CRAY T90 Series Control System Overview

Figures

Tables

Introduction

The CRAY T90 series control system monitors various conditions within the components of CRAY T90 series computer systems and, if necessary, shuts the system down if a monitored condition deviates from the predefined range.

This document provides an overview of the control system as it pertains to CRAY T90 series computer systems, a description of the components and their functions, and information on operation and status, connections, and troubleshooting. For control information for a specific component within the CRAY T90 series computer system (for example, the HEU, mainframe, or HVDC), refer to the specific component power, cooling, and control system document for that component.

Components

The control system consists of the following components:

- Programmable logic controllers (PLCs)
  - Nine-slot rear mount rack
  - Power supply
  - Central processor unit (CPU)
  - State logic processor
  - Genius bus controller
  - TTL input module
  - 12-Vdc output module
  - Analog base converter module
  - Voltage input expander module
  - VMIVME-4132 analog output card
  - 12-V power supply
- I/O remote monitoring blocks
  - Analog I/O monitoring block
  - 115-Vac monitoring block
  - 12/24-Vdc I/O monitoring block
- Support System
- Sensors
  - Level sensors
  - Temperature transducers
  - Pressure transducers
  - Voltage sensors
  - Current monitors
  - Flow transducers

Programmable Logic Controllers

Two programmable logic controllers (PLCs) monitor and control the computer system. Refer to Figure 1. (Two PLCs are used for system reliability and redundancy purposes.) Each PLC consists of several components, which are described on the following pages.

Nine-slot rear mount rack

The nine-slot rear mount rack is used to mount the PLC components to the mainframe. This rack can hold ten PLC components (one power supply and nine other PLC components). The letters *PS* designate the power supply slot and numbers 1 through 9 designate the next nine slots.

Once a component has been installed in a slot, that slot position is keyed so that only the same component can be installed in that slot. When that component is removed, the key is automatically left in that slot position. The key will fit only components that are identical to the one that was removed.

Each rack must be properly grounded. Two steps are necessary to ensure an effective ground. The first step is to connect the ground from the power supply to the rack terminal ground. The second step is to connect the rack terminal ground to a good earth ground.

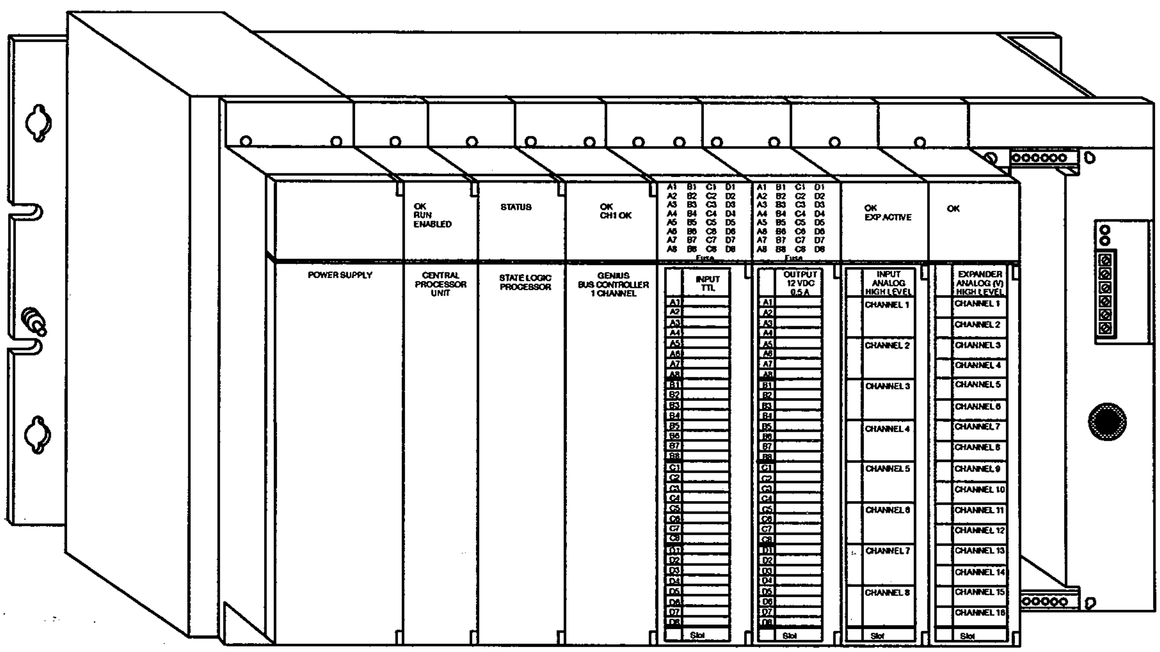


Figure 1. Programmable Logic Controller

Power Supply

The power supply (refer to Figure 2) component provides power to the PLC components and is located on the rack in the leftmost slot position. This slot position is keyed so that only a power supply can be mounted in that slot.

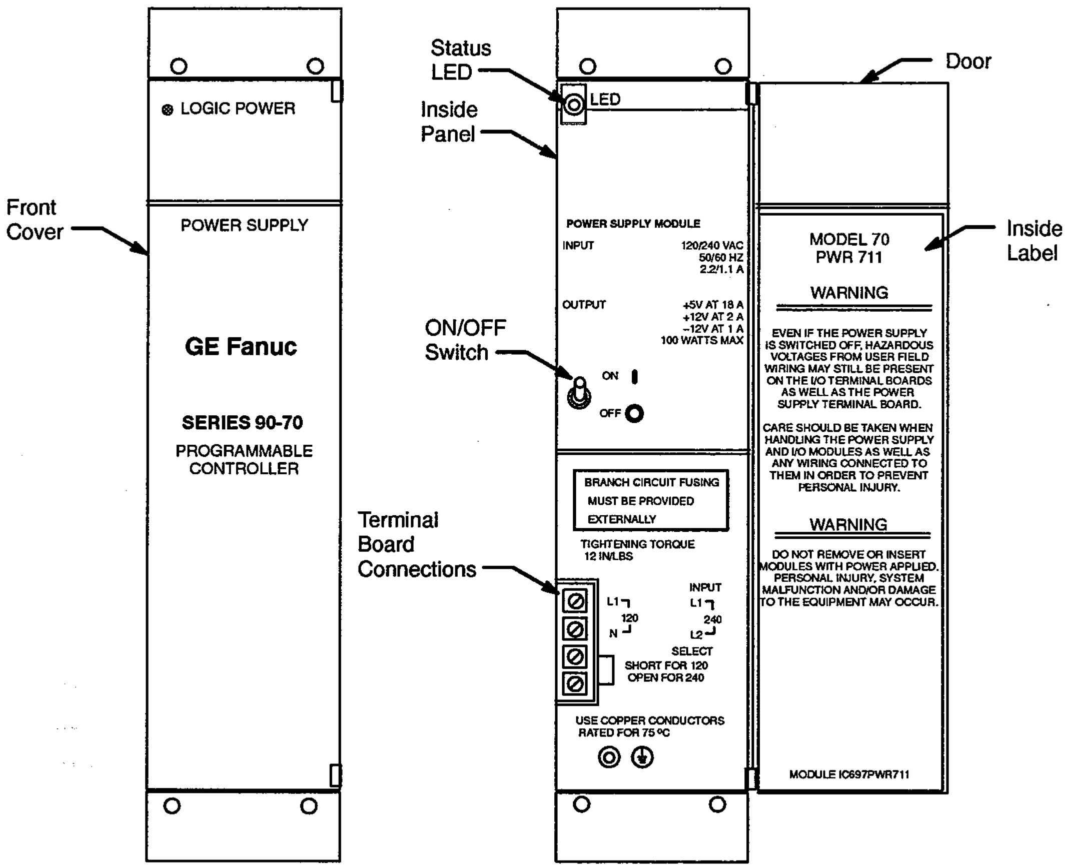


Figure 2. Power Supply

The power supply requires 120-Vac power and provides three output voltages (100 W total): +5 Vdc (up to 18 A), +12 Vdc (up to 2 A), and −12 Vdc (up to 1 A). The power supply connects to the backplane of the rack with a 48-pin connector.

The power supply also has overvoltage protection. If the 5-V bus exceeds 6.2 V (+0.5 V), the power supply output is turned off. In this instance, the power supply has to be powered off to reset it. The power supply also has overcurrent protection. Each output on the power supply has a current rating that, if exceeded, causes the output voltage to fall to a low value. Once the overcurrent condition has been fixed, the voltage returns to a nominal level.

Each power supply has the following features:

- Status LED
- ON/OFF switch
- Terminal board connections
- 5 V standby (not shown)

The status LED indicates the operating status of the power supply. The LED is visible through the power supply faceplate next to the LOGIC POWER label on the front. If the status LED is illuminated, the power supply is operating normally. If the status LED is not illuminated, the power supply has experienced a fault condition and should be replaced.

The ON/OFF switch controls the power of the PLC. When the switch is off, no power is supplied to the PLC components; however, power is still located within the power supply. When the switch is on, power is supplied to the PLC components.

The terminal board connections provide connections for the customer-supplied power and enable power-supply configuration. Each power supply has four terminal board connections located behind the faceplate. The top two connections are used to connect the hot wire (L1 – black wire) and the neutral wire (N – white wire). The ground wire (green) is connected to the rack ground stud. The bottom two terminal connections are used to configure the type of power source. For 120-Vac power, a jumper connects the two terminal connections. The terminal connections are open for 240-Vac power.

The 5 V standby provides a one-cycle ride-through in the event of a power failure. This one-cycle ride-through provides time for the power to be restored or time for the PLC to sequentially stop all processes and power down.

Central Processor Unit

The central processor unit (CPU) controls the operation and functions of the control system. Refer to Figure 3. It contains the microprocessor, memory, and VLSI processor for Boolean operations. The CPU also has an interface for the serial port and the system bus. This CPU module is always located in the first slot position next to the power supply module. All communication for the control system comes from the CPU.

The CPU has the following features:

- Status LEDs
- Mode switch
- Battery
- Battery connections
- Serial port

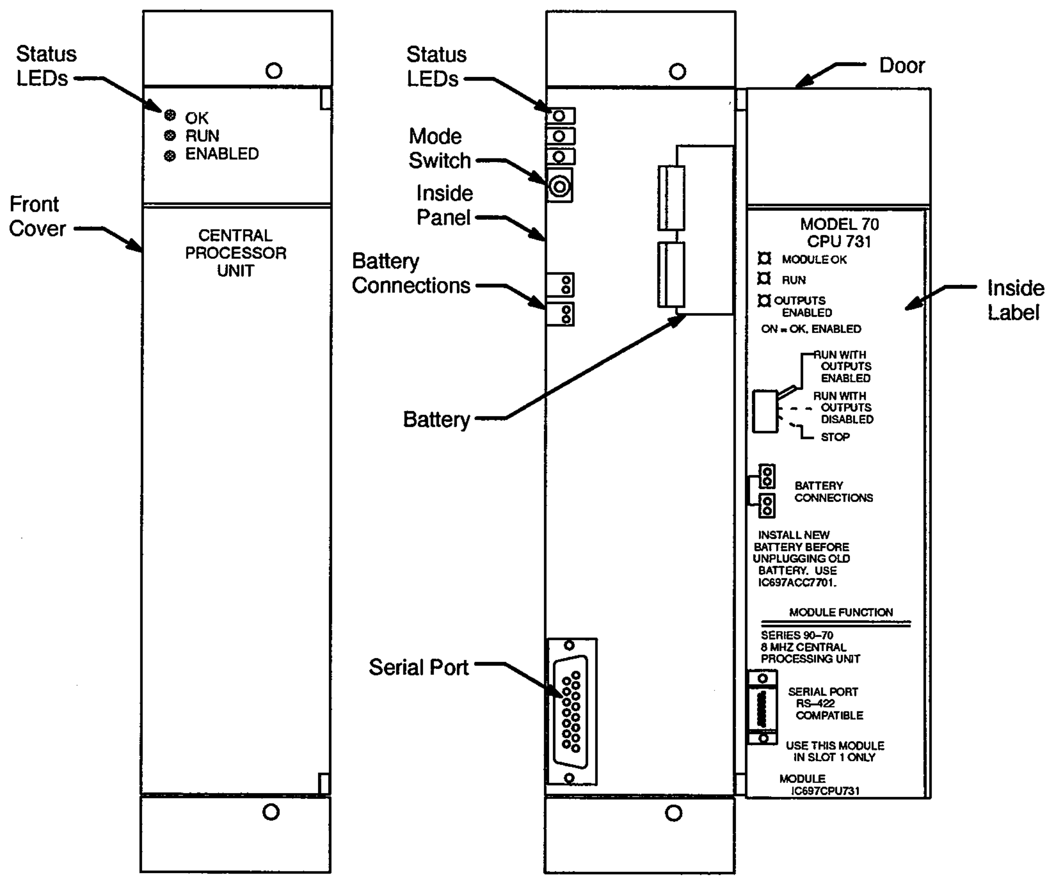


Figure 3. Central Processor Unit

The CPU has three status LEDs that indicate the operating status of the CPU. Table 1 describes each of the status LEDs and their indications.

