HITACHI
L300P Series Inverter Instruction Manual

- Three-phase Input   200V Class
- Three-phase Input   400V Class

UL Version Models

CE Version Models

Hitachi Industrial Equipment Systems Co., Ltd.

Safety Messages

For the best results with the L300P Series inverter, carefully read this manual and all of the warning labels attached to the inverter before installing and operating it, and follow the instructions exactly. Keep this manual handy for quick reference.

Definitions and Symbols

A safety instruction (message) includes a hazard alert symbol and a signal word, WARNING or CAUTION. Each signal word has the following meaning:

This symbol indicates HIGH VOLTAGE. It calls your attention to items or operations that could be dangerous to you and other persons operation this equipment. Read the message and follow the instructions carefully.

This symbol is the "Safety Alert Symbol." It occurs with either of two signal words: CAUTION or WARNING, as described below.

WARNING: Indicates a potentially hazardous situation that, if not avoided, can result in serious injury or death.

CAUTION: Indicates a potentially hazardous situation that, if not avoided, can result in minor to moderate injury, or serious damage to the product. The situation described in the **CAUTION** may, if not avoided, lead to serious results. Important safety measures are described in CAUTION (as well as WARNING), so be sure to observe them.

STEP: A step is one of a series of action steps required to accomplish a goal. The number of the step will be contained in the step symbol.

NOTE: Notes indicate an area or subject of special merit, emphasizing either the product's capabilities or common errors in operation or maintenance.

TIP: Tips give a special instruction that can save time or provide other benefits while installing or using the product. The tip calls attention to an idea that may not be obvious to first-time users of the product.

Hazardous High Voltage

HIGH VOLTAGE: Motor control equipment and electronic controllers are connected to hazardous line voltages. When servicing drives and electronic controllers, there may be exposed components with housings or protrusions at or above line potential. Extreme care should be taken to protect against shock.
Stand on an insulating pad and make it a habit to use only one hand when checking components. Always work with another person in case an emergency occurs. Disconnect power before checking controllers or performing maintenance. Be sure equipment is properly grounded. Wear safety glasses whenever working on electronic controllers or rotating machinery.

General Precautions - Read These First!

WARNING: This equipment should be installed, adjusted, and serviced by qualified electrical maintenance personnel familiar with the construction and operation of the equipment and the hazards involved. Failure to observe this precaution could result in bodily injury.

WARNING: The user is responsible for ensuring that all driven machinery, drive train mechanism not supplied by Hitachi Industrial Equipment Systems Co., Ltd., and process line material are capable of safe operation at an applied frequency of 150% of the maximum selected frequency range to the AC motor. Failure to do so can result in destruction of equipment and injury to personnel should a single-point failure occur.

WARNING: For equipment protection, install a ground leakage type breaker with a fast response circuit capable of handling large currents. The ground fault protection circuit is not designed to protect against personal injury.

HIGH VOLTAGE: HAZARD OF ELECTRICAL SHOCK. DISCONNECT INCOMING POWER BEFORE WORKING ON THIS CONTROL.

WARNING: Wait at least five (5) minutes after turning OFF the input power supply before performing maintenance or an inspection. Otherwise, there is the danger of electric shock.

CAUTION: These instructions should be read and clearly understood before working on L300P series equipment.

CAUTION: Proper grounds, disconnecting devices and other safety devices and their location are the responsibility of the user and are not provided by Hitachi Industrial Equipment Systems Co., Ltd.

CAUTION: Be sure to connect a motor thermal disconnect switch or overload device to the L300P series controller to assure that the inverter will shut down in the event of an overload or an overheated motor.

HIGH VOLTAGE: Dangerous voltage exists until power light is OFF. Wait at least 5 minutes after input power is disconnected before performing maintenance.

CAUTION: This equipment has high leakage current and must be permanently (fixed) hard-wired to ground via two independent cables.

WARNING: Rotating shafts and above-ground electrical potentials can be hazardous. Therefore, it is strongly recommended that all electrical work conform to the National Electrical Codes and local regulations. Installation, alignment and maintenance should be performed only by qualified personnel.
Factory-recommended test procedures included in the instruction manual should be followed. Always disconnect electrical power before working on the unit.

CAUTION:
a) Motor must be connected to protective ground via low resistive path ($< 0.1\Omega$)
b) Any motor used must be of a suitable rating.
c) Motors may have hazardous moving parts. In this event suitable protection must be provided.

CAUTION: Alarm connection may contain hazardous live voltage even when inverter is disconnected. When removing the front cover for maintenance or inspection, confirm that incoming power for alarm connection is completely disconnected.

CAUTION: Hazardous (main) terminals for any interconnection (motor, contact breaker, filter, etc.) must be inaccessible in the final installation.

CAUTION: The end application must be in accordance with BS EN60204-1. Refer to the section "Step-by-Step Basic Installation" on page 2–6. The diagram dimensions are to be suitably amended for your application.

CAUTION: Connection to field wiring terminals must be reliably fixed having two independent means of mechanical support. Using a termination with cable support (figure below), or strain relief, cable clamp, etc.

Terminal (ring lug)   Cable support

                                   Cable
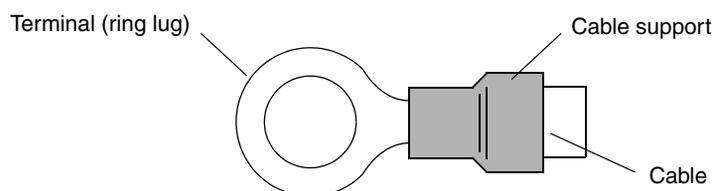
CAUTION: A three-pole disconnection device must be fitted to the incoming main power supply close to the inverter. Additionally, a protection device meeting IEC947-1/IEC947-3 must be fitted at this point (protection device data shown in "Determining Wire and Fuse Sizes" on page 2–14).

NOTE: The above instructions, together with any other requirements are highlighted in this manual, and must be followed for continued LVD (European Low Voltage Directive) compliance.

Index to Warnings and Cautions in This Manual

Installation—Cautions for Mounting Procedures

CAUTION: Be sure to install the unit on flame-resistant material such as a steel plate. Otherwise, there is the danger of fire. 2–6

CAUTION: Be sure not to place any flammable materials near the inverter. Otherwise, there is the danger of fire. 2–6

CAUTION: Be sure not to let the foreign matter enter vent openings in the inverter housing, such as wire clippings, spatter from welding, metal shavings, dust, etc. Otherwise, there is the danger of fire. 2–6

CAUTION: Be sure to install the inverter in a place that can bear the weight according to the specifications in the text (Chapter 1, Specifications Tables). Otherwise, it may fall and cause injury to personnel. 2–6

CAUTION: Be sure to install the unit on a perpendicular wall that is not subject to vibration. Otherwise, it may fall and cause injury to personnel. 2–6

CAUTION: Be sure not to install or operate an inverter that is damaged or has missing parts. Otherwise, it may cause injury to personnel. 2–6

CAUTION: Be sure to install the inverter in a well-ventilated room that does not have direct exposure to sunlight, a tendency for high temperature, high humidity or dew condensation, high levels of dust, corrosive gas, explosive gas, inflammable gas, grinding-fluid mist, salt air, etc. Otherwise, there is the danger of fire. 2–6

CAUTION: Be sure to maintain the specified clearance area around the inverter and to provide adequate ventilation. Otherwise, the inverter may overheat and cause equipment damage or fire. 2–7

Wiring—Warnings for Electrical Practices and Wire Specifications

WARNING: "Use 60/75°C Cu wire only" or equivalent. 2–13

WARNING: "Open Type Equipment." 2–13

WARNING: "A Class 2 circuit wired with Class 1 wire" or equivalent. 2–13

WARNING: "Suitable for use on a circuit capable of delivering not more than 10,000 rms symmetrical amperes, 240 V maximum." For models with suffix L. 2–13

WARNING: "Suitable for use on a circuit capable of delivering not more than 10,000 rms symmetrical amperes, 480 V maximum." For models with suffix H. 2–13

HIGH VOLTAGE: Be sure to ground the unit. Otherwise, there is a danger of electric shock and/or fire.

HIGH VOLTAGE: Wiring work shall be carried out only by qualified personnel. Otherwise, there is a danger of electric shock and/or fire.

HIGH VOLTAGE: Implement wiring after checking that the power supply is OFF. Otherwise, you may incur electric shock and/or fire.

HIGH VOLTAGE: Do not connect wiring to an inverter or operate an inverter that is not mounted according the instructions given in this manual. Otherwise, there is a danger of electric shock and/or injury to personnel.

Wiring—Cautions for Electrical Practices

CAUTION: Be sure that the input voltage matches the inverter specifications: • Three phase 200 to 240V 50/60Hz • Three phase 380 to 480V 50/60Hz

CAUTION: Be sure not to power a three-phase-only inverter with single phase power. Otherwise, there is the possibility of damage to the inverter and the danger of fire.

CAUTION: Be sure not to connect an AC power supply to the output terminals. Otherwise, there is the possibility of damage to the inverter and the danger of injury and/or fire.

Power Input	Power Output
L1 L2 L3	T1 T2 T3
R S T	U V W
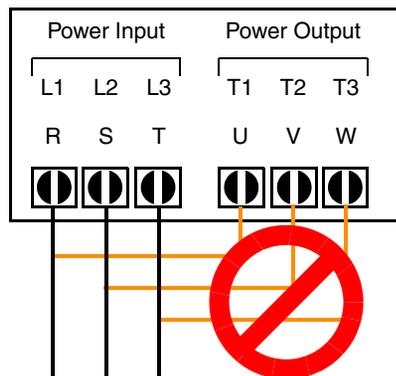
NOTE:

L1, L2, L3: Three-phase 200 to 240V 50/60 Hz
Three-phase 380 to 480V 50/60 Hz

CAUTION: Fasten the screws with the specified fastening torque in the table below. Check for any loosening of screws. Otherwise, there is the danger of fire.

CAUTION: Remarks for using ground fault interrupter breakers in the main power supply: Adjustable frequency inverters with CE-filters (RFI-filter) and shielded (screened) motor cables have a higher leakage current toward Earth GND. Especially at the moment of switching ON this can cause an inadvertent trip of ground fault interrupter breakers. Because of the rectifier on the input side of the inverter there is the possibility to stall the switch-off function through small amounts of DC current. Please observe the following: • Use only short time-invariant and pulse current-sensitive ground fault interrupter breakers with higher trigger current. • Other components should be secured with separate ground fault interrupter breakers. • Ground fault interrupter breakers in the power input wiring of an inverter are not an absolute protection against electric shock.

CAUTION: Be sure to install a fuse in each phase of the main power supply to the inverter. Otherwise, there is the danger of fire.

CAUTION: For motor leads, ground fault interrupter breakers and electro-magnetic contactors, be sure to size these components properly (each must have the capacity for rated current and voltage). Otherwise, there is the danger of fire.

CAUTION: Failure to remove all vent opening covers before electrical operation may result in damage to the inverter.

Powerup Test Caution Messages

CAUTION: The heat sink fins will have a high temperature. Be careful not to touch them. Otherwise, there is the danger of getting burned.

CAUTION: The operation of the inverter can be easily changed from low speed to high speed. Be sure to check the capability and limitations of the motor and machine before operating the inverter. Otherwise, there is the danger of injury.

CAUTION: If you operate a motor at a frequency higher than the inverter standard default setting (50Hz/60Hz), be sure to check the motor and machine specifications with the respective manufacturer. Only operate the motor at elevated frequencies after getting their approval. Otherwise, there is the danger of equipment damage and/or injury to personnel.

CAUTION: Check the following before and during the powerup test. Otherwise, there is the danger of equipment damage. • Is the shorting bar between the [P] and [PD] terminals installed? DO NOT power or operate the inverter if the jumper is removed. • Is the direction of the motor rotation correct? • Did the inverter trip during acceleration or deceleration? • Were the rpm and frequency meter readings as expected? • Were there any abnormal motor vibrations or noise?

Warnings for Operations and Monitoring

WARNING: Be sure to turn ON the input power supply only after closing the front case. While the inverter is energized, be sure not to open the front case. Otherwise, there is the danger of electric shock. ....

WARNING: Be sure not to operate electrical equipment with wet hands. Otherwise, there is the danger of electric shock. ....

WARNING: While the inverter is energized, be sure not to touch the inverter terminals even when the motor is stopped. Otherwise, there is the danger of electric shock. ....

WARNING: If the Retry Mode is selected, the motor may suddenly restart after a trip stop. Be sure to stop the inverter before approaching the machine (be sure to design the machine so that safety for personnel is secure even if it restarts.) Otherwise, it may cause injury to personnel. ....

WARNING: If the power supply is cut OFF for a short period of time, the inverter may restart operation after the power supply recovers if the Run command is active. If a restart may pose danger to personnel, so be sure to use a lock-out circuit so that it will not restart after power recovery. Otherwise, it may cause injury to personnel. ....

WARNING: The Stop Key is effective only when the Stop function is enabled. Be sure to enable the Stop Key separately from the emergency stop. Otherwise, it may cause injury to personnel. ....

WARNING: During a trip event, if the alarm reset is applied and the Run command is present, the inverter will automatically restart. Be sure to apply the alarm reset only after verifying the Run command is OFF. Otherwise, it may cause injury to personnel. ....

WARNING: Be sure not to touch the inside of the energized inverter or to put any conductive object into it. Otherwise, there is a danger of electric shock and/or fire. ....

WARNING: If power is turned ON when the Run command is already active, the motor will automatically start and injury may result. Before turning ON the power, confirm that the RUN command is not present. ....

WARNING: When the Stop key function is disabled, pressing the Stop key does not stop the inverter, nor will it reset a trip alarm. ....

WARNING: Be sure to provide a separate, hard-wired emergency stop switch when the application warrants it. ....

WARNING: If the power is turned ON and the Run command is already active, the motor starts rotation and is dangerous! Before turning power ON, confirm that the external Run command is not active. ....

WARNING: After the Reset command is given and the alarm reset occurs, the motor will restart suddenly if the Run command is already active. Be sure to set the alarm reset after verifying that the Run command is OFF to prevent injury to personnel. ....

Cautions for Operations and Monitoring

CAUTION: The heat sink fins will have a high temperature. Be careful not to touch them. Otherwise, there is the danger of getting burned.

CAUTION: The operation of the inverter can be easily changed from low speed to high speed. Be sure check the capability and limitations of the motor and machine before operating the inverter. Otherwise, it may cause injury to personnel.

CAUTION: If you operate a motor at a frequency higher than the inverter standard default setting (50Hz/60Hz), be sure to check the motor and machine specifications with the respective manufacturer. Only operate the motor at elevated frequencies after getting their approval. Otherwise, there is the danger of equipment damage.

CAUTION: It is possible to damage the inverter or other devices if your application exceeds the maximum current or voltage characteristics of a connection point.

CAUTION: Be careful not to turn PID Clear ON and reset the integrator sum when the inverter is in Run Mode (output to motor is ON). Otherwise, this could cause the motor to decelerate rapidly, resulting in a trip.

CAUTION: When the motor runs at lower speeds, the cooling effect of the motor's internal fan decreases.

### Warnings and Cautions for Troubleshooting and Maintenance

WARNING: Wait at least five (5) minutes after turning OFF the input power supply before performing maintenance or an inspection. Otherwise, there is the danger of electric shock.

WARNING: Make sure that only qualified personnel will perform maintenance, inspection, and part replacement. Before starting to work, remove any metallic objects from your person (wristwatch, bracelet, etc.). Be sure to use tools with insulated handles. Otherwise, there is a danger of electric shock and/or injury to personnel.

WARNING: Never remove connectors by pulling on its wire leads (wires for cooling fan and logic P.C. board). Otherwise, there is danger of fire due to wire breakage and/or injury to personnel.

CAUTION: Do not connect the megger to any control circuit terminals such as intelligent I/O, analog terminals, etc. Doing so could cause damage to the inverter.

CAUTION: Never test the withstand voltage (HIPOT) on the inverter. The inverter has a surge protector between the main circuit terminals above and the chassis ground.

WARNING: The screws that retain the capacitor bank assembly are part of the electrical circuit of the high-voltage internal DC bus. Be sure that all power has been disconnected from the inverter, and that you have waited at least 5 minutes before accessing the terminals or screws. Be sure the charge lamp is extinguished. Otherwise, there is the danger of electrocution to personnel.

CAUTION: Do not operate the inverter unless you have replaced the six screws that connect the capacitor bank assembly to the inverter's circuits. Otherwise, damage to the inverter may occur.

CAUTION: Remove the fan assembly carefully, since it is attached to the unit via connecting wires.

HIGH VOLTAGE: Be careful not to touch wiring or connector terminals when working with the inverters and taking measurements. Be sure to place the measurement circuitry above in an insulated housing before using them.

General Warnings and Cautions

WARNING: Never modify the unit. Otherwise, there is a danger of electric shock and/or injury.

CAUTION: Withstand voltage tests and insulation resistance tests (HIPOT) are executed before the units are shipped, so there is no need to conduct these tests before operation.

CAUTION: Do not attach or remove wiring or connectors when power is applied. Also, do not check signals during operation.

CAUTION: Do not stop operation by switching OFF electromagnetic contactors on the primary or secondary sides of the inverter.
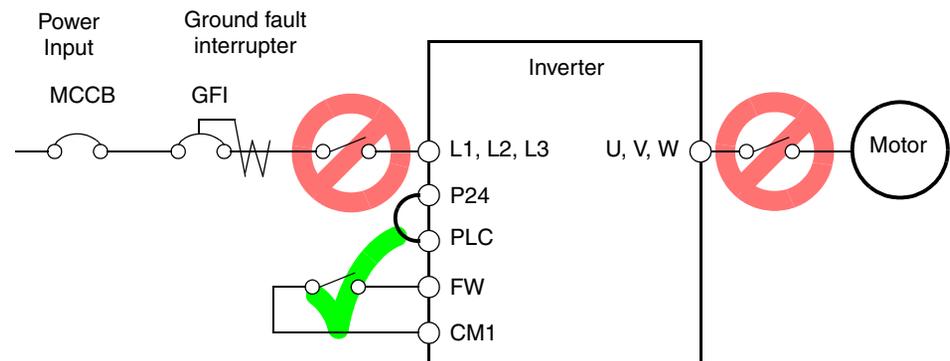
When there has been a sudden power failure while a Run command is active, then the unit may restart operation automatically after the power failure has ended. If there is a possibility that such an occurrence may harm humans, then install an electromagnetic contactor on the power supply side, so that the circuit does not allow automatic restarting after the power supply recovers. If an optional remote operator is used and the retry function has been selected, this will also allow automatic restarting when a Run command is active. So, please be careful.

CAUTION: Do not insert leading power factor capacitors or surge absorbers between the output terminals of the inverter and motor.
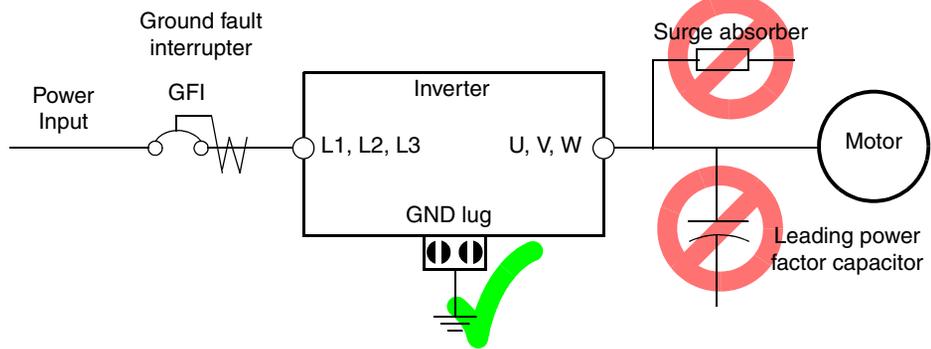
**CAUTION:** Be sure to connect the grounding terminal to earth ground.

CAUTION: When inspecting the unit, be sure to wait five minutes after tuning OFF the power supply before opening the cover.

CAUTION: SUPPRESSION FOR NOISE INTERFERENCE FROM INVERTER
The inverter uses many semiconductor switching elements such as transistors and IGBTs. Thus, a radio receiver or measuring instrument located near the inverter is susceptible to noise interference.
To protect the instruments from erroneous operation due to noise interference, they should be used well away from the inverter. It is also effective to shield the whole inverter structure.
The addition of an EMI filter on the input side of the inverter also reduces the effect of noise from the commercial power line on external devices.
Note that the external dispersion of noise from the power line can be minimized by connecting an EMI filter on the primary side of inverter.
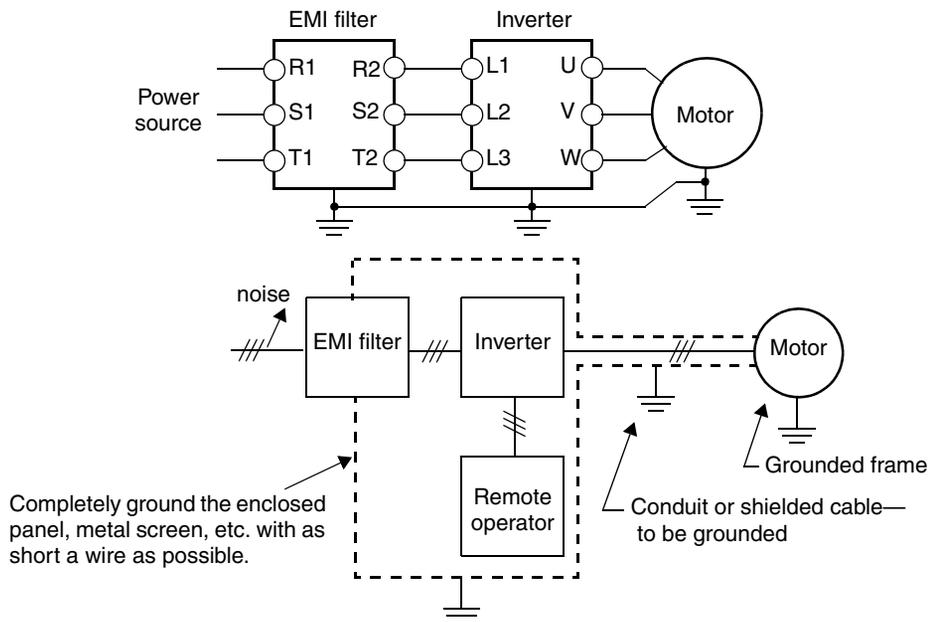
CAUTION: MOTOR TERMINAL VOLTAGE SURGE SUPPRESSION FILTER (For 400 V CLASS Inverters)
In a system using an inverter with the voltage control PWM system, a voltage surge caused by the cable constants such as the cable length (especially when the distance between the motor and inverter is 10 m or more) and cabling method may occur at the motor terminals. A dedicated filter of the 400 V class for suppressing this voltage surge is available. Be sure to install a filter in this situation. (See "LCR filter" on page 5–2, part type HRL–xxxC.)

CAUTION: EFFECTS OF POWER DISTRIBUTION SYSTEMS ON INVERTERS
In the cases below involving a general-purpose inverter, a large peak current can flow on the power supply side, sometimes destroying the converter module:
1. The unbalance factor of the power supply is 3% or higher.
2. The power supply capacity is at least 10 times greater than the inverter capacity (or the power supply capacity is 500 kVA or more).
3. Abrupt power supply changes are expected, due to conditions such as:
    a. Several inverters are interconnected with a short bus.
    b. A thyristor converter and an inverter are interconnected with a short bus.
    c. An installed phase advance capacitor opens and closes.
Where these conditions exist or when the connected equipment must be highly reliable, you MUST install an input-side AC reactor of 3% (at a voltage drop at rated current) with respect to the supply voltage on the power supply side. Also, where the effects of an indirect lightning strike are possible, install a lightning conductor.

CAUTION: Do not install inverters in a corner-grounded Delta distribution system. The resulting line imbalance will cause premature line fuse failure and failure of the inverter input bridge rectifier. Install in a balanced Delta or Wye distribution system only.

CAUTION: When the EEPROM error E8 occurs, be sure to confirm the setting values again.

CAUTION: When using *normally closed* active state settings (C011 to C019) for externally commanded Forward or Reverse terminals [FW] or [RV], the inverter may start automatically *when the external system is powered OFF or disconnected from the inverter!* So, do not use normally closed active state settings for Forward or Reverse terminals [FW] or [RV] unless your system design protects against unintended motor operation.

General Caution

CAUTION: In all the illustrations in this manual, covers and safety devices are occasionally removed to describe the details. While operating the product, make sure that the covers and safety devices are placed as they were specified originally and operate it according to the instruction manual.

UL® Cautions, Warnings, and Instructions

Wiring Warnings for Electrical Practices and Wire Sizes

The Cautions, Warnings, and instructions in this section summarize the procedures necessary to ensure an inverter installation complies with Underwriters Laboratories® guidelines.

WARNING: "Use 60/75°C Cu wire only" or equivalent.

WARNING: "Open Type Equipment." For models L300P–900H to L300P–1320H.

WARNING: "Suitable for use on a circuit capable of delivering not more than 10,000 rms symmetrical amperes, 240 V maximum." For models with suffix L.

WARNING: "Suitable for use on a circuit capable of delivering not more than 10,000 rms symmetrical amperes, 480 V maximum." For models with suffix H.

Terminal Tightening Torque and Wire Size

The wire size range and tightening torque for field wiring terminals are presented in the table below.

Input Voltage	Motor Output		Inverter Models, L300P	Wire Size Range (AWG)	Torque	
	HP	kW			ft-lbs	N-m
200V	2	1.5	-015LFU2	14	1.1	1.5
	3	2.2	-022LFU2	14	1.1	1.5
	5	3.7	-037LFU2	10	1.1	1.5
	7.5	5.5	-055LFU2	8	1.8	2.5
	10	7.5	-075LFU2	6	1.8	2.5
	15	11	-110LFU2	4	3.6	4.9
	20	15	-150LFU2	2	3.6	4.9
	25	18.5	-185LFU2	4 ‖ 4 AWG	3.6	4.9
	30	22	-220LFU2	1/0	6.5	8.8
	40	30	-300LFU2	2 ‖ 2 AWG	6.5	8.8
	50	37	-370LFU2	1 ‖ 1AWG	6.5	8.8
	60	45	-450LFU2	1 ‖ 1 AWG (75°C)	10.1	13.7
	75	55	-550LFU2	2/0 ‖ 2/0 AWG	10.1	13.7
	100	75	-750LFU2	3/0 ‖ 3/0 AWG	10.1	13.7

TIP: AWG = American Wire Gauge. Smaller numbers represent increasing wire thickness.
kcmil = 1,000 circular mils, a measure of wire cross-sectional area
mm^2 = square millimeters, a measure of wire cross-sectional area

| Input Voltage	Motor Output		Inverter Models, L300P	Wire Size Range (AWG)	Torque	
	HP	kW			ft-lbs	N-m
400V	2	1.5	-015HFU2, HFE2	20	1.1	1.5
	3	2.2	-022HFU2, HFE2	18	1.1	1.5
	5	4.0	-040HFU2, HFE2	16	1.1	1.5
	7.5	5.5	-055HFU2, HFE2	14	1.1	1.5
	10	7.5	-075HFU2, HFE2	12	1.8	2.5
	15	11	-110HFU2, HFE2	8	3.6	4.9
	20	15	-150HFU2, HFE2	6	3.6	4.9
	25	18.5	-185HFU2, HFE2	6	3.6	4.9
	30	22	-220HFU2, HFE2	4	3.6	4.9
	40	30	-300HFU2, HFE2	3	3.6	4.9
	50	37	-370HFU2, HFE2	4 ‖ 4 AWG	3.6	4.9
	60	45	-450HFU2, HFE2	1	6.5	8.8
	75	55	-550HFU2, HFE2	2 ‖ 2 AWG	6.5	8.8
	100	75	-750HFU2, HFE2	1 ‖ 1 AWG	6.5	8.8
	125	90	-900HFU2, HFE2	1 ‖ 1 AWG (75°C)	10.1	13.7
	150	110	-1100HFU2, HFE2	2/0 ‖ 2/0 AWG	10.1	13.7
	175	132	-1320HFU2, HFE2	2/0 ‖ 2/0 AWG	10.1	13.7

Circuit Breaker and Fuse Sizes

The inverter's connections to input power must include UL Listed inverse time circuit breakers with 600V rating, or UL Listed fuses as shown in the table below.

Input Voltage	Motor Output		200V Inverter Models, L300P	Circuit Breaker (A)	Fuse (A)	Input Voltage	Motor Output		400V Inverter Models, L300P	Circuit Breaker (A)	Fuse (A)
	HP	kW					HP	kW			
200V	2	1.5	-015LFU2	10	10	400V	2	1.5	-015HFU2, HFE2	10	10
	3	2.2	-022LFU2	15	15		3	2.2	-022HFU2, HFE2	10	10
	5	3.7	-037LFU2	20	20		5	4.0	-040HFU2, HFE2	15	15
	7.5	5.5	-055LFU2	30	30		7.5	5.5	-055HFU2, HFE2	15	15
	10	7.5	-075LFU2	40	40		10	7.5	-075HFU2, HFE2	20	20
	15	11	-110LFU2	60	60		15	11	-110HFU2, HFE2	30	30
	20	15	-150LFU2	70	70		20	15	-150HFU2, HFE2	35	35
	25	18.5	-185LFU2	90	90		25	18.5	-185HFU2, HFE2	50	50
	30	22	-220LFU2	100	100		30	22	-220HFU2, HFE2	50	50
	40	30	-300LFU2	150	150		40	30	-300HFU2, HFE2	70	70
	50	37	-370LFU2	175	175		50	37	-370HFU2, HFE2	80	80
	60	45	-450LFU2	200	200		60	45	-450HFU2, HFE2	100	100
	75	55	-550LFU2	250	250		75	55	-550HFU2, HFE2	125	125
	100	75	-750LFU2	300	300		100	75	-750HFU2, HFE2	150	150
							125	90	-900HFU2, HFE2	—	200
							150	110	-1100HFU2, HFE2	—	225
							175	132	-1320HFU2, HFE2	—	300

Wire Connectors

WARNING: Field wiring connections must be made by a UL Listed and CSA Certified ring lug terminal connector sized for the wire gauge being used. The connector must be fixed using the crimping tool specified by the connector manufacturer.
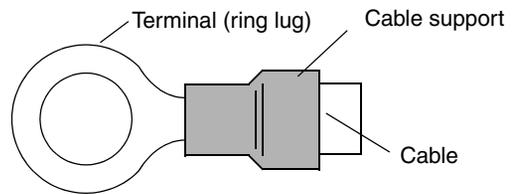
Motor Overload Protection

Hitachi L300P inverters provide solid state motor overload protection, which depends on the proper setting of the following parameters:

• B012 "electronic overload protection"
• B212 "electronic overload protection, 2nd motor"

Set the rated current [Amperes] of the motor(s) with the above parameters. The setting range is 0.2 * rated current to 1.2 * rated current.

WARNING: When two or more motors are connected to the inverter, they cannot be protected by the electronic overload protection. Install an external thermal relay on each motor.

Table of Contents

Revisions

Revision History Table

No.	Revision Comments	Date of Issue	Operation Manual No.
	Initial release of manual NB604X	August 2001	NB604X
1	Added default terminal symbols to tables on 3–43, 3–48 Updated intelligent I/O wiring examples throughout Chapter 4 to use default terminals or otherwise least-used terminals Corrected alarm relay symbols in multiple pages in Chapter 4 Contents, Revisions, Index updates Front cover update	December 2001	NB604XA
2	Updated company name on cover, contact page, and nameplate photo Corrected graphs on pages 3–28 and 3–40 Made a few minor edits throughout	May 2002	NB604XB
3	Added ten new inverter sizes, models –015LFU2 to –075LFU2 and –015HFU2 to –075HFU2... included updates to Safety section wire and fuse size tables, Chapter 1 specs tables and derating curves, Chapter 2 dimension drawings, Chapter 2 wire and fuse size tables, Chapter 2 input power diagrams For new –xFU2 models, added new intelligent input [ROK] and new intelligent output [RMD] descriptions to Chapter 3 tables, Chapter 4 terminal listing and terminal description pages For new –xFU2 models, added new function P050 to Chapter 3 descriptions and Appendix C parameter listing Changed –xFU models references to –xFU2 throughout Added index entries for new –xFU2 functions Expanded derating curve graphs in Chapter 1 Corrected [FM] common terminal to [L] in Chapter 4 Analog Input section Updated wire and fuse sizes for larger horsepower models in Safety section tables and Chapter 2 tables Enhanced Chapter 5 text and diagrams for dynamic braking Other minor corrections / enhancements throughout Contents, Revisions, Index, Cover updates	August 2002	NB604XC
4	Added –xFE2 models in tables and diagrams throughout Updated keypad navigation map in Chapters 2 and 3 Enhanced sink/source input descriptions in Chapter 4 Contents, Revisions, Index, Cover updates	November 2002	NB604XD

Contact Information

Hitachi America, Ltd.
Power and Industrial Division
50 Prospect Avenue
Tarrytown, NY 10591
U.S.A.
Phone: +1-914-631-0600
Fax: +1-914-631-3672

Hitachi Australia Ltd.
Level 3, 82 Waterloo Road
North Ryde, N.S.W. 2113
Australia
Phone: +61-2-9888-4100
Fax: +61-2-9888-4188

Hitachi Europe GmbH
Am Seestern 18
D-40547 Düsseldorf
Germany
Phone: +49-211-5283-0
Fax: +49-211-5283-649

Hitachi Industrial Equipment Systems Co, Ltd.
International Sales Department
WBG MARIVE WEST 16F
6, Nakase 2-chome
Mihama-ku, Chiba-shi,
Chiba 261-7116 Japan
Phone: +81-43-390-3516
Fax: +81-43-390-3810

Hitachi Asia Ltd.
16 Collyer Quay
#20-00 Hitachi Tower, Singapore 049318
Singapore
Phone: +65-538-6511
Fax: +65-538-9011

Hitachi Industrial Equipment Systems Co, Ltd.
Narashino Division
1-1, Higashi-Narashino 7-chome
Narashino-shi, Chiba 275-8611
Japan
Phone: +81-47-474-9921
Fax: +81-47-476-9517

Hitachi Asia (Hong Kong) Ltd.
7th Floor, North Tower
World Finance Centre, Harbour City
Canton Road, Tsimshatsui, Kowloon
Hong Kong
Phone: +852-2735-9218
Fax: +852-2735-6793

NOTE: To receive technical support for the Hitachi inverter you purchased, contact the Hitachi inverter dealer from whom you purchased the unit, or the sales office or factory contact listed above. Please be prepared to provide the following inverter nameplate information:

1. Model
2. Date of purchase
3. Manufacturing number (MFG No.)
4. Symptoms of any inverter problem

If any inverter nameplate information is illegible, please provide your Hitachi contact with any other legible nameplate items. To reduce unpredictable downtime, we recommend that you stock a spare inverter.

Getting Started
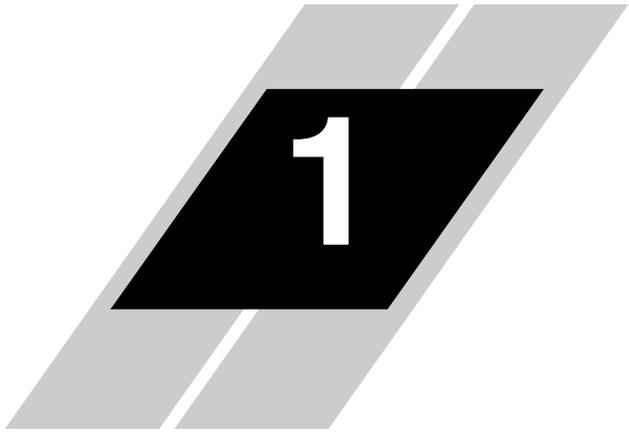
1

In This Chapter.... page

Introduction

Main Features

Congratulations on your purchase of an L300P Series Hitachi inverter! This inverter drive features state-of-the-art circuitry and components to provide high performance. The housing footprint is exceptionally small, given the size of the corresponding motor. The Hitachi L300P product line includes more than twenty inverter models to cover motor sizes from 2 horsepower to 175 horsepower, in either 230 VAC or 480 VAC power input versions. The main features are:

- 200V Class and 400V Class inverters
- UL or CE version available
- Variable frequency control
- Optional regenerative braking circuit
- Different operator keypads available for RUN/STOP control and setting parameters
- Built-in RS-422 communications interface to allow configuration from a PC and for field bus external modules
- Sixteen programmable speed levels
- PID control adjusts motor speed automatically to maintain a process variable value

Model L300P-110HFU2 (UL version)

The design of Hitachi inverters overcomes many of the traditional trade-offs between speed, torque and efficiency. The performance characteristics are:

- Continuous operation at 100% rated torque within a 1:10 speed range (6/60 Hz / 5/50 Hz) without motor derating
- Models up to and including 11kW and 15kW (15 and 20hp) have built-in dynamic braking units
- Cooling fan has ON/OFF selection to provide longer life

Model L300P-110HFE2 (CE Version)

A full line of accessories from Hitachi is available to complete your motor control application. These include:

- Digital remote operator keypad
- Expansion card for digital inputs
- Braking resistors
- Radio noise filters
- CE compliance filters
- Additional factory I/O network interface cards (to be announced)
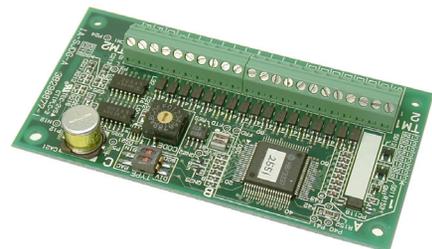
Expansion Card - Digital Inputs

Digital Operator Interface Components

The L300P Series inverters have a detachable keypad (called a digital operator) on the front panel of the housing. The particular keypad that comes with the inverter depends on the country or continent corresponding to the particular model number. The standard digital operators occupy just part of the keypad recess in the panel. Therefore, the inverter comes with a snap-in panel filler plate that mounts below the keypad as shown.

These detachable keypads can be mounted in a NEMA cabinet panel door cut-out, for example. Threaded metal inserts on the rear of the keypads facilitate this external mounting configuration. A short cable then connects the keypad unit to the connector in the inverter keypad recess. See Chapter 3 for information on how to install and use these keypads and cables.
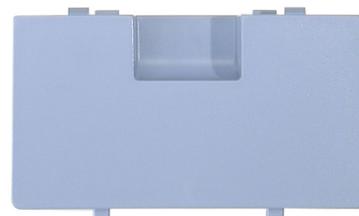
Digital Operator OPE-SRE
standard for -LFU2 and -HFU2 models

Digital Operator OPE-SR
standard for -HFE2 models

The digital operator / copy unit is optional, and occupies the entire keypad recess when mounted. It has the additional capability of reading (uploading) the parameter settings in the inverter into its memory. Then you can install the copy unit on another inverter and write (download) the parameter settings into that inverter. OEMs will find this unit particularly useful, as one can use a single copy unit to transfer parameter settings from one inverter to many.

Other digital operator interfaces may be available from your Hitachi distributor for particular industries or international markets. Contact your Hitachi distributor for further details.

Optional Digital Operator / Copy Unit
SRW-0EX

Removable Components

The L300P Series inverters are designed for long life and ease of service. Several components are removable as shown below, aiding installation or parts replacement. Details on how and when to remove these parts are in the referenced chapters.

Fan Unit
(See Chapter 6 for servicing)

Digital Operator and Panel Filler Plate
(See Chapter 3 for instructions)

Auxiliary fan (on some models)

Control Signal Terminal Block
(See Chapter 4 for wiring)

Capacitor Bank for DC Link
(See Chapter 6 for servicing)

Cable entry/exit plate
(See Chapter 2 for instructions)

Specifications Label and Agency Approvals

The Hitachi L300P inverters have product specifications labels located on the front and the right side of the housing, as pictured to the right. Be sure to verify that the specifications on the labels match your power source, motor, and application safety requirements.

Product Labels

Regulatory agency approvals   Specifications

Inverter model number

Motor capacity for this model

Power Input Rating:
  frequency, voltage, phase, current

Output Rating:
  frequency, voltage, current

Manufacturing codes:
  lot number, date, etc.

HITACHI

Model: L300P -110LFU2
kW/(HP): 15 / (11)
Input/Entrée: 50Hz, 60Hz   V 1Ph   A
              50Hz, 60Hz 200-240V 3Ph   48 A
Output/Sortie: 0.1-400Hz 200-240V 3Ph   44 A
MFG No. 9JH T24495B90006   Date: 9911
Hitachi Industrial Equipment
Systems Co., Ltd.   MADE IN JAPAN NE17124 -204

E178141 [AK]

UL LISTED
IND.CONT.EQ.31UA
c UL

CE c   N155

Model Number Convention

The model number for a specific inverter contains useful information about its operating characteristics. Refer to the model number legend below:

| L300P | — | 110 | H | F | U | 2 |

Version number (_, 2, 3, ...)

Restricted distribution:
  E=Europe, U=USA

Configuration type
  F = with digital operator (keypad)

Input voltage:
  H = three-phase 400V class
  L = three phase only, 200V class

Series name

Applicable motor capacity in kW

015 = 1.5 kW	300 = 30 kW
022 = 2.2 kW	370 = 37 kW
037 = 3.7 kW	450 = 45 kW
055 = 5.5 kW	550 = 55 kW
075 = 7.5 kW	750 = 75 kW
110 = 11 kW	900 = 90 kW
150 = 15 kW	1100 = 110 kW
185 = 18.5 kW	1320 = 132 kW
220 = 22 kW	

L300P Inverter Specifications

Tables for 200V class inverters

Note that "General Specifications" on page 1–9 covers all L300P inverters, followed by footnotes for all specifications tables. Seven 200V models in the tables below (2 to 20 hp) have internal dynamic braking units (see "Dynamic Braking" on page 5–6).

Item			200V Class Specifications				
L300P inverters, 200V models, UL ver.			015LFU2	022LFU2	037LFU2	055LFU2	075LFU2
Applicable motor size, 4-pole *2		**HP**	**2**	**3**	**5**	**7.5**	**10**
		kW	1.5	2.2	3.7	5.5	7.5
Rated capacity (200/240V) kVA			2.5 / 3.1	3.6 / 4.3	5.7 / 6.8	8.3 / 9.9	11 / 13.3
Rated input voltage			3-phase: 200 to 240V ±10%, 50/60 Hz ±5%				
Rated input current (A)			8.3	12	18	26	35
Rated output voltage *3			3-phase (3-wire) 200 to 240V (corresponding to input voltage)				
Rated output current (A)			7.5	10.5	16.5	24	32
Efficiency at 100% rated output, %			92.3	93.2	94.0	94.4	94.6
Watt loss, approximate (W)	at 70% output		102	127	179	242	312
	at 100% output		125	160	235	325	425
Dynamic braking approx. % torque, short time stop *7	without ext. res.		50%	20%			
	with external res.		200%	160%	100%	80%	
DC braking			Variable operating frequency, time, and braking force				
Weight	kg / lb		3.5 / 7.7	3.5 / 7.7	3.5 / 7.7	3.5 / 7.7	5 / 11

Item			200V Class Specifications				
L300P inverters, 200V models, UL ver.			110LFU2	150LFU2	185LFU2	220LFU2	300LFU2
Applicable motor size, 4-pole *2		**HP**	**15**	**20**	**25**	**30**	**40**
		kW	11	15	18.5	22	30
Rated capacity (200/240V) kVA			15.2 / 18.2	20.0 / 24.1	25.2 / 30.3	29.4 / 35.3	39.1 / 46.9
Rated input voltage			3-phase: 200 to 240V ±10%, 50/60 Hz ±5%				
Rated input current (A)			48	64	80	94	124
Rated output voltage *3			3-phase (3-wire) 200 to 240V (corresponding to input voltage)				
Rated output current (A)			44	58	73	85	113
Efficiency at 100% rated output, %			94.8	94.9	95	95	95
Watt loss, approximate (W)	at 70% output		435	575	698	820	1100
	at 100% output		600	800	975	1150	1550
Dynamic braking approx. % torque, short time stop *7	without ext. res.		10%	10%	10%	10%	10%
	with external res.		55%	50%	—		
	with external res. and braking unit		—		25–170%	25–150%	55–110%
DC braking			Variable operating frequency, time, and braking force				
Weight	kg / lb		5 / 11	5 / 11	12 / 26.4	12 / 26.4	12 / 26.4

Item		200V Class Specifications, continued			
L300P inverters, 200V models, UL ver.		370LFU2	450LFU2	550LFU2	750LFU2
Applicable motor size *2	**HP**	**50**	**60**	**75**	**100**
	kW	37	45	55	75
Rated capacity (200/240V) kVA		48.4 / 58.1	58.5 / 70.2	72.7 / 87.2	93.5 / 112.2
Rated input voltage		3-phase: 200 to 240V ±10%, 50/60 Hz ±5%			
Rated input current (A)		154	186	231	297
Rated output voltage *3		3-phase (3-wire) 200 to 240V (corresponding to input voltage)			
Rated output current (A)		140	169	210	270
Efficiency at 100% rated output, %		95.1	95.1	95.1	95.1
Watt loss, approximate (W)	at 70% output	1345	1625	1975	2675
	at 100% output	1900	2300	2800	3800
Dynamic braking approx. % torque, short time stop *7	without external braking unit	10%	10%	10%	10%
	with external res. and braking unit	45–90%	35–75%	30–60%	30–60%
DC braking		Variable operating frequency, time, and braking force			
Weight	kg / lb	20 / 44	30 / 66	30 / 66	50 / 110

Tables for 400V class inverters

Note that covers all L300P inverters, followed by footnotes for all specifications tables. Seven 400V models in the tables below (2 to 20 hp) have internal dynamic braking units (see).

Item		400V Class Specifications				
L300P inverters, 400V models	UL version	015HFU2	022HFU2	040HFU2	055HFU2	075HFU2
	CE version	015HFE2	022HFE2	040HFE2	055HFE2	075HFE2
Applicable motor size *2	**HP**	**2**	**3**	**5**	**7.5**	**10**
	kW	1.5	2.2	4.0	5.5	7.5
Rated capacity (400 / 480V) kVA		2.6 / 3.1	3.6 / 4.4	5.9 / 7.1	8.3 / 9.9	11 / 13.3
Rated input voltage		3-phase (3-wire) 380 to 480V ±10%, 50/60 Hz ±5%				
Rated input current (A)		4.2	5.8	9.5	13	18
Rated output voltage *3		3-phase (3-wire): 380 to 480V (corresponding to input voltage)				
Rated output current (A)		3.8	5.3	8.6	12	16
Efficiency at 100% rated output, %		92.3	93.2	94.0	94.4	94.6
Watt loss, approximate (W)	at 70% output	102	127	179	242	312
	at 100% output	125	160	235	325	425
Dynamic braking approx. % torque, short time stop *7	without ext. res.	50%	20%			
	with external res.	200%		140%		100%
DC braking		Variable operating frequency, time, and braking force				
Weight	kg / lb	3.5 / 7.7	3.5 / 7.7	3.5 / 7.7	3.5 / 7.7	55 / 121

Geting Started

Item			400V Class Specifications					
L300P inverters, 400V models	UL version		110HFU2	150HFU2	185HFU2	220HFU2	300HFU2	370HFU2
	CE version		110HFE2	150HFE2	185HFE2	220HFE2	300HFE2	370HFE2
Applicable motor size *2	HP		**15**	**20**	**25**	**30**	**40**	**50**
	kW		11	15	18.5	22	30	37
Rated capacity (400 / 480V) kVA			15.2 / 18.2	20.0 / 24.1	25.6 / 30.7	29.7 / 35.7	39.4 / 47.3	48.4 / 58.1
Rated input voltage			3-phase (3-wire) 380 to 480V ±10%, 50/60 Hz ±5%					
Rated input current (A)			24	32	41	47	63	77
Rated output voltage *3			3-phase (3-wire): 380 to 480V (corresponding to input voltage)					
Rated output current (A)			22	29	37	43	57	70
Efficiency at 100% rated output, %			94.8	94.9	95	95	95	95.1
Watt loss, approximate (W)	at 70% output		435	575	698	820	1100	1345
	at 100% output		600	800	975	1150	1550	1900
Dynamic braking approx. % torque, short time stop *7	without ext. res.		10%	10%	10%	10%	10%	10%
	with external res.		55%	50%	—			
	with external res. and braking unit		—		40–200%	35–200%	110–170%	90–150%
DC braking			Variable operating frequency, time, and braking force					
Weight	kg / lb		5 / 11	5 / 11	12 / 26.4	12 / 26.4	12 / 26.4	20 / 44

Item			400V Class Specifications					
L300P inverters, 400V models	UL version		450HFU2	550HFU2	750HFU2	900HFU2	1100HFU2	1320HFU2
	CE version		450HFE2	550HFE2	750HFE2	900HFE2	1100HFE2	1320HFE2
Applicable motor size *2	HP		**60**	**75**	**100**	**125**	**150**	**175**
	kW		45	55	75	90	110	132
Rated capacity (400 / 480V) kVA			58.8 / 70.1	72.7 / 87.2	93.5 / 112	111 / 133	135 / 162	159 / 191
Rated input voltage			3-phase (3-wire) 380 to 480V ±10%, 50/60 Hz ±5%					
Rated input current (A)			94	116	149	176	215	253
Rated output voltage *3			3-phase (3-wire): 380 to 480V (corresponding to input voltage)					
Rated output current (A)			85	105	135	160	195	230
Efficiency at 100% rated output, %			95.1	95.1	95.1	95.2	95.2	95.2
Watt loss, approximate (W)	at 70% output		1625	1975	2675	3375	3900	4670
	at 100% output		2300	2800	3800	4800	5550	6650
Dynamic braking approx. % torque, short time stop *7	without external braking unit		10%	10%	10%	10%	10%	10%
	with external res. and braking unit		70–120%	60–100%	45–70%	40–60%	30–50%	25–40%
DC braking			Variable operating frequency, time, and braking force					
Weight	kg / lb		30 / 66	30 / 66	30 / 66	60 / 132	60 / 132	80 / 176

General Specifications   The following table (continued on next page) applies to all L300P inverter models.

Item			General Specifications
Protective enclosure *1 *11			Models L300P–110xxx to 750xxx: IP20 (NEMA 1) Models L300P–900xx to 1320xxx: IP00
Control method			Line-to-line sine wave pulse-width modulation (PWM) control
Output frequency range *4			0.1 to 400 Hz
Frequency accuracy			Digital command: ± 0.01% of the maximum frequency Analog command: ± 0.2% (25°C ± 10°C)
Frequency setting resolution			Digital: ± 0.01 Hz; Analog: (max. frequency)/4000, [O] terminal: 12-bit, 0 to 10V; [OI] terminal: 12-bit, 4-20mA; 12 bit [O2] terminal: 12 bit –10 to +10V
Volt./Freq. characteristic			V/F optionally variable (30 to 400Hz base frequency), V/F control (constant torque, reduced torque)
Overload capacity (output current)			120% for 60 seconds, 150% for 0.5 seconds
Acceleration/deceleration time			0.01 to 3600 sec., (linear curve profiles, accel./decel. selection), two-stage accel./decel.
Input signal	Freq. setting	Operator keypad	Up and Down keys / Value settings
		Potentiometer	Analog setting via potentiometer on operator keypad
		External signal *8	0 to 10 VDC (input impedance 10k Ohms), 4 to 20 mA (input impedance 100 Ohms), Potentiometer (1k to 2k Ohms, 2W)
		Serial port	RS485 interface
	FW/RV Run	Operator panel	Run key / Stop key (change FW/RV by function command)
		External signal	FW Run/Stop (NO contact), RV set by terminal assignment (NC/NO), 3-wire input available
	Intelligent Input terminals (assign eight functions to terminals)		RV (reverse run/stop), CF1~CF4 (multi-speed select), JG (jogging), DB (external DC braking), SET (set 2nd motor data), 2CH (2-stage accel./decel.), FRS (free-run stop), EXT (external trip), USP (unattended start protection), CS (commercial power source), SFT (software lock), AT (analog input voltage/current select), RS (reset inverter), STA (start, 3-wire interface), STP (stop, 3-wire interface), F/R (FW/RV 3-wire interface), PID (PID ON/OFF), PIDC (PID reset), CAS (control gain setting), UP (remote control Up function, motorized speed pot.), DWN (remote control Down function, motorized speed pot.), UDC (remote control data clearing), OPE (Operator control), SF1-SF7 (Multispeed bits 0-7), OLR (Overload limit change)
	Thermistor input		One terminal (PTC characteristics)
Output signal	Intelligent Output terminals (assign three functions to two relay N.O. (1 Form A) outputs and one relay N.O.-N.C. (1 Form C) contact		RUN (run signal), FA1 (Frequency arrival type 1 – constant speed), FA2 (Frequency arrival type 2 – over-frequency), OL (overload advance notice signal 1), OD (Output deviation for PID control), AL (alarm signal), FA3 (Frequency arrival type 3 – at-frequency), IP (Instantaneous power failure signal), UV (Under-voltage signal), RNT (Run time over), ONT (Power-ON time over), THM (thermal alarm)
	Intelligent monitor output terminals		Analog voltage monitor, analog current monitor (8-bit resolution), and PWM output, on terminals [AM], [AMI], and [FM]
Display monitor			Output frequency, output current, motor torque, scaled value of output frequency, trip history, I/O terminal condition, input power, output voltage
Other user-settable parameters			V/F free-setting (up to 7 points), frequency upper/lower limit, frequency jump, accel/ decel curve selection, manual torque boost value and frequency adjustment, analog meter tuning, start frequency, carrier frequency, electronic thermal protection level, external frequency output zero/span reference, external frequency input bias start/end, analog input selection, retry after trip, restart after instantaneous power failure, overload restriction, default value setting (US, Europe, Japan)
Carrier frequency range			Models L300P–015xxx to 750xxx: 0.5 to 12 kHz Models L300P–900Hxx to 1320Hxx: 0.5 to 8 kHz

| Item		General Specifications
Protective functions		Over-current, overload, braking resistor overload, over-voltage, EEPROM error, under-voltage error, CT (current transformer) error, CPU error, external trip, USP error, ground fault, input over-voltage, instantaneous power failure, inverter thermal trip, phase failure detection, IGBT error, thermistor error, expansion card 1 error, expansion card 2 error, under-voltage waiting error
Environ-ment	Temperature *10	Operating (ambient): -10 to 40°C / Storage: -20 to 65°C
	Humidity	20 to 90% humidity (non-condensing)
	Vibration *7	Models L300P–110xxx to 300xxx: 5.9 m/s^2 (0.6G), 10 to 55 Hz Models L300P–370xx to 1320xxx: 2.94 m/s^2 (0.3G), 10 to 55 Hz
	Location *8	Altitude 1,000 m or less, indoors (no corrosive gasses or dust)
Coating color		Models L300P–110xxx to 750xxx: Blue (D.I C14 version No. 436) Models L300P–900xx to 1320xxx: Gray (MUNSELL 8.5YR6.2/0.2)
Accessories	Digital input PCB	SJ-DG (4-digit BCD / 16-bit binary)
	Others	EMI filters, input/output reactors, DC reactors, radio noise filters, braking resistors, braking units, LCR filter, communication cables, factory I/O network interface cards
Operator input devices *9		OPE–SRE (4-digit LED with potentiometer) / OPE–S (4-digit LED w/o potentiometer), Optional: OPE-SR (4-digit LED with potentiometer, Japanese/English overlay), SRW–0EX Multilingual operator with copy function (English, French, German, Italian, Spanish, and Portuguese)

Footnotes for the preceding tables:

Note 1: The protection method conforms to JEM 1030.

Note 2: The applicable motor refers to Hitachi standard 3-phase motor (4-pole). When using other motors, care must be taken to prevent the rated motor current (50/60 Hz) from exceeding the rated output current of the inverter.

Note 3: The output voltage decreases as the main supply voltage decreases (except when using the AVR function). In any case, the output voltage cannot exceed the input power supply voltage.

Note 4: To operate the motor beyond 50/60 Hz, consult the motor manufacturer for the maximum allowable rotation speed.

Note 5: The braking resistor is not installed in the inverter. When your application requires a high regenerative torque, use the optional regenerative braking unit and resistor (see Chapter 5).

Note 6: The storage temperature refers to the short-term temperature during transport.

Note 7: Conforms to the test method specified in JIS C0911 (1984). For the model types excluded in the standard specifications, contact your Hitachi sales representative.

Note 8: When using the inverter in a dust-prone area, we recommend the optional varnish coating specification for the inverter.

Note 9: When using a remote operator keypad and cable, be sure to remove the RJ45 modular interconnect from the inverter's keypad port before connecting the cable.

Note 10: When using the inverter from 40° to 50°C ambient, the output current of the inverter must be derated (see the next section on derating curves).

Note 11: NEMA 1 applies to inverter models up to 30kW (–300xxx). An optional wire-entry conduit box is required for inverter models 37kW to 75kW (–370 to –750xxx) to meet the NEMA 1 rating.

Derating Curves

The maximum available inverter current output is limited by the carrier frequency and ambient temperature. The carrier frequency is the inverter's internal power switching frequency, settable from 0.5 kHz to 12 kHz, or 0.5 kHz to 8 kHz for higher horsepower models. Choosing a higher carrier frequency tends to decrease audible noise, but it also increases the internal heating of the inverter, thus decreasing (derating) the maximum current output capability. Ambient temperature is the temperature just outside the inverter housing—such as inside the control cabinet where the inverter is mounted. A higher ambient temperature decreases (derates) the inverter's maximum current output capacity.

Use the following derating curves to help determine the optimal carrier frequency setting for your inverter, and to find the output current derating. Be sure to use the proper curve for your particular L300P inverter model number.

Legend:	————————	Output current at 40 °C ambient
	- - - - - - - -	Output current at 50 °C ambient

**L300P 1.5 to 22 kW 200V class**

**Carrier Frequency (kHz)**
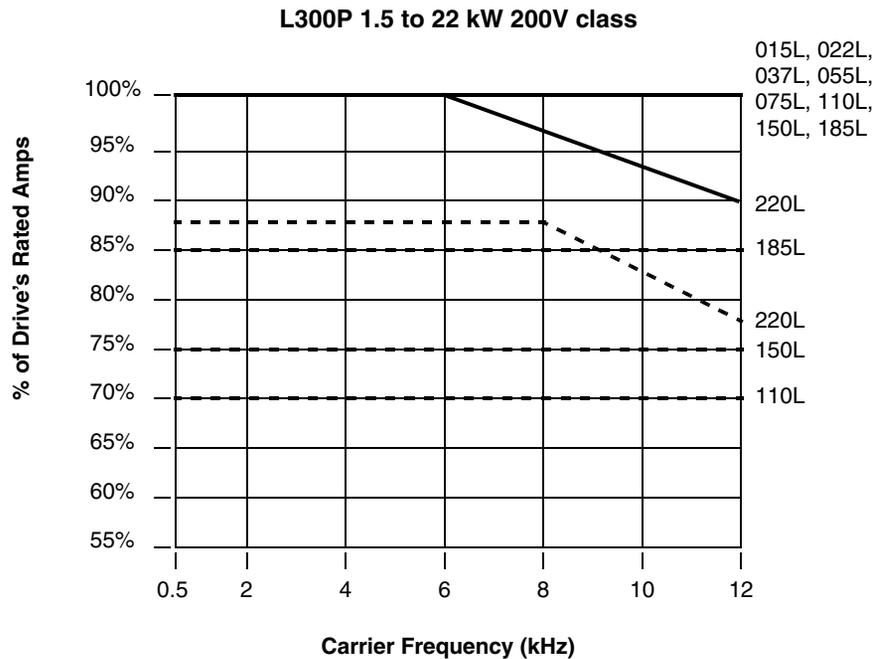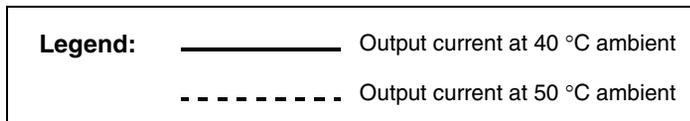
Derating curves, continued...

**L300P 30 to 37 kW 200V class**
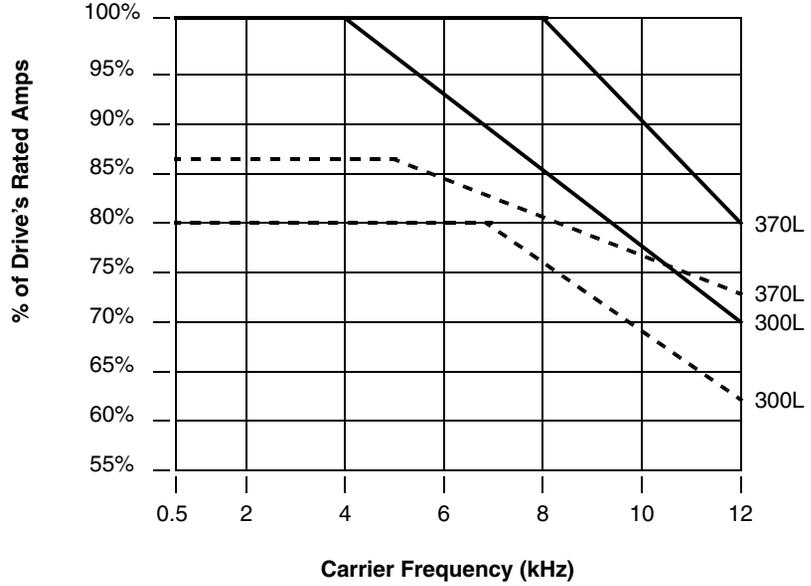
L300P 45 to 75 kW 200V class

Derating curves, continued...

L300P 1.5 to 22 kW 400V class

015H, 022H,
030H, 040H,
055H, 075H,
110H, 150H,
185H, 220H

% of Drive's Rated Amps

95%

90%

85% — — — — — — — — — — — — 185H, 220H

80%

75% — — — — — — — — — — — — 150H

70% — — — — — — — — — — — — 110H

65%

60%

55%

0.5   2   4   6   8   10   12

Carrier Frequency (kHz)

L300P 30 to 37 kW 400V class

% of Drive's Rated Amps

95%

90%   300H

85%

80%   370H

75%   370H

70%   300H

65%

60%

55%

0.5   2   4   6   8   10   12

Carrier Frequency (kHz)
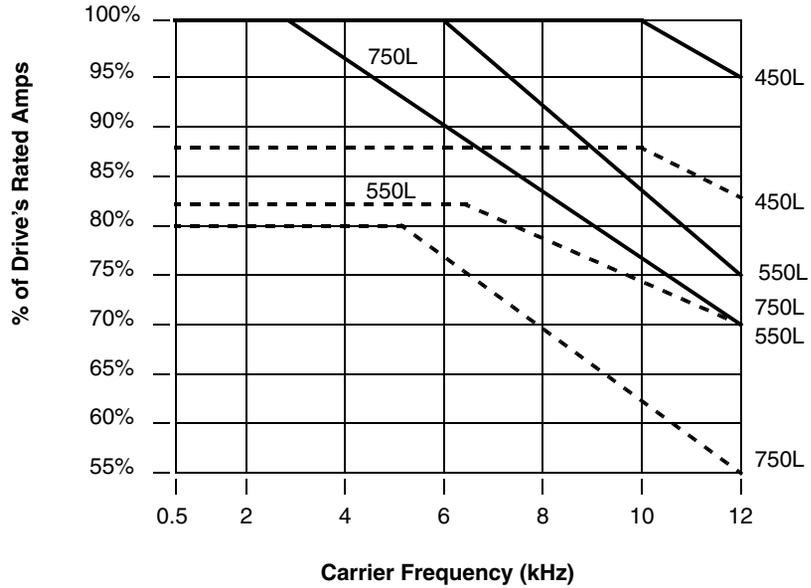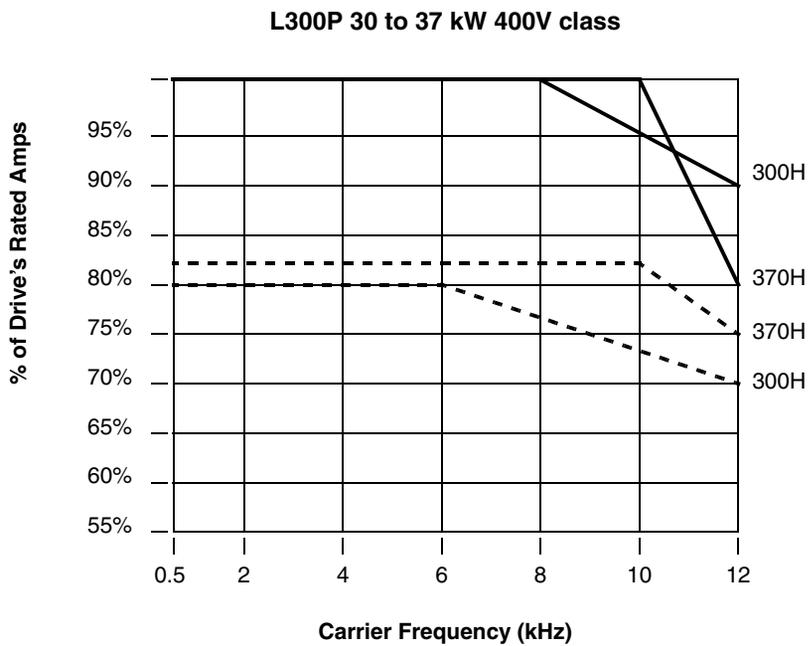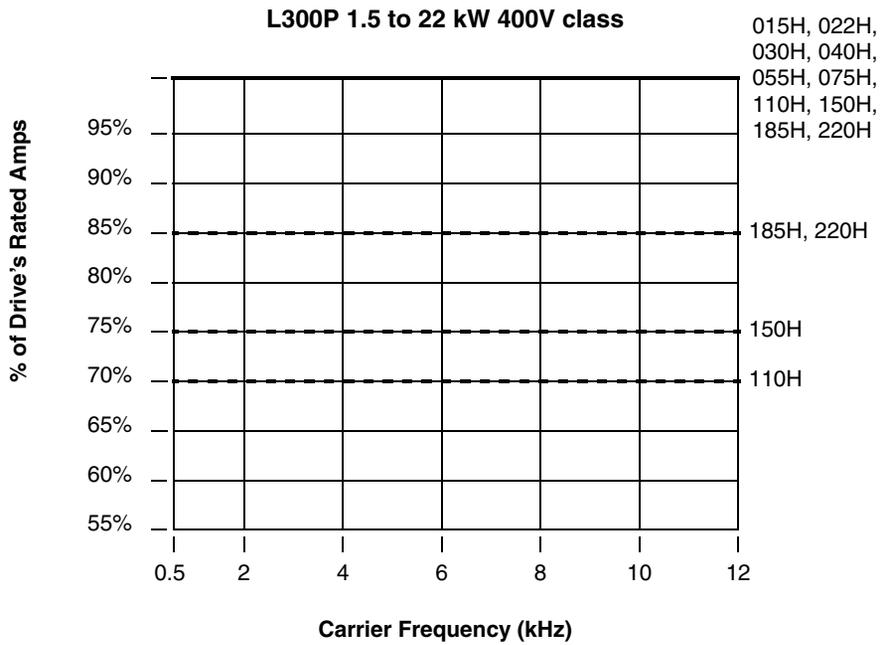
Derating curves, continued...

L300P 45 to 75 kW 400V class

Carrier Frequency (kHz)
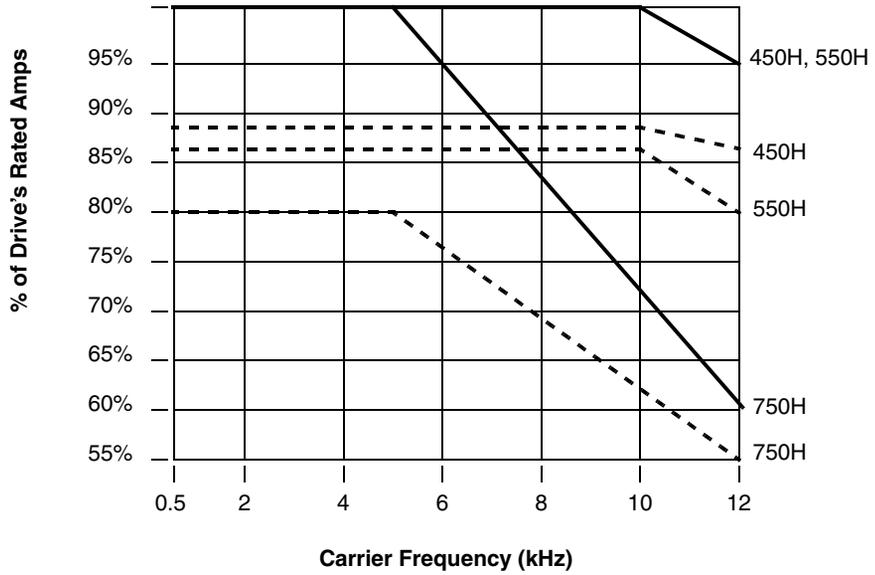
L300P 90 to 132 kW 400V class

Carrier Frequency (kHz)
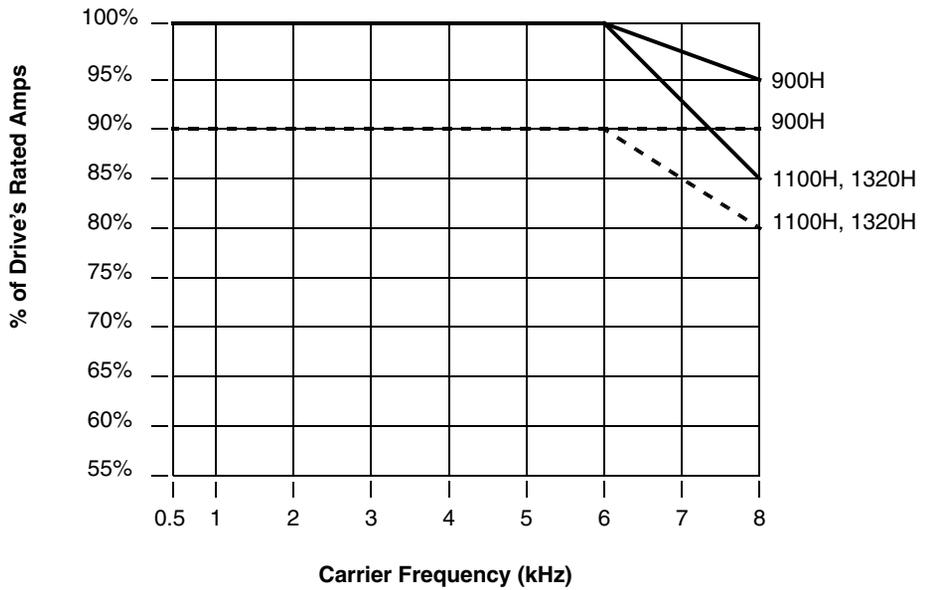
Introduction to Variable-Frequency Drives

The Purpose of Motor Speed Control for Industry

Hitachi inverters provide accurate speed control for 3-phase AC induction motors. You connect AC power to the inverter, and connect the inverter to the motor. Many applications can benefit from the use of variable-speed drives in several ways:

- Energy savings - HVAC
- Need to coordinate speed with an adjacent process - textiles and printing presses
- Need to control acceleration and deceleration (torque)
- Sensitive loads - elevators, food processing, pharmaceuticals

What is an Inverter?

