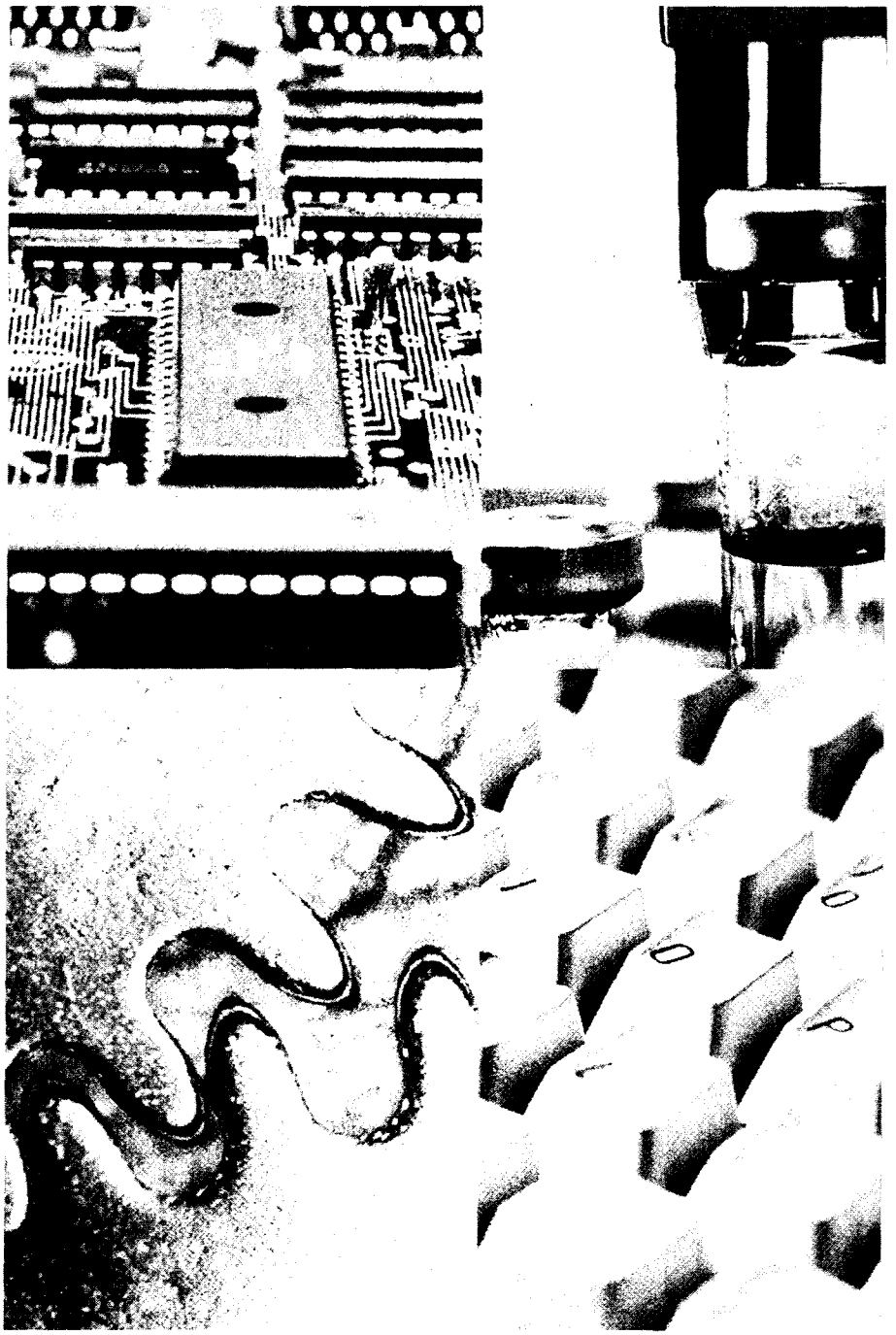
Modicon 984–680/685 and 984–780/785 System Planning and Installation Guide

GM–0984–501 Rev. A



GROUPE SCHNEIDER

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Modicon
984–680/685 and 984–780/785
System Planning and Installation Guide

GM–0984–501 Rev. A

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Preface

This guide describes the PC–0984–680/685 and PC–0984–780/785 Programmable Logic Controllers and their available options, together with procedures for system planning and installation.

Throughout this manual, the terms "Programmable Controller," "Programmable Logic Controller," and "PC" have been abbreviated to "controller" for the sake of brevity. For clarity and your convenience, the Models PC–0984–680, –685, –780, and –785 are referred to in context as the 984–680 (or 780) or simply "685" or "785", etc. Chapter 1 deals specifically with the Models 680 and 685; Chapter 2, with the Models 780 and 785. Since the remaining chapters 3–6 discuss components and functions common to all four devices, the 680/685/780/785 is referred to simply as "the controller" or "the 984" in these four chapters. Any topic unique to a particular device is clearly noted.

☞ **Note** This manual describes system planning and installation information for the Modicon 680, 685, 780, and 785 controllers, *exclusive of Modbus Plus™ communications* (in the case of the 685 and 785). Information regarding the Model 685 and 785 controllers in connection with a Modbus Plus™ network, including DIP switch settings and network system configuration, is found in GM–MBPL–001, Rev. A, *Modicon Modbus Plus Network Planning and Installation Guide.*

Objectives

This manual will help you plan, configure, mount, wire, connect, check out, and troubleshoot your 984 slot–mount controller system, including 984/800 Series Remote I/O. After reading this book:

- A Control Engineer will be able to identify and physically plan the location and mounting of system components.
- A Plant Electrician/Installer will be able to install, power–up, and check out the system.
- A Maintenance Technician will be able to recognize, locate, identify, and resolve or report system failures.

How To Use This Manual

Chapter 1 describes the 984–680/685 controller system and its functions.

Chapter 2 describes the 984–780/785 controller system and its functions.

Chapter 3 offers information for planning your installation with local I/O.

Chapter 4 is an installation procedure for your controller with local I/O.

Chapter 5 offers information for planning your Remote I/O configuration and installation.

Chapter 6 is a collection of topical installation procedures for your Remote I/O.

Appendix A gives system specifications including Remote I/O cable and accessories.

Appendix B describes post–installation Remote I/O cable checking techniques and procedures.

Appendix C gives Error Codes, Customer Service/Technical Support telephone numbers, and modbus cable connector pinouts.

