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GE Fanuc Automation

Programmable Control Products

Series 90™ Micro PLC

User's Manual

GFK-1065F

June 1998

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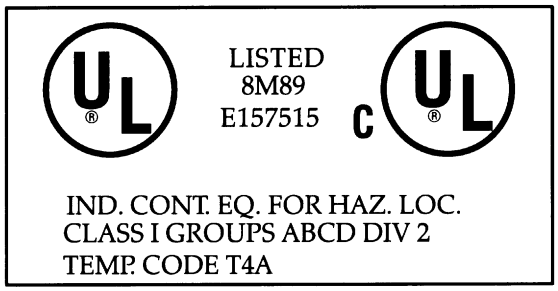
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Content of This Manual

This manual provides information necessary to enable you to integrate a Series 90 Micro Programmable Logic Controller (PLC) into a wide variety of control applications. This manual contains descriptions of hardware components, installation procedures, system operation information, and maintenance information for the Series 90 Micro PLC.

Revisions to This Manual

This manual revision (GFK-1065E) incorporates the following changes:

- A new 14-point Micro PLC, IC693UDD104, is now available. Technical information pertaining to this unit has been added where appropriate.
- Additional corrections have been made as needed.

Content of This Manual

Chapter 1. Quick Start. Brief procedures for getting the Micro PLC up and running. Includes "Frequently Asked Questions" and "Programming Examples."

Chapter 2. Introduction. An overview of the Micro PLC functional and physical characteristics. Describes compatibility with other Series 90 PLCs and lists model specifications.

Chapter 3. Installation. Procedures for installing the Micro PLC and preparing the system for use. Included in this chapter are instructions for unpacking, inspecting, and installing the Micro PLC. Instructions are also provided for connecting cables to programming devices.

Chapter 4. Field Wiring. Power and I/O specifications, and wiring information for the Micro PLC.

Chapter 5. Configuration. Configuration and programming using the Logicmaster 90 Micro software or the Hand-Held Programmer.

Chapter 6. High Speed Counters. Features, operation, and configuration of the High Speed Counter function.

Chapter 7. Analog I/O. Features, operation, and configuration of the Analog I/O function, a feature of the 23-point Micro PLC.

Chapter 8. System Operation. System operation of the Micro PLC. Includes a discussion of the PLC system sweep sequences, the power-up and power-down sequences, clocks and timers, security through password assignment, and the I/O system.

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Chapter 9. Diagnostics. A guide to troubleshooting the Micro PLC system. Section 1 describes how to use the self-diagnostic LED blink codes. Section 2 describes how the Micro PLC handles system faults.

Appendix A. Instruction Timing. Tables showing the memory size and execution time required for each function.

Appendix B. Reference Types. Listing of user references and references for fault reporting. Also contains tables listing memory locations that are reserved for I/O functions.

Appendix C. PLC/Software Cross Reference. A comparative listing of the instructions and function blocks supported by the Series 90 Micro PLC and the Series 90-20 PLC.

Appendix D. Serial Port and Cables. Description of the serial port, converter, and cables used to connect Series 90 PLCs for Series 90 Protocol (SNP).

Appendix E. Converters. Detailed description of the RS-422/RS-485 to RS-232 Converter for the Series 90 PLCs. Describes the Miniconverter Kit for and the Isolated Repeater/Converter with Series 90 PLCs.

Appendix F. Cable Data Sheets. Data sheets describing each of the Series 90 PLC cable types that are commonly used with the Micro PLC.

Appendix G. Sample Application for PWM and Pulse Outputs. An example of the use of analog I/O through a signal conditioning unit.

Appendix H. Case Histories. Brief summaries of applications that use the Micro PLC.

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Related Publications

Logicmaster™ 90 Series 90-30/20/Micro Programming Software User's Manual *(*GFK-0466*)*

Series 90™-30/20/Micro Programmable Controllers Reference Manual (GFK-0467)

Workmaster® II PLC Programming Unit Guide to Operation (GFK-0401*)*

Workmaster Programmable Control Information Center Guide to Operation *(GEK-25373)*

Hand-Held Programmer, Series 90™-30/20/Micro Programmable Controllers User's Manual (GFK-0402)

Series 90™-30 Programmable Controller Installation Manual (GFK-0356)

Series 90™-70 Programmable Controller Installation Manual (GFK-0262)

Series 90™ PLC Serial Communications User's Manua*l* (GFK-0582)

Series 90™ Micro Field Processor User's Manua*l* (GFK-0711)

Important Product Information, Micro PLC (GFK-1094)

Important Product Information, Micro Expansion Unit (GFK-1474)

Data Sheet, 14-Point Micro PLCs (GFK-1087)

Data Sheet, 28-Point Micro PLCs (GFK-1222)

Data Sheet, 23-Point Micro PLC (GFK-1459)

Data Sheet, Micro Expansion Unit (GFK-1460)

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Senior Technical Writer

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Chapter 1 Quick Start

This chapter provides an overview of the steps required to get your Micro PLC set up and running. The Series 90 Micro PLC product line offers models with different capabilities and special features to meet the needs of a wide range of applications. For this reason, you will need to refer to other chapters in this manual for details pertaining to the specific Micro PLC that you have. For summaries of Micro PLC features and specifications for each model, refer to Chapter 2.

No. of I/O Points	I/O Configuration	Power Supply	Catalog Numbers
14	8 DC inputs, 6 relay outputs	100 to 240 VAC	IC693UDR001
14	8 DC inputs, 6 relay outputs	12 to 24 VDC	IC693UDR002
14	8 AC inputs, 6 AC outputs	100 to 240 VAC	IC693UAA003
14	8 DC inputs, 6 DC outputs	12 to 24 VDC	IC693UDD104
14	8 DC inputs, 6 relay outputs (expansion unit)	100 to 240 VAC	IC693UEX011
23	13 DC inputs, 1 DC output, 9 relay outputs, 2 analog in, 1 analog out	100 to 240 VAC	IC693UAL006
28	16 DC inputs, 1 DC output, 11 relay outputs	100 to 240 VAC	IC693UDR005
28	16 AC inputs, 12 AC outputs	100 to 240 VAC	IC693UAA007
28	16 DC inputs, 1 DC output, 11 relay outputs	24 VDC	IC693UDR010

What You Will Need

- One of the Micro PLCs listed above.
- Logicmaster 90-30/20/Micro software (or Logicmaster 90 Micro software).
- Programming device and appropriate cables: Workmaster® II or CIMSTAR I industrial computer, an IBM® AT, PS/2® or other MS-DOS compatible Personal Computer (with 386 or higher microprocessor and 2 MB memory), or a Hand-Held Programmer and cable.
- RS-422 to RS-232 Interface. Logicmaster 90 software can use a Work Station Interface (WSI) board, an RS-422 port, or a standard RS-232 interface with an RS-422 to RS-232 converter. The WSI board is installed in the Workmaster II computer at the factory.
- Tools for mounting the Micro PLC and connecting field wiring cables.

To run Logicmaster 90-30/20/Micro software, the programmer (computer) will need:

- At least 4MB of free disk space.
- At least 520KB (532,480 bytes) of available DOS application memory for the WSI version; at least 564KB (577,536 bytes) of available DOS application memory, or 520 KB and 42 KB of available High Memory Area, Upper Memory Block, or Expanded Memory. For details, see the *Logicmaster™ 90-30/30/Micro Programming Software User's Manual*, GFK-0466.

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Getting Started

The following procedure outlines the steps required to put your Micro PLC into operation.

Step 1. Unpack the Micro PLC

First, carefully inspect all shipping containers for damage. Unpack the shipping container and verify the contents. Record all serial numbers. For details, see "Unpacking" in Chapter 3.

Step 2. Install the Micro PLC

Mount the Micro PLC on a vertical surface: a wall or panel using screws or on a 35mm DIN rail. The Micro PLC requires a minimum clearance of 1.99 inches (50mm) on each side for cooling.

For details, see "Installation Requirements" and "Installation" in Chapter 3.

Step 3. Connect Ground and Power Wiring

- For safe operation of your Micro PLC, the installation must meet the requirements of "Grounding Procedures" in Chapter 3.
- For power connections, refer to the wiring diagram for the Micro PLC model that you have. (See "Field Wiring Installation" in Chapter 4.)

Step 4. Power-up Test

Warning

Ensure that the protective cover is installed over terminals on the terminal board when power is applied to the unit. The cover protects against accidental shock hazard which could cause severe or fatal injury to personnel.

Apply the required power to the system. The Micro PLC should perform a self-diagnostic test. The OK indicator will blink during power-up diagnostics. When self-diagnostics have been successfully completed, the OK indicator will remain lighted. For details, refer to "Powerup Self-test" in Chapter 3.

Step 5. Connect a Programmer to the PLC

Connect a programming device to the RS-422 serial port (Port 1) on the Micro PLC. (Port 2 on 28 and 23-point Micro PLCs does not support configuration and programming.) For cabling diagrams, refer to "Connecting a Programming Device" in Chapter 3.

If Logicmaster 90 software is not installed on your programmer, install it according to the procedures in the *Logicmaster™ 90-30/20/Micro Programming Software User's Manual*, GFK-0466.

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Step 6. Configure the Micro PLC

The Logicmaster 90 configuration function is used to select Micro PLC operating parameters to meet the requirements of your system.

A. Start up your computer in DOS mode.

B. At the DOS prompt, type **CD LM90** and press the **ENTER** key.

C. Type **LM90** and press **ENTER**.

D. When the main menu for the Logicmaster 90 software appears, press **SHIFT** + **F1**. A list of PLCs will appear.

E. From the list, select the type of Micro PLC that you have and press **ENTER**.

F. Press **F2**. The Software Configuration menu will appear.

For details on configuration, refer to Chapters 5, 6, and 7. When you have finished configuring the Micro PLC, press **ESC** to return to the main menu.

Step 7. Enter a Ladder Program

A. In the Logicmaster 90 main menu, press **F2**. The Programming Software menu will appear.

B. Press **F1**, Program Display Edit. An empty program folder will appear. For details on using the programming software, refer to the *Logicmaster 90-30/20/Micro Programming Software User's Manual*, GFK-0466. A sample program for the Micro PLC is provided in the *Series 90™ Micro Programmable Logic Controller Self-Teach Manual*, GFK-1104.

Warning

Turn off power to the Micro PLC before connecting field wiring.

Step 8. Connect Field Wiring

Refer to "Field Wiring Installation" in Chapter 4 for general wiring information and wiring diagrams for each Micro PLC model.

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Frequently Asked Questions

1. What causes a "No Communications" message when I toggle to MONITOR or ONLINE?

Following are a few possible causes:

- Insufficient conventional memory (at least 545Kbytes) in your personal computer to load the Logicmaster 90 communications driver.

Make sure the config.sys file in your computer is properly configured. For details on configuring your config.sys file, refer to "Software Installation" in the *Logicmaster™ 90 Series 90™-30/20/Micro Programming Software User's Manual*, GFK-0466. For additional assistance, call your personal computer help line or GE Fanuc PLC Technical Support at 1-800-GEFANUC.

- Configuration mismatch between Logicmaster 90 in your computer and the PLC configuration.

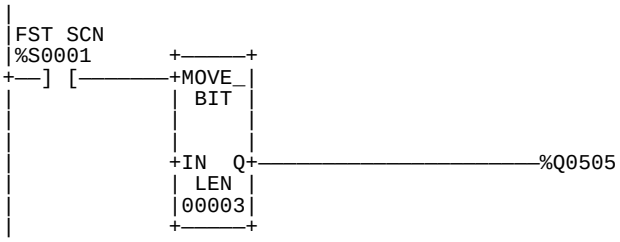
Make sure that the computer and the PLC are using the same baud rate and parity. From the main menu in Logicmaster 90, press **F2** to enter the configuration software. To check the computer settings, press **F7**, Programmer Mode and Setup, and then **F4**, PLC Communications Serial Port Setup. To check the PLC settings, press **F1**, I/O Configuration. The PLC baud rate and parity will be displayed in the Software Configuration Screen.

- Broken cable between your computer and PLC or broken or missing RS-232/RS-422 converter.

For information on installing the converter, refer to Appendix E in this manual.

2. How do you set up the High Speed Counters (HSCs)?

Using the Logicmaster 90 configuration software or a Hand-Held Programmer (HHP), enable each HSC that you want to use. If you want the HSC to drive an output, you must enable its output in the software configuration and set its Enable Output bit in your program or in the data tables. For example, if HSC 1 is configured with its output enabled and its Output Enable bit, %Q505 is set, it will control Q1. (HSC 1 will continually report to the CPU memory location %AI06.) A sample rung that sets the Output Enable bit for HSC 1 is shown below.



For more information, refer to "High Speed Counter/CPU Interface" in Chapter 6 of this manual.

Simple (A-type) counters and A-Quad-B (B-type) HSCs count *continuously* by default, resetting themselves automatically when a high or low limit is reached. A-type HSCs can also be configured for *one-shot* counting, in which the HSC counts to one past the limit and then stops.

In one-shot mode, the HSC can be reset by the program using a Communications Request (COMM_REQ) function to write a zero to the Accumulator. The HSC can also be reset by the Preload input. If the counter's Preload/Strobe parameter is set to PRELOAD (default), the configured preload value will be loaded to the Accumulator when the Preload/Strobe signal goes

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active. For example, if PRELOAD is configured and the default Preload Value of 0 is used, an input on I2 will reset the Accumulator for HSC 1.

For wiring information, refer to the diagrams in "High Speed Counter Inputs" and the wiring diagrams provided in "General Wiring Procedures" in Chapter 4.

Warning

When the Micro PLC goes from RUN to STOP mode, the HSCs will continue to operate. Also, the HSCs will remain in run mode through a power cycle. Therefore, if an HSC is running when power is lost, it will run when power is restored.

3. How do I program the Micro PLC?

You can use a Hand Held Programmer (IC693PRG300) or Logicmaster 90 software (IC640HWP300, includes a 2-meter programming cable) loaded into a DOS-based personal computer. The personal computer must have at least a 386 processor and at least 2 megabytes of RAM.

For a new-user programming lesson, refer to Appendix A of the *Software User's Manual*, GFK-0466. Chapter 4 of the *Series 90™-30/20/Micro Programmable Controllers Reference Manual*, GFK-0467 provides descriptions and examples of programming commands for the Micro PLC.

4. What should I do when I get a "Password disabled" or "insufficient privilege" message?

There are two possible causes for these messages:

- Password is set to DISABLE in the Software Configuration screen for the Micro PLC.

The default configuration for password is ENABLE. When changed to DISABLE and stored to the Micro PLC, the setting is permanent. If the configuration is changed back to ENABLE and stored, the "password disabled" error message will be generated and the store will not be allowed. You can either change the configuration back to DISABLE, or use an HHP to erase the program and configuration, thereby restoring the default configuration.

- Insufficient privilege has been set in the Software Configuration and stored to the PLC.

The OEM password cannot be overwritten. To remove the OEM password, you must use the HHP to clear the PLC memory.

If a password has been set from the level 4 menu and then forgotten, you can override it. This procedure is documented in Chapter 5 in the *Software User's Manual*, GFK-0466. (The original program disks are required.)

5. What does it mean when OK LED is blinking or the Run LED is not lighted?

Each time power is applied, the CPU performs a self check for several seconds. The OK LED blinks during the self-test and then changes to a steady on state.

If the Run LED does not light when you go to run mode, the cause could be invalid configuration or a fatal error in the CPU fault table.

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Programming Examples

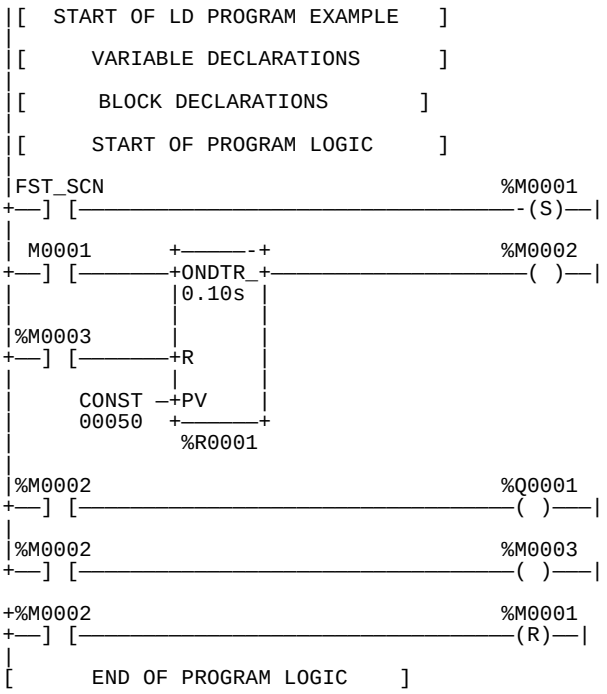
Test Rung

In the following test rung, an input on I1 will turn on output Q1.



On-Delay Timer

In the following LD, the set coil, M0001, turns on the timer, which counts to 5 seconds (00050 x 0.10s) and then activates %M0002. %M0002 turns on the output, %Q0001, activates %M0003 to reset the timer, and resets M0001.



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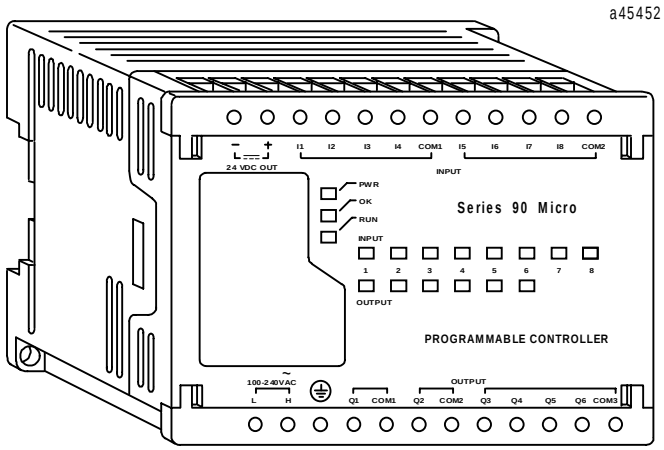
Chapter 2 Introduction

Series 90 Micro PLCs offer an array of useful features, including:

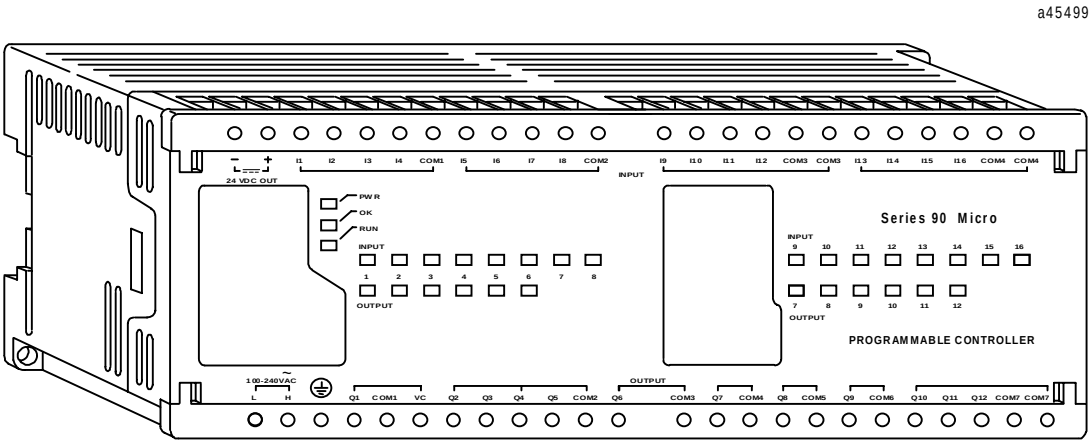
- Compatibility with Logicmaster 90-30/20/Micro programming software
- Support for the 90-30 Hand-Held Programmer (HHP)
- An alarm processor function
- Password protection to limit access to PLC contents
- A built-in High Speed Counter (HSC) function that can be configured as four type A counters or as one type B counter and one type A counter (DC in/relay out Micro PLCs only)
- Two potentiometers that provide selectable analog inputs to %AI16 and %AI17 (with configurable filtering)
- Configurable software filtering of discrete inputs
- Series 90 (SNP) and SNP Extended (SNPX), and RTU slave communication protocols
- A *pulse catch input* function, selectable on up to four inputs, that detects pulses at least 100 microseconds in width
- Pulse train and Pulse Width Modulation (PWM) outputs (Micro PLCs with DC output only)
- Compatibility with 14-point expansion unit (23 and 28-point Micro PLCs)
- Pager Enunciation function that can be configured to send a specified byte string from Serial Port 2 (23 and 28-point Micro PLCs)
- Two analog inputs and one analog output (23-point Micro PLC)

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The Micro PLC hardware consists of a single module that includes CPU, I/O, and power supply functions (Figure 2-1). The compact, lightweight unit is designed for 35mm DIN rail or panel mounting.



Typical 14-Point Micro PLC



Typical 28-Point Micro PLC

Figure 2-1. Series 90 Micro Programmable Logic Controllers

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Compatibility

- Logicmaster 90-30/20/Micro software(IC641SWP301, 304, 306, 307), release 8.01 or later
- Series 90-30 firmware release 5.0 and later
- Series 90-30 Hand-Held Programmer (IC693PRG300)
- Series 90 Protocol (SNP and SNPX) and RTU Slave protocol
- Series 90-20 PLCs (Micro PLCs with relay output – IC693UDR005/010 and UAL006 – only)

Table 2-1. Configuration/Programming Software Versions for Partial Compatibility

Logicmaster 90 Software Version	Store to Micro Rel. 2 or Earlier	Store to Micro Rel. 3 or Later	Load from Micro Rel. 2 or Earlier	Load from Micro Rel. 3 or Later
8.00 or later	No	Yes	Yes	Yes
5.01 or later	Yes	Yes	Yes	No
6.01 or later	Yes	Yes	Yes	No

Table 2-2. Micro to Micro Compatibility

Component	Rel. 3 reads from Memcard Written by a Rel. 2 Micro	Rel. 2 reads from Memcard Written by a Rel. 3 Micro
Program	Yes	Yes
Registers	Yes	No
Configuration	Yes	No

Instructions and Function Blocks

The Series 90 Micro PLC supports most 90-30 instruction functions and function blocks. Detailed descriptions and examples of the use of these instructions can be found in the *Logicmaster 90-30/20/Micro Programming Software User's Manual* (GFK-0466), *Series 90-30/20 Programmable Controllers Reference Manual* (GFK-0467), and *Hand-Held Programmer, Series 90-30/20/Micro Programmable Controllers User's Manual (*GFK-0402).

See Appendix A for a list of instructions supported by the Series 90 Micro PLC.

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Functional Description

The Micro PLC contains a CPU circuit board, an I/O board, and a Power Supply board. Figure 2-2 provides an overview of Micro PLC inputs and outputs and of the functions performed by each circuit board.

CPU Board

The CPU contains and executes the user program and communicates with the programmer (HHP or computer running Logicmaster 90-30/90-20/Micro software). The primary capabilities of the Micro PLC CPU hardware are listed in Table 2-3

Table 2-3. CPU Capabilities

14-Point Micro PLCs	23 and 28-Point Micro PLCs
H8/3003 microprocessor running at 9.84Mhz Powerup reset circuit Interrupt for power fail warning (2.0 ms) Internal Coils - 1024 Four configurable 5Khz HSCs	
512K x 8 sectored flash memory for operating system and nonvolatile user program storage (3K words of user flash memory)	256K x 16 sectored flash memory for operating system and nonvolatile user program storage (6K words of user flash memory)
32 Kbyte RAM backed by super cap (provides data retention for 3–4 days with the power off at 25°C)	64 Kbyte RAM backed by lithium battery Real time clock backed up by lithium battery
Maximum User Program - 3K words	Maximum User Program – 6K words
Registers - 256 words	Registers – 2K words
Typical Scan Rate: 1.8 ms/K of logic (Boolean contacts)	Typical Scan Rate: 1.0 ms/K of logic (Boolean contacts)
An RS-422 serial port that supports SNP, SNPX and RTU Slave protocols	Two RS-422 serial ports: Port 1 supports SNP/SNPX slave protocols; Port 2 supports SNP/SNPX Slave and Master protocols and RTU Slave protocol. (Port 2 does not support the HHP.)
	Ability to support up to four expansion units

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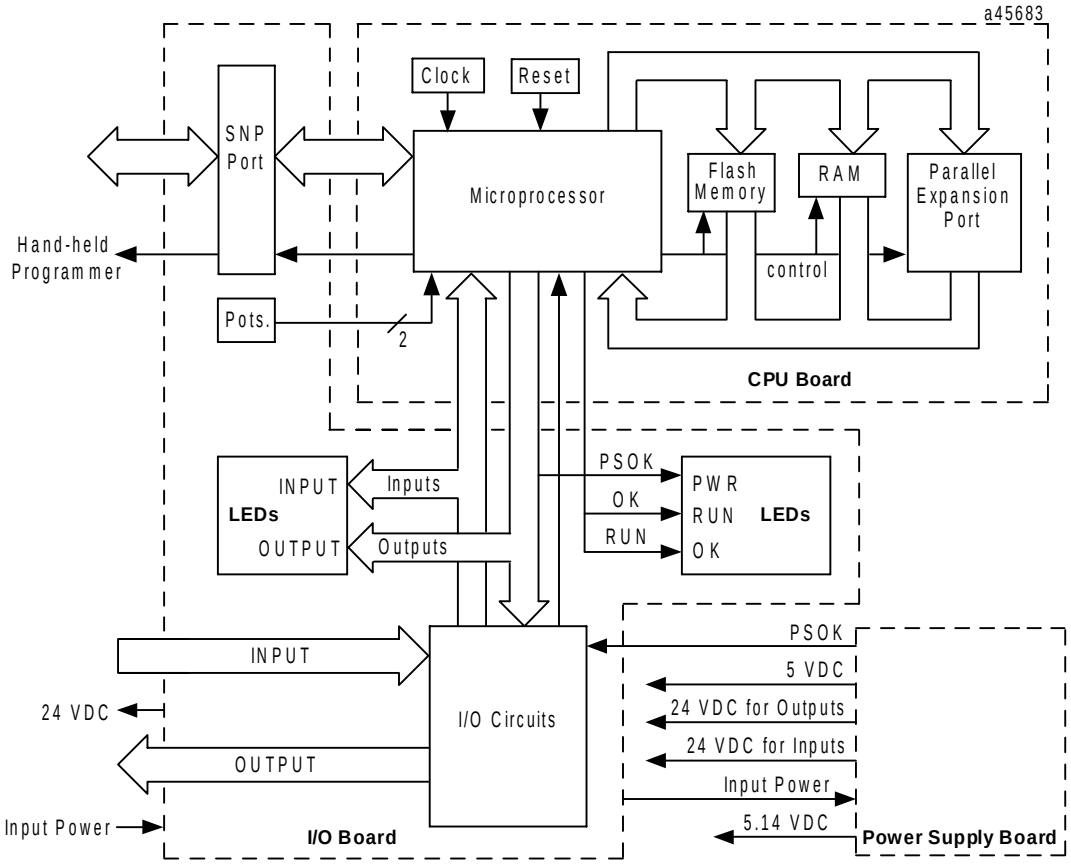


Figure 2-2. Micro PLC Functional Block Diagram

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High Speed Counters (IC693UDR011/002/005, IC693UAL006, IC693UDR010)

The high speed counter (HSC) function consists of four built-in counters. Each counter provides direct processing of rapid pulse signals up to 5Khz for industrial control applications such as: meter proving, turbine flowmeter, velocity measurement, material handling, motion control, and process control. Because it uses direct processing, the HSC can sense inputs, count, and respond with outputs without needing to communicate with the CPU.

The HSC function can be configured to operate in one of two modes:

A4 – four identical, independent, simple (type A) counters that can count up or down
B1–3, A4 – counters 1–3 configured as one type B counter; counter 4 as one type A counter.

In either mode, each counter can be enabled independently. Type A counters can be configured for up or down counting (default is up) and for positive or negative edge detection (default is positive).

The HSC function is configured using the Series 90-30 and 90-20 Hand-Held Programmer or the Logicmaster 90-30/20/Micro software configurator function. Many features can also be configured from an application program using the COMM_REQ function block.

Type A Counters

A type A counter accepts a count input that increments a 16 bit accumulator. It also accepts a preload/strobe input that can either preload the counter accumulator with a user-defined value (PRELOAD mode) or strobe the accumulator (STROBE mode) into a 16-bit register.

The four type A counters provide 15 words of %AI data or 16 bits of %I data to the PLC. They receive 16 bits of %Q data from the PLC. Each counter has two discrete inputs and one discrete output.

Type B Counter

The type B counter provides an AQUADB counting function. An AQUADB input consists of two signals (designated *A* and *B*). A count occurs for each transition of *either A or B*. The counter uses the phase relationship between A and B to determine count direction.

DC Output (IC693UDR005/010, UAL006)

The high-speed DC output (%Q1) can be configured for PWM, pulse train, or HSC output. Counter channel 1 can be configured for only one of these outputs at a time. Because AQUADB counting uses channels 1–3, the PWM and pulse train outputs are not available when a type B counter is configured.

PWM Output

The frequency of the PWM output (19hz to 2Khz) is selected by writing a value to memory location %AQ2. A PWM duty ratio (the amount of time that the signal is active compared to the signal period) within the range of 0 to 100% can be selected by writing a value to memory location %AQ3.

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Pulse Output

The frequency (10hz to 2Khz) of the pulse train is selected by writing a value to memory location %AQ123. The number of pulses to be output (0 to 32767) is selected by writing a value to memory location %AQ124.

ASCII Output (IC693UDR005/010, UAL006)

This feature allows you to send a specified byte string out the serial port by including a COMM_REQ (Communications Request) instruction in a ladder diagram. The Micro PLC can automatically send a message to a remote location that has the ability to display an ASCII string, such as a pager. As an example of how pager enunciation could be used, when a specific alarm condition is detected by the PLC, the PLC would execute a COMM_REQ instruction to autodial the modem attached to the serial port. If the autodial COMM_REQ is successful, a second COMM_REQ would be executed to send an informative ASCII string to the pager where it can be viewed by the user. Finally, a third COMM_REQ would be sent to hang up the pager.

I/O Board

The I/O board provides the interface to the front panel input, output, and power supply connections for the Micro PLC.

Input Circuits

DC Input Circuits (IC693UDR001/002/005/010, UAL006)

The DC input circuits condition and filter 24 VDC input voltages so that they can be properly detected by the CPU module. The input points can be used in either positive or negative logic mode.

The DC inputs can be used as regular inputs or to supply count and preload/strobe inputs for HSCs. For more details on the operation of HSCs see Chapter 6.

AC Input Circuits (IC693UAA003/007)

The AC input circuits accept 120 VAC, 50/60 Hz signals. Input characteristics are compatible with a wide range of user-supplied input devices, such as pushbuttons, limit switches, and electronic proximity switches.

Potentiometer Inputs (All Models)

Two potentiometers are provided to allow adjustment of the values in analog registers %AI16 and %AI17. The potentiometers can be turned by inserting a small screwdriver through an access hole in the Micro PLC front panel (see Figure 2-3.)

A potential use for the potentiometers would be to set threshold values for use in logical relationships with other inputs/outputs.

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Output Circuits

Relay Output Circuits (IC693UDR001/002/005/010, UEX011, UAL006)

The 2-amp, isolated, normally open output circuits allow the low-level signals from the CPU module to control relay devices. There is no fusing on relay outputs. The user should provide external fusing to protect the outputs. The outputs can be configured as regular outputs or as outputs controlled by the HSCs.

AC Output Circuits (IC693UAA003/007)

The AC output points provide 120/240 VAC, 50/60 Hz, 0.5 A signals.

DC Output (IC693UDR005/010, IC693UAL006)

The DC output circuit provides a 24 VDC output voltage. This output can be used as a normal DC output, HSC-controlled output, pulse train output, or pulse width modulation (PWM) output.

Analog I/O (IC693UAL006)

The 23-point Micro PLC features two analog input channels that map to %AI0018 and %AI0019 in the PLC. In voltage mode, the analog-to-digital (A/D) range of 0—32,000 counts corresponds to a 0—10 V input signal. In 0—20mA current mode, the A/D range of 0—32,000 counts corresponds to a 0—20mA input signal. In 4—20mA current mode, the A/D range of 0—32,000 counts corresponds to a 4—20mA input signal.

The analog output channel maps to %AQ0012. In voltage mode, the output channel digital-to-analog (D/A) range of 0 to 32,000 counts corresponds to a 0—10V output. In 0—20mA current mode, a range of 0 to 32,000 counts corresponds to a 0—20mA output signal. In 4—20mA current mode, the A/D range of 0—32,000 counts corresponds to a 4—20mA output signal.

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Input/Output Connectors

Serial Ports

Port 1 on the Micro PLC is intended to be used as the programmer serial port. A second RS-422 compatible serial port, to be used by monitoring devices, is provided on 23 and 28-point Micro PLCs.

Serial Communications Protocols

Table 2-4. Communication Protocols Supported

Micro PLCs	SNP/SNPX Slave	SNP/SNPX Master*	4-Wire RTU Slave*	2-Wire RTU Slave*
14-point	Port 1 All releases	not supported	Port 1 Rel. 3.00 and later	Port 1 Rel. 3.10 and later
23-point	Ports 1 and 2, Rel. 3.00 and later	Port 2 Rel. 3.00 and later	Port 2 Rel. 3.00 and later	Port 2 Rel. 3.10 and later
28-point	Ports 1 and 2, Rel. 2.01 and later	Port 2 Rel. 3.00 and later	Port 2 Rel. 3.00 and later	Port 2 Rel. 3.10 and later

*Also requires the following versions or later hardware: IC693UDR001LP1, IC693UDR002LP1, IC693UAA003JP1, IC693UDR005JP1, IC693UAL006BP1, IC693UAA007HP1, and IC693UDR010BP1.

SNP/SNPX

The full set of SNP(X) Master commands, as described in "SNP-X Commands" in the *Series 90 PLC Serial Communications User's Manual*, GFK-0582, is supported on Port 2 of the 23- and 28-point Micro PLCs.

RTU Slave

This feature is implemented as specified in the *Series 90 PLC Serial Communications User's Manual*, GFK-0582. RTU as implemented in the Micro PLC is a subset of the Modbus™ Remote Terminal Unit serial communications protocol. Prior to Release 3.10, RTU protocol is only supported in the 4-wire implementation. Support for 2-Wire RTU was added in Release 3.10. Table 2-5 lists the function codes supported by the Micro PLC.

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Table 2-5. RTU Function Codes

Function Code	Description
1	Read Output Table
2	Read Input Table
3	Read Registers
4	Read Analog Input
5	Force (Write) Single Output
6	Preset Single Register
7	Read Exception Status
8	Loopback Maintenance
15	Force (Write) Multiple Outputs
16	Preset Multiple Registers
17	Report Device Type
67	Read Scratch Pad Memory

For the 14 point unit, an additional feature is implemented that automatically detects whether the configuration/programming software is attached to the Micro PLC. The firmware will auto-detect the presence of the programmer when RTU is the active protocol, so that you only need to begin using the configuration/programming software for a 14 point Micro to be able to communicate with it.

Port 1 (All Models)

A 15-pin D-type, female connector on the front of the Micro PLC provides the connection to an RS-422 compatible serial port which is used to communicate with Logicmaster 90-30/20/Micro software, the HHP, or for general purpose communications. This port supports SNP and SNPX protocols. On 14-point Micro PLCs, this port also supports RTU Slave protocols. The RS-422 connector is protected by an access door. This port can be configured using the Logicmaster 90 configuration program or the HHP, except for RTU communications, which must be configured by a COMM_REQ function in ladder logic.

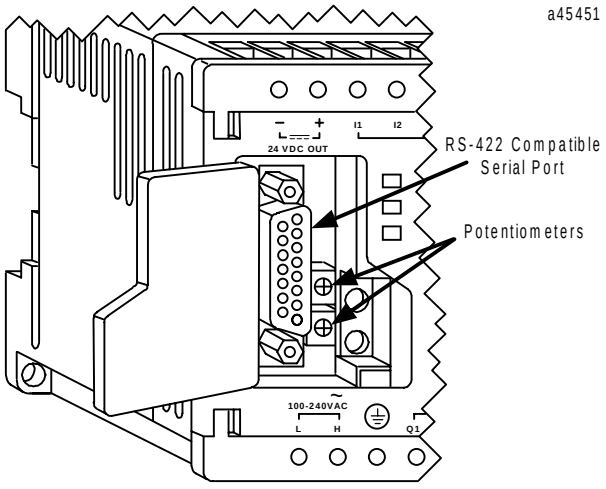


Figure 2-3. Micro PLC RS-422 Serial Port

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Port 2 (23 and 28-Point Models)

A second RS-422 compatible serial port, also protected by an access door, is provided on 23 and 28-point Micro PLCs. This port can be used for general purpose communications using SNP, SNPX, and RTU Slave protocol. Serial Port 2 can also be configured as an SNP/SNPX Master port. The following programming/configuration software features are supported through Port 2 when there is no programmer connected to Port 1:

1. The status line correctly displays current information about the PLC. If the proper folder is selected and verified, the status line will show LOGIC EQUAL.
2. You can view any of the reference memories on the TABLES page in Logicmaster 90 and can change individual values.
3. When ONLINE and LOGIC EQUAL are displayed in the status line, the references will be displayed correctly when you view the program logic.
4. You can set the privilege level to 1 or 2. (Privilege levels 3 and 4 can not be accessed.)
5. The PLC and IO fault tables are displayed.
6. The Time-Of-Day clock can be set and its current value displayed.
7. The RUN/STOP state of the PLC can be changed, either by pressing **ALT+R** or using the PLCRUN screen.

It is not possible to load and store programs and configuration through Port 2, because the privilege level is restricted to level 2 by the PLC firmware. Autobaud is not supported on Port 2. Port 2 can be configured using the Logicmaster 90 configuration software or by a COMM_REQ function block within a ladder logic program (see "Configuring Serial Ports" in Chapter 5).

On release 3.0 and later 28-point Micro PLCs, a separate SNP ID for Port 2 can be configured using Logicmaster 90 software release 8.00 or later. On earlier releases, Port 2 shares the SNP ID with Port 1 and the SNP ID can only be changed through Port 1. (For more information about the SNP ID, refer to "Selecting SNP Connections" and "CPU Configuration" in the *LogicmasterSeries 90-30/20/Micro Programming Software Users Manual*, GFK-0466.)

Communication through Port 2 may be lost (host may time out) while operations that involve writing to flash memory, including storing the program, are being performed through Port 1.

Expansion Port (23 and 28-Point Models)

A 40-pin connector is provided on the right side of the Micro PLC for connection to an expansion unit using a short (3 CM) ribbon cable (provided with the Micro Expansion Unit—***this ribbon must be used/substitutes are not compatible***). The Micro PLC can support up to four expansion units connected in series.

Table 2-6. Expansion Unit Compatibility

Micro PLCs	Release
14-point	not supported
23-point	Rel. 3.00 and later
28-point	Rel. 3.00 and later

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Terminal Strips

The Micro PLC module has two non-removable terminal strips. The input connections are on the top terminal strip and the power supply and output connections are on the bottom terminal strip. Refer to Chapter 4 for field wiring information and diagrams.

An optional removable terminal strip (IC693ACC002) , shown in Figure 2-4, is available for Micro PLCs. (They can be placed side-by-side on 28-point Micro PLCs.) The removable terminal strips can be used on the top or bottom of the Micro PLC and are inserted under the existing screw terminals.

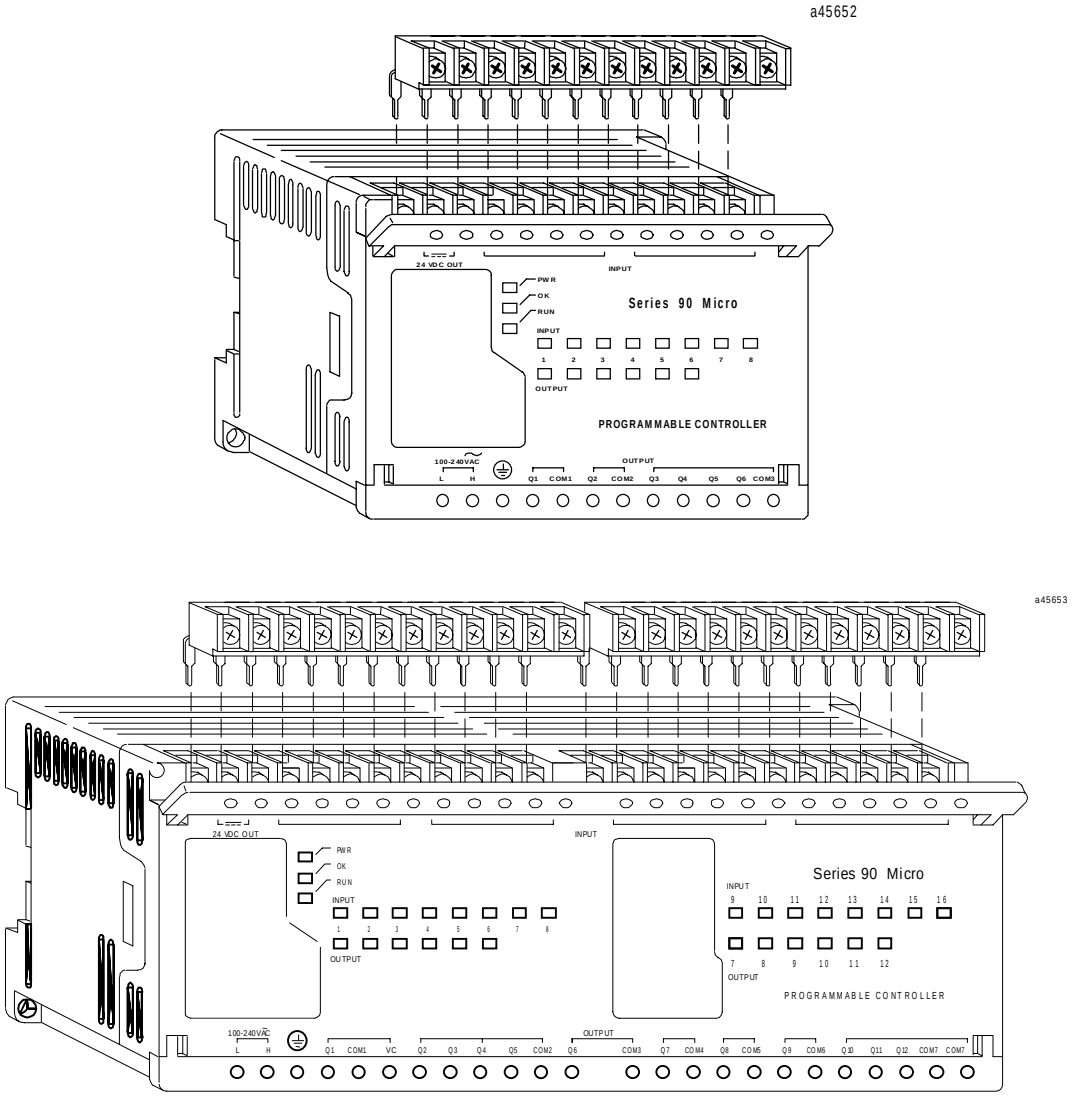


Figure 2-4. Removable Terminal Strips

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Status Indicators

The module contains LEDs that provide the user with a visual indication of the CPU and I/O status.

Table 2-7. Indicators

LED Name	Function
PWR	Lighted if power is supplied to the unit and the power supply is operating correctly. Not lighted if a power supply fault occurs or if power is not applied.
OK	Blinks during self-diagnostics. Blinks (with RUN indicator) if a fault is detected during self-diagnostics. When lighted steadily, indicates that self diagnostics have all passed.
RUN	Lighted when the PLC is executing the logic program entered by the user (RUN mode). Blinks if a fault is detected during self-diagnostics.
INPUT	These LEDs indicate the status of individual input points. If the associated LED is lighted, the voltage at the input point is high enough to energize the input circuit. If the LED is not lighted, the voltage is too low to energize the input circuit (see "I/O Specifications" in Chapter 4 for thresholds). The input LEDs indicate the input status in all CPU modes: STOP with I/O Disabled, STOP with I/O Enabled and RUN (standard sweep or constant sweep).
OUTPUT	These LEDs indicate the status of individual output points. An LED is lighted when its corresponding output is commanded to turn ON (for example if %Q1 = 1, OUTPUT 1 LED will be lighted). All outputs turn OFF in the STOP with I/O Disabled mode. Outputs will hold last state or the present user-commanded state in the STOP with I/O Enabled mode. In the RUN mode, the outputs are controlled by the ladder logic program.

Power Supply Board

The power supply converts the AC or DC input source power to voltages required for internal circuitry. Power requirements are listed in Tables 2-12 and 2-13.

On DC-input Micro PLCs, the power supply board also provides an isolated 24VDC supply to power input circuits and user devices. (Refer to page 2-16 for maximum current loads for each model.) These outputs do not have fuse protection. The user should provide external fuses to protect the outputs.

On 23-point Micro PLCs (IC693UAL006), the power supply board provides internal 15VDC power for the analog output current loop and a ±15VDC supply for the analog input and output voltage circuits.

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Configuration and Programming

The Micro PLC can be configured and programmed using any of the following methods.

- Logicmaster 90-30/20/Micro software on one of the following types of computers:
  - Workmaster™ II or a CIMSTAR™ I industrial computer
  - IBM® PC-AT, PS/2® (Personal System 2®) with 2 Mbyte RAM and an Intel 386 or higher processor
  - MS-DOS compatible Personal Computer with 2 Mbyte RAM and an Intel 386 or higher processor
- Logicmaster 90 Micro software with any of the above computers.
- Series 90-30/90-20 Hand-Held Programmer (IC693PRG300).

Configuration and programming can be accomplished off-line from the PLC using the Logicmaster 90 programmer. If you are using an HHP, configuration and programming can be done on-line with the HHP attached to and interfacing with the PLC. Programming and configuration communications must use Port 1.

The Micro PLC provides flash memory for non-volatile user program storage and for system firmware. The user program is always executed from flash memory. However, the Micro PLC can be configured to read its configuration at powerup from either RAM or flash memory (ROM).

Use of the programming and configuration software is described in the *Logicmaster 90-30/20/Micro 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 HHP is described in the *Hand-Held Programmer, Series 90-30/20/Micro Programmable Controllers User's Manual*, GFK-0402.

Fault Reporting

The Micro PLC monitors internal operations for system and user problems. These faults are reported through the %S references and through an internal fault table. Access to %S information is available through the Logicmaster 90 software or the HHP. The fault table can only be accessed by Logicmaster 90 software. For more details on faults and fault reporting, see Chapter 9.

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Specifications

The following tables list ordering information, physical and functional characteristics, and input power requirements for the Micro PLCs. Specifications for input and output signals are provided in Chapter 4.

Table 2-8. I/O Point Configurations

Description	Input Points (points/common)*	Output Points (points/common)*	Catalog Numbers
14 point DC in/relay out, AC power	8 DC (4 and 4)	6 relay (1, 1, and 4)	IC693UDR001
14 point DC in/relay out, DC power	8 DC (4 and 4)	6 relay (1, 1, and 4)	IC693UDR002
14 point DC in/DC out, DC power	8 DC (4 and 4)	6 DC (6)	IC693UDD004
14 point AC in/ AC out, AC power	8 AC (4 and 4)	6 AC (2 and 4)	IC693UAA003
28 point DC in/relay and DC out, AC power	16 DC (4, 4, 4, and 4)	1 DC, 11 relay (1, 4, 1, 1, 1, 1, and 3)	IC693UDR005
28 point AC in/AC out, AC power	16 AC (4, 4, 4, and 4)	12 AC (2, 4, 2, and 4)	IC693UAA007
28 point DC in/relay out, DC power	16 DC (4, 4, 4, and 4)	1 DC, 11 relay (1, 4, 1, 1, 1, 1, and 3)	IC693UDR010
23 point analog DC in/relay and DC out, AC power	13 DC, 2 analog (4, 4, 4, and 2)	1 DC, 9 relay 1 analog (1, 4, 1, 1, 1, and 1)	IC693UAL006
14-point Expansion Unit DC in/relay out, AC power	8 DC (4 and 4)	6 relay (1, 1, and 4)	IC6963UEX011

*See Chapter 4 for fusing information.

Accessories	
Description	**Catalog Numbers**
Series 90 Micro PLC Programming Software, Cable Kit, and manuals	IC640HWP300
Hand-Held Programmer with Cables and Manual (includes IC693CBL303)	IC693PRG300
Hand-Held Programmer Memory Card	IC693ACC303
Logicmaster 90 Software (software only)	IC641SWP300
Removable Terminal Strip	IC693ACC002
Expansion Unit Cable	IC693ACC003

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Table 2-9. Physical and Functional Characteristics (14-Point PLCs)

Weight: IC693UDR001/002/UAA003/UEX011	0.86 lbs (390 g)
Module Dimensions	Height: 3.2” (82mm) Depth: 3.0” (76mm) Width: 4.5” (115mm)
Typical Scan Rate	1.8 ms/K of logic (Boolean contacts)
Maximum number of Discrete Physical I/O Points	14 (8 inputs/6 outputs)
Maximum number of slave devices per network	8 (can be increased with a repeater)
Output Power Supplies **IC693UDR001/002/UEX011**	24VDC for input circuits & user devices, 100mA max. +5VDC on pin 5 of Serial Port, 155mA max (for UDR001/002 only)
Super cap backup for RAM	Provides data retention for 3–4 days with the power off at 25°C.

Table 2-10. Physical and Functional Characteristics (28-Point PLCs)

Weight IC693UDR005 IC693UAA007 IC693UDR010	1.5 lbs (680 g.) 1.54 lbs (700 g.) 1.54 lbs (700 g.)
Module Dimensions	Height: 3.2” (82mm) Width: 8.6” (218mm) Depth: 3.0” (76mm)
Typical Scan Rate	1.0 ms/K of logic (Boolean contacts)
Real Time Clock accuracy 10°C 25°C 55°C	 4.54 sec./day 5.22 sec./day 10.66 sec/day
Maximum number of Discrete Physical I/O Points	28 (16 inputs/12 outputs)
Maximum number of slave devices per network	8 (can be increased with a repeater)
+24 VDC Output Power Supply (IC693UDR005/010) (for input circuits and user devices)	200 mA maximum
+5 VDC on pin 5 of Serial Ports Serial Port 1 Serial Port 2 Serial Ports 1 & 2 combined	 155mA maximum 100mA maximum 255mA maximum (The load on either port can exceed the individual ratings listed above, if the combined load does not exceed 255mA.) *See “Caution” below.*
Lithium battery lifetime	Shelf life (powered down) Up to 7 years typical at 30 °C Up to 5 years typical at 55 °C

Caution

If you are using loads greater than the individual current ratings for the +5VDC supply on pin 5 of Port 1 or Port 2, operator interface devices must be connected and disconnected with the power to the Micro PLC off. (This precaution is not necessary if the loads on both ports are less than their individual current ratings.)

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Table 2-11. Physical and Functional Characteristics (23-Point Micro PLC, IC693UAL006)

Weight	1.52 lbs (690g)
Module Dimensions	Height: 3.2" (82mm) Width: 8.6" (218mm) Depth: 3.0" (76mm)
Typical Scan Rate	1.0 ms/K of logic (Boolean contacts)
Real Time Clock accuracy 10°C (with internal 15 °C rise) 25°C (with internal 15 °C rise) 55°C (with internal 15 °C rise)	 4.54 sec./day 5.22 sec./day 10.66 sec/day
Maximum number of Discrete Physical I/O Points	23 (13 inputs/10 outputs)
Maximum number of slave devices per network	8 (can be increased with a repeater)
+24 VDC Output Power Supply (for input circuits and user devices)	200 mA maximum
+5 VDC on pin 5 of Serial Ports Serial Port 1 Serial Port 2 Serial Ports 1 & 2 combined	 155mA maximum 100mA maximum 255mA maximum (The load on either port can exceed the individual ratings listed above, if the combined load does not exceed 255mA.) *See "Caution" below.*
Lithium battery lifetime	Shelf life (powered down) Up to 7 years typical at 30 °C Up to 5 years typical at 55 °C
Analog inputs	Two, differential
Input ranges	0 to 10 V (10.24V maximum) 0 to 20 mA (20.5mA maximum) 4 to 20 mA (20.5mA maximum)
Resolution: 0 to 10 V range 0 to 20 mA range 4 to 20 mA range	10 bits (1 LSB = 10mV) 9 bits (1 LSB = 40µA) 8+ bits (1 LSB = 40µA)
Accuracy	1% of full scale over full operating temperature range
Linearity	±3 LSB maximum
Common mode voltage	200 V maximum
Filter response time	20.2ms to reach 1% error for step response
Analog outputs	1, single-ended, non-isolated
Output ranges	0 to 10V (10.24V maximum) 0 to 20mA (20.5mA maximum) 4 to 20mA (20.5mA maximum)
Resolution	12 bits over 0 to 10V range (1 LSB = 2.5mV) 12 bits over 0 to 20mA range (1 LSB = 5µA) 11+ bits over 4 to 20mA range (1 LSB = 5µA)
Accuracy	±1% of full scale over full operating temperature range (0°C to 55°C)

Caution

If you are using loads greater than the individual current ratings for the +5VDC supply on pin 5 of Port 1 or Port 2, operator interface devices must be connected and disconnected with the power to the Micro PLC off. (This precaution is not necessary if the loads on both ports are less than their individual current ratings.)

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Table 2-12. AC Power Requirements

AC Power Requirements – (IC693UDR001, IC693UAA003/007, IC693UDR005, IC693UEX011)		
Range		100 -15% to 240 +10% VAC
Frequency		50 -5% to 60 +5% Hz
Hold-up		10 ms at 85 VAC
Inrush Time		2 ms for 40 A
Inrush Current	14-point Micro PLCs and 14-point Micro Expansion Unit	18 A maximum at 120 VAC 30 A maximum at 200 VAC 40 A maximum at 265 VAC
	28-point Micro PLCs	30 A maximum at 200 VAC 40 A maximum at 265 VAC
Input Current	14-point Micro PLCs	0.12 A typical at 200 VAC 0.25 A typical at 100 VAC
	28-point, DC In/Relay Out Micro PLCs	0.26 A typical at 100 VAC 0.12 A typical at 200 VAC
	28-point, AC In/AC Out Micro PLCs	0.16 A typical at 100 VAC 0.09 A typical at 200 VAC
Input Power Supply Rating	UDR001	35 VA
	UAA003	20 VA
	UAA007	25 VA
	UDR005	40 VA
	UEX011	35 VA
AC Power Requirements – (IC693UAL006)		
Range		100 -15% to 240 +10% VAC
Frequency		50 -5% to 60 +5% Hz
Hold-up		10 ms at 85 VAC
Inrush Time		2 ms for 40 A
Inrush Currents		35 A maximum at 200 VAC 46 A maximum at 265 VAC
Input Current		0.35 A typical at 100 VAC 0.22 A typical at 200 VAC
Isolation		1500VAC rms field side to logic (both power supply input and 24 VDC power supply output)
Input Power Supply Rating		50 VA

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Table 2-13. DC Power Requirements

DC Power Requirements – (IC693UDR002/010)		
Range	14-point Micro PLC	12 -15% to 24 +25% VDC 12 -15% to 24 +10% VAC
	28-point Micro PLCs	24 -20%, +25% VDC 24 -15%, +10% VAC
Hold-up	14-point Micro PLCs	4 ms at 10 VDC 10 ms at 12 VDC
	28-point Micro PLCs	2ms at 9.5 VDC
Inrush Current	14-point Micro PLC	65 A maximum at 24 VDC 81 A maximum at 30 VDC
	28-point Micro PLC[1]	65 A maximum at 24 VDC 81 A maximum at 30 VDC
Inrush Time	14-point Micro PLC	10 ms for 81 A
	28-point Micro PLC	10 ms for 81 A
Input Current	14-point Micro PLC[2]	0.4 A typical at 24 VDC 0.8 A typical at 12 VDC
	28-point Micro PLC	1.4 A typical at 24 VDC
Input Power Supply Rating	UDR002	15 W
	UDR010	20 W

Notes

1. If configured to disable powerup diagnostics, the 28-point DC In/ Relay Out/DC Power unit (IC693UDR010) will begin logic solution 100ms after the voltage level of the power supply input reaches and maintains 24VDC. The 24VDC power source for the UDR010 unit must have enough transient current capability to support the inrush current of the power supply and maintain a 24VDC voltage level (see power supply specifications for inrush requirements above).
2. The DC power supply requires more current at startup voltage (approximately 4 VDC) than at rated input voltage. A minimum of 2.0 A is necessary to start up the DC power supply.

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Table 2-14. Environmental Requirements

Operating temperature	0 to 55 °C
Storage temperature	-40 °C to 85 °C
Relative humidity	5% to 95%

Table 2-15. Memory Allocation

Type	14-Point Micro PLCs	23 and 28-Point Micro PLCs
Application Program	3K words	6K words
%R	256 words	2K words
%AI	128 words	128 words
%AQ	128 words	128 words
%I	512 bits	512 bits
%Q	512 bits	512 bits
%G	1280 bits	1280 bits
%M	1024 bits	1024 bits
%T	256 bits	256 bits
%S	128 bits	128 bits

For a list of reserved memory locations, refer to Appendix B.

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Chapter 3 Installation

This chapter describes the procedures for installing the Micro PLC and preparing the system for use. Included in this chapter are instructions for unpacking, inspecting, and installing the Micro PLC. Instructions are also provided for connecting cables to programming devices.

Minimum Hardware Requirements

To install and set up the Micro PLC, you will need:

- Micro PLC Module.
- Programming device (this can be one of the following items):
  - A. Hand-Held Programmer and cable.
  - B. Logicmaster 90-30/20 Micro software (or Logicmaster 90 Micro software), a Workmaster II or CIMSTAR I industrial computer, or an IBM AT, PS/2 or other MS-DOS compatible Personal Computer (with 386 or higher microprocessor and 2 Mbyte memory) and appropriate cables.
- Tools for mounting the Micro PLC and connecting field wiring.

If the PLC is to be programmed using Logicmaster 90 software, a Workmaster II, CIMSTAR I, or an IBM or IBM-compatible computer is required. Logicmaster 90 software can use a Work Station Interface (WSI) board, an RS-422 port, or a standard RS-232 interface with an RS-422 to RS-232 converter. The WSI board is installed in the Workmaster II computer at the factory.

Unpacking

1. **Visual inspection.** Upon receiving your Micro PLC system, carefully inspect all shipping containers for damage that may have occurred during shipping. If any part of the system is damaged, notify the carrier immediately. The damaged shipping container should be saved as evidence for inspection by the carrier.

   It is your responsibility to register a claim with the carrier for damage incurred during shipment. However, GE Fanuc will fully cooperate with you, if such action is necessary.

2. **Unpacking.** Unpack all shipping cartons and verify the contents. All shipping containers and packing material should be saved in case it is necessary to transport or ship any part of the system.

3. **Pre-installation Check.** After unpacking the Micro PLC, record all serial numbers. These serial numbers will be required if you need to request product service during the warranty period of the equipment.

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Installation Requirements

The Micro PLC should be installed in a location that meets the environmental requirements listed on page 3-20. For best performance of your Micro PLC, the installation location should also adhere to the following guidelines:

- The temperature must not change so rapidly that condensation could form on or inside the unit.
- No combustible gases.
- No dust, salty air, or conductive materials (iron powder, etc.) that could cause internal shorts.
- If possible, do not install the Micro PLC where it will be exposed to direct sunlight.
- Provide adequate ventilation space. Recommended minimum space allowances are approximately: 50mm (2 inches) top, sides and bottom. See Figures 3-1 through 3-3.
- Do not install the Micro PLC above equipment that generates a large amount of heat.
- If the ambient temperature exceeds 55°C, provide a ventilation fan or air conditioner.
- Do not install the Micro PLC within 200mm (8 inches) of any high voltage (more than 1000V) or high current (more than 1A) line (except for outputs controlled by the Micro PLC).
- For ease of maintenance and safety, locate the Micro PLC as far away from high voltage equipment and power generation equipment as possible.
- For recommended field wiring practices, refer to “General Wiring Procedures” in Chapter 4.

Installation

The Micro PLC can be mounted on a wall or panel using screws, or on a 35 mm DIN rail. The Micro PLC must be mounted on a vertical surface. Do not mount it on a horizontal surface. (See Figures 3-1 through 3-3 for recommended mounting orientation and spacing requirements.)

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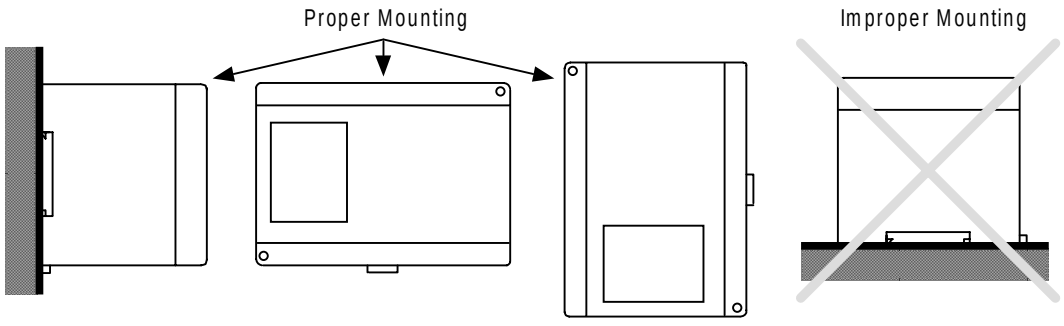


Figure 3-1. Recommended Mounting Orientations for the Micro PLC

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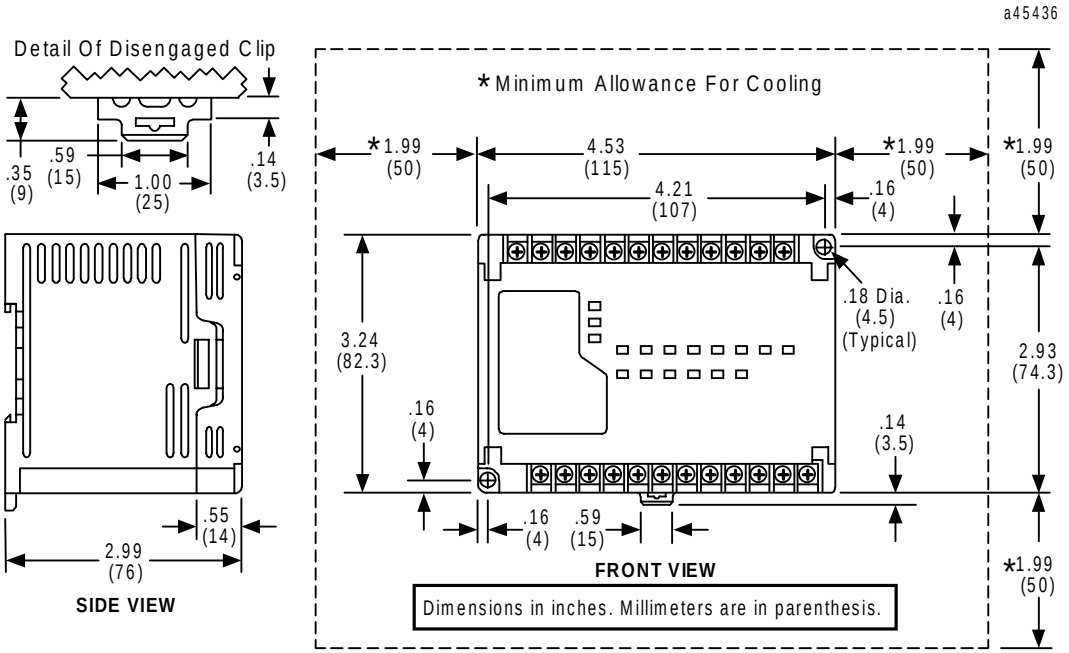


Figure 3-2. Micro PLC Mounting Dimensions and Spacing Requirements, 14-Point

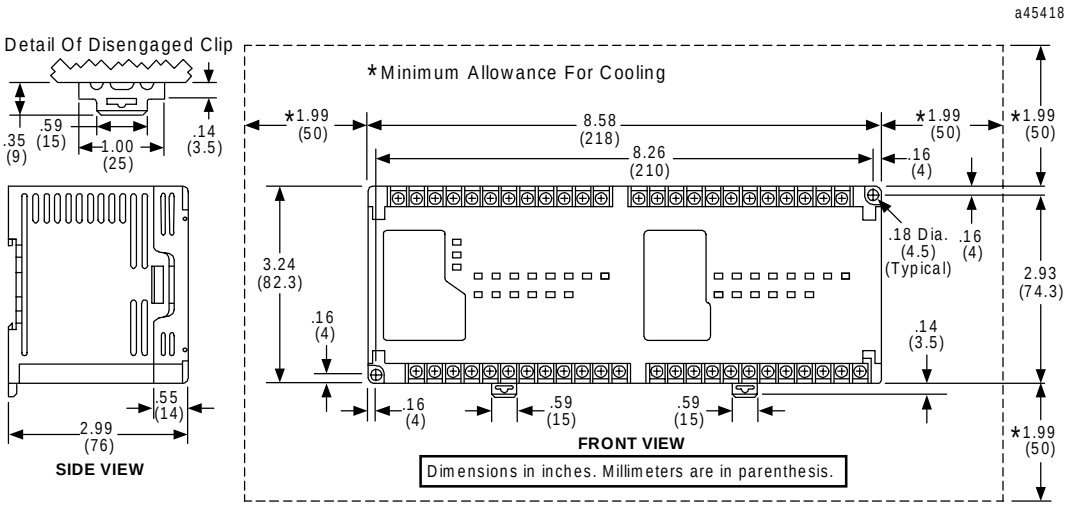


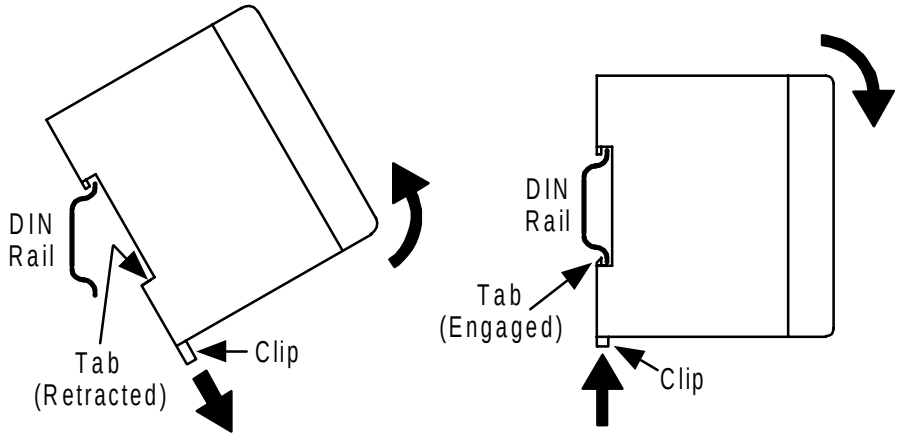
Figure 3-3. Micro PLC Mounting Dimensions and Spacing Requirements, 23 and 28-Point

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Mounting a Unit on a DIN Rail

The method of mounting a Micro PLC unit on a 35 mm DIN rail is shown below. A small clip on the back of the unit holds it in place on the rail.

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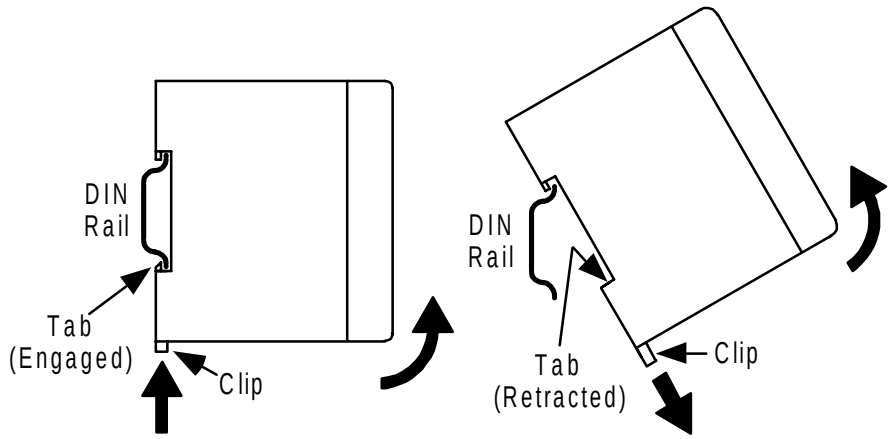
Position the upper edge of the unit over the DIN rail, so that the rail is behind the tab as shown above. Pull the clip down.

Pivot the unit downward (for a unit being mounted right side up) until the unit is over the DIN rail. Press the clip firmly into place.

Removing a Unit From a DIN Rail

To remove a unit from a DIN rail, follow the procedure shown below.

a45441



Pull clip at the bottom of the unit down until it is disengaged from the DIN rail.

Pivot the unit away from the rail.

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Grounding Procedures

Equipment grounding recommendations and procedures are listed below. These grounding procedures must be properly followed for safe operation of your Micro PLC system.

- The maximum recommended resistance to ground is 200mΩ (equivalent to 100 feet of AWG #12 – 3.29mm^2 – copper cable).
- Grounding installation must conform to National Electrical Code (NEC) standards.
- Ground conductors should be connected with separate branches routed to a central earth ground point. This method is shown in the figure below.
- Ground conductors should be as short and as large in size as possible. Braided straps or ground cables – AWG #12 (3.29mm^2) or larger – can be used to minimize resistance. Conductors must always be large enough to carry the maximum short circuit current of the path being considered.

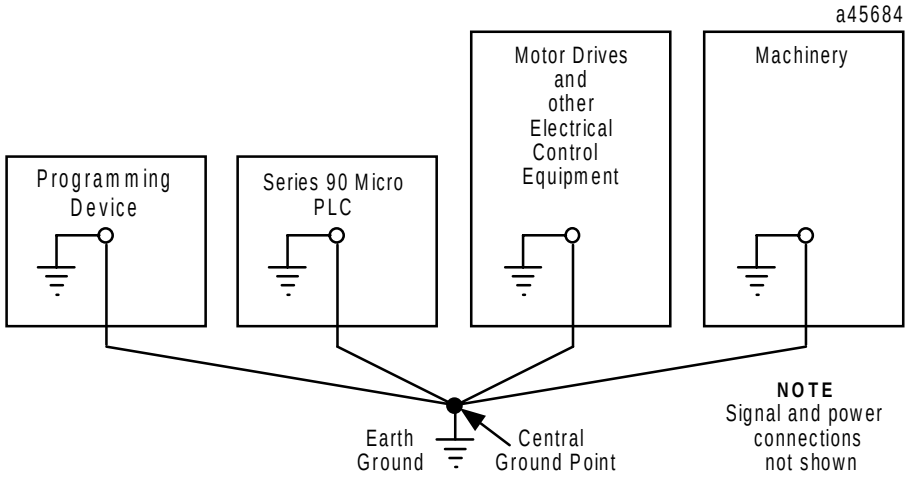


Figure 3-4. Recommended System Grounding

Logicmaster Programming Device Grounding

For proper operation, the programmer for Logicmaster 90 Micro software (Workmaster II or CIMSTAR I, or IBM-PC or compatible computer) must have a ground connection in common with the Micro PLC. Normally, this common ground connection is provided by ensuring that the programmer's power cord is connected to the same power source (with the same ground reference point) as the Micro PLC, but this will need to be verified for each installation.

I/O Installation and Wiring

Wiring connections to and from user-supplied input and output field devices are terminated at two terminal strips on the Micro PLC front panel. I/O connections are defined on the Micro PLC front panel. Wiring diagrams are provided in the "Field Wiring" section of Chapter 4.

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Powerup Self-test

Warning

Ensure that the protective cover is installed over terminals on the terminal board when power is applied to the unit. The cover protects against accidental shock hazard which could cause severe or fatal injury to the operator or maintenance personnel.

After the proper power connections have been made, the Micro PLC can be powered up to verify that the unit is installed correctly.

Normal Powerup Sequence

Apply the required power to the power inputs.

- The Power indicator, labeled PWR, should light.
- The CPU status indicator, labeled OK, blinks during the power-up self diagnostics. When self-diagnostics have been successfully completed, the OK indicator will remain lighted. (The Micro PLC can be configured to power up without running diagnostics. Unless your application requires fast power up, it is recommended that you leave powerup diagnostics enabled. For configuration information, refer to Chapter 5.)
- The CPU status indicator, labeled RUN, should light if the unit is configured to run on power-up.
- If any of the input points have been wired to field devices that energize those circuits and the RUN indicator is lighted, the corresponding input LEDs should light.
- If the RUN indicator is not lighted, all output indicators should be dark (in the STOP with I/O Disabled mode).

After verifying that a valid power-up sequence has occurred, attach a programming device (Hand-Held Programmer or computer with Logicmaster 90 software) to configure the Micro PLC and develop programs for the unit.

Caution

During a gradual power down, when the input power supply voltage is below the minimum operating voltage, the Micro PLC may power off and then power on again until the input voltage drops low enough to prevent power on again. You should take precautions if this type of behavior cannot be tolerated in your application.

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Fast Powerup

Powerup diagnostics can be disabled using the Logicmaster 90 configuration software. Unless your application requires unusually fast powerup, it is recommended that you leave this feature enabled. Disabling powerup diagnostics has the following effects:

The I/O Link Interface Expansion Unit will not work.

No expansion units can be used. (If expansion units are connected while powerup diagnostics are disabled, faults will be logged in the I/O tables.)

All HHP key sequences will be ignored when the Micro PLC is powering up.

Table 3-1. Powerup Times with Powerup Diagnostics Disabled

Model	Time
28-point units	
IC693UDR010	100ms
IC693UDR005/UAA007	300ms (typical)
All 14-point units	350ms (typical)

Error Detection And Correction

If the Micro PLC fails the power-up self-test, one of the conditions listed in Table 3-2 will be observed after applying power.

Table 3-2. Powerup Sequence Troubleshooting

Symptom	Action
PWR indicator does not light.	1. Check that the proper power source is provided and is on. 2. With power supply off, check wiring to the module unit to be sure it is connected correctly.
PWR indicator lighted but OK indicator is not lighted.	(This indicates that the power source is good and that the CPU has detected an internal fault.) Refer to “Powerup Diagnostics” in Chapter 9.
PWR indicator on, but OK and RUN indicators are blinking.	The Micro PLC features built-in blink codes to assist in troubleshooting. For definitions, refer to “Powerup Diagnostics” in Chapter 9.

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Connecting a Programming Device

The Micro PLC can be programmed and configured using either the HHP or the Logicmaster 90 software (included in IC640HWP300). Both of these methods are described in Chapter 5.

An RS-422 compatible serial port is provided on the front of the Micro PLC for communication with Logicmaster 90-30/20/Micro software or the HHP. This port can also be used for general purpose communications using the Series 90 Protocols (SNP and SNPX). On 14-point Micro PLCs, this port can also be used for RTU Slave communications.

A second RS-422 compatible port (Serial Port 2) is provided on 28-point Micro PLCs. This port can be used for general purpose communications using SNP, SNPX and RTU Slave. It is not possible to load and store programs and configuration through Port 2, because the privilege level is restricted to level 2 by the PLC firmware. Communications through Port 2 may be lost (host may time out) while operations that involve writing to flash memory, including storing the program, are being performed through Port 1.

For additional information on the functions of the serial ports, refer to “Serial Ports” in Chapter 2. For serial port orientation and pinouts, see Appendix D.

Connecting the Hand-Held Programmer

The Hand-Held Programmer (IC693PRG300) is a compact programming device that connects to the Micro PLC 15-pin serial port through a 6 foot (1.83 meter) cable that conforms to the RS-485 specification.

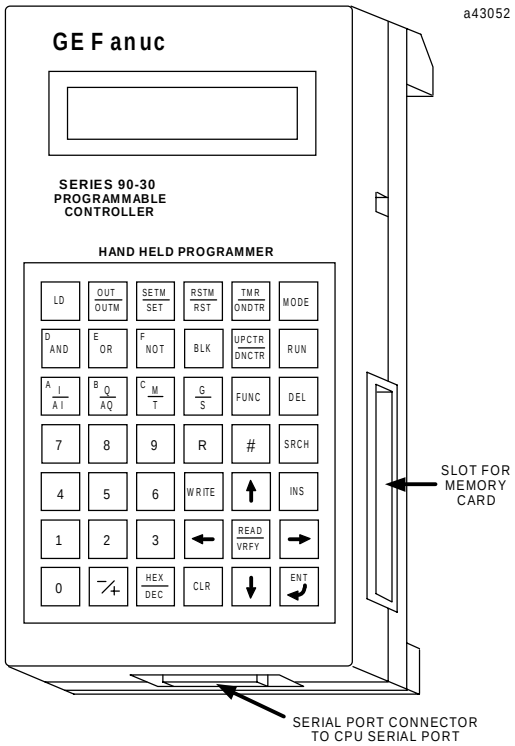


Figure 3-5. Hand-Held Programmer

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Warning

Always connect the cable to the Hand-Held Programmer first, then connect the cable to the Micro PLC. This avoids any chance of shorting the +5 volt supply on the PLC which could cause incorrect operation of the Micro PLC. Incorrect operation of the PLC could damage the equipment or cause personal injury to an operator.

To connect the Hand-Held Programmer cable:

- Attach the 15-pin male D connector on one end to the mating 15-pin female D connector on the Hand-Held Programmer.
- Attach the connector on the other end of the cable to the RS-422 connector on the Micro PLC (Port 1 on the 28-point Micro PLC). These connections are shown in Figure 3-6.

Note

Port 2 on the 28-point Micro PLC does not support the HHP. You must connect the HHP to Port 1.

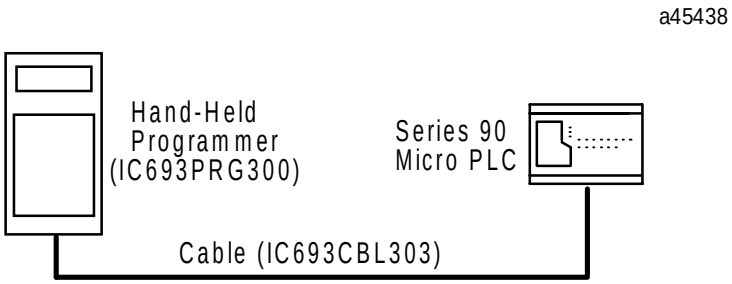


Figure 3-6. Hand-Held Programmer Cable Connection to a Micro PLC

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Connections for Using Logicmaster 90-30/20/Micro Software

You need a Software and Cable Kit package (IC640HWP300) to use Logicmaster 90 Micro software with the Micro PLC.

Workmaster II Computer with WSI

The cable connection for this configuration is from the connector on the WSI board (IC647WMI920) to the Micro PLC serial port as shown below.