The term *inverter* and *variable-frequency drive* are related and somewhat interchangeable. An electronic drive for an AC motor controls the motor's speed by *varying the frequency* of the power sent to the motor.

An inverter, in general, is a device that converts DC power to AC power. The figure below shows how the variable-frequency drive employs an internal inverter. The drive first converts incoming AC power to DC through a rectifier bridge, creating an internal DC bus voltage. Then the inverter circuit converts the DC back to AC again to power the motor. The special inverter can vary its output frequency and voltage according to the desired motor speed.


Variable-frequency Drive
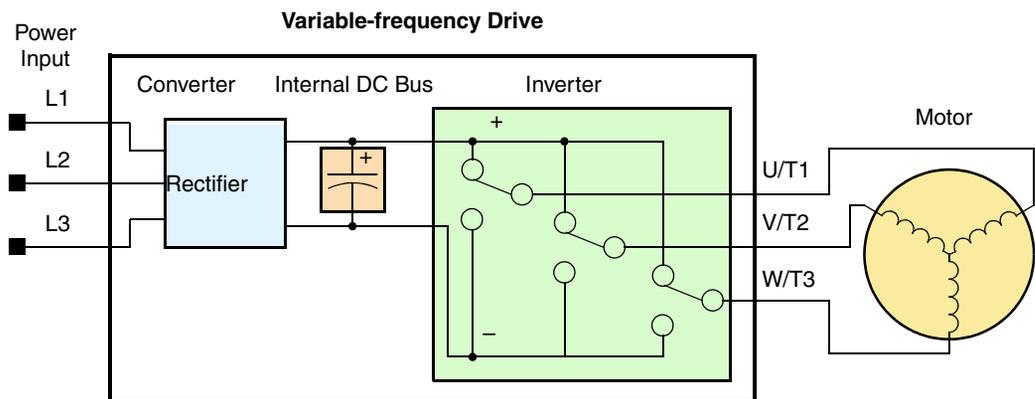
The simplified drawing of the inverter shows three double-throw switches. In Hitachi inverters, the switches are actually IGBTs (isolated gate bipolar transistors). Using a commutation algorithm, the microprocessor in the drive switches the IGBTs ON and OFF at a very high speed to create the desired output waveforms. The inductance of the motor windings helps smooth out the pulses.

Torque and Constant Volts/ Hertz Operation

In the past, AC variable speed drives used an open loop (scalar) technique to control speed. The constant-volts-per-hertz operation maintains a constant ratio between the applied voltage and the applied frequency. With these conditions, AC induction motors inherently delivered constant torque across the operating speed range. For some applications, this scalar technique was adequate.

Today, with the advent of sophisticated micro-processors and digital signal processors (DSPs), it is possible to control the speed and torque of AC induction motors with unprece-dented accuracy. The L300P utilizes these devices to perform complex mathematical calculations required to achieve superior performance. You can choose various torque curves to fit the needs of your application. *Constant torque* applies the same torque level across the frequency (speed) range. *Variable torque*, also called *reduced torque*, lowers the torque delivered at mid-

level frequencies. A torque boost setting will add additional torque in the lower half of the frequency range for the constant and variable torque curves. With the *free-setting torque* curve feature, you can specify a series of data points that will define a custom torque curve to fit your application.
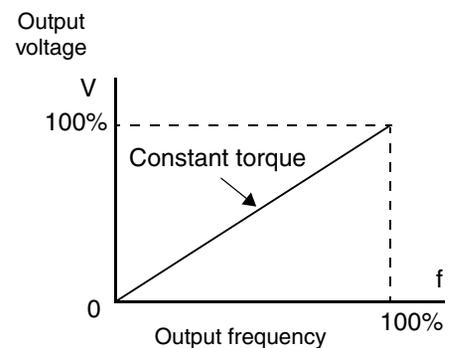
Inverter Input and Three-Phase Power

The Hitachi L300P Series of inverters includes two sub-groups: the 200V class and the 400V class inverters. The drives described in this manual may be used in either the United States or Europe, although the exact voltage level for commercial power may be slightly different from country to country. Accordingly, a 200V class inverter requires (nominal) 200 to 240VAC, and a 400V class inverter requires from 380 to 480VAC. All L300P inverters require three-phase input power, whether 200V or 400V class.

TIP: If your application only has single phase power available, refer to the Hitachi L100 Series inverters. L100 inverters of 3HP or less can accept single phase input power.

The common terminology for single phase power is Line (L) and Neutral (N). Three-phase power connections are usually labeled Line 1 (L1), Line 2 (L2) and Line 3 (L3). In any case, the power source should include a ground connection. That ground connection will need to connect to the inverter chassis and to the motor frame (see).

Inverter Output to the Motor

The AC motor must be connected only to the inverter's output terminals. The output terminals are uniquely labeled (to differentiate them from the input terminals) with the designations U/T1, V/T2, and W/T3. This corresponds to typical motor lead connection designations T1, T2, and T3. It is often not necessary to connect a particular inverter output to a particular motor lead for a new application. The consequence of swapping any two of the three connections is the reversal of the motor direction. In applications where reversed rotation could cause equipment damage or personnel injury, be sure to verify direction of rotation before attempting full-speed operation. For safety to personnel, you must connect the motor chassis ground to the ground connection at the bottom of the inverter housing.
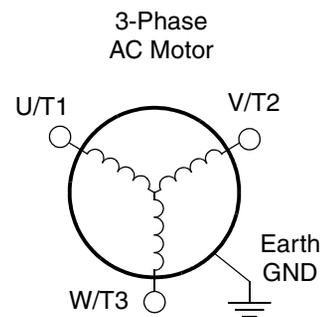
Notice the three connections to the motor do not include one marked "Neutral" or "Return." The motor represents a balanced "Y" impedance to the inverter, so there is no need for a separate return. In other words, each of the three "Hot" connections serves also as a return for the other connections, because of their phase relationship.

The Hitachi inverter is a rugged and reliable device. The intention is for the inverter to assume the role of controlling power to the motor during all normal operations. Therefore, this manual instructs you not to switch OFF power to the inverter *while the motor is running* (unless it is an emergency stop). Also, do not install or use disconnect switches in the wiring from the inverter to the motor (except thermal disconnect). Of course, safety-related devices such as fuses must be in the design to break power during a malfunction, as required by NEC and local codes.

Intelligent Functions and Parameters

Much of this manual is devoted to describing how to use inverter functions and how to configure inverter parameters. The inverter is microprocessor-controlled, and has many independent functions. The microprocessor has an on-board EEPROM for parameter storage. The inverter's front panel keypad provides access to all functions and parameters, which you can access through other devices as well. The general name for all these devices is the *digital operator*, or *digital operator panel*. Chapter 2 will show you how to get a motor running, using a minimal set of function commands or configuring parameters.

The optional read/write programmer will let you read and write inverter EEPROM contents from the programmer. This feature is particularly useful for OEMs who need to duplicate a particular inverter's settings in many other inverters in assembly-line fashion.

Braking

In general, braking is a force that attempts to slow or stop motor rotation. So it is associated with motor deceleration, but may also occur even when the load attempts to drive the motor faster than the desired speed (overhauling). If you need the motor and load to decelerate quicker than their natural deceleration during coasting, we recommend installing a braking resistor. The dynamic braking unit (built into certain L300P models) sends excess motor energy into a resistor to slow the motor and load (see "Introduction" on page 5–2 and "Dynamic Braking" on page 5–6 for more information). For loads that continuously overhaul the motor for extended periods of time, the L300P may not be suitable (contact your Hitachi distributor).

The inverter parameters include acceleration and deceleration, which you can set to match the needs of the application. For a particular inverter, motor, and load, there will be a range of practically achievable accelerations and decelerations.

Velocity Profiles

The L300P inverter is capable of sophisticated speed control. A graphical representation of that capability will help you understand and configure the associated parameters. This manual makes use of the velocity profile graph used in industry (shown at right). In the example, the acceleration is a ramp to a set speed, and the deceleration is a decline to a stop.


Velocity Profile
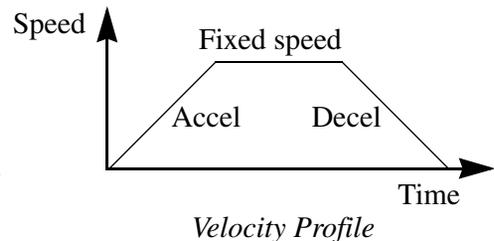
Acceleration and deceleration settings specify the time required to go from a stop to maximum frequency (or visa versa). The resulting slope (speed change divided by time) is the acceleration or deceleration. An increase in output frequency uses the accel-eration slope, while a decrease uses the deceleration slope. The accel or decel time a particular speed change depends on the starting and ending frequencies. However, the slope is constant, corresponding to the full-scale accel or decel time setting.

For example, the full-scale acceleration setting (time) may be 10 seconds—the time required to go from 0 to 60 Hz.

The L300P inverter can store up to 16 preset speeds. And, it can apply separate accelera-tion and deceleration transitions from any preset to any other preset speed. A multi-speed profile (shown at right) uses two or more preset speeds, which you can select via intelligent input terminals. This external control can apply any preset speed at any time. Alternatively, the selected speed is infinitely variable across the speed range. You can use the potentiometer control on the keypad for manual control. The drive accepts analog 0-10V signals and 4-20 mA control signals as well.

Multi-speed Profile

The inverter can drive the motor in either direction. Separate FW and RV commands select the direction of rotation. The motion profile example shows a forward motion followed by a reverse motion of shorter duration. The speed presets and analog signals control the magnitude of the speed, while the FW and RV commands determine the direction before the motion starts.

Bi-directional Profile
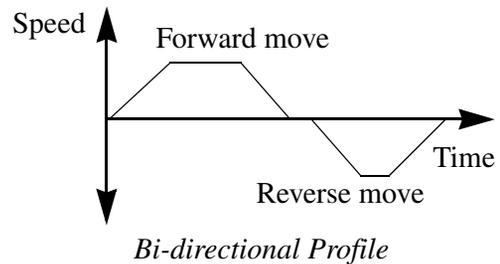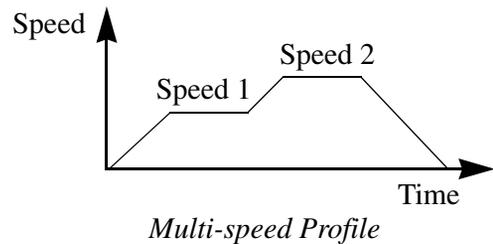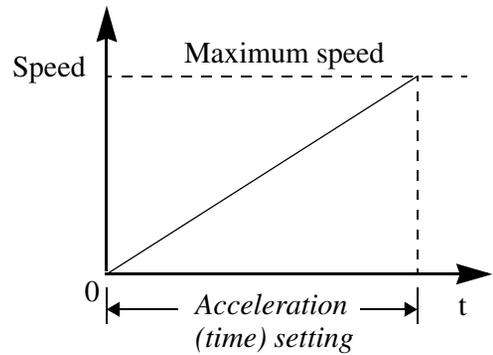
NOTE: The L300P can move loads in both directions. However, it is not designed for use in servo-type applications that use a bipolar velocity signal that determines direction.

Frequently Asked Questions

Q. What is the main advantage in using an inverter to drive a motor, compared to alternative solutions?

A. An inverter can vary the motor speed with very little energy loss, unlike mechanical or hydraulic speed control solutions. The resulting energy savings can often pay for the inverter in a relatively short time.

Q. The term "inverter" is a little confusing, since we also use "drive" and "amplifier" to describe the electronic unit that controls a motor. What does "inverter" mean?

A. The terms are used somewhat interchangeably in industry. Nowadays, the terms *drive*, *variable-frequency drive*, *variable-speed drive*, and *inverter* are generally used to describe electronic, microprocessor-based motor speed controllers. In the past, *variable speed drive* also referred to various mechanical means to vary speed. *Amplifier* is a term almost exclusively used to describe drives for servo or stepper motors.

Q. Although the L300P inverter is a variable speed drive, can I use it in a fixed-speed application?

A. Yes, sometimes an inverter can be used simply as a "soft-start" device, providing controlled acceleration and deceleration to a fixed speed. Other functions of the L300P may be useful in such applications, as well. However, using a variable speed drive can benefit many types of industrial and commercial motor applications, by providing controlled acceleration and deceleration, high torque at low speeds, and energy savings over alternative solutions.

Q. Does the optional digital operator interface or the PC software (DOP Professional) provide features beyond what is available from the keypad on the unit?

A. Yes. However, note first that the same set of parameters and functions are equally accessible from either the unit's keypad or from remote devices. The DOP Professional PC software lets you save or load inverter configurations to or from a disk file. And, the hand-held digital operator provides hard-wired terminals, a safety requirement for some installations.

Q. Why does the manual or other documentation use terminology such as "200V class" instead of naming the actual voltage, such as "230 VAC?"

A. A specific inverter model is set at the factory to work across a voltage range particular to the destination country for that model. The model specifications are on the label on the side of the inverter. A European 200V class inverter ("EU" marking) has different parameter settings than a USA 200V class inverter ("US" marking). The initialization procedure (see "Restoring Factory Default Settings" on page 6–9) can set up the inverter for European or US commercial voltage ranges.

Q. Why doesn't the motor have a neutral connection as a return to the inverter?

A. The motor theoretically represents a "balanced Y" load if all three stator windings have the same impedance. The Y connection allows each of the three wires to alternately serve as input or return on alternate half-cycles.

Q. Does the motor need a chassis ground connection?

A. Yes, for several reasons. Most importantly, this provides protection in the event of a short in the motor that puts a hazardous voltage on its housing. Secondly, motors exhibit leakage currents that increase with aging. Lastly, a grounded chassis generally emits less electrical noise than an ungrounded one.

Q. What type of motor is compatible with the Hitachi inverters?

A. **Motor type** – It must be a three phase AC induction motor. Use an inverter-grade motor that has 800V insulation for 200V class inverters, or 1600V insulation for 400V class.
Motor size – In practice, it's better to find the right size motor for your application; then look for the inverter to match the motor.

NOTE: There may be other factors that will affect motor selection, including heat dissipation, motor operating speed profile, enclosure type, and cooling method.

Q. How many poles should the motor have?

A. Hitachi inverters can be configured to operate motors with 2, 4, 6, or 8 poles. The greater the number of poles, the slower the top motor speed will be, but it will have higher torque at the base speed.

Q. Will I be able to add dynamic (resistive) braking to my Hitachi L300P drive after the initial installation?

A. Yes. Models L300P-110xxx and L300P-150xxx have built-in dynamic braking units. You can add an external resistor to these models to improve braking performance. Models L300P-185xxx through L300P-1320xxx require you to add an external braking unit. The braking resistor connects to the external braking unit for those models. More information on dynamic braking is located in Chapter 5.

Q. How will I know if my application will require resistive braking?

A. For new applications, it may be difficult to tell before you actually test a motor/drive solution. In general, some applications can rely on system losses such as friction to serve as the decelerating force, or otherwise can tolerate a long decel time. These applications will not need dynamic braking. However, applications with a combination of a high-inertia load and a required short decel time will need dynamic braking. This is a physics question that may be answered either empirically or through extensive calculations.

Q. Several options related to electrical noise suppression are available for the Hitachi inverters. How can I know if my application will require any of these options?

A. The purpose of these noise filters is to reduce the inverter electrical noise so the operation of nearby electrical devices is not affected. Some applications are governed by particular regulatory agencies, and noise suppression is mandatory. In those cases, the inverter must have the corresponding noise filter installed. Other applications may not need noise suppression, unless you notice electrical interference with the operation of other devices.

Q. The L300P features a PID loop feature. PID loops are usually associated with chemical processes, heating, or process industries in general. How could the PID loop feature be useful in my application?

A. You will need to determine the particular main variable in your application the motor affects. That is the process variable (PV) for the motor. Over time, a faster motor speed will cause a faster change in the PV than a slow motor speed will. By using the PID loop feature, the inverter commands the motor to run at the optimal speed required to maintain the PV at the desired value for current conditions. Using the PID loop feature will require an additional sensor and other wiring, and is considered an advanced application.

Inverter Mounting and Installation

2

In This Chapter....   page

Orientation to Inverter Features

Unpacking and Inspection

Please take a few moments to unpack your new L300P inverter and perform these steps:

1. Look for any damage that may have occurred during shipping.

2. Verify the contents of the box include:

    a. One L300P inverter

    b. One Instruction Manual (supplied by printed book for –FU2/–FR models, supplied on CR-ROM for –FE2 models)

    c. One L300P Quick Reference Guide

    d. One packet of desiccant—discard (not for human consumption)

3. Inspect the specifications label on the front or side of the inverter. Make sure it matches the product part number you ordered.

Main Physical Features

The L300P Series inverters vary in size according to the current output rating and motor size for each model number. All feature the same basic keypad and connector interface for consistent ease of use. The inverter construction has a heat sink at the back of the housing. The fans enhance heat sink performance. Mounting holes are pre-drilled in the heat sink for your convenience. Never touch the heat sink during or just after operation; it can be very hot.

The electronics housing and front panel are built onto the front of the heat sink. The front panel has three levels of physical access designed for convenience and safety:

*   **First-level access** – for basic use of inverter and editing parameters during powered operation (power is ON)

*   **Second-level access** – for wiring the inverter power supply or motor (power is OFF)

*   **Third-level access** – for accessing the expansion bay for adding/removing expansion boards (power is OFF)

1. **First-level Access** - View the unit just as it came from the box as shown. The OPE-SRE or OPE-SR digital operator keypad comes installed in the inverter. The four-digit display can show a variety of performance parameters. LEDs indicate whether the display units are Hertz, Volts, Amperes, or kW. Other LEDs indicate Power (external), and Run/Stop Mode and Program/Monitor Mode status. Membrane keys Run and Stop/Reset, and a Min/Max frequency control knob control motor operation. These controls and indicators are usually the only ones needed after the inverter installation is complete.

    The FUNC., $\triangle$, ∇, and STR keys allow an operator to change the inverter's functions and parameter values, or to select the one monitored on the 4-digit display. Note that some parameters may not be edited if the inverter is in Run mode.

2. **Second-level access** - First, ensure no power source of any kind is connected to the inverter. If power has been connected, wait five minutes after powerdown and verify the Charge Lamp indicator is OFF to proceed. Then locate the recessed retention screw at the bottom of the main front panel. Use a small Phillips screwdriver to remove the screw. Press the two latch release areas near the "L300P" label as shown, and simultaneously slide the lower front downward to release for removal.

Press here and slide cover downward

Retention screw

Notice the large power terminals at the bottom of the wiring area. The rubber grommets below the power terminals are for wire entry/exit to the power source and motor. Never operate the inverter with the front panel removed.

The control terminals connect logic or analog signals for control and monitoring of the inverter. The nearby alarm relay provides both normally-open and normally-closed logic for interface to an external alarm. The alarm circuit may carry hazardous live voltages even when the main power to the inverter is OFF. So, never directly touch any terminal or circuit component.

Logic Connector

Power terminals

Wire entry/exit plate

Charge lamp indicator
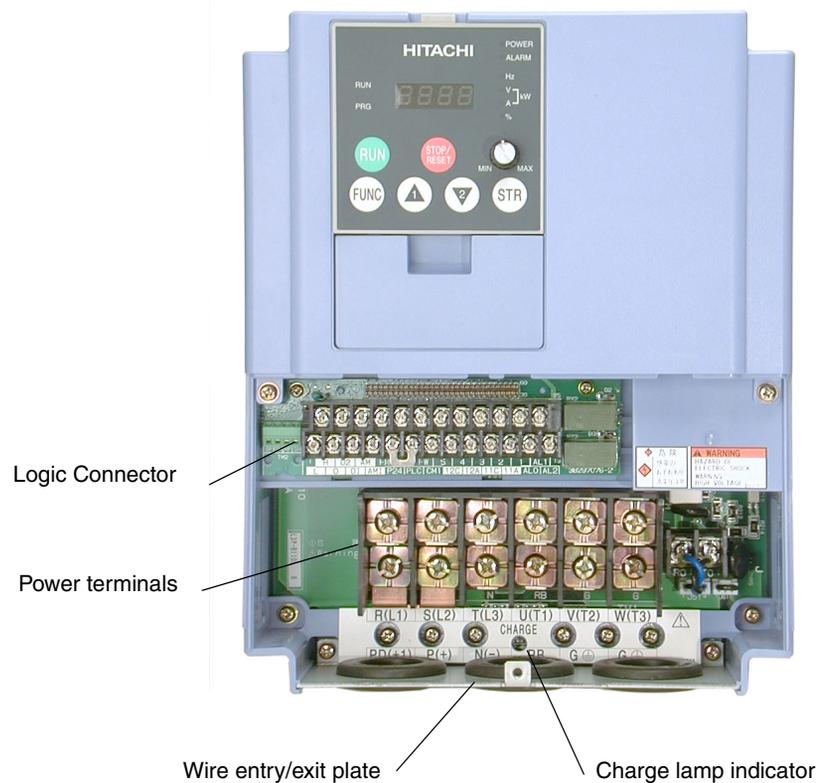
WARNING: Be sure to wait five minutes after powerdown and verify the charge lamp indicator is OFF to proceed. Otherwise there is the risk of electric shock.

3. Third-level access - The L300P provides for field installation of interface circuits. These circuits are on expansion cards, to be installed in the expansion bay. To access the expansion bay, you will need to remove the upper front panel. Use the latch to release the digital operator (the panel filler plate may remain). Remove the two retention screws the bottom corners of the upper front panel. Lift up at the bottom, then disengage the two hinge latches at the top.

Latch to release digital operator

Retention screws

The expansion bay has two sites for adding expansion cards. Each card connects via the interface connector, and mounts using three standoff screw locations. Further details on accessories are in Chapter 5. You may also refer to the instruction manual that comes with each type of expansion card.

Expansion bay   Expansion connectors
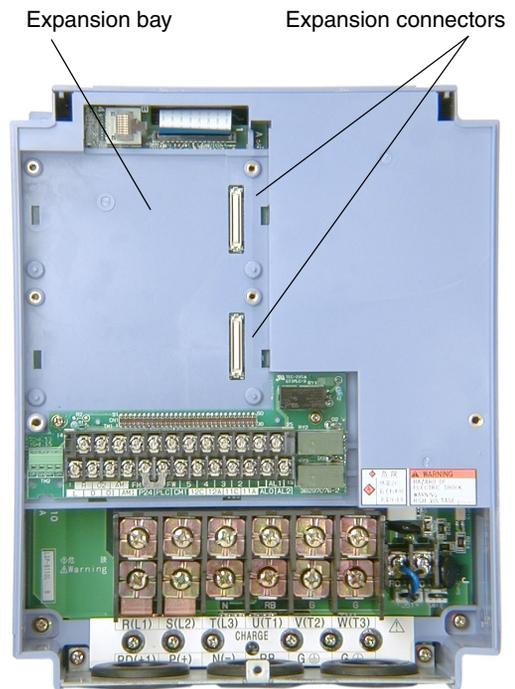
The following sections will describe the system design and guide you through a step-by-step installation process. After the section on wiring, this chapter will show how to use the front panel keys to access functions and edit parameters.

Basic System Description

A motor control system will obviously include a motor and inverter, as well as a breaker or fuses for safety. If you are connecting a motor to the inverter on a test bench just to get started, that's all you may need for now. But a system can also have a variety of additional components. Some can be for noise suppression, while others may enhance the inverter's braking performance. The figure and table below show a system with all the optional components you may need in your finished application.
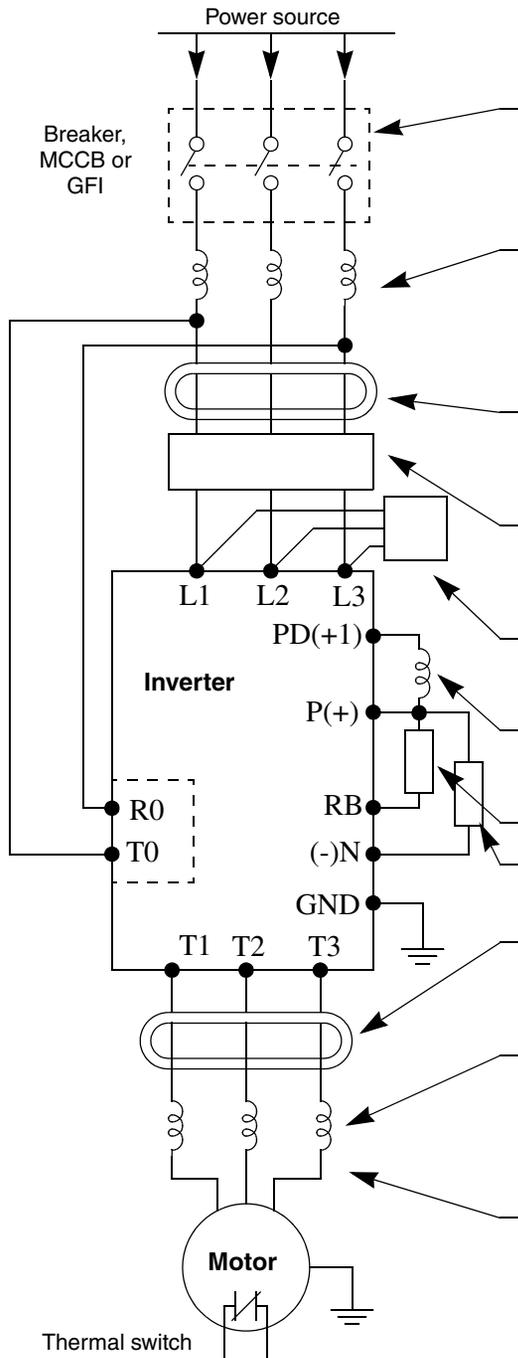
| Name	Function
Breaker / disconnect	A molded-case circuit breaker (MCCB), ground fault interrupter breaker (GFI), or a fused disconnect device. NOTE: The installer must refer to the NEC and local codes to ensure safety and compliance.
Input side AC Reactor	This is useful in suppressing harmonics induced on the power supply lines, or when the main power voltage imbalance exceeds 3% (and power source capacity is more than 500 kVA), or to smooth out line fluctuations. It also improves the power factor.
Radio noise filter	Electrical noise interference may occur on nearby equipment such as a radio receiver. This magnetic choke filter helps reduce radiated noise (can also be used on output).
EMI filter (for CE applications, see Appendix D)	This filter reduces the conducted noise in the power supply wiring between the inverter and the power distribution system. Connect it to the inverter primary (input side).
Radio noise filter (use in non-CE applications)	This capacitive filter reduces radiated noise from the main power wires in the inverter input side.
DC link choke	The choke suppresses harmonics generated by the inverter. However, it will not protect the input diode bridge rectifier.
Braking resistor / Braking unit	Braking components are useful for increasing the inverter's control torque for high duty-cycle (ON-OFF) applications, and improving the decelerating capability.
Radio noise filter	Electrical noise interference may occur on nearby equipment such as a radio receiver. This magnetic choke filter helps reduce radiated noise (can also be used at input).
Output side AC reactor	This reactor reduces the vibrations in the motor caused by the inverter's switching waveform, by smoothing the waveform to approximate commercial power quality. It is also useful to reduce harmonics when wiring from the inverter to the motor is more than 10m in length.
LCR filter	Sine wave shaping filter for output side.

Power source

Breaker, MCCB or GFI

Inverter

L1 L2 L3

PD(+1)

P(+)

R0
T0

RB

(-)N

GND

T1 T2 T3

Motor

Thermal switch

NOTE: Some components are required for regulatory agency compliance (see Chapter 5 and Appendix D).

Step-by-Step Basic Installation

This section will guide you through the following basic steps of installation:

1. Study the warnings associated with mounting the inverter.

2. Select a suitable mounting location.

NOTE: If the installation is in an EU country, study the EMC installation guidelines in Appendix D.

3. Cover the inverter's top ventilation openings to prevent debris from falling inside.

4. Check the inverter mounting dimensions for footprint and mounting hole locations.

5. Study the caution and warning messages associated with wiring the inverter.

6. Connect wiring for the inverter power input.

7. Connect wiring to the motor.

8. Uncover the inverter's ventilation openings that were covered in Step 3.

9. Perform a powerup test.

10. Make observations and check your installation.

Step 1: Study the following caution messages associated with mounting the inverter. This is the time when mistakes are most likely to occur that will result in expensive rework, equipment damage, or personal injury.

1

**Choosing a
Mounting
Location**

CAUTION: Be sure to install the unit on flame-resistant material such as a steel plate. Otherwise, there is the danger of fire.

CAUTION: Be sure not to place any flammable materials near the inverter. Otherwise, there is the danger of fire.

CAUTION: Be sure not to let the foreign matter enter vent openings in the inverter housing, such as wire clippings, spatter from welding, metal shavings, dust, etc. Otherwise, there is the danger of fire.

CAUTION: Be sure to install the inverter in a place that can bear the weight according to the specifications in the text (Chapter 1, Specifications Tables). Otherwise, it may fall and cause injury to personnel.

CAUTION: Be sure to install the unit on a perpendicular wall that is not subject to vibration. Otherwise, it may fall and cause injury to personnel.

CAUTION: Be sure not to install or operate an inverter that is damaged or has missing parts. Otherwise, it may cause injury to personnel.

CAUTION: Be sure to install the inverter in a well-ventilated room that does not have direct exposure to sunlight, a tendency for high temperature, high humidity or dew condensation, high levels of dust, corrosive gas, explosive gas, inflammable gas, grinding-fluid mist, salt air, etc. Otherwise, there is the danger of fire.

2

Ensure Adequate Ventilation

Step 2: To summarize the caution messages—you will need to find a solid, non-flammable, vertical surface that is in a relatively clean and dry environment. In order to ensure enough room for air circulation around the inverter to aid in cooling, maintain the specified clearance around the inverter specified in the diagram.
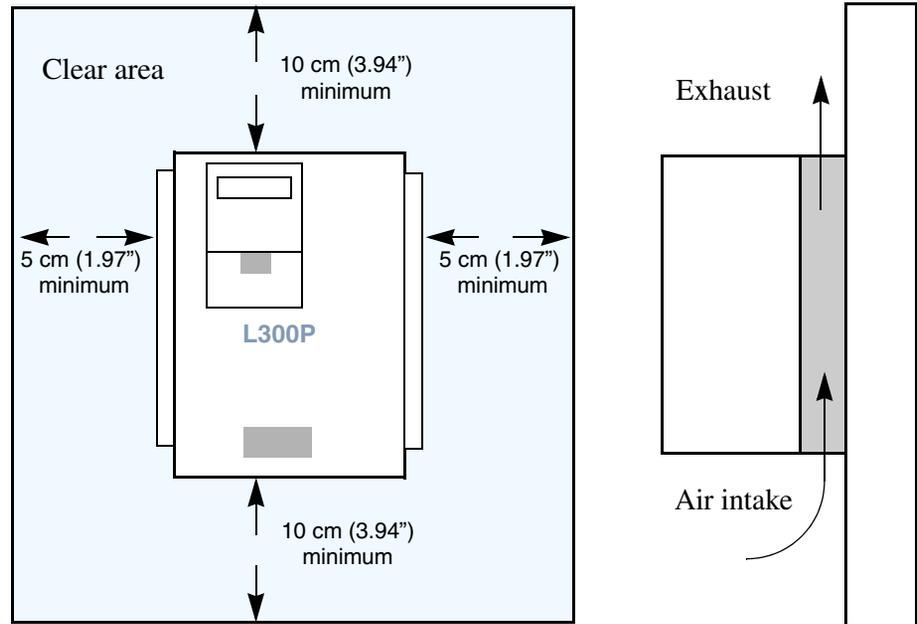
Clear area

10 cm (3.94")
minimum

5 cm (1.97")
minimum

5 cm (1.97")
minimum

L300P

10 cm (3.94")
minimum

Exhaust

Air intake

CAUTION: Be sure to maintain the specified clearance area around the inverter and to provide adequate ventilation. Otherwise, the inverter may overheat and cause equipment damage or fire.

3

Keep Debris Out of Inverter Vents

Step 3: Before proceeding to the wiring section, it's a good time to *temporarily* cover the inverter's ventilation openings. Paper and masking tape are all that is needed. This will prevent harmful debris such as wire clippings and metal shavings from entering the inverter during installation.

Please observe this checklist while mounting the inverter:

1. The ambient temperature must be in the range of -10 to 40°C. If the range will be up to 50°C (maximum rating), you will need to refer to .

2. Keep any other heat-producing equipment as far away from the inverter as possible.

3. When installing the inverter in an enclosure, maintain the clearance around the inverter and verify that its ambient temperature is within specification when the enclosure door is closed.

4. Do not open the main front panel door at any time during operation.

Cover the fan outlet vents

Cover the ventilation slots, both sides
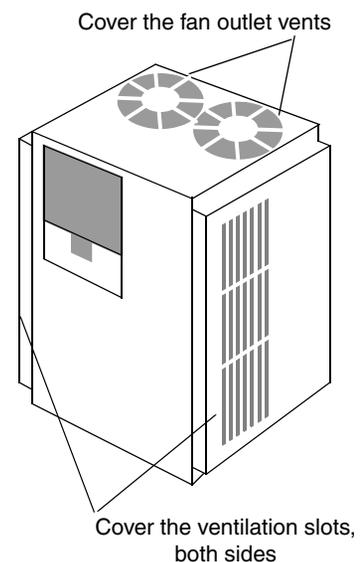
4

**Check Inverter
Dimensions**

Step 4: Locate the applicable drawing on the following pages for your inverter.
Dimensions are given in millimeters (inches) format. The optional NEMA 1 wire entry conduit
box is shown for inverter models 37kW to 75kW (–370 to –550LFU2 / –370 to –750 HFU2,
U.S. models only).

Model
L300P -015LFU2
       -015HFU2
       -022LFU2
       -022HFU2
       -037LFU2
       -037HFU2
       -055LFU2
       -055HFU2
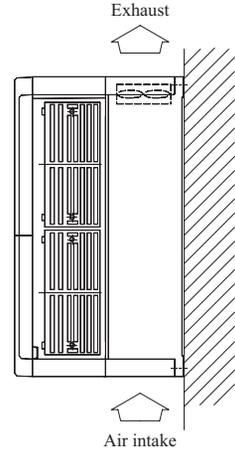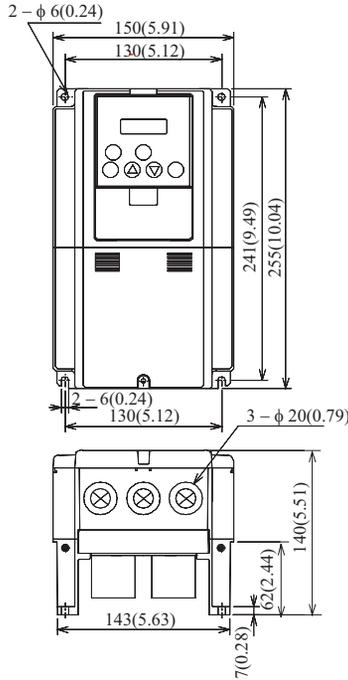
Model
L300P -075LFU2
       -075HFU2, HFE2
       -110LFU2
       -110HFU2, HFE2
       -150LFU2
       -150HFU2, HFE2

Inverter Mounting
and Installation
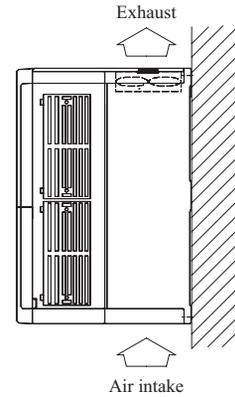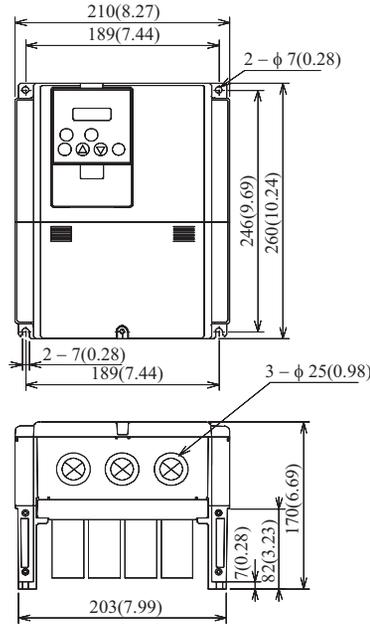
Model
L300P -185LFU2
      -185HFU2, HFE2
      -220LFU2
      -220HFU2, HFE2
      -300LFU2
      -300HFU2, HFE2

2 – φ 7(0.28)
250(9.84)
229(9.02)

376(14.80)
390(15.35)

Exhaust

2 – 7(0.28)
229(9.02)

4 – φ 29.5(1.16)

Air intake

190(7.48)

244(9.61)

9.5(0.37)
83(3.27)
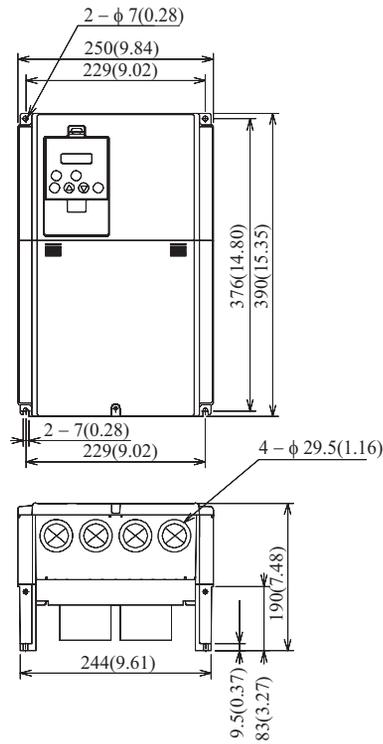
Model
L300P -370LFU2
      -370HFU2, HFE2

2 – φ 10(0.39)

Exhaust

510(20.08)
540(21.26)

100(3.94)

2 – 10(0.39)

265(10.43)
307(12.09)
310(7.68)

130(5.12)

Optional adapter
for NEMA1 rating

74(2.91)

Air intake

195(7.68)
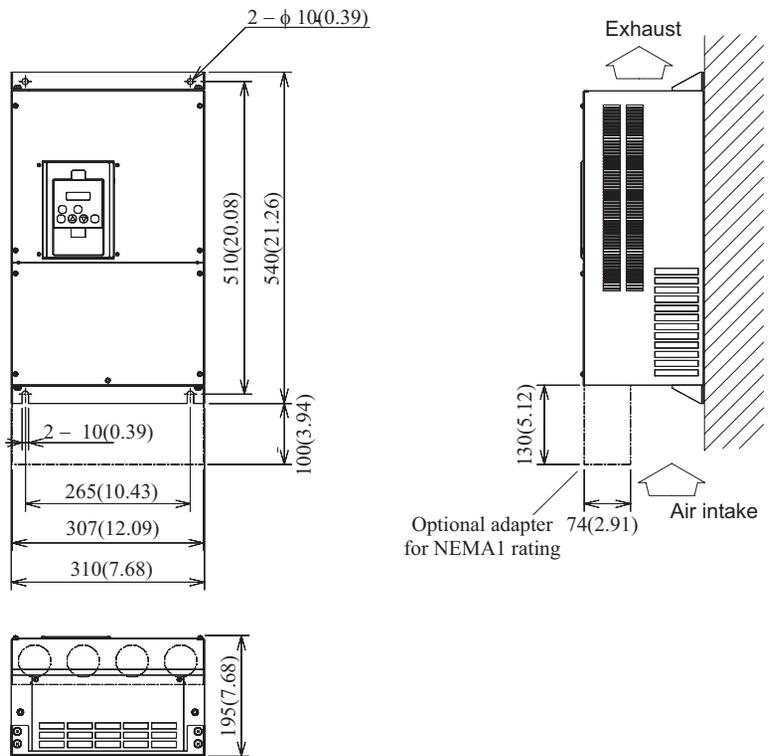
NOTE: Be sure to use lock washers or other means to ensure screws do not loosen
due to vibration.

Inverter Mounting and Installation

Dimensional drawings, continued...

Model

L300P -450LFU2
       -450HFU2, HFE2
       -550LFU2
       -550HFU2, HFE2
       -750HFU2, HFE2
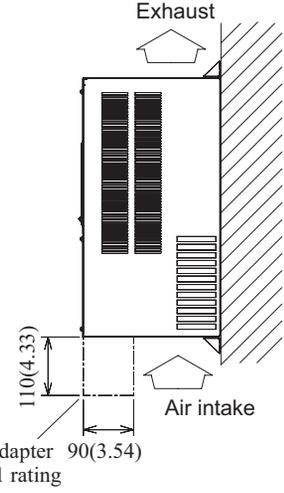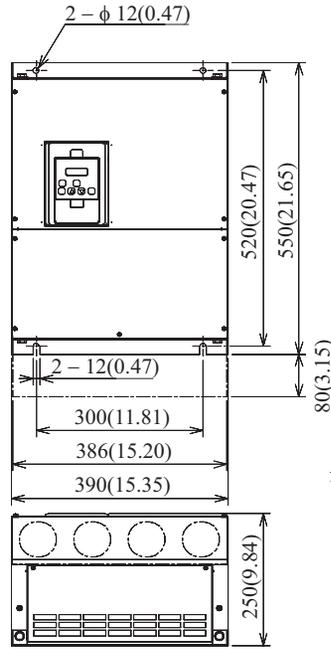
2 – φ 12(0.47)

520(20.47)
550(21.65)
80(3.15)

2 – 12(0.47)
300(11.81)
386(15.20)
390(15.35)

250(9.84)

Exhaust

110(4.33)

Air intake

Optional adapter   90(3.54)
for NEMA1 rating

Model

L300P -750LFU2

2 – φ 12(0.47)

670(26.38)
700(27.56)
70(2.76)

2 – 12(0.47)
380(14.96)
476(18.74)
480(18.90)

250(9.84)

Exhaust

Air intake

Dimensional drawings, continued...

Model
L300P -900HFU2, HFE2
-1100HFU2, HFE2

2 − φ 12(0.47)

700(27.56)
670(26.38)

2 − 12(0.47)
300(11.81)
390(15.34)

270(10.63)

Exhaust

Air intake
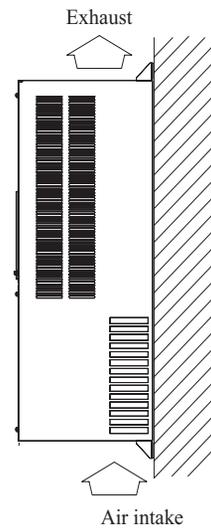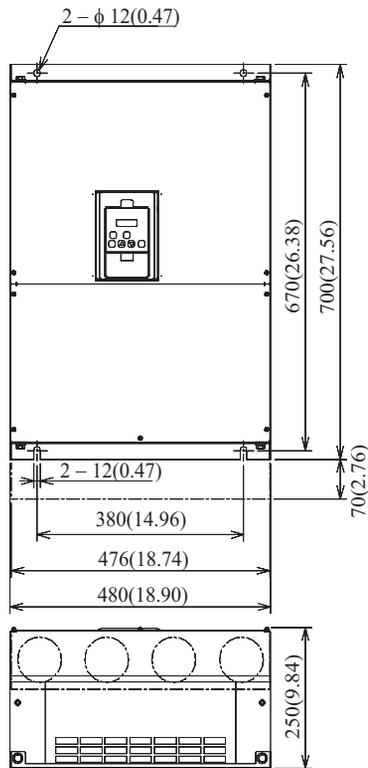
Inverter Mounting
and Installation
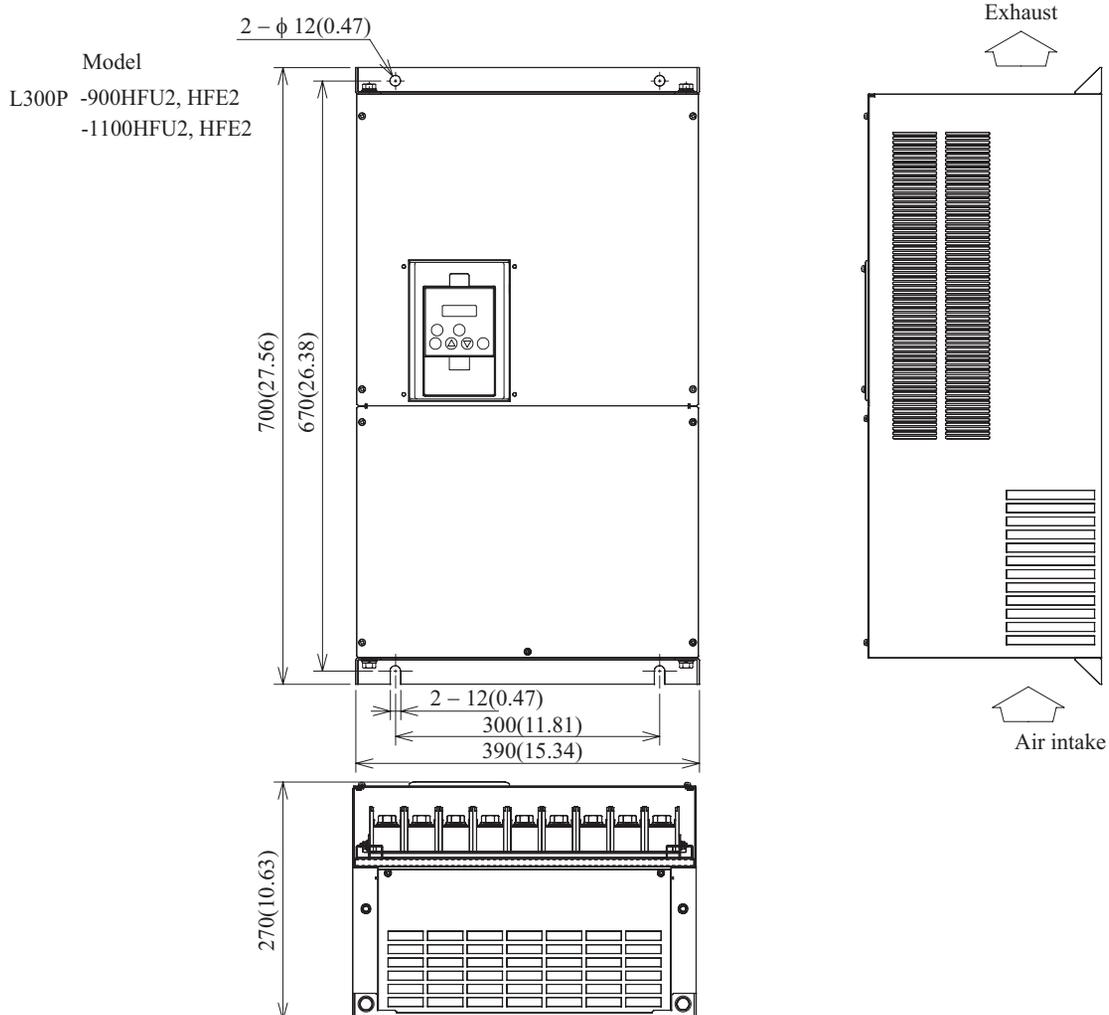
Dimensional drawings, continued...

Model
L300P -1320HFU2, HFE2

2 − φ 12(0.47)

Exhaust

740(29.13)
710(27.95)

2 − 12(0.47)

380(14.96)
480(18.90)

Air intake

270(10.63)
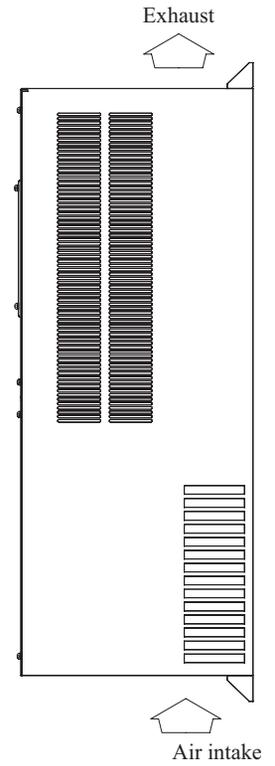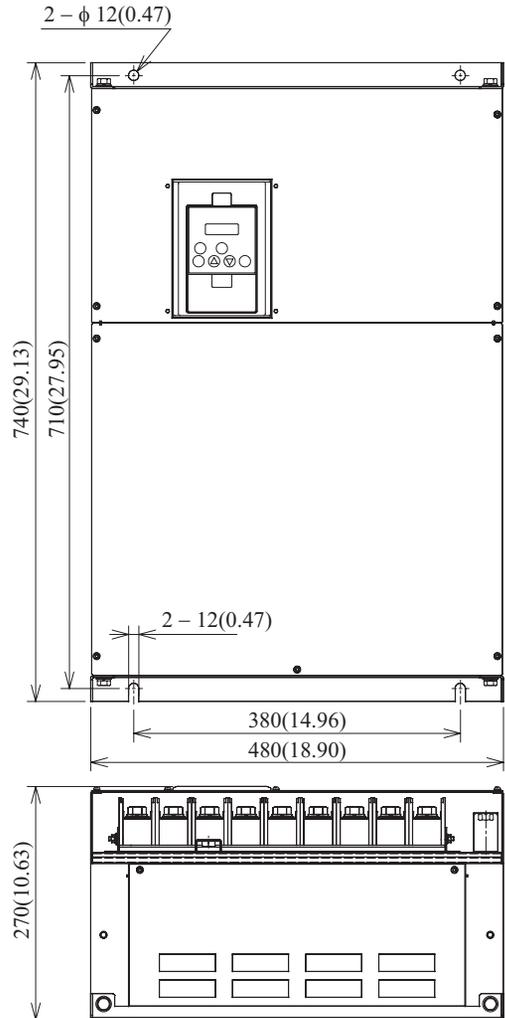
5

Prepare for Wiring

Step 5: The wiring enters the inverter through the entry/exit plate as shown to the right. The rubber grommets have a solid, thin membrane, so that unused ones continue to seal the opening. To create an opening, use a sharp knife and carefully cut an "X" in the center of the grommet as shown. Be especially careful to avoid cutting into the thick outer ring, so that the wiring will have a cushion from contacting the metal plate.

NOTE: Some inverter models will have a wiring box for NEMA rating compliance. Make sure the wire entry to the NEMA box also has protective cushion from chaffing of insulation.
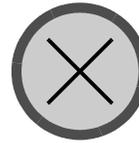
Cut grommet(s) for use as shown

Before proceeding, please study the caution and warning messages below.

WARNING: "Use 60/75°C Cu wire only" or equivalent.

WARNING: "Open Type Equipment."

WARNING: "A Class 2 circuit wired with Class 1 wire" or equivalent.

WARNING: "Suitable for use on a circuit capable of delivering not more than 10,000 rms symmetrical amperes, 240 V maximum." For models with suffix L.

WARNING: "Suitable for use on a circuit capable of delivering not more than 10,000 rms symmetrical amperes, 480 V maximum." For models with suffix H.

HIGH VOLTAGE: Be sure to ground the unit. Otherwise, there is a danger of electric shock and/or fire.

HIGH VOLTAGE: Wiring work shall be carried out only by qualified personnel. Otherwise, there is a danger of electric shock and/or fire.

HIGH VOLTAGE: Implement wiring after checking that the power supply is OFF. Otherwise, you may incur electric shock and/or fire.

HIGH VOLTAGE: Do not connect wiring to an inverter or operate an inverter that is not mounted according the instructions given in this manual. Otherwise, there is a danger of electric shock and/or injury to personnel.

Determining Wire and Fuse Sizes

This section includes tables for 200V class and 400V class inverters (on the next page). The following notes will help you read the tables in this section:

- Locate the row corresponding to the motor size and particular inverter in your application. The maximum motor current determines the recommended wire sizes.

- The length column specifies that some inverters can optionally use a smaller wire gauge if the wires are shorter than 10m and the inverter is located in an enclosure.

- Power Lines columns include wires connecting to terminals [R, S, T, U, V, W, P, PD, and N]. Only power input and motor leads will be fused: [R, S, T, U, V, and W]. The breaker ratings (GFI—ground fault interrupter) are slightly higher than fuse ratings to allow for nominal surges without tripping.

- The chassis ground columns list the Hitachi-recommended AWG and the minimal AWG for UL conformity.

- The optional external braking resistor wiring only applies to a few models that have a built-in braking unit. The other models use an optional external braking unit.

- Parallel wires increase effective wire gauge, and are denoted by "∥" in the tables.

- Signal Lines, not listed in these tables, connect to the removable logic connector. The recommended wire gauge for all wiring to the logic connector is 28 AWG (0.75 mm^2). Be sure to use shielded wire for any analog signals.

Motor Output		200V Inverter Models, L300P	Wiring *1									
			Power Lines *3					Chassis Ground			Brake Res.	
HP	kW		Length *4	AWG *3	mm^2 *3	Fuse (UL-rated, class J, 600V)	Breaker (GFI type) *2	AWG, rec.	AWG, UL	mm^2	AWG	mm^2
2	1.5	–015LFU2	—	14	2	10A	15A	16	14	1.25	14	2
3	2.2	–022LFU2	—	14	2	15A	20A	16	14	1.25	14	2
5	3.7	–037LFU2	—	10	3.5	20A	30A	10	12	3.5	10	3.5
7.5	5.5	–055LFU2	—	8	5.5	30A	50A	8	10	5.5	8	5.5
10	7.5	–075LFU2	—	6	8	40A	60A	8	10	8	8	5.5
15	11	–110LFU2	—	4	14	60A	75A	4	10	14	8	5.5
20	15	–150LFU2	≥10m	2	22	70A	100A	3	8	22	8	5.5
			< 10m	4 (110°C)	14 (110°C)							
25	18.5	–185LFU2	—	4 ∥ 4	14 ∥ 2	90A	100A	3	8	22	—	—
30	22	–220LFU2	—	1/0	38	100A	150A	2	8	30	—	—
40	30	–300LFU2	≥10m	2 ∥ 2	22 ∥ 22	150A	200A	2	6	30	—	—
			< 10m	2 (110°C)	30 (110°C)							
50	37	–370LFU2	≥10m	1 ∥ 1	30 ∥ 30	175A	225A	1/0	6	50	—	—
			<10m	1 (110°C)	38 (110°C)							
60	45	–450LFU2	—	1 ∥ 1 (75°C)	38 ∥ 38	200A	225A	3/0	6	80	—	—
75	55	–550LFU2	≥10m	2/0 ∥ 2/0	60 ∥ 60	250A	350A	3/0	4	80	—	—
			< 10m	3/0 (110°C)	80 (110°C)							

Motor Output		200V Inverter Models, L300P	Wiring *1									
			Power Lines *3					Chassis Ground			Brake Res.	
HP	kW		Length *4	AWG *3	mm² *3	Fuse (UL-rated, class J, 600V)	Breaker (GFI type) *2	AWG, rec.	AWG, UL	mm²	AWG	mm²
100	75	–750LFU2	≥10m	3/0 ‖ 3/0	80 ‖ 80	300A	350A	3/0	4	80	—	—
			< 10m	250 kcmil (110°C)	125 (110°C)							

The following table lists wire and fuse sizes for 400V models.

Motor Output		400V Inverter Models, L300P	Wiring *1									
			Power Lines *3					Chassis Ground			Brake Res.	
HP	kW		AWG *1, *3	mm² *3	Fuse (UL-rated, class J, 600V)	Breaker (GFI type) *2	AWG, rec.	AWG, UL	mm²	AWG	mm²
2	1.5	–015HFU2, HFE2	18	2	10A	10A	16	14	1.25	18	2
3	2.2	–022HFU2, HFE2	16	2	10A	10A	16	14	1.25	16	2
5	4.0	–040HFU2, HFE2	14	2	15A	15A	16	14	1.25	14	2
7.5	5.5	–050HFU2, HFE2	12	2	15A	30A	14	14	2	12	2
10	7.5	–075HFU2, HFE2	10	3.5	20A	30A	10	12	3.5	10	3.5
15	11	–110HFU2, HFE2	8	5.5	30A	50A	8	10	5.5	8	5.5
20	15	–150HFU2, HFE2	6	8	35A	60A	8	10	8	8	5.5
25	18.5	–185HFU2, HFE2	6	14	50A	60A	4	10	14	—	—
30	22	–220HFU2, HFE2	4	14	50A	75A	4	10	14	—	—
40	30	–300HFU2, HFE2	3	22	70A	100A	3	10	22	—	—
50	37	–370HFU2, HFE2	4 ‖ 4	14 ‖ 14	80A	100A	3	8	22	—	—
60	45	–450HFU2, HFE2	1	38	100A	150A	1	8	22	—	—
75	55	–550HFU2, HFE2	2 ‖ 2	22 ‖ 22	125A	175A	1	6	30	—	—
100	75	–750HFU2, HFE2	1 ‖ 1	30 ‖ 30	150A	225A	1/0	6	50	—	—
125	90	–900HFU2, HFE2	1 ‖ 1 (75°C)	30 ‖ 30	200A	225A	3/0	6	50	—	—
150	110	–1100HFU2, HFE2	2/0 ‖ 2/0	50 ‖ 50	250A	350A	3/0	4	80	—	—
175	132	–1320HFU2, HFE2	2/0 ‖ 2/0	60 ‖ 60	300A	350A	4/0	4	100	—	—

Note 1: Field wiring must be made by a UL-listed and CSA certified ring lug terminal connector sized for the wire gauge involved. The connector must be fixed by using the crimping tool specified by the connector manufacturer.

Note 2: Be sure to consider the capacity of the circuit breaker to be used.

Note 3: Be sure to use a larger wire gauge if power line length exceeds 66 ft (20m).

Note 4: The optional smaller gauge wires for shorter lengths must be rated for 110°C.

Note 5: 1 AWG wiring must be rated for 75°C where noted.

Inverter Mounting
and Installation

Terminal Dimensions and Torque Specs

The following tables list the screw size of terminal and recommended torque for tightening for each of the L300P inverter models (400V models are on the next page).

CAUTION: Fasten the screws with the specified fastening torque in the table below. Check for any loosening of screws. Otherwise, there is the danger of fire.

Input Voltage	Motor Output		200V Inverter Models, L300P	Length of power wiring	Screw size of terminal	Ring Lug Connector *1		Torque	
	HP	kW				(AWG–bolt)	(mm^2–bolt)	ft-lbs	N-m
200V	2	1.5	–015LFU2	—	M4	14–#10	2–4	1.1	1.5
	3	2.2	–022LFU2	—	M4	14–#10	2–4	1.1	1.5
	5	3.7	–037LFU2	—	M4	10–#10	3.5–4	1.1	1.5
	7.5	5.5	–055LFU2	—	M5	8–#12	5.5–5	1.8	2.5
	10	7.5	–075LFU2	—	M5	8–#12	8–5	1.8	2.5
	15	11	-110LFU2	—	M6	4–1/4	14–6	3.6	4.9
	20	15	-150LFU2	≥10m	M6	2–1/4	22–6	3.6	4.9
				< 10m		4–1/4	14–6		
	25	18.5	-185LFU2	—	M6	4–1/4	14–6	3.6	4.9
	30	22	-220LFU2	—	M8	1–5/16	38–8	6.5	8.8
	40	30	-300LFU2	≥10m	M8	2–5/16	22–8	6.5	8.8
				< 10m		2–5/16	30–8		
	50	37	-370LFU2	≥10m	M8	2–5/16	30–8	6.5	8.8
				< 10m		1–5/16	38–8		
	60	45	-450LFU2	—	M10	1–1/2	38–10	10.1	13.7
	75	55	-550LFU2	≥10m	M10	2/0–1/2	60–10	10.1	13.7
				< 10m		3/0–1/2	80–10		
	100	75	-750LFU2	≥10m	M10	3/0–1/2	80–10	10.1	13.7
				< 10m		250kcmil–1/2	125–10		

Note 1: The recommended ring lug connector listing consists of wire size – screw size format. The wire sizes are in AWG or mm^2 format. For AWG wire sizes, bolt sizes for the ring lug centers are: #10, #12, 1/4", 5/16", and 1/2". For metric wire sizes, bolt sizes for the ring lug centers are: 6 = 6M, 8 = 8M, 10 = 10M

TIP: AWG = American Wire Gauge. Smaller numbers represent increasing wire thickness. kcmil = 1,000 circular mils, a measure of wire cross-sectional area mm^2 = square millimeters, a measure of wire cross-sectional area

Inverter Mounting
and Installation

Terminal dimensions and torque specs, continued...

Input Voltage	Motor Output		400V Inverter Models, L300P	Length of power wiring	Screw size of terminal	Ring Lug Connector *1		Torque	
	HP	kW				(AWG–bolt)	(mm^2–bolt)	ft-lbs	N-m
400V	2	1.5	–015HFU2, HFE2	—	M4	14–10	2–4	1.1	1.5
	3	2.2	–022HFU2, HFE2	—	M4	14–10	2–4	1.1	1.5
	5	4.0	–040HFU2, HFE2	—	M4	14–10	2–4	1.1	1.5
	7.5	5.5	–050HFU2, HFE2	—	M5	14–12	2–5	1.8	2.5
	10	7.5	–075HFU2, HFE2	—	M5	10–12	3.5–5	1.8	2.5
	15	11	-110HFU2, HFE2	—	M6	8–1/4	5.5–6	3.6	4.9
	20	15	-150HFU2, HFE2	—	M6	6–1/4	8–6	3.6	4.9
	25	18.5	-185HFU2, HFE2	—	M6	6–1/4	14–6	3.6	4.9
	30	22	-220HFU2, HFE2	—	M6	4–1/4	14–6	3.6	4.9
	40	30	-300HFU2, HFE2	—	M6	3–1/4	22–6	3.6	4.9
	50	37	-370HFU2, HFE2	—	M6	4–1/4	14–6	3.6	4.9
	60	45	-450HFU2, HFE2	—	M8	1–5/16	38–8	6.5	8.8
	75	55	-550HFU2, HFE2	—	M8	3–5/16	22–8	6.5	8.8
	100	75	-750HFU2, HFE2	—	M8	2–5/16	30–8	6.5	8.8
	125	90	-900HFU2, HFE2	—	M10	1–1/2	38–10	10.1	13.7
	150	110	-1100HFU2, HFE2	—	M10	1/0–1/2	50–10	10.1	13.7
	175	132	-1320HFU2, HFE2	—	M10	2/0–1/2	60–10	10.1	13.7

Note 1: The recommended ring lug connector listing consists of wire size – screw size format. The wire sizes are in AWG or mm^2 format. For AWG wire sizes, bolt sizes for the ring lug centers are: #10, #12, 1/4", 5/16", and 1/2". For metric wire sizes, bolt sizes for the ring lug centers are: 6 = 6M, 8 = 8M, 10 = 10M.

Inverter Mounting
and Installation

6

Wire the Inverter Input to a Supply

Step 6: In this step, you will connect wiring to the input of the inverter. All models have the same power connector terminals labeled R(L1), S(L2), and T(L3) for three-phase input. The three phases may be connected in any order, as they are isolated from chassis ground and do not determine motor direction of rotation. **Please refer to the specifications label (on the front or side of the inverter) for the acceptable input voltage ranges!**
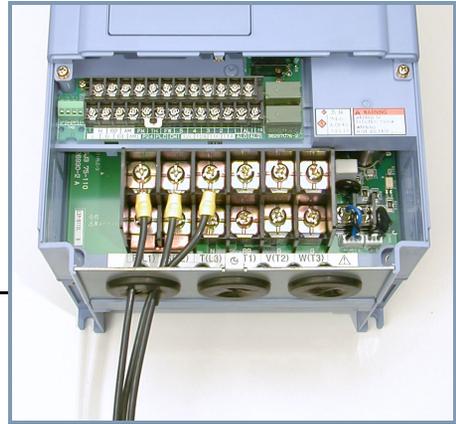
NOTE: The wiring example to the right shows an L300P-110LFU2 inverter. The terminal locations will vary, depending on the inverter model (see below). Note the use of ring lug connectors for a secure connection.

Please use the terminal arrangement below corresponding to your inverter model.

–015 to –055LFU2
–015 to –055HFU2, HFE2

R (L1)	S (L2)	T (L3)	U (T1)	V (T2)	W (T3)

R0 (R0)	T0 (T0)		PD (+1)	P (+)	N (–)	RB (RB)	⏚ (G)	⏚ (G)

Jumper bar

–075LFU2
–075HFU2, HFE2
–110LFU2
–110HFU2, HFE2
–150LFU2
–150HFU2, HFE2

R (L1)	S (L2)	T (L3)	U (T1)	V (T2)	W (T3)
PD (+1)	P (+)	N (–)	RB (RB)	⏚ (G)	⏚ (G)

R0 (R0)	T0 (T0)

Jumper bar

–185LFU2, –185 to –370HFU2, HFE2
–370LFU2, –450 to –750HFU2, HFE2

R0 (R0)	T0 (T0)

⏚ (G)	R (L1)	S (L2)	T (L3)	PD (+1)	P (+)	N (–)	U (T1)	V (T2)	W (T3)	⏚ (G)

Jumper bar

–220LFU2, –300LFU2,
–450 to –750LFU2, –900 to –1320HFU2, HFE2

R0 (R0)	T0 (T0)

R (L1)	S (L2)	T (L3)	PD (+1)	P (+)	N (–)	U (T1)	V (T2)	W (T3)

⏚   Jumper bar   ⏚

NOTE: An inverter powered by a portable or emergency diesel power generator may result in a distorted power waveform, overheating the generator. In general, the generator capacity should be at least five times that of the inverter (kVA).

CAUTION: Be sure that the input voltage matches the inverter specifications:
• Three phase 200 to 240V 50/60Hz
• Three phase 380 to 480V 50/60Hz

CAUTION: Be sure not to power a three-phase-only inverter with single phase power. Otherwise, there is the possibility of damage to the inverter and the danger of fire.

CAUTION: Be sure not to connect an AC power supply to the output terminals. Otherwise, there is the possibility of damage to the inverter and the danger of injury and/or fire.

Power Input	Power Output
L1 L2 L3	T1 T2 T3
R S T	U V W
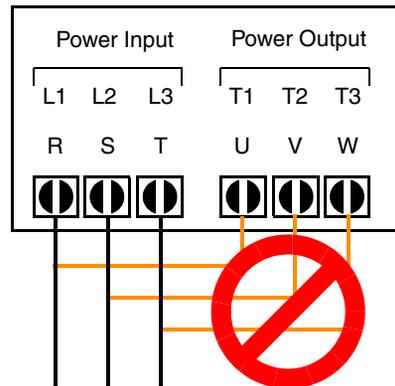
NOTE:

L1, L2, L3:

Three-phase 200 to 240V 50/60 Hz
Three-phase 380 to 480V 50/60 Hz

CAUTION: Remarks for using ground fault interrupter breakers in the main power supply: Adjustable frequency inverters with CE-filters (RFI-filter) and shielded (screened) motor cables have a higher leakage current toward Earth GND. Especially at the moment of switching ON this can cause an inadvertent trip of ground fault interrupter breakers. Because of the rectifier on the input side of the inverter there is the possibility to stall the switch-off function through small amounts of DC current. Please observe the following:
• Use only short time-invariant and pulse current-sensitive ground fault interrupter breakers with higher trigger current.
• Other components should be secured with separate ground fault interrupter breakers.
• Ground fault interrupter breakers in the power input wiring of an inverter are not an absolute protection against electric shock.

CAUTION: Be sure to install a fuse in each phase of the main power supply to the inverter. Otherwise, there is the danger of fire.

CAUTION: For motor leads, ground fault interrupter breakers and electromagnetic contactors, be sure to size these components properly (each must have the capacity for rated current and voltage). Otherwise, there is the danger of fire.

7

Wire the Inverter Output to Motor

Step 7: The process of motor selection is beyond the scope of this manual. However, it must be a three-phase AC induction motor. It should also come with a chassis ground lug. If the motor does not have three power input leads, stop the installation and verify the motor type. Other guidelines for wiring the motor include:

• Use an inverter-grade motor for maximum motor life (1600V insulation).

• For standard motors, use an output filter if the wiring between the inverter and motor exceeds 10 meters in length.

Simply connect the motor to the terminals [U/T1], [V/T2], and [W/T3] indicated on the inverter to the right. This is a good time to connect the chassis ground lug on the drive as well. The motor chassis ground must also connect to the same point. Use a star ground (single-point) arrangement, and never daisy-chain the grounds (point-to-point).

Use the same wire gauge on the motor and chassis ground wiring as you used on the power input wiring in the previous step. After completing the wiring:

• Check the mechanical integrity of each wire crimp and terminal connection.

• Replace the front panel and secure the retention screw firmly.

To Power Source   To Chassis Ground   To Motor

Logic Control Wiring

After completing the initial installation and powerup test in this chapter, you may need to wire the logic signal connector for your application. For new inverter users/applications, we highly recommend that you first complete the powerup test in this chapter without adding any logic control wiring. Then you will be ready to set the required parameters for logic control as covered in Chapter 4, Operations and Monitoring.

8

Uncover the Vents

Step 8: After mounting and wiring the inverter, remove any protective material covering the inverter ventilation openings from Step 3. This includes covers over the side ventilation ports as well as the fan outlet area.

CAUTION: Failure to remove all vent opening covers before electrical operation may result in damage to the inverter.

