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User's Manual

GE Fanuc Automation

June 1990 GFK-0122B

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Preface

This manual contains the information that will enable you to install, operate, and maintain the Series Five Programmable Logic Controller PLC). The Series Five PLC is a powerful, mid-range PLC with a design that provides fast program execution, easy installation, a broad range of functional capabilities, and it is easy to use. It is well suited for the needs of many applications.

The Series Five PLC is programmed with the Logicmaster 5 Programming and Documentation Software package installed in a Workmaster®, Workmaster® II, CIMSTAR industrial computer, or an IBM®-PC, PC-XT®, PC-AT®, PS/2® or compatible personal computer.

Chapter 1. Introduction to the Series Five PLC: provides an overview of the Series Five PLC, with emphasis on features, system capabilities, general specifications, and available options.

Chapter 2. Physical Equipment Configuration: provides a description of the hardware components, with an emphasis on the features and functions of each component that the user will need to be familiar with in order to specify components and understand how they relate to the overall system.

Chapter 3. Installation Instructions: contains the information required to assemble, install, and wire a Series Five PLC system to field devices.

Chapter 4. Operation: describes the features of the Series Five that the user needs to know in order to program and operate a Series Five PLC control system. Included is information on valid references, assigning references to real I/O, execution times of programming functions, definition of special purpose coils, registers, scratch pad bytes used for error messages, error code definitions, and CPU operation.

Chapter 5. Maintenance: is a guide to basic maintenance of a Series Five PLC system. A troubleshooting flow chart provides the information that should enable you to troubleshoot the majority of any problems that may occur. Instructions are provided as a guide to replacement of system components.

Appendix A. Glossary of Terms: This appendix is a glossary of terminology pertinent to the Series Five PLC.

Appendix B. Electronic Bulletin Board for the Series Five PLC: This appendix describes the Series Five Electronic Bulletin Board, which is dedicated to and maintained solely for the use of Series Five PLC users.

Appendix C. CCM Memory Types: This appendix provides an expanded listing of the Communications Control Module (CCM) memory types. This expanded listing includes the memory mapping for:

- Types 2 and 4 (Inputs/Byte) -- Table C-1
- Types 3 and 5 (Outputs/Byte) -- Table C-2

Following the appendices, a comprehensive index is provided as a guide to enable you to quickly find a particular item of interest in the manual.

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Related Publications

GFK-0023	*Logicmaster 5 Programming and Documentation Software User's manual*
GFK-0123	*Series Five PLC I/O Module Specifications*
GFK-0181	*Series Five PLC Operator Interface Unit User's Manual*
GFK-0248	*Series Five Genius Bus Controller User's Manual*
GFK-0269	*Series Five Programmable Controller ASCII/BASIC Module User's Manual*
GFK-0355	*Series Five Programmable Controller High Speed Counter User's Manual*
GFK-0401	*Workmaster II PLC Programming Unit Guide to Operation*
GFK-0449	*Series Five Programmable Controller Axis Positioning Module User's Manual*
GEK-25373	*Workmaster Guide to Operation*
GEK-90527	*Cimstar I Industrial Computer Reference Manual*

Henry A. Konat
Senior Technical Writer

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The Series Five Programmable Logic Controller and its associated modules have been tested and found to meet or exceed the requirements of FCC Rule, Part 15, Subpart J. The FCC requires that the following note be published.

NOTE

This equipment generates, uses, and can radiate radio frequency energy and if not installed in accordance with the instruction manual, may cause interference to radio communications. It has been tested and found to comply with the limits of a Class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference, in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

The Canadian Department of Communications requires that the following note be published.

NOTE

This digital apparatus does not exceed the Class A limits for radio noise emissions from digital apparatus set out in the radio interference regulations of the Canadian Department of Communications.

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Chapter 1

1-1 Introduction to the Series Five Programmable Logic Controller

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Introduction

The Series Five programmable logic controller is a compact, modular, mid-range, programmable logic controller designed for ease of use and programming. The Series Five programmable logic controller offers a wide range of features when compared to other programmable logic controllers in the same I/O range. The range of applications which may be controlled by a Series Five programmable logic controller are many and varied and are easily implemented once your system is designed and installed.

Programmable Logic Controllers (PLCs) are also referred to as Programmable Controllers (PCs). In this manual, in order to avoid any confusion, we will refer to these electronic control devices as programmable logic controllers or PLCs, since the use of the acronym PC is universally used when referring to Personal Computers.

What are Programmable Logic Controllers?

Programmable logic controllers are general purpose microprocessor controls that have been designed specifically for operation in the harsh environment usually encountered in the factory. A programmable logic controller accepts data from input devices, such as limit switches, proximity switches, and sensors. It then performs logical decisions in an orderly and repetitive sequence as determined by a program entered in memory by the user, and provides output control for machines or processes.

Input modules convert electrical signals provided by the input devices to logic levels for processing by the Central Processing Unit (CPU) and Output modules convert signals from the CPU to the proper electrical signals for control of machines or processes. The Input and Output (I/O) modules also provide electrical isolation of signals in the CPU from electrical noise typically found in the factory environment. The following figure is a basic block diagram of a programmable logic controller.

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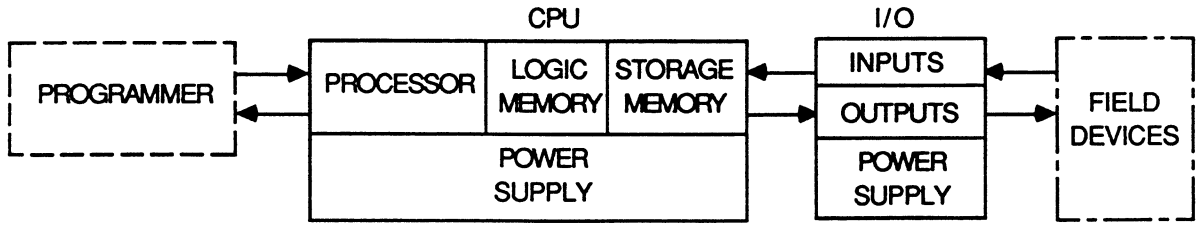

Figure 1-1. Programmable Logic Controller Block Diagram

Advantages of Programmable Logic Controllers

Programmable Logic Controllers offer many advantages over other control devices, such as electrical timers and counters, relays, and drum type mechanical controllers. Some of the many advantages to be considered when planning a system include:

- Improved reliability, you do not need to be concerned with frequent breakdown of electro-mechanical devices.
- Less space is required, since a proliferation of hardware, including relays, electrical timers, and similar items, are not needed
- Easier to maintain. Built-in diagnostics and reliable solid-state devices equate to few breakdowns. When failures do occur, they are quickly detected and repaired.
- A PLC system is easily reprogrammed if control requirements should change.
- Flexibility - one device is able to perform many control functions.

Series Five Programmable Logic Controller

The Series Five PLC combines many features and functions of other GE Fanuc PLCs, including the Series One™ PLC family, Series Three™ PLC, and Series Six™ Plus PLCs. Hardware is modular, with a system comprised of a power supply, CPU, I/O, and system interface modules mounted on a base unit. Base units are available in two versions, either 6 I/O slots or 8 I/O slots. The base unit containing the CPU is referred to as the CPU base unit; a base unit containing only I/O and system interface modules is an I/O expansion base unit. Discrete I/O modules are available with either 16 or 32 circuits. Other available modules include Analog Input and Output, ASCII/BASIC, CCM Communications, High Speed Counter, and Axis Positioning. Programs are entered using Logicmaster™ 5 applications software with a Workmaster® computer, CIMSTAR™ I computer, or an IBM® PC, XT, AT, or PS/2 personal computer connected through a built-in CCM port in the CPU module. The programming language includes most functions available for programming a Series Six Plus PLC.

A system requiring more I/O than can be contained in the CPU rack, is expanded by adding up to 7 base units in a Local chain, Each base unit can contain up to 8 I/O modules with a total of 64 I/O modules in a system. Each I/O base unit must have a Local I/O Interface module in order for the I/O modules installed in the base unit to communicate with the CPU through the I/O bus. Base units are connected through an I/O Expander cable to an I/O expansion connector either on the right or left side of the base unit. The last base unit in an I/O system must have an I/O terminator plug installed on the remaining expansion connector. This system configuration is a Local I/O chain and can have up to 2048 I/O points (1024 Inputs and 1024 Outputs). A Local I/O chain can have standard Series Five I/O and Series Three I/O. Series Three I/O requires a Series Three base unit and power supply and connects to the Series Five PLC through an interface module in the Series Five PLC's base unit. Series Five PLC and Series Three PLC I/O modules cannot be mounted in the same rack.

Each base unit must be assigned an identification number from 0 to 7, selected by configuring a rotary switch, located above the left I/O expansion connector, to the selected ID number. ID numbers determine the order in which base units are assigned addresses by the CPU, but do not necessarily relate to the order in which they are physically configured. The total number of I/O points in a Local I/O system can be 2048 (1024 Inputs and 1024 Outputs). This can be all Series Five I/O, or Series Three I/O, or any combination of the two I/O systems - not to exceed 2048 I/O total.

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By adding a Series Five Genius Bus Controller to a system, the system can be expanded to include 2048 Genius I/O points. These I/O points are addressed using the I+ and O+ references. Genius Bus Controllers also provide the capability of having high speed CPU-to-CPU communications.

User memory is provided on convenient cartridges, which plug into the front of the CPU. Memory cartridges are available with CMOS RAM memory, which has a built-in battery back-up for memory retention under no-power conditions; EPROM memory or EEPROM memory, which are both non-volatile and do not require a battery to retain the contents of memory. User memory can be either 4, 8, or 16K words and register memory can be either 4k or 16K registers which are available for general use. RAM memory cartridges contain a replaceable Lithium battery for memory back-up. Register memory is backed-up by a lithium battery mounted on the inside of the large CPU door.

The Series Five Operator Interface Unit provides a convenient means for CPU setup and operation, I/O monitoring, timer, counter, and register monitoring, programming of EPROM and EEPROM memory cartridges, message display in ASCII format, and password operation.

The following illustration of a Series Five Programmable Logic Controller shows the location of modules in the CPU base unit. I/O and CPU base units are available having either 6 or 8 module slots. The power supply is always installed in the leftmost slot and the CPU is in the slot immediately to its right (in a CPU base unit). An expansion base unit must contain a Local I/O Interface module in the slot next to the power supply.

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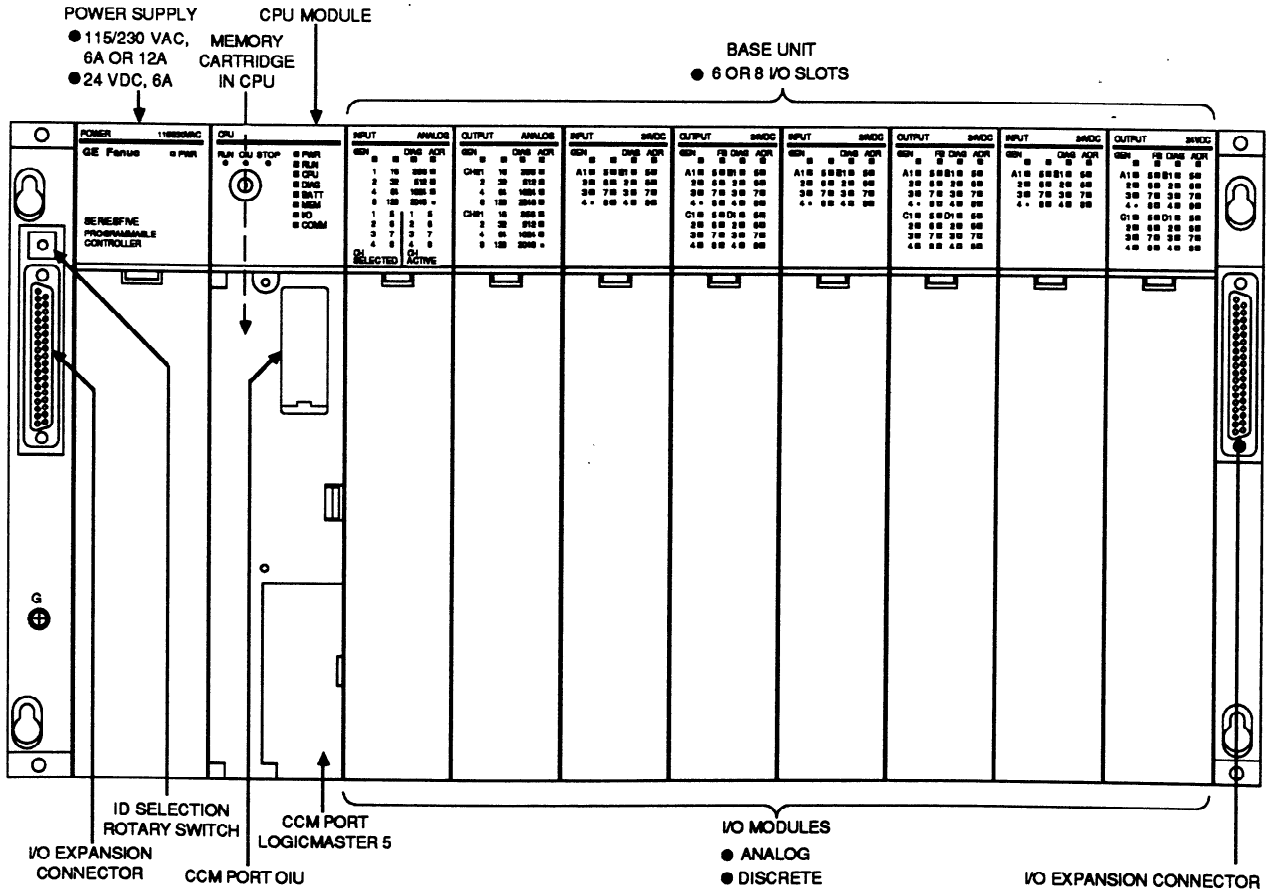

Figure 1-2. Series Five Programmable Logic Controller

The number and variation of possible system configurations that are available for a Series Five PLC are many. You can configure a system in a Local I/O chain with all Series Five I/O, all Series Three I/O, or a combination of Series Five and Series Three I/O - and you can add Genius I/O, depending on the requirements of your system. The following figure shows a typical Series Five PLC system configuration using only Local I/O.

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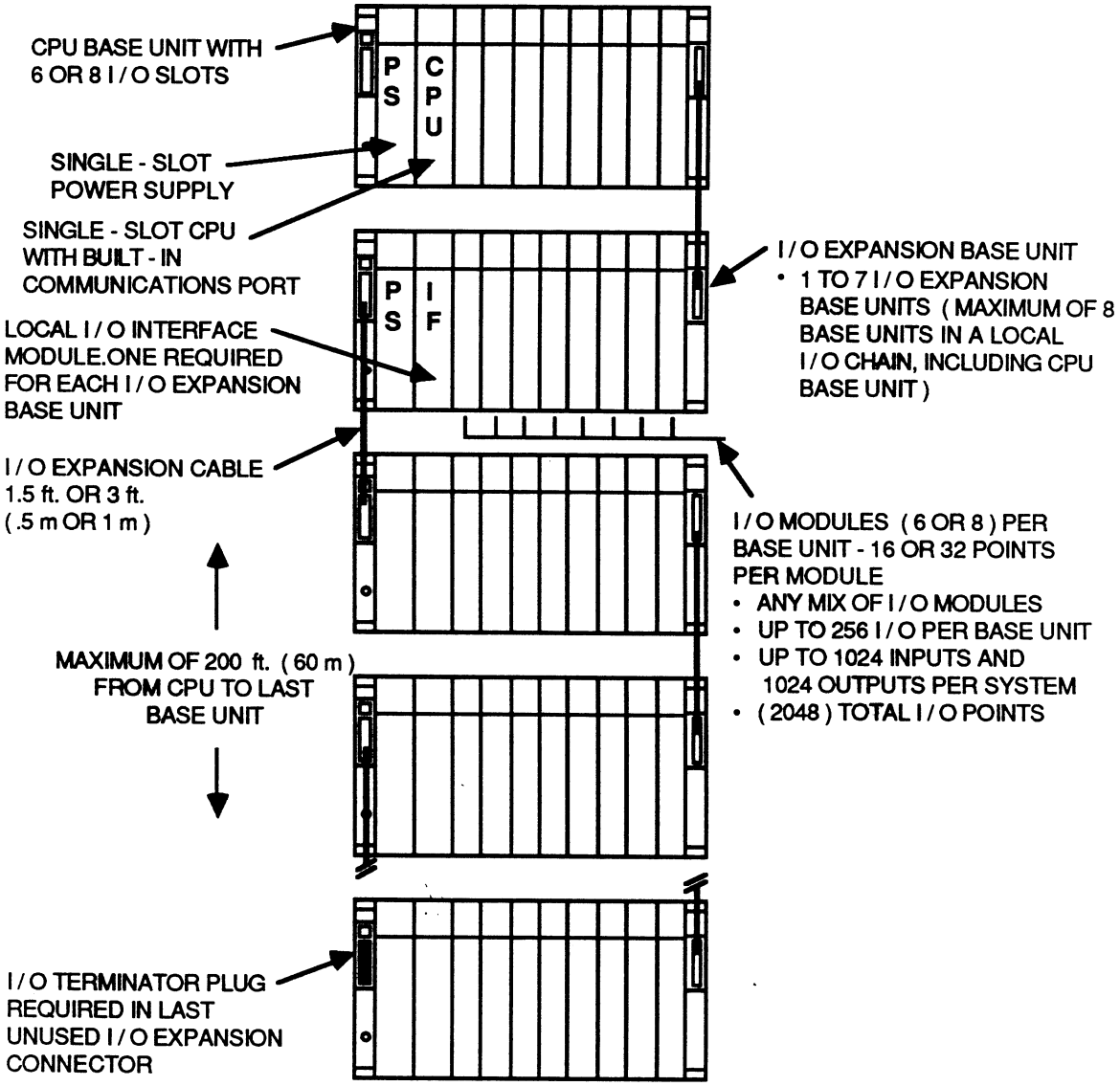

Figure 1-3. Example of Series Five PLC Local I/O System Configuration

NOTE

All base units in the Local I/O chain must be connected to a common ground point and ac powered supplies must operate from the same ac power source.

Features of the Series Five PLC

The Series Five PLC has many features which make it desirable for use in applications requiring mid-size controllers. Many of the features and advantages are listed in the following table and are described on the following pages.

Table 1-1. Series Five PLC Features

Feature	Benefit
Modular System	Allows easy configuration of hardware.
Program (User) Memory Type	CMOS RAM with battery backup, EPROM, or EEPROM.
Memory Form	A compact removable cartridge containing Logic (User), or Register memory. Some memory cartridges are used for both CPU logic memory and ABM expansion memory.
Memory Cartridges available in 5 Versions	4K RAM User Memory (1) 16K RAM User Memory (2) 8K EPROM User memory (1) 16K EPROM User Memory (2) 4K EEPROM User memory
Password Operation	Provides program security by against unauthorized access to user programs.
Compact Size	Can be mounted in a 5.47 inch deep cabinet.
I/O Point Capacity (2048 Total Available)	1024 Inputs and 1024 Outputs in a Local I/O chain and 1024 Inputs and 1024 Outputs in a Remote I/O (usually Genius I/O) chain.
Power Supplies	115/230 Vac, 6 A/12 A versions, 24 Vdc, 6 A
Programming	Logicmaster 5 (subset of Logicmaster 6) via a Workmaster II or Cimstar computer, or an IBM PC, PC-XT, PC-AT, or PS/2 personal computer.
Communications Options	Communications Control Function - Built-in RS-232/RS-422 compatibility. Provides a connection to the programming device or can be used for general communications. Compatible with the GE Fanuc CCM protocol.
I/O Interface Module	Series Three I/O Interface - Allows use of existing Series Three I/O modules in a Series Five I/O system, controlled by the Series Five CPU.
ASCII/BASIC Module	Interfaces to serial devices - Has built-in BASIC language. Exchanges information with Series Five PLC.
High Speed Counter	Allows Series Five PLC to monitor and control process variables at a faster speed than the CPU can handle - count speed - 50 Khz.
Operator Interface Unit	Compact, portable hand-held device provides many useful functions - monitors I/O, registers, configure Genius I/O network, etc.
Axis Positioning Module	An intelligent, programmable, easy-to-use single axis positioning controller ideal for simple point-to-point positioning tasks.

1. The same catalog number can also be used to expand ASCII/BASIC module memory by an additional 24K bytes.
2. 16K RAM and EPROM memory cartridges are shipped with 16K register upgrade kits.

CPU Related Features

- Built-in CCM port for direct connection to programmer or OIU, or for general communications use.
- Single bit non-ambiguous forcing of I/O points through the CCM port.
- Extremely fast monitoring of random data points within the CPU through the CCM port.
- Soft I/O configuration can be done remotely, no need to set DIP switches.
- A source code compiler allows downloading of a new program while the CPU is running with minimal interruption when the new program starts running.

- Internal battery backed real-time clock/calendar accessible to user program.
- Scan time registers for longest, minimum, and last scan.
- Scan count registers allow specific scan execution (good for debug and troubleshooting).
- Override tables for all real and internal I/O (except diagnostic contacts).
- Watchdog timer duration can be set by user.

- Convenient battery-backed plug-in memory cartridges allow storing of program or registers.
- Programmable I/O bus retry for I/O parity errors.
- Extensive CPU and I/O diagnostics available to user logic through registers and special internal contacts.
- Program names with time and date stamps are stored with the program in the memory cartridge in the CPU, and can be read by Logicmaster 5 software at a later time.
- Genius diagnostics - add/loss of device can be disabled from user logic.
- Simple setup of Genius Bus Controller - no setup required at all for Genius I/O blocks.

I/O Related Features

- Detection of missing or loose terminal strips, and missing external 24 V dc power supply with fault reporting to the CPU.
- Blown fuse LED indicator on I/O module and CPU.
- Removable terminal strips and removable terminal strip protective covers.
- LEDs on face of module can show module addresss as well as I/O status indication.
- Removable fuses.

- Local I/O bus can be extended to a total length of 200 feet (60 meters).
- Compatible with Series Five I/O, Series Three I/O modules, and Genius I/O.
- Genius serial bus can be up to 7500 feet (2283 meters) from the CPU.
- Totally enclosed modules prevent damage while troubleshooting or while in storage.
- I/O module circuit boards are mounted on solid metal chassis for noise protection.

- Modules have opto-isolators to protect internal circuitry from external noise.
- Positive screw locking holds modules firmly in place.
- Differential I/O bus with parity checking. Rugged industrial backplane design.
- I/O modules keyed to prevent accidental insertion of a wired connector on the wrong type of module, for example, ac to dc.
- CPU detects I/O configuration on power-up and alerts user of any configuration change since last power-up.
- Convenient wiring labels inside terminal strip covers.
- All installations and wiring can be done with either a phillips or flat blade screwdriver.

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Table 1-2. General Specifications

Operating Temperature	0 to 60°C (32 to 140°F) (at outside of rack, no fans or forced air)
Storage Temperature	-20 to 70°C (-4 to 158°F)
Humidity (Non-Condensing)	5% to 95%
AC Power Source	115/230 Vac (Jumper Selectable)
Frequency	47 to 63 Hz
Maximum Load (12A Supply)	170 vA
Maximum Load (6A Supply)	85 vA
DC Power Source (6A)	20 to 29 Vdc (24 Vdc Supply)
Maximum Load	180 vA
Typical Battery Life under Load	2 to 5 years
Shelf Life (No Load)	8 to 10 years
Base Plate Dimensions	
8 I/O Slots	19.0(W) x 9.9(H) x 5.47(D) inches 483 x 250 x 139 millimeters
6 I/O Slots	15.7(W) x 9.9(H) x 5.47(D) inches 399 x 250 x 139 millimeters
Typical Execution Rate	1.0 mSec per K of user memory for boolean instructions.
Real-Time Clock Accuracy at 25° C	± 60 parts per million ± 155 seconds per month ± 2 minutes and 35 seconds per month
Over range of 0° to 60° C	+ 60 parts per million to -150 parts per million + 155 seconds per month to - 400 seconds per month
Meets Agency Standards for:	
Showering Arc Test	NEMA ICS 2.230.40
Shock	Mil-std 810C method 514.2 JIS.C 0911 11 B
Vibration	Mil-std 810C method 516.2 JIS.C 0912 10 G
Radio Frequency Interference	FCC Class A, part 15, subpart J
Insulation resistance	1500 Vac Hipot
Noise Immunity	Sanki 1 mSec, 1 KV pulses
Maximum Wire Size (With Terminal Cover on and all wires connected).	One AWG #16 or Two AWG #18 with 1/4″ spade lugs.

GENIUS I/O System

In addition to Series Five and Series Three I/O modules, the Series Five PLC supports the Genius I/O system. The Genius bus is used in the Series Five PLC to provide access to Genius blocks, provide a peer-to-peer communications network using multiple CPUs, and allow remote I/O capability. Genius I/O is available in units called blocks, and includes both discrete and analog blocks. Genius I/O blocks are connected to the Series Five CPU through the Series Five Genius Bus Controller module over a single twisted-pair serial communications link, and may be located up to 7500 feet (2283 meters) from the CPU. Bus Controllers must be installed in the CPU base unit, which allows a maximum of eight Bus Controllers in a Series Five PLC system. Each Bus Controller can have up to 32 Genius compatible devices connected to it on the serial bus. For detailed information on the Genius I/O system, refer to GEK-90846, the Genius I/O System User's Manual. Some of the many benefits of the Genius I/O system are:

- Each block is a stand-alone unit, no separate rack or power supply required.
- A convenient, easy to use Genius Hand-Held Monitor (HHM) is used for system configuration, calibration, and troubleshooting.
- The circuits on most discrete blocks can be configured to be inputs, outputs, or any combination of inputs or outputs.
- Extensive diagnostics monitor not only the blocks, but also field devices.
- There are no fuses to be concerned with, since the discrete outputs have built-in electronic fusing for circuit protection.
- Easier installation and troubleshooting, and fewer spare parts required in inventory provide a significant cost savings over traditional I/O systems.

Table 1-3. Genius I/O Blocks

Block Type	Current/Voltage/Description	Number of Circuits
115 V ac Grouped	2 A, Total 15 A	8
115 Vac/125 Vdc Isolated	2 A, Total 15 A	8
115 V ac, Input only	9.9 mA preload current	16
24/48 V dc Source 3 wire sensor compatible	2 A per circuit, 15 A total	16
24/48 V dc Sink, 3 wire sensor compatible	2 A per circuit, 15 A total	16
12/24 V dc Source	0.5 A, total 16 A	32
5/12/24 V dc Sink	0.5 A, total 16 A	32
Analog, 12-bit (two versions available - 115 V ac or 24/48 V dc)	0 to +10 V dc, -10 to +10 V dc, -5 to +5 V dc, 0 to +5 V dc, 4 to 20 mA (or +1 to +5 V dc)	4 In/2 Out
24 V dc, Sink, 2 and 3 wire sensor compatible	2 A per circuit, 15 A total	16
24 V dc, Source, 2 and 3 wire sensor compatible	2 A per circuit, 15 A total	16
Relay, 115/230 V ac, NC	2 A per circuit	16
Relay, 115/230 V ac, NO	2 A per circuit	16
RTD, 115 V ac/125 V dc	Platinum, copper, nickel RTD	6
RTD, 24/48 V dc	Platinum, copper, nickel RTD	6
High Speed Counter	AC or 10 - 30 V dc	4

If a system is to include Genius I/O blocks and/or CPU-to-CPU communications, it can be configured as shown in the following two figures.

NOTE

For applications involving a redundant CPU driving a Genius network, refer to publishaed application information or contact your GE Fanuc Application Engineer.

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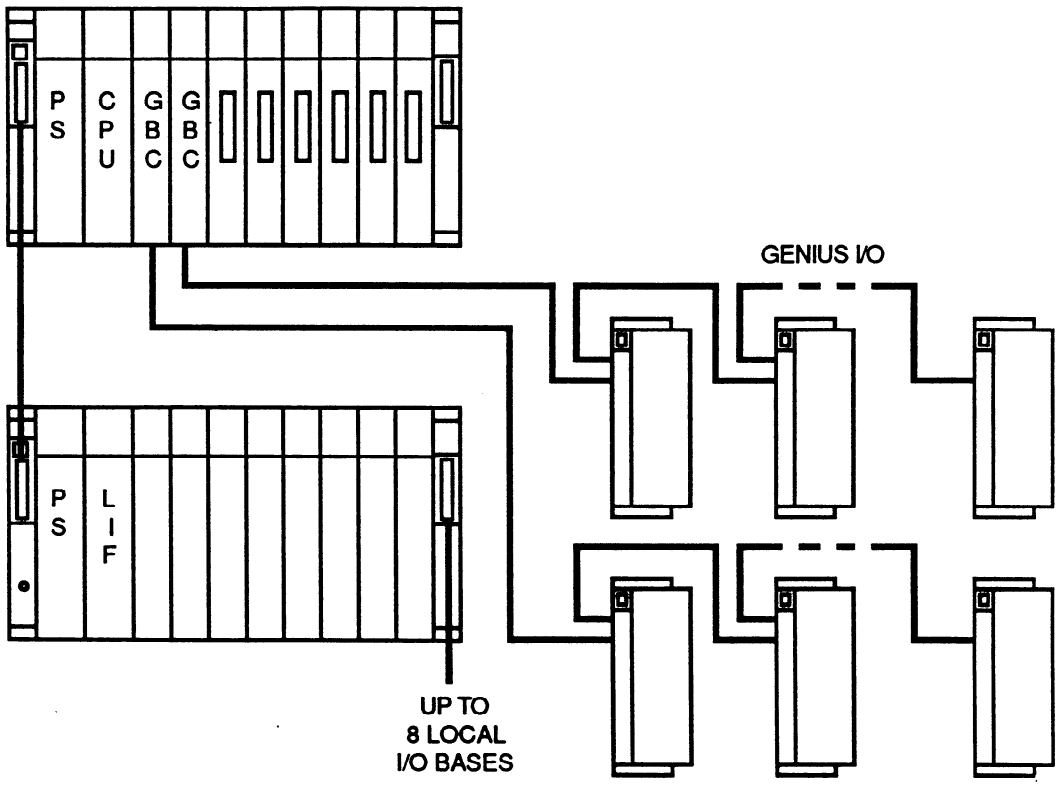

Figure 1-4. Example of Local I/O and Genius I/O System Configuration

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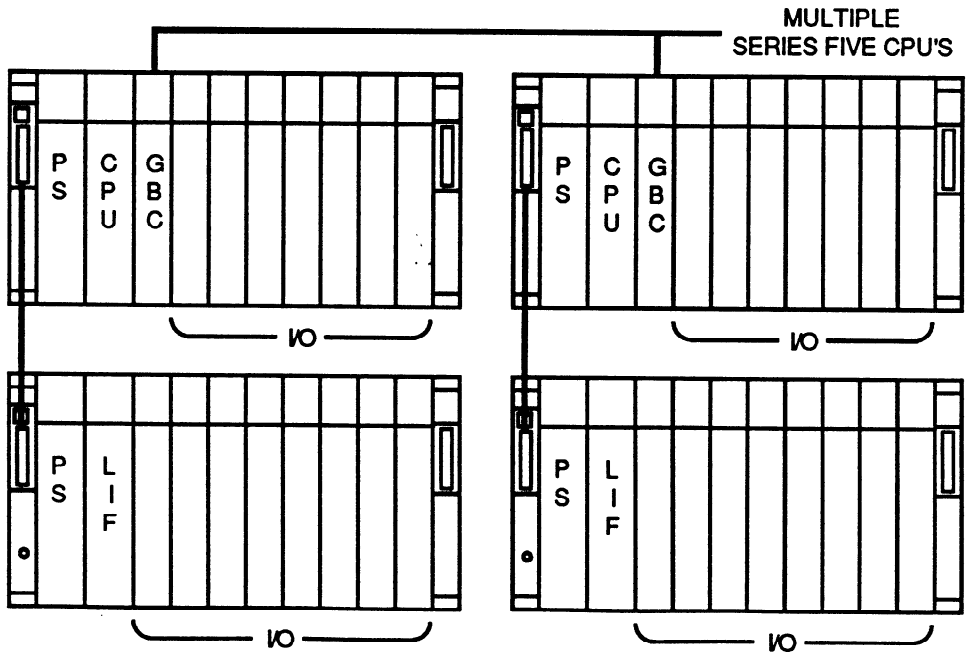

Figure 1-5. CPU-TO-CPU Communications Through GENIUS LAN

Programming the Series Five PLC

Programs are entered, edited, and monitored with a Workmaster or Workmaster II portable computer or the Cimstar industrial computer using software available on 3.5″ diskettes. Software is also available on 5.25″ diskettes for use with an IBM PC, PC-XT, PC-AT, or PS/2 personal computer . The programming package for the Series Five PLC is Logicmaster 5. The programming language is relay ladder logic which has been expanded to include instructions for applications more complex than those requiring only the basic relay ladder logic functions. The programming language is a subset of the Series Six instruction set. Logicmaster 5 software communicates with a Series Five PLC through the CPU's CCM port.

Logicmaster 5 software operates in one of three modes, which are on-line, off-line, or monitor. After a program is developed, it is simple to transfer it to the CPU. The Logicmaster 5 programming software can be used on-line with one or more operating CPUs to provide continuously-updated displays of reference tables and program logic. The logic display features symbolic power flow through the rungs, so program execution can easily be monitored.

Logicmaster 5 Programming Software Features

Logicmaster 5 software offers a full range of programming functions, such as:

- Basic relay contacts, coils, timers, and counters.
- Signed single-precision, and double-precision arithmetic.
- Data Move, Table Move, List operations, and Matrix functions.
- Up to 32 subroutines in a single program. Other control functions such as
- Master Control Relay and Skip.
- Support for up to 16K CPU registers.
- Able to interface with multiple CPUs through an RS-422 link.
- Extensive, easy-to-display Help files.
- Print-out of display screens, programs, annotation, and tables.
- Program storage on diskettes or hard disk.
- The ability to combine part or all of one ladder logic program with another.

The Logicmaster 5 system can easily be used to create programs off-line, in a location far from the Series Five PLC. With Logicmaster 5 software, one computer can be used to create programs for many Series Five PLCs. These programs can be stored on diskettes or a hard disk, and used whenever and wherever they are needed.

A Scratch Pad function is used to match the programming features of Logicmaster 5 software to the CPU, and to establish CPU operating parameters. When you select the Scratch Pad function from the Supervisor menu, the Scratch Pad display appears. Here, you can select the features you want to include in the program for a specific CPU.

For detailed information on programming the Series Five PLC, refer to the *Logicmaster 5 Programming and Documentation Software User's Manual, GFK-0023.*

Workmaster II Computer

The Workmaster II computer, with Logicmaster 5 software, is the main device used for developing and entering new user's programs, editing existing programs, or real-time system monitoring of the PLC.

The Workmaster II computer is an IBM compatible programming device with system architecture based on the 80386 microprocessor resulting in high performance. The Workmaster II computer is a self-contained portable, and is factory-hardened to withstand the wide temperature variations, shock, and vibration usually present in the factory environment. Program storage in the Workmaster II computer is provided in the form of a 1.44 MB, 3.5-inch diskette drive, and a 60 MB fixed drive. The keyboard is a 101-key keyboard; the display is a plasma display.

A serial port, which is fully programmable and supports asynchronous communications, provides the interface to the Series 90-30 PLC. The portability, high-storage capacity, and ease of use of the Workmaster II computer with Logicmaster 5 software provide a powerful programming and system monitoring tool for virtually any PLC application.

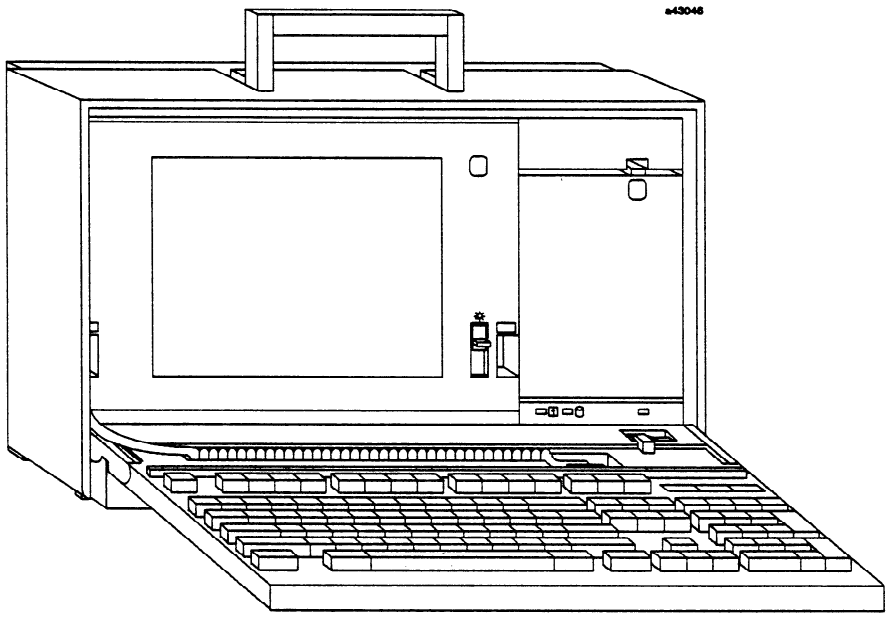

Figure 1-6. Workmaster II Computer

Cimstar I Industrial Computer

The Cimstar I Industrial computer can also be used as the programming device for the Series Five PLC. The Cimstar I computer was designed for interaction with PLCs and other automation equipment in the industrial environment. It is the industrial equivalent of the IBM PC AT. The Cimstar I computer has a rugged frame which can be mounted vertically in a 19″ rack or panel mounted in a standard 10″ deep enclosure. The system is modular with each module or board enclosed in its own steel shroud. Modules are easily installed or removed. Cimstar I computer configuration options can include one or two 20 M Byte hard disks (total of 40 M Bytes per system), and four diskette drives, which can be any combination of 5.25″ or 3.5″ drives.

A standard Workmaster/Logicmaster style keyboard is available for use as the console device for entering and editing Series Five PLC programs. For further information on progamming with a Cimstar I computer, refer to the *Logicmaster 5 Programming and Documentation Software User's Manual, GFK-0023*.

Programming Functions for the Series Five PLC

Programming functions for the Series Five PLC are listed in the following table.

Table 1-4. Series Five Function Set

FUNCTION	DESCRIPTION
Relay Functions	Normally Open Contacts Normally Closed Contacts Coils (Relay, One-Shot, and Latch)
Timers and Counters	Timer Preset and Accumulate Counter Preset and Accumulate
Shift/Move Functions	Binary-to-BCD Conversion BCD-to-Binary Conversion
Special Functions	Master Control Relay (MCR) Skip No Operation End Sweep Read/Write CCM Read/Write Device Transfer
Data Move Functions	Move A to B Move Left 8 Bits Move Right 8 Bits Block Move
Arithmetic Functions	Signed Addition/Subtraction Signed Multiplication/Division Double Precision Addition/Subtraction Greater Than Equal
Table Move Functions	Source to Table Move Table to Destination Move Move Table
List Functions	Add to Top Remove from Bottom Remove from Top
Matrix Functions	Logical AND Logical Inclusive OR Logical Exclusive OR Logical Invert Bit Set/Clear/Sense Shift Right/Shift Left
Control Functions	Do Subroutine Return from Subroutine Suspend I/O Do I/O

Programmable Logic Controller Concepts

When using a new product for the first time, there are new concepts and terms to become familiar with. Some of these PLC concpts and terms are described in the following section.

Function of the Central Processor Unit

The Central Processor Unit (CPU) is basically a microprocessor containing the circuitry that performs logical decision making functions. It reads in the status of the control system, makes decisions based upon the logic that has been programmed, and then provides decisions to the actuating portion of the control system. CPU operation is performed in a repetitive process called scanning. Scan time varies with program size.

The CPU also performs self checking of its internal operation to ensure reliable operation through a circuit called the watchdog timer. The watchdog timer is a software timer adjustable from Logicmaster 5 and stored in Scratch Pad memory in the CPU. This timer ensures that memory or internal circuit faults do not cause the CPU to enter an endless loop due to hardware failure. The range of settings are 20 to 998 ms (milliseconds) in 2 ms increments with the default setting being 200 ms. If a scan is not completed at least once during the selected time duration, the watchdog timer will time-out, and the hardware will shut the CPU down and turn the outputs OFF. If an error is detected, the CPU will shut itself down. The logic entered by the programmer is stored in the CPU along with storage for the operation of timers and counters. The CPU has a scan timer and counter to keep track of the last, minimum, and longest scan time and records these times in user accessible registers.

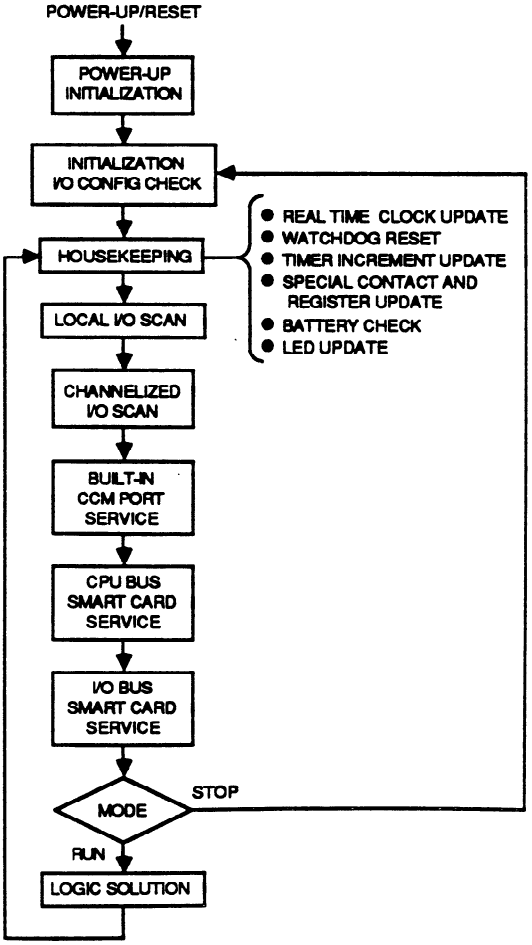

Figure 1-7. Series Five CPU Scanning Sequence

Memory for the Series Five PLC

User accessible memory for the Series Five PLC is contained in compact plug-in cartridges. All internal memory functions necessary for system operation, including the operating system, and Scratch Pad for storing system parameters are on circuit boards within the CPU. Internal CMOS RAM memory devices are battery-backed with a Lithium battery mounted on the inside of the large hinged door on the front of the CPU module. The memory provided for storage functions is normally measured in K words, where K is an abbreviation for kilo or 1024. Typically, one word is required for storage of each relay function such as a relay contact or output. The number of words required per function varies, with more complex programming functions requiring up to 9 words each.

Five different user memory cartridges are available which should be selected to suit your application requirements depending on the user logic memory and register memory requirements. Memory cartridges are available that contain either CMOS RAM, EPROM, or EEPROM memory devices. Available cartridges are: 4K RAM, 16K RAM, 8K EPROM, 16K EPROM, and 4K EEPROM. The 16K RAM and 16K EPROM cartridges have a 16K register chip included with them, which replaces the 4K chip standard in the CPU.

CMOS RAM Memory

The most common type of memory used in PLCs to store both logic and data is CMOS RAM. CMOS RAM is an acronym commonly used for Complimentary Metal-Oxide Semiconductor, Random Access Memory. CMOS RAM is a fast, low power memory that can be easily examined (read) and changed (written). However, it is volatile, in that it can lose its content if power is removed.

To avoid reloading memory (and losing counts and system status) every time power is turned off, the CMOS RAM memory is provided with a long-life Lithium battery mounted inside of the memory cartridge to maintain its content (not system operation) when power fails. Due to the low power drain of CMOS RAM memory device, a single new lithium battery can maintain memory without application of power for 2 to 5 years. The battery is not used when power is applied and the system is operating normally. Its storage or shelf life is typically 8 to 10 years. This battery is easily replaced if needed.

EPROM and EEPROM Memory

Both of these memory types are Programmable Read Only Memory devices, which are also fast, low power devices. They are retentive upon loss of power and do not require a back-up battery. The content of these types of memory is not easily changed. They can be examined (read) at anytime, but to change (write) the contents requires some special action on the part of the user. Both the EPROM and EEPROM cartridges are programmed by inserting them in the Series Five OIU. If the EPROM cartridge has been previously programmed, it must be erased by exposure to ultraviolet light. EPROM memory cartridges are shipped in the erased state. EEPROM memory cartridges can be electrically erased by inserting them in the Series Five Operator Interface Unit (CPU revision 2.2/3.0 or later is required to use EEPROM cartridges).

Function of the Input/Output Circuitry

Electrical noise such as spikes on the power lines, inductive kickback from loads, or interference picked up from field wiring is very prevalent in industrial applications.

Since the CPU operates at relatively low voltage levels (typically 5 volts), this noise would have serious impact on its operation if allowed to reach the CPU's internal circuits. The I/O section, both inputs and outputs, protects the CPU from electrical noise entering through the I/O modules or wiring by the use of

optical-isolation. The I/O section is where status signals are filtered to remove noise, voltage levels are validated, and decisions made by the CPU are put into operation. Inputs provide their status to a storage area within the CPU and outputs are driven from similar stored status in the CPU.

Series Five I/O Modules

The following table is a list of the available Series Five I/O modules. For detailed information on I/O module types and capacities, refer to the Series Five I/O Specifications Manual, GFK-0123. The type of I/O module to be specified, for example, 115 V ac or 24 V dc, is usually determined by the field device selected by the user.

Table 1-5. Series Five I/O Modules

Catalog Number	Module Description	Current/Voltage Rating	No. of Circuits
IC655MDL501	12 - 24 VDC Input, Negative Logic	7 mA @ 12 VDC 15 mA @ 24 VDC	16
IC655MDL502	12 - 24 VDC Input, Negative Logic	10 mA @ 24 VDC	32
IC655MDL503	24 VDC Input, Positive/Negative Logic	5 mA @ 24 VDC	64
IC655MDL511	24 - 48 VAC/DC Isolated Input, Positive Logic	7 mA @ 24 VDC 14 mA @ 48 VDC	16
IC655MDL512	12 - 24 VAC/DC Input, Positive Logic	10 mA @ 24 VDC	32
IC655MDL524	Input Simulator	n/a	16 or 32
IC655MDL525	115/230 VAC Input	8.4 mA @ 115 VAC 18 mA @ 230 VAC	16
IC655MDL526	115 VAC Input	14.5 mA @ 115 VAC	32
IC655MDL527	115/230 VAC Isolated Input	8.4 mA @ 115 VAC 18 mA @ 230 VAC	16
IC655MDL533	5 - 12 VDC TTL Input, Positive/Negative Logic	2.5 mA @ 5 VDC 7.5 mA @ 12 VDC	64
IC655MDL551	12 - 24 VDC Output, Negative Logic	2A	16
IC655MDL552	12 - 24 VDC Output, Negative Logic	0.5A	32
IC655MDL555	12 - 24 VDC Output, Positive Logic	2A	16
IC655MDL556	12 - 24 VDC Output, Positive Logic	0.5A	32
IC655MDL575	115/230 VAC Output	2A	16
IC655MDL576	115/230 VAC Isolated Output	2A	16
IC655MDL577	115/230 VAC Output	1A	32
IC655MDL580	Relay Output	2A Resistive	16
IC655MDL581	Relay Output	2A Resistive	32
IC655MDL586	Isolated Relay Output	2A Resistive	16
IC655MDL593	5 - 12 VDC TTL Output, Positive Logic	90 mA @ 14 VDC (current sinking)	64
IC655ALG516	Analog Input, 8 Channels	1 to 5 V, 0 to +10 V -10 to + 10 V 4 to 20 mA	8
IC655ALG566	Analog Output, 2 Channels	0 to +10 V 4 to 20 mA	2
IC655ALG567	Analog Output, 2 Channel	-10 to +10 V	2

Series Three I/O Modules in a Series Five I/O System

The following Series Three PLC I/O modules can be used in conjunction with a Series Five CPU. An interface module is required to connect a Series Three rack to a Series Five Rack. For complete details and specifications on these modules, refer to the Series Three User's Manual, GEK-25376.

Table 1-6. Series Three PLC I/O Modules

PART NO. IC630	NAME	CIRCUITS	VOLTAGE RANGE	CURRENT (MAX.)
MDL325	115Vac Input	16	97-132Vac/dc	11ma
MDL375	115Vac Output	16	97-265Vac	2 amps
MDL327	230Vac Input	16	180-265Vac	18ma
MDL301	24Vdc Input	16	21.5-26.5Vdc	15ma
MDL306	24Vdc Input	32	21.5-26.5Vdc	7ma
MDL311	24Vac/dc Source Input	16	20-28Vac/dc	13ma
MDL303	5-12Vdc Input (TTL Compatible)	32	4.75-13.2Vdc	8ma
MDL351	24Vdc Sink Output	8	21.5-26.5Vdc	2 amps
MDL352	24Vdc Sink Output	16	21.5-26.5Vdc	1 amp
MDL357	24Vdc Source Output	16	5-24Vdc	1 amp
MDL356	24Vdc Output	32	21.5-26.5Vdc	0.5 amp
MDL354	5-12Vdc Output (TTL Compatible)	32	4.75-13.2Vdc	0.5-1.5ma
MDL380	Relay Output (NO)	16	5-265Vac/dc	4 amp (Resistive)
MDL326	115Vac Input (Isolated)	8	97-132Vac/dc	11ma
MDL376	115/230Vac Output (Isolated)	8	97-265Vac	2 amps
MDL310	High Speed Counter	1	10Khz pulse	16ma
MDL324	I/O Simulator (16 Inputs)	16		
MDL316	Analog Input	2	1-5Vdc 1-10Vdc 0-10Vdc	4-20ma
MDL366	4-20ma Analog Output	2	1.6-8Vdc	20ma
MDL367	-10 to +10Vdc Analog Output	2	-10 to +10 Vdc	20ma
MDL368	0-10Vdc Analog Output	2	0-10Vdc	20ma

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Series Five Interface and Intelligent Modules

In addition to the Series Five and Series Three I/O modules listed previously, other Series Five modules include system interface modules and intelligent modules. These modules and basic descriptions of each module are listed below.

Table 1-7. Other Modules for the Series Five PLC

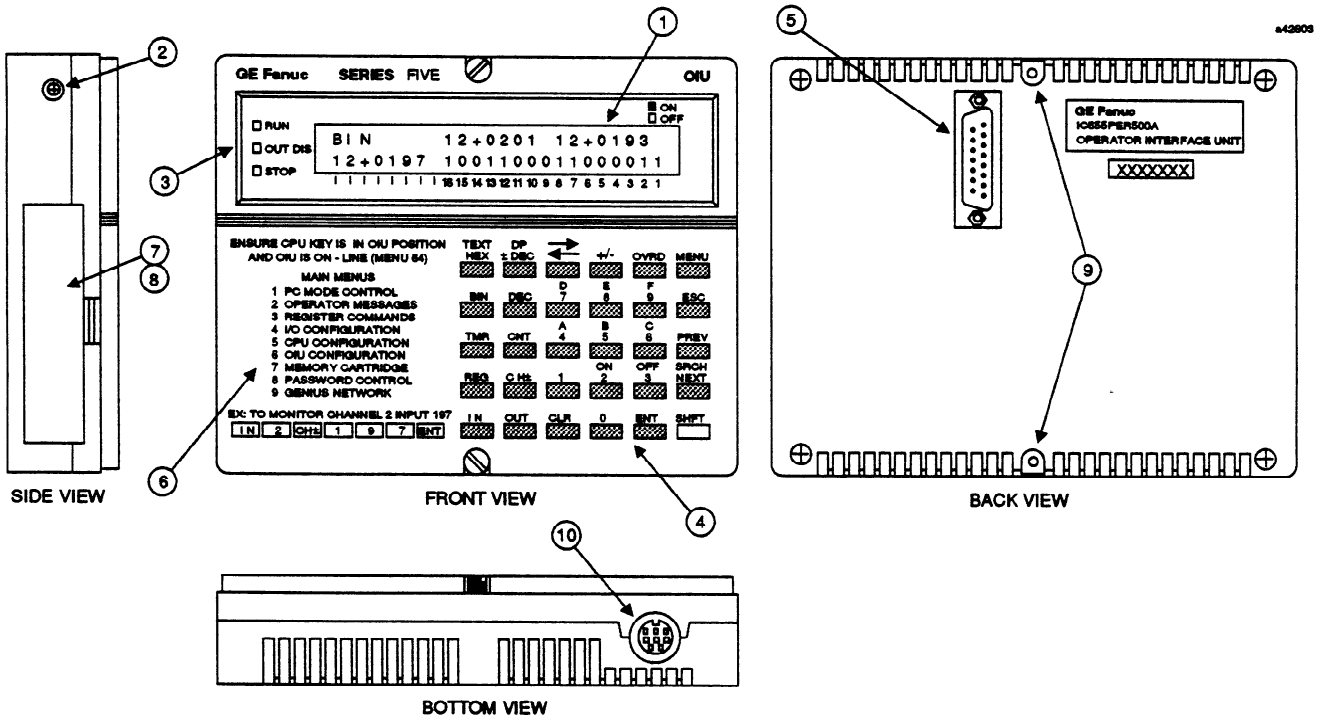
Module	Description
Local I/O Interface	Interfaces the parallel I/O bus to Series Five I/O modules in an I/O expansion base unit up to 200 feet * (60 meters) from the CPU. One of these modules must be installed in each I/O expansion base unit used in a Local I/O system.
Series Three I/O Interface Module	Series Three I/O Interface - Allows use of existing Series Three I/O modules in a Series Five Local I/O system - controlled by the Series Five CPU.
Genius Bus Controller Module	Interfaces Series Five PLCs to the Genius serial bus. Allows use of Genius I/O and/or a Genius communications network which provides for CPU-to-CPU communications between multiple Series Five CPUs. Up to eight units can be installed.
CCM Communications Module	Provides a serial communication link to other PLCs or host computers using the GE Fanuc CCM2 and CCM3 protocols. Allows master-to-slave communications with user selectable baud rates. Up to eight units can be installed.
ASCII/BASIC Module	Programmable in BASIC language with custom commands. 32K of user logic on board, expandable to 56K by using Series Five memory cartridges. Two on-board serial ports for communications with terminals, bar-code readers, magnetic card readers, or other ASCII/BASIC modules. A Trap Monitor feature prevents unauthorized access and listing of programs. Up to eight units can be installed.
High Speed Counter Module	Allows counting pulses up to 50 kHz. Has a single preset. Can be located anywhere in the Local I/O chain. Up to eight units can be installed.
Axis Positioning Module	Provides a single axis positioning controller for simple point-to-point positioning tasks and has programmable velocity and acceleration parameters. Can be installed in any I/O slot in the Series Five I/O system. Multiple units can be installed in the same system.

* All base units in the Local I/O chain must be connected to a common ground point and AC powered supplies must operate from the same AC power source.

Operator Interface Unit

The Series Five Operator Interface Unit (OIU) is a compact device that allows an operator to access the CPU for set up and operation; allows on-line monitoring of I/O and registers and writing to I/O and registers, on-line monitoring of timers and counters, and writing to timers and counters; provides a convenient means of programming EPROMs; provides a way of displaying user defined messages in ASCII format controlled by the user logic program; provides user access to password functions (lock and unlock CPU); and allows configuration of the Series Five Genius Bus Controller.

The viewing screen on the OIU is an LCD display that has two lines with 24 characters in each line. The OIU plugs directly onto the CPU or attaches to the CPU by a 5 or 10 foot cable for hand-held operation. It can also be mounted on a panel using an optional mounting bracket.



1. Liquid Crystal Display
2. Contrast Adjustment Screw
3. CPU Mode LEDs
4. Keypad
5. Port Connector
6. Main Menu List
7. Memory Cartridge Slot
8. EPROM Memory Burner
9. Captive Screw Fasteners
10. RS-232 Communications Port

Figure 1-8. Operator Interface Unit

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GENET Factory LAN

For applications requiring much broader communications capabilities than the Communications Module can provide, or a Local Area Network (LAN) for communications with other factory automation equipment, the GEnet Factory LAN is an available option for use with a Series Five PLC. The GEnet Factory LAN is a 10M bps broadband token passing bus which provides high speed communications between GE Fanuc equipment, including Programmable Logic Controllers, Numerical Control equipment and higher level factory level management control systems.

The GEnet Factory LAN is based on accepted industry standards. It uses the International Standards Organization's Open System Interconnection (OSI) model as the basis for its communications architecture. GEnet complies with the General Motors Manufacturing Automation Protocol (MAP) specification and with the ANSI/IEEE Standard 802.4-1985 for token bus networks.

The Programmable Logic Controllers and Numerical Control equipment interface to the broadband token bus through a Bus Interface Unit (BIU). The BIU is tailored by loading device specific software to provide the required interface to the various automation products. As an example, any device supporting the CCM protocol can access the GEnet Factory LAN with translation to MAP through the BIU.

Other basic components of the GEnet Factory LAN are the Network Management Console (NMC) and the Head End Remodulator. The NMC provides overall system configuration management and control. It operates on a Workmaster or Cimstar I industrial computer equipped with PLC-BIU hardware and network management software. The head end contains the equipment required to provide for RF operation on the broadband cable. For further information on the GEnet Factory LAN, refer to the *System User's Manual, GEK-96608 and the Network Management Console User's Manual, GEK-96607.*

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The following figure illustrates a typical configuration for a GEnet Factory Local Area Network.

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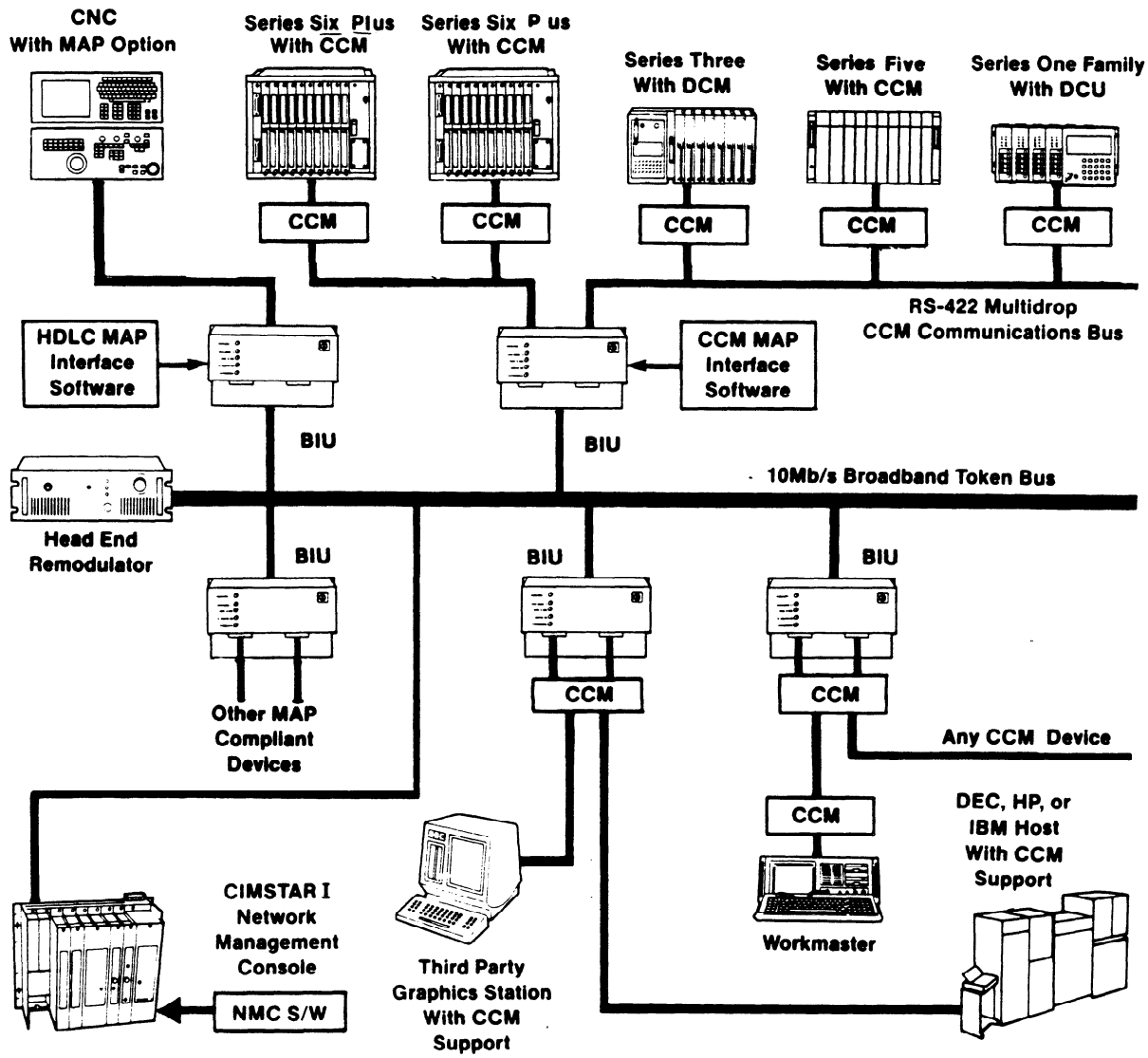

Figure 1-9. GENET Factory LAN

RS-232/RS-422 Adaptor Unit

The RS-232/RS-422 Adaptor Unit (IC655CCM590) converts RS-232 signal levels to RS-422 signal levels and can be used to isolate and repeat communications signals. If a device uses RS-422 signal levels for communications, the Adaptor, when connected between those devices and devices requiring RS-232 signal levels can be used with no loss in baud rate. The Adaptor unit also has a multidrop capability that can expand a normal eight device RS-422 link into a 64 device link by using eight Adaptor units. If an RS-422 link should be required to extend beyond its normal 4000 feet (1.2 Km), the Adaptor can be used as a repeater to boost the signal levels and obtain another 4000 feet of driving distance for the signals.

a42418

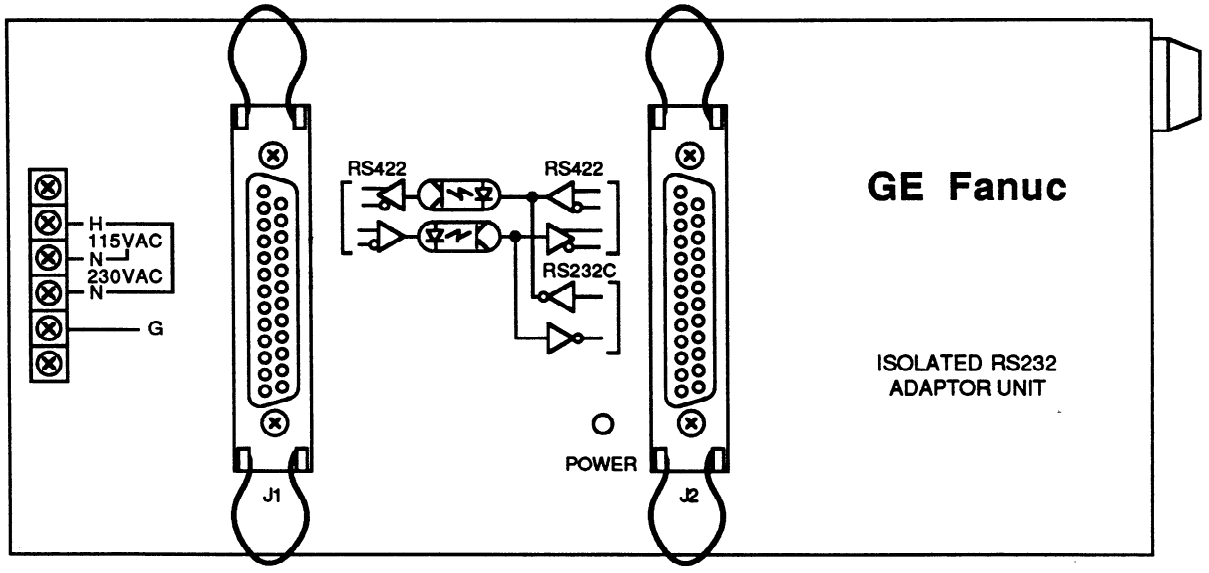

Figure 1-10. RS-232/RS-422 Adaptor Unit

System Planning

Decisions such as the number of 115 V ac solenoids, 24 V dc solenoids, motor starters, limit switches (operating voltages), control panel lamps (voltage required), pushbuttons, and external relays have a major impact on the configuration of any PLC. These parameters should be established as early as possible in the overall design of the control system. Being a flexible device, the PLC configuration, either on paper or in hardware, can easily be changed if requirements change. Typically, the user provides the field devices, wires them to the I/O section, and provides the power source to operate them.

