GE Fanuc Automation

Programmable Control Products

Series 90™ Programmable Controllers

Product Summary

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GFT-057B

September, 1991

WARNING, CAUTION, AND NOTES AS USED IN THIS PUBLICATION

WARNING

Warning notices are used in this publication to emphasize that hazardous voltages, currents, temperatures, or other conditions that could cause personal injury exist in this equipment or may be associated with its use.

In situations where inattention could cause either personal injury or damage to equipment, a Warning notice is used.

CAUTION

Caution notices are used where equipment might be damaged if care is not taken.

NOTE

Notes merely call attention to information that is especially significant to understanding and operating the equipment.

This document is based on information available at the time of its publication. While efforts have been made to be accurate, the information contained herein does not purport to cover all details or variations in hardware and software, nor to provide for every possible contingency in connection with installation, operation, and maintenance. Features may be described herein which are not present in all hardware and software systems. GE Fanuc Automation assumes no obligation of notice to holders of this document with respect to changes subsequently made.

GE Fanuc Automation makes no representation or warranty, expressed, implied, or statutory with respect to, and assumes no responsibility for the accuracy, completeness, sufficiency or usefulness of the information contained herein. No warranties of merchantability of fitness for purpose shall apply.

This Product Summary is an introduction to the GE Fanuc family of quality Programmable Logic Controllers (PLC) and related products. The intent of this document is to introduce you to our products and provide the information to enable you to select the right GE Fanuc PLC for your application. Your GE Fanuc PLC distributor or GE Fanuc sales representative is available to provide you with more detailed information about any of the products described in this Product Summary.

Related Series 90™ Publications

The following publications should be referenced for information pertaining to specific Series 90 products. For availability of these manuals, see your local GE Fanuc PLC distributor or GE Fanuc sales office.

GFK-0255 - Series 90 Programmable Coprocessor Module and Support Software User's Manual
GFK-0256 - MegaBasic Programming Reference Manual
GFK-0262 - Series 90-70 PLC Installation Manual
GFK-0263 - Logicmaster 90 Programming Software User's Manual
GFK-0265 - Logicmaster 90 Programming Software Reference Manual
GFK-0293 - Series 90-30 High Speed Counter User's Manual
GFK-0356 - Series 90-30 PLC Installation Manual
GFK-0398 - Series 90-70 Genius Bus Controller User's Manual
GFK-0401 - Workmaster II PLC Programming Unit Guide to Operation
GFK-0402 - Series 90-30 and 90-20 PLC Hand-Held Programmer User's Manual
GFK-0412 - Series 90-30 Genius Communications Module User's Manual
GFK-0448 - User's Guide to Integration of 3rd Party VME Modules
GFK-0466 - Logicmaster 90 Series 90-30 and 90-20 Programming Software User's Manual
GFK-0467 - Logicmaster 90 Series 90-30 and 90-20 Programming Software Reference Manual
GFK-0487 - Series 90 PCM Development Software (PCOP) User's Manual
GFK-0499 - CIMPLICITY 90-ADS Alphanumeric Display System User's Manual
GFK-0534 - CIMPLICITY-70 Graphics Display System User's Manual
GFK-0551 - Series 90-20 PLC User's Manual
GFK-0579 - Series 90-70 Remote I/O Scanner User's Guide
GFK-0582 - Series 90 PLC Serial Communications User's Manual
GFK-0585 - Series 90 PLC SNP Communications Driver User's Manual
GFK-0600 - Series 90-70 Data Sheet Manual
GFK-0641 - CIMPLICITY 90-ADS Alphanumeric Display System Reference Manual

Quality System - ISO 9000 Registration

GE Fanuc Automation is one of the first manufacturing companies in the United States to be registered to ISO 9001 Quality Standards. ISO 9001 is the most comprehensive in a series of standards in the ISO 9000 Series which assures customers of a sound quality system in Marketing, Design, Manufacturing, and Service.

ISO 9000 is a series of quality standards which define how you can establish, document and maintain an effective quality system which demonstrates to your customers your ability to supply them high quality products. The standards provide a framework for implementing a working quality management system. Interest in ISO 9000 is growing in the United States, particularly among firms dealing in the global marketplace.

The International Organization for Standardization (ISO) has published ISO Quality System standards (ISO 9000 Series) using submissions from its member countries. These standards have been so widely accepted that most industrialized countries have replaced their national standards with ISO 9000 series. The equivalents for ISO 9001 in the United States and United Kingdom are ANSI/ASQC Q90-94, and BS5750 part 1-4, respectively.

GE Fanuc Automation has embraced the concept of ISO quality system management and registration. Ultimately the adoption of ISO 9000 standards will spread throughout the United States, resulting in our suppliers and customers gaining registration status as well. Our supplier involvement is particularly significant since it will promote a common understanding of quality and continuous improvement throughout the process/product chain. GE Fanuc will accept ISO 9000 registration in lieu of a quality system audit. We have also modified our Supplier Quality System survey to include ISO 9000 series criteria.

The ISO 9000 Series includes a guidance document ISO 9004, and ISO 9001, 9002, and 9003 which address contractual requirements for quality systems and are used for external quality assurance assessment. ISO 9001 is the most comprehensive standard and is defined as : ''Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing''. This most comprehensive and stringent standard assesses the producer's ability to design as well as manufacture and test good product.

GE Fanuc Automation completed the registration process successfully in June, 1991, being one of the first automation companies in this country to do so. In order to assure international acceptance of the registration GE Fanuc Automation is jointly registered by UL (USA), BSI (UK), and CSA (Canada). On-going surveilance visits by the above agencies will continue annually at a minimum to assure compliance to the standards.

If there are any questions/inquiries about ISO, please contact:

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Kris Sateesh                          Jim Satira
Manager, Quality Control    -or-      Customer Quality Engineer
(804) 978-5133                        (804) 978-5383
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Or write to either of the above at:

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GE Fanuc Automation N.A., Inc.
P.O Box 8106
Charlottesville, VA 22906
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A copy of the ISO 9001 Registration for GE Fanuc is shown below.

PDST June 28, 1991

Registration Of Firms Of Assessed Capability To ISO 9001

GE FANUC AUTOMATION NORTH AMERICA INC **A2003 (R)**
RTE 29 N RTE 606 P O BOX 8106,
CHARLOTTESVILLE VA 22906

SIC Category (SIC Number): i.e., "Industrial Control and Control Accessories" (SIC)3625 (US).
SIC Category (SIC Number): i.e., "Electrical Instrument and Control System" (SIC)3443 (UK).

The design production supply, and servicing of Series Six™, and Series 90™ Programmable logic controllers, Workmaster® industrial computers, GENIUS™ distributed I/O systems and CIMPLICITY™ U/D software products to specifications agreed with independent distribution centers or special customers.

976911001 **Underwriters Laboratories Inc.®** |1|/0196103

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Figure

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Chapter 1
PLC for the 90's - the Series 90™ PLCs

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Programmable Logic Controllers

The Programmable Logic Controller (PLC), since its development in the early 1970's has become an integral part of the automation of control systems and process control. Programmable Logic Controllers, which are industrially-hardened computers, have evolved to successfully challenge not only relays, but other discrete control devices such as stepping switches, drum programmers, and other similar devices. Within the industrial control field, PLCs have been successfully used to replace solid state logic, analog controllers, and even minicomputers. Their capabilities are rapidly expanding and new, innovative ideas are appearing on an almost monthly basis.

GE Fanuc Automation is committed to excellence in the design and development of Programmable Logic Controllers by offering innovative concepts to challenge other industrial control devices, whether they are relays, other Programmable Logic Controllers, or mini-computers.

PLC Development Over the Years

PLCs were developed to be able to quickly respond to changes in application requirements by being easily reprogrammed and without the need to make physical hardware changes. They were immediately accepted in the automotive industry and have found countless applications in virtually all industries. As their acceptance grew, so did the demands for increased functions, more memory, and larger Input/Output (I/O) capacities.

Most manufacturers responded to these requirements by introducing new models of PLCs covering small (50-150 relays), medium (150-500 relays), and large (500-3000 relays) applications. Generally, however, these various models were not compatible with each other. Programs on one would not function on another; I/O structures were not interchangeable except by the addition of adapters that increased cost and maintenance since new peripheral devices such as a programmer or an adapter had to be purchased.

The Family Concept

In the late 1970's, the concept of a family design was developed to meet the market needs with a minimum amount of hardware and a maximum of commonality.

The GE Fanuc Series Six™ PLC was the first in a succession of developments in that family concept. The original three models of the Series Six PLC family were the 60, 600, and 6000. The capacity of each model for both memory and Input/Output (I/O) increased as the model number increased. Next came the Series Six Plus PLC, which was an extension of the successful Series Six family of PLC's.

The Series Six Plus PLC, introduced in mid 1986, was structured such that many different configurations may be selected to be contained in a single CPU rack. All system memory circuits including logic, register and internal are contained on a single memory module with six different versions available, allowing the user to select up to 64K of 16-bit logic memory for user program and 16K of 16-bit register memory for storage of numerical values.

Common Features

Within this Series Six PLC family concept, common features between models include:

- Same Programming Language
- Same Reference Numbers
- Same Programming Package
- Same I/O Structure (modules, racks, receivers, drivers, cables, etc.)
- Transportable programs from one module/size to another larger or smaller
- Same options available for each model

The family concept allows a user to select a PLC tailored more specifically to the user's requirements, without adversely impacting support costs. Savings can be obtained with this concept in multiple controller installations in the following areas.

Spare Parts - Entire controllers of different models need not be purchased as spares. Since many CPU and I/O modules are identical, one spare module can support several different models of controller.

Training - Design and maintenance personnel are trained once and can then work with any model (small, medium or large). The simplicity of the PLC design allows this training to be conducted in a minimum of time, typically 2-5 days.

Documentation - Since the same language and reference numbers are used, as well as I/O terminal layout, preparing documentation to maintain the control system is simplified.

Trend Setting features

In keeping with the rapid advances in technology and changes in user requirements, GE Fanuc has offered a number of trend setting features well before other manufacturers. These include high density I/O in 1982, small physically compact, low price PLCs in 1983 (Series One™ family), industrial IBM® compatible programmer (Workmaster® computer) in 1984, and the innovative Genius™ I/O in 1985.

The industrial programmer (Workmaster and Cimstar™ I computers) can both program and provide hard copy printouts of that program including relevant comments. This provides a general purpose device to replace dedicated programmers and offers many more functions, such as data collection and analysis, and color graphics. The Workmaster computer is compatible with many control devices such as the GE Fanuc Series One, Series Three™, Series Five™, Series Six Plus, and Series 90™ PLCs.

In mid-1989 a more powerful compact successor to the Workmaster computer was introduced by GE Fanuc. This is the Workmaster® II portable computer. Workmaster II is a compact (less than 20 pounds), IBM compatible programming device with its system architecture based on the 80386 microprocesser - resulting in high performance.

Genius I/O offers the user an optional I/O subsystem that provides inherent distribution, user selected customization, and outstanding system diagnostic features. In many applications, it can pay for itself with either installation cost savings or downtime reductions.

The Genius I/O subsystem can be used with rack-type Series Six PLC I/O and is compatible with all Series Six PLCs shipped since 1981, Series Five PLCs which began shipping in early 1988, and Series 90™ PLCs, which are the newest generation of PLCs from GE Fanuc.

PLC for the 1990's

In mid-1989 GE Fanuc introduced the Series 90™ family of Programmable Logic Controllers, a new generation of PLC's designed by GE Fanuc to encompass the advanced technology of today, yet they are designed for ease of operation. The initial offering of the Series 90 PLC was the Series 90-70 PLC introduced in early 1989.

In early 1990 - the beginning of the decade of the 1990s, GE Fanuc introduced the Series 90™-30 small to mid-range PLC. With the beginning of 1991, the newest offering in the Series 90 family tree - a small fixed-I/O PLC - the Series 90-20 was announced. With the Series 90-20 introduction to the world, GE Fanuc continues its tradition of providing the market with a wide range of Programmable Logic Controllers.

Series 90-70 PLC

The Series 90-70 PLC is a PLC system built to serve factory automation applications in the 1990s. This PLC provides the user with a full function controller that is easy to install and configure, offers advanced programming features, and is designed for compatibility with other PLCs to be offered in the Series 90 family of PLCs. The Series 90-70's use of the latest technology

and open architecture VMEbus provides a powerful cost effective platform for small applications through the very largest.

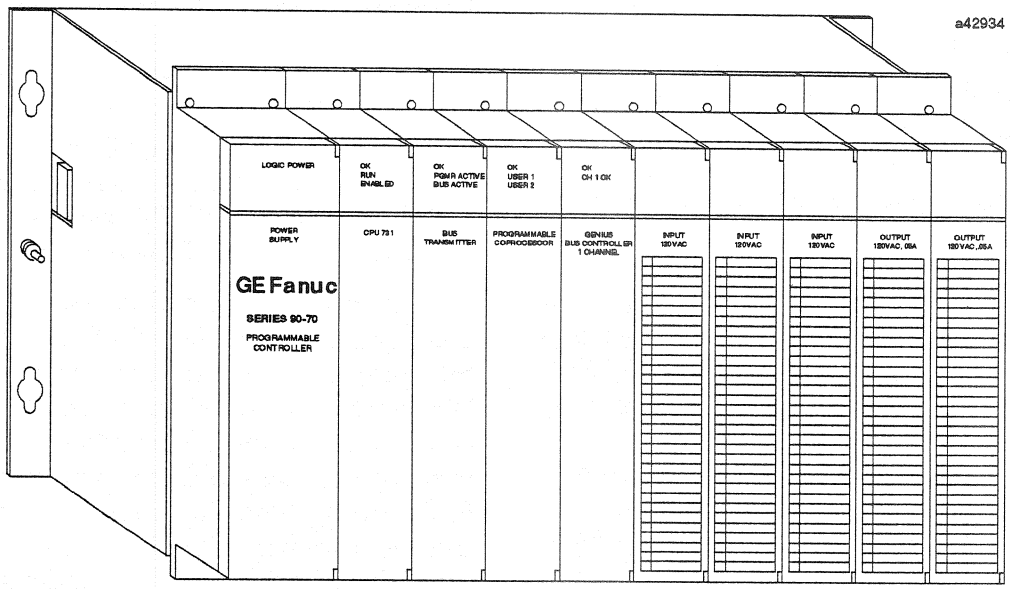

Figure 1-1. Series 90-70 PLC

The advantages offered to the PLC market by Series 90-70 PLC are:

- To provide easier system integration;
- To increase reliability;
- To increase programming efficiency;
- To provide for improved cost effectiveness;

while providing the latest technology and enhancing user friendly basic Programmable Logic Controller features.

The Series 90-70 PLC is described in detail in Chapters 2 through 4 in this Product Summary.

Series 90-70 PLC Hardware

Series 90-70 PLC system components include a family of six CPU models, racks, power supplies, bus expansion modules (Bus Transmitter, Bus Receiver, and Remote I/O Scanner), a rack-type I/O system, a Programmable Coprocessor Module (PCM), expansion memory for CPUs and PCMs, Genius Bus Controller, Graphics Display Coprocessor (for CIMPLICITY™-70 Graphics Display System), Alphanumeric Display Coprocessor (for CIMPLICITY 90-ADS Alphanumeric Display System), MAP carrierband and broadband interface modules, an MMS Ethernet Controller module, and a Communications Coprocessor module.

VME Standard Backplane

The Series 90-70 PLC system is designed to support industry standard boards which can be plugged into a VMEbus backplane. The design is based on the VME standard with improvements made to the bus interface drivers to run at lower power and improve noise immunity while at the same time preserving compatibility with VME. Adoption of the VME standard provides a link with the future by allowing adoption of required options without "reinventing the wheel". Your options are kept open for the future.

Advanced Manufacturing Technology

State-of-the-art manufacturing technology is used by GE Fanuc to produce a low cost, high density product. Surface mount CMOS, fine line, multi-layer and VLSI technologies are effectively

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employed in the Series 90-70 PLC. Use of this advanced technology results in higher component density, lower heat generation and higher system reliability.

CPU Architecture

The Series 90-70 CPU architecture is based on the Intel 80X86 family of microprocessors with the addition of a VLSI Boolean Coprocessor (BCP, designed by GE Fanuc), and an optional 80X87 Floating Point Math Coprocessor. This combination provides the flexibility of a general purpose microprocessor with the high speed of the BCP resulting in the execution of ladder diagram elements in 0.4 microseconds, and the ability to perform floating point math calculations.

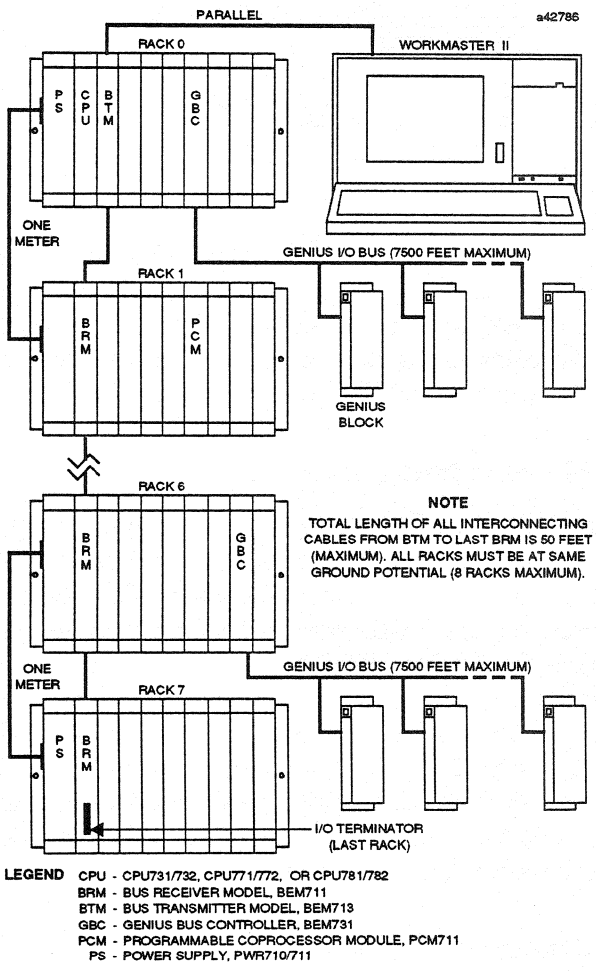


Figure 1-2. Typical Series 90-70 PLC System

Series 90-70 PLC Software

Programming Software for the Series 90-70 PLC is the Logicmaster™ 90 Software package, which consists of Programming and Documentation Software, and Configuration functions. Logicmaster 90 software allows ON-Line and OFF-Line program development and documentation. In addition, the Logicmaster 90 Configuration functions relieve you of most of the physical hardware configuration chores, such as setting I/O module address DIP switches, configuration of board jumpers, and many others.

Now to make configuration tasks easier, they are done by the Logicmaster 90 Software installed in the programming device, which can be a Workmaster II or Cimstar computer, or IBM compatible Personal Computer. The programming device communicates with the Series 90-70 PLC through a parallel communications link to a Bus Transmitter Module in the CPU rack or through a serial communications link to an RS-422/485 compatible serial port built into the CPU module.

Logicmaster 90 Software Architecture

The software architecture is such that it provides a structured platform upon which to build your control programs. Programs consist of one or more modules called *Program Blocks*. The program always has a *Main Program Block* that contains the logic used when the program is started. The Main Program Block can call other Program Blocks as it executes. Programs can be built from many Program Blocks each of which is related to a control function. Structured programs permit parallel development of a complete program as a collection of Program Blocks developed independently by many different individuals or OEMs, or from libraries of Program Blocks.

Structured Programs

The typical Programmable Logic Controller program, as it is developed today, is a single linear program in which all of the code is executed each scan whether or not it is required. With Logicmaster 90 software, logic can be structured, that is partitioned into sub-programs, each with

local and global memory, and executed as needed. This tool leads to significant improvements in programming efficiency, faster debug time, easier to understand and maintain programs, and faster scan times.

An example of the value of structured programming is in controlling a self-teach pick and place robot. In this application there are four modes of operation: power-up, run, manual, and teach. Using structured programming, each mode of operation would be a separate program block. Only the needed logic would be executed (improving scan time). Readability of documentation is improved by full partitioning of the logic.

Program Development Made Simpler

Structured programming simplifies program development when more than one individual is involved. Each person can write code in their own personal program block using local memory, but would have access to all the I/O and a common set of boolean and word memory. This methodology allows the maximum amount of independence between programmers.

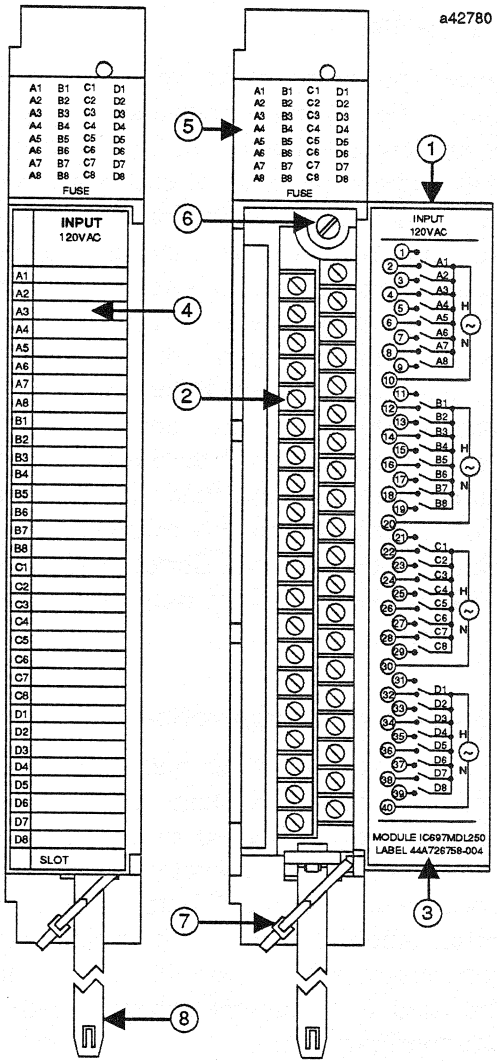
Structured programs are easier to understand and debug. A control program may be built of many smaller Program Blocks each of which can relate to a specific machine function. This approach makes it easier to isolate and associate control logic with machine functions.

Scan Time Benefits

Structured programs offer unique scan saving benefits. For example, consider a large sheet metal treating application of 36 tanks with as many as 30 parts per tank. If each part requires a separate timer, this application represents over 1000 timers. If it takes 33 microseconds to solve each timer, this represents a scan time contribution of 35.6 milliseconds. With a Series 90-70 PLC's structured program, the solution of the 1000 timers could be scheduled over ten sweeps by placing 100 timers into each of ten Program Blocks. If the solution of the Program Blocks is scheduled over ten scans, then the scan time contribution is reduced to 3.6 milliseconds. This technique is possible since Series 90-70 PLC Program Blocks keep track of time even when they are not active.

Logicmaster 90 Configuration Utility

Logicmaster 90 configures and fully documents the Series 90-70 PLC system. A self-prompting configurator utility is used to configure system memory, I/O module parameters, alarm action on fault occurrence, and module locations. Once all the information is captured in a file, graphical systems representation and full configuration data can be used to document changes made to the system configuration.



① HINGED DOOR COVERS WIRING FIELD
② HIGH DENSITITY REMOVABLE 40-TERMINAL CONNECTOR
③ CIRCUIT WIRING DIAGRAM
④ OUTER LABEL FOR CIRCUIT IDENTIFICATION
⑤ I/O POINT STATUS INDICATOR LEDS BEHIND LENS
⑥ JACKSCREW
⑦ CABLE TIE
⑧ TERMINAL BOARD STRAP

Figure 1-3. Model 70 I/O Module Features

Fault Handling - Series 90-70 PLC

Faults are handled by a built-in software utility called the *Alarm Processor* which time-stamps and logs I/O and system faults in two tables which can be displayed by the programmer or uploaded to a host computer or other coprocessor.

The alarm processor maps detectable faults automatically into fault sensing contacts which allows straight forward integration into ladder logic. Comprehensive diagnostic screens complete with fault description, time stamp of fault, and the ability to clear faults are built into Logicmaster 90. Faults are detected from the CPU, Model 70 I/O, coprocessors, and Genius I/O.

Series 90-70 Rack-Type I/O System

Series 90-70 PLC I/O is a conventional rack-type I/O system and is the interface between a Series 90-70 PLC and the user supplied input and output devices. The I/O system for the Series 90-70 PLC is called the Model 70 I/O and consists of 16 and 32 point discrete modules available in a wide range of voltage levels. Analog I/O is flexible, easy to use and provides automatic diagnostics. Analog inputs can be cost-effectively multiplexed with up to 120 circuits per rack.

Optional Modules for the Series 90-70 PLC

In addition to the bus expansion modules (BTM, BRM) and I/O modules, option modules currently available for use with the Series 90-70 PLC include: Genius Bus Controller (GBC), Programmable Coprocessor Module (PCM), Graphics Display Coprocessor module (GDC), Alphanumeric Display Coprocessor module (ADC), MAP Carrierband Interface module, MAP Broadband Interface module, and MMS-Ethernet Controller module.

Genius I/O System

GE Fanuc's innovative Genius I/O system can be used exclusively with Series 90-70 PLCs or can be mixed with standard rack-type Series 90-70 I/O as well as third party VME I/O.

Genius Bus Controller

The Bus Controller (GBC) for the Series 90-70 PLC provides the interface between the Series 90-70 PLC and a Genius I/O communications system. This system can be I/O control using Genius I/O blocks, or it can be a Genius Local

Area Network. Configuration of the GBC is simplified by use of the configurator functions of the Logicmaster 90 software.

Each Genius I/O bus can have up to 30 Genius I/O blocks connected to it. Any type of Genius I/O block, as long as it is a phase B block, may be connected to these buses. Detailed information on the Genius Bus Controller can be found in the Series 90-70 Bus Controller User's manual, GFK-0398. Information on Genius I/O blocks available for use on a Genius I/O network, can be found in the Genius I/O Discrete and Analog Block User's manual, GEK-90486-2.

Remote I/O Scanner

The Remote I/O Scanner provides the means for Series 90-70 I/O to be distributed on the Genius I/O link at a location remote from where the Series 90-70 CPU is physically located. This module resides in a standard 5 or 9 slot Series 90 rack along with Series 90-70 discrete and/or analog I/O modules. This subsystem is referred to as a remote rack. The Remote I/O Scanner operates similar to a Series 90-70 CPU in that it controls all I/O functions within the remote rack in which it resides, however it does not perform any logic solution. All I/O data for that rack is communicated to and from the Series 90-70 CPU over the Genius I/O link.

The Remote I/O Scanner can handle any mix of discrete and analog inputs and outputs up to a total of 1024 discrete inputs and 1024 discrete outputs, or 64 analog inputs and 64 analog outputs (regardless of the number of racks in the remote drop). A remote drop can include all presently-available Series 90-70 discrete modules, analog modules, and analog expander modules. Bus Transmitter, Bus Receiver, PCM, GDS, and ADS modules can also be placed in a remote drop. A remote drop cannot have any I/O module interrupts, bus controllers, communications modules, or other modules that depend on COMREQ instructions for their operations. For detailed information, see the Remote I/O Scanner User's Manual, GFK-0579.

Programmable Coprocessor Module

A powerful intelligent module available as an option for use in a Series 90-70 PLC system is the *Programmable Coprocessor Module* (PCM). The PCM is a high performance microcomputer designed to perform coprocessor functions in a Series 90-70 PLC system. It combines the function of the Series Six Communications Control Module (CCM) and a powerful coprocessor computer into a single module.

The PCM is closely coupled to the Series 90-70 PLC through the VMEbus. Its 12Mhz 80186, 512K byte program memory, dual serial port (one is DMA), and high-speed backplane interface provide a powerful platform for coprocessing.

The PCM has two independent ports which can perform communication functions and/or ASCII/BASIC type functions. The PCM is a very powerful single slot module which can use up to 512K bytes of memory.

As a programmable coprocessor, the PCM can be programmed with a powerful BASIC language interpreter called MegaBasic™ to perform data acquisition, data storage and retrieval, real-time computing, and operator interface functions. MegaBasic is a fast executing version of BASIC that is rich in instructions including bit manipulation and string handling. An IBM compatible development system simplifies off-line program generation. MegaBasic has been enhanced to permit reading and writing of data in the PLC.

The PCM can be configured as two independent serial CCM2 (CCM is the GE Fanuc communications protocol) ports, or for dual tasking with one CCM port and one MegaBasic application, or for one MegaBasic application using one or both serial ports. For more information, refer to the Series 90™ Programmable Coprocessor Module User's Manual, GFK-0255.

Graphics Display Coprocessor Module

The Graphics Display Coprocessor (GDC) is a coprocessor to the Series 90-70 PLC CPU. It is

programmed to perform CIMPLICITY-70 display functions when coupled with the CIMPLICITY System 3000 Graphics Display Terminal (GDT). It communicates with the Series 90-70 CPU over the system backplane.

Many Graphics Display Coprocessors can be supported in a single Series 90-70 PLC system and can be located in either the main rack or expansion racks.

Operation of the module may be initialized by depressing a pushbutton on the module or by an attached GDC (PCOP) development system. The status of the GDC is indicated by three green LEDs on the front of the module.

For detailed information on the Graphics Display Coprocessor Module, refer to the CIMPLICITY-70 Graphics Display System User's Manual, GFK-0534.

Alphanumeric Display Coprocessor Module

The Alphanumeric Display Coprocessor Module is a coprocessor to the Series 90-70 PLC CPU. It is programmed to perform CIMPLICITY 90-ADS display, report, and alarm functions through an Operator Interface Terminal, which can be a GE Fanuc OIT or Mini OIT, a VT100 compatible terminal, or a Workmaster II, or IBM compatible personal computer running TERMF. It communicates with the Series 90-70 CPU over the system backplane.

Many Alphanumeric Display Coprocessor modules can be supported in a single Series 90-70 PLC system and can be located in either the main rack or expansion racks.

Operation of the module may be initialized by depressing a pushbutton on the module or by an attached ADS (PCOP) development system. The status of the ADC is indicated by three green LEDs on the front of the module.

For detailed information on using the Alphanumeric Display Coprocessor Module in the CIMPLICITY 90-ADS System, refer to the CIMPLICITY 90-ADS User's Manual, GFK-0499 and CIMPLICITY 90-ADS Reference Manual, GFK-0641.

Carrierband MAP Interface Module

The Carrierband MAP Interface module is a member of the family of GEnet Factory LAN hardware and software products. The Carrierband MAP Interface module provides direct connection for a Series 90-70 Programmable Logic Controller (PLC) to an IEEE 802.4 carrierband network.

The GEnet Factory LAN architecture is based on standards set forth in the Manufacturing Automation Protocol (MAP) specification. MAP is the single networking scheme that allows all the vendors involved in automating a factory to work on a common communications architecture.

The Series 90-70 LAN Interface module supports the MAP specification version 3.0. The MAP protocol software is loaded into Random Access Memory (RAM) on the LAN Interface module. This allows upgrade to a new revision of software without modification to the hardware.

For detailed information on the Carrierband MAP Interface module, refer to GFK-0418, the GEnet Factory LAN Series 90-70 PLC Network Interface User's Manual.

Broadband MAP interface module

The Broadband MAP LAN Interface module provides direct connection for a Series 90-70 Programmable Logic Controller (PLC) to an IEEE 802.4 Broadband network.

The Broadband MAP LAN Interface module supports the MAP specification version 3.0. The MAP protocol software is loaded into Random Access Memory (RAM) on the LAN Interface module. This allows upgrade to a new revision of software without modification to the hardware.

For detailed information on the Broadband MAP LAN Interface module, refer to GFK-0418, the GEnet Factory LAN Series 90-70 PLC Network Interface User's Manual.

MMS-Ethernet Controller Module

The MMS-Ethernet Controller plugs into a single slot in a Series 90-70 PLC rack providing an

802.3-standard 15-pin D-connector for attachment of a user-supplied AUI (or transceiver) cable. The AUI cable connects to a user-supplied transceiver that is directly connected to the Ethernet trunk cable.

Transceivers are available to operate on a variety of media including thickwire coaxial cable (10Base5) and thinwire coaxial cable (10Base2).

The MMS-Ethernet Controller supports the MMS (Manufacturing Message Specification - ISO 9506) communications protocol over a 7-Layer ISO protocol stack.

The MMS-Ethernet executable software is loaded into Random Access Memory (RAM) on the MMS-Ethernet Controller module. This software can be loaded either serially from the Local GEnet System Manager (GSM) or across the Ethernet network from the Network GSM. This allows upgrade to a new revision of software without modification to the hardware.

Series 90 Protocol (SNP)

The Series 90 Protocol is a serial protocol used in the Series 90 PLC family to communicate between a host device and the Programmable Logic Controller (PLC) CPU through the CPU's serial port. A protocol is a set of rules that define an orderly transmission of data. In the case of SNP, it is a set of rules that establishes and maintains a serial communications link between a Master (host device running the master implementation of the SNP protocol) and a Slave (Series 90 PLC CPU).

SNP is a Master/Slave protocol where the master initiates all communications and the slave responds to the master's requests. Currently, There is no peer-to-peer capability with the SNP protocol (i.e., a PLC cannot be the master; the PLC can only be a slave).

SNP is a half-duplex protocol that uses the RS-485 (enhanced version of RS-422) electrical interface. Several system configurations are possible. There may be just one PLC on the serial link (direct, point-to-point port connection), or there may be many Series 90 PLCs on a serial link (multi-drop port connection). Only one SNP master may be on a multi-drop link. SNP also supports communication over modems.

An RS-232 to RS-422 Converter (catalog number IC690ACC900) provides an RS-232 interface to devices communicating with the Series 90 PLCs which require the RS-232 serial interface.

Where isolation is required, the RS-422 to RS-232 Isolated Repeater/Converter (catalog number IC655CCM590) can be used in place of the RS-232/RS-422 Converter (IC690ACC900). In addition to converting from RS-232 to RS-422 communications, this unit provides ground isolation where a common ground cannot otherwise be established between components.

For more detailed information on the Series 90 Protocol, refer to GFK-0529, which is the the Series 90 SNP Communications User's Manual, and GFK-0585, the Series 90 SNP Communications Driver User's Manual.

Series 90-30 PLC

The Series 90-30 PLC is a small easy to use member of the GE Fanuc Series 90™ PLC family of advanced Programmable Logic Controllers (PLCs). The Series 90-30 PLC is easy to install and configure, offers advanced programming features, and is designed for compatibility with the Series 90 family of PLCs.

There are two CPU models available for the Series 90-30 PLC: Model 311 (5-slot and 10-slot) and Model 331, the difference being speed, I/O capacity, and user memory size. Through the use of today's advanced technology, the Series 90-30 PLC provides a cost-effective platform for small to mid-size applications.

An overview of the Series 90-30 PLC is provided in the following paragraphs. For a detailed product description of this PLC, refer to Chapters 5 through 7 in this Product Summary.

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Series 90-30 PLC Hardware

Series 90-30 PLC system components include:

- Series 90-30 PLC with Model 311 CPU embedded in backplane:
  - 5-slot baseplate with built-in CPU
  - 10-slot baseplate with built-in CPU
  - 30 watt power supply (three versions: 120/240 VAC, 120/240 VAC or 125 VDC and 24/48 VDC source input power)
  - Model 30 eight, 16, and 32 point discrete Input and Output modules
  - Model 30 Analog Input (4 channel) and Analog Output (2 channel) modules
  - Genius Communications Module
  - High Speed Counter
  - Hand-Held Programmer

- Series 90-30 PLC with Model 331 CPU
  - 5 and 10-slot CPU baseplates
  - 5 and 10-slot expansion baseplates
  - 5 and 10-slot remote baseplates
  - 30 watt power supply (three versions: 120/240 VAC, 120/240 VAC or 125 VDC, and 24/48 VDC source input power)
  - Single slot CPU
  - Model 30 eight, 16, and 32 point discrete Input and Output modules
  - Model 30 Analog Input (4 channel) and Analog Output (2 channel) modules
  - Genius Communications Module
  - High Speed Counter
  - Programmable Coprocessor Module
  - Alphanumeric Display Coprocessor Module
  - Hand-Held Programmer

In addition to the above listed products, additional products are planned for the Series 90-30 PLC, including an Axis Positioning Module (APM) which will be available in late 1991.

The CPU architecture is based on an 80188 microprocessor as the main processing element. Additionally, the Model 331 has a built-in coprocessor for performing boolean operations.

Series 90-30 PLC Features

The Series 90-30 PLC combines desired features of traditional PLCs, with many improvements and product enhancements. The traditional features found in most PLCs, include:

- An industrial computer that has been hardened to operate in the harsh environment commonly encountered in the factory;
- Familiar relay ladder diagram programming;
- I/O control through user logic programming;
- Instruction set designed specifically for the industrial control and process environment;
- Communications with cell controllers, operator interface terminals, dumb terminals, personal computers, and similar devices.

The Series 90-30 PLC adds an array of features including:

- Family compatibility throughout the entire product line;
- Sophisticated Logicmaster programming software.
- Extensive module diagnostics for ease of troubleshooting;
- A Configuration Software package which provides for easy system configuration;
- An alarm processor function;
- No jumpers or DIP switches to set on modules (only DIP switches are on expansion baseplates for baseplate ID);
- Hand-Held Programmer for programming in Statement List Language
- Password protection to limit access to PLC contents;
- Built-in battery-backed calendar/clock (Model 331).

Product Description of the Series 90-30 PLC

In addition to the above items, the Series 90-30 PLC offers many desirable features, including small physical size for ease of mounting and handling, built-in RS-485/422 serial port for connection to a Hand-Held Programmer or Logicmaster 90™ programmer, a fixed scan time option, a Lithium battery for backup of CMOS RAM memory, and password protection with multiple security levels.

The Series 90-30 PLC Model 311 is available in two versions, a 5 slot baseplate and a 10 slot baseplate. The same CPU is built into each of these baseplates. Each baseplate requires a power supply module, which is installed in the leftmost slot on the baseplate. All 5 or 10 slots are available for Model 30 I/O.

The Model 331 PLC is available in a 5 or 10 slot baseplate configuration. A CPU module must reside in the first or CPU baseplate. When more than one baseplate is required for a system, expansion and remote baseplates are available with either 5 or 10 slots. A maximum configured Model 331 can have up to 5 baseplates. Up to 4 expansion or remote baseplates can be connected in a chain to the CPU baseplate (requires only a cable connection, no additional modules needed) to increase the number of I/O modules which can be installed in a system.

Specialized option modules, such as the PCM, must reside in the CPU baseplate. All other Model 30 I/O modules may reside in any slot in the other four baseplates.

The I/O expansion system can be either a local expansion system with the last expansion baseplate located no more than 50 feet (15 meters) from the CPU, or a remote expansion system with the last remote baseplate located up to 7500 feet (213 meters) from the CPU.

A remote expansion system can include remote and expansion baseplates, as long as the 50 foot distance limitation for the expansion baseplates is maintained and the recommended cable type for remote baseplates is used.

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Series 90-30 PLC - Model 311 CPU

The 5 and 10-slot Series 90-30 PLC Model 311 baseplates, which have the CPU built into the backplane of the baseplate, are shown in the following figure. With the CPU built into the backplane, the Model 311 has all 5 or 10 slots available for I/O and option modules. Note that specialized option modules, such as the Programmable Coprocessor Module and Alphanumeric Display Coprocessor module cannot be used in a Model 311 PLC system configuration.

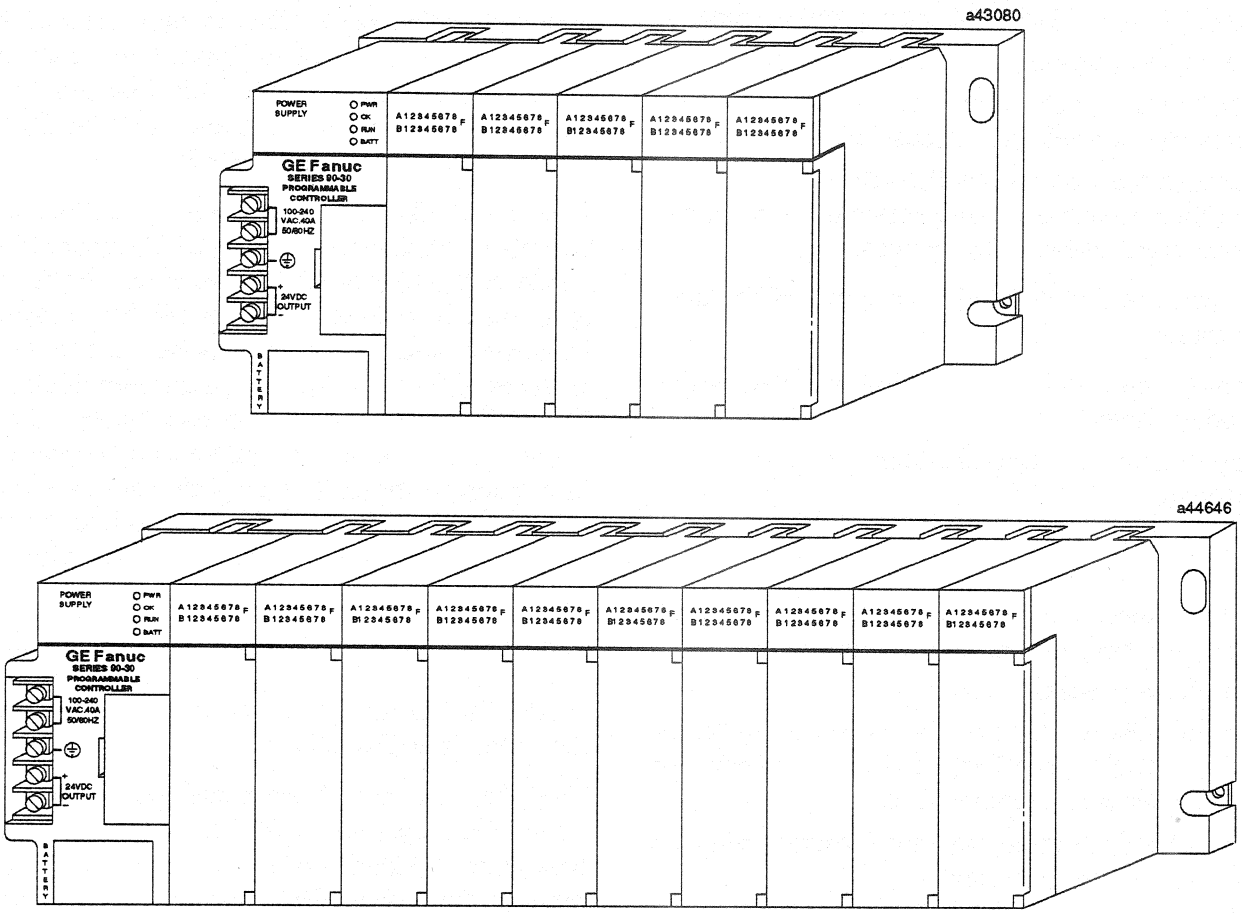

Figure 1-4. Series 90-30, Model 311 (5 and 10-Slot) Programmable Logic Controller

Series 90-30 PLC - Model 331 CPU

The 5-slot and 10-slot versions of the Series 90-30 PLC Model 331, which has a single-slot plug-in CPU module, are shown in the following figure.

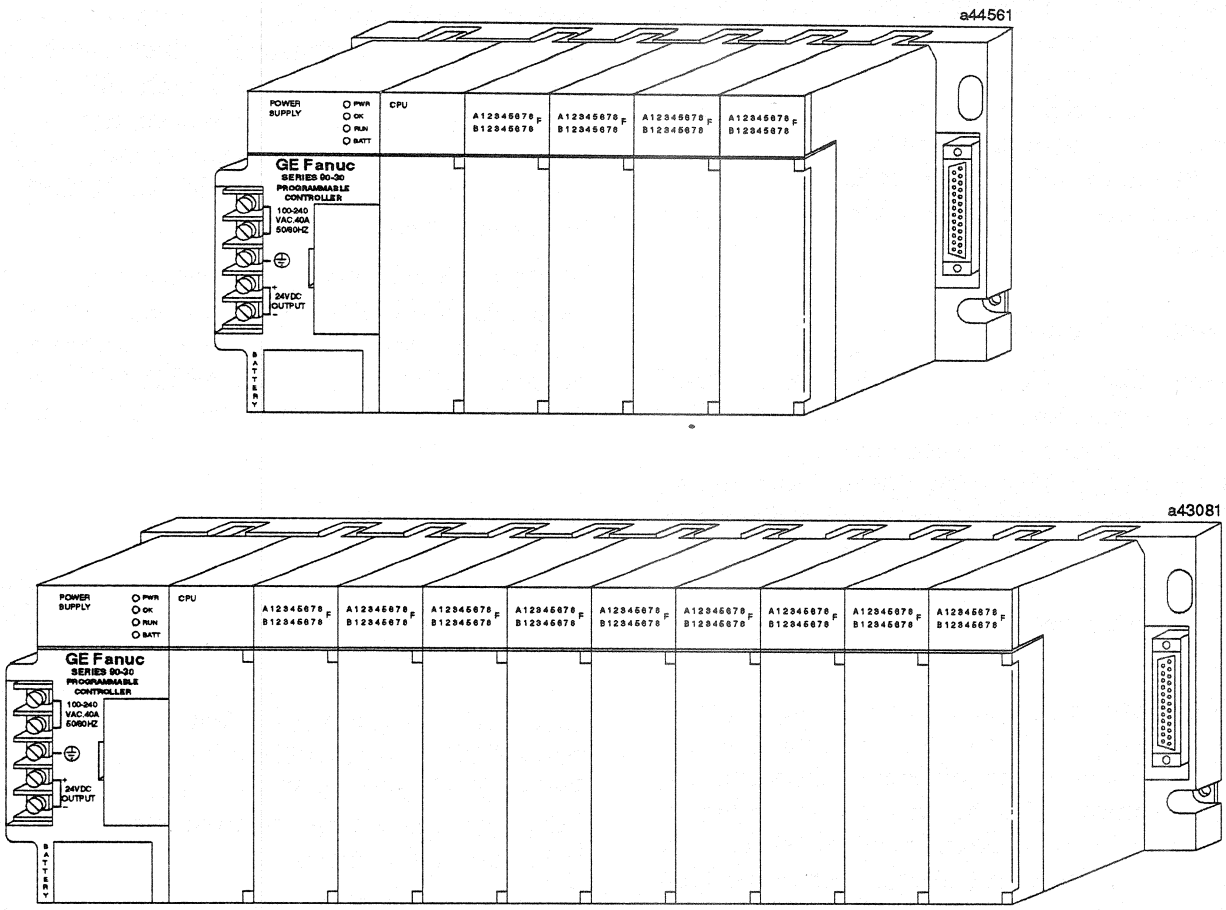

Figure 1-5. Series 90-30 Model 331 (5 and 10-slot CPU Baseplate) Programmable Logic Controller

Series 90-30 PLC I/O System

The Series 90-30 PLC I/O system provides the interface between the Series 90-30 PLC and user supplied input and output devices. The I/O system also supports Global Genius I/O and PCMs.

Option Modules for the Series 90-30 PLC

In addition to discrete and analog I/O modules, option modules are available for use with a Series 90-30 PLC. Option modules for use with all Series 90-30 PLCs are a Genius Communications Module (GCM) and High Speed Counter (HSC). Also, specialized option modules are available for use with the Model 331; a Programmable Coprocessor Module (PCM) and Alphanumeric Display Coprocessor module (ADC). An Axis Positioning Module will be available in late 1991 or early 1992.

Genius Communications Module

The Genius Communications module provides CPU-to-CPU communications between Series 90-30 PLCs, and other PLCs on a Genius I/O Communications bus. These PLCs are the Series 90-70, Series Six, and Series Five PLCs which interface to the bus via their respective Genius

Bus Controllers. The Genius I/O communications bus is a token passing, peer-to-peer, noise immune bus that provides high speed transfer of real time control data. This data transferred between PLCs on the bus is called Global Data; 32 bits of data are transmitted per scan. A Series 90-30 PLC can communicate with up to seven other Series 90 or other PLCs in any combination over a single serial Genius I/O Communications bus through a standard twisted pair, shielded cable. For more information, refer to the Genius Communications Module User's Manual, GFK-0412.

High Speed Counter

The High Speed Counter for the Series 90-30 PLC is a single-slot module used in applications where pulse input rates exceed the input capability of the PLC. The High Speed Counter provides direct processing of rapid pulse signals up to 80 KHz. With direct processing the module is able to sense inputs, count, and respond with outputs without needing to communicate with a CPU.

The High Speed Counter can be configured to count either up or down, to count both up and down, or to count the difference between two changing values. The module can be configured to provide 1, 2, or 4 counters of differing complexity. For more information, refer to the High Speed Counter User's Manual, GFK-0293.

Programmable Coprocessor Module

As previously described, the PCM enhances the overall operation of the Series 90-30 PLC Model 331 (not available for a Model 311) by providing a high performance coprocessor having 160, 192, or 640 Kbytes (depending on version) of on-board CMOS battery-backed user memory.

The PCM supports the GE Fanuc CCM communications protocol, has two serial ports, supports the MegaBasic programming language, and is programmed using a Workmaster II or Cimstar industrial computer, or an IBM or compatible personal computer.

For more information, refer to the Programmable Coprocessor Module User's Manual, GFK-0255.

Alphanumeric Display Coprocessor

The Alphanumeric Display Coprocessor Module is a coprocessor to the Series 90-30 PLC CPU for use in a CIMPLICITY 90-ADS System. It is programmed to perform CIMPLICITY 90-ADS display, report, and alarm functions through an Operator Interface Terminal, which can be a GE Fanuc OIT, Mini OIT, Mini Touch OIT, a VT100 compatible terminal, or a Workmaster or IBM compatible personal computer running TERMF. It communicates with the Series 90-30 CPU over the system backplane.

Multiple ADCs can be supported in a single Series 90-30 PLC system; however, they can only be used in a Model 331 system. For more information, refer to the CIMPLICITY 90-ADS User's Manual, GFK-0499 and Reference Manual, GFK-0641.

Series 90-20 PLC

The Series 90-20 PLC is the newest product offering of the GE Fanuc Series 90 PLC family. The Series 90-20 PLC a low end fixed I/O PLC that is easy to install and configure, yet offers advanced programming features. The Series 90-20 PLC is compatible with other PLCs in the Series 90 family of PLCs. The Series 90-20 PLC provides a cost-effective platform for low I/O count applications.

An overview of the Series 90-20 PLC is provided in the following paragraphs. For detailed information, refer to Chapters 8 and 9 in this Product Summary.

Series 90-20 PLC Hardware

Series 90-20 PLC system components include:

- I/O Power Supply Base Module - two versions currently available (this module combines both the power supply, and input and output circuits on one module).
- CPU Module (CPU 211) - same CPU is used with all models of the I/O Power Supply base module;
- Hand-Held Programmer or Logicmaster 90-30/20 programming software.

Series 90-20 PLC Features

As with all Series 90 PLCs, the Series 90-20 PLC combines the desired features of the traditional PLC, with many improvements and product enhancements. The features traditionally found in most PLCs, include:

- An industrial computer hardened to operate in the harsh environment commonly encountered in the factory environment;
- Familiar relay ladder diagram programming;
- I/O control through user logic programming;
- Instruction set designed specifically for the industrial control and process environment;
- Communications with cell controllers, operator interface terminals, dumb terminals, personal computers, and similar devices.

The Series 90-20 PLC adds many desirable features including:

- Family compatibility throughout the entire Series 90 product line;
- Sophisticated Logicmaster programming software;
- A Configuration Software package which provides for easy system configuration;
- A powerful instruction set which includes 20 basic instructions, 60 advanced functions, and full function math;
- Built-in High Speed Counter
- An alarm processor function;
- No jumpers to set on boards;
- Hand-Held Programmer for programming in Statement List language;
- Password protection to limit access to PLC contents;
- Removable terminal strips;
- User replaceable fuses;
- Three memory options: CMOS RAM, EPROM and EEPROM;
- Modular design for easy replacement and repair of components.

An example of the Series 90-20 PLC is shown in the following figure.

