SAFTRONICS

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PC7

INSTRUCTION MANUAL

Overview

Chapter 1: Installation

Chapter 2: Quickstart

Chapter 3: Wiring

Chapter 4: Programming

I. THANK YOU !

We at Saftronics appreciate your purchase of this PC7 model adjustable frequency drive. When properly installed, operated, and maintained, this unit will provide a lifetime of reliable, troublefree operation.

This manual was written to serve as a tool for *qualified* personnel to use in the installation, programming, and troubleshooting of this equipment. It is **IMPORTANT** the installer thoroughly reads and understands the information contained herein before any action is taken. This document is organized via numbered chapters, which should be read in sequence before any work is performed.

II. SAFETY/HAZARDS

The safety of personnel is of utmost importance to Saftronics, Inc. This symbol is used throughout this manual to identify specific hazards which can lead to personal injury, death, property damage or economic loss. The applicable procedures must be performed only by qualified personnel who have been instructed with respect to the hazards involved with potentially lethal voltages.

III. WAIVER OF LIABILITY

No patent liability is assumed with respect to the use of the information contained herein. Moreover, because we at Saftronics are constantly improving our high quality products, the information contained in this manual is subject to change without notice. Every precaution has been taken in the preparation of this manual. Nevertheless, Saftronics assumes no responsibility for errors or omissions. Neither is any liability assumed for damages resulting from the use of the information contained in this publication. In no event will Saftronics be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

IV. COPYRIGHT

V. INTRODUCTION

The PC7 is a high performance, microprocessor-based AC motor speed controller. Its inherent programming and mechanical flexibility make it the *ultimate* general purpose inverter for distributor and OEM alike. It is available as a protected chassis. The ultra-compact protected chassis units are available through 10 HP at 230V and through 10 HP at 460V. (see notes on product specifications)

VI. ABOUT THIS MANUAL

This document will serve as the installation, programming and troubleshooting manual for the PC7 Mini Vector. It must be read in its entirety before any installation or troubleshooting is performed. This manual should be followed in sequence, starting with Chapter 1. The chapters are organized as follows:

Chapter 1: Installation
Chapter 2: Quickstart
Chapter 3: Wiring
Chapter 4: Programming
Chapter 5: PM & Troubleshooting

The PC7 adjustments are made through a family of programming parameters which have a number designator. By convention, this manual will print the FUNCTION numbers in bold to highlight them.

VII. IF YOU HAVE DIFFICULTY

Please reread the applicable sections of this manual. If you still have difficulty, contact your local distributor or authorized representative. If they are unable to answer your questions, please contact Saftronics technical support by phone at 941-693-7200 or by fax at 941-693-2431. Before you contact the factory, make sure you have the unit model number, serial number, program data and wiring diagram available. Your cooperation will help us serve you promptly and efficiently.

VIII. PRODUCT OVERVIEW

The PC7 was designed as a compact, yet powerful platform to handle a wide variety of general purpose applications. This product uses the latest in microprocessor technology to provide a precise, reliable controller for three-phase AC motors.

The PC7 can be used with a single phase input, but must always be used with 3 phase AC motors. Consult with the factory for special input power requirements.

The PC7 has programmable I/O and will satisfy a wide variety of applications. This allows the product to suit the requirements of the user, distributor, or OEM.

IX. STANDARD FEATURES

- ☑ Latest generation of power device technology
- ☑ Compact physical size
- ☑ High carrier frequency (low noise) without derate
- ☑ Keypad is standard
- ☑ Single-phase operation
- ☑ Programmable I/O
- ☑ Fan ventilated design (no cooling fans)
- ☑ Keypad for storage of program
- ☑ RS-485 communications port is standard
- ☑ DC injection braking & DB transistor are included
- ☑ Designed to meet requirements of CE
- ☑ Meets requirements of cUL
- ☑ 400 Hz maximum output
- ☑ Comprehensive keypad displays
- ☑ 4 fault memory (nonvolatile to retain even after power removal)
- ☑ Comprehensive ground fault protection

X. CE MARKING

This product complies with the low voltage directive (73/23/EEC), the generic standard for industrial immunity (EN50081-2) and the CE marking directive (93/68/EEC). The PC7 also complies with the Electromagnetic Compatibility (EMC) Directive (89/336/EEC) when the following requirements for a conforming installation are applied:

- ☑ An input RFI filter must be installed to limit conducted emissions.
- ☑ The controller must be mounted in electromagnetically shielded enclosure to reduce radiated emissions. A typical NEMA or IEC metal enclosure is adequate, provided there are no vents and the seams are continuously welded.
- ☑ The motor cables should be shielded cable or in metal conduit to attenuate radiated emissions.
- ☑ Motor cable length must be kept as short as possible.

Please Note: *The conformity of the PC7 controller and any applicable filters does not necessarily guarantee that the entire installation will conform. Many installation specific factors (wire routing, proper grounding, etc.) can influence the total installation and only direct measurements can ensure total conformity.*

XI. PRODUCT SPECIFICATIONS: 230V

Voltage Class		230V Single-/3-Phase								
Model PC7-XXXX 3-Phase		20P1	20P2	20P4	20P7	21P5	22P2	23P7	25P5	27P5
Max. Applicable Motor Output kW (HP)†		0.1 (0.13)	0.2 (0.25)	0.55 (0.75)	1.1 (1)	1.5 (2)	2.2 (3)	3.7 (5)	5.5 (7.5)	7.5 (10)
Output Characteristics	Inverter Capacity (kVA)	0.3	0.6	1.1	1.9	3.0	4.2	6.7	9.5	13
	Rated Output Current (A)	0.8	1.6	3	5	8	11	17.5	25	33
	Max. Output Voltage (V)	3-Phase, 200 to 230V (proportional to input voltage) Single-Phase, 200 to 240V (proportional to input voltage)								
	Max. Output Frequency (Hz)	400 Hz (programmable)								
Power Supply	Rated Input Voltage and Frequency	3-Phase, 200 to 230V, 50/60Hz Single-Phase, 200 to 240V, 50/60Hz								
	Allowable Voltage Fluctuation	-15 to +10%								
	Allowable Frequency Fluctuation	±5%								
Control Characteristics	Control Method	Sine Wave PWM (V/f control open loop vector control selectable)								
	Frequency Control Range	0.1 to 400Hz								
	Frequency Accuracy (Temperature Change)	Digital Reference: ±0.01% (-10 to +50°C) Analog Reference: ±0.5% (25 ±10°C)								
	Frequency Setting Resolution	Digital Reference: 0.01Hz (less than 100Hz)/0.1Hz (100Hz or more) Analog Reference: 1/1000 of max. output frequency								
	Output Frequency Resolution	0.01Hz								
	Overload Capacity	150% rated output current for one minute								
	Frequency Reference Signal	0 to 10VDC (20Ω), 4 to 20mA (250Ω), 0 to 20mA (250Ω) pulse train input, frequency setting volume (selectable)								
	Accel/Decel Time	0.01 to 6000 sec. (accel/decel time are independently programmed)								
	Braking Torque	Short-term average deceleration torque‡ 0.1, 0.25kW (0.13HP, 0.25HP): 150% 0.55, 1.1kW (0.5HP, 1HP): 100% 1.5kW (2HP): 50% 2.2kW (3HP) or more: 20% Continuous regenerative torque: Approx. 20% (150% with optional braking resistor, braking transistor built-in)								
	V/f Characteristics	Possible to program an V/f pattern								

PRODUCT SPECIFICATIONS: 230V

Voltage Class			230V Single-/3-Phase								
Model		3-Phase	20P1	20P2	20P4	20P7	21P5	22P2	23P7	25P5	27P5
Protective Functions	Motor Overload Protection		Electronic thermal overload relay								
	Instantaneous Overcurrent		Motor coasts to a stop at approx. 250% of inverter rated current								
	Overload		Motor coasts to a stop after 1 minute at 150% of inverter rated output current								
	Overvoltage		Motor coasts to a stop if DC bus voltage exceed 410V								
	Undervoltage		Stops when DC bus voltage is approx. 200V or less								
	Momentary Power Loss		Following items are selectable: Not provided (stops if power loss is 15ms or longer), continuous operation if power loss is approx. 0.5s or shorter, continuous operation								
	Cooling Fin Overheat		Protected by electronic circuit								
	Stall Prevention Level		Can be set individual level during accel/decel, provided/not provided available during coast to a stop								
	Cooling Fan Fault		Protected by electronic circuit (fan lock detection)								
	Ground Fault		Protected by electronic circuit (overcurrent level)								
Other Functions	Power Charge Indication		ON until the DC bus voltage becomes 50V or less. RUN lamp stays ON or digital operator LED stays ON. (Charge LED is provided for 400V)								
	Input Signals	Multi-Function Input	Seven of the following input signals are selectable: Forward/reverse run (3-wire sequence), fault reset, external fault (NO/NC contact input), multi-step speed operation, Jog command, accel/decel time select, external baseblock (NO/NC contact input), speed search command, accel/decel hold command, LOCAL/REMOTE selection, communication/control circuit terminal selection, emergency stop fault emergency stop alarm								
	Output Signals	Multi-Function Output	Following output signals are selectable (1 NO/NC contact output, 2 photo-coupler outputs): Fault, running, zero speed, at frequency, frequency detection (output frequency < or > set value), during overtorque detection, during undervoltage detection, minor error, during baseblock, operation mode, inverter run ready, during fault retry, during UV, during speed search, data output through communication								
	Standard Functions		Voltage vector control, full-range automatic torque boost, slip compensation, DC injection braking current/time at stop (50% of inverter rated current, 0.5 sec. or less), frequency reference bias/gain, MEMOBUS communications (RS-485/422, max. 19.2K bps), PID control, energy-saving control, constant copy, frequency reference with built-in speed control								

PRODUCT SPECIFICATIONS: 230V

Voltage Class			230V Single-/3-Phase								
Model PC7-XXXX		3-Phase	20P1	20P2	20P4	20P7	21P5	22P2	23P7	25P5	27P5
Other Functions	Display	Status Indicator (LED)	RUN and ALARM provided as standard LED's								
		Digital Operator (JVOP-140)	Available to monitor frequency reference, output frequency, output current								
	Terminals		Main circuit: screw terminals Control circuit: plug-in screw terminal								
	Wiring Distance between Inverter and Motor		100m (328ft or less)								
Enclosure			Open chassis or enclosed wall-mounted								
Cooling Method			Cooling fan is provided for 200V, 0.75kW (3-/single-phase), 400V, 1.5kW (3-phase), others are self-cooling								
Environmental Conditions	Ambient Temperature		Open Chassis: -10 to +50°C (14 to 122°F) Enclosed wall-mounted: -10 to +40°C (14 to 105°F) (not frozen)								
	Humidity		95% RH or less (non-condensing)								
	Storage Temperature**		-20 to +60°C (-4 to 140°F)								
	Location		Indoor (free from corrosive gases or dust)								
	Elevation		1000m (3280ft) or less								
	Vibration		Up to 9.8 / S^2 (1G) at less than 20Hz, Up to 2m / S^2 (0.2G) at less than 20 to 50Hz								

** Temperature during shipping (for short period)

PRODUCT SPECIFICATIONS: 460V

Voltage Class			460V 3-Phase							
Model PC7-XXXX		3-Phase	40P2	40P4	40P7	41P5	42P2	43P7	45P5	47P5
Max. Applicable Motor Output kW(HP)			0.37 (0.5)	0.55 (0.75/1)	1.1 (1.5/2)	1.5 (3)	2.2 (3)	3.7 (5)	5.5 (7.5)	7.5 (10)
Output Characteristics	Inverter Capacity (kVA)		0.9	1.4	2.6	3.7	4.2	7.0	11	14
	Rated Output Current (A)		1.2	1.8	3.4	4.8	5.5	9.2	14.8	18
	Max. Output Voltage (V)		3-phase, 380 to 460V (proportional to input voltage)							
	Max. Output Frequency (Hz)		400Hz (programmable)							
Power Supply	Rated Input Voltage and Frequency		3-phase, 380 to 460V, 50/60Hz							
	Allowable Voltage Fluctuation		-15 to +10%							
	Allowable Frequency Fluctuation		±5%							
Control Characteristics	Control Method		Sine wave PWM (V/f control/voltage control selectable)							
	Frequency Control Range		0.1 to 400Hz							
	Frequency Accuracy (Temperature Change)		Digital reference: ±0.01%, -10 to + 50°C (14 to 122°F) Analog reference: ±0.5%, 25 ± 10°C (59 to 95°F)							
	Frequency Setting Resolution		Digital reference: 0.01Hz (less than 100Hz)/0.1Hz (100Hz or more) Analog reference: 1/1000 of max. output frequency							
	Output Frequency Resolution		0.01Hz							
	Overload Capacity		150% rated output current for one minute							
	Frequency Reference Signal		0 to 10VDC (20kΩ), 4 to 20mA (250Ω), 0 to 20mA (250Ω) pulse train input, frequency setting volume (selectable)							
	Accel/Decel Time		0.01 to 6000 sec. (accel/decel time are independently programmed)							
	Braking Torque		Short-term average decelertion torque‡ 0.2kW: 150% 0.75kW: 100% 1.5kW (2HP): 50% 2.2kW (3HP) or more: 20% Continuous regenerative torque: Approx. 20% (150% with optional braking resistor, braking transistor built-in)							
	V/f Characteristics		Possible to program any V/f pattern							

PRODUCT SPECIFICATIONS: 460V

Voltage			460V 3-Phase							
Model PC7-XXXX		3-Phase	40P2	40P4	40P7	41P5	42P2	43P7	45P5	47P5
Protective Functions	Motor Overload Protection		Electronic thermal overload relay							
	Instantaneous Overcurrent		Motor coasts to a stop at approx. 250% of inverter rated current							
	Overload		Motor coasts to a stop after 1 minute at 150% of inverter rated output current							
	Overvoltage		Motor coasts to a stop if DC bus voltage exceed 820V							
	Undervoltage		Stops when DC bus voltage is approx. 400V or less							
	Momentary Power Loss		Following items are selectable: Not provided (stops if power loss is 15ms or longer), continuous operation if power loss is approx. 0.5s or shorter, continuous operation							
	Cooling Fin Overheat		Protected by electronic circuit							
	Stall Prevention Level		Can be set to individual levels during accel/decel, provided/not provided available during coast to a stop							
	Cooling Fan Fault		Protected by electronic circuit (fan look detection)							
	Ground Fault		Protected by electronic circuit (overcurrent level)							
Other Functions	Power Charge Indication		ON until the DC bus voltage becomes 50V or less. Run lamp says ON or digital operator LED stays ON. (Charge LED is provided for 400V)							
	Input Signals	Multi-Function Input	Seven of the following input signals are selectable: Forward/Reverse run (3-wire sequence), fault reset, external fault (NO/NC contact input), multi-step speed operation, Jog command, accel/decel time select, external baseblock (NO/NC contact input), speed search command, accel/decel hold command, LOCAL/REMOTE selection, communication/control circuit terminal selection, emergency stop fault emergency stop alarm							
	Output Signals	Multi-Function Output	Following output signals are selectable (1 NO/NC contact output, 2 photo-coupler outputs): Fault, running, zero speed, at frequency, frequency detection (output frequency < or > set value), during overtorque detection, during undervoltage detection, minor error, during baseblock, operation mode, inverter run ready, during fault retry, during UV, during speed search, data output through communication							
	Standard Functions		Voltage vector control, full-range automatic torque boost, slip compensation, DC injection braking current/time at stop (50% of inverter rated current, 0.5 sec. or less), frequency reference bias/gain, MEMOBUS communications (RS-485/422, max. 19.2K bps) PID control, energy-saving control, constant copy, frequency reference with built-in speed control							

PRODUCT SPECIFICATIONS: 460V

Voltage Class			460V 3-Phase							
Model PC7-XXXX		3-Phase	40P2	40P4	40P7	41P5	42P2	43P7	45P5	47P5
Other Functions	Display	Status Indicator (LED)	RUN and ALARM provided as standard LED's							
		Digital Operator (JVOP-140)	Available to monitor frequency reference, output frequency, output current							
	Terminals		Main circuit: screw terminals Control circuit: plug-in screw terminal							
	Wiring Distance between Inverter and Motor		100m (328ft or less)							
Enclosure			Open chassis or enclosed wall-mounted							
Cooling Method			Cooling fan is provided for 200V, 0.75kW (3-/single-phase), 200V, 0.75kW (1.5HP), others are self-cooling							
Environmental Conditions	Ambient Temperature		Open chassis: -10 to +50°C (14 to 122°F) Enclosed wall mounted: -10 to +40°C (-14 to +105°) (not frozen)							
	Humidity		95% RH or less (non-condensing)							
	Storage Temperature**		-20 to +60°C (-4 to 140°F)							
	Location		Indoor (free from corrosive gases or dust)							
	Elevation		1000m (3280ft) or less							
	Vibration		Up to 9.8m / S^2 (1G) at less than 20Hz Up to 2m / S^2 (0.2G) at less than 20 to 50Hz							

** Temperature during shipping (for short period)

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Chapter 1:
Installation

What this chapter tells you:

1) How to properly receive the PC7.
2) How to assess the installation environment.
3) How to properly mount the PC7.
4) The unit dimensions and heat dissipation.

You must confirm the model number and output current (HP) rating of the inverter before you apply power. Application of the wrong power supply can cause unit damage.

1.0 RECEIVING

The PC7 has been subjected to demanding tests prior to shipment from Saftronics' factory. To ensure proper operation and life of the equipment you must verify the model number is proper for the application. Please do the following before applying power:

- ☑ Inspect the shipping container. If damaged, you should immediately notify both Saftronics and the carrier and file a claim with the carrier within 14 days of receipt of the unit.
- ☑ Verify that the model number on the box (and the inverter) matches the invoice and the original purchase order.
- ☑ If you find any discrepancy, please notify either your distributor or authorized Saftronics agent immediately so corrective action can be implemented.

1.1 ASSESS THE ENVIRONMENT

The selection of the proper mounting location of the PC7 is imperative to achieve maximum operating performance and reliability. These units were designed to withstand the harsh demands of industrial installations. Nevertheless, caution should be exercised to ensure the chosen environment meets the following:

- ☑ Ambient temperature: 14 to 122^{0}F (-10 to +50^0)
- ☑ Protect from rain or moisture
- ☑ Protect from corrosive gases or liquids
- ☑ Shelter from direct sunlight
- ☑ Free from excessive mechanical vibration
- ☑ Free from radioactivity
- ☑ Free from oil sprays or splashes
- ☑ Relative humidity: 95% maximum, non-condensing
- ☑ Protect from salt spray
- ☑ Protect from dust or metallic particles in the air
- ☑ Protect from magnetic noise: welding machines, power devices, etc.
- ☑ Combustibles: thinner, solvents, etc.

1.2 POSITIONING

Make sure there is a minimum clearance of 1.18" (30 mm) around the sides of the PC7 unit and at least 4 inches above and below it to provide effective cooling and to meet NEC wiring requirements. The unit should be installed on a flat, vertical and level surface with the heatsink ribs oriented vertically.

1.3 MODEL NUMBERS

The PC7 is available as a protected chassis unit. The table below gives the various model numbers.

PC7 Mini Vector Model Numbers

Input Voltage	Model Number 3-Phase	HP (kW)	Rated Output Current
3-Phase 200V - 230V	PC720P1	0.13 (.01)	0.8
	PC720P2	0.25 (0.2)	1.6
	PC720P4	0.50 / 0.75 (0.4)	3
	PC720P7	1.0 (0.75)	5
	PC721P5	2.0 (1.5)	8
	PC722P2	3.0 (2.2)	11
	PC723P7	5.0 (3.7)	17.5
	PC725P5	7.5 (5.5)	25
	PC727P5	10 (7.5)	33
3-Phase 380V - 460V	PC740P2	0.50 (0.2)	1.2
	PC740P4	0.75 / 1.0 (0.4)	1.8
	PC740P7	1.5 / 2.0 (0.75)	3.4
	PC741P5	3.0 (1.5)	4.8
	PC742P2	3.0 (2.2)	5.5
	PC743P7	5.0 (3.7)	9.2
	PC745P5	7.5 (5.5)	14.8
	PC747P5	10 (7.5)	18

1.4 DIMENSIONS AND WEIGHTS

The PC7 is available as a NEMA 1 unit, the table gives the dimensions in inches (mm), mass in lbs (kg) and heat loss (W). (For single-phase information consult factory.

PC7 Mini Vector Dimensions

Voltage Class	Capacity HP (kW)	Overall Dimensions Inches (mm)									Mass	Heat Loss (W)			Fig.
		W	H	D	W1	H1	H2	H3	H4	d	Lb (kg)	Heat-sink	Unit	Total	
230V 3-Phase	0.13 (0.1)	2.68 (68)	5.83 (148)	2.99 (76)	2.20 (56)	4.65 (118)	0.20 (5)	5.04 (128)	0.79 (20)	M4	1.55 (0.7)	3.7	9.3	13	1
	0.25 (0.2)	2.68 (68)	5.83 (148)	2.99 (76)	2.20 (56)	4.65 (118)	0.20 (5)	5.04 (128)	0.79 (20)	M4	1.55 (0.7)	7.7	10.3	18	1
	0.50 (0.4)	2.68 (68)	5.83 (148)	4.25 (108)	2.20 (56)	4.65 (118)	0.20 (5)	5.04 (128)	0.79 (20)	M4	2.20 (1.0)	15.8	12.3	28.1	1
	1.0 (0.75)	4.25 (108)	5.83 (148)	5.04 (140)	2.20 (56)	4.65 (118)	0.20 (5)	5.04 (128)	0.79 (20)	M4	2.65 (1.2)	28.4	16.7	45.1	1
	2.0 (1.5)	4.25 (108)	5.83 (148)	5.16 (131)	3.78 (96)	4.65 (118)	0.20 (5)	5.04 (128)	0.79 (20)	M4	3.53 (1.6)	53.7	19.1	72.8	2
	3.0 (2.2)	4.25 (108)	5.83 (148)	5.51 (140)	3.78 (96)	4.65 (118)	0.20 (5)	5.04 (128)	0.79 (20)	M4	3.75 (1.7)	60.4	34.4	94.8	2
	5.0 (3.7)	5.51 (140)	5.83 (148)	5.63 (143)	5.04 (128)	4.65 (118)	0.20 (5)	5.04 (128)	0.79 (20)	M4	5.30 (2.4)	96.7	52.4	149.1	2
	7.5* (5.5)	7.09 (180)	10.24 (260)	6.69 (170)	6.46 (164)	9.61 (244)	0.31 (8)	10.24 260)	0	M4	10.13 (4.6)	170.4	79.4	249.8	2
	10* (7.5)	7.09 (180)	10.24 (260)	6.69 (170)	6.46 (164)	9.61 (244)	0.31 (8)	10.24 260)	0	M5	10.57 (4.8)	219.2	98.6	318.1	2
460V 3-Phase	0.50 (0.2)	4.25 (108)	5.83 (148)	3.62 (92)	3.78 (96)	4.65 (118)	0.20 (5)	5.04 (128)	0.79 (20)	M4	2.65 (1.2)	9.4	13.7	23.1	2
	0.75 (0.4)	4.25 (108)	5.83 (148)	4.43 (110)	3.78 (96)	4.65 (118)	0.20 (5)	5.04 (128)	0.79 (20)	M4	2.65 (1.2)	15.1	15.0	30.1	2
	1.5 / 2 (0.75)	4.25 (108)	5.83 (148)	5.51 (140)	3.78 (96)	4.65 (118)	0.20 (5)	5.04 (128)	0.79 (20)	M4	3.75 (1.7)	30.3	24.6	54.9	2
	3.0 (1.5)	4.25 (108)	5.83 (148)	6.14 (156)	3.78 (96)	4.65 (118)	0.20 (5)	5.04 (128)	0.79 (20)	M4	3.75 (1.7)	45.8	29.9	75.7	2
	3.0 (2.2)	4.25 (108)	5.83 148)	6.14 (156)	3.78 (96)	4.65 (118)	0.20 (5)	5.04 (128)	0.79 (20)	M4	3.75 (1.7)	50.5	32.5	83	2
	5.0 (3.7)	5.51 (140)	5.83 (148)	5.63 (143)	5.04 (128)	4.65 (118)	0.20 (5)	5.04 (128)	0.79 (20)	M4	5.30 (2.4)	73.4	44.5	117.9	2
	7.5* (5.5)	7.09 (180)	10.24 (260)	6.69 (170)	6.46 (164)	9.61 (244)	0.31 (8)	10.24 260)	0	M5	10.57 (4.8)	168.8	87.7	256.5	2
	10* (7.5)	7.09 (180)	10.24 260)	6.69 (170)	6.46 (164)	9.61 (244)	0.31 (8)	10.24 (260)	0	M5	10.57 (4.8)	209.6	99.3	308.9	2

*200/400V class, 7.5/10 HP (5.5/7.5 kW) inverters can be used as "IPOO" if the top and bottom covers are removed.

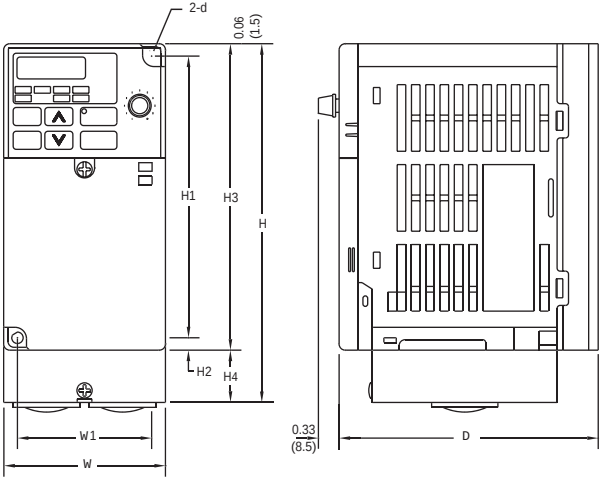


Fig. 1

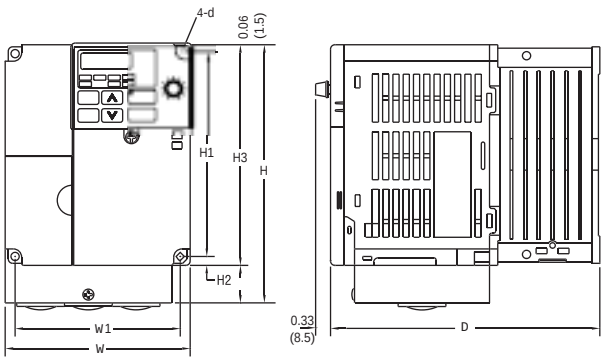


Fig. 2

1.5 HEAT DISSIPATION

The wattage figures given in the table above should be used for evaluating enclosure size for non-ventilated NEMA 12 and NEMA 4 enclosures.

1.6 NEMA 4 MODEL NUMBERS

The PC7 is available as a Nema 4 unit. The table below gives the NEMA 4 model numbers.

PC7 NEMA 4 Mini Vector Model Numbers

Input Voltage	Model Number 3-Phase NEMA 4 w/OP	Model Number 3-Phase NEMA 4 w/o OP	HP (kW)	Rated Output Current
3-Phase 200 - 230V	PC720P14	PC720P14B	0.13 (.01)	0.8
	PC720P24	PC720P24B	0.25 (0.2)	1.6
	PC720P44	PC720P44B	0.50 / 0.75 (0.4)	3
	PC720P74	PC720P74B	1.0 (0.75)	5
3-Phase 380V - 460V	PC740P24	PC740P24B	0.50 (0.2)	1.2
	PC740P44	PC740P44B	0.75 / 1.0 (0.4)	1.8
	PC740P74	PC740P74B	1.5 / 2.0 (0.75)	3.4

NOTE: You must supply liquid-tight conduit to comply with NEC codes and local applicable codes for a NEMA 4 enclosure. The NEC code states that the properly sized terminal fittings must be utilized in the connection between the conduit and the NEMA 4 enclosure to insure the NEMA 4 integrity of the system.

1.7 NEMA 4 DIMENSIONS

The PC7 is available as a NEMA 4 unit, the table below gives the overall dimensions.

PC7 NEMA 4 Mini Vector Dimensions

Voltage Class	Capacity HP (kW)	Overall Dimensions Inches (mm)			Figure
		Height	Width	Depth*	
230V 3-Phase	0.13 (0.1)	9.74 (247)	7.5 (191)	5.48 (139)	3
	0.25 (0.2)	9.74 (247)	7.5 (191)	5.48 (139)	3
	0.50 (0.4)	9.74 (247)	7.5 (191)	5.48 (139)	3
	1.0 (0.75)	9.74 (247)	7.5 (191)	5.48 (139)	3
460V 3-Phase	0.50 (0.2)	9.74 (247)	7.5 (191)	5.48 (139)	3
	0.75 (0.4)	9.74 (247)	7.5 (191)	5.48 (139)	3
	1.5 / 2 (0.75)	9.74 (247)	7.5 (191)	5.48 (139)	3

*Add .71" (18 mm) for NEMA 4 with speed pot

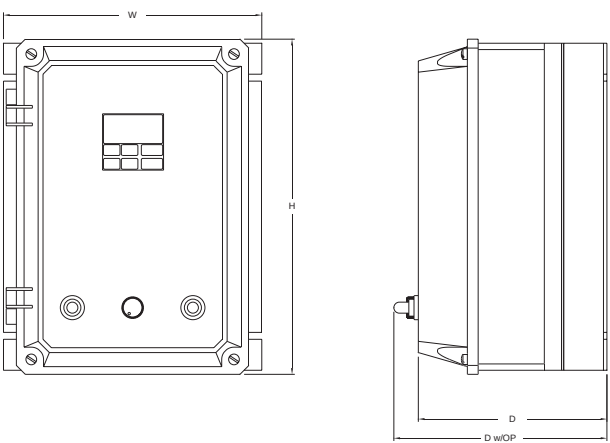


Fig. 3

Chapter 2:
Quickstart

What this chapter tells you:

1) The features of the digital operator.
2) The functions of the digital operator.
3) The monitoring constants of the PC7.
4) Simple data setting of the PC7.

Only qualified personnel should attempt start-up of this equipment. Improper operation could present a hazard to personnel safety or to the driven equipment. This manual must be read and understood in its entirety before any changes are made to the programming parameters. Potentially lethal voltages are present in and around this equipment and extreme caution must be exercised at all times.

2.0 PRE-POWER CHECKS

You must first inspect the installation to make sure the inverter is mounted and wired in accordance with Chapters 1 & 2 of this manual. Take special care to look for the following:

- ☑ Make sure power is off (the red charged LED on the unit must also be off).
- ☑ Check to make sure wiring is secure and all screw terminals are tight.
- ☑ Make sure there is no loose debris in or around the inverter (closely check for metal filings).
- ☑ If possible, make sure the motor is uncoupled from the load. If this isn't possible, make sure the equipment is ready for rotation and be prepared to verify the direction of rotation.
- ☑ Measure the input voltage and make sure it is within the inverter's specifications.
- ☑ Verify the proper direction of motor rotation. This can easily be done by using the Run key on the keypad and apply a FREF to the drive.

You must confirm the model number and output current (HP) rating of the inverter before you apply power. Application of the wrong power supply can cause unit damage.

2.1 OPERATING THE INVERTER

Initially set the control mode parameter (n002) to the V/f mode.

Test Run

The inverter will not operate until the frequency reference (speed) is set. There are three types of run command modes for the PC7:

1. Run command from the digital operator (volume/digital setting).

2. Run command from the control circuit terminal.

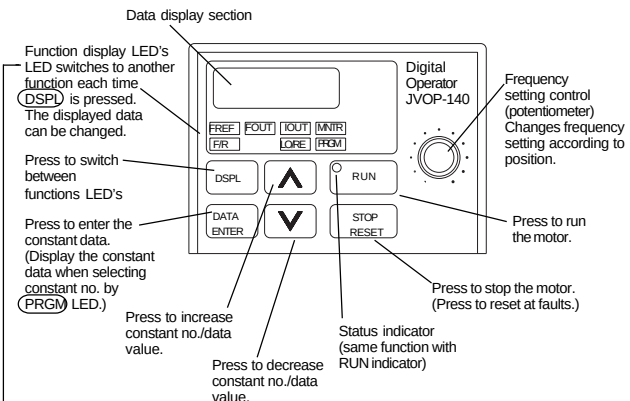
3. Run command from communications (MODBUS communications).

Prior to shipping, the drive is set up to receive run command and frequency reference from the terminals. Table on page 2-5 has instructions for running the PC7 using the digital operator. For instructions on operation, refer to pages 2-5 and 2-11.

2.2 OPERATING THE DIGITAL OPERATOR

All functions of the PC7 are set by the digital operator. Below are descriptions of the display and keypad sections.