Uncover the fan outlet vents
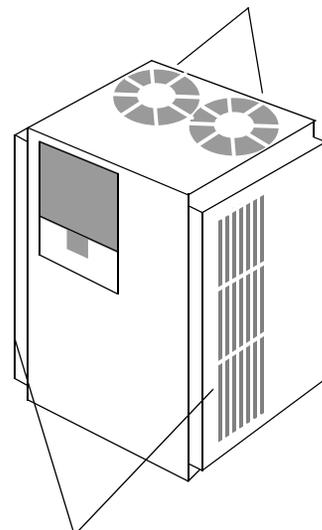
Uncover the ventilation slots, both sides

Powerup Test

9

Perform the Powerup Test

Step 9: After wiring the inverter and motor, you're ready to do a powerup test. The procedure that follows is designed for the first-time use of the drive. Please verify the following conditions before conducting the powerup test:

- You have followed all the steps in this chapter up to this step.
- The inverter is new, and is securely mounted to a non-flammable vertical surface
- The inverter is connected to a power source and motor.
- No additional wiring of inverter connectors or terminals has been done.
- The power supply is reliable, and the motor is a known working unit, and the motor nameplate ratings match the inverter ratings.
- The motor is securely mounted, and is not connected to any load.

Goals for the Powerup Test

If there are any exceptions to the above conditions at this step, please take a moment to take any measures necessary to reach this basic starting point. The specific goals of this powerup test are:

1. Verify that the wiring to the power supply and motor is correct.
2. Demonstrate that the inverter and motor are generally compatible.
3. Give a brief introduction to the use of the built-in operator keypad.

The powerup test gives you an important starting point to ensure a safe and successful application of the Hitachi inverter. We highly recommend performing this test before proceeding to the other chapters in this manual.

Pre-test and Operational Precautions

The following instructions apply to the powerup test, or to any time the inverter is powered and operating. Please study the following instructions and messages before proceeding with the powerup test.

1. The power supply must have fusing suitable for the load. Check the fuse size chart presented in Step 5, if necessary.
2. Be sure you have access to a disconnect switch for the drive input power if necessary. However, do not turn OFF power to the inverter during its operation unless it is an emergency.
3. Turn the inverter's front panel potentiometer (if it exists) to the *MIN* position (fully counter-clockwise).

CAUTION: The heat sink fins will have a high temperature. Be careful not to touch them. Otherwise, there is the danger of getting burned.

CAUTION: The operation of the inverter can be easily changed from low speed to high speed. Be sure to check the capability and limitations of the motor and machine before operating the inverter. Otherwise, there is the danger of injury.

Inverter Mounting
and Installation

CAUTION: If you operate a motor at a frequency higher than the inverter standard default setting (50Hz/60Hz), be sure to check the motor and machine specifications with the respective manufacturer. Only operate the motor at elevated frequencies after getting their approval. Otherwise, there is the danger of equipment damage and/or injury to personnel.

CAUTION: Check the following before and during the powerup test. Otherwise, there is the danger of equipment damage.
- Is the shorting bar between the [P] and [PD] terminals installed? DO NOT power or operate the inverter if the jumper is removed.
- Is the direction of the motor rotation correct?
- Did the inverter trip during acceleration or deceleration?
- Were the rpm and frequency meter readings as expected?
- Were there any abnormal motor vibrations or noise?

Powering the Inverter

If you have followed all the steps, cautions and warnings up to this point, you're ready to apply power. After doing so, the following events should occur:

- The *POWER* LED will illuminate.
- The numeric (7-segment) LEDs will display a test pattern, then stop at *0.0*.
- The *Hz* LED will be ON.

If the motor starts running unexpectedly or any other problem occurs, press the *STOP* key. Only if necessary should you remove power to the inverter as a remedy.

NOTE: If the inverter has been previously powered and programmed, the LEDs (other than the POWER LED) may illuminate differently than as indicated above. If necessary, you can initialize all parameters to the factory default settings. See "Restoring Factory Default Settings" on page 6–9.

Using the Front Panel Keypad

Front Panel Introduction

Please take a moment to familiarize yourself with the keypad layout shown in the figure below.
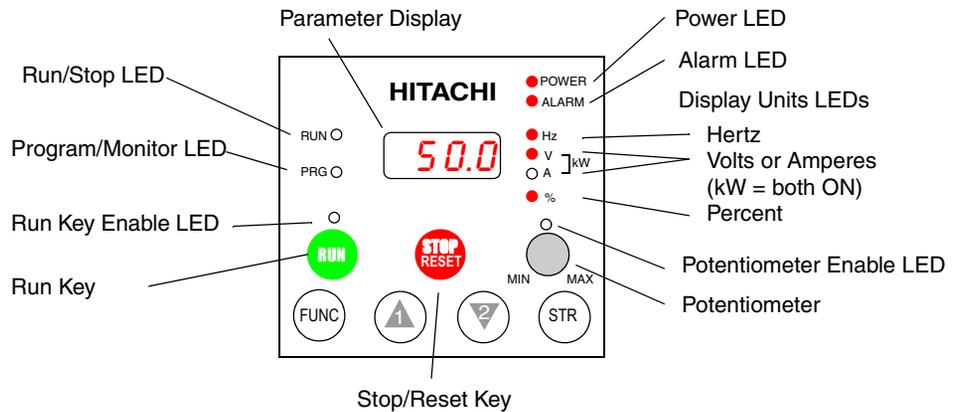
The display is used in programming the inverter's parameters, as well as monitoring specific parameter values during operation. Many functions are applicable only during the initial installation, while others are more useful for maintenance or monitoring.

Parameter Editing and Controls

The front panel controls and indicators are described as follows:

- **Run/Stop LED** – ON when the inverter output is ON and the motor is developing torque, and OFF when the inverter output is OFF (Stop Mode).

- **Program/Monitor LED** – This LED is ON when the inverter is ready for parameter editing (Program Mode). It is normally OFF when the parameter display is monitoring data (Monitor Mode). However, the PRG LED will be ON whenever you are monitoring the value of parameter D001. (When the keypad is enabled as the frequency source via A001=02, you can edit the inverter frequency directly from D001 monitor display by using the Up/Down keys.)

- **Run Key Enable LED** – is ON when the inverter is ready to respond to the Run key, OFF when the Run key is disabled.

- **Run Key** – Press this key to run the motor (the Run Enable LED must be ON first). Parameter F004, Keypad Run Key Routing, determines whether the Run key generates a Run FWD or Run REV command.

- **Stop/Reset Key** – Press this key to stop the motor when it is running (uses the programmed deceleration rate). This key will also reset an alarm that has tripped.

- **Potentiometer** – allows an operator to directly set the motor speed when the potentiometer is enabled for output frequency control.

- **Potentiometer Enable LED** – ON when the potentiometer is enabled for value entry.

- **Parameter Display** – a 4-digit, 7-segment display for parameters and function codes.

- **Display Units: Hertz/Volts/Amperes/kW/%** – These LEDs indicate the units associated with the parameter display. When the display is monitoring a parameter, the appropriate LED is ON. In the case of kW units, both Volts and Amperes LEDs will be ON. An easy way to remember this is that kW = (V x A)/1000.

- **Power LED** – This LED is ON when the power input to the inverter is ON.

- **Alarm LED** – This LED is ON when an alarm condition has tripped the inverter. Clearing the alarm will turn this LED OFF again. See Chapter 6 for details on clearing alarms.

Inverter Mounting and Installation

- **Function Key** – This key is used to navigate through the lists of parameters and functions for setting and monitoring parameter values.
- **Up/Down ($\triangle$, $\triangledown$) Keys** – Use these keys alternately to move up or down the lists of parameter and functions shown in the display, and increment/decrement values.
- **Store ((STR)) Key** – When the unit is in Program Mode and the operator has edited a parameter value, press the Store key to write the new value to the EEPROM. This parameter is then displayed at powerup by default. If you want to change the powerup default, navigate to a new parameter value and press the Store key.

HITACHI

● POWER
● ALARM

RUN ○

50.0

● Hz
● V
○ A   ] kW

PRG ○

○

● %

RUN   STOP/RESET

MIN   MAX

FUNC   △   ▽   STR

Function key   Up/Down keys   Store key
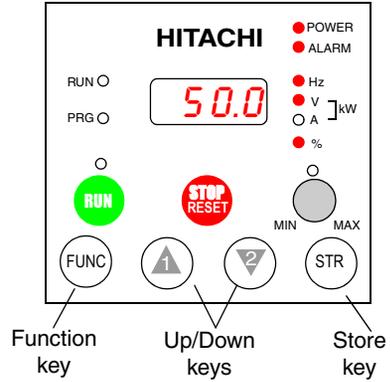
Keys, Modes, and Parameters

Purpose of the keypad is to provide a way to change modes and parameters. The term *function* applies to both monitoring modes and parameters. These are all accessible through *function codes* that are primarily 3 or 4-character codes. The various functions are separated into related groups identifiable by the left-most character, as the table shows.

Function Group	Type (Category) of Function	Mode to Access	PGM LED Indicator
"D"	Monitoring functions	Monitor	○ or ●
"F"	Main profile parameters	Program	●
"A"	Standard functions	Program	●
"B"	Fine tuning functions	Program	●
"C"	Intelligent terminal functions	Program	●
"H"	Motor constant functions	Program	●
"P"	Expansion card functions	Program	●
"U"	User-selectable menu functions	Monitor	○
"E"	Error codes	—	—

For example, function "A004" is the *base frequency setting* for the motor, typically 50 Hz or 60 Hz. To edit the parameter, the inverter must be in Program Mode (PGM LED will be ON). You use the front panel keys to first select the function code "A004." After displaying the value for "A004," use the Up/Down ($\triangle$ or $\triangledown$) keys to edit the value.

NOTE: The inverter 7-segment display shows lower case "b" and "d", meaning the same as the upper case letters "B" and "D" used in this manual (for uniformity "A to F").

The inverter automatically switches into Monitor Mode when you access "D" Group functions. It switches into Program Mode when you access any other group, because they all have editable parameters. Error codes use the "E" Group, and appear automatically when a fault event occurs. Refer to for error code details.

MONITOR

"D" Group

PROGRAM

"A" Group
"B" Group
"C" Group
"H" Group
"P" Group
"U" Group
"F" Group
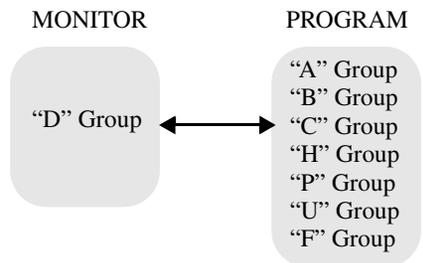
**Keypad
Navigational Map**

The L300P Series inverter drives have many programmable functions and parameters. Chapter 3 will cover these in detail, but you need to access just a few items to perform the powerup test. The menu structure makes use of function codes and parameter codes to allow programming and monitoring with only a 4-digit display and a few keys and LEDs. So, it is important to become familiar with the basic navigational map of parameters and functions in the diagram below. You can later use this map as a reference.

Inverter Mounting and Installation
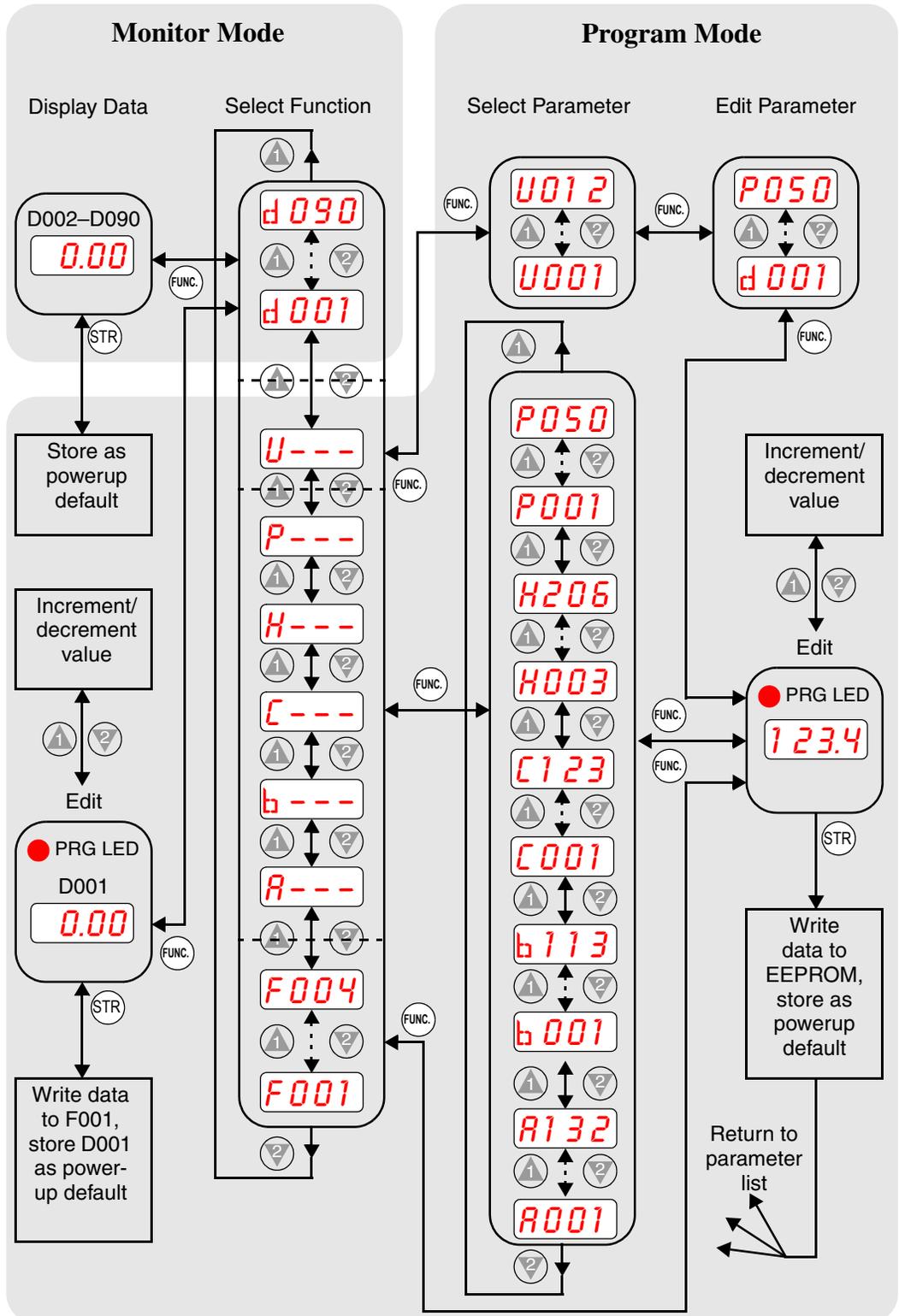
Selecting Functions and Editing Parameters

In order to run the motor for the powerup test, this section will show how to:

• select the inverter's maximum output frequency to the motor

• select the keypad potentiometer as the source of motor speed command

• select the keypad as the source of the RUN command

• set the number of poles for the motor

• enable the RUN command

The following series of programming tables are designed for successive use. Each table uses the previous table's final state as the starting point. Therefore, start with the first and continue programming until the last one. If you get lost or concerned that some of the other parameters settings may be incorrect, refer to .

CAUTION: If you operate a motor at a frequency higher than the inverter standard default setting (50Hz/60Hz), be sure to check the motor and machine specifications with the respective manufacturer. Only operate the motor at elevated frequencies after getting their approval. Otherwise, there is the danger of equipment damage.

Setting the Motor Base Frequency - The motor is designed to operate at a specific AC frequency. Most commercial motors are designed for 50/60 Hz operation. First, check the motor specifications. Then follow the steps in the table below to verify the setting or correct for your motor. DO NOT set it for greater than 50/60 Hz unless the motor manufacturer specifically approves operation at the higher frequency.

Action	Display	Func./Parameter
Press the (FUNC) key.	d 001	Monitor functions
Press the (▲) or (▽2) keys until ->	A - - -	"A" Group selected
Press the (FUNC) key.	A001	First "A" parameter
Press the (▲) key twice.	A003	Base frequency setting
Press the (FUNC) key.	60 or 50	Default value for base frequency US = 60 Hz, Europe = 50 Hz
Press the (▲) or (▽2) key as needed.	60	Set to your motor specs (your display may be different)
Press the (STR) key.	A003	Stores parameter, returns to "A" Group list

TIP: If you need to scroll through a function or parameter list, press and hold the ⚠ or ⚡ key to auto-increment through the list.

Select the Potentiometer for Speed Command - The motor speed may be controlled from the following sources:

• Potentiometer on front panel keypad (if present)

• Control terminals

• Remote panel

Then follow the steps in the table below to select the potentiometer for the speed command (the table resumes action from the end of the previous table).

Action	Display	Func./Parameter
Press the (2) key twice.	_A001_	Speed command source setting
Press the (FUNC) key.	_01_	0 = potentiometer 1 = control terminals (default) 2 = keypad
Press the (2) key.	_00_	0 = potentiometer (selected)
Press the (STR) key.	_A001_	Stores parameter, returns to "A" Group list

Select the Keypad for the RUN Command - The RUN command causes the inverter to accelerate the motor to the selected speed. You can program the inverter to respond to either the control terminal signal or the keypad RUN key. Follow the steps in the table below to select the front panel RUN key as the source for the RUN Command (the table resumes action from the end of the previous table).

Action	Display	Func./Parameter
Press the (▲) key.	_A002_	Run command source
Press the (FUNC) key.	_01_	1 = control terminals (default) 2 = keypad
Press the (▲) key.	_02_	2 = keypad (selected)
Press the (STR) key.	_A002_	Stores parameter, returns to "A" Group list

NOTE: When you press the STR key in the last step above (and the display = 02), the Run Enable LED above the RUN switch on the keypad will turn ON. This is normal, and does not mean the motor is trying to run. It means that the RUN key is now enabled.
DO NOT press the RUN key at this time—finish out the programming exercise first.

Configure the Inverter for the Number of Motor Poles- The number of magnetic poles of a motor is determined by the motor's internal winding arrangement. The specifications label on the motor usually indicates its number of poles. For proper operation, verify the parameter setting matches the motor poles. Many industrial motors have four poles, corresponding to the default setting in the inverter.

Follow the steps in the table below to verify the motor poles setting and change it if necessary (the table resumes action from the end of the previous table.)

Action	Display	Func./Parameter
Press the (FUNC) key.	A - - -	"A" Group selected
Press the (▲) key three times.	H - - -	"H" Group selected
Press the (FUNC) key.	$H003$	First "H" parameter
Press the (▲) key once.	$H004$	Motor poles parameter
Press the (FUNC) key.	4	2 = 2 poles 4 = 4 poles (default) 6 = 6 poles 8 = 8 poles
Press the (▲) or (▼) key as needed.	4	Set to match your motor (your display may be different)
Press the (STR) key.	$H004$	Stores parameter, returns to "H" Group list

This step concludes the parameter setups for the inverter. You are almost ready to run the motor for the first time!

TIP: If you became lost during any of these steps, first observe the state of the PRG LED. Then study the "Keypad Navigational Map" on page 2–25 to determine the current state of the keypad controls and display. As long as you do not press the STR key, no parameters will be changed by keypad entry errors. Note that power cycling the inverter will not cause it to reset to a particular programming state.

The next section will show you how to monitor a particular parameter from the display. Then you will be ready to run the motor.

Monitoring Parameters with the Display

After using the keypad for parameter editing, it's a good idea to switch the inverter from Program Mode to Monitor Mode. This will turn out the PRG LED, and the Hertz, Volt, Ampere, or % LED indicates the display units.
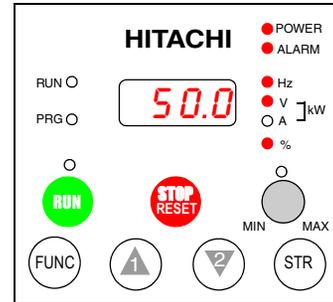
For the powerup test, monitor the motor speed indirectly by viewing the inverter's output frequency. The *output frequency* must not be confused with *base frequency* (50/60 Hz) of the motor, or the *carrier frequency* (switching frequency of the inverter, in the kHz range). The monitoring functions are in the "D" list, located near the top left of the diagram in the .

Output frequency (speed) monitor - Resuming the keypad programming from the previous table, follow the steps in the table below.

Action	Display	Func./Parameter
Press the (FUNC) key.	$H - - -$	"H" Group selected
Press the (▲) key.	$d\ 001$	Output frequency selected
Press the (FUNC) key.	0.00	Output frequency displayed

When the *d 01* function code appeared, the PRG LED went OFF. This confirms the inverter is no longer in programming mode, even while you are selecting the particular monitoring parameter. After pressing the (FUNC) key, the display shows the current speed (is zero at this point).

Running the Motor

If you have programmed all the parameters up to this point, you're ready to run the motor! First, review this checklist:

1. Verify the Power LED is ON. If not, check the power connections.
2. Verify the Run Key Enable LED is ON. If not, review the programming steps to find the problem.
3. Verify the PRG LED is OFF. If it is ON, review the instructions above.
4. Make sure the motor is disconnected from any mechanical load.
5. Turn the potentiometer to the MIN position (completely counterclockwise).
6. Now, press the RUN key on the keypad. The RUN LED will turn ON.
7. Slowly increase the potentiometer setting in clockwise fashion. The motor should start turning when the indicator is in the 9:00 position and beyond.
8. Press the STOP key to stop the motor rotation.

Inverter Mounting
and Installation

10

Powerup Test Observations and Summary

Step 10: Reading this section will help you make some useful observations when first running the motor.

Error Codes - If the inverter displays an error code (LED format is "*EXX*"), see to interpret and clear the error.

Acceleration and Deceleration - The L300P inverter has programmable acceleration and deceleration values. The test procedure left these at the default value, 10 seconds. You can observe this by setting the potentiometer at about half speed before running the motor. Then press RUN, and the motor will take 5 seconds to reach a steady speed. Press the STOP key to see a 5 second deceleration to a stop.

State of Inverter at Stop - If you adjust the motor's speed to zero, the motor will slow to a near stop, and the inverter turns the outputs OFF.

Interpreting the Display - First, refer to the output frequency display readout. The maximum frequency setting (parameter A004) defaults to 50 Hz or 60 Hz (Europe and United States, respectively) for your application.

Example: Suppose a 4-pole motor is rated for 60 Hz operation, so the inverter is configured to output 60 Hz at full scale. Use the following formula to calculate the RPM.

$$\text{RPM} = \frac{Frequency \times 60}{\text{Pairs of poles}} = \frac{Frequency \times 120}{\text{\# of poles}} = \frac{60 \times 120}{4} = 1800\,\text{RPM}$$

The theoretical speed for the motor is 1800 RPM (synchronous speed). However, an induction motor cannot generate torque unless its shaft turns at a slightly different speed. This difference is called *slip*. So it's common to see a rated speed of approximately 1750 RPM on a 60 Hz, 4-pole motor. Using a tachometer to measure shaft speed, you can see the difference between the inverter output frequency and the actual motor speed. The slip increases slightly as the motor's load increases. This is why the inverter output value is called "frequency," since it is not exactly equal to motor speed. You can program the inverter to display output frequency in units more directly related to the load speed by entering a constant (discussed more in depth on).

Run/Stop Versus Monitor/Program Modes – The Run LED on the inverter is ON in Run Mode, and OFF in Stop Mode. The Program LED is ON when the inverter is in Program Mode, and OFF for Monitor Mode. All four mode combinations are possible. The diagram to the right depicts the modes and the mode transitions via keypad.
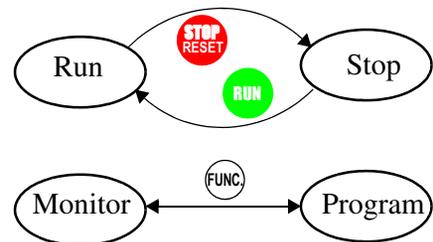
NOTE: Some factory automation devices such as PLCs have alternate Run/Program modes; the device is in either one mode or the other. In the Hitachi inverter, however, Run Mode alternates with Stop Mode, and Program Mode alternates with Monitor Mode. This arrangement lets you program some values while the inverter is operating—providing flexibility for maintenance personnel.

Configuring
Drive Parameters

3

Choosing a Programming Device

Introduction

Hitachi variable frequency drives (inverters) use the latest electronics technology for getting the right AC waveform to the motor at the right time. The benefits are many, including energy savings and higher machine output or productivity. The flexibility required to handle a broad range of applications has required ever more configurable options and parameters—inverters are now a complex industrial automation component. And this can make a product seem difficult to use, but the goal of this chapter is to make this easier for you.

As the powerup test in Chapter 2 demonstrated, you do not have to program very many parameters to run the motor. In fact, most applications would benefit only from programming just a few, specific parameters. This chapter will explain the purpose of each set of parameters, and help you choose the ones that are important to your application.

If you are developing a new application for the inverter and a motor, finding the right parameters to change is mostly an exercise in optimization. Therefore, it is okay to begin running the motor with a loosely tuned system. By making specific, individual changes and observing their effects, you can achieve a finely tuned system.

Inverter Programming Keypads

The front panel keypad is the first and best way to get to know the inverter's capabilities. Every function or programmable parameter is accessible from the keypad. All keypads have the same basic layout, but with different features. The OPE–SRE has a potentiometer knob for frequency setting input. The SRW–0EX Read/write Copy Unit has the ability to upload (copy) or download (write) all inverter parameter data to/from memory in the copy unit itself. This unit is useful in transferring one inverter's settings to another.

The following table shows various programming options, the features unique to each device, and the cables required.

Device	Part Number	Parameter Access	Parameter setting storage	Cables (for optional external mounting)	
				Part number	Length
Inverter keypad, U.S. version	OPE–SRE	Monitor and program	EEPROM in inverter	ICS–1	1 meter
				ICS–3	3 meters
Inverter keypad, European version	OPE–S	Monitor and program	EEPROM in inverter	Use same two cables as above	
Read/write Copy Unit with Keypad	SRW–0EX	Monitor and program; read or write all data	EEPROM in inverter or in copy unit	Use same two cables as above	

TIP: Other special-purpose keypads are available, such as ones to serve the needs of the HVAC market (heating, ventilating & air conditioning). Please contact your Hitachi distributor for details.

Configuring Drive Parameters

Using Keypad Devices

Inverter Front Panel Keypad

The L300P Series inverter front keypad contains all the elements for both monitoring and programming parameters. The keypad layout (OPE–SRE) is shown below. All other programming devices for the inverter have a similar key arrangement and function.
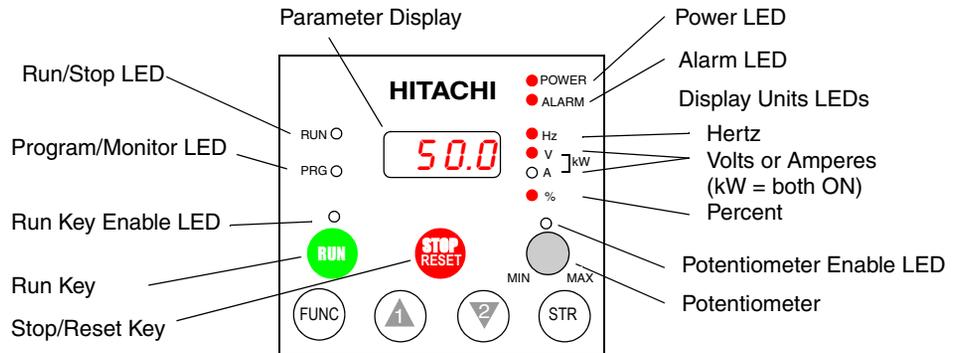
Key and Indicator Legend

• **Run/Stop LED** – ON when the inverter output is ON and the motor is developing torque, and OFF when the inverter output is OFF (Stop Mode).

• **Program/Monitor LED** – This LED is ON when the inverter is ready for parameter editing (Program Mode). It is normally OFF when the parameter display is monitoring data (Monitor Mode). However, the PRG LED will be ON whenever you are monitoring the value of parameter D001. (When the keypad is enabled as the frequency source via A001=02, you can edit the inverter frequency directly from D001 monitor display by using the Up/Down keys.)

• **Run Key** – Press this key to run the motor (the Run Enable LED must be ON first). Parameter F004, Keypad Run Key Routing, determines whether the Run key generates a Run FWD or Run REV command.

• **Run Key Enable LED** – is ON when the inverter is ready to respond to the Run key, OFF when the Run key is disabled.

• **Stop/Reset Key** – Press this key to stop the motor when it is running (uses the programmed deceleration rate). This key will also reset an alarm that has tripped.

• **Potentiometer** – allows an operator to directly set the motor speed when the potentiometer is enabled for output frequency control

• **Potentiometer Enable LED** – ON when the potentiometer is enabled for value entry.

• **Parameter Display** – a 4-digit, 7-segment display for parameters and function codes.

• **Display Units: Hertz/Volts/Amperes/kW/%** – These LEDs indicate the units associated with the parameter display. When the display is monitoring a parameter, the appropriate LED is ON. In the case of kW units, both Volts and Amperes LEDs will be ON. An easy way to remember this is that kW = (V x A)/1000.

• **Power LED** – This LED is ON when the power input to the inverter is ON.

• **Alarm LED** – This LED is ON when an alarm condition has tripped the inverter. Clearing the alarm will turn this LED OFF again. See Chapter 6 for details on clearing alarms.

• **Function Key** – This key is used to navigate through the lists of parameters and functions for setting and monitoring parameter values.

• **Up/Down ($\triangle$, $\triangledown$) Keys** – Use these keys to alternately move up or down the lists of parameter and functions shown in the display, and increment/decrement values.

• **Store ((STR)) Key** – When the unit is in Program Mode and the operator has edited a parameter value, press the Store key to write the new value to the EEPROM. This parameter is then displayed at powerup by default. If you want to change the powerup default, navigate to a new parameter value and press the Store key.

Configuring Drive
Parameters

Keypad Navigational Map

Whether you use the keypad on the inverter or the read-write copy unit, each navigates the same way. The diagram below shows the basic navigational map of parameters and functions.
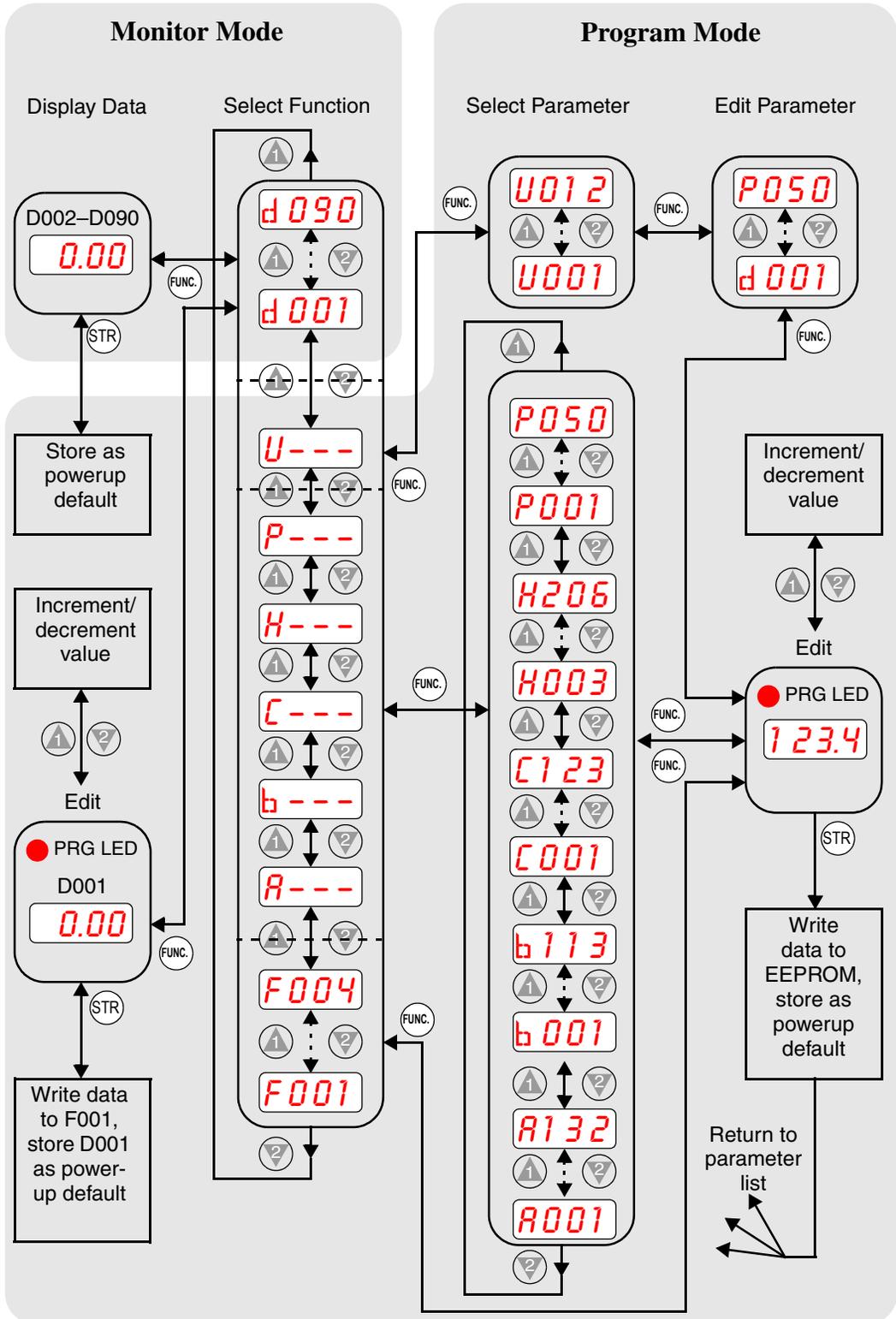
NOTE: The inverter 7-segment display shows lower case "b" and "d", meaning the same as the upper case letters "B" and "D" used in this manual (for uniformity "A to F").

Operational Modes

The RUN and PGM LEDs tell just part of the story; Run Mode and Program Modes are independent modes, not opposite modes. In the state diagram to the right, Run alternates with Stop, and Program Mode alternates with Monitor Mode. This is a very important ability, for it shows that a technician can approach a running machine and change some parameters without shutting down the machine.
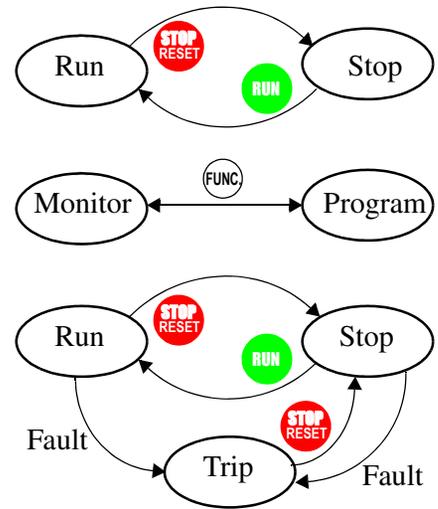
The occurrence of a fault during operation will cause the inverter to enter the Trip Mode as shown. An event such as an output overload will cause the inverter to exit the Run Mode and turn OFF its output to the motor. In the Trip Mode, any request to run the motor is ignored. You must clear the error by pressing the Stop/Reset switch. See .

Run Mode Edits

The inverter can be in Run Mode (inverter output is controlling motor) and still allow you to edit certain parameters. This is useful in applications that must run continuously, yet need some inverter parameter adjustment.

The parameter tables in this chapter have a column titled "Run Mode Edit." An Ex mark ✘ means the parameter cannot be edited; a Check mark ✔ means the parameter can be edited. You'll notice in the table example to the right the two adjacent marks: "✘ ✔". The two marks, (that can also be "✘ ✘" or "✔ ✔") correspond to these levels of access to editing:

Run Mode Edit Lo Hi	
✘	✔

• Low-access level to Run Mode edits (indicated by *left-most* mark)

• High-access level to Run Mode edits (indicated by *right-most* mark)

The Software Lock Setting (parameter B031) determines the particular access level that is in effect during Run Mode and access in other conditions, as well. It is the responsibility of the user to choose a useful and safe software lock setting for the inverter operating conditions and personnel. Please refer to page for more information.

Control Algorithms

The motor control program in the L300P inverter has several sinusoidal PWM switching algorithms. The intent is that you select the best algorithm for the motor characteristics in your application. Each algorithm generates the frequency output in a unique way. Once configured, the algorithm is the basis for other parameter settings as well (see). Therefore, choose the best algorithm early in your application design process.

Inverter Torque Control Algorithms
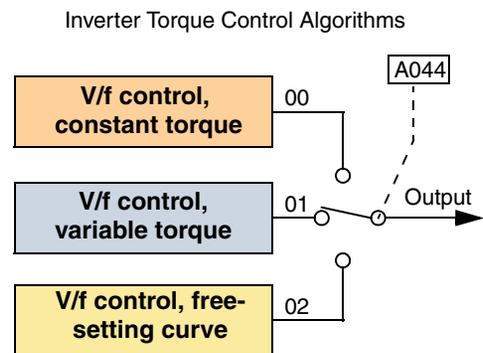
"D" Group: Monitoring Functions

Parameter Monitoring Functions

You can access important system parameter values with the "D" Group monitoring functions, whether the inverter is in Run Mode or Stop Mode. After selecting the function code number for the parameter you want to monitor, press the Function key once to show the value on the display. In Functions D005 and D006 the intelligent terminals use individual segments of the display to show ON/OFF status.

"D" Function			Run Mode Edit	Range and Units	SRW Display
Func. Code	Name	Description			
D001	Output frequency monitor	Real-time display of output frequency to motor, from 0.0 to 400.0 Hz	—	0.0 to 400.0 Hz	FM 0000.00Hz
D002	Output current monitor	Filtered display of output current to motor (100 mS internal filter time constant)	—	A	Iout 0000.0A
D003	Rotation direction monitor	Three different indications: "F". Forward "o". Stop "r" Reverse	—	—	Dir STOP
D004	Process variable (PV), PID feedback monitor	Displays the scaled PID process variable (feedback) value (A75 is scale factor)	—	—	PID-FB 0000.00%
D005	Intelligent input terminal status	Displays the state of the intelligent input terminals:	—	—	IN-TM LLLLLLLLL
D006	Intelligent output terminal status	Displays the state of the intelligent output terminals:	—	—	OUT-TM LLLLLL
D007	Scaled output frequency monitor	Displays the output frequency scaled by the constant in B86. Decimal point indicates range: XX.XX 0.00 to 99.99 XXX.X 100.0 to 999.9 XXXX. 1000 to 9999 XXXX 10000 to 99990	—	User-defined	F-CNV 000000.00
D013	Output voltage monitor	Voltage of output to motor, range is 0.0 to 600.0V	—	VAC	Vout 000.0V
D014	Power monitor	0.0 to 999.9	—	kW	Power 000.0kW
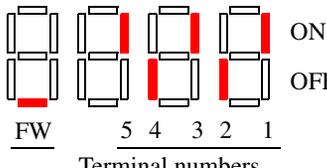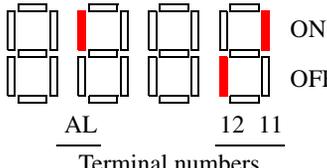
"D" Function			Run Mode Edit	Range and Units	SRW Display
Func. Code	Name	Description			
D016	Cumulative operation RUN time monitor	Displays total time the inverter has been in RUN mode in hours. Range is 0 to 9999 / 1000 to 9999/ 100 to 999 (10,000 to 99,900) hrs.	—	hours	`RUN     0000000hr`
D017	Cumulative power-on time monitor	Displays total time the inverter has had input power (ON) in hours. Range is: 0 to 9999 / 100.0 to 999.9 / 1000 to 9999 / 100 to 999 hrs.	—	hours	`ON      0000000hr`

Trip Event and Programming Error Monitoring

The trip event and history monitoring feature lets you cycle through related information using the keypad. See "Monitoring Trip Events, History, & Conditions" on page 6–5.

Programming errors generate an error code that begins with the special 🔴 character. See "Programming Error Codes" on page 3–60 for more information.

"D" Function			Run Mode Edit Lo Hi	Range and Units	SRW Display
Func. Code	Name	Description			
D080	Trip Counter	Number of trip events	—	—	`ERR COUNT   00000`
D081 to D086	Trip monitor 1 to 6	Displays trip event information	—	—	`(Trip event type)`
D090	Programming error monitor	Displays programming error code	—	—	`XXXX`

Configuring Drive Parameters

"F" Group: Main Profile Parameters

The basic frequency (speed) profile is defined by parameters contained in the "F" Group as shown to the right. The output frequency is set in Hz, but acceleration and deceleration are specified seconds (the time to ramp from zero to maximum frequency, or from maximum frequency to zero). The motor direction parameter determines whether the keypad Run key produces a FW or RV command. This parameter does not affect the [FW] terminal or [RV] intelligent terminal function, which you configure separately.
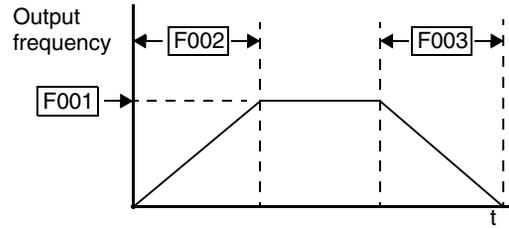
Acceleration 1 and Deceleration 1 are the standard default accel and decel values for the main profile. Accel and decel values for an alternative profile are specified by using parameters Ax92 through Ax93. The motor direction selection (F004) determines the direction of rotation as commanded only from the keypad. This setting applies to either motor profile (1st or 2nd) in use at a particular time.

"F" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
F001	Output frequency setting	Standard default target frequency that determines constant motor speed Range is 0 to 360 Hz	✔ ✔	0.00	0.00	0.00	Hz	>F001 SET-Freq. TM 0000.00Hz 2FS 0000.00Hz 3FS 0000.00Hz TM 0000.00Hz JG 0000.00Hz 1S 0000.00Hz 15S 0000.00Hz OP1 0000.00Hz OP2 0000.00Hz RS485 0000.00Hz
F002	Acceleration (1) time setting	Standard default acceleration Range is 0.01 to 3600 sec.	✔ ✔	30.0	60.0	30.0	sec.	>F002 ACCEL TIME1 0030.00s
F202	Acceleration (1) time setting, 2nd motor	Standard default acceleration, 2nd motor Range is 0.01 to 3600 sec.	✔ ✔	30.0	60.0	30.0	sec.	>F202 2ACCEL TIME1 0030.00s
F003	Deceleration (1) time setting	Standard default deceleration Range is 0.01 to 3600 sec.	✔ ✔	30.0	60.0	30.0	sec.	>F003 DECEL TIME1 0030.00s
F203	Deceleration (1) time setting, 2nd motor	Standard default deceleration, 2nd motor Range is 0.01 to 3600 sec.	✔ ✔	30.0	60.0	30.0	sec.	>F203 2DECEL TIME1 0030.00s
F004	Keypad Run key routing	Two options; select codes: 00 Forward 01 Reverse	✘ ✘	00	00	00	—	>F004 DIG-RUN SELECT FW

"A" Group: Standard Functions

Basic Parameter Settings

These settings affect the most fundamental behavior of the inverter—the outputs to the motor. The frequency of the inverter's AC output determines the motor speed. You may select from three different sources for the reference speed. During application development you may prefer using the potentiometer, but you may switch to an external source (control terminal setting) in the finished application, for example.

The base frequency and maximum frequency settings interact according to the graph below (left). The inverter output operation follows the constant V/f curve until it reaches the full-scale output voltage. This initial straight line is the constant-torque part of the operating characteristic. The horizontal line over to the maximum frequency serves to let the motor run faster, but at a reduced torque. This is the constant-horsepower part of the characteristic. If you want the motor to output constant torque over its entire operating range (limited to the motor nameplate voltage and frequency rating), then set the base frequency and maximum frequency equal as shown (below right).

"A" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
A001	Frequency source setting	Six options; select codes: 00 Keypad potentiometer 01 Control terminal 02 Function F001 setting 03 RS485 serial command 04 Expansion board 1 05 Expansion board 2	✗ ✗	01	01	00	—	>A001 F-SET SELECT TRM
A002	Run command source setting	Five options; select codes: 01 Input terminal [FW] or [RV] (assignable) 02 Run key on keypad, or digital operator 03 RS485 serial command 04 Start/Stop, expansion card #1 05 Start/Stop, expansion card #2	✗ ✗	01	01	02	—	>A002 F/R SELECT TRM
A003	Base frequency setting	Settable from 30 Hz to the maximum frequency	✗ ✗	50.	60.	60.	Hz	>A003 F-BASE F 0060Hz

Configuring Drive Parameters

"A" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
A203	Base frequency setting, 2nd motor	Settable from 30 Hz to the maximum frequency	✗ ✗	50.	60.	60.	Hz	>A203 2F-BASE F 0060Hz
A004	Maximum frequency setting	Settable from 30 Hz to 400 Hz	✗ ✗	50.	60.	60.	Hz	>A004 F-max F 0060Hz
A204	Maximum frequency setting, 2nd motor	Settable from 30 Hz to 400 Hz	✗ ✗	50.	60.	60.	Hz	>A204 2F-max F 0060Hz

NOTE: The base frequency must be less than or equal to the maximum frequency (ensure that A003 ≤ A004).

Analog Input Settings

The inverter has the capability to accept external analog inputs that can command the output frequency to the motor. Signals including voltage input (0 to +10V) at terminal [O], bipolar input (-10 to +10V) at terminal [O2], and current input (4 to 20mA) at terminal [OI] are available. Terminal [L] serves as signal ground for the three analog inputs. The analog input settings adjust the curve characteristics between the analog input and the frequency output.

Adjusting [O–L] characteristics – In the graph to the right, A013 and A014 select the active portion of the input voltage range. Parameters A011 and A012 select the start and end frequency of the converted output frequency range, respectively. Together, these four parameters define the major line segment as shown. When the line does not begin at the origin (A011 and A013 > 0), then A015 defines whether the inverter outputs 0Hz or the A011-specified frequency when the analog input value is less than the A013 setting. When the input voltage is greater than the A014 ending value, the inverter outputs the ending frequency specified by A012.
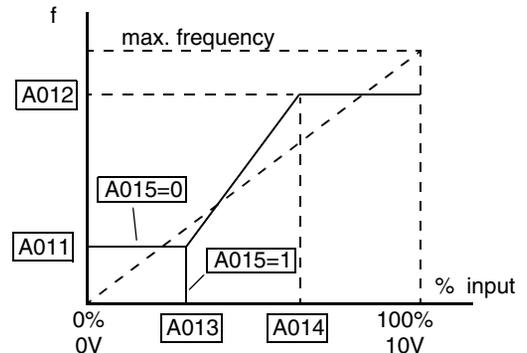
Adjusting [OI–L] characteristics – In the graph to the right, A103 and A104 select the active portion of the input current range. Parameters A101 and A102 select the start and end frequency of the converted output frequency range, respectively. Together, these four parameters define the major line segment as shown. When the line does not begin at the origin (A101 and A103 > 0), then A105 defines whether the inverter outputs 0Hz or the A101-specified frequency when the analog input value is less than the A103 setting. When the input voltage is greater than the A104 ending value, the inverter outputs the ending frequency specified by A102.
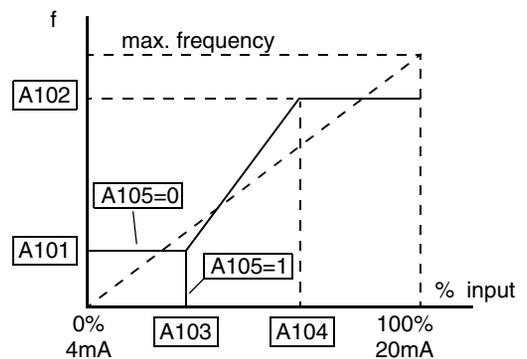
Adjusting [O2–L] characteristics – In the graph to the right, A113 and A144 select the active portion of the input voltage range. Parameters A111 and A112 select the start and end frequency of the converted output frequency range, respectively. Together, these four parameters define the major line segment as shown. When the input voltage is less than the A113 input starting value, the inverter outputs the starting frequency specified by A111. When the input voltage is greater than the A114 ending value, the inverter outputs the ending frequency specified by A112.

Configuring Drive Parameters

"A" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
A005	[AT] selection	Two options; select codes: 00 Select between [O] and [OI] at [AT] 01 Select between [O] and [O2] at [AT]	✗ ✗	00	00	00	—	>A005 AT SELECT O/OI
A006	[O2] selection	Three options; select codes: 00 Independent 01 Only positive 02 Both positive and negative	✗ ✗	00	00	00	—	>A006 O2 SELECT O2
A011	[O]–[L] input active range start frequency	The output frequency corresponding to the voltage input range starting point Range is 0.00 to 400.00 Hz	✗ ✔	0.00	0.00	0.00	Hz	>A011 INPUT-O EXS 0000.00Hz
A012	[O]–[L] input active range end frequency	The output frequency corresponding to the voltage input range ending point Range is 0.00 to 400.00 Hz	✗ ✔	0.00	60.0	0.00	Hz	>A012 INPUT-O EXE 0000.00Hz
A013	[O]–[L] input active range start voltage	The starting point for the voltage input range Range is 0 to 100%	✗ ✔	0.	0.	0.	%	>A013 INPUT-O EX%S 000%
A014	[O]–[L] input active range end voltage	The ending point for the voltage input range Range is 0 to 100%	✗ ✔	100.	100.	100.	%	>A014 INPUT-O EX%E 100%
A015	[O]–[L] input start frequency enable	Two options; select codes: 00 Use A011 start value 01 Use 0 Hz	✗ ✔	01	01	01	—	>A015 INPUT-O LEVEL 0Hz
A016	External frequency filter time constant	Range n = 1 to 30, where n = number of samples for avg.	✗ ✔	8.	8.	8.	Samples	>A016 INPUT F-SAMP 08

Multi-speed and Jog Frequency Settings

The L300P inverter has the capability to store and output up to 16 preset frequencies to the motor (A020 to A035). As in traditional motion terminology, we call this *multi-speed profile* capability. These preset frequencies are selected by means of digital inputs to the inverter. The inverter applies the current acceleration or deceleration setting to change from the current output frequency to the new one. The first multi-speed setting is duplicated for the second motor settings (the remaining 15 multi-speeds apply only to the first motor).

The jog speed setting is used whenever the Jog command is active. The jog speed setting range is arbitrarily limited to 10 Hz to provide safety during manual operation. The acceleration to the jog frequency is instantaneous, but you can choose from six modes for the best method for stopping the jog operation.

"A" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
A019	Multi-speed operation selection	Two options; select codes: 00 Binary; up to 16-stage speed using 4 intelligent terminals 01 Single-bit; up to 8-stage speed using 7 intelligent terminals	✗ ✗	00	00	00	—	>A019 SPEED SELECT BINARY
A020	Multi-speed frequency setting	Defines the first speed of a multi-speed profile, range is 0 to 360 Hz A020 = Speed 1 (1st motor)	✔ ✔	0.00	0.00	0.00	Hz	>A020 SPEED FS 0000.00Hz
A220	Multi-speed frequency setting, 2nd motor	Defines the first speed of a multi-speed profile for 2nd motor, range is 0 to 360 Hz A220 = Speed 1 (2nd motor)	✔ ✔	0.00	0.00	0.00	Hz	>A220 SPEED 2FS 0000.00Hz
A021 to A035	Multi-speed frequency settings (for both motors)	Defines 15 more speeds, range is 0 to 360 Hz. A021 = Speed 2... A035 = Speed 16	✔ ✔	0.00	0.00	0.00	Hz	>A021 SPEED 01S 0000.00Hz
A038	Jog frequency setting	Defines limited speed for jog, range is 0.5 to 9.99 Hz	✔ ✔	1.00	1.00	1.00	Hz	>A038 Jogging F 01.00Hz
A039	Jog stop mode	Define how end of jog stops the motor; six options: 00 Free-run stop, jogging disabled during motor run 01 Controlled deceleration, jogging disabled during motor run 02 DC braking to stop, jogging disabled during motor run 03 Free-run stop, jogging always enabled 04 Controlled deceleration, jogging always enabled 05 DC braking to stop, jogging always enabled	✗ ✔	00	00	00	—	>A039 Jogging Mode FRS

Configuring Drive Parameters

Torque Control Algorithms

The inverter generates the motor output according to the V/f algorithm. Parameter A044 selects the inverter torque control algorithm for generating the frequency output, as shown in the diagram to the right (A244 for 2nd motor). The factory default is 00 (constant torque V/f control).

Review the following descriptions to help you choose the best torque control algorithm for your application.

Inverter Torque Control Algorithms

- The built-in V/f curves are oriented toward developing constant torque or variable torque characteristics (see graphs below).

- The free-setting curve provides an even more flexible characteristic, but it requires more parameter settings.
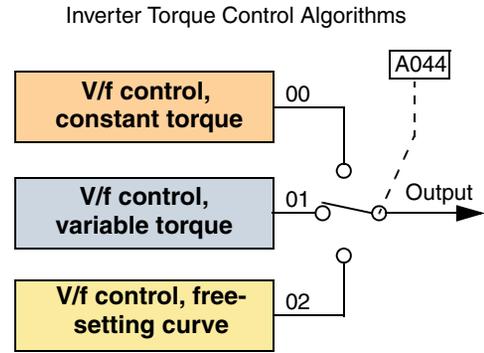
Constant and Variable Torque – The graph below (left) shows the constant torque characteristic from 0Hz to the base frequency A003. The voltage remains constant for output frequencies higher than the base frequency.
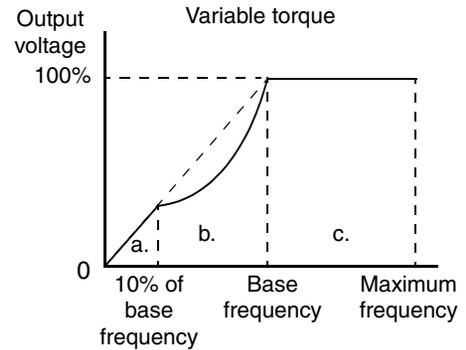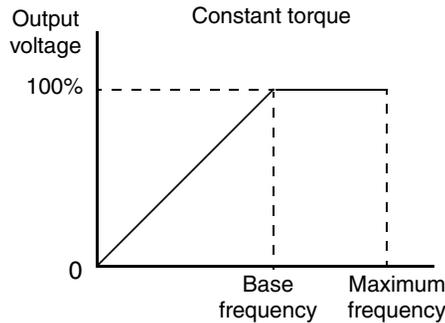
The graph above (right) shows the general characteristic for variable torque. The curve may be best described in three sections, as follows:

a. The range from 0Hz to 10% of the base frequency is the constant torque characteristic. For example, a base frequency of 60Hz ends the constant torque characteristic segment at 6Hz.

b. The range from 10% of the base frequency to the base frequency is the variable (reduced) torque characteristic. The voltage is output in the curve of frequency to the 1.7 power.

c. After reaching the base frequency, the characteristic maintains a constant output voltage for higher frequencies.

Using parameter A045 you can modify the voltage gain of the inverter. This is specified as a percentage of the full-scale setting AVR (Automatic Voltage Regulation) in parameter A082. The gain can be set from 20% to 100%. It must be adjusted in accordance with the motor specifications.

Torque Boost – The Constant and Variable Torque algorithms feature an adjustable *torque boost* curve. When the motor load has a lot of inertia or starting friction, you may need to increase the low frequency starting torque characteristics by boosting the voltage above the normal V/f ratio (shown at right). The boost is applied from zero to 1/2 the base frequency. You set the breakpoint of the boost (point A on the graph) by using parameters A042 and A043. The manual boost is calculated as an addition to the standard straight V/f line (constant torque curve).
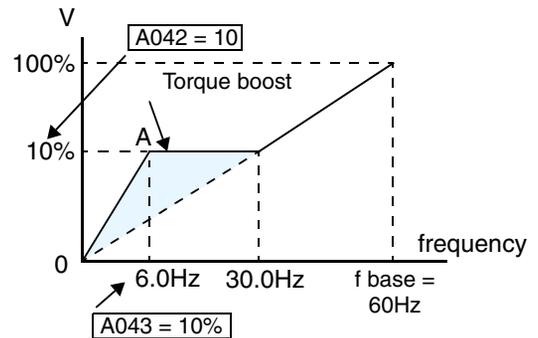
Be aware that running the motor at a low speed for a long time can cause motor overheating. This is particularly true when manual torque boost is ON or if the motor relies on a built-in fan for cooling.

NOTE: Manual torque boost applies only to constant torque (A044=00) and variable torque (A044=01) V/f control.

V/f Free-setting – The free-setting V/f inverter mode of operation uses voltage and frequency parameter pairs to define seven points on a V/f graph. This provides a way to define a multi-segment V/f curve that best suits your application.

The frequency settings do require that F1 ≤ F2 ≤ F3 ≤ F4 ≤ F5 ≤ F6 ≤ F7; their values must have this ascending order relationship. However, the voltages V1 to V7 may either increase or decrease from one to the next. The example to the right shows the definition of a complex curve by following the setting requirements.

Free-setting f7 (B112) becomes the maximum frequency of the inverter. Therefore, we recommend setting f7 first, since the initial value of all default frequencies f1–f7 is 0Hz.
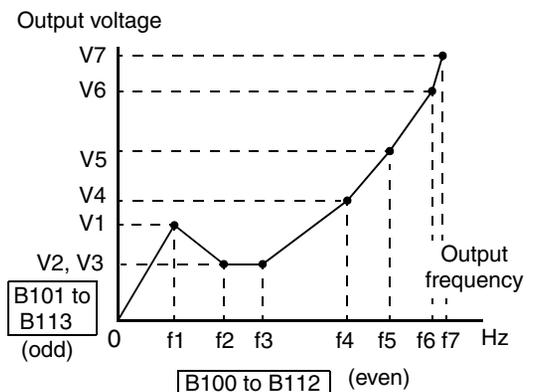
NOTE: The using of V/f free-setting operation specifies parameters that override (make invalid) certain other parameters. The parameters that become invalid are torque boost (A041/A241), base frequency (A003/A203/A303), and maximum frequency (A004/A204/A304). In this case, we recommend leaving their settings at the factory default values.

The V/f free-setting endpoint f7/V7 parameters must stay within the more basic inverter limits in order for the specified free-setting characteristic curve to be achieved. For example, the inverter cannot output a higher voltage than the input voltage or the AVR setting voltage (Automatic Voltage Regulation), set by parameter A082. The graph to the right shows how the inverter input voltage would clip (limit) the characteristic curve if exceeded.
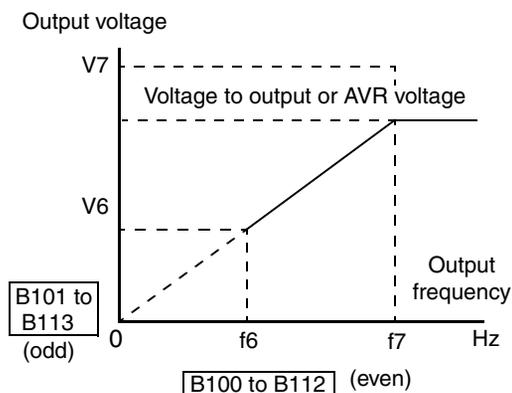
The following table shows the methods of torque control selection.

"A" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
A041	Torque boost method selection	Two options: 00 Manual torque boost 01 Automatic torque boost	✘ ✘	00	00	00	—	>A041 V-Boost Mode MANUAL
A241	Torque boost method selection, 2nd motor	Two options (for 2nd motor): 00 Manual torque boost 01 Automatic torque boost	✘ ✘	00	00	00	—	>A241 2V-Boost Mode MANUAL
A042	Manual torque boost value	Can boost starting torque between 0 and 20% above normal V/f curve, from 0 to 1/2 base frequency	✔ ✔	1.0	1.0	1.0	—	>A042 V-Boost Code 01.0%
A242	Manual torque boost value, 2nd motor	Can boost starting torque between 0 and 20% above normal V/f curve, from 0 to 1/2 base frequency	✔ ✔	1.0	1.0	1.0	—	>A242 2V-Boost Code 01.0%
A043	Manual torque boost frequency adjustment	Sets the frequency of the V/f breakpoint A in graph (top of previous page) for torque boost	✔ ✔	5.0	5.0	5.0	%	>A043 V-Boost F 05.0%
A243	Manual torque boost frequency adjustment, 2nd motor	Sets the frequency of the V/f breakpoint A in graph (top of previous page) for torque boost	✔ ✔	5.0	5.0	5.0	%	>A243 2V-Boost F 05.0%
A044	V/f characteristic curve selection, 1st motor	Three torque control modes: 00 V/f constant torque 01 V/f variable torque 02 V/f free-setting curve	✘ ✘	00	01	00	—	>A044 Control 1st VC
A244	V/f characteristic curve selection, 2nd motor	Three torque control modes: 00 V/f constant torque 01 V/f variable torque 02 V/f free-setting curve	✘ ✘	00	01	00	—	>A244 2Control 2nd VC
A045	V/f gain setting	Sets voltage gain of the inverter from 20 to 100%	✔ ✔	100.	100.	100.	%	>A045 V-Gain Gain 100%

DC Braking Settings

The DC braking feature can provide additional stopping torque when compared to a normal deceleration to a stop. It can also ensure the motor and load are stopped before acceleration.

When decelerating – DC braking is particularly useful at low speeds when normal deceleration torque is minimal. During deceleration, the inverter injects a DC voltage into the motor windings during deceleration below a frequency you can specify (A052). The braking power (A054) and duration (A055) can both be set. You can optionally specify a wait time before DC braking (A053), during which the motor will free run (coast).
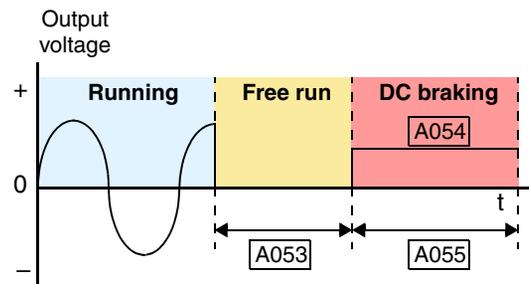
When starting – You can also apply DC braking upon the application of a Run command, specifying both the DC braking force level (A057) and the duration (A058). This will serve to stop the rotation of the motor and the load, when the load is capable of driving the motor. This effect, sometimes called "windmilling," is common in fan applications. Often, air moving in duct work will drive the fan in a backward direc-

tion. If an inverter is started into such a backward-rotating load, over-current trips can occur. Use DC braking as an "anti-windmilling" technique to stop the motor and load, and allow a normal acceleration from a stop. See also the "Acceleration Pause Function" on page 3–20.
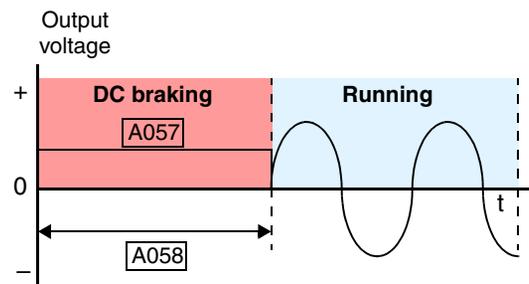
You can configure the inverter to apply DC braking at stopping only, at starting only, or both. DC braking power (0–100%) can be set separately for stopping and starting cases.

You can configure DC braking to initiate in one of two ways:

1. **Internal DC braking** – Set A051=01 to enable internal braking. The inverter automatically applies DC braking as configured (during stopping, starting, or both).

2. **External DC braking** – Configure an input terminal with option code 7 [DB] (see "External Signal for DC Braking" on page 4–16 for more details). Leave A051=00, although this setting is ignored when a [DB] input is configured. The DC braking force settings (A054 and A057) still apply. However, the braking time settings (A055 and A058) do not apply (see level and edge triggered descriptions below). Use A056 to select level or edge detection for the external input.

   a. Level triggered – When the [DB] input signal is ON, the inverter immediately applies DC injection braking, whether the inverter is in Run Mode or Stop Mode. You control DC braking time by the duration of the [DB] pulse.

   b. Edge triggered – When the [DB] input transitions OFF-to-ON and the inverter is in Run Mode, it will apply DC braking only until the motor stops... then DC braking is OFF. During Stop Mode, the inverter ignores OFF-to-ON transitions. Therefore, do not use edge triggered operation when you need DC braking before acceleration.

CAUTION: Be careful to avoid specifying a braking time that is long enough to cause motor overheating. If you use DC braking, we recommend using a motor with a built-in thermistor and wiring it to the inverter's thermistor input (see "Thermistor Thermal Protection" on page 4–27). Also refer to the motor manufacturer's specifications for duty-cycle recommendations during DC braking.

Configuring Drive Parameters

"A" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
A051	DC braking enable	Two options; select codes: 00 Disable 01 Enable	✘ ✔	00	00	00	—	>A051 DCB Mode OFF
A052	DC braking frequency setting	The frequency at which DC braking activates during decel. Range is 0.00 to 60.00 Hz	✘ ✔	0.50	0.50	0.50	Hz	>A052 DCB F 00.50Hz
A053	DC braking wait time	The delay after reaching the DC braking frequency, or [DB] signal, before DC braking begins. Range is 0.0 to 5.0 seconds	✘ ✔	0.0	0.0	0.0	sec.	>A053 DCB WAIT 0.0s
A054	DC braking force during deceleration	Variable DC braking force. Range is from 0% to 70%	✘ ✔	0.	0.	0.	%	>A054 DCB STP-V 000%
A055	DC braking time for deceleration	Sets the duration for DC braking during decel. Range is 0.0 to 60.0 seconds	✘ ✔	0.0	0.0	0.0	sec.	>A055 DCB STP-T 00.0s
A056	DC braking / edge or level detection for [DB] input	Two options; select codes: 00 Edge detection 01 Level detection	✘ ✔	01	01	01	—	>A056 DCB KIND LEVEL
A057	DC braking force for starting	Variable DC braking force. Range is 0 to 70%	✘ ✔	0.	0.	0.	%	>A057 DCB STA-V 000%
A058	DC braking time for starting	Sets the duration for DC braking before accel. Range is 0.0 to 60.0 seconds	✘ ✔	0.0	0.0	0.0	sec.	>A058 DCB STA-T 00.0s
A059	DC braking carrier frequency setting	Range is 0.5 to 12 kHZ for models up to –750xxx, range is 0.5 to 8kHz for 900xxx – 1320xxx models	✘ ✘	3.0	3.0	3.0	kHz	>A059 DCB CARRIER 05.0kHz

Derating of DC Braking – The inverter uses an internal carrier frequency (set by A059) to generate a DC braking voltage (do not confuse with main inverter output carrier frequency set by B083). The maximum DC braking force available to the inverter is more limited with higher DC braking carrier frequency settings for A059 according to the graphs below.

Maximum braking ratio (%) — **Models 11 – 75kW** — DC braking carrier frequency

Maximum braking ratio (%) — **Models 90 – 132kW** — DC braking carrier frequency
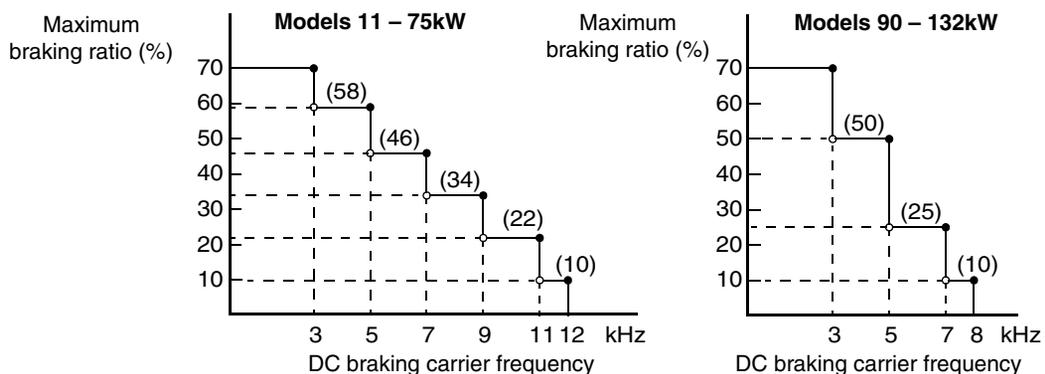
Frequency-related Functions

Frequency Limits – Upper and lower limits can be imposed on the inverter output frequency. These limits will apply regardless of the source of the speed reference. You can configure the lower frequency limit to be greater than zero as shown in the graph to the right. The upper limit must not exceed the rating of the motor or capability of the machinery.

Output frequency

A061 Upper limit

Settable range

A062 Lower limit

Frequency command

"A" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
A061	Frequency upper limit setting	Sets a limit on output frequency less than the maximum frequency (A004) Range is 0.50 to 400.0 Hz 0.00 setting is disabled >0.10 setting is enabled	✘ ✔	0.00	0.00	0.00	Hz	>A061 LIMIT HIGH 0000.00Hz
A261	Frequency upper limit setting, 2nd motor	Sets a limit on output frequency less than the maximum frequency (A004) Range is 0.50 to 400.0 Hz 0.00 setting is disabled >0.10 setting is enabled	✘ ✔	0.00	0.00	0.00	Hz	>A261 2LIMIT HIGH 0000.00Hz
A062	Frequency lower limit setting	Sets a limit on output frequency greater than zero Range is 0.50 to 400.0 Hz 0.00 setting is disabled >0.1 setting is enabled	✘ ✔	0.00	0.00	0.00	Hz	>A062 LIMIT LOW 0000.00Hz
A262	Frequency lower limit setting, 2nd motor	Sets a limit on output frequency greater than zero Range is 0.50 to 400.0 Hz 0.00 setting is disabled >0.10 setting is enabled	✘ ✔	0.00	0.00	0.00	Hz	>A262 2LIMIT LOW 0000.00Hz

Jump Frequencies – Some motors or machines exhibit resonances at particular speed(s), which can be destructive for prolonged running at those speeds. The inverter has up to three *jump frequencies* as shown in the graph. The hysteresis around the jump frequencies causes the inverter output to skip around the sensitive frequency values.

