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SAFTRONICS



FP5/GP5 Series
User's Manual

Variable Torque Inverter
(with software version 5110/5120 and newer)

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⚠WARNING

PRECAUTIONS

1) Read this manual in its entirety before installing or operating the FP5/GP5 inverter. This manual applies to inverters with software versions 5110 and 5120 only and is not intended to be used in conjunction with any other software.
2) Do not connect or disconnect wiring, or perform signal checks while the power supply is turned ON.
3) The FP5/GP5 internal capacitor may be charged even after the power supply is turned OFF. To prevent electrical shock, disconnect all power before servicing the inverter. Then wait at least five minutes after the power supply is disconnected and all LEDs are extinguished.
4) Do not perform a withstand voltage test or a megger test on any part of the FP5/GP5. This electronic equipment uses semiconductors and is vulnerable to high voltage.
5) Do not remove the operator unless the power supply is turned OFF. Never touch the printed control board while the power supply is turned ON.
6) The FP5/GP5 is suitable for use on a circuit capable of delivering not more than 65,000 RMS symmetrical amperes, 480 Volts maximum (460V class units), 240 Volts maximum (230V class units).

Failure to observe these and other precautions highlighted in this manual will expose the user to high voltages, resulting in equipment damage, serious injury or death.

NOTICE

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- CHAPTER 1 -

RECEIVING & INSTALLATION

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1.1 INTRODUCTION

The FP5/GP5 is a series of high quality, full featured inverters. With a power range of 5 to 500 HP, it provides all the functionality of prior series, in a compact, low cost package. This functionality includes proprietary features like full-range automatic torque boost, electronic thermal motor overload, energy savings and PID operation, low-noise operation and various other features. It also features a new digital operator for simple programming. Utilizing the latest microprocessor technology, members of the design team have collaborated to make the FP5/GP5 the world's first optimized inverter specifically designed for variable torque and constant torque applications.

This manual details installation, start-up and operating procedures for the FP5/GP5 series adjustable frequency drive controller. Descriptions of diagnostic and troubleshooting procedures are also included herein.

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1.2 SPECIFICATIONS

FP5/GP5

	Inverter Model CIMR-P5U	20P4	20P7	21P5	22P2	23P7	25P5	27P5	2011	2015	-
Output Characteristics	Motor Output (HP) *	0.5	1	2	3	5	7.5	10	20	25	-
	Capacity (kVA)	1.2	2.3	3.0	4.2	6.7	9.5	13	19	24	-
	Rated Output Current (A)-VT**	3.2	6	8	11	17.5	27	36	54	68	-
	Rated Output Current (A)-CT**	3.2	6	8	11	17.5	25	33	49	64	-
	Max. Voltage	3-Phase, 200/208/220/230V (Proportional to input voltage)									
	Rated Output Frequency	0.1 to 400 Hz									
	Overload Capacity - VT	120% Rated Output Current for 1 minute									
	Overload Capacity - CT	150% Rated Output Current for 1 minute									
Power Supply	Input Current (A)	3.9	7.2	9.6	13.2	21	33	44	65	82	-
	Rated Voltage & Frequency	3-Phase 220 - 230V, 50/60Hz									
	Voltage Fluctuation	+10%, -15%									
	Frequency Fluctuation	±5%									
	CIMR-P5U	40P4	40P7	41P5	42P2	43P7	44P0	45P5	47P5	4011	4015
Output Characteristics	Motor Output (HP) *	0.5	1	2	3	5	7.5	10	15	20	25
	Capacity (kVA)	1.4	2.6	3.7	4.7	6.1	8.6	11	14	21	26
	Rated Output Current (A)-VT**	1.9	3.6	5.1	6.6	8.5	11.7	14.8	21.0	28.6	34.0
	Rated Output Current (A)-CT**	1.9	3.6	5.1	6.6	8.5	11.7	14.8	18	28.6	34.0
	Max. Voltage #	3-Phase, 380/400/415/440/460V (Proportional to input voltage)									
	Rated Output Frequency	0.1 to 400 Hz									
	Overload Capacity-VT**	120% Rated Output Current for 1 minute (Model 47P5 is rated 150% / 1 minute)									
	Overload Capacity-CT**	150% Rated Output Current for 1 minute									
Power Supply	Input Current (A)	2.3	4.3	6.1	8.0	10.2	14.0	17.8	26.0	35.0	40.0
	Rated Voltage & Frequency #	3-Phase 380 -440 - 460V, 50/60Hz									
	Voltage Fluctuation	+10%, -15%									
	Frequency Fluctuation	±5%									

* HP ratings based on standard NEMA 4-pole motor data.

For 380V operation, the motor rated current must be less than or equal to the inverter rated current.

** VT: Variable Torque rating (n116=1), CT: Constant Torque rating (n116=0)

Note: Shaded areas indicate factory settings.

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Control Characteristics	Control Method	Sine wave PWM with full-range, automatic torque boost
	Frequency Control Range	0.1 to 400 Hz
	Frequency Accuracy	Digital command: 0.01%, Analog command: 0.1%
	Frequency Setting Resolution	Digital Operator Reference: 0.1Hz, Analog Reference: 0.06Hz (@60Hz)
	Output Frequency Resolution	0.01 Hz
	Frequency Setting	0 to +10VDC (20kΩ), 4-20mA (250Ω)
	Accel/Decel Time	0.0 to 3600.0 sec. (Accel/Decel time setting independently: 0.1 sec)
	Braking Torque	Approx. 20%
	No. of V-f Patterns	1 preset V/f pattern and 1 custom pattern
Protective Functions	Motor Overload Protection	Electronic thermal overload relay (I^2T)
	Instantaneous Overcurrent	Motor coasts to stop at approx. 200% rated output current.
	Fuse Protection	Motor coasts to stop at blown fuse.
	Overload	Motor coasts to stop after 1 min. at rated overload capacity.
	Overvoltage	Motor coasts to a stop if converter output voltage exceeds 410VDC (820VDC at 460V input)
	Undervoltage	Motor coasts to stop if converter output voltage drops below user adjustable value
	Momentary Power Loss	Immediate stop after 15 ms or longer power loss. (Continuous system operation during power loss less than 2 sec is equipped as standard.)
	Heatsink Overheat	Thermistor - OH1, OH2
	Stall Prevention	Stall prevention at acceleration/deceleration and constant speed operation
	Ground Fault	Provided by electronic circuit
	Power Charge Indication	Charge LED stays on until voltage drops below 50VDC
	Input Phase Loss	Single-phase protection
Environmental Conditions	Location	Indoor (protected from corrosive gases and dust)
	Ambient Temperature	+14 to 104°F (-10 to 40°C) for NEMA 1 type (not frozen) +14 to 113°F (-10 to 45°C) for open chassis type
	Storage Temperature	-4 to 140°F (-20 to 60°C)
	Humidity	95% RH (non-condensing)
	Vibration	9.8m/s^2 (1G) less than 20Hz, up to 1.96m/s^2 (0.2G) at 20 to 50Hz

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FP5/GP5

	Inverter Model CIMR-P5U	2018	2022	2030	2037	2045	2055	2075	
Output Characteristics	Motor Output (HP) *	30	40	50	60	75	100	125	—
	Capacity (kVA)	30	37	50	61	70	85	110	
	Rated Output Current (A) - VT **	80	104	130	160	192	248	312	
	Rated Output Current (A) - CT **	64	83	104	128	154	198	250	
	Max. Voltage	3-Phase, 200/208/220/230V (Proportional to input voltage)							
	Rated Output Frequency	0.1 to 400 Hz							
	Overload Capacity - VT **	120% Rated Output Current / 1 minute							
	Overload Capacity - CT **	150% Rated Output Current / 1 minute							
Power Supply	Input Current (A)	88	119	143	176	212	270	344	—
	Rated Voltage & Frequency	3-Phase 220 - 230V, 50/60Hz							
	Voltage Fluctuation	+10%, -15%							
	Frequency Fluctuation	±5%							

	CIMR-P5U	4018	4022	4030	4037	4045	4055	4075	4110	4160	4185	4220	4300
Output Characteristics	Motor Output (HP) *	30	40	50	60	75	100	150	200	250	300	400	500
	Capacity (kVA)	31	40	50	61	73	98	130	170	230	260	340	460
	Rated Output Current (A) - VT **	41	52	65	80	96	128	180	240	302	380	506	675
	Rated Output Current (A) - CT **	32	42	52	64	77	102	144	182	242	304	404	540
	Max. Voltage #	3-Phase, 380/400/415/440/460V (Proportional to input voltage)											
	Rated Output Frequency	0.1 to 400 Hz											
	Overload Capacity - VT **	120% Rated Current / 1 minute											
	Overload Capacity - CT **	150% Rated Current / 1 minute											
Power Supply	Input Current (A)	46	58	72	88	106	141	198	264	330	456	608	810
	Rated Voltage & Frequency #	3-Phase 380 -440 - 460V, 50/60Hz											
	Voltage Fluctuation	+10%, -15%											
	Frequency Fluctuation	±5%											

* HP ratings based on standard NEMA 4-pole motor data.

\# For 380V operation, the motor rated current must be less than or equal to the inverter rated current.

** VT: Variable Torque rating (n116=1), CT: Constant Torque rating (n116=0)

Note: Shaded areas indicate factory settings.

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Control Characteristics	Control Method	Sine wave PWM with full-range, automatic torque boost
	Frequency Control Range	0.1 to 400 Hz
	Frequency Accuracy	Digital command: 0.01%, Analog command: 0.1%
	Frequency Setting Resolution	Digital Operator Reference: 0.1Hz, Analog Reference: 0.06Hz (@60Hz)
	Output Frequency Resolution	0.01 Hz
	Frequency Setting	0 to +10VDC (20kΩ), 4-20mA (250Ω)
	Accel/Decel Time	0.0 to 3600.0 sec. (Accel/Decel time setting independently: 0.1 sec)
	Braking Torque	Approx. 20%
	No. of V-f Patterns	1 preset V/f pattern and 1 custom pattern
Protective Functions	Motor Overload Protection	Electronic thermal overload relay (I^2T)
	Instantaneous Overcurrent	Motor coasts to stop at approx. 180% rated output current.
	Fuse Protection	Motor coasts to stop at blown fuse.
	Overload	Motor coasts to stop after 1 min. at rated overload capacity.
	Overvoltage	Motor coasts to stop if converter output voltage exceeds 410VDC (820VDC at 460V input)
	Undervoltage	Motor coasts to stop if converter output voltage drops below user adjustable value
	Momentary Power Loss	Immediately stop after 15 ms or longer power loss. (Continuous system operation during power loss less than 2 sec is equipped as standard.)
	Heatsink Overheat	Thermistor - OH1, OH2
	Stall Prevention	Stall prevention at acceleration/deceleration and constant speed operation
	Ground Fault	Provided by electronic circuit
	Power Charge Indication	Charge LED stays on until voltage drops below 50VDC
	Input Phase Loss	Single-phase protection
Environmental Conditions	Location	Indoor (protected from corrosive gases and dust)
	Ambient Temperature	+14 to 104°F (-10 to 40°C) for NEMA 1 type (not frozen) +14 to 113°F (-10 to 45°C) for open chassis type
	Storage Temperature	-4 to 140°F (-20 to 60°C)
	Humidity	95% RH (non-condensing)
	Vibration	9.8m/s^2 (1G) less than 20Hz, up to 1.96m/s^2 (0.2G) at 20 to 50Hz

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1.3 PRELIMINARY INSPECTION

Receiving

After unpacking the FP5/GP5:

- Verify that the part numbers on the drive nameplate match the numbers on your purchase order or packing slip.
- Check the unit for physical damage which may have occurred during shipping. If any part of the drive is missing or damaged, notify the carrier and your Saftronics representative immediately.
- Verify that all internal hardware (i.e. components, screws, etc.) is seated properly and fastened securely.

- If the drive will be stored after receiving, place it in its original packaging and store according to temperature specifications on page 8.

Checking the Nameplate

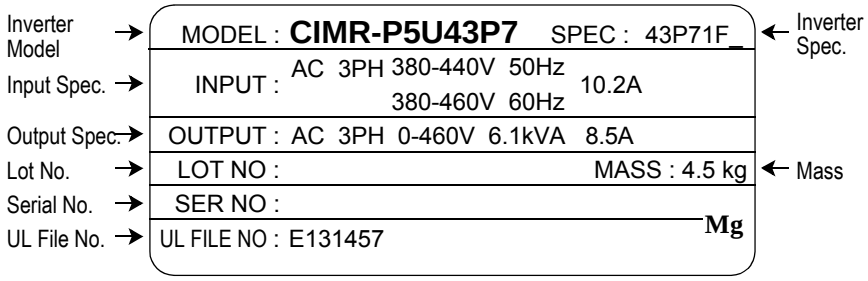


Figure 1 Nameplate Example of American Model P5U43P7

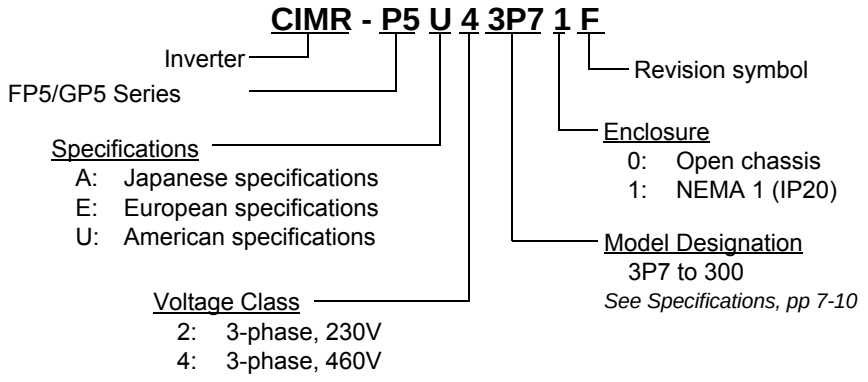


Figure 2 Nameplate Description

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Identifying the Parts

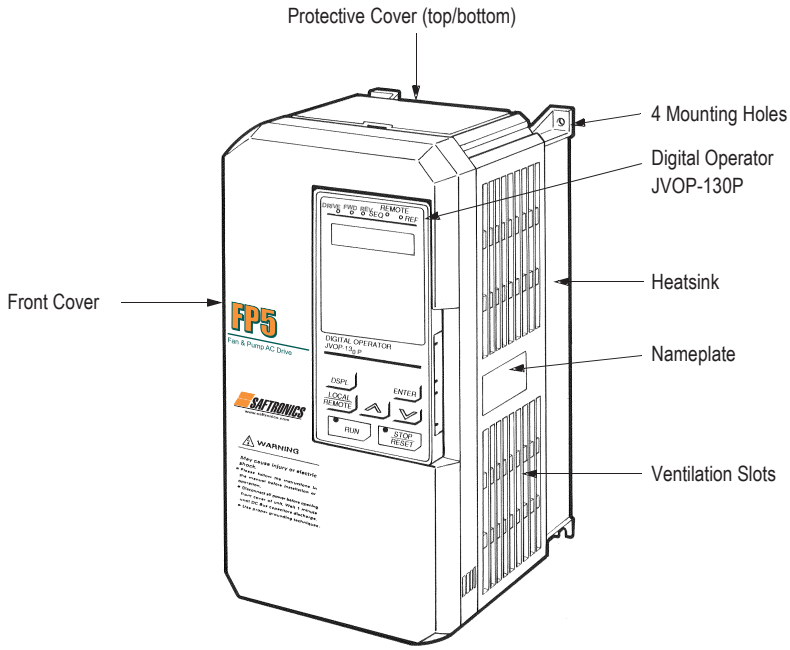


Figure 3 Parts Identification - Model P5U43P7

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1.4 MOUNTING

⚠CAUTION

PRECAUTIONS

1) When preparing to mount the FP5/GP5, lift it by its base. Never lift it by the front cover.
2) Mount the inverter onto nonflammable material.
3) The FP5/GP5 generates heat. For the most effective cooling possible, mount it vertically. For more details, refer to "Dimensions/ Heat Loss" on pages 15 & 16 and "Clearances" on page 17.
4) When mounting units in an enclosure, install a fan or other cooling device to keep the intake air temperature below 113°F (45°C).

Failure to observe these precautions may result in equipment damage.

Choosing a Location

Be sure that the inverter is mounted in a location protected against the following conditions:

- Extreme cold and heat. Use only within the ambient temperature range: 14 to 104°F (-10 to 40°C).
- Direct sunlight (not for use outdoors)
- Rain, moisture
- High humidity
- Oil sprays, splashes
- Salt spray
- Dust or metallic particles in the air
- Corrosive gases (e.g. sulfurized gas) or liquids
- Radioactive substances
- Combustibles (e.g. thinner, solvents, etc.)
- Physical shock, vibration
- Magnetic noise (e.g. welding machines, power devices, etc.)

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Removing and Replacing the Digital Operator

To remove the digital operator from the front cover, push the operator lever in the direction shown by arrow 1 and lift the digital operator in the direction shown by arrow 2 (see Figure 4).
To replace the digital operator, engage the operator onto retaining tabs A in the direction shown by arrow 1 and then onto retaining tabs B in the direction shown by arrow 2, locking the digital operator into place (see Figure 5).

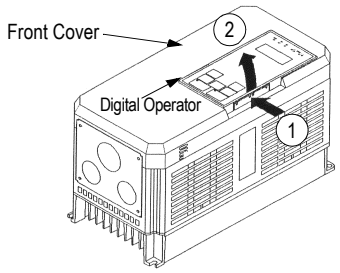


Figure 4 Removing the Digital Operator

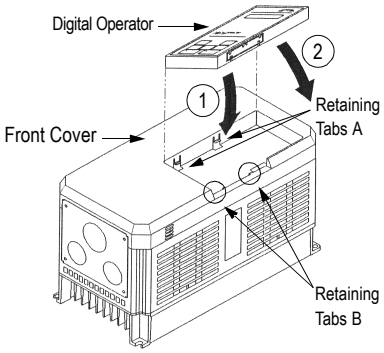


Figure 5 Replacing the Digital Operator

Removing and Replacing the Front Cover

To remove the front cover, first remove the digital operator (see previous section). Then squeeze the cover on both sides in the direction shown by arrows 2 and lift the cover in the direction shown by arrow 3.

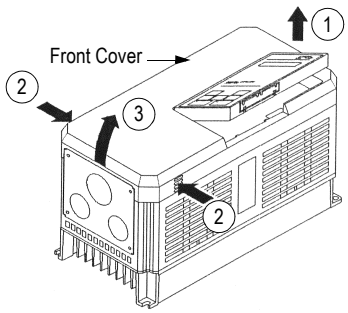


Figure 6 Removing and Replacing the Front Cover

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Dimensions/Heat Loss

Open Chassis Type (IP00)

Voltage	Model CIMR -P5U	Open Chassis Dimensions in inches (mm)						Mass lbs (kg)	Heat Loss (W)		
		W	H	D	W1	H1	H2		Heat sink	Inside unit	Total
230V	20P4	5.51 (140)	11.02 (280)	6.30 (160)	4.96 (126)	10.47 (266)	0.28 (7)	6.5 (3)	15	50	65
	20P7								25	65	90
	21P5								40	80	120
	22P2	5.51 (140)	11.02 (280)	7.09 (180)	4.96 (126)	10.47 (266)	0.28 (7)	10 (4.5)	80	60	140
	23P7								135	80	215
	25P5	7.87 (200)	11.81 (300)	8.07 (205)	7.32 (186)	11.22 (285)	0.31 (8)	12 (5.5)	210	90	300
	27P5							13 (6)	235	110	345
	2011	9.84 (250)	14.96 (380)	8.86 (225)	9.29 (236)	14.37 (365)	0.30 (7.5)	24 (11)	425	160	585
	2015								525	200	725
	2018	12.80 (325)	17.72 (450)	11.22 (285)	10.83 (275)	17.13 (435)	0.30 (7.5)	62 (28)	655	230	885
	2022								830	280	1110
	2030	16.73 (425)	26.57 (675)	13.78 (350)	12.60 (320)	25.59 (650)	0.49 (12.5)	134 (61)	1050	500	1550
	2037							137 (62)	1250	700	1950
	2045	18.70 (475)	31.50 (800)	13.78 (350)	14.57 (370)	30.51 (775)	0.49 (12.5)	176 (80)	1550	750	2300
	2055								1950	1000	2950
	2075	22.64 (575)	36.42 (925)	15.75 (400)	17.52 (445)	35.24 (895)	0.59 (15)	298 (135)	2300	1300	3600
460V	40P4	5.51 (140)	11.02 (280)	6.30 (160)	4.96 (126)	10.47 (266)	0.28 (7)	6.5 (3)	10	50	60
	40P7								20	65	85
	41P5							8.8 (4)	30	80	110
	42P2	5.51 (140)	11.02 (280)	7.09 (180)	4.96 (126)	10.47 (266)	0.28 (7)	10 (4.5)	65	60	125
	43P7								80	65	145
	44P0								120	80	200
	45P5	7.87 (200)	11.81 (300)	8.07 (205)	7.32 (186)	11.22 (285)	0.31 (8)	13 (6)	135	85	220
	47P5								240	120	360
	4011	9.84 (250)	14.96 (380)	8.86 (225)	9.29 (236)	14.37 (365)	0.30 (7.5)	24 (11)	305	150	455
	4015								390	180	570
	4018	12.80 (325)	17.72 (450)	11.22 (285)	10.83 (275)	17.13 (435)	0.30 (7.5)	60 (27)	465	195	660
	4022								620	260	880
	4030	12.80 (325)	24.61 (625)	11.22 (285)	10.83 (275)	24.02 (610)	0.30 (7.5)	97 (44)	705	315	1020
	4037								875	370	1245
	4045								970	415	1385
	4055	17.91 (455)	32.28 (820)	13.78 (350)	13.78 (350)	31.30 (795)	0.49 (12.5)	174 (79)	1110	710	1820
	4075							176 (80)	1430	890	2320
	4110	22.64 (575)	36.42 (925)	14.76 (375)	17.52 (445)	35.24 (895)	0.59 (15)	298 (135)	1870	1160	3030
	4160			15.75 (400)				320 (145)	2670	1520	4190
	4185	37.40 (950)	57.09 (1450)	17.13 (435)	29.53 (750)	55.12 (1400)	0.98 (25)	794 (360)	3400	1510	4910
	4220								4740	2110	6850
	4300	37.80 (960)	62.99 (1600)	17.91 (455)	29.53 (750)	61.02 (1550)	0.98 (25)	926 (420)	6820	2910	9730

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Enclosed Type (NEMA 1, IP20)

Voltage	Model (CIMR-P5U)	NEMA 1 Dimensions in inches (mm)						Mass lbs (kg)
		W	H	D	W1	H1	H2	
230V	20P4	5.51 (140)	11.02 (280)	6.30 (160)	4.96 (126)	10.47 (266)	0.28 (7)	6.5 (3)
	20P7							
	21P5							
	22P2	5.51 (140)	11.02 (280)	7.09 (180)	4.96 (126)	10.47 (266)	0.28 (7)	10 (4.5)
	23P7							
	25P5	7.87 (200)	11.81 (300)	8.07 (205)	7.32 (186)	11.22 (285)	0.31 (8)	12 (5.5)
	27P5							13 (6)
	2011	9.84 (250)	14.96 (380)	8.86 (225)	9.29 (236)	14.37 (365)	0.30 (7.5)	24 (11)
	2015		15.75 (400)				1.08 (27.5)	
	2018	12.99 (330)	24.02 (610)	11.22 (285)	10.83 (275)	17.13 (435)	3.44 (87.5)	71 (32)
	2022		26.57 (675)				6.00 (152.5)	
	2030	16.93 (430)	38.78 (985)	13.78 (350)	12.60 (320)	25.59 (650)	8.37 (212.5)	148 (67)
	2037							150 (68)
	2045 2055	18.90 (480)	43.70 (1110)	13.78 (350)	14.57 (370)	30.51 (775)	8.37 (212.5)	192 (87)
	2075	22.83 (580)	50.79 (1290)	15.75 (400)	17.52 (445)	35.24 (895)	10.63 (270)	320 (145)
460V	40P4	5.51 (140)	11.02 (280)	6.30 (160)	4.96 (126)	10.47 (266)	0.28 (7)	6.5 (3)
	40P7							
	41P5							8.8 (4)
	42P2	5.51 (140)	11.02 (280)	7.09 (180)	4.96 (126)	10.47 (266)	0.28 (7)	10 (4.5)
	43P7							
	44P0							
	45P5 47P5	7.87 (200)	11.81 (300)	8.07 (205)	7.32 (186)	11.22 (285)	0.31 (8)	13 (6)
	4011 4015	9.84 (250)	14.96 (380)	8.86 (225)	9.29 (236)	14.37 (365)	0.30 (7.5)	24 (11)
	4018 4022	12.99 (330)	24.02 (610)	11.22 (285)	10.83 (275)	17.13 (435)	3.44 (87.5)	68 (31)
	4030 4037	12.99 (330)	30.91 (785)	11.22 (285)	10.83 (275)	24.02 (610)	3.44 (87.5)	106 (48)
	4045		33.46 (850)				6.00 (152.5)	
	4055	18.11 (460)	44.49 (1130)	13.78 (350)	13.78 (350)	31.30 (795)	8.37 (212.5)	187 (85)
	4075							190 (86)
	4110	22.83 (580)	50.79 (1290)	14.76 (375)	17.52 (445)	35.24 (895)	10.63 (270)	320 (145)
	4160			15.75 (400)				342 (155)

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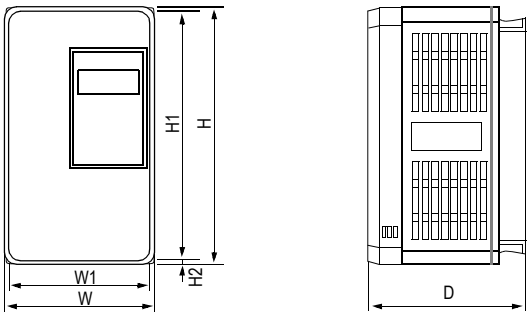


Figure 7 FP5/GP5 Dimension Diagram

Clearances

When mounting the FP5/GP5, allow sufficient clearances for effective cooling as shown below:

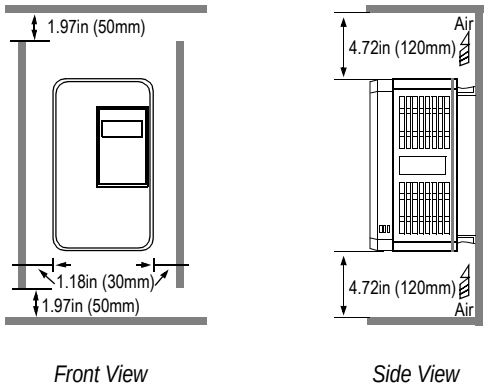


Figure 8 FP5/GP5 Clearances

Notes:

1) The required clearances at the top, bottom, and both sides of the inverter are the same for both open chassis and NEMA 1 enclosures.
2) For inverter models 25HP and less (230V & 460V), remove the top and bottom covers to convert NEMA 1 units to open chassis
3) Allowable intake air temperature:
   Open chassis: 14°F to 113°F (-10°C to +45°C)
   NEMA 1: 14°F to 104°F (-10°C to 40°C)
4) When mounting units in an enclosure, install a fan or other cooling device to limit the air temperature within the inverter to below 113°F (45°C).