Related Documents

GM–0984–001	Rev B	P190 Programming Guide
GM–0984–IBM	Rev B	IBM Programming Guide
ML–P190–USE	Rev C	984–680/P190 PC System User Manual
GM–T984–001	Rev A	984–680/P190 PC System Tape Loader
GM–HIBM–002	Rev A	IBM Load/Record Verify User's Guide

Minimum Revision Levels

The minimum prom revision levels for the 984–780 and 785 slot–mount controller options are:

Option	Exec Part Number	Rev. Level	Min. Prom Number
D908	AS–9592–000	C	1002
S908	AS–E908–031	E	1004
S911	AS–S945–022	E	1004

The minimum revision levels for programming software diskettes and tapes are:

	Part Number	Version	Description
IBM Disks	PG–DIBM–904	5.1	Configurator
	PG–DIBM–902	4.0	Traffic Cop
	PG–DIBM–984	4.2	Programmer
	PG–DIBM–592	3.2	Load/Record/Verify
	PG–DIBM–905	3.1	Ladder Lister
	PG–DIBM–593	2.1	ASCII Programmer
P190 Tapes	PG–T984–304	3.0	Configurator
	PG–T984–302	3.0	Traffic Cop (2 tapes)
	PG–T984–301	2.1	Programmer
	PG–T984–305	2.0	Utility
	PG–T190–401	2.1	P190 Tape Loader
	PG–T984–003	2.0	ASCII Programmer

Incoming Inspection Guidelines

Guidelines for Inspection

- Before you do anything, verify your shipment is complete and undamaged. If the shipment is incomplete or damaged, notify the carrier and your distributor.
- Remove everything from its packing and check for physical defects or damage. If the equipment is physically defective or damaged, notify your Modicon representative.

☞ **Note** Save shipping materials until installation is complete.

Sending Something Back?

- Whenever possible, use the original packing materials supplied by Modicon.
- All equipment should be firmly packed so that it cannot move around in its shipping container.
- All equipment should be protected against impact during shipment.
- All equipment should be clearly marked with its Return Authorization Number (RA#).

Table of Contents

Figures

Figures (continued)

Tables

Chapter 1
Introducing Your 680/685 Controller

This chapter describes your 984, Model 680/685 Programmable Controller system.

If you have purchased a Model 984–685 Controller, use the instructions in Chapter 1 to install it. Information regarding the Model 685 controller in connection with a Modbus Plus™ network, including DIP switch settings and network system configuration, is found in GM–MBPL–001, Rev. A, *Modicon Modbus Plus Network Planning and Installation Guide.*

984–680/685 Programmable Controller

The 984–680/685 Controller is designed to work with your Modicon P190 Programmer or IBM Personal Computer; Modicon 800 series housings, interfaces and I/O modules; and Modicon 984 software in order to provide an automated control system characterized by high reliability and ease of operation.

The 984 Model 680 or 685 (984–680/685) Controller is a midsized Programmable Logic Controller providing large controller power in a modular, expandable, architecture. The 680/685 supports the same logic set as the 984 controller, uses the same instruction set and is programmed by the same tapes and P190/IBM accessories.

The Model 680/685 controller features 8–16K words of User Logic and 1920 Registers of state RAM for a total user memory of 10–18K words. The Model 680/685's user logic and state RAM will support one local drop of 32 modules with up to 1024 discrete points of local I/O (512 in/512 out).

The Model 680/685 also supports up to 31 RI/O drops (using the optional S908 Remote I/O Processor) with a maximum of 1024 more discrete I/O points on one drop or spread over them all for total I/O support capacity of 2048 discrete I/O points (any mix).

The Model 680/685 also supports up to 1920 Analog points in 16–bit words.

The 984–680/685 system features user–changeable executive operating routines and user memory on plug–in daughter boards and PROMs known as executive and memory cartridges, respectively.

Each 984–680/685 system module is housed in a rugged metal chassis designed to withstand specified temperature and humidity extremes as well as vibration, shock, and ambient atmospheric conditions consistent with the "factory floor."

Figure 1 is a perspective view of the 984–680/685 system's one and one–half wide, controller module with built–in power supply. Certain physical features are noted.

Shown in Figure 2, the shielded backplane provides for internal communications within each module housing (sometimes referred to as an enclosure). The backplane protects the internal system communications from both electromagnetic (EMI) and radio frequency interference (RFI).