Output frequency

Jump frequencies

A067

A065

A063

A068
A068

A066
A066

Hysteresis values

A064
A064

Frequency command

"A" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
A063 A065 A067	Jump (center) frequency setting	Up to 3 output frequencies can be defined for the output to jump past to avoid motor resonances (center frequency) Range is 0.00 to 400.0 Hz	✘ ✔	0.00	0.00	0.00	Hz	>A063 JUMP F1 0000.00Hz >A065 JUMP F2 0000.00Hz >A067 JUMP F3 0000.00Hz
A064 A066 A068	Jump (hysteresis) frequency width setting	Defines the distance from the center frequency at which the jump occurs Range is 0.0 to 10.0 Hz	✘ ✔	0.50	0.50	0.50	Hz	>A064 JUMP W1 00.50Hz >A066 JUMP W2 00.50Hz >A068 JUMP W3 00.50Hz

Acceleration Pause Function

The acceleration pause function can be used to minimize the occurrence of over-current trips when accelerating high inertia loads. It introduces a dwell or pause in the acceleration ramp. You can control the frequency at which this dwell occurs (A069), and the duration of the pause time (A070). This function can also be used as an anti-windmilling tool, when the load might have a tendency to drive the motor in a reverse direction while the inverter is in a Stop mode. Initiating a normal acceleration in such a situation may result in over-current trips. This function can be used to keep the inverter output frequency and voltage at low levels long enough to bring the load to a stop, and commence turning in the desired direction before the acceleration ramp resumes. See also .
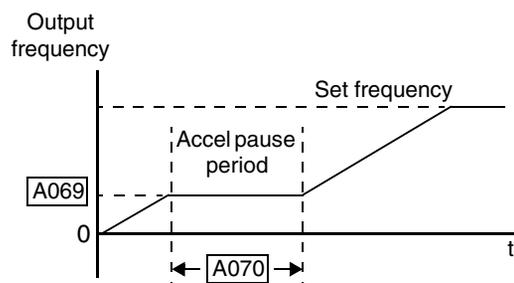
"A" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
A069	Acceleration pause frequency setting	Range is 0.00 to 400.0Hz	✘ ✔	0.00	0.00	0.00	Hz	>A069 F-STOP F 0000.00H
A070	Acceleration pause time setting	Range is 0.0 to 60.0 sec.	✘ ✔	0.0	0.0	0.0	sec.	>A070 F-STOP T 00.0s

PID Control

When enabled, the built-in PID loop calculates an ideal inverter output value to cause a loop feedback process variable (PV) to move closer in value to the setpoint (SP). The current frequency command serves as the SP. The PID loop algorithm will read the analog input for the process variable (you specify either current or voltage input) and calculate the output.

- A scale factor in A075 lets you multiply the PV by a factor, converting it into engineering units for the process.
- Proportional, integral, and derivative gains are all adjustable.
- Optional – You can assign an intelligent input terminal the option code 23, PID Disable. When active, this input disables PID operation. See .
- See for more information.

"A" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
A071	PID Enable	Enables PID function, two option codes: 00 PID operation OFF 01 PID operation ON	✘ ✔	00	00	00	—	>A071 PID SW OFF
A072	PID proportional gain	Proportional gain has a range of 0.2 to 5.0	✔ ✔	1.0	1.0	1.0	—	>A072 PID P 1.0
A073	PID integral time constant	Integral time constant has a range of 0.0 to 3600 seconds	✔ ✔	1.0	1.0	1.0	sec.	>A073 PID I 0001.0s
A074	PID derivative time constant	Derivative time constant has a range of 0.0 to 100 seconds	✔ ✔	0.0	0.0	0.0	sec.	>A074 PID D 000.00
A075	PV scale conversion	Process Variable (PV) scale factor (multiplier), range of 0.01 to 99.99	✘ ✔	1.00	1.00	1.00	—	>A075 PID CONV 001.00
A076	PV source setting	Selects source of Process Variable (PV), option codes: 00 [OI] terminal (current input) 01 [O] terminal (voltage input)	✘ ✔	00	00	00	—	>A076 PID INPUT OI

NOTE: The setting A073 for the integrator is the integrator's time constant Ti, not the gain. The integrator gain Ki = 1/Ti. When you set A073 = 0, the integrator is disabled.

Configuring Drive Parameters

Automatic Voltage Regulation (AVR) Function

The automatic voltage regulation (AVR) feature keeps the inverter output voltage at a relatively constant amplitude during power input fluctuations. This can be useful if the installation is subject to input voltage disturbances. However, the inverter cannot boost its motor output to a voltage higher than the power input voltage. If you enable this feature, be sure to select the proper voltage class setting for your motor.

"A" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
A081	AVR function select	Automatic (output) voltage regulation, selects from three type of AVR functions, three option codes: 00 AVR enabled 01 AVR disabled 02 AVR enabled except during deceleration	✘ ✘	00	00	02	—	>A081 AVR MODE DOFF
A082	AVR voltage select	200V class inverter settings: 200/215/220/230/240 400V class inverter settings: 380/400/415/440/460/480	✘ ✘	230/ 400	230/ 460	200/ 400	V	>A082 AVR AC 230

Energy Savings Mode

This function allows the inverter to deliver the minimum power necessary to maintain speed at any given frequency. This works best when driving variable torque characteristic loads such as fans and pumps. Parameter A085 enables this function and A086 controls the degree of its effect. A setting of 0.0 yields slow response but high accuracy, while a setting of 100 will yield a fast response with lower accuracy.

"A" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
A085	Operation mode selection	Two options: 00 Normal operation 01 Energy-saver operation	✘ ✘	00	00	00	—	>A085 RUN MODE NOR
A086	Energy saving mode tuning	Range is 0.0 to 100 sec.	✔ ✔	50.0	50.0	50.0	sec.	>A086 RUN ECO 0050.0s

Configuring Drive Parameters

Second Acceleration and Deceleration Functions

The L300P inverter features two-stage acceleration and deceleration ramps. This gives flexibility in the profile shape. You can specify the frequency transition point, the point at which the standard acceleration (F002) or deceleration (F003) changes to the second acceleration (A092) or deceleration (A093). These profile options are also available for the second motor settings and third motor settings. All acceleration and deceleration times are time to ramp from zero speed to full speed or full speed to zero speed. Select a transition method via A094 as depicted below. Be careful not to confuse the *second acceleration/deceleration settings* with settings for the *second motor*!

"A" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
A092	Acceleration (2) time setting	Duration of 2nd segment of acceleration, range is: 0.01 to 3600 sec.	✔ ✔	15.0	15.0	15.0	sec.	>A092 ACCEL TIME2 0015.00s
A292	Acceleration (2) time setting, 2nd motor	Duration of 2nd segment of acceleration, 2nd motor, range is: 0.01 to 3600 sec.	✔ ✔	15.0	15.0	15.0	sec.	>A292 2ACCEL TIME2 0015.00s
A093	Deceleration (2) time setting	Duration of 2nd segment of deceleration, range is: 0.01 to 3600 sec.	✔ ✔	15.0	15.0	15.0	sec.	>A093 DECEL TIME2 0015.00s
A293	Deceleration (2) time setting, 2nd motor	Duration of 2nd segment of deceleration, 2nd motor, range is: 0.01 to 3600 sec.	✔ ✔	15.0	15.0	15.0	sec.	>A293 2DECEL TIME2 0015.00s
A094	Select method to switch to Acc2/Dec2 profile	Two options for switching from 1st to 2nd accel/decel: 00 2CH input from terminal 01 transition frequency	✘ ✘	00	00	00	—	>A094 ACCEL CHANGE TM
A294	Select method to switch to Acc2/Dec2 profile, 2nd motor	Two options for switching from 1st to 2nd accel/decel: 00 2CH input from terminal 01 transition frequency (2nd motor)	✘ ✘	00	00	00	—	>A294 ACCEL CHANGE TM
A095	Acc1 to Acc2 frequency transition point	Output frequency at which Accel1 switches to Accel2, range is 0.00 to 400.0 Hz	✘ ✘	0.0	0.0	0.0	Hz	>A095 ACCEL CHFr 0000.00Hz
A295	Acc1 to Acc2 frequency transition point, 2nd motor	Output frequency at which Accel1 switches to Accel2, range is 0.00 to 400.0 Hz (2nd motor)	✘ ✘	0.0	0.0	0.0	Hz	>A295 2ACCEL CHFr 0000.00Hz

"A" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
A096	Dec1 to Dec2 frequency transition point	Output frequency at which Decel1 switches to Decel2, range is 0.00 to 400.0 Hz	✘ ✘	0.0	0.0	0.0	Hz	>A096 DECEL CHFr 0000.00Hz
A296	Dec1 to Dec2 frequency transition point, 2nd motor	Output frequency at which Decel1 switches to Decel2, range is 0.00 to 400.0 Hz (2nd motor)	✘ ✘	0.0	0.0	0.0	Hz	>A296 2DECEL CHFr 0000.00Hz

NOTE: For A095 and A096 (and for 2nd motor settings), if you set a very rapid Acc1 or Dec1 time (less than 1.0 second), the inverter may not be able to change rates to Acc2 or Dec2 before reaching the target frequency. In that case, the inverter decreases the rate of Acc1 or Dec1 in order to achieve the second ramp to the target frequency.

Accel/Decel Characteristics

Standard (default) acceleration and deceleration is linear with time. The inverter CPU can also calculate other curves shown in the graphs below. The sigmoid, U-shape, and reverse U-shape curves are useful for favoring the load characteristics in particular applications. Curve settings for acceleration and deceleration are independently selected parameters A097 and A098 respectively. You can use the same or different curve types for acceleration and deceleration.

Set value	00	01	02	03
Curve	Linear	Sigmoid	U-shape	Reverse U-shape
Accel [A97]	Output frequency ... time	Output frequency ... time	Output frequency ... time	Output frequency ... time
Decel [A98]	Output frequency ... time	Output frequency ... time	Output frequency ... time	Output frequency ... time
Typical applications	Linear acceleration and deceleration for general-purpose use	Avoid jerk on start/stop for elevators; use for delicate loads on conveyors	Tension control for winding applications, web presses, roller/accumulators	

Configuring Drive Parameters

"A" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
A097	Acceleration curve selection	Set the characteristic curve of Accel1 and Accel2, four options: 00 Linear 01 S-curve 02 U-shape 03 Reverse U-shape	✗ ✗	00	00	00	—	>A097 ACCEL LINE Linear
A098	Deceleration curve selection	Set the characteristic curve of Decel1 and Decel2, four options: 00 Linear 01 S-curve 02 U-shape 03 Reverse U-shape	✗ ✗	00	00	00	—	>A098 DECEL LINE Linear

The acceleration and deceleration curves can deviate from a straight line to a varying degree. Parameters A131 and A132 control the amount of deviation for the acceleration and deceleration curves respectively. The following graphs show intermediate output frequency points as a percentage of the target frequency, for 25%, 50%, and 75% acceleration time intervals.

"A" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
A131	Acceleration curve constants setting	Sets the curve deviation from straight-line acceleration in ten levels: 01 smallest deviation 10 largest deviation	✗ ✔	02	02	02	—	>A131 ACCEL GAIN 02
A132	Deceleration curve constants setting	Sets the curve deviation from straight-line deceleration in ten levels: 01 smallest deviation 10 largest deviation	✗ ✔	02	02	02	—	>A132 DECEL GAIN 02

Additional Analog Input Settings

The parameters in the following table adjust the input characteristics of the analog inputs. When using the inputs to command the inverter output frequency, these parameters adjust the starting and ending ranges for the voltage or current, as well as the output frequency range. Related characteristic diagrams are located in "Analog Input Settings" on page 3–11.

"A" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
A101	[OI]–[L] input active range start frequency	The output frequency corresponding to the current input range starting point. Range is 0.00 to 400.0 Hz	✘ ✔	00.0	00.0	00.0	Hz	>A101 INPUT-OI EXS 0000.00Hz
A102	[OI]–[L] input active range end frequency	The output frequency corresponding to the current input range ending point. Range is 0.00 to 400.0 Hz	✘ ✔	00.0	60.0	00.0	Hz	>A102 INPUT-OI EXE 0000.00Hz
A103	[OI]–[L] input active range start current	The starting point for the current input range. Range is 0 to 100%	✘ ✔	20.	20.	20.	%	>A103 INPUT-OI EX%S 020%
A104	[OI]–[L] input active range end current	The ending point for the current input range. Range is 0 to 100%	✘ ✔	100.	100.	100.	%	>A104 INPUT-OI EX%E 100%
A105	[OI]–[L] input start frequency enable	Two options: 00 Use A101 start value 01 Use 0Hz	✘ ✔	01	01	01	Hz	>A105 INPUT-OI LEVEL 0Hz
A111	[O2]–[L] input active range start frequency	The output frequency corresponding to the bipolar voltage input range starting point. Range is –400. to 400. Hz	✘ ✔	0.00	0.00	0.00	Hz	>A111 INPUT-O2 EXS +000.00Hz
A112	[O2]–[L] input active range end frequency	The output frequency corresponding to the bipolar voltage input range ending point. Range is –400. to 400. Hz	✘ ✔	0.00	0.00	0.00	Hz	>A112 INPUT-O2 EXE +000.00Hz
A113	[O2]–[L] input active range start voltage	The starting point for the bipolar voltage input range. Range is –100 to 100%	✘ ✔	-100.	-100.	-100.	%	>A113 INPUT-O2 EX%S -100%
A114	[O2]–[L] input active range end voltage	The ending point for the bipolar voltage input range. Range is –100 to 100%	✘ ✔	100.	100.	100.	%	>A114 INPUT-O2 EX%E +100%

Configuring Drive Parameters

"B" Group: Fine-Tuning Functions

The "B" Group of functions and parameters adjust some of the more subtle but useful aspects of motor control and system configuration.

Automatic Restart Mode and Phase Loss

The restart mode determines how the inverter will resume operation after a fault causes a trip event. The four options provide advantages for various situations. Frequency matching allows the inverter to read the motor speed by virtue of its residual magnetic flux and restart the output at the corresponding frequency. The inverter can attempt a restart a certain number of times depending on the particular trip event:

- Over-current trip, restart up to 3 times
- Over-voltage trip, restart up to 3 times
- Under-voltage trip, restart up to 16 times

When the inverter reaches the maximum number of restarts (3 or 16), you must power-cycle the inverter to reset its operation.

Other parameters specify the allowable under-voltage level and the delay time before restarting. The proper settings depend on the typical fault conditions for your application, the necessity of restarting the process in unattended situations, and whether restarting is always safe.

"B" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
B001	Selection of automatic restart mode	Select inverter restart method, four option codes: 00 Alarm output after trip, automatic restart disabled 01 Restart at 0Hz 02 Resume operation after frequency matching 03 Resume previous freq. after freq. matching, then decelerate to stop and display trip info	✗ ✔	00	00	00	—	>b001 IPS POWER ALM

"B" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
B002	Allowable under-voltage power failure time	The amount of time a power input under-voltage can occur without tripping the power failure alarm. If under-voltage exists longer than this time, the inverter trips, even if the restart mode is selected. If it exists less than this time retry will be attempted. Range is 0.3 to 1.0 sec.	✘ ✔	1.0	1.0	1.0	sec.	>b002 IPS TIME 1.0s
B003	Retry wait time before motor restart	Time delay after a trip condition goes away before the inverter restarts the motor. Range is 0.3 to 100 seconds.	✘ ✔	1.0	1.0	1.0	sec.	>b003 IPS WAIT 001.0s
B004	Instantaneous power failure / under-voltage trip alarm enable	Three option codes: 00 Disable 01 Enable 02 Disable during stop and ramp to stop	✘ ✔	00	00	00	—	>b004 IPS TRIP OFF
B005	Number of restarts on power failure / under-voltage trip events	Two option codes: 00 Restart 16 times 01 Always restart	✘ ✔	00	00	00	—	>b005 IPS RETRY 16
B006	Phase loss detection enable	Two option codes: 00 Disable – no trip on phase loss 01 Enable – trip on phase loss	✘ ✔	00	00	00	—	>b006 PH-FAIL SELECT OFF
B007	Restart frequency threshold	When the frequency of the motor is less than this value, the inverter will restart at 0 Hz. Range is 0.00 to 400.0 Hz	✘ ✔	0.00	0.00	0.00	Hz	>b007 IPS F 0000.00Hz

⚠️ **CAUTION:** When a loss of phase occurs, increased ripple current will markedly reduce main capacitor life over time. Diode bridge failure can also result. If phase loss occurs under load, the inverter could be damaged. Please pay particular attention to the setting of function B006.

Electronic Thermal Overload Alarm Setting

The thermal overload detection protects the inverter and motor from overheating due to an excessive load. It uses a current/inverse time curve to determine the trip point. The thermal overload alarm [THM] is the resulting intelligent output.

First, use B013 to select the torque characteristic that matches your load. This allows the inverter to utilize the best thermal overload characteristic for your application.
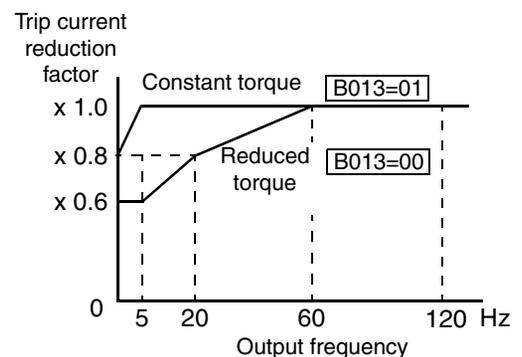
The torque developed in a motor is directly proportional to the current in the windings, which is also proportional to the heat generated (and temperature, over time). Therefore, you must set the thermal overload threshold in terms of current (amperes) with parameter B012. The range is 50% to 120% of the rated current for each inverter model. If the current exceeds the level you specify, the inverter will trip and log an event (error E5) in the history table. The inverter turns the motor output OFF when tripped. Separate settings are available for the second and third motors (if applicable), as shown in the table below.

Function Code	Function/Description	Data or Range
B012 / B212	Electronic thermal setting (calculated within the inverter from current output)	Range is 0.2 * rated current to 1.2 * rated current

For example, suppose you have inverter model L300P-110LFU2. The rated motor current is 44A. The setting range is (0.2 * 44) to (1.2 *44), or 8.8A to 52.8A. For a setting of B012 = 44A (current at 100%) and output frequency = 60Hz, the figure to the right shows the curve.

The electronic thermal characteristic adjusts the way the inverter calculates thermal heating, based on the type of load connected to the motor, as set by parameter B013.
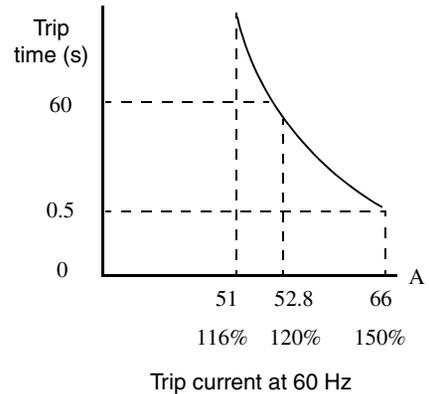
CAUTION: When the motor runs at lower speeds, the cooling effect of the motor's internal fan decreases.

Trip time (s)

60

0.5

0

51   52.8   66   A

116%   120%   150%

Trip current at 60 Hz

The table below shows the torque profile settings. Use the one that matches your load.

Function Code	Data	Function/Description
B013 / B213	00	Reduced torque
	01	Constant torque
	02	Free-setting

Reduced Torque Characteristic – The left graph below shows the effect of the reduced torque characteristic curve. For example, at 20Hz, the output current level to cause overheating in a fixed time period is reduced by a factor of 0.8. The right graph below shows the reduced trip current levels in those conditions for given trip times.

Trip current reduction factor

x 1.0

x 0.8

x 0.6

0

5   20   60   Hz

Trip time (s)

60

0.5

0

40.8   42.2   52.8   A

92.8%   96%   120%

Reduced trip current at 20 Hz

Constant Torque Characteristic – The left graph below shows the effect of the constant torque characteristic curve. For example, at 2.5Hz, the output current level to cause overheating in a fixed time period is reduced by a factor of 0.9. The right graph below shows the reduced trip current levels in those conditions for given trip times.

Reduced trip current at 2.5 Hz

Free Thermal Characteristic - It is possible to set the electronic thermal characteristic using a free-form curve defined by three data points, according to the table below.

Function Code	Name	Description	Range
B015 / B017 / B019	Free-setting electronic thermal frequency 1, 2, 3	Data point coordinates for Hz axis (horizontal) in the free-form curve	0 to 400Hz
B016 / B018 / B020	Free setting electronic thermal current 1, 2, 3	Data point coordinates for Ampere axis (vertical) in the free-form curve	0.0 = (disable) 0.1 to 1000.

The left graph below shows the region for possible free-setting curves. The right graph below shows an example curve defined by three data points specified by B015 – B020.

Suppose the electronic thermal setting (B012) is set to 44 Amperes. The left graph below shows the effect of the free setting torque characteristic curve. For example, at (B017) Hz, the output current level to cause overheating in a fixed time period is reduced by a factor of (B018). The right graph below shows the reduced trip current levels in those conditions for given trip times.

Trip time (s)

60

0.5

0

(x)   (y)   (z)   A

(x) = B018 value x 116%
(y) = B018 value x 120%
(z) = B018 value x 150%

Reduced trip current at (B017) Hz
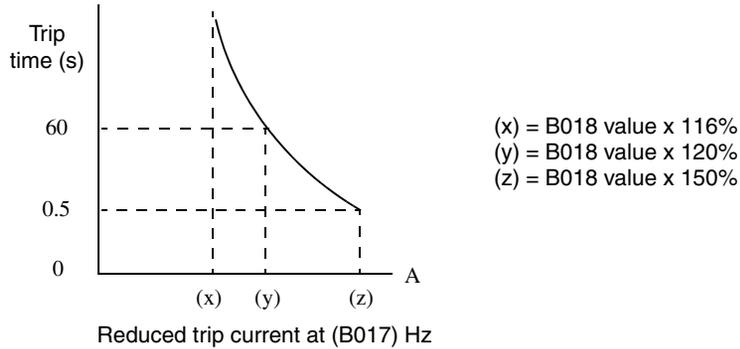
Any intelligent output terminal may be programmed to indicate a thermal warning [THM]. Parameter C061 determines the warning threshold. Please see for more details.

"B" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
B012	Level of electronic thermal setting	Set a level between 50% and 120% of the inverter rated current	✘ ✔	rated current for each inverter model			%	>b012 E-THM LEVEL 0016.5A
B212	Level of electronic thermal setting, 2nd motor	Set a level between 50% and 120% of the inverter rated current	✘ ✔	rated current for each inverter model			%	>b212 2E-THM LEVEL 0016.5A
B013	Electronic thermal characteristic	Select from three curves, option codes: 00 Reduced torque 01 Constant torque 02 V/f free-setting	✘ ✔	01	00	00	—	>b013 E-THM CHAR CRT
B213	Electronic thermal characteristic, 2nd motor	Select from three curves, option codes: 00 Reduced torque 01 Constant torque 02 V/f free-setting	✘ ✔	01	00	00	—	>b213 2E-THM CHAR CRT
B015	Free setting, electronic thermal frequency (1)	Range is 0.0 to 400.0 Hz	✘ ✔	0.	0.	0.	Hz	>b015 E-THM F1 0000Hz
B016	Free setting, electronic thermal current (1)	Range is 0.0 to 1000. A	✘ ✔	0.0	0.0	0.0	A	>b016 E-THM A1 0000.0A
B017	Free setting, electronic thermal frequency (2)	Range is 0.0 to 400.0 Hz	✘ ✔	0.	0.	0.	Hz	>b017 E-THM F2 0000Hz
B018	Free setting, electronic thermal current (2)	Range is 0.0 to 1000. A	✘ ✔	0.0	0.0	0.0	A	>b018 E-THM A2 0000.0A
B019	Free setting, electronic thermal frequency (3)	Range is 0.0 to 400.0 Hz	✘ ✔	0.	0.	0.	Hz	>b019 E-THM F3 0000Hz
B020	Free setting, electronic thermal current (3)	Range is 0.0 to 1000. A	✘ ✔	0.0	0.0	0.0	A	>b020 E-THM A3 0000.0A

Overload Restriction

If the inverter's output current exceeds a preset current level you specify during acceleration or constant speed, the overload restriction feature automatically reduces the output frequency to restrict the overload. This feature does not generate an alarm or trip event. You can instruct the inverter to apply overload restriction only during constant speed, thus allowing higher currents for acceleration. Or, you may use the same threshold for both acceleration and constant speed. In the case of controlled deceleration, the inverter monitors both output current and DC bus voltage. The inverter will increase output frequency to try to avoid a trip due to over-current or over-voltage (due to regeneration).
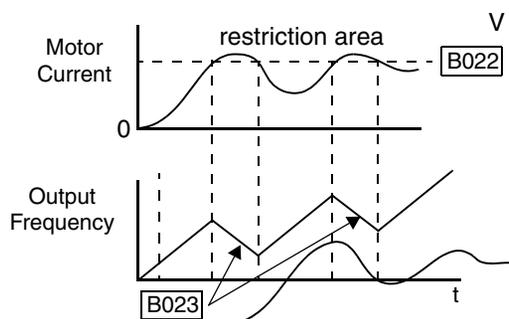
When the inverter detects an overload, it must decelerate the motor to reduce the current until it is less than the threshold. You can choose the rate of deceleration that the inverter uses to lower the output current.

"B" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
B021	Overload restriction operation mode	Select the operating mode during overload conditions, three options, option codes: 00 Disabled 01 Enabled for acceleration and constant speed 02 Enabled for constant speed only 03 Enabled for accel, decel, and constant speed	✘ ✔	01	01	01	—	>b021 OLOAD 1MODE ON
B022	Overload restriction setting	Sets the level for overload restriction, between 50% and 150% of the rated current of the inverter, setting resolution is 1% of rated current	✘ ✔	rated current times 1.20	rated current times 1.10	rated current times 1.20	A	>b022 OLOAD 1LEVEL 0024.8A
B023	Deceleration rate at overload restriction	Sets the deceleration rate when inverter detects overload, range is 0.1 to 30.0, resolution is 0.1.	✘ ✔	1.00	15.0	1.00	sec.	>b023 OLOAD 1CONST 01.00
B024	Overload restriction operation mode (2)	Select the operating mode motor during overload conditions, three options, option codes: 00 Disabled 01 Enabled for acceleration and constant speed 02 Enabled for constant speed only 03 Enabled for accel, decel, and constant speed	✘ ✔	01	01	01	—	>b024 OLOAD 2MODE ON

"B" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
B025	Overload restriction setting (2)	Sets the level for overload restriction (2), between 50% and 150% of the rated current of the inverter, setting resolution is 1% of rated current	✗ ✔	rated current times 1.20			A	>b025 OLOAD 2LEVEL 0024.8A
B026	Deceleration rate at overload restriction (2)	Sets the deceleration rate (2) when inverter detects overload, range is 0.1 to 30.0, resolution is 0.1.	✗ ✔	1.00	1.00	1.00	sec.	>b026 OLOAD 2CONST 01.00

Configuring Drive Parameters

Software Lock Mode

The software lock function keeps personnel from accidentally changing parameters in the inverter memory. Use B031 to select from various protection levels.

The table below lists all combinations of B031 option codes and the ON/OFF state of the [SFT] input. Each Check ✔ or Ex ✘ indicates whether the corresponding parameter(s) can be edited. The Standard Parameters column below lists Low and High level access for some lock modes. These refer to the parameter tables throughout this chapter, each of which includes a column titled *Run Mode Edit* as shown to the right. The two marks (Check ✔ or Ex ✘) under the "Lo Hi" subtitle indicate whether Low-level and/or High-level access

Run Mode Edit Lo Hi	
✘	✔

applies to each parameter as defined in the table below. In some lock modes, you can edit only F001 and the Multi-speed parameter group that includes A020, A220, A320, A021–A035, and A038 (Jog). However, it does not include A019, Multi-speed operation selection. The editing access to B031 itself is unique, and is specified in the right-most two columns below.

B031 Lock Mode	[SFT] Intelligent Input	Standard Parameters		F001 and Multi-speed	B031	
		Stop	**Run**	**Stop or Run**	**Stop**	**Run**
00	OFF	✔	Low-level	✔	✔	✘
	ON	✘	✘	✘	✔	✘
01	OFF	✔	Low-level	✔	✔	✘
	ON	✘	✘	✔	✔	✘
02	(ignored)	✘	✘	✘	✔	✘
03	(ignored)	✘	✘	✔	✔	✘
10	(ignored)	✔	High-level	✔	✔	✔

NOTE: Since the software lock function B031 is always accessible when the motor is stopped, this feature is not the same as password protection used in other industrial control devices.

"B" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	**Name**	**Description**		**–FE2 (CE)**	**–FU2 (UL)**	**–FR (Jpn)**		
B031	Software lock mode selection	Prevents parameter changes in five options: 00 Low-level access, [SFT] input blocks all edits 01 Low-level access, [SFT] input blocks edits (except F001 and Multi-speed parameters) 02 No access to edits 03 No access to edits except F001 and Multi-speed parameters 10 High-level access, including B031	✘ ✔	01	01	01	—	>b031 S-LOCK Mode MD1

NOTE: To disable parameter editing when using B031 lock modes 00 and 01, assign the [SFT] function to one of the intelligent input terminals. See .

Configuring Drive Parameters

Configuring Drive Parameters

Miscellaneous Settings

The miscellaneous settings include scaling factors, initialization modes, and others. This section covers some of the most important settings you may need to configure.

"B" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
B034	Run/power-on warning time	Range is 0 to 65,530 hours	✗ ✔	0.	0.	0.	hrs.	>b034 TIME WARN 00000
B035	Rotational direction restriction	Three option codes: 00 Enable for both dir. 01 Enable for forward only 02 Enable for reverse only	✗ ✗	00	00	00	—	>b035 LIMIT F/R FREE
B036	Reduced voltage start selection	Seven option codes: 00 Short 01, 02, 03, 04, 05 (middle) 06 Long	✗ ✔	06	06	06	—	>b036 RVS ADJUST 06

Function Code Display Restriction – The inverter has the (optional) capability to suppress the display and editing of certain parameters. Use B037 to select the display options. The purpose of this feature is to hide particular secondary parameters that become unused or not applicable based on more fundamental parameter settings. For example, setting A001 = 01 configures the inverter to get its frequency command from the front keypad potentiometer. In this case, the inverter will not use the analog inputs nor their adjustment parameters for an external frequency command.

"B" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
B037	Function code display restriction	Three option codes: 00 Display all 01 Display only utilized functions (see table below) 02 Display user-selected functions only (configure with U01 to U12)	✗ ✔	00	00	00	—	>b037 DISP Mode ALL

For example, you can set B037=01 to have the inverter suppress the displaying of all analog
input parameters when A001=01, as shown in the first row of the following table.

Function Code	Data	Resulting Non-displayed Functions (when B37 = 01)	Notes
A001	01	A005, A006, A011 – A016, A101–A105, A111 – A114, C081 – C083, C121 – C123	[O], [OI], [O2] terminal functions
A002	01, 03, 04, 05	B087	Stop key function
A019	00	A028 – A035	Multi-speed function
C001 – C005	02, 03, 04, 05		
A044, A244	02	B100 – B113	Control methods
A051	01	A052 – A059	DC braking
A071	01	A072 – A076, C044	PID function
A094	01	A095 – A096	2-stage adjustable frequency
A294	01	A0295 – A296	
B013, B213	02	B015 – B020	Electric thermal characteristic
B021	01, 02	B022, B023	Overload restriction
B024	01, 02	B025, B026	Overload restriction 2
B095	01, 02	B090 – B096	Dynamic braking function
C001 – C005	06	A038, A039	Jogging
	08	A203, A204, A220, A241 – A244, A261, A262, A292, A293 – A296, B212, B213, H203, H204, H206	2nd motor control
	11	B088	Free-run stop
	18	C102	Reset
	27, 28, 29	C101	UP/DWN
A094	01	A131	Select method to switch to second accel/decel profile
A294	01	A095, A096	Select method to switch to second accel/decel profile, 2nd motor
A097	01, 02, 03	A131	Acceleration pattern constant
A098	01, 02, 03	A132	Deceleration pattern constant
B098	01, 02	B099, C085	Thermistor function
C021, C022, C026	02, 06	C042, C043	Frequency arrival signal

Configuring Drive
Parameters

Miscellaneous functions, continued...

B083: Carrier frequency adjustment – The internal *switching frequency* of the inverter circuitry (also called the *chopper frequency*). It is called the carrier frequency because the lower AC output frequency of the inverter "rides" the carrier. The faint, high-pitched sound you hear when the inverter is in Run Mode is characteristic of switching power supplies in general. The carrier frequency is adjustable from 500 Hz to 12 kHz (the upper limit varies, depending on the inverter rating). The audible sound decreases at the higher frequencies, but RFI noise and leakage current may be increased. Refer to the specification derating curves in Chapter 1 to determine the maximum allowable carrier frequency setting for your particular inverter and environmental conditions.

NOTE: The carrier frequency setting must stay within specified limits for inverter-motor applications that must comply with particular regulatory agencies. For example, a European CE-approved application requires the inverter carrier to be less than 5 kHz.

B084, B085: Initialization codes – These functions allow you to restore the factory default settings. Please refer to .

B086: Frequency display scaling – You can convert the output frequency monitor on D001 to a scaled number (engineering units) monitored at function D007. For example, the motor may run a conveyor that is monitored in feet per minute. Use this formula:

Scaled output frequency (D007) = Output frequency (D001) × Factor (B086)

"B" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
B080	[AM] terminal analog meter adjustment	Adjust 8-bit gain to analog meter connected to terminal [AM], range is 0 to 255	✔ ✔	180	180	180	—	>b080 AM-MONITOR ADJUST 180
B081	[FM] terminal analog meter adjustment	Adjust 8-bit gain to analog meter connected to terminal [FM], range is 0 to 255	✔ ✔	60	60	60	—	>b081 FM-MONITOR ADJUST 060
B082	Start frequency adjustment	Sets the starting frequency for the inverter output, range is 0.10 to 9.99 Hz	✘ ✔	0.50	0.50	0.50	Hz	>b082 fmin F 00.50Hz
B083	Carrier frequency setting	Sets the PWM carrier (internal switching frequency). Range is 0.5 to 8.0 kHz for –015xxx to –750xxx models and 0.5 to 12.0 kHz for –900Hxx to 1320Hxx	✘ ✔	3.0	3.0	3.0	kHz	>b083 CARRIER F 05.0kHz
B084	Initialization mode (parameters or trip history)	Select the type of initialization to occur, two option codes: 00 Trip history clear 01 Parameter initialization 02 Trip history clear and parameter initialization	✘ ✘	00	00	00	—	>b084 INITIAL MODE TRP
B085	Country code for initialization	Select default parameter values for country on initialization, four option codes: 00 Japan version 01 Europe version 02 US version 03 reserved (do not set)	✘ ✘	01	02	00	—	>b085 INITIAL SELECT USA
B86	Frequency scaling conversion factor	Specify a constant to scale D007 to display in engineering units. Range is 0.1 to 99.9	✔ ✔	1.0	1.0	1.0	—	>b086 F-CONV Gain 001.0
B087	STOP key enable	Select whether the STOP key on the keypad is enabled (req. A002=01, 03, 04, or 05). Two option codes: 00 Enable 01 Disable	✘ ✔	00	00	00	—	>b087 STOP-SW SELECT ON

Configuring Drive Parameters

Configuring Drive
Parameters

Miscellaneous functions, continued...

B091/B088: Stop Mode / Restart Mode Configuration – You can configure how the inverter performs a standard stop (each time Run FWD and REV signals turn OFF). Setting B091 determines whether the inverter will control the deceleration, or whether it will perform a free-run stop (coast to a stop). When using the free-run stop selection, it is imperative to also configure how you want the inverter to resume control of motor speed. Setting B088 determines whether the inverter will ensure the motor always resumes at 0 Hz, or whether the motor resumes from its current coasting speed (also called *frequency matching*). The Run command may turn OFF briefly, allowing the motor to coast to a slower speed from which normal operation can resume.

In most applications a controlled deceleration is desirable, corresponding to B091=00. However, applications such as HVAC fan control will often use a free-run stop (B091=01). This practice decreases dynamic stress on system components, prolonging system life. In this case, you will typically set B088=01 in order to resume from the current speed after a free-run stop (see diagram below, right). Note that using the default setting, B088=00, can cause trip events when the inverter attempts to force the load quickly to zero speed.

NOTE: Other events can cause (or be configured to cause) a free-run stop, such as power loss (see "Automatic Restart Mode and Phase Loss" on page 3–28), and inverter trip events in general (see "Miscellaneous Functions" on page 3–55). If all free-run stop behavior is important to your application (such as HVAC), be sure to configure each event accordingly.

Some additional parameters further configure all instances of a free-run stop. Parameter B003, Retry Wait Time Before Motor Restart, sets the minimum time the inverter will free-run. For example, if B003 = 4 seconds (and B091=01) and the cause of the free-run stop lasts 10 seconds, the inverter will free-run (coast) for a total of 14 seconds before driving the motor again. Parameter B007, Restart Frequency Threshold, sets the motor frequency at which the inverter will no longer resume and accelerate, instead resuming from 0 Hz (complete stop).

2

"B" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
B088	Restart mode after FRS	Selects how the inverter resumes operation when the free-run stop (FRS) is cancelled, two option codes: 00 Restart from 0Hz 01 Restart from frequency detected from actual speed of motor	✗ ✔	00	00	00	—	>b088 RUN FRS ZST

"B" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
B090	Dynamic braking usage ratio	Selects the braking duty cycle for the dynamic braking resistor (total brake % ON-time per 100 sec. interval). Range is 0.0 to 100.0% 0% Dynamic braking disabled >0% Enabled, per value	✗ ✔	00	00	00	—	>b090 BRD %ED 000.0%
B091	Stop mode selection	Selects how the inverter normally stops the motor (Run command or signal goes OFF) Two option codes: 00 DEC (decelerate and stop) 01 FRS (free-run to stop)	✗ ✗	00	00	00	—	>b091 RUN STOP DEC
B092	Cooling fan control (see note below)	Two option codes: 00 Fan always ON 01 Fan ON during RUN, OFF during STOP	✗ ✗	00	00	00	—	>b092 INITIAL FAN-CTL OFF
B095	Dynamic braking control	Three option codes: 00 Disable 01 Enable during RUN only 02 Enable always	✗ ✔	00	00	00	—	>b095 BRD Mode OFF
B096	Dynamic braking activation level	Range is: 330 to 380V (200V class), 660 to 760V (400V class)	✗ ✔	360/ 720	360/ 720	360/ 720	V	>b096 BRD LEVEL 360Vdc
B098	Thermistor for thermal protection control	Three option codes: 00 Disable 01 Enable-PTC thermistor 02 Enable-NTC thermistor	✗ ✔	00	00	00	—	>b098 THERM SELECT OFF
B099	Thermal protection level setting	Thermistor resistance threshold at which trip occurs. Range is 0.0 to 9999 Ohms	✗ ✔	3000	3000	3000	Ohms	>b099 THERM LEVEL 3000ohm

B090: Dynamic braking usage ratio – This parameter limits the amount of time the inverter can use the dynamic braking accessory device without entering the Trip Mode. Please refer to for more information on dynamic braking accessories.

NOTE: When cooling fan control is enabled (B092=01) the inverter always turns the fan ON for 5 minutes immediately after powerup. This will cool the inverter in case the inverter / motor is still warm from prior running before a short power outage.

Configuring Drive Parameters

Free-setting V/f Pattern

The free-setting V/f inverter mode of operation uses voltage and frequency parameter pairs to define seven points on a V/f graph. This provides a way to define a multi-segment V/f curve that best suits your application.

The frequency settings do require that F1 ≤ F2 ≤ F3 ≤ F4 ≤ F5 ≤ F6 ≤ F7; their values must have this ascending order relationship. To satisfy this criterion during initial parameter editing, set F7 (B012) and work backwards when setting these values, since the defaults are all 0 Hz. However, the voltages V1 to V7 may either increase or decrease from one to the next. Therefore, you may set these parameters in any order.

"B" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
B100	Free-setting V/f frequency (1)	V/f point 1, frequency coordinate	✗ ✗	0.	0.	0.	Hz	>b101 FREE-V/F V1 000.0V
B101	Free-setting V/f voltage (1)	V.F point 1, voltage coordinate	✗ ✗	0.0	0.0	0.0	V	>b102 FREE-V/F F1 0000Hz
B102	Free-setting V/f frequency (2)	V/f point 2, frequency coordinate	✗ ✗	0.	0.	0.	Hz	>b103 FREE-V/F V2 000.0V
B103	Free-setting V/f voltage (2)	V.F point 2, voltage coordinate	✗ ✗	0.0	0.0	0.0	V	>b104 FREE-V/F F2 0000Hz
B104	Free-setting V/f frequency (3)	V/f point 3, frequency coordinate	✗ ✗	0.	0.	0.	Hz	>b105 FREE-V/F V3 000.0V
B105	Free-setting V/f voltage (3)	V.F point 3, voltage coordinate	✗ ✗	0.0	0.0	0.0	V	>b106 FREE-V/F F3 0000Hz
B106	Free-setting V/f frequency (4)	V/f point 4, frequency coordinate	✗ ✗	0.	0.	0.	Hz	>b107 FREE-V/F V4 000.0V
B107	Free-setting V/f voltage (4)	V.F point 4, voltage coordinate	✗ ✗	0.0	0.0	0.0	V	>b108 FREE-V/F F4 0000Hz
B108	Free-setting V/f frequency (5)	V/f point 5, frequency coordinate	✗ ✗	0.	0.	0.	Hz	>b109 FREE-V/F V5 000.0V
B109	Free-setting V/f voltage (5)	V.F point 5, voltage coordinate	✗ ✗	0.0	0.0	0.0	V	>b110 FREE-V/F F5 0000Hz
B110	Free-setting V/f frequency (6)	V/f point 6, frequency coordinate	✗ ✗	0.	0.	0.	Hz	>b111 FREE-V/F V6 000.0V
B111	Free-setting V/f voltage (6)	V.F point 6, voltage coordinate	✗ ✗	0.0	0.0	0.0	V	>b112 FREE-V/F F6 0000Hz
B112	Free-setting V/f frequency (7)	V/f point 7, frequency coordinate	✗ ✗	0.	0.	0.	Hz	>b113 FREE-V/F V7 000.0V
B113	Free-setting V/f voltage (7)	V.F point 7, voltage coordinate	✗ ✗	0.0	0.0	0.0	V	>b114 FREE-V/F F7 0000Hz

"C" Group: Intelligent Terminal Functions

The five input terminals [**1**], [**2**], [**3**], [**4**], and [5] can be configured for any of 33 different functions (34 functions for –xFE2/–xFU2 models). The next two tables show how to configure the five terminals. The inputs are logical, in that they are either OFF or ON. We define these states as OFF=0, and ON=1.

The inverter comes with default options for the five terminals. These default settings are initially unique, each one having its own setting. Note that European and US versions have different default settings. You can use any option on any terminal.

Input Terminal Configuration

Functions and Options – The *function codes* in the following table let you assign one of 33 (or 34) options to any of the five logic inputs for the L300P inverters. The functions C001 through C005 configure the terminals [1] through [5] respectively. The "value" of these particular parameters is not a scalar value, but it is a discrete number that selects one option from many available *options*.

For example, if you set function C001=01, you have assigned option 01 (Reverse Run) to terminal [1]. The option codes and the specifics of how each one works are in Chapter 4.

"C" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
C001	Terminal [1] function	33 programmable functions (34 functions for –xFE2/–xFU2 models) available for terminals (see next section)	✘ ✔	18 [RS]	18 [RS]	18 [RS]	—	>C001 IN-TM 1　　　　RS
C002	Terminal [2] function		✘ ✔	16 [AT]	16 [AT]	16 [AT]	—	>C002 IN-TM 2　　　　AT
C003	Terminal [3] function		✘ ✔	03 [CF2]	13 [USP]	03 [CF2]	—	>C003 IN-TM 3　　　　JG
C004	Terminal [4] function		✘ ✔	02 [CF1]	02 [CF1]	02 [CF1]	—	>C004 IN-TM 4　　　　FRS
C005	Terminal [5] function		✘ ✔	01 [RV]	01 [RV]	01 [RV]	—	>C005 IN-TM 5　　　　2CH

Configuring Drive Parameters

Configuring Drive
Parameters

The input logic convention is programmable for each of the six inputs. Most inputs default to normally open (active high), but you can select normally closed (active low) in order to invert the sense of the logic.

"C" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
C011	Terminal [1] active state	Select logic convention, two option codes: 00 normally openN.O. 01 normally closed N.C.	✘ ✔	00	00	00	—	>C011 IN-TM O/C-1 NO
C012	Terminal [2] active state		✘ ✔	00	00	00	—	>C012 IN-TM O/C-2 NO
C013	Terminal [3] active state		✘ ✔	00	01	00	—	>C013 IN-TM O/C-3 NO
C014	Terminal [4] active state		✘ ✔	00	00	00	—	>C014 IN-TM O/C-4 NO
C015	Terminal [5] active state		✘ ✔	00	00	00	—	>C015 IN-TM O/C-5 NO
C019	Terminal [FW] active state		✘ ✔	00	00	00	—	>C019 IN-TM O/C-FW NO

NOTE: An input terminal configured for option code 18 ([RS] Reset command) cannot be configured for normally closed operation.

Intelligent Input Terminal Overview

Each of the five intelligent terminals may be assigned any of the options in the following table. When you program one of the option codes for terminal assignments C001 to C005, the respective terminal assumes the function role of that option code. The terminal functions have a symbol or abbreviation that we use to label a terminal using that function. For example the "Reverse Run" command is [RV]. The physical label on the terminal block connector is simply **1**, **2**, **3**, **4**, **or 5**. However, schematic examples in this manual also use the terminal function symbol (such as [RV]) to show the assigned option. The option codes for C011 to C015 and C019 determine the active state of the logical input (active high or active low).

Summary Table - This table shows all thirty-three intelligent input functions at a glance. Detailed descriptions of these functions, related parameters and settings, and example wiring diagrams are in .

Input Function Summary Table				
Option Code	**Terminal Symbol**	**Function Name**	**Description**	
01	RV	Reverse Run/Stop	ON	Inverter is in Run Mode, motor runs reverse
			OFF	Inverter is in Stop Mode, motor stops
02	CF1	Multi-speed select, Bit 0 (LSB)	ON	Binary encoded speed select, Bit 0, logical 1
			OFF	Binary encoded speed select, Bit 0, logical 0
03	CF2	Multi-speed select, Bit 1	ON	Binary encoded speed select, Bit 1, logical 1
			OFF	Binary encoded speed select, Bit 1, logical 0
04	CF3	Multi-speed select, Bit 2	ON	Binary encoded speed select, Bit 2, logical 1
			OFF	Binary encoded speed select, Bit 2, logical 0
05	CF4	Multi-speed select, Bit 3 (MSB)	ON	Binary encoded speed select, Bit 3, logical 1
			OFF	Binary encoded speed select, Bit 3, logical 0
06	JG	Jogging	ON	Inverter is in Run Mode, output to motor runs at jog parameter frequency A038
			OFF	Inverter is in Stop Mode
07	DB	External DC Braking	ON	DC braking will be applied during deceleration
			OFF	DC braking will not be applied
08	SET	Set (select) 2nd Motor Data	ON	The inverter uses 2nd motor parameters for generating frequency output to motor
			OFF	The inverter uses 1st (main) motor parameters for generating frequency output to motor
09	2CH	2-stage Acceleration and Deceleration	ON	Frequency output uses 2nd-stage acceleration and deceleration values
			OFF	Frequency output uses standard acceleration and deceleration values
11	FRS	Free-run Stop	ON	Causes output to turn OFF, allowing motor to free run (coast) to stop
			OFF	Output operates normally, so controlled deceleration stops motor
12	EXT	External Trip	ON	When assigned input transitions OFF to ON, inverter latches trip event and displays E12
			OFF	No trip event for ON to OFF transition; any recorded trip events remain in history until Reset

Configuring Drive Parameters

Input Function Summary Table				
Option Code	**Terminal Symbol**	**Function Name**	**Description**	
13	USP	Unattended Start Protection	ON	ON powerup, the inverter will not resume a Run command (mostly used in the US)
			OFF	ON powerup, the inverter will resume a RUN command that was active before power loss
14	CS	Commercial Power Source	ON	OFF-to-ON transition signals the inverter that the motor is already running at powerup (via bypass), thus suppressing the inverter's motor output in Run Mode
			OFF	ON-to-OFF transition signals the inverter to apply a time delay (B003), frequency match its output to existing motor speed, and resume normal Run Mode operation
15	SFT	Software Lock	ON	The keypad and remote programming devices are prevented from changing parameters
			OFF	The parameters may be edited and stored
16	AT	Analog Input Voltage/ current Select	ON	Terminal [OI] is enabled for current input (uses terminal [L] for signal return)
			OFF	Terminal [O] is enabled for voltage input (uses terminal [L] for signal return)
18	RS	Reset Inverter	ON	The trip condition is reset, the motor output is turned OFF, and powerup reset is asserted
			OFF	Normal power-on operation
20	STA	START (3-wire interface)	ON	Starts the motor rotation
			OFF	No change to present motor status
21	STP	STOP (3-wire interface)	ON	Stops the motor rotation
			OFF	No change to present motor status
22	F/R	FWD, REV (3-wire interface)	ON	Selects the direction of motor rotation: ON = FWD. While the motor is rotating, a change of F/R will start a deceleration, followed by a change in direction.
			OFF	Selects the direction of motor rotation: OFF =REV. While the motor is rotating, a change of F/R will start a deceleration, followed by a change in direction.
23	PID	PID Disable	ON	Temporarily disables PID loop control. Inverter output turns OFF as long as PID Enable is active (A071=1).
			OFF	Has no effect on PID loop operation, which operates normally if PID Enable is active (A071 = 1).
24	PIDC	PID Reset	ON	Resets the PID loop controller. The main consequence is that the integrator sum is forced to zero.
			OFF	No effect on PID loop controller
27	UP	Remote Control UP Function (motor- ized speed pot.)	ON	Accelerates (increases output frequency) motor from current frequency
			OFF	No change to output frequency

Input Function Summary Table				
Option Code	Terminal Symbol	Function Name	Description	
28	DWN	Remote Control DOWN Function (motorized speed pot.)	ON	Decelerates (decreases output frequency) motor from current frequency
			OFF	No change to output frequency
29	UDC	Remote Control Data Clearing	ON	Clears the UP/DWN frequency memory by forcing it to equal the set frequency parameter F001. Setting C101 must be set=00 to enable this function to work.
			OFF	UP/DWN frequency memory is not changed
31	OPE	Operator Control	ON	Forces the source of the output frequency setting (A001) and the source of the RUN command (A002) to be from the digital operator
			OFF	Source of output frequency set by (A001) and source of run command set by (A002) is used
32	SF1	Multispeed bit 1	ON	Logical 1
			OFF	Logical 0
33	SF2	Multispeed bit 2	ON	Logical 1
			OFF	Logical 0
34	SF3	Multispeed bit 3	ON	Logical 1
			OFF	Logical 0
35	SF4	Multispeed bit 4	ON	Logical 1
			OFF	Logical 0
36	SF5	Multispeed bit 5	ON	Logical 1
			OFF	Logical 0
37	SF6	Multispeed bit 6	ON	Logical 1
			OFF	Logical 0
38	SF7	Multispeed bit 7	ON	Logical 1
			OFF	Logical 0
39	OLR	Overload restriction	ON	Selects current overload parameter set 2 (B024, B025, B026)
			OFF	Selects current overload parameter set 1 (B021, B022, B023)
49	ROK *1	Run Enable for FW/RV (–xFU2 and –xFE2 models only)	ON	[FW] and [RV] inputs and operator Run key press operate normally
			OFF	[FW] and [RV] inputs and operator Run key press are ignored; inverter output remains OFF
no	—	Not selected	ON	(input ignored)
			OFF	(input ignored)

Note 1: To ensure safe inverter operation in networked applications, you cannot change an intelligent terminal assignment to/from [ROK] (option code 49) via the network. However, you can still read an [ROK] input assignment over the network.

Configuring Drive
Parameters

Output Terminal Configuration

The inverter provides configuration for logic (discrete) and analog outputs, shown in the table below.

"C" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
C021	Terminal [11] function	12 programmable functions (13 functions for –xFE2/–xFU2 models) available for logic (discrete) outputs (see next section)	✘ ✔	01 [FA1]	01 [FA1]	01 [FA1]	—	>C021 OUT-TM 11 FA1
C022	Terminal [12] function		✘ ✔	00 [RUN]	00 [RUN]	00 [RUN]	—	>C022 OUT-TM 12 RUN
C026	Alarm relay terminal function		✘ ✔	05 [AL]	05 [AL]	05 [AL]	—	>C026 OUT-TM AL AL
C027	[FM] signal selection	7 programmable functions available for analog outputs (see after next section)	✘ ✔	00 output freq.	00 output freq.	00 output freq.	—	>C027 FM-MONITOR KIND A-F
C028	[AM] signal selection		✘ ✔	00 output freq.	00 output freq.	00 output freq.	—	>C028 AM-MONITOR KIND A-F
C029	[AMI] signal selection		✘ ✔	00 output freq.	00 output freq.	00 output freq.	—	>C029 AMI-MON KIND A-F

The output logic convention is programmable for terminals [11], [12], and the alarm relay terminals. The open-collector output terminals [11] and [12] default to normally open (active low), but you can select normally closed (active high) for the terminals in order to invert the sense of the logic. You can invert the logical sense of the alarm relay output as well.

"C" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
C031	Terminal [11] active state	Select logic convention, two option codes: 00 normally open N.O. 01 normally closed N.C.	✘ ✔	00	00	00	—	>C031 OUT-TM O/C-11 NO
C032	Terminal [12] active state		✘ ✔	00	00	00	—	>C032 OUT-TM O/C-12 NO
C036	Alarm relay terminal active state		✘ ✔	01	01	01	—	>C036 OUT-TM O/C-AL NC

Output Summary Table - This table shows all 12 functions (13 for –xFU2 models) for the logic outputs terminals [11] and [12] at a glance. Detailed function descriptions, related parameters and settings, and example wiring diagrams are in .

		Output Function Summary Table		
Option Code	**Terminal Symbol**	**Function Name**		**Description**
00	RUN	Run signal	ON	Inverter is in Run Mode, motor running
			OFF	Inverter is in Stop Mode, motor stopped
01	FA1	Frequency arrival type 1 – constant speed	ON	when output to motor is at the standard set frequency F001
			OFF	when output to motor is not at the set frequency F001
02	FA2	Frequency arrival type 2 – over-frequency	ON	when output to motor is at or above the FA threshold 1(C042) during accel
			OFF	when the output to motor is below the FA threshold 1 (C043) during decel
03	OL	Overload advance notice signal (1)	ON	when output current is more than the set threshold for the overload signal (set with C041)
			OFF	when output current is less than the set threshold for the overload signal
04	OD	Output deviation for PID control	ON	when PID error is more than the set threshold for the deviation signal
			OFF	when PID error is less than the set threshold for the deviation signal
05	AL	Alarm signal	ON	when the alarm condition has been met and not reset
			OFF	when the alarm had not tripped since the previous power cycle or since the previous keypad reset
06	FA3	Frequency arrival type 3 – at frequency	ON	when output to motor is at the FA threshold 1 (C042) during accel, or at C043 during decel
			OFF	when the output to motor is not at either the FA threshold 1 (C042) during accel or at C43 during decel
08	IP	Instantaneous power failure signal	ON	when the inverter input power has decreased below the acceptable input voltage level
			OFF	when the inverter input power is within rated range
09	UV	Under-voltage signal	ON	when the inverter input power has decreased below the acceptable input voltage level
			OFF	when the inverter input power is within rated range
11	RNT	Operation time over	ON	when the inverter Run time exceeds the limit set by Run/power-on warning time (B034)
			OFF	when the inverter Run time is less than the limit set by Run/power-on warning time (B034)
12	ONT	Plug-in time over	ON	when the inverter plug-in time exceeds the set limit
			OFF	when the inverter plug-in time is less than the limit

Configuring Drive Parameters

Output Function Summary Table				
Option Code	**Terminal Symbol**	**Function Name**	**Description**	
13	THM	Thermal alarm signal	ON	when the thermal limit for the motor is exceeded
			OFF	when the thermal limit is not exceeded
27	RMD *1	Run command source monitor (–xFU2 and –xFE2 models only)	ON	when the Run command source is the operator keypad (A002=02)
			OFF	when the Run command source *is not* the operator keypad (A002=01, 03, 04, or 05)

Note 1: To ensure safe inverter operation in networked applications, you cannot change an intelligent terminal assignment to/from [RMD] (option code 27) via the network. However, you can still read an [RMD] output assignment over the network.

Analog Summary Table - The following table shows all seven functions available for assignment to the three analog output terminals [FM], [AM], [AMI] at a glance. Detailed descriptions, related parameters and settings, and example wiring diagrams are in .

Analog Output Function Summary Table			
Option Code	**Function Name**	**Description**	**Corresponding Signal Range**
00	Output frequency	Actual motor speed, represented by PWM signal	0 to max. frequency in Hz
01	Output current	Motor current (% of maximum rated output current), represented by PWM signal	0 to 200%
03	Digital output frequency	Output frequency (available only at FM output)	0 to max. frequency in Hz
04	Output voltage	Rated output voltage to motor	0 to 100%
05	Input power	Rated input power	0 to 200%
06	Electronic thermal overload	Percentage of electronic overload attained	0 to 100%
07	LAD frequency	Internal ramp generator frequency	0 to max. frequency in Hz

Output Function Adjustment Parameters

The following parameters work in conjunction with the intelligent output function, when configured. The overload level parameter (C041) sets the motor current level at which the overload signal [OL] turns ON. The range of settings is from 0% to 200% of the rated current for the inverter. This function is for generating an early warning logic output, without causing either a trip event or a restriction of the motor current (those effects are available on other functions).

The frequency arrival signal, [FA1] to [FA5], is intended to indicate when the inverter output has reached (arrived at) the target frequency. You can adjust the timing of the leading and trailing edges of the signal via two parameters specific to acceleration and deceleration ramps, C042 and C043.

The Error for the PID loop is the magnitude (absolute value) of the difference between the Setpoint (desired value) and Process Variable (actual value). The PID output deviation signal [OD] (output terminal function option code 04) indicates when the error magnitude has exceeded a magnitude you define.

Configuring Drive Parameters

"C" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
C040	Overload signal output mode	Choose when the overload signal is enabled; two option codes: 00 During accel/decel 01 During constant speed	✗ ✔	01	01	01	—	>C040 OL Mode CRT
C041	Overload level setting	Range is 0.00 * rated current to 2.00 * rated current	✗ ✔	Rated current for each inverter			A	>C041 OL LEVEL 0016.5A
C042	Frequency arrival setting for acceleration	Sets the frequency arrival setting threshold for the output frequency during acceleration	✗ ✔	0.00	0.00	0.00	Hz	>C042 ARV ACC 0000.00Hz
C043	Arrival frequency setting for deceleration	Sets the frequency arrival setting threshold for the output frequency during deceleration	✗ ✔	0.00	0.00	0.00	Hz	>C043 ARV DEC 0000.00Hz

"C" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
C044	PID deviation level setting	Sets the PID loop error threshold |SP - PV| (absolute value) to trigger intelligent output [OD]. Range is 0.0 to 100%, resolution is 0.1%	✘ ✔	3.0	3.0	3.0	%	>C044 PID LEVEL 003.0%
C061	Electronic thermal warning level setting	Sets the threshold for intelligent output [THM]. Range is 0 to 100%	✘ ✔	80.	80.	80.	%	>C061 E-THM WARN 080%

Serial Communications

The following table configures the communications port of the L300P inverter. You can have up to thirty-two devices on the serial communications network. The inverters are slaves and the computer or digital operator is the master. Thus, all inverters on the serial connection must use the same baud rate, data length, parity, and stop bits. However, each device on the serial network must have a unique node address. Please see Appendix B for more information.

"C" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
C070	Data command method	Four option codes: 02 Digital operator 03 RS485 04 Expansion Card #1 05 Expansion Card #2	✗ ✗	02	02	02	—	>C070 PARAM SELECT REM
C071	Communication speed selection	Five option codes: 02 (Test) 03 2400bps 04 4800bps 05 9600bps 06 19200bps	✗ ✔	04	04	04	bps	>C071 RS485 BAU 4800bps
C072	Node allocation	Set the address of the inverter on the network. Range is 1 to 32.	✗ ✔	1.	1.	1.	—	>C072 RS485 ADDRESS 01
C073	Communication data length selection	Two option codes: 07 7-bit data 08 8-bit data	✗ ✔	7	7	7	—	>C073 RS485 BIT 7BIT
C074	Communication parity selection	Three option codes: 00 No parity 01 Even parity 02 Odd parity	✗ ✔	00	00	00	—	>C074 RS485 PARITY NO
C075	Communication stop bit selection	Two option codes: 01 1 stop bit 02 2 stop bits	✗ ✔	1	1	1	—	>C075 RS485 STOPBIT 1BIT
C078	Communication wait time	Time the inverter waits after receiving a message before it transmits. Range is 0.0 to 1000 ms	✗ ✔	0.	0.	0.	—	>C078 RS485 WAIT 0000ms

Configuring Drive Parameters

Configuring Drive
Parameters

Analog Signal Calibration Settings

The functions in the following table configure the signals for the analog output terminals. Note that these settings do not change the current/voltage or sink/source characteristics – only the zero and span (scaling) of the signals.

"C" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
C081	[O] input span calibration	Range is 0 to 65530	✔ ✔	Factory-calibrated			—	>C081 O-ADJUST TOP 02119
C082	[OI] input span calibration	Range is 0 to 65530	✔ ✔	Factory-calibrated			—	>C082 OI-ADJUST TOP 02512
C083	[O2] input span calibration	Range is 0 to 65530	✔ ✔	Factory-calibrated			—	>C083 O2-ADJUST TOP 02818
C085	Thermistor input tuning	Range is 0.0 to 1000	✔ ✔	105.0	105.0	105.0	—	>C085 THERM ADJUST 0105.0
C086	[AM] terminal offset tuning	Range is 0.0 to 10.0V	✔ ✔	0.0	0.0	0.0	V	>C086 AM-MONITOR OFFSET 00.0V
C087	[AMI] terminal meter tuning	Range is 0.0 to 250%	✔ ✔	80.	80.	80.	%	>C087 AMI-MON ADJUST 080
C088	[AMI] terminal offset tuning	Range is 0 to 20mA	✔ ✔	Factory-calibrated			mA	>C088 AMI-MON OFFSET 04.0mA
C121	[O] input zero calibration	Range is 0 to 6553 (65530)	✔ ✔	Factory-calibrated			—	>C121 O-ADJUST ZERO 00000
C122	[OI] input zero calibration	Range is 0 to 6553 (65530)	✔ ✔	Factory-calibrated			—	>C122 OI-ADJUST ZERO 00000
C123	[O2] input zero calibration	Range is 0 to 6553 (65530)	✔ ✔	Factory-calibrated			—	>C123 O2-ADJUST ZERO 03622

NOTE: Settings C081, C082, C083, C121, C122, C123 are factory-calibrated for each inverter. Do not change these settings unless absolutely necessary. Note that if you restore factory defaults for all parameters, these settings will not change.

Miscellaneous Functions

The following table contains miscellaneous functions not in other function groups.

"C" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
C091	Debug mode enable	Two option codes: 00 Display 01 No display	✗ ✔	00	00	00	—	>C091 INITIAL DEBG OFF
C101	Up/Down memory mode selection	Controls speed setpoint for the inverter after power cycle. Two option codes: 00 Clear last frequency (return to default frequency F001) 01 Keep last frequency adjusted by UP/DWN	✗ ✔	00	00	00	—	>C101 UP/DWN DATA NO-STR

C102/C103: Reset Mode / Restart Mode – The reset mode selection, set via parameter C102, determines how the inverter responds to the [RS] intelligent input signal or keypad Stop/Reset key in a trip condition. The options allow you to cancel the trip on either the OFF-to-ON or ON-to-OFF transition of [RS], and if desired, stop the inverter if it is in Run Mode. A trip event causes the inverter output to the motor to turn OFF immediately. If in Run Mode when the trip occurred, the inverter and motor will enter free-run stop (coasting) operation. In some applications, the motor and load will still be coasting when the inverter returns to normal Run Mode operation. For that situation, you can configure the inverter output (C103=00) to resume operation from 0 Hz and accelerate normally. Or, you can configure the inverter (C103=01) to resume operation from the current speed of the motor (*frequency matching*)—often used in applications such as HVAC.

"C" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
C102	Reset mode selection	Determines response to Reset input [RS]. Three option codes: 00 Cancel trip state at input signal ON transition, Stops inverter if in Run Mode 01 Cancel trip state at signal OFF transition, Stops inverter if in Run Mode 02 Cancel trip state at input signal ON transition, no effect if in Run Mode	✔ ✔	00	00	00	—	>C102 RESET SELECT ON
C103	Restart mode after reset	Two option codes: 00 Restart at 0 Hz 01 Resume operation after frequency matching	✗ ✔	00	00	00	—	>C103 RESET f-Mode ZST

Configuring Drive Parameters

"H" Group: Motor Constants Functions

Introduction

The "H" Group parameters configure the inverter for the motor characteristics. You must manually set H003 and H004 values to match the motor. The remaining H206 parameters are factory-set. If you want to reset the parameters to the factory default settings, use the procedure in .

Inverter Torque Control Algorithms

"H" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
H003	Motor capacity, 1st motor	Select 0.2 to 75.0 kW for models up to –550xxx, 0.2 to 160.0 kW for models –900xxx to –1320xxx	✘ ✘	Factory set			kW	>H003 AUX K 003.70kW
H203	Motor capacity, 2nd setting	Select 0.2 to 75.0 kW for models up to –550xxx, 0.2 to 160.0 kW for models –900xxx to –1320xxx	✘ ✘	Factory set			kW	>H203 2AUX K 003.70kW
H004	Motor poles setting, 1st motor	Four selections: 2 / 4 / 6 / 8	✘ ✘	4	4	4	Poles	>H004 AUX P 4P
H204	Motor poles setting, 2nd motor	Four selections: 2 / 4 / 6 / 8	✘ ✘	4	4	4	Poles	>H204 2AUX P 4P
H006	Motor stabilization constant, 1st motor	Motor constant (factory set), range is 0 to 255	✔ ✔	100.	100.	100.	—	>H006 AUX KCD 00100
H206	Motor stabilization constant, 2nd motor	Motor constant (factory set), range is 0 to 255	✔ ✔	100.	100.	100.	—	>H206 2AUX KCD 00100

"P" Group: Expansion Card Functions

The two (optional) expansion cards for the L300P have associated configuration data. The following table defines the functions and their value ranges. Please refer to the expansion card manual for more details.

"P" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
P001	Operation mode on expansion card 1 error	Two option codes: 00 Trip (stop motor) 01 Continuous operation	✘ ✔	00	00	00	—	>P001 OPTION1 SELECT TRP
P002	Operation mode on expansion card 2 error	Two option codes: 00 Trip (stop motor) 01 Continuous operation	✘ ✔	00	00	00	—	>P002 OPTION2 SELECT TRP
P031	Accel/decel time input selection	Three options: 00 Inverter 01 Expansion card 1 02 Expansion card 2	✘ ✘	00	00	00	—	>P031 ACC/DEC SELECT REM
P044	DeviceNet comm watchdog timer	Range is 0.00 99.99 seconds	✘ ✘	1.00	1.00	1.00	—	>P044 DEVICENET TIMER 01.00s
P045	Inverter action on DeviceNet comm error	Five options: 00 Trip 01 Decelerate and trip 02 Hold last speed 03 Free run stop 04 Decelerate and stop	✘ ✘	01	01	01	—	>P045 DEVICENET T-OUT FTP
P046	DeviceNet polled I/O: Output instance number	Three settings: 20, 21, 100	✘ ✘	21	21	21	—	>P046 DEVICENET O-AS-INS 021
P047	DeviceNet polled I/O: Input instance number	Three settings: 70, 71, 101	✘ ✘	71	71	71	—	>P047 DEVICENET O-AS-INS 071
P048	Inverter action on DeviceNet idle mode	Five options: 00 Trip 01 Decelerate and trip 02 Hold last speed 03 Free run stop 04 Decelerate and stop	✘ ✘	01	01	01	—	>P048 DEVICENET IDLE FTP
P049	DeviceNet motor poles setting for RPM	Range is 0 to 38 (even numbers only)	✘ ✘	0	0	0	poles	>P049 DEVICENET P 00P

NOTE: Parameters P044 to P049 are available only in inverters with manufacturing code x8K xxxxxx xxxxx or later. The manufacturing code is printed on the product specifications labels, located on the front and side of the inverter housing.

Miscellaneous Functions

The following table contains miscellaneous function(s) not in other function groups. Note that P050 is only available on –xFE2/–xFU2 models.

"P" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
P050	Output frequency on analog reference signal loss (–xFE2/–xFU2 models only) *1	Four option codes: 00 Output freq. forced to 0 Hz; 500ms wait to recover 01 Output forced to 0 Hz; no wait to recover 02 Output freq. forced to max. freq. A004 03 Output freq. forced to A020/A220	✗ ✔	00	00	—	—	>P050 OPTION1 SELECT OFF

Note 1: To ensure safe inverter operation in networked applications, you cannot change (write) the value of P050 via the network; reading P050 is also prohibited.

P050: Output Frequency on Analog Reference Signal Loss – This function allows you to configure the inverter's frequency output level in the event the analog reference input it is using is (apparently) disconnected during operation. When the Frequency Source Setting is set to control terminal input (A001=01), the [O], [O2], and [OI] inputs are available frequency reference sources. If the active analog input signal value remains lower than the Start Frequency Adjustment value (B082), the inverter presumes the analog input signal may be disconnected.

The inverter application will determine the best option to use in the event of an analog signal disconnect. Be sure to consider personnel safety and equipment limitations such as range of travel and maximum speed. The available output responses to analog reference signal loss are:

1. P050=00: The output frequency is forced to 0 Hz. It follows the analog input value immediately when it becomes greater than the Start Frequency value (without 500ms wait).

2. P050=01: The output frequency is forced to 0 Hz, recovering 500ms after the analog input exceeds the Start Frequency value.

3. P050=02: The output frequency is forced to the Maximum Frequency value (A004), recovering 500ms after the analog input exceeds the Start Frequency value.

4. P050=03: The output frequency is forced to the Multi-Speed 1 setting (A020/A220), recovering 500ms after the analog input exceeds the Start Frequency value.