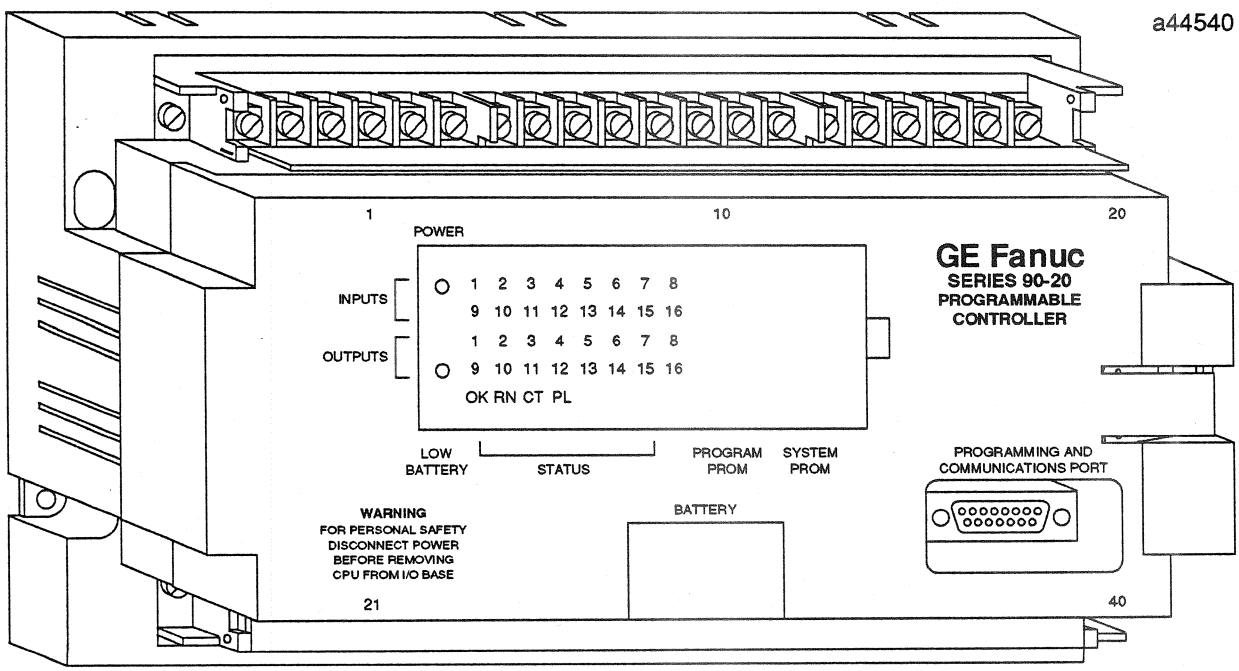

Figure 1-6. Series 90-20 Programmable Logic Controller

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Product Description of the Series 90-20 PLC

The Series 90-20 PLC hardware configuration consists of a combination I/O and Power Supply Base Module (baseplate) and a plug-on CPU module. The I/O configuration consists of 16 Inputs and 12 Outputs per module. Additionally a 10Khz Type A High Speed Counter is built into the I/O and Power Supply Base module.

The base module contains the discrete input and output circuits, high speed counter, power supply and removable terminal strips for user field wiring. Different I/O and power supply combinations are available to meet the customers requirements for various applications.

The CPU module executes and contains the user program, communicates to the programmer (Hand-Held Programmer or computer running Logicmaster 90-30/20 software), contains LED indicators for CPU and I/O status, and a battery for backup of memory. Two discrete LEDs provide power and battery status, a matrix of four rows of LEDs provide I/O status (unused LEDs can be user defined), and four LEDs on the bottom row provide an indication of certain CPU and High Speed Counter status.

The Series 90-20 PLC is easy to install. Basic physical installation consists of mounting the I/O and Power Supply Base module, attaching the CPU module to the I/O and Power Supply Base module, connecting a 120 VAC power source, connecting input and output wiring from field devices.

Configuration and programming can be done using either the Logicmaster 90-30 and 90-20 Programming Software package, or the Series 90-30 and 90-20 Hand-Held Programmer. User developed programs are transportable between the Series 90-20 and Series 90-30 PLCs. Once you are familiar with the Series 90-20, you can easily upgrade to the more powerful Series 90-30.

For detailed information on the components, installation, and wiring of the Series 90-20 PLC, refer to the Series 90-20 PLC User's Manual, GFK-0551. For information on configuration and programming the Series 90-20 PLC, refer to the Logicmaster 90-30 and 90-20 Software User's Manual, GFK-0466 and the Logicmaster 90-30 and 90-20 Programming Software Reference Manual, GFK-0467.

Chapter 2
Series 90-70 PLC Hardware Description

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Introduction to the Series 90-70 PLC

The Series 90-70 PLC continues the family concept by offering six logic processors (Central Processing Units), each with different levels of performance. The processors feature single slot construction, high speed boolean logic processing, configurable memory allocation, and a built-in serial port.

The Series 90-70 PLC offers all the PLC features you expect in a world class PLC. A full instruction set simplifies programming, register memory simplifies data handling, and a built-in real-time clock is available for convenient time stamping.

The Series 90-70 CPUs use a common instruction set. Programs are fully transferable between CPUs making program movement between different processors easy. The Series 90-70 PLC offers a truly open architecture based on the VME standard. All CPUs are closely coupled to the VME backplane, providing high-speed movement of data to I/O, coprocessors, and intelligent modules. Embedded VME Read/Modify/Write commands facilitate integration of 3rd party VME boards.

A VME qualification program has been established by GE Fanuc to help minimize any potential problems resulting from integration of products from multiple vendors when purchased for use in a Series 90-70 PLC system.

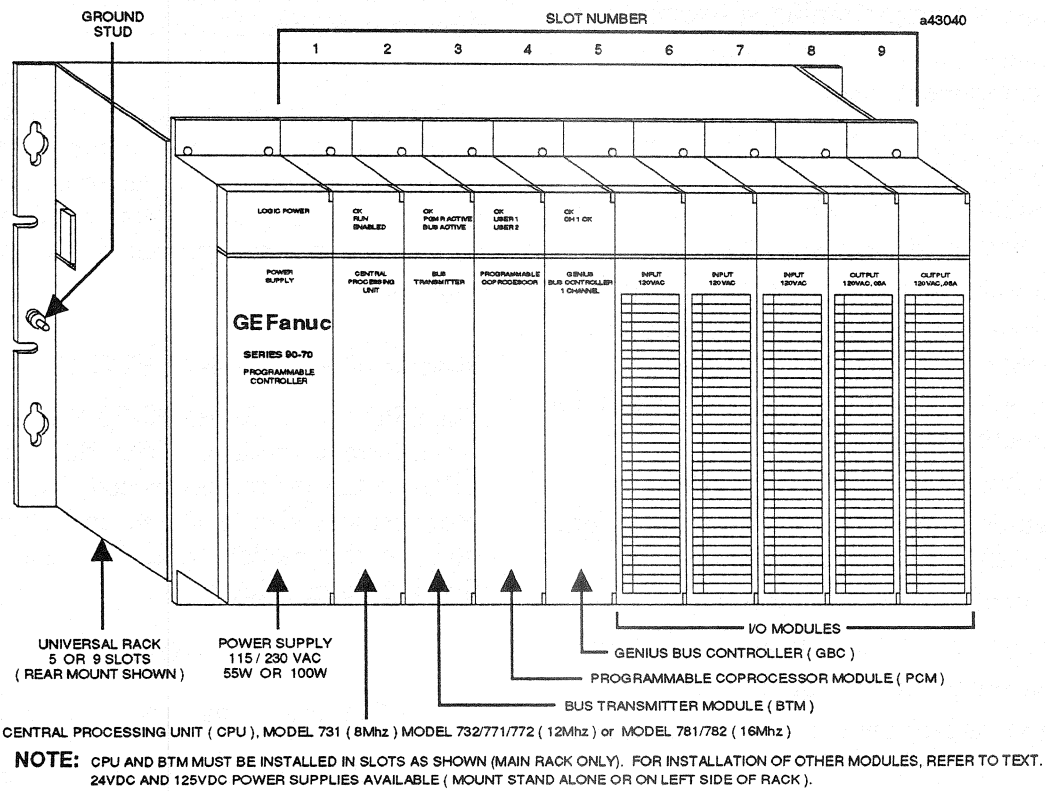

Figure 2-1. Example of Series 90-70 Programmable Logic Controller

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Traditional PLC Features

The Series 90-70 PLC combines the desired features of the traditional PLC with a host of improvements and product enhancements. Features traditionally found in most PLC's, include:

- An industrial computer that has been hardened to operate reliably in the harsh environment commonly encountered in the factory;
- Familiar relay ladder diagram programming;
- I/O control through user logic programming;
- Instruction set designed specifically for the industrial control and process environment;
- Communications with cell controllers, operator interface terminals, dumb terminals, personal computers, and similar devices.

Series 90-70 PLC Features

To these features, the Series 90-70 PLC adds an impressive array of new features including:

- A high density single slot CPU;
- Logicmaster 90 programming software;
- An industry standard VMEbus interface between component boards;
- High density (32 points) AC and DC I/O on a single board;
- Easy module keying, which prevents plugging-in a wrong I/O module type;
- Two-rack operation from one power supply;
- Both discrete and analog interrupts for fast system response with standard hardware;
- Extensive system and module diagnostics for ease of troubleshooting;
- Built-in battery-backed calendar/clock;
- A Configuration Software package which provides for easy system configuration;
- Software configurable analog modules;
- An alarm processor fault diagnostic function;
- Structured relay ladder programming;
- No jumpers or DIP switches to set on boards;
- Genius I/O subsystem.

Series 90-70 PLC Product Description

The Series 90-70 PLC has many other desirable features, including user memory expandable up to 512 Kbytes, built-in serial port, a fast boolean coprocessor ***(.4μs per instruction)***, a fixed scan time option, and up to 64 hardware interrupts.

A Lithium backup battery maintains the contents of the CMOS RAM memory under no-power conditions and can be replaced with power on. Your application programs can be password protected for selective security.

The Series 90-70 PLC is available in a 19 inch wide (rack/panel mounting), and a 13 inch wide rack (panel mounting). All racks are physically identical, whether used as a CPU rack, or an I/O expansion rack.

A 19 inch rack can contain 9 modules plus power supply, or power supply connection; the 13 inch rack can contain 5 modules plus power supply, or power supply connection. Rack slots are identified, from left to right, as PS, then slots 1 through 9 for the 19 inch rack, and PS, then slots 1 through 5 for the 13 inch rack.

Power supplies are available in several versions to handle the various load and voltage requirements of many different modules. Available versions include two AC input source, and two DC input source supplies. These combinations allow you to select the appropriate supply for your application.

Models of Series 90-70 PLC CPU

The CPU for the Series 90-70 PLC is available in six different models. The difference between CPUs is the processing speed, I/O capacity, and user memory size as shown in Table 2-1. Additionally, the models 732, 772, and 782 support floating point calculations.

NOTE

The processing speed of the model 731 CPU will be converted to 12 MHz when the processor is upgraded in late 1991.

Table 2-1. Series 90-70 CPU Capacities

CPU Model	Speed (MHz)	Processor	Input Points	Output Points	On-Board User Memory	Expansion Memory (KBytes)	Floating Point Math
731	8	80C186	512 †	512 †	32K (Bytes)	not available	No
732	12	80C186	512 †	512 †	32K (Bytes)	not available	Yes
771	12	80C186	2048 ‡	2048 ‡	not available	64/128/256/512	No
772	12	80C186	2048 ‡	2048 ‡	not available	64/128/256/512	Yes
781	16	80386DX	12288 *	12288 *	not available	128/256/512	No
782	16	80386DX	12288 *	12288 *	not available	128/256/512	Yes

† The total number of Input points and Output points on CPU models 731/732 cannot exceed 512.
‡ The total number of Input points and Output points on CPU models 771/772 cannot exceed 2048.
* The total number of Input points and Output points on CPU models 781/782 cannot exceed 12288.
- Model 731 processing speed will be upgraded to 12 MHz in late 1991.

Series 90-70 PLC Racks

The rack in which the CPU resides requires a power supply (or a two-rack power cable for use when one power supply provides power for two racks), a CPU module installed in slot 1, and an optional Bus Transmitter Module (BTM) installed in slot 2. The BTM module can be used to provide a high speed parallel communications link to the programmer and to additional racks. The remaining slots can contain combinations of I/O or intelligent modules to suit the needs of your application. If the rest of the modules in a CPU rack are high-density 32 point I/O modules, a 5-slot rack can accommodate up to 128 total I/O points, while a 9-slot rack can accommodate up to 256 total I/O points.

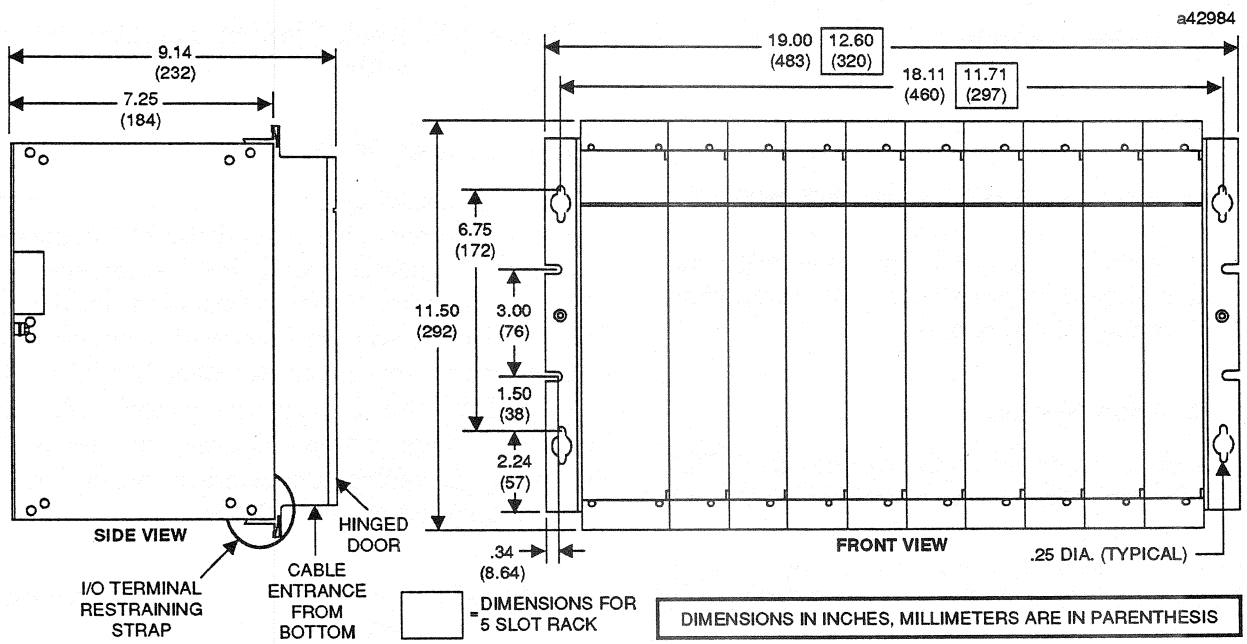

Figure 2-2. Rack Outline and Dimensions

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Physical Description of Rack

Series 90-70 PLC modules are installed in either a 5-slot (IC697CHS750) rear mount, 9-slot (IC697CHS790) rear mount, or a 9-slot (IC697CHS791) front mount universal rack. Additionally, a slot is provided for a power supply. The racks are identical as far as the height and depth of modules they will accept. The 5-slot rack is 12.6 inches (320 mm) wide, and the 9-slot racks are 19 inches (483 mm) wide. The 5-slot rack is usually referred to as a 13 inch rack. The rack slots are identified, from left to right, as PS - then slots 1 through 5, for the 13 inch rack; and as PS - then slots 1 through 9 for the 19 inch racks. The first slot at the left in each rack must contain the power supply or the power supply connection for that rack.

The slot adjacent to the power supply in the main rack (also called rack 0) must always contain the CPU module. Rack sizes may be mixed in a system installation to suit the requirements of your application. Racks may be panel mounted or rack mounted.

Rack Mounting Criteria

Racks must be mounted in a horizontal orientation (as shown in illustrations in this text). These racks do not require a fan for cooling as long as sufficient space is left around the rack when it is mounted. Installation instructions supplied with each rack provide a guide to recommended distances that should be allowed to maintain proper air flow through the modules.

I/O Expansion System

If more I/O is required in the Series 90-70 PLC control system than can be contained in a single rack, additional racks can be added to the system. Up to a maximum of eight (including the CPU rack) racks can be included in a local I/O expansion system.

Multiple racks in a system are identified by a unique number between 0 and 7, which is assigned to each rack by configuring a group of four rack number jumpers which are located on the backplane next to the power supply slot. Rack number 0 (assigned to the CPU rack) must always be present in a system.

Rack numbers assigned to other racks in a system do not need to be contiguously numbered; they can be randomly assigned. ***However, for proper system operation rack numbers must not be duplicated in a multiple rack system.***

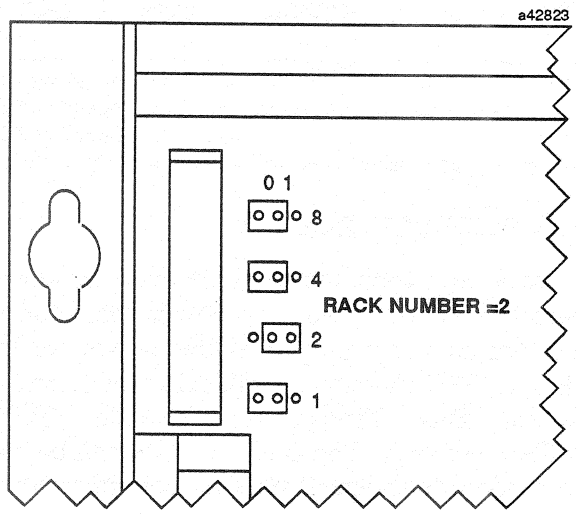

Figure 2-3. Rack Number Jumpers (Shown with Rack Two Selected)

I/O Expansion Racks

Expansion racks connect to the CPU through an 18 twisted-pair cable (called the I/O cable) with one end connected to the lower connector on a Bus Transmitter Module installed in the CPU rack in slot 2, and the other end connected to the top connector on a Bus Receiver Module (BRM) installed in slot 1 in an expansion rack. Each additional rack is then connected in a daisy chain through I/O cables connected to the top and bottom connectors on the BRMs.

Table 2-2. Cables for Connecting Expansion Racks

Catalog Number	Length
IC600WD005	5 feet (1.5 meters)
IC600WD010	10 feet (3.0 meters)
IC600WD025	25 feet (7.5 meters)
IC600WD050	50 feet (15.0 meters)

The total cable length from the CPU rack to the last expansion rack may be a maximum of 50 feet (15 meters). I/O cables are available in various lengths from 5 to 50 feet (0.6 to 15 meters) as shown in the Table 2-2. Additionally, a single power supply can power two racks (within listed current limits) when connected by an available cable three feet (1 meter) in length. *The maximum number of racks permitted in a local system is eight (CPU rack plus seven expansion racks).*

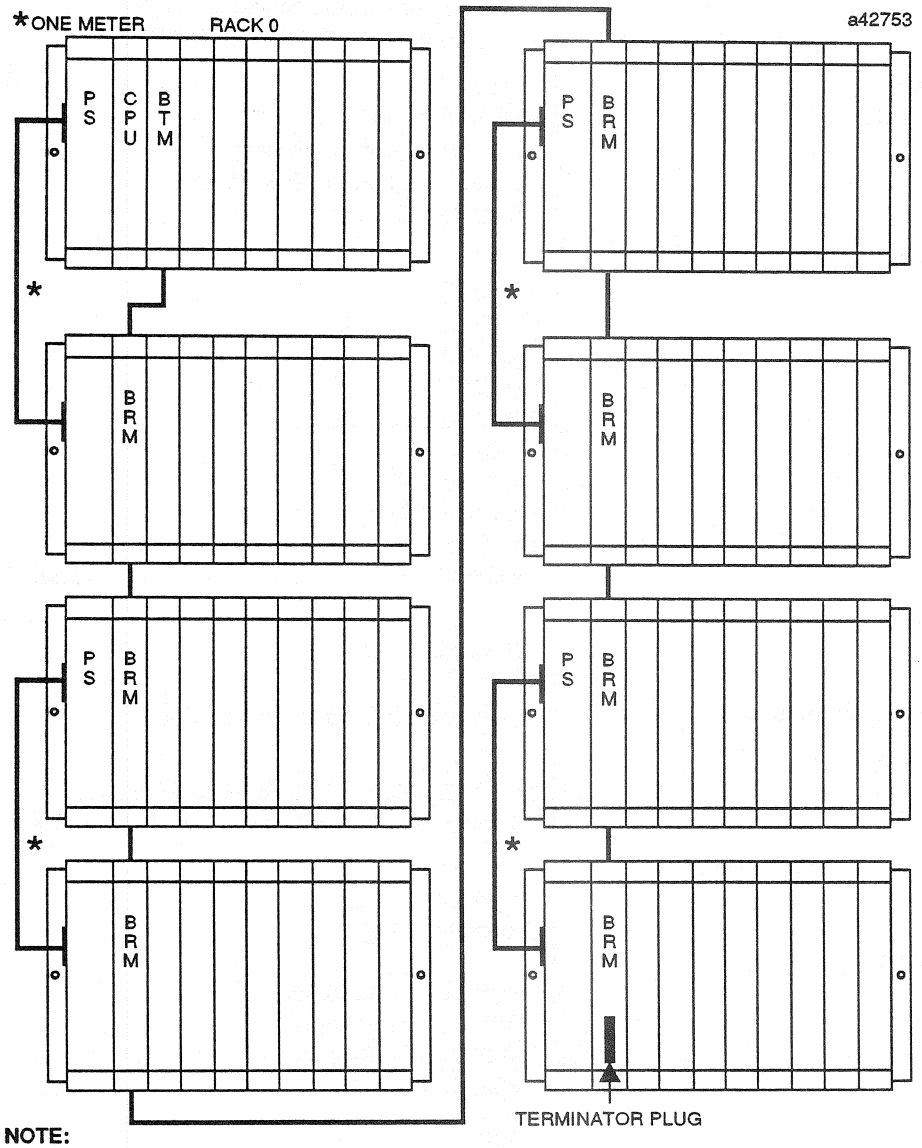

Figure 2-4. Example of a Maximum System Local Configuration

The I/O bus in an expanded system must be terminated by installing an I/O bus Terminator plug on the bottom connector of the last BRM in the system. This Terminator plug contains a resistor pack configured for proper I/O bus termination. If there are more than two racks in an expansion system, the intermediate expansion racks must not have the Terminator plug installed.

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General Specifications

General specifications for the Series 90-70 PLC are provided in the following table. Most Series 90-70 modules are UL listed and CSA certified.

Typical Execution Rate	Boolean Contacts, .4 ms per K elements
Maximum number of Discrete I/O Points	512, any mix (CPU Model 731/732) 2048, any mix (CPU Model 771/772) 12228, any mix (CPU Model 781/782)
Operating Temperature	0° to 60°C (32° to 140°F), (inlet air at bottom of rack)
Storage Temperature	-40° to 85°C (-40° to 185°F)
Humidity	5% to 95% (non-condensing)
Vibration	3.5 mm, 5-9 Hz: 1.0 G 9-150 Hz
Shock	15 g's for 11 msec
Complies with Standards	
IEC	435, 380
JIS	C 0912, JIS C 0911
DIN	435, 380
UL	508, 1012
CSA	C22.2 No. 142, C22.2
NEMA/ICS	2-230.40
ANSI/IEEE	C-37.90A-1978
VDE	805, 806, 871-877
FCC	15J Part A
VME	System designed to support the VME standard C.1
AC Power Source	
Voltage	120 or 240 VAC
Frequency	47 to 63 Hz
Output Power (maximum)	55 watts or 100 watts (two models)
DC Power Source	
Voltage	24 VDC or 125 VDC (depending on model)
Output Power (maximum)	90 watts (24 VDC PS), 60 watts (125 VDC PS)
Rack Weight (approximate, filled)	
9 slot	15 pounds (6.8 kg)
5 slot	9 pounds (4 kg)
Rack Dimensions	
9 slot	Height 10.47″ (266mm) Width 19.0″ (483mm) Depth 7.25″ (184mm) Depth 9.14″ (232mm), with modules installed
5 slot	Height 10.47″ (266mm) Width 12.6″ (320mm) Depth 7.25″ (184mm) Depth 9.14″ (232mm), with modules installed
	Note that all modules in the Series 90-70 PLC system extend 1.89″ (48mm) beyond the front of the rack.
Back-up Battery Type	Lithium, long-life
Typical Battery Life, Loaded	6 months @ 40°C ambient (104°)F (all CPUs/PCM/ADC/GDC)
Battery Shelf Life, No Load	8 to 10 years @ 25°C

Series 90-70 PLC Power Supply

The power supply for the Series 90-70 PLC is available in four versions:

- IC697PWR710, 120/240 VAC input, +5 VDC output, 55 watts
- IC697PWR711, 120/240 VAC input, +5 and ±12 VDC outputs, 100 watts
- IC697PWR721 (with PSA), 24 VDC input, +5 and ±12 VDC outputs, 90 watts
- IC697PWR731 (with PSA), 125 VDC input, +5 and ±12 VDC outputs, 60 watts

Four versions of the power supply are available to handle the differing load and voltage requirements of various modules. For load ratings of modules, refer to the Series 90-70 Installation and Operation User's Manual, GFK-0262.

The AC power supply plugs into the leftmost slot (labeled #PS) of the rack directly to the backplane through a connector - no wiring required. The input source of AC or DC power connects to the Series 90-70 PLC system through a group of protected connections on the power supply faceplate. On the AC input versions, a jumper must be configured on the two bottom terminals for either 120 or 240 VAC to match the power source.

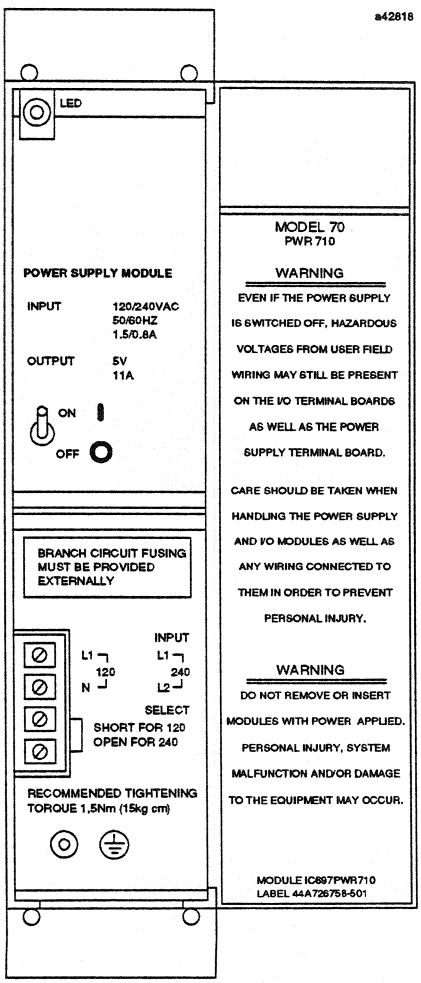

Figure 2-5. Series 90-70 PLC AC Power Supply

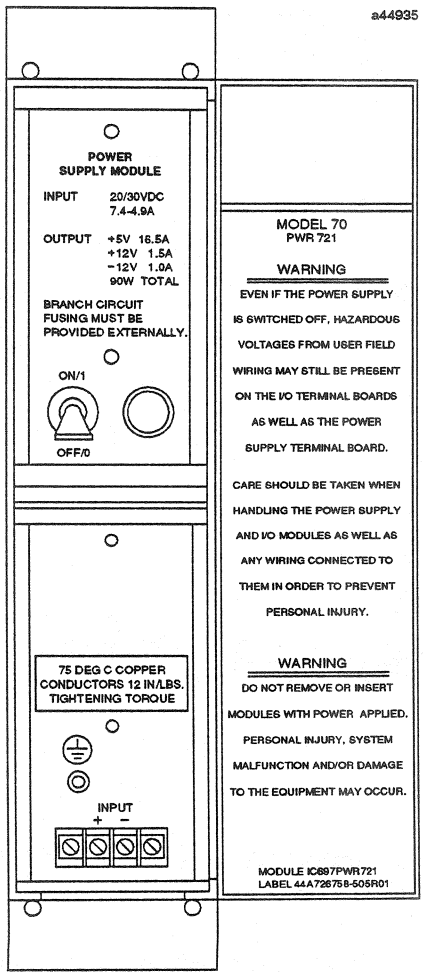

Figure 2-6. Series 90-70 PLC DC Power Supply (24V Version Shown)

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The 55 watt AC power supply should be sufficient to handle the load requirements for most racks, however if the total load requirements are to be greater than 55 watts (and/or a module requires ±12 VDC, e.g. Broadband MAP Interface or some third party boards) the 100 watt AC input, or 60 or 90 watt DC input power supply must be used.

The 24 VDC and 125 VDC power supplies require a Power Supply Adapter (PSA) module, catalog number IC697PWR720, which is an interface between these two power supplies and the Series 90-70 rack backplane. The PSA is included with the power supplies when ordered as catalog numbers IC69PWR721 (24 VDC PS) or IC697PWR731 (125 VDC PS). The 24 or 125 VDC power supply can be mounted on the left side of the Series 90-70 rack, or by attaching a bracket to the right side of the power supply the supply can be used in a stand alone installation and mounted separately on a panel.

The following figure shows a typical installation of a DC input power supply with the required Power Supply Adapter module. Note that for the installation as shown, the power supply is mounted on the left side of the Series 90-70 rack.

Detailed information on mounting the DC power supplies can be found in the data sheet included with each supply - GFK-0624 for the 24 VDC power supply and GFK-0625 for the 125 VDC power supply.

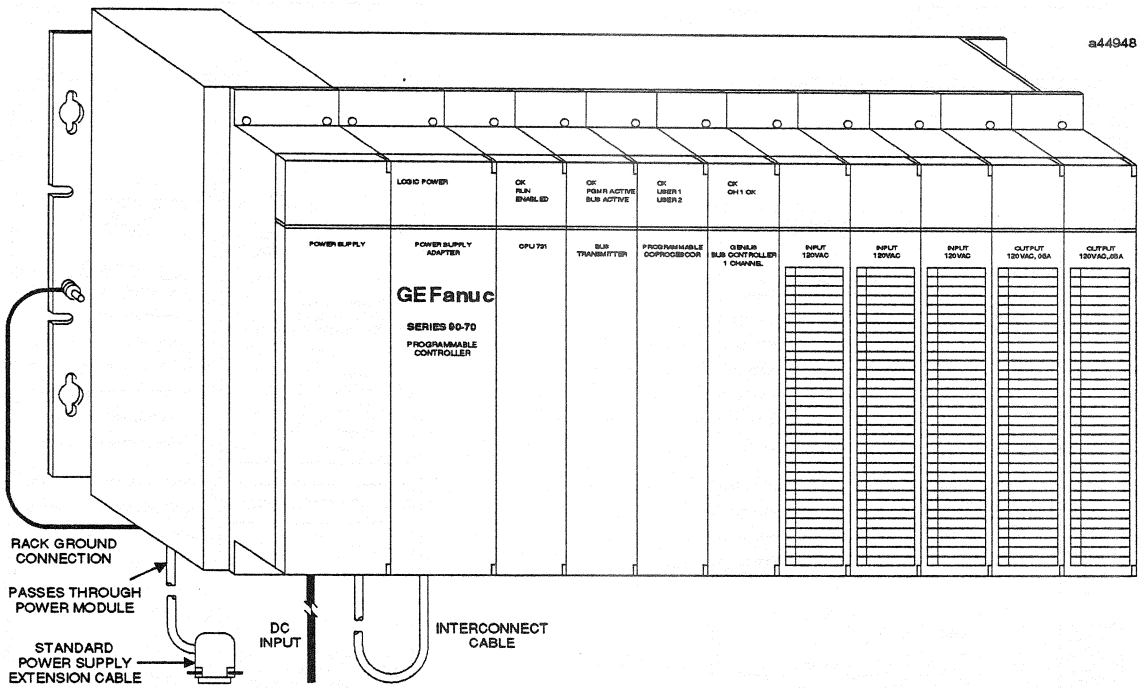

Figure 2-7. DC Power Supply Installation: Left Side of Series 90-70 Rack

Power Supply Adapter

The Power Supply Adapter Module (PSA) is a single-slot module that plugs into the power supply slot, which is the leftmost slot in a Series 90-70 rack. The PSA module must be connected to an external power supply through a cable. The external power supply can be a GE Fanuc power supply module or other external power supply. The PSA allows use of 3rd Party power supplies which meet published specifications. For those applications where maintaining power to the rack is a must, a second power supply can be connected to the terminal board on the PSA to provide power supply redundancy.

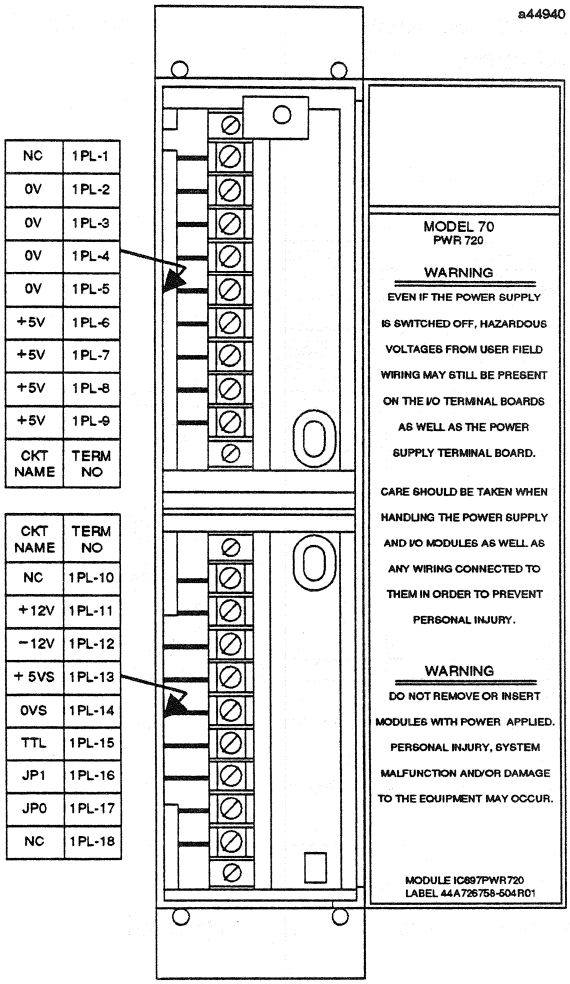

Figure 2-8. Power Supply Adapter Module

The PSA module is installed in the power supply slot (leftmost slot) and connects to either the 24 or 125 VDC power supply through a cable installed in the power supply. The free end of the cable should have spring spade or ring lugs which must be connected to designated terminals on a terminal board on the front of the PSA. This terminal board is accessed by opening the hinged door on the PSA module.

The +5, +12, and -12 VDC outputs, as well as the 5V remote sense, which are generated by an external power supply are connected to the Series 90-70 rack backplane through the PSA. The maximum currents that can be supplied to the backplane through the PSA are: 18 amps on the +5 volt output, 2 amps on the +12 volt output, and 1 amp on the -12 volt output.

The PSA monitors the +5 volt output and the ttl compatible Input Power OK signal (TTL) from the external power supply. The Input Power OK signal (TTL) indicates that the external power supply input voltage is adequate to maintain hold-up time for an orderly system shutdown. The PSA also developes two backplane signals, ACFAIL* and SYSRESET*, which are for the power-up/power-down sequence.

It is recommended that the external power supply have a +5V Remote Sense. When the Remote Sense is connected to the PSA terminal board (positive remote sense to +5VS and negative to 0VS) the +5 volts at the backplane will be regulated to the level set by the power supply.

The Power Supply Adapter Module operates from +5 VDC power which it receives from the +5 VDC power bus on the Series 90-70 rack backplane. The PSA can be used in an application with the 24 VDC PS whereby a single external power supply can provide power for two racks. When used in this application, the Power Supply Adapter module must be installed in the first rack. For more information on the Power Supply Adapter module, refer to GFK-0626, which is the data sheet for the module.

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DC Power Supply Mounting Options

The following two figures show the mounting options, including dimensions, for the DC power supplies as used in a Series 90-70 PLC installation.

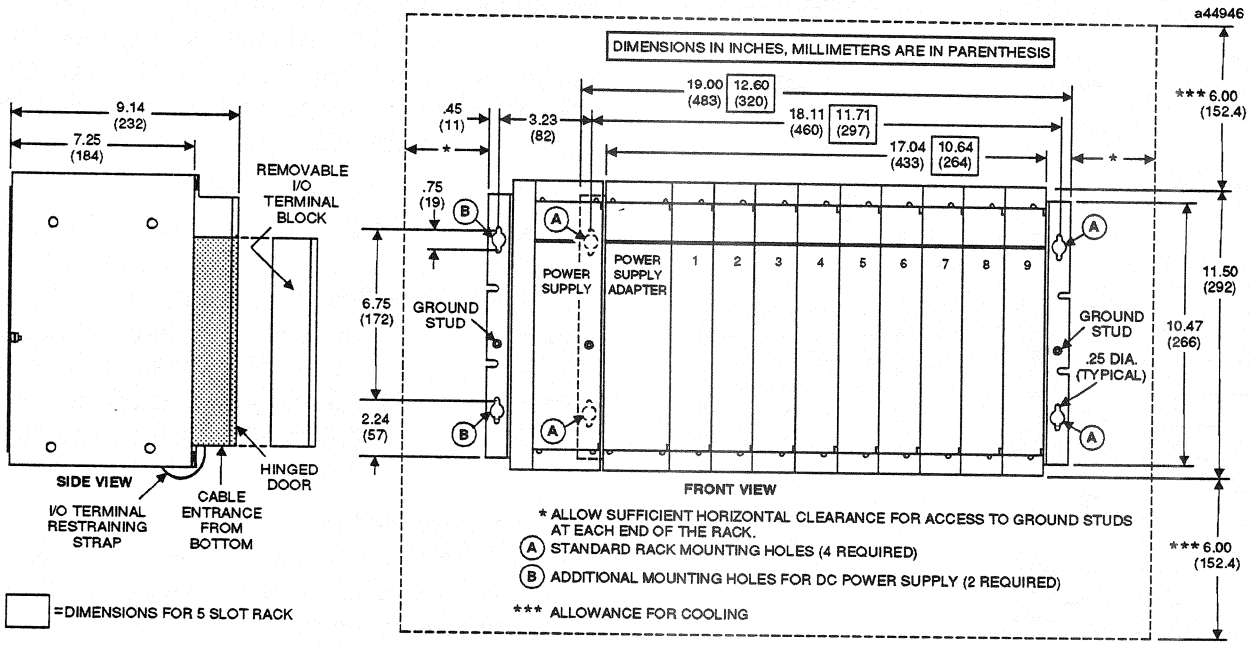

Figure 2-9. Rack Mounting Dimensions with DC Power Supply Attached

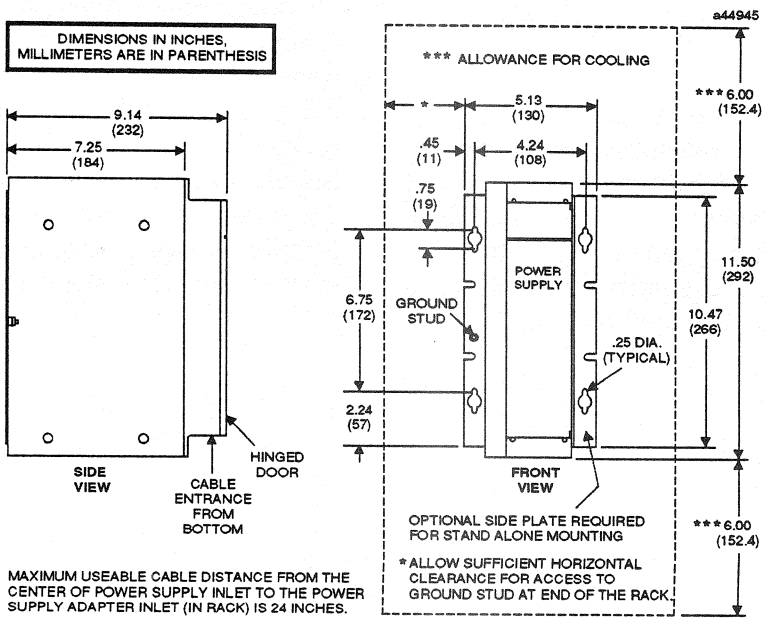

Figure 2-10. DC Power Supply Installation: Stand Alone

Rack Fan Assembly

The Rack Fan Assembly, catalog number IC697ACC721, is an easily installed accessory for use with Series 90-70 nine-slot racks. The fan assembly consists of three fans wired in parallel. This fan assembly provides additional rack cooling for installations where heat buildup could be a problem. The fans have a low noise level and are assembled using ball bearings for extended life. The only tool needed for installation of the fan assembly is a #2 Phillips screwdriver.

The following illustration shows the position of the fan assembly when it is mounted on a rack. Note that it is mounted on the bottom of the rack with air flow from the bottom towards the top of the rack.

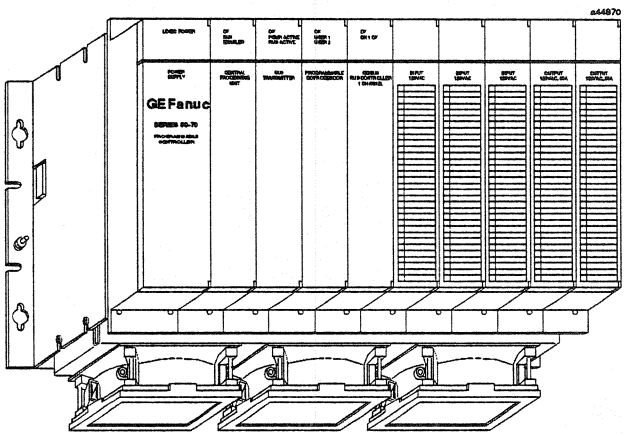

Figure 2-11. Fan Assembly Mounted on Rack

The three fans on the fan assembly are wired in parallel. The fan on the left (looking at front of rack) has a three foot cable to be wired to the 120 VAC power source. The other two fans are connected through a cable/connector assembly to this fan. It is recommended that the fans be wired to the same source of power as the Series 90-70 PLC so that the fans are energized regardless of whether or not the PLC is energized. This will ensure that the fans are running when the PLC is active.

This fan assembly is currently compatible with Series 90-70 racks having the following catalog number:

- IC697CHS790D, or later versions

Blank Slot Interrupt Jumper

The Blank Slot Interrupt Jumper, catalog number IC697ACC722 (6 per pack), is an accessory which has been designed to allow you to reserve a slot in the Series 90-70 rack for future expansion. The Blank Slot Interrupt jumper is a single connector mounted on a board which easily connects to the backplane connector in the selected slot. This jumper, when installed in a blank slot, allows for continuation of the interrupt signal through the backplane. Use of this board is required when there are modules installed to its right which may interrupt the CPU.

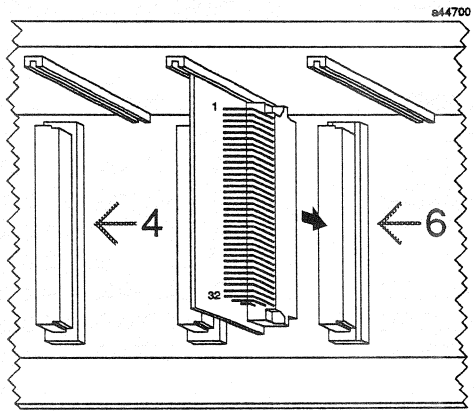

Figure 2-12. Installation of Blank Slot Interrupt Jumper

The Blank Slot Interrupt jumper, when installed, must be added to the system configuration using the Logicmaster 90 Configuration Software. For more information, refer to GFK-0262, the Series 90-70 Installation Manual.

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Module Load Capacity

The following table shows the DC load required by each module. When specifying a power supply, both the individual and the maximum power ratings for all output voltages must be considered. The maximum power rating of the 11 amp AC power supply is 55 watts across all voltages. The maximum power rating of the 18 amp AC power supply is 100 watts. Maximum power rating of the 16.5 amp DC supply is 90 watts, and the 12 amp DC supply is 60 watts. All ratings in the table are given in amperes.

Table 2-3. Module Load Capacity (Amps)

Catalog Number	Module	+5 VDC	+12 VDC	-12 VDC
IC697CPU731/732	CPU 731/732	1.0		
IC697CPU771/772	CPU 771/772, with Expansion Memory (all sizes)	1.2		
IC697CPU781/782	CPU 781/782, with/Expansion Memory (all sizes)	1.6		
IC697BEM713	Bus Transmitter	1.4		
IC697BEM711	Bus Receiver	0.8		
IC697PCM711	Programmable Coprocessor Module	1.0		
IC697CMM711	Communications Coprocessor Module	0.7		
IC697CMM721 †	Carrierband MAP Interface	1.0	.10	.15
IC697CMM731 †	Broadband MAP Interface	1.7	.60	.30
IC697CMM741 †	MMS-Ethernet Controller	1.2	.50	
IC697ADC701	Alphanumeric Display Coprocessor	1.0		
IC697GDC701	Graphics Display Coprocessor	1.2		
IC697BEM731	Genius Bus Controller	1.3		
IC697BEM733	Remote I/O Scanner	0.8		
IC697MDL240	120 VAC Isolated, Input, 16 points	0.25		
IC697MDL241	240 VAC Isolated, Input, 16 points	0.25		
IC697MDL250	120 VAC Input, 32 point	0.35		
IC697MDL650	24 VDC Input, 32 point	0.3		
IC697MDL651	TTL, Negative Logic Input, 32 points	.525		
IC697MDL652	12 VDC Pos/Neg Logic Input, 32 points	0.30		
IC697MDL653	24 VDC Pos/Neg Logic Input, 32 points	0.30		
IC697MDL654	48 VDC Pos/Neg Logic Input, 32 points	0.30		
IC697MDL340	120 VAC Output, 16 point	0.25		
IC697MDL341	120/240 VAC Isolated 2A Output, 16 points	0.25		
IC697MDL350	120 VAC Output, 32 point	0.5		
IC697MDL740	24/48 VDC Output, 16 point	0.25		
IC697MDL750	24/48 VDC Output, 32 point	0.15		
IC697MDL752	12 VDC 0.5A Output, 32 points	0.50		
IC697MDL753	5/48 VDC 0.5A Neg Logic Output, 32 points	0.50		
IC697MDL940	Relay Output 16 points	0.75		
IC697ALG230	Analog Input Base Converter	0.80		
IC697ALG440	Analog Input Current Expander	0.40		
IC697ALG441	Analog Input Voltage Expander	0.40		
IC697ALG320	High Level Analog Output, Voltage/Current	1.66		

† These modules require ±12 VDC: use the 100 watt (IC697PWR711), 90 watt (IC697PWR721), or 60 watt (IC697PWR731) power supply for correct operation.

Power Supplied to Two Racks

Most of the Series 90-70 PLC power supplies can provide power for one or two racks (depending upon total rack power requirements). The connection from the rack with the power supply to the second rack is made through a two-rack cable (catalog number IC697CBL700) three feet (one meter) in length. This configuration is cost effective since only one power supply is needed for two racks.

NOTE

The 125 VDC input power supply (IC697PWR731/732) can only be used to power one rack.

The dual rack configuration is shown in the following figure.

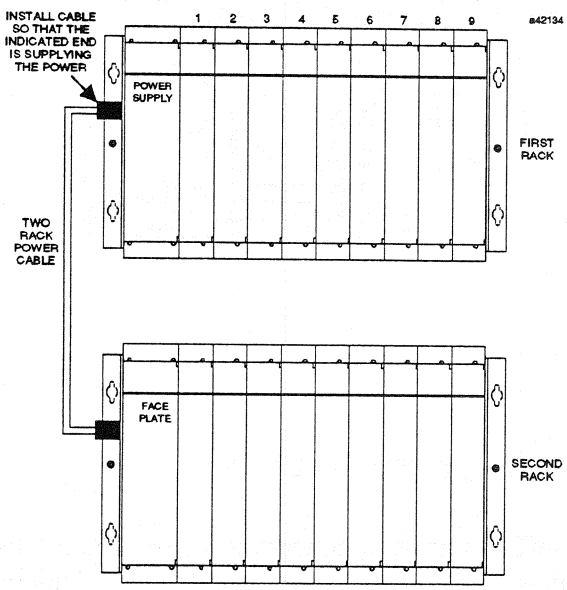

Figure 2-13. Two Racks Sharing One Power Supply

A single power supply can provide power for two racks under the following conditions:

- Only the 5 VDC power is required in the second rack, and the total power required by both racks must be within the capability of the power supply.
- The total current drawn by all modules in the second rack is less than 5.2 amperes.
- The two racks must be mounted in close proximity as limited by the three foot cable described above.

Central Processing Unit (CPU)

As previously described, the CPU for the Series 90-70 PLC is available in six versions; Models 731, 732, 771, 772, 781, and 782. The Series 90-70 PLC CPU contains an 80186 or 80386 microprocessor (see Table 2-1) as the main processing element, on board memory (fixed configuration or expansion memory board depending on model), a dedicated VLSI processor for performing boolean operations and interfaces to a serial port and the system bus.

The microprocessor provides all fundamental sweep and operation control, plus execution of non-boolean functions. Boolean functions are handled by a dedicated, VLSI Boolean Coprocessor (BCP) designed by GE Fanuc.

Additionally, CPU models 732, 772, and 782 have an 80X87 Floating Point Math Coprocessor which gives those models the ability to perform floating point math calculations.

Watchdog Timer

The CPU provides a watchdog timer to detect certain failure conditions. The value of this timer is software selectable by the user. The valid range of the watchdog timer is 10 milliseconds to 2550 milliseconds with the default value being 200 milliseconds. The watchdog timer resets at the beginning of each sweep.

CPU Features

The CPU selected as the logic processor for the Series 90-70 PLC must always reside in Slot 1 in the main rack, which is usually referred to as the CPU rack. Examples of the CPUs for the Series 90-70 PLC are shown in the following figure.

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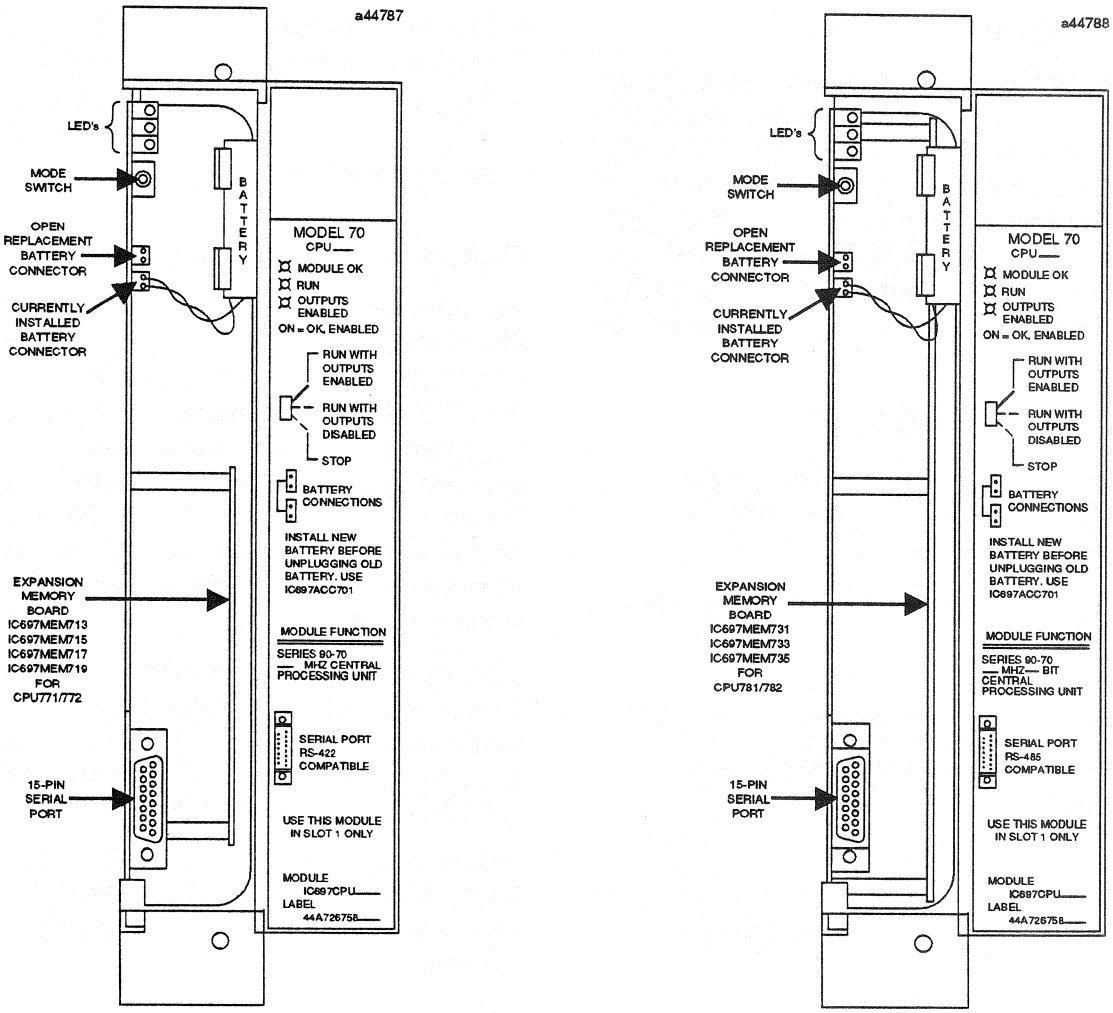

CPU models 731 and 732 do not require an expansion memory board.