Digital Operator: JVOP-140



FREF Frequency reference setting/monitoring (GREEN)	FOUT Output frequency monitor (GREEN)	IOUT Output current monitor (GREEN)	MNTR Multi-function monitor (GREEN)
F/R Operator RUN command FWD/REV selection (GREEN)		LO/RE LOCAL/REMOTE Selection (RED)	PRGM Constant no./data (RED)

PC7 Digital Operator

Operation Steps	Operator Display	12-LED Display	Status Indicator LED
1. Turn the power ON.	0.00	FREF	RUN ☼ ALARM ●
2. Turn the speed control fully to the left.	0.00	FREF	RUN ☼ ALARM ●
3. F/R blinks. Select FWD/REV run using keys.	FOR or REV	F/R	RUN ☼ ALARM ●
NOTE: Never select REV when reverse run is prohibited.			
4. Press DSPL to blink FREF. Then press RUN.	0.00	FREF	RUN ☼ ALARM ●
5. Operates the motor by turning the speed control to the right. (frequency reference corresponds to the speed control position is displayed.)	0.00 to 60.00 Minimum output frequency is 1.50Hz	FREF	RUN ☼ ALARM ●
NOTE: If the speed control is switched rapidly, the motor also accelerates or decelerates rapidly corresponding to the speed control movement. Pay attention to load status and switch the volume with the speed not to affect motor movement.			

Status Indicator Lamp ☼ : ON ☼ : Blinking ● : OFF

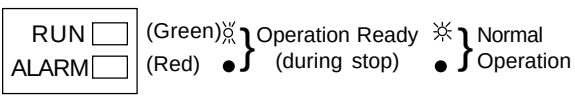
Operation Check Points

- ☑ Motor rotates smoothly
- ☑ Motor rotates in the correct direction
- ☑ Motor does not have abnormal vibration or noise
- ☑ Acceleration or deceleration is smooth
- ☑ Current matching the load flows
- ☑ Status indicator LED's and digital operator display are correct

Description of Status Indicator LED's

There are two LED's on the middle right section of the face of the PC7. The inverter status is indicated by various combinations of ON, BLINKING, and OFF LED's. RUN indicator and status indicator on the RUN button have the same function.

☼ ON ☼ Blinking (Long Blinking) ☼ Blinking ● OFF



For details on how the status indicator LED's function at inverter faults, refer to Chapter 5 "PM and TROUBLESHOOTING" on page 5-6. If a fault occurs, the ALARM LED lights.

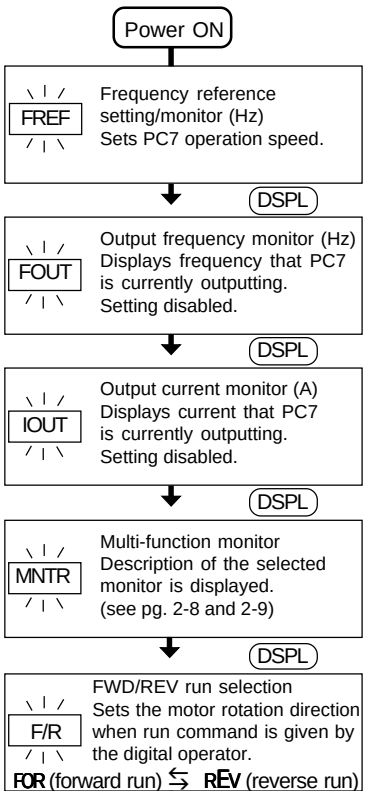
NOTE:

The fault can be reset by turning ON the fault reset signal (or pressing STOP RESET key on the digital operator) with the operation signal OFF or by turning OFF the power supply. If the operation signal is ON, the fault cannot be reset by the fault reset signal.

2.3 LED DESCRIPTION

By pressing (DSPL) on the digital operator, each of the function LED's can be selected.

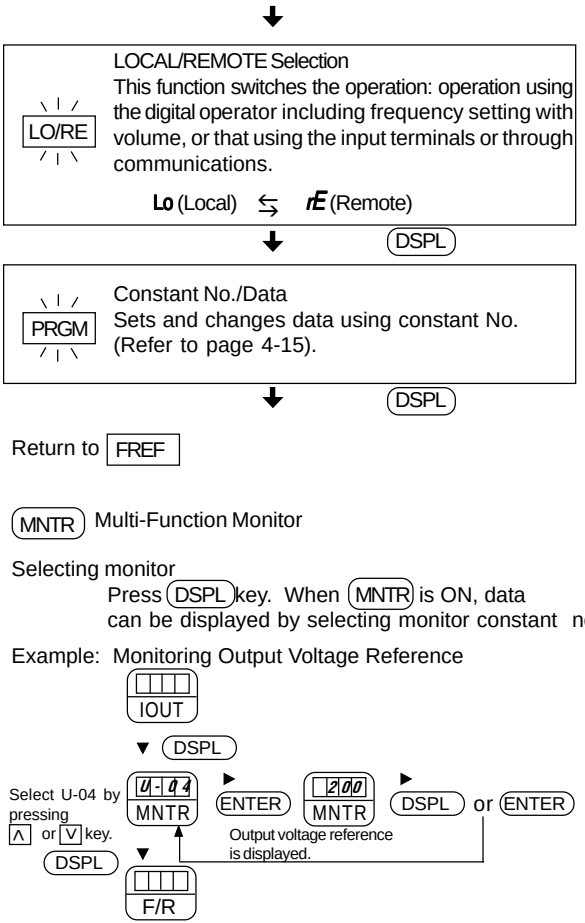
The following flowchart describes each function LED.



If the PC7 loses power while in one of these modes, it will return to this mode once power is restored.

Monitor No.

- U-01: Frequency reference (FREF)
- U-02: Output frequency (FOUT)
- U-03: Output current (IOUT)
- U-04: Output voltage reference (Unit: 1V)
- U-05: DC bus voltage (Unit: 1V)
- U-06: Input terminal status
- U-07: Output terminal status
- U-08: Torque monitor
- U-09: Fault History
- U-10: Software No.
- U-11: Output power
- U-15: Data reception error
- U-16: PID feedback
- U-17: PID output
- U-18: PID output



2.4 MONITORING

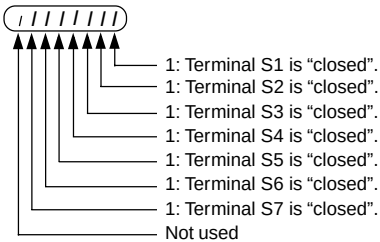
Following items can be monitored by U-constants.

Constant Number	Name		Description
U-01	Frequency reference (FREF) *1	Hz	Frequency reference can be monitored. (Same as FREF)
U-02	Output frequency (FOUT) *1	Hz	Output frequency can be monitored. (Same as FOUT)
U-03	Output current (IOUT)*1	Hz	Output current can be monitored. (Same as IOUT).
U-04	Output voltage	V	Output voltage can be monitored.
U-05	DC bus voltage	V	DC bus voltage can be monitored.
U-06	Input terminal status *2	-	Input terminal status of control circuit terminals can be monitored.
U-07	Output terminal status *2	-	Output terminal status of control circuit terminals can be monitored.
U-08	Torque monitor	%	The amount of output torque can be monitored. When V/f control mode is selected, "___" is displayed.
U-09	Fault history (last 4 faults)	-	Last four fault history is displayed.
U-10	Software No.	-	Software No. can be checked.
U-11	Output power *3	kW	Output power can be monitored.
U-15	Data reception error *4	-	Contents of MODBUS communication data reception error can be checked. (contents of transmission register No. 003DH are the same)
U-16	PID feedback *5	%	Input 100(%) / Max. output frequency or equivalent.
U-17	PID output *5	%	±100(%) / ± Max. output frequency.
U-18	PID output *5	%	± 100(%) / ± Max. output frequency.

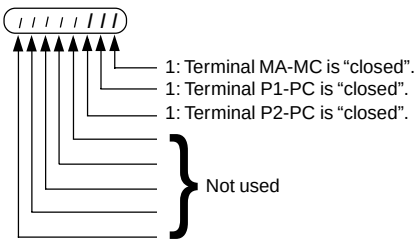
*1 The status indicator LED is not turned ON.
*2 Refer to the next page for input/output terminal status.
*3 The display range is from -9.99 kW to 99.99 kW. When regenerating, the output power will be displayed in units of 0.01 kW. When -9.99 kW or less and in units of 0.1 kW when more than -9.99 kW. Only displayed in vector mode.
*4 Refer to the next page for data reception error.
*5 Displayed in units of 0.1% when less than 100% and in units of 1% when 100% or more. The display range is from -999% to 999%.

Input/Output terminal status

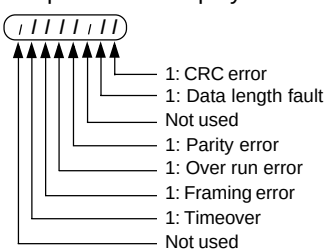
U-06 Input terminal status



U-07 Output terminal status



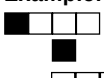
U-15 Data reception error display



Fault history display method

When U-09 is selected, a four-digit box is displayed. The three digits from the right show the fault description, and the digit on the left shows the order of fault (from one to four). Number 1 represents the latest fault, and 2, 3, 4, in ascending order of fault occurrence.

Example:



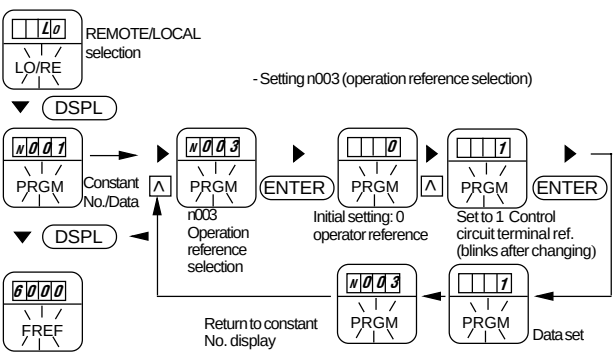
..... 4-digit numbers
: Order of fault (1 to 4)
: Fault description
"---" is displayed if there is no fault.
(Refer to page 5-6 for details.)

- Switching fault history - Order of the fault history can be changed by [^] or [v] key.
- Clearing fault history - Set constant n001 to 6 to clear fault history. Display returns to n001 after completion of 6 setting.

NOTE: Constant initialize (n001 = 8, 9, 10, 11) clears fault history.

2.5 SETTING AND REFERENCING CONSTANTS

The following shows how to select and change constants



2.6 SIMPLE DATA SETTING

Speed control setting [refer to page 2-5 (Step 5) OPERATING THE INVERTER] and digital setting are both available for simple accel/decel operation of the PC7. Following is an example in which the digital operator keys are used to set frequency reference, acceleration time, deceleration time, motor direction and start/stop.

Operation Steps	Operator Display	LED Display	Status Indicator LED
1. Turn ON the power supply.	0.00	FREF	RUN ☼ ALARM ●
2. Set constant n004 to 1 (frequency reference selection)	1	PRGM	RUN ☼ ALARM ●
3. Set the following constants			
n019 : 15.0 (acceleration time)	15.0	PRGM	RUN ☼ ALARM ●
n020 : 5.0 (deceleration time)	5.0		
4. Select forward or reverse run by pressing [∧] or [∨] key.	FOR (Forward) or rEV (Reverse)	F/R	RUN ☼ ALARM ●
NOTE: Examine the application. (Never select REV when reverse run is prohibited.)			
5. Set the reference by pressing [∧] or [∨] key.	60.00	FREF	RUN ☼ ALARM ●
6. Press (RUN).	0.00 to 60.00	FOUT	RUN ☼ ALARM ●
7. Press (STOP) to stop.	60.00 to 0.00	FOUT	↓ RUN ☼ ALARM ●

Chapter 3:
Wiring

What this chapter tells you:

1) General wiring precautions.
2) How to wire the power circuit.
3) How to wire the control circuit.
4) How to connect to a RS-485 network.
5) Proper grounding practice.

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Only trained, qualified personnel should be used to install the PC7. Hazardous voltage levels are present that could jeopardize the safety of personnel. Do not attempt any wiring with power in the drive cabinet. Never change any inverter wiring until power is removed and the red charge LED on the PC7 is extinguished.

3.0 GENERAL PRECAUTIONS

Do not attempt to change any wiring while there is voltage present in the cabinet. Never trust the visual position of a disconnect switch or input contactor alone without using a meter or suitable test device to *guarantee* that all power sources have been disconnected. In particular, look for yellow wiring to indicate external control power supply.

Connect the main AC power to the input power terminals L1 (R), L2 (S) & L3 (T). Do not connect the input power supply to the PC7 output terminals T1 (U), T2 (V) & T3 (W). Failure to follow this warning could lead to unit damage.

The local codes and the NEC guidelines should be followed when connecting the wiring.

Please try to run the motor wiring in separate conduit or wire tray from the inverter's input power wiring.

Branch circuit protection must be provided externally to comply with the NEC.

Make sure all screws are tightened before any power is applied to the unit.

Check for loose debris or wire clippings before power is applied.

Make sure no wires strands are touching adjacent strands.

Physically separate the inverter's control wiring from power wiring. If they must cross, do so at right angles (90°).

Size the incoming power feeder per NEC in keeping the voltage drop to within 2%, depending upon the wiring distance.

3.1 POWER WIRING

NOTE: You must provide branch circuit protection to comply with the requirements of the NEC and any other applicable local codes. Do not attempt any wiring unless all power is removed from the drive cabinet and the red Power LED on the control board is extinguished.

3.1.1 Power Wiring Precautions

Be sure to provide either branch circuit protection (either CB or input fuses) between the incoming power source and the PC7 inverter.

Make sure that any ground fault interrupter is rated for a minimum of 200 mA earth leakage current to prevent nuisance trips.

If the source is greater than 600 KVA you should connect a 3% impedance input line reactor to minimize the short circuit currents in the system.

If you choose to connect a contactor between the inverter output and the motor, you must make sure the contactor is never switched while the inverter is operating. Otherwise, the peak currents or voltage could cause nuisance trips.

Never connect the incoming AC input power to the output terminals [T1 (U), T2 (V), or T3 (W)].

Separate the incoming power leads from the inverter output wiring whenever possible.

Separate control leads (120 V or less) from power leads. If they must cross, make sure they do so at 90° angles.

Use R-C surge suppressors across the coils of all contactors installed in a control panel with the inverter.

You must install separate motor thermal protection (overload relay or thermostat) whenever more than one motor is connected to the inverter output.

Make sure the resistance to earth is less than 100 Ω (230 V units) or 10 Ω (460 V units). Never ground the inverter in common with welding machines, large motors, arc furnaces, or other high current devices.

Never connect power factor correction capacitors directly to the input or output of the PC7.

3.1.2 Input Protection

The following are only recommended values. You must always conform to the NEC and local applicable codes.

You must install branch circuit protection between the inverter input and the incoming AC power supply. Our recommendations are given in the table below.

Recommended Input Protection

Model Number PC7- 3-Phase	Input Ratings (A)	Time Delay Fuse MCCB
20P1	1.1	5A / (5A)
20P2	1.8	5A / (5A)
20P4	3.9	5A / (10A)
20P7	6.4	10A / (20A)
21P5	11	20A / (20A)
22P2	15.1	20A / (40A)
23P7	24	30A / (50A)
25P5	34	50A
27P5	45	60A
40P2	1.6	5A
40P4	2.4	5A
40P7	4.2	5A
41P5	7.0	10A
42P2	8.1	10A
43P7	13.5	20A
45P5	19.8	30A
47P5	28.0	40A

3.1.3 Wire Selection Recommendations

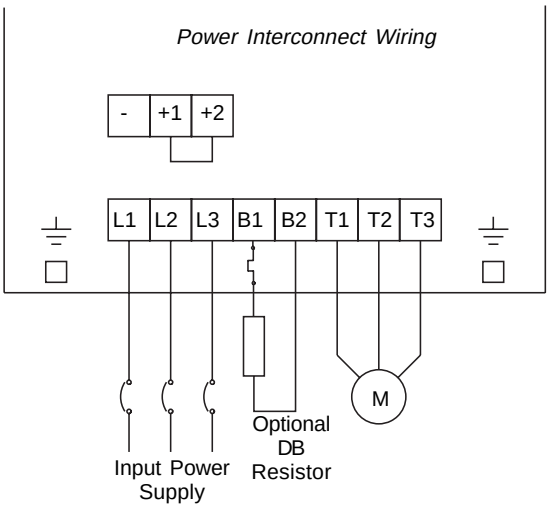
The table below gives recommended *minimum* wire sizes for the PC7 inverter. You must size the wiring in accordance with NEC and with locally accepted practices.

Recommended Wire Sizes

Model Number PC7- 3-Phase	Power (AWG / MM²)		Control (AWG / MM²)
20P1	14 / 2.1	14 / 2	18 / 0.82
20P2	14 / 2.1	14 / 2	
20P4	14 / 2.1	14 / 2	
20P7	14 / 2.1	12 / 3.3	
21P5	14 / 2.1	10 / 5.3	
22P2	12 / 3.3	10 / 5.3	
23P7	12 / 3.3	8 / 8.4	
25P5	8 / 8		
27P5	8 / 8		
40P2	14 / 2.1		
40P4	14 / 2.1		
40P7	14 / 2.1		
41P5	14 / 2.1		
42P2	14 / 2.1		
44P0	14 / 2.1		
45P5	10 / 5.5		
47P5	10 / 5.5		

3.1.4 Power Interconnect Wiring

Please refer to the figure below for the proper power interconnections.



The terminal arrangement for 200/400 V class, 3-Phase input series 7.5/10 HP is shown below.

Power Interconnect Wiring for 7.5/10 HP

Models PC7 - 25P5, 27P5, 45P5, 47P5

⏚											
⏚	R/L1	S/L2	T/L3	-	+1	+2	B1	B2	U/T1	V/T2	W/T3

3.1.5 DB Resistor Values

The PC7 contains the required electronics for Dynamic Braking (DB). DB allows the motor to develop up to 150% rated braking torque for rapid deceleration or to dissipate regenerative loads. You must make sure the DB resistor (connected between terminals B1 and B2 as shown in the figure on page 3-9) is *greater than* the following minimum resistor values.

DB Resistor Values

Voltage	Maximum Applicable Output HP(kW)	Inverter Model		Braking Resistor (10% Duty Cycle)			
		3PH PC7-	1PH PC7-	Resistor Specification (Res / Watts)	Minimum Res.	Part Number	Qty. Req'd
200V	0.13 (0.1)	20P1	B0P1	300 / 100W	300	005-2806	1
	0.25 (0.2)	20P2	B0P2	300 / 100 W	300	005-2806	1
	0.5 (0.4)	20P4	B0P4	300 / 100 W	200	005-2806	1
	1 (0.75)	20P7	B0P7	140 / 100 W	120	005-2805	1
	2 (1.5)	21P5	B1P5	70 / 200 W	60	005-2805(1)	2
	3 (2.2)	22P2	B2P2	70 / 200 W	60	005-2805(1)	2
	5 (3.7)	23P7	P3P7	40 / 400 W	32	005-4118	1
	7.5 (5.5)	25P5	-	20 / 600 W	9.6	005-0605	1
	10 (7.5)	27P5	-	12 / 900 W	9.6	005-0606	1
400V	0.50 (0.2)	40P2	-	750 / 100 W	750	005-2807	1
	0.75 (0.4)	40P4		750 / 100 W	750	005-2807	1
	1.5 (0.75)	40P7		750 / 100 W	510	005-2807	1
	3 (1.5)	41P5		280 / 200 W	240	005-2805(2)	2
	3 (2.2)	42P2		220 / 200 W	200	005-2803(2)	2
	5 (3.7)	43P7		150 / 400 W	100	005-4119	1
	7.5 (5.5)	45P5		70 / 600 W	32	005-4213	1
	10 (7.5)	47P5		70 / 800 W	32	005-4224	1

(1) Resistors to be connected in parallel
(2) Resistors to be connected in series

005-2803 = 110 ohm, 100 W
005-2804 = 140 ohm, 100 W
005-2805 = 140 ohm, 100 W

005-2806 = 300 ohm, 100 W
005-2807 = 750 ohm, 100 W

50 watts without heatsink
100 watts with heatsink

3.2 CONTROL WIRING

Warning: Make sure the input control wiring is consistent with the programmed start/stop method. Wiring 2-wire control inputs into a drive programmed for 3-wire control could result in unexpected operation.

3.2.1 Control Wiring Precautions

Physically separate control wiring from power wiring. If they must cross, make sure they do so at 90° angles.

Use twisted, shielded wires for the analog input or output signals (use Belden no. 8760 for 2 wire and use Belden no. 8770 for 3 wire, or their equivalents).

Control wiring must be less than 164 ft. (50 m) in length. Please note: the maximum allowable cable length is installation dependent due to electrical noise considerations.

Observe proper grounding methods by connecting only one end of the shield sheath to ground. Typically, you should ground the shield on the inverter's side.

Separate any 120 VAC control wiring from the DC wiring. Never connect AC power to any input terminals without using a suitable interface card.

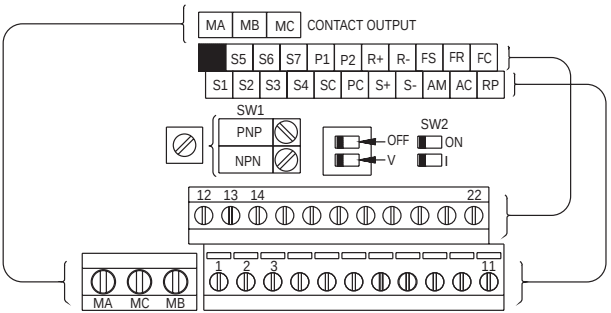
Use R-C type surge absorbers across any contactors in the VFD panel. MOV type absorbers alone are not adequate in reducing electromagnetically coupled noise.

3.2.2 Terminal Locations

The control terminals can be found at the bottom of the control card. These terminals are suitable for 20-16 AWG wire (0.5-1.25 mm^2).

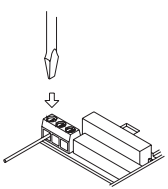
3.2.3 Control Terminal Layout

Pass the cable through wiring hole and connect. Be sure to mount the cover in its original position.

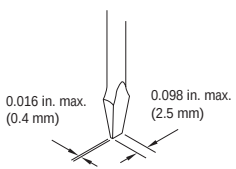


*SW1 can be changed according to input signal polarity.
0V common: NPN side
24 common: PNP side
Refer to page 4-21 for SW2

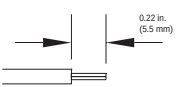
Wiring the control circuit terminals



Screwdriver blade width



Insert the wire into the lower part of the terminal block and connect it tightly with a screwdriver.



Wire sheath strip length must be 0.22 in (5.5 mm).

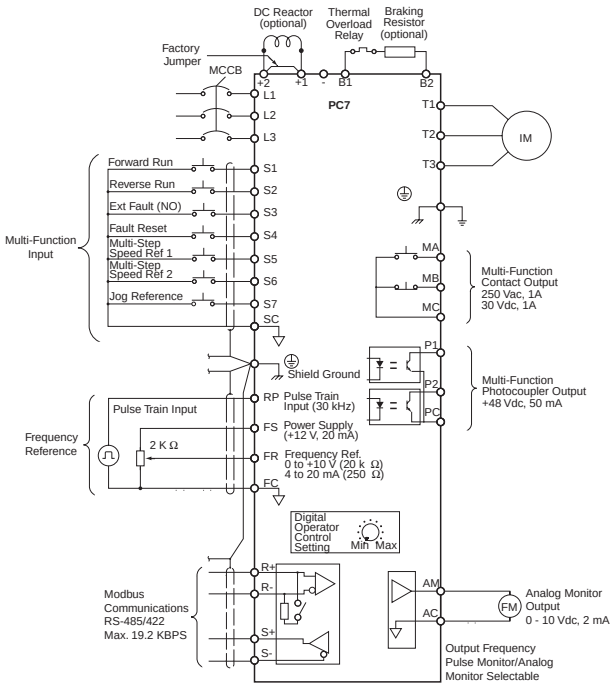
3.2.4 Terminal Definition

The PC7 incorporates multi-function type inputs and outputs in the control circuit. Refer to the table below for the control circuits and function.

Control Terminal Definitions

Type			Terminal	Name	Function (Signal Level)	
Control Circuit	Input	Sequence	S1	Multi-function input selection 1	Factory setting closed: FWD run, open: REV run	Photo-coupler insulation 24 Vdc, 8 mA
			S2	Multi-function input selection 2	Factory setting closed: REV run, open: FWD run	
			S3	Multi-function input selection 3	Factory setting: External fault (NO contact)	
			S4	Multi-function input selection 4	Factory setting: Fault reset	
			S5	Multi-function input selection 5	Factory setting: Multi-step speed reference 1	
			S6	Multi-function input selection 6	Factory setting: Multi-step speed reference 2	
			S7	Multi-function input selection 7	Factory setting: Jog reference	
			SC	Multi-function input selection common	For control signal	
		Frequency reference	RP	Master speed reference pulse train input	30 kHz max	
			FS	Power for frequency setting	+12V (permissible current 20 mA max.)	
			FR	Master speed frequency reference	0 to +10 VDC (20k ohm) or 4 to 20 mA (250k ohm) (1/1000 resolution)	
			FC	Frequency reference common	0V	
	Output	Multi-function contact output	MA	NO contact output	Factory setting: fault	Contact capacity 250 VAC 1A or less, 30 VDC 1A or less
			MB	NC contact output		
			MC	Contact output common		
			P1	Photo-coupler output 1	Factory setting: Run	Photo-coupler output +48 VDC, 50 mA or less
			P2	Photo-coupler output 2	Factory setting: Frequency agreed	
			PC	Photo-coupler output common	0V	
		AM		Analog monitor output	Factory setting: Output frequency 0 to +10 V	+10 VDC, 2 mA or less, 8-bit resolution
		AC		Analog monitor common	0V	
Communication Circuit Terminal	MODBUS communications	R+		Communications input (+)	MODBUS communication Run through RS-485 or RS-422	RS-485/422 MODBUS protocol, 19.2 kps max.
		R-		Communications input (-)		
		S+		Communications output (+)		
		S-		Communications output (-)		

3.2.5 Standard I/O Wiring



3.3 GROUNDING

Warning: A solid ground is required for personnel safety and to guarantee reliable, nuisance free operation.

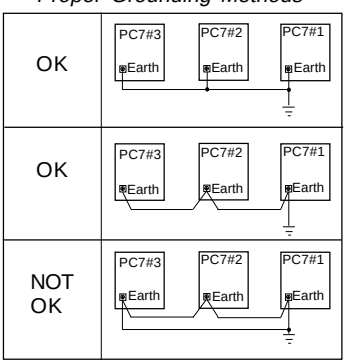
You must provide a low impedance ground connection to the PC7 on the green Earth Ground terminal on the heatsink assembly.

The resistance to ground must be less than 100 Ω (230 V units) or 10 Ω (460 V units). You should always keep the ground connections as short as possible.

Never ground the PC7 in common with large current equipment such as welding machines, arc furnaces, or large motors.

If you have an installation with multiple inverter units, be sure to follow the wiring practice given in the figure below.

Proper Grounding Methods



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Chapter 4:
Programming

Note: ***Refer to Appendix A for a complete listing of parameters***

What this chapter tells you:

1) Introduction to the PC7 keypad.
2) Quick setup for PC7.
3) Simple programming examples.
4) Programming
   - First Functions (pg. 4-10)
   - Second Functions (pg. 4-36)
   - Third Functions (pg. 4-48)
   - Fourth Functions (pg. 4-64)

Note: This chapter must be read in its entirety before any programming changes are attempted. Only authorized personnel should modify the inverter settings as power is applied and lethal voltages may be present.

4.0 PROGRAMMING

This chapter details the programming of the PC7 inverter unit. The programming parameters are organized in a numeric fashion with an appropriate FUNCTION code ("N" prefix). These parameters shouldn't be changed unnecessarily.

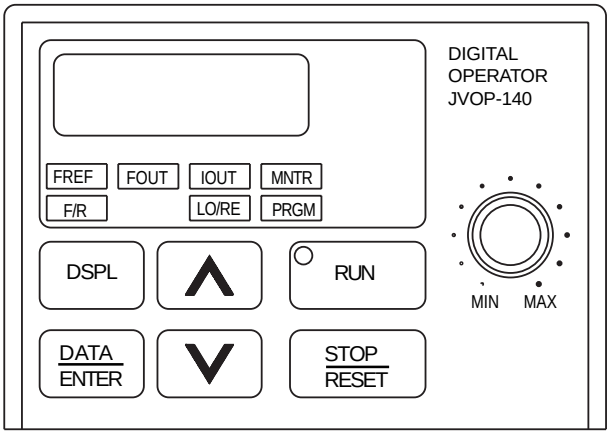
The first part of the chapter deals with the programming method. Step-by-step programming examples are then provided for some of the more commonly changed parameters. Finally, a complete parameter list is provided in Appendix A.

4.1 KEYPAD LAYOUT

The PC7 keypad has 6 buttons and 7 LEDs as shown on the facing page. Please refer to page 4-4 for a detailed description of the LEDs.

4.2 KEY FUNCTIONS

You will only need to use the display (DSPL) and enter keys and the arrow keys to setup the inverter.



4.2.1 Display Key (DSPL)

The Display (DSPL) key is context sensitive and has multiple functions. It is used to navigate between the various drive (operating) modes and the programming (setup) mode. It is also used to switch the display function between the FUNCTION LED's and between the edit screen for each PROGRAM.

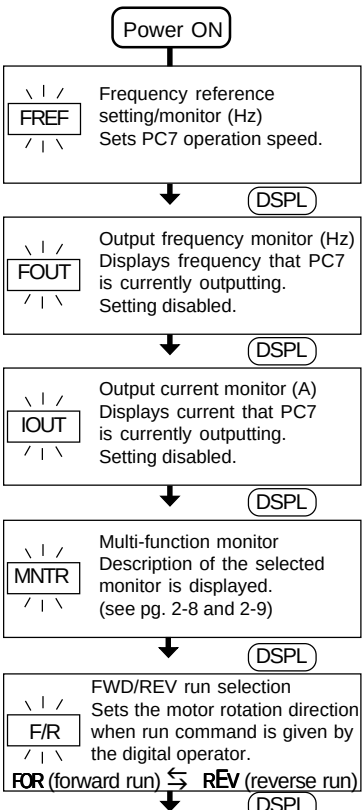
4.2.2 Up/Down Arrows [∧] [∨]

These keys are used to edit the selected data. These keys will allow fine-tuning or a quick scroll, depending upon the length of time the key is depressed.

4.2.3 Basic LED Description

By pressing DSPL on the digital operator, each of the function LED's can be selected.

The following flowchart describes each function LED.



If the PC7 loses power while in one of these modes, it will return to this mode once power is restored.

Monitor No.

- U-01: Frequency reference (FREF)
- U-02: Output frequency (FOUT)
- U-03: Output current (IOUT)
- U-04: Output voltage reference (Unit: 1V)
- U-05: DC Bus voltage (Unit: 1V)
- U-06: Input terminal status
- U-07: Output terminal status
- U-08: Torque monitor
- U-09: Fault History
- U-10: Software No.
- U-11: Output power
- U-15: Data reception error
- U-16: PID feedback
- U-17: PID output
- U-18: PID output

4.2.4 Switching LOCAL/REMOTE Modes

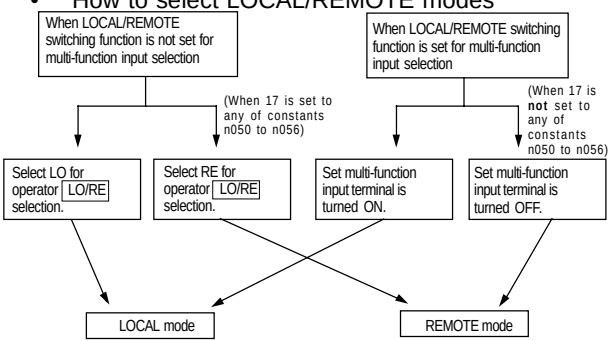
The following functions can be selected by switching the LOCAL or REMOTE mode. To select RUN/STOP commands or frequency reference, change the mode in advance depending on the following applications.

- LOCAL mode: Enables the digital operator for RUN/STOP commands and FWD/REV run commands. Frequency reference can be set by volume or FREF
- REMOTE mode: RUN/STOP commands and FWD/REV run commands can be given by the digital operator, control circuit terminal or transmission.

  n003 = 0: Enables digital operator (LOCAL)
  = 1: Enables control circuit terminal (REMOTE)
  = 2: Enables transmission (MODBUS communications)

Setting of frequency reference selection (n004) becomes valid. (Refer to page 4-7)

- How to select LOCAL/REMOTE modes



4.2.5 Selecting RUN/STOP Commands

Refer to switching LOCAL/REMOTE modes (page 4-5) to select either the LOCAL mode or REMOTE mode. Operation method (RUN/STOP commands, FWD/REV run commands) can be selected by the following method.

