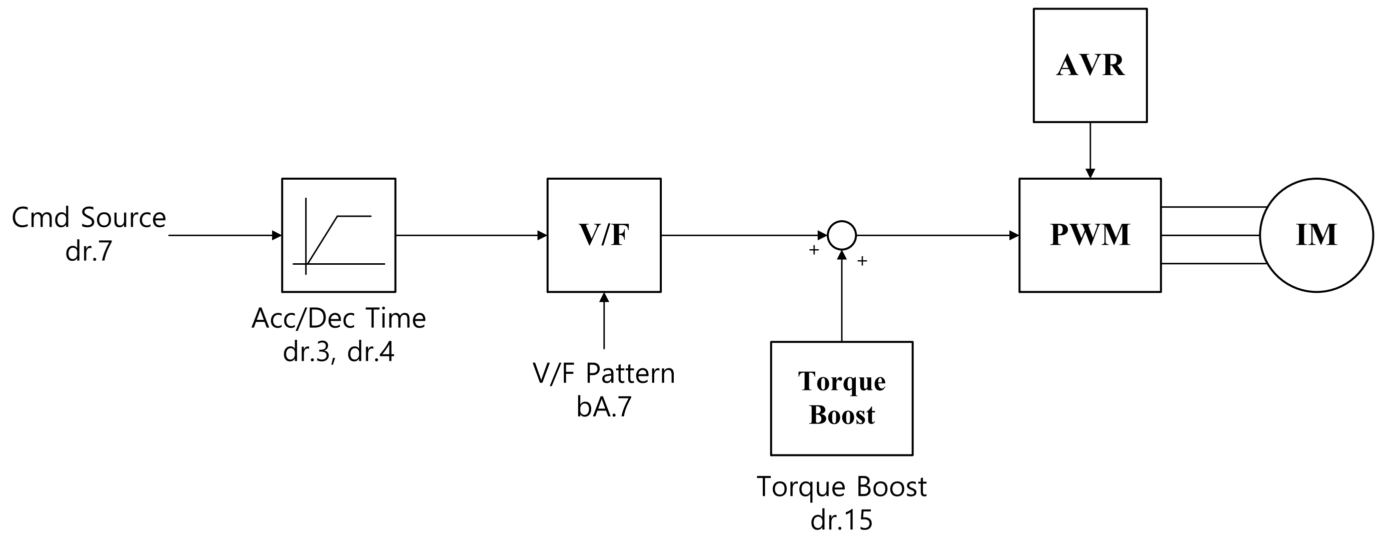
Linear V/F Pattern Setting Details

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

Linear V/F Control Block Diagram

IM V/F Control (IMVF)

When dr.9 is set to 0: VF, the V/F control diagram is as shown here:



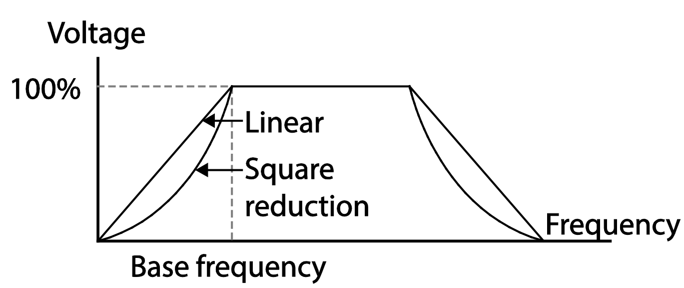
Square Reduction V/F pattern Operation

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	0–3	–
			3	Square2		

Square Reduction V/F pattern Operation – Setting Details

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



User V/F Pattern Operation

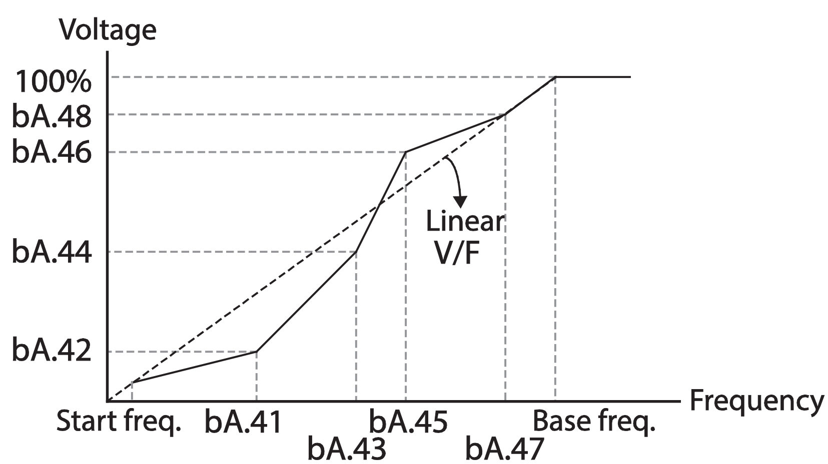
The ACG drive allows the configuration of user–defined V/F patterns to suit the load characteristics of special motors.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
bA	bA.7	V/F pattern	2	User V/F	0–3	–
	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	Maximum frequency		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 bA.15 (motor rated voltage). If bA.15 is set to 0 it will be based on the input voltage.



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

Torque Boost

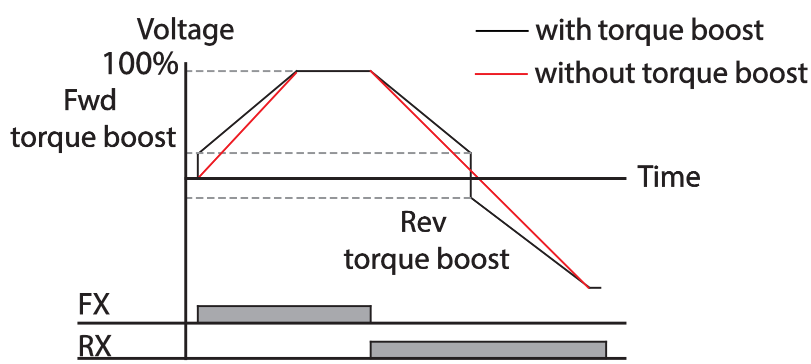
Manual Torque Boost

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

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

Manual Torque Boost Setting Details

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



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

Auto Torque Boost

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	50.0		0.0–300.0	%
	dr.28	Auto torque boost regeneration voltage gain	50.0		0.0–300.0	%

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 dr.18 (base frequency), bA.12 (motor's rated slip frequency), bA.13 (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 (dr.16, dr.17). If the run direction is forward, dr.16 forward torque boost quantity is applied. If the direction is reverse, dr.17 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.

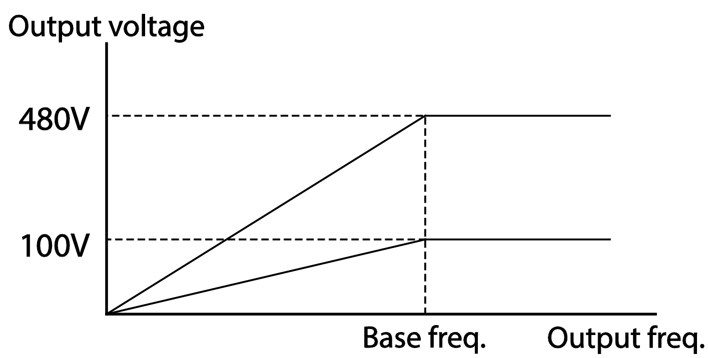
If automatic torque boost is selected (dr.15=1), parameter codes dr.26, dr.27, and dr.28 are enabled and the drive outputs voltage according to the torque boost quantity.

Output Voltage Setting

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

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

Pr. Group	Pr. Code	Name	Parameter Setting	Setting Range	Unit
bA	bA.15	Motor rated voltage	0	0, 100–480	V



Start Mode Setting

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

Acceleration Start

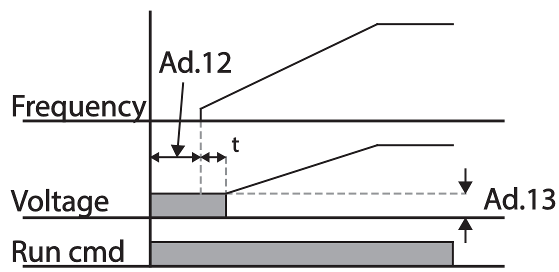
Acceleration start is a general acceleration mode. If there are no extra settings applied, the motor accelerates directly to the frequency reference when the command is input.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Ad	Ad.7	Start mode	0	Acc	0–1	–

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.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Ad	Ad.7	Start mode	1	DC–Start	0–1	–
	Ad.12	Start DC braking time	0.00		0.00–60.00	sec
	Ad.13	DC Injection Level	50		0–Rated Current of Drive/Rated Current of Motor x 100%	%



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

Pre-excite of Stop Status

Use to apply the fluxa current to the motor under a stop status. If you enter the multi-function input signal set with the initial excitation signal, DC voltage will be supplied to the motor.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Ad	Ad.13	Amount of applied DC	50		0–Rated Current of Drive/Rated Current of Motor x 100%	%
In	In.65–In.69	Px terminal setting options	34	Pre excite	–	–

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

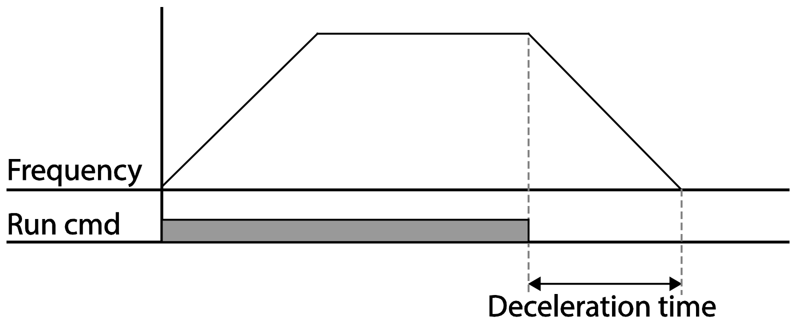
Stop Mode Setting

Select a stop mode to stop the drive operation.

Deceleration Stop

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

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Ad	Ad.8	Stop mode	0	Dec	0–4	–



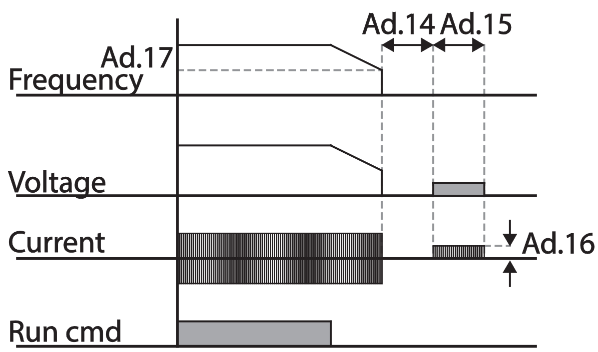
Stop After DC Braking

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

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Ad	Ad.8	Stop mode	0	Dec	0–4	–
	Ad.14	Output block time before braking	0.10		0.00–60.00	sec
	Ad.15	DC braking time	1.00		0–60	sec
	Ad.16	DC braking amount	50		0–Rated Current of Drive/Rated Current of Motor x 100%	%
	Ad.17	DC braking frequency	5.00		0.00–60.00	Hz

DC Braking After Stop Setting Details

Pr. Code	Description
Ad.14 DC–Block Time	Set the time to block the drive output before DC braking. If the inertia of the load is great, or if DC braking frequency (Ad.17) is set too high, a fault trip may occur due to overcurrent conditions when the drive supplies DC voltage to the motor. Prevent overcurrent fault trips by adjusting the output block time before DC braking.
Ad.15 DC–Brake Time	Set the time duration for the DC voltage supply to the motor.
Ad.16 DC–Brake Level	Set the amount of DC braking to apply. The parameter setting is based on the rated current of the motor. The maximum value of the DC braking rate is limited as an 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.

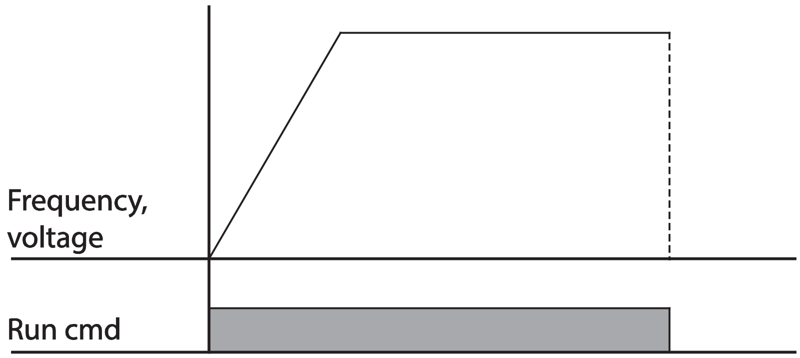


CAUTION: Note that the motor can overheat or be damaged if excessive amount of DC braking is applied to the motor, or DC braking time is set too long.
DC braking is configured based on the motor's rated current. To prevent overheating or damaging motors, do not set the current value higher than the drive's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

Free Run Stop

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

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Ad	Ad.8	Stop Method	2	Free–Run	0–4	–



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

Power Braking

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

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Ad	Ad.8	Stop mode	4	Power Braking	0–4	–

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

Frequency Limit

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

Frequency Limit Using Maximum Frequency and Start Frequency

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

Frequency Limit Using Maximum Frequency and Start Frequency – Setting Details

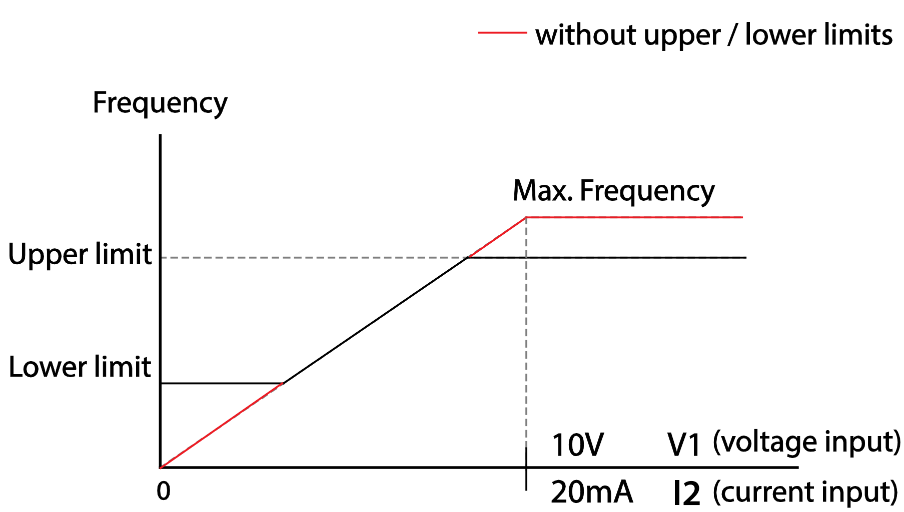
Pr. Code	Description
dr.19 Start Freq	Set the lower limit value for speed unit parameters that are expressed in Hz or rpm. If an input frequency is lower than the start frequency, the parameter value will be 0.00.
dr.20 Max Freq	Set an upper limit frequency to all speed unit parameters that are expressed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

Frequency Limit Using Upper and Lower Limit Frequency Values

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

Frequency Limit Using Upper and Lower Limit Frequencies – Setting Details

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

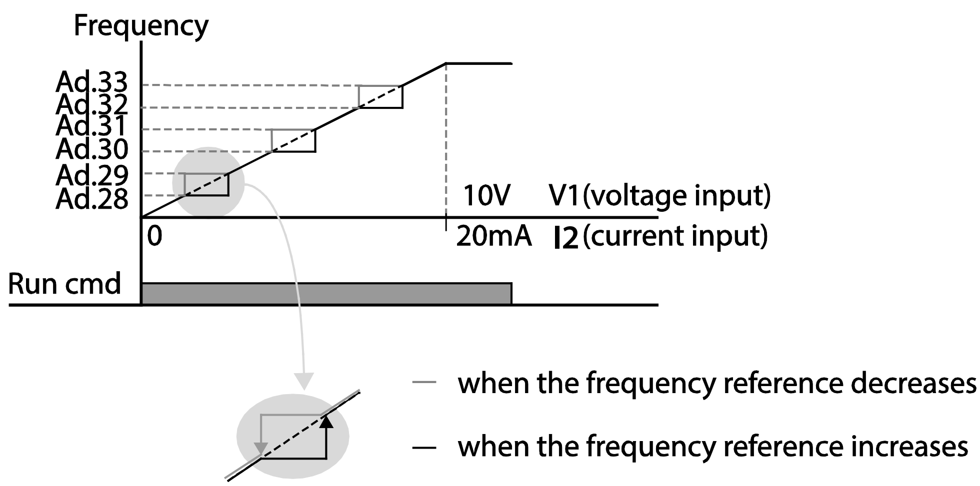


Frequency Jump

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

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

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Ad	Ad.27	Frequency jump	0	No	0–1	–
	Ad.28	Jump frequency lower limit1	10.00		0.00–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		0.00–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		0.00–Jump frequency upper limit 3	Hz
	Ad.33	Jump frequency upper limit 3	35.00		Jump frequency lower limit 3–Maximum frequency	Hz



2nd Operation Mode Setting

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

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

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	drv	Command source	1	Fx/Rx–1 (Fwd Run/Rev Run)	0–4	–
	Frq	Frequency reference source	2	V1	0–8	–
bA	bA.4	2nd Command source	0	Keypad	0–4	–
	bA.5	2nd Frequency reference source	0	Keypad–1	0–8	–
In	In.65–In.69	Px terminal configuration	15	2nd Source	0–52	–

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).

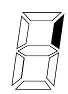
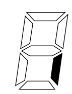
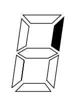
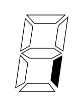
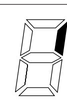
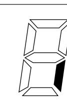
CAUTION:
- *When setting the multi–function terminal to the 2nd command source (2nd Source) and input (On) the signal, operation state is changed because the frequency setting and the Operation command will be changed to the 2nd command. Before shifting input to the multi–function terminal, ensure that 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.*

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 On filter	10	0–10000	ms
	In.86	Multi–function input terminal Off filter	3	0–10000	ms
	In.87	Multi–function input terminal selection	0 0000*	–	–
	In.88	NO/NC selection of operation command	0	0–1	–
	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

<table>
<tr><th>Pr. Code</th><th>Description</th></tr>
<tr><td>In.84 DI Delay Sel</td><td>Select whether or not to activate the time values set at In.85 and In.86. If deactivated, the time values are set to the default values at In.85 and In.86. If activated, the set time values at In.85 and In.86 are set to the corresponding terminals. See "Bit Selection" on page 4–3 for details
<table>
<tr><th>Items</th><th>Enable state of terminal</th><th>Disable state of terminal</th></tr>
<tr><td>Keypad</td><td></td><td></td></tr>
</table></td></tr>
<tr><td>In.85 DI On Delay,
In.86 DI Off Delay</td><td>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.</td></tr>
<tr><td>In.87 DI NC/NO Sel</td><td>Select terminal contact types for each input terminal. The position of the indicator light corresponds to the segment that is on as shown in the table below. With the bottom segment on, it indicates that the terminal is configured as a A terminal (Normally Open) contact. With the top segment on, it indicates that the terminal is configured as a B terminal (Normally Closed) contact. Terminals are numbered P1–P5, from right to left. See "Bit Selection" on page 4–3 for details
<table>
<tr><th>Items</th><th>B contact status</th><th>A contact status</th></tr>
<tr><td>Keypad</td><td></td><td></td></tr>
</table></td></tr>
<tr><td>In.88 FX/RX NO/NC Sel</td><td>Select whether to use the terminal set to FX/RX as NO (Normal Open) only or to use as NO (Normal Open) and NC(Normal Close). If set to 1: NO only, the terminal in which the functions are set to FX/RX cannot be set as NC.
If set to 0: NO/NC, terminals set as FX/RX can also be set as NC.</td></tr>
<tr><td>In.90 DI Status</td><td>Display the configuration of each contact. When a segment is configured as Normally Open (A) terminal using In.87, the On condition is indicated by the top segment turning on. The Off condition is indicated when the bottom segment is turned on. When contacts are configured as Normally Closed (B) terminals, the segment lights behave conversely. Terminals are numbered P1–P5, from right to left. See "Bit Selection" on page 4–3 for details.
If using Extension IO card, use the Left arrow key on the keypad to display the status of P8, P9 and P10.
<table>
<tr><th>Items</th><th>Bit ON when A contact is set</th><th>Bit OFF when A contact is set</th></tr>
<tr><td>Keypad</td><td></td><td></td></tr>
</table></td></tr>
</table>

Fire Mode Operation

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

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

Fire Mode Parameter Settings

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Ad	Ad.80	Fire Mode selection	1	Fire Mode	0–2	–
	Ad.81	Fire Mode frequency	0–60		0–60	–
	Ad.82	Fire Mode run direction	0–1		0–1	–
	Ad.83	Fire Mode operation count	Not configurable		–	–
In	In.65–In.69	Px terminal configuration	51	Fire Mode	0–52	–

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

The drive runs in Fire Mode when Ad.80 (Fire Mode Sel) is set to Fire Mode Test, and the multi-function terminal (In.65-In.69 Px) configured for the fire mode (51: Fire Mode) is turned on. But when the minor fault trips are ignored or there are major fault trips, automatic Reset/Restart is not attempted, and the Fire Mode Count is not increased.

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

Fire Mode Function Setting Details

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

Learning Advanced Features

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

Advanced Tasks	Description	Ref.
Auxiliary frequency operation	Use the main and auxiliary frequencies in the predefined formulas to create various operating conditions. Auxiliary frequency operation is ideal for Draw Operation* as this feature enables fine–tuning of operation speeds.	4–84
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.	4–88
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.	4–89
Safety operation mode	This safety feature allows the drive's operation only after a signal is input to the multi–function terminal designated for the safety operation mode. This feature is useful when extra care is needed in operating the drive using the multi–purpose terminals.	4–92
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.	4–93
Slip compensation	This feature ensures that the motor rotates at a constant speed, by compensating for the motor slip as a load increases.	4–95
PID control	PID control provides constant automated control of flow, pressure, and temperature by adjusting the output frequency of the drive.	4–96
Auto–tuning	Used to automatically measure the motor control parameters to optimize the drive's control mode performance.	4–102
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.	4–104
Energy buffering operation	Used to maintain the DC link voltage for as long as possible by controlling the drive output frequency during power interruptions, thus to delay a low voltage fault trip.	4–109
Energy saving operation	Used to save energy by reducing the voltage supplied to motors during low–load and no–load conditions.	4–112
Speed search operation	Used to prevent fault trips when the drive voltage is output while the motor is idling or free–running.	4–113
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).	4–117
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.	4–119
Commercial power source switch operation	Used to switch the power source to the motor from the drive output to a commercial power source, or vice versa.	4–120
Cooling fan control	Used to control the cooling fan of the drive.	4–121
Multi-function IO Timer settings	Set the timer value and control the On/Off state of the multi–function output and relay.	4–125
Brake control	Used to control the On/Off operation of the load's electronic braking system.	4–126
Multi–function output On/Off control	Set standard values and turn On/Off the output relays according to the analog input value.	4–127
Regeneration prevention for press operation.	Used during a press operation to avoid motor regeneration, by increasing the motor operation speed.	4–127
**Draw operation is an open loop tension control. This feature allows a constant tension to be applied to the material that is drawn by a motor–driven device, by fine–tuning the motor speed using operation frequencies that are proportional to a ratio of the main frequency reference.*		

Operating with Auxiliary References

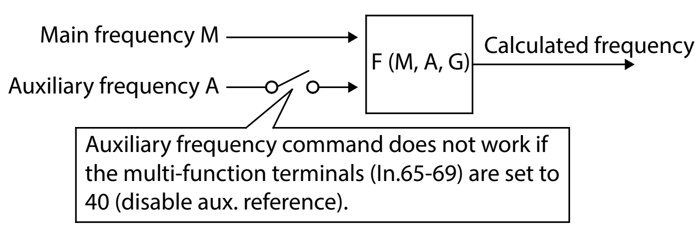
Frequency references can be configured with various calculated conditions that use the main and auxiliary frequency references simultaneously. The main frequency reference is used as the operating frequency, while auxiliary references are used to modify and fine–tune the main reference.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	0	Keypad–1	0–8	–
bA	bA.1	Auxiliary frequency reference source	1	V1	0–4	–
	bA.2	Auxiliary frequency reference calculation type	0	M+(G*A)	0–7	–
	bA.3	Auxiliary frequency reference gain	0.0	–	–200.0–200.0	%
In	In.65– In.69	Px terminal configuration	40	dis Aux Ref	0–52	–

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

Auxiliary Reference Setting Details

<table>
<tr><th>Pr. Code</th><th colspan="3">Description</th></tr>
<tr><td rowspan="6">bA.1 Aux Ref Src</td><td colspan="3">Set the input type to be used for the auxiliary frequency reference</td></tr>
<tr><td colspan="2">Configuration</td><td>Description</td></tr>
<tr><td>0</td><td>None</td><td>Auxiliary frequency reference is disabled.</td></tr>
<tr><td>1</td><td>V1</td><td>Sets the V1 (voltage) terminal at the control terminal block as the source of auxiliary frequency reference.</td></tr>
<tr><td>3</td><td>V0</td><td>Select the potentiometer dial of keypad as auxiliary command.</td></tr>
<tr><td>4</td><td>I2</td><td>Sets the I2 (current) terminal at the control terminal block as the source of auxiliary frequency reference (SW2 must be set to “current”).</td></tr>
<tr><td rowspan="11">bA.2 Aux Calc Type</td><td colspan="3">Set the auxiliary reference gain with bA.3 (Aux Ref Gain) to configure the auxiliary reference and set the percentage to be reflected when calculating the main reference. Note that items 4–7 below may result in either plus (+) or minus (–) references (forward or reverse operation) even when unipolar analog inputs are used.</td></tr>
<tr><td colspan="2">Configuration</td><td>Formula for frequency reference</td></tr>
<tr><td>0</td><td>M+(G*A)</td><td>Main reference+(bA.3xbA.1xIn.1)</td></tr>
<tr><td>1</td><td>M*(G*A)</td><td>x(bA.3xbA.1)</td></tr>
<tr><td>2</td><td>M/(G*A)</td><td>Main reference/(bA.3xbA.1)</td></tr>
<tr><td>3</td><td>M+{M*(G*A)}</td><td>Main reference+{Main reference x(bA.3xbA.1)}</td></tr>
<tr><td>4</td><td>M+G*2*(A–50)</td><td>Main reference+bA.3x2x(bA.1–50)x In.1</td></tr>
<tr><td>5</td><td>M*{G*2*(A–50)}</td><td>Main reference x{bA.3x2x(bA.1–50)}</td></tr>
<tr><td>6</td><td>M/{G*2*(A–50)}</td><td>Main reference/{bA.3x2x(bA.1–50)}</td></tr>
<tr><td>7</td><td>M+M*G*2*(A–50)</td><td>Main reference+Main reference x bA.3x2x(bA.1–50)</td></tr>
<tr><td colspan="3">M: Main frequency reference (Hz or rpm)
G: Auxiliary reference gain (%)
A: Auxiliary frequency reference (Hz or rpm) or gain (%)</td></tr>
<tr><td>bA.3 Aux Ref Gain</td><td colspan="3">Adjust the size of the input (bA.1 Aux Ref Src) configured for auxiliary frequency.</td></tr>
<tr><td>In.65–In.69 Px Define</td><td colspan="3">Set one of the multi–function input terminals to 40(dis Aux Ref) and turn it on to disable the auxiliary frequency reference.
The drive will operate using the main frequency reference only.</td></tr>
</table>



Auxiliary Reference Operation Ex #1

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

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

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

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

Auxiliary Reference Operation Ex #2

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

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

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

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

Auxiliary Reference Operation Ex #3

V1 is Main Frequency and I2 is Auxiliary Frequency

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

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

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

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

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

Jog operation

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

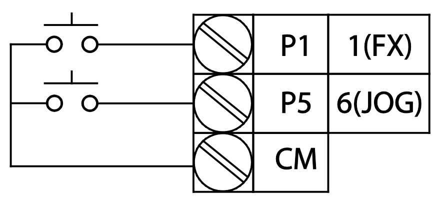
The jog operation is the second highest priority operation, after the dwell operation. If a jog operation is requested while operating the multi–step, up–down, or 3–wire operation modes, the jog operation overrides all other operation modes.

Jog Operation 1–Forward Jog by Multi–function Terminal

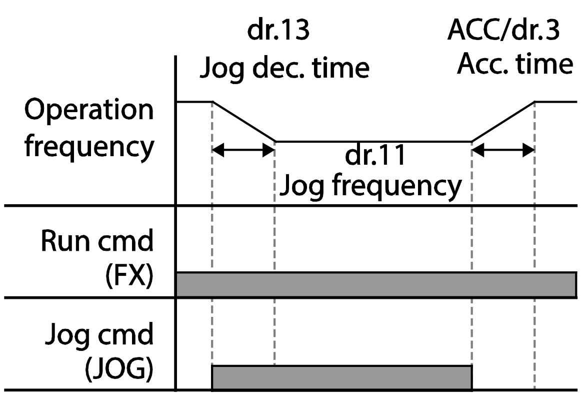
The jog operation is available in either forward or reverse direction, using the keypad or multi–function terminal inputs. The table below lists parameter setting for a forward jog operation using the multi–function terminal inputs.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
dr	dr.11	Jog frequency	10.00		0.50–Maximum frequency	Hz
	dr.12	Jog operation acceleration time	20.00		0.00–600.00	sec
	dr.13	Jog operation deceleration time	30.00		0.00–600.00	sec
In	In.65–In.69	Px terminal configuration	6	JOG	0–52	–

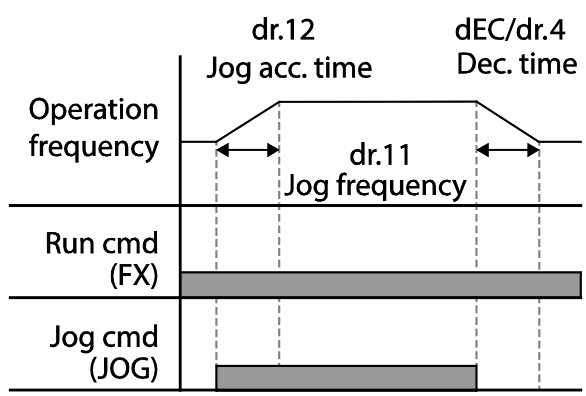
Forward Jog Description Details

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

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



Operation frequency > Jog frequency

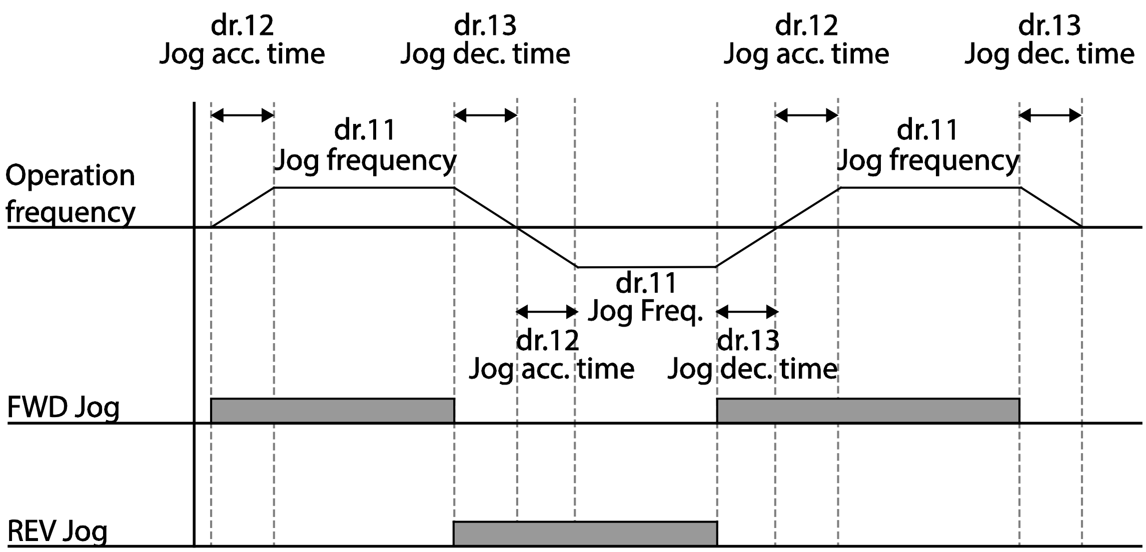


Operation frequency < Jog frequency

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

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

Pr. Group	Pr. Code	Name	Parameter setting		Setting Range	Unit
dr	dr.11	Jog frequency	10.00		0.50–Maximum frequency	Hz
	dr.12	Jog operation acceleration time	20.00		0.00–600.00	sec
	dr.13	Jog operation deceleration time	30.00		0.00–600.00	sec
In	In.65–In.69	Px terminal configuration	46	FWD JOG	0–52	–
			47	REV JOG		



Up–down Operation

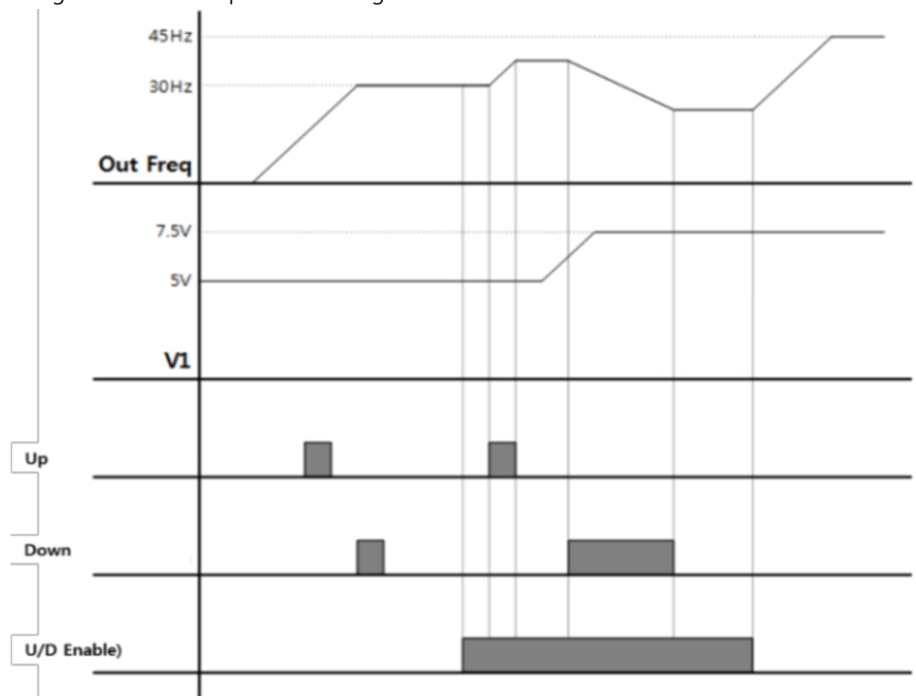
The Acc/Dec time can be controlled through input at the multi–function terminal block. Similar to a flowmeter, the up–down operation can be applied easily to a system that uses the upper–lower limit switch signals for Acc/Dec commands.

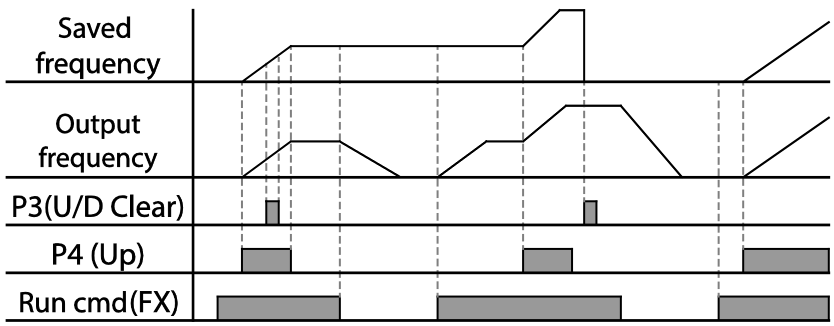
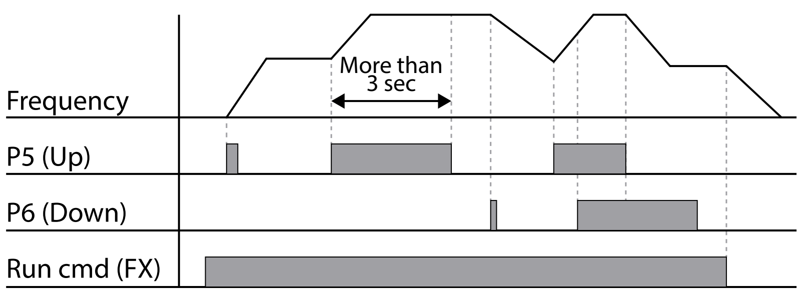
Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Ad	Ad.65	Up–down operation frequency save	1	Yes	0–1	–
	Ad.85	Up–down mode selection	0	U/D Normal	0–2	–
			1	U/D Step		
			2	U/D Step+ Norm		
	Ad.86	Up–down step frequency	0.00		0–Maximum Frequency	Hz

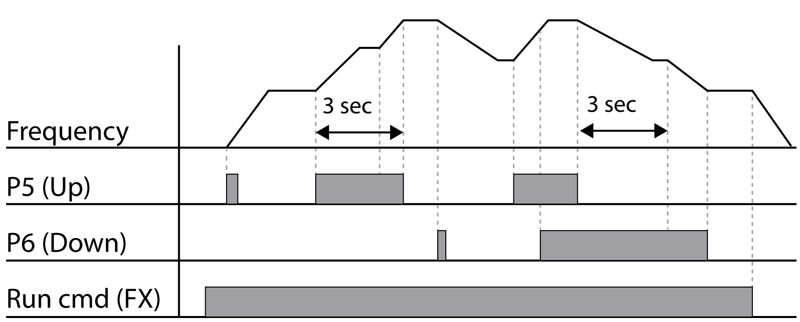
Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
In	In.65–In.69	Px terminal configuration	17	Up	0–52	–
			18	Down		
			20	U/D Clear		
			27	U/D Enable		

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 17 (Up), 18 (Down) and 27 (U/D Enable), respectively. If the up-down switchover (U/D Enable) command is not entered, acceleration/deceleration will follow the operation command set in drv. If the up-down switchover (U/D Enable) command is entered during acceleration/deceleration, acceleration/deceleration will stop to wait for Up and Down commands. • When the operation command and up-down activation command is entered, the operation will be accelerated if the Up terminal signal turns On, and the acceleration will stop to operate as a constant speed if the signal turns Off. • When signal is off, deceleration stops and it operates in constant speed. Deceleration stops and constant speed operation begins when both Up and Down signals are entered at the same time. 

<table>
<tr><th>Pr. Code</th><th colspan="3">Description</th></tr>
<tr><td>Ad.65 U/D Save Mode</td><td colspan="3">During a constant speed operation, the operating frequency is saved automatically in the following conditions: the operation command (Fx or Rx) is off, a fault trip occurs, or the power is off.
When the operation command is turned on again, or when the drive regains the power source or resumes to a normal operation from a fault trip, it resumes operation at the saved frequency. To delete the saved frequency, use the multi–function terminal block. Set one of the multi–function terminals to 20 (U/D Clear) and apply signals to it during constant speed operation. The saved frequency and the up–down operation configuration will be deleted.

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

U/D Step


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

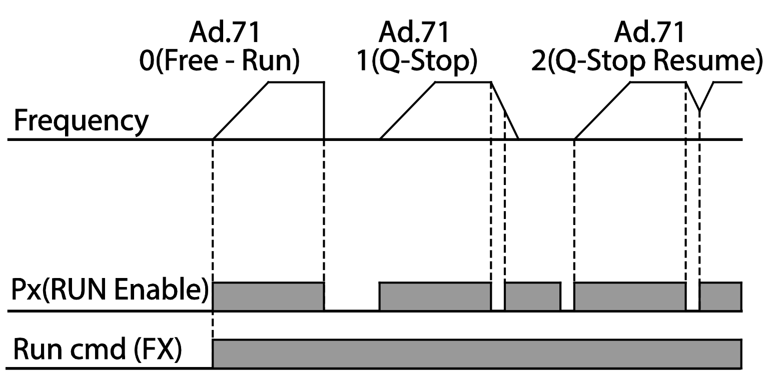
Safe Operation Mode

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

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Ad	Ad.70	Safe operation selection	1	DI Dependent	–	–
	Ad.71	Safe operation stop mode	0	Free–Run	0–2	–
	Ad.72	Safe operation deceleration time	5.0		0.0–600.0	sec
In	In.65–In.69	Px terminal configuration	13	RUN Enable	0–52	–

Safe Operation Mode Setting Details

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



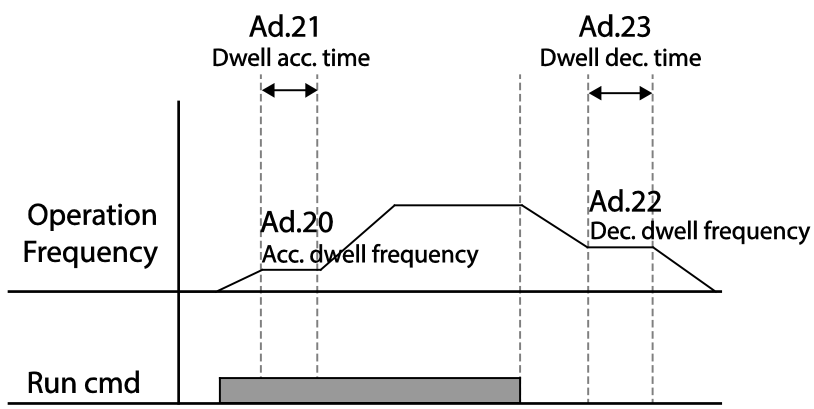
Dwell Operation

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

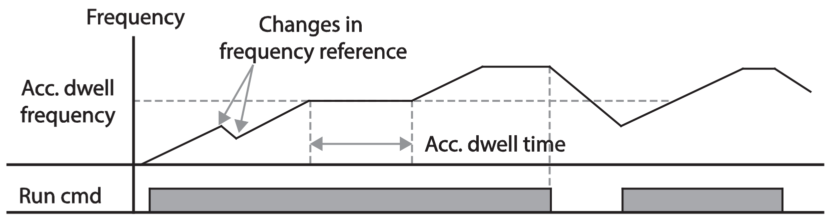
- ***Acceleration Dwell Operation:*** *When an operation command runs, acceleration continues until the acceleration dwell frequency and constant speed is reached within the acceleration dwell operation time (Acc Dwell Time). After the Acc Dwell Time has passed, acceleration is carried out based on the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

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

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

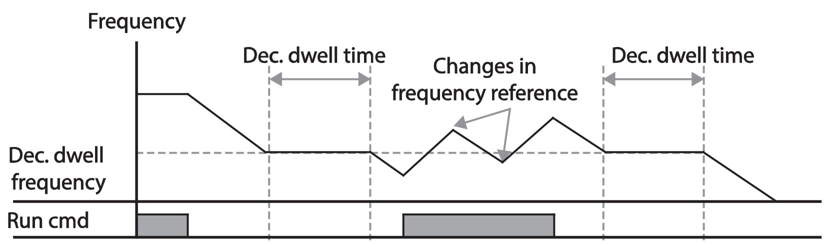


NOTE: Dwell operation does not work when:
- *Dwell operation time is set to 0 sec or dwell frequency is set to 0 Hz.*
- *Re-acceleration is attempted from stop or during deceleration, as only the first acceleration dwell operation command is valid.*



Acceleration dwell operation

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



Deceleration dwell operation

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

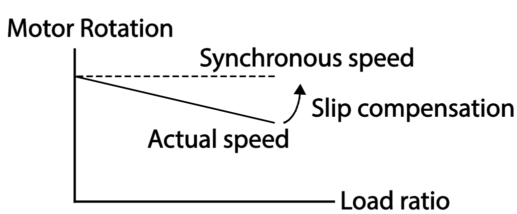
Slip Compensation Operation

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

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
dr	dr.9	Control mode	2	Slip Compen	–	–
	dr.14	Motor capacity	2	0.75 kW (0.75 kW based)	0–15	–
bA	bA.11	Number of motor poles	4		2–48	–
	bA.12	Rated slip speed	90 (0.75 kW based)		0–3000	rpm
	bA.13	Rated motor current	3.6 (0.75 kW based)		1.0–1000.0	A
	bA.14	Motor no–load current	1.6 (0.75 kW based)		0.5–1000.0	A
	bA.16	Motor efficiency	72 (0.75 kW based)		64–100	%
	bA.17	Load inertia rate	0 (0.75 kW based)		0–8	–

Slip Compensation Operation Setting Details

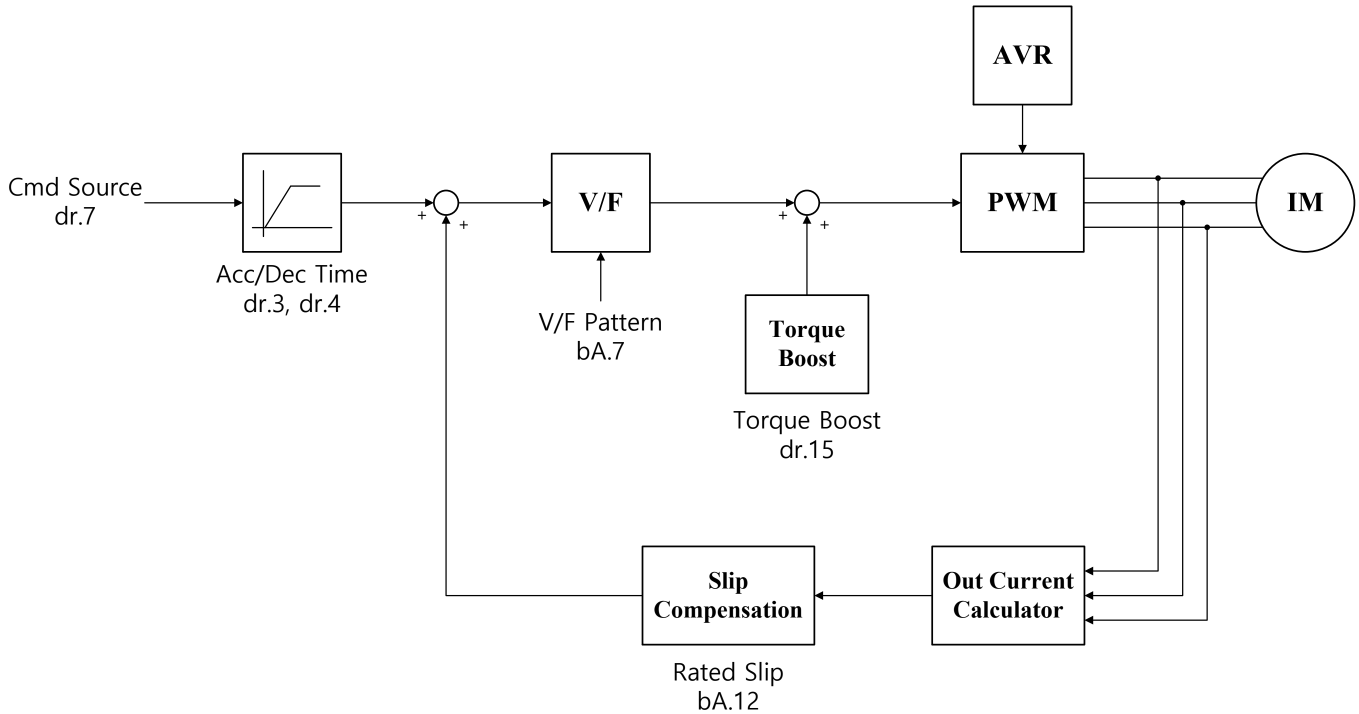
Pr. Code	Description
dr.9 Control Mode	Set dr.9 to 2 (Slip Compen) to carry out the slip compensation operation.
dr.14 Motor Capacity	Set the capacity of the motor connected to the drive.
bA.11 Pole Number	Enter the number of poles from the motor rating plate.
bA.12 Rated Slip	Enter the number of rated rotations from the motor rating plate. $f_s = f_r - \frac{Rpm \times P}{120}$ Where: • f_s = rated slip frequency • f_r = 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 Noload Curr	Enter the measured current when the load on the motor axis is removed and when the motor is operated at the rated frequency. If no–load current is difficult to measure, enter a current equivalent to 30–50% of the rated motor current.