Figure 2-14. Common Features of Series 90-70 PLC CPU's

CPU Mode Switch

A three-position toggle switch, accessed from the front, is vertically mounted at the top of the CPU board. This switch selects one of three operating modes for the CPU: either *RUN WITH OUTPUTS ENABLED, RUN WITH OUTPUTS DISABLED, or STOP*. The top position of the switch is Run with Outputs Enabled. With the switch in this position, the CPU executes all portions of the sweep normally.

The middle position is Run with Outputs Disabled. When the switch is in this position, the CPU executes all portions of the sweep normally, but outputs are held in their default state, and therefore remain unchanged. The bottom position is STOP. With the switch in this position, the CPU only communicates with the programmer and other devices, recovers faulted modules, and outputs are disabled.

CPU Status LEDs

There are three LEDs mounted at the top of the board which indicate the current state of the CPU. The LEDs are ON when the CPU is running. They are OFF or flashing to indicate special or failure conditions.

The top LED (OK) is an indicator of the health of the CPU and is ON when the CPU is functioning

properly. This LED flashes when the CPU executes the power-up diagnostics and when the system has failed; however, when in this state, the CPU can still communicate with the programmer. The LED is OFF when the system has failed and the CPU cannot communicate with the programmer.

The middle LED (RUN) is an indicator of the RUN/STOP status of the CPU. It is ON when the CPU is in the RUN/ENABLE or RUN/DISABLE mode. When the CPU is in the STOP mode, the LED is OFF. The bottom LED (ENABLED) indicates the state of the outputs. This LED is ON when outputs are enabled, and OFF when outputs are disabled.

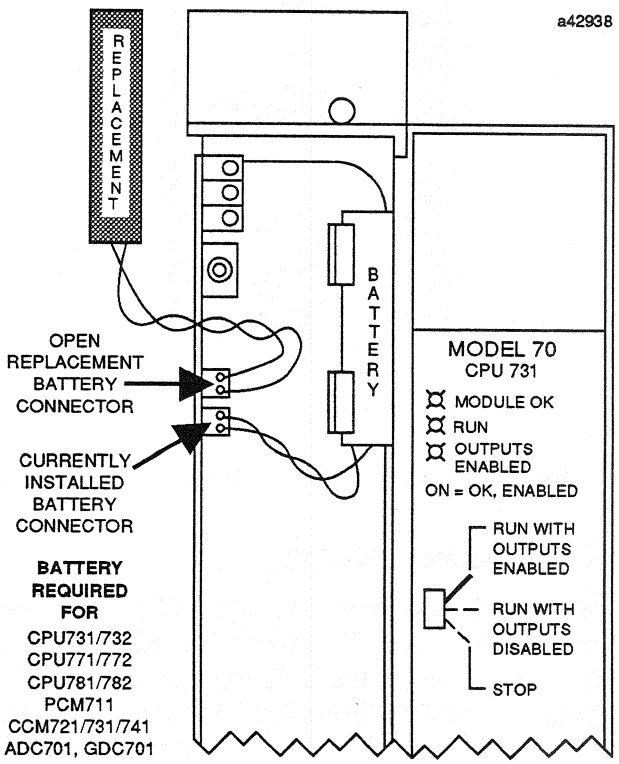

Figure 2-15. Location of CMOS Memory Backup Battery

Battery Connectors

The Lithium battery that backs up the CMOS memory has a cable wired to it with a connector that plugs into one of two identical battery connectors on the board. This scheme allows the battery to be replaced, if required, without the need to power-down the system. The battery being replaced is not disconnected until the new battery is connected, which minimizes the possibility of losing data.

Serial Port Connector

The 9-pin D-connector at the bottom of the module provides the connection to an RS-422 serial port. This port is compatible with the RS485 interface specification. This port provides a serial connection to a 25-pin connector on the programmer's Work Station Interface board. The Work Station Interface is physically installed in the programmer (an IBM computer); the connector is located on the rear of the Work Station Interface board.

Logic Memory for the Series 90-70 PLC

The type of logic memory in the Series 90-70 PLC is CMOS RAM. CMOS RAM is an acronym commonly used for Complimentary Metal-Oxide Semiconductor, Random Access Memory. CMOS RAM is a fast, highly reliable, low power memory that can easily be examined (read) and changed (written to). However, CMOS RAM memory is volatile, which means that it can lose its content if power is removed.

To retain the contents of CMOS RAM memory under no-power conditions, a back-up battery is provided in the form of a lithium battery.

Because of the low power drain of Series 90-70 PLC memory devices, a lithium battery can maintain the contents of memory without application of another power source for approximately 6 months. The storage, or shelf life, of a new lithium battery is typically 8 to 10 years.

The Model 731 and 732 CPUs have 32K bytes of on-board memory available for application program and register data storage. The total user memory size for the Model 771, 772, 781, and 782 CPUs can be customized to suit the requirements of your application and is determined by selection of an expansion memory board which is installed on the main CPU board.

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CMOS Expansion Memory Boards

Storage of user developed programs and register data on the Model 771 and 772 CPU requires a memory expansion board which mounts on the main CPU board. The memory expansion board has battery-backed CMOS RAM memory devices for program storage.

These same boards can also be used with the Programmable Coprocessor Module for memory expansion. Four versions of this memory expansion board are available.

Table 2-4. Expansion Memory Boards, CPU Models 771/772 and PCM

Catalog Number	Memory Size
IC697MEM713	64K Bytes
IC697MEM715	128K Bytes
IC697MEM717	256K Bytes
IC697MEM719	512K Bytes

The Models 781 and 782 use a different expansion memory board. These expansion memory boards are arranged in a 32-bit memory configuration and can only be used on the model 781 and 782 CPUs.

These memory boards are not compatible with the model 771 and 772 CPUs or the PCM. Three versions of the 32-bit memory expansion board are available.

Table 2-5. Expansion Memory Boards, CPU Models 781/782

Catalog Number	Memory Size
IC697MEM731	128K Bytes
IC697MEM733	256K Bytes
IC697MEM735	512K Bytes

The expansion memory boards are easily installed on the CPU or PCM module by mounting them on a connector provided for that purpose. Memory on the boards is backed-up by the Lithium battery mounted on the CPU faceplate.

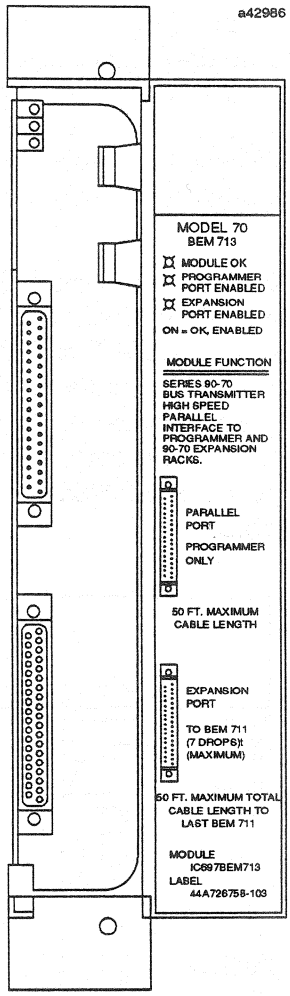

Figure 2-16. Bus Transmitter Module

Bus Transmitter Module

The Bus Transmitter Module (BTM), catalog number IC697BEM713, when included in a system must reside in the CPU rack in slot 2. This module is the link from the CPU rack to expansion racks if more than one rack is required in the Series 90-70 PLC system. The BTM is a high speed parallel interface that propagates the I/O bus signals to a Bus Receiver Module in the first I/O expansion rack. The BTM also provides a high speed parallel connection to the programmer.

The following figure shows how the expansion racks are connected through the BTM in the CPU rack to BRMs in the expansion racks in a local expansion system. Note that the total length of

the cable between all racks can be no more than 50 feet.

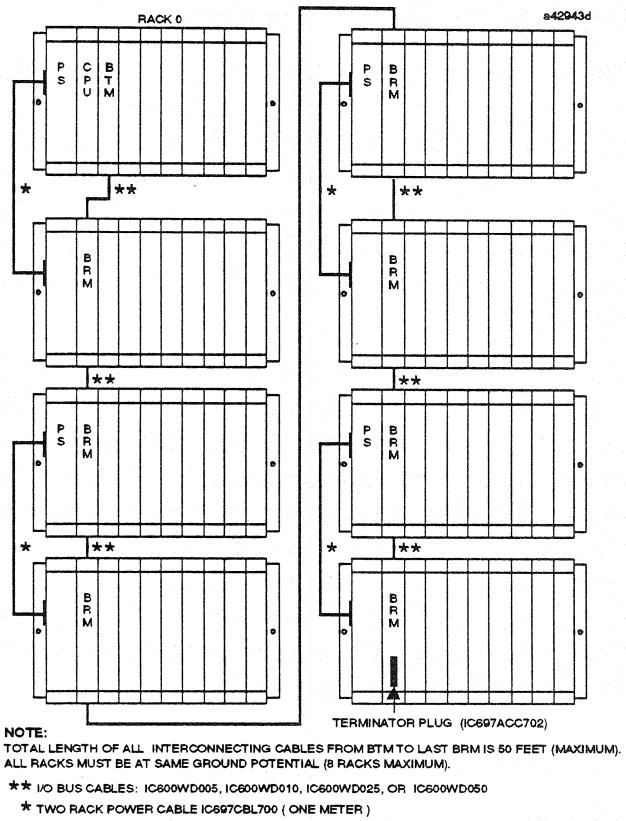

Figure 2-17. Connection of Expansion Racks

Bus Transmitter Module Status Indicators

There are three LED status indicators on the BTM. The top LED, labeled OK, indicates that the CPU has completed its power-up configuration of the BTM and has polled each system expansion rack. The middle LED, labeled PGMR ACTIVE, provides an indication that the PLC and the attached programmer are communicating. The bottom LED, labeled BUS ACTIVE, provides an indication of the communications status of the expansion bus.

Bus Transmitter Module Connectors

There are two connectors on the front of the BTM. The top one connects to a Work Station Interface (WSI) board installed in the programmer (an IBM Personal Computer or compatible computer) for the Series 90-70 PLC. This connection is made through a programmer cable having a maximum length of 50 feet (15 meters). This cable (catalog number IC600WD005A) is wired the same as the cable used to connect the BTM's lower connector to a Bus Receiver Module in the first expansion rack.

However, the programmer cable is different from the I/O cable in that the exit direction from the connector hood at the WSI end is from the side rather than the end. These cables may be interchanged in an emergency, but the specified programmer cable is preferred. Both BTM connectors are D-Type sub-miniature connectors and have 37-pins. The top one is a male connector, while the lower one is a female connector.

Bus Receiver Module

The Bus Receiver Module (BRM), catalog number IC697BEM711, must be installed in slot 1 of each expansion rack in a system so that the rack can interface to the I/O Bus. This is the link from the CPU to the I/O Bus for I/O modules installed in an expansion rack.

The BRM in the first expansion rack connects to the BTM in the CPU rack through a parallel I/O Bus cable. This cable is connected to the bottom connector on the BTM, and to the top connector on the BRM. The next rack to be included in the I/O Bus chain is connected to the lower connector on the BRM in the first expansion rack and the top connector of the BRM in the next rack.

Connection of the I/O expansion racks in this daisy-chain fashion continues until the required number or a maximum of 7 expansion racks is connected. The total cable length of all cables between racks on the I/O Bus cannot exceed 50 feet (15 meters).

The I/O Bus signals are terminated at the end of the bus by installing a resistor pack, located inside of a Terminator plug (catalog number IC697ACC702) on the bottom connector of the BRM module installed in the last I/O expansion rack in the system. Each BRM module has a Terminator plug with it when shipped from the factory.

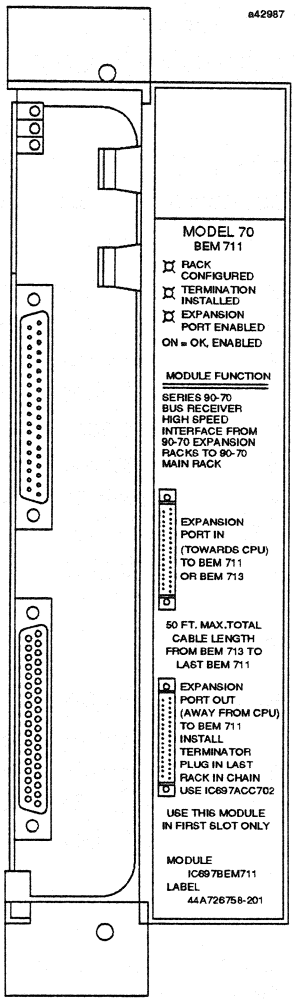

Figure 2-18. Bus Receiver Module

Bus Receiver Module Status Indicators

There are three LEDs located at the top of the BRM which are labeled: OK, LAST RACK, and BUS ACTIVE. The top LED is the board OK LED, and is ON when the CPU completes its power-up configuration of the expansion rack and at least one module in that rack responds to the CPU requests for information. The middle LED is the Last Rack LED and is ON when the I/O bus terminator plug is installed in the bottom connector of this BRM, and is Off when it is not installed. The bottom LED, BUS ACTIVE, is an indicator of the operating status of the expansion bus. This LED is ON when the BRM has detected activity on the expansion bus within the last 500 ms, otherwise it is OFF.

Bus Receiver Module Connectors

The BRM has two connectors mounted on the front of the board. The top connector is for the I/O cable connection to either the lower connector on a BTM in the CPU rack or the lower connector on a previous or upstream BRM. The lower connector is for an I/O cable connection to the upper connector of a BRM in another expansion rack.

The I/O cable is an 18 twisted-pair cable with a ground shield and is the same type as the cable used to connect the Work Station Interface board to the upper connector on the BTM in the CPU rack. The total maximum cable length from the CPU rack to the most distant expansion rack, which must be at the same ground potential as all other racks, is 50 feet. Standard I/O bus cables that meet this specification may be purchased in lengths of 5, 10, 25, and 50 feet.

Genius I/O Bus Controller

The Bus Controller (GBC), catalog number IC697BEM731, for the Series 90-70 PLC interfaces the Series 90-70 PLC to a Genius I/O communications system (refer to Chapter 5 for more information on Genius I/O). This system can be I/O control using Genius I/O blocks, or it can be a Genius Local Area Network. Configuration of the GBC is simple by use of the configurator functions of the Logicmaster 90 software.

Each Genius I/O bus can have up to 30 Genius I/O blocks connected to it. Any type of Genius I/O block, as long as it is a phase B block, may be connected to these buses.

The GBC supports directed communications initiated by a Communication Service Request from the CPU. Faults which are reported by the GBCs are managed by the PLC Alarm Processor Function which time stamps and queues faults in a table.

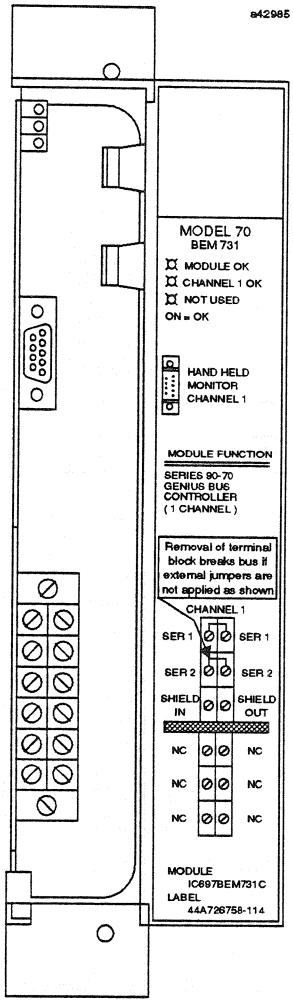

Figure 2-19. Series 90-70 Genius I/O Bus Controller

Bus Controller Operation

The GBC contains an 80186 microprocessor as its main processing element, a 6303 microcontroller for communicating with the Genius I/O bus, on board memory, a custom VLSI chip for interfacing to the Genius I/O bus, and an interface to the Genius I/O bus.

The 80186 microprocessor handles all interfacing with the system bus, passing I/O commands and data between the CPU and the 6303 microcontrollers. The GBC thereby removes from the CPU direct management of the Genius I/O links. I/O data, background messages and status information move between blocks on the Genius I/O links and the CPU.

As a safety feature, a watchdog timer protects each Genius I/O link. This timer is periodically reset by the Genius Bus Controller software, If it should ever expire, the microcontroller on the board ceases functioning and the Link LED turns off. If this happens the Genius I/O blocks connected on the link will default their outputs to the appropriate predetermined state. The cause of the link failure must be determined to re-establish communications.

GBC Features of Interest to the User

A GBC can be installed in any slot in any rack in the system, except for slot 1 in the CPU rack which is always reserved for the CPU module, or slot 1 in an I/O expansion rack, which is reserved for the Bus Receiver Module. Refer to the illustration of the Genius Bus Controller for the location of the items described in the following text.

GBC Status Indicators

The GBC has three LEDs for status indication. The top LED is an indicator of the health (state) of the board, and the middle LED is an indication that communications is OK on the Genius I/O bus; the bottom LED is not used. When the board is functioning properly, the top two LEDs will be ON. These LEDs are either flashing or OFF to indicate special or failure conditions.

GBC Connectors

A GBC has two connectors for communications with the Genius I/O bus. A dedicated nine-pin connector provides a connection to the Genius I/O Hand-Held Monitor. Bus connections are made through a 12-point removable terminal board. Six of these terminals are used for connection to the Genius I/O bus. A GBC may be located on either end or in the middle of the bus.

The Genius I/O Bus

The Genius I/O bus physically consists of a shielded, twisted pair cable which connects the Genius Bus Controller to up to 31 other devices. These may be Genius I/O Blocks, Hand-Held

Monitors, Bus Controllers, or Remote I/O Scanners. An example of a Genius I/O bus is illustrated in the following figure.

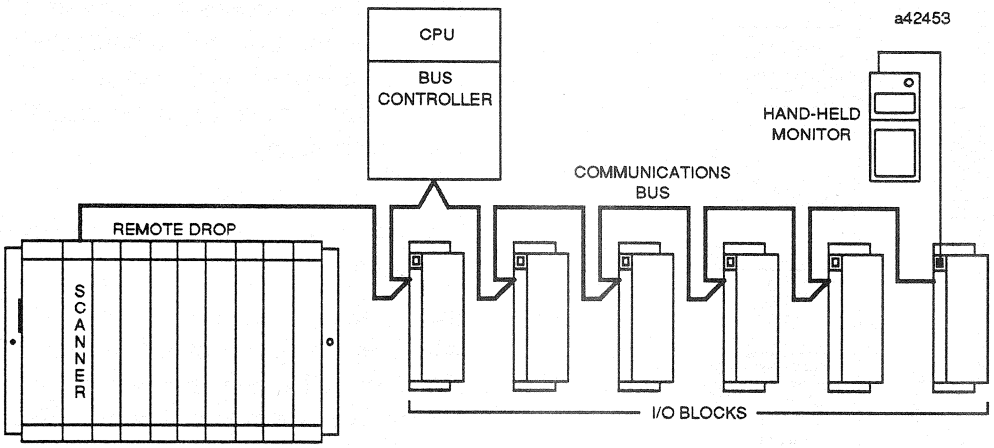

Figure 2-20. Example of Devices on a Genius I/O Bus

Remote I/O Scanner

The Remote I/O Scanner, catalog number IC697BEM733, allows Series 90-70 I/O to be distributed on the Genius I/O link at a location remote from the Series 90-70 CPU. This module is installed in a standard 5 or 9 slot Series 90 rack. This subsystem is referred to as a remote rack.

The Remote I/O Scanner operates similar to a Series 90-70 CPU in that it controls all I/O functions within the remote rack it resides in, however it does not perform any logic solution. All I/O data for that rack is communicated to and from the Series 90-70 CPU over the Genius I/O link. The Remote I/O Scanner and the modules it serves make up a remote drop on the Genius bus.

A remote drop can have up to eight racks, linked by Bus Transmitters and Bus Receiver modules. The maximum distance from the first rack to the last rack in a remote drop is 50 feet.

The Remote I/O Scanner can handle any mix of discrete and analog base converter I/O modules with up to 1024 inputs and 1024 outputs, or up to 64 analog input channels and 64 analog output channels, or any combination that does not exceed a 128 byte input and 128 byte output limit (regardless of the number of racks in a remote drop).

A remote drop can include all currently available discrete modules, analog modules, and analog expander modules. It can also include Bus Transmitter, Bus Receiver, Programmable Coprocessor, Graphics Display Coprocessor, and Alphanumeric Display Coprocessor modules.

A remote drop cannot have any I/O module interrupts, bus controllers, communications modules, or other modules that depend on COMREQ instructions for their operation.

The Remote I/O Scanner also supports both CPU and Genius bus redundancy. For more information on redundancy, refer to the Remote I/O Scanner User's Manual, GFK-0579 (version A or later).

Use of analog expander, PCM, GDC, and ADC modules requires the use of catalog number IC697BEM733B or later of the Remote I/O Scanner module. This version is also required for redundancy installations and in order to have more than one rack in the remote drop.

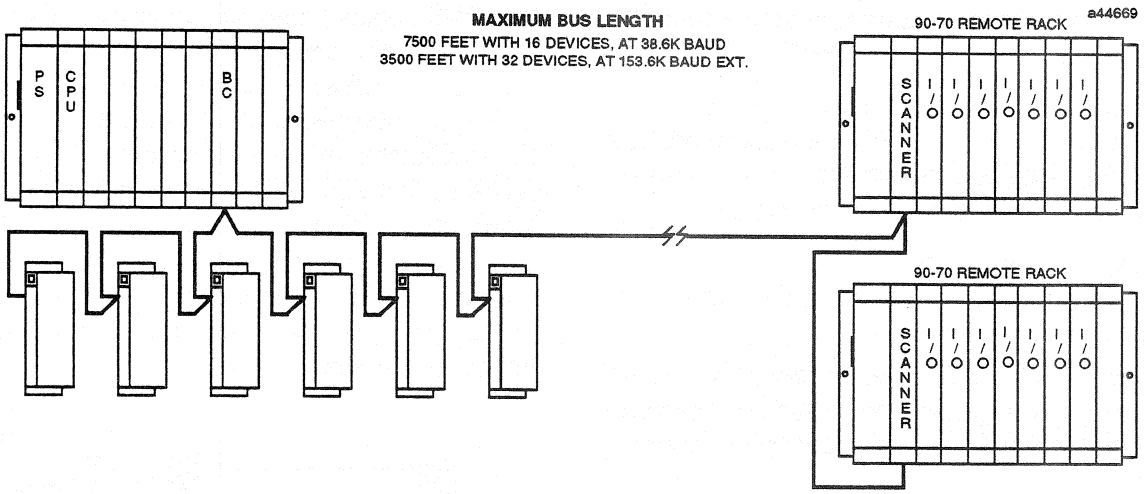

Figure 2-21. Remote I/O Scanner Location on Genius I/O Bus

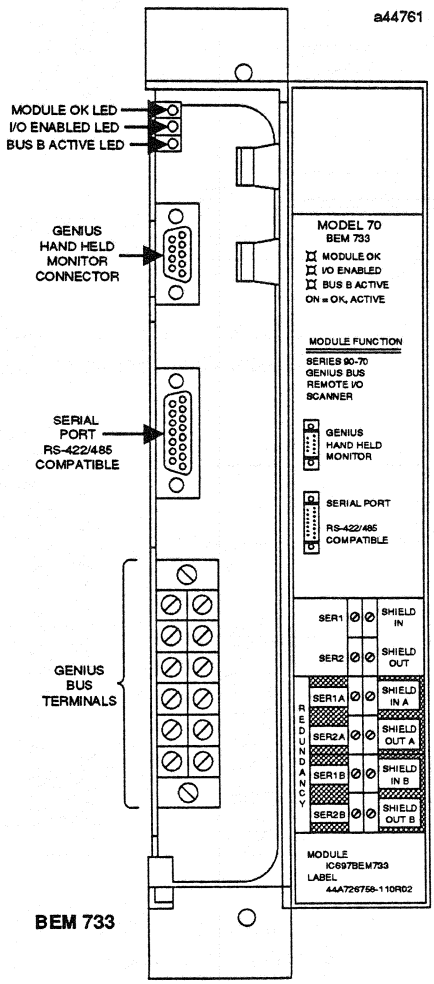

Figure 2-22. Remote I/O Scanner Module

Remote I/O Scanner Operation

The Remote I/O Scanner contains two separate, but closely linked, microprocessor systems. An 80186 microprocessor controls all activity within the remote rack, which includes configuration, programmer communication, and I/O scanning. A 64180 microprocessor along with a custom VLSI device handles all Genius communications. These two microprocessor systems are coupled together through shared memory. All I/O data, as well as diagnostic and system specific data, is passed through this memory.

A 15-pin connector provides an RS-422/RS-485 compatible serial port for connection to a Work Station Interface board installed in the programming computer.

A 9-pin connector, located directly below the LEDs, is a dedicated port for attaching a Genius Hand-Held Monitor. The Genius bus is physically connected through a removable terminal board identical to the board on the Genius Bus Controller module.

LED Status Indicators

The Genius Remote I/O Scanner module has three LEDs labeled from top to bottom, OK, I/O ENABLED, and BUS B ACTIVE. The OK LED (Module OK) turns on to indicate that the module has passed its diagnostic tests following

power-up. It may also flash to indicate that certain error conditions have occurred.

The I/O ENABLED LED turns on when I/O points in the remote rack are being serviced with data received from the controller. It will turn off if any of the following conditions occur:

- The Genius bus linking the Remote I/O Scanner to the Genius Bus Controller is cut or otherwise seriously disrupted.
- The Series 90-70 PLC is Stopped (in STOP mode), or is configured in a manner that prevents the Genius Bus Controller from servicing the remote rack.
- The remote I/O Scanner has been placed in STOP mode and has not been returned to RUN mode.

The I/O ENABLED LED may also flash under certain conditions.

The BUS B ACTIVE LED turns on whenever Genius Bus B is active in redundant bus configurations where the Remote I/O Scanner has been configured as the Bus Switching Module Controller. *This feature requires version B, or later, of the Remote I/O Scanner module.* The BUS B ACTIVE LED is off under all other conditions.

For detailed information on the Remote I/O Scanner, refer to GFK-0579, the Series 90-70 Remote I/O Scanner User's Manual.

Programmer Connection to CPU

The programmer running Logicmaster 90 software can communicate with the Series 90-70 PLC through a Work Station Interface board installed in the programming computer, or it can connect to the CPU using standard serial communications through an RS-232 to RS-422 converter. *The standard serial communications feature will be available in late 1991.*

Work Station Interface (WSI)

The programmer can communicate with the Series 90-70 PLC on a high speed parallel link, or on an RS422 compatible serial link through a Work Station Interface (WSI) board.

The WSI board (two versions available) resides in a slot in the computer which executes the programming software, rather than in a PLC slot. This computer can be a Workmaster, Workmaster II or Cimstar industrial computer, or an IBM PC-XT, PC-AT, PS/2 or compatible Personal Computer. The WSI board is included with Logicmaster 90 software and is installed in the Workmaster II computer at the factory. The following figures show the location of the WSI board in a system.

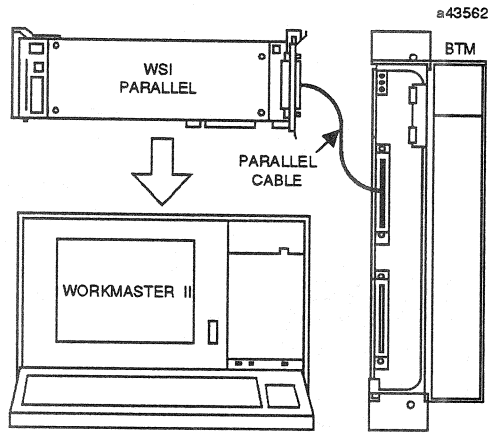

Figure 2-23. Workmaster II to Parallel Work Station Interface

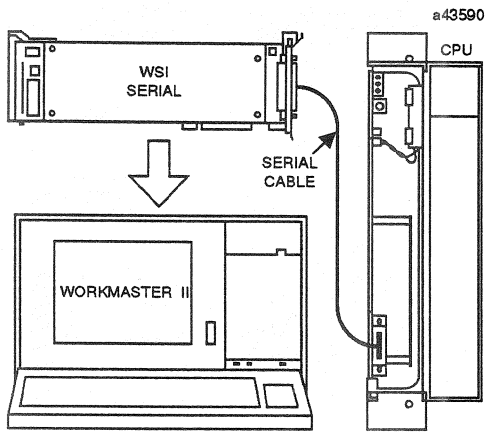

Figure 2-24. Workmaster II to Serial Work Station Interface

The WSI contains an 80188 microprocessor as the main processing element, on-board memory,

an interface to the host computer bus, and provides a parallel interface to the CPU. The parallel interface allows the WSI to communicate with the CPU in the same manner as other intelligent Series 90-70 PLC option modules. The WSI operating software is downloaded from the programmer when Logicmaster 90 is initialized.

Standard serial communications allowing connection to the programmer without needing a WSI board installed in the computer will be available at the end of 1991.

The standard serial communications connection will require using the RS-422/RS-485 to RS-232 converter (IC690ACC900), or for those applications using multidrop configurations or requiring isolation - the isolated repeater/converter (IC655CCM590).

WSI Status Indicator

The WSI board has two LEDs which can be seen only when the computer's cover is partially disassembled. The LED on th WSI main board flashes during the power-up diagnostics. If a board failure is detected by the power-up diagnostics, the LED will turn off and remain off, otherwise it is on. If this condition should occur, it is an indication that the board needs to be replaced. A second LED, located on the daughter board, is normally *ON* during a communications session and for 500 ms after receiving a message from the CPU; otherwise, it is *OFF*.

WSI Connectors

There is one 37-pin connector for parallel or serial communications. The connection to the PLC is from this connector, through a parallel I/O cable (catalog number IC647CBL703) to the top connector on the BTM, or through a serial cable (catalog number IC647CBL704) to the serial port connector on the CPU. The parallel I/O cable connection can no more than 50 feet (15 meters).

The serial connection can be configured in a system for multidrop communications up to 4000 feet (1220 meters), and communications to Series 90-30 PLCs as well. An illustration of a typical multidrop configuration can be found at the end of this chapter (see Figure 2-41).

Programmable Coprocessor Module (PCM)

The Programmable Coprocessor Module (PCM), catalog number IC697PCM711, is a general purpose microcomputer on a single board which enhances the functionality of the Series 90-70 PLC.

The PCM has two serial ports, each with its own port connector, for interfacing to serial RS232/485 devices. It supports the GE Fanuc CCM communications protocol, the MegaBasic programming language, and is programmed using a Workmaster, Workmaster II or Cimstar industrial computer, or an IBM or compatible Personal Computer.

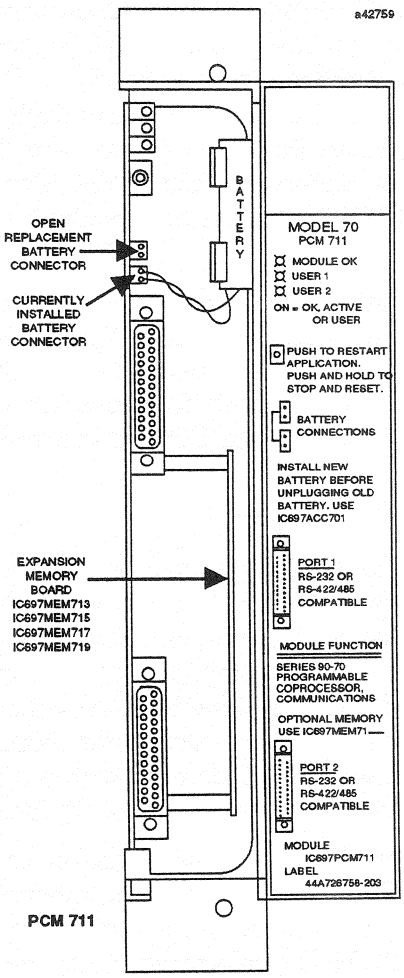

Figure 2-25. Programmable Coprocessor Module

The PCM has 128K bytes of on-board CMOS battery-backed user memory which may be expanded up to 640K bytes by installing an available memory expansion board on the PCM. These are the same memory expansion boards available for use with the CPU models 771 and 772. Even with fully expanded memory the PCM still requires only one slot in a rack. The mode of operation is selected by a combination of PCM software configuration and user wiring.

PCM Architecture

The (PCM) board contains an 80186 microprocessor as its main processing element, on-board memory, an interface to the system bus and the serial ports, and a watchdog timer. The 80186 microprocessor handles all processing and operation control on the board. The 72001 Advance Multi-Purpose Serial Controller controls the interface to the serial ports. The PCM has 128K bytes battery backed RAM Memory, and up to 512K bytes battery backed expansion RAMs.

An application program is not required in the PLC CPU to use the PCM. The PCM can be installed in any I/O slot in any rack in the system (installation in a remote drop requires version B, or later, of the Remote I/O Scanner module).

Dual Tasking Capability

Since up to 63 PCMs can be supported by a single Series 90-70 PLC system, up to 63 separate 80186-based coprocessors can be assigned by the user to computing, filing, and communications tasks. This architecture frees the CPU for more critical real time tasks. For example, as a file server, several PCMs each with a file of up to 512K bytes may divide the task of file lookup.

In addition, the two serial ports on each of the PCM's could then be used for other functions, such as a bar code reader interface, at the same time the PCM is performing a file server function. The PCM can run two simultaneous CCM tasks or one MegaBasic and one CCM task.

PCM Status Indicators

Three LEDs, labeled MODULE OK, USER1, and USER2, are visible through the clear plastic lens at the top of the module. The top LED, MODULE OK, is an indicator of the current status of the module. This LED is ON when the module has successfully completed it's power-up diagnostics, configuration data for the module is good, and the module is functioning normally.

The LED is off when a module malfunction has been detected during the power-up diagnostics, or the module has failed during operation. A blinking LED indicates that the configuration data downloaded from the programmer to the PLC does not match current configuration data stored in the PCM module.

The function of the middle and bottom LEDs can be assigned by the user through programming. Typically, they are used to indicate activity on the serial ports and can be defined to display any combination of the following serial port status:

- Transmit on serial port 1
- Receive on serial port 1
- Transmit on serial port 2
- Receive on serial port 2
- Transmit on backplane
- Receive on backplane
- Application task defined

Restart/Reset Pushbutton

A Restart/Reset pushbutton is located below the USER2 LED. This pushbutton is used in conjunction with the PCM OK LED to reinitialize the PCM module, by initiating a hard or soft reset. A *hard reset* is initiated if the pushbutton is depressed continuously for 5 seconds or more. The PCM will perform a reset operation and reinitialize to the factory default configuration. All user tasks and CCM tasks will be stopped.

A *soft reset* is initiated if the pushbutton is depressed for less than 5 seconds. The PCM will be reinitialized from the user's configuration data, any active I/O and timer requests will be cancelled, and a power cycle will also attempt to restart the software in the user configuration mode.

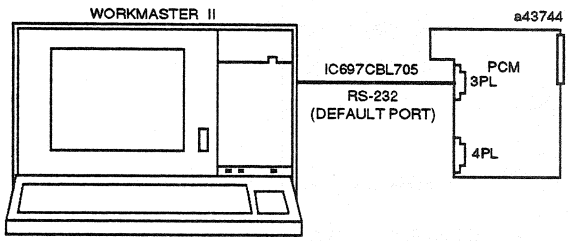

Figure 2-26. PCM to Workmaster II or PS/2 Computer

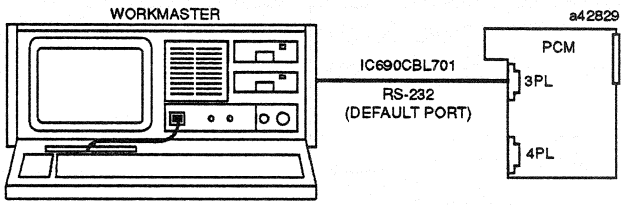

Figure 2-27. PCM to Workmaster or PC-XT Computer

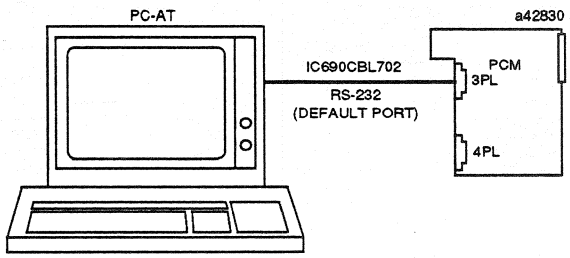

Figure 2-28. PCM to PC-AT Computer

PCM Serial Port Connectors

Two serial port connectors provide connections to the PCM's serial interfaces. Access to these connectors is provided by opening the hinged door on the module. These ports are identified as PORT 1 and PORT 2; both ports support RS-232 and RS-485 modes which are configurable through user programming. Although either port can be used for most purposes, certain operations require a specific port to be used.

Port 1 can be used in higher performance applications since it supports DMA (Direct Memory Access) transfers. Port 1 is used for connecting the programming device with PCM Programming and Configuration software.

Three prewired cables are available to connect the PCM to the programming device. Examples of programmer to PCM connections are shown in Figures 2-24, 2-25, and 2-26.

PCM Backup Battery Connectors

Two identical battery connectors are on the board for connection to the lithium backup battery for on-board and expansion board CMOS RAM memory. Two connectors are provided as a convenience in the event that the battery requires replacement.

The battery currently installed can remain connected until the new battery is connected to the unused connector. The connector wired to the lithium backup battery cable plugs into one of the connectors. The battery can be replaced with the rack powered-on.

PCM Option Connector

An option connector, located at the bottom of the PCM board, allows installation of additional user expansion memory. A memory expansion board may be added to the PCM board (required for MegaBasic programs). These memory expansion boards are the same boards that can be installed on the Model 771 or 772 CPU to increase its total on-board memory capacity.

Four memory expansion boards are available: 64, 128K, 256K, or 512K Bytes (see Table 2-4). The memory expansion board mounts on a single connector on the PCM.

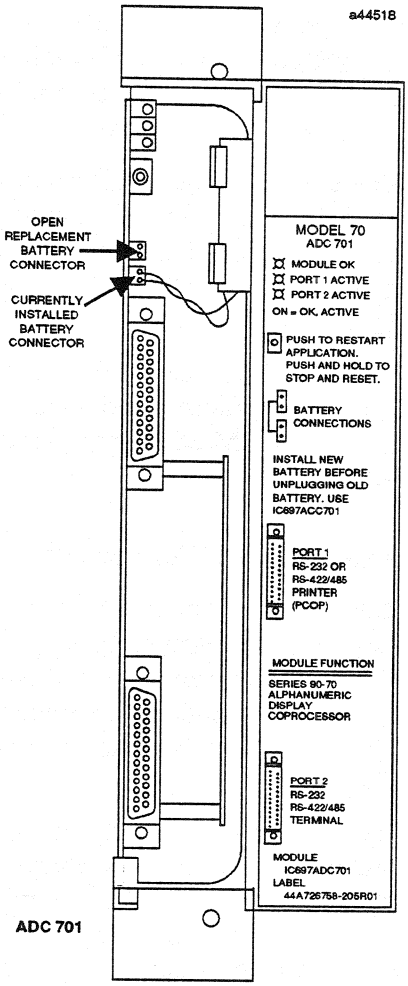

Figure 2-29. Alphanumeric Display Coprocessor Module

Alphanumeric Display Coprocessor Module

The Alphanumeric Display Coprocessor (ADC) Module, catalog number IC697ADC701, is a coprocessor to the Series 90-70 PLC CPU and is used in a CIMPLICITY 90-ADS system. It is programmed to perform CIMPLICITY 90 display, report, and alarm functions through an Operator Interface Terminal, which can be a GE Fanuc OIT or Mini OIT, a VT100 compatible terminal, or a Workmaster II, or IBM compatible personal computer running TERMF.

The ADC communicates with the Series 90-70 CPU over the system backplane. Multiple Alphanumeric Display Coprocessors can be supported in a single Series 90-70 PLC system and can be located in either the main rack or expansion racks. It can be used in a remote drop when version B, or later, of the Remote I/O Scanner module is present.

ADC Programming and Configuration

A Workmaster II, Workmaster, or an IBM-compatible PC, XT, AT, or PS/2 computer with PCM Development Software (PCOP) installed connects to the top port. The default setting is 19,200 bps. The PCM Development Software is used to configure the serial port parameters and to install the CIMPLICITY 90 software onto the ADC. Refer to the the CIMPLICITY 90-ADS User's Manual, GFK-0499, for details of operation.

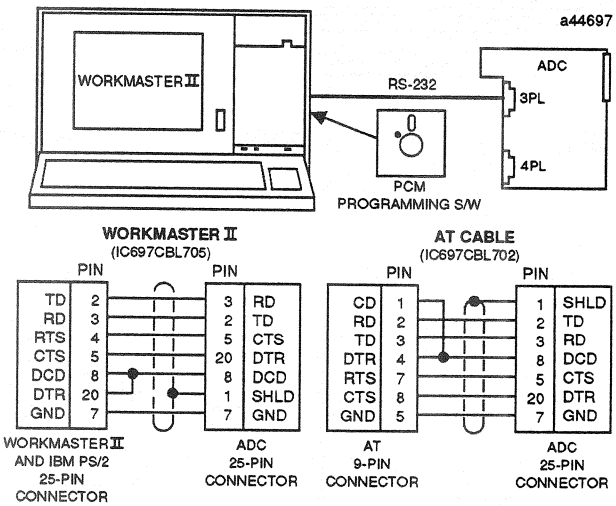

Figure 2-30. Example of PCM Development System Connection to ADC

Graphics Display Coprocessor

The Graphics Display Coprocessor (GDC) Module, catalog number IC697GDC701, is a coprocessor to the Series 90-70 PLC CPU. It is programmed to perform CIMPLICITY-70 display functions when coupled with the CIMPLICITY System 3000 Graphics Display Terminal (GDT).

The GDC communicates with the Series 90-70 CPU over the system backplane. Many Graphics Display Coprocessors can be supported in a single Series 90-70 PLC system and can be located

in either the main rack, expansion racks, or in a remote drop when version B, or later, of the Remote I/O Scanner module is present.

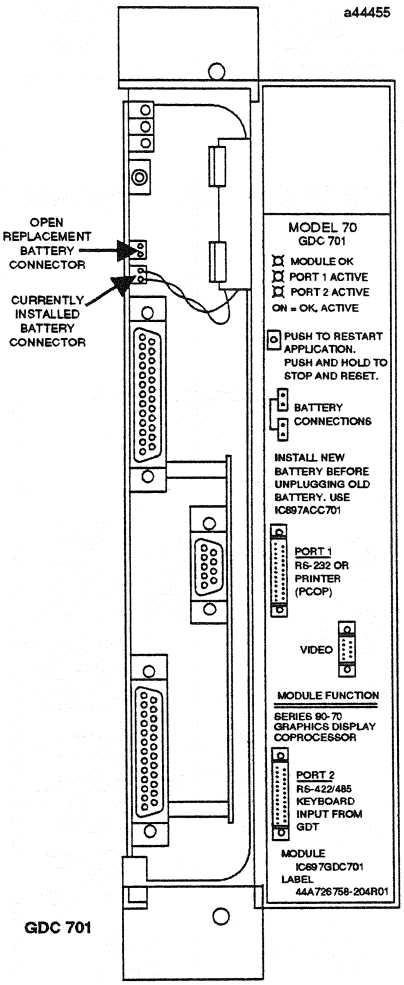

Figure 2-31. Graphics Display Coprocessor Module

GDC Programming and Configuration

A Workmaster II, Workmaster, or an IBM-compatible PC, XT, AT, or PS/2 computer with PCM Development Software (PCOP) installed connects to the top port as shown in the figure below. The default setting is 19,200 bps. The PCM Development Software is used to configure the serial port parameters and to install the CIMPLICITY-70 software onto the GDC.

Refer to the the CIMPLICITY-70 Graphics Display System User's Manual, GFK-0534, for details of operation.

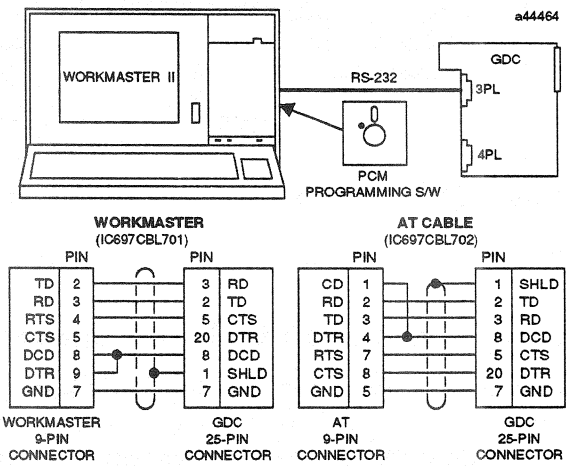

Figure 2-32. Example of PCM Development System Connection to GDC

Carrierband MAP Interface Module

The Carrierband MAP Interface module, catalog number IC697CMM721, is a member of the family of GEnet Factory LAN hardware and software products. The GEnet Family of products provides high performance solutions for interconnecting automation controllers and for integrating them into multi-vendor networks. The Series 90-70 LAN Interface module provides direct connection for a Series 90-70 PLC to an IEEE 802.4 carrierband network.

The GEnet Factory LAN architecture is based on standards set forth in the Manufacturing Automation Protocol (MAP) specification. MAP is the single networking scheme that allows all the vendors involved in automating a factory to work on a common communications architecture.

The Carrierband MAP Interface module supports the MAP specification version 3.0. The MAP protocol software is loaded into Random Access Memory on the LAN Interface module. This allows easy upgrade to a new revision of software without modification to the hardware.

GFT-057

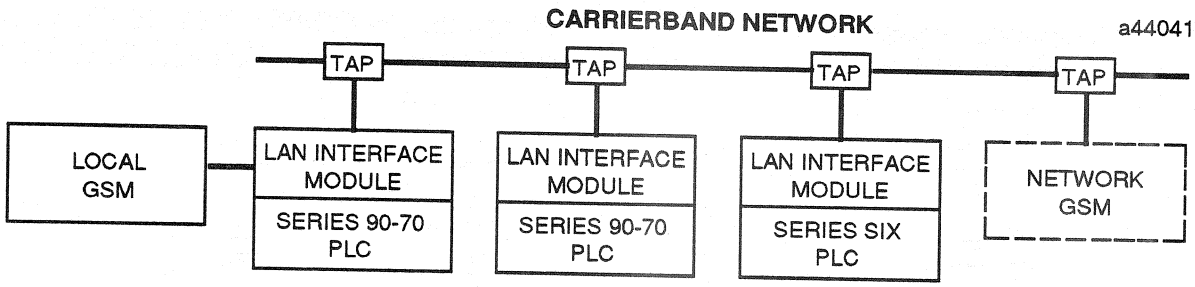

Figure 2-33. LAN Interface Module Connects the Series 90-70 PLC to a Carrierband Network

Features of the Carrierband MAP Interface

The features of the GEnet Factory LAN Interface module are described briefly here. For a more complete description, see the appropriate section in *GEnet Factory LAN Series 90-70 PLC Network Interface User's Manual*, GFK-0418.

The Carrierband MAP Interface is a single-slot module composed of a factory-assembled digital controller and modem. The entire LAN Interface occupies only a single slot in the Series 90-70 PLC rack. The following figure illustrates the LAN Interface module as part of the network.

The Carrierband MAP Interface connects the PLC directly to the carrierband network through the 5 Mbps modem daughterboard on the module. Intermediate devices such as bridges or gateways are not required. The direct connection provides the high performance required for real-time control applications.

Communications software is down-loaded to the LAN Interface and stored in RAM memory. This makes it easy to upgrade the communications software simply by downloading it again rather than by physical replacement of ROM-chips. An on-board battery provides memory retention that prevents loss of the communication software due to power loss for at least six months.

Features of the Carrierband MAP Interface Module are illustrated in the following figure.

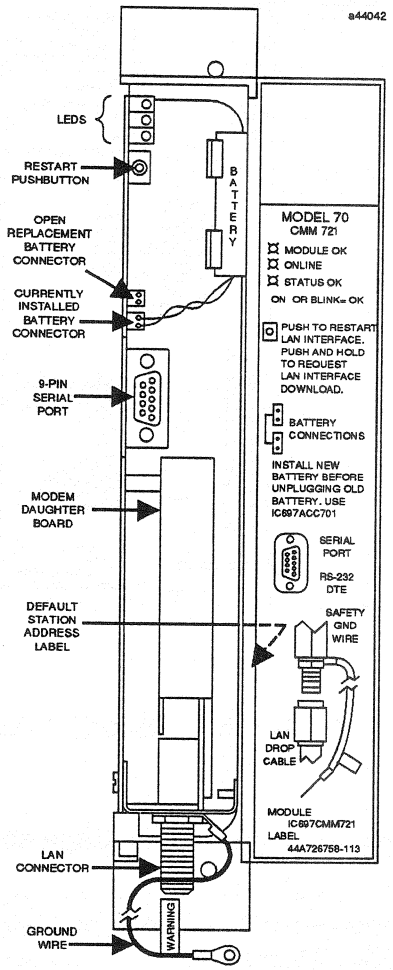

Figure 2-34. Carrierband MAP Interface Module

The LAN Interface provides many built-in maintenance and diagnostic features. Three diagnostic LED's distinguish faults between the module, the network, and module states that require maintenance action.

Default station address permits requesting and accepting a download of software from a centralized management station elsewhere on the LAN. Software switches permit the LAN Interface to operate independently of the PLC application software to facilitate early system checkout.

NOTE

LAN Interface modules require that the Series 90-70 PLC rack provide +12 VDC and -12 VDC power; they must be installed in a rack powered by the 100 watt AC (IC697PWR711), 90 watt DC (IC693PWR721), or 60 watt DC (IC697PWR731) power supply.

Broadband MAP Interface Module

The Broadband MAP Interface module, catalog number IC697CMM731, provides direct connection for a Series 90-70 Programmable Logic Controller (PLC) to an IEEE 802.4 Broadband network.

The GEnet Factory LAN architecture is based on standards set forth in the Manufacturing Automation Protocol (MAP) specification. MAP is the single networking scheme that allows all the vendors involved in automating a factory to work on a common communications architecture.

The Series 90-70 LAN Interface module supports the MAP specification version 3.0. The MAP protocol software is loaded into Random Access Memory on the LAN Interface module. This allows upgrade to a new revision of software without modification to the hardware. The following figure illustrates the LAN Interface module as part of the network.