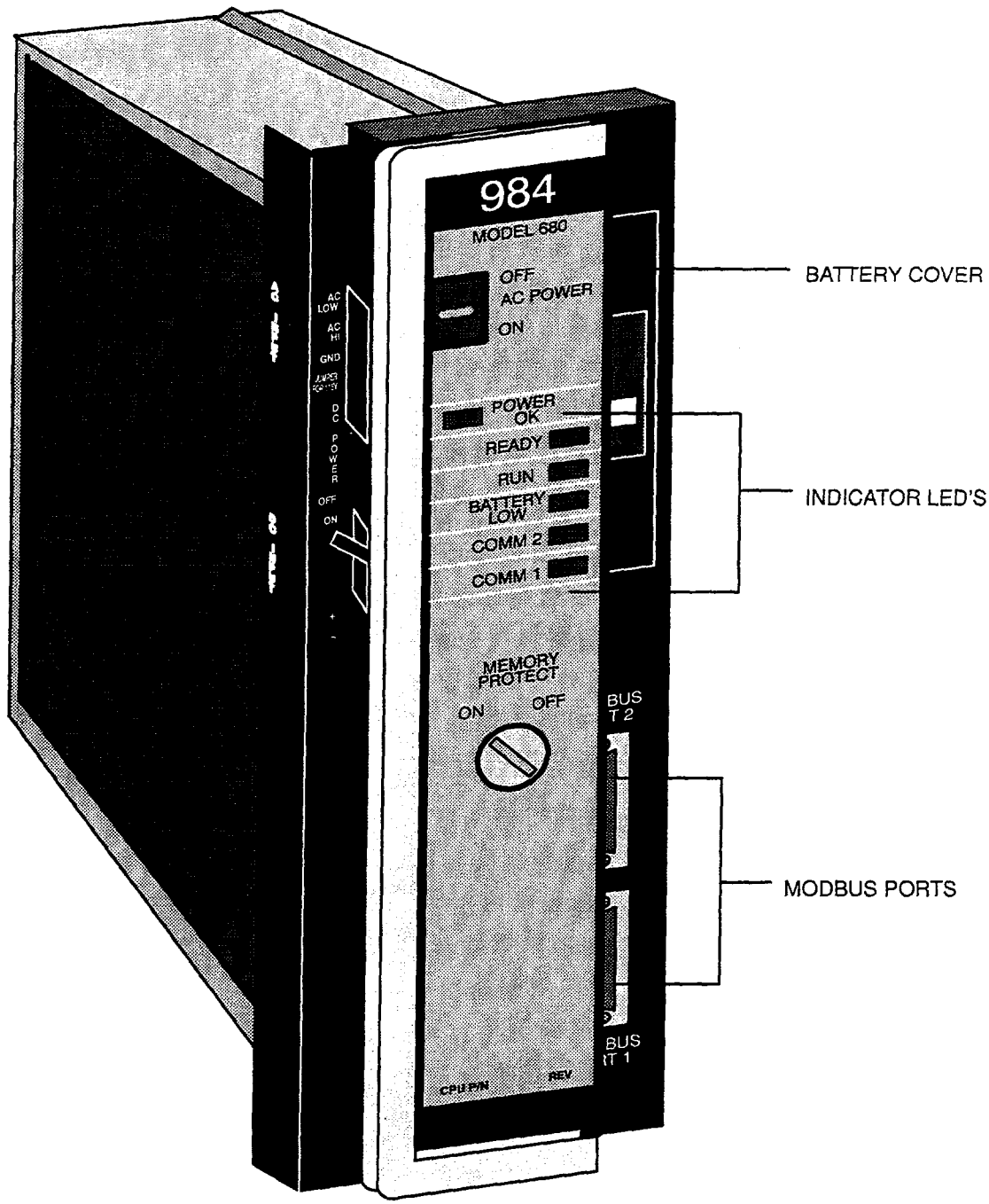


Figure 1 984 Model 680/685 Programmable Controller

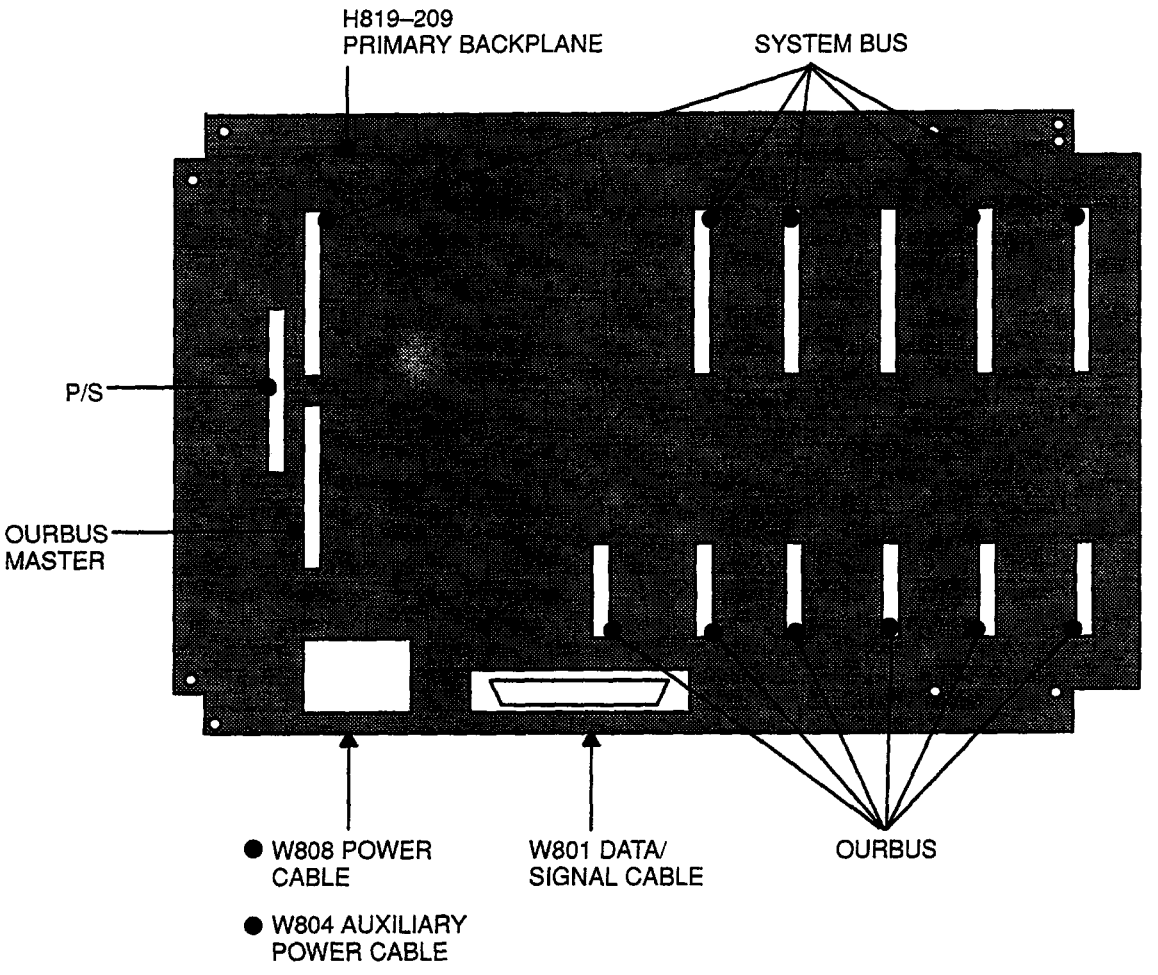


Figure 2 984–680/685 Primary Housing Backplane (H819–209)

The Remote I/O processing (RIOP) option comes in a separate module with a plug–in executive cartridge capable of supporting up to 31 RI/O drops. Local I/O processing is always Drop #1. Figure 3 is a perspective view of the RIOP module.