The timing diagram below illustrates the four available output frequency responses for a disconnect event, using the different P050 settings. For the purpose of this example, the analog input "disconnect" value is less than the start frequency but slightly greater than zero.
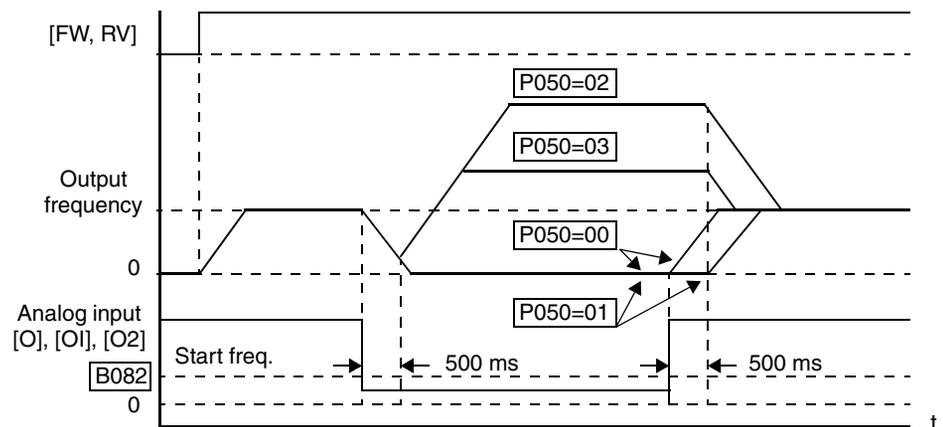
"U" Group: User-selectable Menu Functions

The user-selectable menu functions allow you to configure (select) any twelve of the other functions in the inverter and place them together in a convenient list. This feature provides quick access for the most-used functions needed for your application. Each U Group function can serve as a pointer to any of the other parameters. You do *not* have to use the Store key to retain each association; just scroll to the desired standard parameter for each U Group function and leave it. The setting can point to a monitor-only parameter (such as D001), or point to editable parameters (such as A001). In the case of pointing to an editable functions, you use the Up/Down keys to change the value and the Store key to accept the change into memory—the same procedure as a normal parameter edit.

<div style="writing-mode: vertical-rl">Configuring Drive Parameters</div>

"U" Function			Run Mode Edit Lo Hi	Defaults			Units	SRW Display
Func. Code	Name	Description		–FE2 (CE)	–FU2 (UL)	–FR (Jpn)		
U001			✘ ✔	no	no	no	—	>U001 USER 1 no
U002			✘ ✔	no	no	no	—	>U002 USER 2 no
U003			✘ ✔	no	no	no	—	>U003 USER 3 no
U004			✘ ✔	no	no	no	—	>U004 USER 4 no
U005			✘ ✔	no	no	no	—	>U005 USER 5 no
U006			✘ ✔	no	no	no	—	>U006 USER 6 no
U007	User-selected function	"no" (disabled), or any of the functions D001 to P049	✘ ✔	no	no	no	—	>U007 USER 7 no
U008			✘ ✔	no	no	no	—	>U008 USER 8 no
U009			✘ ✔	no	no	no	—	>U009 USER 9 no
U010			✘ ✔	no	no	no	—	>U010 USER 10 no
U011			✘ ✔	no	no	no	—	>U011 USER 11 no
U012			✘ ✔	no	no	no	—	>U012 USER 12 no

TIP: Function B037 selects the parameter groups to be displayed. If you want to limit the displayed parameters to *only* the U Group functions, set B037=02.

Programming Error Codes

The L300P inverter operator keypad displays a special code (begins with the $\digamma$ character) to indicate a programming error. Programming errors exist when one parameter conflicts with the meaningful range permitted by related parameter(s). Note that particular real-time frequency (speed) input levels can cause a conflict in some situations. After a conflict exists, the error code will appear on the display, or you can view it later with D090 in Monitor Mode. Also, the PGM LED on the display will flash ON/OFF when programming. These indications are automatically cleared when the parameter is corrected to the allowed range.

Programming Error Code	Parameter out of bounds		Boundary defined by...		
	Code	**Description**	**<, >**	**Code**	**Description**
8001 8201	A061 / A261	Frequency upper limit setting; 1st, 2nd motor	>	A004 / A204	Maximum frequency; 1st, 2nd motor
8002 8202	A062 / A262	Frequency lower limit setting; 1st, 2nd motor	>		
8004 8204	A003 / A203	Base frequency setting; 1st, 2nd motor	>		
8005 8205	F001, A020 / A220	Output frequency setting, Multi-speed freq. setting; 1st, 2nd motor	>		
8006 8206	A021 to A035	Multi-speed freq. settings	>		
8012 8212	A062 / A262	Frequency lower limit setting; 1st, 2nd motor	>	A061 / A261	Frequency upper limit setting; 1st, 2nd motor
8015 8215	F001, A020 / A220	Output frequency setting, Multi-speed freq. setting; 1st, 2nd motor	>		
8016 8216	A021 to A035	Multi-speed freq. settings	>		
8021 8221	A061 / A261	Frequency upper limit setting; 1st, 2nd motor	<	A062 / A262	Frequency lower limit setting; 1st, 2nd motor
8025 8225	F001, A020 / A220	Output frequency setting, Multi-speed freq. setting; 1st, 2nd motor	<		
8031 8231	A061 / A261	Frequency upper limit setting; 1st, 2nd motor	<	B082	Start frequency adjustment
8032 8232	A062 / A262	Frequency lower limit setting; 1st, 2nd motor	<		
8035 8235	F001, A020 / A220	Output frequency setting, Multi-speed freq. setting; 1st, 2nd motor	<		
8036	A021 to A035	Multi-speed freq. settings	<		
8037	A038	Jog frequency setting	<		
8085 8285	F001, A020 / A220	Output frequency setting, Multi-speed freq. setting; 1st, 2nd motor	>f-x, <f+x	A063 ± A064 A065 ± A066 A067 ± A068	Jump (center) frequency ± jump (hysteresis) frequency width setting
8086	A021 to A035	Multi-speed freq. settings	>f-x, <f+x		(See note after table)

Programming Error Code	Parameter out of bounds		Boundary defined by...		
	Code	Description	<, >	Code	Description
A091 A291	A061 / A261	Frequency upper limit setting; 1st, 2nd motor	>	B112	Free-setting V/f frequency (7)
A092 A292	A062 / A262	Frequency lower limit setting; 1st, 2nd motor	>		
A095 A295	F001, A020 / A220	Output frequency setting, Multi-speed freq. setting; 1st, 2nd motor	>		
A096	A021 to A035	Multi-speed freq. settings	>		
A110	B100, B102, B104, B106, B108, B110	Free V/f frequency	>		
	B102, B104, B106, B108, B110	Free V/f frequency	>	B100	Free-setting V/f frequency (1)
	B100	Free V/f frequency	<	B102	Free-setting V/f frequency (2)
	B104, B106, B108, B110	Free V/f frequency	>		
	B100, B102	Free V/f frequency	<	B104	Free-setting V/f frequency (3)
	B106, B108, B110	Free V/f frequency	>		
	B100, B102, B104	Free V/f frequency	<	B106	Free-setting V/f frequency (4)
	B108, B110	Free V/f frequency	>		
	B100, B102, B104, B106	Free V/f frequency	<	B108	Free-setting V/f frequency (5)
	B110	Free V/f frequency	>		
	B100, B102, B104, B106, B108	Free V/f frequency	<	B110	Free-setting V/f frequency (6)
A120	B017, B019	Free-setting electronic thermal frequency	<	B015	Free-setting, electronic thermal frequency (1)
	B015	Free-setting electronic thermal frequency	>	B017	Free-setting, electronic thermal frequency (2)
	B019	Free-setting electronic thermal frequency	<		
	B015, B017	Free-setting electronic thermal frequency	>	B019	Free-setting, electronic thermal frequency (3)

NOTE: Set frequency (speed) values are not permitted to be inside the jump frequency ranges, if defined. When a frequency reference value from a real-time source (such as keypad potentiometer or analog input) are inside a jump frequency range, the actual speed is automatically forced to equal the lowest point of the jump range.

Operations
and Monitoring

4

In This Chapter....   page

Introduction

The previous material in Chapter 3 gave a reference listing of all the programmable functions of the inverter. We suggest that you first scan through the listing of inverter functions to gain a general familiarity. This chapter will build on that knowledge in the following ways:

1. **Related functions** – Some parameters interact with or depend on the settings in other functions. This chapter lists "required settings" for a programmable function to serve as a cross-reference and an aid in showing how functions interact.

2. **Intelligent terminals** – Some functions rely on an input signal from control logic terminals or generate output signals in other cases.

3. **Electrical interfaces** – This chapter shows how to make connections between the inverter and other electrical devices.

4. **PID Loop Operation** – The L300P has a built-in PID loop that calculates the optimal inverter output frequency to control an external process. This chapter shows the parameters and input/output terminals associated with PID loop operation.

5. **Multiple motors** – A single L300P inverter may be used with two or more motors in some types of applications. This chapter shows the electrical connections and inverter parameters involved in multiple-motor applications.

The topics in this chapter can help you decide the features that are important to your application, and how to use them. The basic installation covered in Chapter 2 concluded with the powerup test and running the motor. Now, this chapter starts from that point and shows how to make the inverter part of a larger control or automation system.

Cautions for Operating Procedures

Before continuing, please read the following Caution messages.

CAUTION: The heat sink fins will have a high temperature. Be careful not to touch them. Otherwise, there is the danger of getting burned.

CAUTION: The operation of the inverter can be easily changed from low speed to high speed. Be sure check the capability and limitations of the motor and machine before operating the inverter. Otherwise, it may cause injury to personnel.

CAUTION: If you operate a motor at a frequency higher than the inverter standard default setting (50Hz/60Hz), be sure to check the motor and machine specifications with the respective manufacturer. Only operate the motor at elevated frequencies after getting their approval. Otherwise, there is the danger of equipment damage.

Warnings for Operating Procedures

Before continuing, please read the following Warning messages.

WARNING: Be sure to turn ON the input power supply only after closing the front case. While the inverter is energized, be sure not to open the front case. Otherwise, there is the danger of electric shock.

WARNING: Be sure not to operate electrical equipment with wet hands. Otherwise, there is the danger of electric shock.

WARNING: While the inverter is energized, be sure not to touch the inverter terminals even when the motor is stopped. Otherwise, there is the danger of electric shock.

WARNING: If the Retry Mode is selected, the motor may suddenly restart after a trip stop. Be sure to stop the inverter before approaching the machine (be sure to design the machine so that safety for personnel is secure even if it restarts.) Otherwise, it may cause injury to personnel.

WARNING: If the power supply is cut OFF for a short period of time, the inverter may restart operation after the power supply recovers if the Run command is active. If a restart may pose danger to personnel, so be sure to use a lock-out circuit so that it will not restart after power recovery. Otherwise, it may cause injury to personnel.

WARNING: The Stop Key is effective only when the Stop function is enabled. Be sure to enable the Stop Key separately from the emergency stop. Otherwise, it may cause injury to personnel.

WARNING: During a trip event, if the alarm reset is applied and the Run command is present, the inverter will automatically restart. Be sure to apply the alarm reset only after verifying the Run command is OFF. Otherwise, it may cause injury to personnel.

WARNING: Be sure not to touch the inside of the energized inverter or to put any conductive object into it. Otherwise, there is a danger of electric shock and/or fire.

WARNING: If power is turned ON when the Run command is already active, the motor will automatically start and injury may result. Before turning ON the power, confirm that the RUN command is not present.

WARNING: When the Stop key function is disabled, pressing the Stop key does not stop the inverter, nor will it reset a trip alarm.

WARNING: Be sure to provide a separate, hard-wired emergency stop switch when the application warrants it.

Operations and Monitoring

Optional Alarm Output at Power Loss

With the default L300P inverter configuration, a sudden power loss will cause the inverter to shut down immediately. If running at the time, the motor and load will coast to a stop. And without power, the inverter's alarm output will not activate. This default performance may be fine for applications with loads such as fans and pumps. However, you may want an alarm signal upon power loss. This section describes how to harness regenerative energy so that the motor/load actually powers the inverter long enough to power the alarm output.

The diagram below shows the default configuration. Chapter 2 covered wiring the power source to the inverter input and the inverter output to the motor. By default, the inverter's internal control circuit gets its power from two phases (R and T) from the input. The user-accessible 2-wire jumper (R–R0 and T–T0) connects input power to the control circuit.
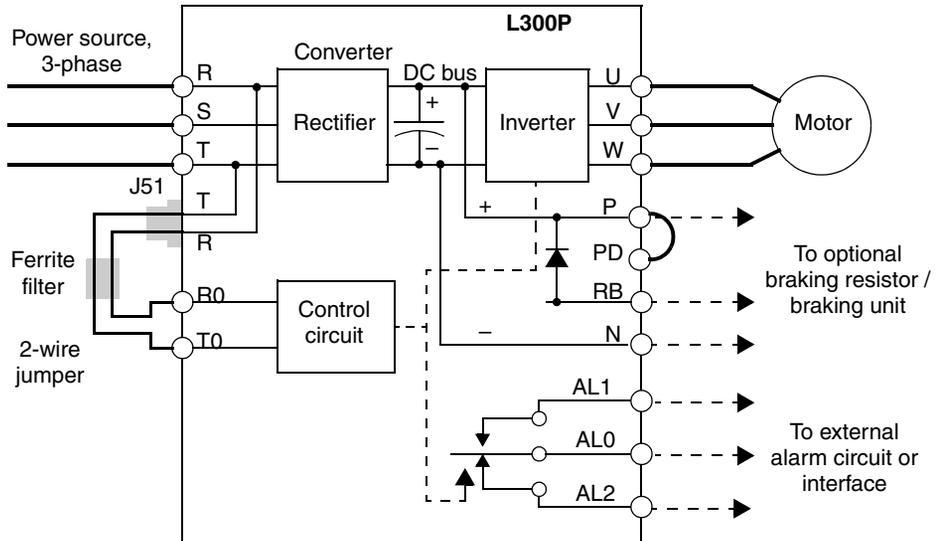
To provide power to the control circuit after input power loss, you must change the control circuit wiring as shown below (steps provided on following page).
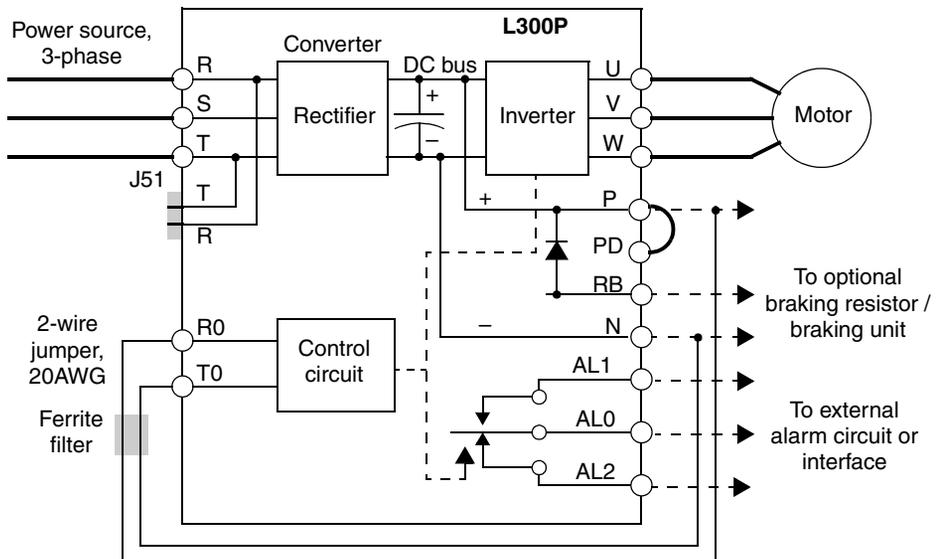
Follow the steps to implement the wiring change shown in the previous diagram.

1. Remove the 2-wire jumper J51 (terminals [R0] and [T0] to connector J51).

2. Procure several inches of multi-strand 20 AWG (0.5mm^2) or slightly heavier wire.

3. Connect a wire to terminal [R0] that is long enough to connect to terminal [P] (do not connect to [P] yet).

4. Connect a wire to terminal [T0] that is long enough to connect to terminal [N] (do not connect to [N] yet).

5. Remove the ferrite filter from the original jumper wire and then slide it onto the new wires connecting to terminals [R0] and [T0]. (Be sure to save the original jumper in a safe place.)

6. Connect the wire from [R0] to [P], and connect the wire from [T0] to [N] as shown.

More information on power loss related alarm functions, see "Instantaneous Power Failure / Under-voltage Signal" on page 4–43.

Operations
and Monitoring

Connecting to PLCs and Other Devices

Hitachi inverters (drives) are useful in many types of applications. During installation, the inverter keypad (or other programming device) will facilitate the initial configuration. After installation, the inverter will generally receive its control commands through the control logic terminals or serial interface from another controlling device. In a simple application such as single-conveyor speed control, a Run/Stop switch and potentiometer will give the operator all the required control. In a sophisticated application, you may have a *programmable logic controller* (PLC) as the system controller with several connections to the inverter.

It is not possible to cover all the possible types of application in this manual. It will be necessary for you to know the electrical characteristics of the devices you want to connect to the inverter. Then, this section and the following sections on I/O terminal functions can help you quickly and safely connect those devices to the inverter.

CAUTION: It is possible to damage the inverter or other devices if your application exceeds the maximum current or voltage characteristics of a connection point.

The connections between the inverter and other devices rely on the electrical input/output characteristics at both ends of each connection, shown in the diagram to the right. The inverter can accept either sourcing or sinking type inputs from an external device (such as a PLC). A terminal jumper configures the input type, connecting the input circuit *common* to the supply (+) or (–). Detailed wiring examples are in "Using Intelligent Input Terminals" on page 4–10. This chapter shows the inverter's internal electrical component(s) at each I/O terminal and how to interface them with external circuits.

In order to avoid equipment damage and get your application running smoothly, we recommend drawing a schematic of each connection between the inverter and the other device. Include the internal components of each device in the schematic, so that it makes a complete circuit loop.

After making the schematic, then:

1. Verify that the current and voltage for each connection is within the operating limits of each device.

2. Make sure that the logic sense (active high or active low) of any ON/OFF connection is correct.

3. Verify inputs are configured correctly (sink/source) to interface to interface to any external devices (PLCs, etc.).

4. Check the zero and span (curve end points) for analog connections, and be sure the scale factor from input to output is correct.

5. Understand what will happen at the system level if any particular device suddenly loses power, or powers up after other devices.
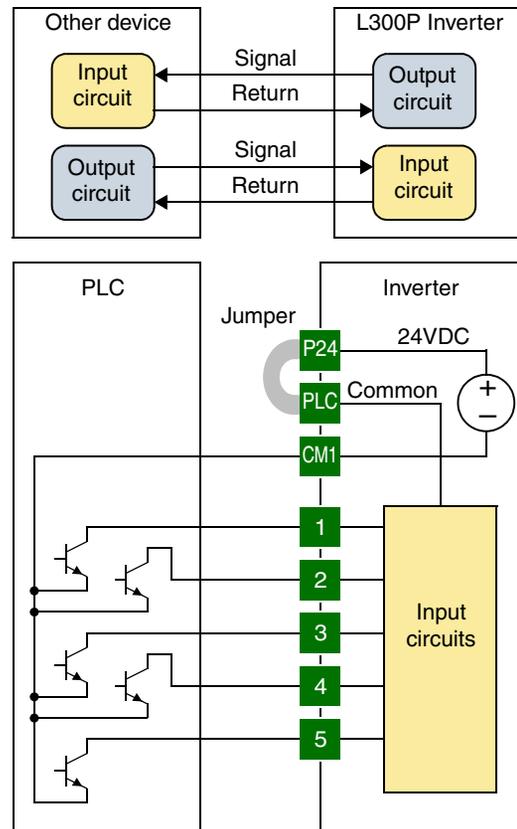
Example Wiring Diagram

The schematic diagram below provides a general example of logic connector wiring, in addition to basic power and motor wiring covered in Chapter 2. The goal of this chapter is to help you determine the proper connections for the various terminals shown below for your specific application needs.
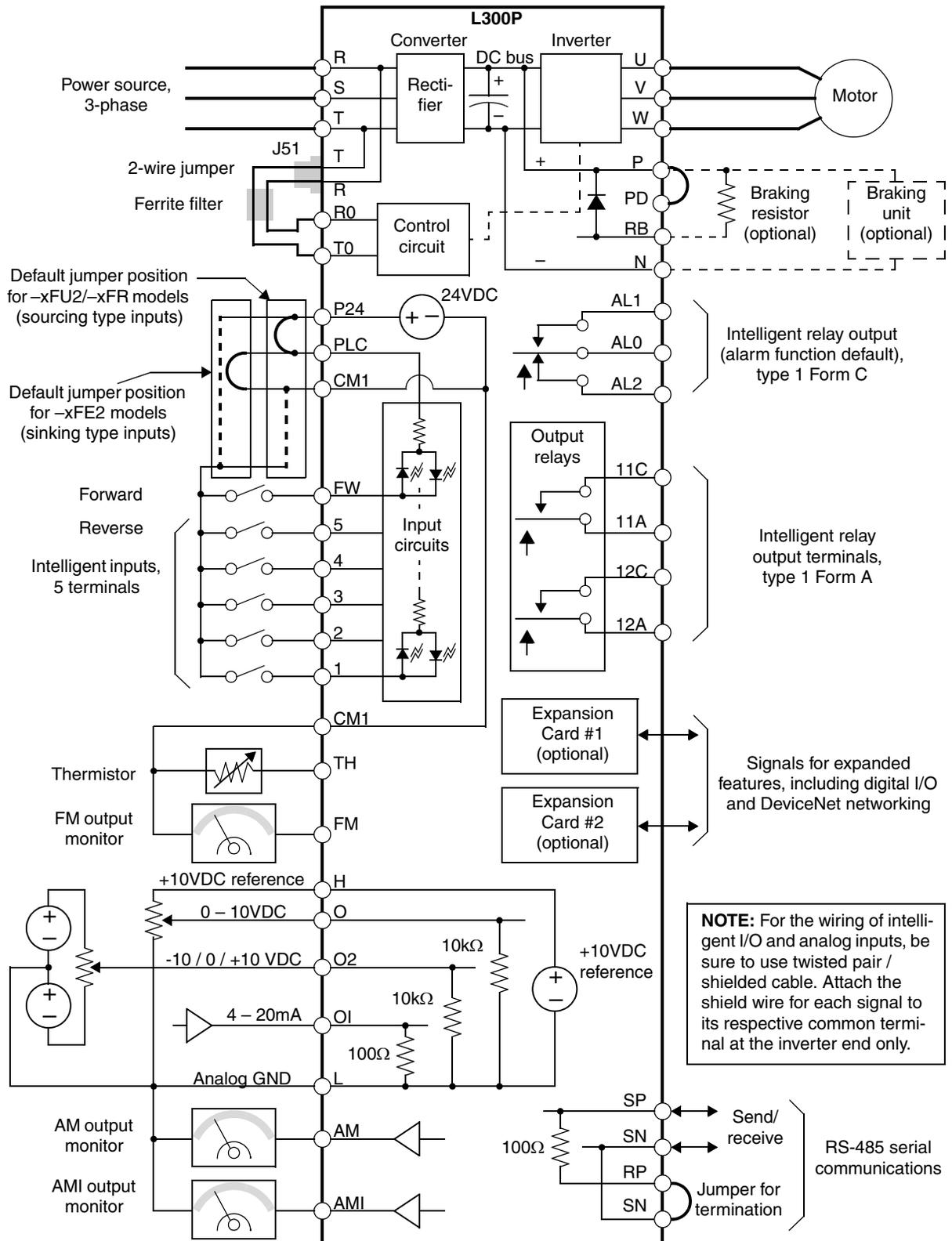
Specifications of Control and Logic Connections

The control logic connector board is removable for wiring convenience, as shown below (first, remove two retaining screws). The small connector to the left is for serial communications.
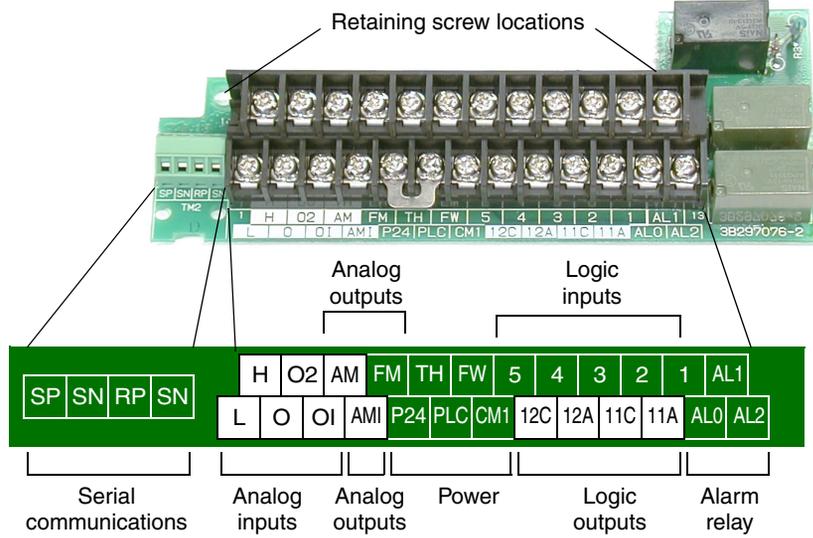
Specifications for the logic connection terminals are in the following table:

Terminal Name	Description	Ratings and Notes
[P24]	+24V power for inputs	24VDC supply, 100 mA max.
[CM1]	+24V common	Common for 24V supply, [FW], [TH], inputs [1] to [8], and [FM]. (Note: Do not ground)
[PLC]	Common for logic inputs	Common for input terminals [1] to [8], jumper to [CM1] for sinking, jumper to [P24] for sourcing
[1], [2], [3], [4], [5]	Intelligent (programmable) discrete logic inputs	27VDC max. (use [P24] or an external supply referenced to terminal [CM1]), 4.7kΩ input impedance
[FW]	Forward/stop command	27VDC max. (use [P24] or an external supply referenced to terminal [CM1]), 4.7kΩ input impedance
[11C]—[11A], [12C]—[12A]	Intelligent (programmable) relay outputs	Normally open contacts (1 Form A), 250 VAC / 30 VDC, 5A (resistive load) maximum 250 VAC / 30 VDC, 1A (inductive load) max. Minimum 5 VDC, 1mA
[TH]	Thermistor input	Reference to [CM1], min. thermistor power 100mW
[FM]	PWM output	0 to 10VDC, 1.2 mA max., 50% duty cycle
[AM]	Voltage analog output	0 to 10VDC, 2 mA max.
[AMI]	Current analog output	4-20 mA, nominal load impedance 250Ω
[L]	Common for analog inputs	Sum of [OI], [O], and [H] currents (return)
[OI]	Analog input, current	4 to 19.6 mA range, 20 mA nominal
[O]	Analog input, voltage	0 to 9.6 VDC range, 10VDC nominal, 12VDC max., input impedance 10 kΩ
[H]	+10V analog reference	10VDC nominal, 10 mA max.
[AL0]	Relay common contact	Contacts AL0–AL1, maximum loads: 250VAC, 2A; 30VDC, 8A resistive load 250VAC, 0.2A; 30VDC, 0.6A inductive load Contacts AL0–AL2, maximum loads:
[AL1]	Relay contact, normally closed during RUN	
[AL2]	Relay contact, normally open during RUN	250VAC, 1A; 30VDC 1A max. resistive load 250VAC, 0.2A; 30VDC, 0.2A max. inductive load Min. loads: 100 VAC, 10mA; 5VDC, 100mA

Terminal Listing Use the following table to locate pages for intelligent input and output material in this chapter.

Intelligent INPUTS				Intelligent OUTPUTS			
Symbol	**Code**	**Name**	**Page**	**Symbol**	**Code**	**Name**	**Page**
RV	01	Reverse Run/Stop	4–11	RUN	00	Run signal	4–36
CF1	02	Multi-speed select, Bit 0 (LSB)	4–12	FA1	01	Freq. arrival type 1 – constant speed	4–37
CF2	03	Multi-speed select, Bit 1	4–12				
CF3	04	Multi-speed select, Bit 2	4–12	FA2	02	Freq. arrival type 2 – over-frequency	4–37
CF4	05	Multi-speed select, Bit 3 (LSB)	4–12				
JG	06	Jogging	4–15	OL	03	Overload advance notice signal	4–39
DB	07	External DC braking	4–16	OD	04	Output deviation for PID control	4–40
SET	08	Set (select) second motor data	4–17	AL	05	Alarm signal	4–41
2CH	09	2-stage accel and decel	4–18	FA3	06	Freq. arrival type 3 – at frequency	4–37
FRS	11	Free-run stop	4–19	IP	08	Instantaneous power failure signal	4–43
EXT	12	External trip	4–20	UV	09	Under-voltage signal	4–43
USP	13	Unattended start protection	4–21	RNT	11	Run time over	4–46
CS	14	Commercial power source	4–22	ONT	12	Power-ON time over	4–46
SFT	15	Software lock	4–24	THM	13	Thermal alarm signal	4–47
AT	16	Analog input voltage/current sel.	4–25	RMD	27	Run command source monitor (–xFU2 and –xFE2 models only)	4–50
RS	18	Reset inverter	4–26				
STA	20	Start (3-wire interface)	4–28				
STP	21	Stop (3-wire interface)	4–28				
F/R	22	FW, RV (3-wire interface)	4–28				
PID	23	PID ON/OFF	4–29				
PIDC	24	PID Reset	4–29				
UP	27	Remote control Up func.	4–30				
DWN	28	Remote control Down func.	4–30				
UDC	29	Remote control data clearing	4–30				
OPE	31	Operator control	4–31				
SF1–7	32–38	Multi-speed bits 1 to 7	4–12				
OLR	39	Overload restriction	4–32				
ROK	49	Run enable for FW/RV (–xFU2 and –xFE2 models only)	4–34				

Operations and Monitoring

Using Intelligent Input Terminals

Intelligent terminals [1], [2], [3], [4] and [5] are identical, programmable inputs for general use. The input circuits can use the inverter's internal (isolated) +24V field supply (P24) to power the inputs. The input circuits connect internally to [PLC] as a common point. To use the internal supply to power the inputs, use the jumper as shown. Remove the jumper to use an external supply, or to interface to a PLC system (or other) that has solid state outputs. If you use an external supply or PLC system, its power return must connect to the [PLC] terminal on the inverter to complete the input circuit.

The following four input configurations are available to interface the inverter inputs to switches or the outputs of another system, such as a PLC.

Sinking inputs, internal supply

24VDC

L300P inverter

common

Input circuits

P24   PLC   CM1   5 4 3 2 1

Jumpered for sinking inputs
(default for –xFE2 models)

Sourcing inputs, internal supply

24VDC

L300P inverter

common

Input circuits

P24   PLC   CM1   5 4 3 2 1

Jumpered for sourcing inputs
(default for –xFU2/–FR models)

Sinking inputs, external supply

24VDC

L300P inverter

common

Input circuits

P24   PLC   CM1   5 4 3 2 1

External
power supply

Sourcing inputs, external supply

24VDC

L300P inverter

common

Input circuits

P24   PLC   CM1   5 4 3 2 1

External
power supply

Operations
and Monitoring

Input Wiring Examples

The input wiring diagrams in this chapter are examples only. Default and non-default input terminal assignments are noted throughout; your particular assignments may be different. The wiring diagrams show the –xFU2/–FR model default [P24]–[PLC] jumper position (U.S./Jpn versions), as shown below on the left. The common (return) for inputs is [CM1] in this case. The diagram on the right shows the default jumper position and example input wiring for –xFE2 models (Europe version). For this case, the common (return) for inputs is [P24]. **Be sure the jumper position and return terminal used match your application wiring needs.**

–xFU2/–FR models (U.S./Jpn versions):

FW RV

| TH | FW | 5 | 4 | 3 | 2 | 1 |

| P24 | PLC | CM1 |

Default jumper position [P24]–[PLC] and wiring example (used throughout this chapter)

← return

–xFE2 models (Europe version):

FW RV

| TH | FW | 5 | 4 | 3 | 2 | 1 |

| P24 | PLC | CM1 |

Default jumper position [PLC]–[CM1] and wiring example
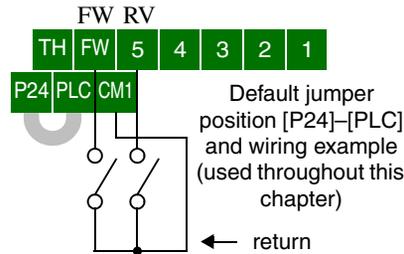
← return
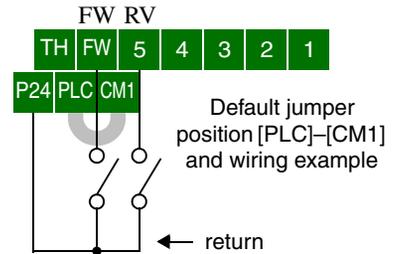
Forward Run/ Stop and Reverse Run/Stop Commands

When you input the Run command via the dedicated terminal [FW], the inverter executes the Forward Run command (high) or Stop command (low). When you input the Run command via the programmable terminal [RV], the inverter executes the Reverse Run command (high) or Stop command (low).

Opt. Code	Symbol	Function Name	State	Description
—	FW	Forward Run/Stop	ON	Inverter is in Run Mode, motor runs forward
			OFF	Inverter is in Stop Mode, motor stops
01	RV	Reverse Run/Stop	ON	Inverter is in Run Mode, motor runs reverse
			OFF	Inverter is in Stop Mode, motor stops
Valid for inputs:	C001, C002, C003, C004, C005			Example: (default input configuration shown—see page 3–43):
Required settings:	A002 = 01			FW RV

Notes:
- When the Forward Run and Reverse Run commands are active at the same time, the inverter enters the Stop Mode.
- When a terminal associated with either [FW] or [RV] function is configured for *normally closed*, the motor starts rotation when that terminal is disconnected or otherwise has no input voltage.

FW RV

| TH | FW | 5 | 4 | 3 | 2 | 1 |

| P24 | PLC | CM1 |

See I/O specs on page 4–8.

NOTE: The parameter F004, Keypad Run Key Routing, determines whether the single Run key issues a Run FWD command or Run REV command. However, it has no effect on the [FW] and [RV] input terminal operation.

WARNING: If the power is turned ON and the Run command is already active, the motor starts rotation and is dangerous! Before turning power ON, confirm that the external Run command is not active.

Operations and Monitoring

Multi-Speed Select

The inverter can store up to 16 different fixed target frequencies (speeds) in parameters A020 to A035. Binary inputs select the speed through four of the intelligent terminals configured as binary-encoded inputs CF1 to CF4 per the table. These can be any of the five inputs, and in any order. You can use fewer inputs if you need eight or fewer speeds.

Multi-speed	Input Function				Multi-speed	Input Function			
	CF4	CF3	CF2	CF1		CF4	CF3	CF2	CF1
Speed 0	0	0	0	0	Speed 8	1	0	0	0
Speed 1	0	0	0	1	Speed 9	1	0	0	1
Speed 2	0	0	1	0	Speed 10	1	0	1	0
Speed 3	0	0	1	1	Speed 11	1	0	1	1
Speed 4	0	1	0	0	Speed 12	1	1	0	0
Speed 5	0	1	0	1	Speed 13	1	1	0	1
Speed 6	0	1	1	0	Speed 14	1	1	1	0
Speed 7	0	1	1	1	Speed 15	1	1	1	1

NOTE: When choosing a subset of speeds to use, always start at the top of the table, and with the least-significant bit: CF1, CF2, etc.

The example with eight speeds in the figure below shows how input switches configured for CF1 – CF3 functions can change the motor speed in real time.

.

Opt. Code	Symbol	Function Name	Input State	Description
02	CF1	Binary speed select, Bit 0 (LSB)	ON	Bit 0, logical 1
			OFF	Bit 0, logical 0
03	CF2	Binary speed select, Bit 1	ON	Bit 1, logical 1
			OFF	Bit 1, logical 0
04	CF3	Binary speed binary select, Bit 2	ON	Bit 2, logical 1
			OFF	Bit 2, logical 0
05	CF4	Binary speed select, Bit 3 (MSB)	ON	Bit 3, logical 1
			OFF	Bit 3, logical 0

Valid for inputs:	C001, C002, C003, C004, C005	Example (some CF inputs require input configuration; some are default inputs— see page 3–43):
Required settings:	F001, A020 to A035 A019=00	

Notes:

- When programming the multi-speed settings, be sure to press the Store key each time and then set the next multi-speed setting. Note that when the Store key is not pressed, no data will be set.
- When a multi-speed setting more than 50Hz(60Hz) is to be set, it is necessary to program the maximum frequency A04 high enough to allow that speed.

See I/O specs on page 4–8.

While using the multi-speed capability, you can monitor the output frequency with monitor function D001 during each segment of a multi-speed operation.

There are two ways to program the speeds into the registers A020 to A035:

1. Standard keypad programming:

   a. Select each parameter A020 to A035.

   b. Press the (FUNC) key to view the parameter value.

   c. Use the ∧ and ∨ keys to edit the value.

   d. Use the (STR) key to save the data to memory.

2. Programming using the CF switches:

   a. Turn the Run command OFF (Stop Mode).

   b. Turn inputs ON to select desired Multi-speed. Display the value of F001 on the digital operator.

   c. Set the desired output frequency by pressing the ∧ and ∨ keys.

   d. Press the (STR) key once to store the set frequency. When this occurs, F001 indicates the output frequency of the selected Multi-speed.

   e. Press the (FUNC) key once to confirm that the indication is the same as the set frequency.

   f. Repeat operations in 2. a) to 2. e) to set the frequency of other Multi-speeds. It can be set also by parameters A020 to A035 in the first procedure 1. a) to 1. d).

Operations and Monitoring

The Bit Operation method of speed control uses up to five intelligent inputs to select any of up to six speeds from a total of eight speeds. (At least two of the SF1–SF7 functions will be unused, since there are only five inputs.) Since the all-switches-OFF combination selects the first speed, you only need N-1 switches to select N speeds. With Bit Operation speed control, only one input is normally active at a time. If multiple switches are ON, the lower numbered input takes precedence (determines the speed). The table and figure below show how the input combinations work.

Multi-speed	Input Function						
	SF7	SF6	SF5	SF4	SF3	SF2	SF1
Speed 0	0	0	0	0	0	0	0
Speed 1	—	—	—	—	—	—	1
Speed 2	—	—	—	—	—	1	0
Speed 3	—	—	—	—	1	0	0
Speed 4	—	—	—	1	0	0	0
Speed 5	—	—	1	0	0	0	0
Speed 6	—	1	0	0	0	0	0
Speed 7	1	0	0	0	0	0	0
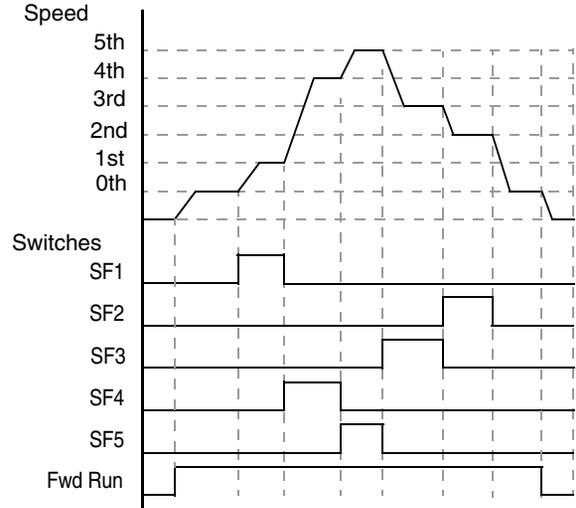
Note: Input functions SF6 and SF7 may be substituted for any of SF1–SF5, to access Speed 7 or Speed 8.

The following table lists the option codes for assigning [SF1 to [SF7] to the intelligent inputs.

Opt. Code	Symbol	Function Name	Description
32	SF1	Bit-level speed select 1	Bit-level speed select, Bit 0
33	SF2	Bit-level speed select 2	Bit-level speed select, Bit 1
34	SF3	Bit-level speed select 3	Bit-level speed select, Bit 2
35	SF4	Bit-level speed select 4	Bit-level speed select, Bit 3
36	SF5	Bit-level speed select 5	Bit-level speed select, Bit 4
37	SF6	Bit-level speed select 6	Bit-level speed select, Bit 5
38	SF7	Bit-level speed select 7	Bit-level speed select, Bit 6
Valid for inputs:	C001, C002, C003, C004, C005		Example (requires input configuration— see page 3–43):
Required settings:	F001, A020 to A035 A019=00		
Notes: • When all [SFx] inputs are OFF, the speed is set by default to the value in F001. • When a multi-speed setting more than 50Hz(60Hz) is to be set, it is necessary to program the maximum frequency A004 high enough to allow that speed.			See I/O specs on page 4–8.

**Jogging
Command**

The Jog input [JG] is used to command the motor to rotate slowly in small increments for manual operation. The speed is limited to 10 Hz. The frequency for the jogging operation is set by parameter A038. Jogging does not use an acceleration ramp. Therefore setting the jogging frequency A038 too high will cause inverter tripping.

A jog command may arrive while the motor is running. You can program the inverter to either ignore or respond to a jog command in this case by using function A039. The type of deceleration used to end a motor jog

is also selectable by programming function A039. Six jog mode options are defined below:
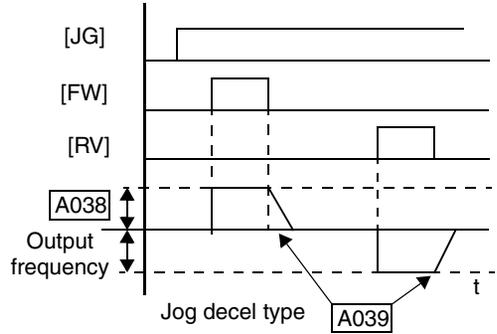
Jogging During Motor Operation		Jog Deceleration Method
Disabled, A039=	Enabled, A039=	
00	03	Free-run stop (coasting)
01	04	Deceleration (normal level) and stop
02	05	Use DC braking and stop

In the left example diagram below, the Jog command is ignored. In the right example diagram, a jog command interrupts a Run mode operation. However, if the Jog command turns ON before the [FW] or [RV] terminal turns ON, the inverter output turns OFF.

Opt. Code	Symbol	Function Name	Input State	Description
06	JG	Jogging	ON	Enters Jog Mode if enabled (see above)
			OFF	Jog is OFF
Valid for inputs:	C001, C002, C003, C004, C005			Example (requires input configuration—see page 3–43):
Required settings:	A002= 01, A038 > B082, A038 > 0, A039=00 to 05			
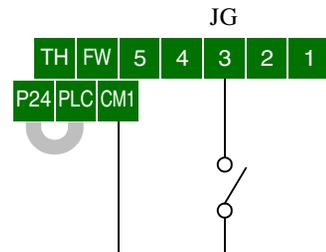
Notes:
- Jogging is not performed when the value of A038 jogging frequency is smaller than the start frequency B082 or the value is 0 Hz.
- Be sure to turn ON [FW] or [RV] *after* the [JG] input turns ON for a jog operation.
- When setting A039 to 02 or 05, you must also set the DC braking parameters.

See I/O specs on page 4–8.

External Signal for DC Braking

When the terminal [DB] is turned ON, the DC braking [DB] feature is enabled. Set the following parameters when the external DC braking terminal is to be used:

- A053 – DC braking delay time setting. The range 0.0 to 5.0 seconds.
- A054 – DC braking force setting. The range is 0 to 100%.

The scenarios to the right help show how DC braking works in various situations.

1. Scenario 1 – The [FW] Run or [RV] Run terminal is ON. When the [DB] terminal turns ON, DC braking is applied. When the [DB] terminal turns OFF again, the inverter output ramps to the previous frequency.

2. Scenario 2 – The Run command is applied from the operator keypad. When the [DB] terminal turns ON, DC braking is applied. When the [DB] terminal turns OFF again, the inverter output remains OFF.

3. Scenario 3 – The Run command is applied from the operator keypad. When the [DB] terminal turns ON, DC braking is applied after the delay time set by A053 expires. The motor is in a free-running (coasting) condition during this delay time. When the [DB] terminal turns OFF again, the inverter output remains OFF.

Scenario 1

Scenario 2

Scenario 3

Opt. Code	Symbol	Function Name	Input State	Description
07	DB	External Signal for DC Injection Braking	ON	applies DC injection braking during deceleration
			OFF	does not apply DC injection braking during deceleration
Valid for inputs:	C001, C002, C003, C004, C005			Example (requires input configuration—see page 3–43):
Required settings:	A053, A054			DB TH FW 5 4 3 2 1 P24 PLC CM1
Notes: • Do not use the [DB] input continuously or for a long time when the DC braking force setting A054 is high (depends on the motor application). • Do not use the [DB] feature for continuous or high duty cycle as a holding brake. The [DB] input is designed to improve stopping performance. Use a mechanical brake for holding a stop position.				See I/O specs on page 4–8.

Set Second Motor If you assign the [SET] function to an intelligent input terminal, you can select between two sets of motor parameters. These second parameters store an alternate set of motor characteristics. When terminal [SET] is turned ON, the inverter will use the second set of parameters, generating the frequency output to the motor. When changing the state of the [SET] input terminal, the change will not take effect until the inverter is stopped.

When you turn ON the [SET] input, the inverter operates per the second set of parameters. When the terminal is turned OFF, the output function returns to the original settings (first set of motor parameters). Refer to "Configuring the Inverter for Multiple Motors" on page 4–59 for details.

Opt. Code	Symbol	Function Name	Input State	Description
08	SET	Set 2nd Motor	ON	causes the inverter to use the 2nd set of motor parameters for generating the frequency output to motor
			OFF	causes the inverter to default to the 1st (main) set of motor parameters for generating the frequency output to motor

Valid for inputs:	C001, C002, C003, C004, C005	Example (requires input configuration— see page 3–43):
Required settings:	(none)	SET TH FW 5 4 3 2 1 P24 PLC CM1
Notes: • If the terminal state is changed while the inverter is running, the inverter continues using the current set of parameters until the inverter is stopped.		See I/O specs on page 4–8.

Two-stage Acceleration and Deceleration

When terminal [2CH] is turned ON, the inverter changes the rate of acceleration and deceleration from the initial settings (F002 and F003) to use the second set of acceleration/deceleration values. When the terminal is turned OFF, the inverter is returned to the original acceleration and deceleration time (F002 acceleration time 1, and F003 deceleration time 1). Use A092 (acceleration time 2) and A093 (deceleration time 2) to set the second stage acceleration and deceleration times.
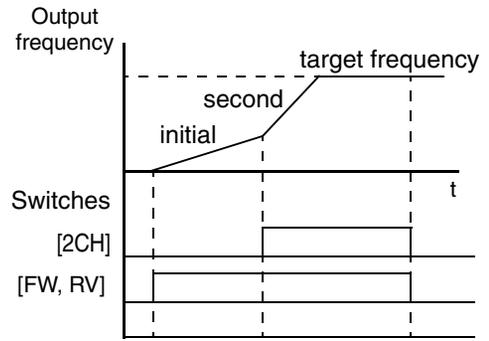
In the graph shown above, the [2CH] signal becomes active during acceleration. This causes the inverter to switch from using acceleration 1 (F002) to acceleration 2 (A092).

Opt. Code	Symbol	Function Name	Input State	Description
09	2CH	Two-stage Acceleration and Deceleration	ON	Frequency output uses 2nd-stage acceleration and deceleration values
			OFF	Frequency output uses the initial acceleration 1 and deceleration 1 values

Valid for inputs:	C001, C002, C003, C004, C005	Example (requires input configuration— see page 3–43):
Required settings:	A092, A093, A094=0	2CH

Notes:

• Function A094 selects the method for second stage acceleration. It must be set = 00 to select the input terminal method in order for the 2CH terminal assignment to operate.

See I/O specs on page 4–8.

Free-run Stop

When the terminal [FRS] is turned ON, the inverter turns OFF the output and the motor enters the free-run state (coasting). If terminal [FRS] is turned OFF, the output resumes sending power to the motor if the Run command is still active. The free-run stop feature works with other parameters to provide flexibility in stopping and starting motor rotation.

In the figure below, parameter B088 selects whether the inverter resumes operation from 0 Hz (left graph) or the current motor rotation speed (right graph) when the [FRS] terminal turns OFF. The application determines the best setting.

Parameter B003 specifies a delay time before resuming operation from a free-run stop. To disable this feature, use a zero delay time.

Resume from 0Hz B088=00   Resume from current speed B088=01

Opt. Code	Symbol	Function Name	Input State	Description
11	FRS	Free-run Stop	ON	Causes output to turn OFF, allowing motor to free run (coast) to stop
			OFF	Output operates normally, so controlled deceleration stops motor

Valid for inputs:	C001, C002, C003, C004, C005
Required settings:	B003, B088, C011 to C015

Example (requires input configuration—see page 3–43):

FRS

TH FW 5 4 3 2 1
P24 PLC CM1

See I/O specs on page 4–8.

Notes:
- When you want the [FRS] terminal to be active low (normally closed logic), change the setting (C011 to C015) that corresponds to the input (C001 to C005) that is assigned the [FRS] function.

External Trip

When the terminal [EXT] is turned ON, the inverter enters the trip state, indicates error code E12, and stops the output. This is a general purpose interrupt type feature, and the meaning of the error depends on what you connect to the [EXT] terminal. Even if [EXT] is turned OFF, the inverter remains in the trip state. You must reset the inverter or cycle power to clear the error, returning the inverter to the Stop Mode.

In the graph below, the [EXT] input turns ON during normal Run Mode operation. The inverter lets the motor free-run to a stop, and the alarm output turns ON immediately. When the operator initiates a Reset command, the alarm and error are cleared. When the Reset is turned OFF, the motor begins rotation since the Run command is already active.

Opt. Code	Symbol	Function Name	Input State	Description
12	EXT	External Trip	ON	When assigned input transitions OFF to ON, inverter latches trip event and displays E12
			OFF	No trip event for ON to OFF, any recorded trip events remain in history until Reset

Valid for inputs:	C001, C002, C003, C004, C005	Example (requires input configuration— see page 3–43):
Required settings:	(none)	
Notes: • If the USP (Unattended Start Protection) feature is in use, the inverter will not automatically restart after cancelling the EXT trip event. In that case, it must receive either another Run command (OFF-to-ON transition), a keypad Reset command, or an [RS] intelligent terminal input signal.		See I/O specs on page 4–8.

Unattended Start Protection

If the Run command is already present when power is turned ON, the inverter starts running immediately after powerup. The Unattended Start Protection (USP) function prevents that automatic startup, so that the inverter *will not* run without outside intervention. When USP is active, there are two ways to reset an alarm and resume running:

1. Turn the Run command OFF, or

2. Perform a reset operation by the terminal [RS] input or the keypad Stop/reset key

The three examples below show how the USP function works in the scenarios described at the bottom of the diagram. The error code E13 indicates the USP trip state and corresponds to the *Alarm* signal in the diagram.
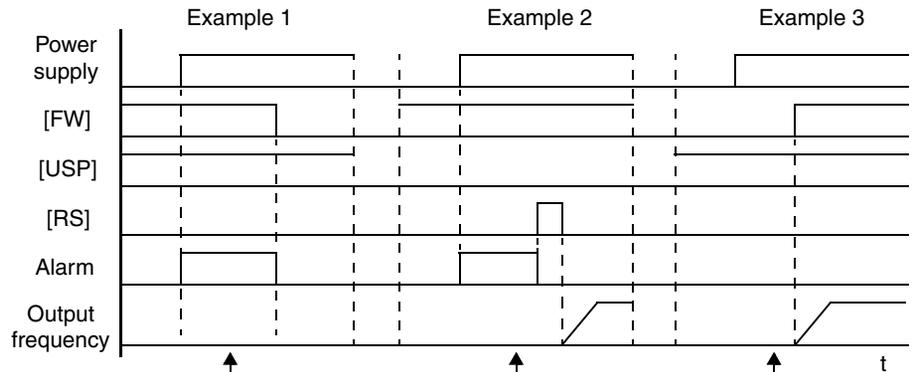
When USP is ON after powerup, the alarm (E13) will clear when the Run command (FW or RV) turns OFF.

If the alarm is cleared during Run command, the inverter output restarts automatically.

If the Run command is already OFF at powerup, the inverter output starts normally.

Opt. Code	Symbol	Function Name	Input State	Description
13	USP	Unattended Start Protection	ON	At powerup, the inverter will not resume a Run command
			OFF	At powerup, the inverter will resume a Run command that was active before power loss

Valid for inputs:	C001, C002, C003, C004, C005	Example (default input configuration shown for -FU2 models; -FE and -F models require input configuration— see page 3–43):
Required settings:	(none)	

Notes:

- Note that when a USP error occurs and it is canceled by a reset from the [RS] terminal input or keypad, the inverter restarts immediately.
- Even when the trip state is canceled by turning the terminal [RS] ON and OFF after an under-voltage trip E09 occurs, the USP function will be performed.
- When the Run command is active immediately after the power is turned ON, a USP error will occur. When this function is used, wait for at least three (3) seconds after powerup before applying a Run command.

USP

See I/O specs on page 4–8.

Operations and Monitoring

Operations
and Monitoring

Commercial Power Source Switching

The commercial power source switching function is useful in systems with excessive starting torque requirements. This feature permits the motor to be started "across the line," sometimes called a *bypass* configuration. After the motor is running, the inverter takes over to control the speed. This feature can eliminate the need to oversize the inverter, reducing cost. However, additional hardware such as magnetic contactors will be required to realize this function. For example, a system may require 55KW to start, but only 15KW to run at constant speed. Therefore, a 15KW rated inverter would be sufficient when using the commercial power source switching.

The following block diagram shows an inverter system with *bypass* capability. When starting the motor directly across the line, relay contacts Mg2 are closed, and Mg1 and Mg3 are open. This is the bypass configuration, since the inverter is isolated from the power source and motor. Then Mg1 contacts close about 0.5 to 1 second after that, supplying power to the inverter.
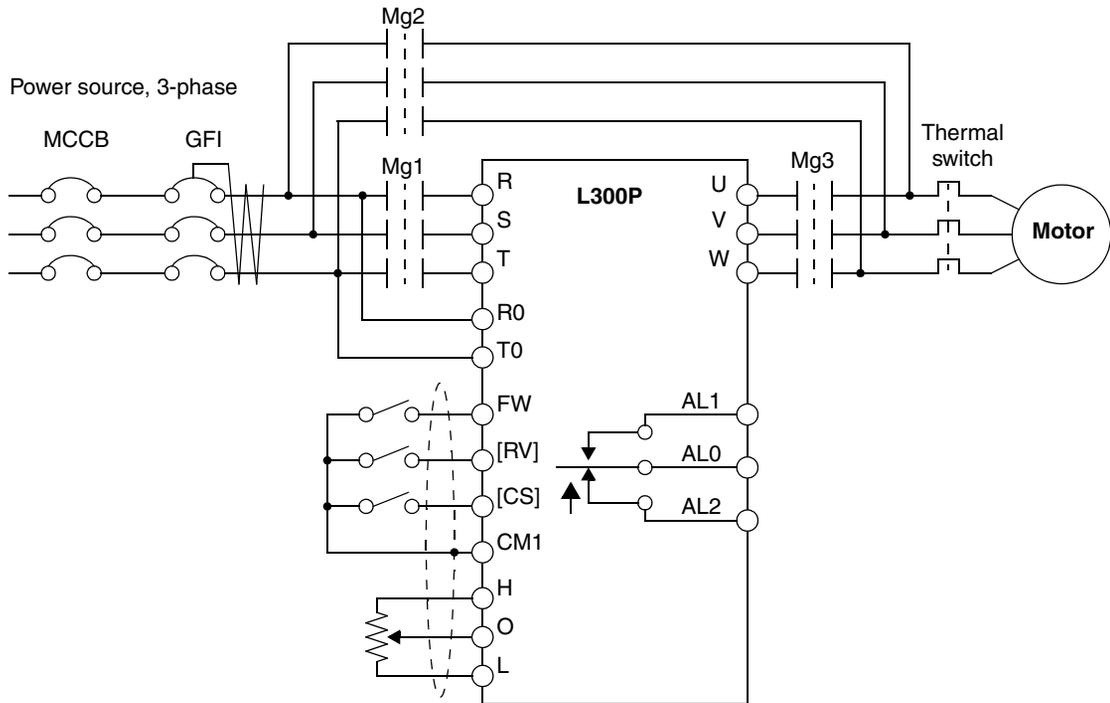
Switching to inverter control occurs after the motor is running at full speed. First, Mg2 relay contacts open. Then about 0.5 to 1 seconds later, relay Mg3 contacts close, connecting the inverter to the motor. The following timing diagram shows the event sequence:
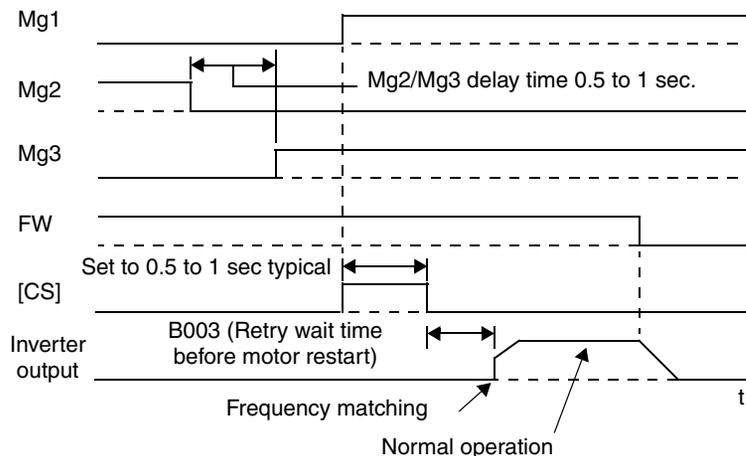
In the previous timing diagram, when the motor has been started across the line, Mg2 is switched OFF and Mg3 is switched ON. With the Forward command to the inverter already ON, the [CS] terminal is switched ON and relay Mg1 contacts close. The inverter will then read the motor RPM (frequency matching). When the [CS] terminal is switched OFF, the inverter applies the *Retry wait time before motor restart* parameter (B003).

Once the delay time has elapsed the inverter will then start and match the frequency (if greater than the threshold set by B007). If the ground fault interrupter breaker (GFI) trips on a ground fault, the bypass circuit will not operate the motor. When an inverter backup is required, take the supply from the bypass circuit GFI. Use control relays for [FW], [RV], and [CS].

The commercial power source switching function requires you to assign [CS] to an intelligent input terminal, using option code 14.

Opt. Code	Symbol	Function Name	Input State	Description
14	CS	Commercial Power Change	ON	OFF-to-ON transition signals the inverter that the motor is already running at powerup (via bypass), thus suppressing the inverter's motor output in Run Mode
			OFF	ON-to-OFF transition signals the inverter to apply a time delay (B003), frequency match its output to existing motor speed, and resume normal Run Mode operation
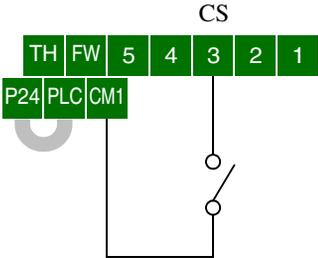
Valid for inputs:	C001, C002, C003, C004, C005	Example (requires input configuration—see page 3–43):
Required settings:	B003, B007	
Notes: • If an over-current trip occurs during frequency matching, extend the retry wait time B003.		See I/O specs on page 4–8.

Software Lock

When the terminal [SFT] is turned ON, the data of all the parameters and functions (except the output frequency, depending on the setting of B031) is locked (prohibited from editing). When the data is locked, the keypad keys cannot edit inverter parameters. To edit parameters again, turn OFF the [SFT] terminal input.

Use parameter B031 to select whether the output frequency is excluded from the lock state or is locked as well.

Opt. Code	Symbol	Function Name	Input State	Description
15	SFT	Software Lock	ON	The keypad and remote programming devices are prevented from changing parameters
			OFF	The parameters may be edited and stored
Valid for inputs:	C001, C002, C003, C004, C005		Example (requires input configuration—see page 3–43):	
Required settings:	B031 (excluded from lock)		SFT	
Notes: • When the [SFT] terminal is turned ON, only the output frequency can be changed. • Software lock can include the output frequency by setting B031. • Software lock by the operator is also possible without the [SFT] terminal being used (B031).			See I/O specs on page 4–8.	
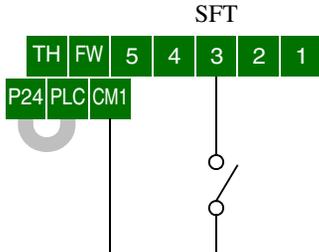
Analog Input Current/Voltage Select

The [AT] terminal operates in conjunction with parameter setting A005 to determine the analog input terminals that are enabled for current or voltage input. Setting A006 determines whether the signal will be bipolar, allowing for a reverse direction range. Note that current input signal cannot be bipolar and cannot reverse direction (must use [FW] and [RV] command with current input operation). The following table shows the basic operation of the [AT] intelligent input. Please refer to for more information on bipolar input configuration, and the operating characteristics of analog inputs.

Opt. Code	Symbol	Function Name	Input State	Description
16	AT	Analog Input Voltage/current Select	ON	• With A005 = 00, [AT] will enable terminals OI–L for current input, 4 to 20mA • With A005=01, [AT] will enable terminals [O2]–[L] for voltage input
			OFF	Terminals [O]–[L] are enabled for voltage input (A005 may be equal to 00 or 01) in this case
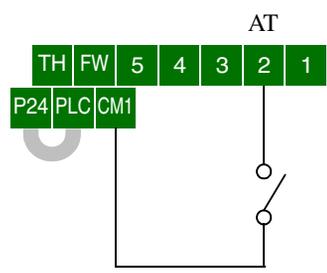
Valid for inputs:	C001, C002, C003, C004, C005
Required settings:	A001 = 01 A005 = 00 / 01 A006 = 00 / 01 / 02

Notes:
• Be sure to set the frequency source setting A001=01 to select the analog input terminals.

Example: (default input configuration shown—see page 3–43):

AT

| TH | FW | 5 | 4 | 3 | 2 | 1 |
| P24 | PLC | CM1 |

See I/O specs on page 4–8.

Reset Inverter

The [RS] terminal causes the inverter to execute the reset operation. If the inverter is in Trip Mode, the reset cancels the Trip state. When the signal [RS] is turned ON and OFF, the inverter executes the reset operation. The minimum pulse width for [RS] must be 12 ms or greater. The alarm output will be cleared within 30 ms after the onset of the Reset command.
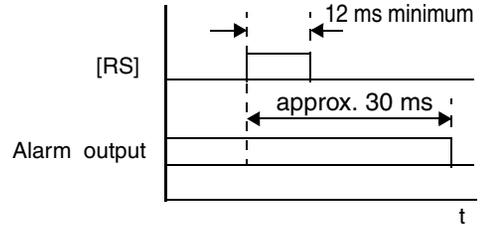
WARNING: After the Reset command is given and the alarm reset occurs, the motor will restart suddenly if the Run command is already active. Be sure to set the alarm reset after verifying that the Run command is OFF to prevent injury to personnel.

Opt. Code	Symbol	Function Name	Input State	Description
18	RS	Reset Inverter	ON	The motor output is turned OFF, the Trip Mode is cleared (if it exists), and powerup reset is applied
			OFF	Normal power-on operation

Valid for inputs:	C001, C002, C003, C004, C005	Example: (default input configuration shown—see page 3–43):
Required settings:	B003, B007, C102, C103	

Notes:

• When the control terminal [RS] input is already ON at powerup for more than 4 seconds, the remote operator display is "R-ERROR COMM<2>" (the display of the digital operator is – – – –). However, the inverter has no error. To clear the digital operator error, turn OFF the terminal [RS] input and press one of the operator keys.

See I/O specs on page 4–8.

• The active edge (leading or trailing) of the [RS] signal is determined by the setting of C102.
• A terminal configured with the [RS] function can only be configured as a normally open contact. The terminal cannot be used in the normally closed contact state.
• When input power is turned ON, the inverter performs the same reset operation as it does when a pulse on the [RS] terminal occurs.

Thermistor Thermal Protection

Motors that are equipped with a thermistor can be protected from overheating. Input terminal [TH] is dedicated to sense a thermistor resistance. The input can be set up (via B098 and B099) to accept a wide variety of NTC or PTC type thermistors. Use this function to protect the motor from overheating.

Opt. Code	Symbol	Function Name	Input State	Description
—	TH	Thermistor Thermal Protection	Sensor	When a thermistor is connected between to terminals [TH] and [CM1], the inverter checks for over-temperature and will cause a trip (E35) and turn OFF the output to the motor
			Open	An open circuit in the thermistor causes a trip, and the inverter turns OFF the output

Valid for inputs:	[TH] only	Example:
Required settings:	B098 and B099	
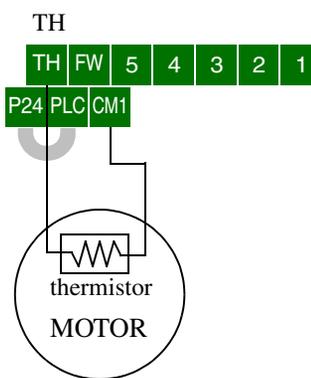
Notes:

• Be sure the thermistor is connected to terminals [TH] and [CM1]. If the resistance is above or below (depending on whether NTC or PTC) the threshold the inverter will trip. When the motor cools down enough, the thermistor resistance will change enough to permit you to clear the error. Press the STOP/ Reset key to clear the error.

TH

TH	FW	5	4	3	2	1

P24	PLC	CM1

thermistor

MOTOR

See I/O specs on page 4–8.

Three-wire Interface Operation

The 3-wire interface is an industry standard motor control interface. This function uses two inputs for momentary contact start/stop control, and a third for selecting forward or reverse direction. To implement the 3-wire interface, assign 20 [STA] (Start), 21 [STP] (Stop), and 22 [F/R] (Forward/Reverse) to three of the intelligent input terminals. Use momentary contact for Start and Stop. Use a selector switch, such as SPST for the Forward/Reverse input. Be sure to set the operation command selection A002=01 for input terminal control of motor.

If you have a motor control interface that needs logic-level control (rather than momentary pulse control), use the [FW] and [RV] inputs instead.

Opt. Code	Symbol	Function Name	Input State	Description
20	STA	Start Motor	ON	Start motor rotation on momentary contact (uses acceleration profile)
			OFF	No change to motor operation
21	STP	Stop Motor	ON	No change to motor operation
			OFF	Stop motor rotation on momentary contact (uses deceleration profile)
22	F/R	Forward/Reverse	ON	Select *reverse* direction of rotation
			OFF	Select *forward* direction of rotation

Valid for inputs:	C001, C002, C003, C004, C005	Example (requires input configuration— see page 3–43):
Required settings:	A002=01	

Notes:
- The STP logic is inverted. Normally the switch will be closed, so you open the switch to stop. In this way, a broken wire causes the motor to stop automatically (safe design).
- When you configure the inverter for 3-wire interface control, the dedicated [FW] terminal is automatically disabled. The [RV] intelligent terminal assignment is also disabled.

See I/O specs on page 4–8.

The diagram below shows the use of 3-wire control. STA (Start Motor) is an edge-sensitive input; an OFF-to-ON transition gives the Start command. The control of direction is level-sensitive, and the direction may be changed at any time. STP (Stop Motor) is also a level-sensitive input.
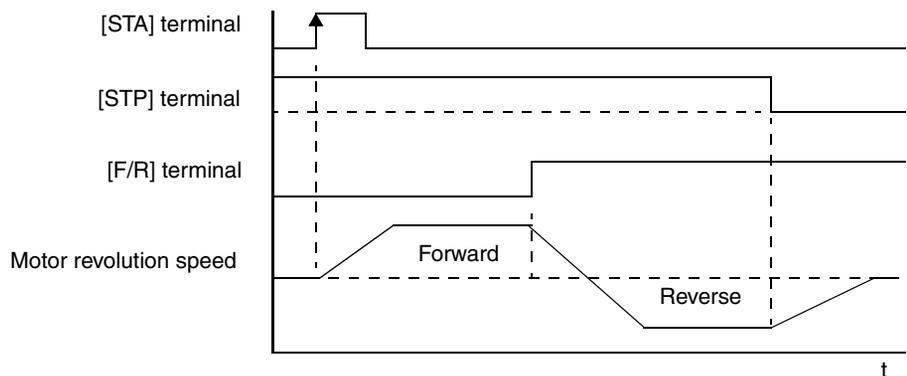
PID ON/OFF and PID Clear

The PID loop function is useful for controlling motor speed to achieve constant flow, pressure, temperature, etc. in many process applications. The PID Disable function temporarily suspends PID loop execution via an intelligent input terminal. It overrides the parameter A071 (PID Enable) to stop PID execution and return to normal motor frequency output characteristics. the use of PID Disable on an intelligent input terminal is optional. Of course, any use of the PID loop control requires setting PID Enable function A071=01.

The PID Clear function forces the PID loop integrator sum = 0. So, when you turn ON an intelligent input configured as [PIDC], the integrator sum is reset to zero. This is useful when switching from manual control to PID loop control and the motor is stopped.

CAUTION: Be careful not to turn PID Clear ON and reset the integrator sum when the inverter is in Run Mode (output to motor is ON). Otherwise, this could cause the motor to decelerate rapidly, resulting in a trip.

Opt. Code	Symbol	Function Name	Input State	Description
23	PID	PID Disable	ON	Disables PID loop execution
			OFF	Allows PID loop execution if A71=01
24	PIDC	PID Clear	ON	Force the value of the integrator to zero
			OFF	No change to PID loop execution

Valid for inputs:	C001, C002, C003, C004, C005	Example (requires input configuration— see page 3–43):
Required settings:	A071	PIDC PID
Notes: • The use of [PID] and [PIDC] terminals are optional. Use A071=01 if you want PID loop control enabled all the time. • Do not enable/disable PID control while the motor is running (inverter is in Run Mode). • Do not turn ON the [PIDC] input while the motor is running (inverter is in Run Mode).		See I/O specs on page 4–8.

Operations and Monitoring

Remote Control Up and Down Functions

The [UP] [DWN] terminal functions can adjust the output frequency for remote control while the motor is running. The acceleration time and deceleration time used with this function is the same as for normal operation ACC1 and DEC1 (2ACC1,2DEC1). The input terminals operate as follows:

- Acceleration - When the [UP] contact is turned ON, the output frequency accelerates from the current value. When it is turned OFF, the output frequency maintains its current value.

- Deceleration - When the [DWN] contact is turned ON, the output frequency decelerates from the current value. When it is turned OFF, the output frequency maintains its current value.

