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RELIANCE ELECTRIC

Installing, Operating, and Maintaining the Three-Phase Input Three-Phase Output General Purpose GP-2000 AC V*S Drives

1/4 to 10 HP at 230 VAC
1/4 to 20 HP at 460 VAC
3 to 20 HP at 575 VAC

IEC Classified

V*S Drives

Instruction Manual D2-3166-10

Rockwell Automation

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DANGER

ONLY QUALIFIED ELECTRICAL PERSONNEL FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF THIS EQUIPMENT AND THE HAZARDS INVOLVED SHOULD INSTALL, ADJUST, OPERATE, AND/OR SERVICE IT. READ AND UNDERSTAND THIS MANUAL IN ITS ENTIRETY BEFORE PROCEEDING. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

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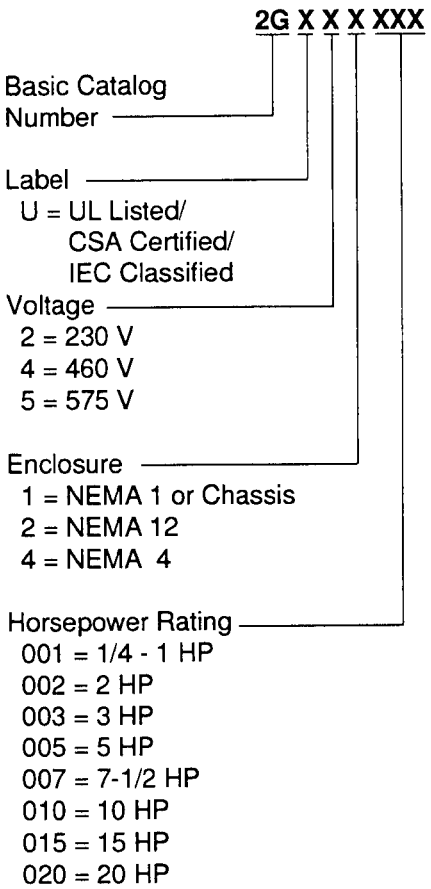
1: Receive and Accept the Controller

The products described in this instruction manual are manufactured by Reliance Electric Industrial Company.

Identify the Controller

Each Reliance Electric GP-2000 A-C V★S® Controller can be positively identified by its model number (standard controller) or sales order number (customer specified controller). This number appears on the shipping label and is stamped on the controller nameplate. Refer to this number whenever discussing the equipment with Reliance Electric personnel.

The standard model number describes the controller as follows:



Receive and Accept the Shipment

Reliance Electric's terms of sale, in all instances, are F.O.B. point of origin. The user is responsible for thoroughly inspecting the equipment before accepting shipment from the transportation company.

If all the items called for on the bill of lading or on the express receipt are not included or if any items are obviously damaged, do not accept the shipment until the freight or express agent makes an appropriate notation on your freight bill or express receipt.

If any concealed loss or damage is discovered later, notify your freight or express agent within 15 days of receipt and request that he make an inspection of the shipment. Keep the entire shipment intact in its original shipping container.

The user is responsible for making claim against the Carrier for any shortage or damage occurring in transit. Claims for loss or damage in shipment must not be deducted from the Reliance Electric invoice, nor should payment of the Reliance® invoice be withheld while awaiting adjustment of such claims since the Carrier guarantees safe delivery.

If considerable damage has been incurred and the situation is urgent, contact the nearest Reliance Electric Sales Office for assistance.

File a Return Request

1. To return equipment, send a written request to Reliance Electric within ten days of receipt.
2. Do not return equipment without a numbered Equipment Return Authorization (ERA) from Reliance Electric.
3. Reliance Electric reserves the right to inspect the equipment on site.

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Store the Controller until Installation

After receipt inspection, repack the GP-2000 A-C V★S Controller in its shipping container until installation. If a period of storage is expected, store in the original shipping container with its internal packing.

To ensure satisfactory drive operation at startup and to maintain warranty coverage, store the equipment

- in its original shipping container in a clean, dry, safe place.
- within an ambient temperature range of -40°C to 65°C (-40°F to 149°F).
- within a relative humidity range of 5 to 95% without condensation.
- away from a highly corrosive atmosphere. In harsh environments, cover the shipping/storage container.
- away from construction areas.

If storage will be longer than five months, contact Reliance for long-term storage instructions.

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2: Know the Controller

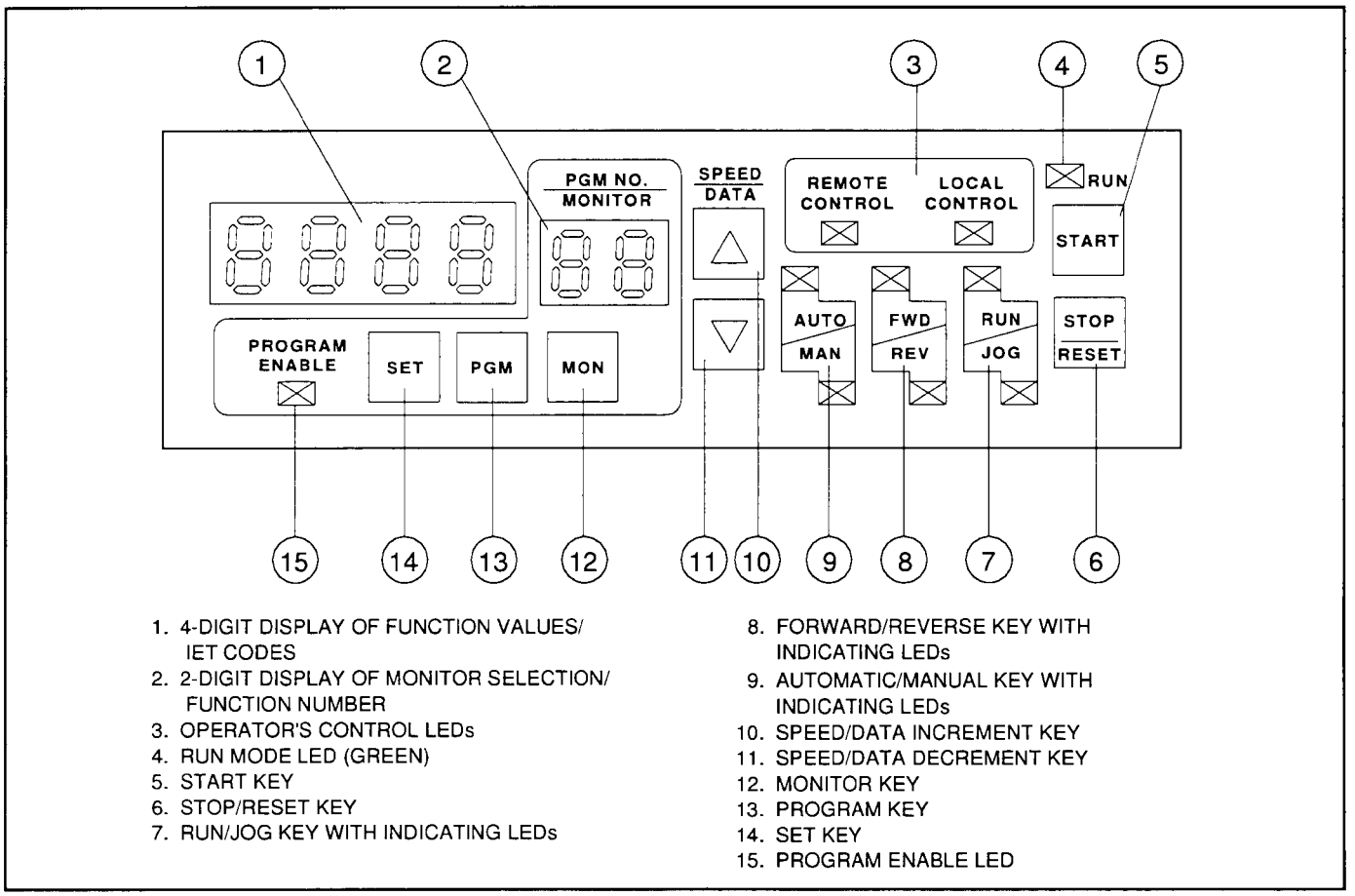
Introduction to the Controller

The GP-2000 controller is a general purpose, variable speed, A-C controller. It fully utilizes state-of-the-art microprocessor digital technology. This results in adjustments and commands that are precise, repeatable, driftless, and highly immune to noise and electromagnetic interference. Many diagnostic capabilities are standard. Because of the many configuration adjustments handled in software through the standard keypad/display, this controller is ideal for a broad range of industrial applications.

Keypad and Display

Controller operation and configuration is easily performed through a convenient keypad/display panel (Figure 2-1). The keypad allows easy selection of START, STOP, RUN/JOG, FORWARD/REVERSE, and AUTOMATIC/MANUAL. Each of the three dual selection keys (RUN/JOG, for example) has a small red LED above and below it that indicates which condition is selected. Also included on the keypad are an increment ▲ key and a decrement ▼ key that are used to increase or decrease the speed of the motor. The increment and decrement keys can also be used with the PGM key and the SET key to configure the GP-2000 controller to a broad range of application requirements.

Also located on the keypad are a 4-digit LED display and a 2-digit LED display that show controller running information (output frequency, voltage, percent of full-load amps, and motor RPM) and error function codes. In addition, these displays are used in configuring the controller.



1. 4-DIGIT DISPLAY OF FUNCTION VALUES/ IET CODES
2. 2-DIGIT DISPLAY OF MONITOR SELECTION/ FUNCTION NUMBER
3. OPERATOR'S CONTROL LEDs
4. RUN MODE LED (GREEN)
5. START KEY
6. STOP/RESET KEY
7. RUN/JOG KEY WITH INDICATING LEDs
8. FORWARD/REVERSE KEY WITH INDICATING LEDs
9. AUTOMATIC/MANUAL KEY WITH INDICATING LEDs
10. SPEED/DATA INCREMENT KEY
11. SPEED/DATA DECREMENT KEY
12. MONITOR KEY
13. PROGRAM KEY
14. SET KEY
15. PROGRAM ENABLE LED

Figure 2-1. Keypad Layout.

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Terminology Used in This Manual

Definitions and Abbreviations

AUTO: See "Speed Reference."

CEC: The abbreviation for the Canadian Electrical Code.

Chassis: The open style of enclosure.

Configure: The process by which the user selects and adjusts one of the standard 57 programmable functions listed in Table 8-3.

Controller: The term substituted throughout this manual for "GP-2000 A-C V★S Drive Controller."

Drive: The reference to the controller and the motor combined as one system.

GP-2000 A-C V★S Drive Controller: See "controller."

Hz: The abbreviation for hertz.

IET: The abbreviation for instantaneous electronic trip.

MAN: See "Speed Reference."

NEC: The abbreviation for the USA National Electrical Code.

NEMA: The abbreviation for the National Electrical Manufacturers Association.

NEMA 1: The type 1 enclosure defined in the NEMA code which provides protection against accidental or inadvertent bodily contact with live parts.

NEMA 12: The type 12 enclosure defined in the NEMA code which provides industrial use, dust-tight and drip-tight, indoor non ventilated.

Process Control: See "Speed Reference."

Program: See "Configure."

PWM: The abbreviation for Pulse Width Modulation.

Run Mode: The condition when output frequency (Hz) and voltage are applied to the A-C motor. The green RUN MODE LED will be lit in this mode.

Set Frequency: The speed setting stored in memory to which the controller will accelerate when the Run mode is initiated. When not monitoring frequency, voltage, or current from the keypad, the 4-digit display shows the set frequency and the 2-digit display is blank.

Speed Pot: The shortened reference for speed potentiometer. One use of the increment ▲ and decrement ▼ keys on the controller keypad is similar to a speed pot: use the increment ▲ key to increase the speed of the motor (like turning a speed pot CW) and the decrement ▼ key to decrease the speed of the motor (like turning a speed pot CCW).

Speed Reference: The MAN (manual) key or the AUTO (automatic) key on the controller keypad determines whether the controller follows speed reference commands from the keypad ▲ and ▼ keys (MAN selected) or from an external process control signal (AUTO selected).

NOTE: *If no process control signal is present when AUTO is selected and Function 31 equals 0, then the controller will run at minimum Hz. See Figure 3-4 for process control configurations.*

Static MOP: An electronic MOP (Motor Operated Potentiometer). The speed can be adjusted remotely by the external contacts.

Stop Mode: The condition when output frequency (Hz) and voltage are ramped down to zero. This condition can be caused by pressing the STOP key, by an external function loss signal, or an internal IET. When an IET occurs, the STOP key also acts as an IET reset.

Dangers, Warnings, and Cautions

Dangers, warnings, and cautions point out potential trouble areas. All three of these precautions are enclosed in a box to call attention to them.

- A **danger** alerts a person that high voltage is present which could result in severe bodily injury or loss of life.
- A **warning** alerts a person of potential bodily injury if procedures are not followed.
- A **caution** alerts a person that, if procedures are not followed, damage to, or destruction of, equipment could result.

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Standard Features

- NEMA 1 or NEMA 12 enclosure
- 0-400 Hz frequency range
- Microprocessor based regulator
- Keypad and display
  - Start/Stop
  - Speed adjustment
  - Forward/Reverse
  - Automatic or manual speed reference
  - Run/Jog
  - Complete drive adjustments
  - Monitor and display of either output frequency, voltage, amperage, or RPM
  - Diagnostic fault monitoring
- Ability to follow a 0-20 mA, 4-20 mA, 0-10 VDC, or frequency pulse input signal for automatic speed control
- PWM control
- Full spectrum switching for reduced motor noise
- Serial communications capability with optional card
- UL Listed/CSA Certified/IEC Classified
- Surface mount technology
- Large scale integration
- Line-to-line and line-to-ground output short circuit protection
- Motoring current limit and regenerative voltage limit
- UL/CSA electronic motor overload which meets NEC/CEC Requirements.
- 57 controller configuration adjustments including
  - Minimum and maximum frequency settings
  - Separate acceleration and deceleration ramps
  - Current limit
  - Automatic flux control for quiet motor operation
  - Torque boost
  - Three preset speed selections
  - Avoidance frequency and bandwidth selections
  - D-C braking
  - Slip compensation
  - Frequency and current level detection
  - Static MOP
  - Output voltage regulation
  - Settable Electronic Motor Overload

Optional Kits and Modifications

The following kits and modifications are available with select controllers. See Table 2-1 for the complete kit listing. Contact a Reliance Electric Sales Office or authorized distributor for more information regarding these kits or modifications.

Kits

- Remote Meter Interface Card
- Remote Digital Meter
- Rail Interface Card
- 1/4 through 20 HP Expanded Cabinet for Kit Mounting
- Pressure-to-Electrical Transducer
- Output Contactor
- RPM A-C Blower Motor Protection
- Main Input Disconnect
- Motor Overload
- Dynamic Braking
- Control Signal Buffer
- Reference Trim Pot
- Remote Operator Station

Modifications

- Input Line Fuse
- NEMA 4 Cabinet
- Magnetic Bypass

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Table 2-1. Controller Kits.

Description	Expanded Cabinet Kit Required	Model Number	Instruction Sheet
Remote Meter Interface Card [1]	No	1MI4000	D2-3168
Remote Digital Meter (230 V Control P/S) [2,3]	No	3DM4000	D2-3169
Remote Digital Meter (115 V Control P/S) [2,3]	No	3DM5000	D2-3169
Rail Interface Card [1,4]	No	1SC4000	D2-3170
Expanded Cabinet [5]	–	1EX4000	D2-3171
Pressure-to-Electrical Transducer	Yes	1PE4020	D2-3175
Output Contactor			
230 V 1/4 thru 10 HP	Yes	1CN4020	D2-3177
460 V 1/4 thru 20 HP	Yes	1CN4020	D2-3177
575 V 3 thru 20 HP	Yes	1CN4020	D2-3177
RPM A-C Blower Motor Protection [6]	Yes	1BM4000	D2-3174
Main Input Disconnect			
230 V, 460 V and 575 V 1/4 thru 10 HP	Yes	1CB4020	D2-3223
		2CB4020 [7]	D2-3235
460 V 1/4 thru 20 HP	Yes	1CB4050	D2-3223
		2CB4050 [7]	D2-3235
Motor Overload			
230 V 1/4 thru 10 HP	Yes	1ML2010	D2-3222
460 V 1/4 thru 20 HP	Yes	1ML4020	D2-3222
Dynamic Braking [2]			
230 V 1/4 thru 5 HP	No	2DB2005	D2-3178
230 V 7-1/2 thru 10 HP	No	2DB2010	D2-3178
460 V 1/4 thru 10 HP	No	2DB4010	D2-3179
460 V 15 thru 20 HP	No	2DB4020	D2-3179
575 V 3 thru 10 HP	No	2DB5010	D2-3180
575 V 15 thru 20 HP	No	2DB5020	D2-3180
Control Signal Buffer	Yes	1SB4000	D2-3176
Reference Trim Pot	No	1TP3000	D2-3213
Remote Operator Station [2]	No	1RS3000	D2-3214
Inverter Fuse Kit			
230 V 1 HP, 7 A	Yes	2FU2001	D2-3211
230 V 2 HP, 12 A	Yes	2FU2002	D2-3211
230 V 3 HP, 17 1/2 A	Yes	2FU4007	D2-3211
230 V 5 HP, 25 A	Yes	2FU4010	D2-3211
230 V 7 1/2 HP, 40 A	Yes	2FU2007	D2-3211
230 V 10 HP, 50 A	Yes	2FU2010	D2-3211
460 V 1 HP, 5 A	Yes	2FU4001	D2-3211
460 V 2 HP, 6 A	Yes	2FU4002	D2-3211
460 V 3 HP, 8 A	Yes	2FU4003	D2-3211
460 V 5 HP, 15 A	Yes	2FU4005	D2-3211
460 V 7 1/2 HP, 17 1/2 A	Yes	2FU4007	D2-3211
460 V 10 HP, 25 A	Yes	2FU4010	D2-3211
460 V 15 HP, 35 A	Yes	2FU4015	D2-3211
460 V 20 HP, 40 A	Yes	2FU4020	D2-3211

(1) The Remote Meter Interface Card and the Rail Interface Card cannot be mounted in the controller at the same time.
(2) These Kits mount remote to the main control cabinet.
(3) Requires the Remote Meter Interface Card.
(4) Rail Interface Card can be used only for Regulator PC Board GPI-2 (Part Number 0-48680-116).
(5) The Expanded Cabinet Kit includes a line reactor and control transformer.
(6) The RPM A-C Blower Motor Protection Kit requires the Expanded Cabinet Kit. Mounting may be mutually exclusive with other kits within the Expanded Cabinet Kit. Contact the nearest Reliance Electric Sales Office for assistance.
(7) Order these model numbers for drives shipped after June, 1992.

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Controller Specifications

Controller Ratings

The controller is intended to operate from a three-phase A-C power source at the rated voltage listed on the controller nameplate. It can operate on 50 or 60 Hz line frequency. The controller provides three-phase variable voltage and variable frequency to the motor. NEMA 1 controller current ratings are listed in Table 2-2.

The controller can be operated from single-phase, 230-volt A-C input power by derating the motor output horsepower. A three-phase motor sized for the controller horsepower must still be used. Drive derating values are listed in Table 2-3.

NEMA 12 controller current ratings are listed in Table 2-4.

Table 2-2. NEMA 1 Controller Ratings with Three-Phase Input Power.

Controller Model Number	Nominal Horsepower Range	Controller 3ϕ Input Volts	Controller Input KVA	Maximum Input Amps	Maximum Motor Sine Wave Amps (1)	Maximum Controller Output Amps
2GU21001	1/4 to 1	230	2.1	5.3	4.1	4.5
2GU21002	2	230	3.5	8.8	6.8	7.5
2GU21003	3	230	5.0	12.5	9.6	10.6
2GU21005	5	230	7.8	19.6	15.2	16.7
2GU21007	7-1/2	230	11.2	28.2	21.8	24.0
2GU21010	10	230	15.5	38.8	30.0	33.0
2GU41001	1/4 to 1	460	2.0	2.5	1.9	2.1
2GU41002	2	460	3.3	4.2	3.1	3.4
2GU41003	3	460	5.1	6.4	4.8	5.3
2GU41005	5	460	7.9	9.9	7.5	8.2
2GU41007	7-1/2	460	10.7	13.4	10.1	11.1
2GU41010	10	460	13.7	17.2	12.9	14.2
2GU41015	15	460	20.2	25.4	19.0	21.0
2GU41020	20	460	26.1	32.7	24.5	27.0
2GU51005	3 to 5	575	7.5	7.5	5.6	6.2
2GU51010	7-1/2 to 10	575	14.4	14.5	11.0	12.0
2GU51020	15 to 20	575	27.8	27.9	21.0	23.0

(1) To obtain motor nameplate horsepower, the controller's sine wave output ampere rating should be equal to or greater than the motor nameplate current. If the motor nameplate amperes are higher than the controller sine wave rating, the motor horsepower should be derated by the ratio of the controller sine wave ampere rating to the motor nameplate current. Refer to "Single-Motor Applications" and "Multi-Motor Applications" for more details.

Table 2-3. NEMA 1 Controller Ratings with Single-Phase Input Power.

Controller Model Number	Nominal Horsepower Range	Controller 1ϕ Input Volts	Controller Input KVA	Maximum Input Amps	Maximum Motor Sine Wave Amps (1)	Maximum Controller Output Amps
2GU21001	1/4 to 1/2	230	1.1	4.6	2.3	2.5
2GU21002	1	230	2.1	9.1	4.1	4.5
2GU21003	1-1/2	230	2.8	12.1	5.5	6.0
2GU21005	2	230	3.5	15.2	6.8	7.5
2GU21007	3	230	5.0	21.6	9.6	10.6

(1) To obtain motor nameplate horsepower, the controller's sine wave output ampere rating should be equal to or greater than the motor nameplate current. If the motor nameplate amperes are higher than the controller sine wave rating, the motor horsepower should be derated by the ratio of the controller sine wave ampere rating to the motor nameplate current. Refer to "Single-Motor Applications" and "Multi-Motor Applications" for more details.

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Table 2-4. NEMA 12 Controller Ratings with Three-Phase Input Power.

Controller Model Number	Nominal Horsepower Range	Controller 3ϕ Input Volts	Controller Input KVA	Maximum Input Amps	Maximum Motor Sine Wave Amps [1]	Maximum Controller Output Amps
2GU22001	1/4 to 1	230	2.1	5.3	4.1	4.5
2GU22002	2	230	3.5	8.8	6.8	7.5
2GU22003	3	230	5.0	12.5	9.6	10.6
2GU22005	5	230	7.8	19.6	15.2	16.7
2GU22007	7.5	230	11.2	28.2	21.8	24.0
2GU42001	1/4 to 1	460	2.0	2.5	1.9	2.1
2GU42002	2	460	3.3	4.2	3.1	3.4
2GU42003	3	460	5.1	6.4	4.8	5.3
2GU42005	5	460	7.9	9.9	7.5	8.2
2GU42007	7.5	460	10.7	13.4	10.1	11.1

[1] To obtain motor nameplate horsepower, the controller's sine wave output ampere rating should be equal to or greater than the motor nameplate current. If the motor nameplate amperes are higher than the controller sine wave rating, the motor horsepower should be derated by the ratio of the controller sine wave ampere rating to the motor nameplate current. Refer to "Single-Motor Applications" and "Multi-Motor Applications" for more details.

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Service Conditions

CAUTION: Salt, chlorine, other corrosive gases and/or liquids must be avoided. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

- Ambient temperature: -10°C to 40°C (14°F to 104°F) for enclosed controllers and -10°C to 55°C (14°F to 131°F) for chassis controllers. [Note: See "Convert from NEMA 1 to Chassis Controller (if required)."]
- Storage temperature: -40°C to 65°C (-40°F to 149°F)
- Atmosphere: 5 to 95% non-condensing relative humidity
- Elevation: To 3300 feet (1000 meters) above sea level without derating. For every 300 feet (91.4 meters) above 3300 feet, derate the current rating by 1%. Consult your Reliance Electric Sales Office for operation above 10,000 feet.
- Line frequency: 50±2 Hz or 60±2 Hz
- Line voltage variation: -10% to +10%
- A-C line distribution system capacity (maximum): 500 KVA for 230 VAC and 1,000 KVA for 460 and 575 VAC, three-phase with 25,000 amps symmetrical fault current capacity.

Controller Application Data

- Pulse Width Modulation (PWM): sine wave
- Service Factor: 1.0
- Displacement Power Factor: 0.96
- Maximum Load: 150% for one minute
- Overcurrent IET: 200% load
- Current Limit Adjustment: 50 to 150%
- Linearity (Speed reference to output frequency): ±1%

WARNING

THIS DRIVE IS INTENDED TO OPERATE AT A PREDETERMINED MINIMUM SPEED UNLESS DISCONNECTED FROM THE POWER SOURCE. IF THE APPLICATION REQUIRES ZERO SPEED OPERATION WITHOUT SUCH DISCONNECTION, THE USER IS RESPONSIBLE FOR ASSURING SAFE CONDITIONS FOR OPERATING PERSONNEL BY PROVIDING SUITABLE GUARDS, AUDIBLE OR VISUAL ALARMS, OR OTHER DEVICES. FAILURE TO OBSERVE THESE PRECAUTIONS COULD RESULT IN BODILY INJURY.

- Minimum Frequency: 5 to 60 Hz (or 0 to 60 Hz programmed with a password)

WARNING

THE USER IS RESPONSIBLE FOR ENSURING THAT DRIVEN MACHINERY, ALL DRIVE-TRAIN MECHANISMS, AND PROCESS LINE MATERIAL ARE CAPABLE OF SAFE OPERATION AT AN APPLIED FREQUENCY OF THE OVERFREQUENCY LIMIT VALUE TO THE A-C MOTOR. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

- Maximum Frequency: 15 Hz to overfrequency limit
- Base Frequency (V/Hz): 30 to 400 Hz
- Frequency Stability Long Term: 0.01% of base speed with digital keypad; 0.5% of base speed with optional analog speed pot
- Acceleration Adjustment: 0.1 to 360 seconds (within the capability of current limit)
- Deceleration Adjustment: 0.1 to 360 seconds (within the energy absorbing capability of the controller)
- Torque Boost: 0 to 10% of input voltage

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Single-Motor Applications

The controller and motor must be sized for the load and speed requirements of the specific application.

If the motor is oversized, the motor operating current must not exceed the controller's rated output current and the motor horsepower must not be more than one size larger than the controller's horsepower rating.

If the motor will be operated at speeds below one-half the motor's rated speed, the motor overload relay may not protect the motor because of the reduction in motor cooling action due to the reduced speed. A motor thermostat, internal to the motor, should be installed because it monitors the actual temperature of the motor windings.

Multi-Motor Applications

One controller can run two or more motors. Adhere to the following requirements to assure correct drive operation:

1. When all the motors connected to the output of the controller are to start and stop at the same time, the sum of the sine wave currents of all the motors must be less than or equal to the maximum motor sine wave current rating of the controller.
2. When one or more of the motors connected to the output of the controller are to start and stop independently,
   - Any motor that starts or stops while the controller is running must have a current rating less than 10% of the maximum motor sine wave current rating of the controller.
   - The sum of the sine wave currents of all the motors connected continuously on the output of the controller and the locked rotor sine wave current of any motor which is to start and stop independently must be less than or equal to the maximum motor sine wave current rating of the controller.

NOTE: *Each motor requires separate overload protection (i.e. a motor relay or a motor thermostat).*

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3: Install the Drive

DANGER

ONLY QUALIFIED ELECTRICAL PERSONNEL FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF THIS EQUIPMENT AND THE HAZARDS INVOLVED SHOULD INSTALL IT. READ AND UNDERSTAND THIS MANUAL IN ITS ENTIRETY BEFORE PROCEEDING. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

DANGER

THE USER IS RESPONSIBLE FOR CONFORMING TO THE NEC AND ALL OTHER APPLICABLE LOCAL CODES. WIRING PRACTICES, GROUNDING, DISCONNECTS, AND OVERCURRENT PROTECTION ARE OF PARTICULAR IMPORTANCE. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

CAUTION: Use of power factor correction capacitors on the output of the controller can result in erratic operation of the motor, nuisance tripping, and /or permanent damage to the controller. Remove power factor capacitors before proceeding. Failure to observe this precaution could result in damage to, or destruciton of the equipment.

Plan the Installation

Read and understand this chapter in its entirety before beginning the actual installation. Follow these guidelines and procedures to minimize both installation and operating problems.

Convert from NEMA 1 to Chassis Controller (if required)

The controller is shipped standard as an enclosed unit, fully assembled in its own NEMA 1 enclosure. If a chassis rather than a NEMA 1 controller is required, do the following:

1. Remove the front cover from the controller.
2. Remove the bottom plate with conduit provisions from the controller.
3. Remove the plate that covers the ventilation slots at the top of the cover by removing the retaining pins or attachment screws.
4. Replace the cover on the controller.

Select Controller Location

1. Verify that the controller can be kept clean, cool, and dry.
2. Check that the controller is away from oil, coolant, and other airborne contaminants.

