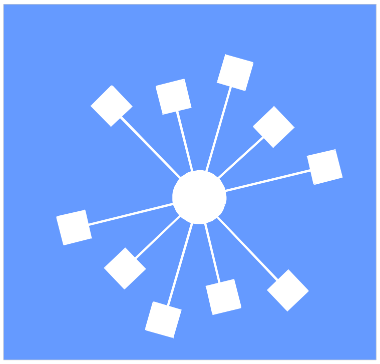
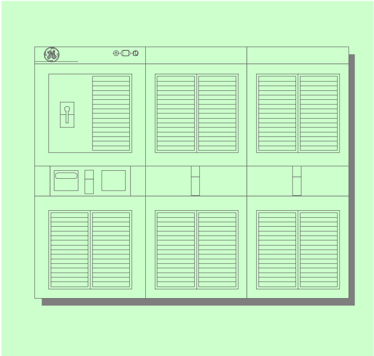
GEH-6392

GE Industrial Systems

Innovation Series

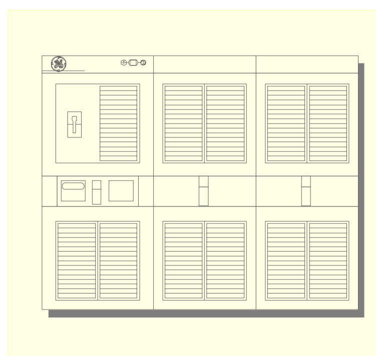


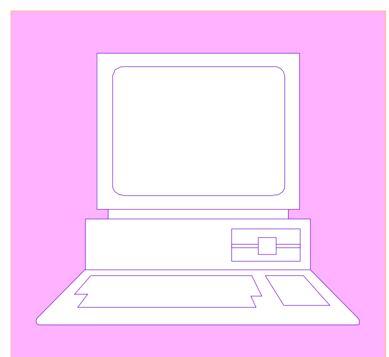


Innovation Series™ Low Voltage Drives

User's Guide

Document: GEH-6392
Issued: 1999-11-19





Innovation Series™ Low Voltage Drives

User's Guide

Printed in the United States of America.

These instructions do not purport to cover all details or variations in equipment, nor to provide every possible contingency to be met during installation, operation, and maintenance. If further information is desired, or if particular problems arise that are not covered sufficiently for the purchaser's purpose, the matter should be referred to GE Industrial Systems, Salem, Virginia, USA.

Document Identification: GEH-6392, original release
Technical Writer/Editor: Ralph Bissell
Technical Responsibility: Anthony Galbraith, John Hamby

Safety Symbol Legend

Warning — **Indicates a procedure, condition, or statement that, if not strictly observed, could result in personal injury or death.**

Caution — **Indicates a procedure, condition, or statement that, if not strictly observed, could result in damage to or destruction of equipment.**

Attention — **Indicates a procedure, condition, or statement that should be strictly followed in order to optimize these applications.**

Note Indicates an essential or important procedure, condition, or statement.

Warning

This equipment contains a potential hazard of electric shock or burn. Only personnel who are adequately trained and thoroughly familiar with the equipment and the instructions should install, operate, or maintain this equipment.

Isolation of test equipment from the equipment under test presents potential electrical hazards. If the test equipment cannot be grounded to the equipment under test, the test equipment's case must be shielded to prevent contact by personnel.

To minimize hazard of electrical shock or burn, approved grounding practices and procedures must be strictly followed.

Warning

To prevent personal injury or equipment damage caused by equipment malfunction, only adequately trained personnel should modify any programmable machine.

Contents

Contents—continued

Contents—continued

Contents—continued

Notes

Chapter 1 Equipment Overview

Introduction to the Drive System

The Innovation Series Low Voltage drive products are made up of a set of sources and dc fed inverters for control of ac induction motors. A common control rack is used throughout all of the sources and inverters (see Figure 1-2).

This chapter provides an overview of the software and hardware components used in a drive system. It is organized as follows:

Section ***Page***

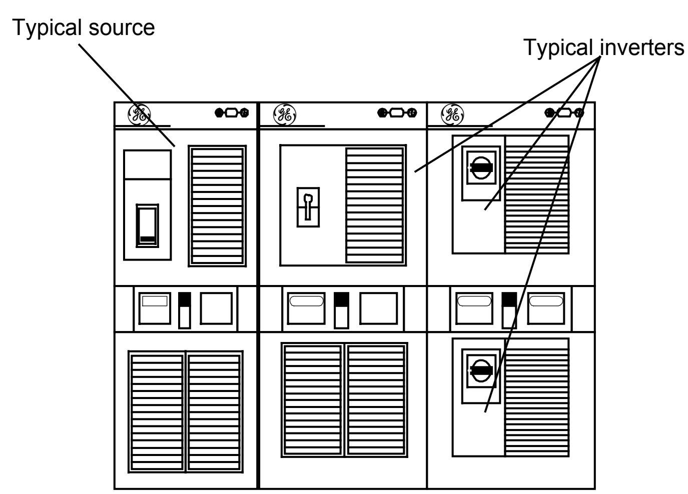
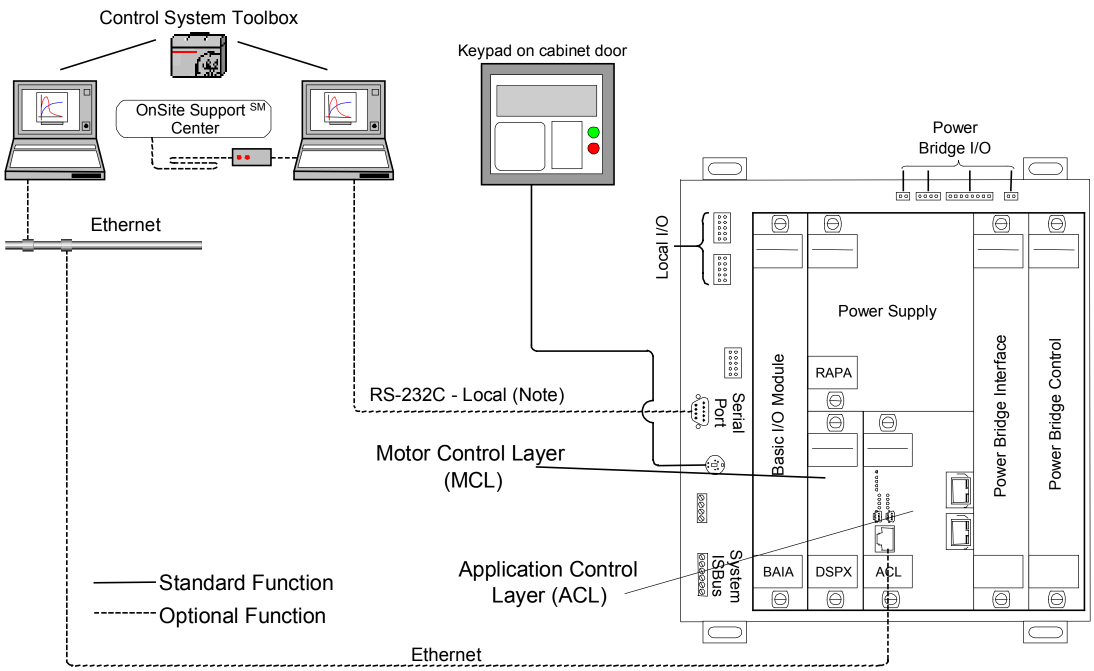


Figure 1-1. Example Drive System Lineup

Configuration, local control, and monitoring of the sources/inverters can occur from either the integral keypad or the Windows®-based Control System Toolbox application (see Figure 1-2).



Note: RS-232C port is standard, configuration with Control System Toolbox is optional.

Figure 1-2. Configuration and Monitoring Connectivity Options

Hardware Overview

Each of the inverters and sources share a common set of features:

- Adaptive Torque Technology™ based motor control
- Heatpipe cooling technology for power devices
- Laminated bus for connection between all power devices
- High power Insulated Gate Bipolar Transistors (IGBTs) used in regenerative sources and inverters
- Modular control platform

A system is assembled from a combination of sources (regenerative and non-regenerative) and inverters based on the requirements of the application.

- Refer to *Appendix B* of this publication for complete drive specifications
- Refer to *GEH-6392* for drive dimensions

Non-regenerative sources convert ac power from the utility to dc power for use by the inverters.

Regenerative sources can operate in 1 of 2 modes:

- When the inverters are collectively motoring, the source converts ac power generated from the utility to dc power for the inverters.
- When the inverters are collectively regenerating, the source converts dc power generated by the inverters to ac power for the utility.
- Inverters can operate in one of two modes:
- When motoring, they pull power from the dc bus and apply it to the motor. An industrial pump and fan normally operates in this mode.
- When regenerating, they pull power from the motor and apply it to the dc bus (requires regenerative source). A tension reel in a metals process line normally operates in this mode.

Equipment Covered

In this document, the term "drive" includes both sources and inverters.

An ac drive lineup is a combination of a source and one or more inverters that generate ac power to a motor at a required frequency and current. The output requirement determines the lineup structure.

The LV drives used in a lineup include common bus non-regenerative sources, common bus regenerative sources available in the following sizes:

Frame* Size	Inverter	Non-Regen. Source	Regen. Source
65	✔		
92	✔		
125	✔		
180	✔		
250	✔		
375	✔		✔
620	✔	✔	✔
1000	✔	✔	✔
1800	✔	✔	✔

*Frame size indicates the approximate current rating.

In firmware (product) number identifies the drive application, as follows:

For additional information about the drive pattern, refer to the Intelligent Part Number section of Appendix A.

Pattern	Drive Application
ACDCF-G	ac drive, dc-fed inverter, general industry applications
ACDCF-S	ac drive, dc-fed inverter, system applications
ACDCF-V	ac drive, dc-fed inverter, V/Hz applications
ACCBN-A	ac drive, common bus non-regenerative source, version A
ACCBR-A	ac drive, common bus regenerative source, version A

Software Overview

The control provided in an inverter or source is determined by the pattern that it is executing. Table 1-1 summarizes the control patterns available for the inverters and sources.

Table 1-1. Available Control Patterns

Control Pattern	Reference Manual	Operates In	Application
Regenerative Source	GEH 6397	Regenerative Sources	Regenerative machines
Non-Regenerative Source	GEH 6396	Non-Regenerative Sources	Non-Regenerative machines
Adaptive Torque Technology for General Industry	GEH 6393	Inverters	Machines that are operated from a revolutions per minute (RPM) perspective
Adaptive Torque Technology for Coordinated Systems	GEH 6394	Inverters	Machines that process a web of paper, steel, etc.
Volts/Hertz Control for Coordinated Systems	GEH 6395	Inverters	Multi-motor applications in a machine that is processing a web

Within a control pattern, software functions are configured and monitored from the integral keypad or Windows®-based Control System Toolbox application. Configuration wizards are available from either the keypad or toolbox, where the user is guided through a question/answer session. An example function for a general industry pattern is shown in Figure 1-3.

Example Control Function:
Parameters for the function are configured using either the keypad or the toolbox

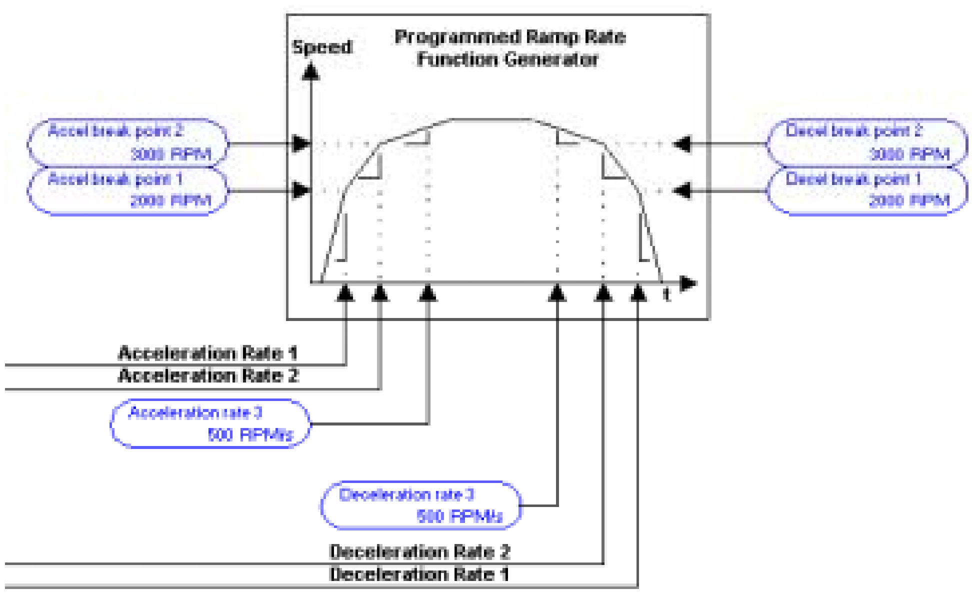
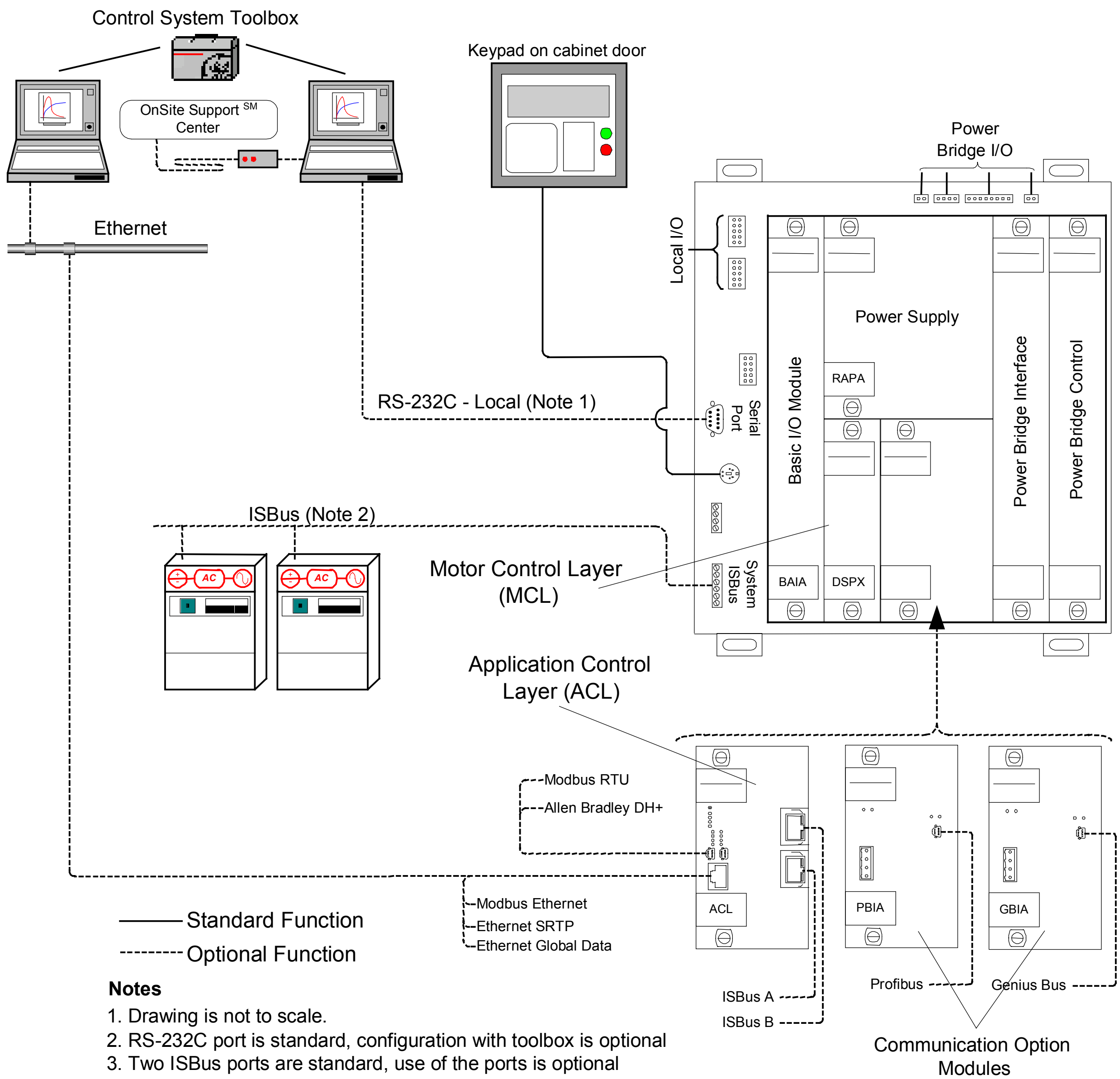


Figure 1-3. General Industry Pattern Function Example

Communications Interfaces

The low voltage drives support several communications options as detailed in Figure 1-4.



Notes

1. Drawing is not to scale.
2. RS-232C port is standard, configuration with toolbox is optional
3. Two ISBus ports are standard, use of the ports is optional

Figure 1-4. Communication Options

How to Get Help

"+" indicates the international access code required when calling from outside of the USA.

If help is needed beyond the instructions provided in the drive system documentation, contact GE as follows:

GE Industrial Systems
Product Service Engineering
1501 Roanoke Blvd.

Salem, VA 24153-6492 USA

Phone: + 1 800 533 5885 (United States, Canada, Mexico)
+ 1 540 378 3280 (International)

Fax: + 1 540 387 8606 (All)

Related Documents

If needed for supplementary information, refer to the following Innovation Series product documents, as applicable:

Subject	Document	Content
LV drives:		
Elementary drawings	GEH-6389	Standard electrical wiring schematics for all LV drive frames
Standard layout and outline drawings	GEH-6390	Standard drive panel layouts showing internal component locations, and standard outlines showing dimensions and weights, for all frames
Installation and Startup	GEH-6392	Procedures for installing the drive, checking and downloading application firmware, starting the drive, and using wizards for tuneup.
Firmware application reference and troubleshooting:		Description of faults codes, firmware functions, associated parameters wizards, and signal mapping for:
ACDCF-G	GEH-6393	dc-fed inverters, general industry applications
ACDCF-S	GEH-6394	dc-fed inverters, system applications
ACDCF-V	GEH-6395	dc-fed inverters, V/Hz applications
ACCBN-A	GEH-6396	common bus non-regenerative sources
ACCBR-A	GEH-6397	common bus regenerative sources
Printed wiring boards	See Appendix C	Board function within the drive, I/O, configuration requirements, and replacement
Related or integral products:		
Installation guidance for Innovation Series equipment	GEH-6380	Drawing content and distribution options; equipment cabling requirements; installation service options
Control system toolbox	GEH-6401	How to use the control system toolbox screens and options for configuring an Innovation Series drive
Trend Recorder	GEH-6408	How to use the Trend Recorder feature of the control system toolbox, including how to record graphical views of drive signals
Receiving, handling, and storage	GEI-100256	Procedures, precautions, and environmental requirements for receiving the drive from the shipper and storing it before installation

Document Distribution

GE Industrial Systems supplies product documents to its customers to support the equipment provided for each requisition. The contract documents define the terms of the document distribution.

If provided (per contract), the following documents contain requisition information about the drive system:

- Requisition drawings, including outlines, layouts, and elementary diagrams
- Renewal Parts listing (see Appendix C)

Note If differences exist between the general product documentation and the requisition documentation, the requisition documentation should be considered the more exact representation of your equipment or system configuration.

Acronyms and Abbreviations

A	ampere(s)
ac	alternating current
ACL	application control layer
ACOM	analog common
ADF	auxiliary device feeder
ADS	auxiliary device (circuit) switch
ATBA	IS200ATBA Application Terminal Board
CCOM	control common
CPT	control power transformer
dc	direct current
DCOM	digital common
DDI	Drive diagnostic interface (keypad)
ft	foot, feet
ft-lbs	foot-pounds (torque)
ft/min	feet per minute
GE	General Electric Company
IGBT	insulated gate bipolar transistor
in.	inch(es)
in-lbs	inch-pounds (torque)
I/O	input and output
IPN	intelligent part number
kg	kilograms
LAN	local area network
LED	light-emitting diode
level H	high-level signal
level H(S)	high-level signal, special handling
level L	low-level signal
level M	medium-level signal
level P	power signal
level P(S)	power signal, special handling
m	meter(s)
max.	maximum
NEC	National Electrical Code®
n-m	Newton-meter (torque)
OSHA	occupation and safety health act.
PC	personal computer
PLC	programmable logic controller
PSI	pounds per square inch
PVC	polyvinylchloride
PWM	pulse-width modulated
SCR	silicon-controlled rectifier
RAPA	IS200RAPA Control Rack Power Supply board
RTDs	resistance thermal devices
SHCOM	shield common
V ac	volts ac (alternating current)
V dc	volts dc (direct current)

Chapter 2 Functional Description

Introduction

The Innovation Series Low Voltage drives are designed for common bus applications. The drive cores are integrated into a family of common cabinets with an integral dc bus. This provides a world class set of drive components for configuration of a drive system lineup. The functional description information is organized as follows:

Section **Page**

The sources and dc fed inverters consist of four major systems:

Power System – In non-regenerative applications, the source converts incoming ac power to dc power for the inverters. The inverters convert this dc power to a pulse width modulated (PWM) signal that is applied to the induction motor.

In regenerative applications, the source either converts incoming ac power to dc power or converts dc power from the inverters to ac power for the utility based on the mode of operation (motoring or regenerative).

Control Power System – Each drive lineup contains a versatile control power distribution system that provides:

- Optional dc disconnect for each inverter
- Ac power for the control racks (control racks can also operate on dc the bus)
- Ac power for motor cooling blowers
- Ac power for shaft brake controls

Control System – The control system consists of configurable motor control functions and several methods to interface with these functions:

- Local keypad
- Control System Toolbox
- Hardwired I/O
- LAN based control from ISBus, Genius, Profibus, or Application Control Layer (ACL)

Communication System – Several communication options for configuration, monitoring, and control provide support for different levels of performance.

This chapter describes how each of these systems work together to meet your application requirements.

Power System

From the perspective of the power system, a low voltage drive lineup consists of a source and 1 or more inverters. The source converts ac power from the utility into dc power that is distributed over an integral dc bus for the inverters. The inverters convert the dc power to a pulse width modulated (PWM) signal that is applied to the induction motors.

In regenerative applications, power can flow both directions through sources and inverters based on the mode of operation (motoring or regenerative). A simplified diagram of the power system is shown in Figure 2-1.

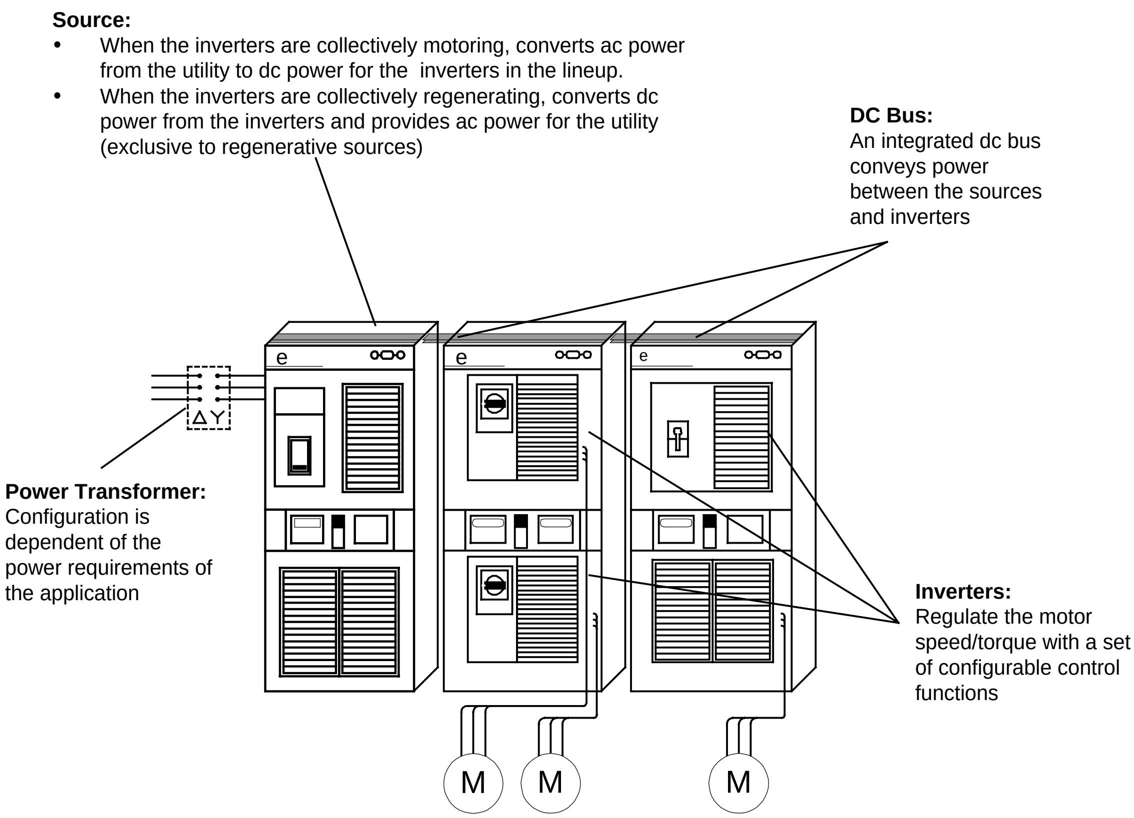


Figure 2-1. Power System Diagram

Sources

Common bus drive systems are frequently used in applications where there is *diversity* amongst the inverters. Diversity in this context means that within a lineup some of the inverters are motoring (power going into the process) and others are regenerating (generating power from the process). See Figure 2-2 for an example.

A metals process line is an example of a process where there is a lot of diversity. A metals process line has a lot of diversity, with a large set of inverters in regeneration as well as a number that are motoring. A more efficient use sources can be achieved with the appropriate pairing of inverters. Each lineup should contain inverters that are primarily motoring with an equal number of inverters that are primarily regenerating.

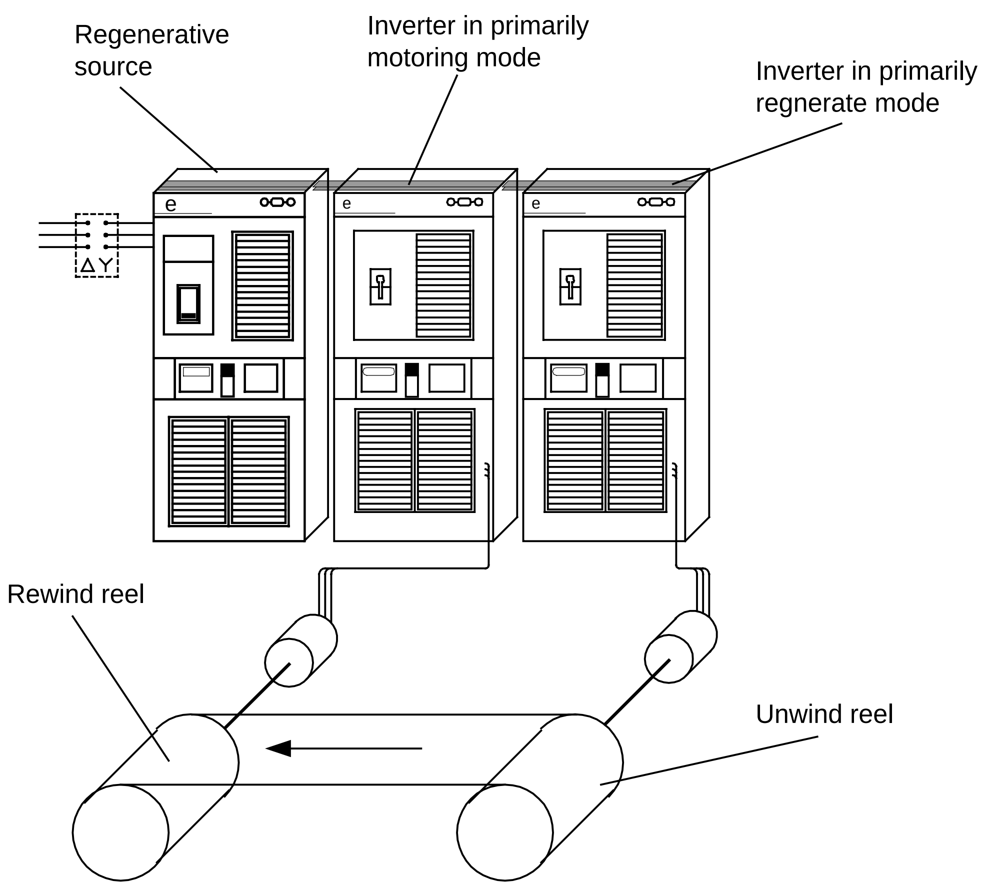


Figure 2-2. Lineup Diversity Example

Non-Regenerative Sources

A simplified power circuit schematic for a non-regenerative source is shown in Figure 2-3.

The SCRs and diodes form a three phase bridge rectifier that converts ac power from the utility to dc power for the inverters in the lineup. Regulation of the dc bus voltage is achieved by monitoring the current/voltage (via the shunts) and controlling the firing angle at which the SCRs are turned on.

The dc bus link reactor and bus fuses provide over current protection for the dc bus.

An optional dynamic braking assembly (for 1000 frame only) provides a means to dissipate energy from inverters that are in a regenerative mode.

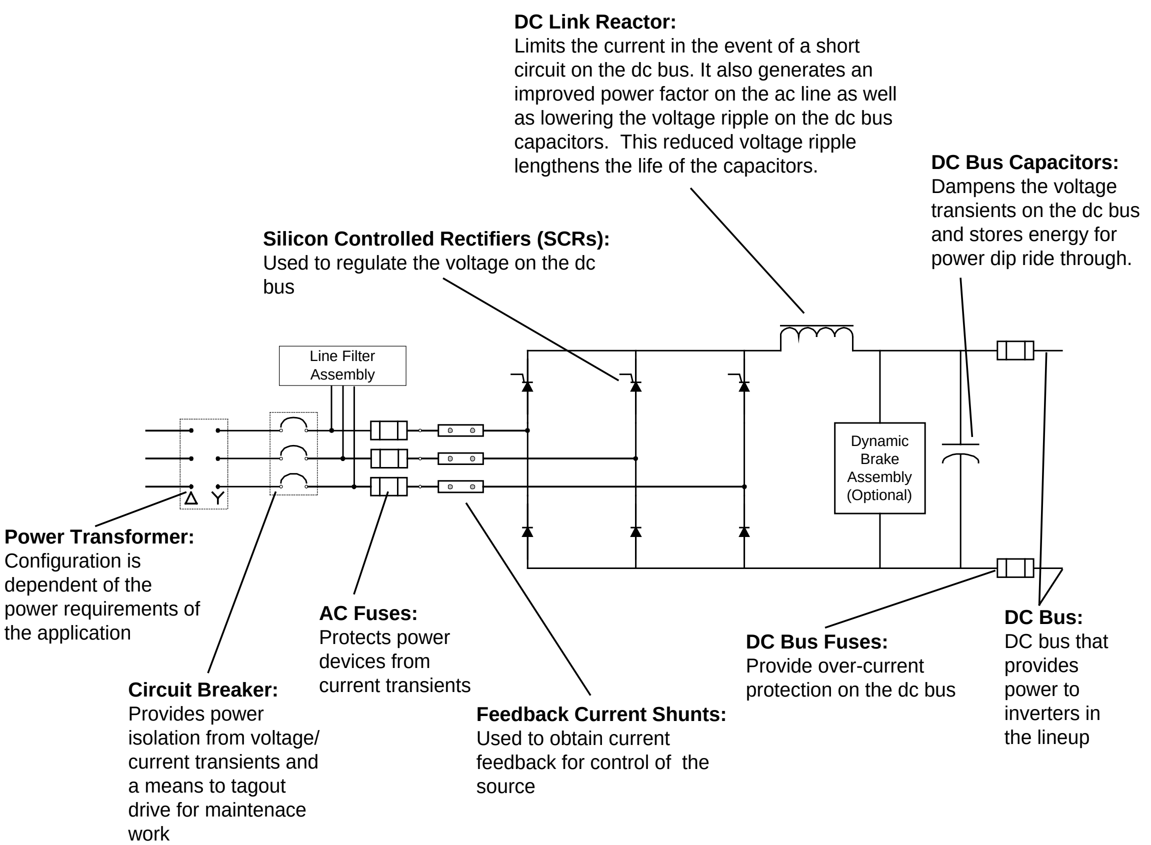


Figure 2-3. Non-regenerative Source Power Circuit Example

References

- Chapter 7 for a procedure on the replacement of the SCRs or diodes
- GEH-6390 for mechanical drawings of the non-regenerative sources
- GEH-6389 for a complete set of electrical schematics on the non-regenerative sources
- Appendix B for electrical specifications on the non-regenerative sources

Regenerative Sources

A simplified power circuit schematic for a regenerative source is shown in Figure 2-4.

The three sets of Insulated Gate Bipolar Transistors (IGBTs) can operate one of two ways:

- In non-regenerative mode (power taken from the utility and fed into the process), incoming ac power is converted to dc power for the inverters.
- In regenerative mode (power taken from the process and fed back into the utility), the source converts dc power from the inverters to ac power for the utility.

Regulation of the dc bus voltage is achieved by monitoring the current/voltage (via the shunts) and controlling the firing angle at which the IGBTs are turned on. Dc bus fuses provide over current protection for the dc bus.