In the graph below, the [UP] and [DWN] terminals activate while the Run command remains ON. The output frequency responds to the [UP] and [DWN] commands.
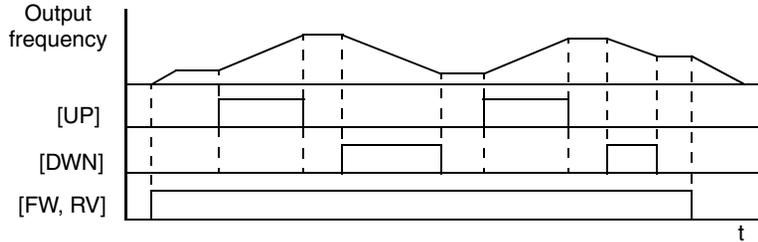
It is possible for the inverter to retain the frequency set from the [UP] and [DWN] terminals through a power loss. Parameter C101 enables/disables the memory. If disabled, the inverter retains the last frequency before an UP/DWN adjustment. Use the [UDC] terminal to clear the memory and return to the original set output frequency.

Opt. Code	Symbol	Function Name	Input State	Description
27	UP	Remote Control UP Function	ON	Accelerates (increases output frequency) motor from current frequency
			OFF	Output to motor operates normally
28	DWN	Remote Control DOWN Function	ON	Decelerates (decreases output frequency) motor from current frequency
			OFF	Output to motor operates normally
29	UDC	Remote Control Data Clear	ON	Clears the Up/down frequency memory
			OFF	No effect on Up/down memory

Valid for inputs:	C001, C002, C003, C004, C005	Example (requires input configuration—see page 3–43):
Required settings:	A001 = 02 C101 = 01 (enables memory)	
Notes: • This feature is available only when the frequency command source is programmed for operator control. Confirm A001 is set to 02. • This function is not available when [JG] is in use. • The range of output frequency is 0 Hz to the value in A004 (maximum frequency setting). • The Remote Control Up/Down function varies the inverter speed by directly writing to the F001 output frequency setting.		See I/O specs on page 4–8.

Force Operation from Digital Operator

This function permits a digital operator interface to override the Run command source setting (A002) when it is configured for a source other than the operator interface. When the [OPE] terminal is ON and the operator interface gives a Run command, the inverter uses the standard output frequency settings to operate the motor.

Opt. Code	Symbol	Function Name	Input State	Description
31	OPE	Force Operation from Digital Operator	ON	Forces the operator interface Run command to over-ride commands from input terminals (such as [FW], [RV]).
			OFF	Run command operates normally, as configured by A002

Valid for inputs:	C001, C002, C003, C004, C005
Required settings:	A001 A002 (set not equal to 02)

Example (requires input configuration—see page 3–43):

OPE

| TH | FW | 5 | 4 | 3 | 2 | 1 |
| P24 | PLC | CM1 |

See I/O specs on page 4–8.
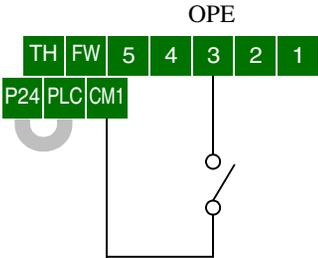
Notes:

• When changing the [OPE] state during Run Mode (inverter is driving the motor), the inverter will stop the motor before the new [OPE] state takes effect.

• If the [OPE] input turns ON and the digital operator gives a Run command while the inverter is already running, the inverter stops the motor. Then the digital operator can control the motor.

Operations and Monitoring

Overload Restriction

The inverter constantly monitors the motor current during acceleration, deceleration, and constant speed. If the inverter reaches the overload restriction level, it adjusts the output frequency automatically to limit the amount of overload. This function prevents an over-current trip by inertia during rapid acceleration or large changes in load at constant speed. It also attempts to prevent an over-voltage trip on deceleration due to regeneration. It accomplishes this by temporarily suspending deceleration and/or increasing the frequency in order to dissipate regenerative energy. Once the DC bus voltage falls sufficiently, deceleration will resume.

OLR Parameter Selection – Two sets of overload restriction parameter settings and values are available as outlined in the table below. Use the B021—B026 group of settings to configure the two set of parameters as needed. By assigning the Overload Restriction function [OLR] to an intelligent terminal, you can select the set of restriction parameters that is in effect.

Function	Function Code		Data or Range	Description
	Set 1	Set 2		
Overload Restriction Operation Mode	B021	B024	00	Disable
			01	Enabled during accel and constant speed
			02	Enabled during constant speed
			03	Enabled during accel, constant speed, and decel
Overload Restriction Setting	B022	B025	Rated current * 0.5 to rated current * 2	Current value at which the restriction begins
Deceleration Rate at Overload Restriction	B023	B026	0.1 to 30 seconds	Deceleration time when overload restriction operates

.

Opt. Code	Symbol	Function Name	Input State	Description
39	OLR	Overload Restriction Selection	ON	Selects Overload Restriction Set 2, B024, B025, B026 settings in effect
			OFF	Selects Overload Restriction Set 1, B021, B022, B023 settings in effect

Opt. Code	Symbol	Function Name	Input State	Description
Valid for inputs:		C001, C002, C003, C004, C005		Example (requires input configuration—see page 3–43):
Required settings:		B021, B022, B023 (Mode 1), B024, B025, B026 (Mode 2)		OLR
Notes: • If the overload restriction constant (B023 or B026) is set too short, an over-voltage trip during deceleration will occur due to regenerative energy from the motor. • When an overload restriction occurs during acceleration, the motor will take longer to reach the target frequency, or may not reach it. The inverter will make the following adjustments: a) Increase the acceleration time b) Raise torque boost c) Raise overload restriction level				

See I/O specs on page 4–8.

The figure below shows the operation during an overload restriction event. The overload restriction level is set by B022 and B025. The overload restriction constant is the time to decelerate to 0Hz from maximum frequency. When this function operates, the acceleration time will be longer than the normal acceleration time.

Output frequency
Overload restriction level
B022 / B025
B022 / B025
Deceleration rate at overload restriction
Maximum frequency
A004
F001
Target frequency
B023 / B026
Deceleration rate at overload restriction
t
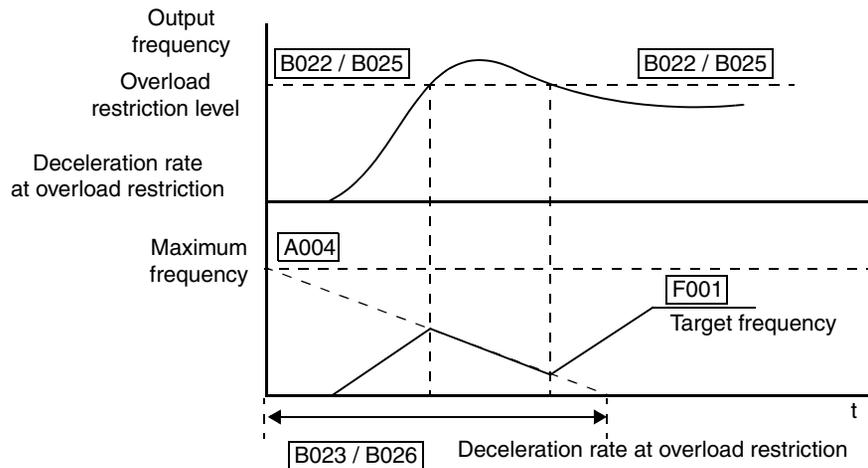
NOTE: The Overload Advance Notice function for intelligent outputs is related to Overload Restriction operation, discussed in "Overload Advance Notice Signal" on page 4–39.

Operations and Monitoring

Run Enable for FW/RV (–xFU2 models only)

The Run Enable for FW/RV input provides a way to enable or disable the [FW] and [RV] input terminals in real time, including a Run command from an operator keypad. This is useful for applications that require a logic type safety interlock for FWD Run or REV Run commands.

The Run Enable for FW/RV function is assigned to an intelligent input terminal using option code 49. When assigned, the output frequency operates as a logical AND of the Run Enable for FW/RV input *and* a [FW], [RV], or keypad Run command input. The Run Enable for RV input is level-sensitive, as shown in the timing diagram below. The leading edges (OFF-to-ON transitions) of the Run Enable for RV input and the [FW] or [RV] input can occur in any order. The output frequency follows the logical AND of these inputs.

Opt. Code	Symbol	Function Name	Input State	Description
49	ROK	Run Enable for FW/RV	ON	[FW] and [RV] inputs and operator Run key press operate normally
			OFF	[FW] and [RV] inputs and operator Run key press are ignored; inverter output remains OFF

Valid for inputs:	C001, C002, C003, C004, C005
Required settings:	(none)

Example (requires input configuration—see page 3–43):

ROK

See I/O specs on page 4–8.

Notes:
- This function is only available on –xFU2 models.
- When the Run Enable for FW/RV function *is not* assigned to any intelligent input terminal, the FWD Run and REV Run commands operate normally (directly control the output frequency).
- To ensure safe inverter operation in networked applications, you cannot change an intelligent terminal assignment to/from [ROK] (option code 49) via the network. However, you can still read an [ROK] input assignment over the network.

Using Intelligent Output Terminals

The intelligent relay terminals are programmable in a similar way to the intelligent input terminals. The inverter has several output functions that you can assign individually to the two intelligent relay outputs. They are normally open (type Form A). In addition to these relay outputs, the alarm relay output (type Form C) has normally open and normally closed contacts. The relay is assigned the alarm function by default, but you can assign it to any of the functions the other two relay outputs can use.
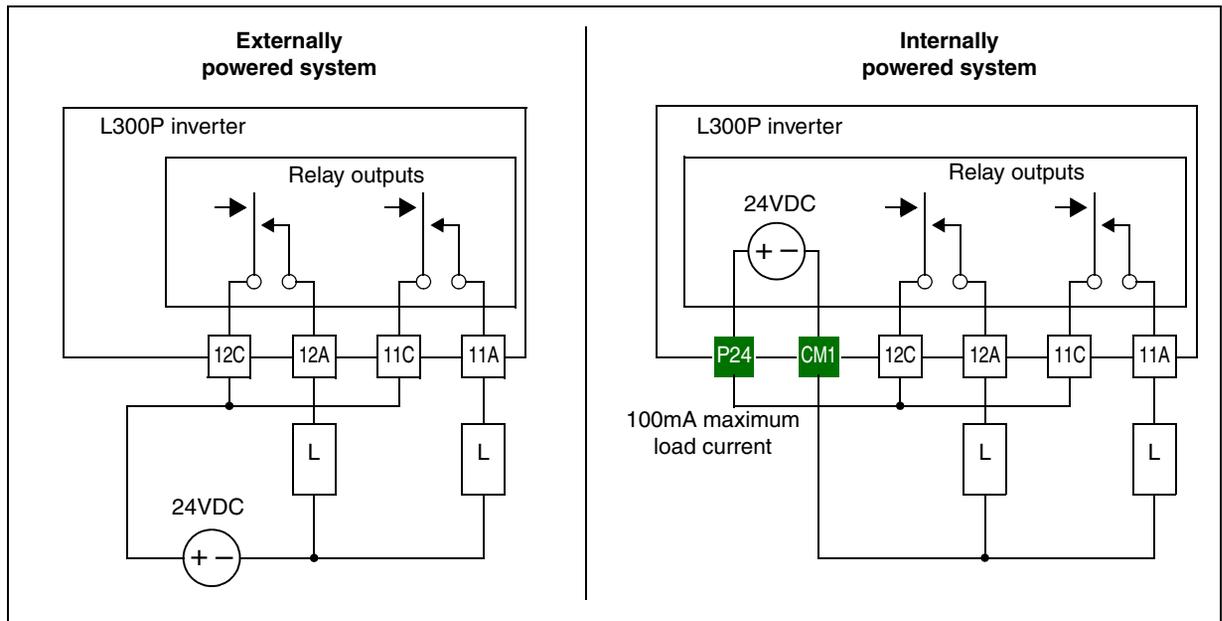
If you use an external supply to power the load(s), the relay contacts can switch up to several amperes. See "Specifications of Control and Logic Connections" on page 4–8 for relay contact ratings.

It is possible to use the inverter's +24VDC supply—however, the total output current available is only 100mA. Note that this includes the loads of relay outputs and all input circuits, if you are powering the inputs from the internal +24VDC supply. If you need more than 100mA, you must use an external supply source.

In the unlikely event you need output current greater than the relay's contact ratings (5A resistive, 1A inductive), use the relay outputs to drive external relays as shown to the right. Be sure to use a diode across the coil of the relay as shown (reverse-biased) in order to suppress the turn-off spike, or use a solid-state relay.
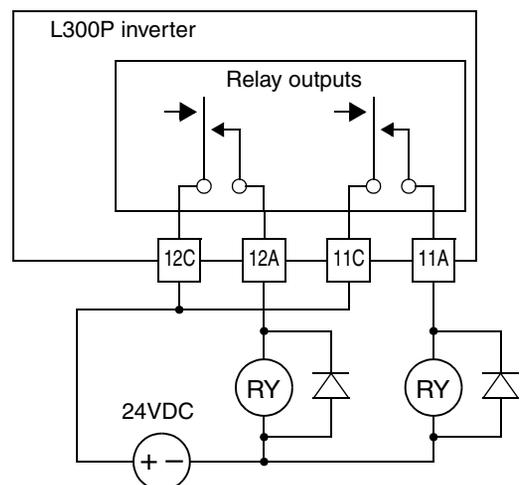
Run Signal

When the [RUN] signal is selected as an intelligent output terminal, the inverter outputs a signal on that terminal when it is in Run Mode. The output logic is active low, and is the open collector type (switch to common).

Opt. Code	Symbol	Function Name	Output State	Description
00	RUN	Run signal	ON	when inverter is in Run Mode
			OFF	when inverter is in Stop Mode

Valid for outputs:	11, 12, AL0 – AL2	Example: (default output configuration shown—see page 3–48):
Required settings:	(none)	Inverter output terminal circuit

Notes:

• The inverter outputs the [RUN] signal whenever the inverter output exceeds the start frequency specified by parameter B082. The start frequency is the initial inverter output frequency when it turns ON.

See I/O specs on page 4–8.

NOTE: The example circuit in the table above drives a relay coil. Note the use of a diode to prevent the negative-going turn-off spike generated by the coil from damaging the inverter's output transistor.

Frequency Arrival Signals

The *Frequency Arrival* group of outputs help coordinate external systems with the current velocity profile of the inverter. As the name implies, output [FA1] turns ON when the output *frequency arrives* at the standard set frequency (parameter F001). Outputs [FA2] through [FA5] provide variations on this function for increased flexibility, relying on two programmable accel/decel thresholds. For example, you can have an output turn ON at one frequency during acceleration, and have it turn OFF at a different frequency during deceleration. All transitions have hysteresis to avoid output chatter if the output frequency is near one of the thresholds.

Opt. Code	Symbol	Function Name	Output State	Description
01	FA1	Frequency arrival type 1 – constant speed	ON	when output to motor is at the standard set frequency F001
			OFF	when output to motor is not at the set frequency F001
02	FA2	Frequency arrival type 2 – over-frequency	ON	when output to motor is at or above the FA threshold 1(C042) during accel
			OFF	when the output to motor is below the FA threshold 1 (C043) during decel
06	FA3	Frequency arrival type 3 – at frequency	ON	when output to motor is at the FA threshold 1 (C042) during accel, or at C043 during decel
			OFF	when the output to motor is not at either the FA threshold 1 (C042) during accel or at C043 during decel

Valid for outputs:	11, 12, AL0 – AL2	Example (requires output configuration—see page 3–48):
Required settings:	F001, for FA1 C042 & C043, for FA2 & FA3	

Notes:

- For most applications you will need to use only one or two of the frequency arrival type outputs (see example). However, it is possible assign all three output terminals to output functions [FA1] through [FA3].
- For each frequency arrival threshold, the output anticipates the threshold (turns ON early) by an amount equal to 1% of the maximum frequency set for the inverter.
- The output turns OFF as the output frequency moves away from the threshold, delayed by an amount equal to 2% of the max. frequency.

Inverter output terminal circuit

See I/O specs on page 4–8.

Frequency arrival output [FA1] uses the standard output frequency (parameter F001) as the threshold for switching. In the figure to the right, the inverter accelerates to the set output frequency, which serves as the threshold for [FA1]. Parameters F_{on} and F_{off} illustrate the hysteresis that prevents output chatter near the threshold value.

- F_{on} is 1% of the max. output frequency
- F_{off} is 2% of the max. output frequency

The hysteresis effect causes the output to turn ON slightly *early* as the speed approaches the threshold. Then the turn-OFF point is slightly *delayed*. The 1% and 2% values also apply to the remaining Frequency arrival outputs, discussed below.

Frequency Arrival outputs [FA2] and [FA4] work the same way; they just use two separate threshold pairs as shown in the figure. These provide for separate acceleration and deceleration thresholds to provide more flexibility than for [FA1]. [FA2] uses C042 and C045 for ON and OFF thresholds, respectively. [FA4] uses C043 and C046 for ON and OFF thresholds, respectively. Having different accel and decel thresholds provides an asymmetrical output function. However, you can use equal ON and OFF thresholds, if desired.

Frequency Arrival outputs [FA3] and [FA5] use the same threshold parameters as [FA2] and [FA4] above, but operate in a slightly different way. Refer to the diagram below. After the frequency arrives at the first threshold during acceleration and turns ON [FA3] or [FA5], they turn OFF again as the output frequency accelerates further. The second thresholds work similarly during deceleration. In this way, we have separate ON/OFF pulses for acceleration and deceleration.
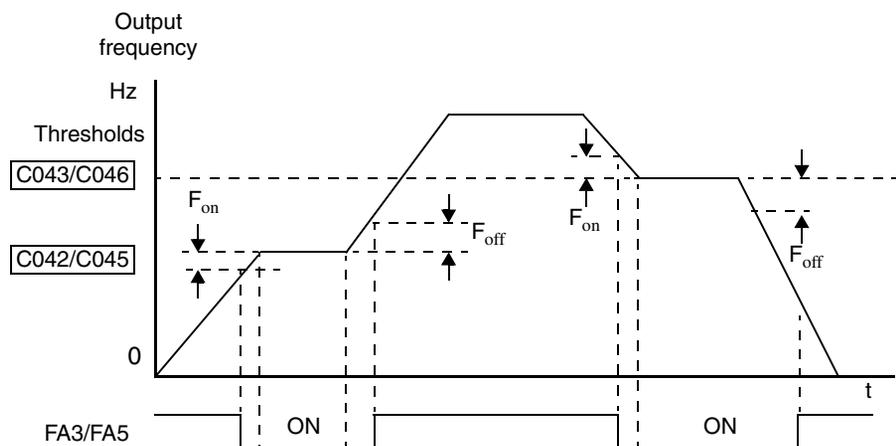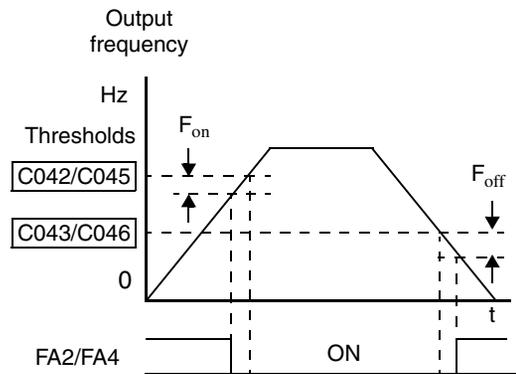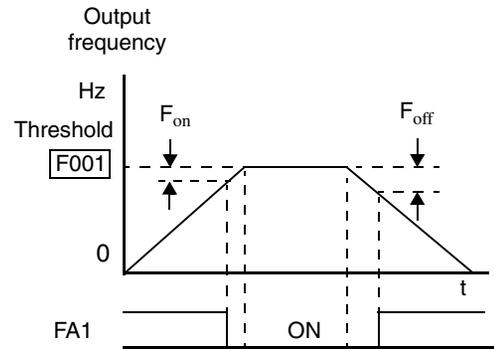
Overload Advance Notice Signal

When the output current exceeds a preset value, the [OL] or [OL2] terminal signal turns ON. The parameter C041 (or C111, respectively) sets the overload threshold. The overload detection circuit operates during powered motor operation and during regenerative braking. The output circuits use open-collector transistors, and are active low.

Opt. Code	Symbol	Function Name	Output State	Description
03	OL	Overload advance notice signal (1)	ON	when output current is more than the set threshold for the overload signal (C041)
			OFF	when output current is less than the set threshold for the overload signal (C041)
Valid for outputs:	11, 12, AL0 – AL2			Example (requires output configuration— see page 3–48):
Required settings:	C041			

Notes:
- The default value is 100%. To change the level from the default, set C041 (overload level).
- The accuracy of this function is the same as the function of the output current monitor on the [FM] terminal (see "Analog Output Operation" on page 4–54).

Inverter output terminal circuit

See I/O specs on page 4–8.

NOTE: The example circuit in the table above drives a relay coil. Note the use of a diode to prevent the negative-going turn-off spike generated by the coil from damaging the inverter's output transistor.

Operations and Monitoring

Output Deviation for PID Control

The PID loop error is defined as the magnitude (absolute value) of the difference between the Setpoint (target value) and the Process Variable (actual value). When the error magnitude exceeds the preset value for C044, the [OD] terminal signal turns ON. Refer to "PID Loop Operation" on page 4–58.

Opt. Code	Symbol	Function Name	Output State	Description
04	OD	Output deviation for PID control	ON	when PID error is more than the set threshold for the deviation signal
			OFF	when PID error is less than the set threshold for the deviation signal

Valid for outputs:	11, 12, AL0 – AL2	Example (requires output configuration—see page 3–48):
Required settings:	C044	

Notes:
- The default deviation value is set to 3%. To change this value, change parameter C044 (deviation level).

See I/O specs on page 4–8.

Operations and Monitoring

NOTE: The example circuit in the table above drives a relay coil. Note the use of a diode to prevent the negative-going turn-off spike generated by the coil from damaging the inverter's output transistor.

Alarm Signal

The inverter alarm signal is active when a fault has occurred and it is in the Trip Mode (refer to the diagram at right). When the fault is cleared the alarm signal becomes inactive.

We must make a distinction between the alarm *signal* AL and the alarm relay *contacts* [AL0], [AL1] and [AL2]. The signal AL is a logic function, which you can assign to the open collector output terminals [11] to [15], or the relay outputs. The most common (and default) use of the relay is for AL, thus the labeling of its terminals. Use an open collector output (terminals [11] to [15]) for a low-current logic signal interface or to energize a small relay (50 mA maximum). Use the relay output to interface to higher voltage and current devices (10 mA minimum).

Alarm signal active

Opt. Code	Symbol	Function Name	Output State	Description
05	AL	Alarm signal	ON	when an alarm has occurred and has not been cleared
			OFF	when no alarm has occurred since the last clearing of alarm(s)

Valid for outputs:	11, 12, AL0 – AL2
Required settings:	C026, C036

Notes:

- When the alarm output is set to normally closed, a time delay of less than 2 seconds occurs until the contact is closed when the power is turned ON.
- Terminals [11] – [15] are open collector outputs, so the electrical specifications of [AL] are different from the contact output terminals [AL0], [AL1], [AL2].
- When the inverter power supply is turned OFF, the alarm signal output is valid as long as the external control circuit has power.
- This signal output has the delay time (300ms nominal) from the fault alarm output.
- The relay contact specifications are in "Specifications of Control and Logic Connections" on page 4–8. The contact diagrams for different conditions are on the next page.

Example for terminals [11C]—[11A] or [12C]—[12A] (requires output configuration—see page 3–48):

Inverter output terminal circuit

Example for terminals [AL0], [AL1], [AL2] (default output configuration shown—see page 3–48):

Inverter output terminal circuit

Relay position shown during normal running (no alarm)

See I/O specs on page 4–8.

Operations and Monitoring

The alarm output terminals operate as shown below (left) by default. The contact logic can be inverted as shown (below right) by using the parameter setting C036. The relay contacts normally open (N.O.) and normally closed (N.O.) convention uses "normal" to mean the inverter has power and is in Run or Stop Mode. The relay contacts switch to the opposite position when it is in Trip Mode or when input power is OFF.

N.C. contacts (after initialization)		N.O. contact (inverted by C036 setting)	
During normal running	When an alarm occurs or power is turned OFF	During normal running or power is turned OFF	When an alarm occurs
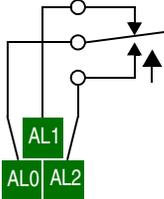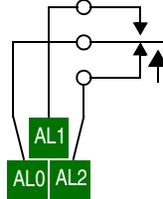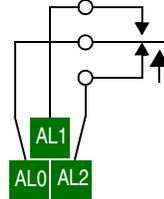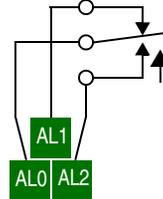
Contact	Power	Run State	AL0-AL1	AL0-AL2
N.C. (after initialize, C036=01)	ON	Normal	Closed	Open
	ON	Trip	Open	Closed
	OFF	–	Open	Closed

Contact	Power	Run State	AL0-AL1	AL0-AL2
N.O. (set C036=00)	ON	Normal	Open	Closed
	ON	Trip	Closed	Open
	OFF	–	Open	Closed

Operations
and Monitoring

Instantaneous Power Failure / Under-voltage Signal

An instantaneous power failure (complete loss) or under-voltage condition (partial loss) of inverter input voltage can occur without warning. L300P Series inverters can be configured to respond to these conditions in different ways. You can select whether the inverter trips or retries (restart attempt) when an instantaneous power failure or under-voltage condition occurs. You can select the retry function with parameter B001.

When enabled, the Retry Function operates in the following ways:

- **Under-voltage conditions** – When an instantaneous power failure or under-voltage condition occurs, the inverter will attempt to restart up to 16 times. A trip condition will occur on the 17th attempt, which must be cleared with the Stop/Reset key.

- **Over-current/voltage conditions** – When retry function is selected and an over-current or an over-voltage condition occurs, a restart is attempted 3 times. A trip will occur on the 4th failed restart attempt. Use parameter B004 to select the trip and alarm response to instantaneous power failure and under-voltage conditions. The following table shows the related parameters to these power fault conditions, and timing diagrams are on the next page.

Code	Function	Data or Range	Description
B001	Selection of automatic restart mode	00	Alarm output after trip, automatic restart disabled
		01	Restart at 0 Hz
		02	Retry with frequency matching to present motor speed
		03	Retry with frequency matching followed by deceleration to stop— then trip alarm
B002	Allowable under-voltage power failure time	0.3 to 1.0 sec.	The amount of time a power input under-voltage can occur without tripping the power failure alarm. If under-voltage exists longer than this time, the inverter trips, even if the restart mode is selected. If it exists less than this time retry will be attempted.
B003	Retry wait time before motor restart	0.3 to 100 sec.	Time delay after a trip condition goes away before the inverter restarts the motor
B004	Instantaneous power failure / voltage trip alarm enable	00	Disable
		01	Enable
		02	Disable during stop and ramp to stop
B005	Number of restarts on power failure / under-voltage trip events	00	Restart up to 16 times on instantaneous power failure or under-voltage
		01	Always restart on instantaneous power failure or an under-voltage condition
B007	Restart frequency threshold	0.00 to 400.0 Hz	When frequency of the motor is less than this value, the inverter will restart at 0 Hz

Operations
and Monitoring

Opt. Code	Symbol	Function Name	Output State	Description
08	IP	Instantaneous Power Failure	ON	when the inverter detects a loss of input power
			OFF	when the inverter has input power
09	UV	Under-voltage condition	ON	when the inverter input power is less than the specified input range
			OFF	when the inverter input power is within the voltage specification

Valid for outputs:	11, 12, AL0 – AL2	Example (requires output configuration—see page 3–48):
Required settings:	B001, B002, B003, B004, B005, B007	

Notes:

- If an over-voltage or over-current trip occurs during the deceleration and an instantaneous power failure error (E16) is displayed the inverter goes into free-run stop. In this case make the deceleration time longer.
- When connecting control power supply terminal [Ro]-[To] to the DC bus [P]-[N], an under-voltage may be detected at power-off and cause a trip. If this is undesirable, set B004 to 00 or 02.
- Frequency matching: The inverter reads the motor RPM and direction. If this speed is higher than the matching setting (B007), the inverter waits until they are equal and then engages the output to drive the motor (example 3). If the actual motor speed is less than the restart frequency setting, the inverter waits for t_2 (value in B003) and restarts from 0 Hz (example 4). The display shows "*0000*" during an actual frequency matching event.

Inverter output terminal circuit

UV   IP

| 12C | 12A | 11C | 11A |

24VDC
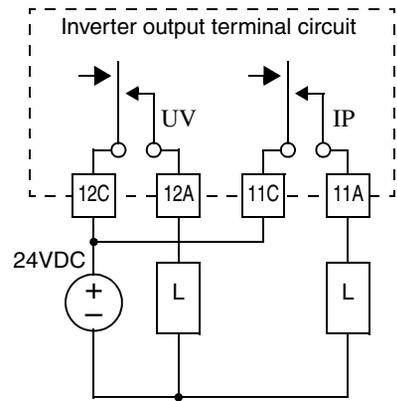
See I/O specs on page 4–8.

In the following examples, t_0 = instantaneous power failure time, t_1 = allowable under-voltage / power failure time (B002), and t_2 = retry wait time (B003).

Example 1: Power failure within allowed limits; resume

Power supply

Inverter output

Free-run

Motor frequency

t_0 t_2 t

t_1
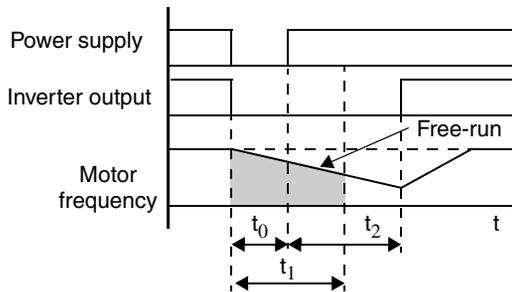
After waiting for t_2 seconds when $t_0 < t_1$; restart

Example 2: Power failure longer than limits; trip

Power supply

Inverter output

Free-run

Motor frequency

t_0 t

t_1
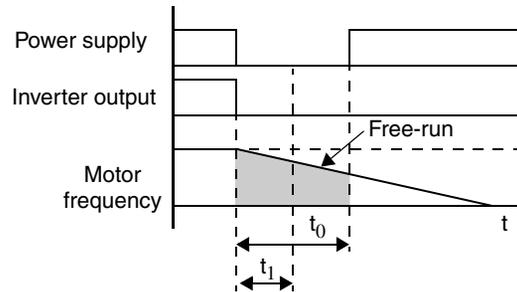
Inverter trips when $t_0 > t_1$

Examples 3 and 4 relate to configuring the inverter to retry upon power failure. Frequency matching is possible if the inverter frequency is greater than the B007 value.

Example 3: Motor resumes via frequency-matching

Power supply

Inverter output

Free-run

Motor frequency

B007

t_0 | t_2 | t

Frequency matching
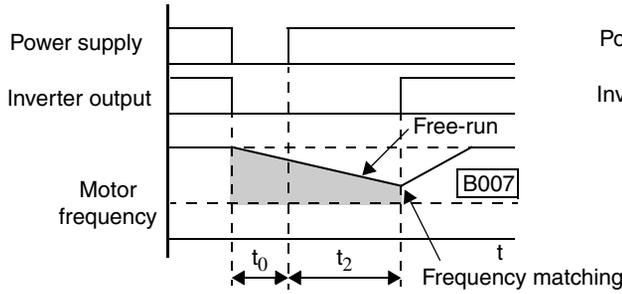
Motor frequency > B007 value at t_2

Example 4: Motor restarts from 0Hz

Power supply

Inverter output

Free-run

Motor frequency

B007

t_0 | t_2 | t

0Hz restart
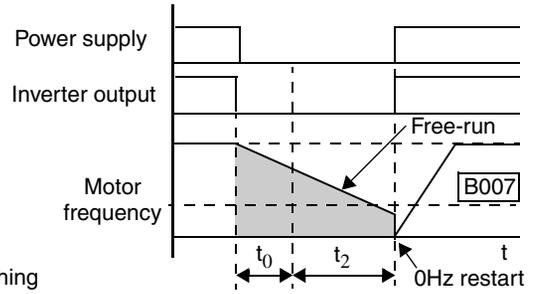
Motor frequency < B007 value at t_2

The Instantaneous Power Failure and Alarm output responses during various power loss conditions are shown in the diagram below. Use B004 to enable/disable the alarm output when instantaneous power failure or under-voltage occurs. The alarm output will continue while the control power of the inverter is present, even if the motor is stopped. Examples 5 to 7 correspond to normal wiring of the inverter's control circuit. Examples 8 to 10 correspond to the wiring of the inverter's control circuit for alarm output after power loss (see).

Instantaneous power failure operation with standard R0–T0 connections
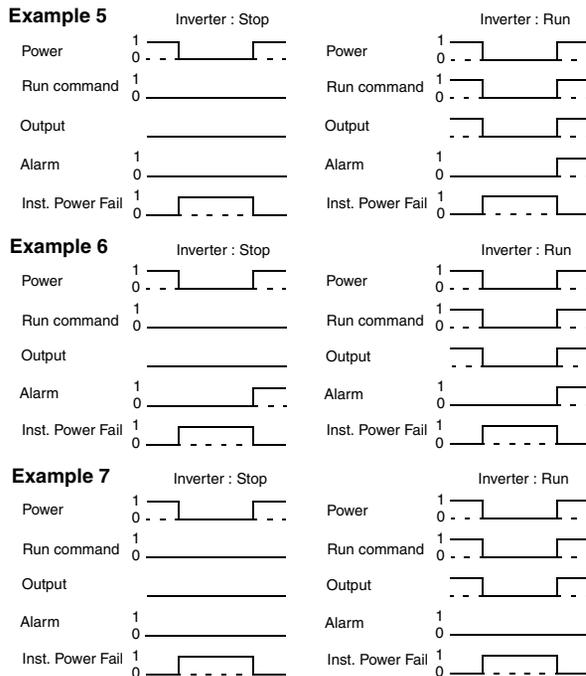
Instantaneous power failure operation with R0–T0 connected to P–N

Example 5 Inverter : Stop / Inverter : Run
Power / Run command / Output / Alarm / Inst. Power Fail

Example 6 Inverter : Stop / Inverter : Run
Power / Run command / Output / Alarm / Inst. Power Fail

Example 7 Inverter : Stop / Inverter : Run
Power / Run command / Output / Alarm / Inst. Power Fail

Example 8 Inverter : Stop / Inverter : Run
Power / Run command / Output / Alarm / Inst. Power Fail

Example 9 Inverter : Stop / Inverter : Run
Power / Run command / Output / Alarm (under-voltage) / Inst. Power Fail

Example 10 Inverter : Stop / Inverter : Run
Power / Run command / Output / Alarm / Inst. Power Fail

Operations and Monitoring

Run Time / Power-On Time Over Signals

L300P Series inverters accumulate the total hours in Run Mode (run time) and the total hours of power-ON time. You can set thresholds for these accumulating timers. Once the threshold is exceeded, an output terminal will turn ON. One use of this is for preventative maintenance. A signal light or audible alert could signal the need for servicing, calibration, etc.

Opt. Code	Symbol	Function Name	Output State	Description
11	RNT	Run Time Over	ON	when the accumulated time spent in Run Mode exceeds the limit (B034)
			OFF	when the accumulated time in Run Mode is still less than the limit (B034)
12	ONT	Power-ON Time Over	ON	when the accumulated power-ON time exceeds the limit (B034)
			OFF	when the accumulated power-ON time is less than the limit (B034)
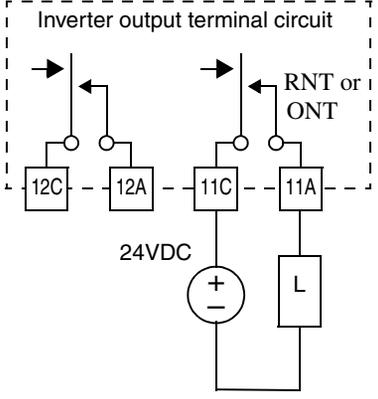
Valid for outputs:	11, 12, AL0 – AL2	Example (requires output configuration— see page 3–48):
Required settings:	B034	

Notes:
- The two outputs [RNT] and [ONT] share the same time threshold parameter, B040. Typically, you will use either the [RNT] or the [ONT] output only—not both at once.
- These outputs are useful for the notification that a preventative maintenance interval has expired.

Inverter output terminal circuit

RNT or ONT

12C — 12A — 11C — 11A

24VDC

+ −   L

See I/O specs on page 4–8.

Thermal Warning Signal

The purpose of the electronic thermal setting is to protect the motor from overloading, overheating and being damaged. The setting is based on the rated motor current. The inverter calculates the thermal rise (heating) of the motor using the current output to the motor squared, integrated over the time spent at those levels. This feature allows the motor to draw excessive current for relatively short periods of time, allowing time for cooling.

The Thermal Warning output [THM] turns ON to provide a warning before the inverter trips for electronic thermal protection. You can set a unique thermal protection level for each of the three motor profiles, as shown in the table below.

Function Code	Function/Description	Data or Range
B012 / B212	Electronic thermal setting (calculated within the inverter from current output)	Range is 0.2 * rated current to 1.2 * rated current

For example, suppose you have inverter model L300P-110LFU2. The rated motor current is 44A. The setting range is (0.2 * 44) to (1.2 *44), or 8.8A to 52.8A. For a setting of B012=44A (current at 100%), the figure to the right shows the curve.

The electronic thermal characteristic adjusts the way the inverter calculates thermal heating, based on the type of torque control the inverter uses.
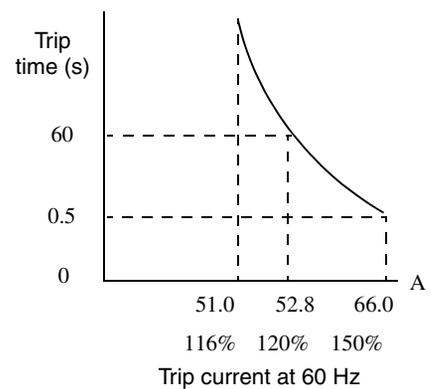
CAUTION: When the motor runs at lower speeds, the cooling effect of the motor's internal fan decreases.

Trip current at 60 Hz

The table below shows the settings and their meanings. Use the one that matches your load.

Function Code	Data	Function/Description
B013 / B213	00	Reduced torque
	01	Constant torque
	02	Free-setting

Reduced Torque Characteristic – The left graph below shows the effect of the reduced torque characteristic curve. For example, at 20Hz, the output current level to cause overheating in a fixed time period is reduced by a factor of 0.8. The right graph below shows the reduced trip current levels in those conditions for given trip times.

Reduced trip current at 20 Hz

Constant Torque Characteristic – The left graph below shows the effect of the constant torque characteristic curve. For example, at 2.5Hz, the output current level to cause overheating in a fixed time period is reduced by a factor of 0.9. The right graph below shows the reduced trip current levels in those conditions for given trip times.

Reduced trip current at 2.5 Hz

Free Thermal Characteristic - It is possible to set the electronic thermal characteristic using a free-form curve defined by three data points, according to the table below.

Function Code	Name	Description	Range
B015 / B017 / B019	Free-setting electronic thermal frequency 1, 2, 3	Data point coordinates for Hz axis (horizontal) in the free-form curve	0 to 400Hz
B016 / B018 / B020	Free setting electronic thermal current 1, 2, 3	Data point coordinates for Ampere axis (vertical) in the free-form curve	0.0 = (disable) 0.1 to 1000.

The left graph below shows the region for possible free-setting curves. The right graph below shows an example curve defined by three data points specified by B015 – B020.

Suppose the electronic thermal setting (B012) is set to 44 Amperes. The graph below shows the effect of the free setting torque characteristic curve. For example, at (B017) Hz, the output current level to cause overheating in a fixed time period is reduced to (B018) A. Points (x), (y), and (z) show the adjusted trip current levels in those conditions for given trip times.

(x) = B018 value x 116%
(y) = B018 value x 120%
(z) = B018 value x 150%

Reduced trip current at (B017) Hz
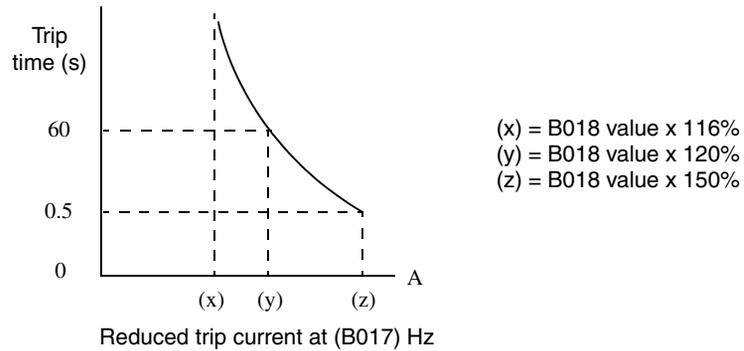
Thermal Warning Output – Using parameter C061, you can set the threshold from 0 to 100% of trip level for turning ON the intelligent output [THM] at that level. In this way, the inverter provides an early warning before the electronic thermal overload trips and turns OFF the output to the motor.

Opt. Code	Symbol	Function Name	Output State	Description
13	THM	Thermal Warning	ON	when the electronic thermal calculation exceeds the set limit
			OFF	when the electronic thermal calculation is less than the set limit

Valid for outputs:	11, 12, AL0 – AL2	Example (requires output configuration—see page 3–48):
Required settings:	C061	

Notes:
- The electronic thermal overload function uses the output current and time to calculate thermal heating of the motor.
- The thermistor input of the inverter is a separate function from the electronic thermal function. You can set a threshold for it to cause a trip alarm at a particular thermistor resistance.

See I/O specs on page 4–8.

Run Command Source Monitor (–xFU2 models only)

The Run Command Source Monitor intelligent output provides a way to monitor the present setting for the Run Command Source Setting parameter (A002). Some applications use devices external to the inverter, such as intelligent keypads or network control hosts, which can change the A002 parameter setting at various times in normal operation. In the control environment of the inverter, a Hand/Auto or Manual/Auto mode change requires writing a new A002 setting. So, the intelligent output Run Command Source Monitor provides a way for external devices to know whether the inverter's Run command source is the operator keypad (A002=02), or some other source (A002=01, 03, 04, or 05).

Opt. Code	Symbol	Function Name	Output State	Description
27	RMD	Run command source monitor	ON	when the Run command source is the operator keypad (A002=02)
			OFF	when the Run command source *is not* the operator keypad (A002=01, 03, 04, or 05)

Valid for outputs:	11, 12, AL0 – AL2
Required settings:	A002

Example (requires output configuration—see page 3–48):

Inverter output terminal circuit

RMD

12C — 12A — 11C — 11A

24VDC

See I/O specs on page 4–8.

Notes:
- This function is available only on –xFU2 models.
- The Run Command Source Monitor output can serve as a Hand/Auto or Manual/Auto input to a building automation system.
- To ensure safe inverter operation in networked applications, you cannot change an intelligent terminal assignment to/from [RMD] (option code 27) via the network. However, you can still read an [RMD] output assignment over the network.

Analog Input Operation

Input Terminal Signals

The L300P inverters provide for an external analog input to command the inverter frequency output value. The analog input terminal group includes the [L], [OI], [O], [O2], and [H] terminals on the control connector, which provide for Voltage [O] and [O2] or Current [OI] input. All analog input signals must use the analog ground [L].

If you use either the voltage or current analog input, you must select one of them using the logic input terminal function [AT] analog type. If terminal [AT] is OFF, the voltage input [O] can command the inverter output frequency. If terminal [AT] is ON, the current input [OI] can command the inverter output frequency. The [AT] terminal function is covered in . Remember that you must also set A001 = 01 to select analog input as the frequency source.
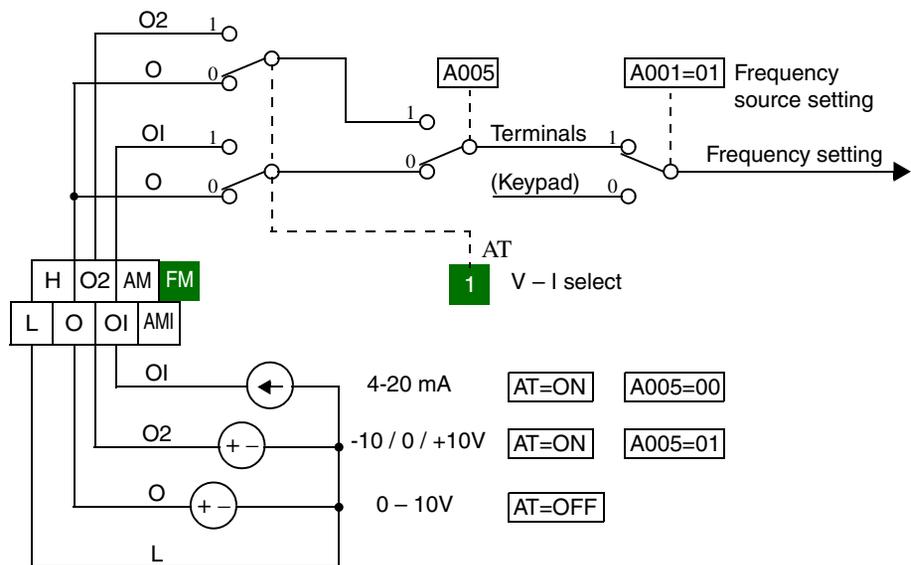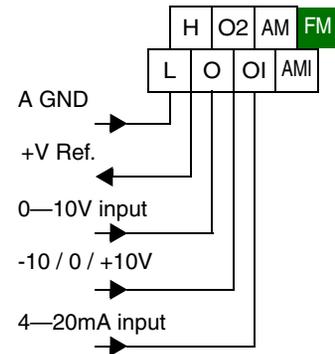
Input Filter

Parameter A016 adjusts an analog input sampling filter that evenly affects all analog inputs shown above. The parameter range is from 1 to 30. Before increasing the filter setting, we recommend trying to find the cause of input analog noise. Check for the following:

• Look for nearby high-current wiring— avoid any parallel runs to the analog signal wires

• Check the impedance between the chassis grounds of the inverter and the analog signal source equipment—a good connection will have a low impedance

• Check the analog signal ground impedance from the inverter to the analog signal source

• Avoid ground loops... measure the current (or voltage drop) on the chassis ground and signal ground connections; the ideal value is zero

After taking steps to minimize the analog signal noise sources, increase the filter time constant (A016) until the motor output frequency (when commanded by analog inputs) becomes stable.

Operations and Monitoring

The following tables show the available analog input settings. Parameters A006, A005, and input terminal [AT] determine the External Frequency Command input terminals that are available and how they function. The Trim Frequency input [O2]—[L] is available (when check marked) for some settings. Other settings make the reverse direction (in addition to forward) available for bipolar input settings (when check marked). A bipolar input responds to positive input voltages with a forward motor rotation, and to negative input voltages with reverse motor rotation.

A006	A005	[AT]	External Frequency Command Input	Trim Frequency Command Input	Reverse avail. (bipolar input)
00	00	OFF	[O]	✘	✘
		ON	[OI]	✘	✘
	01	OFF	[O]	✘	✘
		ON	[O2]	✘	✔
01	00 Example 1	OFF	[O]	[O2]	✘
		ON	[OI]	[O2]	✘
	01	OFF	[O]	[O2]	✘
		ON	[O2]	✘	✔
02	00 Example 2	OFF	[O]	[O2]	✔
		ON	[OI]	[O2]	✔
	01	OFF	[O]	[O2]	✔
		ON	[O2]	✘	✔

The table below applies when the [AT] input function is not assigned to *any* intelligent input terminal. The A005 setting, normally used in conjunction with an [AT] input, is ignored.

A006	A005	[AT]	External Frequency Command Input	Trim Frequency Command Input	Reverse avail. (bipolar input)
00	—	(not assigned to any input terminal)	[O2]	✘	✔
01	—		Summation of [O] and [OI]	[O2]	✘
02	—		Summation of [O] and [OI]	[O2]	✔

CAUTION: Whenever the [AT] input function is *not* assigned to any input terminal and reverse rotation is not desired or is unsafe, be sure to set A006 = 01. This setting makes the [O2] input unipolar only.

The examples below show how the use of the [AT] input during operation enables/disables the Trim Frequency Command input [O2]—[L]. The [O2]—[L] input may be used alone, or as an offset control for the primary analog input.

Example 1: Without reverse

[FW] terminal

[AT] terminal

External frequency command [O/OI] terminal 0

F_{OI}
F_O

Trim frequency command [O2] terminal 0

F_{O2}

Actual frequency 0 command

$F_O + F_{O2}$ $F_{OI} + F_{O2}$

Example 2: With reverse

[FW] terminal

[AT] terminal

External frequency command [O/OI] terminal 0

F_{OI}
F_O

Trim frequency command [O2] terminal 0

F_{O2}

Actual frequency 0 command

forward
reverse

$F_O + F_{O2}$ $F_{OI} + F_{O2}$

Wiring Examples

Using an external potentiometer is a common way to control the inverter output frequency (and a good way to learn how to use the analog inputs). The potentiometer uses the built-in 10V reference [H] and the analog ground [L] for excitation, and the voltage input [O] for the signal. By default, the [AT] terminal selects the voltage input when it is OFF. Take care to use the proper resistance for the potentiometer, which is 1 to 2kΩ, 2 Watts.

1 to 2 kΩ, 2W
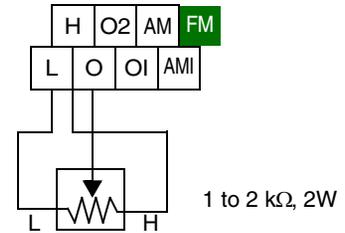
Voltage Input – The 0–10V voltage input circuit uses terminals [L] and [O]. Attach the signal cable's shield wire to terminal [L] on the inverter only. DO NOT ground the shield at its other end. Maintain the voltage within specifications (do not apply negative voltage). Normally a full-span input level (10V) will give the maximum motor frequency. You can use parameter A014 to select a lower voltage for full output frequency (such as using a 5V input signal).

Bipolar Voltage Input – The -10 / 0 / +10V voltage input circuit uses terminals [L] and [O2]. Attach the cable's shield wire to terminal [L] on the inverter only. Maintain the voltage within specifications. Only apply a negative voltage if this input is configured for bipolar use.

Current Input – The current input circuit uses terminals [OI] and [L]. The current comes from a *sourcing* type transmitter; a *sinking* type will not work! This means the current must flow into terminal [OI], and terminal [L] is the return back to the transmitter. The input impedance from [OI] to [L] is 250 Ohms. Attach the cable's shield wire to terminal [L] on the inverter only.

Standard Voltage Input

0 to 9.6 VDC,
0 to 10V nominal

Bipolar Voltage Input

-10 to 9.6 VDC,
0 to 10V nominal

Current Input

4 to 19.6 mA DC,
4 to 20 mA nominal
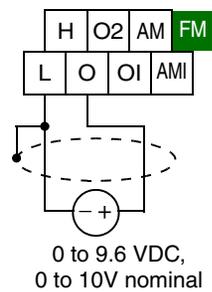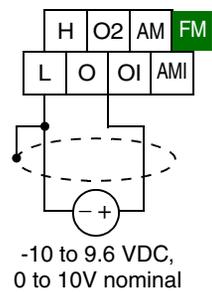
See I/O specs on page 4–8.
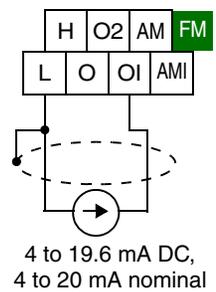
Operations
and Monitoring

Analog Output Operation

In the system design for inverter applications it is sometimes useful to monitor inverter operation from a remote location. In some cases, this requires only a panel-mounted analog meter (moving-coil type). In other cases, a controller device such as a PLC may monitor and command the inverter frequency and other functions. The inverter can transmit the (real-time) output frequency, current, or other parameters to the controller to confirm actual operation. The monitor output terminal [FM] serves these purposes.

[FM] Terminal

The inverter provides an analog/digital output on terminal [FM] (frequency monitor). It uses terminal [CM1] as digital GND reference. While many applications use this terminal to monitor the output frequency, you can configure terminal [FM] to transmit one of several parameters. Most use *pulse-width modulation* (PWM) to represent the value, while one parameter uses *frequency modulation* (FM) to represent the value. Do not confuse the notation for terminal [FM] (with brackets) with FM signal type.

H	O2	AM	FM	TH	FW
L	O	OI	AMI	P24	PLC	CM1

Analog/digital Output

D GND
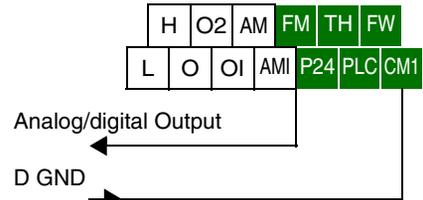
See I/O specs on page <u>4–8</u>.

The following table lists the configurations for terminal [FM]. Use function C027 to configure.

Func.	Code	Description	Waveform	Full Scale Value
C027	00	Output frequency	PWM	0 – Max. frequency (Hz)
	01	Output current	PWM	0 – 200%
	03	Output frequency	FM	0 – Max. frequency (Hz)
	04	Output voltage	PWM	0 – 100%
	05	Input electric power	PWM	0 – 200%
	06	Thermal load ratio	PWM	0 – 100%
	07	LAD frequency	PWM	0 – Max. frequency (Hz)

PWM Signal Type

The *pulse-width modulated* signal at terminal [FM] is primarily designed for driving a moving-coil meter. The pulse-width modulated signal is automatically averaged by the inertia of the moving-coil mechanism—converting the PWM signal to an analog representation. Be sure to use a 10V full-scale DC voltmeter.

H	O2	AM	FM	TH	FW
L	O	OI	AMI	P24	PLC	CM1

+   −

0 to 10V,
1 mA
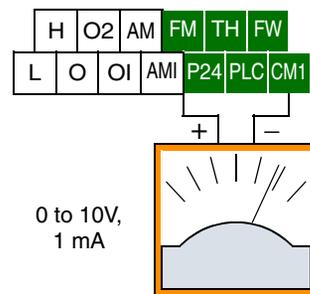
The signal characteristics of terminal [FM] in PWM signal configuration is shown below

[FM]

10V

0 V

t

T

time

Period T = 6.4ms constant (156 Hz)
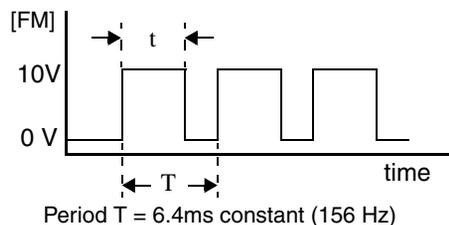
$$[FM] \text{ output value } = \frac{t}{T}$$

$\boxed{B081}$ = [FM] terminal 8-bit gain setting

$\boxed{C27=00, 01, 04, 05, 06, 07}$
Selects FM type output

To calibrate the meter reading, generate a full-scale output (always ON) at terminal [FM]. Then use parameter B081(gain setting from 0 to 255) to adjust the corresponding full-scale reading of the meter. For example, when the inverter output frequency is 60 Hz, change the value of B081 so that the meter reads 60 Hz.

TIP: When using the analog meter for monitoring, adjust the meter so it has a zero reading when the [FM] output is zero. Then use scale factor B081 to adjust the [FM] output so the maximum frequency in the inverter corresponds to a full-scale reading on the meter.

NOTE: The indicator accuracy after adjustment is about ±5%. Depending on the motor, the accuracy may exceed this value.

PWM Smoothing Circuit – Note that standard analog output signals are available on terminals [AM] and [AMI], covered in the next section. However, you may also wish to smooth the PWM signal at the [FM] terminal and convert it to an analog signal. The [FM] terminal will then generate a relatively stable DC analog voltage that represents the output value. To do this, use the circuit shown to the right. Note the output impedance of the circuit is at least 82kΩ, so the monitoring device needs an input impedance of 1MΩ or greater. Otherwise, the impedance of the smoothing circuit will cause a non-linearity in the reading.
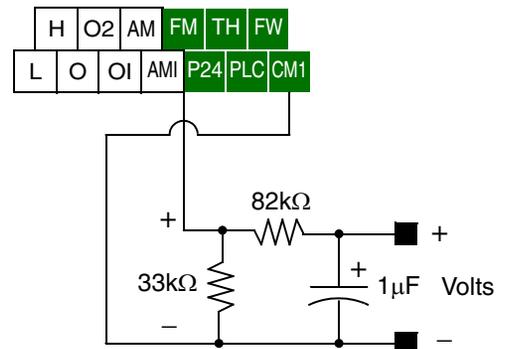
FM Signal Type

The *frequency-modulated* output at terminal [FM] varies its frequency with the inverter output frequency (C027=03). The multiplier is 10, such that the maximum [FM] signal frequency is 10 x 400 = 4 kHz, or 10 times the inverter's maximum output frequency. The signal at [FM] uses the parameter A004 *Maximum frequency setting*. For example, if A004 = 60 Hz, then the maximum signal value at [FM] will be 10 x 60 = 600 Hz. This frequency is digitally controlled for accuracy, and does not use the B081 gain setting when C027=03 (frequency modulation).
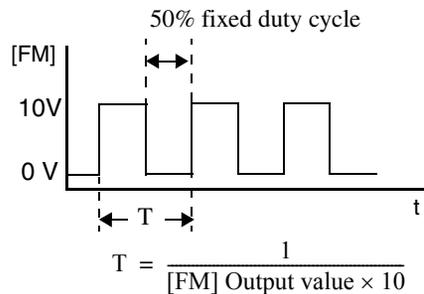
$$[FM] \text{ Output value} = \frac{1}{T \times 10}$$

C027=03 Selects FM type output

$$T = \frac{1}{[FM] \text{ Output value} \times 10}$$

[AM] and [AMI] Terminals

The [AM] and [AMI] terminals provide signals to monitor various inverter parameters such as output frequency, output current, and output voltage. The terminals provide these analog signal types:

- [AM] terminal: 0–10V analog output signal
- [AMI] terminal: 4–20mA analog output signal

These signals both use the [L] terminal for signal return. Six different inverter parameters may be monitored independently at either the [AM] or [AMI] terminal, as listed in the table below. Use C028 to configure terminal [AM], and C029 to configure terminal [AMI].

| H | O2 | AM | FM |
| L | O | OI | AMI |

A GND

0–10V analog output

4–20mA analog output
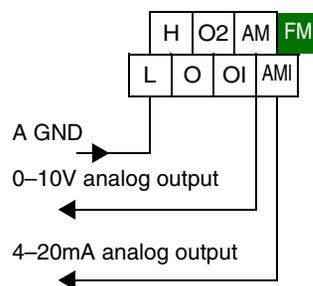
See I/O specs on page 4–8

Func.	Terminal	Code	Description	Full Scale Value
C028 / C029	[AM] / [AMI]	00	Output frequency	0 – Max. frequency (Hz)
		01	Output current	0 – 200%
		04	Output voltage	0 – 100%
		05	Input electric power	0 – 200%
		06	Thermal load ratio	0 – 100%
		07	LAD frequency	0 – Max. frequency (Hz)

The analog signals may need some adjustment for gain or offset to compensate for variances in the system. For example, the signals may drive a panel meter and require a full-scale gain adjustment. The table below lists the function codes and their descriptions. The [AM] and [AMI] terminals have separate gain and offset adjustments. Note the default values.

Func.	Terminal	Description	Range	Default
B080	[AM]	Gain adjustment	0 – 255	180
C086	[AM]	Offset Adjustment	0.0 – 10.0V	0.0V
C087	[AMI]	Gain adjustment	0 – 255	80
C088	[AMI]	Offset Adjustment	0.0 – 20.0mA	0.0mA

Setting Motor Constants

Introduction
The inverter has two separate motor constant sets named *1st*, and *2nd*. The 1st motor constant set is the default, while the SET intelligent input selects the 2nd motor constant set. The following table lists the V/f characteristic control methods:

V/f Characteristic Control Method	1st motor	2nd motor
V/f constant torque	✔	✔
V/f variable torque	✔	✔
V/f free-setting curve	✔	✔

The following table lists the parameters associated with motor constant settings. Set each constant according the motor type in the application. When connecting more than one motor (in parallel) to the inverter, set the constant values that are closest to the total capacity of the combined motors.

Func.	Name	Data	Notes
A044 / A244	V/f characteristic curve selection, 1st / 2nd motors	00	V/f constant torque
		01	V/f variable torque
		02	V/f free-setting curve
H003	Motor capacity, 1st motor	0.2 – 75	Units: kW
H203	Motor capacity, 2nd motor	0.2 – 75	Units: kW
H004	Motor poles setting, 1st motor	2 / 4 / 6 / 8	Units: poles
H204	Motor poles setting, 2nd motor	2 / 4 / 6 / 8	Units: poles
H006	Motor stabilization constant, 1st motor	100	—
H206	Motor stabilization constant, 2nd motor	100	—

Adjusting Motor Stability
Observe the motor for instability, particularly when it is rotating at constant speed. A common symptom of instability, sometimes called "hunting," is marked by a "rattling" sound in the motor. To correct the instability, you can adjust some of the parameters listed above.

- Check the motor capacity (H003 / H203), and ensure it matches the capacity of your motor.
- Check the motor poles setting (H004 / H204), and ensure it matches your motor.
- If you are using a stabilization constant (H006 / H206) that is lower than the default setting, trying raising it gradually up to the default value.
- If the motor you are using is greater than the rated capacity of the inverter, lower the value of H006 / H206.
- If instability persists after you have checked the items above, try the procedures in the table below. As soon as adjusting a parameter seems to produce stability, don't change the parameter further. If adjusting a parameter has no effect, restore it to its original (or default) value.

| Func.	Name	Data Range	Procedure
A045	Output gain	20 – 100	Lower this value
B083	Carrier frequency	0.5 – 8.0	Lower this value
H006 / H206	Motor stabilization constant	0 – 255	Lower or raise this value

PID Loop Operation

In standard operation, the inverter uses a reference source selected by parameter A001 for the output frequency, which may be a fixed value (F001), a variable set by the front panel potenti-ometer, or value from an analog input (voltage or current). To enable PID operation, set A071 = 01. This causes the inverter to *calculate* the target frequency, or setpoint. An optional intelligent input assignment (code 23), PID Disable, will temporarily disable PID operation when active.

A calculated target frequency can have a lot of advantages. It lets the inverter adjust the motor speed to optimize some other process variable of interest, potentially saving energy as well. Refer to the figure below. The motor acts upon the external process. To control that external process, the inverter must monitor the process variable. This requires wiring a sensor to either the analog input terminal [O] (voltage) or terminal [OI] (current).
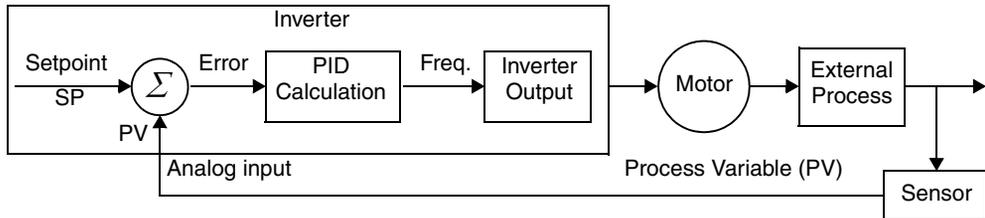
When enabled, the PID loop calculates the ideal output frequency to minimize the loop error. This means we no longer command the inverter to run at a particular frequency, but we specify the ideal value for the process variable. That ideal value is called the *setpoint*, and is specified in the units of the external process variable. For a pump application it may be gallons/minute, or it could be air velocity or temperature for an HVAC unit. Parameter A075 is a scale factor that relates the external process variable units to motor frequency. The figure below is a more detailed diagram of the PID function.

Operations and Monitoring
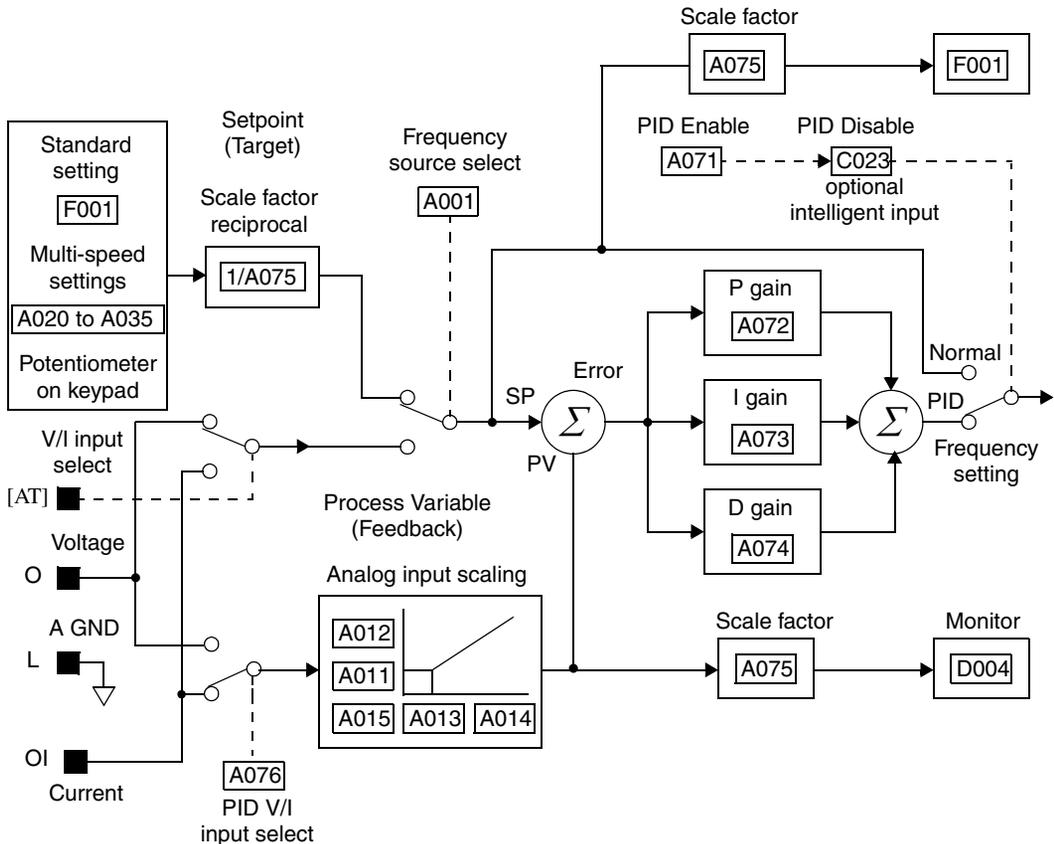
Configuring the Inverter for Multiple Motors

Simultaneous Connections

For some applications, you may need to connect two or more motors (wired in parallel) to a single inverter's output. For example, this is common in conveyor applications where two separate conveyors need to have approximately the same speed. The use of two motors may be less expensive than making the mechanical link for one motor to drive multiple conveyors.

Some of the requirements when using multiple motors with one drive are:

- The inverter output must be rated to handle the sum of the currents from the motors.

- You must use separate thermal protection switches or devices to protect each motor. Locate the device for each motor inside the motor housing or as close to it as possible.

- The wiring for the motors must be permanently connected in parallel (do not remove one motor from the circuit during operation).
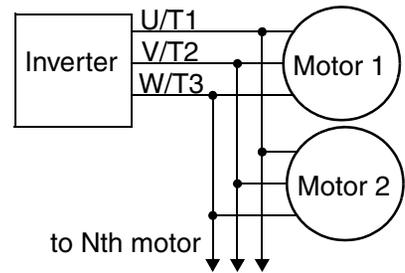
NOTE: The motor speeds are identical only in theory. That is because slight differences in their loads will cause one motor to slip a little more than another, even if the motors are identical. Therefore, do not use this technique for multi-axis machinery that must maintain a fixed position reference between its axes.

Inverter Configuration for Multiple Motor Types

Some equipment manufacturers may have a single type of machine that has to support three different motor types—and only one motor will be connected at a time. For example, an OEM may sell basically the same machine to the US market and the European market. Some reasons why the OEM needs two motor profiles are:

- The inverter power input voltage is different for these markets.

- The required motor type is also different for each destination.

In other cases, the inverter needs two profiles because the machine characteristics vary according to these situations:

- Sometimes the motor load is very light and can move fast. Other times the motor load is heavy and must move slower. Using two profiles allows the motor speed, acceleration and deceleration to be optimal for the load and avoid inverter trip (fault) events.

- Sometimes the slower version of the machine does not have special braking options, but a higher performance version does have braking features.

Having multiple motor profiles lets you store different "personalities" for motors in one inverter's memory. The inverter allows the final selection between two motor types to be made in the field through the use of the intelligent input terminal functions [SET]. This provides an extra level of flexibility needed in particular situations. See the following page.

Operations and Monitoring

Parameters for the second motor have function codes of the form x2xx. They appear immediately after the first motor's parameter in the menu listing order. The following table lists the parameters that have the second parameter registers for programming.

Function Name	Parameter Codes	
	1st motor	**2nd motor**
Multi-speed frequency setting	A020	A220
Acceleration time setting (Acceleration 1)	F002	F202
Deceleration time setting (Deceleration 1)	F003	F203
Second acceleration time setting (Acceleration 2)	A092	A292
Second deceleration time setting (Deceleration 2)	A093	A293
Select method to use 2nd acceleration/deceleration	A094	A294
Acc1 to Acc2 frequency transition point	A095	A295
Dec1 to Dec2 frequency transition point	A096	A296
Level of electronic thermal setting	B012	B212
Select electronic thermal characteristic	B013	B213
Torque boost method selection	A041	A241
Manual torque boost value	A042	A242
Manual torque boost frequency adjustment	A043	A243
V/F characteristic curve selection	A044	A244
Base frequency setting	A003	A203
Maximum frequency setting	A004	A204
Select motor constant	H002	H202
Motor capacity setting	H003	H203
Motor poles setting	H004	H204
Motor stabilization constant	H006	H206

Operations
and Monitoring

Inverter System Accessories

5

In This Chapter....   page

Introduction

A motor speed control system will obviously include a motor and inverter, as well as fuses for safety. If you are connecting a motor to the inverter on a test bench just to get started, that's all you may need for now. But a fully developed system can also have a variety of additional components. Some can be for noise suppression, while others may enhance the inverter's braking performance. The figure below shows a system with several possible optional components, and the table gives part number information.