- LOCAL mode

  When LO (local mode) is selected for digital operator [LO/RE] selection, run operations (run/stop) is enabled by the [STOP] or [RUN] button of the digital operator, and forward/reverse run is enabled by blinking F/R lamp (using [∧] or [∨] key).

- REMOTE mode
  - Select remote mode.

Following are two methods to select remote modes.

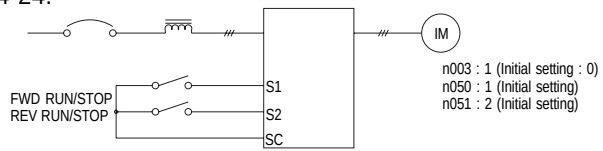
1. Select rE (remote mode) for [LO/RE] selection.
2. When the local/remote switching function is selected for multi-function input selection, turn OFF the input terminal to select remote mode.

- Select operation method by setting the constant n003.

  n003 = 0 : Enables the digital operator (same with local mode).
  = 1 : Enables the multi-function input terminals (figure on following page).
  = 2 : Enables serial communications (refer to page 4-76).
  = 3 : Enables communication card (optional)

Example for using the multi-function input terminal as operation reference (two-wire sequence).

For an example of three-wire sequence, refer to page 4-24.



Note: When inverter is operated without the digital operator, always set the constant n010 to 0.

n010 = 0 : Digital operator connection fault is not detected (initial setting).

= 1 : Digital operator connection fault is detected.

- Operating (RUN/STOP commands) by communications Setting constant n003 to 2 in REMOTE mode can give RUN/STOP commands by communication (MODBUS communications). For the command by transmission, refer to page 4-76.

4.2.6 Selecting Frequency Reference (n004)

Frequency reference can be selected by the following methods.

- Setting by operator
  Select REMOTE or LOCAL mode in advance. For method for selecting the mode, refer to page 4-5.
- LOCAL mode

  Select command method by constant n004.

n004 = 0 : Enables the setting by potentiometer on digital operator.

= 1 : Enables the digital setting by digital operator, setting value is stored in constant n024 (frequency reference 1).

- Digital setting by digital operator
  Input frequency while FREF is lit (ENTER after setting the numeric value).

- LOCAL mode
  Select command method by parameter n008.

  n008 = 0 : Enables the setting by potentiometer on digital operator.
  = 1 : Enables the digital setting by digital operator. (Initial setting)
  Factory setting of the model with digital operator (with potentiometer) JVOP-140 is n008=0.

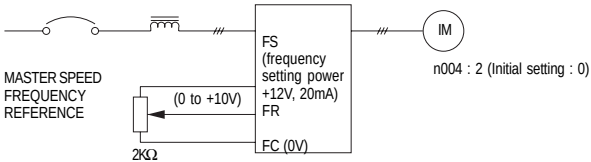
  n009 = 0 : Enables frequency reference setting by ENTER key.
  = 1 : Disables frequency reference setting by ENTER key.

* Frequency reference setting is effective when 1 (factory setting) is set to constant n009 instead of pressing ENTER key

- REMOTE mode
  Select command method by constant n004.

n004 = 0 : Enables frequency reference setting by potentiometer on digital operator.
= 1 : Effective frequency reference 1 (constant n024)
= 2 : Voltage reference (0 to 10V) (See figure below)
= 3 : Current reference (4 to 20mA) (Refer to page 4-22)
= 4 : Current reference (0 to 20mA) (Refer to page 4-22)
= 5 : Pulse train reference (Refer to page 4-75)
= 6 : Communication (Refer to page 4-76)
=7 : Voltage reference from digital operator circuit terminal (0-10V) (CN2)
=8 : Current reference from digital operator circuit terminal (4-20mA) (CN2)
=9 : Communication

Example of frequency reference by a voltage signal



- Setting by transmission
  LOCAL/REMOTE switching function is selected for multi-function input selection, turn OFF the terminal input to set the remote mode.

4.3 FIRST FUNCTION (n001 - n039)

Factory settings of the constants are shown as in the tables.

4.3.1 Constant Set-up and Initialization (n001)

The following table describes the data which can be set or read when n001 is set.

Unused constants among n001 to n179 are not displayed.

n001 Setting	Constant that can be set	Constant that can be viewed
0	n001	n001 to n179
1	n001 to n049*	n001 to n049
2	n001 to n079*	n001 to n079
3	n001 to n119*	n001 to n119
4	n001 to n179*	n001 to n179
5	Not used	
6	Fault history cleared	
10	Initialize (2 wire sequence)	
11	Initalize (3 wire sequence)	

*Excluding setting disabled constants.

NOTE: ***"ERR"*** appears on the LED display for one second and the set data returns to its initial values in the following cases:

(1) The set values of input terminal function selection S1 to S7 (n050 to n056) are the same.

(2) If the following conditions are not satisfied in the Volt/Hz pattern setting (V/f pattern setting):

Max. output frequency (n011) ≧ Max. voltage output frequency (n013)
> Mid. output frequency (n014)
≦ Min. output frequency (n016)

For details, refer to "Adjusting torque according to application" (V/f pattern setting) on page 4-15.

(3) If the following conditions are not satisfied in the Jump frequency setting:

Jump frequency 3 (n085) ≦ Jump frequency 2 (n084)
≦ Jump frequency 1 (n083)

(4) If frequency reference lower limit (n034) ≦ Frequency reference upper limit (033)

(5) If Electronic thermal reference current (n036) ≦150% of inverter rated current

(6) Constant n018 is set to 1 (accel/decel time unit is 0.01 sec.) when n018 is set to 0 and the value exceeding 600.0 sec. is set to accel/decel time (n019 to n022).

4.3.2 Control Method (n002)

Determine the proper control method for the application.

Open Loop Vector Control - Parameter n002 = 1. Open loop vector control method should be used for most constant torque applications of the PC7. With this control method there is excellent starting torque and speed regulation.

V/f Control - Parameter n002 = 0. V/f control should be used for most variable torque applications. Variable torque applications would include: fan, blower, centrifugal pump, and mixers. Generally, variable torque loads do not require high levels of starting torque. V/f control can also be used for some constant torque loads where starting torque and speed regulation are not critical and multiple motor applications.

4.3.3 Precaution for Vector Control Application

For optimal performance in the vector mode, the motor parameter data must be programmed in the PC7. The following parameters must be programmed with the motor nameplate data.

No.	Name	Unit	Setting Range	Initial Setting
n106	Motor rated slip	0.1Hz	0.0 to 20.0Hz	*
n107	Motor line-to-line resistance	0.001Ω (less than 10Ω) 0.01Ω (10Ω or more)	0.000 to 65.50Ω	*
n036	Motor rated current	0.1A	0 to 150% of inverter rated current	*
n110	Motor no-load current	1%	0 to 99% (100%=motor rated current)	150

*Setting depends on inverter capacity.

Adjustment of torque compensation time parameter (n104) and torque iron loss compensation parameter (n105) are normally not required.

Adjust torque compensation parameter under the following conditions:

- Increase setting when the motor generates vibration.
- Reduce setting when motor response is low.

To adjust for slip compensation gain (n111), reduce load so that motor speed reaches target value. Increase or decrease the value by 0.1.

- When speed is less than target value, increase slip compensation gain.
- When speed is more than target value, reduce slip compensation gain.

Adjustment of slip compensation gain time parameter (n112) is normally not required. Adjust under the following conditions:

- Reduce the setting when response is slow.
- Increase the setting when speed is unstable.

4.3.4 Motor Constant Calculation

The following shows an example of motor constant calculation.

(1) Motor rated slip (n106)

$$= \frac{\text{Synchronous speed at (nameplate RPM)} - \text{Motor speed with 100\% load at (nameplate RPM)}}{120 / \text{Motor Poles}}$$

Example

$$\frac{1800 - 1763 \text{ (r / min)}}{120 / 4} = 1.2 \text{ Hz}$$

(2) Motor line-to-line resistance (n107)

$$= \text{Line-to-line resistance of insulation class temperature} \times \frac{273 = (25^{o}C + \text{Insulation class temperature}) / 2}{273 + \text{Insulation class temperature}}$$

Example

$$0.145 \times \frac{273 + (25 + 115) / 2}{273 + 115} = 0.128\Omega$$

(3) Motor rated current (n036)
= Output current with 100% load at (nameplate FLA)

(4) Motor no-load current (n110)

$$= \frac{\text{No-load output current at 60Hz}}{\text{Rated Full Load Amp (FLA)}} \times 100$$

Example

$$\frac{11.7}{43.0} = 27\%$$

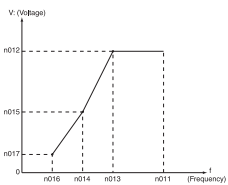
Set 106 (motor rated slip), n036 (motor rated current), n107 (motor line-to-line resistance) and n110 (motor no-load current) according to the motor test report.
To connect a reactor between the inverter and the motor, set n108 to the value of "n108 (leaking inductance) initial value + externally-mounted reactor value". Unless a reactor is connected, n108 (leaking inductance) does not have to be set according to the motor.

4.3.5 Using V/f Mode

Adjust motor torque by using "V/f pattern" and "full-range automatic torque boost".

• V/f pattern setting

Set V/f pattern by n011 to n017 as described below. Set each pattern when using a special motor (high-speed motor, etc.) or when requiring special torque adjustment of machine.



Be sure to satisfy the following conditions for the setting of n011 to n017.
n016 ≦ n014 < n013 ≦ n011
If n016 = n014 is set, the set value of n015 is disabled.

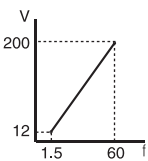
Constants Number	Name	Unit	Setting Range	Initial Setting
n011	Max. output frequency	0.1	50 to 400	60
n012	Max. voltage	1V	1 to 255V (0.1 to 510V)	230V (460V)
n013	Max. voltage output frequency (base frequency)	0.1	0.2 to 400	60
n014	Mid. output frequency	0.1	0.1 to 399.9	1.5
n015	Mid. output frequency voltage	1V	0.1 to 255V (0.1 to 510V)	12V (24V)
n016	Min. output frequency	0.1	0.1 to 10	1.5
n017	Min. output frequency voltage	1V	1 to 50V (0.1 to 100V)	12V (24V)

• Typical setting of V/f pattern
Set the V/f pattern according to the application as described below. For 400V class, the voltage values(n012, n015, and n017) should be doubled. When running at a frequency exceeding 50Hz/60Hz, change the maximum output frequency (n011).

NOTE: Be sure to set the maximum output frequency according to the motor characteristics.

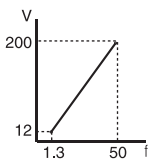
(1) For general-purpose applications

Motor Specifications: 60
(Factory Setting)



Constant	Setting
n011	60
n012	200
n013	60
n014	1.5
n015	12
n016	1.5
n017	12

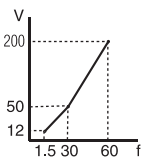
Motor Specifications: 50



Constant	Setting
n011	50
n012	200
n013	50
n014	1.3
n015	12
n016	1.3
n017	12

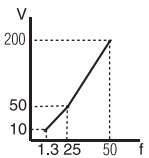
(2) For fans/pumps

Motor Specifications: 60



Constant	Setting
n011	60
n012	200
n013	60
n014	30
n015	50
n016	1.5
n017	10

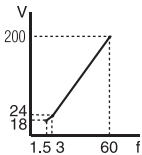
Motor Specifications: 50



Constant	Setting
n011	50
n012	200
n013	50
n014	25
n015	50
n016	1.3
n017	10

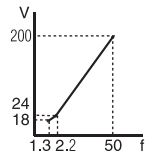
(3) For applications requiring high starting torque

Motor Specifications: 60



Constant	Setting
n011	60
n012	200
n013	60
n014	3
n015	24
n016	1,5
n017	18

Motor Specifications: 50

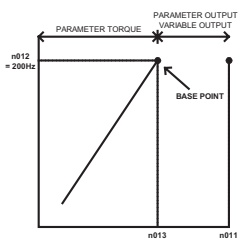


Constant	Setting
n011	50
n012	200
n013	50
n014	2,5
n015	24
n016	1,3
n017	18

Increasing voltage of V/f pattern increases motor torque, but an excessive increase may cause motor overexcitation, motor overheat or vibration.

NOTE: n012 is to set to motor rated voltage.

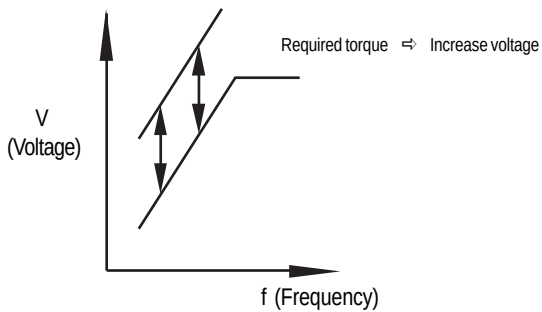
When operating with frequency larger than 60Hz, change only maximum output frequency (n011).



Full-range automatic torque boost (only when in V/f mode n002 = 0) Motor torque requirement changes according to load conditions. Full-range automatic torque boost adjusts voltage of V/f pattern according to the requirement. The PC7 automatically adjusts the voltage during constant-speed operation as well as during acceleration.
The required torque is calculated by the inverter.
This ensures tripless operation and energy-saving effects.

Output voltage	α	Automatic torque boost gain (n103)	x	Required torque

- Operation

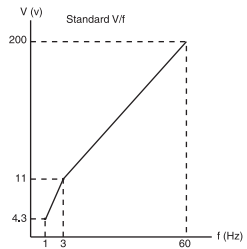


Normally, no adjustment is necessary for automatic torque boost gain (n103 factory setting : 1). When the wiring distance between the inverter and the motor is long, or when the motor generates vibration, decrease the automatic torque boost gain (n103).

Note: α means proportional to

4.3.6 When Torque is not sufficient at Low Speed

If sufficient torque cannot be obtained, change the V/f pattern settings of n011 to n017 to those for high-start V/f.



4.3.7 Decreasing Motor Speed Fluctuation

As the load becomes larger, motor speed is reduced and motor slip value is increased. The slip compensating function controls the motor speed at a constant value even if the load varies.

When inverter output current is equal to the motor rated current (electronic thermal reference current, n036), the compensation frequency is added to the output frequency.

Compensation frequency = Motor rated slip (n106)

$$\times \frac{\text{Output current - Motor no-load current (n110)}}{\text{Motor rated current - Motor no-load current (n110)}}$$

$\times$ Slip Compensation gain (n111)

Related Parameters

Parameters Number	Name	Unit	Setting Range	Factory Setting
n036	Motor rated current	0.1A	0 to 150% of inverter rated current	
n111	Slip compensation gain	0.1	0.0 to 2.5	0.0
n110	Motor no-load current	1%	0 to 99% (100% = Motor rated current n036)	
n112	Slip compensation primary delay time	0.1s	0.0 to 25.5s When 0.0s is set, delay time becomes 2.0s.	2.0s
n106	Motor rated slip	0.1	0.0 to 20	

* Differs depending on inverter capacity.

NOTE:

(1) Slip compensation is not performed in the following condition: Output frequency < minimum output frequency (n016).
(2) Slip compensation is not performed during regeneration.
(3) Slip compensation is not performed when motor rated current (n036) is set to 0.0A.
(4) Parameter n113 enables or disables slip compensation during regeneration. Factor setting is disabled.

4.3.8 Selecting RUN/STOP Commands (n003)

Refer to switching LOCAL/REMOTE modes (page 4-5) to select either the LOCAL mode or REMOTE mode.
Operation method (RUN/STOP commands, FWD/REV run commands) can be selected by the following method.

- LOCAL mode
  When LO (local mode) is selected for digital operator LO/RE selection, run operations (run/stop) is enabled by the STOP or RUN button on the digital operator, and forward/reverse run is enabled by blinking F/R lamp (using ▽ or △ key).
  LO/RE is not effective when local/remote switching function is selected for multi-function input selection.

- REMOTE mode
  - Select remote mode.

Following are two methods to select remote modes.

1. Select "**rE**" (remote mode) for LO/RE selection.
2. When the local/remote switching function is selected for multi-functIon input selection, turn OFF the input terminal to select remote mode.

- Select operation method by setting the constant n003.

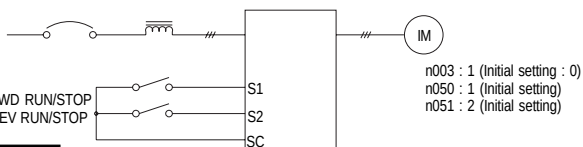
n003 = 0 : Enables the digital operator (same with local mode) (Factory Setting)

= 1 : Enables the multi-function input terminal (see fig. below)

= 2 : Enables communications (refer to page 4-76)

Example for using the multi-function input terminal as operation reference (two-wire sequence).

For example of three-wire sequence, refer to page 4-24.



NOTE:

When inverter is operated without the digital operator, always set the constant n010 to 0.

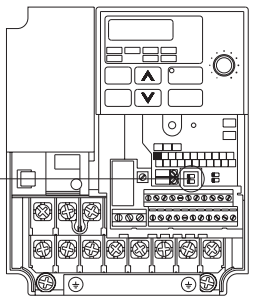
n010 = 0 : Digital operator connection fault is not detected (initial setting).

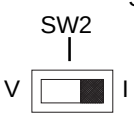
= 1 : Digital operator connection fault is detected.

- Operating (RUN/STOP commands) by communications Setting constant n003 to 2 in REMOTE mode can give RUN/STOP commands by communication (MODBUS communications). For the command by transmission, refer to page 4-76).

4.3.9 Selecting Frequency by Current Reference Input (n004)

When setting frequency by inputting current reference (4-20mA) from control circuit terminal FR, switch the dip switch SW2 on the control circuit board to "I" side.
SW2 is accessed by removing the digital operator.



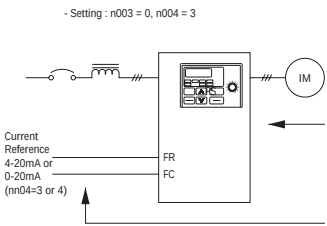


NOTE:

Never input voltage reference to control circuit terminal FR when DIP switch SW2 is switched to "I" side.
Current reference selection
Select current reference as shown below.
4-20mA.....n004 = 3
0-20mA.....n004 = 4

Refer to 4-7 for more information on n004.

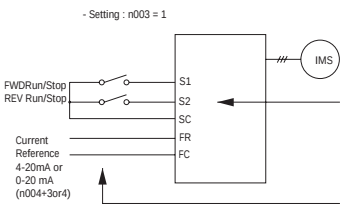
After changing DIP switch (SW2), select PRGM on the digital operator, then set the following constants.



Press the digital operator keys to run or stop the inverter. Switch run and stop direction by setting F/R LED.

Set frequency by the analog current signal [0-100% (max. frequency)/4-20mA] connected to the control circuit terminal.

Switch run/stop and FWD/REV run with switching device connected to the control circuit terminal (2-wire start/stop).



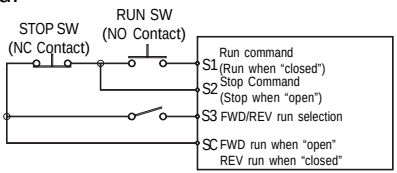
Multi-function input terminals S1 and S2 are set to Forward run / stop (n050 = 1) and Reverse RUN /STOP (n051 = 2) respectively.

Set frequency by the analog current signal [0-100% (max. frequency)/4-20mA] connected to the control circuit terminal.

Frequency reference gain (n060)/bias (n061) can be set even when current reference input is selected. For details, refer to "Adjusting Frequency Reference Signal" on page 4-41.

Terminal Function - 3-Wire Sequence Selection

When 0 is set at the terminal S3 (n052), terminal S1 becomes run command, terminal S2 becomes stop command, and terminal S3 becomes FWD/REV command.



- LOCAL/REMOTE select (setting: 17)
  (Refer to page 4-37)
  Selects operation reference by the digital operator or by the multi-function input terminal. LOCAL/REMOTE select is abailable only during stop.

  Open : Run according to the setting of run command selection (n003) or frequency reference selection (n004).
  Closed: Run by frequency reference and run command from the digital operator.

Frequency reference changes according to the setting of

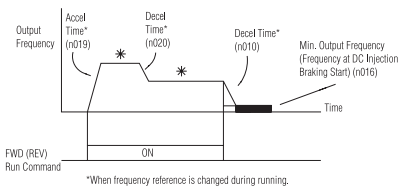
Example: Set n003 = 1, n004 = 2, n008 = 0
Open : Run by frequency reference from multi-function input terminal FR and run command from multi-function terminals S1 to S7.
Closed: Run by volume frequency reference and run command from the digital operator.

4.3.10 Selecting Stopping Method (n005)

Selects the stopping method suitable for the application.

Setting	Description
	Deceleration to Stop
1	Coast to stop

- Deceleration to stop
  Example when accel/decel time 1 is selected



Upon removal of the FWD (REV) run command, the motor decelerates at the decel rate determined by the time set to decel time 1 (n020) and DC injection braking is applied immediately before stop. If the decel time is short or the load inertia is large, overvoltage (OV) fault may occur at deceleration. In this case, increase the decel time or install an optional braking resistor.

Braking Torque:

Without braking resistor:	Approx. 20% torque of motor rating
With braking resistor:	Approx. 150% torque of motor rating

4.3.11 Setting Reverse Run Prohibit (n006)

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

Setting	Description
0	Reverse run enabled
1	Reverse run disabled

4.3.12 Operator Stop Key Selection (n007)

Selects processing when STOP key is pressed during operation from multi-function input terminal.

Setting	Description
0	STOP key effective when running from multi-function input terminals. When STOP key is pressed, the inverter stops according to the setting of constant n005. At this time, the digital operator displays "***STP***" alarm (blinking). This stop command is held in the inverter until both forward and reverse run commands are open.
1	STOP key ineffective when running from multi-function input terminals.

n008 Refer to page 4-8
n009 Refer to page 4-8
n010 = 0 : Digital operator connection fault is not detected (Factory Setting)
= 1 : Digital operator connection fault is detected

Volts per Hertz Setting

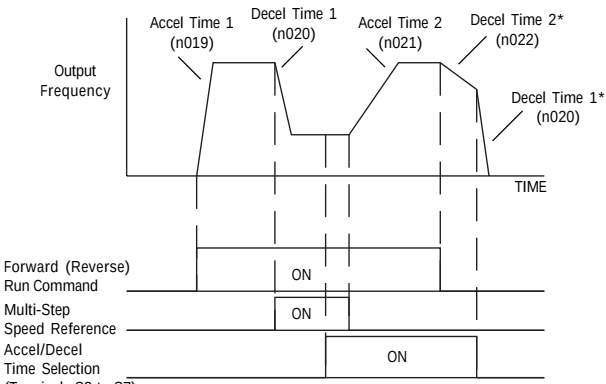
n011-n017 Refer to control method (n002) page 4-15

4.3.13 Using Two Accel/Decel Times (n018 to n022)

- n018 Setting

No.	Setting	Unit	Setting Range
n018	0	0.1 sec.	0.0 - 999.9 sec. (1000 sec. or less) 1000 - 6000 sec. (1000 sec. or more)
	1	0.01 sec.	0.00 - 99.99 sec. (100 sec. or less) 100.0 - 600 sec. (100 sec. or more)

- If the numeric value exceeds 600 sec., set accel/decel time n018 = 0 (in units of 0.1 sec.)
- Accel time
  Set the time needed for output frequency to reach 100% from 0%
- Decel time
  Set the time needed for output frequency to reach 0% from 100%



*When "deceleration to a stop" is selected (n005 = 0)

By setting input terminal function selection (either of n052 to n056) to "11 (accel/decel time select)", accel/decel time is selected by turning ON/OFF the accel/decel time select (terminal S3 to S7).

At OFF:	n019 (accel time 1)
	n020 (decel time 1)
At ON:	n021 (accel time 2)
	n022 (decel time 2)

No.	Name	Unit	Setting Range	Factory Setting
n019	Accel Time 1	Refer to n018 Setting	Refer to n018 Setting	10s
n020	Decel Time 1			10s
n021	Accel Time 2			10s
n022	Decel Time 2			10s

4.3.14 Soft-Start Characteristics (n023)

To prevent shock at machine, start/stop and accel/decel can be performed in S-curve pattern.

Setting	S-Curve Characteristic Time
0	S-curve characteristic not provided
1	0.2 second
2	0.5 second
3	1.0 second

NOTE:
S-curve characteristic time is the time from accel/decel rate 0 to a regular accel/decel rate determined by the set accel/decel time.

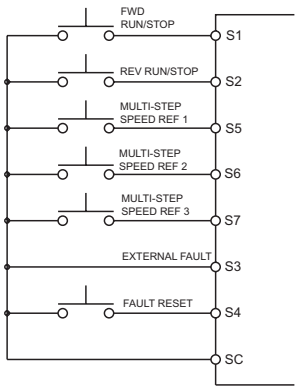
4.3.15 Setting Preset Speeds (n024 to n031)

By combining frequency reference and input terminal function selections, up to 16 preset speeds can be set.

8-Step Speed Change

n003 = 1 (Operation mode selection)
n004 = 1 (Frequency reference selection)
n024 = 25 (Frequency reference 1)
n025 = 30 (Frequency reference 2)
n026 = 35 (Frequency reference 3)
n027 = 40 (Frequency reference 4)
n028 = 45 (Frequency reference 5)
n029 = 50 (Frequency reference 6)
n030 = 55 (Frequency reference 7)
n031 = 60 (Frequency reference 8)

n054 = 6 (Multi-function contact input terminal 5)
n055 = 7 (Multi-function contact input terminal 6)
n056 = 8 (Multi-function contact input terminal 7)
n053 = 1

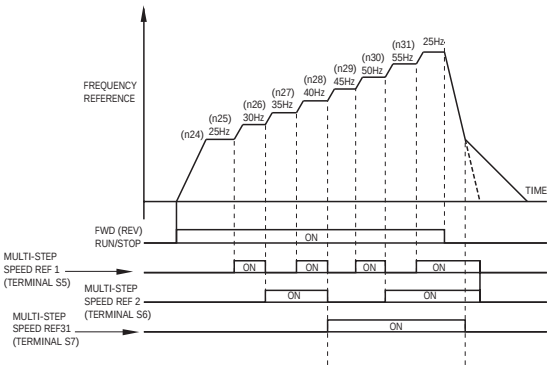


NOTE:

When n004 is set at 1, 2, 3, 4, 5, or 6, frequency reference 1 (n024) becomes disabled.

Only when multi-step speed input ref. 1 is closed and n077 = 1, the effective frequency reference becomes the CN2 analog input signal.

n050 = 1 (Input terminal S1) Factory Setting
n051 = 2 (Input terminal S2) Factory Setting
n052 = 3 (Input terminal S3) Factory Setting
n053 = 5 (Input terminal S4) Factory Setting
n054 = 6 (Input terminal S5) Factory Setting
n055 = 7 (Input terminal S6) Factory Setting
n056 = 10 (Input terminal S7) Change the setting to 8



16 Step Speed Operation (n120 - n127)

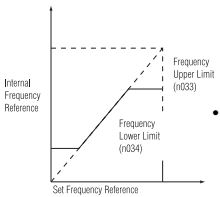
- Set frequency reference n120 - n127
- Set input terminal to multi-step speed reference for multi-function input selection

4.3.16 Jog Frequency Reference (n032)

By inputting a jog command and a forward (reverse) run command, will operate at the jog frequency set in n032. When multi-step speed reference 1, 2, 3, or 4 are input simultaneously with job command, the jog command has priority.

Name	Constant No.	Setting
Jog frequency reference	n032	Factory setting : 6Hz
Jog Command	n052 to n056	Set to "10" for any constant

4.3.17 Adjusting Upper/Lower Limits (n033 to n034)



- Frequency reference upper limit (n033)
  Sets the upper limit of the frequency reference in units of 1%.
  (n011 : Maximum output frequency = 100%)
  *Factory setting : 100%

- Frequency reference lower limit (n034)
  Sets the lower limit of the frequency reference in units of 1%.
  (n011 : Maximum output frequency = 100%)
  When operating at frequency reference 0, operation is continued at the frequency reference lower limit.

  However, when frequency reference lower limit is set to less than the minimum output frequency (n016), operation is not performed.
  *Factory setting : 0%

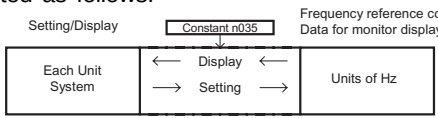
4.3.18 Unit Selection for Frequency Reference (n035)

- **Function Outline**
  The frequency reference, output frequency and the numerical data of frequency reference constant can be displayed in %, r/min, m/min according to the set value of constant n035.

Setting	Description
0	· Setting unit: 0.01 Hz (less than 100 Hz), 0.1 Hz (100 Hz and more) · Setting range: min {Fmax (n011) x Frequency reference lower limit (n034) to Fmax (n011) Frequency reference upper limit (n033), 400 Hz}
1	· Setting in units of 0.1% : 100.0 % / Fmax (n011) · Setting range: min {Frequency reference lower limit (n034) to Frequency reference upper limit (n033), (400 Hz / Fmax (n011) 100% }
2 to 39	· Setting in units of 1 r/min: r/min = 120 x Frequency reference (Hz) / n035 (Set the number of motor poles for n035) · Setting range: min {120 (Fmax x (n011) Frequency reference lower limit (n034) / n035 ~ 120 x (Fmax (n011) x Frequency reference upper limit (n033)) n035, 400 Hz x 120 P, 9999 r/min · Set the display value at 100% of frequency reference (set value of Fmax (n011)) at 1 of n035.
40 to 399	· Set the display value at 100% of frequency reference (set value of Fmax (n011)) at 1st to 4th digit of n035. By a number of 4th digit of n035, set the position of decimal point. By 1st to 4th digit of n035, set a 3-digit figure excluding decimal point. Number of 4th digit, position of decimal point 40 to 3999 0 ❑❑❑ 1 ❑❑.❑ 2 ❑.❑❑ 3 0.❑❑❑ **Example:** To display 20.0 at 100% of frequency reference, set n035 to "1200". · Setting range: min {(Lower 3-digits of n035) x Frequency reference lower limit (n034) to (Lower 3-digits of n035) x Frequency reference upper limit (n033), 400 Hz (lower 3-digits of n035) Fmax (n011), 999} Max. upper limit value: (Set value / (Lower 3-digits of n035)) x Fmax (n011) < 400 Hz

NOTE:

(1) The frequency reference constants and monitor display data for which this selection of unit function is valid, are stored in the inverter in units of Hz. The units are converted as follows:



(2) The upper limit for each unit is the figure whose fractions below the significant digits are cut off.

Example: Where the upper limit value for the unit Hz is 60.00 Hz and n035 - 39, 120 x 60.00 Hz / 39 = 184.9, accordingly 184 r/min is displayed for the upper limit value. For the display other than upper limit value, the fractions below the significant digits are rounded.

(3) The execute VERIFY for constant COPY function, frequency reference constants (in units of Hz) is applied.

4.3.19 Motor Overload Protection (n036 to n038)

The PC7 protects against motor overload with a built-in electronic thermal overload relay.

- Motor rated current (n036)
  Set to the rated current value shown on the motor nameplate.

  NOTE: Setting to 0.0A disables the motor overload protective function.

- Motor overload protection selection (n037, n038)

n037 Setting	Electronic Thermal Characteristics
0	Applied to general-purpose motor, standard ratings (TEFC)
1	Applied to inverter rated motor, short-term ratings (TENV, TEBC)
2	Electronic thermal overload protection disabled

Constant No.	Name	Unit	Setting Range	Factory Setting
n038	Protection constant selection	1 min	1 to 60 min	8 min

The electronic thermal overload function monitors motor temperature, based on inverter output current and time, to protect the motor from overheating. When electronic thermal overload relay is enabled, 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.

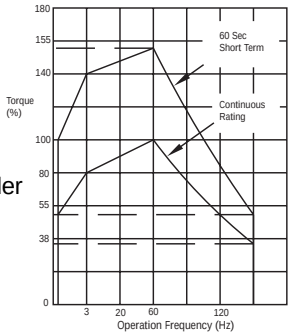
- **General-purpose motor and inverter motor**
  Induction motors are classified as general-purpose motors or inverter motors, based on their cooling capabilities. Therefore, the motor overload function operates differently between these two motor types.

General-Purpose Motor (TEFC)

- Cooling Effect
Effective when operated at 50/60Hz from commercial power supply.