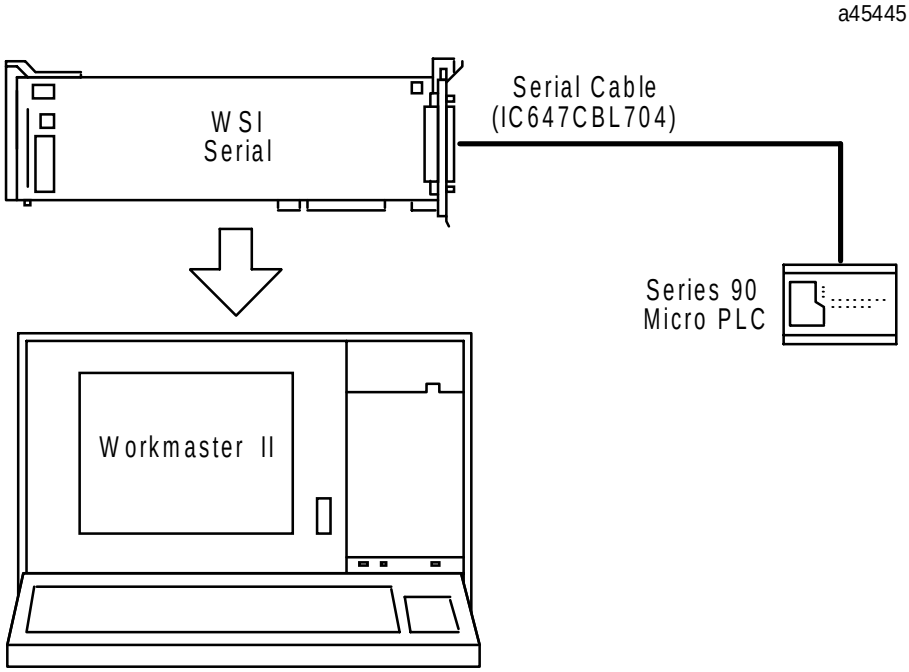


Figure 3-7. Logicmaster 90 Micro Programmer Connection through a WSI

IBM-PC Compatible Computer

This configuration uses a standard RS-422 or RS-232 serial communications port on the IBM-PC compatible computer. An RS-422/RS-232 miniconverter (IC690ACC901) is required. Examples of cable connections for this type of interface are shown in Figure 3-8. Refer to Appendix E, “Converters” for a complete description of the miniconverter.

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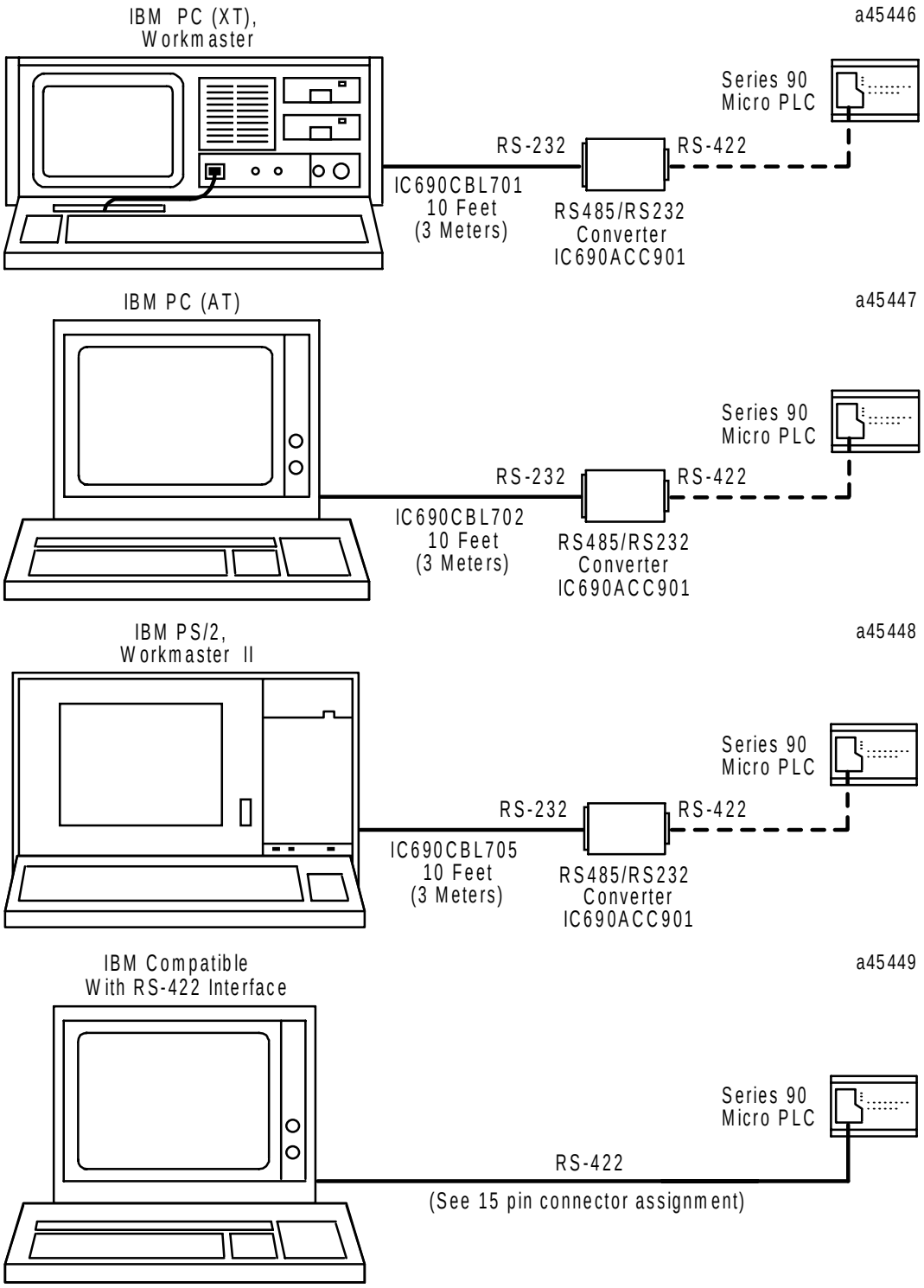


Figure 3-8. Examples of Serial Connection from Series 90 Micro PLC to Computer

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Multidrop Serial Data Configuration to Series 90 PLCs

Note

Any installation that includes PLCs over 50 feet (15.2 meters) apart must include optical isolation.

The Series 90 Micro PLC supports a maximum of eight devices on a single serial link per network. This number can be increased with the use of a repeater. For additional information on serial communications, refer to the *Series 90 PLC Serial Communications User's Manual*, GFK-0582.

Termination resistance for the Receive Data (RD) signal needs to be connected only on units at the end of the line. This termination is made on the Series 90 Micro PLC products by connecting a jumper between pins 9 and 10 inside the 15-pin D-shell. Sample cabling for multidrop installations is provided in Appendix D, "Serial Ports and Cables" and Appendix E, "Converters."

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Replacing Fuses (AC In/AC Out Models Only)

Caution

There are *no* user-replaceable parts in the DC In/Relay Out Micro PLCs (UDR001/002/005/010, UAL006, UEX011).

The AC In/AC Out model Micro PLCs (IC693UAA003/007) provide user-replaceable fuses for their AC output points. Because each output fuse is on the common of several circuits, a blown fuse will prevent the entire group associated with it from working. (Refer to Table 3-3 and to the field wiring diagrams in Chapter 4.)

Warning

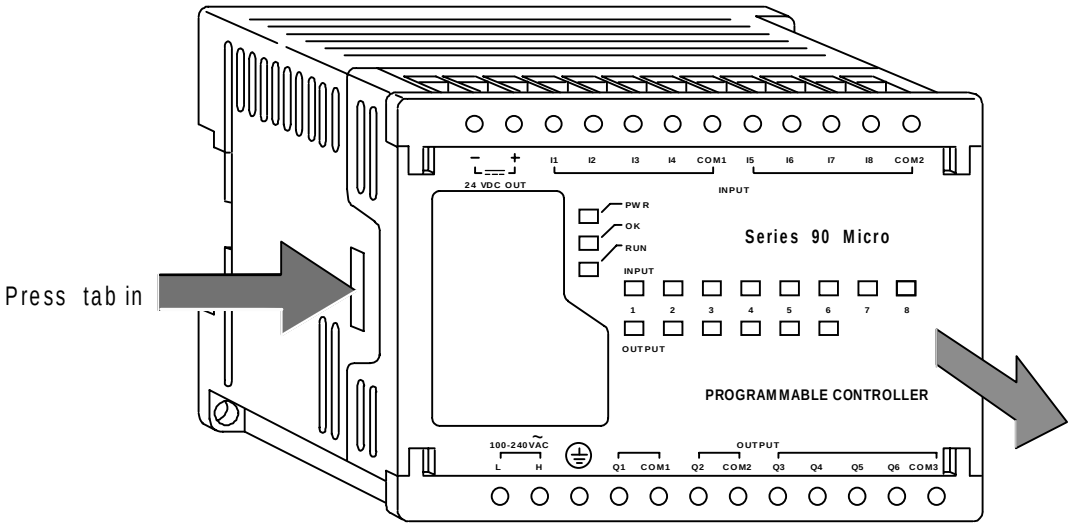
Remove power from the unit before removing field wiring or removing the front cover. Failure to remove power from the unit before disassembling it could cause severe or fatal injury to personnel.

Caution

Do not attempt to remove the circuit boards from the Micro PLC assembly, or to replace fuses on the power supply board. Any disassembly beyond removing the front cover and replacing AC output fuses could damage the unit and will invalidate the warranty.

The plug-in fuses are located on the I/O circuit board (Figure 3-9), which is located immediately behind the Micro PLC front cover. To replace these fuses:

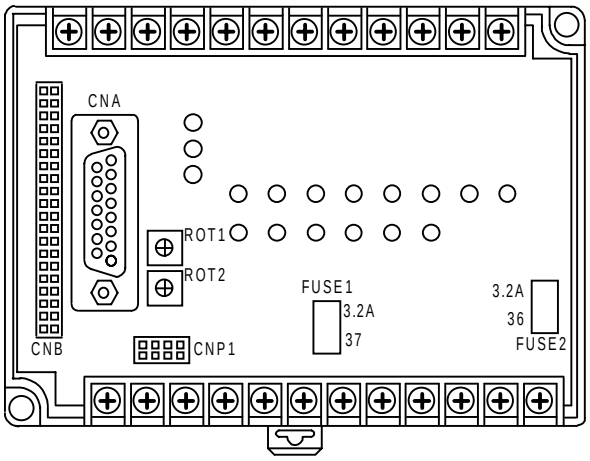
1. Remove power from the unit and I/O devices.
2. Remove field wiring from the unit.
3. Remove front cover from the unit. (Gently press inward one of the tabs located on the sides of the unit and pull the cover off.)



4. Replace each blown fuse with the appropriate fuse type, listed in Table 3-3.

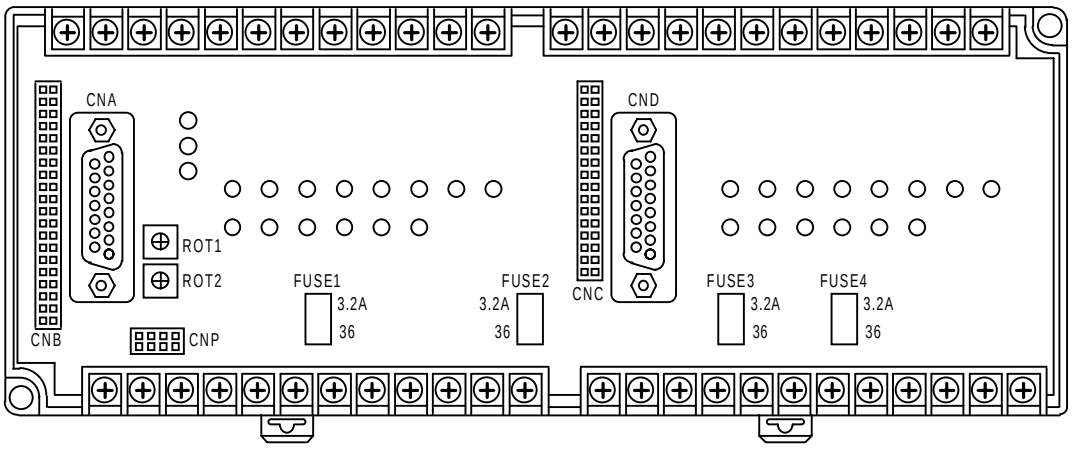
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a45443



14-Point Micro PLC (IC693UAA003)

a45415



28-Point Micro PLC (IC693UAA007)

Figure 3-9. Locations of Fuses on AC In/AC Out I/O Board

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Caution

The fuse on the power supply board, which is located at the bottom of the unit, is *not replaceable* and cannot be easily accessed. This fuse is provided as a safety precaution. If it blows, a fault in the power supply is indicated and the Micro PLC should be replaced.

Note

The fuses listed below are only for the output points on the AC In/AC Out Micro PLCs (IC693UAA003/UAA007). You can easily access these fuses by removing the PLC front cover. *There are no user-replaceable parts in the DC In/Relay Out Micro PLCs.*

Table 3-3. List of Fuses for AC In/AC Out I/O Boards

Micro PLC	Location	Output Points Controlled
IC693UAA003, IC693UAA007	FUSE 1	Q1–Q2
	FUSE 2	Q3–Q6
IC693UAA007	FUSE 3	Q7–Q8
	FUSE 4	Q9–Q12

Table 3-4. Fuse Specifications

Current Rating	3.2 A

Catalog Number	Available From
GE Fanuc: IC693ACC001 (5/package)	GE Fanuc Automation N.A., Inc. – Asia Pacific Operations No. 1 Teban Gardens Crescent Jurong – Singapore 608919 Phone: (65) 566-9902 or (65) 566-4918 Fax: 011 (65) 567-1856 or 011 (65) 566-7703
Third Party: Daito HM32	See “Distributors,” below*

***Distributors**

U.S.A.	MHOTRONICS, Inc. 960 Corporate Woods Parkway Vernon Hills, IL 60061	Phone: 847-913-9566 Fax: 847-913-9587
Europe	OESS Gmbll Frankfurt Office Senefelder Street 1 63110 Rodgau, Germany	Phone: 6106-750313 Fax: 6106-72719
Singapore	B.B.S. Electronics PTE. LTD 1 Genting Link, #05-03 Perfecindustrial Building Singapore 1334	Phone: 748-8400 Fax: 748-8466

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Expansion Unit Installation

The 23-point Micro PLCs support the Series 90 Micro Expansion Units (IC693UEX011), Generic (third party) expansion units, and the I/O Link Interface unit (IC693UEX013). Up to four expansion units can be connected in series to a base Micro PLC.

Caution

Power down the Micro PLC before connecting an Expansion Unit. Connecting an Expansion Unit with the Micro PLC powered up will damage the unit.

Note

If you are connecting a third-party expansion unit, you will need to provide a ribbon cable. Software filtering of generic (third-party) expansion I/O is not supported. Hardware filtering should be supplied to meet the required noise immunity on these units.

Micro Expansion Unit

The Micro Expansion Unit (IC693UEX011) connects to a 23-point Micro PLC to provide additional I/O points (8 inputs and 6 outputs per each unit). This expansion unit has the following features:

- Ribbon cable for connection to 28-point Micro PLC is provided with expansion unit. This ribbon cable is 3 CM in length and cannot be substituted. That is, you must use the ribbon supplied with the unit.
- The Micro PLC firmware supports input filtering of the 14-point expansion units.

The expansion unit has a 40-pin female connector at each end. The left connector can be connected to either a base Micro PLC or to another expansion unit's right-side 40-pin female connector via a short ribbon cable. Table 3-5 lists pin assignments for the expansion ports.

Caution

The 40-pin ribbon cable provided with the Micro Expansion Unit has keyed connectors to prevent incorrect connection. Powering up the system with the cable improperly installed can damage the Expansion Unit. Do not substitute the ribbon cable provided with this Micro PLC with a generic ribbon cable. If you need to order replacements, the part number is IC693ACC003.

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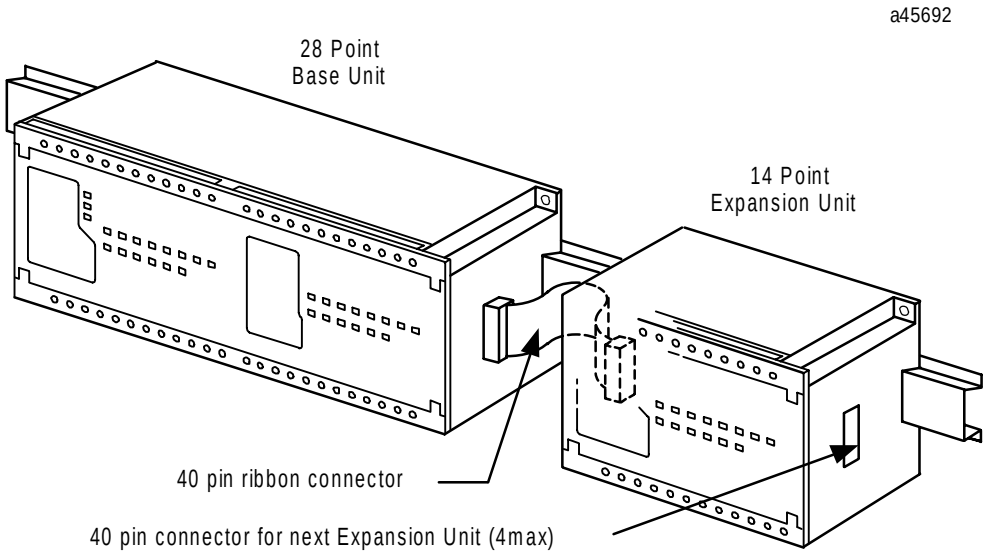


Figure 3-10. Expansion Unit Installation

Note

Cable length is fixed at minimum length to eliminate noise.

Micro Expansion Unit Orientation

Caution

The Micro Expansion Unit's input expansion port must be connected to the output expansion port of the base Micro PLC (or another expansion unit). Connecting the unit in the reverse position will damage the DC input circuit when the system is powered up.

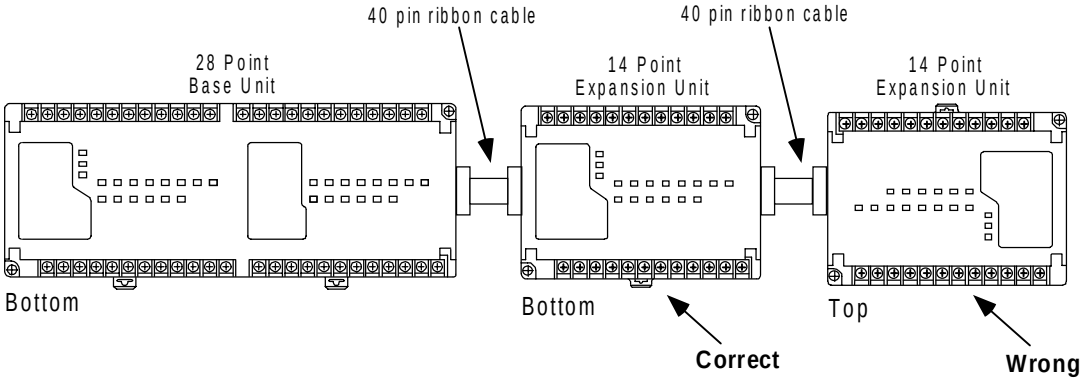


Figure 3-11. Micro Expansion Unit Orientation

Note

The part number for the Micro expansion ribbon is IC693ACC003. These ribbons come in a 12-pack.

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Electromagnetic Compatibility

To meet the electromagnetic compatibility requirements of FCC Rule part 15, subpart J, the Micro Expansion Unit must be installed as described in the *Important Product Information* (IPI) document, GFK-1474. This IPI is provided with the Micro Expansion Unit and covers installation and shielding requirements.

Physical Order of Different Types of Expansion Units

Different types of expansion units can be connected to a base unit. The installation must meet the following requirements:

1. Generic expansion units must be located immediately after the Micro PLC base unit and before any other types of expansion units.
2. Standard Micro (IC693UEX011) expansion units must be located after any generic expansion units and before the I/O Link Interface expansion unit.
3. The I/O Link Interface expansion unit (I/O Link IEU) must be located after all other types of expansion units. Because the I/O Link IEU has only one expansion connector, it must be the last unit if other units are connected to the same base Micro PLC. This also means that there can be only one I/O Link IEU per Micro PLC base unit.

Note

The I/O Link IEU (IC693UEX013) is not sold in the United States. For details on installation and operation, refer to the documentation provided with the I/O Link IEU.

Additionally, if two or more generic expansion units are used in a system, they should be configured and physically located with their address offsets in ascending order.

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Table 3-5. Micro Expansion Port Pin Assignments

IN (Left Connector on Expansion Unit)			OUT (Right Connector on Micro PLC and Expansion Unit)		
Pin	**Signal Name**	**Function**	**Pin**	**Signal Name**	**Function**
A01	Reserved*	NA	A01	GND	Ground
A02	Reserved*	NA	A02	/WR	Write
A03	Reserved*	NA	A03	A7	Address 07
A04	Reserved*	NA	A04	A8	Address 08
A05	Reserved*	NA	A05	A9	Address 9
A06	/WAIT	Wait state control	A06	A11	Address 11
A07	GND	Ground	A07	/RD	Read
A08	D3	Data 3	A08	A10	Address 10
A09	D2	Data 2	A09	A0	Address 00
A10	D6	Data 6	A10	D0	Data 0
A11	D0	Data 0	A11	D6	Data 6
A12	A0	Address 0	A12	D2	Data 2
A13	A10	Address 10	A13	D3	Data 3
A14	/RD	Read	A14	GND	Ground
A15	A11	Address 11	A15	/WAIT	Wait state control
A16	A9	Address 9	A16	Reserved*	NA
A17	A8	Address 8	A17	Reserved*	NA
A18	A7	Address 7	A18	Reserved*	NA
A19	/WR	Write	A19	Reserved*	NA
A20	GND	Ground	A20	Reserved*	NA
B01	Reserved*	NA	B01	GND	Ground
B02	Reserved*	NA	B02	GND	Ground
B03	ERRI	IO link status	B03	GND	Ground
B04	Reserved*	NA	B04	A6	Address 06
B05	/CS2	Expansion select	B05	A5	Address 05
B06	/IORST	Expansion reset	B06	A4	Address 04
B07	Reserved*	NA	B07	A3	Address 03
B08	D4	Data 4	B08	A2	Address 02
B09	D5	Data 5	B09	A1	Address 01
B10	D1	Data 1	B10	D7	Data 7
B11	D7	Data 7	B11	D1	Data 1
B12	A1	Address 1	B12	D5	Data 5
B13	A2	Address 2	B13	D4	Data 4
B14	A3	Address 3	B14	Reserved*	NA
B15	A4	Address 4	B15	/IORST	Expansion reset
B16	A5	Address 5	B16	/CS2	Expansion select
B17	A6	Address 6	B17	Reserved*	NA
B18	GND	Ground	B18	Reserved*	NA
B19	GND	Ground	B19	ERRI	IO link status
B20	GND	Ground	B20	Reserved*	NA

* All reserved pins should remain unconnected by expansion units.

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Agency Approvals, Standards, and General Specifications for Series 90 Micro PLC

The Series 90 Micro PLC products supplied by GE Fanuc are global products which are designed and manufactured for application in industrial environments throughout the world. They should be installed and used in conformance with product specific guidelines as well as the following agency approvals, standards and general specifications:

AGENCY APPROVALS OVERVIEW[1]		***Comments***
Industrial Control Equipment [Safety]	UL508, CUL	Certification by Underwriters Laboratories for selected modules
Hazardous Locations [Safety] Class I, Div II, A, B, C, D	UL1604 with C-UL	Certification by Underwriters Laboratories for selected modules
European EMC Directive	CE Mark	Selected modules

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STANDARDS OVERVIEW[2]		*Conditions*
ENVIRONMENTAL		
Vibration	IEC68-2-6, JISC0911	1G @40-150Hz, 0.012in p-p @10-40Hz
Shock	IEC68-2-27, JISC0912	15G, 11ms
Operating Temperature[3]		0°C to 55°C [ambient]
Storage Temperature		–40°C to +85°C
Humidity		5% to 95%, non-condensing
Enclosure Protection	IEC529	Enclosure per IP54; protection from dust & splashing water
EMC EMISSIONS		
Radiated, Conducted	CISPR11, EN55011 FCC	Group 1, Class A [applies to CE Marked modules] part 15, subpart J
EMC IMMUNITY		**[applies to CE Marked modules]**
Electrostatic Discharge EN 61000-4-2	IEC801-2	8KV Air Discharge, 4KV Contact Discharge
Radiated RF ENV 50140, ENV50204	IEC801-3	$10V_{rms}$ /m, 80Mhz to 1000Mhz, modulated
Fast Transient Burst, EN61000-4-4	IEC801-4	2KV: power supplies, 1KV: I/O, communications
Surge Withstand, EN61000-4-5	IEC 1000-4-5 IEC 1000-4-12	Power supply: >50V, 2KV (line-to-ground), 1KV (line-to-line) <50V, 0.5KV (line-to-ground), 0.5KV (line-to-line) Communications port and I/O: 1KV
Conducted RF, EN50141	IEC801-6	10V, 150kHz to 80Mhz injection for comm cables >30m
ISOLATION		
Dielectric Withstand	UL508, UL840, IEC664	1.5KV for modules rated from 51V to 250V
POWER SUPPLY		
Input Dips, Variations	IEC1000-4-11	During Operation: Dips to 30% and 100%, Variation for AC ±10%, Variation for DC ±20%

Note 1: Module-specific approvals are listed on the GE Fanuc Electronic Bulletin Board Service [BBS]. The BBS can be reached at 804-975-1300 with the following modem settings: up to 33,600 baud, 8 data bits, 1 parity bit, no stop bits. After accessing the BBS, select the BBS File area (*PLC:AGENCY STATUS*) and the file (*AGENSTDS.XLS)*. This information is also available on the Internet at our technical support World Wide Web site at the address: http://www.gefanucsupport.com

Note 2: Refer to module-specific data sheets and installation guidelines in the following publications:
Important Product Information, Micro PLC (GFK-1094)
Important Product Information, Micro Expansion Units (GFK-1474)
Data Sheet, 14-Point Micro PLC, GFK-1087
*Data Sheet, 28-Point Micro PLC***,** GFK-1222
Data Sheet, Micro Expansion Unit, GFK-1460
Data Sheet, 23-Point Micro PLC, GFK-1459
Data Sheet, 14-Point Micro PLC (DC In/Out), GFK-1553

Note 3: Selected modules may be derated.

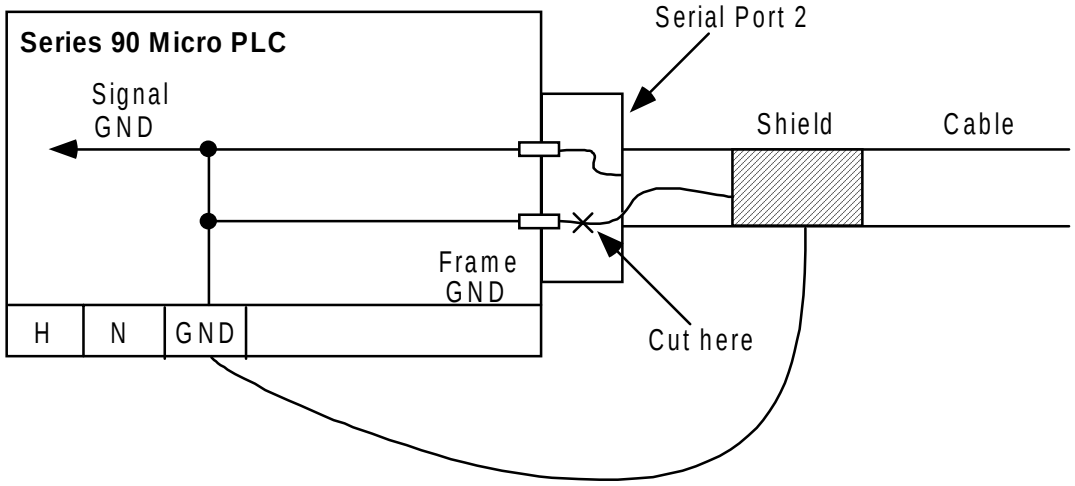
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CE Mark Installation Requirements

The following requirements for surge, electrostatic discharge (ESD), and fast transient burst (FTB) protection must be met for applications that require CE Mark listing:

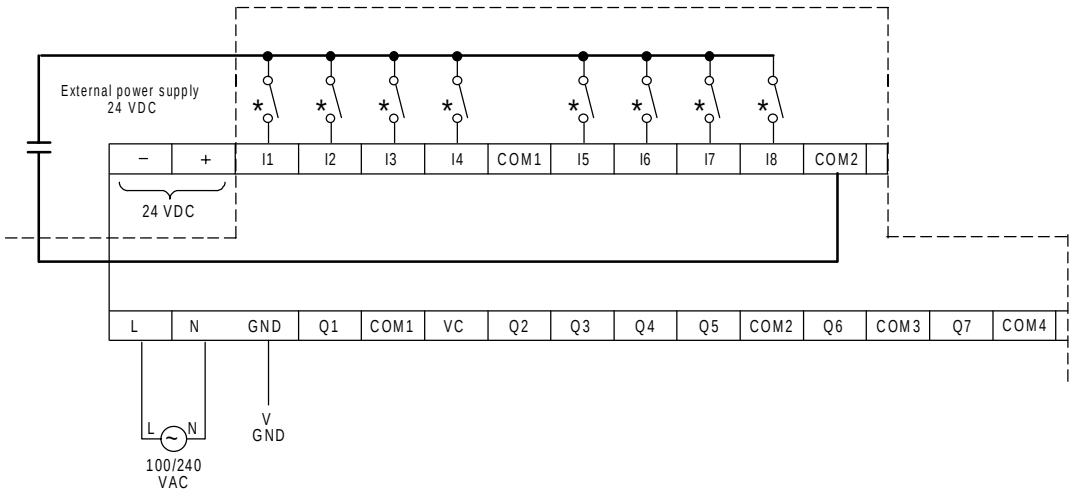
- The series 90 Micro PLC is considered to be open equipment and should therefore be installed in an enclosure (IP54) .
- This equipment is intended for use in typical industrial environments that utilize anti-static materials such as concrete or wood flooring. If the equipment is used in an environment that contains static material, such as carpets, personnel should discharge themselves by touching a safely grounded surface before accessing the equipment.
- If the AC mains are used to provide power for I/O, these lines should be suppressed prior to distribution to the I/O so that immunity levels for the I/O are not exceeded. Suppression for the AC I/O power can be made using line-rated MOVs that are connected line-to-line, as well as line-to-ground. A good high-frequency ground connection must be made to the line-to-ground MOVs.
- AC or DC power sources less than 50V are assumed to be derived locally from the AC mains. The length of the wires between these power sources and the Series 90 Micro PLC should be less than a maximum of approximately 10 meters.
- Installation must be indoors with primary facility surge protection on the incoming AC power lines.
- On Micro PLCs that have DC inputs (IC693UDR001/002/005/010, /UAL006, UEX011): The wires between the 24 VDC output and COM1 (on the 23-point Micros only) must be as short as possible.
- On 23 and 28-point DC In/Relay Out Micro PLCs (IC693UDR005/010, UAL006): The cable connection to Serial Port 2 should be configured as shown in Figure 3-12 to minimize noise. (The wire between the cable shield and the FRAME GND pin of the D-SUB connector on the cable should be cut. The cable shield should then be connected to the GND terminal screw on the Micro PLC unit.)
- On 28-point DC In/Relay Out Micro PLCs (IC693UDR005/010): Inputs used as high speed counter inputs must be powered separately. An external power supply should be provided for the high speed counter inputs as shown in Figure 3-13. For wiring of discrete inputs and outputs, refer to the field wiring diagrams in Chapter 4.
- On 28-point DC In/Relay Out Micro PLCs (IC693UDR005/010): Under the conditions of the Surge Withstand test (EN61000-4-5), HSC miscounts could occur. These additional counts can be minimized by using shielded cable and by keeping the cabling length less than 30 meters.
- In the presence of noise, serial communications could be interrupted.

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28-Point DC In/Relay Out/AC Power Micro PLC (IC693UDR005)

Figure 3-12. CE Mark Requirements for Cable Connection to Serial Port 2



* High speed counter inputs should be powerd separetly from discrete inputs. The switching devices should be solid state to avoid bounce, which could cause unintended counts or strobes.

This example is connected for positive logic. The inputs can be wired for negative logic be reversing the 24 VDC external power supply connections.

28-Point DC In/Relay Out/AC Power Micro PLC (IC693UDR005)

Figure 3-13. CE Mark Requirements for Power Supply to High Speed Counter Inputs

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Chapter 4 Field Wiring

This chapter contains power and I/O specifications and wiring information for the Series 90 Micro PLC.

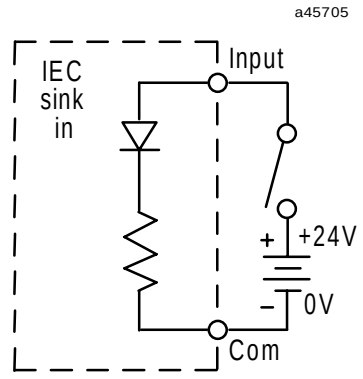
Positive and Negative Logic Definitions

The IEC definitions for positive logic and negative logic, as applied to the Series 90 Micro PLC I/O circuits, are defined as follows.

Input Points – Positive Logic

Characteristics:

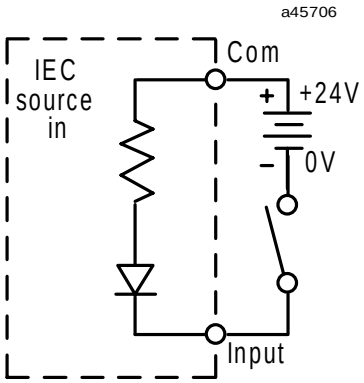
- Equivalent to IEC sink input points.
- Sink current from the input device to the user common or negative power bus.
- The input device is connected between the positive power bus and the input terminal. The negative bus is connected to the input circuit common.



Input Points – Negative Logic

Characteristics:

- Equivalent to IEC source inputs.
- Source current through the input device to the user common or positive power bus.
- The input device is connected between the negative power bus and the input terminal. The positive bus is connected to the input circuit common.

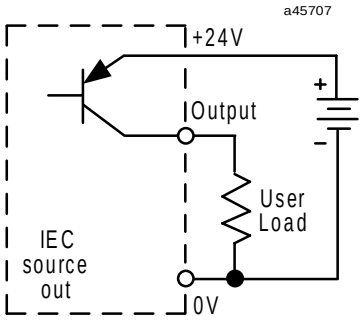


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Output Points – Positive Logic

Characteristics:

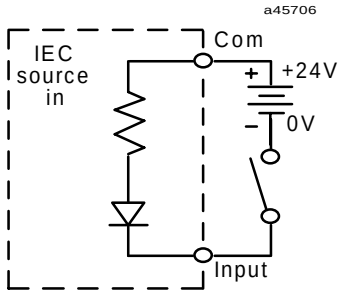
- Equivalent to IEC source output points.
- Source current to the loads from the user common or positive power bus. The load is connected between the negative power bus and the module output.



Output Points – Negative Logic

Characteristics:

- Equivalent to IEC sink outputs.
- Sink current from the loads to the user common or negative power bus.
- The load is connected between the positive power bus and the output terminal.



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Interface Specifications

Input/output and power supply characteristics are listed below for each Series 90 Micro PLC model. Refer to the pages listed for detailed specifications for the type of input or output and to the field wiring diagrams for each model.

Model Summaries

14-Point DC In/Relay Out/AC Power (IC693UDR001/UEX011)

Inputs	Eight 24 VDC positive/negative logic input circuits	*See page 4-7.*
Outputs	Six normally open 2 amp relay circuits	*See page 4-10.*
24 VDC	Isolated 24 VDC output power supply	*See page 4-12.*
Field wiring diagram		*See page 4-22.*

AC Power Requirements – User/Internal (IC693UDR001/UEX011)	
Range	100 -15% to 240 +10% VAC
Frequency	50 -5% to 60 +5% Hz
Hold-up	10 ms at 85 VAC
Inrush Current	18 A maximum at 120 VAC 30 A maximum at 200 VAC 40 A maximum at 265 VAC
Inrush Time	2 ms for 40A
Input Current	0.12 A typical at 200 VAC 0.25 A typical at 100 VAC
Input Power Supply Rating	35 VA

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14-Point DC In/Relay Out/DC Power (IC693UDR002), 14 Point DC In/DC Out/DC Power (IC693UDD104)

Inputs	Eight 24 VDC positive/negative logic input circuits	*See page 4-7.*
Outputs	Six normally open 2 amp relay circuits	*See page 4-10.*
24 VDC	Isolated 24 VDC output power supply	*See page 4-12.*
Field wiring diagram		*See page 4-22.*

DC Power Requirements – User/Internal (IC693UDR002/UDD104)	
Range	12 -15% to 24 +25% VDC 12 -15% to 24 +10% VAC
Hold-up	4 ms at 10 VDC 10 ms at 12 VDC
Inrush Current	65 A maximum at 24 VDC 81 A maximum at 30 VDC
Inrush Time	10 ms for 81 A
Input Current	0.8 A typical at 12 VDC 0.4 A typical at 24 VDC
Input Power Supply Rating	15W/20VA

Note: The DC power supply requires more current at startup voltage (approximately 4 VDC) than at rated input voltage. A minimum of 2.0 A is required to start up the DC power supply.

14-Point AC In/AC Out/AC Power (IC693UAA003)

Inputs	Eight AC inputs	*See page 4-15.*
Outputs	Six AC outputs	*See page 4-18.*
Field wiring diagram		*See page 4-22.*

AC Power Requirements – User/Internal (IC693UAA003)	
Range Frequency Hold-up	100 -15% to 240 +10% VAC 50 -5% to 60 +5% Hz 10 ms at 85 VAC
Inrush Current	18 A maximum at 120 VAC 30 A maximum at 200 VAC 40 A maximum at 265 VAC
Inrush Time	2 ms for 40 A
Input Current	0.25 A typical at 100 VAC 0.12 A typical at 200 VAC
Input Power Supply Rating	20 VA

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28-Point DC In/DC & Relay Out/AC Power (IC693UDR005)

Inputs	Sixteen 24 volt DC positive/negative logic input circuits	*See page 4-7.*
	Potentiometers	*See page 4-8.*
Outputs	One DC output (Q1)	*See page 4-12.*
	Eleven normally open 2 amp relay circuits	*See page 4-10.*
24 VDC	Isolated 24 VDC output power supply	*See page 4-12.*
Field wiring diagram		*See page 4-23.*

AC Power Requirements – User/Internal (IC693UDR005)	
Range	100 -15% to 240 +10% VAC
Frequency	50 -5% to 60 +5% Hz
Hold-up	10 ms at 85 VAC
Inrush Current	30 A maximum at 200 VAC 40 A maximum at 265 VAC
Inrush Time	2 ms for 40 A
Input Current	0.26 A typical at 100 VAC 0.12 A typical at 200 VAC
Input Power Supply Rating	40 VA

23-Point DC In/DC & Relay Out/Analog I/O/AC Power (IC693UAL006)

Inputs	Thirteen 24VDC positive/negative logic input circuits	*See page 4-7.*
	Two analog inputs	*See page 4-15*
	Potentiometers	*See page 4-8*
Outputs	Nine normally open 2 amp relay circuits	*See page 4-12*
	One DC output (Q1)	*See page 4-12.*
	One analog output	*See page 4-16*
24 VDC	Isolated 24 VDC output power supply	*See page 4-12.*
Field wiring diagram		*See page 4-23.*

AC Power Requirements – User/Internal (IC693UAL006)	
Range	100 -15% to 240 +10% VAC
Frequency	50 -5% to 60 +5% Hz
Hold-up	10 ms at 85 VAC
Inrush Current	35 A maximum at 200 VAC 46 A maximum at 265 VAC
Inrush Time	2 ms for 40 A
Input Current	0.35 A typical at 100 VAC 0.22 A typical at 200 VAC
Isolation	1500VAC rms field side to logic (both power supply input and 24 VDC power supply output)
Input Power Supply Rating	50 VA

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28-Point AC In/AC Out/AC Power (IC693UAA007)

Inputs	16 AC inputs	*See page 4-17.*
Outputs	12 AC outputs	*See page 4-18.*
Field wiring diagram		*See page 4-24.*

AC Power Requirements – User/Internal (IC693UAA007)	
Range	100 -15% to 240 +10% VAC
Frequency	50 -5% to 60 +5% Hz
Hold-up	10 ms at 85 VAC
Inrush Current	30 A maximum at 200 VAC 40 A maximum at 265 VAC
Inrush Time	2 ms for 40 A
Input Current	0.16 A typical at 100 VAC 0.09 A typical at 200 VAC
Input Power Supply Rating	25 VA

28-Point DC/DC & Relay Out/DC Power (IC693UDR010)

Inputs	Sixteen 24 VDC positive/negative logic input circuits	*See page 4-7.*
Outputs	Eleven normally open 2 amp relay circuits One DC output (Q1)	*See page 4-10.* *See page 4-12*
24 VDC	Isolated 24 VDC output power supply	*See page 4-12.*
Field wiring diagram		*See page 4-23.*

DC Power Requirements – User/Internal (IC693UDR010)	
Range	24 -20%, +25% VDC 24 -15%, +10% VAC
Hold-up	2 ms at 9.5 VDC
Inrush Current	65 A maximum at 24 VDC 81 A maximum at 30 VDC
Inrush Time	10 ms for 81 A
Input Current	1.4 A typical at 24 VDC
Input Power Supply Rating	20 W/40 VA

Note

The DC power supply requires more current at startup voltage (approximately 4 VDC) than at rated input voltage. A minimum of 2.0 A is required to start up the DC power supply.

Note

If configured to disable powerup diagnostics, the 28-point DC In/ Relay Out/DC Power unit (IC693UDR010) will begin logic solution 100ms after the voltage level of the power supply input reaches and maintains 24VDC. The 24VDC power source for the UDR010 unit must have enough transient current capability to support the inrush current of the power supply and maintain a 24VDC voltage level (see power supply specifications for inrush requirements above).

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Positive/Negative Logic Inputs (IC693UDR001/002/005/010, UDD00104, UAL006, UEX011)

The 24 volt DC positive/negative logic input circuits are designed to have positive or negative logic characteristics. Current into an input point results in a logic 1 in the input status table (%I). For an overview of positive and negative logic, see page 4-1.

Input characteristics are compatible with a wide range of input devices, such as: pushbuttons, limit switches, and electronic proximity switches. Power to operate field devices and the input circuits is supplied by an isolated +24 VDC supply.

Table 4-1. Specifications for 24 VDC Input Circuits

Rated Input Voltage		24 volts DC
Input Voltage Range		0 to 30 volts DC
Input Current		7.5mA typical
Input Resistance		2.8 Kohms
Input Threshold Voltage	**ON**	15V minimum
	OFF	5V maximum
Input Threshold Current	**ON**	4.5mA maximum
	OFF	1.5mA minimum
Response Time		0.5 to 20ms (user configurable) as regular input; 100µs as HSC input *See "Software Filters" in Chapter 8 for details.*
Isolation Voltage		500VAC RMS field side to logic side 500V RMS between groups, if one group is powered by an external 24V power supply.

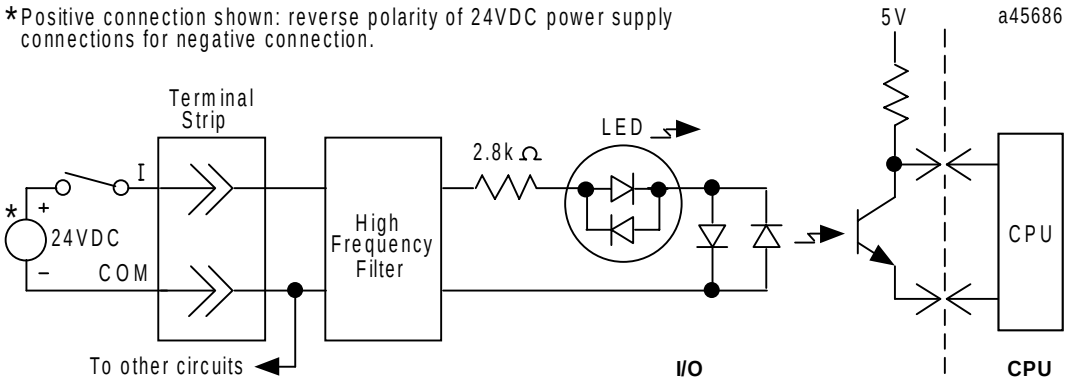


Figure 4-1. Typical 24 VDC Positive/Negative Logic Input Circuit

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Potentiometer Analog Inputs (All Models)

Two potentiometers, located on the front panel of the Micro PLC, allow you to manually set input values that are stored in %AI16 and %AI17. The top potentiometer controls %AI16, and the bottom one controls %AI17 (see Figure 2-3).

Due to the nature of analog input, the values seen in %AI16 and %AI17 will have some fluctuation. The Micro PLC uses an averaging filter to stabilize these inputs. The number of samples to be averaged is controlled by the value in %AQ1 as described in "Analog Input Filtering" in Chapter 8.

Table 4-2. Potentiometer Analog Specifications

For details, see "Analog Potentiometer Input Filtering" in Chapter 8.	
Reference locations	AI16, AI17
Resolution	10 bits
Range	0–1023 per ¾ turn

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High Speed Counter Inputs (IC693UDR001/002/005/010, UAL006)

The 24 VDC input positive/negative logic circuits can be used as inputs for the High Speed Counter (HSC) function provided by the Series 90 Micro PLC. These inputs can be connected either as positive or negative inputs as described in the DC input circuit section. The maximum frequency for the HSC inputs is 5Khz.

The HSCs can be configured as four type A counters, or as one type B counter and one type A counter. Unused HSC inputs can be used as standard DC inputs. (Refer to Chapter 6 for input assignments.)

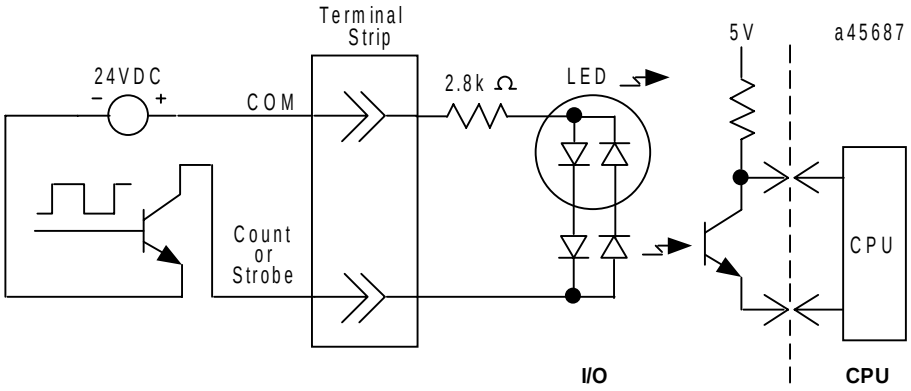


Figure 4-2. High Speed Counter Circuit - Negative Logic Connection

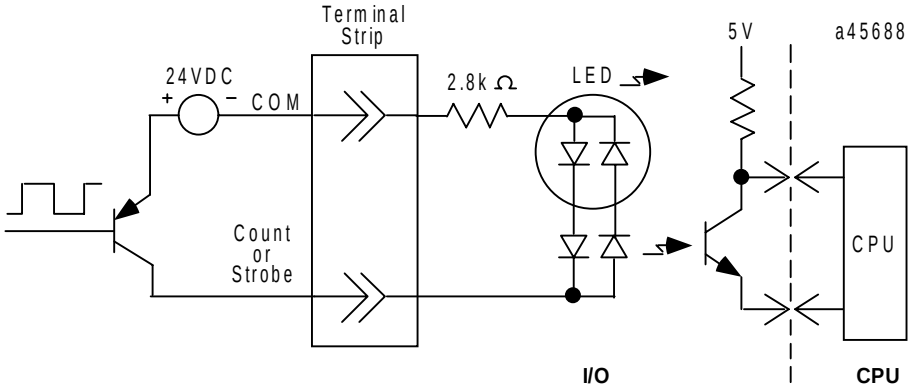


Figure 4-3. High Speed Counter Circuit - Positive Logic Connection

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Relay Outputs (IC693UDR001/002/005/010, UAL006, UEX011)

These normally open relay outputs can control a wide range of user-supplied load devices, such as motor starters, solenoids, and indicators. The switching capacity of each of these circuits is 2 amps. Power for the internal relay coils is provided by the +26 volt DC internal supply. The user must supply the AC or DC power to operate field devices.

Table 4-3. Specifications for Relay Output, 2 Amp Circuits

Operating Voltage	5 to 30 VDC 5 to 250 VAC
Isolation	1500 V RMS between field side and logic side 500 V RMS between groups
Leakage Current	1 mA at 240 VAC maximum
Maximum UL Pilot Duty Rating	2 amps at 24 VDC and 240 VAC
Maximum Resistive Load Rating	2 amps at 24 VDC and 240 VAC
Minimum Load	10 mA
Maximum Inrush	5 amps per half cycle
On Response Time	15 ms maximum
Off Response Time	15 ms maximum
Contact Life	(also refer to Table 4-4.)
Mechanical	20 x 10^6 mechanical operations
Electrical	200,000 electrical operations resistive load (2A)

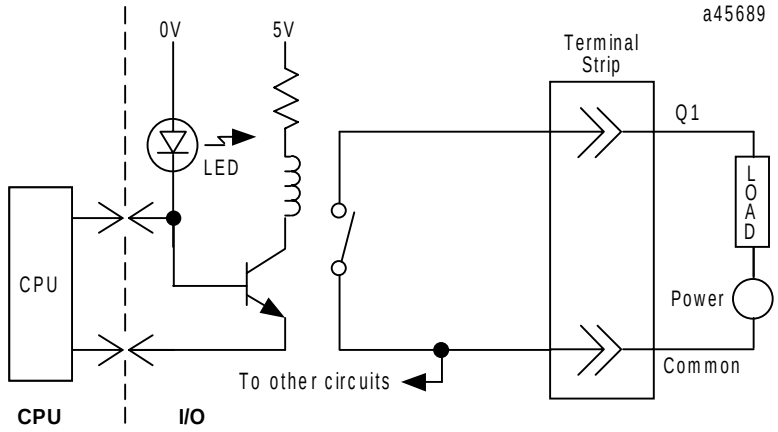


Figure 4-4. Typical Relay Output Circuit

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Output Circuit Protection

Caution

These relay outputs do not have fuse protection. It is recommended that each output point be externally fused (maximum 2 amp) to protect the output point contacts from damage.

When controlling inductive loads, it is recommended that the user provide suppression circuits as shown in Figure 4-5. In addition, relay contact life, when switching inductive loads, will approach resistive load contact life if suppression circuits are used. The 1A, 100V diode shown in the typical DC load suppression circuit is an industry standard 1N4934.

Table 4-4. Typical Contact Life

Voltage	Current		Typical Operations
	Resistive	Lamp and Solenoid	
240VAC, 120VAC, 24VDC	2A	0.6A	200,000
240VAC, 120VAC, 24VDC	1A	0.3A	400,000
240VAC, 120VAC, 24VDC	0.5A	0.1A	800,000

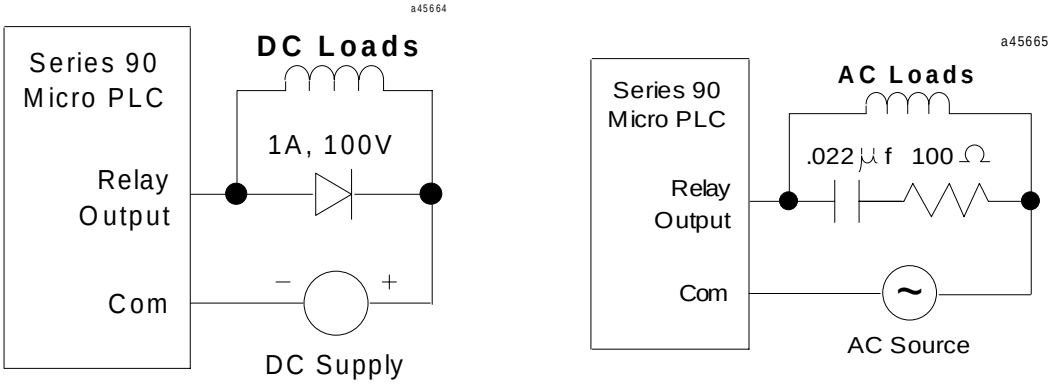


Figure 4-5. Suppression Circuits

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High Speed Counter Outputs (IC693UDR001/002/005, IC693UAL006)

Micro PLC outputs %Q1 through %Q8 can be configured to be controlled by the HSC function. HSC output for Q1 can not be enabled if it is being used as a PWM or pulse train output. (Unused HSC outputs can be used as standard relay outputs.)

Connections and specifications for HSC outputs are the same as for standard relay outputs.

DC Outputs (IC693UDR005/010 and IC693UAL006)

The DC output circuit (Q1) can be configured to provide High Speed Counter, pulse train or PWM output.

Table 4-5. Specifications for DC Output Circuit

Operating Voltage		24VDC / 12VDC / 5VDC
Voltage Range		24 VDC, +20%, –79%
Maximum UL Pilot Duty Rating		0.75A at 24 VDC
Maximum Resistive Load Rating		0.75A at 24 VDC 0.5A at 12 VDC 0.25A at 5 VDC
Output Voltage Drop		0.3 VDC maximum
Response	ON	0.1ms maximum (24 VDC, 0.2A)
	OFF	0.1ms maximum (24 VDC, 0.2A)
OFF state leakage		0.1mA maximum
Isolation		1500 VAC between field side and logic side 500 VAC between groups

Note

A pulldown resistor, connected between Q1 and COM1, is required for high frequency Pulse and PWM (up to 2 Khz—refer to Chapter 5 for low value)outputs and for duty cycles in the lower ranges (5% and lower). A 1.5 Kohm, 0.5 watt resistor is recommended for this purpose.

Transistor Outputs 24VDC (IC693UDD104)

The transistor output circuits allow to switch devices like valves, lamps or contactors. These transistor outputs are not protected. The user should provide external fusing to protect the outputs. The outputs can be configured as regular outputs or as outputs controlled by the High Speed Counters. Some outputs can be used as pulse train or pulse width modulation (PWM) outputs (refer to the “PMW Output” section of Chapter 5).

All outputs are isolated between field and logic and are switching positive voltage. Outputs of IC693UDD104 have one common incoming supply (VC) and one common ground (COM).

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The outputs are able to drive high inrush currents (8 times the rated current) and are protected against negative voltage pulses. This makes it possible to switch lamps and inductive loads.

The outputs are not short circuit proof and require external fuses for each output to be effectively protected. For this purpose fast fuses are recommended.

Table 4-6. Specifications for Transistor Outputs 24 VDC

Voltage Range	24VDC +20% -15% (at VC)
Maximum Load	1A per point (Q1 - Q2) at 100 % ON duration 0.5A per point (Q2 - Q6) at 100 % ON duration plus additional for UDD110 : 0.5A per point (Q7 - Q10) at 100 % ON duration 1A per point (Q11 - Q12) at 100 % ON duration
Maximum Inrush Current	8A for 20ms, 1 pulse (1A outputs) 4A for 20ms, 1 pulse (0.5A outputs)
Output Voltage Drop	0,5V maximum
OFF state leakage	100µA maximum
Response	
OFF → ON:	6µs typical
ON → OFF:	100µs typical
Isolation Voltage	500V_{AC} between field side and logic side

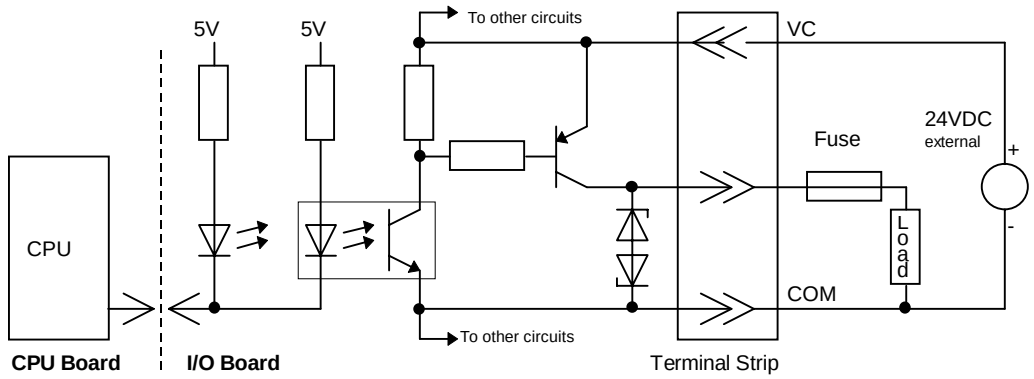


Figure 4-6. Typical Transistor Output Circuit 24 VDC

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24 VDC Output Power Supply (IC693UDR001/002/005/010, IC693UDD104, IC693UAL006, IC693UEX011)

An isolated 24 VDC output power supply is available for user devices and can be used to power the DC input circuits at about 7.5 mA per input. The combination of input circuit current and external device current must not exceed 100 mA for 14-point units and 200 mA for 23 and 28-point units.

Table 4-7. Specifications for 24 VDC Power Supply, Micro PLCs

Voltage	24 VDC, ±10%
Current 14-point Micro 23-point Micro 28-point Micro	 100 mA maximum 200 mA maximum 200 mA maximum
14-point Expansion Unit	100 mA maximum

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Analog Inputs (IC693UAL006)

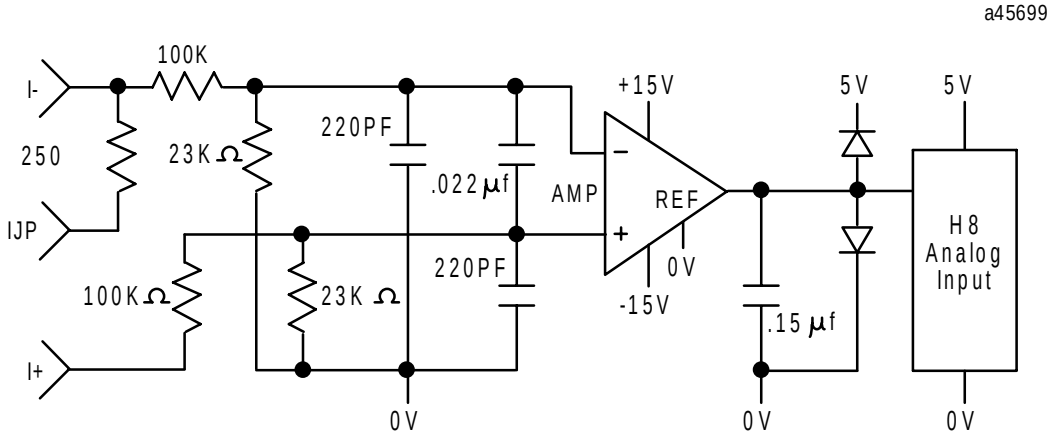


Figure 4-7. Analog Input Circuit

Table 4-8. Analog Input Specifications

Analog Input Channels		2, differential
Input ranges		0 to 10V (10.24V max.) 0 to 20mA (20.5mA max.) 4 to 20 mA (20.5mA max.)
Resolution:	0 to 10 V range 0 to 20 mA range 4 to 20 mA range	10 bits (1 LSB = 10mV) 9 bits (1 LSB = 40µA) 8+ bits (1 LSB = 40µA)
Accuracy		1% of full scale over full operating temperature range
Linearity		±3 LSB maximum
Common mode voltage		±200 V maximum
Current input impedance		250 ohms
Voltage input impedance		800 Kohms
Input filter time		20.2ms to reach 1% error for step input

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Analog Output (IC693UAL006)

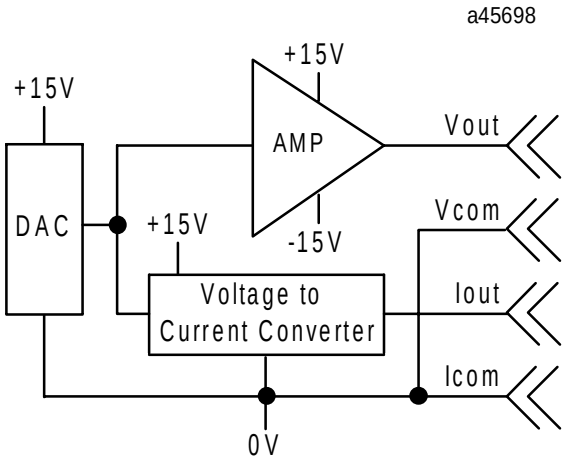


Figure 4-8. Analog Output Circuit

Table 4-9. Analog Output Specifications

Analog Output Channel	1, single-ended, non isolated
Output ranges	0 to 10V (10.24V maximum) 0 to 20mA (20.5mA maximum) 4 to 20mA (20.5mA maximum)
Resolution 0 to 10 V range 0 to 20 mA range 4 to 20 mA range	12 bits (1 LSB = 2.5mV) 12 bits (1 LSB = 5µA) 11+ bits (1 LSB = 5µA)
Accuracy	±1% of full scale over full operating temperature range (0°C to 55°C)
Current: maximum compliance voltage, at 20mA user load range output load capacitance output load inductance	10V 0 to 500 ohms 2000 pF maximum 1 henry maximum
Voltage: output loading output load capacitance	2 Kohm minimum at 10 volts 1 µF maximum

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AC Inputs (IC693UAA003/007)

The 120 VAC input circuits are reactive (resistor/capacitor) inputs. Current into an input point results in a logic 1 in the input status table (%I). Input characteristics are compatible with a wide range of user-supplied input devices, such as pushbuttons, limit switches, and electronic proximity switches. Power to operate the field devices must be supplied by the user. The input circuits require an AC power source: they cannot be used with a DC power source.

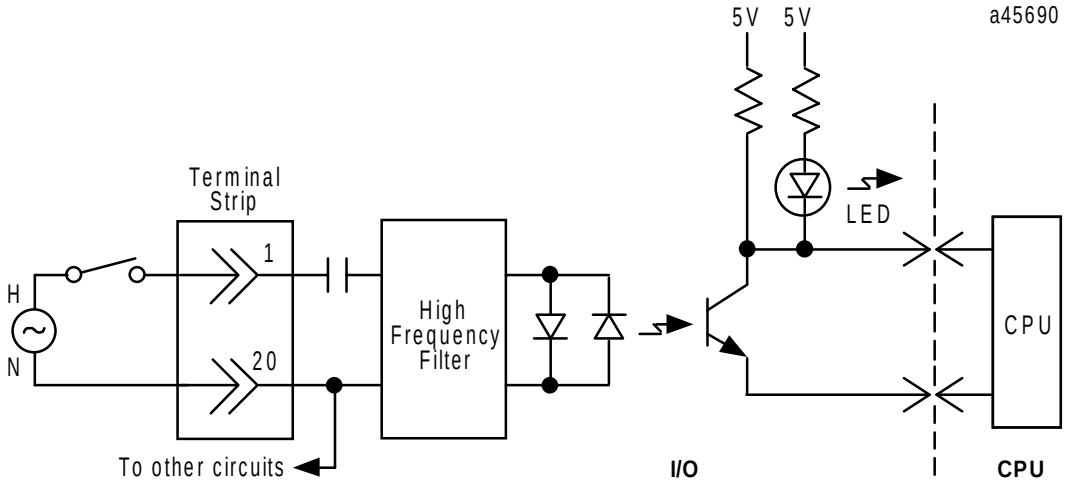


Figure 4-9. Typical 120 VAC Input Circuit

Table 4-10. AC Input Circuit Specifications

Points/Common		4 (I1–I4) and (I5–I8)
Rated Load Voltage		85–132 VAC, 50 -5% to 60 +5% Hz
Maximum Input Voltage		132V rms, 50/60 Hz
Input Current		8 mA rms (100 VAC, 60 Hz)
Voltage	**ON**	minimum 80V rms, 4.5 mA rms
	OFF	maximum 30V rms, 2 mA rms
Response Time	**OFF→ON** **ON→OFF**	maximum 25 ms maximum 30 ms
Isolation		1500V rms field side to logic side 500V rms between groups

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AC Outputs (IC693UAA003/007)

The 120 VAC, 0.5 A output points are provided in isolated groups. A circuit diagram is shown in Figure 4-9. The commons are not tied together inside the module. This allows each group to be used on different phases of the AC supply, or to be powered from the same supply. Each group is protected with a 3.2 amp fuse for its common. Also, an RC snubber is provided for each output to protect against transient electrical noise on the power line. This module provides a high degree of inrush current (10x the rated current) which makes the outputs suitable for controlling a wide range of inductive and incandescent loads. An inrush derating curve is provided in Figure 4-10.

AC power to operate loads connected to outputs must be supplied by the user. This module requires an AC power source, it cannot be used with a DC power source.

User-replaceable fuses are supplied internally on the common of each output group. This fuse does not guarantee that the output point will be protected from a direct short. It is recommended that each output point be externally fused (minimum 1 amp) to protect the output point. For lighter loads, the internal common fuse (3.2 amp) can be replaced with a 1 amp fuse to protect the output point without adding the external fusing.

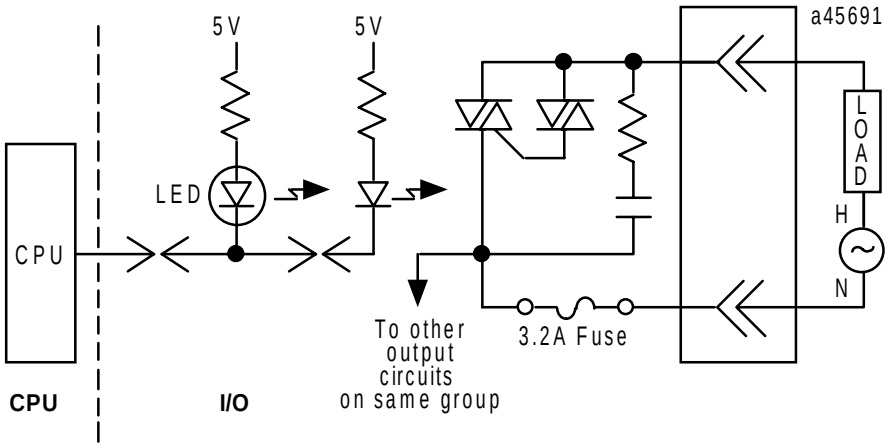


Figure 4-10. Typical 120 VAC Triac Output Circuit

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Table 4-11. AC Output Circuit Specifications

Points/Common	two (Q1–Q2, Q7–Q8) and four (Q3–Q6, Q9–Q12)
Rated Load Voltage	100 -15% to 240 +10% VAC, 50 -5% to 60 +5% Hz
Maximum Resistive Load Current	14-point: 0.5 A/point (0.6 A max. on COM 1; 1.2 A max. on COM 2) 28 point: 0.5 A/point (0.6 A max. on COM1 and COM3; 1.2 A max. on COM 2 and COM 4)
Maximum UL Pilot Duty Rating (all models)	0.5 A/point at 240 VAC
Maximum Inrush Current	5A (1 period)/point 10A (1 period)/common
Maximum voltage drop when ON	1.5 V rms
Maximum leak current when OFF	1.8 mA rms (115 VAC) 3.5 mA rms (230 VAC)
Response Time OFF→ON ON→OFF	maximum 1 ms half of the load frequency + 1 ms or less
Isolation	1500V rms field side to logic side 500V rms between groups

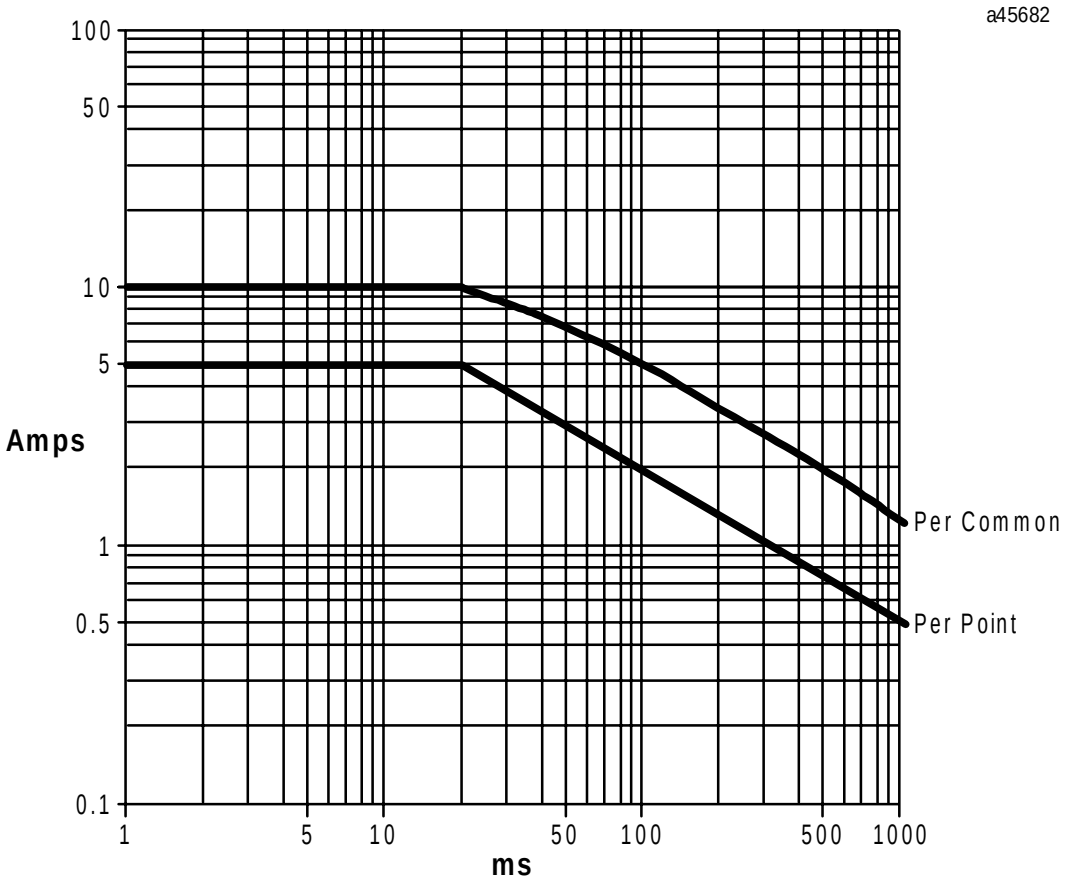


Figure 4-11. Inrush Derating Curve for AC Output

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Field Wiring Installation

Wire Connection Information

Wire connection information for power supply and I/O connections for Series 90 Micro PLCs is detailed below.

Warning

The Series 90 Micro PLC must be grounded to minimize electrical shock hazard. Failure to do so could result in injury to personnel.

Warning

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

Caution

When connecting stranded conductors, insure that there are no projecting strands of wire. These could cause a short circuit, thereby damaging equipment or causing it to malfunction.

Power Supply and I/O Connections

- Each terminal can accept solid or stranded wires, but the wires into any given terminal should be of the same type and size.
- Use copper conductors rated for 75 °C (167 °F) for all wiring. You can use one AWG #14 (2.1 mm^2) conductor or two smaller conductors – AWG #16 (1.3 mm^2) through AWG #20 (0.36mm^2) – per terminal.
- The suggested torque for the terminal connections is 5 in-lbs (5.76 kg-cm).

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General Wiring Procedures

The following procedures should be followed when routing and connecting field wiring from user devices to the Series 90 Micro PLC inputs and outputs. Figures 4-11 through 4-15 provide wiring information for connecting user-supplied input and output devices and power sources for the Series 90 Micro PLCs.

- Turn off power to the Series 90 Micro PLC before connecting field wiring.
- All low level signal wires should be run separately from other field wiring.
- AC power wiring should be run separately from DC field wiring.
- Field wiring should not be routed close to any device that could be a potential source of electrical interference.
- If severe noise problems are present, additional power supply filtering or an isolation transformer may be required.
- Ensure that proper grounding procedures are followed to minimize potential safety hazards to personnel.
- Label all wires to and from I/O devices.

Note

All DC inputs can be connected as either positive or negative logic. In the following field wiring diagrams, DC inputs I1 through I4 are connected as positive and the remaining inputs are connected as negative.

Note

If you are controlling inductive loads, you should provide suppression across each inductive load. For illustrations of typical suppression circuits for AC and DC loads, see Figure 4-5.

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Note

All DC inputs can be connected as either positive or negative logic. In the following figure, I1 through I4 are connected as positive and I5 through I8 are connected as negative.

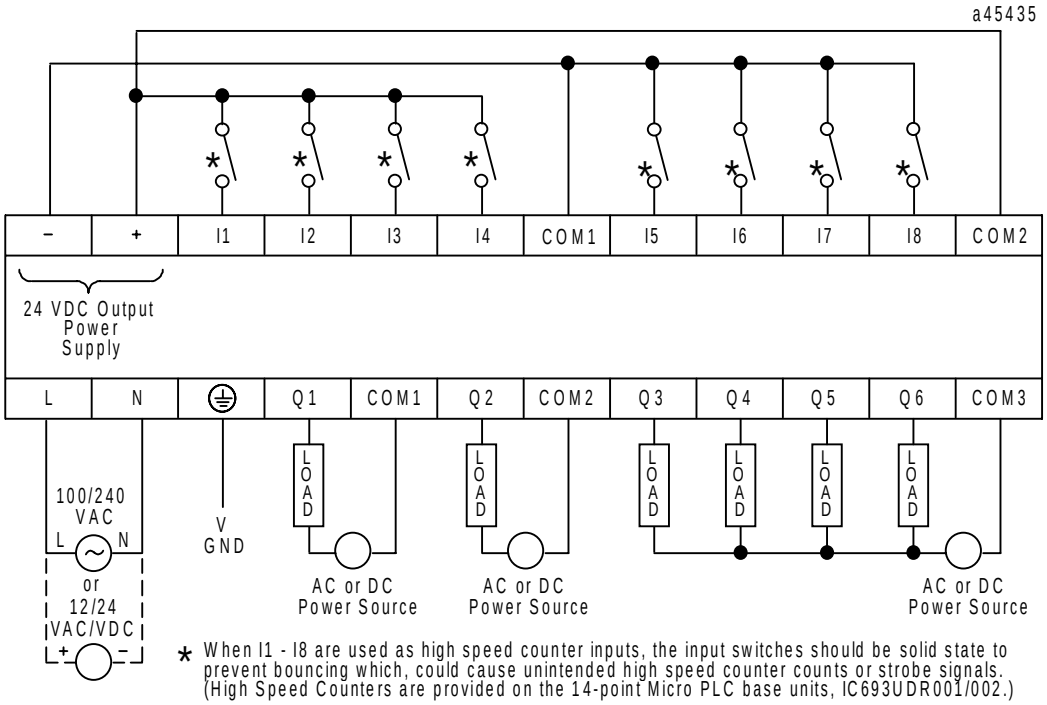


Figure 4-12. Field Wiring, 14-Point DC In/Relay Out Modules (IC693UDR001/002, IC693UEX011)

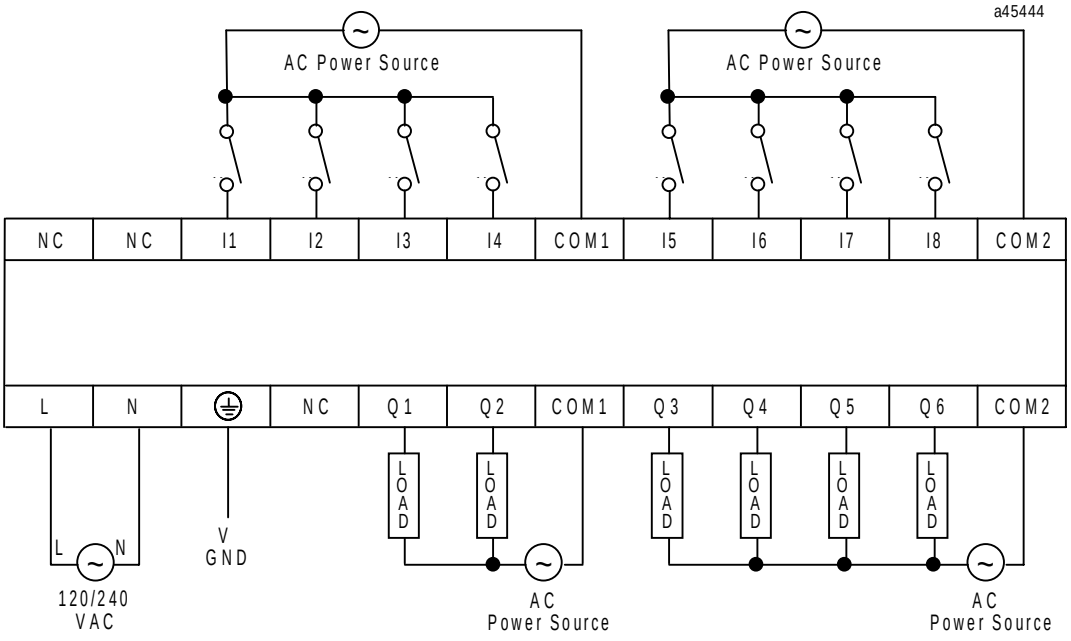


Figure 4-13. Field Wiring, 14-Point AC In/AC Out Modules (IC693UAA003)

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Note

All DC inputs can be connected as either positive or negative logic. In the following figure, I1 through I8 are connected as positive and I9 through I16 are connected as negative.