CAUTION: Salt, chlorine, other corrosive gases and/or liquids must be avoided. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

3. Check that temperatures in the controller vicinity are between –10°C to 40°C (14°F to 104°F) for enclosed controllers and -10°C to 55°C (14°F to 131°F) for chassis controllers.
4. Check that relative humidity is between 5 and 95% (non-condensing).
5. Do not install above 3300 feet (1000 meters) without derating. For every 300 feet (91.4 meters) above 3300 feet, derate the current rating by 1%. Consult your Reliance Electric Sales Office for operation above 10,000 feet.

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Mount the Controller

Mount the NEMA 1 or NEMA 12 Controller

1. In the location selected, mount the enclosed controller vertically with the input/output terminals at the bottom.
2. Make sure surrounding components do not hinder service access. See Figure 3-1 for mounting dimensions.
3. Provide adequate clearance for air ventilation:
   - At least 2 inches from the sides and 4 inches from the top and bottom of the controller to adjacent non-heat producing equipment, such as a cabinet wall.
   - At least 2 inches from the sides and 10 inches from the top and bottom of adjacent controllers. For the best air movement with three or more controllers, do not mount the controllers in a vertical stack; offset the controllers.

Mount the Chassis Controller

CAUTION: Complete all drilling, cutting, welding, etc., before mounting the chassis in a user-supplied metal enclosure. During installation protect the chassis from metal chips, weld splatters, and other debris. Failure to observe these precautions could result in damage to, or destruction of, the equipment.

1. In the location selected, mount the user-supplied metal enclosure in which the chassis will be mounted. If the enclosure is totally enclosed, size the metal enclosure using the following equation along with Table 3-1:

$$S = S_s + \frac{4}{3}S_t + \frac{2}{3}S_b \text{ (1)}$$

where:

S_s = Area of enclosure's four side surfaces
S_t = Area of enclosure's ceiling surface
S_b = Area of enclosure's bottom surface

(1) If a surface does not have at least a 1/2" layer of air beside it, it does not have any cooling effect. Use a zero area on the equation for any such surface.

For example, if you want to enclose a 2 HP chassis in an enclosure that is 30" high by 20" wide by 16" deep and the back side is 1/2" off the mounting wall, solve the equation and verify the answer with the Table 3-1 specifications.

$$S = 2(30 \times 20) + 2(30 \times 16) + \frac{4}{3}(16 \times 20) + \frac{2}{3}(16 \times 20)$$
$$= 2800 \text{ sq. in.}$$

Referring to Table 3-1, note that a 2 HP controller requires 2.8 times 10^3 or 2800 square inches of surface area. The example enclosure meets the size requirements.

2. Mount the chassis directly to the enclosure mounting panel. Standoff hardware is not necessary. See Figure 3-1 for mounting dimensions.
3. Provide adequate clearance for air ventilation within the enclosure:
   - At least 2 inches from the sides and 4 inches from the top and bottom of the controller to adjacent non-heat producing equipment, such as a cabinet wall.
   - At least 2 inches from the sides and 10 inches from the top and bottom of adjacent controllers. For the best air movement with three or more controllers, do not mount the controllers in a vertical stack; offset the controllers.

Table 3-1. Sizing a User-Supplied Enclosure To House the Chassis.

HP (1)	Power Loss (watts)	Effective Surface (S) Area	
		sq cm	sq in.
1/4 - 2	100	1.8×10^4	2.8×10^3
3	150	2.7×10^4	4.2×10^3
5	200	3.6×10^4	5.6×10^3
7-1/2	250	4.5×10^4	7.0×10^3
10	300	5.4×10^4	8.4×10^3
15	400	7.2×10^4	1.1×10^4
20	550	9.9×10^4	1.5×10^4

(1) Applies to 230, 460, and 575 VAC controllers.

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Install the Motor

NOTE: *For multi-motor application requirements, refer to "Multi-Motor Applications" in Chapter 2.*

1. Verify the motor is the appropriate size to use with the controller.

   Derate the A-C motor to compensate for additional heating in the motor caused by harmonics.

2. Install the A-C motor according to its instruction manual.

3. If the motor is overframed, verify that the motor operating current does not exceed the controller's output current and the motor horsepower is not more than one size larger than the controller's horsepower rating. Then select the electronic motor overload to be equal to or less than the controller output current rating.

   If the motor will be operated at speeds below one-half the motor's rated speed, use the thermal responsive type of protection device because it monitors the actual temperature of the motor windings. The motor overload relay may not protect the motor because of the reduction in motor cooling action due to the reduced speed.

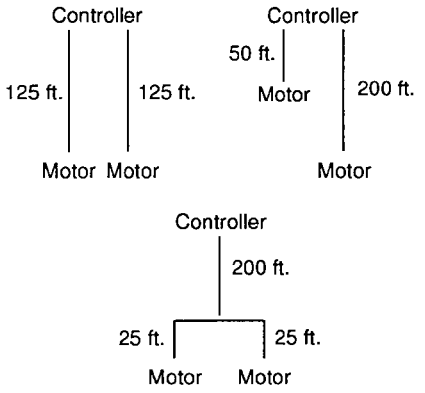
4. Make sure the motor is properly aligned with the driven machine to minimize unnecessary motor loading from shaft misalignment.

5. If the motor is accessible while it is running, install a protective guard around all exposed rotating parts.

Motor Lead Lengths

For applications using one motor connected to the controller, individual motor lead lengths cannot exceed 250 feet per phase. For applications where multiple motors are used, total lead lengths on each phase cannot exceed 250 feet, and each motor connection cannot exceed 250 feet.

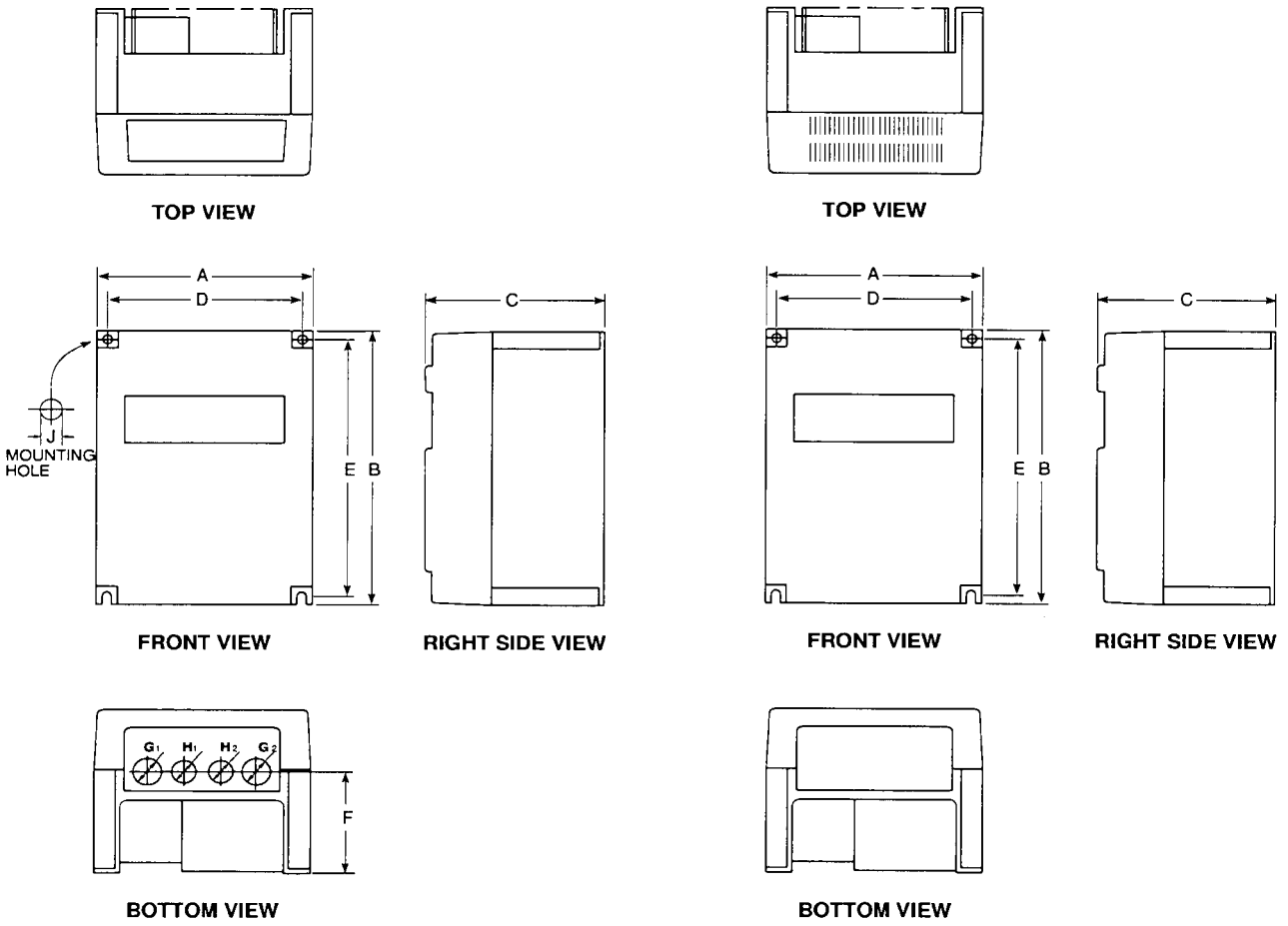
For example, the following illustrates correct application connections:



NOTE: *Each line to the motor represents a 3-phase connection.*

If total 3-phase lead length exceeds 250 feet, nuisance tripping may occur. These trips are caused by capacitive current flow to ground and are not an indication of any problem with the controller. If the lead length must be exceeded, output line reactors or other steps must be taken to correct the problem.

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NEMA 1 and Chassis

HP	VOLTS	DIMENSIONS IN MILLIMETERS (INCHES)											WEIGHT IN KG (LBS)
		A	B	C	D	E	F	G_1	G_2	H_1	H_2	J	
1/4-5	230	220 (8.66)	300 (11.81)	180 (7.09)	200 (7.87)	280 (11.02)	112 (4.41)	27.8 (1.09)	27.8 (1.09)	22.2 (0.87)	—	7.2 (0.28)	6.4 (14.1)
7.5-10	230	250 (9.84)	400 (15.75)	200 (7.87)	230 (9.06)	380 (14.96)	127 (5.0)	27.8 (1.09)	27.8 (1.09)	22.2 (0.87)	—	10 (0.39)	10 (22)
1/4-10	460	250 (9.84)	400 (15.75)	200 (7.87)	230 (9.06)	380 (14.96)	127 (5.0)	27.8 (1.09)	27.8 (1.09)	22.2 (0.87)	22.2 (0.87)	10 (0.39)	12 (26.4)
15-20	460	280 (11.02)	500 (19.68)	277 (10.90)	230 (9.06)	480 (18.89)	197 (7.75)	27.8 (1.09)	27.8 (1.09)	22.2 (0.87)	22.2 (0.87)	10 (0.39)	25 (55)
3-10	575	250 (9.84)	400 (15.75)	200 (7.87)	230 (9.06)	380 (14.96)	127 (5.0)	27.8 (1.09)	27.8 (1.09)	22.2 (0.87)	22.2 (0.87)	10 (0.39)	12 (26.4)
15-20	575	280 (11.02)	500 (19.68)	277 (10.90)	230 (9.06)	480 (18.89)	197 (7.75)	27.8 (1.09)	27.8 (1.09)	22.2 (0.87)	22.2 (0.87)	10 (0.39)	25 (55)

NEMA 12

HP	VOLTS	DIMENSIONS IN MILLIMETERS (INCHES)									WEIGHT IN KG (LBS)
		A	B	C	D	E	F	G_1/G_2	H_1/H_2	J	
1/4-7.5	230/460	256 (10.08)	408 (16.06)	202 (7.95)	230 (9.06)	380 (14.96)	132 (5.2)	27.8 (1.09)	22.2 (0.87)	10 (0.39)	13 (28.7)

Figure 3-1. Physical Dimensions and Weights.

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Install an Input Disconnect

DANGER

NEC/CEC REQUIRES THAT AN INPUT DISCONNECT BE PROVIDED IN THE INCOMING POWER LINE. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

1. Install an input disconnect in the incoming power line according to the NEC/CEC.
2. Size the disconnect taking into consideration the transformer inrush current (if used) as well as any additional loads the disconnect may supply.
3. Wire this disconnect in the primary circuit of the controller isolation transformer (if used).

Table 3-2. A-C Input Line Branch Circuit Protection with Three-Phase Input.

Controller Horsepower	Controller 3ϕ Input Volts	Input Current (Amps)	Recommended Input Fuse Rating (1)	Max Allowable Input Fuse Rating (1)
			Rating (Amps)	Rating (Amps)
1/4 to 1	230	5.3	7	10
2	230	8.8	12	15
3	230	12.5	17.5	20
5	230	19.6	25	30
7-1/2	230	28.2	40	50
10	230	38.8	50	60
1/4 to 1	460	2.5	5	6
2	460	4.2	6	8
3	460	6.4	8	12
5	460	9.9	15	20
7-1/2	460	13.4	17.5	20
10	460	17.2	25	30
15	460	25.4	35	40
20	460	32.7	45	50
3 to 5	575	7.5	10	15
7-1/2 to 10	575	14.5	20	25
15 to 20	575	27.9	30	40

(1) Fuses shall be Class RK5 or Class J time delay.

Install A-C Input Branch Circuit Protection

DANGER

NEC/CEC REQUIRES THAT UPSTREAM BRANCH CIRCUIT PROTECTION BE PROVIDED TO PROTECT INPUT POWER WIRING. INSTALL THE RECOMMENDED RATING IN TABLE 3-2 OR 3-3. IF THE FUSE RATING IS INCREASED DUE TO LOADS REQUIRING HIGH STARTING CURRENTS, DO NOT EXCEED THE MAX ALLOWABLE RATINGS IN TABLE 3-2 OR 3-3. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

CAUTION: The Input Fuse Ratings listed in Table 3-2 (up to 5 HP) are applicable for one drive per branch circuit. No other load can be applied to that fused branch circuit. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

1. Install branch circuit protection according to the NEC/CEC.
2. Size the branch circuit according to Table 3-2 or 3-3.

Table 3-3. A-C Input Line Branch Circuit Protection with Single-Phase Input.

Controller Model Number	Applicable Horsepower Range	Controller 1ϕ Input Volts	Input Current (Amps)	Recommended Input Fuse Rating (1)	Max Allowable Input Fuse Rating (1)
				Rating (Amps)	Rating (Amps)
2GU21001	1/4 to 1/2	230	4.6	8	10
2GU21002	1	230	9.1	12	15
2GU21003	1-1/2	230	12.1	17.5	20
2GU21005	2	230	15.2	20	25
2GU21007	3	230	21.6	30	35

(1) Fuses shall be Class RK5 or Class J time delay.

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Install a Transformer (if needed)

In all applications requiring the use of an output transformer, contact your Reliance Electric Sales Office for assistance.

Input transformers step up or step down input voltage and can be either auto-transformers or isolation transformers. Isolation transformers help eliminate

- Damaging A-C line voltage transients from reaching the controller.
- Line noise from the controller back to the incoming power.
- Damaging currents, which could develop if a point inside the controller becomes grounded.

If an input transformer is installed ahead of the controller, a power disconnecting device must be installed between the power line and the primary of the transformer. If this power disconnecting device is a circuit breaker, the circuit breaker trip rating must be coordinated with the inrush current (10 to 12 times full-load current) of the input transformer. Do not connect an input transformer rated at more than 500 KVA for 230 VAC (1000 KVA for 460 or 575 VAC) to the controller.

CAUTION: Distribution system capacity above 500 KVA for 230 VAC (1000 KVA for 460 or 575 VAC) requires an isolation transformer, a line reactor, or other means of adding similar impedance. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

Wire the Drive

Ground the Drive

DANGER

THE USER IS RESPONSIBLE FOR MEETING ALL CODE REQUIREMENTS WITH RESPECT TO GROUNDING ALL EQUIPMENT. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

1. Remove the controller cover.
2. Run a suitable equipment grounding conductor **unbroken** from the controller ground terminal (Figure 3-2 or 3-3) to the grounding electrode conductor (earth ground).
3. Connect a suitable equipment grounding conductor to the motor frame, the remote control station (if used), the transformer (if required), and the controller enclosure. Run each conductor **unbroken** to the grounding electrode conductor (earth ground).
4. When required by code, the 24 VDC Start/Stop circuit can be grounded. Run a suitable grounding conductor **unbroken** from terminal 19 to the controller ground terminal. (See Figure 3-2 or 3-3 and Figure 3-5.)

Install Power Wiring

DANGER

EXTERNAL POWER WIRING, IF USED, MAY REMAIN ENERGIZED WHEN THE MAIN A-C POWER IS DISCONNECTED. IDENTIFY ALL SUCH EXTERNAL WIRING. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

1. Verify that input power to the controller corresponds to the controller nameplate voltage and frequency and that the plant supply is of sufficient capacity to support the input current requirements of the controller.

CAUTION: If an incorrect voltage is applied to the controller, an IET could result from a variation in line voltage outside the ±10% range. Failure to observe this precaution could result in damage to, or destruction of, the controller.

2. Provide a transformer between the plant power supply and the controller if the correct input line voltage is not available. Refer to "Install a Transformer (if needed)" in this chapter.
3. Use the appropriate tightening torque listed in Table 3-4 for wire connections to input terminals and output terminals in the controller.
4. Use only copper wire with a minimum temperature rating of 60/75°C.
5. Size input and output power wiring, according to applicable codes, to handle the maximum controller current listed in Table 2-2, 2-3 or 2-4.
6. Refer to Figure 3-2 (230 VAC controllers) or Figure 3-3 (460 and 575 VAC controllers) for the wiring locations.

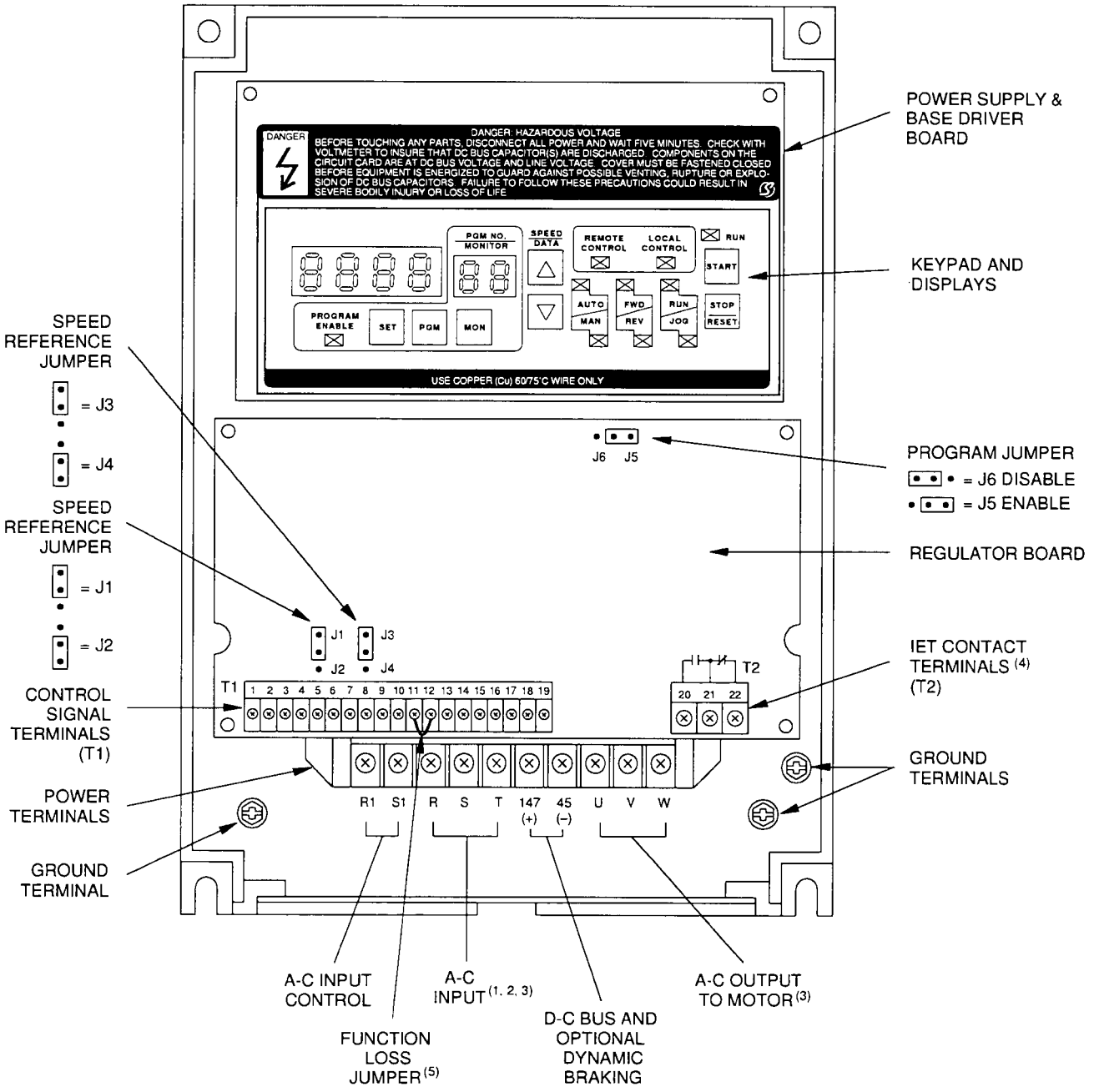
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7. Install the power wiring. Use Figures 3-2 through 3-4 (Local Control) or Figures 3-4 and 3-5 (Remote Control).
8. Route A-C input leads through the bottom left opening of the controller to terminals R, S, and T.
9. Route motor leads through the bottom right opening of the controller to terminals U, V, and W.

Table 3-4. Terminal Tightening Torques (lb-in).

Controller		Input Terminals R, S, T R1, S1	Output Terminals U, V, W 147, 45
HP	Volts		
1/4 - 5	230	15.9	15.9
7-1/2 - 10	230	23.9	23.9
1/4 - 10	460	15.9	15.9
15 - 20	460	23.9	23.9
3 - 20	575	23.9	23.9

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(1) **CAUTION:** Input line voltage must correspond to the controller nameplate rating. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

(2) With single-phase input, connect to terminals R and S.

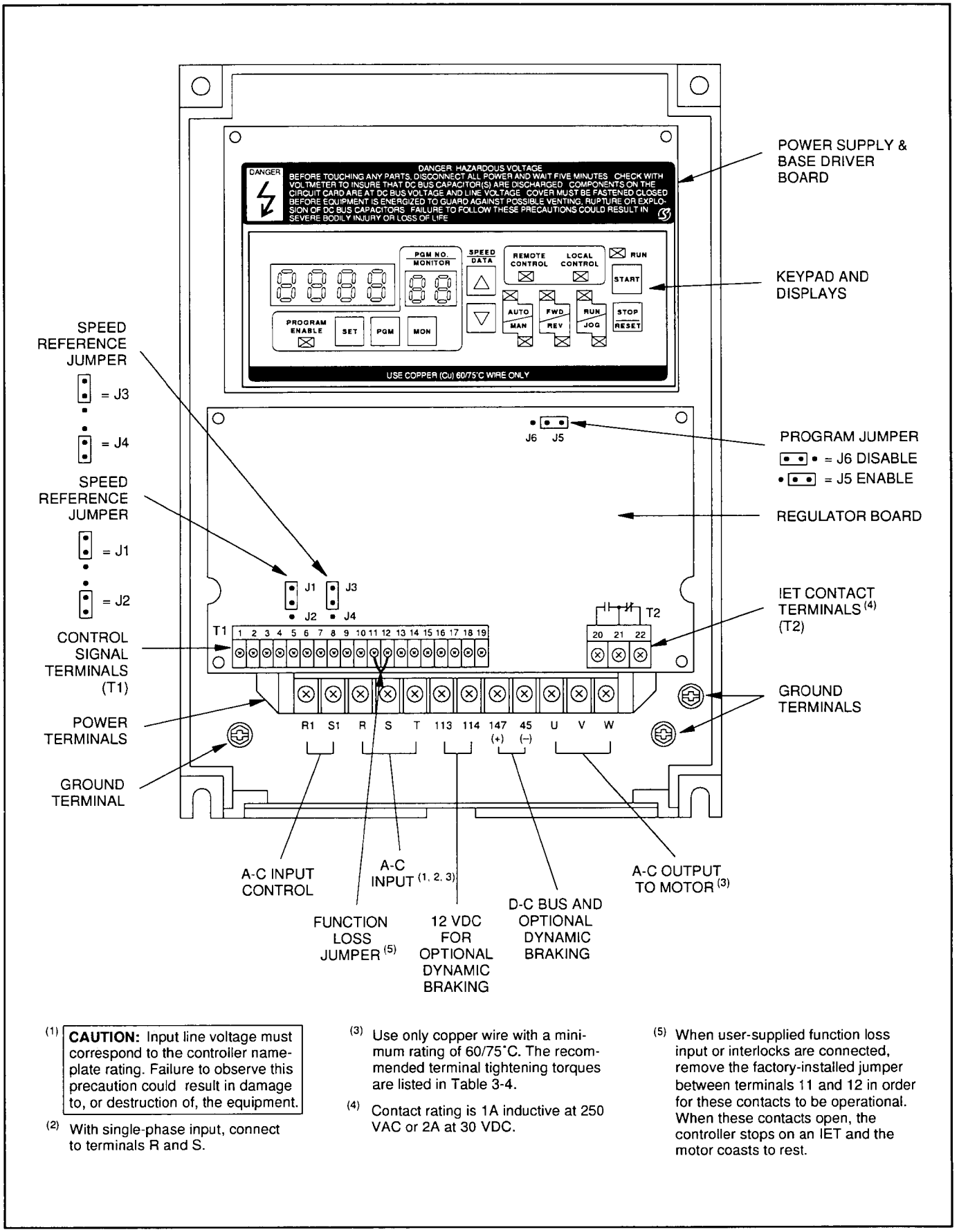
(3) Use only copper wire with a minimum rating of 60/75°C. The recommended terminal tightening torques are listed in Table 3-4.

(4) Contact rating is 1A inductive at 250 VAC or 2A at 30 VDC.

(5) When user-supplied function loss input or interlocks are connected, remove the factory-installed jumper between terminals 11 and 12 in order for these contacts to be operational. When these contacts open, the controller stops on an IET and the motor coasts to rest.

Figure 3-2. Typical 230 VAC Controller Wiring Locations.

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(1) **CAUTION:** Input line voltage must correspond to the controller nameplate rating. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

(2) With single-phase input, connect to terminals R and S.

(3) Use only copper wire with a minimum rating of 60/75°C. The recommended terminal tightening torques are listed in Table 3-4.

(4) Contact rating is 1A inductive at 250 VAC or 2A at 30 VDC.

(5) When user-supplied function loss input or interlocks are connected, remove the factory-installed jumper between terminals 11 and 12 in order for these contacts to be operational. When these contacts open, the controller stops on an IET and the motor coasts to rest.

Figure 3-3. Typical 460 and 575 VAC Controller Wiring Locations.

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Install Control and Signal Wiring (if used)

Size and install all wiring in conformance with the NEC/CEC and all other applicable local codes.

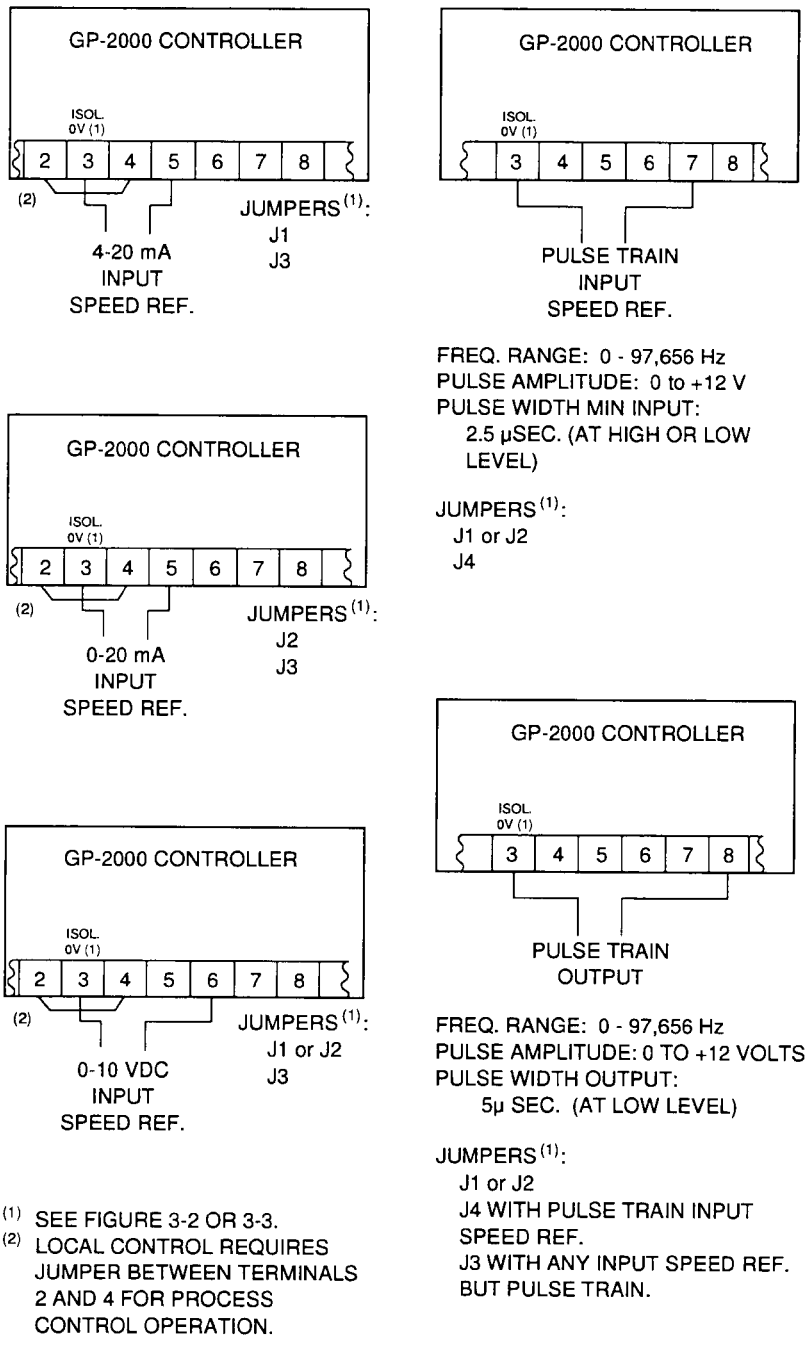
1. For 24 VDC control and signal wiring, use twisted wire having two to three twists per inch. If you use shielded wire rather than twisted wire, the shields should not attach to any ground point; they should "float."