Slip Compensation Control Block Diagram

IM V/F Control (IMVF with Slip compensation)

When dr.9 is set to 2: Slip Compen, the V/F control with Slip comp. diagram is as shown below:



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

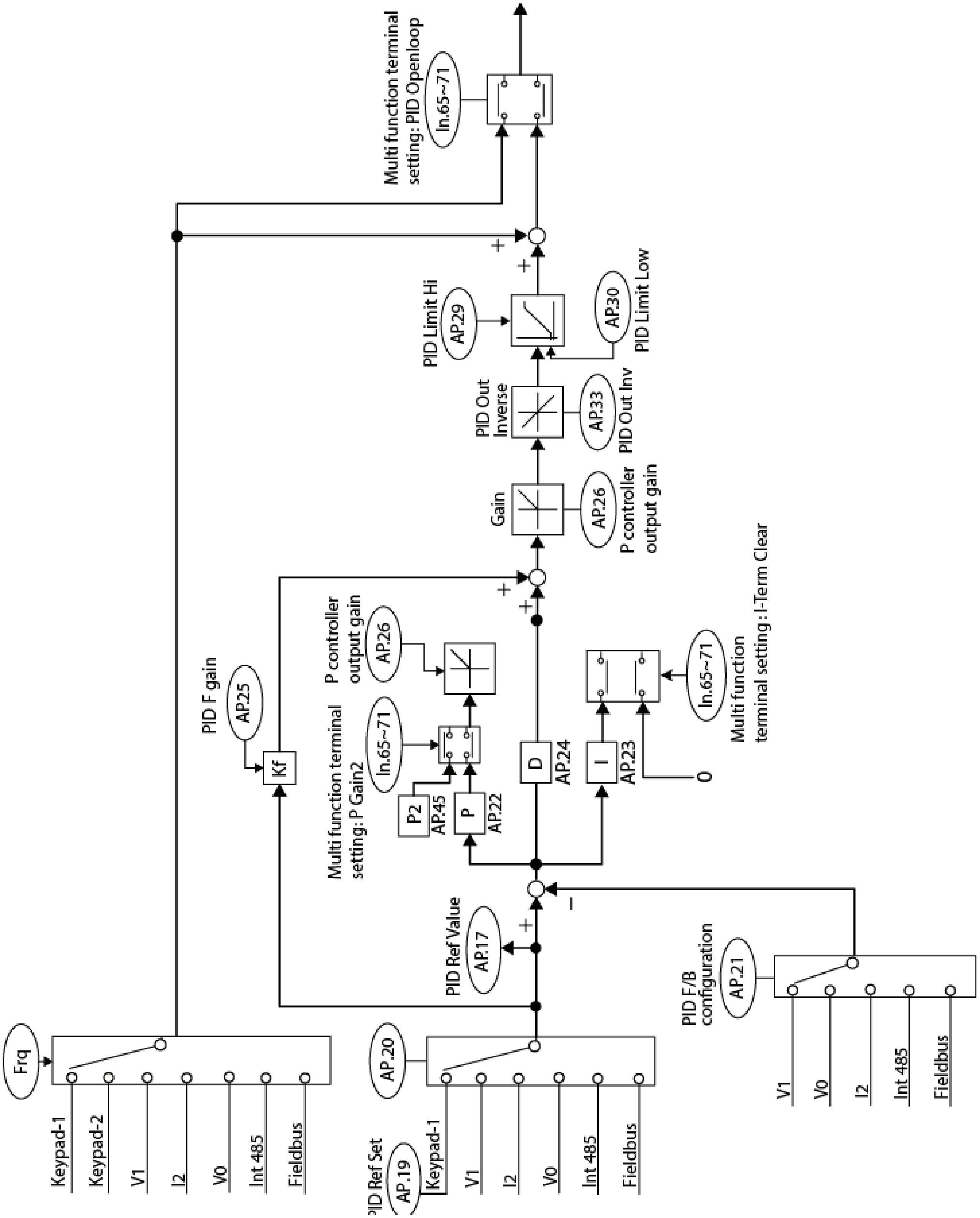
PID operates by controlling the output frequency of the drive, through automated system process control to maintain speed, pressure, flow, temperature and tension.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
AP	AP.1	Application function selection	2	Proc PID	0–2	–
	AP.16	PID output monitor	–		–	–
	AP.17	PID reference monitor	–		–	–
	AP.18	PID feedback monitor	–		–	–
	AP.19	PID reference setting	50.00		–100.00–100.00	%
	AP.20	PID reference source	0	Keypad	0–7	–
	AP.21	PID feedback source	0	V1	0–6	–
	AP.22	PID controller proportional gain	50.0		0.0–1000.0	%
	AP.23	PID controller integral time	10.0		0.0–200.0	sec
	AP.24	PID controller differential time	0		0–1000	msec
	AP.25	PID controller feed–forward compensation gain	0.0		0–1000	%
	AP.26	Proportional gain scale	100.0		0.0–100.0	%
	AP.27	PID output filter	0		0–10000	ms
	AP.28	PID mode	0	Process PID	0–1	
	AP.29	PID maximum frequency	60.00		–300.00–300.00	Hz
	AP.30	PID minimum frequency	0.5		–300.00–300.00	Hz
	AP.32	PID output scale	100.0		0.1–1000.0	%
	AP.33	PID output inverse	0	No	0–1	–
	AP.34	PID controller motion frequency	0.00		0–Maximum frequency	Hz
	AP.35	PID controller motion level	0.0		0.0–100.0	%
	AP.36	PID controller motion delay time	600		0–9999	sec
	AP.37	PID sleep mode delay time	60.0		0–999.9	sec
	AP.38	PID sleep mode frequency	0.00		0–Maximum frequency	Hz
	AP.39	PID wake–up level	35		0–100	%
	AP.40	PID wake–up mode selection	0	Below Level	0–2	–
	AP.43	PID unit gain	100.0		0–300	%
	AP.44	PID unit scale	2	x 1	0–4	–
	AP.45	PID 2nd proportional gain	100.00		0–1000	%
In	In.65–In.69	Px terminal configuration	22	I–Term Clear	0–52	–
			23	PID Openloop		
			24	P Gain2		

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 dr.20 (MaxFreq) parameter setting.

PID Basic Operation Setting Details

<table>
<tr><th>Pr. Code</th><th colspan="3">Description</th></tr>
<tr><td>AP.1 App Mode</td><td colspan="3">Set the code to 2 (Proc PID) to select functions for the process PID.</td></tr>
<tr><td>AP.16 PID Output</td><td colspan="3">Displays the existing output value of the PID controller. The gain and scale that were set at AP.43–AP.44 are applied on the display.</td></tr>
<tr><td>AP.17 PID Ref Value</td><td colspan="3">Displays the existing reference value set for the PID controller. The gain and scale that were set at AP.43–AP.44 are applied on the display.</td></tr>
<tr><td>AP.18 PID Fdb Value</td><td colspan="3">Displays the input value of the PID controller that is included in the latest feedback. The gain and scale that were set at AP.43–AP.44 are applied on the display.</td></tr>
<tr><td>AP.19 PID Ref Set</td><td colspan="3">When AP.20 (PID control reference source) is set to 0 (Keypad), the reference value can be entered. If the reference source is set to any other value, the setting values for AP.19 are void.</td></tr>
<tr><td rowspan="9">AP.20 PID Ref Source</td><td colspan="3">Selects the reference input for the PID control. If the V1 terminal is set to PID feedback source (PID F/B Source), the V1 terminal cannot be set to the PID reference source (PID Ref Source). To set V1 as a reference source, change the feedback source.</td></tr>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>Keypad</td><td>Keypad</td></tr>
<tr><td>1</td><td>V1</td><td>–10–10V input voltage terminal</td></tr>
<tr><td>3</td><td>V0</td><td>Potentiometer dial input of keypad</td></tr>
<tr><td>4</td><td>I2</td><td>4–20 mA input current terminal</td></tr>
<tr><td>5</td><td>Int. 485</td><td>RS–485 input terminal</td></tr>
<tr><td>7</td><td>Fieldbus (Ethernet)</td><td>Communication command via a communication option card</td></tr>
<tr><td colspan="3">When using the keypad, the PID reference setting can be displayed at AP.17.</td></tr>
<tr><td>AP.21 PID F/B Source</td><td colspan="3">Selects feedback input for PID control. Items can be selected as reference input, except the keypad input (Keypad–1 and Keypad–2). Feedback cannot be set to an input item that is identical to the item selected as the reference. For example, when Ap.20 (Ref Source) is set to 1 (V1), for AP. 21 (PID F/B Source), an input other than the V1 terminal must be selected.</td></tr>
<tr><td>AP.22 PID P–Gain,
AP.26 P Gain Scale</td><td colspan="3">Sets the output ratio for differences (errors) between reference and feedback. If the P-gain is set to 50%, then 50% of the error is output. The setting range for P-gain is 0.0–1, 000%. For ratios below 0.1%, use AP.26 (P Gain Scale).</td></tr>
<tr><td>AP.23 PID I– Time</td><td colspan="3">Sets the time to output accumulated errors. When the error is 100%, the time taken for 100% output is set. When the integral time (PID I–Time) is set to 1 second, 100% output occurs after 1 second of the error remaining at 100%. Differences in a normal state can be reduced by PID I Time. When the multi–function terminal block is set to 21(I–Term Clear) and is turned on, all of the accumulated errors are deleted.</td></tr>
<tr><td>AP.24 PID D–Time</td><td colspan="3">Sets the output volume for the rate of change in errors. If the differential time (PID D–Time) is set to 1ms and the rate of change in errors per sec is 100%, output occurs at 1% per 10ms.</td></tr>
<tr><td>AP.25 PID F–Gain</td><td colspan="3">Sets the ratio that adds the target to the PID output. Adjusting this value leads to a faster response.</td></tr>
<tr><td>AP.27 PID Out LPF</td><td colspan="3">Used when the output of the PID controller changes too fast or the entire system is unstable, due to severe oscillation. In general, a lower value (default value=0) is used to speed up response time, but in some cases a higher value increases stability. The higher the value, the more stable the PID controller output is, but the slower the response time.</td></tr>
<tr><td>AP.28 PID Mode</td><td colspan="3">By default, parameter AP.28 is set to "Proc PID". This adds the main frequency reference based on the setting in frq/DRV07. This is more commonly suited for industrial applications that may be running a PID loop with a trim input.
If you are running a fan or pump application with a PID loop it is recommended to set this to "Normal PID". Reference the function block diagram for more info.</td></tr>
<tr><td>AP.29 PID Limit Hi,
AP.30 PID Limit Lo</td><td colspan="3">Limits the output of the controller.</td></tr>
<tr><td>AP.32 PID Out Scale</td><td colspan="3">Adjusts the volume of the controller output.</td></tr>
<tr><td>AP.43 PID Unit Gain,
AP.44 PID Unit Scale</td><td colspan="3">Adjusts the size to fit the unit selected at AP.41 PID Unit Sel.</td></tr>
<tr><td>AP.45 PID P2–Gain</td><td colspan="3">The PID controller’s gain can be adjusted using the multi–function terminal. When a terminal is selected from In.65–In.69 and set to 24 (P Gain2), and if the selected terminal is entered, the gain set in AP.22 and AP.23 can be switched to the gain set in AP.45.</td></tr>
</table>



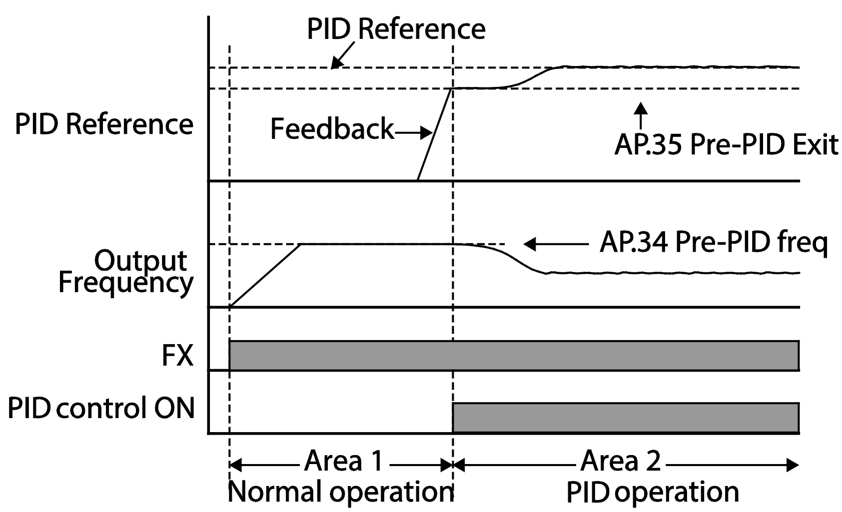
PID control block diagram

Pre–PID Operation

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

Pre–PID Operation Setting Details

Pr. Code	Description
AP.34 Pre–PID Freq	When general acceleration is required without the PID control, the frequency up to general acceleration is entered. If Pre–PID Freq is set to 30Hz, the general operation continues until the control variable (PID feedback variable) set at AP. 35 is exceeded.
AP.35 Pre–PID Exit, AP.36 Pre–PID Delay	When the feedback variable of the PID controller is higher than the value set at AP. 35, the PID control operation begins. However, when a value is set for AP.36 (Pre–PID Delay) and a feedback variable less than the value set at AP.36 is maintained for a set amount of time, the "pre–PID Fail" fault trip will occur and the output will be blocked.

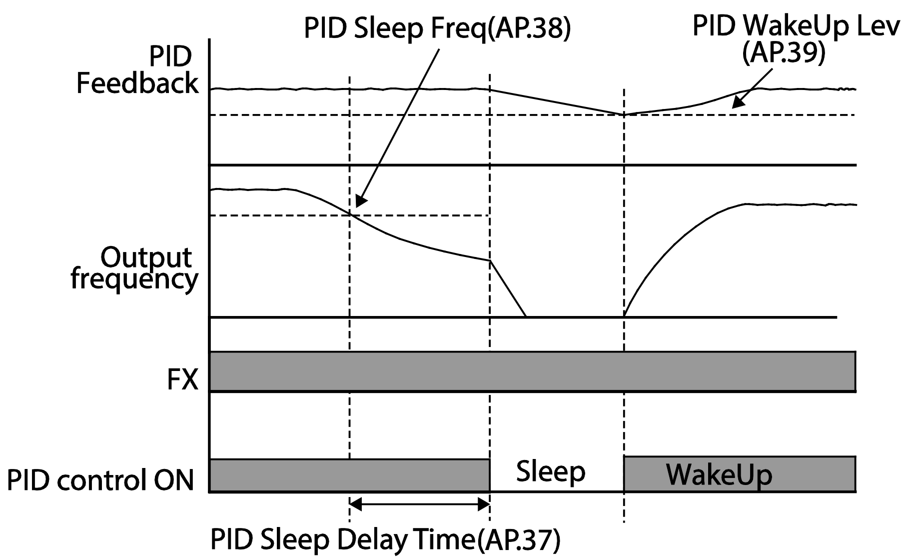


PID Operation Sleep Mode

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

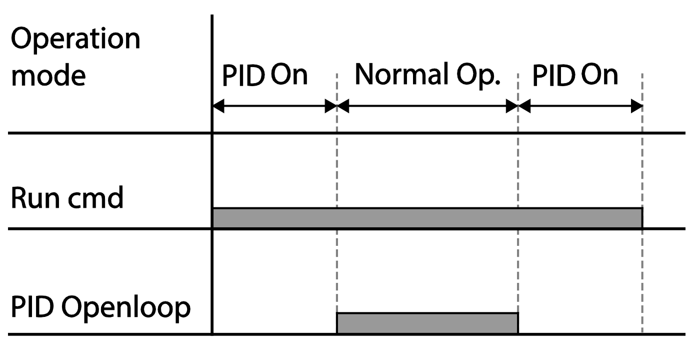
PID Operation Sleep Mode Setting Details

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



PID Switching (PID Openloop)

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



Auto Tuning

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

Example – Auto Tuning Based on 1HP (0.75kW), 230V, 60Hz, 4-pole Motor

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
dr	dr.14	Motor capacity	1	0.75 kW	0–15	–
bA	bA.11	Motor pole number	4		2–48	–
	bA.12	Rated slip speed	70		0–3000	rpm
	bA.13	Rated motor current	3.3		1.0–1000.0	A
	bA.14	Motor no–load current	1.7		0.5–1000.0	A
	bA.15	Motor rated voltage	220		170–480	V
	bA.16	Motor efficiency	83		64–100	%
	bA.20	Auto tuning	0	None	–	–
	bA.21	Stator resistance	2.951		Depends on the motor setting	Ω
	bA.22	Leakage inductance	25.20		Depends on the motor setting	mH
	bA.23	Stator inductance	171.1		Depends on the motor setting	mH
	bA.24	Rotor time constant	137		25–5000	ms

Auto Tuning Default Parameter Setting

Motor Capacity kW (HP)		Rated Current (A)	No–load Current (A)	Rated Slip Frequency(Rpm)	Stator Resistance(Ω)	Leakage Inductance (mH)
230V	0.2 (0.25)	1.1	0.8	100	14.0	40.4
	0.4 (0.5)	1.9	1.0	90	6.42	38.8
	0.75 (1.0)	3.3	1.7	70	2.951	25.20
	1.5 (2.0)	5.9	2.7	70	1.156	12.07
	2.2 (3.0)	8.6	3.9	50	0.809	6.44
	3.7 (5.0)	13.8	5.7	50	0.485	4.02
	5.5 (7.5)	20.0	6.2	50	0.283	3.24
	7.5 (10)	25.5	7.4	50	0.183	2.523
	11 (15)	40.0	12.4	30	0.120	1.488
	15 (20)	53.6	15.5	30	0.084	1.118
	18.5 (25)	65.6	19.0	30	0.068	0.819
	22 (30)	76.8	21.5	30	0.056	0.948

Motor Capacity kW (HP)		Rated Current (A)	No–load Current (A)	Rated Slip Frequency(Rpm)	Stator Resistance(Ω)	Leakage Inductance (mH)
460V	0.2 (0.25)	0.7	0.5	100	28.00	121.2
	0.4 (0.5)	1.1	0.6	90	19.40	117.0
	0.75 (1.0)	1.9	0.9	70	8.97	76.3
	1.5 (2.0)	3.4	1.7	70	3.51	37.3
	2.2 (3.0)	4.3	2.3	50	3.069	24.92
	3.7 (5.0)	6.9	3.2	50	1.820	15.36
	5.5 (7.5)	11.5	3.6	50	0.819	9.77
	7.5 (10)	15.0	4.4	50	0.526	7.58
	11 (15)	23.2	7.2	30	0.360	4.48
	15 (20)	31.0	9.0	30	0.250	3.38
	18.5 (25)	38.0	11.0	30	0.168	2.457
	22 (30)	44.5	12.5	30	0.168	2.844

Auto Tuning Parameter Setting Details

Pr. Code	Description		
bA.20 Auto Tuning	Select an auto tuning type and run it. Select one of the options and then press the [ENT] key to run the auto tuning.		
	Setting		Function
	0	None	Auto tuning function is not enabled. Also, if you select one of the auto tuning options and run it, the parameter value will revert back to “0” when the auto tuning is complete.
	1	All (rotating type)	Measures all motor parameters, including stator resistance (Rs), stator inductance (Lsigma), no–load current (Noload Curr), rotor time constant (Tr), etc., while the motor is rotating. As the motor is rotating while the parameters are being measured, if the load is connected to the motor spindle, the parameters may not be measured accurately. For accurate measurements, remove the load attached to the motor spindle. However, note that the rotor time constant (Tr) must be measured in a stopped position.
	2	All (static type)	Measures all parameters while the motor is in the stopped position. Measures stator resistance (Rs), stator inductance (Lsigma), no–load current (Noload Curr), rotor time constant (Tr), etc., while the motor is in the stopped position. As the motor is not rotating while the parameters are measured, the measurements are not affected when the load is connected to the motor spindle. However, when measuring parameters, do not rotate the motor spindle on the load side.
	3	Rs+Lsigma (rotating type)	Measures parameters while the motor is rotating. The measured motor parameters are used for auto torque boost or sensorless vector control.
	6	Tr (static type)	Measures the rotor time constant (Tr) with the motor in the stopped position and Control Mode (dr.9) is set to IM Sensorless (4).
bA.14 Noload Curr, bA.21 Rs – bA.24 Tr	Displays motor parameters measured by auto tuning. For parameters that are not included in the auto tuning measurement list, the default setting will be displayed.		

CAUTION:

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

Sensorless Vector Control for Induction Motors

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

Pr. Group	Pr. Code	Name	Parameter Setting	Setting Range	Unit
dr	dr.9	Control mode	4: IM Sensorless	–	–
	dr.14	Motor capacity	Enter motor nameplate data	0–15	–
	dr.18	Base frequency	60	30–400	Hz
bA	bA.11	Motor pole number	4	2–48	–
	bA.12	Rated slip speed	Enter motor nameplate data	0–3000	Hz
	bA.13	Rated motor current	Enter motor nameplate data	1–1000	A
	bA.14	Motor no–load current	Enter motor nameplate data	0.0–1000	A
	bA.15	Rated motor voltage	220/380/440/480	170–480	V
	bA.16	Motor efficiency	Enter motor nameplate data	64–100	%
	bA.20	Auto tuning	1: All	–	–

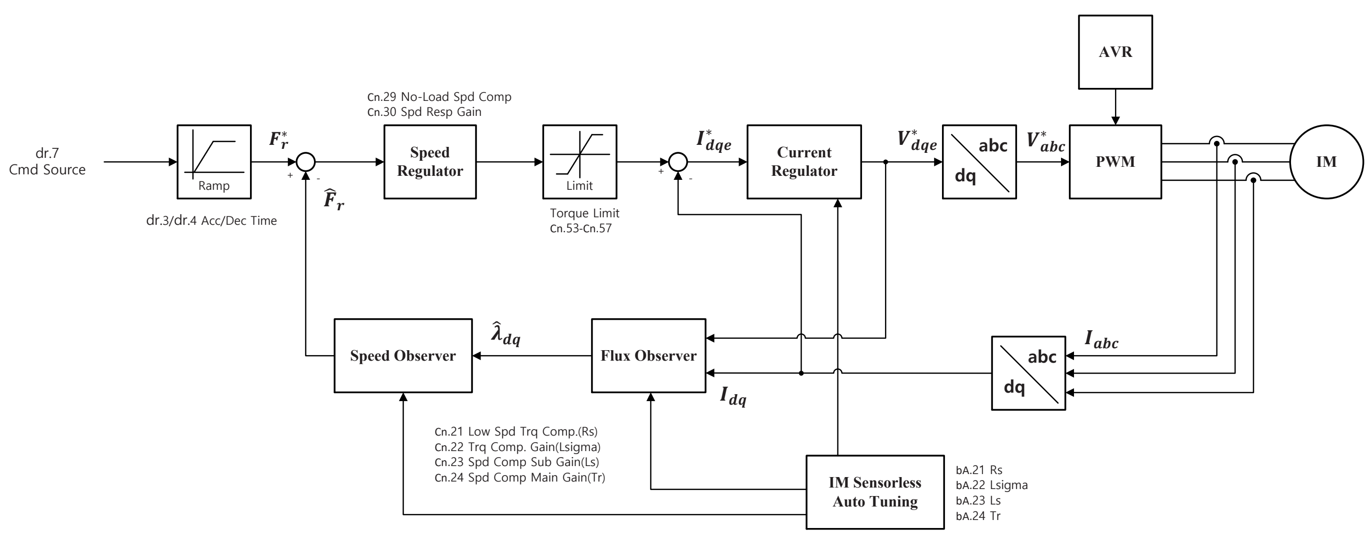
Pr. Group	Pr. Code	Name	Parameter Setting	Setting Range	Unit
Cn	Cn.9	Pre–Excite time	1.0	0.0–60.0	s
	Cn.10	Pre–Excite amount	100.0	100.0–300.0	%
	Cn.21	Low-speed torque compensation gain	See Sensorless Vector Control Operation Guide for Induction Motors on page 4–108	50–300	%
	Cn.22	Output torque compensation gain		50–300	%
	Cn.23	Speed deviation compensation gain		50–300	%
	Cn.24	Main compensation speed deviation		50–300	%
	Cn.29	No load speed deviation compensation gain	1.06	0.50–2.00	–
	Cn.30	Speed response adjustment gain	4.0	2.0–10.0	–
	Cn.53	Torque limit setting	0: Keypad–1	0–12	–
	Cn.54	Forward direction retrograde torque limit	180.0	0.0–200.0	%
	Cn.55	Forward direction regenerative torque limit	180.0	0.0–200.0	%
	Cn.56	Reverse direction regenerative torque limit	180.0	0.0–200.0	%
	Cn.57	Reverse direction retrograde torque limit	180.0	0.0–200.0	%

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

Sensorless Vector Control Block Diagram

IM Sensorless Vector Control (IMSVC) – Speed Control

When dr.9 is set to 4: IM Sensorless & dr.10 is set to 0, the IM Sensorless Speed Control diagram is as shown here:



Sensorless Vector Control Operation Setting for Induction Motors

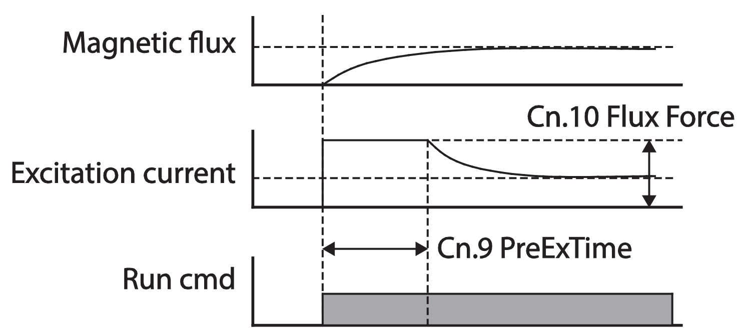
To run sensorless vector control operation, set dr.9 (Control Mode) to 4 (IM sensorless), select the capacity of the motor you will use at dr.14 (Motor Capacity), and select the appropriate codes to enter the rating plate information of the motor.

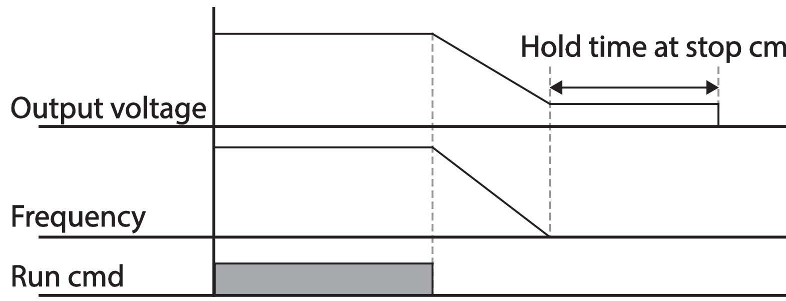
Pr. Code	Input (Motor Rating Plate Information)
dr.18 Base Freq	Base frequency
bA.11 Pole Number	Motor pole number
bA.12 Rated Slip	Rated slip
bA.13 Rated Curr	Rated current
bA.15 Rated Volt	Rated voltage
bA.16 Efficiency	Efficiency (when no information is on the rating plate, default values are used.)

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

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

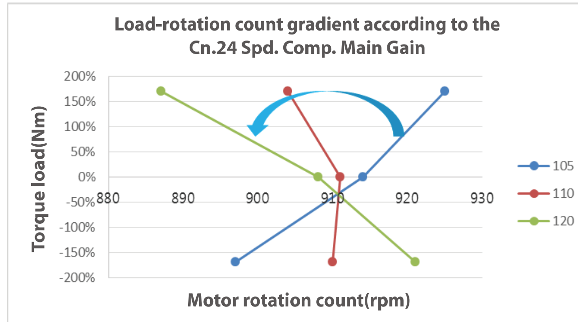
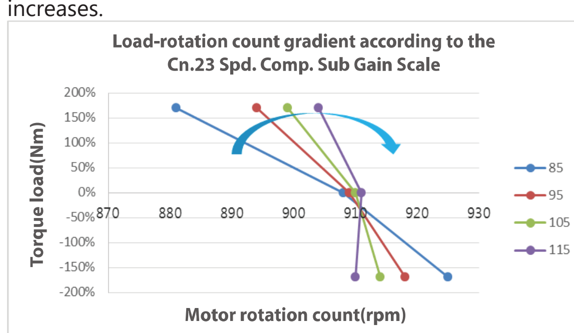
<u>Sensorless Vector Control Operation Setting Details for Induction Motors</u>

Pr. Code	Description
Cn.9 PreExTime	Sets pre–excitation time. Pre–excitation is used to start the operation after performing excitation up to the motor's rated flux.
Cn.10 Flux Force	Allows for the reduction of the pre–excitation time. The motor flux increases up to the rated flux with the time constant as shown in the following figure. To reduce the time taken to reach the rated flux, a higher motor flux base value than the rated flux must be provided. When the magnetic flux reaches the rated flux, the provided motor flux base value is reduced. 

<table>
<tr><th>Pr. Code</th><th>Description</th></tr>
<tr><td>Cn.11 Hold Time</td><td>Sets the zero–speed control time (hold time) in the stopped position. The output is blocked after zero–speed operation for a set period when the motor decelerates and is stopped by a stop command.

</td></tr>
<tr><td>Cn.21 Out Trq. Comp. Gain at Low Spd</td><td>Cn.21 mainly has an effect on low-speed operations. For details, refer to Sensorless Vector Control Operation Guide for Induction Motors.</td></tr>
<tr><td>Cn.22 ScaleOut Trq. Comp. Gain</td><td>Cn.22 is related to the torque load quantity that can mostly be produced by the drive. For details, refer to Sensorless Vector Control Operation Guide for Induction Motors.</td></tr>
<tr><td>Cn.23 Spd. Comp. Sub Gain</td><td>Cn.23 mainly has an effect on the motor speed. For details, refer to Sensorless Vector Control Operation Guide for Induction Motors.</td></tr>
<tr><td>Cn.24 Spd. Comp. Main Gain</td><td>Cn.24 mainly has an effect on the motor speed. For details, refer to Sensorless Vector Control Operation Guide for Induction Motors.</td></tr>
<tr><td>Cn.29 Spd. Comp. Gain at No-load</td><td>Cn.29 mostly has an effect on the error level of the estimated frequency during no load. For details, refer to Sensorless Vector Control Operation Guide for Induction Motors.</td></tr>
<tr><td>Cn.30 Spd. Response Adjustment Gain</td><td>Cn.30 is the value that is mainly changed according to the load inertia. For details, refer to Sensorless Vector Control Operation Guide for Induction Motors.</td></tr>
<tr><td>Cn.53 Torque Lmt Src</td><td>Select a type of torque limit setting, using the keypad, terminal block analog input (V1 and I2) or communication power. When setting torque limit, adjust the torque size by limiting the speed controller output. Set the retrograde and regenerative limits for forward and reverse operation.
<table>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>Keypad–1</td><td rowspan="2">Sets the torque limit with the keypad.</td></tr>
<tr><td>1</td><td>Keypad–2</td></tr>
<tr><td>2</td><td>V1</td><td>Sets the torque limit with the V1 input terminal of the terminal block.</td></tr>
<tr><td>4</td><td>V0</td><td>Sets the torque limit with the potentiometer dial of the keypad.</td></tr>
<tr><td>5</td><td>I2</td><td>Sets the torque limit with the I2 input terminal of the terminal block.</td></tr>
<tr><td>6</td><td>Int 485</td><td>Sets the torque limit with the communication terminal of the terminal block.</td></tr>
<tr><td>8</td><td>Fieldbus (Ethernet)</td><td>Sets the torque limit with the Fieldbus (Ethernet) communication option.</td></tr>
</table>
The torque limit can be set up to 200% of the rated motor torque.</td></tr>
<tr><td>Cn.54 FWD +Trq Lmt</td><td>Sets the torque limit for forward retrograde (motoring) operation.</td></tr>
<tr><td>Cn.55 FWD –Trq Lmt</td><td>Sets the torque limit for forward regenerative operation.</td></tr>
<tr><td>Cn.56 REV +Trq Lmt</td><td>Sets the torque limit for reverse regenerative operation.</td></tr>
<tr><td>Cn.57 REV –Trq Lmt</td><td>Sets the torque limit for reverse retrograde (motoring) operation.</td></tr>
<tr><td>In.2 Torque at 100%</td><td>Sets the maximum torque. For example, if In.2 is set to 200% and an input voltage (V1) is used, the torque limit is 200% when 10V is entered.</td></tr>
</table>

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

Sensorless Vector Control Operation Guide for Induction Motors

Problem	Relevant function code	Troubleshooting
If the number of motor rotations drops due to the lack of torque.	Cn.22 Out Trq. Comp. Gain	If there is a severe drop in the motor rotation to 36 RPM or more, increase the Cn.22 Out Trq. Comp. Gain value in 10% units.
If the motor rotation count error factor is 18rpm or greater, even though there is a sufficient amount of torque.	Cn.23 Spd. Comp. Sub Gain Cn.24 Spd. Comp. Main Gain	Change the Cn.24 Spd. Comp. Main Gain value in 5% units. Refer to the load-rotation count gradient according to the Cn.24 Spd. Comp. Main Gain value below. Example: The gradient slants counterclockwise as the Cn.24 Spd. Comp. Main Gain value increases.  Change the Cn.23 Spd. Comp. Sub Gain value in 5% units. Refer to the load-rotation count gradient according to the Cn.23 Spd. Comp. Sub Gain value below. Example: The gradient slants clockwise as Cn.23 Spd. Comp. Sub Gain value increases. 
If torque is lacking due to a load increase in low speed (5Hz or less).	Cn.21 Out Trq. Comp. Gain at Low Spd	If torque is lacking under low speed, increase the Cn.21 value in 5% units.
If rotating in reverse direction due to a load increase in low speed (5Hz or less).	Cn.21 Out Trq. Comp. Gain at Low Spd	If rotating in reverse direction due to a load increase in low speed, decrease the Cn.21 value 5% at a time.
If low speed (3Hz or less) out-of-phase occurs because the inertia of load is high.	Cn.30 Spd. Response Adjustment Gain	Sometimes control is not possible under a low speed due to high load inertia. In this case, increase the Cn.30 value by 1 unit at a time.
If motor count error margin occurs during no load.	Cn.29 Spd. Comp. Gain at No-load	If over 10 RPM of motor rotation count error occurs during no load operation, adjust the Cn.29 value by 0.01 unit at a time.
If speed response is required.	Cn.30 Spd.Response Adjustment Gain	Although the speed response is improved the greater the Cn.30 value, speed control may become unstable. Excessive setup may cause an drive trip.

Kinetic Energy Buffering Operation

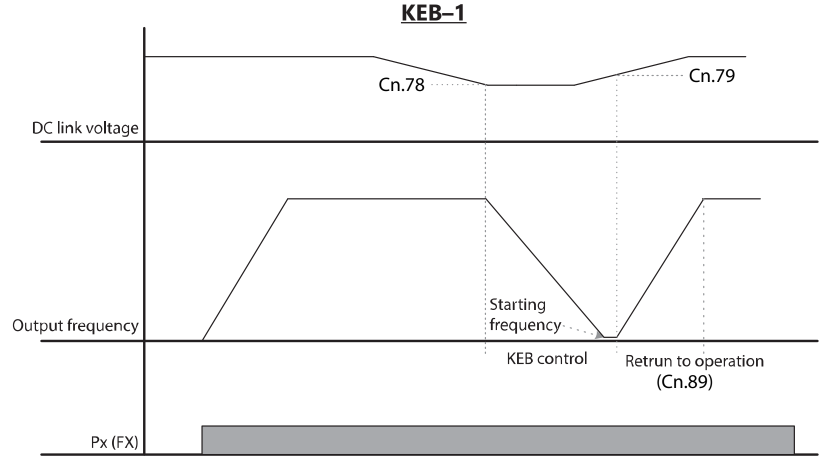
When the input power supply is disconnected, the drive's DC link voltage decreases, and a low voltage trip occurs blocking the output. A kinetic energy buffering operation uses regenerative energy generated by the motor during the blackout to maintain the DC link voltage. This extends the time for a low voltage trip to occur, after an instantaneous power interruption. For the KEB feature to operate properly, bA.19 input power voltage parameter must be set to match the voltage of input power.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
bA	bA.19	Input power voltage settings	220/380		170-480	V
Cn	Cn.77	Kinetic energy buffering selection	0	None	0–2	–
			1	KEB–1		
			2	KEB–2		
	Cn.78	Kinetic energy buffering start level	125.0		110.0–200.0	%
	Cn.79	Kinetic energy buffering stop level	130.0		Cn.78–210.0	%
	Cn.80	Energy buffering P gain	1000		1–20000	–
	Cn.81	Energy buffering I gain	500		0–20000	–
	Cn.82	Energy buffering Slip gain	30.0		0–2000.0	%
	Cn.83	Energy buffering acceleration time	10.0		0.0–600.0	s
In	In.65–In.69	Px terminal function setting	52	KEB–1 Select	–	–

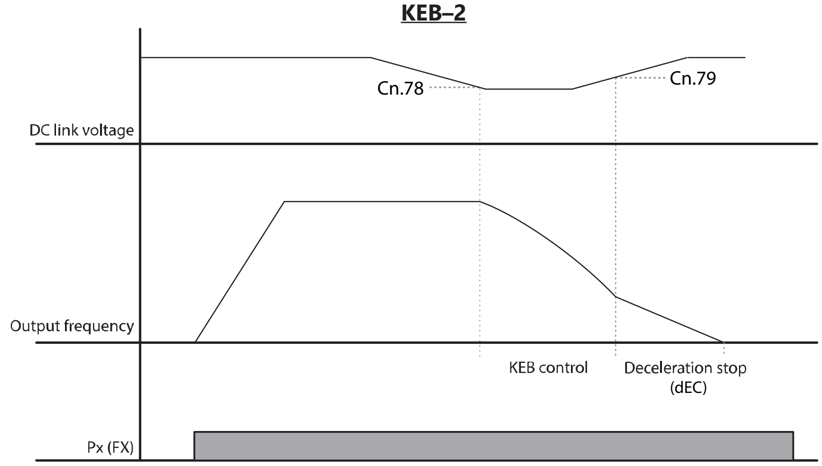
Kinetic Energy Buffering Operation Setting Details

<table>
<tr><th>Pr. Code</th><th colspan="3">Description</th></tr>
<tr><td rowspan="6">Cn.77 KEB Select</td><td colspan="3">Select the kinetic energy buffering operation when the input power is disconnected. If 1 or 2 is selected, it controls the drive's output frequency and charges the DC link (drive's DC part) with energy generated from the motor. Also, this function can be set using a terminal input. From the Px terminal function settings, select KEB–1 Select, and then turn on the terminal block to run the KEB–1 function. (If KEB–1 Select is selected, KEB–1 or KEB–2 cannot be set in Cn.77.)</td></tr>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>None</td><td>General deceleration is carried out until a low voltage trip occurs.</td></tr>
<tr><td>1</td><td>KEB–1</td><td>When the input power is blocked, it charges the DC link with regenerated energy. When the input power is restored, it restores normal operation from the energy buffering operation to the frequency reference operation. KEB Acc Time in Cn.83 is applied as the operation frequency acceleration time when restoring to the normal operation.</td></tr>
<tr><td>2</td><td>KEB–2</td><td>When the input power is blocked, it charges the DC link with regenerated energy. When the input power is restored, it changes from the energy buffering operation to the deceleration stop operation. The Dec Time in dr.4 is applied as the operation frequency deceleration time during the deceleration stop operation.</td></tr>
<tr><td colspan="3">

<u>KEB–1</u>



<u>KEB–2</u>



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

Pr. Code	Description
Cn.82 KEB Slip Gain	The slip gain is for preventing a low voltage trip due to load when the kinetic energy buffering operation start from blackout.
Cn.83 KEB Acc Time	Set the acceleration time of operation frequency when it restores normal operation from the kinetic energy buffering operation and under the input power is restored and when KEB-1 mode is selected.

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

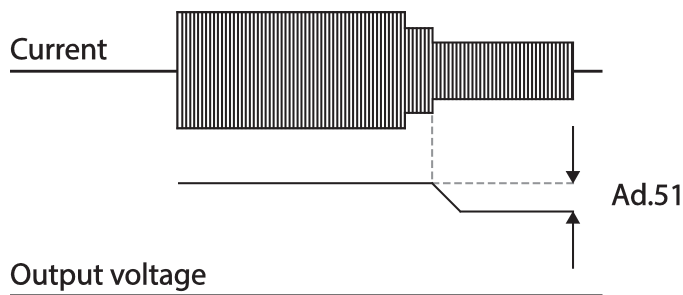
NOTE:
- *The performance of KEB function may vary depending on the loads (capacity, inertia, etc...). You can set a KEB Gain value for better performance.*
- *A low voltage trip may occur immediately after a power interruption if the load is too high or the load inertia is too low. In this case, you can improve the performance by increasing the KEB I Gain value or the KEB Slip Gain value.*
- *If the motor vibrates or the current fluctuation increases after a power interruption, you can improve the performance by increasing the KEB P Gain value or lowering the KEB I Gain value.*

Energy Saving Operation

Manual Energy Saving Operation

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

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



Automatic Energy Saving Operation

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

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Ad	Ad.50	Energy saving operation	2	Auto	–	–

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

Speed Search Operation

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

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Cn	Cn.70	Speed search mode	0	Flying Start–1	0–1	–
			1	Flying Start–2		
	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	100		0–9999	–
	Cn.74	Speed search integral gain	200		0–9999	–
	Cn.75	Output block time before speed search	1.0		0–60	sec
OU	OU.31	Multi–function Relay1 define	19	Speed Search	–	–
	OU.33	Multi–function Relay2 define				

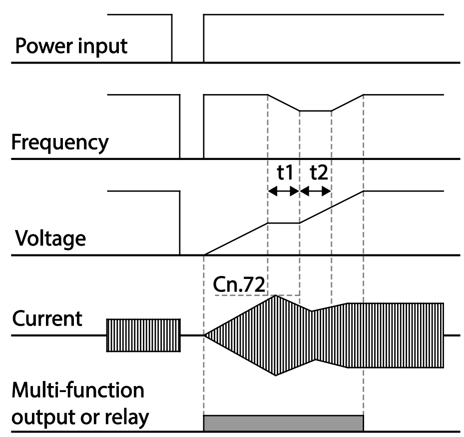
**See "Bit Selection" on page 4–3 for details*

Speed Search Operation Setting Details

Pr. Code	Description		
Cn.70 SS Mode	Select a speed search type.		
	Setting		Function
	0	Flying Start–1	The speed search is carried out as it controls the drive output current during idling below the Cn.72 (SS Sup–Current) parameter setting. If the direction of the idling motor and the direction of operation command at restart are the same, a stable speed search function can be performed at about 10Hz or lower. However, if the direction of the idling motor and the direction of operation command at restart are different, the speed search does not produce a satisfactory result because the direction of idling cannot be established.
	1	Flying Start–2	The speed search is carried out as the PI controls the ripple current which is generated by the counter electromotive force during no–load rotation. Because this mode establishes the direction of the idling motor (forward/ reverse), the speed search function is stable regardless of the direction of the idling motor and direction of operation command. However because the ripple current is used which is generated by the counter electromotive force at idle (the counter electromotive force is proportional to the idle speed), the idle frequency is not determined accurately and re–acceleration may start from zero speed when the speed search is performed for the idling motor at low speed (about 10 – 15 Hz, though it depends on motor characteristics).