Table 1. CPU Status LEDs

LED	Status	Indicates
OK	On	The CPU is functioning properly.
	Blinking	The system has failed. **NOTE:** This LED will blink during the power-up process while the CPU is performing self-check diagnostics.
	Off	The system has failed and all communications have ceased.
RUN	On	The CPU is in the normal run mode.
	Off	The CPU is in the stop mode. **NOTE:** This LED should be on; if it is not, check the mode switch for the proper setting.
ENABLED	On	The CPU outputs are enabled.
	Off	The CPU outputs are disabled.

The mode switch is a three-position switch that controls the operating mode of the CPU. **The top position is the *run with outputs enabled* position. This is the position that the switch should be in at all times. No adjustments to this switch should be necessary.** The middle position is the *run with outputs disabled* position; the bottom position is the *stop* position. The current switch position is displayed using the CPU status LEDs.

The CPU CMOS memory is protected with a backup battery. If the CPU loses power, the battery provides backup power until power is restored. The PLC monitors the battery and sends a signal when the battery needs to be replaced. The control system software sends a signal back to the MWS that indicates that the battery needs to be replaced.

The CPU has two battery connections that connect the battery to CMOS memory devices. If the battery needs to be replaced, the old battery may remain connected while the new battery is being installed. This protects the CMOS memory from being lost if a power interruption occurs during the battery replacement procedure.

The serial port provides a connection to a programming terminal. This port should not have to be used in the field. Any program changes can be made through the maintenance workstation (MWS-E).

State Logic Processor

The state logic processor (refer to Figure 4) contains the application program and is responsible for all system processing. It processes the system data and passes it back to the CPU, which communicates all commands and information back to the control system.

The state logic processor has the following features:

- Status LED
- Reset pushbutton
- Battery
- Battery connections
- Serial ports

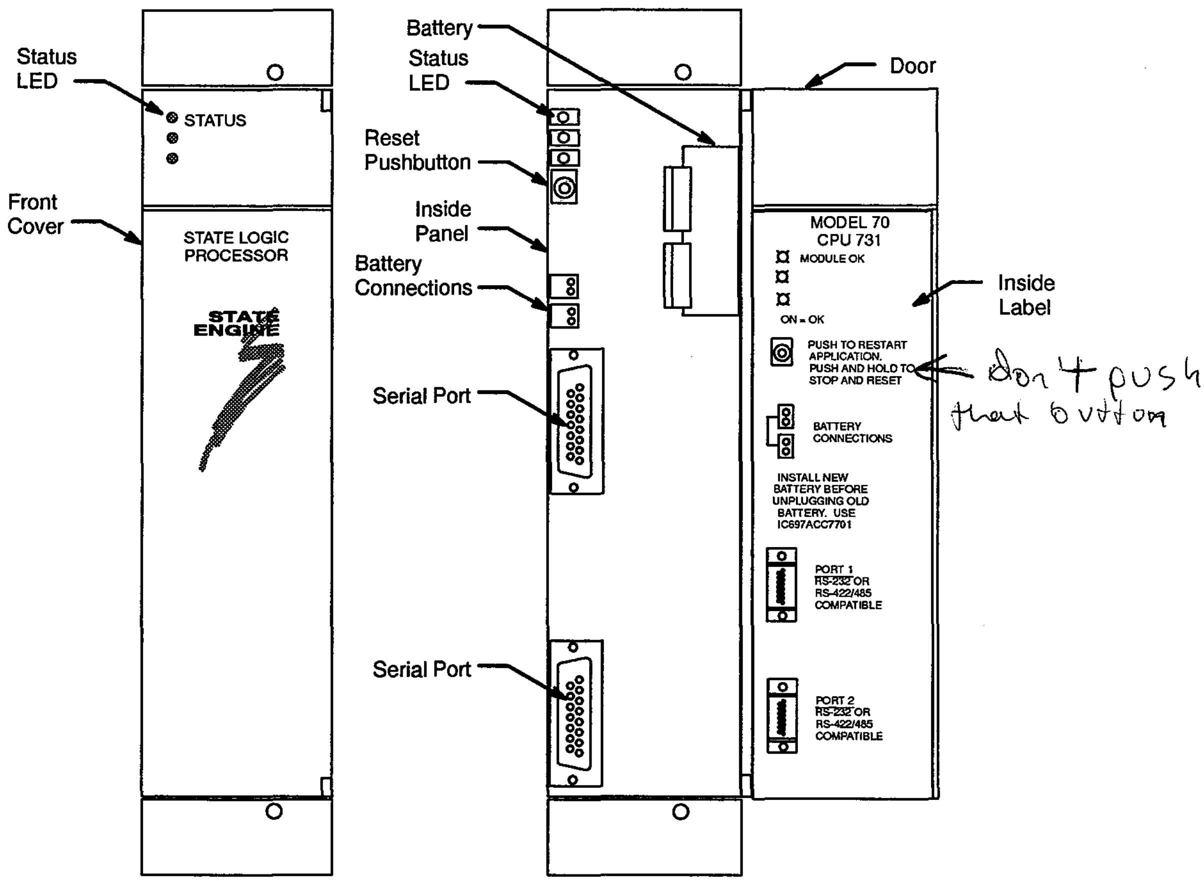


Figure 4. State Logic Processor

The Status LED provides the operating status of the state logic processor. When the Status LED is illuminated, the state logic processor is communicating with the control system.

The reset pushbutton resets the application program when it is pushed; however, if the button is pushed and held, the application program is stopped and reset.

CAUTION
Do not push the reset button. Pressing the reset pushbutton destroys the program memory and application!

The CMOS memory is protected with a backup battery. If the state logic processor loses power, the battery provides backup power until power is restored.

The state logic processor has two battery connections that connect the battery to CMOS memory devices. The PLC monitors the battery and sends a signal when the battery needs to be replaced. The control system software sends a signal back to the MWS that indicates that the battery needs to be replaced.

If the battery needs to be replaced, the old battery may remain connected while the new battery is being installed. This protects the CMOS memory from being lost if a power interruption occurs during the battery replacement procedure.

The serial ports provide the standard connections to the MWS. Any program changes can be made through the MWS.

Genius Bus Controller

The Genius bus controller (GBC) provides the interface and control for the I/O network, which consists of I/O remote monitoring blocks. Refer to Figure 5. The I/O remote monitoring blocks are connected to this module, which sends the I/O information along the backplane of the rack to the CPU module. In addition, any commands from the CPU module are routed through this module to the remote monitoring blocks.

The GBC has the following features:

- Status LEDs
- Hand-held monitor port
- Twelve-point removable terminal board

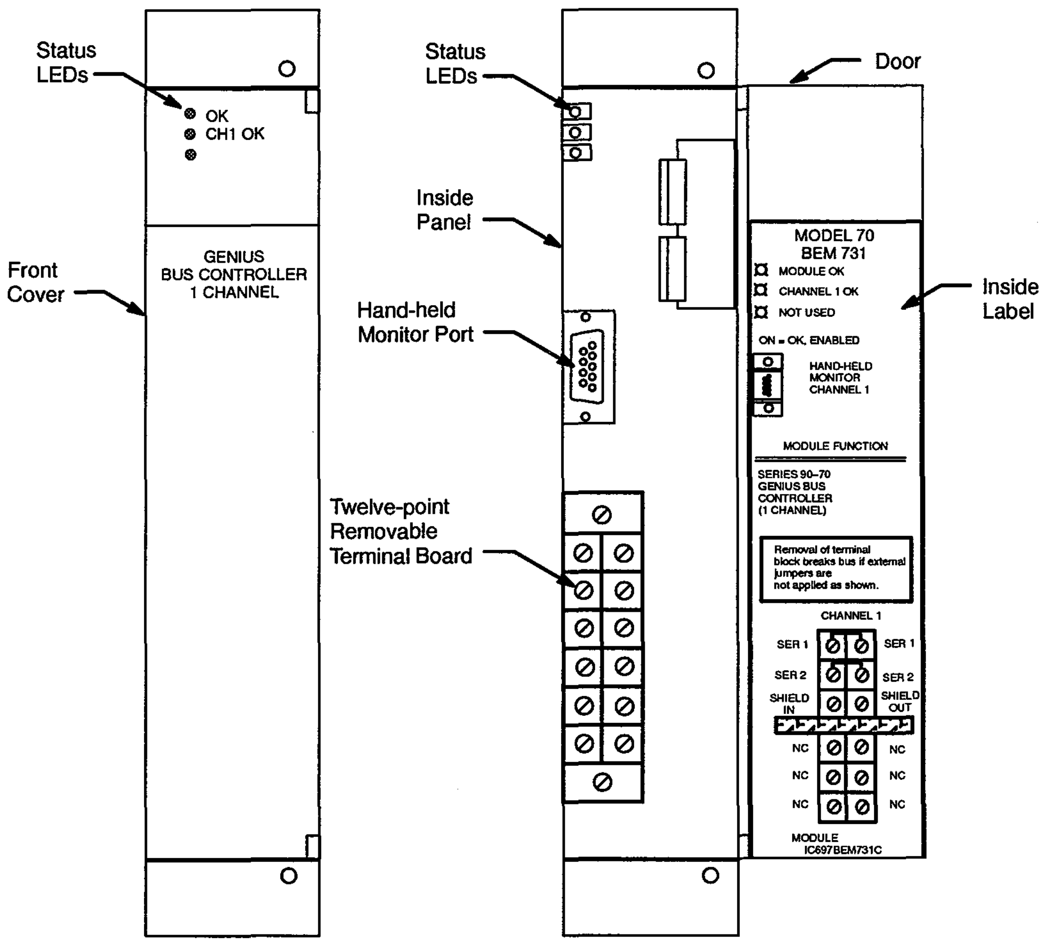


Figure 5. Genius Bus Controller

The GBC has two status LEDs, which indicate the operating status of the GBC. Table 2 describes each of the status LEDs and their indications.

Table 2. GBC Status LEDs

LED	Status	Indicates
OK	On	The GBC is functioning properly.
	Blinking	The GBC has been installed in a slot that was not configured for it. **NOTE:** This LED will blink during the power-up process while the GBC is performing self-check diagnostics.
	Off	The GBC has failed during operation or during power-up diagnostics.
CH1 OK	On	The GBC is functioning properly and all self-check diagnostics have completed.
	Off	The GBC has failed during power-up diagnostics. Or The GBC has had a bus or bus controller failure while the CPU was running. **NOTE:** If the failure is a bus controller failure, the LED will stay off. However, if the failure is a bus failure, the LED will illuminate after the bus failure (for example, a broken wire or too many bus errors) is corrected.