- Torque Characteristics
For low-speed operation, torque must be limited in order to stop motor temperature rise.

- Electronic Thermal Overload
"oL1" error (motor overload protection) occurs when continuously operated at 50/60Hz or less at 100% load.



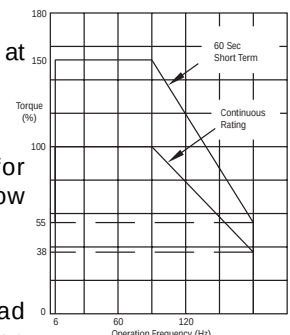
Base Frequency 60Hz
(V/f for 60Hz, 220V Input Voltage)

Inverter Motor (TENV, TEBC)

- Cooling Effect
Effective even when operated at low speed (approx. 6Hz)

- Torque Characteristics
Use an inverter motor for continuous operation at low speed.

- Electronic Thermal Overload
Electronic thermal overload protection not activated even when continuously operated at 50/60Hz or less at 100% load.



Base Frequency 60Hz
(V/f for 60Hz, 220V Input Voltage)

4.3.20 Selecting Cooling Fan Operation (n039)

In order to increase lifetime, the cooling fan can be set to operate only when inverter is running.

n039 = 0 : Operates only when inverter is running (continues operation for 1 minute after inverter is stopped) (Factory setting)

= 1 : Operates with power ON

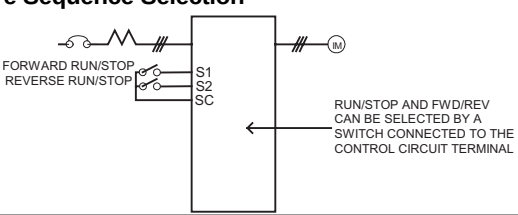
4.4 SECOND FUNCTIONS

4.4.1 Building Interface Circuits with External Devices

Multi-function input terminal S1 to S7 functions can be changed when necessary by setting constants n050 - n056 respectively. The same value cannot be set to different constant settings.

No.	Terminal	Factory Setting	Function
n050	S1	1	Forward run command (2-wire sequence)
n051	S2	2	Reverse run command (2-wire sequence)
n052	S3	3	External fault
n053	S4	5	Fault reset
n054	S5	6	Multi-step speed reference 1
n055	S6	7	Multi-step speed reference 2
n056	S7	10	JOG command

2-Wire Sequence Selection



Setting	Name	Description	Ref.
0	FWD/REV Run Command (3-wire sequence selection)	Setting enabled only for n052	4-24
1	Forward Run (2-wire sequence selection)		4-7
2	Reverse Run (2-wire sequence selection)		4.21
3	External Fault (NO contact input)	Inverter stops by external fault signal input. Digital operator display is alarm (blinking).	-
4	External Fault (NC contact input)		-
5	Fault Reset	Resets the fault. Fault reset not effective with the run signal ON.	-
6	Multi-Step Speed Reference 1		4-28
7	Multi-Step Speed Reference 2		
8	Multi-Step Speed Reference 3		
9	Multi-Step Speed Reference 4		
10	JOG Command		4-30
11	Accel/Decel Time Select		4-27
12	External Baseblock (NO contact input)	Motor coasts to a stop by this signal input. Digital operator display is alarm (blinking).	-
13	External Baseblock (NC contact input)		-
14	Search Command from Maximum Frequency	Speed search reference signal	4-38
15	Search Command from Set Frequency		4-38
16	Accel/Decel Hold Command		4-61
17	LOCAL/REMOTE Selection		4-24
18	Communication/Control Circuit Terminal Selection		
19	Emergency Stop Fault (NO contact input)	Inverter stops by emergency stop signal input according to stopping method selection (n005). When frequency coasting to a stop (n005 is set to 1) method is selected, inverter coasts to a stop according to decel time setting 2 (n022). Digital operator display is stopped. (lit at fault, blinking at alarm)	-
20	Emergency Stop Alarm (NO contact input)		-
21	Emergency Stop Fault (NC contact input)		-
22	Emergency Stop Alarm (NC contact input)		-
34	UP/DOWN Command		4-59
35	Self-Test	Setting enabled only for n056 (terminal S7)	4-91

To operate coasting motor without trip, use the speed search command or DC injection braking at start.

- **Speed search command**
  Restarts a coasting motor without stopping it. This function enables smooth switching between motor commercial power supply operation and inverter operation.

  Set input terminal function selection (n052 to n056) to "14" (search command from maximum output frequency) or "15" (search command from set frequency).

4.4.2 Programming Output Terminals (n057, n058, n059)

Multi-function output terminal MA, MB, P1 and P2 functions can be changed when necessary by setting constants n057, n058, and n059.

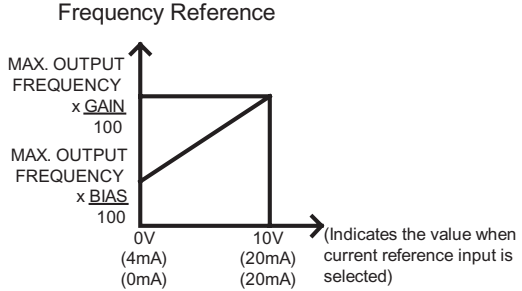
Factory setting of multi-function output terminal

No.	Terminals	Factory Setting
n057	MA, MB	0 (fault)
n058	P1	1 (in operation)
n059	P2	2 (frequency agreed)

Setting	Name	Description	Ref. Page
0	Fault	Closed when inverter fault occurs.	5-6
1	In Operation	Closed when either FWD/REV command is input or voltage is output from the inverter.	-
2	Agreed Frequency	Closed when setting frequency agrees with inverter output frequency	-
3	Zero Speed	Closed when inverter output frequency is less than minimum output frequency	-
4	Frequency Detection	Output frequency ≧ frequency detection level (n095).	4-56
5	Frequency Detection	Output frequency ≦ frequency detection level (n095).	4-56
6	Overtorque Detection (NO contact output)	(n098 - n099)	4-57
7	Overtorque Detection (NC contact output)	(n098 - n099)	4-57
10	Minor Fault	Closed when the alarm is indicated.	-
11	Baseblocked	Closed when the inverter output is shut off.	-
12	Operation Mode	Closed when "LOCAL" is selected by LOCAL/REMOTE selection.	-
13	Inverter Operation Ready	Closed when inverter fault is not detected, and operation is ready.	-
14	Fault Restart	Closed during fault retry.	-
15	In UV	Closed when undervoltage is detected.	-
16	In Reverse Run	Closed during reverse run.	-
17	In Speed Search	Closed when inverter conducts speed search.	-
18	Data Output from Communication	Operates multi-function output terminal independently from inverter operation (by MODBUS communications).	4-76
19	PID feedback loss	Closed during PID feedback loss.	-
20	Frequency reference is missing	Closed when frequency reference is missing.	-
21	Inverter overheating pre-alarm OH3	Closed when inverter overheating pre-alarm is input. Digital operator display is "OH3" (blinking).	-

4.4.3 Adjusting Frequency Reference Signal (n060, n061, n062)

To provide frequency reference by analog input of control circuit terminal FR to FC, the relationship between analog input and frequency reference can be set.

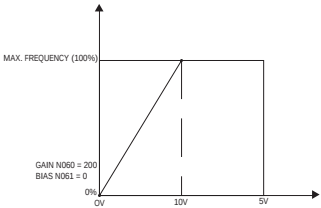


(a) Frequency reference gain (n060)
The analog input voltage value for the maximum output frequency (n011) can be set in units of 0.01 times.
(n011 maximum output frequency = 100%)
*Factory Setting : 100%

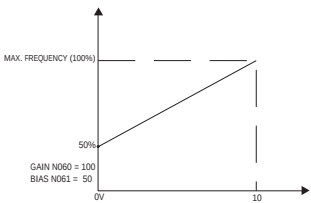
(b) Frequency reference bias (n061)
The frequency reference provided when analog input is 0V (4mA or 0mA) can be set in units of 1%.
(n011 maximum output frequency = 100%)
*Factory Setting : 0%

Typical Setting

To operate the inverter with frequency reference of 50% to 100% at 0 to 5V input



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



(c) Analog frequency reference filter time constant (n062)
Range 0.00 to 2.00 sec.
*Factory Setting : 0.10 sec.

4.4.4 Using Analog Output (AM-AC) as a Pulse Train Signal Output (n065)

Analog output AM-AC can be used as a pulse train output (output frequency monitor).

Set n065 to 1 when using pulse train output.

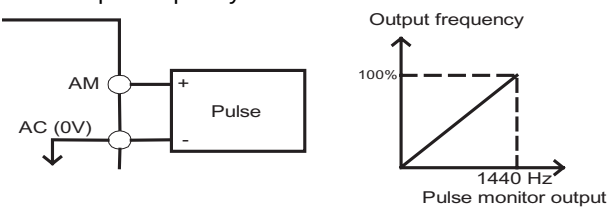
Parameters No.	Name	Unit	Setting range	Factory Setting
n065	Monitor output type selection	1	0, 1	0

n065 = 0 : Analog monitor output
= 1 : Pulse monitor output (Output frequency monitor)

Pulse train signal can be selected by setting n150.

n150 Setting	Description
0	1440Hz / Max. frequency (n011)
1	1F : Output frequency x 1
6	6F : Output frequency x 6
12	12F : Output frequency x 12
24	24F : Output frequency x 24
36	36F : Output frequency x 36

At the factory setting the pulse of 1440Hz can be output when output frequency is 100%.

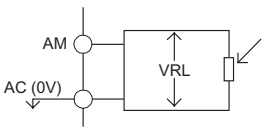


Pulse monitor output can be adjusted with the parameter n067.

NOTE:
Peripheral devices must be connected according to the following load conditions when using pulse monitor output. The machine might be damaged when the conditions are not satisfied.

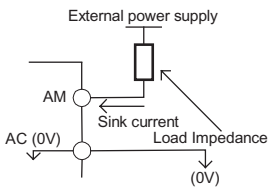
Used as a sourcing output

Output voltage VRL (V)	Load impedance (kΩ)
+5V	1.5 kΩ or more
+8V	3.5 KΩ or more
+8V	10 KΩ or more



Used as a sinking input

External power supply (V)	+12VDC+5%
Sinking current (mA)	16mA or less

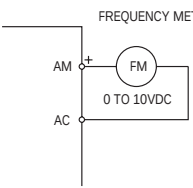


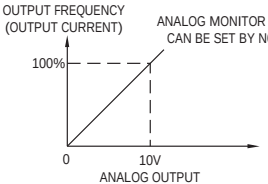
4.4.5 Using Frequency Meter or Ammeter (n066)

Selects to output either output fequency or output current to analog output terminals AM-AC for monitoring.

Setting	Description
0	Output Frequency
1	Output Current
2	DC Bus Voltage
3	Torque Monitor
4	Output Power
5	Output voltage reference

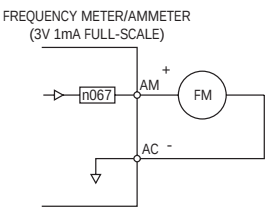
In initial setting, analog voltage of approx. 10V is output when output frequency (output current) is 100%.

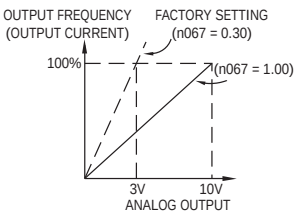




4.4.6 Calibrating Frequency Meter or Ammeter (n067)

Used to adjust analog output gain





Set the analog output voltage at 100% of output frequency (output current). Frequency meter displays 0 to 60Hz at 0 to 3V.

$$10V \times \frac{\text{n067 Setting}}{0.30} = 3V$$

3V Output frequency becomes 100% at this time.

4.4.7 Using Multi-Function Analog Input (n077 to n079)

The input analog signal (0 to 10 V or 4 mA to 20 mA) for the CN2 terminal of the JVOP-140 digital operator can be used as an auxiliary function for the main speed frequency reference input to the control circuit terminals (FR or RP). Refer to the block diagram on page 4-69 for details of the input signal.

NOTE:

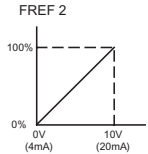
When using the signal for the CN2 terminal of the JVOP-140 digital operator's a multi-function analog input, never use it as the target value or the feedback value of PID control. (PID control is disabled when n128 is set to 0).

- n077 Multi-Function Input Selection

Setting	Name	Description
0	Disabled	The multi-function input is disabled.
1	Auxiliary frequency reference (FREF2)	When frequency reference 2 is selected in multi-step speed reference, the input analog signal for the CN2 terminal becomes the frequency reference. The n025 setting becomes invalid. Note: Set frequency reference gain to n068 or n071, and frequency reference bias to n069 or n072.
2	Frequency reference gain (FGAIN)	Provides gain to main frequency reference.
3	Frequency reference (FBIAS)	Set the FGAIN to parameter n060 or n074 and the FBIAS to parameter n061 or n075 for the main speed frequency reference. Then, add the FBIAS to the resulting frequency reference. The amount of the FBIAS to be added is set to n079.
4	VBIAS	Add the VBIAS to the output voltage after V/f conversion.

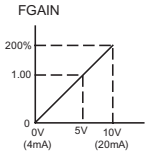
Analog input level

(1) Auxiliary frequency reference (n077 = 1)

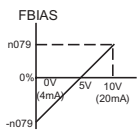


100%=Max. output frequency (n011)

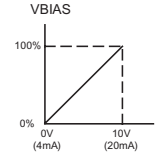
(2) Frequency reference gain (n077 = 2)



(3) Frequency reference bias (n077 = 3)



(4) Output voltage bias (n077 = 4)



The VBIAS value to be added is doubled for 400V class inverters.

- Multi-Function Analog Input Signal Selection (n078)

Constant No.	Name	Unit	Setting Range	Factory Setting
n078	Multi-function analog input signal selection	-	0 = Digital operator terminal (Voltage: 0 to 10 V) 1 = Digital operator terminal (Current: 4 to 20 mA)	0

- Frequency Reference Bias Setting (n079)

Constant No.	Name	Unit	Setting Range	Factory Setting
n079	Frequency reference bias setting	%	0 to 50 100% / Max. output frequency (n011)	10

4.5 THIRD FUNCTIONS

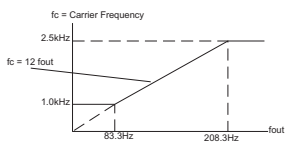
4.5.1 Carrier Frequency (n080)

The parameter enables the changing of the output transistor switching frequency (carrier frequency).

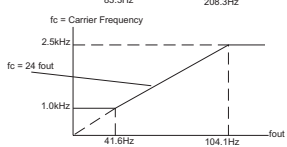
Setting	Carrier Frequency (kHz)	Metallic Noise from Motor	Noise and Current Leakage
7	12 fout	Higher ↕ Not Audible	Smaller ↕ Larger
8	24 fout		
9	36 fout		
1	2.5		
2	5.0		
3	7.5		
4	10.0		

Setting values 7, 8, or 9 multiplies carrier frequency according to output frequency value.

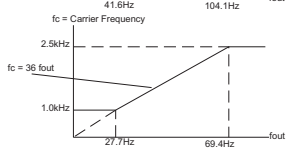
n080 = 7



n080 = 8



n080 = 9



Factory setting varies according to inverter capacity (kVA).

Voltage Class (V)	Capacity HP (kW)	Factory Setting		Maximum Continuous Output Current (A)*	Reduced Current
		Setting	Carrier Frequency		
200 Single-Phase 3-Phase	0.13 (0.1)	4	10 kHz	0.8	-
	0.25 (0.2)	4	10 kHz	1.6	
	0.5 (0.4)	4	10 kHz	3.0	
	1 (0.75)	4	10 kHz	5.0	
	2 (1.5)	3	7.5 kHz	8.0	7.0
	3 (2.2)	3	7.5 kHz	11.0	10.0
	5 (3.7)	3	7.5 kHz	17.5	16.5
	7.5 (5.5)	3	7.5 kHz	25	23
	10 (7.5)	3	7.5 kHz	33	30
400 3-Phase	0.5 (0.2)	3	7.5 kHz	1.2	1.0
	0.75 (0.4)	3	7.5 kHz	1.8	1.6
	2 (0.75)	3	7.5 kHz	3.4	3.0
	3 (1.5)	3	7.5 kHz	4.8	4.0
	3 (2.2)	3	7.5 kHz	5.5	4.8
	3 (3.0)	3	7.5 kHz	7.2	6.3
	5 (3.7)	3	7.5 kHz	9.2	7.6
	7.5 (5.5)	3	7.5 kHz	14.8	*
	10 (7.5)	3	7.5 kHz	18	17

*Reduction not necessary

(1) Reduce continuous output current when changing carrier frequency to 4 (10kHz) for the 200V class (1.5 kW or more) and 400V class inverters. Refer to the table above for the reduced current. [Operation Condition]

- Input power supply voltage: 3-phase 200 to 230V (200V class) Single-phase 200 to 240V (200V class) 3-phase 380 to 460V (400V class)
- Ambient temperature: -10° to +50°C (Protection structure: ☐ open chassis type IP20)

(2) If the wiring distance is long, reduce the inverter carrier frequency as described below.

Wiring Distance between Inverter and Motor	Up to 164 ft. (50m)	Up to 328 ft. (100m)	More than 328 ft. (100m)
Carrier Frequency (n080 setting)	10kHz or less (n080 = 1, 2, 3, 4, 7, 8, 9)	5kHz or less (n080 = 1, 2, 7, 8, 9)	2.5kHz or less (n080 = 1, 7, 8, 9)

4.5.2 Auto-Restart after Momentary Power Loss (n081)

When momentary power loss occurs, operation restarts automatically.

Factory Setting	Description
0	Continuous operation after momentary power loss not provided.
1*	Continuous operation after power recovery within momentary power loss ride thru time.
2*†	Continuous operation after power recovery (fault output not provided).

* Hold the operation command to continue the operation after recovery from a memomentary power loss.

† When 2 is selected, operation restarts if power supply voltage reaches its normal level. No fault signal is output.

4.5.3 Continue Operation by Auto-Fault Reset (n082)

Sets the inverter to restart and reset fault detection after a fault occurs. The number of self-diagnoses and retry attempts can be set at n082 up to 10. The inverter will automatically restart after the following faults occur:

- OC (overcurrent)
- OV (overvoltage)

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

(1) If no other fault occurs within 10 minutes after retry.

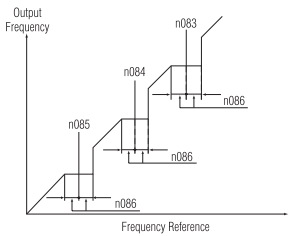
(2) When the fault reset signal is ON after the fault is detected.

(3) Power supply is turned OFF.

4.5.4 Jump Frequencies (n083 to n086)

This function allows the prohibition or "jumping" of critical frequencies so that the motor can operate without resonance caused by mechanical systems. This function is also used for dead band control. Setting the value to 0.00Hz disables this function.

Set prohibited frequency 1, 2 or 3 as follows:



n083 ≧ n084 ≧ n085
If this condition is not satisfied, the inverter displays **"*ERR*"** for one minute and restores the data to original settings.

4.5.5 Elapsed Timer (n088)

Factory Setting	Description
0	Inverter power-on time (Counts the elapsed time that there is inverter output)
1	Inverter running time (Counts the elapsed time that there is inverter output)

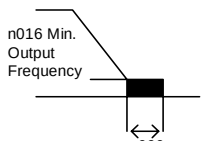
Cumulative operation time setting. Inverter operating time set with parameter n087 is accumulated by the unit of 10H. Accumulation starts from the time set with parameter n088.

Parameter No.	Name	Unit	Setting Range	Factory Setting
n088	Cumulative operation	1 = 10H	0 to 6550 (65500H)	0 (H)

4.5.6 Applying DC Injection Braking (n089 to n091)

- **DC injection braking current (n089)**
  Sets DC injection braking current in units of 1%. (Inverter Rated Current = 100%)
- **DC injection braking time at stop (n090)**
  Sets the DC injection braking time at stopping in units of 0.1 second. When the setting of n090 is 0, DC injection braking is not performed but inverter output is shut OFF at the timing of DC injection braking start.

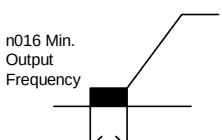
  When coasting to a stop is specified in stopping method selection (n005), DC injection braking at stop does not operate.



DC Injection Braking Time at Stop

- **DC injection braking at start (n089, n091)**
  Restarts a coasting motor after stopping it. Set the DC injection braking time at start in n091 in units of 0.1 second. Set DC injection braking current in n089 in units of 1% (inverter rated current = 100%). When the setting of n091 is "0", DC injection braking is not performed and acceleration starts from the minimum output frequency.

  When n089 is set to 0, acceleration starts from the minimum output frequency after the baseblocking for n091 setting time.

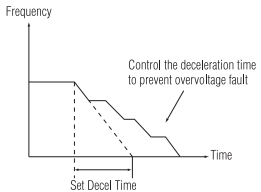


DC Injection Braking Time at Start

4.5.7 Stall Prevention During Decel (n092)

- To prevent overvoltage during deceleration the inverter automatically extends the deceleration time according to the value DC Bus voltage. When using an optional braking resistor, set n092 to 1.

Setting	Stall prevention (current limit) during deceleration
0	Provided
1	Not Provided (when braking resistor mounted)

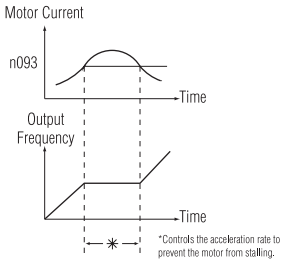


4.5.8 Preventing Motor From Stalling (n093)

(Current Limit) Automatically adjusts the output frequency and output current according to the load to continue operation without stalling the motor.

- **Stall prevention (current limit) level during acceleration** (n093). Sets the stall prevention (current limit) level during acceleration in units of 1%. (Inverter Rated Current = 100%)
  * Factory Setting : 170%

A setting of 200% disables the stall prevention (current limit) during acceleration. During acceleration, if the output current exceeds the value set for n093, acceleration stops and frequency is maintained. When the output current goes down to the value set for n093, acceleration starts.



In the constant horsepower area [output frequency ≥ max. voltage output frequency (n013)], the stall prevention (current limit) level during acceleration is changed by the following equation.

Stall prevention (current limit) level during accel in constant HP area = Stall prevention (current limit) level during accel (n093) × Max. voltage output frequency (n013) / Output Frequency

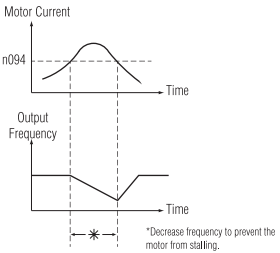
4.5.9 Stall Prevention During Run (n094)

- Sets the stall prevention (current limit) level during running in units of 1%.
  (Inverter Rated Current = 100%)
  * Factory Setting : 160%

A setting of 200% disables the stall prevention (current limit) during running.

During agreed speed if the output current exceeds the value set for n094, deceleration starts.

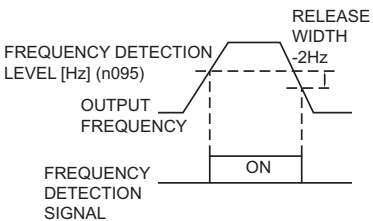
When the output current exceeds the value for n094, deceleration continues. When the output current goes down to the value set for n094, acceleration starts, up to the set frequency.



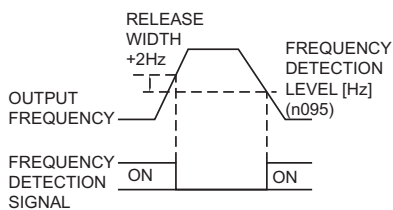
4.5.10 Frequency Detection (n095)

Effective when either of output terminal function selections n057, n058 or n059 are set to "frequency detection" (setting: 4 or 5). "Frequency detection" turns ON when output frequency is higher or lower than the frequency detection level (n095).

- Frequency detection 1 (output frequency ≧ frequency detection level) (set n057, n058, or n059 to "4")



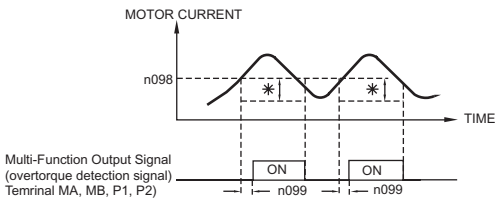
- Frequency detection 2 (output frequency ≦ frequency detection level) (set n057, n058, or n059 to "5")



4.5.11 Torque Detection (n096 to n099)

If an excessive load is applied to the machine, output current increases can be detected by a output alarm signal to multi-function output terminals MA, MB, P1 and P2.

To output an overtorque detection signal, set output terminal function selection n057 to n059 to "overtorque detection" [Setting : 6 (NO contact) or 7 (NC contact)].



* Overtorque detection release width (hysterisis) is se at approx. 5% of inverter rated current.

- **Overtorque detection function selection 1 (n096)**

Factory Setting	Description
0	Overtorque detection not provided.
1	Detected during constant-speed running, and operation continues after detection.
2	Detected during constant-speed running, and operation stops during detection.
3	Detected during running, and operation continues after detection.
4	Detected during running, and operation stops during detection.

(1) To detect overtorque at accel/decel, set to 3 or 4.
(2) To continue the operation after an overtorque detection, set to 1 or 3. During detection, the operator displays ***"oL3"*** alarm (blinking).
(3) To halt the inverter by a fault at overtorque detection, set to 2 or 4. At detection, the operator displays ***"oL3"*** fault (ON).

- **Overtorque detection function selection 2 (n097)**
  When vector control mode is selected, overtorque detection can be performed either by output current or by output torque.
  When V/f control mode is selected, n097 setting becomes invalid, and overtorque is detected by output current.

Factory Setting	Description
0	Detected by output torque
1	Detected by output current

- **Overtorque detection level (n098)**
  Sets the overtorque detection current level in units of 1%. (Inverter Rated Current = 100%)
  *Factory Setting: 160%

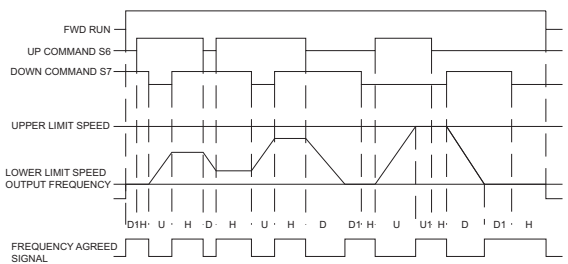
- **Overtorque detection time (n099)**
  When motor current exceeds the overtorque detection level (n098) is longer than overtorque detection time (n099), the overtorque detection function operates.
  *Factory Setting: 0.1 sec.

4.5.12 Timing Chart UP/DOWN Command Input (n100)

- **UP/DOWN command (setting: n056 = 034)**

  With the FWD (REV) run command entered, accel/decel is enabled by inputting the UP or DOWN signals to multi-function input terminals S6 and S7 without changing the frequency reference, so that operation can be performed at the desired speed. When UP/DOWN commands are specified by n056, any function set to n055 becomes disabled; terminal S6 becomes an input terminal for the UP command and terminal S7 for the DOWN command.

Multi-Function Input Terminal S6 (Up Command)	Closed	Open	Open	Closed
Multi-Function Input Terminal S7 (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
U1 = UP status, clamping at upper limit speed
D1 = DOWN status, clamping at lower limit speed

NOTE:

1. When UP/DOWN command is selected, the upper limit speed is set regardless of frequency refer ence.

   Upper limit speed = Maximum output frequency (n013)
   x Frequency reference upper limit (n033)/100

2. Lower limit value is either minimum output frequency (n016) or frequency reference lower limit (n034) (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 command is input while running by the UP/ DOWN command, the jog command has priority.
5. Multi-step speed reference 1 to 4 is not effective when UP/DOWN command is selected. Multi-step speed reference is effective during running in hold status.
6. Output frequency is retained when hold reference memory selection (n100) is set to 1.

n100 Settings

Factory Setting	Description
0	Disabled.
1	Enabled. Output frequency in hold status is retained, and restarted after operation stoppage at the frequency reference.

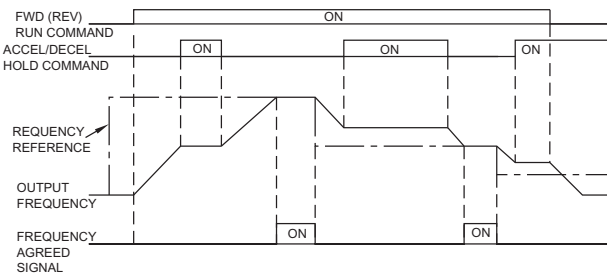
4.5.13 Holding Accel/Decel Temporarily

To hold acceleration or deceleration, input accel/decel hold command. The output frequency is maintained when the accel/decel hold command is input during acceleration or deceleration.

The stop command releases the accel/decel hold and the operation ramps to stop.

Set multi-function input terminal selection (n052 to n056) to 16 (accel/decel hold command).

Time Chart at Accel/Decel hold command input



NOTE:

When the FWD (REV) run command is input along with the accel/decel hold command, the motor does not operate. However, when frequency reference lower limit (n034) is set greater than or equal to minimum output frequency (n016), the motor operates at frequency reference lower limit (n034).

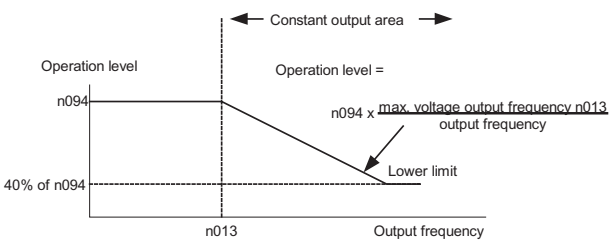
Refer to page 4-18 for n103
Refer to page 4-13 for n104 and n105
Refer to page 4-12 for n106, n107 and n110
Refer to page 4-13 for n111 and n112

4.5.14 Stall Prevention During Operation (n115)

- Stall prevention automatic decrease selection (n115) The stall prevention level can be increased automatically in the parameter output range.

Parameter No.	Name	Unit	Setting Range	Factory Setting
n115	Stall prevention automatic decrease selection	-	0 = Disabled 1 = Enabled	0

Setting	Function
0	The stall prevention level becomes the level set for the parameter n094 in all frequency areas.
1	The following shows that the stall prevention level is automatically decreased in the parameter output range (Max. frequency > Max. voltage output frequency). The lower limit is 40% of the set value of n094.



4.5.15 Accel/Decel Time Selection During Stall Prevention (n116)

With this function, acceleration/deceleration time when moving to prevent stalling during operations can be assigned to the two parameters, n021 and n022.

Parameter No.	Name	Unit	Setting Range	Factory Setting
n116	Accel/decel time selection during stall prevention	-	0 = Disabled 1 = Enabled	0

Factory Setting	Function
0	Accel/decel time is set by accel/decel time 1 or 2.
1	Accel/decel time is fixed at accel/decel time 2 (n021, n022).

4.6 FOURTH FUNCTION (n120 to n179)

Refer to page 4-29 for n120 to n127

4.6.1 Using PID Control Mode (n128 to n138)

For details of the PID control setting, refer to the block diagram (page 4-69) of the Inverter's internal PID control or the block diagram of the operator analog speed reference. Refer to Appendix B for additional information on the setup of PID.

Parameter No.	Name	Unit	Setting Range	Factory Setting
n128	PID control selection	-	0 to 8	0

n128 Settings

Setting	Function	PID Output Characteristics
0	Disabled	Forward
1	Enabled: deviation is subject to differential control	
2	Enabled: feedback signal is subject to differential control	
3	Enabled: frequency reference + PID control, and deviation are subject to differential control	
4	Enabled: frequency reference + PID control, and feedback signal are subject to differential control	
5	Enabled: deviation is subject to differential control	Reverse
6	Enabled: feedback signal is subject to differential control	
7	Enabled: frequency reference + PID control, and deviation are subject to differential control	
8	Enabled: frequency reference + PID control and feedback signal are subject to differential control	

Set one of the above values when using PID control.

n164 Setting	Description
0	Control circuit terminal FR (Voltage 0 to 10 V)
1	Control circuit terminal (Current 4 to 20 mA)
2	Control circuit terminal (Current 0 to 20 mA)
3	Operator terminal (Voltage 0 to 10 V) (CN2)
4	Operator terminal (Current 4 to 20 mA) (CN2)
5	Pulse train

The following table shows how to determine the target value and the feedback value to be input when the PID control is enabled.