The source is capable of supplying reactive current to the incoming ac line, both when used as a regenerative source to ac drives or as a stand alone reactive volt-ampere (VAR) compensator. In either case, the primary use is to supply leading reactive VARs to the incoming supply to compensate for other connected loads lagging VARs and thereby correct the power factor of the overall system load to near unity (1.0) power factor. The lagging VARs are typically generated by other loads on the system, such as auxiliary induction motors, lighting, or dc drives.

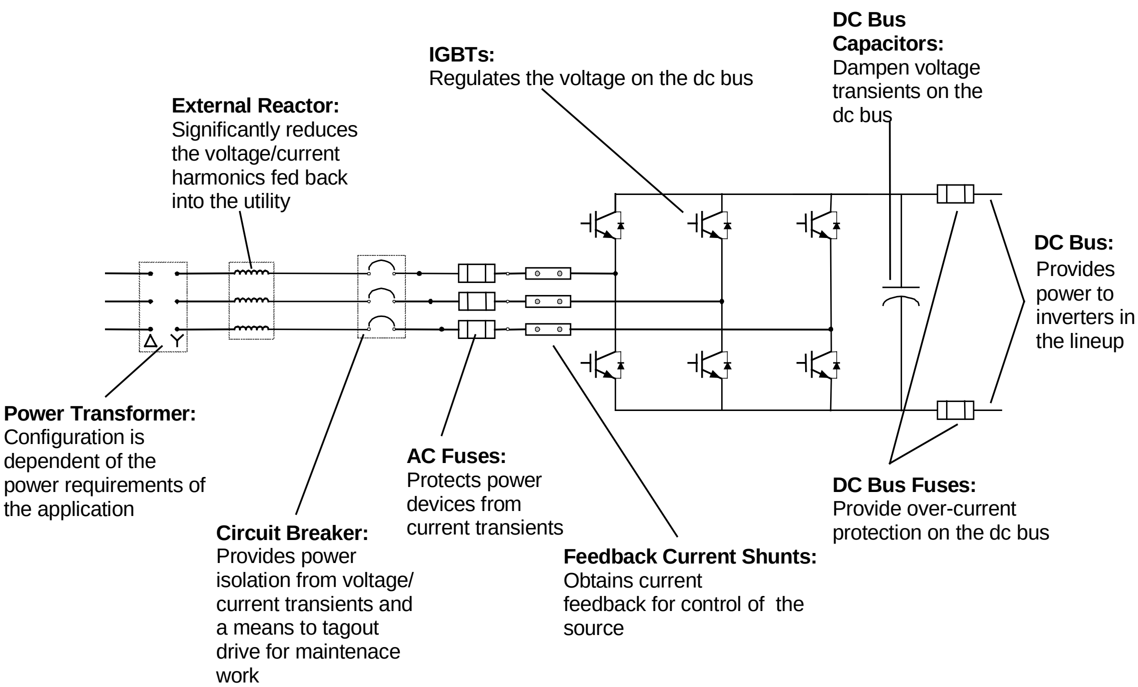
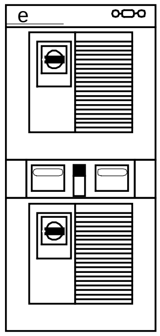


Figure 2-4. Regenerative Source Power Circuit Example

References

- Chapter 7 for a procedure on the replacement of the IGBTs or diodes
- GEH-6390 for mechanical drawings of the regenerative sources
- GEH-6389 for a complete set of electrical schematics on the regenerative sources
- Appendix B for electrical specifications on the regenerative sources

Inverters



125 Frame Inverter
(two per cabinet)

Functionally, each of the low voltage inverters operate in a similar fashion. In non-regenerative applications, the inverter takes dc power from the bus and converts it to a pulse width modulated (PWM) signal that is applied to the induction motor. Power is always being taken from the dc bus and being fed into the process.

In regenerative applications, power flows in both directions based on whether the inverter is motoring (power is being fed into the process) or is in the regenerative mode (power is being taken from the process). In either mode, speed and torque is controlled with a PWM signal that is applied to the induction motor.

A simplified power circuit schematic for an inverter is shown in Figure 2-5.

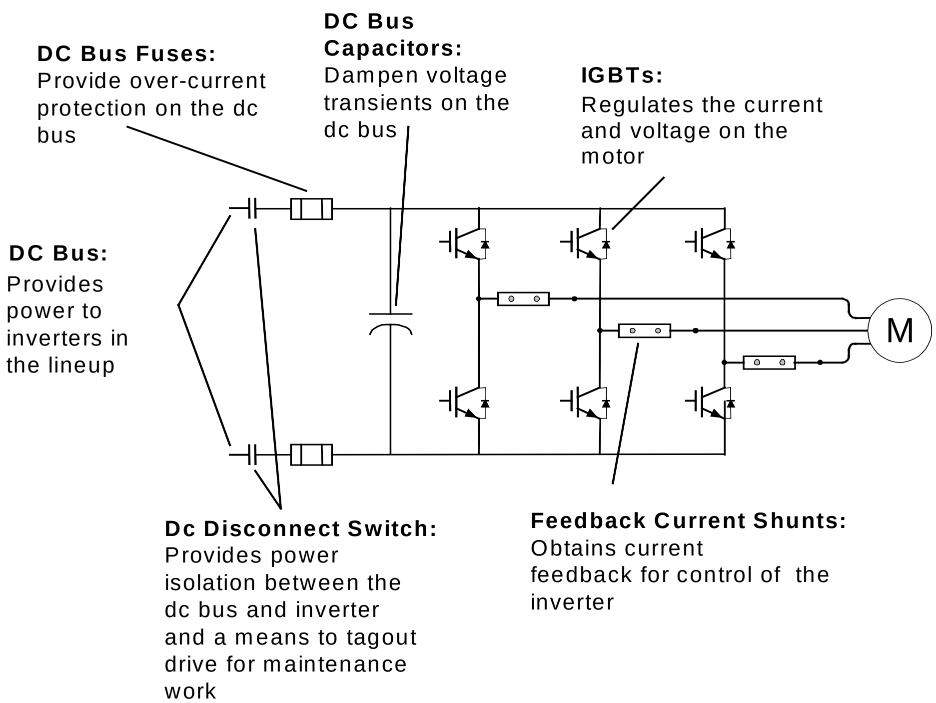


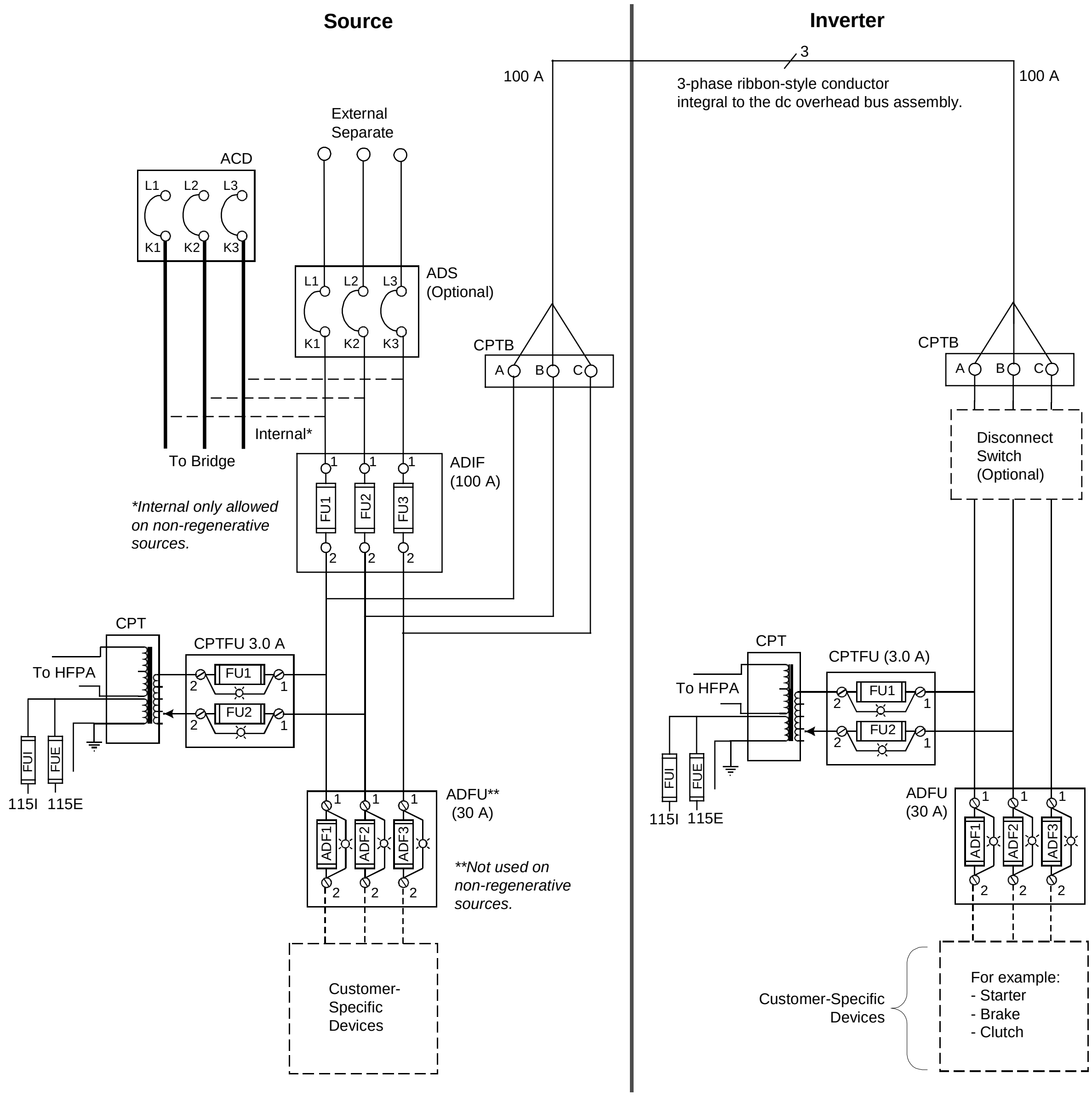
Figure 2-5. Inverter Power Circuit Example

References

- Chapter 7 for a procedure on the replacement of the IGBTs or diodes
- GEH-6390 for mechanical drawings of the inverters
- GEH-6389 for a complete set of electrical schematics of the inverters
- Appendix B for electrical specifications on the inverters

Control Power System

Control power for the drive lineup is derived from an internal 3-phase control circuit called the Auxiliary Device Feeder (ADF). The ADF is a 100 A ac, 3-phase power feeder circuit originating at the source and distributed in the overhead dc bus assembly to each dc-fed inverter.



Name	Function	Name	Function
ACD	Ac power disconnect	CPTFU	Control power transformer primary fuses
ADFU	Auxiliary device feeder fuses	CPTB	Control power terminal board
ADIF	Auxiliary device input feeder fuses	HFPA	High frequency power supply board
ADS	Auxiliary device switch	115E	115 V for **external** connections at DIN-rail
CPT	Control power transformer	115I	115 V for **internal** connections at DIN-rail

Figure 2-6. Control Power System

The source's ADIF fuses provide branch circuit protection for the 100 A conductor located in the overhead dc bus assembly. 30 A branch-fuse protection (ADF1 – ADF3) is provided with each inverter to power special devices, such as motor cooling blowers and shaft brake controls. The optional dc disconnect switch serves as a cutoff for the ADF power in each inverter.

Caution

To prevent equipment damage, make sure that the total connected load currents do not exceed the ADF circuit's rating of 100 A.

In the **non-regenerative source**, the circuit can connect to either the ac incoming power lines that feed the source or to an independent power feed. An optional auxiliary device feeder (ADF) disconnect switch provides a cutoff for the incoming power.

In the **regenerative source**, the circuit must connect to an external source or from the line side of the source's ac reactor. This circuit **must not** connect to the load side of the reactor.

The CPT is mounted inside a sheet-metal subassembly within the drive cabinet. Its primary fusing is located outside this subassembly.

The control power transformer (CPT) primary taps are provided for voltage selection at the front of the sheet metal assembly that supports the control rack. Each CPT has a 230 V, .43 A and a 115 V, 3.47 A secondary output. 2 A of the 115 V is available at DIN-rail 115E. Secondary output fuses FUI and FUE are mounted on the DIN-rail. (Refer to Figure 2-7.)

Caution

Before power is applied, verify that the CPT primary winding's tap configuration plug is configured for the proper voltage selection.

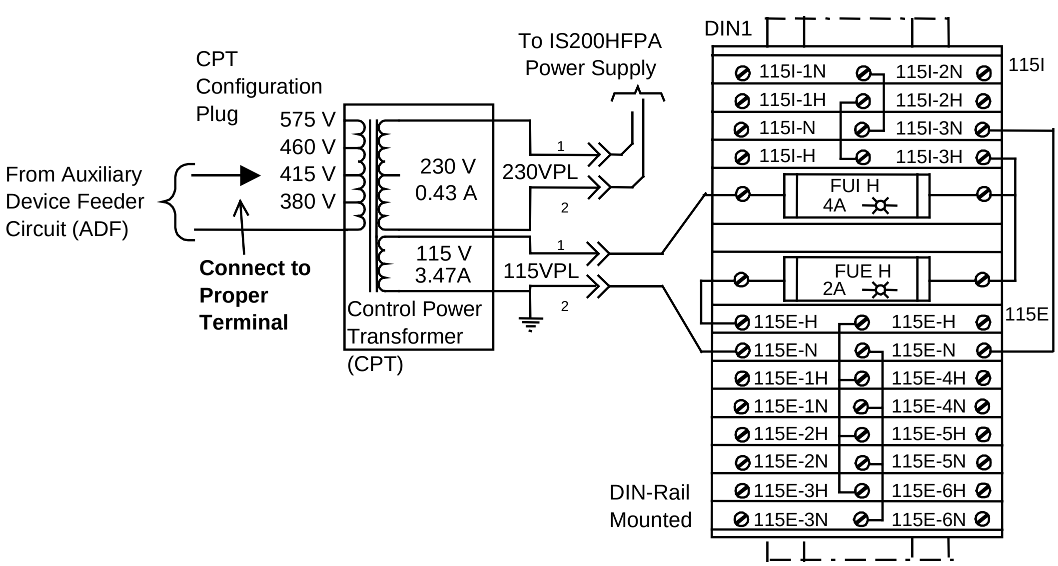


Figure 2-7. CPT Power Input and Output

Control System

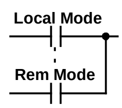
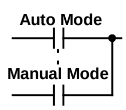
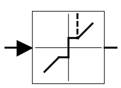
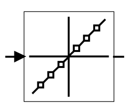
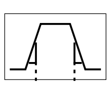
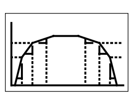
Low voltage sources and inverters are controlled by a combination of configured functions and commands from a keypad, toolbox, I/O, or local area network (LAN). The sources and inverters operate in either a local or remote mode.

- In local mode, the keypad or toolbox commands coupled with the configured functions control operation.
- In remote mode, the I/O or LAN commands coupled with the configured functions control operation.

A summary of the control functions available in the inverters are described in Table 2-1 through Table 2-4. The functions are available in all of the inverter control patterns unless noted otherwise.

Speed Reference Functions

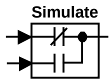
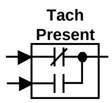
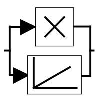
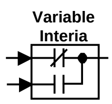
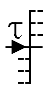
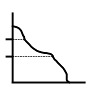
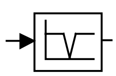
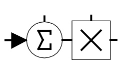
Table 2-1. Speed Reference Control Functions

Function	Description
	Local/Remote speed reference selection
	Automatic/Manual speed reference selection
	Clamp speed reference at minimum value*
	Critical speed avoidance, three speed zones*
	Linear time ramp with alternate rates and emergency stop rate
	Profiled speed ramp with six breakpoints*

*Not available in the Adaptive Torque Technology for Coordinated Systems pattern.

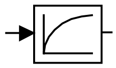
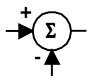
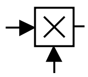
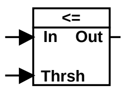
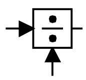
Speed/Torque Regulator Functions

I/O Table 2-2. Speed/Torque Regulator Control Functions

<table>
<tr><th>Function</th><th>Description</th></tr>
<tr><td>
</td><td>Simulation mode for testing and training</td></tr>
<tr><td>
</td><td>Speed/torque regulation with or without an encoder. Automatic transition to encoderless operation upon the loss of an encoder. Not available in the volts/hertz control for coordinated systems pattern.</td></tr>
<tr><td></td><td>Speed regulator with four modes:
• Speed
• Torque
• Speed with spillover torque limit
• Torque with spillover speed limit
Not available in the volts/hertz control for coordinated systems pattern.</td></tr>
<tr><td>
</td><td>Variable or fixed inertia</td></tr>
<tr><td></td><td>Motoring and regeneration torque limits with three primary settings:
• Primary
• Variable
• Alternate</td></tr>
<tr><td></td><td>Power dip ride through with two thresholds:
• Motoring action level
• Undervoltage trip level</td></tr>
<tr><td></td><td>Notch filter for elimination of mechanical resonance problems. Only available in the Adaptive Torque Technology for coordinated systems pattern.</td></tr>
<tr><td></td><td>Four forms of load compensation:
• Inertia
• Friction
• Windage
• Impact
Not available in the Adaptive Torque Technology for general industry pattern.</td></tr>
</table>

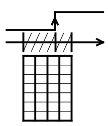
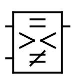
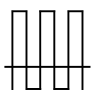
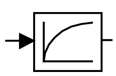
I/O Functions

Table 2-3. I/O Control Functions

Function	Description
	First order low pass filter for each discrete analog input and the encoder input
	Offset for each analog input and output
	Gain for each analog input
	Signal loss detection for each analog input
	Scaling for each analog output

Diagnostic Functions

Table 2-4. Diagnostic Control Functions

Function	Description
	Capture buffer that is configurable: • 1-4 variables • 1-512 samples before trigger • 1-512 samples after trigger
	Three signal level comparators that are configurable
	General purpose oscillator that is configurable: • Cycle time • Positive magnitude • Negative magnitude
	Four general purpose first order low pass filters
$K_{1/2/3}$	Three general purpose constants

Control From the Keypad

There are several control functions available from the keypad that is integrated into the door of the cabinet. Refer to Figure 2-8 for an illustration of these functions.

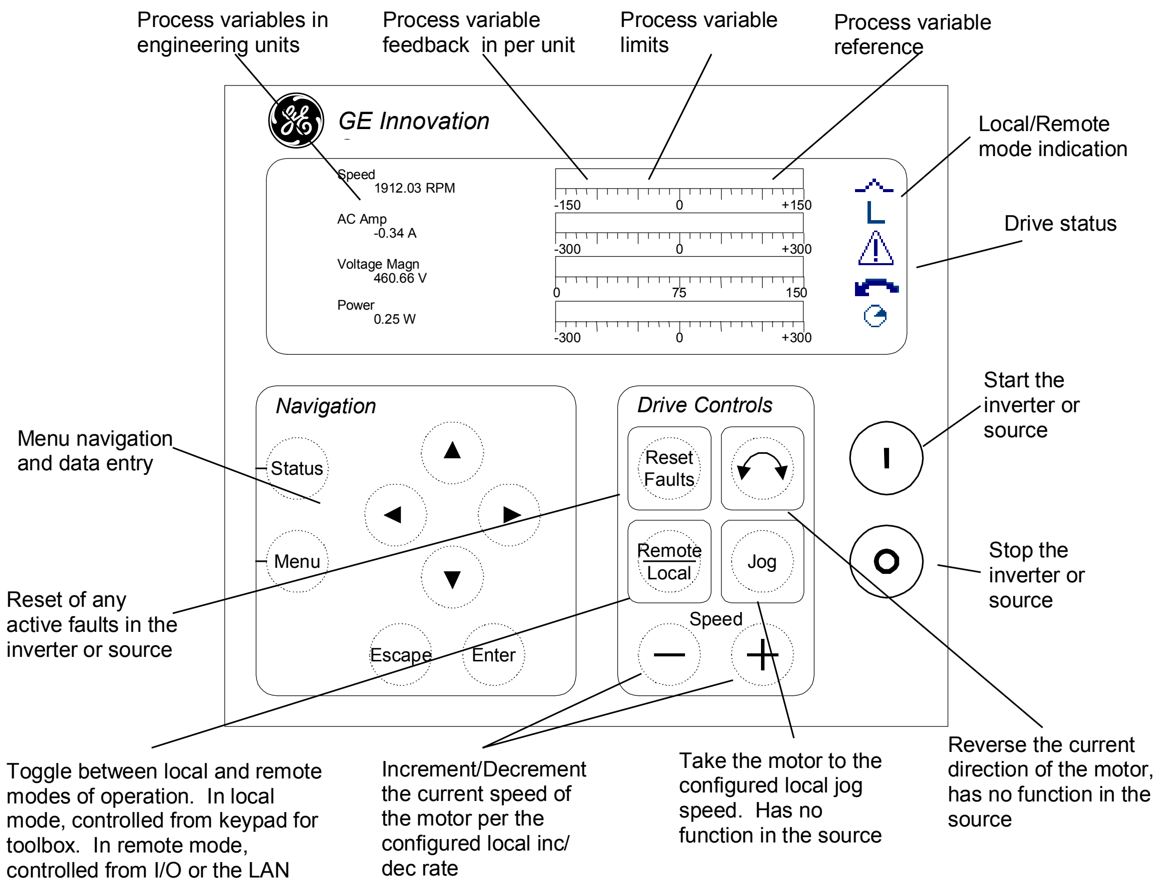


Figure 2-8. Innovation Series Drive Keypad

Control From the Control System Toolbox

The PC-based toolbox application includes a keypad window where several control functions are available. Refer to Figure 2-9 for an illustration of these functions.

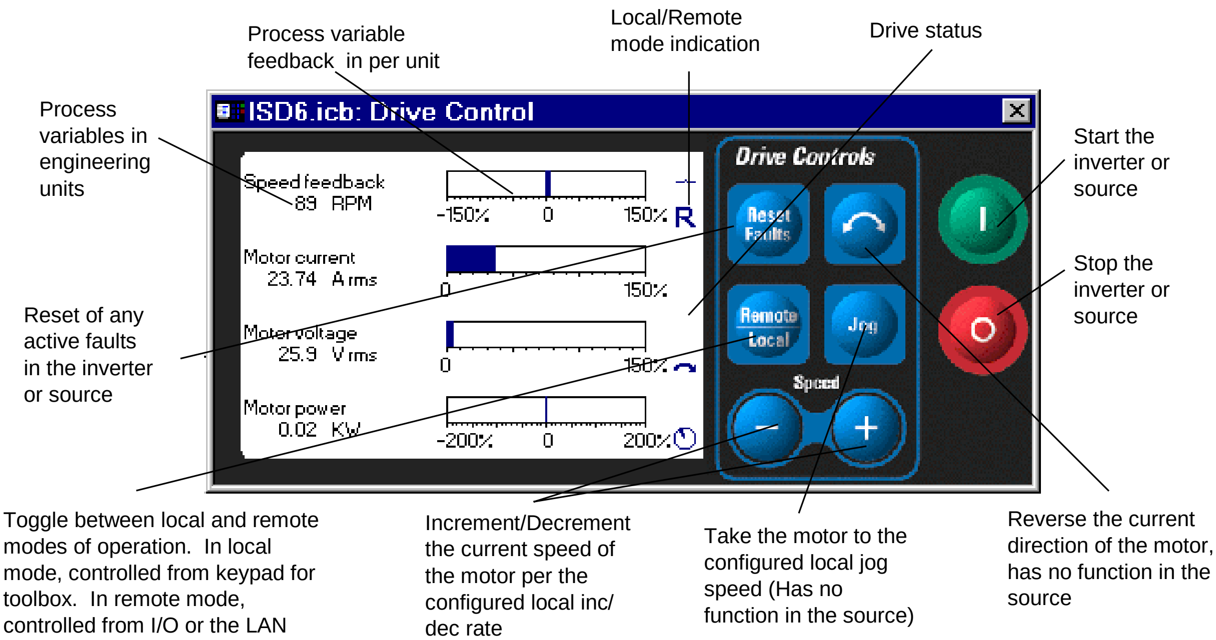


Figure 2-9. Toolbox Keypad Window

Control from I/O and LAN

There are I/O and LAN interfaces available for control commands and feedback. The source and inverters can be fully controlled from one, or a combination of these interfaces. I/O points and LAN signals are mapped to parameters and variables of like data type through configuration. For a detailed definition of the parameters, variables, and LAN interface signals associated with a control pattern refer to the appropriate manual listed in *Chapter 1, Related Documents* section.

Use of Discrete Inputs for Control

Discrete inputs can be mapped to Boolean parameters through configuration from the keypad or toolbox. An example of this is shown in Figure 2-10.

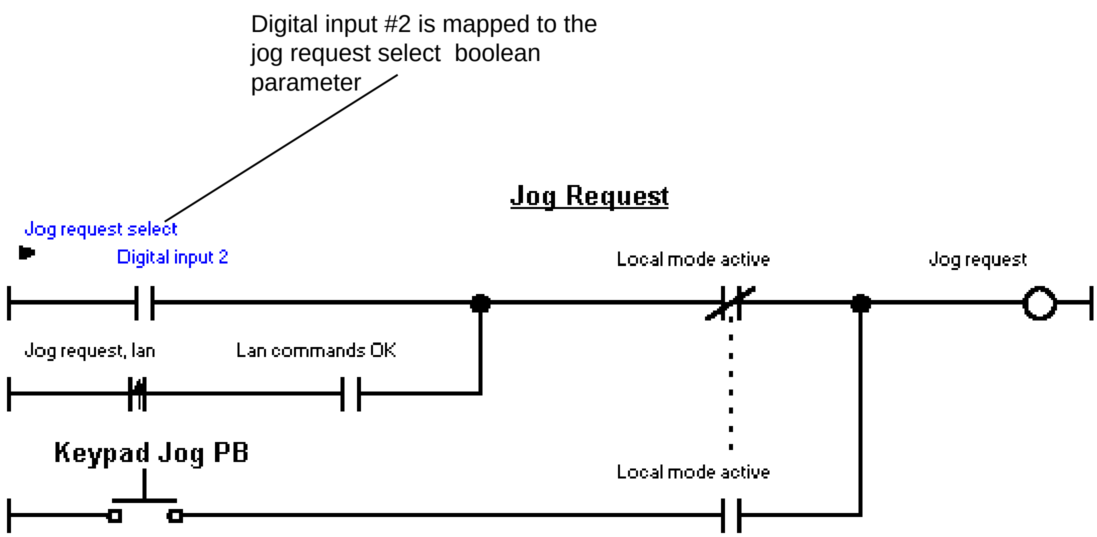


Figure 2-10. Discreet Input Mapping

Use of Analog Inputs for Control

Analog inputs can be mapped to floating point parameters through configuration from the keypad or toolbox. An example of this is shown in Figure 2-11.

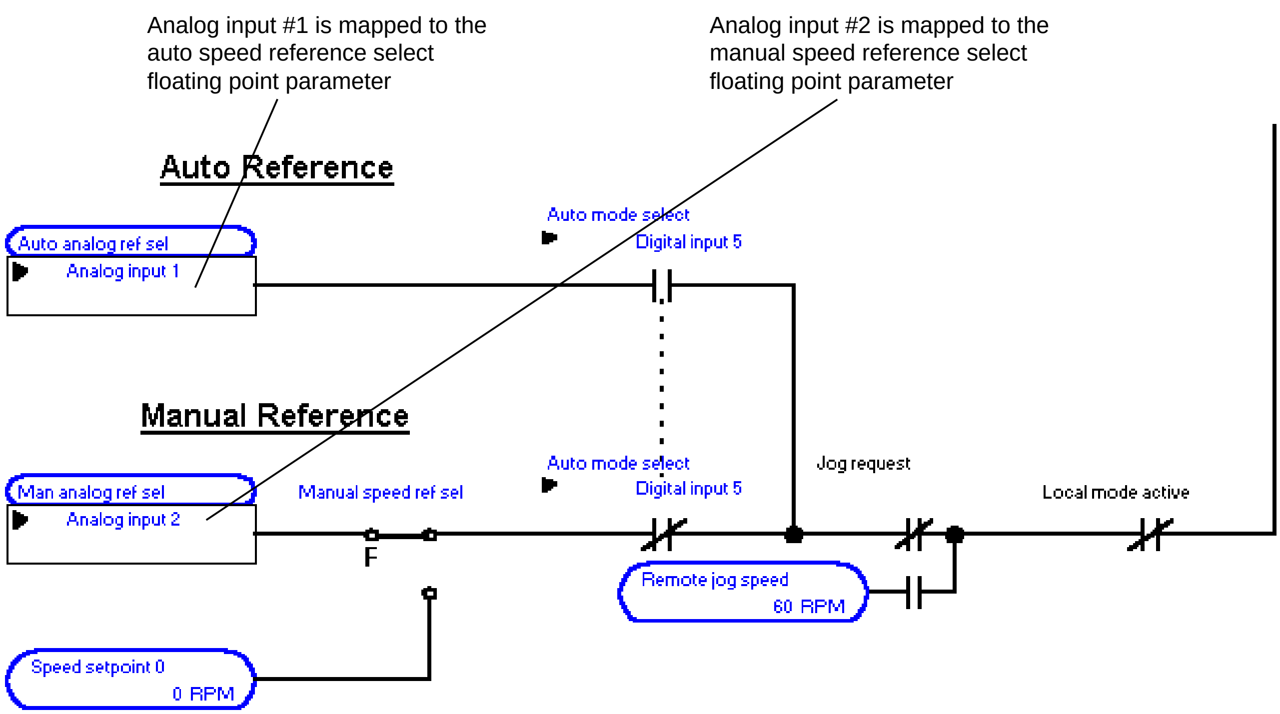


Figure 2-11. Analog Input Mapping

Use of Discrete Outputs for Monitoring and Feedback

Boolean variables can be mapped to discrete outputs for monitoring drive operation or feedback to another component in the system through configuration from the keypad or toolbox. An example of this is shown in Figure 2-12.

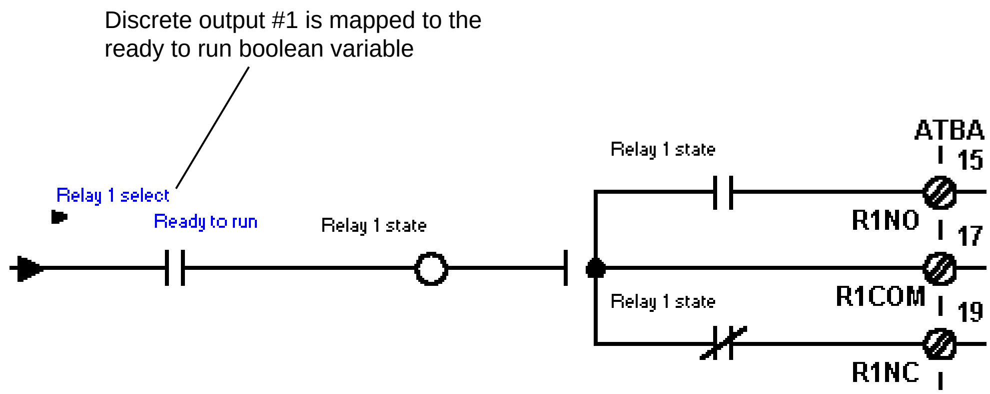


Figure 2-12. Discreet Outputs for Monitoring and Feedback

Use of Analog Outputs for Monitoring and Feedback

Floating point variables can be mapped to analog outputs for monitoring drive operation or feedback to another component in the system through configuration from the keypad or toolbox. An example of this is shown in Figure 2-13.

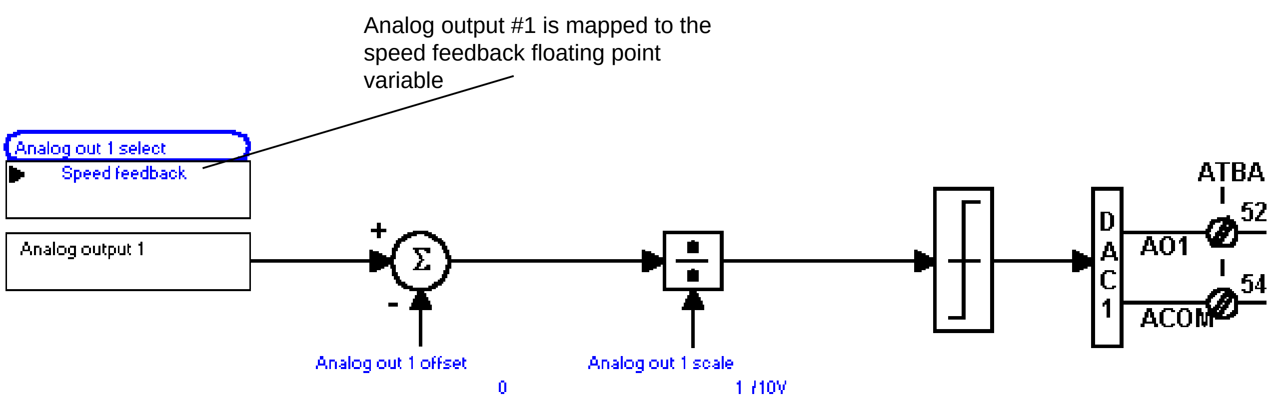


Figure 2-13. Analog Outputs for Monitoring and Feedback

Use of Discrete LAN Commands for Control

Discrete LAN commands can be mapped to discrete parameters through configuration from the keypad or toolbox. An example of this is shown in Figure 2-14.