Typical Applications Using PLCs

Programmable Logic Controllers are used in a wide variety of machine and process control applications. These applications range from replacing a few relays to controlling complete factory automation projects. The following table contains a partial list of typical applications that can be controlled by a Series Five PLC.

This list is only a very small sampling of possible PLC applications. Many other applications are possible and more are being identified all the time For further information on any of the applications listed here or any other application you may have, contact your local GE Fanuc Programmable Logic Controller Distributor, GE Fanuc sales office or GE Fanuc Automation North America, Inc. in Charlottesville, Virginia.

Table 1-8. Typical PLC Applications

Auto Insertion	Energy Management	Railroad Switching
Bagging	Engines	Robots
Baking	Engine Test Stands	Rolling
Bonding	Extrusion	Routing
Boxing	Forging	Security Systems
Brewing	Gas Fields	Sewage Treatment
Capping	Gauging	Solar Energy
Casting	Generators	Sorting
Cement Batching	Grinding	Spool winding
Combustion Control	Heat Treating	Stackers
Compression Molding	Injection Molding	Tire Body Building
Conveyors	Joining	Traffic Control
Cranes	Milling	Treating
Cutting	Mining Operations	Turbines
Data Collection	Navigation	Water Treatment
Dipping	Nuclear Plants	Weaving
Drawing	Oil Fields	Welding
Drilling	Pipelines	Well Flooding

Chapter 2
Physical Equipment Configuration

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A Series Five Programmable Logic Controller is easy to assemble and use. A basic understanding of electronics and programming is generally all that is required, since all components are modular and the programming requirements are provided through the Logicmaster 5 programming software. This chapter describes the hardware components of a Series Five PLC. Included are descriptions of the Central Processing Unit, power supplies, memory cartridges, base units, I/O system communication modules, optional modules, system configuration, standard Series Five I/O system, Series Three I/O system, Genius I/O system, and peripheral devices. When a component of the system is mentioned for the first time, the catalog number is provided. For a complete list of available hardware and software, refer to GEP-761, Products and Publications Master Price List. For further information on any of the items mentioned in this chapter that are not Series Five PLC modules or related hardware, refer to the applicable manual.

Product Structure for the Series Five PLC

The product structure for the Series Five PLC is such that many different configurations, including combinations of I/O Interface and I/O modules, may be contained in a single CPU base unit. The design is flexible to readily meet the user's requirements. The following figure illustrates this basic product structure, showing the location of modules residing in the CPU base unit.

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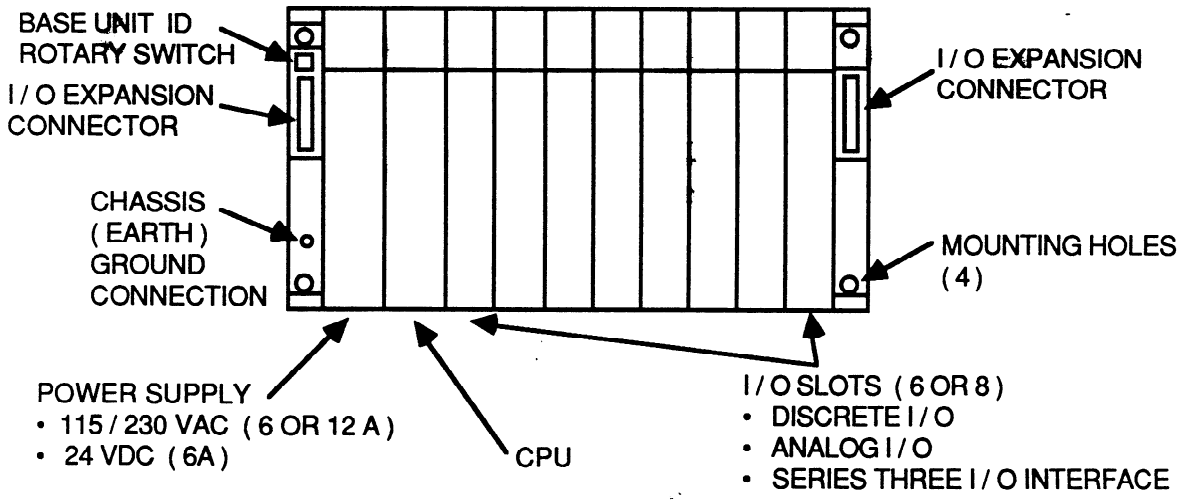

Figure 2-1. Basic Product Structure for the Series Five PLC

Each of the system components shown in the figure is described on the following pages. The descriptions include information relative to module location in the baseplate, and the function of each module in the system. For installation instructions, refer to Chapter 3.

Series Five CPU Base Unit Configuration

The base unit used to contain the Series Five PLC modules is designed for mounting in any NEMA panel or similar surface. With modules mounted on the base unit, a base unit can be mounted in a 5.5 inch deep cabinet. Base units are available in two versions, one (catalog number IC655CHS508) 19 inches (483 mm) wide, and the other (catalog number IC655CHS506) 16 inches (399 mm) wide. Figure The figure below, is an illustration of a base unit. The 19 inch base unit has slots to contain a power supply, CPU, and up to 8 I/O modules. The 16 inch base unit contains a power supply, CPU and up to 6 I/O modules.

Module addresses are usually assigned manually through Logicmaster 5, and I/O references can be assigned to any slot. Any module in the I/O system (either discrete, analog, Series Three I/O Interface, or other optional modules) can be placed in any of these I/O slots as long as their total power requirements, including the CPU, do not exceed the power output of the power supply. Some of the intelligent modules must be installed in the CPU base unit, therefore, the number of slots required for those modules should be reserved for those modules.

Power supplies are available in three versions; 115/230 V ac (ac input voltage jumper selectable) at 12 amps, 115/230 V ac (ac input voltage jumper selectable) at 6 amps, and 24 V dc input voltage at 6 amps. Each of the power supplies provides 5 V dc to the backplane on the base unit. A list of power requirements for each I/O module can be found in Chapter 3, Installation.

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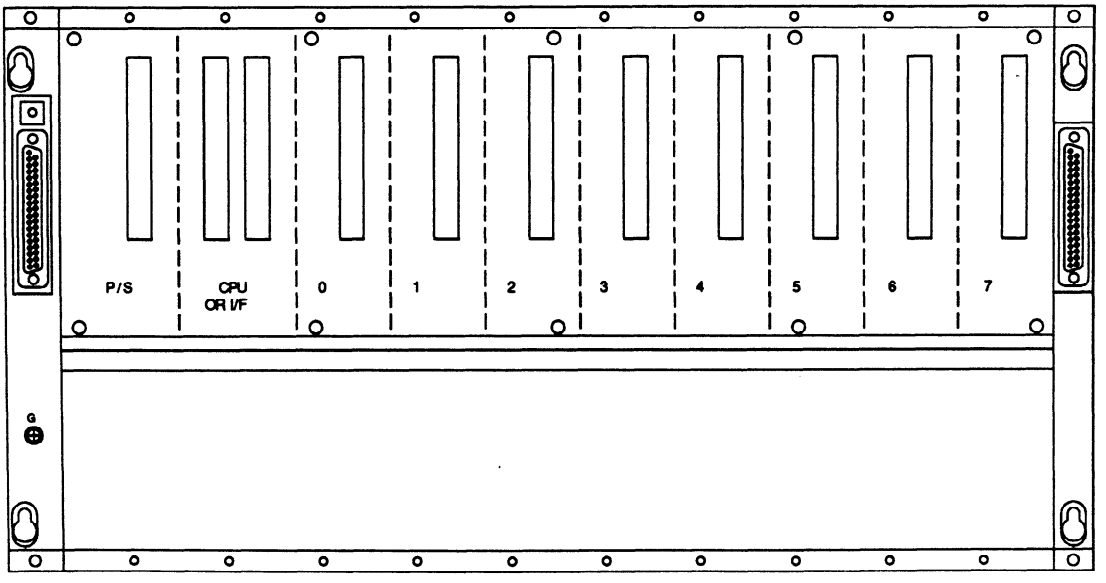

Figure 2-2. Series Five Base Unit

Note that the I/O slot numbers are numbered 0 through 7, not 1 through 8, and the slot numbers begin with the slot next to the CPU.

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Series Five CPU Module

The CPU for the Series Five PLC (catalog number IC655CPU500) must be mounted adjacent to the power supply in the CPU base unit. The CPU plugs directly into the backplane and is secured to the backplane by two captive screws, one at the top and one at the bottom of the module. Two hinged doors on the front of the CPU provide access to user devices. The memory cartridge installed in the CPU contains the program required to execute the programming instructions as entered with Logicmaster 5 programming software. An internal clock in the CPU provides the timing which allows basic ladder relay one-word functions, such as normally-open and normally-closed contacts, to be executed in .5 microseconds. Other functions take longer to execute according to the number of words required and the complexity of the function. The CPU has user configurable DIP switches which are described later in this chapter. Another feature of the CPU is a real-time battery-backed clock/calendar which is user accessible for program use.

CPU Hardware Features

The following figure is an illustration of the Series Five CPU module. Its features as shown are described in the paragraphs following the illustration. This Chapter describes the physical features of the CPU. For information on operation of the CPU, refer to Chapter 4 of this manual. For information on programming, refer to the Logicmaster 5 Programming and Documentation Software User's Manual, GFK-0023.

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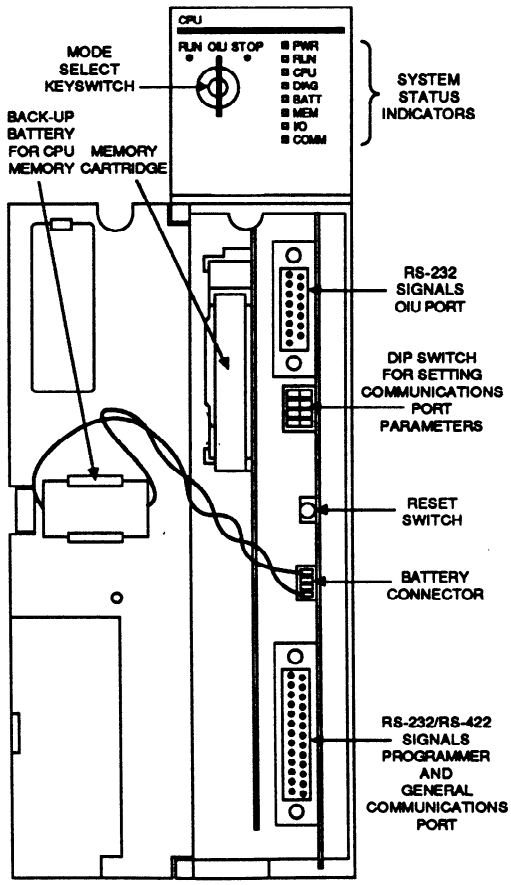

Figure 2-3. Series Five CPU Module

Mode Switch

The CPU mode switch is located at the top of the CPU module and is a three-position keyswitch, with positions labeled: **RUN, OIU, and STOP.** The key is removable in any position. The keyswitch is used to place the CPU in the desired mode of operation. The RUN position places the CPU in the RUN mode with the CPU scan active and with outputs enabled, which is the normal PLC operating mode. The OIU mode, when selected allows use of the Series Five Operator Interface Unit functions, which are:

- Access to certain CPU features for setup and operation.
- Monitoring of I/O points to observe their operation status.
- Monitoring timer and counter accumulated value registers, and data registers.
- Access to the password feature, allows the user to log onto a system that has been assigned a password, and log off of a system having a password.
- Messages entered using Logicmaster 5 can be displayed on the two-line viewing area on the Series Five OIU under user program control.

When the STOP position is selected, it stops the CPU's normal operation (scan is halted and outputs are disabled).

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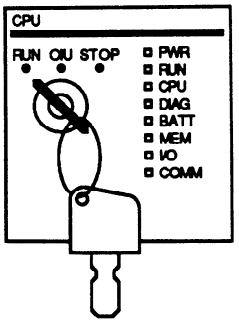

Figure 2-4. CPU Mode Switch

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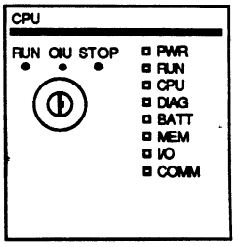

Figure 2-5. CPU Status Display

WARNING

If the CPU mode keyswitch is in the RUN position and the CPU has been stopped by Logicmaster 5, and a power failure occurs - the CPU will power-up in the RUN mode. To guarantee that the CPU stays in the STOP mode on power-up, the keyswitch must be turned to the STOP position before power-up.

CPU Status Display

There are eight LEDs located at the top right of the CPU. These LEDs provide the user with visual indicators of system operation and provide certain diagnostic information. The location of these indicators on the CPU is shown in the previous figure and the following table provides a definition of each of the indicators.

Table 2-1. CPU Status Indicator Definitions

LED	COLOR	DESCRIPTION
PWR	GREEN	ON - Power is applied to the CPU and the +5 Vdc operating voltage is within specified tolerance. OFF - Ac or dc input power source is missing or the +5 Vdc operating voltage is not within specified tolerance.
RUN	GREEN	ON - CPU is in the RUN mode. OFF - CPU operation is halted,
CPU	RED	ON - A malfunction exists in the CPU or the watchdog timer has timed out. OFF - CPU is operating normally and the watchdog timer has not timed out.
DIAG	RED	ON - CPU has detected an internal fault that causes the CPU to halt its scanning operation (e.g. program parity error, fatal I/O fault, etc). OFF - Operation normal, no faults detected.
BATT	AMBER	ON - A memory backup battery voltage is low or has failed. Can be either in the CPU or memory cartridge battery. OFF - Both backup batteries operating normally.
MEM	AMBER	ON - A program memory error has been detected. OFF - All memory operating without error.
I/O	AMBER	ON - An I/O error has been detected. OFF - No I/O errors have been detected.
COMM	AMBER	ON - A communications error has been detected. OFF - Communications operating without error.

CPU Communications Port

Two connectors on the CPU module provide a communications port for external devices communicating with the CPU. The top connector, which is a D-subminiature 15-pin connector, provides RS-232 signals for interfacing to the Series Five Operator Interface Unit (OIU).

The lower connector is a 25-pin D-subminiature connector which also interfaces the CPU to devices capable of communicating via the CCM protocol, such as host computers. This connector provides both RS-232 and RS-422 signals for communications purposes and can be used for general communications networks. This is the connector to be used for programming with Logicmaster 5 software. The Workmaster II computer or other programming device for the Series Five PLC must be connected to this connector.

There is only one logical port as far as the CPU is concerned, since both are connected to the same internal circuitry. However, the 15-pin port takes priority if an attempt is made to access both ports at the same time. For example, if the 25-pin port is communicating with a device, and an OIU is connected to the 15-pin port and is forced on-line, communications activity will switch to the OIU connected to the 15-pin port.

If the OIU is connected to the 15-pin port, and power is cycled, the OIU will power-up in the same mode it was in before the power cycle. The CCM ports built into the CPU function only as slave devices.

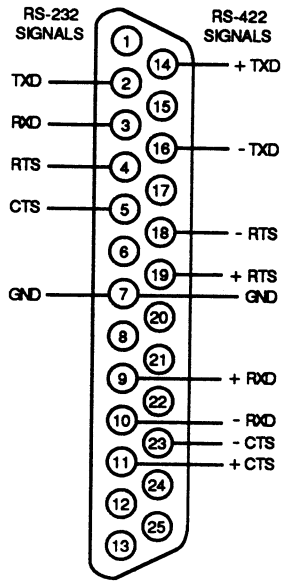

Figure 2-6. RS-232/RS-422 Communications Port Pin Assignments

CAUTION

The circuits connected to these ports are not isolated from the backplane, therefore caution should be taken when connecting external devices to the ports. It is recommended that any device connected to these ports be connected to the same power source as the Series Five PLC. For long distance communications via an RS-422 link, it is recommended that the GE Fanuc Adaptor Unit (IC655CCM590), which has an RS-422/422 and RS-232/422 isolating repeater feature, be used, especially if ground potential differences exist between the host device and CPU power sources.

Communications Port DIP Switches

Directly below the top communications port is a 4-position DIP switch use for setting certain CCM port operating parameters for the bottom port. Switch 1 is used to select the mode of operation for the CCM communications, either RS-232 or RS-422. Switch 2 selects the CCM port address for communications with Logicmaster 5 or other CCM host device. Switches 3 and 4 select the baud rate for communications. The following table shows these settings and they are listed on a label on the back of the large hinged door.

Table 2-2. CCM Port Dip Switch Definitions

<table>
<tr><th>POSITION</th><th colspan="3">DEFINITION</th></tr>
<tr><td>1</td><td colspan="3">ON - CCM Port communicates via RS-232
OFF - CCM Port communicates via RS-422</td></tr>
<tr><td>2</td><td colspan="3">On - CCM port address is 1
OFF - CCM port address obtained from scratch pad (set through Logicmaster)</td></tr>
<tr><td rowspan="5">3 and 4</td><td colspan="3">BAUD RATE SELECTION</td></tr>
<tr><td>Switch 3</td><td>Switch 4</td><td>Baud Rate (Bps)</td></tr>
<tr><td>OFF</td><td>OFF</td><td>300</td></tr>
<tr><td>OFF</td><td>ON</td><td>1200</td></tr>
<tr><td>ON</td><td>OFF</td><td>9600</td></tr>
<tr><td></td><td>ON</td><td>ON</td><td>19200</td></tr>
</table>

Built-In Communications Capabilities for the Series Five PLC

In addition to the CCM Communications module which provides a CCM master or slave function for the Series Five PLC system, the CPU has a built-in slave CCM2 compatible port. Through use of the CCM2 communications protocol, a host computer, such as the Series Six Plus PLC, can have supervisory control over one or more Series Five PLCs. The data transfer rate, as well as other communications parameters for the CCM port, is DIP-switch selectable. The primary data transfer rate is 19.2 kBps. Other data transfer rates are provided for special purpose interfaces, which include modem configurations. For detailed information on the CCM2 protocol, refer to the *Series Five Data Communications Manual, GFK-0244.*

When a Series Five PLC is part of a communications link with a Series Six Plus PLC, the Series Six Plus PLC may be the master and can initiate communications. The SCREQ function programmed in a Series Six PLus PLC must be executed to begin the communications session. Certain information (see table 2-3) relative to Series Five PLC data must be included as part of this function. The CCM2 protocol must be given the start address (shown as reference number below) and a length. The start address plus the length should not go past the end of a table boundary. The CCM for the Series Five interprets length as BYTES. An expanded listing of CCM memory types can be found in Appendix C.

Table 2-3. Series Five CCM/CPU Mapping

Table Name	Reference	CCM Target Address Decimal	CCM Target Address Hexadecimal	CCM Table Memory Type	CCM Ovrd Type	Data Format
Registers	R00001 - R16384	1-16384	0001-4000H	1	N/A	2 Bytes/Register
I1+ Inputs	I1+0001 - I1+1024	1-128	0001-0080H	2	4	8 Inputs/Byte
I2+ Inputs	I2+0001 - I2+1024	129-256	0081-0100H	2	4	8 Inputs/Byte
Local Inputs	I0001 - I1024	257-384	0101-0180H	2	4	8 Inputs/Byte
Spec. Inputs	I1-0001 - I1-0512	385-448	0181-01C0H	2	N/A	8 Inputs/Byte
O1+ Outputs	O1+0001 - O1+1024	1-128	0001-0080H	3	5	8 Outputs/Byte
O2+ Outputs	O2+0001 - O2+1024	129-256	0081-0100H	3	5	8 Outputs/Byte
Local Outputs	O0001 - O1024	257-384	0101-0180H	3	5	8 Outputs/Byte
Internal Coils	O1-0001 - O1-1024	385-512	0181-0200H	3	5	8 Outputs/Byte
Internal Coils	O2-0001 - O2-1024	513-640	0201-0280H	3	5	8 outputs/Byte
Scratch Pad **	0000 - 0900H	0-2304	0000-0900H	6	N/A	1 Byte/Byte
User Logic	0000 - 16383	0-16383	0000-3FFFH	7	N/A	2 Bytes/Word
CCM Diagnostic	0000 - 0009	0-9	0000-0009H	9	N/A	1 Byte/Byte

H = Hexadecimal

* Use extreme care when writing to any Scratchpad location area through the CCM. This is not recommended without specific information from GE Fanuc.

** Do NOT write to the Scratch Pad without first consulting GE Fanuc Automation.

The Series Five CPU can also initiate unformatted (non-CCM) communications from the CPU's serial port. This scheme may be valuable in simple operator interface applications (refer to pages 4-39 through 4-42).

CCM Diagnostic Status Words

A group of five Diagnostic status words is available using CCM memory type 39H, start address 0000, length 10 bytes. Refer to GFK-0244 for more information.

Address	Meaning
00H - 01H	Port error codes, refer to Chapter 5, GEK-90477
02H - 03H	Number of successful conversions on communications port
03H - 04H	Number of aborted conversions on communications port
05H - 06H	Number of header block retries on communications port
07H - 08H	Number of data block retries on communications port

CPU Reset Button

A red momentary pushbutton switch is located directly beneath the Communication port DIP switches. If the CPU should need to be reset, this pushbutton can be depressed momentarily and released which will reset the CPU. The effect of depressing this pushbutton is the same as cycling power.

WARNING

Reset the CPU with caution, since if the CPU is running, any machine or process connected to it will momentarily stop if the pushbutton is pushed. This is the same as cycling power off and on.

CPU Back-up Battery

A lithium battery (catalog number IC655ACC550), mounted on the back of the larger hinged door, is connected to the CPU through a 4-pin connector located directly below the reset pushbutton. This battery functions as the back-up battery for several internal functions, which are the Scratch Pad (which stores system operating parameters), retentive coils, retentive tables, the real-time clock/calendar, and the user accessible registers for data storage. The CMOS RAM memory cartridge installed in the CPU has a back-up battery inside the cartridge.

The back-up battery mounted on the CPU door is easy to replace if it fails. The lithium battery maintains the voltage level required to retain the CMOS RAM circuitry under no-power conditions. If that voltage level drops too low, the BATT indicator on the CPU turns on. When this happens, *it is recommended that the battery be replaced with a new one within one week.* The battery connects to the internal circuitry through a small cable which attaches to a mating connector on the board. A new battery has this cable wired to it and is ready for installation as required. If the battery is dead (or missing), the BATT indicator will flash.

NOTE

Be sure that the battery cable is not positioned over the reset switch before closing the door. If it is and the door is closed, the wires could push in the button, causing the CPU to be in the reset condition.

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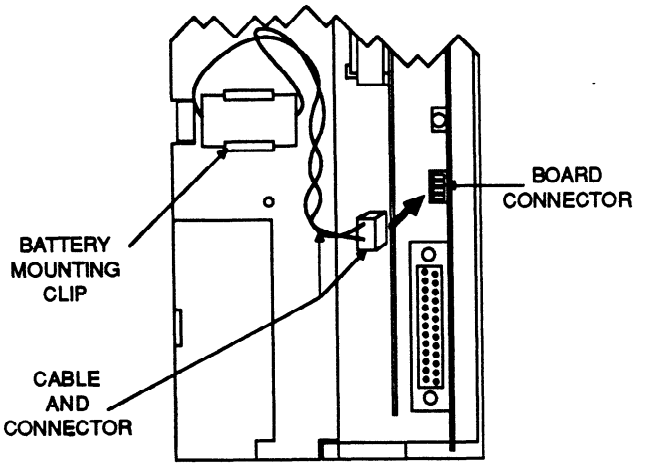


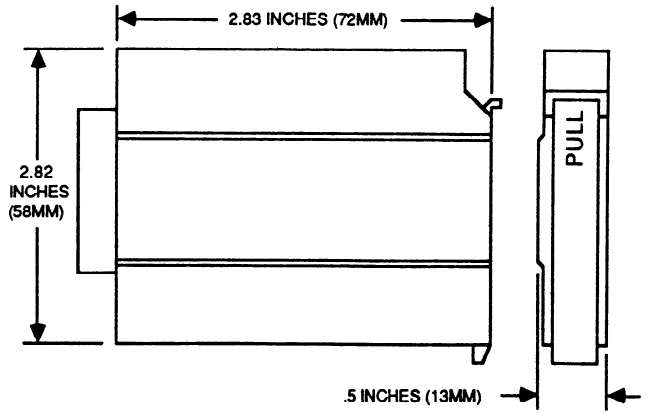
Figure 2-7. Back-Up Battery For CPU Functions

Memory Cartridge

The memory cartridges provide a convenient means of storing user logic programs and I/O configuration, and can also be used to save register contents using the Operator Interface Unit. Different user programs can be entered and saved, each in their own cartridge, for easy storage and use as needed. Their compact size allows them to be easily carried to different job locations. The compact (1/2 inch x 2 inch x 3 inch, (12.5 x 61 x 79mm)) memory cartridge containing the memory devices for storing user logic programs is installed in the CPU in the slot next to the 15-pin OIU port connector. This slot is accessed by opening the largest of the hinged doors on the CPU.

Memory cartridges can contain either RAM, EPROM, or EEPROM memory devices. The CMOS RAM memory cartridge contains a replaceable lithium battery (catalog number IC655ACC549) mounted on a socket for ease of replacement. This provides a battery back-up for the CMOS RAM devices in the cartridge in the event that the system should loose power for any reason, and when the cartridge is not installed. If the battery voltage drops below 4.2 Vdc, the MEM indicator will turn on, and the battery should be replaced as soon as possible. An indication of which battery (CPU door or cartridge) is low is provided by observing which one of the special internal contacts dedicated to battery status turns on or by examining the contents of registers 4078 - 4080 (see Table 4-6). This lithium battery is accessed for replacement by removing the cartridge cover which is held in place with a screw. Power for the memory cartridge is supplied by the internal +5 V dc power supply. Current consumption of the cartridges when under system power is low; RAM memory is 12 mA, EPROM memory is 20 mA, and EEPROM memory is 56 mA. The RAM and EEPROM memory cartridges have a memory protect feature. An illustration of a memory cartridge is shown in the following figure.

GFK-0122



a42267

Figure 2-8. Memory Cartridge

Memory Protect Feature

Each RAM memory cartridge can be Write Protected by configuring a small jumper located inside of the cartridge adjacent to the lithium battery. The jumper is placed over 2 of 3 pins to select whether the user logic program stored in the memory in the cartridge can be written to (WRITE UNPROTECTED) or not written to (MEMORY PROTECT). The factory default setting of this jumper is WRITE UNPROTECTED. To change the jumper configuration, remove the cartridge cover as described above, carefully grasp the jumper with needle nose pliers, remove it from the current position, and place it over the other position. When the cartridge is Write Protected, you will not be able to change the user logic program. An illustration of the jumper location and positions is shown below.

a42268

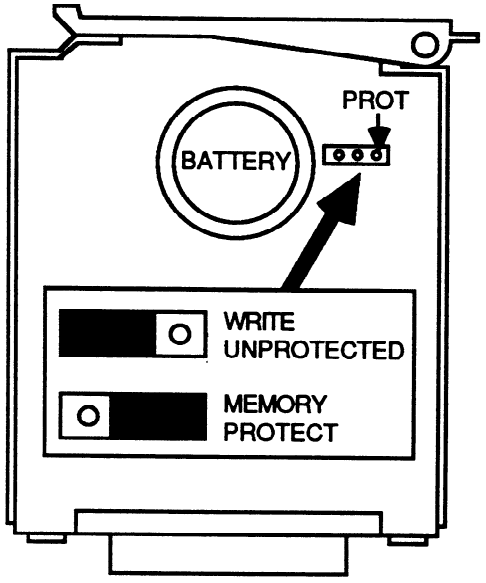


Figure 2-9. Memory Protect Configuration

Register Memory Expansion

The CPU as supplied from the factory comes with 4K (4096) of registers, with 3999 registers available to the user for general use. The 4K of registers is standard when the the 4K RAM (catalog number IC655MEM501) or 4K EEPROM (catalog number IC655MEM521) cartridge is selected. When either the 16K RAM (catalog number IC655MEM503), or 16K EPROM (catalog number IC655MEM513)

cartridge is selected, a 16K RAM is included as a separate item to expand the number of available registers to 16K. This RAM replaces the factory supplied 4K RAM installed in the CPU. The 16K RAM is installed in place of the 4K RAM by removing the side cover on the CPU, carefully removing the 4K RAM from the socket visible on the circuit board, which can now be easily accessed, and replacing it with the 16K RAM. When inserting the 16K RAM, ensure that the orientation is correct by observing how the 4K RAM was removed and the position of the notch in the socket. Match the socket notch with the notch on the RAM.

Jumper Configuration for Register Memory Expansion

When the 16K expansion RAM is installed in the CPU to replace the 4K RAM, a jumper must also be configured for the register memory expansion. The jumper is inserted over 2 of 3 pins on the circuit board according to which RAM memory device is installed in the socket. Factory installation is for 4K of register memory. When a 16K register memory expansion RAM is installed, the jumper must be reconfigured.

To do this, carefully grasp the jumper with a pair of needle nose pliers and pull it off of the pins. Insert it over the 2 pins closest to the word EXPAND, which is printed on the circuit board. Your CPU is now configured for 16K of Register memory. The location and configuration positions for this jumper are shown in the following illustration. The factory installed 4K RAM is a Mitsubishi 5165P-70 and the expansion RAM for 16K registers is a Mitsubishi 51256P-70.

a42269

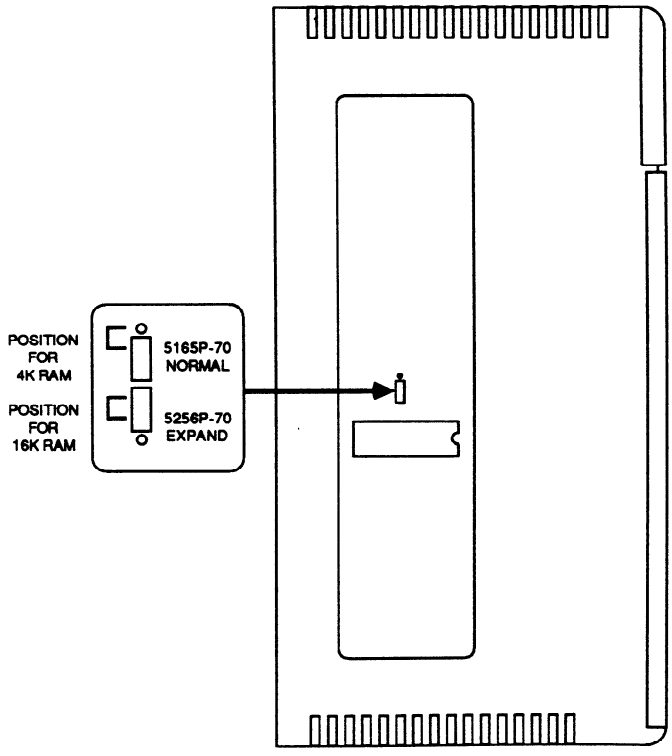


Figure 2-10. 4K/16K Register Jumper Configuration

Power Supply for the Series Five PLC

The operating voltage and current levels for a Series Five CPU base unit or I/O expansion base unit are supplied by a power supply module. The selected power supply (three versions available) for a Series Five PLC base unit must be installed in the leftmost slot on a base unit.

Catalog Number	Description
IC655PWR500	115 or 230 V ac Input (jumper selectable), 6 amps.
IC655PWR501	115 or 230 V ac Input (jumper selectable), 12 amps.
IC655PWR514	24 V dc Input, 6 amps.

Power Supply Specifications

The power supply provides regulated +5 V dc to the base unit backplane to power the GE Fanuc supplied modules installed in the base units. Most input and output devices must be supplied with their own source of power at the proper voltage levels. The ac power supplies accept an input of either 115 V ac, 15% or 230 V ac, 15%. 115 or 230 V ac is selected by configuring a jumper on the terminal block on the front of the power supply module. The dc power supply operates from a 20 to 29 V dc power source.

Table 2-4. Power Supply Specifications

Item	Specification
Operating Temperature	0° to 60°C (32° to 140°F)
Storage Temperature	-20° to +70°C (-4° to 158°F)
Humidity	5% to 95%, (non-condensing)
Atmosphere	No corrosive gases permitted
Vibration Testing	Meets Mil-std 810C method 516.2, JIS.C 0912 10 G
Shock Testing	Meets Mil-std 810C method 514.2, JIS.C 0911 11 B
Insulation Resistance	1500 V ac for 1 minute, Hipot
Noise Immunity	Sanki 1 ms, 1 KV pulses
Showering Arc Test	NEMA ICS 2.230.40
RFI	FCC Class A, part 15, subpart J
AC Power Required	115 or 230 V ac, ±15% (IC655PWR500, IC655PWR501)
Frequency	48 to 63 Hz
DC Power Required	20 to 29 V dc, 10% Ripple, (IC655PWR514)
Maximum Load	85 vA (IC655PWR500), 170 vA (IC655PWR501) 60 watts (IC655PWR514)
Inrush Current	11A at 2 ms (typ); 15A at 5 ms (max) IC655PWR500 13A at 4 ms (typ); 50A at 8 ms (max) IC655PWR501 20A max. (IC655PWR514)
Fuse	2A, 250V, normal blow (IC655PWR500) 3.15A, 250V, normal blow (IC655PWR501) 6A, normal blow (IC655PWR514)
Output Voltage Supplied	5.1 V dc, ±0.204 V dc
Ripple	100 mv, peak to peak
Output Current Supplied	0.1 to 6A (IC655PWR500 and IC655PWR514) 0.1 to 12A (IC655PWR501)
RUN Relay	250 V dc, 5A - Resistive Load
Weight, 6A P/S	34.6 oz (980g)
Weight, 12A P/S	42.3 oz (1200g)

Power Supply Features

The following figure is an illustration of a typical power supply for the Series Five PLC, identifying items of interest to the user. The eight terminals at the bottom of the module are for user wiring connections to the power source, ground connections, and a RUN relay.

a42270

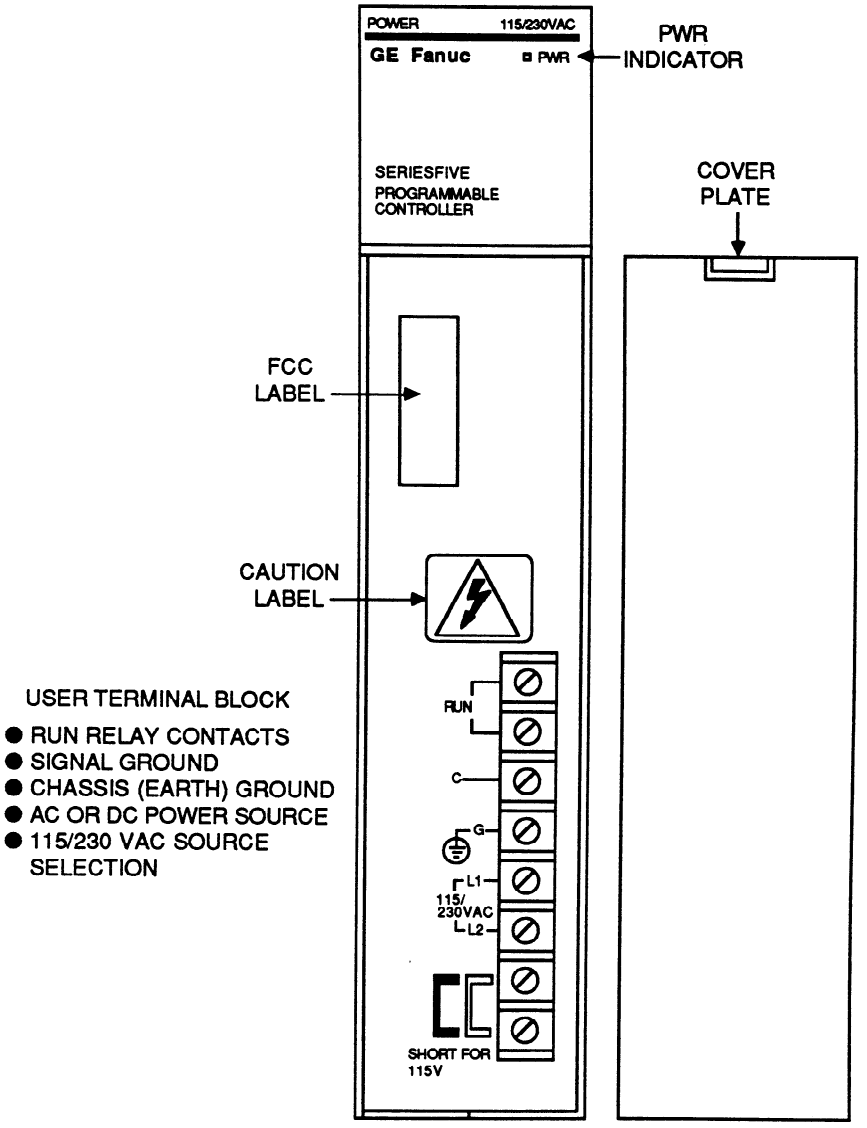


Figure 2-11. Series Five PLC Power Supply

PWR Indicator

The PWR light (green LED) at the top right provides a visual indicator that power has been applied to the supply and the +5 V dc output voltage is available and at the proper operating level. If the +5 V dc output voltage falls below its specified operating level, or if the ac or dc power source is lost for any reason, the LED will turn off.

Terminal Block Connections

All field wiring connections for the power supply are made on the terminal block located at the lower right of the power supply. The terminal block is accessed by removing the snap-on plastic terminal cover that protects the user from potentially hazardous voltages that can be on the terminals. The following figure shows the terminal block connections for each terminal.

a44986

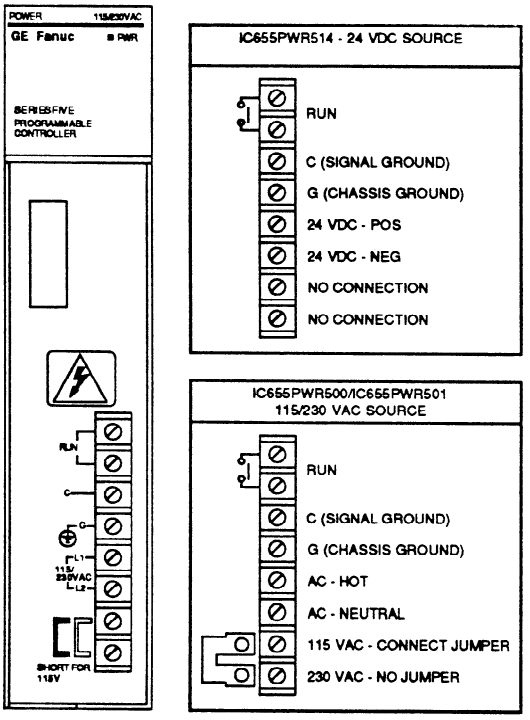


Figure 2-12. Power Supply Terminal Block Connections

RUN Relay Connections

The top two terminals (labeled RUN) are connected internally to a pair of normally-open contacts on the Run relay which is mounted on a circuit board inside the power supply. When the CPU is switched to the RUN mode, the contacts close, which provides the means to monitor the operating status of the CPU. These terminals can be connected to an external device, such as a light or alarm indicator, to sense that the CPU for some reason has gone out of the RUN mode. The RUN relay operates at a maximum of 250 V ac at 5A, through a resistive load. Refer to the specification for the Output Relay module (catalog number IC655MDL580) for complete specifications for this relay -since the RUN relay specifications are the same.

Ground Connections

The third and fourth terminals from the top are connected internally to signal ground (C) and chassis ground (G), in that order. Signal ground connects to 0V internally and chassis ground is earth ground. The ground wire from an ac source, when wiring an ac supply, connects to the chassis ground (G) terminal. If only one rack base unit is in a system, a terminal jumper (supplied with the power supply) must be connected between the C and G terminals. If more than one base unit is in a system, the terminal jumper must be connected only at the CPU (first) base unit. In the case of multiple base units with ac power supplies, it is recommended that all base units be powered from the same ac source. All

of the C terminals should be connected and all of the G terminals should be connected between base units.

CAUTION

When wiring ac power supplies, do not connect the terminal jumper between the C and G terminals on any base unit other than the first one to which the power source is connected. If terminal jumpers are connected on other base units, a difference in potential between base units may damage the circuit boards.

Power Source Connections

The next two terminals are for power source connections. When wiring an ac power supply, the first (fifth from top) of these two terminals is connected to the Hot (L1) side of the ac source, and the lower terminal is connected to the Neutral (L2) side of the ac source. When connecting a source of dc power to the 24 V dc power supply (source can be from 20 to 29 v dc), the fifth terminal from the top connects to the positive (+) side of the power source, and the sixth terminal connects to the negative (-) side of the source.

115/230 V ac Selection

The bottom two terminals on the block are for selection of either a 115 V ac power source or 230 V ac power source. A terminal jumper, provided with the power supply, is used for this configuration. *To select 115 V ac, the terminal jumper must be connected between the two bottom terminals.* For a 230 V ac power source, do not connect the terminal jumper.

a42272

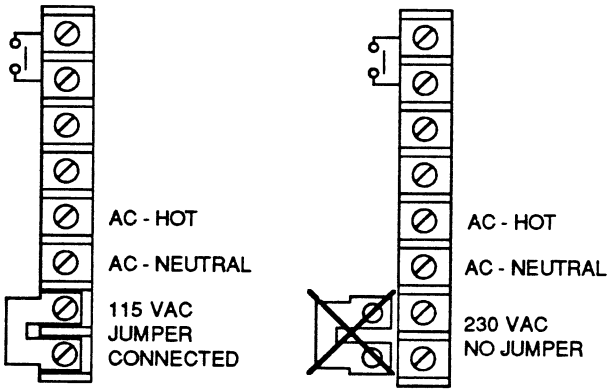


Figure 2-13. Configuration of Terminal Jumper for 115 or 230 V AC Power

I/O Expansion

A complete Series Five PLC system can be contained in one 8-slot CPU base unit with up to 256 I/O points if all of the installed I/O modules are 32 point modules. Also, the total current requirements of all modules cannot exceed the current capacity of the installed power supply. If a system requires more I/O points than can be contained in the CPU base unit, or if the current capacity of all modules is greater that the capacity of the power supply, or if your application requires that all base units not be grouped at one location, an I/O expansion base unit or base units can be added to the system.

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I/O Expansion Base Units

The base unit used for I/O expansion is the same physical base unit that is used for the CPU base unit. Base units in an I/O expansion system are connected together through available I/O expansion cables, either 1 foot (0.5m), 3 feet (1m), 15 feet (5m), 30 feet (10m), 80 feet (25m), or 160 feet (50m) in length to either of two I/O expansion connectors, one mounted on the left side of the base unit and one mounted on the right side of the base unit. The user can construct I/O expansion cables if desired (total cable length cannot exceed 200 feet (60 meters)). Both connectors on the base unit are identically wired to the I/O bus, so either may be used. The next downstream base unit connects to the unused connector on the previous base unit until the configuration is complete. An I/O chain configured in this manner is called a Local I/O chain.

A Local I/O chain can have a maximum of eight base units, including the CPU base unit. The unused connector on the last base unit in the Local I/O chain must have an I/O Terminator plug connected to it to ensure proper termination of the I/O bus signals. If there is only a CPU base unit in a system, the I/O Terminator plug goes on the right connector. An example of a group of base units connected together in a chain is shown in the following illustration. The configuration, as shown, is an example of the most basic Series Five PLC I/O expansion system; a CPU base unit and 1 to 7 expansion base units connected in a daisy chain.

a42273

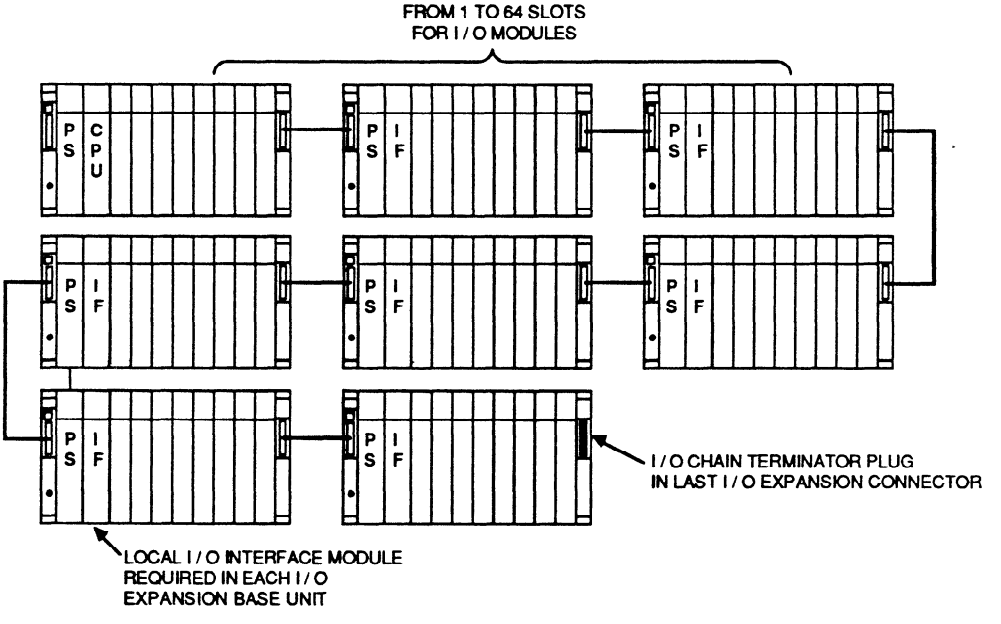

Figure 2-14. Example of Local I/O Expansion Chain

System Heat Dissipation

To ensure reliable operation of your Series Five PLC, the ambient temperature of the air entering the bottom of the modules should not be higher than 60°C (140°F). The base unit and modules installed in it are designed to dissipate internal heat by convection cooling and do not require a fan for forced air cooling. When mounting a system inside of a panel or rack, the flow of air should not be inhibited at the top and bottom of the unit. When mounted in a panel or rack, the base units should be mounted in the horizontal position (when looking at the unit) as shown in the figure below. A minimum of 2 inches (50mm) at the top and 2 inches (50mm) at the bottom of a base unit is recommended as the space required for proper air flow. When multiple base units are mounted together, 2 inches (50mm) is recommended as the minimum distance between base units. Both sides should be free of obstacles to allow easy installation or removal of a unit. At a minimum, 2 inches (50mm) from each side is recommended.

a42274

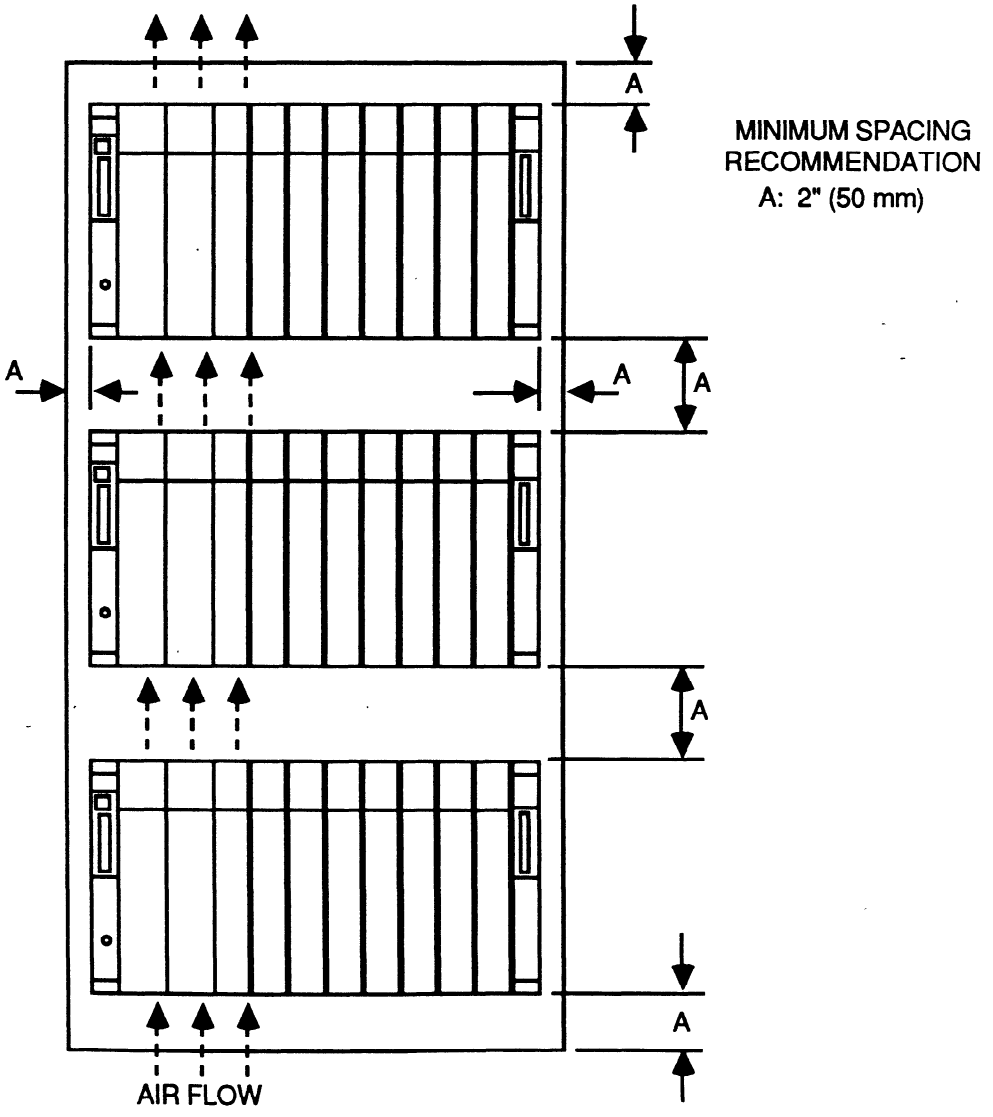

Figure 2-15. Base Unit Mounting for Proper Heat Dissipation

Local I/O Configuration

A Local I/O system, configured using 32 point I/O modules in all available I/O slots in an 8-slot base unit, can have from 256 to the maximum of 2048 I/O points, determined by the number of base units in your system. The maximum I/O vs. base unit configurations possible in a basic system using 8-slot base units, with one to eight base units, are shown in the following figure.

a42275

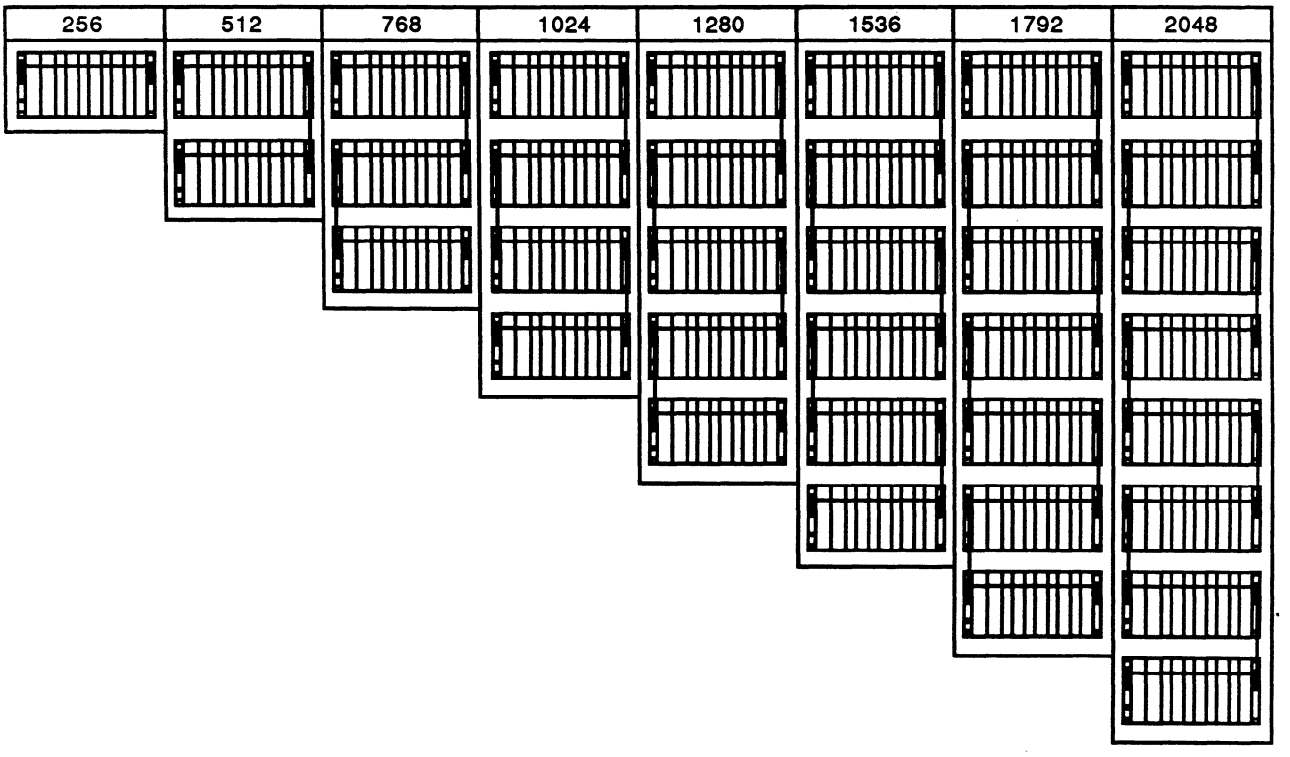

Figure 2-16. Maximum I/O Contained in 1 to 8 Base Units

Base Unit Identification

Each base unit in a system must have an identification number assigned to it for communication purposes. Base unit ID numbers, from 0 through 7, are assigned by setting a small rotary switch, located directly above the I/O expansion connector on the left side of the base unit, to the desired ID number. The ID numbers can be assigned in any order to satisfy the application, they do not have to be assigned sequentially, however, the rack containing the CPU must be assigned ID 0 (zero).

ID numbers must not be duplicated. Use each ID number once and only once. I/O references for individual modules can be assigned in any sequence to suit the requirements of the user's application. The location and physical appearance of the base unit ID switch is shown below along with an example of typical settings for two different systems.

a42276

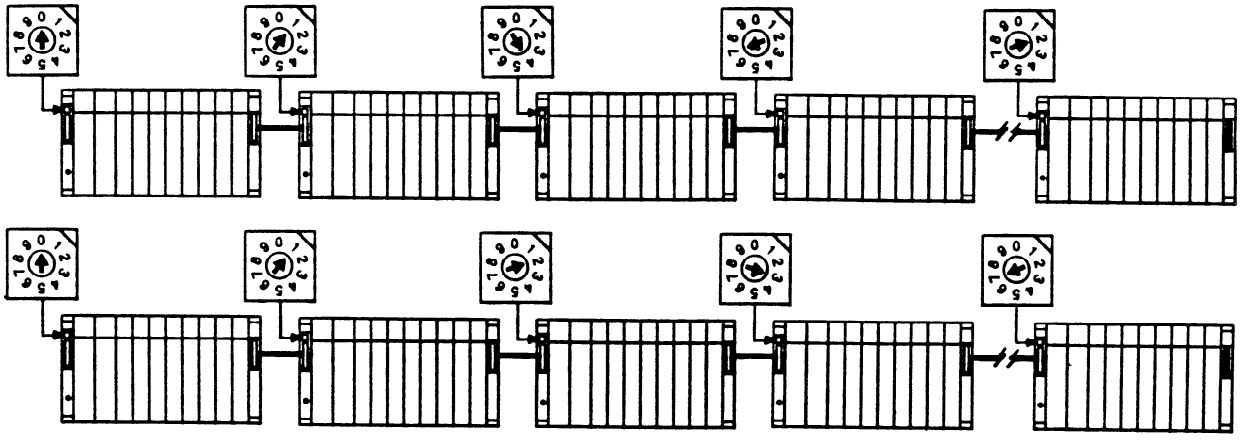

Figure 2-17. Examples of Base Unit Identification Switch Settings

Local I/O Interface Module

Each I/O expansion base unit must contain a Local I/O Interface module (catalog number IC655BEM500) which allows the modules in the base unit to communicate with the I/O bus. The Local I/O Interface module analyzes data from the CPU on the I/O bus and converts the signal levels to proper levels for processing by modules in that base unit. The I/O bus is designed for high reliability, and provides parity checking to ensure correct data transmission to I/O points on the bus. To help ensure date integrity under adverse noise conditions, the I/O bus uses differential drivers and receivers. The Local I/O Interface module must always be installed in the module slot adjacent to the power supply in an I/O expansion base unit. This is the same slot in which the CPU is installed in the CPU base unit. There are no switches or jumpers on this module that require user configuration.

a42277

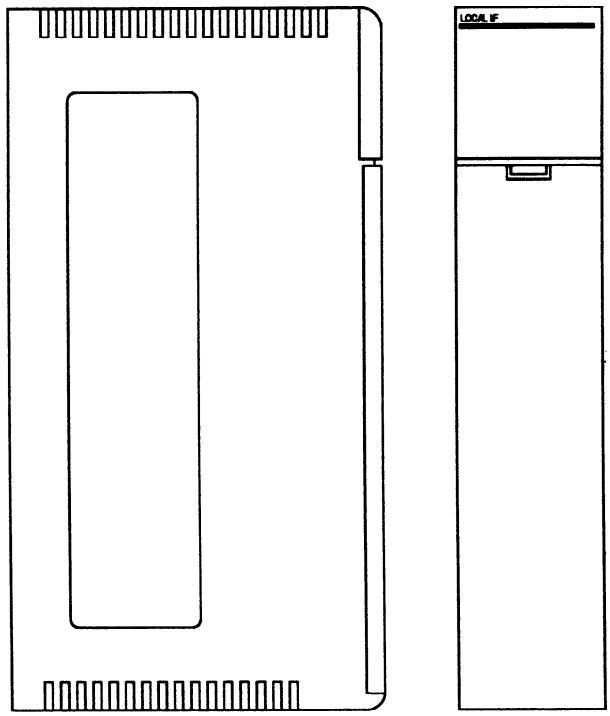

Figure 2-18. Local I/O Interface Module

I/O Expansion Cables

Six I/O expansion cables are available in different lengths for connecting base units in an I/O expansion system. Each of the cables has a 37-pin male D-subminiature connector wired to each end. One end of the I/O expansion cable plugs into one of the two available mating connectors mounted on either end of a base unit, the other end plugs into either of the I/O expansion connectors on the next base unit in the chain. Available Catalog numbers and lengths are as follows:

Catalog Number	Length
IC655CBL500	1.5 feet (0.5 meter)
IC655CBL501	3 feet (1 meter)
IC655CBL502	15 feet (5 meters)
IC655CBL503	30 feet (10 meters)
IC655CBL504	80 feet (25 meters)
IC655CBL505	160 feet (50 meters)

I/O Expansion Cable Specifications and Wiring Information

I/O expansion cable specifications and wiring information are provided below for those users who may have applications that require cables with lengths different than the factory supplied cables.

WARNING

Racks connected through any length of I/O expansion cable must be connected to the same ground system. Failure to do so may result in damaged equipment, and/or erratic system operation.

Maximum Cable Length:	200 Feet (60 meters) - This is the total cable length and includes all cables in a Local I/O chain.
Cable Characteristics:	28 AWG wire or larger, with at least 18 twisted pair. Overall or individual shields, insulation to meet user requirements for environmental resistance. Most cables that meet RS-422 requirements are acceptable.
Connectors:	D-subminiature, 37-pin male, with 2.6 x 4 metric threads.

The following cables are suggested for use, however, the user must ensure that all of the requirements listed above are followed.

- Alpha 6089/18, 6079/19 (multiple shields must be tied together), X5499/19
- Belden 9819 or 9837
- Furukawa OAVV(C)-SB
- Belden 8118 (this is the best choice)

NOTE

Twisted pairs must be matched so that they are connected exactly as shown in the illustration. If this is ignored, cross-talk will result from the mismatching which will cause the I/O system to malfunction.