   NOTE: *All customer interlocks shall be suitable for operation with 24 V, 2 mA signals.*

2. For distances of less than 150 feet, use a minimum of #22 AWG. For distances of more than 150 feet and less than 300 feet, use a minimum of #16 AWG. For distances of more than 300 feet, contact your Reliance Electric Sales Office.

WARNING
THE FACTORY-INSTALLED JUMPER ACROSS TERMINALS 11 AND 12 MUST BE REMOVED WHEN FUNCTION LOSS INPUT OR INTERLOCKS ARE USED SO THESE CONTACTS WILL OPEN TO STOP THE CONTROLLER. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

3. Route user-supplied interlock and function loss input wiring (if used) through a center opening in the bottom of the controller. Remove the factory-installed jumper across terminals 11 and 12.



(1) SEE FIGURE 3-2 OR 3-3.
(2) LOCAL CONTROL REQUIRES JUMPER BETWEEN TERMINALS 2 AND 4 FOR PROCESS CONTROL OPERATION.

SETTINGS FUNCTION 0	REFERENCE SELECTION	CONTROL	SPEED REFERENCE
LOCAL	MAN (3)	KEYPAD	KEYPAD
LOCAL	AUTO (3)	KEYPAD	TERMINAL STRIP (4), (6)
REMOTE	MAN (5)	TERMINAL STRIP	SPEED POT INPUT (6)
REMOTE	AUTO (5)	TERMINAL STRIP	PROCESS SIGNAL (6)

(3) AUTO/MAN SELECTED BY KEYPAD (SEE FUNCTION 37).
(4) REFERENCE FROM SPEED POT, PROCESS SIGNAL OR PULSE TRAIN INPUT.
(5) AUTO/MAN SELECTED BY TERMINALS 2 AND 4 IN REMOTE MODE.
(6) THE INPUT REFERENCE SIGNAL CAN BE MONITORED WHILE THE DRIVE IS IN THE STOP MODE BY PRESSING THE ▲ KEY OR ▼ KEY ONE TIME.

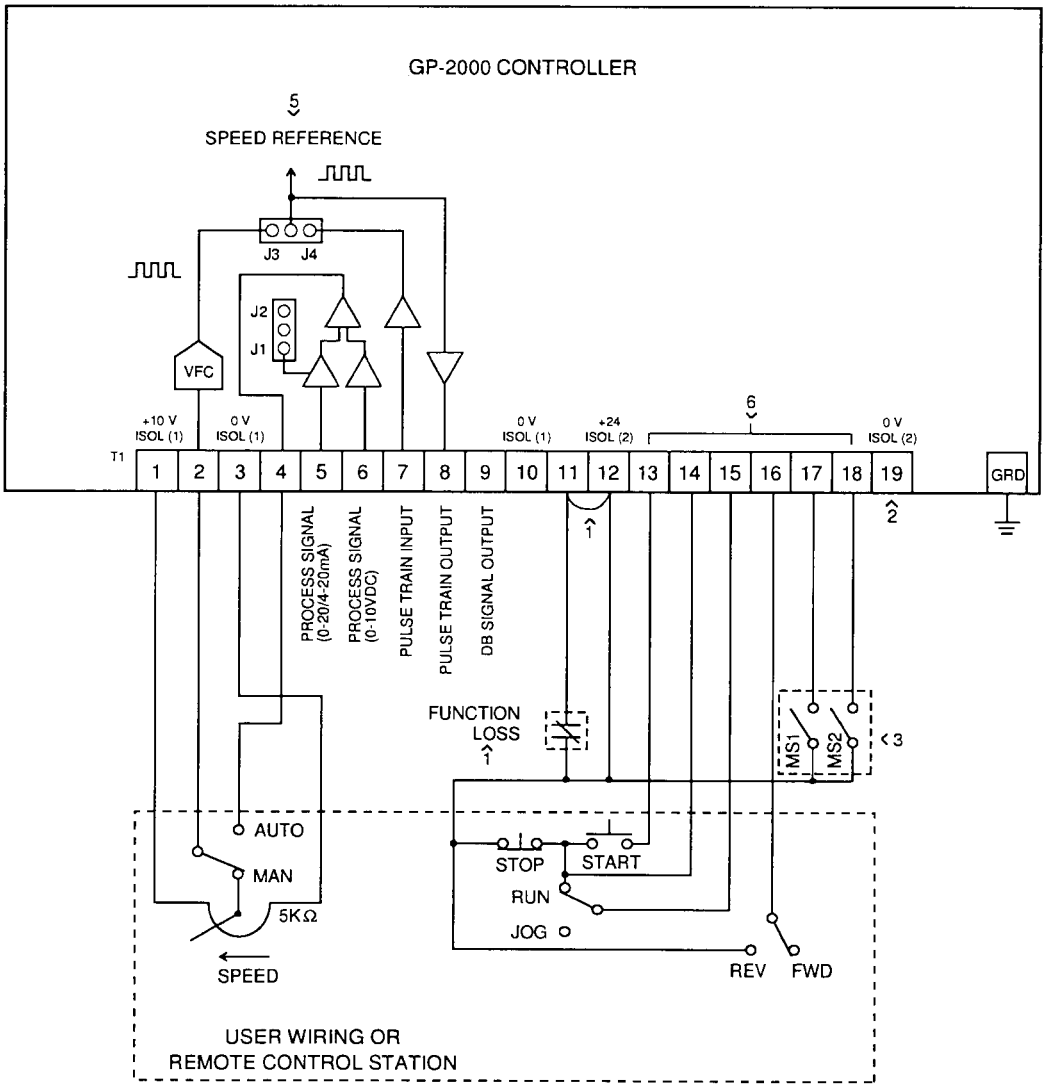
Figure 3-4. Speed Reference Terminal Wiring.

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WARNING
GP2000 CONTROLLERS WITHOUT THE OPTIONAL BYPASS MODIFICATION ARE NOT EQUIPPED WITH A COAST-STOP PUSHBUTTON. THE USER MUST INSTALL A HARDWIRED, OPERATOR-ACCESSIBLE PUSHBUTTON THAT PROVIDES A POSITIVE INTERRUPT AND SHUTS DOWN THE DRIVE. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

4. Route external control wiring (if used) through a center opening in the bottom of the controller in separate steel conduit to eliminate electrical noise pick-up. The conduit can be rigid or flexible armored steel.
5. Do not route any signal wire through junction or terminal boxes that contain power or control wire.
6. Do not route any signal wire in close proximity to devices producing external magnetic fields.

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1> When user-supplied function loss input or interlocks are connected, remove the factory-installed jumper between terminals 11 and 12 in order for these contacts to be operational. When these contacts open, the controller stops on an IET and the motor coasts to rest.

2> Used to ground 24VDC Start/Stop circuit if required by code.

3> When parameter 0 is selected in Function 57, terminals 17 and 18 are inputs for the Multi-Speed Preset MS1, MS2, and MS3. The third preset speed, MS3, is enabled when both MS1 and MS2 contacts are closed.
When parameter 1 is selected in Function 57, the same terminals 17 and 18 will be inputs for the Static MOP, not for the Multi-Speed Preset.

4> A remote reset contact is optional since the STOP/RESET key on the keypad is functional under all conditions.

5> This is the speed reference when either in the:
A. Remote Mode (Function 0) or
B. Local Mode (Function 0) with the AUTO/MAN Key in the AUTO position.

6> The terminals from 13 to 18 are active only when parameter 1 (Remote Mode) is selected in Function 0.

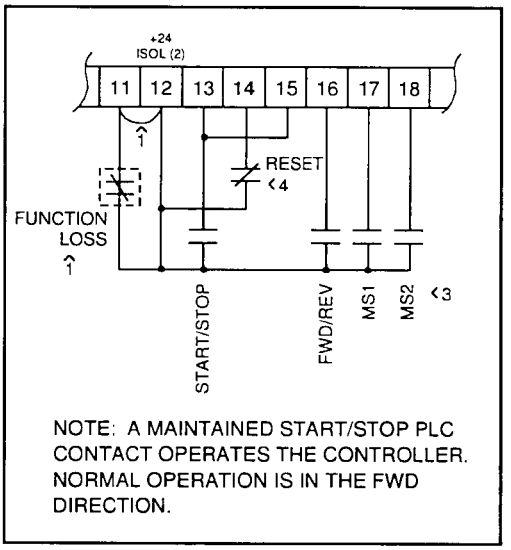


Figure 3-5. Typical Remote Control Wiring.

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4: Start the Drive

DANGER

ONLY QUALIFIED ELECTRICAL PERSONNEL FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF THIS EQUIPMENT AND THE HAZARDS INVOLVED SHOULD START AND ADJUST IT. READ AND UNDERSTAND THIS MANUAL IN ITS ENTIRETY BEFORE PROCEEDING. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

Test Equipment Needed

CAUTION: Do not use a Megger to perform continuity checks in the drive equipment. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

For controller output measurements of voltage, amperage, and frequency as applied to the motor power leads, the 4-digit display on the controller keypad is satisfactory. For all other voltage, amperage, and ohmic measurements, an analog or digital volt-ohmmeter is required. Make certain the selected volt-ohmmeter is rated for the intended measurement values.

Although not required for controller startup and adjustment, the best method of obtaining actual motor voltage, current, and speed measurements is with a fundamental voltmeter, digital clamp-on ammeter, and a hand-held tachometer, respectively.

Check the Installation

DANGER

THIS EQUIPMENT IS AT LINE VOLTAGE WHEN A-C POWER IS CONNECTED TO THE CONTROLLER. DISCONNECT ALL UNGROUNDED CONDUCTORS OF THE A-C POWER LINE FROM THE CONTROLLER. AFTER POWER IS REMOVED, VERIFY WITH A VOLTMETER AT TERMINALS 147(+) AND 45(-) THAT THE D-C BUS CAPACITOR(S) IS DISCHARGED BEFORE TOUCHING ANY INTERNAL PARTS OF THE CONTROLLER. FAILURE TO OBSERVE THESE PRECAUTIONS COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

1. Make sure the input disconnect is in the OFF position (power OFF).
2. Make sure the drive shutdown interlocks, such as safety switches installed around the driven machine, are operational. When activated, they should shut down the drive.

WARNING

GP2000 CONTROLLERS WITHOUT THE OPTIONAL BYPASS MODIFICATION ARE NOT EQUIPPED WITH A COAST-STOP PUSHBUTTON. THE USER MUST INSTALL A HARDWIRED, OPERATOR-ACCESSIBLE PUSHBUTTON THAT PROVIDES A POSITIVE INTERRUPT AND SHUTS DOWN THE DRIVE. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

CAUTION: Make sure electrical commons are not intermixed when monitoring voltage and current points in the controller. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

Check the Controller and Enclosure

1. Remove the controller enclosure cover, if not already removed.
2. Look for physical damage, remaining installation debris, wire strands, etc.
3. Use clean, dry, low pressure air (below 25 psi) for removing debris from the controller.
4. Check that there is adequate clearance around the controller for air flow.
5. Check that the controller is wired correctly. See Figure 3-2 (230 VAC controller, Local Control), Figure 3-3 (460 VAC and 575 VAC controllers, Local Control), Figure 3-4 (speed reference), and/or Figure 3-5 (Remote Control).
6. When a motor overload device and/or user-supplied interlocks or function loss devices are installed, make sure the factory-installed jumper across terminals 11 and 12 is removed. (See Figure 3-2 or 3-3.)

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7. Using a voltmeter, check that rated power is available on the incoming line side and outgoing load side of the input disconnect.

CAUTION: Line voltage must correspond to controller rating. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

8. Check that all control and power terminal connections are tight. (See Table 3-3 for input and output power terminal tightening torques.)
9. Check that user-supplied input fuses are in place and seated in the fuseholders. Verify that the fuses are correctly rated for the controller. Refer to Table 2-2, 2-3 or 2-4 for controller ratings.
10. Check the continuity of the fuses. Replace any fuse that reads open.

Check the Motor

1. Verify that motor nameplate data corresponds to the controller output ratings:
   - Voltage: Three-phase. If the motor has dual voltage capability, verify that it is connected for the voltage corresponding to the input voltage.
   - Current: Verify that full-load current does not exceed the controller's motor sine wave current rating. If the motor is overframed, verify that the motor operating current does not exceed the controller's rated current and the motor horsepower rating is not more than one size larger than the controller's horsepower rating.
   - Frequency: 60 or 50 hertz or other frequency consistent with the controller output frequency.

   For synchronous motor applications, consult your Reliance Electric Sales Office.
2. Check that the motor is installed according to the motor instruction manual.
3. Disconnect any power factor correction capacitors connected to the motor.
4. If possible, uncouple the motor from the driven machinery.
5. Rotate the motor shaft by hand to check that the motor is free from any binding or mechanical load problem.
6. Check that no loose items, such as shaft keys, couplings, etc., are present.
7. Check all connections for tightness and proper insulation.
8. Check that any motor thermal switch or overload device is wired correctly.

Motor Overspeed

WARNING

THE USER IS RESPONSIBLE FOR ENSURING THAT DRIVEN MACHINERY, ALL DRIVE-TRAIN MECHANISMS, AND PROCESS LINE MATERIAL ARE CAPABLE OF SAFE OPERATION AT AN APPLIED FREQUENCY OF THE OVERFREQUENCY LIMIT VALUE TO THE A-C MOTOR. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

Check the Transformer (if used)

1. Check that the rating of the transformer (if used) matches the controller requirements. Refer to "Install a Transformer" in Chapter 3.
2. Check that the transformer is connected for the proper voltages.

Check the Grounding

DANGER

THE USER IS RESPONSIBLE TO MEET ALL CODE REQUIREMENTS WITH RESPECT TO GROUNDING ALL EQUIPMENT. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SERVE BODILY INJURY OR LOSS OF LIFE.

1. Verify that a properly sized ground wire is installed between the controller ground terminal and a suitable earth ground. Verify that the connections are tight.
2. With an ohmmeter, check for and eliminate any grounds between the input power leads to the controller ground terminal and between the output power leads to the controller ground terminal.
3. Verify that a properly sized ground wire is installed between the motor frame and a suitable earth ground and that the connections are tight.
4. With an ohmmeter, check for and eliminate any grounds between the motor frame and the motor power leads.
5. Verify that a properly sized ground wire is installed between the Remote Control Station (if used) and a suitable earth ground and that the connections are tight.
6. Verify that a properly sized ground wire is installed between the transformer (if used) and a suitable earth ground and that the connections are tight.
7. Verify the above ground wires are run **unbroken**.

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Start the Controller

In most cases, the following startup procedure will successfully start and run the controller. This procedure requires the controller to be controlled locally from the keypad (Local Control). Reconfiguring the controller programmable functions is not necessary.

1. Follow the "Check the Installation" procedure if not already performed.
2. Make sure all power is OFF.
3. Set a voltmeter on the 500 VDC, 1000 VDC, or a similar high voltage scale. Connect the voltmeter to terminals 147(+) and 45(-). Read this voltmeter every time you turn power OFF to verify that the D-C bus capacitor(s) is fully discharged. Within one minute after power is OFF, the bus voltage should measure about 50 VDC. The red Bus Charge LED on the Power Supply and Base Driver board will gradually fade as the voltage decreases to zero.
4. If the controller has been stored for less than six months, proceed to Step 5. If he controller has been stored for over six months, form the capacitor(s) as follows:

DANGER

THE REMAINING STEPS TO FORM THE CAPACITOR(S) ARE MADE WITH POWER ON. EXERCISE EXTREME CAUTION BECAUSE HAZARDOUS VOLTAGE EXISTS. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

- Disconnect the motor leads from the controller, if connected.
- Turn the power ON.

  NOTE: *When the power is turned ON for the first time, the 2-digit display will be blank and the 4-digit display will show SELF for approximately 1 second while the controller performs a self-diagnostic test.*

  At the end of a successful test, the 4-digit display will show 5.0.

  At the end of an unsuccessful test, the 2-digit display will show a hexadecimal number and the 4-digit display will continue to show SELF. Refer to "Troubleshoot the Controller" if this condition exists.
- Observe that the voltmeter reading is the no load value with respect to the appropriated A-C input voltage listed in Table 4-1.
- Let the controller sit undisturbed for fifteen minutes while the capacitor(s) charges. **Put a tag on the controller that power is ON and hazardous voltage exists.**
- Turn the power OFF. Verify the D-C bus voltage is zero (read the voltmeter) and the Bus Charge LED has faded out.

Table 4-1. D-C Bus Voltage Value.

A-C Input Line Voltage	D-C Voltage between 147(+) and 45 (-)	
	No Load in Stop Mode	Full Load in Run Mode
230 VAC	325 VDC	310 VDC
460 VAC	649 VDC	621 VDC
575 VAC	810 VDC	777 VDC

5. With the power OFF, connect the motor leads to the controller, if disconnected. **Uncouple the driven equipment from the motor, if possible.**

DANGER

THE REMAINING STEPS ARE MADE WITH POWER ON. EXERCISE EXTREME CAUTION BECAUSE HAZARDOUS VOLTAGE EXISTS. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

6. Turn the power ON. Observe that the voltmeter reading is the no load value listed in Table 4-1.

   NOTE: *When the power is turned ON for the first time, the 2-digit display will be blank and the 4-digit display will show SELF for approximately 1 second while the controller performs a self-diagnostic test.*

   At the end of a successful test, the 4-digit display will show 5.0. The following (red) LEDs will light: Local Control, RUN, FWD, and MAN.

   At the end of an unsuccessful test, the 2-digit display will show a hexadecimal number and the 4-digit display will continue to show SELF. Refer to "Troubleshoot the Controller" if this condition exists.
7. Verify that the following controls are selected (The red LED of each selected control key will be lit.):
   RUN
   FWD
   MAN

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8. Press the START key. The green RUN LED will light, indicating the controller is in the Run mode. The controller will ramp to the preset output Hz. The 4-digit display will show the output Hz (The controller is shipped with minimum Hz factory set at 5 Hz.); the 2-digit display will show H.

WARNING

THIS DRIVE IS INTENDED TO OPERATE AT A PREDETERMINED MINIMUM SPEED UNLESS DISCONNECTED FROM THE POWER SOURCE. IF THE APPLICATION REQUIRES ZERO SPEED OPERATION WITHOUT SUCH DISCONNECTION, THE USER IS RESPONSIBLE FOR ASSURING SAFE CONDITIONS FOR OPERATING PERSONNEL BY PROVIDING SUITABLE GUARDS, AUDIBLE OR VISUAL ALARMS, OR OTHER DEVICES. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

NOTE: *If the motor does not start, press the ▲ key to increase the speed enough to start motor shaft rotation.*

9. While the controller is in the Run mode, you can monitor the output frequency, the output voltage, and the percentage of full-load amps of the controller. Press the MON key and watch the displays. The 2-digit display shows which output is being monitored: H for frequency, U for voltage, and PA for percentage of controller full-load amps. The 4-digit display shows the actual value of output frequency, voltage, or percentage amperage. The display scrolls to the next output reading each time the MON key is pressed. You can also monitor RPM, if necessary. Refer to Function 46, 47, and 48 in Chapter 5.

   NOTE: *While in the STOP mode, the 4-digit display can show the set speed (the speed at which the controller will accelerate to once a start command is given) by pressing the ▲ or ▼ key one time. The set speed will either show the internal speed reference in Hz (if "LOCAL" and "MAN" selections are made) or show the external speed reference (if "LOCAL" and "AUTO" or "REMOTE" and "MAN" or "REMOTE" and "AUTO" selections are made). It is useful to observe the external speed reference as in the latter case to make sure the controller is in fact receiving a speed signal.*

   While in the RUN mode, the same internal and external set speed signals can be observed. This is also done by pressing the ▲ or ▼ key one time.

10. Press the STOP key to initiate the Stop mode. The 4-digit display will show the changing values of the output being monitored at the time the STOP key is pressed.

11. If the direction of shaft rotation is correct, go to Step 12. If shaft rotation is incorrect, change the rotation direction as follows:

    - Press the STOP key and wait until the motor has completely stopped.
    - Turn the power OFF.
    - After verifying the D-C bus voltage is zero, reverse any two of the three motor power leads.
    - Turn the power ON and press the START key.

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12. The speed of the A-C induction motor shaft varies with the controller output Hz. (See Chapter 6 for a description of controller fundamentals.) Changing the output Hz setting is similar to changing the position of a speed pot with analog controllers. Pressing the ▲ or ▼ keys will change the output Hz settings; then, pressing the SET key will lock in the values. The SET key is needed to lock in the new values. The output Hz setting may be changed while either in the Run mode or Stop mode using the ▲, ▼, and SET keys. The 4-digit display will show this value in Hz and the 2-digit display will be blank.

    Using the ▲ key or ▼ key, change the output Hz settings and run the motor without any load across the speed range. (The controller is shipped with the speed range factory set at 5.0 to 60 Hz.)

    NOTE: *If the application requires the minimum and maximum Hz settings to be changed, see Functions 3, 4, 38, and 43 in Chapter 5.*

13. If the motor is unloaded and does not operate satisfactorily, go to Chapter 7; otherwise, go to Step 14.

14. Press the STOP key. Wait for the motor to completely stop. Turn the power OFF.

DANGER

THIS EQUIPMENT IS AT LINE VOLTAGE WHEN A-C POWER IS CONNECTED TO THE CONTROLLER. DISCONNECT ALL UNGROUNDED CONDUCTORS OF THE A-C POWER LINE FROM THE CONTROLLER. AFTER POWER IS REMOVED, VERIFY WITH A VOLTMETER AT TERMINALS 147(+) AND 45(-) THAT THE D-C BUS CAPACITOR(S) IS DISCHARGED BEFORE TOUCHING ANY INTERNAL PARTS OF THE CONTROLLER. FAILURE TO OBSERVE THESE PRECAUTIONS COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

15. Couple the driven equipment to the motor, if not already coupled.

16. With the power ON, press the START key.

17. Run the drive across the speed range under load.

18. Press the STOP key.

19. Turn the power OFF. After verifying the D-C bus voltage is zero, remove the voltmeter and any other instrumentation connected during startup.

20. Replace and secure the controller enclosure cover.

    If the drive operates satisfactorily, startup is complete.

    If the drive does not operate satisfactorily, go the Chapter 5. The factory set values of programmable functions, such as the following, may need to be adjusted:

    - acceleration and deceleration times (Functions 1, 2, 44, and 45)
    - minimum and maximum speed (Functions 3, 4, 38, and 43)
    - current limit (Function 5)
    - manual torque boost (Function 7)
    - base frequency (Function 11)
    - Stop mode selection (Function 9)
    - line-dip-ride-through (Function 27).

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5: Adjust the Controller Functions

DANGER

ONLY QUALIFIED ELECTRICAL PERSONNEL FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF THIS EQUIPMENT AND THE HAZARDS INVOLVED SHOULD START AND ADJUST IT. READ AND UNDERSTAND THIS MANUAL IN ITS ENTIRETY BEFORE PROCEEDING. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

Introduction to Programmable Functions

The controller offers users 57 software functions that are either selectable or adjustable by using the program keys on the keypad. The factory preset values for these functions suit a wide range of standard applications. To configure the controller for a specific application, activate and adjust the values of these functions as necessary.

This chapter describes how to configure the controller using the keypad and displays. It also gives a complete description of each function by its assigned function number. The functions list is in numerical order by the assigned function numbers. You can scroll through the list in ascending order with the PGM key. A quick reference summary of these functions, also in numerical order by the function number, is given in Table 8-3 at the end of this manual.

Function Menus and Passwords

To simplify the configuration process, the software functions list is divided into two menus. The first menu contains seven functions (0 through 6). Functions 0 through 5 are commonly used to adjust the controller for simple applications. Function 6, which permits access to the second menu, requires a password before it can be changed to allow access to Functions 7 through 57. Until the password is given and the Function 6 parameter is changed, you can scroll and modify only the first menu functions.

The second menu functions allow you to adjust the controller for more complex applications. Some of these functions cannot be selected without entering a second password. These functions are safety related and should be used only with a thorough understanding of their nature.

Configuring the Controller

1. Turn the power ON if not already ON.
2. Press the STOP key to confirm the controller is in the Stop mode.
3. Press the PGM key. The Program Enable LED will light.

   NOTE: *The controller is shipped from the factory with the Program jumper in the J5 position. This jumper must be in the J5 position in order for the Program Enable LED to light and configuration of the controller to be possible. If this LED does not light, the jumper is in the J6 position. To change its position, perform the following:*

   - *Turn the power OFF.*
   - *Remove the front cover.*
   - *Verify with a voltmeter at terminals 147(+) and 45(-) that the D-C bus voltage is zero.*
   - *Locate the Program jumper on the regulator (see Figure 3-2 or 3-3).*
   - *Change the jumper position.*

     In the J5 (Program Enable) position, the Program Enable LED will light when the PGM key is pressed and changing the controller configuration will be possible.

     In the J6 (Program Disable) position, the Program Enable LED will not light and unauthorized data entry will be prevented. Function values can be viewed on the 4-digit display but cannot be changed.
   - *Replace the cover.*
   - *Turn the power ON and wait for the controller to complete its self-diagnostic test.*

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4. Press the PGM key to scroll through the functions list to the desired function number. The function number will show on the 2-digit display and the function value stored in memory will show on the 4-digit display.

5. To change the value of a particular function, scroll to the function number (2-digit display). Each function has a range of values that can be entered or selected. Press the ▲ or ▼ key to increase or decrease the value shown in the 4-digit display. The software will not allow you to make selections outside the function's range.

   NOTE: *The function description included in this chapter gives the available selections or the value range, as applicable. The value set at the factory (initial factory setting) is also listed.*

6. After changing a function value with the ▲ and ▼ keys, press the SET key to lock the new data in the controller memory.

   Depending on the specific application, an IET fault may occur with this new setting when the controller is put in the Run mode. If an IET does occur, the controller will stop and the 4-digit display will indicate the code of the IET causing the failure. Table 7-1 summarizes these codes. The controller cannot run while in an IET state. Reset the controller by pressing the STOP key. Clear the fault which may require a new function value to be entered.

   NOTE: *The controller is shipped with preset values that will not cause IET trips under normal conditions.*

7. When selections and changes are complete, press the MON key one time to return to the Stop mode.

   If the MON key is pressed a second time, the 4-digit display will show the code of the last occurring IET. If there have been no IETs, the display will show 0000. To return to the Stop mode, press the STOP key.

8. While in the Run mode, the Program Enable is locked out; the Program Enable LED will not light even if the PGM key is pressed. To return the monitor feature, press the MON key.

First Menu Functions

0 Local/Remote Operation Control

Parameter Selection

0 = Local Control (Keypad)
1 = Remote Control (Terminal Strip)
2 = Remote Control (Reliance I/O Port — requires optional Rail Interface Card)

Initial Setting

0

Description

When 0 is selected, operational control is through the keypad and the LOCAL LED is lit. When 1 or 2 is selected, the controller is operated remotely and the REMOTE LED is lit. In the Remote mode (1 or 2), the controller deactivates the RUN/JOG, FWD/REV, and AUTO/MAN keypad keys. The STOP key remains functional. The controller will not allow selection of 2 unless the optional Rail Interface Card is installed and wired in the controller.

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1 Acceleration Time

Adjustment Range

5.0 - 360.0 seconds

Initial Setting

20.0

Description

Acceleration time is the normal time in which the motor reaches maximum Hz after starting. The acceleration rate (hertz/second) depends on the maximum Hz setting. If an acceleration time faster than 5 seconds is required, see Function 44. If the motor load inertia is high and/or the current limit (Function 5) setting is too low, acceleration time will be longer than the preset time. For jog acceleration time, see Function 51.