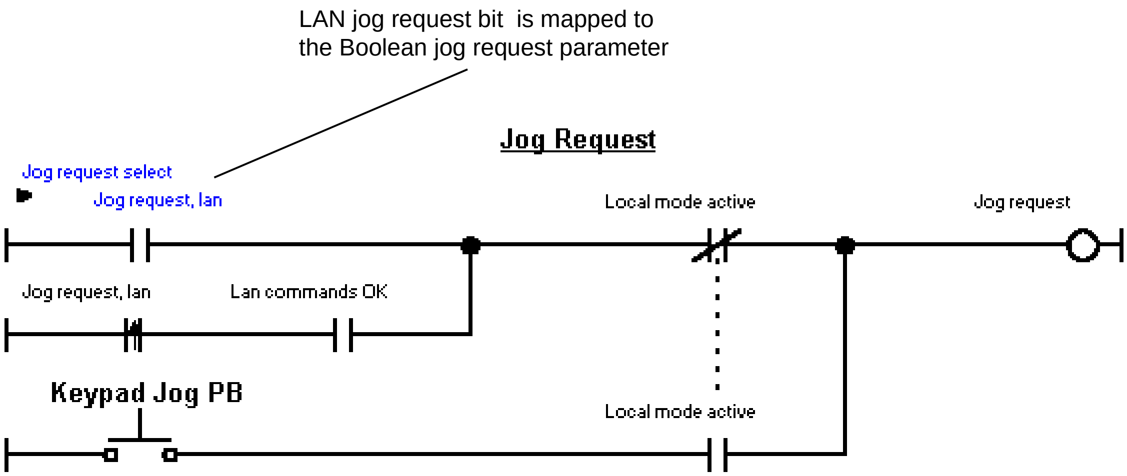


Figure 2-14. Discreet LAN Commands for Control

Use of Analog LAN Commands for Control

LAN-based signal (floating point) commands can be mapped to floating point parameters through configuration from the keypad or toolbox. An example of this is shown in Figure 2-15.

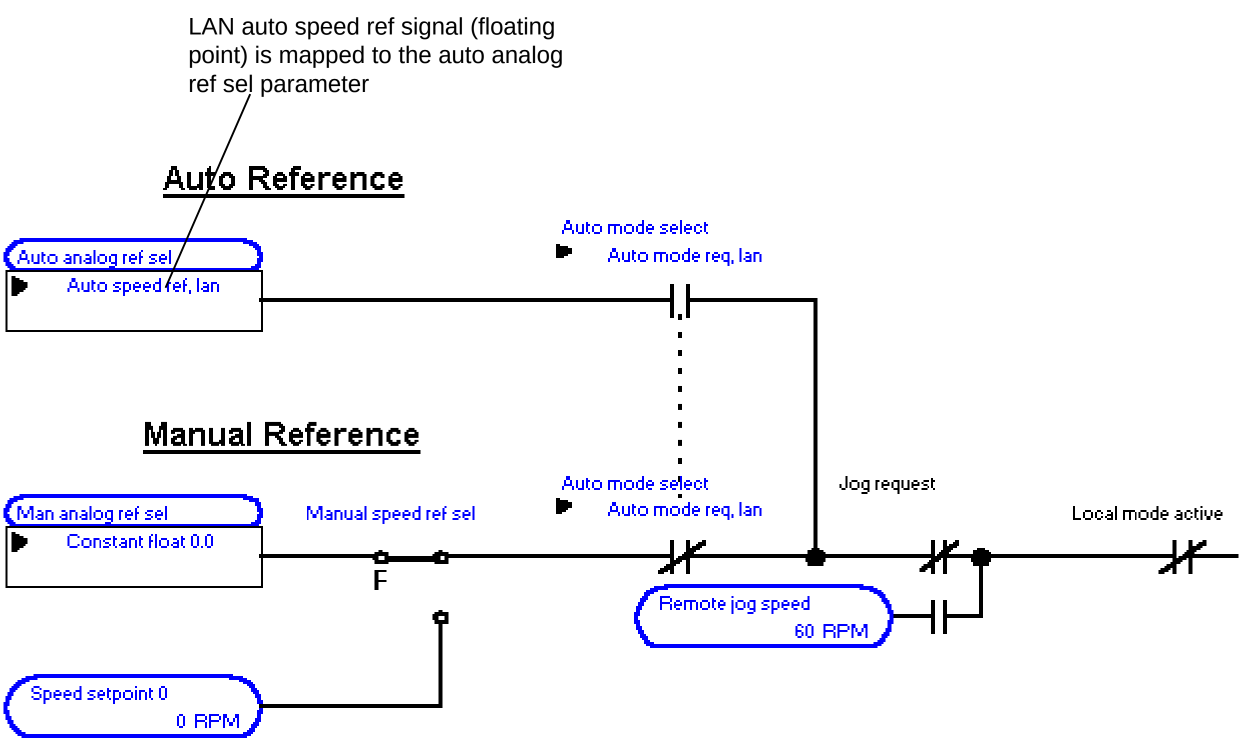


Figure 2-15. Analog LAN Commands for Control

Use of LAN Signals for Monitoring and Feedback

Variables can be mapped to LAN-based signals for monitoring and feedback through configuration from the keypad or toolbox. Bytes 1-32 of this interface are detailed in Figure 2-16.

Note Full LAN maps are provided in the Reference and Troubleshooting manuals listed in Chapter 1, *Related Documents* section.

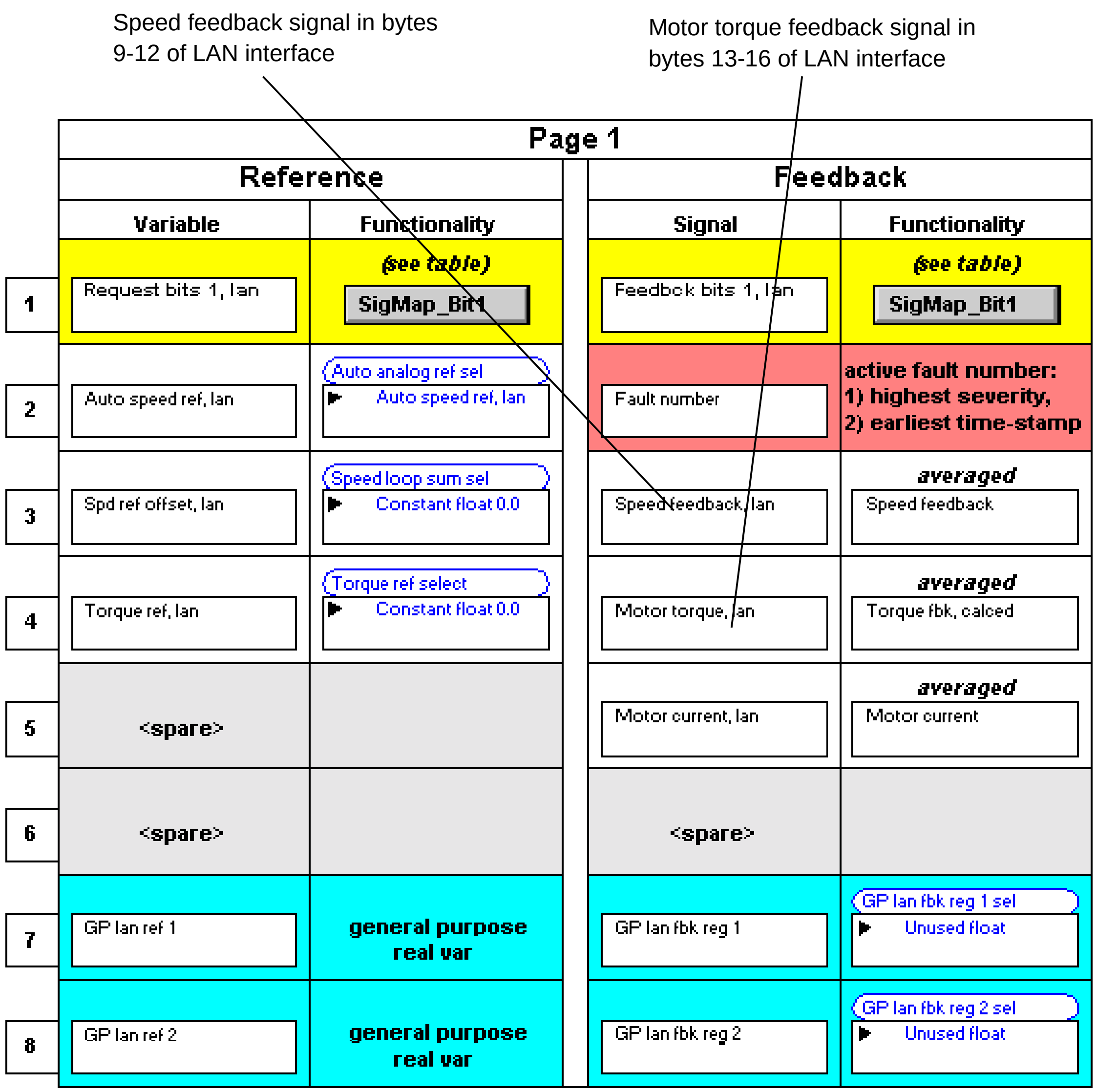


Figure 2-16. LAN Signals for Monitoring and Feedback

Notes

Chapter 3 Printed Wiring Board Overview

Introduction

The drive's control electronics consists of microprocessor-based printed wiring boards and components configured to manage the bridge firing functions. These boards functionally fall into two categories:

- Control rack boards, which make up the control rack assembly within the control cabinet
- Power bridge boards, which connect at the bridge components within the converter cabinet

Section ***Page***

Control Rack Boards

The **control rack** includes the following boards (refer to Figure 3-1):

- IS215ACL_ Application Control Layer Module (ACL_) (optional)
- IS200BAIA Drive Basic I/O Interface (BAIA)
- IS200BICL Bridge Interface (BICL)
- IS200BPIA IGBT Bridge Personality Interface, 65 – 620 Frames (BPIA)
- IS200BPIB IGBT Bridge Personality Interface, 1000 and 1800 Frames (BPIB)
- IS200CABP Control Assembly Backplane (CAPB)
- IS200DSPX Digital Signal Processor Control (DSPX)
- IS215GBIA Auxiliary Genius Interface Module (GBIA) (optional)
- IS200ISBB ISBus Bypass Relay (ISBB) (optional)
- IS200ISBD ISBus Delay (ISBD) (optional)
- IS200ISBE ISBus Extender (ISBE) (optional)
- IS215PBIAH ProfiBus-DP Interface Module (PBIA) (optional)
- IS200RAPA Drive Rack Power Supply (RAPA)
- IS200SCNV SCR-Diode Converter Interface (SCNV)

BAIA Board

The BAIA converts digital inputs from the DSPX to analog outputs: channels A and B are available for customer use at the terminal board; channels C and D are used to drive panel meters. The BAIA provides an RS-232C I/O interface between the DSPX and the drive's keypad and PC connections.

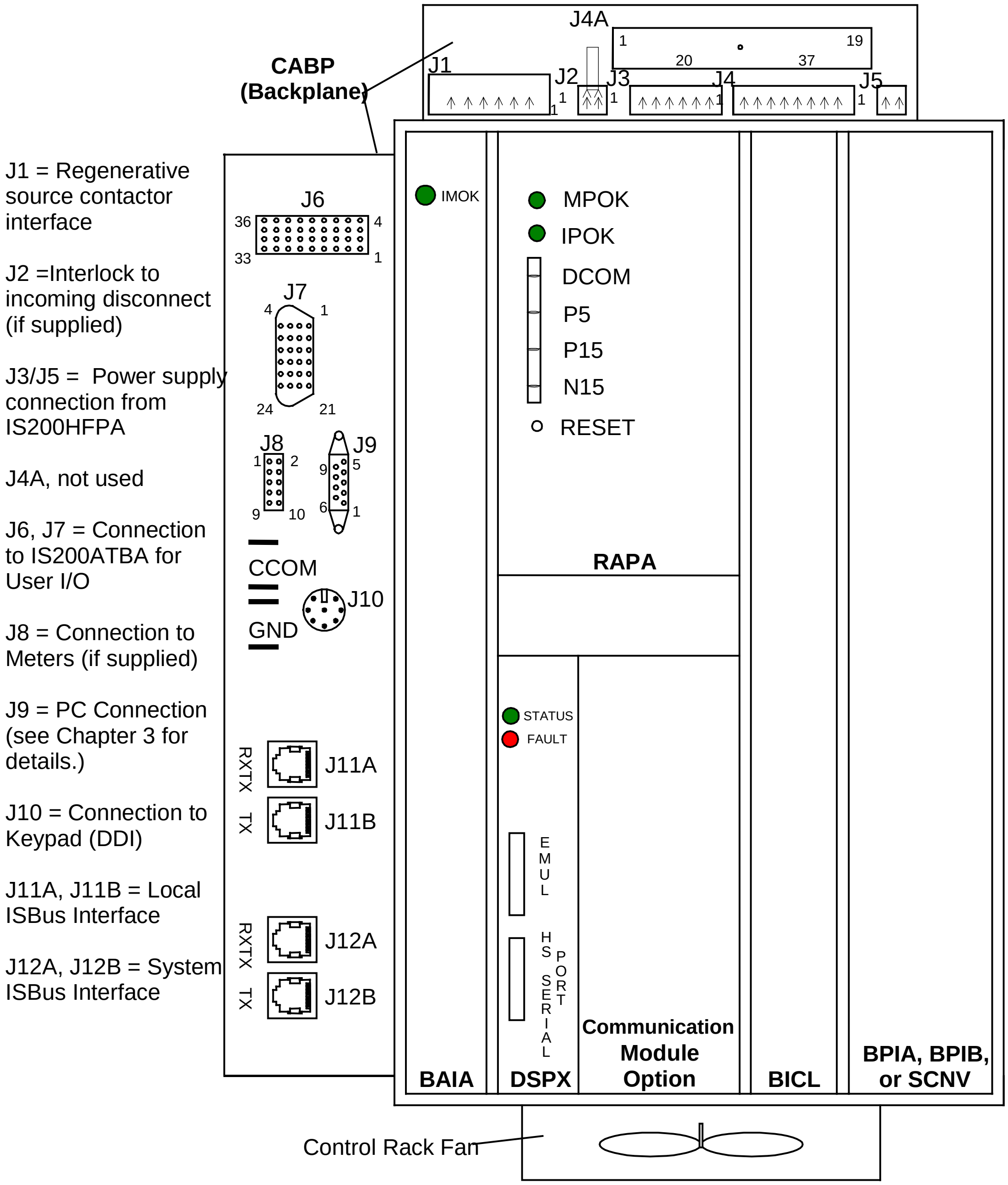
The BAIA board provides isolation and an earth ground reference for all signal inputs from user terminal boards. It outputs customizable and application to the processor board, as follows:

- Six isolated, differential, universal 115 V ac, 50/60 Hz sinusoidal (or 24–105 V dc) discrete logic
- Three separately controlled form C relay contacts provide discrete outputs
- Two bipolar (±10V) analog input channels, each with a differential amplifier followed by a synchronous voltage-controlled oscillator (VCO)
- VCO pulse trains transmitted differentially to isolate the analog inputs
- Two user analog outputs and two analog meter outputs
- RS232C and ISBus transceivers
- Isolated tachometer input

For more information refer to GEI-100268.

BICL Board

The BICL board provides an interface between the main control board and the bridge personality interface boards. Bridge control, fault string interface, temperature monitoring, and fan control connections are made through the P1 connector. The main control board and logic power supply connections are made through the P2 connector. For more information refer to GEI-100264.



Control Rack

Board	***Function***
BAIA	Basic I/O
BICL	Bridge Interface
BPIA/B	Bridge Personality
CABP	Control Rack
DSPX	Digital Signal
SCNV	SCR/Diode Converter

Communication Module

Module	***Function***
ACL_	Application Control
GBIA	Genius™ Bus Interface
PBIA	PROFIBUS-DP

Figure 3-1. Control Rack

BPIA Board

The BPIA board provides an interface between the control and power electronics of an IGBT 3-phase ac drive. The interface consists of:

- Six isolated IGBT gate driver circuits
- Three isolated shunt voltage controlled oscillator (VCO feedback circuits)
- Isolated VCO feedback circuits to monitor the dc link, VAB, and VBC output voltages
- Hardware phase overcurrent
- IGBT desaturation fault protection

For more information refer to GEI-100265.

BPIB Board

The BPIB board provides the signal conditioning and isolated feedback circuits. The board also reports fault information. The main control interface is through the P1 connector. The BPIB board is able to control six driver boards in parallel bridge configuration or three driver boards for single bridge configuration. For more information refer to GEI-100266.

CABP Backplane

Refer to Figure 3-1.

The CABP is the control rack backplane that interconnects the control rack boards. It also serves as an external signal interface with the following connections:

- Stab-on connectors for CCOM and GND
- Feedback sense input and contactor pilot relay (main and charge) contacts (J1)
- DC disconnect sense (J2)
- HFPA power supply (J3 and J5)
- Drive ambient temperature sensor (J4)
- Customer I/O (J6 for >50 V, J7 for <50 V)
- Meters (J8)
- Operator interface (J9 for PC, J10 for keypad)
- RJ-45 ISBus interface (J11A and J11B for local, J12A and J12B for system)

For more information refer to GEI-100270.

DSPX Board

The DSPX is the primary controller for the bridge and motor regulator and gating functions. The board provides the logic, processing, and interface functions. The DSPX monitors status inputs from other boards and responds as programmed. This includes shutting down gating signals to the bridge if invalid voltages are detected on bridge interface boards.

The drive control sends gating signals to the bridge and receives bridge feedback and status input through the BICL interface boards. For more information refer to GEI-100267.

RAPA Board

The RAPA board converts a 48 V, 25 kHz square wave input into the dc control voltages for other boards in the rack. It also supplies the Power On and Master Reset functions for the control, and includes an onboard Reset switch. For more information refer to GEI-100261

SCNV Board

The SCNV board is the control to bridge interface board for SCR-diode sources (1800 and 1000 frame stand-alone units). The board is used for 6-pulse sources, driving three SCRs per board. It is not used for driving paralleled SCRs from the same board.

The board includes:

- Three input current sense circuits
- Three SCR gate drive currents
- Two line-to-line voltage feedback circuits
- One dc link voltage feedback circuit
- One dynamic braking IGBT VCE feedback circuit
- One dynamic braking IGBT gate drive circuit

For more information refer to GEI-100280.

ACL_ Module (optional)

The ACL_ module is a microprocessor-based master controller used to perform multiple duties over LANs such as Ethernet and ISBus. The ACL_ mounts in a standard board rack and occupies two half-slots. The board's P1 connector plugs into the CABP board. Depending on the drive configuration, the ACL_ may consist of a single module or a base module and daughterboard attached to its PC/104 header. The ACL_ can be ordered in two different I/O configurations:

- IS215ACLAH1A Board w/10BaseT Ethernet
- IS215ACLIH1A Board w/10BaseT Ethernet and ISBus interface

For more information refer to GEI-100434.

GBIA Module (optional)

The GBIA module models the drive as an I/O block on the Genius bus, providing seamless integration between the drive and the controller (see Figure 3-2). The module is made up of a BLIG board and an IC660ELB912 µGENI Network Interface Board (µGeni). It interfaces to the drive through its backplane connector, P8. All power and digital I/O signals are routed through this connector. The µGeni board mounts to the BLIG board on four standoffs (to create the GBIA module) and communicates to it through connectors P1 and P2. The module connects to the CABP board in the drive board rack. For more information refer to GEI-100269.

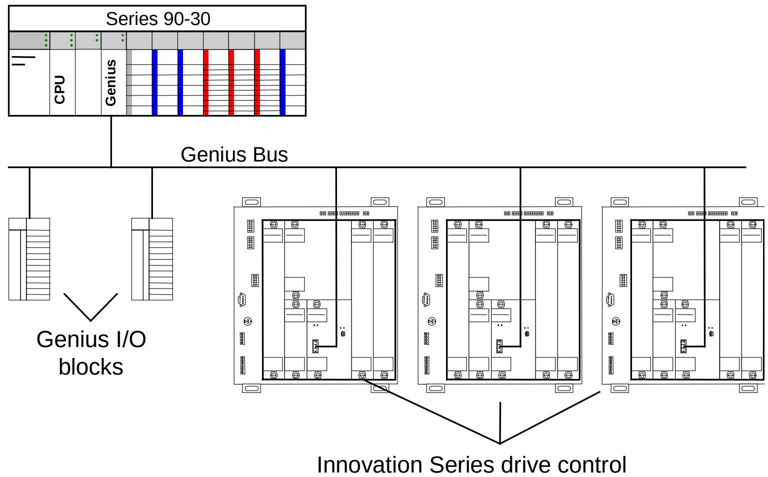


Figure 3-2. Genius Bus Network Example

PBIA Module (optional)

The PBIA module models the Innovation Series drive as an I/O block on a Profibus-DP network (see Figure 3-3), providing seamless integration between the drive and controller.

- Discrete commands and references are sent from the controller (typically a PLC) to the drive.
- Selected discrete and word variables are fed back from the drive.

The module provides a floating-point variable map between the drive and controller. A floating-point map is defined with all of the variables in engineering units. Configuration of the interface is done with either the local keypad or the toolbox.

The PBIA module is made up of a BLIG board and a Universal Communications System Profibus-DP board (UCS™, manufactured by SST Inc.). The module connects to the CABP board in the board rack and interfaces to the drive through its backplane connector, P8. For more information refer to GEI-100419.

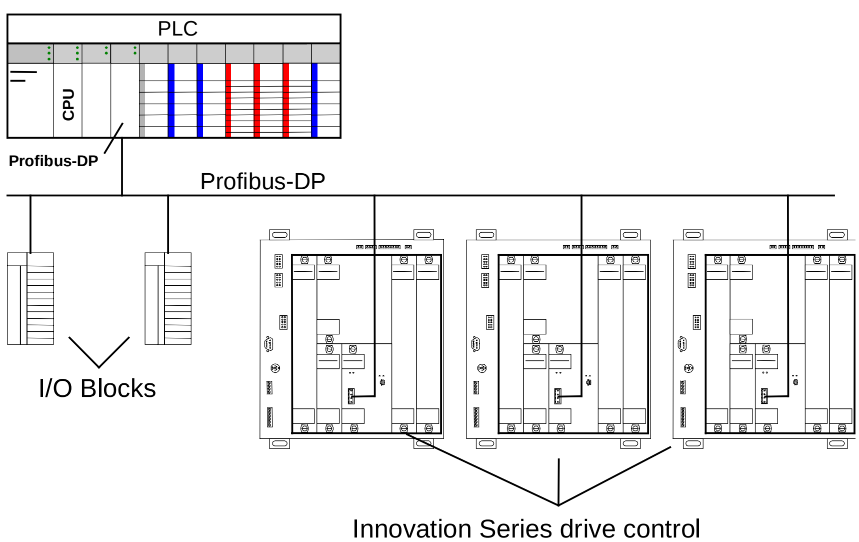


Figure 3-3. Profibus-DP Network Example

Power Bridge Boards

The **power bridge** contains the following boards:

- IS200ALSA Ac Line Snubber (ALSA)
- IS200DAM_ IGBT Gate Drive Amplifier and Interface (DAM_, A/B/C/D/E)
- IS200DSFC 1000/1800 Frame IGBT Gate Driver/Shunt Feedback (DSFC)
- IS200HFPA High Frequency Ac/Fan Power Supply (HFPA)
- IS200RCSA 1800 and 1000 Frame Snubber (RCSA)
- IS200RCSB 620 Frame Snubber (RCSB)

ALSA Board

The ALSA board is a wye connected, resistor/capacitor snubber designed to operate on the ac line input to the reactor feeding the source bridge. The board is designed to keep the rise time of the PWM square wave (noise) being ALSA is limited by its power dissipation/current carrying capabilities. For more information refer to GEI-100257.

DAM_ Boards

The DAM_ boards provide an interface between the control rack and the power switching devices (IGBTs). There are six variations of the gate drive boards, determined by the drive power rating. The boards connect directly the IGBT gate, emitter, and collector terminals and to the control rack's bridge personality interface board. For more information refer to GEI-100262.

DSFC Board

The DSFC board is designed for use with the 1800 and 1000 frame source bridges and inverters. It contains a current sensing circuit, a fault detection circuit, and two IGBT gate drive circuits. The board interfaces to the drive control through the IS200BPIB Drive Bridge Personality Interface Board (BPIB). A 1000 frame source bridge or inverter requires three DSFC boards, one per phase. An 1800 frame source bridge or inverter requires six DSFC boards, two daisy chained boards per phase. For more information refer to GEI-100263.

HFPA Board

The HFPA high frequency power supply board creates control power for the control electronics and the bridge gating. The supply converts the input voltages to a 48 V, 25 kHz square wave, a 48 V dc supply for cooling fans, and an isolated 17.7 V, 25 kHz square wave for power circuitry isolated from high voltage. For more information refer to GEI-100255.

RCSA Board

The RCSA board provides the snubber circuitry for the power devices (SCR and diode) that make up one phase of an 1800 or 1000 frame. There are three RCSA boards per 1800 or 1000 frame source bridge. For more information refer to GEI-100303.

RCSB Board

The RCSB board provides the snubber capacitors for the SCRs and diodes that make up one phase of a 620 frame. There is one board per 620 frame source bridge. For more information refer to GEI-100295.

Related Board Publications

For a more detailed description of each board's circuitry and application data, refer to the following documents:

- GEI-100434 IS215ACL_ Application Control Layer Module
- GEI-100257 IS200ALSA AC Line Snubber
- GEI-100268 IS200BAIA Drive Basic I/O Interface
- GEI-100264 IS200BICL Bridge Interface
- GEI-100265 IS200BPIA IGBT Bridge Personality Interface, 65 – 620 Frames
- GEI-100266 IS200BPIB IGBT Bridge Personality Interface Board, 1000 and 1800 Frames
- GEI-100270 IS200CAPB Control Assembly Backplane
- GEI-100262 IS200DAM_ Gate Drive Amplifier and Interface boards
- GEI-100263 IS200DSFC 1000/1800 Frame IGBT Gate Driver/Shunt Feedback
- GEI-100267 IS200DSPX Digital Signal Processor Control
- GEI-100269 IS215GBIA Auxiliary Genius Bus Interface Module
- GEI-100255 IS200HFPA High Frequency Ac/Fan Power Supply
- GEI-100419 IS215PBIA Auxiliary Profibus-DP Interface Module
- GEI-100261 IS200RAPA Drive Rack Power Supply
- GEI-100303 IS200RCSA 1800 and 1000 Frame Snubber
- GEI-100295 IS200RCSB 620 Frame Snubber
- GEI-100280 IS200SCNV SCR-Diode Converter Interface Board
- GEH-6416 ISBus User's Guide (IS200ISBB, ISBD, and ISBE boards)

Chapter 4 Terminal Board and Communications I/O

Introduction

This chapter describes drive inputs and outputs (I/O) available through terminal board wiring and control rack backplane connections. The information is organized as follows:

Section ***Page***

Drive I/O

Drive I/O consists of discrete signals, control signals, and logic power. Some I/O serves as **variables** for drive software functions. All wiring connections for customer I/O are made on a DIN-rail-mounted terminal board within the control cabinet, ATBA.

Terminal points are labeled screw connections, rated as follows:

Signal I/O:	5 A, 300 V
Control:	30 A, 600 V
Power:	100 A, 600 V

The terminal point labels match those used in the drive elementary diagrams. The drive outline drawings show cable entry locations.

Warning **Power must be de-energized before performing any adjustments, servicing, or other act requiring physical contact with the electrical components or wiring of the drive.**

Software Adjustable I/O

When connected to the drive through the ATBA terminal board wiring, the following I/O is adjustable in software:

- Six digital inputs
- Three digital outputs (relays)
- One solid-state relay driver
- Two analog inputs (VCOs)
- Two analog outputs (DACs)
- Four meter driver outputs
- One digital tachometer input with power supply
- One drive output contactor pilot relay and status input
- System fault string input
- Local fault string input

This I/O can be configured in software using either the keypad or PC tools (GE control system toolbox). The following sections describe the I/O in detail.

ATBA Digital Inputs

Six discrete digital inputs provide a logic interface to the drive control (refer to Table 4-1 and Figure 4-1). The inputs are isolated and differential (+ and - terminals) to the ATBA board. The board and elementary label for these inputs identifies the signal. For example, label *DI6P* indicates digital input 6, positive (+) differential line.

Table 4-1. ATBA Board Digital Input Specifications

Specification	Value
Input voltage	115 V ac ±10%, 50/60 Hz sinusoidal 24 – 105 V dc
Minimum isolation	2500 Vrms for 1 second
Maximum load (draw)	20 mA
Maximum leakage	0.75 mA
Typical turn-on	16 V dc, 4.6 mA; 3.5 ms
Typical turn-off	11 V dc, 1 mA; 2.5 ms

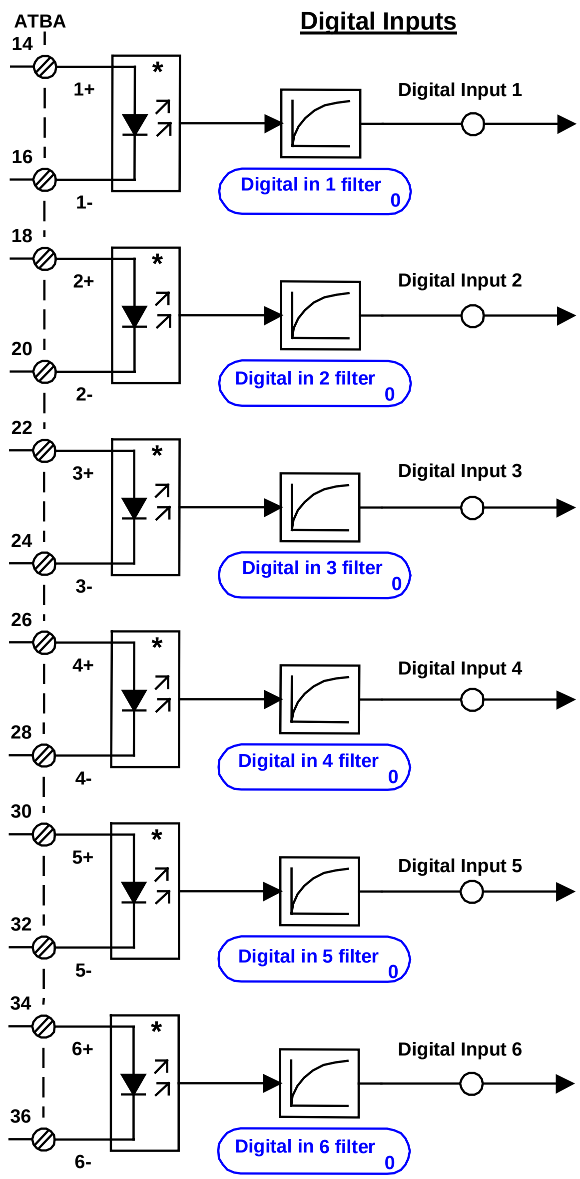


Figure 4-1. ATBA Board Digital Inputs

ATBA Digital Outputs (Relays)

Three separately controlled Form C relay contacts are provided for discrete outputs (refer to Table 4-2 and Figure 4-2). Each relay output has a common (COM), normally open (NO), and normally closed (NC) line. The board and elementary labels identify these (for example, *R1NO*). These relays are de-energized when reset or powered down.

If contacts are used with an inductive load, the load must have a suppresser to limit voltage transients to <300 Vpk.

Table 4-2. ATBA Board Form C Contact Specifications

Contact ratings	Value
115 V ac (50/60 Hz sinusoidal)	0.6A resistive/ inductive
24 V dc	2 A non-inductive, 0.6 A inductive
Pickup time	3 ms typical, 24 ms maximum
Dropout time	5 ms typical, 24 ms maximum

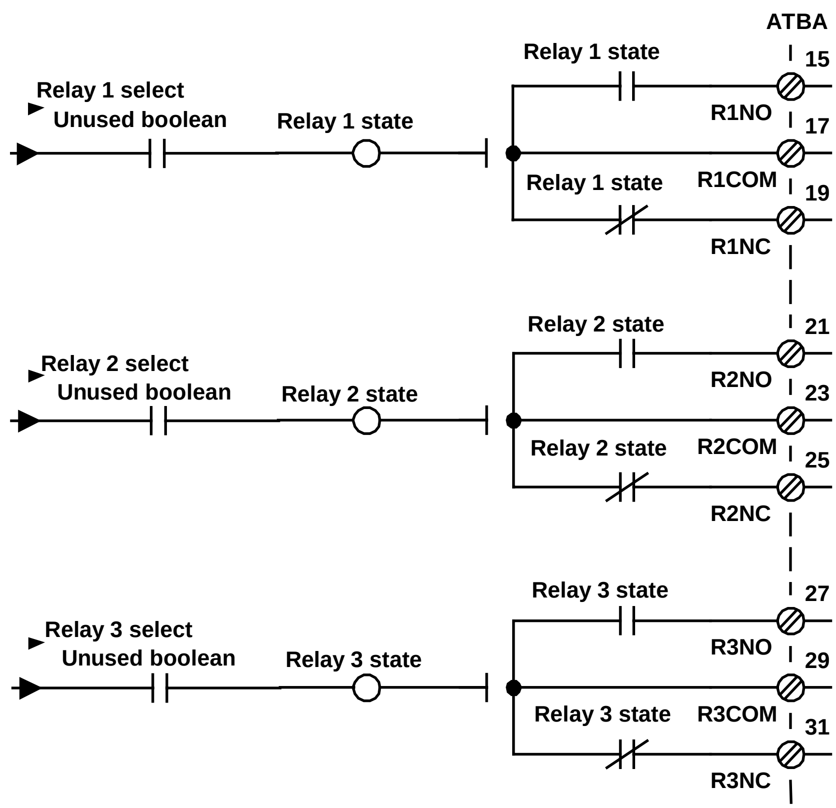


Figure 4-2. ATBA Board Digital Relay Outputs

ATBA Solid-State Relay Driver Output

A relay driver circuit is provided on the ATBA board (terminal 11) for controlling a 24 V dc, 10 mA solid-state relay (refer to Figure 4-3). This circuit is for use *only* with the 24 V dc logic control power supply provided at ATBA board terminals 33 or 37 (see Figure 4-4). This 24 V dc input has a maximum load (draw) of 20 mA.