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a42405

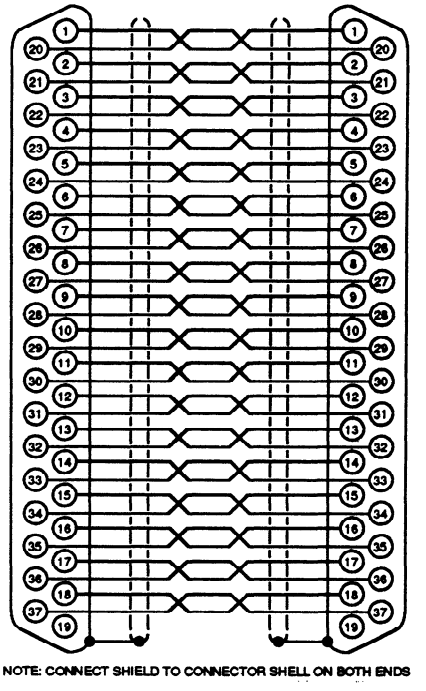

Figure 2-19. I/O Expansion Cable Connections

Extending the Local I/O Chain to 400 Feet (120 meters)

The specified maximum local I/O chain distance is 200 feet (60 meters). Although this distance will work with most systems, it may not be possible in an extremely high-noise environment. Please note that under certain circumstances, it is possible to extend the maximum local I/O chain distance to 400 feet (120 meters) **if the following guidelines are absolutely met.**

1. The cable type MUST BE BELDEN 8118. This cable has been tested and will work at the extended distance.
2. The cable extends from point A to point B with no "taps".
3. The systems at both ends of the cable and all points in between must be fed by the same power system. It may be necessary to run 115/230 V ac and ground from a single source to all the racks to ensure that this is the case.
4. The ground potentials at both ends and all intermediate points must be at the same potential.
5. The operating environment must be a low-noise environment.

Please note that if a system does not operate properly at 200 feet, it will not operate at 400 feet.

I/O Chain Terminator Plug

The unused connector on the last base unit in the Local I/O chain must have an I/O Terminator plug (IC655CHS590) connected to it for proper termination of the I/O bus signals. The I/O Terminator plug is required, regardless of whether the last base unit is a CPU base unit or an I/O expansion base unit.

NOTE

If there is only one base unit in a system (CPU base unit), the I/O Terminator plug must be installed on the I/O bus connector on the right side of the base unit.

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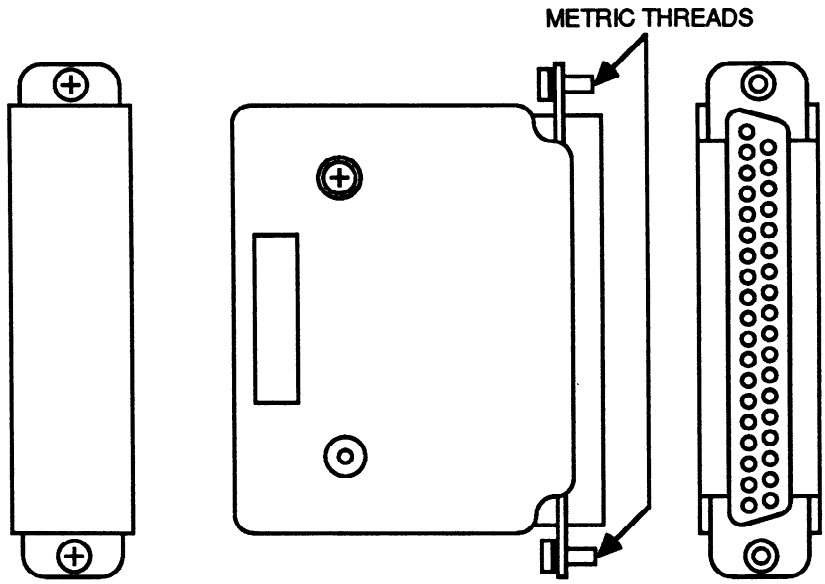


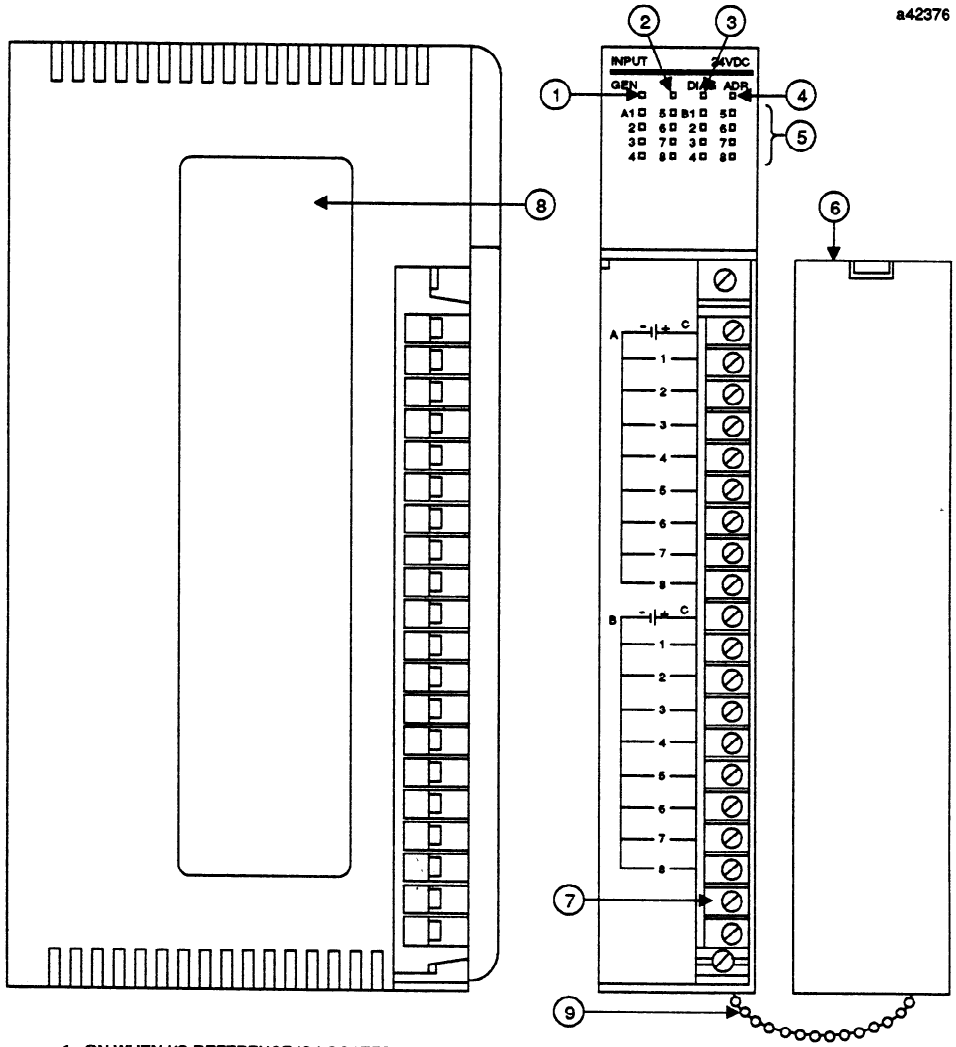
Figure 2-20. I/O Chain Terminator Plug

CAUTION

Ensure that the I/O Terminator plug is present on the unused base unit connector on the last base unit in the I/O chain. If the I/O Terminator plug is not properly installed unreliable operation of the I/O system may be observed.

I/O Modules for the Series Five PLC

Available I/O modules for the Series Five PLC include discrete input and output, analog input and output, High Speed Counter, ASCII/BASIC module, and an Axis Positioning Module. All I/O modules are enclosed in a plastic case. Modules having features requiring user access, such as replaceable fuses or DIP switches requiring configuration, have a removable cover on the side of the module. For information about fuses in specific modules, refer to the Series Five I/O Module Specifications Manual, GFK-0123.



1. ON WHEN I/O REFERENCE IS LOCATED IN I1+, O1+, I2+ OR O2+ STATUS TABLE.
2. UNUSED ON INPUT MODULES FB - BLOWN FUSE INDICATOR ON OUTPUT MODULES.
3. OFF : OPERATION NORMAL ON : LOOSE OR MISSING TERMINAL BLOCK, NO VOLTAGE FROM EXTERNAL POWER SOURCE, OR OTHER PROBLEM WITH THIS MODULE.
4. OFF : 16 OR 32 LEDs BELOW INDICATE ON OR OFF STATUS OF I / O POINTS ON : STARTING ADDRESS OF MODULE INDICATED BY TOP 16 LEDs.
5. LED INDICATORS SHOW STATUS OF I / O POINTS OR STARTING I / O ADDRESS OF MODULE. 32 POINT MODULES HAVE 4 GROUPS A1-8, B1-8, C1-8, D1-8.
6. FACEPLATE COVER. INSERT FOR CIRCUIT IDENTIFICATION ATTACHES TO BACK.
7. TERMINAL BLOCK FOR FIELD WIRING TO 16 AND 32 POINT MODULES.
8. REMOVABLE COVER FOR ACCESS TO USER ITEMS (IF ANY).
9. BEAD CHAIN INCLUDED WITH EACH MODULE.

Figure 2-21. Typical I/O Module with Removable Terminal Block

Sixteen and 32 point I/O modules connect to the backplane through a single connector on the module which mates with a connector mounted on the base plate directly behind each I/O slot. 64 point I/O modules connect to field devices through two 37-pin D-type connectors mounted on the module's faceplate. No special tools are required to install I/O modules. Modules are held firmly in place by fastening two easily accessible captive screws, one at the top and one at the bottom of the module. Each module is color coded with a narrow horizontal stripe across the top of the faceplate. A red stripe indicates a high-voltage module, a blue stripe indicates a low-voltage module, and a white stripe indicates a signal level or other type.

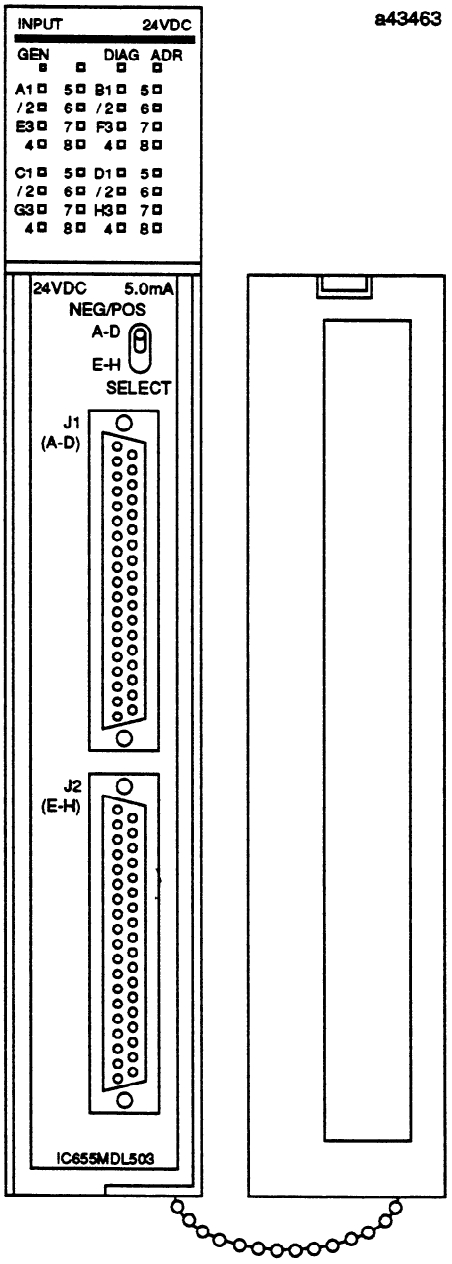


Figure 2-22. Typical I/O Module with Connectors

I/O Module Keying

All 16 and 32 point I/O modules can be keyed by the user to prevent accidental connection of a prewired connector to the wrong module type (for example, when installing a new module, troubleshooting a system, or when replacing a module). Individual module keying is done by the user at installation. Instructions and required parts are provided with each module.

The CPU also provides a diagnostic "keying" check of the I/O modules to ensure that a previously installed module has been replaced in the correct slot. If the module configuration in the I/O slots is different than it was on the previous power-up, the CPU optionally detects this and provides an error indication, if the I/O configuration check is enabled. Normal operation cannot proceed until the modules are inserted correctly, or until Logicmaster 5 or the OIU tells the CPU to accept the new configuration, or to continue running assuming the old configuration.

Connection of Field Wiring to 16 and 32 Point Modules

An easily removed cover on the front of the module provides access to a connector block for connection of field wiring. Connector blocks have either 20 (16 circuit modules) or 38 (32 circuit modules) terminals. The connector is removable to allow for prewiring of systems, and easy replacement of modules. Terminals on the connector block will accept one AWG #16 or two AWG #18 wires with 1/4" spade lugs. Field wiring to the connector is routed into the bottom of the module through a cutout in the bottom front of the case. All screws used in the Series Five PLC have metric threads.

Connection of Field Wiring to 64 Point Modules

Each of the 64 point I/O modules has two 37-pin subminiature D-type connectors mounted on the front of the module for connecting user supplied input devices to Input modules, or for connecting Output modules to user supplied loads. Each connector provides for connection to 32 of the 64 circuits on a module. Each 64 point I/O module is shipped with two unwired male connectors which mate with the connectors on the module. These connectors are provided for building cables for connection to field devices.

A toggle switch on the front of the module allows the user to choose the groups of I/O points to be monitored by the 32 status indicators located at the top of the module, either group A through D, or group E through H. The top connector provides connection to groups A1 through A8, B1 through B8, C1 through C8, and D1 through D8, while the bottom connector provides connection to groups E1 through E8, F1 through F8, G1 through G8, and H1 through H8.

Faceplate Cover

Each module has a protective plastic cover over the terminal block. This cover protects the user from coming in contact with potentially hazardous voltages present at the terminal block. A short length of plastic bead chain is included with each I/O module and attaches to the faceplate and module. When attached, this bead chain allows the faceplate cover to hang from the module and not be misplaced. A self-adhesive light gray insert is provided with each module to be attached to the back of the cover. This insert has a lined area marked off in sections corresponding to the terminals on the block, which provides a convenient place to record circuit identification information.

Status Indicators

The ON or OFF status of each I/O point is indicated by the state of a corresponding LED, which is either ON or OFF. 32 point I/O modules have 35 or 36 LEDs and the 16 point I/O modules have 19 or 20

LEDs that are visible at the top of the module. 16 or 32 of these LEDs indicate the ON or OFF status of the module's input or output circuits, as applicable. For 64 point modules, the 32 LEDs indicate the status of the 32 inputs or outputs associated with one connector. A toggle switch provides a choice between the two groups of 32 (total 64) Inputs or Outputs being monitored; either group A to D or group E to H. The top 16 LEDs can also be programmed, through Logicmaster 5 or the Series Five Operator Interface Unit, to indicate the starting I/O address of the module instead of the module I/O point status. The other 3 or 4 LEDs (Output modules have 4, Input modules have 3) are used for diagnostic purposes as described below.

GEN On when the I/O reference assigned to the module is located in either the I1+, O1+, I2+, or O2+ table.

FB Output modules only. When ON, indicates that a fuse has blown in the module (output point must be ON, a load must be connected, and the CPU must be in the RUN mode). This location is blank on Input modules.

DIAG When ON, indicates a loose or missing terminal block, no external supply voltage, or that an internal failure has been detected in the module.

ADR If ON, indicates that the LEDs normally used for circuit ON or OFF status have been commanded by the CPU to display the module's starting I/O address.

I/O Modules For The Series Five PLC

I/O modules are summarized in the following table. For detailed information on I/O modules, refer to the *Series Five I/O Module Specifications Manual, GFK-0123.*

Table 2-5. Series Five I/O Modules

Catalog Number	Module Description	Current/Voltage Rating	No. of Circuits
IC655MDL501	12 - 24 VDC Input, Negative Logic	7 mA @ 12 VDC 15 mA @ 24 VDC	16
IC655MDL502	12 - 24 VDC Input, Negative Logic	10 mA @ 24 VDC	32
IC655MDL503	24 VDC Input, Positive/Negative Logic	5 mA @ 24 VDC	64
IC655MDL511	24 - 48 VAC/DC Isolated Input, Positive Logic	7 mA @ 24 VDC 14 mA @ 48 VDC	16
IC655MDL512	12 - 24 VAC/DC Input, Positive Logic	10 mA @ 24 VDC	32
IC655MDL524	Input Simulator	n/a	16 or 32
IC655MDL525	115/230 VAC Input	8.4 mA @ 115 VAC 18 mA @ 230 VAC	16
IC655MDL526	115 VAC Input	14.5 mA @ 115 VAC	32
IC655MDL527	115/230 VAC Isolated Input	8.4 mA @ 115 VAC 18 mA @ 230 VAC	16
IC655MDL533	5 - 12 VDC TTL Input, Positive/Negative Logic	2.5 mA @ 5 VDC 7.5 mA @ 12 VDC	64
IC655MDL551	12 - 24 VDC Output, Negative Logic	2A	16
IC655MDL552	12 - 24 VDC Output, Negative Logic	0.5A	32
IC655MDL555	12 - 24 VDC Output, Positive Logic	2A	16
IC655MDL556	12 - 24 VDC Output, Positive Logic	0.5A	32
IC655MDL575	115/230 VAC Output	2A	16
IC655MDL576	115/230 VAC Isolated Output	2A	16
IC655MDL577	115/230 VAC Output	1A	32
IC655MDL580	Relay Output	2A Resistive	16
IC655MDL581	Relay Output	2A Resistive	32
IC655MDL586	Isolated Relay Output	2A Resistive	16
IC655MDL593	5 - 12 VDC TTL Output, Positive Logic	90 mA @ 14 VDC (current sinking)	64

Table 2-5. Series Five I/O Modules - Continued

Catalog Number	Module Description	Current/Voltage Rating	No. of Circuits
IC655ALG516	Analog Input, 8 Channels	1 to 5 V, 0 to +10 V -10 to + 10 V 4 to 20 mA	8
IC655ALG566	Analog Output, 2 Channels	0 to +10 V 4 to 20 mA	2
IC655ALG567	Analog Output, 2 Channel	-10 to +10 V	2

Using Series Three PLC I/O Modules with a Series Five PLC

Series Three PLC I/O modules can be included in a Series Five PLC Local I/O chain as part of an I/O expansion system. Most of the Series Three PLC I/O modules can be used in the Series Three PLC I/O system expanded from a Series Five PLC. Series Three PLC I/O modules, installed in standard Series Three PLC I/O base units, interface to the CPU in a Series Five PLC through the Series Three PLC I/O Interface module.

Series Three PLC I/O Interface Module

A Series Three PLC I/O Interface module (catalog number IC655BEM530) can be installed in any valid Series Five PLC I/O slot. A maximum of three Series Three PLC base units can be connected to a Series Three PLC I/O Interface module. Up to four Series Three PLC I/O Interface modules can be included in a Series Five PLC I/O system. A Series Three PLC I/O Interface module can service up to 512 I/O points (512 Inputs/512 Outputs).

NOTE

The total number of I/O points in a Series Five Local I/O chain cannot exceed 2048, which includes all combinations of Inputs and Outputs used in the system.

The number of I/O points serviced by each I/O Interface module is selected by configuring a DIP switch on the Series Three PLC I/O Interface module in groups of 32 I/O. The module has one status indicator, (LINK), at the top of the faceplate. This LED will be ON when the I/O communications link between the Series Three PLC I/O Interface module and Series Three PLC I/O is established, and valid I/O data is being transmitted and received by the module. If the link is broken for any reason, the LED will be OFF.

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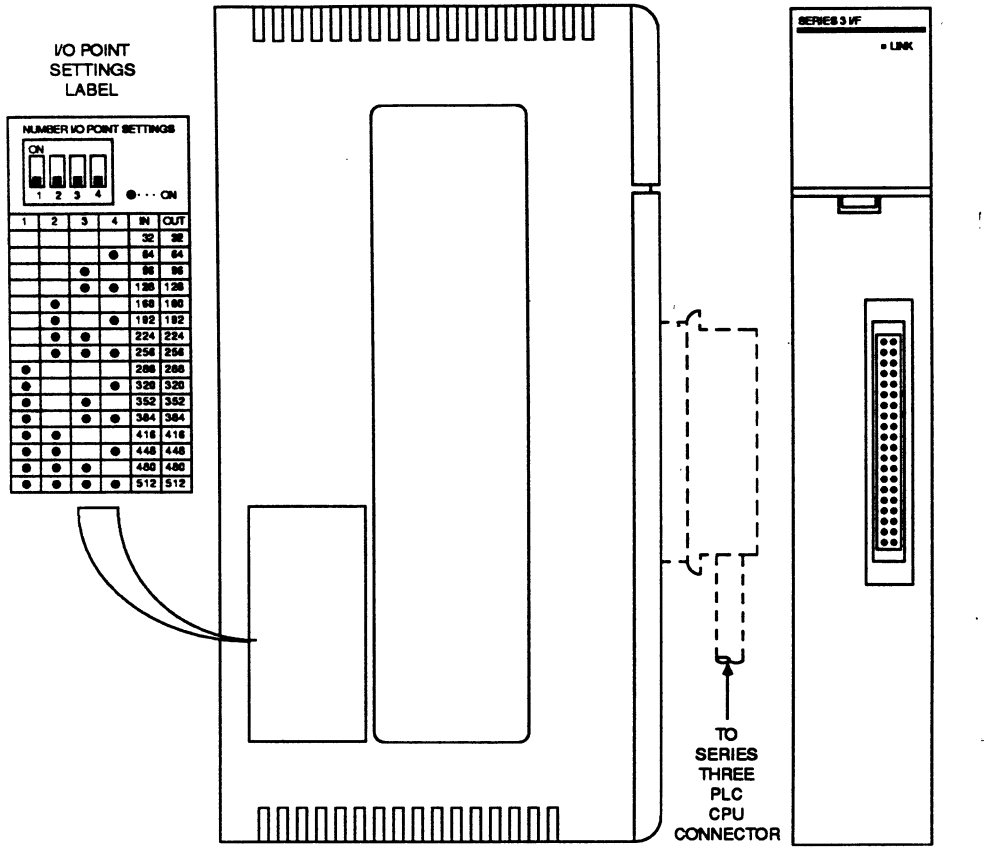

Figure 2-23. Series Three PLC I/O Interface Module

Series Three PLC I/O Configuration

Most valid Series Three PLC I/O system configurations can be included as a part of a Series Five PLC system. Series Three PLC I/O modules can be installed in a maximum of three base units, connected directly to a Series Three PLC I/O Interface module, or multiple groups of Series Three PLC base units can be in a system (each group of three connected to a Series Three PLC I/O Interface module). A Series Three PLC Remote I/O system can be included by installing an I/O Link Local module in a Series Three PLC base unit and connecting it to an I/O Link Remote module in a base unit located up to 3300 feet (1 Km) from the first base unit. Communications through this link is RS-422 compatible and the physical connection is through a twisted-pair cable. Most rules for using Series Three PLC I/O in a Series Three PLC Remote I/O system apply with the exception that only inputs or only outputs may be used in a base unit. Inputs and outputs may not be mixed in any one slot (e.g. remote I/O). Additionally, the number of remote I/O points to be transmitted can be set for 8, 16, 32, and 64; 48 is not allowed.

Series Three Analog Inputs in a Series Three I/O System

The following note applies when using Series Three Analog Input modules with a Series Five PLC through a Series Three I/O Interface module.

NOTE

When the CPU is in the RUN Disabled mode, the LEDs on the Series Three Analog Input module may oscillate rapidly. However, the incorrect data is not fed back to the CPU.

Series Three I/O Modules for the Series Five PLC I/0 System

Following is a list of available Series Three PLC I/O modules which can be used in a Series Five PLC I/O system. Note that Series Three I/O modules having both inputs and outputs can not be used in a Remote I/O system.

Table 2-6. Series Three PLC I/O Modules

PART NO. IC630	NAME	CIRCUITS	VOLTAGE RANGE	CURRENT (MAX.)
MDL325	115Vac Input	16	97-132Vac/dc	11ma
MDL375	115Vac Output	16	97-265Vac	2 amps
MDL327	230Vac Input	16	180-265Vac	18ma
MDL301	24Vdc Input	16	21.5-26.5Vdc	15ma
MDL306	24Vdc Input	32	21.5-26.5Vdc	7ma
MDL311	24Vac/dc Source Input	16	20-28Vac/dc	13ma
MDL303	5-12Vdc Input (TTL Compatible)	32	4.75-13.2Vdc	8ma
MDL351	24Vdc Sink Output	8	21.5-26.5Vdc	2 amps
MDL352	24Vdc Sink Output	16	21.5-26.5Vdc	1 amp
MDL357	24Vdc Source Output	16	5-24Vdc	1 amp
MDL356	24Vdc Output	32	21.5-26.5Vdc	0.5 amp
MDL354	5-12Vdc Output (TTL Compatible)	32	4.75-13.2Vdc	0.5-1.5ma
MDL380	Relay Output (NO)	16	5-265Vac/dc	4 amp (Resistive)
MDL326	115Vac Input (Isolated)	8	97-132Vac/dc	11ma
MDL376	115/230Vac Output (Isolated)	8	97-265Vac	2 amps
MDL310	High Speed Counter	1	10Khz pulse	16ma
MDL324	I/O Simulator (16 Inputs)	16		
MDL316	Analog Input	2	1-5Vdc 1-10Vdc 0-10Vdc	4-20ma
MDL366	4-20ma Analog Output	2	1.6-8Vdc	20ma
MDL367	-10 to +10Vdc Analog Output	2	-10 to +10 Vdc	20ma
MDL368	0-10Vdc Analog Output	2	0-10Vdc	20ma

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Genius Bus Controller

The Series Five Genius Bus Controller (GBC), catalog number IC655BEM510, is the required interface between a Series Five PLC and a Genius I/O network. The Genius network as used in a Series Five PLC system provides two primary functions: (1) compatibility with Genius I/O blocks, and (2) CPU to CPU communications (Global Data Communications). Both of these functions provide a remote I/O capability within a Series Five PLC system. A Series Five Genius network can have up to 32 Genius compatible devices communicating over a serial bus. Communications on the serial bus is half duplex at selectable baud rates from 38.4 to 153.6 Kbps.

NOTE

For applications involving Series Five Genius redundancy - refer to published application notes, or contact your GE Fanuc Applications Engineer.

There can be multiple Genius networks in a system. These networks can be configured to be used for many types of applications. The simplest type of network is for I/O control, with many I/O devices on the bus, which requires no communications programming on the part of the user. A network can also be used primarily for CPU-to-CPU communication purposes, with up to eight Bus Controllers and CPUs on the bus, with no I/O devices. Or, a network can combine I/O control and communications. Global Data communication between CPUs is comprised of transmitting and receiving register data.

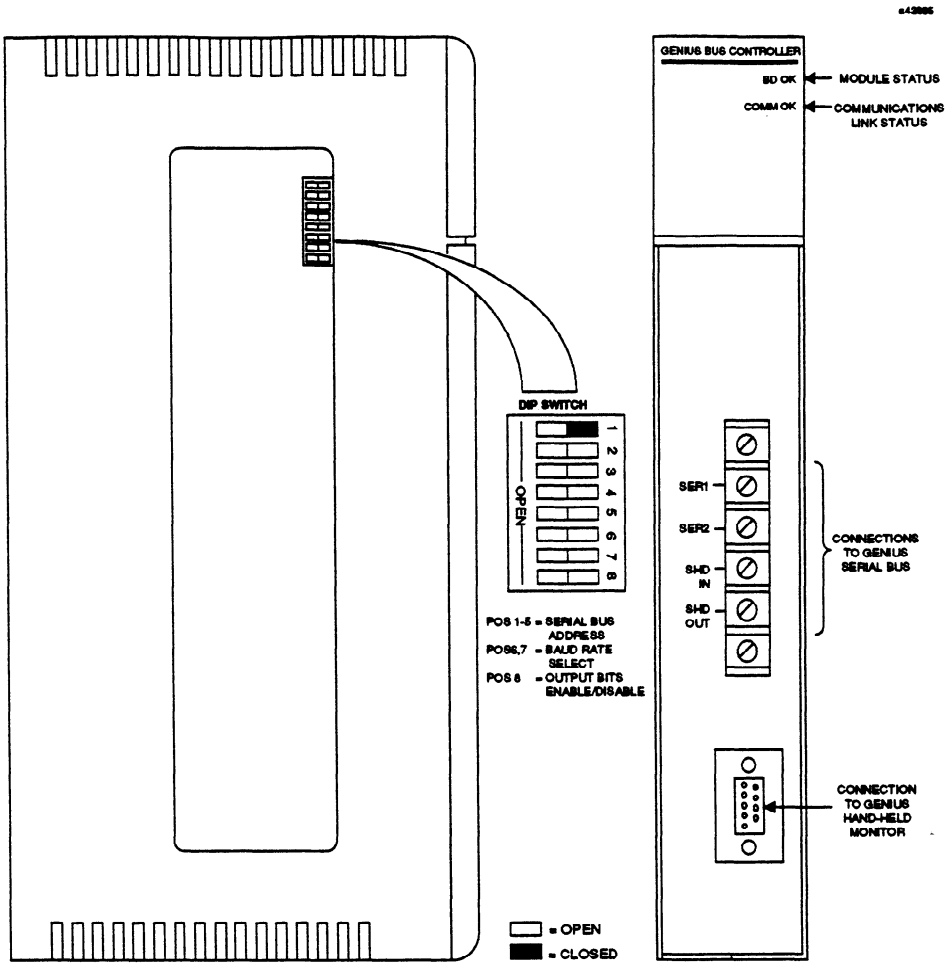

Figure 2-24. Genius Bus Controller for the Series Five PLC

It is possible to use any of the I1+, I2+, O1+, O2+, or Register tables for Genius I/O blocks, or for expanded CPU to CPU data transfers. In addition, communications with Series Six PLCs and other GE Fanuc devices is possible through the Global Data communications setup. Note that Series Five Genius Global Data defaults are compatible with the GE Fanuc "Long" form for Global Data communications.

The Genius Bus Controller provides a method of including an I/O system in the overall Series Five PLC control system that can be located up to 7500 feet (2283 meters) from the CPU. A Genius Bus Controller can be installed in any of the eight I/O slots in a Series Five CPU base unit, thereby allowing up to eight Genius Bus Controllers in a CPU base unit. Each Bus Controller can have up to 31 Genius compatible devices connected to it, these devices can be Genius I/O blocks, other Series Five Genius Bus Controllers, and one or more Genius Hand-Held Monitors. Each device, including the Genius Bus Controller, on each bus must be assigned a Serial Bus Address (SBA) from 0 to 31.

Genius Bus Controller setup can be done with Logicmaster 5 in the GENIUS BUS CONTROLLER SETUP screen, or with the OIU by accessing Menu 9 (sub menu 91) and following the on-screen prompts. For further information on Genius I/O and using Genius I/O with a Series Five PLC, refer to the following documentation:

GFK-0248, Series Five Genius Bus Controller User's Manual;
GEK-90486, Genius I/O System User's Manual;
GFK-0171, Series Six Bus Controller User's Manual.

CCM Communications Module

The CCM Communications Module (CCM), catalog number IC655CCM500, provides a serial interface between the Series Five PLC and any intelligent device that can initiate or receive communications based on the GE Fanuc CCM2 protocol and CCM electrical interface requirements. The CCM has one active logical serial port with two connectors that provide RS-232C and RS-422 interface capability. RS-232C is normally used for direct connections at a maximum distance of 50 feet (15 meters). The RS-422 interface allows direct connection up to 4000 feet (1200 meters). The CCM can be connected directly to short haul or telephone line modems through the RS-232 interface if transmission distances greater than the 4000 feet allowed by RS-422 are required. The CCM also provides a built-in RS-232 to RS-422 converter to allow RS-232 compatible computers access to the RS-422 multidrop link.

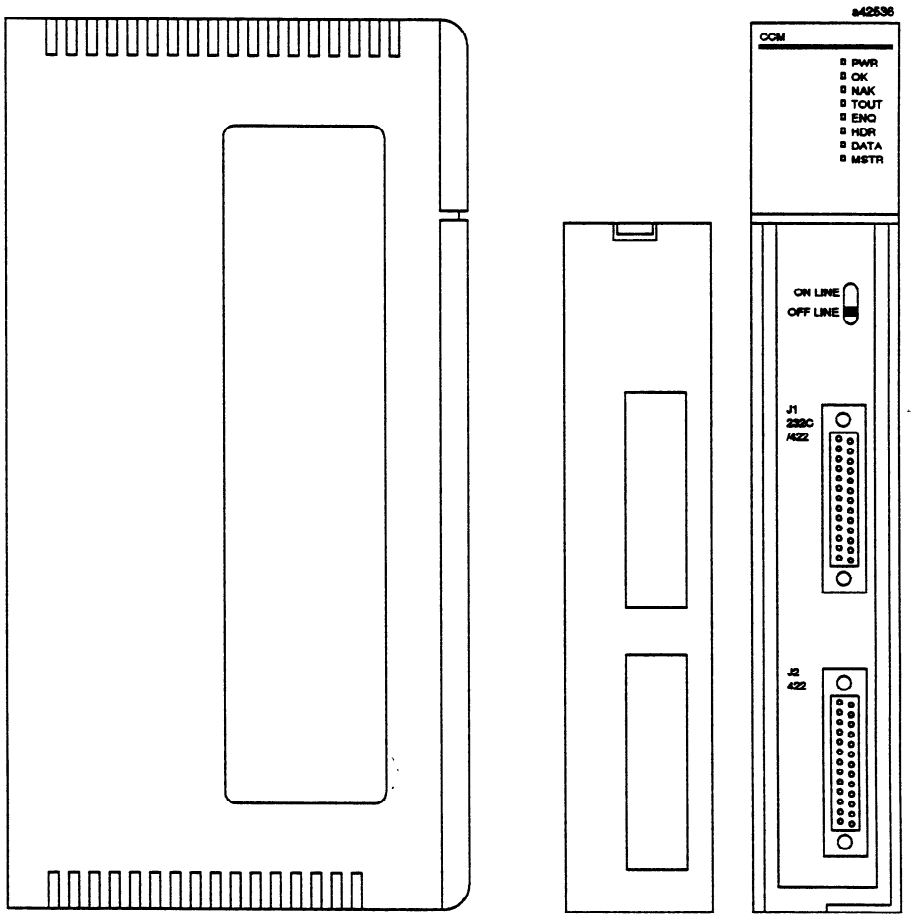

Figure 2-25. Series Five PLC CCM Communications Module

The CCM communications link can also be extended beyond its normal 4000 feet by inserting an Adaptor Unit (IC655CCM590) at the end of the link and taking advantage of its repeater feature. This will boost the RS-422 signal levels and provide another 4000 feet of communications distance. The CCM can operate at speeds up to 19.2K baud, and can originate messages with control by the PLC's ladder diagram logic.

Examples of intelligent devices that can be interfaced to the CCM include:

- Other GE Fanuc PLCs
- A host computer or microprocessor based devices.
- Color graphics terminals
- GENET Factory Local Area Network

The CCM is capable of initiating data transfers to most Series Five PLC memory types, including registers, input and output tables, override tables, scratch pad, and user logic. When a Series Five is connected through a CCM to a host computer or other device that is not a Series Five, Series Three, Series One, or Series Six PLC, the user must either write or purchase the software necessary to communicate with the CCM. Flow charts detailing the operation of the CCM are available in the Series Five Data Communications Manual. Based on these charts, the user can write driver software to interact with the CCM. Sample driver programs are available on the Series Five PLC Bulletin Board.

Since the Series Five PLC can have multiple CCM ports (one in the CPU and up to eight CCM Master Modules), it is possible for several external devices to read and write data to the CPU. The areas available for reading and writing are shown in table 2.3.

When writing data to the CPU, care must be exercised by the user to ensure that undesirable system interactions do not occur as a result of more than one external CCM device writing to the same CPU. Reading the CPU by multiple devices does not create any problems, but writing to the CPU by more than one device is not recommended.

System Configuration

Two types of system configurations are supported by the CCM: multidrop, and GEnet. In the multidrop configuration, one CCM or host device is configured as the master and one or more CCMs are configured as slaves; only the master-slave protocol can be used. The GEnet Factory LAN is a Local Area Network through which many devices can be connected. A Bus Interface Unit (BIU) allows series Five PLCs to access the GEnet Factory LAN, and can support a maximum of four CCMs. By using multiple BIUs, a maximum of 254 Series Five PLCs with CCMs can be connected to the network.

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General Specifications

General specifications for the Series Five CCM Communications Module are listed below. For further information, refer to GFK-0244, the Series Five Data Communications Manual.

Table 2-7. CCM Communications Module General Specifications

Catalog Number	IC655CCM500
Installation Requirements	One I/O slot in a CPU base unit, thereby allowing up to eight CCM modules in a CPU base unit.
Power Requirements	5 V dc, ±5% at 1A (maximum), supplied by the Series Five power supply installed in the base unit.
Diagnostic Capabilities	Eight LEDs on faceplate provide diagnostic and operating information.
Transmission Parameters	Half-Duplex, Asynchronous. Serial Data Format: 1 Start Bit, 8 Data Bits, 1 parity bit, odd (or none), 1 Stop Bit
Electrical Interface	RS-232C or RS-422, accessible through 25-pin connectors mounted on the module's faceplate.
Transmission Distance	RS-232C - Up to 50 feet (15 meters) RS-422 - Up to 4000 feet (1200 meters) through a two wire twisted, shielded cable. Can be increased by connection to short haul or telephone line modems (through RS-232C interface). Distance can be increased an additional 4000 feet by inserting a repeater (GE Fanuc Adaptor Unit, (IC655CCM590)) at end of link to boost RS-422 signal levels.
Transmission Speed	User selectable: 300, 600, 1200, 2400, 4800, 9600, or 19.2K baud, by setting a DIP switch.
System Protocol	Conforms to GE Fanuc CCM2 and CCM3 (RTU) protocol
Error Check Method	Parity check and LRC check

User Items

The CCM must be installed in one of the I/O slots in the CPU base unit. The two connectors on the board provide RS-232C and RS-422 operation. Port 1 is a 25-pin D-subminiature female connector which provides access to RS-232C signals, and port 2 is a 25-pin D-subminiature female connector providing access to RS-422 signals. Port 1 also provides converted RS-422 outputs which can be used to connect to the remote slaves in a multidrop network. The required mating connectors for the CCM ports must be ordered as a separate line item. The catalog number for the CCM connector is IC655ACC525.

Eight LEDs on the board, which are viewed through the top of the faceplate lens, are indicators of the operating status of the module. The following table contains a description of these indicators.

Table 2-8. CCM Status Indicator Definitions

LED	Color	Status	Definition
PWR	GREEN	ON	+5 V dc is present in this module and operating at the proper level.
		OFF	+5 V dc not present. Problem in this module or with the base unit power supply.
OK	GREEN	ON	Board has passed internal tests and is communicating properly with the CPU in this base unit.
		OFF	Internal problem with this board.
NAK	RED	ON	The last transmission was rejected by the target source.
		OFF	Transmission not rejected.
TOUT	RED	ON	Communications link has timed out.
		OFF	Communications link has not timed out.
ENQ*	AMBER	ON	Control character being sent to slave device to initiate communications when CCM is master, or an ENQ sequence has been received.
		OFF	No attempt being made to establish communications with slave device by CCM master, or no ENQ sequence has been received.
HDR*	AMBER	ON	A header block is being transmitted or received.
		OFF	Header block is not being transmitted or received.
DATA*	AMBER	ON	A data block is being transmitted or received.
		OFF	No data block is currently being transmitted or received.
MSTR*	AMBER	ON	CCM master module is configured as a master device and can initiate communications with slave devices.
		OFF	CCM is configured as a slave device.

* During normal operation, these LEDs will blink.

ASCII/BASIC Module

The ASCII/BASIC module (catalog number IC655APU500) for the Series Five Programmable Logic Controller is a compact module requiring only a single slot in the CPU or any expansion rack. The ASCII/BASIC module does not require any I/O reference for communication with the CPU, but uses the background communication feature of the Series Five PLC for Intelligent Modules.

Purpose of the ASCII/BASIC Module

The ASCII/BASIC module is used to interface with external serial devices, such as CRTs, printers, bar code readers, and scales. The ASCII/BASIC module, under control of the resident BASIC programming language, can exchange information with the PLC. This information can be the status of any Input or Output point or internal reference, as well as all Register data. With appropriate programming, the ASCII/BASIC module can read and write any I/O point and any Register.

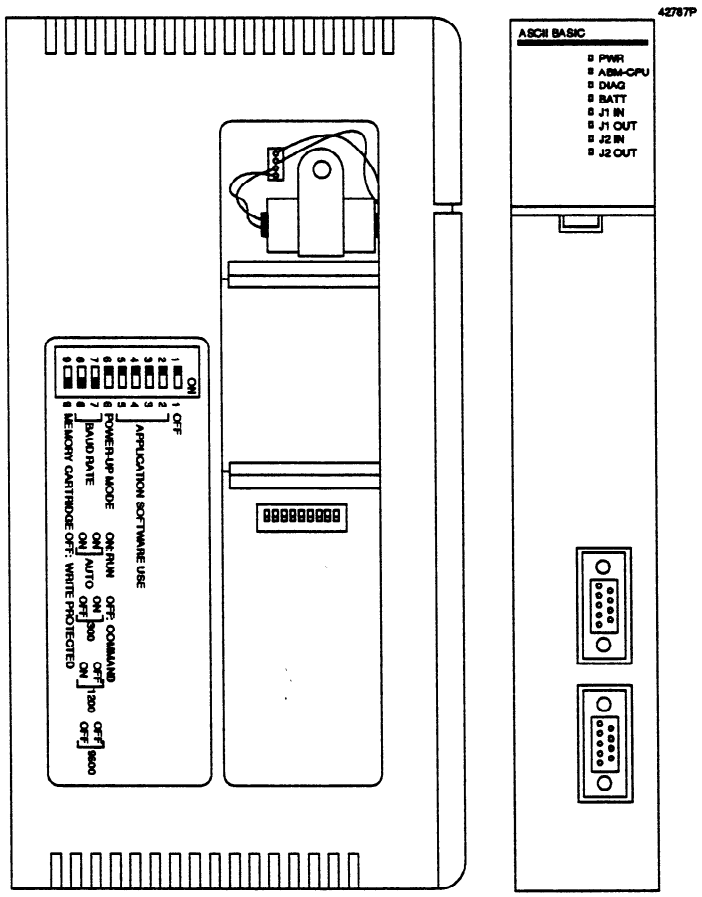

Figure 2-26. Series Five PLC ASCII/BASIC Module

General Specifications

General specifications for the Series Five ASCII/BASIC module are as follows:

Operating Temperature	0°C to 60°C (32°F to 140°F)
Storage Temperature	-20°C to 70°C (-4°F to 158°F)
Humidity	5% to 95% (non-condensing)
Power requirements	600mA from 5 V dc supply
Environment	No corrosive gases
Meets Agency Standards For:	
Radio Frequency Interference	FCC Class A, part 15, subpart J
Shock	Mil-std 810C method 514.2, rank F JIS.C 0912 10 G
Vibration	Mil-std 810C method 516.2 JIS.C 0912 10 G
Noise Immunity	NEMA ICS3-304 RFI - 150, 450 Mhz Impulse 1000 V, 1 µs pulses
Clock Rate	9.8304 Mhz
Memory	32K RAM, Battery backed, plus 24K EPROM/RAM cartridge, Battery backed (same cartridge used by Series Five CPU).
Battery	Lithium (catalog number IC655ACC550), replaceable
Battery Life	One year, worst case. Three years, typical. Battery should be replaced within one week of the BATT indicator turning on. Once the battery has been removed from the module, it must be replaced within thirty minutes to ensure that RAM memory contents are maintained.
BASIC Language	Intel® MCS® BASIC-52, with additional commands by GE Fanuc.
Communications	Through built-in RS-232 and RS-422 Serial Ports
Baud Rates	300 to 19,200 baud, selectable through programming
Diagnostic/Status	LEDs controlled by CPU with additional LEDs controlled by user's BASIC program.

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ASCII/BASIC Module Communications

The ASCII/BASIC module has two built-in serial communications ports, which give it the ability to interface to virtually any ASCII device. These devices can be dumb CRT terminals, printers, modems, robots, other ASCII/BASIC Modules, and numerous other serial devices. The ASCII/BASIC module, under control of the resident BASIC programming language, can access most of the Series Five internal memories.

ASCII/BASIC Module Configuration

No addressing has to be done on the ASCII/BASIC module, the DIP switches on board are only related to the mode of operation (e.g., baud rate, Power-Up mode, etc.). Multiple modules may be included in a system as long as the load on the rack power supply is not exceeded.

BASIC Language

The BASIC language for this ASCII/BASIC module is a subset of the Intel MCS BASIC-52, with additional commands provided by GE Fanuc. These additional commands provide the ability to perform string comparison, calculate string length, perform other string manipulations, renumber BASIC program lines, change baud rate, and reliably transfer data between the CPU and the ASCII/BASIC module. Revision C and later ASCII/BASIC modules provide additional string, interrupt, and communication buffer functions.

Modes of Operation for Memory Use

Initially, the ASCII/BASIC module comes with 32K byte battery backed RAM on board. There are two memory cartridges available to allow memory expansion: one cartridge (catalog number IC655MEM501) gives you a total of 56K of battery-backed RAM for BASIC programs, and a 24K EPROM cartridge (catalog number IC655MEM512) for permanent program storage. The EPROM is programmed while installed in the ASCII/BASIC module.

ABMHelper2

ABMHelper2 is designed to run at 9600 baud using communications port 1. If you have an application where these parameters *cannot* be used, contact your GE Fanuc Applications Engineer for help. Note that ABMHelper2 cannot run at 19200 baud, but the ASCII/BASIC module can.

For detailed information on the Series Five ASCII/BASIC Module, refer to GFK-0269, which is the *Series Five PLC ASCII/BASIC Module User's Manual.*

Axis Positioning Module

The Axis Positioning Module (APM), catalog number IC655APU521, for the Series Five™ PLC is a low cost, intelligent, programmable, easy to use single axis positioning controller integrated into the Series Five PLC I/O system. This controller is ideal for simple point-to-point positioning tasks, and provides programmable velocity and acceleration parameters. Position commands are programmed in incremental or absolute mode in any units convenient to the user (scaling is performed in the module, not in the CPU logic program). Velocity override can be changed in the middle of a move.

The positioning can be controlled automatically through programming in the Series Five PLC, or manually using jog switches, Logicmaster™ 5 programming software, or the Operator Interface Unit (OIU) for the Series Five PLC.

PLC Interface

The data interface from the APM to the Series Five PLC uses the RD DEV and WR DEV instructions, and is easy to apply. The APM also uses 16 input and 16 output points which are used to activate the various functions, and to report module status.

When used for automatic operation, the CPU user logic sends data representing desired position, velocity, velocity override, and acceleration values. After initiating the move, the CPU passes control of the move to the APM. The APM controls acceleration to the desired velocity, maintains that velocity, then controls deceleration to the desired new position. The APM then informs the CPU that the move has been completed.

APM Hardware Features

The module is designed to handle incremental A Quad B encoder positioning inputs (to 100K PPS, ± 6 digits), and provide an analog servo output (± 10 volts) to the controlled axis. The module also contains built-in discrete interfaces for limit switches and servo control and sensing.

The front panel provides connection points to the servo and controlled machine, and contains 32 status LEDs for setup and troubleshooting use. Servo adjustment potentiometers are also available on the front panel.

Module DIP switch settings can be read by the CPU's logic program to allow the program to check for correct module setup.

Multiple APMs can be used in the same Series Five PLC system.

VolksMotion Program

A software program - the VolksMotion demonstration/training software program is available for use on a Series Five ASCII/BASIC Module (ABM) interfacing with a personal computer as a control panel. This program provides a user friendly mechanism to help learn the APM, and determine correct APM/Axis parameter setups. This software is available by ordering catalog number IC641GBE665. Both 5.25 inch and 3.5 inch diskettes are included in this package. Refer to Appendix C for detailed information on the VolksMotion program.

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APM Features, Benefits and Modes of Operation

The following table is a list of the features of the APM, benefits to the user, and general description of the modes of operation. For more detailed information, refer to the Axis Positioning Module User's Manual, GFK-0449.

Table 2-9. APM Features, Benefits, and Modes

Can be used in any I/O slot:	Multiple APMs can be used in the same system.
Programmable Acceleration and Deceleration Ramps:	Maximizes drive capabilities, and improves system performance.
Absolute and Incremental Positioning Modes:	Provides user programming flexibility.
Front Panel Servo Adjustments:	Allows quick adjustment of parameters without reprogramming.
Front Panel Status Indicators:	Simplifies debug as well as initial setup.
Jog Modes	Allows manual as well as automatic positioning.
User Defined Positioning Units:	The position commands can be programmed in any units convenient to the user. Scaling is done internally by the module.
Normal Mode:	The CPU sends parameters for new position, velocity, and acceleration. After the autostart signal is received, the module accelerates at its programmed rate to its programmed velocity. The module then decides the point at which deceleration must begin to reach "in-position".
Override:	Override allows the programmed velocity in automatic mode to be overridden in 1% increments. The velocity may be changed by the CPU logic program at any time during the move by changing the override pointer value.
Find Home Position Mode:	A preprogrammed sequence which causes the APM to search for the home position switch, and sets the home position to any desired value within the programming range of the system.
Sink or Source Connections:	Allows flexibility in wiring of the machine, servo, and encoder.

General Specifications

The following table is a list of general specifications for the APM.

Table 2-10. General Specifications

Operating Temperature	0° to 60°C (32 to 140°F) (at outside of rack, no fans or forced air required)
Storage Temperature	-20° to 70°C (-4 to 158° F)
Humidity	5% to 95% (non-condensing)
Environment	no corrosive gases
Dielectric Withstand	1500 VAC for one minute
Insulation Resistance	>10 Mohms @ 500 VDC (between chassis and power source)
Meets Agency Standards for:	
Showering Arc Test	NEMA ICS 2.230.40
Shock	Mil-std 810C method 516.2 JIS.C 0911 11 B
Vibration	Mil-std 810C method 514.2 JIS.C 0912 10 G
Radio Frequency Interference	FCC Class A, part 15, subpart J
Insulation resistance	1500 VAC Hipot
Noise Immunity	Sanki 1 mSec, 1 KV pulses
Maximum Wire Size (With Faceplate Cover on and all wires connected)	One AWG #16 or Two AWG #18 with 1/4″ spade lugs.

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Functional Specifications

This table contains a description of the functional specifications and operating parameters for the APM.

Table 2-11. Functional Specifications

Number of controlled axes per module	1
Physical range of control	±999,999 encoder pulses
Programming range	Up to ±6 digits (±999,999 with no scaling in effect)
Feedback device	incremental encoder (A quad B)
Servo Output voltage	0 to ±10 VDC maximum into 10K ohms (maximum)
Positioning format (write or read)	Absolute or incremental
In position zone	Selectable for ±1 to ±99 units, set with DIP switches or programmed by CPU.
Position loop gain	20 to 50 x 1/Sec, in 2 x 1/Sec increments, adjusted by front panel rotary switch
Positioning feedback pulse rate	Maximum 100K PPS (Pulses Per Second)
Position scaling	Up to 6 digits (999,999)
Feedback pulse multiplication	X1, X2, X4
Velocity range	
In AUTO mode	1% to 100% of maximum velocity in 1% steps
In MANUAL (jog) mode	1% to 100% of maximum velocity in 1% steps
FIND HOME mode	Programmable coarse and fine velocities (1% to 100%)
Velocity Override	10% to 100% in 1% steps, up to 10 programmable values available at any time during the move
Minimum velocity	Equivalent to 100 PPS from encoder, actual axis speed depends on encoder PPR (Pulses Per Revolution) and gearing to axis
Acceleration	20 ms to 2000 ms to reach programmed speed, programmable in 20 ms steps
Delta position calculation rate	10 ms
Interface to PLC	32 bit data through Series Five CPU's RD DEV and WR DEV commands, and discrete I/O points
I/O assignment	Module uses 16 input points and 16 output points
CPU diagnostics for the APM	R4080 will report loss of 24V power, I1- status bits are not used.
Error indications	Front panel LEDS and APM error registers available for reading by the CPU.
Power requirements	From internal supply, 5V at 500 mA
	From external supply, 24 VDC at 100 mA
Compatibility	Series Five PLC CPU version D or later is required. version B or later is required.

Features of the APM

The following illustration shows the faceplate of the APM with the I/O terminal board cover removed.

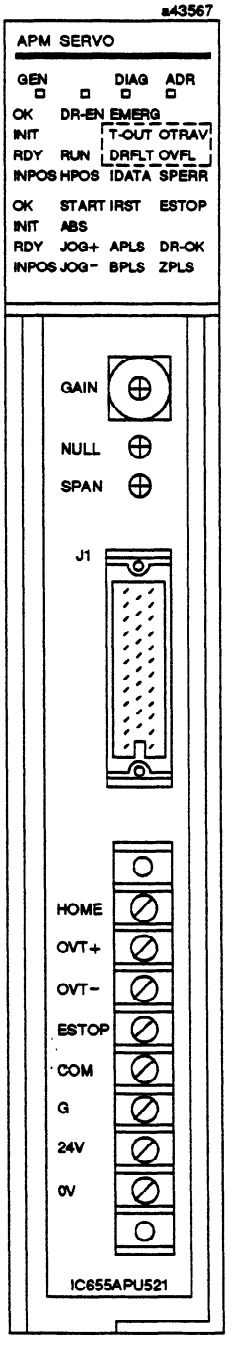

Figure 2-27. APM Features and User Items

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High Speed Counter

The High Speed Counter (HSC) module, catalog number IC655APU510, allows the Series Five PLC to monitor and control a variety of process variables (position, velocity, flow rate) that the Series Five CPU cannot accommodate because of timing constraints. A direction sensing encoder is typically used to interface the module's counter with the process variable, however other devices which meet the application needs and the module's I/O specifications may also be used. Encoders of this type represent clockwise and counterclockwise motion with two separate pulse trains that increment and decrement the current value of the counter.

The High Speed Counter has two count Input channels, with the function of the channels selected by setting a DIP switch. One open collector output is provided so that the module can react immediately when specific preset values are reached, without intervention by the Series Five CPU.

The High Speed Counter module can be installed in any I/O slot in the CPU base unit or in an I/O expansion base unit, and uses 16 Input and 16 Output references to interface with user logic. Characteristics for the module are listed in the following table. For more detailed information, refer to the High Speed Counter User's Manual, GFK-0355.

Table 2-12. High Speed Counter Characteristics

Counter Range	± Eight BCD digits (the sign is available through an Input reference, therefore it is possible to read negative count values but not write negative preset values)
Counter Modes	Up/down preset counter and Up/down ring counter
Parameters	Write: Preset value register and Count buffer register Read: Current value register
Count Speed	50 Khz
Input Modes	Count up and count down inputs A quad B incremental encoder inputs
I/O references	Five output references used (occupies 16 output references) Eight input references used (occupies 16 input references)
Count Inputs	5 V, 12 V, 24 V dc, either differential Positive Logic, or Negative Logic (source or sink)
Control Inputs	5 V, 12 V, 24 V dc, either Positive Logic or Negative Logic (source or sink)
Equal output (external)	Positive or Negative Logic (source or sink) 0.3 A, 40 V dc latched

Module Features

The following illustration shows the features of the High Speed Counter module. These features are described following the illustration.

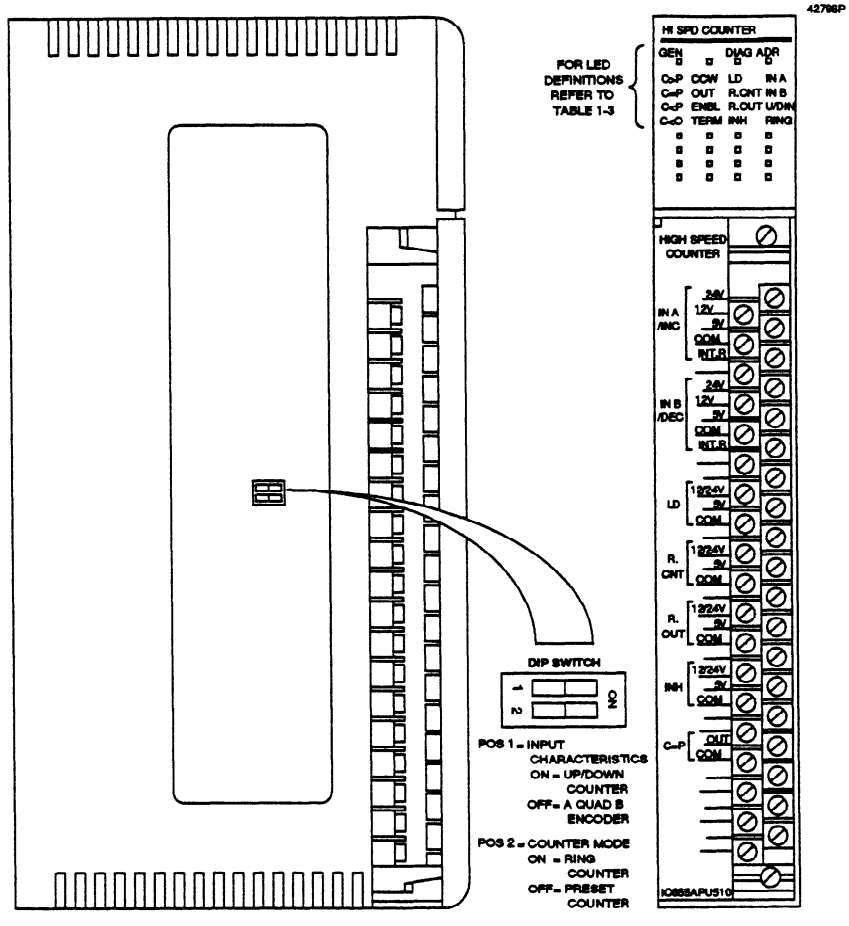

Figure 2-28. High Speed Counter Features

Function of DIP Switches 1 and 2

There are two DIP switches mounted on the module's circuit board assembly. DIP switch 1 selects the input characteristics of the High Speed Counter, and DIP switch 2 selects the counter mode of operation.

Table 2-13. Input Characteristics and Counter Mode Selections

DIP SWITCH	ON	OFF
DIP Switch 1 Input Characteristics	Up/Down Counter	A Quad B Encoder
DIP Switch 2 Counter Mode	Ring Counter	Preset Counter

Input Characteristics

- Up/Down Counter (DIP Switch 1 ON)
  - If this Input Characteristic is selected, the *IN A* input causes the current count register to count up (increment) when receiving pulses. Pulses received at the *IN B* input will cause the current count register to count down (decrement).

- A Quad B Encoder (DIP Switch 1 OFF)
  - When this Input Characteristic is selected, the *IN A* and *IN B* inputs are used to connect an incremental encoder which provides two separate pulse trains (90° phase shift). The High Speed Counter module senses the direction (clockwise or counter clockwise) of the encoder and increments or decrements the Current Count register accordingly.

Counter Modes

- Ring Counter (DIP Switch 2 ON)
  - When this mode is selected, the counter increments until the Current Count equals the Preset value. When this happens, the *COUNT = PRESET* flag is set and the Current Count register resets to 0 (zero). The next pulse will cause the to again begin recording count pulses and the register will contain a 1 (one), and will continue incrementing.

- Up/Down Preset Counter (DIP Switch 2 OFF)
  - Selection of this mode allows Up or Down counting in the range of -9999 9999 to +9999 9999 Binary Coded Decimal (BCD).

NOTE

Only positive values in the range of 0 to +9999 9999 (BCD) can be preset in the High Speed Counter, although counting can occur throughout the ± range.

General Specifications

General specifications for the High Speed Counter module are provided in the following table.

Table 2-14. General Specifications

Operating Temperature	0°C to 60°C (32°F to 140°F)
Storage Temperature	-25°C to -85°C (-13°F to 185°F)
Humidity (non-condensing)	20% to 95%
Environmental Considerations	No corrosive gases
Meets Agency Standards for:	
Vibration	MIL-std 810C, Method 514.2
Shock	MIL-std 810C, Method 516.2
Dielectric Resistance	1.5 KVAC for 1 minute between module housing, output and input 2 KV between primary side and secondary side of photocoupler Leakage current: 1 mA
Insulation Resistance	At 500 V dc, greater than 100 MΩ between module housing, output and input
Noise Immunity	NEMA ICS3-304 Impulse: 1 µsec, 1 KV pulses (Sanki test) Noise applied to power source line and I/O points
Radio Frequency Interference	FCC Class A, part 15, subpart J
Dimensions	1.57 x 9.84 x 5.12 inches 40 x 250 x 130 millimeters
Weight	17.64 oz (500 g)
Internal Power Consumption	5 V dc, 100 mA
Power Failure Back-up	24 Hours (super capacitor)

High Speed Counter Module Installation

The High Speed Counter module requires only a single slot in a base unit. It can be installed in any I/O slot in a CPU base unit or I/O expansion base unit. A High Speed Counter uses 16 Input and 16 Output references in the Local or Genius I/O Status Tables to interface with user logic.

When installing a High Speed Counter module, the internal power consumed by the module must be added to the current requirements of all other modules installed, or that will be installed in a base unit. The user must ensure that the total current required by all modules in a base unit does not exceed the current supplied by the base unit's power supply. A High Speed Counter module consumes 100 mA of current at 5 V dc. Multiple High Speed Counters may be installed in a system.

After the module is installed, it must be assigned an address.

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Programming the Series Five PLC

The Series Five PLC is programmed using Logicmaster™ 5 Programming and Documentation Software. Logicmaster 5 software uses serial communications with the Series Five PLC and runs on a Workmaster II or Cimstar I computer, an IBM PC, PC-XT, PC-AT, PS/2; or on most IBM-compatible personal computers.

NOTE

When the term IBM PC is used in this manual, the information also applies to the XT, AT, and PS/2 PCs, unless otherwise indicated. However, operation with IBM-compatible personal computers is not assured.

With a completed program transferred to a Series Five CPU and successfully compiled, the software can then be used to monitor program execution and communicate certain operator changes to the program. The software allows communication over long distance and to more than one CPU.

Using Logicmaster 5 Software with a Workmaster II Computer

The Logicmaster 5 systems application software is completely compatible and portable from previous PLC applications programmed with a Workmaster computer to the Workmaster II computer. Any previous application ladder logic programs for Logicmaster™ 5 software may be installed and run on the Workmaster II computer without modification.

Diskette Types

The Workmaster II computer is equipped with a 3.5 inch, 1.44 Mb diskette drive (1.44 is printed on the eject button). This drive uses 2.0 Mb capacity (HD) and 1.0 Mb capacity (2DD) diskettes.

- 1.0 Mb capacity, stores 720 Kb of data. (compatible with the earlier Workmaster computer 720 K floppy diskette)
- 2.0 Mb capacity, stores 1.44 Mb of data.

Ports and Cables

Interface compatibility for the Workmaster II computer has been maintained. The serial port is fully programmable and supports asynchronous communications. The 25-pin D-shell, connector interfaces to standard RS-232 devices. The 25-pin, D-shell, parallel port, is used primarily for printers.