The hand-held monitor port is used during troubleshooting of the control system. The hand-held monitor plugs into this port, which is used for troubleshooting and configuring control system components. For more information about the hand-held monitor, refer to the "Hand-held Monitor" subsection at the end of this document.

The twelve-point removable terminal board connects the bus controller to the I/O remote monitoring blocks. The SHIELD IN side of the terminal board connects the corresponding terminal wires (SER 1, SER 2, and SHIELD OUT) to the first I/O remote monitoring block in the daisy chain.

The SHIELD OUT side of the terminal board connects to the corresponding SHIELD OUT side of the bus controller on the second PLC rack.

TTL Input Module – Negative Logic

The TTL input module (refer to Figure 6) provides 32 TTL input points. This module provides negative TTL characteristics (it sinks current from the input device to the common return). The TTL input module has its own 5-V supply and does not need any additional power.

The TTL input module has the following features:

- Status LEDs
- Terminal board

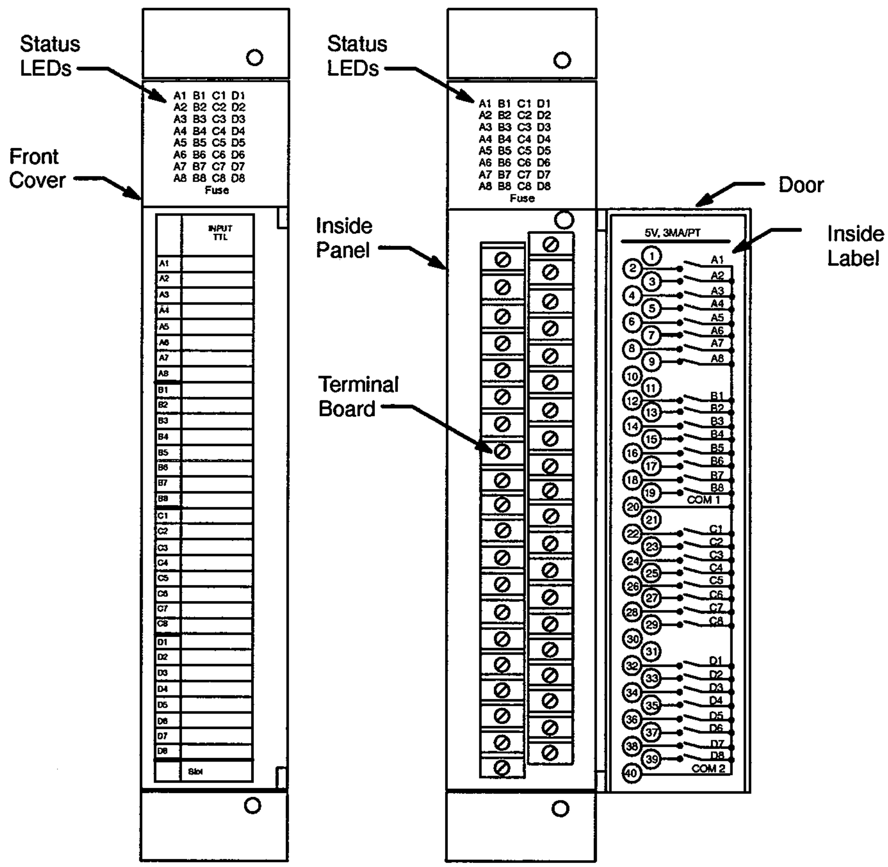


Figure 6. TTL Input Module - Negative Logic

The status LEDs are located at the top of the module. Each LED represents the ON/OFF status of each input point on the logic side of the circuit. The input current in the ON state is typically 1.7 mA; a maximum of 1.1 mA leakage current can exist in the OFF state before the LED will illuminate.

The terminal board provides the connection for the 32 input points. Each input point has its own individual pull-up resistor. The terminal board is configured with two common points, which makes wiring easier.

12-Vdc Output Module

The 12-Vdc output module (refer to Figure 7) provides 32 points (4 groups of 8). This module provides a high degree of inrush current for a variety of outputs, such as control valves and indicators.

The 12-Vdc output module has the following features:

- Status LEDs
- Terminal board

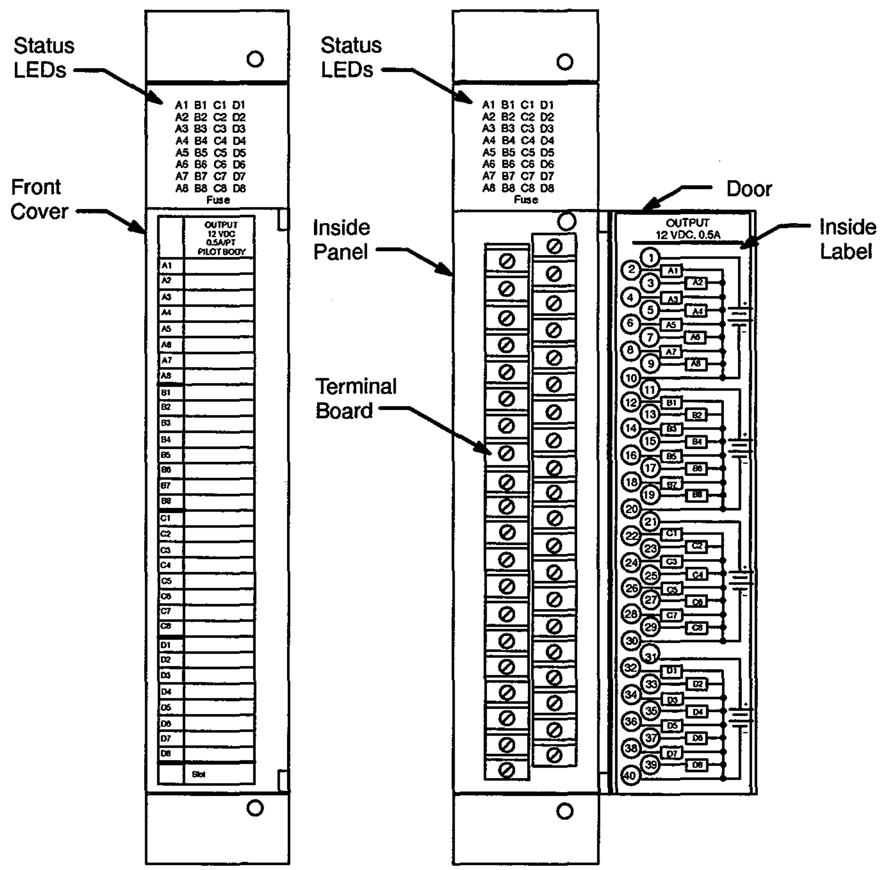


Figure 7. 12-Vdc Output Module

The status LEDs are located at the top of the module. Each LED represents the ON/OFF status of each input point on the logic side of the circuit.

The terminal board provides the connection for the 32 output points. The group of 32 output points is divided into 4 groups of 8 output points. Each group of output points can sustain a total of 2 A, with each point capable of providing 0.5 A.

Analog Base Converter Module

The analog base converter module (refer to Figure 8) accepts analog inputs of up to ± 10 volts or 4 to 20 mA current loop signals. These inputs are converted to digital form for use by the CPU. These digital signals are sent to the CPU using the controller backplane.

The analog base converter module has 8 different inputs. In addition, it has an expansion port that enables a voltage expander module to be configured. Each of the 8 inputs can be configured for either voltage or current and can be scaled accordingly.

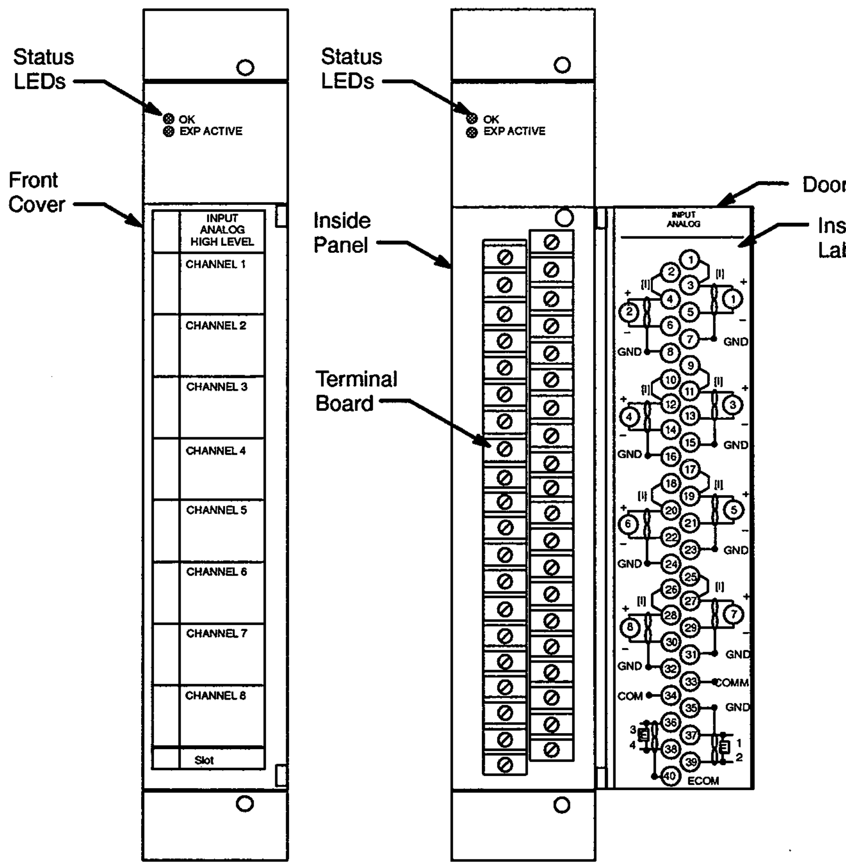


Figure 8. Analog Base Converter Module

Voltage Input Expander Module

The voltage input expander module (refer to Figure 9) works in conjunction with the base converter module. This module has 16 voltage inputs, which accept up to ± 10 V signals.

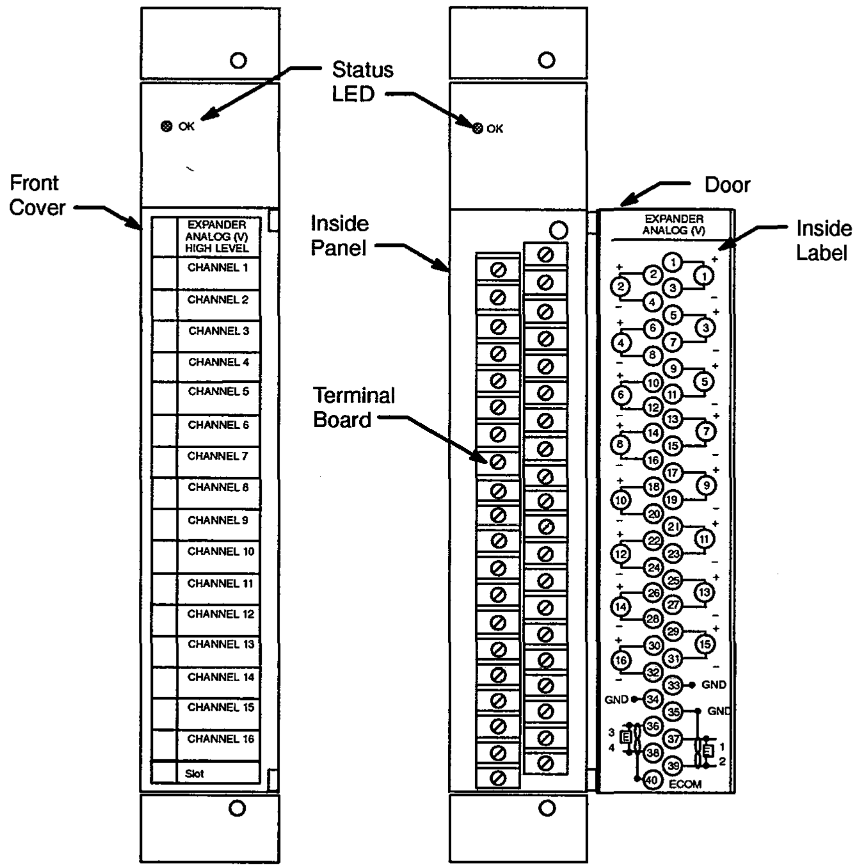


Figure 9. Voltage Input Expander Module

VMIVME-4132 Analog Output Card

The VMIVME-4132 analog output card (refer to Figure 10) is used for power supply voltage adjustment. (Any power supply voltage adjustments are made using the software program running on the MWS.) This output card has 32 analog output channels, which connect to the power supplies. The output card has a connector in which the wires for the voltage adjustment are connected and also has a self-test LED that indicates whether the output card has failed. If the LED is illuminated, there is a failure; however, during the power-up cycle, the LED will not indicate any failures until the system has stabilized.