From power supply
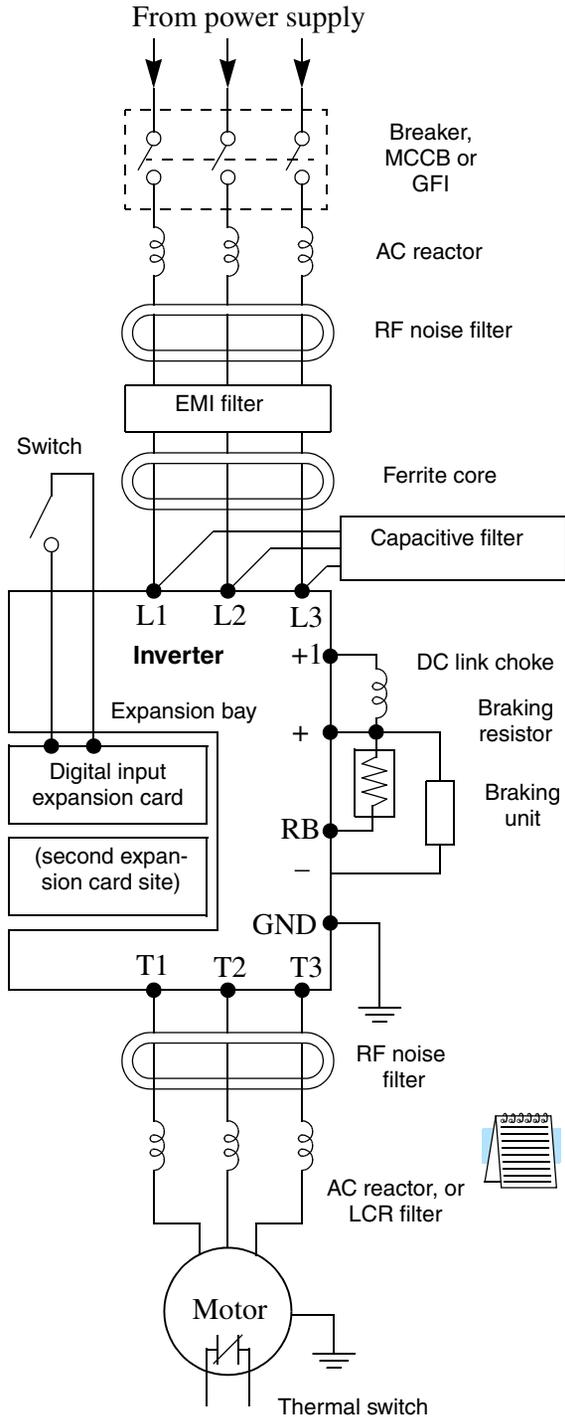
Name	Part No. Series		See page
	Europe, Japan	USA	
AC reactor, input side	ALI–xxx	HRL–x	5–3
RF noise filter, input side	ZCL–x	ZCL–x	5–4
EMI filter (EMC Class A)	NF–CEHx	NF–CEHxx	5–4
EMI filter (EMC Class B)	NF–CEHx, with FC–Hx	NF–CEHxx, with FC–Hx	5–4
Capacitive filter	CFI–x	CFI–x	5–4
DC link choke	—	HDC–xxx	5–4
Braking resistor	JRB–xxx–x, SRB–xxx–x	JRB–xxx, SRB–xxx	5–9
Braking resistor, NEMA-rated	—	HRB1-x, HRB2-x HRB3-x	5–9
Resistance braking unit	BRD–xxx	BRD–xxx	5–8
RF noise filter, output side	ZCL–xxx	ZCL–xxx	5–4
AC reactor, output side	ALI–xxx	HRL–xxx	5–3
LCR filter	—	HRL–xxxC	5–3
Digital input expansion card	SJ-DG		5–5

Motor Control Accessories

NOTE: The Hitachi part number series for accessories includes different sizes of each part type, specified by the –x suffix. Hitachi product literature can help match size and rating of your inverter to the proper accessory size.

Each inverter accessory comes with its own printed instruction manual. Please refer to those manuals for complete installation details. This chapter gives only an overview of these optional system devices. For more information on Hitachi inverter system accessories, please contact your Hitachi sales office or distributor.

Component Descriptions

AC Reactors, Input Side

This is useful in suppressing harmonics induced on the power supply lines, or when the main power voltage imbalance exceeds 3% (and power source capacity is more than 500 kVA), or to smooth out line fluctuations. It also improves the power factor.

In the following cases for a general-purpose inverter, a large peak current flows on the main power supply side, and is able to destroy the inverter module:

- If the unbalanced factor of the power supply is 3% or higher
- If the power supply capacity is at least 10 times greater than the inverter capacity (the power supply capacity is 500 kVA or more)
- If abrupt power supply changes are expected

Examples of these situations include:

1. Several inverters are connected in parallel, sharing the same power bus
2. A thyristor converter and an inverter are connected in parallel, sharing the same power bus
3. An installed phase-advance (power factor correction) capacitor opens and closes

Where these conditions exist or when the connected equipment must be highly reliable, install an AC reactor between the power supply and the inverter. Also, where the effects of an indirect lightning strike is possible, install a lightning conductor.

Example calculation:

V_{RS} = 205V, V_{ST} = 203V, V_{TR} = 197V,
where V_{RS} is R-S line voltage, V_{ST} is S-T line voltage, V_{TR} is T-R line voltage

$$\text{Unbalance factor of voltage} = \frac{\text{Max. line voltage (min.)} - \text{Mean line voltage}}{\text{Meanline voltage}} \times 100$$

$$= \frac{V_{RS} - (V_{RS} + V_{ST} + V_{TR})/3}{(V_{RS} + V_{ST} + V_{TR})/3} \times 100 = \frac{205 - 202}{202} \times 100 = 1.5\%$$

Please refer to the documentation that comes with the AC reactor for installation instructions.

AC Reactor or LCR Filter, Output Side

This reactor reduces the vibrations in the motor caused by the inverter's switching waveforms, by smoothing the waveforms to approximate commercial power quality. It is also useful to reduce the reflected voltage wave phenomenon when wiring from the inverter to the motor is more than 10m in length. Please refer to the documentation that comes with the AC reactor for installation instructions.

Motor Control
Accessories

Zero-phase Reactor (RF Noise Filter)

Electrical noise interference may occur on nearby equipment such as a radio receiver. The zero-phase reactor helps reduce radiated noise from the inverter wiring. It can be used on the input or output side of the inverter. The example zero-phase reactor shown to the right comes with a mounting bracket. The wiring must go through the opening to reduce the RF component of the electrical noise. Loop the wires three times (four turns) to attain the full RF filtering effect. For larger wire sizes, place multiple zero-phase reactors (up to four) side-by-side for a greater filtering effect.

ZCL–x

EMI Filter

The EMI filter reduces the conducted noise on the power supply wiring generated by the inverter. Connect the EMI filter to the inverter primary (input side). The NF–CEH–x series filter is required for compliance to the EMC Class A directive (Europe) and C-TICK (Australia). See .

WARNING: The EMI filter has high internal leakage current from power wiring to the chassis. Therefore, connect the chassis ground of the EMI filter before making the power connections to avoid danger of shock or injury.

NF–CEHxx

Ferrite Core

To meet EMC Class B limit an optional ferrite core (FC–Hx) must be inserted between the NF–CEHx filter (above) and the inverter.

RF Noise Filter (Capacitive)

This capacitive filter reduces radiated noise from the main power wires in the inverter input side. This filter is not for achieving CE compliance and is applicable only to the input side only of the inverter. It comes in two versions—for 200V class inverters or 400V class inverters. Please refer to the documentation that comes with the radio noise filter for installation instructions.

DC Link Choke

The DC choke (reactor) suppresses harmonics generated by the inverter. It attenuates the high-frequency components on the inverter's internal DC bus (link). However, note that it does not protect the diode rectifiers in the inverter input circuit.

Motor Control
Accessories

Expansion Card   The SJ–DG Digital Input Card installs in the inverter's expansion bay. This card accepts up to eight digital input signals, in addition to the intelligent inputs on the inverter's control terminal connector. All wiring associated with card connects to its PWB connectors as shown.

PWB connector to external wiring

The digital input card can be used for external input of accel/decel values. Use parameter A001 to configure a digital input card for the frequency setting source. Use parameter P31 to configure a digital input card for the acceleration and deceleration time setting source. Refer to the SJ–DG manual for more information.
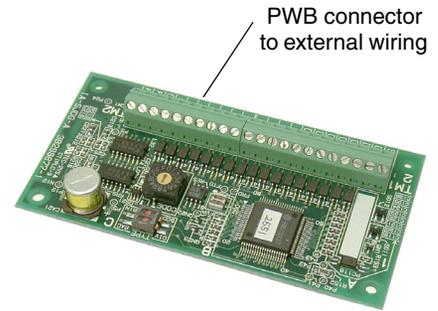
SJ-DG Digital Input Card

NOTE: You can install the SJ–DG card in either expansion slots or both, if needed. The SJ–FB Encoder input card may not be used with the L300P inverter.

The SJ–DN DeviceNet Interface Card (not shown) installs in the inverter's expansion bay. It connects directly to a DeviceNet network. Inverter parameters P044 to P049 configure the card. Only one DeviceNet card may be installed in an inverter. For more information, please refer to the DeviceNet Expansion Card Instruction Manual.

Motor Control
Accessories

Dynamic Braking

Introduction

The purpose of dynamic braking is to improve the ability of the inverter to stop (decelerate) the motor and load. This becomes necessary when an application has some or all of the following characteristics:

- High load inertia compared to the available motor torque
- The application requires frequent or sudden changes in speed
- System losses are not great enough to slow the motor as needed

When the inverter reduces its output frequency to decelerate the load, the motor can temporarily become a generator. This occurs when the motor rotation frequency is higher than the inverter output frequency. This condition can cause the inverter DC bus voltage to rise, resulting in an over-voltage trip. In many applications, the over-voltage condition serves as a warning signal that we have exceeded the deceleration capabilities of the system. L300P inverters rated 20hp (15kW) and below have a built-in braking unit, which sends the regenerative energy from the motor during deceleration to the optional braking resistor(s). External braking units may also be used if higher braking torques and/or duty cycles are required. The dynamic braking resistor serves as a load, developing heat to stop the motor just as brakes on an automobile develop heat during braking.

The braking resistor is the main component of a braking resistor assembly that includes an integral thermal fuse and thermally activated alarm relay for safety. However, be careful to avoid overheating its resistor. The thermal fuse and thermal relay are safeguards for extreme conditions, but the inverter can maintain braking usage in a safe zone.

Braking Resistor

Dynamic Braking Usage Ratio

The inverter controls braking via a duty cycle method (percent of the time braking is ON versus total time). Parameter B090 sets the dynamic braking usage ratio. In the graph to the right, the example shows three uses of dynamic braking in a 100-second period. The inverter calculates the average percentage usage in that time (T%). The percentage of usage is proportional to the heat dissipated. If T% is greater than the B090 parameter setting, the inverter enters the Trip Mode and turns OFF the frequency output.
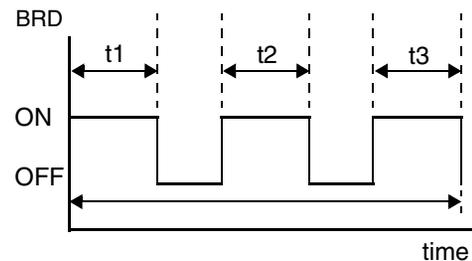
$$\boxed{B90} \quad T\% = \frac{(t1 + t2 + t3 + ...)}{100 \text{ seconds}} \times 100$$

Please note the following (for L300P–110LF/HF and L300P–150LF/HF).

- When B090 is set for 0%, dynamic braking is not performed.
- When the T% value exceeds the limit set by B090, the inverter will trip (ending the dynamic braking).
- The cable from the external resistor to the inverter must not exceed 5 m (16 ft.) length.
- The individual wires from the resistor to the inverter must not be bundled together.

NOTE: Inverters rated 25hp (18.5kW) and above (L300P–185LF/HF to L300P–750LF/1320HF) do not include an internal braking unit. Parameters B090, B095, and B096 do not apply to these models.

**L300P
Dynamic Braking
Selection Tables**

The L300P Series 200V and 400V class inverter models in the 2 to 20 hp range have internal braking units. Additional stopping torque is available by adding external resistors. The required braking torque depends on your particular application. Other tables in this section will help you choose the proper resistor.

2 to 20 hp (1.5 to 15 kW)			Using Internal Resistor		Using Optional External Resistor		Performance @ Minimum Resistance		Minimum Resistance @ 100% Braking Duty Cycle, Ohms
Voltage Class	Model Number, L300P	Motor hp	Braking Unit	Braking Torque @ 60Hz, (without external resistor), %	External Resistance, Ohms	Braking Torque @60Hz, %	Minimum Resistance, Ohms	Max. Braking Duty Cycle, %	
200V	–015LFU2	2	Built-in	50	35	200	35	10	100
	–022LFU2	3	Built-in	20	35	160	35	10	100
	–037LFU2	5	Built-in	20	35	100	35	10	100
	–055LFU2	7.5	Built-in	20	17	80	17	10	50
	–075LFU2	10	Built-in	20	17	80	17	10	50
	–110LFU2	15	Built-in	10	17	55	17	10	50
	–150LFU2	20	Built-in	10	17	50	17	10	50
400V	–015HFU2, HFE2	2	Built-in	50	100	200	100	10	300
	–022HFU2, HFE2	3	Built-in	20	100	200	100	10	300
	–037HFU2, HFE2	5	Built-in	20	100	140	70	10	200
	–055HFU2, HFE2	7.5	Built-in	20	70	100	70	10	200
	–075HFU2, HFE2	10	Built-in	20	70	100	50	10	150
	–110HFU2, HFE2	15	Built-in	10	70	55	50	10	150
	–150HFU2, HFE2	20	Built-in	10	70	50	50	10	150

Motor Control
Accessories

Choosing a Braking Unit

The L300P Series 200V and 400V class inverter models in the 25 to 175 hp range require external braking units to increase their braking torque. Braking units come in sizes corresponding to the power handing requirements for particular resistor selections. Be sure to follow the installation instructions accompanying each braking unit. The following table lists the L300P inverter models and their applicable braking units.

25 to 175 hp (18.5 to 132 kW)			Peformance Versus External Braking Unit				
			Without Braking Unit	With Braking Unit			
Voltage Class	Model Number L300P	Motor hp	Braking Torque, %	Braking Unit Model	Minimum Resistance, Ohms	Max. Braking Duty Cycle, %	Minimum Resistance @ 100% Braking Duty Cycle, Ohms
200V	–185LFU2	25	10	BRD–E2	17	10	46
			10	BRD–E2–30K	4	20	6
	–220LFU2	30	10	BRD–E2	17	10	46
			10	BRD–E2–30K	4	20	6
	–300LFU2	40	10	BRD–E2–30K	4	20	6
			10	BRD–E2–55K	2	20	4
	–370LFU2	50	10	BRD–E2–55K	2	20	4
	–450LFU2	60	10	BRD–E2–55K	2	20	4
	–550LFU2	75	10	BRD–E2–55K	2	20	4
	–750LFU2	100	10	BRD–E2–55K	2	20	4
400V	–185HFU2, HFE2	25	10	BRD–EZ2	20	10	34
			10	BRD–E2–30K	10	10	24
	–220HFU2, HFE2	30	10	BRD–EZ2	20	10	34
			10	BRD–E2–30K	10	10	24
	–300HFU2, HFE2	40	10	BRD–EZ2–55K	6	20	12
	–370HFU2, HFE2	50	10	BRD–EZ2–55K	6	20	12
	–450HFU2, HFE2	60	10	BRD–EZ2–55K	6	20	12
	–550HFU2, HFE2	75	10	BRD–EZ2–55K	6	20	12
	–750HFU2, HFE2	100	10	BRD–EZ2–55K	6	20	12
	–900HFU2, HFE2	125	10	BRD–EZ2–55K	6	20	12
	–1100HFU2, HFE2	150	10	BRD–EZ2–55K	6	20	12
	–1320HFU2, HFE2	175	10	BRD–EZ2–55K	6	20	12

Selecting a Braking Resistor

You can add one or more resistors to your inverter configuration to increase braking torque performance. The number of resistors and their configuration (series or parallel) depends on the desired braking torque. The tables below list the resistor types for inverter models with internal braking units. Tables for inverters with external braking units are on the next two pages.

- Total Ohms – lists the resistance value of the resistor or, if using multiple resistors, their combined resistance
- Total Watts – lists the power dissipation of the resistor or, if using multiple resistors, their combined power dissipation
- Maximum Duty Cycle – the maximum allowable percentage of braking time over any 100-second interval to avoid overheating the resistor(s)
- Maximum braking torque – the maximum braking torque that the inverter / resistor combination can deliver

NOTE: If your application requires resistors with NEMA ratings, be sure to use the HRB type.

200V Class	Dynamic Braking Resistor Selection												Max. Braking Torque, %
	JRB Series				SRB/NSRB Series				HRB Series				
Model Number L300P	Type & (qty)	Total Ohms	Total Watts	Max. Duty Cycle, %	Type & (qty)	Total Ohms	Total Watts	Max. Duty Cycle, %	Type & (qty)	Total Ohms	Total Watts	Max. Duty Cycle, %	
–015LFU2	120–4	35	120	1.0	400–1	35	400	7.5					200
–022LFU2	120–4	35	120	1.0	400–1	35	400	7.5					160
–037LFU2	120–4	35	120	1.0	400–1	35	400	7.5					100
–055LFU2	120–4 x (2) in parallel	17.5	240	1.0	400–1 x (2) in parallel	17.5	800	7.5	HRB3	17	1200	10	80
–075LFU2		17.5	240	1.0		17.5	800	7.5	HRB3	17	1200	10	80
–110LFU2		17.5	240	1.0		17.5	800	7.5	HRB3	17	1200	10	55
–150LFU2		17.5	240	1.0		17.5	800	7.5	HRB3	17	1200	10	50

400V Class	Dynamic Braking Resistor Selection												Max. Braking Torque, %
	JRB Series				SRB/NSRB Series				HRB Series				
Model Number L300P	Type & (qty)	Total Ohms	Total Watts	Max. Duty Cycle, %	Type & (qty)	Total Ohms	Total Watts	Max. Duty Cycle, %	Type & (qty)	Total Ohms	Total Watts	Max. Duty Cycle, %	
–015HFU2, HFE2	120–2	100	120	1.5	200–2	100	200	7.5					200
–022HFU2, HFE2	120–2	100	120	1.5	200–2	100	200	7.5					200
–040HFU2, HFE2	120–2	100	120	1.5	200–2	100	200	7.5	HRB2 x (2) in series	100	800	10	140
–055HFU2, HFE2	120–4 x (2) in series	70	240	1.0	400–1 x (2) in series	70	800	7.5	HRB2 x (2) in series	70	1200	10	120
–075HFU2, HFE2		70	240	1.0		70	800	7.5		70	1200	10	100
–110HFU2, HFE2		70	240	1.0		70	800	7.5		70	1200	10	55
–150HFU2, HFE2		70	240	1.0		70	800	7.5		70	1200	10	50

Motor Control
Accessories

The table below lists the performance of 200V-class inverter models with the optional **external** braking units. In some cases, the resistor selection specifies multiple resistors in a parallel, series, or combination parallel/series configuration. The example diagram shows a parallel configuration. Please refer to the braking resistor documentation for detailed wiring diagrams.

Example configuration

HRB3 x (4) parallel
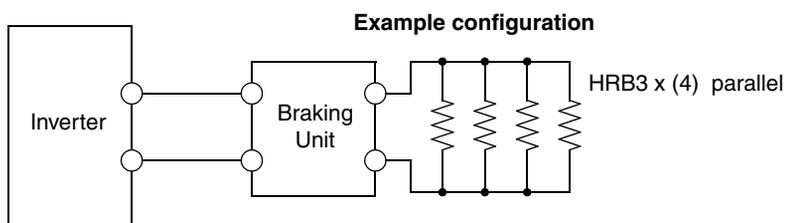
200V Class	Braking Unit	Dynamic Braking Resistor Selection						Max. Braking Torque, %
Model Number L300P	Type	Type x (quantity)	Series or Parallel	Total Ohms	Total Watts	Max. Duty Cycle, %		
–185LFU2	BRD–E2	HRB1	—	50	400	10		25
		HRB2	—	35	600	10		30
		HRB3	—	17	1200	10		50
	BRD–E2–30K	HRB3 x (2)	parallel	8.5	2400	20		90
		HRB3 x (3)	parallel	5.7	3600	20		130
		HRB3 x (4)	parallel	4.3	4800	20		170
–220LFU2	BRD–E2	HRB1	—	50	400	10		25
		HRB2	—	35	600	10		30
		HRB3	—	17	1200	10		45
	BRD–E2–30K	HRB3 x (2)	parallel	8.5	2400	20		80
		HRB3 x (3)	parallel	5.7	3600	20		110
		HRB3 x (4)	parallel	4.3	4800	20		150
–300LFU2	BRD–E2–30K	HRB3 x (2)	parallel	8.5	2400	20		55
		HRB3 x (3)	parallel	5.7	3600	20		80
		HRB3 x (4)	parallel	4.3	4800	20		110
–370LFU2	BRD–E2–30K	HRB3 x (2)	parallel	8.5	2400	20		45
		HRB3 x (3)	parallel	5.7	3600	20		65
		HRB3 x (4)	parallel	4.3	4800	20		90
–450LFU2	BRD–E2–30K	HRB3 x (2)	parallel	8.5	2400	20		35
		HRB3 x (3)	parallel	5.7	3600	20		50
		HRB3 x (4)	parallel	4.3	4800	20		75
–550LFU2	BRD–E2–30K	HRB3 x (2)	parallel	8.5	2400	20		30
		HRB3 x (3)	parallel	5.7	3600	20		40
		HRB3 x (4)	parallel	4.3	4800	20		60
–750LFU2	BRD–E2–30K	HRB3 x (2)	parallel	8.5	2400	20		30
		HRB3 x (3)	Parallel	5.7	3600	20		40
		HRB3 x (4)	parallel	4.3	4800	20		60

Motor Control
Accessories

The table below lists the performance of 400V-class inverter models with the optional **external** braking units. In some cases, the resistor selection specifies multiple resistors in a parallel, series, or combination parallel/series configuration. The example diagram shows a combination parallel / series configuration. Please refer to the braking unit manual for detailed wiring diagrams.
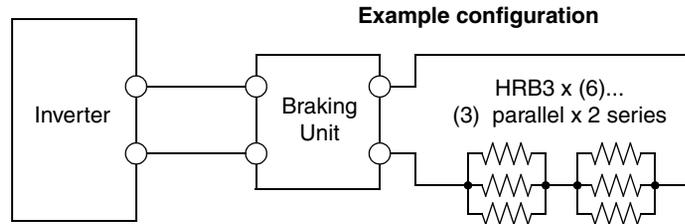
Example configuration

400V Class	Braking Unit	Dynamic Braking Resistor Selection					Max. Braking Torque, %
Model Number L300P	Type	Type x (quantity)	Series / Parallel	Total Ohms	Total Watts	Max. Duty Cycle, %	
−185HFU2, HFE2	BRD–EZ2	HRB1 x (2)	series	100	800	10	40
		HRB2 x (2)	series	70	1200	10	50
		HRB3 x (2)	series	34	2400	10	90
	BRD–EZ2–30K	HRB3 x (4)	(2) parallel x 2 series	17	4800	10	170
		HRB3 x (6)	(3) parallel x 2 series	11.3	7200	10	200
−220HFU2, HFE2	BRD–EZ2	HRB1 x (2)	series	100	800	10	35
		HRB2 x (2)	series	70	1200	10	45
		HRB3 x (2)	series	34	2400	10	80
	BRD–EZ2–30K	HRB3 x (4)	(2) parallel x 2 series	17	4800	10	150
		HRB3 x (6)	(3) parallel x 2 series	11.3	7200	10	200
−300HFU2, HFE2	BRD–EZ2–55K	HRB3 x (4)	(2) parallel x 2 series	17	4800	10	110
		HRB3 x (6)	(3) parallel x 2 series	11.3	7200	10	170
−370HFU2, HFE2	BRD–EZ2–55K	HRB3 x (4)	(2) parallel x 2 series	17	4800	10	90
		HRB3 x (6)	(3) parallel x 2 series	11.3	7200	10	150
−450HFU2, HFE2	BRD–EZ2–55K	HRB3 x (4)	(2) parallel x 2 series	17	4800	10	70
		HRB3 x (6)	(3) parallel x 2 series	11.3	7200	10	120
−550HFU2, HFE2	BRD–EZ2–55K	HRB3 x (4)	(2) parallel x 2 series	17	4800	10	60
		HRB3 x (6)	(3) parallel x 2 series	11.3	7200	10	100

Motor Control
Accessories

400V Class	Braking Unit	Dynamic Braking Resistor Selection					Max. Braking Torque, %
Model Number L300P	Type	Type x (quantity)	Series / Parallel	Total Ohms	Total Watts	Max. Duty Cycle, %	
–750HFU2, HFE2	BRD–EZ2–55K	HRB3 x (4)	(2) parallel x 2 series	17	4800	10	45
		HRB3 x (6)	(3) parallel x 2 series	11.3	7200	10	70
–900HFU2, HFE2	BRD–EZ2–55K	HRB3 x (4)	(2) parallel x 2 series	17	4800	10	40
		HRB3 x (6)	(3) parallel x 2 series	11.3	7200	10	60
–1100HFU2, HFE2	BRD–EZ2–55K	HRB3 x (4)	(2) parallel x 2 series	17	4800	10	30
		HRB3 x (6)	(3) parallel x 2 series	11.3	7200	10	50
–1320HFU2, HFE2	BRD–EZ2–55K	HRB3 x (4)	(2) parallel x 2 series	17	4800	10	25
		HRB3 x (6)	(3) parallel x 2 series	11.3	7200	10	40

NOTE: Other braking units and resistors are also available. For braking requirements beyond those in the tables, contact your Hitachi distributor.

Motor Control
Accessories

Troubleshooting and Maintenance

6

In This Chapter....   page

Troubleshooting

Safety Messages
Please read the following safety messages before troubleshooting or performing maintenance on the inverter and motor system.

WARNING: Wait at least five (5) minutes after turning OFF the input power supply before performing maintenance or an inspection. Otherwise, there is the danger of electric shock.

WARNING: Make sure that only qualified personnel will perform maintenance, inspection, and part replacement. Before starting to work, remove any metallic objects from your person (wristwatch, bracelet, etc.). Be sure to use tools with insulated handles. Otherwise, there is a danger of electric shock and/or injury to personnel.

WARNING: Never remove connectors by pulling on its wire leads (wires for cooling fan and logic P.C. board). Otherwise, there is danger of fire due to wire breakage and/or injury to personnel.

General Precautions and Notes

• Always keep the unit clean so that dust or other foreign matter does not enter the inverter.

• Take special care to avoid breaking wires or making connection mistakes.

• Firmly connect terminals and connectors.

• Keep electronic equipment away from moisture and oil. Dust, steel filings and other foreign matter can damage the inverter, causing unexpected accidents, so take special care.

Inspection Items
This chapter provides instructions or checklists for these inspection items:

• Daily inspection

• Periodic inspection (approximately once a year)

• Insulation resistance test

Troubleshooting
and Maintenance

Troubleshooting Tips

The table below lists typical symptoms and the corresponding solution(s).

Symptom/condition		Probable Cause	Solution
The motor will not run.	The inverter outputs U, V, W are not supplying voltage.	• Is the frequency command source A001 parameter setting correct? • Is the Run command source A002 parameter setting correct?	• Make sure the parameter setting A001 is correct. • Make sure the parameter setting A002 is correct.
		• Is power being supplied to terminals [R], [S], and [T] ([L1], [L2], and [L3])? If so, the POWER lamp should be ON.	• Check terminals [R], [S], and [T] ([L1], [L2], and [L3]), then [U], [V], and [W] ([T1], [T2], and [T3]). • Turn ON the power supply or check fuses.
		• Is there an error code *EXX.X* displayed?	• Press the Func. key and determine the error type. Eliminate the error cause, then clear the error (Reset).
		• Are the signals to the intelligent input terminals correct? • Is the Run Command active? • Is the [FW] terminal (or [RV]) connected to P24 (via switch, etc.)	• Verify the terminal functions for C001 - C005 are correct. • Turn ON Run command enable. • Supply 24V to [FW] or [RV] terminal, if configured.
		• Has the frequency setting for F001 been set greater than zero? • Are the control circuit terminals [H], [O], and [L] connected to the potentiometer?	• Set the parameter for F001 to a safe, non-zero value. • If the potentiometer is the frequency setting source, verify voltage at [O] > 0V.
		• Is the RS (reset) function or FRS (free-run stop) function ON?	• Turn OFF the command(s).
	Inverter outputs U, V, W are supplying voltage.	• Is the motor load too heavy?	• Reduce load or test the motor independently of the load.
The direction of the motor is reversed.		• Are the connections of output terminals [U/T1], [V/T2], and [W/T3] correct? • Is the phase sequence of the motor forward or reverse with respect to [U/T1],[V/T2], and [W/T3]?	• Make connections according to the phase sequence of the motor. In general: FWD = U-V-W, and REV=U-W-V.
		• Are the control terminals [FW] and [RV] wired correctly? • Is parameter F004 properly set?	• Use terminal [FW] for forward, and [RV] for reverse. • Set motor direction in F004.

Troubleshooting and Maintenance

Symptom/condition		Probable Cause	Solution
The motor speed will not reach the target frequency (desired speed).		• If using the analog input, is there current or voltage at [O] or [OI]?	• Check the wiring. • Check the potentiometer or signal generating device.
		• Is the load too heavy?	• Reduce the load. • Heavy loads activate the overload restriction feature (reduces output as needed).
		• Is the inverter internally limiting the output frequency?	• Check max frequency setting (A004) • Check frequency upper limit setting (A061) • If using analog inputs, check their settings (A101– A104) or (A111–A114), or (A011–A014)
The rotation is unstable.		• Is the load fluctuation too great? • Is the supply voltage unstable? • Is the problem occurring at a particular frequency? • Does the instability occur at various frequencies?	• Increase the motor capacity (both inverter and motor). • Fix power supply problem. • Change the output frequency slightly, or use the jump frequency setting to skip the problem frequency. • Try adjusting H006 up or down. • See "Adjusting Motor Stability" on page 4–57.
The RPM of the motor does not match the inverter output frequency setting.		• Is the maximum frequency setting A004 correct? • Does the monitor function D001 display the expected output frequency?	• Verify the V/F settings match motor specifications. • Make sure all scaling (such as A011 to A014) is properly set.
A parameter will not change after an edit (reverts to old setting).	True for certain parameters	• Is the inverter in Run Mode? Some parameters cannot be edited during Run Mode.	• Put inverter in Stop Mode (press the Stop/reset key). Then edit the parameter.
	True for all parameters	• If you're using the [SFT] intelligent input (software lock function)—is the [SFT] input ON?	• Change the state of the SFT input, and check the B031 parameter (SFT mode).

Monitoring Trip Events, History, & Conditions

Fault Detection and Clearing

The microprocessor in the inverter detects a variety of fault conditions and captures the event, recording it in a history table. The inverter output turns OFF, or "trips" similar to the way a circuit breaker trips due to an over-current condition. Most faults occur when the motor is running (refer to the diagram to the right). However, the inverter could have an internal fault and trip in Stop Mode. In either case, you can clear the fault by pressing the Stop/Reset key. Additionally, you can clear the inverter's cumulative trip history by performing the procedure "Restoring Factory Default Settings" on page 6–9 (setting B_84=00 will clear the trip history but leave inverter settings intact).
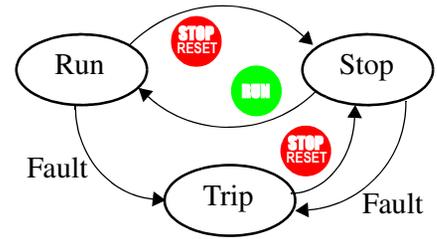
Error Status Codes

The conditions at the time of an error provide important clues to help you understand the cause. The L300P inverter displays a "status at trip point" digit to the right of the decimal point for some error codes. For example, *E07.2* means Error 7 occurred and the inverter status was condition # "2" when the error occurred.

Status Codes	Inverter Status	Status Codes	Inverter Status
---.0	Reset	---.5	f0 stop
---.1	Stop	---.6	Starting
---.2	Deceleration	---.7	DC braking
---.3	Constant speed	---.8	Overload restriction
---.4	Acceleration	---.9	Auto-tuning

Error Codes

An error code will appear on the display automatically when a fault causes the inverter to trip. The following table lists the cause associated with the error.

Error Code	Name	Probable Cause(s)
E01	Over current event while at constant speed	The inverter output was short-circuited, or the motor shaft is locked or has a heavy load. These conditions cause excessive current for the inverter, so the inverter output is turned OFF. The dual-voltage motor is wired incorrectly. Note: The L300P will over current trip at nominally 150% of rated current.
E02	Over current event during deceleration	
E03	Over current event during acceleration	
E04	Over current event during other conditions	DC braking power(A054) is set too high, or a current transformer error occurred, or a noise source induced the error.
E05	Overload protection	When a motor overload is detected by the electronic thermal function, the inverter trips and turns OFF its output.

Troubleshooting and Maintenance

Error Code	Name	Probable Cause(s)
E06	Braking resistor overload	When the regenerative braking resistor exceeds the usage time allowance or usage ratio, the inverter trips and turns OFF its output to the motor.
E07	Over voltage protection	When the DC bus voltage exceeds a threshold, due to regenerative energy from the motor.
E08	EEPROM error	When the built-in EEPROM memory has problems due to noise or excessive temperature, the inverter trips and turns OFF its output to the motor.
E09	Under-voltage error	A decrease of internal DC bus voltage below a threshold results in a control circuit fault. This condition can also generate excessive motor heat or cause low torque. The inverter trips and turns OFF its output.
E10	CT (current transformer) error	If a strong source of electrical interference is close to the inverter or a fault occurs in a built-in CT (current transformer), the inverter trips and turns its output OFF.
E11	CPU error	A malfunction in the built-in CPU has occurred, so the inverter trips and turns OFF its output to the motor.
E12	External trip	A signal on an intelligent input terminal configured as EXT has occurred. The inverter trips and turns OFF the output to the motor.
E13	USP	When the Unattended Start Protection (USP) is enabled, an error occurred when power is applied while a Run signal is present. The inverter trips and does not go into Run Mode until the error is cleared.
E14	Ground fault	The inverter is protected by the detection of ground faults between the inverter output and the motor during powerup tests. This feature protects the inverter, and does not protect humans.
E15	Input over-voltage	When the input voltage is higher than the specified value, it is detected 60 seconds after powerup and the inverter trips and turns OFF its output.
E16	Instantaneous power failure	When the input power is removed for more than 15ms, the inverter trips and the output to the motor turns OFF. If the power failure duration exceeds the duration set in parameter B002, it is considered a power failure. When input power is restored, the inverter restarts if the Run signal is present, depending on the restart condition.
E21	Inverter thermal trip	When the inverter internal temperature is above the threshold, the thermal sensor in the inverter module detects the excessive temperature of the power devices and trips, turning the inverter output OFF.
E23	Gate array error	An internal inverter error has occurred in communications between the CPU and gate array IC.

Error Code	Name	Probable Cause(s)
E24	Phase failure detection	One of three lines of the 3-phase power is missing.
E30	IGBT error	When an instantaneous over-current condition occurs on any IGBT (output transistor) device, the inverter alarm trips. then it turns the outputs OFF in order to protect the circuitry.
E35	Thermistor	When a thermistor is connected to terminals [THM] and [CM1] and the inverter has sensed the temperature is too high, the inverter trips and turns OFF the output.
----	Under-voltage (brownout) with output shutoff	Due to low input voltage, the inverter turns its output OFF and tries to restart. If it fails to restart, then the alarm trips to record the under-voltage error event.
E6X	Expansion card #1 connection error	An error has occurred in an expansion card or at its connecting terminals. Please refer to the manual for the expansion card for additional details.
E7X	Expansion card #2 connection error	

NOTE: If an EEPROM error (E08) occurs, be sure to confirm the parameter data values are still correct.

Trip History and Inverter Status

We recommend that you first find the cause of the fault before attempting clearing it. When a fault occurs, the inverter stores important performance data at the moment of the fault. To access the data, use the monitor functions (Dxxx) and select D081 for details about the present fault (E_n). The previous five faults are stored in D081 to D086, with D (E_{n-1} to E_{n-5}). Each error shifts D081–D085 to D082–D086, and writes the new error to D081.

The following Monitor Menu map shows how to access the error codes. When fault(s) exist, you can review their details by first selecting the proper function: D081 is most recent, and D086 is the oldest.

Monitor Menu

Trip History

d 086

d 081   d 082

FUNC.

Error exists?   No   No error ____   FUNC.

Yes

Current Trip Conditions

E 07.2   Error Code

60.00   Output frequency at trip point

4.00   Motor current at trip point

270.0   DC bus voltage at trip point

1 5   Cumulative inverter operation time at trip point

1 8   Cumulative power-ON time at trip point

FUNC.
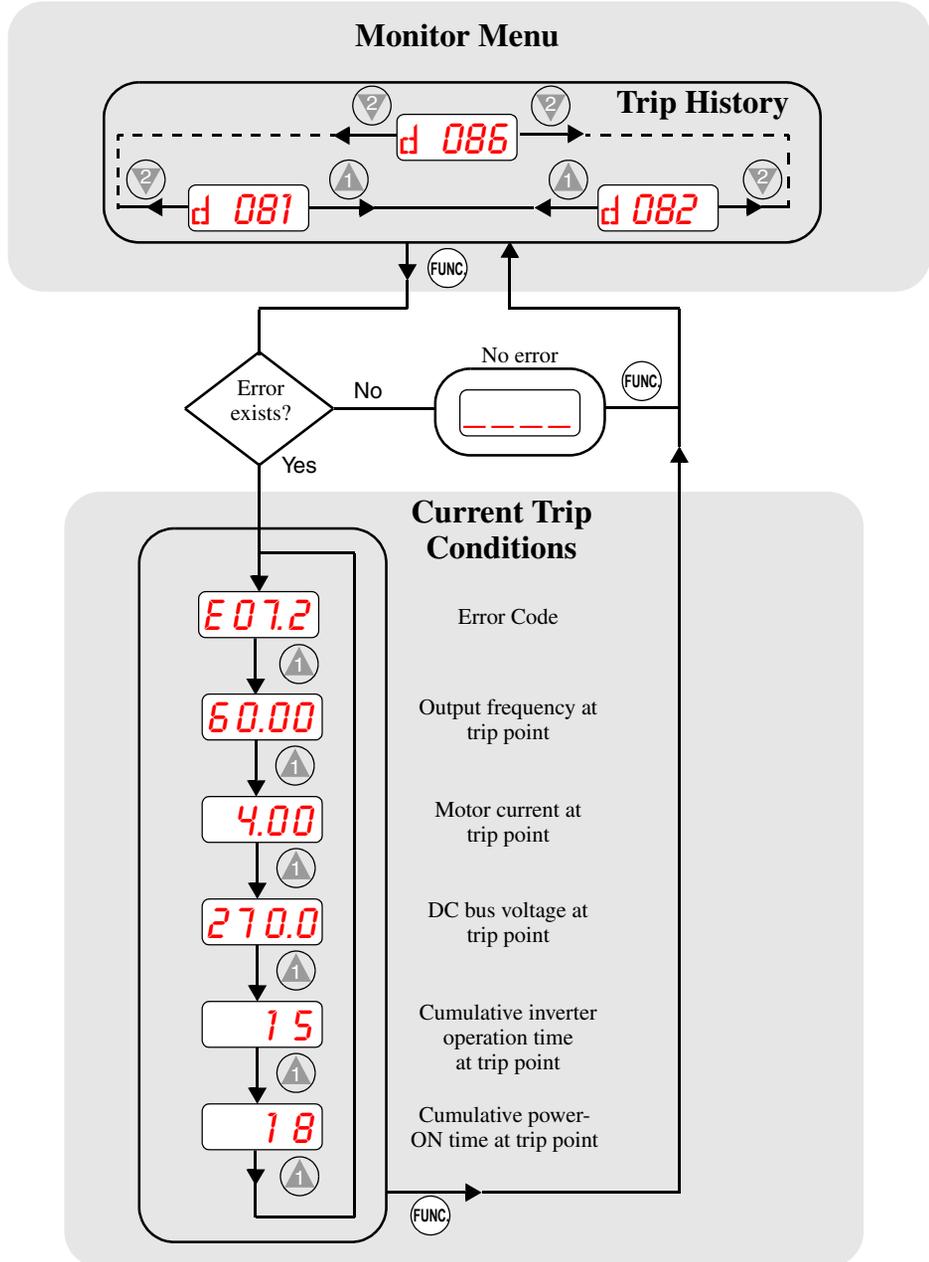
Restoring Factory Default Settings

You can restore all inverter parameters to the original factory (default) settings for the intended country of use. After initializing the inverter, use the powerup test in Chapter 2 to get the motor running again. To initialize the inverter, follow the steps below.

No.	Action	Display	Func./Parameter
1	Use the (FUNC), (▲), and (▼) keys to navigate to the "B" Group.	b − −	"B" Group selected
2	Press the (FUNC) key.	b 001	First "B" parameter selected
3	Press and hold the (▲) key until ->	b 08	Country code for initialization selected
4	Press the (FUNC) key.	02	00 = Japan, 01 = Europe, 02 = U.S.
5	Confirm the country code is correct. Do not change it unless you are absolutely sure the power input voltage range and frequency match the country code setting. To change the country code, press (▲) or (▼) to set; (STR) to store.		
6	Press the (FUNC) key.	b 085	Country code for initialization selected
7	Press the (▼) key.	b 084	Initialization function selected
8	Press the (FUNC) key.	00	00 = initialization disabled, clear trip history only
9	Press the (▲) key.	01	01 = enable initialization
10	Press the (STR) key.	b 084	Initialization now enabled to restore all defaults
11	Press and hold the (FUNC), (▲), and (▼) keys. Do not let release yet.	b 084	First part of special key sequence, the "B" is flashing.
12	Holding the keys above, press and hold the (STOP RESET) (STOP) key for 3 sec.	b 084	Final part of special key sequence, "B084" is flashing
13	When the *b084* display function begins blinking, release the (STOP RESET), (FUNC), (▲), and (▼) keys together.	0 EU or 0USA	Default parameter country code shown during initialization process (left-most character displays alternating pattern)
14	Initialization is complete.	d 01	Function code for output frequency monitor shown
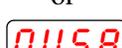
NOTE: Initialization cannot be performed with a remote operator panel. Disconnect the device and use the inverter's front panel keypad.

Troubleshooting and Maintenance

Maintenance and Inspection

**Monthly and
Yearly Inspection
Chart**

Item Inspected		Check for...	Inspection Cycle		Inspection Method	Criteria
			Month	**Year**		
Overall	Ambient environment	Extreme temperatures & humidity	✔		Thermometer, hygrometer	Ambient temperature between -10 to 50°C, non-condensing
	Major devices	Abnormal vibration, noise	✔		Visual and aural	Stable environment for electronic controls
	Power supply voltage	Voltage tolerance	✔		Digital volt meter, measure between inverter terminals [L1], [L2], [L3]	200V class: 200 to 240V 50/60 Hz 400V class: 380 to 460V 50/60 Hz
Main circuit	Ground Insulation	Adequate resistance		✔	Megger test	500VDC, reading of 5M ohms or greater, see next section for test details
	Mounting	No loose screws		✔	Torque wrench	M3: 0.5 – 0.6 Nm M4: 0.98 – 1.3 Nm M5: 1.5 – 2.0 Nm
	Components	Overheating		✔	Thermal trip events	No trip events
	Housing	Dirt, dust		✔	Visual	Vacuum dust and dirt
	Terminal block	Secure connections		✔	Visual	No abnormalities
	Smoothing capacitor	Leaking, swelling	✔		Visual	No abnormalities
	Relay(s)	Chattering		✔	Aural	Single click when switching ON or OFF
	Resistors	Cracks or discoloring		✔	Visual	Use Ohm meter to check braking resistors
	Cooling fan	Noise	✔		Power down, manually rotate	Rotation must be smooth
		Dust	✔		Visual	Vacuum to clean
Control circuit	Overall	No odor, discoloring, corrosion		✔	Visual	No abnormalities
	Capacitor	No leaks or deformation	✔		Visual	Undistorted appearance
Display	LEDs	Legibility	✔		Visual	All LED segments work

Note 1: The life of a capacitor is affected by the ambient temperature. See "Capacitor Life Curve" on page 6–12.

Note 2: The inverter must be cleaned periodically. If dust accumulates on the fan and heat sink, it can cause overheating of the inverter.

Troubleshooting
and Maintenance

Megger Test

The *megger* is a piece of test equipment that uses a high voltage to determine if an insulation degradation has occurred. For inverters, it is important that the power terminals be isolated from the Earth GND terminal via the proper amount of insulation.

The circuit diagram below shows the inverter wiring for performing the megger test. Just follow the steps to perform the test:

1. Remove power from the inverter and wait at least 5 minutes before proceeding.

2. Open the front housing panel to access the power wiring.

3. Remove all wires to terminals [R, S, T, PD, P, N, RB, U, V, and W]. Most importantly, the input power and motor wires will be disconnected from the inverter.

4. Remove the jumper at connector J61. It is located on the main circuit board beside the power terminals.

5. Use a bare wire and short terminals [R, S, T, PD, P, N, RB, U, V, and W] together as shown in the diagram.

6. Connect the megger to the inverter Earth GND and to the shorted power terminals as shown. Then perform the megger test at 500 VDC and verify 5MΩ or greater resistance.
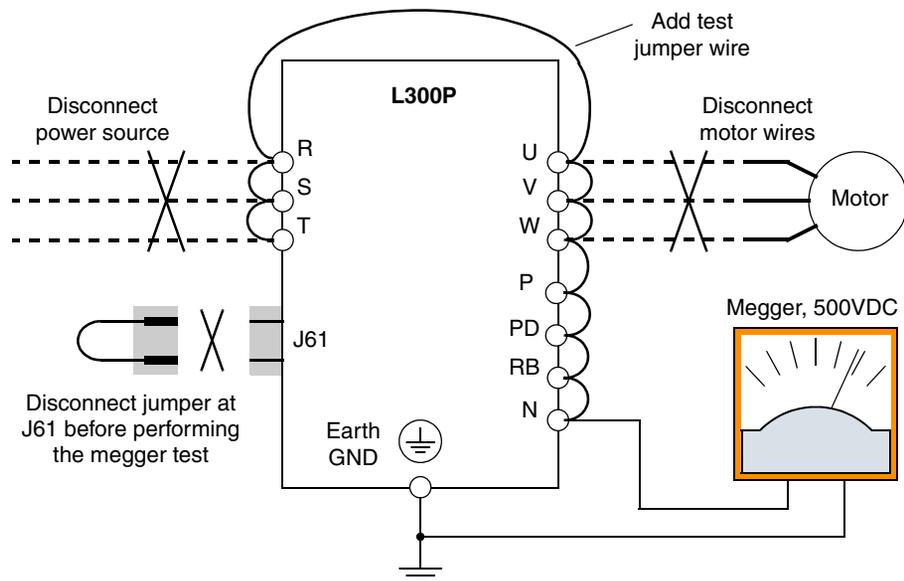
7. After completing the test, disconnect the megger from the inverter.

8. Reconnect the jumper at connector J61 as before.

9. Reconnect the original wires to terminals [R, S, T, PD, P, N, RB, U, V, and W].

CAUTION: Do not connect the megger to any control circuit terminals such as intelligent I/O, analog terminals, etc. Doing so could cause damage to the inverter.

CAUTION: Never test the withstand voltage (HIPOT) on the inverter. The inverter has a surge protector between the main circuit terminals above and the chassis ground.

Troubleshooting and Maintenance

Spare parts

We recommend that you stock spare parts to reduce down time, including parts listed below:

Part description	Symbol	Quantity		Notes
		Used	**Spare**	
Cooling fan	FAN	1, 2, 3... (depends on model)	1 or 2	Fan unit at top of housing in all models
Auxiliary cooling fan	FAN	0 or 1... (depends on model)	0 or 1	–185Lxx, –220Lxx, and –300Lxx models
Capacitor bank	CB	1	1	All models

Capacitor Life Curve

The DC bus inside the inverter uses a large capacitor as shown in the diagram below. The capacitor handles high voltage and current as it smooths the power for use by the inverter. So, any degradation of the capacitor will affect the performance of the inverter. The capacitor bank in L300P series inverters is replaceable. This section will show you how to replace it in the field.
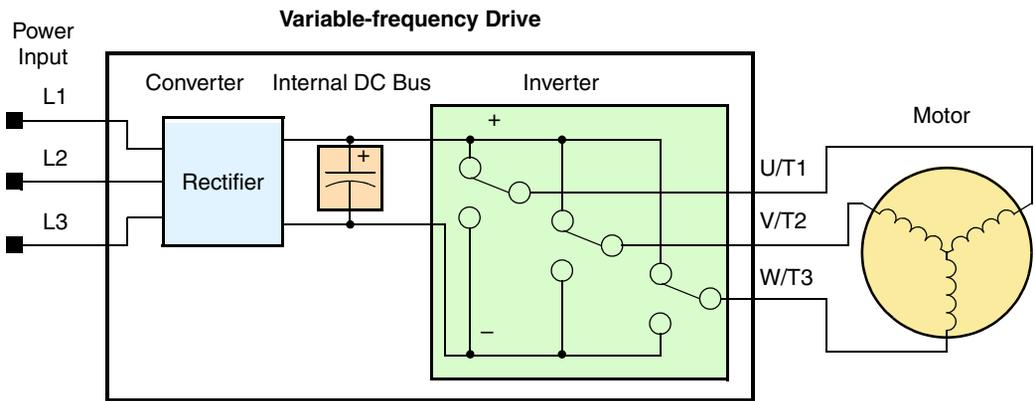
Capacitor life is reduced in higher ambient temperatures, as the graph below demonstrates. Be sure to keep the ambient temperature at acceptable levels, and perform maintenance inspections on the fan, heat sink, and other components. If the inverter is installed on a cabinet, the ambient temperature is the temperature inside the cabinet.

Capacitor Life Curve
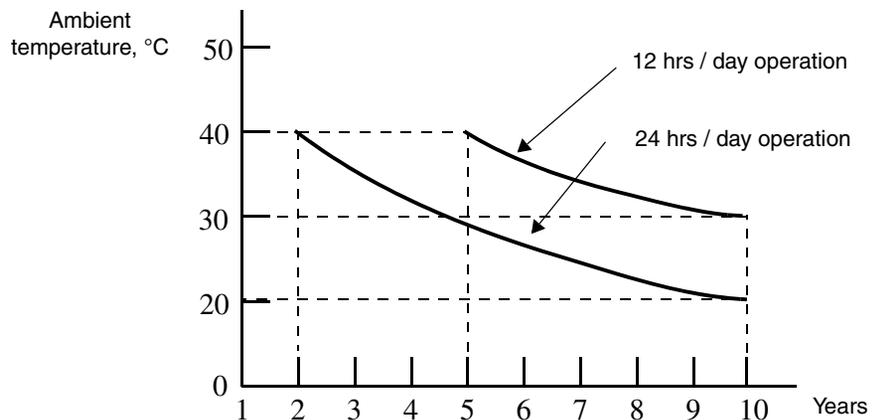
Capacitor Replacement

The capacitor bank consists of an assembly that slides out of the L300P unit. This means that no soldering is required!

1. First, make sure that all power is removed from the unit, and that you have waited 5 minutes before accessing the wiring area. Then you'll need to remove the metal wire entry plate located at the bottom of the unit. This may require you to disconnect all wires to the power terminals. Then, just loosen the screws as shown, and slide the wire entry plate outward on its guides to remove.

Retention screws for wire entry plate

WARNING: The screws that retain the capacitor bank assembly are part of the electrical circuit of the high-voltage internal DC bus. Be sure that all power has been disconnected from the inverter, and that you have waited at least 5 minutes before accessing the terminals or screws. Be sure the charge lamp is extinguished. Otherwise, there is the danger of electrocution to personnel.

2. The capacitor bank assembly is locked into the inverter via six screws that also make several electrical connections. These six screws are accessible just below the power terminals as shown to the right.
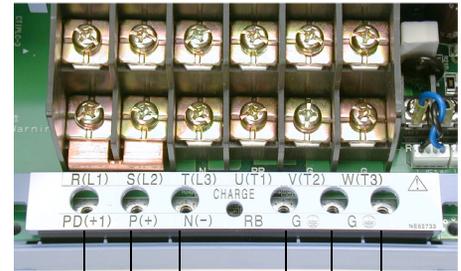
Retention screws locations for capacitor bank

3. Grasp the capacitor bank assembly and gently slide it out of the unit as shown to the right. DO NOT try to force the removal; it will slide out easily if all the screws in the steps above have been removed.

4. Then slide in the new unit and replace all the screws removed in steps 1) and 2).

CAUTION: Do not operate the inverter unless you have replaced the six screws that connect the capacitor bank assembly to the inverter's circuits. Otherwise, damage to the inverter may occur.
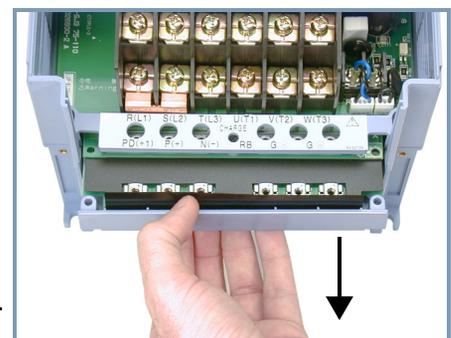
Pull capacitor bank assembly outward from L300P unit to remove

Troubleshooting and Maintenance

Fan Assembly Replacement

The L300P Series inverters have field-replaceable fan units. They include an internal connector for easy removal and replacement. You will need to remove the front panel covers to remove the fan assembly. First, be sure to remove power from the unit and wait at least 5 minutes before accessing the wiring area.

1. Remove the digital operator from the front panel. Then remove the bottom front panel to expose the wiring area as shown. This will also expose the retention screws for the top front panel. Remove these screws, which will allow the front panel to hinge upward and unfasten from the unit.

Digital operator keypad removal

Upper panel retention screws
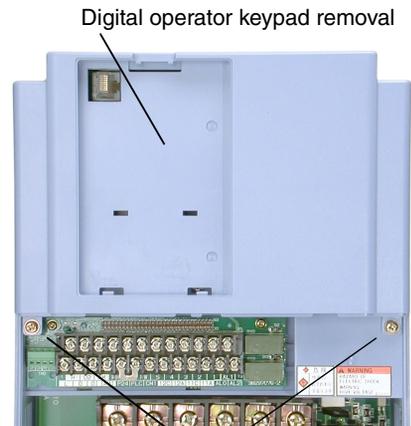
2. After removing all front panel pieces, locate the thumb latches in the top of the inverter housing. Grasp and push the releases inward as shown to the right, and gently pull upward to remove the fan assembly.

CAUTION: Remove the fan assembly carefully, since it is attached to the unit via connecting wires.
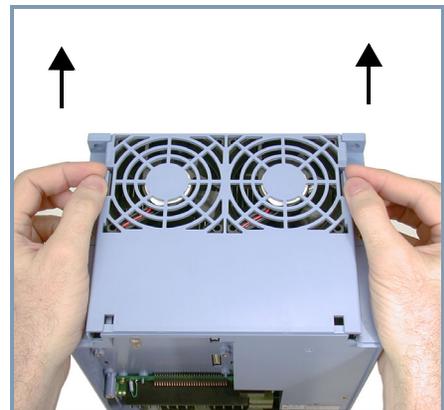
3. After unfastening the fan assembly, turn it over to expose the connecting wires. Then locate the PWB connector as shown. Disconnect the wiring.

4. Connect the new fan assembly wiring. The polarized plug will ensure a proper connection.

5. Snap the replacement fan into place.

6. Replace all front panel pieces and retention screws.

PWB connector for fan assembly wiring

Troubleshooting and Maintenance

General Inverter Electrical Measurements

The following table specifies how to measure key system electrical parameters. The diagrams on the next page show inverter-motor systems and the location of measurement points for these parameters.

Parameter	Circuit location of measurement	Measuring instrument	Notes	Reference Value
Supply voltage E_1	E_R – across L1 and L2 E_S – across L2 and L3 E_T – across L3 and L1	Moving-coil type voltmeter or rectifier type voltmeter	Fundamental wave effective value	Commercial supply voltage (200V class) 200-240V, 50/60 Hz 400V class 380-460V, 50/60 Hz
Supply current I_1	I_r – L1, I_s – L2, I_t – L3	Moving-coil type ammeter	Total effective value	—
Supply power W_1	W_{11} – across L1 and L2 W_{12} – across L2 and L3	Electronic type wattmeter	Total effective value	—
Supply power factor Pf_1	$$Pf_1 = \frac{W_1}{\sqrt{3} \times E_1 \times I_1} \times 100\%$$			—
Output voltage E_0	E_U – across U and V E_V – across V and W E_W – across W and U	Rectifier type voltmeter	Total effective value	—
Output current I_o	I_U – U I_V – V I_W – W	Moving-coil type ammeter	Total effective value	—
Output power W_o	W_{01} – across U and V W_{02} – across V and W	Electronic type wattmeter	Total effective value	—
Output power factor Pf_o	Calculate the output power factor from the output voltage E, output current I, and output power W. $$Pf_0 = \frac{W_0}{\sqrt{3} \times E_0 \times I_0} \times 100\%$$			—

Note 1: Use a meter indicating a fundamental wave effective value for voltage, and meters indicating total effective values for current and power.

Note 2: The inverter output has a distorted waveform, and harmonic frequencies may cause erroneous readings. However, the measuring instruments and methods listed above provide reasonably accurate results.

Note 3: A general-purpose digital volt meter (DVM) is not usually suitable to measure a distorted waveform (not pure sinusoid).

Troubleshooting and Maintenance

The figure below shows measurement locations for voltage, current, and power measurements listed in the table on the previous page. The voltage to be measured is the fundamental wave effective voltage. The power to be measured is the total effective power.

Three-phase measurement diagram
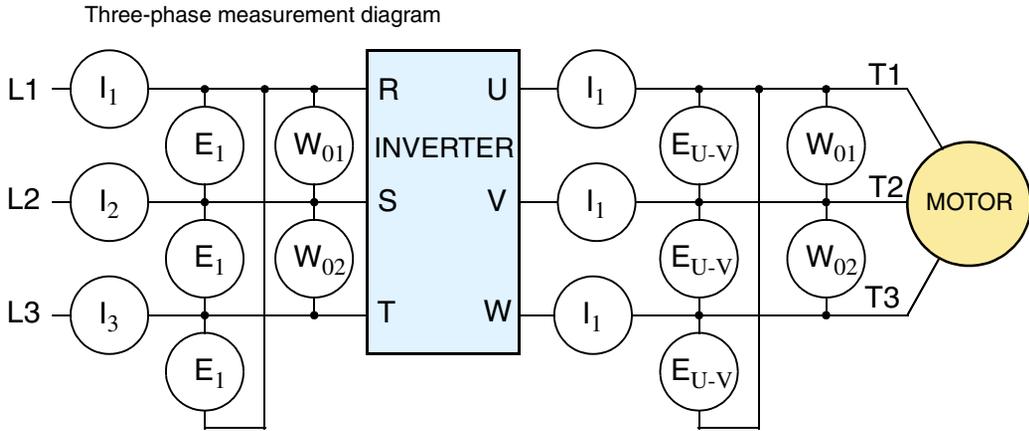
Inverter Output Voltage Measurement Techniques

Taking voltage measurements around drives equipment requires the right equipment and a safe approach. You are working with high voltages and high-frequency switching waveforms that are not pure sinusoids. Digital voltmeters will not usually produce reliable readings for these waveforms. And, it is usually risky to connect high voltage signals to oscilloscopes. The inverter output semiconductors have some leakage, and no-load measurements produce misleading results. So, we highly recommend using the following circuits to measure voltage for performing the equipment inspections.

Voltage measurement *with* load
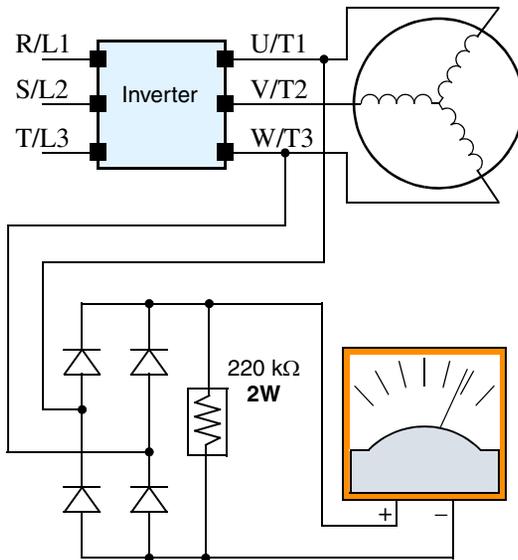
V class	Diode bridge	Voltmeter
200V class	600V 0.01A min.	300V range
400V class	1000V 0.1 A min.	600V range

Voltage measurement *without* load
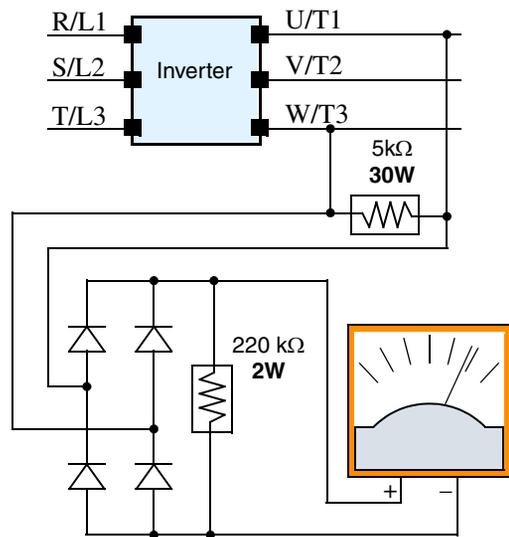
V class	Diode bridge	Voltmeter
200V class	600V 0.01A min.	300V range
400V class	1000V 0.1 A min.	600V range

HIGH VOLTAGE: Be careful not to touch wiring or connector terminals when working with the inverters and taking measurements. Be sure to place the measurement circuitry above in an insulated housing before using them.

IGBT Test Method

The following procedure will check the inverter transistors (IGBTs) and diodes:

1. Disconnect input power to terminals [R, S, and T] and motor terminals [U, V, and W].

2. Disconnect any wires from terminals [P] and [RB] for regenerative braking.

3. Use a Digital Volt Meter (DVM) and set it for 1 ohm resistance range. You can check the status of the charging state of terminals [R, S, T, U, V, W, RB, P, and N] of the inverter and the probe of the DVM by measuring the charging state.

Almost infinite ohms = "non-conducting," and 0 to 10 ohms = "conducting."

NOTE: The resistance values for the diodes or the transistors will not be exactly the same, but they will be close. If you find a significance difference, a problem may exist.

NOTE: Before measuring the voltage between [P] and [N] with the DC current range, confirm that the smoothing capacitor is discharged fully, then execute the tests.
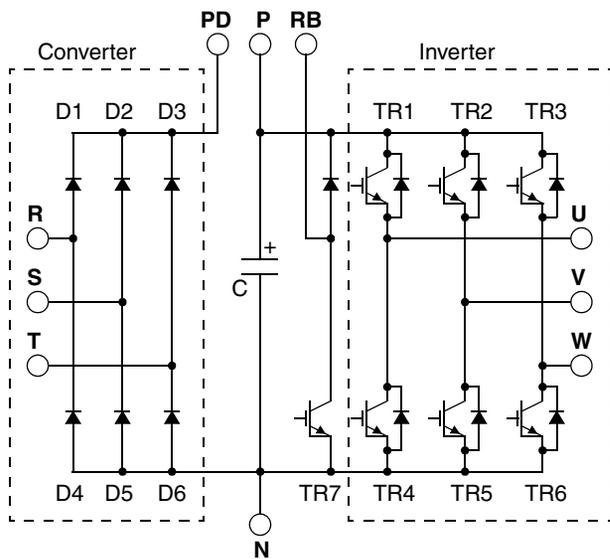
Circuit Type		DVM Probe		Measured Value
		+	–	
Converter	D1	R	PD	Non-conducting
		PD	R	Conducting
	D2	S	PD	Non-conducting
		PD	S	Conducting
	D3	T	PD	Non-conducting
		PD	T	Conducting
	D4	R	N	Conducting
		N	R	Non-conducting
	D5	S	N	Conducting
		N	S	Non-conducting
	D6	T	N	Conducting
		N	T	Non-conducting
Inverter	TR1	U	P	Non-conducting
		P	U	Conducting
	TR2	V	P	Non-conducting
		P	V	Conducting
	TR3	W	P	Non-conducting
		P	W	Conducting
	TR4	U	N	Conducting
		N	U	Non-conducting
	TR5	V	N	Conduct
		N	V	Non-conducting
	TR6	W	N	Conducting
		N	W	Non-conducting
Dynamic Braking (11kW–15kW)	TR7	RB	P	Non-conducting
		P	RB	Conducting
		RB	N	Non-conducting
		N	RB	Non-conducting

Warranty

Warranty Terms

The warranty period under normal installation and handling conditions shall be two (2) years from the date of manufacture ("DATE" on product nameplate), or one (1) year from the date of installation, whichever occurs first. The warranty shall cover the repair or replacement, at Hitachi's sole discretion, of ONLY the inverter that was installed.

1. Service in the following cases, even within the warranty period, shall be charged to the purchaser:
   a. Malfunction or damage caused by mis-operation or modification or improper repair
   b. Malfunction or damage caused by a drop after purchase and transportation
   c. Malfunction or damage caused by fire, earthquake, flood, lightning, abnormal input voltage, contamination, or other natural disasters

2. When service is required for the product at your work site, all expenses associated with field repair shall be charged to the purchaser.

3. Always keep this manual handy; please do not lose it. Please contact your Hitachi distributor to purchase replacement or additional manuals.

Glossary and Bibliography

A
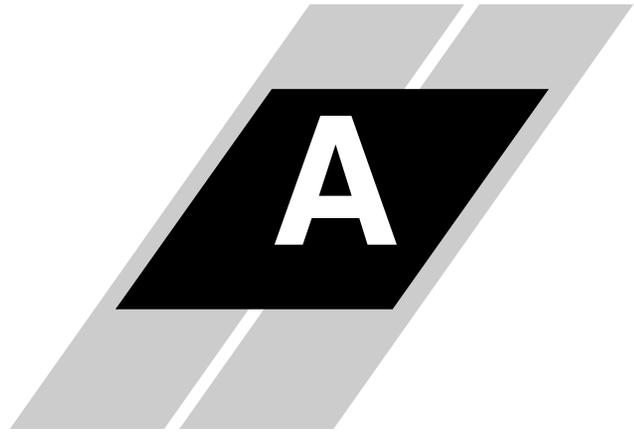
In This Appendix....   page

Glossary

Ambient Temperature
The air temperature in the chamber containing a powered electronic unit. A unit's heat sinks rely on a lower ambient temperature in order to dissipate heat away from sensitive electronics.

Arrival Frequency
The arrival frequency refers to the set output frequency of the inverter for the constant speed setting. The arrival frequency feature turns ON an output when the inverter reaches the set constant speed. The inverter has various arrival frequencies and pulsed or latched logic options.

Auto-tuning
The ability of a controller to execute a procedure that interacts with a load to determine the proper coefficients to use in the control algorithm. Auto-tuning is a common feature of process controllers with PID loops. Hitachi inverters such as the SJ300 series feature auto-tuning to determine motor parameters for optimal control.

Base Frequency
The power input frequency for which an AC induction motor is designed to operate. Most motors will specify a 50 to 60 Hz value. The Hitachi inverters have a programmable base frequency, so you must ensure that parameter matches the attached motor. The term *base frequency* helps differentiate it from the carrier frequency. See also *carrier frequency* and *frequency setting*.

Braking Resistor
An energy-absorbing resistor that dissipates energy from a decelerating load. Load inertia causes the motor to act as a generator during deceleration. See also *four-quadrant operation* and *dynamic braking.*

Break-away Torque
The torque a motor must produce to overcome the static friction of a load in order to start the load moving.

Carrier Frequency
The frequency of the constant, periodic, switching waveform that the inverter modulates to generate the AC output to the motor. See also *PWM*.

CE
A regulatory agency for governing the performance of electronic products in Europe. Drive installations designed to have CE approval must have particular filter(s) installed in the application.

Choke
An inductor that is tuned to react at radio frequencies is called a "choke," since it attenuates (chokes) frequencies above a particular threshold. Tuning is often accomplished by using a movable magnetic core. In variable-frequency drive systems, a choke positioned around high-current wiring can help attenuate harmful harmonics and protect equipment. See also *harmonics*.

DC Braking
The inverter DC braking feature stops the AC commutation to the motor, and sends a DC current through the motor windings in order to stop the motor. Also called "DC injection braking," it has little effect at high speed, and is used as the motor is nearing a stop.

DC Link
The portion of the variable frequency drive between the input rectifiers and the output stages. It delivers smoothed DC power to the control and output stages of the drive.

Deadband
In a control system, the range of input change for which there is no perceptible change in the output. In PID loops, the error term may have a deadband associated with it. Deadband may or may not be desirable; it depends on the needs of the application.

Digital Operator Panel
For Hitachi inverters, "digital operator panel" (DOP) refers first to the operator keypad on the front panel of the inverter. It also includes hand-held remote keypads, which connect to the inverter via a cable. Finally, the DOP Professional is a PC-based software simulation of the keypad devices.

Diode
A semiconductor device that has a voltage-current characteristic that allows current to flow only in one direction, with negligible leakage current in the reverse direction. See also *rectifier*.

Duty Cycle
1. The percent of time a square wave of fixed frequency is ON (high) versus OFF (low). 2. The ratio of operating time of a motor, braking resistor, etc. to its resting time. This parameter usually is specified in association with the allowable thermal rise for the device.

Dynamic Braking
The inverter dynamic braking feature shunts the motor-generated EMF energy into a special braking resistor. The added dissipation (braking torque) is effective at higher speeds, having a reduced effect as the motor nears a stop.

Error
In process control, the error is the difference between the desired value or setpoint (SP) and the actual value of a the process variable (PV). See also *process variable* and *PID Loop*.