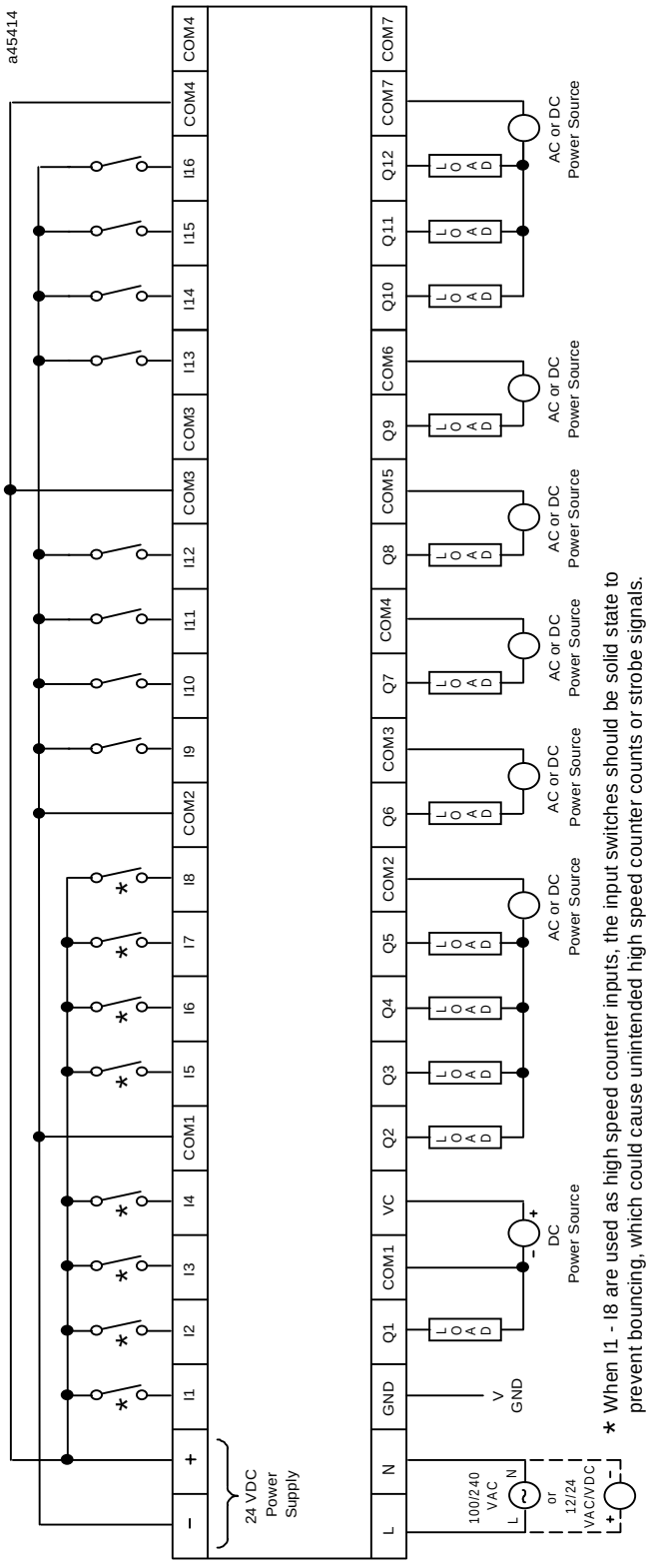


Figure 4-14. 28-Point DC In/Relay Out Modules (IC693UDR005/010)

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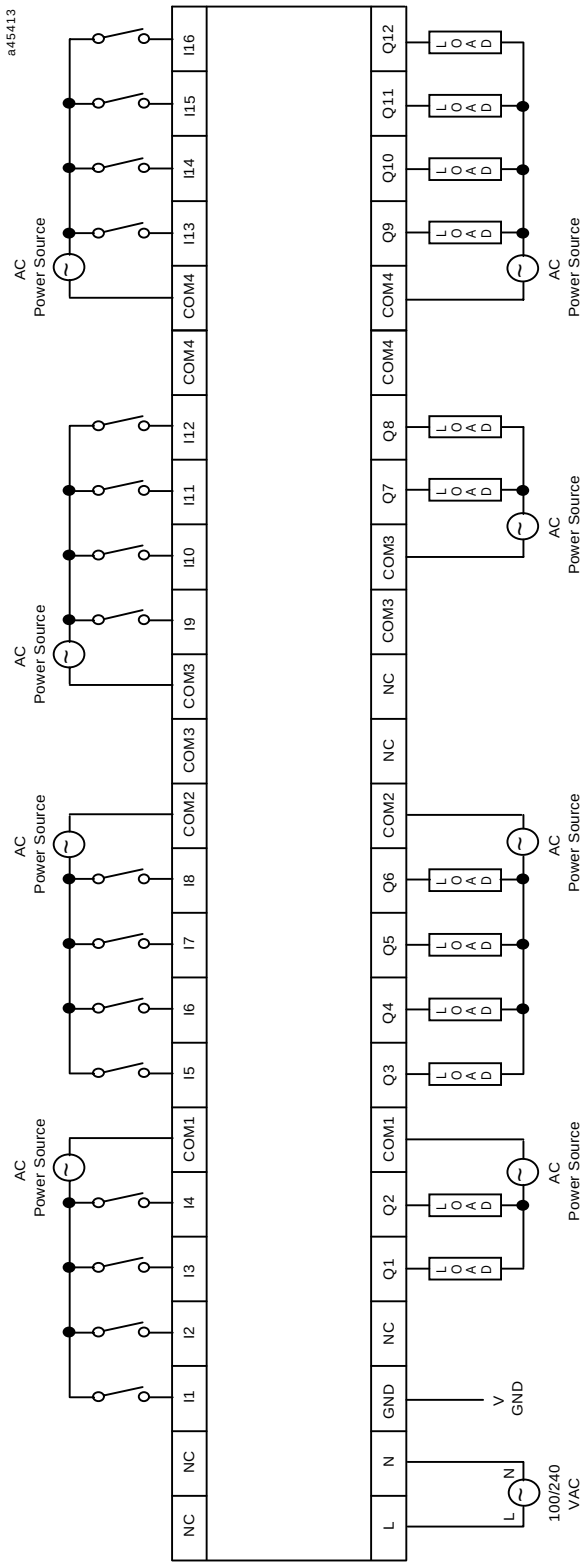


Figure 4-15. 28-Point AC In/AC Out Modules (IC693UAA007)

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Notes

All DC inputs can be connected as either positive or negative logic. In the following figure, I1 through I8 are connected as positive and I9 through I13 are connected as negative.

The 250-ohm resistors on the analog input circuits are internal.

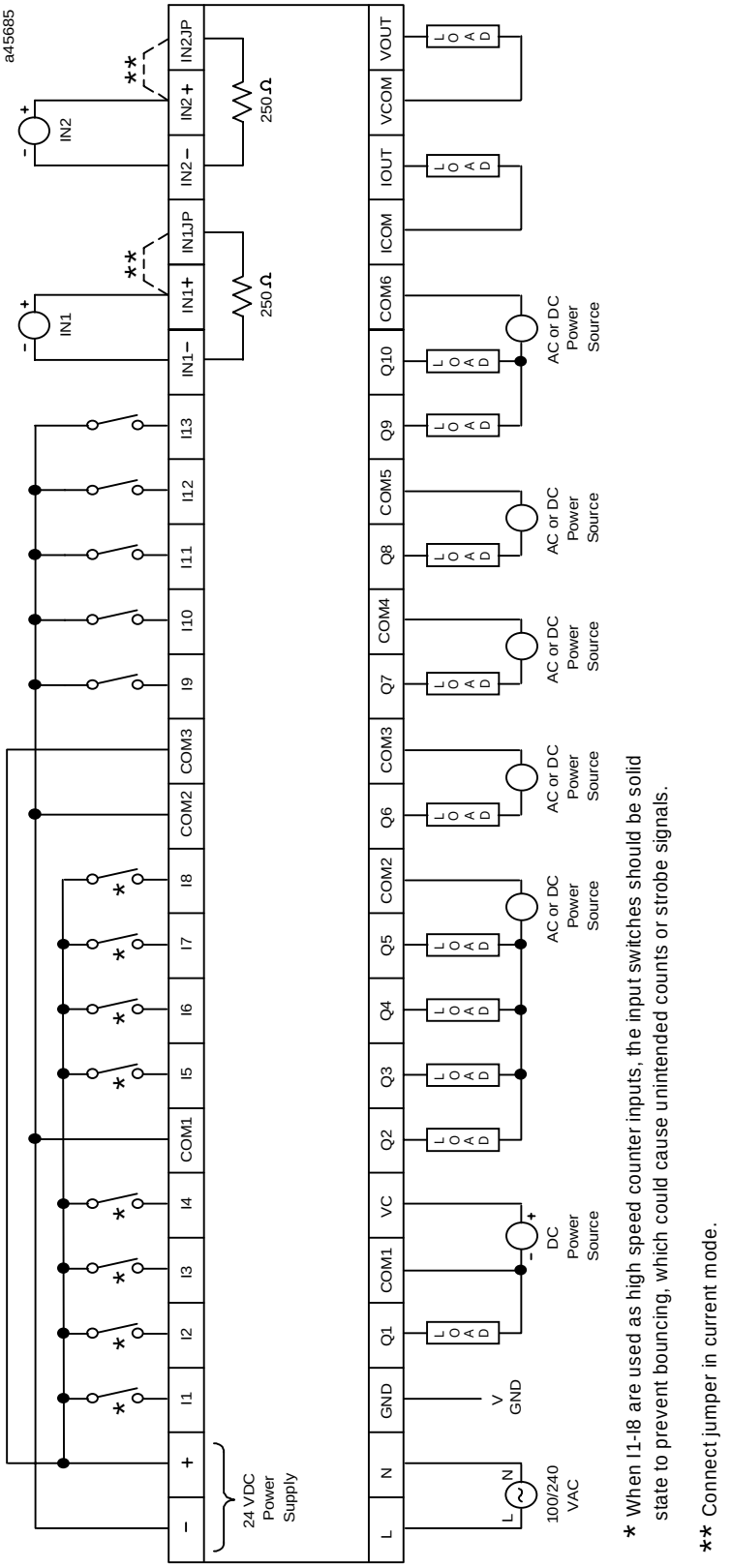


Figure 4-16. 23-Point DC In/Relay and DC Out (IC693UAL006)

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Chapter 5 Configuration

The Series 90 Micro PLC can be configured and programmed using any of the following methods.

- Logicmaster 90-30/20/Micro software on a Workmaster II or CIMSTAR I industrial computer, or an IBM® PC-AT, PS/2® (Personal System 2®) or compatible Personal Computer.
- Logicmaster 90 Micro software (part of IC640HWP300) on any of the above computers.
- Series 90-30/90-20 Hand-Held Programmer (IC693PRG300).

Both configuration and programming can be done off-line from the PLC, using the Logicmaster 90 Micro software. Configuration and programming using the Hand-Held Programmer (HHP) must be done with the HHP attached to and interfacing with the PLC.

For more information about the use of these programmers, refer to the following:

- *Logicmaster 90-30/20/Micro Programming Software User's Manual*, GFK-0466
- *Series 90-30/90-20 Programmable Controllers Reference Manual*, GFK-0467
- *Workmaster II PLC Programming Unit Guide to Operation Manual*, GFK-0401
- *Hand-Held Programmer, Series 90-30/20/Micro Programmable Controllers User's Manual*, GFK-0402.

Micro PLC Parameters

Table 5-1 lists general parameters for the Micro PLC. Configuration parameters for features that apply only to specific models are discussed later in this chapter. See page 5-12 for configuration of Serial Port 2 and page 5-26 for configuration of expansion units. Configuration of the High Speed Counters is discussed in Chapter 6. Configuration of Analog I/O is discussed in Chapter 7.

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Table 5-1. Micro PLC Parameters

Parameter	Description	Possible Values	Default Value
I/O Scan-Stop	Determines whether I/O is to be scanned while the PLC is in STOP mode.	YES NO	NO
Pwr Up Mode	Selects powerup mode.	LAST STOP RUN	LAST
Cfg From	Source of configuration when the PLC is powered up. (Logic source is always flash memory.)	RAM PROM (flash memory)	RAM
Registers	Selects source of register data when PLC is powered up.	RAM PROM (flash memory)	RAM
Passwords	Determines whether the password feature is enabled or disabled. (If passwords are disabled, the only way to enable them is to clear the Micro PLC memory by power cycling the unit and pressing the appropriate HHP keys.) See page 5-8.	ENABLED DISABLED	ENABLED
Pwr Up Diag*	The DISABLED setting causes the Micro PLC to power up without running diagnostics. Unless your application requires fast power up, it is recommended that you leave this setting ENABLED.	ENABLED DISABLED	ENABLED
Baud Rate	Data transmission rate (in bits per second).	300 600 1200 2400 4800 9600 19200	19200
Data Bits	Determines whether the CPU recognizes 7-bit or 8-bit words (SNP/SNPX requires 8 bits).	7 8	8
Parity	Determines whether parity is added to words	ODD EVEN NONE	ODD
Stop Bits	Number of stop bits used in transmission. (Most serial devices use one stop bit; slower devices use two.)	1 2	1
Modem TT	Modem turnaround time (10ms/unit) This is the time required for the modem to start data transmission after receiving the transmit request.	0–255	0
Idle Time	Time (in seconds) the CPU waits to receive the next message from the programming device before it assumes that the programming device has failed and proceeds to its base state. Communication with the programmer is terminated and will have to be reestablished.	1–60	10
Sweep Mode	Normal: sweep runs until it is complete. Constant: sweep runs for time specified in Sweep Tmr.	NORMAL CNST SWP	NORMAL
Sweep Tmr	Constant sweep time (in milliseconds). Editable when sweep mode is CNST SWP; non-editable otherwise.	NORMAL mode: N/A CNST SWP mode: 5–200	N/A 100

* If configured to disable powerup diagnostics, the 28-point DC In/ Relay Out/DC Power unit (IC693UDR010) will begin logic solution 100ms after the voltage level of the power supply input reaches and maintains 24VDC. The 24VDC power source for the UDR010 unit must have enough transient current capability to support the inrush current of the power supply and maintain a 24VDC voltage level (see power supply specifications for inrush requirements in Chapter 2).

Disabling powerup diagnostics has the following effects: The I/O Link Interface Expansion Unit will not work. No expansion units can be used. (If expansion units are connected while powerup diagnostics are disabled, faults will be logged in the I/O tables.) All HHP key sequences will be ignored when the Micro PLC is powering up.

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Table 5-1. Micro PLC Parameters – Continued

Parameter	Description	Possible Values	Default Value
In RefAddr	Discrete input reference **not editable**	%I00001	%I00001
Input Size	Discrete input size **not editable**	8 (14-point) 16 (28-point) 13 (23-point)	8 16 13
Out RefAddr	Discrete output reference **not editable**	%Q00001	%Q00001
Output Size	Discrete output size **not editable**	6 (14-point) 12 (28-point) 10 (23-point)	6 12 10

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Configuration and Programming Using the HHP

You can use the HHP to perform the following tasks:

- *Statement List* logic program development, including insert, edit, and delete functions. The Statement List programming instructions provide basic (Boolean) instructions to execute logical operations such as AND and OR, and many functions that 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
- 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 HHP and a removable Memory Card (IC693ACC303). This allows programs to be moved between PLCs or loaded into multiple PLCs.
- Start or stop the PLC from any mode of operation

HHP Configuration Screens

1. The following screen (Main Menu) will be displayed on the HHP after the Series 90 Micro PLC has successfully completed its power-up sequence.



This screen allows you to select the mode of operation of the program. The choices are: PROGRAM, DATA, PROTECTION, and CONFIGURATION. (Use the ↑ and ↓ cursor keys to scroll the menu selection display.) For information on using these modes refer to the *Hand-Held Programmer User's Manual*, GFK-0402.

2. Enter the configuration mode by pressing the **4** key then the **ENT** key from the Main Menu screen. The first configuration screen will appear.

   The ↑ and ↓ cursor keys allow you to move between power supply configuration, CPU configuration, Input configuration, Output configuration, and HSC configuration. The ← and → keys allow selection of parameters within each of the configurations.



   This screen indicates that the CPU function is located in rack 0 and slot 01 (R01:01). For compatibility with Series 90-30 PLCs, the different Micro PLC functions map to rack and slot locations in the software. The Series 90 Micro PLC system is always in rack 0. The following table shows the fixed slot assignments for the different functions of the Micro PLC.

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Table 5-2. Slot Assignments for Micro PLC Functions

Slot (as seen on HHP)	Function	Fixed/Configurable
0	Power Supply	Fixed
1	CPU Parameters	Configurable
2	Input Locations	Fixed: %I1 to %I8
3	Output Locations	Fixed: %Q1 to %Q6
4	High Speed Counter	Fixed: I00497–I00512 Q00497–Q00512 AI00001–AI00015
5	%AI18—19 (IC693UAL006 only)	Fixed for IC693UAL006; configurable for other units
6	%AQ12 (IC693UAL006 only)	Fixed for IC693UAL006; configurable for other units
7	Expansion Unit 1 (23 and 28-point units)	Configurable
8	Expansion Unit 2 (23 and 28-point units)	Configurable
9	Expansion Unit 3 (23 and 28-point units)	Configurable
10	Expansion Unit 4 (23 and 28-point units)	Configurable
11	Unused	Unused

If you want to transfer a program developed for a Series 90 Micro PLC to a Series 90-30 PLC, the I/O modules in the Series 90-30 PLC must be in the above listed rack and slot locations for the program and configuration to work properly.

The screen shown above also shows the first configuration item, which allows you to change the Hand-Held Programmer Key Click feature. The default is KEY CLK: OFF.

3. Pressing the ↑ key causes the next screen to be displayed:

```
R0:00 PWR SUP <S
IO BASE: I8/Q6
```

This screen indicates that the baseplate located at rack 0 and slot 00 is a generic 8 Input/6 Output module.

4. Pressing the ↓ key causes the previous screen to be displayed:

```
R0:01 PLC     <S
KEY CLK: OFF
```

Use the ← and → keys to view the other Micro PLC parameters for configuration and the -/+ key to select the items within each parameter. Refer to Table 5-1 for acceptable values and default values for Micro PLC parameters.

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5. When all Micro PLC parameters have been configured, press the ↓ key again to cause the input screen to be displayed (this is not configurable):

```
R0:02 I       <S
 I16:I0001-I0008
```

   If the program is transferred to a Series 90-30 Model 311, 313, 331, 340, 341 or 351, the input module should be located in the first I/O slot (slot 02 on the Model 331, 340, 341, or 351, and slot 01 on the Model 311 and Model 313).

6. Pressing the ↓ key again causes the output screen to be displayed (this is not configurable):

```
R0:03 Q       <S
 Q16:Q0001-Q0006
```

   If the program is transferred to a Series 90-30 Model 311, 313, 331, 340 341, or 351, the output module should be located in the second I/O slot (slot 03 on the Model 331, 340, 341, or 351, and slot 02 on the Model 311 and Model 313).

7. Pressing the ↓ key again causes the first HSC screen to be displayed (DC In/Relay Out and DC In/DC Out/Relay Out models only):

```
R0:04 HSC     <S
 CTR TYPE: ALL A
```

   If the program is transferred to a Series 90-30 Model 311, 313, 331, 340 341, or 351, the HSC module should be located in the third I/O slot (slot 04 on the Model 331, 340, 341, or 351 and slot 03 on the Model 311 and Model 313).

The remaining HSC configuration screens are discussed in Chapter 6.

The following two screens are displayed only for Micro PLCs that have DC output (IC693UDR005/010 and UAL006).

Note

The PWM Out and PULSE OUT options are available only on counter channel 1. These outputs are also controlled by values in memory locations AQ2 and AQ3 (PWM), and AQ123, AQ124, Q494 and I494 (Pulse Train). See page 5-35 for additional configuration details.

PWM Output

This option can only be enabled if the CTRx option and the PULSE OUTx option for channel 1 are disabled. This screen selects PWM as the counter output.

```
R0:04 HSC         <S
PWMOUTX: DISABLE
```


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Pulse Output

This option can only be enabled if the CTRx option and the PWM OUTx option for channel 1 are disabled. This screen selects a pulse train as the counter output.

```
R0:04 HSC          <S
PULSEOUTX: DISABLE
```

Storing the User Program Using the HHP

Note

If the Micro PLC loses power during a program store operation, configuration and reference tables will be deleted from flash memory. You will need to restore not only your program, but the configuration and reference tables.

After editing a program, you must save it in nonvolatile flash memory. To do this, perform the following steps:

1. With the HHP showing a screen that resembles the following, press the **WRITE** key.

```
#XXXX              <S
<END OF PROGRAM>
```

   The following screen will result:

```
WRITE MEM CARD<S
PRG CFG REG
```

2. Next, press the **±** key twice. The following screen will appear:

```
WRITE USR PRG <S
ONLY
```

3. Finally, press the **ENT** key. This will store the edited user program to non-volatile flash memory. Note that this may take 5 to 10 seconds. When the program has been stored, the following screen will be displayed:

```
WRITE OK           <S
```

   At this point the program can be put into RUN mode.

4. To return to the program edit mode, press the **ENT** key.

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Storing Configuration and Register Data Using the HHP

Because the user program is stored in non-volatile flash memory, only one copy is maintained, even after you invoke the **Write to EEPROM/FLASH** function in Logicmaster 90, or using the HHP. However, separate copies of the user configuration and reference tables are maintained in the EEPROM/FLASH areas of the flash memory.

The configuration entry, **Cfg From** (see table on page 5-2), determines only whether the user configuration is obtained from RAM or PROM. *The user program is always read from flash (PROM) memory.*

To store the configuration and register data:

1. From the END OF PROGRAM screen, press the **WRITE** key (see steps 1 and 2 above).
2. Press the ± key until the following screen appears:

```
WRITE PROM     <S
CFG REG ONLY
```

3. Press the **ENT** key. This will store the configuration and register data only. (*Program data will not be stored.*) When the store operation is complete, the WRITE OK screen will be displayed.
4. To return to the edit mode, press the **ENT** key.

Other HHP Functions

Note

If the Micro PLC is configured with powerup diagnostics disabled, it will ignore all HHP key sequences when powering up. Disabling powerup diagnostics for the Micro PLC is *not* recommended.

Clearing User Memory Using the HHP

To clear user RAM (configuration, registers, user program and passwords), power cycle or reset the Micro PLC with the following HHP keys pressed:

CLR and **M/T**

To boot up without loading memory from the EEPROM, power cycle or reset the Micro PLC with the following HHP keys pressed:

LD and **NOT**

To clear memory when powerup diagnostics are disabled, go to Program mode and press the following key sequence: **#**, **±**, **999**, **DEL**. For detailed information about using the HHP, see the *Hand-Held Programmer, Series 90-30/20/Micro Programmable Controllers User's Manual*, GFK-0402.

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Booting up in Stop Mode Without Clearing Memory

Power cycle or reset the Micro PLC with the following HHP keys pressed:

RUN and **NOT**

Setting the Time of Day Clock (23 and 28-Point PLCs)

To set the month, day, year, hour, minutes, and seconds for the time of day clock function:

1. From the initial power-up screen, shown on page 5-4, press the **4** key to enter the configuration mode.
2. Select CPU Configuration.
3. Use the → key to scroll through the PLC parameters until the clock parameter is displayed.
4. Continue to press the → key to select each of the clock parameters in turn. To change a parameter, enter the new value and press the **ENT** key.

Note

You can also use the SVCREQ function number 7 to read and set the time-of-day clock within a Logicmaster 90 program. Refer to the *Series 90™-30/20/Micro Programmable Controllers Reference Manual*, GFK-4067, for information on using the SVCREQ function.

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Configuration and Programming Using Logicmaster 90 Software

Using the configuration software, which is part of the Logicmaster 90 software package, you can:

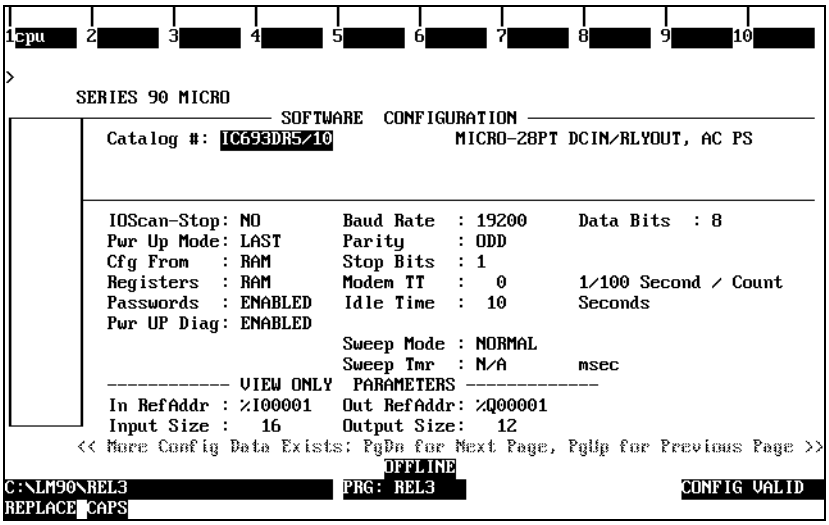
- Specify a name for the system
- Configure CPU parameters
- Configure/enable the HSCs (see Chapter 6)
- Archive or save the configuration in a file
- Transfer configurations between the PLC and the programmer

The programming software portion of the Logicmaster 90 Micro software package provides the following capabilities:

- 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 to a printer or a file

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The general Micro PLC parameters are shown in the following configuration screen. Acceptable values, including default values, for these parameters are listed on page 5-2. To see additional configuration screens, press **PAGE DOWN**. The *Logicmaster 90-30/20/Micro Programming Software User's Manual*, GFK-0466, provides details on the use of the configuration software.



Note

If the Micro PLC loses power during a program store operation, configuration and reference tables will be deleted from flash memory. You will need to restore not only your program, but the configuration and reference tables.

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Configuring Serial Ports

Port 1, an RS-422 compatible serial port, is used to communicate with Logicmaster 90-30/20/Micro software, the HHP, or for general purpose communications. This port supports SNP and SNPX protocols. On 14-point Micro PLCs, it also supports RTU slave protocol. Port 1 is configured as part of the general parameters for the Micro PLC using the Logicmaster 90 configuration program or the HHP, except for RTU communications, which must be configured by a COMM_REQ function in ladder logic. (For definitions of general parameters, see page 5-2.)

Note

To support RTU Slave protocol on Port 1 of the 14-point Micro PLC, a programmer attach feature is supported. This feature allows connection of the programmer while the port is configured as RTU. For a description of this feature, see "Programmer Attach Feature," on page 5-20.

COMM_REQs directed to Port 1 of the 14-point Micro PLC will *not* be processed while the HHP is attached. Any COMM_REQ sent to Port 1 of the 14-point Micro PLC when the HHP is attached will be queued and processed when the HHP is removed.

On 23 and 28-point Micro PLCs, Port 2 is provided for general purpose communications using SNP, SNPX and RTU slave protocols. Port 2 can also be configured as an SNP/SNPX master. This port can be used to monitor the Micro PLC's status while programmer functions are being performed on the primary serial port (Port 1). Also, when no programmer is connected through Port 1, Logicmaster 90 can monitor program execution and read and write data through Port 2.

Port 2 does not have autobaud capability (Port 1 does). On release 3.0 and later 28-point Micro PLCs, a separate SNP ID for Port 2 can be configured using Logicmaster 90 software release 8.01 or later. On earlier releases, Port 2 shares the SNP ID with Port 1 and the SNP ID can only be changed through Port 1.

Port 2 configuration can be changed through the Logicmaster 90 hardware configuration utility, or by using the COMM_REQ (communications request) function block within a ladder logic program.

Communication Protocols

For detailed descriptions of the protocols used with Series 90 PLCs, refer to the *Series 90 PLC Serial Communications User's Manual*, GFK-0582.

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Logicmaster 90 Configuration of Serial Port 2

The Port 2 configuration screen immediately follows the general parameter screen for the Micro PLC. The set of parameters listed depends on the Port 2 Mode selection. Parameter definitions are provided in Table 5-3. The screen shown below shows the parameters for the default mode, SNP.

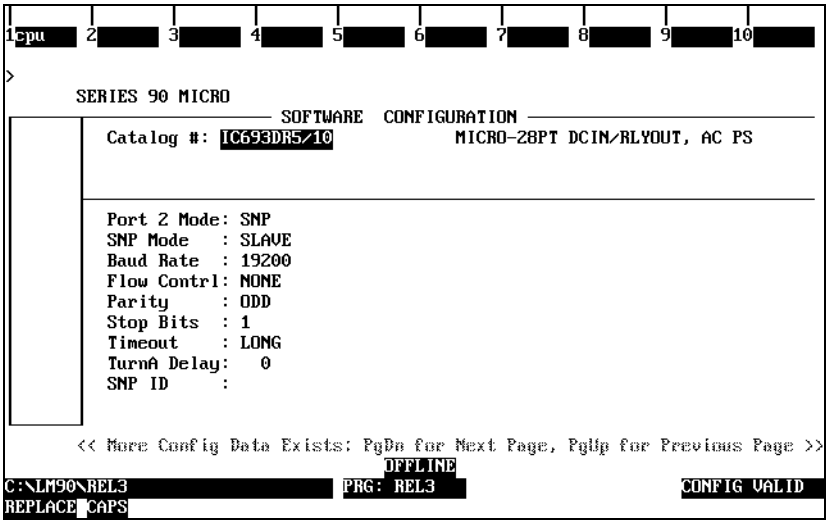


Table 5-3. Configuration Parameters for Serial Port 2

Parameter	Description	Possible Values	Default Value
Port 2 Mode	(23 and 28-point units only)	SNP CUSTOM RTU DISABLED	SNP
Port 2 Mode is SNP			
SNP Mode	Configures the serial port as a slave (the responding device) or a master (the initiating device) in a master/slave system.	SLAVE MASTER	SLAVE
Baud Rate	Data transmission rate (in bits per second)	300 600 1200 2400 4800 9600 19200	19200
Flow Control	not applicable	NONE	NONE
Parity	Determines whether parity is added to words	ODD NONE EVEN	ODD
Stop Bits	Number of stop bits used in transmission. (Most serial devices use one stop bit; slower devices use two.)	1 2	1
Timeout	Specifies the set of timeout values to be used by protocol.	LONG MEDIUM SHORT NONE	LONG
TurnA Delay	Turnaround delay time	0–255	0
SNP ID	Identifier that distinguishes this device from others on the same network	user-provided	none

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Table 5-3. Configuration Parameters for Serial Port 2 - Continued

Parameter	Description	Possible Values	Default Value
Port 2 Mode is RTU			
Baud Rate	Data transmission rate (in bits per second)	300 600 1200 2400 4800 9600 19200	19200
Flow Control	Specifies the method of flow control to use.	NONE HARDWARE	NONE
Parity	Determines whether parity is added to words	ODD NONE EVEN	ODD
Station Address	Identifier that distinguishes this device from others on the same network.	1-247	1
Port 2 Mode is CUSTOM			
Data Bits	Determines whether the CPU recognizes 7-bit or 8-bit words (SNP/SNPX requires 8 bits.)	8 7	8
Baud Rate	Data transmission rate (in bits per second)	300 600 1200 2400 4800 600 9600 1200 19200 2400	19200
Flow Control	Specifies the method of flow control to use.	NONE HARDWARE SOFTWARE	NONE
Parity	Determines whether parity is added to words	ODD NONE EVEN	ODD
Stop Bits	Number of stop bits used in transmission. (Most serial devices use one stop bit; slower devices use two.)	1 2	1
TurnA Delay	Turnaround delay time	0-255	
Timeout	Specifies the set of timeout values to be used by protocol.	LONG MEDIUM SHORT NONE	LONG
Port 2 Mode is DISABLED			
There are no parameters for this mode.			

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Configuring Serial Ports Using the COMM_REQ Function

The PLC ladder program sends Data Commands using the COMM_REQ function. The COMM_REQ requires that all its command data be placed in the correct order (in a *command block*) in the CPU memory before it is executed. The COMM_REQ should then be executed by a contact of a one-shot coil to prevent sending the data multiple times.

Command Block

A series of Block Move (BLKMV) commands should be used to move the words to create a command block in the Register tables (refer to the *Series 90™-30/20/Micro Programmable Controllers Reference Manual*, GFK-0467, for information on using the Block Move function). For details on command blocks for configuring communications, refer to the *Series 90™ PLC Serial Communications User's Manual*, GFK-0582.

The following tables list the command block values required for setting up a Serial Port for SNP, RTU, and Custom protocols. (All values are in hexadecimal unless otherwise indicated.) The BLKMV commands that are used to create the command block are described in the example on page 5-16 and shown in Figure 5-1.

Note

The Micro PLC ignores the WAIT flag for all COMM_REQs.

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Table 5-4. COMM_REQ Command Block for SNP Protocol

Example Register	Address	Definition	Values
%R0101	Start address	Data Block Length	10H
%R0102	Start address + 1	WAIT/NOWAIT Flag	reserved (ignored by Micro PLC)
%R0103	Start address + 2	Status Word Pointer Memory Type	0008 = %R, register memory
%R0104	Start address + 3	Status Word Pointer Offset	Zero-based number that gives the address of the SNP status word (for example, a value of 99 gives an address of 100 for the status word)
%R0105	Start address + 4	Idle Timeout Value	reserved (ignored by Micro PLC)
%R0106	Start address + 5	Maximum Communication Time	reserved (ignored by Micro PLC)
%R0107	Start address + 6	Command Word (serial port setup)	FFF0H (programmed as 0FFF0H)
%R0108	Start address + 7	Protocol: 1=SNP	0001
%R0109	Start address + 8	Port Mode	0000=Slave, 0001=Master (master available only on 23 and 24 point Micros)
%R0110	Start address + 9	Data Rate	6=19200, 5=9600, 4=4800, 3=2400, 2=1200, 1=600, 0=300
%R0111	Start address + 10	Parity	0 = None, 1 = Odd, 2 = Even
%R0112	Start address + 11	Flow Control	0 = Hardware (SNP Master only), 1 = None
%R0113	Start address + 12	Turnaround Delay	0 = None, 1 = 10ms, 2 = 100ms, 3 = 500ms
%R0114	Start address + 13	Timeout	0 = Long, 1 = Medium, 2 = Short, 3 = None
%R0115	Start address + 14	Bits Per Character	1=8 bits
%R0116	Start address + 15	Stop Bits	0 = 1 Stop bit, 1 = 2 Stop bits
%R0117	Start address + 16	Interface	reserved
%R0118	Start address + 17	Duplex Mode	reserved
%R0119	Start address + 18	Device identifier (0 for SNP)	0000
%R0120	Start address + 19	Device identifier bytes 1 and 2	user-provided*
%R0121	Start address + 20	Device identifier bytes 3 and 4	user-provided*
%R0122	Start address + 21	Device identifier bytes 5 and 6	user-provided*
%R0123	Start address + 22	Device identifier bytes 7 and 8	user-provided*

* The device identifier for SNP Slave ports is packed into words with the least significant character in the least significant byte of the word. For example, if the first two characters are “A” and “B,” the start address + 18 will contain the hex value 4241.

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Table 5-5. COMM_REQ Data Block for RTU Protocol

Example Register	Word	Definition	Values
%R0101—%R0106	First 6 words	Reserved for COMM_REQ use.	See Table 5-4 for details.
%R0107	Start address + 6	Command	FFF0H
%R0108	Start address + 7	Protocol: 0003=RTU	0003
%R0109	Start address + 8	Port Mode: 0000=Slave	0000
%R0110	Start address + 9	Data Rate	6=19200, 5=9600, 4=4800, 3=2400, 2=1200, 1=600, 0=300
%R0111	Start address + 10	Parity	0 = None, 1 = Odd, 2 = Even
%R0112	Start address + 11	Flow Control	0 = Hardware, 1 = None
%R0113	Start address + 12	Turnaround delay	reserved
%R0114	Start address + 13	Timeout	reserved
%R0115	Start address + 14	Bits per Character	1=8 bits
%R0116	Start address + 15	Stop Bits	reserved
%R0117	Start address + 16	Interface	reserved
%R0118	Start address + 17	Duplex Mode	reserved
%R0119	Start address + 18	Device Identifier	Station Address (1-247)
%R0120—22	Start address + 19—21	Device Identifier	reserved

Table 5-6. COMM_REQ Data Block for Custom Protocol

Example Register	Word	Definition	Values
%R0101—%R0106	First 6 words	Reserved for COMM_REQ use.	See Table 5-4 for details.
%R0107	Start address + 6	Command	FFF0H
%R0108	Start address + 7	Protocol: 0005=Custom	0005
%R0109	Start address + 8	Port Mode	1=Master
%R0110	Start address + 9	Data Rate	6=19200, 5=9600, 4=4800, 3=2400, 2=1200, 1=600, 0=300
%R0111	Start address + 10	Parity	0 = None, 1 = Odd, 2 = Even
%R0112	Start address + 11	Flow Control	0 = Hardware, 1 = None, 2 = Software
%R0113	Start address + 12	Turnaround Delay	0 = None, 1 = 10ms, 2 = 100ms, 3 = 500ms
%R0114	Start address + 13	Timeout	0 = Long, 1 = Medium, 2 = Short, 3 = None
%R0115	Start address + 14	Bits per Character	1=8 bits
%R0116	Start address + 15	Stop Bits	0 = 1 stop bit, 1 = 2 stop bits
%R0117	Start address + 16	Interface	reserved
%R0118	Start address + 17	Duplex Mode	reserved
%R0119—%R0122	Start address + 18—21	Device Identifier	reserved

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Example

A sample ladder diagram for changing the default settings for Port 2 of the 28-point Micro PLC is provided in Figure 5-1.

Rung 4 uses a one-shot coil (%T0002) to execute the COMM_REQ once. This prevents multiple messages from being sent.

Rung 5 contains the Block Move Word function and is used to load the commands, which are listed in Tables 5-4 through 5-6. In this example, %R0101 through %R0115 are used for the COMM_REQ command block. (Any registers can be used except for %R1617 through %R1814, which are reserved on the 23 and 28 point Micro PLCs.) The example command block contains the following settings:

%R0107	Start address + 6	Command	FFF0
%R0108	Start address + 7	Protocol	SNP (0001)
%R0109	Start address + 8	Port Mode	Slave (0000)
%R0110	Start address + 9	Data Rate	19200 (0006)
%R0111	Start address + 10	Parity	Odd (0001)
%R0112	Start address + 11	Flow Control	None (0001
%R0113	Start address + 12	Turnaround Delay	None (0000)
%R0114	Start address + 13	Timeout	Long (0000)
%R0115	Start address + 14	Bits per Character	1
%R0116	Start address + 15	Stop Bits 1	(0000)
%R0117	Start address + 16	Interface	reserved (0000)
%R0118	Start address + 17	Duplex mode	reserved (0000)
%R0119	Start address + 18	Device identifier (0 for SNP)	0000
%R0120	Start address + 19	Device identifier bytes 1 and 2	B, A (4241)
%R0121	Start address + 20	Device identifier bytes 3 and 4	0000
%R0122	Start address + 21	Device identifier bytes 5 and 6	0000
%R0123	Start address + 22	Device identifier bytes 7 and 8	0000

* The device identifier for SNP Slave ports is packed into words with the least significant character in the least significant byte of the word. For example, if the first two characters are “A” and “B,” the start address + 18 would contain the hex value 4241.

The COMM_REQ function, executed in Rung 6, has four inputs. %T0002 is used to enable the COMM_REQ function. The IN input points to the starting address of the command block, which is %R0101. The SYS_ID will always be 1. The last input, TASK, points to Port 2 (hexadecimal 0002 or integer 2).

Note

The TASK input on the COMM_REQ function determines which serial port is addressed:

2 (0002H)	Port 2 (All 28-point Micro PLC releases including release 3.0)

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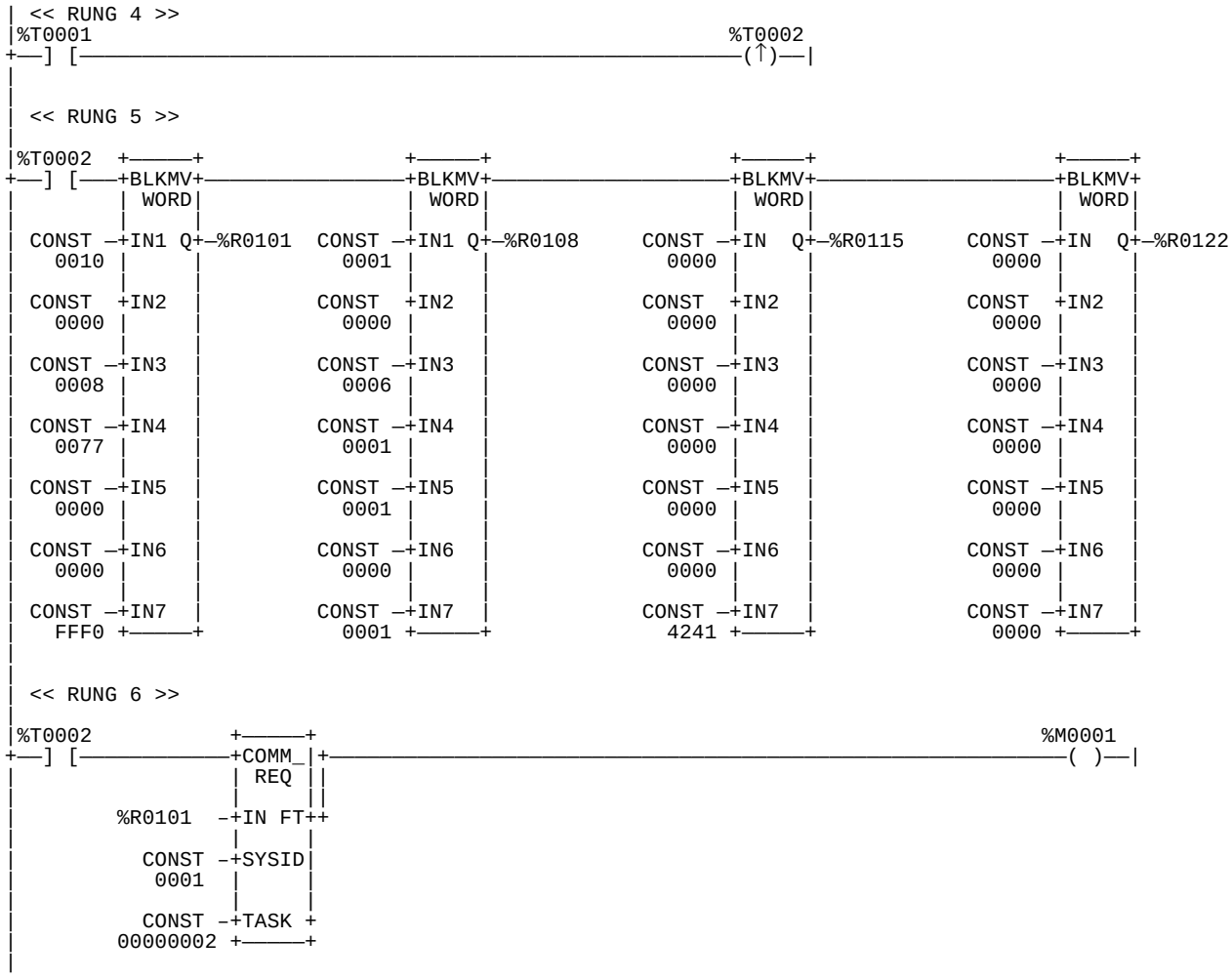


Figure 5-1. Ladder Logic Example for Serial Port Configuration

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Programmer Attach Feature (14-Point Micro PLCs)

This feature of the RTU Slave protocol allows you to connect a PLC programmer to the port while RTU Slave is active. When the Micro PLC detects a programmer attachment (requires appropriately configured PLC ID for multidrop connections), the RTU Slave protocol is removed from the port and SNP Slave is installed as the currently active protocol on the port. The programmer connection must have the same serial configuration (i.e., baud rate, parity, stop bits, etc.) as the currently active RTU Slave protocol for it to be recognized. This also means that autobaud will not be supported for initiating a programmer connection. Once the programmer connection has been enabled, normal programmer communications can take place through the port.

Upon a loss of the programmer connection, the most recently established port protocol will be installed as the active protocol on the port. This could be either the RTU Slave protocol (the protocol running before the programmer was attached), a new protocol received through a configuration store, or a new protocol from a Serial Port Setup COMM_REQ. Installing the most recently established port protocol puts that protocol back to its initial state. In the normal case, upon loss of the programmer connection, the RTU Slave protocol will be reinstalled on the port.

It is important to note that there will be a delay of approximately 20 seconds from the time you remove the programmer from the serial line, and the time that it is detected as missing. Therefore, in the normal case mentioned above, there will be an interval after disconnecting the programmer during which no RTU messages can be processed on that port. This delay is implemented to prevent brief periods of signal instability from being mistaken as loss of programmer.

If a new configuration has been stored while the port is attached to the programmer, the newly configured port protocol will become the most recently established protocol and will be installed on the port upon a loss of programmer communications.

Example: If RTU Slave is running on Port 1 at 9600 baud and a PLC programmer (running at 9600 baud) is attached to the port, SNP Slave will be installed on the port, and the programmer will communicate as normal. If during that communications session a configuration store is done which sets up the port for SNP Slave at 4800 baud, this setup will *not* take effect until the port loses communications with the programmer. Upon loss of programmer communications, the SNP Slave protocol at 4800 baud will be installed.

Any COMM_REQs sent to the port by the application program while the PLC is attached to the programmer will be processed by the SNP Slave protocol. A COMM_REQ that is supported by the RTU Slave protocol, but is not supported by SNP Slave, will be rejected. For the case of a Serial Port Change COMM_REQ, which is supported by both protocols, the new active port protocol supplied by this COMM_REQ will *not* take effect immediately, but will become the most recently established port protocol. This means that the new port configuration supplied by the Serial Port Change COMM_REQ will not take effect until the programmer is disconnected.

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Configuring ASCII Output

This feature allows the Micro PLC to automatically dial a pager via modem and send a specified byte string from Serial Port 2. Pager dialing and message transmission are set up by COMM_REQ functions in the ladder logic.

Note

To implement this feature, Serial Port 2 must be configured as a CUSTOM port (see page 5-13).

Pager enunciation is implemented by three commands, requiring three COMM_REQ command blocks:

Autodial: 04400 (1130H) Dials the modem. This command works the same way that the SNP Master Autodial command 7400 does.

Put string: 04401 (1131H) Specifies an ASCII string, from 1 to 250 bytes in length, to send from the serial port.

Autodial: 04400 (1130H) It is the responsibility of the PLC application program to hang up the phone connection. This is accomplished by reissuing the autodial command and sending the hangup command string.

Autodial Command Block

The Autodial command automatically transmits an Escape sequence that follows the Hayes convention. If you are using a modem that does not support the Hayes convention, you may be able to use the Put String command to dial the modem.

Examples of commonly used command strings for Hayes-compatible modems are listed below:

Command String	Length	Function
ATDP15035559999<CR>	16 (10H)	Pulse dial the number 1-503-555-9999
ATDT15035559999<CR>	16 (10H)	Tone dial the number 1-503-555-9999
ATDT9,15035559999<CR>	18 (10H)	Tone dial using outside line with pause
ATHO<CR>	5 (05H)	Hang up the phone
ATZ <CR>	4 (04H)	Restore modem configuration to internally saved values

Table 5-7 lists a sample COMM_REQ command block that dials the number 234-5678 using a Hayes-compatible modem. The ladder logic that creates this command block is shown in Figure 5-2. For a more detailed example of the use of COMM_REQ functions and command blocks, refer to Figure 5-1.

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Table 5-7. Sample Command Block for CUSTOM Protocol Autodial Command

Word	Definition	Values
1	0009H	CUSTOM data block length (includes command string)
2	0000H	NOWAIT mode
3	0008H	Status word memory type (%R)
4	0000H	Status word address minus 1 (Register 1)
5	0000H	reserved
6	0000H	reserved
7	04400 command (1130H)	Autodial command number
8	00030 (0001H)	Modem response timeout (30 seconds)
9	0012 (000CH)	Number of bytes in command string
10	5441H	A (41H), T (54H)
11	5444H	D (44H), T (54H)
12	3332H	Phone number: 2 (32H), 3 (33H)
13	3534H	4 (34H), 5 (35H)
14	3736H	6 (36H), 7 (37H)
15	0D38H	8 (38H) <CR> (0DH)

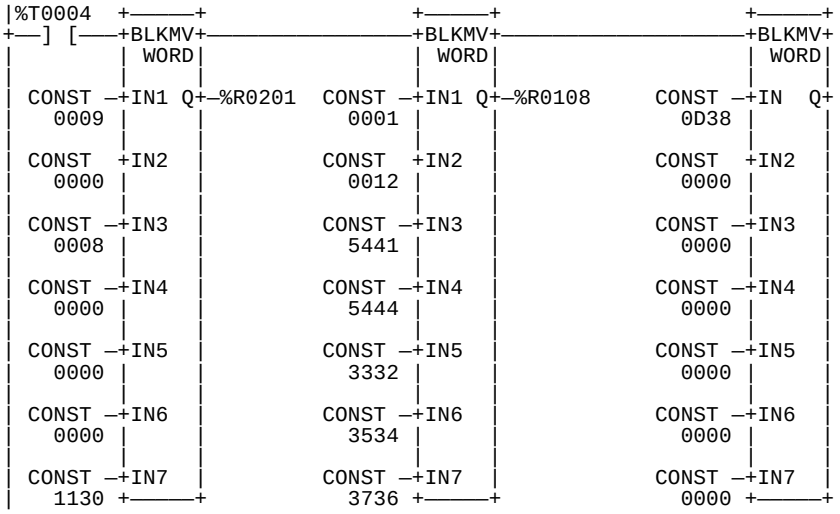


Figure 5-2. Sample Autodial Command Block (Tone dials the number 234-5678.)

Note

After the Put String command block has been sent, an Autodial command block must be sent to hang up the phone connection. In the example above, you would replace the string DT in word 11 with the string HO (48H, 4FH).

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Put String Command Block

Table 5-8 lists a sample COMM_REQ command block that sends the data string, “hello world” using the Put String command (04401). The ladder logic rung that creates this command block is shown in Figure 5-3. A maximum transmit timeout of 30 seconds is specified. The string data begins at Word 10. This command is similar to the Autodial command except that Put String does not send the escape sequence for Hayes-compatible modems.

The *Maximum Transmit Timeout* field specifies, in seconds, the maximum time interval the COMM_REQ will wait for the entire string to be sent. If this time is set to 0, a default value of 4 seconds plus the time required to transmit the number of characters is used. If the string is not transmitted during the specified interval or the default interval, an error code is generated.

The *Number of Bytes in Command String* field specifies the length of the command string to be sent. This length includes all characters. A status code indicating successful transmission will be returned when the string has been completely sent out the serial port.

Table 5-8. Sample Command Block for Put String Command

Word	Definition	Values
1	0009H	CUSTOM data block length (includes command string)
2	0000H	NOWAIT mode
3	0008H	Status word memory type (%R)
4	0000H	Status word address minus 1 (Register 1)
5	0000H	reserved
6	0000H	reserved
7	04401 command (1131H)	Put String command number
8	001EH	Maximum transmit timeout (30 seconds)
9	000BH	Number of bytes in command string
10	6568H	h (68H), e (65H)
11	6C6CH	l (6CH), l (6CH)
12	206FH	o (6F), “ “ (20H)
13	6F77H	w (77H), o (6FH)
14	6C72H	r (72H), l (6CH)
15	0064H	d (64H)

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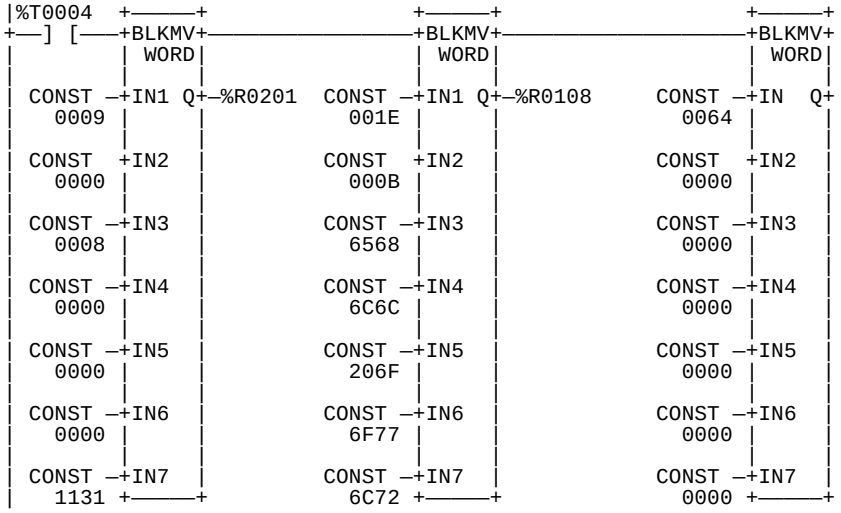


Figure 5-3. Sample Put String Command Block (Sends the string, “hello world.”)

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Status Word for Custom Protocol COMM_REQs

A value of 1 will be returned in the COMM_REQ status word upon successful completion of a CUSTOM protocol command. Any other value returned in the COMM_REQ status word is an error code where the low byte is a major error code and the high byte is a minor error code.

Table 5-9. Status Codes for Custom Protocol

Major Status Code	Description	
1 (01H)	Successful Completion (this is the expected completion value in the COMM_REQ status word).	
12 (0CH)	Local CSTM_PROT error — Port configuration command 65520 (FFF0H). An error occurred while processing a local command. The minor error code identifies the specific error.	
	2 (02H)	COMM_REQ command is not supported.
13 (0DH)	Remote CSTM_PROT error — Put String command 4401 (1131H). An error occurred while processing a remote command. The minor error code identifies the specific error.	
	2 (02H)	String length exceeds end of reference memory type.
	3 (03H)	COMM_REQ data block length is too small. String data is missing or incomplete.
	48 (30H)	Serial output timeout. The serial port was unable to transmit the string. (Could be due to missing CTS signal when the serial port is configured to use hardware flow control.)
	50 (32h)	COMM_REQ timeout. The COMM_REQ did not complete within a 20-second time limit.
14 (0EH)	Autodial Error — Autodial command 4400 (1130). An error occurred while attempting to send a command string to an attached external modem. The minor error code identifies the specific error.	
	1 (01H)	Not used.
	2 (02H)	The modem command string length exceeds end of reference memory type.
	3 (03H)	COMM_REQ Data Block Length is too small. Output command string data is missing or incomplete.
	4 (04H)	Serial output timeout. The serial port was unable to transmit the modem autodial output. (May be due to missing CTS signal when the serial port is configured to use hardware flow control.)
	5 (05H)	Response was not received from modem. Check modem and cable.
	6 (06H)	Modem responded with BUSY. Modem is unable to complete the requested connection. The remote modem is already in use; retry the connection request at a later time.
	7 (07H)	Modem responded with NO CARRIER. Modem is unable to complete the requested connection. Check the local and remote modems and the telephone line.
	8 (08H)	Modem responded with NO DIALTONE. Modem is unable to complete the requested connection. Check the modem connections and the telephone line.
	9 (09H)	Modem responded with ERROR. Modem is unable to complete the requested command. Check the modem command string and modem.
	10 (0AH)	Modem responded with RING, indicating that the modem is being called by another modem. Modem is unable to complete the requested command. Retry the modem command at a later time.
	11 (0BH)	An unknown response was received from the modem. Modem is unable to complete the requested command. Check the modem command string and modem. The modem response is expected to be either CONNECT or OK.
	50 (32H)	COMM_REQ timeout. The COMM_REQ did not complete within a 20-second time limit.

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Configuring Expansion Units (23 and 28-Point Micro PLCs)

Each 23 and 28-point Micro PLC can support up to four expansion units. (See Chapter 3 for installation instructions.) The expansion unit configuration screens follow immediately after the high speed counter screens (or the Serial Port 2 screen). Table 5-10 lists the parameters for each type of expansion module available. The default selection is EMPTY UNIT, as shown in the screen below. To configure an expansion module, press TAB to select EMPTY UNIT, press the ↓ key to choose the model, and press ENTER.

There are three types of expansion units

- Series 90 14-point standard expansion units which have 8 discrete inputs and 6 discrete outputs
- Generic expansion units which can have a mixture of %I, %Q, %AI, and/or %AQ references (14PTGENERIC and GENERICEXP)
- I/O Link Interface expansion unit which has 32 bytes of input data and 32 bytes of output data that can be mapped to any valid reference memory except %S (IC693UEX013)

Table 5-10. Configuration Parameters for Expansion Units

Parameter	Description	Possible Values	Default Value
Expansion Module		EMPTY UNIT IC693UEX1/2 14PTGENERIC IC693UEX013 GENERICEXP	EMPTY UNIT
IC693UEX1/2 and 14PTGENERIC			
%I Ref Adr	Discrete input reference **not editable**	%I0017	%I0017
%I Size (Bits)	Discrete input size **not editable**	8	8
%Q Ref Adr	Discrete output reference **not editable**	%Q0017	%Q0017
%Q Size (Bits)	Discrete output size **not editable**	6	6
IC693UEX013			
%I Ref Adr	Discrete input reference	%I0049–0257	%I0049
%I Size (Bits)	Discrete input size **not editable**	256	256
%Q Ref Adr	Discrete output reference	%Q0049–0257	%Q0049
%Q Size (Bits)	Discrete output size **not editable**	6	6

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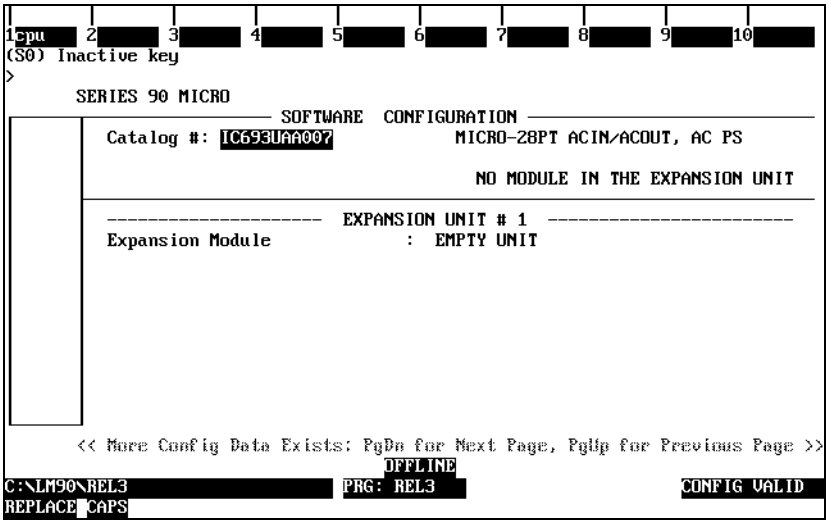
Table 5-10. Configuration Parameters for Expansion Units - Continued

Parameter	Description	Possible Values	Default Value
GENERICEXP			
Address Offset (hex)		0300–0F00	0300
%I Ref Adr	Discrete input reference	%I0305	%I0305
%I Ref Size (Bits)	Discrete input size	0–208	0
%Q Ref Adr	Discrete output reference	%Q305	%Q305
%Q Ref Size (Bits)	Discrete output size	0–208	0
%AI Ref Adr	Analog input reference	%AI0020	%AI0020
%AI Ref Size (Words)	Analog input size	0–208	0
%AQ Ref Adr	Analog input reference	%AQ013	%AQ013
%AQ Ref Size (Words)	Analog input size	0	0

Logicmaster Screens for Configuring Expansion Units

The expansion unit configuration screens follow immediately after the high speed counter screens (or the Serial Port 2 screen). The default expansion unit selection is EMPTY UNIT. The configuration parameters that you see will depend on the type of expansion module selected.

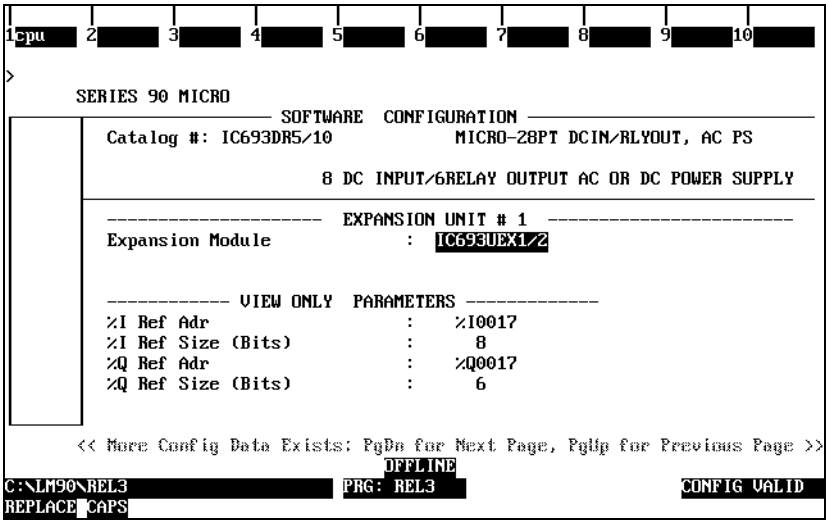
To configure an expansion unit, use the → key to move the cursor to EMPTY UNIT and press the **TAB** key to change the type of expansion module. The parameters displayed depend on the expansion module selected.



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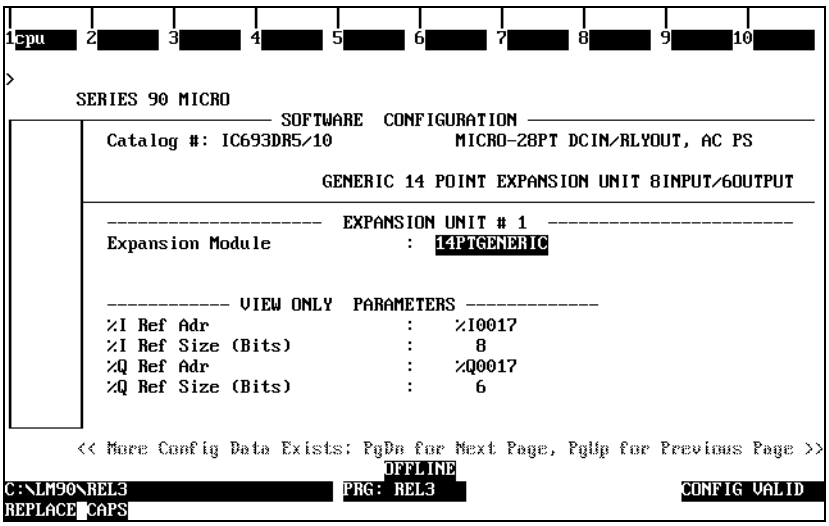
Series 90 Micro 14-Point Expansion Unit

The expansion unit, IC693UEX011 (AC input power), can be connected to a Micro PLC base unit to provide additional I/O points (8 DC inputs and 6 relay outputs). The Micro expansion units have no configurable parameters.



14-Point Generic Expansion Unit

This screen allows you to configure a third-party 14-point expansion unit.

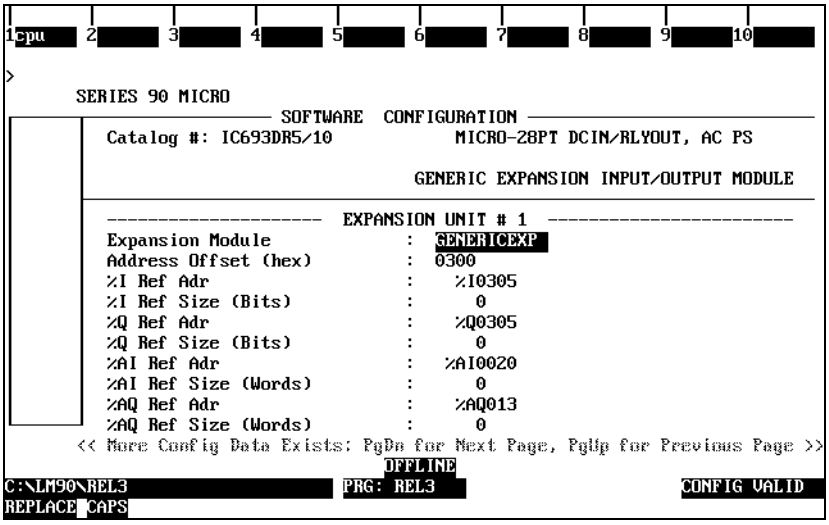


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Generic Expansion Unit

The Logicmaster 90 configuration software provides the Generic Expansion Input/Output Module configuration so that third parties can develop a wide range of input/output modules with varying amounts of discrete or analog I/O.

Generic input/output modules can be placed on any 256-byte boundaries except for the four 256-byte areas reserved for the 14-point expansion units. The configuration software maps the I/O to open locations in the read/write tables within the PLC on byte boundaries. Each table can be independently mapped.



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I/O Link Interface Expansion Unit

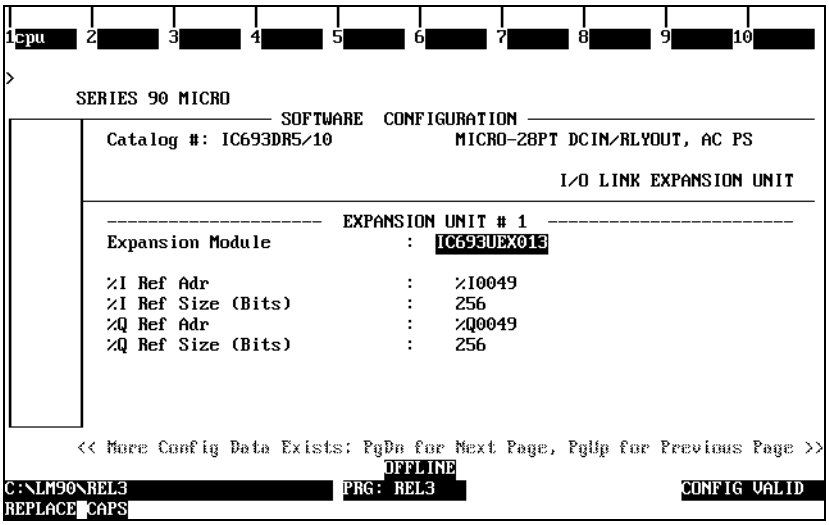
Note

The I/O Link IEU (IC693UEX013) is not sold in the United States. This page is for informational purposes only. For details on installation and operation, refer to the documentation provided with the I/O Link IEU.

The I/O Link IEU is a slave device on an I/O link. This device connects to a Micro PLC base unit or to an expansion unit and allows the Micro PLC to reside on an I/O Link network. The I/O Link IEU receives 32, 64, 128, or 256 inputs from the I/O link and transmits 32, 64, 128, or 256 to the I/O link. Because the I/O Link IEU has only one expansion connector, it must be the last unit in a chain of expansion units if other units are connected to the same base Micro PLC. This also means that there can be only one I/O Link IEU per Micro PLC.

Any available %Q discrete reference memory address can be used for the output data and any available %I discrete reference memory address can be used for the input data as long as it does not overlap the input reference address of other input devices. The I/O Link IEU's reference addresses will default to %I0049 and %Q0049 when the Micro PLC's configuration is defaulted.

If the Micro PLC logs a Loss of Expansion Unit fault while scanning the input data from the I/O Link IEU, the input reference memory data will be set to all zeros.



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HHP Screens for Configuring Expansion Units

As an example, suppose a setup contains a generic expansion unit, a standard expansion unit, and an I/O Link Interface expansion unit.

When the CPU's Default I/O parameter is enabled, expansion units are automatically configured. For the purposes of this example, Default I/O is disabled. Note that when manually configuring expansion units with the HHP, the expansion unit must be physically present and you must press **READ** + **ENT** on the HHP to initiate the configuration process.

Configuring Generic Expansion Units

In the following example, the generic expansion unit has 2 bytes of discrete input data, 1 byte of discrete output data, 15 words of analog input data, and 2 words of analog output data. The address offset for the generic unit is 0A00h.

1. Press ↓ until configuration for R0:S7 appears and press **READ** + **ENT**:

```
R0:07 GENERIC >S
ADDR: 0A00
```

2. Press → to go to %I reference screen:

```
R0:07 GENERIC <S
I0016:
```

3. Press **4** + **9** + **ENT** to configure discrete input data at %I49–64:

```
R0:07 GENERIC <S
I0016:I0049-0064
```

4. Press → to go to %AI reference screen:

```
R0:07 GENERIC <S
AI015:
```

5. Press **2** + **0** + **ENT** to configure analog input data at %AI20–34:

```
R0:07 GENERIC <S
AI015:AI020-034
```


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6. Press → to go to %Q reference screen:

```
R0:07 GENERIC <S
Q0008:
```

7. Press **4** + **9** + **ENT** to configure discrete output data at %Q49–56:

```
R0:07 GENERIC <S
Q0008:Q0049-0056
```

8. Press → to go to %AQ reference screen:

```
R0:07 GENERIC <S
AQ002:
```

9. Press **1** + **3** + **ENT** to configure analog input data at %AQ13–14:

```
R0:07 GENERIC <S
AQ002:AQ013-014
```

Configuring Standard Expansion Units

1. Press ↓ to go to the next slot:

```
R0:08          <S
```

2. Press **READ** + **ENT** to configure the standard expansion unit:

```
R0:08 MIXED    <S
I8/Q6:QI0017
```


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Configuring I/O Link Interface Expansion Units

1. Press ↓ to go to the next slot:

```
R0:09          <S
```

2. Press **READ** + **ENT** to configure the I/O Link Interface expansion unit:

```
R0:09 I/O Link<S
32in/32out bytes
```

3. Press → to configure input data reference:

```
R0:09 32in     <S
```

4. Press **R** + **ENT** to select %R memory type:

```
R0:09 32in     <S
R16:
```

5. Press **1** + **ENT** to select %R1–16 for input reference:

```
R0:09 32in     <S
R16:R0001-0016
```

6. Press → to configure output data reference:

```
R0:09 32out    <S
```

7. Press **Q** + **ENT** to select %Q memory type:

```
R0:09 32out    <S
Q256:
```

8. Press **5 + 7** + **ENT** to select %Q57–312 for output reference:

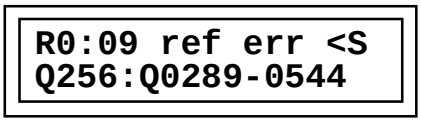
```
R0:09 32out    <S
Q256:Q0057-0312
```


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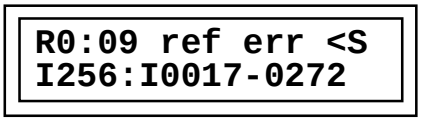
Reference Error Checking

When configuring the references for generic and I/O Link Interface expansion units, the HHP will verify that the specified reference + length doesn't go beyond the end of the corresponding reference table. It will also verify that input data references do not overlap those of other input devices that have been configured in the system.

When Past End of Ref Memory error is detected, the HHP will display an error message as follows:



When an Overlapping Input reference error is detected, the HHP will display an error message as follows:



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Configuring Q1 for PWM or Pulse Output (IC693UDR005/010 and IC693UAL006)

The high-speed DC output (Q1) can be configured for PWM, pulse train, or HSC output. Counter channel 1 can be configured for only one of these outputs at a time. Because AQUADB counting uses channels 1–3, the PWM and pulse train outputs are not available when a type B counter is configured. (In the sample screen below, PWM is enabled.)

Note

The configurations for HSC, PWM, and Pulse outputs are sent to the CPU when the Micro PLC changes from STOP to RUN mode. When the transition to RUN mode occurs, the currently configured output stops running and the new configuration takes over.

Note

A pulldown resistor, connected between Q1 and COM1, is required for high frequency Pulse and PWM (up to 2Khz) outputs and for duty cycles in the lower ranges (5% and lower). A 1.5 Kohm, 0.5 watt resistor is recommended for this purpose.

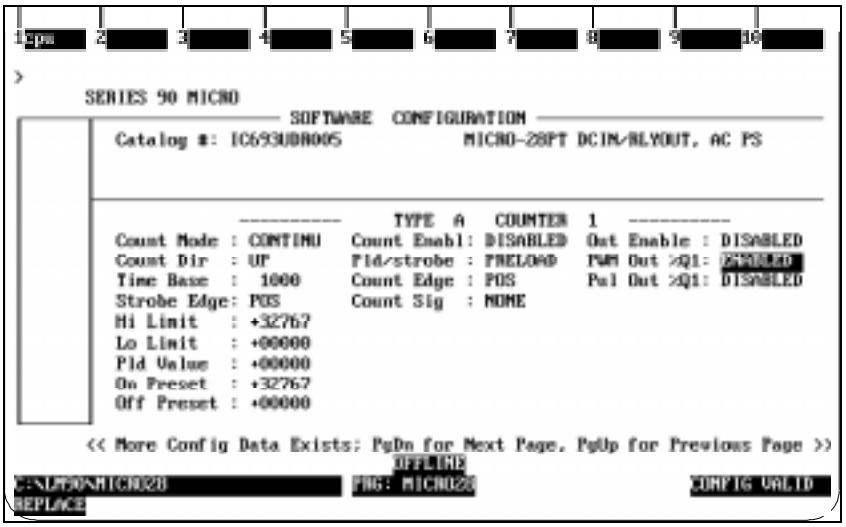


Table 5-11. Memory Locations for PWM and Pulse Train Parameters

Output	Parameter	Memory Location
PWM	PWM Frequency, Q1	AQ2
	PWM Duty Cycle, Q2	AQ3
Pulse Train	Pulse Train Frequency	AQ123
	Number of pulses to send	AQ124
	Start pulse train	Q494
	Pulse train complete on Q1	I494

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PWM Output

PWM output can be used to control DC and stepper motors. You can select the frequency of the PWM output (19hz to 2Khz) by writing a value to memory location AQ2. The PWM duty cycle (0 to 100%) is selected by writing a value to memory location AQ3. Sample calculations of PWM duty cycle and frequency are provided in Table 5-12.

Warning

When the Micro PLC goes from RUN to STOP mode, PWM will continue to operate. Also PWM will continue to operate over a power cycle. Therefore, if PWM is running when power is lost, it will run when power is restored.

Table 5-12. Sample Values for PWM Duty Cycle and Frequency

Contents of Frequency Register (AQ2)[1]			Contents of Duty Cycle Register (AQ3)[1]				Typical On Duty
Decimal	Hex	Two's Complement	Decimal	Hex	Two's Complement	Frequency[2]	Cycle (%)[3] 24VDC, 200mA
0	0	–	0	0	–	0 (default)	100 (default)
614	266	–	491	1EB	–	2 Khz	98
819	333	–	614	266	–	1.5 Khz	85
1,229	4CD	–	860	35C	–	1 Khz	77
2459	99B	–	1475	5C3	–	500 Hz	63
4919	1337	–	2460	99C	–	250 Hz	52
12299	300B	–	4920	1338	–	100 Hz	41
35142	8946	–30394	1230	4CE	–30394	35 Hz	4
40999	A027	–24537	7380	1CD4	–24637	30 Hz	18
64736	FCDF	–801	6553	1999	–1037	19 Hz	10

Formulas:

1. Values greater than 32767 cannot be entered as decimal numbers. They can be entered as hex or as two's complement values.
2. Frequency calculation: $\%AQ2 = \frac{9.84\,MHz}{8 * frequency} - 1$ *Frequency tolerance is ±0.01%*
3. On Duty Cycle calculation: $\%AQ3 = \left(\frac{on_duty_cycle}{100 * frequency} - delta_delay\right)\left(\frac{9.84\,MHz}{8}\right) - 1$

Where *on duty cycle* is a value from 0 to 100% and *delta delay* is the difference between the off and on response times of the output device. (See Table 5-13 for typical *delta delay* values.)

4. On Time calculation: $AQ3 = \left[\left(ontime - delta_delay\right)\frac{9.84\,MHz}{8}\right] - 1$

5 Off Time calculation: Off Time = $\frac{1}{frequency} - ontime$

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Table 5-13. Typical Values for Delta Delay

Units **Revision/Date Code for IC693UDR005**	**Typical Delta Delay** at 24VDC, 16mA output (1.5 Kohm load)
IC693UDR005 Revision B with date code less than 606	0.22ms
IC693UDR005 Revision C or later, or Revision B with date code equal to or greater than 606	0.09ms
IC693UDR010/IC593UAL006	0.09ms

Note

In Logicmaster 90, when entering hexadecimal numbers in a reference table, a leading A through F must be preceded by a zero (for example, 0FFFF). To enter a two's complement number, enter it as a negative integer (**int**). For additional information on editing values in reference tables, see "Reference Tables" in the *Logicmaster™ 90 Series 90™-30/20/Micro Programming Software User's Manual*, GFK-0466.

Sample calculation for PWM Output: The formulas provided with Table 5-12 can be used to determine the value of %AQ3 required at the fastest frequency to produce a minimum ON and OFF pulse width when the application is primarily concerned with varying the frequency. For example, an application might require a PWM output of 0 to 2Khz with an input device that requires a minimum pulse width of 50µs. With a fixed ON time, the worst-case OFF time occurs at 2Khz. Therefore, the value of AQ3 that will guarantee at least a 50µs OFF pulse width is given by:

OFF time=Period – ON time

50µs OFF=500µs – ON time

ON time = 450µs

$$\%AQ = \frac{(450\mu s - 0.09ms) \times 9.84\,MHz}{8} - 1 = 443$$

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Pulse Train Output

You can select the frequency (10Hz to 2Khz) of the pulse train output (PTO) by writing a value (-32768 to 32767) to memory location AQ123. The number of pulses to be output is selected by writing a value to memory location AQ124.

The pulse train is started when the Q494 bit is set to 1 by the ladder logic program. Starting the pulse train clears I494. When the number of pulses specified in AQ124 has been generated, the I494 bit will be set to 1 and Q494 will be cleared. For sample pulse train frequency calculations, refer to the table below.

Warning

When the Micro PLC goes from RUN to STOP mode, PTO will continue to operate. Also, PTO will continue to operate over a power cycle. Therefore, if PTO is running when power is lost, it will run when power is restored.

Table 5-14. Example Values for Pulse Output Frequency

Contents of Frequency Register (AQ123)[1]		Frequency (Hz)[2]
Decimal	**Hex**	
0	0	0 (default)
307	133	1,997
409	199	1,500
614	266	1,000
1,229	4CD	500
2459	99B	250
6,149	1805	100
20,499	5013	30
30, 749	781D	20

Formulas:

1. Values greater than 32767 cannot be entered as decimal numbers. Enter them as hex, or as two's complement.

2. $\%AQ123 = \frac{9.84\,MHz}{frequency * 16} - 1$ *Frequency tolerance is ±0.01%*

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Configuring of Outputs Q1 to Q5 (IC693UDD104)

Certain transistor outputs of model IC693UDD104 can be configured to be PWM-, Pulse Train, or HSC-outputs.
For simultaneous use of these functionalities there are some restrictions for possible combinations :

Table 5-15. Combinations with A4 Configuration (4 CountersType A)

Counter 1 at Q1	or	PWM Output Q1	or	Pulse Train Output Q1
Counter 2 at Q2	or	PWM Output Q2	or	Pulse Train Output Q3
Counter 3 at Q3	or	PWM Output Q3	or	Pulse Train Output Q5
Counter 4 at Q4	or	PWM Output Q4		

Example for a permissible combination:

Counter 1 at Q1 + PWM Output Q2 + Pulse Train Output Q5 + PWM Output Q4

Example for a not permissible combination:

Counter 2 at Q2 + Pulse Train Output Q3

Table 5-16. Combinations with B1-3,A4 Configuration (1 Counter Type B + 1 Counter Type A)

1 x Type B Counter at Q1	or	PWM Output Q1	or	Pulse Train Output Q1
			AND	
		PWM Output Q2	or	Pulse Train Output Q3
Counter 4 at Q4	or	PWM Output Q4		

Example for a permissible combination:

Type B Counter at Q1 + PWM Output Q4

Example for a not permissible combination:

Type B Counter at Q1+ Pulse Train Output Q3

Note

A bias resistor, connected between the output and COM1, is required for high frequency Pulse and PWM (up to 2 Khz) outputs and for duty cycles in the lower ranges (5% and lower). A 1.5 Kohm, 0.5 watt resistor is recommended for this purpose.

Note

The configurations for HSC, PWM, and Pulse outputs are sent to the CPU when the Micro PLC changes from STOP to RUN mode. When the transition to RUN mode occurs, the currently configured output stops running and the new configuration takes over.

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Table 5-17. Memory Locations for PWM and Pulse Train Parameters

Output	Parameter	Memory Location
PWM Q1	PWM Frequency	AQ2
	PWM Duty Cycle	AQ3
PWM Q2	PWM Frequency	AQ4
	PWM Duty Cycle	AQ5
PWM Q3	PWM Frequency	AQ6
	PWM Duty Cycle	AQ7
PWM Q4	PWM Frequency	AQ8
	PWM Duty Cycle	AQ9
Pulse Train Q1	Pulse Train Frequency	AQ123
	Number of pulses to send	AQ124
	Start pulse train	Q494
	Pulse train complete	I494
Pulse Train Q3	Pulse Train Frequency	AQ125
	Number of pulses to send	AQ126
	Start pulse train	Q495
	Pulse train complete	I495
Pulse Train Q5	Pulse Train Frequency	AQ127
	Number of pulses to send	AQ128
	Start pulse train	Q496
	Pulse train complete	I496

PWM Output (IC693UDD104)

PWM output can be used to control DC and stepper motors. You can select the frequency of the PWM output (19 hz to 2 Khz) by writing a value to e.g. memory location AQ2.
The PWM duty cycle (0 to 100 %) is selected by writing a value to e.g. memory location AQ3.
Sample calculations of PWM duty cycle and frequency are provided in Table 4-6.

Warning

When the Micro PLC goes from RUN to STOP mode, PWM will continue to operate. Also PWM will continue to operate over a power cycle. Therefore, if PWM is running when power is lost, it will run when power is restored.