The solid-state relay driver is particularly useful for control circuits that demand a high number of relay operations. Such circuits would be limited by the lifetime of a standard mechanical relay.

Caution

No additional current limit protection is provided for this circuit. Care must be taken to avoid direct connection of the 24 V dc logic control power to common (shorted circuit).

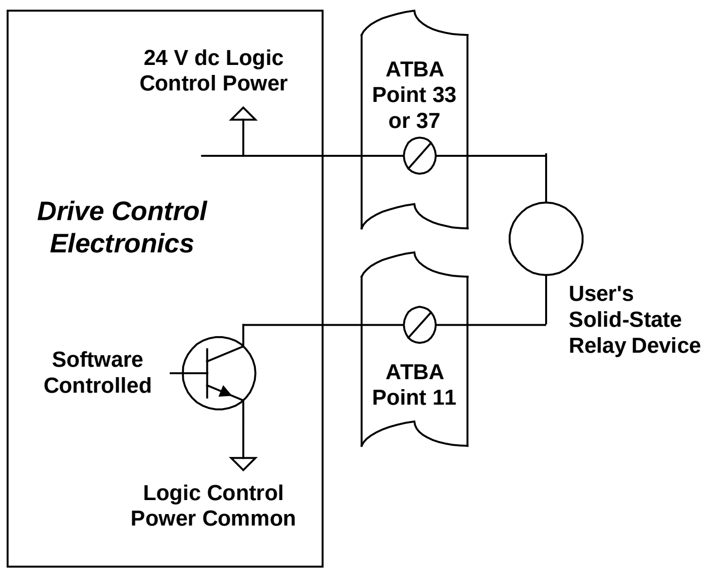


Figure 4-3. Typical Solid-State Relay Driver Circuit Connections

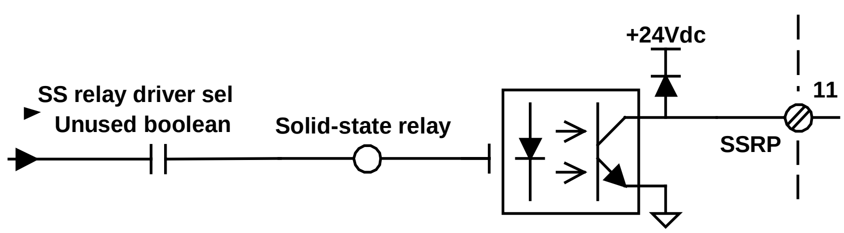


Figure 4-4. Solid-State Relay Drive Output

ATBA Contactor Control Pilot Relays and Status Indication I/O

A pilot relay for the **MA contactor** controls the drive output contactor (if supplied). An MA sense input can be used with an interlock on the output contactor to inhibit bridge firing if the output contactor does not pick up when commanded (refer to Table 4-3 and Figure 4-5). A second contactor pilot relay, **MB**, is provided, but without a dedicated sense input for the MB contactor.

One side of these contacts is tied together at MABCOM.

The MA relay has a common (COM), normally open (NO), and normally closed (NC) line, identified on the board and elementary labels (for example, *MANO*). The MB relay only has a NO contact. The normally open contacts of both relays are wired to the J1 backplane connector (refer to Figure 4-6). The MA relay's NO contact is also wire to ATBA (MB is not wired to ATBA).

Caution

To prevent potential wiring errors, GE recommends that either ATBA or J1 be used for contactor pilot relay connections, but not both.

The Local and System fault string inputs are logically ANDed in hardware to provide a master enable for the both the MA and MB contactor pilot relays. Dropping out either or both of these inputs drops out both relays. Hardware configuration disables bridge firing before the MA or MB contactors drop out.

Table 4-3. ATBA Board Contactor Pilot Relay and Sense Input Specifications

MA (form C) and MB (form B) contactor pilot	
Voltage	**Current**
125 V ac and 110 V dc:	.6A
30 V dc:	2 A
MA sense input:	
24 to 115 V ac/dc	4 – 10 mA peak

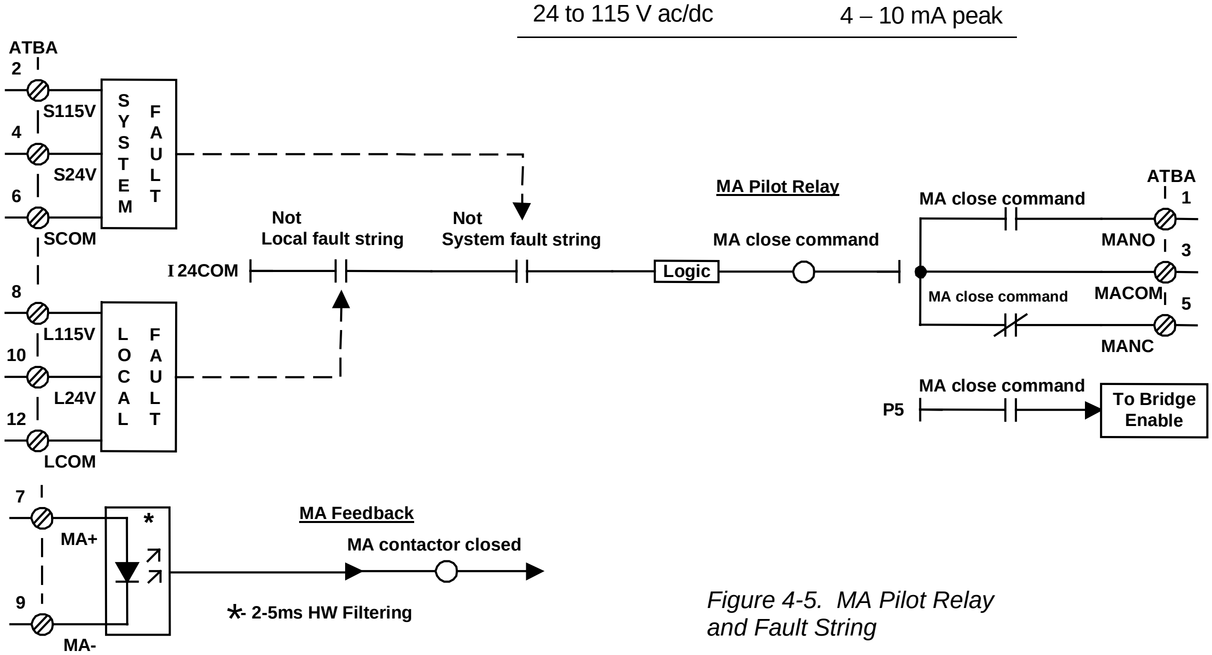


Figure 4-5. MA Pilot Relay and Fault String

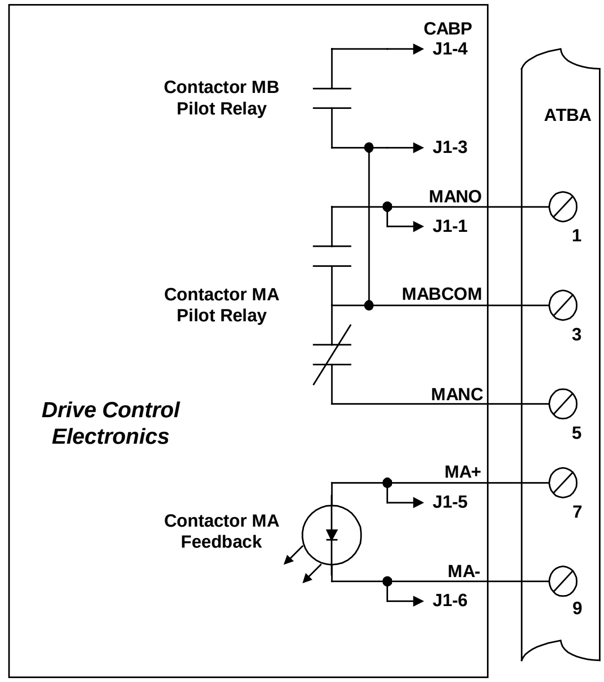


Figure 4-6. Contactor MA and MB Pilot Relay Connections on ATBA and J1

ATBA Local and System Fault String Inputs

The Local and System Fault circuit provides a hardwired, fail-safe shut down of the drive. The circuit consists of two independent isolated relays that are logically ANDed in hardware so that that loss of either input shuts down the drive control. Fault string relay input voltage can be either 24 V dc or 115 V ac with 20 mA maximum loading (draw). Refer to Figure 4-5.

- The Local Fault String is intended for use with hardwired circuits specific to the drive (for example, mechanical overspeed, over-travel limits, lockout).
- The System Fault String input is intended for circuits common to multiple drives in a system (for example, system e-stop).

Each relay has a common (COM), 24 V dc, and 115 V ac input on the ATBA, identified on the board and elementary labels (for example, *L24V* and *S24V*). Typical connections are between the common and one of the voltage terminals. The inputs are independently isolated, so one string can be operated at 24 V dc while the other is operated at 115 V ac.

Note One of the specified voltages must be applied to both inputs for normal operation.

The control monitors the state of the fault inputs for sequencing and diagnostics. If either drops out while the drive is running, a sequenced shutdown occurs.

ATBA Tachometer Interface

A quadrature encoder with marker interface is provided to the control electronics for motor speed feedback and incremental position indication. The interface is good for standard, differential 5 or 15 V dc signal encoders without circuit re-configuration. A 15 V dc, 150 mA isolated power supply is also available for powering the encoder electronics (refer to Table 4-4 and Figure 4-7).

Note The inputs have a cable termination impedance made from a series R_C circuit of 100 ohms and 0.0047 F.

Encoders with integral line CMOS drivers, such as the Intel® 88C30, are preferred for the most robust interface.

Table 4-4. Tachometer Input Signal Specifications

Specification	Value
Voltage	+3.5 V dc to +15 V dc (square-wave)
Load (draw)	< 4.0 mA per channel
Maximum frequency	125 kHz
Input isolation (minimum)	2500 Vrms for 1 sec
Recommended cable	Belden 9773
Tachometer power supply	+15 V dc, 150 mA maximum

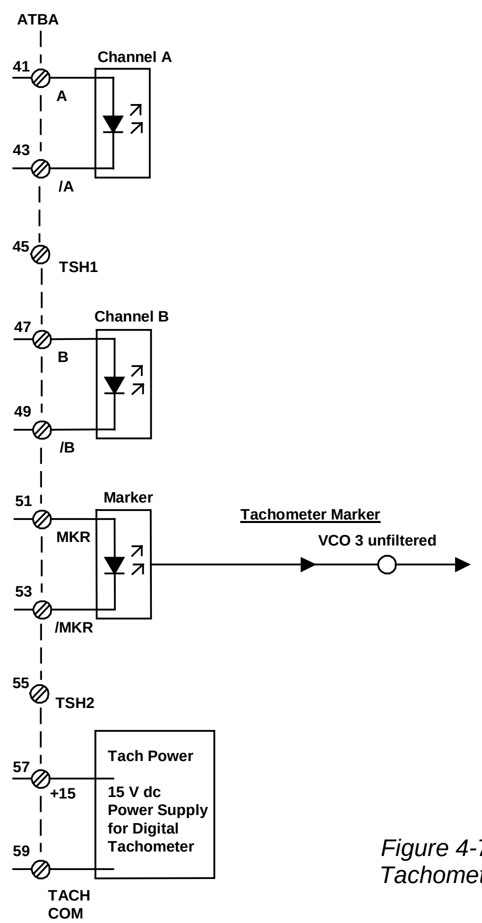


Figure 4-7. ATBA Digital Tachometer Connections

ATBA Analog Inputs (VCOs)

Two bipolar (±10 V) analog input channels (to BAIA board) are provided on the ATBA board. Each channel uses a differential amplifier followed by a VCO (voltage-controlled oscillator). These inputs can be configured with software filters, scaling, and offset, as well as programmable signal loss detection (refer to Table 4-5 and Figure 4-8).

For each analog input circuit, the control rack's BAIA board includes a hardware option to convert a 4 to 20 mA input to a 2 to 10 V dc input (refer to Table 4-6 and Figure 4-9).

The BAIA board includes buffered testpoints (refer to Figure 4-9) for monitoring analog inputs AIN1 and AIN2 while setting their offset and gain in software (refer to Figure 4-8). These testpoints are accessible from the control rack and buffered to protect metering instruments.

Note Because the bias and gain vary slightly from board to board, the circuit's software gain and offset adjustment should be recalibrated each time the BAIA board is replaced.

Table 4-5. Analog Input to VCO Specifications

Specification	Value
Net sense accuracy	0.3%
Offset drift (25 to 65 °C ±)	0.009% per °C
Gain drift (25 to 65 °C)	±0.005% per °C
Input impedance:	
Single ended	4090 Ω
Differential	8180 Ω
Resolution	-12.45 to +12.45 V dc = 0 to 2 MHz
Common mode range	30 V dc (plus 10 V dc signal)
Minimum slew rate	0.5 V/ s
Maximum bandwidth	3 to 5 kHz

Table 4-6. BAIA Board Jumper Position Setting Options

Jumper	Position*	Description
AIN1	J5A (VIN)	Analog input 1 in 2–10 V dc mode
	J5B (4–20 mA)	Analog input 1 in 4–20 mA mode
AIN2	J6A (VIN)	Analog input 2 in 2–10 V dc mode
	J6B (4–20 mA)	Analog input 2 in 4–20 mA mode

*If not using the 4-20 mA setting, the jumpers should be in the VIN position.

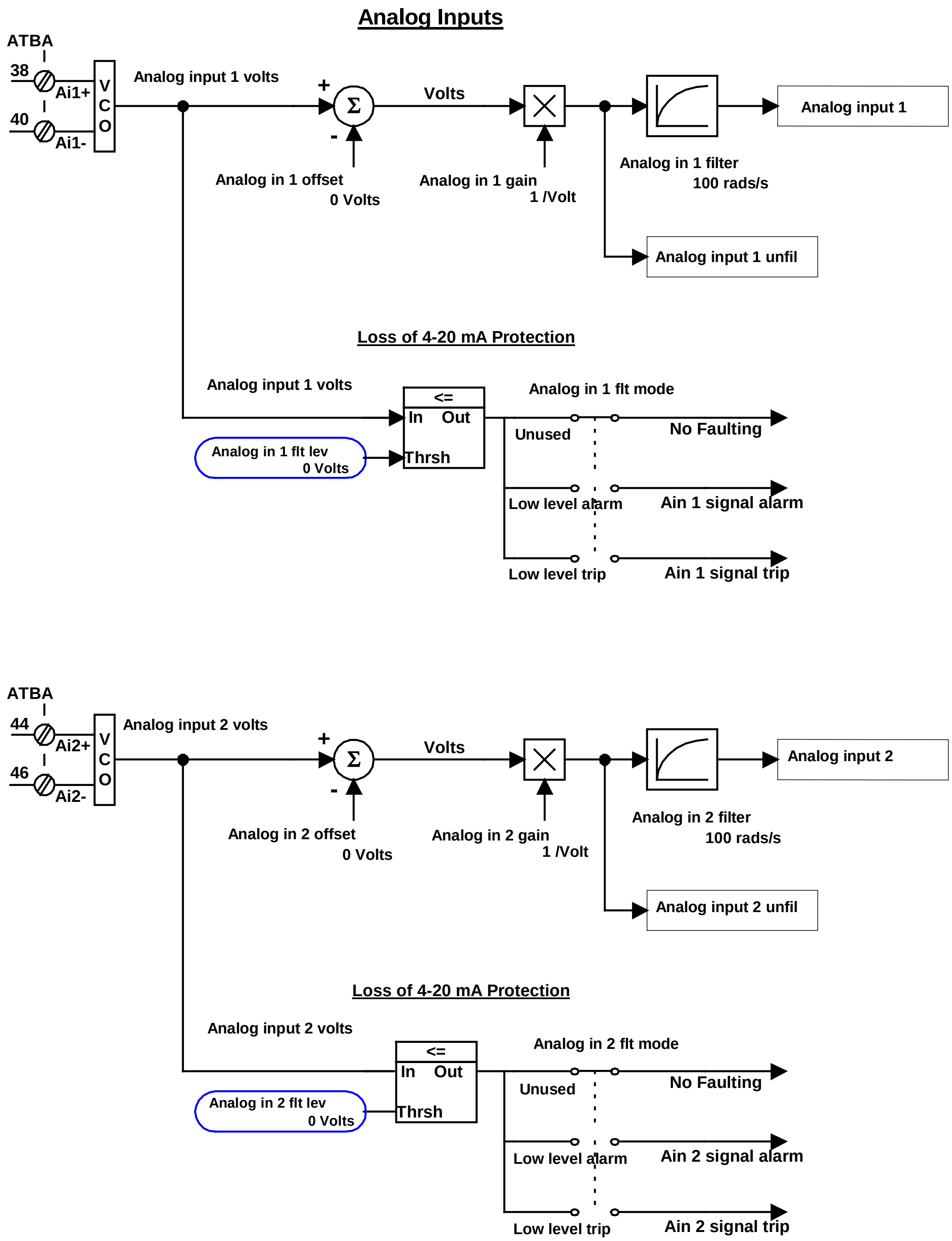


Figure 4-8. ATBA Analog Inputs (VCOs)

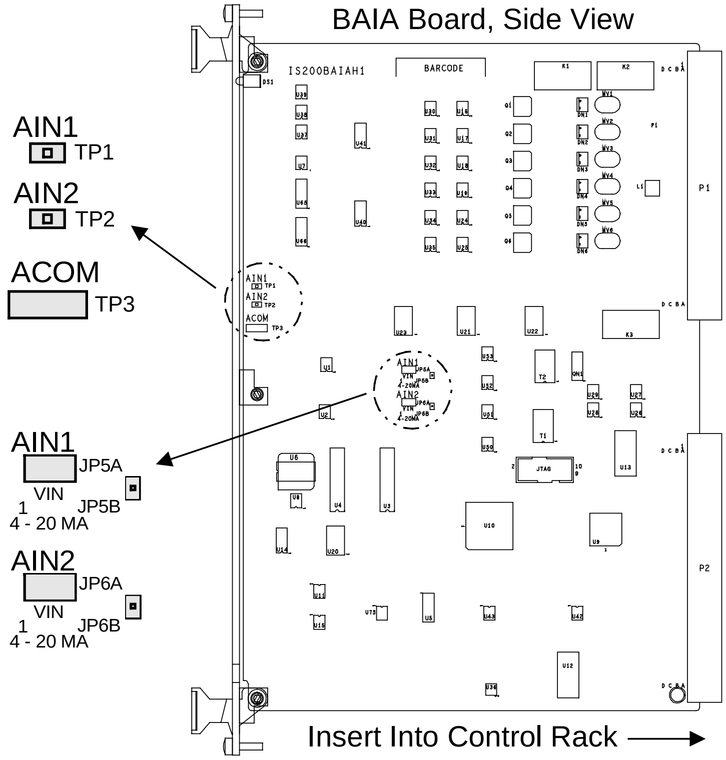


Figure 4-9. Analog Input Jumpers and Testpoints on BAIA Board

ATBA Analog Outputs (DACs)

Two bipolar, 10 V dc analog outputs are supplied for drive variable indication and process control. The ATBA outputs are to single-ended, 12-bit digital-to-analog converters (DACs) on the BAIA board. The analog outputs are referenced to ACOM, short-circuit protected and can be filtered (using GP- SW filters), scaled, and offset in software. During a reset, the D/A outputs are forced to zero (refer to Table 4-7 and Figure 4-10).

Attention **The analog outputs should be fed into differential inputs with the return side of the outputs isolated from the chassis by a resistance (10K). False output readings (because of noise or current loops) can result if the input is sensing with reference to chassis.**

Note Because the bias and gain vary slightly from board to board, the circuit's software gain and offset adjustment should be recalibrated each time the BAIA is replaced.

Table 4-7. Analog Output (DAC) Specifications

Specification	Value
Voltage	±10 volts
Current	7.5 mA
Resolution	12-bit
DC offset	≦ 25 mV
Impedance	≦ 30 Ohms
Linearity	0.1% of full scale
Gain error	<.5% of full scale (least significant 2 bits)

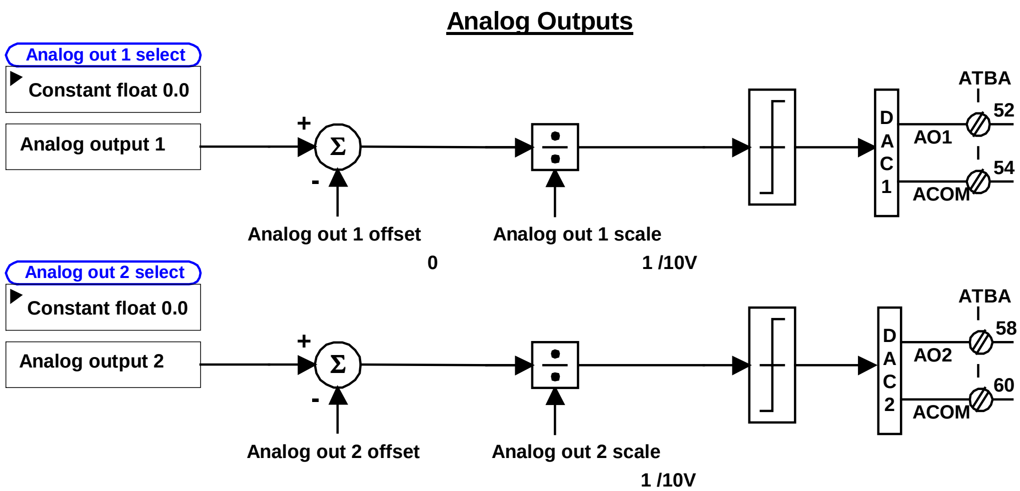


Figure 4-10. ATBA Board Analog Outputs (DACs)

Meter Driver Outputs

The BAIA board supplies four bipolar, 10 V dc analog outputs to drive's optional door-mounted meters: (Refer to Table 4-8 and Figure 4-11.)

- Meters 1 and 2 outputs, driven by a 12-bit DAC
- Meters 3 and 4 outputs, driven by a converted PWM (pulse-width modulated) signal (A 1 kHz, 1st order filter is applied to the PWM meter driver signal outputs.)

The meter driver outputs are available only from the CABP backplane connector J8 as shown in Table 4-9. These outputs can be filtered (using GP- SW filters), scaled, and offset in software.

•

Note Because the bias and gain vary slightly from board to board, the circuit's software gain and offset adjustment should be recalibrated each time the BAIA is replaced.

Table 4-8. D/A Outputs Specifications

Specification	Value
Meter 1 and Meter 2	
Voltage	±10 volts
Current	7.5 mA
Resolution	12-bit
DC offset	≦ 25 mV
Impedance	≦ 30 Ohms
Linearity	0.1% of full scale
Gain error	<.5% of full scale (least significant 2 bits)
Meter 3 and Meter 4 (PWM)	
Voltage	±10 volts
Current	5 mA
Resolution	24 kHz, 10-bit duty cycle, filtered PWM signal
Accuracy	10%

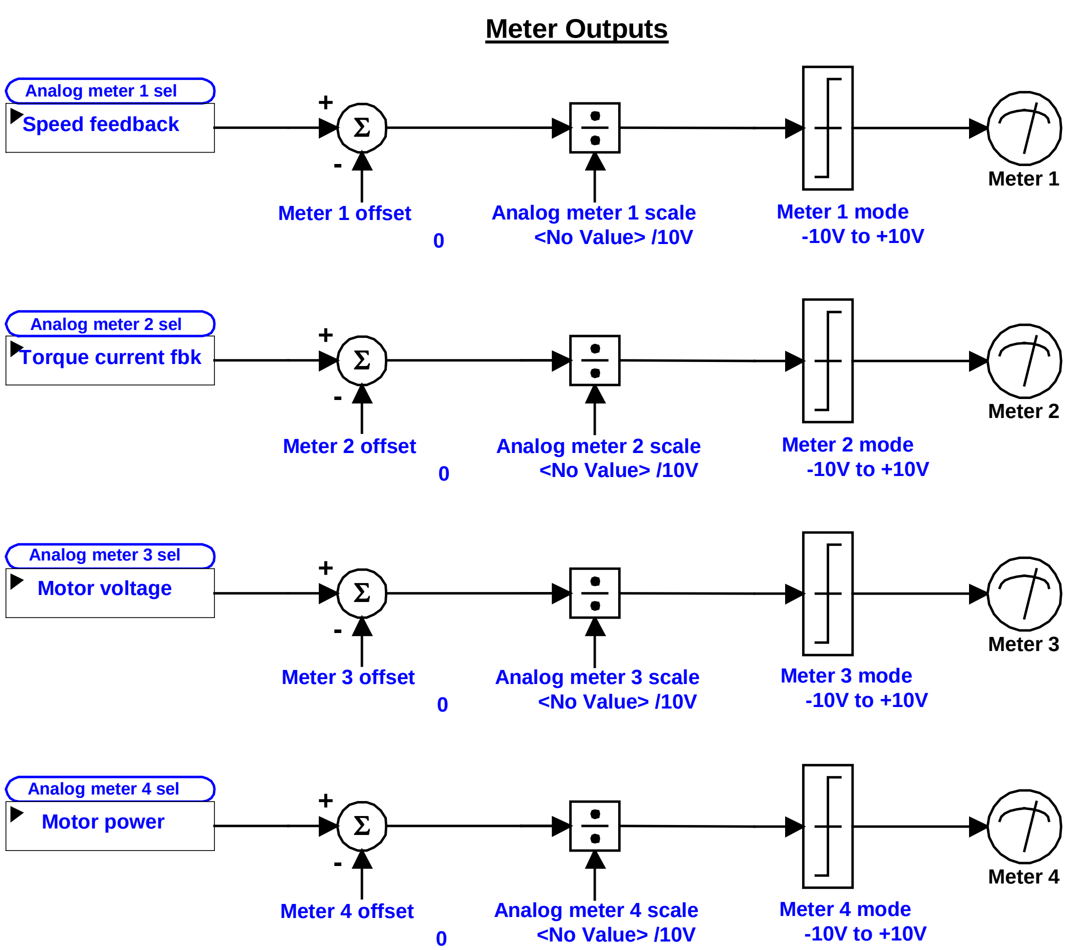


Figure 4-11. Meter Driver Outputs

Table 4-9. CABP Board Connector J8 Meter Driver Output Signals

Pin No.	Name	Status During Reset
1, 2	Not connected	-------
3, 8	DCOM	-------
4	MTR4P	Undefined
5	MTR3P	Undefined
6	MTR2P	Forced to 0 V
7	MTR1P	Forced to 0 V

ATBA Power Supply Connections

The drive dc power bus provides a 24 V dc power supply for logic control I/O wiring to the drive electronics. It supports applications that are sensitive to ac power dips. A bipolar 15 V dc power supply for a speed reference potentiometer is also supplied and referenced to ACOM (refer to Table 4-10 and Figure 4-12).

Table 4-10. ATBA Board Power Supply Connection Specifications

Specification	Value
24 V dc power supply, logic control	
Voltage	24 V dc (unregulated)
Current	1.2 A maximum
15 V dc power supply, speed reference potentiometer	
Voltage	±15 V dc, ±5%
Current	7.5mA maximum (each supply)

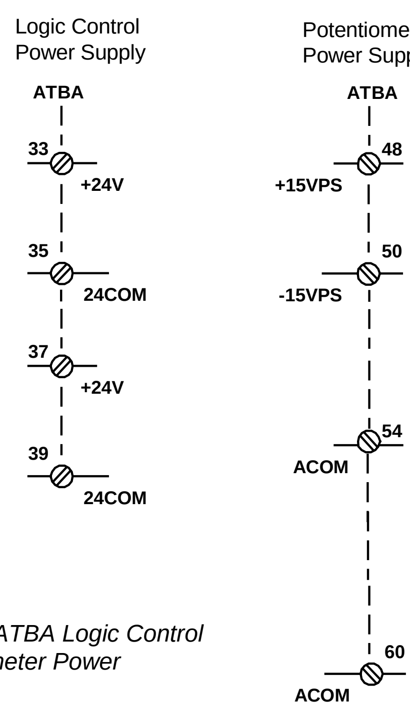


Figure 4-12. ATBA Logic Control and Potentiometer Power

ISBus Transceivers

Two ISBus connections are available via four RJ45 jacks on the CABP board:

- System ISBus for drive communications with a host or master controller (RXTX port on J12A and TX port J12B)
- Local ISBus is for drive I/O expansion (RXTX port on J11A and TX port on J11B)

The ISBus requires two twisted-pair cables, one for incoming (receiver) data and the other for outgoing (transmitter) data. All connections between ISBus nodes are configured as a point-to-point ring, not as a daisychain or parallel connection.

For additional ISBus information, refer to the ISBus User's Manual, GEH-6416. See GEI-100434 for additional information on the ACL_.

Additionally, optional boards convert the ISBus data to fiber-optic transmissions (for long distances) and/or for automatically bypassing an ISBus drop. The optional ACL_ module automatically “inserts” the application control layer (ACL) software into the system ISBus ring that exists between connectors J12A, J12B, and the DSPX board. If the ACL_ module is not present, the backplane routes the ring directly to the DSPX board.

Operator Interface Connections

The CABP board provides dedicated RS-232C serial communications ports for connecting operator interfaces as follows: (Refer to Figure 4-13.)

- J9 for a PC to run the (optional) control system toolbox (see Table 4-11)
- J10 for the door-mounted keypad

Table 4-11. CABP Board J9 PC Connection Specifications

Specification	Value
Voltage	Ground loop isolated, minimum 2500 Vrms for 1sec
Interface baud rate	Configurable from keypad and PC
Cable recommendations	Maximum 2500 pF capacitive load, <25 feet @ 19.2 kbaud

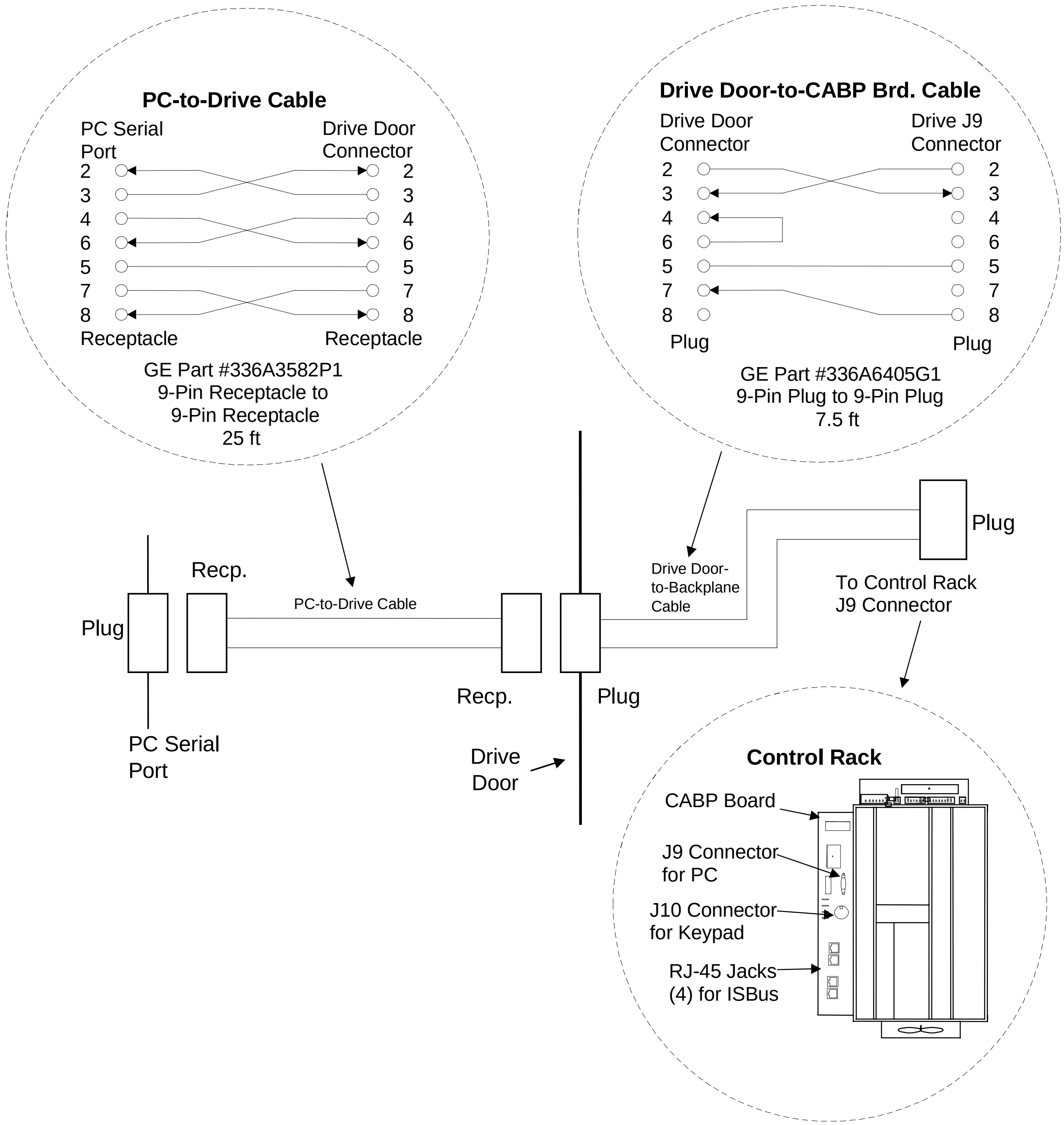


Figure 4-13. Cabling and Connections Between PC and Drive

Chapter 5 Drive Diagnostic Interface

Introduction

The keypad is a door-mounted, local control unit that enables you to:

- Monitor speed, current, power, and voltage
- Start and stop the drive
- Set and adjust configuration parameters
- Examine and reset fault conditions
- Commission the drive through wizards

This chapter provides operating guidelines for the Drive Diagnostic Interface (DDI), more commonly called *the keypad.* This section is organized as follows:

Using the Pushbuttons

The keypad includes membrane-type pushbuttons that enable you to access drive values and to control the drive. Tables 5-1 and 5-2 define the pushbutton functions for menu navigation and drive control (see Figure 5-1).