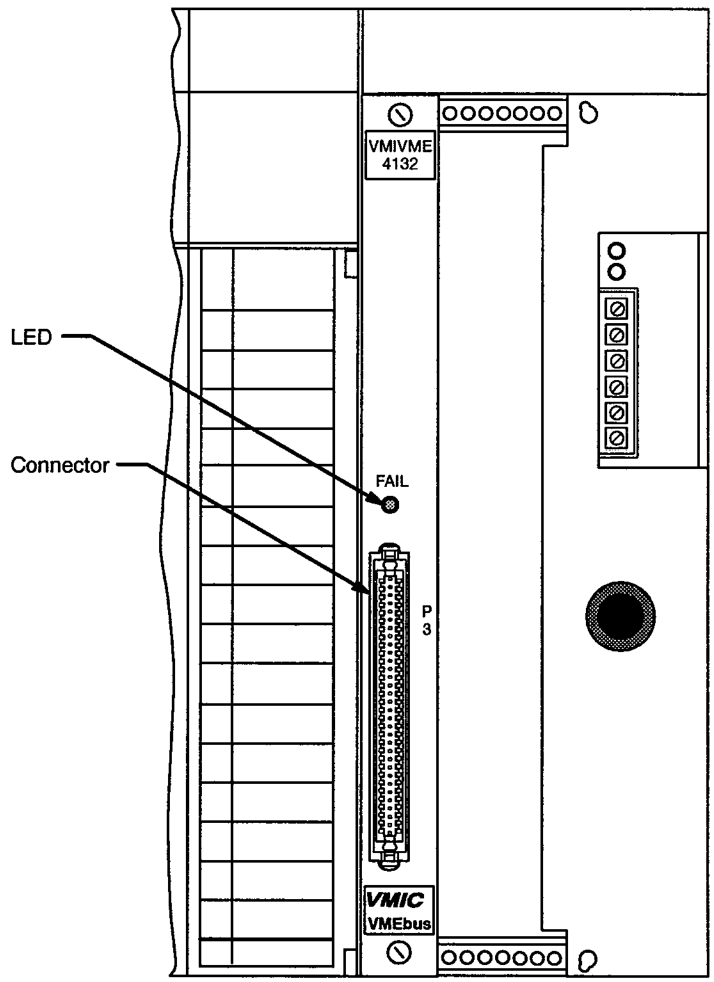


Figure 10. VMIVME-4132 Analog Output Card

12-V Power Supply

The 12-V power supply provides 12 volts of power to the level sensors and the solenoid control valve.

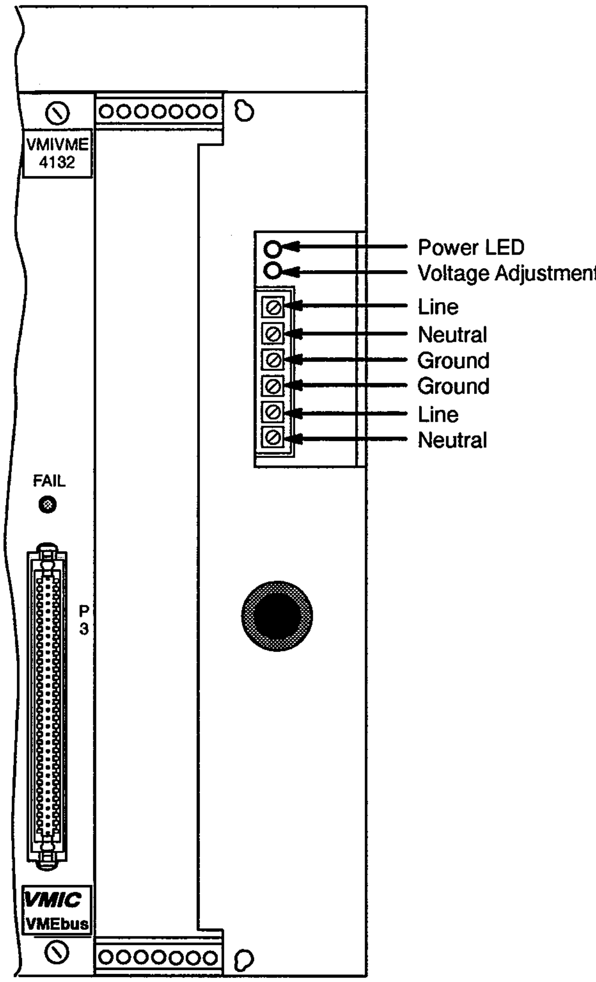


Figure 11. 12-V Power Supply

I/O Remote Monitoring Blocks

The I/O remote monitoring blocks are mounted on peripheral devices (for example, an HEU or HVDC device) and interface with the PLC through the GBC module. Three types of monitoring blocks are used: analog I/O monitoring blocks, 115 Vac monitoring blocks, and 12/24-Vdc I/O monitoring blocks. Each monitoring block has a standard configuration that is automatically sent through the GBC module. During the replacement procedure, all configuration data is stored in the terminal block assembly.

Each remote monitoring block is considered a combination-type block because it has both inputs and outputs.

Analog I/O Monitoring Block

Analog I/O monitoring blocks (refer to Figure 12) receive 4-to-20 mA sensor information and send 4-to-20 mA signals to components within the peripheral device. Each analog I/O monitoring block can receive inputs from four sensors and can control two components within the monitored peripheral device.

Sensor information from the sensors mounted on the peripheral device is sent to the analog I/O monitoring block, which sends this information to the GBC modules on the PLC racks. In addition, the analog I/O monitoring block receives control information from the control system. This control information is routed to the designated component (for example, a control valve).

The analog I/O monitoring block has the following features:

- Serial 1 and Serial 2 connections
- Shield In/Out connections
- Power connections
- Two output connections
- Four input connections
- Status LEDs
- Hand-held monitor port

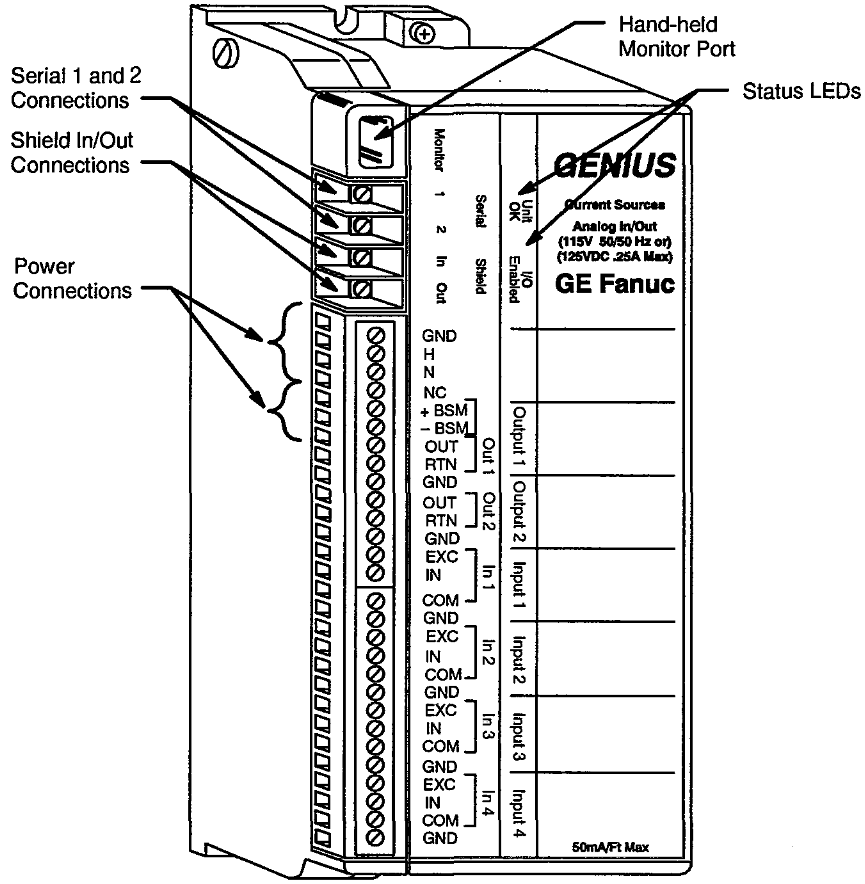


Figure 12. Analog I/O Monitoring Block

The Serial 1 and Serial 2 and the Shield In/Out connections provide the connections to the serial 1 and serial 2 and the shield in/out connections of the previous component in the control system daisy chain. All communication with the control system occurs through these connections.

The power connections (GND, H, N) provide the connections to AC power. The GND terminal provides the ground connection with the block chassis and terminals 13, 16, 20, 24, 28, and 32. The H terminal provides the 120-Vac power source connection, while the N terminal provides the neutral connection.

The two output connections provide control capability for components within the monitored device. For example, the analog I/O monitoring block can adjust control valves by changing the amount of current that the control valve is receiving. Each output connection can control currents of 0 mA to 24 mA.

Each output connection consists of three terminals: OUT, RTN, and GND. The OUT and RTN terminals are connected to the monitoring component. The GND terminal is connected to the main GND terminal for the block.

The four 4-to-20 mA inputs provide monitoring capability by using sensors within the monitored device. The monitored conditions provide analog currents to the analog I/O monitoring block, which changes analog currents to digital values. The I/O monitoring block sends this value to the CPU in the PLC rack. Each input connection is programmed with upper and lower limits; if the range deviates from these limits, the monitoring block indicates a fault and also sends a fault message to the CPU and hand-held monitor port.

Each input circuit has an isolated 24-V current loop power supply, which is capable of providing 25 mA of current to the sensors. This power supply uses the EXC connection on the analog I/O monitoring block.

The two status LEDs, Unit OK and I/O Enabled, indicate their operating statuses. The Unit OK LED indicates that the unit is operating normally. The I/O Enabled LED indicates that the monitoring block is communicating with the CPU. (Refer to the "Troubleshooting" subsection at the end of this document for information about these LEDs. Different statuses and combinations of these LEDs indicate different things.)

The hand-held monitoring port provides the connection for the hand-held monitor, which is used as a troubleshooting and configuration tool. Refer to the "Hand-held Monitor" subsection at the end of this document for information about the hand-held monitor and how to use it to troubleshoot the control system.

115 Vac Monitoring Block

The 115-Vac monitoring block (refer to Figure 13) has eight input/output channels that can control or monitor eight components within the monitored peripheral device. Each of these eight channels can be configured as either input or output channels. Input channels are used for signals that are coming from the designated component through the 115-Vac monitoring block, which are then sent to the PLC. The output channels are used for signals coming from the PLC through the 115-Vac monitoring block, which then sends the signal to the designated component for that channel.