To run Logicmaster 5 software with the Workmaster II computer, the Workmaster II computer must have the following:

- GE Fanuc DOS version 1 (equivalent to MS-DOS 3.2). For a hard disk system, this DOS version should be copied to the hard disk.

NOTE

DOS software must be ordered as a separate line item.

Communicating with the Series Five PLC

Logicmaster 5 software communicates with the Series Five PLC over a serial communications channel. The Workmaster II computer connects to the CCM port in the Series Five CPU. Communication is possible over a long distance, using a wide range of baud rates, with or without modems. The system can communicate with one CPU, or be used in a multidrop configuration with up to eight CPUs.

Serial Port Connection

Point-to-point serial communications at distances up to 50 feet with the Series Five CPU is made through a serial cable connected to the CCM port on the Series Five CPU to the 25-pin serial port on the Workmaster II computer. Connection at the Workmaster II computer is made to the 25-pin serial port located on the back of the Workmaster II computer.

NOTE

The available serial cable (IC655CBL54) can be used with a converter plug assembly (IC647ACV103) for connection to the Workmaster II 25-pin serial port.

For more information on using Workmaster II, refer to GFK-0401, the Workmaster II Programming Unit Guide to Operation. The following figure is an illustration of this converter plug.

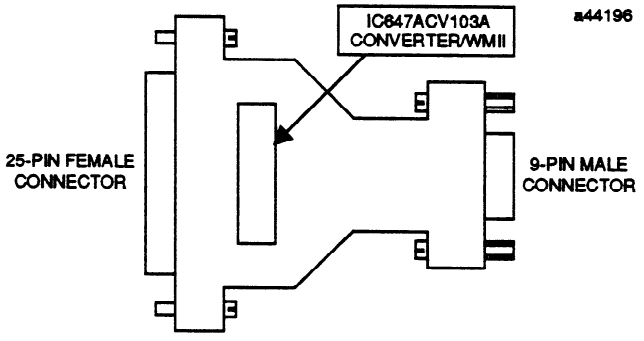

Figure 2-29. Connector Converter Assembly

If point-to-point communications over distances greater than 50 feet or RS-422 multidrop communications are used, connection must be made to the serial port on the Series Five PLC through the GE Fanuc RS-232/422 Adaptor Unit (converter box), IC655CCM590. The following figure shows a typical RS-232 serial port cable which can be used to connect a Series Five PLC to the Workmaster II computer.

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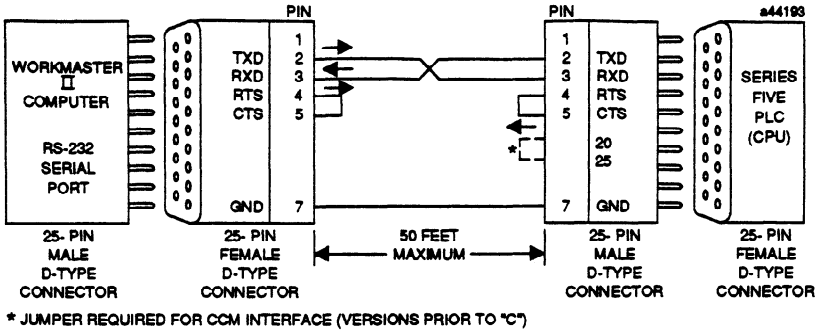

Figure 2-30. Series Five PLC Serial Port to Workmaster II

Cable Specifications

The cable assembly presents one of the most common causes of communication failure. For best performance construct the cable assembly according to the recommended connector parts and specifications.

Table 2-15. Cable Specifications

Item	Description
Mating Connector:	Serial (RS-232) Port: 25-pin female, D-Subminiature Type, Cannon DB25S (solder pot) with DB110963-3 hood or equivalent (standard RS-232 connector) Parallel (printer) Port: 25-pin male, D-Subminiature Type, Cannon DB25P (solder pot) with DB110963-3 hood or equivalent. (Printer Connector: Amphenol 36-pin male, ribbon-type connector)
Cable:	24 AWG (minimum) -- Overall shield 50 feet (15 meters) maximum cable length for RS-232 4000 feet (1200 meters) maximum cable length for RS-422 The following cables provide acceptable operation for data rates up to 19.2 Bbps and 4000 feet for RS-422. Belden 9184 Belden 9302 or NEC 222P1SLCBT At shorter distances (under 1000 feet, 300 meters) almost any twisted pair or shielded twisted pair may be used for RS-422 operation. Twisted-pair cable is not recommended for RS-232 operation.

Using the Cimstar I Computer with a Series Five PLC

The Cimstar I Industrial computer can also be used as the programming device for the Series Five PLC. The Cimstar I computer was designed to interact with PLCs and other automation equipment in the industrial environment. It is the industrial equivalent of the IBM PC AT. The Cimstar I computer has a rugged frame and can be mounted in a 19″ rack or panel mounted in a standard 10″ deep enclosure. The system is modular with each module or board enclosed in its own steel shroud. Modules are easily installed or removed. Cimstar I computer configuration options can include one or two 20 M Byte hard disks (total of 40 M Bytes per system), and four diskette drives, which can be any combination of 5.25″ or 3.5″ drives. Both standard and enhanced Workmaster/Logicmaster style keyboards can be used as console devices for entering and editing programs.

Refer to GFK-0023, the Logicmaster 5 Programming and Documentation Software User's manual, and GEK-90527, the Cimstar I Industrial Computer Reference Manual, for further information on the Cimstar I computer hardware requirements and use.

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Using Logicmaster 5 Software with a Cimstar I Computer

The Logicmaster 5 software, when installed in a Cimstar I computer, communicates with a Series Five PLC over a serial communications channel to the CCM port in the Series Five PLC. Communication is possible over a long distance using a wide range of baud rates, either with or without modems. The system can communicate with a single CPU, or be used in a multidrop configuration having up to eight CCM modules and CPUs.

Programming a Series Five PLC with an IBM PC

The IBM PC version of the Logicmaster 5 software is used to program a Series Five PLC when it is installed in an IBM PC, IBM PC-XT, or IBM PC-AT computer that meets the following requirements:

- 640K total available programmer memory (RAM).
- PC-DOS version 2.1 or 3.1 for the IBM PC and PC-XT. PC-DOS version 3.1 or
- 3.2 for the IBM PC-AT.
- Either a color or monographics monitor adapter card. The software will also support the Enhanced Graphics Adaptor (EGA) card.

Using Logicmaster 5 Software with an IBM PC

Logicmaster 5 software for the IBM PC version is available as a set of three 5 1/4" 360K diskettes. Performance of the software with other versions of DOS or on other IBM PC-compatible computers is not guaranteed. The system supports the IBM monochrome adaptor board and the asynchronous communications adaptor board. *Serial communications adaptors NOT based on the 8250 UART may not operate properly..*

An IBM PC-based Logicmaster 5 system communicates with a Series Five PLC through its serial port, to the CCM port in the Series Five CPU. The IBM PC version of Logicmaster 5 software communicates and functions in the same way as does the serial version for the Workmaster computer. The available Series Five to Workmaster cable will not work properly with an IBM PC-AT or AT compatible personal computer. If an IBM PC-AT compatible personal computer is to be used as the programming device, it is recommended that a cable be built, as shown in the first figure below. A PC-XT requires a cable as shown in the second figure.

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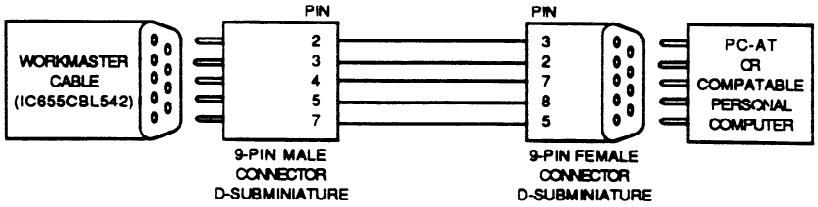

Figure 2-31. Cable for Series Five PLC to PC-AT Computer

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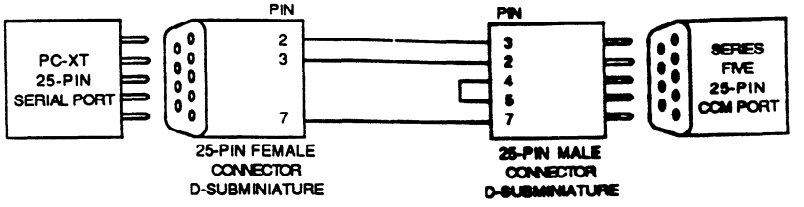

Figure 2-32. Cable for Series Five to PC-XT Computer

Accessory Kit for the Series Five PLC

An accessory kit (IC655ACC520) is available to support the Series Five PLC. This kit contains many of the most commonly used components that may get damaged or lost during normal operation, such as fuses, screws, terminal covers, etc. Rather than attempting to order all of these parts separately, this kit provides a convenient means of ordering and storing these parts. Each kit should be sufficient to support several PLCs, depending on their I/O count. Items included in the kit are listed below.

Table 2-16. Accessory Kit

Item	Quantity in Kit
CPU keys	2 sets (2 keys per set)
CPU door, with CCM hinged door and OIU port cover	1
I/O wiring labels for inside faceplate, 16/32 pt	50 of each type
Plastic bead chain (I/O faceplate to module)	20
Screws/washers, all sizes	10 of each
Dust covers for I/O bus port connector	4
Dust covers for I/O expansion port connector	2
Fuses, fast blow - 2A, 3A, 3.15A, 5A, 8A	5 of each
Faceplate for I/O module	3
Faceplate for power supply	1
Module access side cover	3
Jumper bar for power supply	2
Jumper for register size configuration	2
Keying inserts for terminal blocks, 16/32 point	10 of each
Memory Cartridge labels (CMOS RAM, EPROM, EEPROM)	36 labels of each type

Chapter 3
Installation Instructions

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Introduction

This chapter contains the information required for installing a Series Five Programmable Logic Controller and preparing the system for use. Included are instructions for unpacking/packing, inspecting, installing on a panel or wall, setting internal switches, and connecting cables. A list of questions that may arise when bringing up a new system is included at the end of this chapter.

Helpful Startup Hints
For The Series Five Programmable Logic Controller

Please read this information before attempting to install your Series Five PLC. These hints are intended to make the installation and implementation of your Series Five PLC easier. This information is intended to be an aid to help you get your system up and running quickly.

YOU SHOULD HAVE RECEIVED THE FOLLOWING ITEMS WITH YOUR SYSTEM

CPU box: Contains CPU with a long-life lithium back-up battery installed, 2 keys, and I/O bus Terminator Plug.

Memory Cartridge: with back-up battery included.

Power Supply box: contains power supply and jumpers.

Base Unit box: contains base unit with connector dust covers installed.

I/O Module boxes: each box has an I/O module with faceplate cover and plastic bag containing plastic chain, terminal block keys, and self adhesive label for faceplate cover.

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- Each I/O module has a plastic zip-lock bag packed with it. ****** DO NOT ACCIDENTALLY THROW THIS BAG AWAY ****.** This bag contains a 2″ length of black plastic bead chain, plastic keys for the module terminal block with instructions for installing the keys, and a self-adhesive label which mounts on the back of the faceplate cover.
- The plastic bead chain is a safeguard to prevent a faceplate cover from being misplaced when it is removed from a module. One end of the plastic chain connects to a slot in the bottom of the faceplate cover and the other end connects to a slot at the bottom of the module.
- The plastic keys are installed in terminal blocks to key each block to a module to prevent a terminal block from being placed on the wrong type of module. Refer to the instruction sheet packed in the plastic bag for information on proper installation of the keys. Do this as soon as you unpack each module, so that modules are keyed correctly.
- Leave dust covers on connectors until the connector is to be used.

Important Items You Should Be Aware Of

- *Do not insert or remove I/O modules or memory cartridges with power on. The I/O modules or memory cartridges may be damaged if they are inserted or removed with power on.*
- Handle RAM memory cartridges with care, since excess charges of static electricity could damage the memory devices in the cartridge.
- Be sure that the source of power is correct for your power supply.
- Check position of the jumper for 115/230 V ac input on ac power supplies. *REMEMBER! 115 V ac - Requires the jumper, 230 V ac - jumper NOT needed.*
- Visually inspect all wiring - ensure that all electrical connections are tight and there are no bare wires showing which could short out or shock personnel.
- Ensure that the I/O Terminator Plug is installed on the proper I/O expansion connector. (Connector on right on CPU base unit, or the unused connector on an I/O expansion base unit).
- Check position of CPU DIP switches for proper settings.
- Check base unit ID switches for proper settings. Do not duplicate settings!
- MS™ -DOS Version 3.2 (GE Fanuc version 1.10), or later required for Logicmaster 5 operation is not included on the Logicmaster 5 diskette(s), and must be purchased separately.
- Refer to Chapter 2, Sections 1, 2, and 3 of the Logicmaster 5 Programming and Documentation Software User's Manual, GFK-0023, for Logicmaster Five startup hints.
- All screws used in the Series Five PLC have metric threads. All connectors require metric screws for connection. Spare screws are available in the Accessory Kit.

Minimum System Requirements

CPU -- Memory Cartridge -- Power Supply -- 6 or 8-Slot Base Unit -- I/O Modules -- I/O Terminator Plug -- Logicmaster 5 Programming and Documentation Software on either 3.5″ or 5.25″ Diskettes, as required -- Programming Device, which can be a Workmaster or Cimstar I Computer or an IBM PC, PC-XT, or PC-AT Personal Computer, or compatible -- Logicmaster 5 to CPU Cable

Minimum Tools Required for Installation

Screwdriver, phillips or medium flat blade (blade at least 6″ in length for mounted base units, shorter if not mounted) - for screw connections on terminal blocks and for tightening captive-screws on modules.

Screwdriver, narrow flat blade (length same as above) - for configuration of rotary switch for selection of base unit ID number.

Electric Drill and Bits - for drilling mounting holes for base unit.

™MS is a trademark of Microsoft Corporation

Installation Hints

1. Use spacers, as required, behind a base unit when mounting on an irregular surface.
2. Be sure that you select the base unit ID number by configuring the rotary switch located at the upper left of the base unit, directly over top of the left I/O Expander connector - before mounting the base unit in a panel. You may not be able to easily access the rotary switch once the base unit has been mounted.
3. When installing I/O modules and connecting field wiring:
   A. Install I/O modules one-at-a-time, and connect field wiring beginning with the right I/O slot. This will ensure that you have adequate space for connecting wires.
   B. Connect field wiring beginning with the bottom screw on the terminal block and proceeding upward to the top screw. This provides a neater looking and easier to handle wiring harness to the terminal block.
   C. The screws for electrical connections to the terminal blocks are not captive-type screws - so that they cannot be accidentally stripped. Be careful when handling these screws - DO NOT LOOSE THEM!
   D. Carefully label wires to and from field devices AND annotate the markable label for each I/O module with relevant circuit information and affix the label to the inside of the faceplate cover.
4. Ensure that the CPU back-up battery is properly connected.
5. If you want to write protect a RAM memory cartridge - it should be done at this time. Instructions can be found in Chapter 3 in this manual.
6. If register memory is to be upgraded to 16k - also do this now. Instructions can also be found in Chapter 3 of the manual.
7. Both hinged doors on the CPU are removable. If they are removed - put them in a safe place - **DO NOT LOSE THEM.**
8. When installing faceplate covers, seat the bottom first - then push in on the top of the cover until it snaps in place.

You now have the basic information required to get your Series Five PLC up-and-running. For more detailed information - continue on with Chapter 3.

Quality Control

Each Series Five PLC undergoes a thorough quality control inspection and extensive system testing before being shipped. Each part of a system undergoes environmental and operational tests before leaving the factory. If any problems should arise with a Series Five PLC system, contact GE Fanuc - NA Product Service for instructions at (804) 978-5624.

Packaging

All of the hardware components of a Series Five PLC system are shipped in individual containers. The basic hardware components of a system are:

- A base unit or base units, with quantity determined by the size of your system.
- A power supply module, either ac or dc, for each base unit. CPU module
- I/O expansion cables, if required - either 1 , or 3 feet in length. If user constructed, can be up to 200 feet (60 meters), which is the total length for all I/O expansion cables used in a Local I/O chain.
- CPU to Workmaster cable, 10 feet in length (IC655CBL542). An adaptor plug assembly (IC647ACV103) is needed for connection to Workmaster II.
- The applicable memory cartridge, either RAM, EPROM, or EEPROM, with the required memory size.
- Local I/O Interface module, required for each I/O expansion base unit.
- I/O Terminator plug, included with the CPU, which must be plugged into the unused connector on the last base unit in the I/O chain.
- Discrete and Analog I/O modules, as required.

Inspection of Received Equipment

After receiving your Series Five PLC system, carefully inspect all shipping containers for damage incurred during shipping. If any part of the system is damaged, notify the carrier immediately. The damaged shipping container should be saved as evidence for inspection by the carrier. It is the responsibility of the consignee to register a claim with the carrier for any damage incurred during shipment. However, GE Fanuc - NA will fully cooperate with the customer should such an action be necessary.

After unpacking your Series Five PLC system, all warranty cards should be filled out and forwarded to GE Fanuc - NA. Verify that the system components received agree with your order. If there are any problems noted at this time, call GE Fanuc - NA Customer Service in Charlottesville, VA, at (804) 978-6359 for assistance.

Any peripheral equipment, including the Workmaster or Cimstar I industrial computer is packed in a separate shipping container. It is recommended that the shipping containers and all packing material be saved in the event that it becomes necessary to transport or ship any part of the system.

Base Unit Installation

The following procedures are recommended when mounting a base unit. A base unit can be panel or wall mounted. The following figure shows both 6 and 8-slot base units, with dimensions required for mounting. Since base units are available with either 6 or 8 I/O slots, note the difference in the center to center dimensions for mounting (on the horizontal plane). Mounting depth of a panel should be 5.5 inches (139 mm) or deeper, if required by the module configuration installed in the base unit.

- Using the base unit as a template, mark where the four mounting holes are to be drilled.
- Drill the four mounting holes (1/4 inch (6 mm)) if using pass through bolts, or 3/16 inch (5 mm) if using tapped holes.
- Insert the two top bolts (3/16 inch x 1 1/2 inch or 5 mm by 40 mm), put the base unit in place and loosely secure with washers, lock-washers and nuts.

or

Tap holes and insert the two top bolts. Place the base unit onto the mounting bolts (do not tighten these bolts at this time).

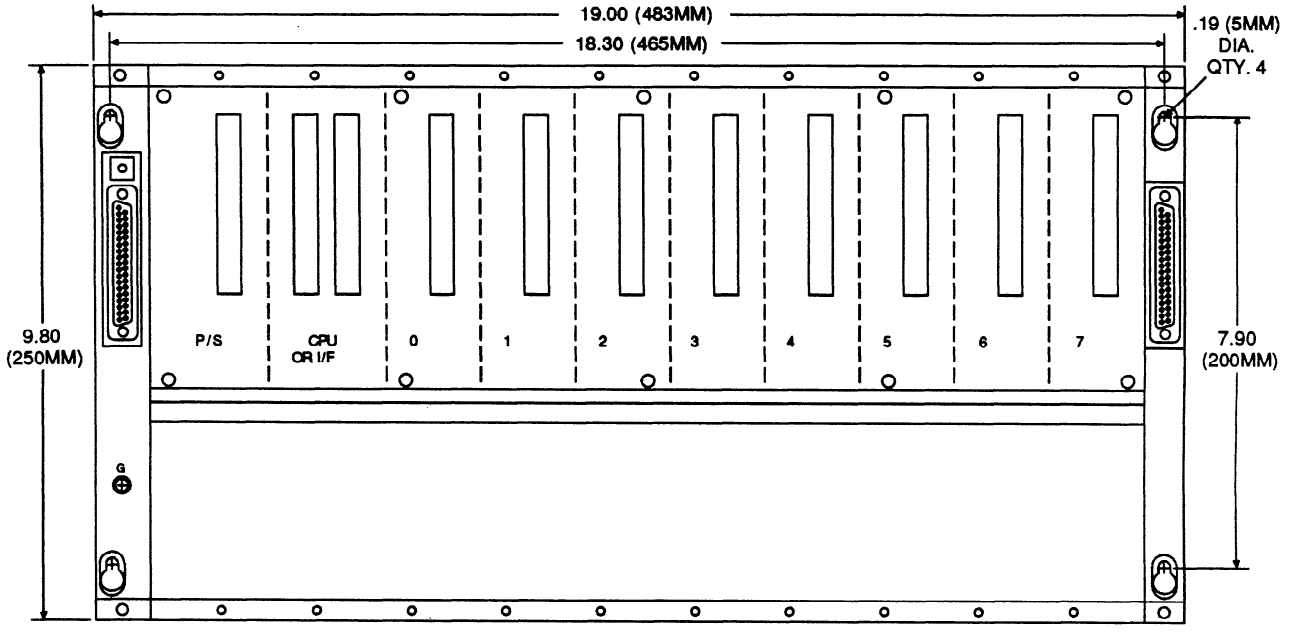
- Complete installation of the two bottom bolts and tighten all of the mounting hardware.
- If additional base units are required for I/O expansion, repeat the above steps, as required.
- If additional base units are installed, the I/O expander cable or cables should now be connected.

Catalog numbers for base units and I/O expander cables are listed below.

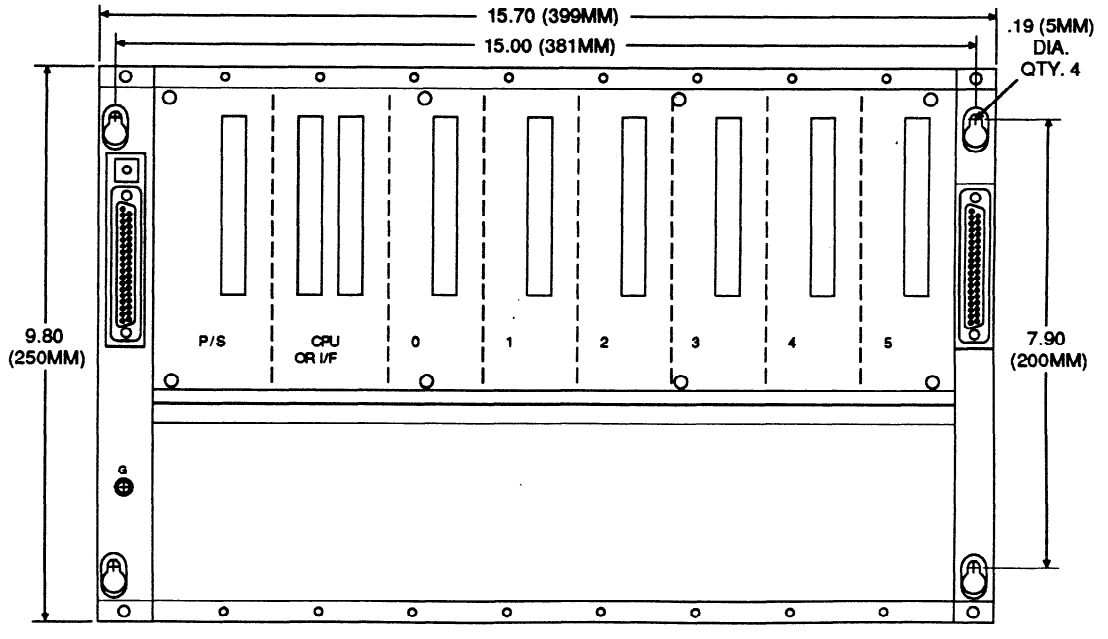
Table 3-1. Base Units and I/O Expander Cables

Catalog Number	Description
IC655CHS506	Base unit, with 6 I/O slots
IC655CHS508	Base unit, with 8 I/O slots
IC655CBL500	I/O expander cable, 1.5 feet (0.5 m)
IC655CBL501	I/O expander cable, 3 feet (1.0 m)
IC655CBL502	I/O expander cable, 15 feet (5.0 m)
IC655CBL503	I/O expander cable, 30 feet (10.0 m)
IC655CBL504	I/O expander cable, 80 feet (25.0 m)
IC655CBL505	I/O expander cable, 160 feet (50.0 m)

a42280



8 SLOT BASE UNIT



6 SLOT BASE UNIT

DIMENSIONS IN INCHES, MILLIMETERS ARE IN PARENTHESIS

Figure 3-1. Base Unit Mounting Information

Base Unit Installation in 19 Inch Racks

A set of mounting brackets (catalog number IC655ACC553) is available for adapting Series Five PLC base units for mounting in standard 19 inch racks. To install these brackets, use the following procedure:

- First mount both the left and right 19 inch rack adapter brackets to the left and right side of the front vertical rack frame using the appropriate screws.
- After mounting the brackets, mount the Series Five base unit from the rear of the rack to these brackets as shown in the following illustration.

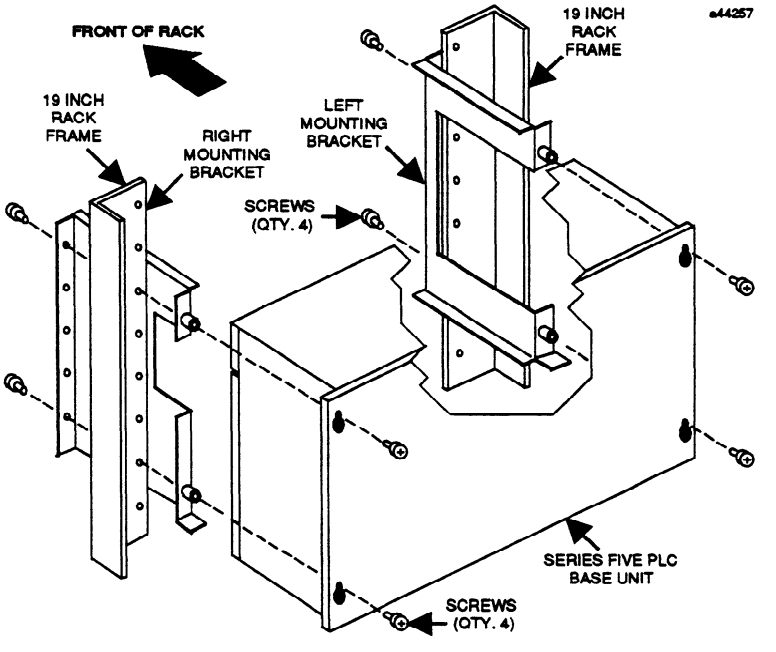


Figure 3-2. Base Unit Installation in a 19 Inch Rack

I/O Expansion Base Units

From one to eight base units can be included in a Series Five PLC Local I/O system, depending on the total number of I/O points and mix of modules required by the system. If more than one base unit is to be included in your system, they must be connected in a daisy chain. Catalog numbers for the required components of a Series Five PLC Local I/O system are listed for your information.

a42281

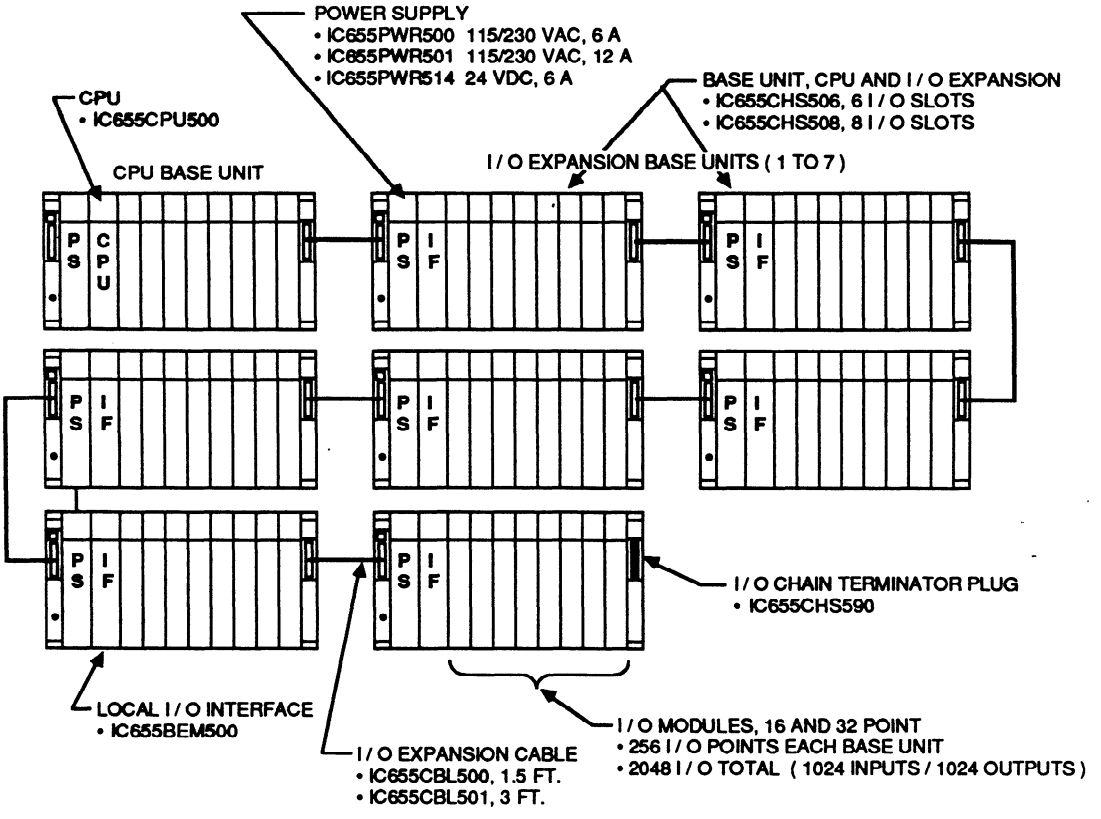


Figure 3-3. Connection of I/O Expansion Base Units

Base Unit Spacing for Proper Ventilation

When installing one or more base units in a rack or panel, sufficient space should be left around the units to provide proper ventilation and working room for wiring, maintenance or inspection. The following figure shows the recommended space between units and the mounting enclosure. A base unit can be mounted in a 5.5 inch deep panel if there are no modules requiring connectors to be attached to faceplate connectors. The depth of panels depends on the configuration of modules installed in a base unit, since modules with connectors installed on the front require a greater mounting depth.

a42282

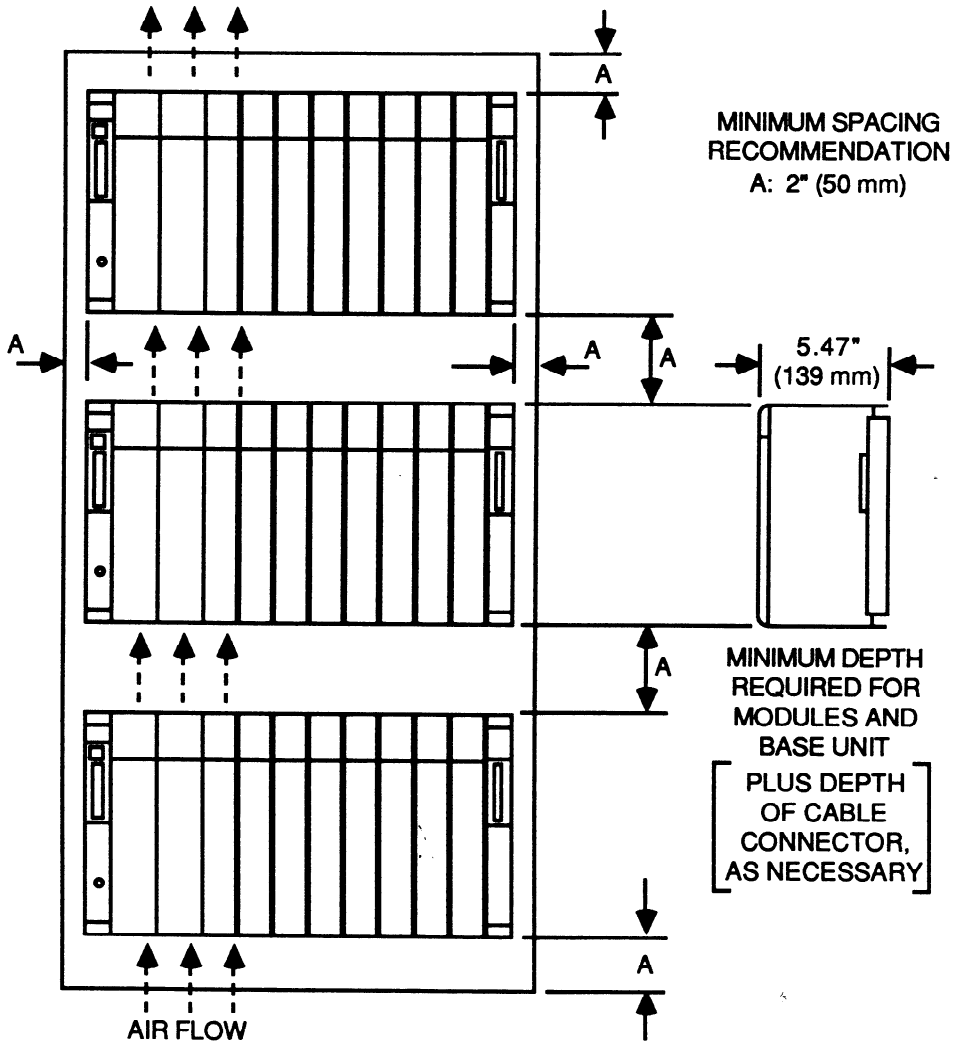


Figure 3-4. Spacing of Base Units

Setting a Base Unit Identification Number

As described in the previous chapter, each base unit must be assigned a base unit ID number. This ID number is used by Logicmaster 5 to ensure orderly communications with base units. The Identification number can be assigned in any order to meet the needs of your application. The numbers do not need to be assigned sequentially, however, the base unit containing the CPU must be assigned an ID of 0 (zero).

CAUTION

Once an Identification number has been assigned to a base unit, it must not be duplicated by assigning it to another base unit. If this were done, multiple base units would be addressed simultaneously by the CPU. A situation such as this could result in improper and erratic operation of your PLC system.

- Set the selected Identification number (0 to 7, positions 8 and 9 not used) for each base unit in the system by inserting a narrow bladed screwdriver in the slot in the small rotary switch located at the upper left side of the base unit, directly above the left I/O expansion connector, as shown in the figure below.
- Rotate the screwdriver until the desired Identification number is selected.

a42283

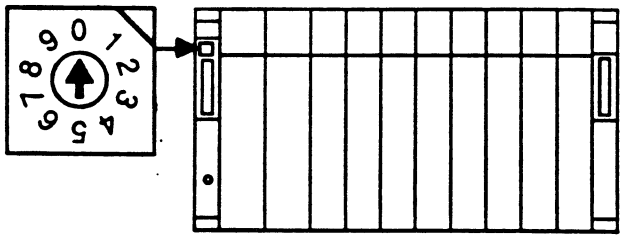


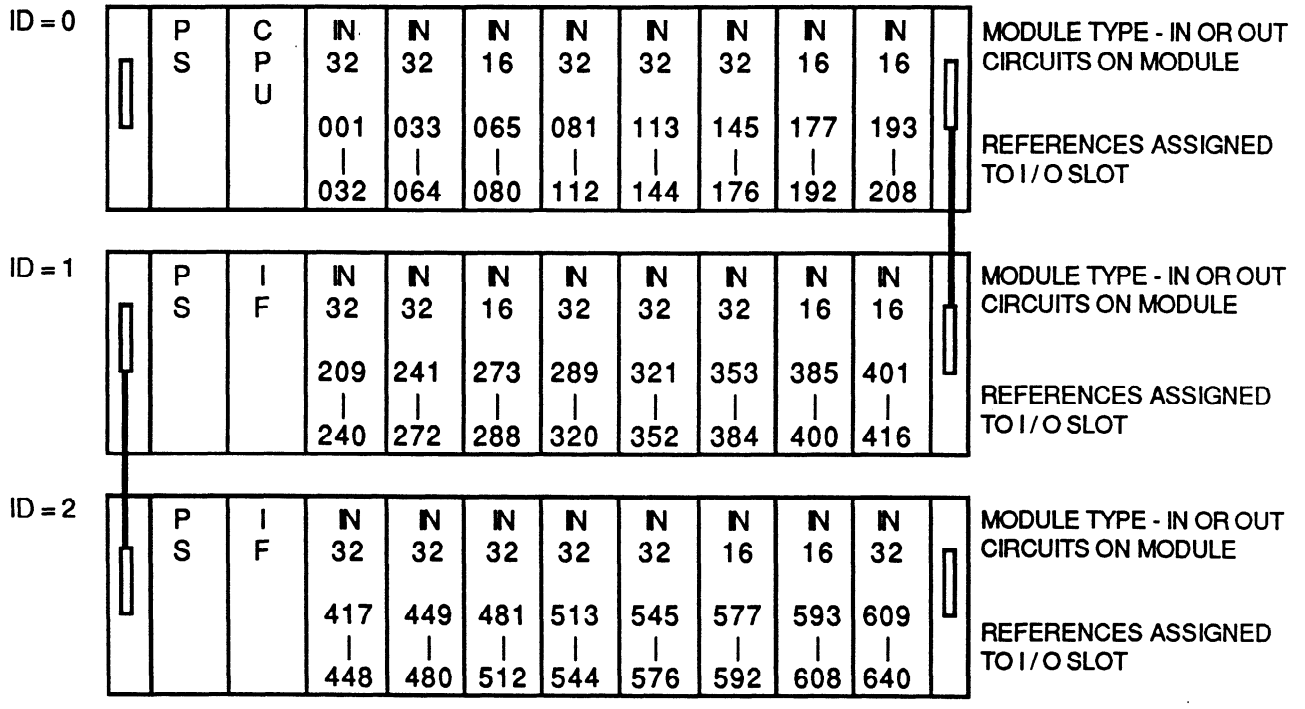
Figure 3-5. Base Unit Identification Selection

Base Unit Identification Selection Examples

The examples in the following figure show how the base unit identification number selection affects the automatically assigned I/O addresses for base units. The examples shown are for illustrative purposes only, since I/O modules can be installed in any order to suit the requirements of your application. If addresses are assigned manually by the user, which is the recommended method, they do not have to be in sequential order as shown.

a42284

EXAMPLE 1. INPUTS ONLY



EXAMPLE 2. INPUTS AND OUTPUTS COMBINED

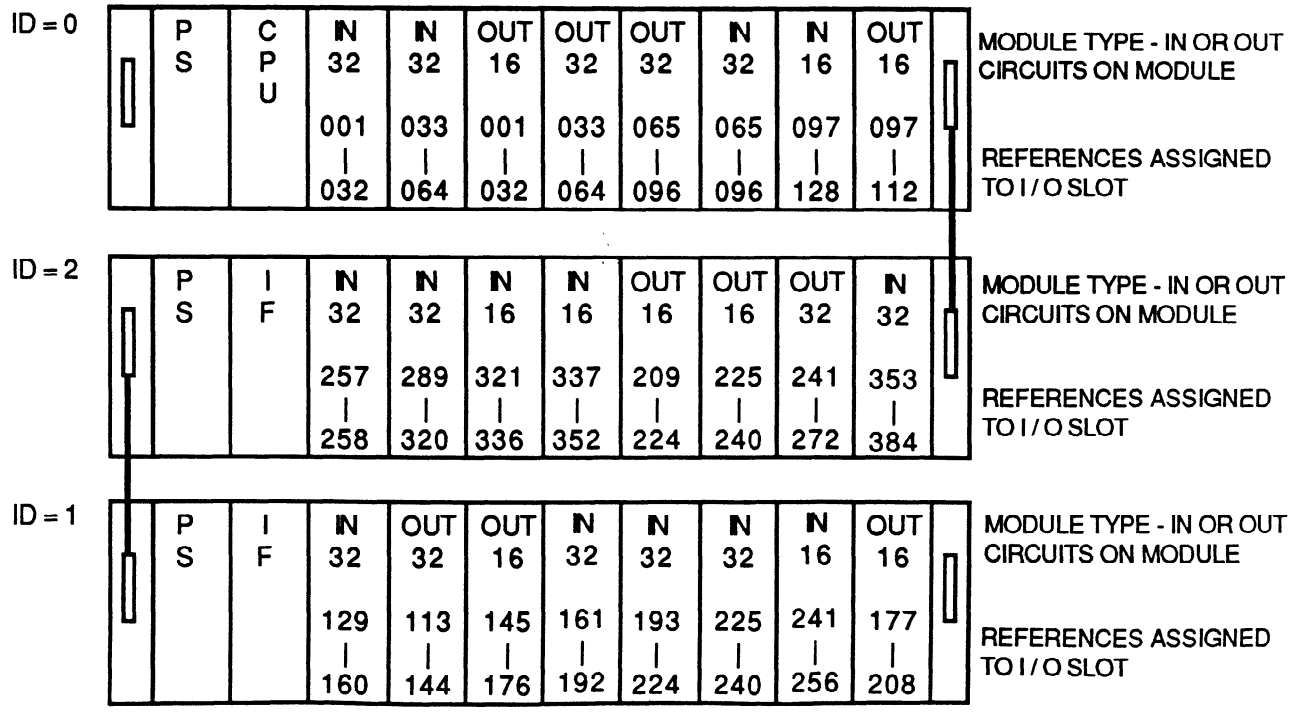


Figure 3-6. Examples of Assigned I/O Addresses

Power Supply Installation

After installing a base unit or base units, install the selected power supply (see table below) on each base unit. Power supplies must be installed in the leftmost slot in a base unit.

- Install the power supply by lining it up with the connector in the left slot and pushing it in firmly so that the connector on the back of the power supply is securely mated with the connector on the base unit.
- Secure the power supply to the base unit by fastening the two captive screw fasteners, one at the top and one at the bottom of the module, with a long, narrow bladed or phillips screwdriver.

Table 3-2. Power Supplies

catalog Number	Description
IC655PWR500	115/230 V ac Input, 6 amps (maximum)
IC655PWR501	115/230 V ac Input, 12 amps (maximum)
IC655PWR514	24 V dc Input, 6 amps (maximum)

Power Supply User Connections

A terminal block with eight screw terminals is located at the bottom right front of the power supply module. Field wiring to the power supply is made to these screw terminals. AC power wiring should be run in conduit separate from signal wiring. This will help to minimize any effects of electrical interference from the power lines. The following figure shows the power supply terminal block and the required connections.

a42285

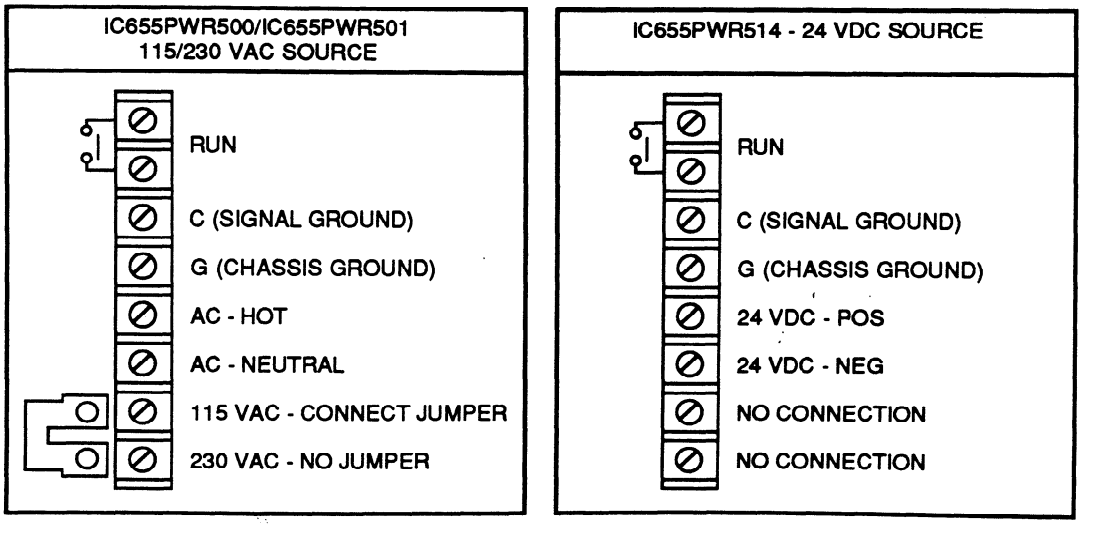


Figure 3-7. Power Supply Terminal Block

Run Terminals

- The two top terminals, labeled RUN, are connected internally to a pair of normally open contacts on the RUN relay. This set of contacts is closed when the CPU is switched to the RUN mode during normal operation. These terminals can be connected to an external device (light, alarm indicator, etc.) to indicate that the PLC has gone out of the RUN mode when certain system errors occur, such as the Watchdog Timer timing out.

CAUTION

The user device connected to the RUN Relay contacts should present a resistive load of no more than 5A or an inductive load of no more than 1.0A at 230 V ac.

Ground Connections

- The third and fourth terminals from the top are connected internally to signal ground (C) and chassis ground (G), in that order. Signal ground is connected to 0V internally and chassis ground is earth ground.
- The ground wire from an ac power source, when wiring an ac supply, connects to the chassis ground (G) terminal. A terminal jumper (supplied with the power supply) must be connected between the C and G terminals on the base unit. If more than one base unit is in a system, the terminal jumper should be connected only at the CPU (first) base unit. In the case of multiple base units with ac power supplies, it is recommended that all base units be powered from the same ac source. All of the C terminals should be connected between base units and all of the G terminals should be connected between base units.

CAUTION

When wiring ac power supplies, do not connect the terminal jumper between the C and G terminals on any base unit other than the first one to which the power source is connected. If the terminal jumpers were connected on other base units, a difference in potential between base units could cause damage to the circuit boards.

AC Power Source Connections

- The next two terminals on the block are for power source connections. When wiring an ac power supply, the first (fifth from top) of these two terminals is connected to the Hot (L1) side (black wire) of the ac source, and the lower terminal is connected to the Neutral (L2) side (white wire) of the ac source.

DC Power Source Connections

- When connecting a source of dc power to the 24 V dc power supply (source can be from 20 to 29 V dc), the fifth terminal from the top connects to the positive (+) side of the power source, and the sixth terminal connects to the negative (-) side of the power source.

115/230 V ac Selection

- The bottom two terminals on the block are used to configure the power supply to operate from either a 115 V ac power source or a 230 V ac power source. A terminal jumper, provided with the power supply, is used for this configuration.
- To select 115 V ac, the terminal jumper must be connected between the two bottom terminals.
- If the ac power source is to be 230 V ac, do not connect the terminal jumper. The following figure illustrates the correct positions for the terminal jumper for ac source voltage selection.

a42272

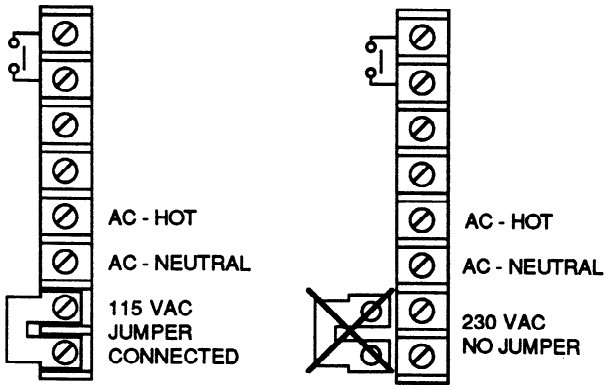


Figure 3-8. Terminal Jumper for AC Power Source Configuration

Grounding Considerations

When installing your Series Five PLC system, it is recommended that the following guidelines for grounding be followed to ensure that damage to the equipment does not occur because of faulty grounding.

- *AC Power Supplies.* The green wire (ground) from the ac power source must be connected to chassis ground (G terminal).
- *AC Power Supplies.* Chassis ground (G terminal) and signal ground (C terminal) should be tied together only at the power supply in the base unit containing the CPU.
- *AC and DC Power Supplies.* If more than one base unit in a system, all chassis grounds must be tied together at the G terminals.
- *AC and DC Power Supplies.* If more than one base unit in a system, all signal grounds must be tied together at the C terminals.

Additional Important Grounding Information

All components of a programmable control system and the devices it is controlling should be properly grounded. This is particularly important for the reasons stated below.

- SAFETY CONSIDERATIONS - A low resistance path from all parts of a system to earth minimizes exposure to shock in the event of short circuits or equipment malfunction.
- PROPER EQUIPMENT OPERATION - Some components of the Series Five PLC system require a common ground connection between racks to guarantee correct operation.

Recommended Grounding Practices

The following grounding practices are recommended to ensure proper operator safety and correct equipment operation when installing and using a PLC system.

Ground Conductors

- Ground conductors should be connected in a tree fashion with branches routed to a central earth ground point. This ensures that no ground conductor carries current from any other branch. This method is illustrated in the following figure.

a42286

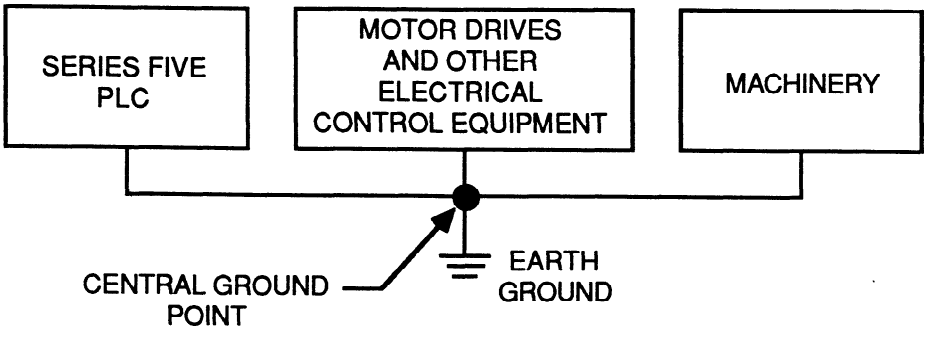


Figure 3-9. Recommended PLC System Grounding

- All ground conductors should be as short and as large in size as possible. Braided straps or welding cables (AWG No. 8 or larger) can be used to minimize resistance. Conductors must always be large enough to carry the maximum short circuit current of the path being considered.

Series Five PLC Equipment Grounding

Base Unit Grounding - Important requirements to consider when grounding Series Five PLC CPU and I/O expansion base units are listed below.

- *Safety Ground.*This connection should be made from the G terminal on the power supply terminal block directly to system earth ground. The purpose of this connection is to provide a guaranteed current path to ground in case a malfunction occurs within the base unit or the base unit is incorrectly wired. The following figure illustrates recommended wiring for the base unit safety ground.
- *Signal Ground* - **All base units that are grouped together in a Local I/O chain must have a common ground connection, i.e, they must be connected to the same power source.** This is especially important for base units in the same Local I/O chain which are not mounted in the same control cabinet. If this situation exists, the control cabinets MUST be tied together using the shortest possible connections.
- The G terminal of the base unit power supply should not be used as the signal ground connection between racks. The best way to provide signal ground connections is to ensure that the Series Five PLC base unit metal frames are connected directly to the control panels or racks in which the base units are mounted. This can be done by connecting a ground strap from the screw (labeled G) located in the lower left of the base unit to the control panel or cabinet as shown in the following figure.

a42287

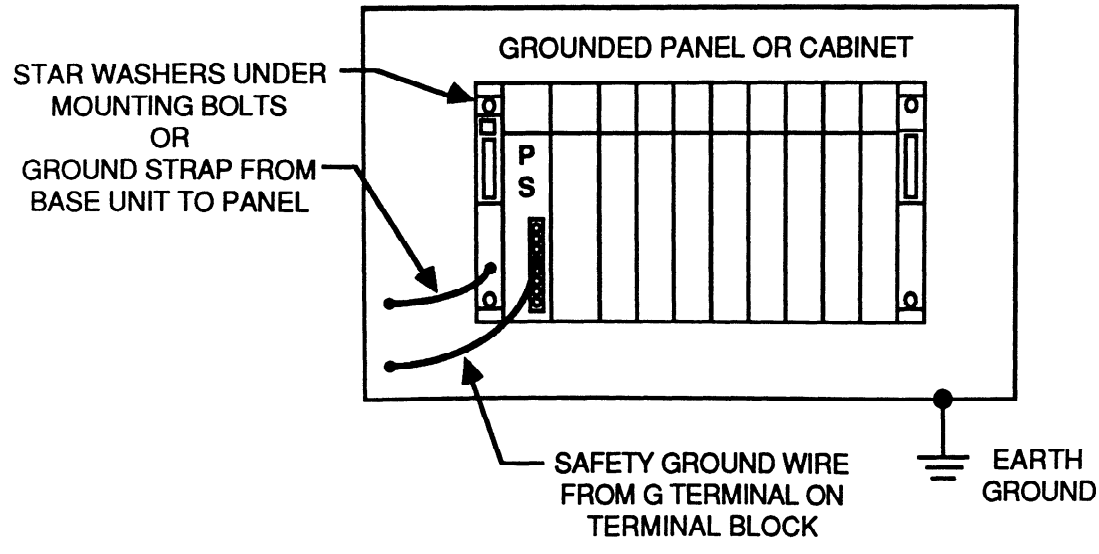


Figure 3-10. Base Unit Safety and Signal Ground Connections

Programming Device Grounding

- For proper operation, the programming device (Workmaster or Workmaster II computer, Cimstar I computer, IBM-PC, PC-XT, PC-AT, PS/2, or IBM compatible computer) must have a ground connection in common with the CPU base unit to which the programmer interface cable is connected. Normally, this common ground connection is provided by ensuring that the programmer's power cord is connected to the same power source (with the same ground reference point) as the CPU base unit as shown below.

a42288

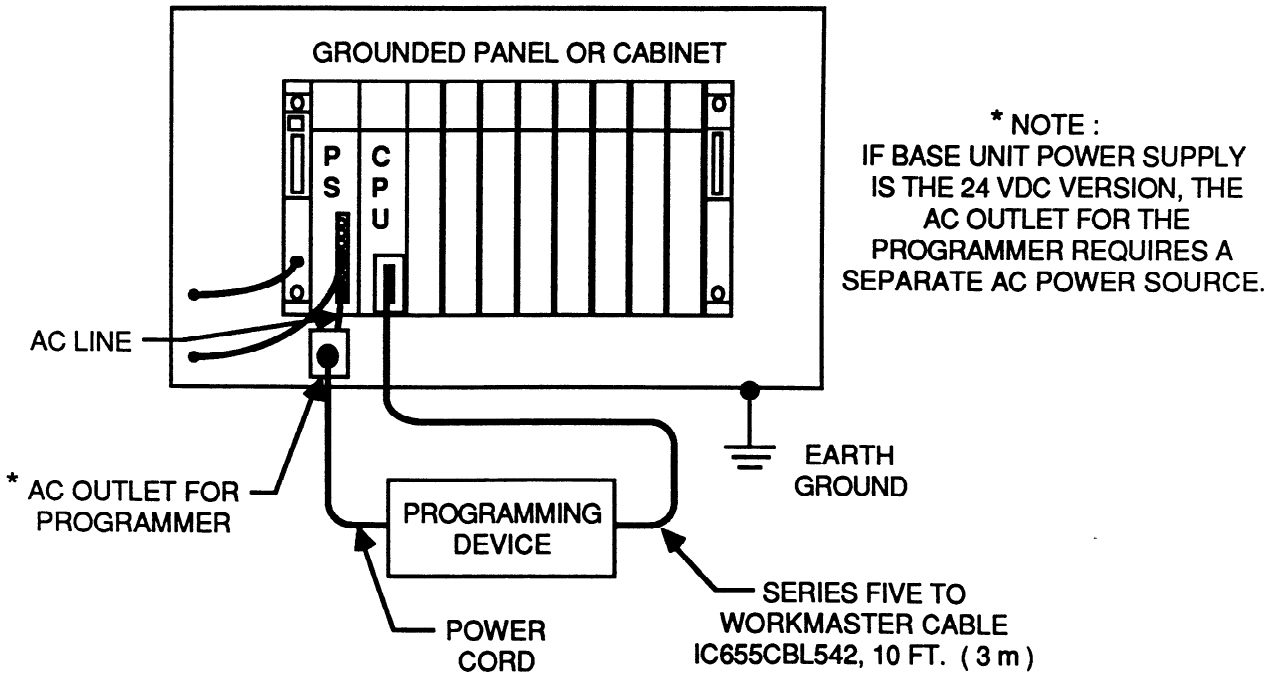


Figure 3-11. Programming Device Ground Connection

Power Source Wiring to Multiple Base Units

The following figure is an example of the proper method for connecting ac power source wiring to multiple base units. Grounding recommendations discussed in the previous paragraphs are included in the figure. A system may have both AC and DC power supplies. **All C and G terminals must be connected to both AC and DC supplies as described previously.**

GFK-0122

a42289

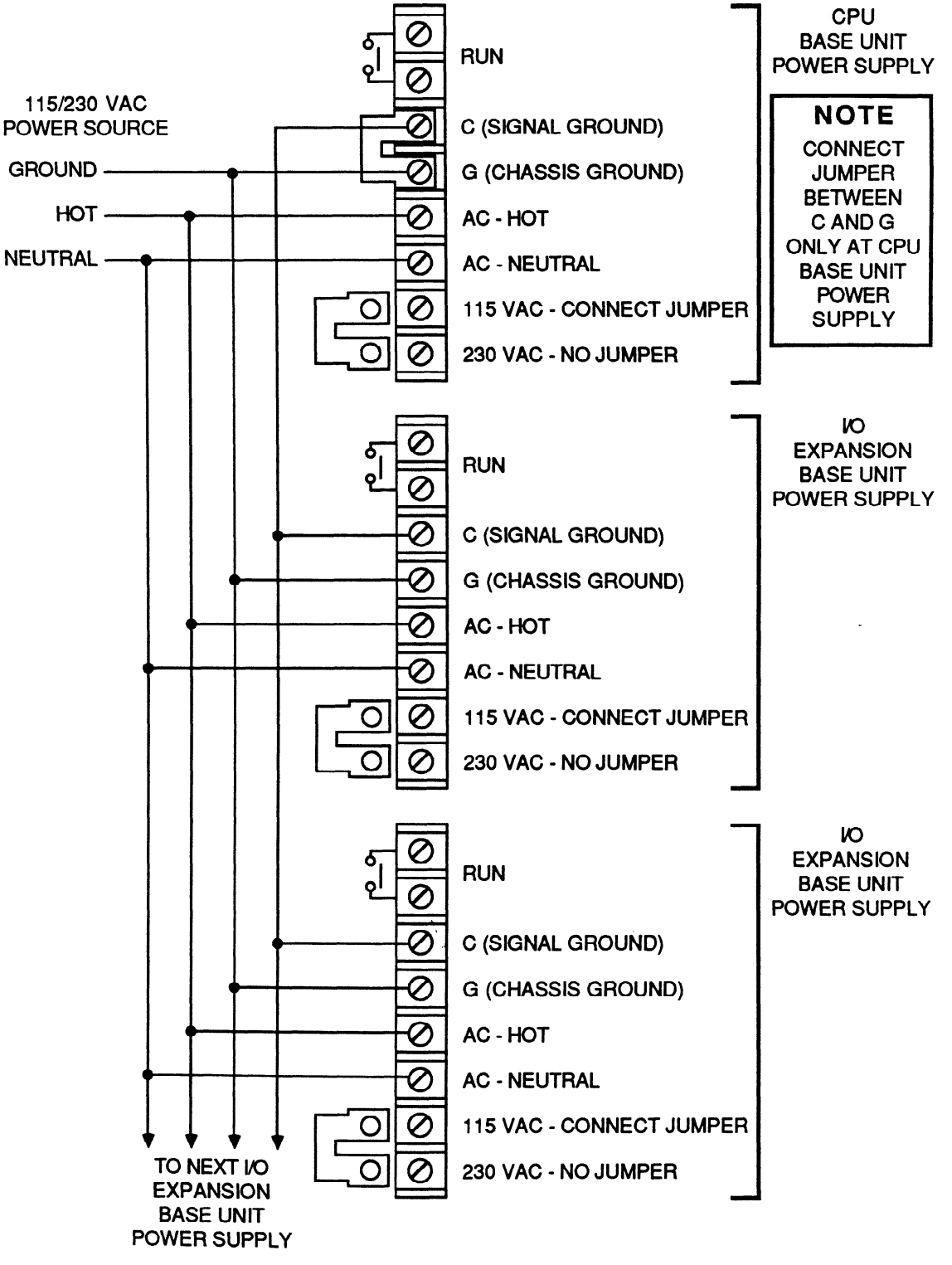


Figure 3-12. Example of Connecting Power Wiring to Multiple Base Units

CPU Installation

The CPU must be installed in the second position on a base unit. There are two connectors on the base unit backplane for connection to the CPU module. Ensure that power is off at the base unit before installing or removing a CPU.

- Place the CPU over the second slot position (second and third connectors on base unit) from the left (next to the power supply module) so that the connectors on the back of the CPU are lined up with the mating connectors on the base unit.
- Firmly push the CPU onto the base unit connectors so that it is securely mated with them.
- Secure the CPU to the base unit by fastening the 2 captive screw fasteners, one at the top and one at the bottom of the module, with a long, narrow bladed or phillips screwdriver.

User Configurable Items

Directly below the top communications port (15-pin connector) is a 4-position DIP switch used for setting certain CCM operating parameters for the bottom port.

- Switch 1 is used to select the mode of operation for CCM communications, either RS-232 or RS-422.
- Switch 2 selects the CCM port address for communications with Logicmaster 5 or other CCM host device.
- Switches 3 and 4 select the baud rate for communications. The following table is a guide to these settings and the settings are also listed on a label on the back of the large hinged door on the front of the CPU.

Table 3-3. CCM Port Dip Switch Definitions

POSITION	DEFINITION		
1	ON - CCM Port communicates via RS-232 † OFF - CCM Port communicates via RS-422		
2	On - CCM port address is 1; parity is "none" † OFF - CCM port address obtained from scratch pad (set through Logicmaster)		
3 and 4	BAUD RATE SELECTION		
	Switch 3	Switch 4	Baud Rate (Bps)
	OFF	OFF	300
	OFF	ON	1200
	ON	OFF	9600
	ON	ON	19200 †

† = Factory (default) setting. These default settings are compatible with Logicmaster 5 default settings.

CPU Back-up Battery

A lithium battery (catalog number IC655ACC550), mounted on the back of the larger hinged door, connects to the CPU through a cable connected to a 4-pin connector which mates with a 4-pin connector located directly below the reset pushbutton. The battery connector is plugged in at the factory and requires no action by the user at installation. If a battery must be replaced, the new battery has the cable wired to it and is ready for installation by the user.