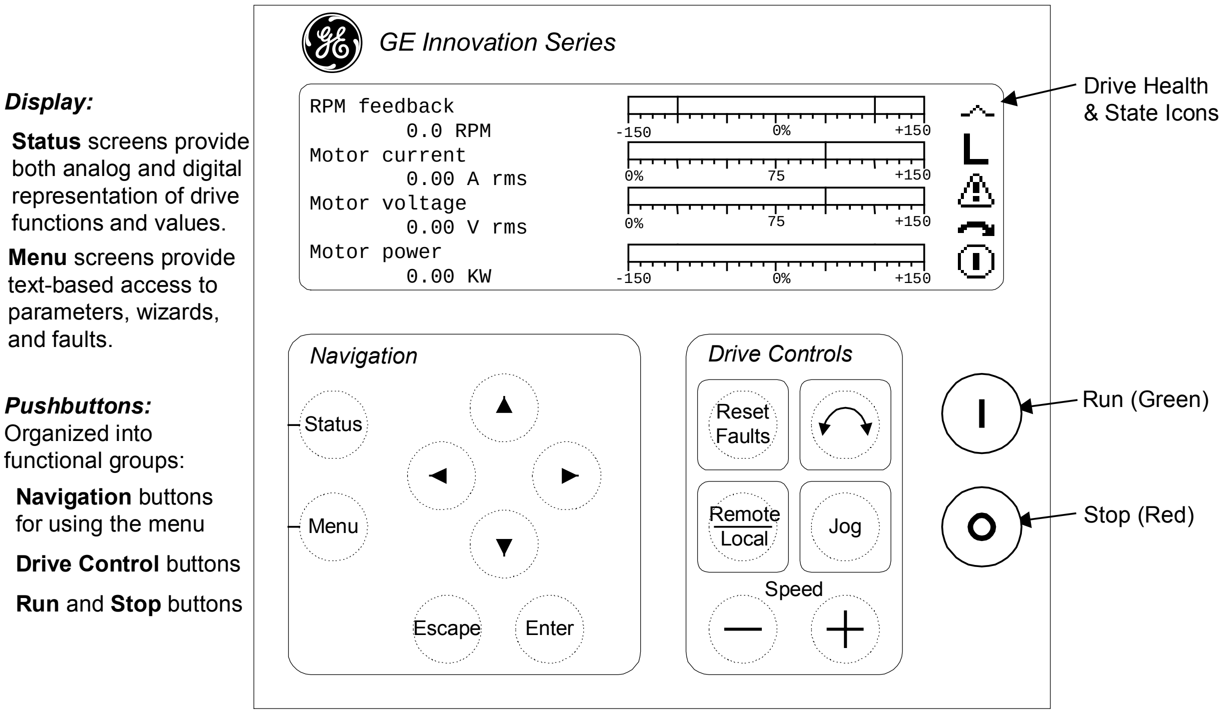


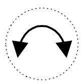
Figure 5-1. Keypad (Front View)

Table 5-1. Navigation Pushbuttons

Button	Active* L	Active* R	Active* W	Function
Status	✔	✔		Displays the default Status Screen, which shows four parameters as digital numbers or bar graphs. A set of Health icons (displayed at all times; see *Drive Health and State Icons*) provide additional drive status information.
Menu	✔	✔		If pressed while displaying a Menu screen (see *Menu Selections*), displays the Main Menu.If pressed while displaying a Status screen, displays the last Menu screen.
▲ ▼	✔	✔	✔	Menu Navigation: Used to highlight (reverse image) an item in a menu of options. Entry of Numeric Parameter: Used to index through numbers (0-9, ., -) when editing a parameter. Entry of Option Parameter: Used to index through 1 – n choices. (See *Parameter Configuration.)*
◄ ►	✔	✔	✔	Menu Navigation: Right Arrow button displays the next selected level down in a menu tree. Left Arrow button displays next level up in menu tree. Wizard Navigation: Displays the previous or next wizard screen. Entry of Numeric Parameter: Used to select a digit when editing a parameter. Entry of Option Parameter or Command Execution: Not functional.
Escape	✔	✔	✔	Menu Navigation: Displays the next level up in menu tree. Wizard Navigation: Exits wizard and displays the Main Menu. Entry of Parameter: Displays the parameter list.
Enter	✔	✔	✔	Menu Navigation: Displays the next level down in menu tree. Wizard Navigation: Selects the highlighted item on the wizard page for parameter editing or command execution. Entry of Parameter: Accepts editing of parameter.

* **L** = Local mode
R = Remote mode
W = While wizard is running

Table 5-2. Drive Control Pushbuttons

Button	Active* L	Active* R	Active* W	Function
Reset Faults	✔	✔		Resets faults.
	✔			Converter drives: Toggles direction of the drive for Run and Jog commands. The currently selected direction is shown with an icon (see *Drive Health and State Icons*). If pressed while in Remote mode, an error screen displays. Source drives: No function.
Remote / Local	✔	✔		Toggles the mode of the drive between Local and Remote. The currently selected mode is shown in the right side of the display with an R or an L (see *Drive Health and State Icons*).
Jog	✔			Converter drives: Jogs drive in the selected direction at the configured jog speed. If pressed while in Remote mode, an error screen displays. Source drives: No function.
—	✔			Converter drives: Increments/decrements the Local Speed Reference associated with the keypad Run/Stop commands. If pressed while in Remote mode, an error screen displays. Source drives: No function.
I	✔			Local Run command. If pressed while running in Remote mode, an error screen displays.
O	✔	✔	✔	Local Stop command.

* **L** = Local mode
R = Remote mode
W = While wizard is running

Reading the Display

The keypad displays information as both text and animated graphics. There are two types of content screens, selected by pressing the corresponding Navigation button: Status and Menu.

The **Status Screen** (Figure 5-2) is the default screen that displays after drive startup, following an initialization screen. It uses animated meters with associated text to present drive performance data. An alternate Status Screen can also be accessed (see *Status Screen*).

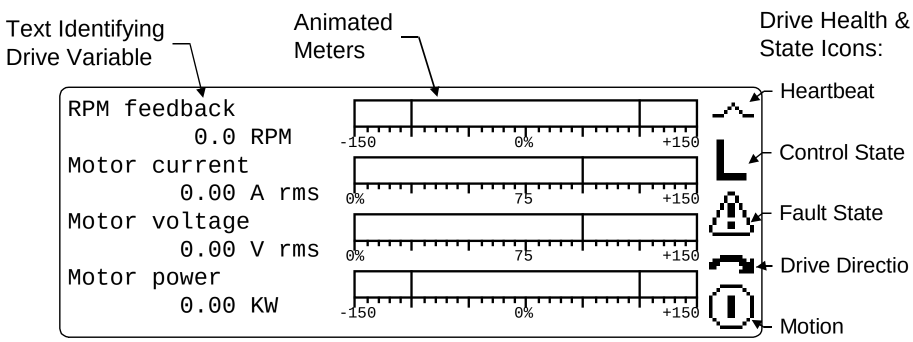


Figure 5-2. Status Screen Example

The **Menu Screen** (see Figure 5-3) lists and provides access to menu-based functions for adjusting parameters, running wizards, and viewing faults (see *Menu Selections*).

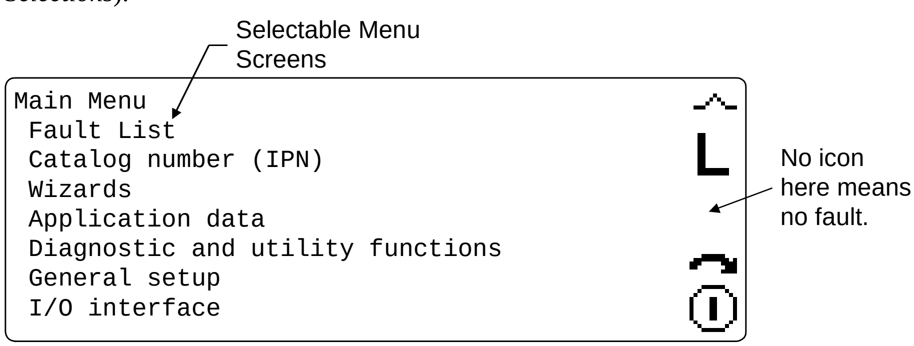
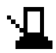
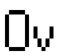
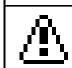
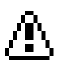
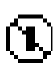
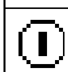
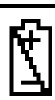
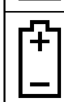
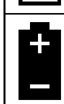


Figure 5-3. Menu Screen Example

The **Drive Health and State Icons** continually show on the right hand side of all display screens. They indicate if the drive functioning correctly and its running state. These icons are displayed in five functional groups, as shown below. You can change the **display units** and adjust the **display contrast**, if needed.

Table 5-3. Drive Health and State Icons

Group	Icon	Indication	Description
Heartbeat		Communications OK	Animated line (its center raises and lowers) shows that there is communication between the keypad and the drive.
		Communications not established	Animated metronome icon shows that the keypad is attempting to establish communication with the drive, but cannot.
Control	L	Local mode	Drive can be controlled (start, stop, jog, direction, speed) locally from the keypad.
	R	Remote mode	Drive control is from a remote station. This disables the local keypad drive control functions (start, stop, jog, direction, speed).
	T	Test mode	The drive is performing a diagnostic test.
Fault State	Blank	Drive OK	When no icon displays, the drive is operating correctly.
		Abnormal	Displayed when the drive has over-ridden parameters.
		Alarm state	Displayed when an alarm condition occurs.
	 blinking	Trip fault	Displayed when a fault state occurs.
Drive Direction		Forward rotation	Indicates the direction of motion currently selected. This does not necessarily match the direction of motion as viewed from the motor shaft. Not shown with source drives, which are not connected to a rotating machine.
		Reverse rotation	
Motion (not applicable when keypad is located on a source drive)		Drive not ready to run	Mimic of the keypad Start button, displayed with a diagonal line through the symbol to indicate that the drive is not running and cannot be started.
		Drive not running	Mimic of the keypad Start button. Indicates that the drive is not running, but can be started (ready to run).
		Drive running	Animated motion icon, indicates that the drive is running (speed feedback is not zero). The icon rotates in the direction that the motor is running (described in Table 5-1).
Battery (applicable only when keypad is located on a source drive)		Drive not ready to run	Mimic of a battery, displayed with a diagonal line through the symbol to indicate that the source drive is not running and cannot be started.
		Drive not running or is charging	“Empty” (not charged) battery indicates that the drive is not running, but can be started (ready to run).
		Drive running	“Full” (charged) battery indicates that the drive is running (speed feedback is not zero).

Changing Display Units

➢ **To change the type of measurement units displayed**

1. From the Main Menu, select **General Setup**.
2. Select **Display Units**.
3. Select the display units parameter to edit it (see below).
4. Highlight, then select the preferred display units.

```
Press ENTER to accept, ESC to leave

Display units
New Value     = Metric (SI)
Present Value = Metric (SI)
```

Adjusting Display Contrast

➢ **To adjust the display contrast**

1. From the Main Menu, select **General Setup**.
2. Then select:
   a. **Keypad**
   b. **Keypad Functions**
   c. **Adjust Screen Contrast**

This displays the following screen.

```
          - CONTRAST ADJUSTMENT -

        HOLD  UP  ARROW TO INCREASE
        HOLD DOWN ARROW TO DECREASE

          Press ESCAPE to Continue
```

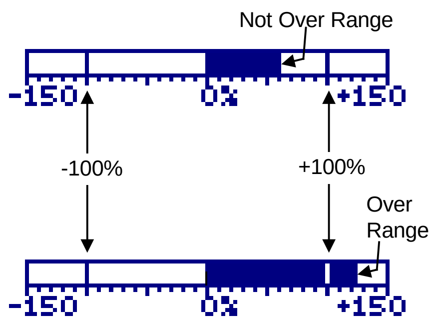
3. Press the **Escape** button to save the contrast value and return to the previous menu.

Status Screen

The Status screen displays four types of **drive variables** (parameters) using both text and animated meters. Tables 5-4 and 5-5 define characteristics of the bar graphs for these parameters.

Reading the Meters

A variable shown as a bar graph is **over range** when it is either greater than + 100% or less than –100%. The over range mark is shown with a vertical bar through the bar graph at the +100% and the –100% marks.



➢ To change the range of the variables displayed on the Status screen

1. From the Main Menu, select:
   a. **General Setup**
   b. **Keypad**
   c. **Keypad Meters**
2. Select the Keypad meter # range (where # can be a 1, 2, 3, or 4) that is to be changed. This displays the screen shown below.
3. Adjust the variable as follows:
   a. Use the **Up** or **Down Arrow** buttons to change the value.
   b. Press **Enter** to accept, or **Escape** to exit and keep the present setting.

```
Press ENTER to accept, ESC to leave

Keypad meter 1 range
New Value     = -150 to +150
Present Value = -150 to +150
```

*Table 5-4. Animated Meter Characteristics (Default) for **Converter Drive** Status Screen*

Bar Graph Variable	Numeric Display	Units in Bar Graph
RPM feedback	Speed feedback in units of rpm (Spd_Fbk_Fil)	Percentage of applied top rpm (Motor_NT)
Motor current	Magnitude of motor current (I_Mag_Fil)	Percentage of motor-rated current (Amps)
Motor voltage	Magnitude of motor voltage (V_Mag_Fil)	Percentage of crossover voltage (Xover_Volts)
Motor power	Motor shaft power (Mtr_Shft_Pwr)	Percentage of motor-rated power (Power)

*Table 5-5. Animated Meter Characteristics (Default) for **Source Drive** Status Screen*

Bar Graph Variable	Numeric Display	Units in Bar Graph
DC bus voltage	Magnitude of dc bus voltage (Vdc_Fil)	Percentage of dc per unit volts (VDC_PU)
AC line current	Magnitude of ac line current (I_Mag_Fil)	Percentage of source top-rated current (I_PU)
AC line voltage	Magnitude of ac line voltage (Line_Mag_Fil)	Percentage of ac line top-rated voltage (V_PU)
DC bus power	Dc bus power (Dc_Bus_Pwr)	Percentage of top-rated dc bus power (Pwr_PU)

Changing Meter Variables

➢ **To change the variables displayed on the Status screen meters**

1. From the Main Menu, select:
   a. **General Setup**
   b. **Keypad**
   c. **Keypad Meters**
2. Select Keypad meter # sel that corresponds to the meter variable to be replaced.
3. Adjust the setting as follows:
   a. Use the **Up** or **Down Arrow** buttons to change the value.
   b. Press **Enter** to accept, or **Escape** to exit and keep the present setting.

Alternate Status Screen (Display I/O)

The keypad has an **alternate** Status screen that displays the following I/O:

- Status of the digital inputs
- Relay outputs
- Local and system fault string inputs
- Contactor command outputs
- Contactor feedback inputs

To toggle between the Meter Status Screen and the I/O Status Screen, press any of the **Arrow** buttons.

The circle under each heading indicates the status of the corresponding I/O point, as follows:

- ● = True
- ○ = False

```
Display I/O Status

 Input   1 2 3 4 5 6  LOC  SYS  CntA
 Status  ● ○ ○ ○ ○ ●   ○    ○    ○

 Output  1 2 3 4      CntA CntB
 Status  ○ ● ○ ○       ○    ○
```

Using the Menus

The keypad's Main Menu leads to other menu screens, where data can be reviewed and modified. The Main Menu can be accessed from any screen, as follows:

- If already in a Menu screen, press the Menu button.
- If in a Status screen, press the Menu button once or twice.

```
Main Menu
 Fault List
 Catalog number (IPN)
 Wizards
 Application data
 Diagnostic and utility functions
 General setup
 I/O interface
```

```
Main Menu
 Motor data
 Protection
 Sequencing
 System data
 Parameter backup functions
```

Note The Main Menu selections may vary from product to product.

➢ **Use the Navigation buttons to move through the menus, select items, and adjust values**

1. Press the **Up** or **Down Arrow** buttons to move through and highlight menu items.
2. Press the **Enter** button to select a highlighted item
3. To return to a previous menu screen, press the **Escape** button, **Left Arrow** button, or follow onscreen instructions.

4. When a menu items require more than one:
    a. Move to the next screen by highlighting the last item on the displayed screen, then pressing the **Down Arrow** button once more.
    b. If the last menu item is reached, then pressing the **Down Arrow** button will wrap back to the first item on that menu.

Viewing and Resetting Faults

When the display indicates either a **Trip** or an **Alarm** fault (refer to *Reading the Display*), you can view information and reset (clear) current faults, as follows:

1. From the Main Menu, select **Fault List**, then select **Display Active Faults**. The following screen displays.

Faults are displayed in order of occurrence with the most recent fault at the top.

```
         ACTIVE FAULT DISPLAY
 50 Trip      HtSink temp low, B
108 Brief     DC bus voltage low
 12 Trip      Gnd flt, coarse
113 Trip      Invalid board set
        --- RESET FAULTS NOW ---
```

2. To view **detail** on a particular fault, select that fault (listed on the Active Fault Display screen). The following screen displays.

```
    SELECTED FAULT - PRESS ESCAPE
HtSink temp low, B
    000  04:40:11.008
The heat sink B temperature was too
low.  The heatsink thermistor may be
missing or damage. Check input to
backplane connector J4 pins 3 & 4.
```

3. Reset the faults **either** of two ways:

    - Select **Reset Faults Now** in the Fault Display screen.
    - Press the **Reset Faults** button.

➢ **To view the drive's Fault History (a list of previously cleared faults and fault resets)**

This display list may be multiple screens long.

- From the Main Menu, select **Fault List**, then select **Display Fault History**.

```
         FAULT HISTORY DISPLAY
  0 Cleared   Fault reset
108 Brief Clr DC bus voltage low
 50 Trip      HtSink temp low, B
108 Brief     DC bus voltage low
 12 Trip      Gnd flt, coarse
113 Trip      Invalid board set
        --- RESET FAULTS NOW ---
```

Editing Parameters

There are two types of parameters that can be changed using the keypad:

- **Option** parameters lists items (options) for you to select. For example, *True/False* is an option parameter.
- **Numeric** parameters lists valid digits that you select to create a number.

➢ To edit a parameter

1. From a drive Parameters screen, select the parameter that is to be changed.

```
Parameters
Fixed inertia       =   10.0000 kg*m2
Variable inertia sel=Unused
Spd reg net gain    =   50.0000 rad/s
Spd reg init val sel=Zero
Spd reg integral gn =   12.5000 rad/s
Spd reg neg err lim =   0.00000 RPM
Spd reg pos err lim =   0.00000 RPM
```

   This displays either an Option or Numeric parameter screen (see both below) with the **New Value** line highlighted.

2. For an **Option** parameter:
   a. Use the **Up** or **Down Arrow** buttons to select a new parameter value.
   b. Press the **Enter** button to accept the change or **Escape** to exit and keep the present value.

```
Press ENTER to accept, ESC to leave

Regulator type
New Value     = Torque, spd override
Present Value = Speed regulator
```

3. For a **Numeric** parameter:
   a. Use the **Left** or **Right Arrow** buttons to highlight the digit to be changed.
      If you continue pressing the **Left Arrow** button after reaching the left-most digit of the edit field, the field fills with blanks. Pressing **Enter** when the entire number is blanked out saves a *<No Value>*.
   b. Use the **Up** and **Down Arrow** buttons to index through the valid digits (0, 1, 2, 3, 4, 5, 6, 7, 8, 9, e, ., -).
      The *e* in the digit selection represents the start of the exponent in scientific notation. If the *e* is used, all digits to the right of the *e* make up the number's exponent.

```
Press ENTER to accept, ESC to leave

Fixed inertia
New Value     =       10.00000 kg*m2
Present Value =       10.00000 kg*m2
Low Limit     =      0.0000000
High Limit    =   3.4028239e38
```

4. When all of the digits have been changed, press **Enter** to accept the new value or press **Escape** to exit and keep the present value.

Parameter Backup

It is good practice to keep a backup copy of the drive's working parameter configuration. You can then restore this file, if needed, or compare it with a re-configured file to determine differences.

➢ **To Save active parameters**

1. From the Main Menu, select **Parameter Backup Functions** then select **Save Parameters to Backup**.

Each new backup overwrites the previous backup copy, which cannot then be restored.

```
    Save Parameters to Backup


  Save current parameter values.



Press ENTER to continue.  ESC cancels.
```

2. Press **Enter** to make a backup copy of the parameters or **Escape** to cancel.

➢ **To restore a parameter from backup**

1. Stop the drive. (This function cannot be executed with the drive running.)
2. From the Main Menu, select **Parameter Backup Functions** then select **Restore Parameters from Backup**.

```
    Press to restore Parameters from Backup

             -- WARNING --
The active parameter values will be
replaced, and can not be recovered.


Press ENTER to continue.  ESC cancels.
```

3. Press **Enter** to restore the backup parameters or **Escape** to cancel.

Caution

Restoring parameters from a backup file overwrites the currently active parameter values, which cannot then be restored.

➢ To compare the active parameter set to the backup parameter set

1. From the Main Menu, select **Parameter Backup Functions** then select **Compare Current Parameters to Backup**.

```
   BACKUP DIFFERENCES     <More ↑>
Capture period      =Task 3 rate
     Backup value   =Task 2 rate
Normal stop mode    =Ramp stop
     Backup value   =Coast stop
Simulated inertia   =   10.0000 kg*m2
     Backup value   =   50.0000 kg*m2
                          <More ↓>
```

2. Use the **Up** and **Down Arrow** buttons to scroll through the list of backup differences.

3. Press **Escape** to return to the previous menu.

Tuning the Drive

The drive can be tuned using the keypad wizards.

➢ To access the wizards

1. Recommended: Back up the currently active parameters (see Parameter Backup) before each wizard is started. This enables you to easily restore parameters if tuneup is exited or fails.

2. From the Main Menu, select **Wizards**, then select **Start Wizard Menu**. This displays the wizard list.

```
Wizards
 Drive Commissioning Wizard (Required)
 Cell Test Wizard (Required)
 Motor Control Tuneup Wizard (Required)
 Speed Regulator tuneup Wizard (Required)
 Panel Meter Setup Wizard
 DAC Setup Wizard
 Simulator Setup Wizard
```

The path taken by the wizard depends in part on the choices made. The same wizard may ask different questions and execute different commands for different applications.

During a complete tune-up process, you normally run all of the required wizards in the order displayed, from first to last.

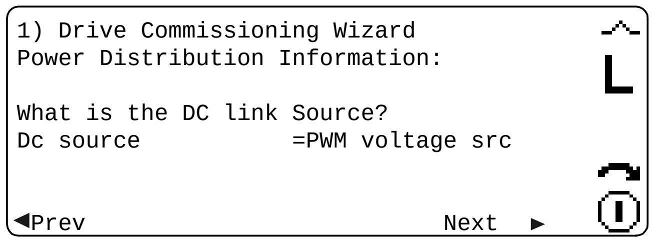
3. Use the **Up** and **Down Arrow** keys to scroll to the desired wizard, then press **Enter** to select and start it. (Press **Escape** to return to the Main Menu.)

   The selected wizard displays a series of screens and prompts that guide you through that part of the tuneup process.

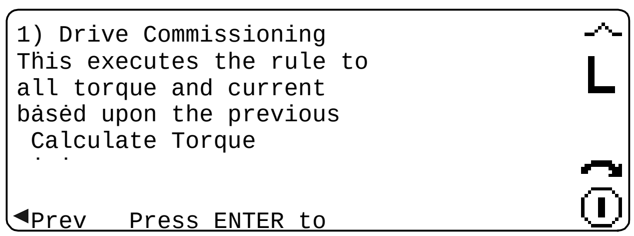
Some keypad pushbuttons do not function while a wizard is running (refer to Table 5-1). However, the Stop *button always functions.*

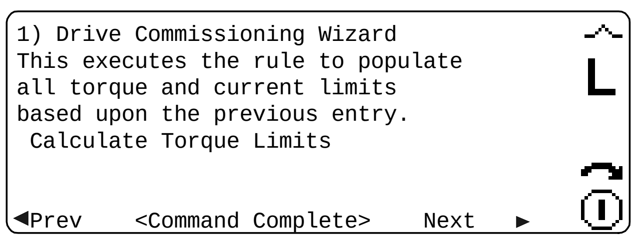
4. Proceed through the wizard as prompted, using the following conventions:

- After starting a wizard, you should either complete or exit it before taking any other action.
- Pressing the **Escape** button exits the wizard, but any parameter edits made to that point remain. (See Step 1.)
- Parameters presented in a wizard may be changed or left alone (as appropriate), but all calculations and commands presented must be attempted.
- At each step, the wizard indicates whether you can proceed to the next step using the **Right Arrow** button or can back up to the previous step, using **Left Arrow** button (see below). If the **Next** prompt does not appear, the command still must be completed successfully.



- When a command completes successfully, you cannot execute it again within the same step. To repeat a command (for example, if required by external conditions), press the **Left Arrow** button to return to the previous step. Then repeat the command.





- If a command fails, the wizard fails. To continue the tuneup, correct the condition causing the failure, then repeat the command.
- When you complete all steps, the wizard displays the following screen. At this time, push the **Right Arrow** button (per the Finish prompt) to exit the wizard and return to the **Wizard Menu**.

```
1) Drive Commissioning Wizard
This concludes the
Drive Commissioning Wizard.




◄Prev                         Finish  ►
```

Firmware and Hardware Information

➢ **To view the firmware versions for the DSPX board and the keypad**

- From the Main Menu select:
    a. **General Setup**
    b. **Firmware Version & Hardware Info**
    c. **Display Firmware Version**

The following screen displays:

```
        GE Innovation Control

       ACDCF-S
DSPX Firmware Version:     V02.06.00B
DSPX Boot Monitor Version: V02.02.00C
DDI  Firmware Version:     V02.00.00B

Press ESC to exit
```

➢ **To view drive hardware information**

- From the Main Menu select:
    a. **General Setup**
    b. **Firmware Version & Hardware Info**
    c. **Display Hardware Information**

The following screen displays:

```
        GE Innovation Control
Hardware Information:
 IS200BPIAG1ACB  XMT1V
 IS215ACLAH1AA  8790040
 IS200BICLH1ABB 3340595
 IS200DSPXH1AAA 3341057
 IS200BAIAH1BCB 3341430   <More  ↓>
ESC to exit
```

Protecting the Keypad

To protect the drive from unauthorized operation or reconfiguration, the keypad includes two **security controls**, Password and Privilege Level.

The **Password** is a 5-digit number that protects the Password and Privilege Level from being changed by unauthorized personnel. The **default** Password is *00000*.

Privilege Level specifies which operational and configuration functions are disabled in the keypad. There are three levels:

- **Read Only** disables both the Drive Control and the Configuration functions. An operator can view but not edit parameters.
- **Operate & Read Only** enables the Drive Control function, but disables Configuration functions. An operator can view, but not edit parameters.
- **Configure & Operate** enables both the Drive Control and the Configuration functions. This is the default setting.

If you try to execute a function that is disabled in the active Privilege Level, the keypad displays the following error message.

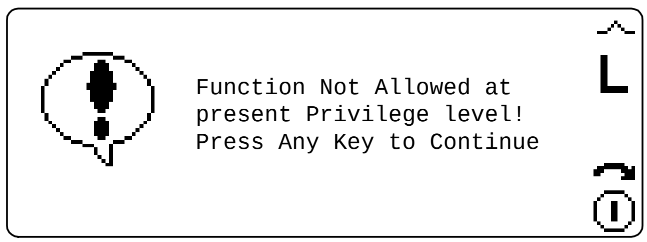


Table 5-6. Keypad Function Privileges

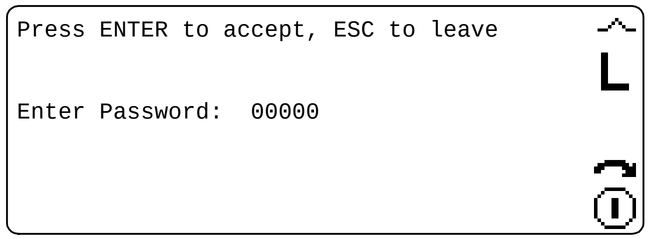
Keypad Function	Privilege Level: Read Only	Operate & Read-Only	Configure & Read-Only
Drive Control			
Stop Button	✔	✔	✔
Start Button		✔	✔
Reset Faults Button	✔	✔	✔
Change Direction Button		✔	✔
Remote/Local Button		✔	✔
Jog Button		✔	✔
Speed Increment Button		✔	✔
Speed Decrement Button		✔	✔
Menu			
Navigation Buttons (Status, Menu, Arrows, Escape, Enter)	✔	✔	✔
Display Active Faults	✔	✔	✔
Display Fault History	✔	✔	✔
View Parameters	✔	✔	✔
Edit Parameters			✔
View Variables	✔	✔	✔
Wizards			✔
Adjust Screen Contrast	✔	✔	✔
Display Firmware Revision	✔	✔	✔
Display Hardware Information	✔	✔	✔
Save Parameters to Backup			✔
Restore Parameters from Backup			✔
Compare Current Parameters to Backup	✔	✔	✔
View Overrides	✔	✔	✔

Modifying the Protections

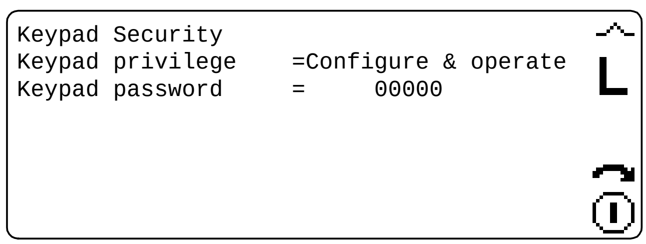
➢ **To modify the Password and Privilege Levels**

1. From the Main Menu, select:
   a. **General Setup**
   b. **Keypad**
   c. **Keypad Security**

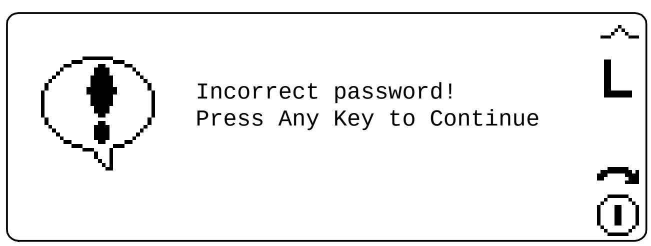
The following screen displays:



2. Enter the password as follows:
   a. Use the **Up** and **Down Arrow** buttons to index through the valid digits (0 through 9).
   b. Use the **Right** and **Left Arrow** buttons to move the cursor to the digit to edit.
   - Press **Enter** to accept the Password.
   - If the password that was entered matches the saved Password value, you can then modify the Privilege Level or Password.



If it does not match, the keypad displays an error message.



5. Use the **Up** and **Down Arrow** buttons to select either the Privilege Level or Password
6. Press **Enter** to edit the parameter. (See *Editing Parameters*.)

Note When you modify the keypad password, be sure to select *Save Parameters To Backup*. Otherwise, the password stored in the active parameter will not match the backup parameter set. That causes the *Compare Current Parameters to Backup* to identify the Keypad Password parameter as different.

Notes

Chapter 6 Preventive Maintenance

Introduction

Periodic preventive maintenance extends equipment-operating life and minimizes downtime. This involves specific power-on and more intensive power-off checks, when permitted. With both checks, necessary repairs should be undertaken when needed.

Warning

This equipment contains a potential hazard of electric shock or burn. Only adequately trained persons who are thoroughly familiar with the equipment and the instructions should maintain this equipment.

To prevent electric shock while servicing the equipment, personnel must understand and follow all safety requirements for working around dangerous voltages.

When de-energizing and re-energizing the drive, refer to the procedures in Figures 6-1 and 6-2.