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1.5 WIRING

⚠CAUTION

PRECAUTIONS

1) Do not connect or disconnect wiring, or perform signal checks while the power supply is turned ON.
2) Connect the power supply wiring to terminals L1, L2 and L3 on the main circuit input section. DO NOT connect the power supply wiring to output terminals T1, T2 and T3.
3) Connect the motor wiring to terminals T1, T2 and T3 on the main circuit output section.
4) *Never* touch the output circuit directly or place the output line in contact with the inverter enclosure.
5) Do not connect a phase-advancing capacitor or an LC/RC noise filter to the output circuit.
6) The motor wiring must be less than 328ft (100m) in length and in a separate conduit from the input power wiring.
7) Control wiring must be less than 164ft (50m) in length and in a separate conduit from both the motor wiring and the power wiring.
8) Tighten the screws on the main circuit and control circuit terminals.
9) Low voltage wires shall be wired with Class 1 wiring.
10) Please observe national electrical code (NEC) when wiring electrical devices.

Failure to observe these precautions may result in equipment damage.

Inspection

After wiring is complete, verify that:

All wiring is correctly installed.
Excess screws and wire clippings are removed from inside of the unit.
Screws are securely tightened.
Exposed wire has no contact with other wiring or terminals.

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FP5/GP5 Standard Connection Diagram

230V: Models 20P4 through 27P5
460V: Models 40P4 through 4015

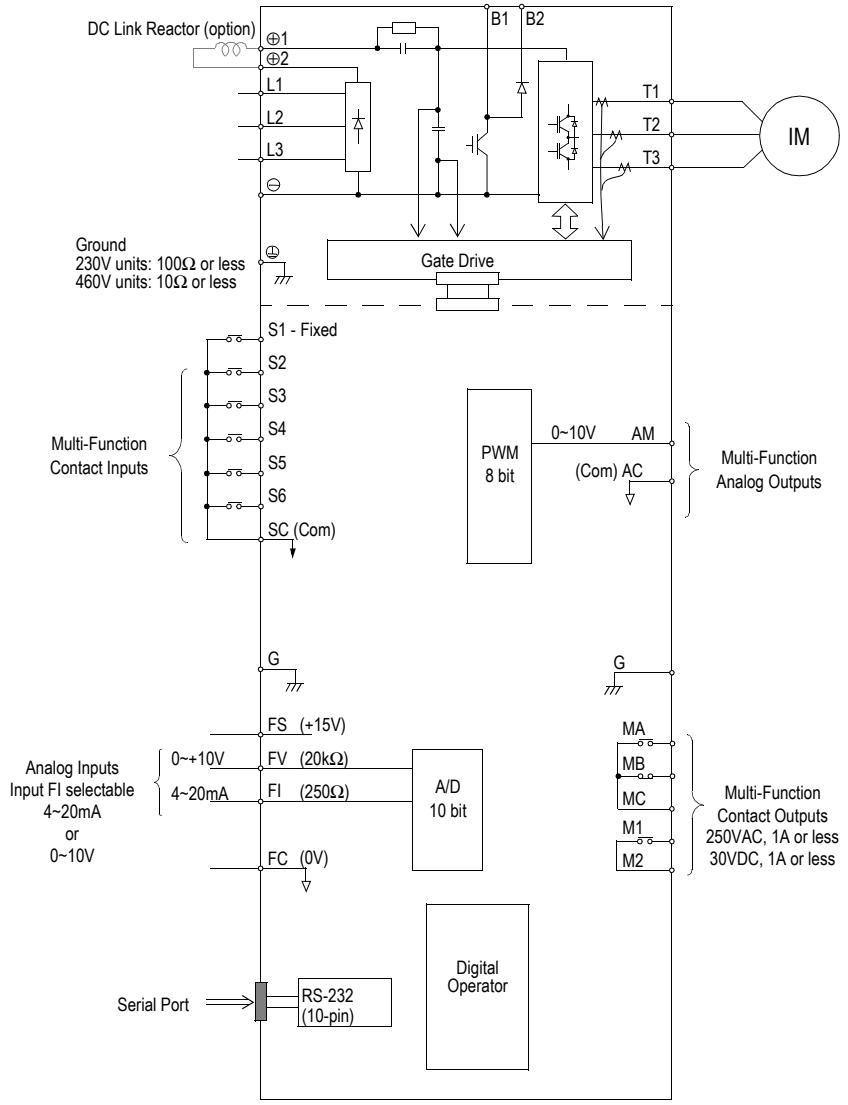


Figure 9 FP5/GP5 Terminal Diagram

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FP5/GP5 Standard Connection Diagram

230V: Models 2018 through 2075
460V: Models 4018 through 4160

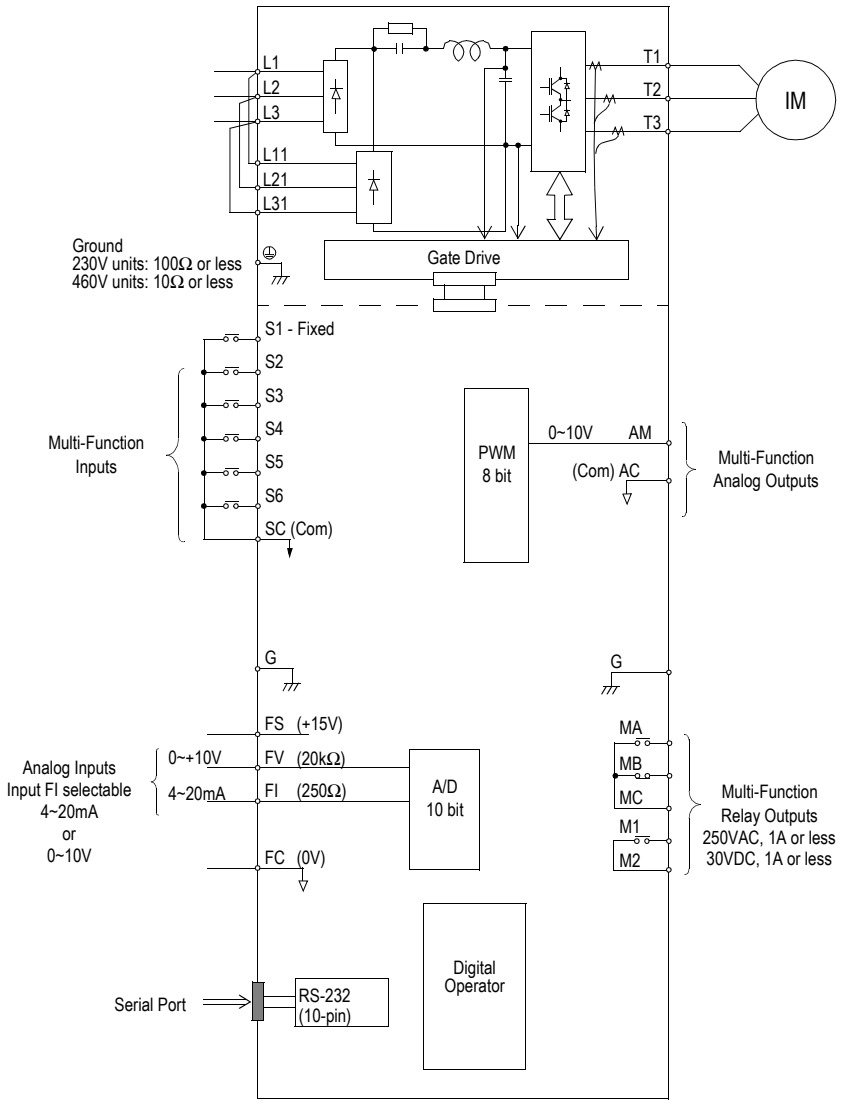


Figure 10 FP5/GP5 Terminal Diagram

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Main Circuit Wiring

Input Wiring

- Molded-Case Circuit Breaker (MCCB)

  Be sure to connect MCCBs or fuses between the AC main circuit power supply and FP5/GP5 input terminals L1, L2 and L3, to protect the power supply wiring.

- Ground Fault Interrupter

  When connecting a ground fault interrupter to input terminals L1, L2 and L3, select one that is not affected by high frequency.

  Examples: NV series by Mitsubishi Electric Co., Ltd. (manufactured in or after 1988), EGSG series by Fuji Electric Co., Ltd. (manufactured in or after 1984).

- Magnetic Contactor (MC)

  Inverters can be used without an MC installed on the power supply side. An MC can be used instead of an MCCB to apply the main circuit power supply. However, when an MC is switched OFF on the primary side, dynamic braking does not function and the motor coasts to stop.

  The load can be operated/stopped by closing/opening the MC on the primary side. However, frequent switching may cause the inverter to malfunction.

  When using a braking resistor unit, use an MC to break the power supply side of the inverter in the event of a dynamic braking overload relay trip. Otherwise, if the inverter malfunctions, the braking resistor unit may be burned out.

- Terminal Block Connection Sequence

  Input power supply phases can be connected to any terminal regardless of the order of L1, L2 and L3 on the terminal block.

- AC Reactor

  When connecting an inverter (230V/460V, 25HP or less) to a large capacity power supply transformer (600kVA or more), or when switching a phase-advancing capacitor, excessive peak current flows through the input power supply circuit, which may damage the converter section. In such cases, install a DC reactor (optional) between inverter ⊕1 and ⊕2 terminals, or an AC reactor (optional) on the input side. Installation of a reactor is also effective for improving power factor on the power supply side.

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· Surge Suppressor

For inductive loads (i.e. magnetic contactors, magnetic relays, magnetic valves, solenoids, magnetic brakes, etc.) connected near the inverter, use a surge suppressor across the coils to limit the transients on the supply lines.

Output Wiring

· Motor Connection

Connect motor lead wires to output terminals T1, T2 and T3. Verify that the motor rotates in the forward direction (CCW: counterclockwise when viewed from the motor load side) with the forward run command. If the motor rotation is incorrect, exchange any two of the motor leads.

· Magnetic Starter

Do not connect a magnetic starter or a magnetic contactor to the output circuit. If the motor load is connected or disconnected while the inverter is running, the inverter overcurrent protective circuitry may trip.

· Thermal Overload Relay

An electronic overload protective function (I^2t) is incorporated into the inverter. However, when driving several motors with one inverter, or when switching between multiple windings of a multiple winding motor, use an external thermal overload relay(s). In this case, set parameter *n034* to "Disabled".

· Wiring Distance Between Inverter and Motor

If the total wiring distance between inverter and motor is excessively long and the inverter carrier frequency (IGBT switching frequency) is high, harmonic leakage current from the wiring will adversely affect the inverter and peripheral devices. If the wiring distance is long, reduce the inverter carrier frequency as described below. Carrier frequency can be set by parameter *n054*.

Wiring Distance Between Inverter and Motor

Wiring Distance between Inverter and Motor	Up to 164 ft. (50m)	Up to 328 ft. (100m)	More than 328 ft. (100m)
Carrier Frequency * (Set value of parameter *n054*)	15kHz or less (6)	10kHz or less (4)	5kHz or less (2)

* Increasing the carrier frequency above the factory default value requires current derating. Contact your Saftronics representative for details.

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Grounding

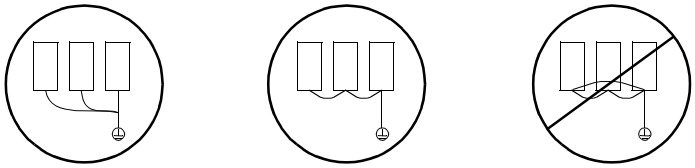
- Ground Resistance

  230V class: 100Ω or less, 460V class: 10Ω or less.

- Never ground the FP5/GP5 in common with welding machines, motors, or other high-current electrical equipment. Run all ground wiring in a separate conduit.

- Use ground wiring as specified in "Wire and Terminal Screw Sizes" on page 25, and keep the length as short as possible.

- When using several FP5/GP5 units side by side, ground the units as shown in Figure 10, (a) or (b). Do not loop the wires as shown in (c).



(a) Acceptable *(b) Acceptable* *(c) Not Acceptable*

Figure 11 Grounding Example of 3 FP5/GP5 Inverters

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Terminal Functions

230V Class Terminal Functions

Model CIMR-P5U	20P4 to 27P5	2011 to 2015	2018 to 2075
Nominal Motor Output	0.5 to 10HP	20 to 25HP	30 to 125HP
L1	Main circuit input power supply		Main circuit input power supply
L2			
L3			
L11	---		
L21			
L31			
T1	Inverter output		
T2			
T3			
B1	Braking resistor unit	---	
B2			
⊖	DC reactor (⊕1 - ⊕2) DC power supply (⊕1 - ⊖)	DC reactor (⊕1 - ⊕2) DC power supply (⊕1 - ⊖) Braking unit (⊕3 - ⊖)	---
⊕1			
⊕2			
⊕3	---		
⏚	Ground terminal (Ground resistance: 100Ω or less)		

460V Class Terminal Functions

Model CIMR-P5U	40P4 to 4015	4018 to 4045	4055 to 4160	4185 to 4300
Nominal Motor Output	0.5 to 25HP	30 to 75HP	100 to 250HP	300 to 500HP
L1	Main circuit input power supply	Main circuit input power supply		Main circuit input power supply
L2				
L3				
L11	---			---
L21				
L31				
T1	Inverter output			
T2				
T3				
B1	Braking resistor unit	---		
B2				
⊖	DC reactor (⊕1 - ⊕2) DC power supply (⊕1 - ⊖)	---		
⊕1				
⊕2				
r	---		Cooling fan power supply (Control power supply) r - s 200: 200 to 230 VAC input r - s 400: 380 to 460 VAC input	
s 200				
s 400				
⏚	Ground terminal (Ground resistance: 10Ω or less)			

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Wire and Terminal Screw Sizes

230V Class Wire Size

Circuit	Model CIMR-	Terminal Symbol	Terminal Screw	Wire Size *		Max. Torque lb-in (N·m)	Wire Type
				AWG	mm^2		
Main	P5U20P4	L1, L2, L3,⊖,⊕1, ⊕2, B1, B2, T1, T2, T3	M4	14 - 10	2 - 5.5	12.4 (1.4)	Power cable: 600V vinyl sheathed wire or equivalent
		⏚					
	P5U20P7	L1, L2, L3,⊖,⊕1, ⊕2, B1, B2, T1, T2, T3	M4	14 - 10	2 - 5.5	12.4 (1.4)	
		⏚					
	P5U21P5	L1, L2, L3,⊖,⊕1, ⊕2, B1, B2, T1, T2, T3	M4	14 - 10	2 - 5.5	12.4 (1.4)	
		⏚		12 - 10	3.5 - 5.5		
	P5U22P2	L1, L2, L3,⊖,⊕1, ⊕2, B1, B2, T1, T2, T3	M4	12 - 10	3.5 - 5.5	12.4 (1.4)	
		⏚					
	P5U23P7	L1, L2, L3,⊖,⊕1, ⊕2, B1, B2, T1, T2, T3	M4	10	5.5	12.4 (1.4)	
		⏚					
	P5U25P5	L1, L2, L3,⊖,⊕1, ⊕2, B1, B2, T1, T2, T3	M5	8	8	22.1 (2.5)	
		⏚		10 - 8	5.5 - 8		
	P5U27P5	L1, L2, L3,⊖,⊕1, ⊕2, B1, B2, T1, T2, T3	M5	8	8	22.1 (2.5)	
		⏚		10 - 8	5.5 - 8		
	P5U2011	L1, L2, L3,⊖, ⊕1, ⊕2, ⊕3, T1, T2, T3	M6	4	22	45.1 (5.1)	
		⏚		8	8		
	P5U2015	L1, L2, L3,⊖, ⊕1, ⊕2, ⊕3, T1, T2, T3	M8	3	30	90.3 (10.2)	
		⏚	M6	8	8	45.1 (5.1)	
	P5U2018	L1, L2, L3, L11, L21, L31, T1, T2, T3	M8	3	30	90.3 (10.2)	
		⏚		6	14		
	P5U2022	L1, L2, L3, L11, L21, L31, T1, T2, T3	M8	2	38	90.3 (10.2)	
		⏚		6	14		
	P5U2030	L1, L2, L3, L11, L21, L31, T1, T2, T3	M10	4/0	100	203.6 (23.0)	
		⏚	M8	4	22	90.3 (10.2)	
	P5U2037	L1, L2, L3, L11, L21, L31, T1, T2, T3	M10	1/0 x 2P	60 x 2P	203.6 (23.0)	
		⏚	M8	4	22	90.3 (10.2)	
	P5U2045	L1, L2, L3, L11, L21, L31, T1, T2, T3	M10	1/0 x 2P	60 x 2P	203.6 (23.0)	
		⏚	M8	4	22	90.3 (10.2)	
	P5U2055	L1, L2, L3, L11, L21, L31, T1, T2, T3	M10	1/0 x 2P	60 x 2P	203.6 (23.0)	
		⏚	M8	3	30	90.3 (10.2)	
	P5U2075	L1, L2, L3, L11, L21, L31, T1, T2, T3	M12	4/0 x 2P	100 x 2P	349.6 (39.5)	
		⏚	M8	1	50	90.3 (10.2)	
Control	Common to all models	S1, S2, S3, S4, S5, S6, SC FV, FI, FS, FC AM, AC, M1, M2, MA, MB, MC	-	20 - 16	Stranded 0.5 - 1.25 Solid 0.5 - 1.25	-	Twisted shielded wire with Class 1 wiring
		G	M3.5	20 - 14	0.5 - 2	8.9 (1.0)	

* Wire sizes are based on 75°C copper wire.

Note:

Voltage drop should be considered when determining wire size. Voltage drop can be calculated using the following equation:

Phase-to phase voltage drop (V)

$= \sqrt{3}$ wire resistance (Ω/km) x wiring distance (m) x current (A) x 10^{-3}

Select a wire size so that voltage drop will be less than 2% of the normal rated voltage.

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460V Class Wire Size

Circuit	Model CIMR-	Terminal Symbol	Terminal Screw	Wire Size *		Max. Torque lb-in (N·m)	Wire Type
				AWG	mm^2		
Main	P5U40P4	L1, L2, L3, ⊖, ⊕1, ⊕2, B1, B2, T1, T2, T3	M4	14 - 10	2 - 5.5	12.4 (1.4)	Power cable: 600V vinyl sheathed wire or equivalent
		⏚					
	P5U40P7	L1, L2, L3, ⊖, ⊕1, ⊕2, B1, B2, T1, T2, T3	M4	14 - 10	2 - 5.5	12.4 (1.4)	
		⏚		12 - 10	3.5 - 5.5		
	P5U41P5	L1, L2, L3, ⊖, ⊕1, ⊕2, B1, B2, T1, T2, T3	M4	14 - 10	2 - 5.5	12.4 (1.4)	
		⏚		12 - 10	3.5 - 5.5		
	P5U42P2	L1, L2, L3, ⊖, ⊕1, ⊕2, B1, B2, T1, T2, T3	M4	14 - 10	2 - 5.5	12.4 (1.4)	
		⏚		12 - 10	3.5 - 5.5		
	P5U43P7	L1, L2, L3, ⊖, ⊕1, ⊕2, B1, B2, T1, T2, T3	M4	14 - 10	2 - 5.5	12.4 (1.4)	
		⏚		12 - 10	3.5 - 5.5		
	P5U45P5	L1, L2, L3, ⊖, ⊕1, ⊕2, B1, B2, T1, T2, T3	M4	12 - 10	3.5 - 5.5	12.4 (1.4)	
		⏚					
	P5U47P5	L1, L2, L3, ⊖, ⊕1, ⊕2, B1, B2, T1, T2, T3	M5	8 - 6	8 - 14	22.1 (2.5)	
		⏚					
	P5U4011	L1, L2, L3, ⊖, ⊕1, ⊕2, B1, B2, T1, T2, T3	M5	8 - 6	8 - 14	22.1 (2.5)	
		⏚	M6	8 - 6	8 - 14	45.1 (5.1)	
	P5U4015	L1, L2, L3, ⊖, ⊕1, ⊕2, B1, B2, T1, T2, T3	M5	8 - 6	8 - 14	22.1 (2.5)	
		⏚	M6	8 - 6	8 - 14	45.1 (5.1)	
	P5U4018	L1, L2, L3, L11, L21, L31, T1, T2, T3	M6	6	14	45.1 (5.1)	
		⏚	M8	8 - 6	8 - 14	90.3 (10.2)	
	P5U4022	L1, L2, L3, L11, L21, L31, T1, T2, T3	M6	4	22	45.1 (5.1)	
		⏚	M8	4	22	90.3 (10.2)	
	P5U4030	L1, L2, L3, L11, L21, L31, T1, T2, T3	M8	4	22	90.3 (10.2)	
		⏚		4	22		
	P5U4037	L1, L2, L3, L11, L21, L31, T1, T2, T3	M8	3	30	90.3 (10.2)	
		⏚		4	22		
	P5U4045	L1, L2, L3, L11, L21, L31, T1, T2, T3	M8	1	50	90.3 (10.2)	
		⏚		3	30		
	P5U4055	L1, L2, L3, L11, L21, L31, T1, T2, T3	M10	4/0	100	203.6 (23.0)	
		⏚	M8	1	50	90.3 (10.2)	
	P5U4075	L1, L2, L3, L11, L21, L31, T1, T2, T3	M10	1/0 x 2P	60 x 2P	203.6 (23.0)	
		⏚	M8	1/0	60	90.3 (10.2)	
	P5U4110	L1, L2, L3, L11, L21, L31, T1, T2, T3	M10	1/0 x 2P	60 x 2P	203.6 (23.0)	
		⏚	M8	1/0	60	90.3 (10.2)	
	P5U4160	L1, L2, L3, L11, L21, L31, T1, T2, T3	M12	4/0 x 2P	100 x 2P	349.6 (39.5)	
		⏚	M8	4/0	100	90.3 (10.2)	
	P5U4185	L1, L2, L3, ⊖, ⊕1, ⊕3, T1, T2, T3	M16	650MCM x 2P	325 x 2P	867.4 (98.0)	
		⏚	M8	650MCM	325	90.3 (10.2)	
		r, s200, s400	M4	20 - 10	0.5 - 5.5	12.4 (1.4)	
	P5U4220	L1, L2, L3, ⊖, ⊕1, ⊕3, T1, T2, T3	M16	650MCM x 2P	325 x 2P	867.4 (98.0)	
		⏚	M8	650MCM	325	90.3 (10.2)	
		r, s200, s400	M4	20 - 10	0.5 - 5.5	12.4 (1.4)	
	P5U4300	L1, L2, L3, ⊖, ⊕1, ⊕3, T1, T2, T3	M16	650MCM x 2P	325 x 2P	867.4 (98.0)	
		⏚	M8	650MCM	325	90.3 (10.2)	
		r, s200, s400	M4	20 - 10	0.5 - 5.5	12.4 (1.4)	
Control	Common to all models	S1, S2, S3, S4, S5, S6, SC FV, FI, FS, FC AM, AC, M1, M2, MA, MB, MC	-	20 - 16	Stranded 0.5 - 1.25 Solid 0.5 - 1.25	-	Twisted shielded wire with Class 1 wiring
		G	M3.5	20 - 14	0.5 - 2	8.9 (1.0)	

* Wire sizes are based on 75°C copper wire.