	Input	Condition
Target Value	The currently selected frequency reference	Determined by the frequency reference selection (n004). When the local mode is selected, the target value is determined by frequency reference selection in local mode (n008). When the multi-step speed reference is selected, the currently selected frequency reference becomes the target value.
Feedback Value	The frequency reference that is set to the PID feedback value selection (n164)	-

NOTE:

1. When selecting frequency reference from the control circuit terminal FR as the target or feedback value, the V-I switch of SW2 on the control circuit board must be selected depending on the input method (current or voltage input).
2. Never use the frequency reference from the control circuit terminal FR for both the target and feedback values. The frequency reference for both the target value and the feedback value becomes the same.

Example: When the frequency reference from the control circuit terminal FR, with a voltage of 0 to 10 V, is selected as the target value and n004 = 2, and at the same time the frequency reference from the control circuit terminal FR, with a current of 4 to 20 mA, is selected as the fedback value and n164 = 1, the feedback value will be set as the frequency reference from the control circuit terminal Fr.

3. When using the analog signal (0 to 10 V / 4 to 20 mA) which inputs to the CN2 terminal of the digital operator JVOP-140 as the target or feedback value of PID control, never use it as a multi-analog input. Parameter n077 (multi-function analog input) should be set to 0 (disabled).

- **PID Feedback Value Adjusting Gain (n129)**

Parameter n129 is the gain that adjusts the feedback value.

Parameter No.	Name	Unit	Setting Range	Factory Setting
n129	PID feedback value adjusting gain	Multiples	0.0 to 10.0	1.0

- **Proportional gain (P), Integral Time (I), Differential Time (D) (n130, n131, n132)**

Adjust the response of the PID control with the proportional gain (P), integral time (I), and differential time (D).

Parameter No.	Name	Unit	Setting Range	Factory Setting
n130	Porportional gain (P)	Multiples	0.0 to 25.0	1.0
n131	Integral Time (I)	1.0 s	0.0 to 360.0	1.0
n132	Differential Time (D)	1.0 s	0.00 to 2.50	0.00

Optimize the responsiveness by adjusting it while operating an actual load (mechanical system). Any control (P, I, or D) that is set to zero (0.0, 0.00) will not operate.

- **PID Proportional Gain (n130)**

Proportional gain is the value by which the error signal is multiplied to generate a new PID controller output. A higher setting will result in a more responsive system. A lower setting will result in a more stable system.

Parameter No.	Name	Unit	Setting Range	Factory Setting
n130	PID Proportional Gain	-	0.00 to 10.00	1.0

- **PID Integral Time (n131)**

This parameter determines how fast the PID controller will seek to eliminate any steady-state error. The lower the setting, the faster the error will be eliminated. To eliminate the integral function entirely, set this parameter to 0.0 seconds. A lower setting will result in a more responsive system. A higher setting will result in a more stable system.

Parameter No.	Name	Unit	Setting Range	Factory Setting
n131	PID Integral Time	sec.	0.00 to 360.0	1.0

- **Derivative Time (n132)**

This parameter can be adjusted to increase system response to fast load or reference changes, and to reduce overshoot upon startup. To eliminate the differential function entirely, set this parameter to 0.00 seconds.

Parameter No.	Name	Unit	Setting Range	Factory Setting
n132	Derivative Time	sec.	0.00 to 10.0	0.00

- **PID Offset Adjustment (n133)**

Parameter n133 adjusts the PID control offset.
If both the target value and the feedback values are set to zero, adjust the inverter output frequency to zero.

Parameter No.	Name	Unit	Setting Range	Factory Setting
n133	PID Offset Adjustment	%	-100 to 100	0

- **Integral (I) Limit (n134)**

This parameter prevents the calculated value of the integral control from exceeding the fixed amount. There is normally no need to change the setting.

Reduce the setting if there is a risk of load damage, or of the motor going out of step by the inverter's response when the load suddenly changes. If the setting is reduced too much, the target value and the feedback value will not match.

Set this parameter as a percentage of the maximum output frequency with the maximum frequency as 100%.

Parameter No.	Name	Unit	Setting Range	Factory Setting
n134	Integral (I) Limit	%	0 to 100	100

- **PID Primary Delay Time Parameter (n135)**

Parameter No.	Name	Unit	Setting Range	Factory Setting
n135	PID primary delay time parameter	Seconds	0.0 to 100	0.0

Parameter n135 is the low-pass filter setting for PID control outputs. If the friction of the mechanical system is too high, or if the rigidity is too low, the system can oscillate. Increasing this parameter will dampen those oscillations.

- **PID Output Gain (n163)**

Parameter No.	Name	Unit	Setting Range	Factory Setting
n163	PID Output Gain	Multiples	0.0 to 25.0	1.0

This parameter adjusts the output gain.

- **PID Feedback Loss Detection (n136, n137, n138)**

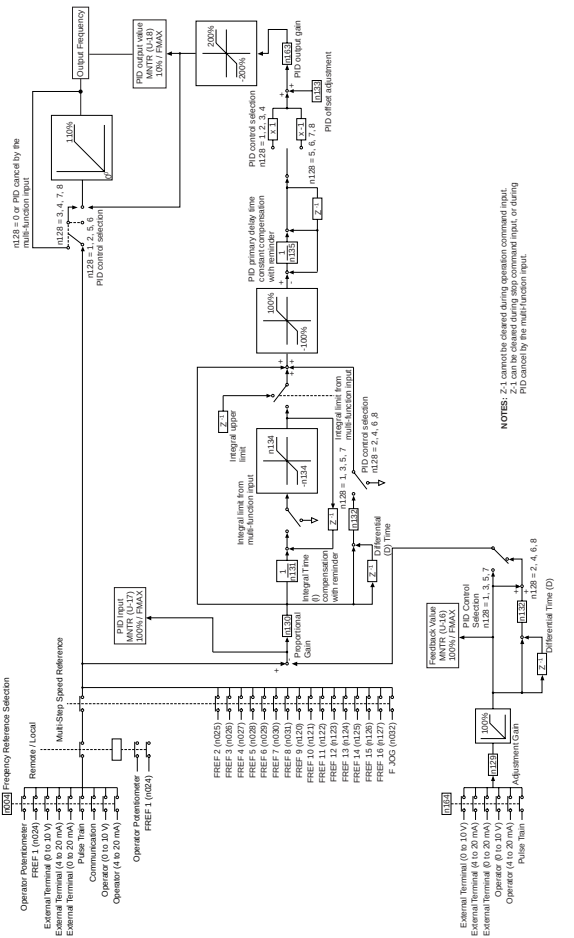
Parameter No.	Name	Unit	Setting Range	Factory Setting
n136	Selection of PID feedback loss detection	-	0: No detection of PID feedback loss 1: Detection of PID feedback loss (operation continued: FbL alarm) 2: Detection of PID feedback loss (output shut down: fault)	0
n137	PID feedback loss detection level	%	0 to 100 100% / Max. output frequency	0
n138	PID feedback loss detection time	%	0.0 to 25.5	1.0

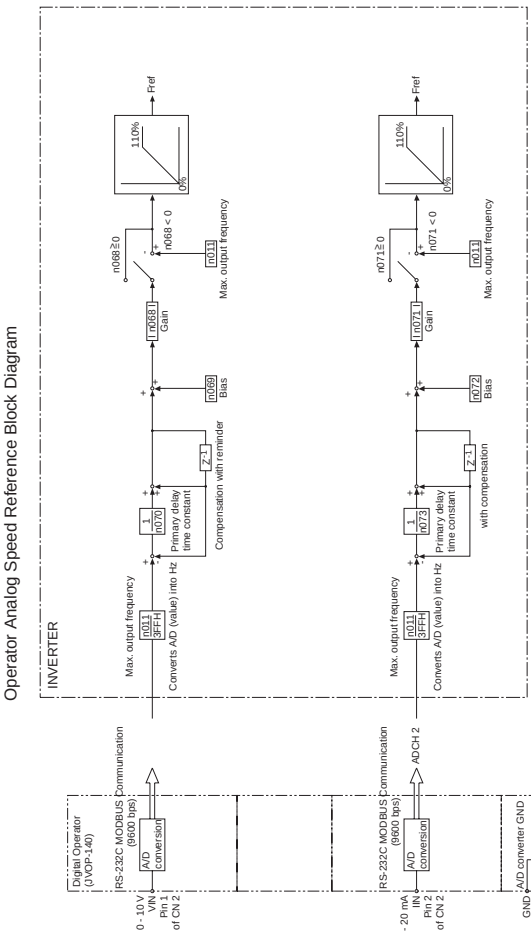
- **PID Limit**

Sets the limite after PID control as a percentage of the maximum output frequency.

- **Prohibition of PID output**

The output frequency is limited to zero Hz even if the PID calculature yields a negative number (The motor will not "back up").




Operator Analog Speed Reference Block Diagram
INVERTER
Digital Operator (JVOP-140)
RS-232C MODBUS communication (9600 bps)
A/D conversion
0 - 10 V Vin Pin 3 of CN 2
4 - 20 mA Iin Pin 4 of CN 2
GND Pin 3 of CN 2
A/D converter GND
0V
AD CH 2
Max. output frequency
n011 3FFH
Converts A/D (value) into Hz
1 n070
Primary delay time constant
Z-1
Compensation with reminder
n069 Bias
n068 Gain
n068≥0
n068 < 0
n011 Max. output frequency
110%
0%
Fref
1 n073
with compensation
n072 Bias
n071 Gain
n071≥0
n071 < 0

4.6.2 Using Energy-saving Control Mode (n139 to n140)

Verify that the parameter n002 is set to 0 (V/f control mode) when performing energy-saving control. Setting n139 to 1 enables the energy-saving control function.

Parameter No.	Name	Unit	Setting Range	Factory Setting
n139	Energy-saving control selection	-	0 : Disabled 1 : Enabled	0

Normally it is not necessary to change the setting. However, if the motor characteristics are different from a standard motor, refer to the description below and change the parameter setting accordingly.

- **Energy-saving Control Mode (n140 and n158)**

Calculates the voltage for the best motor efficiency when operating in energy-saving control mode. The calculated voltage becomes the output voltage reference. The factory setting is set to the maximum applicable motor capacity of a standard motor.

The greater the energy-saving coefficient, the greater the output voltage. When using a motor other than a standard motor, set the motor code corresponding to the voltage and capacity to n158. Change the setting of the energy-saving coefficient K2 (n140) by 5%, so that the output power becomes the smallest.

When the motor code is set to n158, the energy-saving coefficient K2, which corresponds to the motor code, is set n140.

Parameter No.	Name	Unit	Setting Range	Factory Setting
n140	Energy-saving control coefficient K2	-	0.0 to 6550	*
n158	Motor code	-	0 to 70	*

*setting depends on inverter capacity

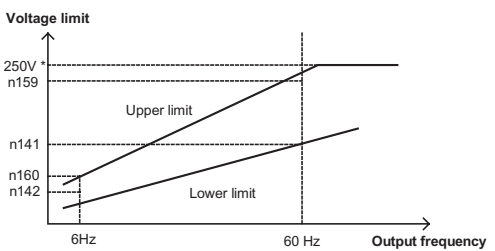
The energy-saving coefficient K2 (n140) is set to a value that corresponds with that motor code (n158).

Motor Type	Voltage Class	Capacity	Motor Code: n158	Energy-Saving coefficient K2: n140
Typical General Purpose Motor	200 V	0.1 kW	0	481.7
		0.2 kW	1	356.9
		0.4 kW	2	288.2
		0.75 kW	3	223.7
		1.5 kW	4	169.4
		2.2 kW	5	156.8
		3.7 kW	7	122.9
		5.5 kW	9	94.8
		7.5 kW	10	72.7
	400 V	0.2 kW	21	713.8
		0.4 kW	22	576.4
		0.75 kW	23	447.4
		1.5 kW	24	338.8
		2.2 kW	25	313.6
		3.0 kW	26	245.8
		3.7 kW	27	245.8
		5.5 kW	29	189.5
		7.5 kW	30	145.4
Typical Inverter Motor	200 V	0.1 kW	40	481.7
		0.2 kW	41	356.9
		0.4 kW	42	300.9
		0.75 kW	43	224.7
		1.5 kW	44	160.4
		2.2 kW	45	138.9
		3.7 kW	47	106.9
		5.5 kW	49	84.1
		7.5 kW	50	71.7
	400 V	0.2 kW	61	713.8
		0.4 kW	62	601.8
		0.75 kW	63	449.4
		1.5 kW	64	320.8
		2.2 kW	65	277.8
		3.0 kW	66	213.8
		3.7 kW	67	213.8
		5.5 kW	69	168.3
		7.5 kW	70	143.3

- **Energy-saving voltage lower/upper limit (n141, n142, n159, n160)**

Sets the upper and lower limits of the output voltage. When the value calculated in the energy-saving control mode is larger than the upper limit (or smaller than the lower limit), the value is output as a voltage reference value. The upper limit is set to prevent over-excitation, and the lower limit is set to prevent stalls when the load is light. The voltage limit is set for machines using 6Hz/60Hz. For any voltage other than 6Hz/60Hz, set the (value of the) voltage limit according to linear interpolation. The parameters are set in % for 200V/400V inverters.

Parameter No.	Name	Unit	Setting Range	Factory Setting
n141	Energy-saving voltage lower limit (60 Hz)	%	0 to 120	50
n142	Energy-saving voltage lower limit (6 Hz)	%	0 to 25	12
n159	Energy-saving voltage upper limit (60 Hz)	%	0 to 120	120
n160	Energy-saving voltage upper limit (6 Hz)	%	0 to 25	16



*Doubled for the 400V class inverters.

In the energy control mode, the maximum applicable voltage is calculated using the output power. However, a temperature change will change the fixed parameters, and the maximum applicable voltage may not be emitted. In the search operation, change the voltage slightly so that the maximum appliable voltage can be obtained.

- **Search Operation Voltage Limit (n144)**

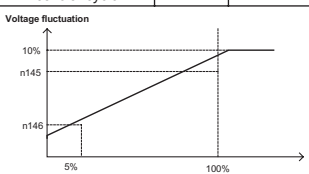
Limits the range where the voltage can be controlled. The parameters are set in % for 200V/400V inverters. The search operation is not performed when set to).

Parameter No.	Name	Unit	Setting Range	Factory Setting
n144	Search operation voltage limit	%	0 to 100	0

- **Search Operation Voltage Step (n145, n146)**

Sets the voltage fluctuations for one cycle of the search operation. Increase the value and the fluctuation of the rotation speed will also increase. The value calculated by linear interpolation is set for voltage other than above.

Parameter No.	Name	Unit	Setting Range	Factory Setting
n145	Search operation voltage step (100%)	%	0.1 to 10.0	0.5
n146	Search operation voltage step (100%)	%	0.1 to 10.0	0.2
n143	Search operation control cycle	x24 ms	1 to 2000	1 (24ms)



4.6.3 Frequency Command by Pulse Train Input (n149)

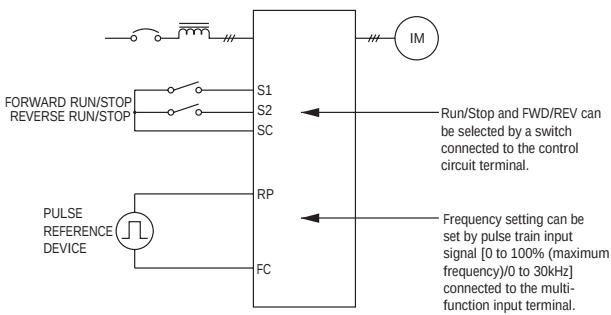
Frequency reference can be set by pulse train input from the multi-function input terminal (RP).

- **Input pulse specifications**
  - Low-level voltage : 0.8 or less
  - High-level voltage : 3.5 to 13.2 V
  - H duty : 30 to 70%
  - Pulse frequency : 0 to 30 kHz

- **Frequency reference method**

Frequency reference is a value obtained by multiplying the ratio of the maximum input pulse frequency and acutal input pulse frequency by the maximum output frequency.

$$\text{Reference Frequency (n011)} = \frac{\text{Input Pulse Frequency}}{\text{Maximum Pulse Train Frequency (n149)}} \times \text{Maximum Output Frequency}$$



No.	Name	Setting	Factory Setting
n003	Run command selection	1	0
n004	Frequency reference selection	5	0
n149	Pulse train input scaling 1 = 10Hz	3000 (30kHz)	2500 (25kHz)

Refer to Page 4-43 for n150.

4.6.4 Using MODBUS Communications (n151 to n157)

Serial transmission is available with the PC7 via MODBUS protocol.

- **MODBUS Communications**

A MODBUS system is composed of a single master (PLC) and some number of slaves (1 to 31 PC7 units).
Communication between the master and the slave(s) (serial communication) is controlled by the master program with the master initiating communication and the slave responding to those requests.

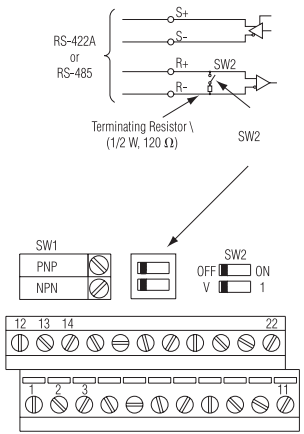
The master sends a signal to one slave at a time. Each slave has a pre-registered address number. The master specifies the address number along with the transmitted data communication. The slave receives the communications to carry out designated functions and reply to the master.

Interface	RS-422, RS485
Synchronization	Asynchronous (Start-Stop synchronization)
Communication Parameters	Baud rate: Selected from 2400/4800/9600/19200 bps Data length: 8 bit fixed Parity: Selected from even/odd/none Stop bits: 1 bit fixed
Communication protocol	MODBUS (RTU mode only)
Max. number of inverters that can be connected	31 units (when using RS-485)

4.6.4.1 Serial Communications Wiring

Use the following S+, S-, R+ and R- terminals for MODBUS communications. Change the termination resistor as shown below.

At RS-422, RS-485 communications: Turn ON SW2 ON/ OFF switch of only the inverter at the termination viewed from the PLC.



NOTE:

1. Separate the wiring for communications from the main circuit wiring or other power lines.
2. Use shielded cables for communication wiring; connect the shielded sheath to the ground terminal and terminate the other end to prevent it from being connected (to prevent noise malfunction).
3. When communication is performed through RS-485, connect S+ and R+, S- and R- terminals inside the inverter as shown above on the right side.

4.6.4.2 Procedure for Communication with PLC

The following shows the procedure for communications with PLC.

(1) Connect the communication cable between the PLC and the PC7 with the power supply turned OFF.

(2) Turn the power ON.

(3) Set the parameters (n151 to n157) required for communication by using the digital operator.

(4) Turn the power OFF once to verify that the digital operator displays have been completely erased.

(5) Turn the power ON again.

(6) Communications with the PLC starts.

4.6.4.3 Setting Parameters for Communication

Communication related parameters must be set for MODBUS communication. Parameters n151 to n157 cannot be set during communication. Always set them prior to performing communication.

Parameter	Name	Description	Factory Setting
n003	Run command selection	0: operator 1: control circuit terminals 2: communication 3: communication card (optional)	0
n004	Frequency reference selection	0: local potentiometer (digital operator) 1: frequency ref. 1 (n024) 2: control circuit terminals (voltage 0 to 10 V) 3: control circuit terminals (current 4 to 20 mA) 4: control circuit terminals (current 0 to 20 mA) 5: pulse train 6: MODBUS communication (register no, 000211) 7: operator circuit terminals (voltage 0 to 10 V) 8: operator circuit terminals (current 4 to 20 mA) 9: communication card (optional)	0
n151	Timeover detection selection Monitors transmission time between the receiving the correct data from the PLC (Timeover: 2 sec)	0: timeover detection (free run stop) 1: timeover detection (coasting to a stop with speed reduction time 1) 2: timeover detection (coasting to a stop with speed reduction time 2) 3: timeover detection (continuous operation, warning display) 4: timeover detection not provided	0
n152	Communication frequency Reference monitor unit selection	0: 0,1 Hz 1: 0:0.1 Hz 2: 30000/100% (30000 = max. output frequency) 3: 0.1%	0
n153	Slave address	Setting range: 0 to 32*	0
n154	Baud rate selection	0: 2400 bps 1: 4800 bps 2: 9600 bps 3: 19200 bps	2
n155	Parity selection	0: even parity 1: odd parity 2: no parity	0
156	Sending waiting time	Setting limit: 10 ms to 65 ms setting unit: 1ms	10 ms
n157	RTS control	0: RTS control 1: no RTS control (RS-422A 1 to 1 communication)	0

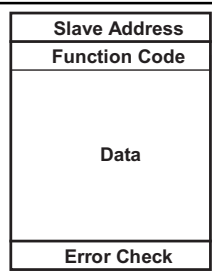
*The slave does not respond to the command from the master when set to 0.

Monitoring run status from the MODBUS master setting/ referencing of parameters, fault reset and multi-function input reference can be done regardless of run command or frequency reference selection.

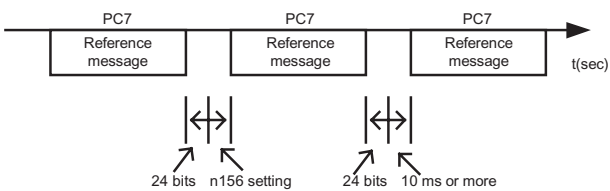
Multi-function input reference from PLC is logically OR'd with the digital input commands from S1 to S7 multi-function input terminals.

4.6.4.4 Message Format

For communications, the master (PLC) sends a command to the slave (PC7) and the slave responds to it. The message format is shown on the right. The length of the data varies according to the contents of commands (functions).



The interval between messages must be maintained at the following amount.



- **Slave address:** Inverter address (0 to 32).

Setting to 0 indicates simultaneous (global) broadcasting. The inverter does not respond to the command from the master.

- **Function code:** Command codes (See below)

Function Code	Function	Reference Message		Response Message	
		Min. (Byte)	Max. (Byte)	Min. (Byte)	Max. (Byte)
01H	Reading holding resistor contents	8	8	7	37
08H	Loop back test	8	8	8	8
10H	Write in several holding resistors	11	41	8	8

- **Data:** Composes a series of data by combining holding register numbers (test codes for loop-back numbers) and their data. Data length depends on the contents of the commands.

- **Error check:** CRC-16 (Calculate the value by the following method).

1. The default value at calculation of CRC-16 is normally 0. In the MODBUS system, change the default to 1 (all 1 to 16-bit).
2. Calculate CRC-16 assuming that the loop address LSB is MSB and the last data MSB is LSB.
3. Also calculate CRC-16 for a response message from the slave and refer it to CRC-16 in the response message.

4.6.4.5 Data Read Command [03H]

This command reads out the contents of the holding registers with the continuous numbers for the specified quantity. The contents of holding register is divided into the upper 8 bits and the lower 8 bits. They become the data items in response message in the order of numbers.

Example: Reads out status signal, fault contents, data link status and frequency reference from the PC7 (slave 2).

Reference message (at normal operation)

Slave Address	02H	
Function Code	03H	
Start Number	Upper	00H
	Lower	20H
Quantity	Upper	00H
	Lower	04H
CRC-16	Upper	45H
	Lower	F0H

Response message (at normal operation)

Slave Address	02H	
Function Code	03H	
Number of Data*	08H	
First holding resistor	Upper	00H
	Lower	65H
Next holding resistor	Upper	00H
	Lower	00H
Next holding resistor	Upper	00H
	Lower	00H
Next holding resistor	Upper	01H
	Lower	F4H
CRC-16	Upper	AFH
	Lower	82H

*Twice as much as the number of reference message.

Response message (at fault occurence)

Slave Address	02H	
Function Code	83H	
Error Code	03H	
CRC-16	Upper	F1H
	Lower	31H

4.6.4.6 Example of Loop-Back Test (08H)

Command message is returned as a response message without being changed. This function is used to check transmission between the master and the slave. Any arbitrary values can be used for test codes or data.

Example: Loop-back test of slave 1 and PC7.

Response message (at normal operation)

Slave Address	01H	
Function Code	08H	
Start Number	Upper	00H
	Lower	00H
Quantity	Upper	A5H
	Lower	37H
CRC-16	Upper	DAH
	Lower	8DH

Response message (at normal operation)

Slave Address	01H	
Function Code	08H	
Start Number	Upper	00H
	Lower	00H
Quantity	Upper	A5H
	Lower	37H
CRC-16	Upper	DAH
	Lower	8DH

Reference message (at fault occurence)

Slave Address	01H	
Function Code	89h	
Error Code	01H	
CRC-16	Upper	86h
	Lower	50H

4.6.4.7 Data Write Command [10H]

Specified data can be written into multiple consecutive registers. Written data must be arranged in a command message in the order of the holding register numbers: from upper eight bits to lower eight bits.

Example: Set forward run at frequency reference 60.0 Hz to slave 1 PC7 from the PLC.

Reference message (at normal operation)

Slave Address		01H
Function Code		10H
Start Number	Upper	00H
	Lower	01H
Quantity	Upper	00H
	Lower	02H
Number of Data*		04H
First Data	Upper	00H
	Lower	01H
Next Data	Upper	02H
	Lower	58H
CRC-16	Upper	63H
	Lower	39H

*Sets twice as large as the actual number

Response message (at normal operation)

Slave Address		01H
Function Code		10H
Start Number	Upper	00h
	Lower	01H
Quantity	Upper	00H
	Lower	02H
CRC-16	Upper	10H
	Lower	08H

Reference message (at fault occurence)

Slave Address		01H
Function Code		89H
Error Code		01H
CRC-16	Upper	86H
	Lower	50H

4.6.4.8 Data

- **Reference Data** (available to read out / write in)

Register No.	bit	Description	
0000H	Reserved		
0001H	0	Run Command	1 : Run 0 : Stop
	1	Reverse Run	1 : Reverse Run 0 : Forward Run
	2	External Fault	1 : Fault (EFO)
	3	Fault Reset	1 : Reset command
	4	Multi-function input reference 1	(Function selected by n050)
	5	Multi-function input reference 2	(Function selected by n051)
	6	Multi-function input reference 3	(Function selected by n052)
	7	Multi-function input reference 4	(Function selected by n053)
	8	Multi-function input reference 5	(Function selected by n054)
	9	Multi-function input reference 6	(Function selected by n055)
	A	Multi-function input reference 7	(Function selected by n056)
	B-F	(Not Used)	
0002H	Frequency reference (unit : n152)		
0003H	V/f gain (1000/100%)		Setting range : 2.0% ~ 200.0%
0004H-0008H	Reserved		
0009H	0	Multi-function output reference 1 (Effective when n057 = 18)	(1 : MA ON 0 = MA OFF)
	1	Multi-function output reference 2 (Effective when n058 = 18)	(1 : P1 ON 0 = MA OFF)
	2	Multi-function output reference 3 (Effective when n059 = 18)	(1 : P2 ON 0 = MA OFF)
	3-F	(Not Used)	
000AH-001FH	Reserved		

Note: Write in "0" for unused bit. Never write in data for the reserved register.

- **Simultaneous (Global) Broadcasting Data**
  (available only for data writes)

Register No.	bit	Description		
0001H	0	Run Command	1 : Run	0 : Stop
	1	Reverse Run	1 : Reverse Run	0 : Forward Run
	2	(Not Used)		
	3	(Not Used)		
	4	External Fault	1 : Fault (EFO)	
	5	Fault Reset	1 : Fault reset command	
	6-F	(Not Used)		
0002H	30000/100% fixed unit (Data is converted into 0.01 Hz inside the inverter, and fractions are rounded off).			

Bit signals not defined as the global broadcast signals are used as the local station data signals.

- **Monitor Data (Read only)**

Register No.		bit	Description		
0020H	Status Signal	0	Run Command	1 : Run	0 : Stop
		1	Reverse Run	1 : Reverse run	0 : Forward run
		2	Inverter operation ready	1 : Ready	0 : Not ready
		3	Fault	1 : Fault	
		4	Data setting error	1 : Error	
		5	Multi-function output 1	(1 : MA ON	0 : MA OFF)
		6	Multi-function output 2	(1 : P1 ON	0 : OFF)
		7	Multi-function output 3	(1 : P2 ON	0 : OFF)
		8-F	(Not Used)		
0021H	Fault Description	0	Overcurrent (OC)		
		1	Overvoltage (OV)		
		2	Inverter overload (OL2)		
		3	Inverter overheat (OH)		
		4	(Not Used)		
		5	(Not Used)		
		6	PID feeback loss (FbL)		
		7	External fault (EF, EFO)	Emergency stop (STP)	
		8	Hardware fault (Fxx)		
		9	Motor overload (OL1)		
		A	Overtorque detection (OL3)		
		B	(Not Used)		
		C	Power loss (UV1)		
		D	Control power fault (UV2)		
		E	MODBUS communications timeover (CE)		
		F	Operator connection (OPR)		

Register No.		bit	Description		
0022H	Data Link Status	0	Data write in		
		1	(Not Used)		
		2	(Not Used)		
		3	Upper / lower limit fault		
		4	Consistency fault		
		5-F	(Not Used)		
0023H	Frequency reference (Unit : n152)				
0024H	Output frequency (Unit : n152)				
0025H-0026H	(Not Used)				
0027H	Output current (10 / 1 A)				
0028H	Output voltage reference (1 / 1 V)				
0029H-002AH	Reserved				
002BH	Sequence Input Status	0	Terminal S1	1 : Closed	0 : Open
		1	Terminal S2	1 : Closed	0 : Open
		2	Terminal S3	1 : Closed	0 : Open
		3	Terminal S4	1 : Closed	0 : Open
		4	Terminal S5	1 : Closed	0 : Open
		6	Terminal S6	1 : Closed	0 : Open
		7-F	(Not Used)		
002CH	Inverter Status	0	Run	1 : Run	
		1	Zero - speed	1 : Zero - speed	
		2	Frequency agreed	1 : Agreed	
		3	Minor fault (Alarm is indicated)		
		4	Frequency detection 1	1 : Output frequency ≦ (n095)	
		5	Frequency detection 2	1 : Output frequency ≦ (n095)	
		6	Inverter operation ready	1 : Ready	
		7	Undervoltage detection	1 : Undervoltage detection	
		8	Baseblock	1 : Inverter output baseblock	
		9	Frequency reference mode	1 : Other than communications	0 : communications
		A	Run command mode	1 : Other than communications	0 : communications
		B	Overtorque detection	1: Detection or overtorque fault	
		C	(Not Used)		
		D	Fault restart		
		E	Fault (Including MODBUS communications timeover)		1 : Fault
		F	MODBUS communications timeover		1 : Timeover

Register No.		bit	Description		
002DH		0	MA "ON"	1 : Closed	0 : Open
		1	P1 "ON"	1 : Closed	0 : Open
		2	P2 "ON"	1 : Closed	0 : Open
		3-F	(Not Used)		
002EH-0030H	Reserved				
0031H	Main circuit DC voltage (1 / 1 V)				
0032H	Torque monitor				
0033H-0036H	(Not Used)				
0037H	Output power (1 / 1 W : with sign)				
0038H	PID feedback value (100%/Input equivalent to max. output frequency; 10/1%; without sign)				
0039H	PID input value (* 100% / * Max. output frequency; 10/1%; with sign)				
003AH	PID input value (* 100% / * Max. output frequency; 10/1%; with sign)				
003DH	Communications Error	0	CRC error		
		1	P1 "ON"		
		2	(Not Used)		
		3	Parity error		
		4	Overrun error		
		5	Framing error		
		6	Timeover		
		7	(Not Used)		
003EH-00FFH	Reserved				

* Communications error contents are saved until fault reset is input. (Reset is enabled during run.)

- **Storing Parameters** [Enter Command] (can be written only)

Register Number	Name	Contents	Setting Range	Default
0900H	ENTER command	Write-in parameter data to non-volatile memory (EEPROM)	0000H to FFFFH	-

When a parameter is written serially by the MODBUS PLC, the parameter is written to the parameter data area on the RAM in the PC7. ENTER command is a command to transfer the parameter data from RAM to the non-volatile memory in the inverter. Writing data (can be undefined) to register number 0900H during stop executes this ENTER command.

Maximum number of writes of the non-volatile memory used in the PC7 is 100,000; do not execute the ENTER command excessively. When a parameter is changed from the digital operator, the parameter data on the RAM is written to the non-volatile memory without ENTER command.

Register number 0900H is used only for writing of data. If this register is defined as monitor (read only), a register number error (error code: 02H) occurs.

• Error Codes

Error Code	Contents
01H	Function code error · Function code from PLC is other than 03H, 08H or 10H.
02H	Improper register number · No register numbers to be accessed have been registered. · ENTER command "0900H" that is an exclusive-use register for write-in was read out.
03H	Improper quantity · The number of data items to be read or write-in is not in the range between 1 and 16. · The number of data items in a message is not the value obtained by multiplying the quantity by two in the write-in mode.
21H	Data setting error · A simple upper/lower limit error occurred with control data or parameter write-in. · A parameter setting error occurred when a parameter was written.
22H	Write-in mode error · Attempt to write-in a parameter from PLC was made during running. · Attempt to write-in an ENTER command from PLC was made during running. · Attempt to write-in a parameter from PLC was made during UV occurrence. · Attempt to write-in an ENTER command from PLC was made during UV occurrence. · Attempt to write-in a parameter other than n001 = 12, 13 (initialization) from PLC was made during "F04" occurrence. · Attempt to write-in a parameter from PLC was made while data were being stored. · Attempt to write-in data exclusive for read-out from PLC was made.