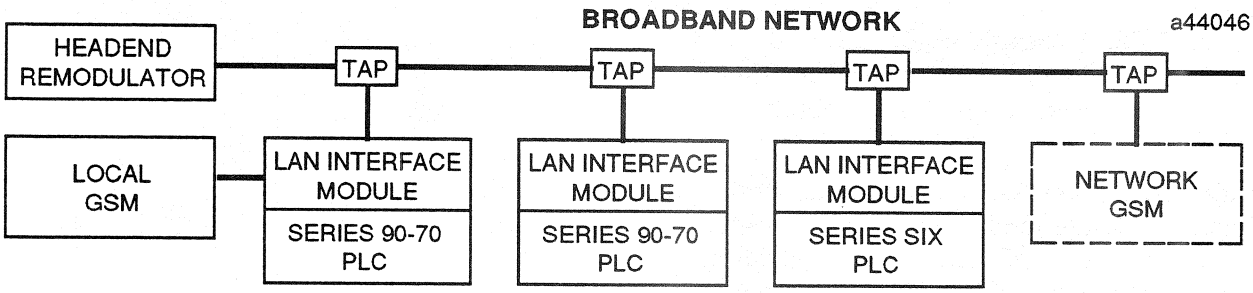

Figure 2-35. LAN Interface Module Connects the Series 90-70 PLC to a Broadband Network

Features of the Broadband MAP Interface

The features of the Broadband MAP Interface module are described briefly here. For a more complete description see the appropriate section in *GEnet Series 90-70 PLC Network Interface User's Manual*, GFK-0418.

This LAN Interface, for broadband application, is composed of separate controller and modem boards interconnected by a flat ribbon cable. The module plugs directly into two slots in a Series 90-70 PLC rack. The Broadband MAP Interface connects the PLC directly to the broadband network through the 10 Mbps modem. Intermediate devices such as bridges or gateways are not required. The direct connection provides the high performance required for real-time control applications.

The communications software is down-loaded to the LAN Interface and stored in Random Access Memory. This makes it easy to upgrade the communications software simply by downloading it again rather than by physical replacement of ROM-chips. An on-board battery provides memory retention that prevents loss of the communication software due to power loss for at least six months.

The Broadband MAP Interface provides a many built-in maintenance and diagnostic features.

Three diagnostic LEDs distinguish faults between the module, the network, and module states that require maintenance action. Default station address permits requesting and accepting a download of software from a centralized management station elsewhere on the LAN. Software switches permit the LAN Interface to operate independently from the PLC application software to facilitate early system checkout.

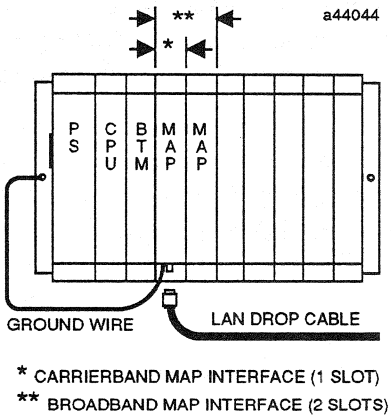

Figure 2-36. Example of Broadband MAP Interface Module Location in Series 90-70 PLC Rack

Broadband Networks: Broadband networks are designed to handle medium to large-size applications with hundreds of stations as a typical number that might be attached. Broadband networks can extend over cable distances as far as 10km. GEnet broadband complies with the IEEE 802.4 broadband standard and operates at 10 Mbps.

Broadband cable plant design and installation must be in accordance with IEEE 802.7 and requires special expertise. GE Fanuc Automation recommends that you contract professional specialists for these services. Consult your GE Fanuc sales representative or field service office for help in identifying local specialists.

Controller Board

The digital controller board, catalog number IC697CMM798, connects the LAN Interface to the backplane of the Series 90-70 PLC, allowing data to flow to and from the PLC. It contains RAM storage for LAN communication software that is downloaded to the board using the GEnet System Manager (GSM). The GSM is a separate computer running GSM software that is available from GE Fanuc Automation. Features of the Controller are shown in the following figure.

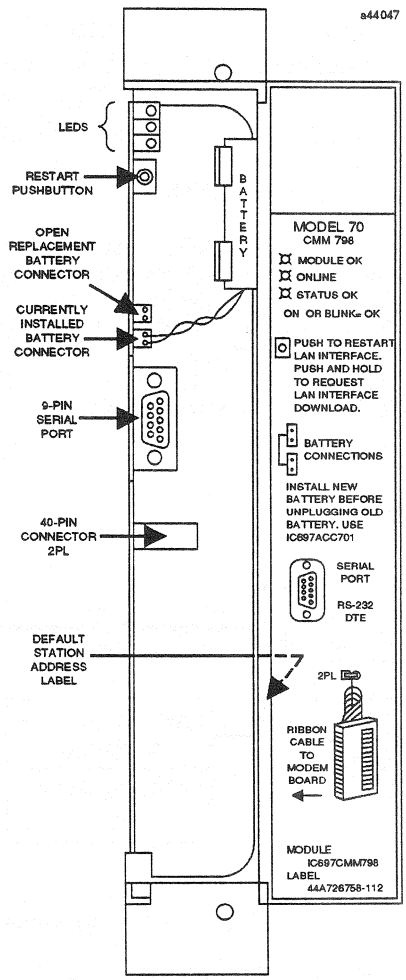

Figure 2-37. Broadband MAP Interface Controller Board

Three LEDs are located at the top of the LAN Interface module. The Restart pushbutton is located immediately below the LEDs. The battery and battery holder is located to the right of the LEDs. The battery connectors are located on the controller board between the Restart button and the 9-pin connector to the serial port. The LAN connector, mounted on the modem daughterboard, is positioned downward on the lower

front edge of the LAN Interface module. Also exiting from the lower front edge of the module is a safety ground wire.

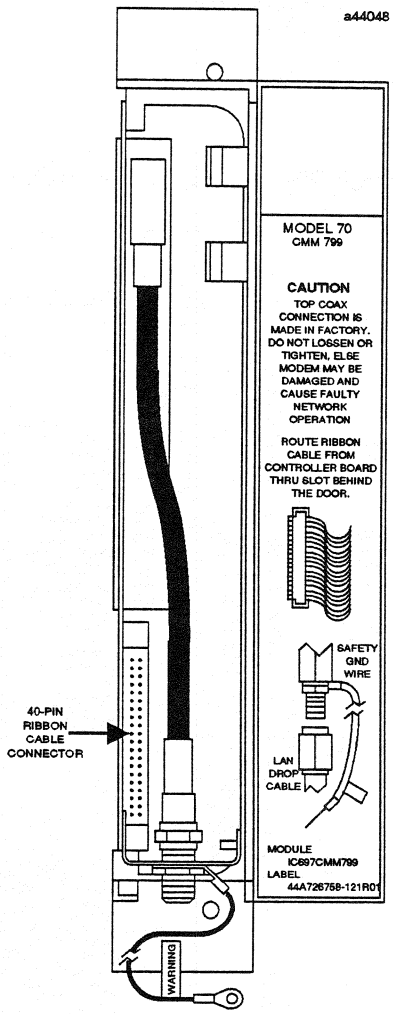

Figure 2-38. Broadband MAP Interface Modem Board

Modem Board

The modem (modulator/demodulator), catalog number IC697CMM799, provides the electrical and mechanical interface to the user-provided IEEE 802.4 coaxial drop cable. The broadband modem occupies a slot by itself and must be positioned directly to the left of the controller module in the Series 90-70 PLC rack. The Type II broadband modem board used with the Series 90-70 PLC is frequency agile; this means that it is not limited but can be programmed to operate on any of the three MAP recommended broadband channels.

MMS-Ethernet LAN Controller

The MMS-Ethernet LAN Controller, catalog number IC697CMM741, is a single-slot board which provides an 802.3-standard 15-pin D-connector for attachment of a user-supplied AUI (or transceiver) cable. The AUI cable connects to a user-supplied transceiver that is directly connected to the Ethernet trunk cable. Transceivers are available to operate on a variety of media including thickwire coaxial cable (10Base5) and thinwire coaxial cable (10Base2).

The MMS-Ethernet Controller supports the MMS (Manufacturing Message Specification - ISO 9506) communications protocol over a 7-Layer ISO protocol stack.

The MMS-Ethernet executable software is loaded into Random Access Memory (RAM) on the MMS-Ethernet Controller module. This software can be loaded either serially from the Local GEnet System Manager (GSM) or across the Ethernet network from the Network GSM. This allows upgrade to a new revision of software without modification to the hardware.

Figure 2-37 shows the relationship between the MMS-Ethernet Controller and the Local and Remote GSMs.

Features of the MMS-Ethernet Controller

The features of the MMS-Ethernet controller are briefly described in the following paragraphs. For a more complete description, see the appropriate section in *GEnet™ Factory LAN for Series 90-70 PLCs MAP 3.0 and MMS-Ethernet User's Manual, GFK-0533*.

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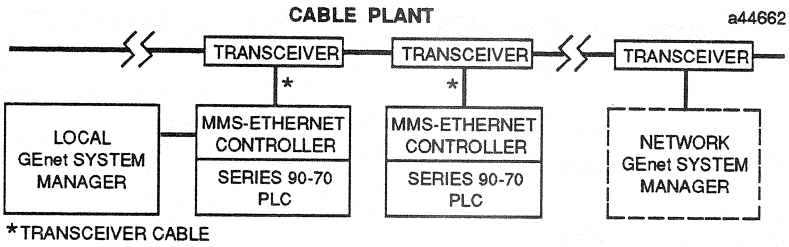

Figure 2-39. MMS-Ethernet Controller Connects the Series 90-70 PLC to an 802.3 LAN

Module Physical Description

The MMS-Ethernet Controller can be plugged directly into the Series 90-70 CPU rack or expansion rack. The MMS-Ethernet Controller is a single-slot module that is connected via a user-provided transceiver cable to an external transceiver. The transceiver is attached directly to the IEEE 802.3 network cable. The MMS-Ethernet Controller operates at 10 MB/S on the network.

The MMS-Ethernet Controller provides many built-in maintenance and diagnostic features. The three diagnostic LED's indicate operating conditions which may require maintenance action as: module, the network, and module states.

A Default Station Address permits requesting and accepting a download of software from a centralized management station elsewhere on the LAN. "Soft Switches" permit tailoring the MMS-Ethernet Controller to your needs without jumpers or switches on the board which simplifies module replacement.

The MMS-Ethernet Controller is a special-purpose microcontroller. It contains RAM storage for LAN communication software that is downloaded to the board using the GEnet System Manager (GSM). A GSM is optional software residing on a separate computer which is available from GE Fanuc Automation.

The following figure shows the physical layout of the MMS-Ethernet Controller.

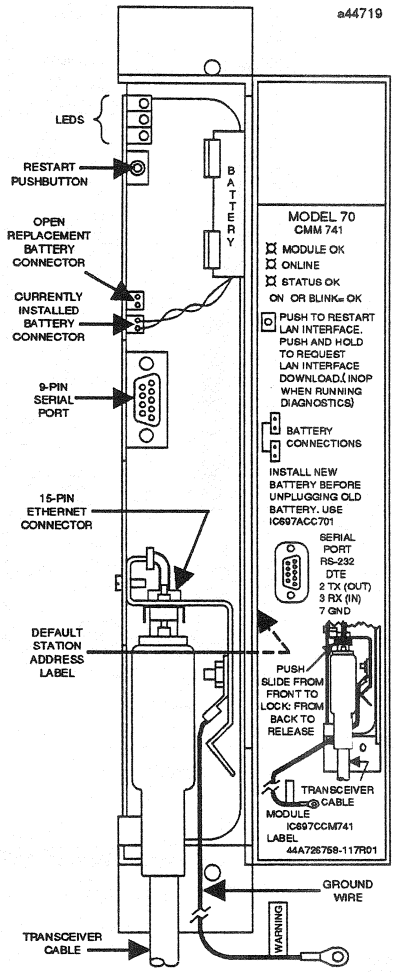

Figure 2-40. MMS-Ethernet Controller Board

IEEE 802.3 Media

Various Ethernet media can be interconnected by appropriate repeaters. Capabilities and limitations are defined in IEEE 802.3I "System Considerations for Multi-Segment 10 Mbps Baseband Networks".

The MMS-Ethernet Controller can be used on any of the following media by an appropriate (user supplied) transceiver cable and transceiver. IEEE 802.3 specifies the definitive requirements of each of these media.

Thickwire Ethernet: The thickwire Ethernet (10Base5) uses a 0.4 inch diameter 50-ohm coaxial cable. The maximum length of a cable segment (single span of cable) is 150 feet (500 meters). The distance between any two stations must meet certain cable-length requirements. A maximum of 100 stations is allowed on a thickwire Ethernet segment. A segment can be connected to longer network lengths using repeaters. A terminator has to be attached to each end of a trunk cable segment.

Thinwire Ethernet: The Thinwire Ethernet (10Base2) uses a less expensive 0.2 inch diameter 50-ohm coaxial cable. The maximum length of a thinwire cable segment is 55 feet (185 meters). A maximum of 30 stations is allowed on a thinwire Ethernet segment.

Communications Coprocessor Module

The Communications Coprocessor Module (CMM), catalog number IC697CMM711, provides both communications control (CCM) and remote terminal (RTU) functionality.

CCM and RTU are available on either or both serial ports in any of four possible configurations: CCM/CCM, CCM/RTU, RTU/CCM, RTU/RTU. Simultaneous communications is provided on both ports at up to 19.2 Kbps of full duplex data communications. The CCM protocol can operate as a master, slave, or peer device, while the RTU Modbus protocol operates as a slave only.

The CMM provides both the RS-232 and RS-485 Interfaces and communicates with the PLC CPU over the backplane. Many CMMs can be placed in a single Series 90-70 PLC system as illustrated by Figure 2-40.

Series 90 PLC functions provided by the CMM module in the CCM mode of operation are: read/write of register, input and output tables; bit set/clear of inputs and outputs; read of scratch pad; Q sequence (slave response); and the ability to modify the diagnostic status word.

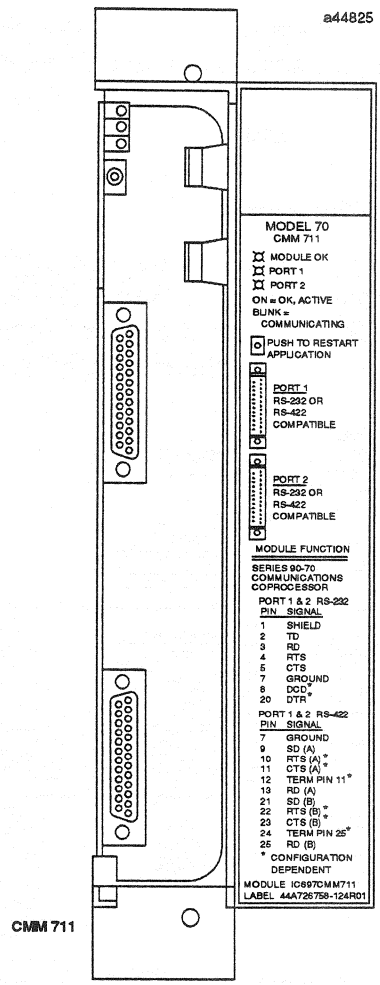

Figure 2-41. Communications Coprocessor Module

In the master and peer CCM configurations, the CMM module initiates communications with remote devices through application ladder programs communications requests (COMREQs).

The RTU mode of operation is a query/response protocol used for communicating between the CMM and a host computer. The host computer is the master device and transmits the query to the RTU slave which responds to the master. In RTU mode, only slave configuration is available.

In the RTU slave protocol the following functions are provided: read input and output tables, read analog input, read register table, read

scratchpad, and read exception status, force a single or multiple output(s), preset a single or multiple register(s), report the device type, and perform loopback maintenance.

System Configuration

The following figure illustrates a typical CMM interface installation into a Series 90 PLC system. Note that CMM modules can be installed in the CPU rack and any of the expansion racks.

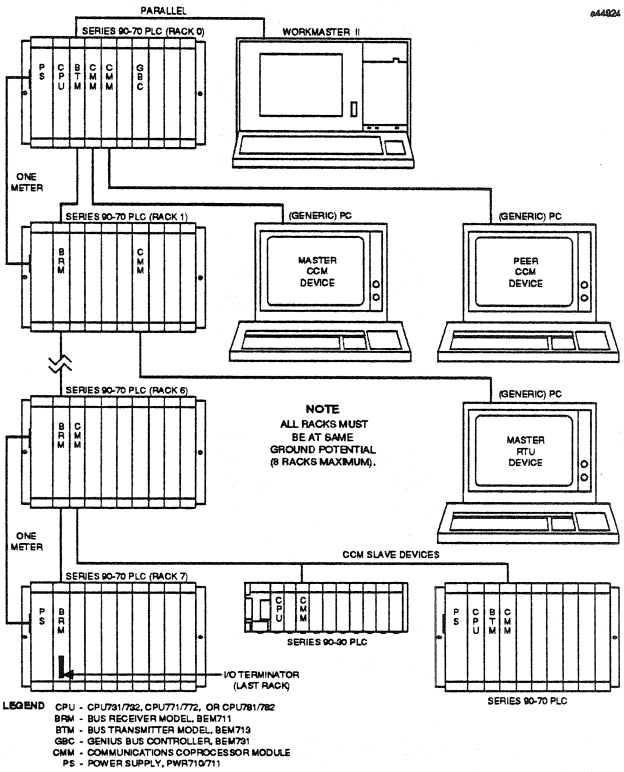

Figure 2-42. Example of CCM Modules in a Series 90-70 PLC System

Module Physical Description

The CMM module is a single-slot module that plugs into either the Series 90 PLC main or expansion rack. There are three status LEDs located at the top of the CMM module. The top LED indicates the condition of the module. The middle LED indicates activity on port 1, and the bottom LED indicates activity on port 2. The restart pushbutton located immediately beneath the LEDs is used to reinitialize communications.

There are two serial ports. Both ports are accessed through a 25-pin female connector and both provide RS-232 and RS-422/RS-485 communication. There are no user DIP switches or jumpers on this board for configuration. However, the board must be configured before operation using Logicmaster 90.

Multidrop Configuration

The following figure is an example of a multidrop configuration for Series 90 PLCs.

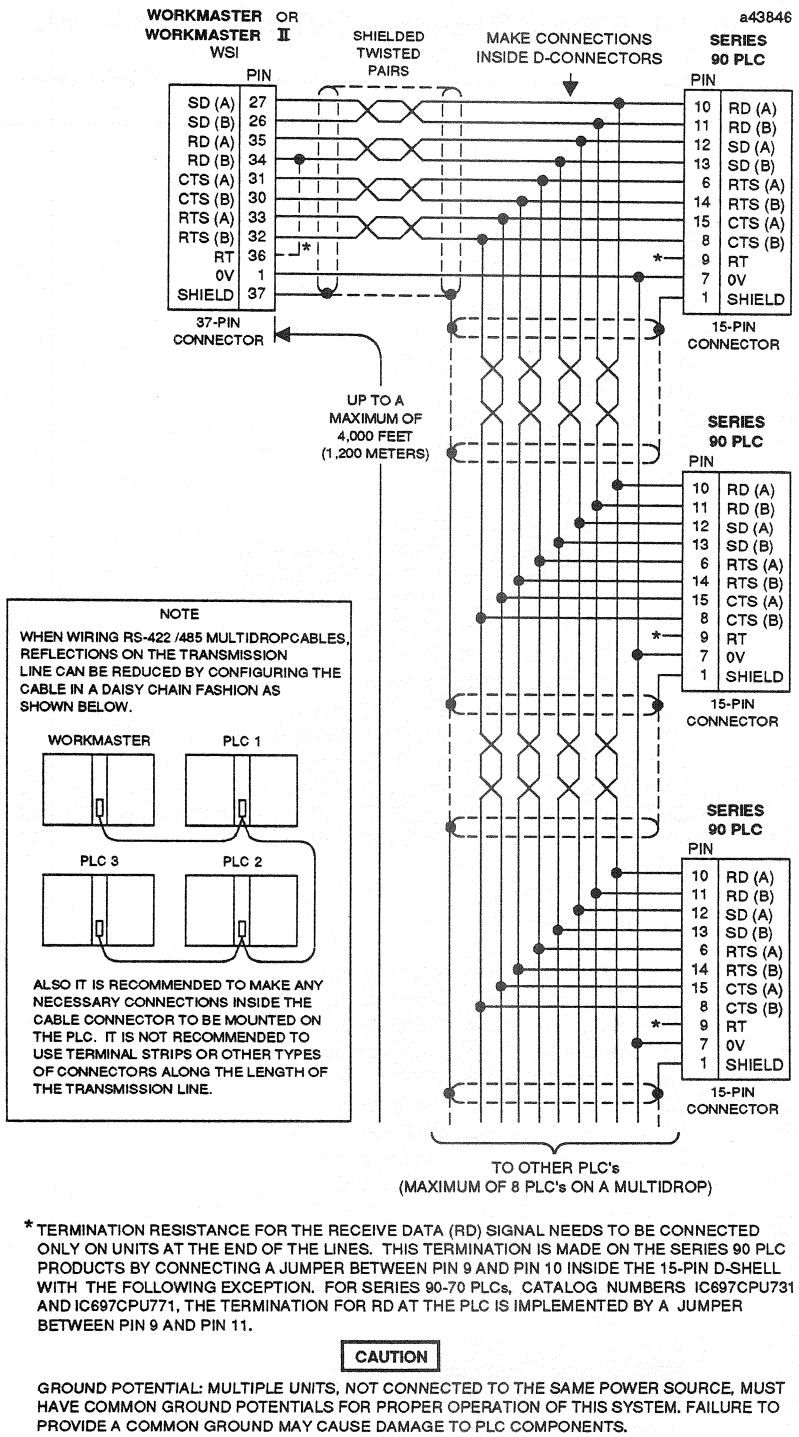

Figure 2-43. 8-Wire Multidrop, Serial Data Configuration with WSI Board

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Catalog Numbers for Series 90-70 PLC Hardware

The following table lists the components for a Series 90-70 PLC system. A list of Series 90-70 I/O modules is included in Chapter 4, which describes the I/O system.

Table 2-6. Catalog Numbers - Series 90-70 Hardware

Catalog Number	Description
IC697CHS750	Rack, 5-slot Rear (Panel) Mount
IC697CHS790	Rack, 9-slot Rear (Panel) Mount
IC697CHS791	Rack, 9-slot Front (Rack) Mount
IC697PWR710	Power Supply, 120/240 VAC, 55W
IC697PWR711	Power Supply, 120/240 VAC, 100W
IC697PWR721	Power Supply (with PSA), 24 VDC, 90W
IC697PWR722	Power Supply, 24 VDC, 90W
IC697PWR731	Power Supply (with PSA), 125 VDC, 60W
IC697PWR732	Power Supply, 125 VDC, 60W
IC697PWR720	Power Supply Adapter
IC697CBL700	Two Rack Power Cable
IC697ACC715	VME Option Kit for J2 Backplane
IC697ACC722	Blank Slot Interrupt Jumper
IC697ACC721	Rack Fan Assembly
IC697CPU731	Central Processing Unit, 8 Mhz
IC697CPU732	Central Processing Unit, 12 Mhz, Floating Point
IC697CPU771	Central Processing Unit, 12 Mhz, Expandable
IC697CPU772	Central Processing Unit, 12 Mhz, Expandable, Floating Point
IC697CPU781	Central Processing Unit, 16 Mhz, 32-Bit, Expandable
IC697CPU782	Central Processing Unit, 16 Mhz, 32-Bit, Expandable, Floating Point
IC697MEM713	CMOS Expansion Memory, 64K bytes (for model 771/772 CPUs)
IC697MEM715	CMOS Expansion Memory, 128K bytes (for model 771/772 CPUs)
IC697MEM717	CMOS Expansion Memory, 256K bytes (for model 771/772 CPUs)
IC697MEM719	CMOS Expansion Memory, 512K bytes (for model 771/772 CPUs)
IC697MEM731	CMOS Expansion Memory, 32-Bit, 128K bytes (for model 781/782 CPUs)
IC697MEM733	CMOS Expansion Memory, 32-Bit, 256K bytes (for model 781/782 CPUs)
IC697MEM735	CMOS Expansion Memory, 32-Bit, 512K bytes (for model 781/782 CPUs)
IC697BEM713	Bus Transmitter Module
IC697BEM711	Bus Receiver Module
IC697BEM733	Remote I/O Scanner
IC697ACC702	Terminator Plug
IC600WD0xxx	Parallel I/O Bus Cable (5/10/25/50 feet)
IC640WMI910	Work Station Interface, Workmaster, PC-XT/AT
IC647WMI920	Work Station Interface, Workmaster II, PS/2
IC647CBL703	Bus Transmitter Module to Workmaster II Programmer Parallel Cable
IC647CBL704	Workmaster II to Series 90 PLC Serial Cable
IC690ACC900	RS-422/RS-485 to RS-232 Converter
IC655CCM590	RS-422 to RS-232 Isolated Repeater/Converter
IC697PCM711	Programmable Coprocessor Module
IC697CBL701	PCM to Workmaster or PC-XT Cable
IC697CBL702	PCM to IBM-AT Cable
IC697CBL705	PCM to Workmaster II or PS/2
IC697BEM731	Genius Bus Controller
IC697CMM711	Communications Coprocessor Module (CMM)
IC697CMM721	Carrierband MAP Interface
IC697CMM731	Broadband MAP Interface
IC697CMM741	MMS-Ethernet Controller
IC697ADC701	Alphanumeric Display Coprocessor
IC697GDC701	Graphics Display Coprocessor

Chapter 3 Programming the Series 90-70 PLC

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Logicmaster 90 Programming Software

The Logicmaster 90 Programming Software for the Series 90-70 PLC is designed for use on Workmaster II and Cimstar I industrial computers, and IBM and IBM compatible Personal Computers. It was built by the same core team that developed Logicmaster 6 Programming Software, recognized as the PLC industry leader. Significant improvements are:

- two levels of function keys which provide operator "look-ahead" to avoid menu tree-climbing;
- a zooming concept which works in conjunction with the program structure of the CPU;
- full programming and documentation, both On-Line and Off-Line;
- programs may be displayed at a high level with details revealed through use of the zoom key.
- Uses an IEC-compliant program structure for programming the PLC;

The system is configured with a powerful software configurator tool, which is part of a family of products for programming the Series 90-70 PLC. Jumpers and DIP switches are virtually eliminated from the Series 90-70 PLC and the configuration is self-documenting (can be outputted to a printer, including catalog numbers, reference addresses, and slot numbers).

Programming Software Package

The Programming Software package is used to create ladder logic programs. It offers a full range of programming functions, such as:

- Basic contacts, coils, timers, and counters;
- Unsigned binary, signed single-precision, double precision numbers, and floating point numbers;
- Data Move functions, Table Move functions, Relational functions, List operations, Matrix, Bit operations, PID functions, Conversion functions, Control functions, and math functions including Trigonometric and Logarithmic functions
- Supports both Series 90-70 rack-type I/O and the cost effective Genius I/O system;
- Develop ladder diagram programs off-line;
- Monitor and change reference values on-line;
- Change and document a program on-line;
- Transfer programs and configuration data between the PLC and programmer;
- Store programs automatically on disk;
- Annotate programs;
- Print programs with annotation and/or cross references;
- Print display screens, and tables;
- Print programs and configurations on a variety of printers;
- Display of Help information;
- Uses symbolic references.

Programmer Requirements

The computer that can be used to run Logicmaster 90 software can be:

- A Workmaster, or Cimstar I industrial computer with an 83-key or 101-key keyboard;
- A Workmaster II industrial computer with a 101-key keyboard;
- An IBM PS/2 computer with a 101-key keyboard;
- An IBM PC-XT, or AT personal computer with an 83 or 101-key keyboard;
- An industrial IBM-AT computer with a standard 101-key keyboard.

The temperature enhanced Workmaster II and industrial-hardened Cimstar I computers are recommended for installations where programs must be transferred, monitored, or edited in the harsh conditions of the factory floor. The Workmaster II computer has the additional advantage of being portable.

The Workmaster II computer weighs under 20 pounds and packs a lot of power in a small package. Workmaster II is an 80386 based 16 MHz system which provides significant speed advantages when using Logicmaster 90 software.

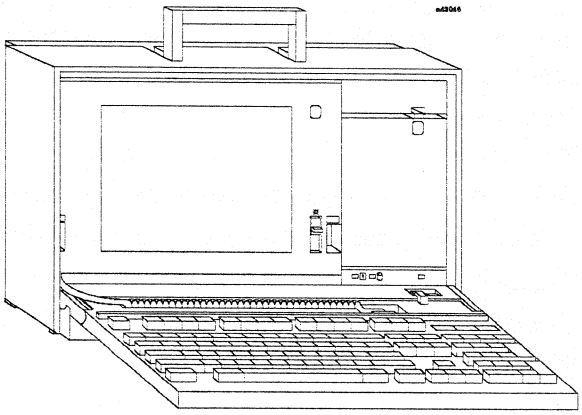

Figure 3-1. Workmaster II Computer

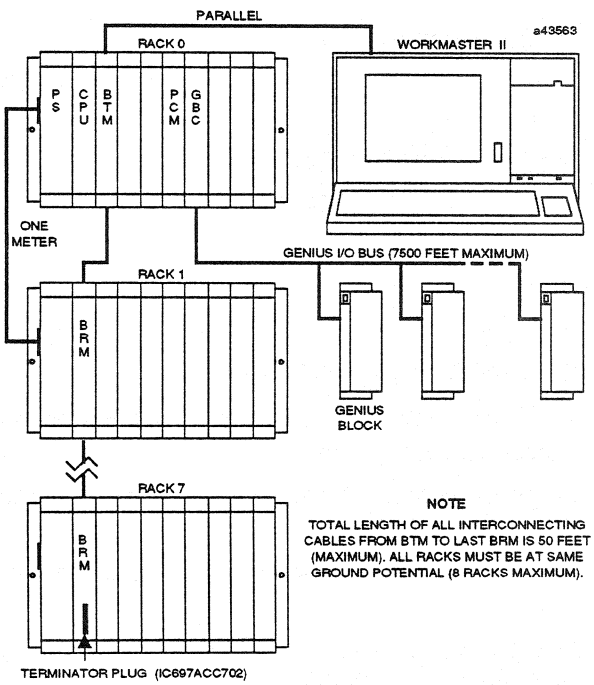

Figure 3-2. System Configuration - Parallel Interface to Workmaster II

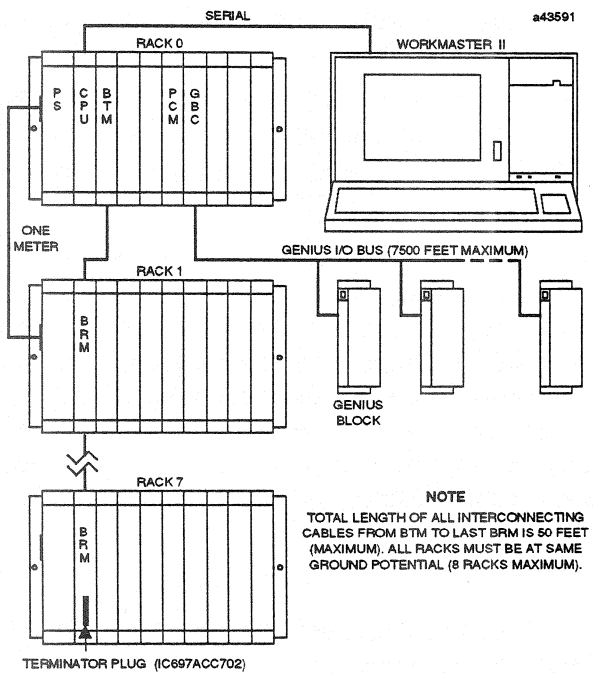

Figure 3-3. System Configuration - Serial Interface to Workmaster II

The Logicmaster 90 programmer software communicates with the Series 90-70 PLC through a Workstation Interface (WSI) board which is installed in the computer to be used for programming. Both parallel and serial communications are available. The WSI is only required for on-line and load/store functions. An available interface cable (IC647CBL703) connects the WSI board to the PLC.

The connection on the PLC end of the parallel communications link is to the top connector on a Bus Transmitter Module, which must be installed in slot 2 in the CPU rack, next to the CPU.

A high-speed serial communications link connects the serial port of the CPU, through a serial cable (IC647CBL704) to the WSI board. A combination parallel/serial Workstation Interface board (IC647WMI920) is available for the Workmaster II computer or IBM Personal System/2® (PS/2®). A combination parallel/serial WSI board (IC647WMI910) is also available for PC-XT or PC-AT compatible computers.

A new feature (standard serial communications) will be available in late 1991 which will allow the programmer to be connected to the serial port

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of the CPU without the requirement of having a WSI board installed in the programming computer. This configuration will require use of an RS-422/485 to RS-232 converter since the CPU serial port signals are RS-485 and the Workmaster II serial port signals are RS-232. Standard serial communications operation will also require that DOS version 5.0 and memory management software be installed on the programming computer.

Programmer Operating Modes

The programmer has three modes of operation available for use during different phases of programming and system operation.

OFF-LINE This mode provides a convenient way to develop programs Off-Line without being connected to the PLC. Programs may be written in one location, then downloaded to a PLC at a different location or to multiple locations.

ON-LINE This mode provides real-time displays and allows program and documentation changes to be made while the PLC is operating.

MONITOR The Monitor mode allows the programmer or operator to read data from the PLC, but data may not be transferred to or from it.

The operating mode can be selected by any computer used as a programmer by simultaneously pressing the Alt and M keys. Each time those keys are pressed, the mode will switch.

Another way to select the operating mode is through the Programmer Setup screen in Logicmaster 90 Programming Software. Additionally, the Workmaster (not Workmaster II) and Cimstar I industrial computers have a keyswitch on the front for selection of the operating mode.

Programming Overview

Series 90-70 PLC programs are structured which means they consist of one or more units referred to as program blocks. Each of these program blocks can be up to 8K words in size.

The program always has a *Main Program Block* that contains the logic used when the program is started up. This Main Program Block is executed repeatedly by the PLC. A Main Program Block can call other Program Blocks as it executes its application program.

Program Blocks can also call other Program Blocks. As with the Main Program Blocks, the other Program Blocks can contain up to 8K words. Dividing a program into a series of program blocks can simplify programming and reduce the overall amount of logic needed for the program.

Logicmaster 90 programming software allows up to eight levels of calls to Program Blocks. Up to 256 program blocks may be programmed in a single CPU.

Calling Program Blocks

An example of Program Block calls is shown in the following figure. The example shows a Main Program Block calling other Program Blocks, and these, in turn calling other Program Blocks.

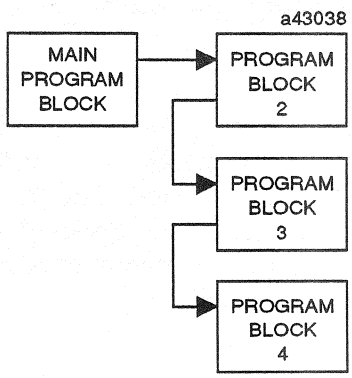


Figure 3-4. Example of Program Block Calls

Programming References

Data in the Series 90-70 PLC programs is referenced by its address in the PLC system. A reference indicates the way that data is stored in the PLC. A reference specifies both a memory type

and a precise address within that memory type. For example:

%I00001 specifies address 1 in input memory

%R00256 specifies address 256 in register memory

The % symbol is used to distinguish machine references from symbolic nicknames.

Configuration Software

A minimum amount of physical configuration is required for hardware items during installation of a Series 90-70 PLC; the majority of system parameters are configured using the configuration software function, which is a part of the standard Logicmaster 90 software package. This system configuration and programming is accomplished with Logicmaster 90 software executing on the programming computer. Both configuration and programming may be done with the programming computer either on-line or off-line from the PLC.

Although programming may occur before configuration, it is recommended that configuration be done before programming so that the programming software can check that certain memory constraints have not been exceeded during programming. Use of the Programming and Configuration software is described in the *Logicmaster™ 90 Programming Software User's Manual* (GFK-0263).

The programming language and representation are based on the developing IEC standard. Eventual adoption of this standard will make it easier to create programs which can be understood globally. It establishes the Series 90-70 PLC in the vanguard of the movement toward recognized international standards.

Password Protection

Password protection is a configurable feature of the Series 90-70 PLC. The use of passwords is an optional feature; four levels of passwords may be assigned or not used at all. The purpose of passwords is to provide different levels of access privilege for the PLC when the programmer is in the On-line or Monitor mode.

Passwords are not used if the programmer is Off-line. This is a safety measure to prevent unauthorized personnel from accessing and/or changing programs. Passwords can be used to restrict access to certain PLC features, which are: changing I/O and PLC configuration data, changing programs, reading PLC data, and reading programs.

Annotating Programs

Programs developed for the Series 90-70 PLC can have annotation added as explanatory text. Annotation can be developed Off-Line or added On-Line. The use of annotation makes programs easier to read and understand. There are three types of annotation that may be added to programs:

Nicknames

Reference Descriptions

Comments

Nicknames

A nickname is simply another name for an input, an output, or a register. A nickname can have up to 7 characters. An example of using a nickname in a program is annotating an input as *SWITCH1* in addition to *%I00201*. This makes the programming elements more meaningful and easier to interpret.

Reference Description

A reference description is descriptive text associated with a machine reference. A reference description can have up to 32 characters. An example of a reference description text entry is: *Emergency Stop Pushbutton*. Reference descriptions can be printed with a program, or displayed as part of the Variable Declaration table.

The Variable Declaration Table is used to create, display, and change nicknames and reference descriptions assigned to machine references. Nicknames can also be assigned to machine references in the program logic.

Comment

Finally, comments can be entered to describe the function the logic performs, an assumed initial

status, and procedures to follow if the logic does not perform as expected, or any other relevant comments.

A comment can have up to 2048 characters of text. Comments can be read by selecting the zoom feature, and they can be printed out. Comments can be created by placing the text in a separate file from the program and they can be searched for in a program by the comment name.

Data Flow Concept

The Series 90-70 PLC extends data flow beyond the normal concept of discrete power flow to include numerical data flow. The benefit to the user is fewer keystrokes because intermediate storage references need not be keyed in. Performance is improved because of better memory utilization. Comprehension is better because more logic can be displayed on a single screen. The Data Flow concept is supported by the developing IEC standard.

System Configuration Software Package

With the system Configuration Software package you can do the following:

- Assign I/O addresses to each Series 90-70 I/O and Genius I/O module;
- Specify the rack and slot location of each module in the system;
- Specify any unique set-up options for each module in the system;
- Assign memory in the PLC for analog I/O, status tables, and user program space;
- Set passwords;
- Specify a name for the program folder;
- Configure the Series 90-70 PLC system off-line for later loading into the CPU;
- Select the action taken by the CPU for various fault conditions;
- Transfer configurations between the PLC and the programmer.

User Reference Types

The prefix of a reference indicates the type of data it references in the PLC. The data used in an application program is stored as either register or discrete references.

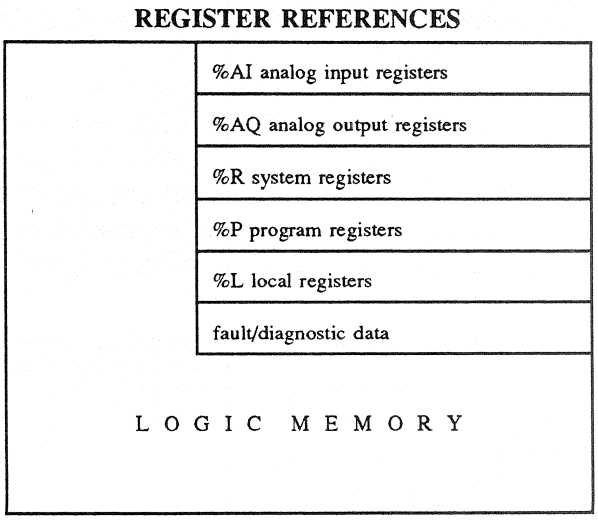


Figure 3-5. Register Data Structure

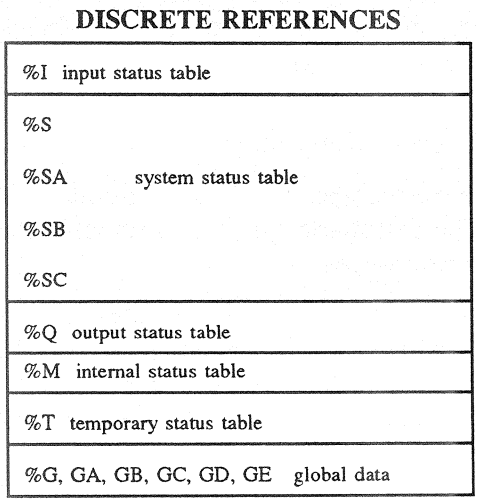


Figure 3-6. Discrete Data Structure

User Register References

Registers are referenced as 16-bit words. Descriptions of user register references are as follows:

- %AI - This prefix references an analog input register. It is followed by the register address of the reference, for example: %AI0002. The reference occupies 16 consecutive bits in %AI registers, beginning at the specified address (%AI0002).
- %AQ - This prefix references an analog output register. It is followed by the register address of the reference, for example: %AQ0056. The reference occupies 16 consecutive bits in %AQ registers, beginning at the specified address (%AQ0056).
- %R - This prefix is used to assign system register references that will store program data, such as the results of calculations. Register memory can be configured up to 16K words in 1K increments.
- %P - This prefix is used to assign program register references, which will store program data from the main program block. This data can be accessed from all program blocks.
- %L - This prefix is used to assign local register references, which will store program data unique to a program block.
- Logic memory is used to store application programs. It is not directly addressable by the application programs.

User Discrete References

Discrete references represent individual bits of data. The following types of user references are discrete references.

- %I - The prefix %I references discrete machine inputs. This prefix is followed by the reference's address in the input status table. For example, %I0012. The %I references are located in the input status table, which stores the states of inputs received from the hardware during the last input scan.
- %Q - The prefix %Q references discrete machine outputs. This prefix is followed by the reference's address in the output status table. For example, %Q0012. The %Q references are located in the output status table, which stores the states of outputs as last set by the application program. A %Q reference can only be used one time in the program. These references are retained through loss of power unless used with non-retentive coils.
- %M - This prefix is used to reference internal coils. They are used in boolean logic when the result will be used again in the program. The %M references are retained through loss of power unless used with a non-retentive coil. Since they do not reference actual machine outputs, any available location in %M memory can be assigned. For example, %MQ00064.
- %T - The %T reference is used to represent temporary internal coils which may not be retained through loss of power. Temporary coils function like the %M references in that they can be used as often as needed as conditional contacts to control logic within a program.
- %S - The %S prefix references special discrete system status references. These discrete references are used to access special PLC data, such as timers, scan information, and fault information. %S, %SA, %SB, and %SC can be used on any contacts. %SA, %SB, and %SC can be used on retentive coils -(M)-. %S can be used as word or bit-string input arguments to functions or function blocks. Examples of contacts that have a special meaning assigned to them are:

```
%SA0002 OV_SWP  Exceeded constant sweep time
%SA0009 CFG_MM  System configuration mismatch
%SB0011 BAD_PWD Password access failure
```

Table 3-1. User Reference Sizes

Item	CPU Model		
	731/732	771/772	781/782
maximum %I reference	512 points	2048 points	12288 points
maximum %Q reference	512 points	2048 points	12288 points
maximum physical I/O (%I + %Q)	512 points	2048 points	12288 points
maximum %M reference	2048 points	4096 points	12288 points
maximum %T reference	256 points	256 points	256 points
%S total (S, SA, SB, SC)	512 points	512 points	512 points
%G (GA, GB, GC, GD, GE)	1280 points	7680 points	7680 points
On-board User RAM	32K bytes	none	none
Expansion Board RAM	none	512K bytes, max.	512K bytes, max.
%AI	8K words, max.	8K words, max.	8K words, max.
%AQ	8K words, max.	8K words, max.	8K words, max.
%R, 1K word increments	16K words, max.	16K words, max.	16K words, max.
%L (Per program block)	8K words, max.	8K words, max.	8K words, max.
%P	8K words, max.	8K words, max.	8K words, max.

Table 3-2. Default Memory Sizes

Memory Type	CPU Model		
	731/732	771/772	781/782
%AI	64 words	64 words	64 words
%AQ	64 words	64 words	64 words
%R	1024 words	1024 words	1024 words
%P	0 words	0 words	0 words
%L	0 words	0 words	0 words

Accessing VME Data

Third party VME boards are accessed by the user's application program through the VME Read, VME Write, VME Read/Modify/Write, and VME Test and Set function blocks. Since these Third party VME boards are not standard GE Fanuc I/O modules they are not accessible during the normal I/O servicing portion of the sweep or the Systems Communications Window.

When these VME function blocks execute during the Logic Scan portion of the sweep, the appropriate data transfer command is sent to the VME board and data is exchanged immediately during the execution of the function block.

VME Qualification Plan

GE Fanuc has implemented a VME qualification program as an aid to our customers to help ensure successful integration of 3rd party modules when purchased for use in a Series 90-70 PLC system. To ensure successful integration of 3rd party VME modules in a Series 90-70 PLC:

- The module must be compatible with the particular characteristics of the Industrialized VMEbus (VME-I) as implemented on the Series 90-70 PLC.
- The selected module must not interfere with the normal operation of the Series 90-70 PLC system.

The VME standard specifies two backplanes, designated J1 and J2, however, the Series 90-70 PLC system only contains the J1 backplane. A VME Option Kit, catalog number IC697ACC715, is available which contains the

hardware and rail necessary to install a J2 backplane. The kit does not include a J2 backplane which must be purchased from a VME vendor.

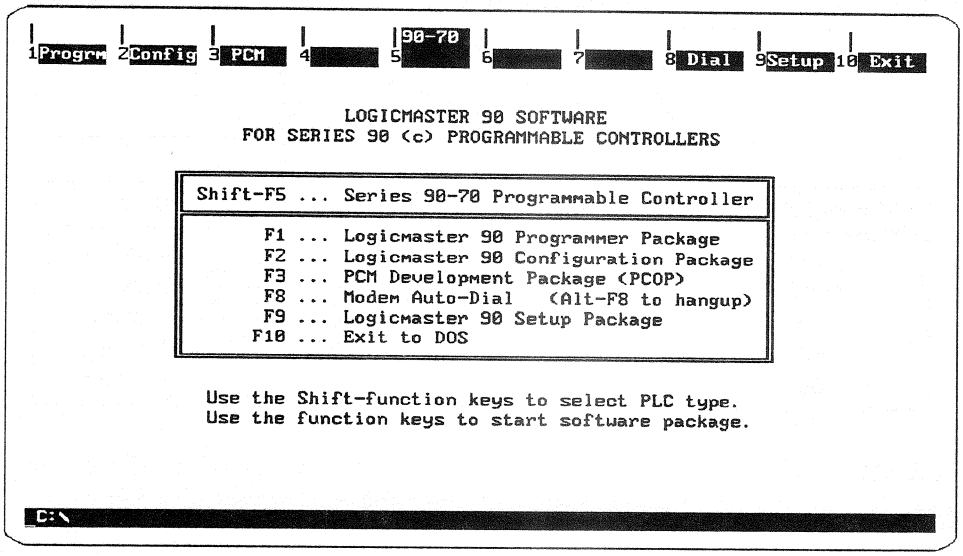
Detailed information on selecting 3rd party VME modules can be found in GFK-0448, which is the *Series 90-70 PLC User's Guide To Integration of 3rd Party VME Modules.*

Floating-Point Numbers

Logicmaster 90 programming software provides the ability to edit, display, store, and retrieve numbers with real values. Some of the functions operate on floating-point numbers. To use floating-point numbers, a model 732, 772, or 782 CPU must be installed in the PLC. Floating-point numbers are represented in decimal scientific notation, with a display of six significant digits.

Logicmaster 90 Screen Example

An example of a Logicmaster 90 Programming Software screen is shown below. After the Logicmaster 90 software has been installed on the programming computer, the first screen displayed is the menu of Series 90 PLCs and functions as shown. This screen allows you to select the items from the menu as shown on the screen by pressing the applicable Function key (F1, F2, F3, F8, or F9).



List of Programming Functions

A list of the programming functions that are available with the Logicmaster 90 programming software package is provided on the following page. These are the functions used to develop programs for a Series 90-70 PLC.

The programming functions in the list are grouped by functionality (Relay, Timer and Counter, Arithmetic, etc.) with the acronym for each function and a brief description of the function.

Detailed information on using each of the functions can be found in GFK-0265, which is the *Logicmaster 90 Programming Software Reference Manual.*

Relay Functions

-] [-	Normally open contact
-]/[-	Normally closed contact
-]↑[-	Positive transition contact
-]↓[-	Negative transition contact
-[FAULT]-	Fault contact
-[NOFLT]-	No fault contact
-[HIALR]-	High alarm contact
-[LOALR]-	Low alarm contact
-( )-	coil
-(/)-	Negated coil
-(↑)-	Positive transition coil
-(↓)-	Negative transition coil
-(SM)-	Retentive SET coil
-(RM)-	Retentive RESET coil
-(M)-	Retentive coil
-(/M)-	Negated retentive coil
-(S)-	SET coil
-(R)-	RESET coil
|	Vertical link
-------	Horizontal link

Timer and Counter Functions

ONDTR	On delay "stopwatch" timer
OFDT	Off delay timer
TMR	Elapsed timer
UPCTR	Up counter
DNCTR	Down counter

Arithmetic Functions

ADD	Addition
SUB	Subtraction
MUL	Multiplication
DIV	Division
MOD	Modulo division
SQRT	Square Root
ABS	Absolute value
Trigonometric:	
SIN	Sine
COS	Cosine
TAN	Tangent
ASIN	Inverse Sine
ACOS	Inverse Cosine
ATAN	Inverse Tangent
Log/Exponential:	
LOG	Base 10 log
LN	Natural log
EXP	Power of e
EXPT	Power of x
Radian Conversion:	
DEG	To degrees
RAD	To radians

Relational Functions

EQ	Equal test
NE	Not equal test
GT	Greater than test
GE	Greater than or equal to test
LT	Less than test
LE	Less than or equal test
CMP	Comparison test

Bit Operation Functions

AND	Bitwise AND
OR	Bitwise OR
XOR	Bitwise exclusive OR
NOT	Bitwise one's complement negation
SHL	Bit shift left
SHR	Bit shift right
ROL	Bit rotate left
ROR	Bit rotate right
BTST	Bit test (sense)
BSET	Bit set
BCLR	Bit clear
BPOS	Bit position
MCMP	Bit array masked compare

Data Movement Functions

MOVE	Move
BLKMOV	Constant block move
BLKCLR	Memory block clear
SHFR	Shift register
BITSEQ	Bit sequencer
COMMREQ	Communications request
VMERD	VME read
VMEWR	VME write
VMERMW	VME read/modify/write
VMETST	VME test and set
SWAP	Swap bytes or words

Table Functions

TBLRD	Table read
TBLWRT	Table write
LIFORD	LIFO read
LIFOWRT	LIFO write
FIFORD	FIFO read
FIFOWRT	FIFO write
SORT	Table sort

Conversion Functions

BCD4	Convert to 4-digit BCD
BCD8	Convert to 8-digit BCD
INT	Convert to integer
UINT	Convert to unsigned integer
DIT	Convert to double precision integer
REAL	Convert to real number
TRINT	Truncate real number

Control Functions

CALL	Program Block call
DOIO	Perform an immediate I/O update
SUSIO	Suspend I/O servicing
MCR	Master Control Relay
ENDMCR	End of Master Control Relay
LABEL	Target location for jump instruction
JUMP	Jump (to label)
COMMENT	Rung Explanation (Comment)
SVCREQ	Request special PLC service
PIDIND	Independent term PID algorithm
PIDISA	ISA standard PID algorithm

Data Type

The following data types can be added to an instruction by using an underscore (_) as a separator (e.g. ADD_INT)

_INT	Signed integer
_UINT	Unsigned integer
_DINT	Double precision integer
_BIT	Bit
_WORD	Word
_DWORD	Double word
_BCD4	4-digit BCD
_BCD8	8-digit BCD
_REAL	Floating point
_MIXED	Mixed
_S	Seconds
_TEN	Tenths of seconds
_HUN	Hundredths of seconds
_TH	Thousands of seconds

Chapter 4
Series 90-70 PLC I/O System

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Overview of Series 90-70 I/O System

The Series 90-70 PLC I/O system provides the interface between the Series 90-70 PLC and user supplied input and output devices. The I/O system supports Model 90-70 rack-type I/O as well as the Genius I/O system. The Genius I/O system can include Genius I/O blocks, and with the addition of a Remote I/O Scanner on the Genius I/O bus Series 90-70 I/O can be distributed at a location remote from the CPU rack. In addition to supporting these two I/O subsystems, LAN Interface modules, PCMs, and third party VME modules are supported.