The 115-Vac monitoring block has the following features:

- Serial 1 and serial 2 connections
- Shield in/out connections
- Power connections
- Eight input/output connections
- Status LEDs
- Hand-held monitor port

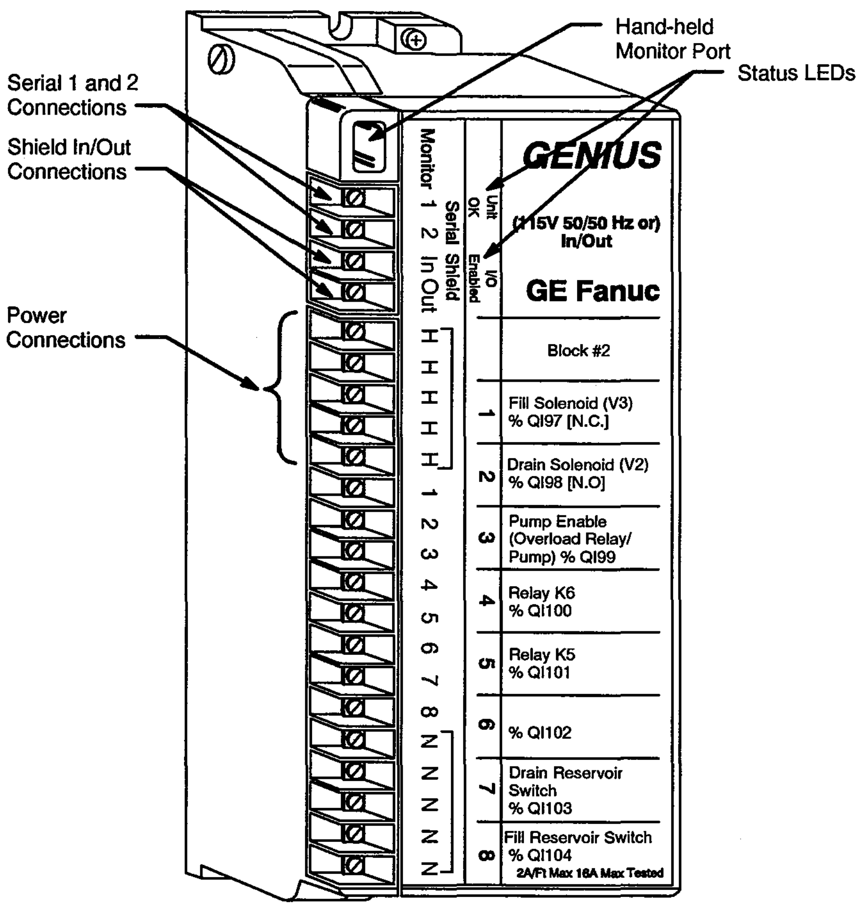


Figure 13. 115-Vac Monitoring Block

The Serial 1 and Serial 2 and the Shield In/Out connections provide the connections to the serial 1 and serial 2 and the shield in/out connections of the previous component in the control system. All communication with the control system occurs through these connections.

The power connections (H and N terminals) connect the AC power source to the monitoring block. The monitoring block has four H terminals and four N terminals. One H terminal is used to connect the power source, and one N terminal is used to connect the neutral wire. The remaining H and N terminals are extra terminals that can be used to connect multiple wires if necessary. All H and N terminals are internally bussed.

The input/output connections connect the device that is being electrically controlled to the control system. Each of these connections can be configured by the CPU as either input or output connections, which means that the CPU can send electric signals to the device through these connections or the device can send electric signals to the CPU through these connections.

The two status LEDs, Unit OK and I/O Enabled, indicate the 115-Vac monitoring block operating status. The Unit OK LED indicates that the monitoring block is operating normally. The I/O Enabled LED indicates that the monitoring block is communicating with the CPU. (Refer to the "Troubleshooting" subsection at the end of this document for information about these LEDs. Different statuses and combinations of these LEDs indicate different things.)

The hand-held monitoring port provides the connection for the hand-held monitor, which is used as a troubleshooting and configuration tool. Refer to the "Hand-held Monitor" subsection at the end of this document for information about the hand-held monitor and how to use it to troubleshoot the control system.

Each analog I/O monitoring block has a standard configuration that is preset during the computer system installation. However, if a failure makes it necessary to replace the monitoring block, the block ID and block reference number need to be programmed. This programming can be done using the hand-held monitor.

12/24-Vdc I/O Monitoring Block

The 12/24-Vdc I/O monitoring block (refer to Figure 14) is a 32-circuit device that provides current (12 to 24 Vdc) to such devices as relays or contactors. Each circuit can be configured as an output or input. Inputs are used for signals coming from the PLC while the outputs are for sending current to designated components within the peripheral device.

The 12/24-Vdc I/O monitoring block has the following features:

- Serial 1 and serial 2 connections
- Shield in/out connections
- Power connections
- Thirty-two input/output connections
- Status LEDs
- Hand-held monitor port

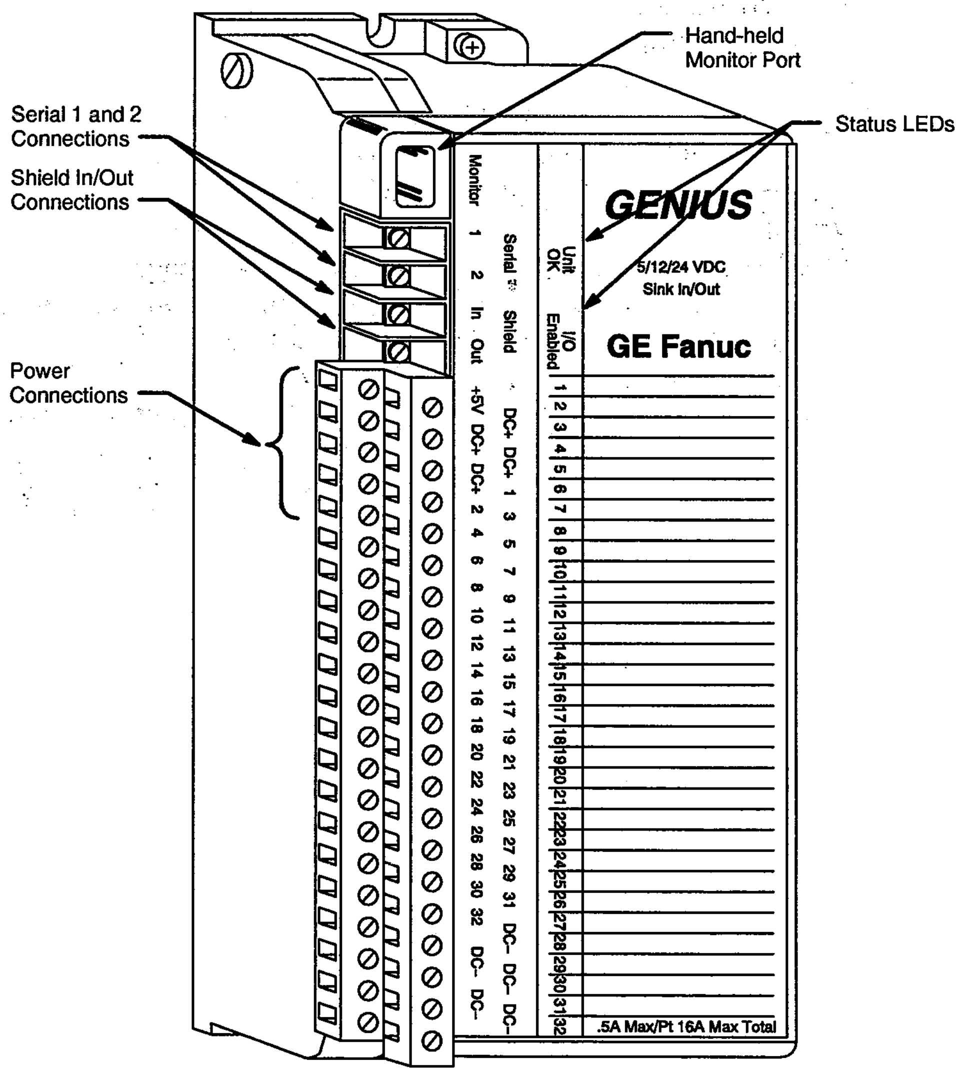


Figure 14. 12/24-Vdc I/O Monitoring Block

The Serial 1 and Serial 2 and the Shield In/Out connections provide the connections to the serial 1 and serial 2 and the shield in/out connections of the previous component in the control system. All communication with the control system occurs through these connections.

The power connections connect the DC power to the monitoring block. The monitoring block has five terminals that connect this power. The terminal block is a double row terminal block. The upper terminal block uses the first two terminal connections for the DC+ connections while the lower terminal block uses the first three terminal connections for the +5 V, DC+, and DC+ connections.

The input/output connections connect the device that is being electrically controlled to the control system. Each of these connections can be configured by the CPU as either input or output connections, which means that the CPU can send electric signals to the device through these connections, or the device can send electric signals to the CPU through these connections.

The two status LEDs, Unit OK and I/O Enabled, indicate the 12/24-Vdc monitoring block operating status. The Unit OK LED indicates that the monitoring block is operating normally. The I/O Enabled LED indicates that the monitoring block is communicating with the CPU. (Refer to the "Troubleshooting" subsection at the end of this document for information about these LEDs. Different statuses and combinations of these LEDs indicate different things.)

The hand-held monitoring port provides the connection for the hand-held monitor, which is used as a troubleshooting and configuration tool. Refer to the "Hand-held Monitor" subsection in this document for information about the hand-held monitor and how to use it to troubleshoot the control system.

Each 12/24-Vdc I/O monitoring block has a standard configuration that is preset during the computer system installation. Once configured, no additional configuration needs to be done. If the electronics assembly needs to be replaced, configuration data is retained in the terminal block assembly.

Support System

The support system consists primarily of a VME-based chassis and two Sun Microsystems, Inc. SPARCstation 5, Model S5TX1 workstations. One workstation is the maintenance workstation (MWS); the other is the operator workstation (OWS), which is dedicated for customer use.

The MWS contains the diagnostics and other programs used to perform system maintenance and troubleshooting. Included in this set of programs is a program called `nwacs`. (Information about how to run the `nwacs` program can be found in the *xelog, xcfg, and nwacs User Information* document, publication number HDM-012-0.) `nwacs` can run by itself or can be run with the System Maintenance And Remote Testing Environment (SMARTE), which is an online maintenance system package used to perform hardware verification, error detection, error isolation, and automated degradation of faulty hardware components. SMARTE is documented in *The System Maintenance and Remote Testing Environment (SMARTE) Users Guide*, publication number SPM-1017 2.0.

Sensors

A variety of sensors monitor the computer system. These sensors send information to the PLC or I/O remote monitoring block.

Level Sensor — Monitors the level of dielectric coolant within the mainframe (switches) and HEU (4-to-20 mA output)

Temperature Transducer — Monitors the temperature of the dielectric coolant and water/glycol mixture within the HEU and the temperature of the dielectric coolant within the mainframe (4-to-20 mA output)

Pressure Transducer — Monitors the pressure of dielectric coolant within the heat exchanger unit (4-to-20 mA output)

Voltage Sensor — Monitors the power supply or bus voltage

Current Monitor — Monitors the power supply current

Flow Transducer — Monitors the flow of the dielectric coolant and/or water/glycol mixture within the heat exchanger unit (4-to-20 mA output)

Theory of Operation

Figure 15 provides a block diagram of how the control system communicates with the computer system.

The control system operates on a local area network (LAN) in which the PLCs are the central components. Each component within the system is daisy chained and communicates on the LAN serial bus.