NOTE: *With very fast acceleration times, the motor may draw excessive current resulting in an overcurrent (OC-A) IET. To avoid this condition, reset the acceleration time for a longer period.*

2 Deceleration Time

Adjustment Range

5.0 - 360.0 seconds

Initial Setting

20.0

Description

Deceleration time is the normal time in which the motor decreases from maximum Hz to zero Hz. Therefore, the deceleration rate (hertz/second) depends on the maximum Hz setting. If a deceleration time faster than 5 seconds is required, see Function 45. For jog deceleration time, see Function 52.

Note: *Motor load inertia and input line conditions can extend the deceleration time to a value greater than the preset time. With very fast deceleration times, regenerative motor voltage may charge up the D-C bus voltage causing a high bus voltage (HU) IET. To avoid an IET condition, reset the deceleration time for a longer period. If a deceleration time faster than the acceptable range is required, install an optional Dynamic Braking Kit.*

3 Minimum Hz

Adjustment Range

5.0 - 60.0 Hz

Initial Setting

5.0

Description

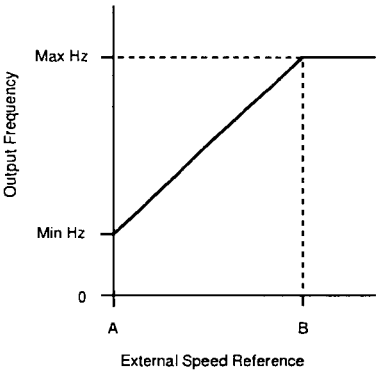
DANGER

THE DRIVE IS INTENDED TO OPERATE AT A PREDETERMINED MINIMUM SPEED UNLESS DISCONNECTED FROM THE POWER SOURCE. IF THE APPLICATION REQUIRES ZERO SPEED OPERATION WITHOUT SUCH DISCONNECTION, THE USER IS RESPONSIBLE FOR ASSURING SAFE CONDITIONS FOR OPERATING PERSONNEL BY PROVIDING SUITABLE GUARDS, AUDIBLE OR VISUAL ALARMS, OR OTHER DEVICES. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

Minimum Hz is the minimum output frequency value that can be reached with the ▼ key. Minimum Hz should always be lower than maximum Hz (Function 4), and the speed setting value must always be within minimum and maximum Hz. When the AUTO key is selected to control speed by an external process control signal, the gain (output frequency/speed reference) can be adjusted with the minimum Hz setting and/or the maximum Hz setting. See Figure 5-1.

If a minimum Hz lower than 5 Hz is required, contact Reliance Electric for the second password to access Function 43, Extended Minimum Hz Range.

Minimum Hz speed value takes priority over other function settings such as jog and preset speeds.



WHERE:
A = MINIMUM INPUT REFERENCE
B = MAXIMUM INPUT REFERENCE

REFERENCE TYPE	A	B
VOLTAGE	O VDC	9.5 ± 0.5 VDC
CURRENT	4 mA	19 ± 1 mA
CURRENT	0 mA	19 ± 1 mA
FREQUENCY	0 Hz	97.656 KHz

Figure 5-1. Relationship of Output Frequency and Speed Reference for Process Control Auto Selection.

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4 Maximum Hz

Adjustment Range

15.0 - Overfrequency Limit

NOTE: *Overfrequency Limit (Function 38) is factory set at 90 Hz.*

Initial Setting

60.0

Description

WARNING

THE USER IS RESPONSIBLE FOR ENSURING THAT DRIVEN MACHINERY, ALL DRIVE-TRAIN MECHANISMS, AND PROCESS LINE MATERIAL ARE CAPABLE OF SAFE OPERATION AT A SPEED EQUIVALENT TO AT LEAST THAT WHICH WOULD RESULT FROM AN APPLIED FREQUENCY 20% ABOVE THE OVERFREQUENCY LIMIT (FUNCTION 38). FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

Maximum frequency is the maximum output frequency value that can be reached with the ▲ key. When AUTO is selected to provide an external speed reference of 10 VDC, 20 mA, or 100 KHz into the controller, the gain can be adjusted with the minimum Hz setting and/or the maximum Hz setting. See Figure 5-1.

Maximum Hz can be programmed between 15 Hz and 90 Hz in the first menu. If a maximum Hz higher than 90 Hz is required, contact Reliance Electric for the second password to access Function 38, Overfrequency Limit

5 Current Limit

Adjustment Range

50 - 150% rated current

Initial Setting

150

Description

This feature provides the means to limit motor output torque. When output current attempts to exceed the preset current limit level, motor speed is decreased. This feature automatically provides an adjustable torque limit for the driven equipment. (See Function 55 if IET tripping occurred, under current limit conditions.)

6 Expand to Second Menu

Parameter Selection

0 = Basic (First Menu Only)
1 = Expand to Second Menu

Initial Setting

0

Password

0306

Description

Most simple applications will require only the adjustable functions found in the first menu. When you scroll through the functions list with the PGM key, at Function 6 the list will complete its cycle and return to Function 0. Note that the Program Enable LED goes off when you reach Function 6. This indicates that you cannot modify this function without a password.

DANGER

ONLY QUALIFIED ELECTRICAL PERSONNEL FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF THIS EQUIPMENT AND THE HAZARDS INVOLVED SHOULD START, ADJUST, OPERATE, AND/OR SERVICE IT. READ AND UNDERSTAND THIS MANUAL IN ITS ENTIRETY BEFORE PROCEEDING. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

If your application requires changing any function found in the second menu, complete the following to gain access to the second menu:

- With the PGM key, select Function 6.
- Press and hold in the SET key until 0000 flashes in the 4-digit display (approximately 3 seconds).
- Enter password 0306 with the ▲ and ▼ keys. When the 4-digit display shows this value, press the SET key.
- The 4-digit display will change to 0 (Function 6 value for Basic — first menu only), and the Program Enable LED will light.
- Change the 0 value to 1 with the ▲ key and press the SET key.

Now, when you press the PGM key to scroll the function list, you will scroll to Function 7 and on through the list. As long as the parameter remains selected at 1, you can view and modify most of the functions in the list. To change Function 6 back to "first menu only," repeat this password process and select 0.

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Second Menu Functions

7 Manual Torque Boost

Adjustment Range

0 - 10% voltage

Initial Setting

2

Description

WARNING

THE DRIVE IS INTENDED TO OPERATE AT A PREDETERMINED MINIMUM SPEED UNLESS DISCONNECTED FROM THE POWER SOURCE. TO ENSURE MOTOR ROTATION AT THE MINIMUM SPEED SETTING, TORQUE BOOST MUST BE PROPERLY ADJUSTED. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

Torque boost is required to offset the voltage drop of the A-C motor at low speeds to produce a constant torque capability. For friction loads and large inertia loads, a high starting torque level may be needed. Manual torque boost is effective only at speeds lower than half of base frequency. Figure 5-2 illustrates the manual torque boost adjustable range and the V/Hz characteristics.

If the torque boost setting is too high or the acceleration ramp is too fast, the motor may draw excessive starting current. This could cause an overcurrent (OC-A or OC) IET. Also, too much torque boost may cause excessive motor heat and motor noise.

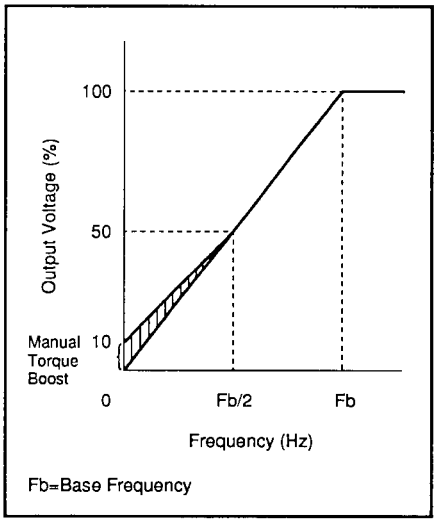


Figure 5-2. Manual Torque Boost Adjustable Range.

8 Jog Frequency

Adjustment Range

0.0 - 60.0 Hz

Initial Setting

5.0

Description

Jogging can be accomplished in either Local Control or Remote Control. Jog frequency can be set from 0.0 to 60.0 Hz and is independent from any other set speed. The actual output frequency for jog is automatically limited between minimum and maximum Hz.

Jog speed cannot be changed with the ▲ and ▼ keys while the controller is in the Run mode. The only way to change Jog speed is to put the controller in the Stop mode, select Function 8 with the PGM key, and reset the jog frequency value.

The frequency of jog speed overrides the avoidance frequency of Function 19, 20, 21 and 22.

9 Stop Mode Selection

Parameter Selection

0 = Coast-to-rest
1 = Ramp-to-rest

Initial Setting

0

Description

With parameter "0" selected, pressing the STOP key or giving an external Stop command causes the motor to coast to a rest. With parameter "1" selected, pressing the STOP key or giving an external Stop command causes the motor to ramp to a rest within a time equal to or greater than the preset deceleration time (Function 2).

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10 Automatic Flux Control

Adjustment Range

0 - 5% rated voltage

Initial Setting

0

Description

Automatic flux control optimizes the motor magnetic flux and, thus, the motor output torque. It senses the output current and adjusts the corresponding voltage to provide the ideal flux and torque conditions of the motor. This compensated voltage is adjustable from 0 to 5% rated voltage at 100% full load current of the controller.

Figure 5-3 illustrates the automatic flux control adjustable range as well as the V/Hz characteristics with both automatic flux control and manual torque boost. For optimum performance, low torque loads should be set at the low end of the range (≅0%) and high torque loads at the high end (≅5%).

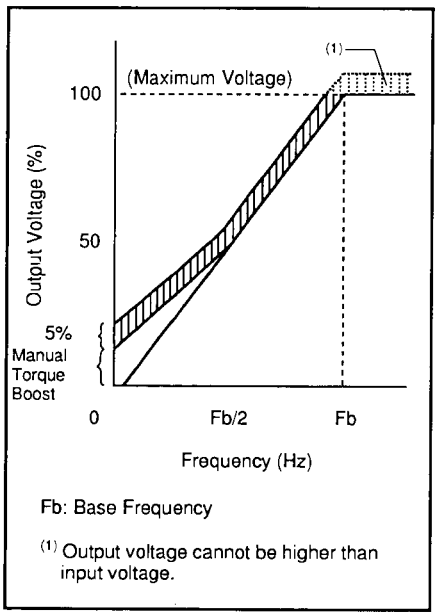


Figure 5-3. Automatic Flux Control Adjustable Range.

11 Base Frequency Selection (Volts/Hz Ratio)

Adjustment Range

30.0 - 400.0 Hz

Initial Setting

60.0

Description

The base frequency selection is used to adjust the controller output volts/hertz ratio. Base frequency is the set frequency between 30 - 400 Hz at which the output voltage reaches maximum voltage. Maximum voltage is adjustable, if necessary. See Function 49 and 50.

Below base frequency, output voltage varies with output frequency according to the V/Hz adjustment (referred to as the constant torque range). Above base frequency, output voltage is held constant as frequency increases (referred to as the constant horsepower range). Figure 5-4 shows the relationship of base frequency and V/Hz.

NOTE: *The V/Hz ratio is affected by the settings of automatic flux control (Function 10) and manual torque boost (Function 7).*

In normal constant torque applications, base frequency should equal maximum Hz.

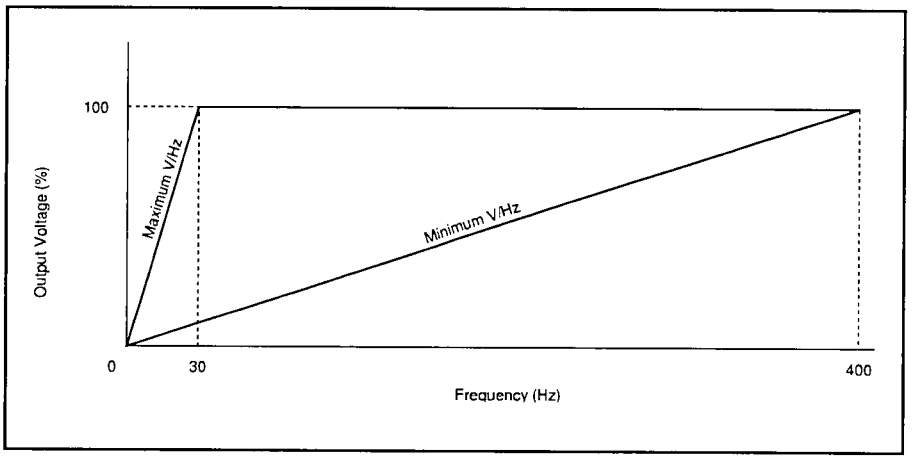


Figure 5-4. Relationship of Base Frequency and V/Hz Selection for Constant Torque Applications.

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12 Electronic Thermal Overload Selection

Parameter Selection

0 = Normal Motor
1 = Forced Cooled Motor

Initial Setting

0

Description

The function of an electronic thermal overload is similar to a motor overload relay because it limits output current to the motor. Function 12 allows selection of an output current profile best suited for the type of motor to be run. Function 13 allows adjustment of the output current value. Note that, while the electronic thermal overload functions similarly to a motor overload relay, it is not accurate below 5 Hz and does not measure actual motor temperature. A temperature measuring device is the best way to thermally protect a motor under all conditions.

A Function 12, 0 selection is best suited for motors with cooling fans integral to the motor shaft, such as totally enclosed fan cooled TEFC or open dripproof ODP motor types. Selection 1 is best suited for motors with cooling that is independent of motor speed, such as motors with constant speed cooling fans or totally enclosed non-ventilated TENV motor types. Figure 5-5 shows the allowable continuous current with respect to speed (output Hz) for each selection with Function 13 set at 50% and 100%.

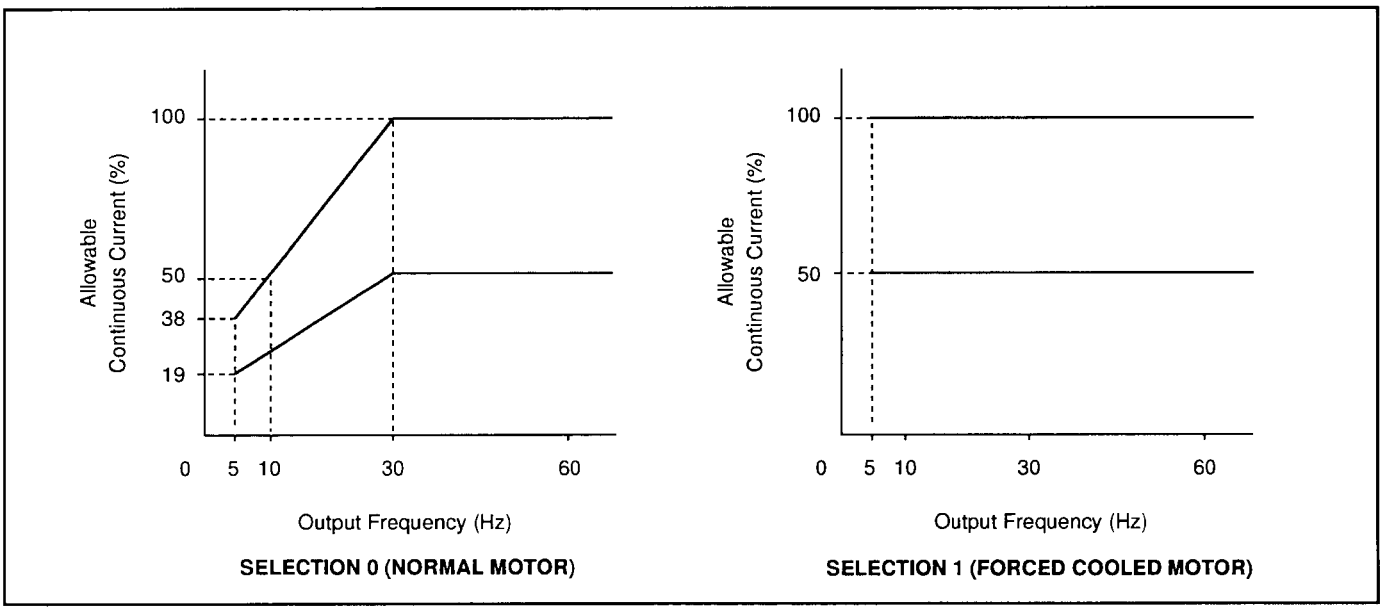


Figure 5-5. Allowable Continuous Current vs Output Hz (with Function 13 at 50% and 100% Settings).

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13 Electronic Thermal Overload Level

Adjustment Range

20 - 100% rated current

Initial Setting

100

Description

The adjustment of this function is useful if the motor horsepower rating is less than the controller horsepower size. Using the formula below, calculate the setting level as a percentage of maximum continuous current:

$$\text{Setting Level (\%)} = \frac{\text{Motor Full Load Current}}{\text{Controller Output Rated Current}} \times 100$$

Figure 5-6 illustrates curves for the electronic thermal overload with the forced cooled motor selection at 100% and 50%. Table 5-1 shows the approximate trip time in seconds vs. the output current at various electronic overload levels and frequencies. For example, if the overload setting level is 100%, when a motor runs with 150% load at 60 Hz, an IET will occur after one minute.

NOTE: *The calculated trip times given in Table 5-1 are based upon one overload trip. If successive trips occur, the trip times are shortened to more closely simulate the operation of a mechanical temperature overload device.*

CAUTION: If motors are wired in parallel on the output of the controller, do not use the electronic thermal overload function. Use separate motor overload relays on each individual motor. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

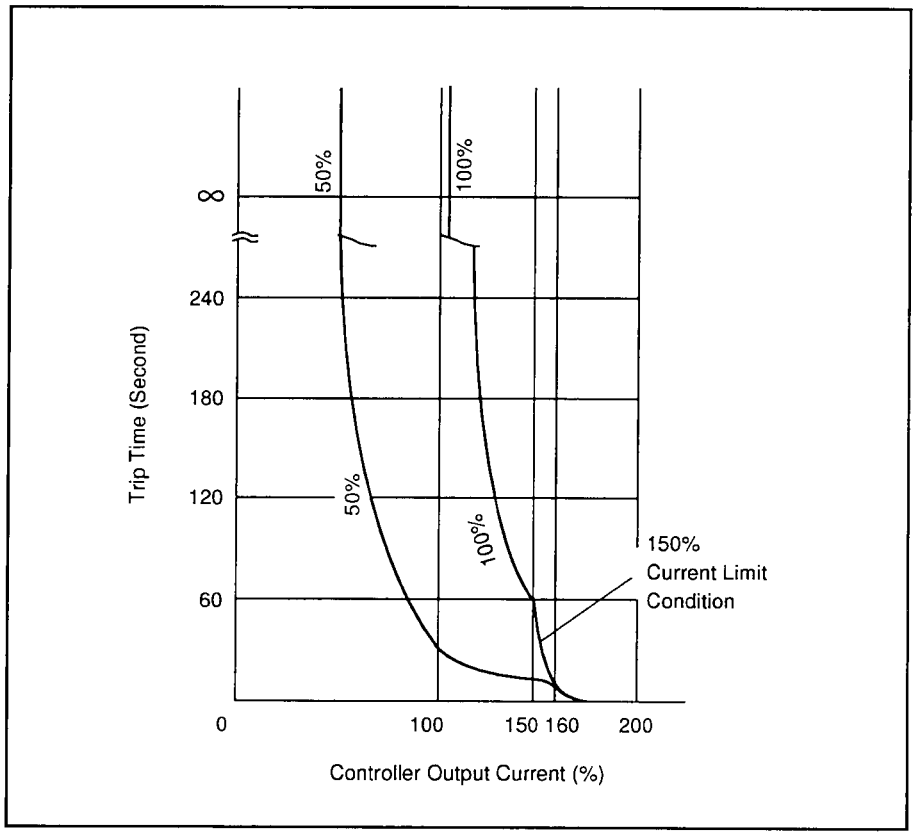


Figure 5-6. Electronic Thermal Overload Curves for Forced Cooled Motor Selection at 50% and 100% Overload Levels.

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Table 5-1. Trip Time for Overload Protection Based on First Trip.

NOTE: *Function 12, Electronic Thermal Overload, is set at 0.*

Electronic Thermal Overload Level (%)	Output Current (%)	Trip Time (second)					
		Output Frequency (Hz)					
		60 to 30	25	20	15	10	5
100	30	∞	∞	∞	∞	∞	∞
	40	∞	∞	∞	∞	∞	4349
	50	∞	∞	∞	∞	∞	255
	60	∞	∞	∞	∞	361	131
	70	∞	∞	∞	619	155	88
	80	∞	∞	2168	188	98	66
	90	∞	∞	241	111	72	53
	100	∞	334	127	79	57	45
	110	542	149	86	61	47	38
	120	181	96	65	50	40	33
	130	108	71	53	42	35	30
	140	77	56	44	36	31	27
	150	60	46	38	32	28	24
90	90	∞	334	127	79	57	45
	100	443	141	83	59	46	38
	110	157	89	62	48	39	33
	130	69	51	41	34	29	26
	150	44	36	31	27	24	21
80	80	∞	334	127	79	57	45
	90	361	131	80	58	45	37
	100	135	82	58	45	37	32
	110	83	59	46	38	32	28
	130	47	38	32	28	25	22
	150	33	28	25	22	20	18
70	70	∞	334	127	79	57	45
	80	292	121	76	55	44	36
	90	115	74	54	43	35	30
	100	71	53	42	35	30	26
	110	52	41	34	30	26	23
	130	34	29	25	22	20	18
	150	25	22	20	18	17	15
60	60	∞	334	127	79	57	45
	70	232	109	71	53	42	35
	80	96	65	49	40	33	29
	90	60	46	38	32	28	24
	100	44	36	31	27	24	21
	110	35	30	26	23	21	19
	130	24	22	20	18	16	15
	150	19	17	16	15	14	13
50	50	∞	334	127	79	57	45
	60	181	96	65	50	40	33
	70	77	56	44	36	31	27
	80	49	40	33	29	25	22
	90	36	31	27	24	21	19
	100	29	25	22	20	18	17
	110	24	21	19	17	16	15
	130	17	16	15	14	13	12
	150	14	13	12	12	11	10

14 Linear/S-Curve Acceleration

Parameter Selection

0 = Linear Acceleration
1 = S-Curve Acceleration

Initial Setting

0

Description

When S-Curve Acceleration is selected, acceleration will begin and end slowly. The acceleration time set at Function 1 will remain the same. Figure 5-7 illustrates S-Curve acceleration.

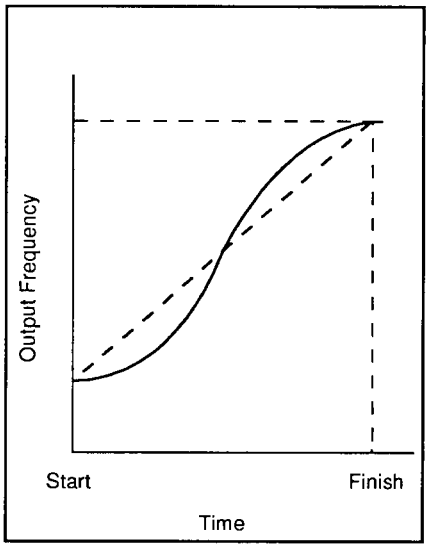


Figure 5-7. S-Curve Acceleration.

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15 Linear/S-Curve Deceleration

Parameter Selection

0 = Linear Deceleration
1 = S-Curve Deceleration

Initial Setting

0

Description

When S-Curve deceleration is selected, deceleration will begin and end slowly. The deceleration time set at Function 2 will remain the same. Figure 5-8 illustrates S-Curve deceleration.

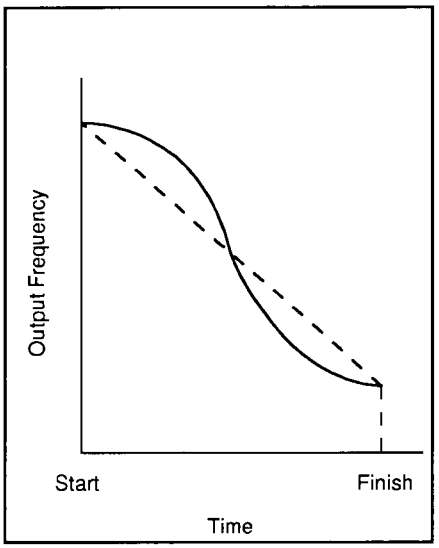


Figure 5-8. S-Curve Deceleration.

16, 17, 18 Multi-Speed Preset (MS1, MS2, MS3)

Adjustment Range

0.0 - 400.0 Hz

Initial Setting

5.0

Description

When the controller is controlled remotely (Function 0, Parameter 1 or 2), the controller can be configured to run at three different preset speeds. The frequency of each preset speed is limited between minimum and maximum Hz.

To select 1 to 3 preset speed values,

- Set the frequency level for each desired speed level (Functions 16, 17, and 18) using the ▲, ▼, and SET keys.
- Enable the desired speed level by wiring to the appropriate terminals according to Table 5-2. See Figure 3-5.

When the circuit is closed, the Multi-Speed Preset function overrides the external speed reference, causing the output frequency to accelerate or decelerate to the preset level (MS1, MS2, or MS3). When the circuit is open, control is returned to the external speed reference signal. The frequency of each preset speed overrides the avoidance frequency of Function 19, 20, 21, and 22. Figure 5-9 shows a typical multi-speed preset applica-tion.

NOTE: *The Multi-Speed Preset is enabled when parameter 0 is selected in Function 57. When parameter 1 is selected in Function 57, the same terminals 17 and 18 will become inputs for the Static MOP.*

Table 5-2. Terminal Connections for Multi-Speed Preset.

Function Number	Preset Speed	Terminal (T1) Connection
16	MS1	17 to 12
17	MS2	18 to 12
18	MS3	17 and 18 to 12

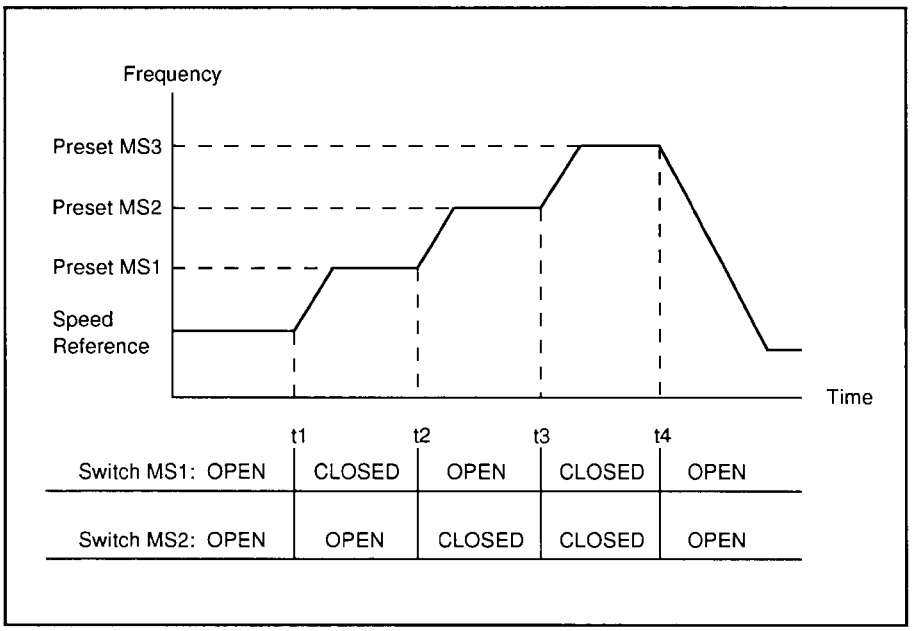


Figure 5-9. Typical Multi-Speed Preset Application.

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19, 20, 21 Avoidance Frequency (AF1, AF2, AF3)

Adjustment Range

0.0 - 400.0 Hz

Initial Setting

0.0

Description

Operating a motor continuously at a particular frequency may cause vibrational resonance within the machine. Three independent avoidance frequencies can be programmed to prevent motor vibration at these critical frequencies. See Figure 5-10.

The actual output frequency is limited between minimum and maximum Hz. This function (19, 20, or 21) is used with Function 22, Avoidance Frequency Band.

The avoidance frequency function is effective in both local and remote control. Normal acceleration and deceleration is unaffected by this function.

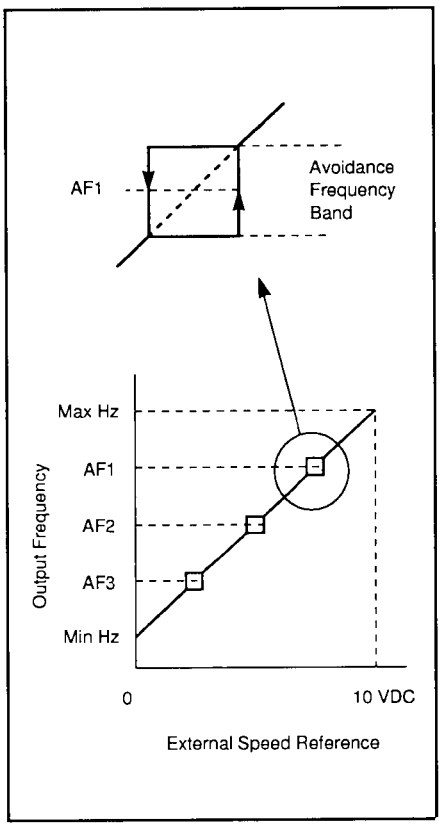


Figure 5-10. Avoidance Frequency Operation.