<table>
<tr><th>Pr. Code</th><th colspan="5">Description</th></tr>
<tr><td rowspan="9">Cn.71 Speed Search</td><td colspan="5">Speed search can be selected from the following 4 options. If the top display segment is on it is enabled (On), and if the bottom segment is on it is disabled (Off). *See "Bit Selection" on page 4–3 for details</td></tr>
<tr><td colspan="5">Type and Functions of Speed Search Setting</td></tr>
<tr><td colspan="4">Setting</td><td rowspan="2">Function</td></tr>
<tr><td>bit4</td><td>bit3</td><td>bit2</td><td>bit1</td></tr>
<tr><td></td><td></td><td></td><td>X</td><td>Speed search for general acceleration</td></tr>
<tr><td></td><td></td><td>X</td><td></td><td>Initialization after a fault trip</td></tr>
<tr><td></td><td>X</td><td></td><td></td><td>Restart after instantaneous power interruption</td></tr>
<tr><td>X</td><td></td><td></td><td></td><td>Starting with power–on</td></tr>
<tr><td colspan="5">

Speed search for general acceleration: If bit 1 is set to 1 and the drive operation command runs, acceleration starts with speed search operation. When the motor is rotating under load, a fault trip may occur if the operation command is run for the drive to provide output voltage. The speed search function prevents such fault trip from occurring.
Initialization after a fault trip: If Bit 2 is set to 1 and Pr.8 (RST Restart) is set to 1 (Yes), the speed search operation automatically accelerates the motor to the operation frequency used before the fault trip, when the [Reset] key is pressed (or the terminal block is initialized) after a fault trip.
Automatic restart after reset of a fault trip: If bit 3 is set to 1, and if a low voltage trip occurs due to a power interruption but the power is restored before the internal power shuts down, the speed search operation accelerates the motor back to its frequency reference before the low voltage trip.

If an instantaneous power interruption occurs and the input power is disconnected, the drive generates a low voltage trip and blocks the output. When the input power returns, the operation frequency before the low voltage trip and the voltage is increased by the drive’s inner PI control.
If the current increases above the value set at Cn.72, the voltage stops increasing and the frequency decreases (t1 zone). If the current decreases below the value set at Cn.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.

</td></tr>
<tr><td>Cn.72 SS Sup–Current</td><td colspan="5">The amount of current flow is controlled during speed search operation based on the motor’s rated current. If Cn.70 (SS mode) is set to 1 (Flying Start–2), this code is not visible.</td></tr>
<tr><td>Cn.73 SS P/I–Gain,
Cn.75 SS Block Time</td><td colspan="5">The P/I gain of the speed search controller can be adjusted. If Cn.70 (SS Mode) is set to 1 (Flying Start–2), different factory defaults based on motor capacity are used and defined in dr.14 (Motor Capacity).</td></tr>
</table>

NOTE:

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

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

Auto Restart Settings

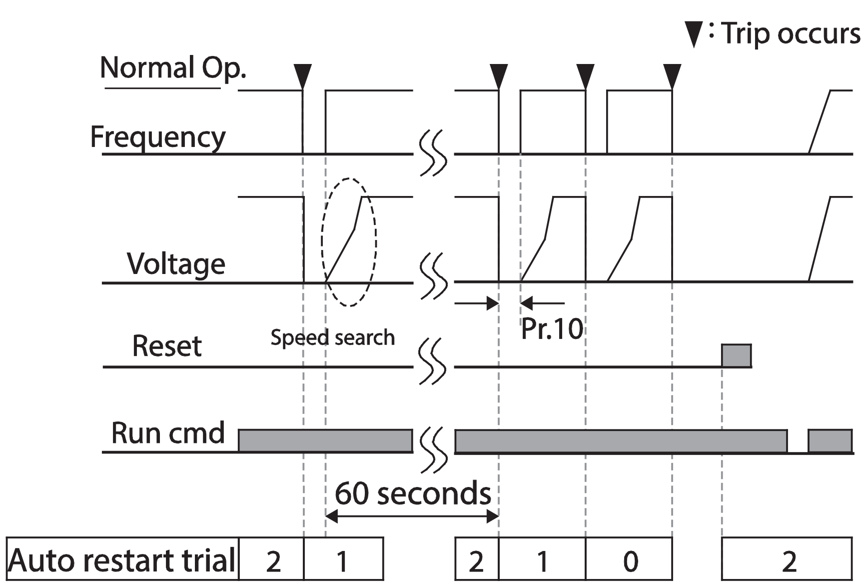
When drive operation stops due to a fault and a fault trip is activated, the drive automatically restarts based on the parameter settings.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Pr	Pr.8	Select start at trip reset	0	No	0–1	–
	Pr.9	Auto restart count	0		0–10	–
	Pr.10	Auto restart delay time	1.0		0.0–60.0	s
Cn	Cn.71	Select speed search operation	–		0000*–1111	bit
	Cn.72	Speed search startup current	150		80–200	%
	Cn.73	Speed search proportional gain	100		0–9999	–
	Cn.74	Speed search integral gain	200		0–9999	–
	Cn.75	Output block time before speed search.	1.0		0.0–60.0	s

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

Auto Restart Setting Details

Pr. Code	Description
Pr.8 RST Restart ***Pr.9 Retry Number*** ***Pr.10 Retry Delay***	Only operates when Pr.8 (RST Restart) is set to 1(Yes). The number of attempts to try the auto restart is set at Pr.9 (Auto Restart Count). If a fault trip occurs during operation, the drive automatically restarts after the set time programmed at Pr.10 (Retry Delay). At each restart, the drive counts the number of tries and subtracts it from the number set at Pr.9 until the retry number count reaches 0. After an auto restart, if a fault trip does not occur within 60 sec, it will increase the restart count number. The maximum count number is limited by the number set at Pr.9 (Auto Restart Count). If the drive stops due to low voltage, emergency stop (Bx), drive overheating, or hardware diagnosis, an auto restart is not activated. At auto restart, the acceleration options are identical to those of speed search operation. Codes Cn.72–Cn.75 can be set based on the load. Information about the speed search function can be found at "Speed Search Operation" on page 4–113.



Example of auto restart with a setting of 2

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

Operational Noise Settings (carrier frequency settings)

Pr. Group	Pr. Code	Name	Parameter Setting	Setting Range		Unit
Cn	Cn.4	Carrier Frequency	3.0	0.5–5 hp	2.0–15.0	kHz
				7.5–30 hp	1.0–15.0	

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.

Refer to the table below for the change of carrier frequency settings according to the load level, control mode, and capacity.

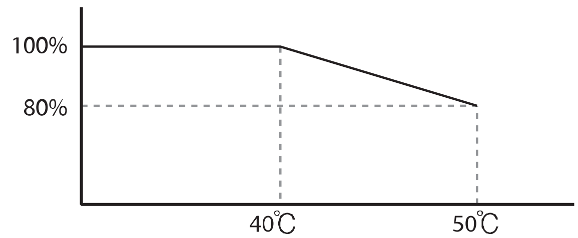
Capacity	Heavy Load (HD)					Normal Load (ND)				
	Setting Range				Initial Value	Setting Range				Initial Value
	V/F, Slip		IM Sensorless			V/F, Slip		IM Sensorless		
	Min	Max	Min	Max		Min	Max	Min	Max	
0.5–5 hp	2	15	2	15	3	2	5	2	5	2
7.5–30 hp	1	15	2	15		1	5	2	5	

NOTE:
Factory default carrier frequency:
- *Normal Load (ND): 2kHz (max 5kHz)*
- *Heavy Load (HD): 3kHz (max 15kHz)*

ACG Series Drive Derating Standard

The ACG drive is designed to respond to two types of load rates. Heavy load (heavy duty, also referred to as constant torque) and normal load (normal duty, also referred to as variable torque). The overload rate represents an acceptable load amount that exceeds rated load, and is expressed in a ratio based on the rated load and the duration. The overload capacity on the ACG series drive is 150%/1min for heavy loads, and 120%/1min for normal loads. The current rating differs from the load rating, as it also has an ambient temperature limit. For derating specifications, refer to Continuous Rated Current Derating.

Current rating for ambient temperature at normal load operation:



Below shows the carrier frequency rated current guaranteed area according to the load.

Drive Capacity	Normal Load	Heavy Load
230V: 1/2 hp – 3hp ***460V: 1/2 hp – 5hp***	2kHz	6kHz
230V: 5hp – 20hp ***460V: 7.5 hp – 30hp***	2kHz	4kHz

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	26	2nd Motor	0–52	–

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 26 (2nd Motor) to display M2 (2nd motor group) group. An input signal to a multi–function terminal set to 2nd motor will operate the motor according to the code settings listed below. However, if the drive is in operation, input signals to the multi–function terminals will not read as a 2nd motor parameter. Pr.50 (Stall Prevent) must be set first, before M2.28 (M2–Stall Lev) settings can be used. Also, Pr.40 (Electronic Thermal [ETH] Trip Sel) must be set first, before M2.29 (M2 Electronic Thermal 1 minute rating) and M2.30 (M2 Electronic Thermal continuous rating) settings.

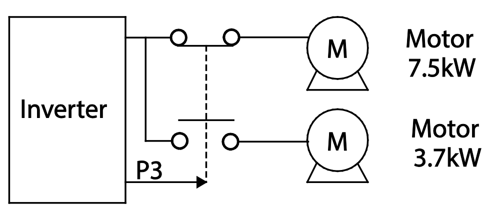
Parameter Setting at Multi–function Terminal Input on a 2nd Motor

Pr. Code	Description	Pr. Code	Description
M2.4 Acc Time	Acceleration time	***M2.16 Inertia Rt***	Load inertia rate
M2.5 Dec Time	Deceleration time	***M2.17 Rs***	Stator resistance
M2.6 Capacity	Motor capacity	***M2.18 Lsigma***	Leakage inductance
M2.7 Base Freq	Motor base frequency	***M2.19 Ls***	Stator inductance
M2.8 Ctrl Mode	Control mode*	***M2.20 Tr***	Rotor time constant
M2.10 Pole Num	Pole number	***M2.25 V/F Patt***	V/F pattern
M2.11 Rate Slip	Rated slip	***M2.26 Fwd Boost***	Forward torque boost
M2.12 Rated Curr	Rated current	***M2.27 Rev Boost***	Reverse torque boost
M2.13 Noload Curr	No–load current	***M2.28 Stall Lev***	Stall prevention level
M2.14 Rated Volt	Motor rated voltage	***M2.29 ETH 1min***	Motor Elec. Thermal protection 1min rating
M2.15 Efficiency	Motor efficiency	***M2.30 ETH Cont***	Motor Elec. Thermal protection continuous rating

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	26	2nd Motor	–	–
M2	M2.6	Motor capacity	–	3.7kW	–	–
	M2.8	Control mode	0	V/F	–	–



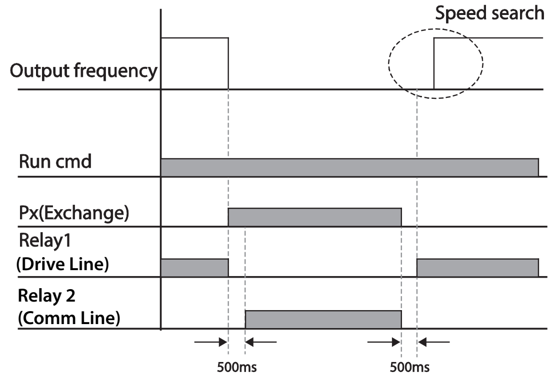
Supply Power Transition

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

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
In	In.65–In.69	Px terminal configuration	16	Exchange	0–52	–
OU	OU.31	Multi–function Relay1 define	17	Drive Line	–	–
	OU.33	Multi–function Relay2 define	18	Comm Line	–	–

Supply Power Transition Setting Details

<table>
<tr><th>Pr. Code</th><th>Description</th></tr>
<tr><td>In.65–In.69 Px Define</td><td>When the motor power source changes from drive output to main supply power, select a terminal to use and set the code value to 16 (Exchange). Power will be switched when the selected terminal is on. To reverse the transition, switch off the terminal.</td></tr>
<tr><td>OU.31 Relay1 Define (A1, B1, C1 terminals),

OU.33 Relay2 Define (A2, C2 terminals)</td><td>Set multi–function relay to 17 (Drive Line) or 18 (COMM line). Relay operation sequence is as follows.

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

Cooling Fan Control

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

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

Cooling Fan Control Detail Settings

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

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

Input Power Frequency and Voltage Settings

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

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

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

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

Parameter Save

The parameters the user has changed through the compatible common area are not saved in the drive memory. They are used for saving the changed parameter into the drive memory after changing the compatible common area parameter. The parameters cannot be saved if the drive is operating.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
dr	dr.92	Parameter save	0	No	0–1	–
			1	Parameter save		

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
dr	dr.93	Parameter initialization	0	No	0–14	–

Parameter Initialization Setting Details

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

Parameter Lock

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

Pr. Group	Pr. Code	Name	Parameter Setting	Setting Range	Unit
dr	dr.94	Password registration	–	0–9999	–
	dr.95	Parameter lock password	–	0–9999	–

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

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 memorize the password.

Changed Parameter Display

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

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
dr	dr.89	Display changed parameter	0	View All	0–1	–

Changed Parameter Display Setting Details

Pr. Code	Description		
dr.89 Display changed parameter	Setting		Function
	0	View All	Display all parameters
	1	View Changed	Display changed parameters only

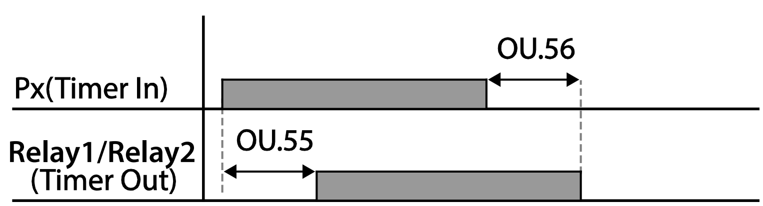
Multi-function IO Timer Settings

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

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
In	In.65–In.69	Px terminal configuration	38	Timer In	0–52	–
OU	OU.31	Multi–function Relay1 define	28	Timer Out	–	–
	OU.33	Multi–function Relay2 define				
	OU.55	Timer on delay	3.00		0.00–100	sec
	OU.56	Timer off delay	1.00		0.00–100	sec

Timer Setting Details

Pr. Code	Description
In.65–69 Px Define	Choose one of the multi–function input terminals and change it to a timer terminal by setting it to 38 (Timer In).
OU.31 Relay1, OU.33 Relay2	Set multi–function output relay to be used as a timer to 28 (Timer out).
OU.55 TimerOn Delay, OU.56 TimerOff Delay	Input a signal (On) to the timer terminal to operate a timer output (Timer out) after the time set at OU.55 has passed. When the multi–function input terminal is off, multi–function output or relay turns off after the time set at OU.56.



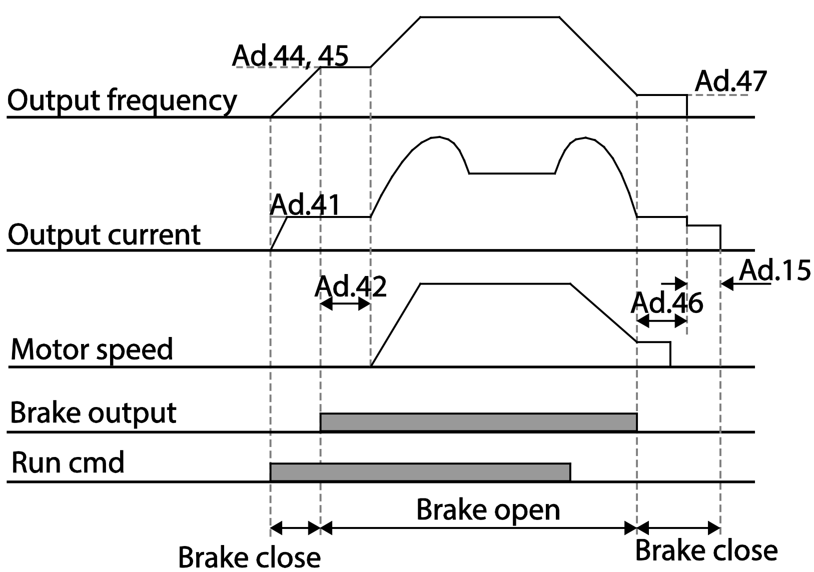
Brake Control

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

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Ad	Ad.41	Brake release current	50.0		0.0–180%	%
	Ad.42	Brake release delay time	1.00		0.0–10.0	sec
	Ad.44	Brake release forward frequency	1.00		0–Maximum frequency	Hz
	Ad.45	Brake release reverse frequency	1.00		0–Maximum frequency	Hz
	Ad.46	Brake engage delay time	1.00		0.00–10.00	sec
	Ad.47	Brake engage frequency	2.00		0–Maximum frequency	Hz
OU	OU.31	Multi–function Relay1 define	35	BR Control	–	–
	OU.33	Multi–function Relay2 define				

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

- ***Brake release sequence:*** *During motor stop state, if an operation command is entered, the drive accelerates up to brake release frequency (Ad.44–Ad.45) in forward or in reverse direction. After reaching brake release frequency, if motor current reaches brake release current (BR Rls Curr), the output relay for brake control sends a release signal. Once the signal has been sent, acceleration will begin after maintaining frequency for brake release delay time (BR Rls Dly).*
- ***Brake engage sequence:*** *If a stop command is sent during operation, the motor decelerates. Once the output frequency reaches brake engage frequency (BR Eng Fr), the motor stops deceleration and sends out a brake engage signal to a preset output terminal. Frequency is maintained for the brake engage delay time (BR Eng Dly) and will become 0 afterwards. If DC braking time (Ad.15) and DC braking resistance (Ad.16) are set, drive output is blocked after DC braking. For DC braking, refer to "Stop After DC Braking" on page 4–76.*



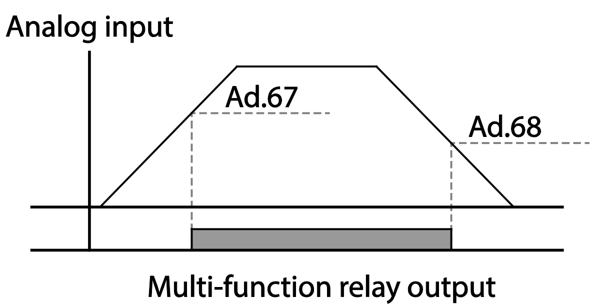
Multi–Function Output Relay On/Off Control

Set reference values (on/off level) for analog input and output relays on/off status accordingly.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Ad	Ad.66	Output terminal on/off control mode	1	V1	–	–
	Ad.67	Output terminal on level	90.00		Output terminal off level– 100.00%	%
	Ad.68	Output terminal off level	10.00		0.00–Output terminal on level	%
OU	OU.31	Multi–function Relay1 define	34	On/Off	–	–
	OU.33	Multi–function Relay2 define				

Multi–function Output On/Off Control Setting Details

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



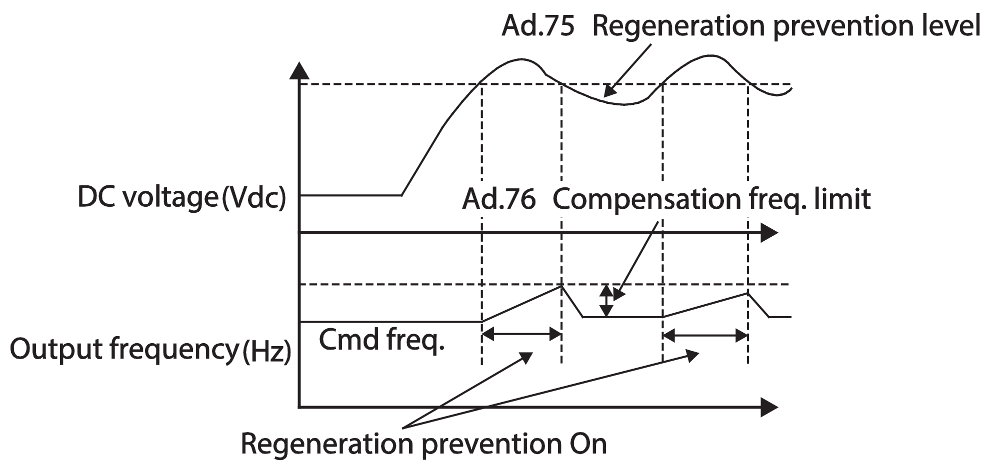
Press Regeneration Prevention

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

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

Press Regeneration Prevention Setting Details

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



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

Analog Output

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

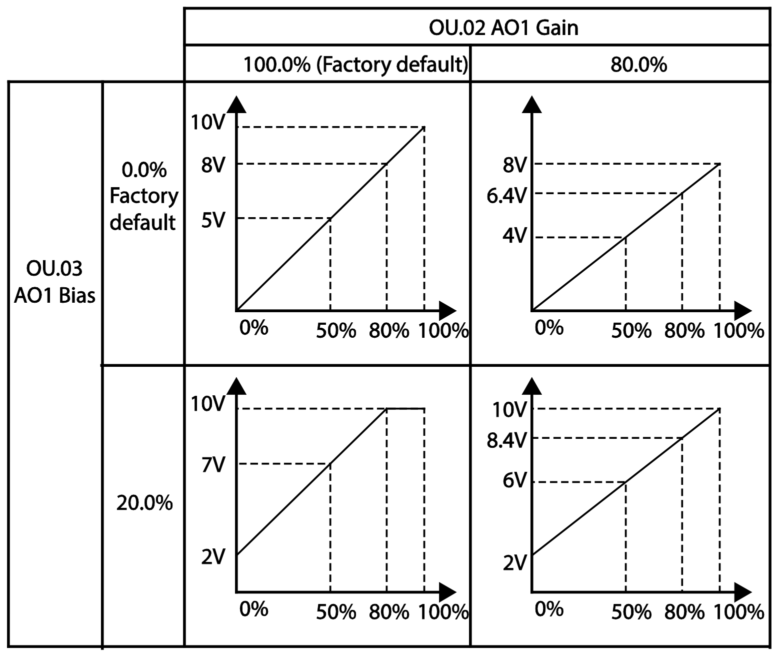
Voltage and Current Analog Output

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	0–15	–
	OU.2	Analog output1 gain	100.0		–1000.0–1000.0	%
	OU.3	Analog output1 bias	0.0		–100.0–100.0	%
	OU.4	Analog output1 filter	5		0–10000	ms
	OU.5	Analog constant output1	0.0		0.0–100.0	%
	OU.6	Analog output1 monitor	0.0		0.0–1000.0	%

Voltage and Current Analog Output Setting Details

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

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

Digital Output

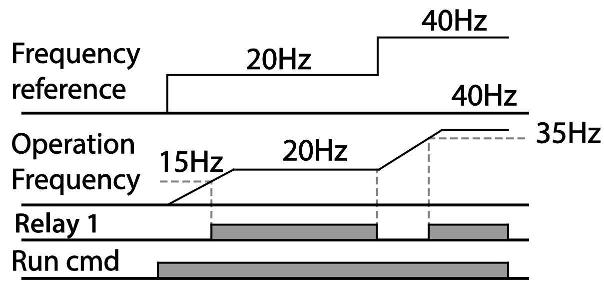
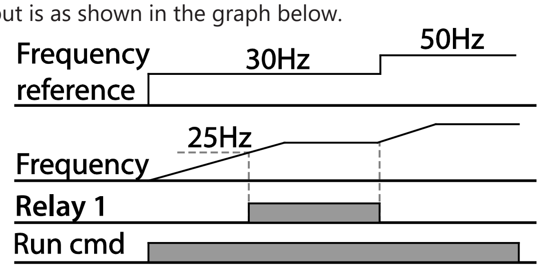
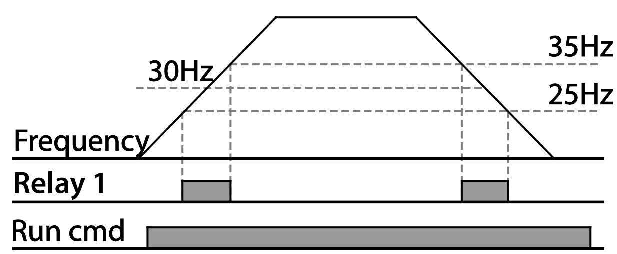
Multi–function Output Relay Settings

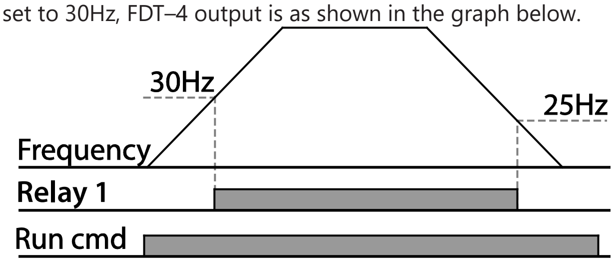
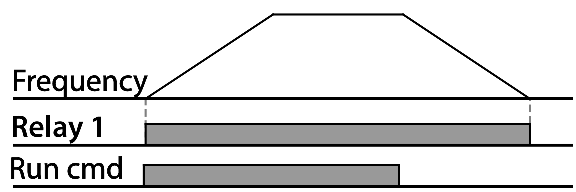
Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
OU	OU.30	Fault output item	010*		–	bit
	OU.31	Multi–function Relay1 define	29	Trip	0–45	–
	OU.33	Multi–function Relay2 define	14	Run	0–45	–
	OU.41	Multi–function output monitor	–		00– 11	bit
	OU.57	Detection frequency	30.00		0.00–Maximum frequency	Hz
	OU.58	Detection frequency band	10.00			
In	In.65–In.69	Px terminal setting options	16	Exchange	–	–

*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. See Digital Output OU.31/OU.33 Functions on page 4–132.
OU.33 Relay2	Set the Relay2 output multi-function selection. See Digital Output OU.31/OU.33 Functions on page 4–132.
OU.41 Output	Indicates the status of OU.31 and OU.33 (On or Off). See "Bit Selection" on page 4–3 for details.
OU.57 FDT Freq ***OU.58 FDT Band***	Reference OU.31/OU.33 FDT-x options 1,2,3,4,23 in the table below. When these options are used, set OU.57 FDT (Frequency), OU.58 (FDT Band) according to fault trip conditions.

Pr. Code	Digital Output OU.31/OU.33 Functions		
	Setting		Function
OU.31/ OU.33 Multi-function Selections	***0***	None	No output signal.
	1	FDT–1	Detects drive output frequency reaching the user set frequency. Outputs a signal when the absolute value (set frequency–output frequency) < detected frequency width/2. When detected frequency width is 10Hz (OU.58 FDT Band), FDT–1 output is as shown in the graph below. 
	2	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. [Absolute value (set frequency–detected frequency) < detected frequency width/2]&[FDT–1] Detected frequency width is 10Hz (OU.58 FDT Band). When the detected frequency is set to 30Hz, FDT–2 output is as shown in the graph below. 
	3	FDT–3	Outputs a signal when the Absolute value (output frequency–operation frequency) < detected frequency width/2. Detected frequency width is 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. 

Pr. Code	Digital Output OU.31/OU.33 Functions		
	Setting		Function
OU.31/ OU.33 Multi-function Selections	***4***	FDT–4	Output signal can be separately set for acceleration and deceleration conditions. • **In acceleration:** Operation frequency≥Detected frequency • **In deceleration:** Operation frequency>(Detected frequency–Detected frequency width/2) Detected frequency width is 10Hz (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. 
	5	Overload	Outputs a signal at motor overload.
	6	IOL	Outputs a signal when a fault is triggered from a protective function operation by drive overload inverse proportion.
	7	Underload	Outputs a signal at load fault warning.
	8	Fan Warning	Outputs a signal at fan fault warning.
	9	Stall	Outputs a signal when a motor is overloaded and stalled.
	10	Over voltage	Outputs a signal when the drive DC link voltage rises above the protective operation voltage.
	11	Low Voltage	Outputs a signal when the drive DC link voltage drops below the low voltage protective level.
	12	Over Heat	Outputs signal when the drive overheats.
	13	Lost command	Outputs a signal when there is a loss of analog input terminal and RS–485 communication command at the terminal block. Outputs a signal when communication power and expansion an I/O power card is installed, and also outputs a signal when losing analog input and communication power commands.
	14	RUN	Outputs a signal when operation command is entered and the drive outputs voltage. No signal output during DC braking. 
	15	Stop	Outputs a signal at operation command off, and when there is no drive output voltage.
	16	Steady	Outputs a signal in steady operation.
	17	Drive line	Outputs a signal while the motor is driven by the drive line.
	18	Comm line	Outputs a signal while the motor is driven by a commercial power source. For details, refer to "Supply Power Transition" on page 4–120.
	19	Speed search	Outputs a signal during drive speed search operation. For details, refer to "Speed Search Operation" on page 4–113.
	21	Regeneration	Outputs signal if the motor is operating under regeneration mode. Braking resistance is activated when the drive DC voltage is higher than the voltage set in Ad-79 and this feature operates only when the drive is operating.
	22	Ready	Outputs signal when the drive is in stand by operation and ready to receive an external operation command.
	23	FDT-5 (Zspd)	Outputs signal that is lower than the frequency set in OU.57 and OU.58.

Pr. Code	Digital Output OU.31/OU.33 Functions		
	Setting		Function
OU.31/ OU.33 Multi-function Selections	***28***	Timer Out	A timer function to operate terminal output after a certain time by using multi–function terminal block input. For more details, refer to "Multi-function IO Timer Settings" on page 4–125.
	29	Trip	Outputs a signal after a fault trip Refer to "Multi–function Output On/Off Control Setting Details" on page 4–127.
	31	DB Warn %ED	Refer to "Dynamic Braking" on page 4–147.
	34	On/Off Control	Outputs a signal using an analog input value as a standard. Refer to "Multi–function Output On/Off Control Setting Details" on page 4–127.
	35	BR Control	Outputs a brake release signal. Refer to "Brake Control" on page 4–126.
	38	Fire Mode	Outputs a signal when the drive is operating in Fire Mode. Refer to Fire Mode Operation on page 4–82.
	40	KEB Operating	This outputs when the energy buffering operation is started because of low voltage of the drive's DC power section due to a power failure on the input power. (This outputs in the energy buffering state before the input power restoration regardless of KEB–1 and KEB–2 mode settings.)
	42	Minor Fault	Outputs signal when drive is under warning status.
	43	Prt Trq Det 1	Set torque detection protection action.
	44	Prt Trq Det 2	Set torque detection protection action.
	45	PID Sleep	Outputs signal when drive is under PID Sleep status.

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.33	Multi–function Relay2 define	14	Run	0–45	–
	OU.53	Fault trip output on delay	0.00		0.00–100.00	sec
	OU.54	Fault trip output off delay	0.00		0.00–100.00	sec

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

<table>
<tr><th>Pr. Code</th><th colspan="4">Description</th></tr>
<tr><td rowspan="6">OU.30 Trip Out Mode</td><td colspan="4">Fault trip relay operates based on the fault trip output settings. When a fault trip occurs in the drive, the relevant terminal and relay will operate. Depending on the fault trip type, terminal and relay operation can be configured as shown in the table below. *See "Bit Selection" on page 4–3 for details.

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.</td></tr>
<tr><td colspan="3">Setting</td><td rowspan="2">Function</td></tr>
<tr><td>bit3</td><td>bit2</td><td>bit1</td></tr>
<tr><td></td><td></td><td>X</td><td>Operates when low voltage fault trips occur</td></tr>
<tr><td></td><td>X</td><td></td><td>Operates when fault trips other than low voltage occur</td></tr>
<tr><td>X</td><td></td><td></td><td>Operates when auto restart fails (Pr.8 and Pr.9)</td></tr>
<tr><td>OU.31 Relay1</td><td colspan="4">Set the Relay1 output multi-function selection.</td></tr>
<tr><td>OU.33 Relay2</td><td colspan="4">Set the Relay2 output multi-function selection.</td></tr>
<tr><td>OU.53 Trip Out On Dly,
OU.54 Trip Out Off Dly</td><td colspan="4">If a fault trip occurs, trip relay or multi–function output operates after the time delay set in OU.53. Terminal is off with the input initialized after the time delay set in OU.54.</td></tr>
</table>

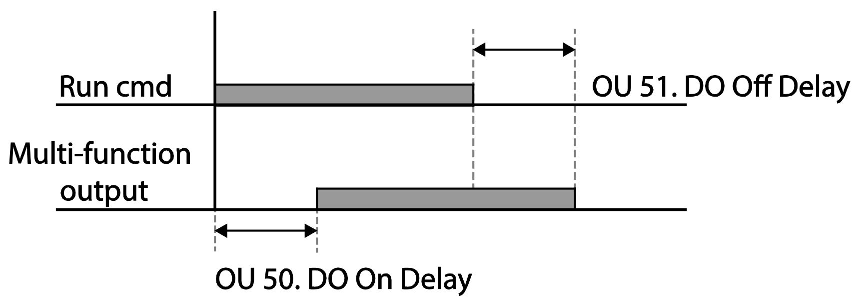
Multi–function Output Relay Delay Time Settings

Set on–delay and off–delay times separately to control the relay operation times. The delay time set at codes OU.50–OU.51 applies to multi–function output Relay1 and Relay2, except when the multi–function output is set to fault trip mode.

Pr. Group	Pr. Code	Name	Parameter Setting	Setting Range	Unit
OU	OU.50	Multi–function output On delay	0.00	0.00–100.00	s
	OU.51	Multi–function output Off delay	0.00	0.00–100.00	s
	OU.52	Select multi–function output terminal	00*	00–11	bit
**See "Bit Selection" on page 4–3 for details*					

Output Relay Delay Time Setting Details

Pr. Code	Description
OU.52 DO NC/NO Sel	Select the contact type of Relay1 and Relay2. By setting the relevant bit to 0, it will operate A terminal (Normally Open), and setting it to 1 will operate B terminal (Normally Closed).



Base Block

This feature is used when output is blocked while operating the drive or when the multi-function relay must maintain the operating status by blocking output while stopping. If the multi-function signal set as base block is entered during operation, the motor will run freely. If the base block signal is disabled, speed search operation will start with the value set in Cn.72–Cn.75 even if the Cn.71 speed search operation selection parameter is not activated. The output being blocked by the base block feature does not have effect on the multi-function relay and will be recognized as being in operation even if there is no drive output.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
In	In.65–In.69	Px terminal setting options	33	Base Block	1–52	–
OU	OU.31	Multi-function Relay1 define	14	Run	1–44	–
	OU.33	Multi-function Relay2 define			–	–

Base Block Operation Setting Details

Pr. Code	Description
In.65–In.69 Px define	Select the multi-function input terminal to receive the base block signal and set the applicable terminal to 33 (Base Block).
OU.31 Relay1 OU.33 Relay2	Set the multi-function relay terminal to 14 (Run). If the operation command is given, the drive will accelerate up to the command frequency. If the base block signal is entered during acceleration or constant speed operation, the drive will block the output immediately and start free-run. If the base block signal is disabled, the drive will accelerate as a speed search operation until it reaches the command frequency, without receiving a specific reset command. "bb" will be displayed on the keypad during the base block operation. Disabling the base block will reset the drive automatically and the base block will not be recorded in the trip history.

Load Speed Display Setting

These parameters adjust the display value in the operation menu rpm parameter. Use this parameter to scale or show a different value based on the drive RPM.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
Ad	Ad.61	Rotation count speed gain (RPM Display)	–	100.0	1–6000.0%	%
M2	M2.40					

Parameters adjust the RPM display value based on this formula:

RPM DISPLAY X <AD.61 VALUE>%

Example:

If the line speed or process value is "300" at 800rpm, set the following:

Ad.61 = 37.5%

Now the operation menu montioring parameter rpm is displayed on the keypad as 300 instead of 800 (rpm).

Learning Protection Features

Protection features provided by the ACG series drive are categorized into two types: protection from overheating damage to the motor, and protection against the drive malfunction.

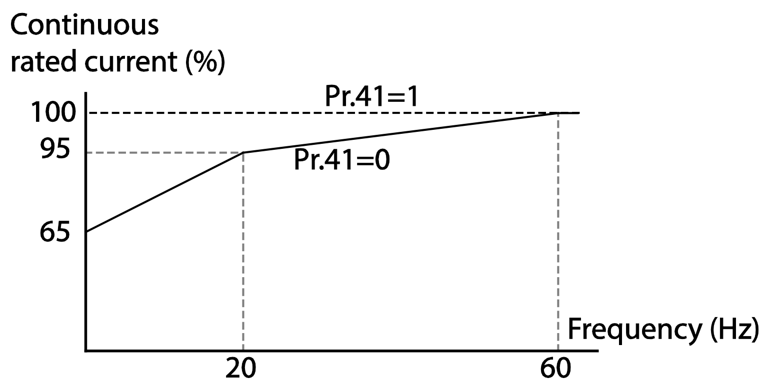
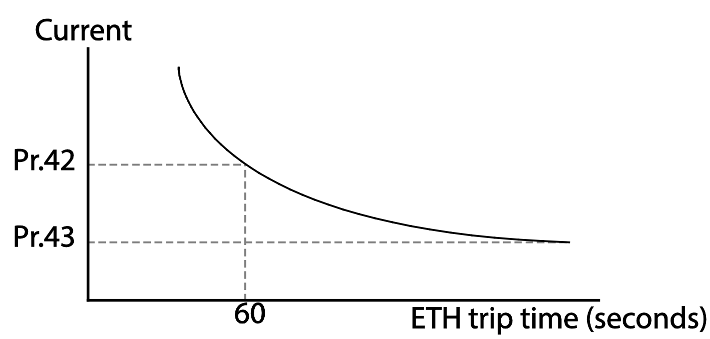
Motor Protection

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	0	None	0–2	–
	Pr.41	Motor cooling fan type	0	Self–cool	–	–
	Pr.42	Electronic thermal one minute rating	150		120–200	%
	Pr.43	Electronic thermal prevention continuous rating	120		50–150	%

Electronic Thermal (ETH) Prevention Function Setting Details

<table>
<tr><th>Pr. Code</th><th colspan="3">Description</th></tr>
<tr><td rowspan="5">Pr.40 ETH Trip Sel</td><td colspan="3">Electronic Thermal (ETH) can be selected to provide motor thermal protection.</td></tr>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>None</td><td>The ETH function is not activated.</td></tr>
<tr><td>1</td><td>Free–Run</td><td>The drive output is blocked. The motor coasts to a halt (free–run).</td></tr>
<tr><td>2</td><td>Dec</td><td>The drive decelerates the motor to a stop.</td></tr>
<tr><td rowspan="5">Pr.41 Motor Cooling</td><td colspan="3">Select the drive mode of the cooling fan, attached to the motor.</td></tr>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>Self–cool</td><td>As the cooling fan is connected to the motor axis, the cooling effect varies, based on motor speed. Most universal induction motors have this design.</td></tr>
<tr><td>1</td><td>Forced–cool</td><td>Additional power is supplied to operate the cooling fan. This provides extended operation at low speeds. Motors designed for drives typically have this design.</td></tr>
<tr><td colspan="3">
</td></tr>
<tr><td>Pr.42 Electronic thermal one minute rating</td><td colspan="3">The amount of input current that can be continuously supplied to the motor for 1 minute, based on the motor–rated current (bA.13).</td></tr>
<tr><td>Pr.43 Electronic thermal prevention continuous rating</td><td colspan="3">Sets the amount of current with the ETH function activated. The range below details the set values that can be used during continuous operation without the protection function.

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

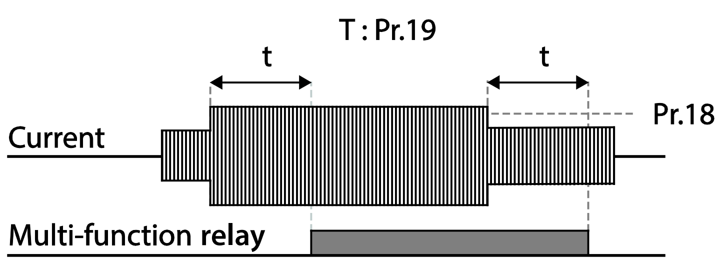
Overload Early Warning and Trip

A warning or fault ‘trip’ (cutoff) occurs when the motor reaches an overload state, based on the motor’s rated current. The amount of current for warnings and trips can be set separately.

<table>
<tr><th>Pr. Group</th><th>Pr. Code</th><th>Name</th><th colspan="2">Parameter Setting</th><th>Setting range</th><th>Unit</th></tr>
<tr><td rowspan="7">Pr</td><td>Pr.4</td><td>Load level setting</td><td>1</td><td>Heavy Load (HD)</td><td>–</td><td>–</td></tr>
<tr><td>Pr.17</td><td>Overload warning selection</td><td>1</td><td>Yes</td><td>0–1</td><td>–</td></tr>
<tr><td>Pr.18</td><td>Overload warning level</td><td colspan="2">150</td><td>30–180</td><td>%</td></tr>
<tr><td>Pr.19</td><td>Overload warning time</td><td colspan="2">10.0</td><td>0–30</td><td>s</td></tr>
<tr><td>Pr.20</td><td>Motion at overload trip</td><td>1</td><td>Free–Run</td><td>–</td><td>–</td></tr>
<tr><td>Pr.21</td><td>Overload trip level</td><td colspan="2">180</td><td>30–200</td><td>%</td></tr>
<tr><td>Pr.22</td><td>Overload trip time</td><td colspan="2">60.0</td><td>0–60.0</td><td>s</td></tr>
<tr><td rowspan="2">OU</td><td>OU.31</td><td>Multi–function Relay1 define</td><td rowspan="2">5</td><td rowspan="2">Over Load</td><td rowspan="2">–</td><td rowspan="2">–</td></tr>
<tr><td>OU.33</td><td>Multi–function Relay2 define</td></tr>
</table>

Overload Early Warning and Trip Setting Details

<table>
<tr><th>Pr. Coden</th><th colspan="3">Description</th></tr>
<tr><td rowspan="4">Pr.4 Load Duty</td><td colspan="3">Select the load level.</td></tr>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>Normal Load (ND)</td><td>Used in variable torque applications, like fans and pumps
(overload tolerance: 120% of rated underload current for 1 minute).</td></tr>
<tr><td>1</td><td>Heavy Load (HD)</td><td>Used in heavy loads, like hoists, cranes, and parking devices (overload tolerance: 150% of rated heavy load current for 1 minute).</td></tr>
<tr><td>Pr.17 OL Warn Select</td><td colspan="3">If the overload reaches the warning level, the multi–function output relays are used to output a warning signal. If 1 (Yes) is selected, it will operate. If 0 (No) is selected, it will not operate.</td></tr>
<tr><td>Pr.18 OL Warn Level, Pr.19 OL Warn Time</td><td colspan="3">When the input current to the motor is greater than the overload warning level (OL Warn Level) and continues at that level during the overload warning time (OL Warn Time), the multi–function output (Relay1, Relay2) sends a warning signal. When Over Load is selected at OU.31 and OU.33, the multi–function relay outputs a signal. The signal output does not block the drive output.</td></tr>
<tr><td rowspan="5">Pr.20 OL Trip Select</td><td colspan="3">Select the drive protective action in the event of an overload fault trip.</td></tr>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>None</td><td>No protective action is taken.</td></tr>
<tr><td>1</td><td>Free–Run</td><td>In the event of an overload fault, drive output is blocked and the motor will free–run due to inertia.</td></tr>
<tr><td>2</td><td>Dec</td><td>If a fault trip occurs, the motor decelerates and stops.</td></tr>
<tr><td>Pr.21 OL Trip Level, Pr.22 OL Trip Time</td><td colspan="3">When the current supplied to the motor is greater than the preset value at the overload trip level (OL Trip Level) and continues to be supplied during the overload trip time (OL Trip Time), the drive output is either blocked according to the preset mode from Pr.17 or slows to a stop after deceleration.</td></tr>
</table>



NOTE: Overload warnings warn of an overload before an overload fault trip occurs. The overload warning signal may not work in an overload fault trip situation, if the overload warn level (OL Warn Level) and the overload warn time (OL Warn Time) are set higher than the overload trip level (OL Trip Level) and overload trip time (OL Trip Time).

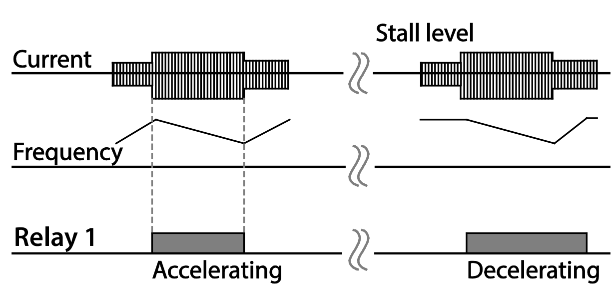
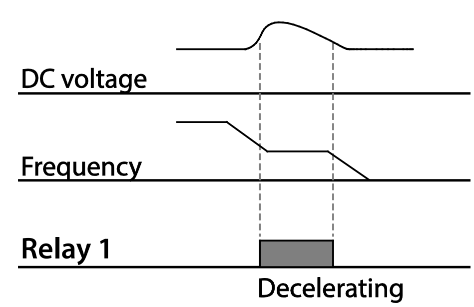
Stall Prevention and Flux Braking

The stall prevention function is a protective function that prevents motor stall caused by overloads. If a motor stall occurs due to an overload, the drive operation frequency is adjusted automatically. When stall is caused by overload, high currents are induced in the motor may cause motor overheat or damage the motor and interrupt operation of the motor–driven devices.

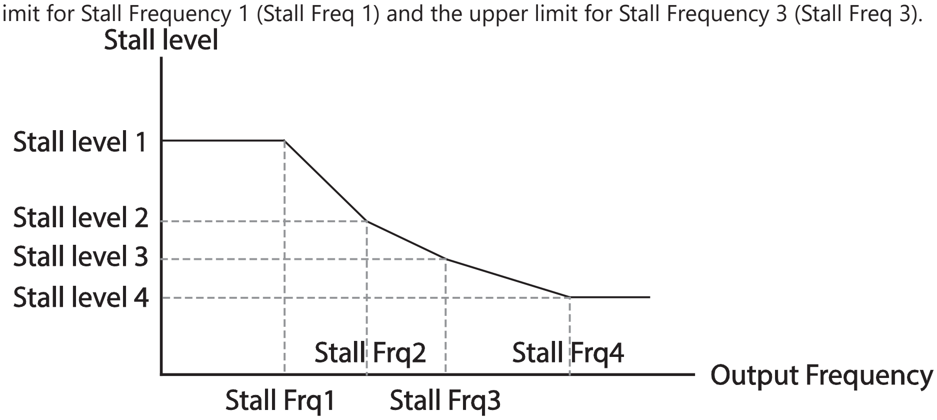
Flux braking is used to gain the optimum deceleration time without the braking resistance. If the deceleration time is too short, over voltage trip may occur due to the regeneration energy from the motor. When using flux braking, ideal deceleration time may be gained without over voltage trip because regenerative energy is expended at the motor. Flux braking stops operating when the control mode is IM Sensorless.