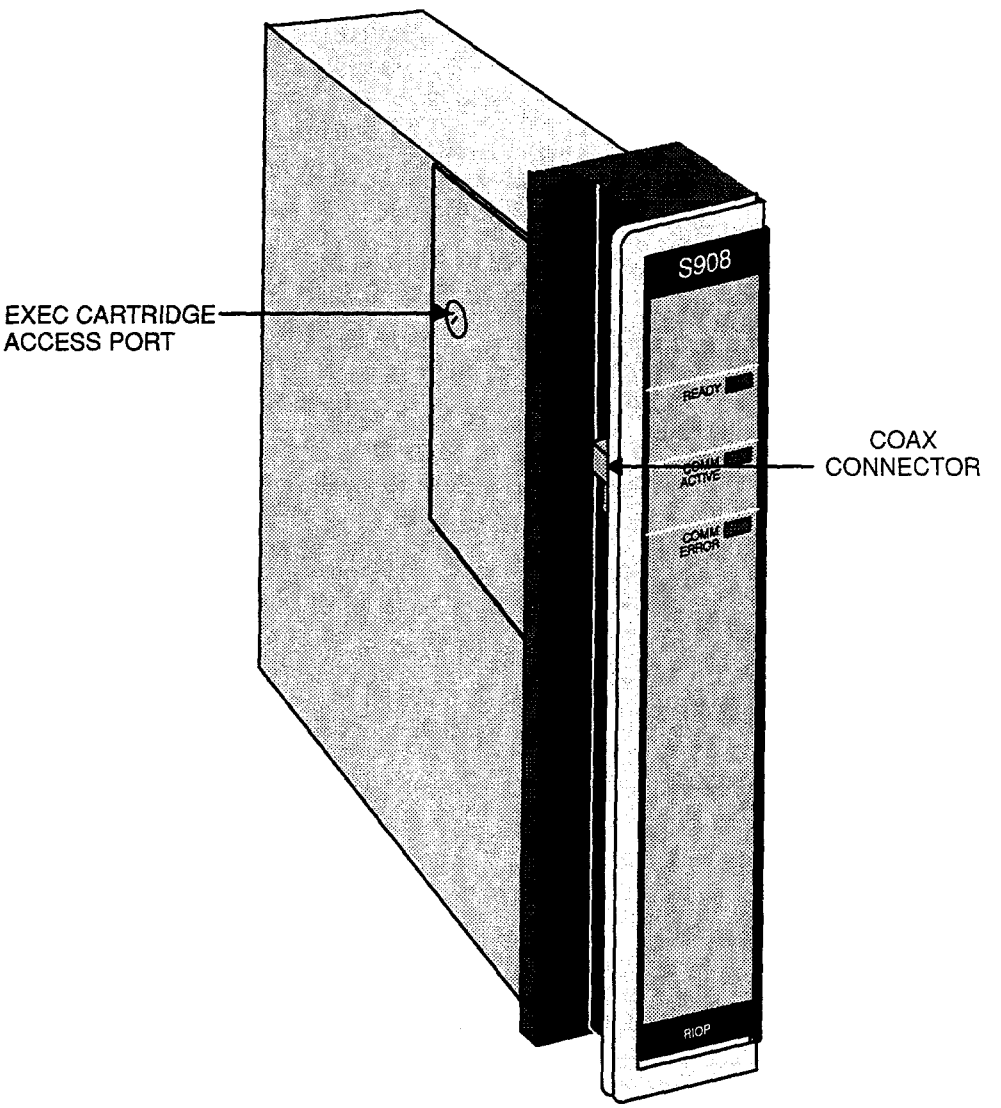


Figure 3 RIOP (S908) Module (S908–110)

As shown in Figure 4, the 984–680/685 system uses an 800 series primary housing for its modules (controller, remote I/O processor and local I/O). The H819–209 Primary Housing can house one auxiliary power supply (if required) and up to five local I/O modules or seven I/O modules without the power supply; the H827–209 Primary Housing can house one auxiliary power supply (if required) and up to nine local I/O modules or eleven I/O modules without the power supply.

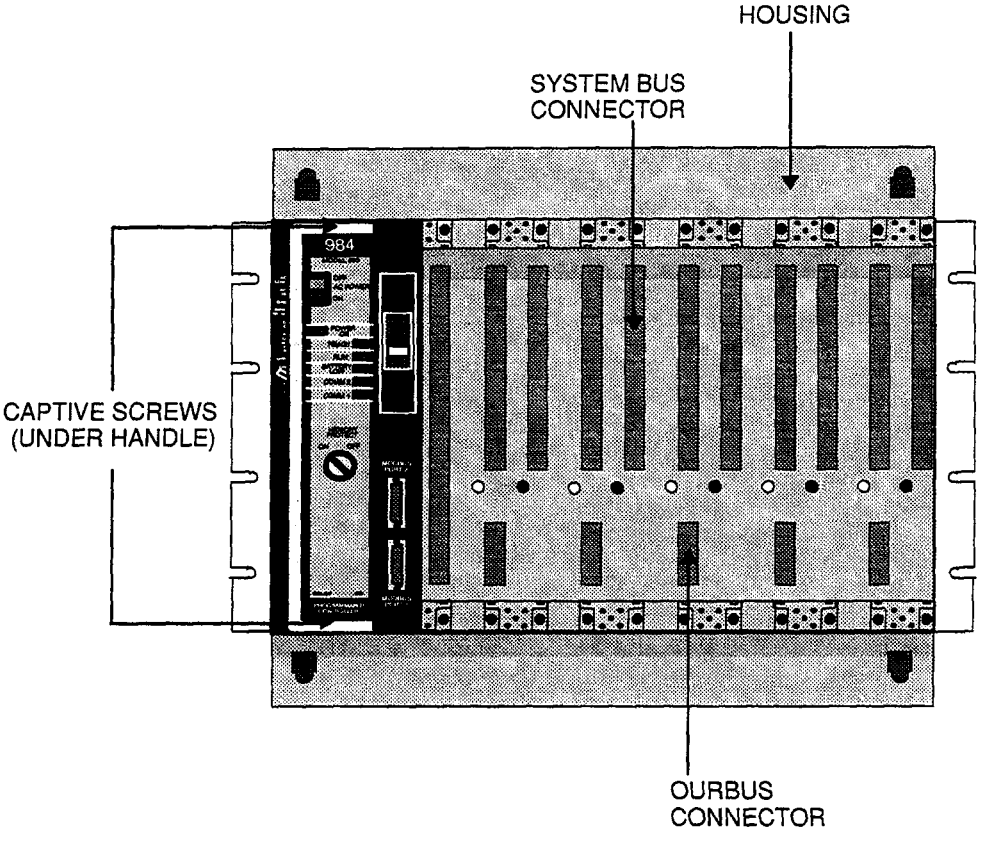


Figure 4 984–680/685 Controller in Primary Housing (H819–209)

The amount of I/O modules that may be mounted in the local drop depends on the number of slots used by options. The 19 inch primary housing, for example, requires two slots for the controller module and an additional slot for the RIOP, leaving room for four I/O modules.

The total amount of local I/O that can be serviced is 1024 I/O points (512 Input and 512 Output).

Modules configured to the 984–680/685 Controller's remote I/O system will be housed in standard 800 series enclosures; i.e., seven/eleven slot (19" to 27") housings. Nominally, each RI/O drop would utilize one P810 auxiliary power supply and a J890 I/O adapter module (J892 if ASCII is required). The total amount of Remote I/O that can be serviced is also 1024 I/O points (512 Input and 512 Output).

Captive screws secure all I/O modules and auxiliary power supplies in the housings. Key pin protection is available. The modules are convection cooled. Detailed functional descriptions follow.

Power Supply Function (AC and DC)

The power supply resident in the controller module provides 40 Watts of power for local I/O purposes and 7.5 Watts for the CPU totaling 47.5 Watts of 4.3 VDC and 5 VDC power available for the CPU and I/O modules in the primary housing.

As shown in Figure 5, the 984–680/685 runs on 115 or 230VAC (47 to 63 Hertz) and/or 24VDC. The AC input, primary power variable is selected by means of a customer installed jumper. The primary power input connector is located at the front, left side of the module and shown on the drawing as "115V operation jumper." Once connected, AC POWER is switched ON/OFF with a front panel rocker switch.