22 Avoidance Frequency Band (AFB)

Adjustment Range

0.2 - 10.0 Hz

Initial Setting

0.2

Description

This function is applicable with Functions 19, 20, and 21 (Avoidance Frequency). The avoidance frequency band selection will apply to each of the three avoidance frequencies set in Functions 19, 20, and 21. The actual range of avoidance frequency is calculated by the following formula:

$$AF1 - \frac{AFB}{2} < F_R < AF1 + \frac{AFB}{2}$$

where:

AF1 = Avoidance Frequency (set with Functions 19, 20, and 21)

AFB = Avoidance Frequency Band (set with Function 22)

F_R = Avoidance Range

To select 1 to 3 avoidance frequency bands:

- Using the ▲, ▼, and SET keys, set each avoidance frequency value (AF1, AF2, and AF3 at Function 19, 20, and 21, respectively) as needed. Each of these values must be between minimum and maximum Hz.
- Using the ▲, ▼, and SET keys while at Function 22, select the desired avoidance frequency band that will be applied to each avoidance frequency value.

The following example illustrates how avoidance frequency works. Assume the following:

- Minimum Hz is set at 10.0.
- Maximum Hz is set at 60.0.
- Output speed follows a 0-10 VDC process signal.
- Desired avoidance frequency (AF1) is 40 Hz.
- Desired avoidance frequency bandwidth (AFB) is 10 Hz.

$$40 - \frac{10}{2} < F_R < 40 + \frac{10}{2}$$

$$35\,Hz < F_R < 45\,Hz$$

Before applying avoidance frequency values, the process signal voltage produces output frequency as follows:

0 VDC = 10.0 Hz
5.0 VDC = 35.0 Hz
5.8 VDC = 39.0 Hz
5.9 VDC = 39.5 Hz
6.6 VDC = 43.0 Hz
7.0 VDC = 45.0 Hz
7.1 VDC = 45.5 Hz
10.0 VDC = 60.0 Hz

After applying avoidance frequency values, the output frequency will be:

Reference Increase
0 VDC = 10.0 Hz
5.0 VDC = 35.0 Hz
5.8 VDC = 35.0 Hz
5.9 VDC = 35.0 Hz
6.6 VDC = 35.0 Hz
7.0 VDC = 35.0 Hz
7.1 VDC = 45.5 Hz
10.0 VDC = 60.0 Hz

Reference Decrease
7.1 VDC = 45.5 Hz
7.0 VDC = 45.0 Hz
6.6 VDC = 45.0 Hz
5.9 VDC = 45.0 Hz
5.8 VDC = 45.0 Hz
5.0 VDC = 35.0 Hz
0 VDC = 10.0 Hz

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23 Variable Torque Volts/Hz Curve Selection

Parameter Selection

0 = Constant Torque Curve
1 = Variable Torque Curve

Initial Setting

0

Description

WARNING

THE DRIVE IS INTENDED TO OPERATE AT A PREDETERMINED MINIMUM SPEED UNLESS DISCONNECTED FROM THE POWER SOURCE. TO ENSURE MOTOR ROTATION AT THE MINIMUM SPEED SETTING, TORQUE BOOST (FUNCTION 7) MUST BE PROPERLY ADJUSTED. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

The constant torque curve is used for constant torque loads; the variable torque curve is used for variable torque loads. Figure 5-11 shows the variable torque curve.

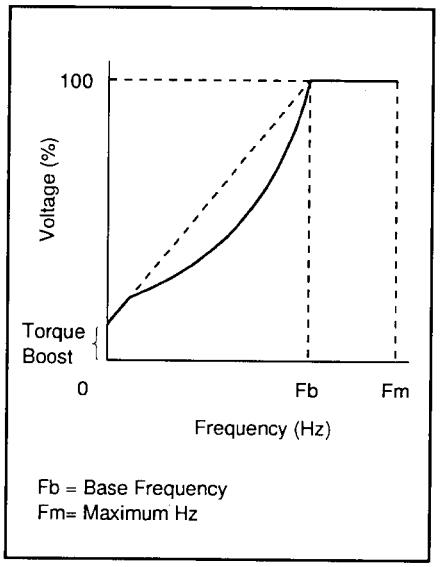


Figure 5-11. Variable Torque Curve.

24, 25, 26 D-C Braking

Adjustment Range

24 Operation Time: 0.0 - 10.0 seconds
25 Voltage: 0-20% voltage
26 Frequency: 0.5 - 10.0 Hz

Initial Setting

24 Operation Time: 0.0
25 Voltage: 0
26 Frequency: 1.0

Description

D-C braking is used to provide additional motor braking at speeds of 10 Hz or lower. If D-C braking is required, all three D-C braking functions (24, 25, and 26) must be adjusted. When the motor decelerates to the preset start frequency (Function 26), the preset constant D-C voltage (Function 25) is momentarily applied to the motor for the preset time (Function 24). Figure 5-12 shows the operation of D-C braking. This function will not provide the holding torque of a mechanical brake.

NOTE: *D-C braking is only operational when Function 9 (Stop Mode Selection) is set at 1 (Ramp-to-rest).*

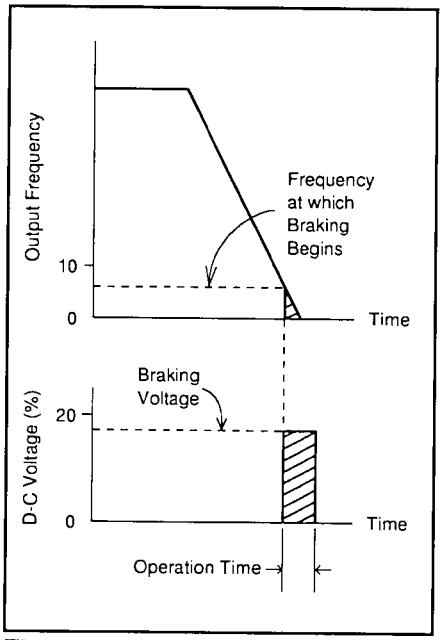


Figure 5-12. D-C Braking Operation.

27 Line-Dip-Ride-Through

Adjustment Range

15 - 500 milliseconds

Initial Setting

15

Description

During a line voltage dip, the standard controller has enough energy storage to keep the regulator active for up to 500 milliseconds. The actual ride-through time depends upon the setting of this function and the characteristics of the load. For example, if the load deceleration is slow (high inertia, low frictional loss), the controller may be able to maintain enough D-C bus voltage to ride through a line dip of up to 500 milliseconds. If the load deceleration is fast (low inertia, high frictional loss), the controller may only be able to keep the regulator active for 15 milliseconds.

If a voltage line dip occurs that exceeds the capability or line dip voltage setting of the controller, an IET will occur. If the line-dip-ride-through time is set at greater than 15 milliseconds, the IET will cause the 4-digit display to show Ld1P but only for as long as the bus voltage can maintain enough voltage for the LED display (approximately 500 milliseconds to 8 seconds).

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28, 29 Output Relay (1 and 2)

Parameter Selection

0 = Not Used
1 = Zero Speed Detect
2 = Reserved
3 = Output Contactor
4 = Frequency Level Detection 1
5 = Frequency Level Detection 2
6 = Current Level Detection
7 = Reverse Rotation
8 = D-C Braking Operation
9 = Reserved

Initial Setting

0

Description

These functions require the Remote Meter Interface Card (option), which includes two relays. Each relay operates according to the parameter (0-9) selected. Function 28 configures output relay 1 and Function 29 configures output relay 2. Output relay 1 provides a form C contact (1NO and 1NC), and output relay 2 provides a form A contact (1NO). The response time of each relay is typically 8 milliseconds.

These functions can also be used with Rail Interface Card (option). Rail Interface Card cannot be used with the Remote Meter Interface Card as both cards require the same installation area on the regulator board.

For more information, refer to instruction sheets of each optional kits.

The ten parameters are described as follows:

0: The relay does not operate.

1: The relay is energized while output frequency is equal to or higher than 0.5 Hz.

2: Reserved.

3: This provides the control signal for an output contactor. The relay energizes when the controller is put into the Run mode.

4: The relay energizes when the output frequency is equal to or higher than the frequency level set in Function 33.

5: The relay energizes when the output frequency level is equal to or higher than the frequency set in Function 34.

6: The relay energizes when the output current level is equal to or higher than the current set in Function 35.

7: The relay energizes when the phase sequence of the output frequency is in reverse rotation.

8: The relay energizes when the D-C braking voltage is applied to the motor. This relay is not required for D-C braking to be operational.

NOTE: *The relay is only operational when Function 9 (Stop Mode Selection) is set at 1 (Ramp-to-rest).*

9: Reserved.

30 Slip Compensation

Adjustment Range

0.0 - 5.0 Hz

Initial Setting

0.0

Description

Actual motor shaft speed is determined by two factors: the applied Hz and the slip of the motor. The controller keypad regulates the applied Hz to an accuracy of 0.01% of base frequency. The slip of the motor, however, is fully determined by the type of induction motor and varies with the driven load.

Slip compensation senses motor slip and adjusts the applied Hz automatically. Because of changes in the load, the actual speed regulation of the motor is greatly improved with this function properly adjusted.

High efficiency motors have less slip and, therefore, have improved speed regulation capability. See Table 5-3 for slip adjustment values to achieve 1% speed regulation with Reliance XE™ high efficiency motors.

NOTE: *Slip compensation improves speed regulation by automatically adjusting the output Hz to the motor. This can be viewed on the 4-digit display when monitoring frequency (Hz).*

Table 5-3. Slip Compensation Adjustment.[1]

HP	Slip Adjustment
1/4 to 1	2.0
2	2.3
3	1.5
5	1.7
7-1/2	1.3
10	1.5
15	1.0
20	1.0

[1] Based on Reliance TEFC XE high efficiency motors to obtain 1% speed regulation:

$$\text{Speed Regulation} = \frac{\left(\begin{matrix}\text{No Load}\\ \text{RPM}\end{matrix}\right) - \left(\begin{matrix}\text{Full Load}\\ \text{RPM}\end{matrix}\right)}{\text{Full Load RPM}}$$

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31 Inverse Reference

Parameter Selection

0 = Normal
1 = Inverse

Initial Setting

0

Password

Enter Second Password: 1123

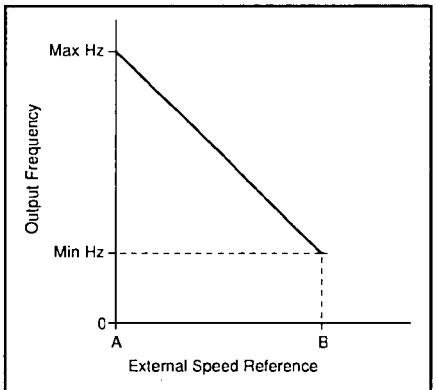
Description

WARNING

WITH THE INVERSE REFERENCE FUNCTION ENABLED, LOSS OF THE EXTERNAL SPEED REFERENCE SIGNAL WILL CAUSE THE DRIVE TO GO TO MAXIMUM FREQUENCY. EXERCISE EXTREME CARE WHEN USING THIS FUNCTION. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

This function will invert the signal of an external speed reference. Refer to Figure 5-13.

NOTE: *This function inverses all external speed references to the controller (i.e. AUTO selection in local operation and AUTO or MAN selection in remote operation).*



WHERE:
A = MINIMUM INPUT REFERENCE
B = MAXIMUM INPUT REFERENCE

REFERENCE TYPE	A	B
VOLTAGE	0 VDC	9.5 ± 0.5 VDC
CURRENT	4 mA	19 ± 1 mA
CURRENT	0 mA	19 ± 1 mA
FREQUENCY	0 Hz	97.656 KHz

Figure 5-13. Inverse Relationship of Speed Reference and Output Frequency.

32 Function Loss Selection

Parameter Selection

0 = IET at Function Loss
1 = Coast-to-rest without an IET Output at Function Loss

Initial Setting

0

Password

Enter Second Password: 1123

Description

WARNING

GP2000 CONTROLLERS WITHOUT THE OPTIONAL BYPASS MODIFICATION ARE NOT EQUIPPED WITH A COAST-STOP PUSHBUTTON. THE USER MUST INSTALL A HARDWIRED, OPERATOR-ACCESSIBLE PUSHBUTTON THAT PROVIDES A POSITIVE INTERRUPT AND SHUTS DOWN THE DRIVE. (IF FUNCTION 32 IS SET TO "0", THE CONTROLLER WILL IET AT FUNCTION LOSS. IF FUNCTION 32 IS SET TO "1", THE CONTROLER WILL COAST TO REST.) FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

If parameter "0" is selected, a function loss signal causes the controller to stop, resulting in the following:

- The motor will coast to rest.
- The 4-digit display will show "FL" (function loss).
- The internal speed reference will be reset to zero.
- The IET relay will be latched on.
- The IET can be reset with the STOP key after the cause of the function loss is removed.
- The controller will restart with the START key after the IET is reset.

If parameter "1" is selected, a function loss signal causes the controller to stop, resulting in the following:

- The motor will coast to rest.
- The 4-digit display will indicate "CS" (coast stop).
- The internal speed reference will be reset to zero.
- The controller will restart with the START key after the cause of the function loss is removed.

33, 34 Frequency Level Detection (1 and 2)

Adjustment Range

0.5 - 405.0 Hz

Initial Setting

0.5

Description

This function is effective and displayed only when parameter 4 or 5 is selected at Function 28 or 29. When the output frequency is equal to or higher than the set detection level, the selected output relay located on the optional Remote Meter Interface Card will energize as shown in Figure 5-14.

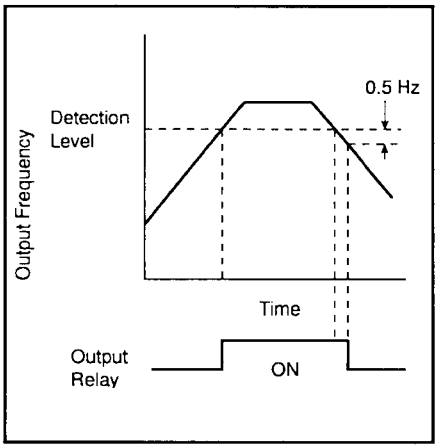


Figure 5-14. Frequency Level Detection Operation.

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35 Current Level Detection

Adjustment Range

30 - 150% Rated Current

Initial Setting

100

Description

This function is effective and displayed only when parameter 6 is selected at Function 28 or 29. When the output current is equal to or higher than the set detection level, the selected output relay located on the optional Remote Meter Interface Card will energize as shown in Figure 5-15.

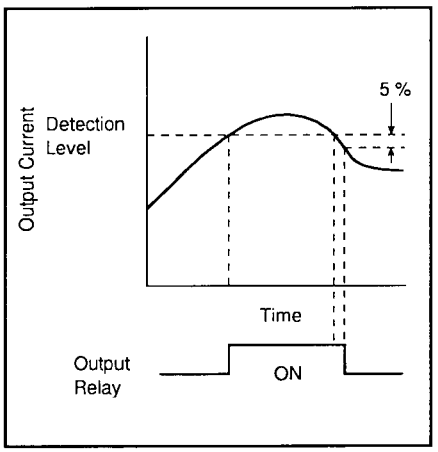


Figure 5-15. Current Level Detection Operation.

36 Reverse Disable

Parameter Selection

0 = Forward/Reverse Enable
1 = Reverse Disable on Keypad

Initial Setting

0

Description

This function is effective only when the controller is controlled locally (Function 0, parameter 0). If parameter 1 is selected, the FWD/REV key is locked in the forward position, preventing the motor from rotating in the reverse direction.

37 Automatic (Process Control) Disable on Local Control

Parameter Selection

0 = AUTO/MAN Key Enable
1 = AUTO Disable on Keypad

Initial Setting

0

Description

This function is effective only when the controller is controlled locally (Function 0, parameter 0). If parameter 1 is selected, the AUTO/MAN key is locked in the manual position, preventing the motor from responding to any external speed command.

38 Overfrequency Limit

Adjustment Range

50.0 - 405.0 Hz

Initial Setting

90.0

Password

Enter Second Password: 1123

Description

The overfrequency limit is factory set at 90 Hz. The Maximum Hz setting (Function 4) is limited by the setting of this function. This overfrequency limit setting takes priority over all other output Hz settings - including slip compensation (Function 30).

39 D-C Offset Enable

Parameter Selection

0 = Offset Disable
1 = Offset Enable

Initial Setting

0

Password

Enter Second Password: 1123

Description

When parameter 0 is selected, D-C offset is disabled for normal operation of an induction motor. When this function is enabled (selection 1), the D-C offset function allows some D-C voltage to be output to the motor terminals at 0 Hz. The magnitude of this voltage is equal to the manual torque boost setting at Function 7. This may be required to synchronize the rotor of a permanent magnet synchronous motor to avoid high starting currents. When this function is enabled (selection 1), slip compensation (Function 30) is not operational.

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40, 41, 42 Auto-reset

Parameter Selection

40 Enable
0 = Auto-reset Disable
1 = Auto-reset Enable

Adjustment Range

41 Time: 0 - 10 times
42 Interval Time: 1 - 60 seconds

Initial Setting

40 Enable: 0
41 Time: 0
42 Interval Time: 1

Password

40 Enable: Enter Second Password: 1123

Description

DANGER

THE DRIVE MAY RESTART AUTOMATICALLY WITH THE AUTO-RESET ENABLED (FUNCTION 40, PARAMETER 1). ATTACH A WARNING TAG TO THE APPROPRIATE DRIVEN EQUIPMENT. BEFORE WORKING ON THIS EQUIPMENT, BE SURE THAT POWER IS REMOVED AND LOCKED OUT FROM THE DRIVE. FAILURE TO OBSERVE THIS PRECAUTION MAY RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

Select Auto-reset enable (Function 40, parameter 1) to automatically restart the controller when one of the following IETs occur: overcurrent (OC, OC-A, OC-d, OC-g), high bus voltage, low bus voltage, or a line dip. (See Table 7-1.)

NOTE: *If a line-dip-ride-through time longer than 15 milliseconds was selected at Function 27 and a line power supply interruption is long enough that bus voltage cannot maintain enough voltage for the LED display (approximately 500 milliseconds to 8 seconds), the controller will not restart automatically.*

The auto-reset operation can be repeated the number of times set in Function 41 (0 - 10 times) after the time interval set in Function 42 (1 - 60 seconds). This "count down" to restart is displayed in the 2-digit LED indicating the time in seconds before the next re-start is attempted. The repeat number is returned to zero when the controller restarts successfully.

43 Extended Minimum Hz Range

Parameter Selection

0 = Disable (5 - 60 Hz)
1 = Enable (0 - 60 Hz)

Initial Setting

0

Password

Enter Second Password: 1123

Description

DANGER

THE DRIVE IS INTENDED TO OPERATE AT A PREDETERMINED MINIMUM SPEED UNLESS DISCONNECTED FROM THE POWER SOURCE. IF THE APPLICATION REQUIRES ZERO SPEED OPERATION WITHOUT SUCH DISCONNECTION, THE USER IS RESPONSIBLE FOR ASSURING SAFE CONDITIONS FOR OPERATING PERSONNEL BY PROVIDING SUITABLE GUARDS, AUDIBLE OR VISUAL ALARMS, OR OTHER DEVICES. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

If a minimum Hz lower than 5 Hz is required, select parameter 1. Return to Function 3 and set the desired minimum Hz.

44 Extended Acceleration Time Range

Parameter Selection

0 = Disable (5.0 - 360.0 seconds)
1 = Enable (0.1 - 360.0 seconds)

Initial Setting

0

Description

When an acceleration time shorter than 5 seconds is required, select parameter 1. Return to Function 1 and set the desired acceleration time.

NOTE: *With very fast acceleration and/or high manual torque boost settings, the motor may draw excessive current resulting in an IET.*

45 Extended Deceleration Time Range

Parameter Selection

0 = Disable (5.0 - 360.0 seconds)
1 = Enable (0.1 - 360.0 seconds)

Initial Setting

0

Description

When a deceleration time shorter than 5 seconds is required, select parameter 1. Return to Function 2 and set the desired deceleration time.

NOTE: *With very fast deceleration, the regenerative motor voltage may charge up the D-C bus voltage causing an IET. To avoid such an IET, increase the deceleration time or install a Dynamic Braking Kit (option).*

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46, 47, 48 RPM Monitor

Parameter Selection

46 Display Enable
0 = Disable
1 = Enable

47 Range Selection
0 = 150 - 9999 RPM
1 = 0 - 9999 RPM

Adjustment Range

48 Base Frequency Selection
150 - 9999 RPM

Initial Setting

46 Display Enable: 0
47 Range Selection: 0
48 Base Frequency Selection: 1750

Password

47 Range Selection: Enter Second Password: 1123

Description

When parameter 0 is selected in Function 46, you can monitor the output frequency, the output voltage, and the percentage of full-load amps of the controller. When parameter 1 is selected in Function 46, you can additionally monitor the motor RPM. The display can be scrolled by pressing the MON key. The 2-digit display shows "SP" at the RPM monitor.

Function 46, 47, and 48 can also be used to scale the 4-digit display readout differently. This can also be done by entering a value for "Base Frequency" selection (Function 11) that is different than actual motor speed but represents some other speed of the application. When Base Frequency selection of Function 48 is programmed, use the following formula:

Base Frequency Selection (Function 48) =

$$\frac{\left(\text{Motor Rated RPM}^{(1)}\right)}{\left(\text{Motor Rated Hz}^{(2)}\right)} \times \left(\text{Base Frequency in Hz}\right)^{(3)}$$

Where,

(1) = "Motor Rated RPM" equals the RPM of the motor under full load and motor rated frequency conditions. This value for RPM can be found on the motor nameplate.

(2) = "Motor Rated Hz" equals the base frequency of the motor. This value can be found on the motor nameplate.

(3) = "Base Frequency" equals the setting of Function Number 11.

Example:

"Motor Rated RPM" = 1750 RPM (Motor nameplate)
"Motor Rated Hz" = 60 Hz
"Base Frequency Hz" (or number entered into Function 48) = 60 Hz

Function 48 would be equal to the following using the above equation:

$$\frac{1750}{60} \times 60 = 1750$$

Upon entering 1750 for Function 48, the 4-digit display would indicate "1750" at 60 Hz controller output, or full speed. In this case 1750 would be a good approximation of the actual motor speed. If it is desired that the display show the approximate speed of the motor of something other than the motor RPM, enter a different number in Function 48 that is scaled to the needed application. Table 5-4 shows how Function 48 can be used.

WARNING

WHEN SETTING RPM VALUE OF FUNCTION 48 (MONITOR BASE FREQUENCY SELECTION) TO A ZERO OR A LOW VALUE, THE RPM MONITOR DISPLAY WILL SHOW A ZERO OR A LOW VALUE EVEN IF THE MOTOR SPEED REACHES TO THE RATED HZ. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

When setting RPM to a value smaller than 150, select parameter 1 in Function 47. This requires the Second Password.

Note that the RPM monitor display ignores the slip compensated frequency if Slip Compensation (Function 30) is programmed.

Table 5-4. Example of Relationship between Output Hz and RPM Monitor.

Output Hz to Motor	Actual Motor Speed in RPM	Function 11 Enter:	Function 48 Enter:	4-digit Display Reads:
60.0 Hz	1750	60.0	1750	1750
30.0 Hz	850	60.0	1400	700

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49 Output Voltage Regulation Mode Selection

Parameter Selection

0 = Proportional to Input
1 = Fixed to Maximum Voltage (See Function 50)

Initial Setting

0

Description

When parameter 0 is selected, the maximum output voltage will be proportional to the input voltage. When parameter 1 is selected, the maximum output voltage will be equal to the setting value of Function 50. The output voltage or the V/Hz will be fixed even if the input voltage varies.

50 Maximum Voltage

Parameter Selection

190.0 - 230.0 Volts [1]
380.0 - 460.0 Volts [2]
475 - 575 Volts [3]

Initial Setting

230.0 [1]
460.0 [2]
575 [3]

[1] 230 VAC Controllers
[2] 460 VAC Controllers
[3] 575 VAC Controllers

Description

When the output frequency reaches the Base Frequency of Function 11, the output voltage will be equal to the Maximum voltage of Function 50. The regulator board discriminates between the three types of controllers mentioned above, by sensing the PSBD power supply board.

51 Jog Acceleration Value

Parameter Selection

0.1 - 360.0 Seconds

Initial Setting

20.0

Description

Jog Acceleration Time can be set, converting the jog Hz to the maximum Hz. When parameter "0" is selected in Function 53, use the following formula:

Jog Accel =

$$\left(\frac{\text{Max Hz}}{\text{Jog Hz}}\right) \times \left(\text{Jog Accel Time}\right)$$

Where:
Jog Accel: setting of Function 51
Max Hz: setting of Function 4
Jog Hz: setting of Function 8
Jog Accel Time: time to reach from Zero Hz to Jog Hz

If you want 2 seconds for the Jog Acceleration Time while 60 Hz is set in Function 4 and 10 Hz is set in Function 8, you should set 12 seconds ((60/10) ¥ 2) in Function 51.

When parameter "1" (S-Curve Acceleration) is selected in Function 53, use the following formula:

Jog Accel =

$$\sqrt{\frac{\text{Max Hz}}{\text{Jog Hz}}} \times \left(\text{Jog Accel Time}\right)$$

52 Jog Deceleration Value

Parameter Selection

0.1 - 360.0 Seconds

Initial Setting

20.0

Description

Jog Deceleration Time can be set, converting the jog Hz to the maximum Hz. When parameter "0" is selected in Function 54, use the following formula:

Jog Decel =

$$\left(\frac{\text{Max Hz}}{\text{Jog Hz}}\right) \times \left(\text{Jog Decel Time}\right)$$

Where:
Jog Decel: setting of Function 52
Max Hz: setting of Function 4
Jog Hz: setting of Function 8
Jog Decel Time: time to reach from Jog Hz to Zero Hz

If you want 4 seconds for the Jog Deceleration Time while 60 Hz is set in Function 4 and 20 Hz is set in Function 8, you should set 12 seconds ((60/20) ¥ 4) in Function 52.

When parameter "1" (S-Curve Deceleration) is selected in Function 54, use the following formula:

Jog Decel =

$$\sqrt{\frac{\text{Max Hz}}{\text{Jog Hz}}} \times \left(\text{Jog Decel Time}\right)$$

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53 Jog Acceleration Selection

Parameter Selection

0 = Linear Acceleration
1 = S-Curve Acceleration

Initial Setting

0

Description

When the S-Curve Jog Acceleration is selected, acceleration will begin and end slowly. Refer to Function 14.

54 Jog Deceleration Selection

Parameter Selection

0 = Linear Deceleration
1 = S-Curve Deceleration

Initial Setting

0

Description

When the S-Curve Jog Deceleration is selected, deceleration will begin and end slowly.

55 Current Limit Deceleration Rate

Parameter Selection

0 - 100 Hz/Seconds

Initial Setting

90

Description

When the output current attempts to exceed the preset current limit (Function 5), the motor speed will decrease at a predefined adjustable rate. Adjustment of this function can suppress instability of current that could cause an IET trip during a current limit condition. The amount of adjustment lower or higher will depend on all application parameters such as motor, controller HP, application load, line voltage, etc. If adjusting Function 55 will not correct the condition, Functions 1 (Acceleration Time) and 5 (Preset Current Limit) should be adjusted.

56 Start into a Rotating Motor

Parameter Selection

0 = Enable
1 = Disable (Quick Start)

Initial Setting

0

Description

When parameter 0 is selected, the controller can start into a rotating motor without causing an IET trip. When the motor speed is zero or very low, it takes approximately 0.5 seconds to measure the speed before the controller can go into a start condition. This delay can be avoided by disabling the "start into a rotating load feature" by selecting parameter 1.

57 MS Terminals Selection

Parameter Selection

0 = Multi-Speed Preset
1 = Static MOP

Initial Setting

0

Password

Enter Second Password: 1123

Description

When Remote Control "1" is selected in Function 0, Function 57 can be changed. (When parameter 0 is selected, terminals 17 and 18 can be used for the Multi-Speed Preset Selection. Refer to Functions 16, 17, and 18.) When parameter 1 of Function 57 is selected, terminals 17 and 18 can be used for the Static MOP. When terminal 17 is connected to terminal 12, the output frequency will increase with the same acceleration rate as Function 1. When terminal 18 is connected to terminal 12, the output frequency will decrease with the same deceleration rate as Function 2. When both terminals 17 and 18 are opened or closed simultaneously, the output frequency will not change and is held constant.

98 Reserved

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6: How the Controller Operates

Fundamentals of Variable Voltage, Variable Frequency Controllers

An A-C motor is normally a fixed speed machine operating from a constant voltage, constant frequency source, such as 230 VAC and 60 Hz. To vary the speed of the motor, the voltage and frequency of the source to the motor must be variable. A controller provides this source. The controller transforms its input (three-phase, constant A-C voltage, constant frequency) into an output compatible with the A-C adjustable speed requirement of the A-C motor (three-phase, variable voltage, variable frequency).