NOTE

Be sure that the battery cable is not positioned over the reset pushbutton before closing the door. If it is and the door is closed, the wires could push in the button, causing the CPU to always be in the reset condition.

a42290

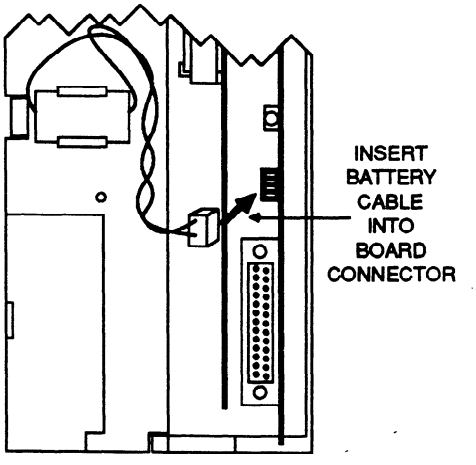


Figure 3-13. Back-Up Battery Mounting and Connection

Memory Cartridge

The memory cartridge for your Series Five PLC should be selected and made available for installation. Install the memory cartridge in the slot next to the 15-pin connector at the top of the module behind the large hinged door on the CPU.

CAUTION

Turn power off before installing or removing a memory cartridge. Handle RAM memory cartridges with care, since excess charges of static electricity could damage the memory devices in the cartridge.

- To install a memory cartridge: slide the memory cartridge into the guides in the slot until it firmly plugs into the connector at the back of the slot.
- To remove a memory cartridge, pull the top of the plastic strip on the memory cartridge at the point marked "PULL". The cartridge can then be easily pulled out of its connector and mounting slot.

The available memory cartridges and catalog numbers are listed in the following table.

Table 3-4. Memory Cartridges

Catalog Number	Description
IC655MEM501	4K/24K* RAM memory with battery back-up
IC655MEM503	16K RAM memory with battery back-up
IC655MEM512	8K/24K* EPROM memory (UV erasable)
IC655MEM513	16K EPROM memory (UV erasable)
IC655MEM521	4K EEPROM memory (electrically erasable)

* 24K if used with an ASCII/BASIC module.

Memory Protect Jumper Configuration

If a RAM memory cartridge is to be Memory Protected so that the program or other data stored in memory cannot be overwritten, a jumper inside the cartridge must be configured so that this cannot happen. The procedure for configuring this jumper is as listed below. The factory default position for the jumper is Write Unprotected.

- Remove the cover on the side of the RAM memory cartridge by carefully removing the small phillips-head screw located on the side of the cartridge that has the product label.
- Referring to the figure below, note that there is a jumper which must be placed on two of three pins on the board. A label inside of the cover shows the proper position of the jumper: either WRITE UNPROTECTED or MEMORY PROTECT.
- To change the position of the jumper, carefully grasp the jumper with a pair of needle-nose pliers and pull the jumper off of the pins.
- Place the jumper over the desired two pins and push down until it is firmly in place. Replace the cover and phillips-head screw.

The following figure shows the location of the jumper pins and configuration positions.

a42268

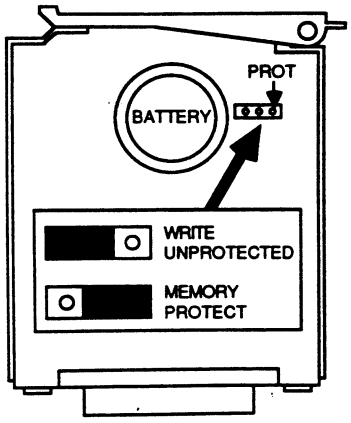


Figure 3-14. Jumper Positions for Memory Protect Configuration

Register Memory Expansion in a CPU

If the selected memory cartridge for your system is either IC655MEM503 (16K RAM), or IC655MEM513 (16K EPROM), a 16K RAM will be included with it as a separate item to expand the number of available data registers from the factory standard 4K to 16K registers. The procedure for replacing the 4K RAM with the 16K RAM is described below. A jumper next to the RAM socket in the CPU must also be configured to reflect whether a 4K or 16K RAM is installed in the socket. The following figure shows the location of the socket and jumper configuration.

a42401

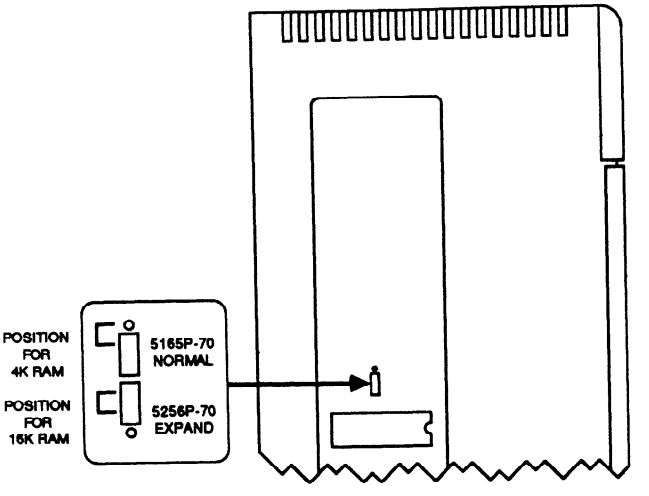


Figure 3-15. Socket for Register Memory Expansion

Installation of 16K RAM for Register Memory Expansion

- Remove the rectangular cover from the left side of the CPU module case.
- The RAM socket is located in the lower center of the board as shown above.
- Remove the existing RAM (5165P-70) from the socket.
- Carefully insert the 16K RAM (5256P-70) in the socket, observing the proper orientation. Ensure that none of the pins on the RAM are bent under the RAM during installation.

Configuration of Jumper for Register Memory Expansion

- The position of the pins and jumper for configuration of either 4K or 16K registers, is next to the RAM socket. The possible positions for the jumper are also shown on a label on the inside of the cover.
- To change the configuration for 16K register memory expansion, carefully grasp the jumper with a pair of needle nose pliers and pull it off of the two pins closest to the socket, which is the proper configuration for 4K registers.
- Place the jumper over the two pins closest to the word "EXPAND" and push it down until it is firmly seated in place.
- Replace side cover after the 16K RAM is installed and jumper is properly configured.

Local I/O Interface Module Installation

Each I/O expansion base unit must contain a Local I/O Interface module (IC655BEM500) to allow the Series Five PLC I/O modules installed in a base unit to communicate with the CPU. A Local I/O Interface module does not have any items requiring user configuration. The following figure shows the location of this module in a base unit, followed by installation instructions.

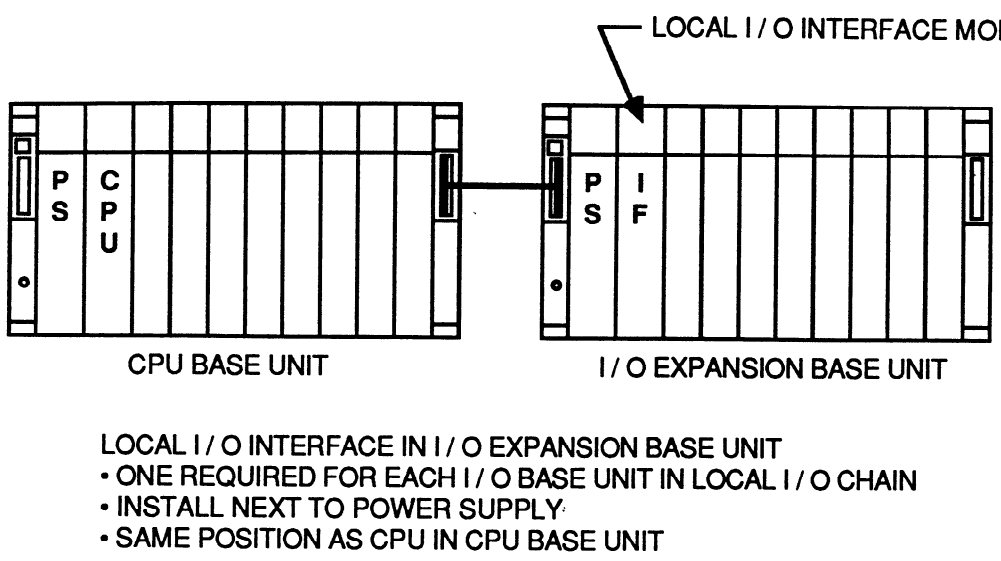


Figure 3-16. Location of Local I/O Interface in Base Unit

- Install the Local I/O Interface module next to the power supply in an I/O expansion base unit. This is the same location in which a CPU is installed in the CPU base unit.
- Place the Local I/O Interface module over the second slot position (second and third connectors on base unit) from the left (next to the power supply module) so that the connectors on the back of the module are lined up with the mating connectors on the base unit.
- Firmly push the Local I/O Interface module onto the base unit connectors so that it is securely mated with them.
- Secure the Local I/O Interface module to the base unit by fastening the two captive screw fasteners, one at the top and one at the bottom of the module, with a long, narrow bladed or phillips screwdriver.

Installation of Series Five PLC I/O Modules

Series Five PLC I/O modules can be installed in any available I/O slot in a base unit. A base unit can contain either 6 (IC655CHS506) or 8 (IC655CHS508) I/O modules. Installation instructions common to all I/O modules are listed below. For field wiring instructions for individual I/O modules, refer to the Series Five PLC I/O Module Specifications Manual, GFK-0123.

Typical I/O Module

Field wiring to most I/O modules is made to a removable terminal block on the module. The terminal block can be easily removed to replace a module, for troubleshooting, or for prewiring of terminal blocks. Terminal blocks have either 20 or 38 screw terminals. Each terminal will accept one AWG #16 (1.2 mm^2) or two AWG #18 (1 mm^2) wires with 1/4″ spade lugs. The following figure shows a typical I/O module.

a42292

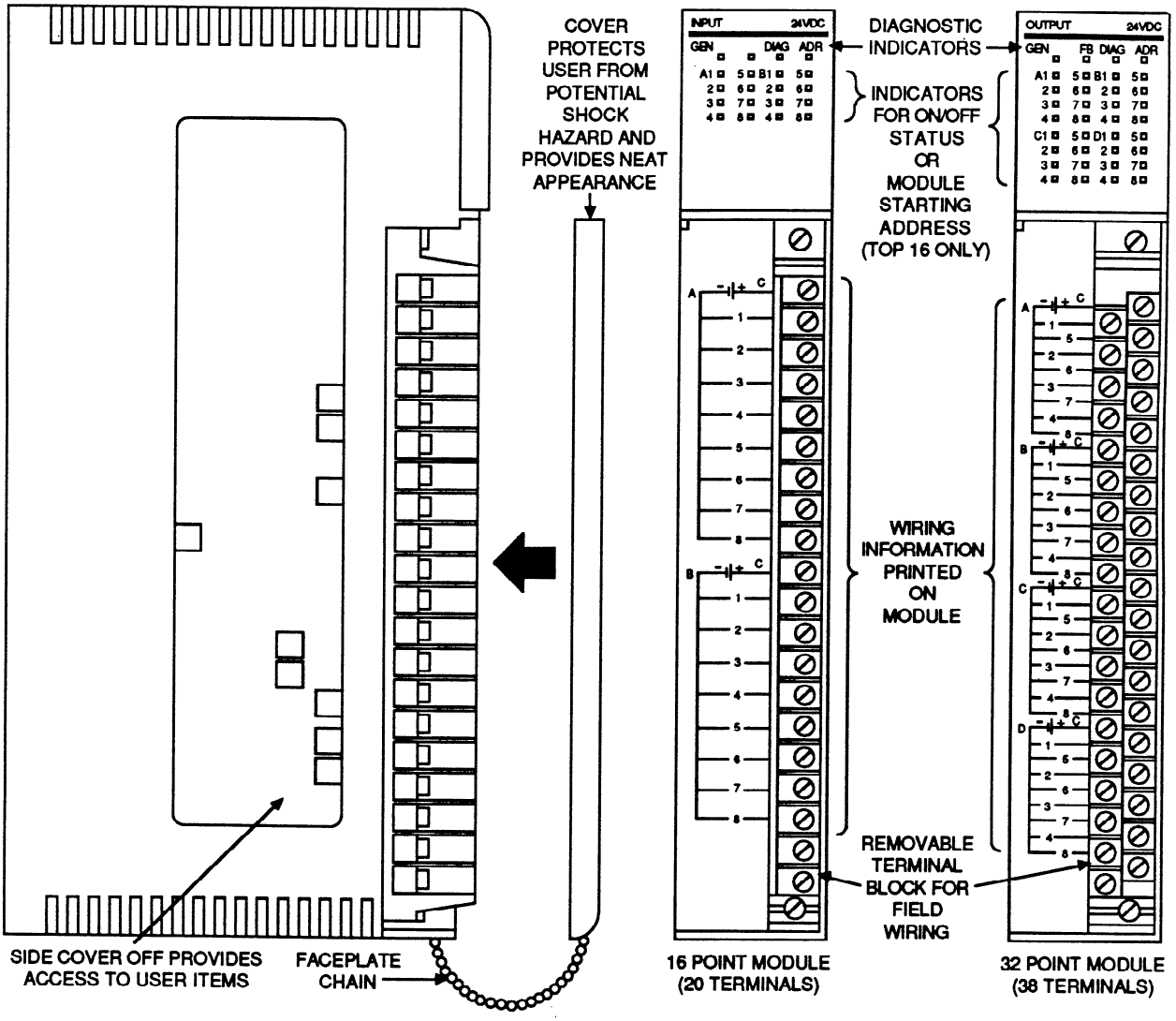


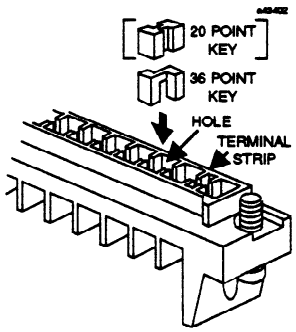
Figure 3-17. Typical I/O Module

Installing the Faceplate Chain

The short length of plastic bead chain provided with each module is a safeguard to prevent the module's faceplate cover from being misplaced when it is removed from the module. Install the bead chain by fitting one end of it into a slot on the bottom front edge of the module housing, and the other end into the small slot at the bottom of the faceplate cover.

I/O Module Keying

All I/O modules are mechanically keyed to prevent accidental connection of a prewired removable connector to the wrong module type, for example, 115 V ac connector onto a 24 V dc board. Individual module keying should be done by the user at installation according to a predetermined key chart. Each I/O module is shipped with a set of instructions and the required key type. There are two types of keys, one type for modules with 20 terminals on the connector, and one type for modules with 38 terminals on the connector. The correct type of keys are included with each I/O module. The following figure is an illustration of the instruction sheet packed with each module.



Module Type	Terminal Block Type	Catalog Number	Product Description	Key Position						
				A1	A2	A3	A4	B1	B2	B3
Input Module	20 Point	IC655MDL501	12-24 VDC Neg. Logic	•	•					
		IC655MDL525	115/230 VAC	•						•
	38 Point	IC655MDL502	12-24 VDC Neg. Logic	•		•				
		IC655MDL511	24-48 VAC/DC		•	•				
		IC655MDL512	12-24 VAC/DC	•				•		
		IC655MDL526	115 VAC	•					•	
		IC655MDL527	115/230 VAC Isolated			•				•
Output Module	20 Point	IC655MDL551	12-24 VDC Neg. Logic					•	•	
		IC655MDL555	12-24 VDC Pos. Logic					•		•
		IC655MDL575	115/230 VAC		•					•
		IC655MDL580	Relay			•		•		
	38 Point	IC655MDL552	12-24 VDC Neg Logic						•	•
		IC655MDL556	12-24 VDC Pos. Logic			•		•		
		IC655MDL576	115/230 VAC Isolated		•					•
		IC655MDL577	116/230 VAC		•			•		
		IC655MDL581	Relay			•			•	
		IC655MDL586	Relay Isolated	•						•
Special Module	20 Point	IC655ALG566	Analog Output	•				•		
		IC655ALG567	Analog Output	•				•		
	38 Point	IC655ALG516	Analog Input		•				•	
		IC655APU510	High Speed Counter					•		•

Figure 3-18. I/O Module Terminal Block Key Location Chart

I/O Module Installation Procedures

- *Do not install or remove any I/O module when power is applied to a base unit.*
- Install the I/O module by placing it over the selected slot position. Slot positions are numbered 0 to 5 in a 6-slot base unit and 0 to 7 in an 8-slot base unit. Position the I/O module so that the connector on the back of the module is lined up with the mating connector on the base unit.
- Firmly push the I/O module onto the base unit connector so that it is securely mated with it.
- Secure the I/O module to the base unit by fastening the 2 captive screw fasteners, one at the top and one at the bottom of the module, with a long, narrow bladed or phillips screwdriver.
- After installing modules, you should then run field wiring to the terminal block on each module. Recommended routing of field wiring is to run the wiring harness along the bottom of the modules, then break-out the wires for each module and route them to the terminal block on each connector through the cutout at the bottom front of the module.

WARNING

Hazardous voltages from user devices may be present on a module's screw terminals, even though power to a base unit is turned off. Care must be taken any time you are handling the module's terminal board or any wires connected to it.

Field Wiring Considerations

It is recommended that the following procedures be followed when routing and connecting field wiring from input devices to the PLC or to output devices to be controlled by the PLC.

- All low level signal wires should be be run separate from other field wiring.
- AC power wiring should be run separately from dc field wiring.

WARNING

The user should calculate the maximum current for each wire and observe proper wiring practices. Failure to do so may cause injury to personnel or damage to equipment.

- Field wiring should not be routed close to any device that could be a potential source of electrical interference.
- If severe noise problems are present, additional power supply filtering or an isolation transformer may be required.
- Ensure that proper grounding procedures are followed to minimize potential safety hazards to personnel.
- Label all wires to I/O devices. Record circuit identification numbers or other pertinent data on the inserts provided for attachment to the back of module covers.

Safety Considerations

Safety must always be a prime consideration when planning the layout of a PLC system. System planning should include procedures and methods to ensure the physical safety of personnel, the Series Five PLC system, and the machine or process being controlled. Those personnel responsible for planning and implementing a system should be familiar with and follow all local and national electrical codes, in addition to the installation instructions in this manual.

All practices should be followed as specified by the IEEE (Institute of Electrical and Electronic Engineers) Standard 510, which includes tray and conduit spacing, and recommended wiring procedures.

Power Supply Load Capacity

If the current capacity of the power supply in any base unit is exceeded, causing the power supply to become overloaded, unpredictable system operation may occur. To ensure that this does not happen, the total current requirements of all modules in a base unit must not exceed the current carrying capabilities (load capacity) of the power supply in the base unit.

The load capacity of the power supply in a Series Five PLC base unit is the sum of the internal loads placed on it by each of the modules and is expressed in milliamps.

Current Supplied by Power Supplies

Current capacities for each of the Series Five PLC power supplies is listed in the following table.

Table 3-5. Current Supplied by Power Supplies

Catalog Number	Power Source Voltage	Output Voltage and Maximum Current
IC655PWR500	115/230 V ac	5 V dc at 6 Amps
IC655PWR501	115/230 V ac	5 V dc at 12 Amps
IC655PWR514	24 V dc	5 V dc at 6 Amps

Current Requirements for Series Five PLC Modules

The number of I/O modules that can be used in a rack is determined by adding up the loads of all CPU modules and subtracting that load from the total load capacity of the installed power supply.

Summary of Module Load Requirements

The load requirements for Series Five PLC modules is listed in the following table. Use this table to determine the total current requirements for all modules to be installed in a base unit and for selection of the power supply that will be installed in the base unit to satisfy those current requirements.

Table 3-6. Summary of Module Power Consumption

Catalog Number	Module Description and Number of Circuits	Supply Current (Milliamps)	
		Typical	Maximum
IC655ALG516	Analog Input, (8)	-	250
IC655ALG566	Analog Output, (2)	-	150
IC655ALG567	Analog Output, (2)	-	150
IC655BEM500	Local I/O Interface	-	380
IC655BEM530	Series Three I/O Interface	-	200
IC655CPU500	CPU	-	1500
IC655MDL501	12 - 24 VDC Input, Negative Logic (16)	64	80
IC655MDL502	12 - 24 VDC Input, Negative Logic (32)	130	150
IC655MDL503	24 VDC Input, Positive/Negative Logic (64)	136	180
IC655MDL511	24 - 48 VAC/DC, Isolated Input, Positive Logic (16)	80	100
IC655MDL512	12 - 24 VAC/DC Input, Pos. Logic (32)	160	180
IC655MDL524	Input Simulator (16 or 32)	112	200
IC655MDL525	115/230 VAC Input, (16)	64	100
IC655MDL526	115 VAC Input, (3)	160	180
IC655MDL527	115/230 VAC Isolated Input (16)	64	100
IC655MDL533	5 - 12 VDC TTL Input (64)	136	180
IC655MDL551	12 - 24 VDC Output, Negative Logic (16)	150	170
IC655MDL552	12 - 24 VDC Output, Negative Logic (32)	260	300
IC655MDL555	12 - 24 VDC Output, Positive Logic (16)	150	170
IC655MDL556	12 - 24 VDC Output, Positive Logic (32)	600	800
IC655MDL575	115/230 VAC Output, (16)	560	650
IC655MDL576	115/230 VAC Isolated Output, (16)	560	650
IC655MDL577	115/230 VAC Output, (32)	580	640
IC655MDL580	Relay Output, (16)	152	180
IC655MDL581	Relay Output, (32)	260	300
IC655MDL586	Isolated Relay output (16)	152	180
IC655MDL593	5 - 12 VDC TTL Output (64)	360	450
IC655APU500	ASCII/BASIC Module	-	600
IC655APU510	High Speed Counter	-	100
IC655APU521	Axis Positioning Module	-	500
IC655BEM510	Genius Bus Controller	-	500
IC655CCM500	CCM Communications	-	1000
IC655PER500	Operator Interface Unit	-	400 (when loading PROMs - up to 1 amp)

Examples of Typical System Configurations

Examples of the total load requirements for all modules installed in a base unit are shown below. These are only typical examples, and will vary with the module requirements for your application. If the load requirements for all modules is close to, or exceeds the maximum current supplied by the power supply installed in the base unit, you will need to upgrade the power supply, add an additional base unit, or install a different mix of modules. The maximum load for an I/O module is shown; typical load values would normally be less during normal system operation.

Example for System 1:

Power supply: IC655PWR501, supplies 12 amps (12000 mA) total load.
Base unit: IC655CHS508, 8 I/O slots

Quantity	Catalog No.	Description and No. of Circuits	Load/Module	Total Load in mA
1	IC655CPU500	CPU	1500	1500
4	IC655MDL525	115/230 V ac In, 16	100	400
4	IC655MDL576	115/230 V ac Isolated Out, 16	650	2600
1	IC655PER500	OIU, if attached (the OIU load can be as much as 1 amp, when used to load PROM memory).	400	400
			Total	4900

Example for System 2:

Power supply: IC655PWR500, supplies 6 amps (6000 mA) total load.
Base unit: IC655CHS508, 8 I/O slots

Quantity	Catalog No.	Description and No. of Circuits	Load/Module	Total Load in mA
1	IC655CPU500	CPU	1500	1500
3	IC655MDL502	12 - 24 V dc In, Negative Logic, 32	150	450
5	IC655MDL556	12 - 24 V dc Out, Positive Logic, 32	800	4000
1	IC655PER500	OIU, if attached	400	400
			Total	6350

In the example for system 2, the total of the load requirements is greater than the load capacity of the power supply, therefore this configuration is not acceptable. Select either a different mix of modules, upgrade the power supply to the 12 amp version, or add an expansion base unit.

Example for System 3:

Power supply: IC655PWR500, supplies 6 amps (6000 mA) total load.
Base unit: IC655CHS506, 6 I/O slots

Quantity	Catalog No.	Description and No. of Circuits	Load/Module	Total Load in mA
1	IC655CPU500	CPU	1500	1500
3	IC655MDL512	12 - 24 V ac/dc In, Positive Logic, 32	160	480
3	IC655MDL556	12 - 24 V dc Out, Positive Logic, 32	800	2400
1	IC655PER500	OIU, if attached	400	400
			Total	4780

Installing Series Three PLC I/O in a Series Five PLC System

The basic hardware requirements for adding Standard Series Three PLC I/O modules to a Series Five PLC system are:

- A *Series Three PLC I/O Interface Module* (catalog number IC655BEM530), which can be installed in any Series Five PLC I/O slot. A maximum of four of these modules ar supported in a system.
- *Series Three PLC Base Unit* (IC630CHS308, IC630CHS306, IC630CHS304), 1 to 3 base units can be connected to a Series Three PLC I/O Interface module.
- *Series Three PLC Power Supply* (IC630PWR310, IC630PWR314), each base unit requires a power supply.
- *Series Five PLC to Series Three PLC I/O cable* (1C655CBL530, 3 feet (1 meter) in length)). This cable connects the Series Three PLC I/O Interface module in a Series Five PLC base unit to the CPU connector on the Series Three PLC power supply in the first Series Three PLC base unit.
- *Series Three PLC I/O Expander Cable,* either IC630CBL304, 19 inches (.5 m) or IC630CBL305, 3 feet (1 m) in length. One of these cables is required to connect each additional Series Three PLC base unit in a Series Three PLC I/O expansion system, if more I/O modules are required than can be contained in a single base unit.

Series Three PLC I/O Interface Module

A Series Three PLC I/O Interface module can be located in any valid Series Five PLC I/O slot. Up to four Series Three PLC I/O Interface module can be included in a Series Five PLC I/O system. One Series Three PLC I/O Interface module can service up to 1024 I/O points (512 Inputs/512 Outputs). The number of I/O points to be serviced by each interface module is selected by configuring a DIP switch on the Series Three PLC I/O Interface module to groups of 32 I/O. The following figure shows the location of a Series Three PLC I/O Interface module in a Series Five PLC base unit and the cable connection required to enable Series Three PLC I/O to be used in a Series Five PLC system.

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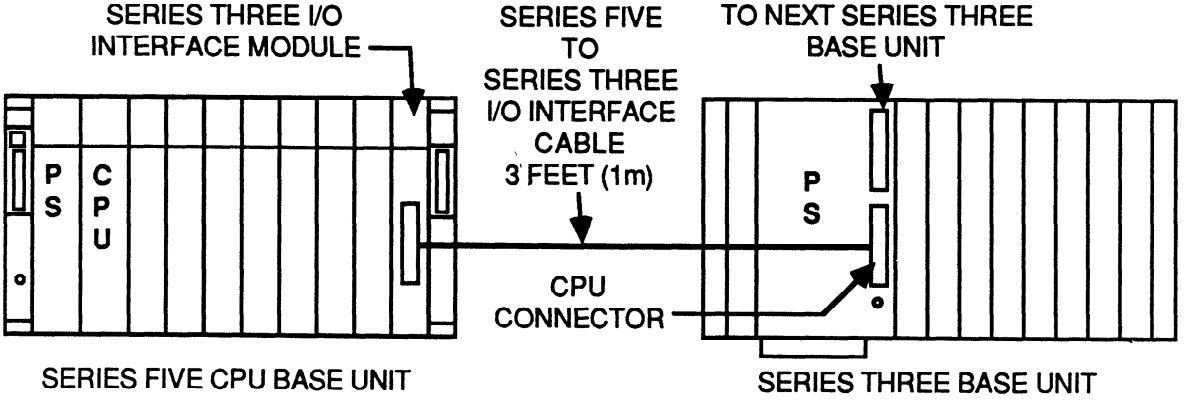

Figure 3-19. Series Three PLC I/O Interface to a Series Five PLC

Installing a Series Three PLC I/O Interface Module

A Series Three PLC I/O Interface module can be installed in any I/O slot in a Series Five PLC 6-slot or 8-slot base unit.

- Install the Series Three PLC I/O Interface by lining it up with the selected I/O slot position. Slot positions are numbered 0 to 5 in a 6-slot base unit and 0 to 7 in an 8-slot base unit. Position the module so that the connector on the back of the module is lined up with the mating connector on the base unit.
- Firmly push the Series Three PLC I/O Interface module onto the base unit connector so that it is securely mated with it.
- Secure the Series Three PLC I/O Interface module to the base unit by fastening the 2 captive screw fasteners, one at the top and one at the bottom of the module, with a long, narrow bladed or phillips screwdriver.

Configuration of Number of I/O Points

The number of Series Three I/O points to be serviced by the Series Three I/O Interface module must be specified by setting a 4-position DIP switch to the quantity of I/O points required by the application. The number of I/O points is selected in groups of 32, ranging from 32 to 512. A setting of 32 specifies 32 inputs and 32 outputs.

- To access the DIP switch for configuration, remove the plastic cover located on the left side of the module, as shown in Figure 2-23.
- A label on the back of the cover is a guide to DIP switch settings. The following figure is an illustration of this label and the DIP switch settings.

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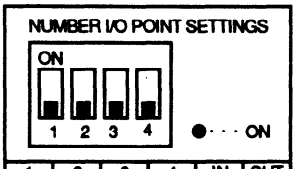

1	2	3	4	IN	OUT
				32	32
			●	64	64
		●		96	96
		●	●	128	128
	●			160	160
	●		●	192	192
	●	●		224	224
	●	●	●	256	256
●				288	288
●			●	320	320
●		●		352	352
●		●	●	384	384
●	●			416	416
●	●		●	448	448
●	●	●		480	480
●	●	●	●	512	512

Figure 3-20. Dip Switch Settings for Number of Series Three PLC I/O Points

Addressing Series Three I/O

The following information about addressing Series Three I/O through use of the Series Three PLC I/O Interface Module must be followed to ensure proper operation of the total Series Five I/O system. These guidelines must be followed to ensure that addressing conflicts do not happen.

- The first Series Three I/O Interface module in a Series Five PLC base unit will automatically be assigned starting addresses I0001 and O0001, regardless of whether you are using automatic (CPU assigned) or manual (user assigned) address assignment. If you have manually assigned a different address to the slot which contains the Series Three PLC I/O Interface Module, the CPU will change it to I0001 and O0001.
- The number of I/O points used by the Series Three I/O Interface module depends on the DIP switch setting. An equal number of Input and Output points are used (as read from the DIP switch), regardless of the actual number of installed I/O points in the Series Three rack.
- ***One Series Three I/O Interface module in a system.*** If you are using CPU addressing, it is recommended that the Series Three I/O Interface module be installed in rack 0, slot 0 since I0001 and O0001 will be assigned to the module. With this configuration, all downstream I/O addresses will be assigned correctly. If a different module type (for example, discrete I/O) were installed in a slot before the Series Three I/O Interface module, that module would also be assigned starting address I0001 or O0001, and a conflict would occur.
- ***More than one Series Three I/O Interface module in a system.*** Using CPU addressing, the CPU will automatically address all Series Three I/O Interface modules in the system sequentially starting at I0001 and O0001. For example, if the first module uses 128 I/O points and the second one uses 64 points, the starting addresses will be I/O 0001 and I/O 0129, respectively. The next module, if present, will be assigned starting addresss I/O 0193.
- If you are assigning addresses manually (user assigned) be sure to assign addresses to other modules in the system which will not conflict with the total number of I/O assigned by the DIP switches to **all** Series Three I/O Interface modules in the system.

Field Wiring a Series Three PLC I/O System

For detailed information on power wiring to base units, I/O module installation, and field wiring to Series Three PLC I/O modules, refer to GEK-25376, the Series Three PLC User's Manual.

Typical Series Three PLC I/O System

The following figure is an example of the hardware required for a typical system configuration using Series Three PLC I/O in a Series Five PLC system.

Series Three PLC Power Supply
- IC630PWR310, 115/230 V ac
- IC630PWR314, 24 V dc

Series Three I/O Interface Module To Series Three I/O Cable
- IC655CBL530, 3 ft. (1 m)

Series Three PLC Base Units
- IC630CHS308, 8-Slots
- IC630CHS306, 6-Slots
- IC630CHS304, 4-Slots

Series Three PLC I/O Expander Cables
- IC630CBL304, 1.5 ft. (0.5 m)
- IC630CBL305, 3 ft. (1 m)

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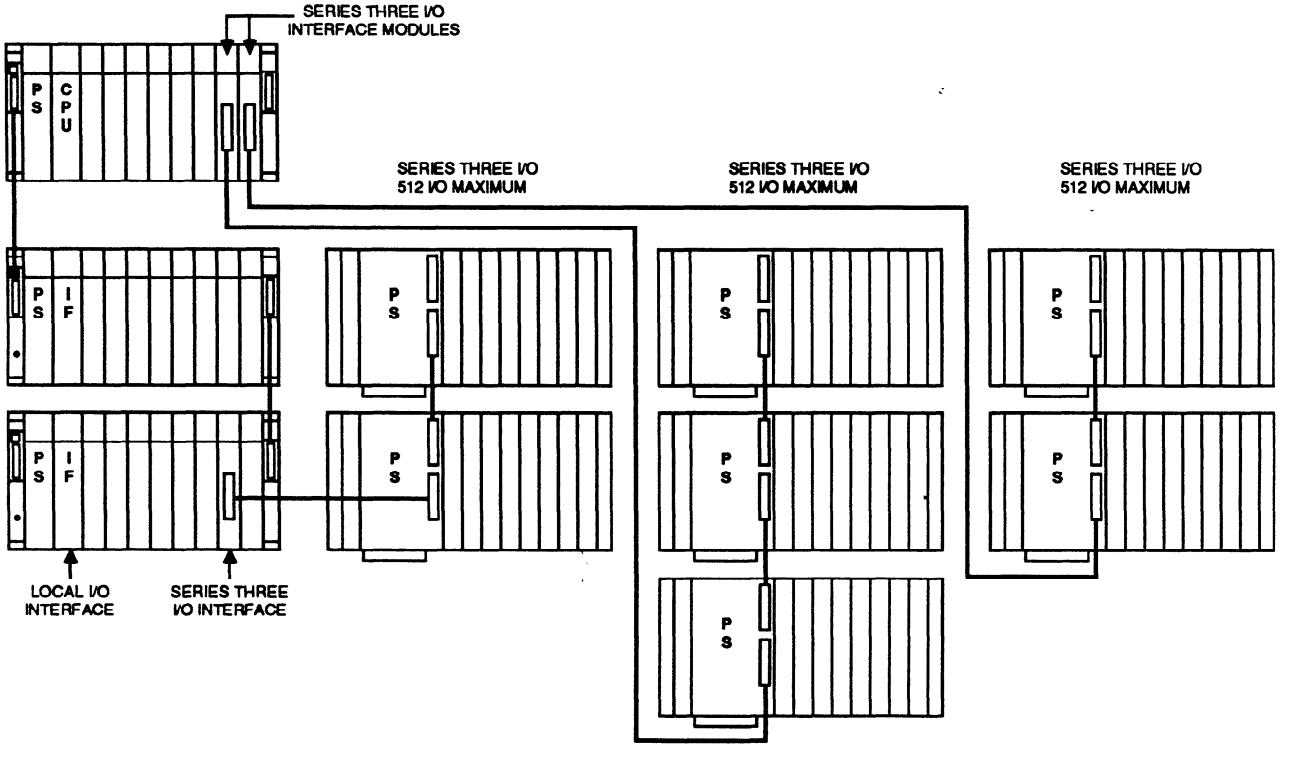


Figure 3-21. Example of Series Five PLC System Using Series Three PLC I/O

Filler Module

A Filler module (catalog number IC655ACC552), which is an empty plastic enclosure, is available to fill-in any unused slots in a Series Five base unit. This Filler module, when installed, provides a finished, streamlined appearance for your Series Five PLC. Installation of this module is identical to any other module for your Series Five PLC system. An illustration of this module is shown in the following figure.

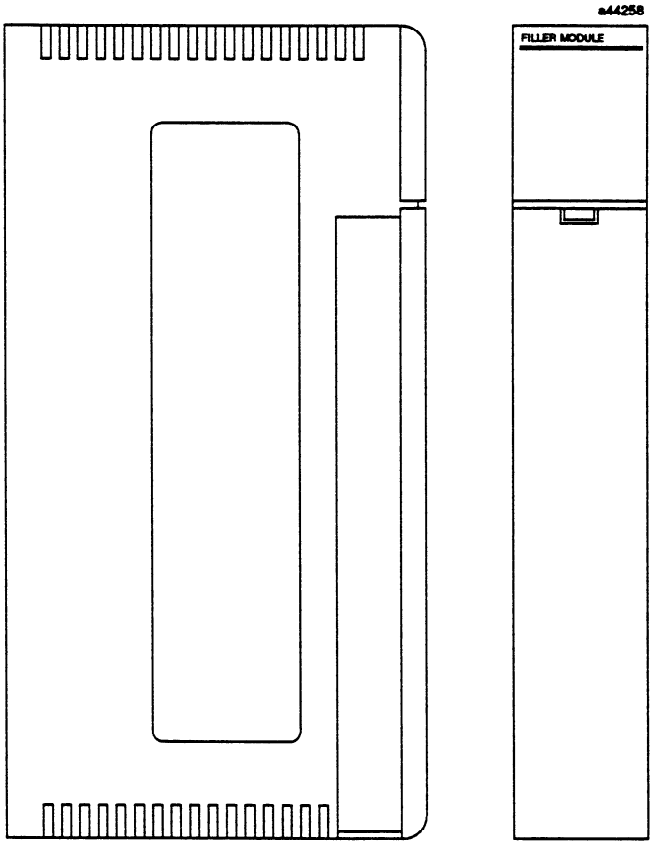


Figure 3-22. Filler Module

Oversized Faceplate

An optional oversized faceplate (catalog number IC655ACC551) is available to use in place of the standard I/O module faceplate in installations where the wire bundle is too large for the standard faceplate to be used.

Operator Interface Mounting Bracket

A mounting bracket (catalog number IC655ACC554) is available which allows the Operator Interface Unit for the Series Five PLC to be mounted on a panel. A pair of terminals are provided on the rear of the panel for a user supplied power switch switch which allows power to the OIU to be turned off and on at the panel. Since power must be removed from the OIU when installing or removing memory cartridges, addition of this switch allows power to be turned off and on at the OIU without the need to do so at the Series Five base unit. This mouting bracket installs on a panel that has had an appropriate opening cut-out and mounting holes drilled. The following illustration provides the dimensions required for preparing the panel to accept the OIU mounting bracket. To install the OIU mounting bracket, use the following procedure:

- Cut-out the opening in the panel as shown in the following illustration and drill the required mounting holes.
- Install the mounting bracket on the panel using four screws as shown in the illustration.
- Attach one of the two available OIU to CPU cables (IC655CBL540, 5 feet (1.5 m) or IC655CBL541 (10 feet (3 m)) to the 15-pin connector mounted on the rear of the mounting bracket.
- Install the OIU by lining-up the connector on the rear of the OIU with the connector on the front of the mounting bracket and firmly pressing it into place.
- Fasten two screws on the front top and bottom of the OIU to the mounting bracket.

NOTE

Ensure that power is removed from the OIU whenever Memory Cartridges are inserted into or removed from the OIU. Terminals are provided on the bracket for this purpose.

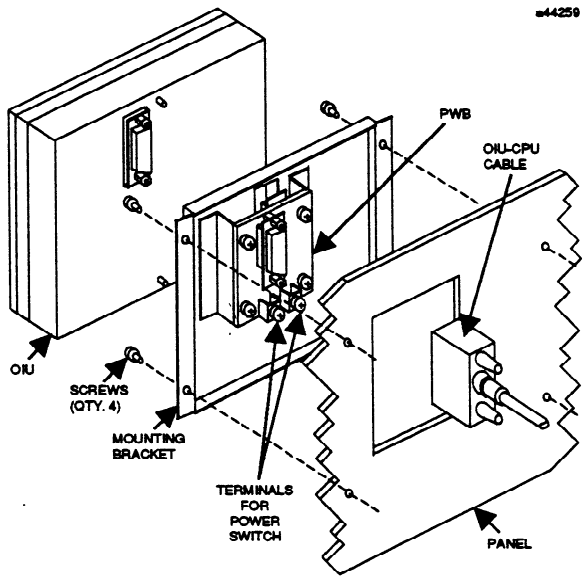


Figure 3-23. Installing the OIU Mounting Bracket

Installation of Optional Modules

For detailed information on installation of optional modules (CCM Communications, ASCII/BASIC, Axis Positioning, Genius Bus Controller, or High Speed Counter) refer to the applicable manual.

Questions That May Arise During Initial Startup

Following are several questions or concerns that may arise during the initial start-up of your Series Five PLC system once the hardware has been installed.

- *Why does the I/O LED on the CPU turn on when I power-up?*

  This indicates that the I/O configuration is different than the last time the CPU was powered-up. Store the I/O assignment map, or execute a NEW CONFIG function from LM5.

- *Why can't I communicate with Logicmaster 5?*

  Ensure that the connectors on both ends of the Workmaster computer to Series Five PLC cable are firmly attached, and that you are using the correct cable. Communications problems may also occur in the future when the OIU is available and attached to your system. If the OIU is connected, and a power cycle occurs, the OIU comes up in the mode it was in when power went down. If the OIU had been on-line, it will be on-line when it comes up after a power cycle, and the Logicmaster 5 port on the CPU will be disabled. Ensure that the OIU is off-line to allow communications between the CPU and Logicmaster 5. Also check the DIP switches in the CPU, and compare these to the Logicmaster 5 port setup features.

- *I can't find the CONFIRM key on the Logicmaster 5 Programmer!*

  You can use ALT X from any menu.

- *Why am I getting an I/O ADDRESS DUPLICATION error when I power-up?*

  You may have added a module that did not have a previously assigned address in the I/O assignment map, and the CPU would try to give it an address starting at I0001 or O0001. This may conflict with addresses which were assigned in the map. The solution is to assign the new module an address that does not conflict with those already assigned in the map, then download the I/O assignment map to the CPU.

- *My programmer is an IBM PC-AT (or compatible). When I display the Scratch Pad screen, the status line of Logicmaster 5 shows CCM ID = 0, and other data appears to be incorrect, what's wrong?*

  You probably used the Series Five PLC to Workmaster computer cable between the AT compatible serial computer port and the CPU communications port. The cable wiring is different for PC-AT compatible ports and PC-XT compatible ports. The IC655CBL542 cable works fine with a Workmaster computer, but PC-ATs require an adapter cable between that cable and the computer's serial port.

- *After loading DOS, I start up Logicmaster 5 and get an error on the screen, or the program halts with a blank screen. To recover. I must reboot the system, what's wrong?*

  This may mean that you have a already have a program resident in RAM memory, such as VTERM or SIDEKICK. Logicmaster 5 requires 640K of RAM memory to operate, therefore any other programs must be deleted before attempting to run Logicmaster 5.

Quick Start-Up of a Series Five PLC System

NOTE

This information is not recommended as a substitute for reading the manual. The procedure below is a general outline which assumes familiarity with the Series Five PLC system.

1. Remove the power supply jumpers from the back of the power supply or from the back of the faceplate cover. Add the jumper to the 115 VAC position on the terminal block on the front of the power supply (115 VAC only).
2. Install the power supply, CPU, and other modules in the base unit. Install the I/O chain terminator plug on the righthand base unit connector. ***Multiple base unit systems require the terminator plug only in the last base unit.***
3. With power OFF on the CPU, put a blank (RAM) memory cartridge in the CPU.
4. Set all the dipswitches in the CPU to the ON position.
5. Connect the CPU to a Workmaster II computer using cable IC655CBL542, or to another computer with a cable ***known to work properly in this application***. Refer to the Logicmaster 5 Programming and Software Documentation Software User's manual appendix for cable pinouts if you are using your own cable. Generally, the CPU communications port (the 25 pin connector) needs RXD, TXD, and ground connected to the other system. RTS/CTS (pins 4-5) can be connected together at the CPU. Your computer must supply RXD, TXD and ground, and should probably have RTS/CTS connected together. Depending on configuration of the port you are connecting to, you may also need some other signals jumpered. Also, depending on the port, the pinouts shown in the manual may not work. You must determine the correct cabling based on your own port configuration.
6. Power-up the Series Five PLC system after checking all wiring. The MEM, I/O, and some other CPU leds may be on. Put the CPU mode switch in the STOP position.
7. Power-up Logicmaster 5 on your computer. You should be using version 2.02 (shown during power up). ***If you have version 1.01, you are entitled to a free upgrade (this is strongly recommended).***
8. Do not change the LM5 port setup default values (19200 baud, no parity, CCM port 1.
9. Go to the on-line mode using the keyswitch (if available) or Alt/1 keys.
10. Go to the Supervisor menu, then select the Scratchpad (F4) key.
11. Look for the status line. If you show any CCM ID other than 1, ***your cable is NOT correct.*** Go back to the supervisor menu, and press the F3 (reference tables) key. Press the key sequence Ctrl R, 4087, F8, F7, F3. You should see *R4087* directly under the cursor in HEX mode. This is the Series Five CPU seconds counter. You should be able to watch each second roll over. If you notice sporadic updating of this seconds counter, your cable may still not be correct.
12. Look for the CPU revision numbers. It will be displayed as X/Y; X should be 2.0, 2.2, or 2.4 and Y should be 2.9 through 3.4. If X is smaller than 2.0, or Y is smaller than 2.9, you have pre-production test firmware ***which must be replaced***. Pre-production versions were shipped only to GE Fanuc field application engineers.
13. Go to the F1 subscreen. Then push the F3 (CPU initialize) key. To confirm select the (Conf) confirm key by pressing Shift 0 (or ALT/X).

14. Go back to the supervisor menu, select F7 (Setup and Diag screen), then F6 (I/O assignment screen). Press the STORE TO CPU softkey - the CPU assigned I/O addresses will appear. If these are not what you want, reassign them manually. GE Fanuc recommends that all addresses be manually assigned for future flexibility. Once manually assigned, the CPU will not arbitrarily change the address if modules are removed or inserted in the future.
15. Put the CPU keyswitch in the RUN position. You should see the RUN LED come on. You are now running a blank program.
16. For GENIUS I/O setup, refer to the Series Five Genius Bus Controller User's Manual (GFK-0248); however, ***PLEASE NOTE THAT*** the only setup required to operate Genius I/O blocks is to set the SBA (Serial Bus Address) switches on the bus controller, and enable all the active devices on the bus with the output enable bits in the Logicmaster 5 Genius setup menu. ***You do NOT need to change or set the broadcast input length, directed output length, or status table address fields unless you want to use Global Data.***

Chapter 4 Operation

GFK-0122

Introduction

This chapter provides information that the user must know or be aware of to use a Series Five PLC. The Series Five PLC has many advanced features that can benefit both end users and OEMs. These features are described in detail in this chapter.

Series Five PLC Programming References

All programming functions in the Series Five PLC must be identified by a reference, consisting of a prefix and a number. The references identify to the CPU whether the function is an input, an output, a timer or counter, a coil used for internal purposes in the program, data registers, etc. References are assigned with Logicmaster 5 software. The prefixes, range of numbers, and quantity available for these references are as follows:

Reference	Purpose	Quantity
I0001 to I1024	Local Inputs	1024
O0001 to O1024	Local Outputs	1024
I1+0001 to I1+1024	I1+ Tables (Remote I/O)*	1024
O1+0001 to O1+1024	O1+ Tables (Remote I/O)*	1024
O1-0001 to O1-1024	Internal Coils	1024
O2-0001 to O2-1024	Internal Coils	1024
I1-0001 to I1-0512	Special Purpose Contacts	512
I2+0001 to I2+1024	I2+ Tables (Remote I/O)	1024
O2+0001 to O2+1024	O2+ Tables (Remote I/O)	1024
R00001 to R16384	Data Registers	16384 (4096 in 4K system)

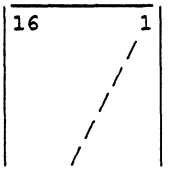
* These tables are generally used for Genius blocks, but can also be used with Local I/O or with Genius Global communications.

Purpose of Tables

When a reference is programmed and transferred to the CPU, it is entered into a special storage area in the CPU called a table. Each reference group has its own table to keep track of the references used that correspond to the table. The table maintains the status of each reference, keeping track of whether its corresponding bit or group of bits is turned ON or OFF. The table format for each of the reference types is illustrated below.

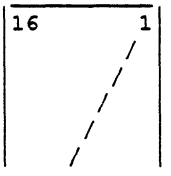
Local Input Status Table

I0001 to I1024



Local Output Status Table

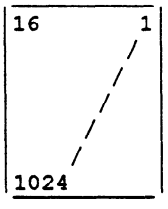
O0001 to O1024



These tables are used to maintain the status of real inputs and outputs in the Local I/O system. Each reference corresponds to a bit in the table. Can be addressed as individual bits or on a word boundary (word = 16 bits).

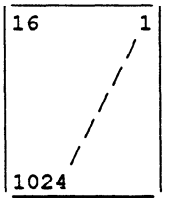
I1+ Input Status Table

I1+0001 to I1+1024



O1+ Output Status Table

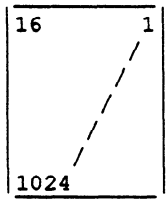
O1+0001 to O1+1024



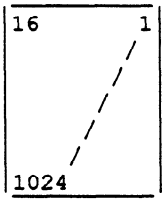
These tables maintain the status of real inputs and outputs typically in the Genius I/O system. Each of the references correspond to a bit in the table. These references can be addressed as individual bits or on a word boundary.

Internal I/O Status Tables

O1-0001 to O1-1024



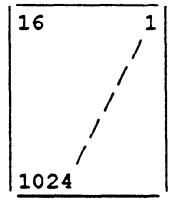
O2-0001 to O2-1024



These tables maintain the state of the internal I/O discrete references. These bits can be used for program references as needed, but are not available as real outputs. Can be addressed as individual bits or on a word boundary. References O2-1000 to O2-1024 have special meaning and are defined later in this chapter.

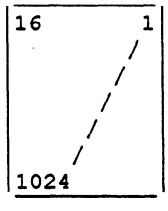
I2+ Input Status Table

I2+0001 to I2+1024



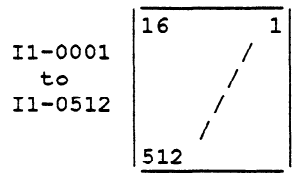
O2+ Output Status Table

O2+0001 to O2+1024



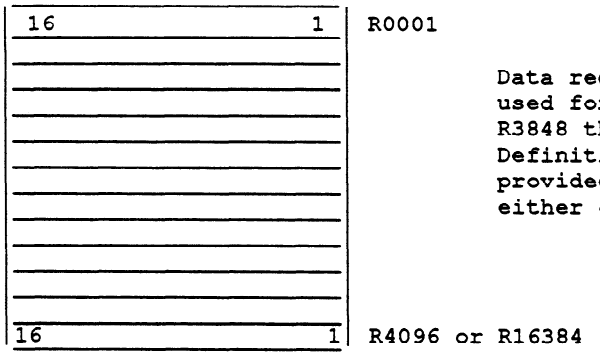
These tables maintain the status of real inputs and outputs typically in the Genius I/O system. Each of the references correspond to a bit in the table. These references can be addressed as individual bits or on a word boundary.

Special Purpose Contacts



The internal contacts have special meaning and can be used as conditional contacts in a user program when certain conditions represented by one or more of these contacts must be monitored or otherwise kept track of. A list of these contacts and their definitions are provided later in this chapter.

Registers



Data registers are 16 bits in length and can be used for general purpose data storage, except for R3848 through R4096, which have special meaning. Definitions for these special registers are provided later in this chapter. a system can have either 4K or 16K of registers.

Override Table

The CPU memory also contains an override table. The override table is used by relay contacts and outputs, counters, timers, latches, and one-shots to maintain the state of a bit that it was in when the override was applied. This state remains the same until the override is removed or its state is changed.

The I, O, I1+, O1+, O1-, O2-, I2+, and O2+ tables can all be overridden; the I1- table cannot be overridden.

I/O References and I/O Configuration

There are several important facts to consider regarding assignment of I/O references and I/O configuration. The following pages present an overview of these considerations, followed by a more detailed explanation of both subjects. The basic information you need to know is presented first.

Significance of Assigning I/O References

I/O modules in a Series Five PLC I/O system are addressed by assigning unique references to each module. These references are used by the CPU to identify them with the corresponding references used in the user logic program. Also, the CPU must be told whether or not to check if there has been a difference in the current installed I/O configuration since the last power cycle.

Recommended Procedures for I/O Assignment

The procedures for assigning I/O Addresses to modules are described below. The Initial Assignment of I/O Addresses procedure only needs to be done once for a specific system design. Once assigned, the I/O configuration can be copied and loaded to new systems without repeating these steps.

Initial Assignment of I/O Addresses

1. Power-up the CPU with all available I/O modules and the memory cartridge installed. The CPU will flag an I/O configuration error since this I/O configuration is different than the factory default (which was the the previous configuration).
2. Using Logicmaster 5, create an I/O assignment map that reflects as closely as possible the maximum future I/O configuration of the system. Blank slots which are planned to contain modules in the future should be assigned addresses. Slots which have modules that may not be located there permanently should also have addressses assigned.
3. Store the new I/O assignment to the CPU.
4. Under normal conditions, set the I/O CONFIG CHECK mode to ENABLE.

Adding a Module at a Future Date

1. Power-down the system and install the new modules.
2. Power-up the system, an I/O CONFIG CHANGED error will be displayed on the SCRATCH PAD or I/O ADDRESS ASSIGNMENT screen, if the I/O CONFIG CHECK is enabled.
3. If the new module or modules have previously been assigned an address, go to the I/O CONFIGURATION UTILITIES screen from the SCRATCH PAD screen and execute a NEW CONFIG command.
4. If the new module or modules have not been assigned an address, go to the I/O ADDRESS ASSIGNMENT screen, add the new addresses as required, and do a STORE TO CPU.

Removing a Module at a Future Date

1. Power-down the CPU and remove the module or modules.
2. Power-up the system. An I/O CONFIG CHANGED error will be displayed if the I/O CFG CHK is enabled.
3. Use the OLD CONFIG soft key, then command the CPU to run with the CPU keyswitch or the RUN softkey. The system will run until the next power loss, then the CPU will again inform the user of an I/O CONFIG CHANGED error. When the module is replaced, the error will not be present.

Or the following method can be used instead of step 3.

4. Use the NEW CONFIG softkey to register the loss of module. The I/O CONFIG CHANGED error will not be trapped on power-up. If the module is reinserted later, it is necessary to again use the NEW CONFIG softkey to re-register the added module.

Summary of Basic I/O Assignment Information

As a summary of the I/O Assignment and I/O configuration overview discussed in the preceding paragraphs, there are four basic rules to follow:

1. I/O addresses should be assigned in advance using the I/O ASSIGNMENT screen in Logicmaster 5 (accessed from the SETUP/DIAG screen).
2. For future I/O CONFIG CHANGED ERRORS, during debugging or system expansion, use the OLD CONFIG or NEW CONFIG function.

3. Leave the SET/CLR I/O CFG CHK enabled, except when debugging, troubleshooting, or under other unusual circumstances.
4. Do not execute the NEW CONFIG command, or STORE TO CPU commands if a module is installed and does not have a user assigned address. If you do, the CPU will assign an address starting at I0001 or O0001.

I/O Configuration Check

The CPU checks its I/O configuration on each power-up cycle (if I/O check is configured through Logicmaster 5) to determine if its I/O structure has changed since the last power-up. If it has changed, an I/O CONFIG CHANGED ERROR will occur. This error indication is to inform the user of a potentially dangerous situation, such as a module removed or a rack that has been disconnected from the I/O chain.

It may be desirable for the user to temporarily disable the I/O CONFIG CHECK function on power-up. If you will be removing and installing modules and require frequent power cycles, such as during debugging or troubleshooting, and if user addresses have been assigned to all modules to be installed, you may want to disable the I/O CONFIG CHECK function, until debugging or troubleshooting has been completed. After debugging or troubleshooting, the I/O CONFIG CHECK function should be enabled so that I/O configuration changes are detected if the I/O structure is changed.

I/O Config Changed Error Recovery

If an I/O CONFIG CHANGED error occurs, the recovery procedures are as follows:

- If the error is because of a new, added module that has not been assigned an address by the user, the user should assign an address to the module, and store the new I/O map to the CPU. For more information on how to do this, refer to the information on the I/O assignment screen later in this discussion.
- If the error is due to an added or removed module that already has a user assigned address, and the I/O configuration change should be flagged as an error on the next power-up, execute the OLD CONFIG command.
- If the error is due to an added or removed module that has previously been assigned an address by the user, and the change should not be flagged as an error on the next power-up, execute the NEW CONFIG (accessed from the SCRATCH PAD: I/O CONFIG screen) command (Store to CPU in the I/O ASSIGNMENT screen can also be used, without first editing the I/O assignment map).

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Detailed Information on I/O Addressing and I/O Configuration

The following discussion contains additional information on I/O Addressing and I/O Configuration for those who wish to read more on the subject. The required basic information on I/O Addressing was discussed on the previous pages.

I/O Address Assignment and I/O Configuration Screens

The screens in Logicmaster 5 important to I/O assignments and I/O configuration are described below.

I/O Address Assignment Screen

The key to initial assignment and observation of the I/O assignments by the user, is the I/O ADDRESS ASSIGNMENT screen accessed from the SETUP/DIAGNOSTICS menu in Logicmaster 5. This screen displays a map of the current I/O references assigned to each I/O module, and allows the user to assign I/O references. While in this screen, the user can assign input or output references to modules. These references represent the STARTING ADDRESS of a module in a particular slot.

To avoid address duplication errors, the user must know the number of I/O points for each module, and ensure that the reference numbers do not overlap. I/O slots can be empty, and the addressing does not have to be consecutive.

It is recommended that addresses be assigned to empty slots that will have modules installed in them in the future. As addresses are entered by the user, they will be rounded to the nearest lower valid starting address.

This screen is normally used by the designer of the Series Five PLC application software and hardware to set up a map of the desired I/O assignments. All I/O slots which will eventually be used should be assigned addresses, even if the hardware is not yet available for installation.

If addresses are not assigned, the CPU will attempt to assign addresses beginning at I0001 and O0001 to modules which are later installed in slots that do not have addresses assigned, even if these addresses duplicate user assigned addresses (this causes an I/O DUPLICATE ADDRESS error). The options available through the I/O ADDRESS ASSIGNMENT Screen are described below.

LOAD FROM CPU

- Reads the I/O assignment map currently in the CPU. This is performed automatically upon entry to the screens.
- Error checks the I/O assignment map.

STORE TO CPU

- Tells the CPU to use the I/O assignment map that is displayed. To avoid errors, the user should be sure that addresses are assigned for all currently installed modules.
- Tells the CPU to register any added modules, and delete any removed modules from the registration. This new registration will be used in future I/O Config checks on power-up and on a STOP mode to RUN mode transition.
- Error checks the I/O map and flags an error.

NOTE

> If modules are physically installed, but have not been assigned addresses before using this function, the CPU will assign the modules consecutive addresses starting at reference I0001 or O0001.

CLEAR CPU

This command prepares the CPU for CPU addressing, and is not normally used. If followed by the STORE TO CPU or NEW CONFIG commands, the CPU assigns addresses. These commands should be used with caution.

CLEAR FIELD

During editing of the I/O assignment map, selection of this soft key clears both I and O entries at the cursor location.

BASES 0 - 3, BASES 4 - 7

Selects which base unit map is to be displayed.

LED/I/O ADDR

When selected, tells I/O status LEDs to display the starting I/O address of the module.

I/O Configuration Screen

This screen is accessed from the SCRATCH PAD screen. This screen is used after a complete, accurate I/O map has been stored to the CPU as described above. While system debugging or troubleshooting, it may be necessary to remove an I/O module, or install an I/O module not previously available, but which did have an address assigned by the user.

If modules are inserted or removed, an I/O CONFIG CHANGED ERROR will occur. When this happens, one of the functions described below must be executed.

NEW CONFIG - This function is used after a module is inserted or removed from the I/O structure. When executed, this function tells the CPU to accept the present configuration of modules even though it is not the same as the previous configuration. On the next power-up sequence, this new configuration will be the one that the CPU checks to see if it has changed.

NOTE

When executed, this function also causes the CPU to assign addresses starting with Input I0001 or Output O0001 to any modules that do not already have addresses.

OLD CONFIG - This function allows you to temporarily override the I/O CONFIG CHANGED ERROR. After selecting this function, the CPU will operate normally until the next power cycle. When power is next cycled, another I/O CONFIG CHANGED ERROR will occur to inform the user that the configuration is still not the same as the original configuration.

SET/CLR I/O CFG CHK - This function is used to tell the CPU whether or not to check the actual installed I/O modules against the configuration currently stored in the memory cartridge (the "OLD" Configuration). This is usually the configuration when power was last removed from the system. It is recommended that this function remain in the ENABLE (checked) mode except when debugging or troubleshooting a system.

Functions Used During Future Additions or Removals of I/O Modules

Following is a more detailed description of the Logicmaster 5 functions used when adding or removing modules in a system that is already up and running.

NEW CONFIG

This is used when new modules are added (if addresses have already been assigned), or if modules are removed for troubleshooting. After adding the new module or removing a module, an I/O CONFIG

CHANGED error will be displayed on the screen. The NEW CONFIG function clears the error and does the following:

- Tells the CPU to register any modules that have been added and unregister any removed modules.
- The CPU attempts to address any modules that were not assigned addresses in the I/O assignment map. CPU assigned addresses will start at I0001 and O0001.
- Error checks the I/O map and flags an error. To avoid any errors, the address should already have been assigned for this module.
- Tells the CPU to include this new module in future I/O configuration checks at power-up or STOP to RUN mode transitions.

OLD CONFIG

If a new module is to be added and an address has not yet been assigned for the added module, this soft key should not be used. The user should, instead, proceed to the I/O ADDRESS ASSIGNMENT screen, edit the I/O ASSIGNMENT map to reflect the new module, and STORE TO CPU.

The OLD CONFIG function is also used when modules are added or removed. After adding a new module or removing a module, an I/O CONFIG CHANGED error will be displayed. This function temporarily clears the error and causes the following to happen:

- It **DOES NOT** permanently register the new added module or a removed module.
- The CPU ignores the fact that the current real I/O configuration is different than the previous real I/O configuration (read from the memory cartridge).
- The CPU goes to the RUN mode when commanded to do so.
- On the next power-up sequence, an I/O CONFIG CHANGED error will be detected and displayed, and the CPU will stay in the STOP mode.

If a module is added, and an address has not already been assigned to it, do not use this soft key. The user, should instead, proceed to the I/O ADDRESS ASSIGNMENT screen, edit the I/O assignment map to reflect the change, and STORE TO CPU.

SET/CLR I/O CFG CK

This function enables or disables the CPU checking of the actual I/O configuration compared to the I/O assignments stored in the memory cartridge, which are detected on power-up, or when going from the STOP to RUN mode.

I/O Configuration Check

When the CPU is powered-up or a STOP to RUN mode transition is made, the actual I/O module configuration is checked with the previous configuration stored in the memory cartridge. If the configurations are different, the CPU issues an I/O CONFIG CHANGED error. The I/O Configuration Check function selected through Logicmaster 5 should normally be left enabled. However, if the system is to continue to operate normally through a power cycle, even though modules have been added or removed, this function can be set to be disabled.