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Table 5-18. Sample Values for PWM Duty Cycle and Frequency

Contents of Frequency Register e.g. AQ2		Contents of Duty Cycle Register e.g. AQ3	Typical On Duty Cycle (%) at 24 VDC, 16 mA, 1.5Kohm load	
Decimal	**Hex**	**Decimal**		**Frequency**
0	0	0	100 % (default)	0 (default)
614	266	491	98%	2 kHz
819	333	614	85%	1,5 kHz
1229	4CD	860	77%	1 kHz
2459	99B	1475	63%	500 Hz
4919	1337	2460	52%	250 Hz
12299	300B	4920	41%	100 Hz
35142	8946	7250	21%	35 Hz
40999	A027	7380	18%	30 Hz
64736	FCDF	6553	10%	19 Hz

Formulas :

9. Values greater than 32767 cannot be entered as decimal numbers. They can be entered as hex or as two´s complement values.

10. Frequency calculation :

AQ2 =(9,84 MHz / (8 x frequency)) - 1 Frequency tolerance is +-0,01%

11. On Duty Cycle calculation :

AQ3 = ((On_duty_cycle / (100 x frequency)) - delta_delay)(9,84MHz/8) -1

On Duty Cycle = 0 to 100 %
Delta Delay = Difference between the off and on response times of the output device (see Table 4-7 for typical delta delay values)

4. On Time calculation :

AQ3 = ((ontime - delta_delay) * (9,84 MHz / 8)) - 1

5. Off Time calculation :

Off Time= (1 / frequency) - ontime

Table 5-19. Typical Values for Delta Delay

Model	Typical Delta Delay at 24 VDC, 16mA output (1,5Kohm load)
IC693UDD104 Version B	0,09 ms

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Note

In Logicmaster 90, when entering hexadecimal numbers in a reference table, a leading A through F must be preceeded by a zero (for example, 0FFFF). To enter a two´s complement number, enter it as a negative integer (**int**). For additional information on editing values in reference tables, see “Reference Tables” in the Logicmaster™ 90 Series 90™ -30/20/Micro Programming Software User´s Manual (GFK-0466).

Sample Calculation for PWM Output

The formulas provided with Table 4-6 can be used to determine the value of AQ3 required at the fastest frequency to produce a minimum ON and OFF pulse width when the application is primarily concerned with varying the frequency. For example, an application might require a PWM output of 0 to 2 Khz with an input device that requires a minimum pulse width of 50 µs. With a fixed ON time, the worst-case OFF time occurs at 2 Khz. Therefore, the value of AQ3 that will guarantee at least a 50 µs OFF pulse width is given by

OFF time = Period - ON time

50 µs OFF = 500 µs - ON time

ON time = 450 µs

AQ3 = ((450µs-90µs)*(9,84Mhz / 8))-1 = 443

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Pulse Output (IC693UDD104)

You can select the frequency (10Hz to 2Khz) of the pulse train by writing a value (-32768 to 32767) to memory location e.g. AQ123. The number of pulses to be output is selected by writing a value to memory location e.g. AQ124.

The pulse train is started when the e.g. Q494 bit is set to 1 by the ladder logic program. Starting the pulse train clears, for example, I494. When the number of pulses specified in AQ124 has been generated, the I494 bit will be set to 1 and Q494 will be cleared.
For sample pulse train frequency calculations, refer to the table shown below.

Warning

When the Micro PLC goes from RUN to STOP mode, Pulse Train Output will continue to operate. Also Pulse Train Output will continue to operate over a power cycle. Therefore, if Pulse Train Output is running when power is lost, it will run when power is restored.

Table 5-20. Example Values for Pulse Output Frequency

Contents of Frequency Register (e.g., AQ123)		
Decimal	**Hex**	**Frequency (Hz)**
0	0	0 (default)
307	133	1997
409	199	1500
614	266	1000
1229	4CD	500
2459	99B	250
6149	1805	100
20499	5013	30
30749	781D	20

Formulas:

1. Values greater than 32767 cannot be entered as decimal numbers. Enter them as hex, or as two´s complement.
2. **AQ123 = (9,84 MHz / (frequency * 16)) - 1** Frequency tolerance is +- 0,01 %

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Chapter 6 High Speed Counters

The Series 90 Micro PLC has four built-in high speed counters (HSCs). Each counter provides direct processing of rapid pulse signals up to 5KHz for industrial control applications such as meter proving, turbine flowmeter, velocity measurement, material handling, motion control, and process control. This chapter describes the features, operation, and configuration of the HSCs. For electrical and circuit specifications for the HSCs, refer to Chapter 4.

The HSCs are configured using the Series 90-30/20 Hand-Held Programmer or the configuration function provided by the Logicmaster 90-30/20/Micro software. Many features can also be configured from the application program. The HSC function can operate in one of two modes:

A4 – four identical, independent simple (type A) counters.

B1–3, A4 – one type B counter (for A-Quad-B counting) and one type A counter.

In either mode, each counter can be enabled independently. Type A counters can be configured for up or down counting (default is up) and for positive or negative edge detection (default is positive). The HSCs run independently of the PLC logic. If the PLC is in STOP mode, outputs that are configured for HSC operation can be configured to operate in one of three failure modes described on page 6-7. Type A counter operation is described on page 6-8, and type B counter operation is described on page 6-14.

Warning

When the Micro PLC goes from RUN to STOP mode, the HSCs will continue to operate. Also, the HSCs will remain in run mode through a power cycle. Therefore, if an HSC is running when power is lost, it will run when power is restored.

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Table 6-1. High Speed Counter Terminal Assignments

	Point	A4 Configuration	B1–3, A4 Configuration
Input	I1	Count 1	B counter (Phase 1)
	I2	Preload/Strobe 1	Not used
	I3	Count 2	B counter (Phase 2)
	I4	Preload/Strobe 2	Not used
	I5	Count 3	Not used
	I6	Preload/Strobe 3	Preload/Strobe for B counter
	I7	Count 4	Count 4 (A counter)
	I8	Preload/Strobe 4	Preload/Strobe 4
	I9-I13 (23-point)	Not used	Not used
	I9-I16 (28-point)	Not used	Not used
Output	Q1	COUNTER 1	TYPE B COUNTERS 1–3
	Q2	COUNTER 2	Not used
	Q3	COUNTER 3	Not used
	Q4	COUNTER 4	TYPE A COUNTER 4
	Q5–Q6	Not used	Not used
	Q7-Q9 (23-point units)	Not used	Not used
	Q7–Q12 (28-point units)	Not used	Not used

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High Speed Counter/CPU Interface

During each I/O scan, the HSC automatically sends 15 words (%AI) of Register Data Values and 16 status bits (%I) to the CPU, and the CPU sends 16 bits (%Q) of output data to the HSC. COMM_REQ function blocks in the user program can be used to send additional data commands to the HSC (See page 6-34).

Registers

Counts per Timebase Register

The 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 (increments of 10 milliseconds).

Preload Register

This register is used if the counter's Preload/Strobe parameter is set to Preload. (Preload and Strobe cannot be active at the same time.) This parameter must be set by the Logicmaster 90 configuration software or the HHP. It cannot be changed by a COMM_REQ.

When a preload input occurs, the configured preload value is inserted into the Accumulator and a Preload flag is set to indicate this to the CPU. If the application program uses this flag, it should clear the flag before the next preload occurs. The appropriate edge (either rising or falling, depending on configuration) on the Preload input always loads the Accumulator regardless of the state of the Preload flag. In the Preload mode, the Preload/Strobe input is normally used to perform the reset function for each counter. Therefore, the Preload default value has been set to 0 (zero). However, the Preload value can be configured to any value within the counter's selected range.

If a Preload input occurs, the corresponding Preload Status bit is set. See "Status Bits (%I)" on page 6-5. The application program can monitor this bit, and if necessary, reset it using the Reset Preload output bit.

The application program can adjust the value in the Accumulator by sending the HSC a Communications Request (COMM_REQ) from the CPU (see page 6-34). *This adjustment can be any value between –128 and +127*. The adjustment value is summed with the contents of the Accumulator. Alternately, the value in the Accumulator can be set in the Logicmaster 90 Configuration software, duplicating the preload functionality.

Note

If a count is received at the same time the CPU adjusts the Accumulator value, the count will be lost. This happens because the CPU must read the Accumulator, add the specified adjustment value, and write back to it, during which time received counts are ignored.

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Strobe Register

This register is used if the counter's Preload/Strobe parameter is set to Strobe. (Preload and Strobe cannot be active at the same time.) This parameter must be set by the Logicmaster 90 configuration software or the HHP. It cannot be changed by a COMM_REQ.

When the Strobe signal goes active, the current value in the Accumulator is stored in the associated Strobe register and a Strobe flag (status bit) is set to indicate to the CPU that a Strobe value was captured. This value remains in the Strobe register until the Strobe signal goes active again and is overwritten. The Strobe flag stays on until the application program clears it. The Strobe input always updates the Strobe register with the latest Accumulator value regardless of the state of the Strobe flag.

Data Automatically Sent by the HSC

Analog Input (%AI) Data

The 15 words (%AI) of Analog Input data values and 16 Status bits (%I) sent to the CPU are listed in Table 6-2.

Table 6-2. Description of %AI Data

Reference	Description	Value
%AI01	HSC Status Code	(see Table 6-3)
%AI02	Counts per timebase HSC1	–32768 to 32767
%AI03	Counts per timebase HSC2	–32768 to 32767
%AI04	Counts per timebase HSC3	–32768 to 32767
%AI05	Counts per timebase HSC4	–32768 to 32767
%AI06	Accumulator HSC1	–32768 to 32767
%AI07	Strobe Register HSC1	–32768 to 32767
%AI08	Accumulator HSC2	–32768 to 32767
%AI09	Strobe Register HSC2	–32768 to 32767
%AI10	Accumulator HSC3	–32768 to 32767
%AI11	Strobe Register HSC3	–32768 to 32767
%AI12	Accumulator HSC4	–32768 to 32767
%AI13	Strobe Register HSC4	–32768 to 32767
%AI14–%AI15	not used	0

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High Speed Counter Status Codes

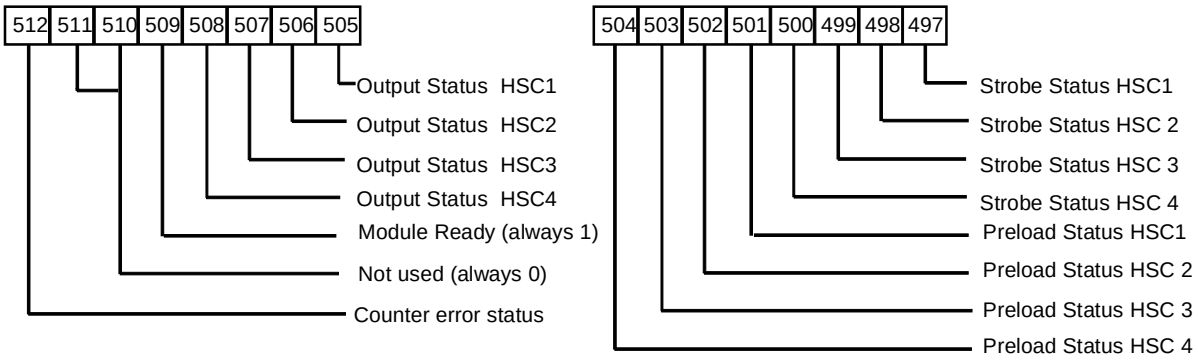
The HSC Status Code in the %AI Input Data contains the error codes returned to the PLC. These codes are set as a result of message or configuration command errors. To clear this code, the CLEAR ERROR bit in the discrete outputs (%Q) should be set.

Table 6-3. Error Codes Returned

Code	Description	Definition
0–2	not used	N/A
3	Invalid Command	Command number received was invalid for the HSC.
4–5	Unused	N/A
6	Invalid Counter Number	Counter number in the Data Command Word was not a valid counter based on the current configuration.
7–10	Unused	N/A
11 12 13 14	Counter 1 Limit Error Counter 2 Limit Error Counter 3 Limit Error Counter 4 Limit Error	Counter configuration limit was rejected because the new values set would be incompatible (High limit < > Low limit) with current High and Low limit values.

Status Bits (%I)

These status bits are sent to the CPU as inputs, and can influence outputs sent from the CPU to the HSC. Data formats for the HSC are shown on the following pages.



Strobe/Preload Status: The HSC sets these bits when a strobe or preload occurs. The CPU must clear the bit using the corresponding Reset Strobe/Reset Preload output.

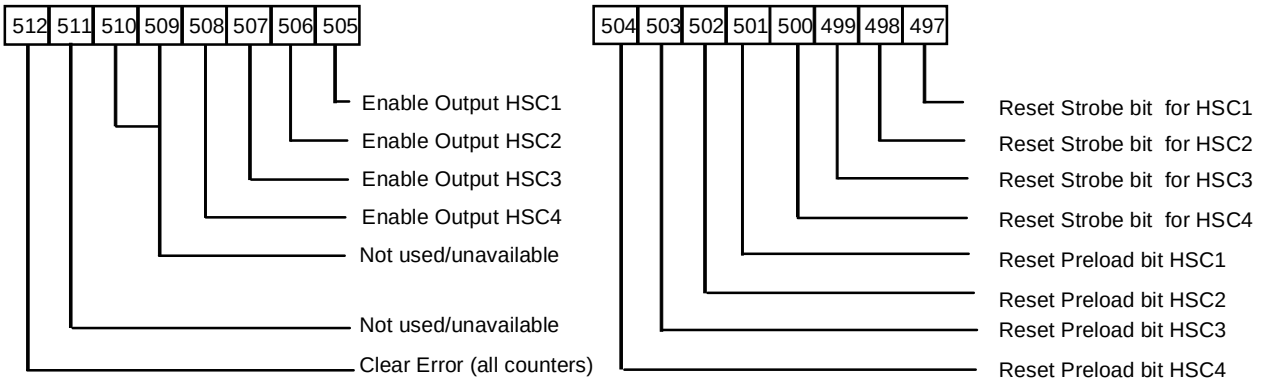
Module Ready: Always a 1.

Error: Set to indicate an error condition. When this occurs, the error code is returned in the HSC Status code (word 1). When the error is acknowledged by the CPU, it should be cleared by sending the Clear Error output.

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Data Automatically Sent to the HSC (%Q)

Once each I/O scan, the CPU sends 16 bits (%Q) of data to the HSC. The application program can use these %Q references to send commands to the HSC. The %Q data format for the counter is shown below.



Enable Output — Bits 505 through 508 are used to enable or disable the module's outputs. If an enable bit is 0, the corresponding HSC output will always remain 0.

Clear Error — Set by the CPU to clear an error after it has been acknowledged. It clears errors for all counters.

Reset Strobe — Clears the HSC's corresponding Strobe input status bit. For example, Reset Strobe bit 1 is used to reset the HSC's Strobe status bit 1. If the corresponding Strobe input status changes to 1, the program logic should set this bit to 1 and then back to 0 on the next I/O scan.

Reset Preload — Clears the HSC's corresponding Preload input status bit. For example, reset Preload bit 1 is used to reset the HSC's Preload status bit 1. If the corresponding Preload input status changes to 1, the program logic should set this bit to 1 and then back to 0 on the next I/O scan.

In addition to the %Q discrete output data that is sent every sweep to the HSC, commands can be sent by the CPU (using the COMM_REQ function in the ladder diagram) to change some of the operating parameters of the counters. For a description of how to use the COMM_REQ function, see page 6-34.

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Output Failure Mode

This parameter applies to all counters, no matter what their configuration. When the Micro PLC transitions from RUN to STOP mode for any reason, the HSC outputs respond according to the setting of this parameter:

NORMAL (default setting) The inputs will continue to be processed and the outputs will continue to operate under control of the counters. If Normal is selected, the transition from RUN to STOP mode has no effect on counter outputs.

FRCOFF All outputs will be forced off. The counters will continue to operate but will not change the state of the outputs.

HOLD The HSCs retain the last state of the output points before the PLC stopped. The counters will continue to operate but will not change the states of the outputs.

These responses remain in effect until the Micro PLC returns to the RUN mode.

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Type A Counter Operation

Type A Counter Overview

Each type A counter consists of one 16-bit Accumulator that can be programmed to count either up or down. The counter accepts two inputs: (The Accumulator can also be changed by loading a new value from the CPU or by applying a Preset Input.)

- A ***Count input*** that increments or decrements a 16-bit Accumulator. The count input can be configured to be positive current or negative current edge-sensitive.
- ***Preload/Strobe input*** that either preloads a user-defined value into the Accumulator or strobes the Accumulator into a register. The Preload/Strobe signal can be configured to be positive current or negative current edge-sensitive.

The counter has one ***output*** with programmable on and off presets.

Details of the Type A counter are shown in Figure 6-1. The counter has an Accumulator register, a Counts per Timebase register, one Strobe register, and one set of ON/OFF Preset values.

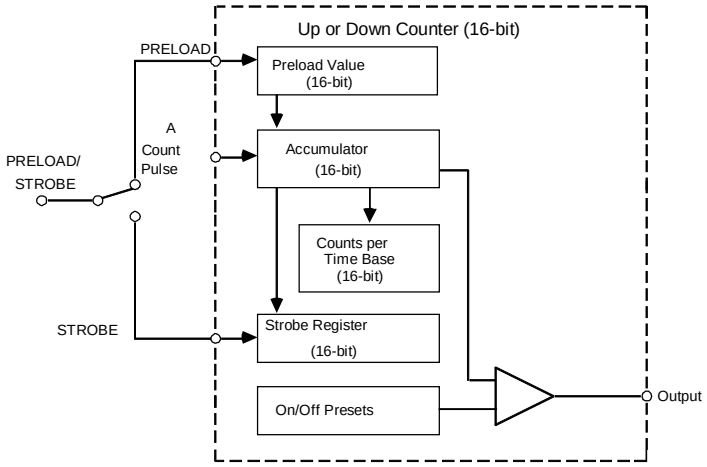
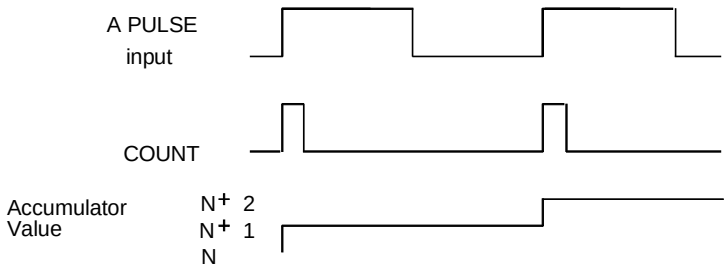


Figure 6-1. Type A Counter Block Diagram

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Type A Operating Parameters

How the HSC function operates depends on how its operating parameters are configured. For example, the figure below illustrates the case where the counter has been configured to count on the low to high transition of the A PULSE input. The COUNT signal represents an internal signal that indicates where counting occurs with respect to the pulse input.



The following paragraphs describe how the operating parameters affect the operation of an A-type counter. For details on configuring the parameters, refer to “Configuration” on page 6-20.

Counter Enable/Disable

When disabled, the HSC is inactive and the output associated with the counter is available to the user program. When enabled, the HSC is active and its output is dependent on the Output Enable parameter. (This parameter must be set by the Logicmaster 90 software or the HHP; it cannot be changed by a COMM_REQ.)

Counter Output Enable/Disable

When disabled, the HSC output is available to the user program. When enabled, the output is reserved for the HSC and cannot be controlled by the user program. (This parameter must be set by the Logicmaster 90 software or the HHP; it cannot be changed by a COMM_REQ.)

Preload/Strobe

If Preload is selected, the configured Preload Value will be loaded into the Accumulator when the Preload/Strobe signal is active. If Strobe is selected, the Accumulator value is placed in the strobe register when the Preload/Strobe signal is active. (This parameter must be set by the Logicmaster 90 software or the HHP; it cannot be changed by a COMM_REQ.)

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Count Mode

Each counter has programmable count limits that define its range (Hi Limit and Lo Limit). The counter can either count continuously within these limits, or count to either limit, then stop. This parameter applies only to A-type counters and is ignored for B-type counters.

Note

If *n* is the desired number of pulses to be counted, you must configure the counter so that high limit = *n–1* for up-counting, or low limit = *n+1* for down-counting.

Continuous (default) The Accumulator wraps when the *n+1* (or *n-1*) count is reached and continues counting. For example, if the Count Direction is UP and the Hi Limit is *n*, the Accumulator will wrap to the Lo Limit when it reaches *n+1*.

One-Shot The counter stops at 1 past the limit (i.e. at *n+1* if *n* is the high limit, and *n–1* if *n* is the low limit). When the counter is at the limit, counts in the opposite direction will count it back off the limit.

In either mode, when the counter is at the limit, counts in the opposite direction will count it back off the limit. (This parameter must be set by the Logicmaster 90 software or the HHP; it cannot be changed by a COMM_REQ.)

Count Direction

Each A-type counter can be configured to count either up (the Accumulator increments for each count received) or down (the accumulator decrements for each count). The default is up.

Strobe/Count Edge

For A-type counters, Strobe and Count inputs are edge sensitive. Each Strobe and Count input on the module can be individually configured to have either the positive or the negative edge active. By default, they are positive-edge sensitive. (These parameters must be set by the Logicmaster 90 software or the HHP; they cannot be changed by a COMM_REQ.)

Positive (default)	A count occurs on a positive-to-negative transition.
Negative	A count occurs on a negative-to-positive transition.

Counter Time Base

For each counter, the time base represents a span of time that can be used to measure the rate of counting. For example, the program could be required to monitor the number of count pulses that occur during a 30-second interval.

A timebase from 10 msec to 65535 msec can be selected for each counter. The counter timebase is set to 1 second (1000 msec) by default. The module stores the number of counts that occurred during the last-completed timebase interval in the Counts/Timebase register. Up counts are positive (+) and down counts are negative (-). The range of the Counts/Timebase register is –

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32768 and +32767 counts. The timebase value selected should not allow the Counts/Timebase register to overflow at the maximum count frequency. If it does, the sign of the Counts/Timebase will change from (+) to (–) or (–) to (+).

Anytime you modify the counter configuration using the COMM_REQ function, you will cause the counts/timebase value to be reset, except for changes to On/Off Presets and Preload. For example: If Count Direction is changed for an A-type counter, the counts/timebase value is reset.

Count Limits

Each counter must be assigned upper and lower count limits. Default values are 0 (Lo Limit) and 32767 (Hi Limit). All Accumulator preload values and output on/off preset values must lie within these limits. Both the Hi and Lo limits can be positive, or both can be negative, but the high limit is always greater than the low limit.

When setting the limits using the COMM_REQ function, the Hi Limit must be greater than or equal to Lo Limit, On Preset, Off Preset, Preload, and current Accumulator value. The Lo Limit must be less than or equal to Hi Limit, On Preset, Off Preset, Preload, and current Accumulator value. (The Logicmaster 90 configuration software and the HHP will not allow you to set incompatible limits.)

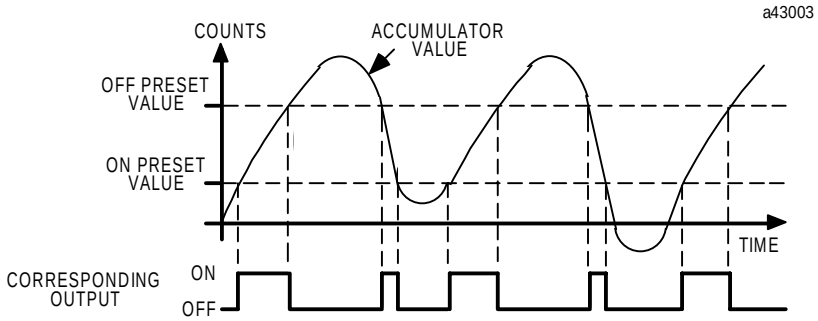
If a COMM_REQ sets new limits that are incompatible, they will be rejected and the old limits retained. In this case a counter limit error code will be returned. To avoid this situation when the limits are changed one at a time, a good rule to follow is: always move the high limit first when shifting the limits up and always move the low limit first when shifting them down.

The limit range for both Type A and Type B counters is –32,768 to +32,767.

Output Preset Points

Each counter output has a preset ON and OFF point which must be located between the Hi and Lo limits. The output state indicates when the Accumulator value is between the ON and OFF Preset points.

For example:

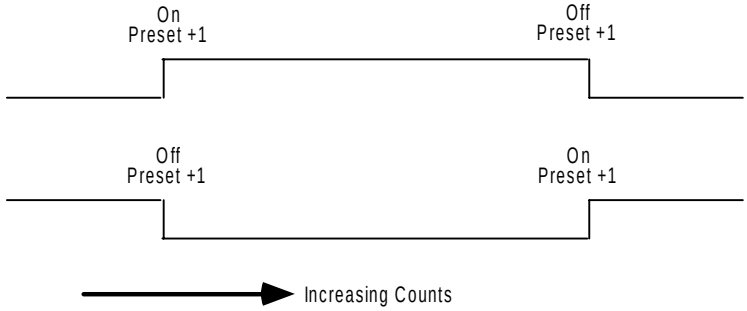


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If the output is enabled for the HSC channel being used, the output will turn on in accordance with the following table:

Preset closest to low limit	Output ON	Output OFF
ON	>ON Preset < = OFF Preset	> OFF Preset < = ON Preset
OFF	< = OFF Preset > ON Preset	< = ON Preset > OFF Preset

As the following example shows, the output can be either on or off when the Accumulator value lies between the Preset points.



Note

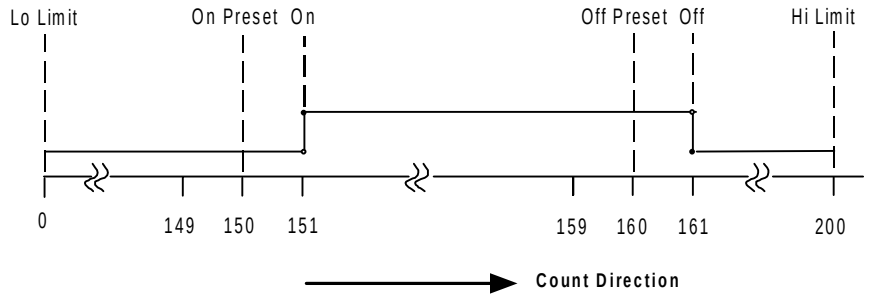
If your program issues a COMM_REQ that changes count direction, the counter will go immediately into the new mode. You should be aware that the output does not change states at exactly the same points on an Up-counter as it does on a Down-counter.

The output takes the value of the On or Off preset after the Accumulator has gone through the preset point (*n+1* for an up counter and *n-1* for a down counter).

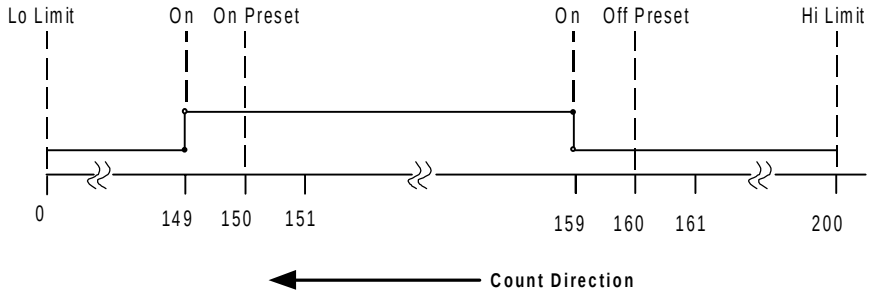
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Example for A-type counter: Lo Limit = 0 Hi Limit = 200
On Preset = 150 Off Preset = 160

Count Direction = Up



Count Direction = Down



Preload Value

When a preload input occurs, the configured preload value is inserted into the Accumulator and a Preload flag is set to indicate this to the CPU. The preload value can be configured to any value within the counter's selected range.

For each counter, you can specify a starting count value that will be used when the Preload input is activated. This value must be located between the Hi and Lo limits. The Accumulator is initialized to the Preload value on a STOP to RUN transition. (The default value is 0.)

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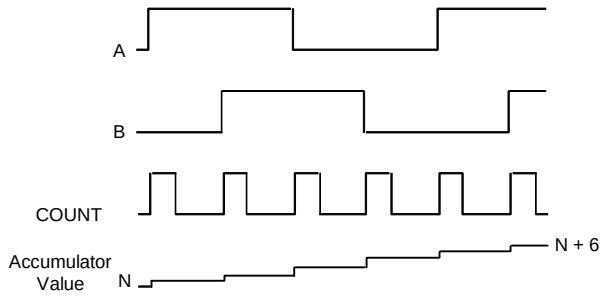
Type B Counter Operation

The primary difference between a type B counter and a type A counter is the way counting is handled to generate a change to the Accumulator. A type A counter simply counts input pulses and increments or decrements the Accumulator. A type B counter uses two input signals for A-Quad-B counting.

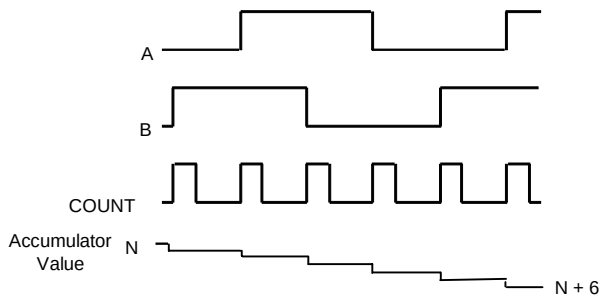
A-Quad-B Counting

If a counter is configured for A-Quad-B counting, a count occurs for *each transition* of *either A or B*. There are four counts for each A-Quad-B cycle. Counts are evenly spaced with respect to the input waveforms when the phase relationship between A and B is shifted by 1/4 cycle. The phase relationship between A and B determines count direction, as shown below.

The count direction is up if A leads B.



The count direction is down if A lags B.



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Type B Counter Overview

As shown in Figure 6-2, the Micro PLC's B-type counter has a Preload/Strobe input (I6), two Count Pulse inputs, and one output with On/Off Presets (Q1). The type B counter has a Strobe Register, a 16-bit Accumulator, and a Counts-per-Timebase Register. The maximum count rate is 5 KHz.

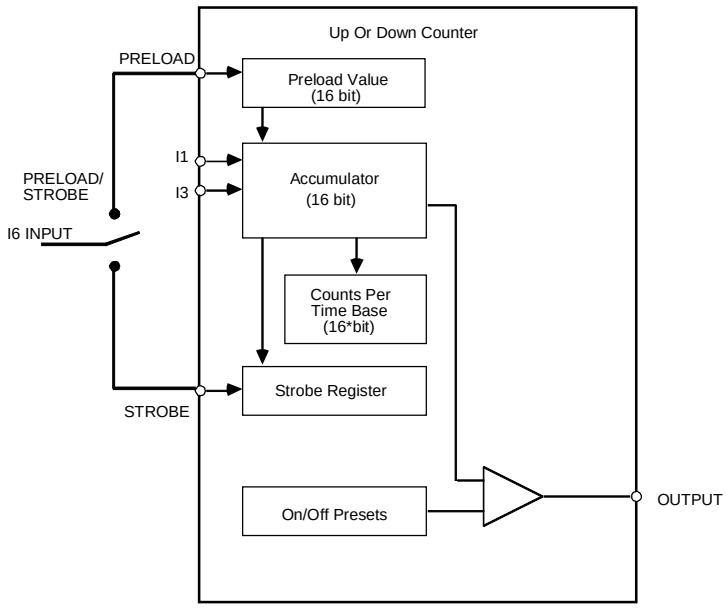


Figure 6-2. Type B Counter Block Diagram

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Type B Operating Parameters

The following paragraphs describe how the operating parameters affect the operation of a B-type counter. (The following parameters have no effect on the operation of a B-type counter even though they can be changed in the configuration software screens: Count Mode, Count Edge, and Count Direction.)

For details on configuring the parameters, refer to "Configuration," which begins on page 6-20.

Counter Enable/Disable

When disabled, the HSC is inactive and the output associated with the counter is available to the user program. When enabled, the HSC is active and its output is dependent on the Output Enable parameter. (This parameter must be set by the Logicmaster 90 software or the HHP; it cannot be changed by a COMM_REQ.)

Counter Output Enable/Disable

When disabled, the HSC output is available to the user program. When enabled, the output is reserved for the HSC and can not be controlled by the user program. (This parameter must be set by the Logicmaster 90 software or the HHP; it cannot be changed by a COMM_REQ.)

Preload/Strobe

If preload is selected, the configured Preload Value will be loaded into the Accumulator when the Preload/Strobe signal is active. If Strobe is selected, the Accumulator value is placed in the strobe register when the Preload/Strobe signal is active. (This parameter must be set by the Logicmaster 90 software or the HHP; it cannot be changed by a COMM_REQ.)

Count Mode

This parameter applies to only to A-type counters and is ignored for the B-type counter. The B-type counter always counts in *continuous mode*. The Accumulator wraps when the *n+1* (or *n-1*) count is reached and continues counting. For example, if the Hi Limit is *n*, the Accumulator will wrap to the Lo Limit when it reaches *n+1*. When the counter is at the limit, counts in the opposite direction will count it back off the limit.

Note

If *n* is the desired number of pulses to be counted, you must configure the counter so that high limit = *n–1* for up-counting, or low limit = *n+1* for down-counting.

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Strobe Edge

Each Strobe input on the module can be individually configured to have either the positive or the negative edge active. By default, they are positive-edge sensitive. (This parameter must be set by the Logicmaster 90 software or the HHP; it cannot be changed by a COMM_REQ.)

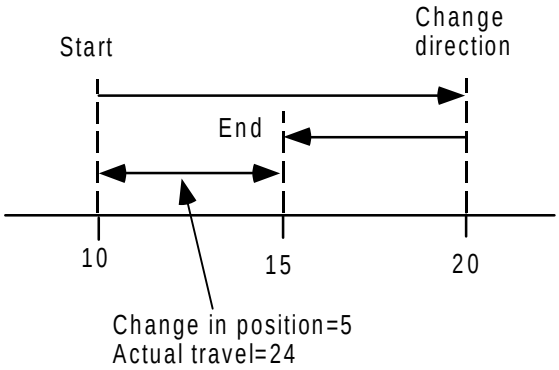
Positive (default) A count occurs on a positive-to-negative transition.

Negative A count occurs on a negative-to-positive transition.

Counter Time Base

A timebase from 10 msec to 65535 msec can be selected. The counter timebase is set to 1 second (1000 msec) by default. The module stores the number of counts that occurred during the last-completed timebase interval in the Counts/Timebase register. Up counts are positive (+) and down counts are negative (-). The range of the Counts/Timebase register is –32768 and +32767 counts. The timebase value selected should not allow the Counts/Timebase register to overflow at the maximum count frequency. If it does, the sign of the Counts/Timebase will change from (+) to (–) or (–) to (+).

For a B-type counter, the counts per timebase value represents the relative shift over the sample time, not the exact number of counts. This value indicates a relative change in position. For example, if the counter starts at 10, counts up to 20, and then counts back to 15, the resulting counts per timebase is 5.



Count Limits

Each counter can be assigned upper and lower count limits. All Accumulator preload values and output on/off preset values must lie within these limits. Both the Hi and Lo limits can be positive, or both can be negative, but the high limit is always greater than the low limit.

When setting the limits using the COMM_REQ function, the Hi Limit must be greater than or equal to Lo Limit, On Preset, Off Preset, Preload, and current Accumulator value. The Lo Limit must be less than or equal to Hi Limit, On Preset, Off Preset, Preload, and current Accumulator value. (The Logicmaster 90 configuration software and the HHP will not allow you to set incompatible limits.)

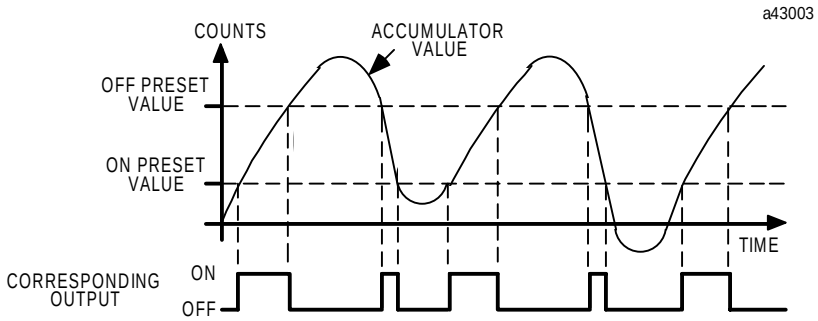
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If a COMM_REQ sets new limits that are incompatible, they will be rejected and the old limits retained. In this case a counter limit error code will be returned. To avoid this situation when the limits are changed one at a time, a good rule to follow is: always move the high limit first when shifting the limits up and always move the low limit first when shifting them down.

The limit range for both Type A and Type B counters is –32,768 to +32,767.

Output Preset Points

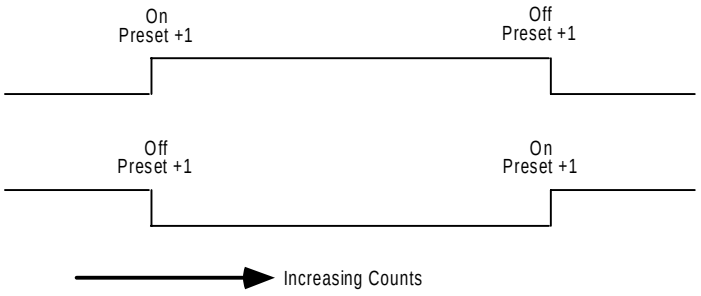
Each counter output has a preset ON and OFF point which must be located between the Hi and Lo limits. The output state indicates when the Accumulator value is between the ON and OFF preset points. For example:



If the output is enabled for the HSC channel being used, the output will turn on in accordance with the following table:

Preset closest to low limit	Output ON	Output OFF
ON	> ON Preset < = OFF Preset	> OFF Preset < = ON Preset
OFF	< = OFF Preset > ON Preset	< = ON Preset > OFF Preset

As the following example shows, the output can be either on or off when the Accumulator value lies between the Preset points. The output takes the value of the On or Off preset after the Accumulator has gone through the preset point (*n+1* when counting up and *n-1* when counting down).



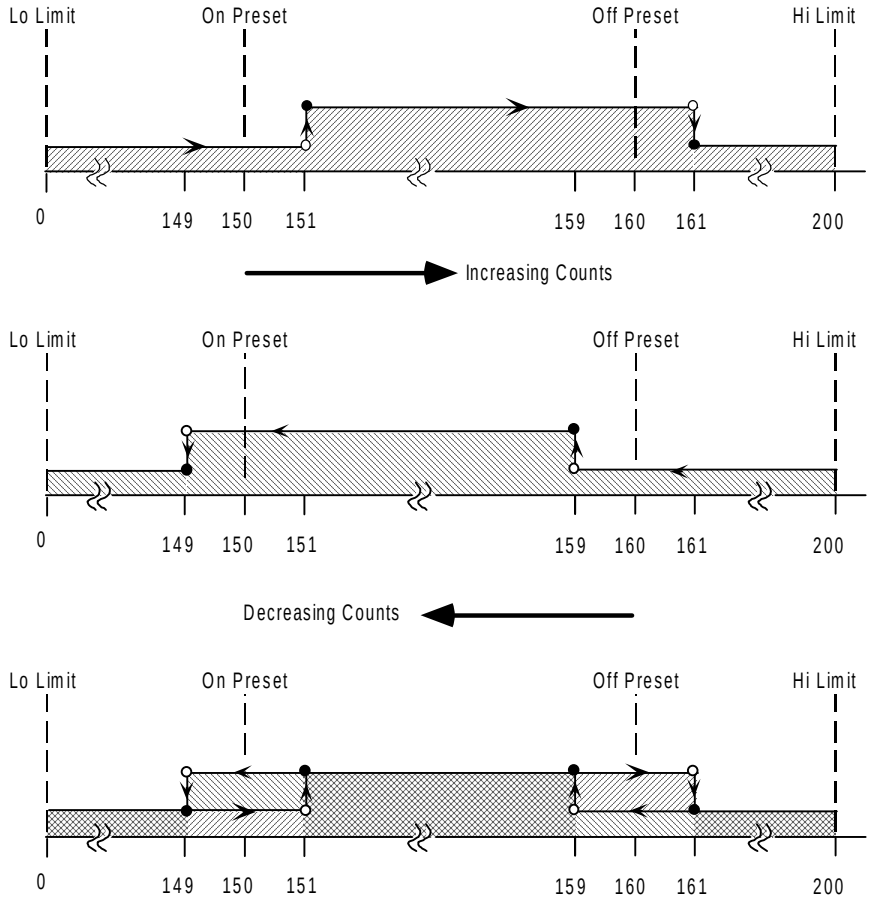
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Note

You should be aware that the output does not change states at the same points when the Accumulator is increasing as it does when it is decreasing (see the figures below). The *exception* to this is when the Preload input activates (as when a COMM_REQ within the program changes the Accumulator); in this case the waveform will change state at the preset point instead of at 1 past the preset.

Example for B-type counter: Lo Limit = 0 Hi Limit = 200

On Preset = 150 Off Preset = 160



Preload Value

For each counter, you can specify a starting count value that will be used when the Preload input is activated. This value must be located between the Hi and Lo limits. The Accumulator is initialized to the Preload value on a STOP to RUN transition. (The default value is 0.)

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Configuration

Note

When the Micro PLC changes from STOP to RUN mode, the configurations for HSC, PWM, and Pulse outputs are sent to the HSC from the CPU. This has the net result of stopping the currently running counters, reconfiguring all counters to the current CPU configurations, and restarting them according to the new configuration.

When the Series 90 Micro PLC first powers up, it has default values for all the HSC parameters. To meet the requirements of most applications, the HSCs will have to be configured before they can be used.

Configuration of the HSC can be accomplished in three ways:

- Using the configuration function in the Logicmaster 90-30/20/Micro software package (page 6-24).
- Using the Series 90-30 Hand-Held Programmer (screens are shown beginning on page 6-27).
- Sending data using the COMM_REQ command in ladder logic programs (see page 6-34). If configuration is to be done using a COMM_REQ, the counters must first be enabled in the HHP or Logicmaster 90 software configuration.

Tables 6-4 through 6-6 list the configuration parameters for the HSC function and the abbreviations for those parameters as they are displayed on the Hand-Held Programmer and in the Logicmaster 90 screens. For details on how these parameters control operation of A-type counters, refer to page 6-9; for B-type counters, refer to page 6-16.

Table 6-4. Parameters Common to A and B-type Counter Configurations

Parameter	Logicmaster 90 Abbreviation	HHP Screen	HHP Abbreviation	Value 1	Value 2	Value 3	Default
Counter Type	Ctr Types	1	CNTR TYPE	ALL A	B1–3/A4	–	ALL A
Output Failure Mode	Failure Mde	2	FAIL MODE	NORMAL	FRCOFF	HOLD	NORMAL

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Table 6-5. Abbreviations for ALL A-type Counter Configuration

Parameter	Logicmaster 90 Abbreviation	HHP Screen No.	HHP Abbreviation	Value 1	Value 2	Default
Counter 1 Enable/Disable	Count Enabl	3	CTR1	ENABLE	DISABLE	DISABLE
Counter 1 Output Enable/Disable	Out Enable	4	CTR1 OUT	ENABLE	DISABLE	DISABLE
Counter 1 Direction	Count Dir	5	CTR1 DIR	UP	DOWN	UP
Counter 1 Mode	Count Mode	6	CTR1 MODE	CONT	1 SHOT	CONT
Counter 1 Preload/Strobe selection	Pld/strobe	7	CTR1	PRELOAD	STROBE	PRELOAD
Counter 1 Strobe Edge	Strobe Edge	8	STB EDGE1	POS	NEG	POS
Counter 1 Count Edge	Count Edge	9	CNT1 EDGE	POS	NEG	POS
Time Base 1	Time Base	10	TIME BS 1	–	–	1000mS
High Limit 1	Hi Limit	11	HI LIM 1	–	–	+32767
Low Limit 1	Lo Limit	12	LO LIM 1	–	–	0
ON Preset 1	On Preset	13	ON PST 1	–	–	+32767
OFF Preset 1	Off Preset	14	OFF PST1	–	–	0
Preload 1	Pld Value	15	PRELD 1	–	–	0
Counter 1 PWM Output Enable/Disable*	PWM Out %Q1	16	PWMOUT1	ENABLE	DISABLE	DISABLE
Counter 1 Pulse Output Enable/Disable*	Pul Out %Q1	17	PULSEOUT1	ENABLE	DISABLE	DISABLE
Counter Signal	Count Sig	–	–	NONE	–	–
Counter 2 Enable/Disable	Count Enabl	18	CTR2	ENABLE	DISABLE	DISABLE
Counter 2 Output Enable/Disable	Out Enable	19	CTR2 OUT	ENABLE	DISABLE	DISABLE
Counter 2 Direction	Count Dir	20	CTR2 DIR	UP	DOWN	UP
Counter 2 Mode	Count Mode	21	CTR2 MODE	CONT	1 SHOT	CONT
Counter 2 Preload/Strobe selection	Pld/strobe	22	CTR2	PRELOAD	STROBE	PRELOAD
Counter 2 Strobe Edge	Strobe Edge	23	STB EDGE2	POS	NEG	POS
Counter 2 Count Edge	Count Edge	24	CNT2 EDGE	POS	NEG	POS
Time Base 2	Time Bas	25	TIME BS 2	–	–	1000mS
High Limit 2	Hi Limit	26	HI LIM 2	–	–	+32767
Low Limit 2	Lo Limit	27	LO LIM 2	–	–	0
ON Preset 2	On Preset	28	ON PST 2	–	–	+32767
OFF Preset 2	Pld Value	29	OFF PST2	–	–	0
Preload 2	Pld Value	30	PRELD 2	–	–	0
Counter Signal	Count Sig	–	–	NONE	–	–

*These parameters apply only to Micro PLCs that have a DC output (IC693UDR005/010 and UAL006).

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Table 6-5. Abbreviations for ALL A-type Counter Configuration - Continued

Parameter	Logicmaster 90 Abbreviation	HHP Screen	HHP Abbreviation	Value 1	Value 2	Default
Counter 3 Enable/Disable	Count Enabl	31	CTR3	ENABLE	DISABLE	DISABLE
Counter 3 Output Enable/Disable	Out Enable	32	CTR3 OUT	ENABLE	DISABLE	DISABLE
Counter 3 Direction	Count Dir	33	CTR3 DIR	UP	DOWN	UP
Counter 3 Mode	Count Mode	34	CTR3 MODE	CONT	1 SHOT	CONT
Counter 3 Preload/Strobe selection	Pld/strobe	35	CTR3	PRELOAD	STROBE	PRELOAD
Counter 3 Strobe Edge	Strobe Edge	36	STB EDGE3	POS	NEG	POS
Counter 3 Count Edge	Count Edge	37	CNT3 EDGE	POS	NEG	POS
Time Base 3	Time Bas	38	TIME BS 3	–	–	1000mS
High Limit 3	Hi Limit	39	HI LIM 3	–	–	+32767
Low Limit 3	Lo Limit	40	LO LIM 3	–	–	0
ON Preset 3	On Preset	41	ON PST 3	–	–	+32767
OFF Preset 3	Off Preset	42	OFF PST3	–	–	0
Preload 3	Pld Value	43	PRELD 3	–	–	0
Counter Signal	Count Sig	–	–	NONE	–	–
Counter 4 Enable/Disable	Count Enabl	44	CTR4	ENABLE	DISABLE	DISABLE
Counter 4 Output Enable/Disable	Out Enable	45	CTR4 OUT	ENABLE	DISABLE	DISABLE
Counter 4 Direction	Count Dir	46	CTR4 DIR	UP	DOWN	UP
Counter 4 Mode	Count Mode	47	CTR4 MODE	CONT	1 SHOT	CONT
Counter 4 Preload/Strobe selection	Pld/strobe	48	CTR4	PRELOAD	STROBE	PRELOAD
Counter 4 Strobe Edge	Strobe Edge	49	STB EDGE4	POS	NEG	POS
Counter 4 Count Edge	Count Edge	50	CNT4 EDGE	POS	NEG	POS
Time Base 4	Time Bas	51	TIME BS 4	–	–	1000
High Limit 4	Hi Limit	52	HI LIM 4	–	–	+32767
Low Limit 4	Lo Limit	53	LO LIM 4	–	–	0
ON Preset 4	On Preset	54	ON PST 4	–	–	+32767
OFF Preset 4	Off Preset	55	OFF PST4	–	–	0
Preload 4	Pld Value	56	PRELD 4	–	–	0
Counter Signal	Count Sig	–	–	NONE	–	–

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Table 6-6. Abbreviations for B1–3/A4 Counter Configuration

Parameter	Logicmaster 90 Abbreviation	HHP Screen	HHP Abbreviation	Value 1	Value 2	Default
Counter 1 Enable/Disable	Count Enabl	3	CTR1	ENABLE	DISABLE	DISABLE
Counter 1 Output Enable/Disable	Out Enable	4	CTR1 OUT	ENABLE	DISABLE	DISABLE
Counter 1 Direction*	Count Dir	5	CTR1 DIR	N/A	N/A	UP
Counter 1 Mode*	Count Mode	6	CTR1 MODE	CONT	1 SHOT	CONT
Counter 1 Preload/Strobe selection	Pld/strobe	7	CTR1	PRELOAD	STROBE	PRELOAD
Counter 1 Strobe Edge	Strobe Edge	8	STB EDGE1	POS	NEG	POS
Counter 1 Count Edge*	Count Edge	9	CNT1 EDGE	POS	NEG	POS
Time Base 1	Time Base	10	TIME BS 1	–	–	1000mS
High Limit 1	Hi Limit	11	HI LIM 1	–	–	+32767
Low Limit 1	Lo Limit	12	LO LIM 1	–	–	0
ON Preset 1	On Preset	13	ON PST 1	–	–	+32767
OFF Preset 1	Off Preset	14	OFF PST1	–	–	0
Preload 1	Pld Value	15	PRELD 1	–	–	0
Counter 1 PWM Output Enable/Disable**	PWM Out %Q1	16	PWMOUT1	ENABLE	DISABLE	DISABLE
Counter 1 Pulse Output Enable/Disable**	Pul Out %Q1	17	PULSEOUT1	ENABLE	DISABLE	DISABLE
Counter Signal	Count Sig	–	–	A-QUAD-B	–	–
Counter 4 Enable/Disable	Count Enabl	18	CTR4	ENABLE	DISABLE	DISABLE
Counter 4 Output Enable/Disable	Out Enable	19	CTR4 OUT	ENABLE	DISABLE	DISABLE
Counter 4 Direction	Count Dir	20	CTR4 DIR	UP	DOWN	UP
Counter 4 Mode	Count Mode	21	CTR4 MODE	CONT	1 SHOT	CONT
Counter 4 Preload/Strobe selection	Pld/strobe	22	CTR4	PRELOAD	STROBE	PRELOAD
Counter 4 Strobe Edge	Strobe Edge	23	STB EDGE4	POS	NEG	POS
Counter 4 Count Edge	Count Edge	24	CNT4 EDGE	POS	NEG	POS
Time Base 4	Time Base	25	TIME BS 4	–	–	1000
High Limit 4	Hi Limit	26	HI LIM 4	–	–	+32767
Low Limit 4	Lo Limit	27	LO LIM 4	–	–	0
ON Preset 4	On Preset	28	ON PST 4	–	–	+32767
OFF Preset 4	Off Preset	29	OFF PST4	–	–	0
Preload 4	Pld Value	30	PRELD 4	–	–	0
Counter Signal	Count Sig	–	–	NONE	–	–

*Count Direction, Count Mode, and Count Edge are ignored for the type B counter.

**PWM and Pulse Output parameters apply only to DC IN/DC OUT Micro PLCs and are not available when the B1–3, A4 mode is selected.

Note

Counter 1 is an A-QUAD-B counter and counter 4 is an A type counter.

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Logicmaster 90 Software

The HSC parameters are shown in the following configuration screens.

Refer to the *Logicmaster 90-30/20/Micro Programming Software User's Manual*, GFK-0466, for details on the use of the configuration software.

I/O Scanner and Counter Type Configuration

The first HSC screen, shown below, displays the counter types, failure mode, and I/O configuration.

Counter types. The counter function can operate with four type A counters (A4), or with one type B counter and one type A counter (B1-3, A4).

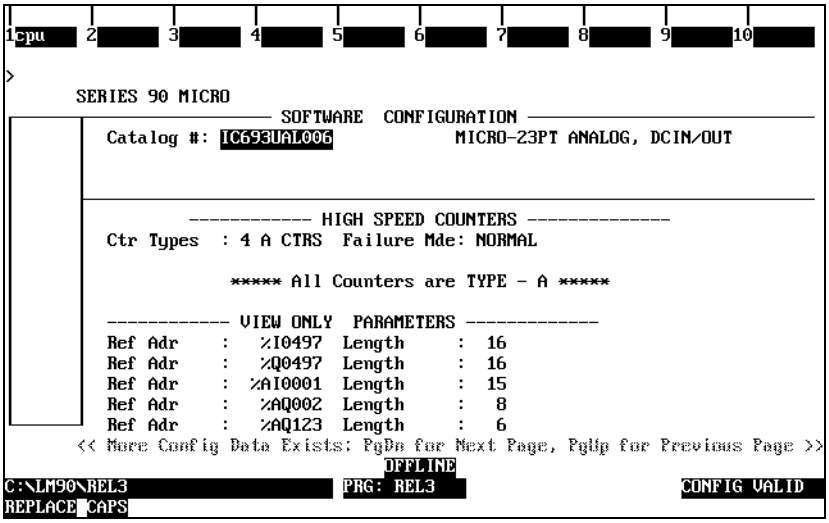
Failure mode. This parameter selects the state the outputs will assume when the PLC transitions from RUN to STOP mode. These responses remain in effect until the Micro PLC returns to the RUN mode.

NORMAL (default setting): The inputs will continue to be processed and the outputs will continue to operate under control of the counters. If Normal is selected, the transition from RUN to STOP mode has no effect on counter outputs.

FRCOFF: All outputs will be forced off. The counters will continue to operate but will not change the state of the outputs.

HOLD: The HSCs retain the last state of the output points before the PLC stopped. The counters will continue to operate but will not change the state of the outputs.

The **I/O configuration** (View Only Parameters) cannot be modified.



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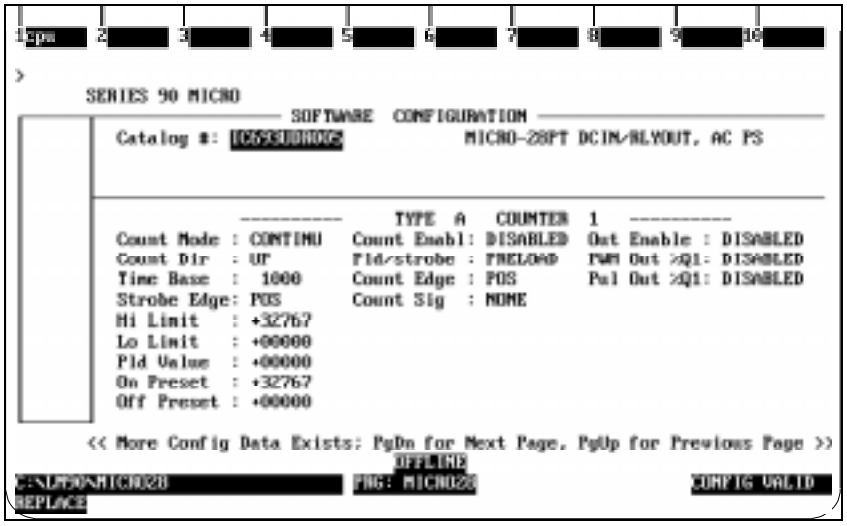
Counter-specific Configuration

Examples of configuration screens for a type A counter and a type B counter are provided in this section. For details on how these parameters control operation of A-type counters, refer to page 6-9; for B-type counters, refer to page 6-16.

Type A Counter

Type A counters 1–4 are all configured in the same way, with the exception of Counter 1 in models that have Pulse and PWM output (IC693UDR005/010 and IC693UAL006).

The following screen presents the parameters for a type A Counter 1 in a Micro PLC that has Pulse and PWM output. Configuration for counters in other relay-output Micro PLCs is the same except for these two outputs.

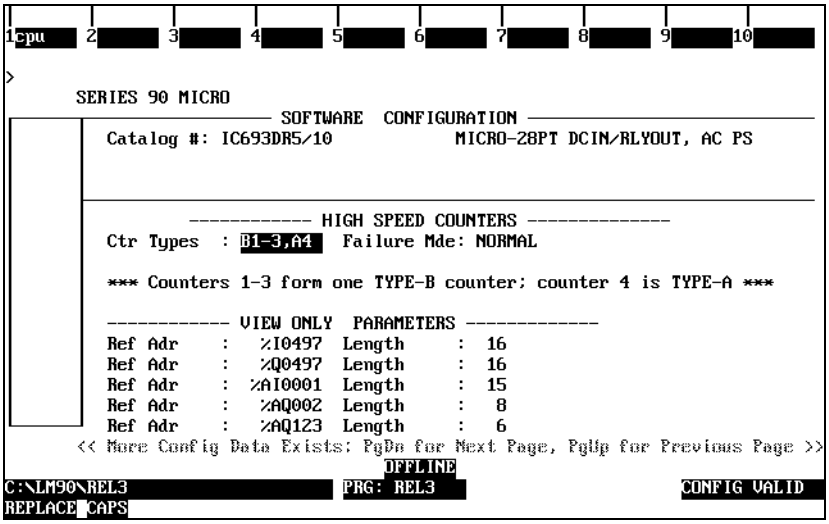


To proceed to the screen for the next counter, press the **PGDN** key.

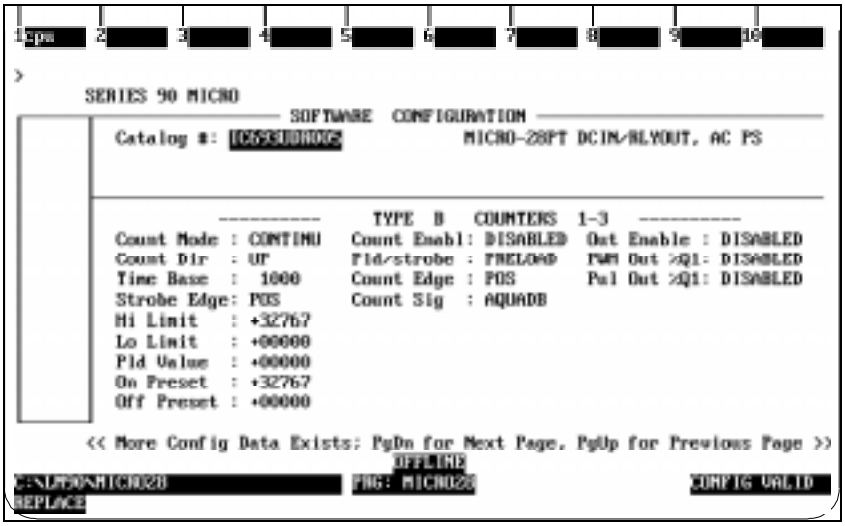
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Type B Counter

In the following screen, the B1–3, A4 counter configuration is selected. (In the B1–3, A4 configuration, counters 1–3 form a single type B counter.)



The following screen presents the configuration parameters for the type B counter. (On DC-output Micro PLCs, Pulse and PWM outputs are not available when the type B counter is configured.) Refer to Table 6-6 for parameter definitions. For details on how these parameters control operation of B-type counters, refer to page 6-16.



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Hand-Held Programmer

If you have just configured the Series 90 Micro PLC parameters using the Hand-Held Programmer (see Chapter 5) all you need to do is press the ↓ key to go to the slot assigned to HSC. For details on how these parameters control operation of A-type counters, refer to page 6-9; for B-type counters, refer to page 6-16.

Note: The Series 90 Micro PLC functions are assigned to rack and slot locations corresponding to those in the Series 90-30 PLCs. The Series 90 Micro PLC system is always in rack 0, and its HSC functions are in slot 4.

Configuration Screens Common to A4 and B1-3A4 Configurations

The following series of screens shows the parameters common to both counter types in the HSC. Press the ± key to toggle the screen display, then press the ENT key to record the value. If you change your mind about a parameter, press the CLR key instead of ENT to recall the original value. To get to the next screen in the series, press the → key. To back up to previous parameters (screens), press the ← key. (Screen numbers correspond to numbers listed in Tables 6-4 through 6-6.)

Screen 1 - Counter Type



Press the ± key to select the type of counter, then press the ENT key. The CLR key (before ENT is pressed) will cancel the operation.

Screen 2 - Output Default/Module Failure Mode



This screen selects the state that the outputs assume if the PLC goes to STOP mode.

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A4 Counter Specific Screens

The following screens will be displayed when **ALL A** is selected in Screen 1.

Screens 3, 18, 31, 44 - Counter Enable

These screens enable or disable the specified counter. Each counter enabled will use certain portions of PLC reference memory and PLC input and output resources. If CTR1 is set to ENABLE, screens 4–15 will appear (or 19–30 for counter number 2, 32–43 for counter number 3, and 45–56 for counter number 4).

```
R0:04 HSC          <S
CTRx :DISABLE
```

Screens 4, 19, 32, 45 - Count Output Enable

Note

If the configured Series 90 Micro PLC is a DC IN/DC OUT type, this screen will only appear for Counter 1 if the PWM OUTx option and the PULSE OUTx option for the same channel are disabled (see screens 16 and 17 on page 6-30).

This series of four screens is used to set the counter output enable.

```
R0:04 HSC          <S
CTRx OUT:ENABLE
```

Screens 5, 20, 33, 46 - Count Direction

These screens are used to set the count direction for each counter.

```
R0:04 HSC          <S
CTRx DIR:UP
```

Screens 6, 21, 34, 47 - Count Mode

These screens specify the Count Mode: continuous or one-shot.

```
R0:04 HSC          <S
CTRx MODE:CONT
```

Screens 7, 22, 35, 48 - Counter Strobe/Preload Selection

This series of screens is used to select PRELOAD or STROBE operation for Counters 1–4.

```
R0:04 HSC          <S
CTRx :PRELOAD
```


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Screens 8, 23, 36, 49 - Strobe Edge

These screens configure the Preload/Strobe edge to trigger on a positive or negative-going signal.



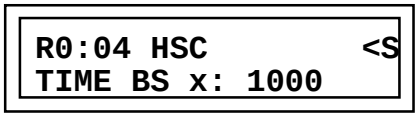
Screens 9, 24, 37, 50 - Count Edge

These screens configure the counter input edge to trigger on a positive or negative-going signal.



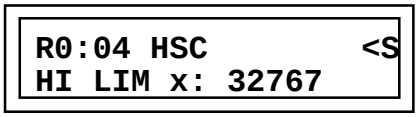
Screens 10, 25, 38, 51 - Time Base Value

These screens allow you to enter the time base to be used in the Counts Per Time Base calculation. The default is 1000 milliseconds (1 second). To change the time base, use the numeric keys on the HHP to select the value, then press the **ENT** key to record the value.



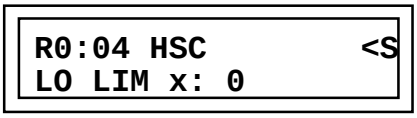
Screens 11, 26, 39, 52 - High Limit

These screens are used to specify the highest (most positive) value the count Accumulator can reach. The default is 32767, which is the maximum value the counters can handle. As with the time base, use the HHP numeric keys to change the value, then press the **ENT** key to record it. Pressing **CLR** instead of **ENT** cancels the entry.



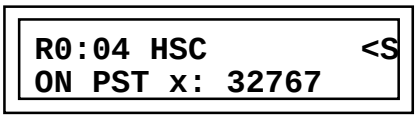
Screens 12, 27, 40, 53 - Low Limit

These screens specify the lowest (most negative) value for the Count Accumulator.



Screens 13, 28, 41, 54 - ON Preset Value

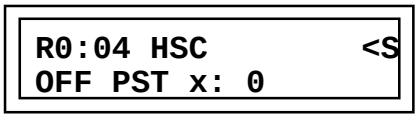
When the counter Accumulator exceeds this value (depending also on the value of the OFF preset) the associated output is turned on (depending on the state, either enabled or disabled, of the output control flags in the %Q data word). For details, see “Output Preset Points” on page 6-18.



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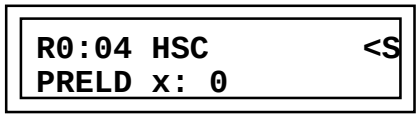
Screens 14, 29, 42, 55 - OFF Preset Value

When the counter Accumulator exceeds this value, the associated output is turned off.



Screens 15, 30, 43, 56 - Preload Value

This parameter specifies the value that will be loaded into the Accumulator when the associated PRELOAD input on the terminal strip is asserted. It is also the value loaded to the Accumulator on a STOP to RUN transition.



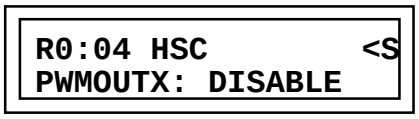
The following two screens will be seen only for Micro PLCs that have DC output (IC693UDR005/010 and UAL006).

Note

The PWM Out and PULSE OUT options are available only on counter channel 1. For additional details, see "Configuring DC Outputs" in Chapter 5.

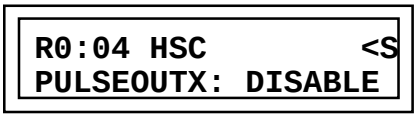
Screen 16 - PWM Output

This option can only be enabled if the CTRx option and the PULSE OUTx option for channel 1 are disabled. This screen selects PWM as the counter output.



Screen 17 - Pulse Output

This option can only be enabled if the CTRx option and the PWM OUTx option for channel 1 are disabled. This screen selects a pulse train as the counter output.



Note

When the Micro PLC changes from STOP to RUN mode, the configurations for HSC, PWM, and Pulse outputs are sent to the HSC from the CPU. This has the net result of stopping the currently running counters, reconfiguring all counters to the current CPU configurations, and restarting them according to the new configuration.

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Type B Counter Specific Screens

The following screens are specific to B1-3/A4 counters and are displayed when B1-3, A4 is selected as the counter type in Screen 1. In this configuration, counter 1 is the A-Quad-B and counter 4 is the A-type counter.

Screens 3, 18 - Count Enable

This series of two screens enables or disables a specified counter. This means that each counter enabled will use certain portions of PLC reference memory and PLC input and output resources. Only one set of the two screens is shown here. All of the other counters are configured in the same manner, except that the counter number is different. Note that if CTR1 is set to ENABLE screens 4–15 will appear (or 19–30 for counter number 4).



Screens 4, 19 - Count Output Enable

This series of three screens is used to set the counter output enable.



Screens 5, 20 - Count Direction

This parameter has no effect on the operation of the B-type counter and is ignored.



Screens 6, 21 - Count Mode

This parameter has no effect on the operation of the B-type counter and is ignored.



Screens 7, 22 - Counter Strobe/Preload Selection

This series of screens is used to select PRELOAD or STROBE operation for the counters.





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Screens 8, 23 - Strobe Edge

These screens configure the Preload/Strobe input edge to trigger on a positive or negative-going signal.

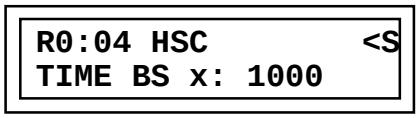
Screens 9, 24 - Count Edge

Although this parameter can be configured for a type B counter (screen 9), it is ignored because every transition causes a count in A-QUAD-B counting.



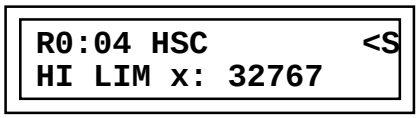
Screens 10, 25 - Time Base Value

These screens allow you to enter the time base that is used in the Counts Per Time Base calculation. The default is 1000 milliseconds (1 second). To change the time base, select the value using the numeric keys on the Hand-Held Programmer, and then press the ENT key to record the value.



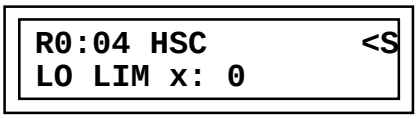
Screens 11, 26 - High Limit

These screens are used to specify the highest (most positive) value of the Count Accumulator. The default is 32767, which is the maximum value the counters can handle. As with the timebase, use the Hand-Held Programmer numeric keys to change the value, then press the ENT key to record it. Pressing CLR instead of ENT cancels the entry.



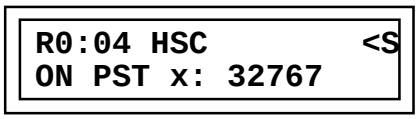
Screens 12, 27 - Low Limit

These screens specify the lowest (most negative) value for the Count Accumulator.



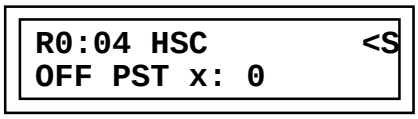
Screens 13, 28 - ON Preset Value

When the counter Accumulator exceeds this value (depending also on the value of the OFF preset) the associated output is turned on (depending on the state, either enabled or disabled, of the output control flags in the %Q data word). For details, see “Output Preset Points” on page 6-18.



Screens 14, 29 - OFF Preset Value

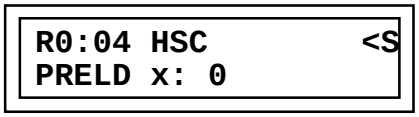
When the Accumulator exceeds this value (dependent also on the state of the ON Preset), the associated output is turned off.



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Screens 15, 30 - Preload Value

This parameter specifies the value that will be loaded into the Accumulator when the associated PRELOAD input on the terminal strip is asserted. It is also the value loaded to the Accumulator on a STOP to RUN transition.



Note

The PWM Out and PULSE OUT outputs are not available when the B1–3, A4 counter configuration is selected.

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COMM_REQ Function

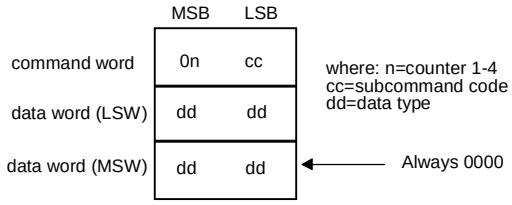
In addition to the %Q discrete output data that is sent every sweep to the HSC, commands can be sent by the CPU (using the COMM_REQ function block) to change some of the operating parameters of the counters. These commands are all 6 bytes in length.

The PLC ladder program sends Data Commands using the COMM_REQ (Communication Request) function. The COMM_REQ requires that all its command data be placed in the correct order (in a *command block*) in the CPU memory before it is executed. It should then be executed by a one-shot coil to prevent sending the data to the HSC multiple times.

The COMM_REQ function is effective only on counters that are enabled.

Command Block

The format for Data Commands is as follows:



The command block used to send Data Commands is composed of 13 words arranged as shown in Table 6-7 (all values in hexadecimal unless otherwise indicated). Use the Block Move (BLKMV) function to move these values to the Register tables (see the *Series 90™-30/20/Micro Programmable Controllers Reference Manual*, GFK-0467, for information on using the BLKMV and COMM_REQ functions).

Table 6-7. Command Block for Data Commands

Location	Data	Description
%R0001	0004	Always 0004 for this HSC application
%R0002	don't care	Not used (Always zero) Micro PLC ignores the WAIT flag for all COMM_REQ functions.
%R0003	don't care	Not used
%R0004	don't care	Not used
%R0005	don't care	Not used
%R0006	don't care	Not used
%R0007	don't care	Not used
%R0008	don't care	Not used
%R0009	0008	Data type (8 = registers)
%R0010	000A	Start location of Command word–1 (%R0011)
%R0011	nnnn	Command word (See Table 6-8, Table 6-9)
%R0012	nnnn	LS data word
%R0013	nnnn	MS data word *not used by Micro PLC*

*The command block can be placed in any word-oriented area of memory that is not reserved.

Table 6-8 lists the Data Command words for type A counters. Table 6-9 lists the Data Command words for type B counters. Following the tables are descriptions of each command.

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Table 6-8. Data Commands – Type A Counter

Command Name	Command Word (Hexadecimal)
Load Accumulator n	0n 01
Load Hi Limit n	0n 02
Load Lo Limit n	0n 03
Load Acc n Increment	0n 04
Set Cntr n Direction	0n 05
Load Timebase n	0n 06
Load ON Preset n	0n 0B
Load OFF Preset n	0n 15
Load Preload n	0n 1F
*n = Counter #1–4 The bytes in the command word are always treated as independent bytes, consisting of a counter ID byte and a command code byte.	

Note

Command words can be entered in decimal format. For example,

Load Accumulator	02 01 (hex.) or 513 (decimal)
Load Hi Limit	02 02 (hex) or 514 (decimal)
Load Lo Limit	02 03 (hex) or 515 (decimal)

Load Accumulator	Command Code = 01H Used to set any value within counter limits directly into the Accumulator. Example: To set Counter 3 to 1234H, load COMM_REQ command registers with: Command word: 0301 LS data word: 1234
Load Hi Limit	Command Code = 02H
Load Lo Limit	Command Code = 03H Used to set the Hi and Lo limits to any value within the counter range. Example: To change the upper limit of counter 4 to 10000 (2710H), load registers with: Command word: 0402 LS data word: 2710 Note: If the limits are loaded in the wrong order, they could be rejected and cause an error flag to be set. To avoid this, remember to always move the Lo Limit first when shifting the limits down or the Hi Limit first when shifting the limits up. Also, if the new value of the Hi/Lo limit is out of range with the current Accumulator value, the load operation will be rejected. It is only successful if all parameters, including the current Accumulator value, are within the new Hi/Lo range.

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Load Acc Increment	Command Code = 04H Used to offset a counter Accumulator by a small number of counts (up to +127 or –128). Only the least significant byte of data is used with this command. Example: To offset counter 3 by –7 counts, load: Command word: 0304 LS data word: 00F9 This can be done at any time, even while the counter is counting at maximum rate. If the offset causes the counter to exceed its limits, this parameter will be rejected. If a count is received at the same time the CPU updates the Accumulator value, the count will be lost.
Set Cntr Direction	Command Code = 05H Used to change the count direction (up or down) of a type A counter. Only the LSB of the first data word is used for this command (00 = up, 01 = down). Example: To set the direction of counter 4 to down, load: Command word: 0405 LS data word: 0001
Load Timebase	Command Code = 06H Used to change the time interval referenced by the counter when computing its counts/timebase register data. Example: To change the timebase for counter 2 to 600 ms (258H), load: Command word: 0206 LS data word: 0258 Note: The maximum range of the counts/timebase (CTB) register is +32767 and –32768 counts. The length of the timebase and the maximum count frequency should be coordinated so that these limits are not exceeded. The indication will roll over from (+) to (–) or (–) to (+) if exceeded.
Load ON Preset	Command Code = 0BH
Load OFF Preset	Command Code = 15H Used to set up the output turn on/off points within the counter range. There is one output associated with each counter. Example: To set counter 3 output to turn on at 5000 (1388H) counts, load: Command Code: 030B LS data word: 1388 and off at 12000 (2EE0H) counts, load: Command Code: 0315 LS data word: 2EE0
Load Preload	Command Code = 1FH Used to change the count value that will be loaded into the counter Accumulator when the Preload input is activated. Example: To make counter 2 start at 2500 (09C4H) counts at its preload signal, load: Command word: 021F LS data word: 09C4

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Table 6-9. Data Commands – Type B Counter

Command Name	Command Word (Hexadecimal)
Load Accumulator n	0n 01
Load Hi Limit n	0n 02
Load Lo Limit n	0n 03
Load Acc n Increment	0n 04
Load Timebase n	0n 06
Load ON Preset n	0n 0B
Load OFF Preset n	0n 15
Load Preload n	0n 1F
Note: n = Counter #1 or 4 (only counter 1 is B-type) The bytes in the command word are always treated as independent bytes – a counter ID byte and a command code byte.	

Note

Command words can be entered in decimal format. For example:

Load Counter 1 Accumulator	01 01 (hex.) or 1025 (decimal)
Load Counter 1 Hi Limit	01 02 (hex) or 1026 (decimal)
Load Counter 1 Lo Limit	01 03 (hex) or 1027 (decimal)

Load Accumulator	Command Code = 01H Used to set any value within counter limits directly into the Accumulator. (If a count is received at the same time the CPU updates the Accumulator value, the count will be lost. This happens because the CPU must read the Accumulator, increment it, and write back to it, during which time received counts are ignored.) Example: To set Counter 1 to 2211H, load COMM_REQ command registers with: Command word: 0101 LS data word: 2211
Load Hi Limit	Command Code = 02H
Load Lo Limit	Command Code = 03H Used to set the Hi and Lo limits to any value within the counter range. Example: To change the upper limit of counter 1 to 1690 (4240H), load registers with: Command word: 0103 LS data word: 4240 Note: If the limits are loaded in the wrong order, they could be rejected and cause an error flag to be set. To avoid this, remember to always move the Lo Limit first when shifting the limits down or the Hi Limit first when shifting the limits up. Also, if the new value of the Hi/Lo limit is out of range with the current Accumulator value, the load operation will be rejected. It is only successful if all parameters, including the current Accumulator Value, are within the new Hi/Lo range.
Load Acc Increment	Command Code = 04H Used to offset a counter Accumulator by a small number of counts (up to +127 or –128). Example: To offset counter 1 by 9 counts, load: Command word: 0104 LS data word: 0009 This can be done at any time, even while the counter is counting at maximum rate. If the offset causes the counter to exceed its limits, this parameter will be rejected. If a count is received at the same time the CPU updates the Accumulator value, the count will be lost.

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Load Timebase	Command Code = 06H Used to change the time interval referenced by the counter when computing its counts/timebase register data. Example: To change the timebase for counter 1 to 600 ms (258H), load: Command word: 0106 LS data word: 0258 Note: The maximum range of the counts/timebase (CTB) register is +32767 and –32768 counts. The length of the timebase and the maximum count frequency should be coordinated so that these limits are not exceeded. The indication will roll over from (+) to (–) or (–) to (+) if exceeded.
Load ON Preset	Command Code = 0BH
Load OFF Preset	Command Code = 15H Used to set up the output turn on/off points within the counter range. Example: To set counter 1 output to turn on at 5000 (1388H) counts, load: Command word: 010B LS data word: 1388 and off at 12000 (2EE0H) counts, load: Command word: 0115 LS data word: 2EE0
Load Preload	Command Code = 1FH Used to change the count value that will be loaded into the counter Accumulator when the preload input is activated. Example: To make counter 1 start at 9632 (25A0H) counts at its preload signal, load: Command word: 011F LS data word: 25A0

Example

The COMM_REQ function is conditionally executed in the ladder logic to communicate a request to the HSC. A sample ladder diagram for configuring the HSC function is provided in Figure 6-3. In this example, the Accumulator for Counter 3 is loaded with 1234.

Rung 4 uses a one-shot coil (%T0002) to execute the COMM_REQ once. This prevents multiple messages from being sent.

Rung 5 contains the Block Move Word function and is used to load the commands, which are listed in Tables 6- 8 and 6-9. In this example, %R0101 through %R0114 are used for the COMM_REQ command block. (Any registers can be used except for %R1617 through %R1814, which are reserved.)

The COMM_REQ function, executed in Rung 6, has four inputs and one output.

Parameter	Description
enable	%T0002 is used to enable the COMM_REQ function.
IN	Points to the starting address of the command block, which is %R0101.
SYSID	Indicates which rack and slot to send the message to (physical location of HSC module). The SYSID is always 0004 for the HSCs in the Series 90 Micro PLC.
TASK	This parameter is ignored during HSC communications and should be set to zero.
FT	This output is energized if an error is detected during processing of the COMM_REQ.