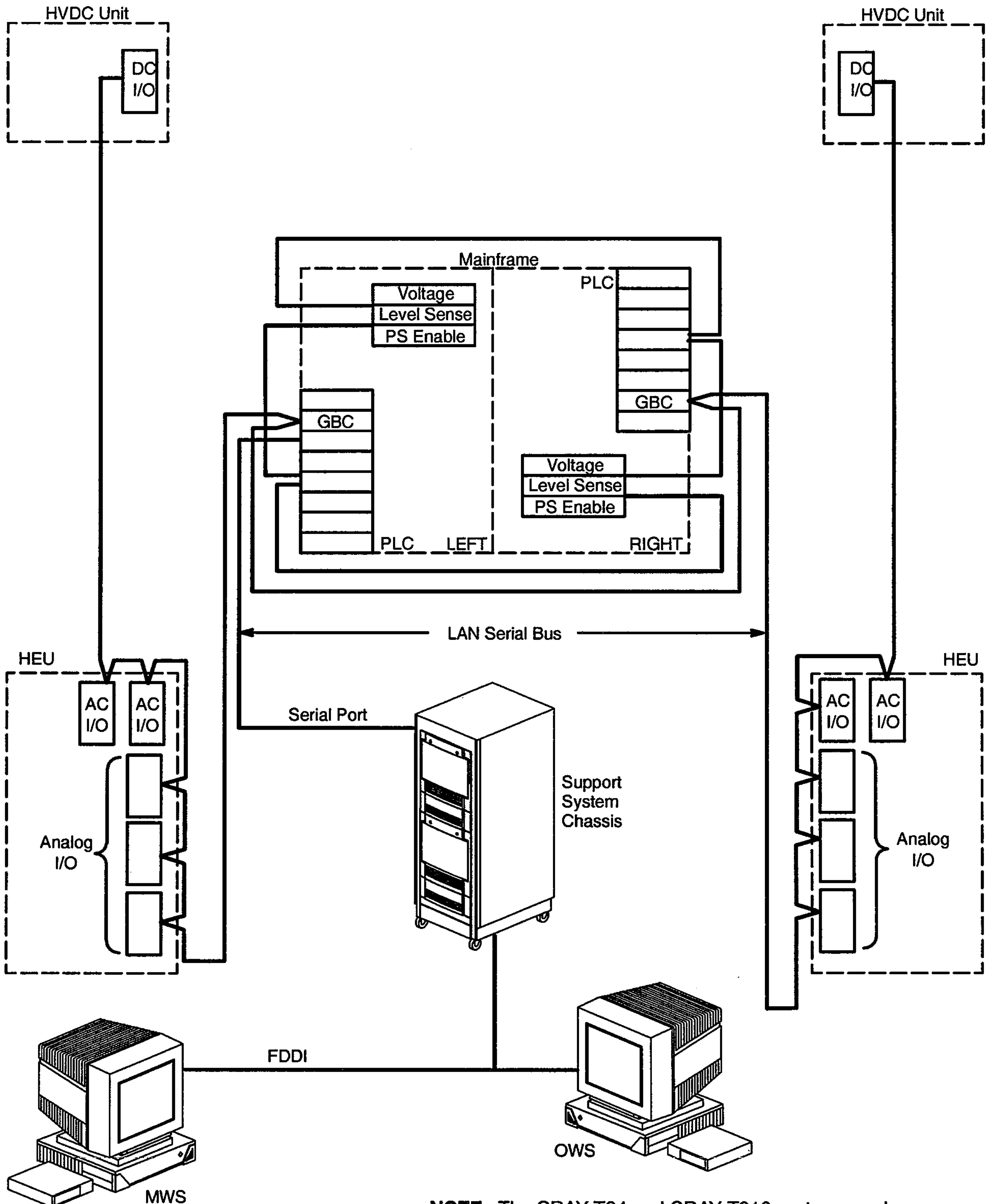
The control system uses two rack-mounted PLCs to provide for system redundancy. Each rack is identical except that the redundant controller does not have a VMIVME-4132 analog output card, which enables power supply margining.

The two racks are identified as the main rack and the hot standby rack. Both racks receive data from the remote I/O remote monitoring blocks (in the HVDC and HEU) and the local sensors (within the mainframe). However, the remote I/O monitoring blocks receive commands only from the main rack until the main rack does not report to the remote I/O monitoring blocks for three bus scans. After three bus scans, the remote I/O monitoring blocks switch over to the hot standby rack.

When the main rack comes back online, it reads the standby rack for system status and configuration information. The main rack then takes control of the control system.

The control system operation relies upon the information sent back from the sensors, which are located in both the mainframe chassis and peripheral equipment (HVDC and HEU). The sensor location determines the routing of the sensor information.

The sensors located within the peripheral equipment route the information to the I/O remote monitoring blocks located on the peripheral device. The information is routed through the control system to the Genius block controller (GBC) module on both racks.



NOTE: The CRAY T94 and CRAY T916 systems each have two PLCs, but they each have only one HEU and one HVDC.

Figure 15. CRAY T932 Control System Block Diagram

The sensors located within the mainframe route information to the rack controller differently than the sensors located on a peripheral device. This sensor information is routed to an interconnect board; the information is then routed to either the TTL input module, the base converter module, or the voltage input expander module, depending upon the type of information. Refer to Figure 16 for a block diagram of how the rack controller components route information.

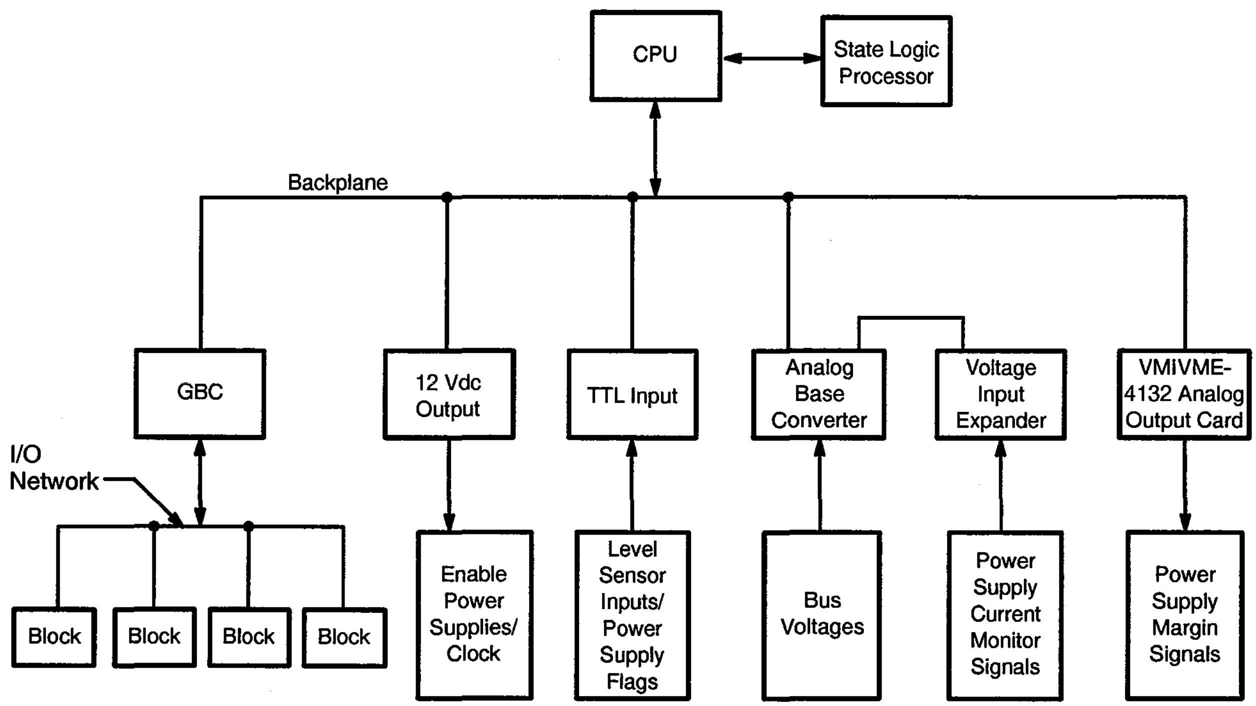


Figure 16. Controller Rack Block Diagram

The CPU performs a sweep of the rack components to obtain status and fault messages. This status or fault information is stored in memory on the CPU module. During this sweep, the CPU can also send messages to rack components. The CPU sends the messages, status, and fault information along the rack backplane.

The control system stores data as either discrete or register references, depending on the signal. Both references are indicated by a percent sign (%) followed by one or two letters. This sequence of characters, called the reference prefix, represents the type of data being sent. The prefix is followed by the reference's address within the input/output table. (The input table stores all of the inputs from the input modules during the last input scan; the output table stores the values of the output references as they were last set by the application program.) Table 3 lists the reference prefix, data types, description of what each type represents, and components that use that reference type.

Table 3. Data Types

Reference Prefix	Type	Description	Component
%I	Discrete	Input reference	TTL input module
%QI	Discrete	Output/input reference	12-Vdc output module 115-Vac monitoring block
%AI	Register	Analog input register that holds the value of one analog input	Analog base converter module Voltage input expander module Analog I/O monitoring block (input channels)
%AQ	Register	Analog output register that holds the value of one analog output	Analog I/O monitoring block (output channels)

Hand-held Monitor

The hand-held monitor (HHM) is used to troubleshoot and configure the control I/O system components. Refer to Figure 17 for an illustration of the HHM. The hand-held monitor plugs into the GBC and I/O remote monitoring block monitor ports.

The hand-held monitor has the following physical features:

- Mode select key switch
- LCD display
- Function keys
- Keypad
- Charger/adapter connection
- Rechargeable battery pack
- Cable

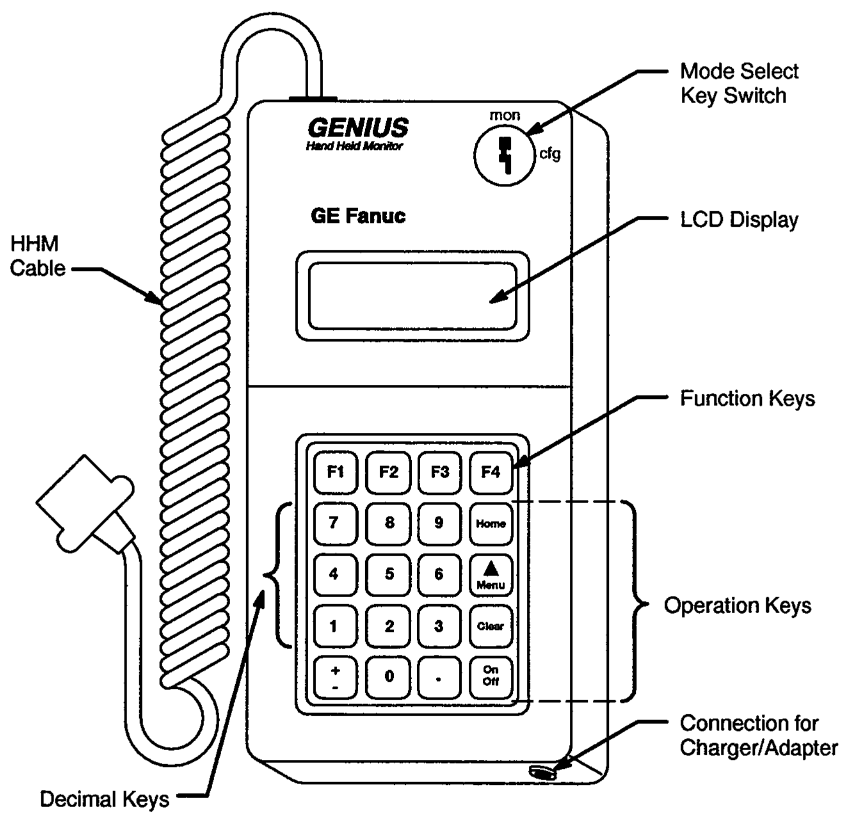


Figure 17. Hand-held Monitor

The mode select key switch has two positions: mon and cfg. The mon position is the monitoring position, which enables the hand-held monitor to only monitor conditions and does not allow any changes to be made. The cfg position is the configuration position, which enables certain conditions to be changed.