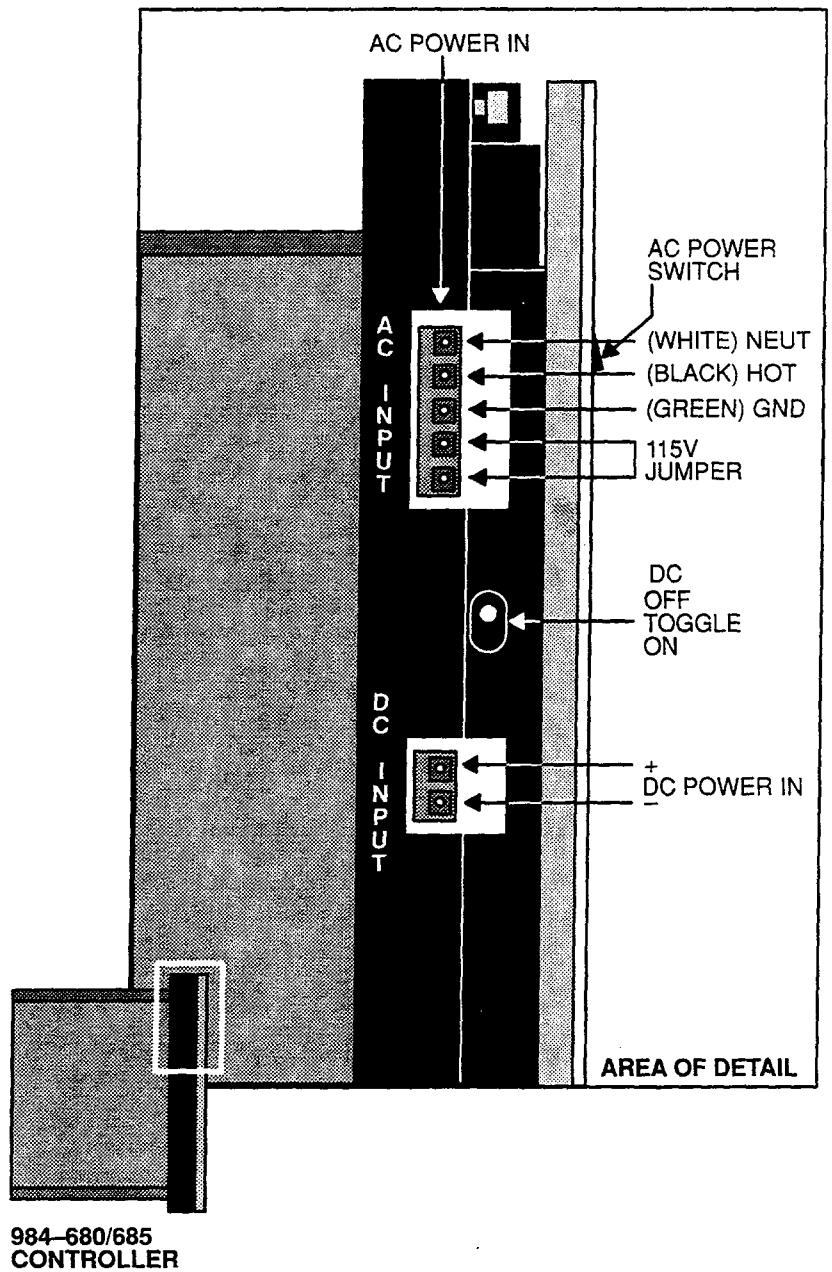


Figure 5 984 680/685 Power Supply Connections

The CPU will also operate on 24VDC, either continuously as its only source or from a power supply or battery as part of a backup power supply system. Note the DC prima power input connector for customer supplied 24VDC power. Once connected, an auto–switching DC backup feature is enabled by setting the DC toggle switch (shown) to ON.

Memory Function

A complementary metal oxide semiconductor (CMOS) random access memory (RAM) cartridge provides 8 or 16K words of available user logic on user accessible plug–in boards. An optional state RAM memory can be provided to add up to 1920 words of register space.

Figure 6 shows the 984–680/685 CPU board from the module's right side. The Executive and RAM cartridge plug–in daughter boards are shown through the user access port in the module's case (cover not shown). The port parameter selection switches for DIP mode are shown at the bottom of the drawing. Access to the DIP switches is through the bottom of the module casing.

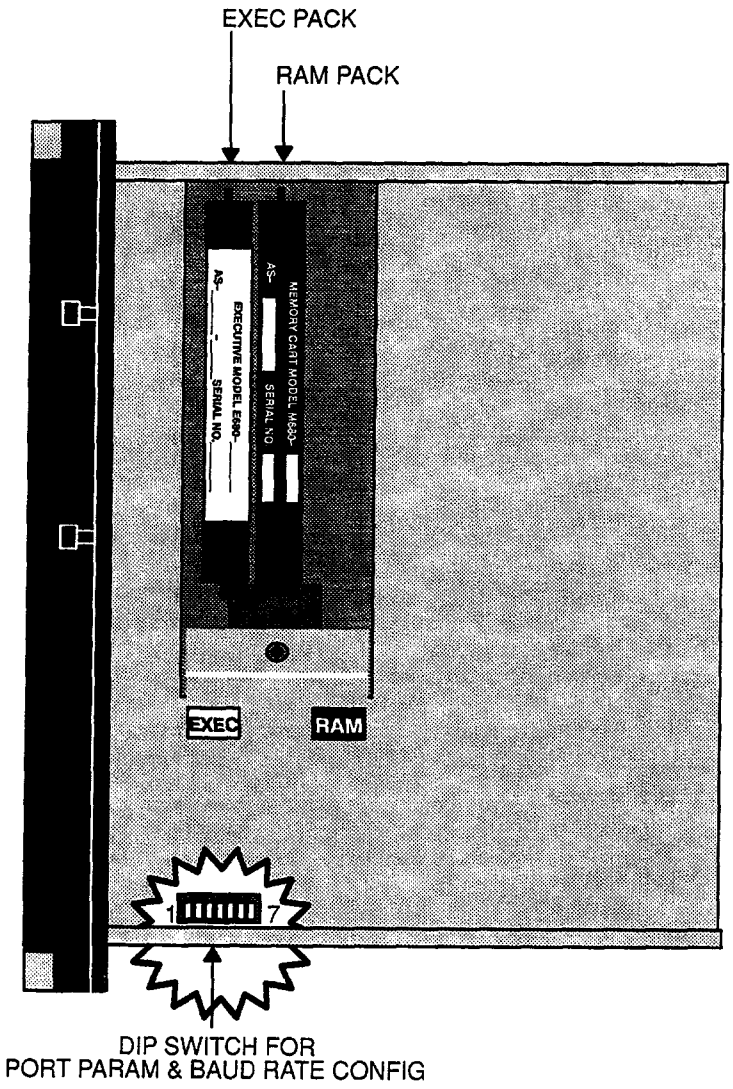


Figure 6 984–680/685 CPU Board – Right Side View (PROM Access Cover Removed)

User memory is protected for up to one year by the CPU's lithium backup battery that has a five–year shelf life.

A manually operated memory–protect key switch prevents accidental access to the user's program. The operating key may be removed to limit access to designated personnel.

Central Processing Unit (CPU) Function

The 984–680's 16–bit CPU, which is fully compatible with the Modicon 984 controller instruction set, solves user logic at a nominal rate of 3 ms per thousand nodes of user logic (the 984–685 scans at 2ms/K).

For special applications, a time–of–day clock is provided. The clock shares power with the CPU's backup battery. The module is shipped with the battery installed and the clock running.

An external run–status indicator monitors the module's activity. The 984–680/685 CPU has an Amber READY light on the front bezel. When ON, this light indicates that the processor has passed power–up diagnostics, is healthy and ready to be configured.

Remote Input/Output (RI/O) Processor Option

In addition to the local I/O drop, the separate RI/O processor used with 800 series I/O will support up to 31 RI/O drops; any drop can be configured to the maximum I/O allowance of the 680/685.

The 984–680/685's RIOP (S908) is designed to support RI/O up to 5,000 feet away (this distance can be increased depending upon the cable selection and certain other customer application considerations).