<table>
<tr><th>Pr. Group</th><th>Pr. Code</th><th>Name</th><th colspan="2">Parameter Setting</th><th>Setting range</th><th>Unit</th></tr>
<tr><td rowspan="9">Pr</td><td>Pr.50</td><td>Stall prevention and flux braking</td><td colspan="2">0000*</td><td>–</td><td>bit</td></tr>
<tr><td>Pr.51</td><td>Stall frequency 1</td><td colspan="2">60.00</td><td>Start frequency–Stall Freq 1</td><td>Hz</td></tr>
<tr><td>Pr.52</td><td>Stall level 1</td><td colspan="2">180</td><td>30–250</td><td>%</td></tr>
<tr><td>Pr.53</td><td>Stall frequency 2</td><td colspan="2">60.00</td><td>Stall Freq 1–Stall Freq 3</td><td>Hz</td></tr>
<tr><td>Pr.54</td><td>Stall level 2</td><td colspan="2">180</td><td>30–250</td><td>%</td></tr>
<tr><td>Pr.55</td><td>Stall frequency 3</td><td colspan="2">60.00</td><td>Stall Freq 2–Stall Freq 4</td><td>Hz</td></tr>
<tr><td>Pr.56</td><td>Stall level 3</td><td colspan="2">180</td><td>30–250</td><td>%</td></tr>
<tr><td>Pr.57</td><td>Stall frequency 4</td><td colspan="2">60.00</td><td>Stall Freq 3–Maximum frequency</td><td>Hz</td></tr>
<tr><td>Pr.58</td><td>Stall level 4</td><td colspan="2">180</td><td>30–250</td><td>%</td></tr>
<tr><td rowspan="2">OU</td><td>OU.31</td><td>Multi–function Relay1</td><td rowspan="2">9</td><td rowspan="2">Stall</td><td rowspan="2">–</td><td rowspan="2">–</td></tr>
<tr><td>OU.33</td><td>Multi–function Relay2</td></tr>
<tr><td colspan="7">*See "Bit Selection" on page 4–3 for details</td></tr>
</table>

Stall Prevention Function and Flux Braking Setting Details

Pr. Code	Description				
Pr.50 Stall Prevent	Stall prevention can be configured for acceleration, deceleration, or while operating a motor at constant speed. When the top 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
	X				Flux braking during deceleration
	Setting		Function		
	0001	Stall protection during acceleration	If drive output current exceeds the preset stall level (Pr.52, 54, 56, 58) during acceleration, the motor stops accelerating and starts decelerating. If current level stays above the stall level, the motor decelerates to the start frequency (dr.19). If the current level causes deceleration below the preset level while operating the stall protection function, the motor resumes acceleration.		
	0010	Stall protection while operating at constant speed	Similar to stall protection function during acceleration, the output frequency automatically decelerates when the current level exceeds the preset stall level while operating at constant speed. When the load current decelerates below the preset level, it resumes acceleration. During acceleration, the operation will follow the stall protection settings for acceleration.		
	0100	Stall protection during deceleration	The drive decelerates and keeps the DC link voltage below a certain level to prevent an over voltage fault trip during deceleration. As a result, deceleration times can be longer than the set time depending on the load.		
	1000	Flux braking during deceleration	When using flux braking, deceleration time may be reduced because regenerative energy is expended at the motor.		
	1100	Stall protection and flux braking during deceleration	Stall protection and flux braking operate together during deceleration to achieve the shortest and most stable deceleration performance.		
					

<table>
<tr><th>Pr. Code</th><th>Description</th></tr>
<tr><td>Pr.51 – Pr.58
Stall Freq 1-4
Stall Level 1-4</td><td>Additional stall protection levels can be configured for different frequencies, based on the load type. As shown in the graph below, the stall level can be set above the base frequency. The lower and upper limits are set using numbers that correspond in ascending order. For example, the range for Stall Frequency 2 (Stall Freq 2) becomes the lower limit for Stall Frequency 1 (Stall Freq 1) and the upper limit for Stall Frequency 3 (Stall Freq 3).



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

NOTE: Stall protection and flux braking operate together only during deceleration. Turn on the third and fourth bits of Pr.50 (Stall Prevention) to achieve the shortest and most stable deceleration performance without triggering an overvoltage fault trip for loads with high inertia and short deceleration times. Do not use this function when frequent deceleration of the load is required, as the motor can overheat and may be damaged easily.
When operating Brake resistor, the motor may vibrate under the Flux braking operation. In this case, please turn off the Flux braking (Pr.50).

CAUTION: Use caution when decelerating while using stall protection as depending on the load, the deceleration time can take longer than the time set. Acceleration stops when stall protection operates during acceleration. This may make the actual acceleration time longer than the preset acceleration time.
When the motor is operating, Stall Level 1 applies and determines the operation of stall protection.

Drive and Sequence Protection

Input/Output Open–phase Protection

Open–phase protection is used to prevent overcurrent levels induced at the drive inputs due to an open–phase within the input power supply. Open–phase output protection is also available. An open–phase at the connection between the motor and the drive output may cause the motor to stall, due to a lack of torque.

Pr. Group	Pr. Code	Name	Parameter Setting	Setting range	Unit
Pr	Pr.5	Input/output open–phase protection	00*	–	bit
	Pr.6	Open–phase input voltage band	15	1–100V	V

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

<u>Input and Output Open–phase Protection Setting Details</u>

<table>
<tr><th>Pr. Code</th><th colspan="3">Description</th></tr>
<tr><td rowspan="11">Pr.5 Phase Loss Chk,
Pr.6 IPO V Band</td><td colspan="3">When open–phase protection is operating, input and output configurations are displayed differently. When the top LED segment is On, the corresponding bit is set to On. When the bottom LED segment is On, the corresponding bit is set to Off. *See "Bit Selection" on page 4–3 for details</td></tr>
<tr><td colspan="2">Setting</td><td rowspan="2">Function</td></tr>
<tr><td>Bit 2</td><td>Bit 1</td></tr>
<tr><td></td><td>X</td><td>Output open–phase protection</td></tr>
<tr><td>X</td><td></td><td>Input open–phase protection</td></tr>
<tr><td colspan="3">Initial values by each product on input voltage range during open-phase are shown as below.</td></tr>
<tr><td>Items</td><td>Initial Value</td><td>Unit</td></tr>
<tr><td>230V and 460V: 0.5–3 hp</td><td>15</td><td rowspan="3">V</td></tr>
<tr><td>230V and 460V: 5–10 hp</td><td>13</td></tr>
<tr><td>230V and 460V: 15 hp and up</td><td>15</td></tr>
</table>

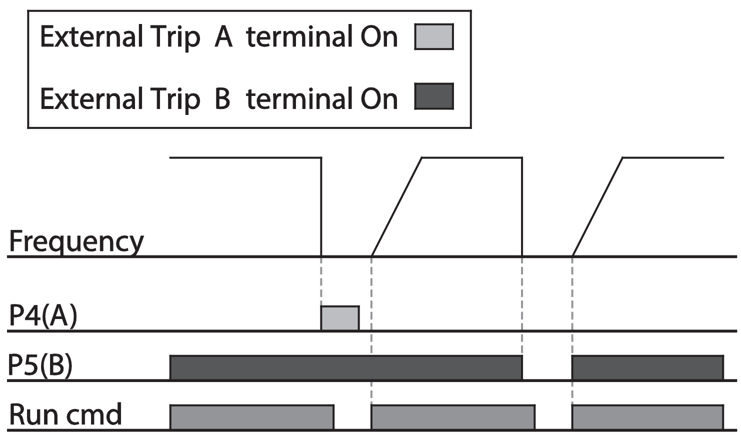
External Trip Signal

Set one of the multi–function input terminals to 4 (External Trip) to allow the drive to stop operation by using external signals.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting range	Unit
In	In.65–In.69	Px terminal setting options	4	External Trip	0–52	–
	In.87	Multi–function input contact selction	00000*		–	bit
*See "Bit Selection" on page 4–3 for details						

External Trip Signal Setting Details

<table>
<tr><th>Pr. Code</th><th colspan="6">Description</th></tr>
<tr><td rowspan="3">In.87 DI NC/NO Sel</td><td colspan="6">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:</td></tr>
<tr><td>Bit</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td></tr>
<tr><td>Terminal</td><td>P5</td><td>P4</td><td>P3</td><td>P2</td><td>P1</td></tr>
</table>



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	–	–
	OU.33	Multi–function Relay2				

NOTE: A warning signal output can be provided in advance by the multi-function output relay before the drive overload protection function (IOL) operates. When the overcurrent time reaches 60% of the allowed overcurrent (150%, 1 min), a warning signal output is provided (signal output at 150%, 36sec).

Speed Command Loss

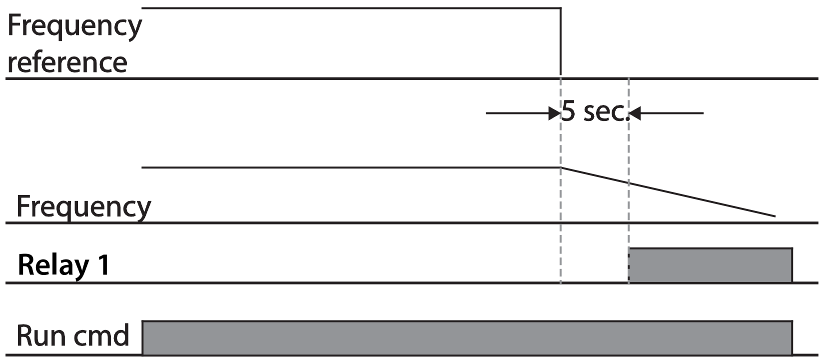
When setting operation speed using an analog input, serial/ethernet communications, or the keypad, speed command loss setting can be used to select the drive operation for situations when the speed command is lost due to the disconnection of signal cables.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting range	Unit
Pr	Pr.12	Speed command loss operation mode	1	Free–Run	–	–
	Pr.13	Time to determine speed command loss	1.0		0.1–120	s
	Pr.14	Operation frequency at speed command loss	0.00		Start frequency–Max. frequency	Hz
	Pr.15	Analog input loss decision level	0	Half of x1	–	–
OU	OU.31	Multi–function Relay1	13	Lost Command	–	–
	OU.33	Multi–function Relay2				

Speed Command Loss Setting Details

<table>
<tr><th>Pr. Code</th><th colspan="3">Description</th></tr>
<tr><td rowspan="8">Pr.12 Lost Cmd Mode</td><td colspan="3">In situations when speed commands are lost, the drive can be configured to operate in a specific mode:</td></tr>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>None</td><td>The speed command immediately becomes the operation frequency without any protection function.</td></tr>
<tr><td>1</td><td>Free–Run</td><td>The drive blocks output. The motor performs in free–run condition.</td></tr>
<tr><td>2</td><td>Dec</td><td>The motor decelerates and then stops at the time set at Pr.7 (Trip Dec Time).</td></tr>
<tr><td>3</td><td>Hold Input</td><td>The drive calculates the average input value for 10 seconds before the loss of the speed command and uses it as the speed reference.</td></tr>
<tr><td>4</td><td>Hold Output</td><td>The drive calculates the average output value for 10 seconds before the loss of the speed command and uses it as the speed reference.</td></tr>
<tr><td>5</td><td>Lost Preset</td><td>The drive operates at the frequency set at Pr. 14 (Lost Preset F).</td></tr>
<tr><td rowspan="4">Pr.15 AI Lost Level,
Pr.13 Lst Cmd Time</td><td colspan="3">Configure the voltage and decision time for speed command loss when using analog input.</td></tr>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>Half of x1</td><td>Based on the values set at In.8 and In.12, protective operation starts when the input signal is reduced to half of the initial value of the analog input set using the speed command (Frq code of Operation group) and it continues for the time (speed loss decision time) set at Pr. 13 (Lost Cmd Time). For example, set the speed command to 2 (V1) at the Frq code in the Operation group, and In.6 (V1 Polarity) to 0 (Unipolar). When the voltage input drops to less than half of the value set at In.8 (V1 Volt x 1), the protective function is activated.</td></tr>
<tr><td>1</td><td>Below x1</td><td>The protective operation starts when the signal becomes smaller than the initial value of the analog input set by the speed command and it continues for the speed loss decision time set at Pr.13 (Lost Cmd Time). Codes In.8 and In.12 are used to set the standard values.</td></tr>
<tr><td>Pr.14 Operation frequency at speed command loss</td><td colspan="3">In situations where speed commands are lost, set the operation mode (Pr.12 Lost Cmd Mode) to 5 (Lost Preset). This operates the protection function and sets the frequency so that the operation can continue.</td></tr>
</table>

Set Pr.15 (Al Lost Level) to 1 (Below x 1), Pr.12 (Lost Cmd Mode) to 2 (Dec), and Pr.13 (Lost Cmd Time) to 5 sec. Then it operates as follows:



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

Dynamic Braking

Dynamic Braking (DB) Resistor Configuration

For ACG series, the braking resistor circuit is integrated inside the drive. For Dynamic braking with external resistor, set the desired turn on level with AD.79. Ensure AD.74=0. Monitor the DC bus voltage by parameter dCL in the operation menu and check voltage on terminals B1/B2 (0.5–10 hp) or P2/B (15–30 hp) to verify activation to brake resistor.

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.66	Braking resistor configuration	10		0–30	%
OU	OU.31	Multi–function Relay1 item	31	DB Warn %ED	–	–
	OU.33	Multi–function Relay2 item				
Ad	Ad.74	Selection of regeneration evasion function for press	0	No	0–1	–
	Ad.79	DB Unit turn on voltage level	230V	390V	350–400V	V
			460V	780V	600–800V	

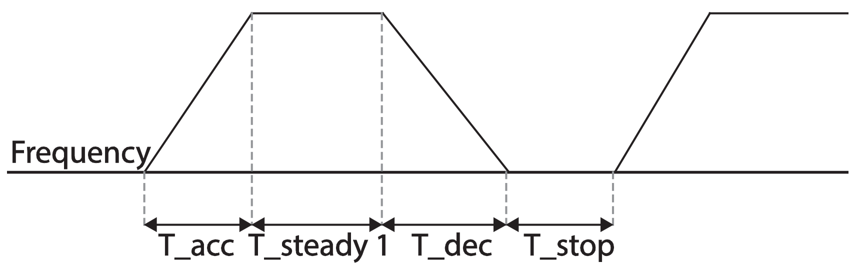
Dynamic Breaking Resistor Setting Details

<table>
<tr><th>Pr. Code</th><th>Description</th></tr>
<tr><td>Pr.66 DB Warn %ED</td><td>
Set the mount of braking resistor (%ED: Duty cycle) for use. Braking resistor configuration sets the rate at which the braking resistor operates for one operation cycle. The maximum time for continuous braking is 15 sec and the braking resistor signal is not output from the drive after the 15 sec period has expired. The time until braking resistance is available again after continuous use of braking resistance for 15 seconds is calculated as below.

$$T = \frac{(100\%\text{-}\%ED)x15}{\%ED}\ [s]$$

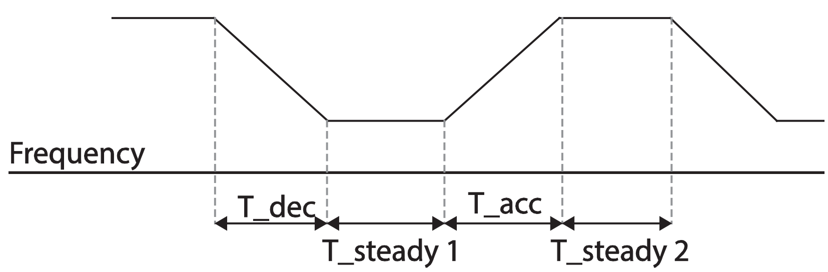
If the braking resistor usage rate is set to 0%, braking resistance can be used without usage rate restriction. However, precaution is necessary since there is risk of fire if the braking resistance usage is higher than the power consumption of braking resistance.
An example of braking resistor set up is as follows:
<u>Example 1</u>

$$\%ED = \frac{T\_dec}{T\_acc + T\_steady + T\_dec + T\_stop} \times 100\%$$



<u>Example 2</u>

$$\%ED = \frac{T\_dec}{T\_dec + T\_steady1 + T\_acc + T\_steady2} \times 100\%$$



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

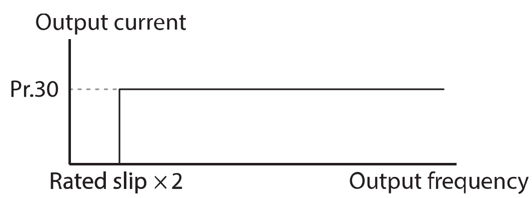
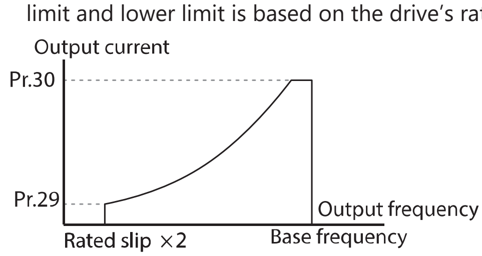
</td></tr>
</table>

CAUTION: Do not set the braking resistor to exceed the resistor's power rating. If overloaded, it can overheat and cause a fire. When using a resistor with a heat sensor, the sensor output can be used as an external trip signal for the drive's multi–function input.

Under load Fault Trip and Warning

Pr. Group	Pr. Code	Name	Parameter Setting		Setting range	Unit
Pr	Pr.4	Load level setting	0	Normal Load (ND)	–	–
	Pr.25	Under load warning selection	1	Yes	0–1	–
	Pr.26	Under load warning time	10.0		0–600	sec
	Pr.27	Under load trip selection	1	Free–Run	–	–
	Pr.28	Under load trip timer	30.0		0–600	sec
	Pr.29	Under load upper limit level	30		10–100	%
	Pr.30	Under load lower limit level	30		10–100	%

Under Load Trip and Warning Setting Details

Pr. Code	Description
Pr.27 UL Trip Sel	Sets the occurrence of the under load trip. If set to 0 (None), the underload fault trip is not detected. If set to 1 (Free-Run), the output is blocked in an underload fault trip situation. If set to 2 (Dec), the motor decelerates and stops when an underload trip occurs. If set to 3 (Underload Sleep), When PID operation, drive will start PID Sleep operation in underload trip situation. and according to PID Wake Up setting, it will start Wake Up operation.
Pr.25 UL Warn Sel	Sets the underload warning options. Set to 1(Yes) and set the multi–function output relay (at OU.31 and 33) to 7 (Underload). The warning signals are output when an underload condition arises.
Pr.26 UL Warn Time, Pr.28 UL Trip Time	The protection function operates when the underload level condition explained above is maintained for a set warning time or fault trip time. This function does not operate if energy–saving operation is activated at Ad.50 (E–Save Mode).
Pr.29 UL LF Level Pr.30 UL BF Level	Setting Heavy Load (HD) • Do not support Pr.29. • At Pr.30, the underload level is decided based on the motor's rated current.  Setting Normal Load (ND) • At Pr.29, the under load rate is decided based on twice the operation frequency of the motor's rated slip speed (bA.12 Rated Slip). • At Pr.30, the under load rate is decided based on the base frequency set at dr.18 (Base Freq). An upper limit and lower limit is based on the drive's rated current. 

Fan Fault Detection

Pr. Group	Pr. Code	Name	Parameter Setting		Setting range	Unit
Pr	Pr.79	Cooling fan fault selection	0		Trip	–
OU	OU.31	Multi–function Relay1	8	FAN Warning	–	–
	OU.33	Multi–function Relay2				

Fan Fault Detection Setting Details

<table>
<tr><th>Pr. Code</th><th colspan="3">Description</th></tr>
<tr><td rowspan="4">Pr.79 FAN Trip Mode</td><td colspan="3">Set the cooling fan fault mode.</td></tr>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>Trip</td><td>The drive output is blocked and the fan trip is displayed when a cooling fan error is detected.</td></tr>
<tr><td>1</td><td>Warning</td><td>When OU.33 (Relay2) and OU.31 (Relay1) are set to 8 (FAN Warning), the fan error signal is output and the operation continues.</td></tr>
<tr><td>OU.31 Relay1
OU.33 Relay2</td><td colspan="3">When the code value is set to 8 (FAN Warning), the fan error signal is output and operation continues. However, when the drive inside temperature rises above a certain level, output is blocked due to activation of overheat protection.</td></tr>
</table>

Lifetime Diagnosis for Fans

Enter the Pr.87 (Fan exchange warning level) code (%). After the selected usage (%) is reached (out of 50,000 hours), the fan exchange warning message will appear in the multi-functional output or keypad.

The total fan usage level (%) appears at Pr.86. When exchanging fans, you may initialize the accumulated value to 0 by setting the Pr.88 (Initializing accumulated time for cooling fans) to 1.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting range	Unit
Pr	Pr.86	Accumulated percent of fan usage	0.0		0.0–6553.5	%
	Pr.87	Fan exchange warning Level	90.0		0.0–100.0	%
OU	OU.31	Multi-function Relay1	37	FAN Exchange	–	–
	OU.33	Multi-function Relay2				

Low Voltage Fault Trip

When drive input power is lost and the internal DC link voltage drops below a certain voltage level, the drive stops output and a low voltage trip occurs.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting range	Unit
Pr	Pr.81	Low voltage trip decision delay time	0.0		0–60	sec
OU	OU.31	Multi–function Relay1	11	Low Voltage	–	–
	OU.33	Multi–function Relay2				

Low Voltage Fault Trip Setting Details

Pr. Code	Description
Pr.81 LVT Delay	If the OU.31 code value is set to 11 (Low Voltage), the drive stops the output first when a low voltage trip condition arises, then a fault trip occurs after the low voltage trip decision time is passed. The warning signal for a low voltage fault trip can be provided using the multi–function relay. However, the low voltage trip delay time (LVT Delay time) does not apply to warning signals.

Output Block by Multi–Function Terminal

When the multi–function input terminal is set as the output block signal terminal and the signal is input to the terminal, then the operation stops.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting range	Unit
In	In.65–In.69	Px terminal setting options	5	BX	0–52	–

Output Block by Multi–Function Terminal Setting Details

Pr. Code	Description
In.65–In.69 Px Define	When the operation of the multi–function input terminal is set to 5 (BX) and is turned on during operation, the drive blocks the output and 'BX' is displayed on the keypad display. While 'BX' is displayed on the keypad screen, the drive's operation information including the operation frequency and current at the time of BX signal can be monitored. The drive resumes operation when the BX terminal turns off and operation command is input.

Trip Status Reset

Restart the drive using the keypad or analog input terminal, to reset the trip status.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting range	Unit
In	In.65–In.69	Px terminal setting options	3	RST	0–52	–

Trip Status Reset Setting Details

Pr. Code	Description
In.65–In.69 Px Define	Press [Stop/Reset] key on the keypad or use the multi–function input terminal to restart the drive. Set the multi–function input terminal to 3 (RST) and turn on the terminal to reset the trip status.

Drive Diagnosis State

Check the diagnosis of components or devices for drive to check if they need to be replaced.

Pr. Group	Pr. Code	Name	Parameter Setting	Setting Range		Unit
Pr	Pr.89	FAN replacement warning	*	Bit	00–01	Bit
				00	–	
				01	FAN Warning	
*See "Bit Selection" on page 4–3 for details						

Operation Mode on Communication Option Card Trip

Option card (ACG-ET2) trips may occur when an option card is used with the drive. Set the operation mode for the drive when a communication error occurs between the option card and the drive body, or when the option card is detached during operation.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting range	Unit
Pr	Pr.80	Operation mode on Fieldbus (Ethernet) Communication option card trip	0	None	0–3	–
			1	Free–Run		
			2	Dec		

Operation Mode on Option Trip Setting Details

Pr. Code	Description		
Pr.80 Option Card (Comms) Trip Mode	Setting		Function
	0	None	No operation
	1	Free–Run	The drive output is blocked and fault trip information is shown on the keypad.
	2	Dec	The motor decelerates to the value set at Pr.7 (Trip Dec Time).

No Motor Trip

If an operation command is run when the motor is disconnected from the drive output terminal, a ‘no motor trip’ occurs and a protective operation is performed by the system.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting range	Unit
Pr	Pr.31	Operation on no motor trip	0	None	0–1	–
			1	Free-Run		
	Pr.32	No motor trip current level	5		1–100	%
	Pr.33	No motor detection time	3.0		0.1–10	s

No Motor Trip Setting Details

Pr. Code	Description
Pr.32 No Motor Level, Pr.33 No Motor Time	If the output current value [based on the rated current (bA.13)] is lower than the value set at Pr.32 (No Motor Level), and if this continues for the time set at Pr.33 (No Motor Time), a ‘no motor trip’ occurs.

CAUTION: If bA.7 (V/F Pattern) is set to 1 (Square), set Pr.32 (No Motor Level) to a value lower than the factory default. Otherwise, ‘no motor trip’ due to a lack of output current will result when the ‘no motor trip’ operation is set.

Low voltage trip 2

If you set the Pr.82 (LV2 Selection) code to 1 (Yes), the trip notification is displayed when a low voltage trip occurs. In this case, even if the voltage of the DC Link bus is higher than the trip level, the LV2 trip will remain active. To reset the trip, reset the drive. The trip history will not be saved.

Pr. Group	Pr. Code	Name	Parameter Setting	Setting Range	Unit
Pr	Pr.82	LV2 Selection	1: Yes	0/1	–

Drive Pre-overheat Warning

This feature outputs a warning if the drive temperature exceeds the temperature set by the user in Pr.77. The user can set up the operation for when the warning is generated before four types of overheating and output warning with the multi-function relay.

<table>
<tr><th>Pr. Group</th><th>Pr. Code</th><th>Name</th><th>Parameter Setting</th><th colspan="2">Setting range</th><th>Unit</th></tr>
<tr><td rowspan="5">Pr</td><td>Pr.77</td><td>Pre-overheat warning temperature</td><td>90</td><td colspan="2">90–110</td><td>°C</td></tr>
<tr><td rowspan="4">Pr.78</td><td rowspan="4">Pre-overheat warning operation setting</td><td rowspan="4">0:None</td><td>0</td><td>None</td><td rowspan="4">–</td></tr>
<tr><td>1</td><td>Warning</td></tr>
<tr><td>2</td><td>Free-Run</td></tr>
<tr><td>3</td><td>Dec</td></tr>
<tr><td rowspan="2">OU</td><td>OU.31</td><td>Multi-function Relay1</td><td rowspan="2">41: Pre Over Heat</td><td colspan="2" rowspan="2">0–44</td><td rowspan="2">–</td></tr>
<tr><td>OU.33</td><td>Multi-function Relay2</td></tr>
</table>

Pre-overheat Warning Operation Setting Details

<table>
<tr><th>Pr. Code</th><th colspan="3">Description</th></tr>
<tr><td>Pr.77 Pre-overheat warning temperature</td><td colspan="3">Set the pre-overheat warning temperature. Setting Range: 90–110 °C.</td></tr>
<tr><td rowspan="5">Pr.78 Pre-overheat warning operation setting</td><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>None</td><td>No pre-overheat warning operation</td></tr>
<tr><td>1</td><td>Warning</td><td>If the pre-overheat warning temperature is exceeded, warning message is displayed on the keypad and drive will operate normally.</td></tr>
<tr><td>2</td><td>Free-Run</td><td>If the pre-overheat warning temperature is exceeded, a pre-overheat trip occurs and free-run will stop</td></tr>
<tr><td>3</td><td>Dec</td><td>If the pre-overheat warning temperature is exceeded, a pre-overheat trip occurs and deceleration will stop.</td></tr>
<tr><td rowspan="2">OU.31, multi-function Relay1
OU.33, multi-function Relay2</td><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>38</td><td>Pre-overheat warning</td><td>Signal is output if a pre-overheat warning or trip occurs.</td></tr>
</table>

Torque Detection Protection Action

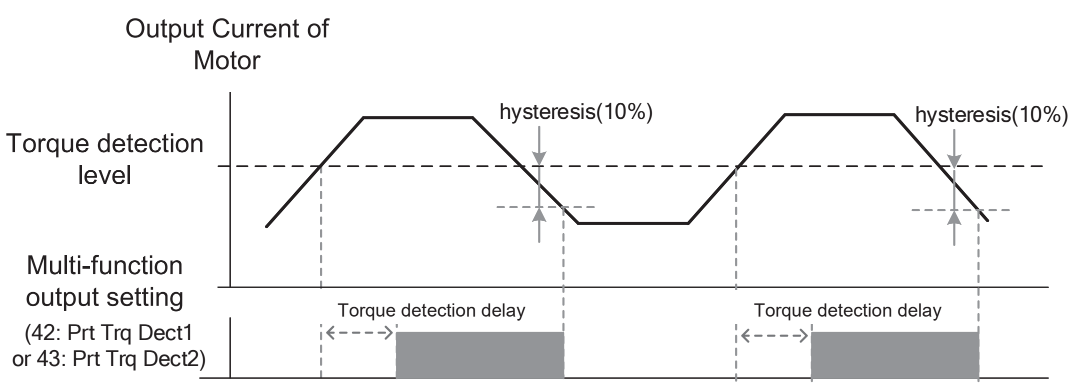
This feature outputs torque status to the multi-function relay if a motor overload or sudden underload occurs. This feature is activated when the multi-function relay (OU.31, OU.33) is set to 43, 44.

Pr. Group	Pr. Code	Name	Parameter Setting		Setting Range	Unit
OU	OU.31	Multi-function Relay1	43	Prt Trq Det 1	0–44	–
	OU.33	Multi-function Relay2	44	Prt Trq Det 2	0–44	–
	OU.67*	Torque detection 1 operation setting	0	None	0–8	–
	OU.68*	Torque detection 1 level	100		0–200.0	%
	OU.69*	Torque detection 1 delay time	0.1		0.0–10.0	s
	OU.70**	Torque detection 2 operation setting	0	None	0–8	–
	OU.71**	Torque detection 2 level	100		0–200.0	%
	OU.72**	Torque detection 2 delay time	0.1		0.0–10.0	s

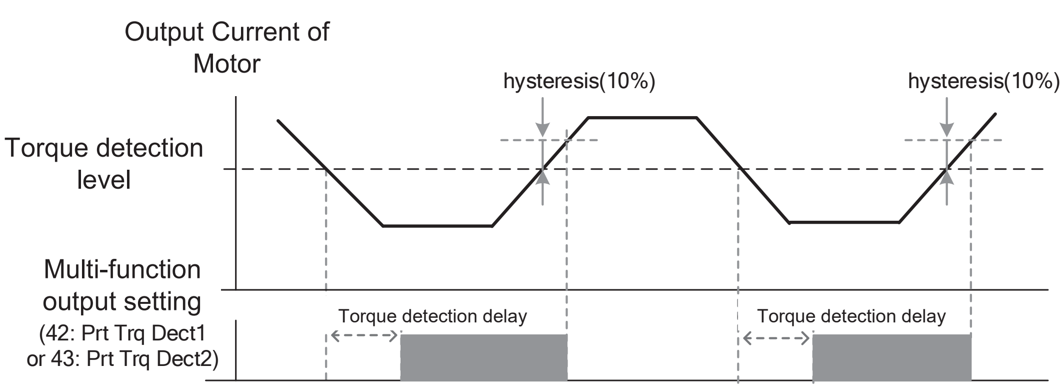
** Visible only when the multi-function relay (OU.31, 33) is set to 43 (Prt Trq Det 1).*
***Visible only when the multi-function relay (OU.31, 33) is set to 44 (Prt Trq Det 2).*

The over and under torque detection action operates as shown in the figure by having a hysteresis level of 10% compared to the motor's rated current.

Over Torque Detection Action



Under Torque Detection Action



The over and under torque detection level set as OU68, 71 parameters are set as the ratio on motor's rated current.

Torque Detection Operation Setting Details

Pr. Code	Description		
OU.67, Torque detection 1 operation setting ***OU.70, Torque detection 2 operation setting***	Setting		Function
	0	None	Torque detection is not operating.
	1	OT CmdSpd Warn	Detects over torque and outputs warning only when the drive output frequency is the same as the command frequency.
	2	OT Warning	Detects over torque during the operation and outputs warning.
	3	OT CmdSpdTrip	Detects over torque and generates a trip only when the drive output frequency is the same as the command frequency.
	4	OT Trip	Detects over torque during operation and generates a trip.
	5	UT CmdSpd Warn	Detects under torque and outputs warning only when the drive output frequency is the same as the command frequency.
	6	OT Warning	Detects under torque during the operation and outputs warning.
	7	UT CmdSpd Trip	Detects under torque and generates a trip only when the drive output frequency is the same as the command frequency.
	8	UT Trip	Detects under torque during operation and generates a trip.
OU.68, Torque detection 1 level ***OU.71, Torque detection 2 level***	Sets the torque detection level of torque detection 1, 2. The set value is a % of the motor's rated current. The detection level must be higher than bA.14 no load current value.		
OU.69, Torque detection 1 delay time ***OU.72, Torque detection 2 delay time***	Sets the delay time on torque detection 1, 2. When over or under torque is detected, a warning or trip is output after the torque detection delay time.		

Fault/Warning List

The following list shows the types of faults and warnings that can occur while using the ACG drive. For specific fault codes, details, and troubleshooting steps, refer to page 6–7. Explanation of user controlled faults and warnings can be found in"Learning Protection Features" on page 4–138.

<table>
<tr><th colspan="2">Category</th><th>Details</th></tr>
<tr><td rowspan="29">Major fault</td><td rowspan="23">Latch type</td><td>Over current trip</td></tr>
<tr><td>Over voltage trip</td></tr>
<tr><td>Trip due to an external signal</td></tr>
<tr><td>Temperature sensor fault trip</td></tr>
<tr><td>ARM short current fault trip</td></tr>
<tr><td>Option (communication card) fault trip*</td></tr>
<tr><td>Over heat fault trip</td></tr>
<tr><td>Output open–phase fault trip</td></tr>
<tr><td>Input open–phase fault trip</td></tr>
<tr><td>Drive overload fault trip</td></tr>
<tr><td>Ground fault trip**</td></tr>
<tr><td>Fan fault trip</td></tr>
<tr><td>Motor overheat fault trip</td></tr>
<tr><td>Pre–PID operation failure</td></tr>
<tr><td>IO Board connection fault trip</td></tr>
<tr><td>External brake fault trip</td></tr>
<tr><td>No motor fault trip</td></tr>
<tr><td>Low voltage fault trip during operation</td></tr>
<tr><td>Drive pre-overheat trip</td></tr>
<tr><td>Over torque 1 trip</td></tr>
<tr><td>Under torque 1 trip</td></tr>
<tr><td>Over torque 2 trip</td></tr>
<tr><td>Under torque 2 trip</td></tr>
<tr><td rowspan="3">Level type</td><td>Low voltage fault trip</td></tr>
<tr><td>Emergency stop fault trip</td></tr>
<tr><td>Command loss trip</td></tr>
<tr><td rowspan="3">Hardware damage</td><td>External memory error</td></tr>
<tr><td>Analog input error</td></tr>
<tr><td>CPU Watch Dog fault trip</td></tr>
<tr><td colspan="2" rowspan="2">Minor fault</td><td>Motor overload fault trip</td></tr>
<tr><td>Motor underload fault trip</td></tr>
<tr><td colspan="3">* Applies only when a communication card (ACG-ET2) is used.
**Ground detection feature is provided only in 230V/460V 7.5–30 hp products. Other products protect drive with OVT/OCT/OC2 trip when grounding occurs.</td></tr>
</table>

Category	Details
Warning	Command loss fault trip warning
	Overload warning
	Under load warning
	Drive overload warning
	Fan operation warning
	Braking resistor braking rate warning
	Rotor time constant tuning error
	Fan replacement warning
	Drive pre-overheat warning
	Over torque 1 warning
	Under torque 1 warning
	Over torque 2 warning
	Under torque 2 warning
** Applies only when a communication card (ACG-ET2) is used. **Ground detection feature is provided only in 230V/460V 7.5–30 hp products. Other products protect drive with OVT/OCT/OC2 trip when grounding occurs.*	

Chapter 5: Serial Communications

Chapter 5

Table of Contents

Serial RS-485 Communication Features

This chapter details how to control an ACG series drive with a PLC or a computer using the RS-485 serial communication features. The ACG series drive terminals S+, S- 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.

Following the RS-485 communication standards, ACG 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.

NOTE: Ethernet connectivity for EtherNet/IP and Modbus TCP communication is possible with an optional communication card (ACG-ET2). Refer to Appendix B: Ethernet Module ACG-ET2 for details

Communication Standards

Following the RS-485 communication standards, ACG 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	ACG Series
Number of connected drives/ Transmission distance	Maximum of 16 drives / Maximum1,200m (recommended distance: within 700m)
Recommended cable size	0.75mm^2, (18AWG), shielded type twisted-pair (STP) wire
Installation type	Dedicated terminals (S+/S-) on the control terminal block connected to the RJ-45 connector (no 1-pin S+, no 8-pin S-)
Power supply	Supplied by the drive - insulated power source from the drive's internal circuit
Communication speed	1,200/2,400/9,600/19,200/38,400/57,600/115,200 bps
Control procedure	Asynchronous communications system
Communication system	Half duplex system
Character system	Modbus-RTU: Binary
Stop bit length	1-bit/2-bit
Frame error check	2 bytes
Parity check	None/Even/Odd

Common Third-Party Modbus RTU Masters

- *Modbus Poll from www.modbustools.com*

AutomationDirect PLCs as Modbus Master

Serial Modbus-capable AutomationDirect PLCs can communicate with the ACG drive. Serial Modbus control is easier to accomplish from a PLC that has a built-in RS-485 port and supports dedicated Modbus messaging. [RS-232-only PLCs will require an RS-232/RS-485 converter (FA-ISOCON); and older PLCs may require programming to construct the Modbus strings.] We recommend PLCs with built-in RS-485 ports and dedicated Modbus serial commands: CLICK (with RS-485 ports), P1000, P2000, P3000, BRX/Do-more, DirectLogic (DL06, D2-260, or D2-262). Other PLC-Drive connectivity is possible: Please refer to the chart below

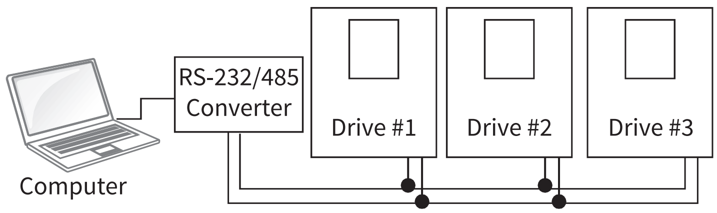
Typical ADC PLC to ACG Serial Communications Connectivity

<table>
<tr><th colspan="6">Typical ADC PLC to ACG Serial Communications Connectivity Matrix*</th></tr>
<tr><th colspan="3">Recommended PLC Connectivity</th><th rowspan="2">Communication</th><th rowspan="2">Direct Cable</th><th>ACG</th></tr>
<tr><th>PLC</th><th>Port #</th><th>Port Type</th><th>Terminals</th></tr>
<tr><td>CLICK</td><td>3</td><td>3 screw terminals</td><td>RS-485</td><td>Q8304-1 cable</td><td rowspan="17">S+
S-</td></tr>
<tr><td>D2-262</td><td>2</td><td>HD15</td><td>RS-485</td><td>D2-DSCBL-2</td></tr>
<tr><td>DL06</td><td>2</td><td>HD15</td><td>RS-485</td><td>D2-DSCBL-2</td></tr>
<tr><td>BRX/Do-more</td><td>RS-485</td><td>3 screw terminals</td><td>RS-485</td><td>Q8304-1 cable</td></tr>
<tr><td>LS XEM-DN32HP, XEM-DP32HP, XEM-DN32H2, and XEM-DP32H2</td><td>RS-485</td><td>3 push-in terminals</td><td>RS-485</td><td>Q8304-1 cable</td></tr>
<tr><td>P1-540 and P1-550</td><td>RS-485</td><td>4 screw terminals</td><td>RS-485</td><td>Q8304-1 cable</td></tr>
<tr><td>P2-550 and P2-622</td><td>RS-485</td><td>3 screw terminals</td><td>RS-485</td><td>Q8304-1 cable</td></tr>
<tr><td>P3-530</td><td>RS-485</td><td>3 screw terminals</td><td>RS-485</td><td>Q8304-1 cable</td></tr>
<tr><td>P3-550E</td><td>RS-485</td><td>3 screw terminals</td><td>RS-485</td><td>Q8304-1 cable</td></tr>
<tr><th colspan="3">Other PLC Connectivity</th><th>Communication</th><th>Direct Cable</th></tr>
<tr><td>D4-454</td><td>1</td><td>DB25</td><td>RS-232 to RS-485</td><td>FA-ISOCON with L19954 cable</td></tr>
<tr><td>DL05</td><td>2</td><td>RJ12</td><td>RS-232 to RS-485</td><td>FA-ISOCON with L19954 cable</td></tr>
<tr><td>DL06 + DCM</td><td>2</td><td>HD15</td><td>RS-485</td><td>D2-DSCBL-2</td></tr>
<tr><td>Do-more H2-DM1 + H2-SERIO-4</td><td>3</td><td>5 screw terminals</td><td>RS-485</td><td>Q304-1 cable</td></tr>
<tr><td>Do-more T1H-DM1</td><td>RS-232</td><td>RJ12</td><td>RS-232 to RS-485</td><td>FA-ISOCON with L19954 cable</td></tr>
<tr><td>P2-SCM</td><td>4</td><td>4 screw terminals</td><td>RS-485</td><td>Q304-1 cable</td></tr>
<tr><td>P3-SCM</td><td>4</td><td>4 screw terminals</td><td>RS-485</td><td>Q304-1 cable</td></tr>
<tr><td colspan="6">*Ethernet connectivity for EtherNet/IP or Modbus TCP communication is possible with an optional communication card ACG-ET2. Refer to Appendix B: Ethernet Module ACG-ET2 for details</td></tr>
</table>

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 following FA-ISOCON drawings).

Connect the wires and configure the communication parameters on the drive by referring to the following illustration of the communication system configuration.



RS-232C to RS-485 Conversion

Many AutomationDirect PLCs have only RS-232C communication ports, and require an FA-ISOCON (RS-232C to RS-422/485 network adapter) in order to make an RS-485 connection.

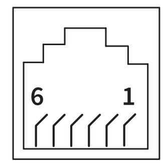
NOTE: If an FA-ISOCON module is used, set the module dipswitches as required. Refer to the FA-ISOCON manual for more detailed information.

FA-ISOCON Switch Settings:

- *S21–S23: OFF, ON, ON (19200 baud)*
- *S24–S27: OFF (Automatic Network Transmit Enable)*
- *Terminate: ON (end of run term resistors)*
- *Bias (2): ON (end of run bias resistors)*
- *1/2 DPX (2): ON (RS-485 TXD/RXD jumpers)*

Helpful Hint: Some applications require that the FA-ISOCON baud rate is set faster than the drive/network baud rate.

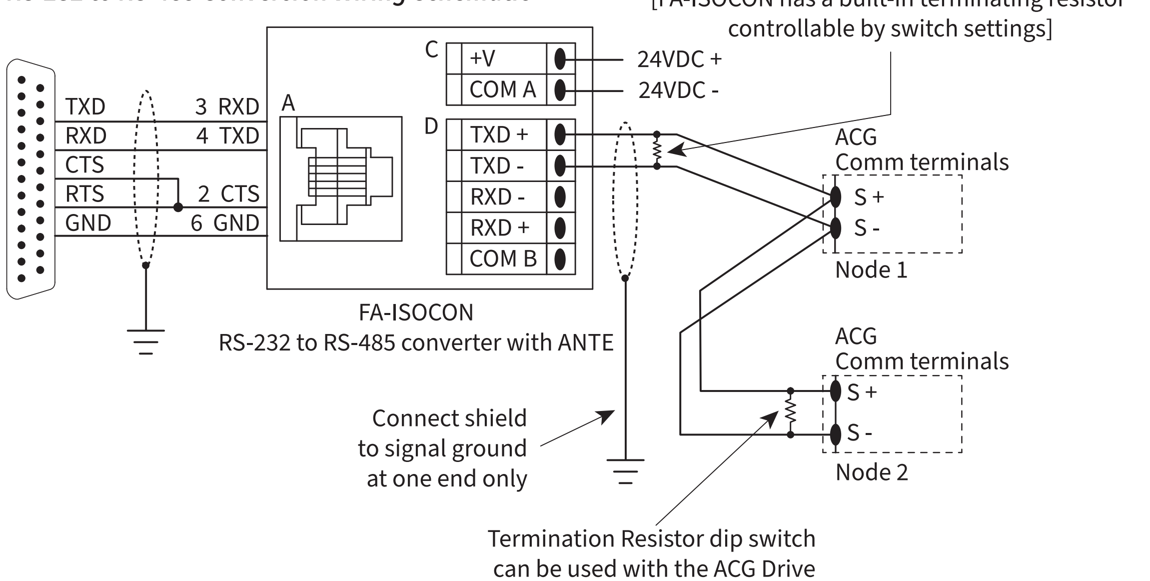
FA-ISOCON RJ-12 Serial Comm Port A
RS-232 Input Port



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

FA-ISOCON Wiring

RS-232 to RS-485 Conversion Wiring Schematic



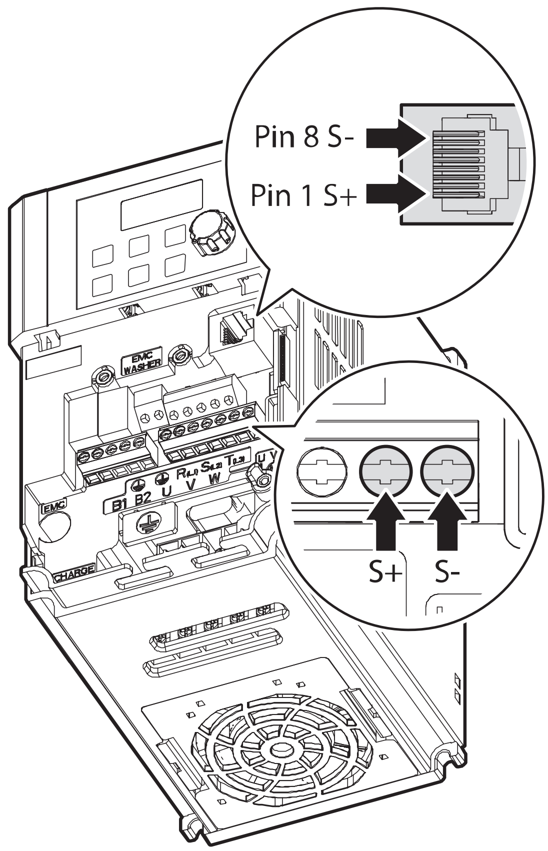
NOTE: For information regarding configuration of AutomationDirect PLCs or other PLCs, please refer to the applicable PLC user manual for your application.