The basic equation to determine motor synchronous speed is

$$\left(\begin{matrix}\text{Synchronous}\\ \text{RPM}\end{matrix}\right) = \frac{\left(\begin{matrix}\text{Controller}\\ \text{Output Frequency}\end{matrix}\right) \times 120}{\left(\begin{matrix}\text{Number of}\\ \text{A-C Motor Poles}\end{matrix}\right)}$$

The relationship between output voltage and operating frequency is the "Volts per Hertz" ratio (V/Hz). Except at low speed, this ratio is usually a constant determined by this equation:

$$\text{V/Hz} = \frac{\text{Motor Nameplate Voltage}}{\text{Motor Nameplate Frequency}}$$

A typical functional block diagram is given in Figure 6-1 (230 VAC controller) and Figure 6-2 (460 and 575 VAC controllers). The two major sections of a controller are the power circuit and the regulator. The power circuit consists of a diode bridge that converts A-C to D-C voltage and a solid state transistor module that transforms the constant D-C voltage into variable A-C voltage and variable frequency output power. The regulator controls the ON/OFF switching of the solid state transistor module in the power circuit.

Power Circuit Operation

A-C power is supplied to terminals R, S, and T and is full-wave rectified by the diode cube to constant D-C voltage through a leakage current sensor. The leakage current sensor detects a line-to-ground short circuit. Three suppressors (MOV) limit voltage transients within the maximum voltage rating of the diodes.

The rectified voltage is then fed into the D-C bus capacitor, which is charged through a precharge resistor to limit the charging current. Relay DCR is energized and shorts out the precharge resistor when the bus capacitor voltage reaches approximately 90% of the rated bus voltage. The positive D-C bus voltage lines run through the Hall Effect current sensor to detect D-C bus current. The Hall Effect current sensor detects a line-to-line short circuit within each transistor arm.

The filtered D-C bus voltage is fed into the transistor module, which transforms D-C bus voltage into three-phase A-C variable voltage, variable frequency by switching. Two of the three output lines on the transistor module run through the current transformers to detect A-C output current. The A-C output current feedback protects against an overload or a line-to-line short circuit among the three-phase output lines.

In summary, constant D-C voltage is produced by rectifying and filtering the incoming A-C power line. Variable voltage, variable frequency is produced by six output transistors inverting the constant D-C voltage to a PWM voltage waveform.

Controller Regulator Operation

The regulator is divided into three sections: the Regulator board, the Power Supply and Base Driver board, and the Keypad.

The regulator is made by surface mount technology and is fully digital with two microprocessors. The PWM signal is produced by software. All adjustments are made via keypad inputs. The regulator is designed so that the controller can be controlled either locally from the keypad or remotely from a variety of speed signals, such as a start/stop control command. An external analog signal input for speed is converted to a pulse train adaptive for the microprocessor through the V/F converter. All external signals are optically isolated. The regulator provides an IET relay.

The Power Supply and Base Driver board provides the control power supply, the isolated base driver for the transistors, and the interface for high voltage feedback. The control power supply is composed of a switching regulator and a high frequency multi-winding transformer.

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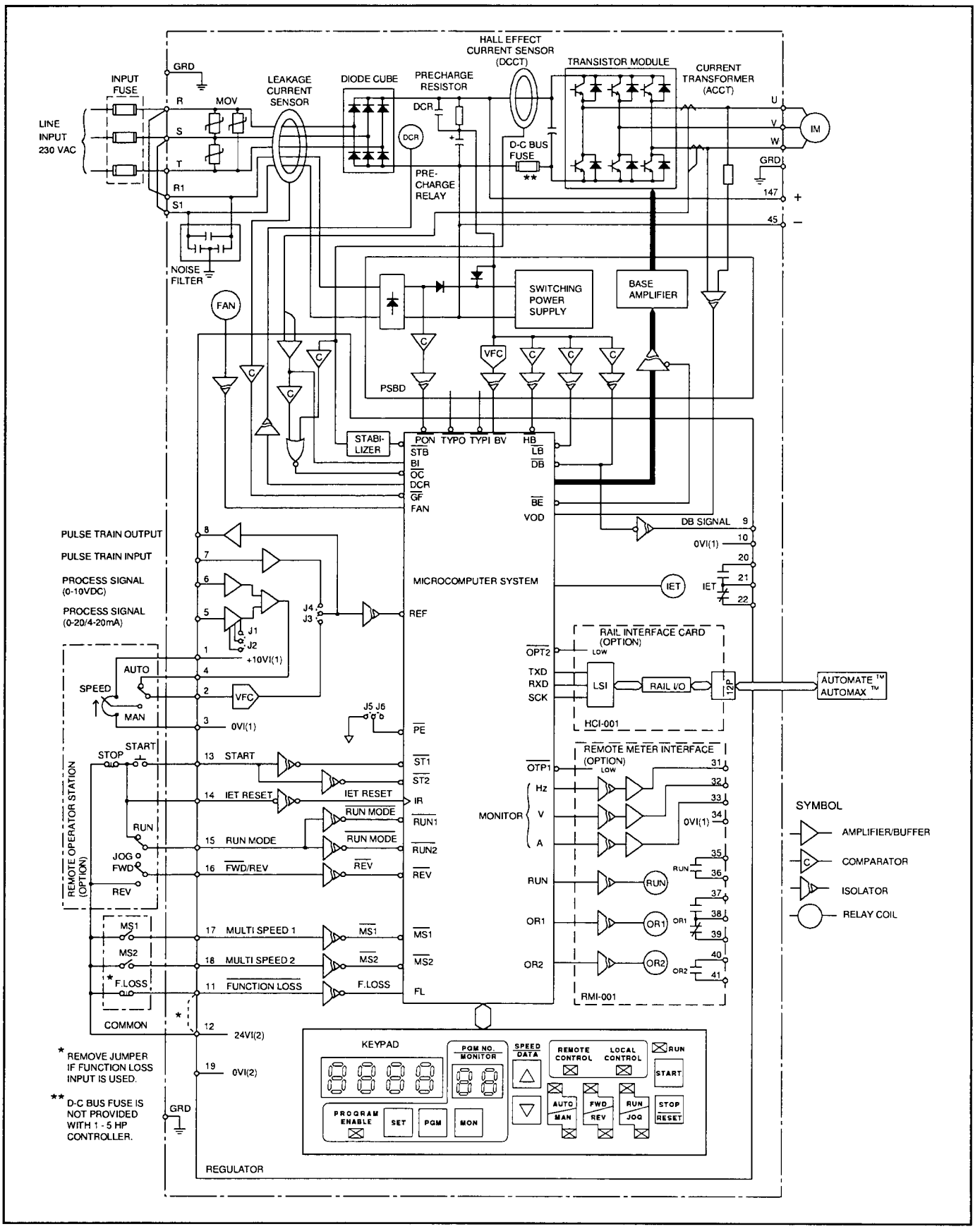


Figure 6-1. Typical Functional Block Diagram (230 VAC Controller).

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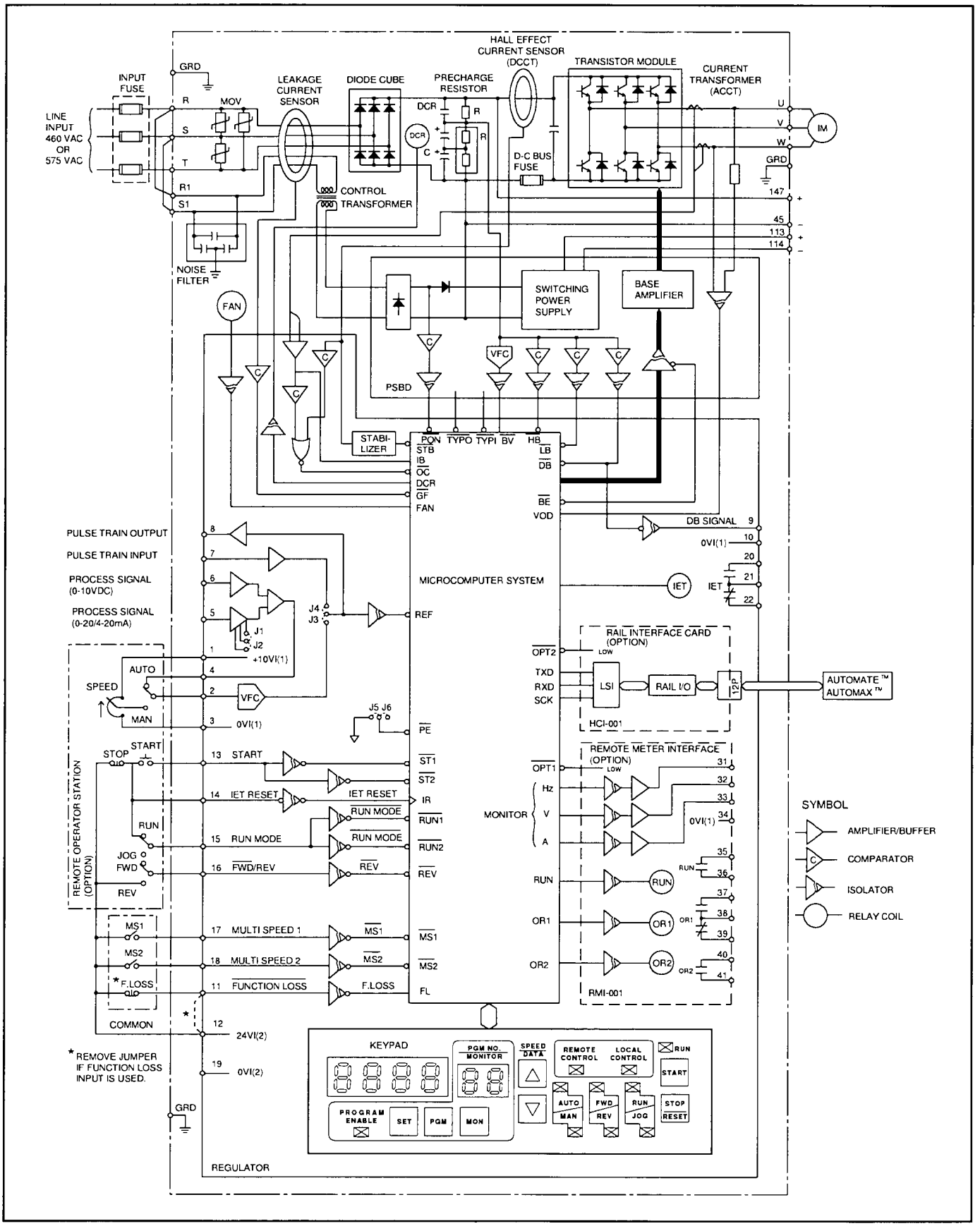


Figure 6-2. Typical Functional Block Diagram (460 and 575 VAC Controllers).

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7: Troubleshoot the Controller

DANGER

ONLY QUALIFIED ELECTRICAL PERSONNEL FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF THIS EQUIPMENT AND THE HAZARDS INVOLVED SHOULD SERVICE IT. READ AND UNDERSTAND THIS MANUAL IN ITS ENTIRETY BEFORE PROCEEDING. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

Test Equipment Needed

CAUTION: Do not use a Megger to perform continuity checks in the drive equipment. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

For controller output measurements of voltage, amperage, and frequency as applied to the motor power leads, the 4-digit display on the controller keypad is satisfactory. For all other voltage, amperage, and ohmic measurements, an analog or digital volt-ohmmeter is satisfactory. Make certain the selected volt-ohmmeter is rated for the intended measurement values.

Although not required for controller startup and adjustments, the best method of obtaining actual motor voltage, current, and speed measurements is with a fundamental voltmeter, digital clamp-on ammeter, and a hand-held tachometer, respectively.

Troubleshooting Aids

Several aids are provided for assisting with the troubleshooting procedure: a controller self-diagnostic test, an IET troubleshooting table, component identification figures, and wiring diagrams.

1. Whenever power is turned ON, the controller will perform a self-diagnostic test that takes approximately 1 second. If the test fails, a hexadecimal number will show in the 2-digit display and SELF will show in the 4-digit display. Should this "failed" condition occur, the Regulator board may be defective; contact Reliance Electric.
2. Table 7-1 lists the possible cause of an IET and gives the recommended action to eliminate the problem.
3. Figures 7-1 through 7-7 identify components mounted behind the Regulator and Power Supply & Base Driver (PS&BD) boards. Refer to the appropriate table (Table 7-2 through 7-6) for the replacement parts number of these components.
4. Refer to the appropriate wiring diagram as necessary:
   - 1/4 through 5 HP, 230 VAC controllers (Figure 7-8)
   - 7-1/2 through 10 HP, 230 VAC controllers (Figure 7-9)
   - 1/4 through 20 HP, 460 VAC controllers (Figure 7-10)
   - 3 through 20 HP, 575 VAC controllers (Figure 7-11)

Helpful Reminders:

1. When an IET occurs, the IET relay energizes and the motor coasts to rest. The 4-digit display simultaneously will show the IET code of the first fault causing the IET.
2. To view the last three causes of an IET, make sure the controller is in the STOP mode; then press the MON key. Use the ▲ and ▼ keys to scroll through the last three IET causes.
3. The controller cannot start until the fault is cleared and the controller is reset. Press the STOP/RESET key to reset the controller.
4. To clear any stored IET fault history from controller memory:
   - An IET code must be showing on the 4-digit display.
   - Press and hold in the STOP key until "0000" shows on the 4-digit display (approximately 3 seconds).
5. The controller cannot be configured unless the Program jumper is in the J5 position. See Figure 3-2 or 3-3.
6. Refer to specific instruction manuals provided with all optional kits.

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Troubleshooting Procedure

1. Check the 4-digit display for the following:
   - If an IET code displays, proceed to Table 7-1 for the possible IET cause and the action to take.
   - Clear the fault.
   - Reset the controller by pressing the STOP/RESET key.
   - Restart the controller. If the controller does not start, proceed to Step 2.
2. Turn the power OFF.

DANGER

THIS EQUIPMENT IS AT LINE VOLTAGE WHEN A-C POWER IS CONNECTED TO THE CONTROLLER. DISCONNECT ALL UNGROUNDED CONDUCTORS OF THE A-C POWER LINE FROM THE CONTROLLER. AFTER POWER IS REMOVED, VERIFY WITH A VOLTMETER AT TERMINALS 147(+) AND 45(-) THAT THE D-C BUS CAPACITOR(S) IS DISCHARGED BEFORE TOUCHING ANY INTERNAL PARTS OF THE CONTROLLER. FAILURE TO OBSERVE THESE PRECAUTIONS COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

3. Verify that the input power voltage is within ±10% of the controller nameplate rating. If voltage is not within this range, apply the correct input voltage or add a transformer.
4. Make a complete physical inspection of all control and motor wiring. Check that connections are tight. Using Figures 3-2 through 3-5, verify that the drive is wired correctly.
5. Verify that wiring was installed according to the NEC and all local codes.
6. Check for ground faults and shorts.
7. Check for a bus fuse if it is provided.
8. Verify that service conditions are met. See "Service Conditions" in Chapter 2 of this manual.
9. Individually check that nearby relays, solenoids, brake coils, etc., are not causing electrical noise. Suppress any device that is inducing noise in the equipment.
10. With the motor connected to the controller and the motor uncoupled from the load if possible, verify that the motor will run.
    - If the motor runs, the problem could be the wrong controller for the application. Contact Reliance Electric.
    - If the motor does not run, disconnect the motor from the controller. Reconnect the motor to an external line and start the motor. If the motor still does not run, the motor may be defective and should be checked.
11. With the motor connected to the controller, verify that the controller will operate under Local Control. Place the controller under Local Control (Function 0, Parameter 0) and press the START key.
    - If the controller operates correctly, the problem could be a faulty process control signal or a defective Remote Control Station, if used.
    - If the controller does not operate correctly, the problem could be misadjusted controller functions.
12. Verify the controller is adjusted properly. Record the current adjustment settings and then return the controller to the initial factory settings. See Table 8-4. If possible, disconnect the motor from the controller. With the controller in Local Control, press the START key.
    - If the controller operates correctly with the initial settings, your controller was mis-adjusted. Readjust the controller as necessary.
    - If the controller does not operate correctly, contact Reliance Electric.

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Table 7-1. Troubleshooting IETs.

IET Code	Type of IET	Possible Cause	Action
HU	High Bus Voltage	Input voltage too high	• Check input voltage. If incorrect, add transformer (see Chapter 3).
		Deceleration time too short	• Increase deceleration time. • Install DB kit.
LU	Low Bus Voltage	Input voltage too low	• Check input voltage. If incorrect, add transformer (see Chapter 3). • Check D-C bus voltage. If incorrect, possible diode cube is defective; replace diode.
OC-A	Overcurrent-A	Acceleration time too short	• Increase acceleration time.
		Momentary overload	• Check for motor overload; reduce load on motor.
		Torque boost or V/Hz too high	• Adjust torque boost (Function 7) or V/Hz (Function 11).
OC-d	Overcurrent-D	Deceleration time too short	• Increase deceleration time.
OC-G	Overcurrent-G	Output line-to-ground	• Check isolation between ground and output terminals. Remove any grounds. • Possible leakage of current sensor; replace current sensor.
OC	Overcurrent	Output line-to-line	• Check isolation among each output line. Correct as necessary.
		Bus voltage line-to-line	• Check the transistor module for correct output. If incorrect, possible defective PS&BD board; replace PS&BD board. • Possible bad Hall Effect device; replace Hall device.
		Momentary overload	• Check for motor overload; reduce load on motor.
		Torque boost or V/Hz too high	• Adjust torque boost (Function 7) or V/Hz (Function 11).
OL	Overload	Internal thermal overload	• Reduce load on motor. • Reduce torque boost (Function 7).
OH	Overheat	Cooling fan fault	• Check cooling fan; correct as necessary.
LdIP	Line dip	A-C power supply interrupt	• Check input voltage. If incorrect, install appropriate A-C reactor in input line.
CPU	CPU error	Microprocessor logic error.	• Turn power OFF for about 10 seconds, then turn power ON. • Possible bad Regulator board; replace Regulator board.
Err1	Error 1	Memory error	• Turn power OFF for about 10 seconds, then turn power ON. • If error not corrected, scroll function list for incorrect parameter (------ in 4-digit display); readjust parameter. • If no parameter shows ------, possible Regulator board defect; contact Reliance Electric.
Err2	Error 2	Start/Stop or Run regulator circuit fault (during Remote Control operation only).	• Possible Regulator board defect; contact Reliance Electric.
FL	Function Loss	Function loss input is open (0 VDC) (Function 32, parameter 0)	• Check external interlocks connected at terminals 11-12; correct as necessary. • Check for external short circuit between terminals 11-19; correct as necessary.
CS	Coast Stop	Function loss input is open (0 VDC) (Function 32, parameter 1)	• Check external interlocks connected at terminals 11-12; correct as necessary. (Note: Controller will start with START key after cause of function loss is removed.) • Check for external short circuit between terminals 11-19; correct as necessary. (Note: Controller will start with START key after cause of function loss is removed.)
OP	1SC4000 Fault	Rail Interface Card Fault	• Refer to 1SC4000 Instruction Sheet (D2-3170).
CF			

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Table 7-2. NEMA1 Replacement Parts List (230 VAC Controller).

Description	Qty. Per Controller	Reliance Part Number
Diode Cube		
1/4 to 3 HP	1	701819-40AG
5 HP	1	701819-41AG
7.5 HP	1	402410-110A
10 HP	1	402410-110B
Transistor Module		
1/4 to 1 HP	1	402410-210A
2 HP	1	402410-210B
3 HP	1	402410-210C
5 HP	1	402410-210D
7.5 HP	1	402410-210E
10 HP	1	402410-210F
D-C Bus Capacitor		
1/4 to 1 HP	1	402410-412A
2 HP	1	402410-412B
3 HP	1	402410-412C
5 HP	1	402410-412D
7.5 HP	1	402410-412E
10 HP	1	402410-412F
Precharge Relay		
1/4 to 2 HP	1	402410-612A
3 to 5 HP	1	402410-612B
7.5 to 10 HP	1	402410-612C
Precharge Resistor		
1/4 to 2 HP	1	402410-710A
3 to 5 HP	1	402410-710B
7.5 to 10 HP	1	402410-710C
Voltage Detect Resistor		
1/4 to 10 HP	1	402410-711B
Input Suppressor Assembly		
1/4 to 7.5 HP	1	612180-502R
10 HP	1	612180-502S
D-C Buse Fuse		
7.5 HP	1	402410-515A [1]
10 HP	1	402410-515B [2]
Regulator PC Board		
1/4 to 10 HP	1	0-48680-116

Description	Qty. Per Controller	Reliance Part Number
Fan Assembly		
3 to 5 HP	1	612180-902R
7.5 to 10 HP	1	612180-902S
Leakage Current Sensor Assembly		
1/4 to 7.5 HP	1	612180-603R
10 HP	1	612180-603S
Current Transformer Assembly		
1/4 to 1 HP	2	612180-604R
2 HP	2	612180-604S
3 HP	2	612180-604T
5 HP	2	612180-604U
7.5 HP	2	612180-604V
10 HP	2	612180-604W
Bus Clamp Assembly		
1/4 to 3 HP	1	612180-301R
5 HP	1	612180-301S
7.5 to 10 HP	1	612180-301T
Power Supply & Base Driver PC Board		
1/4 to 5 HP	1	0-48680-207
7.5 to 10 HP	1	0-48680-209
Keypad Assembly		
1/4 to 10 HP	1	612180-801S
Hall Effect Current Sensor		
1/4-1, 5 HP	1	402410-304A
2, 3, 7.5 HP	1	402410-304B
10 HP	1	402410-304C
Noise Filter		
1/4 to 5 HP	1	612180-608A
7.5 to 10 HP	1	612180-609A
Discharge Resistor		
2HP	1	612180-201R
3HP	1	612180-201S
5HP	1	612180-201T
7.5 to 10 HP	1	402410-711B

[1] 500 VOLT, 40 AMP (GOULD A50P40, BRUSH RFV40 or XL50F40)
[2] 500 VOLT, 60 AMP (GOULD A50P60, BRUSH RFV60 or XL50F60)

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Table 7-3. NEMA 1 Replacement Parts List (460 VAC Controller).

Description	Qty. Per Controller	Reliance Part Number
Diode Cube		
1/4 to 7.5 HP	1	402410-110C
10 HP	1	402410-110D
15 HP	1	402410-110E
20 HP	1	402410-110F
Transistor Module		
1/4 to 3 HP	1	402410-210G
5 HP	1	402410-210H
7.5 to 10 HP	1	402410-210J
15 to 20 HP	3	402410-210K
D-C Bus Capacitor		
1/4 to 3 HP	2	402410-412G
5 HP	2	402410-412H
7.5 HP	2	402410-412J
10 HP	2	402410-412K
15 HP	2	402410-412L
20 HP	2	402410-412M
Precharge Relay		
1/4 to 10 HP	1	402410-612B
15 to 20 HP	1	402410-612C
Precharge Resistor		
1/4 to 5 HP	1	402410-710D
7.5 to 10 HP	1	402410-710E
15 to 20 HP	1	402410-710F
Voltage Detect Resistor		
1/4 to 20 HP	1	402410-711G
Discharge Resistor		
1/4 to 3 HP	1	402410-711A
5 HP	1	402410-711B
7.5 to 10 HP	1	402410-711C
15 to 20 HP	1	402410-711D
Input Suppressor Assembly		
1/4 to 15 HP	1	612180-502T
20 HP	1	612180-502U
Regulator PC Board		
1/4 to 20 HP	1	0-48680-116
D-C Bus Fuse		
1/4 to 3 HP	1	402410-515C [1]
5 to 10 HP	1	402410-515D [2]
15 to 20 HP	1	

Description	Qty. Per Controller	Reliance Part Number
Power Supply & Base Driver		
PC Board		
1/4 to 20 HP	1	0-48680-211
Fan Assembly		
7.5 to 10 HP	1	612180-902S
15 to 20 HP	1	612180-902T
Leakage Current Sensor		
Assembly		
1/4 to 15 HP	1	612180-603R
20 HP	1	612180-603S
Current Transformer		
Assembly		
1/4 to 1 HP	2	612180-605R
2 HP	2	612180-605S
3 HP	2	612180-605T
5 HP	2	612180-605U
7.5 HP	2	612180-605V
10 HP	2	612180-605W
15 HP	2	612180-605X
20 HP	2	612180-605Y
Bus Clamp Assembly		
1/4 to 5 HP	1	612180-301U
7.5 to 10 HP	2	612180-301V
15 to 20 HP	4	612180-301V
Control Transformer		
Assembly		
1/4 to 10 HP	1	612180-607R
15 to 20 HP	1	612180-607S
Keypad Assembly		
1/4 to 20 HP	1	612180-801S
Hall Effect Current Sensor		
1/4-5, 10 HP	1	402410-304A
7.5, 15 HP	1	402410-304B
20 HP	1	402410-304C
Noise Filter		
1/4 to 15 HP	1	612180-608B
20 HP	1	612180-608C

[1] 700 VOLT, 15 AMP (GOULD A70P15, BRUSH RFL15 or XL70F15)
[2] 700 VOLT, 30 AMP (GOULD A70P30, BRUSH RFL30 or XL70F30)
[3] 700 VOLT, 50 AMP (GOULD A70P50, BRUSH RFL50 or XL70F50)

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Table 7-4. NEMA 1 Replacement Parts List (575 VAC Controller).

Description	Qty. Per Controller	Reliance Part Number
Diode Cube		
3 to 10 HP	1	402410-110D
15 to 20 HP	1	402410-110E
Transistor Module		
3 to 10 HP	1	402410-210L
15 to 20 HP	3	402410-210M
D-C Bus Capacitor		
3 to 10 HP	3	402410-412N
15 to 20 HP	3	402410-412P
Precharge Relay		
3 to 10 HP	1	402410-612B
15 to 20 HP	1	402410-612C
Precharge Resistor		
3 to 10 HP	1	402410-710E
15 to 20 HP	1	402410-710F
Voltage Detect Resistor		
3 to 20 HP	1	402410-711G
Discharge Resistor		
3 to 10 HP	1	402410-711E
15 to 20 HP	1	402410-711F
Input Suppressor Assembly		
3 to 20 HP	1	612180-502V
Regulator PC Board		
3 to 20 HP	1	0-48680-116
D-C Bus Fuse		
3 to 10 HP	1	402410-515F [1]
15 to 20 HP	1	

Description	Qty. Per Controller	Reliance Part Number
Power Supply & Base Driver PC Board		
3 to 20 HP	1	0-48680-212
Fan Assembly		
7.5 to 10 HP	1	612180-902S
15 to 20 HP	1	612180-902T
Leakage Current Sensor Assembly		
3 to 20 HP	1	612180-603R
Current Transformer Assembly		
3 to 5 HP	2	612180-606R
7.5 to 10 HP	2	612180-606S
15 to 20 HP	2	612180-606T
Bus Clamp Assembly		
3 to 10 HP	3	612180-301W
15 to 20 HP	6	612180-301X
Control Transformer Assembly		
3 to 10 HP	1	612180-607T
15 to 20 HP	1	612180-607U
Keypad Assembly		
3 to 20 HP	1	612180-801S
Hall Effect Current Sensor		
3 to 20 HP	1	402410-304B

[1] 1,000 VOLT, 25 AMP (GOULD A100P25, BRUSH RFK25 or XL100F25)
[2] 1,000 VOLT, 35 AMP (GOULD A100P35, BRUSH RFK35 or XL100F35)

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Table 7-5. NEMA 12 Replacement Parts List (230 VAC Controller).