*Refer to the parameters list for parameters that can be changed during operation.

4.6.5 Performing Self-test

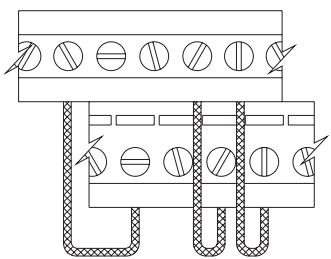
PC7 is provided with a self diagnostic check. It is available to test the serial communication I/F circuit. This function is called "self-test". During connect the sending terminal with the receiving terminal in the communications section. It assures that the data received by the PC7 is not being changed. It also checks if the data can be received normally. Carry out the self-test in the following procedure.

(1) Turn ON the PC7 mini power supply. Set parameter n056 to 35 (self-test).

(2) Turn OFF the PC7 mini power supply.

(3) Make the following wiring with the power supply turned OFF.

(4) Turn the power ON.



(Note: Select NPN side for SW1)

Normal operation: Operator displays frequency reference value.

Fault operation: Operator displays "CE", fault signal is turned ON and inverter ready signal is turned OFF.

Refer to page 4-71 for n158 to n160

4.6.6 Search Operation Power Detection Hold Width (n161)

When the power fluctuation is less than this value, the output voltage is held for 3 seconds. Then the search operation mode is activated. Set the hold width in % of the power which is currently held.

Parameter No.	Name	Unit	Setting Range	Factory Setting
n161	Search operation voltage limit	%	0 to 100	0

- **Power Detection Filter Time Parameter (n162)**

Response to load changes are improved when this value is reduced. However, at low frequency, unstable rotation may result.

Parameter No.	Name	Unit	Setting Range	Factory Setting
n162	Power detection filter time parameter	x 4 ms	0 to 225	5 (20 ms)

Refer to page 4-64 for n163 to n164

• Installed Braking Resistor Overheating protection Selection (n165) Set "0" when braking resistor is not connected

Setting	Description
0	Overheating protection is not provided
1	Overheating protection is provided

4.6.7 Using Constant Copy Function (n176, n177)

The PC7 standard digital operator JVOP-140 can store constants from one inverter. A backup power supply is not necessary since EEPROM is used.

Constant copy function is possible only for the inverters with the same product series, power supply specifications and control mode (V/f control or vector control). However, some constants may not be copied. It is also impossible to copy constants between PC7 and VSM inverters.

The prohibition of the reading of constants from the inverter can be set at n177. The constant data cannot be changed when this constant is set.

If any alarm occurs during constant copy, the PRGM will blink and copying will continue.

4.6.7.1 Constant Copy Function Selection (n176)

Depending on the setting of n176 for constant copy function selection, the following functions are available.

(1) Read all the constants from the inverter (READ) and store them in EEPROM in the digital operator.

(2) Copies the constants stored in the digital operator to the inverter (COPY).

(3) Verify the constants in the digital operator and the constants in the inverter are the same (VERIFY).

(4) Displays the maximum applicable motor capacity and the voltage class of the inverter that has the constants stored in the digital operator.

(5) Displays the software number of the inverter that has the constants stored in the digital operator.

Parameter No.	Name	Unit	Setting Range	Factory Setting
n176	Constant copy function selection	-	rdy: READY rEd: READ CPy: COPY vFy: VERIFY vA: Inverter capacity display Sno: Software No. display	rdy

4.6.7.2 Prohibiting Constant Read Selection (n177)

Select this function to prevent accidentally overwriting the constants stored in EEPROM or in the digital operator. Reading is not possible when this constant is set to 0.

The constant data stored in the digital operator are safe from accidental overwriting.

When reading is performed while this constant is set to 0, PrE will blink. Press the DSPL or ENTER and return to the constant number display.

Parameter No.	Name	Unit	Setting Range	Factory Setting
n177	Constant read selection prohibit	1	0: READ prohibited 1: READ allowed	0

4.6.7.3 Read (Upload) Function

The function of the parameter is to upload parameters. This command will instruct the digital operator to read all of the inverter parameters. These parameters can than be copied to other inverters by simply executing the parameter "write" command. This "copy" unit function can be used to quickly program multiple inverters.

Example: Store the constants from the inverter in the EEPROM inside the digital operator.

Explanation		Operator Display
• Enable the setting of the constants n001 to n179	• Press DSPL to light [PRGM]	001 (Can be a different constant No.)
	• Press ENTER to display the set value	1 (Lit) (Can be a different set value)
	• Change the set value to 4 by pressing ∧ or ∨ key.	4 (Blinks)
	• Press ENTER.	4 (Lit for one second)
• Set constant read prohibited selection (n177) to READ enabled. *1	• Change the constant NO. to n177 by pressing ∧ or ∨ key.	n177
	• Press ENTER to display the set value.	0 (Lit)
	• Change the set value to 1 by pressing the ∧ or ∨ key.	1 (Blinks)
	• Press ENTER.	1 (Lit for one second)
		n177 (The constant displayed)
• Execute parameter upload (READ) by Function n176.	• Change the constant No. by pressing ∧ or ∨ key.	n176
	• Press ENTER to display the set value.	rEd (Lit)
	• Change the set value to rEd by pressing ∧ or ∨ key.	rEd (Lit)
		rEd (Blinks while executing READ)
	• Press ENTER	End (End is displayed after the execution of READ is completed)
	• Press DSPL or ENTER	n176 (The constant is displayed)
• Set constant read prohibited selection (n177) to READ disabled. *2	• Change the constant number to n177 by pressing ∧ or ∨ key.	n177
	• Press ENTER to display the set value.	1 (Lit)
	• Change the set value to 0 by pressing ∧ or ∨ key.	0 (Blinks
	• Press ENTER	0 (Lit for one minute)
		n177 (The constant number is displayed)

*1 When READ is enabled (n177 = 1), this setting is not necessary.
*2 The setting is not necessary unless READ prohibition is selected.

4.6.7.4 Copy (Download) Function

Writes the constant stored inside the digital operator to the PC7. This download is possible only when inverters with the same product series, power supply specifications and control mode (V/f control or vector control).
Therefore, writing from 200 V class to 400 V class (or vice versa), from V/f control mode to vector control mode (or vice versa), and from the PC7 to any other inverter is not possible.
Constant Copy Function (n176), Constant Read Prohibited (n177), Fault History (n178), Inverter Software Number (n179) and hold output frequency are not written.
The following constants are not written if the inverter capacity is different.

Constant No.	Name	Constant No.	Name
n011 to n017	V/f setting	n108	Motor leakage inductance
n036	Motor rated current	n109	Torque compensation voltage limiter
n080	Carrier frequency	n110	Motor no-load current
n105	Torque compensation iron loss	n140	Energy-saving coefficient K2
n106	Motor rated slip	n158	Motor code
n107	Motor resistance for one phase		

Example:
Write the constants from EEPROM inside the digital operator to the inverter.

Explanation		Operator Display
· Enable the setting for the constants n001 to n179	· Press DSPL to light [PRGM]	n001 (Can be a different constant No.)
	· Press ENTER to display the set value.	1 (Lit) (Can be a different set value)
	· Change the set value to 4 by pressing [∧] or [∨] key.	4 (Blinks)
	· Press ENTER.	4 (Lit for one second)
		n001 (The constant No. is displayed)
· Execute download (COPY) by constant copy function (n176)	· Change the constant No. to n176 by pressing [∧] or [∨] key.	n176
	· Press ENTER to display the set value.	rdY (Lit)
	· Change the set value to CPy by pressing [∧] or [∨] key.	CPy (Lit)
	· Press ENTER	CPy (Blinks while executing CPY)
	· Press DSPL or ENTER	End (End is displayed when the execution of CPY is completed)
		n176 (The constant No. is displayed)

A setting range check and matching check for the transferred constants are executed after the constants are copied from the digital operator to the inverter. If any constant error is found, the written constants are discarded and the previous are retained.
When a setting range error is found, the constant number where an error occurs is indicated by blinking.
When a matching error is found, oP □ (□ : a number) is indicated by blinking.

4.6.7.5 Verify Function

This function compares the constants stored in the digital operator with the constants in the inverter. As well as download, VERIFY is possible only for the inverters with same product series, power supply specifications and control mode (V/f control or vector control). When the constants stored in the digital operator match those in the inverter, ***vFy*** is displayed by blinking, the End is displayed. **Example:** Compare the constants stored in EEPROM inside the digital operator with the constants in the inverter.

Explanation		Operator Display
· Enable the setting for the constants n001 to n179	· Press DSPL to light [PRGM]	n001 (Can be a different constant No.)
	· Press ENTER to display the set value.	1 (Lit) (Can be a different set value)
	· Change the set value to 4 by pressing [Λ] or [V] key.	4 (Blinks)
	· Press ENTER.	4 (Lit for one second)
		n001 (The constant No. is displayed)
· Execute VERIFY by constant copy function selection (n176)	· Change the constant No. to n176 by pressing [Λ] or [V] key.	n176
	· Press ENTER to display the set value.	rdY (Lit)
	· Change the set value to vFy pressing [Λ] or [V] key.	vFy (Lit)
	· Press ENTER	vFy (Blinks while executing VERIFY)
· Display the unmatched constant No.		n001 (Blinks) (When n001 is unmatched)
· Display the constant value in the inverter		60.0 (Blinks)
	· Press ENTER	50.0 (Blinks)
· Display the constant value in the digital operator.	· Press ENTER	
· Continue the execution of VERIFY.	· Press [Λ] key.	vFy (Blinks while executing VERIFY)
	· Press DSPL or ENTER	End (End is displayed when the execution of VERIFY is completed)
		n176 (The constant No. is displayed)

While an unmatched constant number is displayed or a constant value is displayed pressing STOP/RESET interrups the execution of VERIFY and End is displayed. Pressing DSPL or ENTER returns to the constant number.

4.6.7.6 Inverter Capacity Display

The voltage class and maximum applicable motor capacity (whose constants stored in the digital operator are read out) are displayed.

Example: Display the voltage class and maximum applicable motor capacity for the inverter whose constants stored in EEPROM inside the digital operator.

Explanation		Operator Display
· Enable the setting for the constants n001 to n179	· Press DSPL to light [PRGM] · Press ENTER to display the set value. · Change the set value to 4 by pressing [^] or [v] key. · Press ENTER.	n001 (Can be a different constant No.) 1 (Lit) (Can be a different set value) 4 (Blinks) 4 (Lit for one second) n001 (The constant No. is displayed)
· Execute Inverter Capacity Display (vA) by constant copy function selection (n176)	· Change the constant No. to n176 by pressing [^] or [v] key. · Press ENTER to display the set value. · Change the set value to vA by pressing [^] or [v] key. · Press ENTER · Press DSPL or ENTER.	n176 rdY (Lit) vA (Lit) 20.7 (Lit) (For 20P7)* n176 (The constant No. is displayed)

The following shows the explanation of Inverter Capacity Display.

2 0. 7

	Voltage Class
2	Three-Phase 200 V
b	Single-Phase 200 V
4	Three-Phase 400 V

	Max Applicable Motor Capacity	
	200 V Class	400 V Class
0.1	0.1 kW	-
0.2	0.25 kW	0.37 kW
0.4	0.55 kW	0.55 kW
0.7	1.1 kW	1.1 kW
1.5	1.5 kW	1.5 kW
2.2	2.2 kW	2.2 kW
3.0	-	3.0 kW
4.0	4.0 kW	4.0 kW

4.6.7.7 Software Number Display

The software version number (of the inverter whose constants stored in the digital operator are read out) is displayed.

Example: Display the software number of the inverter whose constants stored EEPROM inside the digital operator.

Explanation		Operator Display
· Enable the setting for the constants n001 to n179	· Press DSPL to light [PRGM] · Press ENTER to display the set value. · Change the set value to 4 by pressing ∧ or ∨ key. · Press ENTER.	n001 (Can be a different constant No.) 1 (Lit) (Can be a different set value) 4 (Blinks) 4 (Lit for one second) n001 (The constant No. is displayed)
· Execute Software No. Display (Sno)* by constant copy function selection (n176).	· Change the constant No. to n176 by pressing ∧ or ∨ key. · Press ENTER to display the set value. · Change the set value to vA by pressing ∧ or ∨ key. · Press ENTER · Press DSPL or ENTER.	n176 rdY (Lit) Sno (Lit) 0013 (Lit) (software version: VSP010013) n176 (The constant No. is displayed)

*Displays last 4 digits of the software version.

Display List

Operator Display	Description	Corrective Action
rdY	Lit: Setting for constant copy function selection enabled	-
rEd	Lit: READ selected Flashed: READ under execution	-
CPy	Lit: Writing (COPY) selected	-
vFy	Lit: VERIFY selected Flashed: VERIFY under execution	-
vA	Lit: Inverter capacity display selected	-
Sno	Lit: Software No. display selected	-
End	Lit: READ, COPY (writing) or VERIFY completed	-
PrE	Blinks: Attempt to execute READ while Constant Read Prohibited Selection (n177) is set to 0.	Confirm the necessity to execute READ, then set constant Read Prohibited Selection (n177) to 1 to execute READ.
rdE	Blinks: The constant could not be read properly be READ operation. Or, a main circuit low voltage is detected during READ operation.	Confirm that the main circuit power supply voltage is correct, then re-execute READ.
CSE	Blinks: A check sum error occurs in the constant data stored in the digital operator.	The constants stored in the digital operator cannot be use. Re-execute READ to store the constants in the digital operator.
dPS	Blinks: A download has been attempted from one model inverter to a different model.	Check if they are the same product series.
ndR	Blinks: No constant data stored in the digital operator.	Execute READ.
CPE	Blinks: Attempt to execute writing (COPY) or VERIFY between different voltage classes or different control modes.	Check each voltage class and control mode.
CYE	Blinks: A main circuit low voltage is detected during writing (COPY) operation.	Confirm that the main circuit power supply voltage is correct, the re-execute writing (COPY).
F04	Lit: A check sum error occurs in the constant date stored in the inverter.	Initialize the constants. If an error occurs again, replace the inverter due to a failure of constant memory element (EEPROM) in the inverter.
uRE	Blinks: Attempt to execute VERIFY between different inverter capacities.	Press ENTER to continue the execution of VERIFY. Press STOP to interrupt the execution of VERIFY.
rFE	Blinks: A communication error occurs between the inverter and the digital operator.	Check the connection between the inverter and the digital operator. If a communication error occurs during READ operation or writing (COPY) operation, be sure to re-execute READ or COPY.

Note: While rEd, CPy, or vFy is displayed by blinking, key input on the digital operator is disabled. While rEd, CPy and vFy are not displayed by blinking, pressing DSPL or ENTER redisplays the constant number.

Chapter 5: PM& Troubleshooting

What this chapter tells you:

1) Periodic inspection.
2) Parts replacement schedule.
3) Troubleshooting poor operation.
4) Fault diagnostics.

Never touch any high voltage terminals in the inverter. Replace all protective covers before powering up the inverter. Only authorized personnel should be permitted to perform service on this unit.

5.0 PERIODIC INSPECTION

The PC7 will provide a long, useful operational life when you observe all of the precautions in this manual. It is, however, a good idea to perform regular, periodic inspections to make sure there are no unexpected problems. These checks are very simple and will not require much time. Table 5.1 (page 5-3) summarizes the recommended checks.

5.1 PARTS REPLACEMENT SCHEDULE

Table 5.2 (page 5-3) gives a recommended parts replacement schedule. While this is not absolutely required, it can further prolong the useful life of the PC7.

5.2 OPERATIONAL FAULTS

The PC7 gives advanced diagnostic displays to assist in the troubleshooting of operational problems. Some problems, however, may not result in a unit fault trip. Refer to Table 5.3 (page 5-4) for typical corrective actions.

Table 5.1 Periodic Inspection

Component	Check	Corrective Action
External terminal, connectors, mounting screws	Loose terminals or connections	Secure (do not overtighten)
Heatsink	Build-up of dust, dirt or oil	Blow with clean, dry compressed air
Printed Circuit Board	Accumulation of dust or dirt or discoloration	Blow with clean, dry compressed air. If problem persists, replace component
Power Components		
Bus Capacitor	Discoloration, odor, discharge	Replace the capacitor or the inverter
Cooling fan	Abnormal noise or vibration	Replace the cooling fan

Table 5.2 Parts Replacement Schedule

Component	Approximate Interval	Remarks
Bus Capacitor(s)	5 years	Inspect and replace
Fuses	10 years	Replace
Cooling fan	2 to 3 years	Replace
Smoothing capacitor	5 years	Replace (Inspection needed to determine condition)
Breaker relays	-	(Inspection needed to determine condition)
Aluminum capacitors on PCBs	5 years	Replace (Inspection needed to determine condition)

Table 5.3 Operational Problems

Observed Problem	Check	Corrective Action
No keypad illumination	Incoming power supply	Measure input voltage and make sure it is within unit tolerance.
	DC Bus Voltage	Verify DC bus voltage is present. (320 VDC - 650 VDC) (Charge LED on)
Motor is turning wrong direction	T1, T2, T3 wiring	Reverse any two motor leads after power is removed and display is OFF.
	Control Wiring	Make sure control wiring is ok. Check programming of unit to be sure that 2-wire/3-wire programming is correct.
Keypad does not allow parameter changes	Check Access	1. Must be in program mode. 2. Set parameter n001 for access.
Motor does not accelerate	Run LED	Make sure the drive is getting a valid run command
	LO/RE Status	Press LOCAL/REMOTE key
	Reference	Valid reference present
	Output Voltage	Check with rectifier type voltmeter. Look for balanced AC voltage.
	Fault Code	Refer to fault display tables, pages 5-7 thru 5-13
	Load	Make sure motor is not overloaded.
Motor current is high	Single-Phase	Use clamp on ammeter to verify balanced, three-phase output current.
	Motor connections	Is motor connected for correct voltage.
	V/Hz	Make sure the V/Hz pattern matches the motor nameplate.
	Load	Excessive load.

Replacement of Cooling Fan

· Inverter of W-Dimension (width) 2.68 inches, 5.51 inches, 6.64 inches

1. Removal

(1) Press the right and left clicks of the fan cover and pull them to remove the fan cover from the inverter unit.
(2) Pull the wiring from the fan cover rear face and remove the protective tube and connector.
(3) Open the left and righ sides of the fan cover to remove the cooling fan from cover.

2. Mounting

(1) Mount the cooling fan on the fan cover. The arrow mark to indicate the wind direction of the cooling fan must be in the opposite side to the cover.
(2) Connect the connector and mount the protective tube firmly. Mount the connector joint section on the fan cover rear face.
(3) Mount the fan cover on the inverter. Be sure to mount the right and left clicks of the fan cover on the heatsink.

· Inverter of W-Dimension (width) 4.25 inches

1. Removal

(1) Remove the front cover and terminal cover, and remove the cooling fan connector (CN4)
(2) Press the right and left clicks of the fan cover and pull the fan cover to remove it from the inverter.
(3) Open the right and left sides of the fan cover to remove the cover from the cooling fan.

2. Mounting

(1) Mount the cooling fan on the fan cover. The arrow mark to indicate the wind direction must be opposite the cover.
(2) Mount the fan cover on the inverter. Be sure to mount the right and left clicks of the fan cover on the heatsink. Lead in the wiring from the cable lead-in hole at the bottom of the plastic case to the inside of the inverter.
(3) Connect the wiring to the cooling fan connector (CN4) and mount the front cover and the terminal cover.

5.3 ALARM AND FAULT CODES

This section describes the alarm and fault displays, explanations for fault conditions and corrective actions to be taken if the PC7 malfunctions.

< Corrective actions for models with blank cover >

1. Input fault reset or cycle the power supply OFF and ON.
2. When a fault cannot be corrected:
   a. Turn the power supply OFF and check the wiring control logic.
   b. Turn the power supply OFF and replace the blank cover with the digital operator to display faults.

< Corrective actions of models with digital cover >

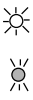
☼ : ON ☼ :BLINKING ● : OFF

Alarm Display and Contents

Alarm Display		Inverter Status	Explanation	Causes and Corrective Actions
Digital Operator	Run (Green) Alarm (Red)			
Uu Blinking	☼	WARNING Fault contacts do not change state.	UV (Main circuit low voltage) Main circuit DC voltage drops below the low-voltage detection level while the inverter output is OFF 200V: Stops at DC Bus voltage below approx. 200V (160V for single-phase) 400V: Stops at DC Bus voltage below approx. 400V	Check the following: • Power supply voltage • Main circuit power supply wiring is connected • Terminal screws are securely tightened
ov Blinking	☼		OV (Main circuit over voltage) DC Bus voltage exceeds the overvoltage detection level while the inverter output is OFF. Detection level: 230 V class approx. 410V or 460V class approx. 820 VDC)	Check the power supply voltage Increase the decel time
oH Blinking			OH (Cooling fin overheat) Intake air temperature rises while the inverter output is OFF.	Check the intake air temperature.
oH3 Blinking			OH3 (Inverter overheating pre-alarm)* signal is input	Release the input of inverter overheating pre-alarm signal.
CAL Blinking			CAL (MODBUS communications waiting) Correct data has not been received from the PLC when the constants n003 (operation command selection) is 2 or n004 (frequency reference selection) is 6, and power is turned ON.	Check communication devices and transmission signals.

*Display only applies to 200/400V class. 7.5/10Hp (5.5/7.5 kW) inverters.

Alarm Display		Inverter Status	Explanation	Causes and Corrective Actions
Digital Operator	Run (Green) Alarm (Red)			
oP□ Blinking	*uU* 	**WARNING** Fault contacts do not change state.	OP□ (Constant setting error when the constant setting is performed through the MODBUS communications. OP1: Two or more values are set for multi-function input selection. (constants n050 to 056) OP2: Relationship among V/f constants is not correct. (constants n011, n013, n014, n016) OP3: Setting value of electronic thermal standard current exceeds 150% of inverter rated current. (constant n036) OP4: Upper/lower limit of frequency reference is reversed. (constants n033, n034) OP5: (constants n083 to n085)	Check the setting values.
oL 3 Blinking			OL 3 (Overtorque detection) Motor current exceeded the preset value in constant n098.	Reduce the load, and expand the accel/decel time.
SEr Blinking			SER (Sequence error) Inverter receives LOCAL/REMOTE select command or communications/ control circuit terminal changing signals from the multi-function terminal while the inverter is outputting.	Check the external circuit (sequence).

Alarm Display		Inverter Status	Explanation	Causes and Corrective Actions
Digital Operator	Run (Green) Alarm (Red)			
bb Blinking		**WARNING** Fault contacts do not change state.	BB (External baseblock) Baseblock command at multi-function terminal is active, the inverter output is shut OFF (motor coasting). Temporary condition is cleared when input command is removed.	Check the external circuit (sequence)
EF Blinking			EF (Simultaneous FWD/REV run commands) When FWD and REV run commands are simultaneously input for over 500ms, the inverter stops according to constant n005.	Check the external circuit (sequence)
STP Blinking	or		STP (Operator function stop) STOP RESET is pressed during running by the control circuit terminals FWD/REV command. The inverter stops according to constant n005. STP (Emergency stop) Inverter receives emergency stop alarm signal. Inverter stops according to constant n005.	Open FWD/REV command of control circuit terminals Check the external circuit (sequence)
FAn Blinking			FAN (Cooling fan fault) Cooling fan is locked.	Check the following: • Cooling fan • Cooling fan wiring is not connected
CE Blinking			CE (MEMOBUS) communications fault	Check the communication devices or communication signals
FbL Blinking			FBL (PID feedback loss detection) PID feedback value drops below the detection level. When PID feedback loss is detected, the inverter operates according to the n136 setting.	Check the mechanical system and correct the cause, or increase the value of n137
bUS Blinking			Option card communications fault. Communication fault has occurred in a mode that run command and frequency reference are set from the communication option card.	Check the communication devices or communication signals.

Fault Display		Inverter Status	Explanation	Causes and Corrective Actions
Digital Operator	Run (Green) Alarm (Red)			
oC	☼	Protective Operation Output is shut OFF and motor coasts to a stop.	OC (Overcurrent) Inverter output current momentarily exceeds approx. 250% of rated current.	• Short circuit or grounding at inverter output side • Excessive load GD^2 • Extremely rapid accel/decel time (constants n019 to n022) • Special motor used • Starting motor during coasting • Motor of a capacity greater than the inverter rating has been started • Magnetic contactor open/closed at the inverter output side
SC			Load Short-circuit)* The Inverter output or load was short circuited.	A short circuit or ground fault. ⇩ Reset the fault correcting its cause.
GF			(Ground Fault)* The ground fault current at the Inverter output exceeded approximately 50% of the Inverter rated output current.	A ground fault occurred at the Inverter output. ⇩ Reset the fault after correcting its cause.
ov			OV (Main circuit overvoltage) Main circuit DC voltage exceeds the overvoltage detection level because of excessive regenerative energy from the motor. Detection level: 230V: Stops at DC Bus voltage below approx. 410V 460V: Stops at DC Bus voltage approx. 820V or more	• Insufficient decel time (constants n020 and n022) • Lowering of minus load (elevator, etc) ⇩ • Increase decel time • Connect optional braking resistor
Uu1			UV1 (Main circuit low voltage) Main circuit DC voltage drops below the low-voltage detection level while the inverter output is ON. 230V: Stops at DC Bus voltage below approx. 200V (160V for single-phase) 460V: Stops at DC Bus voltage approx. 400V or more	• Reduction of input power supply voltage • Open phase of input supply • Occurrence of momentary power loss ⇩ Check the following: • Power supply voltage • Main circuit power supply wiring is connected • Terminal screws are securely tightened

*Display only applies to 200/400V class, 7.5/10Hp, 5.5/7.5kW inverters.

Fault Display		Inverter Status	Explanation	Causes and Corrective Actions
Digital Operator	Run (Green) Alarm (Red)			
Uu2			UV2 (Control power supply fault) Voltage fault of control power supply is detected.	Cycle power. If the fault remains, replace the inverter.
PF	●		(Main Circuit Voltage Fault)* The main circuit DC voltage oscillates unusually (not when regenerating).	• An open-phase occurred in the input power supply. • A momentary power oss occurred. • The voltage fluctuations in the input power supply are too large. • The line voltage balance is bad. ⇩ • Check the following: Main circuit power supply wiring is connected. • Power supply voltage • Terminal screws are securely tightened.
LF	☼	Protective Operation Output is shut OFF and motor coasts to a stop.	(Output Open-Phase)* An open-phase occurred at the Inverter output	• There is a broken wire in the output cable. • There is a broken wire in the motor winding. • The output terminals are loose. ⇩ • Output wiring is connected. • Motor impedance. • Output terminal screws are securely tightened.
oH			OH (Cooling fin overheat) Temperature rise because of inverter overload operation or intake air temperature rise.	• Excessive load. • Improper V/f pattern setting. • Insufficient accel time if the fault occurs during acceleration. • Intake air temperature exceeding 122ºF (50ºC). ⇩ Check the following: • Load size. • V/f pattern setting (constants n011 to • n017). Intake air temperature.

*Display only applies to 200/400V class, 7.5/10Hp, 5.5/7.5kW inverters.

Fault Display		Inverter Status	Explanation	Causes and Corrective Actions
Digital Operator	Run (Green) Alarm (Red)			
rH	● ☼	Protective Operation Output is shut OFF and motor coasts to a stop.	RH (Installed type braking resistor overheating) The protection function has operated.	• The declaration time is too short. • The regenerative energy from the motor is too large. • Increase the deceleration time. • Reduce the regenerative load.
rr			(Internal Braking Transistor Fault) The braking transistor is not operating properly.	• Replace the Inverter
oL 1			OL1 (Motor overload) Motor overload protection operates by built-in electronic thermal overload relay.	• Check the load size or V/f pattern setting (constants n011 to n017) • Set the motor rated current shown on the nameplate by constant n036
oL 2			OL2 (Inverter overload) Inverter overload protection operates by built-in electronic thermal overload relay.	• Check the load size or V/f pattern setting (constants n011 to n017) • Check the inverter capacity
oL 3			OL3 (Overtorque detection) V/f Mode: Inverter output current exceeded the preset value in constant n098. Vector Mode: Motor current or torque exceeded the preset value in constants n097 and n098 When overtorque is detected, inverter performs operation according to the preset setting of constant n096.	Check the driven machine and correct the cause of the fault, or increase the value of constant n098 up to the highest value allowed for the machine.

Fault Display		Inverter Status	Explanation	Causes and Corrective Actions
Digital Operator	Run (Green) Alarm (Red)			
EF □	● ☼	Protective Operation Output is shut OFF and motor coasts to a stop	EF □ (External fault) Inverter receives an external fault input from control circuit terminal. EF0: External fault reference through MEMOBUS communications EF1: External fault input command from control circuit terminal S1 EF2: External fault input command from control circuit terminal S2 EF3: External fault input command from control circuit terminal S3 EF4: External fault input command from control circuit terminal S4 EF5: External fault input command from control circuit terminal S5 EF6: External fault input command from control circuit terminal S6 EF7: External fault input command from control circuit terminal S7	Check the external circuit (sequence).
F00			CPF-00 Inverter cannot communicate with the digital operator for 5 sec. or more when power is turned ON.	Cycle power after checking the digital operator is securely mounted. If the fault remains, replace the digital operator or inverter.
F01			CPF-01 Transmission fault occurred for 5 sec. or more when transmission starts with the digital operator.	Cycle power after checking the digital operator is securely mounted. If the faults remains, replace the digital operator or inverter.
F04			CPF-04 EEPROM fault of inverter control circuit is detected.	• Record all constant data and initialize the constants. (refer to page 4-10 for constant initialization). • Cycle power. If the fault remains, replace the inverter.

Fault Display		Inverter Status	Explanation	Causes and Corrective Actions
Digital Operator	Run (Green) Alarm (Red)			
F0 5	● ☼	Protective Operation Output is shut OFF and motor coasts to a stop	CPF-05 AD converter fault is detected.	Cycle power. If the fault remains, replace the inverter.
F0 6			CPF-06 Option card connecting fault.	Remove power to the inverter. Check the connection of the digital operator.
F0 7			CPF-07 Operator control circuit (EEPROM or AD converter) fault.	Cycle power after checking the digital operator is securely mounted. If the fault remains, replace the digital operator or inverter.
F21			Communication option card self diagnostic error	Option Card fault Replace the option card
F22			Communication option card model code error	
F23			Communication option card DPRAM error	
oPR			OPR (operator connecting fault)	Cycle power. If the fault remains, replace the inverter.
CE			CE (MODBUS communications fault)	Check the communication devices or communication signals.

Fault Display		Inverter Status	Explanation	Causes and Corrective Actions
Digital Operator	Run (Green) Alarm (Red)			
STP		Stops according to constants	STP (Emergency Stop) The inverter stops according to constant n005 after receiving the emergency stop fault signal.	Check the external circuit (sequence).
FbL			FBL (PID feedback loss detection) PID feedback value drops below the detection level. When PID feedback loss is detected, the inverter operates according to the n136 setting.	Check the mechanical system and correct the cause, or increase the value of n137.
bUS			Option card communications fault. Communication fault has occurred in a mode that run command and frequency reference are set from the communication option card.	Check the communications devices or communication signals.
OFF			• Insufficient power supply voltage • Control power supply fault Hardware fault	Check the following: • Power supply voltage • Main circuit power supply wiring is • connected Terminal screws are • securely tightened Control sequence Replace the inverter

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Appendix A:
Parameter List

This Appendix provides a complete listing of the program parameters.