A Series 90-70 PLC I/O System configuration has few limitations. All discrete modules, analog modules, intelligent modules, coprocessor, communications, and other such modules can be located anywhere along the I/O Bus in a local system configuration.

A Genius Bus Controller (GBC) provides an interface between the Series 90-70 PLC CPU and one Genius bus for each Bus Controller in the system. The Series 90-70 PLC I/O system can support multiple GBCs with up to 30 blocks and a Hand-Held Monitor (HHM) connected to each Genius bus. All Genius I/O blocks may be used with the Series 90-70 (refer to the Genius I/O User's Manual for information on individual Genius I/O blocks). Additionally Series 90-70 discrete, analog, and most intelligent modules can be distributed on the Genius I/O link when located in remote drops linked by a Remote I/O Scanner in the first remote rack (up to eight racks on a remote drop). A remote link cannot have communications modules or modules that depend on COMREQ instructions for their operation.

The Series 90-70 PLC I/O system is VME compatible. This allows certain 3rd party VME boards to reside in the system. However, use of 3rd party hardware can pose compatibility problems. As an aid to our customers in identifying those 3rd party boards that have already been qualified, GE Fanuc maintains a list of those qualified 3rd party VME boards.

The criteria for VME board qualification is described in GFK-0448, which is the *User's Guide to Integration of 3rd Party VME modules for the Series 90-70 PLC*. Contact your local GE Fanuc PLC distributor, or GE Fanuc sales representative for further information on compatible 3rd party VME products.

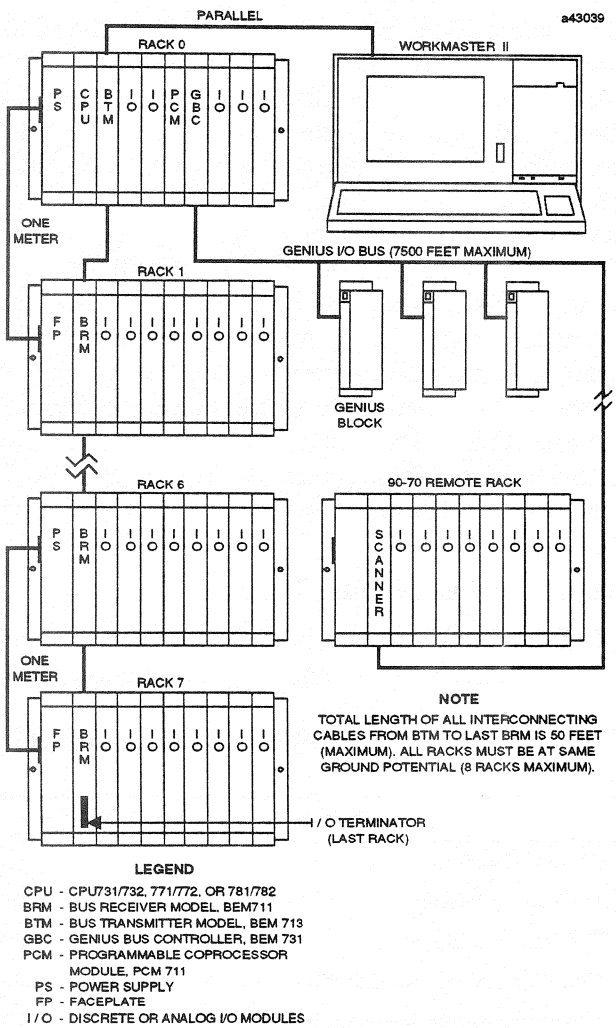

Figure 4-1. Example of Series 90-70 I/O System

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Series 90-70 Rack-Type I/O Subsystem

The rack-type I/O subsystem for the Series 90-70 PLC is the Series 90-70 PLC I/O. I/O modules are referred to as ***Model 70 I/O***. Model 70 I/O modules plug directly into the Series 90-70 PLC backplane. I/O modules can be installed in any available I/O slot in the CPU rack, or in any I/O slot in an expansion rack.

The Series 90-70 PLC I/O system does not require a dedicated I/O Controller, as with other I/O subsystems. However, if more than one rack is required in a system, the I/O bus signals must be propagated to the added racks through a Bus Transmitter Module in the CPU rack to a Bus Receiver Module in the I/O expansion rack.

Each succeeding I/O expansion rack in the chain must have a Bus Receiver Module installed to continue the I/O bus through to the last rack in the system. In a single rack system, the CPU performs the I/O interface functions. A maximum configured Series 90-70 I/O local system supports up to 63 Model 70 I/O modules. Additionally, when Series 90-70 I/O is distributed on a Genius Bus in a remote drop with a Remote I/O Scanner, a much larger maximum system configuration is possible, depending on the number of drops and the baud rate of the Genius communications link. For details of I/O configuration using remote drops, refer to the Series 90-70 Remote I/O Scanner User's Manual, GFK-0579.

Model 70 I/O Module Types

Model 70 PLC I/O modules are available as five types: discrete inputs and outputs, analog inputs and outputs, and intelligent I/O modules. The Series 90-70 rack-mounted I/O system offers a full line of discrete I/O modules which will interface to most sensors and actuators. With the wide variety of available voltages, density, and current ratings a module well suited to virtually any application can be chosen.

Analog inputs can be cost-effectively multiplexed up to 120 circuits per rack. Interrupts may be configured from input point 1 of any DC or analog input module. Input filters may be selected to be 1 ms or 10 ms time constants on any DC input module. The circuit status of each I/O point is indicated by a green LED mounted at the top of the module and viewable through the clear plastic lens cover.

Each of the I/O modules has an insert installed between the inside and outside surface of the hinged door. One side of the insert (viewed with the hinged door in the closed position) has space to record circuit identification information for each point on the module, while the opposite or inside surface has a circuit wiring diagram, and the module type and catalog number. The outside edge of the insert is color coded to quickly identify the module as a high voltage (red) or low voltage (blue) type.

Discrete I/O Modules

Most discrete modules have either 16 or 32 points, depending on the type of module. Important features and benefits for the discrete I/O modules, and available module types are listed in the following tables.

Table 4-1. Discrete I/O Module - Features and Benefits

Feature	Benefit
16 and 32 point modules	High I/O density in a limited space
Mechanical keying	Prevents putting wrong type of module in a configured slot
Software configured	Eliminates DIP switches and jumpers and maintains flexibility
Connector system accepts 40 No. 14 AWG wires	Easy to wire
Connector system has large labels	Easy to read labels and wiring diagrams
One configurable interrupt point on each DC input module	Standard product can be applied in time critical applications

Table 4-2. Available Discrete I/O Module types

Module	Model 70 Input	Model 70 Output	Genius I/O
5VDC	32 point	32 point, .5A	32 point, .5A
12VDC	32 point	32 point, .5A	32 point, .5A
24VDC	32 point	32 point, .5A; 16 point, 2A	32 point, .5A; 16 point 2A
48VDC	32 point	32 point, .5A; 16 point, 2A	16 point, 2A
125VDC			8 point, 2A
120VAC	32 point	32 point, .5A; 16 point, 2A	8 point, 2A; 16 point In
	16 point isolated	12 point isolated	8 point, 2A isolated
240VAC	16 point isolated	16 point, 2A	n/a
Relay		16 point	16 point

Analog I/O Modules

The Series 90-70 I/O system includes high-level analog input system modules and a high level analog output module (±10VDC, 0 to +10VDC, 4 to 20mA) that interface to most analog sensors and transducers. These modules provide 14-bit resolution. An input expander provides a very easy, user friendly means of cost effectively inputting large numbers of analog signals. All Series 90-70 and Genius I/O analog modules automatically put data in word memory, thereby simplifying programming data access. Also, scaling of Inputs can be done by the board per user defined configuration. Embedded into the programmer and logic process are high and low value alarm contacts for simplified integration into ladder logic.

For applications requiring distributed I/O, RTD inputs, or thermocouple inputs, the Genius I/O system provides the ideal solution. The Genius analog products provide a cost effective means of distributing analog I/O. Some applications have specialized analog requirements; high sampling rates, specialized signals, or 16-bit resolution are not uncommon. Through the GE Fanuc 3rd party VME qualification program a whole new vista of I/O options has been opened. You can select from a large list of specialty options for a wide variety of applications. Analog I/O module options are listed in the following table.

Table 4-3. GE Fanuc Analog I/O Module Options

Module Type	Model 70 I/O	Genius I/O	3rd Party VME
High level analog output	4 channel	2 channel †	Yes
High level analog input	8 channel	4 channel †	Yes
Analog input multiplexer	16 channel/bd; 120 channels maximum per 1 input module	No	Yes
RTD	-	Yes	Yes
Thermocouple	-	Yes	Yes
Other: strain gauge, 16-bit resolution, etc.	-	future	Yes

† Combined I/O on one block.

Intelligent I/O Modules

With the Series 90-70 PLC system, you have available a full compliment of intelligent I/O modules which are tightly coupled to the Series 90-70 CPU. The intelligent I/O modules are configurable through user friendly interfaces to allow the customization to suit the application. Genius I/O intelligent modules (such as the Genius PowerTRAC power monitor) are also fully operational with the Series 90-70 I/O system.

The Series 90-70 3rd party VME qualification program provides a means of selecting additional

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intelligent modules to be used with the Series 90-70 PLC system. 3rd party VME modules are available in a wide variety of functions providing the capability to simplify systems integration by embedding what were previously stand-alone subsystems directly into the Series 90-70 PLC rack. This scheme replaces costly, low performance interfaces with a direct, high speed backplane interface.

I/O Module Features

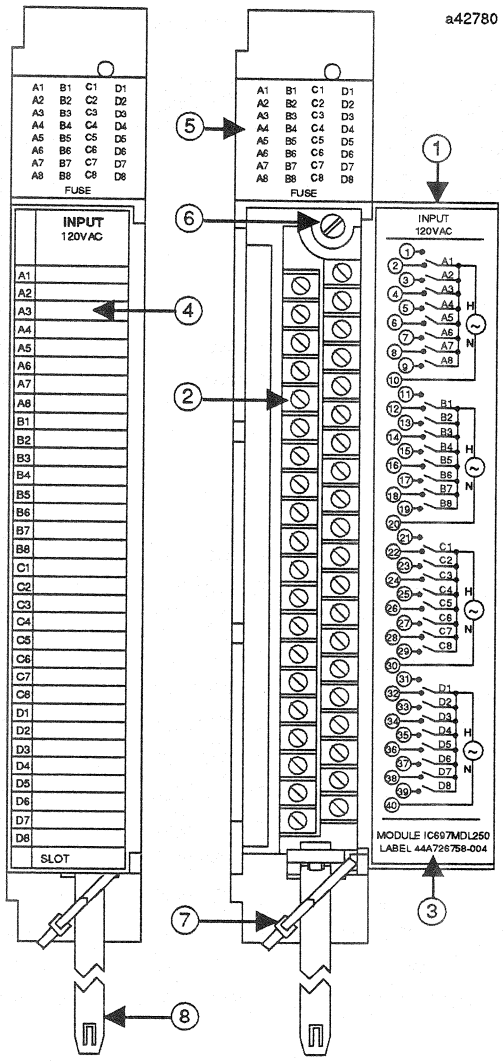
All Model 70 I/O modules are retained in their slots by molded latches that automatically snap onto the upper and lower rails of the rack when the module is fully inserted into its slot. For applications where racks will be installed in high vibration areas, screws can be used to further secure the modules in the rack. A cable tie cleat is molded into the bottom front of each module, which provides a convenient place to secure a cable tie wrapped around the wire bundle.

Detachable Terminal Boards

All Model 70 I/O modules have as a standard feature detachable field wiring terminal boards. This convenient feature makes it easy to prewire field wiring to the user supplied input and output devices, and to replace modules in the field without disturbing existing field wiring. The I/O connector terminals will accept up to one AWG #14 wire or two AWG #16 wires. Wires are routed out of the bottom of the terminal board cavity and secured by a cable tie as previously described. A terminal board strap on the bottom of the terminal board fastens to a slot in the bottom card guide grill to securely fasten the terminal board to the rack.

Mechanical Keying

All of the Model 70 I/O modules are mechanically interlocked by means of a key to prevent the accidental interchange of one module type for another. For example, you would not want to have a DC Output module inserted into a slot where the terminal board has been wired for an AC Input module. The mechanical key is a safeguard to help prevent this from happening.



① HINGED DOOR COVERS WIRING FIELD
② HIGH DENSITITY REMOVABLE 40-TERMINAL CONNECTOR
③ CIRCUIT WIRING DIAGRAM
④ OUTER LABEL FOR CIRCUIT IDENTIFICATION
⑤ I/O POINT STATUS INDICATOR LEDS BEHIND LENS
⑥ JACKSCREW
⑦ CABLE TIE
⑧ TERMINAL BOARD STRAP

Figure 4-2. Features of a Typical Model 70 I/O Module

A unique key is provided with each module. When a module is initially installed in a rack, the key automatically latches onto the center rail on the backplane, where it remains when a module is removed. Only the correct module type can then be inserted into that rack slot.

I/O Module Addressing

Module addressing is determined by the position (slot number) in the rack in which it is installed. There are no jumpers to be positioned or DIP switch settings required for addressing of modules.

Actual reference addresses for each module are assigned by the user with the configuration function of the Logicmaster 90 software package. The configurator function of Logicmaster 90 allows the user to assign reference addresses to the I/O modules on a slot-by-slot basis.

Table 4-4. Series 90-70 I/O Modules

Catalog Number †	Points	Description	Data Sheet Number
		Discrete Input Modules	
IC697MDL240	16	Input 120 VAC Isolated	GFK-0375
IC697MDL241	16	Input 240 VAC Isolated	GFK-0376
IC697MDL250	32	Input 120 VAC	GFK-0084
IC697MDL650	32	Input 24 VDC, Positive Logic	GFK-0080
IC697MDL651	32	Input TTL	GFK-0377
IC697MDL652	32	Input 12 VDC, Positive/Negative Logic	GFK-0378
IC697MDL653	32	Input 24 VDC, Positive/Negative Logic	GFK-0379
IC697MDL654	32	Input 48 VDC, Positive/Negative Logic	GFK-0380
		Discrete Output Modules	
IC697MDL340	16	Output 120 VAC, 2A	GFK-0082
IC697MDL341	12	Output 120/240 VAC, 2A, Isolated	GFK-0382
IC697MDL350	32	Output 120 VAC, 0.5A	GFK-0081
IC697MDL740	16	Output 24/48 VDC, 2A, Positive Logic	GFK-0086
IC697MDL750	32	Output 24/48 VDC, 0.5A, Positive Logic	GFK-0085
IC697MDL752	32	Output 12 VDC, 0.5A	GFK-0381
IC697MDL753	32	Output 5 to 48 VDC, 0.5A	GFK-0383
IC697MDL940	16	Output Relay	GFK-0384
		Analog Modules	
IC697ALG230	-	Analog Input, High Level (8 channel)	GFK-0385
IC697ALG440	-	Analog Expander, Current (16 channel)	GFK-0385
IC697ALG441	-	Analog Expander, Voltage (16 channel)	GFK-0385
IC697ALG320	-	Analog Output, Current/Voltage (4 channel)	GFK-0388
		Intelligent I/O Modules	
IC697ADC701	-	Alphanumeric Display Coprocessor	GFK-0521
IC697BEM731	-	Genius Bus Controller	GFK-0165
IC697CMM711	-	Communications Coprocessor Module	GFK-0370
IC697CMM721	-	Carrierband MAP Interface	GFK-0368
IC697CMM731	-	Broadband MAP Interface	GFK-0369
IC697CMM741	-	MMS-Ethernet LAN Interface	GFK-0532
IC697GDC701	-	Graphics Display Coprocessor	GFK-0519
IC697PCM711	-	Programmable Coprocessor Module	GFK-0164
IC697APU700	-	High Speed Counter	GFK-0393
IC697APU710	-	Axis Positioning Module	GFK-0394

† Some of the I/O modules and applicable data sheets listed above may not be available at the time this manual is printed. For current availability consult your GE Fanuc PLC distributor, or local GE Fanuc sales representative.

Module Location in Main (CPU) Rack

Two versions of Series 90-70 PLC racks are available; one has 5 slots (plus power supply slot), the other has 9 slots (plus power supply slot). Module placement in both size racks is the same; the only difference being the number of modules the rack can contain.

The first slot to the left is for the power supply or power supply connection (used when one power supply supplies power to two racks) to that rack. The next slot, labeled SLOT 1 on the backplane, in the main or CPU rack (rack 0) must always contain the CPU module. If rack 0 is the only rack in a system, the remaining 4 or 8 slots may contain either intelligent modules or I/O modules. The Bus Transmitter Module provides a high speed parallel connection to the programmer. The Bus Transmitter Module, if present, must installed in slot 2, adjacent to the CPU. If a serial connection is to be used for communications with the programmer, the BTM is not required in a single rack system, since the serial connection is made to the serial port on the CPU.

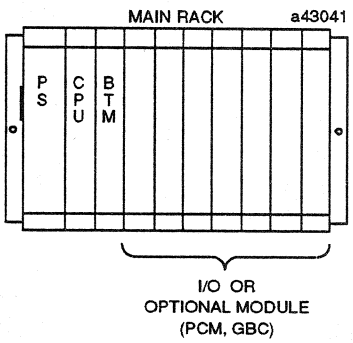


Figure 4-3. Main Rack Configuration

Module Location in Local Expansion System

When a Series 90-70 PLC application is such that it requires expansion racks to be included in the local system, slot 2 in rack 0 (CPU rack) must contain a Bus Transmitter Module (BTM).

The bottom connector of the Bus Transmitter Module is wired to the first physical expansion rack by connecting it to the top connector of a Bus Receiver Module (BRM) through an I/O cable. The bottom connector of this Bus Receiver Module is then connected to the top connector of the Bus Receiver Module installed in the next expansion rack. This process of connecting racks through Bus Receiver Modules is continued until all of the required racks in the system are connected in a chain.

The BTM and BRMs transmit information relative to system status, input/output data and other messages between the CPU and all attached devices. Bus expansion racks do not have all of the VME signals available in the CPU rack, therefore certain modules must be installed in the main (CPU) rack. The BRM controls the bus in an expansion rack. In the main rack, the CPU provides the system clock and acts as the bus arbitrator.

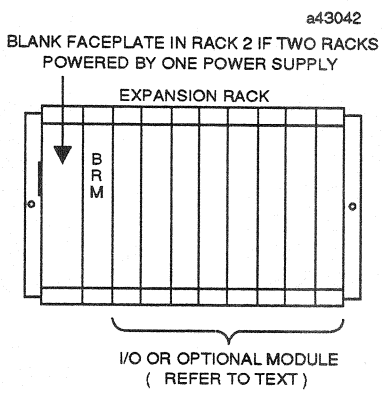


Figure 4-4. Expansion Rack Configuration

A BRM must reside in slot 1 of an expansion rack. Model 70 I/O modules can be placed in any available I/O slot in the rack. When intelligent modules are installed in a rack (PCM, GBC), all slots to the left of these modules must be occupied for proper operation.

The Series 90-70 PLC CPU communicates with the programmer through the top connector on the BTM. Only the programmer may be attached to this connector.

Distance Between Racks

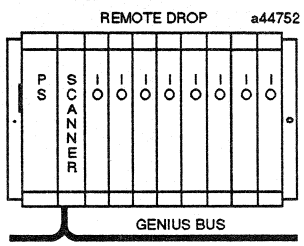
The maximum cable distance from the main (CPU) rack to the last expansion rack is 50 feet (15 meters). When expansion racks are mounted

in the same or nearby cabinets, there may be no more than a total of 50 feet of cable connecting all racks.

Since none of the daisy-chained signals (all at the same ground potential) are broken at a rack, any rack can be independently powered down without affecting the operation of the rest of the system (if the LOSS_OF_RACK fault is configured as a non-fatal fault). However, whenever a rack is powered-off it does generate a LOSS_OF_RACK fault in the PLC fault table. Until the rack is powered back on and all modules recovered, I/O points residing in that rack are considered to be faulted.

Module Location in a Remote Rack

When a remote rack is included as a drop on a Genius I/O link, certain restrictions apply when installing modules. The Remote I/O Scanner module must be located in slot 1, next to the power supply. The rest of the slots can contain any mix of discrete input and output modules, analog input (base converter and expander modules) and output modules, PCM, and ADC modules. The remote rack cannot have any I/O module interrupts, bus controllers, communications modules, or any other modules that depend on COMREQ instructions for their operation. As shown in the following figure a Remote I/O Scanner and the I/O modules in the rack with it make up a remote drop on the Genius bus.



A remote drop can include any mix of discrete and analog input and output modules, up to a total of 1024 discrete inputs and 1024 discrete outputs, or 64 analog inputs and 64 analog outputs. Any mix of discrete and analog modules can be used, as long as the total amount of data does not exceed 128 bytes of inputs and 128 bytes of outputs (8 discrete points represent one byte and 1 analog channel uses 2 bytes).

Model 70 I/O Modules

There are five types of Model 70 I/O modules available that can be used in a Series 90-70 PLC system.

- Discrete input and output
- Analog input and output
- Intelligent option modules

The following paragraphs provide an overview of the Series 90-70 PLC I/O modules. Circuit descriptions and wiring information for each of the I/O modules can be found in the data sheet that is included with each module (see Table 4-4).

Model 70 Discrete Input Modules

Discrete input modules convert AC and DC input power levels to the logic levels required by the Series 90-70 PLC. An optical coupler provides isolation between the incoming signal and the logic.

The input module gathers data regarding the state of each input point and provides it upon demand to the CPU. When input point 1 on DC input boards is configured as an interrupt, the input module also interrupts the CPU when an input occurs on point 1.

Model 70 Discrete Output Modules

Discrete output modules convert and isolate logic levels into AC and DC power levels for driving real-world devices. A power semiconductor provides the drive for each output point.

The output module receives data regarding the desired state of each output point from the CPU, and controls the outputs. It also controls the default state when ordered to do so by the CPU or when it detects a system failure. The default state for outputs may be user configured (through Logicmaster 90 configuration software) to either ***Off*** or ***Hold Last State*** on a per module basis.

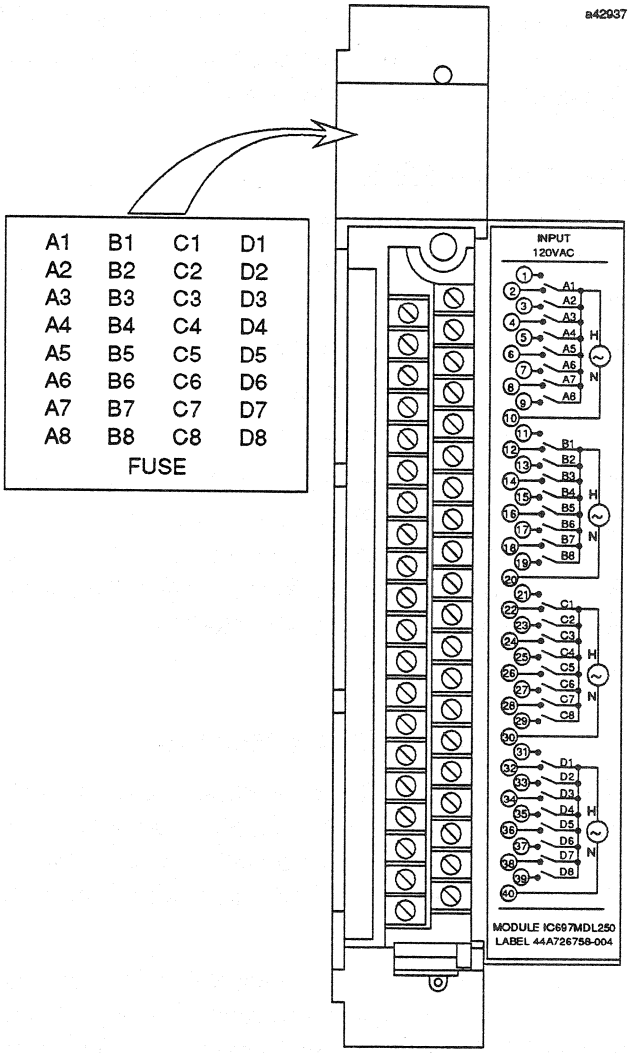


Figure 4-5. I/O Point Status Indicator LEDs for Discrete I/O Modules

Discrete I/O Module LEDs

An LED block consisting of four columns of eight LEDs is mounted at the top of each discrete I/O board. A bezel that overlays the LED block has a letter/number identification for each LED.

Each LED indicates the state of the logic, either ON or OFF, for the corresponding input or output point. The LED does not indicate the state of the power connection. Each discrete I/O board, regardless of the number of points and type (input or output) uses the same LED block.

For 32-point modules, all LEDs are used; for 16-point modules only the first four LEDs (from the top) in each column are used: A1 through A4, B1 through B4, C1 through C4, and D1 through D4. An LED located at the bottom of the fuse block indicates the status of the on-board fuses for output modules. If one or more of the fuses should blow, this LED will turn on.

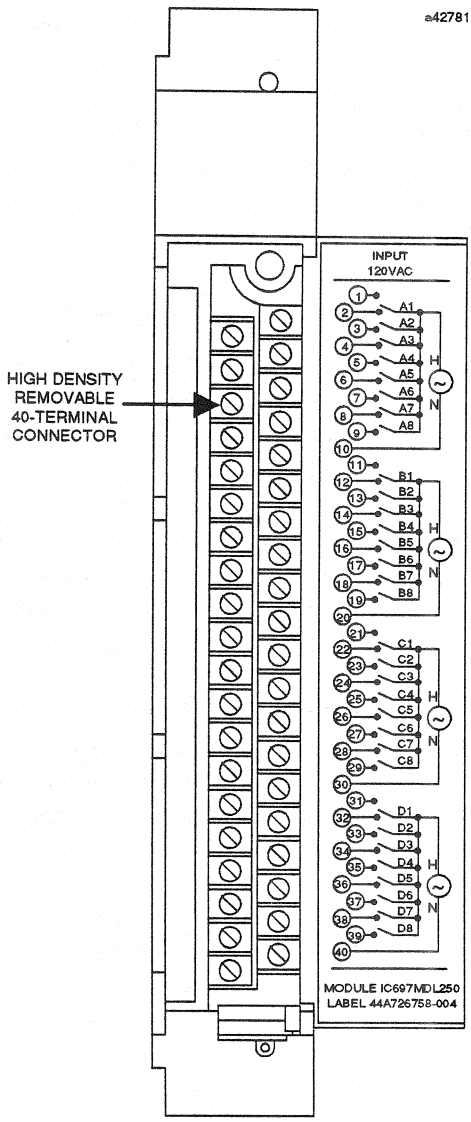


Figure 4-6. Discrete I/O Module Terminal Board

Discrete I/O Module Wiring Connections

The removable connector for field wiring on discrete I/O modules has terminals for connections to the external AC or DC power source, power return, and field devices supplied by the user.

Each discrete I/O module, regardless of type (input or output) uses an identical 40-terminal connector. A wiring connection diagram for each discrete I/O module can be found in the data sheet for each module. An example of this terminal board is shown in the following figure.

Model 70 Analog Input Modules

Model 70 Analog Input Modules include a high-level eight channel module (base converter), an analog expander 16 channel current module and an analog expander 16 channel voltage module.

High-Level Analog Input Module

The high-level input module contains eight high-speed analog inputs, a low-speed expansion input channel which can be shared by multiple expander modules, a 14-bit A/D (Analog to Digital) converter, 16-bit microprocessors, and the backplane interface to the system.

Analog Input Expander Modules

The expander modules contain 16 current or 16 voltage input channels, an analog multiplexer and a serial interface to the expander bus. Analog data from the expander modules is transmitted to the analog input module on the expander bus. Up to seven expander modules can be interfaced to an analog input module to expand the number of inputs to 120.

The high-level analog input module and its associated expander modules must be installed in the same rack with the high-level analog input module in the lowest slot position of the group. It is recommended that the expander modules be installed to the right of the analog input module and in adjacent consecutive slots to assure contiguous addressing beginning with the address assigned to the analog input module.

Analog Input Characteristics

Each analog channel is capable of converting an analog input signal to a digital signal which can be used as required by the application. With no analog expansion modules present, all eight channels of the input module are updated every 2.8 milliseconds.

The input ranges for these analog inputs can be -10 to +10 volts and 4 to 20 mA. Each channel of the high level analog input module is individually soft configurable, with the configurator software, for either voltage or current ranges, user scaling, alarm limits and diagnostics. Built-in resistors are selectable at the terminal board for current inputs.

The expander module is also soft configurable and is available in two versions: one with all current inputs and one with all voltage inputs. Resolution of the converted signal is 14 bits binary (1 part in 16384), including sign, resolving 1.25 millivolts on voltage range, or 50 microamps on current range. The input data format is 2's complement binary.

Wiring Connections to Analog Input Channels

Connection to the analog input modules from user devices is made to screw terminals on a removable 40-terminal connector. A circuit wiring diagram for high-level analog input modules and expander modules can be found in the data sheet included with each module and is also printed on the inside surface of the label in the module's hinged door.

The expansion channel bus connections consist of two differential wire pairs which must be connected between the expander modules and the analog input module. This connection must be made with shielded, twisted pair cable to the 40-terminal connector.

Module Status Indicator

The high-level analog input modules have two LEDs located at the top front of the module. The top LED, labeled *BOARD OK*, indicates that the board has powered-up, passed its power-up diagnostic tests, and has received good configuration data. The second LED, labeled *PORT OK*, is an indication that the expander bus is connected and operating properly.

High/Low Alarm Function

The high-level analog input module input points have a High/Low Alarm function which indicates that an input is outside of a range of upper and lower limits set by the user with the configuration software.

When a high or low alarm limit is exceeded, the appropriate fault contacts are set, either --[HIALR]-- or --[LOALR]--, and the fault will automatically be logged in the Alarm Fault Table.

Model 70 Analog Output Modules

Model 70 Analog Output Modules are available in two versions: an Output Analog Voltage/Current module that allows each channel to be configured for either current or voltage, and an Output Analog Voltage module that provides voltage outputs only. Each of the analog output modules has four channels.

High-Level Analog Output Modules

The high-level analog output module is available as one configurable module having both voltage and current outputs. This module contains four high-speed analog outputs, separate 14-bit D/A (Digital to Analog) converters, a 16-bit microprocessor and the backplane interface to the system. The high-level analog output system accepts digital data from the PLC CPU and converts this data to analog outputs for use as required by the application.

Analog Output Characteristics

Each analog channel is capable of converting a digital signal to an analog signal. Operating ranges for the output channels are -10 to +10 volts for voltage outputs and 4 to 20 mA for current outputs. Resolution of the converted signal is 14 bits binary (1 part in 16384) for a -10 to +10 VDC output, and 13 bits binary (1 part in 8192) for a 4 to 20 mA output. Calibration is set at the factory and stored in a non-volatile memory (EEPROM) which eliminates the need for manual calibration by the user. The proper calibration for each channel on the analog output module, which can be configured for either voltage or current, is set by the configurator software as are scaling and diagnostic features.

Wiring Connections to Analog Output Channels

Connection to the analog output modules from user devices is made to screw terminals on a removable 40-terminal connector. A circuit wiring diagram for high-level analog output modules can be found in the data sheet included with each module and on the inside surface of the label in the module's hinged door.

Module Status Indicator

The analog output modules have one LED located at the top front of the module. This status indicator, labeled *BOARD OK*, indicates that the board has powered-up, passed its power-up diagnostic tests, and has received good configuration data.

Intelligent Option Modules

The following paragraphs provide a brief description of the Intelligent Module options for the Serie 90-70. For a more complete description, refer to Chapter 2.

Operator Interface Systems

The Series 90-70 PLC supports two integrated operator interface systems which are high performance, cost effective, and easy to configure. Two basic systems are offered: a pixel graphics system and a character graphics system. These two systems allow a wide range of applications to be served.

CIMPLICITY-70 Graphics Display System

The CIMPLICITY-70 Graphics Display System (GDS) is a high performance, low cost pixel-based, interactive color operator interface system. It is available as a single slot module (Graphics Display Coprocessor) that contains graphics processing circuits to update screens in less than 200 msec. The module features powerful screen building tools, a large array of graphics

functions (e.g. object rotate, scaling, movement, and fill), built-in trending capability, and RGB monitor capability. The module has high speed access to the Series 90-70 CPU register and I/O memory through the backplane which provides for fast updates.

The CIMPLICITY-70 GDS system allows the operator to monitor, display, and supervise automated process plant facilities. Multiple systems allow you to operate multiple independent workstations from a single PLC platform. It also includes a Recipes function that allows control of an automated process by downloading predeterminaed sets of values to the PLC.

A companion Graphics Display Terminal is available from GE Fanuc. This is a Nema 4 (14 inch) industrial monitor specifically designed for the Cimplicity system that can be mounted 1000 feet from the Graphics Display Module.

CIMPLICITY 90-ADS

CIMPLICITY 90-ADS (Alphanumeric Display System) is a low cost character graphic operator interface system . This display system consists of three elements: the Series 90-70 Alphanumeric Display Coprocessor Module (ADC), an operator interface terminal, which can be a GE Fanuc OIT, Mini OIT, Mini Touch OIT, a VT100 compatible terminal, or a Workmaster II computer or IBM compatible Personal Computer, and the applicable configuration software. The configuration software allows for fast screen creation, thereby simplifying the creation of the operator interface.

Additional information on these products can be obtained from your GE Fanuc PLC distributor or local GE Fanuc PLC sales representative.

Series 90-70 PLC Communications

Serial communications is a necessary element for any PLC system. The Series 90-70 supports various communications systems and protocols. The Series 90-70 PLC supports the core GE Fanuc communications systems, which are CCM, Genius, MAP (Manufacturing Automation Protocol), MMS (Manufacturing Message Specification) and the Series 90 Protocol (SNP). The availability of these systems simplifies connecting a Series 90-70 PLC to existing GE Fanuc products.

CCM Communications

CCM communications is an integral part of the Programmable Coprocessor Module and is run as a task on one serial port, or both serial ports of the PCM. Also, an available Communications Coprocessor Module (CMM) provides communications control (CCM) and remote terminal (RTU) functionality. The Communications Coprocessor Module provides both the RS-232 and RS-485 interfaces and communicates with the Series 90-70 CPU over the backplane.

Genius Communications

The Genius Bus Controller supports the Genius LAN (Local Area Network) functionality. Global data and datagrams are also supported. Default settings make it a simple procedure to configure a standard network capable of running global data.

MAP Communications

GE Fanuc provides both Carrierband and Broadband embedded MAP (Manufacturing Automation Protocol) interfaces for the Series 90-70 PLC. Both of these modules are members of the GEnet Factory LAN hardware and software products. The Carrierband Interface resides on a single-slot board which can be located in any I/O slot on the parallel I/O bus. The Broadband Interface is a two-board option (Controller board and Modem board) which can also reside in any I/O slot on the parallel I/O bus. Both MAP Interfaces support the MAP specification version 3.0.

MMS Communications

The MMS-Ethernet LAN Controller module is a single board option which is a member of the GEnet Factory LAN hardware and software products. This module supports the MMS (Manufacturing Message Specification - ISO 9506) communications protocol over a 7-Layer ISO protocol stack.

The MAP and MMS LAN Interface boards require 12 VDC, which means that the 100 watt power supply must be used in the rack in which they reside. Multiple MAP and MMS Interfaces may be used in a single Series 90-70 PLC system.

Series 90 Protocol (SNP) Communications

The Series 90 Protocol is a serial protocol used in the Series 90 PLC family to communicate between a host device and the Programmable Logic Controller (PLC) CPU through the CPU's serial port. A protocol is a set of rules that define an orderly transmission of data. In the case of SNP, it is a set of rules that establishes and maintains a serial communications link between a Master (host device running the master implementation of the SNP protocol) and a Slave (Series 90 PLC CPU). SNP is a Master/Slave protocol where the master initiates all communications and the slave responds to the master's requests. There is no peer-to-peer capability with the SNP protocol (i.e., a PLC cannot be the master; the PLC can only be a slave).

SNP is a half-duplex protocol that uses the RS-485 (enhanced version of RS-422) electrical interface. Several system configurations are possible. There may be just one PLC on the serial link (direct, point-to-point port connection), or there may be many Series 90 PLCs on a serial link (multi-drop port connection). Only one SNP master may be on a multi-drop link. SNP also supports communication over modems.

An RS-422/RS-485 to RS-232 converter (catalog number IC690ACC900) is available for your applications requiring RS-232 devices to be connected to the RS-485 serial port on the Series 90-70 CPUs.

Where isolation is required, the RS-422 Isolated Repeater/RS-232 Converter (catalog number IC655CCM590) can be used in place of the RS-422/RS-485 to RS-232 converter. In addition to converting from RS-232 to RS-422/485 communications, this unit provides ground isolation where a common ground cannot otherwise be established between components.

Table 4-5. GE Fanuc Communications Modules

Catalog Number	Module Description
IC697CMM711	Communications Coprocessor Module - both CCM and RTU functionality
IC697CMM721	Carrierband MAP Interface - supports MAP 3.0
IC697CMM731	Broadband MAP Interface - supports MAP 3.0
IC697CMM741	MMS-Ethernet LAN Controller - supports MMS communications protocol

Chapter 5
Series 90-30 PLC Hardware Description

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The Series 90-30 Programmable Logic Controller is an easy to configure and use small to mid-range Programmable Logic Controller. Coupled with the variety of available and future planned hardware plus the power and speed of Logicmaster 90 Programming software running on a Workmaster II computer - or the easy-to-use Hand-Held Programmer, virtually any application within the physical range of the Series 90-30 can be easily handled.

A basic description of the system hardware components for the Series 90-30 PLC system is provided on the following pages. For more detailed hardware information, refer to GFK-0356, which is the *Series 90-30 PLC User's Manual.*

The basic hardware components required for the two models of the Series 90-30 PLC; Model 311 and Model 331 are as listed in the following table. The I/O system and I/O modules are described in Chapter 7.

Table 5-1. Series 90-30 PLC System Components

Catalog Number	Description
IC693CPU311	Model 311, 5-slot baseplate with built-in CPU
IC693CPU321	Model 311, 10-slot baseplate with built-in CPU
IC693CPU331	Model 331 CPU module
IC693CHS391	Model 331 10-slot Baseplate, Main
IC693CHS392	Model 331 10-slot Baseplate, Expansion
IC693CHS393	Model 331 10-slot Baseplate, Remote
IC693CHS397	Model 331 5-slot Baseplate, Main
IC693CHS398	Model 331 5-slot Baseplate, Expansion
IC693CHS399	Model 331 5-slot Baseplate, Remote
IC693CBL300	Expansion Cable, 3 feet (1m) (Model 331)
IC693CBL301	Expansion Cable, 6 feet (2m) (Model 331)
IC693CBL302	Expansion Cable, 50 feet (15m) (Model 331)
IC693PWR321	Power Supply, 120/240 VAC, 30 watts
IC693PWR321K	Power Supply, 120/240 VAC and 125 VDC, 30 watts
IC697PWR322	Power Supply, 24/48 VDC, 30 watts
IC693PRG300	Hand-Held Programmer with IC693CBL303 cable
IC693ACC301	Replacement Battery, Lithium
IC693ACC307	I/O Bus Terminator Plug

Series 90-30 CPU Capacities

The capacities of each model of CPU for the Series 90-30 PLC are as shown in the following table.

Table 5-2. CPU Capacities

PLC	Speed (MHz)	Processor	Input Points	Output Points	Register Memory	Maximum User Program Memory
Model 331 CPU	8	80188	512	512	4K (Bytes)	16K (Bytes)
Model 311 CPU	8	80188	160	160	1K (Bytes)	6K (Words)

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General Specifications

General specifications for the Series 90-30 PLC are as shown in the following table.

Table 5-3. General Specifications for the Series 90-30 PLC

Operating Temperature	0 to 60°C (32 to 140°F), with air at bottom of baseplate
Storage Temperature	-40° to 85°C (-40° to 185°F)
Humidity	5% to 95% (non-condensing)
Vibration	3.5 mm, 5-9 Hz: 1.0g 9-150 Hz
Shock	15 g's for 11 msec
Standards	UL, CSA
AC Power Source	
120 VAC Nominal Input	90 to 132 VAC
240 VAC Nominal Input	180 to 264 VAC
Frequency	47 to 63 Hz
DC Power Source	
24 or 48 VDC Nominal Input	Start: 21 to 56 VDC; Run: 18 to 56 VDC
125 VDC Nominal Input	100 to 150 VDC
Input Power	50 watts maximum (full load)
Output Power (maximum)	30 watts (total of all outputs combined)
5V	15 watts
24V Relay	15 watts
24V Isolated	15 watts

Rack Dimensions	Height	Width	Depth
10 Slot Baseplate (all)	5.12″ (130mm)	17.44″ (443mm)	5.59″ (142mm)
5 Slot Baseplate (all)	5.12″ (130mm)	10.43″ (245mm)	5.59″ (142mm)

Back-up Battery Type	Lithium, long-life
Typical Battery Life, Loaded	CPU331: about 6 months; CPU311 and PCM modules: about 2 years (depending on temperature)
Battery Shelf Life, No Load	8 to 10 years
Typical Scan Rate	
Model 331	0.4 ms/1K of logic (boolean contacts)
Model 311	18.0 ms/1K of logic (boolean contacts)
Maximum number of I/O Points	
Model 331	512 (any mix)
Model 311	160 (any mix)

Internal Functions	Model 311	Model 331
Output Coils	160	512
Internal Coils	1024	1024
Timers/Counters	170	>500
Shift Registers	yes	yes
Data Registers	512	512
Analog (12 bit)	64 In	128 In
	32 Out	64 Out
Override	no	yes

Baseplate Description

Series 90-30 PLC hardware modules are installed on baseplates. Baseplates containing a power supply and configured with modules are referred to as racks. Baseplates for the Series 90-30 PLCs are described in the following paragraphs.

Model 311 Baseplates

Series 90-30 PLC Model 311 is available as a 5-slot baseplate (IC693CPU311) or as a 10-slot baseplate (IC693CPU321). Both versions have the CPU physically located (embedded) on the backplane. The power supply for the PLC is mounted on the left side of the baseplate. This scheme allows all 5 or 10 slots to be available for I/O modules.

There are no switches or jumpers on either of the Model 311 baseplates requiring configuration. Both the 5 and 10-slot baseplates are designed to be panel mounted. However, an optional mounting bracket (IC693ACC308) is available which allows the 10-slot baseplate to be mounted in a 19 inch rack.

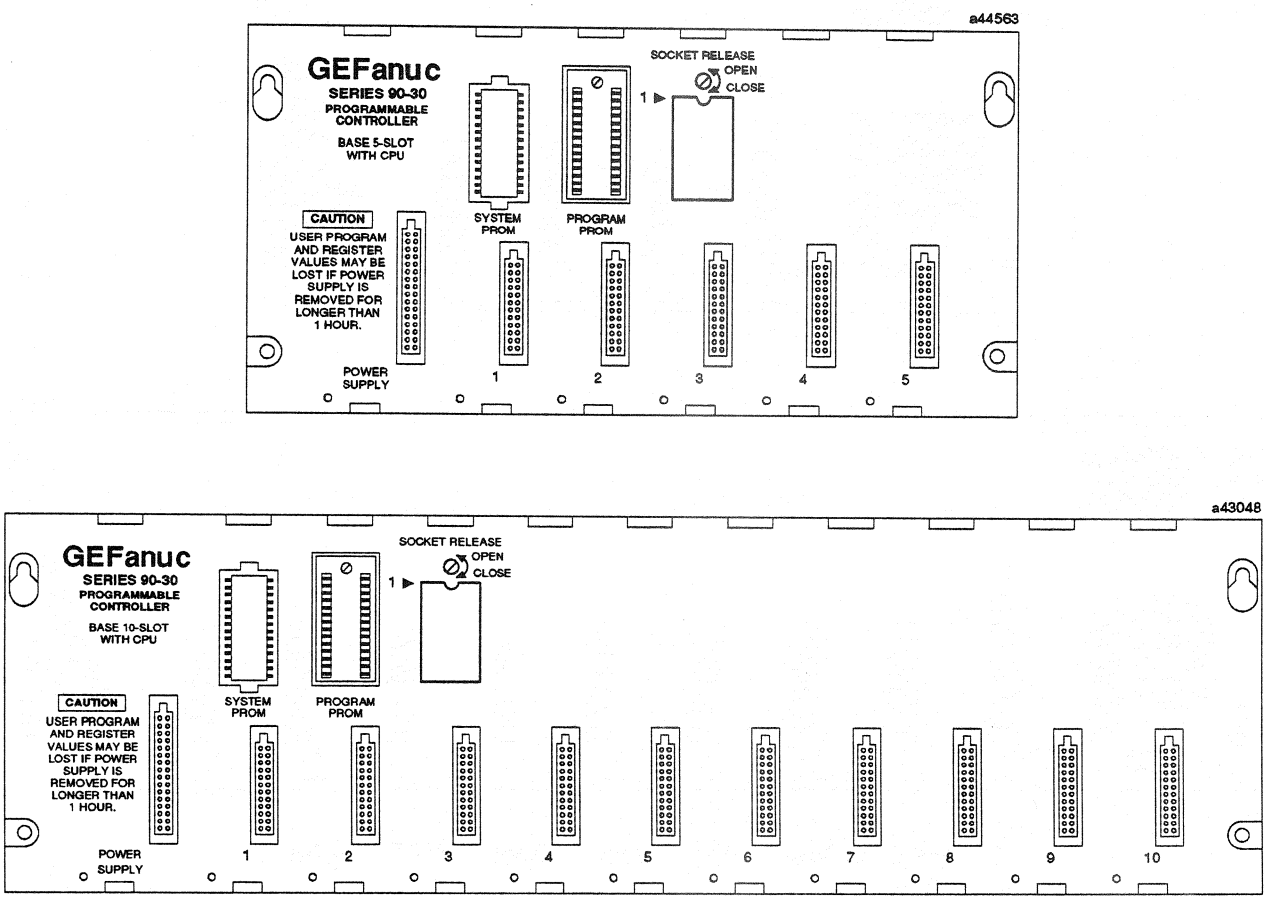

Figure 5-1. Series 90-30 PLC Model 311 5-Slot and 10-Slot Baseplates

Model 331 CPU Baseplate

Series 90-30 PLC Model 331 CPU baseplates have either 5 slots (IC693CHS397) or 10 slots (IC693CHS391) for modules plus a slot for the power supply. The power supply must be installed in the leftmost slot on the baseplate. The Series 90-30 PLC Model 331 ***CPU baseplate*** must *always* contain the CPU module, which must be installed in slot 1 adjacent to the power supply. The remaining nine slots in the CPU baseplate are available for I/O or option modules. A 25-pin D-type female connector is located at the far right of the baseplate for connection to an expansion or remote baseplate.

If additional system capacity is required beyond the CPU baseplate, up to four expansion or remote baseplates may be connected through available I/O expansion cables in a chain to form a high-capacity PLC.

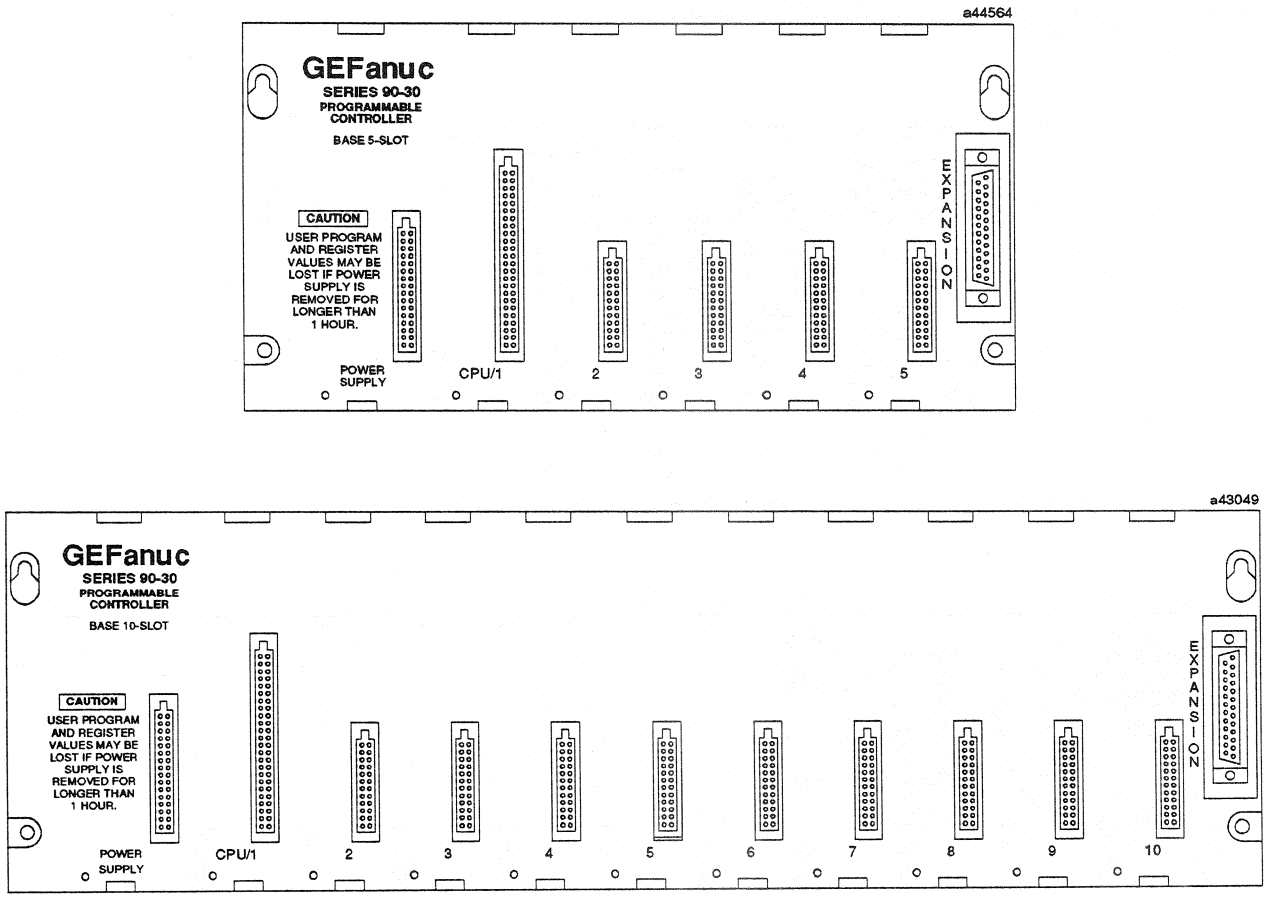

Figure 5-2. Model 331 5 and 10-Slot CPU Baseplates

Model 331 Expansion Baseplates

The Series 90-30 PLC Model 331 ***expansion baseplates*** also have available either 5 slots (IC693CHS398) or 10 slots (IC693CHS392) for modules and a power supply slot. Physically, they are similar to the CPU baseplate, with the exception that they have a rack number selection DIP switch (the CPU baseplate does not have this DIP switch). Discrete I/O, Analog I/O, and most option modules can reside in any slot in an expansion baseplate.