Communication Cable Connection

After checking that the drive power is fully blocked, connect the RS-485 communication line to S+ or S-terminal of the control terminal or RJ45 connector (no.1 pin S+, no.8 pin S-) of the I/O board. The maximum number of inverters you can connect is 16. For communication lines, use shielded twisted pair (STP) cables.

The maximum length of the communication line is 1,200 meters, but it is recommended to use no more than 700 meters of communication line to ensure stable communication. Please use a repeater to enhance the communication speed when using a communication line longer than 1,200 meters or when using a large number of devices. A repeater is effective when smooth communication is not available due to noise interference.

NOTE: Recommended RS-485 cable: Belden 9842, AutomationDirect Q8304-1 series, or equivalent.



Serial Communication to VFD Suite Software

For instruction on serial communication to VFD Suite, see Replacement Cooling Fans on page A–22.

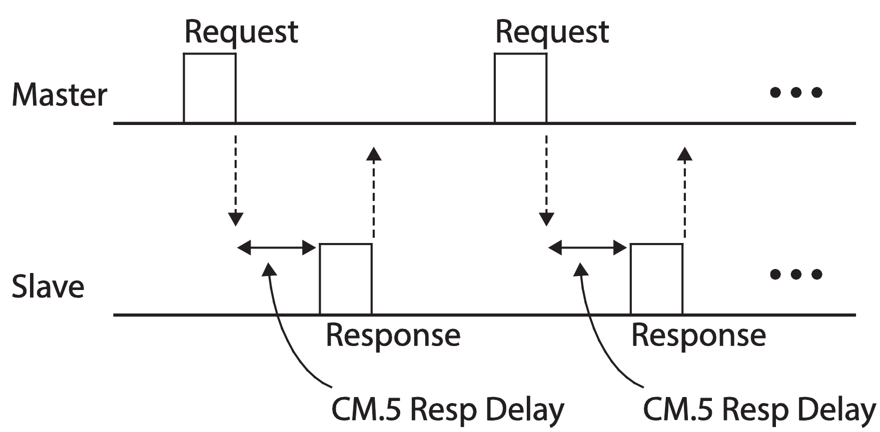
Setting Communication Parameters

Before proceeding with setting communication configurations, make sure that the communication cables are connected properly. Turn on the drive and set the communication parameters.

Setting Communication Parameters						
Parameter Group	Parameter Number	Name	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, 2	-
	CM.3	Built-in communication speed	3	9600 bps	0-7	-
	CM.4	Built-in communication frame setting	0	D8/PN/S1	0-3	-
	CM.5	Transmission delay after reception	5		0-1000	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 Proto	***Select one of the two built-in protocols: Modbus-RTU***		
	Setting		***Function***
	0	Modbus-RTU	Modbus-RTU compatible protocol
	2	Not supported	–

Communication Parameters Setting Details			
Parameter	**Description**		
CM.3 Int485 Baudrate	***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
	6		56 Kbps
	7		115 Kbps
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
CM.5 Resp 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 (Int 485) and the Frq code of the operation group to 6 (Int 485) 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	Int485	0-4	-
	Frq	Frequency setting method	6	Int485	0-8	-

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
	3	Hold Input	The drive continues using the speed command input before the loss of communication.
	4	Hold Output	The drive continues using the operation frequency before the loss of communication.
	5	Lost Preset	The drive operates at the frequency set at Pr. 14 (Lost Preset F).

Setting Virtual Multi-Function Input

Multi-function input can be controlled using a communication address (0h0385). Set codes CM.70–CM.77 to the functions to operate, and then set the BIT relevant to the function to 1 at 0h0322 to operate it. Virtual multi-function operates independently from In.65–In.69 analog multi-function inputs and cannot be set redundantly. Virtual multi-function input can be monitored using CM.86 (Virt Dl Status). Before you configure the virtual multi-function inputs, set the parameter code drv (operation group) according to the command source.

Setting Virtual Multi-Function Input						
Parameter Group	**Parameter Number**	**Name**	**Parameter Setting**		**Setting Range**	**Unit**
CM	CM.70-CM.77	Communication multi-function input x	0	None	0-49	-
	CM.86	Communication multi-function input monitoring	-	-	-	-

Example: When sending an FX command by controlling virtual multi-function input in the common area via Int485, set CM.70 to FX. Then, assign a 0h0001 value to the communication address 0h0322 to operate the forward direction operation (FX) feature.

NOTE: The following are values and functions that are applied to address 0h0322

Values and functions that are applied to address 0h0385	
Setting	**Function**
0h0001	Forward operation (Fx)
0h0003	Reverse operation (Rx)
0h0000	Stop

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 inverter, the changes are lost and the values changed via communication revert to the previous setting values when you turn on the inverter.

Setting address 0h03E0 to 0 and then setting it again to 1 via communication allows the existing parameter settings to be saved. However, setting address 0h03E0 to 1 and then setting it to 0 does not carry out the same function.

Total Memory Map for Communication

Total Memory Map for Communication		
Item	**Memory Map**	**Details**
Parameter registration type area	0h0100-0h01FF	Areas registered at CM.31–CM.38 and CM.51–CM.58
Drive communication common area	0h0300-0h037F	Drive monitoring area
	0h0380-0h03DF	Drive control area
	0h03E0-0h03FF	Drive memory control area
	0h0400-0h0FFF	Reserved
	0h1100	dr Group
	0h1200	bA Group
	0h1300	Ad Group
	0h1400	Cn Group
	0h1500	In Group
	0h1600	OU Group
	0h1700	CM Group
	0h1800	AP Group
	0h1B00	Pr Group
	0h1C00	M2 Group

Parameter Group for Data Transmission

By defining a parameter group for data transmission, the communication addresses registered in the communication function group (CM) can be used in communication. Parameter group for data transmission may be defined to transmit multiple parameters at once, into the communication frame.

Parameter Group for Data Transmission						
Parameter Group	**Parameter Number**	**Name**	**Parameter Setting**		**Setting Range**	**Unit**
CM	CM.31-CM.38	Output communication address x	-	-	0000-FFFF	Hex
	CM.51-CM.58	Input communication address x	-	-	0000-FFFF	Hex

Currently Registered CM Group Parameter

Currently Registered CM Group Parameter		
Address	**Parameter**	**Assigned content by bit**
0h0100-0h0107	Status Parameter-1- Status Parameter-8	Parameter communication code value registered at CM.31-CM.38 (Read-only)

Currently Registered CM Group Parameter		
Address	**Parameter**	**Assigned content by bit**
0h0110-0h0117	Control Parameter-1- Control Parameter-8	Parameter communication code value registered at CM.51-CM.58 (Read/Write access)

NOTE: When registering control parameters, register the operation speed (0h0005, 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.

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	Number of Points
Data Lo	
…	
…	
Data Hi	
Data Lo	
CRC Lo	
CRC Hi	

Function Code #04: Read Input Register

Query Field Name
Station ID
Function(0x04)
Starting Address Hi
Starting Address Lo
Number of Points Hi
Number of Points Lo
CRC Lo
CRC Hi

Response Field Name	
Station ID	
Function(0x04)	
Byte Count	
Data Hi	Number of Points
Data Lo	
…	
…	
Data Hi	
Data Lo	
CRC Lo	
CRC Hi	

Function Code #06: Preset Single Register

Query Field Name
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 ADRESS
03: ILLEAL DATA VALUE
06: SLAVE DEVICE BUSY

Response

Field Name
Station ID
Function (The function value uses the top level bit for all query values.)
Exception Code
CRC Lo
CRC Hi

Example of Modbus-RTU Communication in Use

When the muti-step acceleration time1 (Communication address 0x1246) is changed to 5.0 sec and the Multi-step deceleration time1 (Communication address 0x1247) 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	0x1245	0x0002	0x04	0x0032	0x0064	0x4324
Description	CM.01 Int485 St ID	Preset Multiple Register	Starting Address -1 (0x1246-1)	-	-	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	0x1245	0x0002	0x5565
Description	CM.01 Int485 St ID	Preset Multiple Register	Starting Address -1 (0x1246-1)	-	-

Compatible Common Area Parameter

Comm. Address	Parameter	Scale	Unit	R/W	Assigned Content by Bit	
0h0000	Drive Model	–	–	R	16: ACG	
0h0001	Drive capacity	–	–	R	0	0.75 kW (1 hp)
					1	1.5 kW (2 hp)
					2	2.2 kW (3 hp)
					4	5.5 kW (7.5 hp)
					5	7.5 kW (10 hp)
					6	11 kW (15 hp)
					7	15 kW (20 hp)
					8	18.5 kW (25 hp)
					9	22 kW (30 hp)
					256	0.4 kW (1/2 hp)
					259	4.0 kW (5 hp)
0h0002	Drive input voltage	–	–	R	0	230V level
					1	460V level
0h0003	Version	–	–	R	0h0100	Version 1.00
					0h0101	Version 1.01 (etc.)
0h0004	Reserved	–	–	R/W	–	
0h0005	Target frequency	0.01	Hz	R/W	–	

Comm. Address	Parameter	Scale	Unit	R/W	Assigned Content by Bit	
0h0006	Operation command (option)	–	–	R	B15	Reserved
					B14 B13 B12 B11 B10 B9	0: Keypad Freq 1: Keypad Torq limit 2-16 Terminal block multi-step speed 17: Up, 18: Down 19: STEADY 22: V1, 24: V0, 25: I2 26: Reserved 27: Built-in 485 28: Communication option 30: JOG, 31: PID
					B8 B7 B6	0: Keypad 1: FX/RX-1 2: FX/RX-2 3: Built-in 485 4: Communication option
				R/W	B5	Reserved
					B4	Emergency stop
					B3	W: Trip (0→1)
					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	Outputpower	0.1	kW	R	–	
0h000E	Operation status	–	–	–	B15	Reserved
					B14	1: Frequency command source by communication (built-in, option)
					B13	1: Operation command source by communication (built-in, option)
					B12	Reverse operation command
					B11	Forward operation command
					B10	Brake release signal
					B9	Jog mode
					B8	Drive stopping
					B7	DC braking
					B6	Speed reached
					B5	Decelerating
					B4	Accelerating
					B3	Fault Trip - operates according to OU.30 setting
					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–B11	Reserved
					B10	H/W-Diag
					B9–B4	Reserved
					B3	Level type trip
					B2–B1	Reserved
					B0	Latch type trip
0h0010	Input terminal information	–	–	R	B15–B5	Reserved
					B4	P5
					B3	P4
					B2	P3
					B1	P2
					B0	P1
0h0011	Output relay information	–	–	R	B15–B2	Reserved
					B1	Relay2
					B0	Relay1
0h0012	V1	0.01	%	R	V1 voltage input	
0h0013	V0	0.01	%	R	Potentiometer voltage input	
0h0014	I2	0.01	%	R	I2 current input	
0h0015	Motor rotation speed	1	Rpm	R	Displays existing motor rotation speed	
0h0016–0h0019	Reserved	–	–	–	–	
0h001A	Select Hz/rpm	–	–	R	0: Hz, 1: Rpm	
0h001B	Display the number of poles for the selected motor	–	–	R	Display the number of poles for the selected motor	

Drive Expansion Common Area Parameter

Monitoring Area Parameter (Read Only)

Monitoring Area Parameter (Read Only)							
Comm. Address			Parameter	Scale	Unit	Assigned Content by Bit	
Hex	Modbus RTU	Modbus TCP					
0h0300	***40768***	***40769***	Drive model	-	-	ACG: 0010h	
0h0301	***40769***	***40770***	Drive capacity	-	-	0.4 kW	1900h
						0.75 kW	3200h
						1.5 kW	4015h
						2.2 kW	4022h
						3.0 kW	4030h
						4.0 kW	4040h
						5.5 kW	4055h
						7.5 kW	4075h
						11kW	40B0h
						15kW	40F0h
						18.5 kW	4125h
						22kW	4160h
0h0302	***40770***	***40771***	Drive input voltage/power (Single phase, 3-phase)/cooling method	-	-	230V 3-phase forced cooling: 0231h	
						460V single phase self cooling: 0420h	
						230V single phase self cooling: 0220h	
						460V 3-phase self cooling: 0430h	
						230V 3-phase self cooling: 0230h	
						460V single phase forced cooling: 0421h	
						230V single phase forced cooling: 0221h	
						460V 3-phase forced cooling: 0431h	
0h0303	***40771***	***40772***	Drive S/W version	-	-	(Ex) 0h0100: Version 1.00	
						(Ex) 0h0101: Version 1.01	
0h0304	***40772***	***40773***	Reserved	-	-	-	

Monitoring Area Parameter (Read Only)								
Comm. Address			Parameter	Scale	Unit	Assigned Content by Bit		
Hex	Modbus RTU	Modbus TCP						
0h0305	***40773***	***40774***	Drive operation state	-	-	B12–B15	0	Normal state
							4	Warning occurred
							8	Fault occurred [operates according to Pr. 30 (Trip Out Mode) setting.]
						B8–B11	-	
						B4–B7	1	Speed searching
							2	Accelerating
							3	Operating at constant rate
							4	Decelerating
							5	Decelerating to stop
							6	H/W OCS
							7	S/W OCS
							8	Dwell operating
						B0–B3	0	Stopped
							1	Operating in forward direction
							2	Operating in reverse direction
							3	DC operating (0 speed control)
0h0306	***40774***	***40775***	Drive operation frequency command source	-	-	B8–B15	Operation command source	
							0	Keypad
							1	Communication option
							3	Built-in RS 485
							4	Terminal block
						B0–B7	Frequency command source	
							0	Keypad speed
							1	Keypad torque limit
							2–4	Up/Down operation speed
							5	V1
							7	V0
							8	I2
							10	Built-in RS 485
							11	Communication option
							13	Jog
							14	PID
							25-39	Multi-step speed frequency
0h0307–0h030F	***40775–40783***	***40776–40784***	Reserved	-	-	–		
0h0310	***40784***	***40785***	Output current	0.1	A	-		
0h0311	***40785***	***40786***	Output frequency	0.01	Hz	-		
0h0312	***40786***	***40787***	Output rpm	0	rpm	-		
0h0313	***40787***	***40788***	Motor feedback speed	0	rpm	-32768 rpm-32767 rpm (directional)		
0h0314	***40788***	***40789***	Output voltage	1	V	-		
0h0315	***40789***	***40790***	DC Link voltage	1	V	-		

Monitoring Area Parameter (Read Only)							
Comm. Address			Parameter	Scale	Unit	Assigned Content by Bit	
Hex	Modbus RTU	Modbus TCP					
0h0316	***40790***	***40791***	Output power	0.1	kW	-	
0h0317	***40791***	***40792***	Output torque	0.1	%	-	
0h0318	***40792***	***40793***	PID reference	0.1	%	-	
0h0319	***40793***	***40794***	PID feedback	0.1	%	-	
0h031A	***40794***	***40795***	Display the number of poles for the first motor	-	-	Displays the number of poles for the first motor	
0h031B	***40795***	***40796***	Display the number of poles for the second motor	-	-	Displays the number of poles for the second motor	
0h031C	***40796***	***40797***	Display the number of poles for the selected motor	-	-	Displays the number of poles for the selected motor	
0h031D	***40797***	***40798***	Select Hz/rpm	-	-	0	Hz
						1	RPM
0h031E - 0h031F	***40798 - 40799***	***40799 - 40800***	Reserved	-	-	-	
0h0320	***40800***	***40801***	Digital input information	-	-	B5–B15	Reserved
						B4	P5(I/O board)
						B3	P4(I/O board)
						B2	P3(I/O board)
						B1	P2(I/O board)
						B0	P1(I/O board)
0h0321	***40801***	***40802***	Digital output information	-	-	B2–BI5	Reserved
						B1	Relay2
						B0	Relay1
0h0322	***40802***	***40803***	Virtual digital input information	-	-	B8–B15	Reserved
						B7	Virtual DI 8(CM.77)
						B6	Virtual DI 7(CM.76)
						B5	Virtual DI 6(CM.75)
						B4	Virtual DI 5(CM.74)
						B3	Virtual DI 4(CM.73)
						B2	Virtual DI 3(CM.72)
						B1	Virtual DI 2(CM.71)
						B0	Virtual DI 1(CM.70)
0h0323	***40803***	***40804***	Display the selected motor	-	-	0	First Motor
						1	Second Motor
0h0324	***40804***	***40805***	V1	0.01	%	Analog input V1 (I/O board)	
0h0325	***40805***	***40806***	Reserved	0.01	%		
0h0326	***40806***	***40807***	V0	0.01	%	Potentiometer dial	
0h0327	***40807***	***40808***	I2	0.01	%	Analog input I2 (I/O board)	
0h0328	***40808***	***40809***	AO1	0.01	%	Analog output 1 (I/O board)	
0h0329	***40809***	***40810***	AO2	0.01	%	Analog output 2 (I/O board)	

Monitoring Area Parameter (Read Only)							
Comm. Address			Parameter	Scale	Unit	Assigned Content by Bit	
Hex	Modbus RTU	Modbus TCP					
0h032A	***40810***	***40811***	Reserved	0.01	%	Reserved	
0h032B	***40811***	***40812***	Reserved	0.01	%	Reserved	
0h032C	***40812***	***40813***	Reserved	-	-	-	
0h032D	***40813***	***40814***	Drive module temperature	1	°C	-	
0h032E	***40814***	***40815***	Drive power consumption	1	kWh	-	
0h032F	***40815***	***40816***	Drive power consumption		MWh	-	
0h0330	***40816***	***40817***	Latch type trip information - 1	-	-	BI5	Fuse Open Trip
						BI4	Over Heat Trip
						BI3	Arm Short
						BI2	External Trip
						BI1	Overvoltage Trip
						BI0	Overcurrent Trip
						B9	NTC Trip
						B8	Reserved
						B7	Reserved
						B6	Input open-phase trip
						B5	Output open-phase trip
						B4	Ground Fault Trip
						B3	E-Thermal Trip
						B2	Drive Overload Trip
						B1	Underload Trip
						B0	Overload Trip
0h0331	***40817***	***40818***	Latch type trip information - 2	-	-	BI5	Reserved
						BI4	Pre Over Heat Trip
						BI3	Reserved
						BI2	Reserved
						BI1	Reserved
						BI0	Bad option card
						B9	No motor trip
						B8	External brake trip
						B7	Bad contact at basic I/O board
						B6	Pre PID Fail
						B5	Reserved
						B4	Reserved
						B3	FAN Trip
						B2	Reserved
						B1	Reserved
						B0	Reserved

Monitoring Area Parameter (Read Only)							
Comm. Address			Parameter	Scale	Unit	Assigned Content by Bit	
Hex	Modbus RTU	Modbus TCP					
0h0332	***40818***	***40819***	Level type trip information	-	-	B4–B15	Reserved
						B3	Keypad Lost Command
						B2	Lost Command
						B1	Low Voltage Trip
						B0	BX
0h0333	***40819***	***40820***	H/W Diagnosis Trip information	-	-	B6–B15	Reserved
						B5	Queue Full
						B4	Reserved
						B3	Watchdog-2 error
						B2	Watchdog-1 error
						B1	EEPROM error
						B0	ADC error
0h0334	***40820***	***40821***	Warning information	-	-	B10–B15	Reserved
						B9	Auto Tuning failed
						B8	Keypad lost
						B7	Encoder disconnection
						B6	Wrong installation of encoder
						B5	DB
						B4	FAN running
						B3	Lost command
						B2	Drive Overload
						B1	Underload
						B0	Overload
0h0335	***40821***	***40822***	Latch type trip information – 3	–	–	B3	Under torque detection 2
						B2	Over torque detection
						B1	Under torque detection 1
						B0	Over torque detection 1
0h0336 - 0h033F	***40822 - 40831***	***40823 - 40832***	Reserved	-	-	-	
0h0340	***40832***	***40833***	On Time date	0	Day	Total number of days the drive has been powered on	
0h0341	***40833***	***40834***	On Time minute	0	Min	Total number of minutes excluding the total number of On Time days	
0h0342	***40834***	***40835***	Run Time date	0	Day	Total number of days the drive has driven the motor	
0h0343	***40835***	***40836***	Run Time minute	0	Min	Total number of minutes excluding the total number of Run Time days	
0h0344	***40836***	***40837***	Fan Time date	0	Day	Total number of days the heat sink fan has been running	
0h0345	***40837***	***40838***	Fan Time minute	0	Min	Total number of minutes excluding the total number of Fan Time days	
0h0346 - 0h0348	***40838 - 40840***	***40839 - 40841***	Reserved	-	-	-	
0h0349	***40841***	***40842***	Reserved	-	-	-	
0h034A	***40842***	***40843***	Option 1	-	-	0	None
						11	EtherNet/IP or Mod TCP

Monitoring Area Parameter (Read Only)						
Comm. Address			Parameter	Scale	Unit	Assigned Content by Bit
Hex	Modbus RTU	Modbus TCP				
0h034B	***40843***	***40844***	Reserved	-	-	-
0h034C	***40844***	***40845***	Reserved	-	-	-

Control Area Parameter (Read/ Write)

Control Area Parameter (Read/ Write)								
Comm. Address			Parameter	Scale	Unit	Assigned Content by Bit		
Hex	Modbus RTU	Modbus TCP						
0h0380	***40896***	***40897***	Frequency command	0.01	Hz	Command frequency setting		
0h0381	***40897***	***40898***	RPM command	1	rpm	Command rpm setting		
0h0382	***40898***	***40899***	Operation command	-	-	B7	Reserved	
						B6	Reserved	
						B5	Reserved	
						B4	Reserved	
						B3	0 → 1: Free-run stop	
						B2	0 → 1: Trip initialization	
						B1	0: Reverse command	
							1: Forward command	
						B0	0	Stop command
							1	Run command
						Example: Forward operation command 0003h, Reverse operation command 0001h.		
0h0383	***40899***	***40900***	Acceleration time	0.1	s	Acceleration time setting		
0h0384	***40900***	***40901***	Deceleration time	0.1	s	Deceleration time setting		
0h0385	***40901***	***40902***	Virtual digital input control (0: Off, 1:On)	-	-	B8–B15	Reserved	
						B7	Virtual DI 8(CM.77)	
						B6	Virtual DI 7(CM.76)	
						B5	Virtual DI 6(CM.75)	
						B4	Virtual DI 5(CM.74)	
						B3	Virtual DI 4(CM.73)	
						B2	Virtual DI 3(CM.72)	
						B1	Virtual DI 2(CM.71)	
						B0	Virtual DI 1(CM.70)	
0h0386	***40902***	***40903***	Digital output control (0:Off, 1:On)	-	-	B5–B2	Reserved	
						B1	Relay2	
						B0	Relay1 (0.4~7.5kW, OU.31: None)	
0h0387	***40903***	***40904***	Reserved	-	-	Reserved		
0h0388	***40904***	***40905***	PID reference	0.1	%	PID reference command		
0h0389	***40905***	***40906***	PID feedback value	0.1	%	PID feedback value		

Control Area Parameter (Read/ Write)						
Comm. Address			Parameter	Scale	Unit	Assigned Content by Bit
Hex	Modbus RTU	Modbus TCP				
0h038A	***40906***	***40907***	Motor rated current	0.1	A	-
0h038B	***40907***	***40908***	Motor rated voltage	1	V	-
0h038C-0h038F	***40908 - 40911***	***40909 - 40912***	Reserved	-	-	-
0h0390	***40912***	***40913***	Torque Ref	0.1	%	Torque command
0h0391	***40913***	***40914***	Fwd Pos Torque Limit	0.1	%	Forward motoring torque limit
0h0392	***40914***	***40915***	Fwd Neg Torque Limit	0.1	%	Forward regenerative torque limit
0h0393	***40915***	***40916***	Rev Pos Torque Limit	0.1	%	Reverse motoring torque limit
0h0394	***40916***	***40917***	Rev Neg Torque Limit	0.1	%	Reverse regenerative torque limit
0h0395	***40917***	***40918***	Torque Bias	0.1	%	Torque bias

A frequency set via communication using the common area frequency address (0h0380) is not saved even when used with the parameter save function. To save a changed frequency to use after a power cycle, follow these steps:

1) *Set Frq to 0:Keypad-1 and select a random target frequency.*
2) *Set the frequency via communication into the parameter area frequency address (0h1D04).*
3) *Perform the parameter save (0h03E0: '1') before turning off the power. After the power cycle, the frequency set before turning off the power is displayed.*

Drive Memory Control Area Parameter (Read and Write)

- *♦R/W – Parameter Write–enabled during Operation (Run mode)*
- *R/W – Parameter Write–enabled when stopped*
- *Parameter Read Only*

Drive Memory Control Area Parameter (Read and Write)								
Comm. Address			Parameter	Scale	Unit	R/W	Function	
Hex	Modbus RTU	Modbus TCP						
0h03E0	***40992***	***40993***	Save parameters	-	-	R/W	0	No
							1	Yes
0h03E1	***40993***	***40994***	Monitor mode initialization	-	-	♦R/W	0	No
							1	Yes
0h03E2	***40994***	***40995***	Parameter initialization	-	-	R/W	0	No
							1	All Grp
							2	Drv Grp
							3	bA Grp
							4	Ad Grp
							5	Cn Grp
							6	In Grp
							7	OU Grp
							8	CM Grp
							9	AP Grp
							12	Pr Grp
							13	M2 Grp
							14	Operation Grp
							Setting is prohibited during fault trip interruptions.	
0h03E3	***40995***	***40996***	Display changed parameters	-	-	♦R/W	0	No
							1	Yes
0h03E4	***40996***	***40997***	Reserved	-	-	–	-	
0h03E5	***40997***	***40998***	Delete all fault history	-	-	♦R/W	0	No
							1	Yes
0h03E6	***40998***	***40999***	Delete user-registrated codes	-	-	♦R/W	0	No
							1	Yes
0h03E7	***40999***	***41000***	Hide parameter mode	0	Hex	♦R/W	Write: 0-9999	
							Read	
							0	Unlock
							1	Lock
0h03E8	***41000***	***41001***	Lock parameter mode	0	Hex	♦R/W	Write: 0-9999	
							Read	
							0	Unlock
							1	Lock
0h03E9	***41001***	***41002***	Reserved	–	–	–	–	–

Drive Memory Control Area Parameter (Read and Write)								
Comm. Address			Parameter	Scale	Unit	R/W	Function	
Hex	Modbus RTU	Modbus TCP						
0h03EA	***41002***	***41003***	Initializing power consumption	-	-	♦R/W	0	No
							1	Yes
0h03EB	***41003***	***41004***	Initialize drive operation accumulative time	-	-	♦R/W	0	No
							1	Yes
0h03EC	***41004***	***41005***	Initialize cooling fan accumulated operation time	-	-	♦R/W	0	No
							1	Yes

When setting parameters in the drive memory control area, the values are reflected to the drive operation and saved. Parameters set in other areas via communication are reflected to the drive operation, but are not saved. All set values are cleared following a drive power cycle and revert back to its previous values. When setting parameters via communication, ensure that a parameter save is completed prior to shutting the drive down.

Whereas the drive may respond and operate to new parameters written via communications, some parameters set via communications are not retentive upon a power cycle UNLESS the new parameter values have been SAVED prior to the power cycle.

- *Parameter SET via Communications + NOT Saved + Power Cycle = Parameters reverts back to previous setting.*
- *Parameter SET via Communications + SAVED + Power Cycle = Parameters holds saved value.*

The addresses 0h03E7 and 0h03E8 are parameters for entering the password. When the password is entered, the condition will change from Lock to Unlock, and vice versa. When the same parameter value is entered continuously, the parameter is executed just once. Therefore, if the same value is entered again, change it to another value first and then re-enter the previous value. For example, if you want to enter 244 twice, enter it in the following order: 244 → 0 → 244.

NOTE: It may take longer to set the parameter values in the drive memory control area because all data is saved to the drive. Be careful as communication may be lost during parameter setup if parameter setup is continues for an extended period of time.

Drive Parameter Modbus Communication Addresses

The following tables list the specific modbus addresses for all parameters in the ACN series drive. Please note, the Modbus RTU addresses for serial use are different than the Modbus TCP addresses for use with the ACN-ETH communications option card. Hex Address 0000 is unavailable with Modbus RTU.

Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal	Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal
Drive Group							
dr.09	1109	44361	44362	***dr.27***	111B	44379	44380
dr.11	110B	44363	44364	***dr.28***	111C	44380	44381
dr.12	110C	44364	44365	***dr.80***	1150	44432	44433
dr.13	110D	44365	44366	***dr.81***	1151	44433	44434
dr.14	110E	44366	44367	***dr.89***	1159	40995	40996
dr.15	110F	44367	44368	***dr.91***	115B	44443	44444
dr.16	1110	44368	44369	***dr.93***	115D	44445	44446
dr.17	1111	44369	44370	***dr.94***	115E	44446	44447
dr.18	1112	44370	44371	***dr.95***	115F	44447	44448
dr.19	1113	44371	44372	***dr.97***	1161	44449	44450
dr.20	1114	44372	44373	***dr.98***	1162	44450	44451
dr.26	111A	44378	44379				

Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal	Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal
Basic Group							
bA.1	1201	44609	44610	***bA.43***	122B	44651	44652
bA.2	1202	44610	44611	***bA.44***	122C	44652	44653
bA.3	1203	44611	44612	***bA.45***	122D	44653	44654
bA.4	1204	44612	44613	***bA.46***	122E	44654	44655
bA.5	1205	44613	44614	***bA.47***	122F	44655	44656
bA.7	1207	44615	44616	***bA.48***	1230	44656	44657
bA.8	1208	44616	44617	***bA.53***	1235	44661	44662
bA.9	1209	44617	44618	***bA.54***	1236	44662	44663
bA.10	120A	44618	44619	***bA.55***	1237	44663	44664
bA.11	120B	44619	44620	***bA.56***	1238	44664	44665
bA.12	120C	44620	44621	***bA.70***	1246	44678	44679
bA.13	120D	44621	44622	***bA.71***	1247	44679	44680
bA.14	120E	44622	44623	***bA.72***	1248	44680	44681
bA.15	120F	44623	44624	***bA.73***	1249	44681	44682
bA.16	1210	44624	44625	***bA.74***	124A	44682	44683
bA.17	1211	44625	44626	***bA.75***	124B	44683	44684
bA.18	1212	44626	44627	***bA.76***	124C	44684	44685
bA.19	1213	44627	44628	***bA.77***	124D	44685	44686
bA.20	-	-	-	***bA.78***	124E	44686	44687
bA.21	-	-	-	***bA.79***	124F	44687	44688
bA.22	-	-	-	***bA.80***	1250	44688	44689
bA.23	-	-	-	***bA.81***	1251	44689	44690
bA.24	-	-	-	***bA.82***	1252	44690	44691
bA.41	1229	44649	44650	***bA.83***	1253	44691	44692
bA.42	122A	44650	44651				
Advanced Group							
Ad.1	1301	44865	44866	***Ad.42***	132A	44906	44907
Ad.2	1302	44866	44867	***Ad.44***	132C	44908	44909
Ad.3	1303	44867	44868	***Ad.45***	132D	44909	44910
Ad.4	1304	44868	44869	***Ad.46***	132E	44910	44911
Ad.5	1305	44869	44870	***Ad.47***	132F	44911	44912
Ad.6	1306	44870	44871	***Ad.50***	1332	44914	44915
Ad.7	1307	44871	44872	***Ad.51***	1333	44915	44916
Ad.8	1308	44872	44873	***Ad.60***	133C	44924	44925
Ad.9	1309	44873	44874	***Ad.61***	133D	44925	44926
Ad.10	130A	44874	44875	***Ad.62***	133E	44926	44927
Ad.12	130C	44876	44877	***Ad.63***	133F	44927	44928
Ad.13	130D	44877	44878	***Ad.64***	1340	44928	44929
Ad.14	130E	44878	44879	***Ad.65***	1341	44929	44930
Ad.15	130F	44879	44880	***Ad.66***	1342	44930	44931
Ad.16	1310	44880	44881	***Ad.67***	1343	44931	44932
Ad.17	1311	44881	44882	***Ad.68***	1344	44932	44933
Ad.20	1314	44884	44885	***Ad.70***	1346	44934	44935

Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal	Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal
Ad.21	1315	44885	44886	***Ad.71***	1347	44935	44936
Ad.22	1316	44886	44887	***Ad.72***	1348	44936	44937
Ad.23	1317	44887	44888	***Ad.74***	134A	44938	44939
Ad.24	1318	44888	44889	***Ad.75***	134B	44939	44940
Ad.25	1319	44889	44890	***Ad.76***	134C	44940	44941
Ad.26	131A	44890	44891	***Ad.77***	134D	44941	44942
Ad.27	131B	44891	44892	***Ad.78***	134E	44942	44943
Ad.28	131C	44892	44893	***Ad.79***	134F	44943	44944
Ad.29	131D	44893	44894	***Ad.80***	1350	44944	44945
Ad.30	131E	44894	44895	***Ad.81***	1351	44945	44946
Ad.31	131F	44895	44896	***Ad.82***	1352	44946	44947
Ad.32	1320	44896	44897	***Ad.83***	-	-	-
Ad.33	1321	44897	44898	***Ad.85***	1355	44949	44950
Ad.41	1329	44905	44906	***Ad.86***	1356	44950	44951
Control Group							
Cn.4	1404	45124	45125	***Cn.57***	1439	45177	45178
Cn.5	1405	45125	45126	***Cn.70***	1446	45190	45191
Cn.9	1409	45129	45130	***Cn.71***	1447	45191	45192
Cn.10	140A	45130	45131	***Cn.72***	1448	45192	45193
Cn.11	140B	45131	45132	***Cn.73***	1449	45193	45194
Cn.21	1415	45141	45142	***Cn.74***	144A	45194	45195
Cn.22	1416	45142	45143	***Cn.75***	144B	45195	45196
Cn.23	1417	45143	45144	***Cn.76***	144C	45196	45197
Cn.24	1418	45144	45145	***Cn.77***	144D	45197	45198
Cn.29	141D	45149	45150	***Cn.78***	144E	45198	45199
Cn.30	141E	45150	45151	***Cn.79***	144F	45199	45200
Cn.53	1435	45173	45174	***Cn.80***	1450	45200	45201
Cn.54	1436	45174	45175	***Cn.81***	1451	45201	45202
Cn.55	1437	45175	45176	***Cn.82***	1452	45202	45203
Cn.56	1438	45176	45177	***Cn.83***	1453	45203	45204
Input Group							
In.1	1501	45377	45378	***In.47***	152F	45423	45424
In.2	1502	45378	45379	***In.50***	1532	45426	45427
In.5	1505	45381	45382	***In.52***	1534	45428	45429
In.6	1506	45382	45383	***In.53***	1535	45429	45430
In.7	1507	45383	45384	***In.54***	1536	45430	45431
In.8	1508	45384	45385	***In.55***	1537	45431	45432
In.9	1509	45385	45386	***In.56***	1538	45432	45433
In.10	150A	45386	45387	***In.61***	153D	45437	45438
In.11	150B	45387	45388	***In.62***	153E	45438	45439
In.12	150C	45388	45389	***In.65***	1541	45441	45442
In.13	150D	45389	45390	***In.66***	1542	45442	45443
In.14	150E	45390	45391	***In.67***	1543	45443	45444
In.15	150F	45391	45392	***In.68***	1544	45444	45445

Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal	Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal
In.16	1510	45392	45393	***In.69***	1545	45445	45446
In.17	1511	45393	45394	***In.84***	1554	45460	45461
In.35	1523	45411	45412	***In.85***	1555	45461	45462
In.37	1525	45413	45414	***In.86***	1556	45462	45463
In.38	1526	45414	45415	***In.87***	1557	45463	45464
In.39	1527	45415	45416	***In.88***	1558	45464	45465
In.40	1528	45416	45417	***In.89***	1559	45465	45466
In.41	1529	45417	45418	***In.90***	155A	45466	45467
In.46	152E	45422	45423	***In.99***	1563	45475	45476
Output Group							
OU.1	1601	45633	45634	***OU.53***	1635	45685	45686
OU.2	1602	45634	45635	***OU.54***	1636	45686	45687
OU.3	1603	45635	45636	***OU.55***	1637	45687	45688
OU.4	1604	45636	45637	***OU.56***	1638	45688	45689
OU.5	1605	45637	45638	***OU.57***	1639	45689	45690
OU.6	1606	45638	45639	***OU.58***	163A	45690	45691
OU.30	161E	45662	45663	***OU.67***	1643	45699	45700
OU.31	161F	45663	45664	***OU.68***	1644	45700	45701
OU.33	1621	45665	45666	***OU.69***	1645	45701	45702
OU.41	1629	45673	45674	***OU.70***	1646	45702	45703
OU.50	1632	45682	45683	***OU.71***	1647	45703	45704
OU.51	1633	45683	45684	***OU.72***	1648	45704	45705
OU.52	1634	45684	45685				

Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal	Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal
Communication Group							
CM.1	1701	45889	45890	***CM.43***	172B	45931	45932
CM.2	1702	45890	45891	***CM.44***	172C	45932	45933
CM.3	1703	45891	45892	***CM.45***	172D	45933	45934
CM.4	1704	45892	45893	***CM.46***	172E	45934	45935
CM.5	1705	45893	45894	***CM.50***	1732	45938	45939
CM.6	1706	45894	45895	***CM.51***	1733	45939	45940
CM.7	1707	45895	45896	***CM.52***	1734	45940	45941
CM.8	1708	45896	45897	***CM.53***	1735	45941	45942
CM.9	1709	45897	45898	***CM.54***	1736	45942	45943
CM.10	170A	45898	45899	***CM.55***	1737	45943	45944
CM.11	170B	45899	45900	***CM.56***	1738	45944	45945
CM.12	170C	45900	45901	***CM.57***	1739	45945	45946
CM.13	170D	45901	45902	***CM.58***	173A	45946	45947
CM.14	170E	45902	45903	***CM.59***	173B	45947	45948
CM.15	170F	45903	45904	***CM.60***	173C	45948	45949
CM.16	1710	45904	45905	***CM.61***	173D	45949	45950
CM.17	1711	45905	45906	***CM.62***	173E	45950	45951
CM.18	1712	45906	45907	***CM.63***	173F	45951	45952
CM.19	1713	45907	45908	***CM.64***	1740	45952	45953
CM.20	1714	45908	45909	***CM.65***	1741	45953	45954
CM.21	1715	45909	45910	***CM.66***	1742	45954	45955
CM.22	1716	45910	45911	***CM.68***	1744	45956	45957
CM.23	1717	45911	45912	***CM.70***	1746	45958	45959
CM.24	1718	45912	45913	***CM.71***	1747	45959	45960
CM.30	171E	45918	45919	***CM.72***	1748	45960	45961
CM.31	171F	45919	45920	***CM.73***	1749	45961	45962
CM.32	1720	45920	45921	***CM.74***	174A	45962	45963
CM.33	1721	45921	45922	***CM.75***	174B	45963	45964
CM.34	1722	45922	45923	***CM.76***	174C	45964	45965
CM.35	1723	45923	45924	***CM.77***	174D	45965	45966
CM.36	1724	45924	45925	***CM.86***	1756	45974	45975
CM.37	1725	45925	45926	***CM.90***	175A	45978	45979
CM.38	1726	45926	45927	***CM.91***	175B	45979	45980
CM.39	1727	45927	45928	***CM.92***	175C	45980	45981
CM.40	1728	45928	45929	***CM.93***	175D	45981	45982
CM.41	1729	45929	45930	***CM.94***	-	-	-
CM.42	172A	45930	45931				

Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal	Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal
Application Group							
AP.1	1801	46145	46146	***AP.29***	181D	46173	46174
AP.16	1810	46160	46161	***AP.30***	181E	46174	46175
AP.17	1811	46161	46162	***AP.31***	181F	46175	46176
AP.18	1812	46162	46163	***AP.32***	1820	46176	46177
AP.19	1813	46163	46164	***AP.34***	1822	46178	46179
AP.20	1814	46164	46165	***AP.35***	1823	46179	46180
AP.21	1815	46165	46166	***AP.36***	1824	46180	46181
AP.22	1816	46166	46167	***AP.37***	1825	46181	46182
AP.23	1817	46167	46168	***AP.38***	1826	46182	46183
AP.24	1818	46168	46169	***AP.39***	1827	46183	46184
AP.25	1819	46169	46170	***AP.40***	1828	46184	46185
AP.26	181A	46170	46171	***AP.43***	182B	46187	46188
AP.27	181B	46171	46172	***AP.44***	182C	46188	46189
AP.28	181C	46172	46173	***AP.45***	182D	46189	46190
Protection Group							
Pr.4	1B04	46916	46917	***Pr.43***	1B2B	46955	46956
Pr.5	1B05	46917	46918	***Pr.45***	1B2D	46957	46958
Pr.6	1B06	46918	46919	***Pr.50***	1B32	46962	46963
Pr.7	1B07	46919	46920	***Pr.51***	1B33	46963	46964
Pr.8	1B08	46920	46921	***Pr.52***	1B34	46964	46965
Pr.9	1B09	46921	46922	***Pr.53***	1B35	46965	46966
Pr.10	1B0A	46922	46923	***Pr.54***	1B36	46966	46967
Pr.12	1B0C	46924	46925	***Pr.55***	1B37	46967	46968
Pr.13	1B0D	46925	46926	***Pr.56***	1B38	46968	46969
Pr.14	1B0E	46926	46927	***Pr.57***	1B39	46969	46970
Pr.15	1B0F	46927	46928	***Pr.58***	1B3A	46970	46971
Pr.17	1B11	46929	46930	***Pr.59***	1B3B	46971	46972
Pr.18	1B12	46930	46931	***Pr.66***	1B42	46978	46979
Pr.19	1B13	46931	46932	***Pr.77***	1B4D	46989	46990
Pr.20	1B14	46932	46933	***Pr.78***	1B4E	46990	46991
Pr.21	1B15	46933	46934	***Pr.79***	1B4F	46991	46992
Pr.22	1B16	46934	46935	***Pr.80***	1B50	46992	46993
Pr.25	1B19	46937	46938	***Pr.81***	1B51	46993	46994
Pr.26	1B1A	46938	46939	***Pr.82***	1B52	46994	46995
Pr.27	1B1B	46939	46940	***Pr.86***	1B56	46998	46999
Pr.28	1B1C	46940	46941	***Pr.87***	1B57	46999	47000
Pr.29	1B1D	46941	46942	***Pr.88***	1B58	47000	47001
Pr.30	1B1E	46942	46943	***Pr.89***	1B59	47001	47002
Pr.31	1B1F	46943	46944	***Pr.91***	1B5B	47003	47004
Pr.32	1B20	46944	46945	***Pr.92***	1B5C	47004	47005
Pr.33	1B21	46945	46946	***Pr.93***	1B5D	47005	47006
Pr.40	1B28	46952	46953	***Pr.94***	1B5E	47006	47007
Pr.41	1B29	46953	46954	***Pr.95***	1B5F	47007	47008

Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal	Parameter	HEX	ModbusRTU Decimal	ModbusTCP Decimal
Pr.42	1B2A	46954	46955	***Pr.96***	1B60	47008	47009
2nd Motor Group							
M2.4	1C04	47172	47173	***M2.20***	-	-	-
M2.5	1C05	47173	47174	***M2.25***	1C19	47193	47194
M2.6	1C06	47174	47175	***M2.26***	1C1A	47194	47195
M2.7	1C07	47175	47176	***M2.27***	1C1B	47195	47196
M2.8	1C08	47176	47177	***M2.28***	1C1C	47196	47197
M2.10	1C0A	47178	47179	***M2.29***	1C1D	47197	47198
M2.11	1C0B	47179	47180	***M2.30***	1C1E	47198	47199
M2.12	1C0C	47180	47181	***M2.31***	1C1F	47199	47200
M2.13	1C0D	47181	47182	***M2.32***	1C20	47200	47201
M2.14	1C0E	47182	47183	***M2.33***	1C21	47201	47202
M2.15	1C0F	47183	47184	***M2.34***	1C12	47186	47187
M2.16	1C10	47184	47185	***M2.40***	1C28	47208	47209
M2.17	-	-	-	***M2.41***	1C29	47209	47210
M2.18	-	-	-	***M2.42***	1C2A	47210	47211
M2.19	-	-	-				
Operation Group							
0.00	1F00	47936	47937	***St3***	1F07	47943	47944
ACC	1F01	47937	47938	***Cur***	1F08	47944	47945
dEC	1F02	47938	47939	***RPM***	1F09	47945	47946
drv	1F03	47939	47940	***dCL***	1F0A	47946	47947
Fr9	1F04	47940	47941	***vOL***	1F0B	47947	47948
St1	1F05	47941	47942	***nOn***	1F0C	47948	47949
St2	1F06	47942	47943	***drC***	1F0D	47949	47950

Chapter 6: Maintenance and Troubleshooting

Chapter 6

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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, please confirm that the capacitors have fully discharged.*
- ☑ *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.

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.

Fault 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.90. 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

Reference page 3-3 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.