Description	Qty. Per Controller	Reliance Part Number
Diode Cube		
1/4 to 2 HP	1	701819-40AG
3 to 5 HP	1	701819-41AG
7.5 HP	1	402410-110B
Transistor Module		
1/4 to 1 HP	1	402410-210A
2 HP	1	402410-210B
3 to 5 HP	1	402410-210D
7.5 HP	1	402410-210F
D-C Bus Capacitor		
1/4 to 1 HP	1	402410-412A
2 HP	1	402410-412B
3 to 5 HP	1	402410-412D
7.5 HP	1	402410-412F
Precharge Relay		
1/4 to 5 HP	1	402410-612B
7.5 HP	1	402410-612C
Precharge Resistor		
1/4 to 2 HP	1	402410-710A
3 to 5 HP	1	402410-710B
7.5 HP	1	402410-710C
Voltage Detect Resistor		
1/4 to 7.5 HP	1	402410-711B
Input Suppressor Assembly		
1/4 to 5 HP	1	612180-502R
7.5 HP	1	612180-502S
D-C Bus Fuse		
7.5 HP	1	402410-515B [1]
Regulator PC Board		
1/4 to 7.5 HP	1	0-48680-116

Description	Qty. Per Controller	Reliance Part Number
Fan Assembly		
5 to 7.5 HP	1	612180-902S
Leakage Current Sensor Assembly		
1/4 to 5 HP	1	612180-603R
7.5 HP	1	612180-603S
Current Transformer Assembly		
1/4 to 1 HP	2	612180-604RA
2 HP	2	612180-604SA
3 HP	2	612180-604TA
5 HP	2	612180-604UA
7.5 HP	2	612180-604VA
Bus Clamp Assembly		
1/4 to 2 HP	1	612180-301R
3 to 5 HP	1	612180-301S
7.5 HP	1	612180-301T
Power Supply & Base Driver		
1/4 to 5 HP	1	0-48680-207
7.5 HP	1	0-48680-209
Keypad Assembly		
1/4 to 7.5 HP	1	612180-801S
Hall Effect Current Sensor		
1/4 to 1, 5 HP	1	402410-304A
2, 3, 7.5 HP	1	402410-304B
Noise Filter		
1/4 to 5 HP	1	612180-608A
7.5 HP	1	612180-609A
Discharge Resistor		
2 HP	1	612180-201R
3 to 5 HP	1	612180-201T
7.5 HP	1	612180-711B

[1] 500 VOLT, 60 AMP (GOULD A50P60, BRUSH RFV60 or XL50F60)

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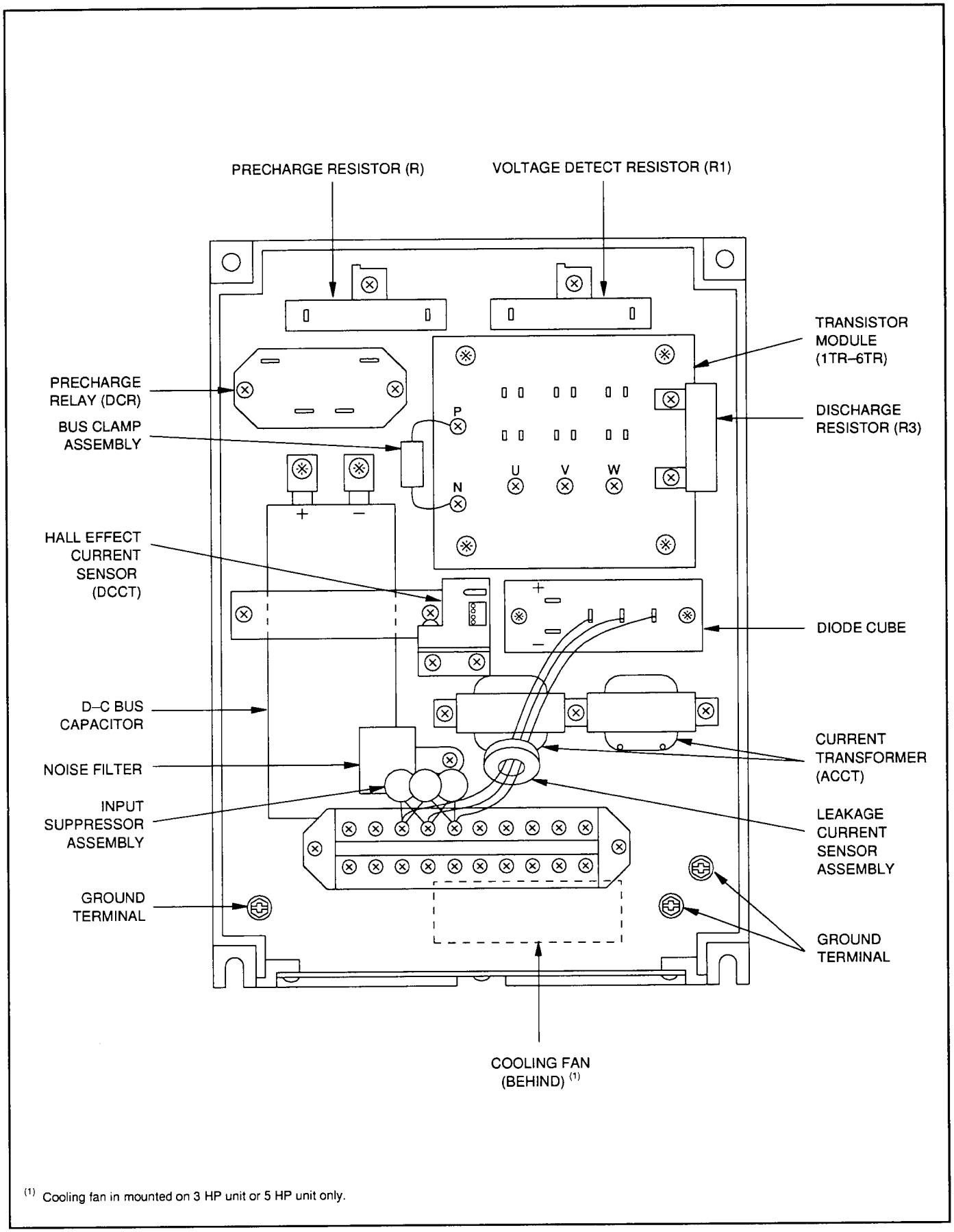
Table 7-6. NEMA 12 Replacement Parts List (460 VAC Controller).

Description	Qty. Per Controller	Reliance Part Number
Diode Cube		
1/4 to 7.5 HP	1	402410-110C
Transistor Module		
1/4 to 3 HP	1	402410-210G
5 HP	1	402410-210H
7.5 HP	1	402410-210J
D-C Bus Capacitor		
1/4 to 3 HP	1	402410-412G
5 HP	1	402410-412H
7.5 HP	1	402410-412J
Precharge Relay		
1/4 to 7.5 HP	1	402410-612B
Precharge Resistor		
1/4 to 5 HP	1	402410-710D
7.5 HP	1	402410-710E
Regulator PC Board		
1/4 to 7.5 HP	1	0-48680-116
Voltage Detect Resistor		
1/4 to 7.5 HP	1	402410-711G
Discharge Resistor		
1/4 to 3 HP	1	402410-711A
5 HP	1	402410-711B
7.5 HP	1	402410-711C
Input Suppressor Assembly		
1/4 to 7.5 HP	1	612180-502T
D-C Bus Fuse		
1/4 to 3 HP	1	402410-515C [1]
5 to 7.5 HP	1	402410-515D [2]

Description	Qty. Per Controller	Reliance Part Number
Fan Assembly		
5 to 7.5 HP	1	612180-902S
Leakage Current Sensor Assembly		
1/4 to 7.5 HP	1	612180-603R
		612180-603S
Current Transformer Assembly		
1/4 to 1 HP	2	612180-605R
2 HP	2	612180-605S
3 HP	2	612180-605T
5 HP	2	612180-605U
7.5 HP	2	612180-605V
Bus Clamp Assembly		
1/4 to 5 HP	1	612180-301U
7.5 HP	1	612180-301V
Control Transformer Aseembly		
1/4 to 7.5 HP	1	612180-607R
Power Supply & Base Driver		
1/4 to 7.5 HP	1	0-48680-211
Keypad Assembly		
1/4 to 7.5 HP	1	612180-801S
Hall Effect Current Sensor		
1/4 to 5 HP	1	402410-304A
7.5 HP	1	402410-304B
Noise Filter		
1/4 to 7.5 HP	1	612180-608B

[1] 700 VOLT, 15 AMP (GOULD A70P15, BRUSH RFL15 or XL70F15)
[2] 700 VOLT, 30 AMP (GOULD A70P30, BRUSH RFL30 or XL70F30)

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(1) Cooling fan in mounted on 3 HP unit or 5 HP unit only.

Figure 7-1. Typical Component Identification (1/4 through 5 HP, 230 VAC Controllers).

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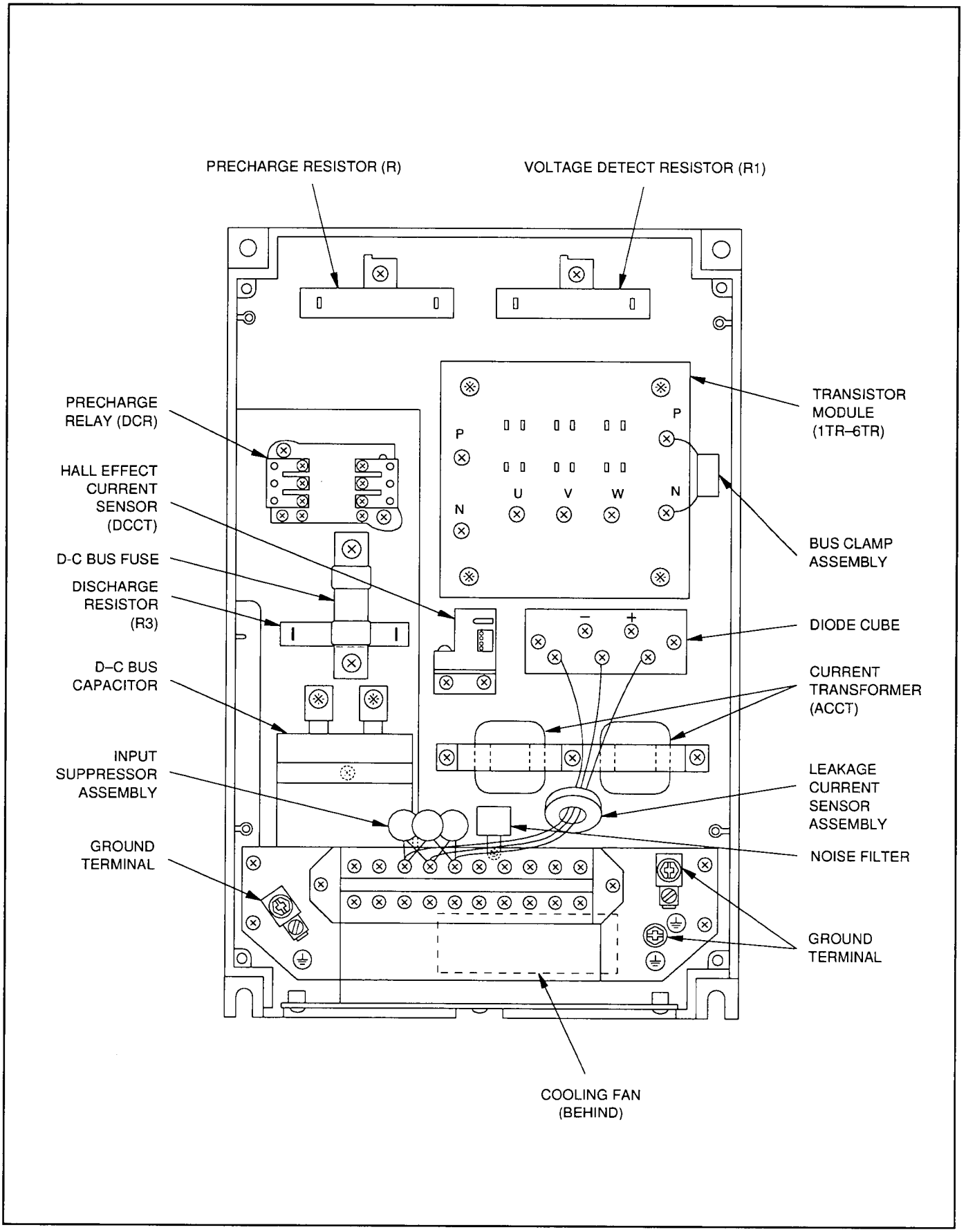


Figure 7-2. Typical Component Identification (7-1/2 through 10 HP, 230 VAC Controllers).

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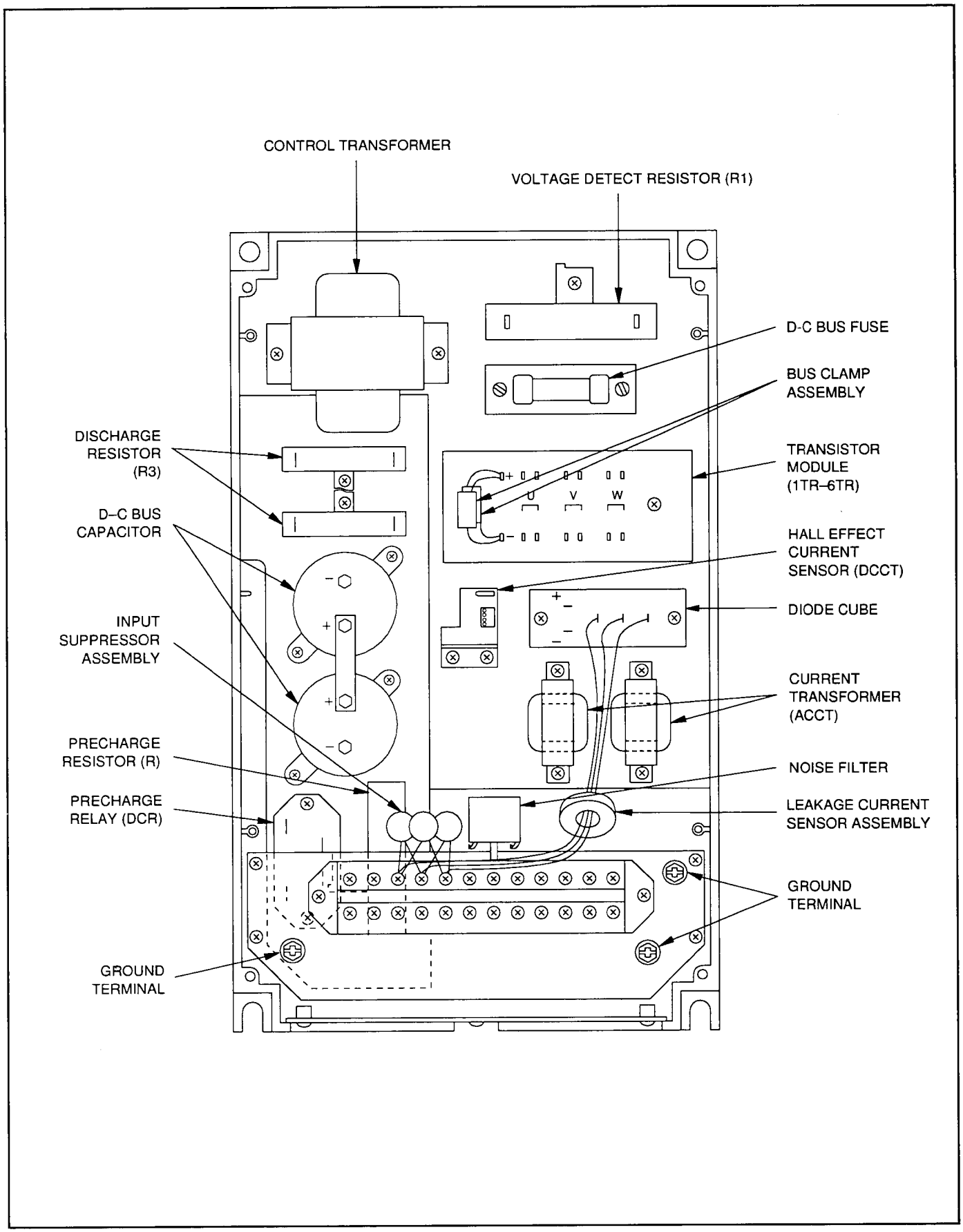


Figure 7-3. Typical Component Identification (1/4 through 5 HP, 460 VAC Controllers).

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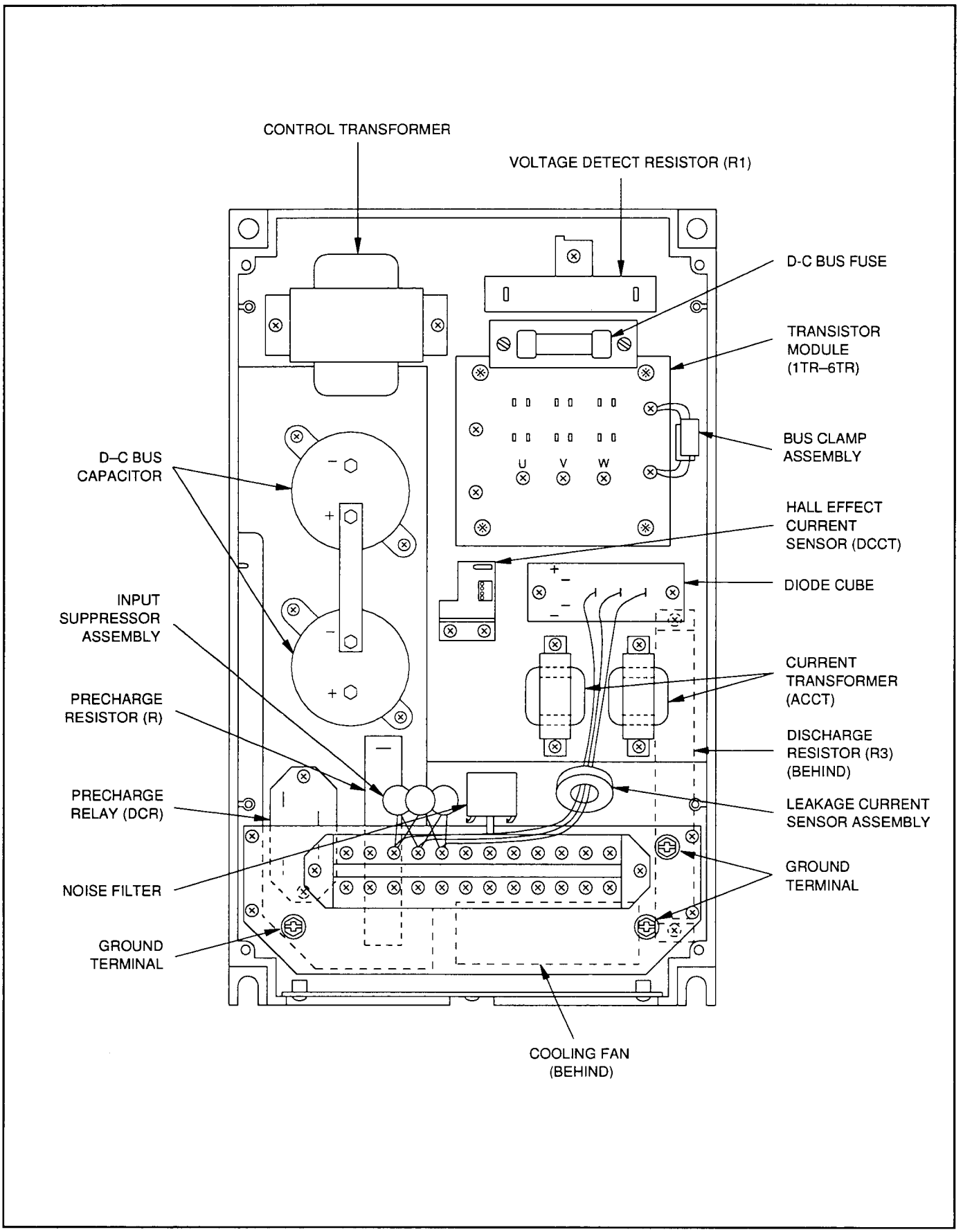


Figure 7-4. Typical Component Identification (7-1/2 through 10 HP, 460 VAC Controllers).

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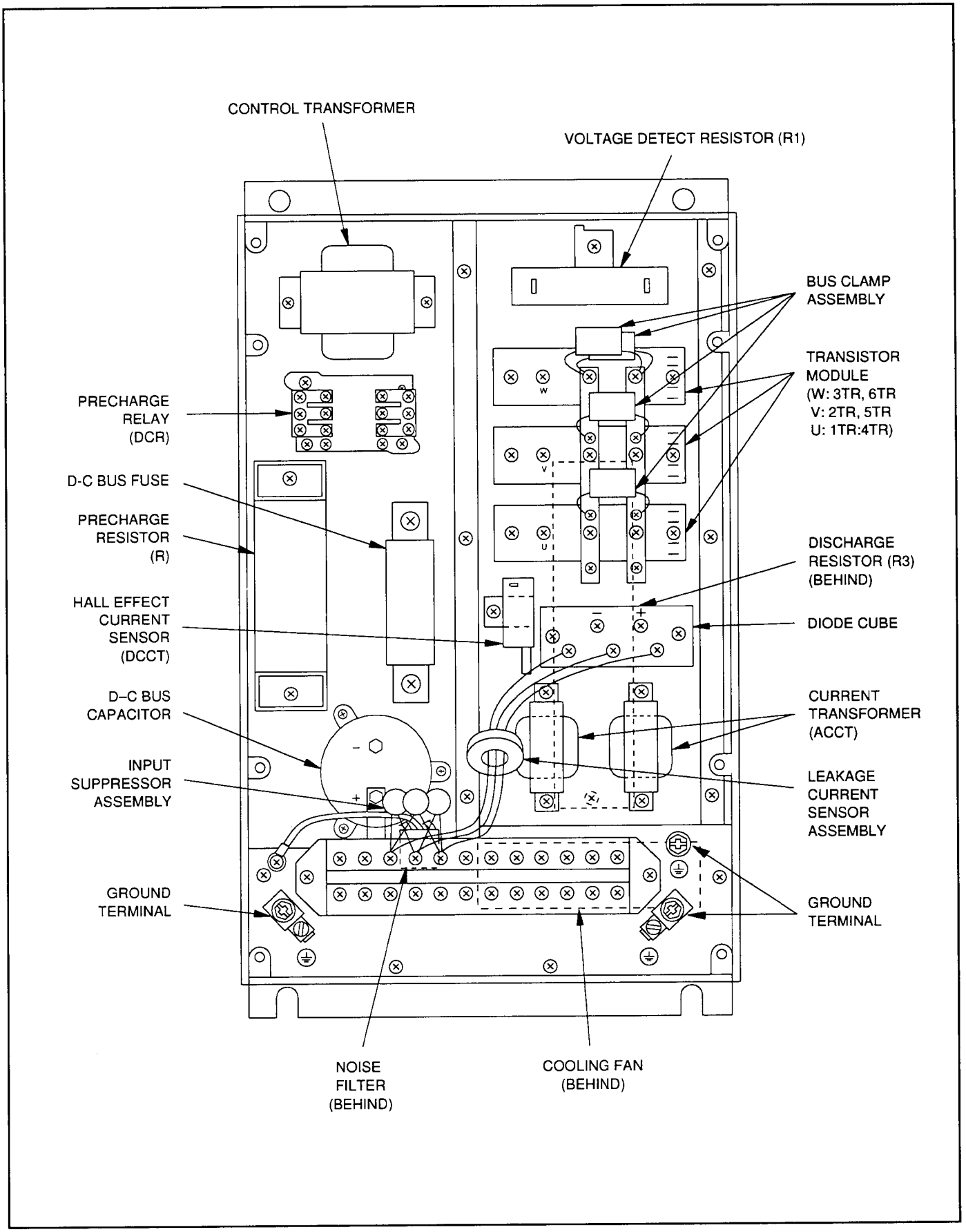


Figure 7-5. Typical Component Identification (15 through 20 HP, 460 VAC Controllers).

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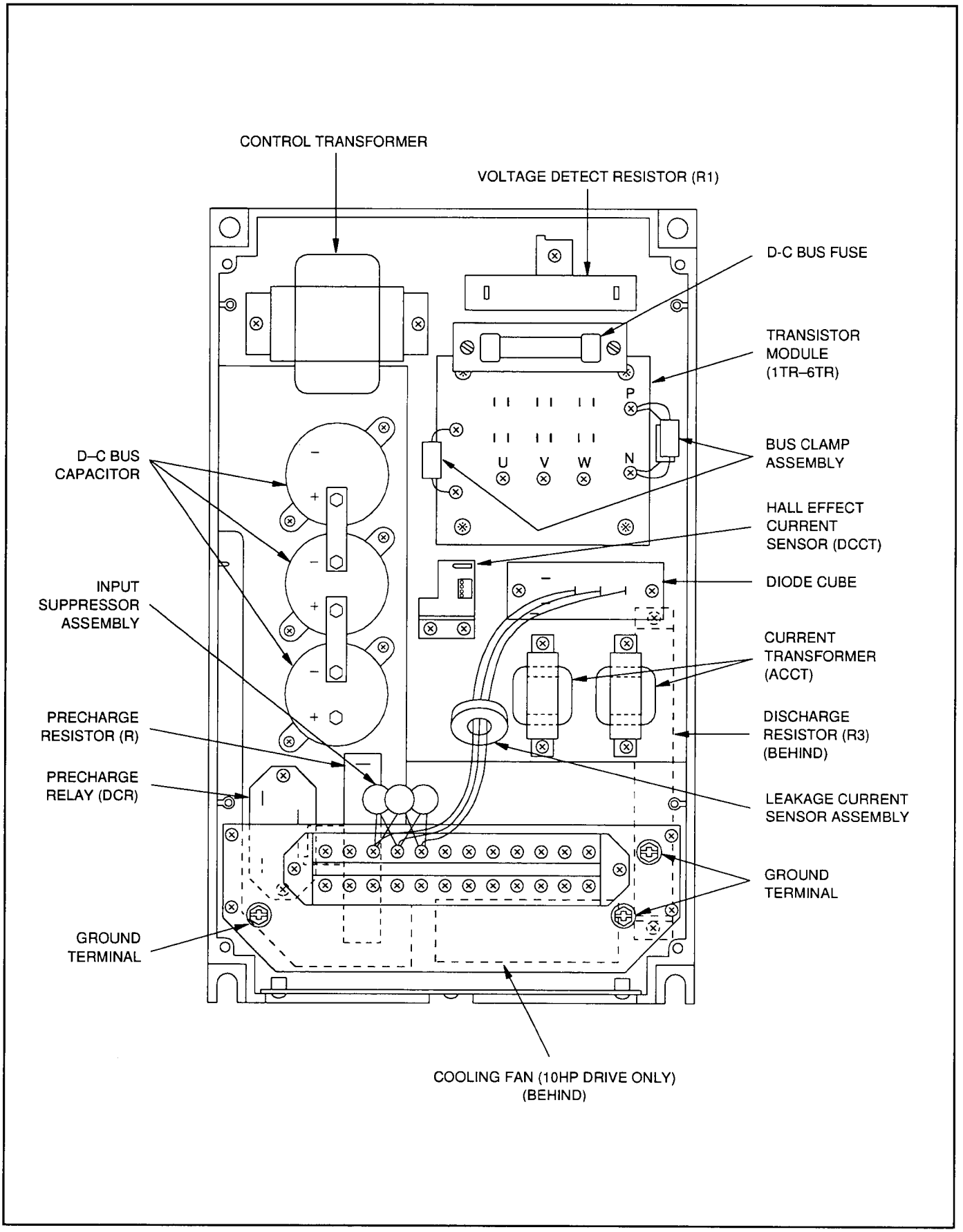


Figure 7-6. Typical Component Identification (3 through 10 HP, 575 VAC Controllers).

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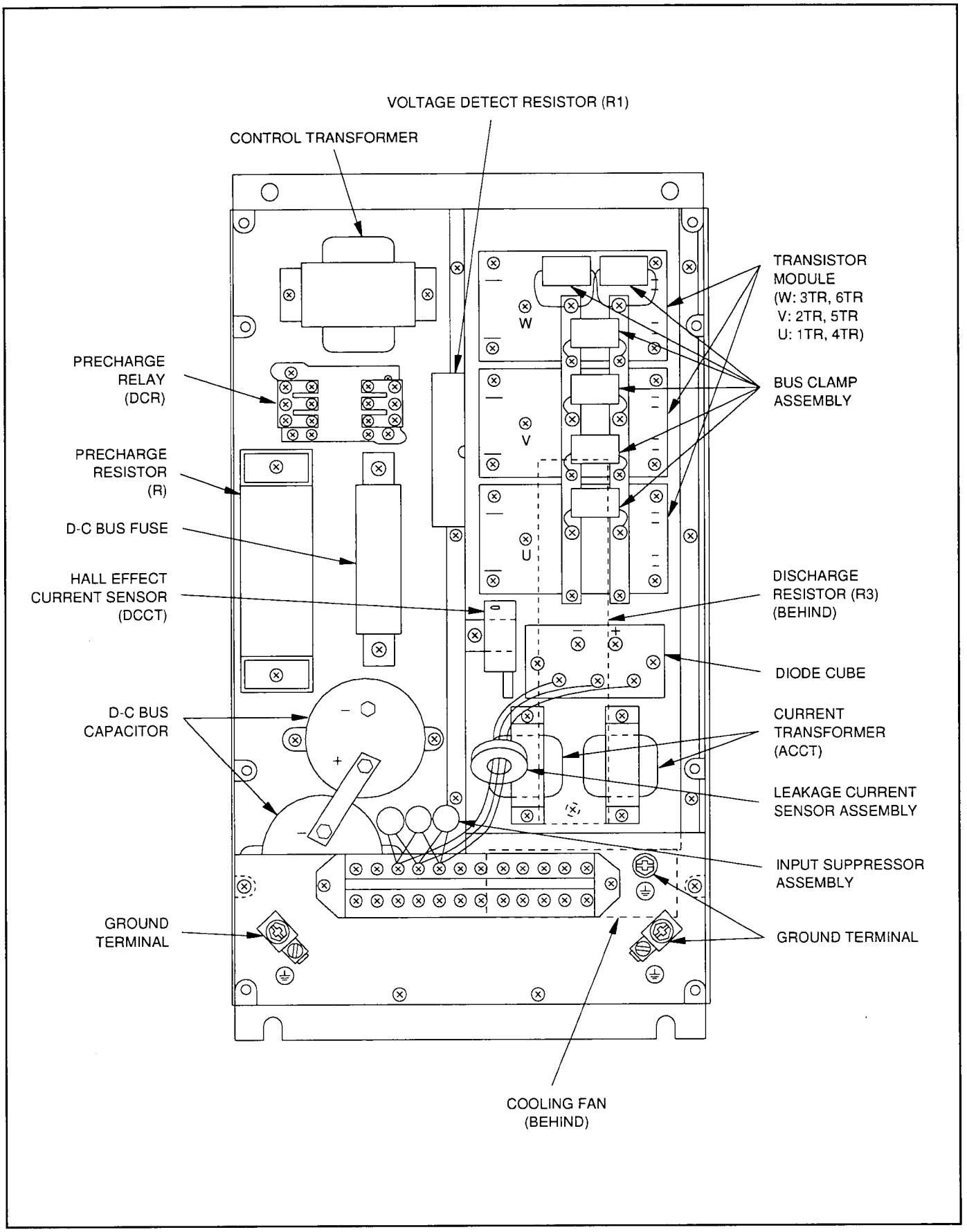


Figure 7-7. Typical Component Identification (15 through 20 HP, 575 VAC Controllers).