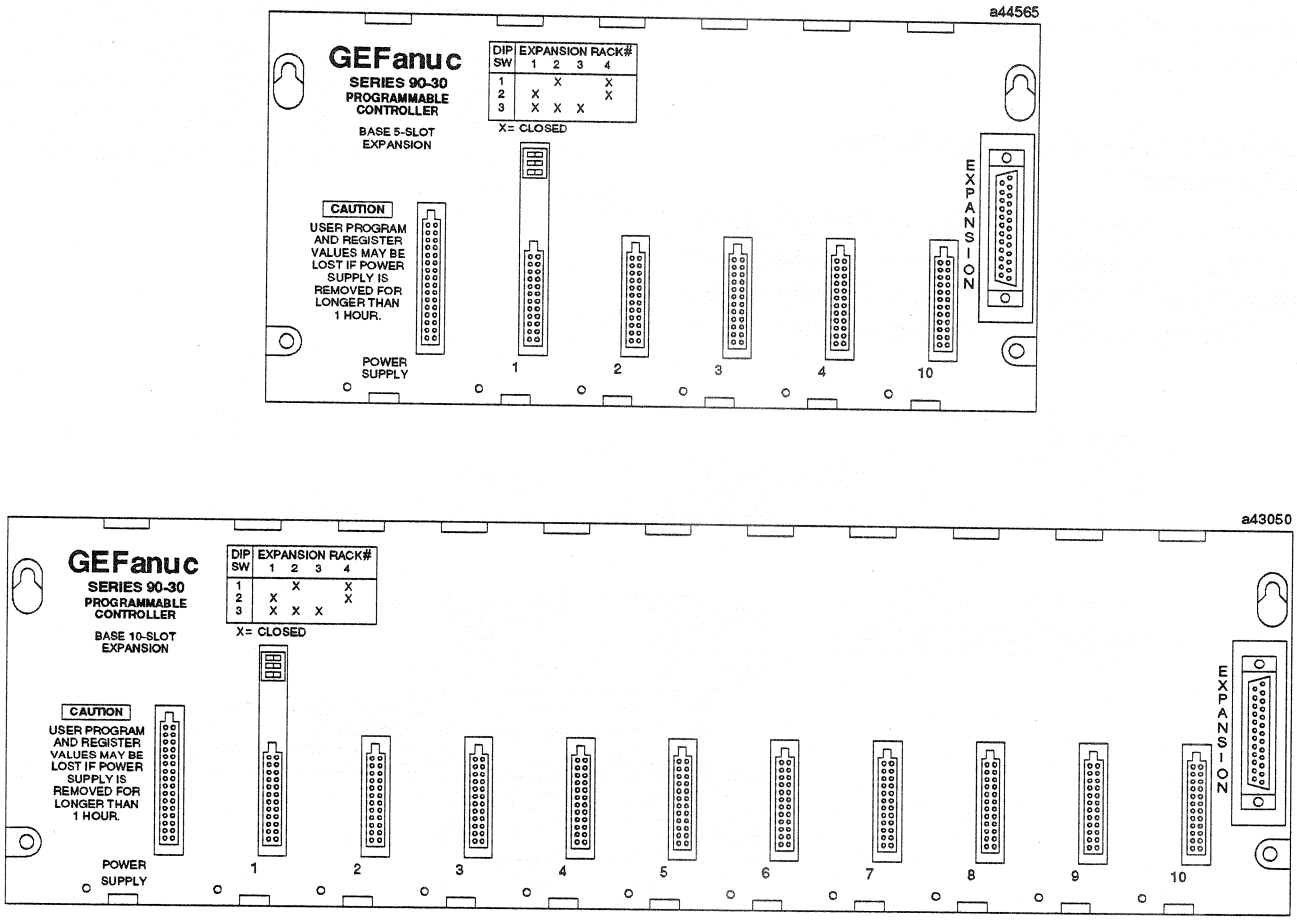

Figure 5-3. Model 331 5 and 10-Slot Expansion Baseplates

The maximum distance from the CPU baseplate to the last expansion baseplate is 50 feet (15 meters). There can be **no more** than a total of 50 feet of cable connecting all baseplates in an expansion system, ***and*** all baseplates must be connected to a common ground.

Each of the expansion baseplates has a 25-pin female D-type connector (labeled EXPANSION) mounted at the far right of the baseplate for connection to another baseplate in an expansion system (the CPU baseplate also has this expansion connector).

Expansion cables can be purchased in three different lengths. Catalog numbers and lengths of these cables are listed in the following table. The 3 foot cable (IC693CBL300) can be used as the WYE adapter between cables and remote baseplates in a remote expansion. Refer to the discussion of remote baseplates for more information on using the WYE cable in a remote expansion installation.

Table 5-4. I/O Expansion Cable Lengths

Catalog Number	Length
IC693CBL300	3 feet (1 meter)
IC693CBL301	6 feet (2 meters)
IC693CBL302	50 feet (15 meters)

The Series 90-30 PLC backplane is a high speed backplane with a dedicated communications bus for I/O. Additionally, the Model 331 backplane has a separate dedicated communications bus for Intelligent (Option) module communications. This bus is available only on the Model 331 CPU baseplate, therefore Intelligent option modules,

such as the PCM or ADC can only reside in the CPU baseplate.

Model 331 Local Expansion System Configuration

An example of a typical Series 90-30 PLC Model 331 local expansion system with its maximum configuration is illustrated in the following figure. The physical hardware configuration for a maximum expanded system consists of a CPU baseplate with the CPU module installed in slot 1, four expansion baseplates and connecting cables, an I/O bus terminator plug, and the various I/O and option modules required for the application.

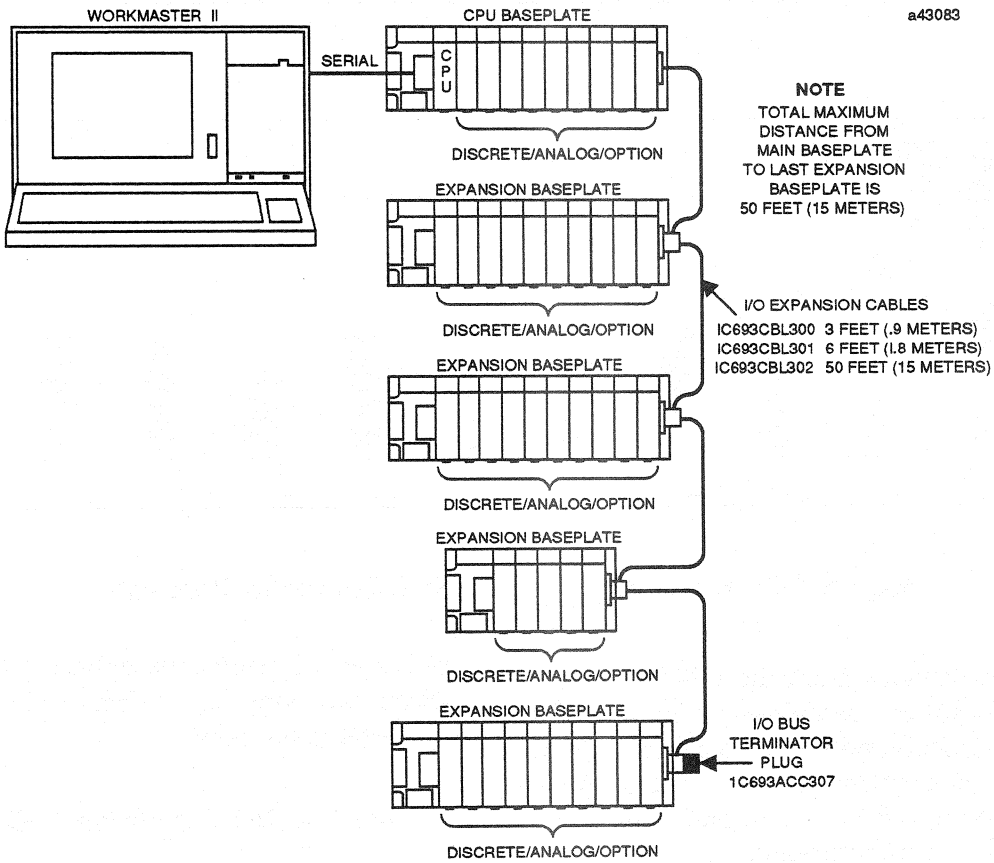

Figure 5-4. Example of Model 331 Local Expansion System

Model 331 Remote Baseplates

Remote baseplates provide extended expansion capability for the Model 331 PLC beyond the 50 feet allowed in a local expansion system. Remote baseplates are available in two versions; a 5-slot (IC693CHS399) and 10-slot (IC693CHS393).

Remote baseplates provide the same functionality as the expansion baseplates with the added feature that they can be used at distances up to 700 feet (213 meters). The remote baseplates are the same physical size, are rack addressable, use the same power supply, and support the same I/O and option modules as the expansion baseplates.

Remote capability is achieved by providing isolation between the +5 volt logic supply used by the I/O modules residing in the baseplate and the

supply for the interface circuit associated with the I/O Interface. Isolation helps prevent problems associated with unbalanced ground conditions. These conditions usually occur when systems are located long distances from each other and do not share the same ground system. However, distance is not always the problem; systems in close proximity should be verified for proper grounding prior to installation.

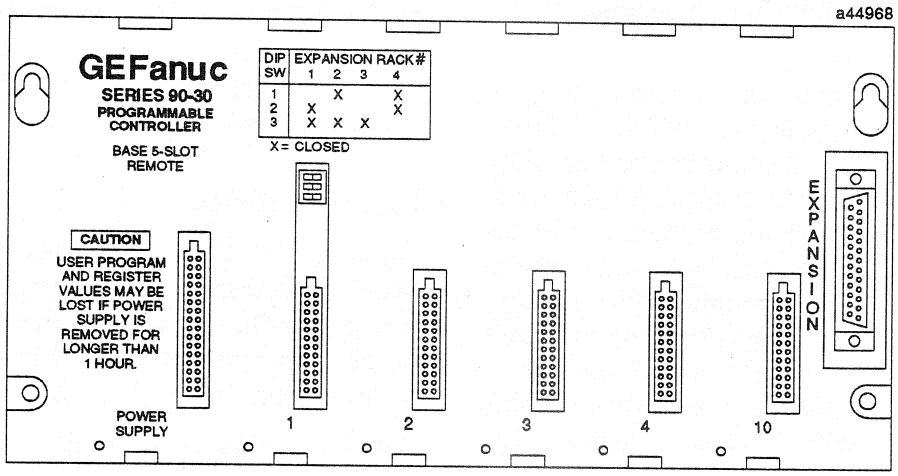

Figure 5-5. Series 90-30 PLC Model 331 5-Slot Remote Baseplate

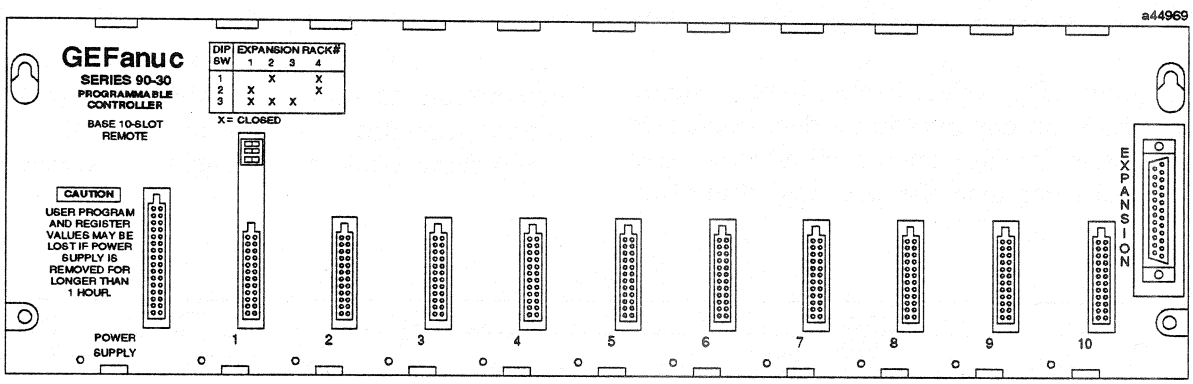

Figure 5-6. Series 90-30 PLC Model 331 10-Slot Remote Baseplate

Use of the remote capability requires some special considerations; one of which is scan time. To operate at long distances, the I/O clock speed must be lowered when communicating with remote racks which will have an impact on performance. The impact will be relatively small for discrete I/O and slightly more for other modules, such as the High Speed Counter or Genius Communications Module. The increase in time to communicate with modules in a remote baseplate will usually be small with respect to the overall scan time.

NOTE

The lower clock rate is only used when communicating with remote baseplates, the CPU continues to communicate with the expansion baseplates at the faster rate.

Another important consideration is the grade of cable used for communicating at longer distances. Propagation of data must be minimized to ensure proper system timing and margins. Any deviation in cable type may result in erratic or improper system operation. Information on suggested cable types is described in GFK-0356, the Series 90-30 PLC Installation Manual.

Expansion and remote baseplates can be configured in the same expansion system as long as certain requirements are followed. These requirements are that the last expansion baseplate must not exceed the 50 foot specification from the CPU to the last expansion baseplate, and the cable recommended for use with the remote baseplate must be used throughout the system. The exception to the cabling is that the prewired 3 foot cable, IC693CBL300, can be used as a WYE adapter to simplify the custom cable assembly associated with the daisy chain concept.

Information on building cables for use with the remote baseplates can be found in Chapter 3 of the Series 90-30 PLC Installation Manual. Basically, two types of cables are required in a remote expansion system; point-to-point cables and WYE cables. Point to point cables have a male connector on one end and a female connector on the other end. The WYE cables have a single male connector on one end and a dual connector (one male, one female) on the other end. If a WYE cable longer than the prewired three foot cable is required, you must build one of the required length.

An I/O Bus Terminator Plug (IC693ACC307) must be plugged into the female side of the WYE cable on the last baseplate (most distant from the CPU) in the remote expansion system. Note that a remote system could have only one cable up to 700 feet in length. This cable would have to be a WYE cable, since an I/O Bus Termination Plug must be installed on the last baseplate on the remote expansion link.

Baseplate Dimensions

Series 90-30 PLC baseplates are designed for panel mounting. Each baseplate has standard attachment flanges for mounting on an electrical panel. An optional adapter bracket is available for mounting 10-slot baseplates in a rack).

Baseplate dimensions and proper spacing for installation planning purposes for the three models of Series 90-30 PLC are shown in the following figures. Figure 5-7 shows the dimensions for the Model 311 baseplates, and Figure 5-8 shows the dimensions for the Model 331 baseplates.

Since there are no internal fans for cooling purposes in the PLCs, they must be mounted in the orientation as shown in the illustrations. If proper mounting procedures are not followed, components could be damaged by excessive heat.

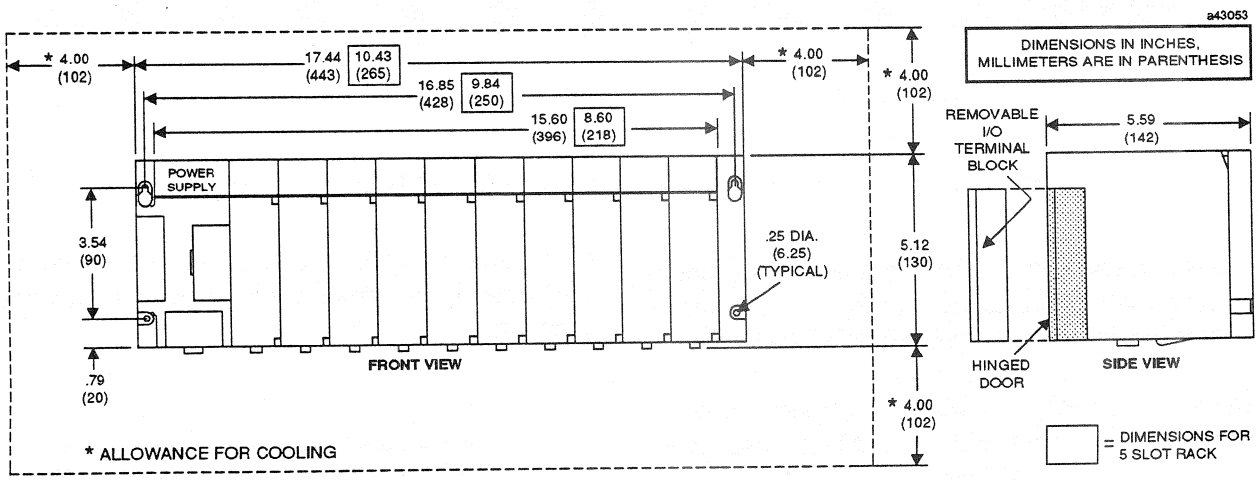

Figure 5-7. Model 311 Baseplate Mounting Dimensions and Spacing Requirements

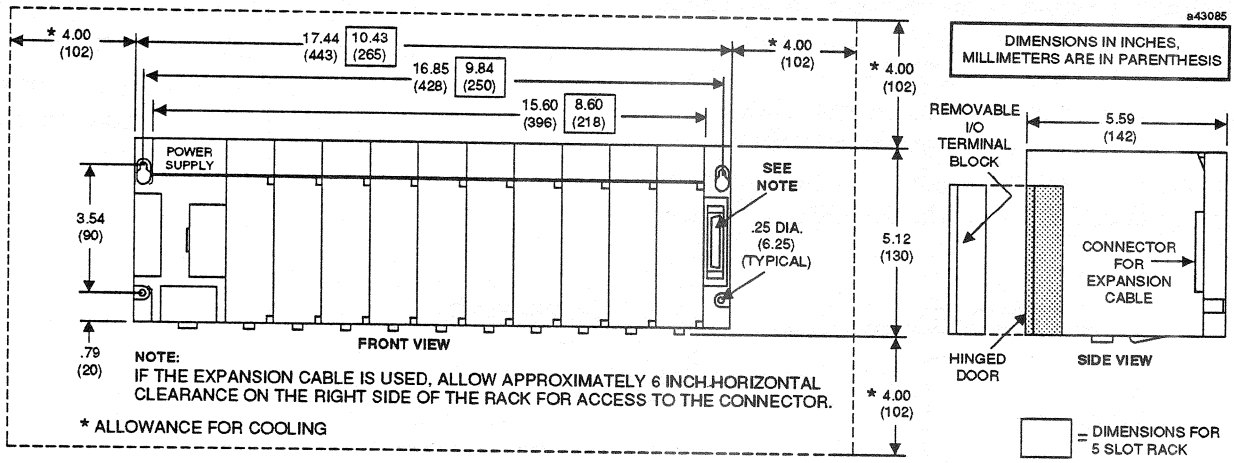

Figure 5-8. Model 331 Baseplate Mounting Dimensions and Spacing Requirements

Terminating the Expansion I/O Bus

When two or more baseplates are cabled together in a Model 331 expansion system, the expansion bus must be properly terminated. This is done by installing a termination resistor pack on the open connector on the last expansion baseplate in the system.

This resistor pack is physically mounted inside of a separate connector. This termination resistor pack is shipped with each baseplate; however, the termination connector must be installed on the expansion connector on the last baseplate when the expansion cables are either the 3 or 6 foot version.

The termination resistors are physically installed in the end connector on the 50 foot expansion cable, since if this cable is used it will be the only expansion cable in the system (total cable length cannot exceed 50 feet).

Rack Number DIP Switch

Each rack that is included in a Model 331 system must be identified by assigning it a unique number between 0 and 4; this is called a *Rack Number*. These rack numbers are selected by the user dusing installation by configuration of a three-position DIP switch located on each expansion baseplate directly above the connector for slot 1.

Rack number 0 must always be present in a system and is assigned to the main rack containing the CPU (the CPU baseplate does not physically have this DIP switch). The other racks do not need to be contiguously numbered, although for consistency and clarity, rack numbers should not be skipped (use 1, 2, 3 - not 1, 2, 4). *Rack numbers must not be duplicated in an expansion system having multiple racks.* The following table shows the DIP switch positions for rack number selection.

Table 5-5. Rack Number Configuration

	Rack Number			
DIP Switch	1	2	3	4
1	open	closed	open	closed
2	closed	open	open	closed
3	closed	closed	closed	open

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Remote Expansion System Configuration

The following figure is an example of a typical Remote expansion system for the Model 331 showing a maximum configuration of a CPU baseplate and four expansion baseplates. A remote system can have both remote and expansion baseplates. The expansion baseplates can be no further than 50 feet from the CPU baseplate and all cables must use the type of cable recommended for remote systems. The WYE cable, as shown, is optional to make wiring easier. You can have a cable made with the WYE built into the cable (this cable configuration would look the same as the local expansion example in figure 5-4).

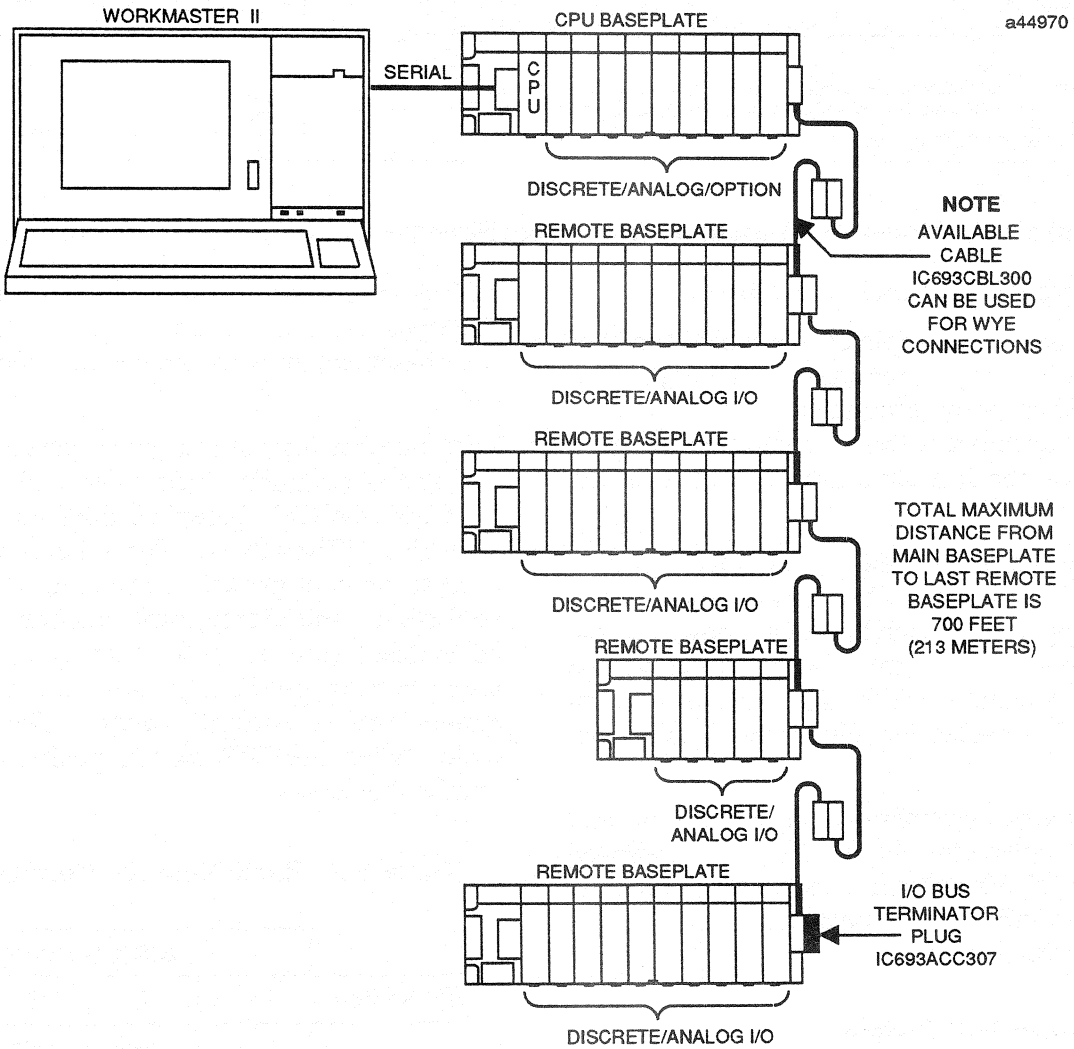

Figure 5-9. Example of Model 331 Remote Expansion System

Power Supply

The Series 90-30 PLC system power supply is a 30 watt supply that is available with either a wide range AC or DC input. These power supplies both provide three output voltages: (1) +5 VDC to the backplane, (2) +24 VDC to the backplane for Series 90-30 Relay Output modules, and (3) +24 VDC isolated to the user terminal board for use with Series 90-30 Input modules. While each of the three outputs may be operated at up to 15 watts maximum, the total of all three outputs can

not exceed 30 watts - this allows maximum application flexibility. The capacities and catalog numbers for the power supplies are shown in the following table. The Series 90-30 PLC power supplies are shown in the following figure.

Table 5-6. Power Supply Specifications for Series 90-30 Baseplates

Catalog Number	Load Capacity	Source Input Voltage	Output Capacities (Voltage/Power) †		
IC693PWR321	30 Watts Total	100 to 240 VAC	+5 VDC 15 watts	+24 VDC Isolated 15 watts, max	+24 VDC Relay 15 watts, max
IC693PWR321K	30 Watts Total	100 to 240 VAC or 125 VDC	+5 VDC 15 watts	+24 VDC Isolated 15 watts, max	+24 VDC Relay 15 watts, max
IC693PWR322	30 Watts Total	24 or 48 VDC	+5 VDC 15 watts	+24 VDC Isolated 15 watts, max	+24 VDC Relay 15 watts, max

† Total of all outputs combined cannot exceed 30 watts.

Power Supply Location on Baseplate

The power supply for the Series 90-30 PLC must reside in the leftmost slot in both the Model 311 baseplates and the Model 331 baseplates. Power supplies are connected to the backplane through the backplane connector to which they are attached; no additional wiring is required. The power supply slot on the Model 311 baseplates and the Model 331 baseplates is labeled ***Power Supply***.

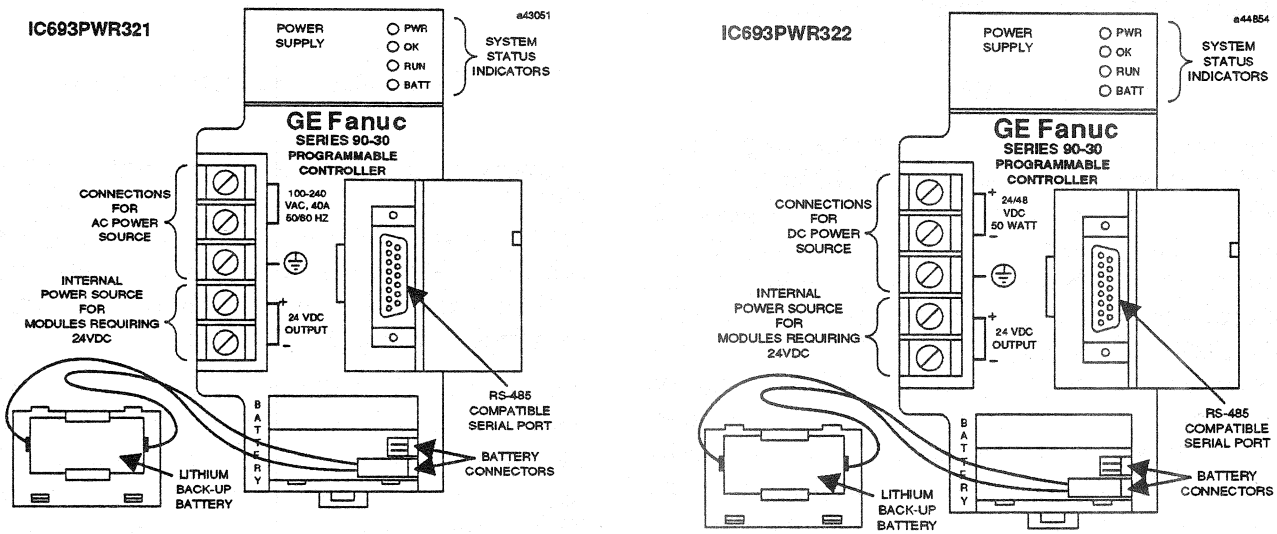

Figure 5-10. Series 90-30 Power Supplies

Field Wiring Connections to Power Supply

The 120/240 VAC, 24/48 VDC or 125 VDC power source connects to the PLC system through protected terminals on the power supply faceplate. Two terminals on the terminal board provide connections to an internally supplied Isolated 24 VDC output. This 24 VDC source can be used to supply power for some input circuits on 24 VDC Input modules.

System Status Indicators on Power Supply

Four LEDs on the power supply function as system status indicators. The purpose of these LEDs is to provide power supply status (PWR), system

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operating status (OK), RUN mode status (RUN), and RAM memory back-up battery status (BATT).

Serial Port Connector on Power Supply

A 15-pin D-type female connector, accessed by opening the hinged door on the right front of the power supply, provides the connection to a serial port which is used to connect the programmer for Logicmaster 90 programming software, or to connect the Hand-Held Programmer to the PLC. This serial port provides RS-422 signals and is RS-485 compatible.

Backup Battery for RAM Memory

A Lithium battery (IC693ACC301) used to maintain the contents of the CMOS RAM memory in the CPU is mounted on a plastic clip on the inside of the faceplate cover. This battery connects to the CPU through a cable which mates with one of two identical connectors mounted on the PLC. As a convenience to the user, this battery may be replaced with power applied to the PLC.

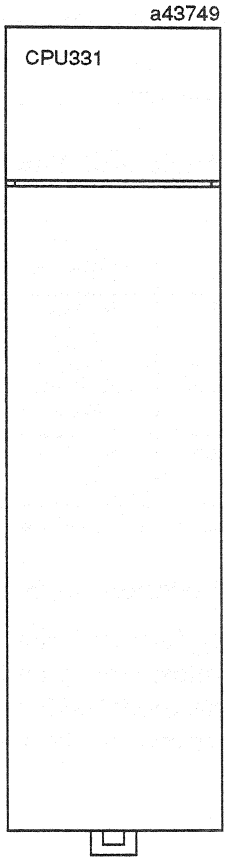

Figure 5-11. Model 331 CPU

Series 90-30 PLC CPUs

The two available Central Processing Units (CPU) for the Series 90-30 PLC differ in speed, I/O capacity, size of user memory, and physical form. The Model 311 CPU is built into the printed circuit board, which also serves as the backplane, and is physically mounted on the baseplate. This CPU (IC693CPU331) is provided as a separate module which must be installed in slot 1 of the CPU baseplate. System run mode and system operating status are indicated by LEDs on the power supply, as is the status of the RAM memory back-up battery.

Each Series 90-30 Model 331 CPU contains an 80188 microprocessor as the main processing element, memory, and a dedicated VLSI coprocessor for performing boolean operations. The 80188 microprocessor provides all fundamental sweep and operation control, and execution of all non-boolean functions. Boolean functions in the Model 331 are handled by a dedicated VLSI Instruction Sequencer Coprocessor (ISCP) with battery-backed RAM memory.

Memory on the CPU board consists of on-board EPROM, and on-board battery protected RAM for the system software and the user's application program. When installing a new or replacement CPU board, ensure that the battery is connected to provide backup for RAM memory.

The Model 331 CPU module has the provision for a battery to be connected directly to the module so that it may be shipped or stored with an application program stored in RAM memory. This battery is not to be used when the CPU module is installed in the baseplate and the backup battery is installed in the power supply.

The Model 311 CPU (located on the baseplate circuit board) must be shipped with the power supply installed and the battery connected in order to maintain the contents of RAM memory, or it can be shipped with EPROM memory installed.

Series 90-30 PLC I/O Subsystem

The I/O subsystem for the Series 90-30 PLC is the Series 90-30 PLC I/O, which is referred to as ***Model 30 I/O***. Model 30 I/O modules plug directly into the Series 90-30 PLC baseplates. Model 30 I/O modules can be installed in any available slot in the CPU baseplate (Model 311 and Model 331), or into any of the slots in any of the expansion baseplates (Model 331 only).

The Model 331 CPU supports up to 49 Model 30 I/O modules. The Model 311 5-slot CPU supports five Model 30 I/O modules, and a Model 311 10-slot CPU supports ten I/O modules.

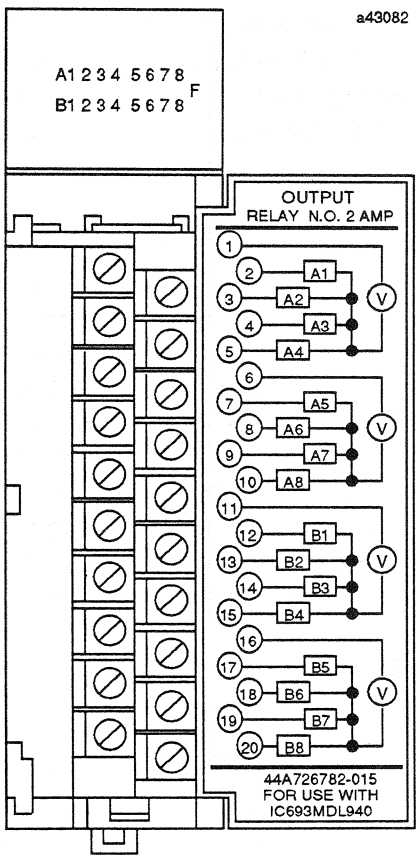

Figure 5-12. Example of Model 30 I/O Module

I/O modules are retained in their slots by molded latches that easily snap onto the upper and lower edges of the baseplate when the module is fully inserted into its slot.

Model 30 I/O Module Types

Model 30 I/O modules are available as five types: discrete inputs and outputs, analog inputs and outputs, and intelligent option modules which are used with Model 311 and Model 331. Additionally, there are special function option modules for use only with the Model 331. Discrete Input modules have either 8, 16, or 32 points; discrete output modules have from 5 to 32 points, depending on type. Analog modules are available as four channel inputs or two channel outputs.

Option Modules

Intelligent option modules include a High Speed Counter (HSC) and a Genius Communications Module (GCM). The special function option modules include three versions of a Programmable Coprocessor Module (PCM), Alphanumeric Display Coprocessor Module (ADC), and a Communications Module (CCM2, RTU)

Programmable Coprocessor Module

The Series 90-30 Programmable Coprocessor Module (PCM) provides a high performance coprocessor for the Series 90-30 PLC Model 331 (PCM not available for Model 311). The PCM is available in three versions, the difference being the size of the available memory for user and system memory requirements.

- IC693PCM300 - 160K Bytes (35K Bytes MegaBasic program)
- IC693PCM301 - 192K Bytes (47K Bytes MegaBasic program)
- IC693PCM311 - 640K Bytes (190K Bytes MegaBasic program)

The PCM supports the GE Fanuc CCM communications protocol, has two serial ports, supports the MegaBasic programming language, and is programmed using a Workmaster or Cimstar industrial computer, or an IBM or compatible personal computer. The PCM contains an 80188 microprocessor as its main processing element, on-board memory, an interface to the system bus and the serial ports, and a watchdog timer. The 80188 microprocessor handles all processing and operation control on the board.

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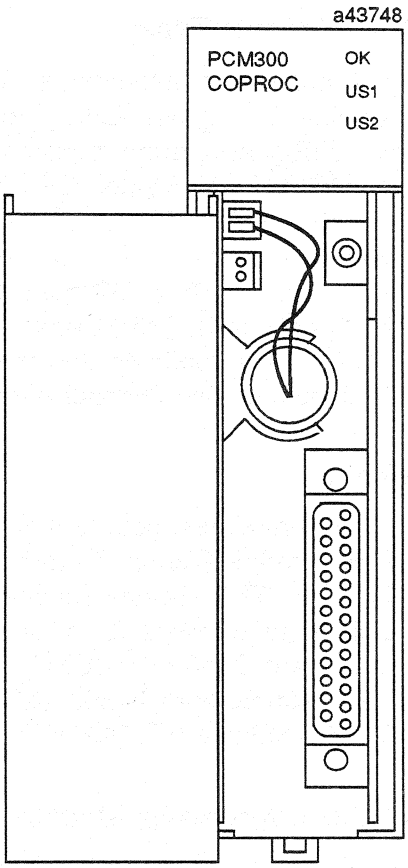

Figure 5-13. Programmable Coprocessor Module

The PCM contains an 80188 microprocessor as its main processing element, on-board memory, an interface to the system bus and the serial ports, and a watchdog timer. The 80188 microprocessor handles all processing and operation control on the board.

Memory on the PCM consists of EPROM, and local and shared RAM, which is battery-backed. A watchdog timer in the PCM is periodically reset by the PCM system software. If the watchdog timer expires, the PCM will stop functioning and the Board OK LED will turn off.

The PCM module has a lithium battery for backing-up RAM memory, three LEDs for system and user status, a Restart/Reset pushbutton, and a single 25-pin connector which supports two ports. Port 1 provides an RS-232 interface, while port 2 provides RS-422 compatible signals.

A PCM can be installed in any I/O slot in the Model 331 CPU baseplate. A Series 90-30 PLC system may have up to four PCMs in the CPU baseplate. The Lithium battery for backup of RAM memory on the board is installed in a battery mounting clip on the inside of the PCM faceplate. This battery is disconnected for shipment from the factory and must be connected prior to installation of the module. When the PCM is stored for extended periods of time, the battery should be disconnected, unless you wish to retain the program in RAM memory.

The PCM must be configured for use in a CCM or MegaBasic application, however, an autoconfiguration file with standard CCM settings is provided as a default configuration. For other applications, the CCM and default port PCM settings may be changed in the Logicmaster 90 configurator or by the PCM support software.

Connection to both ports is made through one 25-pin connector. A port expansion (WYE) cable is supplied with each PCM which allows separation of the RS-232 signals from the RS-485 signals. This cable is one foot in length, and has a right angle male connector on one end and a dual female connector (one for port 1 and one for port 2) on the other end. Two versions of this cable are available; (1) IC693CBL304, used with PCM300, and (2) IC693CBL305, used with PCM301, PCM311, and the Communications Module (CMM311). An example of this connection is shown in the following figure.

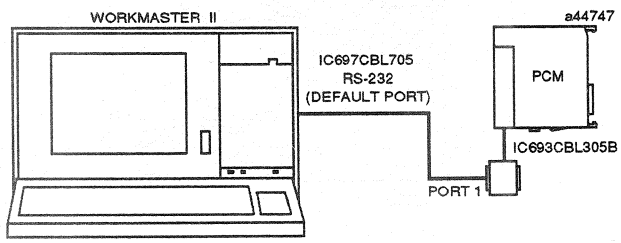

Figure 5-14. PCM to Programmer Connection

For more information on the PCM, refer to GFK-0255, the *Series 90 Programmable Coprocessor Module User's Manual.*

Genius Communications Module

A Genius Communications module, catalog number IC693CMM301, for the Series 90-30 PLC provides Global Communications on a Genius Communications bus between Series 90-30 PLCs, and other GE Fanuc PLCs. Series 90-70, Series Six, and Series Five PLCs communicate on this bus via Genius Bus Controllers.

The Genius Communications bus is a token passing peer-to-peer, noise immune network optimized to provide high speed transfer of real time control data. Up to eight Series 90-30 PLCs, (or other PLCs) in any combination, can communicate with each other over a single Genius I/O serial bus using a standard twisted pair, shielded cable.

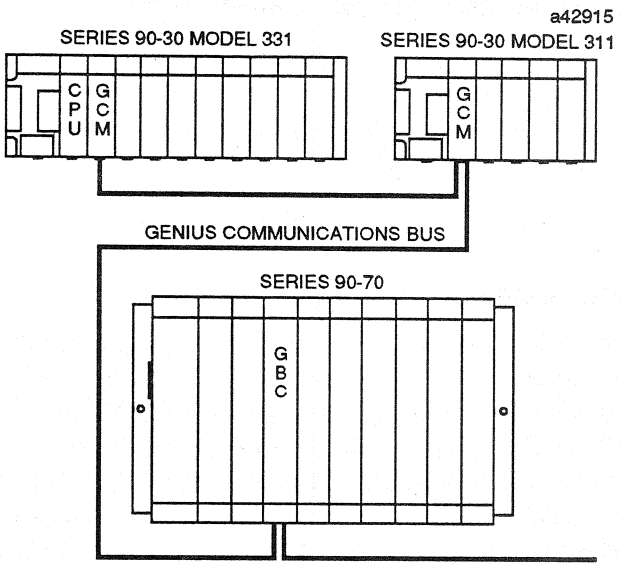

Figure 5-15. Example of Genius Communications Network

Communications Module (CMM)

The Communications Module (CMM), catalog number IC693CMM311, provides a high performance coprocessor for the Model 331. It cannot be used with the Model 311.

The CCM supports the GE Fanuc CCM2 communications protocol and RTU protocol, has two serial ports, and is programmed using a Workmaster II or Cimstar industrial computer, or an IBM or compatible personal computer (programming not needed if defaults used). The CMM hardware is similar to the PCM described above. For detailed information on CMM communications, refer to the Series 90 Data Communications User's Manual, GFK-0582.

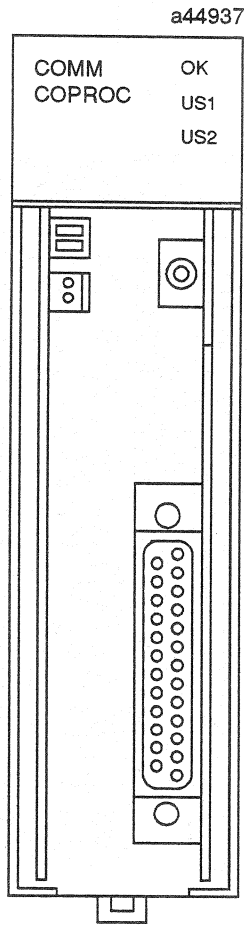

Figure 5-16. Communications Module (CMM)

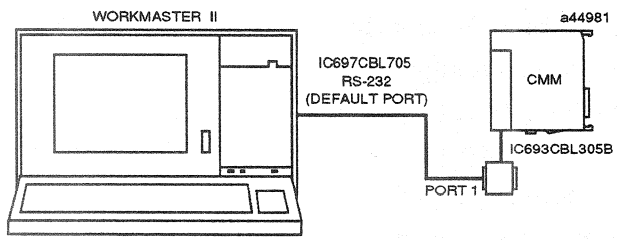

Figure 5-17. CMM to Programmer Connection

High Speed Counter

The High Speed Counter module (IC693APU300) provides direct processing of rapid pulse signals up to 80 kHz for industrial control applications and provides up to four counters per module.

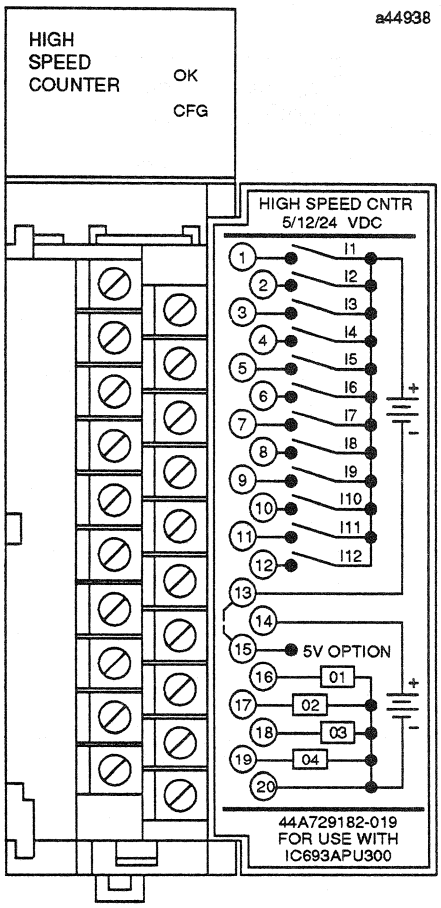

Figure 5-18. High Speed Counter Module

Typical applications for the High Speed Counter are:

- Turbine flowmeter
- Meter proving
- Velocity measurement
- Material handling
- Motion control
- Process control

Direct processing means that the module is able to sense inputs, process the input count information, and control the outputs without needing to communicate with a CPU.

The High Speed Counter is configured using the Series 90-30 Hand-Held Programmer or the Logicmaster™ 90-30 Programming Software Configurator function. Many features can be configured from the user's application program as well. Each feature is set to a factory default configuration which is suitable for many applications. There are no jumpers or DIP switches to set on the module. Two green LEDs at the top of the module indicate the operating status of the module and the status of configuration parameters.

The High Speed Counter provides you with a choice of three different counter types:

- Type A - selects 4 identical, independent simple counters
- Type B - selects 2 identical, independent more complex counters
- Type C - selects 1 complex counter

Alphanumeric Display Coprocessor

The Alphanumeric Display Coprocessor module (IC693ADC311) is a coprocessor to the Series 90-30 PLC CPU and is used in a CIMPLICITY 90-ADS System (Alphanumeric Display System). It is programmed to perform CIMPLICITY 90-ADS display, report, and alarm functions when interfaced to an Operator Interface Terminal, which can be a GE Fanuc OIT, Mini OITor Touch Mini OIT, a VT100 compatible terminal, or a Workmaster II, or IBM compatible personal computer running TERMF. Communications with the Series 90-30 CPU is done over the PLC system backplane.

Operation is simple - you plug the module into the selected slot in the baseplate and follow on-screen prompts through the configuration process. An operator interface system can easily be customized to suit your application. A broad range of features is offered by the CIMPLICITY 90-ADS system, including:

- A single slot Alphanumeric Display Coprocessor module
- Runs CIMPLICITY 90-ADS software
- 8 Mhz, 80C188 microprocessor
- High performance access to PLC memory
- Real time calendar clock synchronized to PLC
- Reset pushbutton; three status LEDs
- Soft Configuration (No DIP switches or jumpers)
- Easy fill-in-the-blank system building
- Windowing, featuring pop-up windows and pull-down menus
- 15 User definable function keys per screen
- Alarm handling
- Printer logging to a serial printer

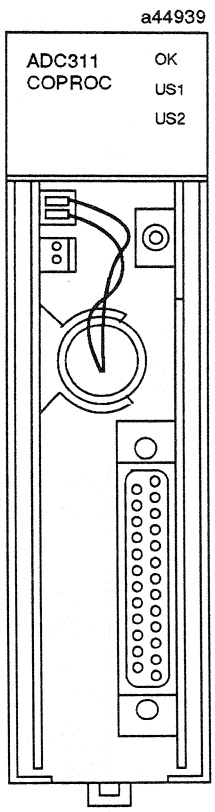

Figure 5-19. Alphanumeric Display Coprocessor Module

Multiple Access 90 Display Coprocessors can be supported in a single Series 90-30 PLC system and must be located in a Model 331 CPU baseplate. This module has two serial ports with each port being dedicated to a specific operation. The top port, port 1 is normally connected to an RS-232 serial COM port of a host computer for communications to PCOP at 19.2 Kilobaud. Alternately, port 1 may be connected to a serial RS-232 printer. Initially, port 2 is configured as a 19.2 Kbaud RS-232 port. The bottom port may be used to interface to a terminal with keyboard input and screen output similar to an OIT.

Programming and configuration are done using a Workmaster II, Workmaster, or an IBM-compatible PC, XT, AT, or PS/2 computer with PCM Development Software (PCOP) installed connects to the top port. The default setting is 19,200 bps. The PCM Development Software is used to configure the serial port parameters and to install the ACCESS 90 software onto the ADC.

There are no DIP switches or jumpers on this board which require configuration by the user. The Alphanumeric Display Coprocessor module must be configured with Logicmaster 90-30 Configuration software prior to using the module. For detailed information on installing the Alphanumeric Display Coprocessor module, selecting the terminal for your application, and installing the ADS software onto the ADC module, refer to GFK-0499, which is the CIMPLICITY 90-ADS User's Manual. For detailed information on building an operator interface system using the CIMPLICITY 90-ADS system, refer to GFK-0641, the CIMPLICITY 90-ADS Reference Manual.

RS-422/RS-485 to RS-232 Converter

An RS-422/RS-485 to RS-232 Converter (IC690ACC900) provides an RS-232 interface to external devices requiring the RS-232 serial interface through conversion of the RS-422/RS-485 signals provided at the RS-422/RS-485 ports in the Series 90-30 PLC. This converter provides a direct serial connection to a Workmaster II or other computer used as the programming device for the Series 90-30 PLC. When this converter is

used. you do not need to have a Work Station Interface installed in the Workmaster II computer when the converter is used.

This converter is a small, convenient, self-contained device which requires only a cable connection to the Series 90-30 RS-422/RS-485 port on one end and a cable connection to the RS-232 device on the opposite end. The following figure illustrates use of the converter in a Series 90-30 PLC system.

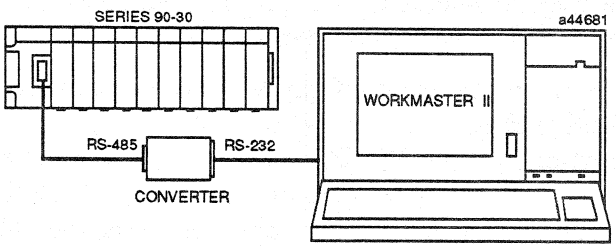

Figure 5-20. RS-422/RS-485 to RS-232 Converter Connection

The converter operates from a +5 VDC source, which is provided from the PLC backplane +5 VDC bus, through the cable connection. The pin assignments for the connections on the cable required for the RS-232 connection are compatible with available PCM compatible serial cables (IC690CBL701, PCM to Workmaster; IC690CBL705, PCM to Workmaster II; and IC690CBL702, PCM to PC-AT). The RS-422/RS-485 connection at the Series 90-30 serial port on the power supply may be made with an available cable (used with the Hand-Held programmer), IC693CBL303.

The three PCM compatible cables (IC690CBL701/702/705) are 10 feet (3 meters) in length, and the HHP compatible cable (IC693CBL303) is 6 feet (2 meters) in length.

You can also custom build the serial cables. Pin assignments and recommended cable types for both cables required for use with the converter are provided in Chapter 3, Installation Procedures, in GFK-0356, the Series 90-30 Installation Manual.

A Miniconverter kit (IC690ACC901) is also available which includes an RS-422 to RS-232 converter, an extension cable, and a converter plug assembly. This miniconverter plugs directly into the Series 90 serial port and attaches to the RS-232 serial device through an extension cable. No external power is needed to operate the moniconverter since power is drawn from the PLC's power supply. The converter plug is required to convert the 9-pin serial port connector on the Miniconverter to the 25-pin connector needed for use with the Workmaster II computer.

Work Station Interface

A Work Station Interface (WSI) board provides a high speed serial interface between a Series 90-30 PLC and the programmer for Logicmaster 90 software.

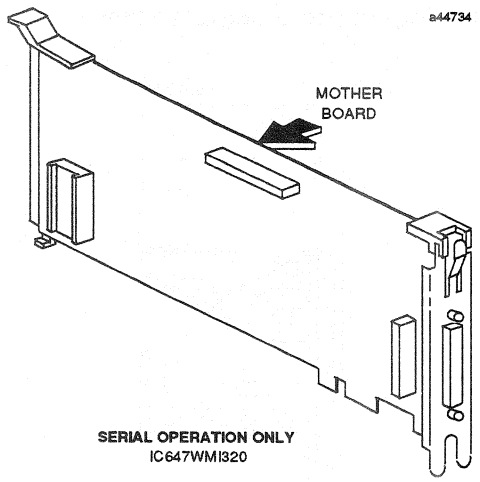

Figure 5-21. Work Station Interface for Workmaster II

The Work Station Interface is available in two serial only versions for the Series 90-30 PLC: (1) IC647WMI320, for Workmaster II, and IBM PS/2 and compatible personal computers, (2) IC640WMI310, for Workmaster of IBM PC or AT, or compatible personal computers. The Work Station Interface can be ordered as part of a package with Logicmaster 90 Programming Software.

The Work Station Interface board resides in a full length slot of the computer which executes the programming software. The computer used for programming can be a Workmaster II or Cimstar

I industrial computer, or an IBM-PC or compatible personal computer. When a Workmaster II computer is purchased as the programming device, the Work Station Interface board, if specified, is factory installed.

Hand-Held Programmer

Another method of programming the Series 90-30 PLC is with the Hand-Held Programmer (HHP), catalog number IC693PRG300. The HHP provides the tool required to program the Series 90-30 PLC using the Statement List Language. With the HHP, you can develop, debug, and monitor logic programs, monitor data tables, and configure PLC and I/O parameters. The required cable for the HHP (IC693CBL303) is included when IC693PRG300 is ordered.