Fault Trips: 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.
ult	Underload	Latch	Displayed when the motor underload trip is activated and the actual load level is less than the set level. Operates when Pr.27 is set to a value other than 0.
oct	Overcurrent	Latch	Displayed when drive output current exceeds the specified value.
ovt	Overvoltage	Latch	Displayed when internal DC circuit voltage exceeds the specified value.
lvt	Low voltage	Level	Displayed when internal DC circuit voltage is less than the specified value.
lv2	Low voltage2	Latch	Displayed when internal DC circuit voltage is less than the specified value during drive operation. Operates when Pr.82 is set to 1.
gft	Ground Trip*	Latch	Displayed when a ground fault trip occurs on the output side of the drive and causes the current to exceed the specified value. The specified value varies depending on drive capacity. (Note: For 230V 5hp/7hp products, check if there is an input phase loss when GFT occurs.)
eth	E-thermal	Latch	Displayed based on inverse time-limit thermal characteristics to prevent motor overheating. Operates when Pr.40 is set to a value other than 0.
pot	Out phase open	Latch	Displayed when a 3-phase drive output has one or more phases in an open circuit condition. Operates when bit 1 of Pr.5 is set to 1.
ipo	In phase open	Latch	Displayed when a 3-phase drive input has one or more phases in an open circuit condition. Operates only when bit 2 of Pr.5 is set to 1.
iol	Drive OLT	Latch	Displayed when the drive has been protected from overload and resultant overheating, based on inverse time-limit thermal characteristics. Allowable overload rates for the drive are 150% for 1 min and 200% for 4 sec (120% for 1 minute, 200% for 2 seconds with low load). Protection is based on drive rated capacity, and may vary depending on the device's capacity.
nmt	No motor trip	Latch	Displayed when the motor is not connected during drive operation. Operates when Pr.31 is set to 1.
rot	Relay open trip	Latch	Occurs when the DC voltage relay is not operating when power is input. The Pr.90 code must be set to 1 to operate. Detected only in 460V 2hp, 3hp, and 5hp capacities.

Fault Trips: Protection Functions for Output Current and Input Voltage			
Keypad Display	**Name**	**Type**	**Description**
otd1	Over torque trip 1	Latch	Occurs when the output current is higher than the level set in Ou.68. Operates when OU.67 is set to 3, 4.
otd2	Over torque trip 2	Latch	Occurs when the output current is higher than the level set in OU.71. Operates when OU.70 is set to 3, 4.
utd1	Under torque trip 1	Latch	Occurs when the output current is lower than the level set in OU.68. Operates when OU.67 is set to 7, 8.
utd2	Under torque trip 2	Latch	Occurs when the output current is lower than the level set in OU.71. Operates when OU.70 is set to 7, 8.
**ACG drives rated for 5hp or less (except for 230V 3hp and 5hp) do not support the ground fault trip (GFT) feature. Therefore, an over current trip (OCT) or over voltage trip (OVT) may occur when there is a low-resistance ground fault.*			

Protection Functions Using Abnormal Internal Circuit Conditions and External Signals

Fault Trips: Protection Functions Using Abnormal Internal Circuit Conditions and External Signals			
Keypad Display	**Name**	**Type**	**Description**
oht	Overheat	Latch	Displayed when the tempertature of the drive heat sink exceeds the specified value.
oc2	Overcurrent2	Latch	Displayed when the DC circuit in the drive detects a specified level of excessive, short circuit current.
ext Ext	External trip	Latch	Displayed when an external fault signal is provided by the multi-function terminal. Set one of the multi-function input terminals at In.65-69 to 4 (External Trip) to enable external trip.
bx	BX	Level	Displayed when the drive output is blocked by a signal provided from the multi-function terminal. Set one of the multi-function input terminals at In.65-69 to 5 (BX) to enable input block function.
hwt	H/W-Diag	Fatal	Displayed when an error is detected in the memory (EEPROM), analog-digital converter output (ADC Off Set), or CPU watchdog (Watch Dog-1, Watch Dog-2). EEP Err: An error in reading/writing parameters due to keypad or memory (EEPROM) fault. ADC Off Set: An error in the current sensing circuit (U/V/W terminal, current sensor, etc.).
ntc	NTC Open	Latch	Displayed when an error is detected in the temperature sensor of the Insulated Gate Bipolar Transistor (IGBT).
fan	Fan Trip	Latch	Displayed when an error is detected in the cooling fan. Set Pr.79 to 0 to activate fan trip.
pid	Pre-PID Fail	Latch	Displayed when pre-PID is operating with functions set at AP.34–AP.36. A fault trip occurs when a controlled variable (PID feedback) is measured below the set value and the low feedback continues, as it is treated as a load fault.
xbr	Ext-Brake	Latch	Operates when the external brake signal is provided by the multi-function terminal. Occurs when the drive output starting current remains below the set value at Ad.41. Set either OU.31 or OU.32 to 35 (BR Control).
oh	Overheat pre alarm	Latch	When the user has set Pr.78 to 2: Free-Run or 3: Dec, pre-overheating warning trip of drive occurs if the drive temperature exceeds the temperature set by the user in Pr.77.

Protection Functions for Communications Options

Fault Trips: Protection Functions for Communications Options			
Keypad Display	**Name**	**Type**	**Description**
lor	Lost Command	Level	Displayed when a frequency or operation command error is detected during drive operation by controllers other than the keypad (e.g., using a terminal block and a communication mode). Activate by setting Pr.12 to any value other than 0.
iot hold	IO Board Trip	Latch	Displayed when the I/O board or external communication card is not connected to the drive or there is a bad connection.
errc			Displayed when the “HOLd” error code continues for more than 5 seconds. (‘Errc’ -> ‘-rrc’ -> E-rc’ -> ‘Er-c’ -> ‘Err-’ -> ‘- -rc’ -> ‘Er- -’ -> ‘- - - -’-> ‘Errc’ -> ...)
opt	Option Trip-1	Latch	Displayed when a communication error is detected between the drive and the communication board. Occurs when the communication option card (ACG-ET2) is installed.

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.

Troubleshooting Fault Trips			
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.
		The set value for the overload trip level (Pr.21) is too low.	Increase the set value for the overload trip level.
ULT	***Under Load***	There is a motor-load connection problem.	Replace the motor and drive with models with lower capacity.
		The set value for underload level (Pr.29, Pr.30) is less than the system's minimum load.	Reduce the set value for the underload level.
OCT	***Over Current1***	Acc/Dec time is too short, compared to load inertia (GD2).	Increase Acc/Dec time.
		The drive load is greater than the rated capacity.	Replace the drive with a model that has increased capacity.
		The drive supplied an output while the motor was idling.	Operate the drive after the motor has stopped or use the speed search function (Cn.60).
		The mechanical brake of the motor is operating too fast.	Check the mechanical brake.
		A ground fault has occurred in the drive output wiring.	Check the output wiring.
		The motor insulation is damaged.	Replace the motor.
OVT	***Over Voltage***	Deceleration time is too short for the load inertia (GD2).	Increase the deceleration time.
		A generative load occurs at the drive output.	Use the braking unit.
		The input voltage is too high.	Determine if the input voltage is above the specified value.
		A ground fault has occurred in the drive output wiring.	Check the output wiring.
		The motor insulation is damaged.	Replace the motor.
LVT	***Low Voltage***	The input voltage is too low.	Determine if the input voltage is below the specificed value.
		A load greater than the power capacity is connected to the system (e.g., a welder, direct motor connection, etc.)	Increase the power capacity.
		The magnetic contactor connected to the power source has a faulty connection.	Replace the magnetic contactor.
LV2	***Low Voltage2***	The input voltage has decreased during the operation.	Determine if the input voltage is above the specified value.
		An input phase-loss has occurred.	Check the input wiring.
		The power supply magnetic contactor is faulty.	Replace the magnetic contractor.
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.

Troubleshooting Fault Trips			
Type	**Name**	**Cause**	**Remedy**
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 set value for electronic thermal protection is too low.	Set an appropriate electronic thermal level.
		The drive has been operated at low speed for an extended duration.	Replace the motor with a model that supplies extra power to the cooling fan.
POT	***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.
IPO	***Input Phase Open***	The magnetic contactor on the input side has a connection fault.	Check the magnetic contactor on the input side.
		The input wiring is faulty.	Check the input wiring.
		The DC link capacitor needs to be replaced.	Replace the DC link capacitor. Contact AutomationDirect Customer Support.
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 40°C.
OC2	***Over Current2***	Output wiring is short-circuited.	Check the output wiring.
		There is a fault with the electronic semiconductor (IGBT).	Do not operate the drive. Contact AutomationDirect Customer Support.
NTC	***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 is not connected.	Connect the fan connector.
		The fan connector needs to be replaced.	Replace the fan connector.

Troubleshooting Other Faults

When a fault other than those identified as fault trips or warnings occurs, refer to the following table for possible causes and remedies.

Troubleshooting Other Faults		
Type	**Cause**	**Remedy**
Parameters cannot be set.	The drive is in operation (run mode).	Stop the drive to change to program mode and set the parameter.
	The parameter access is incorrect.	Check the correct parameter access level and set the parameter.
	The password is incorrect.	Check the password, disable the parameter lock and set the parameter.
	Low voltage is detected.	Check the power input to resolve the low voltage and set the parameter.
The motor does not rotate.	The frequency command source is set incorrectly.	Check the frequency command source setting.
	The operation command source is set incorrectly.	Check the operation command source setting.
	Power is not supplied to the terminal R/S/T.	Check the terminal connections R/S/T and U/V/W.
	The charge lamp is turned off.	Turn on the drive.
	The operation command is off.	Turn on the operation command (RUN).
	The motor is locked.	Unlock the motor or lower the load level.
	The load is too high.	Operate the motor independently.
	An emergency stop signal is input.	Reset the emergency stop signal.
	The wiring for the control circuit terminal is incorrect.	Check the wiring for the control circuit terminal.
	The input option for the frequency command is incorrect.	Check the input option for the frequency command.
	The input voltage or current for the frequency command is incorrect.	Check the input voltage or current for the frequency command.
	The PNP/NPN mode is selected incorrectly.	Check the PNP/NPN mode setting.
	The frequency command value is too low.	Check the frequency command and input a value above the minimum frequency.
	The [STOP/RESET] key is pressed.	Check that the stoppage is normal, if so resume operation normally.
	Motor torque is too low.	Change the operation modes in dr.9 (V/F, IM 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 230V drives and less than 10Ω for 460V drives.
		Check the capacity of the earth leakage breaker and make the appropriate connection, based on the rated current of the drive.
		Lower the carrier frequency.
		Make the cable length between the drive and the motor as short as possible.
The motor vibrates severely and does not rotate normally.	Phase-to-phase voltage of 3-phase power source is not balanced.	Check the input voltage and balance the voltage.
		Check and test the motor’s insulation.
The motor makes humming, or loud noises.	Resonance occurs between the motor's natural frequency and the carrier frequency.	Slightly increase or decrease the carrier frequency.
	Resonance occurs between the motor's natural frequency and the drive’s output frequency.	Slightly increase or decrease the carrier frequency.
		Use the frequency jump function to avoid the frequency band where resonance occurs.
The motor vibrates/hunts.	The frequency input command is an external, analog command.	In situations of noise inflow on the analog input side that results in command interference, change the input filter time constant (In.7).
	The wiring length between the drive and the motor is too long.	Ensure that the total cable length between the drive and the motor is less than 200m (50m for motors rated 3hp or lower).
The motor does not come to a complete stop when the drive output stops.	It is difficult to decelerate sufficiently, because DC braking is not operating normally.	Adjust the DC braking parameter.
		Increase the set value for the DC braking current.
		Increase the set value for the DC braking stopping time.
The output frequency does not increase to the frequency reference.	The frequency reference is within the jump frequency range.	Set the frequency reference higher than the jump frequency range.
	The frequency reference is exceeding the upper limit of the frequency command.	Set the upper limit of the frequency command higher than the frequency reference.
	Because the load is too heavy, the stall prevention function is working.	Replace the drive with a model with increased capacity.
The cooling fan does not rotate.	The control parameter for the cooling fan is set incorrectly.	Check the control parameter setting for the cooling fan.
The motor stops in case of lightning	The product may be reset or a trip (OCT, OC2, OVT) may occur due to lightning.	Restart after checking the peripheral devices of the inverter.

Appendix

A

Appendix A: Accessories

Table of Contents

Fuses/Circuit Breakers

Protection devices are essential to prevent damage to your ACG drive and application equipment. Please use the fuse specification chart below to select fuses that are applicable to your ACG 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	Model*
ACG-20P5	200-240	0.5	10	ECSR10	15	UTE100H
ACG-21P0	200-240	1	10	ECSR10	15	
ACG-22P0	200-240	2	15	ECSR15	15	
ACG-23P0	200-240	3	20	ECSR20	20	
ACG-25P0	200-240	5	30	ECSR30	30	
ACG-27P5	200-240	7.5	50	ECSR50	50	UTS150H
ACG-2010	200-240	10	60	ECSR60	60	
ACG-2015	200-240	15	80	ECSR80	80	
ACG-2020	200-240	20	100	ECSR100	100	
ACG-40P5	380-480	0.5	10	ECSR10	3.2	UTS150L
ACG-41P0	380-480	1	10	ECSR10	6.3	
ACG-42P0	380-480	2	10	ECSR10	12	
ACG-43P0	380-480	3	15	ECSR15	12	
ACG-45P0	380-480	5	20	ECSR20	20	
ACG-47P5	380-480	7.5	30	ECSR30	32	
ACG-4010	380-480	10	35	ECSR35	32	
ACG-4015	380-480	15	50	ECSR50	50	
ACG-4020	380-480	20	60	ECSR60	60	
ACG-4025	380-480	25	70	ECSR70	70	
ACG-4030	380-480	30	100	ECSR100	90	

** Manufactured by LS Electric.*

Caution: Only use 600V Class H or RK5, UL listed input fuses and UL listed circuit breakers. See the table above for the current ratings for fuses and circuit breakers.

Maximum allowed prospective short-circuit current at the input power connection is defined in IEC 60439-1 as 100 kA. Depending on the selected MCCB, the ACG Series is suitable for use in circuits capable of delivering a maximum of 100 kA RMS symmetrical amperes at the drive's maximum rated voltage. The following table shows the recommended MCCB for RMS symmetrical amperes.

High Performance EMI Input Filters

The optional accessories listed in this chapter are available for use with the ACG 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 Chassis Type 1ph *1	Roxburgh High Performance Filters *2	Roxburgh Max Performance Filters *3
ACG-20P5	200-240	0.5	RES90F03	KMF306A	MIF310
ACG-21P0	200-240	1	RES90F10	KMF310A	MIF310
ACG-22P0	200-240	2	RES90F16	KMF318A	MIF316
ACG-23P0	200-240	3	RES90F16	KMF318A	MIF316
ACG-25P0	200-240	5	RES90S20	KMF325A	MIF323
ACG-27P5	200-240	7.5	–	KMF336A	MIF350
ACG-2010	200-240	10	–	KMF350A	MIF350
ACG-2015	200-240	15	–	KMF370A	MIF375
ACG-2020	200-240	20	–	KMF3100A	MIF3100
ACG-40P5	380-480	0.5	–	KMF306A	MIF310
ACG-41P0	380-480	1	–	KMF306A	MIF310
ACG-42P0	380-480	2	–	KMF306A	MIF310
ACG-43P0	380-480	3	–	KMF310A	MIF310
ACG-45P0	380-480	5	–	KMF318A	MIF316
ACG-47P5	380-480	7.5	–	KMF318A	MIF323
ACG-4010	380-480	10	–	KMF336A	MIF330B
ACG-4015	380-480	15	–	KMF336A	MIF350
ACG-4020	380-480	20	–	KMF350A	MIF350
ACG-4025	380-480	25	–	KMF350A	MIF350
ACG-4030	380-480	30	–	KMF370A	MIF375

**1 -EMI rating for motor cable length: C2 to 75Ft, C1 to 30ft*
**2 -EMI rating for motor cable length: C2 to 150Ft, C1 to 75ft*
**3 -EMI rating for motor cable length: C2 to 300Ft, C1 to 150ft*

EMI Filter Installation

Electrical equipment like the ACG 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 ACG family of drives and are recommended for the mitigation of interference and the highest performance When the ACG 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 ACG drive on the same subpanel or metal plate.*
2) *Install the EMI filter as close as possible to the ACG drive.*
3) *Keep wiring between the EMI filter and ACG drive as short as possible.*

4) *The subpanel or metal plate used to support the EMI filter and ACG drive should be well grounded (minimal resistance to ground is typically less then 1Ω).*
5) *To insure that the EMI filter and ACG drive are adequately grounded, insure that both are securely attached to the subpanel or plate.*

Choose suitable motor cable and precautions

Proper installation and the the choice of good motor cable will positively affect the performance of the filter. When selecting motor cable, please observe the following precautions.

1) *Cable shielding (double shielding is best).*
2) *Ground the shield on both ends of the motor cable. Maintain minimum length and employ strong mechanical connection to ground.*
3) *Remove paint on the metal saddle, subpanel or plate to insure good contact to ground.*

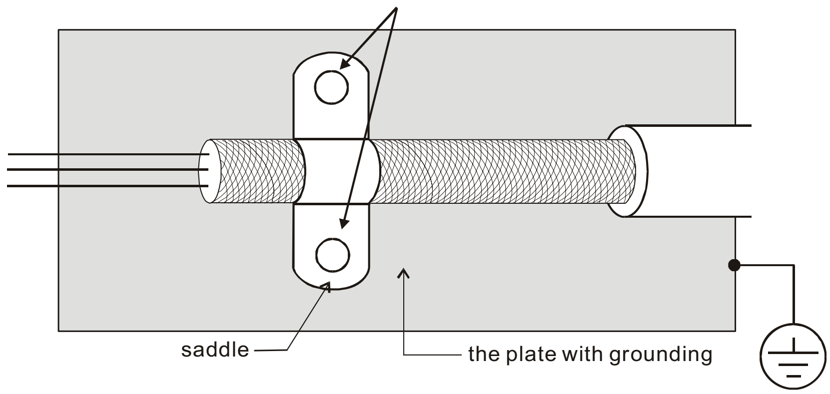


Figure 1

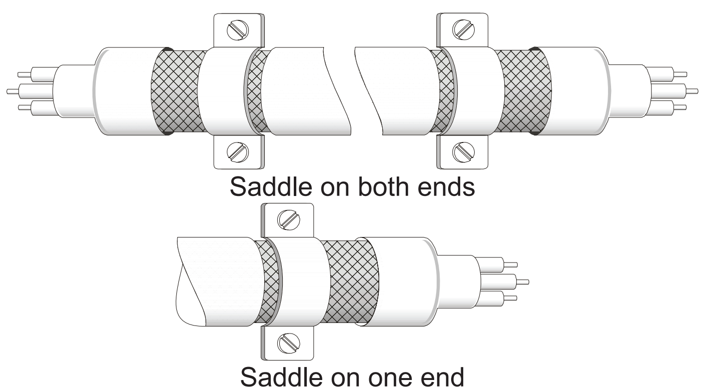


Figure 2

Reflective Wave Phenomenon

The drive section of a PWM drive like the ACG 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 ACG 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 ACG 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 ACG drive to each motor.*
4) *Should an overload relay malfunction occur, lower the ACG drive carrier frequency (Cn.4) or install an output reactor.*
5) *When operating an AC motor with a PWM drive like the ACG, the motor may experience reflective wave as described above. To prevent this situation, please observe the recommendations below:*
   a) Use a motor with enhanced insulation. (1000V, 1200V, 1600V, higher is better)
   b) Connect an output reactor (optional) on the drive output wiring.
   c) Keep motor cable length as short as possible. (65ft, 20m, or less)
   d) Where motor cable lengths will exceed 65ft (20m),

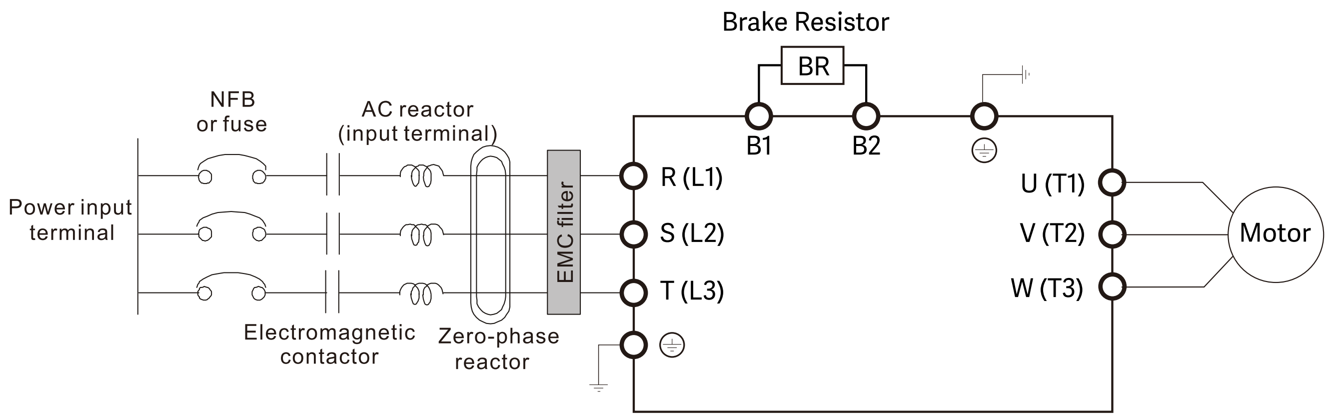
Line Reactors / Voltage Time Filters

Line Reactor

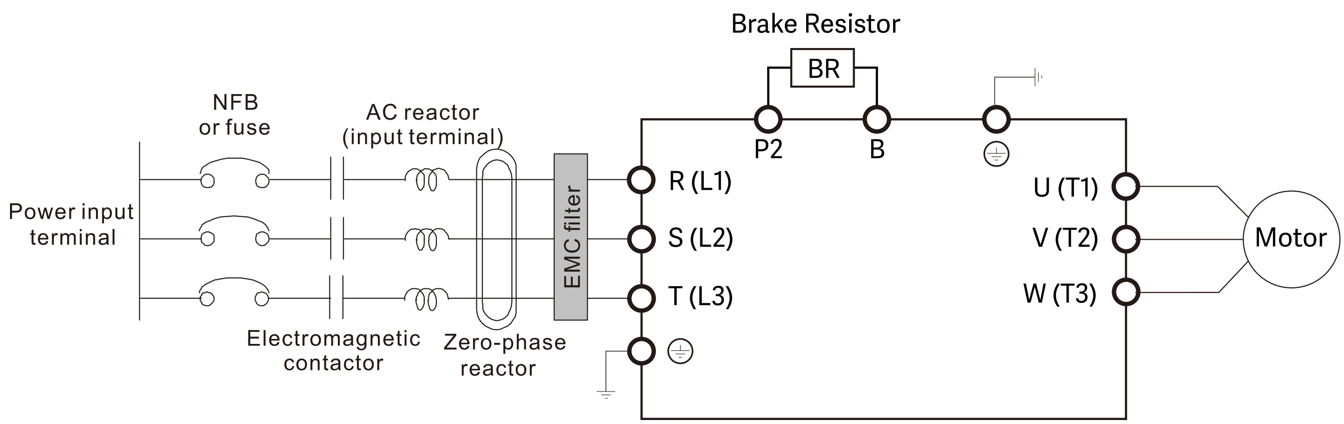
Installing an AC reactor on the input side of an AC motor drive can increase line impedance, improve the power factor, reduce input current, increase system capacity, and reduce interference generated from the motor drive. It also reduces momentary voltage surges or abnormal current spikes from the mains power, further protecting the drive. For example, when the main power capacity is higher than 500 kVA, or when using a phase-compensation capacitor, momentary voltage and current spikes may damage the AC motor drive's internal circuit. An AC reactor on the input side of the AC motor drive protects it by suppressing surges.

Install an AC input reactor in series between the main power and the three input phases R S T, as shown in the figures below:

0.5–10 hp Drives:



15–30 hp Drives:



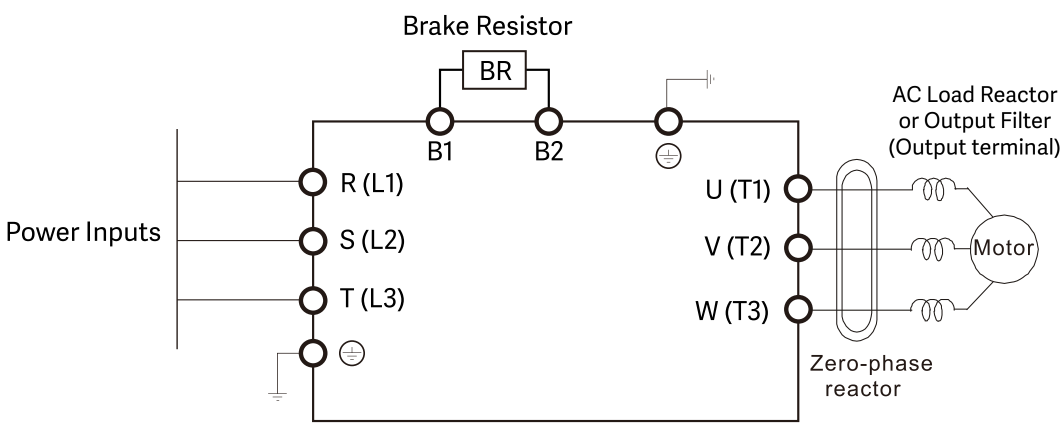
Load Reactor/Voltage Time Filter

When using drives in long wiring output application, ground fault (GFT), over-current (OC) and motor over-voltage (OV) often occur. GFT and OC cause errors due to the drive's self-protective mechanism; over-voltage damages motor insulation.

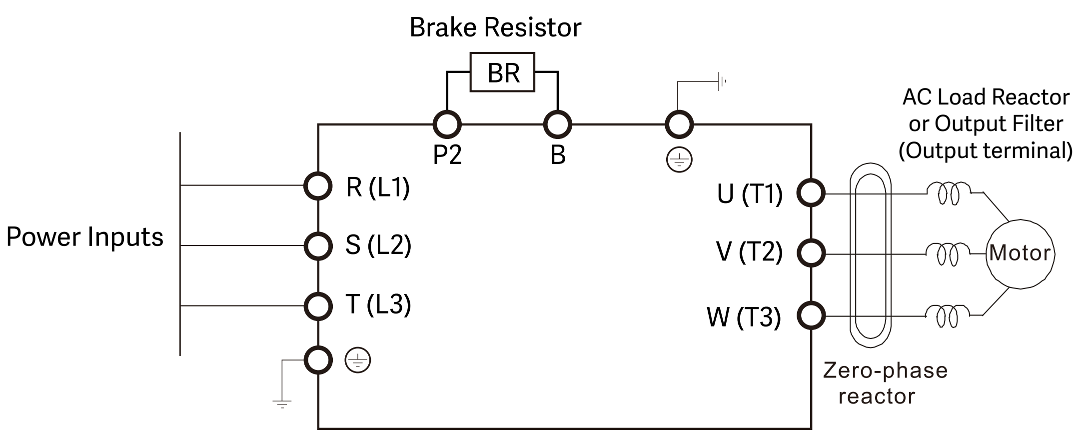
The excessive length of the output wires makes the grounded stray capacitance too large, increases the three-phase output common mode current, and the reflected wave of the long wires makes the motor dv / dt and the motor terminal voltage too high. Thus, installing a reactor on the drive's output side 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 figures below:

0.5–10 hp Drives:



15–30 hp Drives:

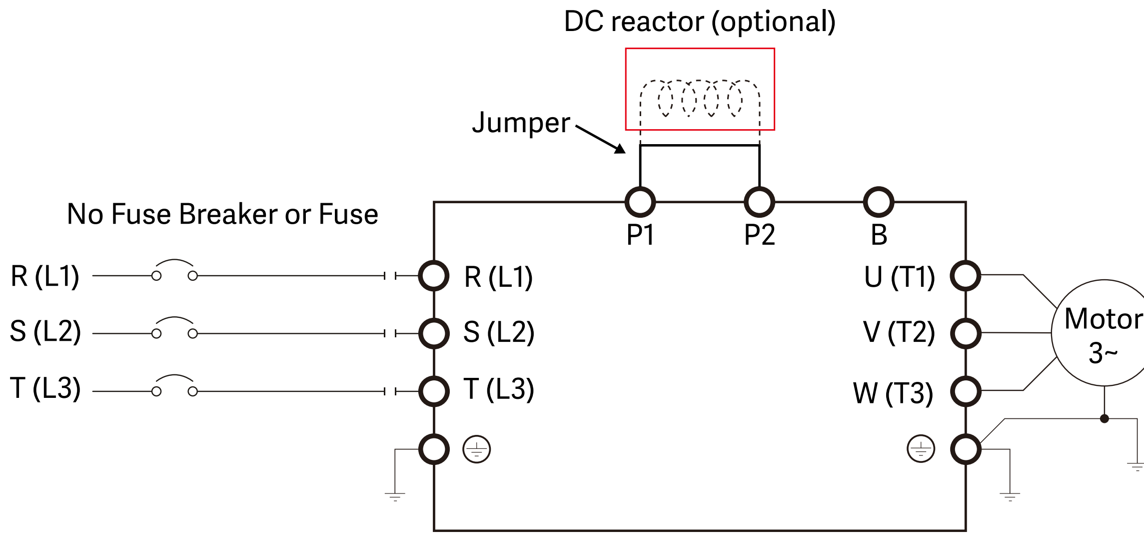


DC Reactor

A DC reactor can also increase line impedance, improve the power factor, reduce input current, increase system power, and reduce interference generated from the motor drive. A DC reactor stabilizes the DC bus voltage. Compared with an AC input reactor, a DC reactor is in smaller size, lower price, and lower voltage drop (lower power dissipation).

Install a DC reactor between terminals P1 and P2 Remove the jumper, as shown in the figure below, before installing a DC reactor.

Note: DC Reactor is only supported on 15–30 hp drives.



When the ACG drive is connected directly to a large-capacity power transformer (600kVA or above) or when a power correction capacitor is switched on, excessive peak currents may occur in the input power circuit resulting in damage to the ACG drive.

To avoid this, install a line reactor in series with the ACG drive on the input side. The installation of a line reactor will reduce input current peaks and improve the output power efficiency.

Line (load) reactors installed on the output side protect the motor insulation against AC drive short circuits and IGBT reflective wave damage, and also allow the motor to run cooler by “smoothing” the motor current waveform. They are recommended for operating any motors where the length of wiring between the AC drive and motor is less than or equal to 100 feet. For AC drive-to-motor wiring distances over 100 feet or or when enhanced protection from reflected waves is critical to the application, use of the VTF series output filter is recommended.

Line/Load Reactors and Output Filters Selection Charts

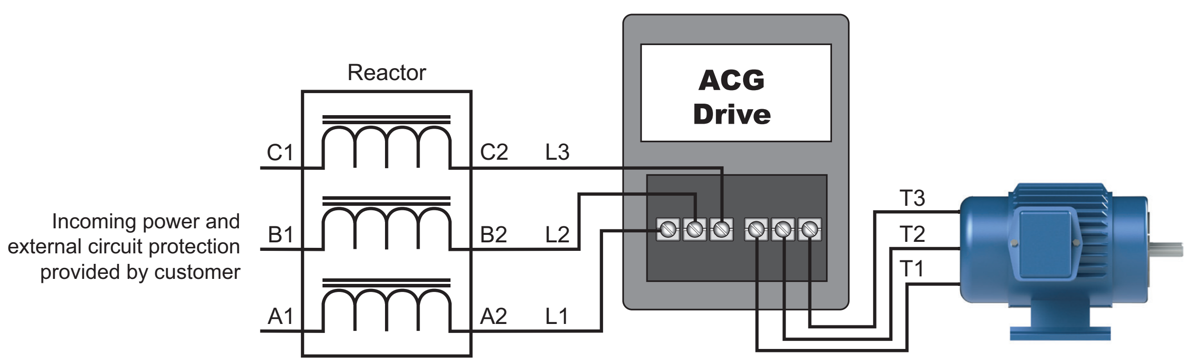
Drive	Voltage	HP	Input (Amps)	Output FLA 3ph (Amps)	AC Input Line Reactor		AC Output Load Reactor		AC dVdT Output Filter**		DC reactor values Induct./ Current
					3ph input	1ph input	3ph input	1ph input	3ph input	1ph input	
ACG-20P5	200-240	0.5	2.2	2.5	LR2-20P5	LR2-20P2	LR2-20P5	LR2-20P2	VTF-246-CFG	VTF-46-DE	*
ACG-21P0		1	4.9	5.0	LR2-21P0	LR2-21P0	LR2-21P0	LR2-20P5	VTF-24-FH	VTF-246-CFG	
ACG-22P0		2	8.4	8.0	LR-23P0	LR-25P0	LR2-22P0	LR2-22P0	VTF-246-GJJ	VTF-24-FH	
ACG-23P0		3	11.8	11.0	LR-23P0	LR-23P0	LR2-22P0	LR2-22P0	VTF-4-M	VTF-246-GJJ	
ACG-25P0		5	18.5	17.0	LR-25P0	LR-2010	LR-25P0	LR2-22P0	VTF-46-LM	VTF-246-HKL	
ACG-27P5		7.5	25.8	24.0	LR-2010	LR-2015	LR-27P5	LR-25P0	VTF-246-KMN	VTF-24-JL	
ACG-2010		10	34.9	32.0	LR-2015	LR-2020	LR-2010	LR-25P0	VTF-246-LPQ	VTF-46-LM	
ACG-2015		15	53.2	47	LR-2020	LR-2030	LR-2015	LR-2010	VTF-246-NRS	VTF-46-NP	0.95/61
ACG-2020		20	68.4	60	LR-2025	LR-2040	LR-2020	LR-2010	VTF-246-PSU	VTF-246-LPQ	0.70/75
ACG-40P5	380-480	0.5	1.1	1.3	LR2-40P5				VTF-46-DE		*
ACG-41P0		1	2.4	2.5	LR2-41P0				VTF-246-CFG		
ACG-42P0		2	4.2	4.0	LR2-42P0				VTF-246-DGH		
ACG-43P0		3	5.9	5.5	LR2-43P0				VTF-24-FH		
ACG-45P0		5	9.8	9.0	LR2-45P0				VTF-46-DE		
ACG-47P5		7.5	12.9	12.0	LR2-47P5				VTF-46-DE		
ACG-4010		10	17.5	16.0	LR-4010				VTF-24-JL		
ACG-4015		15	27.2	24	LR-4015				VTF-246-KMN		1.90/32
ACG-4020		20	35.3	31	LR-4020				VTF-246-LPQ		1.40/41
ACG-4025		25	44.5	39	LR-4025				VTF-246-MQR		1.00/49
ACG-4030		30	51.9	45	LR-4030				VTF-246-MQR		0.70/64

** Only drives from 15–30 hp support DC reactors.*
*** NEMA1 versions also available. Add "-N1" to the end of the part number for NEMA1.*

Line Reactor Applications and Wiring Connections

Input Side of AC Drive

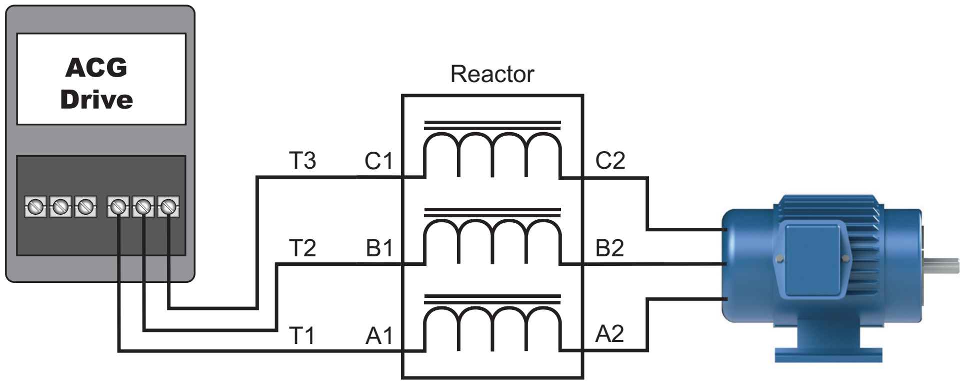
When installed on the input side of the ACG drive, a line reactor will reduce line notching, current peaks, voltage spikes and surges from the incoming line, as well as reduce the available short circuit current. A line reactor will also reduce harmonic distortion from the ACG drive onto the line. The line reactor is installed in front of the ACG drive as shown.



Please refer to "Chapter 2: Installation and Wiring" for detailed wiring information for the ACG drive.

Output Side of AC Drive

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

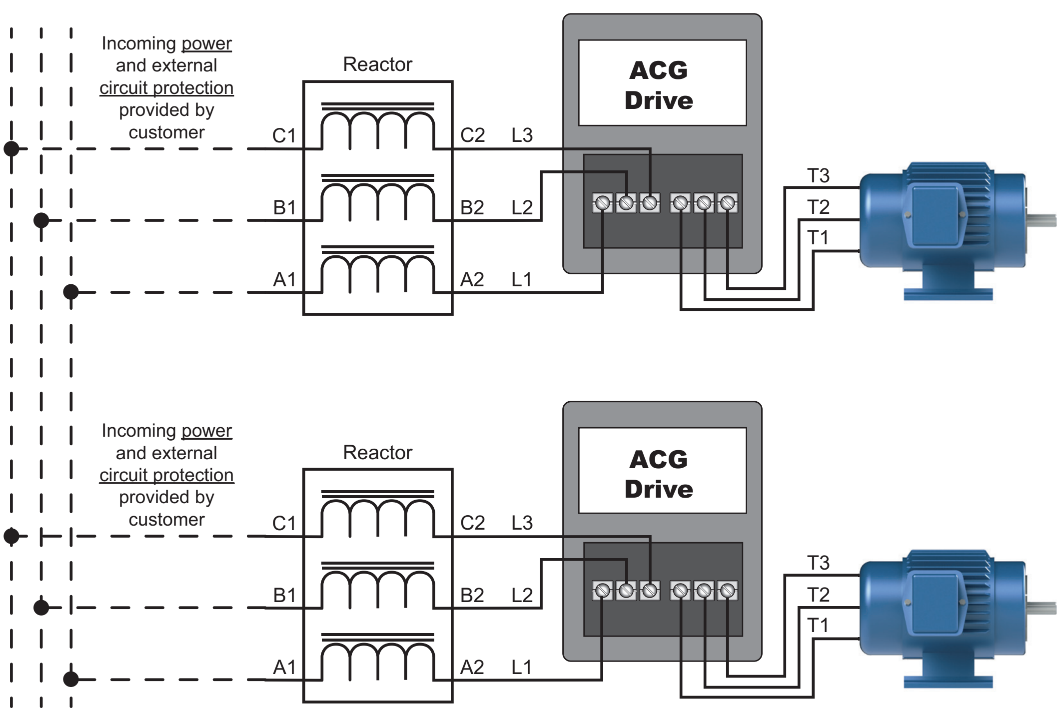


Please refer to "Chapter 2: Installation and Wiring" for detailed wiring information for the ACG drive.

Single phase line reactors should NOT be installed on the output side of an AC Drive. Use only three-phase reactors on drive outputs, and only for three-phase motors.

Multiple AC Drives

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

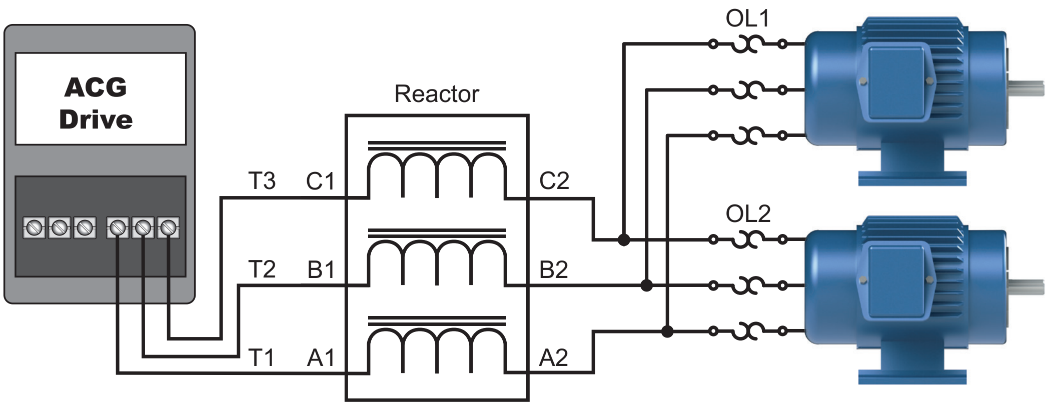


Please refer to "Chapter 2: Installation and Wiring" for detailed wiring information for the ACG drive.

Multiple Motors

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

Multiple motors only work with V/Hz mode.

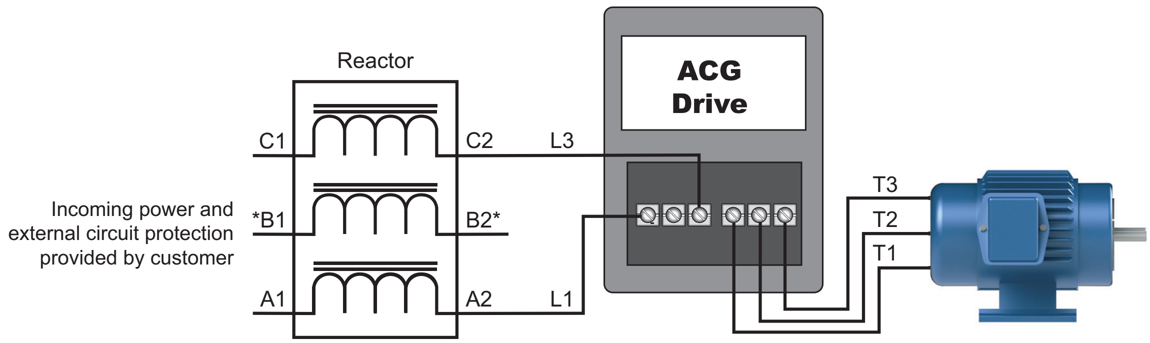


Please refer to "Chapter 2: Installation and Wiring" for detailed wiring information for the ACG drive.

A single reactor should be used with multiple motors ONLY when the motors will operate simultaneously from a single AC drive. OVERLOAD RELAYS are required for use in multiple motor applications.

Single-Phase Applications

Some three-phase line reactors are listed for use with single-phase input power. Follow the connection diagram shown below. Make sure that terminals B1 and B2, if present, are properly insulated before any connections are made. If a 3-phase reactor is used on the line side of a single-phase input drive application, ensure that the actual single-phase current does not exceed the Line Reactor's current rating (example: a 3-phase, 5hp line reactor and 3-phase 5hp drive will not handle enough current to power a 5hp motor on a single-phase supply - both the drive and the line reactor will have to be doubled). An input line reactor is strongly recommended for any single phase applications.



*LR series 1-phase reactors do not include a B-phase winding.

Please refer to "Chapter 2: Installation and Wiring" for detailed wiring information for the ACG drive.

Ensure that you properly insulate terminals B1 and B2 before making any connections to single-phase power.

Recommended Cable Length

Motor Leakage Current

If the cable length is too long, the stray capacitance between cables increases and may cause leakage current. This activates over-current protection, increases leakage current, or may affect the current display. In the worst case, it may damage the AC motor drive. If more than one motor is connected to one AC motor drive, the total wiring length should be the sum of the wiring length from AC motor drive to each motor.

For the 460V series AC motor drive, when you install an overload thermal relay between the drive and the motor to protect the motor from overheating, the connecting cable must be shorter than 50m. However, an overload thermal relay malfunction may still occur. To prevent the malfunction, install an output reactor (optional) to the drive or lower the carrier frequency setting.

Motor Surge Voltage

When a motor is driven by a PWM-type AC drive, the motor terminals experience surge voltages (dv/dt) due to power transistor conversion of the drive. For very long motor cable (especially for the 460V series), surge voltages (dv/dt) may damage the motor insulation and bearing. To prevent this, follow these rules:

A) Use a motor with enhanced insulation.

B) Reduce the cable length between the AC drive and motor to suggested values.

C) Connect an output reactor (optional) to the output terminals of the AC drive.

For drive models < 480V, use a motor with a rated voltage ≤ 500 VAC and an insulation level ≥ 1.35 kVp-p in accordance with IEC 60034-17. For the 575V drive model, use a motor with a rated voltage ≤ 600 VAC and an insulation level ≥ 1.79 kVp-p in accordance with IEC 60034-25.

Dynamic Braking

Dynamic braking resistors dissipate the regeneration energy of AC motors when they are being controlled to a stop faster than a coasting stop. Compatible brake resistors can be viewed by clicking the link in the table below. All drives have the braking function built-in and do not require a separate dynamic braking unit. See "Terminals for Connecting DC Reactor, External Brake Resistor, and DC Circuit" on page 2–18 for brake wiring diagrams.

To avoid possible injury, please refer Chapter 2 of this manual for correct wiring of the braking resistors.

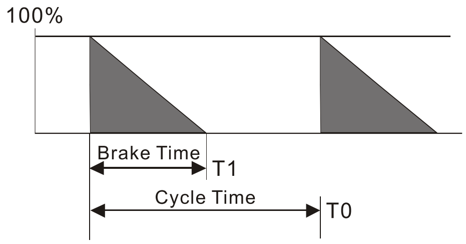
Braking Units

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)	
230V	ACG-20P5	0.5	250.0	1.6	0.6	Click here
	ACG-21P0	1	150.0	2.6	1.0	
	ACG-22P0	2	50.0	7.8	3.0	
	ACG-23P0	3	43.0	9.1	3.5	
	ACG-25P0	5	25.0	15.6	6.1	
	ACG-27P5	7.5	18.0	21.7	8.5	
	ACG-2010	10	14.0	27.9	10.9	
	ACG-2015	15	8.6	45.3	17.7	
	ACG-2020	20	8.0	48.8	19.0	
460V	ACG-40P5	0.5	400.0	2.0	1.5	
	ACG-41P0	1	400.0	2.0	1.5	
	ACG-42P0	2	250.0	3.1	2.4	
	ACG-43P0	3	180.0	4.3	3.4	
	ACG-45P0	5	85.0	9.2	7.2	
	ACG-47P5	7.5	75.0	10.4	8.1	
	ACG-4010	10	49.0	15.9	12.4	
	ACG-4015	15	40.0	19.5	15.2	
	ACG-4020	20	22.0	35.5	27.7	
	ACG-4025	25	20.0	39.0	30.4	
	ACG-4030	30	20.0	39.0	30.4	

Please refer to the Dynamic Braking User Manual for more detailed information on braking resistors by clicking here.

Choosing and Installing a Braking Resistor

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



ED% = T1 / T0 x 100(%)

Explanation:
Brake usage ED (%) is the amount of time needed for the brake unit and brake resistor to dissipate heat generated by braking. When the brake resistor heats up, the resistance increases with temperature, and braking torque decreases accordingly.