This would inhibit I/O CONFIGURATION CHANGED errors at power-up. If this feature is used, it is recommended that all I/O addresses be assigned by the user, and not by the CPU. If the CPU assigns addresses, the addresses will change on each power-up when modules are removed or added.

NOTE

When the CPU mode is changed from SET/CLR I/O CFG CK - DISABLE to ENABLE, the CPU is then in the CPU address assignment mode. Before performing this function, be sure that you have saved your I/O assignments on diskette if you intend to use the same assignments again.

The I/O assignment map created by the user can be stored on diskette and loaded back to a new CPU memory cartridge. For detailed instructions on how to perform this function, refer to the discussion on the Load/Store/Verify (LSV) function in the Logicmaster 5 Programming and Documentation Software User's Manual, GFK-0023.

CPU Addressing

How I/O Reference Numbers are Assigned

There are two ways to assign I/O references in the Series Five PLC.

- *User Assigned.* The user assigns the starting addresses of the I/O modules using Logicmaster 5. This is the recommended method for assigning I/O references.
- *CPU Assigned.* The CPU will assign references if the user has not assigned them to the I/O modules. This method is useful under certain conditions, however, it is **NOT RECOMMENDED** except as described below.

When the CPU Assigns References

It is important to understand that during system start-up or debugging, as modules are inserted or removed, the I/O references WILL CHANGE if CPU addressing has been used. The I/O references WILL NOT CHANGE if the user has assigned them through Logicmaster 5.

On power-up and under certain other conditions, if the CPU finds an installed module that does not have an address that was assigned by the user, the CPU will attempt to assign it an address starting at I0001 or O0001. This may conflict with user assigned addresses. Because of this possible conflict, it is recommended that the user assign all addresses.

When the CPU addressing option is allowed, the CPU looks at its I/O structure and assigns addresses based on the modules that are actually installed. This method requires little effort on the part of the user, but problems can arise if the system is not complete, or as later changes are made to the system. If modules are inserted or removed from the I/O structure, upstream addresses (higher reference numbers) will change until the original configuration is restored.

Addresses that have been assigned by the CPU are reassigned under the following conditions:

- The user has never stored a user assigned configuration from LM5, the CPU is powered-up, a NEW CONFIG command is sent, and the CPU is commanded to the RUN mode.
- If the user stored a user configuration, then later added modules without updating the I/O assignment map, and powered-up the CPU.

NOTE

If it is desired to have the system start up automatically after a power cycle and not have the addressing change, all I/O modules must be user addressed, not CPU addressed, and the I/O CONFIG CHECK function must be disabled.

The user would normally want this done only during a temporary condition, such as debugging or troubleshooting, or during limited operation when all modules are not present.

When to Use CPU Addressing

CPU addressing can be used during initial startup under some circumstances so that the user does not have to assign addresses individually to each slot. Use this method if:

- All modules to be used are available for installation.
- Addresses that will be assigned sequentially by the CPU are acceptable for your application.

How to Use CPU Addressing

If the above conditions are acceptable, use the following procedure for CPU addressing:

- Install all modules and turn on power.
- If you are reusing a memory cartridge that has previously been programmed with address assignments, proceed to the I/O ADDRESS ASSIGNMENT screen and execute a CLEAR CPU command. Otherwise, proceed to the next step.
- Go to the SCRATCH PAD screen menu, select the I/O CONFIGURATION UTILITIES menu, and issue a NEW CONFIG command. This tells the CPU to register all of the modules and create an I/O assignment map starting with references I0001 for inputs and O0001 for outputs.
- Return to the I/O ADDRESS ASSIGNMENT screen and select the LOAD FM CPU function. This causes the CPU generated address assignments to be displayed.
- Execute the STORE TO CPU command. This tells the CPU to interpret the address assignments as user assignments, and should never be changed by the CPU as modules are installed or removed in the future, and should never be CPU assigned.

You now have a user assigned I/O map. For future additions and removals of modules, use the procedures for I/O address assignments that were described previously.

I/O Configuration Check Sequence at Power-Up

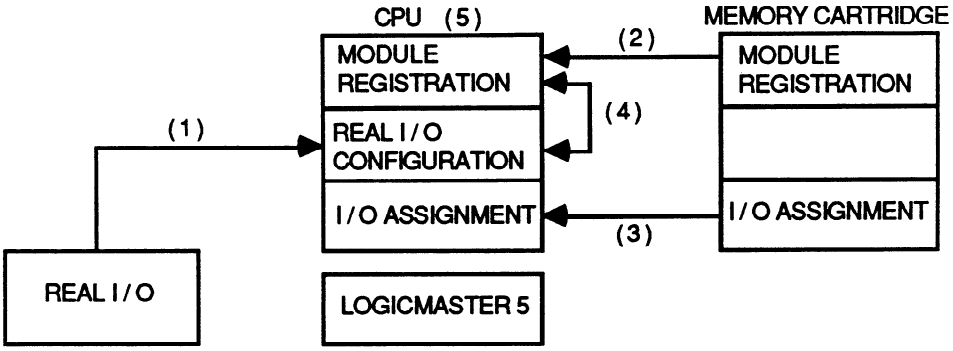
When power is applied, the CPU loads into its memory, the I/O assignment map contained in the memory cartridge. The CPU then checks its current I/O configuration with the previous I/O configuration to determine if a module has been removed, inserted, or become inactive.

If desired, this function can be disabled through the I/O CONFIGURATION CHECK function. If this check is enabled, and the previous I/O configuration is different than the present one, the CPU will flag an I/O CONFIG CHANGED error. The user must do one of the following:

- Key-in a NEW CONFIG command from the I/O CONFIGURATION UTILITIES menu .
- Key-in an OLD CONFIG command from the I/O CONFIGURATION UTILITIES menu.
- Store an I/O assignment map after editing, if necessary, to ensure that all actual installed I/O modules have had addresses assigned to them.

The normal condition is that there will be no I/O CONFIG CHANGED error, and operation will proceed without interruption. The CPU power-up and STOP to RUN mode transition sequence is shown in the following figure and described following the figure.

a42410



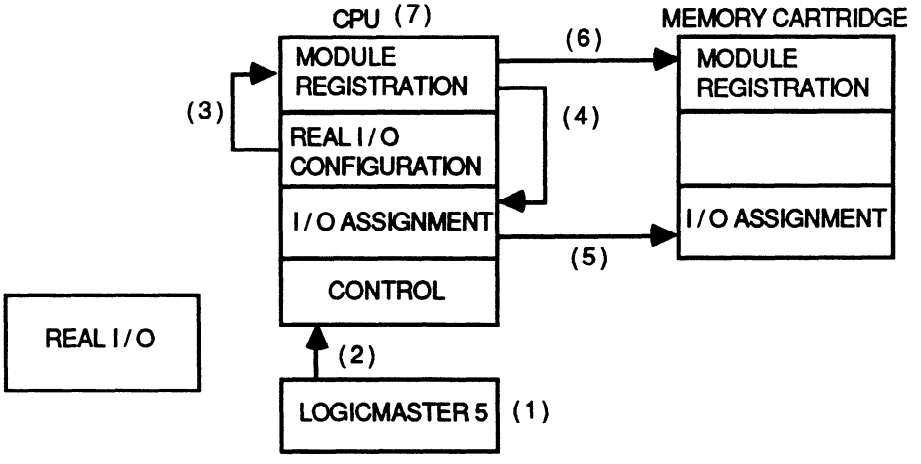
1. CPU looks at real installed I / O and creates configuration map.
2. CPU loads previous I / O registration from memory cartridge.
3. CPU loads previous I / O assignment from memory cartridge.
4. CPU compares previous I / O registration with real I / O configuration. If they are not equal, the CPU sets an error flag for I / O CONFIG CHANGED ERROR (if I / O CONFIG CHECK function is enabled).
5. CPU error checks the I / O assignment map looking for duplicate or overlapping addresses, and addresses out of range.

Figure 4-1. Power-Up and Stop to Run Mode Sequence

Adding or Removing Modules

The following figure describes the sequence that occurs when a module is added or removed.

a42411



1. CPU software detects an I / O CONFIG CHANGED ERROR, which is reported by Logicmaster 5
2. Logicmaster 5 sends NEW CONFIG command to CPU.
3. Any added or removed modules are registered in CPU memory.
4. Modules without addresses will have addresses assigned to them by the CPU at this time. These addresses are added to I / O assignment map.
5. The new I / O assignment is stored in the memory cartridge.
6. The new I / O registration is stored in the memory cartridge.
7. The CPU error checks the I / O assignment map, looking for duplicate or overlapping addresses, and addresses out of range.

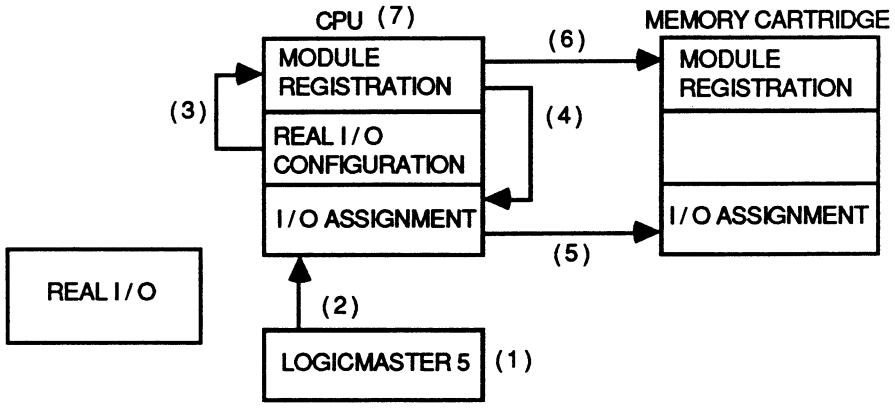
NOTE : If an OLD CONFIG command is selected instead of NEW CONFIG command, steps 3 - 6 above do not occur, however, the CPU can go to the RUN mode, and will continue normal operation until the next power cycle.

Figure 4-2. Module Add or Remove Sequence

I/O Assignment Sequence

The following figure describes the steps that occur during the I/O assignment sequence.

a42412



1. Logicmaster 5 creates the I / O assignment map as selected by the user.
2. Logicmaster 5 stores map to the CPU through the STORE TO CPU function.
3. Logicmaster 5 issues a NEW CONFIG command, and new modules are registered.
4. Modules without addresses have addresses assigned by the CPU, and these addresses are added to the I / O assignment map.
5. The new I / O assignment is stored in the memory cartridge.
6. The new I / O registration is stored in the memory cartridge.
7. The CPU error checks the I / O assignment map, looking for duplicate or overlapping addresses, and addresses out of range.

Figure 4-3. I/O Assignment Sequence

Execution Times and Memory Used for Programming Functions

The following table provides a list of the execution times for each of the Series Five PLC programming functions, and the number of memory words used by each function. This table is helpful for calculating the total scan time of your application program before actually running the program.

Table 4-1. Memory Used and Execution Time

Function	Memory (words)	Execution Time (microseconds)		
		Best	Worst	Inactive
Start Series Branch (NO)	1	.8	-	-
Start Parallel Branch (NO)	1	.8	-	-
Start Series Branch (NC)	1	1.12	-	-
Start Parallel Branch (NC)	1	1.12	-	-
End Series Branch	1	1.44	-	-
End Parallel Branch	1	1.44	-	-
AND (NO, NC)	1	.48	-	-
OR (NO, NC)	1	.48	-	-
Output Relay	1	1.12	-	-
Output One-Shot	1	1.92	-	-
Output Latch	1	.48	-	-
Unlatch	1	1.76	2.08	-
Phantom Output	1	.48	-	-
Preset Register (PREG)	2	2.72	3.52	-
Accumulate Register (ACCG)	2	2.56	-	-
Timer - 1.0 Second (TS)	1	6.56	14.72	-
Timer - 0.1 Second (TT)	1	6.56	14.72	-
Timer - 0.01 Second (TH)	1	6.56	14.72	-
Up Counter (CU)	1	7.36	16.0	-
Down Counter (CD)	1	7.04	11.68	-
BIN TO BCD	2	186.00	249.00	2.40
BCD TO BIN	2	195.00	216.00	2.40
MCR (Master Control Relay)	1	194.00	t1 *	.64
SKIP	1	161.00	t2 *	.64
NO OP	1	.48	-	-
ENDSW	1	144.00	-	-
MOVE A To B	3	120.40	-	1.76
MOVE LEFT 8 Bits	3	11.04	11.20	3.04
MOVE RIGHT 8 Bits	3	11.04	11.20	3.04
BLOCK MOVE	10	283.00	283.00	41.00
Signed Addition (ADDX)	4	20.64	23.76	4.16
Signed Subtraction (SUBX)	4	20.64	24.64	4.16
Signed Multiplication (MPY)	4	60.00	76.00	2.40
Signed Division (DVD)	5 - 6	407.00	426.00	2.40
Double Precision Add (DPADD)	4 - 6	23.36	26.24	4.16
Double Precision Subtract (DPSUB)	4 - 6	23.68	27.20	4.16
GREATER THAN	3 - 5	17.44	19.52	3.52
EQUAL	2	5.12	-	-
SOURCE-TO-TABLE	4	225.00	260.00	3.68
TABLE-TO-DEST	4	230.00	232.00	3.68
MOVE TABLE	4	190.00	952.00	3.68
ADD-TO-TOP	4	248.00	1151.00	3.68

Table 4-1. Memory Used and Execution Time - Continued

Function	Memory (words)	Execution Time (microseconds)		
		Best	Worst	Inactive
REM-FM-BOTTOM	4	231.00	242.00	3.68
REM-FM-TOP	4	254.00	1133.00	3.68
AND (Logical AND)	5	238.00	5382.00	4.32
IOR (Logical Inclusive OR)	5	220.00	5142.00	4.32
EOR (Logical Exclusive OR)	5	241.00	5385.00	4.32
INV (Logical Invert)	4	195.00	4609.00	3.68
BIT SET	4	245.00	259.00	3.68
BIT CLEAR	4	234.00	248.00	3.68
BIT SENSE	4	218.00	232.00	3.68
SHIFT RIGHT	4	251.00	80108.00	3.68
SHIFT LEFT	4	255.00	69859.00	3.68
DO SUB	3	74.00	74.00	3.04
RETURN	1	49.00	-	-
Suspend I/O	1	3.52	-	.64
DO I/O	3	314.00	t3 *	2.88
WINDOW	3	-	-	2.88
RDDEV (Read Device)	2	277.00	6785.00	2.40
WRDEV (Write Device)	2	277.00	7211.00	2.40
RDCCM (Read CCM)	2	403.00	407.00	2.40
WRCCM (Write CCM)	2	484.00	1372.00	2.40

The worst case times for instructions referenced to t1, t2, and t3 are calculated using the following formulas. All times are in microseconds.

t1: 84 + (34 x Number of instructions (except coil) + (101 x Number of coils)) = microseconds
t2: 51 + (34 x Number of instructions (except coil) + (32 x Number of coils)) = microseconds
t3: 277 + (37 x Number of bytes) = microseconds

NOTE

SKIP and MCR instructions should not be used as a mechanism to decrease scan time. As shown by the formula, scan time may increase when these instructions are active (based on the individual program).

I/O Update Time Calculation

The total I/O update time for your Series Five PLC is the total update time for all Input modules plus total update time for all output modules in the Series Five I/O system. I/O update time calculation is as follows:

Input update.....Tin = (77.0 x IM) + 6μs for 32 point modules

Input update.....Tin = (38.5 x IM) + 6μs for 16 point modules

where IM = number of input modules

Add these two figures to get the total input update time.

Output update.....Tout = (92.0 x OM) + 6μs for 32 point modules

Output update.....Tout = (46.0 x OM) + 6μs for 16 point modules

where OM = number of output modules

Add these two figures to get the total output update time.

For example, your system has five 32 point input modules and seven 16 point output modules; total I/O update time is:

Tin + Tout = (77 x 5) + 6 + (46 x 7) + 6

Tin + Tout = 719 microseconds

Special Purpose Contacts, Registers and Scratch Pad Bytes

The Series Five PLC has several areas of memory which provide either special functions, system status information, or error reporting information. These are the special purpose contacts, dedicated registers, and the CPU's scratch pad memory. The special contacts and dedicated registers can be used, if desired, by the user logic program as part of a custom diagnostic package. Definitions for these items are provided in the following tables.

Special Purpose Contacts

Special purpose contacts are a group of 512 internal contacts that have special system meaning. Some of these contacts provide special functions to the user, such as a clock having a specific pulse width or time duration, while others provide system error information. These contacts are not available as real world inputs, but can be used within the user logic program as needed. References for these contacts are I1-0001 through I1-0512. Special purpose contacts listed as not used or for internal use by the CPU are not available to the user. A 1 in the table (under definition) indicates a logic 1.

Table 4-2. Special Purpose Contact Definition

Reference	Purpose	Definition
I1-0001	Initial Reset	Off in stop mode; on for first scan after going to RUN; off thereafter.
I1-0002	Always On	Used as an "always" on conditional contact.
If the minimum pulse width is longer than the scan time -- the following five clocks are no longer accurate.		
I1-0004	1 Minute Clock	Provides a pulse 30 seconds off, 30 seconds on.
I1-0005	1 Second Clock	Provides a pulse .5 Seconds off, .5 seconds on.
I1-0006	100 msec. Clock	Provides a pulse 50 msec. off, 50 msec. on.
I1-0007	50 msec. Clock	Provides a pulse 24 msec. off, 26 msec. on.
I1-0008	Scan time Clock	Provides a pulse on for 1 scan, off for 1 scan.
I1-0009	Not used	- Not available for program use -
I1-0010	Forced RUN	1 = running, CPU keyswitch in the RUN position.
I1-0011	OIU RUN	1 = running, CPU keyswitch in the OIU position.
I1-0015	OIU STOP	1 = CPU stopped, keyswitch in the OIU position.
I1-0016	Stop Relay	CPU is stopped for any reason
I1-0020	Suspend I/O	1 = I/O is suspended
I1-0033	Critical System Error	1 = error, CPU goes to STOP mode.
I1-0034	Non-Critical System Error	1 = error, CPU remains in RUN mode.
I1-0035	Diagnostic Error	1 = error detected
I1-0036	Battery Not Normal	1 = CPU or memory cartridge battery voltage low.
I1-0037	Memory Error	1 = latches if a memory cartridge error occurs.
I1-0038	I/O Error	1 = latches if I/O bus error is detected.
I1-0039	Communications Error	1 = Turned ON by a CCM error. Next successful communications will turn it off.
I1-0040	I/O Configuration Error	1 = error detected, I/O configuration has changed since last power-up.
I1-0041	Internal use	- Not available for program use -
I1-0042	Watchdog Timeout	1 = Watchdog timer has timed out.
I1-0043	Internal Program Error	1 = Error (this should never occur.
I1-0044	Internal Math Error	1 = Error
I1-0045	Smart Module Communications Error	1 = Error
I1-0046 to I1-0064	Internal use	- Not available for program use -
I1-0065	I/O Retry Parity Status	1 = Parity error after specified number of retries 0 = OK, no parity error detected
I1-0066	Non-Critical Rack	1 = Non-critical rack, 0 = Critical rack (that reported parity error setting I1-0065)
I1-0067 to I1-0076	Internal use	- Not available for program use -
I1-0077	RD CCM	1 = RD CCM thru CPU is busy; 0 = not busy
I1-0078	RD CCM	1 = RD CCM thru CPU error (see below); 0 =no error
I1-0079	WR CCM	1 = WR CCM thru CPU is busy; 0 = not busy
I1-0080	WR CCM	1 = WR CCM thru CPU error (see below); 0 =no error
I1-0081 to I1-0208	Smart Module Communication Status - see Table 4.3	
I10209 to I1-464		

NOTE

When running a program using retentive contacts, the battery low contact (I1-0036) should be used to stop the CPU (using a Transfer instruction). This would normally apply when using RAM memory, but not necessarily with PROM memory since some applications require the use of PROM memory with no battery required in the system. These applications cannot have any retentive contacts, since there will be no battery.

Smart Module Communication Status

I1-0081 to I1-0208 are special purpose contacts for the smart module communication status.

There are two special purpose contact references for each slot in each rack, as shown in the table. Each reference is a status bit for smart module communications status, if a smart module is installed in that slot. Each reference has two possible conditions, 1 (ON) and 0 (OFF).

Status definition for the first reference (e.g., I1-81) is: 0 = not executing, 1 = executing.
Status definition for the second reference (e.g., I1-82) is: 0 = no error, 1 = error.

Table 4-3. Special Internal Inputs Definition (Smart Module)

Slot	Rack 0	Rack 1	Rack 2	Rack 3	Rack 4	Rack 5	Rack 6	Rack 7
0	I1-81 I1-82	I1-97 I1-98	I1-113 I1-114	I1-129 I1-130	I1-145 I1-146	I1-161 I1-162	I1-177 I1-178	I1-193 I1-194
1	I1-83 I1-84	I1-99 I1-100	I1-115 I1-116	I1-131 I1-132	I1-147 I1-148	I1-163 I1-164	I1-179 I1-180	I1-195 I1-196
2	I1-85 I1-86	I1-101 I1-102	I1-117 I1-118	I1-133 I1-134	I1-149 I1-150	I1-165 I1-166	I1-181 I1-182	I1-197 I1-198
3	I1-87 I1-88	I1-103 I1-104	I1-119 I1-120	I1-135 I1-136	I1-151 I1-152	I1-167 I1-168	I1-183 I1-184	I1-199 I1-200
4	I1-89 I1-90	I1-105 I1-106	I1-121 I1-122	I1-137 I1-138	I1-153 I1-154	I1-169 I1-170	I1-185 I1-186	I1-201 I1-202
5	I1-91 I1-92	I1-107 I1-108	I1-123 I1-124	I1-139 I1-140	I1-155 I1-156	I1-171 I1-172	I1-187 I1-188	I1-203 I1-204
6	I1-93 I1-94	I1-109 I1-110	I1-125 I1-126	I1-141 I1-142	I1-157 I1-158	I1-173 I1-174	I1-189 I1-190	I1-205 I1-206
7	I1-95 I1-96	I1-111 I1-112	I1-127 I1-128	I1-143 I1-144	I1-159 I1-160	I1-175 I1-176	I1-191 I1-192	I1-207 I1-208

Genius Communications Status

Input bits I1-0209 to I1-0464 show the status of Genius communications. (0 = Not Communicating, 1 = Communicating)

Table 4-4. Special Purpose Contacts for Genius I/O Communications Status

Serial Bus Address	Slot 0	Slot 1	Slot 2	Slot 3	Slot 4	Slot 5	Slot 6	Slot 7
0	I1-0209	I1-0241	I1-0273	I1-0305	I1-0337	I1-0369	I1-0401	I1-0433
1	I1-0210	I1-0242	I1-0274	I1-0306	I1-0338	I1-0370	I1-0402	I1-0434
2	I1-0211	I1-0243	I1-0275	I1-0307	I1-0339	I1-0371	I1-0403	I1-0435
3	I1-0212	I1-0244	I1-0276	I1-0308	I1-0340	I1-0372	I1-0404	I1-0436
4	I1-0213	I1-0245	I1-0277	I1-0309	I1-0341	I1-0373	I1-0405	I1-0437
5	I1-0214	I1-0246	I1-0278	I1-0310	I1-0342	I1-0374	I1-0406	I1-0438
6	I1-0215	I1-0247	I1-0279	I1-0311	I1-0343	I1-0375	I1-0407	I1-0439
7	I1-0216	I1-0248	I1-0280	I1-0312	I1-0344	I1-0376	I1-0408	I1-0440
8	I1-0217	I1-0249	I1-0281	I1-0313	I1-0345	I1-0377	I1-0409	I1-0441
9	I1-0218	I1-0250	I1-0282	I1-0314	I1-0346	I1-0378	I1-0410	I1-0442
10	I1-0219	I1-0251	I1-0283	I1-0315	I1-0347	I1-0379	I1-0411	I1-0443
11	I1-0220	I1-0252	I1-0284	I1-0316	I1-0348	I1-0380	I1-0412	I1-0444
12	I1-0221	I1-0253	I1-0285	I1-0317	I1-0349	I1-0381	I1-0413	I1-0445
13	I1-0222	I1-0254	I1-0286	I1-0318	I1-0350	I1-0382	I1-0414	I1-0446
14	I1-0223	I1-0255	I1-0287	I1-0319	I1-0351	I1-0383	I1-0415	I1-0447
15	I1-0224	I1-0256	I1-0288	I1-0320	I1-0352	I1-0384	I1-0416	I1-0448
16	I1-0225	I1-0257	I1-0289	I1-0321	I1-0353	I1-0385	I1-0417	I1-0449
17	I1-0226	I1-0258	I1-0290	I1-0322	I1-0354	I1-0386	I1-0418	I1-0450
18	I1-0227	I1-0259	I1-0291	I1-0323	I1-0355	I1-0387	I1-0419	I1-0451
19	I1-0228	I1-0260	I1-0292	I1-0324	I1-0356	I1-0388	I1-0420	I1-0452
20	I1-0229	I1-0261	I1-0293	I1-0325	I1-0357	I1-0389	I1-0421	I1-0453
21	I1-0230	I1-0262	I1-0294	I1-0326	I1-0358	I1-0390	I1-0422	I1-0454
22	I1-0231	I1-0263	I1-0295	I1-0327	I1-0359	I1-0391	I1-0423	I1-0455
23	I1-0232	I1-0264	I1-0296	I1-0328	I1-0360	I1-0392	I1-0424	I1-0456
24	I1-0233	I1-0265	I1-0297	I1-0329	I1-0361	I1-0393	I1-0425	I1-0457
25	I1-0234	I1-0266	I1-0298	I1-0330	I1-0362	I1-0394	I1-0426	I1-0458
26	I1-0235	I1-0267	I1-0299	I1-0331	I1-0363	I1-0395	I1-0427	I1-0459
27	I1-0236	I1-0268	I1-0300	I1-0332	I1-0364	I1-0396	I1-0428	I1-0460
28	I1-0237	I1-0269	I1-0301	I1-0333	I1-0365	I1-0397	I1-0429	I1-0461
29	I1-0238	I1-0270	I1-0302	I1-0334	I1-0366	I1-0398	I1-0430	I1-0462
30	I1-0239	I1-0271	I1-0303	I1-0335	I1-0367	I1-0399	I1-0431	I1-0463
31	I1-0240	I1-0272	I1-0304	I1-0336	I1-0368	I1-0400	I1-0432	I1-0464

Special Outputs Definition

A group of bits in the internal output status table are reserved for use with the Series Five Genius bus controller or Operator Interface Unit. These internal outputs are references O2-1000 through O2-1024.

Table 4-5. Special Purpose Internal Coils

Reference	Written By		Definition
	CPU	User	
02-1000			1 = OIU Escape key locked; 0 = unlocked; can be set by user program
02-1001			1 = OIU buzzer ON; 0 = buzzer OFF; can be set by user program
02-1002			1 = OIU keyclick ON; 0 = keyclick OFF; can be set by user program
02-1003			1 = OIU backlight ON; 0 = backlight OFF; can be set by user program
02-1004			Printer output start: 1 = set by user program; 0 = ready, (set by OIU)
02-1005			Transfer cartridge ID start: 1 = set by user program; 0 = set by OIU
02-1006			Transfer data from OIU to CPU: 1 = set by user program; 0 = ready, (set by OIU)
02-1007			Transfer data from CPU to OIU: 1 = set by user program; 0 = ready, (set by OIU)
02-1008			Clear memory cartridge: 1 = set by user program; 0 = done, (set by OIU)
02-1009			1 = printer error; 0 = printer OK, no error.
02-1010			1 = memory cartridge error; 0 = memory cartridge OK, no error.
02-1011 to 02-1018			Reserved for future use.
02-1019	X		SETUP ERROR - If set by the CPU, the data in registers R04049 -R04051 is incorrect. The register data is only checked when the ENABLE Genius DIAGNOSTICS bit (02-1024) transitions from CLEARED to SET, or during power-up if the CPU is in RUN or RUN DISABLED mode and the ENABLE Genius DIAGNOSTICS bit is SET. If a SETUP ERROR exists, the Genius diagnostic routine is not executed.
02-1020	X		FAULT TABLE OVERFLOW - If SET by the CPU, this bit indicates that a fault table overflow exists. An overflow occurs if the value of the NUMBER OF FAULTS register (R04051) is greater than the value of the LENGTH OF FAULT TABLE register (R4050). This bit remains set as long as the overflow condition exists. The CPU will CLEAR the bit when there is no overflow condition. If diagnostics are enabled this bit will be updated every sweep when the CPU is in the RUN or RUN DISABLED mode.
02-1021	X	X	PULSE TEST - If set by user logic, the CPU sends a PULSE TEST datagram to all logged in devices in the system. The CPU monitors this bit, and if it is SET the CPU directs a PULSE TEST datagram to each logged-in device in the system (a maximum of one PULSE TEST datagram is sent by each Genius bus controller in the system per CPU sweep.) When the PULSE TEST datagram has been sent all devices in the system, the CPU CLEARS this bit.

Table 4-5. Special Purpose Internal Coils - Continued

Reference	Written By		Definition
	CPU	User	
			If diagnostics are enabled, this bit will be checked every sweep when the CPU is in the RUN or RUN/DISABLED mode, except when the pulse test or clear all faults function is in progress. If the PULSE TEST bit and the CLEAR ALL FAULTS bit are SET at the same time, the clear all faults function will be performed first.
02-1022	X	X	CLEAR ALL FAULTS - To initiate a Clear All Faults command to all logged in devices in the system, this bit should be set by user logic. The CPU monitors this bit, and if it is SET the CPU will CLEAR the NUMBER OF FAULTS register (R04051). The CPU will then direct a CLEAR ALL FAULTS datagram to each logged-in device in the system (a maximum of one CLEAR ALL FAULTS datagram is sent by each GENI in the system per CPU sweep). When the CLEAR ALL FAULTS datagram has been sent to all devices in the system, the CPU will CLEAR this bit. If diagnostics are enabled, this bit will be checked every sweep when the CPU is in the RUN or RUN DISABLED mode, except when the pulse test or clear all faults function is in progress. If the PULSE TEST bit and the CLEAR ALL FAULTS bit are SET at the same time, the clear all faults function will be performed first.
02-1023		X	REPORT ADD/LOSS OF BLOCK AS FAULT - If this bit is SET by the logic, the addition or loss of a device in the system will be reported as a fault in the fault table, otherwise these conditions are not entered into the fault table. If diagnostics are enabled, this bit will be checked every sweep when the CPU is in the RUN or RUN DISABLED mode.
02-1024		X	ENABLE Genius DIAGNOSTICS - If this bit is SET, then Genius diagnostics will be processed by the CPU. If the bit is CLEARED, then Genius diagnostics routine is not executed, and the CPU will not write to internal outputs 02-1019 through 02-1022. This bit will be checked every sweep when the CPU is in the RUN or RUN Disabled mode.

Reserved Register Definitions

Registers R4000 - R4096 are generally used by the Series Five CPU and are not available for general use. Also, registers 3850 through 3999 (when using Genius I/O default values) are reserved by the system and the data to be stored in them has special meaning as listed below.

Some of the registers contain valuable information pertaining to various system errors. For example, when certain system errors or conditions occur, information relative to the error or condition is stored in specified registers, and is available for user intervention. These registers should not be used as general purpose registers for data storage or data manipulation.

Table 4-6. Reserved Register Definition

Register Reference	Definition - Contents of Register	Data Format
R3850 - R3999	Default Genius diagnostics faults (10 per fault)	
R4000	OIU Memory Cartridge Data Transfer register	Binary
R4001	OIU Printer register pointer	Binary
R4002	OIU Printer port setup register	Binary
R4003	OIU Display register pointer	Binary
R4004 - R4040	Reserved for future use	
R4041	Genius bus scan time (slot 0)	Binary
R4042	Genius bus scan time (slot 1)	Binary
R4043	Genius bus scan time (slot 2)	Binary
R4044	Genius bus scan time (slot 3)	Binary
R4045	Genius bus scan time (slot 4)	Binary
R4046	Genius bus scan time (slot 5)	Binary
R4047	Genius bus scan time (slot 6)	Binary
R4048	Genius bus scan time (slot 7)	Binary
R4049	Genius diag - starting register for fault table (DEF=R3850)	Binary
R4050	Genius diag - number of faults to be registered (DEF=max=15)	Binary
R4051	Genius diagnostics -- number of actual faults	Binary
R4052 - R4056	Reserved for future use	Binary
R4057	GENI Slot 0 SBA conflict address/CCM RCV Buffer Pointer	Binary
R4058	GENI Slot 1 SBA conflict address/ :	Binary
R4059	GENI Slot 2 SBA conflict address/ :	Binary
R4060	GENI Slot 3 SBA conflict address/ :	Binary
R4061	GENI Slot 4 SBA conflict address/ :	Binary
R4062	GENI Slot 5 SBA conflict address/ :	Binary
R4063	GENI Slot 6 SBA conflict address/ :	Binary
R4064	GENI Slot 7 SBA conflict address/ :	Binary
R4065	OIU Start address of timer register area	Binary
R4066	OIU Number of timers	Binary
R4067	OIU Start address of counter register area	Binary
R4068	OIU Number of counters	Binary
R4069	OIU Message pointer for ASCII display	Binary
R4070	OIU Key code buffer for operator key entry	Binary
R4071	OIU Message pointer for ASCII display (upper line)	Binary
R4072	OIU Mode register	Binary
R4073	Address of math error	
R4074	Not used	n/a
R4075	Current ID of module - I/O CONFIG ERROR	Binary
R4076	Previous ID of module - I/O CONFIG ERROR	Binary
R4077	Rack and Slot numbers - I/O CONFIG ERROR	BCD
R4078	Critical system error; (e.g., no memory cartridge) CPU stops	BCD
R4079	Somewhat critical system error; (e.g., blown fuse) CPU continues running.	BCD
R4080	System error - not serious; (e.g., battery voltage low) CPU continues running.	BCD
R4081	Error Code - MODULE ERROR	BCD
R4082	Circuit number - MODULE ERROR	BCD
R4083	Rack and Slot number - MODULE ERROR	BCD
R4084 - R4085	Reserved for future use	n/a
R4086	Scan counter	Binary
R4087	Seconds - calendar/clock	BCD
R4088	Minutes - calendar/clock	BCD
R4089	Hour - calendar/clock	BCD
R4090	Day of Week - calendar/clock (2)	BCD
R4091	Day - calendar/clock	BCD
R4092	Month - calendar/clock	BCD
R4093	Year - calendar/clock	BCD
R4094	Last Scan Time (in milliseconds)	Binary
R4095	Minimum Scan Time (in milliseconds)	Binary
R4096	Maximum Scan Time (in milliseconds)	Binary

1. The OIU for the Series Five PLC will be available in the second half of 1988.
2. For day of week display on programmer: 0 = Sunday 1 = Monday 2 = Tuesday 3 = Wednesday 4 = Thursday 5 = Friday 6 = Saturday
3. View BCD data format in hexadecimal mode.

CPU Error Flag Display and Messages

When faults are detected by the CPU during normal operation or during self-checks, an error flag is set in scratch pad memory and displayed on the SCRATCH PAD display CPU ERROR FLAGS line. The CPU ERROR FLAG display contains CPU errors encountered since the last time the errors were cleared. The scratch pad error display is made up of 4 bytes (Scratch pad bytes 10 through 13), with each bit being prioritized to ensure that all error messages are reported in a prioritized order. The contents of all 4 bytes are displayed in binary format on the scratch pad display. This allows all of the error bits to be displayed, even though only one error message can be displayed at-a-time. A HELP text is available that shows the meaning of 24 of the bits (byte 13 contains operating system errors which are not displayed on the HELP screen). The bit priorities range from 1 to 32, with 1 being the highest priority.

If any error flags are set, a message appears on the line directly below the error flags line. *The message displayed will be for the highest priority error.* The following table is a list of all errors with scratch pad bit location and priority.

Table 4-7. Location and Priority for all Error Messages

Scratch Pad Byte	Bit	Priority	Message and (ERROR CODE)
10	0	26	Compilation Error
	1	28	Program Parity Error (E04)
	2	27	Program Error
	3	25	I/O Parity Error (E251)
	4	09	Reserved for future use
	5	24	I/O Bus Error (E250)
	6	05	NO Memory Cartridge Error (E101)
	7	08	I/O Config Changed (E252)
11	0 - 4	18 to 22	X = Don't Care
	5	13	I/O Module Removed (E202)
	6	14	Duplicate I/O Address Error (E261)
	7	15	I/O Address Range Error (E262)
12	0	29	Don't Care
	1	30	Don't Care
	2	23	Watchdog timer timed Out (E03)
	3	12	I/O Error - Refer to table 4.5 in this chapter
	4	10	Memory Battery Low (E41)
	5	11	CPU Battery Low (E41)
	6	06	No Battery in memory cartridge (E44)
	7	07	No CPU battery (E42)

Table 4-7. Location and Priority for all Error Messages - Continued

Scratch Pad Byte	Bit	Priority	Message and (ERROR CODE)
13	0 - 3	01 to 04	Operating system error (not displayed)
	4	16	Operating system error (not displayed)
	5	17	Operating system error (not displayed)
	6	31	Operating system error (not displayed)
	7	32	Operating system error (not displayed)

Table 4-8. Priority Order for Displayed Error Messages

Scratch Pad Byte	Bit	Message and (Error Code)
10	6	NO Memory Cartridge Error (E101)
12	6	No Battery in memory cartridge (E44)
12	7	No CPU battery (E42)
10	7	I/O Config Changed (E252)
12	4	Memory Battery Low (E41)
12	5	CPU Battery Low (E41)
12	3	I/O Error - Refer to table 4.5 in this chapter
11	5	I/O Module Removed (E202)
11	6	Duplicate I/O Address Error (E261)
11	7	I/O Address Range Error (E262)
12	2	Watchdog timer timed Out (E03)
10	5	I/O Bus Error (E250)
10	3	I/O Parity Error (E251)
10	1	CPU Memory Parity Error (E04)

Password Protection for User Logic

A password, consisting of eight decimal digits, for protection of user logic memory in the CPU may be entered through the CPU PASSWORD PROTECTION MENU in LM5. A password protects the program from unauthorized viewing and access, and protects the Series Five PLC from accidental or unauthorized downloads of program data. Passwords do not protect register contents, I/O forcing, or CPU configuration data. To prevent access to that data, the programming device and/or OIU should be removed from the CPU.

When to Use a Password

You may want to use the password function if you wish to protect your user logic program from unauthorized viewing, copying, or overwriting. If these situations are not likely to occur, it is recommended that a password not be used with your application since there is the possibility that the assigned password may be forgotten, or if written down it may be lost, or if the memory cartridge back-up battery is changed the password will be lost. If you do not need a password - don't assign one.

If you only want to protect the user logic program from accidental overwriting, configure the Write Protect Jumper in the memory cartridge to the PROTECT position. This does not prevent you from reading the program.

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Important Password Information

The following information is relevant to password operation, and is important to know when using or considering using password protection for your user logic program.

1. The memory cartridge installed in the CPU contains the password for the user logic program stored in that cartridge.
2. The password can be cleared (reset to 00000000, which is the same as no password) by initializing the CPU Scratch Pad with the INIT CPU function in the CPU CONFIGURATION UTILITIES menu in Logicmaster 5. However, invoking this function will also clear the user logic program and all CPU configuration parameters that have been selected. All of the CPU configuration parameters will be reset to the factory default settings. It will then be necessary to reload the program and configuration parameters.
3. Once the memory cartridge has been unlocked, the password can be changed to a different password than the one in the CPU before it was unlocked, and then again locked - but with a different password. This could be done by anyone who has access to the Series Five PLC

CAUTION

For maximum security when using a password, do not leave the CPU unattended when it is unlocked.

4. When a password has been assigned, locking the CPU does not lock the program stored in Logicmaster 5 memory, only the program stored in the CPU. If Logicmaster 5 is running, and the LM5 program is equal to the CPU program, then the CPU is locked, and the program is still in Logicmaster 5 memory. The user program in Logicmaster 5 memory is available to and accessible to anyone who can see it or copy it to disk.

CAUTION

If you have just locked the CPU and intend to leave Logicmaster 5 connected, Logicmaster 5 memory should be cleared to provide maximum security.

5. Once a password has been entered and the CPU locked, there is no way to gain access to the user program stored in the memory cartridge in the CPU, except to unlock the CPU through Logicmaster 5 by entering the correct password, or by clearing the CPU with the INITIALIZE CPU function - this also clears the user logic memory.
6. Ensure that you record the password and keep it in a safe place, so that if you should forget the password, you will somehow have access to it.
7. Make a copy of your program that is not password protected on a spare memory cartridge and keep it in a safe place.
8. Use a unique password combination, such as your Great Aunt's birthday, that would have no meaning to someone else.
9. If for some reason the password is changed unexpectedly, for example, if the back-up battery voltage is depleted and the password changes, you can recover by using one of the following methods.
   - Use the INIT CPU function to ensure that the memory cartridge is totally cleared. Reload the program from disk and re-enter your password.
   - Use the spare memory cartridge containing a copy of your program with the original unchanged password, or an unprotected copy of your program stored in a memory cartridge.

Initialize CPU Function

The INIT CPU function is accessed from the Scratch Pad menu. When executed, it resets the CPU and clears the contents of the memory cartridge.

CAUTION

The INITIALIZE CPU function should be used with caution since it resets the CPU to all of its factory-set configuration parameters, clears the contents of the memory cartridge, and clears the internal Logicmaster 5 program.

This function is normally used under the following circumstances:

- The user has forgotten the password. When the function is executed, the password will be reset to 00000000, however, the user logic in the memory cartridge will also be cleared.
- A parity error exists in the memory cartridge. Downloading a new program with Logicmaster 5 will usually clear the parity error, however, if the parity error is located in the CPU configuration storage area of the memory cartridge, the INITIALIZE CPU function may be required to clear the error.

It is recommended that before performing this function, be sure that you have a backup copy of the user logic program, and have saved the CPU parameters with the Load/Store/Verify function using Logicmaster 5 software.

Results of Initializing the CPU

When the CPU is reset with the INITIALIZE CPU function, the program residing in Logicmaster 5 memory is cleared, and all of the internal CPU parameters are configured to reflect the following:

- Watchdog Timer is set to 200 milliseconds.
- Password is set to 00000000, which is the same as no password. The previous password will no longer be valid.
- User logic in the memory cartridge is completely cleared.
- Logicmaster 5 memory is cleared.
- A SOURCE NOT EQUAL TO OBJECT error flag is cleared.
- A translation error flag is cleared.
- The CCM address is set to 1.
- The CCM parity is set to NONE
- Sets file name to nulls, i.e., all 0H (H = Hexadecimal)
- I/O CONFIG checking is set to enabled.
- The LED mode for I/O modules is set to I/O status.
- The I/O assignment mode is set for the CPU to assign addresses. Previous User assigned addresses will be lost.
- Scan timers and the scan counter will be set to 0.
- All error flags will be cleared.
- All tables will be cleared.

Table 4-9. User Configured CPU Parameters

	Set With *	Initialize CPU	When Transferred to Memory Cartridge	When Loaded from Memory Cartridge	When Transferred to or from Disk
Parity	OIU	No Parity	Next Power-up cycle	Next power-up cycle	User program
Watchdog Timer	OIU, LM5	200 ms	In STOP mode	Next power-up cycle	CONFIG
I/O Assignment Map	OIU, LM5	CPU assigns	In STOP mode	Next power-up cycle	CONFIG
CCM ID	OIU, LM5	ID = 1	In STOP mode	Next power-up cycle	User program
CPU Program Name	OIU Read LM5 R/W	CPU clears	In STOP mode	Next power-up cycle	Normal, On or Off Line
Password	LM5	CPU clears to 00000000	In STOP mode	Next power-up cycle	Normal, On or Off Line
User Logic	LM5	CPU clears	After download	Next power-up cycle	Normal, On or Off Line
I/O Config Check	OIU, LM5	Check Cnfg	N/A	N/A	N/A
LED mode	OIU, LM5	I/O Status	N/A	N/A	N/A
Clock/Calendar	OIU, LM5	No change	N/A	N/A	N/A
Scan Counter and Timers	CPU	= 0	N/A	N/A	N/A
Registers	OIU Loads	No change	On OIU command	On OIU command	Normal Off Line

* OIU = Operator Interface Unit.
LM5 = Logicmaster 5 Programming Software.

Data Storage and Transfers in the Series Five CPU

During operation of the Series Five PLC, the data used by the CPU consists of the following:

- Source code for the user program, stored by the user. This data also includes a time and date stamp for the program, and the program name.
- Compiled code for the user source program.
- A CCM ID for the CPU, set from Logicmaster 5.
- CCM parity for the CPU. This is normally NO PARITY, unless set by the OIU to odd.
- The user password, set through Logicmaster 5.
- I/O Assignment map, which is a list of addresses associated with each I/O slot.
- I/O Configuration map, which is a list of module types associated with each slot.
- The setting value of the Watchdog Timer, which is set through Logicmaster 5, or the OIU.
- Various internal CPU constants.
- Data stored in registers.

All of the above information, except data registers, is stored in the memory cartridge installed in the CPU. Data register information is stored in the RAM memory device mounted on the CPU board.

NOTE

All of the information listed above, except data registers, is loaded from the memory cartridge into the CPU on each power-up cycle.

This data represents all of the information that the CPU needs in order to be properly configured, and to operate an application program. Since some of this data is related directly to the program, and other data is related to the CPU configuration, the items listed above may need to be transferred separately to the CPU and memory cartridge. For example, if a user has multiple machines, which are almost identical, but the user programs are not identical, the user may want to reuse the CPU parameters to avoid re-entering them repeatedly. The user program may be slightly different, however, to account for the differences in applications. Because of this requirement, it is possible to transfer the user program related information independent of the CPU configuration parameter information.

The source code for the user programs is saved to the memory cartridge when a STORE USER PROGRAM TO CPU command is executed in Logicmaster 5. The compiled code in the CPU is created and stored after the compile command is given by the CPU, at the end of the STORE PROGRAM TO CPU process.

The other items in the list are stored in the memory cartridge when the CPU is in the STOP mode, when the parameters are changed through Logicmaster 5, or with the OIU.

NOTE

In order for the data to be stored in the memory cartridge as described above, the memory cartridge must not be write protected.

The I/O assignment map and I/O configuration map are rewritten in the memory cartridge when the following conditions occur:

- A STORE CPU CONFIG file command is issued from Logicmaster 5. This transfers the configuration data from a specified file to the CPU (stores it in the memory cartridge).
- A STORE TO CPU command is issued from Logicmaster 5, while in the I/O ADDRESS ASSIGNMENT screen. This stores the displayed I/O assignment map to the CPU (memory cartridge).
- After a NEW CONFIG command is issued from Logicmaster 5.

Saving the User Program to Diskette or CPU

When the user program is saved to diskette, or to the CPU, the following parameters are transferred:

- The source code for the Series Five PLC program created by the user. This includes the time and date stamp for the program, and the program name.
- A CCM ID for the CPU set by Logicmaster 5.
- CCM parity for the CPU. This is normally NO PARITY, unless set by the OIU to odd.
- Unique user selected password, set through Logicmaster 5.
- Various internal CPU constants.

When a STORE PROGRAM TO CPU is executed, the above parameters are transferred to the memory cartridge (the memory cartridge must not be write protected). This data includes all of the information related to the user program.

Saving CPU Parameters to Diskette or CPU

When the LOAD CONFIG or STORE CONFIG functions are used, the following parameters are transferred to disk or to the memory cartridge in the CPU.

- I/O assignment map, which is a list of addresses associated with each I/O slot.
- I/O configuration map, which is a list of the module types associated with each I/O slot.
- The setting value for the Watchdog timer, set by Logicmaster 5 or the OIU.

The above data includes all of the information related to configuration parameters required by the CPU.

NOTE

It is recommended that after a system has been finalized, both the user program and CPU configuration parameters be saved to disk for possible future use.

NOTE

OEMs who plan on sending program upgrade Memory Cartridges to end users who do not have Logicmaster 5 **MUST** save the original configuration to diskette. This configuration should then be downloaded to the new Memory Cartridge before shipping it.

Moving Memory Cartridges Between Systems

The small physical size of the memory cartridges for the Series Five PLC allows them to be portable and easy to move between systems if required. They provide a convenient way to store the same program in multiple cartridges for use in multiple Series Five PLCs, or different programs for use in the same or multiple Series FIve PLCs. Since the cartridges can so easily be removed from one system and used in another, there are several important items to be aware of. These items are described below.

- The memory cartridge contains the setup data for the last system configuration. If the I/O system in the new system is different than the original one, an I/O CONFIG CHANGED ERROR will result if the I/O Config check on power-up is enabled. If this happens, it is possible to run the program in the new system by using the OLD CONFIG function. Use of this function allows the user program to execute, but does not change the I/O assignment map, or the I/O configuration map stored in the memory cartridge in the CPU.

  You can also use the NEW CONFIG function to clear the I/O CONFIG CHANGED ERROR, or an I/O assignment map STORE TO CPU function. However, use of these functions will tell the CPU to accept the actual I/O configuration as valid, and will change the internal parameters stored in the memory cartridge.
- If the memory cartridge being moved is an EPROM cartridge, or the RAM memory cartridge is write protected, the STORE TO CPU and NEW CONFIG functions can be used without changing the setup data stored in the memory cartridge, however, the changes will only remain until the next power cycle.

CAUTION

Do not remove or insert memory cartridges with power on. When memory cartridges are removed from the CPU, they must be handled with care. If exposed to excessive static electricity, the memory cartridges can be damaged, and the program stored in them will be lost.

I/O Module Starting Address Display

In addition to providing the on or off status of I/O points, the 16 LEDs located directly below the 4 diagnostic LEDs in the top row on an I/O module, provide a dual function in that they also allow you to read the starting I/O address of the module when commanded to do so through Logicmaster 5. To do this from Logicmaster 5, you must be in the I/O CONFIGURATION UTILITIES menu and select F6, which is the I/O Module Address/Status softkey. This allows you to select whether the status of the I/O points or the starting address of the module will be displayed on the LEDs.

The Logicmaster 5 software allows you to toggle between these two modes when the system is on-line. When the I/O Address mode is selected, the ADR indicator on the top row of LEDs will turn on to indicate that the 16 I/O Address/Status LEDs are in the I/O Address mode, and the starting address of each module will be displayed on the LEDs.

When the LEDs are commanded to the I/O Address mode, the starting address of each module in the system is displayed as a 4-digit BCD number, with the least significant bit (1's digit) read on the four LEDs in the right vertical column, and the most significant bit (1000's digit) read on the four LEDs in the left vertical column. The binary weight of the four LEDs in each column, reading from top-to-bottom, is 1 - 2 - 4 - 8.

The following example shows how to read a typical starting address of an I/O module on the LEDs.

a42398

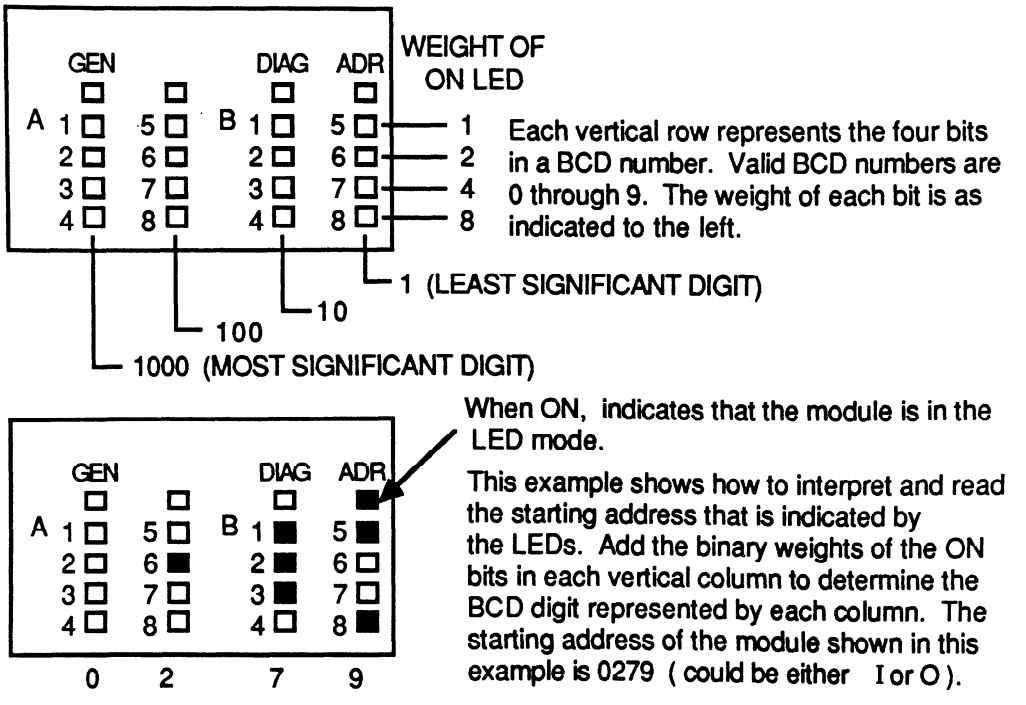

Figure 4-4. Reading I/O Module Starting Address on LEDs

This function is useful during debugging a new system or for troubleshooting, or anytime that you may want to verify the starting address of a module in a particular slot.

To return the LEDs to the I/O point status indication mode, you must return to the I/O CONFIGURATION UTILITIES menu, select the F6 softkey, and toggle to STATUS.

I/O Bus Setup

A menu called I/O BUS SETUP FUNCTIONS is available in Logicmaster 5 which allows you to set the number of I/O parity retries and specify the number of critical I/O base units. The I/O BUS SETUP FUNCTIONS menu is accessed by pressing a soft key while in the SETUP/DIAGNOSTICS FUNCTIONS menu.

Setting Parity Retry

After a pre-determined number of attempts at I/O communication have been unsuccessful, usually due to electrical noise near the Series Five PLC which could cause interference during the I/O scanning, the CPU reports an I/O parity error. The default for the number of retries is three, however up to sixteen retries can be specified, through the PARITY RETRY menu, by selecting a number from 0 to F (Hexadecimal).

The CPU normally stops after the specified number of communication attempt failures, however, you can tell the CPU to continue running after repeated failures by setting the most significant bit of the byte entered in the work area of Logicmaster 5 while in the PARITY RETRY screen. For example, the data entry 0A (Hexadecimal) specifies that the CPU will stop after ten unsuccessful retries. The data entry

8A (Hexadecimal) indicates that after ten unsuccessful retries, the CPU should continue transmission, resuming at the next address.

Specifying Critical Base Units

When a system is running and a problem is detected in the I/O system, the CPU normally halts in the STOP mode with a diagnostic and/or I/O parity error. However, it may be desirable for the CPU to continue running in spite of loss-of-power or problems occurring in base units specified as non-critical. All base units are considered to be critical when a system is first configured. To specify non-critical base units, select the Specify Non-Critical Bases function from the I/O BUS SETUP FUNCTIONS menu and enter a byte of data in the work area. A "1"in a bit position indicates that the base unit having an ID number corresponding to that position is non-critical. For example, the data entry 1C (Hexadecimal) corresponds to 00011100 (Binary), meaning that base units 2, 3, and 4 are non-critical - all others (0, 1, 5, 6, 7) are critical. The CPU will continue to run even if power is lost on a non-critical base unit.

Writing Data to CPU from Multiple Devices

Since the Series Five PLC can have multiple CCM ports (one in the CPU and up to eight CCM Master Modules), as well as the ASCII/BASIC module, it is possible for several external devices to write data to the CPU. When writing data to the CPU, the user must ensure that undesirable system interactions do not occur as a result of more than one external CCM device writing to the same CPU. Reading the CPU by multiple devices does not create any problems, but writing to the CPU by more than one device is not recommended.

The following pages describe two new functions (Set/Reset and Data Monitoring) that allow external devices to write data through a CCM request to the CPU's scratch pad. They are used by Logicmaster 5 during normal operation. If Logicmaster 5 is not in use, a single external device may use these functions.

CAUTION

Extreme care must be exercised by the user to ensure that one and only one device uses the Set/Reset and Data Monitoring functions. If Logicmaster 5 is operating, no other devices may use these functions.

Set/Reset Bit (Through Scratch Pad) Function

When forcing I/O points on or off through a normal serial interface, there is the possibility that other bits within the same byte may accidentally be turned on through interaction with user logic. The Series Five PLC prevents this from happening through use of the Bit Set/Reset function which uses a specific area of the scratch pad as a buffer. This function allows the forcing on or off of one or more bits in a single byte of a discrete Input or Output status table.

Data required for this function is written to a buffer in the scratch pad by a write request from a CCM device. Five consecutive bytes are required for this function. The location of these bytes in the scratch pad, the data required for the CCM request, and the return data after the function is initialized is shown below.

Scratch Pad Address (Hex)	Data at Request	Return (Same Location)
600	Function Code	Complete Code (0)
601	CCM Memory Type + 30H	OK (88H) or Error (FCH)
602	Reference Address (LSB)	Error Code (LSB)
603	Reference Address (MSB)	Error Code (MSB)
604	Bit Mask	Not Used

The function code for the first byte can be either 44H for bit set, 45H for bit reset, or 52H for a toggle. The CCM memory type for this byte can be 32H (input tables), 33H (output tables), 34H (input override tables), or 35H (output override tables). The reference address can be the values 1 to 180H for memory types 32H and 34H, or the values 1 to 280H for memory types 33H and 35H. The reference address identifies the byte in which the desired bit or bits are located. The mask identifies which bits in the byte are to be affected.

Force ON Function

If a bit is to be turned on, a corresponding bit in the mask is set to a 1. To turn on more than one bit, set all of the corresponding bits to a 1. Any bits that are not to be turned on, should be 0. The resultant mask byte can be used in an OR operation with the status byte to provide the requested status. For example, to turn on I0097 and I0103 with a CCM master device, the following data must be written to the scratch pad buffer:

Scratch Pad Address (Hex)	At Request
600	44 (Hex)
601	32 (Hex)
602	0D (Hex)
603	01 (Hex)
604	01000001 (41H)

Force OFF Function

If a bit is to be turned off, a corresponding bit in the mask is set to a 0. To turn off more than one bit, set all of the corresponding bits to be turned off to a 0. Any bits that are not to be turned off, should be a 1. The resultant mask byte can be used in an AND operation with the status byte to provide the requested status. For example, to turn off O0050 and O0053 with Logicmaster 5, the following data must be written to the scratch pad buffer:

Scratch Pad Address (Hex)	At Request
600	45 (Hex)
601	33 (Hex)
602	07 (Hex)
603	01 (Hex)
604	11101101 (ECH)

Executing the Bit Set/Reset Function

The procedure for initiating and executing the Bit Set/Reset function is described below.

- Initialize the Force Bit Buffer in the scratch pad as described previously.
- The Series Five CPU detects a request of 44H (Bit Set) or 45H (Bit Reset) and performs the function in the same CPU sweep in which the request was detected.
- If no error is detected, the Series Five CPU sets byte 2 (location 601H) in the scratch pad buffer to an "OK" code (88H).
- If an error is detected, the CPU sets byte 2 to an error code (FCH), and writes the error code values into bytes 3 (LSB) and bytes 4 (MSB).
- When the operation is complete, the CPU sets byte 1 (Complete Code) to a 0.

Data Monitoring Through a CCM Device

A function is available which allows fast monitoring of a specified number of items (from 1 to 88 items) in a single CCM communication, even if the items are widely distributed in the CCM target memory space. These items (coils, contacts, etc.) can be located anywhere that is accessible to the external CCM device. There are no qualifiers, such as being in sequential order.

The addresses of the items to be monitored are written to a consecutive area of scratch pad memory called the Request Buffer, and the values of those items are written by the CPU to a like number of locations in another area of scratch pad memory called the Return Buffer. The location of these buffers in scratch pad memory and the data contained in the buffers is as follows:

Scratch Pad Address (Hex)	Request Buffer	Scratch Pad Address (Hex)	Return Buffer
610	Function code		
611	Number of items	752	OK/Error Code
612	Item 1 Address (LSB)	753	Item 1 Value (LSB)
613	Item 1 Address (MSB)	754	Item 1 (1) (MSB)
614	Item 1 Address (LSB)	755	Item 2 Value (LSB)
615	Item 1 Address (MSB)	756	Item 2 (1) (MSB)
.	.	.	.
.	.	.	.
.	.	.	.
6BE	Item 87 Address (LSB)	801	Item 87 Value (LSB)
6BF	Item 87 Address (MSB)	802	Item 87 (1) (MSB)
6C0	Item 88 Address (LSB)	803	Item 88 Value (LSB)
6C1	Item 88 Address (MSB)	804	Item 88 (1) (MSB)
	WRITE ONLY		READ ONLY

(1) Override table value if an I/O table, or MSB if a register value.

Request Buffer

The data required to be entered in the Request Buffer is:

- The function code value must be 42 (Hexadecimal) to request this function.
- The number of items that can be requested to be monitored is from 1 to 88 (decimal).
- The reference address for each of the requested items must be entered in the remaining buffer locations. Each reference address requires two locations, the first is the Least Significant Byte of the reference address, the second is the Most Significant Byte of the reference address. The valid entries for the addresses are as follows:

Reference Address	Byte Address MSB/LSB	Reference Address	Byte Address MSB/LSB
R1	4001H	O1+0001	C001H
R3FFFH	7FFFH	O1+1024	C080H
I1+0001	8001H	O2+0001	C081H
I1+1024	8080H	O2+1024	C100H
I2+0001	8081H	O0001	C101H
I2+1024	8100H	O1024	C180H
I0001	8101H	O1-0001	C181H
I1024	8180H	O1-1024	C200H
		O2-0001	C201H
Scratch Pad	0H	O2-1024	C280H

Return Buffer

The return buffer will contain the values of the items specified in the request buffer after the function has been executed. The first location will contain the "OK" code 88H if no errors are detected during execution of the function, or if an error is detected, the value FCH will be written to the first location. The data values that will be written to the return buffer can take two forms:

1. Register Data - a word value with the Least Significant Byte in the lower byte and the Most Significant Byte in the higher byte.
2. Discrete data - The lower byte will contain a byte value of the discrete byte containing the requested address. The high byte will contain the byte value of the override byte containing the requested address.

Executing the Data Monitoring Function

The procedure for initiating and executing the Data Monitoring function is described below.