Section ***Page***

Maintenance Schedule

For maximum benefit, preventive maintenance needs to be performed at scheduled intervals by a qualified technician. The required frequency for each procedure depends on:

- How much the equipment is used
- Ambient environmental conditions

The schedule should include an inspection of wiring and components before re-applying power after an overcurrent trip.

Maintenance Record

GE recommends that the customer keep a detailed record of maintenance (such as a log book) for every drive. This record serves two purposes:

- It verifies that all equipment is routinely checked
- It aids troubleshooting and prevention of equipment failure by providing a history of equipment maintenance and problems

Equipment/Material Needed

The equipment and material in the following checklists should be available to perform the recommended procedures.

Safety Equipment

- Safety gear (safety boots, safety glasses, hard-hat, high voltage gloves, face shield)
- High voltage ac/dc detector (using an insulated pole of appropriate length)
- Locks and tags, danger and caution tape
- Protective grounding cables and grounding stick
- Static-charge wrist straps

Typical Maintenance Tools

- High quality tools, including screwdrivers and pliers, designed specifically for working with electrical wiring systems
- Socket set (metric and standard)
- Hex wrenches (metric and standard)
- 1-inch adjustable wrench
- Torque wrench
- Electrical tape
- Fine file
- Clean dry cloth
- Soft-bristled brush (such as a paintbrush)
- Mild solution of distilled water and household or laboratory detergent

- Isopropyl alcohol
- One megger tester capable of insulation testing 500 V max.
- Source of dry, low-pressure compressed air
- Vacuum cleaner with non-metallic nozzle and finely woven, high efficiency filter
- Fuse puller
- Replacement components (if required) including fuses, wiring, cabling, and door filters

Power-On Checks

The following preventive maintenance procedures need to be conducted with power on within the control cabinet *only*.

Warning

With power applied, extremely high voltages are present on some circuitry. To prevent accidental injury, do not touch any circuitry without first ensuring that it does not carry these voltages and is grounded.

1. Open the control cabinet door while the equipment is running and locate the fan (should be underneath the board rack).

2. **Without touching any circuitry**, look to see that the fan is running.
   - If it is not, **use the procedures in Figure 6-1 to de-energize the drive,** then replace the fan. (The fan is held in place by four screws.)
   - If proceeding with other maintenance, do not re-energize the drive.

If no other maintenance is planned and the drive is ready for operation, use the procedures in Figure 6-2 to re-energize the drive.

Power-Off Checks

Power-off checks involve cleaning the equipment and checking for wear and damage through visual inspection and functional tests.

Before Starting Maintenance

Warning

Power must be de-energized before performing any adjustments, servicing, or other act requiring physical contact with the electrical components or wiring.

Before starting, de-energize the drive using the instructions in Figure 6-1.

Do not deviate from the stated de-energizing procedures. If safety requirements cannot be met completely, or if you do not understand them, **do not work on the equipment**.

De-energizing the Drive

Warning

To prevent potentially hazardous electric shock, power must be properly de-energized before anyone is allowed to make any type of physical contact with the electrical components or wiring of the drive.

When checking for zero ac or dc voltage, the high voltage detector must be rated appropriately for the equipment voltages.

De-energizing an Inverter

1. Check that the drive is stopped.
2. Factory wiring of the dc disconnect for all inverters removes power from:
   - Power bridge components
   - Control components
   - Auxiliary ac power components associated with the inverter

   For 65 – 180 frames, open both the top and bottom dc disconnects, then lock-out and tag-out both inverters.

   For 250 – 1800 frames, open the dc disconnect, then lock-out and tag-out the inverter.
3. Check the load side of the inverter of zero ac voltage.
4. Wait **5 minutes minimum** to discharge the dc capacitors. Capacitive voltages above 30 V ac or 42.2 V ac (peak) may be present.

De-energizing a Source

1. Check that all drives in the line-up are stopped.
2. Depending on the type of source and selected options, the auxiliary ac power (including control power) may be fed independent of the main circuit breaker.
   - In **regenerative sources**, the auxiliary ac power feed is independent of the main circuit breaker. To de-energize the lineup, open the main circuit breaker for the source and the auxiliary ac power feed switch, then lock-out and tag-out the source.
   - In **non-regenerative sources**, there is an option to have the auxiliary ac power feed be independent of the main circuit breaker.
     – If that option is *selected*, open the main circuit breaker for the source and the auxiliary ac power feed switch to de-energize the lineup, then lock-out and tag-out the source.
     – If that option is *not selected*, open the main circuit breaker for the source to de-energize the lineup, then lock-out and tag-out the source.
3. Wait **5 minutes minimum** to discharge the dc capacitors. Capacitive voltages above 30 V ac or 42.2 V ac (peak) may be present.

Figure 6-1. Power-Down (De-energizing) Procedures

Re-energizing the Drive

Warning

Power must be properly re-energized to prevent personnel from having potentially hazardous contact with dangerous voltages.

1. Close and secure the converter doors.
2. Clear all locks and tags from the switchgear and drive.
3. Close all disconnects that were opened when de-energizing the inverter/source.
4. Close and secure the control cabinet door.

Figure 6-2. Power-Up (Re-energizing) Procedures

Dust Removal

Caution

Build up of dust on electrical components and wiring can damage components and cause mis-operation.

Build-up of dust on components can increase operating temperature, reducing their normal life. On standoff insulators, it can collect enough moisture to produce a current path from bus bars to chassis ground.

Dust (especially metallic dust) on wire surfaces can cause "tracking" between connector pins. Tracking is usually capacitive in nature and involves a build-up of electrical charge along the wire surface. This can cause intermittent problems that are hard to find. Check for and remove accumulated dust as follows:

Make sure that the air source is directed so that dust and foreign matter is removed rather than relocatd.

1. Clean bus bars and standoff insulators with a clean dry cloth – **do not use any solvents**.
2. Using a fine-filtered vacuum cleaner with a non-metallic nozzle, remove dust and dirt from wiring and electrical components.

Caution

Do not use *high-pressure* compressed air, which may damage components.

3. Inspect cabinet air filters, if equipped. Shake or vacuum filters clean, or replace, as required.

Loose Connections

Vibration during equipment operation can loosen mechanical and electrical connections and cause intermittent equipment failure. Additionally, dust and moisture in loose connections can cause loss of low-level signals at terminal boards and also thermal runaway at bus connections.

1. Check all hardware and electrical connections, and tighten if needed.
2. Tighten or replace any loosened crimp-style lugs.
3. Tighten or replace all loose or missing hardware.
4. Inspect printed wiring boards for correct seating, and check that any plugs, wiring, and bus connectors are tight.

Caution

To prevent component damage caused by static electricity, treat all boards and devices with static-sensitive handling techniques. Wear a wrist grounding strap when handling boards or components, but only after boards or components have been removed from potentially energized equipment and are at a normally grounded workstation.

To prevent equipment damage, do not remove, insert, or adjust board connections while power is applied to the equipment.

Damaged Insulation

Wires and cables with damaged insulation are dangerous when carrying electricity. They can also intermittently short, causing equipment and functional failure.

1. Check all wires and cables for fraying, chipping, nicks, wear, or rodent damage.
2. Check all wires and cables for signs of overheating or carbonization.
3. Repair minor low voltage insulation damage with a good grade of electrical tape. If a damaged cable carries high voltages, replace the cable.
4. Replace any cables or wires that have more than mild damage.

Contactors and Relays

1. If possible, manually trip the device to ensure that it works properly.
2. Inspect contacts on open (as opposed to sealed) contactors and relays. (Discoloration and rough contact surfaces are normal.)
3. If beads have formed because of severe arcing:
   a. Dress the contact faces with a fine file. (Do not use emery cloth or sandpaper.)
   b. Identify and correct the cause of arcing.

Note Refer to the component's publication for detailed instructions on maintenance, repair, and replacement procedures.

Printed Wiring Boards

Clean boards as follows if dirty:

1. Vacuum to remove dust from around the board connections before and after unplugging.

2. Remove the boards per the instructions in Section 7. Be sure to observe the personal and equipment safety instructions.

3. Vacuum to remove dust from the board and connections. A soft-bristled brush may be used to loosen dirt.

Caution

Do not use solvents containing ammonia, aldehydes, alkalis, aromatic hydrocarbons, or ketones. Harsh chemicals and solutions will damage the board.

---

4. If excessively dirty, boards may need to be washed as follows:
   a. Use a soft-bristled brush to scrub the board in a lukewarm (37.7 °C, 100 °F), mild solution of distilled water and household or laboratory detergent.
   b. Rinse thoroughly by dipping the board several times in fresh, lukewarm, distilled water. Do not soak the board.
   c. Dry the board by shaking off excess water, immersing and agitating the board in isopropyl alcohol, then air drying for a few hours.

Short-Circuit Damage

If a short-circuit occurs, overcurrent protective devices on the circuit should cut off power to the equipment. This normally prevents electrical damage, except at the point of the short. However, the heat produced by an electrical arc can carbonize some organic insulating materials, which then lose insulating qualities.

Perform the following procedure after repairing the cause of the short and **before re-energizing** the drive (per Figure 6-2):

1. Inspect the system thoroughly for damage to conductors, insulation, or equipment. Replace, if found (refer to *Damaged Insulation*).

2. Check insulation resistance.

3. Inspect the overcurrent protection devices for damage to insulation and contacts (refer to *Contactors and Relays*). Replace or repair as needed.

4. Check and replace any open fuses.

Notes

Chapter 7 Component Replacement

Introduction

This chapter provides guidelines for replacing components during repair. This information is organized as follows:

Safety Precautions

Warning

With power applied, this equipment contains a potential hazard of electric shock or burn. Only adequately trained persons who are thoroughly familiar with the equipment and the instructions should maintain this equipment.

To prevent electric shock while servicing the equipment, personnel must understand and follow all safety requirements for working around dangerous voltages. Make sure that all power supplies to the equipment are turned off, then ground and discharge the equipment before performing any adjustments, servicing, or other acts requiring physical contact with the electrical components or wiring.

When de-energizing and re-energizing the drive, refer to the procedures in Figures 6-1 and 6-3.

Before starting any maintenance procedures, prepare the equipment as follows:

1. Make sure that shutting down equipment does not interfere with presently required operation.
2. Turn off all power to the equipment to be maintained, and follow all local safety practices of Lock Out/Tag Out.
3. Test all equipment using a multimeter to ensure that power is off.

Replacing Printed Wiring Boards

Because of upgrades, boards of different revision levels may not contain identical hardware. However, GE ensures backward compatibility of replacement boards.

Handling Precautions

Caution

To prevent component damage caused by static electricity, treat all boards with static sensitive handling techniques. Wear a wrist grounding strap when handling boards or components, but only after boards or components have been removed from potentially energized equipment and are at a normally grounded workstation.

Printed wiring boards may contain static-sensitive components. Therefore, GE ships all replacement boards in antistatic bags.

Use the following guidelines when handling boards:

- Store boards in antistatic bags or boxes.
- Use a grounding strap when handling boards or board components (per previous *Caution* criteria).

General Replacement Procedures

Warning

To prevent electric shock, turn off power to the drive, then test to verify that no power exists in the board before touching it or any connected circuits.

Caution

To prevent equipment damage, do not remove, insert, or adjust board connections while power is applied to the equipment.

➢ To remove a printed wiring board

1. Make sure that the drive in which the board resides has been de-energized. (Refer to Figure 6-1, *De-energizing the Drive* for complete procedures.)
2. Open the drive cabinet door, and using equipment designed for high voltages, test any electrical circuits **before touching them** to ensure that power is off.

Caution

To prevent damage to cable and wire connections, hold only the connector, not the cable, when pulling them. To prevent equipment damage, do not remove, insert, or adjust board connections while power is applied to the equipment.

3. Carefully disconnect all cables, as follows:
   - For a cable with a pull tab, carefully pull the tab.
   - For a screw terminal connector, loosen the screw at the top of each terminal and gently pull each wire free.
   - For a fiber-optic connector, press and hold the latch on the mating cable connector while pulling.
   - For ribbon cables, grasp each side of the cable connector and pull the connector and cable loose.
4. Carefully remove the board, as follows:
   - For boards mounted on standoffs with screws, remove the screws to release the board.
   - For boards mounted within a rack, loosen the screws at the top and bottom of the board near the card ejector tabs, then unseat the board by raising the ejector tabs. (The screws are captive in the board front and should not be removed.)

Caution

For boards that have fiber-optic connectors, insert a rubber plug into the fiber-optic connector to prevent contamination and damage to it. Do this immediately upon removal of the board prior to repair or return.

➢ To install a printed wiring board

1. On the replacement (new) board, set all jumpers, pots, and switches in the exact position as those on the board being replaced.

Note If a board revision has added or eliminated a configurable component, or readjustment is needed, refer to the individual board publication.

If the board contains onboard software, refer to the individual board publication for instructions.

Caution

Boards that mount in the rack are mechanically keyed so that they can only be installed into the correct slot. Do not attempt to defeat or override these interlocks. Doing so will damage the electronics.

---

2. To install a board into a rack:
   a. Slide the board into the correct slot in the rack.
   b. Begin seating the board by firmly pressing the top and bottom of the board at the same time with your thumbs.
   c. Finish seating the board in the slot by starting and then tightening the screws at the top and bottom of the board. **Tighten the screws evenly** to ensure that the board is seated squarely.
3. To install a board that is seated on standoffs:
   a. Place the board onto the standoff in the same orientation as the board that was removed.
   b. Secure the boards by replacing and tightening the screws that were removed.
4. Reconnect all cables, making sure that they are properly seated at both ends.

IS200HFPA Power Supply Board Replacement

The IS200HFPA Power Supply Board (HFPA) is located behind the CABP board rack on all frame sizes of the drive.

➢ To remove the HFPA board

1. Make sure that the drive in which the board resides has been de-energized. (Refer to Figure 6-1, *De-energizing the Drive* for complete procedures.)
2. Open the drive cabinet door and, using equipment designed for high voltages, test any electrical circuits **before touching them** to ensure that power is off.
3. Disconnect all wires and plugs from the board rack and tag if necessary for ease of replacement.

Note Disconnecting wires may involve cutting tie wraps and/or removing wires from wire channel to allow removal of the entire board rack/CPT support assembly. Wire sets that pass through lead holes in the CPT assembly must be fished through (for example, plug J3 on the CABP board to plug HFPL on the HFPA board.)

---

4. Remove the board rack/CPT assembly as follows:
   a. Support the assembly, then remove the four bolts holding it to the back panel. (Loosen the bottom screws first, then remove the top screws.)
   b. Allow the assembly to lean forward for better access to the wire channel on top of the board rack.
   c. Pull the entire assembly out of the enclosure while using caution not to damage any insulation or plugs on the surrounding wires.
   d. Place the assembly gently on its left side to allow access to the HFPA board.
5. Remove the HFPA board as follows:
   a. Disconnect all wires or plugs from the HFPA board.
   b. Remove the two #6 nylon nuts visible on the board (closest to the rear of the assembly).
   c. Lift the HFPA board out of its holder and remove.

➢ **Reverse steps 1 through 5 to install the new HFPA board**

Fan Assembly Replacement

The following sections provide instructions for replacing the fan assembly on the low voltage drives. These procedures are organized per frame size and type of drive.

65, 92, 125, and 180 Frame Inverter

➢ **To replace the fan assembly**

1. Disconnect the FCPL wire connection to the lower left side of the fan box assembly.
2. Support the fan assembly, then remove the four ¼-20 bolts connecting the fan box assembly to the heat exchanger assembly and the single ¼-20 bolt in the left side of the fan box assembly that supports the switch bracket.
3. Remove fan assembly and set aside.

➢ **Reverse steps 1 through 3 to re-install.**

250, 375, and 620 Frame Inverter and Regenerative Source

➢ **To replace the fan assembly**

1. Disconnect the FCPL wire connection to the lower left side of the fan box assembly.
2. Disconnect the two dc wire connections to the IGBT bus (HEPL_1 and 3).
3. Support the fan assembly, then remove the eight ¼-20 bolts connecting the fan box assembly to the heat pipe assembly.

Note The inverter has three additional bolts in the left side of the fan box assembly that supports the switch bracket. These bolts must be removed.

4. Remove fan assembly and set aside.

➢ **Reverse steps 1 through 4 to re-install.**

1000 and 1800 Frame Inverter and Regenerative Source

➢ **To replace the fan assembly**

1. Disconnect the FCPL wire connection to the lower left side of the fan box assembly.
2. Disconnect the two dc wire connections to the dc bus (on the right DSFC board labeled DCLN and DCLP).
3. Support the fan assembly, then remove the four ¼-20 bolts connecting the fan box assembly to the heat pipe assembly.
4. Remove fan assembly and set aside.

➢ **Reverse steps 1 through 4 to re-install.**

620 and 1000 Frame Non-regenerative Source

➢ **To replace the fan assembly**

1. Disconnect the FCPL wire connection to the lower left side of the fan box assembly.
2. Disconnect the two dc wire connections to the dc bus (located to the left side of the fan box assembly).
3. Support the fan assembly, then remove the four ¼-20 bolts connecting the fan box assembly to the heat exchanger assembly.
4. Remove fan assembly and set aside.

➢ **Reverse steps 1 through 4 to re-install.**

1800 Frame Non-regenerative Source

➢ **To replace the fan assembly**

1. Disconnect the FCPL wire connection to the lower left side of the fan box assembly.
2. Disconnect the two dc wire connections to the dc bus (located to the right side of the fan box assembly) and remove from the wire tray.
3. Support the fan assembly, then remove the four ¼-20 bolts connecting the fan box assembly to the heat exchanger assembly.
4. Remove fan assembly and set aside.

➢ **Reverse steps 1 through 4 to re-install.**

Heat Exchanger Replacement

The following sections provide instructions for replacing the heat exchanger on the low voltage drives. These procedures are organized per frame size and type of drive.

65, 92, 125, and 180 Frame Inverter

➢ **To replace the heat exchanger**

1. Remove the fan assembly per the *Fan Assembly Replacement* section procedure, then disconnect the wire connections from the DAM_ boards.
2. Remove the shunts and shunt boards as an assembly.
3. Remove the six bolts connecting the capacitor bus to the IGBT.
4. Disconnect the dc power cables from the bottom of the heat exchanger.
5. Support the heat exchanger assembly, then remove the four ¼-20 bolts from the back panel and lift the heat exchanger out of the enclosure.

➢ **Reverse steps 1 through 5 to re-install.**

250, 375, and 620 Frame Inverter or Regenerative Source

➢ **To replace the heat exchanger**

1. Remove the fan assembly per the *Fan Assembly Replacement* section procedure, then label and disconnect all wires from the DAMA or DSFC boards and the shunt boards.
2. Cut the wire ties supporting the wire bundle to the heat exchanger and secure wires away from work area.
3. Remove the shunts and shunt boards as an assembly and set aside.
4. Loosen the bolts connecting the IGBT bus to the capacitor bus (uses captive hardware).
5. Remove the thermistors from the bottom front surface of the heat exchanger.
6. Remove the Identity Panel (refer to GE drwg. 173C8949AB sh. 1).

Note Ground strap must be disconnected from the back side of the Identity Panel.

7. Obtain a heat exchanger liftout tool (cat# 246B9949BPG1) and install it in the cabinet over heat exchanger (refer to GE drwg. 173C8949AB sh. 1).
8. Bolt the hanging lift plate to the four fan assembly holes in the heat exchanger. (The ¼-20 bolts from the fan assembly can be used for this purpose.)
9. Remove the ¼-20 bolts connecting the heat exchanger assembly support bracket to the back panel.
10. Pull the heat exchanger assembly forward until the roller on the liftout tool reaches the end stop pin, then remove the heat exchanger assembly and set it aside.

➢ **Reverse steps 1 through 10 to re-install.**

1000 Frame Inverter or Regenerative Source

➢ **To replace the heat exchanger**

1. Remove the fan assembly per the *Fan Assembly Replacement* section procedure, then remove the Identity Panel (refer to GE drwg. 173C8949AB sh. 1).

Note Ground strap must be disconnected from the back side of the Identity Panel.

2. Label and disconnect all wires from the DSFC board and the shunt boards, then secure wires away from the work area.
3. Loosen the bolt at the bottom of the shunts, then remove the bolts from the connection at the top of the shunts so the shunts can be rotated down and out of the way.
4. Remove the four bolts, lock washers, and flat washers from the right end of the dc buses.
5. Remove the top and bottom dc buses from the IGBT and capacitor buses by removing the 18 nuts, lock washers, and flat washers.
6. Disconnect the four push-on connections in the center of the CBPL connections on the phase C capacitor bus only.
7. Remove the bus connections from the dc-through bus to the switch or splice plate to allow room for the heat exchanger liftout tool (18 bolts, required for phase C only).
8. Obtain a heat exchanger liftout tool (cat# 246B9949BPG1) and install it in the cabinet over heat exchanger (refer to GE drwg. 173C8949AB sh. 1).
9. Bolt the hanging lift plate to the four fan assembly holes in the heat exchanger. (The ¼-20 bolts from the fan assembly can be used for this purpose.)
10. Remove the ¼-20 bolts connecting the heat exchanger assembly support bracket to the back panel.
11. Pull the heat exchanger assembly forward until the roller on the liftout tool reaches the end stop pin, then remove the heat exchanger assembly and set it aside.
12. Repeat the steps 1 through 11 for phases A and B.

➢ **Reverse steps 1 through 12 to re-install.**

620 and 1000 Frame Non-regenerative Source

➢ **To replace the heat exchanger**

1. Remove the fan assembly per the *Fan Assembly Replacement* section procedure, then label and disconnect all wires from the RSCA boards (wire bundles must be cut away from heat exchanger wire support bracket.)
2. Cut the tie wraps holding the shunt leads to the RSCA boards and disconnect from shunt boards, then secure shunt leads/wires away from work area.
3. Unsnap the gate leads from the backside of the RSCA boards.
4. Remove the three kepnuts from each RSCA board, then remove each board and it set aside.

5. Remove the shunt, bus, and fuse assembly as follows:
   a. Remove the center standoff , flat washer, and lock washer from the SCR/diode bricks.
   b. Remove the rear ac fuse bolt, then remove shunt , bus, and fuse as a complete assembly.
   c. Repeat for remaining phases.
6. Remove the two 3/8-16 bolts from the anode collector bus (located at the upper left of the heat sink area).
7. Remove the two ½-13 bolts from the cathode collector bus and secure the bus out of the work area.
8. Disconnect the thermistor leads from the bottom of the heatsink and tie them back out of the way.
9. Disconnect the leads from the dc bus (located to the left of the anode collector bus connection), then cut them away from heat exchanger wire support bracket and secure these leads away from work area .
10. Remove the Identity Panel (refer to GE drwg. 173C8949AB sh. 1).

Note Ground strap must be disconnected from the back side of the Identity Panel.

11. Obtain a heat exchanger liftout tool (cat# 246B9949BPG1) and install it in the cabinet over heat exchanger (refer to GE drwg. 173C8949AB sh. 1).
12. Bolt the hanging lift plate to the four fan assembly holes in the heat exchanger. (The ¼-20 bolts from the fan assembly can be used for this purpose.)
13. Remove the ¼-20 bolts connecting the heat exchanger assembly support bracket to the back panel.
14. Pull the heat exchanger assembly forward until the roller on the liftout tool reaches the end stop pin, then remove the heat exchanger assembly and set it aside.

➢ **Reverse steps 1 through 14 to re-install.**

1800 Frame Non-regenerative Source

➢ **To replace the heat exchanger**

1. Remove the fan assembly per the *Fan Assembly Replacement* section procedure, then label and disconnect all wires from the RSCA/RSCB boards.
2. Cut the tie wraps holding the shunt leads to the RSCA boards, disconnect shunt leads from shunt boards, and tie shunt leads/wires away from work area.
3. Unsnap the gate leads from the backside of the RSCA boards.
4. Remove the kepnuts from each RSCA/RSCB board, then remove the boards and set aside.
5. Remove shunts and shunt boards and set aside.
6. Remove standoffs, lock washers, and flat washers from the SCR/diode bricks and them set aside.
7. Remove the centertap buses from the SCR/diode bricks and set them aside.
8. Disconnect the thermistor leads from the top of the heatsink and tie the leads back out of the way.

9. Disconnect the leads from the dc bus below the dc link fuse.
10. Remove the four bolts connecting the diode (dc negative) bus, remove the bus, and set it aside.
11. Remove the four bolts connecting the SCR bus, remove the bus, and set it aside.
12. Support the heat exchanger assembly and remove the four ¼-20 bolts connecting the heat exchanger assembly to the back panel, then remove it and set aside.

➢ **Reverse steps 1 through 12 to re-install.**

Capacitor Assembly Replacement

The following sections provide instructions for replacing the capacitor assembly on the low voltage drives. These procedures are organized per frame size and type of drive.

65, 92, 125, and 180 Frame Inverter

➢ **To replace the capacitor assembly**

1. Remove the heat exchanger per the *Heat Exchanger Replacement* section procedure.
2. Remove the capacitor bus connection bolts, then remove the capacitor bus.
3. Inspect the capacitor bus insulation to make sure there are no scratches or nicks.
4. Support the capacitor assembly, then remove the four ¼-20 bolts holding the capacitor assembly to the back panel and remove the entire capacitor assembly.

➢ **Reverse steps 1 through 4 to re-install.**

250, 375, and 620 Frame Inverter or Regenerative Source

➢ **To replace the capacitor assembly**

1. Remove the heat exchanger per the *Heat Exchanger Replacement* section procedure.
2. Disconnect the CBPL wires on the lower right corner of the capacitor bus assembly.
3. Remove the bolts connecting the capacitor bus to the dc bus on the left side of the capacitor bus assembly.
4. Support the capacitor assembly, then remove the four ¼-20 bolts holding the capacitor assembly to the back panel and remove the entire capacitor assembly.

➢ **Reverse steps 1 through 4 to re-install.**

1000 and 1800 Frame Inverter or Regenerative Source

➢ **To replace the capacitor assembly**

1. Remove the heat exchanger per the *Heat Exchanger Replacement* section procedure.
2. Support the capacitor assembly, then remove the four ¼-20 bolts holding the capacitor assembly to the back panel and remove the entire capacitor assembly.
3. Repeat steps 1 and 2 for the remaining two phases.

➢ **Reverse steps 1 through 3 to re-install.**

620, 1000, and 1800 Frame Non-regenerative Source

➢ **To replace the capacitor assembly**

1. Remove the heat exchanger per the *Heat Exchanger Replacement* section procedure.
2. Remove the bolts connecting the dc bus to the left side of the capacitor banks.
3. Remove the negative bus and set aside.
4. Loosen the bottom two ¼-20 bolts in the slotted holes in the bottom of the capacitor assembly to be removed.
5. Support the capacitor assembly, remove the top two ¼-20 bolts and lean the top forward, then lift the capacitor assembly up and out of the cabinet.
6. Repeat steps 4 and 5 for the remaining two phases.

Note For the 1800 frame, if necessary the ac bus can be moved for better access to the bottom capacitor bank.

➢ **Reverse steps 1 through 6 to re-install.**

Replacing IGBT Modules

The following sections provide instructions for replacing the IGBT modules on the low voltage drives. These procedures are organized per frame size and type of drive.

620 Frame Drives

If an IGBT fails, both IGBT power modules for that phase should be replaced. Additionally, the DAMA board (IS200DAMA) in the affected phase was probably damaged during the failure, so must be replaced, too.

In the 620 frame drive, all three phases are contained on a singular heat exchanger assembly with six IGBT modules, two modules for each phase (see Figure 7-1).

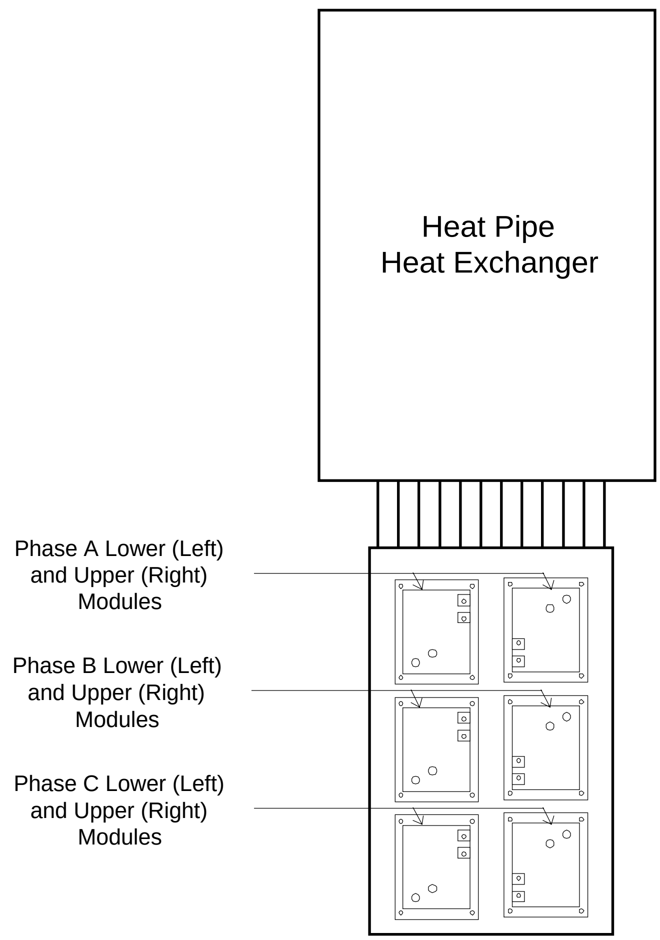


Figure 7-1. IGBT Module Location in 620 Frame Heat Exchanger Assembly

➢ To remove 620 frame IGBT modules from heat exchanger assembly

Note Refer to *Safety Precautions* section of this chapter for general board handling guidelines, including precautions to prevent board and cable damage.

1. Remove cables to the three DAMA boards as follows:
   a. Inspect the cable connections to verify that the cables are labeled with the appropriate connector names. (This will simplify reconnection.)
   b. Remove the cabling to the three DAMA boards and all three shunts.
   c. Secure the cables out of the way.
2. Remove the three DAMA boards by loosening the four slotted screws on each board. (These screws are captive in the board and should not be removed.)
3. Remove the two nuts on each DAMA board.
4. Slide the DAMA boards off the IGBT stud connections (refer to Figure 7-2).
5. Remove the shunt from the shunt bus and place it aside (refer to Figure 7-3).
6. Remove the two wire connections to the IGBT bus. Make note of the wire connections and orientation for re-assembly.
7. On the right hand side of the IGBT bus, remove the eight bolts that connect the bus to the capacitor assembly.
8. Remove the remaining six bolts that connect the IGBT bus to the IGBT modules.

Caution

Care must be taken when handling these buses. If epoxy coating is chipped or scratched, buses must be replaced.

9. Remove the IGBT buses from the IGBT modules by sliding them over the stud connections (refer to Figure 7-2).
10. Remove all three Lexan® shields by sliding them from the IGBT stud connections.
11. Remove the each IGBT by removing the four allen-head screws that secure the IGBT modules to the heat exchanger.
13. Remove the stand-off studs from the IGBTs

➢ To reinstall 620 frame IGBT modules

1. Clean the heat exchanger mounting surface of dirt and old thermal grease.

Note Make sure that IGBTs are installed as matched sets as detailed at the beginning of this section.

2. Apply a thin film (6 mils thick) of Dow Corning 340 Silicone Grease (or equivalent) to the back of the new IGBT modules and to the heat exchanger mounting surface.
3. Orient each IGBT module in the same position as the old IGBT module and start the four M6 bolts, lock washers, and flat washers.
4. Temporarily tighten the mounting bolts in diagonally opposite corners (using an “X” pattern).

5. Then, tighten these same bolts to 45 in-lbs torque in the opposite of step 4 (still using an “X” pattern).
6. Install the standoffs and torque to 13 in-lbs (as shown on Figure 7-2).
7. Install the Lexan shields.
8. Visually inspect the IGBT buses for chips, scratches, or cracks in the epoxy coating. Also look for mechanical deformation or other damage. If buses are marred or damaged, replace them before proceeding to to step 9.
9. Place the IGBT bus back into place over the stud connections.
10. Replace the six bolts that hold the IGBT bus to the IGBT modules and the eight bolts that connect the IGBT bus to the capacitor assembly.
11. Torque these bolts to 96 in-lbs.