The 5000 foot distance allows wide latitudes in system layout and installation. Substantial economies can be realized using planned layouts. In addition, plan to keep the drops and subsequent attenuation losses within the system's 35 dB dynamic range.

The 984–680/685 Controller also supports up to 32 remote ASCII ports; two ports per J892 drop interface.

Communications Processing Function

The Model 680/685 has two built–in Modbus ports for data transfer and remote programming. Through these ports, communication processing on the CPU board links the controller to multiple supervisory and programming devices such as a host computer or Modicon's P190 CRT programmer. The two integral Modbus ports permit a 984–680/685 user to schedule more than one Modbus service per scan. [The Model 685 has one Modbus port and one Modbus Plus port.]

Mainframe Status Indicators

Status indicators on the CPU are:

POWER OK Green LED: Generated by power supply to indicate input power OK and voltage outputs OK.

READY Amber LED: Controller passed power–up diagnostics. Remains ON in Unconfigured, Stopped and Run states as long as health status is OK. Indicator is OFF when an error condition is detected by diagnostics.

RUN Green LED: Controller was started and is solving logic.

BATTERY LOW Red LED: When ON, battery needs to be replaced (14 day holdup from initial indication).

COMM 2 Green LED: When ON, communication processor has unit address and communications are in progress.

COMM 1 Green LED: When ON, communication processor has unit address and communications are in progress.

Mainframe Controls

There are two front panel controls available to the user; the first is an AC POWER ON/OFF switch; the second is a MEMORY PROTECT key switch with removable key.

In addition, behind the backup battery cover, there is a toggle switch enabling the configuration of Modbus port 1 as set in the DIP switches mounted on the bottom of the CPU board. Finally, there is a DC backup power enabling switch (ON/OFF) at the left side of the module (under handle).

Figure 7 is a front view of the 984–680/685 system module. Table 1 shows 984–680/685 system, end–user part numbers.

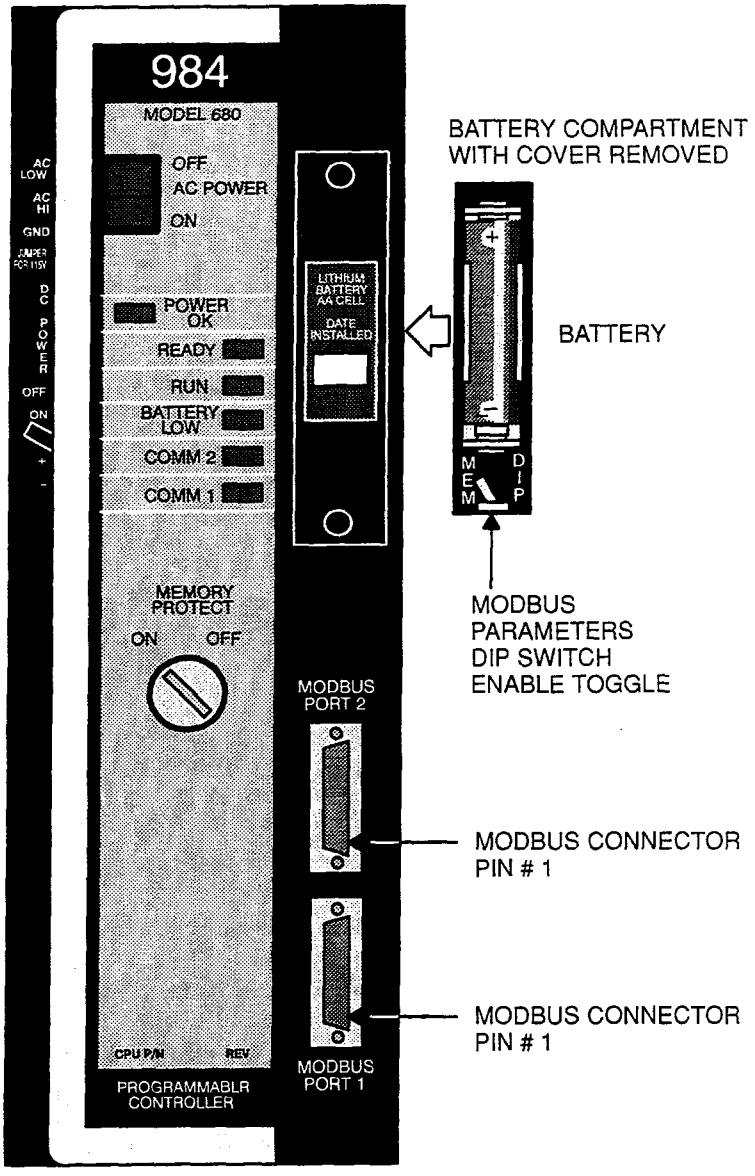


Figure 7 984–680/685 Controller – Front Panel

Table 1 Model 680/685 Controllers – Modicon End–User Part Numbers

PART NUMBER	DESCRIPTION
Hardware	
PC–0984–680/685	CPU/PS (w/o exec cartridge)
AS–E680–902	Standard 984 Executive Cartridge
AS–E680–904	Enhanced 984 Executive Cartridge (for 680)
AS–E685–904	Enhanced 984 Executive Cartridge (for 685)
AS–M680–108	8K Memory Cartridge
AS–M680–116	16K Memory Cartridge
AS–S908–110	S908 RI/O Module (single cable)
AS–S908–120	S908 RI/O Module (dual cable)
AS–E908–006	Executive Cartridge for S908 (6 drops)
AS–E908–031	Executive Cartridge for S908 (31 drops)
Housings	
AS–H819–209	Primary 19" Housing w/ systems bus
AS–H827–209	Primary 27" Housing w/ systems bus
Cables	
AS–W954–006	Modem to 984–X80
AS–W955–012	IBM PC/XT to 984–X80
AS–W955–025	IBM PC/XT to 984–X80
AS–W956–012	IBM PC/AT to 984–X80
AS–W956–025	IBM PC/AT to 984–X80
AS–W953–006	P190 to 984–X80
AS–W953–012	P190 to 984–X80
AS–W953–025	P190 to 984–X80
AS–W801–0xx	Housing interconnect signal cable
AS–W802–012	Housing interconnect power cable
AS–W804–0xx	Housing interconnect aux power cable
AS–W808–0xx	Housing interconnect power cable
Software Tapes and Disc Support for P190 and IBM	
SW–PR9T–0TB	Programming Support Module – P190
SW–DO9T–0TB	Documentor Support Module – P190
SW–CS9T–0TB	Controller Support Module – P190
SW–PR9D–1DB	Programming Support Module – IBM
SW–D09D–1DB	Documentor Support Module – IBM
SW–CS9D–1DB	Controller Support module – IBM

Chapter 2
Introducing Your 780/785 Controller

This chapter describes your 984, Model 780/785 Programmable Controller system.