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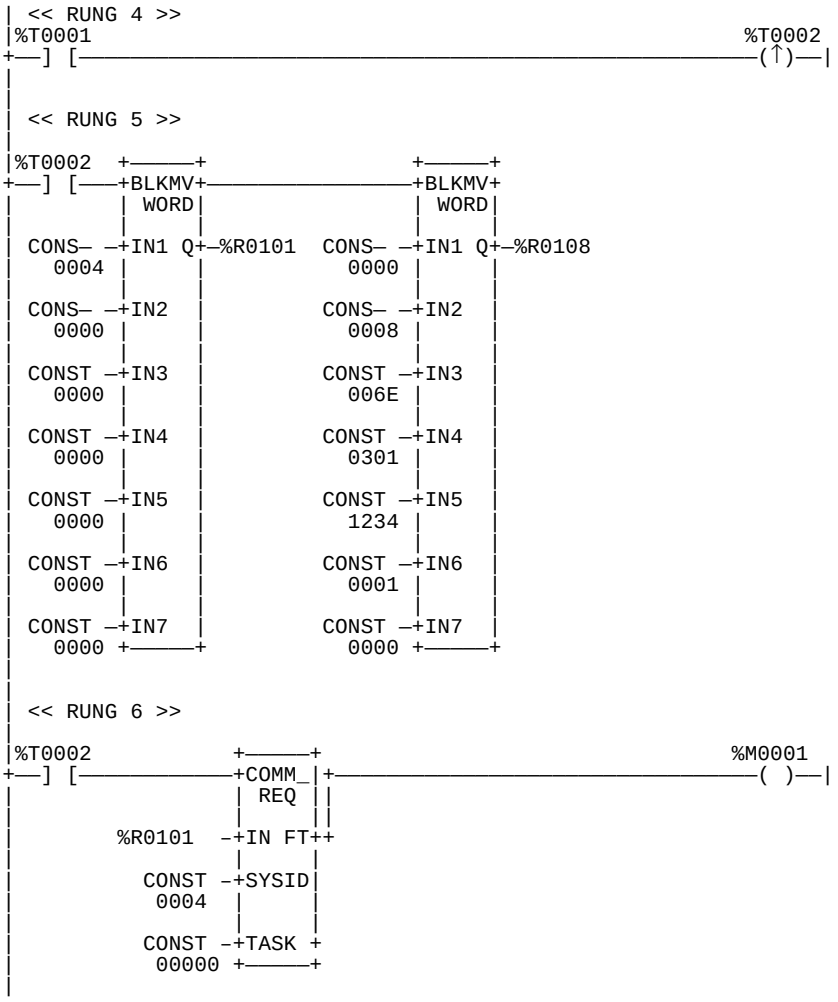


Figure 6-3. Ladder Logic Example for Setting a High Speed Counter Parameter

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Application Examples–RPM Indicator

An RPM indicator is a typical application for a type A HSC.

Feature used: Counts/Timebase Register

The HSC can be used as a position/motion indicator when connected to a feedback device (such as an encoder) that is coupled to a rotary motion. RPM indication can be obtained directly from the counter's Counts/Timebase register (CTB) or derived from it by a simple calculation.

RPM is calculated by:

$$RPM = \frac{CTB}{PPR \times T}$$

where: CTB = counts/timebase reading from the counter
PPR = pulses/revolution produced by the feedback device
T = timebase expressed in minutes

Note that if the pulses/revolution is some integer power of 10, then setting the timebase for 6, 60, 600, 6000, or 60,000 will yield a direct reading of RPM in the CTB register with an assumed decimal placement.

Example 1

If feedback produces 1000 pulses/revolution, CTB reading = 5210, and the timebase is configured for 600ms: then T = 600ms / 60000ms/min = .01 and 1/T = 100

$$RPM = \frac{5210}{1000} \times 100 = 521$$

CTB reading is RPM with .1 RPM resolution.

Example 2

Assume the same conditions as example 1, except the timebase is now set to 60ms, which gives T = 60/60000 = .0001 and 1/T = 1000.

Because the rotation is at the same speed as in example 1, the CTB reading now equals 521 and

$$RPM = \frac{521}{1000} \times 1000 = 521$$

CTB reading is now RPM with 1 RPM resolution.

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Application Example — Input Capture

The HSC strobe inputs can act as *pulse catch inputs* for inputs 2, 4, 6, and 8, by using the Strobe Status bits as a latch.

To use this feature:

1. Configure the Micro PLC to use the HSC function with Strobe input.
2. Enable A-type counter(s). (Any or all of the counters can be enabled.)
   - The corresponding Strobe Status bit will be latched if there is a pulse of at least 100 µsec in width.
   - The Reset Strobe bits can be used as clear functions for the latched status bits.

Example: To capture pulses on input I2, enable Counter 1 and configure **strobe** for the Pld/strobe parameter (see "Configuration" in this chapter). You can also configure **POS** (positive) or **NEG** (negative) for the Strobe Edge parameter.

The Strobe Status bit (%I498) will be latched if there is a 100 microsecond or longer pulse on I2. To clear this bit, the logic program should write a 1, followed by a 0, to the corresponding output to the HSC (%Q498).

(For other inputs, see "Status Bits (%I)" on page 6-5.)

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Chapter 7 Analog I/O

The 23-point Micro PLC (IC693UAL006) features two analog input channels and an output channel, which can be configured in voltage or current mode. The analog I/O function can be configured by the Logicmaster 90 configuration software or by the HHP.

The following topics are discussed in this chapter:

- Overview
- Configuration
- Calibration

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Overview

The two input analog channels use a 10-bit successive-approximation A/D converter. The Micro PLC firmware translates counts from two input channels of the A/D converter into values that are stored in %AI0018 and %AI0019 (Figure 7-1).

As a part of the analog input scan, the firmware calculates the %AI register value using the following formula:

$$\%AI = (A/D\ count\ X\ Gain) + Offset$$

where *Gain* and *Offset* are internally calibrated values (refer to page 7-Calibration for information about calibration).

Any calculated value exceeding 32,767 is clamped at that maximum value. Any calculated value less than 0 will be clamped at 0.

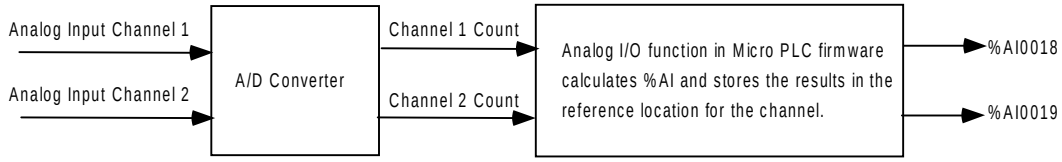


Figure 7-1. Analog Input Channel

To generate the analog output, the value in %AQ0012 is translated into a count value for the D/A converter, which drives the analog output (Figure 7-2). Table 7-1 lists the ranges of values in the PLC analog register and the corresponding quantities on the analog I/O point.

As part of the analog output scan, the firmware will calculate the D/A value using the following formula:

$$D/A\ count = (\%AQ\ X\ Gain) + Offset$$

where *Gain* and *Offset* are internally calibrated values.

Any calculated value that exceeds 4095 will be clamped at that maximum value. Any calculated value less than 0 will be clamped at 0.

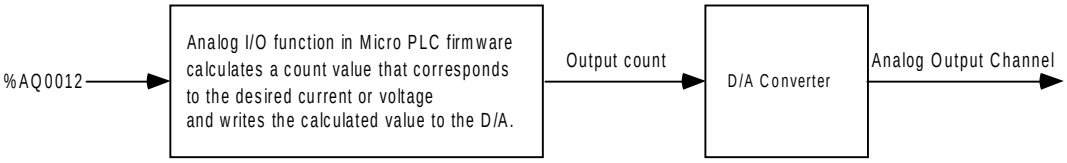


Figure 7-2. Analog Output Channel

Table 7-1 shows the relationship between the analog register value and the actual value on the input or output for each mode. Table 7-2 summarizes the performance characteristics of the analog I/O function. (Refer to “Specifications” in Chapter 2 for general module specifications.) For details of the input and output interface circuitry, refer to “Analog Inputs” and “Analog Outputs” in Chapter 4. For field wiring information and diagram, refer to “General Wiring Procedures” in Chapter 4.

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Table 7-1. Relationship of Register Values to Analog Values*

Mode	Analog Value on Input or Output Point	Register Value in %AQ or %AI	Resolution/Bit	User Counts/Bit
Voltage 0—10V	0 to 10,000mV	0 to 32000	10mV/bit	32
Current 0—20mA	0 to 20,000µA	0 to 32000	40µA/bit	64
Current 4—20mA	4 to 20,000µA	0 to 32000	40µA/bit	64

Mode	Formula
Voltage 0—10V	Register Value = 3.2 x mV
Current 0—20mA	Register Value = 1.6 x µA
Current 4—20mA	Register Value = 2 x µA -8000

*Based on factory-loaded offset and gain.

Example: If the analog input function is configured for Current 4—20mA mode, a 7.5mA current on input, IN1, will result in a value of 7,500µA x 2 -8000 = 14,992 in %AI0018.

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Table 7-2. Analog I/O Specifications

Analog Input Channels	2, differential
Input ranges	0 to 10V (10.24V max.) 0 to 20mA (20.5mA max.) 4 to 20 mA (20.5mA max.)
Calibration	Factory calibrated to 0.313mV per count on 0 to 10V range 0.625µA per count on 0 to 20mA and 4 to 20 mA ranges
Resolution: 0 to 10 V range 0 to 20 mA range 4 to 20 mA range	10 bits (1 LSB=10mV) 9 bits (1 LSB=40µA) 8+ bits (1 LSB=40µA)
Accuracy	1% of full scale over full operating temperature range
Linearity	±3 LSB maximum
Isolation	non-isolated
Common mode voltage	±200 V maximum
Current input impedance	250 ohms
Voltage input impedance	800 Kohms
Input filter time	20.2ms to reach 1% error for step input
Analog Output Channel	1, single-ended, non isolated
Output ranges	0 to 10V (10.24V maximum) 0 to 20mA (20.5mA maximum) 4 to 20mA (20.5mA maximum)
Resolution	12 bits over 0 to 10V range 12 bits over 0 to 20mA range 11+ bits over 4 to 20mA range
Accuracy	±1% of full scale over full operating temperature range (0°C to 55°C)
Current: maximum compliance voltage, at 20mA user load range output load capacitance output load inductance	10V 0 to 500 ohms 2000 pF maximum 1 henry maximum
Voltage: output loading output load capacitance	2 Kohm minimum at 10 volts 1 µF maximum

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Configuration

The analog I/O function can be configured using the Logicmaster 90 configuration software or the HHP.

Table 7-3. Configuration Parameters for Analog I/O

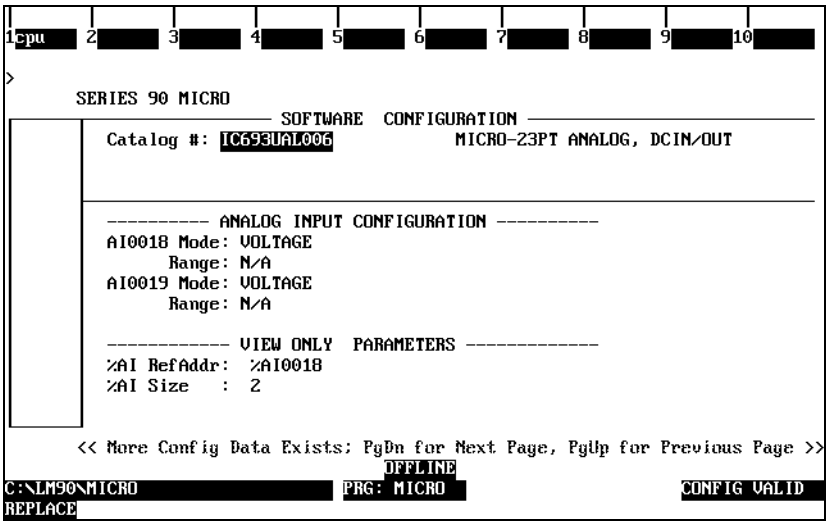
Parameter	Description	Possible Values	Default Value
ANALOG INPUT CONFIGURATION			
AI0018 Mode	Voltage or current mode	VOLTAGE CURRENT	VOLTAGE
Range	Current range selection	4–20mA 0–20mA	4–20mA
AI0019 Mode	Voltage or current mode	VOLTAGE CURRENT	VOLTAGE
Range	Current range selection	4–20mA 0–20mA	4–20mA
%AI Ref Addr	Analog input reference **not editable**	%AI0018	%AI0018
%AI Size	Analog input size **not editable**	2	2
ANALOG OUTPUT CONFIGURATION			
AQ0012 Mode	Voltage or current mode	VOLTAGE CURRENT	VOLTAGE
Range	Current range selection	4–20mA 0–20mA	4–20mA
%AQRef Addr	Analog output reference **not editable**	%AQ0012	%AQ0012
%AQ Size	Analog output size **not editable**	1	1

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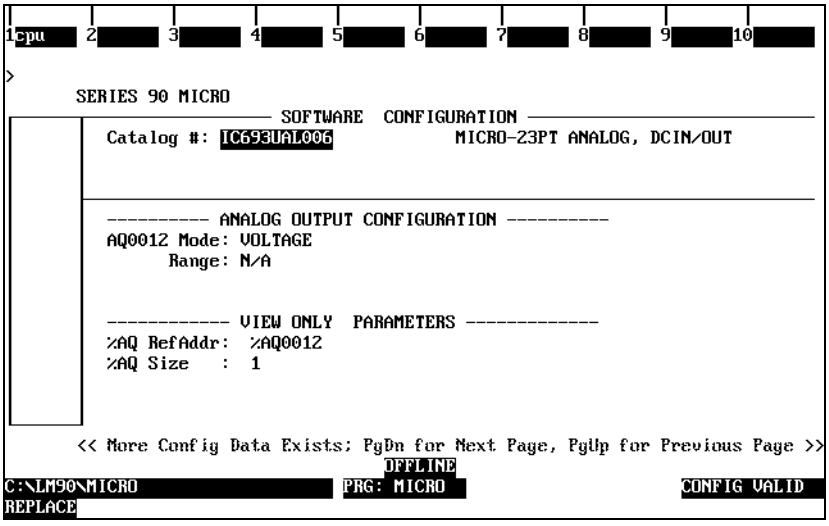
Logicmaster 90 Screens

The screens for configuring the Analog I/O function follow the High Speed Counter configuration screens in the Logicmaster 90 software. (Press the **PAGE DOWN** key to access the Analog I/O configuration screens.)

Analog Input



Analog Output



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HHP Screens

The initial screen for configuring the Analog I/O function follows the HSC screens. For general information on using the HHP, see "Configuration and Programming Using the HHP" in Chapter 5.

1. Press the ↓ key until the configuration for analog input channel screen appears as follows:

```
R0:05 AI      <S
AI2:AI018-AI019
```

2. Press the → key . The following channel 1 mode screen will appear:

```
R0:05 AI      <S
Ch1Mode: voltage
```

3. Press ± to select channel 1 current mode, then press the **ENT** key to accept the change. The following screen will appear:

```
R0:05 AI      <S
Ch1Mode: current
```

4. Press the → key to access the following channel 1 range screen:

```
R0:05 AI      <S
Ch1Range: 4-20mA
```

5. Press the ± key to select the 0–20mA range, then press the **ENT** key to accept the change:

```
R0:05 AI      <S
Ch1Range: 0-20mA
```

6. Press the → key to access the following channel 2 mode screen:

```
R0:05 AI      <S
Ch2Mode: voltage
```

7. Press the ± key to select channel 2 current mode, then press the **ENT** key to accept changes:

```
R0:05 AI      <S
Ch2Mode: current
```

8. Press the → key to access the following channel 2 range screen:

```
R0:05 AI      <S
Ch2Range: 4-20mA
```


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9. Press the ± key to select 0–20mA range and then press the **ENT** key to accept the change:

```
R0:05 AI      <S
Ch2Range: 0-20mA
```

10. Press the ↓ key to go to configuration for the analog output channel, which appears as follows:

```
R0:06 AQ      <S
AQ1:AQ012
```

11. Press the → key to go to the channel 1 mode screen:

```
R0:06 AQ      <S
Ch1Mode: voltage
```

12. Press the ± key to select channel 1 current mode, then press the **ENT** key to accept the change:

```
R0:06 AQ      <S
Ch1Mode: current
```

13. Press the → key to access the following channel 1 range screen:

```
R0:06 AQ      <S
Ch1Range: 4-20mA
```

14. Press the ± key to select the 0–20mA range and then press the **ENT** key to accept the change:

```
R0:06 AQ      <S
Ch1Range: 0-20mA
```


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Calibration

Note

The Analog I/O function is factory calibrated. Under normal circumstances, it should not be necessary to change the calibration. Do not attempt the procedures in this section unless you are familiar with the operation of D/A and A/D converters.

Four calibration values for each analog channel are loaded into the Micro PLC flash memory at the factory: voltage mode gain, voltage mode offset, current mode gain, and current mode offset. These calibration values can be changed through a Service Request (SVCREQ) function. You can calibrate the gain and offset values up to 50 times by following the calibration procedure described in this section. If further calibration is necessary after the allocated number of tries is exhausted, another set of 50 tries can be made available by updating the firmware.

Default Gains and Offsets

A set of default gains and offsets is maintained in the PLC firmware in case you want to restore these values for calibration or for other reasons.

For the input channel, in voltage mode, the %AI range of 0 to 32,000 corresponds to 0 to 1,000 counts of the A/D converter. Therefore, the default input voltage gain is 32 and offset is 0. In current mode, the %AI range of 0 to 500 corresponds to 0 to 32,000 counts, so that default current gain is 64 and offset is 0.

The values for the A/D converter are fixed. In voltage mode, the input channel A/D range of 0 to 1,000 counts corresponds to a 0 to 10,000mV input signal. Therefore, the default input voltage gain is 10 and offset is 0. In current mode, the input channel A/D range of 0 to 500 counts corresponds to a 0 to 20,000µA input signal, for a gain of 40 and an offset of 0.

Input Channel Formula: %AI = (A/D count x Default Gain) + Offset

Table 7-4. Input Channel Gain and Offset

Mode	Fixed Gain Converter/Input Point	Range A/D Converter	Range %AI	Default Gain %AI/Converter	Default Offset
Voltage Mode (0–10,000mV)	10	0 – 1,000 counts	0 – 32,000	32	0
Current Mode (0–20,000µA)	40	0 – 500 counts	0 – 32,000	64	0
Current Mode (4–20,000µA)	40	100 – 500 counts	0 – 32,000	64	0

For the output channel, the D/A range of 0 to 4,000 corresponds to a range of 0 – 32,000 in %AQ, giving a gain of 0.125 and an offset of 0 for both modes.

The values for the D/A converter are fixed. The output channel D/A range of 0 to 4,000 counts corresponds to 0 to 10,000mV in voltage mode and to 0 to 20,000µA in current mode. Therefore, the default output voltage gain is 2.5 and current gain is 5, leaving offsets of 0 for both modes.

Output Channel Formula: D/A count = (%AQ x Default Gain) + Offset

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Table 7-5. Default Output Channel Calibration Values

Mode	Fixed Gain Converter/Output Point	Range D/A Converter	Range %AQ	Default Gain %AQ/Converter	Default Offset
Voltage Mode (0–10,000mV)	2.5	0 – 4,000 counts	0 – 32,000	0.125	0
Current Mode (0–20,000µA)	5	0 – 4,000 counts	0 – 32,000	0.125	0
Current Mode (4000–20,000µA)	5	800 – 4,000 counts	0 – 32,000	0.125	0

Calibration Procedure

To perform the calibration procedures you will need a precision analog meter (1mV voltage accuracy and 1µA current accuracy).

Calibration of Input Channels

For each channel, the procedure consists of the following steps:

1. Apply a reference voltage or current at a low range to the input. (The reference signal must be measured precisely by a precision analog meter.) Record the value.
2. For the channel being calibrated, read the %AI register and record the low value.
3. Apply a reference voltage or current at a high range to the input. Precisely measure the reference signal and record the value.
4. For the channel being calibrated, read the %AI register and record the high value.
5. Store the calculated gain and offset values in RAM or flash memory using a SVCREQ instruction. (See “Storing Calibration Constants.”)

The Micro PLC firmware will automatically calculate the calibration gain and offset using the following formulas:

$$Gain = \frac{Meter_{High} - Meter_{Low}}{\%AI_{High} - \%AI_{Low}} \times DefaultGain$$

$$Offset = Meter_{High} - \frac{\%AI_{High} \times Gain}{DefaultGain}$$

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Calibration of Output Channels

For each channel, the procedure consists of the following steps:

1. Write a low value to the %AQ register.
2. At the output, measure the voltage or current using a precision analog meter and record the value.
3. Write a high value to the %AQ register.
4. At the output, measure the voltage or current using a precision analog meter and record the value.
5. Store the calculated gain and offset values in RAM or flash memory using a SVCREQ instruction. (See “Storing Calibration Constants.”)

The Micro PLC firmware will automatically calculate the calibration gain and offset using the following formulas:

$$Gain = \frac{\%AQ_{High} - \%AQ_{Low}}{Meter_{High} - Meter_{Low}} xDefaultGain$$

$$Offset = \%AQ_{High} \times DefaultGain - Meter_{High} \times Gain$$

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Storing Calibration Constants

The final step of calibrating an analog channel consists of storing the calibration values in flash memory. This step requires the use of two SVCREQ functions:

SVCREQ 34 signals the Micro PLC to enter calibration mode. When SVCREQ 34 is received, the PLC uses default gain and offset so that you can start the calibration process. No parameter block is needed.

SVCREQ 35 performs the calibration. This function requires a parameter block containing the calibration data and control data. Based on these inputs, the PLC computes the gain and offset for each channel and mode specified. When the calibration SVCREQ is successfully completed, the new calibration values will take effect.

The parameter block for SVCREQ 35 contains the 32 input words and 2 output words listed in Table 7-5. After the SVCREQ function executes, the PLC returns the function status and the number of tries available to the 2 output words.

Note

The third parameter in the block, Destination Control (at address +2), determines whether to write the constants in flash or in RAM. You can select the RAM option and calibrate as many times as necessary without burning the calibration constants into the flash memory. When you are satisfied with the calibration, you can select the flash option and finalize the calibration process. When the flash option is selected, the calibration data is copied into RAM as well as burned into flash memory.

It is important to issue a SVCREQ with the flash option selected in the Destination Control parameter field once the desired calibration state is reached. Otherwise, the new calibration values will be lost when the unit is powered off.

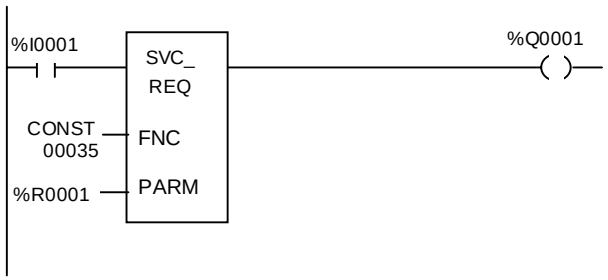
For detailed information on using SVCREQ functions, refer to the *Series 90-30/20/Micro Programmable Controllers Reference Manual*, GFK-0467.

SVCREQ Parameters

enable	When enable is energized, the requested service is performed.
FNC	FNC contains the constant or reference for the requested service. This can be any type of memory except for %S.
PARM	PARM contains the beginning reference for the parameter block for the requested service. This can be any type of word memory (%R, %AI, or %AQ)
ok	The ok output is energized when the function is performed without error.

Example:

In this example, when the enabling input %I0001 is on, SVCREQ function number 35 is called, with the parameter block starting at %R0001. Output coil %Q0001 is set on if the operation succeeds.



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Table 7-6. SVCREQ 35 Parameter Block

Description	Location
Password (“CA” 4143H)	address
Password (“LB” 424CH)	address + 1
Destination Control: 0 for RAM, 1 for flash	address + 2
Select Control AI Ch 1 Vol: 0: last, 1: new, 2: default, 3: factory	address + 3
Input Channel 1 %AI18 High Value, Voltage	address + 4
Input Channel 1 %AI18 Low Value, Voltage	address + 5
Input Channel 1 Meter High Value, Voltage	address + 6
Input Channel 1 Meter Low Value, Voltage	address + 7
Select Control AI Ch 1 Cur: 0: last, 1: new, 2: default, 3: factory	address + 8
Input Channel 1 %AI18 High Value, Current	address + 9
Input Channel 1 %AI18 Low Value, Current	address + 10
Input Channel 1 Meter High Value, Current	address + 11
Input Channel 1 Meter Low Value, Current	address + 12
Select Control AI Ch 2 Vol: 0: last, 1: new, 2: default, 3: factory	address + 13
Input Channel 2 %AI19 High Value, Voltage	address + 14
Input Channel 2 %AI19 Low Value, Voltage	address + 15
Input Channel 2 Meter High Value, Voltage	address + 16
Input Channel 2 Meter Low Value, Voltage	address + 17
Select Control AI Ch 2 Cur: 0: last, 1: new, 2: default, 3: factory	address + 18
Input Channel 2 %AI19 High Value, Current	address + 19
Input Channel 2 %AI19 Low Value, Current	address + 20
Input Channel 2 Meter High Value, Current	address + 21
Input Channel 2 Meter Low Value, Current	address + 22
Select Control AQ Ch 1 Vol: 0: last, 1: new, 2: default, 3: factory	address + 23
Output Channel 1 %AQ12 High Value, Voltage	address + 24
Output Channel 1 %AQ12 Low Value, Voltage	address + 25
Output Channel 1 Meter High Value, Voltage	address + 26
Output Channel 1 Meter Low Value, Voltage	address + 27
Select Control AQ Ch 1 Cur: 0: last, 1: new, 2: default, 3: factory	address + 28
Output Channel 1 %AQ12 High Value, Current	address + 29
Output Channel 1 %AQ12 Low Value, Current	address + 30
Output Channel 1 Meter High Value, Current	address + 31
Output Channel 1 Meter Low Value, Current	address + 32
Status	address + 33
Number of tries available	address + 34

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Notes:

Password Password is set to CALB. No calibration operation will be allowed without the correct password. If an invalid password is provided, the service request will return error 3 in the status word.

Destination Control Determines whether to write the calibration constants in flash memory or in RAM.

Select Control Allows you to calibrate a particular channel in a specific mode. Four choices are allowed for each channel:

0: Last user calibration. The last calibration in flash will be used for the channel and for the mode. (If no user calibration exists, the last factory calibration will be used.)

1: New. The firmware will calculate new gain and offset using the values supplied in the next four words. New calibration value will replace the value in the RAM or flash as determined by the **Destination Control** field.

2: Default. If this option is specified, neither factory nor user calibration value will be used. Default calibration value will be used.

3: Factory. If this option is specified, the last factory calibration value will be used.

Status A status word will be returned by the special service request to notify the user the result of the service request.

1=Complete	4=Not in calibration mode
2=Out of tries	5=Calibration values checksum bad
3=Invalid password	6=Invalid calibration data

Number of Tries Available Because the number of tries is limited per firmware update, the number of tries left will be returned by the service request each time it is performed.

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Chapter 8 System Operation

This chapter describes system operations of the Series 90 Micro PLC. It includes a discussion of the PLC system sweep sequences, the system power-up and power-down sequences, system clocks and timers, system security through password assignment, and the I/O system.

PLC Sweep Summary

The logic program in a PLC executes in a repetitive fashion until stopped by a command from the programmer or by a command from another device, such as a host computer. This repetitive cycle, which includes the sequence of operations necessary to execute a program one time, is called a *sweep*. In addition to executing the logic program, the sweep includes obtaining data from input devices, sending data to output devices, performing internal housekeeping, and servicing the programmer (see Figure 8-1).

The following configuration items affect the Series 90 Micro PLC sweep:

Stop Mode: Stop with I/O Disabled Stop with I/O Enabled

Constant Sweep Mode: Enable/Disable

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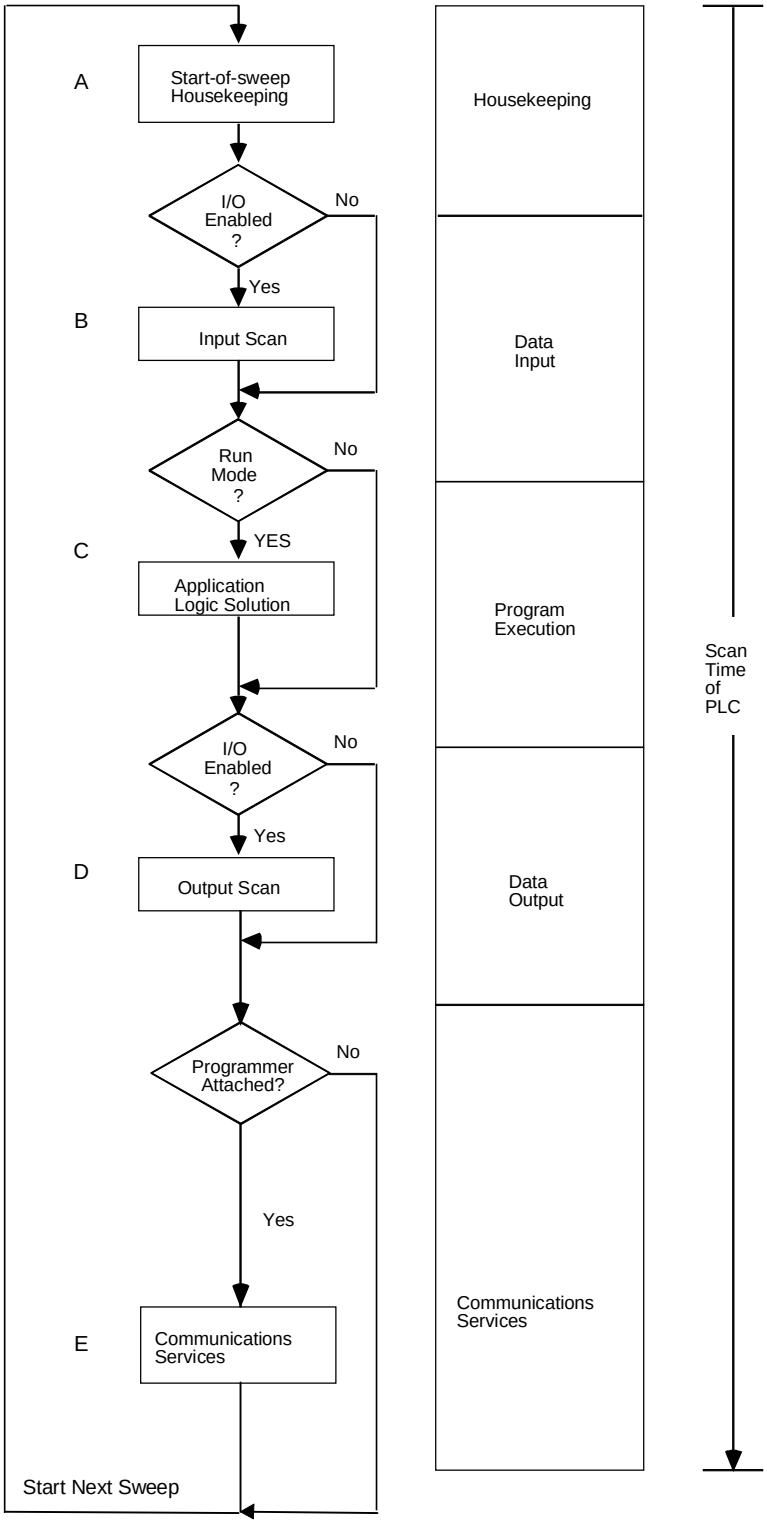


Figure 8-1. PLC Sweep Sequence

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Sweep Time Contribution

Five items contribute to the sweep time of the PLC. The sweep time consists of fixed times (housekeeping and diagnostics) and variable times. The variable times vary according to the I/O configuration, size of the user program, and the type of programming device connected to the PLC.

Table 8-1. Sweep Time Contribution

Sweep Element		Description	Time Contribution (ms)	Time Contribution (ms)
			14-Point	23 and 28-Point
A	Housekeeping	• Schedule start of next sweep • Determine mode of next sweep • Update fault reference tables • Reset watchdog timer	0.368	0.196
B	Data Input	Input data received	On DC-input units, B is increased by an amount determined by the discrete input filter time (see formula below).*	
C	Program Execution	User logic solved	Execution time is dependent on the length of the program and the types of instructions used in the program. Instruction execution times are listed in Appendix A.	
D	Data Output	Output data sent	0.1656	0.121
E	Communications Services	Service requests from programming device	Logicmaster 90: 0.380 HHP: 1.93	Logicmaster 90: 0.095 HHP: 0.333

*B for 14-point Micro PLC $0.365 + 0.036\frac{filtertime \times (A + C + D + E)}{0.5}$

*B for 23 and 28-point Micro PLCs $0.417 + 0.006\frac{filtertime \times (A + C + D + E)}{0.5}$

To determine filter time, see “Discrete Input Filtering” on page 8-16.

Housekeeping

The housekeeping portion of the sweep performs all of the tasks necessary to prepare for the start of the sweep. If the PLC is in the constant sweep mode, the sweep will be delayed until the required sweep time elapses. If the required time has already elapsed, the ***ov_swp*** %SA0002 contact is set and the sweep continues without delay.

Next, the timer values (hundredths, tenths, and seconds) are updated by calculating the difference between the start of the previous sweep and the new sweep time. To maintain accuracy, the actual start of sweep is recorded in 100 microsecond increments. Each timer has a remainder field which contains the number of 100 microsecond ticks that have occurred since the last time the timer value was incremented.

Input Scan

During this part of the sweep, all Series 90 Micro inputs are scanned, from lowest to highest reference address, and their data stored in %I (discrete inputs) or %AI (analog inputs) memory, as appropriate. The %AI1 through %AI15 analog inputs are used by the High Speed Counter. If the CPU is in STOP mode and the **I/OScan-Stop** parameter is configured to **NO**, the input scan will be skipped.

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Program Execution

The application program is executed by the microprocessor on the CPU board. The logic solution always begins with the first instruction in the application program immediately following the completion of the input scan. Solving the logic provides a new set of outputs. The logic solution ends when the END instruction is executed.

The program control capabilities provided by the Control functions are described in the *Series 90-30/20/Micro Programmable Controllers Reference Manual*, GFK-0467, and in the *Hand-Held Programmer User's Manual for Series 90-30/90-20 Programmable Controllers*, GFK-0402. A list of execution times for each programming function can be found in Appendix A.

Output Scan

During the output scan, Micro PLC outputs are scanned from lowest to highest reference address. Outputs are updated using data from the %Q (for discrete outputs) memories. The output scan is completed when all output data has been sent to all Micro PLC outputs.

If the CPU is in STOP mode and the **I/OScan-Stop** parameter is configured to **NO**, the output scan will be skipped and outputs will be cleared.

If the CPU is in STOP mode with I/O scan enabled (**I/OScan-Stop** configured to **YES**), the scan is executed, and the outputs will be updated using data from the %Q memories.

Programmer Service

This part of the sweep is dedicated to communicating with the programmer. If there is a programmer attached, the CPU executes the Programmer Communications Window (Figure 8-2). Support is provided for the HHP and for other programmers that can connect to the serial port and use the Series Ninety Protocol (SNP) protocol.

The CPU performs one operation for the programmer each sweep, that is, it honors one service request or responds to one key press. If the programmer makes a request that requires more than 6 milliseconds to process, the request processing will be spread out over several sweeps so that no sweep is impacted by more than 6 milliseconds.

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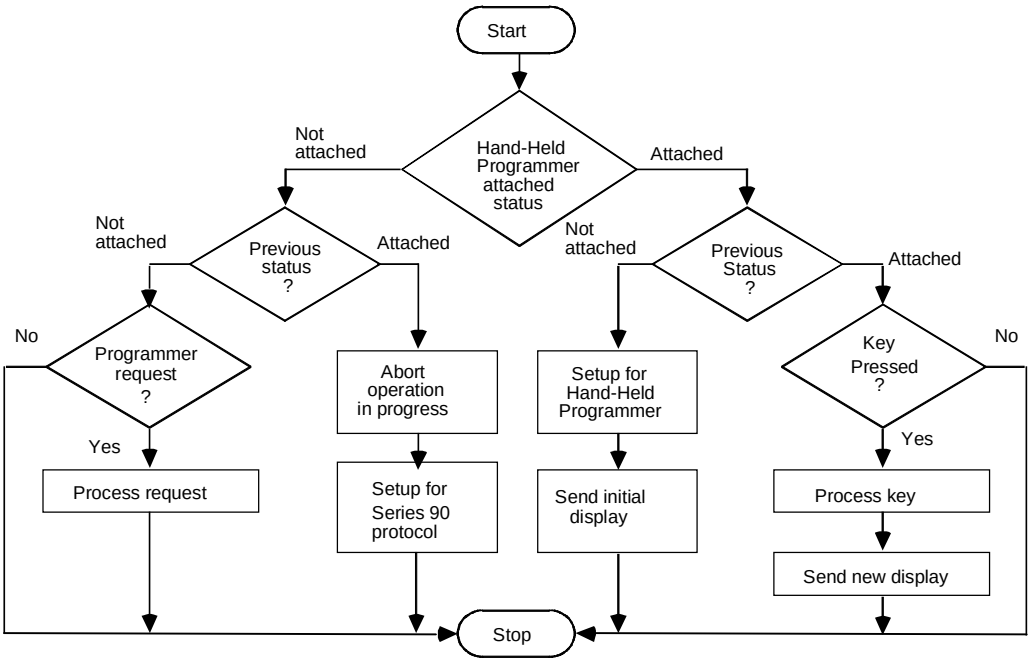


Figure 8-2. Programmer Communications Window Flow Chart

Deviations from the Standard Program Sweep

The user can select certain deviations from the Standard Program Sweep by configuration or by program instructions. These variations are described in the following paragraphs.

Constant Sweep Time Mode

In the Standard Program Sweep, each sweep executes as quickly as possible with a varying amount of time consumed each sweep. An alternative to this is the *Constant Sweep Time* mode. In the Constant Sweep Time mode, each sweep consumes the same amount of time, which can be selected during configuration to be from 5 to 200 milliseconds. For more information on the constant sweep timer, refer to “Clocks and Timers” on page 8-11.

PLC Sweep When in STOP Mode

When the PLC is in STOP mode, the application program is not executed. In this mode, you can choose whether or not the I/O is scanned, and communications with the programmer will continue. For efficiency, the operating system uses larger time-slice values than those that are typically used in RUN mode (usually about 50 ms per window).

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Software Structure

The Series 90 software structure 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 uploading and downloading 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.

Program Structure

Each control program is comprised of a single program block. This includes the user program and some system overhead. The program block must be less than or equal to 3K words (14-point units) or 6K words (23-point and 28 point units).

Data Structure

The Series 90 Micro PLC has nine data memories, each designed for a specific purpose. The following table lists these memories. (For a list of reserved memory addresses, see Appendix B.)

Table 8-2. Memory Data Types

Memory Type	User Reference	Data Type
Discrete Input	%I	bit
Discrete Output	%Q	bit
Discrete User Internals	%M	bit
Discrete Temporaries	%T	bit
Discrete System	%S	bit
Discrete Global	%G	bit
Register	%R	word
Analog Input	%AI	word
Analog Output	%AQ	word

Note: The % symbol is used to distinguish machine references from nicknames and is only used with Logicmaster 90.

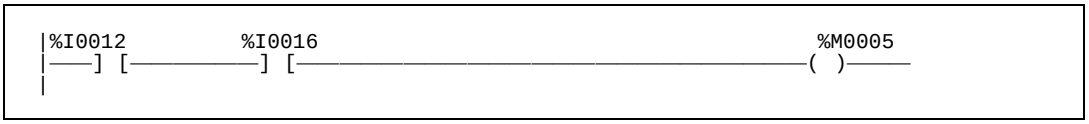
Table 8-3. Discrete Memory Reference Definitions

Type	Definition	Function
%I	Discrete reference input point	The state of the input as detected during the last input scan.
%Q	Discrete reference output point	The state of the output as last set by the application program.
%M	User internal	Internal coil used for boolean logic when the result of a rung is only required to be used later in the program as conditional logic.
%T	Temporary	Internal coil – similar to %M reference except that it is non-retentive.
%S	System discretes (S, SA, SB, SC)	Include system bits used internally by the CPU, fault bits for holding system fault data, and reserved bits for future system expansion.

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Notes for Discrete Memory Definitions

- *Temporary*, %T, references *are not* saved across a power failure; that is, they are non-retentive. %M and %Q memories are *retentive* unless used with a "normal" coil, —( )—, which is non-retentive. Retentive memory is backed up by a super cap (14-point) or lithium battery (23-point and 28-point). For performance specifications for the super cap and battery, see "Specifications" in Chapter 2.
- *User internals* (%M) are useful when the coil in a rung is only required to be used later in the logic solution as conditional logic and not outside the PLC. The following example shows %I0012 and %I0016 being used to set user internal %M0005, similar to the use of a control relay in electromechanical logic.



- *System* discretes (S, SA, SB, SC) include: s*ystem bits*, used internally by the CPU; *fault bits*, for holding system fault data; and *reserved bits*, for future system expansion.

  Many of the fault bits are referenced by the application program to determine what faults exist in the Series 90 Micro PLC system. Examples of these fault contacts are over sweep condition (ov_swp), and low battery (low_bat). The first scan contact (fst_scn) also resides here. Refer to Chapter 9 for more information on Fault bits.
- *Transition bits* are discrete memory locations used internally by the PLC when solving logic that involves transitional coils. This data is not accessible to the user. The PLC sets and resets this transition data based upon changes in the associated status table.

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Powerup and Power-Down Sequence

Powerup Sequence

The powerup sequence for the Micro PLC consists of the following events, as shown in Figure 8-3.

1. The CPU runs self-diagnostics. This includes checking a portion of RAM to determine whether or not the RAM contains valid data. (Powerup diagnostics can be disabled through hardware configuration. It is recommended that you not use this feature unless your application requires unusually rapid powerup. For details, see "Fast Powerup" in the index.)
2. The hardware configuration is compared with the software configuration. Any mismatches detected constitute faults and are alarmed.
3. If there is no software configuration, the CPU will use the default configuration.
4. In the final step of the execution, the mode of the first sweep is determined based on CPU configuration. Figure 8-3 shows the decision sequence followed by the CPU when it decides whether to copy from flash memory or to power-up in STOP or RUN mode. In the figure, text in bold refers to commands entered using the Hand-Held Programmer or the Logicmaster 90 software.

Command	HHP Key Combination
clear	Press **CLR** and **M/T** simultaneously (using HHP)
ld_not	Press **LD** and **NOT** simultaneously (using HHP)
ostop	Press **NOT** and **RUN** simultaneously (using HHP)

Power-Down Conditions

System power-down occurs automatically if the power supply detects that incoming AC power has dropped. The minimum hold time is one half cycle.

Note

During a gradual power down, when the input power supply voltage is below the minimum operating voltage, the Micro PLC may power off and then power on again until the input voltage drops low enough to prevent power on again. You should take precautions if this type of behavior cannot be tolerated in your application.

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Power Cycle

Table 8-4 lists the effects that a power cycle can have on Micro PLC operation under specific conditions.

Table 8-4. Effects of a Power Cycle

Condition	Effects
Micro PLC loses power during a program store operation	Configuration and reference tables will be deleted from flash memory. You will need to restore not only your program, but the configuration and reference tables.
If system includes expansion unit(s):	
Micro PLC base unit loses power before the expansion unit(s)	Expansion units will be reset (all outputs will be set to zero)
Expansion unit(s) lose power before the Micro PLC base unit while Micro PLC is scanning I/O	A *Loss of Expansion Module* fault will be logged.
Micro PLC base unit powers up before the expansion unit(s)	If expansion units do not power up within approximately 3 seconds, a *Loss of Expansion Module* fault will be logged.
Expansion unit(s) power up before the Micro PLC base unit	Expansion unit outputs remain off until the Micro base unit completes powerup and begins scanning I/O.

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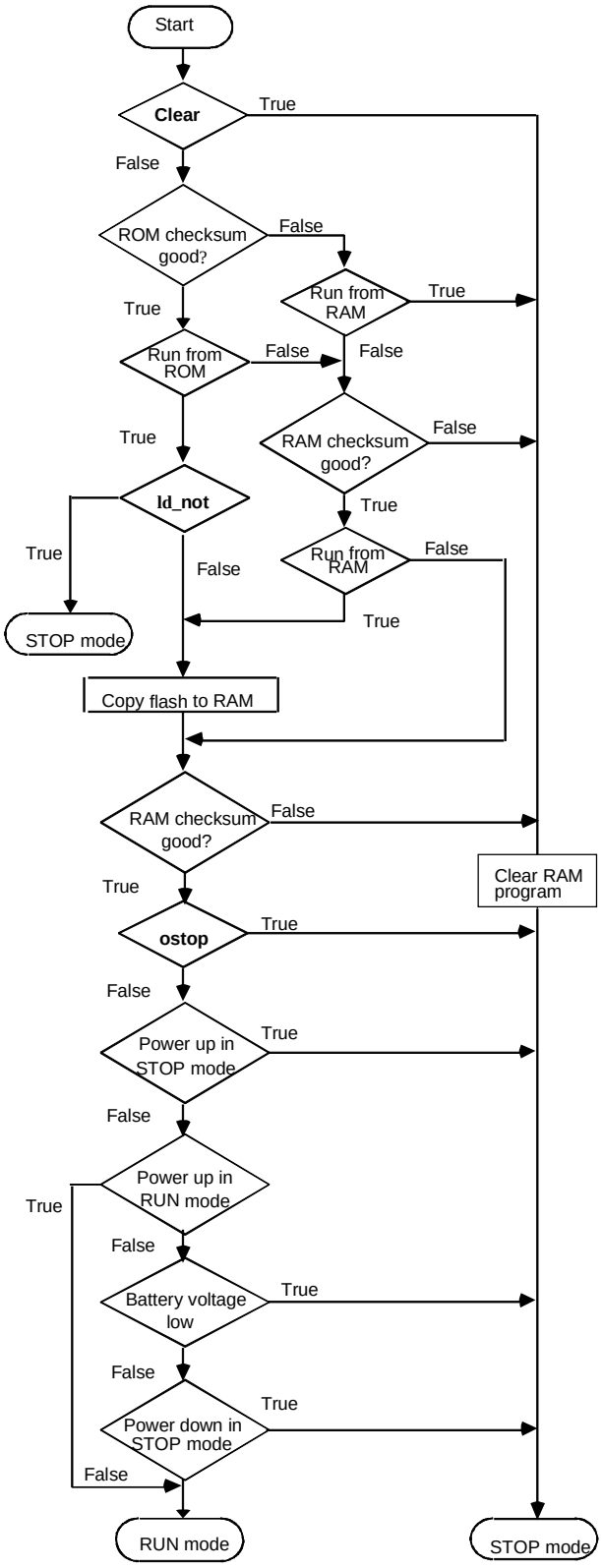


Figure 8-3. Powerup Decision Sequence

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Clocks and Timers

Elapsed Time Clock

The Elapsed Time Clock uses 100-microsecond "ticks" to track the time elapsed since the CPU powered-on. The clock is not retentive across a power failure; it restarts on each power-up. Once per second the hardware interrupts the CPU to enable a seconds count to be recorded. This seconds count rolls over approximately 100 years after the clock begins timing. Because the elapsed time clock provides the base for system software operations and timer function blocks, *it cannot be reset* from the user program or the programmer. However, the application program can read the current value of the elapsed time clock by using Function Number 16 of the SVC_REQ function.

Time of Day Clock (23 and 28-Point Micro PLCs)

This clock maintains the current time and date in 28-point Micro PLCs. These settings can be displayed and changed using the CPU configuration function in the Logicmaster 90 software. You can also use the SVCREQ function number 7 within a Logicmaster 90 program to read and set the time-of-day clock in the Micro PLC. Refer to the *Series 90™-30/20/Micro Programmable Controllers Reference Manual*, GFK-4067, for information on using the SVCREQ instruction.

Watchdog Timer

The Watchdog Timer in the Micro PLC is designed to catch catastrophic failure conditions. The timer value for the Watchdog Timer is 200 milliseconds; this is a fixed value which cannot be changed. The Watchdog Timer starts from zero at the beginning of each sweep. If the Watchdog timeout value is exceeded, the CPU goes through its power-up sequence and the PLC is left in STOP-FAULT mode with a Watchdog Timer fault recorded.

To achieve a watchdog timeout value greater than 200ms, which the Micro PLC requires, the watchdog function is implemented as a two step process. Because the watchdog timer has a maximum timeout of 100ms, the time is first programmed as an interval timer that generates an interrupt after 100ms. If this time elapses, the firmware then programs the timer as a watchdog timer which will reset the microprocessor after an additional 105ms. The second step does not usually occur unless the user program is greater than 100ms. Therefore, if a device holds the wait line before the second step occurs (which only occurs if the user program is greater than 100ms), the microprocessor will hang because it can never service the interrupt service routine that programs the second step of the process.

Constant Sweep Timer

This timer controls the length of a program sweep when the Series 90 Micro PLC operates in Constant Sweep Time mode. In this mode, each sweep consumes the same amount of time. For most application programs, the Input Scan, Application Program Logic Scan, and Output Scan do not require exactly the same amount of execution time in each sweep. The value of the Constant Sweep Timer is set by the programmer and can be any value from 5 to 200 milliseconds. The default value is 100 ms.

If the Constant Sweep Timer expires before the completion of the sweep, and the previous sweep was not complete, the PLC places an over-sweep alarm in the PLC Fault table. At the beginning of the next sweep, the PLC sets the ov_swp fault contact. This contact is reset when the PLC *is not* in Constant Sweep Time mode or if the last sweep did not exceed the Constant Sweep Timer.

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Timer Function Blocks

The Micro PLC supports two types of timer function blocks in the Logicmaster 90 software: an on-delay timer, and a start-reset timer.

Timed Contacts

Four timed contacts, each of which cycles on and off for a specified interval, are available in the Logicmaster 90 software: 0.01 second, 0.1 second, 1 second, and 1 minute.

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System Security

Overview

Security in the Series 90 Micro PLC is designed to restrict access to selected PLC functions. The Series 90 Micro PLC supports two types of system security: password protection and OEM protection. Both types of protection can be accessed through the Status and Control portion of the Logicmaster 90 software or the Hand-Held Programmer.

Password protection and OEM protection are described briefly here. Refer to the *Logicmaster™ 90 Series 90-30/20/Micro Programming Software User's Manual,* GFK-0466, or the *Hand-Held Programmer User's Manual,* GFK-0402, for further details on the use of these system security features.

Password Protection

Privilege Levels

There are four security or *privilege levels* in the PLC password system. The default level (level 4), in a system with no passwords, allows read and write access to all configuration, logic, and data memories. Levels 2 through 4 can be protected by a password.

There is one password for each of levels 2 through 4 in the PLC, and each password may be unique; however, the same password can be used for more than one level. Passwords can only be entered or changed using the Logicmaster 90 Micro programmer or the HHP. Passwords are one to four ASCII characters in length. The HHP only allows the ASCII characters 0 to 9 and A to F.

The privileges granted at each level are a combination of that level, plus all lower levels. The levels and their privileges are:

Level 1

Any data, except passwords, may be read. This includes all data memories (%I, %Q, %AQ, %R, etc.), fault tables, and all program block types: data, value, and constant. No values may be changed in the PLC. *This is the default level for a system with passwords at all levels.*

Level 2

This level allows level 1 privileges plus write access to the data memories (%I, %R, etc.).

Level 3

This level allows levels 1 and 2 privileges plus write access to the application program in STOP mode only.

Level 4

This is the default level in a system with no passwords assigned. This level, the highest, allows the privileges of levels 1 through 3, plus read and write access to all memories, and the ability to display, set, or delete passwords for levels 1 through 3 in both RUN and STOP modes (configuration data can be written only in STOP mode).

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Privilege Level Change Requests

To enter or change passwords, the programmer must be in on-line mode and communicating with the PLC. Entering or changing passwords requires access to the highest level. If no passwords have been set up for the system, this level is automatically available.

Note

Once passwords have been entered, they can only be changed by:

- Entering the correct password to access the highest-level privileges.
- In the configuration software, by placing the master diskette in the system disk drive of the computer and pressing the **ALT** and **O** keys. (It is important to keep the original software master diskettes in a secure location because this allows passwords to be overridden.)

A programmer requests a privilege level change by supplying the new privilege level and the password for that level. A privilege level change will be denied if the password sent by the programmer does not agree with the password stored in the PLC's password access table for the requested level. If you attempt to access or modify information in the PLC using the HHP without the proper privilege level, the HHP will respond with an error message stating that access is denied.

When communicating over a serial link, a privilege level change remains in effect only as long as communications between the PLC and the programmer are intact. There does not need to be any activity, but the communications link must not be broken. If there is no communication for 15 seconds, the privilege level returns to the highest unprotected level.

When the Logicmaster 90 Micro programmer is connected through the serial connection, the programmer could detect a disconnect. If the PLC addresses the programmer and receives no response, the PLC detects a disconnect and then drops the programmer privilege level to the default privilege level (level 4). The PLC detects a disconnect of the HHP using a dedicated hardware signal. When the HHP is disconnected, the PLC reverts to privilege level 4. Upon connection of the PLC, Logicmaster 90 requests the protection status of each privilege level from the PLC. Logicmaster 90 then requests the PLC to move to the highest unprotected level, thereby giving the programmer access to the highest unprotected level without its having to request any particular level. When the HHP is connected to the PLC, the PLC reverts to the highest unprotected level.

OEM Protection

The OEM protection feature provides a higher level of security than password protection and is used by an original equipment manufacturer to further restrict access to program logic and configuration parameters. When OEM protection is enabled (locked), the user has no access to the logic program, and read-only access to the configuration. The OEM protection state is retentive across a power cycle.

Refer to the *Logicmaster™ 90 Series 90-30/20/Micro Programming Software User's Manual*, GFK-0466, and to the Logicmaster 90 on-line HELP screens for details on the use of this feature.

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I/O System for the Series 90 Micro PLC

The I/O system for the Series 90 Micro PLC provides the interface between the Series 90 Micro CPU and the user-supplied input devices and equipment to be controlled. As shown in Figure 8-4, the I/O Scanner writes to %AI, %I, and %M memory and reads from %AQ and %Q memory. It can read and write to %G memory.

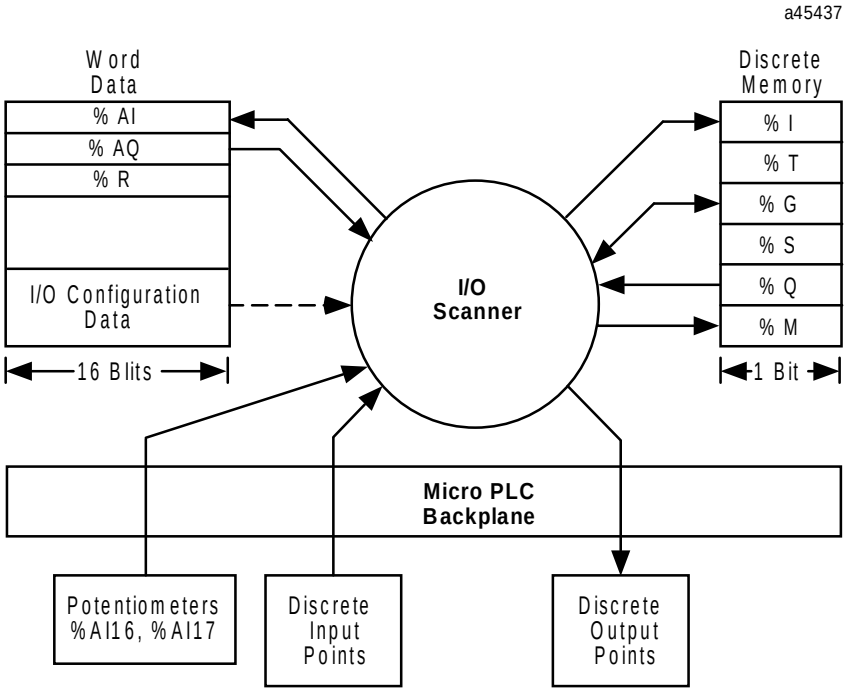


Figure 8-4. Series 90 Micro PLC I/O Structure

I/O Scan Sequence

For more information on scanning and the CPU sweep, refer to the discussion on pages 8-3 through 8-4.

Input Scan Inputs to the Series 90 Micro PLC are scanned from the lowest to the highest reference address.

Output Scan Outputs are scanned during the Output Scan portion of the sweep, immediately following the Logic Solution. Outputs are scanned in the same order as for the Input Scan; from lowest to highest reference address.

Default Conditions for Micro PLC Output Points

At power-up, output points default to OFF. They retain this default condition until the first output scan from the PLC occurs.

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Software Filters

Note

Software filtering is effective on DC-input units only (IC693UAL006 and IC693UDR001/002/005/010).

Discrete Input Filtering

Discrete Input Filtering Control

Filter control reference

Discrete input filtering (%I inputs) is done via software that allows you to change the filtering time on the fly. The filter time for the discrete inputs is adjustable from 0.5ms to 20ms in 0.5ms increments. The memory location %AQ11 is used to store the filter time value. To adjust the filter time, simply change the value in %AQ11.

Each value in %AQ11 represents one 0.5ms increment. For example, if you set %AQ11 to a value of 10, the filter time will be 5ms. If you set %AQ11 to 5, the filter time will be 2.5ms. The minimum value for %AQ11 is 1 (0.5ms) and the maximum value is 40 (20ms). Due to PLC limits, any value under 1 in %AQ11 represents a filter time of 0.5ms, and any value over 40 represents a filter time of 20ms.

Note

Because %AQ11 is used to control the discrete input filtering time, it is recommended that you ***not*** use %AQ11 for any other purpose.

Default filter time

The default value for %AQ11 is 6, which represents a filter time of 3ms.

Accuracy of filter

The filter time set in %AQ11 will be accurate within ±0.5ms.

Limitations of Discrete Input Filtering

What a discrete input will *not* scan.

This software filter only lets in signals that have a duration within ±0.5ms of the set filter time. For example, if the filtering time is set to 5ms, it could allow any signal that is greater than 4.5ms to be seen as an input.

What a discrete input *will* scan.

What will be read on an input is not solely based on the input filter setting. It is also based on the scan time. An input will always be seen if it is longer than both the scan time and the filter time.

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Analog Potentiometer Input Filtering

Input Settings

Two potentiometers, located on the front panel of the Micro PLC, allow you to manually set input values that are stored in %AI16 and %AI17. The top potentiometer controls %AI16, and the bottom one controls %AI17.

Filter Control Reference

Due to the nature of analog input, the values seen in %AI16 and %AI17 will have some fluctuation. This variation could make these inputs unusable for some applications. The Series 90 Micro PLC uses an averaging filter to stabilize these inputs.

The filter used on %AI16 and %AI17 samples the values on these inputs once per sweep. When a predetermined number of samples has been read, it averages them and stores the result in %AI16 and %AI17.

The value in memory reference %AQ1 controls the number of samples to be averaged, calculated as follows:

$$\text{Number of samples} = 2^{\%AQ1}$$

For example, if 4 is placed in %AQ1, 16 samples will be averaged to determine the values to place in %AI16 and %AI17. If 5 is placed in %AQ1, 32 samples will be averaged. You can place any value in %AQ1, however, only the lower 3 bits of %AQ1 are recognized, giving a minimum value of 0 and a maximum value of 7 (for 0 through 128 samples).

The analog value from the potentiometer is not reported until the number of sweeps determined by the value in AQ1 has occurred. If you want to receive a value from the potentiometer on every sweep, including the first sweep, AQ1 must contain 0.

Default Filter Time

The default value in %AQ1 is 4, meaning that 16 samples will be averaged.

Limitations of Analog Potentiometer Input Filtering

As with any filter, the longer the filter time (i.e., the more samples that are taken), the longer the response time. Although the maximum value of 7 could be used in %AQ1, this value might cause a long response time on larger programs. For example, if the sweep time of a program is 100ms, and if the potentiometer value is changed, the new value would not show up for 12.8 seconds.

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Diagnostic Data

Diagnostic bits are available in the %S memory. Diagnostic information is not available for individual I/O points. Refer to Chapter 9 for more information on fault handling.

Flash Memory

The Series 90 Micro PLC provides flash memory for non-volatile user-program storage and for system firmware. In addition, the ***Read/Write/Verify EE/Flash PROM with PLC User Memory*** function, initiated from either Logicmaster 90 or the HHP, uses flash memory for storage of the configuration and reference data.

Because the user program is stored in non-volatile flash memory, only one copy is maintained in flash memory, even after the user invokes the **Write to EEPROM/FLASH** function in the programming/configuration software or with the HHP. (Separate copies of the user configuration and the reference tables are maintained in the EEPROM/FLASH areas of the flash memory.) The Configuration entry **Cfg From** determines only whether the user configuration is obtained from RAM or PROM. The user program is always read from flash (PROM) memory.

In addition, be aware that editing the user program with the HHP stores the edited copy of the program in RAM memory. If you do not save the edited version of the program to flash memory, the changes will be lost. See "Storing the User Program Using the HHP" in Chapter 5, for the key sequence for this procedure.

Table 8-5. Settings for Cfg From Parameter

Default Settings			
Location	**Read From**		
	Configuration	**Program**	**Registers**
RAM	X	N/A	X
EPROM/FLASH	–	X	–
Recommended Settings			
Location	**Read From**		
	Configuration	**Program**	**Registers**
RAM	–	N/A	X
EPROM/FLASH	X	X	X

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Chapter 9 Diagnostics

This chapter provides a guide to troubleshooting the Micro PLC and consists of two sections:

- **Powerup Diagnostics** describes how to use the LED blink codes that the Micro PLC generates if the unit fails the power-up self-test described in Chapter 3.
- **Faults and Fault Handling** discusses how the Micro PLC handles system faults. These faults can be diagnosed and corrected using the Logicmaster 90 software or the HHP.

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Powerup Diagnostics

If the Micro PLC fails the powerup self-test, it will generate an error message in the form of an LED blink code.

Note

Powerup diagnostics can be disabled using the Logicmaster 90 configuration software. Unless your application requires unusually fast powerup, it is recommended that you leave this feature enabled. Disabling powerup diagnostics has the following effects:

The I/O Link Interface Expansion Unit will not work.

No expansion units can be used. (If expansion units are connected while powerup diagnostics are disabled, faults will be logged in the I/O tables.)

All HHP key sequences will be ignored when the Micro PLC is powering up.

Table 9-1. Powerup Diagnostic LED Blink Error Codes

Number of Blinks		Error
RUN LED	OK LED	
1	1	Flags or ALU failed
1	2	Bad registers
1	3	Bad stack mechanism
1	4	Bad stack memory area
1	5	DMA 0 transfer failed
1	6	DMA 1 transfer failed
1	7	DMA 2 transfer failed
1	8	DMA 3 transfer failed
1	9	Addr line fail
2	1	Timer 0 not counting
2	2	Timer 1 not counting
2	3	Timer 2 not counting
2	4	Timer 3 not counting
2	5	Timer 4 not counting
2	6	Interrupt vector RAM failed
2	7	Bad diagnostics memory area
2	8	Bad cache memory area
3	1	Bad system heap RAM
3	2	WDT (watchdog timer) timeout
3	3	Bad nonvolatile RAM
9	9	Other error

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Faults and Fault Handling

Faults occur in the Series 90 Micro PLC system when certain failures or conditions that affect the operation and performance of the system occur. These conditions can affect the ability of the PLC to control a machine or process.

Fault Handling

The condition or failure itself is called a *fault*. When a fault has been received and processed by the *Alarm Processor* software in the CPU, it is called an *alarm*. The interface to the user for the Alarm Processor is through the Logicmaster 90 programming software. Any detected fault is recorded in a Fault Table and displayed on either the PLC Fault Table screen or the I/O Fault Table screens.

More information on faults and fault handling can be found in the *Logicmaster Series 90™-30/20/Micro Programming Software User's Manual*, GFK-0466 and the *Logicmaster Series 90™-30/20/Micro 90-30 Programmable Controllers Reference Manual*, GFK-0467. For information on error detection and correction for Statement List programs and the Hand-Held Programmer, refer to the *Hand-Held Programmer, Series 90™-30/20/Micro Programmable Controllers User's Manual*, GFK-0402.

Classes of Faults

The Micro PLC detects several classes of faults. These include internal failures, external failures, and operational failures. Following are examples of these failures.

- Internal Failures
  - Non-responding circuit boards
  - Memory checksum errors
- External Failures
  - Sequence fault
- Operational Failures
  - Communication failures
  - Configuration failures
  - Password access failures

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System Response to Faults

Some faults can be tolerated, while others require that the system be shut down. I/O failures may be tolerated by the PLC system, but may be intolerable by the application or the process being controlled. Operational failures can normally be tolerated. Micro PLC faults have two attributes:

Fault Table Affected:	I/O Fault Table PLC Fault Table
Fault Action:	Fatal Diagnostic Informational

Fatal faults are recorded in the appropriate table, diagnostic variables (if any) are set, and the system is halted. **Diagnostic** faults are recorded in the appropriate table and any diagnostic variables are set. **Informational** faults are only recorded in the appropriate table. Fault actions are listed in Table 9-2.

Table 9-2. Fault Actions

Fault Action	Response by CPU
Fatal	Log fault in Fault Table Set fault references Go to STOP/FAULT mode
Diagnostic	Log fault in Fault Table Set fault references
Informational	Log fault in Fault Table

Table 9-3 lists the fault groups, their fault actions, the Fault Tables affected, and the mnemonic for system discrete %S points that are affected.

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Table 9-3. Fault Summary

Fault Group	Fault Action	Fault Table	Special Discretes			
System Configuration Mismatch	Fatal	PLC Fault Table	sy_flt	any_flt	sy_pres	cfg_mm
PLC CPU Hardware Failure	Fatal	PLC Fault Table	sy_flt	any_flt	sy_pres	hrd_cpu
Program Checksum Failure	Fatal	PLC Fault Table	sy_flt	any_flt	sy_pres	pb_sum
PLC Fault Table Full	Diagnostic	-	sy_full			
I/O Fault Table Full	Diagnostic	-	io_full			
Application Fault	Diagnostic	PLC Fault Table	sy_flt	any_flt	sy_pres	apl_flt
No User Program on Power-up	Fatal	PLC Fault Table	sy_flt	any_flt	no_prog	
Corrupted User RAM	Fatal	PLC Fault Table	sy_flt	any_flt	sy_pres	bad_ram
Password Access Failure	Diagnostic	PLC Fault Table	sy_flt	any_flt	sy_pres	bad_pwd
PLC Software Failure	Fatal	PLC Fault Table	sy_flt	any_flt	sy_pres	sft_cpu
PLC Store Failure	Fatal	PLC Fault Table	sy_flt	any_flt	sy_pres	stor_er
Constant Sweep Time Exceeded	Diagnostic	PLC Fault Table	sy_flt	any_flt	sy_pres	ov_swp
Unknown PLC Fault	Fatal	PLC Fault Table	sy_flt	any_flt	sy_pres	
Unknown I/O Fault	Fatal	I/O Fault Table	io_flt	any_flt	io_pres	
Loss of Expansion Unit*	Diagnostic	I/O Fault Table	io_flt	any_flt	io_pres	los_iom
Addition of Expansion Unit	Diagnostic	I/O Fault Table	io_flt	any_flt	io_pres	add_iom
Expansion Unit Configuration Mismatch	Fatal	PLC Fault Table	sy_flt	any_flt	sy-pres	cfg_mm

* If the Micro PLC logs a Loss of Expansion Unit fault while scanning the input data from the I/O Link IEU, the input reference memory data will be set to all zeroes.

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Fault Summary References

Fault summary references are set to indicate ***what*** fault occurred. The fault reference remains on until the PLC is cleared or until the application program clears the fault.

An example of a fault bit being set and then clearing the bit is shown in the following example. In this example, the coil *light_01* is turned on when an over sweep condition occurs. The light and the ov_swp contact remain on until the %I0035 contact is closed.

```
| ov_swp                                                    light_01
|──] [──────────────────────────────────────────────────────( )──
|
|%I0035                                                      ov_swp
|──] [──────────────────────────────────────────────────────(R)──
|
```

Fault Reference Definitions

The Alarm Processor maintains the states of the 128 system discrete bits in %S memory. These fault references can be used to indicate where a fault has occurred, and what type of fault it is. Fault references are assigned, with a nickname, to %S, %SA, %SB, and %SC memory. These references are available for use in the application program as required. The mnemonic for these discrete bits and a description of each bit is provided in Table 9-4. Some discrete bits are reserved for future use.

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Table 9-4. System Discrete References

Reference	Nickname	Definition
%S0001	fst_scn	First Scan (Set to 1 when the current sweep is the first sweep.)
%S0002	lst_scn	Last Scan (Reset from 1 to 0 when the current sweep is the last sweep.)
%S0003	T_10MS	0.01 second timer contact
%S0004	T_100MS	0.1 second timer contact
%S0005	T_SEC	1.0 second timer contact
%S0006	T_MIN	1.0 minute timer contact
%S0007	alw_on	Always On
%S0008	alw_off	Always Off
%S0009	sy_full	Set when the PLC Fault Table fills up. Cleared when an entry is removed from the PLC Fault Table and when the PLC Fault Table is cleared.
%S0010	io_full	Set when the I/O Fault Table fills up. Cleared when an entry is removed from the I/O Fault Table and when the I/O Fault Table is cleared.
%S0013	prg_chk	Set when background program check is active.
%SA0002	ov_swp	Set when the PLC detects that the previous sweep took longer than the time specified by the user. Cleared when the PLC detects that the previous sweep did not take longer than the specified time. It is also cleared during the transition from STOP to RUN mode.
%SA0003	apl_flt	Set when an application fault occurs. Cleared when the PLC transitions from STOP mode to RUN mode.
%SA0009	cfg_mm	Set when a configuration mismatch is detected during system power-up. Cleared by powering-up the PLC when no mismatches are present.
%SA0010	hrd_cpu	Set when the diagnostics detect a problem with the CPU hardware. Cleared by replacing the CPU module.
%SB0009	no_prog	Set when an attempt is made to put the PLC in RUN mode when there is no executable application program stored in the CPU. Cleared by storing an application program to the CPU and putting the PLC in RUN mode.
%SB0010	bad_ram	Set when the CPU detects corrupted RAM memory at power-up. Cleared when the CPU detects that RAM memory is valid at power-up.
%SB0011	bad_pwd	Set when a password access violation occurs. Cleared when a password is successfully used to gain a privilege level.
%SB0014	stor_er	Set when an error occurs during a programmer store operation. Cleared when a store operation is completed successfully.
%SC0009	any_flt	Set when any fault occurs. Cleared when both Fault Tables are cleared.
%SC0010	sy_flt	Set when any fault occurs that causes an entry to be placed in the PLC Fault Table. Cleared when the PLC Fault Table is cleared.
%SC0011	io_flt	Set when any fault occurs that causes an entry to be placed in the I/O Fault Table. Cleared when the I/O Fault Table is cleared.
%SC0012	sy_pres	Set as long as there is at least one entry in the PLC Fault Table. Cleared when the PLC Fault Table has no entries.
%SC0013	io_pres	Set as long as there is at least one entry in the I/O Fault Table. Cleared when the I/O Fault Table has no entries.

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Fault Results

Two non-configurable faults have results that you should be aware of:

- **PLC CPU Software Failure**

  Whenever a PLC CPU Software Failure is logged, the Micro PLC ***immediately*** goes into a special Error Sweep mode. The only activity permitted when the PLC is in this mode is communications with the programmer. The only method of clearing this condition is to reset the Micro PLC (i.e., cycle power).

- **PLC Sequence Store Failure**

  A ***sequence store*** is the storage of program blocks and other data preceded by the special Start-of-Sequence command and ending with the End-of-Sequence command. If communications with a programming device performing a sequence store is interrupted or if any other failure occurs that terminates the download, the PLC Sequence Store Failure fault is logged. As long as this fault is present in the system, the PLC will not transition to RUN mode.

Accessing Additional Fault Information

The Fault Tables contain basic information regarding the fault. If more detailed information is needed, a hexadecimal dump of the fault can be obtained by positioning the cursor on the fault entry and pressing the **CTRL + F** keys simultaneously. The hexadecimal information will be displayed on the line directly below the function key display.

Two faults, ***Flash Memory Alarm*** and ***Watchdog Timer Application Fault***, are unique to the Series 90 Micro PLC. Refer to the table below for descriptions and corrective actions for these faults. All other faults applicable to the Series 90 Micro PLC are described in the *Logicmaster™ Series 90-30/20/Micro Programming Software User's Manual,* GFK-0466.

If you find it necessary to contact Field Service concerning a fault, you should be prepared to tell them both the information that is readable directly from the Fault Table *and the hexadecimal information you see when you press the* **CTRL + F** keys. Field Service personnel will give you further instructions.

Table 9-5. PLC CPU Software Faults

Name	**Flash Memory Alarm**
Error Code	BAD_FLASH_OP = 32
Description	The PLC operating system generates this fault when it detects an internal Flash device error during a Flash write or erase operation.
Correction	Display the PLC Fault Table on the Programmer. Contact GE Fanuc PLC Field Service, giving them all the information in the Fault Table.
Name	**Watchdog Timer Application Fault**
Error Code	SFTWR_WD_EXPIRED = 2
Description	The user's program execution time exceeds the watchdog setting of 200 ms. PLC resets and goes to STOP-FAULT mode.
Correction	Modify user program so time is not exceeded. If the user program is not causing the problem, make sure any inductive loads being used are properly suppressed. For more information, see "Output Circuit Protection" in Chapter 4.

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Special Operational Notes

Inaccurate Logic Not Equal Message

When coil use is set to WARN MULTIPLE, Logicmaster 90 software allows multiple coil use with warning messages. This feature can give misleading feedback for Micro PLCs. If coil references are added or deleted in the RLD program, the Logic-Not-Equal warning will be displayed. To correct the inaccurate message, enter the program edit package (press **F1**), and then select Option (press **F7**). From the Multiple Coil Use screen, press **F1** to run the coil check function. Storing the program to the PLC will now result in Logic Equal. You can avoid this problem by disabling the WARN MULTIPLE feature from the Multiple Coil Use screen. For details, refer to "Coil Checking" in the *Logicmaster™ 90 Series 90™-30/20/Micro Software User's Manual*, GFK-0466.

Technical Help

PLC Hotline	
Phone numbers	800-433-2682 (or 804-978-6036)
Internet address	PLCHOTLINE@CHO.GE.COM
Fax number	804-978-5099
GE Fanuc Bulletin Board	Files on this bulletin board are provided by GE Fanuc "as-is" and no warranties apply. The phone number is 804-975-1300 (up to 33,600 baud, 8 data bits, 1 parity bit, no stop bits. After accessing the BBS, select the BBS File area (*PLC:AGENCY STATUS*) and the file (*AGENSTDS.XLS)*. This information is also available on the Internet at our technical support World Wide Web site at the address: http://www.gefanucsupport.com
PLC Fax Link	804-978-5824

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Appendix A Instruction Timing

This appendix contains tables listing the memory size in bytes and the execution time in microseconds for each function supported by the Micro PLC. Memory size is the number of bytes required by the function in a ladder diagram application program.

Two execution times are shown for each function:

Execution Time	Description
Enabled	Time required to execute the function or function block when power flows into and out of the function. Typically, best-case times are when the data used by the block is contained in user RAM (word-oriented memory) and not in the discrete memory.
Disabled	Time required to execute the function when power flows into the function or function block, however, it is in an inactive state (for example, when a timer is held in the reset state).

Notes

1. Times (in microseconds) are based on release 5.0 (14-point Micro PLCs) and release 6.0 (28-point Micro PLCs) of Logicmaster 90 software.
2. Timers and counters are updated each time they are encountered in the logic; timers by the amount of time consumed by the last sweep and counters by one count.
3. For bit operation functions, L = the number of bits. For bit position, N = the bit that is set. For data move functions, N = the number of bits or words. B= the number of bits shifted more than 1 (that is, not counting the first bit). W=the number of words.
4. For table functions, increment is in units of length specified.
5. Enabled time for single length units of type %R, %AI, and %AQ.
6. JUMPs, LABELs, COMMENTs, and non-nested MCRs are included in the Boolean timing spec.
7. Boolean contact execution times are as follows:

   14-point Micro PLCs: 1.8 ms/K of logic for fast %I (%I1–%I64) references
   1.6 ms/K of logic for fast %Q (%Q1–%Q64) references
   . 2.2 ms/K of logic for normal inputs
   2.8 ms/K of logic for normal outputs

   23 and 28-point Micro PLCs: 1.0 ms/K of logic for fast %I (%I1–%I64) references
   1.0 ms/K of logic for fast %Q (%Q1–%Q64) references
   . 1.2 ms/K of logic for normal inputs
   1.6 ms/K of logic for normal outputs

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Table A-1. Instruction Timing

			Execution Time(μ sec.)					
		Size	Enabled		Disabled		Increment	
Group	**Function**	**(bytes)**	14-point	28-point*	14-point	28-point*	14-point	28-point*
Coils/ Relays	Coils/Relays	2	See note 7 on page A-1.				NA	NA
Timers	Off Delay Timer	15	48.8	25.8	64	33.5	NA	NA
	On Delay Timer	15	64.8	33.9	50.4	25.6	NA	NA
	Elapsed Timer	15	59.2	30.3	44.8	24.0	NA	NA
Counters	Up Counter	11	67.2	34.3	66.4	33.9	NA	NA
	Down Counter	11	67.2	34.4	67.2	34.3	NA	NA
Math	Addition (INT)	13	48	26.2	1.4	1.0	NA	NA
	Addition (DINT)	13	49.6	27.6	1.4	1.0	NA	NA
	Subtraction (INT)	13	48.8	26.2	1.4	1.0	NA	NA
	Subtraction (DINT)	13	49.6	27.6	1.4	1.0	NA	NA
	Multiplication (INT)	13	54.4	30.1	1.4	1.0	NA	NA
	Multiplication (DINT)	13	105.6	70.9	1.4	1.0	NA	NA
	Division (INT)	13	60.8	36.0	1.4	1.0	NA	NA
	Division (DINT)	13	103.2	58.3	1.4	1.0	NA	NA
	Modulo Division (INT)	13	63.2	37.0	1.4	1.0	NA	NA
	Modulo Division (DINT)	13	105.6	59.3	1.4	1.0	NA	NA
	Square Root (INT)	–	64	49.4	1.4	1.0	NA	NA
	Square Root (DINT)	–	138.4	88.6	1.4	1.0	NA	NA
Relational	Equal (INT)	9	24.8	12.8	0	0	NA	NA
	Equal (DINT)	9	25.6	13.2	0	0	NA	NA
	Not Equal (INT)	9	24.8	12.8	0	0	NA	NA
	Not Equal (DINT)	9	25.6	13.2	0	0	NA	NA
	Greater Than (INT)	9	24.8	12.8	0	0	NA	NA
	Greater Than (DINT)	9	25.6	13.2	0	0	NA	NA
	Greater Than/Equal (INT)	9	24.8	12.8	0	0	NA	NA
	Greater Than/Equal (DINT)	9	25.6	13.2	0	0	NA	NA
	Less Than (INT)	9	24.8	12.8	0	0	NA	NA
	Less Than (DINT)	9	25.6	13.2	0	0	NA	NA
	Less Than/Equal (INT)	9	24.8	12.8	0	0	NA	NA
	Less Than/Equal (DINT)	9	25.6	13.2	0	0	NA	NA
	Range (INT)	–	32	23.1	1.4	1.0	NA	NA
	Range (DINT)	–	39.2	24.5	1.4	1.0	NA	NA

*Times for 23-point Micro PLCs are the same as those for 28-point Micro PLCs

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Table A-1. Instruction Timing - Continued

			Execution Time(µ sec.)					
		Size	Enabled		Disabled		Increment	
Group	Function	(bytes)	14-point	28-point*	14-point	28-point*	14-point	28-point*
Bit Operation	Logical AND	13	44	25.2	0	0	NA	NA
	Logical OR	13	44	25.2	0	0	NA	NA
	Logical Exclusive OR	13	44	25.2	0	0	NA	NA
	Logical Invert, NOT	9	40.8	22.8	0	0	NA	NA
	Shift Bit Left	15	110.4	61.0	11.2	3.2	22.096W +3.68B	12.0W +1.87B
	Shift Bit Right	15	117.6	65.8	10.4	3.0	23.76W +3.79B	12.59W +1.87B
	Rotate Bit Left	15	124.8	69.7	0	0	24.94W +3.73B	1.83W + 1.87B
	Rotate Bit Right	15	124	68.9	0	0	24.94W +3.73B	1.83W + 1.87B
	Bit Position	13	56.8	23.3	1.4	1.0	7.8W + 5.1B	4.5L + 3.23N
	Bit Clear	13	56.8	33.3	0	0	NA	NA
	Bit Test	13	40.8	23.0	0	0	NA	NA
	Bit Set	13	56.8	32.9	0	0	NA	NA
	Mask Compare (WORD)	–	146.4	78	11.2	7	15.17W + 6.51B	12.96W + 1.71B
	Mask Compare (DWORD)	–	152	87	10.4	6	30.02W + 7.47B	25.79W + 2.24B
Data Move	Move (INT)	13	50.4	29.16 (27.4)	0	0	8.19	5.36N
	Move (BIT)	13	67.2	38.0 (36.8)	0	0	9.8	5.4N (4.89N)
	Move (WORD)	13	50.4	29.16 (27.4)	0	0	8.19	NA
	Block Move	–	91.2	52.0	7.2	2.6	NA	NA
	Block Clear	9	45.6	24.8	0	0	6.6	3.36
	Shift Register (BIT)	15	143.2	75.2	39.2	21.6	0.288	0.176
	Shift Register (WORD)	15	65.6	37.6	19.2	9.6	11.64	6.19
	Bit Sequencer	15	68	36.0	30.4	16.0	NA	0.10
	COMM_REQ	–	74.4	40.8	NA	NA	NA	NA

*Times for 23-point Micro PLCs are the same as those for 28-point Micro PLCs.