FIRST FUNCTIONS (n001 to n049)

No.	Name	Description	Factory Setting	User Setting	Ref. Page
001	Password Parameter Selection /Inialization	0: Parameter n001 set/read, (parameter n002 ~ n179) read only. (FREF of the operator can be set). 1: 1st function (parameters n001 ~ n049) can be set/read. 2: 1st and 2nd functions (parameters n001 ~ n079) can be set/read. 3: 1st, 2nd and 3rd functions (parameters n001 ~ n119) can be set/read. 4: 1st, 2nd, 3rd and 4th functions (parameters n001 ~ n179) can be set/read. 6: Clear fault history 8: 2-wire initialization (Japanese specs) 9: 3-wire initialization (Japanese specs) 10: 2-wire initialization (American specs) 11: 3-wire initialization (American specs)	1		4-10
002	Control mode selection	0: V/f control 1: Voltage vector control	0 *1		4-12
003	Run command selection	0: Operator 1: Control circuit terminal 2: Communication	0		4-20
004	Select frequency reference	0: Potentiometer on digital keypad 1: Frequency reference 1 (n024) 2: Control circuit terminal (voltage 0 - 10 V) 3: Control circuit terminal (current 4 - 20 mA) 4: Control circuit terminal (current 0 - 20 mA) 5: Pulse input 6: Communication (register number 0002H) 7: Voltage reference from digital operator circuit terminal (0-10) (CN2) 8: Current reference from digital operator circuit terminal (4-20mA) (CN2) 9: Communication card (optional)	0 *5		4-7
005	Stopping method selection	0: Decel to stop 1: Coast to stop	0		4-25
006	Reverse run stop	0: Reverse run enabled 1: Reverse run disabled	0		4-26
007	Stop key enable/ disable selection	0: Stop key enabled 1: Stop key is enabled only when run command is selected to the operator.	0		

No.	Name	Description	Factory Setting	User Setting	Ref. Page
008	Frequency reference selection at local mode	0: Volume - (digital operator poteniometer) 1: Frequency reference selection (n024)	0		4-8
009	Frequency reference setting method selection	0: Frequency reference setting by the operator is enabled with the ENTER key. 1: Frequency reference setting by the operator increment/decrement key only. ENTER key is not required.	0		4-8
010	Operator connection fault detection selection	0: Operator connection fault detection disabled 1: Operator connection fault detection enabled	0		4-26
011	Max output frequecy	Setting unit : 0.1Hz Setting range : 50 ~ 400Hz	60Hz		4-15
012	Max. voltage	Setting unit : 0.1V Setting range : 0.1 ~ 255V	230V *2		
013	Max. voltage output frequency	Setting unit : 0.1Hz Setting range : 0.2 ~ 400Hz	60Hz		
014	Mid output frequency	Setting unit : 0.1Hz Setting range : 0.1 ~ 399.9Hz	1.5Hz *3		
015	Mid output frequency voltage	Setting unit : 0.1V Setting range : 0.1 ~ 255V	12V *2 *3		
016	Min. output frequency	Setting unit : 0.1Hz Setting range : 0.1 ~ 10Hz	1.5Hz *3		
017	Min. output frequency voltage	Setting unit : 0.1V Setting range : 0.1 ~ 50V	12V *2 *3		
018	Accel/decel time setting unit	0: 0.1s unit 1: 0.01s unit	0		4-27
019	Acceleration time 1	Setting unit: Depends on parameter n018 setting Setting range: 0.00 ~ 6000s	10s		4-27
020	Deceleration time 1	Setting unit: Depends on parameter n018 setting Setting range: 0.00 ~ 6000s	10s		
021	Acceleration time 2	Setting unit: Depends on parameter n018 setting Setting range: 0.00 ~ 6000s	10s		
022	Deceleration time 2	Setting unit: Depends on parameter n018 setting Setting range: 0.00 ~ 6000s	10s		
023	S-curve time selection	0: No S-curves 1: 0.2s 2: 0.5s 3: 1.0s	0		4-28

No.	Name	Description	Factory Setting	User Setting	Ref. Page
024	Frequency reference 1 (Master speed frequency reference)	Setting unit : 0.01Hz (less than 100Hz), : 0.1Hz (100Hz or greater) Setting range : 0.00 ~ 400Hz	6Hz		4-29
025	Frequency reference 2	Setting unit : 0.01Hz (less than 100Hz), : 0.1Hz (100Hz or greater) Setting range : 0.00 ~ 400Hz	0.00Hz		
026	Frequency reference 3	Setting unit : 0.01Hz (less than 100Hz), : 0.1Hz (100Hz or greater) Setting range : 0.00 ~ 400Hz	0.00Hz		
027	Frequency reference 4	Setting unit : 0.01Hz (less than 100Hz), : 0.1Hz (100Hz or greater) Setting range : 0.00 ~ 400Hz	0.00Hz		
028	Frequency reference 5	Setting unit : 0.01Hz (less than 100Hz), : 0.1Hz (100Hz or greater) Setting range : 0.00 ~ 400Hz	0.00Hz		
029	Frequency reference 6	Setting unit : 0.01Hz (less than 100Hz), : 0.1Hz (100Hz or greater) Setting range : 0.00 ~ 400Hz	0.00Hz		
030	Frequency reference 7	Setting unit : 0.01Hz (less than 100Hz), : 0.1Hz (100Hz or greater) Setting range : 0.00 ~ 400Hz	0.00Hz		
031	Frequency reference 8	Setting unit : 0.01Hz (less than 100Hz), : 0.1Hz (100Hz or greater) Setting range : 0.00 ~ 400Hz	0.00Hz		
032	Jog frequency reference	Setting unit : 0.01Hz (less than 100Hz), : 0.1Hz (100Hz or greater) Setting range : 0.00 ~ 400Hz	6Hz		4-30
033	Frequency reference upper limit value	Setting unit : 1% Setting range : 0~ 110%	100%		4-31
034	Frequency reference lower limit value	Setting unit : 1% Setting range : 0 ~ 110%	0%		
035	Frequency reference unit selection	0: 0.01 Hz 1: 0.1 % unit 40 to 3999: Custom units	0		4-32

No.	Function Name	Description	Factory Setting	User Setting	Ref. Page
036	Motor rated current	Setting unit : 0.1A Setting range : 0 ~ 150% of inverter rated output current **NOTE**: If set to 0.0A, then electronic motor overload is disabled.	Depends on kVA *3		4-33
037	Electronic motor overload protection selection	0: Standard motor application 1: Specialized motor application 2: No electronic motor overload protection	0		
038	Electronic motor overload protection time	Setting unit : 1 min. Setting range : 1 ~ 60 min.	8 min.		
039	Cooling fan operation	0: Operates only during run 1: Operates when power is ON	0		4-36
040 to 049	(RESERVED)				

SECOND FUNCTIONS (n050 to n079)

No.	Name	Description	Factory Setting	User Setting	Ref. Page
050	Multi function input (Terminal S1)	0: FWD/REV run (3-wire sequence) 1: Forward run reference (2-wire sequence) 2: Reverse run reference (2-wire sequence) 3: External fault (N.O. contact input) 4: External fault (N.C. contact input) 5: Fault reset 6: Multi speed reference 1 7: Multi speed reference 2 8: Multi speed reference 3 9: Multi speed reference 4 10: Jog command 11: Accel/decel time switchover 12: External baseblock (N.O. contact input) 13: External baseblock (N.C. contact input) 14: Speed search from max. output frequency 15: Speed search from set frequency 16: Accel/decel hold 17: Local/Remote switchover 18: Communication/control circuit terminal switchover 19: Emergency stop fault (N.O. contact input) 20: Emergency stop alarm (N.O. contact input) 21: Emergency stop fault (N.C. contact input) 22: Emergency stop alarm (N.C. contact input) 23: PID control cancel (ON: PID control disabled) 24: PID control integral reset (ON: Integral reset) 25: PID control hold (ON: Ingral hold) 26: Inverter overheat prediction (0H3) *7 34: UP/DOWN command *10 35: Self-test	1		4-37
051	Multi function input selection 2 (Terminal S2)	Same as parameter 50	2		
052	Multi function input selection 3 (Terminal S3)	0: Forward/reverse command (3-wire sequence) Others are the same as parameter 50.	3		
053	Multi function input selection 4 (Terminal S4)	Same as parameter 50	5		
054	Multi function input selection 5 (Terminal S5)	Same as parameter 50	6		
055	Multi function input selection 6 (Terminal S6)	Same as parameter 50	7		
056	Multi function input selection 7 (Terminal S7)	Sames as parameter 50 34: Up/down reference 35: Self-test (NOTE: valid at power ON/OFF)	10 *10		

No.	Name	Description	Factory Setting	User Setting	Ref. Page
057	Multi function output selection 1 (contact output terminal MA-MB-MC)	0: Fault 1: During run 2: Frequency agree 3: During 0 speed 4: Frequency detection (detection level or greater) 5: Frequency detection (detection level or less) 6: During overtorque detection (N.O. contact output) 7: During overtorque detection (N.C. contact output) 10: Minor fault (during alarm) 11: During baseblock 12: Local mode 13: Inverter run ready 14: During fault retry 15: During UV 16: During reverse 17: During speed search 18: Command through communication 19: During PID feedback loss 20: Frequency reference is missing *7 21: Inverter overheat prediction (0H3) *7	0		4-39
058	Multi function output selection 2 (open collector output terminal P1-PC)	Same as parameter 57	1		
059	Multi function output selection 3 (open collector output terminal P2-PC)	Same as parameter 57	2		
060	Analog frequency reference gain (Control terminal FR input)	Setting unit : 1% Setting range : 0 ~ 255%	100%		4-41
061	Analog frequency reference bias (Control terminal FR input)	Setting unit : 1% Setting range : -100% ~ 100%	0%		
062	Analog frequency reference filter time constant (Control terminal FR input)	Setting unit : 0.01s Setting range : 0.00 ~ 2s NOTE: When 0.00s is set, filter is disabled.	0.10s		
064	Operation select for frequency reference loss	Setting unit : 1 Setting range : 0.1	0		
065	Monitor output type selection	0: Analog monitor output 1: Pulse monitor output	0		4-43

No.	Name	Description	Factory Setting	User Setting	Ref. Page
066	Monitor item selection	0: Output frequency (10V / Max. output frequency 1: Output current (10V / Inverter rated current) 2: DC bus voltage (10V / 400 Vdc [800Vdc]) 3: Torque monitor (10V / Inverter capacity kW) 4: Output power (10V / Inverter capacity kW) Note: Enable only when n065 = 0 (analog monitor output) selection [ ] is for 400V class.	0		4-44
067	Monitor gain	Setting unit : 0.01 Setting range : 0.01 ~ 2	1		4-45
068	Analog frequency gain (CN2)	Setting unit : 1% Setting range : -255 ~ 255%	100%		
069	Analog frequency bias (voltage ref input) (CN2)	Setting unit : 1% Setting range : -100 ~ 100%	0%		
070	Analog frequency reference filter time con-stant(voltage ref input) (CN2)	Setting unit : 0.1s Setting range : 0.00 ~ 2.00s Note: When 0.00s is set, filter is disabled.	0.10s		
071	Analog frequency gain (current ref input) (CN2)	Setting unit : 1% Setting range : -255 ~ 255%	100%		
072	Analog frequency bias (current ref input) (CN2)	Setting unit : 1% Setting range : -100 ~ 100%	0%		
073	Analog frequency reference filter time constant (current ref input) (CN2)	Setting unit : 0.01s Setting range : 0.00 ~ 2.00s Note: When 0.00s is set, filter is disabled.	0.10s		
074	Pulse string frequency referency gain (RP)	Setting unit : 1% Setting range : 0 ~ 255%	100%		
075	Pulse string frequency reference bias (RP)	Setting unit : 1% Setting range : -100 ~ 100%	0%		
076	Pulse string frequency reference filter time constant (RP)	Setting unit : 0.01s Setting range : 0.00 ~ 2.00s Note: When 0.00s is set, filter is disabled	0.10s		
077	Multi-function analog input selection (CN2)	0: Multi-function analog input disabled 1: Aux. frequency reference 2: Frequency gain 3: Frequency bias 4: Voltage bias			4-46
078	Multi-function analog input signal selection	0: 0 ~ 10 V (operator terminal) (CN2) 1: 4 ~ 20 mA (operator terminal) (CN2)			4-47
079	Multi-function analog frequency bias setting	Setting unit : 0.1% Setting range : 0 ~ 50%	10%		4-47

THIRD FUNCTIONS (n080 to n119)

No.	Name	Description	Factory Setting	User Setting	Ref. Page
080	Carrier frequency	Set value : 1 ~ 4 carrier frequency = set value x 2.5kHz Set value : Synchronized carrier 7 ~ 9 lower limit 1kHz and upper limit 2.5kHz	4 *4		4-48
081	Momentary power loss selection	0: Momentary power loss ridethrough disabled 1: Momentary power loss ridethrough enabled within momentary power ridethrough time 2: Momentary power loss enabled at all time. No fault output at UV1	0		4-50
082	Auto fault reset	Setting unit : 1 time Setting range : 0 ~ 10 times	0		
083	Jump frequency 1	Setting unit : 0.1Hz (less than 100Hz), 0.1Hz (100Hz or greater Setting range : 0.00 ~ 400Hz Note: If 0.00Hz is set, jump frequency 1 is disabled	0.00Hz		4-51
084	Jump frequency 2	Setting unit : 0.01Hz (less than 100Hz), 0.1Hz (100Hz or greater) Setting range : 0.00 ~ 400Hz Note: If 0.00Hz is set, jump frequency 2 is disabled	0.00Hz		
085	Jump frequency 3	Setting unit : 0.01Hz (less than 100Hz), 0.1Hz (100Hz or greater) Setting range : 0.00 ~ 400Hz Note: If 0.00Hz is set, jump frequency 3 is disabled	0.00Hz		
086	Jump frequency width	Setting unit : 0.01Hz Setting range : 0.00 ~ 25.5Hz Note: If 0.00Hz is set, jump frequencies 1~3 are disabled	0.00Hz		
087	Cumulative operation time selection	Setting unit : 1 Setting range : 0.1	0		
088	Cumulative operation	Setting unit : 1=10H Setting range : 0 ~ 6550	0H		
089	DC braking current	Setting unit : 1% Setting range : 0 ~ 100% Note: If 0% is set, baseblock is performed	50%		4-52

No.	Name	Description	Factory Setting	User Setting	Ref. Page
090	DC braking time at stop	Setting unit : 0.1s Setting range : 0.0 ~ 25.5s NOTE: If 0.0s is set, this function will not operate	0.5s		4-52
091	DC braking time at start	Setting unit : 0.1s Setting range : 0.0 ~ 25.5s NOTE: If 0.0s is set, this function will not operate	0.0s		
092	Stall prevention selection during deceleration	0: Stall prevention is enabled during deceleration 1: Stall prevention function is disabled during deceleration	0		4-53
093	Stall prevention operation level during acceleration	Setting unit : 1% Setting range : 30 ~ 200% NOTE: If set at 200%, this function is disabled. The operation level is automatically reduced in the voltage saturation range.	170%		4-53
094	Stall prevention operation level during run	Setting unit : 1% Setting range : 30 ~ 200% NOTE: If set at 200%, this function is disabled	160%		4-54
095	Frequency detection level	Setting unit : 0.01Hz (less than 100Hz), 0.1Hz (100Hz or greater Setting range : 0.00 ~ 400Hz	0.00Hz		4-56
096	Overtorque detection selection 1	0: Overtorque detection disabled 1: Detects only at speed agree, operation continues after detection (minor fault) 2: Detects only at speed agree, output is shut down after detection (major fault) 3: Detects during run, operation continues after detection (minor fault) 4: Detects during run, output is shut down after detection (major fault)	0		4-57
097	Overtorque detection selection 2 (vector control mode)	0: Detects overtorque by torque reference 1: Detects overtorque by output current	0 *11		
098	Overtorque detection level	Setting unit : 1% Setting range : 30 ~ 200%	160%		
099	Overtorque detection time	Setting unit : 0.1s Setting range : 0.1 ~ 10s	0.1s		

No.	Function Name	Description	Factory Setting	User Setting	Ref. Page
100	Hold output frequency store selection	0: No hold output frequency is stored 1: Hold output frequency is stored	0		4-59
101	Speed search detection time	Setting Unit : 01s Setting Range : 0.0 - 10.0	2.0s *9		4-38
102	Speed search operation level	Setting Unit : 1% Setting Range : 0 - 200%	150% *9		4-38
103	Torque compensation gain	Setting unit : 0.1s Setting range : 0.0 ~ 2.5s	1.0		4-18
104	Torque compensation time constant	Setting unit : 0.1s Setting range : 0.0 ~ 25.5s Note: When 0.0s is set, the primary delay filter is disabled.	0.3s *10		4-13
105	Torque compensation iron loss (V/f control mode)	Setting unit : 0.1W (less than 1000W), 1W (1000W or greater) Setting range : 0.0 ~ 6550W	*5 *11		4-13
106	Motor rated slip	Setting unit : 0.1Hz Setting range : 0.0 ~ 20Hz	*5		4-12
107	Motor terminal resistance	Setting unit : 0.001Ω (less than 10Ω), 0.01Ω (10Ω or greater) Setting range : 0.000 ~ 65.5Ω Note: Terminal resistance/2 is set	*5		4-12
108	Motor leakage inductance (vector control mode)	Setting unit : 0.01mH (less than 100mH), 0.1mH (100mH or greater) Setting range : 0.00 ~ 655mH	*5		
109	Torque limiter (vector control mode)	Setting unit : 1% Setting range : 0 ~ 250%	150%		-
110	Motor no-load current	Setting unit : 1% Setting range : 0 ~ 99%	*5		4-12 A-17
111	Slip compensation gain	Setting unit : 0.1 Setting range : 0.0 ~ 12.5	0.0 *3		4-13
112	Slip compensation delay time	Setting unit : 0.1s setting range : 0.0 ~ 25.5s Note: When 0.0s is set, primary delay filter is applied by control mode.	2s *3		
113	Slip compensation during regeneration operation (vector control mode)	0: Slip compensation is disabled during regeneration operation 1: Slip compensation is enabled during regereration operation	0		-
115	Stall prevention above base speed during run	0: Disabled (level is based on setting of n094) 1: Enabled (level at Fmax is n094 x 0.4)	0		4-62
116	Accel/Decel time selection during stall prevention	0: Follows accel/decel #1 (n019, n010) or accel/decel #2 (n021, n022) Note: Multi-function selectable 1: Follows accel/decel #2 (n021, n022) always.	0		4-63

FOURTH FUNCTIONS (n120 to n179)

No.	Name	Description	Factory Setting	User Setting	Ref. Page
120	Frequency reference 9	Setting unit : 0.01Hz (less than 100Hz 0.1Hz (100Hz or greater) Setting range : 0.00 ~ 400Hz	0.00Hz		4-29
121	Frequency reference 10	Setting unit : 0.01Hz (less than 100Hz 0.1Hz (100Hz or greater) Setting range : 0.00 ~ 400Hz	0.00Hz		
122	Frequency reference 11	Setting unit : 0.01Hz (less than 100Hz 0.1Hz (100Hz or greater) Setting range : 0.00 ~ 400Hz	0.00Hz		
123	Frequency reference 12	Setting unit : 0.01Hz (less than 100Hz) 0.1Hz (100Hz or greater) Setting range : 0.00 ~ 400Hz	0.00Hz		
124	Frequency reference 13	Setting unit : 0.01Hz (less than 100Hz) 0.1Hz (100Hz or greater) Setting range : 0.00 ~ 400Hz	0.00Hz		
125	Frequency reference 14	Setting unit : 0.01Hz (less than 100Hz) 0.1Hz (100Hz or greater) Setting range : 0.00 ~ 400Hz	0.00Hz		
126	Frequency reference 15	Setting unit : 0.01Hz (less than 100Hz) 0.1Hz (100Hz or greater) Setting range : 0.00 ~ 400Hz	0.00Hz		
127	Frequency reference 16	Setting unit : 0.01Hz (less than 100Hz) 0.1Hz (100Hz or greater) Setting range : 0.00 ~ 400Hz	0.00Hz		
128	PID control selection	0: PID control disabled 1: PID control enabled 2: PID control enabled (Feedback value: Differential control) 3: PID control enabled (Frequency reference + PID output and deviation: Differential control) 4: PID control enabled (Frequency reference + PID output and feedback value: Differential control) 5: PID control enabled (Reverse acting) 6: PID control enabled (Feedback value: Differential control) 7: PID control enabled (Frequency reference + PID output and deviation: Differential control) 8: PID control enabled (Frequency reference + PID output feedback value: Differential control) values 5 ~ 8, PID output becomes inversed	0		4-64
129	PID feedback gain	Setting unit : 0.01 Setting range : 0.00 ~ 10.00	1.00		4-66

No.	Name	Description	Factory Setting	User Setting	Ref. Page
130	Proportional gain (P)	Setting unit: 0.1 Setting range: 0.0 ~ 25.0 Note: When 0.0 is set, P control is disabled.	1.0		4-66
131	Integral time (I)	Setting unit: 0.1s Setting range: 0.0 ~ 360.0 Note: When 0.0 is set, I control is disabled.	1.0		
132	Derivative time (D)	Setting unit: 0.01s Setting range: 0.00 ~ 2.50 Note: When 0.0 is set, D control is disabled.	0.00		
133	PID Offset adjustment	Setting unit: 1% Setting range: -100 ~ 100% (100% of Max. output frequency	0%		4-67
134	Integral (I) upper limit	Setting unit: 1% Setting range: -100 ~ 100% (100% of max. output frequency)	100%		4-67
135	PID output primary delay constant time	Setting unit: 0.1s Setting range: 0.0 ~ 10.0	0.0		4-68
136	PID feedback loss detection selection	0: PID feedback loss detection disabled 1: PID feedback loss detection enabled (operation continues : FbL alarm) 2: PID feedback loss detection enabled (Drive shuts down : FbL fault)	0		
137	PID feedback loss detection level	Setting unit: 1% Setting range: 0 ~ 100% (100% of Max. output frequency)	0%		
138	PID feedback loss detection time	Setting unit: 0.1s Setting range: 0.0 ~ 25.5	1.0		
139	Energy-saving control selection (V/f control mode)	0: Energy-saving control disabled 1: Energy-saving control enabled Note: Energy-saving control becomes enabled by V/f control mode.	0		4-71
140	Energy-saving coefficient K2	Setting unit: 0.1 Setting range: 0.0 ~ 6550 Note: For 1000 or greater : 1 unit	*4		
141	Energy-saving voltage lower limit (at 60 Hz)	Setting unit: 1% Setting range: 0 ~ 120%	50%		4-73
142	Energy-saving voltage low limiter (at 6 Hz)	Setting unit: 1% Setting range: 0 ~ 25%	12%		

No.	Name	Description	Factory Setting	User Setting	Ref. Page
143	Power supply average time	Setting unit : 1 = 24ms Setting range : 1 ~ 200 Note: Common with search operation control period	1 (24ms)		4-73
144	Search operation voltage limiter	Setting unit : 1% Setting range : 1 ~ 100%	0%		
145	Search operation voltage step (at 100%)	Setting unit : 0.1% Setting range : 0.1 ~ 10.0%	0.5%		
146	Search operation voltage step (at 5%)	Setting unit : 0.1% Setting range : 0.1 ~ 10.05	0.2%		
147	Motor rated voltage	Setting unit : 0.1V Setting range : 150.0 ~ 255.0V*3	230.0V *3		-
149	Pulse input scaling *15	Setting unit : 1 = 10 Hz Setting range : 100 ~ 3300 (1 ~ 33kHz)	2500 (25kHz) *1		4-75
150	Pulse monitor output frequency selection	0: 1440 Hz / Max. output frequency 1: 1f output 6: 6f output 12: 12f output 24: 24f output 36: 36f output	0		
151	Timeover detection selection	0: Timeover detection enabled (coast-to-stop) 1: Timeover detection enabled (deceleration stop by declaration time 1) 2: Timeover detection enabled (deceleration stop by declaration time 2) 3: Timeover detection enabled (operation continues, displays alarm) 4: Timeover detection disabled	0		4-76
152	Frequency reference and frequency monitor unit selection by communication	0: 0.1Hz / 1 1: 0.01Hz / 1 2: 100% / 30000 3: 0.1% / 1	0		
153	Slave address	Setting unit : 1 Setting range : 0 ~ 32	0		
154	Baud rate selection	0: 2400 bps 1: 4800 bps 2: 9600 bps 3: 19200 bps	2		
155	Parity selection	0: Even parity 1: Odd parity 2: No parity	0 *1		

No.	Name	Description	Factory Setting	User Setting	Ref. Page
156	Communications waiting time	Setting unit : 1 = 1ms Setting range : 0 ~ 65ms	10ms		4-76
157	RTS control	0: RTS control enabled 1: RTS control disabled	0		
158	Motor code	Setting unit : 1 Setting range : 0 ~ 70	*4		4-72
159	Energy-saving voltage upper limit (at 60Hz)	Setting unit : 1% Setting range : 0 ~ 120%	120%		4-73
160	Energy saving voltage upper limit (at 6Hz)	Setting unit : 1% Setting range : 0 ~ 25%	16%		4-73
161	Search operation power supply detection hold width	Setting unit : 1% Setting range : 0 ~ 100% Note: When 05 is set, it functions by 10% of initial value	10%		4-92
162	Power detection filter time constant	Setting unit : 1 = 4 ms Setting range : 0 ~ 255 Note: When 05 is set, it functions by initial value 5 (20 ms)	5 (20 ms)		
163	PID output gain	Setting unit : 0.1 Setting range 0.0 ~ 25.0	1.0		4-68
164	PID feedback selection	0: Control circuit terminal FR (Voltage 0 - 10V) 1: Control circuit terminal FR (Current 4 -20 mA) 2: Control circuit terminal FR (Current 0 - 20 mA) 3: Operator terminal (Voltage 0 - 10V) 4: Operator terminal (Current 4 - 20 mA) 5: Pulse input	0		4-64
165	Overheat protect select for installed braking resistor	Setting unit : 1 Setting range : 0.1	0		4-93
166	Input open-phase detection level	Setting unit : 1% Setting range : 0 to 100% *8	0%		-
167	Input open-phase detection time	Setting unit : 1 sec. Setting range : 0 to 25.5 sec. *8	0,s		-
168	Output open-phase detection level	Setting unit : 1% Setting range : 0 to 100% *8	0%		-
169	Input open-phase detection time	Setting unit : 0.1 sec. Setting range : 0 to 2.0 sec. *8	0.0,s		-
175	Carrier frequency reduction selection at low speed	0: Disabled 1: Enabled	0		-
176	Parameter copy function selection *16	rdy : READY status rEd : READ executes CPy : COPY executes vFy : VERIFY executes vA : Inverter capacity display Sno : Software No. display	rdy		4-93
177	Parameter read out prohibit selection *16	0: READ prohibited 1: READ allowed	0		4-93
178	Fault history	Four newest events are displayed Note: Setting is disabled	-		-
179	Software No.	Lower four digits of software numbers are displayed. Note: Setting is disabled	-		4-100

NOTE:

1. Not initialized by constant initialization.
2. Upper limit and initial setting of setting range are doubled at 400 class. 10.0 V for 200 V class, 7.5/10HP (5.5/7.5 kW) inverters, and 20.0 V for 7.5/10 HP (5.5/7.5 kw) inverters.
3. Changes depending on control mode. Refer to table below.
4. Changes depending on inverter capacity. Refer to page 4-49.
5. Initial setting of the model with operator JVOP-147 (without potentiometer) is 1. Setting can be set to 0 by constant initialization.
6. Setting 26 of n052 to n056 and setting 20, 21 of n057 to n059 only apply to 200/400 class, 7.5/10 HP (5.5/7.5 kW) inverters.
7. Constants only applies to 200/400 V class, 7.5/10 HP (5.5/7.5 kW) inverters.
8. Initial setting for 200/400 V class, 7.5/10 HP (5.5/7.5 kW) inverters is 1 (enabled).
9. When 34: UP/DOWN command is set to term. S7, term. S6 becomes the UP command, and term. S7 becomes the DOWN command.
10. Valid only in vector mode, when V/f control mode is selected, overtorque detection is enabled by current.

No.	Name	V / f control mode (n002 = 0)	Vector control mode (n002 = 1)
n014	Mid. output frequency	1.5 Hz	3.0 Hz
n015	Mid. output frequency voltage	12.0 V*†	11.0 V*
n016	Minimum output frequency	1.5 Hz	1.0 Hz
n017	Minimum output frequency voltage	12.0 V*†	4.3 V*
n104	Torque compensation time constant	0.3 s	0.2 s
n111	Slip compensation gain	0.0	1.0
n112	Slip compensation gain time constant	2.0 s	0.2 s

* Values are doubled with 400 V class.
† 10.0 V for 200 V class, 7.5/10 HP (5.5/7.5 kW) inverters.
20.0 V for 400 V class, 7.5/10 HP (5.5/7.5 kW) inverters.

n 200 V Class 3-Phase												
No.	**Name**	**Unit**	**Factory Setting**									
-	Inverter capacity	kW	0.1	0.2	0.4	0.75	1.5	2.2	-	3.7	5.5	7.5
n036	Motor rated current	A	0.6	1.1	1.9	3.3	6.2	8.5		14.1	19.6	26.6
n105	Torque compensation iron loss	W	1.7	3.4	4.2	6.5	11.1	11.8		19	28.8	43.9
n106	Motor rated slip	Hz	2.5	2.6	2.9	2.5	2.6	2.9		3.3	1.5	1.3
n107	Motor line-to-line resistance*	Ω	17.99	10.28	4.573	2.575	1.233	0.8		0.385	0.199	0.111
n108	Motor leak inductance	MH	110.4	56.08	42.21	19.07	13.4	9.81		6.34	4.22	2.65
n110	Motor no-load current	%	72	73	62	55	45	35		32	26	30
n 200 V Class Single-Phase												
No.	**Name**	**Unit**	**Factory Setting**									
-	Inverter capacity	kW	0.1	0.2	0.4	0.75	1.5	2.2	-	3.7	-	
n036	Motor rated current	A	0.6	1.1	1.9	3.3	6.2	8.5		14.1		
n105	Torque compensation iron loss	W	1.7	3.4	4.2	6.5	11.1	11.8		19		
n106	Motor rated slip	Hz	2.5	2.6	2.9	2.5	2.6	2.9		3.3		
n107	Motor line-to-line resistance*	Ω	17.99	10.28	4.573	2.575	1.233	0.8		0.385		
n108	Motor leak inductance	MH	110.4	56.08	42.21	19.07	13.4	9.81		6.34		
n110	Motor no-load current	%	72	72	62	55	45	35		32		
n 400 V Class 3-Phase												
No.	**Name**	**Unit**	**Factory Setting**									
-	Inverter capacity	kW	-	0.2	0.4	0.75	1.5	2.2	3.0	3.7	5.5	7.5
n036	Motor rated current	A	-	0.6	1.0	1.6	3.1	4.2	7.0	7.0	9.8	13.3
n105	Torque compensation iron loss	W	-	3.4	4.0	6.1	11.0	11.7	19.3	19.3	28.8	43.9
n106	Motor rated slip	Hz	-	2.5	2.7	2.6	2.5	3.0	3.2	3.2	1.5	1.3
n107	Motor line-to-line resistance*	Ω	-	41.97	19.08	11.22	5.044	3.244	1.514	1.514	0.797	0.443
n108	Motor leak inductance	MH	-	224.3	168.8	80.76	53.25	40.03	24.84	24.84	16.87	10.59
n110	Motor no-load current	%	-	72	63	52	45	35	33	33	26	30

*Values of motor line-to-line resistance are set to half of the standard value.
=Values between V/f and Vector control mode.

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Appendix B:
PID Set-up

PID SET-UP

The following technical note is written to assist in programming the PC7 drive to operate in PID mode**.**

- Set parameter n001=4. This allows reading and writing of all parameters in the drive. (assuming the drive has been initialized for the proper operation 2-wire or 3-wire control)
- Set n002=0. V/f control.
- Determine how the run command is given and set parameter n003 to proper mode. (keypad/terminal/serial)

Once the above programming has been set in the drive, then determine the setpoint and feedback inputs to the drive. Refer to the following table for assistance.