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JST Closed Loop Connectors

Wire Size *		Terminal Screw	JST Closed-Loop Connectors (Lugs)	Max. Torque lb-in (N·m)
AWG	mm^2			
20	0.5	M3.5	1.25 - 3.5	8.9 (1.0)
		M4	1.25 - 4	12.4 (1.4)
18	0.75	M3.5	1.25 - 3.5	8.9 (1.0)
		M4	1.25 - 4	12.4 (1.4)
16	1.25	M3.5	1.25 - 3.5	8.9 (1.0)
		M4	1.25 - 4	12.4 (1.4)
14	2	M3.5	2 - 3.5	8.9 (1.0)
		M4	2 - 4	12.4 (1.4)
		M5	2 - 5	22.1 (2.5)
		M6	2 - 6	45.1 (5.1)
		M8	2 - 8	90.3 (10.2)
12 - 10	3.5 - 5.5	M4	5.5 - 4	12.4 (1.4)
		M5	5.5 - 5	22.1 (2.5)
		M6	5.5 - 6	45.1 (5.1)
		M8	5.5 - 8	90.3 (10.2)
8	8	M5	8 - 5	22.1 (2.5)
		M6	8 - 6	45.1 (5.1)
		M8	8 - 8	90.3 (10.2)
6	14	M6	14 - 6	45.1 (5.1)
		M8	14 - 8	90.3 (10.2)
4	22	M6	22 - 6	45.1 (5.1)
		M8	22 - 8	90.3 (10.2)
3 - 2	30 - 38	M8	38 - 8	90.3 (10.2)
1 - 1/0	50 - 60	M8	60 - 8	90.3 (10.2)
		M10	60 - 10	203.6 (23.0)
3/0	80	M10	80 - 10	203.6 (23.0)
4/0	100		100 - 10	203.6 (23.0)
4/0	100	M12	100 - 12	349.6 (39.5)
300MCM	150		150 - 12	349.6 (39.5)
400MCM	200		200 - 12	349.6 (39.5)
650MCM	325	M12 x 2	325 - 12	349.6 (39.5)
		M16	325 - 16	867.4 (98.0)

Note:

The use of a JST closed-loop connector (lug) is recommended to maintain proper clearances. Please contact your Saftronics representative for more information.

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Control Circuit Wiring

The following table outlines the functions of the control circuit terminals.

Control Circuit Terminals

Classification	Terminal	Function	Description		Signal Level
Multi-function Input Signal	S1	Forward run/stop	Forward run when closed, stop when open		Photo-coupler insulation Input: +24VDC 8mA
	S2	Reverse run/stop	Reverse run when closed, stop when open	Multi-function contact inputs (*n036* to *n040*)	
	S3	External fault input	Fault when closed, normal state when open		
	S4	Fault reset input	Reset when closed		
	S5	Multi-step speed reference 1	Enabled when closed		
	S6	Multi-step speed reference 2	Enabled when closed		
	SC	Sequence input common terminal	—		
Analog Input Signal	FS	+15V Power supply output	For analog command +15V power supply		+15V (allowable current 20mA max.)
	FV	Frequency reference input (voltage)	0 to +10V/100%	*n043* = "FV=MSTR": FV enabled *n043* = "FI=MSTR": FI enabled	0 to +10V (20kΩ)
	FI	Frequency reference input (current)	4 to 20mA/100%		4 to 20mA (250Ω)
	FC	Common terminal	0V		—
	G	Connection to shield sheath of signal lead	—		—
Multi-function Output Signal	M1	During running (N.O. contact)	Closed when running	Multi-function contact output *(n042)*	Dry contact Contact capacity: 250VAC 1A or less 30VDC 1A or less
	M2				
	MA	Fault contact output (N.O./N.C. contact)	Fault when closed between terminals MA and MC Fault when open between terminals MB and MC	Multi-function contact output *(n041)*	
	MB				
	MC				
Analog Output Signal	AM	Frequency meter output	0 to +10V/100% frequency	Multi-function analog monitor 1 *(n052)*	0 to +10V 2mA or less
	AC	Common			

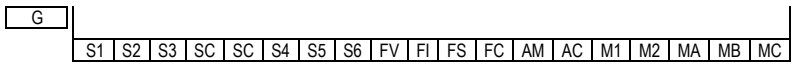


Figure 12 Control Circuit Terminal Arrangement

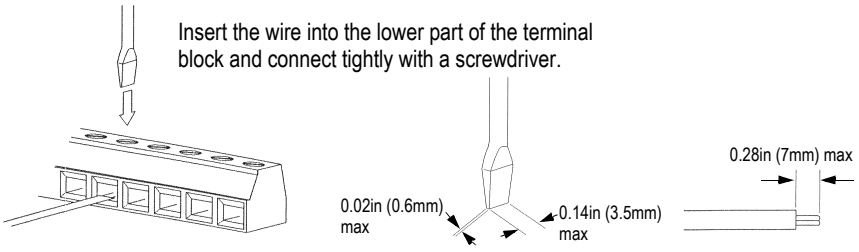


Figure 13 Wiring the Control Circuit Terminal

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- CHAPTER 2 -

OPERATION

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⚠WARNING

PRECAUTIONS

1) Only turn ON the input power supply after replacing the front cover. Do not remove the cover while the inverter is powered up.
2) When the retry function (*n060*) is selected, do not approach the inverter or the load, since it may restart suddenly after being stopped.
3) Since the Stop key can be disabled by a function setting, install a separate emergency stop switch to disconnect power or fault the inverter.
4) Do not touch the heatsink or braking resistor, due to very high temperatures.
5) Since it is very easy to change operation speed from low to high speed, verify the safe working range of the motor and machine before operation.
6) Install a separate holding brake, if necessary.
7) Do not check signals during operation.
8) All inverter parameters have been preset at the factory. Do not change the settings without thorough review of the possible consequences.

Failure to observe these precautions may result in equipment damage, serious personal injury, or death.

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2.1 TRIAL OPERATION

To ensure safety, prior to initial operation, disconnect the machine coupling so that the motor is isolated from the machine. If initial operation must be performed while the motor is still coupled to the machine, use great care to avoid potentially hazardous conditions. Check the following items before a trial run:

- Wiring and terminal connections are proper.
- Wire clippings and other debris removed from the unit.
- Screws are securely tightened.
- Motor is securely mounted.
- All items are correctly grounded.

Digital Operator Display at Power-Up (JVOP-130P)

When the system is ready for operation, turn ON the power supply. Verify that the inverter powers up properly. If any problems are detected, turn OFF the power supply immediately. The digital operator display illuminates as shown below when the power supply is turned ON.

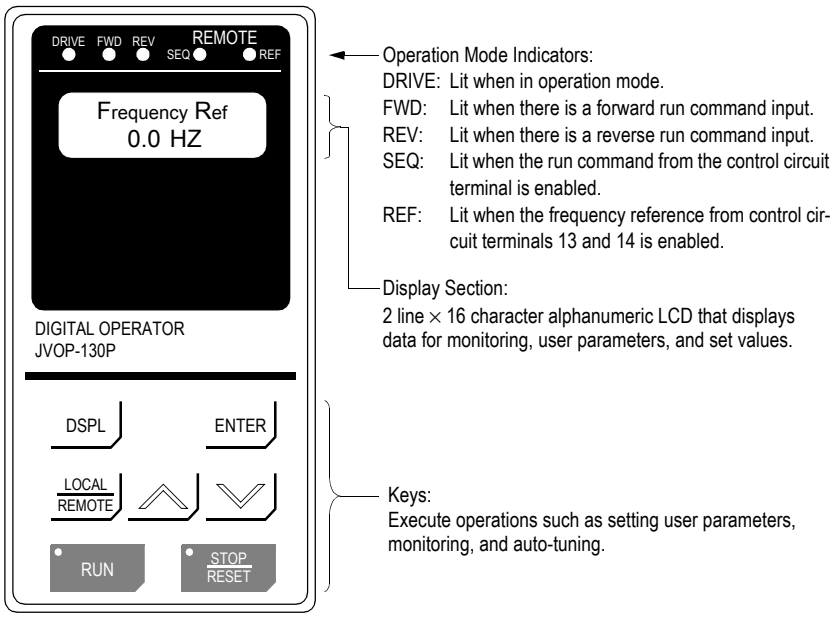


Figure 14 Digital Operator Display at Power-up (JVOP-130P)

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Operation Checkpoints:

- Motor rotates smoothly.
- Motor rotates in the correct direction.
- Motor has no abnormal vibration and is not noisy.
- Acceleration and deceleration are smooth.
- Unit is not overloaded.
- Status indicator LEDs and digital operator display are correct.

Basic Operation

The inverter will operate after receiving a frequency reference. There are two operation modes for the FP5/GP5:

- Run command from the digital operator.
- Run command from the control circuit terminals.

Operation by Digital Operator

The diagram below shows a typical operation pattern using the digital operator. Pressing the LOCAL/REMOTE key once while the inverter is stopped places the inverter in the LOCAL mode. The digital operator, JVOP-130P, can then be used to start and stop and change the reference.

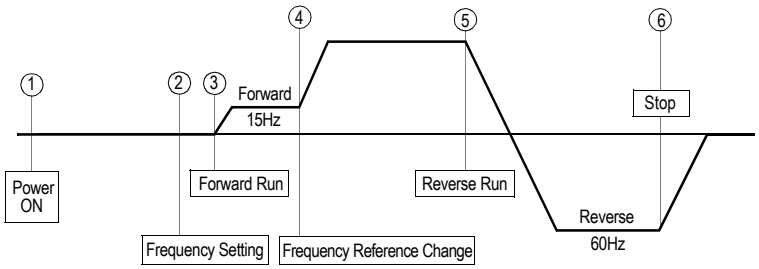


Figure 15 Operation Sequence by Digital Operator

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Typical Operation Example by Digital Operator (JVOP-130P)

Description	Key Sequence	Digital Operator Display
(1) Power ON · Displays frequency reference value.		REMOTE LED (SEQ, REF) ON Frequency Ref 0.0 Hz
Operation Condition Setting · Select LOCAL mode.	LOCAL REMOTE	REMOTE LED (SEQ, REF) OFF
(2) Frequency Setting · Change frequency reference value.	Change the value by depressing	Frequency Ref 15.0 Hz
· Write-in set value.	ENTER	Frequency Ref 15.0 Hz
· Select output frequency monitor display.	DSPL	Output Freq 0.0 Hz
(3) Forward Run · Forward run (15Hz)	RUN	Output Freq 15.0 Hz RUN LED ON
(4) Frequency Reference Value Change (15~60Hz) · Select frequency reference value display.	DSPL Depress 15 times	Frequency Ref 15.0 Hz
· Change set value.	Change the value by depressing	Frequency Ref 60.0 Hz
· Write-in set value.	ENTER	Frequency Ref 60.0 Hz
· Select output frequency monitor display.	DSPL	Output Freq 60.0 Hz
(5) Reverse Run · Select reverse run.	DSPL Depress 3 times.	Forward/Reverse For
	Switch to "rev" by depressing	Forward/Reverse rev REVERSE LED (REV) ON
· Write-in set value.	ENTER	Forward/Reverse rev
· Select output frequency monitor display.	DSPL Depress 13 times.	Output Freq 60.0 Hz
(6) Stop · Decelerates to stop.	STOP RESET	Output Freq 0.0 Hz RUN LED OFF STOP LED ON

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Operation by Control Circuit Terminal Signal

The diagram below shows a typical operation pattern using the control circuit terminal signals.

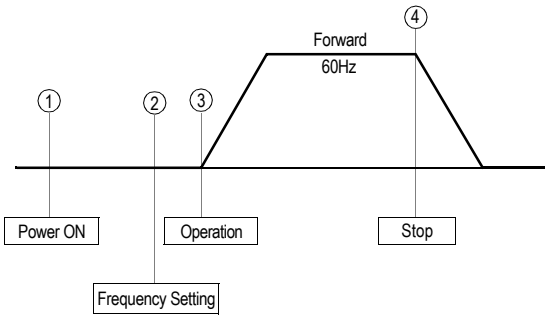


Figure 16 Operation Sequence by Control Circuit Terminal Signal

Typical Operation Example by Control Circuit Terminal Signal

Description	Key Sequence	Digital Operator Display
(1) Power ON · Displays frequency reference value. REMOTE mode is preset at the factory.		Frequency Ref 0.0 Hz REMOTE LED (SEQ, REF) ON
(2) Frequency Setting · Input frequency reference voltage (current) by control circuit terminal FV or FI and verify the input value by the digital operator.		Frequency Ref 60.0 Hz For reference voltage 10V
Output Frequency Display · Write-in set value.	DSPL	Output Freq 0.0 Hz
(3) Forward Run · Close between control circuit terminals S1 and SC to perform forward run.		Output Freq 60.0 Hz RUN LED ON
(4) Stop · Open between control circuit terminals S1 and SC to stop operation.		Output Freq 0.0 Hz STOP LED ON (RUN LED blinking during deceleration)

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2.2 DIGITAL OPERATOR DISPLAY

All functions of the FP5/GP5 are accessed using the JVOP-130P Digital Operator. Below are descriptions of the display and keypad sections.

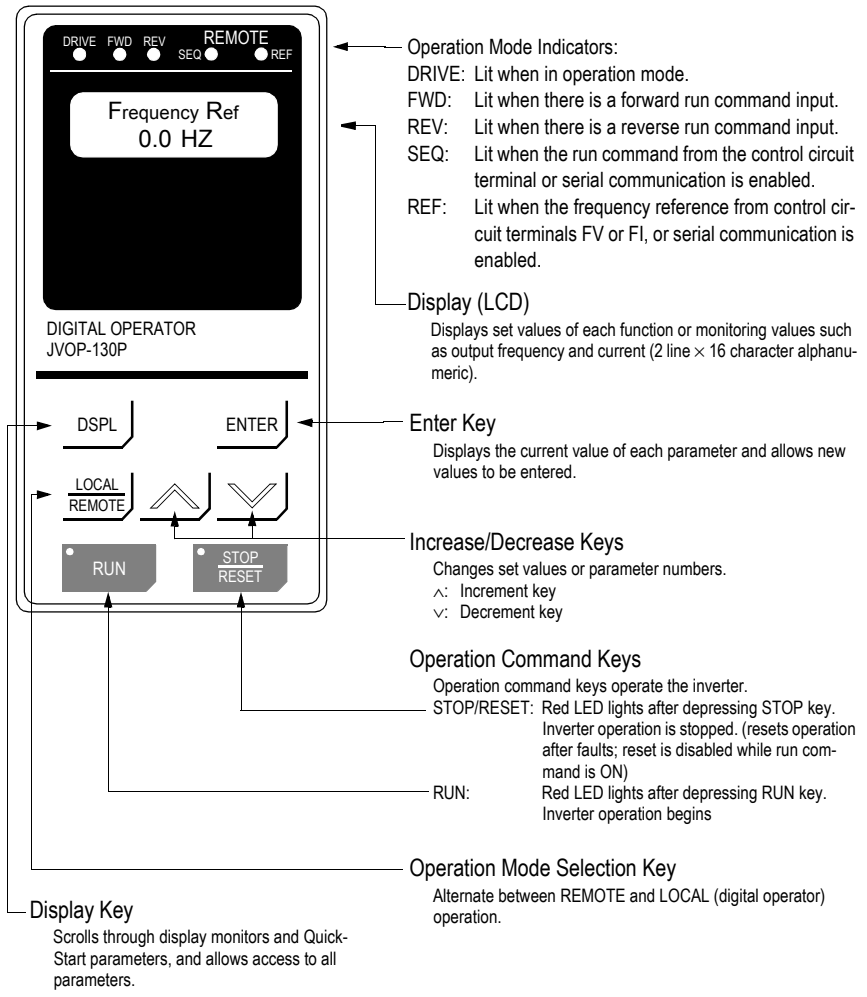


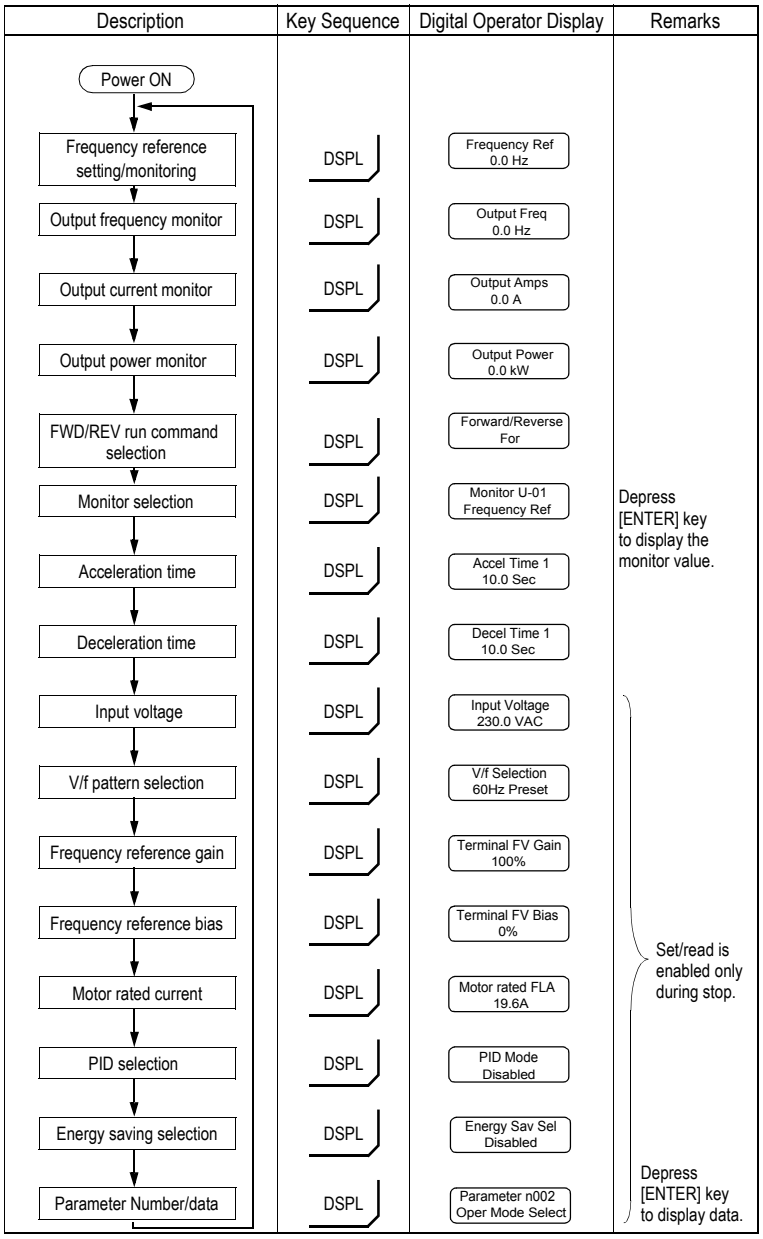
Figure 17 Digital Operator Display at Power-up

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2.3 LED DESCRIPTION

Simple operation of the FP5/GP5 is possible, by using the quick-start displays.

Quick-Start Displays (Example of CIMR-P5U23P7)



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2.4 OPERATION MODE SELECTION *(n002, Oper Mode Select)*

The FP5/GP5 has two operation modes: LOCAL and REMOTE (see table below for description). These two modes can be selected by the digital operator "LOCAL/REMOTE" key only when operation is stopped. The operation mode selected can be verified by observing the SEQ and REF LEDs on the digital operator (as shown below). The operation mode is set to REMOTE (run by control circuit terminals FV and FI frequency reference and run command from control circuit terminals) prior to shipment. Multi-function contact inputs from control circuit terminals S3 to S6 are enabled in both operation modes.

- LOCAL: Both frequency reference and run command are set by the digital operator. Remote SEQ and REF LEDs go OFF.
- REMOTE: Master frequency reference and run command can be selected as described in the table below.

Parameter n111, LOC/REM Change, will determine if the inverter will acknowledge a previously closed run input during a switchover from LOCAL to REMOTE mode.

- When n111 is set to "Cycle Extern Run", the inverter will not start if the run input is closed during the transition from LOCAL to REMOTE.
- When n111 is set to "Acept Extern Run", the inverter will immediately start if the run input is closed during the transition from LOCAL to REMOTE.

Operation Mode Selection

LED Display	LCD Display	Operation Method Selection	SEQ LED	Reference Selection	REF LED
0	SEQ=OPR REF=OPR	Operation by run command from digital operator	OFF	Master frequency reference from digital operator	OFF
1	SEQ=TRM REF=OPR	Operation by run command from control circuit terminal	ON	Master frequency reference from digital operator	OFF
2	SEQ=OPR REF=TRM	Operation by run command from digital operator	OFF	Master frequency reference from control circuit terminals FV and FI	ON
3	SEQ=TRM REF=TRM	Operation by run command from control circuit terminal	ON	Master frequency reference from control circuit terminals FV and FI	ON
4	SEQ=OPR REF=COM	Operation by run command from digital operator	OFF	Master frequency reference set by serial communication	ON
5	SEQ=TRM REF=COM	Operation by run command from control circuit terminal	ON	Master frequency reference set by serial communication	ON
6	SEQ=COM REF=COM	Operation by run command from serial communication	ON	Master frequency reference set by serial communication	ON
7	SEQ=COM REF=OPR	Operation by run command from serial communication	ON	Master frequency reference from digital operator	OFF
8	SEQ=COM REF=TRM	Operation by run command from serial communication	ON	Master frequency reference from control circuit terminals FV and FI	ON

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- CHAPTER 3 -

PROGRAMMING FEATURES

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3.1 FP5/GP5 Parameters *(n001~n116)*

No.	Function Name (LCD Operator Display)	Description	Factory Default	User Setting	Ref. Page
n001	Parameter selection/ initialization (Password)	0: *n001* read and set, *n002~n116* read only 1: *n001~n035* read and set, *n036~n116* read only 2: *n001~n053* read & set, *n054~n116* read only 3: *n001~n116* read and set 4, 5: Not used 6: 2-wire initialization (Japanese specifications) 7: 3-wire initialization (Japanese specifications) 8: 2-wire initialization (American specifications) 9: 3-wire initialization (American specifications)	1		49
n002	Operation mode selection (Oper Mode Select)	LED Setting / LCD Setting / Operation / Reference 0 SEQ=OPR REF=OPR Operator Operator 1 SEQ=TRM REF=OPR Terminal Operator 2 SEQ=OPR REF=TRM Operator Terminal 3 SEQ=TRM REF=TRM Terminal Terminal 4 SEQ=OPR REF=COM Operator Serial com 5 SEQ=TRM REF=COM Terminal Serial com 6 SEQ=COM REF=COM Serial com Serial com 7 SEQ=COM REF=OPR Serial com Operator 8 SEQ=COM REF=TRM Serial com Terminal	SEQ=TRM REF=TRM		37
n003	Input voltage (Input Voltage)	Unit: 0.1V Setting range: 150.0~255.0V (510V for 460V units)	230.0V (460.0V)		-
n004	Stopping method (Stopping Method)	LED Setting / LCD Setting / Description 0 Ramp to stop Ramp to stop 1 Coast to stop Coast to stop 2 Coast w/Timer1 Coast to stop with timer (Run command cycle) 3 Coast w/Timer2 Coast to stop with timer (auto-start after time out)	Ramp to Stop		70
n005	Motor rotation (Motor Rotation)	LED Setting / LCD Setting / Description 0 Rotate C.C.W. CCW shaft rotation 1 Rotate C.W. CW shaft rotation	Rotate C.C.W.		-
n006	Prohibit reverse operation (Reverse Oper)	LED Setting / LCD Setting / Description 0 Rev Allowed Reverse operation enabled 1 Rev Prohibited Reverse operation disabled	Rev Allowed		68
n007	Local/remote key function (Local/Remote Key)	LED Setting / LCD Setting 0 Disabled 1 Enabled	Enabled		37
n008	Stop key function (Oper STOP Key)	LED Setting / LCD Setting / Description 0 Disabled Stop key is disabled when operated from terminals 1 Enabled Stop key is always enabled	Enabled		-
n009	Frequency reference setting method from operator (Operator MOP)	LED Setting / LCD Setting 0 Enter not used 1 Enter key used	Enter key used		-
n010	V/f pattern selection (V/f Selection)	LED Setting / LCD Setting / Description 0 User Defined V/f Custom V/f pattern (n011 ~ n017 can be set) 1 60 Hz Preset Fixed V/f pattern	60 Hz Preset		75,96
n011	Maximum frequency (Max Frequency)	Unit: 0.1Hz Setting range: 50.0~400.0Hz	60.0Hz		76
n012	Maximum voltage (Max Voltage)	Unit: 0.1V Setting range: 0.1~255.0V (510V for 460V units)	230.0V		76
n013	Base frequency (Base Frequency)	Unit: 0.1Hz Setting range: 0.2~400.0Hz	60.0Hz		76