For safety, install a thermal overload relay (O.L) between the brake unit and the brake resistor in conjunction with the magnetic contactor (MC) before the drive for additional protection. The thermal overload relay protects the brake resistor from damage due to frequent or continuous braking. Under such circumstances, turn off the power to prevent damage to the brake resistor and drive.

Note: Never use the thermal overload relay to disconnect the brake resistor.

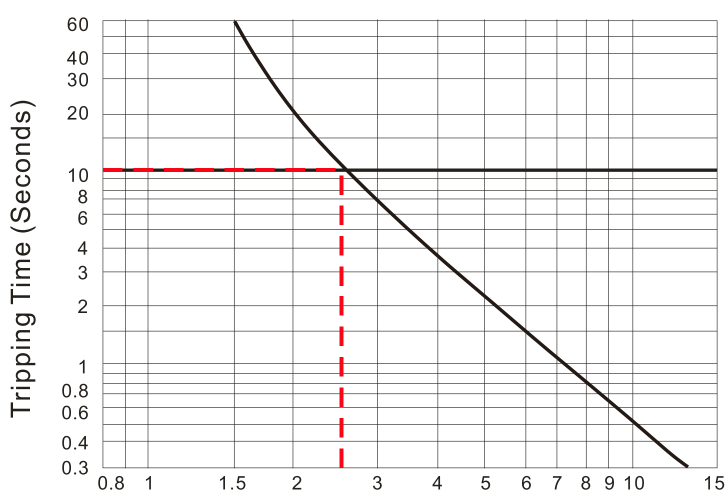
2) Any damage to the drive or other equipment caused by using brake resistors and brake modules that are not provided by AutomationDirect voids the warranty.

3) Consider environmental safety factors when installing the brake resistors. If you use the minimum resistance value, consult AutomationDirect for the power calculation.

4) Refer to the ADC Dynamic Braking unit User Manual for more detail on braking resistors (https://cdn.automationdirect.com/static/manuals/gs3dbm/gs-db_ump.pdf)

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

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



ACG-KPD

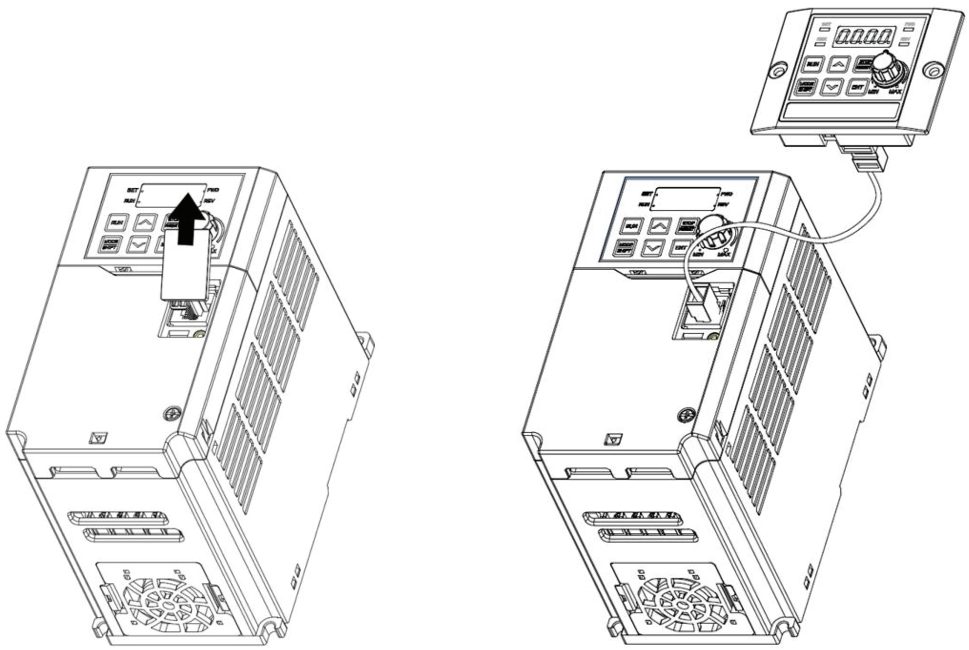
The Remote LED keypad provides access to the ACG series drive from outside of the panel while maintaining the same functionality as the built-in keypad.

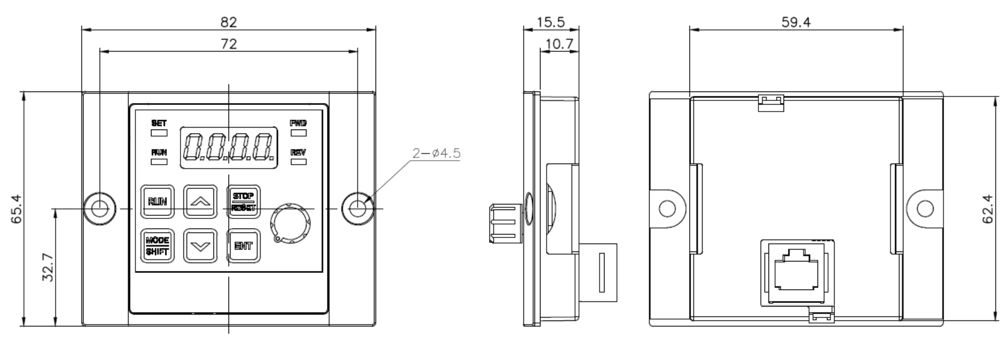
About the Keypad

A keypad is used to set drive parameters, monitor the drive's status, and operate the drive. The ACG-KPD accessory consists of a remote keypad and 5m 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 parameter dr.91.





Installation

1) *Remove the RJ45 terminal cover on the drive I/O cover. Connect the remote keypad cable to the I/O RJ45 connector.*
2) *Connect the other end of the connector of the remote keypad cable to the remote keypad.*

Operation

1) *Once connected to the remote keypad, the drive keypad and the potentiometer dial are ignored. The input is replaced by the keypad and potentiometer dial input from the remote keypad.*
   - *Within 2 seconds of detaching the remote keypad, the input for the keypad and potentiometer dial is reset to the drive keypad. (If the frequency setting is set to potentiometer dial input, the command frequency will instantly switch between the drive keypad potentiometer dial and the remote keypad potentiometer dial when attaching and detaching. Use caution to ensure that the motor does not switch to the wrong frequency.)*
   - *If communication is not linked between the drive and the remote keypad, "E.vEr" is displayed on the 7-Seg of the remote keypad.*

2) *Set the dr.91 parameter to 4 in a state of connecting the remote keypad to copy the parameter settings saved in the drive to the remote keypad.*
   - *"r-UL" is displayed on the drive I/O 7-Seg keypad while upload is in progress. "d" is displayed on the 7-Seg keypad of the remote keypad. After saving, the message disappears and the default screen is displayed.*
   - *If there is an error, such as poor communication while the upload is in progress, a warning message saying "Fail" is displayed for 3 seconds, and the action of saving the parameters into the remote keypad fails.*

3) *After connecting the remote keypad where the parameter settings are copied to the drive product of same model, set the dr 91 parameter to 5, and copy the parameter settings saved in the remote keypad to the drive.*
   - *While saving, a message saying "W-dL" is displayed on the drive I/O 7-Seg. "U" is displayed on the 7-Seg of the remote keypad. After saving, the message disappears and the default screen is displayed. If parameter data is not saved in the remote keypad, you cannot set the dr 91 parameter to 5.*
   - *If there is an error such, as poor communication with the remote keypad, a warning message saying "Fail" is displayed for 3 seconds, and the action of saving the parameters into the drive fails.*
   - *If the parameter code version or the drive model is different (copying parameters between 230V and 460V products), the WErr warning is displayed for 5 seconds, and the action of saving parameters into the drive fails.*

Caution: Only copy parameters between drives of the same model number.

Parameter Lock

Use parameter view lock to hide parameters after registering and entering a user password.

Group	Pr. Code	Name	Parameter Setting	Setting Range	Unit
dr	dr.94	Password registration	–	0–9999	–
	dr.95	Parameter lock settings	–	0–9999	–

Parameter Lock Setting Details

<table>
<tr><th>Code and Features</th><th>Description</th></tr>
<tr><td>dr.94</td><td>Register a password to prohibit parameter modifications. Follow the procedures below to register a password.
<table>
<tr><th>Step</th><th>Procedures</th></tr>
<tr><td>1</td><td>Press the [ENT] key on dr.94 code and the saved password input window will be displayed. If password registration is being made for the first time, enter 0. It is the factory default.</td></tr>
<tr><td>2</td><td>If a saved password has been set, enter the saved password.</td></tr>
<tr><td>3</td><td>If the entered password matches the saved password, then a new window to enter a new password will be displayed. (The process will not move to next stage until the user enters a valid password).</td></tr>
<tr><td>4</td><td>Register a new password.</td></tr>
<tr><td>5</td><td>After registration, Code dr.94 will be displayed.</td></tr>
</table></td></tr>
<tr><td>dr.95</td><td>Press the [ENT] key when the change prevention feature is disabled, and UL (Unlocked) is displayed. Press the [ENT] key again a field to input password is shown. Enter the password and the Locked display is shown. Even if you press [ENT] key from the function code to change the changing the parameter, this will not be changed to edit mode. Enter password again to display UL (Unlocked). The change prevention feature is disabled.</td></tr>
</table>

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

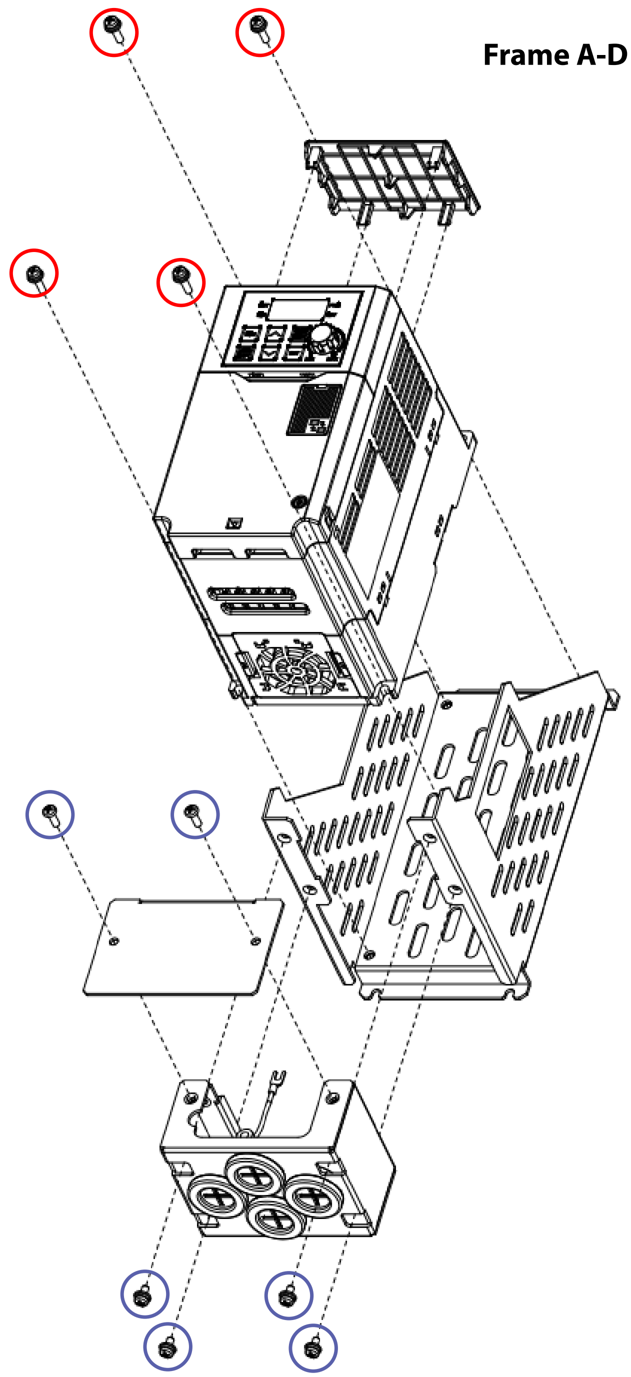
ACG Conduit Boxes

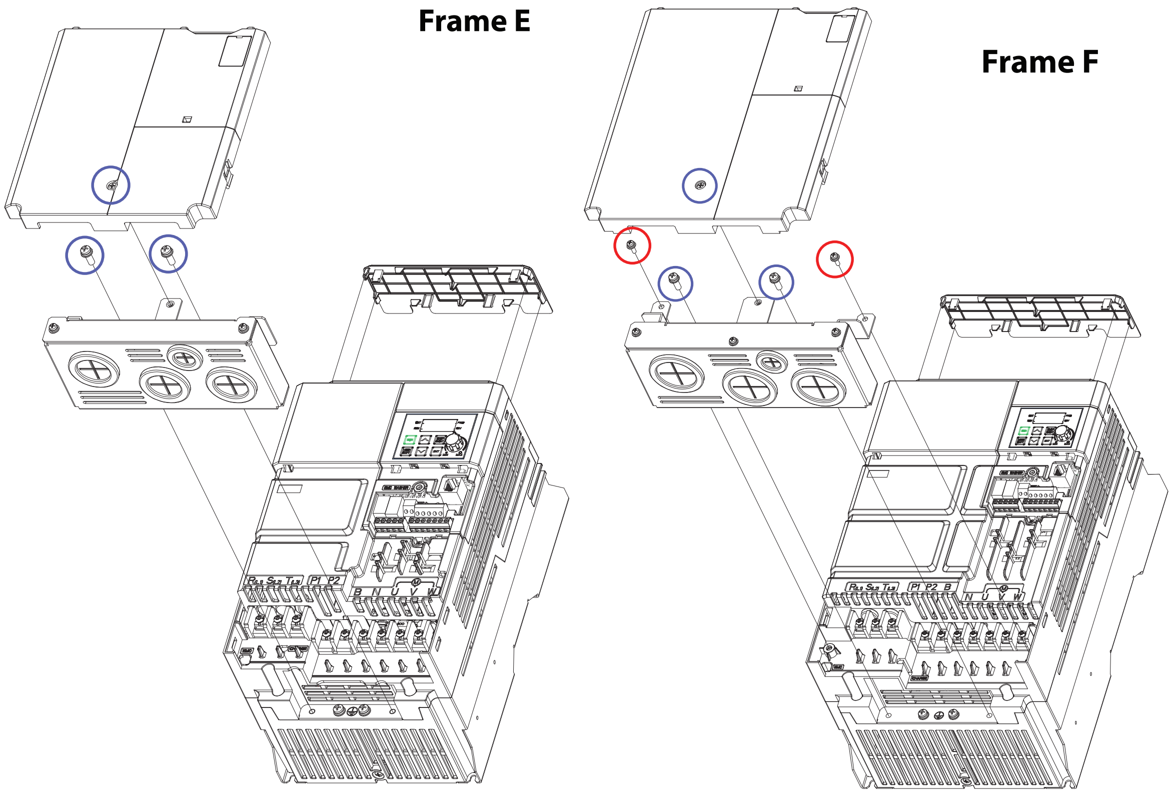
NEMA 1/UL Type 1 compliant conduit boxes are available for all frame sizes (A–F). The following steps illustrate how to install a conduit box on the IronHorse ACG series drive.

WARNING; Ensure all power is removed from the drive before installing or removing the conduit. Failure to comply will damage the drive.

1) *Install the ACG drive into the conduit as shown in the diagrams below.*

Frame A-D

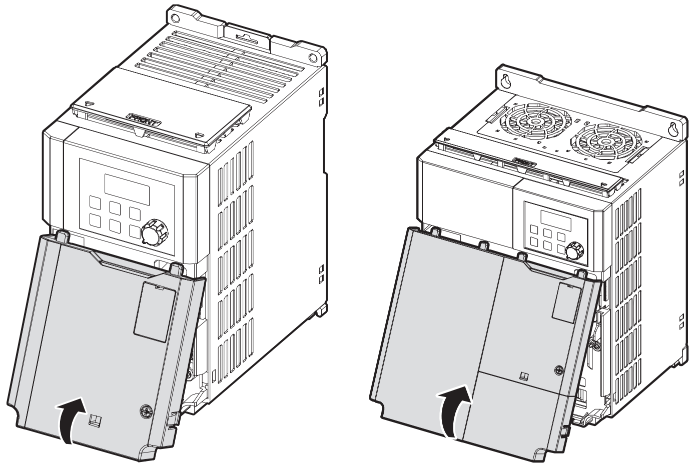




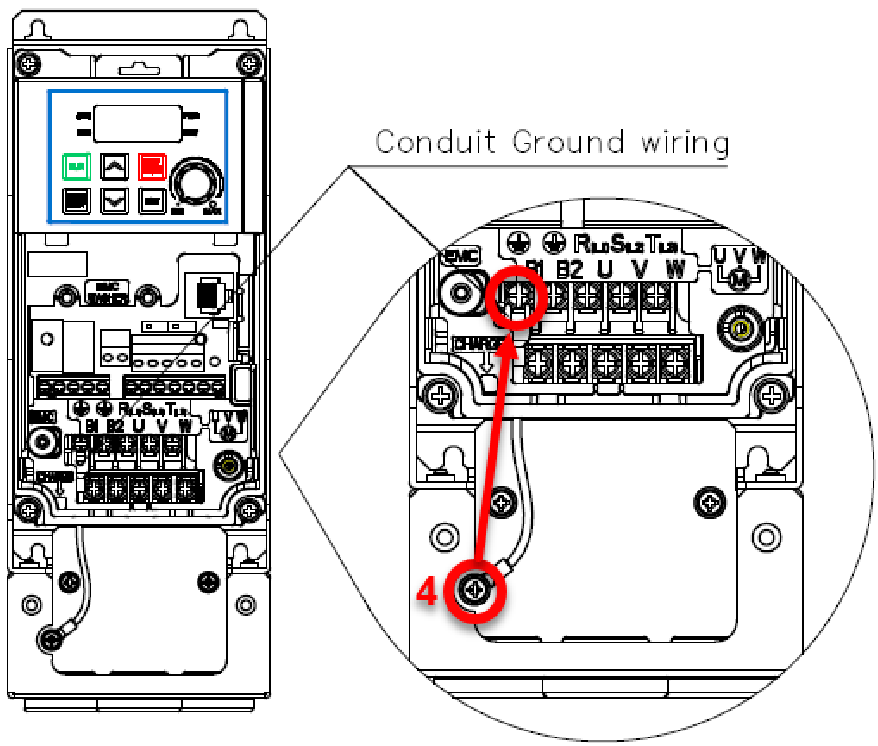
2) *Fasten all of the screws circled in the diagram for your frame size.*

Frame Size	Diagram Screw Color	Number	Screw Size	Torque Value
A	Red	4	M4	10 kgf·cm
	Blue	6	M4	18 kgf·cm
B	Red	4	M4	10 kgf·cm
	Blue	6	M4	18 kgf·cm
C	Red	4	M4	10 kgf·cm
	Blue	6	M4	18 kgf·cm
D	Red	4	M4	10 kgf·cm
	Blue	6	M4	18 kgf·cm
E	Blue	2	M5	35 kgf·cm
F	Red	2	M4	13 kgf·cm
	Blue	2	M5	35 kgf·cm

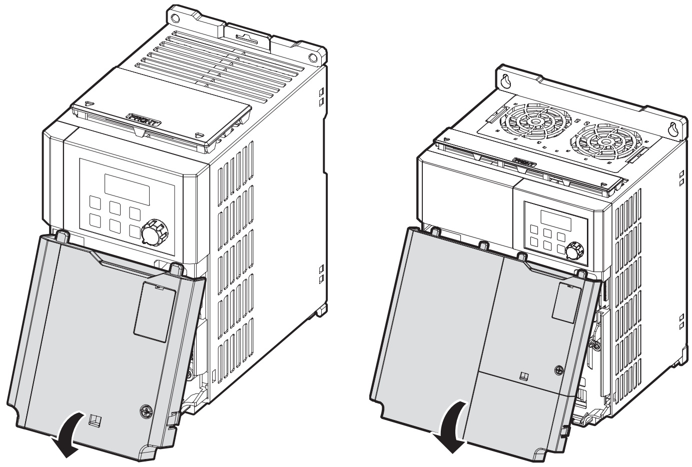
3) *Remove the I/O cover plate from the ACG drive.*



4) *Connect the conduit ground wire to the ACG drive ground terminal as shown below.*



5) *Replace the the I/O cover plate on the ACG drive and re-fasten.*



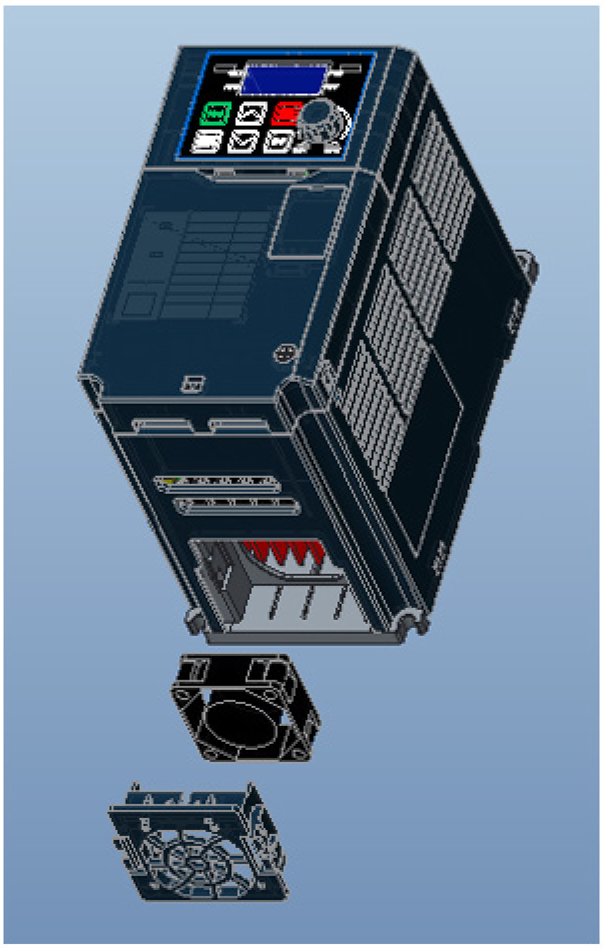
Replacement Cooling Fans

Replacement cooling fans are available for all ACG series drives. Replace the fan if your drive is experiencing overheating issues. We also recommend replacing cooling fans on a 3 year interval.

Replacement Fan	Drive Compatibility
ACG-FAN-A	ACG series 1/2 to 1 hp AC drives.
ACG-FAN-BC	ACG series 2 to 5 hp AC drives.
ACG-FAN-D	ACG series 7.5 to 10 hp AC drives.
ACG-FAN-E15	ACG series 15 hp AC drives.
ACG-FAN-E20F	ACG series 20 to 30 hp AC drives.

To replace the cooling fan in your ACG series drive, follow the steps below:

1) Remove the fan cover by pressing the hook located by the arrow.



2) Disconnect the fan wire and remove the fan from the drive.
3) Attach the fan wire to the new fan and insert the fan into the drive.
4) Replace the fan cover.

VFD Suite

VFD Suite is the configuration software for the Automation Direct Ironhorse AC family of variable frequency drives, featuring the ACG IP20 series and the ACN Nema4X series. It is designed to allow connection of a personal computer to the drives and perform a variety of functions:

- *Create new drive configurations*
- *Upload/Download drive configurations*
- *Edit/Compare drive configurations*
- *Utilize Parameter Wizard for easy configuration*
- *Archive/Store multiple drive configurations on your PC*
- *Trend drive operation parameters*
- *Tune the drive PID loop*
- *View real time key operating parameters*
- *Start/Stop drive and switch directions, provided drive is set up for remote operation*
- *View drive faults*

VFD Suite includes a PDF help file for explanation of the software and features. VFD Suite can be downloaded for free from Automationdirect.com.

System Requirements

Category	Requirement
Windows	Windows 8/10/11
Processor	1 GHz or higher
RAM	1 GB (32-bit) or 2 GB (64-bit)
HDD	16 GB (32-bit) or 20 GB (64-bit)
Graphics	Graphic card supporting MS DirectX 9

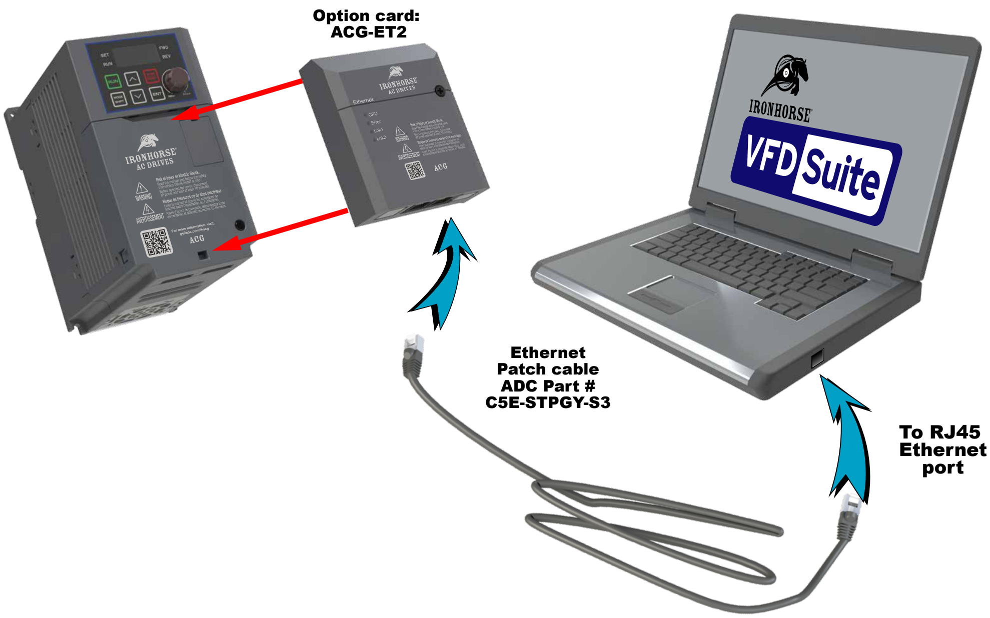
ACG Connection to VFD Suite

Set the network to connect with the drive.

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

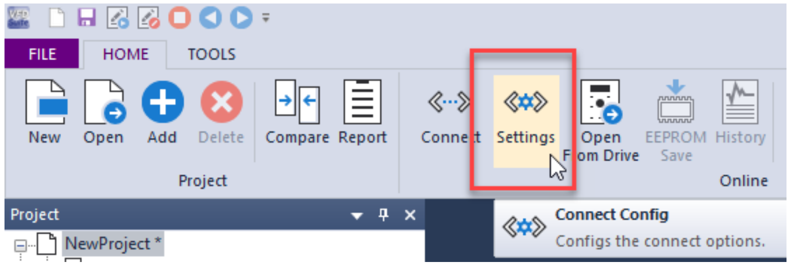
1) Serial communication (Modbus-RTU) via S+ and S- port integrated in the drive and USB-485M adapter.

2) Ethernet communication (Modbus TCP) via the optional ACG-ET2 card

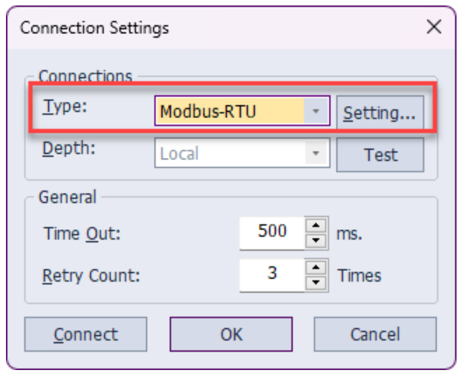


VFD Suite Serial Connection Setup

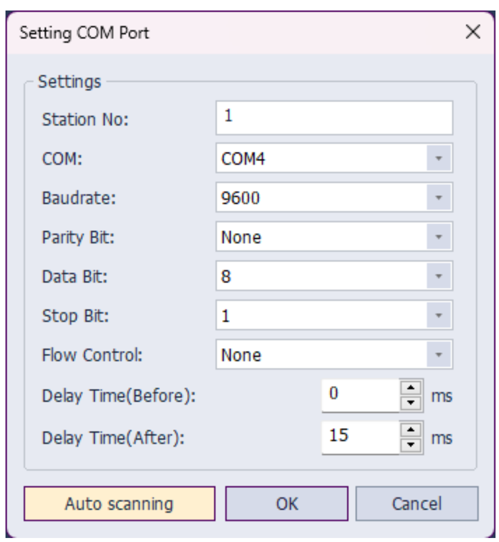
1) Select the menu HOME→Settings.



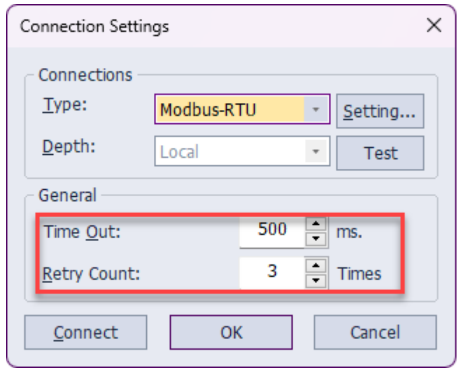
2) Choose Modbus-RTU for the communication type and press the Setting… button.



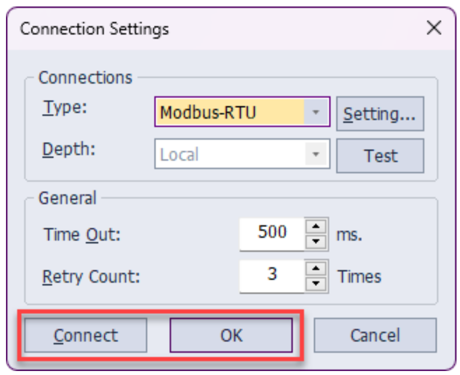
3) Enter in the COM Port settings. Pressing the Auto Scanning button will let VFD Suite try to automatically configure these settings. Press OK when done.



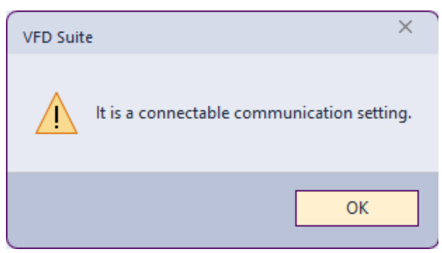
4) Enter the Time out value in milliseconds for setting the communication timeout value. Enter a value in to Retry Count to configure the number of communication attempts to try after communication failure.



5) Press Connect to attempt a connection to the drive over Modbus-RTU. Or Press OK to save connection setting without connecting to the drive.



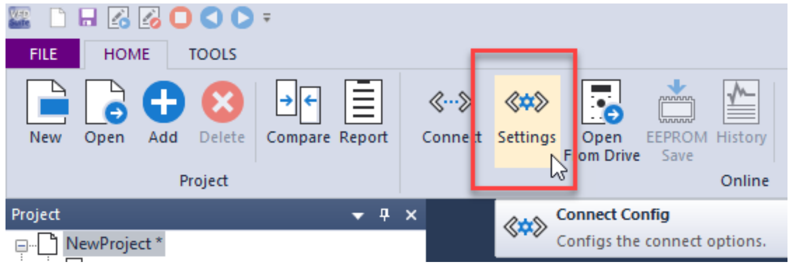
6) VFD Suite will display the below message when successfully connecting to the drive.



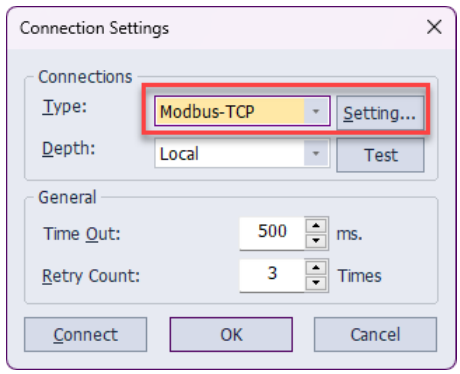
VFD Suite EtherNet Connection Setup

ACG-ET2 has a default IP Address of 192.168.1.101 and a default Subnet mask of 255.255.255.0.

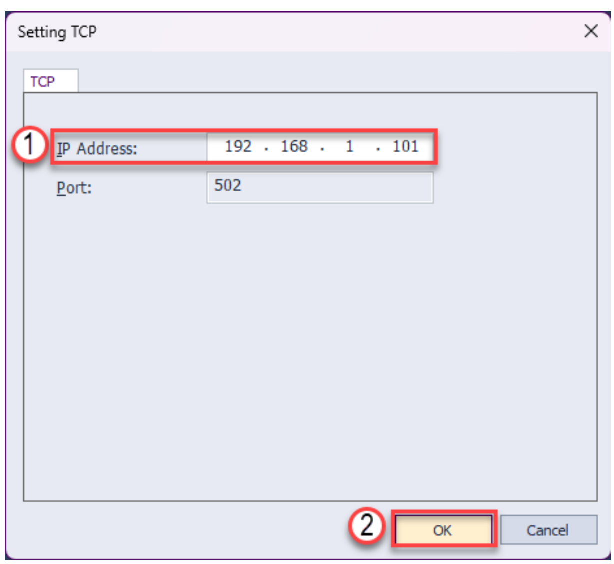
1) Select the menu HOME→Settings.



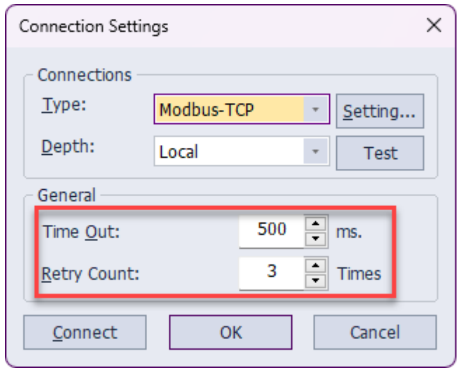
2) Choose Modbus-TCP for the communication type and press the Setting… button.



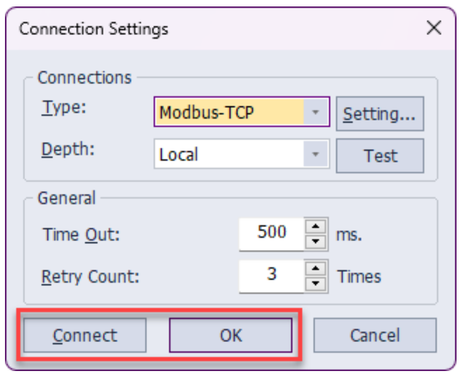
3) Enter in the IP address of the drive and press the OK button.



4) Enter the Time out value in milliseconds for setting the communication timeout value. Enter a value in to Retry Count to configure the number of communication attempts to try after communication failure.



5) Press Connect to attempt a connection to the drive over Modbus TCP. Or Press OK to save connection setting without connecting to the drive.



6) VFD Suite will display a connection status at the bottom of the screen when successful.

NOTE: FOR AN ETHERNET CONNECTION, THE PC MUST HAVE AN ETHERNET PORT CONFIGURED WITH AN IP ADDRESS AND SUBNET MASK IN THE SAME NETWORK RANGE AS THE DRIVE. PING CAN BE USED TO TEST THE CONNECTION BETWEEN THE PC AND THE DRIVE.

Appendix B: Ethernet Module ACG-ET2

Appendix B

Table of Contents

Overview

The ACG-ET2 communication board allows the ACG drive to connect to an Ethernet network that is compliant with international standards, Type 21 of IEC 61158 and RRP of IEC 62439. The ACG-ET2 communication board supports two protocols: EtherNet/IP and Modbus TCP.

By utilizing the 100 Mbps auto negotiation feature, the ACG-ET2 communication board provides real-time network communication without collisions and allows for controlling and monitoring of the drive via PLC sequence programs.

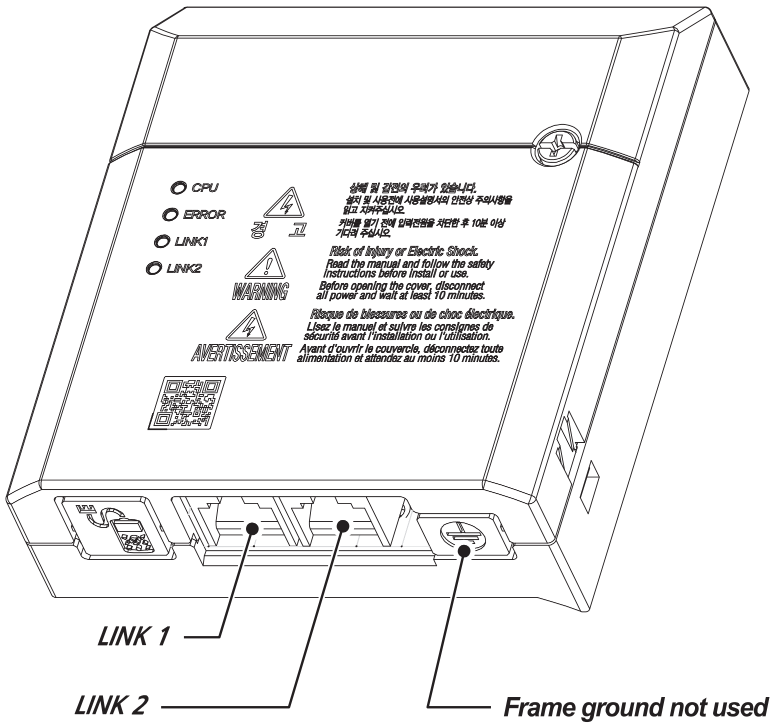
With simple network cable wiring, installation times can be reduced and maintenance becomes easier.

ACG-ET2 Technical Specifications

Items	Description	
Communication Protocol	EtherNet/IP, Modbus TCP	
Communication speed	100Mbps	
Communication type	Auto negotiation	
Communication range	100 m (twisted pair)	
Service	Smart scaling	Up to 8 words
Max. number of stations	64 stations	
Topology	Line/Ring topology	
Communication range	100 m (twisted pair)	
Recommended cable	UTP, FTP, STP	

ACG-ET2 Communication Board Layout and Installation

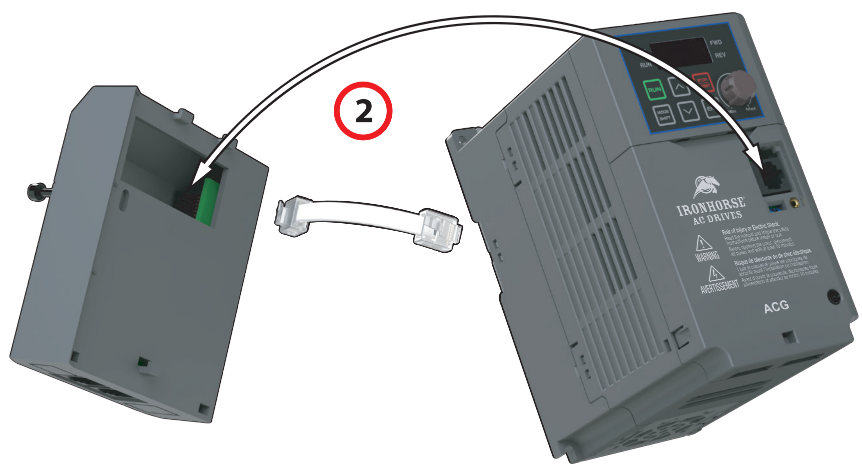
External Layout



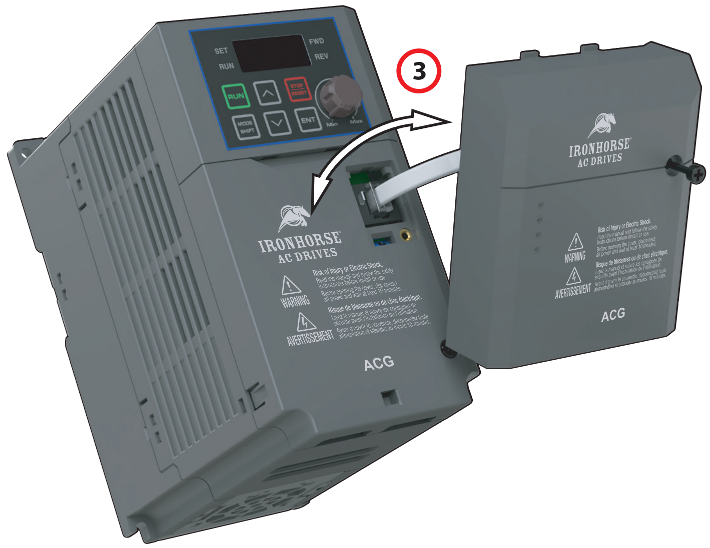
Installing the ACG-ET2 Communication Board

1) Remove the small cover from the front of the ACG drive.

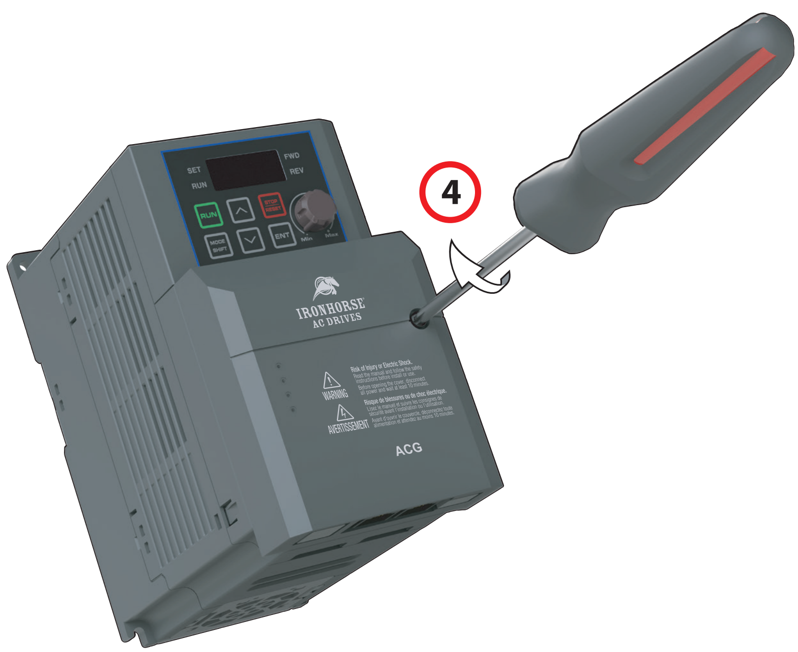
2) Connect the included cable to the ACG-ET2 and the ACG AC drive.



3) Attach the ACG-ET2 communication card to the front of the ACG drive. Ensure the connector cable fits inside the open space on the inside of the communication card. The card should snap loosely into place.



4) Tighten the screw on the front of the communication card to secure the ACG-ET2 to the ACG drive.



WARNING:

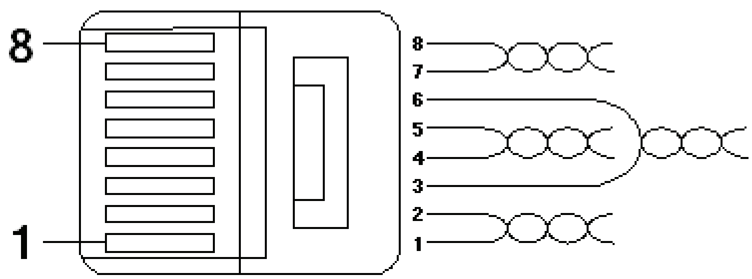
- *DO NOT INSTALL OR REMOVE THE ACG-ET2 COMMUNICATION BOARD TO OR FROM THE ACG DRIVE WHILE THE DRIVE IS TURNED ON.*
- *ENSURE THAT THE ELECTRIC CHARGE IN THE CAPACITORS INSIDE THE DRIVE IS COMPLETELY DISCHARGED BEFORE INSTALLING OR UNINSTALLING THE ACG-ET2 COMMUNICATION BOARD.*
- *ENSURE THAT THE RJ-45 CABLE IS FIRMLY FIXED TO THE DRIVE AND THE OPTION BOARD.*
- *FRAME GROUND (FG) SHOULD NOT BE USED ON THE ACG-ET2 COMMUNICATION OPTION BOARDS.*

Network Connection

Network connection cable wiring

Pin No.	Signal	Description	Cable Color
1	TX+	Data transmission (+)	White/Yellow
2	TX-	Data transmission (-)	Yellow
3	RX+	Data reception (+)	White/Green
4	NONE	Not used	Blue
5	NONE	Not used	White/Blue
6	RX-	Data reception (-)	Green
7	NONE	Not used	White/Brown
8	NONE	Not used	Brown

Communication Cable Connector



NOTE:
*** The cables connected to pin 1 and pin 2 must be twisted in a pair.*
*** The cables connected to pin 3 and pin 6 must be twisted in a pair.*

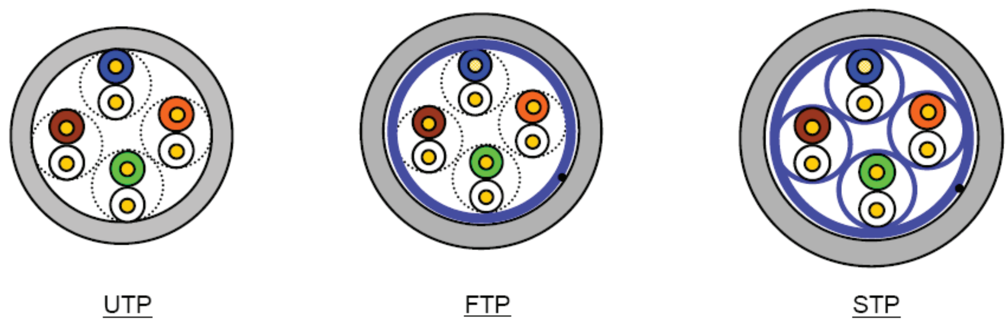
Network cable specifications

Frequency band

There are five types of UTP cable specifications according to different applications, from category 1 through category 5. Category 5 network cables are required for utilizing the ACG-ET2 communication board.

Category 5 network cables support a frequency band up to 100 MHz, with up to 60 MHz channel performance and up to 100 Mbps data transmission speed.