- The CCM master device initializes the Request Buffer as previously described. The function code (42H) must be the last buffer entry to be initialized.
- The Series Five CPU checks for a request of 42H every sweep and begins getting the data and writing it to the scratch pad Return Buffer. The update of the Return Buffer is completed within the same sweep after the logic solution to ensure data integrity.
- If no error is detected, the CPU sets scratch pad location 752H in the Return Buffer to 88H (OK code).
- If an error is detected the CPU sets scratch pad location 752H in the return buffer to an error code (FCH).
- When the operation is complete, the CPU sets byte 1 (Function Code) in the Request Buffer to a 0.

- For the next request of the same data, the master device only needs to change the Function Code from OH to 42H. The Series Five CPU updates the data once per request. If different data is required, the Request Buffer must be loaded with the new addresses.

Example of Data Monitor Request Function

The following examples show the data contained in the two scratch pad buffers at the time of the function request and at completion. The example request is for references R12 and I1+1024.

Content of buffer at function request:

Reference	Scratch Pad Address (Hex)	Request Buffer
	610	42H
	611	O2H
R12	612	OCH
	613	40H
I1+1024	614	80H
	615	80H
	616	0
	617	0
	.	.
	.	.
	.	.
	6C0	0
	6C1	0

Scratch Pad Address (Hex)	Return Buffer
752	88H
753	0
754	0
755	0
756	0
757	0
758	0
.	.
.	.
.	.
801	0
802	0

Content of buffer after function is complete:

Reference	Scratch Pad Address (Hex)	Request Buffer
	610	0
	611	02H
R12	612	0CH
	613	40H
I1+1024	614	80H
	615	80H
	616	0
	617	0
	.	.
	.	.
	.	.
	6C0	0
	6C1	0

Scratch Pad Address (Hex)	Return Buffer
752	88H
753	12H
754	20H
755	00110111 status
756	00000000 override
757	0
758	0
.	.
.	.
.	.
801	0
802	0

In the above example, R12 has the value 2012H and I1+1024 is not overridden. Note that the status of the entire byte, I1+1017 through 1024 is returned.

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Read/Write Unformatted Data

The RD CCM and WR CCM instructions can be used to read and write unformatted data through the 25 pin port in the Series Five CPU (revision C and later). This enables the CPU to directly send register data to a printer, or to an operator display. It is also easy to implement operator input/output via a serial data terminal. When used through the CPU, the data is **not** CCM compatible, it is unformatted. It is necessary to use the CCM Master module to use the Series Five PLC as a CCM Master device.

The WR CCM command sends unformatted register data out the port. The RD CCM can be used in two ways. First, it can read a known number of characters; second is to continue to read characters until a known character string is received.

Data is transmitted from (WR CCM) or written to (RD CCM) the register table at a user specified address. Internal status contacts are used to indicate busy/done status, and error status. These contacts are used in the user logic program to interlock consecutive RD/WR CCM requests, and to verify the validity of received data.

Format for RD CCM Through the CPU Port

```
    I0001  I1-77          RXXXX
|-----][-----][----------[ RD CCM ]-----|


RXXXX = CPU slot (must be 13 decimal)
   +1 = (0 = length mode, 1 = trap mode)
   +2 = (don't care for length mode, trap sequence for trap mode)
   +3 = (don't care for length mode, trap sequence for trap mode)
   +4 = (length mode is the number of registers to fill (1 to 64))
        (trap mode is the maximum number of registers to fill before abort)
   +5 = first register to fill
```

Format for WR CCM Through the CPU Port

```
    I0001  I1-79          RXXXX
|-----][-----][----------[ WR CCM ]-----|


RXXXX = CPU slot (must be 13 decimal)
   +1 = don't care
   +2 = don't care
   +3 = don't care
   +4 = number of consecutive registers to write (1 to 64)
   +5 = first register to write from
```

I1-77; 1 = RD CCM through CPU is busy, 0 = not busy.

I1-78; 1 = RD CCM thru CPU had error (note 1), 0 = no error

I1-79; 1 = WR CCM thru CPU is busy, 0 = not busy

I1-80; 1 = WR CCM thru CPU had error (note 1), 0 = no error

Causes of error are the following:

1. Port already in use by OIU;
2. Data length of RD or WR is <1 or >128 bytes;
3. Trap mode specified for WR CCM function (legal only for read);
4. Framing, parity, or overrun error detected during read;
5. Illegal register specified as operand.

Example of WR CCM

```
    I0001  I1-79          R0010
|-----][-----][----------[ WR CCM ]-----|


R0010 = 00013 (13 = Slot number for CPU)
R0011 = 00000 (don't care)
R0012 = 00000 (don't care)
R0013 = 00000 (don't care)
R0014 = 00004 (write 4 registers of data (8 bytes))
R0015 = 02050 (first register to write is R2050)

R2050 = 3231H ("21")
R2051 = 3433H ("43")
R2052 = 4241H ("BA")
R2053 = 4443H ("DC")
```

When the WR CCM executes, the data string "1234ABCD" is transmitted from the port. From the time the WR CCM is intitiated until the last byte is transmitted, I1-79 will be on (indicating busy). If an error is detected in the data format, then I1-80 will turn on.

Example of RD CCM through the CPU Port (Fixed Length Mode)

```
    I0001     I1-77         R1234
|-----][-------][--------[ RD CCM ]----|


R1234 = 00013 (13 = Slot number for CPU)
R1235 = 00000 (0 = "length mode")
R1236 = 00000 (don't care)
R1237 = 00000 (don't care)
R1238 = 00004 (fill 4 consecutive registers with data, then quit)
R1239 = 03456 (the first register to fill is R3456)
```

If the RD CCM executes, and the data coming in the port is A B C D 1 2 3 4, then the registers would fill up as :

```
R3456 = 4241H ("BA")
R3457 = 4443H ("DC")
R3458 = 3231H ("21")
R3459 = 3433H ("43")
```

Special contact I1-77 will be off until the RD CCM is initiated, then will turn on. When the 8th byte of data has been received, I1-77 goes off, and the received data is transferred to R3456 through R3459. I1-78 will be off until the instruction executes. If an error is detected, I1-78 will turn on.

Example of RD CCM Through CPU Port (Trap Mode)

Instead of waiting for a specified number of characters to be received, data is stored to the specified registers (up to a specified maximum) until a specific data sequence is encountered (normally CR LF, however in this example the data sequence is "CR LF >".

```
    I0001     I1-77         R1234
|-----][-------][--------[ RD CCM ]----|


R1234 = 00013 (13 = Slot number of CPU)
R1235 = 00000 (1 = "trap mode")
R1236 = 0A0DH (Stop receiving on CR LF ......
R1237 = 003EH     ..... ">" sequence)
R1238 = 00004 (If trap sequence is not received, fill 4 registers (maximum))
R1239 = 03456 (the first register to fill is R3456)
```

If the RD CCM executes, and the data coming in the port is B C D CR LF >, the registers would fill up as:

```
R3456 = 4342H ("BC")
R3457 = 0044H ("D")
R3458 = 00000 ( CR LF > is not stored since it is the trap sequence)
R3459 = 00000
```

Special contact I1-77 will be off until the RD CCM command is initiated, then will turn on. When the last byte of the trap sequence has been received, I1-77 goes off, and the received data is transferred to R3456 through R3459. I1-78 will be off until the instruction executes. If an error is detected, I1-78 will turn on.

The trap sequence must be received exactly as specified. For example if the sequence A B CR LF V < is received, the sequence will not be trapped. If a maximum of four registers have been specified, and the sequence A B CR LF V < 1 2 3 4 5 6 is received, the first eight bytes of data are stored in the registers.

The trap sequence can consist of up to four non-0 ASCII characters (1 through FFH).

Chapter 5 Maintenance

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Introduction

This chapter presents a basic guide to troubleshooting procedures for the Series Five Programmable Logic Controller. The Series Five PLC is designed to provide many years of trouble free operation. If a failure should occur, it can usually be quickly isolated and the defective assembly replaced with minimum downtime. It is important to quickly identify the source of the problem, and whether it is hardware or software related. The maintenance concept for the Series Five PLC is to replace failed assemblies (modules), rather than individual components.

Troubleshooting Aids

The CPU has many internal bits and diagnostic registers which can be used in the user program or external CCM compatible computer to implement a custom diagnostic package. Many of these internal bits and registers are used by Logicmaster 5 to report errors. Most typical problems are isolated through interpretation of the LEDs on individual modules or through error codes or messages on the programming device's screen. These troubleshooting aids help diagnose not only the Series Five PLC, but also the total control system. The main diagnostic tool is the programming device, which can be a Workmaster II portable computer, a Workmaster, or Cimstar I industrial computer, or an IBM PC, XT, AT, PS/2 or compatible personal computer with Logicmaster 5 software.

Many hardware related faults can be attributed to incorrect switch settings, loose cables or screw connections - all major faults can be corrected by replacing modules. There are usually no special tools required other than a screwdriver and a voltmeter.

Series Five Diagnostic Aids

The diagnostic features of the Series Five PLC provide the user with a powerful, easy to use troubleshooting tool. These diagnostic features not only tell you that an error has occurred, they also lead you to the location of the problem. These diagnostic features are: status indicators on the CPU and all other modules, special purpose internal coils that turn on to reflect error conditions, reserved registers that indicate an error code number or other informative information, the CPU ERROR FLAGS display in the Scratch Pad screen in Logicmaster 5, and the error display in the OIU. Logicmaster 5 provides the tools for displaying and interpreting error messages and leading you to the cause of the problem.

When a failure occurs, a bit or bits will be set in the CPU ERROR FLAGS line at the bottom of the Scratch Pad display, and an error message will be displayed. In most cases, the cause of the problem is indicated. If additional information about the problem is needed, by accessing a HELP screen, you are directed to an explanation of the bit or bits that are set, i.e., the nature of the error. You can then display the reference table for the special contacts (I1-000 to I1-512) to see which of the contacts has been set to a logic 1 or access the register display and look at registers 4078, 4079, and 4080. These registers will display an error code number. Then refer to table 5.2 for error code definition and the action to take to clear the problem.

The flow chart on the following page shows the recommended troubleshooting procedure for the Series Five PLC.

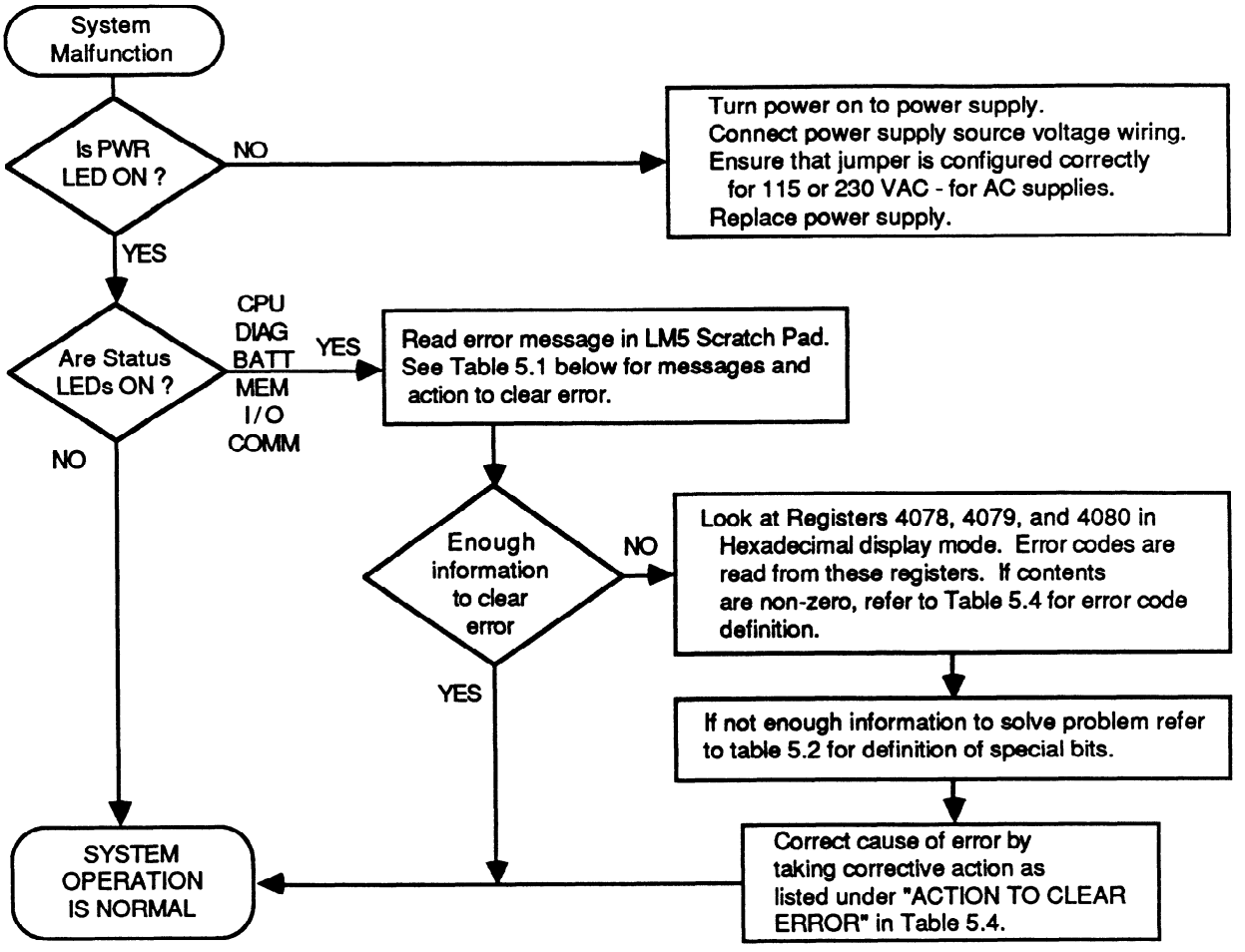

Figure 5-1. Recommended Troubleshooting Sequence Flow Chart

Table 5-1. Scratch Pad Error Messages and Corrective Action

Scratch Pad Error Message	Corrective Action
Compilation Error	Store program to CPU again.
CPU Battery Low	Replace CPU battery within one week.
Duplicate I/O Address Error	Reassign addresses and do a STORE TO CPU.
I/O Address Range Error	Correct user logic and store program again.
I/O Bus Error	Cycle from STOP to RUN, or reset CPU with reset switch, or Recycle power, or replace base unit or device on bus.
I/O Config Changed	Key-in NEW CONFIG or OLD CONFIG command from LM5 or edit I/O map and do a STORE TO CPU, or return to previous I/O configuration.
I/O Error	See Table 5.2 in this chapter for further information.
I/O Module Removed	With power off, replace module. Or edit I/O map and STORE TO CPU
I/O Parity Error	Cycle from STOP to RUN, or reset CPU with reset switch, or cycle power. Replace base unit, or device on I/O bus.
Memory Battery low	Replace memory cartridge battery within one week.
NO CPU BATTERY	Connect or install back-up battery in CPU.
NO Battery in memory cartridge	Install battery in memory cartridge.
No Memory Cartridge Error	With power off - install memory cartridge.
Program Error	Check user program, correct error and store program again.
Program Parity Error	Store program again. Cycle power.
Watchdog Timer Timed Out	Check user logic or increase Watchdog Timer preset value.

Table 5-2. Special Purpose Contact (Bit) Definition

Reference	Error	Definition
I1-0033	Critical System Error	1 = error, CPU goes to STOP mode.
I1-0034	Non-Critical System Error	1 = error, CPU remains in RUN mode.
I1-0035	Diagnostic Error	1 = error detected
I1-0036	Battery Not Normal	1 = CPU or memory cartridge battery voltage low.
I1-0037	Memory Error	1 = latches if a memory cartridge error occurs.
I1-0038	I/O Error	1 = latches if I/O bus error is detected.
I1-0039	Communications Error	1 = Turned ON by a CPU/CCM error. Next successful communications will turn it off.
I1-0040	I/O Configuration Error	1 = error detected, I/O configuration has changed since last power-up.
I1-0042	Watchdog Timeout	1 = Watchdog timer has timed out.
I1-0043	Internal Program Error	1 = Error
I1-0044	Internal Math Error	1 = Error
I1-0045	Smart Module Comm. Error	1 = Error
I1-0065	I/O Retry Parity Status	1 = Parity error after specified number of retries 0 = OK, no parity error detected
I1-0066	Non-Critical Rack	1 = Non-critical rack. 0 = Critical rack (that reported parity error setting I1-0065)

CPU Status Indicator Definitions

The flow chart for basic troubleshooting procedures indicates that observation of system indicator lights is a good starting point to use for troubleshooting. The following table defines the LED status indicators located on the CPU.

Table 5-3. CPU Status Indicator Definitions

LED	COLOR	DESCRIPTION
PWR	GREEN	ON - Power is applied to the CPU and the +5 Vdc operating voltage is within specified tolerance. OFF - Ac or dc input power source is missing or the +5 Vdc operating voltage is not within specified tolerance.
RUN	GREEN	ON - CPU is in the RUN mode. OFF - CPU operation is halted,
CPU	RED	ON - A malfunction exists in the CPU or the watchdog timer has timed out. OFF - CPU is operating normally and the watchdog timer has not timed out.
DIAG	RED	ON - CPU has detected an internal fault that causes the CPU to halt its scanning operation. OFF - Operation normal, no faults detected.
BATT	AMBER	ON - A memory backup battery voltage is low or has failed. Can be either in the CPU or memory cartridge battery. OFF - Both backup batteries operating normally.
MEM	AMBER	ON - A program memory error has been detected. OFF - All memory operating without error.
I/O	AMBER	ON - An I/O error has been detected. OFF - No I/O errors have been detected.
COMM	AMBER	ON - A communications error has been detected. OFF - Communications operating without error.

For detailed error definitions, refer to the Logicmaster 5 Scratch Pad Display and Register tables (R4078, 4079, 4080).

Error Definition and Action Required

The LEDs on the CPU are a good troubleshooting aid. When combined with the capabilities of the programmer with Logicmaster 5 or when using the Series Five Operator Interface Unit, you can quickly troubleshoot the majority of system errors that may occur. The following table lists the errors that may be detected by the CPU. Two tables are found in this section - the first lists the error codes, definitions and corrective actions when using Logicmaster 5 software, and the second table lists error codes and messages, cause of error, and corrective actions when using the Operator Interface Unit. The information in the tables is as follows:

ERROR CODE/MESSAGE:	Error code number and message (message with OIU)
CAUSE OF ERROR:	Action or problem that caused the error.
ACTION TO CLEAR ERROR:	Action required to clear the error.

Table 5-4. Error Code Definitions - Logicmaster 5

Error Code	Cause of Error	Action to Clear Error
E003	Scan time exceeds Preset time of Watchdog timer	Check user logic or increase watchdog timer preset.
E004	CPU memory parity error detected	Cycle power. Store program again.
E041	Voltage of CPU back-up battery too low.	Replace CPU battery within one week.
E042	No back-up battery in CPU.	Install back-up battery in CPU.
E043	Voltage of back-up battery installed in memory cartridge too low.	Replace battery in memory cartridge within one week. Contents of memory cartridge must be copied before you change the battery, or data will be lost.
E044	No battery or dead battery in memory cartridge.	Install battery in memory cartridge.
E101	No memory cartridge in CPU.	With power off, install memory cartridge in CPU.
E102	Memory cartridge contains only CPU parameters.	With power off, insert user program MC in the CPU.
E103	Memory cartridge contains only registers.	With power off, insert user program MC in the CPU.
E150	Register reference is greater than maximum register size.	Change register reference.
E151	Memory parity error in user logic.	Store program again.
E152	Rung too complex to execute.	Change user logic program to have fewer stack levels.
E201	Terminal block removed from I/O module.	With power off, install terminal block.
E202	I/O configuration change since last power-up, or I/O module removed from slot.	With power off, install I/O module in correct slot.
E203	Blown fuse or no fuse in an output module. FU indicator on output module will also be on.	With power off, remove output module and install new fuse, or replace module.
E204	Voltage of external 24 V dc power to output module too low.	Adjust voltage of external power supply.
E221	No power applied to Series Three PLC's I/O base unit connected through a Series Three PLC I/O Interface module.	Apply power to the Series Three PLC's I/O base unit.
E222	A problem exists in the Series Three PLC's I/O system.	Troubleshoot the Series Three PLC's I/O system and replace defective module(s).
E250	Error on I/O bus or device connected to I/O bus.	Recycle power, or push CPU reset pushbutton, or replace base unit or device.

Table 5-4. Error Code Definitions - Logicmaster 5 - Continued

Error Code	Cause of Error	Action to Clear Error
E251	I/O bus parity error, noise.	Cycle power. Replace base unit, or device on I/O bus.
E252	Current I/O configuration is different than the one stored in the memory cartridge.	Key-in NEW CONFIG command or OLD CONFIG command from LM5 or edit I/O map and do a STORE TO CPU.
E261	I/O address duplicated when assigned manually.	Reassign addresses with no duplication.
E262	I/O address in user logic exceeds valid address range.	Correct user logic.
E350	Specified target address is not an intelligent module.	Specify correct target address.
E351	Invalid ID specified for intelligent module (target).	Reassign correct target ID.
E352	Syntax error present in command parameters	Use correct syntax/parameters.
E353	Timeout when communicating with target.	Check target source and all interconnects.
E354	No information obtained from target device	Verify target information.
E4XX	Translated program error.	Check and reload program.

Table 5-5. Error Code Definitions - Operator Interface Unit

Error Message	Cause of Error	Action to Clear Error
E003 S/W TIMEOUT	CPU scan time was greater than software watchdog timer.	Set longer software watchdog (sub-menu 54) or change ladder logic.
E041 CPU BATTERY LOW	Low voltage on CPU back-up battery.	Replace CPU battery, Cat. No. IC655ACC550
E042 NO CPU BATTERY	Missing or disconnected CPU battery.	Install or reconnect CPU battery.
E043 CPU MC BATTERY LOW	Low voltage on CMOS RAM memory cartridge battery.	Copy program to another memory cartridge and replace battery (IC655ACC549).
E044 NO MC BATT	Missing CMOS RAM memory cartridge battery.	Install battery in memory cartridge.
E101 NO CPU MC	Attempt to access CPU MC when it is not installed.	Insert memory cartridge into CPU.
E102 MC HOLDS SYS DATA	Attempt to run CPU with MC installed that contains only system parameter data.	Replace with a program memory cartridge.
E103 MC HOLDS REG DATA	Attempt to run CPU with a memory cartridge that contains register data.	Replace with a program memory cartridge.
E104 WRITE FAILED	Copy operation to CPU MC in Menu 7 failed because cartridge is write protected.	Reconfigure the jumper in memory cartridge to the write enable position. If problem still exists - replace memory cartridge.
E150 REG REF TOO LARGE	Register reference larger than maximum register size.	Change register reference.
E151 BAD COMMAND	Parity check detects error in program stored on the CPU memory cartridge.	Rewrite the invalid code to correct the logic.
E152 PROG STACK OVERFLOW	Rung too complex to execute	Change logic to have fewer stack levels.

Table 5-5. Error Code Definitions - Operator Interface Unit - Continued

Error Message	Cause of Error	Action to Clear Error
E2XX DIAG ERROR MENU 42	An I/O diagnostic error has been reported to the CPU.	Use sub-menu 41 or visual inspection to determine the type of error, and take corrective action. Error can be one or more of errors E201 to E262.
E201 MISSING TERM BLOCK	Loose or missing terminal block on I/O module.	Use sub-menu 41 or visual inspection to find module location. With power off - tighten terminal block or install new terminal block on module.
E202 MISSING I/O MODULE	I/O module loose or missing since last power cycle.	Use sub-menu 41 or visual inspection to determine module type and location of missing module. With power off - install module and secure to base unit.
E203 I/O MDL FUSE BLOWN	Fuse blown on an output module.	Use sub-menu 41 or visually find module type and location. With power off replace fuse or module.
E204 LOW VOLTAGE EXT PS	External 24 Vdc power supply is too low or has failed.	Adjust voltage, correct fault or replace supply.
E208 ILLEGAL MODULE CODE	n/a	n/a
E221 NO SERIES 3 I/O PS	Power supply failed or power off on Series Three I/O base unit.	Turn on power, repair or replace power supply in Series Three base unit.
E222 S3 I/O ABNORMAL OP	Series Three I/O module or modules functioning abnormally.	Determine which module is defective and replace.
E226 PS OVERLOAD	CPU has detected that I/O loading in a base unit exceeds the power supply capacity.	Use high capacity power supply or adjust I/O module arrangement.
E250 I/O CHAIN	Faulty link in the I/O chain.	Check I/O expander cables, Local I/O Interface module.
E251 I/O BUS PARITY	Parity error on I/O bus due to electrical noise or other type of interference.	Cycle power, if CPU won't enter RUN mode, replace base unit or device on bus.
E252 NEW I/O CONFIG/	Current I/O configuration is different than the one stored in CPU memory cartridge.	Use sub-menu 45 to select the former or the new config, or change I/O config to its previous configuration.
E261 I/O ADDR CONFLICT	Attempt made to force a module to an address already assigned to another module.	Use sub-Menu 46 to change one of the modules address to a avoid duplication.
E262 I/O OUT OF RANGE	Attempt made to force a module address to an invalid address.	Use sub-menu 46 to re-enter a valid address.
E311 COMM ERROR 1	A non-existent operation code was included during a CCM communications session.	Key-in CLR to retry the communications.
E312 COMM ERROR 2	A non-existent operation code included during communications with a programmer.	Key-in CLR to retry the communications.
E313 COMM ERROR 3	A non-existent address was included during communications with a programmer.	Key-in CLR to retry the communications.
E316 COMM ERROR 6	A non-existent mode was included during communications with a programmer.	Key-in CLR to retry the communications.

Table 5-5. Error Code Definitions - Operator Interface Unit - Continued

Error Message	Cause of Error	Action to Clear Error
E320 OIU-CPU TOUT	Communications time out between CPU and OIU.	Cycle power. If problem persists - replace faulty unit (OIU or CPU).
E321 OIU-CPU COMM	No reply or NAK from the CPU to an OIU ENQ.	Check link between the OIU and the CPU. Cycle power. If problem persists - replace the CPU.
E350 MODULE ADDR	A base unit and slot address has been specified that does not contain an intelligent module - when attempting communications between intelligent modules or between OIU to intelligent modules.	Reassign the intelligent module address either in the user logic program or through sub-menu 47 on the OIU.
E351 MODULE ID	Invalid communications ID number specified for an intelligent module during communications between intelligent modules.	Reassign the correct intelligent module ID in user logic program.
E352 BGND SETTING	Syntax error occurred during background communications.	Key-in CLR and retry communications.
E353 BGND TOUT	Communications time out during communications session between two intelligent modules.	Key-in CLR and retry communications.
E360 TIME OUT	During communications between a personal computer and OIU, the personal computer did not respond to an enquiry.	Press the CLR key and retry communications.
E361 COMM ERROR	Communications problems between CPU and OIU.	Retry communications, check cable connections, check OIU mounting to CPU.
E4XX NO PROGRAM	Mode keyswitch turned to RUN with no program in the CPU memory cartridge.	Download program from computer to CPU, or insert memory with program.
E501 BAD ENTRY	Invalid key sequence attempted before ENT, PREV, or NEXT keys.	Rekey correct sequence of keys.
E504 BAD REF/VAL	Reference number or value entered is out of range.	Re-enter correct value.
E520 BAD OP-RUN	Attempt made to perform an operation which is illegal when the CPU is in the RUN mode.	Change CPU mode to allow the operation.
E521 BAD OP-RDIS	Attempt made to perform an operation which is illegal when the CPU is in the RUN w/OUTPUTS DISABLED mode.	Change CPU mode to allow the operation.
E524 BAD OP-STOP	Attempt made to perform an operation which is illegal when the CPU is in the STOP mode.	Change CPU mode to allow the operation.
E525 KEYSWITCH	CPU mode keyswitch not in the OIU position.	Turn key to OIU position.
E526 OIU OFFLINE	Attempt to perform an operation while OIU is off-line.	Use sub-menu 64 to put OIU on-line.
E540 CPU LOCKED	Attempt to perform a password protected operation without logging-on to the locked CPU.	Logon to the locked CPU with sub-menu 81, and repeat operation.
E541 WRONG PWORD	Wrong password entered for the memory cartridge in the OIU.	Re-enter correct password for the memory cartridge in the OIU.

Table 5-5. Error Code Definitions - Operator Interface Unit - Continued

Error Message	Cause of Error	Action to Clear Error
E601 MEMORY FULL	Attempt to program instruction too large for available memory.	Copy program onto a larger memory cartridge and continue entering program.
E603 DATA MISSING	While searching for data in registers (sub-menu 33), no data that was specified was found in the specified register range.	Press CLR and respecify data value or register range.
E610 BAD I/O TYPE	Attempt made to read/write an intelligent I/O module through sub-menu 47; however, location specified was for a conventional I/O module.	Retry operation - specify correct base unit/slot for the intelligent module.
E611 BAD COMMS ID	Attempt made to communicate with a CCM station ID that does not exist.	Set correct CCM ID.
E620 OUT OF MEM	Copying operation incomplete because of insufficient memory remaining on memory cartridge.	Change to larger memory cartridge, or restructure program.
E621 MC NOT BLANK	(1) Blank check with sub-menu 74 has detected data on the OIU memory cartridge.	Clear the memory cartridge using sub-menu 75 or use another memory cartridge.
	(2) Attempt to copy to or erase a write protected RAM or EEPROM cartridge.	Change jumper in memory cartridge to unprotected position.
	(3)Attempt to copy to UVEPROM cartridge that already contains data.	Erase contents of UVEPROM cartridge with an ultra violet lamp, or use another UVEPROM cartridge.
E622 NO MC IN OIU	Attempt made to transfer data to or from a memory cartridge in the OIU with no memory cartridge installed in the OIU.	Insert an appropriate memory cartridge into the OIU.
E623 SYSTEM MC	Attempt made to transfer user logic from OIU memory cartridge to CPU memory cartridge when OIU memory cartridge contains other than user logic.	Remove memory cartridge from OIU and insert one that contains user logic.
E624 REGS ONLY	Attempt made to transfer user logic from OIU memory cartridge to CPU memory cartridge when OIU memory cartridge contains register data.	Remove memory cartridge from OIU and insert one that contains user logic, or select register option from sub-menu 72.
E625 PROG ONLY	Attempt made to transfer registers from the OIU memory cartridge to the CPU memory cartridge when the OIU memory cartridge contains user logic.	Remove memory cartridge from OIU and insert one that contains register data, or select program option from sub-menu 72.
E626 EPROM MC	Attempt made to copy data onto an EPROM memory cartridge installed in the CPU.	Install a RAM or EEPROM cartridge in the CPU, or insert the EPROM memory cartridge in the OIU to copy data.
E627 BAD WRITE	RAM or EEPROM cartridge in OIU is write protected, or UVEPROM cartridge in OIU has not been erased, or CPU has detected a mismatch of data while copying data with sub-menu 71 or 72.	Reconfigure the memory cartridge jumper to the write enable position.
E640 MISCOMPARE	Data mismatch detected while performing a verification in sub-menu 73 or 79.	Clear the OIU or CPU memory cartridge, as applicable, and retry the copy operation.

Table 5-5. Error Code Definitions - Operator Interface Unit - Continued

Error Message	Cause of Error	Action to Clear Error
E641 VOLUME LEVEL	Cassette recorder volume level set too high or too low when in sub-menu 77, 78, or 79.	Readjust volume level and repeat operation.
E642 CHKSUM ERROR	Checksum error when copying between cassette tape and OIU, or external computer and OIU.	Repeat operation, after clearing the OIU memory cartridge, or other medium where appropriate.
E650 MACHINE CODE	CPU detected an unknown op code value during execution of a program instruction.	Press CLR key. If problem persists, reload program or provide more protection from electrical noise or other interference for CPU.
E651 SYSTEM ROM	Checksum error exists in OIU ROM.	Press CLR key and repeat operation. If problem persists - replace the OIU.
E652 SYSTEM RAM	Checksum error exists in OIU RAM	Press CLR key and repeat operation. If problem persists - replace the OIU.
E653 MC BATT LOW	Battery voltage in OIU memory cartridge low.	Replace battery in memory cartridge, or use another memory cartridge.

General I/O Troubleshooting Procedures

I/O troubleshooting procedures depend upon knowledge of the logic program installed for your application. The following procedures are general in nature, and should be adjusted to fit your specific application. The following steps assume that the CPU is in the RUN mode - operating with outputs enabled.

1. If the Series Five PLC has stopped with some of the outputs energized, locate the signal (timer, coil, input, etc.,) that should cause the next operation to happen. The state of that signal can be monitored by Logicmaster 5.
2. If the signal is an input, compare the state of the input monitored with the programmer, with the state of the LED for that input on the input module. If they are different, replace the module.

WARNING

Do not install or remove any I/O module when power is applied to the base unit. Failure to adhere to this warning could cause a module to be damaged.

Voltages from user devices may be present on a module's screw terminals, though power to a base unit is turned off. Care must be taken any time that you are handling the module's terminal board or any wires connected to it.

3. If an input state and the applicable LED on the input module agree, compare the LED status with the actual input device (limit switch, pushbutton, etc.). If they are different, measure the voltage at the input module terminals. Refer to the *Series Five Programmable Controller I/O Specifications Manual, GFK-0123,* for specific module information. If the measured voltage indicates a faulty I/O device - replace it, or the field wiring, or its power source. If this does not solve the problem, replace the input module.

4. If the signal is a coil wired to a field device, compare its status to the LED on the applicable output module. If they are different, check the power source to ensure that an excitation voltage is available. If field power to the device is not present, check the power source and its wiring. If the correct field power source is available, but the status is wrong at the output module - replace the output module.
5. If the signal is a coil, and either there is no output module or the output is the same as the coil state, examine the logic driving the output using the programming device, and a hard copy of your program. Working from right towards left, locate the first contact that is not passing power available to it from the conditional logic at its immediate left.

   Troubleshoot that signal using the procedures in steps [2] and [3] if the signal is an input, or steps [4] and [5] if the signal is a coil.
6. If the signal is a timer that has stopped at a non-zero value below its preset value, replace the CPU module.
7. If the signal is the control over a counter, examine the logic that is controlling the reset first - then the count signal. Follow steps [2] through [5].

Replacing Components

The following procedures provide information on replacement of various components of a Series Five PLC system.

Replacing a Power Supply

1. Turn off AC or DC power, as applicable, to the supply.
2. Disconnect field wiring from the power supply terminal block.

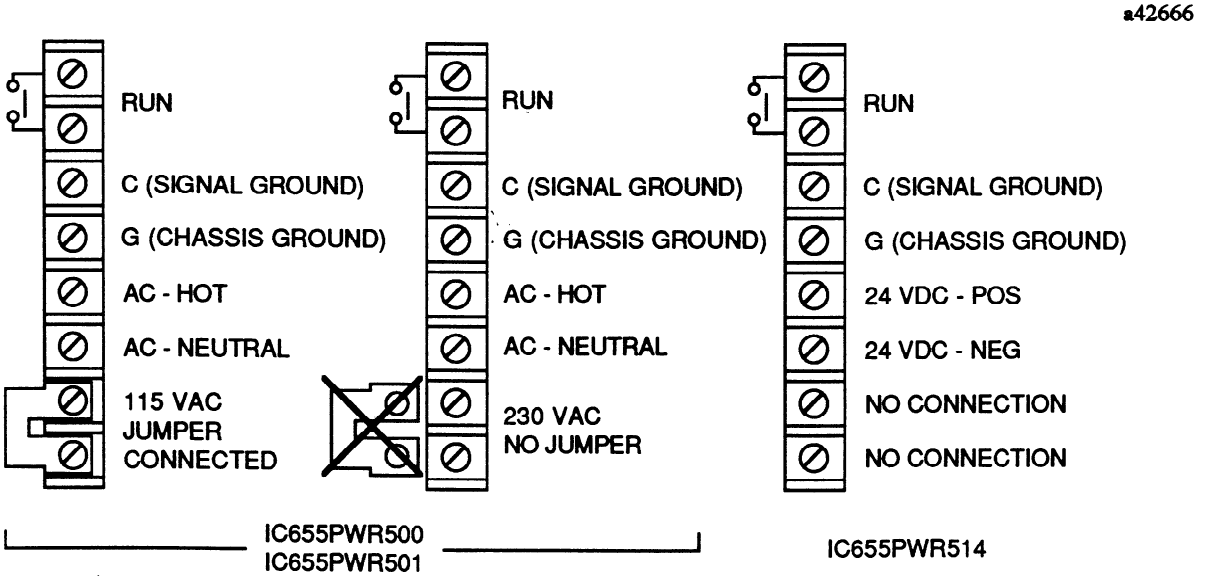

Figure 5-2. Power Supply Terminal Block Connections

3. Remove the power supply by loosening the two captive screw fasteners that are holding the supply in place.
4. Install the new power supply by placing it over the connector on the backplane and pushing down on the module until it is firmly seated.
5. Reconnect field wiring to the power supply terminal block, and verify that the jumper for 115 or 230 V ac is properly configured if the supply is an AC supply.
6. Apply power to the system and check for proper system operation.

Replacing a CPU Module

1. Place the CPU mode switch in the STOP position. Turn off AC or DC power, as applicable, to the power supply.
2. Disconnect any cables that may be attached to the CPU. Remove the memory cartridge installed in the CPU. Write down the DIP switch settings to ensure that the settings on the new CPU are the same.
3. Remove the CPU from its slot by loosening the two captive screws and pulling the module away from its backplane connectors.
4. Install the new CPU module, and tighten the two captive screws.
5. Ensure that the DIP switch settings are correct for your operation and verify that the CPU backup battery is properly installed .
6. Reconnect any cables, you may have removed, to the CCM port connectors on the CPU.
7. Apply power and verify system operation.

Replacing a Memory Cartridge

1. Place the CPU mode switch in the STOP position. Turn off AC or DC power, as applicable, to the power supply.
2. Open the top hinged door on the front of the CPU to gain access to the memory cartridge.
3. Remove the memory cartridge by grasping the top of the plastic strip at the point marked "PULL", then pull it towards you. The cartridge will slide out of its slot.

CAUTION

Do not remove or insert a memory cartridge with power on. Handle RAM memory cartridges with care, since excess charges of static electricity could damage the memory devices in the cartridge.

4. Install the new memory cartridge by orienting the cartridge so that the word "PULL" is towards the top of the CPU, then slide the cartridge carefully into the guides in the slot until it firmly plugs into the connector at the back of the slot.
5. Turn on AC or DC power to the base unit and verify proper system operation.

Replacing a Memory Cartridge Backup Battery

1. Before replacing a memory cartridge battery, the memory contents should be saved, since the memory in the cartridge will be lost when a battery is changed.
2. Remove the memory cartridge as described previously.
3. Remove the phillips head screw that attaches the top cover to the case containing the memory cartridge.

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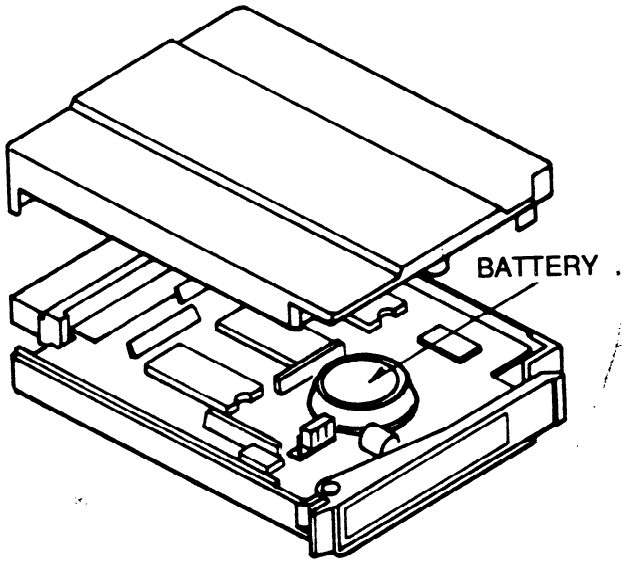

Figure 5-3. Memory Cartridge Battery Location

4. You do not have to remove the circuit board from the case to remove and replace the battery. The battery is mounted on the circuit board and can be removed by very gently pulling up on the bottom of the battery until it is completely free of the socket. It is recommended that you use your fingers or a non-conductive tool for pulling the battery out of the socket.

CAUTION

Be very careful when removing the battery from its mounting holes to ensure that the circuit board is not damaged. Be careful not to short runs or components on the circuit board when using a screwdriver.

5. Notice that the holes into which the battery is inserted are offset to one side, this ensures that proper battery polarity is observed. Insert the new battery into the mounting holes by placing it over the holes, then gently pushing down on the battery case until it is firmly seated in place. Do not bend the two leads on the battery.
6. Replace the cover and replace and tighten the screw. Before turning on power, ensure that the CPU mode keyswitch is in the STOP position.

7. Before turning power on, reinstall the memory cartridge in the CPU. The memory will be blank or have random data in it - you will need to execute an INIT CPU (Initialize CPU) function from the Scratch Pad screen. Reapply power to the system and check the system for proper operation.

Replacing a CPU Backup Battery

1. Ensure that power has been applied to the system at least one minute before changing the battery. Remove AC or DC power, as applicable, from the CPU base unit.
2. Access the battery by opening the large hinged door on the front of the CPU module. The battery is mounted on the inside of the door.
3. Remove the battery connector from the socket in the CPU by grasping it and pulling it straight out until it is free of the socket. To ensure that the wires in the battery do not pull out of the connector, it may be necessary to use a pair of needle nose pliers to grasp and remove the connector.
4. Pull the battery out of the mounting clips on the door.
5. Replacement batteries come with the connector prewired to the battery. To install the new battery, insert it into the mounting clips, and push the battery connector firmly into the socket on the CPU until it is securely in place.
6. Turn on power to the base unit.
7. Reinitialize the CPU. This will cause the CPU system parameters to be reset to their default conditions, and will clear Logicmaster 5 memory and Series Five CPU memory.
8. Verify that system operation is correct.

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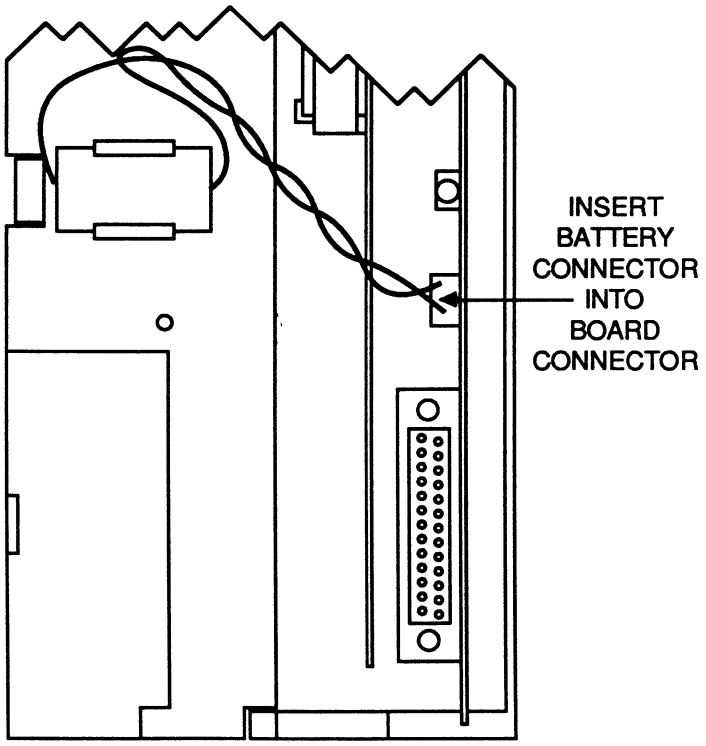

Figure 5-4. CPU Battery Mounting and Connection

Replacing I/O Modules

1. Turn off AC or DC power, as applicable, to the base unit in which the I/O module to be replaced is contained, and from the I/O system.
2. Remove the faceplate from the module to be replaced. There is no need to remove field wiring from the terminal block, since the block is removable. Disconnect the removable terminal block from the module by removing the two captive screws holding the terminal block to the module's circuit board assembly.

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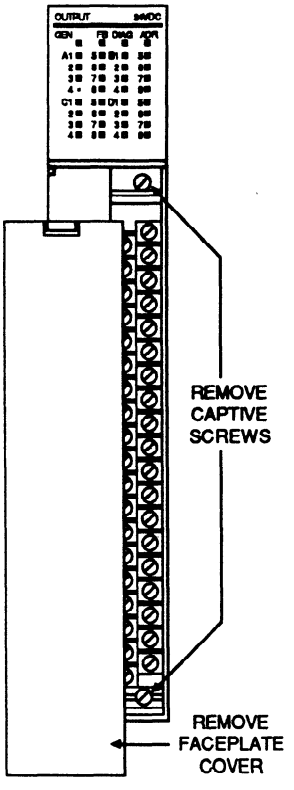

Figure 5-5. Removal of Terminal Block From Module

3. Loosen the two captive screws holding the module in place, and remove the module from its slot by pulling it towards you.
4. Install the new module in the slot by lining it up with the backplane connector for its slot and firmly pushing the module into the connectors until it is securely seated, then tighten the two captive screws.
5. Place the terminal block over the edge connector on the circuit board and firmly push down. Tighten the two screws on the terminal block, then replace the plastic faceplate cover.
6. Reapply power to the base unit and to the field devices, and verify that the system is operating properly.

A list of parts for the Series Five PLC is provided in table 5-6. It is recommended that a spare parts kit be available so that your Series Five PLC system can be returned to service with a minimum amount of downtime if a problem does occur.

Table 5-6. Series Five PLC Parts List

Catalog Number	Description of Item
Base Units/Power Supplies/Cables/Miscellaneous	
IC655CHS506	Base Unit, with 6 I/O slots
IC655CHS508	Base Unit, with 8 I/O slots
IC655CBL500	I/O Expander Cable, 1 feet (.5 m)
IC655CBL501	I/O Expander Cable, 3 feet (1.0 m)
IC655CBL502	I/O Expander Cable, 15 feet (5 meters)
IC655CBL503	I/O Expander Cable, 30 feet (10 meters)
IC655CBL504	I/O Expander Cable, 80 feet (25 meters)
IC655CBL505	I/O Expander Cable, 160 feet (50 meters)
IC655CBL540	OIU to CPU Cable, 5 feet (1.5 m)
IC655CBL541	OIU to CPU Cable, 10 feet (3.0 m)
IC655PWR500	AC Power Supply, 115/230 V ac Input, 6 amps (maximum)
IC655PWR501	AC Power Supply, 115/230 V ac Input, 12 amps (maximum)
IC655PWR514	DC Power Supply, 24 V dc Input, 6 amps (maximum)
IC655CHS590	I/O Rack Terminator Plug
IC655ACC551	Oversized Faceplate
IC655ACC552	Filler Module
IC655ACC553	19 inch Rack Mounting Bracket
IC655ACC554	OIU Mounting Bracket
CPU - Batteries - Memory Cartridges - Interface and Special Modules	
IC655CPU500	CPU module
IC655ACC549	Battery, memory cartridge
IC655ACC550	Battery, CPU
IC655MEM501	4K/24K RAM memory with battery back-up
IC655MEM503	16K RAM memory with battery back-up
IC655MEM512	8K/24K EPROM memory (UV erasable)
IC655MEM513	16K EPROM memory (UV erasable)
IC655MEM521	4K EEPROM memory (electrically erasable)
IC655APU500	ASCII/BASIC Module
IC655APU510	High Speed Counter
IC655APU521	Axis Positioning Module
IC655BEM500	Local I/O Interface module
IC655BEM510	Genius Bus Controller module
IC655BEM530	Series Three I/O Interface module
IC655CBL530	Series Five to Series Three Cable, 3 feet (1m)
IC655CCM500	CCM Communications Module
Input Modules	
IC655ALG516	Analog Input, 1 to 5V, 0 to +10V, -10 to +10V, 4 to 20 mA, 8 Channels
IC655MDL501	12/24 V dc Input, Negative Logic, 16 Circuits
IC655MDL502	12/24 V dc Input, Negative Logic, 32 Circuits
IC655MDL503	24 V dc Input, Positive/Negative Logic, 64 Circuits
IC655MDL511	24/48 V ac/dc, Isolated Input, Positive Logic, 16 Circuits
IC655MDL512	12/24 V ac/dc Input, Positive Logic, 32 Circuits
IC655MDL524	Input Simulator, 16 or 32 Circuits (switchable)
IC655MDL525	115/230 V ac Input, 16 Circuits
IC655MDL526	115 V ac Input, 32 Circuits
IC655MDL527	115/230 V ac, Isolated Input, 16 Circuits
IC655MDL533	5/12 V dc TTL Input, Positive/Negative ogic, 64 Circuits

Table 5-6. Series Five PLC Parts List - Continued

Catalog Number	Description of Item
Output Modules	
IC655ALG566	Analog Output, 0 to +10V, 4 to 20 mA, 2 Channels
IC655ALG567	Analog Output, -10 to +10V, 2 Channels
IC655MDL551	12/24 V dc Output, Negative Logic, 16 Circuits
IC655MDL552	12/24 V dc Output, Negative Logic, 32 Circuits
IC655MDL555	12/24 V dc Output, Positive Logic, 16 Circuits
IC655MDL556	12/24 V dc Output, Positive Logic, 32 Circuits
IC655MDL575	115/230 V ac Output, 16 Circuits
IC655MDL576	115/230 V ac Isolated Output, 16 Circuits
IC655MDL577	115/230 V ac Output, 32 Circuits
IC655MDL580	Relay Output, 16 Circuits
IC655MDL581	Relay Output, 32 Circuits
IC655MDL586	Isolated Relay Output, 16 Circuits
IC655MDL593	5/12 V dc TTL Output, Positive Logic, 64 Circuits

List of Fuses

The following table contains a list of fuses that are used in Series Five Output modules.

Table 5-7. Fuses Used in Output Modules

Module Name	Catalog Number	Fuse Type *	Current Rating	Slow/Fast Blow	Qty On Module	User Replaceable
24 V dc Out, Neg Logic	IC655MDL551	MF51SH8	8 amp	Fast	4	Yes
24 V dc Out, Neg Logic	IC655MDL552	MF51SH3	3 amp	Fast	4	Yes
24 V dc Out, Pos Logic	IC655MDL555	MF51SH8	8 amp	Fast	4	Yes
24 V dc Out, Pos Logic	IC655MDL556	MF51SH3	3 amp	Fast	4	Yes
115/230 V ac Out	IC655MDL575	MF51SH8	8 amp	Fast	2	Yes
115/230 V ac Isol Out	IC655MDL576	MC3	3 amp	Fast	16	No
115/230 v ac Out	IC655MDL577	MC5	5 amp	Fast	4	No
Relay Out	IC655MDL580	MF51SH8	8 amp	Fast	4	Yes

* MF51SH3, MF51SH8 - 20 mm x 5.2 mm - cartridge type
MC3, MC5 - 9 mm x 2.7 mm - pigtail type, soldered-in place

Accessory Kit for the Series Five PLC

An accessory kit (IC655ACC520) is available to support the Series Five PLC. This kit contains many of the most commonly used components that may get damaged or lost during normal operation, such as fuses, screws, terminal covers, etc. Rather than attempting to order all of these parts separately, this kit provides a convenient means of ordering and storing these parts. Each kit should be sufficient to support several PLCs, depending on their I/O count. Items included in the kit are listed below.

Table 5-8. Accessory Kit

Item	Quantity in Kit
CPU keys	2 sets (2 keys per set)
CPU door, with CCM hinged door and OIU port cover	1
I/O wiring labels for inside faceplate, 16/32 pt	50 of each type
Plastic bead chain (I/O faceplate to module)	20
Screws/washers, all sizes	10 of each
Dust covers for I/O bus port connector	4
Dust covers for I/O expansion port connector	2
Fuses, fast blow - 2A, 3A, 3.15A, 5A, 8A	5 of each
Faceplate for I/O module	3
Faceplate for power supply	1
Module access side cover	3
Jumper bar for power supply	2
Jumper for register size configuration	2
Keying inserts for terminal block, 16 and 32 point	10 of each
Memory cartridge labels (CMOS RAM, EPROM, EEPROM)	36 labels, each type

Figure 5.6 is an illustration of the accessory kit location guide, GFJ-011, which is packed with each accessory kit. This guide shows the location and lists the quantity of each item in the kit.

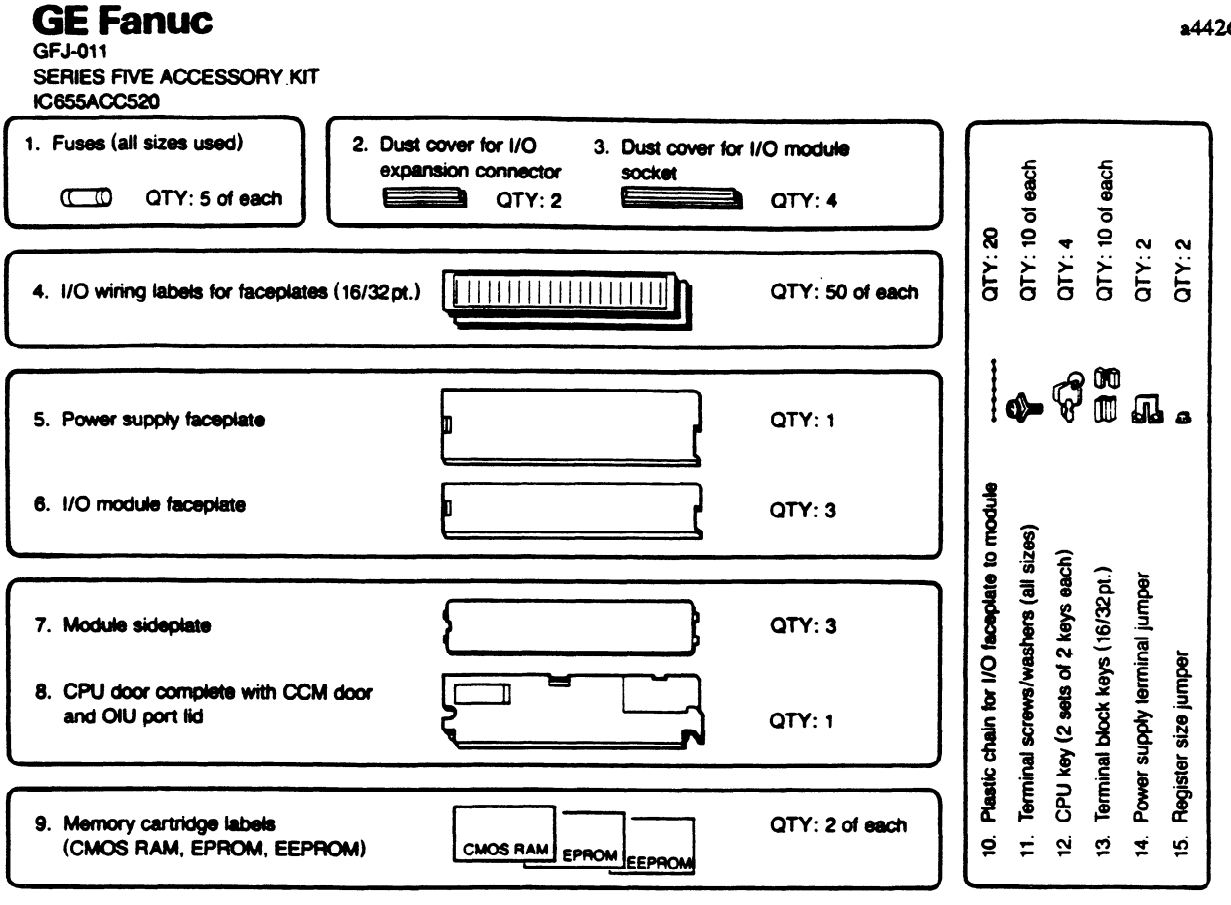

Figure 5-6. Accessory Kit Location Guide

Ring and Spade Lugs

The following list of ring and spade lugs have been tested and can be used for connecting field wiring to the terminal blocks on Series Five I/O modules. Most ring or spade lugs will fit the terminals.

Table 5-9. Recommended Lugs for Field Wiring Connections

Type of Lug	Wire Size Awg # (mm^2)	AMP Catalog Number
spade	22 - 16 (0.38 - 1.2 mm^2)	52929
spade	16 - 14 (1.2 - 1.9 mm^2)	52935
spade	12 - 10 (3.0 - 5.2 mm^2)	52941
ring	16 - 14 (1.2 - 1.9 mm^2)	32422
ring	22 - 18 (0.38 - 1.0 mm^2)	31822

Appendix A
Glossary of Terms

Address A series of decimal numbers assigned to specific program memory locations and used to access those locations. In the Series Five PLC, the addresses can range from 0000 to a maximum of 16383.

Analog A numerical expression of physical variables such as rotation and distance to represent a quantity.

ASCII An 8-level code (7 bits plus 1 parity bit) commonly used for exchange of data which is the American Standard Code for Information Interchange.

Backplane A group of connectors physically mounted at the back of a rack so that printed circuit boards can be mated to them. The connectors are interconnected by wire wrapping.

Base Unit A metal mounting plate with a backplane into which Series Five modules are installed.

Baud A unit of data transmission speed equal to the number of code elements (bits) per second.

BCD (Binary Coded Decimal) A 4-bit system in which individual decimal digits (0 through 9) are represented by 4-bit binary numerals; for example, the number 43 is represented by 0100(4) 0011(3) in the BCD notation.

Binary A numbering system that uses only the digits 0 and 1. This system is also called base 2.

Bit The smallest unit of memory. Can be used to store only one piece of information that has two states (for example, a One/Zero, On/Off, Good/Bad, Yes/No, etc.). Data that requires more than two states (for example, numerical values 000-999) will require multiple bits.

Bus An electrical path for transmitting and receiving data.

Byte A group of binary digits operated on as a single unit. In the Series Five PLC, a byte is made up of 8 bits.

CCM Port A communications port in the CPU conforming to the GE Fanuc CCM communications protocol.

CMOS An acronym for Complementary Metal Oxide Semiconductor. A read/write memory that has a low power consumption but requires a battery in order to retain its content upon loss of power.

CPU (Central Processing Unit) The central device or controller that interprets user instructions, makes decisions and executes the functions based on a stored program. This program specifies actions to be taken to all possible inputs.

Counter A function within the PLC that records events based upon the On/Off transition of a signal. A coil associated with the counter is energized at a user determined preset value.

DIP Switch An acronym for Dual-In-Line Package, which is a group of miniature toggle or slide switches arranged side-by-side in a single package. Commonly used as the physical device for setting the configuration of various parameters necessary to the operation of electronic equipment.

Data Link The equipment including interface modules and cables that allow transmission of information.

Discrete Consisting of individual, distinct things such as bits, characters or circuit components. Also refers to On/Off type of I/O modules.

Field Devices User supplied devices typically providing information to the PLC (Inputs: pushbutton, limit switches, relay contacts, etc.) or performing PLC tasks (Outputs: motor starters, solenoids, indicator lights, etc.).

Firmware A series of instructions contained in ROM (Read Only Memory) which are used for internal processing functions only. These instructions are transparent to the user.

Hardware All of the mechanical, electrical and electronic devices that comprise the Series Five PLC and its application(s).

Hardwired Interconnection of electrical and electronic devices directly through physical wiring.

Hexadecimal A numbering system, having 16 as a base, represented by the digits 0 through 9, then A through F.

Input A signal, typically ON or OFF, that provides information to the PLC. Inputs are usually generated by devices such as limit switches and pushbuttons.

Input Module An I/O module that converts signals from user devices to logic levels used by the CPU.

Interface To connect a programmable logic controller with its application devices, communications channels, and peripherals through various modules and cables.

I/O (Input/Output) That portion of the PLC to which field devices are connected; isolates the CPU from electrical noise generated by external devices.

I/O Electrical Isolation A method of separating field wiring from logic level circuitry. Typically accomplished through the use of optical isolation devices.

I/O Module A printed circuit assembly that interfaces between user devices and the Series Five PLC.

I/O Scan A method by which the CPU monitors all inputs and controls all outputs within a prescribed time.

I/O Terminator Plug A Plug containing resistors that must be installed at the end of an I/O chain to properly terminate the I/O bus signals. In the Series Five it must be installed on the last I/O expansion connector on a base unit.

K An abbreviation for kilo or exactly 1024 in the world of computers. Usually related to 1024 words of memory.

LED An acronym for Light-Emitting-Diode, which is a solid state device commonly used as a visual indicator in electronic equipment.

Ladder Diagram A representation of control logic relay systems. The user programmed logic is expressed in relay equivalent symbology.

Local I/O Chain An I/O system configuration consisting of a maximum of 8 base units, including a CPU base unit, that are connected through I/O expansion cables, and can contain up to 64 I/O modules (1024 Inputs and 1024 Outputs). The last base unit in the chain can be located up to 200 feet (60 meters) maximum distance, from the CPU base unit.

Logic A fixed set of responses (outputs) to various external conditions (inputs). All possible situations for both synchronous and non-synchronous activity must be specified by the user. Also referred to as the program.

Logic Memory Dedicated RAM, EPROM, or EEPROM memory accessible by the user for storage of user ladder diagram programs.

Memory A grouping of physical circuit elements that have data entry, storage and retrieval capability.

Memory Cartridge
A compact device containing RAM, EPROM, or EEPROM devices for storing user memory or data registers. A memory cartridge plugs into a slot in the CPU.

Memory Protect
A hardware capability that prevents user memory from being altered by an external device. This capability is controlled by a jumper in the RAM memory cartridge. In the Series Five PLC, this protection is also provided by a user password function.

Microprocessor An electronic computer processor section consisting of integrated circuit chips that contain arithmetic, logic, register, control and memory functions.

Microsecond (ms)
One millionth of a second. 1×10^{-6} or 0.000001 second.

Millisecond (ms)
One thousandth of a second. 1×10^{-3} or 0.001 second.

Mnemonic An abbreviation given to an instruction, usually an acronym formed by combining initial letters or parts of words.

Modules A replaceable electronic subassembly usually plugged in and secured in place but easily removable in case of fault or system redesign. In the Series Five PLC, a combination of a printed circuit board, a removable terminal block, and a faceplate, which when combined form a complete module.

Nanosecond (ns)
One billionth of a second. 1×10^{-9} or 0.000000001 second.

Noise Undesirable electrical disturbances to normal signals, generally of high frequency content.

Non-Volatile Memory
A memory capable of retaining its stored information under no-power conditions (power removed or turned off).

OFF-Line Equipment or devices that are not connected to a communications line; for example, the Workmaster computer, when off-line, operates independent of the Series Five CPU.

ON-Line Descriptive of equipment or devices that are connected to the communications line.

Optical Isolation
Use of a solid state device to isolate the user input and output devices from internal circuitry of an I/O module and the CPU.