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No.	Function Name (LCD Operator Display)	Description	Factory Default	User Setting	Ref. Page
n014	Mid. output frequency (Mid Frequency)	Unit: 0.1Hz Setting range: 0.1~399.9Hz	3Hz		76
n015	Mid. frequency voltage (Mid Voltage)	Unit: 0.1V Setting range: 0.1~255.0V (510V for 460V units)	17.2V (34.4V)		76
n016	Minimum output frequency (Min Frequency)	Unit: 0.1Hz Setting range: 0.1~10.0Hz	1.5Hz		76
n017	Minimum output voltage (Min Voltage)	Unit: 0.1V Setting range: 0.1~50.0V (510V for 460V units)	11.5V (23.0V)		76
n018	Acceleration time 1 (Accel Time 1)	Unit: 0.1s (1s for 1000s and above) Setting range: 0.0~3600s	10.0s		50,96
n019	Deceleration time 1 (Decel Time 1)	Unit: 0.1s (1s for 1000s and above) Setting range: 0.0~3600s	10.0s		50,96
n020	Acceleration time 2 (Accel Time 2)	Unit: 1s Setting range: 0~255s	10.0s		50
n021	Deceleration time 2 (Decel Time 2)	Unit: 1s Setting range: 0~255s	10.0s		50
n022	S-curve selection (S-Curve Select)	LED Setting / LCD Setting 0 — No S-curve 1 — 0.2s 2 — 0.5s 3 — 1.0s	0.2s		68
n023	Display mode (Display Units)	Setting / Display 0 — 0.1Hz 1 — 0.1% 2~39 — rpm (input # of motor poles) 40~3999 — custom	0		-
n024	Frequency reference 1 (Reference 1)	Setting depends on *n023* setting. Range: 0~9999	0.0Hz		64,95
n025	Frequency reference 2 (Reference 2)	Setting depends on *n023* setting. Range: 0~9999	0.0Hz		64
n026	Frequency reference 3 (Reference 3)	Setting depends on *n023* setting. Range: 0~9999	0.0Hz		64
n027	Frequency reference 4 (Reference 4)	Setting depends on *n023* setting. Range: 0~9999	0.0Hz		64
n028	Not used	-	-	-	-
n029	Not used	-	-	-	-
n030	Jog frequency (Jog Reference)	Setting depends on *n023* setting. Range: 0~9999	6.0Hz		60
n031	Frequency upper limit (Ref Upper Limit)	Unit: 1% Setting range: 0~109%	100%		69
n032	Frequency lower limit (Ref Lower Limit)	Unit: 1% Setting range: 0~100%	0%		69
n033	Motor rated current (Motor Rated FLA)	Unit: 0.1A Range: 10~200% inverter rated current Unit is 1A, when setting is more than 1,000A	kVA dependent		62,96

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<table>
<tr><th>No.</th><th>Function Name
(LCD Operator Display)</th><th>Description</th><th>Factory Default</th><th>User Setting</th><th>Ref. Page</th></tr>
<tr><td>n034</td><td>Motor thermal protection
(Motor OL Sel)</td><td>
<table>
<tr><th>LED Setting</th><th>LCD Setting</th><th>Description</th></tr>
<tr><td>0</td><td>Disabled</td><td>Protection disabled</td></tr>
<tr><td>1</td><td>STD Motor/8 min</td><td>General-purpose motor (time constant 8 min.)</td></tr>
<tr><td>2</td><td>STD Motor/5 min</td><td>General-purpose motor (time constant 5 min.)</td></tr>
<tr><td>3</td><td>INV Motor/8 min</td><td>Blower-cooled motor (time constant 8 min.)</td></tr>
<tr><td>4</td><td>INV Motor/ 5 min</td><td>Blower-cooled motor (time constant 5 min.)</td></tr>
</table>
</td><td>STD Motor/ 8 min</td><td></td><td>62</td></tr>
<tr><td>n035</td><td>Stop method selection - OH1- for inverter overheat pre-alarm
(OH1 Stop Method)</td><td>
<table>
<tr><th>LED Setting</th><th>LCD Setting</th><th>Description</th></tr>
<tr><td>0</td><td>Ramp STOP/Decel 1</td><td>Ramp to stop - Decel 1 (fault)</td></tr>
<tr><td>1</td><td>Coast to STOP</td><td>Coast to stop (fault)</td></tr>
<tr><td>2</td><td>Ramp STOP/Decel 2</td><td>Ramp to stop - Decel 2 (fault)</td></tr>
<tr><td>3</td><td>Continue Oper</td><td>Continue operation (alarm) at 80% of frequency reference</td></tr>
</table>
</td><td>Continue Oper</td><td></td><td>-</td></tr>
<tr><td>n036</td><td>Multi-function input selection 1
(Terminal S2 Sel)</td><td>
<table>
<tr><th>LED Setting</th><th>LCD Setting</th><th>Description</th></tr>
<tr><td>0</td><td>Reverse RUN (2W)</td><td>Reverse run (2-wire sequence)</td></tr>
<tr><td>1</td><td>FWD/REV Cmd (3W)</td><td>Fwd / Rev command (3-wire sequence)</td></tr>
<tr><td>2</td><td>Ext Fault (NO)</td><td>External fault (normally open)</td></tr>
<tr><td>3</td><td>Ext Fault (NC)</td><td>External fault (normally closed)</td></tr>
<tr><td>4</td><td>Fault Reset</td><td>Fault reset</td></tr>
<tr><td>5</td><td>LOCAL/REMOTE Sel</td><td>Local / Remote selection</td></tr>
<tr><td>6</td><td>COM/INV Sel</td><td>Serial com/inverter selection (Fref, RUN command)</td></tr>
<tr><td>7</td><td>STOP Cmd/Dec2 NO</td><td>Fast stop using Decel 2 (normally open)</td></tr>
<tr><td>8</td><td>STOP Cmd/Dec2 NC</td><td>Fast stop using Decel 2 (normally closed)</td></tr>
<tr><td>9</td><td>Master Fref Sel</td><td>Master freq. ref. selection (FV-open or FI-closed)</td></tr>
<tr><td>10</td><td>Multi-Step Spd 1</td><td>Multi-step speed reference command 1</td></tr>
<tr><td>11</td><td>Multi-Step Spd 2</td><td>Multi-step speed reference command 2</td></tr>
<tr><td>12</td><td>Not Used</td><td>Not used</td></tr>
<tr><td>13</td><td>JOG Command</td><td>Jog reference (n030)</td></tr>
<tr><td>14</td><td>Acc/Dec Switch</td><td>Accel / Decel time selection</td></tr>
<tr><td>15</td><td>Ext Baseblk (NO)</td><td>External baseblock (normally open)</td></tr>
<tr><td>16</td><td>Ext Baseblk (NC)</td><td>External baseblock (normally closed)</td></tr>
<tr><td>17</td><td>SpdSrch (MAXFRQ)</td><td>Speed search from maximum frequency</td></tr>
<tr><td>18</td><td>SpdSrch (SETFRQ)</td><td>Speed search from set frequency</td></tr>
<tr><td>19</td><td>Param Lockout</td><td>Parameter setting enable / disable</td></tr>
<tr><td>20</td><td>PID I Reset</td><td>PID integral value reset</td></tr>
<tr><td>21</td><td>PID Disable</td><td>PID control enable / disable</td></tr>
<tr><td>22</td><td>Timer Start Cmd</td><td>Timer function</td></tr>
<tr><td>23</td><td>OH3 Input</td><td>External overheat alarm (OH3)</td></tr>
<tr><td>24</td><td>Ref Sample Hold</td><td>Analog reference sample hold command</td></tr>
<tr><td>25</td><td>KEB Cmd (NO)</td><td>Inertia ridethrough command (normally open)</td></tr>
<tr><td>26</td><td>KEB Cmd (NC)</td><td>Inertia ridethrough command (normally closed)</td></tr>
<tr><td>27</td><td>Hold Command</td><td>Accel / Decel hold command</td></tr>
<tr><td>28</td><td>PID Polarity Sel</td><td>Inverse PID enable / disable</td></tr>
</table>
</td><td>Reverse RUN (2W)</td><td></td><td>78</td></tr>
</table>

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No.	Function Name (LCD Operator Display)	Description	Factory Default	User Setting	Ref. Page
n037	Multi-function input 2 (Terminal S3 Sel)	Set items are same as *n036.* (When *n036="FWD/REV Cmd (3W)*, "In Use By Other" is displayed, and setting is prohibited)	Ext Fault (NO)		78
n038	Multi-function input 3 (Terminal S4 Sel)	Set items are same as *n036.*	Fault Reset		78
n039	Multi-function input 4 (Terminal S5 Sel)	Set items are same as *n036.* (When *n040="Up/Down Control*", "In Use By Other is displayed, and setting is prohibited)	Multi-Step Spd 1		78
n040	Multi-function input 5 (Terminal S6 Sel)	Set items are same as *n036.* LED Setting / LCD Setting / Description 29 / Up / Down control / Up / Down command (Terminal S5=Up command, and terminal S6=Down command).	Multi-Step Spd 2		78
n041	Multi-function output selection 1 (Terminal MA Sel)	LED Setting / LCD Setting / Description 0 / Fault / Fault 1 / During Running / During running 2 / At Speed / Frequency agree 3 / At Desired Speed / Desired frequency agree 4 / Freq Detection 1 / Frequency detection 1 5 / Freq detection 2 / Frequency detection 2 6 / OverTrq Det (NO) / Over/Undertorque detection (normally open) 7 / OverTrq Det (NC) / Over/Undertorque detection (normally closed) 8 / Baseblocked / During baseblock 9 / Operation Mode / Local mode 10 / Ready / Inverter operation ready 11 / Timer Output / Timer function 12 / Auto-Restarting / During auto restart 13 / OL Pre-Alarm / OL pre-alarm (80% OL1 or OL2) 14 / Freq Ref Loss / Frequency reference loss 15 / Set By COM Cntl / Closed by serial communication 16 / PID Fdbk Loss / PID feedback loss 17 / OH1 Alarm / OH1 Alarm (set if *n035* set to "3")	Fault		83
n042	Multi-function output selection 2 (Terminal M1 Sel)	Set items are as same as *n041*	During Running		83
n043	Master analog input selection - FV or FI terminal (Analog Input Sel)	LED Setting / LCD Setting / FV / FI / Remarks 0 / FV=MSTR FI=AUX / Master / Aux. / Enable 1 / FV=AUX FI=MSTR / Aux. / Master / Enable 2 / FV=RST FI=MSTR / Fault reset / Master / Disable Enable: FV/FI switchover function is enabled. Disable: FV/FI switchover function is disabled. Note: When PID is enabled (n084 ≠ 0), FV terminal = PID reference, and FI terminal = PID feedback.	FV=MSTR FI=AUX		82
n044	Aux. analog input selection (Terminal FI Sel)	LED Setting / LCD Setting / Description 0 / 0-10VDC / 0~10V input (Jumper J1 must be cut) 1 / 4-20mA / 4~20mA input	4-20mA		82
n045	Frequency reference retention (MOP Ref Memory)	LED Setting / LCD Setting / Description 0 / Memorize Fref / Retained in frequency reference 1 *(n024)* 1 / Not Memorized / Not retained after power-down	Memorize Fref		82
n046	Operation method for frequency reference loss detection (Ref Loss Detect)	LED Setting / LCD Setting / Description 0 / Not detected / No detection 1 / Run @ n047 Fref / Continue to run at *n047* setting	Not Detected		82

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No.	Function Name (LCD Operator Display)	Description	Factory Default	User Setting	Ref. Page
n047	Frequency reference level at loss of Fref (Fref Lvl@F Loss)	Unit: 1% Setting range: 0~100% of setting Fref	80%		82
n048	Terminal FV gain (Terminal FV Gain)	Unit: 1% Setting range: 0~200%	100%		59,96
n049	Terminal FV bias (Terminal FV Bias)	Unit: 1% Setting range: -100~100%	0%		59,96
n050	Terminal FI gain (Terminal FI Gain)	Unit: 1% Setting range: 0~200%	100%		59
n051	Terminal FI bias (Terminal FI Bias)	Unit: 1% Setting range: -100~100%	0%		59
n052	Multi-function analog output AM (Terminal AM Sel)	LED Setting / LCD Setting / Monitor 0 Output Freq — Output frequency 1 Output Amps — Output current 2 Output kWatts — Output power 3 DC Bus Voltage — DC bus voltage	Output Freq		58
n053	Analog monitor gain (Terminal AM Gain)	Unit: 0.01 Setting range: 0.01~2.00	1.00		58
n054	Carrier frequency (Carrier Freq Sel)	Unit: 1 Setting range: 1~6 (x2.5kHz), 7~9 (custom pattern)	kVA dependent		51
n055	Momentary power loss ridethrough method (PwrL Selection)	LED Setting / LCD Setting / Method 0 Not Provided — Not provided 1 2 Seconds Max — Continuous operation after power recovery within 2s 2 CPU Power Active — Continuous operation after power recovery within control logic time (no fault output)	Not Provided		51
n056	Speed search level - decel time fixed at 2 sec (SpdSrch Current)	Unit: 1% Setting range: 0~200% 100% = inverter rated current	110%		74
n057	Minimum baseblock time (Min Baseblock t)	Unit: 0.1s Setting range: 0.5~10.0s	kVA dependent		71
n058	V/f reduction level during speed search (SpdSrch V/f)	Unit:1% Setting range: 0~100%	kVA dependent		-
n059	Power loss ridethrough time (PwrL Ridethru t)	Unit: 0.1s Setting range: 0.0~2.0s	kVA dependent		-
n060	Automatic retry attempts (Num of Restarts)	Unit: 1 time Setting range: 0~10	0		51
n061	Fault contact selection during automatic retry (Restart Sel)	LED Setting / LCD Setting / Description 0 Activate Flt Rly — Closed during fault retry 1 No Rly Output — Open during fault retry	Activate Flt Rly		-
n062	Jump frequency 1 (Jump Freq 1)	Unit: 0.1Hz Setting range: 0.0~400.0Hz	0.0Hz		60
n063	Jump frequency 2 (Jump Freq 2)	Unit: 0.1Hz Setting range: 0.0~400.0Hz	0.0Hz		60
n064	Jump frequency bandwidth (Jump Bandwidth)	Unit: 0.1Hz Setting range: 0.0~25.5Hz	1.0Hz		60

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No.	Function Name (LCD Operator Display)	Description	Factory Default	User Setting	Ref. Page
n065	Elapsed timer selection (Elapsed Timer)	LED Setting / LCD Setting / Description 0 — Time Power is ON — Accumulate time during power on 1 — Time Running Mtr — Accumulate time during running	Time Running Mtr		-
n066	Elapsed timer 1 (Elapsed Time 1)	Unit: 1 hour Range: 0~9999 * Initial value becomes 0 only when initialized during CPF4 occurrence.	*		-
n067	Elapsed timer 2 (Elapsed Time 2)	Unit: 10,000 hours Range: 0~27 * Initial value becomes 0 only when initialized during CPF4 occurrence.	*		-
n068	DC injection current (DCInj Current)	Unit: 1% Setting range: 0~100% 100% = inverter rated current	50%		54,75
n069	DC injection time at stop (DCInj Time @ Stop)	Unit: 0.1s Setting range: 0.0~10.0s	0.0s		54
n070	DC injection time at start (DCInj Time @ Start)	Unit: 0.1s Setting range: 0.0~10.0s	0.0s		55,75
n071	Torque compensation gain (Torq Comp Gain)	Unit: 0.1 Setting range: 0.0~3.0 (normally, no adjustment is necessary)	1.0		72
n072	Stall prevention during deceleration (StallP Decel Sel)	LED Setting / LCD Setting 0 — Disabled 1 — Enabled	Enabled		54
n073	Current limit/Stall prevention level during acceleration (StallP Accel Lvl)	Unit: 1% Setting range: 30~200% When level is set to 200%, current limit during acceleration is disabled.	kVA dependent		52
n074	Current limit/Stall prevention level during running (StallP Run Level)	Unit: 1% Setting range: 30~200% When level is set to 200%, current limit during running is disabled.	kVA dependent		53
n075	Frequency agree set point (Freq Det Level)	Unit: 0.1Hz Setting range: 0.0~400.0Hz	0.0Hz		57,84
n076	Frequency agree detection width (Freq Det Width)	Unit: 0.1Hz Setting range: 0.0~25.5Hz	2.0Hz		84
n077	Over/Undertorque detection OL3 (Torq Det Sel)	LED Setting / LCD Setting / Description 0 — Disabled — Detection disabled 1 — OT/Spd Agree/Alm — Overtorque detection at speed agree; continue running after detection. (Alarm) 2 — OT/Run/Alm — Overtorque detection at run; continue running after detection. (Alarm) 3 — OT/Spd Agree/Flt — Overtorque detection at speed agree; coast to stop after detection. (Fault) 4 — OT/Run/Flt — Overtorque detection at run; coasts to stop after detection. (Fault) 5 — UT/Spd Agree/Alm — Undertorque detection at speed agree; continue running after detection. (Alarm) 6 — UT/Run/Alm — Undertorque detection at run; continue running after detection. (Alarm) 7 — UT/Spd Agree/Flt — Undertorque detection at speed agree; coast to stop after detection. (Fault) 8 — UT/Run/Flt — Undertorque detection at run; coast to stop after detection. (Fault)	Disabled		73

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No.	Function Name (LCD Operator Display)	Description	Factory Default	User Setting	Ref. Page
n078	Over/Undertorque detection level OL3 (Torq Det Level)	Unit: 1% Setting range: 30~200% 100% = inverter rated current	160%		74
n079	Over/Undertorque detection delay time OL3 (Torq Det Time)	Unit: 0.1s Setting range: 0.1~10.0s	0.1s		74
n080	On-delay timer (On-Delay Timer)	Unit: 0.1s Setting range: 0.0~25.5s	0.0s		80
n081	Off-delay timer (Off-Delay Timer)	Unit: 0.1s Setting range: 0.0~25.5s	0.0s		80
n082	DB resistor overheat function rH (DB Resistor Prot)	LED Setting / LCD Setting / Description 0 Disabled — No DB protection calculated or provided 1 Enabled — Protection provided for Yaskawa 3% ED resistor	Disabled		-
n083	Input phase loss detection level SPI (In Ph Loss Lvl)	Unit: 1% Setting range: 1~100% When setting is 100%, this function is disabled.	7%		65
n084	PID selection (PID Mode)	LED Setting / LCD Setting / Description 0 Disabled — PID disabled 1 Enabled D=Fdbk — PID enabled 2 Enabled D=Fdfwd — PID w / Feed forward 3 Enabled RevFdbk — PID w / Inverted feedback	Disabled		66,96
n085	Feedback calibration gain PID (PID Fdbk Gain)	Unit: 0.01 Setting range: 0.00~10.00	1.00		66
n086	Proportional gain PID (PID P Gain)	Unit: 0.01 Setting range: 0.0~10.0	1.0		66
n087	Integral time PID (PID I Time)	Unit: 0.1s Setting range: 0.0~100.0s	10.0s		66
n088	Derivative time PID (PID D Time)	Unit: 0.01s Setting range: 0.00~1.00s	0.00s		66
n089	Limit of integral value PID (PID I Limit)	Unit: 1% Setting range: 0~109%	100%		67
n090	Feedback loss detection PID (PID FdbkLoss Sel)	LED Setting / LCD Setting / Description 0 Disabled — Detection is disabled. 1 Multi-function Output Only — Detection is enabled.	Disabled		-
n091	Feedback loss detection level PID (PID FdbkLoss Lvl)	Unit: 1% Setting range: 0~100%	0%		-
n092	Feedback loss detection delay time PID (PID FdbkLoss Tim)	Unit: 0.1s Setting range: 0.0~25.5s	1.0s		66
n093	PID output selection (PID Output Sel)	LED Setting / LCD Setting 0 Not Inverted 1 Inverted	Not Inverted		67
n094	Sleep function start level PID (Sleep Start Lvl)	Unit: 0.1Hz Setting range: 0.0~400.0Hz	0.0Hz		67
n095	Sleep function delay time PID (Sleep Delay Time)	Unit: 0.1s Setting range: 0.0~25.5s	0.0s		67

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No.	Function Name (LCD Operator Display)	Description	Factory Default	User Setting	Ref. Page
n096	Energy saving selection (Energy Save Sel)	LED Setting / LCD Setting / Description 0 / Disabled / Energy saving is disabled. 1 / Enabled / Energy saving is enabled.	Disabled		55,96
n097	Energy saving gain K2 (Energy Save Gain)	Unit: 0.01 Setting range: 0.00~655.0 (0=No energy saving)	kVA dependent		55
n098	Energy saving voltage lower limit at 60Hz (EngSavVLLmt@60Hz)	Unit: 1% Setting range: 0~120%	75%		55
n099	Energy saving voltage lower limit at 6Hz (EngSavVLLmt@6Hz)	Unit: 1% Setting range: 0~25%	12%		55
n100	Time of average kW - Energy saving (EngSavTime/AvgkW)	Unit: 1 = 25ms Setting range: 0~200	1		-
n101	Modbus time over detection (MODBUS Timeout)	LED Setting / LCD Setting / Description 0 / Disabled / Time Over Detection is disabled. 1 / Enabled / Time Over Detection is enabled.	Enabled		-
n102	MODBUS stop method at communication error CE (MODBUS Fault Stop)	LED Setting / LCD Setting / Stop method 0 / Ramp STOP/Decel 1 / Ramp to stop - Decel 1 (fault) 1 / Coast to STOP / Coast to stop (fault) 2 / Ramp STOP/Decel 1 / Ramp to stop - Decel 2 (fault) 3 / Continue Oper / Continue operation (alarm)	Coast to STOP		-
n103	MODBUS frequency reference unit (MODBUS Fref Unit)	LED Setting / LCD Setting / Stop method 0 / 1=0.1Hz / 0.1Hz / 1 1 / 2=0.01Hz / 0.01Hz / 1 2 / 3000=100% / 100% / 30000 3 / 1=0.1% / 0.1% / 1	1=0.1Hz		62
n104	MODBUS slave address (MODBUS Address)	Unit: 1 Setting range: 0~31	1		62
n105	MODBUS BPS selection (MODBUS Baud Rate)	LED Setting / LCD Setting 0 / 2400 Baud 1 / 4800 Baud 2 / 9600 Baud	9600 Baud		61
n106	MODBUS parity selection (MODBUS Parity)	LED Setting / LCD Setting 0 / No parity 1 / Even parity 2 / Odd parity	No parity		61
n107	Slip compensation gain (Slip Comp Gain)	Unit: 0.1% [of Base Frequency (n013)] Setting range: 0.0 ~ 9.9%	0.0%		77
n108	Motor no-load current (Mtr No-Load Amp)	Unit: 1% [of Motor Rated Current (n033)] Setting range: 0 ~ 99%	30%		-
n109	Slip compensation primary delay time constant (Slip Comp Delay)	Unit: 0.1s Setting range: 0.0 ~ 25.5s	2.0s		77
n110	Operator connection fault detection selection (Oper Detect Flt)	LED Setting / LCD Setting 0: / Disabled 1: / Enabled	Disabled		-
n111	Local / Remote changeover function selection (LOC/REM Change)	LED Setting / LCD Setting 0 / Cycle Extern RUN command 1 / Acept Extern RUN command	Cycle Extern RUN		37

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No.	Function Name (LCD Operator Display)	Description	Factory Default	User Setting	Ref. Page
n112	Low frequency OL start point (Low Freq OL2 Start)	Unit: 0.1Hz Setting range: 0.0 ~ 10.0Hz	6.0Hz		-
n113	0Hz continuous operation level (OL2_Level_@_0 Hz)	Unit: 1% Setting range: 25 ~ 100%	50%		-
n114	Not used	-	-	-	-
n115	kVA selection (Inverter kVA Sel)	Unit: 1 Setting range: PC5 (0~8, 20~29), P5(9~F, 2A~35)	kVA Dependent		-
n116	CT / VT selection (CT / VT Selection)	LED Setting: 0: CT Operation Constant torque 1: VT Operation Variable torque	-		7,9

3.2 PARAMETER SET-UP & INITIALIZATION

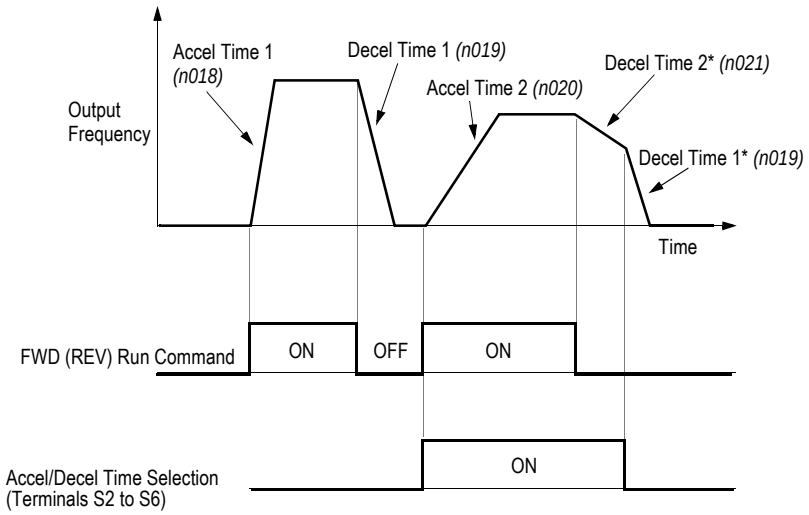
Parameter Selection/Initialization *(n001, Password)*
The following table describes data which can be set or read when parameter n001 is set.