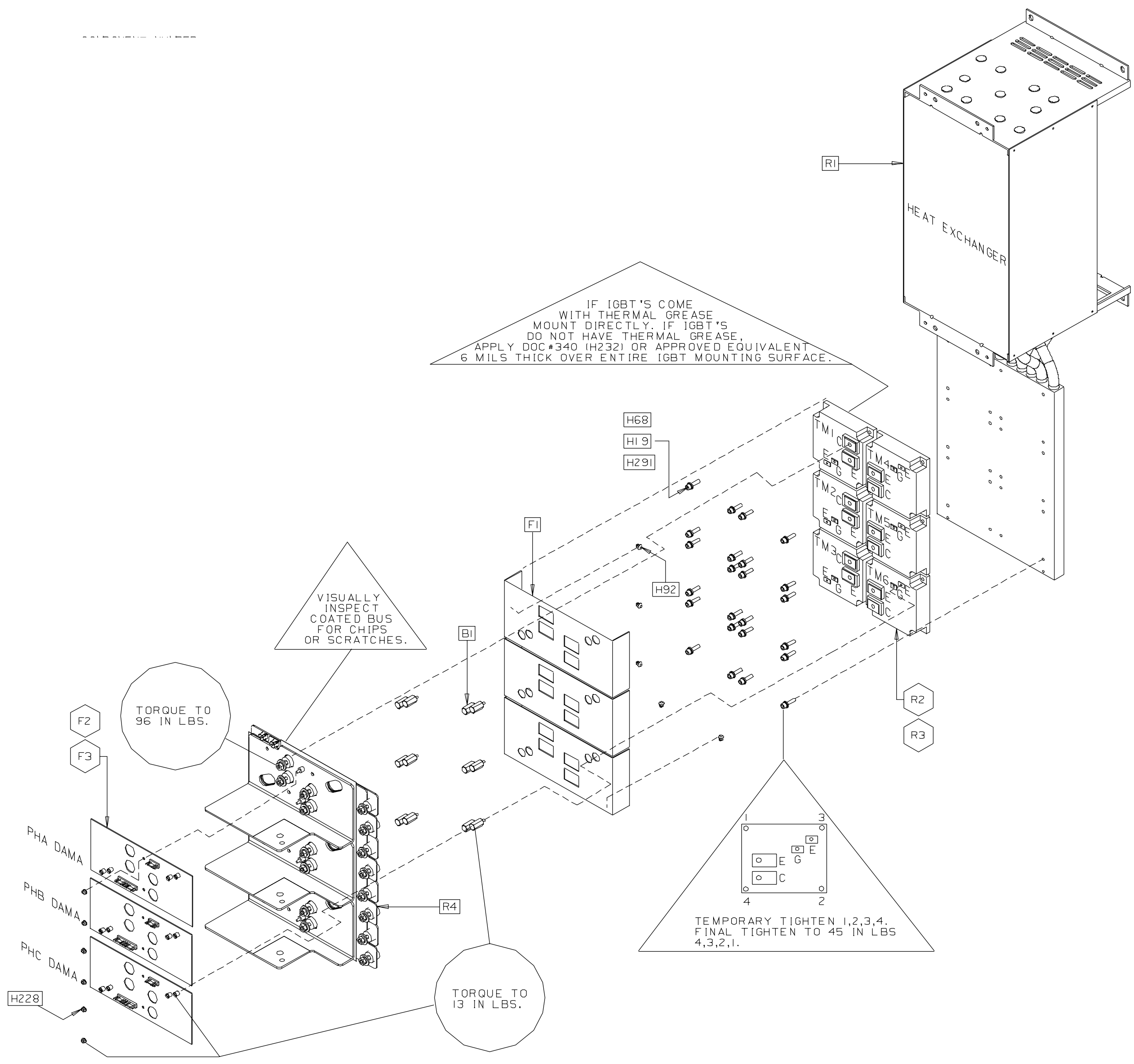


Figure 7-2. 620 Frame Heat Exchanger Assembly

12. Re-connect the two wires to the IGBT bus.
13. Install the shunt.
14. Install each of the DAMA boards, the two nuts, and the four captive screws.

Note In most instances of IGBT module failure, the DAMA board in the affected phase is also damaged and must be replaced.

15. Torque to 13 in-lbs
16. Install the cabling to the DAMA boards and shunt (the label for each cable connection should match the connector name on the board).
17. Verify proper orientation of the connectors before installation. (Cable connections are mechanically keyed.)
18. Visually inspect buses, cable connections, and bolted connections for correct installation.
19. Check that no tools, debris, or hardware is left in the drive before energizing it.

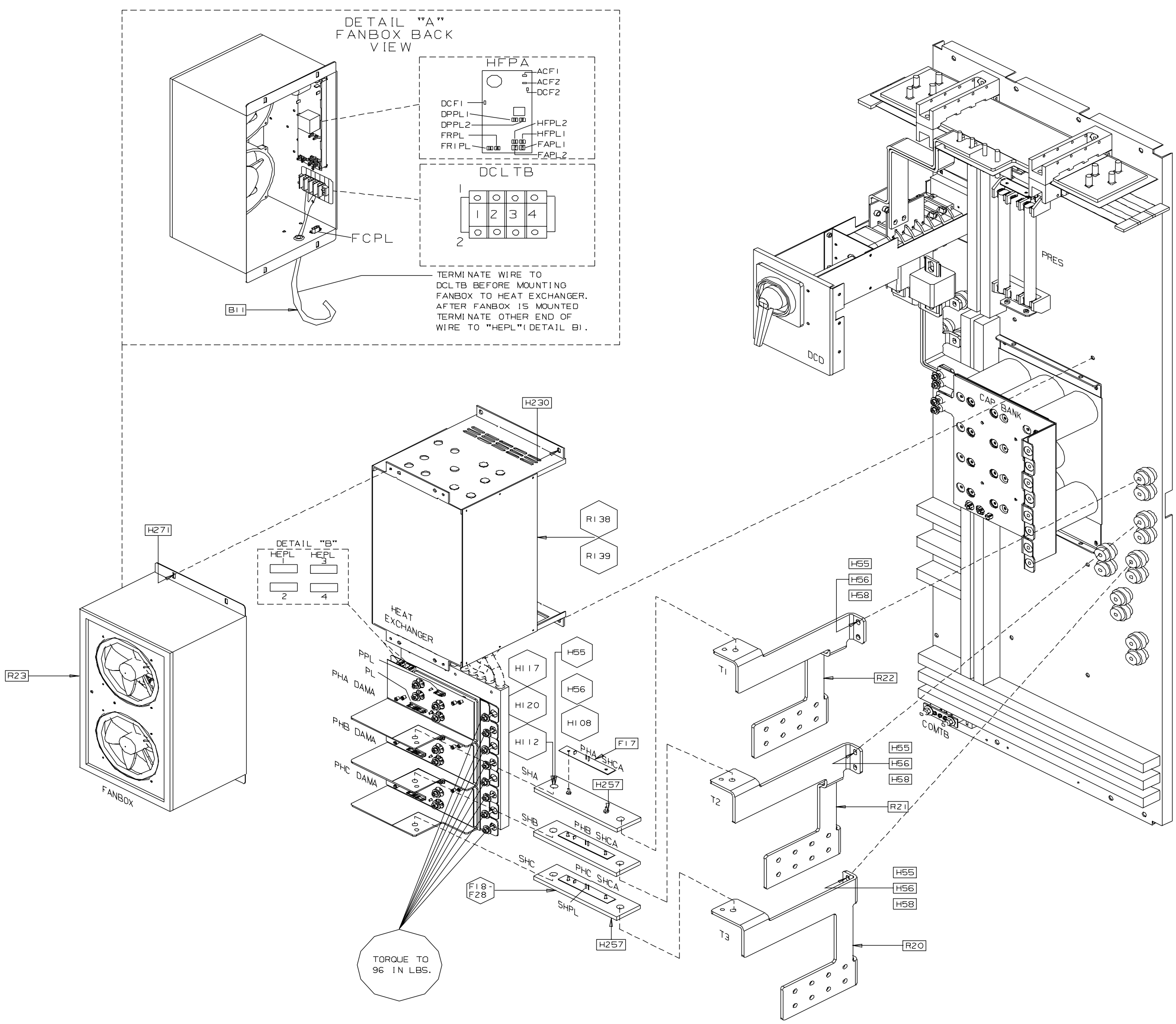


Figure 7-3. 620 Frame Panel Assembly

1000 Frame Drives

If an IGBT fails, all four IGBT power modules for that phase should be replaced. Additionally, the DSFC board (IS200DSFC) in the affected phase was probably damaged during the failure, so must be replaced, too.

In the 1000 frame drive, each phase consists of a singular heat exchanger assembly with four IGBT modules (see Figure 7-4). All four IGBTs should be replaced as a matched set (the white letter on the face of the IGBT Module … I, J, K, L, M…must be the same for all four devices).

Note At a minimum, the IGBTs for the two devices in the *upper* positions of the heat exchanger should be replaced as a matched set of two, and the IGBTs for the two devices in the *lower* positions should be replaced as a matched set of two.

➢ To remove 1000 frame IGBT modules from heat exchanger assembly

Note Refer to *Safety Precautions* section of this chapter for general board handling guidelines, including precautions to prevent board and cable damage.

1. Remove cables to the three DSFC board as follows:
   a. Inspect the cable connections to verify that the cables are labeled with the appropriate connector names. (This will simplify reconnection.)
   b. Remove the cabling to the DSFC.
   c. Secure the cables out of the way.
2. Remove the DSFC board by loosening the eight slotted screws on the board. (These screws are captive in the board, and should not be removed.)
3. Remove the five M4 kepnuts.
4. Slide the DSFC boards off the IGBT stud connections (refer to Figure 7-5).
5. Remove the Lexan shield by sliding it from the IGBT stud connections.
6. Remove the bolt from the connection at the top of the shunt. Then loosen the bolt at the bottom of the shunt so that it can be rotated out of the way (refer to Figure 7-6).
7. Remove the four bolts, lock washers, and flat washers from the right end of the dc buses.
8. Remove the top and bottom dc buses from the IGBT and capacitor buses by removing the 18 nuts, lock washers, and flat washers (6 per phase).

Caution

Care must be taken when handling these buses. If epoxy coating is chipped or scratched, buses must be replaced.

9. Remove the five M8 standoffs, the three M8 bolts, and the eight M4 standoffs.
10. Remove the IGBT buses (refer to Figure 7-5).
11. Remove the IGBTs from the heat exchanger by removing the four M6 bolts, lock washers, and flat washers from each IGBT.

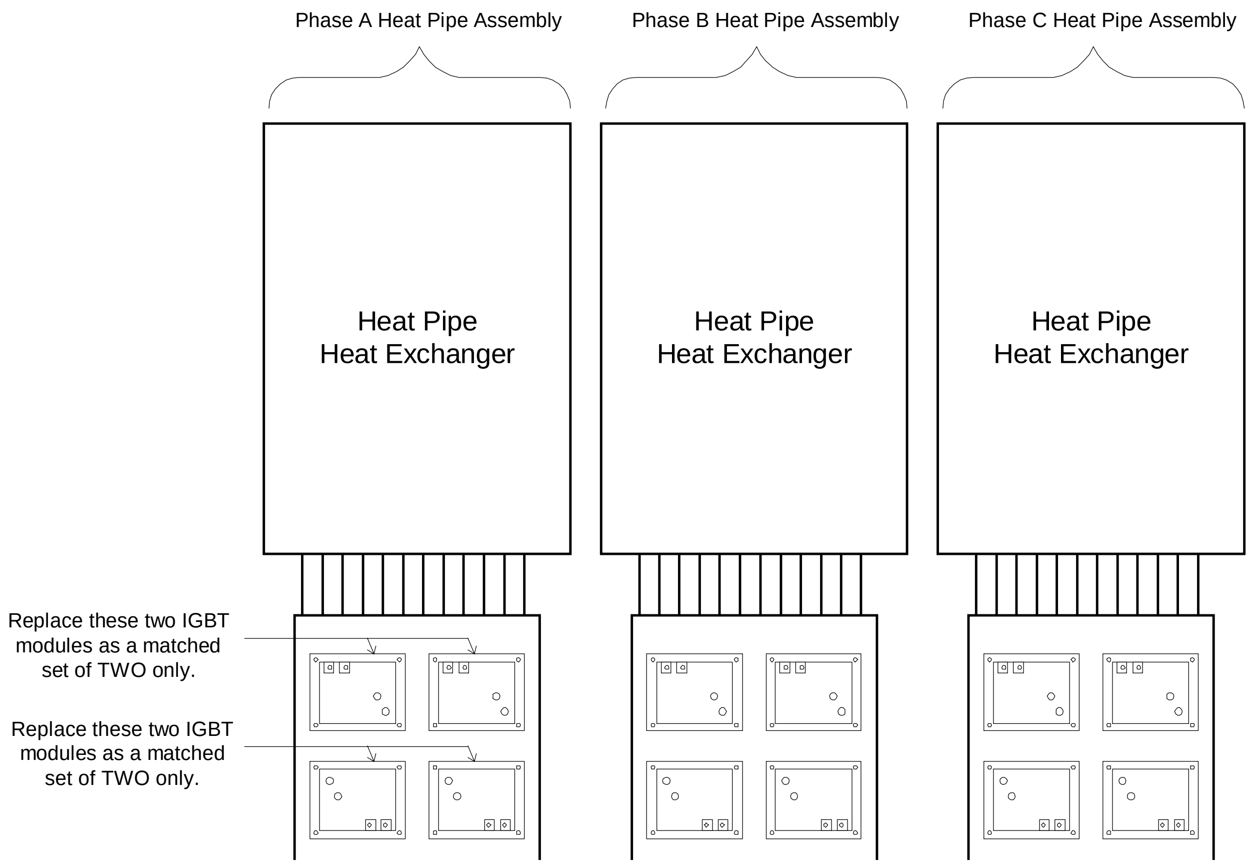


Figure 7-4. IGBT Module Location in 1000 Frame Heat Exchanger Assembly

➢ To reinstall 1000 frame IGBT modules

1. Clean the heat exchanger mounting surface of dirt and old thermal grease.

Note Make sure that IGBTs are installed as matched sets as detailed at the beginning of this section.

2. Apply a thin film (6 mils thick) of Dow Corning 340 Silicone Grease (or equivalent) to the back of each new IGBT module.
3. Orient each IGBT module in the same position as the old IGBT module and start the four M6 bolts, lock washers, and flat washers.
4. Temporarily tighten the mounting bolts in diagonally opposite corners (using an “X” pattern).
5. Then, tighten these same bolts to 45 in-lbs torque in the opposite of step 4 (still using an “X” pattern).
6. Install the eight M4 standoffs and torque to 13 in-lbs (as shown on Figure 7-5).
7. Visually inspect the IGBT buses for chips, scratches, or cracks in the epoxy coating. Also look for mechanical deformation or other damage. If buses are marred or damaged, replace them before proceeding to step 8.
8. Place the IGBT bus back into place over the M4 stud connections.

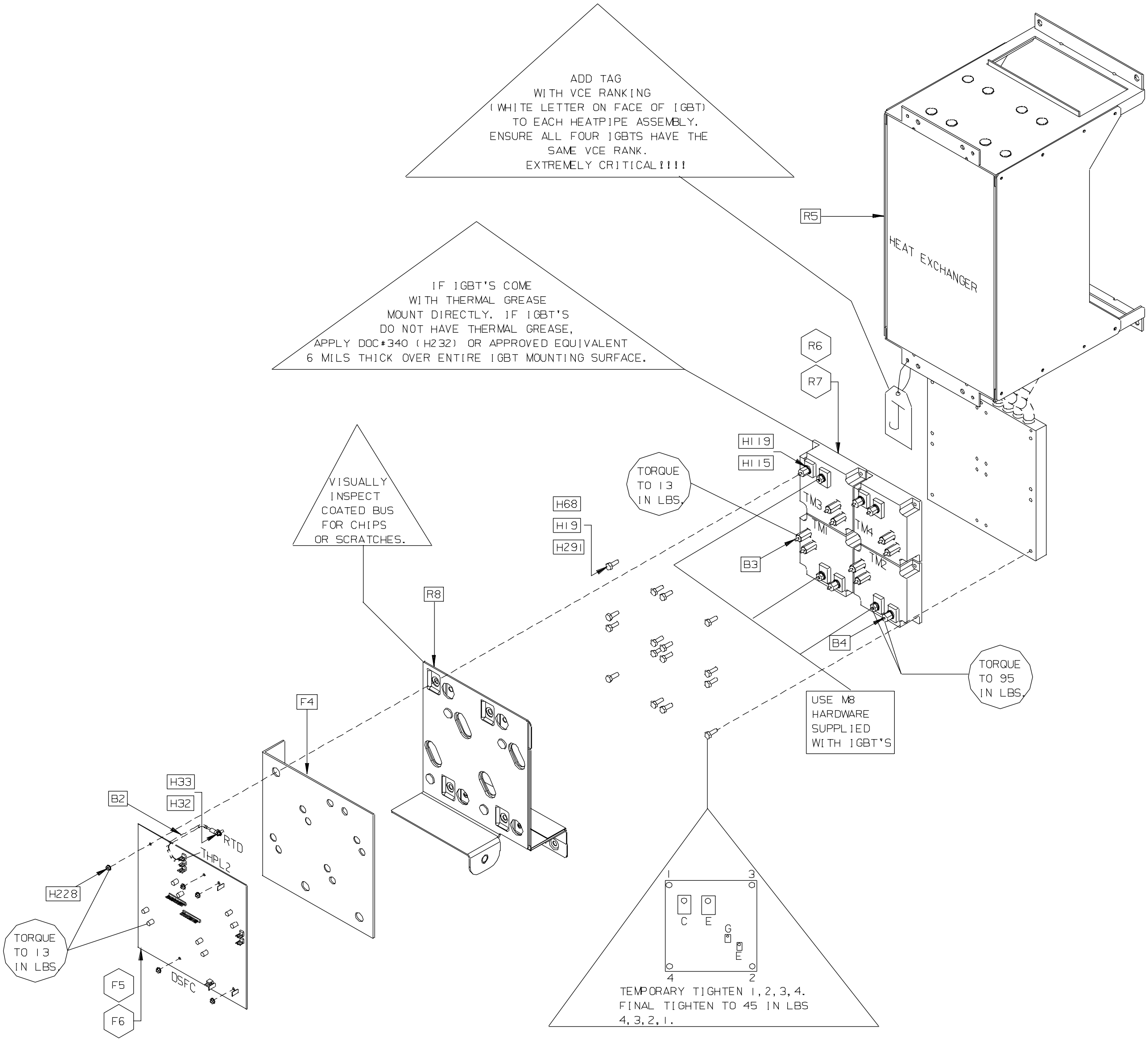


Figure 7-5. 1000 Frame Heat Exchanger Assembly

9. Install the five M8 standoffs and the three M8 bolts. Make sure that the M8 standoffs and M8 bolts are place in the proper positions on the IGBT module.
10. Torque these bolts to 95 in-lbs.
11. Replace the dc buses.
12. Install the shunt.
13. Install the Lexan shield, making sure that it is properly oriented.
14. Install each of the DSFC boards with the five M4 kepnuts and eight captive screws.

Note In most instances of IGBT module failure, the DSFC board in the affected phase is also damaged and must be replaced.

---

15. Torque to 13 in-lbs.
16. Install the cabling to the DSFC board (the label for each cable connection should match the connector name on the board).
17. Verify proper orientation of the connectors before installation. (Cable connections are mechanically keyed.)
18. Visually inspect buses, cable connections, and bolted connections for correct installation.
19. Check that no tools, debris, or hardware is left in the drive before energizing it.

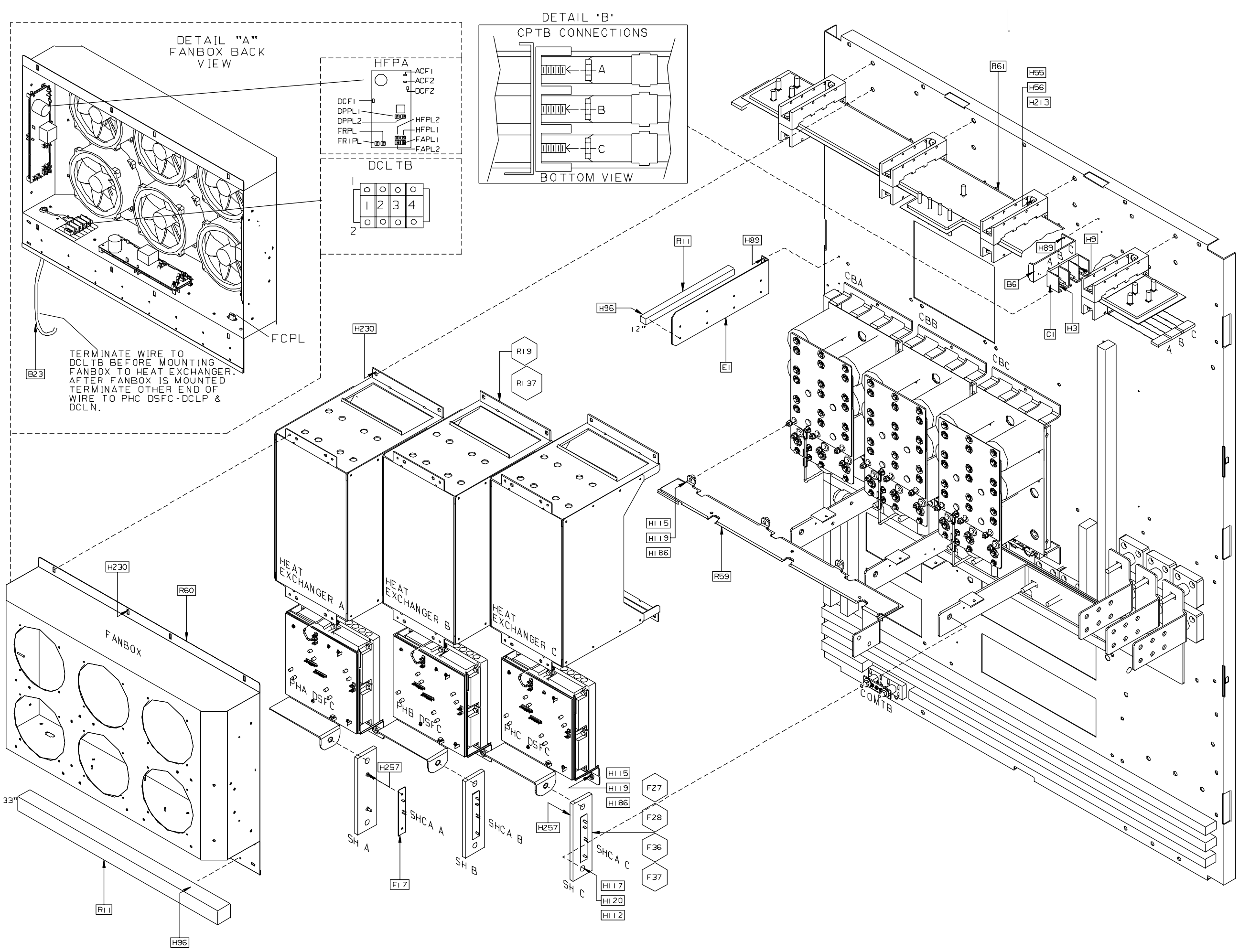


Figure 7-6. 1000 Frame Drive Panel Assembly

1800 Frame Drives

If an IGBT fails, all eight IGBT power modules for that phase and the DSFC board should be replaced (the board is typically damaged, too).

In the 1800 frame drive, each phase consists of two heatpipe assemblies, each with four matched IGBT modules (see Figure 7-7). All eight IGBTs should be replaced as a matched set (the white letter on the face of the IGBT Module … I, J, K, L, M…must be the same for all four devices).

However, **at a minimum,** replace the IGBTs in the *upper* part of the heat exchanger as a matched set of four; likewise, replace the four *lower* IGBTs as a matched set of four.

The following procedures describe steps to remove the IGBT modules from the heat exchanger assembly and install new ones.

➢ To remove 1800 frame IGBT modules from heat exchanger assembly

Note Refer to *Safety Precautions* section of this chapter for general board handling guidelines, including precautions to prevent board and cable damage.

1. Remove cables to the DSFC board as follows:
    a. Inspect the cable connections to verify that the cables are labeled with the appropriate connector names (to simplify reconnection.)
    b. Remove the cabling to the DSFC.
    c. Secure the cables out of the way.
2. Remove the DSFC board by loosening the eight slotted screws on the board. (These screws are captive in the board, and should not be removed.
3. Remove the five M4 kepnuts.
4. Slide the DSFC boards off the IGBT stud connections.
5. Remove the Lexan shield by sliding it from the IGBT stud connections.
6. Remove the bolt from the connection at the top of the shunt. Then loosen the bolt at the bottom of the shunt so that it can be rotated out of the way.
7. For each phase, the dc bus is connected to the adjacent phase by a small connecting splice plate. Remove these plates by removing the 3/16 kepnuts on the top and bottom of the dc bus.
8. If phase A (the leftmost heatpipe assembly) is being repaired, then remove the connecting bus between the dc power incoming power section and the IGBT section.
9. Remove the top and bottom dc buses from the IGBT and capacitor buses by removing the 18 nuts, lock washers, and flat washers (6 per phase).

Caution

Care must be taken when handling these buses. If epoxy coating is chipped or scratched, buses must be replaced.

10. Remove the five M8 standoffs, the three M8 bolts, and the eight M4 standoffs.
11. Remove the IGBT buses.

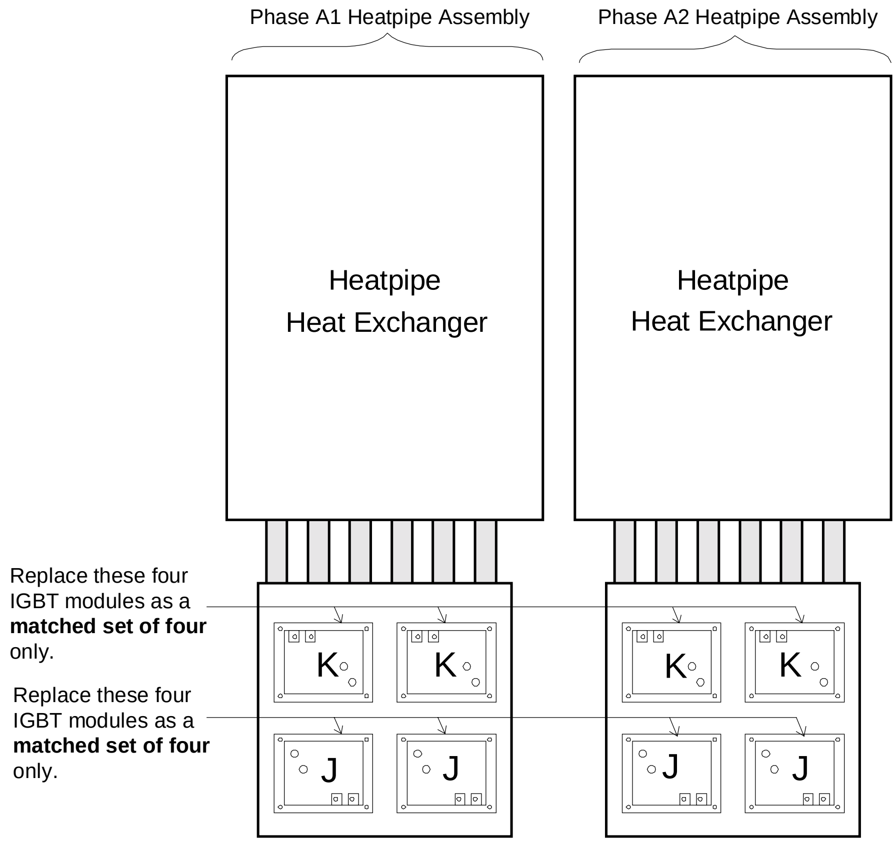


Figure 7-7. IGBT Module Location in 1800 Frame Heat Exchanger Assembly

12. Remove the IGBTs from the heat exchanger by removing the four M6 bolts, lock washers, and flat washers from each IGBT.

➢ To reinstall 1800 frame IGBT modules

1. Clean the heat exchanger mounting surface of dirt and old thermal grease.

Note Make sure that IGBTs are installed as matched sets as detailed at the beginning of this section.

2. Apply a thin film (6 mils thick) of Dow Corning 340 Silicone Grease (or equivalent) to the back of each new IGBT module.
3. Orient each IGBT module in the same position as the old IGBT module, then start the four M6 bolts, lock washers, and flat washers.
4. Temporarily tighten the mounting bolts in diagonally opposite corners (using an “X” pattern).
5. Then, tighten these same bolts to 45 in-lbs torque in the opposite of step 4 (still using an “X” pattern).
6. Install the eight M4 standoffs and torque to 13 in-lbs.
7. Visually inspect the IGBT buses for chips, scratches, or cracks in the epoxy coating. Also, look for mechanical deformation or other damage. If buses are marred or damaged, replace them before proceeding to step 8.

8. Place the IGBT bus back into place over the M4 stud connections.
9. Install the five M8 standoffs and the three M8 bolts. Make sure that the M8 standoffs and M8 bolts are place in the proper positions on the IGBT module.
10. Torque these bolts and standoffs to 95 in-lbs.
11. Replace the dc buses and connecting splice plates.
12. Install the shunt.
13. Install the Lexan shield, making sure that it is properly oriented.
14. Install the DSFC board with the five M4 kepnuts and eight captive screws.

Note In most instances of IGBT module failure, the DSFC board in the affected phase is also damaged and must be replaced.

---

15. Torque to 13 in-lbs.
16. Install the cabling to the DSFC board (the label for each cable connection should match the connector name on the board).
17. Verify proper orientation of the connectors before installation. (Cable connections are mechanically keyed.)
18. Visually inspect buses, cable connections, and bolted connections for correct installation.
19. Check that no tools, debris, or hardware is left in the drive before energizing it.

Appendix A Warranty and Renewal Parts

Introduction

When ordering a replacement part for a GE drive, the customer needs to know:

- How to accurately identify the part
- If the part is under warranty
- How to place the order

This information helps ensure that GE can process the order accurately and as soon as possible.

To minimize system downtime if repair is needed, GE recommends that the customer keep a set of **spare parts** on hand. The *Renewal Parts Quotation* lists recommended spares.

Appendix A of this manual provides information to help the user identify and obtain replacement parts. It is organized as follows:

Section ***Page***

Identifying the Part

A drive component, or part, is identified by its assigned **part number** and **description**. The part number is normally found on a nameplate on the component. The description is included in the parts tables in Appendix C and in the system renewal parts list.

Renewal Parts List

The *Renewal Parts Quotation* is a separate document that lists the parts of a **complete system.** This list applies specifically to the equipment furnished on a customer's particular application (requisition) at the time of shipment. It includes:

- Part numbers and descriptions
- Quantity used
- Recommended spares to keep onhand
- Normal delivery cycle for obtaining each part

GE provides the *Renewal Parts Quotation* with the drive's custom instructions. If this document is missing, contact the nearest GE sales office or service representative to obtain a replacement copy. You need to provide the following information (see Figure A-4) to correctly identify the system:

- Requisition number
- Material List number
- Item number

Part Number Structure

A GE part number is structured so that different portions of the number identify the **type of equipment** and **location of manufacture**. A part falls into one of four categories:

- Order-specific assemblies – Major assemblies or items that make up a specific drive; constructed from common assemblies
- Common assemblies – Subassemblies used in many GE drive products, not just a specific drive
- Components – Individual parts that make up assemblies
- Printed wiring boards

These categories and the makeup of their part numbers are defined below.

Order-Specific Assemblies

These parts make up the particular drive. Other items obtained specifically for the order may also use a similar part number structure, which provides information about the equipment (see Figure A-1).

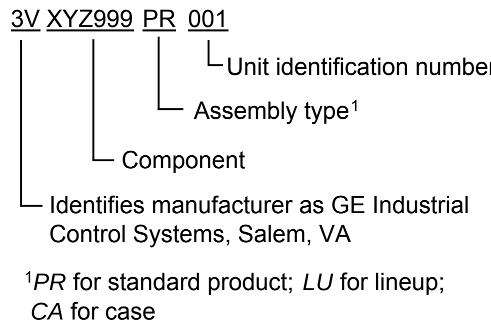


Figure A-1. Sample Part Number for Order-Specific Assembly

Common Assemblies

Common assemblies are subassemblies used as components of order-specific assemblies. Common assemblies are not designed for a particular drive, but provide a function used in other GE products.

A common assembly part number consists of the number *36* followed by an alphanumeric character. It may contain up to 14 characters.

For example, *36C774524AAG48* is the part number for a drive cable.

Components

Components are the **basic parts** that make up assemblies. They represent the lowest discrete level of a system. Component part numbers consist of a combination of alphanumeric characters that define the class and specific item. Figure A-2 shows a sample.

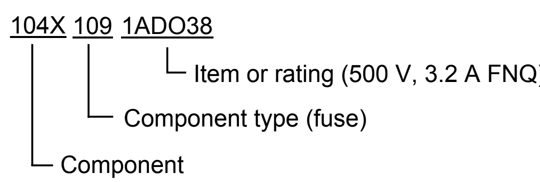


Figure A-2. Sample Part Number for Component

Printed Wiring Boards

A printed wiring board is identified by an alphanumeric part (catalog) number stamped near its edge. Figure A-3 describes the structure of a board's part number.

Note All digits are important when ordering or replacing any board.

The factory may substitute later versions of boards based on availability and design enhancements. However, GE Industrial Systems ensures compatibility of replacement boards.

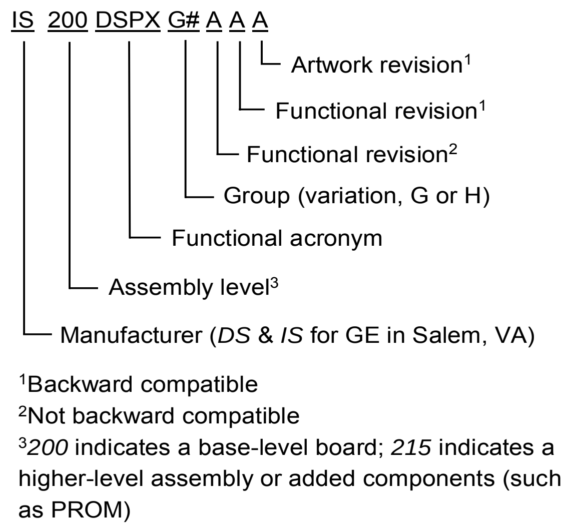


Figure A-3. Sample Board Part Number

Intelligent Part Number

The Intelligent Part Number (IPN) defines the drive configuration, independent of requisition requirements (this number is not unique for each customer order). It is structured so that the Base number indicates the drive type (for example, dc-fed ac drive), while additional digits identify other features (see Figure A-4). The Base and Frame digits together make up the Device ID, which is used in the system firmware.