EMI
Electromagnetic Interference - In motor/drive systems, the switching of high currents and voltages creates the possibility of generating radiated electrical noise that may interfere with the operation of nearby sensitive electrical instruments or devices. Certain aspects of an installation, such as long motor lead wire lengths, tend to increase the chance of EMI. Hitachi provides accessory filter components you can install to decrease the level of EMI.

Four-quadrant operation
Referring to a graph of torque versus speed, a four-quadrant drive can turn the motor either forward or reverse, as well as decelerate in either direction (see also *reverse torque*). A load that has a relatively high inertia and must move in both directions and change directions rapidly requires four-quadrant capability from its drive.

Free-run Stop
A method of stopping a motor, caused when the inverter simply turns OFF its motor output connections. This may allow the motor and load to coast to a stop, or a mechanical brake may intervene and shorten the deceleration time.

Frequency Setting
While frequency has a broad meaning in electronics, it typically refers to motor speed for variable-frequency drives (inverters). This is because the output frequency of the inverter is variable, and is proportional to the attained motor speed. For example, a motor with a base frequency of 60 Hz can be speed controlled with an inverter output varying form 0 to 60 Hz. See also *base frequency*, *carrier frequency*, and *slip*.

Harmonics
A *harmonic* is a whole number multiple of a base of fundamental frequency. The square waves used in inverters produce high-frequency harmonics, even though the main goal is to produce lower-frequency sine waves. These harmonics can be harmful to electronics (including motor windings) and cause radiated energy that interferes with nearby electronic devices. Chokes, line reactors, and filters are sometimes used to suppress the transmission of harmonics in an electrical system. See also *choke*.

Horsepower
A unit of physical measure to quantify the amount of work done per unit of time. You can directly convert between horsepower and Watts as measurements of power.

IGBT
Insulated Gate Bipolar Transistor (IGBT) - A semiconductor transistor capable of conducting very large currents when in saturation and capable of withstanding very high voltages when it is OFF. This high-power bipolar transistor is the type used in Hitachi inverters.

Inertia
The natural resistance of an object to being accelerated or decelerated by an external force. See also *momentum*.

Intelligent Terminal
A configurable input or output logic function on the Hitachi inverters. Each terminal may be assigned one of several functions.

Inverter
A device that electronically changes DC to AC current through a alternating process of switching the input to the output, inverted and non-inverted. A variable speed drive such as the Hitachi L300P is also called an inverter, since it contains three inverter circuits to generate 3-phase output to the motor.

Isolation Transformer	A transformer with 1:1 voltage ratio that provides electrical isolation between its primary and secondary windings. These are typically used on the power input side of the device to be protected. An isolation transformer can protect equipment from a ground fault or other malfunction of nearby equipment, as well as attenuate harmful harmonics and transients on the input power.
Jogging Operation	Usually done manually, a jog command from an operator's panel requests the motor/drive system to run indefinitely in a particular direction, until the machine operator ends the jog operation.
Jump Frequency	A jump frequency is a point on the inverter output frequency range that you want the inverter to skip around. This feature may be used to avoid a resonant frequency, and you can program up to three jump frequencies in the inverter.
Line Reactor	A three-phase inductor generally installed in the AC input circuit of an inverter to minimize harmonics and to limit short-circuit current.
Momentum	The physical property of a body in motion that causes it to continue to remain in motion. In the case of motors, the rotor and attached load are rotating and possess angular momentum.
Multi-speed Operation	The ability of a motor drive to store preset discrete speed levels for the motor, and control motor speed according to the currently selected speed preset. The Hitachi inverters have 16 preset speeds.
Motor Load	In motor terminology, motor load consists of the inertia of the physical mass that is moved by the motor and the related friction from guiding mechanisms. See also *inertia*.
NEC	The National Electric Code is a regulatory document that governs electrical power and device wiring and installation in the United States.
NEMA	The National Electric Manufacturer's Association. NEMA Codes are a published series of device ratings standards. Industry uses these to evaluate or compare the performance of devices made by various manufacturers to a known standard.
Open-collector Outputs	A common logic-type discrete output that uses an NPN transistor that acts as a switch to a power supply common, usually ground. The transistor's *collector* is *open* for external connection (not connected internally). Thus, the output *sinks* external load current to ground.
Power Factor	A ratio that expresses a phase difference (timing offset) between current and voltage supplied by a power source to a load. A perfect power factor = 1.0 (no phase offset). Power factors less than one cause some energy loss in power transmission wiring (source to load).
PID Loop	Proportional-Integral-Derivative – a mathematical model used for process control. A process controller maintains a process variable (PV) at a setpoint (SP) by using its PID algorithm to compensate for dynamic conditions and varies its output to drive the PV toward the desired value. See also *error*.
Process Variable	A physical property of a process that is of interest because it affects the quality of the primary task accomplished by the process. For an industrial oven, temperature is the process variable. See also *PID Loop* and *error*.
PWM	Pulse-width modulation: A type of AC adjustable frequency drive that accomplishes frequency and voltage control at the output section (inverter) of the drive. The drive output voltage waveform is at a constant amplitude, and by "chopping" the waveform (pulse-width-modulating), the average voltage is controlled. The chopping frequency is sometimes called the *carrier frequency*.

Reactance	The impedance of inductors and capacitors has two components. The resistive part is constant, while the reactive part changes with applied frequency. These devices have a complex impedance (complex number), where the resistance is the real part and the reactance is the imaginary part.
Rectifier	An electronic device made of one or more diodes that converts AC power into DC power. Rectifiers are usually used in combination with capacitors to filter (smooth) the rectified waveform to closely approximate a pure DC voltage source.
Regenerative Braking	A particular method of generating reverse torque to a motor, an inverter will switch internally to allow the motor to become a generator and will either store the energy internally, deliver the braking energy back to the main power input, or dissipate it with a resistor.
Regulation	The quality of control applied to maintain a parameter of interest at a desired value. Usually expressed as a percent (+/-) from the nominal, motor regulation usually refers to its shaft speed.
Reverse Torque	The torque applied in the direction opposite to motor shaft rotation. As such, reverse torque is a decelerating force on the motor and its external load.
Rotor	The windings of a motor that rotate, being physically coupled to the motor shaft. See also *stator*.
Saturation Voltage	For a transistor semiconductor device, it is in saturation when an increase in input current no longer results in an increase in the output current. The saturation voltage is the voltage drop across the device. The ideal saturation voltage is zero.
Sensorless Vector Control	A technique used in variable-frequency drives (such as the SJ100 and SJ300 series) to rotate the force vector in the motor without the use of a shaft position sensor (angular). Benefits include an increase in torque at the lowest speed and the cost savings from the lack of a shaft position sensor.
Setpoint (SP)	The setpoint is the desired value of a process variable of interest. See also *Process Variable (PV)* and *PID Loop*.
Single-phase Power	An AC power source consisting of Hot and Neutral wires. An Earth Ground connection usually accompanies them. In theory, the voltage potential on Neutral stays at or near Earth Ground, while Hot varies sinusoidally above and below Neutral. This power source is named Single Phase to differentiate it from three-phase power sources. Some Hitachi inverters can accept single phase input power, but they all output three-phase power to the motor. See also *three-phase*.
Slip	The difference between the theoretical (synchronous) speed of a motor at no load (determined by its inverter output waveforms) and the actual speed. Some slip is essential in order to develop torque to the load, but too much will cause excessive heat in the motor windings and/or cause the motor to stall.
Squirrel Cage	A "nick-name" for the appearance of the rotor frame assembly for an AC induction motor.
Stator	The windings in a motor that are stationary and coupled to the power input of the motor. See also *rotor*.
Start Frequency	The output frequency that the inverter first produces as the frequency command setting increases from zero. The start frequency is programmable, and is important to set properly for the load, etc.
Tachometer	1. A signal generator usually attached to the motor shaft for the purpose of providing feedback to the speed controlling device of the motor. 2. A speed-monitoring test meter that may optically sense shaft rotation speed and display it on a readout.

Thermal Switch   An electromechanical safety device that opens to stop current flow when the temperature at the device reaches a specific temperature threshold. Thermal switches are sometimes installed in the motor in order to protect the windings from heat damage. The inverter can use thermal switch signals to trip (shut down) if the motor overheats. See also *trip*.

Thermistor   A type of temperature sensor that changes its resistance according to its temperature. The sensing range of thermistors and their ruggedness make them ideal for motor overheating detection. Hitachi inverters have built-in thermistor input circuits, which can detect an overheated motor and shut OFF (trip) the inverter output.

Three-phase Power   An AC power source with three Hot connections that have phase offsets of 120 degrees is a 3-phase power source. Usually, Neutral and Earth Ground wires accompany the three Hot connections. Loads may be configured in a delta or Y configuration. A Y-connected load such as an AC induction motor will be a balanced load; the currents in all the Hot connections are the same. Therefore, the Neutral connection is theoretically zero. This is why inverters that generate 3-phase power for motors do not generally have a Neutral connection to the motor. However, the Earth Ground connection is important for safety reasons, and is provided.

Torque   A measure of rotational force. The units of measurement are the product of the distance (radius from shaft center axis) and force (weight) applied at that distance. Units are usually given as pound-feet, ounce-inches, or Newton-meters.

Transistor   A solid state, three-terminal device that provides amplification of signals and can be used for switching and control. While transistors have a linear operating range, inverters use them as high-powered switches. Recent developments in power semiconductors have produced transistors capable of handling high voltages and currents, all with high reliability. The saturation voltage has been decreasing, resulting in less heat dissipation. Hitachi inverters use state-of-the-art semiconductors to provide high performance and reliability in a compact package. See also *IGBT* and *saturation voltage*.

Trip   An event that causes the inverter to stop operation is called a "trip" event (as in *tripping* a circuit breaker). The inverter keeps a history log of trip events. They also require an action to clear.

Watt Loss   A measure of the internal power loss of a component, the difference between the power it consumes and what its output delivers. An inverter's watt loss is the input power minus the power delivered to the motor. The watt loss is typically highest when an inverter is delivering its maximum output. Therefore, watt loss is usually specified for a particular output level. Inverter watt loss specifications are important when designing enclosures.

Bibliography

Title	Author and Publisher
Variable Speed Drive Fundamentals, 2nd Ed.	Phipps, Clarence A. The Fairmont Press, Inc. / Prentice-Hall, Inc. 1997 ISBN 0-13-636390-3
Electronic Variable Speed Drives	Brumbach, Michael E. Delmar Publishers 1997 ISBN 0-8273-6937-9
Hitachi Inverter Technical Guide Book	Published by Hitachi, Ltd. Japan 1995 Publication SIG-E002

Serial Communications

B
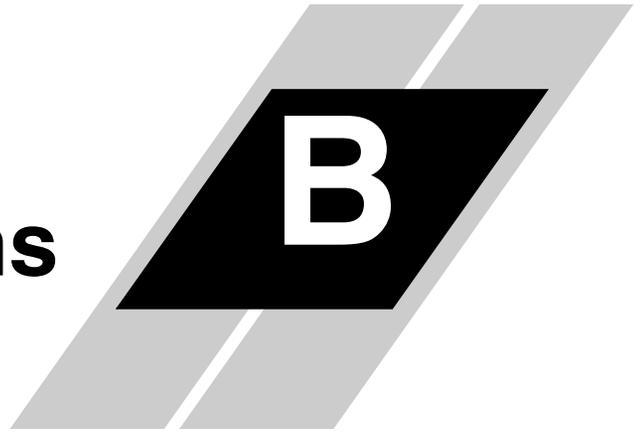
In This Appendix....   page

Introduction

L300P inverters have a built-in RS485 serial communications interface. This serial communications function provides a way of controlling from 1 to 32 inverters on a common serial network. In a typical application, a host computer or controller is the master and each of the inverter(s) is a slave, as shown in the figure below.
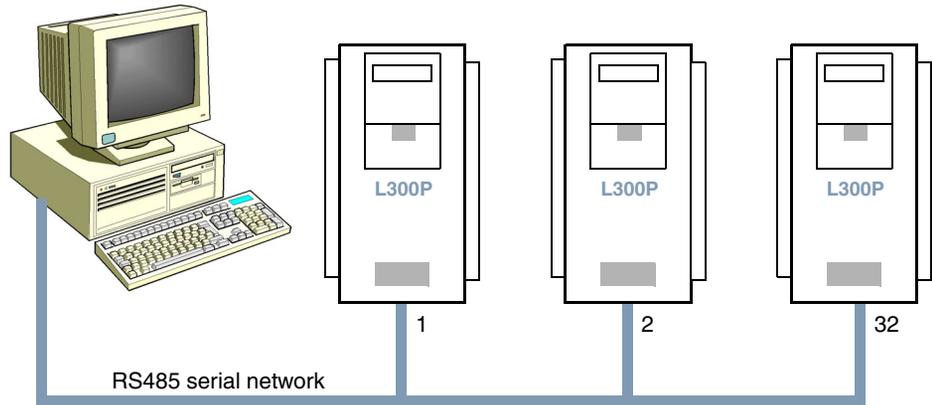
The specifications for L300P Series RS485 serial communications are in the following table:

Item	Specifications	User-selectable
Transmission speed	2400 / 4800 / 9600 / 19200 bps	✔
Communication modes	Half duplex (one device transmits at a time)	✘
Synchronization	Direct current transmission	✘
Character code	ASCII codes	✘
LSB placement	Transmits LBB first	✘
Electrical interface	RS485 differential transceiver	✘
Data bits	7 or 8 bits	✔
Parity	None / even / odd	✔
Stop bits	1 or 2 bits	✔
Start convention	One-way start from host device command	✘
Wait time for response	10 to 1000 ms	✔
Connections	Station address numbers from 1 to 32	✔
Error check	Overrun / Fleming block check code / vertical or horizontal parity	✘

Serial Connection Diagrams

The serial connector is to the left of the control logic connector as shown below:

Serial Communications Connector

SP | SN | RP | SN

Termination resistor (–)
Termination resistor (+)
Send/receive (–) Negative
Send/receive (+) Positive
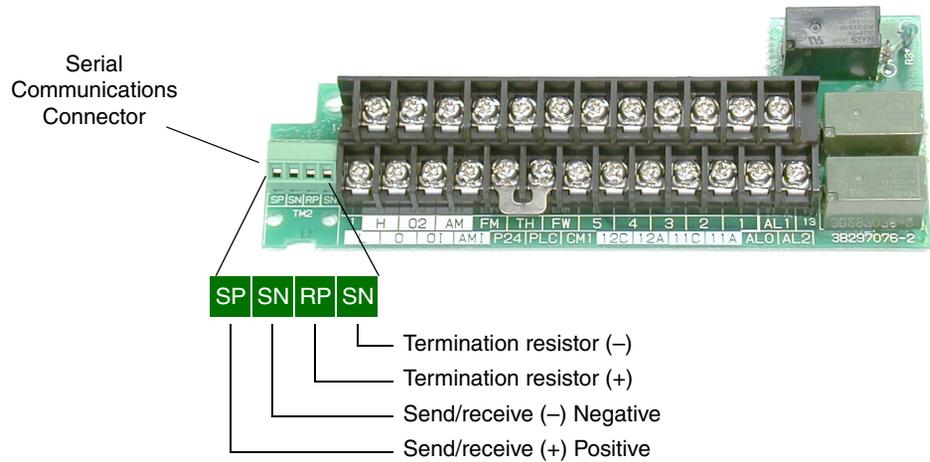
Each device requires just two connections for data transmission and reception. Additionally, the device at each physical end of the wiring requires a termination resistor. The L300P has built-in termination resistors that become part of the circuit when you add a jumper as shown.

L300P   L300P   L300P

SP SN RP SN   SP SN RP SN   SP SN RP SN

Send/receive (–)
Send/receive (+)

Termination jumper
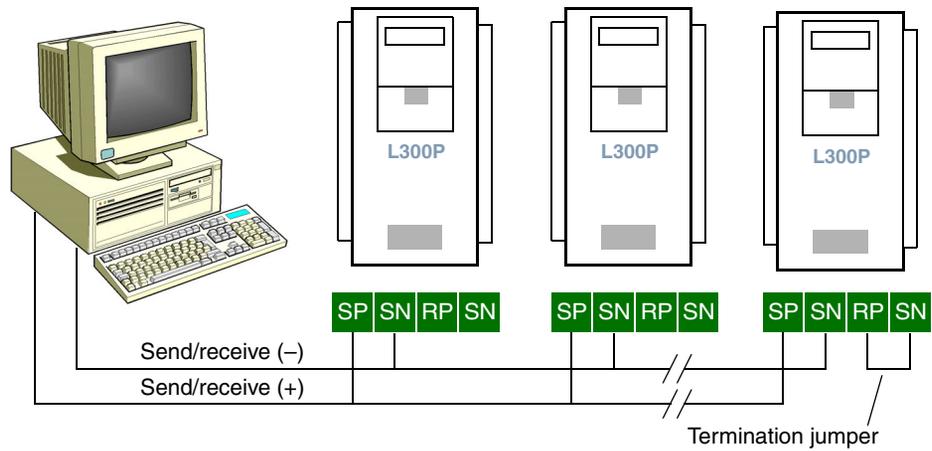
TIP: Each slave device on the serial network must have a unique node address, set by parameter C072. If this is a new application, we recommend connecting one new device at a time and checking the communications after each addition.

Serial Network Parameter Settings

Several parameter settings are necessary to configure serial communications, listed below.

Function Code	Item	Value	Description
C070	Data command source	02	Digital operator
		03	RS485 connector
		04	Expansion card #1
		05	Expansion card #2
C071	Baud rate	02	Loop-back test
		03	2400 bps
		04	4800 bps
		05	9600 bps
		06	19200 bps
C072	Node address	1 to 32, FF	1 to 32 – Node or station address (unique to each inverter or device) FF – Automatic broadcast (to all nodes on transmit, allowed only on certain commands (refer to each command description in this appendix)
C073	Data bits	07	7 bits
		08	8 bits
C074	Parity	00	none
		01	Even parity
		02	Odd parity
C075	Stop bits	01	1 bit
		02	2 bits
C078	Wait time	0 to 1000	0 to 1000 ms time that the inverter waits to respond to network master

For inverters on the same network, some settings must match from inverter to inverter. These include:

- Baud rate
- Data bits
- Parity
- Stop bits

However, the node address on each inverter must be unique, used only once on the network.

Communications Protocol

Introduction to Command List

The network master sends a frame to initiate communications with a slave, as shown in the figure to the right. After the set waiting time (per parameter C078, the inverter responds.
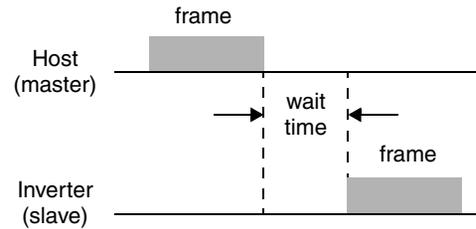
The following table lists the commands, single-character codes sent to a particular device on the network.

Command Code	Description	User-selectable
00	Forward / Reverse / Stop command	✔
01	Setting of frequency in standard profile	✔
02	Setting of intelligent terminal state	✔
03	Read all monitor data (block read)	—
04	Read inverter status	—
05	Read trip history	—
06	Read a single parameter value	—
07	Write a single parameter value	✔
08	Set inverter parameters to default values	✔
09	Verifies that the requested setting can be written to EEPROM.	—
0A	Writes a parameter value to EEPROM	✔
0B	Requests the recalculation of internal constant	✔

NOTE: Use of command 08 – set inverter parameters to default values first requires setting the initialization mode parameter B084 to 01 (initializes parameters only) or 02 (initializes parameters and clears the trip history).

Command – 00

The 00 command controls the Forward, Reverse and Stop mode of the inverter. You must set parameter A002=03 in order for serial communications control of the inverter to apply.

The frame format of command 00 follows the timing diagram and specification table.

Frame format

STX	Node	Command	Data	BCC	[CR]

Element	Description	Size	Value
STX	Control code (STart of TeXt)	1 byte	STX (0x02)
Node	Node (station) address of inverter	2 bytes	01 to 32, and FF (broadcast to all nodes)
Command	Transmission command	2 bytes	00
Data	Transmission data	1 byte	00 = Stop command 01 = Forward command 02 = Reverse command
BCC	Block check sum code	2 bytes	Exclusive OR of Node, Command, and Data
[CR]	Control code (carriage return)	1 byte	[CR] (0x0D)

The example below shows a transmission to the inverter at address Node 1 to rotate the motor in the forward direction.

(STX) | 01 | 00 | 1 | (BCC) | [CR]   ——— to ASCII ———►   02 | 30 31 | 30 30 | 31 | 33 30 | 0D

Command – 01

The 00 command sets the output frequency for the standard profile. You must set parameter A003=01 in order for serial communications control of the inverter to apply.

The frame format of command 00 follows the timing diagram and specification table.

Frame format

STX	Node	Command	Data	BCC	[CR]

Element	Description	Size	Value
STX	Control code (STart of TeXt)	1 byte	STX (0x02)
Node	Node (station) address of inverter	2 bytes	01 to 32, and FF (broadcast to all nodes)
Command	Transmission command	2 bytes	01
Data	Transmission data	6 bytes	ASCII code for ten times the frequency (accommodates two decimal places)
BCC	Block check sum code	2 bytes	Exclusive OR of Node, Command, and Data
[CR]	Control code (carriage return)	1 byte	[CR] (0x0D)

The example below shows a transmission to the inverter at address Node 1 to set the output frequency for 5 Hz. We use a value of 500 in ASCII to represent 5.00 Hz.

(STX) | 01 | 01 | 000500 | (BCC) |

——— to ASCII ———►   02 | 30 31 | 30 31 | 30 30 30 35 30 30 | 30 35 |

Command – 02

The 00 command assigns the function of the intelligent input terminals.

The frame format of command 00 follows the timing diagram and specification table.

Frame format

STX	Node	Command	Data	BCC	[CR]

Element	Description	Size	Value
STX	Control code (STart of TeXt)	1 byte	STX (0x02)
Node	Node (station) address of inverter	2 bytes	01 to 32, and FF (broadcast to all
Command	Transmission command	2 bytes	02
Data	Transmission data	16 bytes	(see table below)
BCC	Block check sum code	2 bytes	Exclusive OR of Node, Command, and Data
[CR]	Control code (carriage return)	1 byte	[CR] (0x0D)

The 16-byte data string is specified in the following table:

Data (Hex)	Description	Data (Hex)	Description
0000000000000001	[FW] Forward command	0000000000100000	[STA] 3-wire Start
0000000000000002	[RV] Reverse command	0000000000200000	[ST]P 3-wire Hold
0000000000000004	[CF1] Multi-speed 1	0000000000400000	[F/R] 3-wire FWD/REV
0000000000000008	[CF2] Multi-speed 2	0000000000800000	[PID] PID enable
0000000000000010	[CF3] Multi-speed 3	0000000001000000	[PIDC] PID integrator reset
0000000000000020	[CF4] Multi-speed 4	0000000002000000	—
0000000000000040	[JG] Jog operation	0000000004000000	—
0000000000000080	[DB] Dynamic braking	0000000008000000	[UP] remote control increment speed
0000000000000100	[SET] set 2nd motor	0000000010000000	[DWN] remote control decrement speed
0000000000000200	[2CH] 2-stage adjustable speed	0000000020000000	[UDC] remote control clear up/down
0000000000000400	—	0000000040000000	—
0000000000000800	[FRS] Free-run stop	0000000080000000	[OPE] Force from operator terminal
0000000000001000	[EXP] External trip	0000000100000000	[SF1] Multi-speed bit-level
0000000000002000	[USP] Unattended start protection	0000000200000000	[SF2] Multi-speed bit-level
0000000000004000	[CS] Commercial power change	0000000400000000	[SF3] Multi-speed bit-level
0000000000008000	[SFT] Software lock	0000000800000000	[SF4] Multi-speed bit-level
0000000000010000	[AT] analog input voltage/current	0000001000000000	[SF5] Multi-speed bit-level
0000000000020000	—	0000002000000000	[SF6] Multi-speed bit-level
0000000000040000	[RS] Reset	0000004000000000	[SF7] Multi-speed bit-level
0000000000080000	—	0000008000000000	[OLR] Overload restriction setting

The arrangement of the terminal assignment data permits you to assign all inputs in a single command. The example below shows a transmission to the inverter at address Node 1 to set the Forward command, Multi-speed 1 and Multi-speed 2.

Sum the three data strings:

$$
\begin{aligned}
&\ 0x0000000000000001 \\
&+\ 0x0000000000000004 \\
&+\ 0x0000000000000008 \\
&=\ 0x000000000000000D
\end{aligned}
$$

(STX) | 01 | 02 | 0x000000000000000D | (BCC) | (CR) $\xrightarrow{\text{to ASCII}}$

02 | 30 31 | 30 31 | 30 30 30 30 30 30 30 30 30 30 30 30 30 30 30 68 | 30 35 | 0D

Command – 03

The 03 command reads the monitor data as a single block.

The frame format of command 02 follows the diagram and specification table. The transmit frame has no data field.

Transmit frame format

STX	Node	Command	BCC	[CR]

Element	Description	Size	Value
STX	Control code (STart of TeXt)	1 byte	STX (0x02)
Node	Node (station) address of inverter	2 bytes	01 to 32
Command	Transmission command	2 bytes	03
BCC	Block check sum code	2 bytes	Exclusive OR of Node, Command, and Data
[CR]	Control code (carriage return)	1 byte	[CR] (0x0D)

The receive frame has a 104-byte data field, containing values for 13 items.

Receive frame format

STX	Node	Data	BCC	[CR]

Element	Description	Size	Value
STX	Control code (STart of TeXt)	1 byte	STX (0x02)
Node	Node (station) address of inverter	2 bytes	01 to 32
Data	Transmission data	104 bytes	(see next table)
BCC	Block check sum code	2 bytes	Exclusive OR of Node, Command, and Data
[CR]	Control code (carriage return)	1 byte	[CR] (0x0D)

Appendix B

The data in the receive frame contains 8-byte values for 13 items, listed in the table below:

No.	Monitor Item	Units	Multiplier
1	Output frequency	Hz	100
2	Output current	A	10
3	Direction of rotation	—	—
4	PID feedback monitor	%	100
5	Intelligent input monitor	—	—
6	Intelligent output monitor	—	—
7	Frequency converting monitor	—	100
8	Output torque monitor	%	1
9	Output voltage monitor	V	10
10	Electric power monitor	kW	10
11	Reserved	—	—
12	Run Mode time monitor	hours	1
13	Power ON time monitor	hours	1

The eight bytes for intelligent input or intelligent output data have a bit set in the data field for each I/O point that is ON, according to the following table:

Terminal	Monitor Item	Data
[FW]	Forward input	00000001
[1]	Input 1	00000002
[2]	Input 2	00000004
[3]	Input 3	00000008
[4]	Input 4	00000010
[5]	Input 5	00000020
[6]	Input 6	00000040
[7]	Input 7	00000080
[8]	Input 8	00000100
[AL]	Alarm relay	00000001
[11]	Output 1	00000002
[12]	Output 2	00000004
[13]	Output 3	00000008
[14]	Output 4	00000010
[15]	Output 5	00000020

Appendix B

Command – 04

The 04 command reads the status of the inverter. The frame format of command 04 follows the diagrams and specification tables. The transmit frame has no data field.

Transmit frame format

| STX | Node | Command | BCC | [CR] |

Element	Description	Size	Value
STX	Control code (STart of TeXt)	1 byte	STX (0x02)
Node	Node (station) address of inverter	2 bytes	01 to 32
Command	Transmission command	2 bytes	04
BCC	Block check sum code	2 bytes	Exclusive OR of Node, Command, and Data
[CR]	Control code (carriage return)	1 byte	[CR] (0x0D)

The receive frame has an 8-byte data field, containing values for three trip items (plus a reserved field).

Receive frame format

| STX | Node | Data | BCC | [CR] |

Element	Description	Size	Value
STX	Control code (STart of TeXt)	1 byte	STX (0x02)
Node	Node (station) address of inverter	2 bytes	01 to 32
Data	Transmission data	8 bytes	(see next table)
BCC	Block check sum code	2 bytes	Exclusive OR of Node, Command, and Data
[CR]	Control code (carriage return)	1 byte	[CR] (0x0D)

Trip data is organized as shown. The table below lists the codes and their meanings.

Data field contents

| Status A | Status B | Status C | (reserved) |

Code	Status A Definition	Status B Definition	Status C Definition
00	Initial status	On stopping	—
01	VDC waiting settlement	On running	Stop
02	On Stopping	On tripping	Deceleration speed
03	On running	—	Constant speed
04	On free-run stop	—	Acceleration speed
05	On jog	—	Forward
06	On dynamic braking	—	Reverse
07	On reading motor freq.	—	Reverse from forward
08	On retry	—	Forward from reverse
09	On under-voltage	—	Forward start
10	On trip	—	Reverse start
11	On waiting reset	—	—

Command – 05

The 05 command reads the inverter's trip history. The frame format of command 05 follows the diagrams and specification tables. The transmit frame has no data field.

Transmit frame format

| STX | Node | Command | BCC | [CR] |

Element	Description	Size	Value
STX	Control code (STart of TeXt)	1 byte	STX (0x02)
Node	Node (station) address of inverter	2 bytes	01 to 32
Command	Transmission command	2 bytes	05
BCC	Block check sum code	2 bytes	Exclusive OR of Node, Command, and Data
[CR]	Control code (carriage return)	1 byte	[CR] (0x0D)

The receive frame has a 440-byte data field. This consists of an 8-byte total accumulated number of trip events, followed by six 72-byte strings for the six most recent trip events as shown below.

Receive frame format

| STX | Node | Data | BCC | [CR] |

Data field contents

| Total count | Trip 1 | Trip 2 | Trip 3 | Trip 4 | Trip 5 | Trip 6 |

Element	Description	Size	Value
STX	Control code (STart of TeXt)	1 byte	STX (0x02)
Node	Node (station) address of inverter	2 bytes	01 to 32
Data	Transmission data	440 bytes	(see next table)
BCC	Block check sum code	2 bytes	Exclusive OR of Node, Command, and Data
[CR]	Control code (carriage return)	1 byte	[CR] (0x0D)

The nine bytes of data for each trip event history is listed below. The data contains the multiplier to adjust the decimal point. Divide the data by that factor to derive the actual value.

No.	Monitor Item	Units	Multiplier
1	Trip factor	—	—
2	Inverter Status A	—	—
3	Inverter Status B	—	—
4	Inverter Status C	—	—
5	Output frequency	Hz	10
6	Accumulated Run Mode time	hours	1
7	Output current	A	10
8	Output voltage	V	10
9	Power ON time	hours	1

Command – 06

The 06 command reads a single parameter value from the inverter, which is specified by the data field this read command.

Transmit frame format

STX	Node	Command	Data	BCC	[CR]

Element	Description	Size	Value
STX	Control code (STart of TeXt)	1 byte	STX (0x02)
Node	Node (station) address of inverter	2 bytes	01 to 32
Command	Transmission command	2 bytes	06
Data	Parameter specified to be read	4 bytes	(see tables below)
BCC	Block check sum code	2 bytes	Exclusive OR of Node, Command, and Data
[CR]	Control code (carriage return)	1 byte	[CR] (0x0D)

The receive frame includes an ACK (acknowledge) character, followed by an 8-byte data field.

Receive frame format

STX	Node	ACK	Data	BCC	[CR]

Element	Description	Size	Value
STX	Control code (STart of TeXt)	1 byte	STX (0x02)
Node	Node (station) address of inverter	2 bytes	01 to 32
ACK	Control code (ACKnowledge)	1 byte	ACK (0x06)
Data	Parameter value	8 bytes	Value of parameter times ten, returned as ASCII char. code, except for H003 and H203 (see table below)
BCC	Block check sum code	2 bytes	Exclusive OR of Node, Command, and Data
[CR]	Control code (carriage return)	1 byte	[CR] (0x0D)

Use the codes in the table below to return parameters for H03 and H203 (motor capacity selection).

Code Data	00	01	02	03	04	05	06	07	08	09	10
U.S. mode (B85=00, 02)	0.2 kW		0.4		0.75		1.5	2.,2		3.7	
EU mode (B85=01)	0.2 kW	0.37		0.55	0.75	1.1	1.5	2.2	3.0		4.0
Code Data	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
U.S. mode (B85=00, 02)	5.5 kW	7.5	11	15	18.5	22	30	37	45	55	75
EU mode (B85=01)	5.5 kW	7.5	11	15	18.5	22	30	37	45	55	75

Command – 07   The 07 command sets a parameter value equal to the value specified in the transmission. The frame format of command 07 follows the diagram and specification table.

Frame format

STX	Node	Command	Parameter	Data	BCC	[CR]

Element	Description	Size	Value
STX	Control code (STart of TeXt)	1 byte	STX (0x02)
Node	Node (station) address of inverter	2 bytes	01 to 32, and FF (broadcast to all nodes)
Command	Transmission command	2 bytes	07
Parameter	Function code of parameter	4 bytes	F002..., A001..., B001..., C001..., H003..., P001...
Data	Transmission data	8 bytes	Value of parameter times ten as ASCII char. code, except for H003 and H203 (see table below)
BCC	Block check sum code	2 bytes	Exclusive OR of Node, Command, and Data
[CR]	Control code (carriage return)	1 byte	[CR] (0x0D)

Note that the parameter F001, the output frequency, can be set more directly with host command 01 instead of with this command. Use the codes in the following table for setting parameters associated with H003 and H203.

Code Data	00	01	02	03	04	05	06	07	08	09	10
U.S. mode (B85=00, 02)	0.2 kW		0.4		0.75		1.5	2.,2		3.7	
EU mode (B85=01)	0.2 kW	0.37		0.55	0.75	1.1	1.5	2.2	3.0		4.0
Code Data	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
U.S. mode (B85=00, 02)	5.5 kW	7.5	11	15	18.5	22	30	37	45	55	75
EU mode (B85=01)	5.5 kW	7.5	11	15	18.5	22	30	37	45	55	75

Command – 08

The 08 command initializes the inverter parameters to the factory default values. First, you must set B84 (use command 07) to specify whether you want to clear the trip history at the same time. Also, set B85 to specify the country code for the initialization (use command 07).

The frame format of command 08 follows the diagram and specification table.

Frame format

STX	Node	Command	BCC	[CR]

Element	Description	Size	Value
STX	Control code (STart of TeXt)	1 byte	STX (0x02)
Node	Node (station) address of inverter	2 bytes	01 to 32, and FF (broadcast to all nodes)
Command	Transmission command	2 bytes	08
BCC	Block check sum code	2 bytes	Exclusive OR of Node, Command, and Data
[CR]	Control code (carriage return)	1 byte	[CR] (0x0D)

Command – 09

The 09 command verifies whether or not it is possible to set a particular parameter in the EEPROM. The frame format of command 08 follows the diagram and specification table.

Transmit frame format

STX	Node	Command	BCC	[CR]

Element	Description	Size	Value
STX	Control code (STart of TeXt)	1 byte	STX (0x02)
Node	Node (station) address of inverter	2 bytes	01 to 32
Command	Transmission command	2 bytes	09
BCC	Block check sum code	2 bytes	Exclusive OR of Node, Command, and Data
[CR]	Control code (carriage return)	1 byte	[CR] (0x0D)

The receive frame includes an ACK (acknowledge) character, followed by a 2-byte data field with the result.

Receive frame format

STX	Node	ACK	Data	BCC	[CR]

Element	Description	Size	Value
STX	Control code (STart of TeXt)	1 byte	STX (0x02)
Node	Node (station) address of inverter	2 bytes	01 to 32
ACK	Control code (ACKnowledge)	1 byte	ACK (0x06)
Data	Parameter value	2 bytes	00 = setting not allowed, 01 = setting is allowed
BCC	Block check sum code	2 bytes	Exclusive OR of Node, Command, and Data
[CR]	Control code (carriage return)	1 byte	[CR] (0x0D)

Command – 0A   The 0A command sets a value in the EEPROM.

The frame format of command 0A follows the diagram and specification table.

Frame format

| STX | Node | Command | BCC | [CR] |

Element	Description	Size	Value
STX	Control code (STart of TeXt)	1 byte	STX (0x02)
Node	Node (station) address of inverter	2 bytes	01 to 32, and FF (broadcast to all nodes)
Command	Transmission command	2 bytes	0A
BCC	Block check sum code	2 bytes	Exclusive OR of Node, Command, and Data
[CR]	Control code (carriage return)	1 byte	[CR] (0x0D)

Command – 0B   The 0B command recalculates the inverter's internal motor constants. Use this function after the base frequency or any Hxxx parameters are changed via the serial link commands.

The frame format of command 0B follows the diagram and specification table.

Frame format

| STX | Node | Command | BCC | [CR] |

Element	Description	Size	Value
STX	Control code (STart of TeXt)	1 byte	STX (0x02)
Node	Node (station) address of inverter	2 bytes	01 to 32
Command	Transmission command	2 bytes	0B
BCC	Block check sum code	2 bytes	Exclusive OR of Node, Command, and Data
[CR]	Control code (carriage return)	1 byte	[CR] (0x0D)

Communications Reference Information

Inverter Affirmative Reply

The standard affirmative reply from the inverter uses the ACK character (acknowledge) in the data field. The frame format of this reply follows the diagram and specification table.

Frame format

STX	Node	ACK	BCC	[CR]

Element	Description	Size	Value
STX	Control code (STart of TeXt)	1 byte	STX (0x02)
Node	Node (station) address of inverter	2 bytes	01 to 32
ACK	Control code (ACKnowledge)	1 byte	ACK (0x06)
BCC	Block check sum code	2 bytes	Exclusive OR of Node and ACK
[CR]	Control code (carriage return)	1 byte	[CR] (0x0D)

Inverter Negative Reply

The standard negative reply from the inverter uses the NAK character (negative acknowledge) in the data field. The frame format of this reply follows the diagram and specification table.

Frame format

STX	Node	NAK	Error code	BCC	[CR]

Element	Description	Size	Value
STX	Control code (STart of TeXt)	1 byte	STX (0x02)
Node	Node (station) address of inverter	2 bytes	01 to 32
Data	Error code – reason for negative acknowledge	2 bytes	(see error codes in next table)
NAK	Control code (Negative ACKnowledge)	1 byte	NAK (0x15)
Error code	Code representing error type	1 byte	(See next table below)
BCC	Block check sum code	2 bytes	Exclusive OR of Node, Data, and NAK
[CR]	Control code (carriage return)	1 byte	[CR] (0x0D)

The error codes for a NAK (negative acknowledge) are:

Error Code	Error Description	Error Code	Error Description
01H	Parity error	07H	Receive buffer overrun error
02H	Check sum error	08H	Receive time-out error
03H	Framing error	11H	Abnormal command code error
04H	Overrun error	13H	Test error code
05H	Protocol error	16H	Abnormal parameter code/value error
06H	ASCII code error	—	—

Block Check Code (BCC)

This section shows how the inverter protocol computes defines a BCC—block check code. The BCC is calculated for each frame transmitted and can be used to verify the integrity of data transmission. The example below shows command 01 setting the inverter frequency to 5Hz.

Frame format

STX	Node	Command	Data	BCC	[CR]

ASCII Code

(0x 02)

0 1   (0x 30 31)

0 1   (0x 30 31)

0 0 0 5 0 0   (0x 30 30 30 35 30 30)

0   (0x 30 35)

(0x 0D)
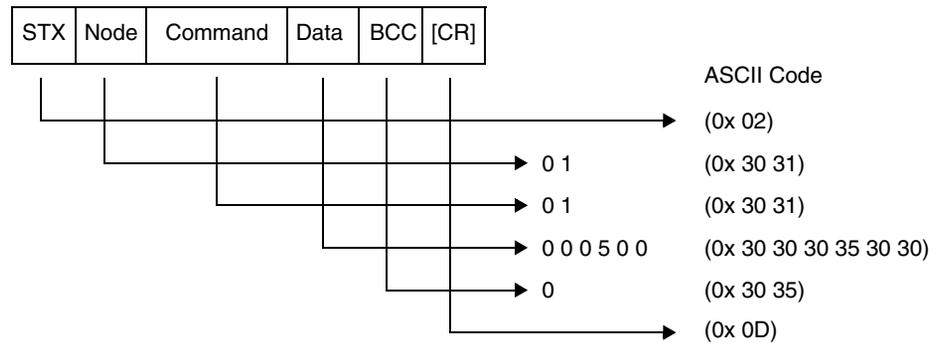
The block check code is computed by using the ASCII codes (shown above) and applying eXclusive OR (XOR) operations. Beginning with the first pair of bytes, the result of their XOR result is then used in an XOR operation with the third byte, and so on. For this example, the BCC calculation is shown below.

Data bytes:

```
30   31   30   31   30   30   30   35   30   30
     01
     31
          00
               30
                    00
                         30
                              05
                                   35
                                        05 ──→ BCC
```

XOR intermediate results
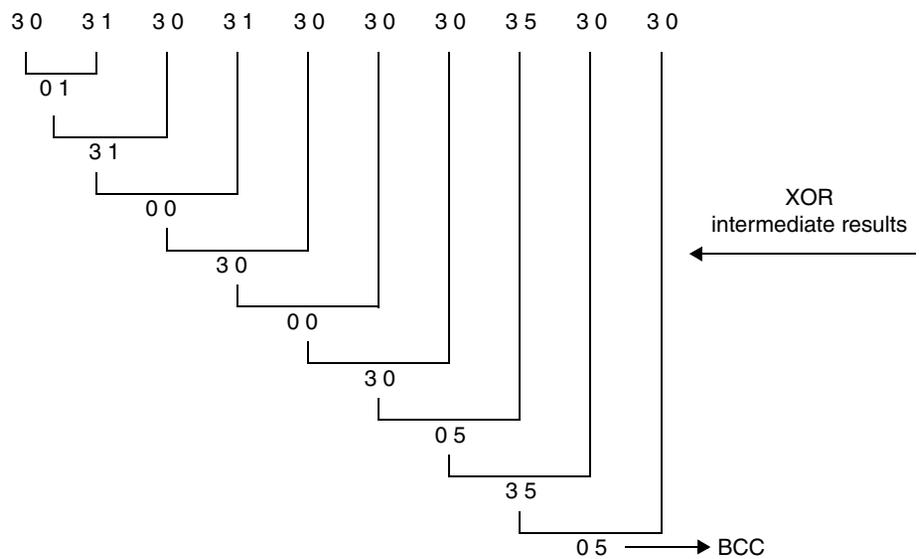
ASCII Code Table

The table below shows only the ASCII codes used for function codes and parameter data.

Character	ASCII Code	Character	ASCII Code	Character	ASCII Code
STX	0 2	4	3 4	C	4 3
ACK	0 6	5	3 5	D	4 4
CR	0 D	6	3 6	E	4 5
NAK	1 5	7	3 7	F	4 6
0	3 0	8	38	H	4 8
1	3 1	9	39	P	5 0
2	3 2	A	4 1	—	—
3	3 3	B	4 2	—	—

Drive Parameter Settings Tables

C

In This Appendix....

Introduction

This appendix lists the user-programmable parameters for the L300P series inverters and the default values for European, U.S. and Japanese product types. The right-most column of the tables is blank so you can record values you have changed from the default. This involves just a few parameters for most applications.
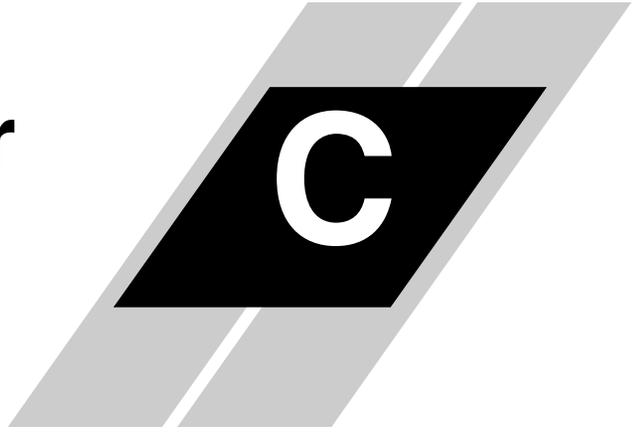
Parameter Settings for Keypad Entry

L300P series inverters provide many functions and parameters that can be configured by the user. We recommend that you record all parameters that have been edited, in order to help in troubleshooting or recovery from a loss of parameter data.

Inverter model   L300P

MFG. No.

} This information is printed on the specification label located on the right side of the inverter.

Main Profile Parameters

"F" Group Parameters		Default Setting			User Setting
Func. Code	Name	-FE2 (Europe)	-FU2 (USA)	-FR (Japan)	
F001	Output frequency setting	0.00	0.00	0.00	
F002	Acceleration (1) time setting	30.0	60.0	30.0	
F202	Acceleration (1) time setting, 2nd motor	30.0	60.0	30.0	
F003	Deceleration (1) time setting	30.0	60.0	30.0	
F203	Deceleration (1) time setting, 2nd motor	30.0	60.0	30.0	
F004	Keypad Run key routing	00	00	00	

Standard Functions

"A" Group Parameters		Default Setting			User Setting
Func. Code	Name	-FE2 (Europe)	-FU2 (USA)	-FR (Japan)	
A001	Frequency source setting	01	01	00	
A002	Run command source setting	01	01	02	
A003	Base frequency setting	50.	60.	60.	
A203	Base frequency setting, 2nd motor	50.	60.	60.	
A004	Maximum frequency setting	50.	60.	60.	
A204	Maximum frequency setting, 2nd motor	50.	60.	60.	
A005	[AT] selection	00	00	00	
A006	[O2] selection	00	00	00	
A011	[O]–[L] input active range start frequency	0.00	0.00	0.00	
A012	[O]–[L] input active range end frequency	0.00	60.00	0.00	
A013	[O]–[L] input active range start voltage	0.	0.	0.	
A014	[O]–[L] input active range end voltage	100.	100.	100.	
A015	[O]–[L] input start frequency enable	01	01	01	
A016	External frequency filter time const.	8.	8.	8.	
A019	Multi-speed operation selection	00	00	00	
A020	Multi-speed frequency setting	0.00	0.00	0.00	
A220	Multi-speed frequency setting, 2nd motor	0.00	0.00	0.00	
A021	Multi-speed 1 setting	0.00	0.00	0.00	
A022	Multi-speed 2 setting	0.00	0.00	0.00	
A023	Multi-speed 3 setting	0.00	0.00	0.00	
A024	Multi-speed 4 setting	0.00	0.00	0.00	
A025	Multi-speed 5 setting	0.00	0.00	0.00	
A026	Multi-speed 6 setting	0.00	0.00	0.00	
A027	Multi-speed 7 setting	0.00	0.00	0.00	
A028	Multi-speed 8 setting	0.00	0.00	0.00	
A029	Multi-speed 9 setting	0.00	0.00	0.00	
A030	Multi-speed 10 setting	0.00	0.00	0.00	
A031	Multi-speed 11 setting	0.00	0.00	0.00	

"A" Group Parameters		Default Setting			User Setting
Func. Code	Name	-FE2 (Europe)	-FU2 (USA)	-FR (Japan)	
A032	Multi-speed 12 setting	0.00	0.00	0.00	
A033	Multi-speed 13 setting	0.00	0.00	0.00	
A034	Multi-speed 14 setting	0.00	0.00	0.00	
A035	Multi-speed 15 setting	0.00	0.00	0.00	
A038	Jog frequency setting	1.00	1.00	1.00	
A039	Jog stop mode	00	00	00	
A041	Torque boost method selection	00	00	00	
A241	Torque boost method selection, 2nd motor	00	00	00	
A042	Manual torque boost value	1.0	1.0	1.0	
A242	Manual torque boost value, 2nd motor	1.0	1.0	1.0	
A43	Manual torque boost frequency adjustment	5.0	5.0	5.0	
A243	Manual torque boost frequency adjustment, 2nd motor	5.0	5.0	5.0	
A44	V/F characteristic curve selection, 1st motor	00	01	00	
A244	V/F characteristic curve selection, 2nd motor	00	01	00	
A045	V/f gain setting	100.	100.	100.	
A051	DC braking enable	00	00	00	
A052	DC braking frequency setting	0.50	0.50	0.50	
A053	DC braking wait time	0.0	0.0	0.0	
A054	DC braking force during deceleration	0.	0.	0.	
A055	DC braking time for deceleration	0.0	0.0	0.0	
A056	DC braking / edge or level detection for [DB] input	01	01	01	
A057	DC braking force for starting	0.	0.	0.	
A058	DC braking time for starting	0.0	0.0	0.0	
A059	DC braking carrier frequency setting	3.0	3.0	3.0	
A061	Frequency upper limit setting	0.00	0.00	0.00	
A0261	Frequency upper limit setting, 2nd motor	0.00	0.00	0.00	
A062	Frequency lower limit setting	0.00	0.00	0.00	
A0262	Frequency lower limit setting, 2nd motor	0.00	0.00	0.00	

"A" Group Parameters		Default Setting			User Setting
Func. Code	**Name**	**-FE2 (Europe)**	**-FU2 (USA)**	**-FR (Japan)**	
A063, A065, A067	Jump (center) frequency setting	0.00	0.00	0.00	
A064, A066, A068	Jump (hysteresis) frequency width setting	0.50	0.50	0.50	
A069	Acceleration stop frequency setting	0.00	0.00	0.00	
A070	Acceleration stop time frequency setting	0.0	0.0	0.0	
A071	PID Function Enable	00	00	00	
A072	PID proportional gain	1.0	1.0	1.0	
A073	PID integral time constant	1.0	1.0	1.0	
A074	PID derivative gain	0.0	0.0	0.0	
A075	PV scale conversion	1.00	1.00	1.00	
A076	PV source setting	00	00	00	
A081	AVR function select	00	00	02	
A082	AVR voltage select	230/400	230/460	200/400	
A085	Operation mode selection	00	00	00	
A086	Energy saving mode tuning	50.0	50.0	50.0	
A092	Acceleration (2) time setting	15.0	15.0	15.0	
A292	Acceleration (2) time setting, 2nd motor	15.0	15.0	15.0	
A093	Deceleration (2) time setting	15.0	15.0	15.0	
A293	Deceleration (2) time setting, 2nd motor	15.0	15.0	15.0	
A094	Select method to switch to Acc2/Dec2 profile	00	00	00	
A294	Select method to switch to Acc2/Dec2, 2nd motor	00	00	00	
A095	Acc1 to Acc2 frequency transition point	0.0	0.0	0.0	
A295	Acc1 to Acc2 frequency transition point, 2nd motor	0.0	0.0	0.0	
A096	Dec1 to Dec2 frequency transition point	0.0	0.0	0.0	
A296	Dec1 to Dec2 frequency transition point, 2nd motor	0.0	0.0	0.0	
A097	Acceleration curve selection	00	00	00	

"A" Group Parameters		Default Setting			User Setting
Func. Code	Name	-FE2 (Europe)	-FU2 (USA)	-FR (Japan)	
A098	Deceleration curve setting	00	00	00	
A101	[OI]–[L] input active range start frequency	0.00	0.00	0.00	
A102	[OI]–[L] input active range end frequency	0.00	60.00	0.00	
A103	[OI]–[L] input active range start current	20.	20.	20.	
A104	[OI]–[L] input active range end current	100.	100.	100.	
A105	[OI]–[L] input start frequency enable	01	01	01	
A111	[O2]–[L] input active range start frequency	0.00	0.00	0.00	
A112	[O2]–[L] input active range end frequency	0.00	0.00	0.00	
A113	[O2]–[L] input active range start voltage	–100.	–100.	–100.	
A114	[O2]–[L] input active range end voltage	100.	100.	100.	
A131	Acceleration curve constants setting	02	02	02	
A132	Deceleration curve constants setting	02	02	02	

Fine Tuning Functions

"B" Group Parameters		Default Setting			User Setting
Func. Code	Name	-FE2 (Europe)	-FU2 (USA)	-FR (Japan)	
B001	Selection of restart mode	00	00	00	
B002	Allowable under-voltage power failure time	1.0	1.0	1.0	
B003	Retry wait time before motor restart	1.0	1.0	1.0	
B004	Instantaneous power failure / under-voltage trip alarm enable	00	00	00	
B005	Number of restarts on power failure / under-voltage trip events	00	00	00	
B006	Phase loss detection enable	00	00	00	
B007	Restart frequency threshold	0.00	0.00	0.00	

"B" Group Parameters		Default Setting			User Setting
Func. Code	Name	-FE2 (Europe)	-FU2 (USA)	-FR (Japan)	
B012	Electronic thermal setting (calculated within the inverter from current output)	Rated current for each inverter	Rated current for each inverter	Rated current for each inverter	
B212	Electronic thermal setting (calculated within the inverter from current output), 2nd motor	Rated current for each inverter	Rated current for each inverter	Rated current for each inverter	
B013	Electronic thermal characteristic	01	00	00	
B213	Electronic thermal characteristic, 2nd motor	01	00	00	
B015	Free setting, electronic thermal frequency (1)	0.	0.	0.	
B016	Free setting, electronic thermal current (1)	0.0	0.0	0.0	
B017	Free setting, electronic thermal frequency (2)	0.	0.	0.	
B018	Free setting, electronic thermal current (2)	0.0	0.0	0.0	
B019	Free setting, electronic thermal frequency (3)	0.	0.	0.	
B020	Free setting, electronic thermal current (3)	0.0	0.0	0.0	
B021	Overload restriction operation mode	01	01	01	
B022	Overload restriction setting	Rated current x 1.20	Rated current x 1.10	Rated current x 1.20	
B023	Deceleration rate at overload restriction	1.0	15.0	1.0	
B024	Overload restriction operation mode (2)	01	01	01	
B025	Overload restriction setting (2)	Rated current x 1.20	Rated current x 1.20	Rated current x 1.20	
B026	Deceleration rate at overload restriction (2)	1.00	1.00	1.00	
B031	Software lock mode selection	01	01	01	
B034	Run/power-on warning time	0.	0.	0.	
B035	Rotational direction restriction	00	00	00	
B036	Reduced voltage start selection	06	06	06	
B037	Function code display restriction	00	00	00	
B080	[AM] terminal analog meter adjustment	180	180	180	
B081	[FM] terminal analog meter adjustment	60	60	60	

"B" Group Parameters		Default Setting			User Setting
Func. Code	Name	-FE2 (Europe)	-FU2 (USA)	-FR (Japan)	
B082	Start frequency adjustment	0.50	0.50	0.50	
B083	Carrier frequency setting	3.0	3.0	3.0	
B084	Initialization mode (parameters or trip history)	00	00	00	
B085	Country code for initialization	01	02	00	
B086	Frequency scaling conversion factor	1.0	1.0	1.0	
B087	STOP key enable	00	00	00	
B088	Restart mode after FRS	00	00	00	
B090	Dynamic braking usage ratio	0.0	0.0	0.0	
B091	Stop mode selection	00	00	00	
B092	Cooling fan control	00	00	00	
B095	Dynamic braking control	00	00	00	
B096	Dynamic braking activation level	360/720	360/720	360/720	
B098	Thermistor for thermal protection control	00	00	00	
B099	Thermal protection level setting	3000.	3000.	3000.	
B100	Free-setting V/f frequency (1)	0.	0.	0.	
B101	Free-setting V/f voltage (1)	0.0	0.0	0.0	
B102	Free-setting V/f frequency (2)	0.	0.	0.	
B103	Free-setting V/f voltage (2)	0.0	0.0	0.0	
B104	Free-setting V/f frequency (3)	0.	0.	0.	
B105	Free-setting V/f voltage (3)	0.0	0.0	0.0	
B106	Free-setting V/f frequency (4)	0.	0.	0.	
B107	Free-setting V/f voltage (4)	0.0	0.0	0.0	
B108	Free-setting V/f frequency (5)	0.	0.	0.	
B109	Free-setting V/f voltage (5)	0.0	0.0	0.0	
B110	Free-setting V/f frequency (6)	0.	0.	0.	
B111	Free-setting V/f voltage (6)	0.0	0.0	0.0	
B112	Free-setting V/f frequency (7)	0.	0.	0.	
B113	Free-setting V/f voltage (7)	0.0	0.0	0.0	

Intelligent Terminal Functions

"C" Group Parameters		Default Setting			User Setting
Func. Code	Name	-FE2 (Europe)	-FU2 (USA)	-FR (Japan)	
C001	Terminal [1] function	18	18	18	
C002	Terminal [2] function	16	16	16	
C003	Terminal [3] function	03	13	03	
C004	Terminal [4] function	02	02	02	
C005	Terminal [5] function	01	01	01	
C011	Terminal [1] active state	00	00	00	
C012	Terminal [2] active state	00	00	00	
C013	Terminal [3] active state	00	01	00	
C014	Terminal [4] active state	00	00	00	
C015	Terminal [5] active state	00	00	00	
C019	Terminal [FW] active state	00	00	00	
C021	Terminal [11] function	01	01	01	
C022	Terminal [12] function	00	00	00	
C026	Alarm relay terminal function	05	05	05	
C027	[FM] signal selection	00	00	00	
C028	[AM] signal selection	00	00	00	
C029	[AMI] signal selection	00	00	00	
C031	Terminal [11] active state	00	00	00	
C032	Terminal [12] active state	00	00	00	
C036	Alarm relay active state	01	01	01	
C040	Overload signal output mode	01	01	01	
C041	Overload level setting	Rated current for each inverter	Rated current for each inverter	Rated current for each inverter	
C042	Frequency arrival setting for accel.	0.00	0.00	0.00	
C043	Arrival frequency setting for decel.	0.00	0.00	0.00	
C044	PID deviation level setting	3.0	3.0	3.0	
C061	Electronic thermal warning level setting	80.	80.	80.	
C070	Data command method	02	02	02	
C071	Communication speed selection	04	04	04	
C072	Node allocation	1.	1.	1.	

"C" Group Parameters		Default Setting			User Setting
Func. Code	**Name**	**-FE2 (Europe)**	**-FU2 (USA)**	**-FR (Japan)**	
C073	Communication data length selection	7	7	7	
C074	Communication parity selection	00	00	00	
C075	Communication stop bit selection	1	1	1	
C078	Communication wait time	0.	0.	0.	
C081	[O] input span calibration	Factory set	Factory set	Factory set	
C082	[OI] input span calibration	Factory set	Factory set	Factory set	
C083	[O2] input span calibration	Factory set	Factory set	Factory set	
C085	Thermistor input tuning	105.0	105.0	105.0	
C086	[AM] terminal offset tuning	0.0	0.0	0.0	
C087	[AMI] terminal meter tuning	80.	80.	80.	
C088	[AMI] terminal offset tuning	Factory set	Factory set	Factory set	
C091	Debug mode enable	00	00	00	Do not edit
C101	Up/Down memory mode selection	00	00	00	
C102	Reset mode selection	00	00	00	
C103	Restart mode after reset	00	00	00	
C121	[O] input zero calibration	Factory set	Factory set	Factory set	
C122	[OI] input zero calibration	Factory set	Factory set	Factory set	
C123	[O2] input zero calibration	Factory set	Factory set	Factory set	

Motor Constants Functions

"H" Group Parameters		Default Setting			User Setting
Func. Code	**Name**	**-FE2 (Europe)**	**-FU2 (USA)**	**-FR (Japan)**	
H003	Motor capacity, 1st motor	Factory set	Factory set	Factory set	
H203	Motor capacity, 2nd setting	Factory set	Factory set	Factory set	
H004	Motor poles setting, 1st motor	4	4	4	
H204	Motor poles setting, 2nd motor	4	4	4	
H006	Motor stabilization constant, 1st motor	100.	100.	100.	
H206	Motor stabilization constant, 2nd motor	100.	100.	100.	

Expansion Card Functions

"P" Group Parameters		Default Setting			User Setting
Func. Code	Name	-FE2 (Europe)	-FU2 (USA)	-FR (Japan)	
P001	Operation mode on expansion card 1 error	00	00	00	
P002	Operation mode on expansion card 2 error	00	00	00	
P031	Accel/decel time input selection	00	00	00	
P044	DeviceNet comm watchdog timer	1.00	1.00	1.00	
P045	Inverter action on DeviceNet comm error	01	01	01	
P046	DeviceNet polled I/O: Output instance number	21	21	21	
P047	DeviceNet polled I/O: Input instance number	71	71	71	
P048	Inverter action on DeviceNet idle mode	01	01	01	
P049	Motor poles setting for RPM	0	0	0	
P050	Output frequency for analog reference signal loss (–xFE2/–xFU2 models only)	00	00	—	

User-selectable Menu Functions

"P" Group Parameters		Default Setting			User Setting
Func. Code	**Name**	**-FE2 (Europe)**	**-FU2 (USA)**	**-FR (Japan)**	
U001	User-selected function... "no" = disabled, or use any of the functions D001 to P049	no	no	no	
U002		no	no	no	
U003		no	no	no	
U004		no	no	no	
U005		no	no	no	
U006		no	no	no	
U007		no	no	no	
U008		no	no	no	
U009		no	no	no	
U010		no	no	no	
U011		no	no	no	
U012		no	no	no	

CE–EMC Installation Guidelines

D
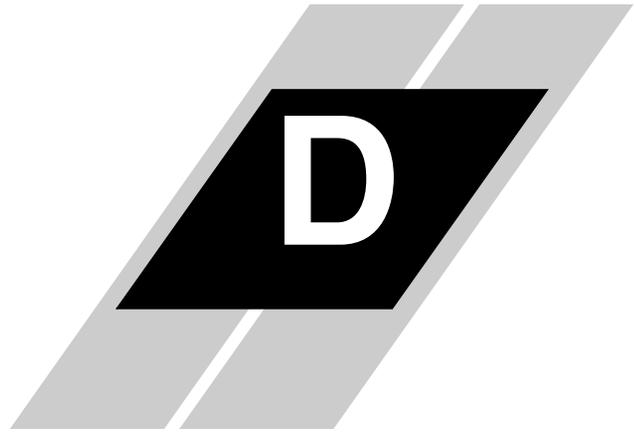
In This Appendix.... page

CE–EMC Installation Guidelines

You are required to satisfy the EMC directive (89/336/EEC) when using an L300P inverter in an EU country. To satisfy the EMC directive and to comply with standard, follow the guidelines in this section.

1. **As user you must ensure that the HF (high frequency) impedance between adjustable frequency inverter, filter, and ground is as small as possible.**

   • Ensure that the connections are metallic and have the largest possible contact areas (zinc-plated mounting plates).

2. **Avoid conductor loops that act like antennas, especially loops that encompass large areas.**

   • Avoid unnecessary conductor loops.

   • Avoid parallel arrangement of low-level signal wiring and power-carrying or noise-prone conductors.

3. **Use shielded wiring for the motor cable and all analog and digital control lines.**

   • Allow the effective shield area of these lines to remain as large as possible; i.e., do not strip away the shield (screen) further away from the cable end than absolutely necessary.

   • With integrated systems (for example, when the adjustable frequency inverter is communicating with some type of supervisory controller or host computer in the same control cabinet and they are connected at the same PE-potential), connect the shields of the control lines to ground + PE (protective earth) at both ends. With distributed systems (for example the communicating supervisory controller or host computer is not in the same control cabinet and there is a distance between the systems), we recommend connecting the shield of the control lines only at the end connecting to the adjustable frequency inverter. If possible, route the other end of the control lines directly to the cable entry section of the supervisory controller or host computer. The shield conductor of the motor cables always must connected to PE at both ends.

   • To achieve a large area contact between shield and PE-potential, use a PG screw with a metallic shell, or use a metallic mounting clip.

   • Use only cable with braided, tinned copper mesh shield (type "CY") with 85% coverage.

   • The shielding continuity should not be broken at any point in the cable. If the use of reactors, contactors, terminals, or safety switches in the motor output is necessary, the unshielded section should be kept as short as possible.

   • Some motors have a rubber gasket between terminal box and motor housing. Very often, the terminal boxes, and particularly the threads for the metal PG screw connections, are painted. Make sure there is always a good metallic connection between the shielding of the motor cable, the metal PG screw connection, the terminal box, and the motor housing. If necessary, carefully remove paint between conducting surfaces.

4. **Take measures to minimize interference that is frequently coupled in through installation cables.**

   • Separate interfering cables with 0.25m minimum from cables susceptible to interference. A particularly critical point is laying parallel cables over longer distances. If two cables intersect (one crosses over the other), the interference is smallest if they intersect at an angle of 90°. Cables susceptible to interference should therefore only intersect motor cables, intermediate circuit cables, or the wiring of a rheostat at right angles and never be laid parallel to them over longer distances.

5. **Minimize the distance between an interference source and an interference sink (interference-threatened device), thereby decreasing the effect of the emitted interference on the interference sink.**

   • You should use only interference-free devices and maintain a minimum distance of 0.25 m from the adjustable frequency inverter.

6. Follow safety measures in the filter installation.

- Ensure that the protective earth terminal (PE) of the filter is properly connected to the PE terminal of the adjustable frequency inverter. An *HF ground connection* via metal contact between the housings of the filter and the adjustable frequency inverter, or solely via cable shield, *is not permitted as a protective conductor connection*. The *filter must be solidly and permanently connected with the ground potential* so as to preclude the danger of electric shock upon touching the filter if a fault occurs.

To achieve a protective ground connection for the filter:

- Ground the filter with a conductor of at least 10 mm^2 cross-sectional area.
- Connect a second grounding conductor, using a separate grounding terminal parallel to the protective conductor. (The cross section of each single protective conductor terminal must be sized for the required nominal load.)

L300P inverter with footprint-type filter
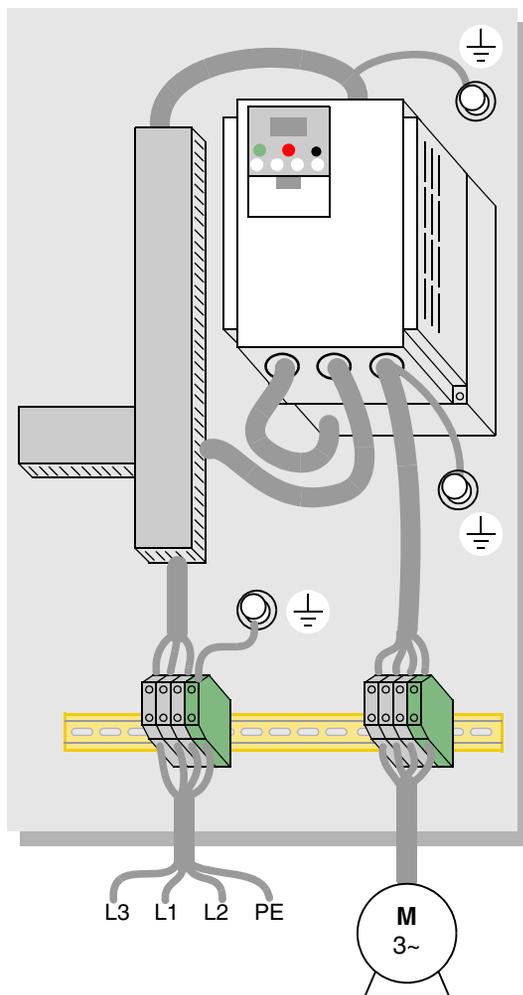
L300P inverter with book-type filter
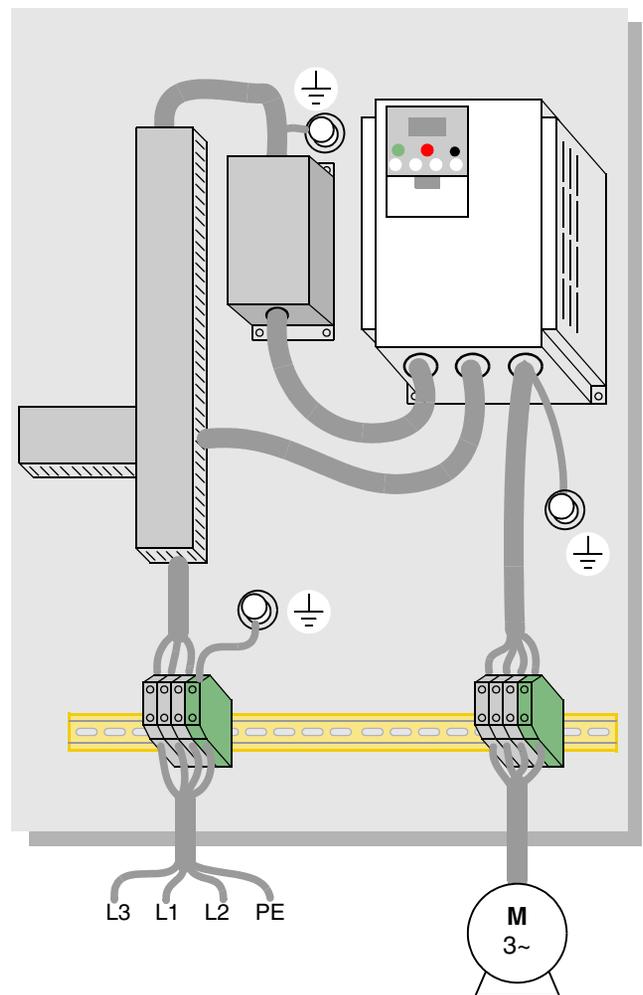
Hitachi EMC Recommendations

WARNING: This equipment should be installed, adjusted, and serviced by qualified personal familiar with construction and operation of the equipment and the hazards involved. Failure to observe this precaution could result in bodily injury.

Use the following checklist to ensure the inverter is within proper operating ranges and conditions.

1. The power supply to L300P inverters must meet these specifications:
   - Voltage fluctuation+/- 10% or less
   - Voltage imbalance +/- 3% or less
   - Frequency variation +/- 4% or less
   - Voltage distortion THD = 10% or less

2. Installation measure:
   - Use a filter designed for L300P inverter.

3. Wiring:
   - Shielded wire (screened cable) is required for motor wiring, and the length must be less than 50 meters.
   - The carrier frequency setting must be less than 5 kHz to satisfy EMC requirements.
   - Separate the power input and motor wiring from the signal/process circuit wiring.

4. Environmental conditions—when using a filter, follow these guidelines:
   - Ambient temperature: –10 to 40 °C
   - Humidity: 20 to 90% RH (non-condensing)
   - Vibration: 5.9 m/sec^2 (0.6 G) 10 ~ 55Hz, L300P–110xxx to L300P–300xxx
     2.94 m/sec^2 (0.3 G) 10 ~ 55Hz, L300P–370xxx to L300P–1320xxx
   - Location: 1000 meters or less altitude, indoors (no corrosive gas or dust)

Index