Setting	Parameters that can be set	Parameters that can be viewed
0 (parameter read-only)	*n001*	*n001* to *n116*
1 *(factory default)*	*n001* to *n035*	*n001* to *n116*
2	*n001* to *n053*	*n001* to *n116*
3	*n001* to *n116*	*n001* to *n116*
4, 5	Not used	
6	Initialize: 2-wire sequence (Japanese specifications)	
7	Initialize: 3-wire sequence (Japanese specifications)	
8	Initialize: 2-wire sequence (American specifications)	
9	Initialize: 3-wire sequence (American specifications)	

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3.3 FP5/GP5 OPERATION

Accel/Decel Time Adjustment



* When "deceleration to stop" is selected (*n004* = "Ramp to STOP")

Figure 18 Timing Diagram of Accel/Decel Time Adjustment

When any of the multi-function input terminal selections (*n036*, *n037*, *n038*, *n039* or *n040*) is set to "Acc/Dec Switch", accel/decel times can be selected by opening or closing the appropriate terminal (S2, S3, S4, S5 or S6).

At OPEN: *n018* (accel time 1), *n019* (decel time 1)
At CLOSED: *n020* (accel time 2), *n021* (decel time 2)

Parameter No.	Name	Unit	Setting Range	Factory Default
n018	Acceleration time 1	0.1s *	0.0 to 3600s	**10.0s**
n019	Deceleration time 1	0.1s *	0.0 to 3600s	**10.0s**
n020	Acceleration time 2	0.1s *	0.0 to 3600s	**10.0s**
n021	Deceleration time 2	0.1s *	0.0 to 3600s	**10.0s**

* Setting unit is 1s for 1,000s and above.

- Acceleration time
  Sets the time necessary for the output frequency to move from 0Hz to maximum output frequency *(n011)*.
- Deceleration time
  Set the time necessary for the output frequency to move from maximum output frequency *(n011)* to 0Hz.

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Automatic Fault Retry (n060, Num of Restarts)

After a fault occurs, the inverter can automatically restart. The number of retry attempts can be set up to 10 times via parameter *n060*. The inverter can be set to automatically restart after the following faults occur:

- Overcurrent (OC)
- Overvoltage (OV)
- Undervoltage PUV (UV1)
- Ground fault (GF)
- Regenerative transistor fault (RR)

The number of retry attempts are cleared to "0" in the following cases:

- If no other fault occurs within 10 minutes after retry.
- When the fault reset signal is ON (closed) after the fault is detected.
- Power supply is turned OFF.

Automatic Restart After Momentary Power Loss (n055, PwrL Selection)

When momentary power loss occurs, operation restarts automatically. The run command must remain closed for this feature to function properly.

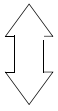
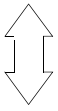
LED Setting	LCD Setting	Description
0	Not Provided	Not provided *(factory default)*
1 *	2 Seconds Max	Continuous operation after power recovery within 2 seconds
2 **	CPU Power Active	Continuous operation after power recovery within control logic time (no fault output)

* Holds the operation signal to continue operation after recovery from momentary power loss.

** When "CPU Power Active" is selected, operation restarts if power supply voltage returns to its normal level (level before power loss). No fault signal is output.

Carrier Frequency (n054, Carrier Freq Sel)

This function sets the inverter output transistor switching frequency (carrier frequency). This is used to reduce motor noise and leakage current. The factory setting for carrier frequency is the maximum allowable carrier frequency at which inverter rated current can continuously be generated. Consult the factory when increasing the carrier above the default values.

Carrier Frequency (kHz)		Metallic Noise from Motor	Leakage Current
LED Setting	LCD Setting	Louder	Smaller
1	2.5		
2	5.0		
3	8.0		
4	10.0		
5	12.5	Inaudible	Larger
6	15.0		

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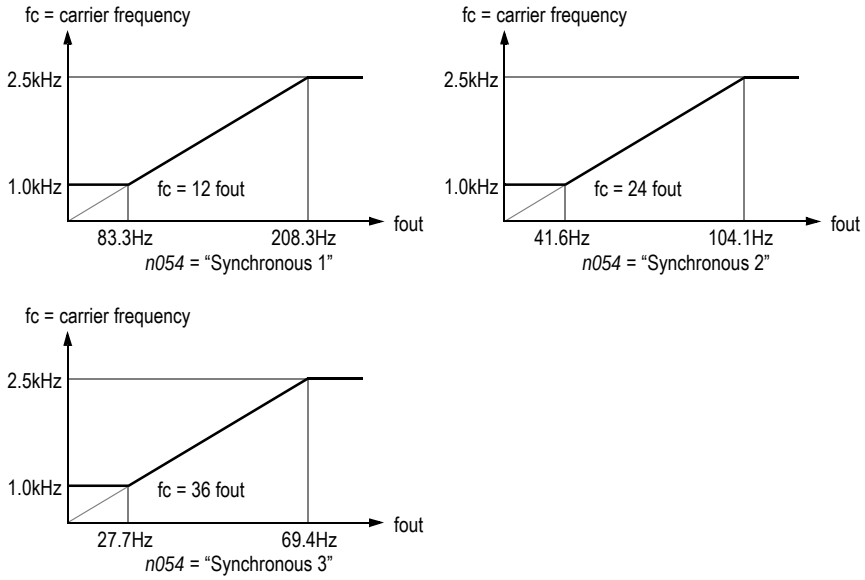


Figure 19 Custom Setting of Carrier Frequency Patterns

Current Limit (Stall Prevention)

This function automatically adjusts the output frequency in response to an increase in load current to continue operation without tripping the inverter.

- Stall Prevention Level During Acceleration *(n073, StallP Accel Lvl)*
  The current limit level during acceleration can be set in units of 1% (inverter rated current = 100%).
  Factory setting: kVA dependent

  A setting of 200% disables current limit during acceleration. During acceleration, if the output current exceeds the value set for *n073*, acceleration stops and frequency is maintained. When the output current goes down below the value set for parameter *n073*, acceleration resumes at the normal acceleration rate.

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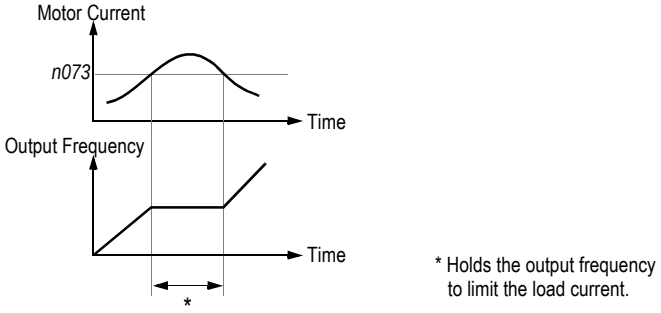


Figure 20 Stall Prevention During Acceleration

In the constant output area [output frequency ≥ base frequency *(n013)*], the current limit level during acceleration is changed by the following equation:

$$\boxed{\text{Current Limit Level During Accel in Constant Output Area}} = \boxed{\text{Current Limit Level During Acceleration } (n073)} \times \frac{\text{Base Frequency } (n013)}{\text{Output Frequency}}$$

- Stall Prevention Level During Running *(n074, StallP Run Level)*
  The stall prevention level during running can be set in units of 1% (inverter rated current = 100%).
  Factory setting: kVA dependent

  A setting of 200% disables current limit during running. During speed agree, if the output current exceeds the value set for parameter *n074*, then deceleration is initiated.
  While the output current exceeds the value set for *n074*, deceleration continues. When the output current goes below the value set for parameter *n074*, acceleration begins at the normal acceleration rate bringing the motor to the set frequency.

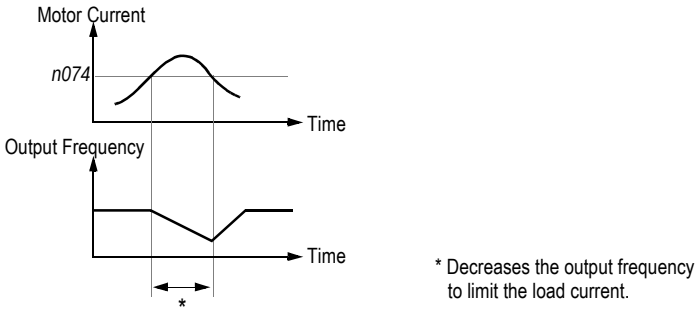


Figure 21 Stall Prevention During Running

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· Stall prevention during deceleration *(n072, StallP Decel Sel)*
To prevent overvoltage during deceleration, the inverter automatically extends the deceleration time according to the value of main circuit DC voltage. When using an optional braking resistor for the FP5/GP5, set parameter *n072* to"0".

LED Setting	LCD Setting	Stall Prevention During Deceleration
0	Disabled	Disabled (when optional braking resistor mounted)
1	Enabled	Enabled (factory default)

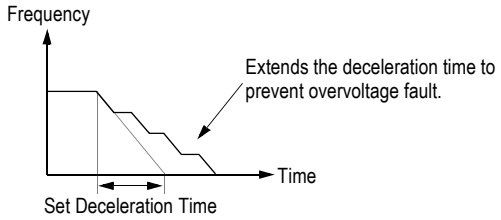


Figure 22 Stall Prevention During Deceleration

DC Injection Braking

· DC Injection Braking Current *(n068, DCInj Current)*
DC injection braking current can be set in increments of 1%. (100% = inverter rated current)

· DC injection Braking Time at Stop *(n069, DCInj Time @ Stop)*
DC injection braking time at stop can be set in increments of 0.1 second. When parameter *n069* is set to "0", DC injection braking at stopping is disabled.

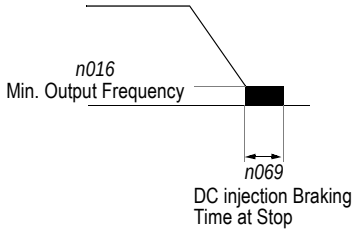


Figure 23a DC Injection Braking Time at Stop

When coast to stop is selected in the stopping method selection *(n004)*, DC injection braking at stop is disabled.

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· DC injection Braking Time at Start *(n070)*
DC injection braking time at start can be set in increments of 0.1 second. When parameter *n070* is set to "0", DC injection braking at starting is disabled.

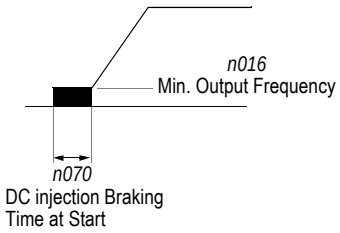


Figure 23b DC Injection Braking Time at Start

Energy Saving Control

To enable energy saving control, set energy saving selection *(n096, Energy Sav Sel)* to "1".

LED Setting	LCD Setting	Description
0	Disabled	Energy saving is disabled *(factory default)*.
1	Enabled	Energy saving is enabled.

Since the parameters used in the energy saving control mode have been preset at the factory to the optimum values, it is not necessary to adjust them under normal operation. If your motor characteristics differ greatly from those of standard induction motors, refer to the following description to adjust the parameters.

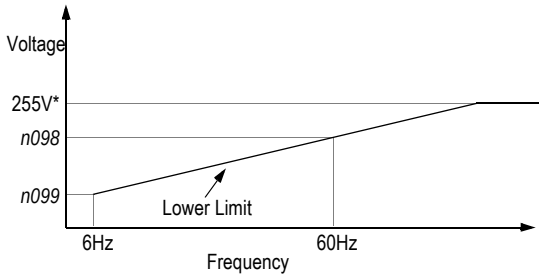
Energy Saving Control Mode

· Energy Saving Gain K2 *(n097, Energy Save Gain)*
Use this energy saving gain when running in the energy saving control mode to calculate the voltage at which motor efficiency will be greatest, and set it as the output voltage reference. This value is preset at the factory to the standard induction motor value prior to shipment. As the energy saving gain increases, output voltage decreases.

· Energy Saving Voltage Lower Limit *(n098, EngSavVLLmt@60Hz; n099, EngSavVLLmt@ 6Hz)*
Sets the output voltage lower limit. If the voltage reference value calculated in the energy saving mode is smaller than the specified lower

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limit, this lower limit value is output as the voltage reference value. The lower limit value is set in order to prevent stalling at light loads. Set voltage limits at 6Hz and 60Hz; a value obtained by linear interpolation should be used to set any limit values other than at 6Hz or 60Hz. Setting is made as a percentage of motor rated voltage.



* This value is doubled for 460V class inverters.

Figure 24 Energy Saving Voltage Lower Limit

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Frequency Agree Set Point (n075, Freq Det Level)

When multi-function contact output selections *n041* or *n042* are set to "Freq Det 1" or "Freq Det 2", frequency detection is enabled. This function is activated when the output frequency is above or below the frequency agree set point *(n075)*.

· Output frequency ≤ Frequency agree set point
Set *n041* or *n042* to "Freq Det 1".

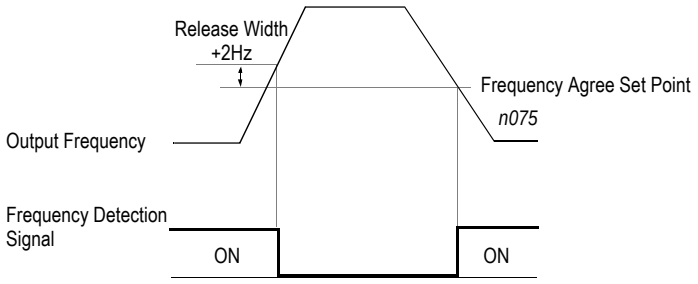


Figure 26 Frequency Agree Set Point Example
(Fout ≤ Frequency Agree Set Point)

· Output frequency ≥ Frequency agree set point
Set *n041* or *n042* to "Freq Det 2".

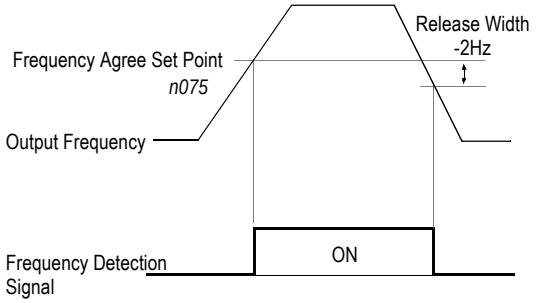


Figure 27 Frequency Agree Set Point Example
(Fout ≥ Frequency agree set point)

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Frequency Meter or Ammeter (n052, Terminal AM Sel)

This parameter selects whether the signal (on terminals AM and AC) is proportional to output frequency, output current, output power, or DC bus voltage for external monitoring.

Setting	Analog Monitor Output Selection
Output Freq	Output frequency (10V/max. frequency) - *factory default*
Output Amps	Output current (10V/inverter rated current)
Output kWatts	Output power (10V/inverter rated power)
DC Bus Voltage	DC bus voltage [10V/400VDC (230V class), 10V/800VDC (460V class)]

Frequency Meter or Ammeter Calibration (n053, Terminal AM Gain)

This function is used to adjust the analog monitor output signal level.

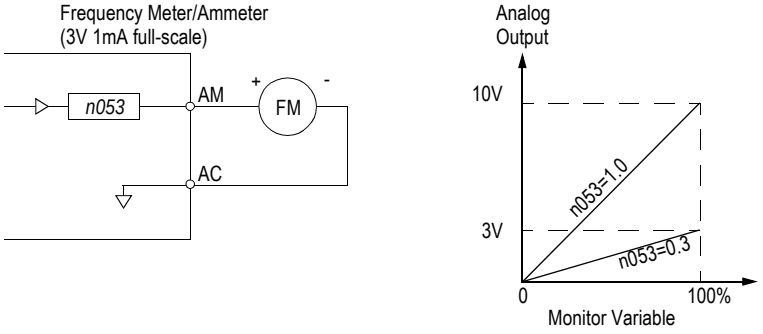


Figure 28 Frequency Meter/Ammeter Calibration

Parameter n053 determines the slope of the signal output on terminal AM for the variable being monitored. Increasing this value increases the slope. Refer to Figure 28.

Frequency Signal Adjustment

When the frequency reference is given by an analog signal at control circuit terminals FV and FI, the relation between analog voltage (or current) and frequency reference can be set.

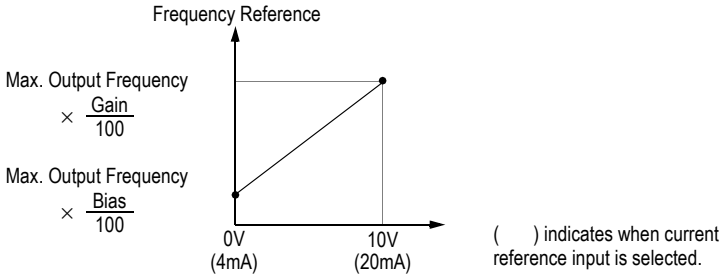


Figure 29 Frequency Signal Adjustment

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· Terminal FV Gain *(n048, Terminal FV Gain)*
The analog input voltage value for the maximum output frequency *(n011)* can be set in units of 1%, from 0 to 200%.
Factory setting: 100%

· Terminal FV Bias *(n049, Terminal FV Bias)*
The frequency reference that is generated when the analog input is 0V can be set in units of 1%, from -100% to 100%. (*n011*: maximum output frequency = 100%)
Factory setting: 0%

· Terminal FI Gain *(n050, Terminal FI Gain)*
The analog input current value for the maximum output frequency *(n011)* can be set in units of 1%, from 0 to 200%.
Factory setting: 100%

· Terminal FI Bias *(n051, Terminal FI Bias)*
The frequency reference that is generated when the analog input is 4mA can be set in units of 1%, from -100% to 100%. (*n011*: maximum output frequency = 100%)
Factory setting: 0%

· Examples
To operate the inverter with a frequency reference of 0% to 100% at a 0 to 5V input:

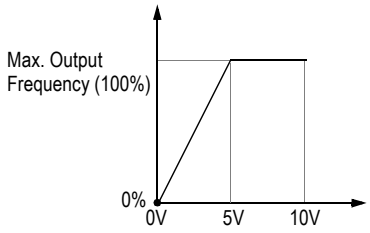


Figure 30 Frequency Signal Adjustment Example - 0 to 5V input

Gain: Parameter *n048* = "200"
Bias: Parameter *n049* = "0"

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To operate the inverter with a frequency reference of 50% to 100% at a 0 to 10V input:

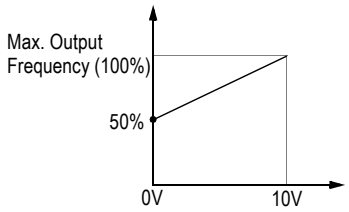


Figure 31 Frequency Signal Adjustment Example - 0 to 10V input

Gain: Parameter *n048* = "100"
Bias: Parameter *n049* = "50"

Jog Operation

Multi-function inputs (Terminals S2 to S6) can be programmed to function as a jog reference selection. Operation can then be enabled at the jog frequency reference set in parameter *n030* by activating this input. A "RUN" command must also be given to start the inverter. When multi-step speed references 1 or 2 are input simultaneously with the jog frequency reference, the jog frequency reference has priority.

Name	Parameter No.	Setting
Jog frequency reference	*n030*	**6.0Hz** *(Factory default)*
Multi-function contact input selection (S2 to S6)	*n036, n037, n038, n039, n040*	Set to "Jog Command" for any parameter.

Jump Frequencies (n062, Jump Freq 1; n063, Jump Freq 2, n064, Jump Bandwidth)

This function enables the "jumping" of critical frequencies so that systems can operate without excessive vibration or noise. Setting the value to 0.0Hz disables this function.

Set jump frequency 1 or 2 such that *n062* ≤ *n063*. If this condition is not satisfied, the inverter displays the parameter setting error "OPE6".

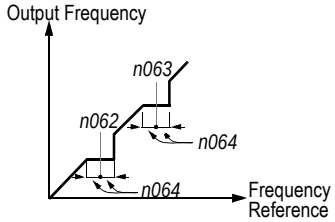


Figure 32 Jump Frequencies

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MODBUS Communication

The FP5/GP5 can perform serial transmission by using a programmable controller (PLC) and MODBUS communication. MODBUS is composed of one master PLC and 1 to 31 (maximum) slave inverters. In signal transmission between master and slave units, the master unit always starts transmission and the slave units respond to it.

The master unit performs signal transmission with one slave unit at a time. Hence, different address numbers must be assigned to each slave unit in advance and the master unit specifies a number to perform signal transmission. The slave unit which receives the command from the master unit executes the function and returns the response to the master unit.

Communication Specifications

- Interface: RS-485, RS-422 (communication interface card SI-K2/P must be mounted.)
- Synchronization: Asynchronous
- Transmission parameter:
  - Baud rate: selectable from 2400, 4800, 9600 BPS (parameter *n105*)
  - Data length: fixed at 8 bits
  - Parity: parity/no parity, even/odd selectable (parameter *n106*)
  - Stop bit: fixed at 1 bit
- Protocol: In accordance with MODBUS
- Maximum number of units to be connected: 31 units (when RS-485 is used)

Data to be Sent/Received by Communication

Data to be sent/received by communication are run commands, frequency reference, fault contents, inverter status and parameter setting/reading.

- Operation Mode Selection *(n002, Oper Mode Select)*
  Select the run command and frequency reference input method in parameter *n002*. To provide a run command and/or frequency reference by communication, set this parameter to a selection that contains "COM" for SEQ and/or REF. Regardless of this selection, monitoring of running status, parameter setting/reading, fault reset and multi-function input commands from the PLC are possible. The multi-function input command becomes "OR" with the command input from control circuit terminals S2 to S6.

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- MODBUS Frequency Reference Unit *(n103, MODBUS Fref Unit)*
  The frequency reference units from the PLC and in the frequency reference and output frequency monitors (by communication) are set with parameter n103. The output frequency resolution of the FP5/GP5 is 0.1Hz. Even if the frequency reference unit is changed to 0.01Hz in parameter *n103*, the value in the hundredth digit of the received frequency reference is rounded off internally. When 30,000/100% in units of 0.1% is selected, the value is rounded off in the same way.
- MODBUS Slave Address *(n104, MODBUS Address)*
  Sets the slave address number. It is necessary to set the address number so that it will not overlap with the address number of another slave unit connected on the same transmission line.

Note: To change the values set in parameters *n104* to *n106* and enable new settings, it is necessary to cycle power after entering the desired values.

Motor Overload Detection

The FP5/GP5 protects against motor overload with a UL-recognized, built-in electronic thermal overload relay function.

- Motor Rated Current *(n033, Motor Rated FLA)*
  Set to the rated current value shown on the motor nameplate.
  Note: setting to 0.0A disables the motor overload protection function.

- Motor overload protection selection *(n034, Motor OL Sel)*

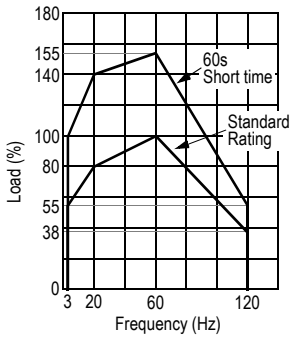
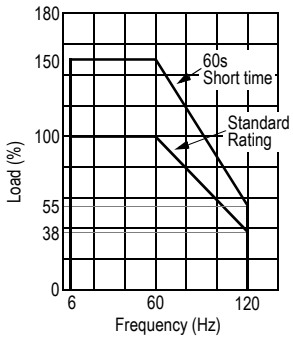
LED Setting	LCD Setting	Electronic Thermal Characteristics
0	Disabled	Protection disabled
1	STD Motor / 8 min	Applied to general-purpose motor, standard rating (Class 20 overload)
2	STD Motor / 5 min	Applied to general-purpose motor, short time rating (Class 10 overload)
3	INV Motor / 8 min	Applied to blower-cooled / inverter duty motor, standard rating (Class 20 overload)
4	INV Motor / 5 min	Applied to blower-cooled / inverter duty motor, short time rating (Class 10 overload)

The electronic thermal overload function estimates motor temperature, based on inverter output current and time, to protect the motor from overheating. When the electronic thermal overload relay is activated, an "oL1" error occurs, shutting OFF the inverter output and preventing excessive overheating in the motor.

When operating with one inverter connected to one motor, an external thermal relay is not needed. When operating several motors with one inverter, install a thermal relay on each motor. In this case, set parameter *n034* to "Disabled".

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· General-purpose and Blower-cooled Motors
Induction motors are classified as general-purpose or blower-cooled motors, based on their cooling capabilities. Hence, the motor overload detection function operates differently for each of these two motor types.