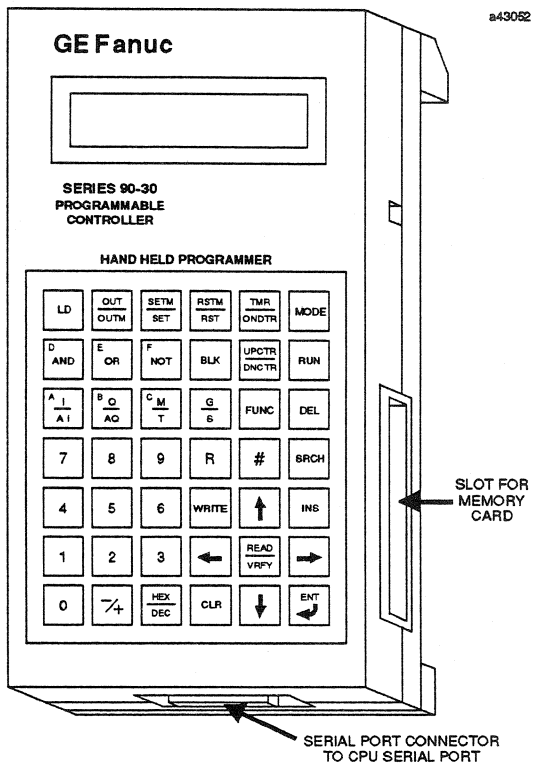

Figure 5-22. Hand-Held Programmer for the Series 90-30 PLC

The HHP connects to the CPU's serial port which is accessed through a 15-pin D-type connector on the Series 90-30 PLC power supply. The physical connection is through a cable that is 6 feet (2 meters) in length. This cable also provides power connections to the HHP, and provides a signal that tells the PLC that an HHP is attached. The HHP can be connected or disconnected to a PLC that is powered-up.

HHP Features

The keypad for the HHP is a sealed type with tactile feedback, and has 42 keys, arranged in a matrix of six keys across by seven keys down. A two-line by 16 character LCD display screen provides a means of visual information to the user.

The HHP also provides an interface to a removable memory card, catalog number IC693ACC303. The HHP can program EEPROM memory devices installed in the memory card which will retain the program stored in it under no-power conditions. This memory card, through the HHP interface, provides a means for off-line storage and retrieval of the user's application program and system configuration data. The memory card plugs into the lower right side of the HHP. This feature provides program portability and a way to store different programs for use as required.

HHP Modes of Operation

The HHP has four modes of operation which are selected through a key sequence on the keypad. These modes are: program mode, protection mode, data mode, and configuration mode.

Program mode allows you to create, change, monitor, and debug Statement List logic programs. While in this mode, you can read, write, and verify functions with the memory card. This mode also allows you to program EEPROMs.

Protection Mode provides a way to control access to (protection of) certain PLC functions, including program logic, reference data, and configuration information. The use of this function is optional; however, it is convenient in that it allows you to protect parts of the PLC system from accidental or deliberate modification. Protection is provided through four levels of passwords assigned by the user.

Data Mode allows you to view, and optionally alter values in various reference tables. Several display formats can be selected in which to view this data: binary, hexadecimal, signed decimal, and timer/counter.

Configuration Mode allows you to define the types of I/O modules that are installed or will be installed in the PLC system. You can also assign I/O module addresses to these modules. This feature is convenient in that it allows you to write and test logic programs using discrete references assigned to I/O modules that are not yet installed. In this mode, you can also configure CPU data, such as CPU type, real-time clock (Model 331 only), coil check, etc., and HHP characteristics, such as turning the keyclick on or off.

For detailed information about the Hand-Held Programmer, refer to GFK-0402, the *Series 90™-30 Hand-Held Programmer User's Manual.*

Chapter 6 Programming the Series 90-30 PLC

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Configuration and Programming

Configuration and Programming of the Series 90-30 PLC can be accomplished through the use of two different methods (Logicmaster 90-30/20 Programming software or Hand-Held Programmer). Application programs and system configuration can be done using Logicmaster™ 90 Programming software on a Workmaster® or Cimstar™ I computer or an IBM® PC or compatible Personal Computer, or they can be done using a convenient easy-to-use Hand-Held Programmer (HHP).

Configuration and programming can both be done with the programmer off-line from the PLC. Although configuration can be done after programming, it is recommended that configuration be done before programming, so that the programming software can check memory constraints.

Configuration and programming with the HHP must be done with the HHP attached to and interfacing with the PLC.

Detailed information on configuration and programming the Series 90-30 PLC can be found in the following manuals. Use of the programming and configuration software is described in the *Logicmaster™ 90 Programming Software User's Manual, (GFK-0263).*

The Workmaster II computer is described in the *Workmaster II PLC Programming Unit Guide to Operation Manual, GFK-0401.* The Hand-Held programmer is described in detail the *Series 90™ 30 PLC Hand-Held Programmer User's Manual, (GFK-0402).*

System Configuration

System configuration of a Series 90-30 PLC with the HHP or with the Configuration Software package, which is included as a part of the total Logicmaster 90-30/20 Programming Software package, can do the following:

- Specify the rack and slot location of each module in the system;
- Specify any unique characteristics for each module in the system;
- Specify a name for the system;
- Validate that the PLC configuration follows certain system rules and guidelines;
- Archive or save the configuration in a file;
- Transfer configurations between the PLC and the programmer (Logicmaster 90-30/20 only).
- Configure certain CPU parameters

Programming with Logicmaster 90-30/20 Software

All Series 90-30 CPU models have an expanded instruction set with a bit sequencer, program block moves, double precision math, easy to read diagnostic fault tables (both PLC and I/O Fault Tables), and four levels of password program protection, plus a level of password protection specifically designed for OEMs.

The Programming Software portion of the Logicmaster 90-30/20 Software package can do the following:

- Develop ladder diagram programs off-line;
- Monitor and change reference values on-line;
- Edit a program on-line;
- Transfer programs and configurations between the PLC and programmer;
- Store programs automatically on disk;
- Annotate programs;
- Print programs with annotation and/or cross references;
- Display help information;
- Use symbolic references;
- Cut and paste program fragments;

- Programmable teach keys;
- Print programs and configurations on various printers.

Programming with the Hand-Held Programmer

The HHP programming capability is used to develop, debug, and monitor ladder logic programs, and to monitor data tables. The HHP can do the following:

- Statement List logic program development, including insert, edit, and delete functions;
- On-line program changes;
- Search logic programs for instructions and/or specific references;
- Monitor reference data while viewing logic program;
- Monitor reference data in table form in binary, hexadecimal, or decimal formats;
- Monitor timer and counter values;
- View PLC scan time, firmware revision code and current logic memory use;
- Program EEPROM;
- Load, store, and verify program logic and configuration between the Hand-Held Programmer and a removable memory card in the PLC, which allows programs to be moved between PLCs or loaded into multiple PLCs;
- Start or stop PLC from any mode of operation.

Statement List Programming instructions provide 18 basic (boolean) instructions to execute logical operations such as AND and OR, and 38 functions to execute advanced operations including arithmetic operations, data conversion, and data transfer.

Software Structure

Series 90-30 PLC software structure uses a common architecture that manages memory and execution priority in the 80188 microprocessor. This operation supports program execution and basic housekeeping tasks such as diagnostic routines, input/output scanners, and alarm processing.

The operating system also contains routines to communicate with the programmer. These routines provide for the upload and download of application programs, return of status information, and control of the PLC.

The application (user logic) program which controls the end process to which the PLC is applied, is called a control program and is controlled by a dedicated Instruction Sequencer Co-processor (ISCP), which is comprised of physical hardware in the Model 331 CPU based system and software in the Model 311 based system.

The 80188 microprocessor and the ISCP can execute simultaneously allowing the microprocessor to service communications while the ISCP is executing the bulk of the application program; however, the microprocessor must execute the higher level instruction sequences.

Fault Handling - Series 90-30 PLC

Faults are handled by a software alarm processor function which logs I/O and system faults in two tables (PLC Fault Table and I/O Fault Table). These tables can be displayed on the Logicmaster 90-30/20 programmer screen or uploaded to a host computer or other coprocessor. In the Model 331, faults are also stamped with time and date information which further expands the diagnostic capability of the PLC.

Programmer Requirements

In order to run the Logicmaster 90-30/20 software, you will need a programming computer which can be one of the following:

- Workmaster computer
- Workmaster II computer with a 101-key keyboard;
- Cimstar I industrial computer with an 83-key or 101-key keyboard;
- IBM PC-XT, or AT personal computer with an 83 or 101-key keyboard;
- IBM-AT or PS/2 computer with a standard 101-key keyboard.

The Workmaster computer, with enhanced temperature specifications, and the Cimstar I computer, which is industrial-hardened, are well-suited for installations where programs must be transferred, monitored, or edited in harsh conditions of the factory floor. The Workmaster II computer has the additional advantage of being portable (under 20 pounds). Information on the Workmaster computer can be found in GFK-25373, the Workmaster Guide To Operation.

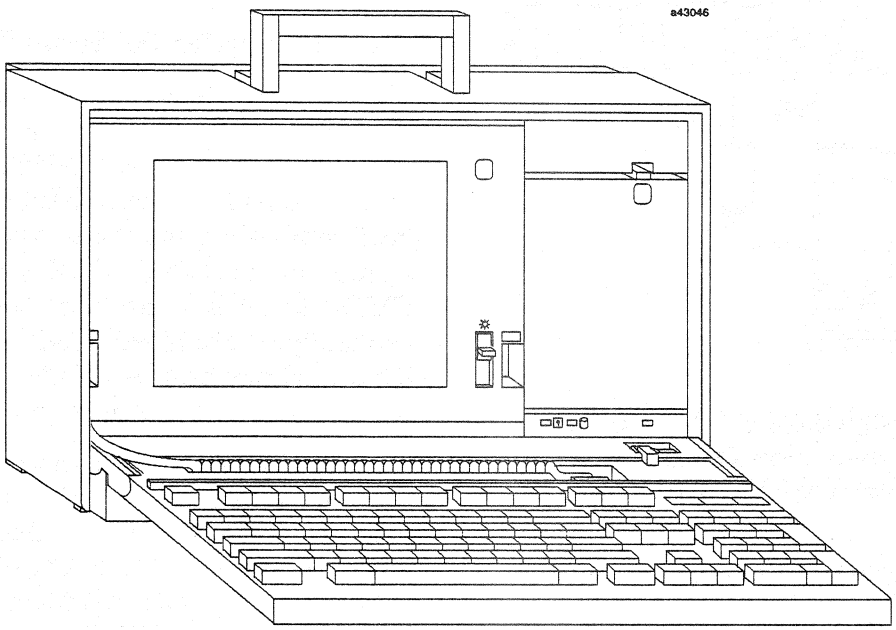

Figure 6-1. Workmaster II Computer

Workmaster II Computer

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, which is built to withstand wide temperature variations, shock, and vibration usually present in the factory environment.

Program storage in the Workmaster II computer is 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, and the display is a plasma display. The interface to the Series 90-30 PLC is through a fully programmable serial port which supports asynchronous communications.

The portability, high-storage capacity, and ease of use of the Workmaster II computer with Logicmaster 90-30/20 programming software provide a powerful programming and system monitoring tool for virtually any PLC application.

Logicmaster 90-30/20 Serial Communications

Logicmaster 90-30/20 Programming software communicates with the Series 90-30 PLC through through a standard RS-232 port in the programming computer when using an available RS-422/RS-485 to RS-232 converter (IC690ACC900) or miniconverter (IC690ACC901), or optionally through a Work Station Interface (WSI) board which must be installed in the computer to be used for programming.

A serial cable provides the physical connection from the programmer (with Logicmaster 90-30/20 Programming software) to the PLC. The connection to the Series 90-30 PLC is to a dedicated serial port connector located on the power supply module in the CPU baseplate. This

connector is accessed by opening a hinged door on the front of the power supply.

The following figure illustrates the serial connection options between the programming computer and the Series 90-30 PLC.

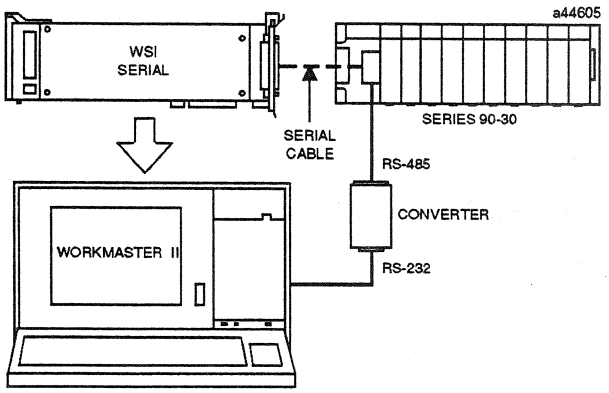

Figure 6-2. Logicmaster 90-30/20 Serial Connection Options to a Series 90-30 PLC

Hand-Held Programmer Communications

The Hand-Held Programmer communicates with a Series 90-30 PLC through a 6 foot (2 meters) long serial cable (IC693CBL303). This cable is included with the Hand-Held Programmer (IC693PRG300). One end attaches to the bottom of the Hand-Held Programmer and the other end attaches to a connector located behind the small hinged door on the PLC power supply.

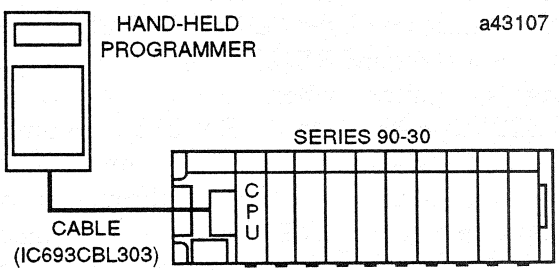

Figure 6-3. Hand-Held Programmer Connection to Series 90-30 PLC

The cable connection supplies power to the Hand-Held Programmer. It also provides an indication to the PLC that a Hand-Held Programmer is attached as the programming device rather than a different programmer, since this is the same connection for the Logicmaster 90-30/20 programmer.

User Memory for the Series 90-30 PLC

The type of memory available to the user is CMOS RAM, which is an acronym commonly used for Complimentary Metal-Oxide Semiconductor, Random Access Memory. User developed application programs and register data are stored in on-board CMOS RAM memory. CMOS RAM is a fast, low power memory that can easily be examined (read) and changed (written to). However, it is volatile, which means that it can lose its content if power is removed.

To retain its content under no-power conditions, a back-up battery is provided in the form of a long-life lithium battery. Because of the low power drain of CMOS RAM memory devices, a lithium battery can maintain the contents of memory without application of power for approximately 6 months. The storage, or shelf life, of a new lithium battery is typically 8 to 10 years.

User References

Data in Series 90-30 programs is referenced by its address in the system. A reference indicates how data is stored in the PLC and specifies both a memory type and a precise address.

%I00001	specifies address 1 in input memory.
%R00256	specifies address 256 in register memory.

The % symbol is used to distinguish machine references from nicknames.

The prefix of a user reference is an indication of the type of data that is referenced. References in the Series 90-30 PLC are either discrete or register references. The following table lists these user references, quantity of each reference, and the range for each reference available for the Series 90-30 PLC.

Table 6-1. Range and Size of User References

Reference Type	Model 311		Model 331 CPU	
	Reference Range	Size	Reference Range	Size
User program logic	Not applicable	6K bytes	Not applicable	16K bytes
Discrete inputs	%I0001 - %I0160	160 bits	%I0001 - %I0512	512 bits
Discrete outputs	%Q0001 - %Q0160	160 bits	%Q0001 - %Q0512	512 bits
Discrete globals	%G0001 - %G1280	1280 bits	%G0001 - %G1280	1280 bits
Internal coils	%M0001 - %M1024	1024 bits	%M0001 - %M1024	1024 bits
Temporary coils	%T0001 - %T0256	256 bits	%T0001 - %T0256	256 bits
System status references	%S0001 - %S0032	32 bits	%S0001 - %S0032	32 bits
	%SA001 - %SA032	32 bits	%SA001 - %SA032	32 bits
	%SB001 - %SB032	32 bits	%SB001 - %SB032	32 bits
	%SC001 - %SC032	32 bits	%SC001 - %SC032	32 bits
System register references	%R0001 - %R0512	512 words	%R0001 - %R2048	2K words
Analog inputs	%AI001 - %AI064	64 words	%AI001 - %AI128	128 words
Analog outputs	%AQ001 - %AQ032	32 words	%AQ001 - %AQ064	64 words
System registers †	%SR001 - %SR016	16 words	%SR001 - %SR016	16 words

† For reference table viewing only; may not be referenced in a user logic program.

User Register References

Register references are referenced as 16-bit words. The following types of references are register references.

- %AI - References analog inputs. This prefix is followed by the actual address of the reference, for example: %AI0016. The reference occupies 16 consecutive bits in %AI memory, beginning at the specified address.
- %AQ - References analog outputs. This prefix is followed by the actual address of the reference, for example: %AQ0056. The reference occupies 16 consecutive bits in %AQ memory, beginning at the specified address.
- %R - This prefix is used to assign register references that will store word-oriented program data, such as the results of calculations. Register memory can be configured up to 2048 words in a Model 331 and up to 512 words in a Model 311. These references are retentive under lodd of power conditions.

User Discrete References

Discrete reference types are addressed as individual bits of data. The following types of references are discrete references.

- %I - References discrete machine inputs. This prefix is followed by the reference's address in the status input table. For example: %I0012. The %I references are located in the input status table, which stores the states of inputs received from the hardware during the last input scan.
- %Q - References discrete machine outputs. This prefix is followed by the reference's address in the output status table. For example: %Q0012. The %Q references are located in the output status table, which stores the states of outputs as last set by the application program. The states of these references are retained through loss of power unless used with a non-retentive coil (i.e. set -(S)- or reset -(R)-.
- %M - This prefix is used to reference internal coils. They are used in boolean logic when the result will be used again in the program. The %M references are retained through loss of power unless used with a ''normal'' coil, -( )-.

Since they do not represent actual machine outputs, any available location in %M memory can be assigned, for example: %M00064. Internal coils referenced as %SM (SET coil) and %RM (RESET coil) are retentive.

- %T - The %T prefix is used to reference temporary internal coils which may not be retained through loss of power. Temporary coils function like the %M references, described above. However, they can be used as often as needed as conditional contacts to control logic within the user program.
- %G - The %G prefix is used to represent Global Data that is shared between multiple devices when using the Genius Communications Module to communicate over a Genius I/O bus.
- %S - The %S prefix references system memory. %S references are retentive. The %S memory for fault references is divided into four sections: %S, %SA, %SB, and %SC. This memory is used by the PLC to store contact references that have special meaning as shown in the following example. Notice that a Reference and a nickname are listed. Nicknames are simply another name assigned to represent a reference. Nicknames are convenient to use in a ladder program since inputs, outputs, or registers are easily identified by the nickname as to their function in the overall control system.

Reference	Nickname	Description
%SA0002	ov_swp	Exceeded constant sweep time
%SA0009	cfg_mm	System configuration mismatch
%SB0011	bad_pwd	Password Access Failure

List of Programming Functions

Following is a list of Series 90-30 programming functions available with the Logicmaster 90-30/20 programming package.

Relay Functions

-] [-	Normally open contact
-]/[-	Normally closed contact
-( )-	coil
-(/)-	Negated coil
-(↑)-	Positive transition coil
-(↓)-	Negative transition coil
-(SM)-	Retentive SET coil
-(RM)-	Retentive RESET coil
-(M)-	Retentive coil
-(/M)-	Negated retentive coil
-(S)-	SET coil
-(R)-	RESET coil
|	Vertical link
-------	Horizontal link

Timer and Counter Functions

ONDTR	On delay "stopwatch" timer
TMR	Elapsed timer
UPCTR	Up counter
DNCTR	Down counter

Arithmetic Functions

ADD	Addition
SUB	Subtraction
MUL	Multiplication
DIV	Division
MOD	Modulo division

Relational Functions

EQ	Equal test
NE	Not equal test
GT	Greater than test
GE	Greater than or equal to test
LT	Less than test
LE	Less than or equal test

Bit Operation Functions

AND	Bitwise AND
OR	Bitwise OR
XOR	Bitwise exclusive OR
NOT	Bitwise one's complement negation
SHL	Bit shift left
SHR	Bit shift right
ROL	Bit rotate left
ROR	Bit rotate right
BITTST	Bit test (sense)
BITSET	Bit set
BITCLR	Bit clear
BITPOS	Bit position

Data Movement Functions

MOVE	Move
BLKMOV	Constant block move
BLKCLR	Memory block clear
SHFREG	Shift register
BITSEQ	Bit sequencer
COMREQ	Communications request

Table Functions

TBLRD	Table read
TBLWRT	Table write
SORT	Table sort

Conversion Functions

BCD4	Convert to 4-digit BCD

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INT	Convert to signed integer

Control Functions

DOIO	Perform an immediate I/O update
MCR	Master Control Relay
ENDMCR	End of Master Control Relay
LABEL	Target location for jump instruction
JUMP	Jump (to label)
COMENT	Rung Explanation (Comment)
SVCREQ	Request special PLC service
PIDIND	Independent term PID algorithm
PIDISA	ISA standard PID algorithm

Types

The following types are available from the Arithmetic, Relational, Bit Operation, and Data Movement functions.

WORD	Word type: 16 bits
BCD 4	BCD type: 4 digits, 16 bits
INT	Signed decimal type: 16 bits
DINT	Signed double-precision decimal type, 32 bits

Chapter 7
Series 90-30 PLC I/O System

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Overview of Series 90-30 I/O System

The rack-type I/O system for the Series 90-30 PLC is called Model 30 I/O. Modules for the Model 30 I/O system are available as single-slot compact modules which are easy to install and use.

There are basically five types of I/O modules available for use with a Series 90-30 PLC system. These five types of modules are briefly described below.

- Discrete Input
  - Model 30 discrete input modules convert AC and DC power levels from user devices to the logic levels required for processing by the PLC. An optical coupler provides isolation between the incoming power and the logic circuitry. Discrete input modules are available with 8, 16, or 32 points.
- Discrete Output
  - Model 30 discrete output modules convert logic levels into AC or DC power levels required for driving user supplied devices. A power semiconductor provides the drive and isolation for each output point. Discrete output modules are available that have 5, 8, 12, 16, or 32 points.
- Analog Input
  - Model 30 analog input modules provide A/D (Analog to Digital) conversion by converting an analog voltage into a scaled 12-bit number. Analog input modules are provided in two versions, a current module, and a voltage module, each having 4 input channels.
- Analog Output
  - Model 30 analog output modules provide D/A (Digital to Analog) conversion by converting a scaled 12-bit number into an analog voltage. Analog output modules are provided in two versions, a current module, and a voltage module, each with 2 output channels.
- Option Modules
  - Option modules for the Series 90-30 PLC include the Genius Communications Module and the High Speed Counter.
  - Specialized option modules can only be used in a Model 331 CPU based system. These modules include the Programmable Coprocessor Modules (available in 3 versions), Alphanumeric Display Coprocessor module, and the Communications Module (CCM).

For more detailed information on discrete and analog Model 30 I/O modules, refer to Chapter 6 of GFK-0356, which is the *Series 90-30 Programmable Controller User's Manual.* The Series 90-30 PLC User's manual contains the specifications and field wiring information for your system planning and installation purposes.

Detailed information on option modules for the Series 90-30 PLC can be found in the following documents:

- GFK-0412 - Genius Communications Module User's Manual
- GFK-0293 - Series 90™-30 High Speed Counter User's Manual
- GFK-0255 - Series 90™ Programmable Coprocessor Module and Support Software User's Manual
- GFK-0487 - Series 90™ PCM Development Software (PCOP) User's Manual
- GFK-0582 - Series 90™ PLC Serial Communications User's Manual
- GFK-0499 - CIMPLICITY™ 90-ADS System User's Manual
- GFK-0641 - CIMPLICITY™ 90-ADS System Reference Manual

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The following table is a list of currently available I/O modules for the Series 90-30 Programmable Logic Controller. Additional I/O modules are planned for the future. For availability of new modules consult your GE Fanuc PLC distributor, or your local GE Fanuc sales representative.

Table 7-1. Series 90-30 I/O Modules

Catalog Number	Description of Module	Typical Response Time	Maximum Current Per Point	Number of I/O Points
	Discrete Modules - Input			
IC693MDL240	120 VAC	30 ms	-	16
IC693MDL630	24 VDC Positive Logic	7 ms	-	8
IC693MDL640	24 VDC Positive Logic	7 ms	-	16
IC693MDL641	24 VDC Negative Logic	7 ms	-	16
IC693MDL643	24 VDC Positive Logic	1 ms	-	16
IC693MDL644	24 VDC Negative Logic	1 ms	-	16
IC693MDL652	24 VDC Positive/Negative Logic	20 ms	-	32
IC693MDL653	24 VDC Positive/Negative Logic	2 ms	-	32
IC693ACC300	Input Simulator	20 ms	-	8/16
	Discrete Modules - Output			
IC693MDL310	120 VAC, 0.5A	-	0.5A	12
IC693MDL330	120/240 VAC, 1A	-	1A	8
IC693MDL390	120/240 VAC Isolated	-	2A	5
IC693MDL730	12/24 VDC Positive Logic	-	2A	8
IC693MDL731	12/24 VDC Negative Logic	-	2A	8
IC693MDL732	12/24 VDC Positive Logic	-	0.5A	8
IC693MDL740	12/24 VDC Positive Logic	-	0.5A	16
IC693MDL741	12/24 VDC Negative Logic	-	0.5A	16
IC693MDL750	12/24 VDC Negative Logic	-	0.3A	32
IC693MDL751	12/24 VDC Positive Logic	-	0.3A	32
IC693MDL930	Relay, N.O., Isolated	-	4A	8
IC693MDL940	Relay, N.O.	-	2A	16
	Analog Modules			
IC693ALG220	Analog Input, Voltage	-	-	4 channel
IC693ALG221	Analog Input, Current	-	-	4 channel
IC693ALG390	Analog Output, Voltage	-	-	2 channel
IC693ALG391	Analog Output, Current	-	-	2 channel
	Option Modules			
IC693PCM300	Programmable Coprocessor Module, 160K	-	-	-
IC693PCM301	Programmable Coprocessor Module, 192K	-	-	-
IC693PCM311	Programmable Coprocessor Module, 640K	-	-	-
IC693ADC311	Alphanumeric Display Coprocessor Module	-	-	-
IC693APU300	High Speed Counter	-	-	-
IC693CMM301	Genius Communications Module	-	-	-
IC693CMM311	Communications Module	-	-	-

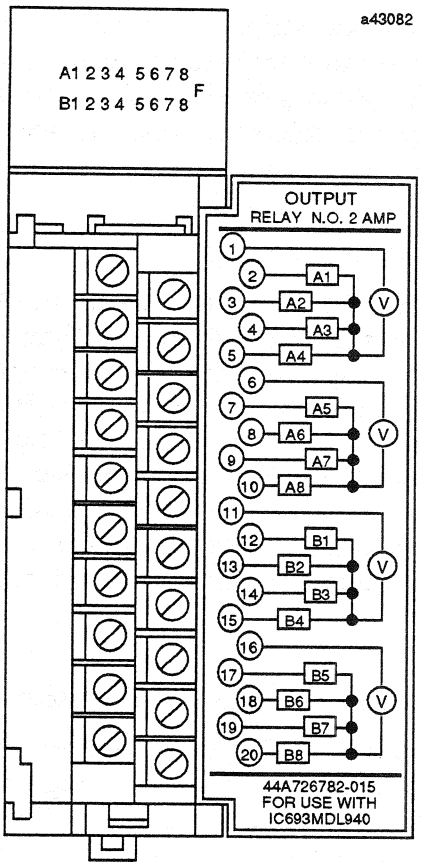

Figure 7-1. Typical Output Module

I/O Module Features

The circuit status of each I/O point is indicated by a green LED mounted at the top of the module. There are two horizontal rows of LEDs with 8 LEDs in each row. The top row is labeled A1 through 8 and the bottom row B1 through 8.

Each module has an insert that goes between the inside and outside surface of the hinged door. The surface towards the inside of the module (when the hinged door is closed) has circuit wiring information for that module type, and the outside surface has space to record circuit identification information.

The outside left edge of the insert is color coded so that you can quickly identify the module as a high voltage (red), low voltage (blue), or signal level (gray) type.

Removable Terminal Boards

All Model 30 I/O modules have, as a standard feature, detachable terminal boards for field wiring connections to user supplied devices. These terminal boards are easily removed and reinstalled in the field. This convenient feature makes it easy to prewire field wiring to the user supplied input and output devices, and to replace modules in the field without disturbing existing field wiring.

All detachable I/O connectors have 20 terminals and will accept up to one AWG #14 wire or two AWG #16 wires using ring or lug type terminals. For modules requiring a 24 volt DC power source an internal source of 24 volts is available on two terminals on the connector. Wires to and from field devices are routed out of the bottom of the terminal board cavity.

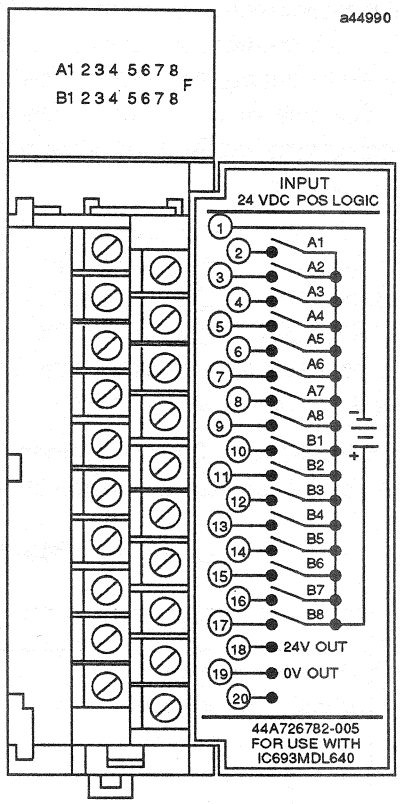

Figure 7-2. Typical Input Module

Field Connections to 32 Point Modules

Connections to the 32 point input modules from field devices and from the 32 point output modules to load devices to be controlled are made through a cable to a 50 pin connector on the front of each module. These cables may be purchased from GE Fanuc and are available as listed below. The wires in these cables are stranded 24 AWG gauge. Catalog numbers and lengths for these cables are:

- IC693CBL306, Extension Cable - 3 feet (1m)
- IC693CBL307, Extension Cable - 6 feet (2m)
- IC693CBL308, I/O Cable - 3 feet (1m)
- IC693CBL309, I/O Cable - 6 feet (2m)

The extension cables have a 50-pin male connector on one end and a 50-pin female connector on the other end. These cables provide a connection from the module connector to a connector mounted on a separate connector interface terminal assembly. A connector interface assembly for connecting field wiring to these high-density I/O modules. The use of a connector interface provides a convenient method of terminating field wiring to the modules.

Weidmuller Electrical and Electronic Connection Systems makes a connector interface assembly, catalog number RS-MR50B (female Honda connector) or RS-MR50S (male Honda connector) which can be used to terminate one or more of the GE Fanuc supplied I/O cables.

The I/O cables have a female connector on one end, and stripped and tinned wires on the other end. Each of the stripped and tinned wires has a label attached to it for ease of identification. The numbers on these labels correspond with the pin number of the connector wired to the opposite end.

I/O Module Addressing

Reference addresses for each module are assigned by the user with the Configuration portion of the Logicmaster 90-30/20 Programming Software package, or with the Hand-Held Programmer. The configurator function of Logicmaster 90-30/20 allows the user to assign reference addresses to the I/O modules on a slot-by-slot basis. There are no jumpers or DIP switch settings required for addressing of modules.

Number of I/O Modules in a System

A Series 90-30 PLC system can contain varying quantities of I/O modules, depending on the type of module and the specific system. These system requirements must be followed to assure proper system operation. The individual load requirements and number of I/O points used by these modules must be taken into consideration when planning your Series 90-30 PLC system.

The following table lists the maximum number of each type of discrete and analog I/O modules, option modules, and intelligent modules that can be installed in a Series 90-30 PLC system.

Table 7-2. Maximum Number of Modules Per System

Module Type	Model 311	Model 331
Discrete Input Module	5 (5-slot); 10 (10-slot)	49
Discrete Output Module	5 (5-slot); 10 (10-slot)	49
Analog Input Module	5 (5-slot); 10 (10-slot)	32
Analog Output Module	5 (5-slot); 10 (10-slot)	32
High Speed Counter	4	8
Genius Communications Module	1	1
Programmable Coprocessor	not applicable	4
Alphanumeric Display Coprocessor	not applicable	8
Communications Module	not applicable	8

† Total number of I/O points cannot exceed the maximum allowable per system (see Table 5-2).

Location of Modules in a System

The following illustration is a guide to the valid location of discrete, analog, and intelligent option modules in Series 90-30 PLC system configurations (Model 311 5-slot and 10-slot baseplate, and Model 331 5-slot and 10-slot CPU and expansion baseplates).

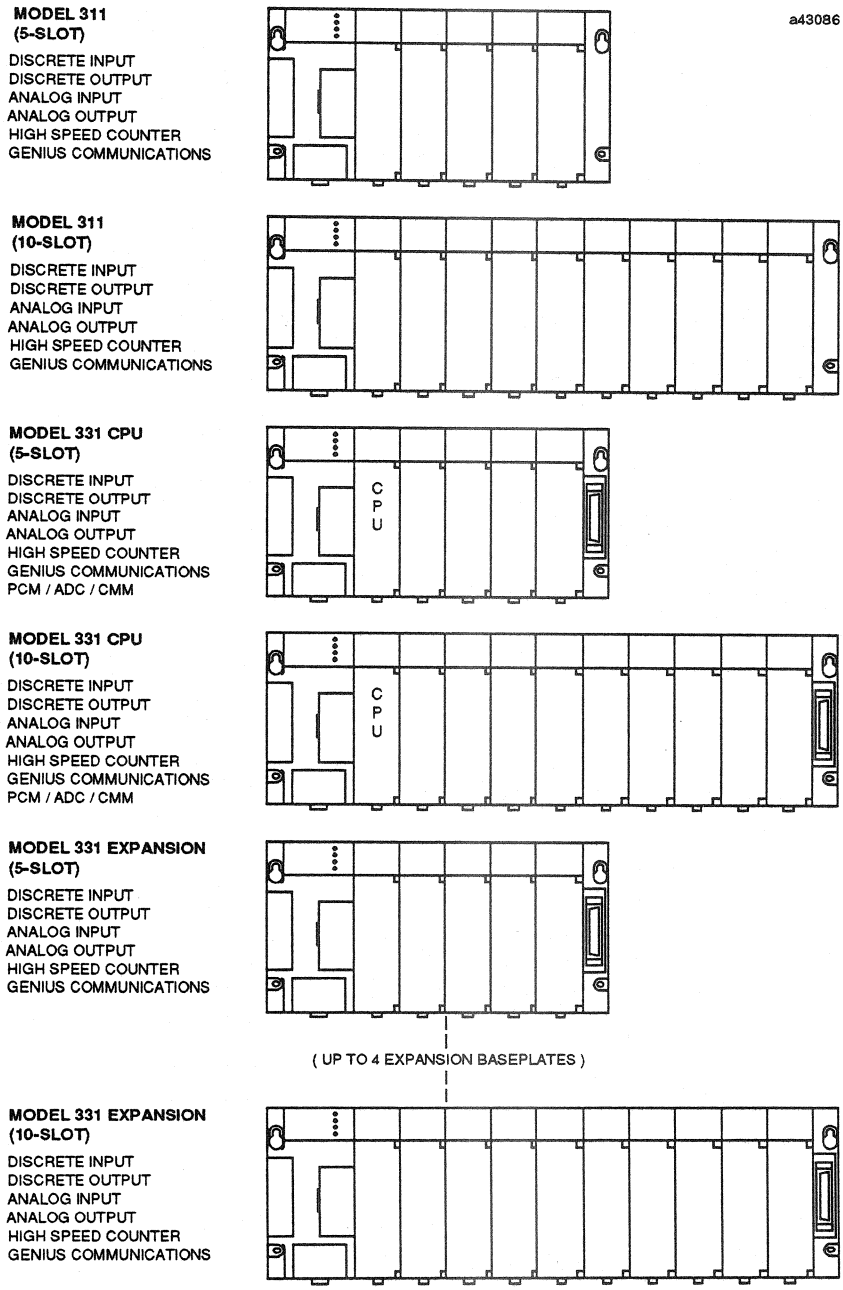

Figure 7-3. Location of Modules in Baseplates

Chapter 8
Series 90-20 PLC Hardware Description

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Introduction to the Series 90-20 PLC

The Series 90-20 PLC is easy to install and configure, offers advanced programming features, and is designed for compatibility with other PLCs in the Series 90 family of PLCs. The Series 90-20 PLC is designed for low I/O count applications and has a fixed I/O configuration of 28 I/O points, which includes 16 input points and 12 output points. The Series 90-20 PLC, as with the other Series 90 PLCs, is factory hardened to provide reliable, long-lasting service in the factory environment. Furthermore, it is designed to meet UL and CSA specifications.

The Series 90-20 PLC is ideal for OEMs who require a low-end PLC that is reliable, yet offers the durability, flexibility and programming ease of the more powerful member of the GE Fanuc Series 90 family of PLCs - the Series 90-30. Installation is easy, simply mount the I/O Base module on a panel, slide the CPU module onto the I/O Base module, and connect field wiring to the convenient detachable terminal strips. The same CPU module is used with all models of the I/O Base unit. This modular construction allows for easy and quick hardware replacement, should it be necessary. For example, a wiring error may result in a blown fuse. If this happens, fuse replacement is easy - remove the CPU, replace the fuse and snap the CPU back in place. You are back in business with a minimum of downtime.

Product Description

The Series 90-20 PLC hardware configuration consists of an I/O and Power Supply Base Module (baseplate) and a plug-on CPU module. The baseplate contains the discrete input and output circuits, high speed counter circuits, the power supply and terminal strips for user field wiring. Different I/O and power supply combinations are available to meet the customers requirements for various applications. The CPU module executes and contains the user program, communicates to the programmer, contains LED status indicators and has a long-life Lithium battery for backup of memory. The programmer can be a Hand-Held Programmer or a Workmaster II computer or IBM compatible personal computer running Logicmaster 90-30/20 software.

Table 8-1. Models of Series 90-20 PLCs

Catalog Number	Description	Discrete Inputs	Discrete Outputs
IC692MDR541	I/O and Power Supply Base Module, 24 VDC In/Relay Out with 120 VAC Power Supply	16 DC or 14 DC + 2 HSC	11 Relay 1 HSC
IC692MDR741	I/O and Power Supply Base Module, 24 VDC In/Relay Out with 240 VAC Power Supply	16 DC or 14 DC + 2 HSC	11 Relay 1 HSC
IC692MAA541	I/O and Power Supply Base Module, 120 VAC In/120 VAC Out with 120 VAC Power Supply	16 AC 2 HSC	11 AC 1 HSC
IC692CPU211	CPU Module, CPU211	-	

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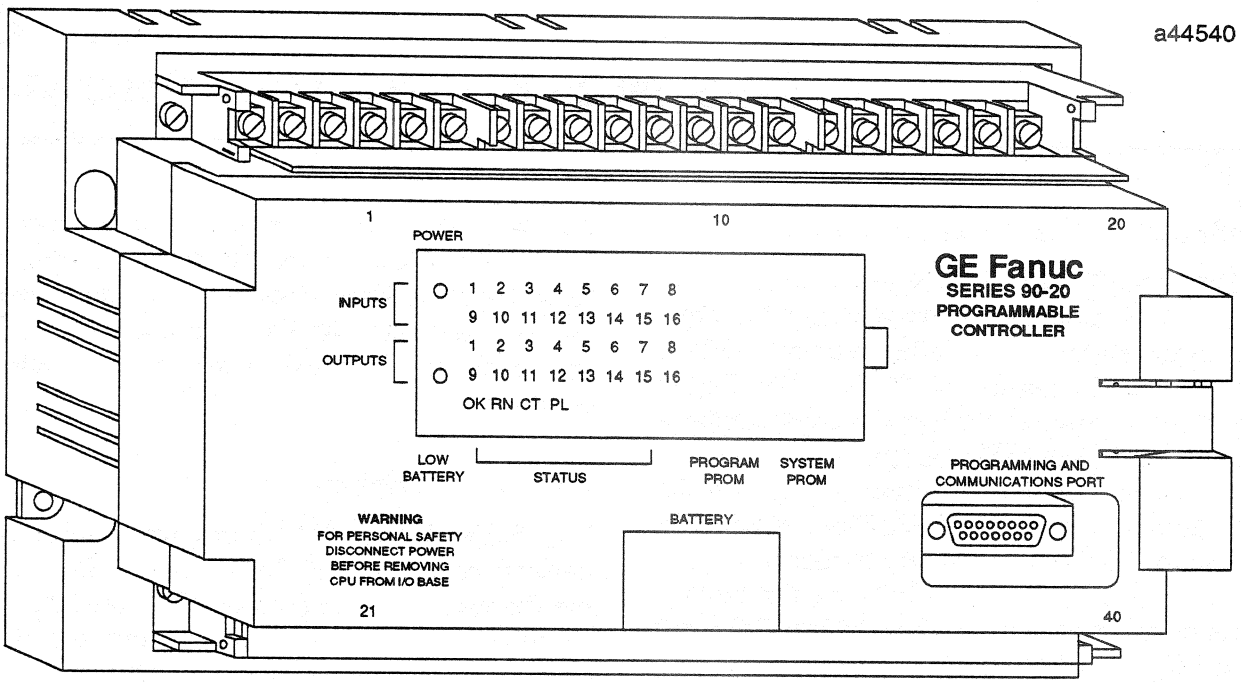

Figure 8-1. Example of Series 90-20 Programmable Logic Controller

General Specifications

General specifications for the Series 90-20 Programmable Logic Controller are provided in the following table.

Operating Temperature:	0° to 60°C 32° to 140°F (inlet air at bottom of rack)
Storage Temperature:	-40° to 85°C (-40° to 185°F)
Humidity:	5% to 95% (non-condensing)
Vibration:	0.2 5-10Hz, 1G 10-200 Hz
Shock:	15 g's for 11 msec
AC Power Source	120 VAC for IC692MAA541 and IC692MDR541; 240 VAC fo IC692MDR741
Module Weight:	
CPU Module:	0..69 pounds (.31 kg)
I/O and Power Supply Base:	3.81 pounds (1.73 kg)
Module Dimensions: **CPU and I/O Module Connected**	Height: 6.4″ (162.6mm) Width: 10.5″ (266.7mm) Depth: 3.54″ (89.9mm)
Back-up Battery Type:	Lithium, long-life
Typical Battery Life	About 5 years
Battery Shelf Life	8 to 10 years
Typical Scan Rate:	18.0 ms/1K of logic (boolean contacts)
Maximum number of Discrete Physical I/O Points:	28 (16 inputs/12 outputs)

CPU 211 Module

The CPU for the Series 90-20 is plugged into the I/O and Power Suppply Base module. This feature is valuable to OEM, since it allows the OEM to provide end users with program upgrades by simply replacing the existing CPUs with CPUs containing the new program.

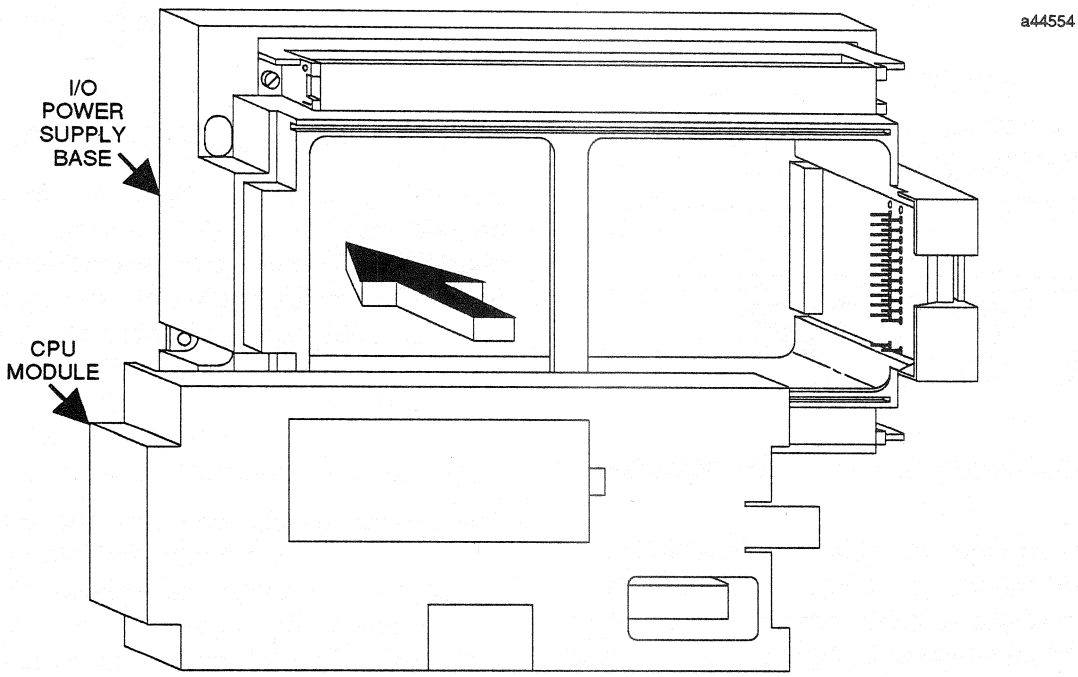

Figure 8-2. Installation of CPU Module on I/O Base Module

System Status Indicators

The Series 90-20 CPU 211 module contains an LED matrix and two discrete LEDs that indicate the I/O and CPU status.

The top LED, labeled POWER, gives an indication of the operating state of the power supply and is ON when the power supply has a correct source of power and is operating properly and OFF when a power supply fault occurs or power is not applied. The bottom red LED, labeled LOW BATTERY, provides the status of the memory backup battery.

The LED matrix provides a visual indication of the ON or OFF status of the input points and output points on the I/O baseplate. The input status is indicated by LEDs 1 through 16 and the output status is indicated by output LEDs 1 through 12. The output LED indicators 13 through 16 are available for user defined status indicators since there are no physical points on the the I/O modules for these references.

The first two LEDs (OK and RN) of the last row of the matrix are used for CPU status. The OK LED provides an indication of the operating status of the CPU and the RN LED, when ON, indicates that the user's logic program is executing and the CPU is in RUN mode.

The last two LEDs (CT and PL) provide a visual indication of the status of the COUNT and PRELOAD/STROBE parameters for the High Speed Counter.

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Battery Backup for RAM Memory

The long-life Lithium battery (IC693ACC301) used to maintain the contents of the CMOS RAM memory in the CPU is accessed by removing the cover plate located at the bottom of the CPU module.

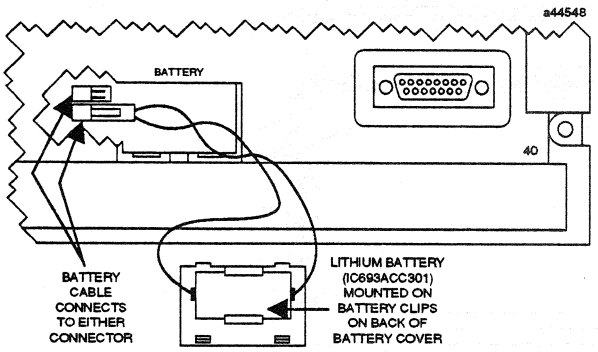

Figure 8-3. Battery Location and Mounting

This battery mounts on a plastic clip attached to the inside of the cover. The battery connects to the CPU through a cable which has one end wired to the positive and negative sides of the battery and the other end wired to a connector that mates with one of two identical connectors mounted on the CPU circuit board. This battery may be replaced with power applied to the PLC. Alternatively, it may be replaced with power OFF or with the CPU module removed from the I/O baseplate by plugging a new battery into the unused connector on the CPU circuit board and then removing the old battery.

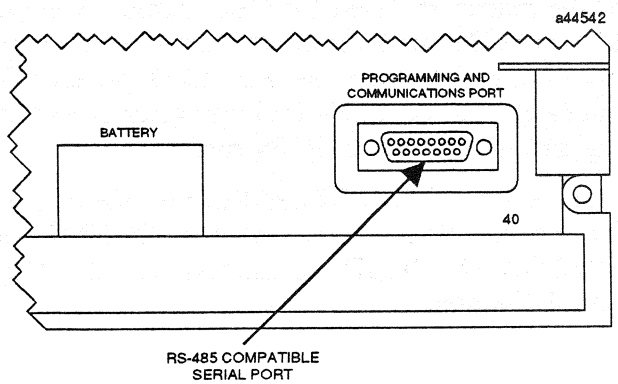

Figure 8-4. Serial Port for the Series 90-20 PLC

CPU Serial Port

A 15 pin D-type, female connector, on the right side of the CPU module provides the connection to an RS-485 compatible serial port which is used to connect to Logicmaster 90 programming software, the Hand-Held Programmer or for general purpose communications using Series 90 Protocol (SNP).

I/O Power Supply Base Module (Baseplate)

The I/O Power Supply Base Module (baseplate) provides user mounting locations, a power supply, I/O conditioning circuits (including the High Speed Counter input circuits) and terminal strips for user field wiring connections. The Series 90-20 PLC provides replaceable fuses located on the I/O power Supply Base module for output points and for a user accessible 24 volt power supply (on DC input models only).

The power supply converts the input source power to voltages required for internal circuitry. In addition, it provides an isolated 24 VDC supply to power dc input circuits, switches and indicators. This 24 volt supply is fused and the fuse is user replaceable. This fuse is accessed by removing the CPU module from the I/O base. A power source connects to the field wiring terminal strip as shown in the following illustration. The power source can be 120 VAC or 240 VAC depending on the model of I/O Base module.

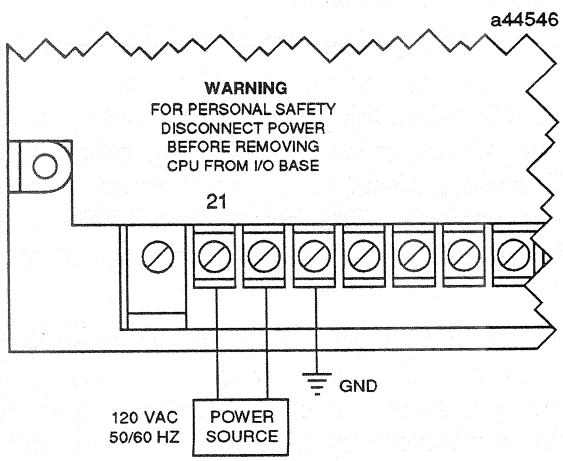

Figure 8-5. Power Source Connections

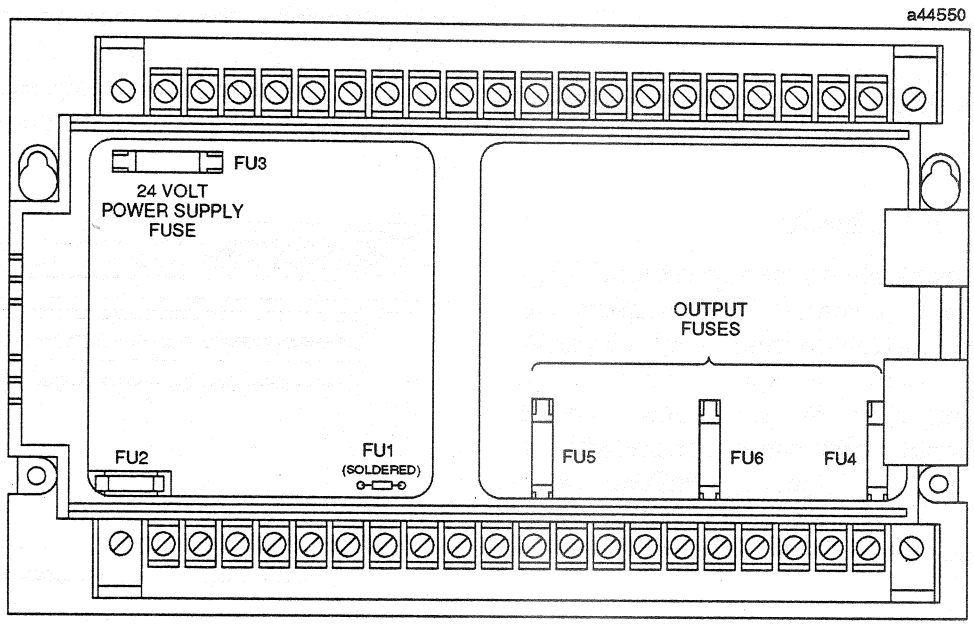

Figure 8-6. I/O Power Supply Base Module (Showing Location of Fuses)

Mounting the Series 90-20 PLC

The baseplate unit can be mounted into a flat panel area by use of mounting screws on the ends of the unit. Each baseplate unit has standard attachment flanges for panel mounting. These mounting locations are in the same location as the Series 90-30 Model 311 and Model 331 PLCs and is a convenient feature should you want to upgrade to the Series 90-30 PLC in the future.