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Table A-1. Instruction Timing - Continued

		Size	Execution Time(µ sec.)					
			Enabled		Disabled		Increment	
Group	Function	(bytes)	14-point	28-point*	14-point	28-point*	14-point	28-point*
Table	Array Move							
	INT	21	104	56.0	8.8	3.2	14.88	7.38N
	DINT	21	116.8	63.2	8	3.2	29.78	15.0N
	BIT	21	163.2	88.0	7.2	2.4	10.56	5.42N
	BYTE	21	96	52.0	8.8	3.2	7.2	3.57N
	Search Equal							
	INT	19	64.8	39.2	7.2	2.4	6.02	2.97N
	DINT	19	71.2	42.4	7.2	2.4	11.24	5.6N
	BYTE	19	64	37.6	7.2	2.4	5.02	2.35N
	Search Not Equal							
	INT	19	64.8	37.6	7.2	2.4	6.02	2.94N
	DINT	19	71.2	42.4	7.2	2.4	11.24	5.54N
	BYTE	19	64	37.6	7.2	2.4	5.02	2.74N
	Search Greater Than/Equal							
	INT	19	64.8	39.2	7.2	2.4	6.02	2.94N
	DINT	19	71.2	42.4	7.2	2.4	11.24	5.54N
	BYTE	19	64	38.4	7.2	2.4	5.02	2.74N
	Search Greater Than							
	INT	19	64.8	39.2	7.2	2.4	6.02	2.94N
	DINT	19	71.2	42.4	7.2	2.4	11.24	5.54N
	BYTE	19	64	38.4	7.2	2.4	5.02	2.74N
	Search Less Than							
	INT	19	64.8	39.2	7.2	2.4	6.02	2.94N
	DINT	19	71.2	42.2	7.2	2.4	11.24	5.54N
	BYTE	19	64	38.4	7.2	2.4	5.02	2.74N
	Search Less Than/Equal							
	INT	19	64.	39.2	7.2	2.4	6.02	2.94N
	DINT	19	71.2	42.4	7.2	2.4	11.24	5.54N
	BYTE	19	64	38.4	7.2	2.4	5.02	2.74N
Conversion	Convert to INT	9	48.0	26.95	1	1	NA	NA
	Convert to BCD-4	9	36.8	20.65	1	1	NA	NA
Control	Do I/O	12	157.9	See Table A-2.				
	Service Request							
	#14	–	236	121.1	0	0	NA	NA
	#15	9	103.2	72.45	0	0	NA	NA
	#16	–	101.6	38.15	0	0	NA	NA
	Nested MCR/ENDMCR (combined)	8	32.8	20.3	12.8	3.2	NA	NA
	PID-ISA	8	830	429	97	49	NA	NA
	PID-IND	8	833	432	97	49	NA	NA

*Times for 23-point Micro PLCs are the same as those for 28-point Micro PLCs, except for Do I/O function (see Table A-2).

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Table A-2. Timing for Do I/O Function

Model	No. Expansion Units	Execution Time(µ sec)	
		Enabled	Disabled
14-point	NA	157.9	25.2
23-point to discrete input	NA	82.9	14.4
23-point (with default analog pt config) to analog input	NA	116.2	14.4
23-point to analog output	NA	90.65	14.4
28-point	0 (outputs 1-16)	74.6	14.4
	1 (outputs 1-24)	83.3	14.4
	2 (outputs 1-32)	91.7	14.4
	3 (outputs 1-40)	100.45	14.4
	4 (outputs 1-48)	112.7	14.4
28-point	0 (inputs 1-16)	82.3	14.4
	1 (inputs 1-24)	98.7	14.4
	2 (inputs 1-32	100.5	14.4
	3 (inputs 1-40)	109.6	14.4
	4 (inputs 1-48)	118.3	14.4

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Appendix B Reference Types

This appendix contains listings of the user reference types supported by the Micro PLC. It also identifies references reserved for fault reporting (page B-2) and memory locations that are reserved for I/O functions (page B-3).

User References

Data in Series 90-30/20/Micro PLC programs is referenced by its address in the system. 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 nicknames and is only used with Logicmaster 90 Micro software. The % symbol is not used with the HHP.

The prefix of a user reference indicates where data is stored in the PLC. References in the Micro PLC are either discrete or register data types. The ranges and sizes of reference types supported by the Micro PLC are listed in the following table.

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Table B-1. Range and Size of User References for Micro PLC

Reference Type	Reference Range	14-Point	23 and 28-Point
User program logic	Not applicable	3K words	6K words
Discrete inputs	%I0001 - %I0008	8 bits	16 bits
Discrete inputs, internal	%I0009 - %I0512	504 bits	504 bits
Discrete outputs	%Q0001 - %Q006	6 bits	12 bits
Discrete outputs, internal	%Q0007 - %Q0512	506 bits	506 bits
Discrete global references	%G0001 - %G1280	1280 bits	1280 bits
Discrete internal coils	%M0001 - %M1024	1024 bits	1024 bits
Discrete temporary coils	%T0001 - %T0256	256 bits	256 bits
System status references	%S0001 - %S0032	32 bits	32 bits
	%SA0001 - %SA0032	32 bits	32 bits
	%SB0001 - %SB0032	32 bits	32 bits
	%SC0001 - %SC0032	32 bits	32 bits
System register references	%R0001 - %R0256	256 words	2K words
Analog and High Speed Counter inputs	%AI0001 - %AI0128	128 words	128 words
Analog outputs	%AQ0001 - %AQ0128	128 words	128 words
System registers*	%SR0001 - %SR0016	16 words	16 words

*For viewing only; cannot be referenced in a user logic program.

References for Fault Reporting

The Series 90 Micro PLC monitors internal operations for either system or user problems called faults. These faults are reported through the %S references and through an internal fault table. Access to %S information is available through Logicmaster 90 Micro software or with the HHP. For more details on faults and fault reporting see Chapter 9.

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Fixed I/O Map Locations

The following tables list memory locations that are reserved for I/O functions. Use of these addresses for other purposes in your ladder logic program is not recommended.

Table B-2. Reserved System Register References

Address	Function
R1617–R1814	If transition coils are used, this area is used to store their previous value.

Table B-3. Reserved Discrete Inputs

Address	Function
I00001	Input 1/Count 1/Encoder +
I00002	Input 2/Preload/Strobe/Interrupt 1
I00003	Input 3/Count 2/Encoder –
I00004	Input 4/Preload/Strobe/Interrupt 2
I00005	Input 5/Count 3
I00006	Input 6/Preload/Strobe/Interrupt 3
I00007	Input 7/Count 4
I00008	Input 8/Preload/Strobe/Interrupt 4
I17—24	First standard expansion unit (if configured)
I25—32	Second standard expansion unit (if configured)
I33—40	Third standard expansion unit (if configured)
I41—48	Fourth standard expansion unit (if configured)
I00494	Pulse Train complete on Q1
I00495	Pulse Train complete on Q3
I00496	Pulse Train complete on Q5
I00497—500	Strobe status HSC1—HSC4
I00501—504	Preload status HSC1—HSC4
I00505—508	Output status HSC1—HSC4
I00509	1 (module ready always 1)
I00510	not used (always 0)
I00511	not used (always 0)
I00512	Counter Error status

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Table B-4. Reserved Discrete Outputs

Address	Function
Q00001	Output 1/PWM Output/Pulse Output
Q00002	Output 2/PWM Output
Q00003	Output 3/PWM Output/Pulse Output
Q00004	Output 4/PWM Output
Q00005	Output 5/PWM Output/Pulse Output
Q00006	Output 6/PWM Output
Q17—24	First standard expansion unit (if configured)
Q25—32	Second standard expansion unit (if configured)
Q33—40	Third standard expansion unit (if configured)
Q41—48	Fourth standard expansion unit (if configured)
Q00494	Start Q1 Pulse Train
Q00495	Start Q3 Pulse Train
Q00496	Start Q5 Pulse Train
Q00497	Clear Strobe bit for HSC 1
Q00498	Clear Strobe bit for HSC 2
Q00499	Clear Strobe bit for HSC 3
Q00500	Clear Strobe bit for HSC 4
Q00501	Reset Preload bit HSC 1
Q00502	Reset Preload bit HSC 2
Q00503	Reset Preload bit HSC 3
Q00504	Reset Preload bit HSC 4
Q00505	Enable Output HSC 1
Q00506	Enable Output HSC 2
Q00507	Enable Output HSC 3
Q00508	Enable Output HSC 4
Q00509	Not used but unavailable
Q00510	Not used but unavailable
Q00511	Clear error (all counters)
Q00512	Not used but unavailable

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Table B-5. Reserved Analog Inputs

Address	Function	
AI00001	Module Status code	
AI00002	Counts per timebase HSC 1	0 to 32767
AI00003	Counts per timebase HSC 2	0 to 32767
AI00004	Counts per timebase HSC 3	0 to 32767
AI00005	Counts per timebase HSC 4	0 to 32767
AI00006	Accumulator HSC 1	–32678 to 32767
AI00007	Strobe Register HSC 1	–32678 to 32767
AI00008	Accumulator HSC 2	–32678 to 32767
AI00009	Strobe Register HSC 2	–32678 to 32767
AI00010	Accumulator HSC 3	–32678 to 32767
AI00011	Strobe Register HSC 3	–32678 to 32767
AI00012	Accumulator HSC 4	–32678 to 32767
AI00013	Strobe Register HSC 4	–32678 to 32767
AI00014	Not used (set to 0)	
AI00015	Not used (set to 0)	
AI00016	Analog potentiometer input filtering (Analog Timer value 0)	
AI00017	Analog potentiometer input filtering (Analog Timer value 1)	
AI00018	Analog input channel 1	
AI00019	Analog input channel 2	

Table B-6. Reserved Analog Outputs

Address	Function
AQ00001	Controls the number of input samples for analog potentiometer input filtering.
AQ00002	PWM Frequency Q1
AQ00003	PWM Duty Cycle Q1
AQ00004	PWM Frequency Q2
AQ00005	PWM Duty Cycle Q2
AQ00006	PWM Frequency Q3
AQ00007	PWM Duty Cycle Q3
AQ00008	PWM Frequency Q4
AQ00009	PWM Duty Cycle Q4
AQ00011	Discrete input filtering time value
AQ00012	Analog output channel
AQ00123	Frequency of Q1 pulse train (0 to 2Khz)
AQ00124	Number of pulses to send to Q1 output (0 to 65535)
AQ00125	Frequency of Q3 pulse train (0 to 2Khz)
AQ00126	Number of pulses to send to Q3 output (0 to 65535)
AQ00127	Frequency of Q5 pulse train (0 to 2Khz)
AQ00128	Number of pulses to send to Q5 output (0 to 65535)

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Appendix C

PLC/Software Cross Reference

Information in this appendix is arranged to provide a convenient means of comparing the capabilities of the Series 90 Micro PLC and the Series 90-20 PLC. Table C-1 lists the Logicmaster 90 software versions that are compatible with Series 90 Micro and Series 90-20 PLCs. The function name and its HHP abbreviation and function number are listed in Table C-2. This table also indicates which models of the Series 90 Micro and Series 90-20 PLCs support each function. A comparison of ranges and sizes of user references is provided in Table C-3.

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Table C-1. Programmer Compatibility

CPU	Logicmaster 90-30/20/Micro Software Revision
14, 23, and 28-point Micro, release 3.0 and later	8.00 or later
28-point Micro, release 2.01 and 2.02	6.01 or later
14-point Micro	5.01 or later
211 CPU	2.01 or later

Table C-2. Programming Function Matrix

			Release		
Function	**HHP Instruction**	**HHP Function Number**	**Logicmaster 90-30/20/Micro Software**	**Micro CPU**	**Series 90-20 CPU (IC692CPU211/212)**
Contacts					
Normally Open Contact	–| |–	NA	all	all	all
Normally Closed Contact	–|/|–	NA	all	all	all
Continuation Contact <+>–	not supported	NA	3.02	all	all
Coils					
Normally Open Coil	–( )–	NA	all	all	all
Negated Retentive Coil	–(/M)–	NA	all	all	all
Negated Coil	–(/)–	NA	all	all	all
Retentive Coil	–(M)–	NA	all	all	all
SET Coil	–(S)–	NA	all	all	all
Retentive SET Coil	–(SM)–	NA	all	all	all
RESET Coil	–(R)–	NA	all	all	all
Retentive RESET Coil	–(RM)–	NA	all	all	all
Positive Transition Coil	–(↑)–	NA	all	all	all
Negative Transition Coil	–(↓)–	NA	all	all	all
Continuation Coil –<+>	not supported	NA	3.02	all	all

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Table C-2. Programming Function Matrix - Continued

			Release		
Function	**HHP Instruction**	**HHP Function Number**	**Logicmaster 90-30/20/Micro Software**	**Micro CPU**	**Series 90-20 CPU (IC692CPU211/212)**
Links					
Horizontal link	———	NA	all	all	all
Vertical link	|	NA	all	all	all
Timers and Counters					
Elapsed Timer	tmr	10	all	all	all
On-Delay Timer	ondtr	13	all	all	all
Off-Delay Timer	ofdt	14	4.5	all	4.40
Up Counter	upctr	15	all	all	all
Down Counter	dnctr	16	all	all	all
Math					
Addition	add	60	all	all	all
Addition, double precision	dpadd	61	all	all	all
Subtraction	sub	62	all	all	all
Subtraction, double precision	dpsub	63	all	all	all
Multiplication	mul	64	all	all	all
Multiplication, double precision	dpmul	65	all	all	all
Division	div	66	all	all	all
Division, double precision	dpdiv	67	all	all	all
Modulo Division	mod	68	all	all	all
Modulo Division, double precision	dpmod	69	all	all	all
Square Root	sqrt	70	3.02	all	all
Square Root, double precision	dpsqrt	71	3.02	all	all

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Table C-2. Programming Function Matrix - Continued

			Release		
Function	**HHP Instruction**	**HHP Function Number**	**Logicmaster 90-30/20/Micro Software**	**Micro CPU**	**Series 90-20 CPU (IC692CPU211/212)**
Relational					
Equal	eq	52	all	all	all
Not Equal	ne	53	all	all	all
Less Than or Equal To	le	54	all	all	all
Greater Than or Equal To	ge	55	all	all	all
Less Than	lt	56	all	all	all
Greater Than	gt	57	all	all	all
Equal, double precision	dpeq	72	all	all	all
Not Equal, double precision	dpne	73	all	all	all
Less Than or Equal To, double precision	dple	74	all	all	all
Greater Than or Equal To, double precision	dpge	75	all	all	all
Less Than, double precision	dplt	76	all	all	all
Greater Than, double precision	dpgt	77	all	all	all
Range, signed integer	rangi	140	4.01	all	4.40
Range, double precision signed integer	rangdi	141	4.01	all	4.40
Range, word	rangw	142	4.01	all	4.40
Range, double word	not supported	NA	4.01	all	4.40

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Table C-2. Programming Function Matrix - Continued

			Release		
Function	**HHP Instruction**	**HHP Function Number**	**Logicmaster 90-30/20/Micro Software**	**Micro CPU**	**Series 90-20 CPU (IC692CPU211/212)**
Bit Operation					
Bit Set	bitset	22	2.01	all	all
Logical AND	and	23	all	all	all
Bit Clear	bitclr	24	2.01	all	all
Logical OR	or	25	all	all	all
Bit Test	bittst	26	2.01	all	all
Logical Exclusive OR	xor	27	all	all	all
Bit Position	bitpos	28	2.01	all	all
Logical Invert	not	29	all	all	all
Shift Left	shl	30	all	all	all
Shift Right	shr	31	all	all	all
Rotate Left	rol	32	all	all	all
Rotate Right	ror	33	all	all	all
Masked Compare, word	mskompw	143	4.01	all	5.00
Masked Compare, double word	mskcmpd	144	4.01	all	5.00
Data Move					
Multiple Integer Move	movin	37	2.01	all	all
Constant Block Move, Integer	bmovi	38	all	all	all
Multiple Bit Move	movbn	40	2.01	all	all
Multiple Word Move	movwn	42	2.01	all	all
Constant Block Move	bmovw	43	all	all	all
Block Clear	blkcl	44	all	all	all
Shift Register Word	shfrw	45	2.01	all	all
Shift Register Bit	shfrb	46	2.01	all	all
Bit Sequencer	seqb	47	all	all	all
Communication Request	comrq	88	all	all	all

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Table C-2. Programming Function Matrix - Continued

			Release		
Function	**HHP Instruction**	**HHP Function Number**	**Logicmaster 90-30/20/Micro Software**	**Micro CPU**	**Series 90-20 CPU (IC692CPU211/212)**
Table Functions					
Search equal to	sreq	101 to 104	3.02	all	all
Search not equal to	srne	105 to 108	3.02	all	all
Search less than	srlt	109 to 112	3.02	all	all
Search less than or equal to	srle	113 to 116	3.02	all	all
Search greater than	srgt	117 to 120	3.02	all	all
Search greater than or equal to	srge	121 to 124	3.02	all	all
Array move	mova	130 to 134	3.02	all	all
Conversion					
Integer to BCD	BCD	80	all	all	all
BCD to integer	INT	81	all	all	all
Control					
Comment	commnt	NA	all	all	all
End	endsw	00	all	all	all
no operation	noop*	01	all	all	all
Nested Jump	jump	03	2.01	all	all
nested master control relay	mcr	04	2.01	all	all
Target number for jump	label	07	2.01	all	all
nested endmcr	mcr	08	2.01	all	all
Master Control Relay (non-nested)	not supported	NA	all	all	all
End Master Control Relay (non-nested)	not supported	NA	2.01	all	all
Do I/O update	do_io	85	4.01	3.00	not supported
pid-isa algorithm	pidisa	86	2.01	all	all
pid-ind algorithm	pidind	87	2.01	all	all
Service Request	svcreq	89	all	all	all

*A comment is displayed by the HHP as a noop instruction. You *cannot* directly program a noop instruction with the HHP or with Logicmaster 90 software.

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Table C-3. Ranges and Sizes of User References

Reference Type	Reference Range			Size		
	14-Point Micro	23 and 28-Point Micro	Series 90-20	14-Point Micro	23 and 28-Point Micro	Series 90-20
User program logic	Not applicable			3K words	6K words	1K words
Discrete inputs	%I0001 - %I0008	%I0001 - %I0006		8 bits	16 bits	
Discrete inputs, internal	%I0009 - %I0512	%I0009 - %I0512	%I0017 - %I0048	504 bits	504 bits	32 bits
Discrete outputs	%Q0001 - %Q006	%Q0001 - %Q0012%		6 bits	12 bits	
Discrete outputs, internal w/ LED indicators	–	–	%Q0013 - %Q0016	–	–	4 bits
Discrete outputs, internal	%Q0007 - %Q0512	%Q0007 - %Q0512	%Q0017 - %Q0048	506 bits	506 bits	32 bits
Discrete globals	%G0001 - %G1280	%G0001 - %G1280		1280 bits	1280 bits	
Discrete internal coils	%M0001 - %M1024	%M0001 - %M1024		1024 bits	1024 bits	
Discrete temporary coils	%T0001 - %T0256	%T0001 - %T0256		256 bits	256 bits	
System status references	%S0001 - %S0032	%S0001 - %S0032		32 bits	32 bits	
	%SA0001 - %SA0032	%SA0001 - %SA0032		32 bits	32 bits	
	%SB0001 - %SB0032	%SB0001 - %SB0032		32 bits	32 bits	
System register references	%SC0001 - %SC0032	%SC0001 - %SC0032		32 bits	32 bits	
	%R0001 - %R0256	%R0001 - %R0256		256 words	2K words	256 words
Analog and High Speed Counter inputs	%AI0001 - %AI0128	%AI0001 - %AI0128	%AI0001 - %AI0016	128 words	128 words	16 words
Analog outputs	%AQ0001 - %AQ0128	%AQ0001 - %AQ0128	%AQ0001 - %AQ0016	128 words	128 words	16 words
System registers*	%SR0001 - %SR0016	%SR0001 - %SR0016		16 words	16 words	

*For viewing only; cannot be referenced in a user logic program.

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Appendix D Serial Port and Cables

This appendix describes the serial port, converter, and cables used to connect Series 90 PLCs for Series 90 Protocol (SNP). Sample cable diagrams are provided for some of the many point-to-point and multidrop system configurations that are possible for Series 90 PLCs.

- RS-422 Interface D-1
- Cable and Connector Specifications D-2
- Port Configurations D-3
- Serial Cable Diagrams D-7
  - Point-to-Point Connections D-7
  - Multidrop Connections D-12

RS-422 Interface

The Series 90 PLC products are compatible with EIA RS-422 specifications. RS-422 drivers and receivers are used to provide communications between system components that use multiple driver/receiver combinations on a single cable with five twisted pairs.

Caution

Care must be taken that common mode voltage specifications are met. Common mode conditions that exceed those specified will result in errors in transmission and/or damage to Series 90 PLC components.

Table D-1. System Connection Specifications

Cable type	Five twisted pairs (See Table D-2 for cable specifications.)
Maximum cable length	4000 feet (1200 meters)
Multidrop system configuration	Up to eight drivers and receivers (Although this number can be increased with the use of a repeater, signal quality may be diminished.)
Maximum common mode voltage between drops	RS-422 standard (+7 volts to -7 volts)
Driver requirements Output Output impedance	 ±2V minimum into 100 ohms 120 Kohms minimum in the high impedance state.
Receiver Input resistance Sensitivity	 12 Kohms or greater ±200 millivolt.

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Cable and Connector Specifications

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

Table D-2. Connector/Cable Specifications

Item	Description
Mating Connectors	**Series 90 PLC:** Serial (RS-422) port with ***metric*** hardware Connector: 15-pin male, D-Subminiature Type, Cannon DA15S (solder pot) Hood: AMP 207470-1 connector shell Hardware Kit: AMP 207871-1 Kit includes 2 metric screws and 2 screw clips
	Workmaster II: Serial (RS-232) port with standard RS-232 connector Connector: 25-pin female, D-Subminiature Type, Cannon DB25S (solder pot) with DB110963-3 hood or equivalent (standard RS-232 connector)
	Workmaster: Serial (RS-232) port with standard RS-232 connector Connector: 9-pin female, D-Subminiature Type, Cannon DE9S (solder pot) with DE110963-1 hood or equivalent (standard RS-232 connector)
	IBM-AT/XT: Serial (RS-232) port with standard RS-232 connector Connector: 9-pin female, D-Subminiature Type, Cannon DE9S (solder pot) with DE110963-31 hood or equivalent (standard RS-232 connector)
	RS-232/RS-485 Converter: one 15-pin male, and one 25-pin male connector 15-pin male connector requires metric hardware (same connector, hood, and hardware as for Series 90 PLC listed above) 25-pin male D-Subminiature Type, Cannon DA25S (solder pot) with DB110963-3 hood or equivalent (standard RS-232 connector)
Cable	Computer grade, 24 AWG (.22 mm^2), minimum with overall shield Catalog Numbers: Belden 9505, Belden 9306, Belden 9832 These cables provide acceptable operation for data rates up to 19.2 Kbps as follows: RS-232: 50 feet (15 meters) maximum cable length RS-422/RS-422: 4000 feet (1200 meters) maximum length. Must not exceed the maximum RS-422 Common Mode specification of +7V to -7V. Isolation at the remote end can be used to reduce or eliminate Common Mode voltages. At shorter distances under 50 feet (15 meters), almost any twisted pair or shielded twisted pair cable will work, as long as the wire pairs are connected correctly. When using RS-422/RS-422, the twisted pairs should be matched so that both transmit signals make up one twisted pair and both receive signals make up the other twisted pair. If this is ignored, cross-talk resulting from the mismatching will affect the performance of the communications system. When routing communication cables outdoors, transient suppression devices can be used to reduce the possibility of damage due to lightning or static discharge. Care should be exercised that all connected devices are grounded to a common point. Failure to do so could result in damage to the equipment.

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Port Configurations

Series 90 PLC Serial Port

The Series 90 PLC serial port is compatible with RS-422. An RS-232 to RS-422 converter is required to interface to systems that provide RS-232 compatible interfaces. The Series 90 PLC, RS-422 serial port provides the physical connection for SNP communication. This port is a 15-pin D-type female connector located as follows:

- Series 90-70, Series 90-20, and Series 90 Micro PLCs – CPU Module
- Series 90-30 PLC – Power Supply

Figure D-1 shows the serial port orientation and connector layout for the Series 90 PLC types. Table D-3 lists the pin numbering and signal assignments, which are the same for both serial port layouts.

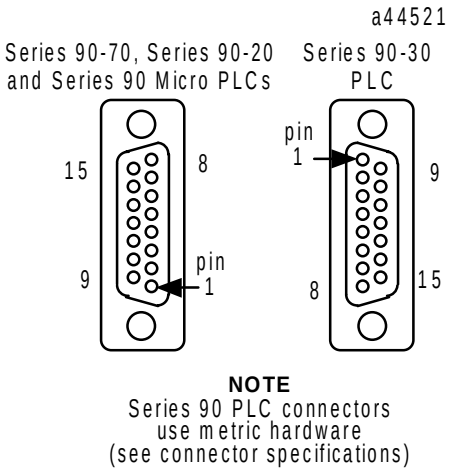


Figure D-1. Series 90 PLC, RS-422 Serial Port Connector Configuration

Note

The cable connector for the Series 90-70, Series 90-30, and Series 90 Micro PLC serial port must be a right angle connector in order for the hinged door on the module to close properly. Refer to “Connector/Cable Specifications,” Table D-2.

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Table D-3. RS-422 15-Pin Connector Assignments

Pin	Signal Name	Description
1	Shield	Shield
2	NC	No connection
3	No connection	No connection
4	ATCH* (Port 1)	Hand-Held Programmer attach signal
	NC (Port 2)	No connection on Serial Port 2 of 28-point Micro PLCs
5	+5VDC*	See “Specifications” in Chapter 2 for capacity on Micro PLCs
6	RTS (A)	Request To Send
7	Signal Ground, 0V	Signal Ground
8	CTS (B’)	Clear to Send
9	RT*	Terminating resistor for RD**
10	RD (A’)	Receive Data
11	RD (B’)	Receive Data
12	SD (A)	Send Data
13	SD (B)	Send Data
14	RTS (B)	Request To Send
15	CTS (A’)	Clear to Send

* Signals available at the connector but are not included in the RS-422 specification.

** Termination resistance for the Receive Data (RD) signal needs to be connected only on units at the end of the lines. This termination is made on the Series 90 PLC products by connecting a jumper between pins 9 and 10 inside the 15-pin D-shell with the following exception. For Series 90-70 PLCs with catalog numbers IC697CPU731J and IC697CPU771G (and earlier), the termination for RD at the PLC is implemented by a jumper between pins 9 and 11.

SD (Send Data) and RD (Receive Data) are the same as TXD and RXD (used in the Series Six PLC). (A) and (B) are the same as - and + . A and B denote outputs, and A’ and B’ denote inputs.

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Workmaster Serial Port

The Workmaster II industrial computer, RS-232 serial port is a 25-pin D-type male connector, and the early model Workmaster is a 9-pin male connector.

Figure D-2 shows the serial port connector layout for both computers. Table D-4 shows the pin numbering and signal assignment for both connector types.

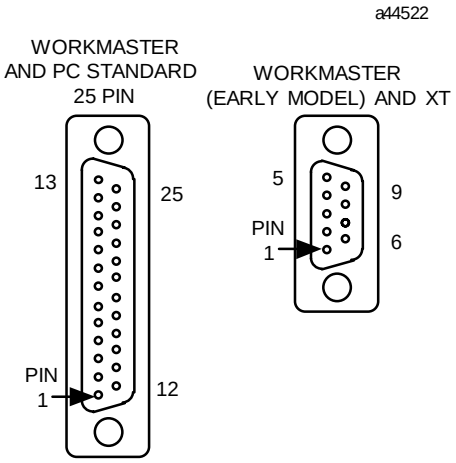


Figure D-2. Workmaster RS-232 Serial Port Connector Configuration

Table D-4. Workmaster RS-232 Serial Port Pinout

Workmaster II (25-pin connector)		
Pin No.	**Signal**	**Description**
1		Not Connected
2	TD	Transmit Data
3	RD	Receive Data
4	RTS	Request to Send
5	CTS	Clear to Send
6		Not Connected
7	GND	Signal Ground
8	DCD	Data Carrier Detect
9,10		Not Connected
11		Tied to line 20
12-19		Not Connected
20	DTR	Data Terminal Ready
21		Not Connected
22		Ring Indicate
23-25		Not Connected

Workmaster (9-pin connector)		
Pin No.	**Signal**	**Description**
1		Not Connected
2	TD	Transmit Data
3	RD	Receive Data
4	RTS	Request to Send
5	CTS	Clear to Send
6		Not Connected
7	GND	Signal Ground, 0V
8	DCD	Data Carrier Detect
9	DTR	Data Terminal Ready

For more information about the Workmaster industrial computer serial port refer to the following manuals:

Workmaster II PLC Programming Unit Guide to Operation, GFK-0401
Workmaster Programmable Control Information Center Guide to Operation, GEK-25373

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IBM-AT Serial Port

The IBM-AT or compatible computer's RS-232 serial port is a 9-pin D-type male connector as shown in the figure below.

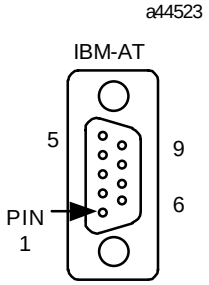


Figure D-3. IBM-AT Serial Port

Table D-5. IBM-AT Serial Port Pinout

IBM-AT Pin No.	Signal	Description
1	DCD	Data Carrier Detect
2	RD	Receive Data
3	TD	Transmit Data
4	DTR	Data Terminal Ready
5	GND	Signal Ground
6		Not Connected
7	RTS	Request to Send
8	CTS	Clear to Send
9		Not Connected

IBM-XT Pin No.	Signal	Description
1		Not Connected
2	TD	Transmit Data
3	RD	Receive Data
4	RTS	Request to Send
5	CTS	Clear to Send
6		Not Connected
7	GND	Signal Ground
8	DCD	Data Carrier Detect
9	DTR	Data Terminal Ready

RS-232/RS-485 Converter

The RS-232/RS-485 Converter (IC690ACC900) can be used to convert from RS-232 to RS-422/RS-485 communications. The converter has one 15-pin female D-type port, and one 25-pin female D-type port.

This converter unit can be purchased from GE Fanuc Automation. Please contact any GE Fanuc Automation sales office or field service representative.

For detailed information on the converter, refer to Appendix E. Examples of serial cable diagrams that include the converter are provided in the remainder of this appendix.

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Serial Cable Diagrams

Point-to-Point Connections

In the point-to-point configuration only two devices can be connected to the same communication line. The communication line can be directly connected using RS-232 (50 feet, 15 meters maximum) or RS-485 (4000 feet, 1200 meters maximum). Modems can be used for longer distances.

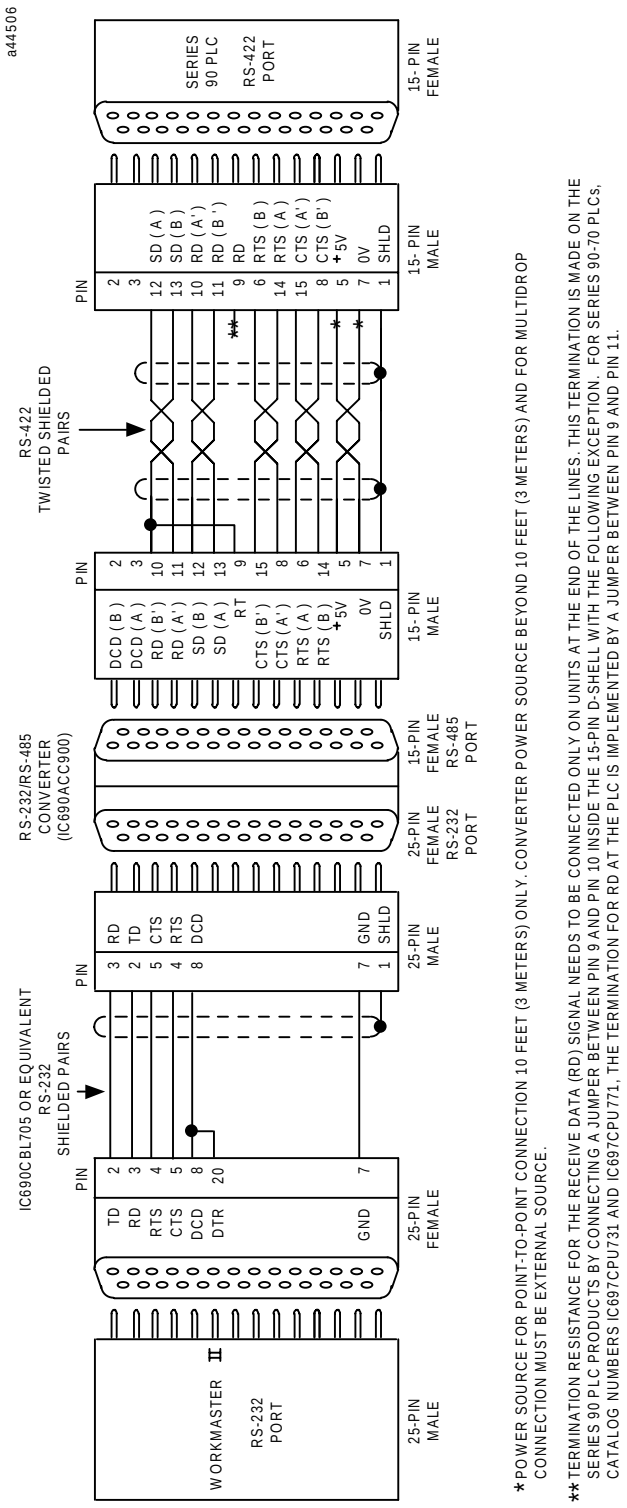
Note

The cable connector for the Series 90-70, Series 90-30, and Series 90 Micro PLC serial port must be a right angle connector in order for the hinged door on the module to close properly. Refer to “Connector/Cable Specifications” in Table D-2.

RS-232 Point-to-Point Connections

Figures D-3 through D-5 illustrate typical RS-232 point-to-point connections to Series 90 PLCs.

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* POWER SOURCE FOR POINT-TO-POINT CONNECTION 10 FEET (3 METERS) ONLY. CONVERTER POWER SOURCE BEYOND 10 FEET (3 METERS) AND FOR MULTIDROP CONNECTION MUST BE EXTERNAL SOURCE.

** TERMINATION RESISTANCE FOR THE RECEIVE DATA (RD) SIGNAL NEEDS TO BE CONNECTED ONLY ON UNITS AT THE END OF THE LINES. THIS TERMINATION IS MADE ON THE SERIES 90 PLC PRODUCTS BY CONNECTING A JUMPER BETWEEN PIN 9 AND PIN 10 INSIDE THE 15-PIN D-SHELL WITH THE FOLLOWING EXCEPTION. FOR SERIES 90-70 PLCs, CATALOG NUMBERS IC697CPU731 AND IC697CPU771, THE TERMINATION FOR RD AT THE PLC IS IMPLEMENTED BY A JUMPER BETWEEN PIN 9 AND PIN 11.

Figure D-4. Workmaster II (25-pin) Serial Connection to Series 90 PLCs

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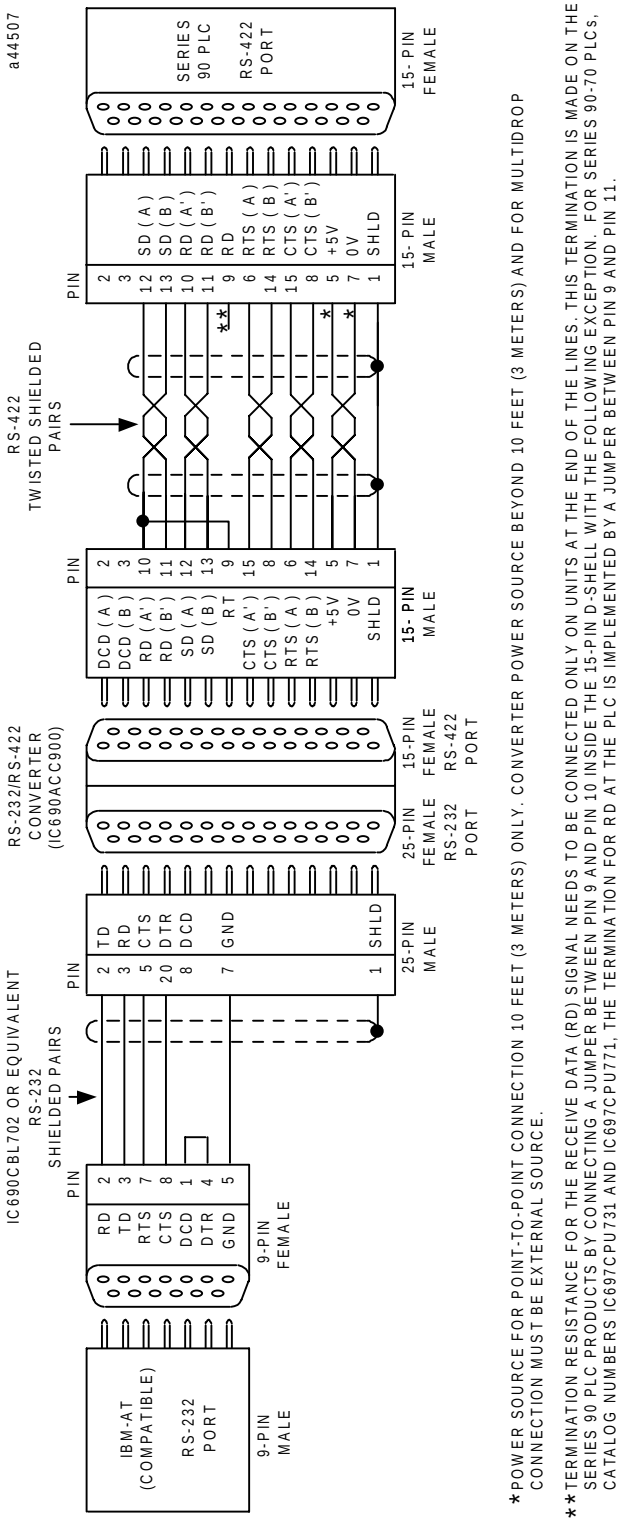


Figure D-5. IBM-AT (compatibles) Personal Computer to Series 90 PLCs

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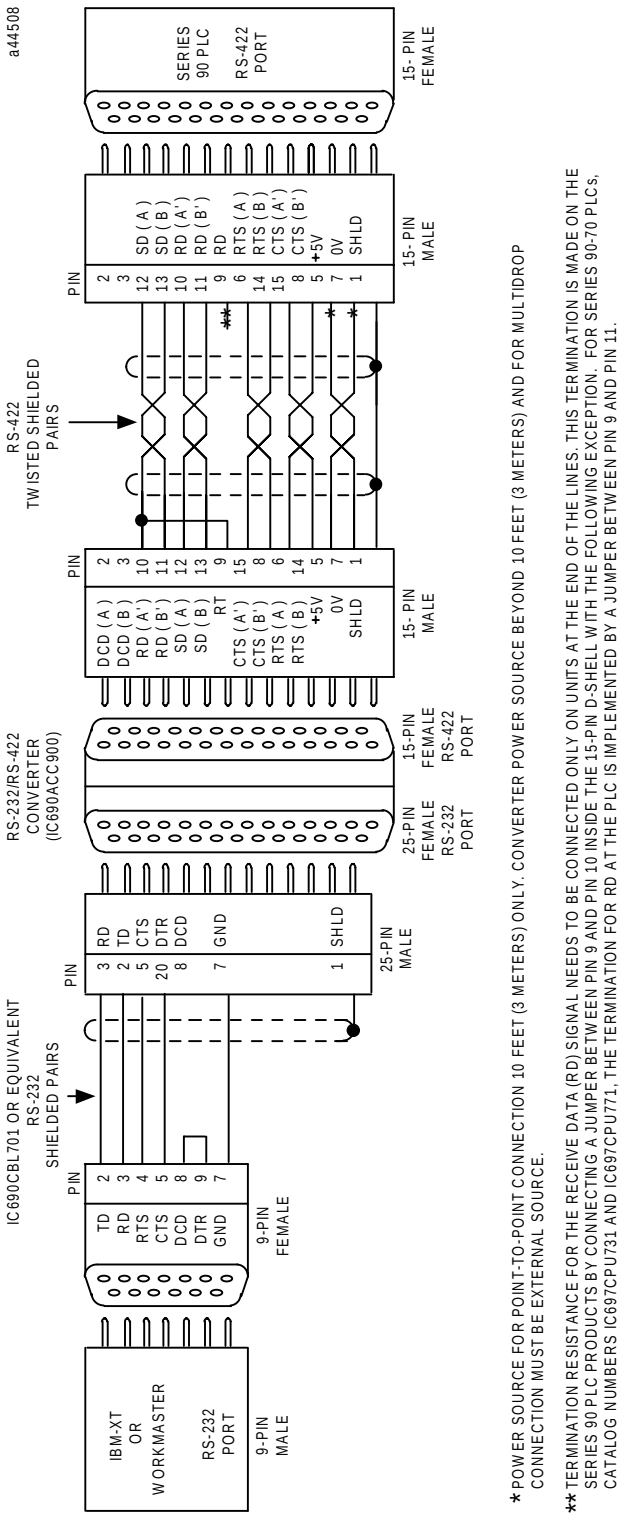
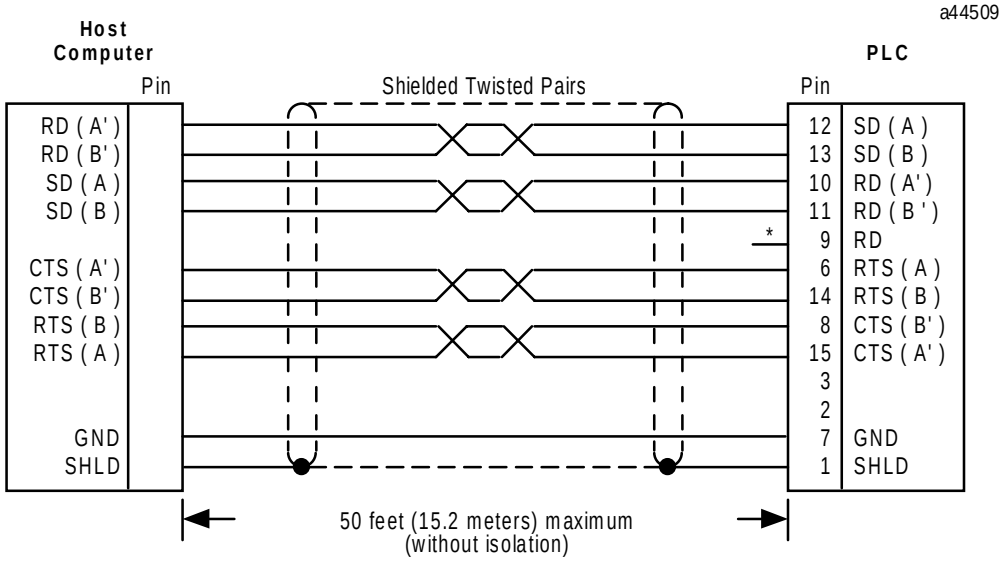


Figure D-6. Workmaster or IBM-XT (compatibles) Personal Computer to Series 90 PLCs

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RS-422 Point-to-Point Connection

If your host device is equipped with an RS-422 card, you can connect directly to Series 90 PLCs as illustrated in the following figure.



* Termination resistance for the receive data (RD) signal needs to be connected only on units at the end of the lines. This termination is made on the Series 90 PLC products by connecting a jumper between pin 9 and pin 10 inside the 15-pin D-shell with the following exception: for Series 90-70 PLCs, catalog numbers IC697CPU731 and IC697CPU771, the termination for RD at the PLC is implemented by a jumper between pin 9 and pin 11.

Figure D-7. Typical RS-422, Host to PLC Connection, with Handshaking

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Multidrop Connections

In a multidrop configuration, the host device is configured as the master and one or more PLCs are configured as slaves. This method can be used when the maximum distance between the master and any slave does not exceed 4000 feet (1200 meters). This figure assumes good quality cables and a moderately noisy environment. A maximum of eight slaves can be connected using RS-422 in a *daisy chain* or multidrop configuration. The RS-422 line must include handshaking and use wire type as specified in the "Cable and Connector Specifications" section.

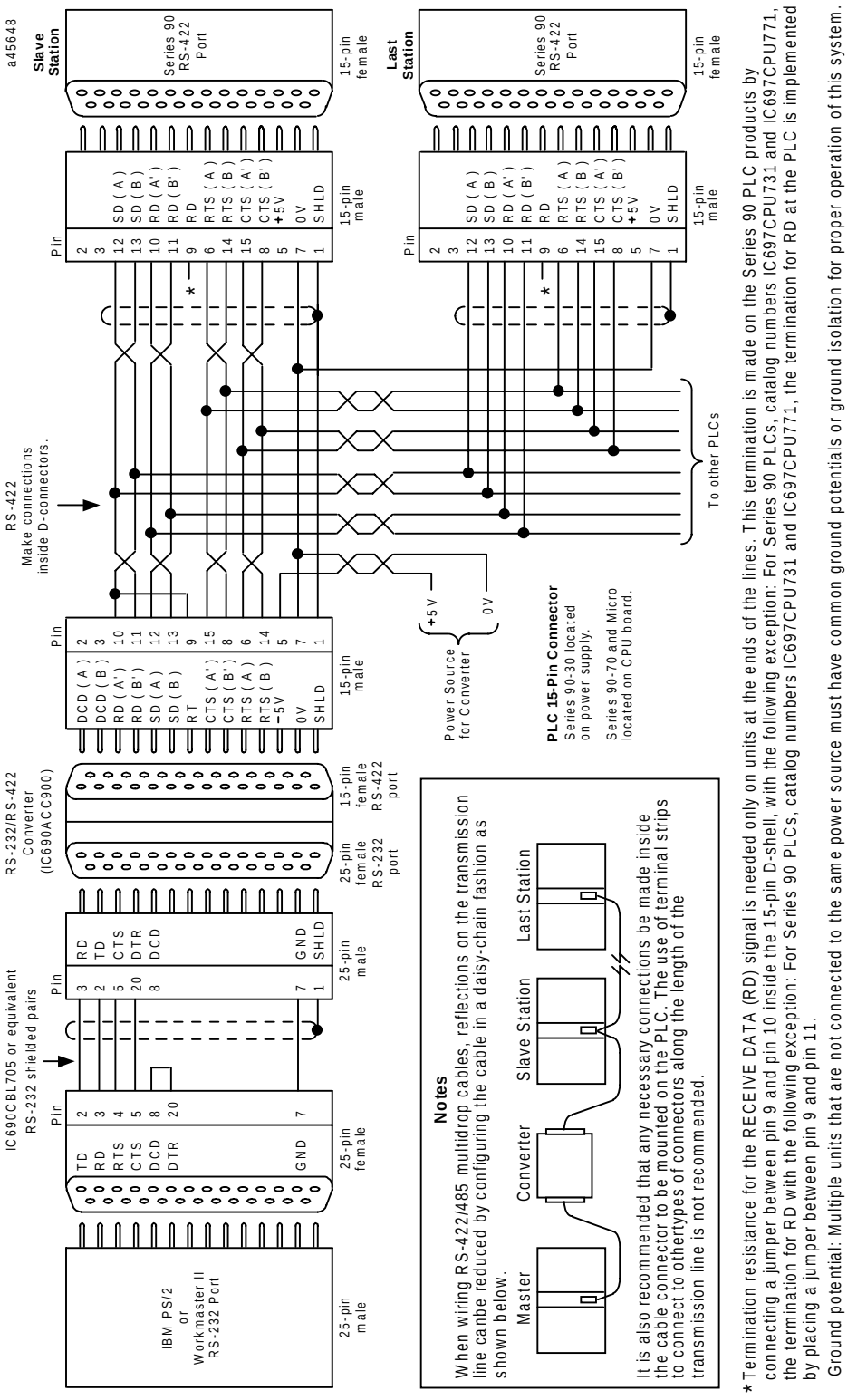
Programmer-to-Series 90 PLC Connections

The following illustrations show wiring diagrams and requirements for connecting a Workmaster II or IBM-PS/2, Workmaster, IBM-AT/XT or compatible computer to Series 90 PLCs in an eight-wire multidrop, serial data configuration.

Figure D-8 provides an example of the wiring configuration required for the multidrop configuration when using the RS-422/RS-485 to RS-232 converter. Figure D-9 illustrates the wiring configuration required when a Work Station Interface (WSI) board is installed in the computer. The 37-pin serial port connector for Workmaster II and Workmaster computers is on the WSI board in the programming computer. The cable type for these connections should be 24 AWG (0.22 mm^2), 30V computer grade. Extra flexible cable construction is recommended for short lengths.

Figures D-10 through D-12 show wiring diagrams and requirements for connecting a Workmaster II or IBM-PS/2, Workmaster, IBM-AT or compatible computer to Series 90 PLCs in an eight-wire multidrop, serial data configuration.

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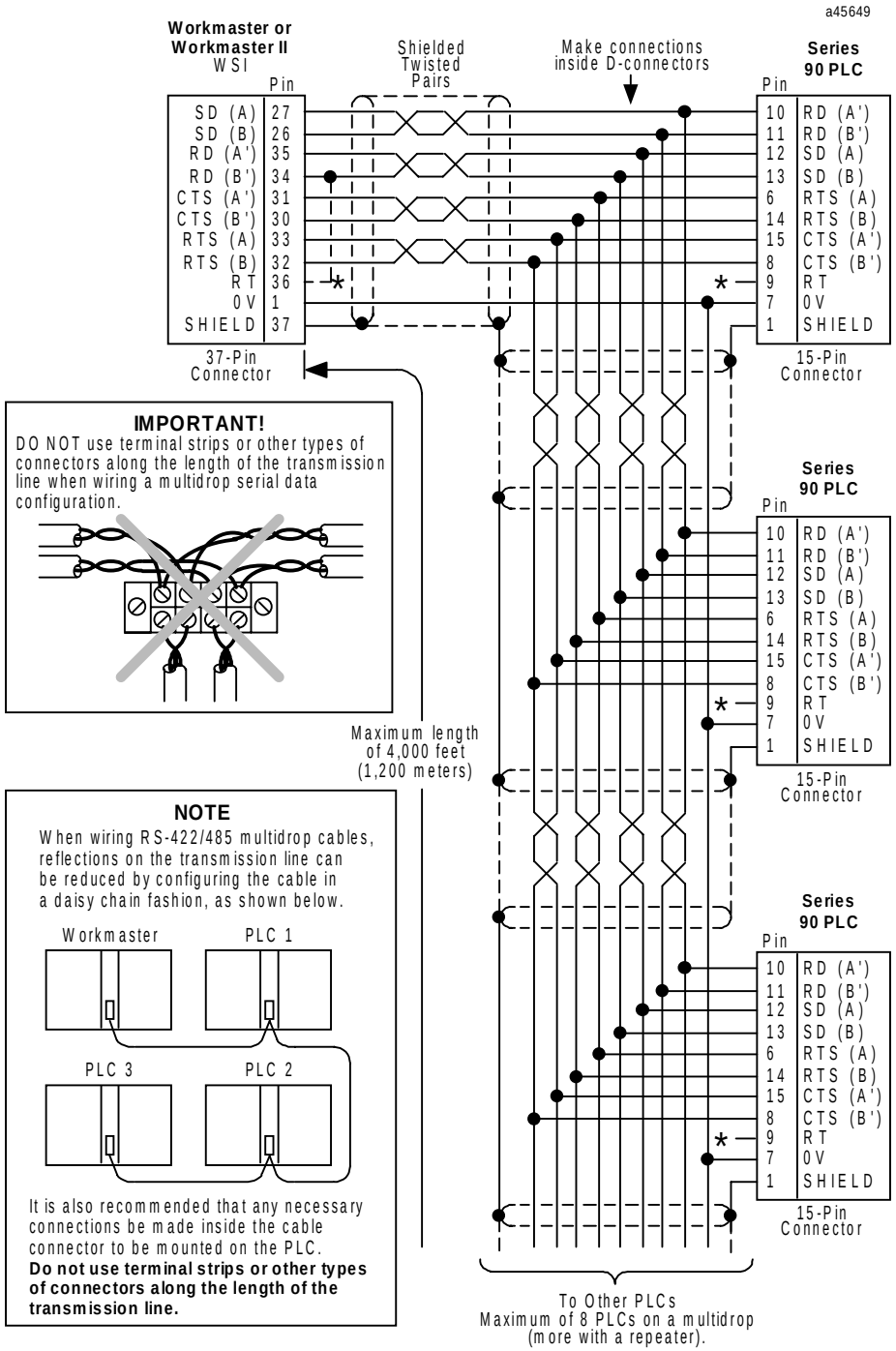


* Termination resistance for the RECEIVE DATA (RD) signal is needed only on units at the ends of the lines. This termination is made on the Series 90 PLC products by connecting a jumper between pin 9 and pin 10 inside the 15-pin D-shell, with the following exception: For Series 90 PLCs, catalog numbers IC697CPU731 and IC697CPU771, the termination for RD with the following exception: For Series 90 PLCs, catalog numbers IC697CPU731 and IC697CPU771, the termination for RD at the PLC is implemented by placing a jumper between pin 9 and pin 11.

Ground potential: Multiple units that are not connected to the same power source must have common ground potentials or ground isolation for proper operation of this system.

Figure D-8. Multidrop Configuration with Converter

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* Termination resistance for the RECEIVE DATA (RD) signal is needed only on units at the ends of the lines. This termination is made on the Series 90 PLC products by connecting a jumper between pin 9 and pin 10 inside the 15-pin D-shell, with the following exception: For Series 90 PLCs, catalog numbers IC697CPU731 and IC697CPU771, the termination for RD at the PLC is implemented by placing a jumper between pin 9 and pin 11.

CAUTION

Ground potential: Multiple units that are not connected to the same power source must have ground potential within ±7V for proper operation of this system. Failure to provide a common ground may cause damage to PLC components.

Figure D-9. WSI Multidrop Cabling to Series 90 PLC

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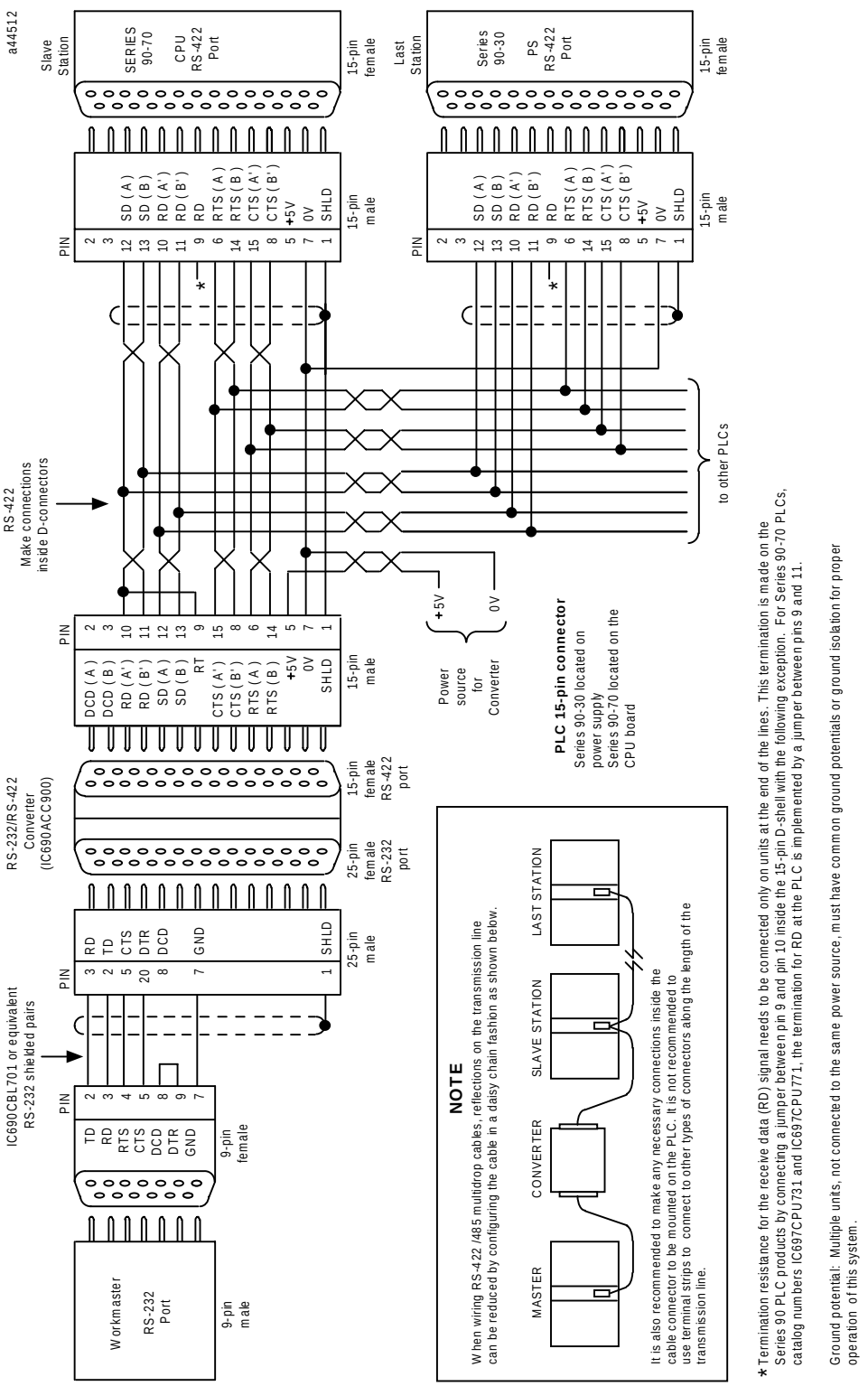


Figure D-10. Workmaster/Series 90 PLC Multidrop Connection

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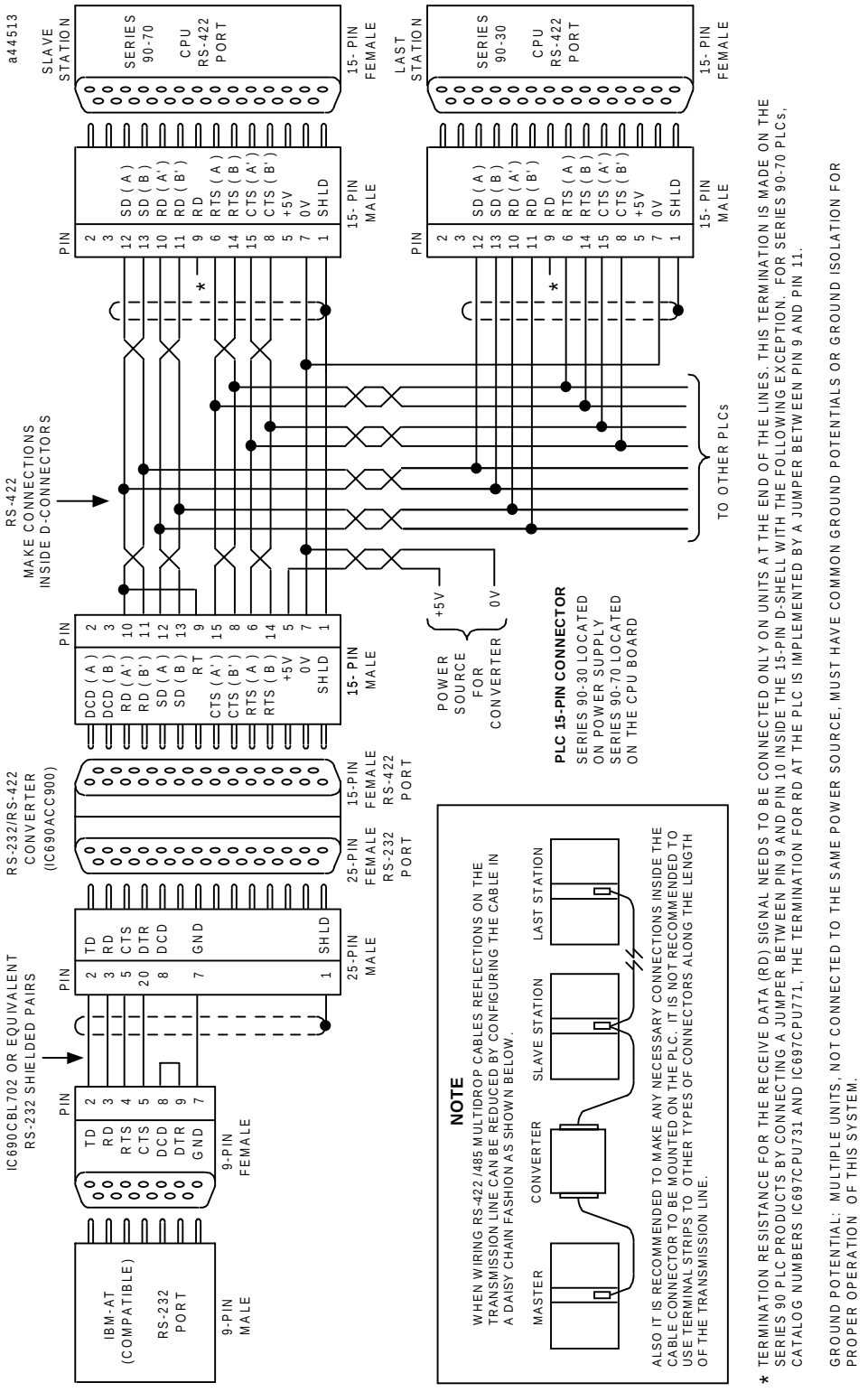


Figure D-11. IBM-AT/Series 90 PLC Multidrop Connection

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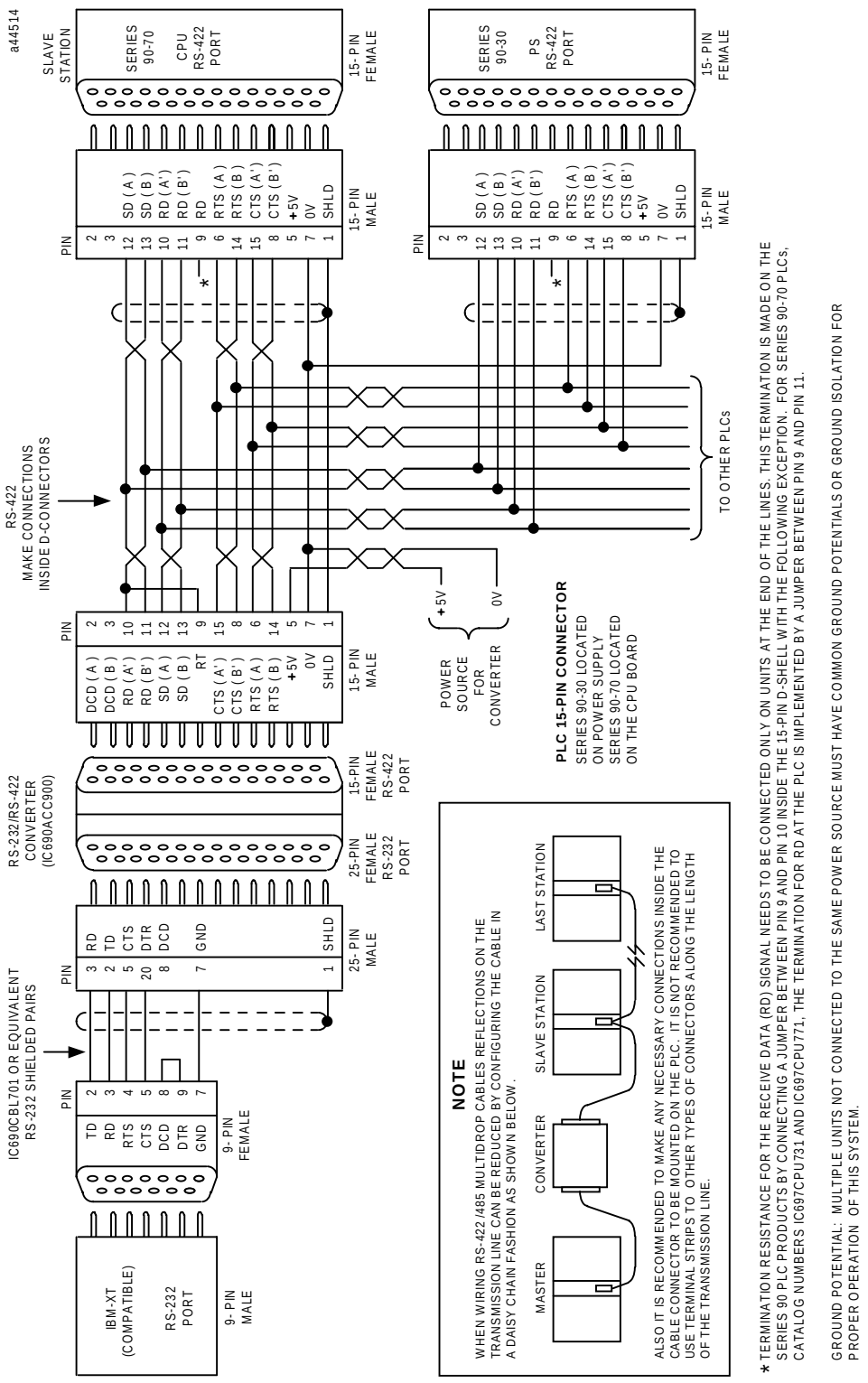


Figure D-12. IBM-XT/Series 90 PLC Multidrop Connection

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PLC-to-PLC Master/Slave Connections

The 23 and 28-point Micro PLCs can operate as an SNP/SNPX master in a multidrop system that meets the requirements for Series 90 devices. For system requirements, see Tables D-1 and D-2. Figure D-13 shows possible configurations of systems that use the 23 or 28-point Micro PLC as an SNP/SNPX master.

Figure D-14 shows a sample multidrop configuration with a Micro PLC as an SNP/SNPX master that controls two Micro PLCs, a Series 90 CMM, and an Isolated Repeater/Converter (IC655CMM590), known as a "Brick." The Brick connects additional Series 90 PLCs. Figure D-15 details the cabling that connects the Micro PLC master to the slave devices. Note that, in this diagram, an RTU master without flow control can replace the SNP/SNPX master. (The Micro PLC operates as an RTU slave only.) To use an RTU master with hardware flow control, cabling must be configured as shown in Figure D-16. For a description of RTU protocol, refer to the *Series 90 PLC Serial Communications User's Manual*, GFK-0582. For details on Series 90 products other than the Micro PLC, refer to the appropriate user's and installation manuals.

Figures D-17 and D-18 detail the cabling that connects the Isolated Repeater/Converter to downstream slave devices, with and without hardware flow control, respectively. (For more information about the Isolated Repeater/Converter, refer to Appendix E.)

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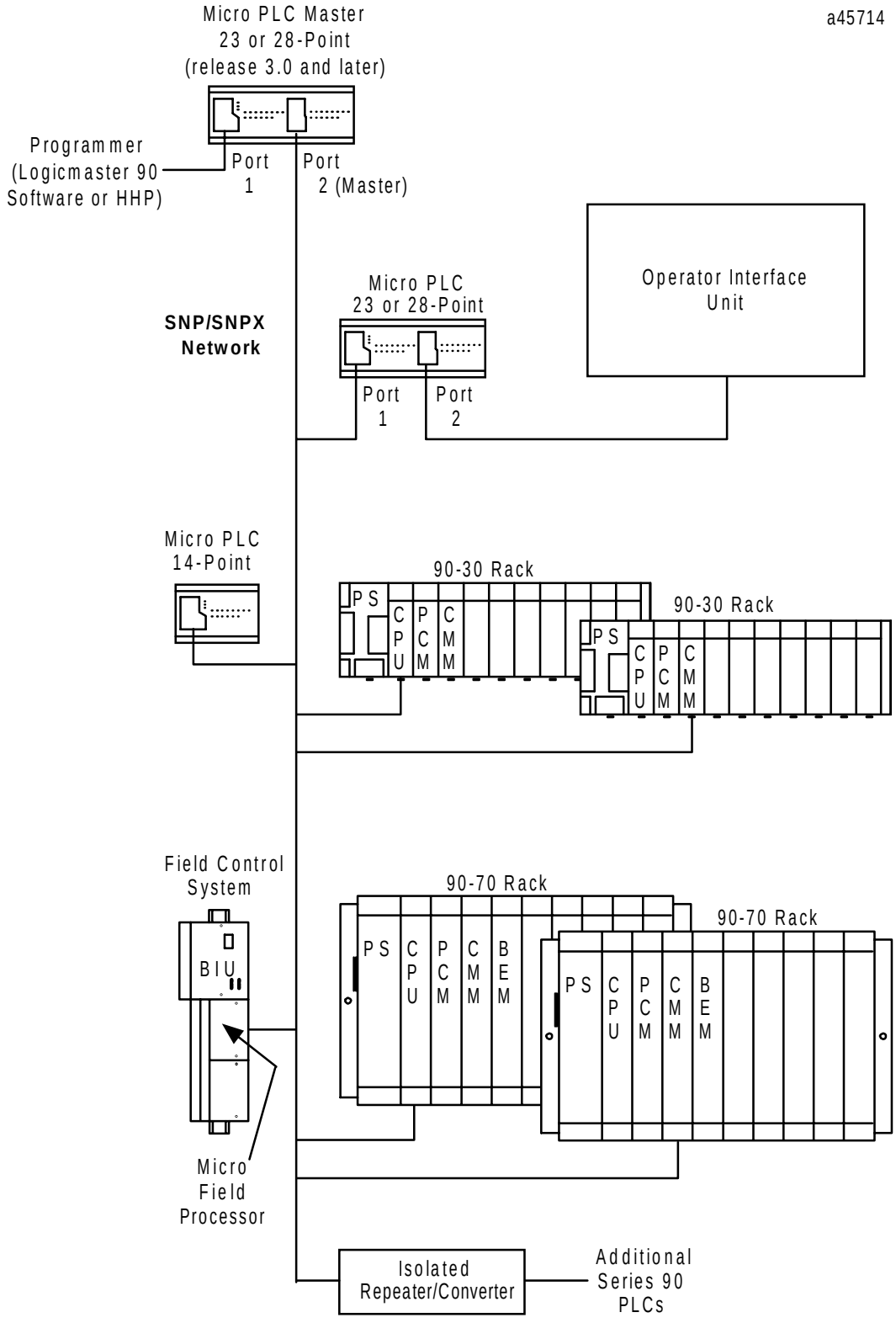
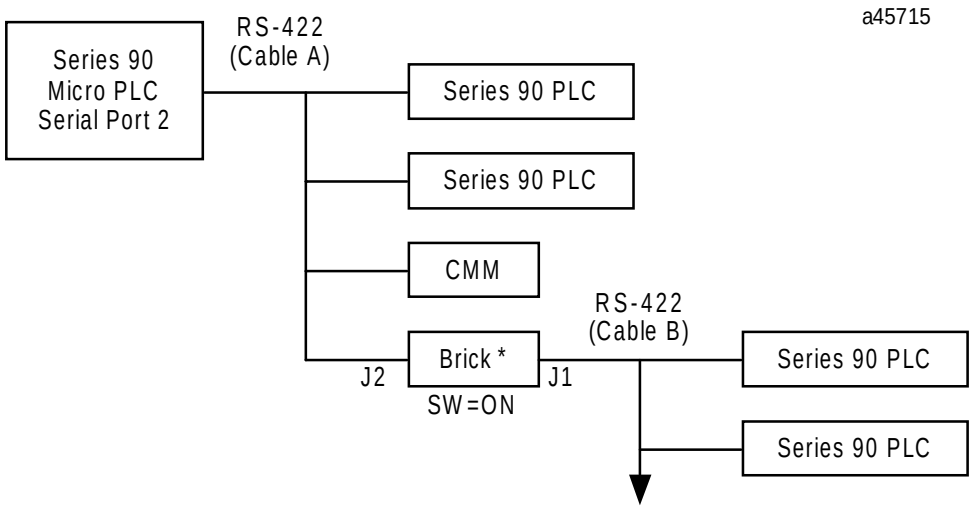


Figure D-13. Example Connections to Micro SNP/SNPX Master

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*Brick is the nickname for the Isolated Repeater/Converter.

Figure D-14. Sample Micro SNP/SNPX Multidrop System

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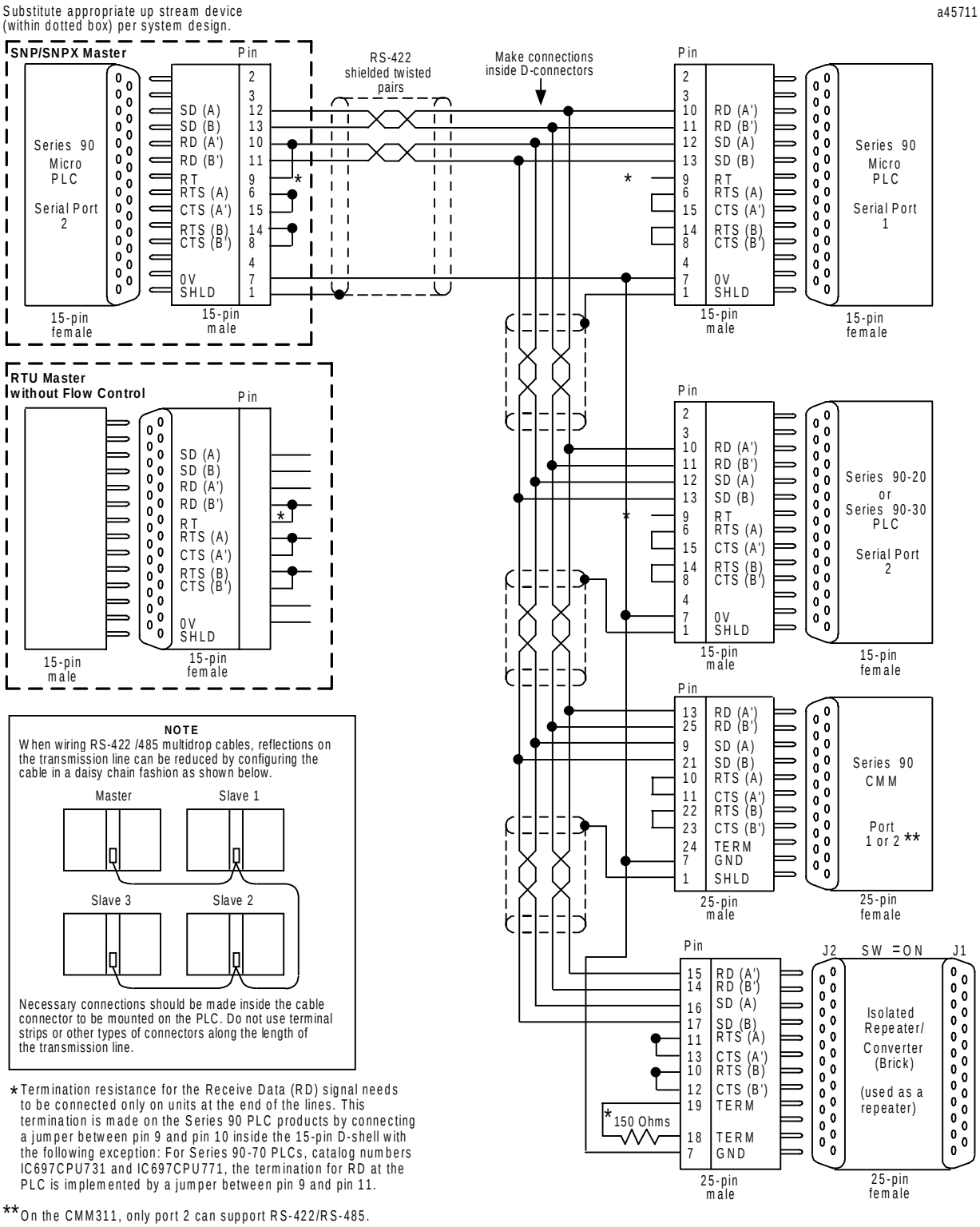
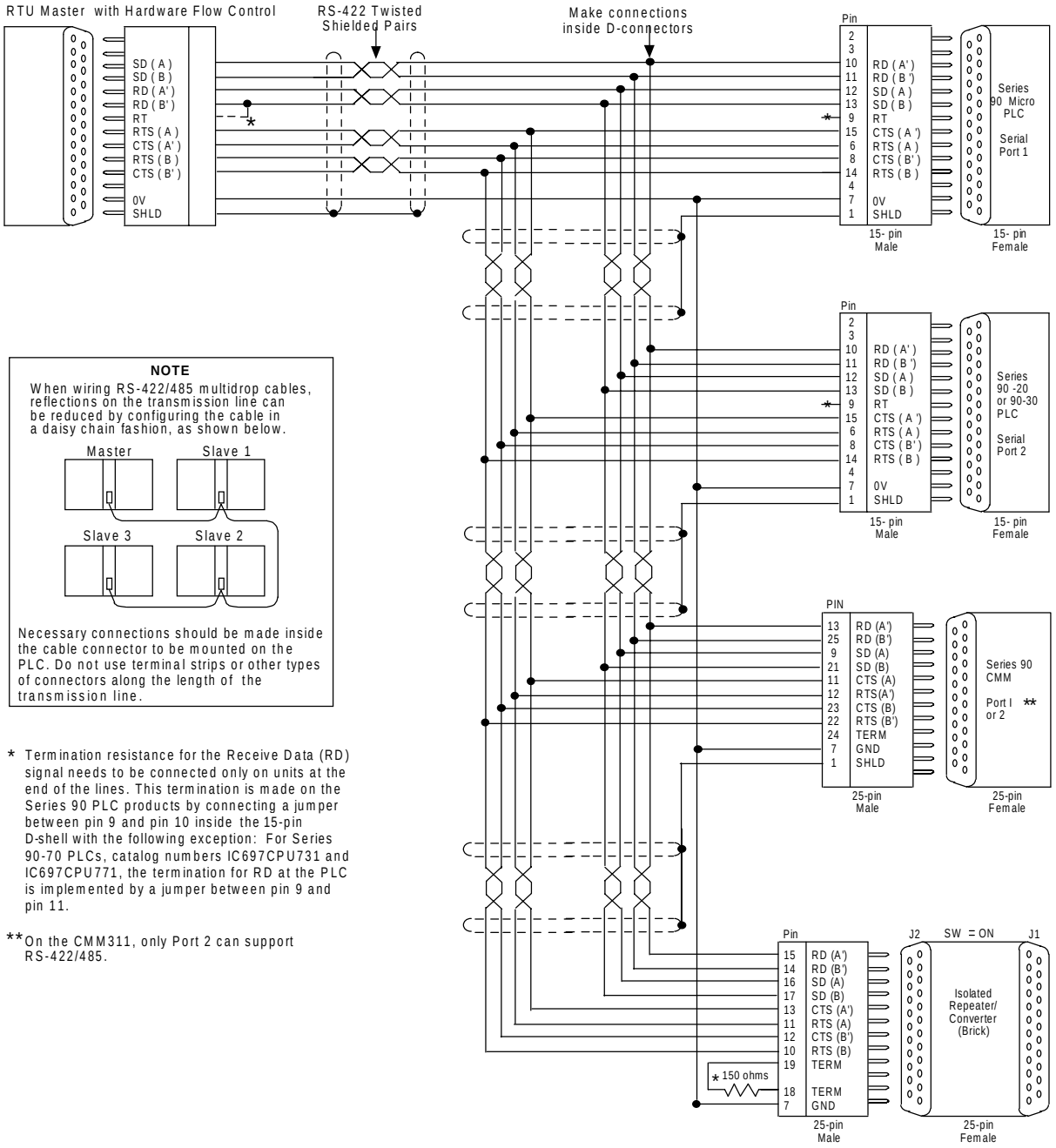


Figure D-15. Cable A: Master to Slaves (SNP Master or RTU Master without Flow Control)

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NOTE

When wiring RS-422/485 multidrop cables, reflections on the transmission line can be reduced by configuring the cable in a daisy chain fashion, as shown below.