	Cooling Effectiveness	Torque Characteristics	Electronic Thermal Overload
General-purpose	Effective when operated at 50/60Hz from commercial power supply.	 Base Frequency 60Hz (V/f for 60Hz, 230V Input Voltage) During continuous operation at low speeds, the load must be limited in order to limit motor temperature rise.	"OL1" error (motor overload protection is enabled when motor is continuously operated at 50/60Hz or less at 100% load).
Blower-cooled	Effective when operated at low speeds (approx. 6Hz).	 Base Frequency 60Hz (V/f for 60Hz, 230V Input Voltage) Use blower-cooled motor for continuous operation at low speeds.	Effective when operated at low speeds (approx. 6Hz).

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Multi-Step Speed Selection

This function allows the programming of up to 4 preset speeds, through multi-function contact input selections.

4-step speed selection

n002 = "SEQ=X REF=OPR", where "X" can be TRM, OPR, or COM
n024 = 30.0Hz *(factory default = 0.0Hz)*
n025 = 40.0Hz *(factory default = 0.0Hz)*
n026 = 50.0Hz *(factory default = 0.0Hz)*
n027 = 60.0Hz *(factory default = 0.0Hz)*
n039 = 9 (multi-function contact input terminal S5)
n040 = 10 (multi-function contact input terminal S6)

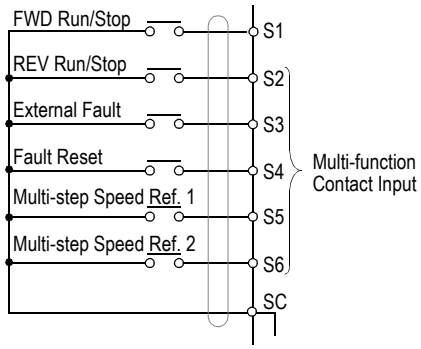


Figure 33 Multi-step Speed Selection - Control Circuit Terminals

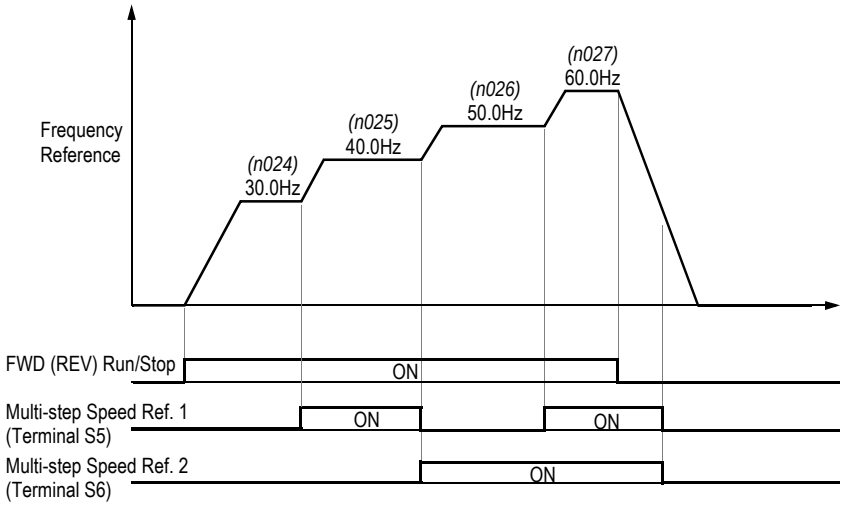


Figure 34 Multi-step Speed Operation - Timing Diagram

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Phase Loss Protection

· Input Phase Loss Detection *(n083, In Ph Loss Lvl)*
The input phase loss detection circuit monitors the DC bus current ripple and activates when one of the input phases are lost. The detection circuit calculates the maximum and minimum values of the DC bus voltage in 1.28 second intervals, and compares the difference (ΔV) between these values with the input phase loss detection level *(n083)*. If ΔV ≥ *n083*, then input phase loss is detected; and after the input phase loss detection delay time (fixed at approximately 10 seconds), an SPI fault occurs, and the motor coasts to stop.

No.	Name	Description	Factory Default
n083	Input phase loss detection level	Unit: 1% Setting range: 1 to 100% of input voltage	**7%**

Input phase loss detection is disabled in the following cases:

- Parameter *n083* is set to "100%"
- A Stop command is input
- Input magnetic contactor (MC) shuts OFF
- CPU A/D converter fault (CPF5)
- During deceleration
- Output current ≤ 30% of Inverter rated current

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PID Control

To enable PID control, set PID selection *(n084)* to "Enabled", according to the description below.

LED Setting	LCD Setting	Description
0	Disabled	PID disabled *(factory default)*
1	Enabled D=Fdbk	PID enabled (deviation is D-controlled.)
2	Enabled D=Fdfwd	PID with feed forward (feedback value is D-controlled)
3	Enabled Rev Fdbk	PID with inverted feedback

Then select the PID control setpoint value and detected feedback value setpoint as follows:

· Setpoint Value Selection
The control circuit terminal FV voltage signal (0 to 10V) or multi-step speed parameters *n024* to *n027* can be used to select the PID setpoint value.

Control circuit terminal FV voltage signal:
Set operation mode selection *(n002)* to "SEQ=OPR REF=TRM" or "SEQ=TRM REF=TRM".

Multi-step speed constants (*n024* to *n027*):
Set operation mode selection *(n002)* to "SEQ=OPR REF=OPR" or "SEQ=TRM REF=OPR".
(combination of multi-step speed reference and jog frequency reference)

· Detected Value Setting
The control circuit terminal FI current signal (4 to 20mA) or voltage signal (0 to 10V) can be used to set the PID detected value.

Control circuit terminal FI current signal:
Set aux. analog input selection *(n044)* to "4-20mA".

Control circuit terminal FI voltage signal:
Set operation mode selection *(n044)* to "0-10VDC".
(Cut jumper J1 on the control PCB board.)

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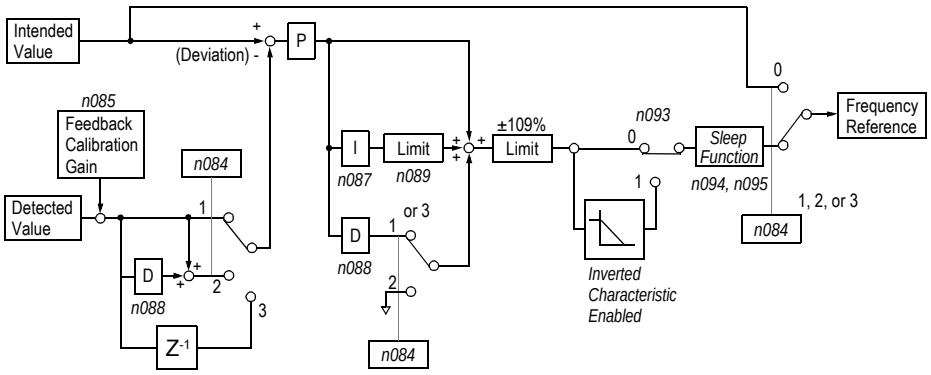


Figure 35a PID Control Block Diagram

Notes:

1) Value I is reset to"0" in the following cases:
   - When operation stops
   - When the integral value reset signal is input by multi-function contact input selection (Any of parameters *n036* to *n040* are set to "PID I Reset").
2) The upper limit of value I can be set by parameter *n089*.
   Increase the value of parameter *n089* to upgrade control capability by integration. If the control system vibrates and it cannot be stopped by adjusting the integral time, output lag filter time, etc., decrease the set value of parameter *n089*.
3. PID control can be canceled by a multi-function contact input signal.
   By setting any of parameters *n036* to *n040* to "PID Disable" and by closing the contact during running, PID control is disabled and the setpoint value signal itself is used as a frequency reference signal.
4. Inverse PID characteristics can be obtained by setting parameter n093 to "Inverted".
5. The PID Sleep feature can be used to automatically turn off the inverter output when the PID output value falls below the sleep function level (n094) for longer than the sleep function time (n095). The inverter will resume normal operation when the PID output is greater than the sleep level for longer than the sleep time. Setting parameter n094 to "0.0" disables this feature.

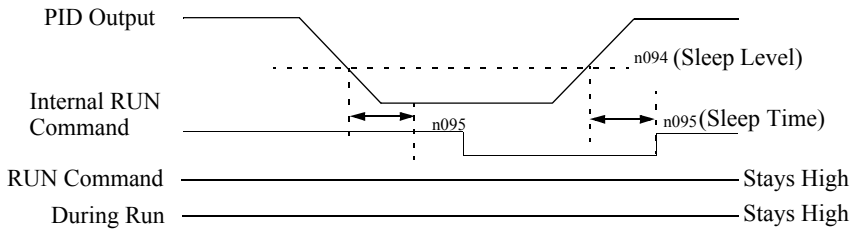


Figure 35b PID Control Timing Chart

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Reverse Run Prohibit (n006, Reverse Oper)

A "reverse run disabled" setting does not accept a reverse run command from the control circuit terminal or the digital operator. This setting is used in applications where a reverse run command can cause problems.

LED Setting	LCD Setting	Description
0	REV Allowed	Reverse run enabled *(factory default)*
1	REV Prohibited	Reverse run disabled

Soft-Start Characteristics (n022, S-Curve Select)

An S-curve pattern is used to reduce shock and provide smooth transitions during machine acceleration and deceleration.

LED Setting	LCD Setting	Description
0	No S-Curve	S-curve not provided
1	0.2 Sec	0.2 second *(factory default)*
2	0.5 Sec	0.5 second
3	1.0 Sec	1.0 second

Note: The S-curve time is the time to reach the set accel/decel rate (as determined by the accel/decel time settings).

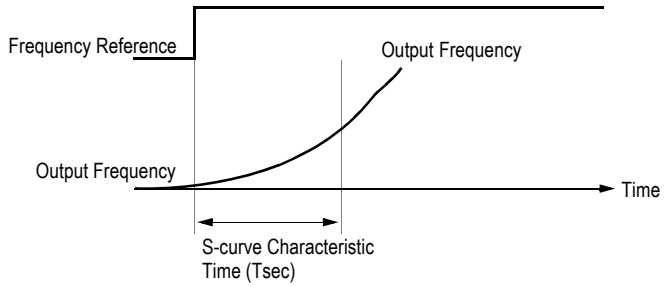


Figure 36 S-curve Characteristic Timing Diagram

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The following figure shows FWD/REV run switching during deceleration to stop.

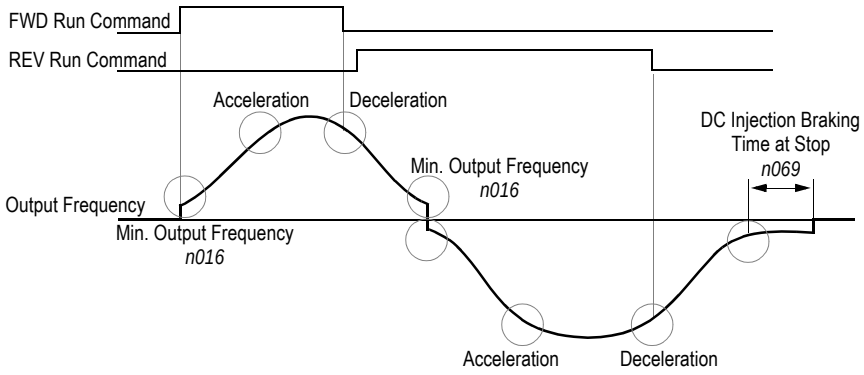


Figure 37 S-curve Characteristics - FWD/REV Operation

Speed Limit Adjustment

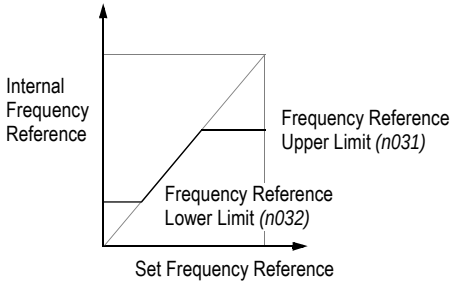


Figure 38 Setting Frequency Upper and Lower Limits

· Frequency Reference Upper Limit *(n031, Ref Upper Limit)*

The upper limit of the frequency reference can be set in increments of 1%. (*n011*: maximum output frequency = 100%)
Factory setting: 100%

· Frequency Reference Lower Limit *(n032, Ref Lower limit)*

The lower limit of the frequency reference can be set in increments of 1%. (*n011*: maximum output frequency = 100%)
Factory setting: 0%

When operating at a frequency reference of 0Hz, operation continues at the frequency reference lower limit. However, when the lower limit is set to less than the minimum output frequency *(n016)*, operation stops.

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Stopping Method (n004, Stopping Method)

This function selects the stopping method suitable for the particular application.

LED Setting	LCD Setting	Description
0	Ramp to STOP	Deceleration to stop *(factory default)*
1	Coast to STOP	Coast to stop
2	Coast w/Timer 1	Coast to stop with timer 1 (run command cycle)
3	Coast w/Timer 2	Coast to stop with timer 2 (auto-start after time out)

· Deceleration to Stop (*n004* = "Ramp to STOP")

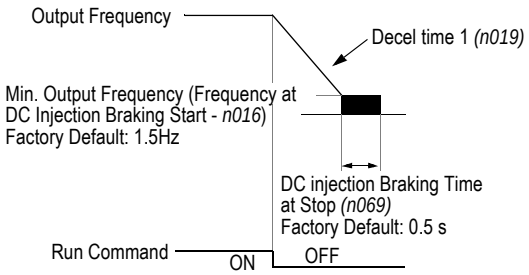


Figure 39 Stopping Method - Deceleration to Stop

Upon removal of the FWD (REV) run command, the motor decelerates at a deceleration rate determined by the time set in deceleration time 1 *(n019)* and DC injection braking is applied immediately before when the minimum output frequency (n016) is reached. If the deceleration time is short or the load inertia is large, an overvoltage fault (OV) may occur during deceleration. In this case, increase the deceleration time or install an optional braking resistor .

Braking torque: w/o braking resistor, approx. 20% of motor rated torque
w/ braking resistor, approx. 150% of motor rated torque

· Coast to Stop (*n004* = "Coast to STOP")

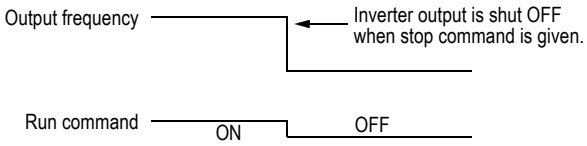


Figure 40 Stopping Method - Coast to Stop

Upon removal of the FWD (REV) run command, the motor coasts.

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· Coast to Stop with Timer 1 (*n004* = "Coast w/Timer 1")

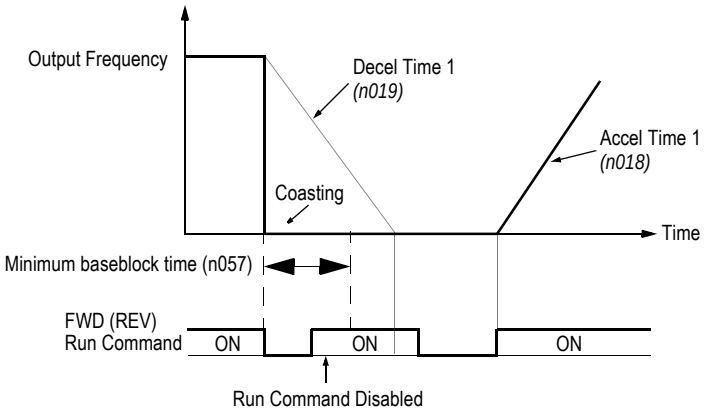


Figure 41 Example of Stopping Method - Coast to Stop w/ Timer 1

Upon removal of the run command, the inverter output is immediately removed, allowing the motor to coast. If the run command is re-applied before the minimum baseblock time *(n057)* elapses, the run command is not accepted.The run command must be cycled to be acknowledged. An initial run command will be accepted if applied after the minimum base-block time elapses.

· Coast to Stop with Timer 2 (*n004* = "Coast w/Timer 2")

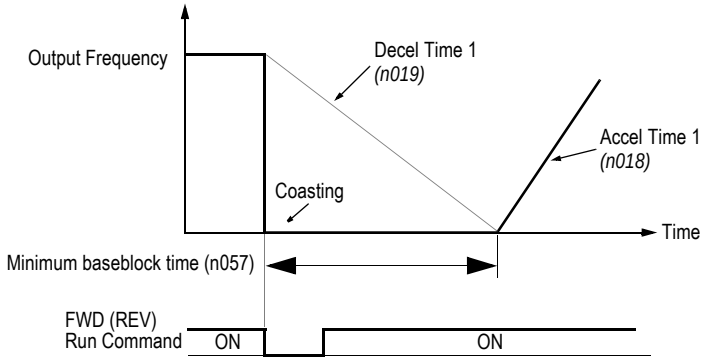


Figure 42 Example of Stopping Method - Coast to Stop w/ Timer 2

Operation is disabled during the minimum baseblock time (n057) after a stop command is given. A run command will be accepted, but operation does not start until the minimum baseblock time runs out. The inverter does not operate during the baseblock time, as shown in Figure 42.

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Torque Adjustment (n071, Torq Comp Gain)

Motor torque can be adjusted by changing the V/f pattern *(n010)* or by adjusting the torque compensation gain *(n071)*. For details on setting the V/f pattern, see "V/f Pattern Adjustment", on page 75.

- Full-range Automatic Torque Boost
  The motor torque requirement changes according to load conditions. Full-range automatic torque boost adjusts the output motor voltage according to the required torque. The FP5/GP5 automatically adjusts the voltage during constant-speed operation as well as during acceleration.

  The required torque is calculated by the inverter. The optimum motor voltage will be output to ensure tripless operation and power savings.

  Output voltage ∝ Torque compensation gain × Required torque

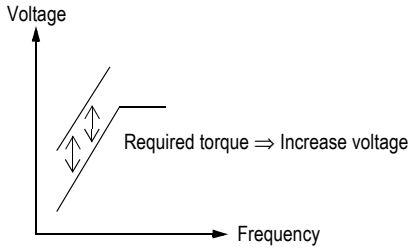


Figure 43 Torque Characteristics

Normally, no adjustment is necessary for torque compensation gain (*n071*, factory default: "**1.0**"). When the wiring distance between the inverter and the motor is long, or when the motor generates vibration, change the torque compensation gain.
Increasing torque compensation gain increases motor torque, but an excessive increase may cause the following:

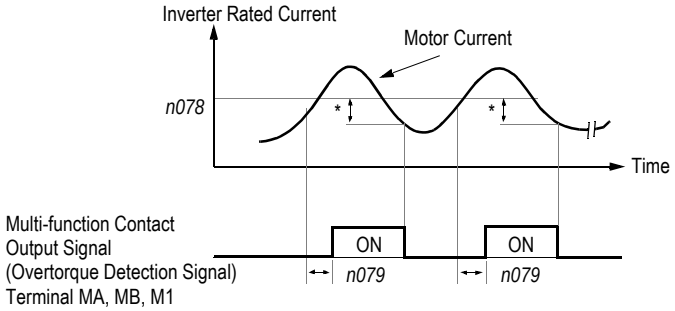
- Inverter trips due to motor overexcitation
- Motor overheat or excessive vibration

If adjustment is necessary, adjust in 0.1 increments.

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Torque Detection

The over/undertorque detection circuit will activate when the motor load causes the motor current to go above or below torque detection level *(n078)* respectively. When the over/undertorque condition is detected, alarm signals are sent to multi-function output terminals MA, MB and/or M1.
To output an over/undertorque detection signal, set multi-function contact output selection *n041* or *n042* to "6" (N.O. contact) or "7" (N.C. contact).



* Release width (hysteresis) during overtorque detection is 5% of the inverter rated current level.

Figure 43 Torque Characteristics

· Over/undertorque Detection Function Selection *(n077, Torq Det Sel)*

LED Setting	LCD Setting	Description
0	Disabled	Detection disabled *(factory default)*
1	OT/SpdAgree/Alm	Overtorque detection begins at speed agree; continue running after detection. (Alarm)
2	OT/Run/Alm	Overtorque detection at run; continue running after detection. (Alarm)
3	OT/SpdAgree/Flt	Overtorque detection begins at speed agree; coast to stop after detection. (Fault)
4	OT/Run/Flt	Overtorque detection at run; coasts to stop after detection. (Fault)
5	UT/SpdAgree/Alm	Undertorque detection begins at speed agree; continue running after detection. (Alarm)
6	UT/Run/Alm	Undertorque detection at run; continue running after detection. (Alarm)
7	UT/SpdAgree/Flt	Undertorque detection begins at speed agree; coast to stop after detection. (Fault)
8	UT/Run/Flt	Undertorque detection at run; coast to stop after detection. (Fault)

Notes:
- To detect torque during acceleration or deceleration, select a setting that contains "RUN".
- To continue operation after over/undertorque detection, select a setting that contains "Alm". During detection, the digital operator displays "oL3" alarm (blinking).
- To stop the inverter after an over/undertorque detection fault, select a setting that contains "Flt". During detection, the digital operator displays "oL3" fault.

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- Over/undertorque Detection Level *(n078, Torq Det Level)*
  Sets the torque detection current level in units of 1%
  Inverter rated current: 100%
  Factory default: 160%
- Over/undertorque Detection Time *(n079, Torq Det Time)*
  The over/undertorque detection delay time inserts a delay, between the time motor current exceeds or falls below the over/undertorque detection current level *(n078)* and when the over/undertorque detection function is enabled.
  Factory default: 0.1 second

  If the time during which motor current exceeds or falls below the over/undertorque detection level *(n078)* is longer than the over/undertorque detection time *(n079)*, the over/undertorque detection function is enabled.

Tripless Operation

When starting into a coasting motor, use the speed search command or DC injection braking at start, to prevent a drive trip and motor burnout.

- **Speed search**
  This function allows the restart of a coasting motor without the necessity to stop. It is useful during inverter bypass operation, when switching between the motor receiving power directly from the line to the inverter.
  Set the multi-function contact input selection *(n036* to *n40)* to "SpdSrch (MAXFREQ)" (start search command from maximum output frequency) or "SpdSrch (SETFREQ)" (start search command from the set frequency).
  Build a sequence so that the FWD (REV) run command is input at the same time as the search command, or after the search command. If the run command is input before the search command, the search command is not effective. Below is a timing diagram of the search command input:

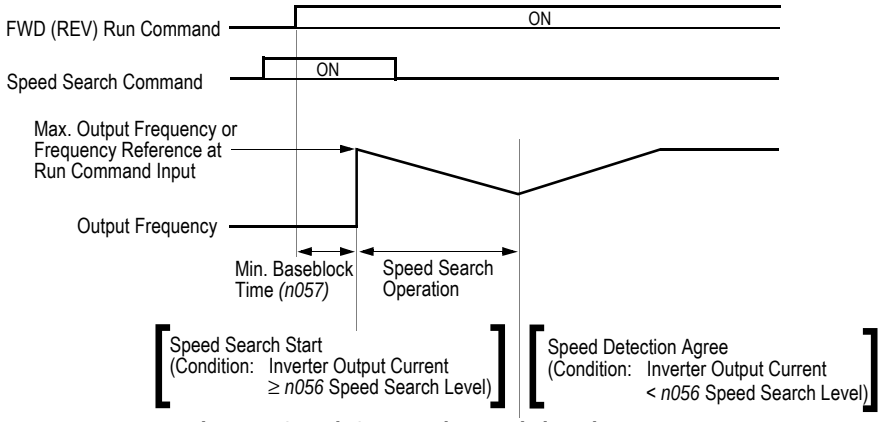


Figure 44 Search Command Input Timing Diagram

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· DC Injection Braking at Start *(n068, DCInj Current; n070, DCInj Time@Start)*

This function restarts a coasting motor after first applying it with DC injection braking. DC injection braking time at start *(n070)* is set in units of 0.1 second. DC injection braking current is set in parameter *n068* in units of 1%. When parameter *n070* is set to "0", DC injection braking is disabled and acceleration starts from the minimum output frequency.

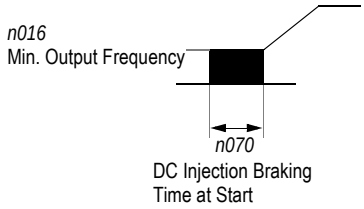


Figure 45 DC Injection Braking at Starting

V/f Pattern Adjustment (n010, V/f Selection)

Set the V/f pattern using parameter *n010* as described below. It may be necessary to change the V/f pattern when using a high-speed motor, or when special torque adjustment is required in the application.

Set values: "60Hz Preset": Fixed V/f pattern
"User defined V/f": Custom V/f pattern can be set

Set the V/f pattern according to the following:

· n010 = "60Hz Preset" (Factory default value)
Set parameter n010 to "60Hz Preset" when a standard 50/60Hz, 230/460V motor is selected. This setting provides a standard linear V/Hz pattern. Parameters n011 through n017 cannot be adjusted.

· n010 = "User defined V/f" (Custom V/f pattern)
Set parameter n010 to "User defined V/f" when a variable torque pattern is required. Parameters n011 through n017 can then be adjusted manually to customize a special V/f pattern. The default settings for parameters n011 through n017 when n010 = "User defined V/f" comprise the standard variable torque pattern.