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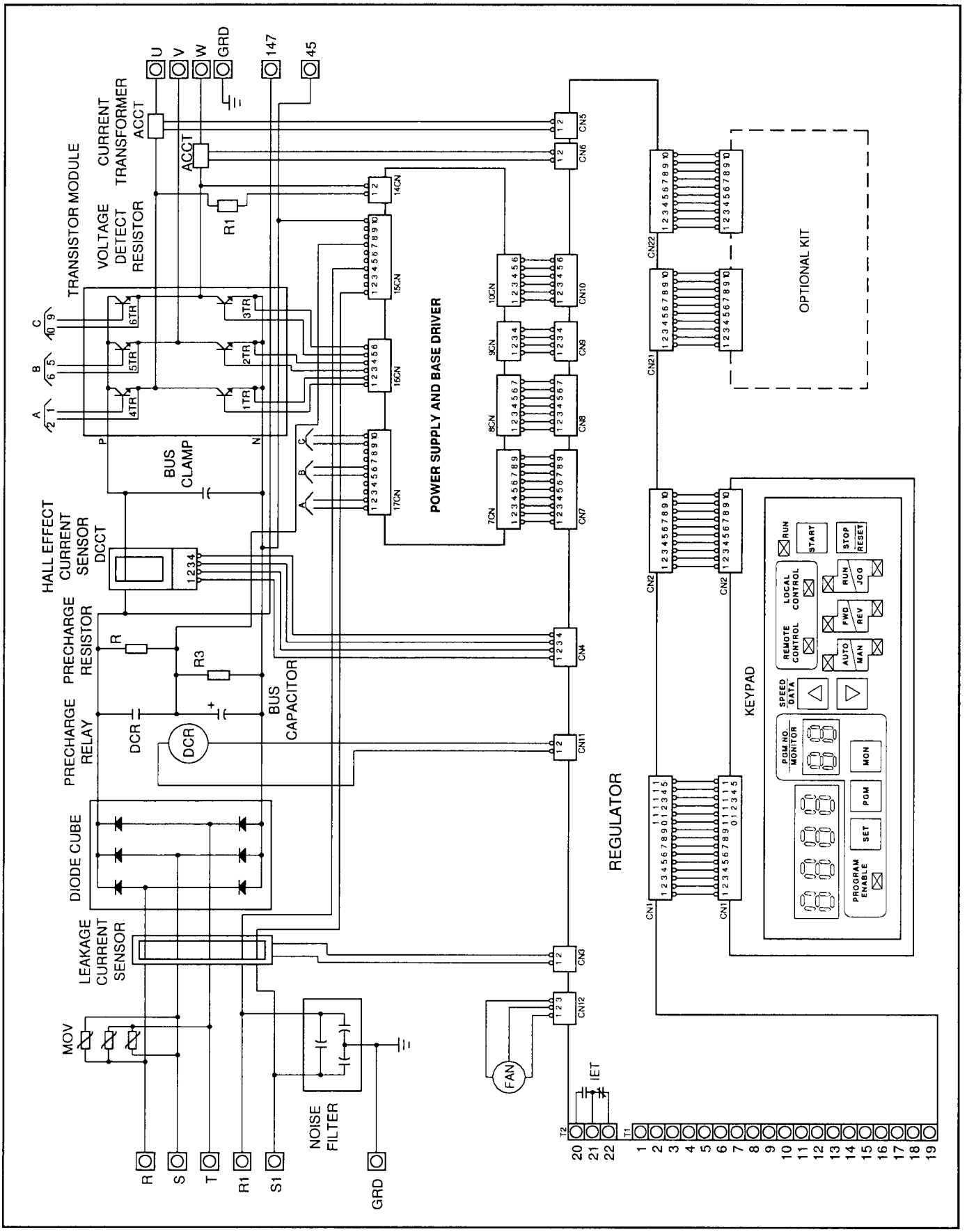


Figure 7-8. Typical Wiring Diagram (1/4 through 5 HP, 230 VAC Controllers).

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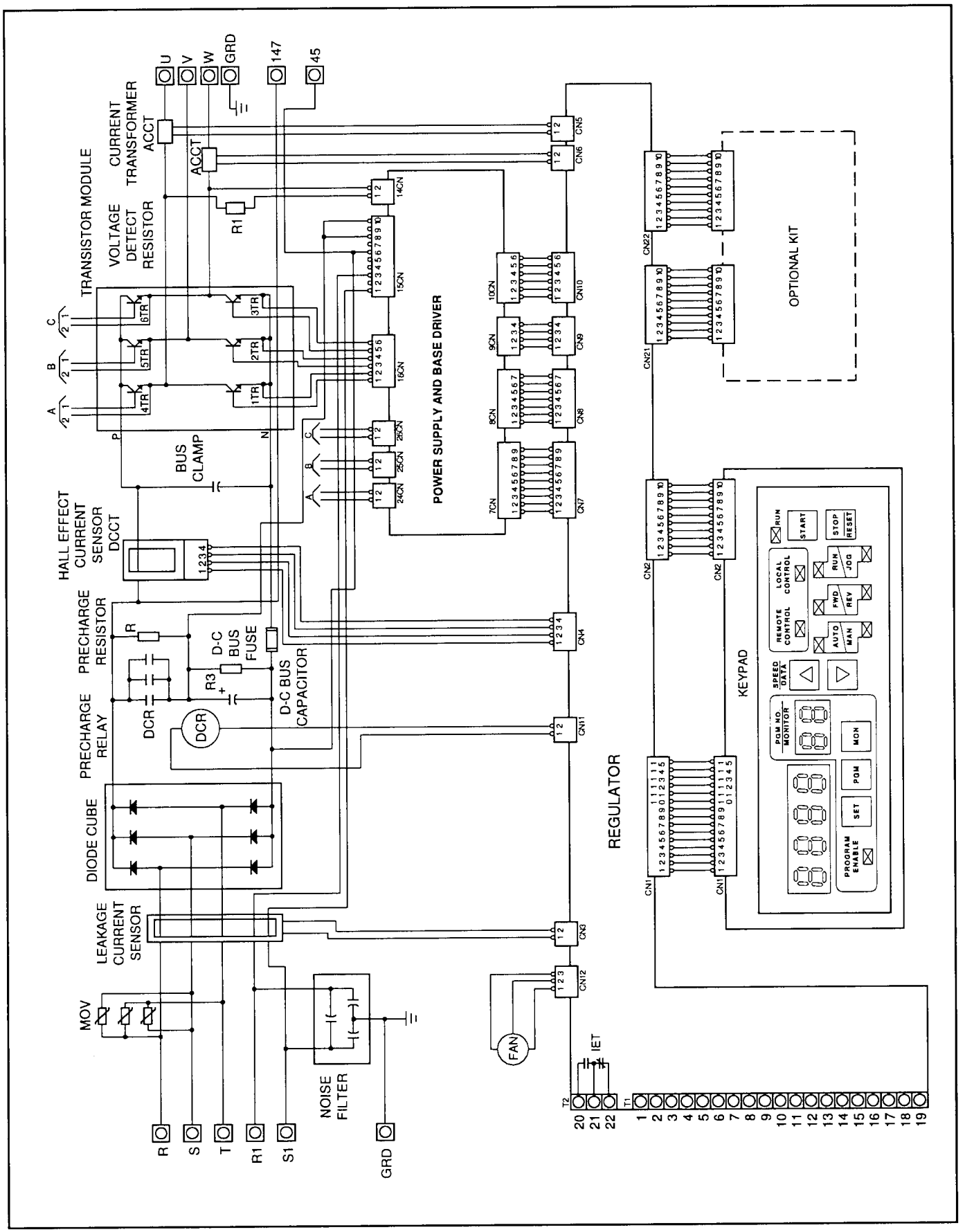


Figure 7-9. Typical Wiring Diagram (7-1/2 through 10 HP, 230 VAC Controllers).

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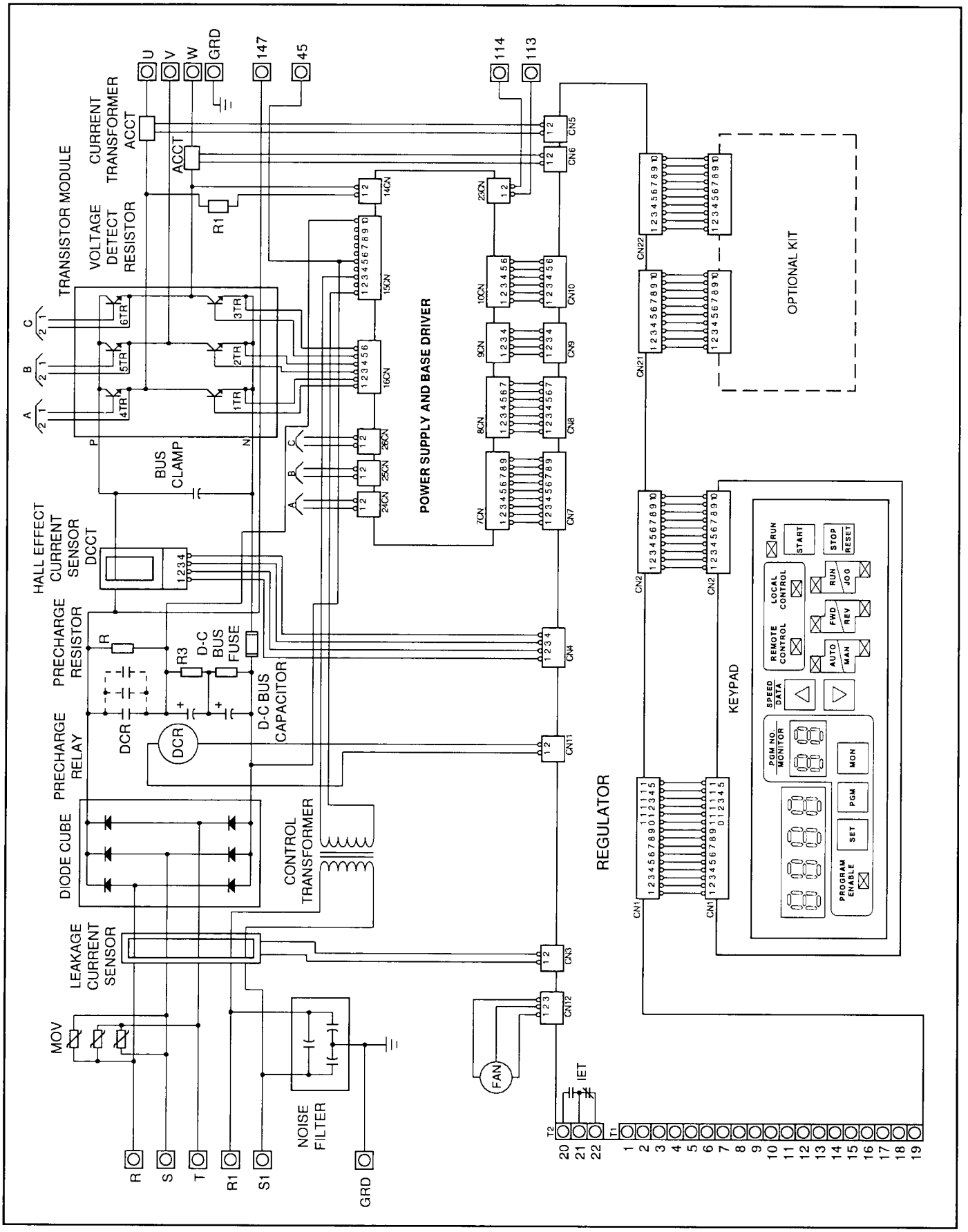


Figure 7-10. Typical Wiring Diagram (1/4 through 20 HP, 460 VAC Controllers).

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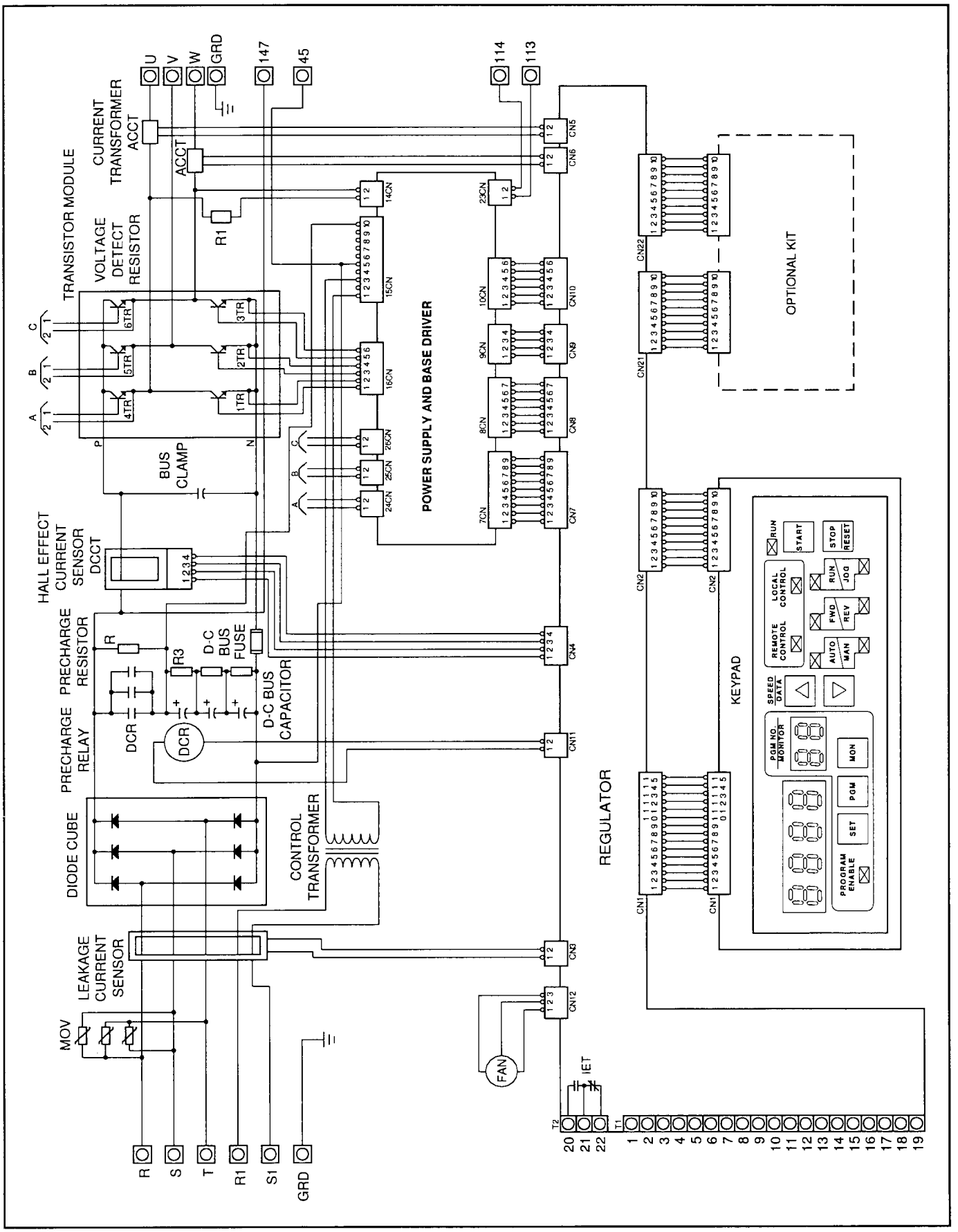


Figure 7-11. Typical Wiring Diagram (3 through 20 HP, 575 VAC Controllers).

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8: Quick Reference Guide

Controller Specifications

Table 8-1. NEMA 1 Controller Three-Phase Ratings.

Controller Model Number	Nominal Horsepower Range	Controller 3ϕ Input Volts	Controller Input KVA	Maximum Input Amps	Maximum Motor Sine Wave Amps (1)	Maximum Controller Output Amps
2GU21001	1/4 to 1	230	2.1	5.3	4.1	4.5
2GU21002	2	230	3.5	8.8	6.8	7.5
2GU21003	3	230	5.0	12.5	9.6	10.6
2GU21005	5	230	7.8	19.6	15.2	16.7
2GU21007	7-1/2	230	11.2	28.2	21.8	24.0
2GU21010	10	230	15.5	38.8	30.0	33.0
2GU41001	1/4 to 1	460	2.0	2.5	1.9	2.1
2GU41002	2	460	3.3	4.2	3.1	3.4
2GU41003	3	460	5.1	6.4	4.8	5.3
2GU41005	5	460	7.9	9.9	7.5	8.2
2GU41007	7-1/2	460	10.7	13.4	10.1	11.1
2GU41010	10	460	13.7	17.2	12.9	14.2
2GU41015	15	460	20.2	25.4	19.0	21.0
2GU41020	20	460	26.1	32.7	24.5	27.0
2GU51005	3 to 5	575	7.5	7.5	5.6	6.2
2GU51010	7-1/2 to 10	575	14.4	14.5	11.0	12.0
2GU51020	15 to 20	575	27.8	27.9	21.0	23.0

(1) To obtain motor nameplate horsepower, the controller's sine wave output ampere rating should be equal to or greater than the motor nameplate current. If the motor nameplate amperes are higher than the controller sine wave rating, the motor horsepower should be derated by the ratio of the controller sine wave ampere rating to the motor nameplate current. Refer to "Single-Motor Applications" and "Multi-Motor Applications" for more details.

Table 8-2. NEMA 1 Controller Single-Phase Ratings.

Controller Model Number	Nominal Horsepower Range	Controller 1ϕ Input Volts	Controller Input KVA	Maximum Input Amps	Maximum Motor Sine Wave Amps (1)	Maximum Controller Output Amps
2GU21001	1/4 to 1/2	230	1.1	4.6	2.3	2.5
2GU21002	1	230	2.1	9.1	4.1	4.5
2GU21003	1-1/2	230	2.8	12.1	5.5	6.0
2GU21005	2	230	3.5	15.2	6.8	7.5
2GU21007	3	230	5.0	21.6	9.6	10.6

(1) To obtain motor nameplate horsepower, the controller's sine wave output ampere rating should be equal to or greater than the motor nameplate current. If the motor nameplate amperes are higher than the controller sine wave rating, the motor horsepower should be derated by the ratio of the controller sine wave ampere rating to the motor nameplate current. Refer to "Single-Motor Applications" and "Multi-Motor Applications" for more details.

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Table 8-3. NEMA 12 Controller Ratings with Three-Phase Input Power.

Controller Model Number	Nominal Horsepower Range	Controller 3ϕ Input Volts	Controller Input KVA	Maximum Input Amps	Maximum Motor Sine Wave Amps [1]	Maximum Controller Output Amps
2GU22001	1/4 to 1	230	2.1	5.3	4.1	4.5
2GU22002	2	230	3.5	8.8	6.8	7.5
2GU22003	3	230	5.0	12.5	9.6	10.6
2GU22005	5	230	7.8	19.6	15.2	16.7
2GU22007	7.5	230	11.2	28.2	21.8	24.0
2GU42001	1/4 to 1	460	2.0	2.5	1.9	2.1
2GU42002	2	460	3.3	4.2	3.1	3.4
2GU42003	3	460	5.1	6.4	4.8	5.3
2GU42005	5	460	7.9	9.9	7.5	8.2
2GU42007	7.5	460	10.7	13.4	10.1	11.1

[1] To obtain motor nameplate horsepower, the controller's sine wave output ampere rating should be equal to or greater than the motor nameplate current. If the motor nameplate amperes are higher than the controller sine wave rating, the motor horsepower should be derated by the ratio of the controller sine wave ampere rating to the motor nameplate current. Refer to "Single-Motor Applications" and "Multi-Motor Applications" for more details.

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Table 8-4. Record of User's Parameter Selections/Adjustments.

WARNING

TABLE 8-4 IS TO BE USED AS A RECORD OF THE USER'S PARAMETER SELECTIONS/ADJUSTMENTS. BEFORE MAKING ANY ADJUSTMENTS TO THE DRIVE, REFER TO THE APPROPRIATE FUNCTION DESCRIPTION IN CHAPTER 5. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

Function Number		Functional Descriptions	Parameter Selection/Adjustment Range	Initial Factory Setting	User Data	
					Date	Setting
First Menu	0	Local/Remote Operation Control (Note: The Rail Interface Card is required with selection 2.)	0 = Local Control 1 = Remote Control/Terminal Strip 2 = Remote Control/I/O Port	0		
	1	Acceleration Time (See Function 44)	5.0 - 360.0 Seconds	20.0		
	2	Deceleration Time (See Function 45)	5.0 - 360.0 Seconds	20.0		
	3	Minimum Hz (See Function 43)	5.0 - 60 Hz	5.0		
	4	Maximum Hz (See Function 38)	15 - Overfrequency Limit	60.0		
	5	Current Limit	50 - 150% Current	150		
	6	Expand to Second Menu (First Password Necessary)	0 = Basic (First Menu Only) 1 = Expand to Second Menu	0		
Second Menu	7	Manual Torque Boost	0 - 10% Voltage	2		
	8	Jog Frequency	0.0 - 60.0 Hz (Note: The actual jog frequency automatically is limited between minimum Hz and maximum Hz.)	5.0		
	9	Stop Mode Selection	0 = Coast-to-rest 1 = Ramp-to-rest	0		
	10	Automatic Flux Control	0 - 5% Rated Voltage	0		
	11	Base Frequency Selection (Volts/Hz Ratio)	30.0 - 400.0 Hz	60.0		
	12	Electronic Thermal Overload Selection	0 = Normal Motor 1 = Forced Cooled Motor	0		
	13	Electronic Thermal Overload Level	20 - 100% Current	100		
	14	Linear/S-Curve Acceleration	0 = Linear Acceleration 1 = S-Curve Acceleration	0		
	15	Linear/S-Curve Deceleration	0 = Linear Deceleration 1 = S-Curve Deceleration	0		
	16	Multi-Speed Preset (1) MS1	0.0 - 400.0 Hz (Note: The actual output frequency automatically is limited between minimum Hz and maximum Hz.)	5.0		
	17	Multi-Speed Preset (1) MS2		5.0		
	18	Multi-Speed Preset (1) MS3		5.0		
	19	Avoidance Frequency 1 AF1	0.0 - 400.0 Hz (Note: The actual output frequency automatically is limited between minimum Hz and maximum Hz.)	0.0		
	20	Avoidance Frequency 2 AF2		0.0		
	21	Avoidance Frequency 3 AF3		0.0		
	22	Avoidance Frequency Band AFB	0.2 - 10.0 Hz	0.2		
	23	Variable Torque Volts/Hz Curve Selection	0 = Constant Torque Curve 1 = Variable Torque Curve	0		
	24	D-C Braking Operation Time (2)	0.0 - 10.0 Seconds	0.0		
	25	D-C Braking Voltage (3)	0 - 20% Voltage	0		
	26	D-C Braking Start Frequency (3)	0.5 - 10.0 Hz	1.0		
	27	Line-Dip-Ride-Through	15 - 500 milliseconds	15		

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Table 8-4. Record of User's Parameter Selections/Adjustments (continued).

Function Number		Functional Descriptions	Parameter Selection/Adjustment Range	Initial Factory Setting	User Data	
					Date	Setting
Second Menu (cont.)	28	Output Relay 1 (Form C Contact) (Note: Requires the Remote Meter Interface Card.)	0 = Not Used 1 = Zero Speed Detect 2 = Reserved 3 = Output Contactor 4 = Frequency Level Detection 1 5 = Frequency Level Detection 2 6 = Current Level Detection 7 = Reverse Rotation 8 = D-C Braking Operation (3) 9 = Reserved	0		
	29	Output Relay 2 (Form A Contact) (Note: Requires the Remote Meter Interface Card.)		0		
	30	Slip Compensation (4)	0.0 - 5.0 Hz	0.0		
	31	Inverse Reference (5) (Second Password Necessary)	0 = Normal 1 = Inverse	0		
	32	Function Loss Selection (Second Password Necessary)	0 = IET at Function Loss 1 = Coast-to-rest without an IET output at Function Loss	0		
	33	Frequency Level Detection 1 (6)	0.5 - 405.0 Hz	0.5		
	34	Frequency Level Detection 2 (7)	0.5 - 405.0 Hz	0.5		
	35	Current Level Detection (8)	30 - 150% Current	100		
	36	Reverse Disable (9)	0 = Forward/Reverse Enable 1 = Reverse Disable on Keypad	0		
	37	Automatic (Process Control) (10) Disable on Local Control	0 = AUTO/MAN key Enable 1 = AUTO Disable on Keypad	0		
	38	Overfrequency Limit (Second Password Necessary)	50.0 - 405.0 Hz	90.0		
	39	D-C Offset Enable (Second Password Necessary)	0 = Offset Disable 1 = Offset Enable	0		
	40	Auto-reset Enable (Second Password Necessary)	0 = Auto-reset Disable 1 = Auto-reset Enable	0		
	41	Auto-reset Time (11)	0 - 10 Times	0		
	42	Auto-reset Interval Time (12)	1 - 60 Seconds	1		
	43	Extended Minimum Hz Range (Second Password Necessary)	0 = Disable (5 - 60 Hz) 1 = Enable (0 - 60 Hz)	0		
	44	Extended Acceleration Time Range	0 = 5.0 - 360.0 Seconds 1 = 0.1 - 360.0 Seconds	0		
	45	Extended Deceleration Time Range	0 = 5.0 - 360.0 Seconds 1 = 0.1 - 360.0 Seconds	0		
	46	RPM Monitor Display Enable	0 = Disable 1 = Enable	0		
	47	RPM Monitor Range Selection (Second Password Necessary)	0 = 150 - 9999 RPM 1 = 0 - 9999 RPM	0		
	48	RPM Monitor Base Frequency Selection (See Function 47)	150 - 9999 RPM	1750		
	49	Output Voltage Regulation Mode Selection (See Function 50)	0 = Proportional to Input 1 = Fixed to Max Voltage	0		
	50	Maximum Voltage	190.0 - 230.0 (13) 380.0 - 460.0 (14) 475 - 575 (15)	230.0 (13) 460.0 (14) 575 (15)		
	51	Jog Acceleration Value	0.1 - 360.0 Seconds	20.0		
	52	Jog Deceleration Value	0.1 - 360.0 Seconds	20.0		

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Table 8-4. Record of User's Parameter Selections/Adjustments (continued).

Function Number		Functional Descriptions	Parameter Selection/Adjustment Range	Initial Factory Setting	User Data	
					Date	Setting
Second Menu (cont.)	53	Jog Acceleration Selection	0 = Linear Acceleration 1 = S-Curve Acceleration	0		
	54	Jog Deceleration Selection	0 = Linear Deceleration 1 = S-Curve Deceleration	0		
	55	Current Limit Deceleration Rate	0 - 100 Hz/Second	90		
	56	Start into a Rotating Motor	0 = Enable 1 = Disable (Quick Start)	0		
	57	MS Terminals Selection [16] (Second Password Necessary)	0 = Multi-Speed Preset 1 = Static MOP	0		
	58	Reserved				

(1) Effective when "1" is selected in Function 0 and "1" is selected in Function 57.
(2) Effective when "1" is selected in Function 9.
(3) Ineffective when 0.0 is set in Function 24.
(4) Effective when "0" is selected in Function 39.
(5) Effective when "1" is selected in Function 0, or when "0" is selected in Function 0 while AUTO mode on key pad is selected.
(6) Effective when "4" is selected in Function 28 or 29.
(7) Effective when "5" is selected in Function 28 or 29.
(8) Effective when "6" is selected in Function 28 or 29.
(9) Effective when "0" is selected in Function 0.
(10) Effective when "0" is selected in Function 0.
(11) Effective when "1" is selected in Function 40.
(12) Ineffective when 0 is set in Function 41.
(13) Effective when the controller is 230 VAC.
(14) Effective when the controller is 460 VAC.
(15) Effective when the controller is 575 VAC.
(16) Effective when "1" is selected in Function 0.

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