If you have purchased a Model 984–785 Controller, use the instructions in Chapter 2 to install it. Information regarding the Model 785 controller in connection with a Modbus Plus™ network, including DIP switch settings and network system configuration, is found in GM–MBPL–001, Rev. A, *Modicon Modbus Plus Network Planning and Installation Guide.*

984–780/785 Programmable Controller

The 984–780/785 Controller is designed to work with your Modicon P190 Programmer or IBM Personal Computer; Modicon 800 series housings, interfaces and I/O modules; and Modicon 984 software in order to provide an automated control system characterized by high reliability and ease of operation.

The 984 Model 780 or 785 (984–780/785) Controller is a midsized Programmable Logic Controller providing large controller power in a modular, expandable, architecture. The 780/785 supports the same logic set as the 984 controller, uses the same instruction set and is programmed by the same tapes and P190/IBM accessories.

The Model 780/785 controller features 16 or 32K words of User Logic and 9999 Registers of state RAM for a total user memory of 26 or 42K words. The Model 780/785's user logic and state RAM will support one local drop of 32 modules with up to 1024 discrete points of local I/O (512 in/512 out).

☞ **Note** The 780 and 785 controllers are equipped with 16K of User Logic as a standard feature. 16K User Logic does **not** require a memory cartridge. Expansion of memory to 32K is achieved with a memory cartridge (Modicon P/N AS–M780–032).

The Model 780/785 also supports up to 31 RI/O drops (using the optional S908 Remote I/O Processor) with a maximum of 1024 more discrete I/O points on one drop or spread over them all for total I/O support capacity of 16,384 discrete I/O points (8192 in/8192 out).

The Model 780/785 also supports up to 2048 Analog points (1024 input/1024 output) in 16–bit words.

The 984–780/785 system features user–changeable executive operating routines and user memory on plug–in daughter boards and PROMs known as executive and memory cartridges, respectively.

Each 984–780/785 system module is housed in a rugged metal chassis designed to withstand specified temperature and humidity extremes as well as vibration, shock, and ambient atmospheric conditions consistent with the "factory floor."

Figure 8 is a perspective view of the 984–780/785 system's one and one–half wide, controller module with built–in power supply. Certain physical features are noted.

As shown in Figure 9, the shielded backplane provides for internal communications within each module housing (sometimes referred to as an enclosure). The backplane protects the internal system communications from both electromagnetic (EMI) and radio frequency interference (RFI).