The LCD display is used to display the menu options and status information.

The keypad consists of numerical keys, an arithmetic key, operation keys, function keys, and an on/off key. The operation keys are as follows:

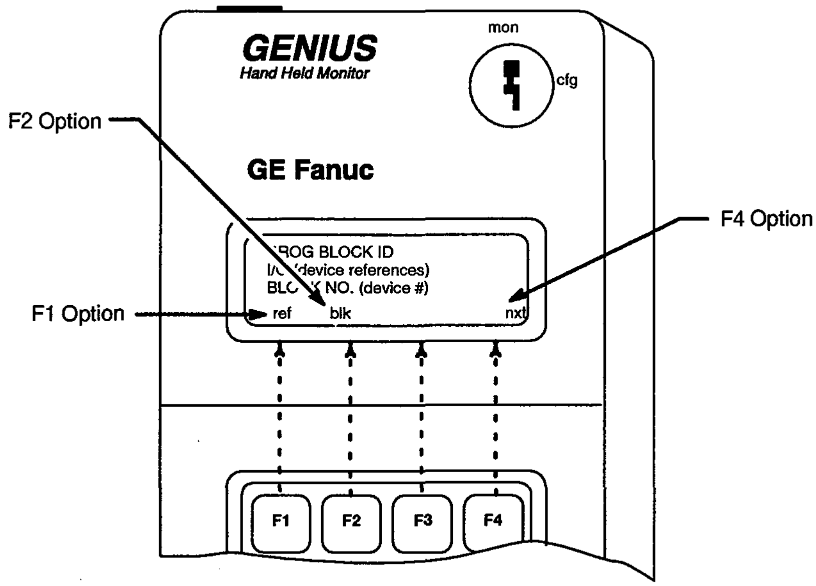
Displays the previous menu.

Displays the HOME menu as described in Table 4.

Clears any errors that you might have made.

Toggles the hand-held monitor on and off.

The function keys are used to execute menu options. Each menu has function key options that are indicated in the menu or with prompts at the bottom of the screen display. These prompts located at the bottom of the screen display line up above the corresponding function keys (refer to the following illustration).



The charger/adapter connection provides the connection for the charger. Each hand-held monitor comes with a battery charger. Prior to use, the battery has to be charged. The screen displays an error message when the battery needs recharging.

The cable includes the plug that connects to the appropriate control system components.

Menus

In addition to these physical features, the hand-held monitor also displays a number of menus on the LCD display. Each menu has a specific purpose and requirements. The main menu is the HOME menu, which displays when the hand-held monitor is first powered on. From the HOME menu, a number of options can be selected. Table 4 provides information about each menu available on the hand-held monitor. Figure 18 provides examples of the hand-held monitor menu displays.

NOTE: Figure 18 does not provide all the menus available. Many additional menus are available with the hand-held monitor.

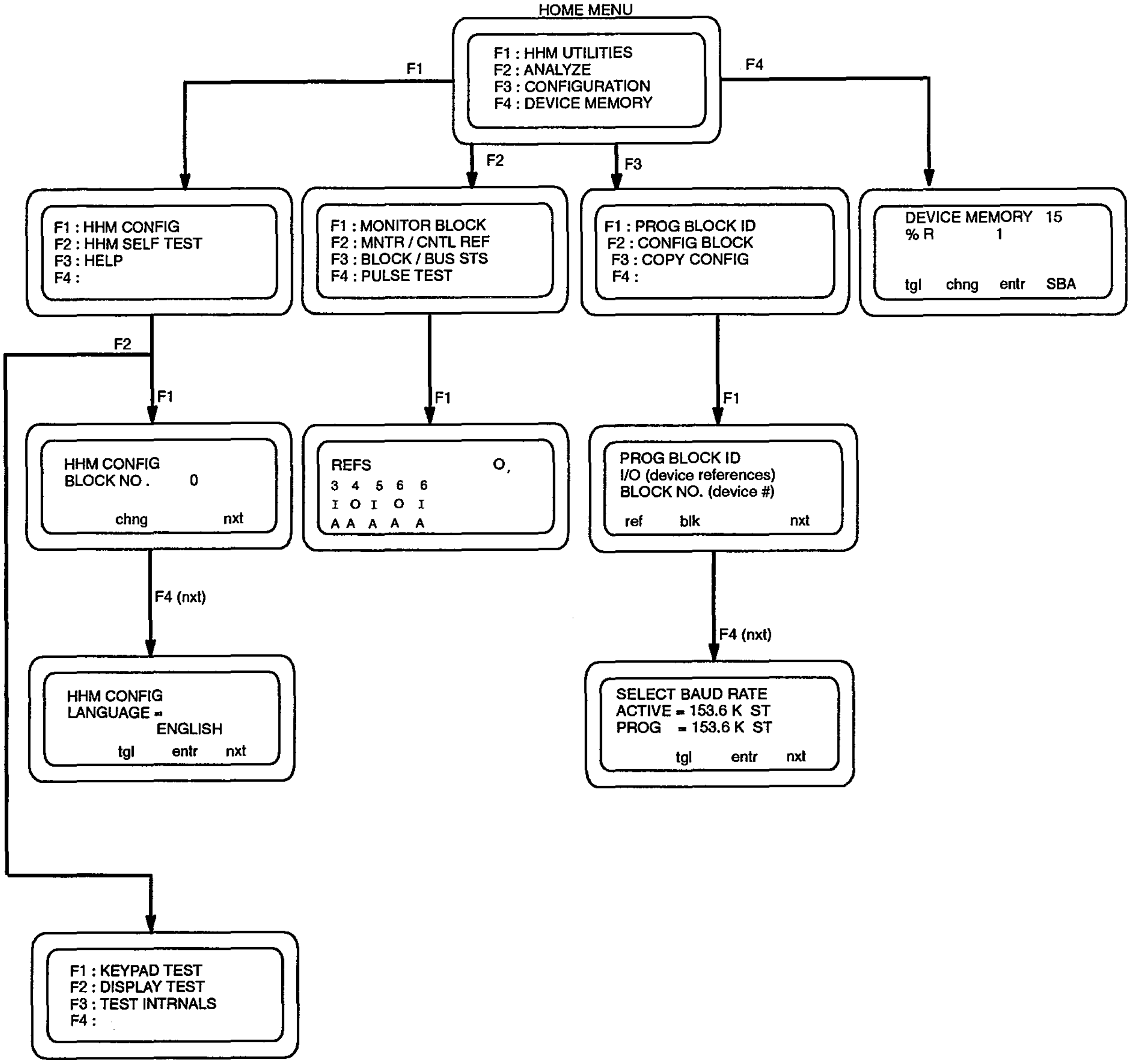


Figure 18. Hand-held Monitor Menu Examples

Table 4. Hand-held Monitor Menus

Home Menu	First Level Submenu	Options	Function Keys	Option Description
F1: HHM UTILITIES	F1: HHM CONFIG	BLOCK NO. #	F2: chng	Changes or assigns the HHM block number. The standard block configuration for the HHM is 0.
			F4: nxt	Moves the display menu to the next option.
		LANGUAGE =	F2: tgl	Toggles the HHM display language between French, German, Italian, and English.
			F3: entr	Saves the change.
			F4: nxt	Moves the display menu to the next option.
		HOST CPU	F2: tgl	Toggles the HOST CPU option between Series Six, Series Five, PCIM/QBIM/GENI, or Series 90. Series 90 is the correct configuration.
			F3: entr	Saves the change.
			F4: nxt	Moves the display menu to the next option.
		AUTO OFF	F2: tgl	Toggles the automatic shutoff function between enabled or disabled. (The automatic shutoff feature turns the battery power off 10 minutes after the last keystroke.)
			F3: entr	Saves the change.
			F4: nxt	Moves the display menu to the next option.
		CHNG BLK ID	F2: tgl	Toggles this option between enabled and disabled. This option, when enabled, allows the HHM to configure I/O block IDs and I/O types.
			F3: entr	Saves the change.
			F4: nxt	Moves the display menu to the next option.

Table 4. Hand-held Monitor Menus (continued)

Home Menu	First Level Submenu	Options	Function Keys	Option Description
F1: HHM UTILITIES (continued)	F1: HHM CONFIG (continued)	CHNG BLK BAUD	F2: tgl	Toggles this option between enabled and disabled. This option, when enabled, allows the HHM to change the baud rate of the devices on the I/O bus.
			F3: entr	Saves the change.
			F4: nxt	Moves the display menu to the next option.
		CHNG BLK CONFIG	F2: tgl	Toggles this option between enabled and disabled. This option, when enabled, allows the HHM to change the configuration of the devices on the I/O bus.
			F3: entr	Saves the change.
			F4: nxt	Moves the display menu to the next option.
		CIRCUIT FORCING	F2: tgl	Toggles this option between enabled and disabled. This option, when enabled, allows the HHM to force I/O circuits on devices in the I/O bus.
			F3: entr	Saves the change.
			F4: nxt	Moves the display menu to the next option.
		CLEAR BLK FAULTS	F2: tgl	Toggles this option between enabled and disabled. This option, when enabled, allows the HHM to clear faults on any I/O blocks.
			F3: entr	Saves the change.
			F4: nxt	Moves the display menu to the next option.
	F2: HHM SELF TEST	F1: KEYPAD TEST	None	Tests keys on the keypad as well as the key switch feature. The display shows the prompt for this option. Press any keypad or turn the key switch after being prompted.
		F2: DISPLAY TEST	None	Tests the HHM display. The display screen displays uppercase letters, special characters, lowercase letters, and then a test pattern that tests for pixel operation.

Table 4. Hand-held Monitor Menus (continued)

Home Menu	First Level Submenu	Options	Function Keys	Option Description
F1: HHM UTILITIES (continued)	F2: HHM SELF TEST (continued)	F3: TEST INTRNALS	None	Tests the internal electronics of the HHM. The display screen will show the status of the test. If the HHM fails the test, press the Clear key and try the test again. If the HHM fails the test again, the HHM needs to be replaced. **NOTE:** A COMM ERROR might indicate that the HHM is attached to an incorrectly terminated bus. Verify that this is not the problem before replacing the HHM.
F2: ANALYZE	F1: MONITOR BLOCK	None	None	Shows current data information for the selected block.
	F2: MNTR/CNTRL REF	None	None	Shows the current data and diagnostic information for the selected block; also can clear faults and can force/unforce I/O.
			F1: >	Displays other circuits.
			F2: force	Forces the displayed circuit. (F3 saves the change; F2 exits without saving.)
			F4: reles	Releases a forced circuit. (F3 saves the change; F2 exits without saving.)
	F3: BLOCK / BUS STS	None	F1: nxt	Provides the status of the next device on the bus.
			F2: prv	Provides the status of the previous device on the bus.
			F3: actv	Makes the device that is currently being displayed the active device. (Active means that the device is the one being monitored.)
			F4: bus	Shows the status of the bus (the active device number and the scan time).
	F4: PULSE TEST	None	F1: exec	Executes a pulse test on the active bus.

Table 4. Hand-held Monitor Menus (continued)

Home Menu	First Level Submenu	Options	Function Keys	Option Description
F3: CONFIGURATION	F1: PROG BLOCK ID	None	F1: ref	Allows the user to configure the device I/O references.
			F2: blk	Allows the user to configure the device block number.
			F3: entr	Saves the changes. If the change is invalid, an error message will appear.
			F4: nxt	Shows the SELECT BAUD RATE SCREEN. F2 allows the user to toggle the baud rate values. F3 saves the change. F4 moves the display menu to the PROG REMOTE MAP screen. This screen is not used.
	F2: CONFIG BLOCK	None	F1: >	Advances the menu through the circuit options and allows the user to choose a circuit.
			F2: tgl or chng	Toggles the options between enabled and disabled. Allows the user to input the appropriate numbers. **NOTE:** The function of this key depends on the screen within the CONFIG BLOCK options. The screen will vary, depending on the type of block that you are configuring.
			F3: entr	Saves the change.
			F4: nxt	Moves the display to the next configuration option screen. No changes are saved using this key.
	F3: COPY CONFIG	None	F3: entr	Saves the change.
			F4: exec	Copies the configuration.