Opto-Isolator A semiconductor device that isolates input or output circuits from the control circuitry on an I/O module. These circuits are coupled together by transmission of light energy from a sender (LED) to a receiver (photo-isolator).

Outputs Signals, typically ON or OFF, originating from the PLC with user supplied power, that control external devices based upon commands from the CPU.

Output Information transferred from the CPU, through a module for level conversion, for controlling an external device or process.

Output Devices Physical devices such as motor starters, solenoids, etc. that receive data from the programmable logic controller.

Output module An I/O module that converts logic levels within the CPU to a usable output signal for controlling a machine or process.

PLC Commonly used acronym for Programmable Logic Controller.

Parity The anticipated state, either odd or even, of a set of binary digits.

Parity Bit A bit added to a memory word to make the sum of the bits in a word always even (even parity) or always odd (odd parity).

Parity Check A check that determines whether the total number of ones in a word is odd or even.

Parity Error A condition that occurs when a computed parity check does not agree with the parity bit.

Peripheral Equipment
External units that can communicate with a PLC, for example, programmers, printers, etc.

Port Connector A socket or plug used to provide an electrical connection with other devices for communication purposes, e.g, the CCM port connector in the CPU.

Program A sequence of functions entered into a programmable logic controller to be executed by the processor for the purpose of controlling a machine or process.

Programmable Logic Controller
A solid-state industrial control device which receives inputs from user-supplied control devices such as switches and sensors, implements them in a precise pattern determined by ladder diagram based programs stored in the user memory, and provides outputs for control of processes or user supplied devices such as relays and motor starters.

Programmer A device for entry, examination and alteration of the PLC's memory, including logic and storage areas.

PROM An acronym for Programmable Read Only Memory. A retentive digital device programmed at the factory and not readily alterable by the user.

Rack A base unit containing modules.

RAM An acronym for Random Access Memory. A solid-state memory that allows individual bits to be stored and accessed. This type of memory is volatile; that is, stored data is lost under no power conditions, therefore a battery backup is required. The Series Five PLC uses a Lithium Manganese Dioxide battery mounted on the circuit board in the memory cartridge.

Reset Pushbutton
A small pushbutton mounted in the CPU, which, when depressed resets the CPU.

RS-232C A standard specified by the Electronics Industries Association (EIA) for the mechanical and electrical characteristics of the interface for connecting Data Communications Equipment (DCE) and Data Terminal Equipment (DTE).

RUN Light An LED indicator on the CPU module which, when on, indicates that the CPU is in the RUN mode with outputs energized.

Read To have data entered from a storage device.

GFK-0122

Reference A number used in a program that tells the CPU where data is coming from or where to transfer the data.

Register Memory
In the Series Five PLC, dedicated CMOS RAM memory accessible by the user for data storage and manipulation.

Scan The technique of examining or solving all logic steps specified by the program in a sequential order from the first step to the last.

Serial Communication
A method of data transfer within a PLC, whereby the bits are handled sequentially rather than simultaneously as in parallel transmission.

Sideplate A rectangular plastic plate or lid installed in the left side of a module housing that allows access to module components requiring action by the user, e.g. DIP switches, potentiometers, and fuses.

Significant Bit A bit that contributes to the precision of a number. The number of significant bits is counted beginning with the bit contributing the most value, referred to as the Most Significant Bit (MSB), and ending with the bit contributing the least value, referred to as the Least Significant Bit (LSB).

Slot A location in a base unit that will accept one module of standard width.

Solid State Electronic circuitry using only transistors, diodes, integrated circuits, etc. This circuitry has high reliability and low power consumption when compared to electro-mechanical devices.

Storage Used synonymous with memory.

Terminal A single electrical connection between the Series Five and the real world through a screw connector.

Terminal Block A removable assembly which attaches to the front of a circuit board, and contains the screw terminals required for user wiring connections.

Terminal Block Keys
Small plastic pegs that are inserted into a terminal block at certain points thereby acting as mechanical keys to prevent accidental installation of the block on the wrong type of I/O module.

Unit of Load An expression used to describe the load placed on a power supply by an I/O module or a CPU module. Also the amount of current or load capacity available from a power supply.

User Memory Term commonly used when referring to the memory circuits within the PLC used for storage of user ladder diagram programs.

Volatile Memory
A memory that will lose the information stored in it if power is removed from the memory circuit devices.

Watchdog Timer
A software timer within the PLC used to ensure that certain hardware conditions are met. Used as a system check. In the Series Five PLC, the duration of the watchdog timer can be configured through Logicmaster 5 from 20 to 998 milliseconds.

Word A measurement of memory length, usually 4, 8, or 16 bits long (16 bits for the Series Five Plus PLC).

Write To transfer, record, or copy data from one storage device to another.

Appendix B
Series Five PLC Bulletin Board

GE Fanuc has a computer bulletin board for the Series Five Programmable Logic Controller. This service is provided free of charge to our customers, and is intended to:

1. Provide Series Five PLC customers with instant access to new information from GE Fanuc.
2. Allow sharing of tips, programs, and other information among Series Five PLC customers.
3. Provide GE Fanuc with feedback from Series Five PLC customers regarding product performance, product enhancement, or other pertinent information.

Logging On for the First Time

To gain access to this bulletin board, you need a computer or terminal, modem, and modem software. Your modem must be set for 1200 or 2400 baud (2400 is preferred, since it saves you time and money), 8 bits per character, and no parity. To download programs or files, your system must be capable of supporting the XMODEM or ASCII protocols. Hayes compatible modems are preferred.

The telephone number for the bulletin board is (804) 978-5046. If the bulletin board is in use, you will get a BUSY or no carrier message. If the bulletin board is not busy, you will see a power-up "LOG IN" screen.

During any communications session, if there is "dead time" (inactivity) for more than 5 minutes on your end, the session will be terminated to allow others to access the bulletin board. You are limited to a total of 60 minutes per day on the bulletin board. Also, if there is no activity in your account for 6 months, your account will be deleted from the bulletin board. You, may, of course, register again at any time.

After connection has been made for the first time, you will be asked to enter responses to several questions for the registration procedure. If you make a typing mistake, and the BACKSPACE does not function, use CONTROL BACKSPACE instead. If this still does not work, continue the logon procedure until you have the option to change the name - select this option instead of registering at this time. The questions asked and responses you should give are as follows:

What type of system are you calling from? If an IBM-PC, PC-XT, PC-AT, or PS/2, or compatible - press ENTER - or, otherwise enter your system type (VAX, etc.) and press *ENTER*.

What is your CITY and STATE? Enter your city and state.

Do you want to Register? - Answer R (Register).

Enter *PASSWORD* you'll use to logon again? Enter a personal password (15 characters maximum) and be sure you remember it or write it down for future logons. *Hint - short relevant passwords are easier to remember.* You will be required to enter this password for future access to the bulletin board, once you have been granted full system access.

Can your terminal display upper and lower case characters? - Normally Yes.

Graphics - None; ASCII; Color - enter N for none at this time.

File transfer type - check your modem software and then make the selection - to download text files only, the ASCII protocol is sufficient; to download Object files which contain non-ASCII characters, XMODEM must be used.

Nulls - answer NO, unless you are using a teletype.

You will then see an introductory message, and will be allowed limited access to the bulletin board. At this time, you should enter C (for Comment) to send your name, address, and telephone number to the Series Five bulletin board system manager, who will grant full system access to you within 48 hours. Please do not experiment with the other menus, or try to enter other commands at this time.

The format of the comment for entering your name, address, and telephone number is not critical, but the following form is recommended;

Your Name
Your Company Name
Mailing Address
City, State, Zip Code
(Area Code) Telephone Number

After entering this comment, Save it by entering the S (Save) command. Then enter Q (Quit) to quit the main menu, then G to say goodbye (sign off) for now. At this point you have completed your initial bulletin board session.

Privileges After Being Granted Full Access To The Bulletin Board

After full access to the bulletin board has been granted, you will have the ability to:

1. Review public questions and comments between users and/or GE Fanuc.
2. Send comments to any or all other users and to GE Fanuc.
3. Load onto your system, programs or files contributed by other users.
4. Contribute programs, files, or other useful information you wish to share with other users.
5. Review material entered into the bulletin board by GE Fanuc, relating to the Series Five PLC product line.

Please note: since this is the Series Five PLC bulletin board, the subject of comments and other information submitted by you, should be restricted to the Series Five PLC. Since material will be contributed from many sources, GE Fanuc is not responsible for the accuracy of any material entered on the bulletin board and reserves the right to delete any material.

Once you have gained expertise in the use of the bulletin board, you may wish to have the menu printing on the screen disabled to save time. When you feel that you can do without the menus, send a comment to the Series Five PLC team, and arrangements will be made for menus to be displayed only on request.

Logging In After Being Granted Full Access

When you logon, you must give your name and password exactly as you specified at initial logon. After logging on, a summary of system bulletins will be displayed. It is important that you review the bulletin descriptions, since this is how you are informed by GE Fanuc of significant items elsewhere in the bulletin board.

Additionally, a listing of messages directed to you, and a list of messages that you have sent is printed on the screen. Next - the MAIN MENU is printed, and from it you can select the FILES MENU and the UTILITY MENU. Select the desired items and follow on-screen prompts. When you wish to logoff - enter G (Goodbye)

A sample printout of a communications session with the Series Five bulletin board follows. Entries required by you are printed in bold type. Comments added for clarification are in parenthesis and are printed in italics. Please note that some of the bulletin board formats and/or comments as shown in the example may be changed for clarity.

Most entries required by you are self explanatory - however, a HELP command is available in the MAIN and FILES MENUS if you do need additional information.

Sample of a Bulletin Board Session

(Dial-in from your location)

CONNECT

WELCOME TO SERIES FIVE
Welcome to the Series Five User Bulletin Board. This service is provided by GE Fanuc to users of Series Five PLC equipment to allow interaction with each other and with GE Fanuc. GE Fanuc does not guarantee the accuracy of information on the bulletin board, and reserves the right to delete any information contributed from any source.

For any session, if there is a "dead" time of more than 5 minutes on your end, the session will be terminated to allow others to get to the BB. Also, if there is no activity in your account for 6 months, your account will be deleted. You will be limited to 60 minutes per day on the BB.

Thank you in advance for your responsible use of the bulletin board. Please help us make it a success.

NICE TO HAVE YOU ABOARD.

What is your FIRST name? **John** *(enter your first name)*
What is your LAST name? **Doe** *(enter your last name)*
Checking users...
Enter Password (dots will echo)? ..... *(enter the password you entered at initial logon)*

Granted access level 5

Logging JOHN DOE

RBBS-PC VERSION CPC14.1C NODE 1
OPERATING AT 1200 BAUD,N,8,1
Times on : 2
Last time on was: 04-15-90 14:25 (time and date of your last session)
Files Downloaded: 0 Uploaded: 0 (number of files you entered or copied)

Your PROFILE (utilities reset)
Novice
GRAPHICS: ASCII
PROTOCOL: Xmodem
UPPER CASE and lower
Line Feeds On
Nulls Off
Prompting Bell Off

========== Bulletin Menu ==========

LAST UPDATED

1 - New product availabilities (New ASCII/BASIC III) MM/DD/YY
2 - Expanded bulletin index (more stuff to read/download)
3 - Bug / compatibility chart
4 - Genius bus controller manual addendum
5 - MORE ABM HINTS (TRANSFER EX, AND HOW TO STOP THE CPU)
6 - Description of New ASCII/BASIC module (also see #10)
7 - More files to download (also see bulletin 2)
8 - Interfacing to serial devices
9 - Series Five UL approvals
10- User manual addendum for new ABM (see bulletin 6 above)

==========

NOTE 1: Bulletins may be downloaded using filename e.g. bulletin 1.

NOTE 2: Use ASCII format to download files unless otherwise instructed. To use Xmodem for non-ASCII files, you may need to change the file protocol default from the utilities menu.

Bulletin # 1 thru 10. List. Press [ENTER] to Continue.

Checking messages.
Sorry, JOHN, NO MAIL for you. *(If you have any new messages, the message numbers, in numerical sequence, will be displayed here)*

Mail you may have left
*3 (message number of previous messages)
Please <K>ill your old or un-needed messages

RBBS--PC Version CPC14.1C Node 1

Caller # 52 active msgs: 18 Next msg # 20 last msg read: 19

58 minutes left (time remaining for this day)

SERIES FIVE BULLETIN BOARD MAIN MENU

SYSTEM INFORMATION	USER MESSAGES
B = Bulletins (list system bulletins)	E = Enter message
C = Comments (Comment to SERIES FIVE team)	K = Kill messages
G = Goodbye (exit bulletin board)	P = Personal mail
H = Help	Q = Quick message scan
I = Initial welcome	R = Read messages
L = Lines per page	S = Scan messages
? = additional help information	

NOTE

Use E to enter new message; K to delete messages; P to list all messages you have received; Q for summary of all your messages; R to read your messages; S to scan all messages)

SUBSYSTEMS

F = Files (enter Files subdivision)
U = Utilities

FUNCTIONS N,J,O,V,W
not supported

FUNCTION X = EXPERT MODE
SYSOP MUST AUTHORIZE (SYSOP is the system operator)

Main Functions <B,C,D,E,F,G,H.I,J,K,L,O,P,Q,R,S,U,V,W,X,?>? **F (enter letter for desired command)**

57 minutes left

FILES MENU

FILE COMMANDS

D = Download a file from bulletin board
L = List files
N = New files listing
S = Search for string in filename
U = Upload a file to the Bulletin Board

OTHER

G = Goodbye
H = Help
Q = Quit to main menu
? = Additional help

FUNCTION X = EXPERT MODE
SYSOP MUST AUTHORIZE

File Function <D,G,H,L,N,Q,S,U,X,?>? **N** *(enter letter for desired command)*
Include files on/after (MMDDYY) [ENTER] = last date or 030888)? *(enter a prior date, or if no date entered, defaults to current days date)*
Directory(s) to scan or all? **##** *(enter directory number, if directory not found - bulletin board will return to FILES MENU)*

56 minutes left

FILES MENU

FILE COMMANDS

D = Download a file from bulletin board
L = List files
N = New files listing
S = Search for string in filename
U = Upload a file to the Bulletin Board

OTHER

G = Goodbye
H = Help
Q = Quit to main menu
? = Additional help

FUNCTION X = EXPERT MODE
SYSOP MUST AUTHORIZE

(At this point you could download a file, however since this is only an example, we will exit to the main menu by typing Q (Quit)

File Function <D,G,H,L,N,Q,S,U,X,?>? **Q** (return to main menu)

55 minutes left

GFK-0122

SERIES FIVE BULLETIN BOARD MAIN MENU

SYSTEM INFORMATION

B = Bulletins (list system bulletins)
C = Comments (Comment to SERIES FIVE team)
G = Goodbye (exit bulletin board)
H = Help
I = Initial welcome
L = Lines per page
? = additional help information

SUBSYSTEMS

F = Files (enter Files subdivision)
U = Utilities

USER MESSAGES

E = Enter message
K = Kill messages

P = Personal mail
Q = Quick message scan
R = Read messages
S = Scan messages

FUNCTIONS N,J,O,V,W not supported

FUNCTION X = EXPERT MODE SYSOP MUST AUTHORIZE

Main Functions <B,C,D,E,F,G,H.I,J,K,L,O,P,Q,R,S,U,V,W,X,?>? **U** *(This puts you in the UTILITIES MENU)*

(Allows you to review or change certain system features - select H (HELP) for a description of each item)

UTILITY MENU

UTILITY FUNCTIONS

B = Baud rate
C = Toggle uppercase only
F = Change file transfer type
G = Graphics
L = Line feeds
M = Msg margin
N = Nulls
P = Password
R = Show reset utilities profile
S = Statistics
T = Time
U = Userlog
I = prompt sound

OTHER

H = Help
Q = Quit to Main Menu

Utility Functions <B,C,F,G,H,L,M,N,P,Q,R,S,T,U,!>? **Q** *(enter letter to select utility function or Q to return to Main Menu)*

55 minutes left

GFK-0122

SERIES FIVE BULLETIN BOARD MAIN MENU

SYSTEM INFORMATION

B = Bulletins (list system bulletins)
C = Comments (Comment to SERIES FIVE team)
G = Goodbye (exit bulletin board)
H = Help
I = Initial welcome
L = Lines per page
? = additional help information

USER MESSAGES

E = Enter message
K = Kill messages
P = Personal mail
Q = Quick message scan
R = Read messages
S = Scan messages

SUBSYSTEMS

F = Files (enter Files subdivision)
U = Utilities

FUNCTIONS N,J,O,V,W
not supported

FUNCTION X = EXPERT MODE
SYSOP MUST AUTHORIZE

Main Functions <B,C,D,E,F,G,H.I,J,K,L,O,P,Q,R,S,U,V,W,X,?>? **G** *(Goodbye - this ends your current session with the bulletin board)*

54 minutes left *(this is the time remaining for you to access the bulletin board today)*

Now 09:23 AM Time on: 3 Min & 15 Sec
JOHN, Thanks for calling and please call again!

(Communications with bulletin board disconnects at this point)

NO CARRIER *(this message should appear on your screen)*

Appendix C
CCM Memory Types

An expanded listing of the Communications Control Module (CCM) memory types is provided in this appendix. This expanded listing includes the memory mapping for:

- Types 2 and 4 (Inputs/Byte) -- Table C-1
- Types 3 and 5 (Outputs/Byte) -- Table C-2

Table C-1. CCM Memory Types 2 and 4 (Inputs/Byte)

Target Address		Table Reference
Decimal	Hexadecimal	
1	1	I1+0001 - I1+0008
2	2	I1+0009 - I1+0016
3	3	I1+0017 - I1+0024
4	4	I1+0025 - I1+0032
5	5	I1+0033 - I1+0040
6	6	I1+0041 - I1+0048
7	7	I1+0049 - I1+0056
8	8	I1+0057 - I1+0064
9	9	I1+0065 - I1+0072
10	A	I1+0073 - I1+0080
11	B	I1+0081 - I1+0088
12	C	I1+0089 - I1+0096
13	D	I1+0097 - I1+0104
14	E	I1+0105 - I1+0112
15	F	I1+0113 - I1+0120
16	10	I1+0121 - I1+0128
17	11	I1+0129 - I1+0136
18	12	I1+0137 - I1+0144
19	13	I1+0145 - I1+0152
20	14	I1+0153 - I1+0160
21	15	I1+0161 - I1+0168
22	16	I1+0169 - I1+0176
23	17	I1+0177 - I1+0184
24	18	I1+0185 - I1+0192
25	19	I1+0193 - I1+0200
26	1A	I1+0201 - I1+0208
27	1B	I1+0209 - I1+0216
28	1C	I1+0217 - I1+0224
29	1D	I1+0225 - I1+0232
30	1E	I1+0233 - I1+0240
31	1F	I1+0241 - I1+0248
32	20	I1+0249 - I1+0256
33	21	I1+0257 - I1+0264
34	22	I1+0265 - I1+0272
35	23	I1+0273 - I1+0280
36	24	I1+0281 - I1+0288
37	25	I1+0289 - I1+0296
38	26	I1+0297 - I1+0304
39	27	I1+0305 - I1+0312
40	28	I1+0313 - I1+0320

Target Address		Table Reference
Decimal	Hexadecimal	
41	29	I1+0321 - I1+0328
42	2A	I1+0329 - I1+0336
43	2B	I1+0337 - I1+0344
44	2C	I1+0345 - I1+0352
45	2D	I1+0353 - I1+0360
46	2E	I1+0361 - I1+0368
47	2F	I1+0369 - I1+0376
48	30	I1+0377 - I1+0384
49	31	I1+0385 - I1+0392
50	32	I1+0393 - I1+0400
51	33	I1+0401 - I1+0408
52	34	I1+0409 - I1+0416
53	35	I1+0417 - I1+0424
54	36	I1+0425 - I1+0432
55	37	I1+0433 - I1+0440
56	38	I1+0441 - I1+0448
57	39	I1+0449 - I1+0456
58	3A	I1+0457 - I1+0464
59	3B	I1+0465 - I1+0472
60	3C	I1+0473 - I1+0480
61	3D	I1+0481 - I1+0488
62	3E	I1+0489 - I1+0496
63	3F	I1+0497 - I1+0504
64	40	I1+0505 - I1+0512
65	41	I1+0513 - I1+0520
66	42	I1+0521 - I1+0528
67	43	I1+0529 - I1+0536
68	44	I1+0537 - I1+0544
69	45	I1+0545 - I1+0552
70	46	I1+0553 - I1+0560
71	47	I1+0561 - I1+0568
72	48	I1+0569 - I1+0576
73	49	I1+0577 - I1+0584
74	4A	I1+0585 - I1+0592
75	4B	I1+0593 - I1+0600
76	4C	I1+0601 - I1+0608
77	4D	I1+0609 - I1+0616
78	4E	I1+0617 - I1+0624
79	4F	I1+0625 - I1+0632
80	50	I1+0633 - I1+0640

Target Address Decimal	Target Address Hexadecimal	Table Reference
81	51	I1+0641 - I1+0648
82	52	I1+0649 - I1+0656
83	53	I1+0657 - I1+0664
84	54	I1+0665 - I1+0672
85	55	I1+0673 - I1+0680
86	56	I1+0681 - I1+0688
87	57	I1+0689 - I1+0696
88	58	I1+0697 - I1+0704
89	59	I1+0705 - I1+0712
90	5A	I1+0713 - I1+0720
91	5B	I1+0721 - I1+0728
92	5C	I1+0729 - I1+0736
93	5D	I1+0737 - I1+0744
94	5E	I1+0745 - I1+0752
95	5F	I1+0753 - I1+0760
96	60	I1+0761 - I1+0768
97	61	I1+0769 - I1+0776
98	62	I1+0777 - I1+0784
99	63	I1+0785 - I1+0792
100	64	I1+0793 - I1+0800
101	65	I1+0801 - I1+0808
102	66	I1+0809 - I1+0816
103	67	I1+0817 - I1+0824
104	68	I1+0825 - I1+0832
105	69	I1+0833 - I1+0840
106	6A	I1+0841 - I1+0848
107	6B	I1+0849 - I1+0856
108	6C	I1+0857 - I1+0864
109	6D	I1+0865 - I1+0872
110	6E	I1+0873 - I1+0880
111	6F	I1+0881 - I1+0888
112	70	I1+0889 - I1+0896
113	71	I1+0897 - I1+0904
114	72	I1+0905 - I1+0912
115	73	I1+0913 - I1+0920
116	74	I1+0921 - I1+0928
117	75	I1+0929 - I1+0936
118	76	I1+0937 - I1+0944
119	77	I1+0945 - I1+0952
120	78	I1+0953 - I1+0960
121	79	I1+0961 - I1+0968
122	7A	I1+0969 - I1+0976
123	7B	I1+0977 - I1+0984
124	7C	I1+0985 - I1+0992
125	7D	I1+0993 - I1+1000
126	7E	I1+1001 - I1+1008
127	7F	I1+1009 - I1+1016
128	80	I1+1017 - I1+1024
129	81	I2+0001 - I2+0008
130	82	I2+0009 - I2+0016
131	83	I2+0017 - I2+0024
132	84	I2+0025 - I2+0032
133	85	I2+0033 - I2+0040
134	86	I2+0041 - I2+0048
135	87	I2+0049 - I2+0056
136	88	I2+0057 - I2+0064

Target Address Decimal	Target Address Hexadecimal	Table Reference
137	89	I2+0065 - I2+0072
138	8A	I2+0073 - I2+0080
139	8B	I2+0081 - I2+0088
140	8C	I2+0089 - I2+0096
141	8D	I2+0097 - I2+0104
142	8E	I2+0105 - I2+0112
143	8F	I2+0113 - I2+0120
144	90	I2+0121 - I2+0128
145	91	I2+0129 - I2+0136
146	92	I2+0137 - I2+0144
147	93	I2+0145 - I2+0152
148	94	I2+0153 - I2+0160
149	95	I2+0161 - I2+0168
150	96	I2+0169 - I2+0176
151	97	I2+0177 - I2+0184
152	98	I2+0185 - I2+0192
153	99	I2+0193 - I2+0200
154	9A	I2+0201 - I2+0208
155	9B	I2+0209 - I2+0216
156	9C	I2+0217 - I2+0224
157	9D	I2+0225 - I2+0232
158	9E	I2+0233 - I2+0240
159	9F	I2+0241 - I2+0248
160	A0	I2+0249 - I2+0256
161	A1	I2+0257 - I2+0264
162	A2	I2+0265 - I2+0272
163	A3	I2+0273 - I2+0280
164	A4	I2+0281 - I2+0288
165	A5	I2+0289 - I2+0296
166	A6	I2+0297 - I2+0304
167	A7	I2+0305 - I2+0312
168	A8	I2+0313 - I2+0320
169	A9	I2+0321 - I2+0328
170	AA	I2+0329 - I2+0336
171	AB	I2+0337 - I2+0344
172	AC	I2+0345 - I2+0352
173	AD	I2+0353 - I2+0360
174	AE	I2+0361 - I2+0368
175	AF	I2+0369 - I2+0376
176	B0	I2+0377 - I2+0384
177	B1	I2+0385 - I2+0392
178	B2	I2+0393 - I2+0400
179	B3	I2+0401 - I2+0408
180	B4	I2+0409 - I2+0416
181	B5	I2+0417 - I2+0424
182	B6	I2+0425 - I2+0432
183	B7	I2+0433 - I2+0440
184	B8	I2+0441 - I2+0448
185	B9	I2+0449 - I2+0456
186	BA	I2+0457 - I2+0464
187	BB	I2+0465 - I2+0472
188	BC	I2+0473 - I2+0480
189	BD	I2+0481 - I2+0488
190	BE	I2+0489 - I2+0496
191	BF	I2+0497 - I2+0504
192	C0	I2+0505 - I2+0512

Target Address Decimal	Target Address Hexadecimal	Table Reference
193	C1	I2+0513 - I2+0520
194	C2	I2+0521 - I2+0528
195	C3	I2+0529 - I2+0536
196	C4	I2+0537 - I2+0544
197	C5	I2+0545 - I2+0552
198	C6	I2+0553 - I2+0560
199	C7	I2+0561 - I2+0568
200	C8	I2+0569 - I2+0576
201	C9	I2+0577 - I2+0584
202	CA	I2+0585 - I2+0592
203	CB	I2+0593 - I2+0600
204	CC	I2+0601 - I2+0608
205	CD	I2+0609 - I2+0616
206	CE	I2+0617 - I2+0624
207	CF	I2+0625 - I2+0632
208	D0	I2+0633 - I2+0640
209	D1	I2+0641 - I2+0648
210	D2	I2+0649 - I2+0656
211	D3	I2+0657 - I2+0664
212	D4	I2+0665 - I2+0672
213	D5	I2+0673 - I2+0680
214	D6	I2+0681 - I2+0688
215	D7	I2+0689 - I2+0696
216	D8	I2+0697 - I2+0704
217	D9	I2+0705 - I2+0712
218	DA	I2+0713 - I2+0720
219	DB	I2+0721 - I2+0728
220	DC	I2+0729 - I2+0736
221	DD	I2+0737 - I2+0744
222	DE	I2+0745 - I2+0752
223	DF	I2+0753 - I2+0760
224	E0	I2+0761 - I2+0768
225	E1	I2+0769 - I2+0776
226	E2	I2+0777 - I2+0784
227	E3	I2+0785 - I2+0792
228	E4	I2+0793 - I2+0800
229	E5	I2+0801 - I2+0808
230	E6	I2+0809 - I2+0816
231	E7	I2+0817 - I2+0824
232	E8	I2+0825 - I2+0832
233	E9	I2+0833 - I2+0840
234	EA	I2+0841 - I2+0848
235	EB	I2+0849 - I2+0856
236	EC	I2+0857 - I2+0864
237	ED	I2+0865 - I2+0872
238	EE	I2+0873 - I2+0880
239	EF	I2+0881 - I2+0888
240	F0	I2+0889 - I2+0896
241	F1	I2+0897 - I2+0904
242	F2	I2+0905 - I2+0912
243	F3	I2+0913 - I2+0920
244	F4	I2+0921 - I2+0928
245	F5	I2+0929 - I2+0936
246	F6	I2+0937 - I2+0944
247	F7	I2+0945 - I2+0952
248	F8	I2+0953 - I2+0960

Target Address Decimal	Target Address Hexadecimal	Table Reference
249	F9	I2+0961 - I2+0968
250	FA	I2+0969 - I2+0976
251	FB	I2+0977 - I2+0984
252	FC	I2+0985 - I2+0992
253	FD	I2+0993 - I2+1000
254	FE	I2+1001 - I2+1008
255	FF	I2+1009 - I2+1016
256	100	I2+1017 - I2+1024
257	101	I0001 - I0008
258	102	I0009 - I0016
259	103	I0017 - I0024
260	104	I0025 - I0032
261	105	I0033 - I0040
262	106	I0041 - I0048
263	107	I0049 - I0056
264	108	I0057 - I0064
265	109	I0065 - I0072
266	10A	I0073 - I0080
267	10B	I0081 - I0088
268	10C	I0089 - I0096
269	10D	I0097 - I0104
270	10E	I0105 - I0112
271	10F	I0113 - I0120
272	110	I0121 - I0128
273	111	I0129 - I0136
274	112	I0137 - I0144
275	113	I0145 - I0152
276	114	I0153 - I0160
277	115	I0161 - I0168
278	116	I0169 - I0176
279	117	I0177 - I0184
280	118	I0185 - I0192
281	119	I0193 - I0200
282	11A	I0201 - I0208
283	11B	I0209 - I0216
284	11C	I0217 - I0224
285	11D	I0225 - I0232
286	11E	I0233 - I0240
287	11F	I0241 - I0248
288	120	I0249 - I0256
289	121	I0257 - I0264
290	122	I0265 - I0272
291	123	I0273 - I0280
292	124	I0281 - I0288
293	125	I0289 - I0296
294	126	I0297 - I0304
295	127	I0305 - I0312
296	128	I0313 - I0320
297	129	I0321 - I0328
298	12A	I0329 - I0336
299	12B	I0337 - I0344
300	12C	I0345 - I0352
301	12D	I0353 - I0360
302	12E	I0361 - I0368
303	12F	I0369 - I0376
304	130	I0377 - I0384

Target Address Decimal	Target Address Hexadecimal	Table Reference
305	131	I0385 - I0392
306	132	I0393 - I0400
307	133	I0401 - I0408
308	134	I0409 - I0416
309	135	I0417 - I0424
310	136	I0425 - I0432
311	137	I0433 - I0440
312	138	I0441 - I0448
313	139	I0449 - I0456
314	13A	I0457 - I0464
315	13B	I0465 - I0472
316	13C	I0473 - I0480
317	13D	I0481 - I0488
318	13E	I0489 - I0496
319	13F	I0497 - I0504
320	140	I0505 - I0512
321	141	I0513 - I0520
322	142	I0521 - I0528
323	143	I0529 - I0536
324	144	I0537 - I0544
325	145	I0545 - I0552
326	146	I0553 - I0560
327	147	I0561 - I0568
328	148	I0569 - I0576
329	149	I0577 - I0584
330	14A	I0585 - I0592
331	14B	I0593 - I0600
332	14C	I0601 - I0608
333	14D	I0609 - I0616
334	14E	I0617 - I0624
335	14F	I0625 - I0632
336	150	I0633 - I0640
337	151	I0641 - I0648
338	152	I0649 - I0656
339	153	I0657 - I0664
340	154	I0665 - I0672
341	155	I0673 - I0680
342	156	I0681 - I0688
343	157	I0689 - I0696
344	158	I0697 - I0704
345	159	I0705 - I0712
346	15A	I0713 - I0720
347	15B	I0721 - I0728
348	15C	I0729 - I0736
349	15D	I0737 - I0744
350	15E	I0745 - I0752
351	15F	I0753 - I0760
352	160	I0761 - I0768
353	161	I0769 - I0776
354	162	I0777 - I0784
355	163	I0785 - I0792
356	164	I0793 - I0800
357	165	I0801 - I0808
358	166	I0809 - I0816
359	167	I0817 - I0824
360	168	I0825 - I0832

Target Address Decimal	Target Address Hexadecimal	Table Reference
361	169	I0833 - I0840
362	16A	I0841 - I0848
363	16B	I0849 - I0856
364	16C	I0857 - I0864
365	16D	I0865 - I0872
366	16E	I0873 - I0880
367	16F	I0881 - I0888
368	170	I0889 - I0896
369	171	I0897 - I0904
370	172	I0905 - I0912
371	173	I0913 - I0920
372	174	I0921 - I0928
373	175	I0929 - I0936
374	176	I0937 - I0944
375	177	I0945 - I0952
376	178	I0953 - I0960
377	179	I0961 - I0968
378	17A	I0969 - I0976
379	17B	I0977 - I0984
380	17C	I0985 - I0992
381	17D	I0993 - I1000
382	17E	I1001 - I1008
383	17F	I1009 - I1016
384	180	I1017 - I1024
385	181	I1-0001 - I1-0008
386	182	I1-0009 - I1-0016
387	183	I1-0017 - I1-0024
388	184	I1-0025 - I1-0032
389	185	I1-0033 - I1-0040
390	186	I1-0041 - I1-0048
391	187	I1-0049 - I1-0056
392	188	I1-0057 - I1-0064
393	189	I1-0065 - I1-0072
394	18A	I1-0073 - I1-0080
395	18B	I1-0081 - I1-0088
396	18C	I1-0089 - I1-0096
397	18D	I1-0097 - I1-0104
398	18E	I1-0105 - I1-0112
399	18F	I1-0113 - I1-0120
400	190	I1-0121 - I1-0128
401	191	I1-0129 - I1-0136
402	192	I1-0137 - I1-0144
403	193	I1-0145 - I1-0152
404	194	I1-0153 - I1-0160
405	195	I1-0161 - I1-0168
406	196	I1-0169 - I1-0176
407	197	I1-0177 - I1-0184
408	198	I1-0185 - I1-0192
409	199	I1-0193 - I1-0200
410	19A	I1-0201 - I1-0208
411	19B	I1-0209 - I1-0216
412	19C	I1-0217 - I1-0224
413	19D	I1-0225 - I1-0232
414	19E	I1-0233 - I1-0240
415	19F	I1-0241 - I1-0248
416	1A0	I1-0249 - I1-0256

Target Address Decimal	Target Address Hexadecimal	Table Reference
417	1A1	I1-0257 - I1-0264
418	1A2	I1-0265 - I1-0272
419	1A3	I1-0273 - I1-0280
420	1A4	I1-0281 - I1-0288
421	1A5	I1-0289 - I1-0296
422	1A6	I1-0297 - I1-0304
423	1A7	I1-0305 - I1-0312
424	1A8	I1-0313 - I1-0320
425	1A9	I1-0321 - I1-0328
426	1AA	I1-0329 - I1-0336
427	1AB	I1-0337 - I1-0344
428	1AC	I1-0345 - I1-0352
429	1AD	I1-0353 - I1-0360
430	1AE	I1-0361 - I1-0368
431	1AF	I1-0369 - I1-0376
432	1B0	I1-0377 - I1-0384

Target Address Decimal	Target Address Hexadecimal	Table Reference
433	1B1	I1-0385 - I1-0392
434	1B2	I1-0393 - I1-0400
435	1B3	I1-0401 - I1-0408
436	1B4	I1-0409 - I1-0416
437	1B5	I1-0417 - I1-0424
438	1B6	I1-0425 - I1-0432
439	1B7	I1-0433 - I1-0440
440	1B8	I1-0441 - I1-0448
441	1B9	I1-0449 - I1-0456
442	1BA	I1-0457 - I1-0464
443	1BB	I1-0465 - I1-0472
444	1BC	I1-0473 - I1-0480
445	1BD	I1-0481 - I1-0488
446	1BE	I1-0489 - I1-0496
447	1BF	I1-0497 - I1-0504
448	1C0	I1-0505 - I1-0512

Table C-2. CCM Memory Types 3 and 5 (Outputs/Byte)

Target Address Decimal	Target Address Hexadecimal	Table Reference
1	1	O1+0001 - O1+0008
2	2	O1+0009 - O1+0016
3	3	O1+0017 - O1+0024
4	4	O1+0025 - O1+0032
5	5	O1+0033 - O1+0040
6	6	O1+0041 - O1+0048
7	7	O1+0049 - O1+0056
8	8	O1+0057 - O1+0064
9	9	O1+0065 - O1+0072
10	A	O1+0073 - O1+0080
11	B	O1+0081 - O1+0088
12	C	O1+0089 - O1+0096
13	D	O1+0097 - O1+0104
14	E	O1+0105 - O1+0112
15	F	O1+0113 - O1+0120
16	10	O1+0121 - O1+0128
17	11	O1+0129 - O1+0136
18	12	O1+0137 - O1+0144
19	13	O1+0145 - O1+0152
20	14	O1+0153 - O1+0160
21	15	O1+0161 - O1+0168
22	16	O1+0169 - O1+0176
23	17	O1+0177 - O1+0184
24	18	O1+0185 - O1+0192
25	19	O1+0193 - O1+0200
26	1A	O1+0201 - O1+0208
27	1B	O1+0209 - O1+0216
28	1C	O1+0217 - O1+0224
29	1D	O1+0225 - O1+0232
30	1E	O1+0233 - O1+0240
31	1F	O1+0241 - O1+0248
32	20	O1+0249 - O1+0256
33	21	O1+0257 - O1+0264
34	22	O1+0265 - O1+0272
35	23	O1+0273 - O1+0280
36	24	O1+0281 - O1+0288
37	25	O1+0289 - O1+0296
38	26	O1+0297 - O1+0304
39	27	O1+0305 - O1+0312
40	28	O1+0313 - O1+0320
41	29	O1+0321 - O1+0328
42	2A	O1+0329 - O1+0336
43	2B	O1+0337 - O1+0344
44	2C	O1+0345 - O1+0352
45	2D	O1+0353 - O1+0360
46	2E	O1+0361 - O1+0368
47	2F	O1+0369 - O1+0376
48	30	O1+0377 - O1+0384

Target Address Decimal	Target Address Hexadecimal	Table Reference
49	31	O1+0385 - O1+0392
50	32	O1+0393 - O1+0400
51	33	O1+0401 - O1+0408
52	34	O1+0409 - O1+0416
53	35	O1+0417 - O1+0424
54	36	O1+0425 - O1+0432
55	37	O1+0433 - O1+0440
56	38	O1+0441 - O1+0448
57	39	O1+0449 - O1+0456
58	3A	O1+0457 - O1+0464
59	3B	O1+0465 - O1+0472
60	3C	O1+0473 - O1+0480
61	3D	O1+0481 - O1+0488
62	3E	O1+0489 - O1+0496
63	3F	O1+0497 - O1+0504
64	40	O1+0505 - O1+0512
65	41	O1+0513 - O1+0520
66	42	O1+0521 - O1+0528
67	43	O1+0529 - O1+0536
68	44	O1+0537 - O1+0544
69	45	O1+0545 - O1+0552
70	46	O1+0553 - O1+0560
71	47	O1+0561 - O1+0568
72	48	O1+0569 - O1+0576
73	49	O1+0577 - O1+0584
74	4A	O1+0585 - O1+0592
75	4B	O1+0593 - O1+0600
76	4C	O1+0601 - O1+0608
77	4D	O1+0609 - O1+0616
78	4E	O1+0617 - O1+0624
79	4F	O1+0625 - O1+0632
80	50	O1+0633 - O1+0640
81	51	O1+0641 - O1+0648
82	52	O1+0649 - O1+0656
83	53	O1+0657 - O1+0664
84	54	O1+0665 - O1+0672
85	55	O1+0673 - O1+0680
86	56	O1+0681 - O1+0688
87	57	O1+0689 - O1+0696
88	58	O1+0697 - O1+0704
89	59	O1+0705 - O1+0712
90	5A	O1+0713 - O1+0720
91	5B	O1+0721 - O1+0728
92	5C	O1+0729 - O1+0736
93	5D	O1+0737 - O1+0744
94	5E	O1+0745 - O1+0752
95	5F	O1+0753 - O1+0760
96	60	O1+0761 - O1+0768

Target Address Decimal	Target Address Hexadecimal	Table Reference
97	61	O1+0769 - O1+0776
98	62	O1+0777 - O1+0784
99	63	O1+0785 - O1+0792
100	64	O1+0793 - O1+0800
101	65	O1+0801 - O1+0808
102	66	O1+0809 - O1+0816
103	67	O1+0817 - O1+0824
104	68	O1+0825 - O1+0832
105	69	O1+0833 - O1+0840
106	6A	O1+0841 - O1+0848
107	6B	O1+0849 - O1+0856
108	6C	O1+0857 - O1+0864
109	6D	O1+0865 - O1+0872
110	6E	O1+0873 - O1+0880
111	6F	O1+0881 - O1+0888
112	70	O1+0889 - O1+0896
113	71	O1+0897 - O1+0904
114	72	O1+0905 - O1+0912
115	73	O1+0913 - O1+0920
116	74	O1+0921 - O1+0928
117	75	O1+0929 - O1+0936
118	76	O1+0937 - O1+0944
119	77	O1+0945 - O1+0952
120	78	O1+0953 - O1+0960
121	79	O1+0961 - O1+0968
122	7A	O1+0969 - O1+0976
123	7B	O1+0977 - O1+0984
124	7C	O1+0985 - O1+0992
125	7D	O1+0993 - O1+1000
126	7E	O1+1001 - O1+1008
127	7F	O1+1009 - O1+1016
128	80	O1+1017 - O1+1024
129	81	O2+0001 - O2+0008
130	82	O2+0009 - O2+0016
131	83	O2+0017 - O2+0024
132	84	O2+0025 - O2+0032
133	85	O2+0033 - O2+0040
134	86	O2+0041 - O2+0048
135	87	O2+0049 - O2+0056
136	88	O2+0057 - O2+0064
137	89	O2+0065 - O2+0072
138	8A	O2+0073 - O2+0080
139	8B	O2+0081 - O2+0088
140	8C	O2+0089 - O2+0096
141	8D	O2+0097 - O2+0104
142	8E	O2+0105 - O2+0112
143	8F	O2+0113 - O2+0120
144	90	O2+0121 - O2+0128
145	91	O2+0129 - O2+0136
146	92	O2+0137 - O2+0144
147	93	O2+0145 - O2+0152
148	94	O2+0153 - O2+0160
149	95	O2+0161 - O2+0168
150	96	O2+0169 - O2+0176
151	97	O2+0177 - O2+0184
152	98	O2+0185 - O2+0192

Target Address Decimal	Target Address Hexadecimal	Table Reference
153	99	O2+0193 - O2+0200
154	9A	O2+0201 - O2+0208
155	9B	O2+0209 - O2+0216
156	9C	O2+0217 - O2+0224
157	9D	O2+0225 - O2+0232
158	9E	O2+0233 - O2+0240
159	9F	O2+0241 - O2+0248
160	A0	O2+0249 - O2+0256
161	A1	O2+0257 - O2+0264
162	A2	O2+0265 - O2+0272
163	A3	O2+0273 - O2+0280
164	A4	O2+0281 - O2+0288
165	A5	O2+0289 - O2+0296
166	A6	O2+0297 - O2+0304
167	A7	O2+0305 - O2+0312
168	A8	O2+0313 - O2+0320
169	A9	O2+0321 - O2+0328
170	AA	O2+0329 - O2+0336
171	AB	O2+0337 - O2+0344
172	AC	O2+0345 - O2+0352
173	AD	O2+0353 - O2+0360
174	AE	O2+0361 - O2+0368
175	AF	O2+0369 - O2+0376
176	B0	O2+0377 - O2+0384
177	B1	O2+0385 - O2+0392
178	B2	O2+0393 - O2+0400
179	B3	O2+0401 - O2+0408
180	B4	O2+0409 - O2+0416
181	B5	O2+0417 - O2+0424
182	B6	O2+0425 - O2+0432
183	B7	O2+0433 - O2+0440
184	B8	O2+0441 - O2+0448
185	B9	O2+0449 - O2+0456
186	BA	O2+0457 - O2+0464
187	BB	O2+0465 - O2+0472
188	BC	O2+0473 - O2+0480
189	BD	O2+0481 - O2+0488
190	BE	O2+0489 - O2+0496
191	BF	O2+0497 - O2+0504
192	C0	O2+0505 - O2+0512
193	C1	O2+0513 - O2+0520
194	C2	O2+0521 - O2+0528
195	C3	O2+0529 - O2+0536
196	C4	O2+0537 - O2+0544
197	C5	O2+0545 - O2+0552
198	C6	O2+0553 - O2+0560
199	C7	O2+0561 - O2+0568
200	C8	O2+0569 - O2+0576
201	C9	O2+0577 - O2+0584
202	CA	O2+0585 - O2+0592
203	CB	O2+0593 - O2+0600
204	CC	O2+0601 - O2+0608
205	CD	O2+0609 - O2+0616
206	CE	O2+0617 - O2+0624
207	CF	O2+0625 - O2+0632
208	D0	O2+0633 - O2+0640

Target Address Decimal	Target Address Hexadecimal	Table Reference
209	D1	O2+0641 - O2+0648
210	D2	O2+0649 - O2+0656
211	D3	O2+0657 - O2+0664
212	D4	O2+0665 - O2+0672
213	D5	O2+0673 - O2+0680
214	D6	O2+0681 - O2+0688
215	D7	O2+0689 - O2+0696
216	D8	O2+0697 - O2+0704
217	D9	O2+0705 - O2+0712
218	DA	O2+0713 - O2+0720
219	DB	O2+0721 - O2+0728
220	DC	O2+0729 - O2+0736
221	DD	O2+0737 - O2+0744
222	DE	O2+0745 - O2+0752
223	DF	O2+0753 - O2+0760
224	E0	O2+0761 - O2+0768
225	E1	O2+0769 - O2+0776
226	E2	O2+0777 - O2+0784
227	E3	O2+0785 - O2+0792
228	E4	O2+0793 - O2+0800
229	E5	O2+0801 - O2+0808
230	E6	O2+0809 - O2+0816
231	E7	O2+0817 - O2+0824
232	E8	O2+0825 - O2+0832
233	E9	O2+0833 - O2+0840
234	EA	O2+0841 - O2+0848
235	EB	O2+0849 - O2+0856
236	EC	O2+0857 - O2+0864
237	ED	O2+0865 - O2+0872
238	EE	O2+0873 - O2+0880
239	EF	O2+0881 - O2+0888
240	F0	O2+0889 - O2+0896
241	F1	O2+0897 - O2+0904
242	F2	O2+0905 - O2+0912
243	F3	O2+0913 - O2+0920
244	F4	O2+0921 - O2+0928
245	F5	O2+0929 - O2+0936
246	F6	O2+0937 - O2+0944
247	F7	O2+0945 - O2+0952
248	F8	O2+0953 - O2+0960
249	F9	O2+0961 - O2+0968
250	FA	O2+0969 - O2+0976
251	FB	O2+0977 - O2+0984
252	FC	O2+0985 - O2+0992
253	FD	O2+0993 - O2+1000
254	FE	O2+1001 - O2+1008
255	FF	O2+1009 - O2+1016
256	100	O2+1017 - O2+1024
257	101	O0001 - O0008
258	102	O0009 - O0016
259	103	O0017 - O0024
260	104	O0025 - O0032
261	105	O0033 - O0040
262	106	O0041 - O0048
263	107	O0049 - O0056
264	108	O0057 - O0064

Target Address Decimal	Target Address Hexadecimal	Table Reference
265	109	O0065 - O0072
266	10A	O0073 - O0080
267	10B	O0081 - O0088
268	10C	O0089 - O0096
269	10D	O0097 - O0104
270	10E	O0105 - O0112
271	10F	O0113 - O0120
272	110	O0121 - O0128
273	111	O0129 - O0136
274	112	O0137 - O0144
275	113	O0145 - O0152
276	114	O0153 - O0160
277	115	O0161 - O0168
278	116	O0169 - O0176
279	117	O0177 - O0184
280	118	O0185 - O0192
281	119	O0193 - O0200
282	11A	O0201 - O0208
283	11B	O0209 - O0216
284	11C	O0217 - O0224
285	11D	O0225 - O0232
286	11E	O0233 - O0240
287	11F	O0241 - O0248
288	120	O0249 - O0256
289	121	O0257 - O0264
290	122	O0265 - O0272
291	123	O0273 - O0280
292	124	O0281 - O0288
293	125	O0289 - O0296
294	126	O0297 - O0304
295	127	O0305 - O0312
296	128	O0313 - O0320
297	129	O0321 - O0328
298	12A	O0329 - O0336
299	12B	O0337 - O0344
300	12C	O0345 - O0352
301	12D	O0353 - O0360
302	12E	O0361 - O0368
303	12F	O0369 - O0376
304	130	O0377 - O0384
305	131	O0385 - O0392
306	132	O0393 - O0400
307	133	O0401 - O0408
308	134	O0409 - O0416
309	135	O0417 - O0424
310	136	O0425 - O0432
311	137	O0433 - O0440
312	138	O0441 - O0448
313	139	O0449 - O0456
314	13A	O0457 - O0464
315	13B	O0465 - O0472
316	13C	O0473 - O0480
317	13D	O0481 - O0488
318	13E	O0489 - O0496
319	13F	O0497 - O0504
320	140	O0505 - O0512

Target Address Decimal	Target Address Hexadecimal	Table Reference
321	141	O0513 - O0520
322	142	O0521 - O0528
323	143	O0529 - O0536
324	144	O0537 - O0544
325	145	O0545 - O0552
326	146	O0553 - O0560
327	147	O0561 - O0568
328	148	O0569 - O0576
329	149	O0577 - O0584
330	14A	O0585 - O0592
331	14B	O0593 - O0600
332	14C	O0601 - O0608
333	14D	O0609 - O0616
334	14E	O0617 - O0624
335	14F	O0625 - O0632
336	150	O0633 - O0640
337	151	O0641 - O0648
338	152	O0649 - O0656
339	153	O0657 - O0664
340	154	O0665 - O0672
341	155	O0673 - O0680
342	156	O0681 - O0688
343	157	O0689 - O0696
344	158	O0697 - O0704
345	159	O0705 - O0712
346	15A	O0713 - O0720
347	15B	O0721 - O0728
348	15C	O0729 - O0736
349	15D	O0737 - O0744
350	15E	O0745 - O0752
351	15F	O0753 - O0760
352	160	O0761 - O0768
353	161	O0769 - O0776
354	162	O0777 - O0784
355	163	O0785 - O0792
356	164	O0793 - O0800
357	165	O0801 - O0808
358	166	O0809 - O0816
359	167	O0817 - O0824
360	168	O0825 - O0832
361	169	O0833 - O0840
362	16A	O0841 - O0848
363	16B	O0849 - O0856
364	16C	O0857 - O0864
365	16D	O0865 - O0872
366	16E	O0873 - O0880
367	16F	O0881 - O0888
368	170	O0889 - O0896
369	171	O0897 - O0904
370	172	O0905 - O0912
371	173	O0913 - O0920
372	174	O0921 - O0928
373	175	O0929 - O0936
374	176	O0937 - O0944
375	177	O0945 - O0952
376	178	O0953 - O0960

Target Address Decimal	Target Address Hexadecimal	Table Reference
377	179	O0961 - O0968
378	17A	O0969 - O0976
379	17B	O0977 - O0984
380	17C	O0985 - O0992
381	17D	O0993 - O1000
382	17E	O1001 - O1008
383	17F	O1009 - O1016
384	180	O1017 - O1024
385	181	O1-0001 - O1-0008
386	182	O1-0009 - O1-0016
387	183	O1-0017 - O1-0024
388	184	O1-0025 - O1-0032
389	185	O1-0033 - O1-0040
390	186	O1-0041 - O1-0048
391	187	O1-0049 - O1-0056
392	188	O1-0057 - O1-0064
393	189	O1-0065 - O1-0072
394	18A	O1-0073 - O1-0080
395	18B	O1-0081 - O1-0088
396	18C	O1-0089 - O1-0096
397	18D	O1-0097 - O1-0104
398	18E	O1-0105 - O1-0112
399	18F	O1-0113 - O1-0120
400	190	O1-0121 - O1-0128
401	191	O1-0129 - O1-0136
402	192	O1-0137 - O1-0144
403	193	O1-0145 - O1-0152
404	194	O1-0153 - O1-0160
405	195	O1-0161 - O1-0168
406	196	O1-0169 - O1-0176
407	197	O1-0177 - O1-0184
408	198	O1-0185 - O1-0192
409	199	O1-0193 - O1-0200
410	19A	O1-0201 - O1-0208
411	19B	O1-0209 - O1-0216
412	19C	O1-0217 - O1-0224
413	19D	O1-0225 - O1-0232
414	19E	O1-0233 - O1-0240
415	19F	O1-0241 - O1-0248
416	1A0	O1-0249 - O1-0256
417	1A1	O1-0257 - O1-0264
418	1A2	O1-0265 - O1-0272
419	1A3	O1-0273 - O1-0280
420	1A4	O1-0281 - O1-0288
421	1A5	O1-0289 - O1-0296
422	1A6	O1-0297 - O1-0304
423	1A7	O1-0305 - O1-0312
424	1A8	O1-0313 - O1-0320
425	1A9	O1-0321 - O1-0328
426	1AA	O1-0329 - O1-0336
427	1AB	O1-0337 - O1-0344
428	1AC	O1-0345 - O1-0352
429	1AD	O1-0353 - O1-0360
430	1AE	O1-0361 - O1-0368
431	1AF	O1-0369 - O1-0376
432	1B0	O1-0377 - O1-0384

Target Address Decimal	Target Address Hexadecimal	Table Reference
433	1B1	O1-0385 - O1-0392
434	1B2	O1-0393 - O1-0400
435	1B3	O1-0401 - O1-0408
436	1B4	O1-0409 - O1-0416
437	1B5	O1-0417 - O1-0424
438	1B6	O1-0425 - O1-0432
439	1B7	O1-0433 - O1-0440
440	1B8	O1-0441 - O1-0448
441	1B9	O1-0449 - O1-0456
442	1BA	O1-0457 - O1-0464
443	1BB	O1-0465 - O1-0472
444	1BC	O1-0473 - O1-0480
445	1BD	O1-0481 - O1-0488
446	1BE	O1-0489 - O1-0496
447	1BF	O1-0497 - O1-0504
448	1C0	O1-0505 - O1-0512
449	1C1	O1-0513 - O1-0520
450	1C2	O1-0521 - O1-0528
451	1C3	O1-0529 - O1-0536
452	1C4	O1-0537 - O1-0544
453	1C5	O1-0545 - O1-0552
454	1C6	O1-0553 - O1-0560
455	1C7	O1-0561 - O1-0568
456	1C8	O1-0569 - O1-0576
457	1C9	O1-0577 - O1-0584
458	1CA	O1-0585 - O1-0592
459	1CB	O1-0593 - O1-0600
460	1CC	O1-0601 - O1-0608
461	1CD	O1-0609 - O1-0616
462	1CE	O1-0617 - O1-0624
463	1CF	O1-0625 - O1-0632
464	1D0	O1-0633 - O1-0640
465	1D1	O1-0641 - O1-0648
466	1D2	O1-0649 - O1-0656
467	1D3	O1-0657 - O1-0664
468	1D4	O1-0665 - O1-0672
469	1D5	O1-0673 - O1-0680
470	1D6	O1-0681 - O1-0688
471	1D7	O1-0689 - O1-0696
472	1D8	O1-0697 - O1-0704
473	1D9	O1-0705 - O1-0712
474	1DA	O1-0713 - O1-0720
475	1DB	O1-0721 - O1-0728
476	1DC	O1-0729 - O1-0736
477	1DD	O1-0737 - O1-0744
478	1DE	O1-0745 - O1-0752
479	1DF	O1-0753 - O1-0760
480	1E0	O1-0761 - O1-0768
481	1E1	O1-0769 - O1-0776
482	1E2	O1-0777 - O1-0784
483	1E3	O1-0785 - O1-0792
484	1E4	O1-0793 - O1-0800
485	1E5	O1-0801 - O1-0808
486	1E6	O1-0809 - O1-0816
487	1E7	O1-0817 - O1-0824
488	1E8	O1-0825 - O1-0832

Target Address Decimal	Target Address Hexadecimal	Table Reference
489	1E9	O1-0833 - O1-0840
490	1EA	O1-0841 - O1-0848
491	1EB	O1-0849 - O1-0856
492	1EC	O1-0857 - O1-0864
493	1ED	O1-0865 - O1-0872
494	1EE	O1-0873 - O1-0880
495	1EF	O1-0881 - O1-0888
496	1F0	O1-0889 - O1-0896
497	1F1	O1-0897 - O1-0904
498	1F2	O1-0905 - O1-0912
499	1F3	O1-0913 - O1-0920
500	1F4	O1-0921 - O1-0928
501	1F5	O1-0929 - O1-0936
502	1F6	O1-0937 - O1-0944
503	1F7	O1-0945 - O1-0952
504	1F8	O1-0953 - O1-0960
505	1F9	O1-0961 - O1-0968
506	1FA	O1-0969 - O1-0976
507	1FB	O1-0977 - O1-0984
508	1FC	O1-0985 - O1-0992
509	1FD	O1-0993 - O1-1000
510	1FE	O1-1001 - O1-1008
511	1FF	O1-1009 - O1-1016
512	200	O1-1017 - O1-1024
513	201	O2-0001 - O2-0008
514	202	O2-0009 - O2-0016
515	203	O2-0017 - O2-0024
516	204	O2-0025 - O2-0032
517	205	O2-0033 - O2-0040
518	206	O2-0041 - O2-0048
519	207	O2-0049 - O2-0056
520	208	O2-0057 - O2-0064
521	209	O2-0065 - O2-0072
522	20A	O2-0073 - O2-0080
523	20B	O2-0081 - O2-0088
524	20C	O2-0089 - O2-0096
525	20D	O2-0097 - O2-0104
526	20E	O2-0105 - O2-0112
527	20F	O2-0113 - O2-0120
528	210	O2-0121 - O2-0128
529	211	O2-0129 - O2-0136
530	212	O2-0137 - O2-0144
531	213	O2-0145 - O2-0152
532	214	O2-0153 - O2-0160
533	215	O2-0161 - O2-0168
534	216	O2-0169 - O2-0176
535	217	O2-0177 - O2-0184
536	218	O2-0185 - O2-0192
537	219	O2-0193 - O2-0200
538	21A	O2-0201 - O2-0208
539	21B	O2-0209 - O2-0216
540	21C	O2-0217 - O2-0224
541	21D	O2-0225 - O2-0232
542	21E	O2-0233 - O2-0240
543	21F	O2-0241 - O2-0248
544	220	O2-0249 - O2-0256

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Target Address Decimal	Target Address Hexadecimal	Table Reference
545	221	O2-0257 - O2-0264
546	222	O2-0265 - O2-0272
547	223	O2-0273 - O2-0280
548	224	O2-0281 - O2-0288
549	225	O2-0289 - O2-0296
550	226	O2-0297 - O2-0304
551	227	O2-0305 - O2-0312
552	228	O2-0313 - O2-0320
553	229	O2-0321 - O2-0328
554	22A	O2-0329 - O2-0336
555	22B	O2-0337 - O2-0344
556	22C	O2-0345 - O2-0352
557	22D	O2-0353 - O2-0360
558	22E	O2-0361 - O2-0368
559	22F	O2-0369 - O2-0376
560	230	O2-0377 - O2-0384
561	231	O2-0385 - O2-0392
562	232	O2-0393 - O2-0400
563	233	O2-0401 - O2-0408
564	234	O2-0409 - O2-0416
565	235	O2-0417 - O2-0424
566	236	O2-0425 - O2-0432
567	237	O2-0433 - O2-0440
568	238	O2-0441 - O2-0448
569	239	O2-0449 - O2-0456
570	23A	O2-0457 - O2-0464
571	23B	O2-0465 - O2-0472
572	23C	O2-0473 - O2-0480
573	23D	O2-0481 - O2-0488
574	23E	O2-0489 - O2-0496
575	23F	O2-0497 - O2-0504
576	240	O2-0505 - O2-0512
577	241	O2-0513 - O2-0520
578	242	O2-0521 - O2-0528
579	243	O2-0529 - O2-0536
580	244	O2-0537 - O2-0544
581	245	O2-0545 - O2-0552
582	246	O2-0553 - O2-0560
583	247	O2-0561 - O2-0568
584	248	O2-0569 - O2-0576
585	249	O2-0577 - O2-0584
586	24A	O2-0585 - O2-0592
587	24B	O2-0593 - O2-0600
588	24C	O2-0601 - O2-0608
589	24D	O2-0609 - O2-0616
590	24E	O2-0617 - O2-0624
591	24F	O2-0625 - O2-0632
592	250	O2-0633 - O2-0640

Target Address Decimal	Target Address Hexadecimal	Table Reference
593	251	O2-0641 - O2-0648
594	252	O2-0649 - O2-0656
595	253	O2-0657 - O2-0664
596	254	O2-0665 - O2-0672
597	255	O2-0673 - O2-0680
598	256	O2-0681 - O2-0688
599	257	O2-0689 - O2-0696
600	258	O2-0697 - O2-0704
601	259	O2-0705 - O2-0712
602	25A	O2-0713 - O2-0720
603	25B	O2-0721 - O2-0728
604	25C	O2-0729 - O2-0736
605	25D	O2-0737 - O2-0744
606	25E	O2-0745 - O2-0752
607	25F	O2-0753 - O2-0760
608	260	O2-0761 - O2-0768
609	261	O2-0769 - O2-0776
610	262	O2-0777 - O2-0784
611	263	O2-0785 - O2-0792
612	264	O2-0793 - O2-0800
613	265	O2-0801 - O2-0808
614	266	O2-0809 - O2-0816
615	267	O2-0817 - O2-0824
616	268	O2-0825 - O2-0832
617	269	O2-0833 - O2-0840
618	26A	O2-0841 - O2-0848
619	26B	O2-0849 - O2-0856
620	26C	O2-0857 - O2-0864
621	26D	O2-0865 - O2-0872
622	26E	O2-0873 - O2-0880
623	26F	O2-0881 - O2-0888
624	270	O2-0889 - O2-0896
625	271	O2-0897 - O2-0904
626	272	O2-0905 - O2-0912
627	273	O2-0913 - O2-0920
628	274	O2-0921 - O2-0928
629	275	O2-0929 - O2-0936
630	276	O2-0937 - O2-0944
631	277	O2-0945 - O2-0952
632	278	O2-0953 - O2-0960
633	279	O2-0961 - O2-0968
634	27A	O2-0969 - O2-0976
635	27B	O2-0977 - O2-0984
636	27C	O2-0985 - O2-0992
637	27D	O2-0993 - O2-1000
638	27E	O2-1001 - O2-1008
639	27F	O2-1009 - O2-1016
640	280	O2-1017 - O2-1024

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