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Be sure to satisfy the following conditions for setting parameters *n011* to *n017*:
$n016 \leq n014 < n013 \leq n011$

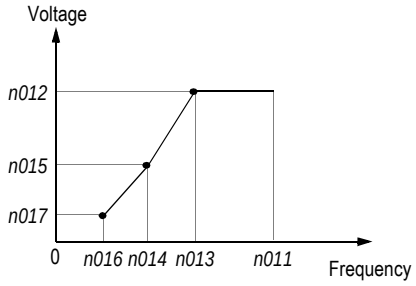


Figure 46 Custom V/f Pattern Setting

Parameter No.	Name	Unit	Setting Range	Factory Default (n010=60Hz Preset)	Factory Default (n010=User defined V/f)
n011	Maximum output frequency	0.1 Hz	50.0 to 400 Hz	**60.0 Hz**	**60.0 Hz**
n012	Maximum voltage	0.1 V	0.1 to 255 V *	**230 V ***	**230 V ***
n013	Maximum voltage output frequency (base frequency)	0.1 Hz	0.2 to 400 Hz	**60.0 Hz**	**60.0 Hz**
n014	Mid. output frequency	0.1 Hz	0.1 to 399.9 Hz	**3.0 Hz**	**30.0 Hz**
n015	Mid. output frequency voltage	0.1 V	0.1 to 255 V *	**17.2 V ***	**57.5 V ***
n016	Minimum output frequency	0.1 Hz	0.1 to 10.0 Hz	**1.5 Hz**	**1.5 Hz**
n017	Minimum output frequency voltage	0.1 V	0.1 to 50.0 V *	**11.5 V ***	**11.5 V ***

* For 460V class units, the value is twice that of 230V class units.

Increasing the voltage in the V/f pattern increases motor torque, however, an excessive increase may cause:

- Inverter fault trips as a result of motor overexcitation
- Motor overheat or excessive vibration

Increase voltage gradually while checking the motor current.

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Slip Compensation

The slip compensation feature allows better speed regulation to be obtained by adjusting the output frequency according to the changing load. This feature compensates for the slip of the motor.

Slip Compensation Gain (n107, Slip Comp Gain)

This parameter is used to input the slip of the motor. The setting is entered as a percent of base frequency (n013). The default value for n107 is 0.0% which disables this feature. To properly set the parameter, use the following equation:

$$n107 = \frac{\text{Synchronous Speed - Full Load Speed}}{\text{Synchronous Speed}}$$

$$\text{Where: Synchronous Speed} = \frac{120 \times \text{Rated Frequency}}{\text{\# of Motor Poles}}$$

$$\text{Full Load Speed} = \text{Motor Nameplate Speed}$$

Slip Compensation Primary Delay Time (n109, Slip Comp Delay)

This parameter sets how fast the inverter output frequency responds to changing loads. A long time will cause a sluggish response (a large momentary speed droop). A short time will cause a fast response (less speed droop). Too short of a time may cause instability.

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3.4 INPUTS & OUTPUTS

Multi-function Input Signals (n036 to n040)

Multi-function contact input terminal S2 to S6 functions can be changed when necessary by setting parameters *n036* to *n040*, respectively. None of these parameters can receive a setting common with the other (no duplication).

- Terminal S2 function: set via parameter *n036*
- Terminal S3 function: set via parameter *n037*
- Terminal S4 function: set via parameter *n038*
- Terminal S5 function: set via parameter *n039*
- Terminal S6 function: set via parameter *n040*

Multi-function Input Signals				Ref. Page
LED Setting	LCD Setting	Description	Remarks	
0	Reverse RUN (2W)	Reverse run (2-wire sequence)	Only parameter *n036* can be set to this value.	79
1	FWD/REV Cmd (3W)	Fwd / Rev command (3-wire sequence)	Only parameter *n036* can be set to this value.	
2	Ext Fault (NO)	External fault (normally open)	Inverter stops at fault when external fault signal is input. Digital operator displays "EFX".	-
3	Ext Fault (NC)	External fault (normally closed)	Inverter stops at fault when external fault signal is input. Digital operator displays "EFX".	
4	Fault Reset	Fault reset	Resets fault. Fault reset is disabled during run command input.	-
5	LOCAL/REMOTE Sel	Local / Remote selection	—	79
6	COM/INV Sel	Serial com/inverter selection (Fref, RUN command)	—	79
7	STOP Cmd/Dec2 NO	Fast stop using Decel 2 (normally open)	Decelerates to stop by decel time 2 *(n021)* when fast stop is input.	-
8	STOP Cmd/Dec2 NC	Fast stop using Decel 2 (normally closed)	Decelerates to stop by decel time 2 *(n021)* when fast stop is input.	-
9	Master Fref Sel	Master freq. ref. selection (FV-open or FI-closed)	Master frequency reference input level (voltage input at "open", current input at "closed") can be selected.	-
10	Multi-Step Spd 1	Multi-step speed reference command 1	—	64
11	Multi-Step Spd 2	Multi-step speed reference command 2	—	
12	Not Used	Not used	—	-
13	JOG Command	Jog reference (n030)	—	59
14	Acc/Dec Switch	Accel / Decel time selection	—	49
15	Ext Baseblk (NO)	External baseblock (normally open)	Coasting signal. Motor starts coasting when the signal is input. Digital operator displays "bb" (blinking).	-
16	Ext Baseblk (NC)	External baseblock (normally closed)	Coasting signal. Motor starts coasting when the signal is input. Digital operator displays "bb" (blinking).	
17	SpdSrch (MAXFRQ)	Speed search from maximum frequency	Speed search command signals.	74
18	SpdSrch (SETFRQ)	Speed search from set frequency	Speed search command signals.	
19	Param Lockout	Parameter setting enable / disable	Permission or prohibition of constant setting from the digital operator or serial communication (setting disabled at "closed", enabled at "open") can be selected.	-
20	PID I Reset	PID integral value reset	—	67
21	PID Disable	PID control enable / disable	—	
22	Timer Start Cmd	Timer function	—	80
23	OH3 Input	External overheat alarm (OH3)	When this signal is input, the digital operator displays "OH3" (blinking). Inverter continues operation.	-
24	Ref Sample Hold	Analog reference sample hold command	Analog frequency reference is sampled at "closed" and held at "open".	80
25	KEB Cmd (NO)	Inertia ridethrough command (normally open)	—	—
26	KEB Cmd (NC)	Inertia ridethrough command (normally closed)	—	—
27	Hold Command	Accel / Decel hold command	—	—
28	PID Polarity Sel	Inverse PID enable / disable	—	—
29	UP/DOWN Cmd	UP/DOWN Command	Only parameter *n040* can be set to this value.	81

* 2 to 6 are displayed in _ corresponding to S2 to S6, respectively.
Factory settings: *n036* = "Reverse RUN (2W)", *n037* = "Ext Fault (NO)", *n038* = "Fault Reset", *n039* = "Multi-Step Spd 1", *n040* = "Multi-Step Spd 2"

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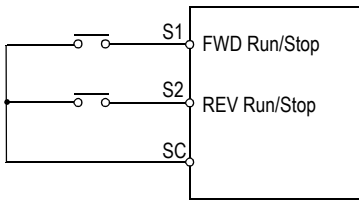


Figure 47a Terminal Function at 2-Wire Sequence Selection (setting: n036="Reverse RUN (2W)")

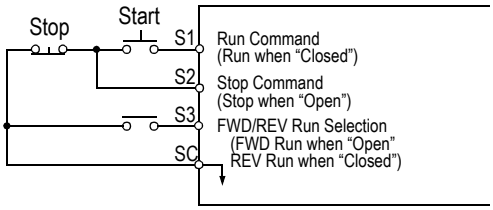


Figure 47b Terminal Function at 3-Wire Sequence Selection (setting: n036="FWD/REV Cmd (3W)")

- **Local/Remote Selection (setting: "LOCAL/REMOTE Sel")**
  Selects whether the run command is received from the digital operator or the control circuit terminal. Local/Remote selection is available only while the inverter is stopped.
  Open: Run according to the setting of operation mode selection *(n002)*.
  Closed: Frequency reference and run command from the digital operator.

  Example: Set *n002* to "SEQ=TRM REF=TRM".
  Open: Frequency reference from control circuit terminals FV & FI, and run command from control circuit terminals S1 and S2.
  Closed: Frequency reference and run command from the digital operator.

- **Serial Communication/Control Circuit Terminal Selection (setting: "COM/INV Sel")**
  Selects operation reference by serial communication or by the control circuit terminal. This selection is available only during stop.
  Open: run according to the setting of operation mode selection *(n002)*.
  Closed: Frequency reference and run command from serial communication.

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Example: Set *n002* to "SEQ=TRM REF=TRM".
Open: Frequency reference from control circuit terminals FV & FI, and run command from control circuit terminals S1 and S2.
Closed: Frequency reference and run command from serial communication.

- **Timer Function (setting: "Timer Start Cmd")**
  The timer function is used in conjunction with the multi-function contact output (parameter n041 or n042 set to "Timer Output").
  When the timer function input is "closed" for longer than the ON-delay timer *(n080)*, the timer function output closes.
  When the timer input is "open" for longer than the OFF-delay timer *(n081)*, the timer function output opens.

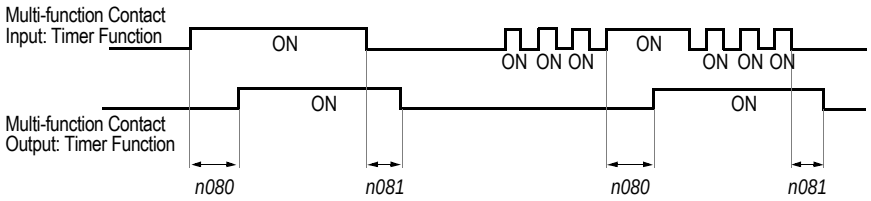


Figure 48 Timing Diagram of Timer Function

- **Analog Reference Sample/Hold Selection (setting:"Ref Sample Hold")**
  This feature allows a single analog signal to be used among multiple inverters to "sample and hold" separate speeds. Each inverter can be commanded to acknowledge the reference at different times. If the analog reference sample/hold input terminal is "closed" for 100ms or longer, the analog frequency reference is sampled; when it opens, the analog frequency reference is held.

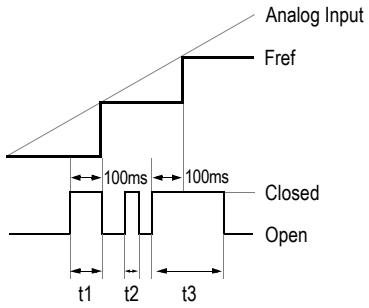


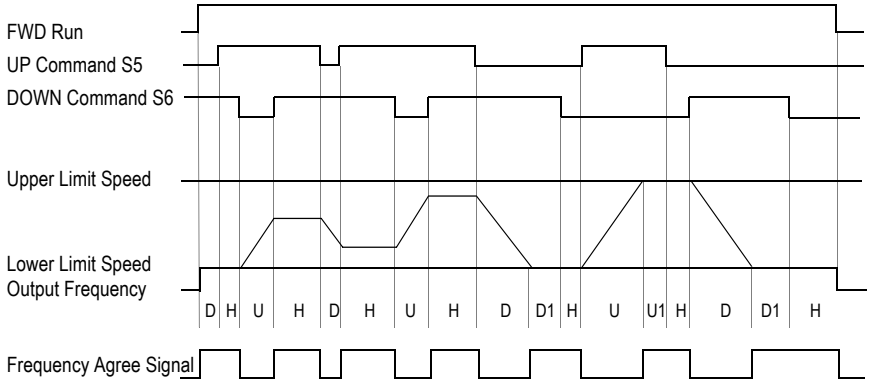
Figure 49 Sample/Hold Selection - Analog Reference

Note: t1, t3 - Reference is sampled once with an input closure of 100ms or longer.
t2 - Reference is not sampled with an input closure of less than 100ms.

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- **Up/Down Command (setting: *n040* = "Up/Down Control")**
  With the FWD (REV) run command entered, a change in frequency is performed by inputting the Up or Down commands to control circuit terminals S5 and S6, so that operation can be performed at the desired speed. When the Down command is specified for terminal S6 by setting n040="Up/Down Control", any function set to terminal S5 via parameter *n039* becomes disabled; terminal S5 becomes an input terminal for the Up command and terminal S6 an input terminal for the Down command.

Control Circuit Terminal S5 (UP command)	Closed	Open	Open	Closed
Control Circuit Terminal S6 (DOWN command)	Open	Closed	Open	Closed
Operation Status	Accel	Decel	Hold	Hold



U: Up (accelerating) status
D: Down (decelerating) status
H: Hold (constant speed) status
UI: Up status, with clamping at upper limit speed
DI: Down status, with clamping at lower limit speed

Figure 50 Timing Diagram of UP/DOWN Command Input

Notes:

1) When the UP/DOWN command is selected, the upper limit speed is set regardless of frequency reference.
   Upper limit speed = Maximum output frequency *(n011)*
   × Frequency reference upper limit *(n031)* /100
2) The lower limit value is either the analog frequency from control circuit terminals FV or FI, or the frequency reference lower limit *(n032)*, whichever is larger.
3) When the FWD (REV) run command is input, operation starts at the lower limit speed without an UP/DOWN command.
4) If the jog frequency reference is input while the drive is running by the UP/DOWN command, the jog frequency reference has priority.

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Analog Input Signals

· Master Analog Input Selection *(n043, Analog Input Sel)*
To input the master frequency reference from the control circuit terminal, use terminal FV (0 to 10V) or terminal FI (4 to 20mA), by setting parameter *n043*.

LED Setting	LCD Setting	Master Frequency Reference Terminal	Input Level
0	FV=MSTR FI=AUX	FV *(factory default)*	0 to 10V input
1	FV=AUX FI=MSTR	FI	4 to 20mA input

· Auxiliary Analog Input Selection *(n044, Terminal FI Sel)*
From the factory, terminal FI is set to accept a 4-20mA signal. To change the control circuit terminal FI input level from current to voltage, set parameter *n044* according to the table below, and be sure to cut the "J1" jumper on the control PCB. The J1 jumper is located near terminal FI on the control PCB.

LED Setting	LCD Setting	Input Level
0 *	0-10 VDC	0 to 10V input
1	4-20 mA	4 to 20mA input *(factory default)*

* To set parameter *n044* to "0", cut jumper J1 on the inverter control PCB board.

· Frequency Reference Retention *(n045, MOP Ref Memory)*
Effective when UP/DOWN or Sample/Hold commands are selected for multi-function contact inputs. To retain the held frequency reference at power OFF, set parameter n045 to"Memorize Fref". When n045="Memorize Fref", the last sampled/held reference will be memorized during power down. When power is re-applied, a run command will run the inverter at this previous speed. When n045="Not Memorized", the last sampled/held frequency will be lost at power down. Upon power-up, a new reference will need to be sampled.

LED Setting	LCD Setting	Description
0	Memorize Fref	Held frequency retained in frequency reference 1 - *n024 (factory default)*
1	Not Memorized	Not retained

· Operation Method for Frequency Reference Loss Detection *(n046, Ref Loss Detect)*
Selects the frequency reference if the frequency reference from the control circuit terminal decreases rapidly (lost signal).

LED Setting	LCD Setting	Description
0	Not Detected	Detection disabled *(factory default)*
1	RUN @ n047 Fref	Detection enabled, continue to run at n047 value × previous reference.

If the frequency reference decreases by 90% within 400ms (when detection is enabled), operation continues at reference equal to the n047 value × previous reference.

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Multi-function Output Signals (n041, Terminal MA Sel; n042, Terminal M1 Sel)

Multi-function output terminal MA, MB and M1 functions can be changed when necessary by setting parameters *n041* and *n042*.

- Terminal MA and MB functions: set via *n041*
- Terminal M1 functions: set via *n042*

Factory defaults: *n041* = "Fault", *n042* = "During Running"

Multi-function Output Signals				Ref. Page
LED Setting	LCD Setting	Description	Remarks	
0	Fault	Fault	"Closed when inverter fault occurs.	-
1	During Running	During running	"Closed when either FWD or REV run command is input or when the inverter outputs voltage.	-
2	At Speed	Frequency agree	-	84
3	At Desired Speed	Desired frequency agree	-	84
4	Freq Detection 1	Frequency detection	-	57
5	Freq Detection 2	Frequency detection	-	57
6	OverTrq Det (NO)	Overtorque detection (N.O. contact)	-	73
7	OverTrq Det (NC)	Overtorque detection (N.C. contact)	-	73
8	BaseBlocked	During baseblock	"Closed when inverter output shuts OFF.	-
9	Operation Mode	Operation mode	"Closed" when run command or frequency reference from digital operator is selected.	-
10	Ready	Inverter operation ready	"Closed" when no inverter fault does not occur and the inverter can be operated.	-
11	Timer Output	Timer function	-	80
12	Auto-Restarting	Automatic restart	"Closed" during fault retry operation.	51
13	OL Pre-Alarm	OL pre-alarm	Outputs an alarm before inverter and motor overload protection are enabled. Pre-alarm level is 150% for 48 sec for the inverter and more than 80% of the overload protection time for the motor.	-
14	Freq Ref Loss	Frequency reference loss	Closes a contact when detecting a loss of reference condition.(See page 82 for n046).	82
15	Set By Com Cntl	Output from serial communication	Activates contact output independently from inverter operation by a command from serial communication (MODBUS).	-
16	PID Fdbk Loss	PID feedback loss	Detects a rapid decrease in feedback and outputs a contact when the PID control mode is set. Detects when the feedback value decreases less than the detection level *(n091)* for longer than the feedback loss detection delay time *(n092)*; the inverter continues operation.	47
17	OH1 Alarm	OH1 alarm	"Closed" during heat sink overtemperature (digital operator displays "OH1" blinking).	-

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Frequency Agree (setting: “At Speed”)

See Figure 51 below for an example of selecting the frequency agree signal as the function of output terminals MA, MB or M1.

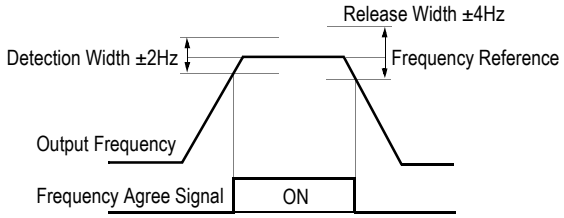


Figure 51 Example of Frequency Agree Signal (setting: “At Speed”)

Desired Frequency Agree (setting: “At Desired Speed”)

See Figure 52 below for an example of selecting the desired frequency agree signal as the function of output terminals MA, MB or M1.

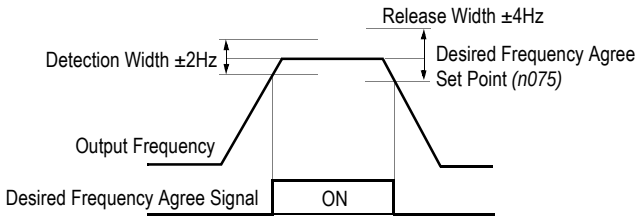


Figure 52 Example of Desired Frequency Agree Signal (setting: “At Desired Speed”)

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- CHAPTER 4 -

DIAGNOSTICS

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⚠WARNING

PRECAUTIONS

1) Never touch high voltage terminals in the inverter.
2) Replace all protective covers before powering up the inverter. When removing the cover, be sure to shut OFF the power supply to the inverter.
3) Perform maintenance or inspection only after verifying that the charge LED has gone OFF, after the main circuit power supply is turned OFF.
4) Only authorized personnel should be permitted to perform maintenance, inspections or parts replacement.

Failure to observe these precautions highlighted in this manual will expose the user to high voltages, resulting in equipment damage, serious injury or death.

⚠CAUTION

PRECAUTIONS

1) The control PCB board employs CMOS ICs. Do not touch the CMOS elements.
2) Do not connect or disconnect wiring or connectors while power is applied to the circuit.

Failure to observe these precautions may result in equipment damage.

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4.1 MAINTENANCE & INSPECTION

This section describes basic maintenance and inspection procedures for the FP5/GP5.

Periodic Inspection

The FP5/GP5 will function longer if it is kept clean, cool and dry, and if all precautions highlighted in this manual are observed. Periodically inspect the inverter as described in the table below to prevent accidents and to ensure high performance with high reliability.
To prevent electrical shock, disconnect all power before servicing the inverter. Then wait at least five minutes after the power supply is disconnected and all LEDs are extinguished.

Component	Check	Corrective Action
External Terminals, Connectors, Mounting Screws, etc.	Loose screws or connectors	Securely tighten.
Heatsink	Build-up of dust and dirt	Blow with dry, compressed air [39.2 $\times 10^4$ to 58.8 $\times 10^4$ Pa (4 to 6kg $\cdot$cm^2) pressure].
Printed Circuit Board (PCB)	Accumulation of conductive dust or oil	Blow with dry, compressed air [39.2 $\times 10^4$ to 58.8 $\times 10^4$ Pa (4 to 6kg $\cdot$cm^2) pressure]. If dust and oil cannot be removed, replace the board.
Cooling Fan	For abnormal noise and vibration	Replace the cooling fan.
Power Components	Accumulation of dust and dirt	Blow with dry, compressed air [39.2 $\times 10^4$ to 58.8 $\times 10^4$ Pa (4 to 6kg $\cdot$cm2) pressure].
Smoothing Capacitor	Discoloration or odor	Replace the capacitor or the inverter.

Parts Replacement Schedule

Replace the following parts periodically, for long, safe, trouble-free operation of the FP5/GP5:

Parts	Approximate Interval	Remarks
Cooling Fan	2 to 3 years	Replace with new one.
Smoothing Capacitor	5 years	Replace with new one (after inspection).
Breakers or Relays	--	Decide after inspection.
Fuses	10 years	Replace with new one.
Aluminum Electrolytic Capacitor on PCB Board	5 years	Replace with new one (after inspection).

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4.2 ALARM & FAULT DISPLAYS

This section describes the alarm and fault displays, explanations for fault conditions, and corrective actions to be taken if the FP5/GP5 malfunctions.

Alarm Display

Unlike faults, alarms do not activate fault contact outputs. After the cause of the alarm is corrected, the inverter returns to its former operation status automatically.

Alarm Display and Explanations

LCD Operator Alarm Display	Contents	Description
Uv Undervoltage (blinking)	Undervoltage detection	Undervoltage has been detected.
oV Overvoltage (blinking)	OV during stop	Main circuit DC voltage exceeds the overvoltage detection level while the inverter output is OFF.
oH1 Overheat 1 (blinking)	Heatsink overheating	When heatsink temperature ≥ OH1 detection level, continuous operation at 0H1 detection is selected.
oL3 Overload 3 (blinking)	Overtorque detection	When inverter output current > *n078* (overtorque detection level), continuous operation at overtorque detection is selected.
bb Base Block (blinking)	External baseblock	External baseblock command is input from control circuit terminal.
EF Ext Fault (blinking)	Simultaneous forward/ reverse run commands	Both forward and reverse run commands are simultaneously input for over 500ms.
CE Modbus Com Err (blinking)	MODBUS transmission waiting	When parameter *n002* (operation method selection) is set to "4" or above, the inverter has not received the normal data from serial communication after power ON.
oH3 Overheat 3 (blinking)	Inverter overheat pre-alarm	Inverter overheat pre-alarm signal is input from control circuit terminal.
CALL Waiting Message (blinking)	MODBUS transmission error	Continuous operation is selected at MODBUS transmission error.
oPE1 KVA Setting Err	Inverter kVA setting fault	Inverter kVA setting error.
oPE3 MF Input Error	Multi-function contact input setting error	One of the following setting errors occurred in the multi-function contact input selection (*n036* to *n040*). · Two or more of the same values are set. · Both 15 and 16 are set at the same time. · Both 22 and 25 are set at the same time. · Either of *n036* to *n039* are set to "25" or "26".
oPE5 V/f Error	V/f data setting error	Setting error of *n011* to *n017* (V/f data)
oPE6 Parameter Error	Parameter setting error	One of the following setting errors occurred. · *n062* (jump frequency 1) > *n063* (jump frequency 2) · *n031* (frequency upper limit) < *n032* (frequency lower limit) · *n033* (motor rated current) < 10% of inverter rated current, or *n033* > 200% of inverter rated current setting

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Fault Display

When the FP5/GP5 detects a fault, the fault is displayed on the digital operator and a fault contact output is activated after which the motor coasts to a stop. Check the causes listed in the table below and take the corresponding corrective actions. To reset the inverter, remove any run command and apply the reset input signal or depress the RESET key on the digital operator, or cycle power. If taking the corrective actions described does not solve the problem, contact your Saftronics representative immediately.

Fault Diagnosis and Corrective Actions

LCD Operator-Fault Display	Name	Description	Corrective Action
Uv1 Undervoltage 1	Main circuit undervoltage (PUV)	Undervoltage in the DC main circuit during running.	· Check the power supply wiring. · Correct the line voltage
Uv2 Undervoltage 2	Control circuit undervoltage (CUV)	Undervoltage in the control circuit during running.	
Uv3 Undervoltage 3	MC fault	The pre-charge contactor opened during running.	
oC Overcurrent	Overcurrent (OC)	The inverter output current exceeded the OC level.	· Check the motor coil resistance. · Extend the accel/decel time. · Check the motor insulation. · Multi-meter check.
oV Overvoltage	Overvoltage (OV)	The main circuit DC voltage exceeded the OV level. Detection level 230V class: approx. 400VDC or less 460V class: approx. 800VDC or less	Extend the deceleration time, add braking circuit.
GF Ground Fault	Ground fault (GF)	Inverter output grounding current exceeded 50% of inverter rated current.	· Check that motor insulation has not deteriorated. · Check that connection between inverter and motor is not damaged.
PUF DC Bus Fuse	Main circuit fault (PUF)	·The DC bus fuse is blown. ·The output transistors were damaged.	Check for damaged transistor, load side short circuit, grounding, etc.