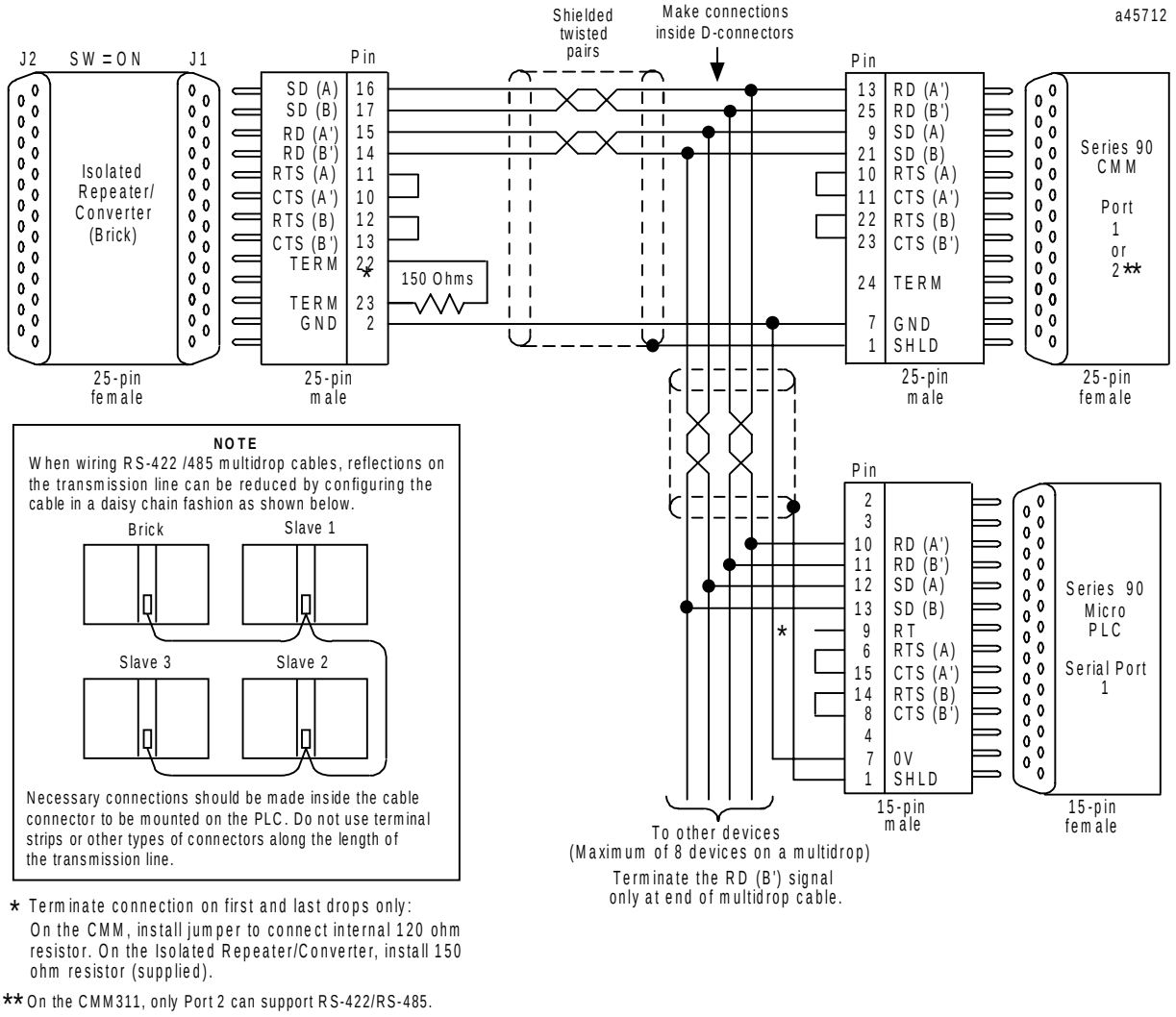
Necessary connections should be made inside the cable connector to be mounted on the PLC. Do not use terminal strips or other types of connectors along the length of the transmission line.

* Termination resistance for the Receive Data (RD) signal needs to be connected only on units at the end of the lines. This termination is made on the Series 90 PLC products by connecting a jumper between pin 9 and pin 10 inside the 15-pin D-shell with the following exception: For Series 90-70 PLCs, catalog numbers IC697CPU731 and IC697CPU771, the termination for RD at the PLC is implemented by a jumper between pin 9 and pin 11.

** On the CMM311, only Port 2 can support RS-422/485.

Figure D-16. Cable A: Master to Slaves (RTU Master with Hardware Flow Control)

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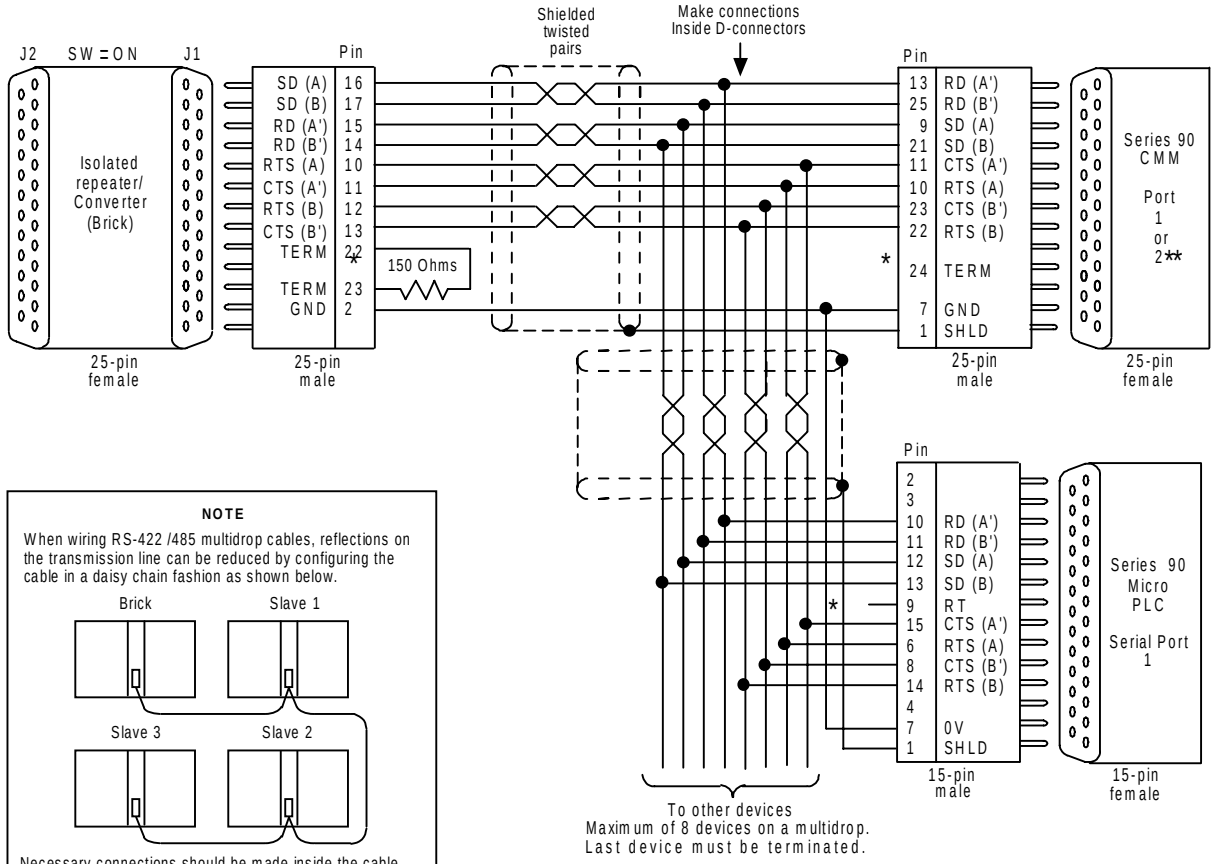


* Terminate connection on first and last drops only: On the CMM, install jumper to connect internal 120 ohm resistor. On the Isolated Repeater/Converter, install 150 ohm resistor (supplied).

** On the CMM311, only Port 2 can support RS-422/RS-485.

Figure D-17. Cable B: Brick to Slaves (without Flow Control)

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* Termination resistance for the Receive Data (RD) signal needs to be connected only on units at the end of the lines. This termination is made on the Series 90 PLC products by connecting a jumper between pin 9 and pin 10 inside the 15-pin D-shell with the following exception: For Series 90-70 PLCs, catalog numbers IC697CPU731 and IC697CPU771, the termination for RD at the PLC is implemented by a jumper between pin 9 and pin 11.

On the CMM, install jumper to connect internal 120 ohm resistor. On the Isolated Repeater/Converter, install 150 ohm resistor (supplied).

** On the CMM311, only Port 2 can support RS-422/RS-485.

Figure D-18. Cable B: Brick to Slaves (with Hardware Flow Control)

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A master/slave network can be made up of 23 and 28-point Micro PLCs as shown in Figure D-19. The Micro PLC firmware does not limit the number of levels in the network. However, the time required for communications between the top and bottom levels could limit the number of levels that can be used in your application.

The RS-422 protocol limits the number of slaves per master to eight. More slaves can be added if a repeater is used. In the example below, each master device acts as a repeater.

To implement a network similar to the one below, Port 2 on each of the master PLCs must be configured as an SNP Master. For a sample ladder logic program that initiates SNP between a master and a slave device, refer to "SNP COMMREQ Programming Examples" in Chapter 6 of the *Series 90™ PLC Serial Communications User's Manual*, GFK-0582.

Note

In communications logic using COMM_REQ function blocks you should use the following parameters:

SYS ID should be 0001 for Rack 0, Slot 1
TASK ID should be 20 (14H) for Micro PLC Port 2

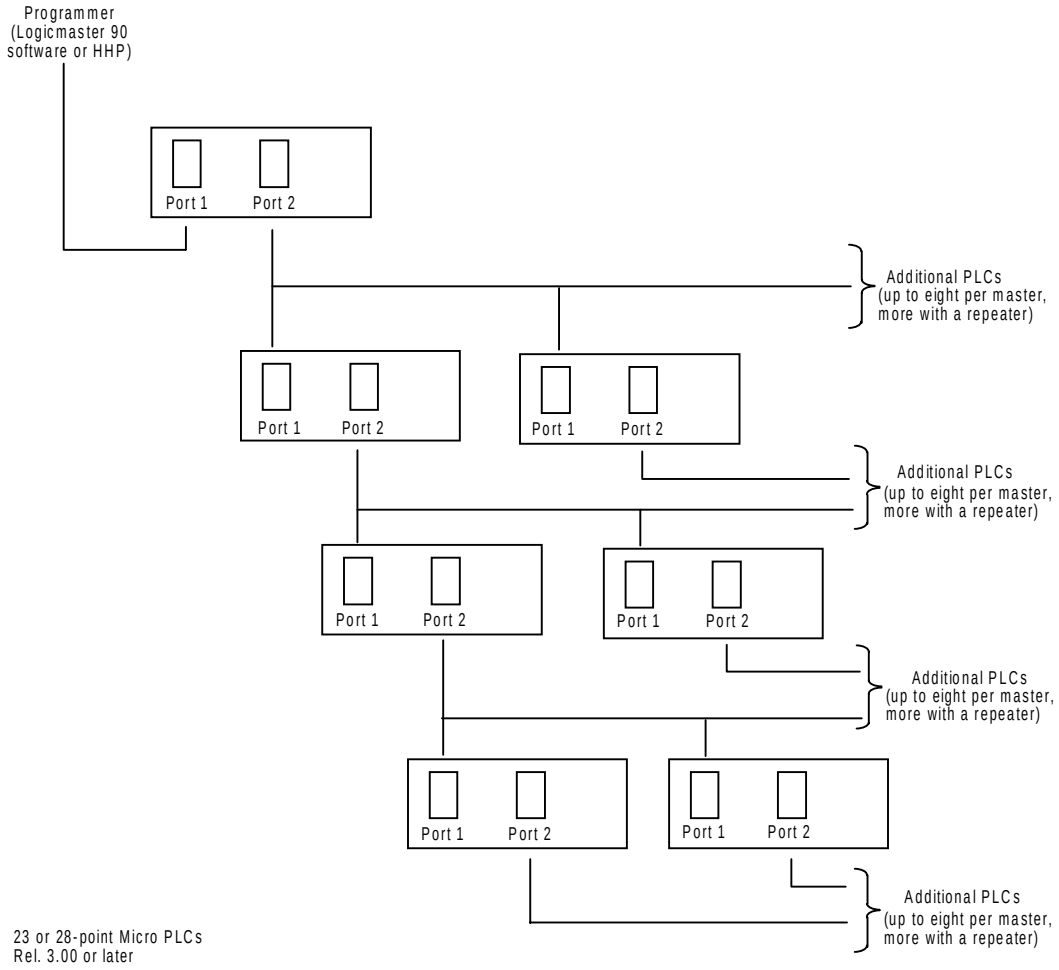


Figure D-19. Sample Micro PLC Network

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Appendix E Converters

This appendix provides detailed descriptions of the following converters:

- RS-422/RS-485 to RS-232 Converter E-2
- Miniconverter Kit E-9
- Isolated Repeater/Converter E-13

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

This section provides a detailed description of the RS-422/RS-485 to RS-232 Converter (IC690ACC900) for the Series 90 Programmable Logic Controllers.

Features

- Provides the Series 90 PLCs with an interface to devices that use the RS-232 interface.
- Allows connection to a programming computer without a Work Station Interface board.
- Easy cable connection to a Series 90-70 PLC, Series 90-30 PLC, or Series 90 Micro PLC.
- No external power needed; operates from +5 volt DC power provided by the Series 90 PLC.
- Convenient, lightweight self-contained unit.

Functions

The RS-422/RS-485 to RS-232 Converter provides an RS-232 serial interface for the Series 90 PLCs, which have a built-in RS-422/RS-485 interface. Specifically, it provides a serial connection between a Series 90 PLC serial port and the serial port on the programming computer without the need for a Work Station Interface to be installed in the computer. The programming computer can be a Workmaster II computer, or IBM PS/2 or compatible computer.

Location in System

The RS-422/RS-485 to RS-232 converter is a free-standing device that requires two cables as the connections between the PLC and the programmer. Its location is limited only by the length of the connecting cables as listed in the interface specifications in "Specifications." The cable at the PLC end that connects to the RS-422/RS-485 connector on the converter can be up to 10 feet in length (without an external source of +5 VDC) and up to 1000 feet (300m) in length with an external source of +5 VDC. The cable from the RS-232 connector on the converter to the programming computer's serial port can be up to 50 feet (15m) in length.

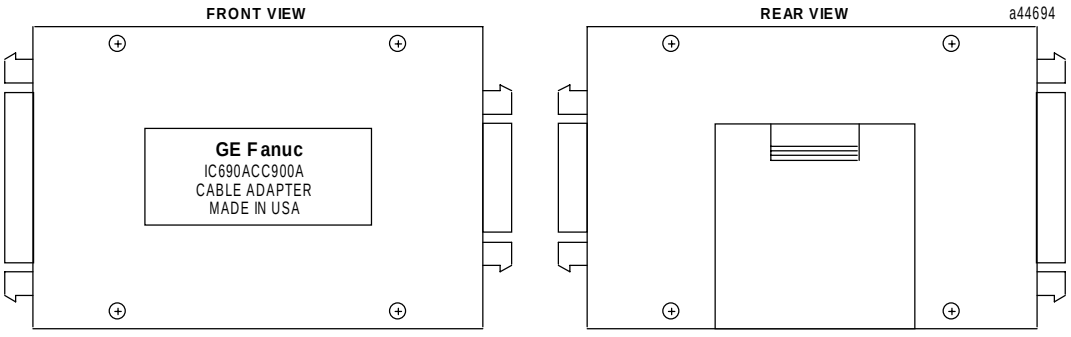


Figure E-1. Front and Rear View of Converter

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Installation

Installation of the RS-422/RS-485 to RS-232 Converter consists of connecting two cables. Select the proper cables for your installation. Prewired cables (see below) are available from GE Fanuc, or if cables of different lengths are required by your application, you can build your own cables. Specifications for building these cables are provided on page E-8.

You do not need to connect an external source of power to the converter for a cable length of 10 feet, or less, since the necessary power connections of +5VDC and signal ground are derived from the PLC's backplane bus through the cable that connects to the PLC.

1. Select one of the three RS-232 compatible cables (10 feet in length) that will connect the programmer's (or other serial device) RS-232 serial port to the RS-232 port on the converter. The catalog numbers of these cables are: IC690CBL701 (use with Workmaster industrial computer, or IBM PC-XT or compatible personal computer), IC690CBL702 (use with IBM PC-AT or compatible personal computer), and IC690CBL705 (use with Workmaster II industrial computer, or IBM PS/2 or compatible personal computer).
2. A standard 6-foot cable (HHP compatible) is available to connect the RS-422/RS-485 port on the converter to the RS-485 port on the PLC. The catalog number of this cable is IC693CBL303.

Installation of these cables should be done with the PLC powered-down.

- Connect the 25-pin male connector on the 10 foot cable to the 25-pin female connector on the converter.
- Connect the female connector (9-pin or 25-pin) on the opposite end of this cable to the male RS-232 connector (serial port) on the selected programming (or other serial) device. If you build your own cable, use a connector that is compatible with your serial device.
- Note that both ends of the 6-foot RS-422/RS-485 compatible cable are the same; a 15-pin male connector is attached at both ends. Connect one end of this cable to the 15-pin female connector on the RS-422/RS-485 connector on the converter.
- Connect the other end of this cable to the 15-pin female connector, which interfaces to the RS-485 compatible serial port on the Series 90 Micro, Series 90-30, or Series 90-70 PLC. For the Series 90-30 PLCs, this connector is accessed by opening the hinged door on the power supply. The serial port connector for the Series 90-70 PLC is on the CPU module and is accessed by opening the hinged door on the module. On Micro PLCs, the serial port is located behind a hinged door on the front of the unit. On 23- and 28-point Micro PLCs, which have two serial ports, be sure to use Port 1 to connect the processor.

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Cable Description

The serial connection to the Series 90-70 PLC (Figure E-2) is to the RS-422/RS-485 compatible serial port connector, located at the bottom of the CPU module behind the hinged door, through an available 6 foot (2 meter) serial interface cable - IC693CBL303. Wiring information and recommended cable and connectors are provided for those who want to build a cable having a different length.

The serial connection to the Series 90-30 PLC is to the RS-485 compatible serial port connector located behind the hinged door on the right front of the power supply, through the same 6 foot serial interface cable, IC693CBL303, or equivalent (Figure E-3).

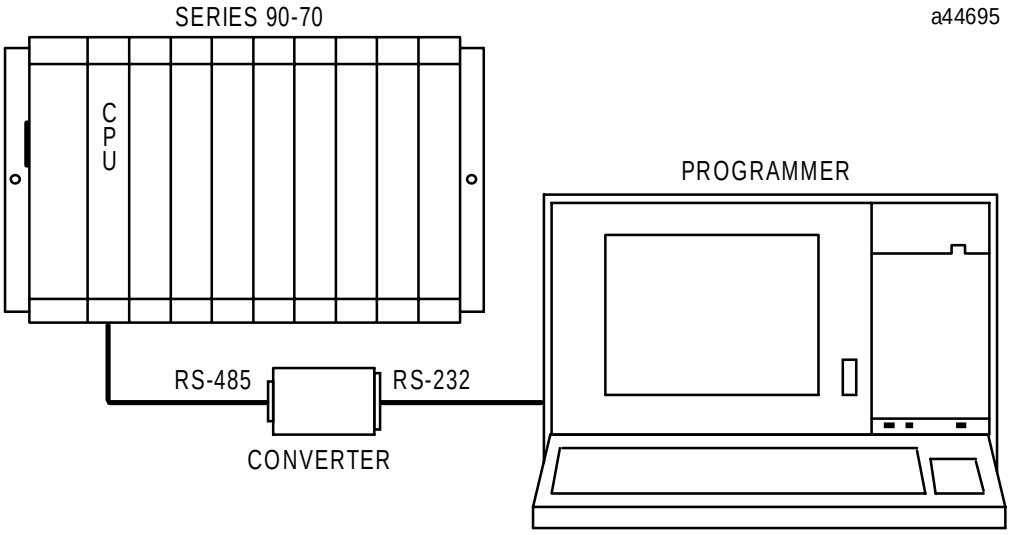


Figure E-2. Typical Configuration with Series 90-70 PLC

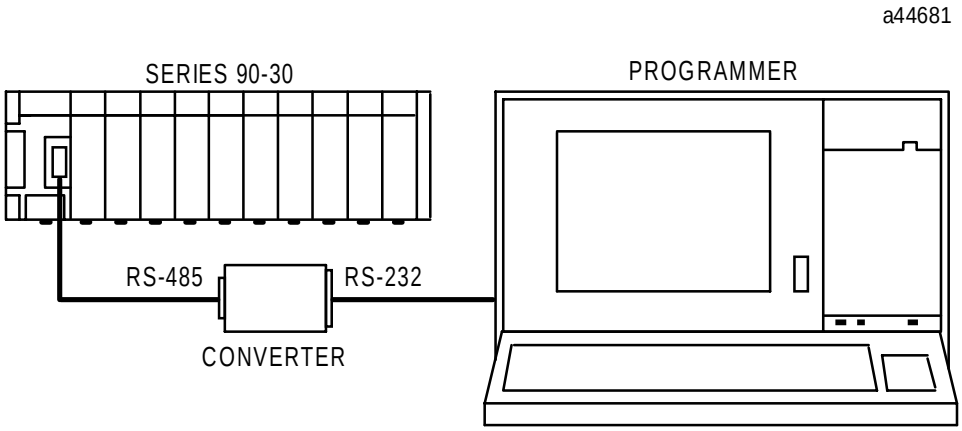


Figure E-3. Typical Configuration with Series 90-30 PLC

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Pin Assignments

Pin assignments and signal definitions for the RS-232 interface and the RS-422/RS-485 interface are listed in the following tables.

Table E-1. RS-232 Interface for Converter

Pin	Signal Name	Function	I/O
1	Shield	Cable shield	-
2	SD	Transmitted Data	Out
3	RD	Received Data	In
4	RTS	Request To Send	Out
5	CTS	Clear To Send	In
6	-	No connection	-
7	SG	Signal Ground	-
8	DCD	Data Carrier Detect	In
9 to 19	-	No connection	-
20	DTR	Data Terminal Ready	Out
21 to 25	-	No connection	-

Table E-2. RS-422/RS-485 Interface for Converter

Pin	Signal Name	Function	I/O
1	Cable Shield	Cable shield	-
2	DCD(A)	Differential Data Carrier Detect	Out
3	DCD(B)	Differential Data Carrier Detect	Out
4	ATCH/	Attach (used with HHP)	n/a
5	+5 VDC	Logic Power	In
6	RTS(A)	Differential Request To Send	Out
7	SG	Signal Ground, 0V	In
8	CTS(B')	Differential Clear To Send	In
9	RT	Resistor Terminator	NA
10	RD(A')	Differential Receive Data	In
11	RD(B')	Differential Receive Data	In
12	SD(A)	Differential Send Data	Out
13	SD(B)	Differential Send Data	Out
14	RTS(B)	Differential Request To Send	Out
15	CTS(A')	Differential Clear To Send	In

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Logic Diagram

The following figure shows the logic diagram for the RS-422/RS-485 to RS-232 Converter.

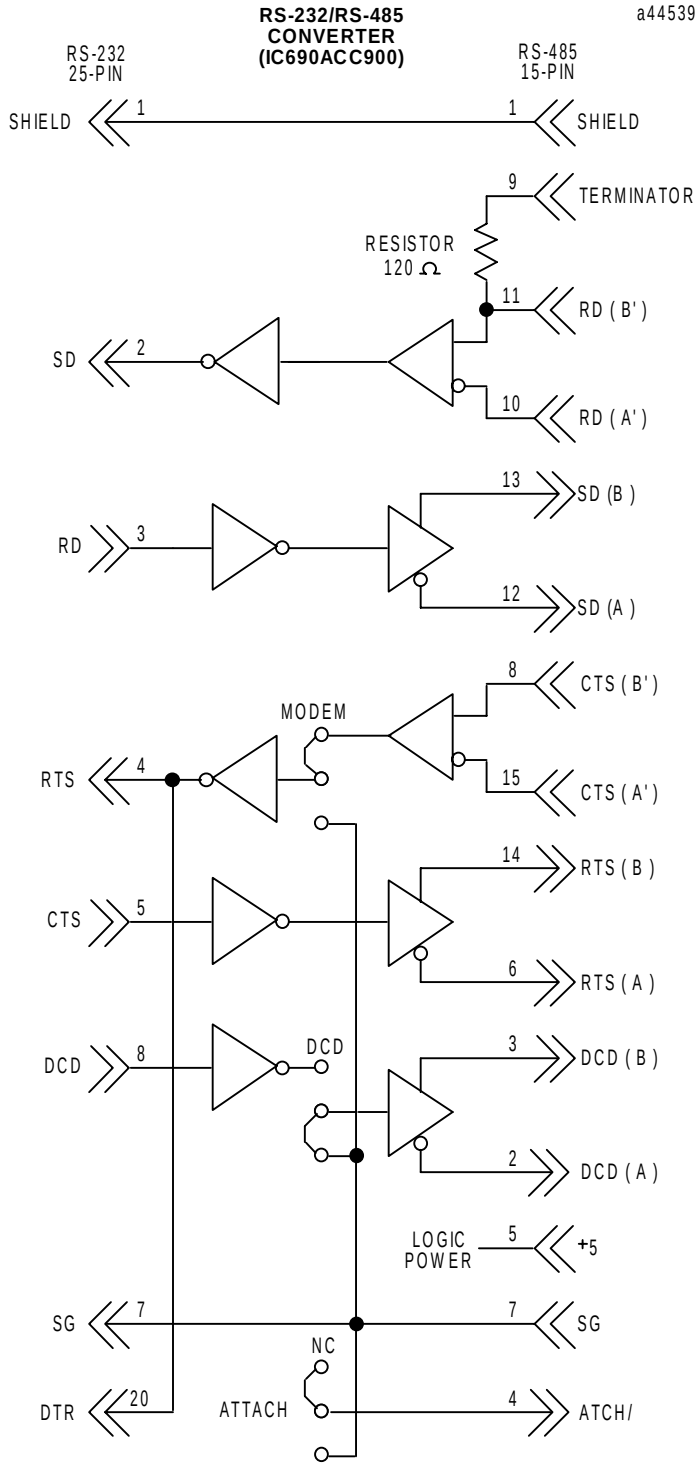


Figure E-4. RS-422/RS-485 to RS-232 Converter Logic Diagram

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Jumper Configuration

There are three jumper locations on the converter board for selection of user options. Each jumper position has three pins, as shown in the following illustration. These jumper positions, labeled JP2, JP3, and JP4, are accessed by removing the square plastic cover on the top of the converter. Configuration can be changed as required by carefully removing one or more of the jumpers with a pair of needle nose pliers and placing it on the desired pair of pins.

Refer to the description of these selectable jumper positions in Table E-3 and place the jumper on the selected pair of pins. The pin numbers are 1, 2, and 3. Default jumper locations are indicated by a rectangle around the pins to be jumpered for each position. The default pin numbers are 1 and 2.

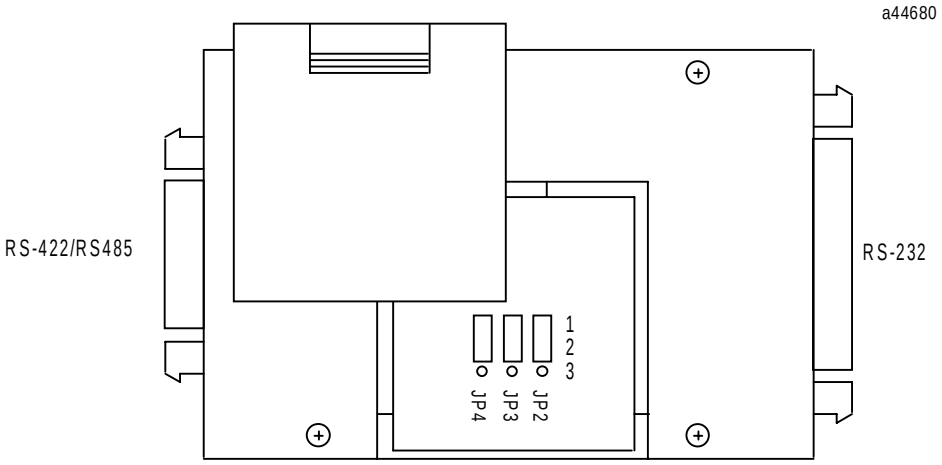


Figure E-5. Location of Jumpers for User Options

Table E-3. Jumper Configuration for RS-422/RS-485 to RS-232 Converter

Jumper Position	Label	Jumper Position	Description*
JP2	DCD	[1 2] 3	Default position 1 and 2 is used when the device communicating with the PLC does not supply the Carrier Detect signal. JP2 forces the DCD signal active on the RS-485 port.
		1 [2 3]	Use jumper positions 2 and 3 if the device does supply the Carrier Detect signal. This allows the programming device to control DCD.
JP3	MODEM	[1 2] 3	Default position 1 and 2 is used when an attached Modem does not require the Clear To Send (CTS) signal. This allows the programming device to control the RTS signal.
		1 [2 3]	Jumper positions 2 and 3 are used when the attached Modem does require the CTS signal (most modems require this signal). Forces RTS to be continually active.
JP4	ATTACH	[1 2] 3	Default position 1 and 2 is used for most applications communicating with the PLC via a serial programming device.
		1 [2 3]	Jumper positions 2 and 3 are used if the device communicating with the PLC is intended to emulate the HHP protocol.

*Refer to the documentation provided with your serial device for signal requirements.

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Specifications

Examples of cable configurations required when using the converter can be found in Appendix D. Specifications for the converter are listed in the following table.

Table E-4. Specifications for IC690ACC900 Converter

Power Requirements	
Voltage	5 volts DC, +5%
Current	170 mA, ±5%
RS-422/RS-485 Interface Cables	
Maximum cable length	1000 feet(300m)
Cable Type: * 6 feet (2m) 30 feet (10m) ** ≥30 feet, up to 1000 feet (300m)**	 Cable type: Belden 9508, AWG #24 (0.22 mm^2) Cable type: Belden 9309, AWG #22 (0.36 mm^2) Same cable as for 30 feet.
Connector Type	15-pin D-type Male Subminiature (both ends)
RS-232 Interface Cable	
Maximum cable length	50 feet (15m)
Connector Type	25-pin D-type Female Subminiature (converter end) 9-pin, 15-pin, or 25-pin (depending on type of connector on your serial device) D-type Female Subminiature (programming device end)

* Catalog numbers are provided as suggestions only. Any cable having the same electrical characteristics is acceptable. It is strongly recommended that you use stranded wire. Since it is sometimes difficult to find a cable with the desired number of twisted pairs (the Belden 9309 has an extra pair), you might end up with a cable with extra pairs.

** For distances over 10 feet, the +5 volt DC logic power source must be provided externally by connecting an external power supply to the +5V and SG (0V) connections at the converter end of the cable. ***The +5V pin at the PLC connector end of the cable must not be connected to the cable.*** The +5V and SG connections from the external power supply must be isolated from its own power line ground connection. Ensure that there is no connection between the external supply and the PLC except the SG cable connection.

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Miniconverter Kit

This section describes the Miniconverter Kit for use with Series 90 PLCs.

Description of Miniconverter

The Miniconverter Kit (IC690ACC901) consists of an RS-422 (SNP) to RS-232 Miniconverter, a 6-foot (2 meter) serial extension cable, and a 9-pin to 25-pin Converter Plug assembly. The 15-pin SNP port connector on the Miniconverter plugs directly into the serial port connector on the Series 90-30 power supply, Series 90-70 CPU, Series 90-20 CPU, or Series 90 Micro CPU. The 9-pin RS-232 port connector on the Miniconverter connects to an RS-232 compatible device.

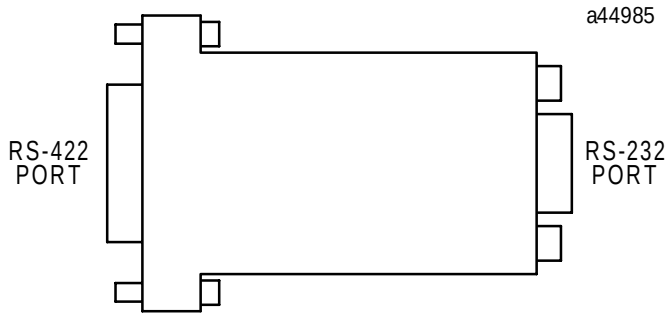


Figure E-6. Series 90 SNP to RS-232 Miniconverter

When used with an IBM PC-AT, or compatible computer, one end of the extension cable plugs into the Miniconverter's 9-pin serial port connector, while the other end plugs into the 9-pin serial port of the computer. The Converter plug (supplied with kit) is required to convert the 9-pin serial port connector on the Miniconverter to the 25-pin serial port connector on the GE Fanuc Workmaster II computer, or an IBM PC-XT or PS/2 Personal Computer.

The GE Fanuc Workmaster computer requires an additional adapter (not supplied with kit - please contact your local GE Fanuc PLC distributor) for use with the Miniconverter.

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Pin Assignments

The pinout of the Miniconverter is shown in the following two tables. Table E-5 lists the pinout for the RS-232 port. The direction of signal flow is with respect to the Miniconverter. The pinouts were chosen to allow direct connection (using a straight through, or 1-to-1 cable (as provided with kit)) to the IBM PC-AT. Most IBM compatible computers equipped with an RS-232 port will provide a pinout compatible with the one shown below.

Table E-5. Miniconverter RS-232 Port

Pin	Signal Name	Direction
2	SD - Send Data	Output
3	RD - Receive Data	Input
5	GND - Ground	NA
7	CTS - Clear To Send	Input
8	RTS - Request To Send	Output

Table E-6 is the pinout for the Miniconverter's RS-422 serial port. The direction of signal flow is also with respect to the Miniconverter.

Table E-6. Miniconverter RS-422 Port

Pin	Signal Name	Direction
1	SHLD - Shield	NA
5	+5VDC - Power	Input
6	CTS(A') - Clear To Send	Input
7	GND - Ground	NA
8	RTS(B) - Request To Send	Output
9	RT - Receive Termination	Output
10	SD(A) - Send Data	Output
11	SD(B) - Send Data	Output
12	RD(A') - Receive Data	Input
13	RD(B') - Receive Data	Input
14	CTS(B') Clear To Send	Input
15	RTS(A) - Request To Send	Output

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System Configurations

The Miniconverter can be used in a point-to-point configuration as described above, or in a multidrop configuration with the host device configured as the master and one or more PLCs configured as slaves.

The multidrop configuration requires a straight through (1-to-1) cable from the Miniconverter's RS-422 port to the first slave PLC's SNP port. Other slaves will require a daisy chain connection between slaves. A maximum of eight devices can be connected in an RS-422 multidrop configuration. All of the devices must have a common ground. If ground isolation is required, you can use the GE Fanuc Isolated Repeater/Converter (IC655CCM590) in place of the Miniconverter.

When using the Miniconverter with a modem connection, it may be necessary to jumper RTS to CTS (consult the user's manual for your modem).

Cable Diagrams (Point-To-Point)

When connecting the Miniconverter to IBM PC and compatible computers with hardware handshaking, the following cable connections should be used.

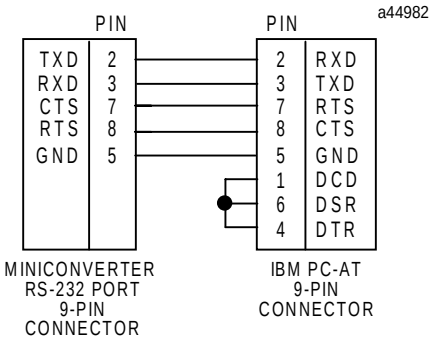


Figure E-7. Miniconverter to PC-AT

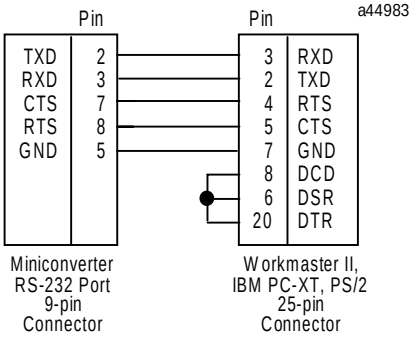


Figure E-8. Miniconverter to Workmaster II, PC-XT, PS/2

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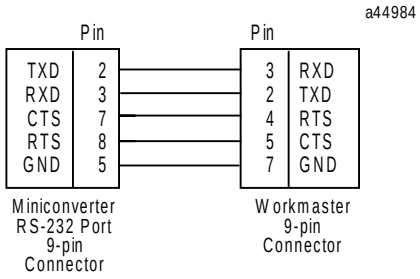


Figure E-9. Miniconverter to 9-Pin Workmaster or PC-XT Computer (Additional Adapter Required)

Table E-7. Miniconverter Specifications

Mechanical	
RS-422	15-pin D-shell male for direct mounting to Series 90 serial port.
RS-232	9-pin D-shell male for connection to RS-232 serial port of a Workmaster II computer or Personal Computer.
Electrical and General	
Voltage Supply	+5VDC (supplied by PLC power supply)
Typical Current	Version A (IC690ACC901A) - 150mA Version B (IC690ACC901B) - 100mA
Operating Temperature	0 to 70° C (32 to 158° F)
Baud Rate	38.4K Baud maximum
Conformance	EIA-422 (Balanced Line) or EIA-423 (Unbalanced Line)
Ground Isolation	Not provided

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Isolated Repeater/Converter

This section describes how to use the Isolated Repeater/Converter (IC655CCM590) with Series 90 PLCs. The following topics are covered in this section:

- Description of the Isolated Repeater/Converter
- System Configurations
- Cable Diagrams

This unit can be purchased from GE Fanuc Automation. Please contact any GE Fanuc Automation sales office or PLC distributor.

Note

The catalog number for the Isolated Repeater/Converter was previously IC630CCM390.

Description of the Isolated Repeater/Converter

The Isolated Repeater/Converter (IC655CCM590) can be used for the following purposes:

- To provide ground isolation where a common ground cannot be established between components.
- To boost RS-422 signals for greater distance and more drops.
- To convert signals from RS-232 to RS-422 or RS-422 to RS-232.

The locations of key features on the unit are shown in Figure E-10.

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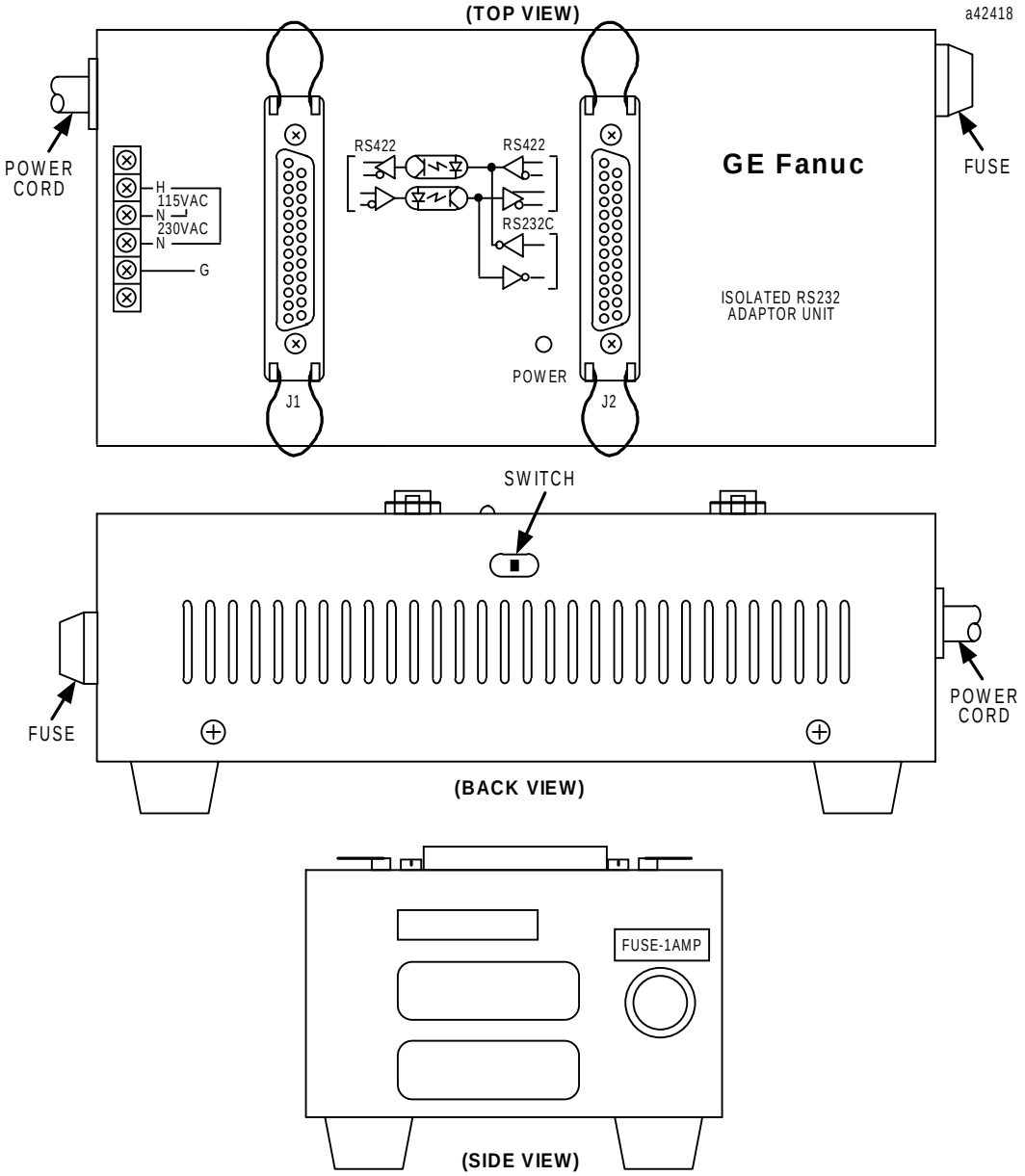


Figure E-10. Isolated/Repeater Converter

The Isolated Repeater/Converter has the following features:

- Two 25-pin female D-type connectors. (Two 25-pin male, D-type connectors (solder pot), are included for user cabling.)
- 115/230 VAC power connection (internal) 4-position terminal block.
- Fused 1-Amp power protection.
- Power ON (green) indicator LED.
- Three-position toggle switch, recessed in the back of the unit, is set according to the system configurations described on page E-18.

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Logic Diagram of the Isolated Repeater/Converter

The figure below provides a functional overview of the unit. Note the three-position switch for controlling the J1 port transmitters. This switch is discussed in “System Configurations” on page E-19

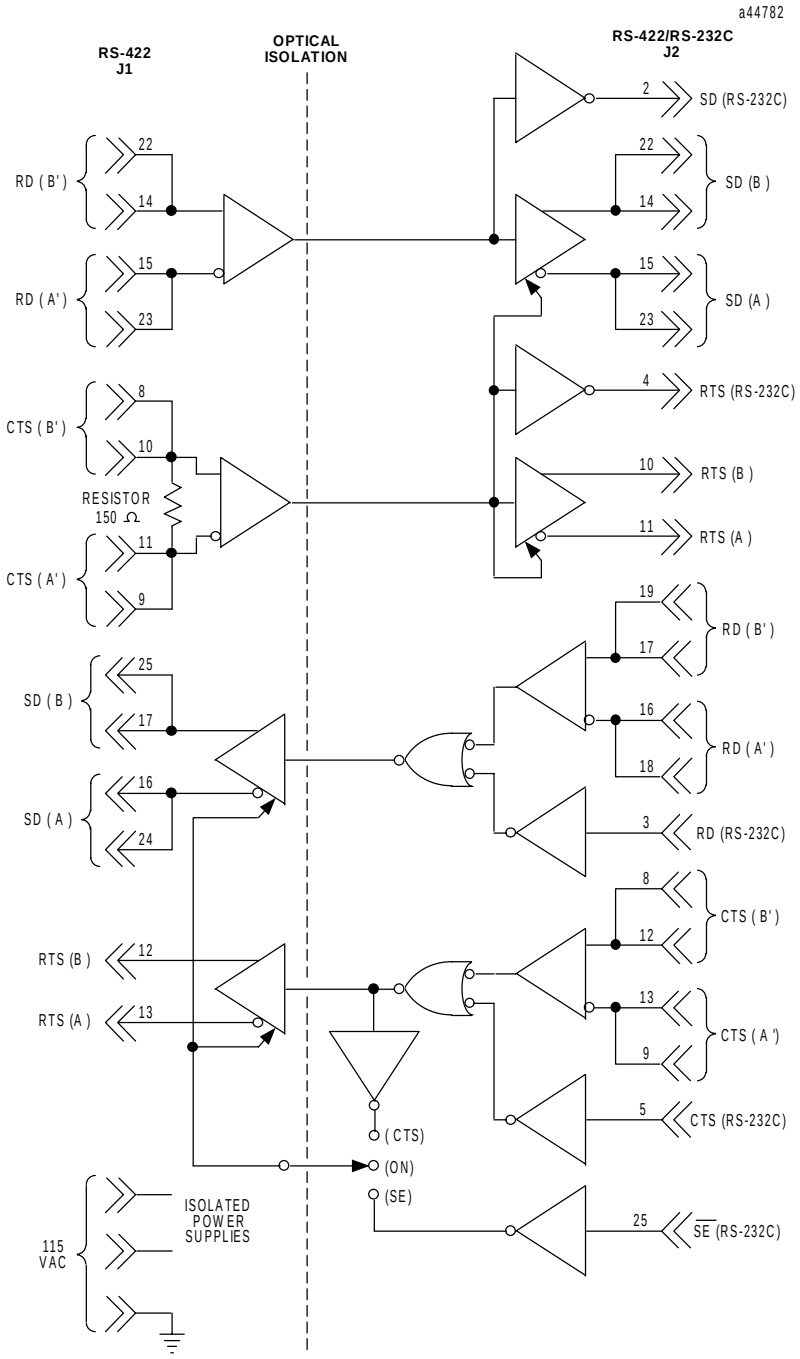


Figure E-11. RS-422 Isolated Repeater/RS-232 Converter Logic Diagram

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Note

All inputs are biased to the inactive state. Inputs left unconnected will produce a binary 1 (OFF) state on the corresponding output.

Pin Assignments for the Isolated Repeater/Converter

Table E-8. Isolated Repeater/Converter Pin Assignments

J1 RS-422 Port (25-pin female connector)		
Pin	**Signal**	**Description**
1	NC	No connection
2	NC	No connection
3	NC	No connection
4	NC	No connection
5	NC	No connection
6	NC	No connection
7	0V	Ground Connection
8	CTS(B')	Clear to Send (Optional Termination)
9	CTS(A')	Clear to Send (Optional Termination)
10	CTS(B')	Clear to Send
11	CTS(A')	Clear to Send
12	RTS(B)	Request to Send
13	RTS(A)	Request to Send
14	RD(B')	Receive Data
15	RD(A')	Receive Data
16	SD(A)	Send Data
17	SD(B)	Send Data
18	NC	No connection
19	NC	No connection
20	NC	No connection
21	NC	No connection
22	RD(B')	Receive Data
23	RD(A')	Receive Data
24	SD(A)	Send Data

J2 RS-422/RS-232 Port (25-pin female connector)		
Pin	**Signal**	**Description**
1	NC	No connection
2	SD	Send Data (RS-232)
3	RD	Receive Data (RS-232)
4	RTS	Request to Send (RS-232)
5	CTS	Clear to Send (RS-232)
6	NC	No connection
7	0V	Ground Connection
8	CTS(B')	Clear to Send Optional Termination)
9	CTS(A')	Clear to Send (Optional Termination)
10	RTS(B)	Request to Send
11	RTS(A)	Request to Send
12	CTS(B')	Clear to Send
13	CTS(A')	Clear to Send
14	SD(B)	Send Data
15	SD(A)	Send Data
16	RD(A')	Receive Data
17	RD(B')	Receive Data
18	RD(A')	Receive Data (Optional Termination)
19	RD(B')	Receive Data (Optional Termination)
20	NC	No connection
21	NC	No connection
22	SD(B)	Send Data (Optional Termination)
23	SD(A)	Send Data (Optional Termination)
24	NC	No connection

SD (Send Data) and RD (Receive Data) are the same as TXD and RXD (used in the Series Six PLC).
(A) and (B) are the same as - and + A and B and denote outputs. A' and B' denote inputs.

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Caution

The signal ground connections (pin 7 on each connector) must be made between the Isolated Repeater/Converter and the PLC for J1, and the Isolated Repeater/Converter and the host computer for J2.

Pin 7 of the J1 port is connected to the metal shell of the J1 connector. Pin 7 of the J2 port is connected to the metal shell of the J2 connector. These two signal ground connections are isolated from each other and from the power system ground (green wire on the terminal block). To maintain proper isolation, these signal grounds cannot be tied together.

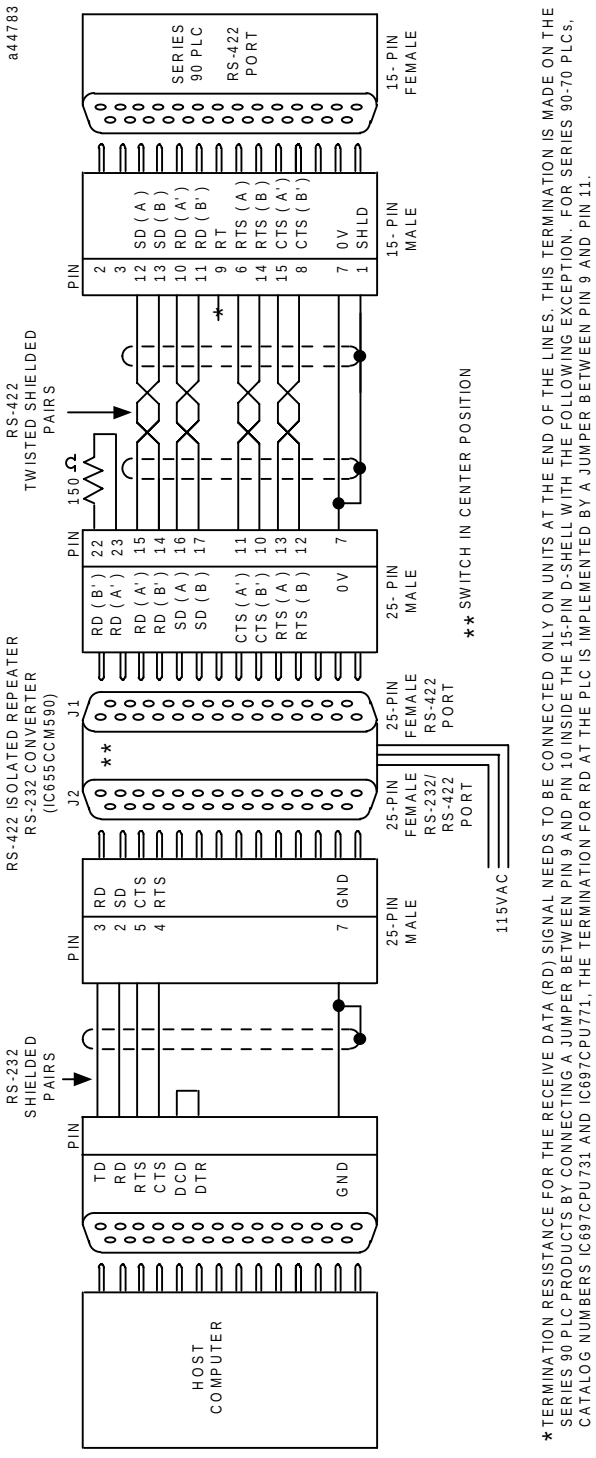


Figure E-12. Example RS-422 Isolated Repeater/RS-232 Converter Connection

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System Configurations

The following figures show various ways you can connect the Isolated Repeater/Converter to convert signals, expand the number of drops, and obtain greater distance. Any system configuration can be reduced to a minimum number of cables, each covering a part of the overall system configuration. The following examples of system configurations refer to these cables as Cables A through E, which are described in “Cable Diagrams” on page E-20.

Downstream and Upstream Contention. In this section, simple multidrop configurations are those where a single Isolated Repeater/Converter is used. Complex multidrop configurations contain one or more multidrop sections where an Isolated Repeater/Converter is included as one of the drops. In both simple and complex multidrop configurations, the transmitters directed downstream from the master can be on at all times. There will be no contention for the communication line because only one device (the master) transmits downstream.

In simple multidrop configurations, there will be no contention when transmitting upstream as long as devices tri-state their drivers when idle and turn them on only when they have something to transmit. This is the case for the Series 90-70 and Series 90-30 CMMs.

In complex multidrop configurations, however, special steps must be taken to switch the upstream transmitters of the Isolated Repeater/Converter.

Switching Upstream Transmitters. For the RS-422 drivers to be active at the J2 port of the Isolated Repeater/Converter, the RTS input at J1 must be true. The state of the RS-422 drivers at the J1 port depends on the position of the switch on the unit. When the switch is in the center position, the J1 transmitters will always be turned on. When the switch is in the CTS position (toward the power cable), then either the RS-232 or RS-422 CTS signal must be true to turn on the J1 drivers.

Note

Note the position of the switch on the Isolated/Repeater Converter in the following system configurations.

Simple Multidrop Configuration

This configuration shows how to connect a single Isolated Repeater/Converter for signal conversion or for greater distance.

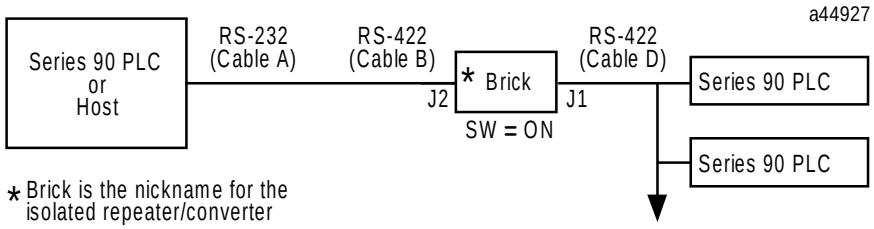


Figure E-13. Simple System Configuration Using the Isolated Repeater/Converter

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Complex Multidrop Configuration

This configuration shows how to connect multiple Isolated Repeater/Converters for signal conversion, greater distance, and more drops.

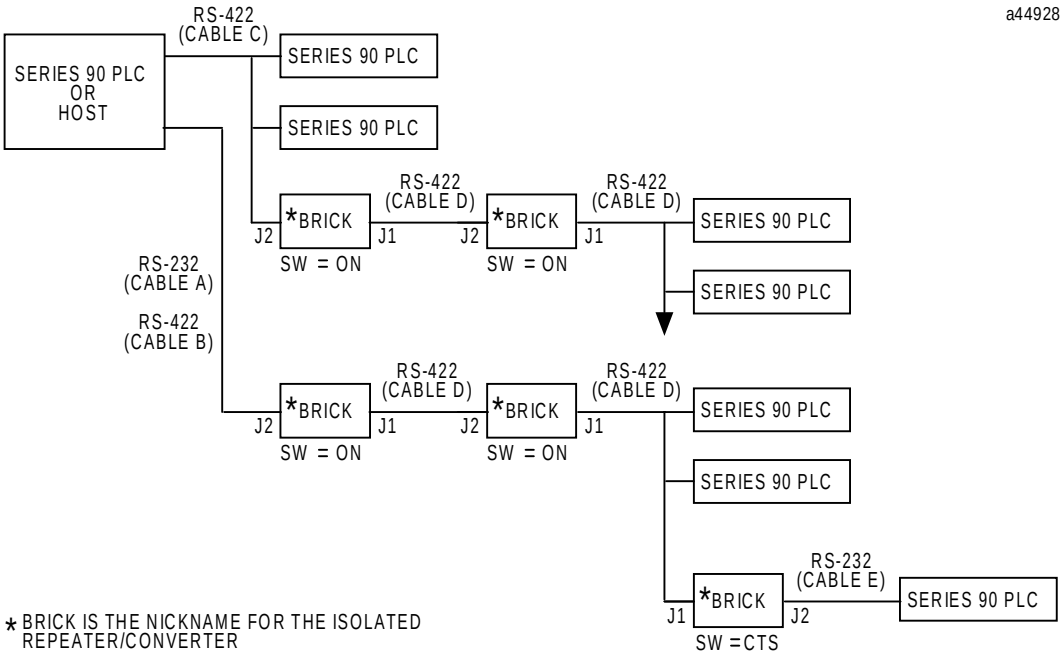


Figure E-14. Complex System Configuration Using the Isolated Repeater/Converter

Rules for Using Repeater/Converters in Complex Networks

When designing a complex multidrop network including PLCs and RS-422 repeater/converters (bricks), the following rules apply:

Rule 1: When using a brick as a repeater, port J2 should always be directed toward the host device, and Port J1 should always be directed away from the host device. The switch located on the side of the brick should always be in the center position (ON). The only case in which Port J1 is directed toward the host is when the brick is used as a converter (RS-232) at the slave. The switch is in the right position (CTS).

Rule 2: If a Series 90 CMM slave device is located downstream of a brick, set the configuration of the CMM serial port to NONE flow control with a 10ms Modem Turnaround Delay (applies to CCM, SNP, and SNP-X protocols only).

Rule 3: Do not place more than three bricks in a single communication path between the host and the slave devices.

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Cable Diagrams

The cable diagrams below are referred to as Cables A-E from the system configurations in the previous figures. These diagrams show the principles for constructing your own cables and can be modified to fit your specific application.

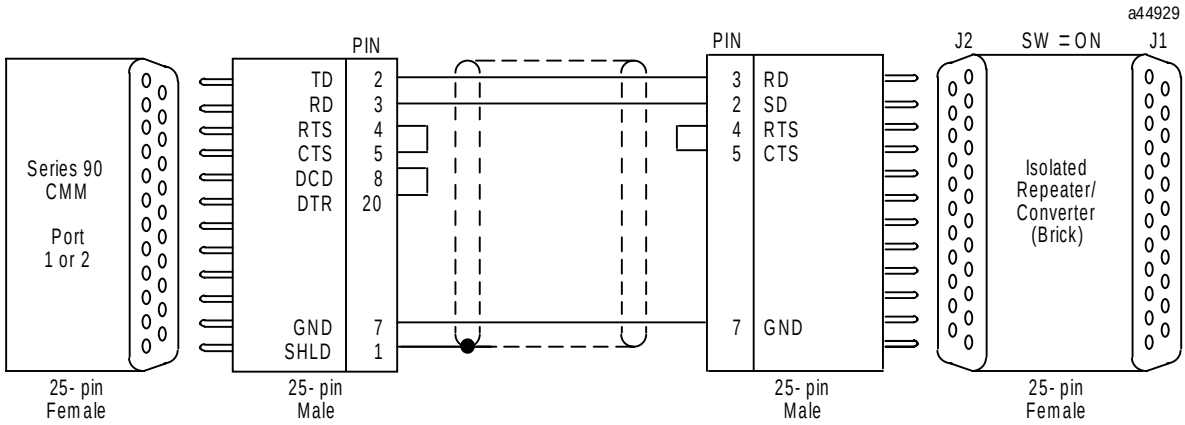
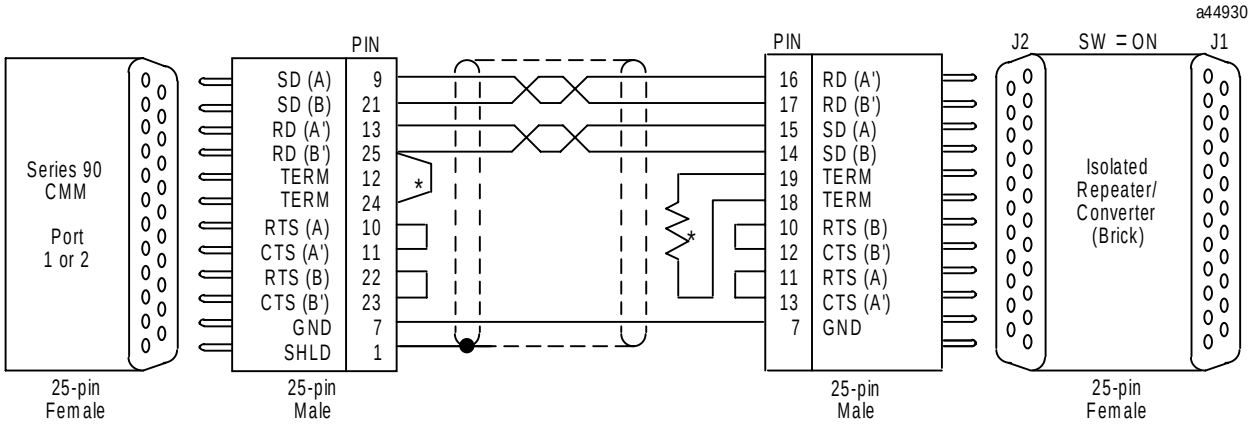


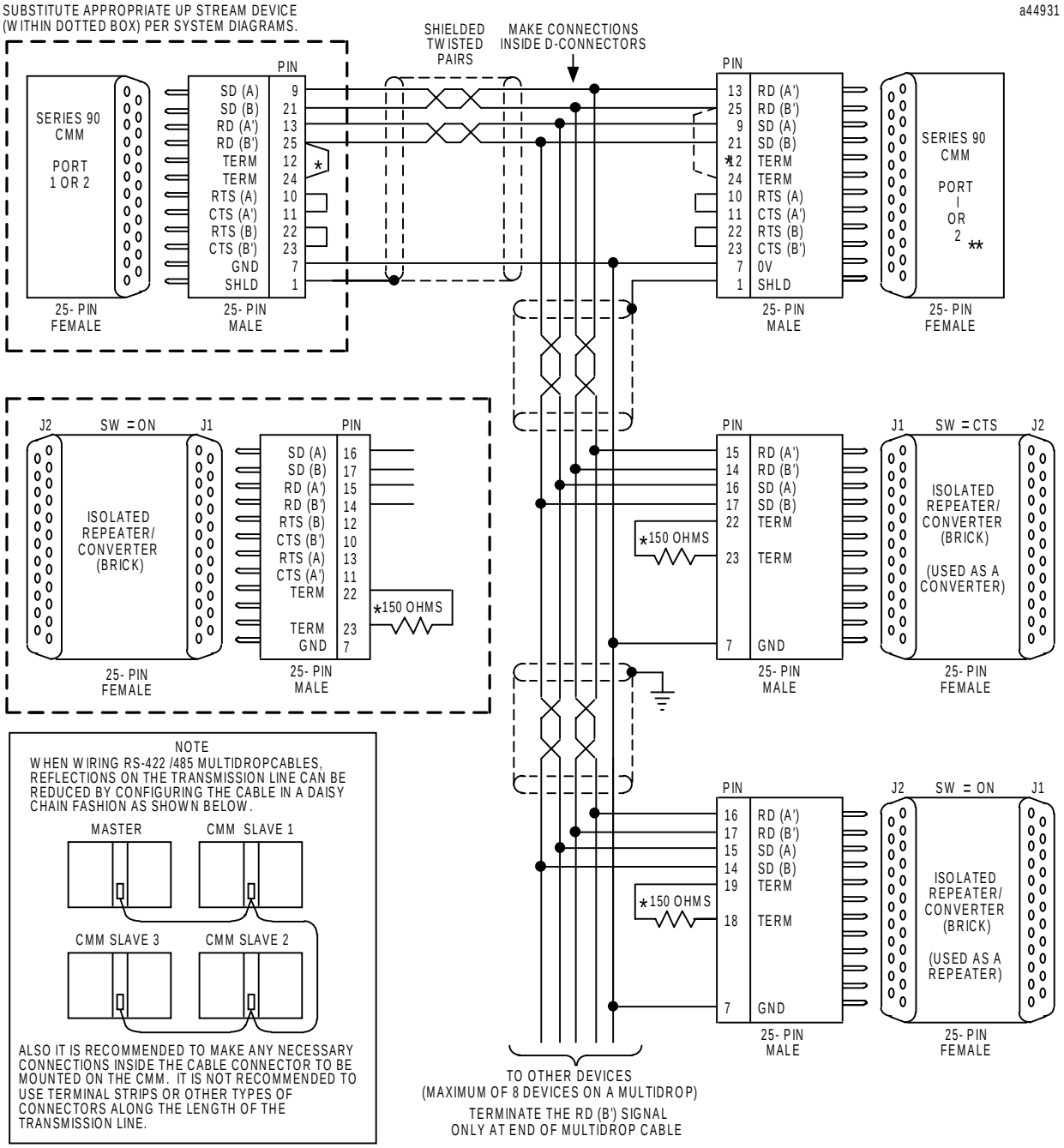
Figure E-15. Cable A: RS-232 CMM To Converter



* Terminate connection: On the CMM, Install jumper to connect internal 120 ohm resistor. On the isolated repeater/converter, install 150 ohm resistor (supplied).

Figure E-16. Cable B: RS-422 CMM To Converter

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*TERMINATE CONNECTION ON FIRST AND LAST DROPS ONLY: ON THE CMM, INSTALL JUMPER TO CONNECT INTERNAL 120 OHM RESISTOR. ON THE ISOLATED REPEATER/CONVERTER, INSTALL 150 OHM RESISTOR (SUPPLIED)

**ON THE CMM311, ONLY PORT 2 CAN SUPPORT RS-422/RS-485.

Figure E-17. Cable C: RS-422 Twisted Pair

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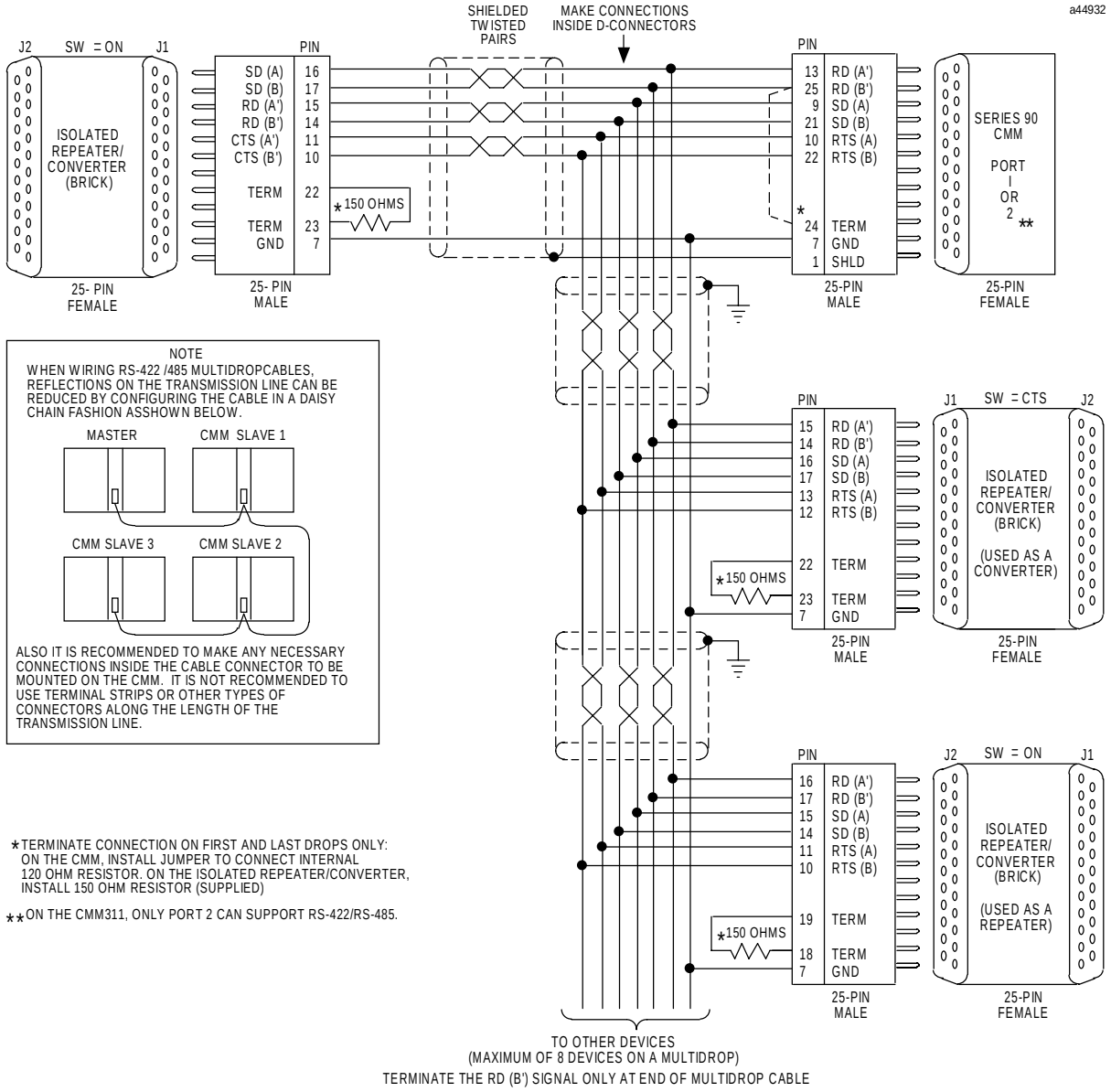


Figure E-18. Cable D: RS-422 Twisted Pair

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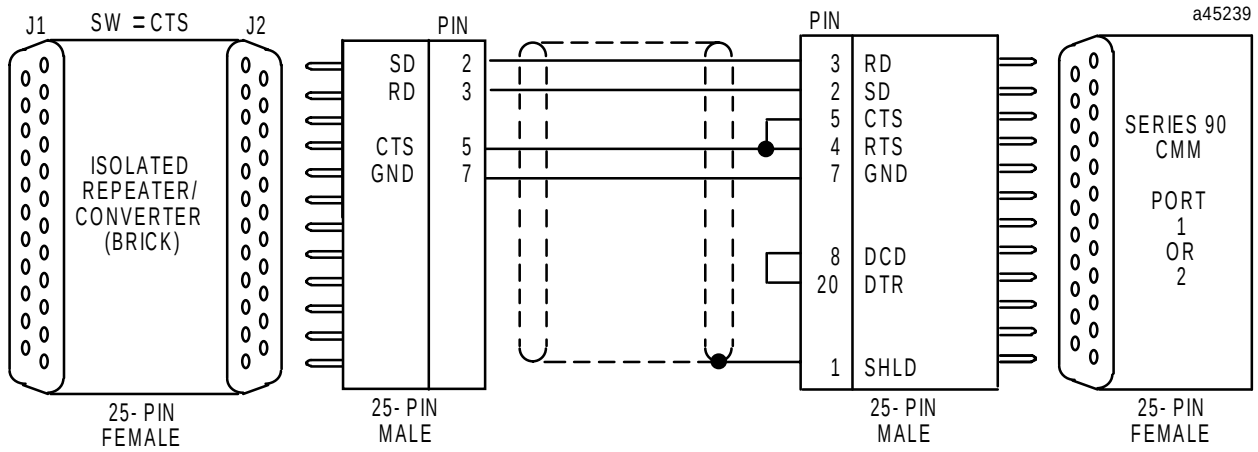


Figure E-19. Cable E: RS-232 Converter to CMM

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Appendix F

Cable Data Sheets

Cables used with Series 90 Micro PLCs are described in this and other documents. This appendix provides a data sheet describing each of the Series 90 Micro PLC cable types so that all cable information can be found in one convenient location. Each data sheet contains the following information:

- Cable name and function
- Applicable catalog numbers
- Hardware description of cable: connector types, cable type, other relevant hardware
- Wiring diagram of cable

Information on the following cables is included in this appendix:

IC693CBL303	Hand-Held Programmer cable	F-2
IC690CBL701	PCM to Workmaster (IBM PC-XT)	F-4
IC690CBL702	PCM to IBM PC-AT	F-5
IC647CBL704	Workstation Interface board to Series 90 CPU	F-6
IC690CBL705	PCM to Workmaster II (IBM PS/2)	F-7
Micro PLCs	2-Wire Cable Diagrams	F-8

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IC693CBL303: Hand-Hand Programmer Cable

The Hand-Held Programmer (HHP) cable provides the connections that allow the HHP and the PLC to communicate. It can also be used to connect the RS-485 serial port on the PLC to the RS-422/RS-485 to RS-232 converter (IC690ACC900).

The prewired cable (IC693CBL303) is 6 feet (2 meters) long. This is the cable used with the HHP. If a different length cable is required for connection to the converter, refer to the information below for specifications and wiring information.

This information is essential if you intend to build your own cable. The recommended cable types for custom cables are listed below and depend on the length of the cable.

Table F-1. Specifications for IC693CBL303 Prewired Cable

Item	Description
Connectors Same connector is on both ends	15-pin male, D-Subminiature Type, Canon DA15S (solder pot)
Hood	AMP 207470-1 connector shell
Hardware Kit	AMP 207871-1, Kit includes 2 metric screws and 2 screw clips
Cable Type	Belden 9508: AWG #24 (.22 mm^2)
Cable Length	6 feet (2 meters)

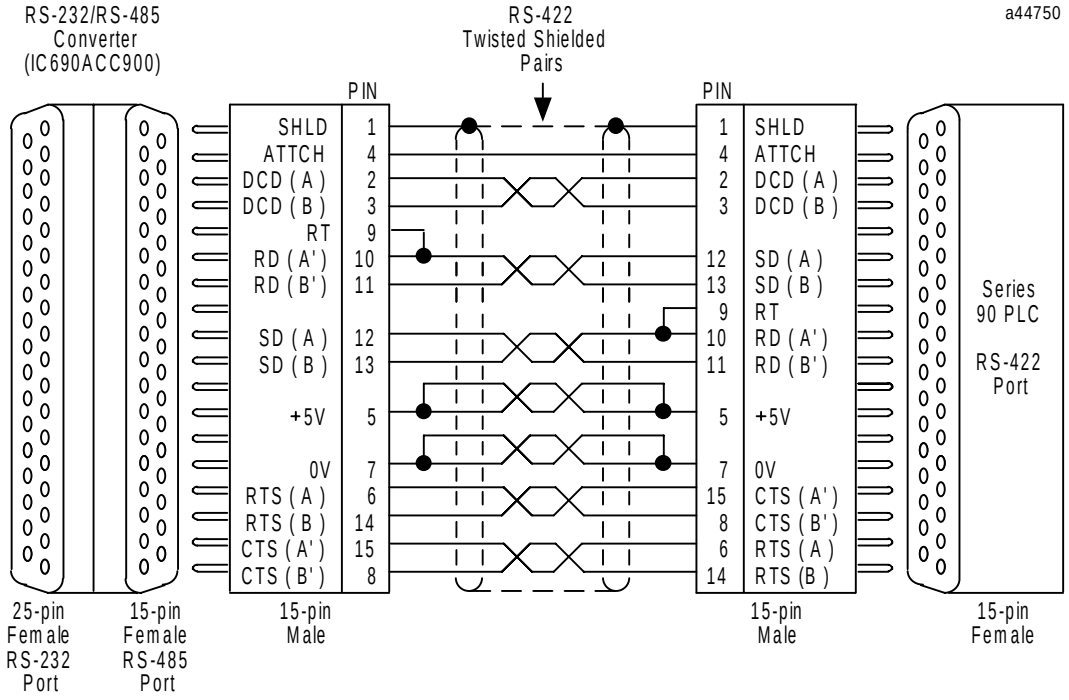
Table F-2. Wire Types for Custom Cables

Cable Length	Wire Size	Catalog Number
30 feet (10m)	22 (.36 mm^2)	Belden 9309
>30 (10m) feet to 980 feet (300m)	22 (.36 mm^2)	Same as for 30 feet. In addition, the+5VDC logic power source for the converter cannot be supplied by the PLC. It must be provided by an external power supply connected to the +5V and SG pins at the converter end of the connector. The +5V pin at the PLC connector must not be connected to the cable. The +5V and SG connections from the power supply must be isolated from their own power line ground connection. Be sure that there is no connection between the external supply and the PLC except the SG cable connection.

1. Catalog numbers are provided as suggestions only. Any cable having the same electrical characteristics is acceptable. It is strongly recommended that you use stranded wire. Since it is sometimes hard to find a cable with the desired number of twisted pairs (the Belden 9309 has an extra pair), you might end up with a cable with extra pairs.
2. A greater cable length between the PLC and the converter increases the possibility of noise coupling into the data and converter logic power circuits within the cable. The cable should be as short as possible in noisy environments. In extreme cases, additional noise protection measures, such as double-shielded cables, could be required.

The following wiring diagram is for the IC693CBL303 cable and for cables that may be built for connection to the IC690ACC900 converter.

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Note: PIns 9 and 10 are jumpered at both ends of cable to connect terminating resistors for the RD signal which is inside the PLC power supply.