Twisted pair cable types



Category.	Description	Specifications/Usage
UTP (U.UTP)	Unshielded Twisted Pair cable for high speed signals.	200 MHz max. Voice + Data + Low quality video signals.
FTP (S.UTP)	Single insulation for the cable core. Insulation material: AL / Plastic complex foil or copper braid.	100 MHz max. Protection against EMI, electrically stable. Voice + Data + Low quality video signals.
STP (S.STP)	Dual insulation for the pair and the cable core. Material for cable pair insulation: AL/Plastic complex foil. Material for cable core insulation: AL / Plastic complex foil or copper braid.	500MHz max. Voice + Data + Video signals Replaces 75Ω coaxial cable

Network CM Parameter Setting Details

IP Address, Subnet Mask, Gateway (CM.10–CM.21) Setting

Ethernet communication cards must have their own unique IP address. The IP addresses (and subnet masks) of the communication card need to be compatible with any other devices that connect to the drive. For an easy subnet mask calculator, please visit www.subnet-calculator. com.

The IPv4 is supported by the Ethernet module. All the addresses and masks are expressed with (decimal).(decimal).(decimal).(decimal) and each decimal number is within 0–255. In the Ethernet communication module, decimal numbers can be entered in Opt Parameter directly. Each Opt Parameter has a value of 0 through 255, which is implemented with each field of addresses divided with '.'.

Example:

To set up IP Address 196.168.10.131, enter the Opt Parameter as shown in the table below.

Pr. Code	Parameter Name	Opt Parameter
CM.10	Opt Parameter 1	196
CM.11	Opt Parameter 2	168
CM.12	Opt Parameter 3	10
CM.13	Opt Parameter 4	131

NOTE: After making changes to parameter CM.7 and parameters CM.10-CM.25, you must set CM.94 (Comm-Update) to "1 (Yes)" to save the changes. (If CM.94 [Comm-Update] has not been set after making the parameter changes, the LED indicator will flash in red at 2-second intervals to warn the user.)

Comm Update (CM.94)

When Communication settings parameters are changed, the value is not applied immediately. The Communication update parameter (CM.94) must be set to 1 to apply the change. After any Comm settings changes be sure to set CM.94=1. This action will restart Ethernet Communication. In addition, this action will prevent any data loss from a drive power loss.

Keypad parameters for ACG-ET2 communication board

The following table lists the drive parameters related to EtherNet/IP and Modbus TCP communication features. Application types for each parameter is specified in the “Protocol” column: E (EtherNet/IP) or M (Modbus TCP).

Set drv parameter (Cmd Source) to “4 (Fieldbus)” using the keypad to operate the ACG drive via the ACG-ET2 communication board.

Set Freq parameter (Frq Ref Src) to “8 (Fieldbus)” using the keypad to provide frequency reference via the ACG-ET2 communication board.

Keypad Parameters Related to ACG-ET2 Communication Board					
Pr. Code	Parameter Name	Default Value	Range	Description	Protocol
drv	Cmd Source	1	0–4	4: Set to “Field Bus.”	E/M
Frq	Freq Ref Src	0	0–8	8: Set to “Field Bus.”	E/M
CM.6	FBus S/W Ver	–	–	Indicates the version of the communication board installed.	E/M
CM.7	FBus ID	10	0–220	Set the station number of the ACG-ET2 communication board.	E
CM.9	FBus Led			Displays the on/off status of the LED indicators on the ACG-ET2 communication board.	E/M
CM.10	Opt Parameter 1	192	0–255	Sets the IP address.	E/M
CM.11	Opt Parameter 2	168	0–255		
CM.12	Opt Parameter 3	1	0–255		
CM.13	Opt Parameter 4	101	0–255		
CM.14	Opt Parameter 5	255	0–255	Set the subnet mask.	E/M
CM.15	Opt Parameter 6	255	0–255		
CM.16	Opt Parameter 7	255	0–255		
CM.17	Opt Parameter 8	0	0–255		
CM.18	Opt Parameter 9	192	0–255	Sets the Gateway address.	E/M
CM.19	Opt Parameter 10	168	0–255		
CM.20	Opt Parameter 11	1	0–255		
CM.21	Opt Parameter 12	10	0–255		
CM.22	Opt Parameter 13	0	0	Set the network communication speed. (fixed to 100 Mbps Auto)	E/M
CM.23	Opt Parameter 14	1	0–11	CIP Input Instance	E/M
CM.24	Opt Parameter 15	1	0–11	CIP Output Instance	E/M

After making changes to parameter CM.07 and parameters CM.10 – 25, you must set CM.94 (Comm-Update) to “1 (Yes)” to save the changes. (If CM.94 [Comm-Update] has not been set after making the parameter changes, the LED indicator will flash in red at 2-second intervals to warn the user.)

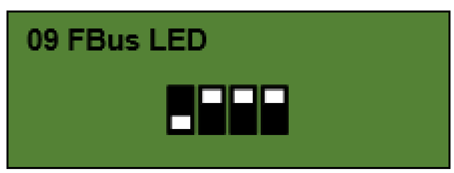
Keypad Parameters Related to ACG-ET2 Communication Board					
Code No.	Parameter Name	Default Value	Range	Description	Protocol
CM.30	Para Status Num	3	0–8	Automatically set according to the CIP Input Instance.	E/M
CM.31	Para Status-1	000A	0x0000–0xFFFF	Sets up the drive data address to be read by the client. (Hex.)	E/M
CM.32	Para Status-2	000E	0x0000–0xFFFF	Sets up the drive data address to be read by the client. (Hex.)	E/M
CM.33	Para Status-3	000F	0x0000–0xFFFF	Sets up the drive data address to be read by the client. (Hex.)	E/M
CM.34	Para Status-4	–	0x0000–0xFFFF	Sets up the drive data address to be read by the client. (Hex.)	E/M
CM.35	Para Status-5	–	0x0000–0xFFFF	Sets up the drive data address to be read by the client. (Hex.)	E/M
CM.36	Para Status-6	–	0x0000–0xFFFF	Sets up the drive data address to be read by the client. (Hex.)	E/M
CM.37	Para Status-7	–	0x0000–0xFFFF	Sets up the drive data address to be read by the client. (Hex.)	E/M
CM.38	Para Status-8	–	0x0000–0xFFFF	Sets up the drive data address to be read by the client. (Hex.)	E/M
CM.50	Para Ctrl Num	2	0–8	Automatically set according to the CIP Output Instance.	E/M
CM.51	Para Control-1	0005	0x0000–0xFFFF	Sets up the client's command address. (Hex.)	E/M
CM.52	Para Control-2	0006	0x0000–0xFFFF	Sets up the client's command address. (Hex.)	E/M
CM.53	Para Control-3	–	0x0000–0xFFFF	Sets up the client's command address. (Hex.)	E/M
CM.54	Para Control-4	–	0x0000–0xFFFF	Sets up the client's command address. (Hex.)	E/M
CM.55	Para Control-5	–	0x0000–0xFFFF	Sets up the client's command address. (Hex.)	E/M
CM.56	Para Control-6	–	0x0000–0xFFFF	Sets up the client's command address. (Hex.)	E/M
CM.57	Para Control-7	–	0x0000–0xFFFF	Sets up the client's command address. (Hex.)	E/M
CM.58	Para Control-8	–	0x0000–0xFFFF	Sets up the client's command address. (Hex.)	E/M
CM.94	Comm Update	0	0: NO 1: YES	Update keypad parameters related to network communication.	E/M
Pr.12	Lost Cmd Mode	None	0: None 1: Free-Run 2: Dec 3: Hold Input 4: Hold Output 5: Lost Preset	Set the drive operation for when a Lost Command has occurred.*	E/M
Pr.13	Lost Cmd Time	1.0	0.1–120	Lost Command trigger time	E/M
Pr.14	Lost Preset F	0.00	0.05–60.00	Sets the Lost Preset speed	E/M
* *Lost Command Mode*					

Ethernet Parameter Details

Operation Group

Code	Parameter Name	Description
drv	Cmd Source: Command Source	Select the command source for the ACG drive. Set to “4 (Field Bus)" to set the ACG-ET2 communication board as the command source and provide commands via network.
Frq	Freq Ref Src: Frequency reference source	Select the frequency command source for the ACG drive. Set to “8 (Field Bus)" to set the ACG-ET2 communication board as the frequency command source and provide frequency commands via network.

CM Group

<table>
<tr><th>Code</th><th>Parameter Name</th><th>Description</th></tr>
<tr><td>CM.6</td><td>FBus S/W Ver:
Communication option S/W version</td><td>Automatically indicates the version of the communication board installed to the ACG drive.</td></tr>
<tr><td>CM.7</td><td>FBus ID:
Station ID of the communication board (communication board ID)</td><td>R: Set the station ID for the ACG-ET2 communication board. A total of 64 station IDs are available from 0 to 63. (The station ID must be set before you can configure network communication using the RAPIEnet protocol.)
When setting the station ID, be careful not to use a station ID that is not already occupied by the PLC system or other network devices.
After making setting changes, you must set CM-94 (Comm Update) to “1 (Yes)” before the changes can take effect.</td></tr>
<tr><td>CM.9</td><td>FBus Led:
Information about LED indicators on the communication board</td><td>Displays on the Keypad the status of the LED indicators on the ACG-ET2 communication board. Refer to sections "11.3/12.4 LED indications and troubleshooting."
Example of the CM.9 (FBus LED) indication:


<table>
<tr><th>LINK1</th><th>LINK2</th><th>ERROR</th><th>CPU</th></tr>
<tr><td>LED is OFF</td><td>LED is ON</td><td>LED is ON</td><td>LED is ON</td></tr>
</table></td></tr>
<tr><td>CM.10–CM.21</td><td>Opt Parameters 1–12</td><td>Set IP address, Mask address, and Gateway address.</td></tr>
<tr><td>CM.22</td><td>Opt Parameter 13:
Network Communication Speed</td><td>Set the network communication speed. (100 Mbps, Auto Negotiation). The Ethernet speed parameter is fixed at "0" by default for 100 Mbps communication speed.</td></tr>
<tr><td>CM.23</td><td>Opt Parameter 14:
CIP Input Instance</td><td>Selection of the data transmission addresses from CM.31 to CM.38 for monitoring.
• This parameter can be set between “0” and “11.” Refer to the table below for data size of each setting.
• The setting cannot be written while the drive is operating. Stop drive operation before making changes to the setting.
• This parameter setting is required for a service via EtherNet/IP protocol. It specifies the data format of the drive status to be transmitted to the client (originator) during an I/O communication via a CIP (Common Industrial Protocol). Refer to the Assembly Object section of the EtherNet/IP.
See Network CM Parameter Setting Details on page B–13 for more information.</td></tr>
</table>

Code	Parameter Name	Description
CM.24	Opt Parameter 15: CIP Output Instance	Select one of the data reception addresses from CM.51 to CM.58 for monitoring. You can set this parameter to between “0” and “11.” The description of the “opt para-15” settings are as follows. • The “opt para-15 (smart scaling reception data index)” setting cannot be written while the drive is operating. Stop drive operation before making changes to the setting. • This parameter is also required for EtherNet/IP protocol service. It configures the format of the command data transmitted to the drive by the client (originator) during the I/O communication via the CIP (Common Industrial Protocol). Refer to the Assembly Object section of the EtherNet/IP. See Network CM Parameter Setting Details on page B–13 for more information.
CM.30	ParaStatus Num: Number of transmission data	You can set CM-23 (opt para-14) to change the number of reception data to between “0” and “8.” The ACG-ET2 communication board can transmit up to 8 pieces of data. You can configure the address of the transmission data with parameters CM-31 through CM-38.
CM.31–CM.38	Para Status1–Para Status8: Transmission data address settings	After setting the number of transmission data with CM-30, enter the matching number of data addresses for the data to transmit to the client (originator) with parameters CM-31 through CM-38.
CM.50	Para Ctrl Num: Number of reception data	You can set CM-24 (opt para-15) to change the number of reception data to between “0” and “8.” The ACG-ET2 communication board can receive up to 8 pieces of data. You can configure the address for the received data with parameters CM-51 through CM-58.
CM.51–CM.58	Para Control1–Para Control8: Reception data address settings	After setting the number of reception data with CM-50, enter the matching number of data addresses for receiving command data from the client (originator) with parameters CM-51 through CM-58.
CM.94	Comm Update: Update setting changes via the communication board	The CM group parameters display the settings stored on the drive connected to the ACG-ET2 communication board and the changes made on the keypad are not directly reflected on the ACG-ET2 communication board. The changed settings will be reflected on the ACG-ET2 communication board when you set COM-94 (Comm Update) to “1 (Yes).” (Parameters that require communication updates include CM-7 and CM 10 through COM-25.)

Pr Group (Lost Command)

<table>
<tr><th>Code</th><th>Parameter Name</th><th>Description</th></tr>
<tr><td>Pr.12</td><td>Lost Cmd Mode: Operation mode for a command loss</td><td>You can select the operation mode for when a network failure or connection failure between the drive and the communication occurs while the drive is operated via network communication.
<table>
<tr><th>Set Value</th><th>Function</th></tr>
<tr><td>"None"</td><td>Maintains the previous status.</td></tr>
<tr><td>"Free-Run"</td><td>Lost Command Trip occurs and a free run stop is made.</td></tr>
<tr><td>"Dec"</td><td>Lost Command Trip occurs and a deceleration stop is made.</td></tr>
<tr><td>"Hold Input"</td><td>Lost Command Warning occurs and the drive operates with the previous speed reference.</td></tr>
<tr><td>"Hold Output"</td><td>Lost Command Warning occurs and the drive operates with the previous running speed.</td></tr>
<tr><td>"Lost Preset"</td><td>Lost Command Warning occurs and the drive operates with speed reference set at Pr.14.</td></tr>
</table></td></tr>
<tr><td>Pr.13</td><td>Lost Cmd Time: Decision time for a command loss</td><td>Set the time duration until the operation mode set with Pr.12 will be reflected following a command loss. You can set a value between "0.1" and "120" seconds.</td></tr>
<tr><td>Pr.14</td><td>Lost Preset F: Operation frequency for a command loss</td><td>When a lost command occurs, a protective function is activated and the drive continues to operate using the frequency set with Pr.14. The setting value is from the start frequency to the max frequency [Hz].</td></tr>
<tr><td>–</td><td>Lost command conditions by protocol</td><td><u>EtherNet/IP</u>
If the implicit message connection (Class 1 Connection) between the originator (a PLC or client) and the target (drive) breaks for longer than one second, the ethernet communication board enters lost command mode, and the drive will operate according to the settings at Pr.12 after the time set with Pr.13 has elapsed.

<u>Modbus TCP</u>
If the Modbus TCP receives no data from the client for five seconds, the Ethernet communication board enters lost command mode, and the drive will operate according to the settings at Pr.12 after the time set with Pr.13 has elapsed.</td></tr>
</table>

Network CM Parameter Setting Details

CIP Input Instance (CM.23)

This parameter sets up the data format of the drive status sent from the drive to the Client (Originator) during the I/O communication module of the CIP (Common Industrial Protocol). Refer to the Assembly Object of the EtherNet/IP.

Set Value	Input Instance Value	Data Size	Parameter Number
0	70	4	X
1	71	4	X
2	110	4	X
3	111	4	X
4	141	2	1
5	142	4	2
6	143	6	3
7	144	8	4
8	145	10	5
9	146	12	6
10	147	14	7
11	148	16	8

CIP Output Instance (CM.24)

This parameter sets up the data format of the drive command sent from the Client (Originator) to control the drive during the I/O communication module of the CIP (Common Industrial Protocol). Refer to the Assembly Object of the EtherNet/IP.

Set Value	Output Instance Value	Data Size	Parameter Number
0	20	4	X
1	21	4	X
2	100	4	X
3	101	4	X
4	121	2	1
5	122	4	2
6	123	6	3
7	124	8	4
8	125	10	5
9	126	12	6
10	127	14	7
11	128	16	8

CM.23 and CM.24 Settings Comarison

CM.23 and CM.24	CM.23		CM.24
Set Value	Input Instance Value		Output Instance Value
0	70	⟷	20
1	71	⟷	21
2	110	⟷	100
3	111	⟷	101
4	141	⟷	121
5	142	⟷	122
6	143	⟷	123
7	144	⟷	124
8	145	⟷	125
9	146	⟷	126
10	147	⟷	127
11	148	⟷	128

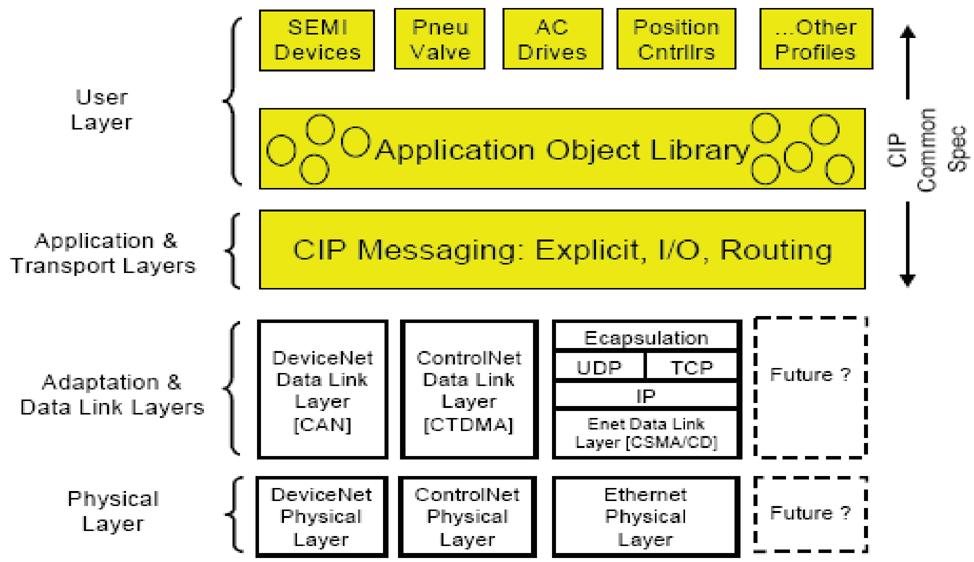
Services

Introduction

This chapter explains the services using EtherNet/IP and Modbus TCP protocols when the communication board is connected with the ACG drive.

EtherNet/IP

Basic Protocol Structure



The EtherNet/IP is a protocol which implements the CIP (Common Industrial Protocol, specified by the ODVA) using the TCP and UDP protocols.

- *Originator: Devices that make connection requests, which are also called clients. PLCs or scanners are examples of originators.*
- *Target: Devices that respond to connection requests, which are also called servers. Drives are examples of targets.*

Implicit message

Implicit messages are also called I/O messages. It refers to the data communicated between the client (originator) and the server (target) at predefined intervals, via input and output instances.

The class 1 connection is used for implicit messages.

Scope of support

- *Transport type*
  - » *Originator->Target: Point to Point*
  - » *Target->Originator: Multicast*
- *Transport trigger: Cyclic*
- *Configuration connection: 1*
- *Connection tag: Not available*
- *Priority*
  - » *Originator->Target: Scheduled*
  - » *Target->Originator: Scheduled*
- *Configuration data: Not available*

Input instances

Input instances refer to the status data periodically sent from the drive to PLC or other client devices.

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
70	0						Running1 (Fwd)		Faulted
	1								
	2	Speed Actual (Low Byte) – RPM unit (note 1)							
	3	Speed Actual (High Byte) – RPM unit							
71	0	At Reference	Ref From Net	Ctrl From Net	Ready	Running 2 (Rev)	Running1 (Fwd)	Warning	Faulted
	1	Drive State							
	2	Speed Actual (Low Byte) – RPM unit							
	3	Speed Actual (High Byte) – RPM unit							
110	0						Running1 (Fwd)		Faulted
	1								
	2	Speed Actual (Low Byte) – Hz unit (note 1)							
	3	Speed Actual (High Byte) – Hz unit							
111	0	At Reference	Ref From Net	Ctrl From Net	Ready	Running 2 (Rev)	Running1 (Fwd)	Warning	Faulted
	1	Drive State							
	2	Speed Actual (Low Byte) – Hz unit							
	3	Speed Actual (High Byte) – Hz unit							
141	0	Status Parameter - 1 data (Low Byte)							
	1	Status Parameter - 1 data (High Byte)							
142	0	Status Parameter - 1 data (Low Byte)							
	1	Status Parameter - 1 data (High Byte)							
	2	Status Parameter - 2 data (Low Byte)							
	3	Status Parameter - 2 data (High Byte)							
143	0	Status Parameter - 1 data (Low Byte)							
	1	Status Parameter - 1 data (High Byte)							
	2	Status Parameter - 2 data (Low Byte)							
	3	Status Parameter - 2 data (High Byte)							
	4	Status Parameter - 3 data (Low Byte)							
	5	Status Parameter - 3 data (High Byte)							
144	0	Status Parameter - 1 data (Low Byte)							
	1	Status Parameter - 1 data (High Byte)							
	2	Status Parameter - 2 data (Low Byte)							
	3	Status Parameter - 2 data (High Byte)							
	4	Status Parameter - 3 data (Low Byte)							
	5	Status Parameter - 3 data (High Byte)							
	6	Status Parameter - 4 data (Low Byte)							
	7	Status Parameter - 4 data (High Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
145	0	Status Parameter - 1 data (Low Byte)							
	1	Status Parameter - 1 data (High Byte)							
	2	Status Parameter - 2 data (Low Byte)							
	3	Status Parameter - 2 data (High Byte)							
	4	Status Parameter - 3 data (Low Byte)							
	5	Status Parameter - 3 data (High Byte)							
	6	Status Parameter - 4 data (Low Byte)							
	7	Status Parameter - 4 data (High Byte)							
	8	Status Parameter - 5 data (Low Byte)							
	9	Status Parameter - 5 data (High Byte)							
146	0	Status Parameter - 1 data (Low Byte)							
	1	Status Parameter - 1 data (High Byte)							
	2	Status Parameter - 2 data (Low Byte)							
	3	Status Parameter - 2 data (High Byte)							
	4	Status Parameter - 3 data (Low Byte)							
	5	Status Parameter - 3 data (High Byte)							
	6	Status Parameter - 4 data (Low Byte)							
	7	Status Parameter - 4 data (High Byte)							
	8	Status Parameter - 5 data (Low Byte)							
	9	Status Parameter - 5 data (High Byte)							
	10	Status Parameter - 6 data (Low Byte)							
	11	Status Parameter - 6 data (High Byte)							
147	0	Status Parameter - 1 data (Low Byte)							
	1	Status Parameter - 1 data (High Byte)							
	2	Status Parameter - 2 data (Low Byte)							
	3	Status Parameter - 2 data (High Byte)							
	4	Status Parameter - 3 data (Low Byte)							
	5	Status Parameter - 3 data (High Byte)							
	6	Status Parameter - 4 data (Low Byte)							
	7	Status Parameter - 4 data (High Byte)							
	8	Status Parameter - 5 data (Low Byte)							
	9	Status Parameter - 5 data (High Byte)							
	10	Status Parameter - 6 data (Low Byte)							
	11	Status Parameter - 6 data (High Byte)							
	12	Status Parameter - 7 data (Low Byte)							
	13	Status Parameter - 7 data (High Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
148	0	Status Parameter - 1 data (Low Byte)							
	1	Status Parameter - 1 data (High Byte)							
	2	Status Parameter - 2 data (Low Byte)							
	3	Status Parameter - 2 data (High Byte)							
	4	Status Parameter - 3 data (Low Byte)							
	5	Status Parameter - 3 data (High Byte)							
	6	Status Parameter - 4 data (Low Byte)							
	7	Status Parameter - 4 data (High Byte)							
	8	Status Parameter - 5 data (Low Byte)							
	9	Status Parameter - 5 data (High Byte)							
	10	Status Parameter - 6 data (Low Byte)							
	11	Status Parameter - 6 data (High Byte)							
	12	Status Parameter - 7 data (Low Byte)							
	13	Status Parameter - 7 data (High Byte)							
	14	Status Parameter - 8 data (Low Byte)							
	15	Status Parameter - 8 data (High Byte)							

The following table explains the data (bytes 0 and 1) for instances 70, 71, 110, and 111.

Name	Description	Related Attribute	
		Class	Attr. ID
Faulted	Drive Error	0x29	10
Warning	Not supported	0x29	11
Running1	Motor is running Forward	0x29	7
Running2	Motor is running Reverse	0x29	8
Ready	Motor is ready for operation	0x29	9
Ctrl From Net	Run/Stop control	0x29	15
Ref From Net	Speed control	0x2A	29
At Reference	Reached reference Speed	0x2A	3
Drive State	Current motor status	0x29	6
Actual speed	Reference speed	0x2A	7

Output Instances

Out instance refers to the status data periodically sent from the PLC or other client devices to the drive.

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
20	0						Fault reset		Run Fwd
	1	0							
	2	Speed Reference (Low Byte) – RPM unit							
	3	Speed Reference (High Byte) – RPM unit							
21	0		NetRef (note 2)	NetCtrl (note2)			Fault reset	Run Rev	Run Fwd
	1	0							
	2	Speed Reference (Low Byte) – RPM unit							
	3	Speed Reference (High Byte) – RPM unit							
100	0						Fault reset		Run Fwd
	1	0							
	2	Speed Reference (Low Byte) – Hz unit							
	3	Speed Reference (High Byte) – Hz unit							
101	0		NetRef	NetCtrl			Fault reset	Run Rev	Run Fwd
	1	0							
	2	Speed Reference (Low Byte) – Hz unit							
	3	Speed Reference (High Byte) – Hz unit							
121	0	Control Parameter - 1 data (Low Byte)							
	1	Control Parameter - 1 data (High Byte)							
122	0	Control Parameter - 1 data (Low Byte)							
	1	Control Parameter - 1 data (High Byte)							
	2	Control Parameter - 2 data (Low Byte)							
	3	Control Parameter - 2 data (High Byte)							
123	0	Control Parameter - 1 data (Low Byte)							
	1	Control Parameter - 1 data (High Byte)							
	2	Control Parameter - 2 data (Low Byte)							
	3	Control Parameter - 2 data (High Byte)							
	4	Control Parameter - 3 data (Low Byte)							
	5	Control Parameter - 3 data (High Byte)							
124	0	Control Parameter - 1 data (Low Byte)							
	1	Control Parameter - 1 data (High Byte)							
	2	Control Parameter - 2 data (Low Byte)							
	3	Control Parameter - 2 data (High Byte)							
	4	Control Parameter - 3 data (Low Byte)							
	5	Control Parameter - 3 data (High Byte)							
	6	Control Parameter - 4 data (Low Byte)							
	7	Control Parameter - 4 data (High Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
125	0	Control Parameter - 1 data (Low Byte)							
	1	Control Parameter - 1 data (High Byte)							
	2	Control Parameter - 2 data (Low Byte)							
	3	Control Parameter - 2 data (High Byte)							
	4	Control Parameter - 3 data (Low Byte)							
	5	Control Parameter - 3 data (High Byte)							
	6	Control Parameter - 4 data (Low Byte)							
	7	Control Parameter - 4 data (High Byte)							
	8	Control Parameter - 5 data (Low Byte)							
	9	Control Parameter - 5 data (High Byte)							
126	0	Control Parameter - 1 data (Low Byte)							
	1	Control Parameter - 1 data (High Byte)							
	2	Control Parameter - 2 data (Low Byte)							
	3	Control Parameter - 2 data (High Byte)							
	4	Control Parameter - 3 data (Low Byte)							
	5	Control Parameter - 3 data (High Byte)							
	6	Control Parameter - 4 data (Low Byte)							
	7	Control Parameter - 4 data (High Byte)							
	8	Control Parameter - 5 data (Low Byte)							
	9	Control Parameter - 5 data (High Byte)							
	10	Control Parameter - 6 data (Low Byte)							
	11	Control Parameter - 6 data (High Byte)							
127	0	Control Parameter - 1 data (Low Byte)							
	1	Control Parameter - 1 data (High Byte)							
	2	Control Parameter - 2 data (Low Byte)							
	3	Control Parameter - 2 data (High Byte)							
	4	Control Parameter - 3 data (Low Byte)							
	5	Control Parameter - 3 data (High Byte)							
	6	Control Parameter - 4 data (Low Byte)							
	7	Control Parameter - 4 data (High Byte)							
	8	Control Parameter - 5 data (Low Byte)							
	9	Control Parameter - 5 data (High Byte)							
	10	Control Parameter - 6 data (Low Byte)							
	11	Control Parameter - 6 data (High Byte)							
	12	Control Parameter - 7 data (Low Byte)							
	13	Control Parameter - 7 data (High Byte)							

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
128	0	Control Parameter - 1 data (Low Byte)							
	1	Control Parameter - 1 data (High Byte)							
	2	Control Parameter - 2 data (Low Byte)							
	3	Control Parameter - 2 data (High Byte)							
	4	Control Parameter - 3 data (Low Byte)							
	5	Control Parameter - 3 data (High Byte)							
	6	Control Parameter - 4 data (Low Byte)							
	7	Control Parameter - 4 data (High Byte)							
	8	Control Parameter - 5 data (Low Byte)							
	9	Control Parameter - 5 data (High Byte)							
	10	Control Parameter - 6 data (Low Byte)							
	11	Control Parameter - 6 data (High Byte)							
	12	Control Parameter - 7 data (Low Byte)							
	13	Control Parameter - 7 data (High Byte)							
	14	Control Parameter - 8 data (Low Byte)							
	15	Control Parameter - 8 data (High Byte)							

The following table explains the data (bits for byte 0) for instances 20, 21, 100, and 101.

Name	Description	Related Attribute	
		Class	Attr. ID
Run Fwd[1]	Forward Run Command	0x29	3
Run Rev[1]	Reverse Run Command	0x29	4
Fault reset[1]	Fault Reset Command	0x29	12
NetRef[2]	Not used	0x2A	4
NetCtrl[2]	Not used	0x29	5
Speed Reference	Reference speed	0x2A	8
1 - Refer to the Drive Run and Fault sections in the "Control Supervisor Object (Class 0x29)". *2 - Reference speed and Run/Stop control can be set only on the LED control panel. Network control instances 21 and 101 (NetRef, NetCtrl) are not available.*			

Explicit Messages

Explicit messages refer to non-periodic data communications used for reading or writing attribute values of an drive or an EtherNet/IP.

Using the UCMM communication, data exchange is made without connecting the originator and the target, and periodic data exchange is available as well using the Class 3 connection.

Supported Objects

Identity Object (Class 0x01, Instance 1)

Attribute				
Attribute ID	**Access**	**Attribute Name**	**Data Length**	**Attribute Value**
1	Get	Vendor ID	Word	259
2	Get	Device Type (drive)	Word	2
3	Get	Product Code	Word	100*
4	Get	Revision High Byte - Major Revision Low Byte - Minor Revision	Word	0x0101**
5	Get	Status	Word	See definition table below
6	Get	Serial Number	Double Word	Serial number uses the last 4 digits of the MAC ID.
7	Get	Product Name	4 Byte	CENT
** – Product Code 100 refers to the ACG drive. ** – The revision number is identical to the version of the ACG-ET2 ethernet communication card. The high byte stands for a major revision number, and the low byte stands for a minor revision number. For example, "0x0102" stands for "version 1.02." The version of the communication card can be displayed on the Keypad using the CM.6 (FBus S/W Ver) parameter.*				

Definition of status bits:

Bit	Description
0	0: Device is not connected to the master 1: Device is connected to the master
1	Reserved
2	Configured (fixed as 0 because ACG EtherNet/IP is not supported)
3	Reserved
4 ***5*** ***6*** ***7***	0: Unknown 2: Faulty IO connection 3: IO connection has not been made 5: Major fault 6: IO connection has been made
8	Minor recoverable fault (Drive is in warning status)
9	Minor unrecoverable fault (N/A)
10	Major recoverable fault (drive H/W trip occurred)
11	Major recoverable fault (drive non-H/W trip occurred)

Service			
Service Code	**Definition**	**Support for Class**	**Support for Instance**
0x0E	Get Attribute Single	No	Yes
0x05	Reset	No	Yes
0x01	Get Attribute All	No	Yes

Motor data object (Class 0x28, Instance 1)

Attribute				
Attribute ID	**Access**	**Attribute Name**	**Range**	**Definition**
3	Get	Motor Type	0–10	0: Non-standard motor 1: PM DC Motor 2: FC DC Motor 3: PM Synchronous Motor 4: FC Synchronous Motor 5: Switched Reluctance Motor 6: Wound Rotor Induction Motor 7: Squirrel Cage Induction Motor 8: Stepper Motor 9: Sinusoidal PM BL Motor 10: Trapezoidal PM BL Motor
6	Get/Set	Motor Rated Curr	0.0–1000.0	[Get] Reads the value at BAS-13 Rated Curr. [Set] Set value is reflected to BAS-13 Rated Curr. Scale 0.1
7	Get/Set	Motor Rated Volt	0–690	[Get] Reads the value of the BAS-15 Rated Voltage. [Set] Set value is reflected in the BAS-15 Rated Voltage. Scale 1

Service			
Service Code	**Definition**	**Support for Class**	**Support for Instance**
0x0E	Get Attribute Single	No	Yes
0x10	Set Attribute Single	No	Yes

Control Supervisor Objects (Class 0x29, Instance 1)

Attribute				
Attribute ID	**Access**	**Attribute Name**	**Range**	**Definition**
3	Get/Set	Forward Run Cmd.	0	Stopped
			1	Forward run (see Run Command table below)
4	Get/Set	Reverse Run Cmd.	0	Stopped
			1	Reverse run (see Run Command table below)
5	N/A	Net Control	-	Configurable only with the drive parameter.
6	Get	Drive State	0	Vendor Specific
			1	Startup
			2	Not Ready (resetting in progress)
			3	Ready (stopping in progress)
			4	Enabled (running, not applicable to deceleration stop)
			5	Stopping (decelerating)
			6	Fault Stop
			7	Faulted (trip occurred)
7	Get	Running Forward	0	Drive stopped.
			1	Running Forward
8	Get	Running Reverse	0	Drive stopped.
			1	Running Reverse
9	Get	Drive Ready	0	Resetting in progress or trip occurred
			1	Drive is ready for operation
10	Get	Drive Fault	0	Trip has not occurred
			1	Trip has occurred
12	Get/Set	Drive Fault Reset	0	Trip reset to release the trip. Resetting will begin only when the value changes from FALSE to TRUE (see drive fault codes below).
			1	
13	Get	Drive Fault Codes		Refer to the following Drive Fault Code table (see drive fault codes below).
14	Get	Control From Net.	0	Commands are made using sources other than the ACG-ET2 communication. → Control is from local
			1	Commands are made using the ACG-ET2 communication as the source. → Control is from Network

Drive Run Drive operation using Command:

Forward Run Cmd. and Reverse Run Cmd.			
Run1	**Run1**	**Trigger Event**	**Run Type**
0	0	Stop	NA
0 → 1	0	Run	Run1
0	0 → 1	Run	Run2
0 → 1	0 → 1	No Action	NA
1	1	No Action	NA
1 → 0	1	Run	Run2
1	1 → 0	Run	Run1

In the table above, Run1 indicates Forward Run Cmd. and Run 2 indicates Reverse Run Cmd. Commands are made by the Ethernet communication board when the value changes from 0 (FALSE) to 1 (TRUE). The Forward Run Cmd. value does not indicate the present operation status of the drive; it indicates the operation command value on the Ethernet communication board.

The Drive Fault becomes TRUE when the drive is tripped.

The Drive Fault Codes for the trips are as follows.

Drive Fault Codes			
Fault Code Number	**Description**		
0x0000	None		
0x1000	Ethermal	Out Phase Open	InverterOLT
	InPhaseOpen	ThermalTrip	UnderLoad
	ParaWriteTrip	IOBoardTrip	PrePIDFail
	OptionTrip1	OptionTrip2	OptionTrip3
	LostCommand	UNDEFINED	LostKeypad
0x2200	OverLoad		
0x2310	OverCurrent1		
0x2330	GFT		
0x2340	OverCurrent2		
0x3210	OverVoltage		
0x3220	LowVoltage		
0x2330	GroundTrip		
0x4000	NTCOpen		
0x4200	OverHeat		
0x5000	FuseOpen	HWDiag	
0x7000	FanTrip		
0x7120	No Motor Trip		
0x7300	EncorderTrip		
0x8401	SpeedDevTrip		
0x8402	OverSpeed		
0x9000	ExternalTrip	BX	

Drive Fault Reset

The Drive Fault Reset gives TRIP RESET reference to the drive when the setting value changes from 0 to 1 (FALSE to TRUE). Overwriting 1 (TRUE) over 1 (TRUE) does not generate RESET reference for a trip. To allow the Ethernet communication board to send a RESET command to the drive when the value is 1 (TRUE), write 0 (FAULT) first, then write 1 (TRUE) again.

Service			
Service Code	**Definition**	**Support for Class**	**Support for Instance**
0x0E	Get Attribute Single	No	Yes
0x10	Set Attribute Single	No	Yes

Drive Objects (Class 0x2A, Instance 1)

Attribute				
Attribute ID	**Access**	**Attribute Name**	**Range**	**Definition**
3	Get	At Reference	0	The output frequency has not reached the reference frequency.
			1	The output frequency has reached the reference frequency.
4	N/A	Net Reference	-	
6	Get	Drive Mode[1]	0	Vendor Specific Mode
			1	Open Loop Speed (Frequency)
			2	Closed Loop Speed Control
			3	Torque Control
			4	Process Control (e.g. PI)
7	Get	SpeedActual	0–24000	Displays the present output frequency in [rpm].
8	Get/Set	SpeedRef	0–24000	Displays the reference frequency in [rpm]. Reflected when operation parameter frq (Freq Ref Src) is set to FieldBus (Ethernet).
9	Get	Actual Current	0–111.0 A	Monitors the present current in 0.1 A increment/decrement.
29	Get	Ref.From Network	0	Command source is not the DeviceNet communication.
			1	Command source is the DeviceNet communication.
100	Get	Actual Hz	0–400.00 Hz	Monitors the present operation frequency (Hz).
101	Get/Set	Reference Hz	0–400.00 Hz	Speed reference may be given via a network communication if DRV-07 (Freq Ref Src) is set to 8 (FieldBus).
102	Get/Set	Acceleration Time[2]	0–6000.0 sec	Sets/monitors the acceleration time of the drive.
103	Get/Set	Deceleration Time[3]	0–6000.0 sec	Sets/monitors the deceleration time of the drive.

1– Related to the DRV-10 (Torque Control) and APP-01 (App Mode) settings. When DRV-10 (Torque Control) is set to Yes, the Drive Mode becomes "Torque Control", and when APP-01 (App Mode) is set to Proc PID, MMC, then the Drive Mode becomes "Process Control (e.g. PI)."
2– Value at DRV-03 (Acc Time)
3– Value at DRV-04 (Dec Time)

Service			
Service Code	**Definition**	**Support for Class**	**Support for Instance**
0x0E	Get Attribute Single	No	Yes
0x10	Set Attribute Single	No	Yes

Class 0x64 (Drive Object) – Manufacture Profile

This object is used to access the Keypad Parameters of the drive.

Attribute				
Instance	**Access**	**Attribute Number**	**Attribute Name**	**Attribute Value**
1 (Dr Group)	Get/Set	Identical to the ACG Manual Code number.	ACG Keypad title (refer to the ACG Drive User Manual)	Parameter setting range for the ACG drive (refer to the ACG Drive User Manual)
2 (bA Group)		Identical to the ACG Manual Code number.		
3 (AD Group)		Identical to the ACG Manual Code number.		
4 (Cn Group)		Identical to the ACG Manual Code number.		
5 (In Group)		Identical to the ACG Manual Code number.		
6 (OU Group)		Identical to the ACG Manual Code number.		
7 (CM Group)		Identical to the ACG Manual Code number.		
8 (AP Group)		Identical to the ACG Manual Code number.		
10 (AP Group)		Identical to the ACG Manual Code number.		
11 (Pr Group)		Identical to the ACG Manual Code number.		
12 (M2 Group)		Identical to the ACG Manual Code number.		

Service			
Service Code	**Definition**	**Support for Class**	**Support for Instance**
0x0E	Get Attribute Single	No	Yes
0x10	Set Attribute Single	No	Yes

Modbus TCP Frame

Modbus TCP frame structure

MBAP Header (7 bytes)	PDU (5 bytes or greater)

In general, Ethernet communication uses Ethernet II frames.

MODBUS Application Protocol header (MBAP header)

The following table explains the components of a MBAP header.

Section	Length	Description
Transaction identifier	2 byte	Unique transmission number, which increases by 1 each time the client sends data frame to the server.
Protocol identifier	2 byte	Fixed at 0.
Length	2 byte	Data frame length of the Modbus communication, which represents the length (in byte unit) from the MBAP header to the unit identifier.
Unit identifier	1 byte	When communications using Modbus TCP and Modbus RTU are connected via a gateway, the unit identifier indicates the slave number. The address is fixed to 0xFF when Modbus TCP communication is used alone.

Protocol Data Unit (PDU)

PDU is the actual data in the Modbus TCP communication, which is composed of a function code and data.

Refer to "Function codes" below for detailed information.

Function codes

The Modbus TCP communication involves clients and a server. During communication, clients send commands to the server, and the server responds to the commands. In general, devices such as a PLC, HMI, and PC are used as the client, and the drive works as a server.

Read Holding registers

Read Input registers are functions used to read the server (drive) data.

The following table explains the components of a request data frame from a client to a server.

Request Frame	Length	Value
Function code	1 byte	0x03
Comm. address	2 byte	0x0000–0xFFFF
Number of data requests	2 byte	1–16 (ACG drives)

The following table explains the components of a response data frame from a server to a master.

Request Frame	Length	Value
Function code	1 byte	0x03
Comm. address	1 byte	2 x the number of data requests
Number of data requests	Number of data requests x 2 bytes	Data value of the given number from the comm. address

Read Input registers

Read Input registers are functions used to read the server (drive) data.

The following table explains the components of a request data frame from a client to a server.

Request Frame	Length	Value
Function code	1 byte	0x04
Comm. address	2 byte	0x0000–0xFFFF
Number of data requests	2 byte	1–16 (ACG drives)

The following table explains the components of a response data frame from a server to a master.

Request Frame	Length	Value
Function code	1 byte	0x03
Comm. address	1 byte	2 x the number of data requests
Number of data requests	Number of data requests x 2 bytes	Data value of the given number from the comm. address

Write Single register

Write Single registers are functions used to write a single server (drive) data.

The following table explains the components of a request data frame from a client to a server.

Request Frame	Length	Value
Function code	1 byte	0x06
Comm. address	2 byte	0x0000–0xFFFF
Data value	2 byte	0x0000–0xFFFF

The following table explains the components of a response data frame from a server to a master.

Request Frame	Length	Value
Function code	1 byte	0x06
Comm. address	2 byte	0x0000–0xFFFF
Data value	2 byte	0x0000–0xFFFF

Write Multiple register

Write Multiple registers are functions used to write 1 to 16 consecutive data items on the server (drive).

The following table explains the components of a request data frame from a client to a server.

Request Frame	Length	Value
Function code	1bytes	0x10
Comm. address	2bytes	0x0000–0xFFFF
Number of data to write	2byte	1–16 (ACG drives)
Byte Count	1byte	2 x the number of data
Number of data to write	The number of data x 2 bytes	Data to write

The following table explains the components of a response data frame from a server to a master.

Request Frame	Length	Value
Function code	1 byte	0x10
Comm. address	2 byte	0x0000–0xFFFF
Number of data to write	2 byte	1–16 (ACG drives)

Read/Write Multiple register

Read/Write Multiple registers are functions used to write 1 to 16 consecutive data items on the server (drive). At the same time this function is used to read data items on the server (drive).

The following table explains the components of a request data frame from a client to a server.

Request Frame	Length	Value
Function code	1bytes	0x17
Comm. address	2bytes	0x0000 ~ 0xFFFF
Number of data to write	2byte	1–16 (ACG drives)
Byte Count	1byte	2 x the number of data
Value of data to write	The number of data x 2	Data to write

Exception (Except) Frame

An exception frame is a response frame from a server when an error occurs while responding to the client.

The following table explains the components of an exception frame.

Error Frame	Length	Value
Error code	1bytes	0x80 + function code requested by the client
Exception code	1bytes	0x0000–0xFFFF

Exception Code

Type	Code	Description
ILLEGAL FUNCTION	0x01	Unsupported function has been requested
ILLEGAL DATA ADDRESS	0x02	An unused address has been requested or modification has been requested for the data at an unused address.
ILLEGAL DATA VALUE	0x03	A data modification request has been made out of the range of the available value.
SLAVE DEVICE FAILURE	0x04	Server error occurred (CAN communication error with the drive, communication board initialization error, or data communication error with the drive)
SLAVE DEVICE BUSY	0x06	Server is unable to respond because it is executing another process (in the middle of a drive parameter initialization or the initial setting of the communication board)
WRITE PERMITION ERROR	0x20	Unique code for ACG drives. An attempt was made to change a write-protected parameter

LED Indications and Troubleshooting

LED Name	Color	Meaning	Status	Description
LINK1	Green	Network normal	ON	Network connection at LINK 1 is operating normal.
	Orange	Check network settings	ON	Check Ethernet settings*. When the communication cycle stops for longer than one second.
	-	LINK 1 Not connected	OFF	Trying Ethernet communication, network cable not connected to LINK 1.
LINK2	Green	Network normal	ON	Network connection at LINK 2 is operating normal.
	Orange	Network fault	ON	Check Ethernet settings*.
	-	LINK 1 Not connected	OFF	Trying Ethernet communication, network cable not connected to LINK 2.
Error	Red	Normal operation	OFF	Communication between the communication board and the drive is normal.
		Network fault	Flashing Synchronous flashing with LED0 (1 second interval)	Communication between the ACG-ET2 communication board and the drive is abnormal.
			Flashing (2 second interval)	The communication board parameters are set differently from the communication parameter settings on the keypad**
			ON	EEPROM failure No network connection to LINK 1 and LINK 2 IP collision occurred
CPU	Green	Normal operation	Flashing (1 second interval)	The communication board has been properly installed on the drive.

** For Ethernet network settings, check keypad parameters CM.10, CM.11, CM.14, CM.15, CM.23, and CM.24, and the settings for the client devices, such as the PLC.*
*** To synchronize the Ethernet communication board settings with the keypad parameter settings, check the CM Group parameter settings and set CM.94 (Comm. Update) to "1 (yes)."*