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LCD Operator-Fault Display	Name	Description	Corrective Action
*oH1 Overheat 1	Heatsink overheat (OH1)	The transistor heatsink temperature exceeded the allowable value (Fin temperature > OH1 detection level).	Check the fan and ambient temperature.
oH2 Overheat 2	Heatsink overheat (OH2)	The transistor heatsink temperature exceeded the allowable value (Fin temperature > OH2 detection level).	
oL1 Overload 1	Motor overload (OL1)	Inverter output exceeded the motor overload level (see *n012*).	Reduce the load.
oL2 Overload 2	Inverter overload (OL2)	Inverter output exceeded the inverter overload level.	Reduce the load, extend the acceleration time.
*oL3 Overload 3	Overtorque detection (OL3)	Inverter output current exceeded the overtorque detection level *(n078)*.	
SC Short Circuit	Load short-circuit (SC)	Inverter output (load) is short-circuited.	· Check the motor coil resistance. · Check the motor installation.
EF0 Opt External Flt	External fault from serial communication	Fault occurred in the external control circuit.	Check the external control circuit.
EF2 External Fault 2	External fault at terminal S2	Fault occurred in the external control circuit.	Check the condition of the input terminal. If the LED lights when terminal is not connected, replace the inverter.
EF3 External Fault 3	External fault at terminal S3		
EF4 External Fault 4	External fault at terminal S4		
EF5 External Fault 5	External fault at terminal S5		
EF6 External Fault 6	External fault at terminal S6		
SPI Input Pha Loss	Excessive ripple in the DC bus	· Inverter input power supply has open phase. · Large unbalance in input line voltage.	· Check the line voltage. · Re-tighten the output terminal screws.
SPo Output Pha Loss	Output open-phase	Inverter output has open phase.	· Check the output wiring.

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LCD Operator-Fault Display	Name	Description	Corrective Action
*CE Modbus Com Err	MODBUS transmission fault	Control data cannot be received normally.	Check the transmission devices or signals.
CPF0 Com-Err (Op +Inv)	Control circuit fault 1 (CPFO) Digital operator transmission fault	· Transmission between the inverter and digital operator cannot be established 5 seconds after supplying power. · MPU peripheral element check fault (on-line)	· Insert the digital operator connector again. · Check the control circuit wiring. · Replace the control card.
CPF1 Com-Err (Op +Inv)	Control circuit fault 2 (CPF1) Digital operator transmission fault	· Transmission between the inverter and digital operator is established once after supplying power, but later transmission fault continues for more than 2 seconds. · MPU peripheral element check fault (on-line).	· Insert the digital operator connector again. · Check the digital control circuit wiring. · Replace the control card.
CPF4 Eprom Error	EEPROM fault (CPF4)	Inverter PCB control board fault.	Replace the control card.
CPF5 External A/O Err	CPU A/D converter fault (CPF5)		
rr Dyn Brk Trans	Regenerative brake transistor failure	Dynamic braking transistor has failed	· Check dynamic brake resistance. · Check for proper wiring of dynamic brake resistor. · Replace power board.
rh Dyn Brk Res	Dynamic brake resistor overheat (DB resistor overload)	Dynamic brake resistor duty cycle value exceeded (>3% ED)	· Check for excessive load. · Increase deceleration time. · Increase time between decelerations.
oPr Operator Failure	LCD operator disconnected	The LCD operator has been disconnected	· Check LCD operator wiring. · Check parameter n110
CPF5 EPROM R/W Err	Parameter read/write error	EPROM life cycle has been exceeded	· Check control card wiring. · Replace the control card.

* Stopping method selection is available for these faults.

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Motor Faults

If a motor fault occurs, follow the checkpoints listed in the table below and take the corresponding corrective actions. If taking the corrective actions described does not solve the problem, contact your Saftronics representative immediately.

Motor Faults and Corrective Actions

Fault	Check Point	Corrective Action
Motor does not rotate	Power supply voltage applied to power supply terminals L1, L2, L3? Charge LED is ON?	· Turn ON power supply. · Turn OFF power supply, and then ON again. · Check power supply voltage. · Make sure terminal screws are tight.
	Use rectifier type voltmeter to test. Voltage output to output terminals T1, T2, T3 correct?	Turn OFF power supply, then turn ON again.
	Motor locks due to excessive load?	Reduce the load and release the lock.
	Fault displayed in operator display?	Check troubleshooting table.
	FWD or REV run command entered?	Check the wiring.
	Frequency setting voltage entered?	· Check the wiring. · Check frequency setting voltage.
	Operation mode setting correct?	Check the operation mode selection *(n002)*.
Motor rotation reverses	Wiring of terminals T1, T2, T3 correct?	Match wiring to the phase order of the motor leads U, V, W.
	FWD and REV wiring run signals entered?	Correct the wiring.
Motor rotates, but variable speed not available.	Wiring of frequency setting circuit correct?	Check the operation mode selection *(n002)*.
	Operation mode setting correct?	Check the operation mode selection *(n002)*.
	Load excessively large?	Reduce the load.
Motor r/min. too high or too low	Motor ratings (number of poles, voltage correct?)	Check motor nameplate specifications.
	Accel/decel speed change ratio for gears, etc. correct?	Check speed changer (gears, etc.)
	Maximum frequency set value correct?	Check the maximum frequency set value.
	Use rectifier voltmeter. Voltage between motor terminals not excessive/reduced?	Check V/f characteristics values.
Motor r/min not stable during operation	Load excessively large?	Reduce the load.
	Load variation excessively large?	· Reduce the load variation. · Increase inverter motor capacity.
	3-phase or single-phase power supply used? For 3-phase power supply, open phase?	· For 3-phase power supply, check the wiring if power supply is open phase. · For single-phase power supply, connect AC reactor to the power supply.

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APPENDIX

Section	Description	Page
A	**APPENDIX**	
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A-1 BRAKING CONNECTION DIAGRAMS

Braking Resistor Unit

230V: 5~25HP
460V: 5~25HP

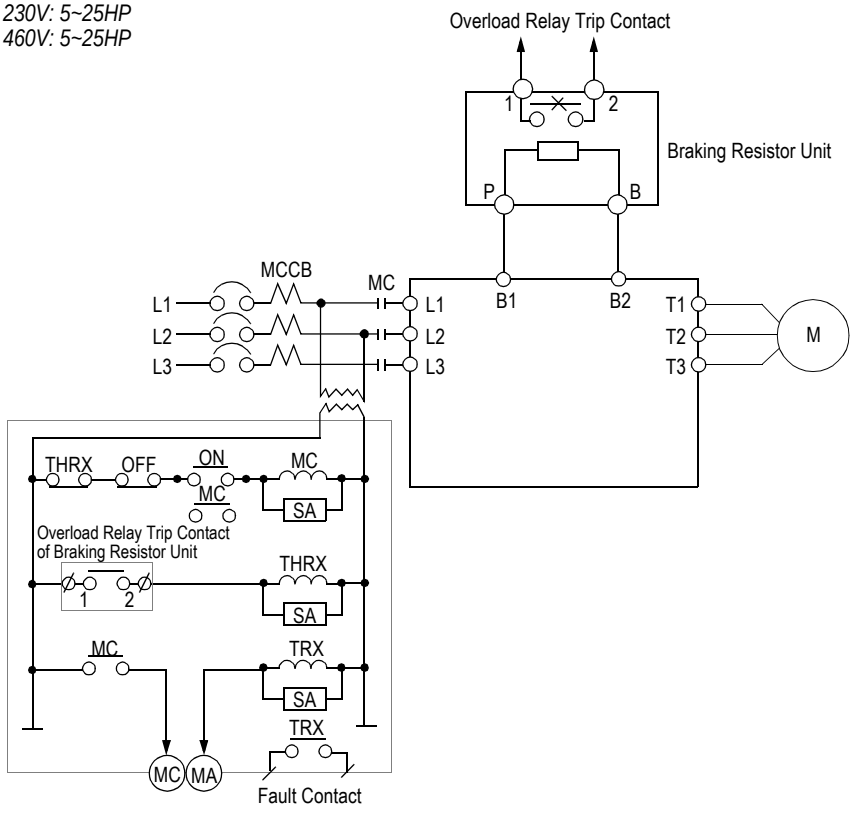


Figure 53 External Control Circuit for FP5/GP5 Braking Resistor Connection

230V: 20~25HP

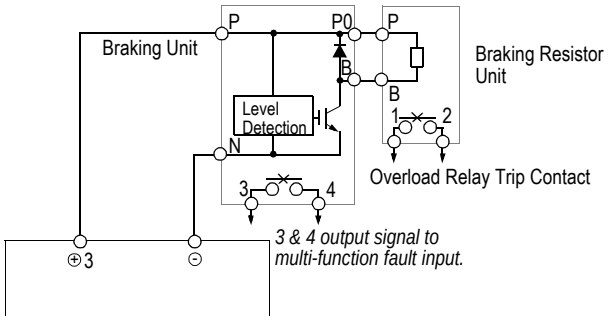


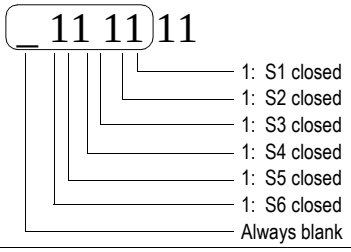
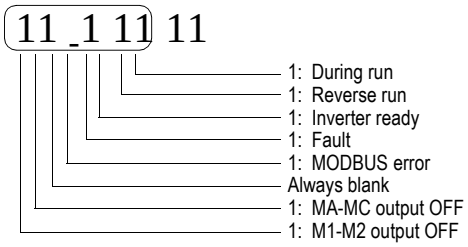
Figure 54 External Control Circuit for FP5/GP5 Braking Unit Connection (CDBR Type)

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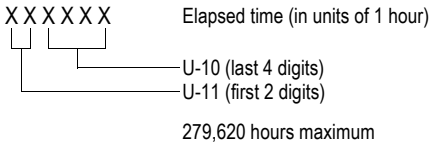
A-2 DIGITAL OPERATOR MONITOR DISPLAY

The following table describes the contents of the digital operator monitor display.

Digital Operator Monitor Display

<table>
<tr><th>Name
(LCD Operator Display)</th><th colspan="2">Description</th></tr>
<tr><td>Frequency Reference
(Frequency Ref)</td><td colspan="2">· Frequency reference can be monitored/set.
· Setting/display unit depends on display mode (n023).</td></tr>
<tr><td>Output Frequency
(Output Freq)</td><td colspan="2">· Output frequency is displayed.
· Display unit depends on display mode (n023).</td></tr>
<tr><td>Output Current
(Output Amps)</td><td colspan="2">Output current is displayed in units of 0.1A (1A for 1,000A and above).</td></tr>
<tr><td>Output Power
(Output Power)</td><td colspan="2">Output power is displayed in units of 0.1kW (1kW for 1,000kW and above).</td></tr>
<tr><td>FWD/REV Run Command
(Forward/Reverse)</td><td colspan="2">· FWD/REV run command can be monitored/set.
· Setting enabled during run command from digital operator.
· FWD run displays “Forward”, REV run displays “Reverse”.</td></tr>
<tr><td rowspan="10">Monitor
(Monitor U-XX)</td><td colspan="2">The following conditions can be monitored.</td></tr>
<tr><td>No.</td><td>Contents</td></tr>
<tr><td>U-01</td><td>Frequency reference</td></tr>
<tr><td>U-02</td><td>Output frequency</td></tr>
<tr><td>U-03</td><td>Output current</td></tr>
<tr><td>U-04</td><td>Output voltage reference is displayed in units of 1V.</td></tr>
<tr><td>U-05</td><td>DC voltage is displayed in units of 1V.</td></tr>
<tr><td>U-06</td><td>Output power</td></tr>
<tr><td>U-07</td><td>Input terminal status is displayed (terminals S1 to S6).

</td></tr>
<tr><td>U-08</td><td>Inverter status is displayed.

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

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Name (LCD Operator Display)	Description	
Monitor (Monitor U-XX)	U-09	Last 4 faults are displayed.
	U-10	Last 4 digits of software revision number are displayed.
	U-11 U-12	Elapsed time is displayed as follows:  279,620 hours maximum
	U-13	PID feedback is displayed in units of 0.1Hz.
	U-15	Kilowatt-hour meter (4 least significant digits)
	U-16	Kilowatt-hour meter (2 most significant digits)
Acceleration Time 1 (Accel Time 1)	Acceleration time 1 *(n018)* can be set/read in units of 0.1s (1s for 1,000s and above).	
Deceleration Time 1 (Decel Time 1)	Deceleration time 1 *(n019)* can be set/read in units of 0.1s (1s for 1,000s and above).	
V/f Pattern Selection (V/f Selection)	V/f pattern selection *(n010)* can be set during stop.	
Frequency Reference Gain (Terminal FV Gain)	Frequency reference gain *(n048)* can be set during stop.	
Frequency Reference Bias (Terminal FV Bias)	Frequency reference bias *(n049)* can be set during stop.	
Motor Rated Current (Motor rated FLA)	Motor rated current *(n033)* can be set during stop.	
PID Selection (PID Mode)	PID selection *(n084)* can be set during stop.	
Energy Saving Selection (Energy sav Sel)	Energy saving selection *(n096)* can be set during stop.	
PRGM Mode (Parameter nXXX)	Parameters can be set/read during stop.	

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A-3 CE Conformance (Applicable to 460V Models Only)

CE CONFORMANCE - Low Voltage Directive (LVD) Compliance

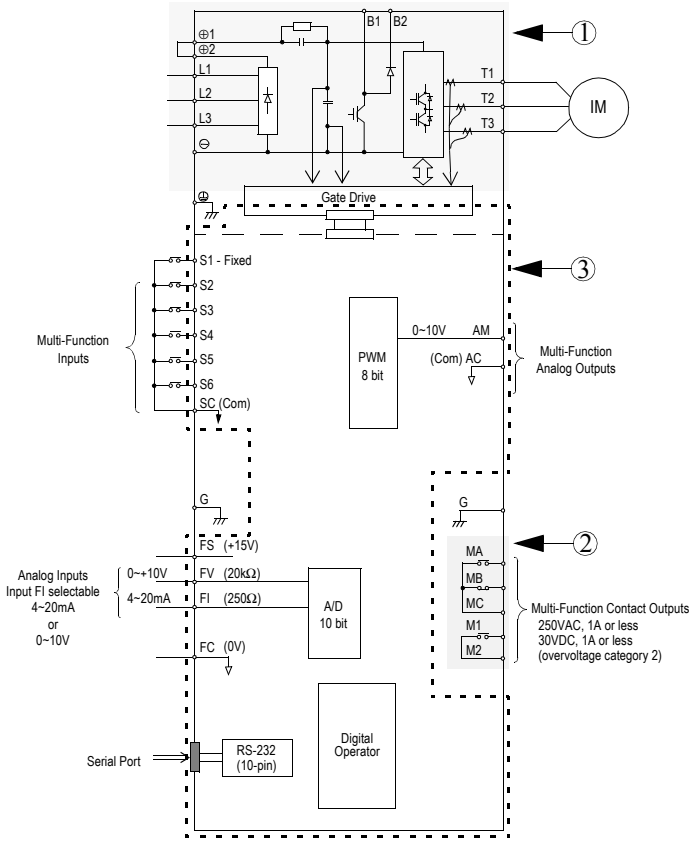


Figure 11 FP5/GP5 Terminal Diagram

① These circuits are hazardous and are separated from accessibility by protective separation.

② These circuits are not separated from hazardous circuits by protective separation, but only with basic insulation. These circuits cannot be accessed and must not be interconnected with any circuits which are accessible, unless they are isolated from accessible circuits by supplemental insulation. These circuits can be connected only to the following circuits:

30VDC or less (overvoltage category 2)
250VAC or less (overvoltage category 2)

③ These circuits are not separated from hazardous circuits by protective separation, but only with basic insulation. These circuits cannot be accessed and must not be interconnected with any circuits which are accessible, unless they are isolated from accessible circuits by supplemental insulation.

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CE CONFORMANCE - Electro-Magnetic Compatibility (EMC) Compliance

In order to conform to EMC standards, exclusive-use methods are required for line filter application, cable shielding and inverter installation. An outline of the methods follows.

The line filter and the inverter must be mounted on the same metal plate. The filter should be mounted as close to the inverter as practical. Keep cable as short as possible. The metal plate should be securely grounded. The ground of the line filter and inverter must be bonded to the metal plate with as much area as possible.

For line power input cable, screened cable is recommended at least within the panel. The screen of the cable should be connected to a solid ground. For the motor cable, screened cable (max. 20m) must be used and the screen of the motor cable is connected to ground at both ends by a short connection, using as large an area as practical.

The following table and figures show the line filter list for EMC standards and the installation/wiring of inverter and line filter.

Line Filter List for EMC Standards

Inverter Model CIMR-P5Uxxxx	Line Filter (Manufactured by Schaffner)			
	Model	Rated Current (A)	Mass (kg)	Dimensions (mm) W × D × H
40P4	FS4874-7/07	7	1.1	50 × 126 × 255
40P7				
41P5				
42P2	FS4874-18/07	18	1.7	55 × 142 × 305
43P7				
44P0				
45P5	FS4874-30/07	30	1.8	60 × 150 × 335
47P5				
4011	FS4874-42/07	42	2.8	70 × 185 × 329
4015				
4018	FS4874-55/07	55	3.1	80 × 185 × 329
4022	FS4874-75/34	75	4.0	80 × 220 × 329
4030				
4037	FS4874-100/35	100	5.5	90 × 220 × 379
4045	FS4874-130/35	130	7.5	110 × 240 × 429
4055	FS4874-180/07	180	11	110 × 240 × 438
4075	FS4874-300/99	300	15	300 × 564 × 160
4110	FS4874-400/99	400	22	300 × 564 × 160
4160				
4185	FS4874-500/99	500	19.5	300 × 564 × 160
4220	FS4874-600/99	600	20.5	300 × 564 × 160
4300	FS4874-900/99	900	33.5	300 × 564 × 160

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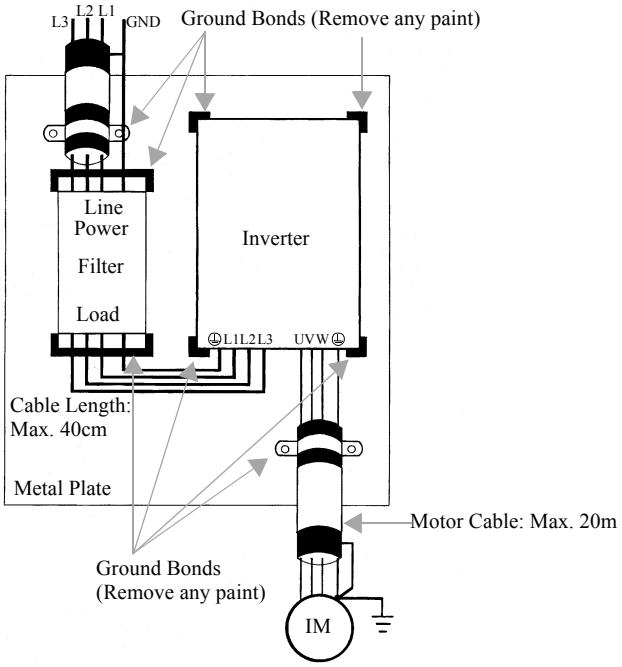


Fig. 12 Installation of Line Filter and Inverter (Models FP5/GP5 40P4 to 4015)

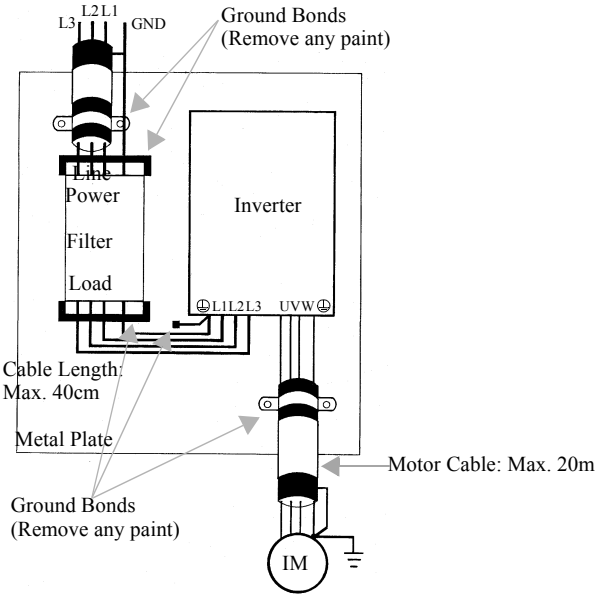


Fig. 13 Installation of Line Filter and Inverter (Models FP5/GP5 4018 to 4300)

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Safety Warnings and Operating Information for Inverters

Introduction
Depending on their protection rating configuration, parts of inverters can have live, uninsulated and hot surfaces during operation. If housing components, the control unit or terminal covers are removed, incorrect installation and operation can lead to serious injuries and damage to other installations. It is thus absolutely essential to observe all the warnings and instructions in the operating manual. Installation, setup and maintenance should only be performed by properly qualified staff. (IEC 364 / Cenelec HD 384 or DIN VDE 0100 and IEC 664 or DIN VDE. The applicable national safety and accident prevention regulations must also be observed.) For the purpose of observance of the safety requirements qualified staff are defined as individuals who are familiar with the installation, setup and operation of the converters and who have the proper qualifications for this work.

Proper use for intended purpose
Inverters are designed for installation in electrical systems or machines. A converter installed in a machine may only be activated if the machine conforms to the provisions of EU directive 89/392/EEC (machine directives). EN 60204 must also be observed. The converter may also only be operated if the requirements of the EMC directive (89/336/EEC) are also satisfied. This frequency converter conforms to the requirements of the low-voltage directive, 73/23/EEC. The harmonized standards of the prEN 50178/DIN VDE 0160 series have been applied, in combination with EN 660439-1 / VDE 06600 Part 500 and EN 60146 / VDE 0558. The specifications on the ratings plate and the specifications and connection requirements described in the documentation must be observed at all times.

Transportation and storage
All instructions for transport, storage and proper handling must be observed. Climatic and environmental conditions must conform to the requirements of prEN 50178.

Installation
The converters must be installed and cooled in compliance with the regulations outlines and referred to in the documentation. The cooling air flow direction is an important requirement that must be observed. This means that the unit may only be installed and operated in the specified orientation (e.g. upright). All distances specified must also be observed. The converters must be protected against excessive stresses. No components may be bent and no distances required for proper insulation may be changed. To prevent the risk of static electricity damage never touch electronic components or contacts.

Electrical connections
All national safety regulations (e.g. VBG 4) must be observed when working on live equipment. The electrical installation of the units must conform to the applicable regulations. For further information please refer to the documentation. In particular, please take care to observe all installation instructions as regards proper EMC immunity, e.g. for shielding, earthing, location of filters and cable routing. This also applies for equipment with CE approvals. Compliance with the EMC legislation limits is the responsibility of the machine or system manufacturer.

RCCBs
For information on the use of RCCBs with inverters please contact your supplier or Saftronics representative.

Operation
In some systems it may be necessary to install additional monitoring and protective facilities to comply with the applicable safety and accident prevention regulations. The only changes permitted are to the operator software of the inverters. Please note that the capacitors can remain charged for up to around 5 minutes after the frequency converter has been disconnected from the power supply. You should thus always wait for a short period before opening the unit and touching the electrical connections.

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EU Manufacturer's Declaration

Products
Static inverter, series FP5/GP5

Scope
Saftronics inverters are components (BDM*___, defined by IEC 22G/21CDV) designed exclusively for installation in machines or systems (end products) by qualified re-users (e.g. mechanical engineering manufacturers).

Responsibility
As a component manufacturer we are responsible for the provision of installation instructions. These can be found in the installation guidelines publication EZZ006908.

Our products have been tested by authorized bodies pursuant to the requirements of the standards listed below. The products conform to these standards, subject to due and proper observation of the installation instructions provided in section 10 of this manual:

Immunity — EMC resistance pursuant to EN50082-2, Part 2:

EN 61000-4-2	Resistance to static discharge
EN 61000-4-4	Resistance to high-speed transients and bursts
EN 61000-4-8	Testing of resistance to magnetic fields with power systems frequencies
ENV 50140	Resistance to high-frequency magnetic fields
ENV 50141	Resistance to conducted interference

Emissions — EMC interference emissions pursuant to EN50081-2, Part 2:

EN 55011	Class A or B limit curve under the conditions described in the operating instructions in the installation guidelines, EZZ006908.

Always observe all the safety instructions provided in this product documentation!

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