Set Point/Target Value n004	PID Feedback Setting n164
0: Digital operator potentiometer	0: 0-10 volt signal on terminal FR and FC
1: Value set on n024	1: 4-20 ma signal on terminal FR and FC
2: 0-10 volt signal on terminal FR and FC	2: 0-20 ma signal on terminal FR and FC
3: 4-20 ma signal on terminal FR and FC	3: 0-10 volt signal on CN2 connector on digital operator (Pins 1 and 3)
4: 0-20 ma signal on terminal FR and FC	4: 4-20 ma signal on CN2 connector on digital operator (Pins 2 and 3)
5: Pulse train input on terminal RP and FC	5: Pulse train input on terminals RP and FC
6: Serial communication	

NOTE:

a) When selecting terminal FR to be the set point or the feedback value, SW2 on the control board must be properly selected according to the input method (current or voltage).

b) When using a analog signal (current or voltage) which connects to the CN2 terminal on the digital operator as the set point or feedback value make sure that n077=0 (disable). For More information on the CN2 connector refer to TN_VFD_PC7039 at www.saftronics.com.

c) Do Not input a voltage to the FR terminal when SW2 is set to the I side.(May cause damage to the control card)

d) Determine the type of feedback signal supplied from the external transducer (0-10 volts or 4-20 ma) and the real world value that it represents in the system.
Example 0-100 PSI 0r 0-250 degrees, etc.

e) Set parameter n035(display units) to equal that maximum number, i.e. 100PSI or 250 degrees, etc.

f) If the maximum number of the transducer falls between 1 and 39, you will need to program n035 as the following: (Refer to page 4-32)

- Maximum number equals 10 then n035=1100. The digital operator will display 1.00 for the maximum value.
- Maximum number equals 1 then n035=2100. The digital operator will display 1.00 for the maximum value.
- Determine the type of PID action desired. Program n128 for the correct value. Refer to the following table for assistance.

n128 settings

Setting	Function	PID Action
0	Disable	Forward
1	Enabled: deviation is subject to differential control (normal acting PID mode)	
2	Enable: feedback signal is subject to differential control	
3	Enabled: frequency reference + PID control, and deviation are subject to differential control	
4	Enabled: frequency reference + PID control, and feedback signal are subject to differential control	
5	Enabled: deviation is subject to differential control (reverse PID mode)	Reverse
6	Enable: feedback signal is subject to differential control	
7	Enabled: frequency reference + PID control, and deviation are subject to differential control	
8	Enabled: frequency reference + PID control, and feedback signal are subject to differential control	

NOTE:

a) For most PID applications, a setting of 1 or 5 will be the only value to enter in parameter n128.

b) Setting 1: The output of the VFD will decrease as the feedback signal increases, i.e.: if trying to keep a certain pressure in a system. As pressure goes up so does the feedback signal, therefore the speed of the motor decreases to bring the pressure down (normal acting PID).

c) Setting 5: The output of the VFD will increase as the feedback signal increase, i.e.: trying to keep a certain temperature in a cooling tower. As temperature goes up so does the feedback signal therefore the speed of the motor must go up to maintain the temperature (reverse acting PID).

Adjustments

There are several parameters that can be adjusted to fine tune the system, but in most cases only two parameters are necessary to adjust to correct any response problems in the system.

1. n130 proportional gain. Adjusts the proportional error of the feedback signal. Default value is 1.0 and the setting range is 0.0 to 25.0. for a faster response increase the value and for a slower response decrease the value.

2. n131 integral time. Adjusts the integration rate of the feedback signal. Default value 1.0 with a range of 0.0 to 360.0. for a quicker response increase the value for a slower response decrease the value.

The Appendix will help in setting up the PID capabilities of the PC7 inverter. This technical note is intended to set up simple PID loops. If the application requires a more complex set up, please contact the technical support group at Saftronics at 1-941-693-7200.

Appendix C:
PC3 to PC7 Parameter Cross Reference

With the introduction of the PC7 to the market place, we have prepared a cross-reference sheet to assist in the transition from PC3 to PC7. This sheet should be used to quickly update your current programming parameters used in the PC3 to the New PC7 units.

PC3	PC7
N00 = Password	N001 = Constant Settings
N01 = Run/Ref Signal Selection	N003 = Operation Reference Selection N004 = Frequency Reference Selection N005 = Stopping Method Selection N008 = Frequency Reference in Local Mode N009 = Setting Method for Frequency Reference
N02 = Max Output Frequency	N011 = Max Output Frequency
N03 = Max Voltage	N012 = Max Voltage
N04 = Max Voltage Output Frequency	N013 = Max Voltage Output Frequency
N05 = Intermediate Output Frequency	N014 = Mid Output Frequency
N06 = Intermediate Output Frequency Voltage	N015 = Mid Output Frequency Voltage
N07 = Min Output Frequency	N016 = Min Output Frequency
N08 = Min Output Frequency Voltage	N017 = Min Output Frequency Voltage
N09 = Acceleration Time 1	N019 = Acceleration Time 1
N10 = Deceleration Time 1	N020 = Deceleration Time 1
N11 = Acceleration Time 2	N021 = Acceleration Time 2
N12 = Deceleration Time 2	N022 = Deceleration Time 2
N13 = Frequency Reference 1	N024 = Frequency Reference 1
N14 = Frequency Reference 2	N025 = Frequency Reference 2
N15 = Frequency Reference 3	N026 = Frequency Reference 3
N16 = Frequency Reference 4	N027 = Frequency Reference 4
N/A	N028 = Frequency Reference 5 N029 = Frequency Reference 6 N030 = Frequency Reference 7 N031 = Frequency Reference 8
N17= Jog Frequency Reference	N032 = Jog Frequency Reference
N18 = Motor Protection Selection	N037 = Electronic Thermal Motor Protection N038 = Electronic Motor O/L Protection Time N039 = Cooling Fan Operation Selection

PC3	PC7
N19 = Motor Rated Current	N036 = Motor Rated current
N20 = Run Signal Selection 2	N006 = Reverse Run Prohibit N092 = Stall Prevention During Deceleration
N21 = Output Monitor Selection/ S-Curve Selection	N066 = Output Monitor Selection N023 = S-Curve Selection Accel/Decel
N22 = Frequency Reference Gain	N060 = Analog Frequency Reference Gain N068 = Analog Frequency Reference Gain (operator voltage input) N071 = Analog Frequency Reference Gain (operator current input) N074 = Pulse String Frequency Reference Gain
N23 = Frequency Reference Bias	N061 = Analog Frequency Reference Bias N069 = Analog Frequency Reference Bias (operator voltage input) N072 = Analog Frequency Reference Bias (operator current input) N075 = Pulse String Frequency Reference Bias
N24 = Frequency Upper Limit	N033 = Frequency Reference Upper Limit
N25 = Frequency Lower Limit	N034 = Frequency Reference Lower Limit
N26 = DC Injection Braking Current	N089 = DC Injection Braking Current
N27 = DC Injection Time at Stop	N090 = DC Injection Braking Time at Stop
N28 = DC Injection Braking Time at Start	N091 = DC Injection Braking Time at Start
N29 = Automatic Torque Boost Gain	N103 = Torque Compensation Gain N104 = Time Constant at Torque Compensation
N30 = Stall Prevention Level While Running	N094 = Stall Prevention During Running
N31 = Stall Prevention Level During Acceleration	N093 = Stall Prevention During Accel
N32 = Multifunction Input 1 (Terminal 3)	N052 = Multifunction Input 3 (Terminal S3)
N33 = Multifunction Input 2 (Terminal 4)	N053 = Multifunction Input 4 (Terminal S4)
N34 = Multifunction Input 3 (Terminal 5)	N054 = Multifunction Input 5 (Terminal S5)
N/A	N055 = Multifunction Input 6 (Terminal S6) N056 = Multifunction Input 7 (Terminal S7)
N35 = Multifunction Analog Input Selection	N077 = Multifunction Analog input Selection N078 = Analog Input Signal Selection N079 = Analog Frequency Bias setting
N36 = Multifunction Output Selection (FLT-A,B,C)	N057 = Multifunction Output Selection (MA, B, C)
N37 = Multifunction Output Selection (Terminal 13)	N058 = Multifunction Output Selection (P1)
N38 = Multifunction Output Selection (Terminal 14)	N059 = Multifunction Output Selection (P2)

PC3	PC7
N39 = Frequency Detection Level	N095 = Frequency Detection Level
N40 = Overtorque Detection Function Selection	N096 = Overtorque Detection 1 N087 = Overtorque Detection 2 (vector mode only)
N41 = Overtorque Detection Level	N098 = Overtorque Detection level
N42 = Overtorque Detection Level (time)	N099 = Overtorque Detection Time
N43 = Carrier Frequency	N080 = Carrier Frequency
N44 = Not Used	N/A
N45 = Analog Monitor Gain	N065 = Monitor Output Selection N066 = Monitor Item Selection N067 = Monitor Gain
N46 = Operation After Momentary Power Loss	N081 = Operation After Momentary Power Loss
N47 = Fault Retry Selection	N082 = Fault Restart
N48 = Fault Record	N178 = Fault History
N49 = PROM No.	N179 = Software Version No.
N50 = Prohibited Frequency	N083 = Jump Frequency 1 N084 = Jump Frequency 2 N085 = Jump Frequency 3
N51 = Prohibited Width	N086 = Jump frequency Width
N52 through N59 Not Used	N/A

Appendix D

TYPES OF ENCLOSURES

The appendix contains brief description of various types of enclosure commonly used in the industry. Definitions of terminology, complete descriptions and test criteria are contained in National Electric Manufactures Association (NEMA) standards publication No. 250. A brief description of the International Electrotechnical Commission (IEC) enclosures requirements and how they compare to NEMA standards. Available enclosures types for Saftronics inverters, and the optional enclosures, are located in the Price Guide part #027-7007.

NOTE:

The design of NEMA type enclosure does not normally protect devices against condition such as condensation, icing, corrosion or contamination which may occur within the enclosures or enter via the conduit or unsealed openings. It is up to the end user to take the additional measures to safeguard against such conditions and satisfy all installation requirements for the equipments protection.

Nema 1	Enclosures are intended for use indoors, primarily to prevent accidental contact of personnel with the enclosed equipment in areas where unusual service conditions do not exist.
Nema 3	Enclosures are intended for outdoor use to provide a degree of protection against windblown dust, rain, sleet, and external ice formation.
Nema 3R	Enclosures are intended for outdoor use primarily to provide a degree of protection against falling rain, sleet, and external ice formation (may be ventilated).

Nema 4	Enclosures are intended for indoors or outdoors use, to protect against splashing water, seepage of water, falling or hose directed water, and severe external condensation. They are sleet resistant but not sleet (ice) proof.
Nema 4X	Type 4X enclosures have the same provisions as Type 4 enclosures and in addition, are corrosion-resistant.
Nema 6P	Type 6P enclosure are intended for indoor or outdoor use primarily to provide degree of protection against the entry of water during prolonged submersion at a limited depth. They are designed to meet air pressure, external icing, and rust-resistance design tests. They are not intended to provide protection against conditions such as internal condensation or internal icing.
Nema 12	Enclosures are intended for use indoors to protect the enclosed equipment against fibers, flyings, lint, dust, and dirt, and light splashing, seepage, dripping and external condensation of noncorrosive liquids.
Nema 13	Enclosures are intended for use indoors primarily to house pilot devices such as limit switches, pilot lights, etc., and to protect these devices against lint and dust, seepage, external condensation, and spraying of water, oil, an coolant.

INTERNATIONAL ELECTROTECHNICAL COMMISSION (ICE)

1st digit Definition

0 No protection of personnel from direct contact with active or moving parts. No protection from access from solid foreign object.

1 Protection of personnel from accidental large area direct contact with active or internal moving parts (hand contact, etc.) but no guard against intentional access to such parts. Protection from access of solid foreign object larger than 50mm in diameter.

2 Protection of personnel from finger contact with active or internal moving parts. Protection from access of solid foreign matter larger than 12mm in diameter.

3 Protection of personnel from touching active or internal moving parts with tools, wires or similar foreign objects thicker than 2.5mm in diameter.

4 Protection of personnel from touching active or internal moving parts with tools, wires or similar foreign objects thicker than 1mm in diameter.

5 Total protection of personnel from touchingvoltage carrying or internal moving parts. Protection from harmful deposit of dust. Access of dust is not completely prevented.

6 Total protection of personnel from touching voltage carrying or internal moving parts. Protection from access of dust.

INTERNATIONAL ELECTROTECHNICAL COMMISSION (ICE)

2nd digit Definition

0 No special protection

1 Water drops falling vertically must not have any harmful effect.

2 Water drops falling at any angle up to 15 degrees from the vertical must not have any harmful effect.

3 Water hitting the object at any angle up to 60 degrees with the vertical must not have any harmful effect.

4 Water splashing against the object from all directions must not have any harmful effect.

5 A jet of water nozzled from all directions must not have harmful effect.

6 Water from a temporary flooding , such as heavy seas, must not enter in any harmful quantity.

7 If the object is dipped into water under the defined conditions of pressure and time, water must not enter in any harmful quantity.

8 If the object is submerged in water, water must not enter in any harmful quantity.

Cross References between NEMA Enclosures and IEC Enclosures

Enclosures / IEC	IP23	IP30	IP32	IP64	IP65	IP66	IP67
1	X						
2		X					
3				X			
3R			X				
4						X	
4X						X	
6							X
12					X		
13					X		

Enclosures for Non-Hazardous Locations

Nema	1	12	13	3R	3	4	4X	6P
IEC	IP23	IP65	IP65	IP32	IP64	IP66	IP66	IP67
For a degree of protection against:	**Indoor Use**			**Outdoor Use**		**Indoor or Outdoor Use**		
Physical contact with internal equipment	X	X	X	X	X	X	X	X
Falling dirt	X	X	X	X	X	X	X	X
Rust	X	X	X	X	X	X	X	X
Dust (windblown; for outdoor types)		X	X		X	X	X	X
Dripping oil of non-corrosive liquids		X	X					
Spraying oil or non-corrosive liquids			X					
Falling rain				X	X	X	X	X
Windblown rain					X	X	X	X
Hose-directed water						X	X	X
Submersion at limited path								X
Sleet and external icing				X	X	X	X	X
Corrosion			X				X	X

ELECTRICAL FORMULAS

OHMS LAW

$R = E \quad I$

$I = E \div R$

$E = I \times R$

WHERE:
R = Ohms
I = Amperes
E = Voltage

POWER IN 3Ø AC CIRCUITS

$$I = \frac{W}{1.732 \times E \times PF}$$

$$kVA = \frac{1.732 \times E \times I \times PF}{1000}$$

$$W = 1.732 \times E \times I \times PF$$

$$PF = \frac{\text{Input W}}{1.732 \times E \times I}$$

WHERE:
I = Amperes
W = Watts
E = Voltage
PF = Power Factor
kVA = Kilovolt-Amperes

HORSEPOWER FORMULAS

ROTATING OBJECTS

$$HP = \frac{T \times N}{5252}$$

WHERE:
T = Torque (lb - ft)
N = Speed (RPM)

LINEAR OBJECTS

$$HP = \frac{F \times V}{33{,}000}$$

WHERE:
F = Force (lb)
V = Velocity (ft/min)

PUMPS

$$HP = \frac{GPM \times FT \times \text{Specific Gravity}}{3960 \times \text{Efficiency of Pump}}$$

$$HP = \frac{GPM \times PSI \times \text{Specific Gravity}}{1713 \times \text{Efficiency of Pump}}$$

WHERE:
GPM = Gallons per Min.
FT = Head in Feet gravity
(2.31 x lbs per square in. gravity)
PSI = Pounds per Square inch

FANS and BLOWERS

$$HP = \frac{CFM \times PSF}{33000 \times \text{Efficiency of Fan}}$$

$$HP = \frac{CFM \times PIW}{6343 \times \text{Efficiency of Fan}}$$

$$HP = \frac{CFM \times PSI}{229 \times \text{Efficiency of Fan}}$$

WHERE:
CFM = Cubic Feet per Minute
PSF = Pounds per Square Foot
PIW = Inches of Water Gauge
PSI = Pounds per Square Inch

TORQUE FORMULAS

$$T\ (ft\ lb) = \frac{HP \times 5252}{N}$$

$$T\ (NM) = \frac{KW \times 9550}{RPM}$$

WHERE:
T (ft lb) = Torque in Ft. lbs
T (NM) = Torque in Newton Meters
HP = Horsepower
KW = Kilowatts

AC MOTOR FORMULAS

$$SP = \frac{F \times 120}{Number\ of\ Poles}$$

$$\%\ Slip = \frac{(SP - FL\ Speed) \times 100}{SP}$$

$$Motor\ I = \frac{HP \times 746}{E \times 1.732 \times Eff \times PF}$$

$$Motor\ I = \frac{kVA \times 1000}{1.73 \times E}$$

$$Motor\ I = \frac{kW \times 1000}{1.73 \times E \times PF}$$

WHERE:
HP = Horsepower
E = Voltage
Eff. = Efficiency of Motor (%/100)
kVA = Kilovolt Amperes
kW = Kilowatts
PF = Power Factor
SP = Synchronous Speed
% Slip = Percent Motor Slip
I = Amperes

MISCELLANEOUS FORMULAS

MOTOR lb PER HP

2 - Pole = 1.5 ft lb per HP
4 - Pole = 3 ft lb per HP
6 - Pole = 4.5 ft lb per HP
8 - Pole = 6 ft lb per HP

DC BUS VOLTAGE

DC Bus Voltage = 1.414 x AC line voltage

LINE VOLTAGE

Line Voltage = DC Bus Voltage x 0.707

GLOSSARY OF TERMS

AC - Alternating-current, current that periodically changes polarity from positive to negative and back to positive.

ACCELERATING TORQUE - The torque required to bring the machine to an operating speed within a given time.

AC CONTACTOR - An alternating-current (AC) contactor is designed for the specific purpose of establishing and interrupting an alternating-current power circuit.

ADJUSTABLE SPEED DRIVE - A motor, drive controller, (electrical or mechanical) and operating controls that can adjust the output speed of the motor to selected speeds.

AMBIENT TEMPERATURE - Ambient temperature is the temperature of the medium such as air, water, or earth into which the heat of the equipment is dissipated.
For self-ventilated equipment, the ambient temperature is the average temperature of the air in the immediate neighborhood of the equipment.

AUXILIARY CONTACTS - Auxiliary contacts of a switching device are contacts in addition to the main-circuit contacts and function with the movement of the latter.

BASE SPEED - The manufacturer's nameplate speed where the motor develops rated horsepower at rated voltage. An AC motor will operate at base speed with 60Hz applied.

BIT - The most basic unit of digital information. A bit can only be one of two states: 1 or 0, Hi or Low, On or Off. In electronic terms, the state of a bit can be determined by the presence or absence of voltage.

BHP - Brake horsepower, Calculated horsepower required at the driven shaft, at the desired speed. Bhp is the term usually used with fans and pumps.

BREAK-AWAY TORQUE - Torque required to overcome friction and inertia, to start a machine from standstill. It will be greater than running torque.

BREAKDOWN TORQUE - Maximum torque an AC motor can develop at rated voltage and frequency.

BYPASS - A control system that may be used to operate the AC motor direct from the AC line instead of from the solid state controller. May be manual or automatic.

BYTE - A string of bits

CHOKE - See Inductor.

CIRCUIT BREAKER - An electrical power-interrupting device. May be used with solid state motor controllers as a manually operated incoming disconnect.

CLOSED-LOOP CONTROL - Generally refers to a control system in which the magnitude of the feedback (motor speed for example) is continuously compared to a set-point reference.

COGGING - A condition in which a motor does not rotate smoothly but "steps" or "jerks" from one position to another during shaft revolution. Cogging is most pronounced at low motor speeds and can cause objectionable vibrations in the driven machine.

CONTINUOUS RATING - The continuous rating is a maximum constant load that can be carried continuously without exceeding established temperature rise limitations under prescribed conditions of test and within the limitations of established standards.

CONTROL CIRCUIT - The control circuit of a control apparatus or system is the circuit which carries the electric signals directing performance of the controller but does not carry the main power circuit.

CONTROL DEVICE - A control device is an individual device used to execute a control function.

CONTROL CIRCUIT TRANSFORMER - A control circuit transformer is a voltage transformer utilized to supply a voltage suitable for the operation of control devices.

CONVERTER - The section of an adjustable frequency control that changes AC voltage to DC voltage. See also rectification.

CRITICAL SPEED - A speed that may result in mechanical resonance of the combined mechanical drive train: motor, coupling, gears, shafts, and driven load. Critical speeds may be inherent in any particular drive train.

CURRENT-LIMIT - A control function that prevents a current from exceeding its prescribed limits. Note: Current-limiting values are usually expressed as percent of rated-load value.

CURRENT-LIMIT ACCELERATION - A system of control in which acceleration is governed that the motor armature current does not exceed an adjustable maximum value.

CURRENT-LIMITING FUSE - A fuse that, when it is melted by a current within its specified current-limiting range, abruptly introduces a high arc voltage to reduce the current magnitude and duration.

DC LINK - The center section of an inverter. Includes devices such as capacitors and inductors to smooth out the DC voltage before it is supplied to the inverter section.

DISPLACEMENT POWER FACTOR - The ratio of the active power of the fundamental wave to the apparent power of the fundamental wave in RMS voltamperes.
Displacement power factor is the power factor for which electrical power utility companies charge penalties for low power factor.

DIMENSION OR OUTLINE DRAWING - A dimension or outline drawing (base plan, floor plan, etc.) is one which shows the physical space and mounting requirements of a piece of equipment. It may also indicate ventilation requirements and space provided for connections or the location to which connections are to be made.

DIODE - A device that passes current in one direction, but blocks reverse current.

DUTY CYCLE - Operating time at specific loads compared to total operating time plus idle time.

EFFICIENCY - The ratio of mechanical output to electrical input expressed in percent. A measure of the energy losses in a system.

ELEVATION - Distance above sea level. The criterion for design of most electronic power equipment is that maximum elevation will not exceed 3300 ft. (1000 M)

ERROR - The difference between a set-point reference signal and the feedback. An error must be present to make a correction in the system.

FAULT CURRENT - Is a current which results from the loss of insulation between conductors or between a conductor and ground.

FEEDBACK - A signal that reflects the actual operating condition for comparison with the command reference signal.

FULL-LOAD CURRENT - The armature current of a motor operated at its full load torque.

FULL-LOAD SPEED - The speed that the output shaft of the drive motor attains with rated load connected and with the drive controller adjusted to deliver rated output at rated speed.

FUSE - A device that protects an electrical circuit from excessive amperes by opening its internal element.

FUSED DISCONNECT - A device that allows AC power to be removed and applied while offering the protection of a fuse.

GAIN - In process control terminology gain is the maximum output of a controlled device for a specified maximum signal output.

HARMONICS - In electrical usage, harmonics are multiple of the frequency of the base sine wave of voltage or current. For example the 5th harmonic of a 60 Hz sine wave is 300 Hz. Nonsinusoidial repetitive waveforms can be broken down into specific values of the fundamental and its harmonics by Fourier analyses.

HEATER ELEMENT (Thermal Overload Relay) - Is the part of a thermal overload relay that is intended to produce heat when conducting current. Heater elements are sometimes referred to as heaters, thermal units, current elements or heating elements.

HERTZ - The frequency of an electrical sinusoidal waveform, in cycles per second. For example 60 cycles per second = 60 Hz.

HORSEPOWER - A measure of work that can be done over time.

$$HP = \frac{\text{Torque (lb-ft)} \times \text{RPM}}{5250}$$

$$HP \times 0.746 = kW$$

I²T PROTECTION - See Inverse-time overload protection

IGBT'S - Insulated Gate Bi-polar Transistors, a high speed switching device capable of switching either polarity, used to produce a PWM output waveform.

INDUCTION MOTOR - An AC machine with electrical connections to the stator only. The rotor includes conductors embedded in laminated iron slots. Voltage is induced into the rotor by the rotating magnetic field in the stator, causing a transfer of energy to the rotor, and subsequently to the motor shaft.

INDUCTOR - A ferro-magnetic assembly installed in line and/or load conductors of a drive to help control the effects of harmonics. Often used in place of isolation transformer. (Does not provide electrical isolation)

INERTIA - A measure of a body's resistance to changes in velocity. Typically expressed as WK^2, which represents its weight times the square if the radius of gyration. It is usually expressed in units of $LbFt^2$.

INSTANTANEOUS OVERCURRENT - A protective feature that will cause a drive to trip when the instantaneous current reaches a predetermined value. Usually results in gate pulse suppression.

INTERRUPTING CAPABILITY - The maximum value of current that a contact assembly is required to successfully interrupt at a specificed voltage for a limited number of operations under specified conditions.

INVERSE-TIME OVERLOAD - A control circuit or device that will cause a trip when the overcurrent-time relationship will cause dangerous overheating. Also known as I^2T protection.

INVERTER - A device used to change DC current to AC current. Commonly used in a generic sense to identify an AC variable frequency drive.

ISOLATION TRANSFORMER - A transformer that electrically isolates a drive from the AC power line. It protects solid state power components from high transient voltage and current, limits line disturbances created by the solid state devices, and protects the line from grounded drive motors.

LINE REACTOR - Device used in the input AC lines of drives to increase the line impedance, which can assist in reducing short circuit kVA, help reduce harmonics and help correct effects of voltage unbalance. Also known as AC line inductors and chokes. See also inductors.

LINE STARTING - Causing an induction motor and its load to start and accelerate to rated speed by applying full line voltage to the motor at standstill.

LOCKED ROTOR AMPERES - The maximum value of amperes that will be present in an AC motor on line starting. It is assumed that the rotor of motor is locked temporarily in a station condition. Usual values of locked rotor amperes are on the order of six to eight time the motor nameplate.

MULTI-MOTOR OPERATION - A system in which one drive operates two or more motors simultaneously.

NEC - National Electrical Code, gives minimum electrical regulations as published by the National Fire Protection Association every 3 years.

NEMA - National Electrical Manufacturers' Association. Provides voluntary standards that aid users and manufacturers in designing, selecting, and specifying electrical devices, enclosures, assemblies, and rotating machines.

NEMA ENCLOSURE DESIGNATIONS - To assist in designing and selecting enclosures for electrical equipment. NEMA standards describe various enclosures by numbers. Each number describes the degree of protection from hazards such as entrance, dust, water, ice, rain, oil, and corrosion, as well as indoor/outdoor service. Typical enclosures, (NEMA publication number 250) include:

NEMA 1 - General purpose indoor type enclosure to prevent accidental contact of personnel with enclosed equipment and meet NEMA specifications for rod entry and rust resistance.

NEMA 3R - Rain proof and sleet (ice) resistant, intended for out-door use to protect enclosed equipment against rain. Requires conduit hub or watertight connection.

NEMA 4 - Watertight and dust tight for use indoors and outdoors. Protects against splashing water, seepage of water, falling or hose directed water, and severe external condensation.

NEMA 4X - Same as NEMA 4, except that enclosure is corrosion resistant.

NEMA 12 - Dust tight and drip tight for industrial indoor use. Protects enclosed equipment against fibers, lint, dust, dirt, and light splashing, seepage, dripping, and external condensation of non corrosive liquids. Enclosures have no knock outs for conduit and are gasketed.

NO-LOAD - The state of a machine rotating at normal speed under rated conditions, but when no output is required of it.

NON-FUSED DISCONNECT - A device that allows AC power to be removed and applied without the protection of a fuse.

NONVOLATILE MEMORY - A memory that does not require power to maintain its contents.

OVERLOAD CAPACITY - NEMA specifies that standard industrial motors should have the capacity of 150% overload for one minute.

PARAMETER - A value in a register of a digital controller which determines an operating mode or condition. Examples are current limit, Max speed, accel/decel ramp, start/stop, etc.

POTENTIOMETER - A three terminal rheostat, or resistor with one or more adjustable sliding contacts, that function as an adjustable voltage divider. Typically used to manually control the operating speed of a drive.

PRESET SPEED - A control function that establishes the desired operating speed of a drive. Usually by means of a contact closure.

PROGRAM - A sequence of instructions that tells a computer how to receive, store, process, and deliver information.

PROTOCOL - A set of conventions or rules governing the format and timing of data communication.

PWM - Pulse Width Modulated drive. This drive uses a diode bridge for a constant voltage DC bus. The DC bus is stabilized by capacitors, and usually will have an inductor to improve power factor. The output is controlled by IGBT's and produces a variable voltage, variable frequency using a high frequency "switching " algorithm. The output closely simulates the line sine wave.

REACTANCE - Any force that opposes a change in current flow. Coils produce inductive reactance that delays the flow of current. Capacitors produce capacitive reactance that accelerates current flow. Reactance is measured in ohms and affects the current and voltage relationships in AC circuits.

RECTIFIER - A device that converts alternating current to direct current.

RELAY - A relay is an electric device that is designed to interpret input conditions in a prescribed manner and after specified conditions are met to respond to cause contact operation or similar abrupt changes in associated electric control circuits.

REMOTE CONTROL - Is a control function which provides for initiation or change of a control function form a remote point.

RESET - To restore a mechanism, storage or device to a prescribed state or condition.

RS232 - A hardware protocol for data communication. Basic characteris tics are common ground for all signals and maximum 50 foot cable length.

RS422/485 - A hardware protocol for data communications. Uses differential, ungrounded signals, has a maximum cable length of 4-5000 feet and can be daisy chained between multiple devices.

SCHEMATIC OR ELEMENTARY DIAGRAM - Is one that shows all circuits and device elements of an eqipment and its associated apparatus or any clearly defined functional portion thereof. Such a diagram emphasizes the device elements of circuit and their functions as distinguished from the physical arrangement of the conductors, devices or elements of a circuit system.

SERIAL COMMUNICATION - A Communication bus that relays information one bit at time. Serial busses use a minimum number of conductors at the cost of communication speed.

SERVICE FACTOR - A value shown on a motor nameplate indicating a percent of loading above the motor nameplate rating that can be tolerated continuously without serious degradation. A 1.15% service factor indicates that the motor can operate at 115% of nameplate value, if necessary, when rated ambient temperature is not exceeded.

SHORT-CIRCUIT CAPACITY - In a distribution system, this is the value of amperes (or kVA) that would flow if the line leads of the system were totally shorted or solidly connected to each other. It is generally the “worst-case” condition used to select protective devices.

SHORT-CIRCUIT RATIO - This is the ratio of the short-circuit capacity, in kVA, to the sum of all inverters (in kVA) connected to a common point in an AC distribution system. Used to obtain a measure of the effect of harmonics that may be present at that point in the system.

SURGE PROTECTOR - MOV (Metal Oxide Varistor) or special RC networks designed to clip or absorb voltage transients form an incoming AC source.

TORQUE - The turning force applied to a shaft. Usually measured in pound-feet or ounce-inches. It is equal to the force applied times the radius through which it acts.

TRANSDUCER - A device used to convert one energy form to another. (e.g. pneumatic to electrical)

UL - Underwriters’ laboratory. An organization concerned primarily with safety considerations of electrical devices and assemblies. UL will “List” or “Recognize” devices or assemblies after specified tests have been passed successfully.

UNDERVOLTAGE PROTECTION - Monitors the DC bus level of a drive and cause the drive to perform a protective shut down when the DC bus falls below a pre-determined level. (Typically when the incoming AC voltage drops)

VARIABLE TORQUE LOAD - A load in which the steady-state torque or turning effort changes with the operating rpm. Centrifugal machines such as pumps and fans have variable torque characteristics, with the steady state load torque increasing as the square of the rpm.

VENTILATED ENCLOSURE - Is an enclosure provided with ameans of to permit circulation of sufficient air to remove excess of heat.

VOLTS PER HERTZ - This is a number derived from rated motor voltage divided by rated motor hertz. This ratio should not exceeded when operating the motor at different frequencies continuously because it will result in excessive amperes.

CONVERSION FACTORS

Area

1 sq. mile = 640 acres
1 acre = 4840 sq. yards
1 acre = 43,560 sq. ft.
1 sq. foot = 144 sq. inches
1 sq. yard = 0.836 sw. meters
1 sq. meter = 1.196 sq. yards
1 sq. ft. = 0.929 sq. meters
1 cir. mil = 7.854×10^{-7} sq. inch.
1 cir. mil = 0.7854 sq. mils
1 sq. mil = 1.273 cir. mils
1 sq. inch = 6.452 sq. cm
1 sq. cm = 0.155 sq. inch

Angle

1 quadrant = 90 degrees
1 quadrant = 1.57 radians
1 radian = 57.3 degress
1 degree = 0.175 radian
1 minute = 0.1667 degree
1 minute = 2.9×10^{-4} radian

Length

1 mile = 5280 feet
1 mile = 1.609 kilometers
1 kilometer = 0.621 miles
1 yard = 0.9144 meters
1 meter = 3.28 feet
1 meter = 39.37 inches
1 meter = 1.094 yards
1 foot = 12 inches
1 foot = 0.3048 meters
1 inch = 2.54 cm
1 centimeter = 0.394 inch
1 fathom = 6 feet
1 rod = 5 1/2 yards

Weight

1 short ton = 2000 pounds
1 short ton = 907.2 kilograms
1 kilogram = 2.205 pounds
1 pound = 453.6 grams
1 ounce = 28.35 grams
1 gram = 0.353 ounces

Dry Volume

1 cu. meter = 1.308 cu. yards
1 cu. yard = 0.7646 cu. meters
1 cu. meter = 35.31 cu. feet
1 cu. foot = 0.283 cu. meters

Liquid Volume

1 U.S. gallon = 3.785 liters
1 liter = 0.2642 U.S. Gallon
1 U.S. quart = 0.9463 liter
1 liter = 1.057 U.S. quarts

Power

1 horsepower = 746 watts
1 horsepower = 33000 ft-lbs/min
1 BTU/hour = 0.293 watts
1 BTU = 252 gram-calories
1 BTU = 778.3 ft-lbs.

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5580 Enterprise Parkway, Fort Myers, Florida 33905
Telephone (941) 693-7200 · Fax (941) 693-2431
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