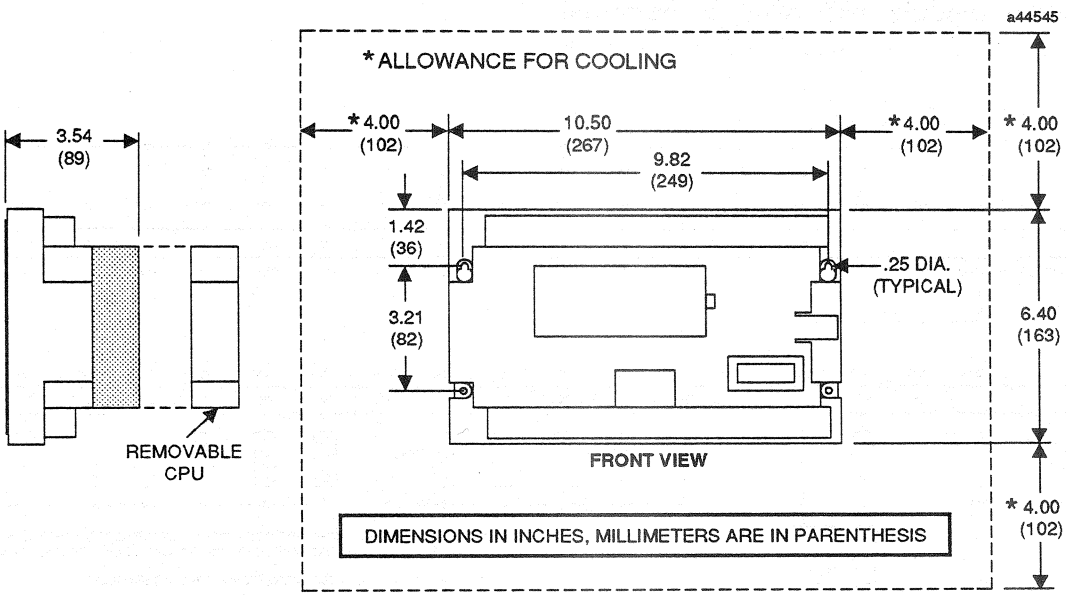

Figure 8-7. Baseplate Mounting Dimensions and Spacing Requirements

Input Circuits

Input circuits are connected to user supplied devices through field wiring to the top terminal strip on the I/O Base module.

High Speed Counter Inputs

Inputs are also available on the top terminal strip fot the High Speed Counter. These inputs are used by the CPU module to implement a Type A counter. This counter accepts a count input which increments a 16 bit accumulator and a preload/strobe input which can either preload the counter accumulator with a user defined value (PRELOAD mode) or strobe the accumulator (STROBE mode) into a 16 bit register.

Output Circuits

The output circuits allow the low level signals from the CPU module to control dc or ac output devices. Each common on a group of output points is fused and can be replaced by the user. Access to the fuses is obtained by removing the CPU module from the I/O base.

Connections to Removable Terminal Strips

The baseplate module has two, 20 terminal removable terminal strips which allow modules to be changed without removing or rewiring field connections to the terminals. The terminal pins for the terminal strips are designed to accept stab on terminals for ease of connection to pre-wired cables

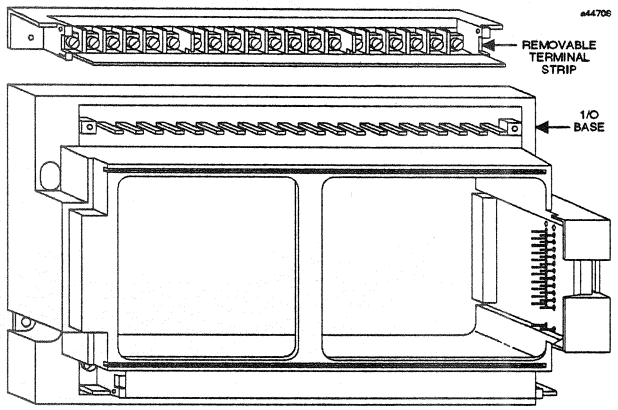

Figure 8-8. Removable Terminal Strip for User Field Wiring Connections

An example of field wiring to the terminal strips on the I/O base module is shown in the following figure.

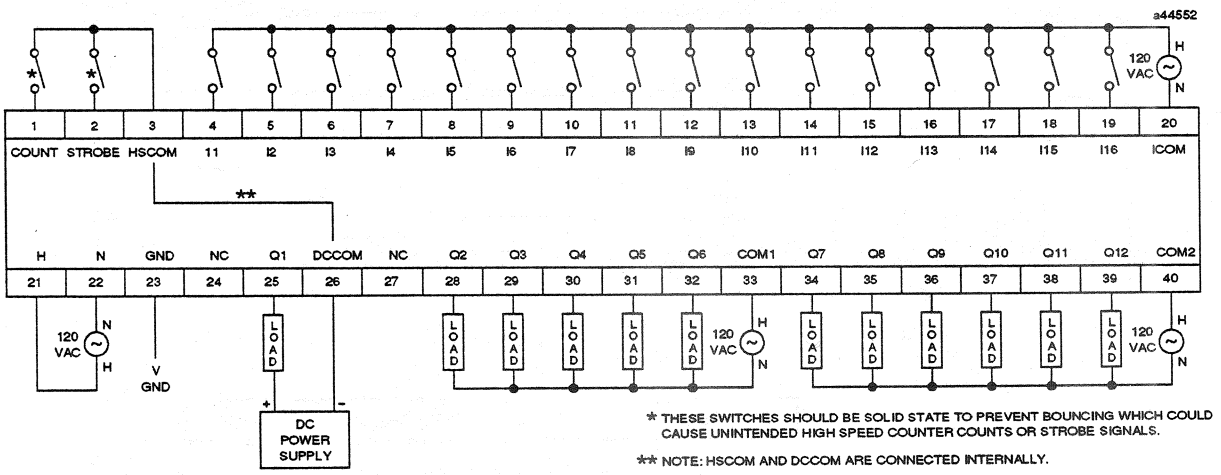

Figure 8-9. Example of Field Wiring Connections (IC693MAA541 Shown)

User PROM Option

Application programs are normally developed in the CPU's RAM memory and executed from RAM memory. If additional program integrity is desired, or operation of the PLC without a battery is desired, an optional EEPROM or EPROM can be installed in a spare socket (labeled PROGRAM PROM). EEPROMs can be read or programmed by the HHP. EPROMS can be read when installed in the PLC, however they must be programmed with an external PROM burning device.

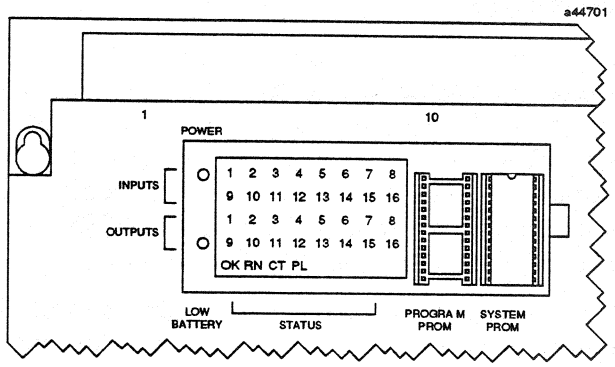

Figure 8-10. Location of Socket for User PROM Option

The EPROM and EEPROM options are a desired feature in that they provide protection against unauthorized programming changes. This is particulaly useful for OEMs and for those users who may have critical applications. A typical scheme for using these devices is to develop programs using an EEPROM. After the program in RAM has been developed and debugged, it is saved to EEPROM. The EEPROM can then be removed from the PLC and used as a master to make backup or multiple copies of the program to EPROM memory. The EPROM can then be installed in a socket in the CPU and used as a non-volatile memory for operation without a battery, or to run the same program in multiple PLCs.

When the EEPROM or EPROM is installed, the application program stored in the device is automatically loaded into RAM memory whenever the CPU is powered-up. However, this only happens, if EEPROM is selected as the PROGRAM SOURCE parameter during configuration with the Hand-Held Programmer or Logicmaster 90 configuration software.

EEPROM and EPROM memory chips are available from GE Fanuc. Catalog numbers for these devices are:

- EEPROM (quantity of four) - IC693ACC305
- EPROM (quantity of four) - IC693ACC306

High Speed Counter

The Series 90-20 PLC hardware configuration includes a built-in High Speed Counter which allows precise measurement of high speed, repetitive applications. This function provides direct processing of rapid pulse signals up to 10 kHz for industrial control applications such as:

- Turbine flowmeter
- Meter proving
- Velocity measurement
- Material handling
- Motion control

Direct processing means that the High Speed Counter is able to sense inputs, process the input count information, and control one output independently of the user ladder program. The High Speed Counter uses 16 words of input memory. This memory consists of 16 bits of discrete memory (%I) and 15 words of analog memory (%AI). These inputs are updated once per CPU sweep. The High Speed Counter also uses 16 bits of discrete output memory (%Q) which are automatically transferred once per sweep from the CPU.

The High Speed Counter can be configured using the Series 90-30/20 Hand-Held Programmer or the Logicmaster 90 Programming Software Configurator function. Many features can be configured from the user's application program as well. Each feature is set to a factory default configuration which is suitable for many applications. There are no jumpers or DIP switches to set. LEDs in the CPU LED matrix indicate the status of the High Speed Counter inputs and outputs.

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The Series 90-20 High Speed Counter is a Type A counter which consists of one 16-bit counter. This counter can be programmed to count either up or down. The counter accepts two inputs:

- Count input which increments or decrements a 16 bit accumulator.
- Preload/Strobe input which either preloads a user defined value into the accumulator or strobes the accumulator into a register. In addition, the counter has one dc output (Q1), with programmable on and off output presets.

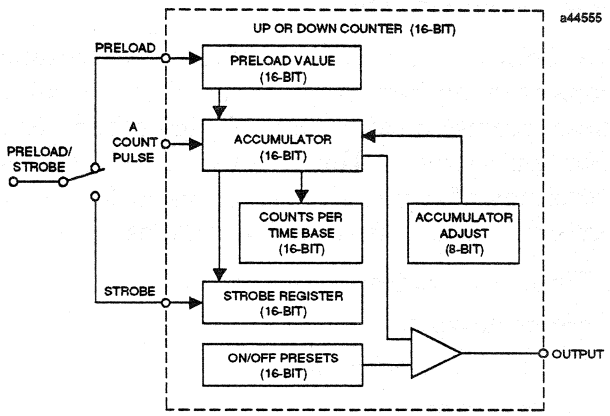

Figure 8-11. Type A Counter

Additional High Speed Counter Features

- Two positive/negative logic inputs with input voltage range of 12 to 30 VDC;
- One negative logic output;
- Counts per timebase register;
- Software configuration;
- Individual LEDs that provide a visual indication of Count input, preload/strobe input and output status.

One input is used as a count signal. The other input is used as a strobe or preload inputs depending on user configuration. The dc output can be used to drive indicating lights, solenoids, relays, and other devices.

Power sources for input and output points must be supplied by the user or by the +24 VDC Isolated output on the Series 90-20 I/O power supply base module.

A Counts per Timebase register indicates the number of counts in a given time interval. The Counts per Timebase data is a 16-bit signed number. The sign indicates up counts (+) or down counts (-). The Timebase value is specified in milliseconds and ranges from 10 to 65535 milliseconds (increments of 10 milliseconds).

All configuration parameters are stored in non-volatile memory in the PLC. An initial (default) set of configuration parameters is used in the absence of user changes to configuration.

Chapter 9 Programming the Series 90-20 PLC

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Programming and Configuration

Programming and configuration of the Series 90-20 PLC can be accomplished through two different methods (Logicmaster 90-30/20 Programming software or Hand-Held Programmer). Application programs and system configuration can be done using either Logicmaster 90-30/20 Programming software on a Workmaster II or Cimstar I industrial computer or an IBM® PC-XT, PC-AT, PS/2® (Personal System 2®), or compatible Personal Computer, or it can be done using a convenient Hand-Held Programmer (IC693PRG300).

Both configuration and programming can be done with the Logicmaster 90-30/20 programmer off-line from the PLC. Configuration and programming with the Hand-Held Programmer must be done with the Hand-Held Programmer attached to and interfacing with the PLC.

More detailed information on programming the Series 90-20 PLC can be found in the manuals listed here. Use of the programming and configuration software is described in the Logicmaster 90-30/20 Programming Software User's Manual, (GFK-0466).

The Workmaster II computer is described in the Workmaster II PLC Programming Unit Guide to Operation Manual, GFK-0401. Use of the Hand-Held Programmer is described in the Series 90-30 and 90-20 PLC Hand-Held Programmer User's Manual, (GFK-0402).

Programming With the Hand-Held Programmer

The Hand-Held Programmer (catalog number IC693PRG300) programming capability is used to develop, debug, and monitor ladder logic programs, and to monitor data tables. An illustration of the Hand-Held Programmer is shown in the following figure.

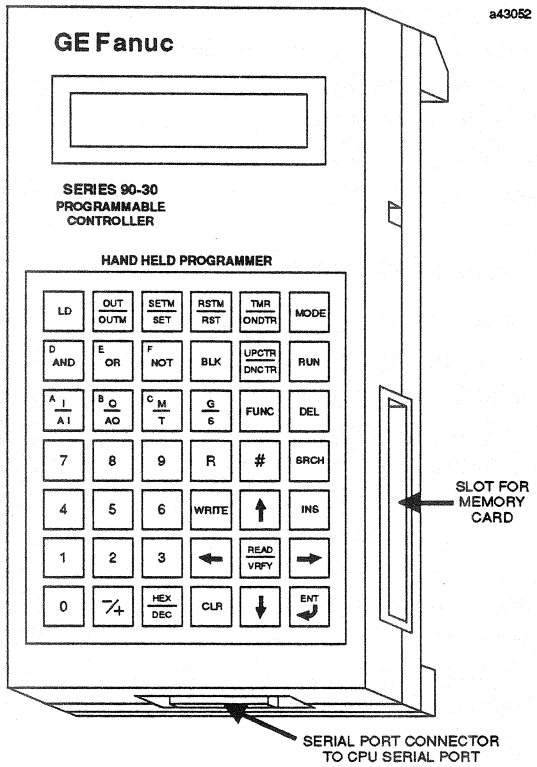

Figure 9-1. Hand-Held Programmer

The Hand-Held Programmer can do the following:

- Statement List logic program development, including insert, edit, and delete functions. The Statement List programming instructions provide 18 basic (boolean) instructions to execute logical operations such as AND and OR, and 38 functions to execute advanced operations including arithmetic operations, data conversion, and data transfer.
- On-line program changes;
- Search logic programs for instructions and/or specific references;
- Monitor reference data while viewing logic program;

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- Monitor reference data in table form in binary, hexadecimal, or decimal formats;
- Monitor timer and counter values;
- View PLC scan time, firmware revision code and current logic memory use;
- Load, store, and verify program logic and configuration between the Hand-Held Programmer and a removable memory card allows programs to be moved between PLCs or loaded into multiple PLCs;
- Start or stop the PLC from any mode of operation.
- Program EEPROM

The Hand-Held Programmer connects to the CPU's serial port through the 15-pin Programming and Communications Port connector on the Series 90-20 CPU module. The physical connection from the Hand-Held Programmer to the CPU is through a cable (IC693CBL303) that is 6 feet (2 meters) in length. The cable is included with the HHP. This cable also provides power connections from the power supply to the Hand-Held Programmer, and provides a signal that tells the PLC that an Hand-Held Programmer is attached. The Hand-Held Programmer can be connected or disconnected to a PLC that is powered-up.

Hand-Held Programmer Features

The keypad for the Hand-Held Programmer is a sealed type with tactile feedback, and has 42 keys, arranged in a matrix of six keys across by seven keys down. A two-line by 16 character LCD display screen provides a means of visual information to the user.

The Hand-Held Programmer also provides an interface to a removable memory card (IC693ACC303). The Hand-Held Programmer can program EEPROM memory devices in the memory card, which will retain the program stored in it under no-power conditions. This memory cartridge, through the Hand-Held Programmer interface, provides a means for off-line storage and retrieval of the user's application program and system configuration data. The memory card plugs into a connector accessed through an opening on the lower right side of the Hand-Held Programmer. This feature provides program portability and a way to store different programs for use as required.

Hand-Held Programmer Modes Of Operation

The Hand-Held Programmer has four modes of operation which are selected through a key sequence on the keypad. These modes are: program mode, protection mode, data mode, and configuration mode.

In ***Program Mode***, you can create, change, monitor, and debug Statement List logic. This mode also allows read, write, and verify functions with the optional memory card or EEPROM memory.

The ***Protection Mode*** provides a way to control access to (protection of) certain PLC functions, including program logic, reference data, and configuration information.

The use of this function is optional; however, it is convenient in that it allows you to protect parts of the PLC system from accidental or deliberate modification. Protection is provided through four levels of passwords which you can assign.

The ***Data Mode*** allows you to view, and optionally alter values in various reference tables. Several display formats can be selected in which to view this data: binary, hexadecimal, signed decimal, and timer/counter.

The ***Configuration Mode*** allows you to define the types of I/O bases that are installed. In this mode, you can also configure CPU data, coil check, and Hand-Held Programmer characteristics, such as turning the keyclick feature on or off.

Programming With Logicmaster 90-30/20 Software

The Programming Software portion of the Logicmaster 90-30/20 Software package can do the following:

- Develop ladder diagram programs off-line;
- Monitor and change reference values on-line;
- Edit a program on-line;
- Transfer programs and configurations between the PLC and programmer;

- Store programs automatically on disk;
- Annotate programs;
- Print programs with annotation and/or cross references;
- Display help information;
- Use symbolic references;
- Cut and paste program fragments;
- Print programs and configurations on various printers.

Programming Functions

The Series 90-20 PLC supports many different instruction functions and function blocks. For details on the use of these instructions refer to the Series 90-30 and 90-20 Hand-Held Programmer User's Manual (GFK-402). A summary of these instructions is listed below:

Basic Instructions

The following basic instructions, consisting of relay ladder contacts and coils, are supported by the Series 90-20 PLC.

Basic Instruction	Description
--] [--	normally open contact
--]/[--	normally closed contact
--( )--	coil
--(/)--	negated coil
--(SET)--	SET coil
--(R)--	RESET coil
--(↑)--	positive transition coil
--(↓)--	negative transition coil
--(M)--	retentive coil
--(/M)--	negated retentive coil
--(SM)--	retentive SET coil
--(RM)--	retentive RESET coil
-------	horizontal link
|	vertical link

Advanced Functions

The following tables list the advanced programming functions for the Series 90-20 PLC. When using the Hand-Held Programmer, the function number is entered in response to a prompt on the Hand-Held Programmer screen. The number entered selects the desired function. The mnemonics listed for the functions in the following tables are as they appear on the Hand-Held Programmer's display.

Timers and Counters

The Series 90-20 PLC supports two types of timers and two types of counters. All four function blocks are updated each time they are encountered in the logic; timers by the amount of time consumed by the last sweep, counters by one count.

Description	Mnemonic	Function Number
TMR timer	TMR	10
On-delay timer	ONDTR	13
Up counter	UPCTR	15
Down counter	DNCTR	16

Arithmetic Functions

The Series 90-20 PLC supports five different arithmetic functions. Each function may be used on any of the following data types: Integer (INT) or Double Integer (DINT).

Description	Mnemonic	Function Number
Add	ADD	60
Subtract	SUB	62
Multiply	MUL	64
Divide	DIV	66
Modulus	MOD	68
Double Precision:		
Add	DPADD	61
Subtract	DPSUB	63
Multiply	DPMUL	65
Divide	DPDIV	67
Modulus	DPMOD	69

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Comparison Functions

The Series 90-20 PLC supports six different comparison functions.

Description	Mnemonic	Function Number
Equal	EQ	52
Not Equal	NE	53
Greater Than	GT	57
Greater Than or Equal	GE	55
Less Than	LT	56
Less Than or Equal	LE	54
Double Precision:		
Equal	DPEQ	72
Not Equal	DPNE	73
Greater Than	DPGT	77
Greater Than or Equal	DPGE	75
Less Than	DPLT	76
Less Than or Equal To	DPLE	74

Bit Operation Functions

The Series 90-20 PLC supports 12 different bit operation functions.

Description	Mnemonic	Function Number
And	AND	23
Or	OR	25
Exclusive OR	XOR	27
Not	NOT	29
Shift Left	SHL	30
Shift Right	SHR	31
Rotate Left	ROL	32
Rotate Right	ROR	33
Bit Set	BITSET	22
Bit Clear	BITCLR	24
Bit Test	BITTST	26
Bit Position	BITPOS	28

Conversion Functions

The Series 90-20 PLC provides two different conversion functions: 4-digit binary coded decimal to 16-bit integer and 16-bit integer to 4-digit binary coded decimal.

Description	Mnemonic	Function Number
To BCD4	TO_BCD4	80
To Integer	TO_INT	81

Control and Communication Functions

The Series 90-20 PLC supports seven different Control and Communication Functions.

Description	Mnemonic	Function Number
Master Control Relay	MCR	6
End MCR	ENDMCR	8
Do I/O	DOIO	85
Communications Request	COMREQ	88
Service Request:	SVCREQ	89
#13 Shut Down PLC		
#14 Clear Fault Tables		
#15 Read Last Fault		
PID ISA	PIDISA	86
PID IND	PIDIND	87

Data Movement Functions

The Series 90-20 PLC supports nine different data Movement functions.

Description	Mnemonic	Function Number
Constant Block Move Word	BMOVW	43
Block Clear	BLKCLR	44
Bit Sequencer	SEQB	47
Shift Register Word	SHFRW	45
Shift Register Bit	SHFRB	46
Constant Block Move Integer	BMOVI	38
Move N* Words	MOVWN	42
Move N* Integers	MOVIN	37
Move N* Bits	MOVBN	40

* Where n is the number of bits, words, or integers.

User Reference Types

The user reference types are the same as are used by the Series 90-30 PLC. The following table lists the range and size of these user references for the Series 90-20. For a description of each type, refer to Chapter 6.

Table 9-1. Range and Size of User References

Reference Type	Reference Range	Size
User program logic	Not applicable	2K bytes
Discrete inputs, *%I1 through %I16 represent physical input points*	%I0001 - %I048	48 bits
Discrete outputs, *%Q1 through %Q12 represent physical output points*	%Q0001 - %Q048	48 bits
Internal coils	%M0001 - %M01024	1024 bits
Temporary coils	%T0001 - %T0256	256 bits
System status references	%S0001 - %S0032	32 bits
	%SA001 - %SA032	32 bits
	%SB001 - %SB032	32 bits
	%SC001 - %SC032	32 bits
System register references	%R0001 - %R0256	256 words
Analog and HS counter inputs	%AI001 - %AI016	16 words
Analog outputs	%AQ001 - %AQ032	16 words
System registers*	%SR001 - %SR016	16 words

* For reference table viewing only; may not be referenced in a user logic program.

Series 90-20 Configuration

The Series 90-20 has a fixed I/O configuration. The table below shows the range of references for this fixed configuration:

Table 9-2. Series 90-20 Fixed I/O Configuration

Reference	Location on Base Module
%I1 to %I16	I1 to I16 on upper terminal strip
%Q1 to %Q12	Q1 to Q12 on lower terminal strip

Configuration With the Hand-Held Programmer or Logicmaster 90-30/20 Software

Configuration of the Series 90-20 Programmable Logic Controller can be done with the Hand-Held Programmer or with the Configuration Software package. The Configuration Software is included as a part of the total Logicmaster 90-30/20 Programming Software package. Configuration allows you to:

- Specify a name for the system;
- Enable the High Speed Counter and change default parameters for the High Speed Counter;
- Configure certain CPU parameters;
- Archive or save the configuration in a file;
- Transfer configurations between the PLC and the programmer (Logicmaster 90-30/20 only).

Fault Handling

Faults for a Series 90-20 PLC system are handled by a software alarm processor function which logs any detected I/O and system faults in two tables (PLC Fault Table and I/O Fault Table). These tables can be displayed on the Logicmaster 90-30/20 programmer screen or uploaded to a host computer or other coprocessor.

Programmer Requirements

In order to run the Logicmaster 90-30/20 software, you will need a programming computer (with 640K RAM memory plus a hard disk) which can be one of the following:

- A Workmaster II computer with a 101-key keyboard.
- A Cimstar I industrial computer with an 83-key or 101-key keyboard.
- An IBM PC-XT, or AT personal computer with an 83 or 101-key keyboard.
- An industrial IBM-AT or Personal System 2 (PS/2) computer with a standard 101-key keyboard.

Both the Workmaster II computer, with its enhanced temperature specifications, and the Cimstar I computer, which is industrial-hardened, are well-suited for installations where programs must be transferred, monitored, or edited in the harsh conditions of the factory floor. The Workmaster II computer has the additional advantage of being portable (under 20 pounds).

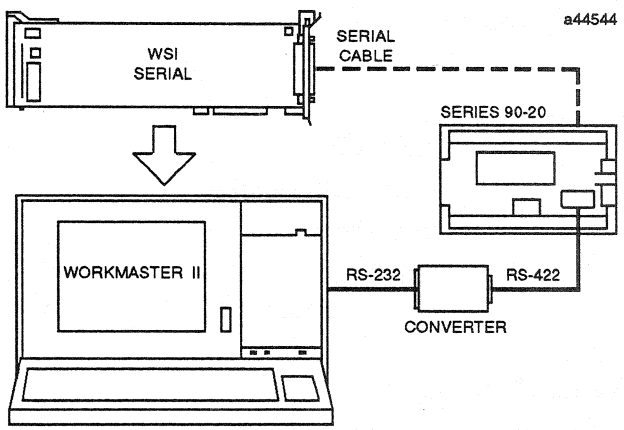

Figure 9-2. Logicmaster 90-30/20 Programmer Connection to the Series 90-20 PLC

Logicmaster 90-30/20 Programming software communicates with the Series 90-20 PLC through a standard RS-232 port on the computer when used with an available RS-232 to RS-422/RS-485 converter or through a Work Station Interface (WSI) board (IC647WMI920) which must be installed in the computer to be used for programming. A serial cable provides the physical connection from the computer running Logicmaster 90-30/20 to the PLC. The connection to the Series 90-20 PLC is to a dedicated RS-485 compatible serial port connector located on the CPU module.

RS-422/RS-485 to RS-232 Converter

The RS-422/RS-485 to RS-232 Converter (IC690ACC900) provides an RS-232 interface to external devices requiring the RS-232 serial interface through conversion of the RS-422/RS-485 signals provided at the RS-422/RS-485 port in the Series 90-20 PLC. This converter provides a direct serial connection to a Workmaster II or other computer used as the programming device when running Logicmaster 90-30/20 software for the Series 90-20 PLC. There is no need to have a Work Station Interface installed in the Workmaster II computer when the converter is used.

The RS-422/RS-485 to RS-232 converter is a small, convenient, self-contained device which requires only a cable connection to the Series 90-20 RS-422/RS-485 port on one end and a cable connection to the RS-232 device on the opposite end.

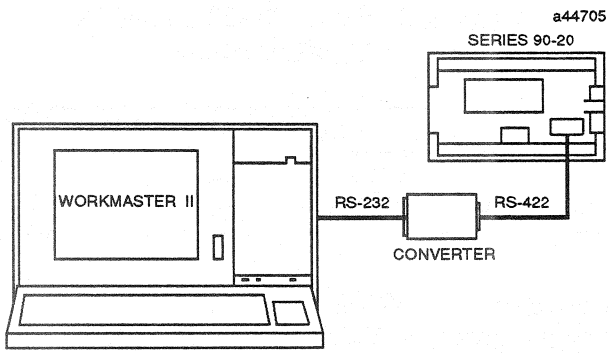

Figure 9-3. Example of RS-422/RS-485 to RS-232 Converter Connection in a Series 90-20 PLC System

The converter operates from a +5 VDC source, which is provided from the PLC backplane +5 VDC bus, through the cable connection. The pin

assignments for the connections on the cable required for the RS-232 connection are compatible with available PCM compatible serial cables (IC690CBL701, PCM to Workmaster; IC690CBL705, PCM to Workmaster II; and IC690CBL702, PCM to PC-AT). The RS-422/RS-485 connection at the Series 90-20 serial port on the CPU module may be made with an available cable (used with the Hand-Held programmer), IC693CBL303.

The three PCM compatible cables (IC690CBL701/702/705) are 10 feet (3 meters) in length, and the Hand-Held Programmer compatible cable (IC693CBL303) is 6 feet (2 meters) in length. For those user's who may want to build their own cables, pin assignments and recommended cable types for both cables required for use with the converter are provided in Chapter 2, Installation.

A Miniconverter kit (IC690ACC901) is also available which includes an RS-422 to RS-232 converter, an extension cable, and a converter plug assembly. This miniconverter plugs directly into the Series 90 serial port and attaches to the RS-232 serial device through an extension cable. The converter plug is required to convert the 9-pin serial port connector on the Miniconverter to the 25-pin connector needed for use with the Workmaster II computer.

Appendix A
Glossary

This appendix is a Glossary of Terms for the Series 90 PLCs. Items in the Glossary of Terms that are unique to a particular model of PLC is annotated as such (i.e. 90-70, 90-30, or 90-20).

Glossary of Terms for Series 90 PLCs

Address A number following a reference type which together refer to a specific user reference, i.e. for %Innnnn; %I is the reference type and nnnnn is the address.

Alarm Processor A software function that time-stamps and logs I/O and system faults in two tables that can be displayed by the programmer or uploaded to a host computer or other coprocessor.

Analog An electrical signal activated by physical variables representing force, pressure, temperature, flow, etc.

AND (Logical) A mathematical operation between bits. All bits must be 1 for the result to be 1.

Annotation Optional explanatory text in a program. There are three basic types of Annotation: Nicknames, Names, and Comments.

Application Program The program written by the user for control of a machine or process, i.e., the application.

ASCII American Standard Code for Information Interchange. An eight-bit (7 bits plus 1 parity bit) code used for data.

Backplane A group of connectors physically mounted on a board at the back of a rack into which modules are inserted. The connectors are wired together by a printed circuit board.

Backup A duplicate version of a program, created prior to editing the program.

Baseplate (90-30) A frame containing the backplane for the system bus, and connectors into which modules are inserted. In the Model 311, the CPU is embedded in the baseplate.

Battery Connector A connector wired to a Lithium battery which connects the battery to the CMOS RAM memory devices by being plugged into a receptacle on the printed circuit board.

Baud A unit of data transmission. Baud rate is the number of bits per second transmitted.

Bit The smallest unit of memory. Can be used to store only one piece of information that has two states (e.g. One/Zero, On/Off, Good/Bad, Yes/No). Data that requires more than two states (e.g. numerical values 000 to 999) requires multiple bits (see Word).

Board Cover A plastic cover mounted on the back of boards with memory devices as protection for those devices.

Bus An electrical path for transmitting and receiving data.

Byte A group of binary digits operated on as a single unit. In the Series 90-70 PLC, a byte is eight bits.

Circuit Wiring Diagram
Field wiring information that provides a guide to users for connecting field devices to input and output modules. Each I/O module has a circuit wiring diagram printed on the inside of the module's hinged door.

CMOS RAM CMOS RAM is an acronym for Complimentary Metal Oxide Semiconductor Random Access Memory. This is a read/write semiconductor memory that has a low power consumption but requires a backup battery to retain its content if power is lost.

CMOS Expansion Memory Board (90-70)
A daughter board consisting of battery backed CMOS RAM memory devices that mounts on the main circuit board of certain CPU models to provide for application program and user data storage, or on the PCM to provide additional application program storage. Four versions of CMOS Expansion Memory boards are available for the models 771/772: 64K Bytes, 128K Bytes, 256K Bytes, and 512K Bytes (also used with PCM). Three versions of a 32-bit CMOS Expansion Memory board are available for models 781/782: 128K Bytes, 256K Bytes, and 512K Bytes.

Code Block (90-30)
A block within the Program Block which contains sequences of ISCP instructions for the Model 331.

Command Line The fourth line at the top of the display screen. It displays typed data and command entries.

Comment A rung explanation consisting of up to 2048 characters of text.

CONFIG.SYS File
A file that describes the system requirements for the software on a personal computer. The CONFIG.SYS file must be custom-tailored to fit the specific hardware configuration of your system and Logicmaster 90 requirements.

Configuration Software
The portion of the Logicmaster 90 Programming Software package that provides the tools for configuration of I/O and many system parameters.

Constant A fixed value or an item of data that does not vary. Can be stored in a register.

Counter A function block used as an operand of a function block (usually optional) which can be programmed to control other devices according to a preset number of on/off transitions.

CPU (Central Processing Unit)
The central device or controller that interprets user instructions, makes decisions, and executes the functions based on a stored application program.

CPU Baseplate (90-30)
The baseplate in a Series 90-30 PLC Model 331 system in which the CPU is installed. This baseplate must always be included in a system and is always assigned rack number "0".

CPU Mode Switch (90-70)
A three-position toggle switch located at the top of the CPU board which is used to select the operating mode of the CPU.

Data Memory User references within the Series 90-70 CPU which are accessible by the application program for storage of discrete or register data.

Data Table A consecutive group of user references of the same size accessed with table read/write functions.

Directory A file which contains the names and specifications of other files in the PCM or other computer.

Discrete The term "discrete" includes both real and internal I/O that are one-bit user references.

Disk A hard disk or floppy diskette, used as an information storage and retrieval device.

DOS (Disk Operating System)
A group of utility programs which provide the structure for system operations on a personal computer.

Drive A floppy-diskette drive or hard disk drive. The identification of the drive, such as Drive A.

EEPROM An acronym for Electrically Erasable Programmable Read Only Memory. This is a low power semiconductor device that can be programmed using the HHP (Series 90-30 and 90-20 PLCs). This device is electrically erasable using the HHP.

EPROM An acronym for Erasable Programmable Read-Only Memory. This is a also a low power semicinductor device that can be programmed using the HHP. This device can be erased by exposing it to an ultraviolet light.

Expansion Baseplate (90-30)
A 10-slot baseplate added to a Model 331 system when the application calls for more modules than the CPU baseplate can contain. A Model 331 system can have up to four expansion baseplates.

Expansion Rack A rack added to a system when the application calls for more modules than the main rack can contain. A Series 90-70 PLC system can have up to 7 local expansion racks.

Expansion Rack Cable
A cable which propagates the parallel I/O bus signals between racks. The total length of all expansion rack cables, from the main rack to the last expansion rack in a system, can be no more than 50 feet (15 meters).

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

Function Key A key (F1 through F10) whose function is controlled by software. This function may change within the program. The Logicmaster 90 software displays the current assignments of the function keys at the top of the screen.

Genius I/O An intelligent I/O system consisting of I/O blocks, Bus Controllers, and other devices.

Genius I/O Block A module which interfaces physical devices with the Bus Controller in the Series 90 PLC. Blocks in a system communicate with the Bus Controller via a serial bus.

Grounding Lug (90-70)
A lug at the bottom of a rack power supply and on each mounting flange on a rack which must be connected to earth ground (through the AC power source) to ensure that the rack is properly and safely grounded.

Grounding Terminal (90-30)
A terminal on each power supply which must be connected to earth ground (through the AC power source) to ensure that the rack is properly and safely grounded.

Hardware All of the mechanical, electrical, and electronic devices that comprise the Series 90-70 PLC and its applications.

Help Screens Instructive text screens. Help is displayed by pressing the ALT and K keys simultaneously.

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

Hinged Door A plastic door on the front of a module which, when open, allows access to certain module hardware features.

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

Input Scan Time The time required for the CPU to scan all I/O controllers for new input values. When input modules are present, this includes the time to actually read each module.

Interrupt Declaration
Used to form an association between an interrupt input from a hardware module and a program block. The program block that will execute in response to the input must have its declaration entered in the Program Block Declarations section of the main program block. Up to 64 interrupt declarations can be used.

I/O An acronym for Input/Output. That portion of the PLC to which field devices are connected and which isolates the CPU from electrical noise.

I/O Electrical Isolation
A method of separating field wiring from logic level circuitry. Typically, this is accomplished through use of solid-state optical isolation devices.

I/O Fault Table A fault table listing I/O faults. These faults are identified by time, date, and location.

I/O Module A printed circuit assembly that interfaces between user devices and the Series 90-70 PLC.

I/O Baseplate (90-20)
The component of a Series 90-20 PLC that contains the power supply, I/O circuits, terminal strips for field wiring, and holes for mounting to a panel.

K An abbreviation for kilo or exactly 1024 in the language of computers.

Ladder Diagram A graphic representation of combinational logic.

LED Block (90-70)
A block having a group of LEDs with four columns of eight LEDs mounted at the top of each discrete I/O board, and one LED at the bottom of the block. Each LED in the group of four columns indicates the state of the respective input or output point on the board. The bottom LED, labeled FUSE, turns on to indicate a blown fuse on the module.

LED Matrix (90-20)
A group of LEDs on the Series 90-20 CPU module which provide status information.

LED Status Display (90-30)
A display consisting of a group of LEDs with two rows of eight LEDs at the top of each discrete I/O module. Each LED in the two groups of eight indicates the state of the respective input or output point on the module.

Link Horizontal and vertical links are used to carry power around an element in a ladder logic program, or to place elements in parallel or series with one another.

List A group of consecutive storage locations in memory, used for data manipulation. The beginning address and length of the list are set up in the user program. Data is accessed from either the top or the bottom of the list.

Load The function used to transfer programs to the Logicmaster 90 system's RAM memory.

Logic Solution Time
The time required to execute all active instructions in the application program.

Main Menu The Main Menu of the Logicmaster 90 software lists all the principal system functions, and the function keys that control these functions.

Main Program Block
The program block which must be present in all application programs. It contains the logic and %P data. The main program block can have up to 8K words of logic.

Main Rack The rack in a Series 90-70 PLC system in which the CPU is installed. This rack must always be included in a system and must always be assigned rack number "0".

Memory Card (90-30, 90-20)
A compact pluggable card, containing EEPROM memory, which is inserted into a slot in the Hand-Held Programmer. This memory cartridge provides the Hand-Held Programmer with a means for off-line storage and retrieval of the application program and system configuration data.

Microsecond One millionth of a second. 1×10^{-6} or 0.000001 second. May be abbreviated as (μs).

Millisecond One thousandth of a second. 1×10^{-3} or 0.001 second. May be abbreviated as ms.

Mnemonic An abbreviation given to an instruction; usually an acronym formed by combining initial letters or parts of words.

Model 30 I/O The I/O subsystem for the Series 90-30 PLC consisting of discrete, analog, and intelligent input and output modules.

Model 70 I/O The Series 90-70 I/O subsystem consisting of discrete, analog, and intelligent input and output modules.

Module A replaceable electronic subassembly usually plugged into connectors on a backplane and secured in place, but easily removed in case of a failure or system redesign. In the Series 90-70 PLC, a combination of a printed circuit board and its associated faceplate (and removable terminal connector, on I/O modules) which, when combined, form a complete assembly.

Molded Hinge (90-30)
A hinge molded into the top rear of each Model 30 I/O module type which, when the module is installed, latches onto the top of the baseplate. This hinge helps to keep the module securely in place.

Molded Latch (90-70)
A unique mechanical key provided with each I/O module type which, when the module is first installed, latches automatically onto the center rail of the backplane, and remains there even when a module is removed. This key provides a mechanical interlock to prevent the accidental interchange of one module type for another.

Monitor mode A mode in the Logicmaster 90 Programmer where the programmer may only retrieve data from the PLC. No data may be changed in the PLC.

Name An optional text description associated with a user reference. A name can be used with or without a nickname. Names are also entered in the Variable Declaration Table.

Nickname An optional 7-character identifier for a machine reference. All nicknames used by the program block will be included in its Variable Declarations Table.

Noise Undesirable electrical disturbances to normal signals, generally of high frequency content.

Non-Retentive Coil
A coil that will turn off upon removal of applied power to the CPU.

Non-Volatile Memory
A memory (e.g. PROM) capable of retaining its stored information under no-power conditions (power removed or turned off).

Off-Line Mode A mode in the Logicmaster 90 programmer where the programmer and PLC do not communicate. The physical communications link may be intact, but the programmer is specifically not performing communications with the PLC.

On-Line Changes Changes to I/O or register references and word-for-word changes, made when the Logicmaster 90 system is in the on-line mode and the programs in both are exactly the same.

On-Line Mode A mode in the Logicmaster 90 Programmer where the programmer and PLC are communicating. Both status data and program block data may be exchanged between the PLC and the programmer.

OR (Logical) A logical operation between bits, whereby if any bit is a 1, the result will be a 1.

Outer Label The portion of the label insert in the hinged door of an I/O module that is viewed when the door is closed, and on which information may be recorded pertaining to each I/O point.

Output Data transferred from the CPU, through a module for level conversion, to be used for controlling an external device or process.

Output Devices Physical devices such as motor starters, solenoids, etc. that are switched by the PLC.

Output Module An I/O module that converts logic level signals within the CPU to usable output signals for controlling a machine or process.

Output Scan Time
The time required for the CPU to update all I/O controllers with new output values. When Model 70 I/O is present, this includes the time to actually write to each module.

Panel Mounting Flanges
Flanges on the rear of a rack used to mount the rack on an electrical panel or wall.

Parallel Communication
A method of data transfer whereby data is transferred on several wires simultaneously.

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 Error A condition that occurs when a computed parity check (checksum) does not agree with the parity bit.

Peripheral Equipment
External devices that can communicate with a PLC; for example, programmers or printers.

PLC Fault Table A fault table listing PLC faults. These faults are identified by time, date, and location.

Power Flow In a ladder diagram, the symbolic flow of power represents the logical execution of program functions. For each function, it is important to know what happens when power is received and under what conditions power flow is output.

Preset Value A numerical value specified in a function which establishes a limit for a counter or timer.

Program Block A unit of an application program that can consist of up to 8K words of ladder logic and 8K words of local registers.

Program Block Declaration
Provides information about additional logic that may be called from the main or other program blocks. Up to 255 program block declarations can be included in a main program block. All program blocks used anywhere in a program must be declared in the main program block.

Program Folder A subdirectory of all the files which constitute a program, including the associated configuration files. The name of the program folder may contain up to seven characters.

Program Name The name of the current program. In most cases, it will be the same as the program folder. The program name also may contain up to seven characters.

Program Sweep Time
The time from the start of one cycle of the application program to the next. The program sweep is composed of the following: perform start of sweep system tasks, read the inputs, execute the user's program, write the outputs, recover faulted boards, complete minimal checksum calculation, schedule the next sweep, communicate with the programmer and other intelligent option modules, execute background tasks.

Programmable Logic Controller (PLC)
A solid-state industrial control device which receives signals from user supplied control devices such as switches and sensors, implements them in a precise pattern determined by ladder diagram based application programs stored in user memory, and provides outputs for control of processes or user supplied devices such as relays or motor starters. It is usually programmed in relay ladder logic and is designed to operate in an industrial environment.

Programmer The hardware device required to run Logicmaster 90 software. A Workstation Interface board must be installed in the programmer to communicate with the Series 90-70 PLC.

Programmer Port
For parallel communications with the Series 90-70, the top connector on the Bus Transmitter Module, accessible through a 37-pin connector, to which the programmer can be connected in order to communicate with the PLC. For serial communications with the Series 90-70, a serial port connector is located on the CPU module. For serial communications with the Series 90-30, the serial port connector is located on the power supply, and on the Series 90-20 the serial port is located on the CPU module.

Programming Software
The portion of the Logicmaster 90 Software package which is used to create ladder logic programs.

PROM An acronym for Programmable Read Only Memory, which is a retentive digital device programmed at the factory and not easily changed by the user. Usually contains software for internal system use.

Rack A Series 90-30 baseplate when it has modules installed in it; in the Series 90-70, the frame with connectors and backplane into which modules are installed.

Rack Mounting Flange
Flanges on the front of each rack for attaching the rack to a standard 19″ hardware rack.

Rack Number (90-30)
In a Series 90-30 PLC system; a unique number, from 0 to 4, assigned to a Model 331 rack for identification purposes. The main rack is always rack 0, expansion racks can be assigned rack number 1 through 4 in any order - but rack numbers cannot be duplicated in a system.

Rack Number (90-70)
In a Series 90-70 PLC system; a unique number, from 0 to 7, assigned to a rack for identification purposes. The main (CPU) rack must always be assigned rack 0, expansion racks can be assigned rack number 1 through 7 in any order - rack numbers cannot be duplicated in a system.

Rack Number DIP Switch (90-30)
A three-position DIP switch, located on the backplane directly behind the power supply, which is configured to select a unique rack number from 1 to 4 for expansion racks in a Model 331 system. Rack numbers must not be duplicated in a system.

Rack Number Jumper
A group of binary encoded jumpers located on the backplane directly behind the power supply which must be configured to select the unique rack number.

RAM An acronym for Random Access Memory, which is a solid-state memory that allows individual bits to be stored and accessed at random. This memory stores the system data, program files, and related data while power is applied to the system. This type of memory, however, is volatile. Because data stored in RAM is lost under no-power conditions, a backup battery is required to retain the contents under those conditions. The Series 90-70 uses a long-life Lithium battery mounted on the CPU and PCM modules.

Read To have data entered or to extract data from a storage device.

Reference Type A specific group of memory types in the Series 90-70 PLC, e.g. %I references discrete inputs and %Q references discrete outputs. The % symbol is used to distinguish machine references from nicknames.

Register A group of 16 consecutive bits in register memory, referenced as %R. Each register is numbered, beginning at 0001. Register memory is used for temporary storage of numerical values, and for bit manipulation.

Release Lever (90-30)
A molded lever on the bottom of each Model 30 I/O module, which when depressed upwards, releases the module in its slot to allow removal of the module.

Removable Terminal Connector
The removable assembly which attaches to the front of a printed wire board, and contains the screw terminals to which field wiring is connected.

Restart Pushbutton
A pushbutton on the front of the PCM used to reinitialize the PCM or to initiate a hard or soft reset.

Retentive Coil A coil that will remain in its last state, even though power has been removed.

RS-232 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). Distance of direct connections can be up to 50 feet.

RS-422 A recommended standard defining electrical interface characteristics to connect Data Terminal Equipment (DTE) or Data Circuit-Transmitting Equipment (DCE). The RS-422 standard permits connections at longer distances and faster data transmission rates than the RS-232 standard. Direct connections can be up to 4000 feet.

RS-485 Similar to RS-422. Contains additional protection for receiver circuits. Also, receivers have greater sensitivity which provides the capability for longer distances and more drops.

RUN Mode A condition or state of the Series 90-70 PLC where the CPU executes the application program. RUN mode may be either RUN/OUTPUTS ENABLED or RUN/OUTPUTS DISABLED. In RUN/OUTPUTS DISABLED, all sweep components execute normally, but outputs are held in their default state.

Rung A sequence or grouping of functions that control one coil. One rung may have up to eight parallel lines of logic connected to the left rail, but these must be combined so that no parallel connections are left unconnected.

Rung Explanation

A rung explanation consists of up to 2048 characters of text. A rung explanation is associated with a specific rung by programming a COMMNT (comment) function block.

Serial Communication

A method of data transfer whereby the bits are handled sequentially rather than simultaneously as in parallel data transmission.

Serial Port *In the Series 90-30* - an RS-422 compatible port accessed through a 15-pin connector on the power supply, to which the programmer is connected in order to communicate with the PLC. Both the Logicmaster 90 and Hand-Held Programmer connect to this port. *In the 90-70* - an RS-422 compatible port on the CPU module, accessed through a 9-pin D-connector. Communicates with the programmer via a cable to the Work Station Interface board installed in the programming computer. *In the Series 90-20* - an RS-485 compatible port is accessed through a 15-pin connector on the CPU module.

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).

Status Line The three lines at the bottom of the display screen. The top line displays information about a PLC and the programmer. The second line identifies the current program, and the third line shows the status of the keyboard. For some programmer functions, the third line may also display additional information.

STOP Mode (90-30)

A condition or state of the Series 90-30 PLC where the CPU no longer executes the application program. STOP mode can be STOP/OUTPUTS DISABLED or STOP/OUTPUTS ENABLED. In STOP/OUTPUTS DISABLED mode, the PLC only communicates with the programmer and other devices (GBC, PCM, etc.), recovers faulted boards, reconfigures boards and executes background tasks. All other portions of the sweep are skipped. In STOP/OUTPUTS ENABLED mode, the PLC CPU can monitor I/O. This feature provides a way to monitor and debug I/O without executing the application program.

STOP Mode (90-70)

A condition or state of the Series 90-70 PLC where the CPU only communicates with the programmer and other devices (Subnet, PCM, etc.), recovers faulted boards, reconfigures boards and executes background tasks. All other portions of the sweep are skipped.

Storage Used synonymous with memory.

Store The function used to transfer programs from the Logicmaster 90 system's RAM memory to the CPU, or to disk.

Subnet A local area network that is subordinate from the main LAN which connects together an entire factory. Subnet refers to a GE Fanuc developed LAN which connects together programmable controllers and other factory devices.

Sweep The CPU's repeated execution of all program logic, I/O service, peripheral service, and self-testing. This occurs automatically, many times each second.

Teach Mode A function used to remember a sequence of keystrokes for later recall.

Terminal Jumper A metal U-shaped jumper which is installed between the two bottom terminals of the power supply terminal block to select 120 VAC as the power source for power supply operation. Jumper not installed selects 240 VAC as the power source.

Termination Resistor Pack
A resistor pack used to properly terminate the I/O bus signals; physically installed inside of a terminator plug.

Terminator Plug A plug containing a resistor pack which must be installed at the end of the I/O bus chain to properly terminate the I/O bus signals. In a Series 90-70 system, this plug must be installed on the unused connector on the last Bus Receiver Module in the I/O bus chain. In a Series 90-30 Model 331 PLC system, this plug must be installed on the unused connector on the last I/O expansion cable in the parallel I/O bus chain when the three or six foot expansion cable is used (terminating resistors are built into the distant connector on the 50 foot cable).

Timer A function block that can be used to control the operating cycle of other devices by a preset and accumulated time interval.

Two Rack Power Cable
The cable used to connect the second rack (without power supply) to the first rack (with power supply) when one power supply provides power for two racks.

User Memory The portion of system memory in which the application program and data is stored. This memory is battery-backed CMOS RAM.

User Reference Type
A reference assigned to data which indicates the memory in which it is stored in the PLC. References can be either bit-oriented (discrete) or word-oriented (register).

Variable Declaration
The portion of a program used to create, display, and change nicknames and names assigned to user references. Variable declarations can be displayed in a table which may have up to 2000 entries.

Verify A function used to compare program content. The program in system RAM memory may be compared with a program from the CPU, or from a disk drive.

VMEbus VME is an acronym for VERSA Module Eurocard. VMEbus is an international standard (IEEE/ANSI STD 1014-1987, and IEC 821 and 297) which defines an architecture for connecting and interfacing microcomputer based modules.

Volatile Memory A type of memory that will lose the information stored in it if power is removed from the memory devices. Requires a backup battery for retention of contents of memory. In the Series 90-70, a Lithium battery is used for this purpose.

GFT-057

Watchdog Timer A timer in the CPU used to ensure that certain hardware conditions are met within a predetermined time. For the Series 90-70 PLC, valid watchdog timer range is 10 ms to 2550 ms, and can be set by the user from the programmer. Default value of this timer is 200 milliseconds. The watchdog timer for the Series 90-30 and 90-20 PLCs is a fixed value of 200 ms, this value cannot be changed.

Word A measurement of memory length, usually 4, 8, or 16 bits long; in the Series 90-70 PLC, a word is 16 bits in length.

Write To transfer, record, or copy data from one storage device to another, e.g, from CPU to disk.

A

B

C

D

E

F

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K

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V

W

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