Figure F-1. Wiring Connections for IC693CBL303

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IC690CBL701: Workmaster (PC-XT) to RS-485/RS-232 Converter Cable

This cable provides RS-232 signal connections between the RS-485/RS-232 converter (IC690ACC901) and a serial port on a Workmaster computer or IBM-XT or equivalent PC.

Table F-3. Cable Specifications, IC690CBL701

Cable Length	10 feet (3 meters)
Connectors PCM/ADC/CMM Side Programmer Side	 25-pin male, D-subminiature type, AMP 205208-1 or equivalent 9-pin male, D-subminiature type, AMP 205203-1 or equivalent
Cable Clamps 25-pin 9-pin	 AMP 207908-7 or equivalent AMP 207908-1 or equivalent
Cable Type	Six conductor, overall shield, non-paired AWG #24 (.21 mm2), Belden 9536 or equivalent

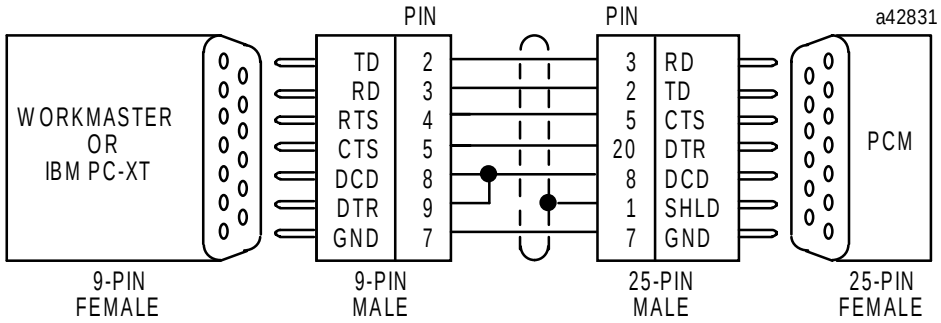


Figure F-2. Converter to Workmaster or PC-XT Serial Cable

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IC690CBL702: PC-AT to RS-485/RS-232 Converter Cable

This cable provides RTS-232 signal connections between the RS-485/RS-232 converter (IC690ACC901) and a serial port on an IBM PC-AT or equivalent PC.

Table F-4. Cable Specifications, IC690CBL702

Cable Length	10 feet (3 meters)
Connectors PCM/ADC/CMM Side Programmer Side	 25-pin male, D-subminiature type, AMP 205208-1 or equivalent 9-pin male, D-subminiature type, AMP 205203-1 or equivalent
Cable Clamps 25-pin 9-pin	 AMP 207908-7 or equivalent AMP 207908-1 or equivalent
Cable Type	Six conductor, overall shield, non-paired AWG #24 (.21 mm2), Belden 9536 or equivalent

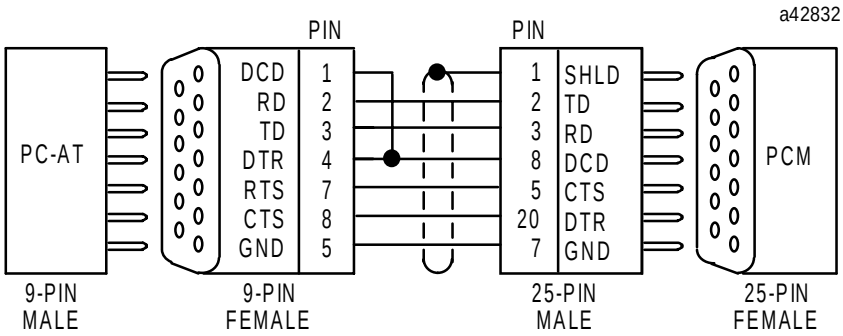


Figure F-3. Converter to Workmaster or PC-AT Serial Cable

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IC647CBL704: Workstation Interface to SNP Port Cable

The serial Workmaster Interface cable has a 15-pin D connector on one end and a 37-pin D connector on the other end. This cable connects the CPU's serial port to the Workstation Interface board installed in the programming computer through an isolated shielded, twisted pair.

Table F-5. Cable Specifications, IC647CBL704

Cable Length	10 feet (3 meters)
Connectors CPU Side Programmer Side	 15-pin male, D-subminiature type with M3 screws and AMP hood 207908-4, or equivalent 37-pin male, D-subminiature type with 4-40 screws and AMP hood 1-207908-0, or equivalent
Hardware Kit	AMP 207871-1. Kit includes two metric screws and two screw clips.
Cable Type	24 AWG (.21 mm2), 30V computer grade. Extra flexible construction recommended for short lengths.

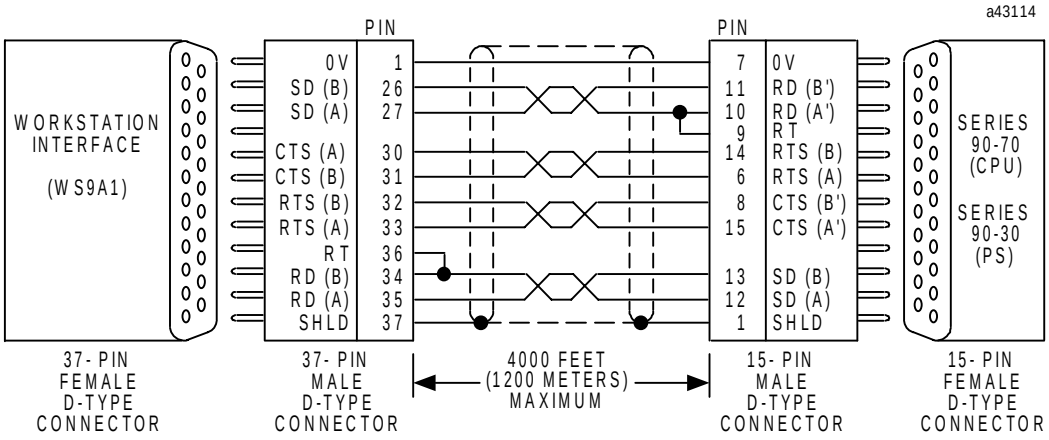


Figure F-4. Series 90 PLC to Workmaster II Serial Cable

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IC690CBL705: Workmaster II (PS/2) to RS-485/RS-232 Converter Cable

This cable provides RTS-232 signal connections between the RS-485/RS-232 converter (IC690ACC901) and a serial port on a Workmaster II or an IBM Personal System 2 (PS/2) or equivalent PC.

Table F-6. Cable Specifications, IC690CBL705

Cable Length	10 feet (3 meters)
Connectors PCM/ADC/CMM Side Programmer Side	 25-pin male, D-subminiature type, AMP 205208-1 or equivalent 25-pin female, D-subminiature type, AMP 205207-1 or equivalent
Cable Clamps 25-pin	 AMP 207908-7 or equivalent
Cable Type	Six conductor, overall shield, non-paired AWG #24 (.21 mm^2), Belden 9536 or equivalent

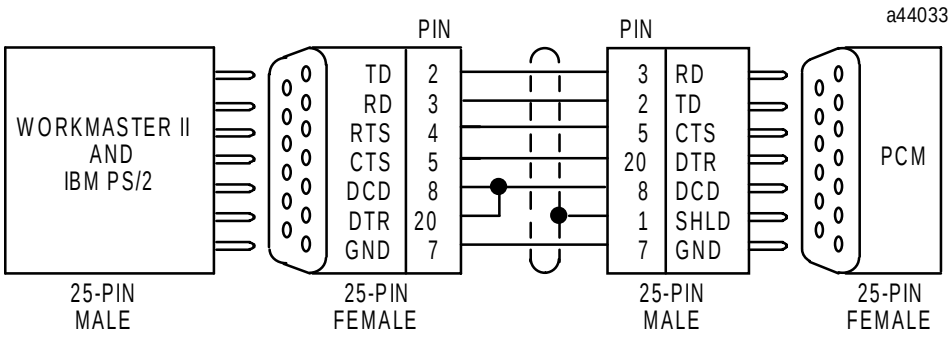


Figure F-5. Converter to Workmaster II or PS/2 Serial Cable

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2-Wire Cable Diagrams

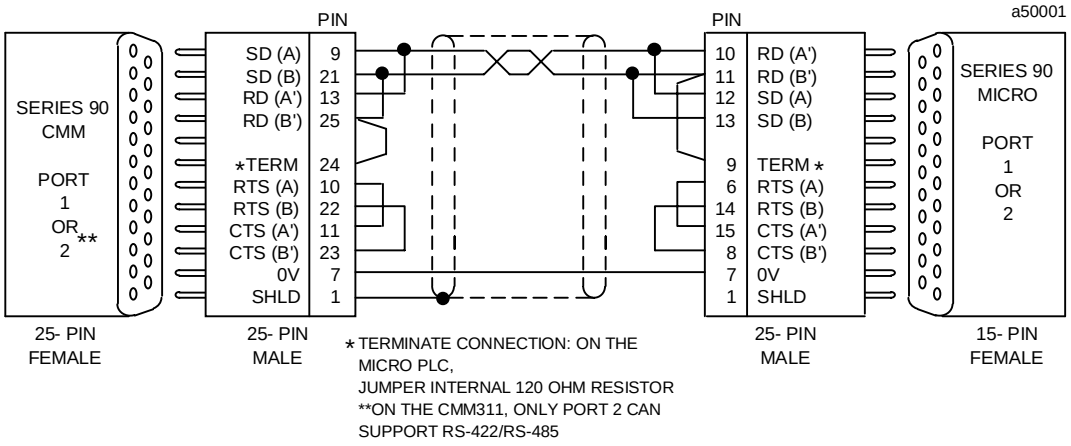


Figure F-6. CMM to Micro with Flow Control=None (2-Wire RS-422/RS-485)

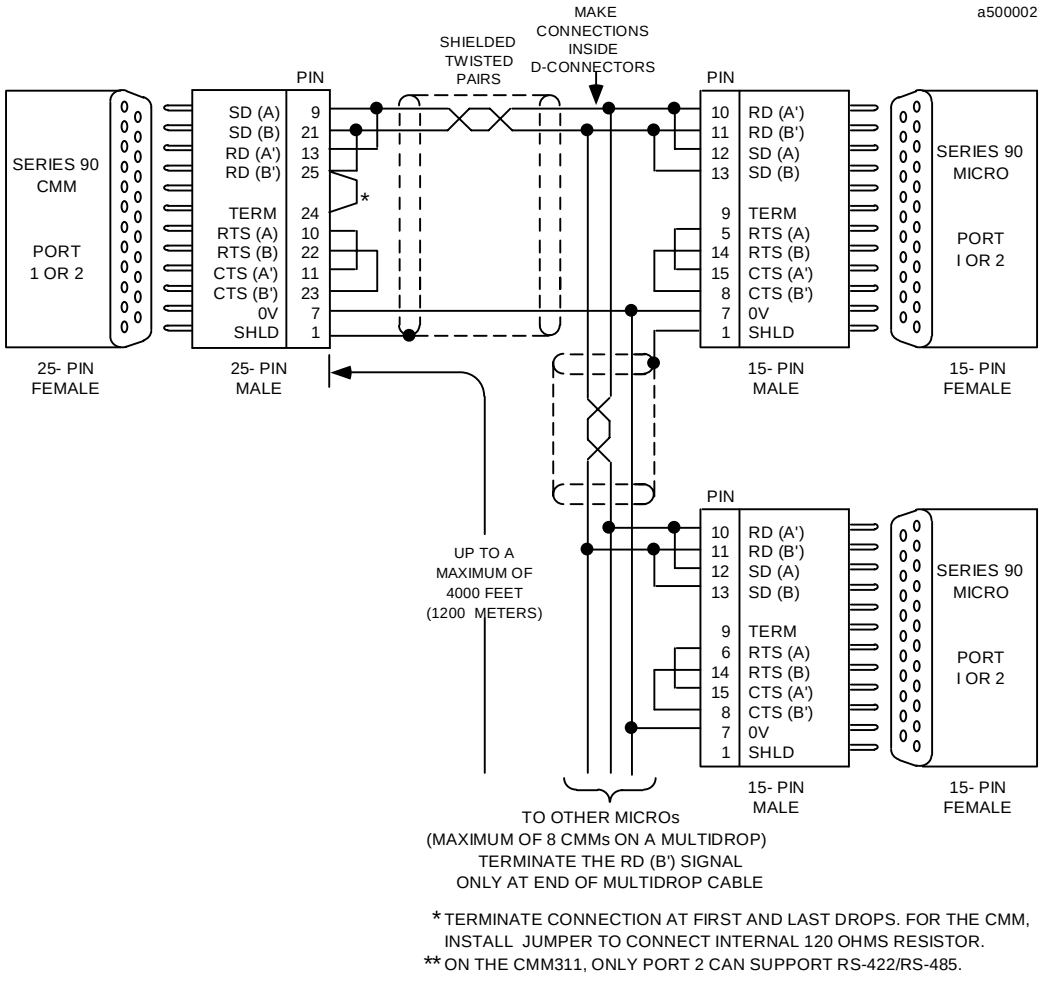


Figure F-7. CMM to Multi-Drop Setup (2-Wire RS-422/RS-485)

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Appendix G Sample Application or PWM and Pulse Outputs

Series 90 Micro PLC Analog I/O Through CALEX Signal Conditioners

Analog I/O is useful in a broad range of applications for such things as pressure and level sensing, positioning, and temperature control. The Series 90 Micro PLC can be used with CALEX signal conditioning units to provide a cost-effective solution. Analog channels can be added on a per channel basis, which allows customers to tailor their system at an incremental cost. CALEX signal conditioning units require only one discrete input (for Analog inputs) or one discrete output (for Analog outputs), with setup for use only required in the configuration of the PLC. Currently available solutions are 11-bit resolution equivalent. Installation is made easy through DIN rail mounting and Phoenix European-style wiring terminals. CALEX signal conditioners are available in Current In, Current Out, Voltage In, Voltage Out, and J-type Thermocouple units. The unit has space requirements of approximately 1.65 inches (42mm) high, 1.06 inches (27mm) wide, and 3.78 inches (96mm) long. The signal conditioning unit weighs only 3 ounces (85 grams).

Application

A user wants to use one analog input channel and one analog output channel to control flow rate. The analog input channel is used to determine fluid level and the analog output channel to control a positioning valve that varies flow rate into a tank. The user would also like to scale the output so that a one-to-one relationship exists between the value entered and the frequency sent out to the Frequency-to-Analog converter.

The Series 90 Micro PWM and pulse train (PT) frequencies are varied by entering values into the AQ2 and AQ123 registers respectively. The frequency that is output has an inverse relationship to the value entered in the register. That is, the lower the value placed in the AQ2 register, the higher the frequency sent out. For example, the PWM output will be set to the maximum frequency of 2khz for a decimal value of 614 written into the AQ2 register and 20hz for a decimal value of 61439. (For sample calculations of PWM and PT frequencies, see “Configuring Q1 for PWM or Pulse Output” in Chapter 5.)

Note

Values greater than 32767 cannot be entered as decimal numbers. They can be entered as hex or as two’s complement values. In Logicmaster 90, when entering hexadecimal numbers in a reference table, a leading A through F must be preceded by a zero (for example, 0FFFF). To enter a two’s complement number, enter it as a negative integer (**int**). For additional information, see “Reference Tables” in the *Logicmaster™ Series 90-30/20/Micro Programming Software User’s Manual*, GFK-0466.

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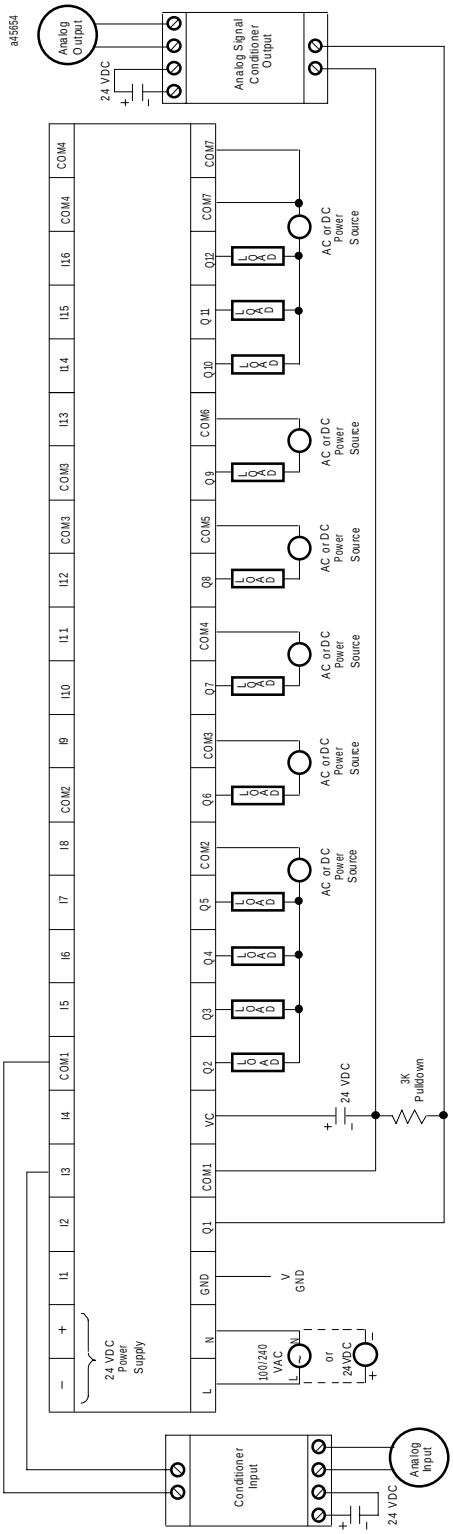


Figure G-1. Sample Wiring Diagram for PWM/Pulse Train Application

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Solution

The proposed solution requires the following:

- Logicmaster Series 90 Micro or Series 90-30/20/Micro Logicmaster software (Release 6.0 or later)
- Double Integer division and multiplication math functions in application code
- Series 90 Micro PLC with DC output
- CALEX signal conditioning input unit
- CALEX signal conditioning output unit

Example 1

The CALEX 8507 input signal conditioner produces a 0 to 5khz wave for a 0 to 10 volt input. The frequency varies proportionally to the voltage applied from the field side of the unit. A frequency of 1.25khz seen by the Series 90 Micro would correspond to a sensor voltage input of 2.5 VDC.

To set up the CALEX signal conditioning input units, run the Logicmaster 90 configuration package and select the I/O option. The signal conditioning input unit sends out a frequency that is proportional to the voltage or current applied from the field side. The frequency is fed into one of the Type A HSC inputs on the Micro PLC.

To configure the Micro PLC, set the HSC type to A, enable counts, and set time base to the number of counts desired (example: a 1000ms timebase will display 2000 count for a 2Khz wave sent out by the signal conditioner). To speed up the effective throughput of the CALEX input unit, decrease the counts per timebase and scale according to user needs in the ladder logic (example: A 500ms timebase will display 1000 counts for a 2Khz wave, which can be scaled to 2000 counts through a multiplication function in the ladder logic). The corresponding frequency can be viewed in the counts per timebase register (for the above example, the HSC 2 counts per timebase register is AI03). It should be noted that the TYPE A counter setup requires two inputs for each counter. If the second input required for a TYPE A counter is not used for strobing the counter, it is still available as an input. This means that the signal conditioning input only requires one input per analog channel in. Additionally, due to hardware constraints, when the high-speed output function is used (PWM or PT), channel one cannot be used as a high-speed counter input. This makes the maximum number of AI set to three when PWM or PT is required in TYPE A counter mode.

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Example 2

The CALEX 8510 output signal conditioner produces a 0 to 5VDC output for a 0 to 2Khz input from the Micro PLC. The voltage output varies proportionally to the applied frequency. A frequency of 1Khz will result in an output voltage of 2.5VDC. It should be noted that the Micro PLC does not allow frequencies of less than 19hz to be produced because the largest supported value for the AQ2 register is hex FFFF. In addition, the frequency that can be output is in increments of 3hz (best case) but varies between 3 and 4hz due to the rounding effects of the equation.

The setup for the signal conditioning output is similar to that for the input, except that values must be written to AQ2 and AQ3 registers to set up frequency and duty cycle respectively. From the Logicmaster 90 configuration package:

- Select the I/O configuration.
- Select TYPE A counter option.
- Disable High Speed Counter 1.
- Enable PWM output.

From the Logicmaster 90 programmer package:

- Set the value of the AQ3 register to 200 decimal (this value produces the proper duty cycle over the full frequency range).
- Set the AQ2 register to the required value to produce the desired frequency according to the equation

$$Frequency = \frac{9.84\,MHz}{8*(AQ2+1)}$$

The frequency output equation is rewritten in terms of AQ2 as follows:

$$AQ2 = \frac{9.84\,MHz}{8*Frequency} - 1$$

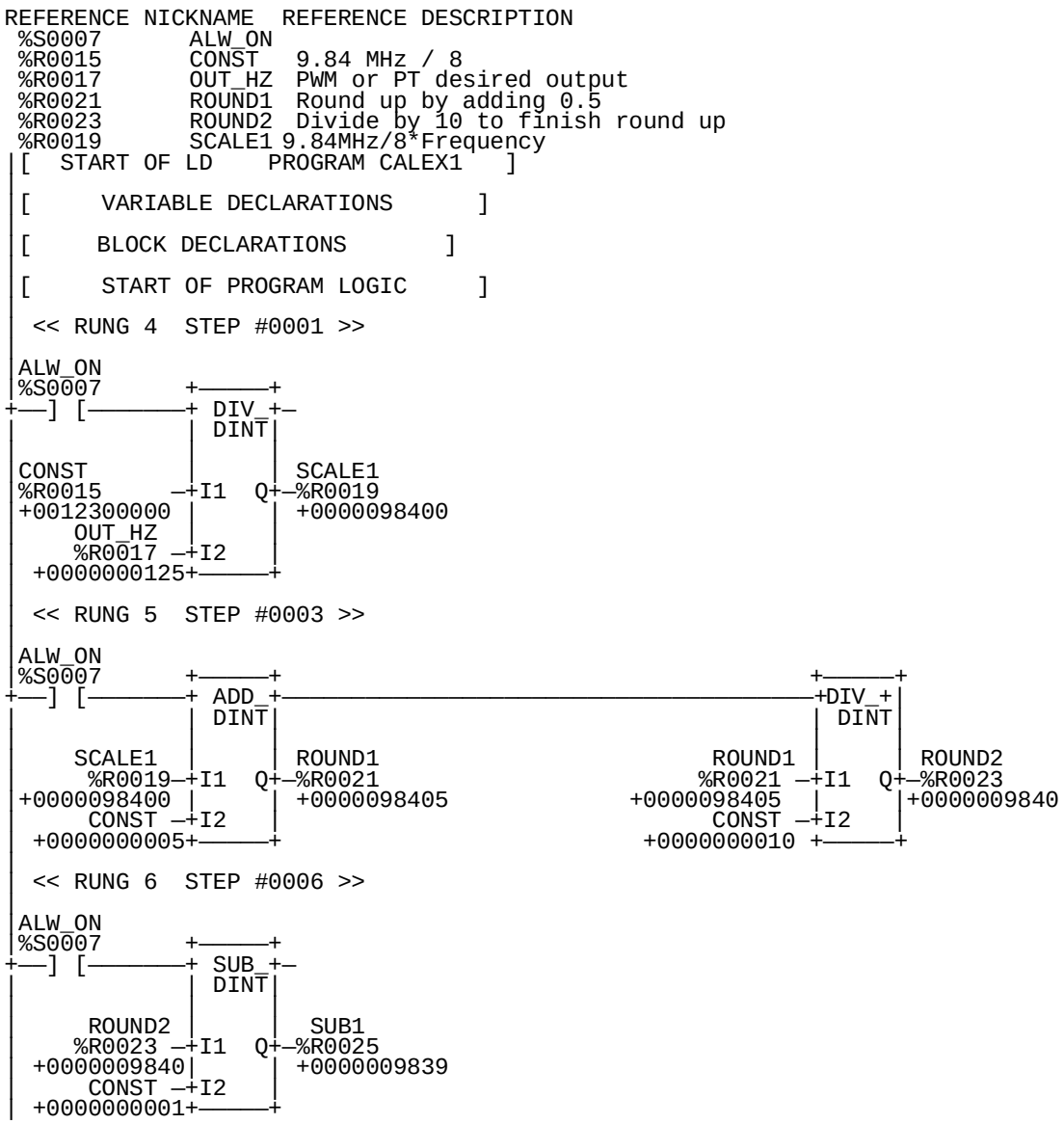
which represents the value that needs to be written into the AQ2 register to produce the desired frequency. The application code provided on pages G-5 through G-6 solves the above equation and writes the value into the AQ2 register. Due to firmware constraints, the lowest frequency that can be obtained is 19hz. Values less than 19 exceed the maximum value allowed for the AQ2 register. The application code will set the frequency to 100% duty cycle (constantly on “1”) for a value of less than 19 written into the AQ2 register.

Benefits

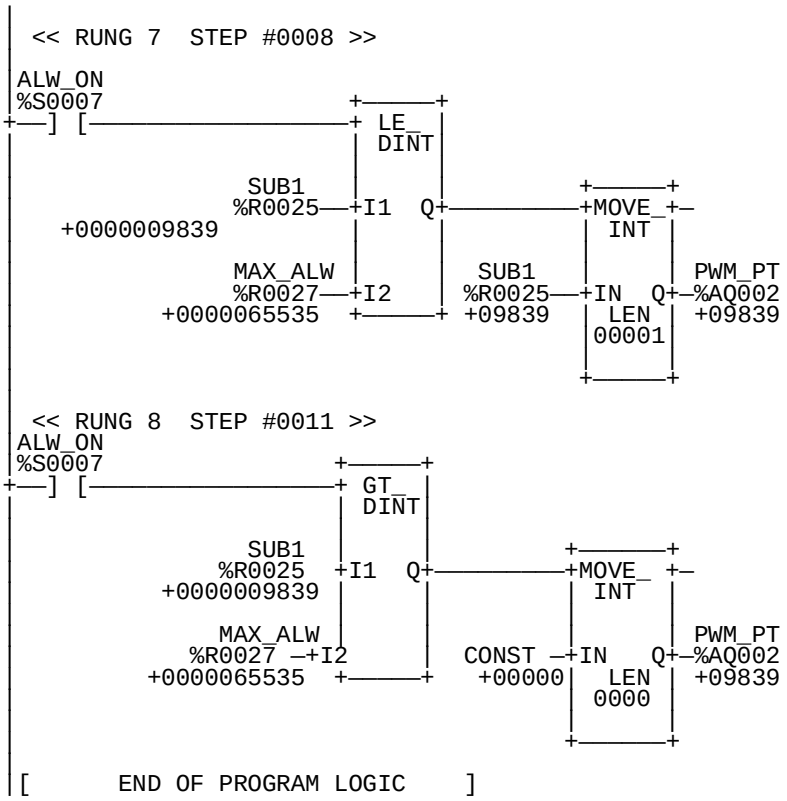
- Analog available on a per-channel basis
- Cost-effective solution
- Ease of ramping output through application code with a one-to-one relationship for scaling
- Readability of desired output frequency without doing conversion prior to entering into AQ2 register

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Sample Ladder Logic Diagram



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Appendix H Case Histories

This appendix contains brief descriptions of applications that use the Series 90 Micro PLC. The Series 90 Micro PLC is an ideal way to replace relays and automate small processes. Its all-in-one construction saves panel space and its powerful features bring productivity and cost savings to almost any control application. It is a perfect solution for such applications as packaging, industrial machinery, material handling, and printing. The Series 90 Micro PLC offers the high standards of reliability and quality you have come to expect from GE Fanuc at a cost lower than traditional control devices.

Sample applications for the following industries are described:

- Automotive H-2
- Bakery H-3
- Chemical H-4
- Commercial Agriculture H-5
- Commercial Laundry H-6
- Construction Equipment H-7
- Entertainment H-8
- General Purpose Machinery H-9
- Lumber H-10
- Material Handling H-11
- Paper H-12
- Petroleum H-12
- Packaging H-13
- Plastics H-15
- Public Emergency Services H-17
- Sports Equipment H-18
- Tubing Manufacturing H-19
- Water and Wastewater H-20
- Wire Manufacturing H-24
- Woodworking H-25

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Automotive Industry

Fluid Pumping Control

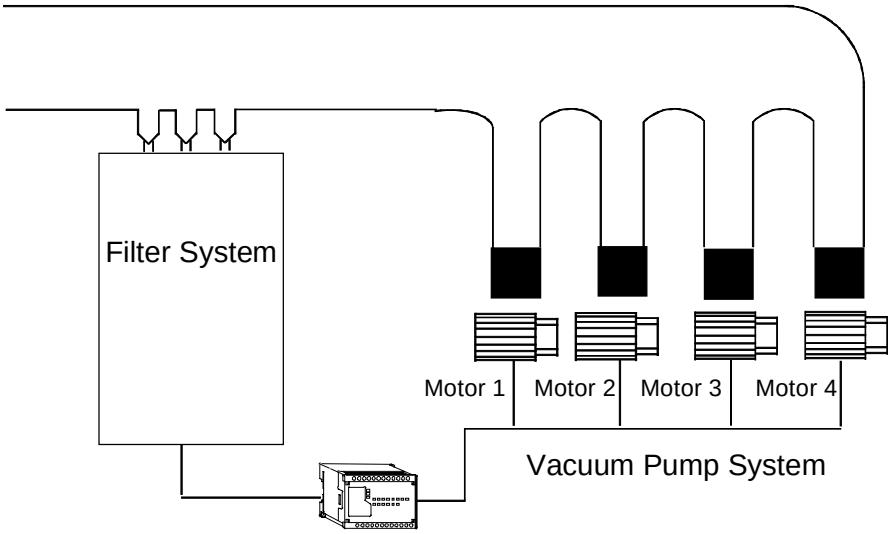
The Need

A cost-effective PLC was needed to replace an expensive, custom-made PC control board that controlled an automated fluid pumping station. The system controls four vacuum pumps, alternates their start-up sequence, delays their run time when alarms are cleared, and controls the clean out filters for the multiple conditions.

It was also important to the customer that a stocking distributor and technical support be available for the PLC.

The Solution

The Series 90 Micro PLC was used to satisfy the needs of this system. The PLC's ease of programming, cost effectiveness, and capabilities made it the logical solution.



The Benefits

Tremendous cost savings are gained by eliminating the custom-made PC board control system. The customer also benefits from the extensive local and national product support. Also, the Series 90 Micro PLC is more versatile than the custom-made board, making the system easy to modify or expand in the future.

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Bakery Industry

Pastry Line Conveyor Control

The Need

The system includes several conveyors for a toaster pastry line, in which on-the-spot decisions on when to transfer pastries to the packaging machine conveyor are made. Decisions are based on the count of pastries, which occurs at high speed, and the downstream packaging machinery loading.

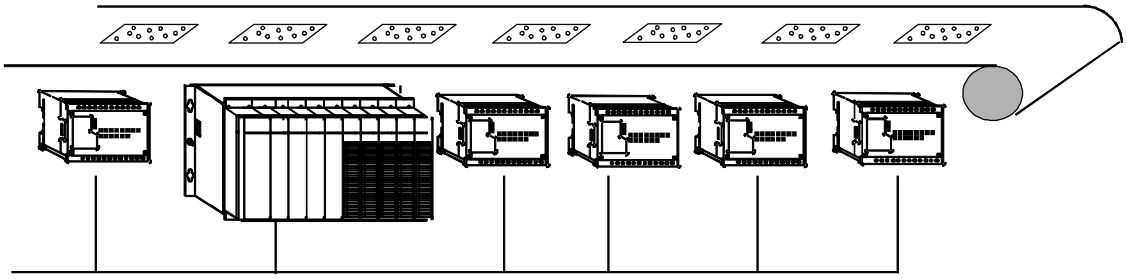
The Solution

GE Fanuc supplied ten Series 90 Micro PLCs and a Series 90-70 PLC. The Micro PLCs are distributed along the conveyor belt at each packaging point. The high-speed counting ability of the Series 90 Micro and its local logic allow it to make the necessary on-the-fly decisions for conveyor control.

System parameters are transmitted using SNP to the Series 90-70 PLC at the heart of the system. The Series 90-70 PLC monitors the overall performance of the system.

The Benefits

The Series 90 Micro PLC affords the customer the advantage of a cost-effective compact package that provides high-speed counting and local logic.



Series 90 Micro PLCs control individual sections of the conveyor as the Series 90-70 PLC controls the overall system.

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Chemical Industry

Chemical Pumping Station

The Need

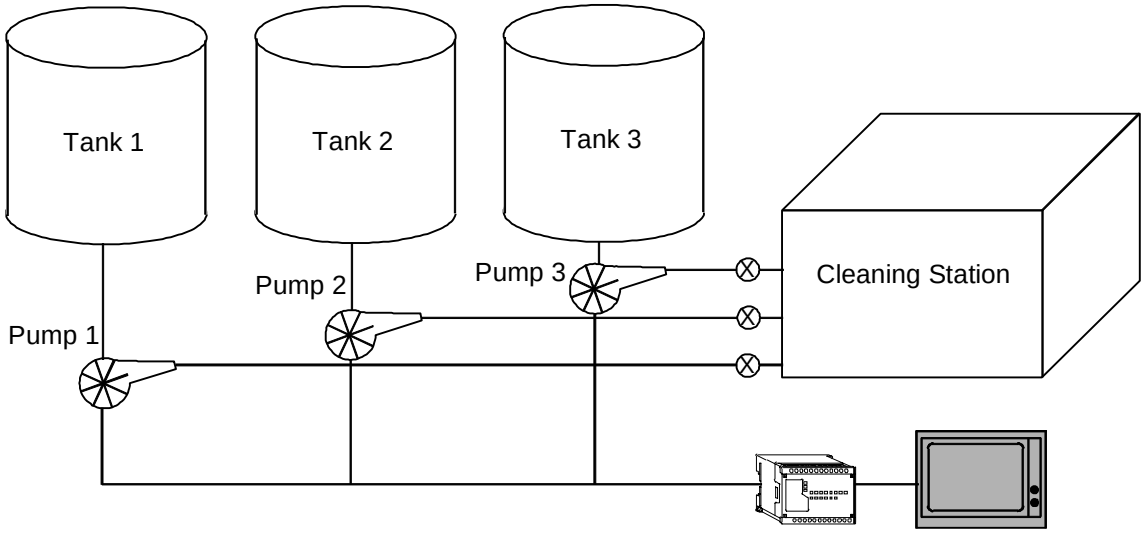
A PLC was needed to replace mechanical timers, counters, and relays that controlled pumping stations delivering chemicals to the cleaning station. The mechanical system was hard-wired and difficult to modify.

The Solution

A 14-point Series 90 Micro PLC was used with a compatible Operator Interface Terminal (OIT).

The Benefits

The Series 90 Micro PLC offered flexibility through programming, reduced need for panel space, and ease of wiring.



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Commercial Agriculture Industry

Grain Processing

The Need

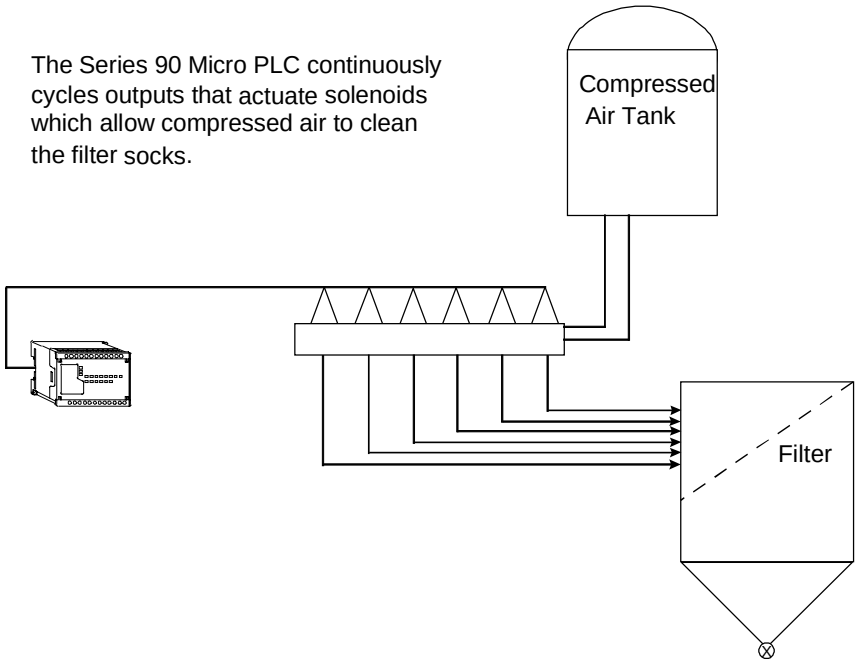
A control system was needed to replace an existing filter timer board and tie in hardwired relay controls. The filter board was replaced with PLCs to standardize the process control.

The Solution

A 14-point Series 90 Micro PLC was installed because it satisfied the system requirements and because the customer was very satisfied with previously owned GE Fanuc equipment.

The Benefits

The Series 90 Micro PLC added flexibility to the system and was a perfect fit for standardization. The Series 90 Micro PLC uses the same programming hardware and software as the Series 90-30 PLC, which was already being used. This saved the cost of purchasing and learning new programming equipment.



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Commercial Laundry Industry

Garment Storage Rail Control

The Need

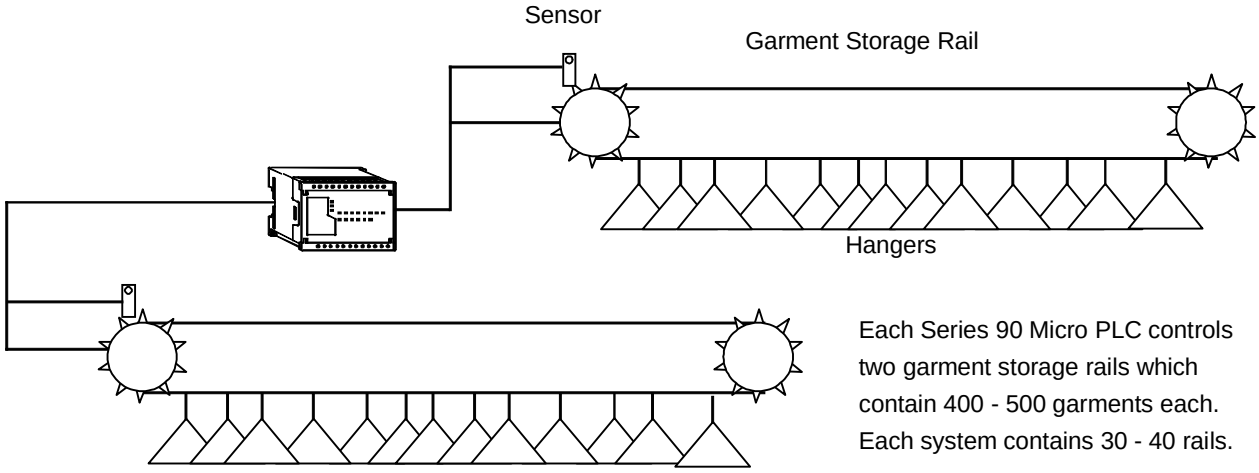
A control system was needed to replace a custom-built PC board that was costly to maintain. The control system must be able to accurately drive the advancement of two garment storage rails and track the number of garments on each rail. The storage systems include 30 to 40 rails, each with 400 to 500 garments.

The Solution

The Series 90 Micro PLC was used because it features built-in 5KHz high-speed counters.

The Benefits

The Series 90 Micro PLC uses the same programming hardware and software as the Series 90-30 PLC, which was already being used. This saved the cost of learning and purchasing new programming equipment. Also, eliminating the high support costs associated with the custom-built board provided significant cost savings.



Each Series 90 Micro PLC controls two garment storage rails which contain 400 - 500 garments each. Each system contains 30 - 40 rails.

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Construction Equipment Industry

Pipe Measuring System

The Need

A control system that accurately measures pieces of 4-foot to 28-foot long pipe in feet and fractions of an inch was needed. It is important to display the data in the same units instead of decimals to make the system easy to use for operators. The information is received from an encoder and then displayed on the operator interface unit (OIU). Operators use the OIU to specify pipe length and the control system measures the pipe and cuts it to the specified length.

The Solution

A 14-point Series 90 Micro PLC and a compatible OIU were installed because they effectively satisfied the cost criteria. Also, the four high-speed counters allowed the Series 90 Micro PLC to interface with a quadrature encoder.

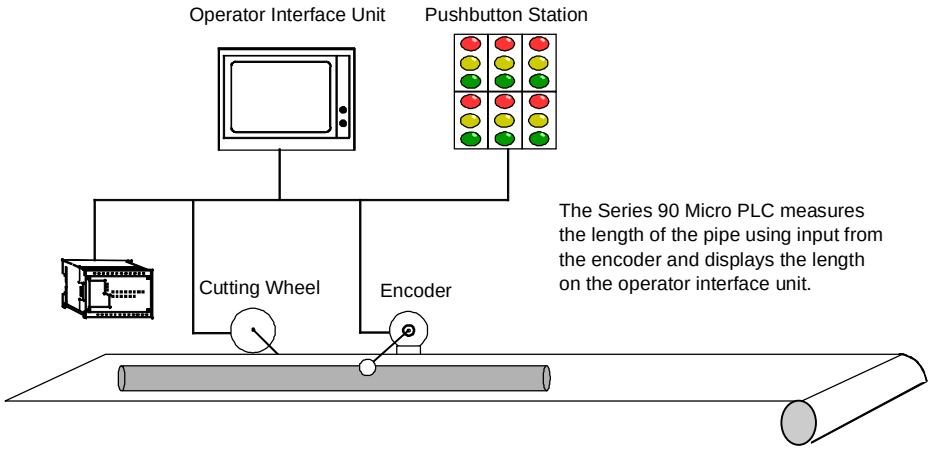
The Benefits

The Series 90 Micro PLC produced more reliable machine operation and improved machine performance. By interfacing with the OIU, the operator is easily able to set parameters in the PLC which reduce order setup time and allows for faster processing of products.

The Series 90 Micro PLC

This provided the best value for small applications. Features include:

- Economical starter pack
- PID functionality
- Built-in potentiometers to set timer/counter presets
- Compatibility with Series 90-30 PLC programming
- 28-point model has two communication ports
- Pulse width modulation on DC output models
- Pulse catch outputs on DC output models



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Entertainment Industry

Nightclub Entertainment

The Need

A pushbutton control system that allows a disc jockey to vary the sequence of blinking lights for a disco display was needed. The display consists of ten blinking lights in an adjustable timed sequence.

The Solution

The Series 90 Micro PLC and a pushbutton assembly were used. The PLC was used because of its size, ease of installation, and programmability. The analog potentiometers on the Series 90 Micro PLC allow the time base to be easily adjusted.

The Benefits

Considerable cost savings were gained due to reduced labor because the Series 90 Micro PLC was easily installed.

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General Purpose Machinery

Automated Picture Frame Stapler

The Need

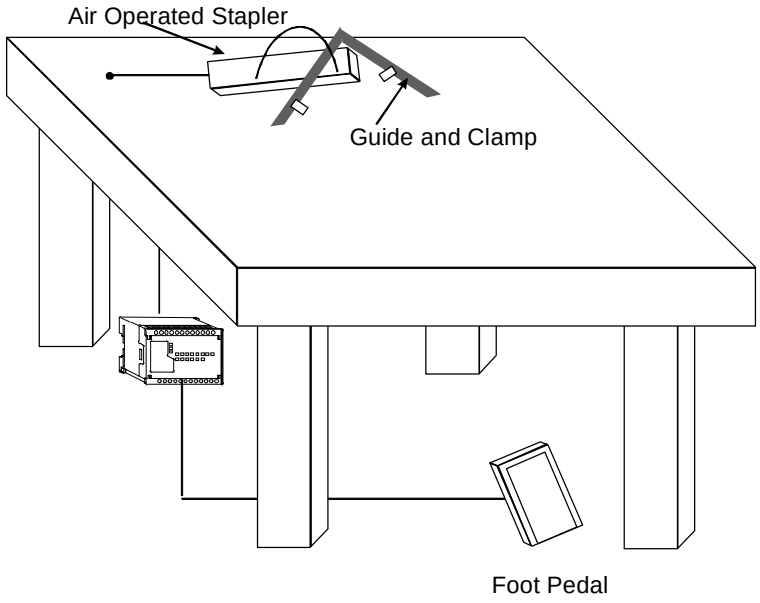
A compact, robust control system was needed for a new machine, to simplify the stapling process in the construction of picture frames.

The Solution

A 28-point Series 90 Micro PLC was used because of the high level of support that GE Fanuc offers and the cost effectiveness of the product.

The Benefits

The reliability and ease of programming of the Series 90 Micro PLC have greatly benefited the customer. Production was doubled with less operator fatigue and the customer realized hundreds of dollars of savings per year.



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Lumber Industry

Pallet Rebuilding

The Need

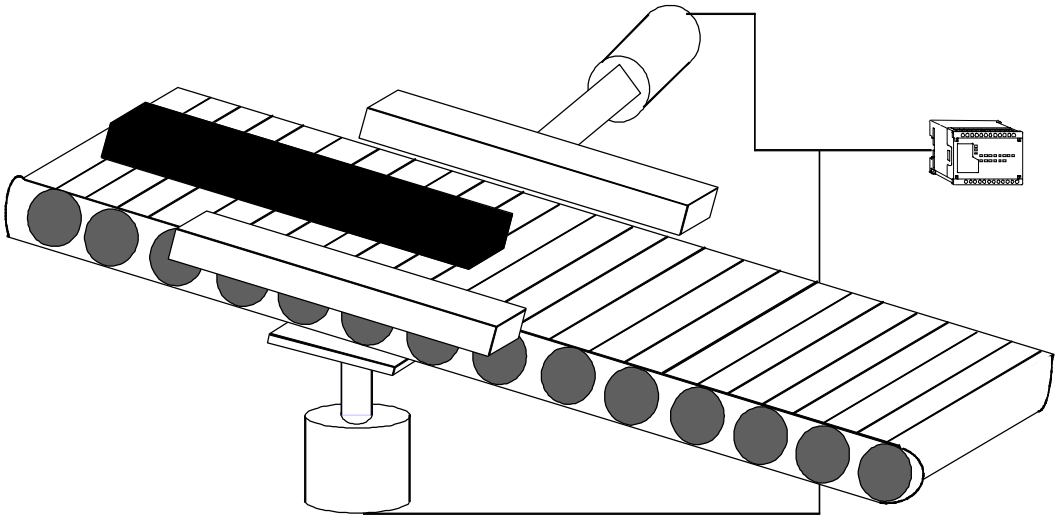
A smaller control system was needed to measure the length of each board and position a hydraulic press to flatten protruding nails. The existing system consisted of a large PLC.

The Solution

A 14-point Series 90 Micro PLC was chosen because it offers compact size and high speed.

The Benefits

The analog potentiometers on the Series 90 Micro PLC allow the operator to fine tune the system to compensate for conveyor speed changes. The customer realized hundreds of dollars in savings per machine by replacing the larger PLC.



The Series 90 Micro PLC receives input from photo sensors on the conveyor to control the cylinders that position the boards.

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Material Handling Industry

Automated Guided Vehicles

The Need

The Automated Guided Vehicles (AGVs) are powered by a 24VDC battery power supply which also operates the control system. The manufacturer of these systems needed to replace the existing PLC that used an excessive amount of the AGVs' battery power.

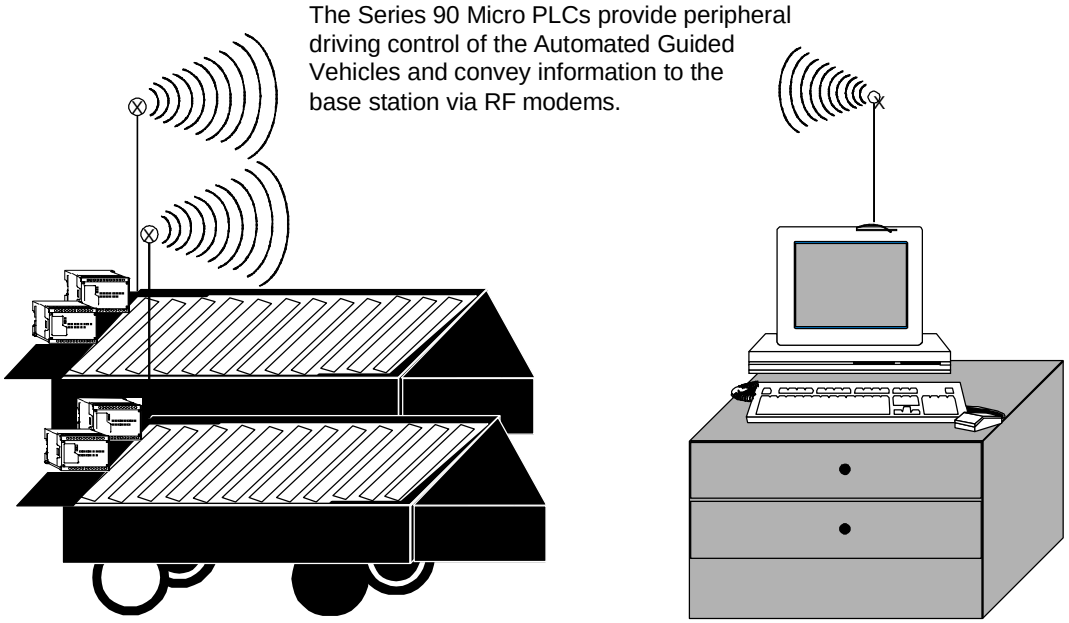
The Solution

Two GE Fanuc Series 90 Micro PLCs per AGV were installed for peripheral driving control of the vehicles and to communicate with the base station via SNP and radio modems.

The Benefits

The system now requires less power and less panel space because the Series 90 Micro PLC replaced the larger PLC. Overall, hundreds of dollars in savings per system were realized.

It was also advantageous to install Series 90 Micro PLCs because the customer was already using GE Fanuc Series 90-30 PLCs. As part of the Series 90 family, Series 90 Micro PLCs use the same programming equipment and software as the Series 90-30 PLC.



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Paper Industry

Gear Pumping Machinery

The Need

Pumps are used to separate chemicals from rinsing water for proper disposal. A cost-effective system was needed to control the logic for sequencing the operation of turning the solenoids and pumps on and off. In addition, the operator must be able to monitor and change each of the 12 timing sequences externally. The process was controlled by timers and relays, which were costly to maintain.

The Solution

A Series 90 Micro PLC and an Operator Interface Terminal (OIT) were used to replace the mechanical system.

The Benefits

The Series 90 Micro PLC was chosen for cost and time effectiveness. It offered added benefits and features, such as flexibility, over the mechanical system without increased cost. It also provides system monitoring capability and allows error messages to be displayed.

Petroleum Industry

Lease Acquisition Control Transfer

The Need

A control system was needed to replace an old and obsolete PLC-relay combination system. The replaced system had constant problems with the relays and replacement parts could not be found for the obsolete PLC. The system is used for *lease acquisition control transfer*, the selling of oil through pipelines.

The Solution

The Series 90 Micro PLC was used because the 28-point model fit the application perfectly and the customer did not have to learn or purchase new programming software. The customer already used a Series 90-30 PLC in other systems, and both PLCs use the same programming hardware and software.

The Benefits

The Series 90 Micro PLC allows the flexibility of upgrading the system to a Series 90-30 PLC without changing the programming language.

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Packaging Industry

Shrink Wrapping Machine

The Need

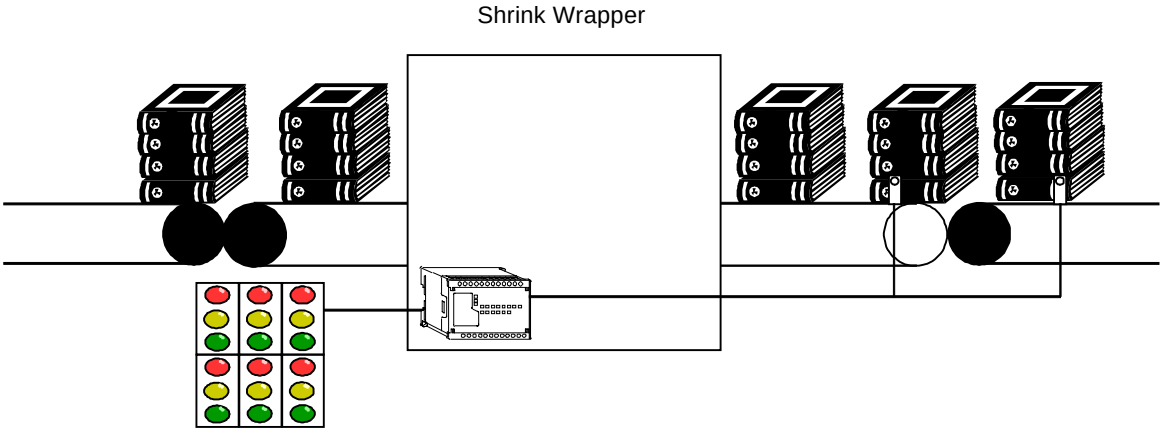
A system was needed to control the operation of a shrink wrapping machine. The system receives inputs from sensors to determine the position of the product and then wraps the product. The system must allow parameters to be easily changed for different products.

The Solution

The 28-point Series 90 Micro PLC was selected because it is cost effective and is a member of the Series 90 family. The Series 90 Micro PLC uses the same programming hardware and software as the Series 90-30 PLC. This allows the customer to buy only one software package to program applications for the shrink machine and other larger machines.

The Benefits

The flexibility of the Series 90 Micro PLC allows the parameters to be changed at a control panel without any programming modifications.



The Series 90 Micro PLC uses input from various sensors to determine the position of product and parameters from the control panel to sequence the wrapping of the products.

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Videocassette Packaging

The Need

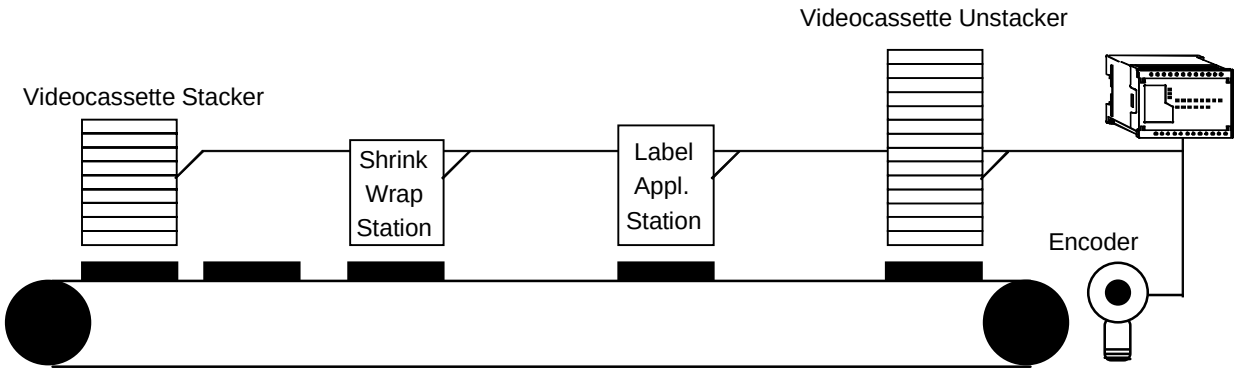
An inexpensive control system was needed to replace relays and hardwired counters. The system must be able to read an encoder and sequence the machine's operation based on input counts. The system must control the conveyor, stacker/unstacker, shrink wrap station, and interfaces to the label applicator control using digital I/O.

The Solution

The Series 90 Micro PLC was selected because it offers built-in high-speed counters, a built-in 24VDC power supply, and cost effectiveness.

The Benefits

The Series 90 Micro PLC proved to be easy to use, cost effective, and easy to install with less wiring. Hundreds of dollars in wiring and device savings were realized per machine.



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Plastics Industry

Injection Molding

The Need

A control system was needed to automate the application of plastic handles to milk and juice jugs. The system needs inputs for counting and sequencing of two jugs that will be joined with one plastic handle (for retail customer convenience).

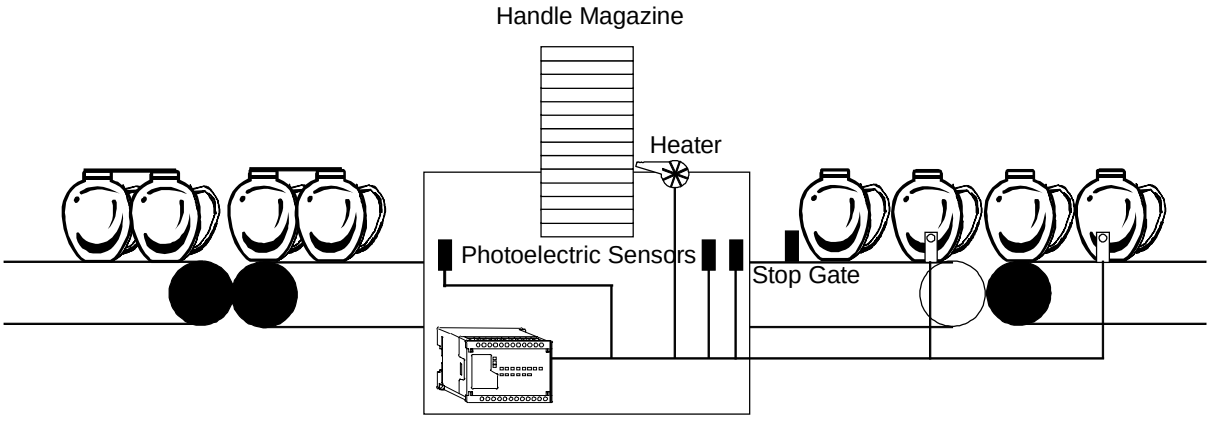
Jugs are queued up before being fed through the handle applicator. The system needs to be flexible for continual or random feeding, and to operate with jugs ranging in size from one quart to a gallon. Handles are heated for easy application but without melting or deforming. The handle magazine level must be monitored with *low* and *out* alarms. Other indicators include: *in feed* and *out feed* jam detection, feed rate, shift, and totaled count.

The Solution

The 14-point Series 90 Micro PLC was selected because it offers compact size, functionality, cost effectiveness, and the customer's experience with local support. Programming compatibility with the Series 90-30 PLC was also a key factor because the system may grow beyond the capability of the Series 90 Micro PLC.

The Benefits

By using the Series 90 Micro PLC the customer has the ability to easily modify the program to match the machine operation in the customers' environment. Also, modifications for unforeseen glitches that are involved with each new installation can be made quickly. The Series 90 Micro PLC is part of a product family that allows the system to grow as needs change without retraining, and the customer is fully supported both locally and nationally.



The Series 90 Micro PLC uses inputs from various sensors to control the handle applicator system.

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Plastic Parts Manufacturing

The Need

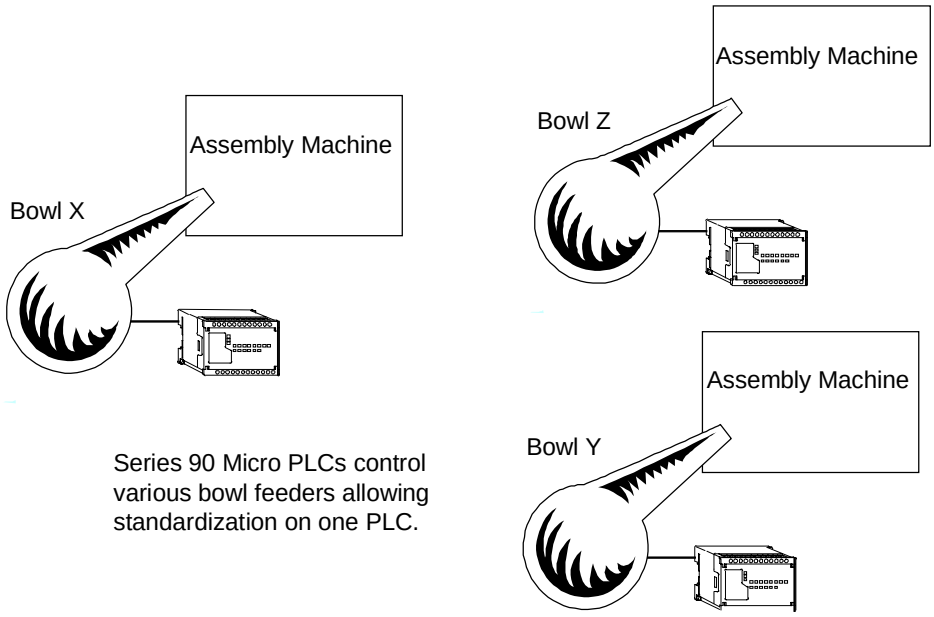
The customer needed the ability to standardize on one PLC product line to control various bowl feeders. The PLC interfaces with sensors throughout the cycle of the bowls to control the output of parts to an assembly machine.

The Solution

The 14-point Series 90 Micro PLC was used because it is part of the Series 90 family.

The Benefits

The Series 90 Micro PLC was chosen because of its programming hardware and software compatibility with the Series 90-30 PLC, which was already being used. Additionally, its cost effectiveness allowed the customer to replace other controls, including other brands of Micro PLCs used by OEM bowl suppliers.



Series 90 Micro PLCs control various bowl feeders allowing standardization on one PLC.

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Public Emergency Services Industry

Storm Warning Systems

The Need

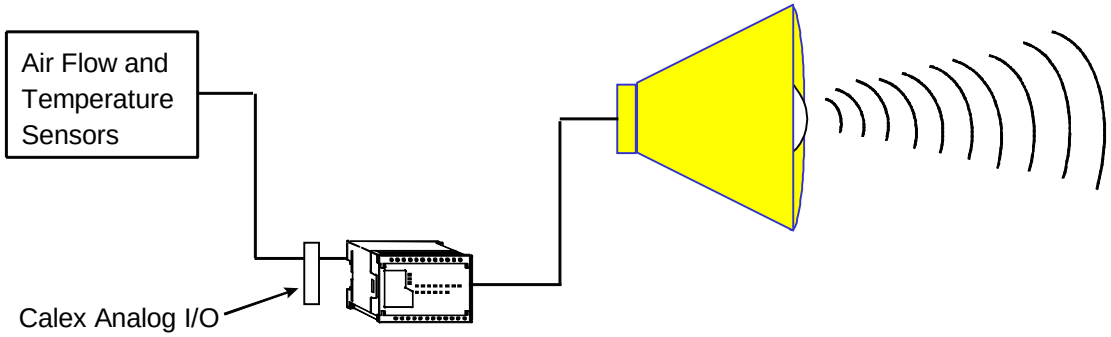
A small PLC control system with enough power and analog capabilities was needed to replace a large modular PLC and relays. The system will receive input from air flow and temperature sensors to determine when to sound the air raid sirens to alert the public of tornadoes and other severe weather.

The Solution

The Series 90 Micro PLC was used with an analog adapter because of its compact yet robust features.

The Benefits

The compact size of the Series 90 Micro PLC allows it to use existing or smaller enclosures, lowering the overall cost for the PLC and associated equipment. Also, its reliability is essential to sound sirens for the public's safety.



The Series 90 Micro performs logic on input from the sensors to alert the town of pending tornadoes and other forms of severe weather.

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Sports Equipment Industry

Boxing Partner

The Need

A compact control system, with large application ability, was needed for a boxing simulation machine designed for amusement and training. The machine allows a person to train for boxing or to try their talents at the sport. The simulator is designed for gyms and amusement areas.

Due to the simulator's movement patterns, a high-speed counter was necessary as well as low-voltage DC inputs.

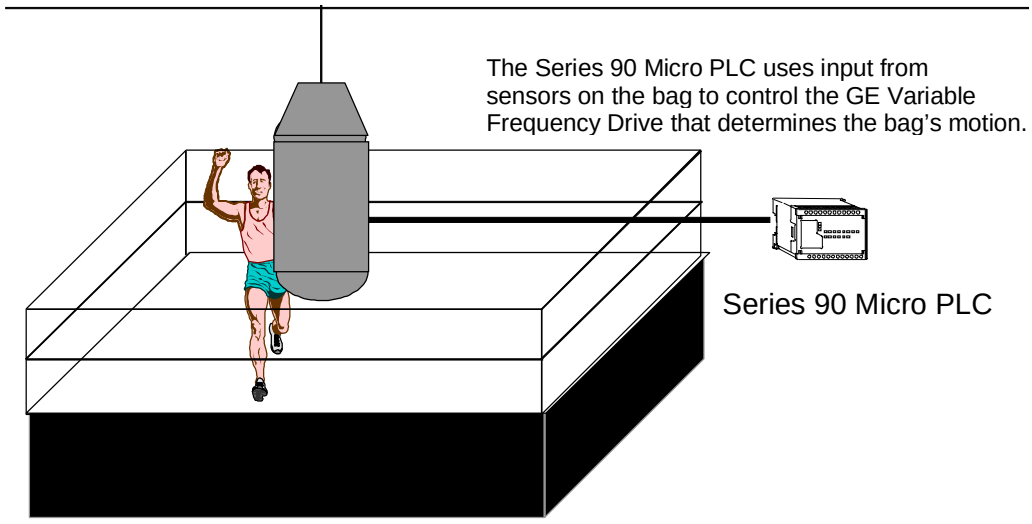
The Solution

A 14-point Series 90 Micro PLC and a GE Variable Frequency Drive were chosen. The Series 90 Micro PLC was chosen because it offers compact size, built-in high-speed counters, and cost effectiveness. Also, it utilizes the same instruction set as the Series 90-30 PLC, which will allow easy expansion for added features.

The Series 90 Micro PLC uses sensor inputs to control a GE Variable Frequency Drive which has seven pre-selected speeds. Together they provide a variety of motions that simulate those of a boxing opponent.

The Benefits

The Series 90 Micro completed the tasks while saving both space and cost.



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Tubing Manufacturing Industry

Tube Bending

The Need

A control system was needed to automate a tube bending process, which was being performed manually by sight with control relays. The objective is to bend the tube to a specific angle which changes by order.

The Solution

A 28-point Series 90 Micro PLC was used with an Operator Interface Terminal (OIT) and three encoders. The Series 90 Micro PLC uses pulse width modulation to control the encoders for positioning and communicates with the operator via the OIT. The operator uses the OIT to adjust the process speed.

The Benefits

The Series 90 Micro PLC is much more accurate than the manual method and therefore material waste was significantly reduced. Also, set-up time between orders was reduced.

The Series 90 Micro PLC

This provided the best value for small applications. Features include:

- Economical starter pack
- PID functionality
- Built-in potentiometers to set timer/counter presets
- Compatibility with Series 90-30 PLC programming
- 28-point model has two communication ports
- Pulse width modulation on DC output models
- Pulse catch outputs on DC output models

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Water and Wastewater Industry

Flood Control Monitoring

The Need

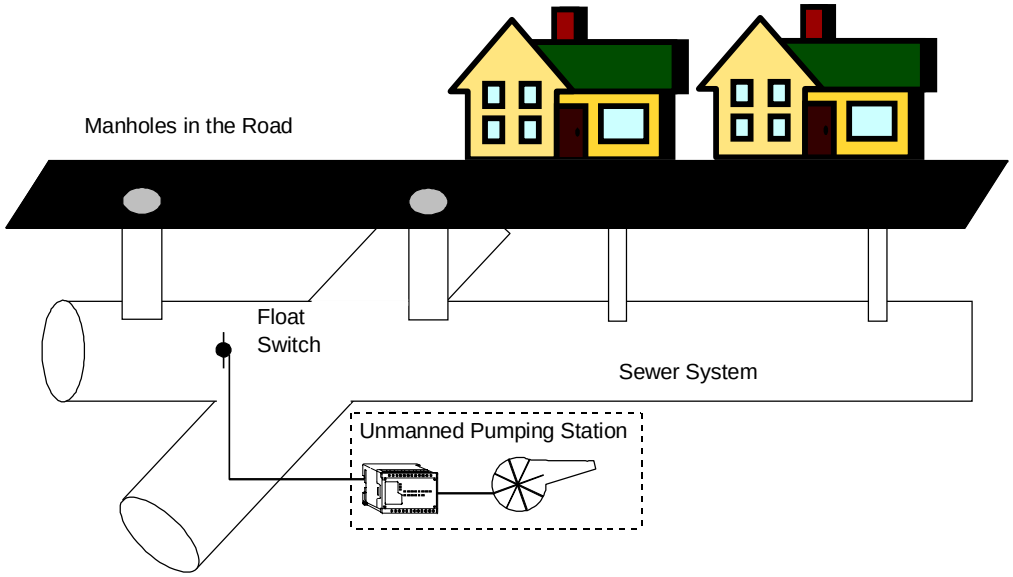
A reliable and cost-effective control system was needed to monitor and control the number of start and stop cycles, elapsed time, on/off status, and fault condition of flood control pumping stations. The previous system used hardwired pilot lights, which conveyed only basic information to the operator and were difficult to maintain.

The Solution

The Series 90 Micro PLC was used with a compatible Operator Interface Unit (OIU) because of its proven reliability.

The Benefits

The Series 90 Micro PLC's reliability and cost effectiveness are the most important benefits to this system. All of the 80 to 90 pumping stations are unmanned, so the high reliability of the Series 90 Micro PLC is a key benefit to the system. Also, through an operator interface unit, the Series 90 Micro PLC is able to convey information much more effectively than the previous pilot lights. This metering information can be used to help the maintenance team identify possible problem areas in the sewer line. The Series 90 Micro PLC provides valuable information about the capabilities of the existing sewer system to handle large amounts of water during heavy storms.



Series 90 Micro PLCs use float switches to monitor the level of water in the sewer system. During storms it cycles relief pumps on and off to prevent the backup of water into houses and businesses.

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Sewage/Wastewater Lift Stations

The Need

A reliable control system was needed to replace a large cabinet containing 6 timers and 140 relays. Lift stations located throughout a town were constantly failing and requiring emergency call-outs of electricians at all hours.

The control system is used to control the water level in a wet well. It operates two pumps alternately, each for a specified amount of time, to reduce the wear and tear on the pumps. It also monitors the valve check arms to verify that the switches are complete and that water is flowing properly. It must also monitor the operating temperature of the motors and shut down the motors if a thermal overload occurs.

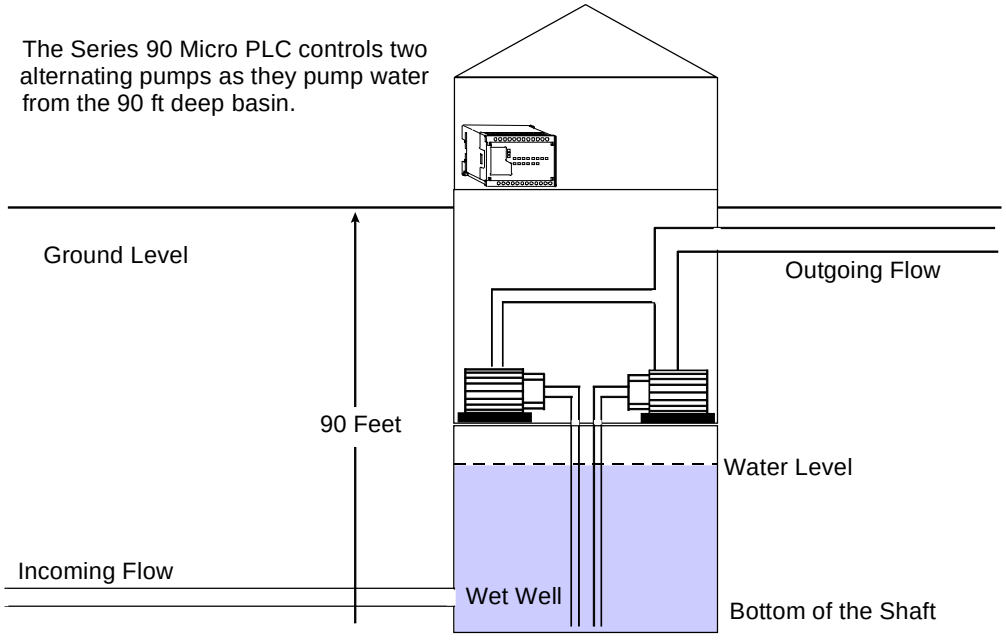
The Solution

The Series 90 Micro PLC was chosen because it offers programming hardware and software compatibility with the Series 90-30 PLC, which was already being used.

In addition, the Series 90 Micro PLC's high capacity for amperage allows the PLC to be directly wired to the coil of the motor starters. Competing brands of micro PLCs did not offer this capability.

The Benefits

Using the Series 90 Micro PLC eliminated the need for emergency maintenance call-outs. The decrease in overtime and downtime costs paid for the Series 90 Micro PLC in less than a month.



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Wastewater Treatment

The Need

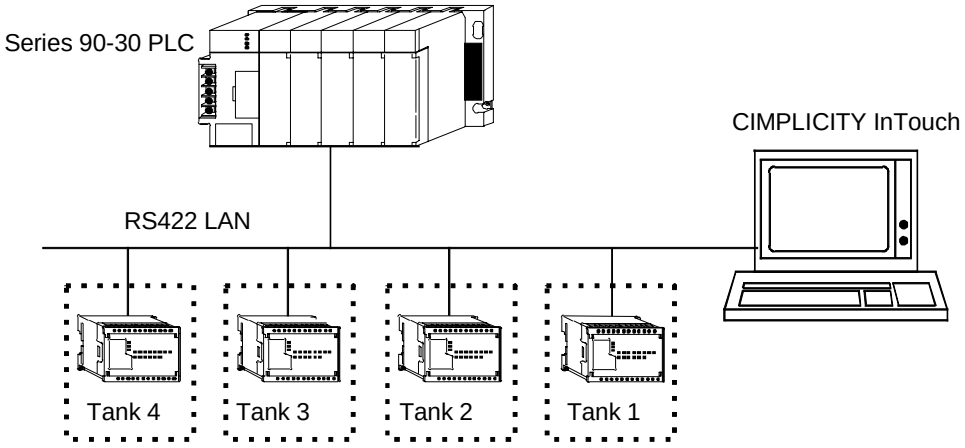
The customer needed to replace an electromechanical control as part of the redesign of wastewater treatment equipment. The system automatically adjusts treatment parameters in response to changes sensed in the influent. It also permanently records all operational functions, to provide information on every function of each cycle for whatever time reference desired. This information is used to indicate if service or maintenance is needed so the operator can use preventive measures to stop failures.

The Solution

Series 90 Micro PLCs were installed with a Series 90-30 PLC and CIMPLICITY InTouch software. The Series 90 Micro PLC was selected because it provides software compatibility with the Series 90-30 PLC.

The Benefits

The compact size and reliability of the Series 90 Micro PLC improved equipment performance and cost efficiency.



Each Series 90 Micro PLC controls a tank and is also connected to the master Series 90-30 PLC for override control.

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Water Flow Control

The Need

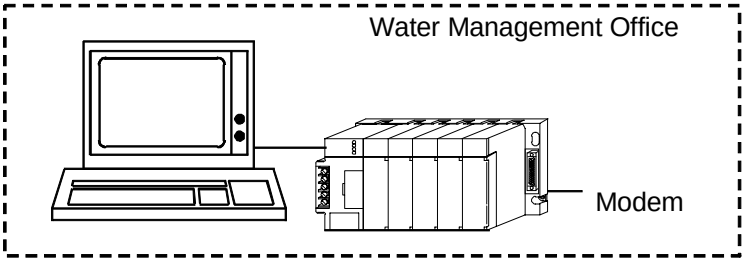
A control system that includes analog and discrete I/O was needed to monitor and control water flow through a treatment facility. Remote well sites are required to operate independently as well as receive override control from a master PLC site via RF modem or short haul modem.

The Solution

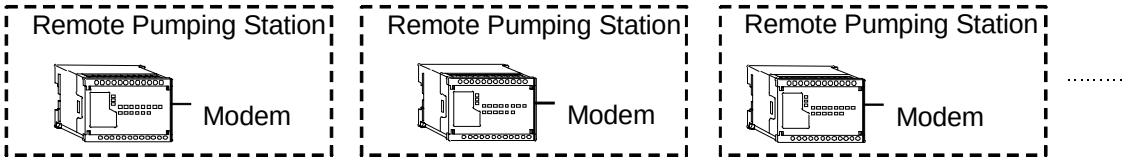
The Series 90 Micro PLC was chosen to be used with the Series 90-30 PLC and CIMPLICITY InTouch and HMI software because of its compatibility and small footprint. The system was able to use Data-Linc Group modems and it was easy to program the logic.

The Benefits

The Series 90 Micro PLC and other GE Fanuc products are proven to be very reliable and interface well with each other.



The master Series 90-30 PLC collects data from the remote Series 90 Micro PLCs and sends it to the CIMPLICITY system, which has overriding control of the system.



The Series 90 Micro PLCs control the water flow at the remote sites and transfer process data to the master Series 90-30 PLC.

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Wire Manufacturing Industry

Quality Control

The Need

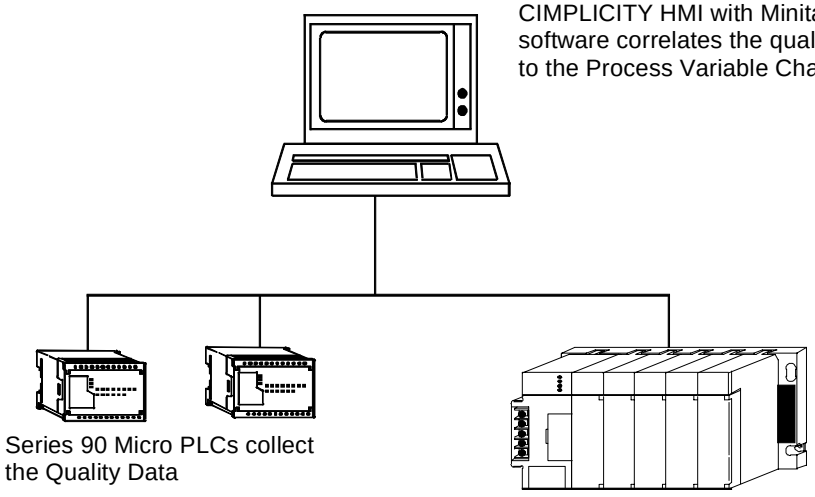
A control system was needed to replace a strip chart that plotted the number of quality defects per 100 feet of wire produced. The data is used to correlate the quality of the wire to the process variables, temperature, and speed. The correlation will be used to achieve a level of Six Sigma Quality.

The Solution

A system consisting of two Series 90 Micro PLCs and CIMPLICITY software was installed to interface with the existing Series 90-30 PLC. The Series 90 Micro PLCs collect quality data, the Series 90-30 PLC collects process variable data, and the CIMPLICITY software correlates, trends, and analyzes the data. The Series 90 Micro PLC was selected because of its cost effectiveness.

The Benefits

The Series 90 Micro PLC automated the data transfer process so that the manual data retrieval and analysis associated with the strip chart was eliminated. The compact size of the Series 90 Micro PLC was also a benefit to the system.



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Woodworking Industry

Conveyor Chain Lubricator

The Need

A control system was needed to automatically lubricate the chains of a conveyor system to decrease wear on the chains.

The Solution

A 14-point Series 90 Micro PLC was selected because it is cost-effective and easily adjusted. The analog potentiometers of the Series 90 Micro PLC allow the operator to vary the time delay between lubrications and the amount of oil applied to the chain without programming equipment.

The Benefits

Material replacement costs were reduced because using the Series 90 Micro PLC system doubled the chain life. Also, the operation is much quieter.

The Series 90 Micro PLC

This provided the best value for small applications. Features include:

- Cost effective
- Economical starter pack
- PID functionality
- Built-in potentiometers to set timer/counter presets
- Compatibility with Series 90-30 PLC programming
- 28-point model has two communication ports
- Pulse width modulation on DC output models
- Pulse catch outputs on DC output models

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