The IPN is found on the system elementary, and may also be included on data nameplate.

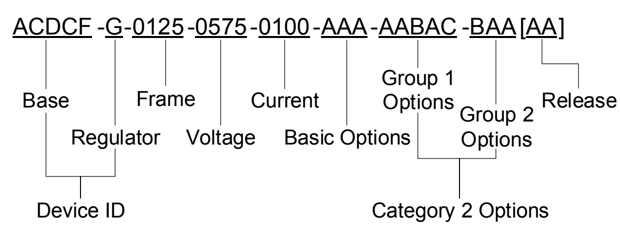


Figure A-4. Intelligent Part Number Structure

Warranty Terms

The GE *Terms and Conditions* brochure details product warranty information, including **warranty period** and **parts and service coverage**. The brochure is included with customer documentation. It may be obtained separately from the nearest GE Sales Office or authorized GE Sales Representative.

Note Standard warranty is 18 months from shipment or 12 months from when power is first applied, whichever comes first.

How to Order Parts

Parts still under **warranty** may be obtained directly from the factory:

GE Industrial Systems
Product Service Engineering
1501 Roanoke Blvd.
Salem, VA 24153-6492 USA

Phone: + 1 800 533 5885 (United States, Canada, Mexico)
+ 1 540 378 3280 (International)

Fax: + 1 540 387 8606 (All)

("+" indicates the international access code required when calling from outside of the USA.)

Renewals (spares or those not under warranty) should be ordered by contacting the nearest GE Sales or Service Office. Be sure to include the following when ordering any warranty or renewal parts:

- Complete part number and description
- Drive serial number
- Drive Material List number

Data Nameplate

The data nameplate is located on the back of the cabinet door. It provides information needed when ordering parts or contacting GE for assistance (see Figure A-5 for example).

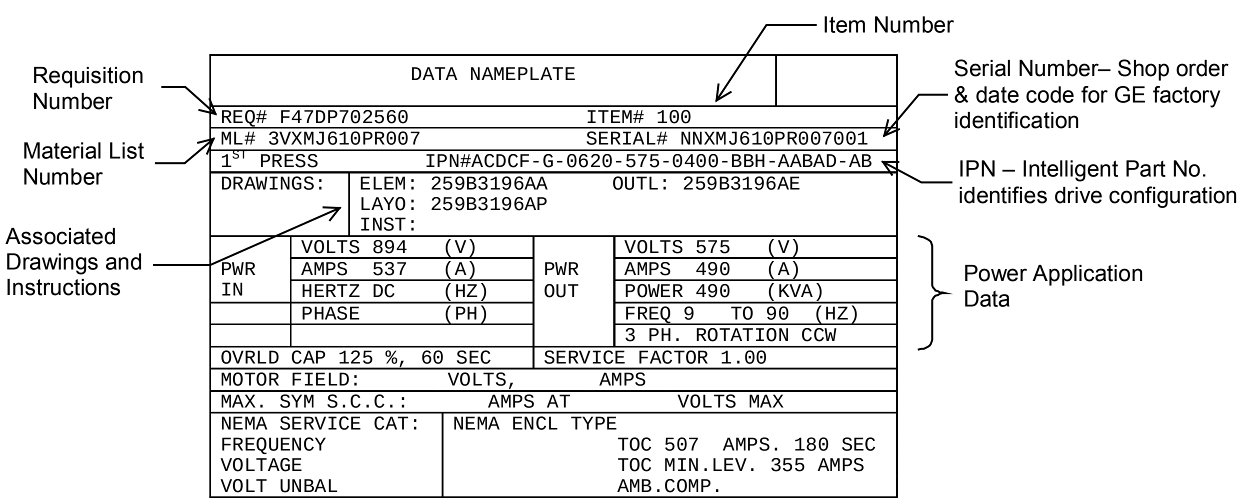


Figure A-5. Typical Data Nameplate

ML Number

Each GE lineup, cabinet (panel)/case, and core unit has a unique identifying catalog number, also called the **part or material list (ML) number**. This number is structured to provide information about that equipment (see Figure A-6 for example). The catalog number links the equipment to its requisition, drawings, components, materials, specification item, and shipping documents.

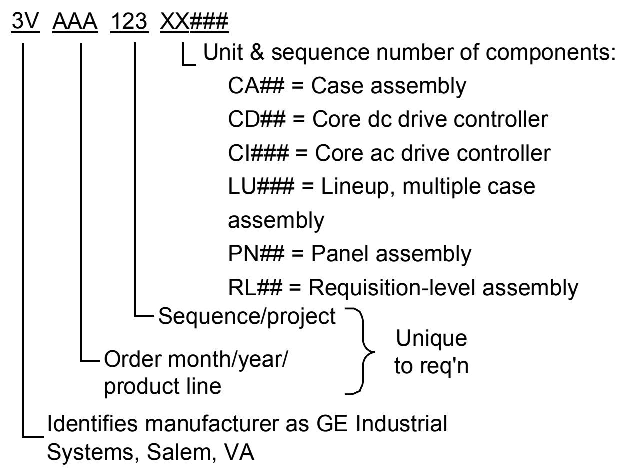


Figure A-6. Sample Drive ML (Catalog) Number

Appendix B Specifications

Source Specifications

Frame	Heat Loss (kW)	Hp (kW)	150% For 60s @ 575 VAC % OL	CONTINUOUS CURRENT RATING (A) - @1.5KHZ 10s	30s	60s	90s	120s
						460/575 V ac		
620	3.2	787 (587)	100%	768	768	768	768	768
			150%	756	756	756	747	737
			200%	683	627	597	580	568
1000	3.9	1052 (785)	100%	1224	1224	1224	1224	1224
			150%	1011	1011	1011	1011	1011
			200%	1011	1011	973	927	897
1800	6.6	1785 (1331)	100%	1820	1820	1820	1820	1820
			150%	1715	1715	1715	1213	1213
			200%	1715	1287	1287	910	910
375	3.0	359 (268)	100%	272	272	272	272	272
			150%	272	272	272	268	263
			200%	204	204	204		
			250%	163	163			
			300%	136				
620	4.8	595 (444)	100%	450	450	450	450	450
			150%	450	450	450	443	435
			200%	337	337	337		
			250%	270	270			
			300%	225				
1000	8.2	1123 (838)	100%	850	850	850	850	850
			150%	850	850	850	845	839
			200%	637	637	637		
			250%	510	510			
			300%	425				
1800	15.1	2022 (1508)	100%	1530	1530	1530	1530	1530
			150%	1530	1530	1530	1521	1510
			200%	1147	1147	1147		
			250%	918	918			
			300%	765				

Notes:

- All source frames are 602mm (24in) in depth.
- The regenerative source power ratings assume a source efficiency of 0.99.

Power Input – Specs		Item – Specs	
Input Voltage Variation	=/-10% Operating*	Control Line Dip/Ride Through	500ms
Input Frequency	50-60 Hz with No Derating	Displacement Power Factor	0.99 with non-regenerative source 1.0 with regenerative source
Voltage Dip/Ride Through	DC bus dips to 50% without tripping Full output torque for 8ms on complete line loss		

* With kW derate below 100% of nominal line voltage.

Non-Regenerative Source Specifications Example

1. Compute dc voltage requirements of the inverter. It is assumed that the source is dedicated to the inverter specified in the application example on page 9.

$$V_{dc\ Inverter} = 1.35 * V_{Source\ line\ to\ line} * (1 - L_{pu}/2)$$
$$= 1.35 * 575 * (1 - 0.05/2)$$
$$= 757\ V$$

L_{pu} = Per unit transformer impedance

2. Compute the dc current requirements of the source.

$$I_{dc\ Source} = \frac{kW_{Inverter} * 1000}{Eff_{Inv} * V_{dc\ Inverter}}$$
$$= \frac{150kW/(0.98*0.954) * 1000}{0.98 * 757}$$
$$= 217\ amps$$

3. The non-regenerative source current rating tables do not have entries for 200%. Thus, the 200% for 10 s requirement takes the 100% entries in the tables to 434 amps (2*217). Scan the 100% for 10 s entries in the non-regenerative source tables for a frame where the continuous current rating exceeds 434 amps. The 620 frame meets this criteria (735 amps), thus is the appropriate non-regenerative source for this applicaiton.

Regenerative Source Specifications Example

When specifying a source, start from the process and work through the motor to the inverter, and then associated source. The following examples illustrate process (continuation of inverter application

1. Compute kW requirements of the inverter. It is assumed that the source is dedicated to the inverter specified in the application example on page 9, and that the source is controlled to unity power factor.

$$kW_{Inverter} = \frac{kW_{Shaft}}{Eff_{Mtr}}$$
$$= \frac{150\ kW}{0.954}$$
$$= 157\ kW$$

2. Compute the kW requirements of the source.

$$kW_{Source} = \frac{kW_{Inverter}}{Eff_{Inverter}}$$
$$= \frac{157\ kW}{0.98}$$
$$= 160\ kW$$

3. Compute continuous current requirements for the source, based on its power requirements.

$$I_{Source\ Phase\ Current} = \frac{kW_{Source} \times 1000}{\sqrt{3} \times V_{Source\ line\ to\ line\ voltage} \times Eff_{Source}}$$
$$= \frac{161\ kW \times 1000}{\sqrt{3} \times 575\ V \times 0.985}$$
$$= 163\ amps$$

4. Scan the 200% for 10s entries in the regenerative source tables for a frame where the continuous current rating exceeds 163 amps. The 375 frame meets this criteria (204 amps); therefore, it is the appropriate regenerative source for this application. Refer to the Renerative Source table.

Note:For sources that are ALWAYS in a mode, a different equation is used to compute its requirements.

$$kW_{Source} = kW_{Shaftx} \times Eff_{Mtr} \times Eff_{Inverter}$$

Inverter Specifications

Frame	Heat Loss (kW)	VT 100% Continuous @ 575 V ac hp (kW)	CT 150% for 60s @ 575 V ac hp (kW)	%OL	Continuous Current Rating (A) - @1.5 kHz 460/575 V ac 10s	30s	60s	90s	120s
65	1	70 (52)	51 (38)	100%	65	65	65	65	65
				110%	61	61	60	60	60
				150%	50	48	47	46	46
				200%	40	38	37		
				300%	29				
92	1.5	99 (74)	72 (54)	100%	92	92	92	92	92
				110%	87	86	85	85	84
				150%	71	68	67	66	65
				200%	57	54	52		
				300%	40				
125	1.8	135 (100)	98 (73)	100%	125	125	125	125	125
				110%	118	117	116	116	115
				150%	96	93	91	89	88
				200%	77	73	71		
				300%	55				
180	2.5	194 (145)	141 (105)	100%	180	180	180	180	180
				110%	169	168	167	166	165
				150%	139	134	131	129	126
				200%	111	106	102		
				300%	79				
250	3.6	269 (201)	195 (145)	100%	250	250	250	250	250
				110%	235	233	232	231	230
				150%	193	186	181	179	175
				200%	155	147	142		
				300%	110				
375	5.2	404 (301)	293 (218)	100%	375	375	375	375	375
				110%	353	350	348	347	346
				150%	289	279	272	268	263
				200%	232	220	212		
				300%	165				
620	8	668 (498)	485 (361)	100%	620	620	620	620	620
				110%	583	579	576	574	573
				150%	478	461	450	443	435
				200%	384	364	351		
				300%	272				
1000	12.5	1077 (803)	915 (682)	100%	1000	1000	1000	1000	1000
				110%	974	968	964	962	960
				150%	886	865	850	845	839
				200%	701	675	660		
				300%	490				
1800	21.5	1938 (1445)	1647 (1228)	100%	1800	1800	1800	1800	1800
				110%	1753	1742	1735	1732	1730
				150%	1594	1557	1530	1521	1510
				200%	1262	1215	1188		
				300%	882				

Notes:

- All inverter frames are 602mm (24 in) in depth.
- The power ratings assume a motor efficiency of 95%, motor power factor of 0.85, ambient temperature of 5-40 °C, and altitude below 1000m (3300 ft) above sea level.
- The specified current ratings are continuous. The referenced overload can be applied to these. Refer to the application example on the following page.
- Each of the inverters support top or bottom cable entry.
- Higher chopping frequencies are available at a reduced rating.
- Refer to the chart on page 9 for VT rating information.

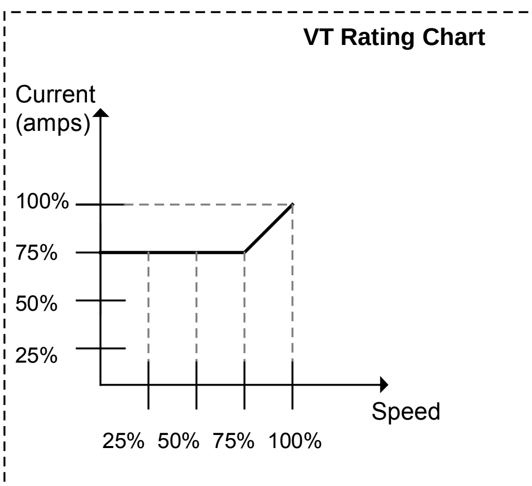
Power Output – Specs		Motor Control – Specs	
Output Voltage	0 - 575V	Speed regulator response with encoder @ default chopping frequency	248 Rad/s **
Output Frequency	0 – 200Hz 0 – 400Hz (*)	Speed regulator response with encoder @ default chopping frequency	15 Rad/s
Output Chopping Frequency	1.5kHz 3kHz (with derating) 6kHz (with derating)	Speed regulator accuracy with encoder, error	<0.01%
Inverter Type	Two level voltage source	Speed regulator accuracy without encoder, error 1% slip motor @ 100% load	<0.2%
Modulation	Pulse Width Modulated (PMW)	Torque regulator response with or without an encoder	1047 Rad/s
Power Semiconductor Technology	Insulated Gate Bipolar Transistor (IGBT) Inverter		
Power Semiconductor Isolation	NEMA, IEC-146-1-1	Torque regulator accuracy with or without encoder	<2%
Power Semiconductor Isolation from Control	Optical Coupled 2500V Isolation		

LAN Connectivity Options:

- ❑ Genius® Bus Interface Module
- ❑ Profibus-DP Interface Module
- ❑ Application Control Layer Module
    - Modbus RTU
    - Allen Bradley DH+
    - Modbus Ethernet™
    - Ethernet™ SRTP
    - Ethernet™ Global Data
    - ISBus (2 channels)
- ❑ ISBus – One channel standard

* Optional operation at 400Hz excludes the use of the Application Control Layer (ACL), Genius Bus communications module or the Profibus-DP communications module.

** Mechanical system permitting

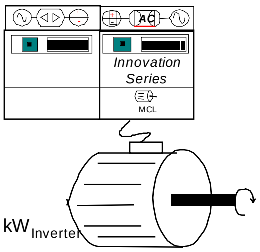


Inverter Specification Example

When specifying an inverter, start from the requirments and work through the motor to the inverter.

The following example illustrates this process:

① Define process requirements.



$kW_{Inverter}$

kW_{Shaft}= 150kW
201hp

Motor to deliver constant torque from zero to base speed of 900 r/min at 575 V ac.

Motor to deliver constant torque from zero to base speed of 900 r/min at 575 V ac.
Duty cycle requires 200% for 10s, with a continuous rating of 150kW.

② Select motor based on process requirements. A TEAO constant torque motor is selected from the GE A$D Buyers Guide:

- ❑ Frame size 449TS
- ❑ 200 hp (150kW)
- ❑ 900 r/min
- ❑ Efficiency = 0.954
- ❑ Power factor = 0.765

$$kVA_{Inverter} = \frac{kW_{Shaft}}{Eff_{Mtr} \times PF_{Mtr}} = \frac{150\ kW}{0.954 \times 0.765} = 206\ kVA$$

③ Based on the selected motor, compute continuous current requirements for the inverter.

Phase Current

$$I_{Inverter} = \frac{kVA_{Inverter} \times 1000}{\sqrt{3} \times V_{Inverter\ line\ to\ voltage}} = \frac{206\ kVA \times 1000}{\sqrt{3} \times 575\ V} = 207\ amps$$

④ Select inverter based on continuous current and overload requirements.

Scan the 200% for 10s entries in the inverter tables for a frame where the continuous current rating exceeds 207 amps. The 375 frame meets this criteria (232 amps); therefore, it is the appropriate inverter for this application. Refer to Inverter Specification table.

		VT 100% Continuous @ 575 V ac	CT 150% for 60s @ 575 V ac	Continuous Current Rating (A) - @1.5 kHz 460/575 V ac					
Frame	**Heat Loss (kW)**	**hp (kW)**	**hp (kW)**	**%OL**	**10s**	**30s**	**60s**	**90s**	**120s**
65	1	70 (52)	51 (38)	100%	65	65	65	65	65
				110%	61	61	60	60	60
				150%	50	48	47	46	46
				200%	40	38	37		
				300%	29				
92	1.5	99 (74)	72 (54)	100%	92	92	92	92	92
				110%	87	86	85	85	84
				150%	71	68	67	66	65
				200%	57	54	52		
				300%	40				
125	1.8	135 (100)	98 (73)	100%	125	125	125	125	125
				110%	118	117	116	116	115
				150%	96	93	91	89	88
				200%	77	73	71		
				300%	55				
180	2.5	194 (145)	141 (105)	100%	180	180	180	180	180
				110%	169	168	167	166	165
				150%	139	134	131	129	126
				200%	111	106	102		
				300%	79				
250	3.6	269 (201)	195 (145)	100%	250	250	250	250	250
				110%	235	233	232	231	230
				150%	193	186	181	179	175
				200%	155	147	142		
				300%	110				
375	5.2	404 (301)	293 (218)	100%	375	375	375	375	375
				110%	353	350	348	347	346
				150%	289	279	272	268	263
				200%	232	220	212		
				300%	165				
620	8	668 (498)	485 (361)	100%	620	620	620	620	620
				110%	583	579	576	574	573
				150%	478	461	450	443	435
				200%	384	364	351		
				300%	272				
1000	12.5	1077 (803)	915 (682)	100%	1000	1000	1000	1000	1000
				110%	974	968	964	962	960
				150%	886	865	850	845	839
				200%	701	675	660		
				300%	490				
1800	21.5	1938 (1445)	1647 (1228)	100%	1800	1800	1800	1800	1800
				110%	1753	1742	1735	1732	1730
				150%	1594	1557	1530	1521	1510
				200%	1262	1215	1188		
				300%	882				

Notes:

- All inverter frames are 602mm (24 in) in depth.
- The power ratings assume a motor efficiency of 95%, motor power factor of 0.85, ambient temperature of 5-40 °C, and altitude below 1000m (3300 ft) above sea level.
- The specified current ratings are continuous. The referenced overload can be applied to these. Refer to the application example on the following page.
- Each of the inverters support top or bottom cable entry.
- Higher chopping frequencies are available at a reduced rating.
- Refer to the chart on page 9 for VT rating information.

Environmental Specifications

Item	Description
Operating Temperature	0 to 40 ºC at rated load, 0 to 50 ºC with derating
Storage Temperature	−25 to 70 ºC
Humidity	5 to 95% relative humidity, non-condensing
Altitude	Normal operation at 0 to 1000 meters. Derate 4% per 1000 meters above 1000 meters.
Cooling	Heatpipe/air heat exchanger, forced air convection through dc powered fans

Additional Specifications

Item	Description
Enclosure	NEMA 1 (1P20), general purpose vented
Vibration	0.075 mm peak acceleration 10 – 57 Hz 1.0 g 57 – 150 Hz, tested per IEC 68.2.6 Test F Sub C
Acoustic Noise	59.8 – 72.7 dBa
EMI/RFI	Emissions and immunity per EN55011, ENV50140, ENV50141, ENV61000-4-2, ENV61000-4-4, ENV61000-4-5
Clearances	NEMA Tables 1-111-1, 1-111-2, CSA 22.2 N0. 14-95

Notes

Glossary of Terms

ACL_ module
IS200ACL_Application Control Layer module. This module contains the ACL controller functions for the drive (job specific, outer layer, drive control loops, and sequencing) and is located in the drive control rack.

application software
Job-specific software resident in the drive, designed specifically for the customer's application.

ACOM
Analog common. Used to supply power and signals to all analog devices and components fed by +50 and -50 V power supplies.

ALSA
IS200ALSA Ac Line Snubber Board, used to regulate the ac line. Located in the power bridge cabinet.

b
Alphabetic symbol for *bit*. Used in measurement (for example, *kb* for *kilobits*.)

B
Alphabetic symbol for *byte*. Used in measurement (for example, *kB* for *kilobytes*.)

BAIA
IS200BAIA Basic Input/Output Board, which provides for custom and application I/O that is located in the drive's control cabinet.

Baud
A measure of data transmission speed, representing the number of signal-state changes per second. Named after French engineer B.M.E. Baudot.

BICL
IS200BICL Bridge Interface Board. Located in the drive control rack.

Bit
A contraction of *binary digit*. The smallest possible unit of information.

Byte
A collection of eight bits. A byte can represent 256 different values or symbols. The common 7-bit ASCII codes used to represent characters in computer use are generally stored in a byte (one byte per character).

blocks (software)
Standard modules (blocks) of microprocessor code that perform specific software functions (for example, a speed regulator). Blocks are configured into the application program.

Board
Printed wiring board.

Boolean
Having two possible values (such as 0 or 1, on or off, true or false). Referring to a system of algebra and logic developed by English mathematician George Boole. This is the logic used by digital computers.
Programming: The type of an expression with two possible values, "true" and "false". Also, a variable of Boolean type or a function with Boolean arguments or results. The most common Boolean functions are AND, OR and NOT.

BPIA
IS200BPIA Bridge Personality Interface Board that is located in the drive control rack .

BPIB
IS200BPIB Bridge Personality Interface Board that is located in the drive control rack.

Bus
An electrical path for transmitting and receiving data.

Cable
A standard single conductor or a combination of conductors insulated from each other.

CABP
IS200CABP Control Rack Backplane Board. Located in the drive’s control cabinet.

coaxial cable
A type of wire cable with a solid metal core surrounded by an insulator, a combination shield and ground wire, and an outer protective jacket.

COM port
Serial controller communication ports (two). COM1 is reserved for diagnostic information and the Serial Loader. COM2 is used for I/O communication

Configure
To select specific options, either by setting the location of hardware jumpers or loading software parameters into memory.

Converter
A device that converts ac power to dc power, or vice-versa.

Connector
A device, either a plug or receptacle, used to terminate or connect cables.

control system
(Industrial.) A means of governing the starting, stopping, direction of motion, acceleration, speed, and retardation of the moving member of any electric apparatus, machine, or system.

control system toolbox
A Windows-based software package used to configure and perform diagnostics on controllers and drives.

CSA
Canadian Standards Association. An independent, nonprofit product standards and certification organization in Canada.

DAC
Digital-to-analog converter. An electronic circuit that converts digital data into analog signals.

DAMA
IS200DAMA 620 Amp IGBT Gate Drive Board. Located in the power bridge cabinet.

Daisychain
A network configuration in which devices are connected to each other in sequence.

DCOM
Digital common. Used to supply power and signals to all digital devices fed by +5, +12, and -12 V power supplies. Sometimes, this is also fed by the +28 V power supply.

DDI
See *Drive Diagnostic Interface*.

Drive
(Industrial.) The equipment used for converting available power into mechanical power suitable for operation of a machine. (See *control system.*)

Drive Diagnostic Interface
The operator interface module located on the front door of the drive's control cabinet Also called *DDI* or *the keypad*.

Device
A configurable component of a process control system.

Diagnostics
Software that checks drive hardware or software, providing error indications that identify the type or location of malfunction.

DSFC

IS200DSFC 1000/1800 Frame IGBT Gate Driver/Shunt Feedback Board. Located in the power bridge cabinet.

DSPX

IS200DSPX Digital Signal Processor board. Is the primary controller for the bridge and motor regulator and gating functions for Innovation Series drives. Located in the drive's control cabinet.

elementary diagram

Also called *elementary*. A schematic drawing that represents the electrical wiring and electrical connections of a device.

EMI

Electromagnetic interference. Any electromagnetic disturbance that interrupts, obstructs, or otherwise degrades or limits the effective performance of electronics/electrical equipment.

Ethernet

LAN with a 10/100 MB baud collision-avoidance/collision-detection system used to link one or more computers together. Basis for TCP/IP and I/O services layers that conforms to the IEEE 802.3 standard, developed by Xerox, Digital, and Intel.

fault code

A number that represents a drive malfunction, such a warning or failure. The drive controller automatically sends this code to the operator interface, such as the DDI (keypad). Also see *warning*, *failure, DDI.*

fiber-optic cable

A type of high speed cable that contains glass or plastic thread as its signal conductor surrounded by cushioning and insulation.

Filter

An electrical circuit that passes frequencies within a specified frequency band and attenuates signals that fall outside of that frequency band. (Also see *line filter, ac*.)

Firmware

The set of executable software that is stored in memory chips that hold their content without electrical power, such as EEPROM.

frame size

Size of drive cabinet, or cabinets. Determined by hardware components required for power application.

function (software)

The highest level of the blockware hierarchy.

GBIA

DS215GBIA Auxiliary Genius Interface Module that is located in the drive's control cabinet.

Genius bus

GE Fanuc's distributed network of intelligent I/O blocks.

Ground

An electrical path designed to disperse high-voltage electrical spikes, usually by routing them to the earth.

hardware (hard) reset

Reset generated by a hardware device, rather than by a software reset. Used to reset the drive boards, clear some faults, and allow certain parameter changes.

Hardwired

Refers to elements of a program or device that cannot be changed. Originally, the term was used to describe functionality that was built into the circuitry (the wires) of a device. Now, the term also is used to describe constants built into software.

Heatpipe

A heat exchanger consisting of a pipe with an interior of capillary material and a small amount of fluid in a partial vacuum. Heat is transferred by absorption at one end of the pipe through vaporization of the fluid and its subsequent condensation at the other end of the pipe.

HFPA

DS200HFPA High Frequency Ac/Fan Power Supply Board. Located in the power bridge cabinet.

IGBT

Insulated-gate bipolar transistor

Inverter

A device for converting direct current into alternating current.

I/O

Input/output. Data flow into and out of a device, or the term for input/output interfaces.

ISBB

IS200ISBB ISBus Bypass Board. Located in the drive's control cabinet

ISBD

IS200ISBB ISBus Delay Board. Located in the drive's control cabinet

ISBE

IS200ISBB ISBus Extender Board. Located in the drive's control cabinet

ISBus

A synchronous bus, serial communications system developed by GE for the Innovation Series drive system LAN. Uses RJ-45 connectors and Category 5 cabling with data transmission rate up to 5 Mbps.

K

Kilo. Alphabetic symbol for one thousand.

Keypad

See *Drive Diagnostic Interface*.

LAN

Local area network. A communications link that enables attached devices to communicate with each other over a limited geographical area. A typical LAN consists of peripheral devices and controllers contained in the same building, and often on the same floor.

layout drawing

A diagram showing the components of a panel (see definition), and their location and connections.

LED

Light-emitting diode. Used as a visual indicator for a board or drive function.

line filter, ac

A filter that connects from ac line to ac line at the input of a power converter. The filter consists of a series configuration of resistors and capacitors, which damps out high frequency oscillations on the ac power line.

m

Milli. Alphabetic symbol for 1 thousandth.

M

Mega. Alphabetic symbol for 1million.

MB

Megabyte. 220 or 1,048,576 bytes.

Mb

Megabit. 220 or 1,048,576 bits.

megger test

A test of an insulation system by using a megohm meter (megger) to pass a high voltage at low current through a device, then measuring resistance, usually in megohms.

Menu

A list of available software functions for selection of an operator, displayed on the computer screen after a software program has been entered or a software selection is made.

Module

(Hardware) An electronic assembly of boards, components, or a combination of these, that together perform a specific function.

(Software) A collection of tasks that have a defined scheduling period.

Network

A data communication system that links two or more computers and peripheral devices.

Noise

Electrical surges, spikes, or transients on transmission lines. Noise can cause slow or immediate damage to sensitive electronic equipment.

non-regenerative

See *regenerative*.

outline drawing

A drawing or diagram that shows the dimensions and non-detailed layout of a device or equipment.

Panel

The side or front of a piece of equipment on which terminations and termination assemblies are mounted.

panel layout drawing

See *layout drawing.*

Parameters

Adjustable software settings used to program and tune the drive. Parameter values, together with the pattern and version, define the drive behavior

PBIA

IS215PBIA ProfiBus-DP Interface Module. Located in the drive's control cabinet.

plug connector

An electrical fitting or termination assembly with contacts constructed to be electrically connected to a receptacle connector by being inserted into the receptacle connector. Also known as male connector.

RAM

Random access memory. Memory that can be both read from and written to.

Reactor

A device (such as a coil, winding, or conductor of small resistance) used to introduce reactance into an alternating-current circuit.

Reboot

See *hardware reset* and *software reset.*

receptacle connector

An electrical fitting or termination assembly with contacts constructed to be connected electrically to a cable by the insertion of the cable's plug connector into the receptacle connector. Also known as *female connector*.

Regenerative

Ability of a drive to return power from the motor armature to the ac line. Creates a braking effect on the motor.

RFI

Electromagnetic radiation in the radio frequency (RF) spectrum from 15 kHz to 100 GHz. The best shielding material against RFI are copper and aluminum alloys.

ring (network configuration)

A communications network topology in which a single cable is connected on both ends to one source, with nodes (or stations) hanging off the ring. Each node is connected to two others in the loop. Data is passed in one direction only, being received by each node and then transferred to the next node.

RAPA

IS200RAPA Control Rack Power Supply board that is located in the drive's control cabinet.

RCSA

IS200RCSA 1800 and 1000 Frame Snubber Board that is located in the power bridge cabinet.

RCSB

IS200RCSB 620 Frame Snubber Board that is located in the power bridge cabinet.

RJ-45

Registered jack-45. A serial connector, typically used in LANs to connect computer-based devices using Category 5 cable. Similar to a telephone jack, but with 8 wires.

RS-232C

An EIA Recommended Standard (RS) for the serial link communications interface for interconnecting data terminal equipment, such as printers, computer monitors, or computers to data communications equipment, such as modems, for transmission over a telephone line or network. RS-232C uses an unbalanced or single-ended voltage interface. (Also see *EIA*.)

RS-422

An EIA Recommended Standard (RS) that defines electrical characteristics of a serial link communications interface. The standard permits greater distances between equipment and faster data transfer than RS-232C. RS-422 is characterized by a balanced or differential voltage interface. (Also see *EIA*.)

safety ground

See *equipment grounding conductor*.

Shunt

A device having appreciable resistance or impedance connected in parallel across other devices or apparatus, and diverting some (but not all) of the current from it. Appreciable voltage exists across the shunted device or apparatus and an appreciable current may exist in it.

software (soft) reset

Reset initiated by software input, rather than by a hardware device. Activated by a serial input, or by pressing the DDI's RESET key.

terminal board

A type of I/O connector in which individual wires from external components are inserted into a connector point and are fastened by turning a screw on the connector.

Toolbox

See *control system toolbox*.

UL

Underwriters Laboratories. An independent, nonprofit organization that publishes standards for public safety. These standards are generally recognized by inspection authorities in the USA.

Wizard

An intelligent menu that leads the operator through a series of parameter edits, calculations, and command executions designed to accomplish a specific task.

Notes

Index

Index—continued

Index—continued

Notes

Reader Comments

General Electric Company

To:

GE Industrial Systems
Documentation Design, Rm. 291
1501 Roanoke Blvd.
Salem, VA 24153-6492 USA

Fax: 1-540-387-8615
(GE Internal DC 8-278-8651)

We welcome comments and suggestions to make this publication more useful.

Your Name	Today's Date	If needed, how can we contact you?
Your Company's Name and Address	Job Site	Fax No. ____
	GE Requisition No.	Phone No. ____
Your Job Function / How You Use This Publication	Publication No.	E-mail ____
	Publication Issue/Revision Date	Address

General Rating

	Excellent	*Good*	*Fair*	*Poor*	*Additional Comments*
Contents	O	O	O	O	____
Organization	O	O	O	O	____
Technical Accuracy	O	O	O	O	____
Clarity	O	O	O	O	____
Completeness	O	O	O	O	____
Drawings / Figures	O	O	O	O	____
Tables	O	O	O	O	____
Referencing	O	O	O	O	____
Readability	O	O	O	O	____

Specific Suggestions *(Corrections, information that could be expanded on, and such.)*

Page No. ***Comments***

Other Comments *(What you like, what could be added, how to improve, and such.)*

Overall grade *(Compared to publications from other manufacturers of similar products, how do you rate this publication?)*

O Superior O Comparable O Inferior O Do not know Comment ____

Detach and fax or mail to the address noted above.

……………………………………………………………Fold here and close with staple or tape ……………………………………………………………………………………

Place
stamp
here.

GE Industrial Systems

Documentation Design, Rm. 291
1501 Roanoke Blvd.
Salem, VA 24153-6492 USA

……………………………………………………………………………………Fold here first……………………………………………………………………………………………

GE Industrial Systems

+ 1 540 387 7000
www.GEindustrial.com

General Electric Company
1501 Roanoke Blvd.
Salem, VA 24153-6492 USA