Table 4. Hand-held Monitor Menus (continued)

Home Menu	First Level Submenu	Options	Function Keys	Option Description
F4: DEVICE MEMORY	None	None	F1: tgl	Selects another memory type.
			F2: chng	Allows the user to select another reference location.
			F3: entr	Displays the contents of the specified memory location.
			F4: SBA	Allows the user to select a different bus device (select bus address).

Special Characters

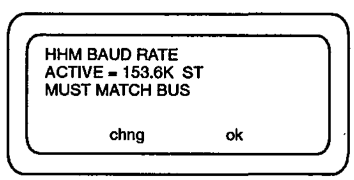
The hand-held monitor uses some special characters in addition to the alphanumeric characters. Table 5 lists the most common special characters and what each one symbolizes. If Table 5 does not list a certain special character, use the F3 (hlp) key in the HHM UTILITIES menu to list all the special characters and what each one stands for.

Table 5. Hand-held Monitor Special Characters

Special Character	Symbolizes
O_I	Output with feedback, or block with both inputs and outputs.
$\underline{\emptyset}$	Circuit is forced off.
$\underline{1}$	Circuit is forced on.
$\underline{o}$	Relay block point is forced open.
$\underline{c}$	Relay block is forced closed.
?	Reference address or device number is not assigned.
*	Reference address is out of range for the hand-held monitor.

Power-up Sequence

When the hand-held monitor is powered up, it performs a self-test. During the self-test, the display shows the following menu:



The hand-held monitor baud rate must match the baud rate of the control system (153.6K ST). If the baud rate matches the control system, press F4 (ok). If the baud rate does not match, press F2 (chng). The next menu allows the baud rate of the hand-held monitor to be changed. Pressing F2 (tgl) of the next menu toggles the baud rates between these four: 153.6K standard (ST), 78.6K, 38.4K, and 153.6K extended (EX). Once the correct baud rate has been selected, pressing F3 (entr) saves the change. Pressing F4 (ok) redisplays the HHM BAUD RATE menu, and pressing F4 (ok) again displays the HOME MENU.

Troubleshooting

Troubleshooting the control system involves a number of steps and components. Problems that occur could be due to a number of things. In order to fix the problem, the actual problem must be isolated. Problems could be caused by either an actual computer system fault or a control system failure. This troubleshooting subsection provides information to help isolate the problem. Actual computer system faults are not included in this subsection; only information pertaining to the control system is provided.

The MWS is the major component in troubleshooting. Checking the MWS is the first step. The MWS runs a program that interfaces with the control system program. The nwacs program reports any monitored condition faults along with any control system faults. If the problem is an actual monitored condition fault, the nwacs program indicates the specific problem, which can then be fixed accordingly. The nwacs program can also indicate a control system fault. The nwacs program indicates the slot number of the control system component that failed and the type of failure.

Two types of control system failures exist: controller rack failure and I/O system failure. The following subsections describe these two failures.

Controller Rack Failure

After the failure has been isolated as a controller rack failure, the next step is to determine which component has failed and why. Table 6 provides a fault chart for the rack controller components.

The first column in the table, *Fault Indication*, lists the information provided by the `nwacs` program on the MWS-E. The second column, *Rack Component*, indicates the rack component located in that slot. The third and fourth columns, *LED* and *Status*, list LED statuses that indicate the respective status for each component. The fifth column, *Possible Problem*, lists the possible problem as indicated by the statuses of the LEDs. The sixth column, *Remedy*, lists the action necessary to fix the problem indicated in the fifth column.

Table 6. Controller Rack Fault Indications

Fault Indication	Rack Component	LED	Status	Possible Problem	Remedy
No faults indicated by `nwacs`	Power supply	LOGIC POWER	On	None	None
			Off	Control system does not have incoming power.	Check incoming power; if there is no incoming power, restore incoming power.
				Power supply has failed.	Replace power supply.
				Ineffective ground connection.	Check ground connection; fix if necessary.
	CPU			See “Slot 1” fault indications below.	
Slot 1	CPU	OK	On	None	None
			Blinking	The system has failed. **NOTE:** This LED blinks during the power-up process while the CPU is performing self-check diagnostics.	Replace CPU module.
			Off	The system has failed and all communications have ceased.	Replace CPU module.
		RUN	On	None	None
			Off	CPU is in the stop mode.	Verify that the CPU mode switch is in the *Run With Outputs Enabled* setting. Change switch setting if necessary.
		ENABLED	On	None	None
			Off	CPU outputs are disabled.	Verify that the CPU mode switch is in the *Run With Outputs Enabled* setting. Change switch setting if necessary.

Table 6. Controller Rack Fault Indications (continued)

Fault Indication	Rack Component	LED	Status	Possible Problem	Remedy
Slot 2	State Logic Processor	STATUS	On	None	None
			Off	State logic processor is not communicating with the system.	Check to see whether any other component has failed; if no other component has failed, replace the state logic processor.
				State logic processor has failed.	Replace the state logic processor module.
Slot 3	Genius Bus Controller (GBC)	OK	On	None	None
			Blinking	GBC has been installed in a slot that is not configured for a GBC. **NOTE:** This LED blinks during the power-up process while the CPU is performing self-check diagnostics.	Install the GBC in the correct location.
			Off	The GBC module has failed.	Check the CH 1 OK LED; if off, replace the GBC module.
		CH 1 OK	On	None	None
			Off	The GBC module has had a bus or bus controller failure while the CPU was running. **NOTE:** If the failure is a bus controller failure, the LED remains off. However, if the failure is a bus failure, the LED illuminates after the bus failure (for example, a broken wire or too many bus errors) is corrected.	Check for an I/O system failure. Refer to the following "I/O System Failure" subsection for more information.

Table 6. Controller Rack Fault Indications (continued)

Fault Indication	Rack Component	LED	Status	Possible Problem	Remedy
Slot 4	TTL Input Module				
Slot 5	12-Vdc Output Module				
Slot 6	Analog Base Converter Module				
Slot 7	Voltage Input Expander Module	OK	On	None	None
			Off	Component has failed.	Replace module.
Slot 8	VMIVME-4132 Analog Output Card	FAIL	On	Card has failed.	Replace card.
			Off	None	None

I/O System Failure

An I/O system failure is indicated by either a GBC module failure (slot 3) or an I/O remote monitoring block failure. A GBC module failure can be indicated by the `nwacs` program as a "slot 3 failure," or by an off "OK" status LED or an off "CH 1 OK" status LED on the GBC module. It is possible that all of these conditions might exist, and any of these conditions can indicate a possible I/O system failure. If all of these conditions exist, the hand-held monitor will probably have to be used. The following subsection describes the hand-held monitor, its function, and its use.

Troubleshooting the I/O system involves determining whether the fault condition is due to the GBC module or an I/O remote monitoring block. Table 7 provides GBC fault information.

The two I/O remote monitoring blocks (analog I/O monitoring block and 115-Vac monitoring block) have identical status LEDs; therefore, the troubleshooting of each of these monitoring blocks is the same. Table 8 provides information about the I/O remote monitoring block status LEDs and their fault indications. Table 9 provides information about troubleshooting the I/O system of the control system.

Table 7. GBC Fault Indications

Component	Problem Indication	Possible Problem	Remedy
GBC	No status LEDs illuminated	GBC is not receiving enough power from the power supply.	Check power supply.
	Is not communicating with the CPU	CPU may be in the wrong operation mode.	Verify the CPU operation mode and correct if necessary.
	Is not communicating with the I/O system bus OK and CH 1 OK LEDs blinking together	Two devices on the I/O bus may have been configured with the same device number.	Check the device numbers using the hand-held monitor; reconfigure any device with inaccurate numbers.
		Serial 1 and serial 2 wires are crossed.	Check these wires and fix if necessary.
		GBC device address is wrong.	Verify that the GBC device address is correct using the hand-held monitor.
		Baud rate is wrong.	Verify that the baud rates are correct for each component on the I/O system.
	Is not operating normally	I/O system is not wired correctly.	Verify that the I/O system is daisy chained correctly.
		I/O system bus cable is too close to high-voltage wiring.	Check cable location and move if necessary.
		Broken cable.	Check for broken cable using the hand-held monitor.
		Cable shielding is not installed or grounded correctly.	Verify cable shielding for correct installation and grounding.

Table 7. GBC Fault Indications (continued)

Component	Problem Indication	Possible Problem	Remedy
GBC (continued)	Communications are intermittent	Remote monitoring blocks may have mixed baud rates.	Verify each remote monitoring block's baud rate using the hand-held monitor; change the baud rate using the hand-held monitor if necessary. **NOTE:** The I/O system cannot have mixed baud rates. Once the baud rate has been changed, the remote monitoring block must be power cycled for the baud rate to take effect.
		Wires may be broken.	Check all wires and connections.

Table 8. I/O Remote Monitoring Block LED Fault Information

Unit OK LED	I/O Enabled	Indication
On	On	Block is functioning and is communicating with the CPU.
On	Off	Block is functioning but has not communicated with the CPU for three bus scans.
On	Blinking	Block is functioning, but the I/O circuit has been forced.
Blinking	On	Block has had a circuit fault but is communicating with the CPU.
Blinking	Off	Block has had a circuit fault and is not communicating with the CPU.
Alternate blinking		Block has had a circuit fault, and the I/O circuit has been forced.
Blinking together		Block is not communicating with the CPU because of a block number conflict.
Off	Off	Block does not have power.
		Block is faulty.
Off	Blinking	The electronics assembly and terminal assembly are mismatched.

Table 9. I/O Remote Monitoring Block Troubleshooting

Problem Indication	Possible Problem	Remedy
Unit OK and I/O Enabled LEDs are blinking together	Components within the I/O system have duplicate device numbers.	Verify the device numbers using the hand-held monitor; assign a device number according to the device number on the block if necessary.
Unit OK LED remains off after power-up	Electronics assembly is not properly attached to the terminal assembly.	Verify that the two assemblies are attached correctly; fix if necessary.
	Block power wires are not connected to the correct terminals.	Verify that the power wires are attached correctly and fix if necessary.
	The I/O system bus may not be terminated properly.	Check to see whether other blocks in the system indicate the same problem; if so, verify that the last component in the I/O system is terminated correctly.
None of the circuits on a block are working	Terminal assembly wiring is not correct.	Verify that the terminal assembly wiring is properly attached.
	Terminal assembly voltage is not correct.	Verify that the voltage is correct for the terminal assembly.
	Device has the same number as another block in the I/O system.	Check to see whether the Unit OK and I/O Enabled LEDs are blinking together; this condition indicates that the block has an incorrect configuration number. Verify that the block has the correct number.
One circuit on the block is not working or is not being recognized by the CPU	Sensor or control valve may not be working.	Switch wire from the sensor or control valve to another circuit on the block to verify the sensor or control valve operation.
	Wiring for that circuit is incorrect.	Check circuit wiring.
	Electronics assembly is not installed correctly.	Reinstall the electronics assembly.
	Improper voltage is being applied to the terminal assembly.	Verify that the voltage levels for the terminal assembly are correct.
	Electronics assembly is faulty.	Replace the electronics assembly.
Unit OK LED is blinking	The block has a faulty circuit.	Check the circuit for the fault using the hand-held monitor.
		Power down the block and then power it up.
		Clear the fault condition using the hand-held monitor by issuing the Clear All Circuit Faults command. If this does not clear the fault condition, the block must be replaced.

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Preliminary Information

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