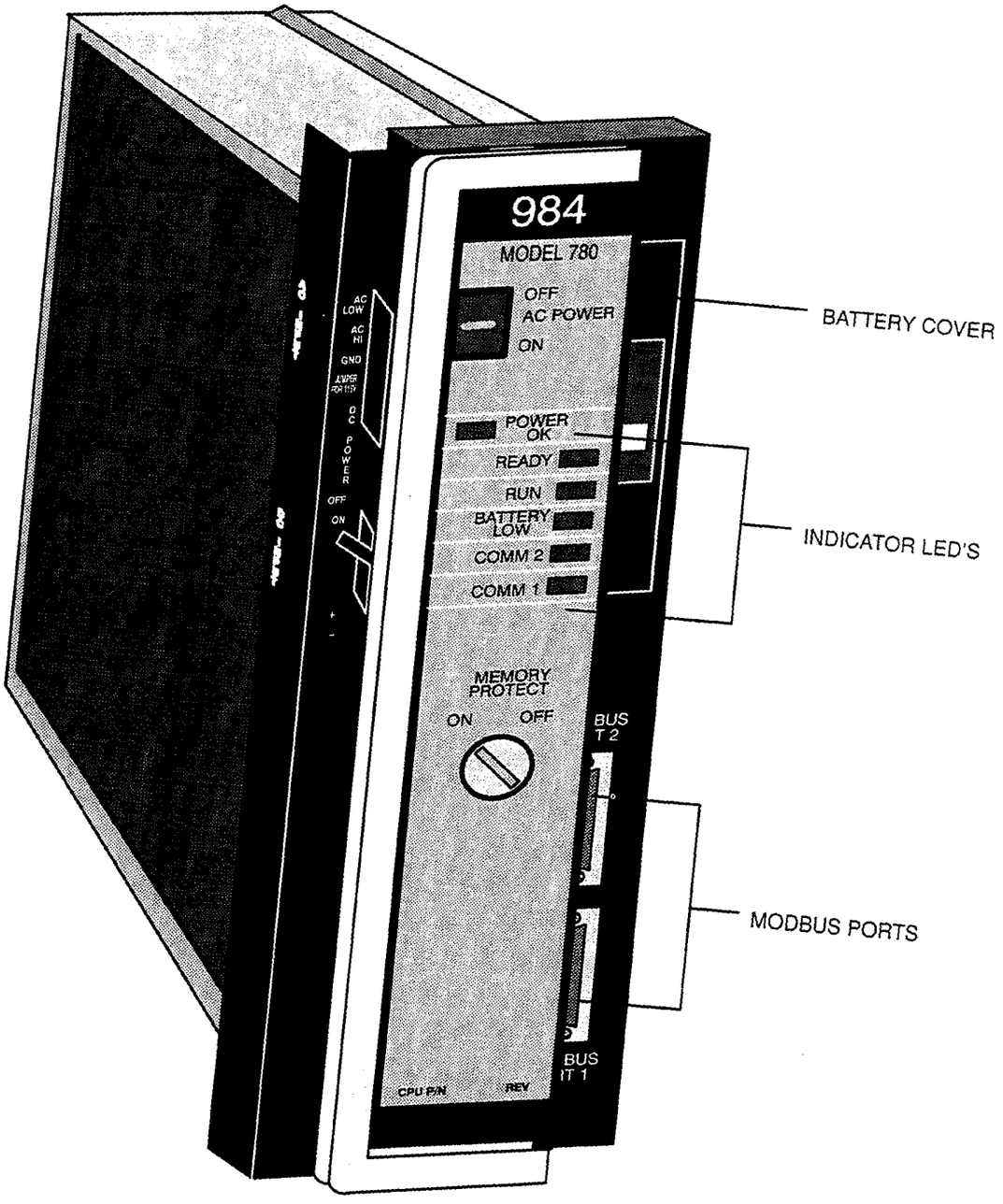


Figure 8 984 Model 780/785 Programmable Controller

GM–0984–501

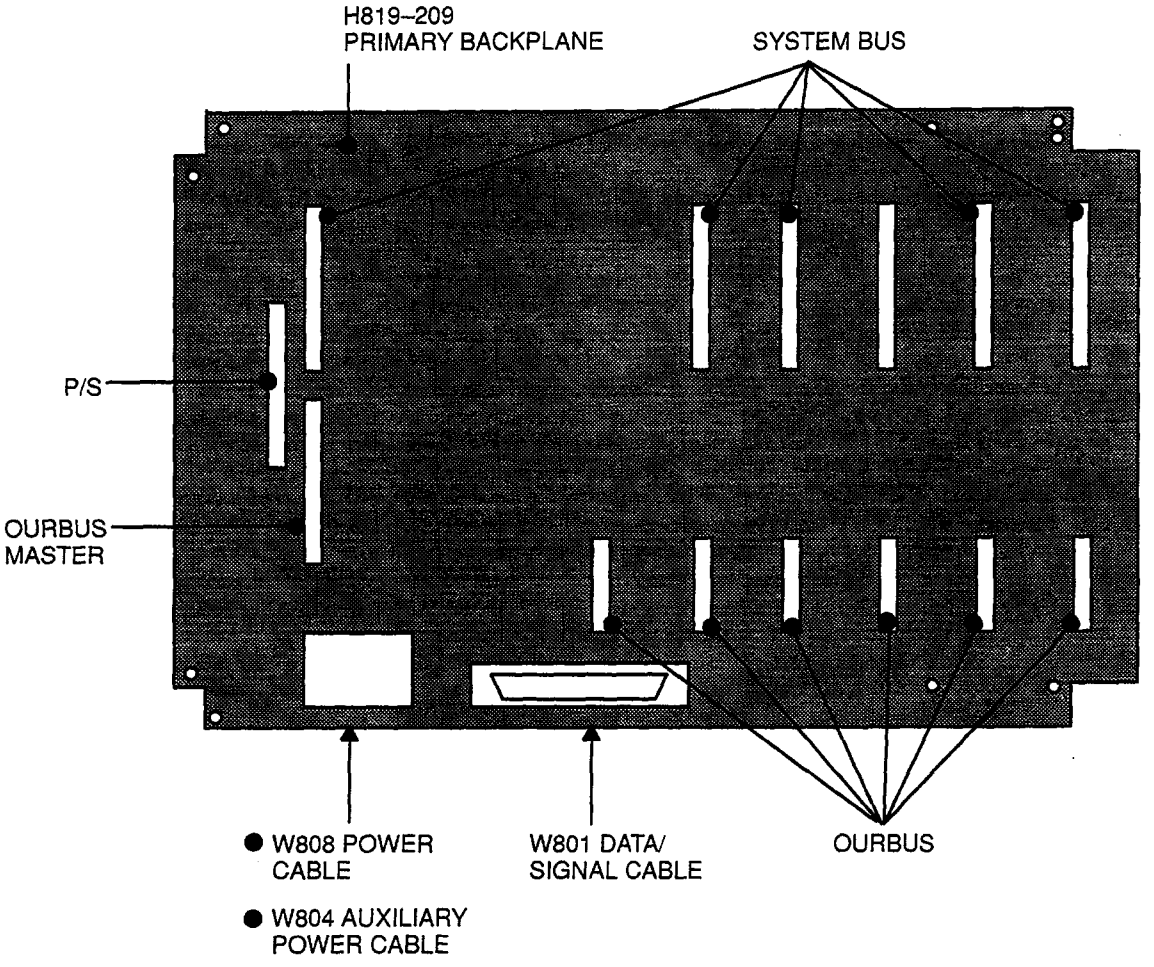


Figure 9 984–780/785 Primary Housing Backplane (H819–209)

GM–0984–501

The Remote I/O processing (RIOP) option comes in a separate module with a plug–in executive cartridge capable of supporting up to 31 RI/O drops. Local I/O processing is always Drop #1. Figure 10 is a perspective view of the RIOP module.

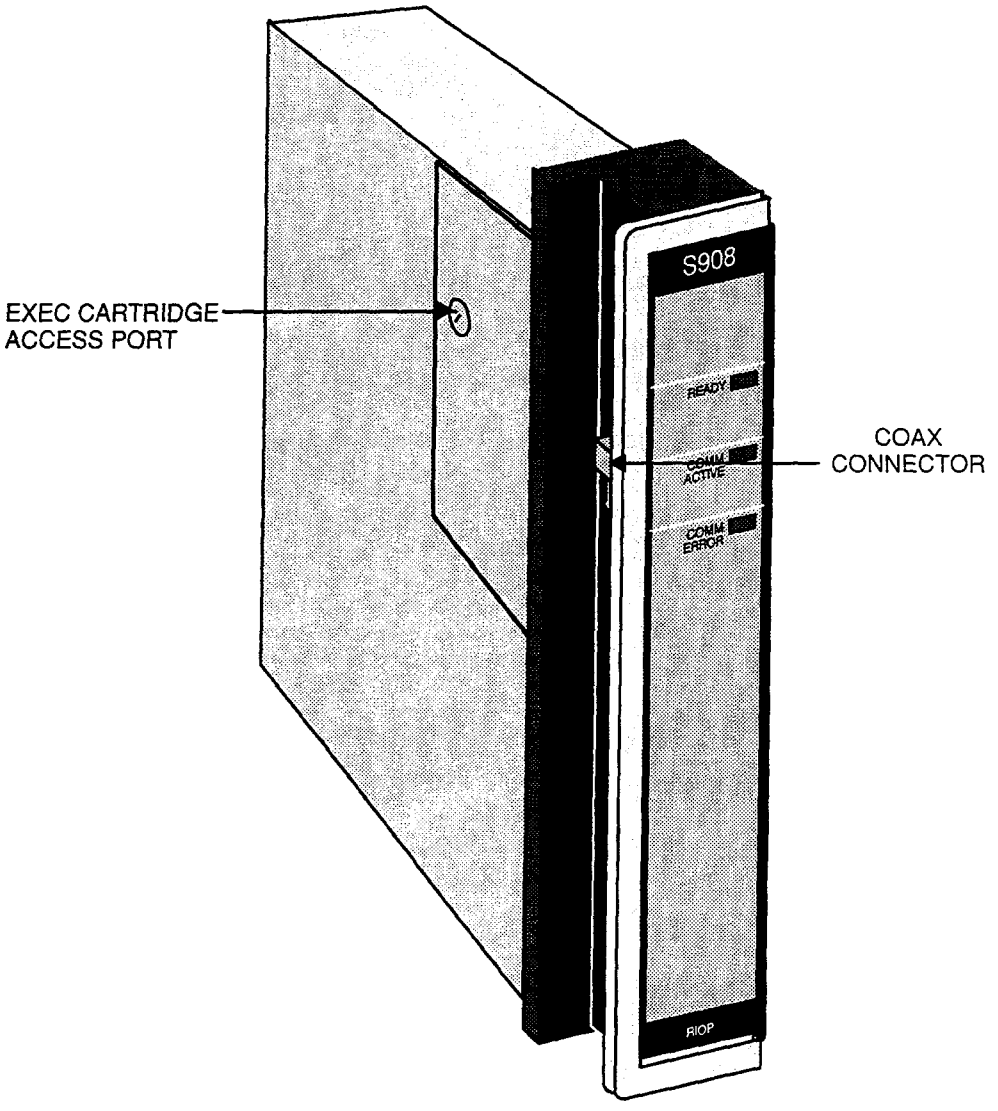


Figure 10 RIOP (S908) Module (S908–110)

As shown in Figure 11, the 984–780/785 system uses an 800 series primary housing for its modules (controller, remote I/O processor and local I/O). The H819–209 Primary Housing can house one auxiliary power supply (if required) and up to five local I/O modules or seven I/O modules without the power supply; the H827–209 Primary Housing can house one auxiliary power supply (if required) and up to nine local I/O modules or eleven I/O modules without the power supply.

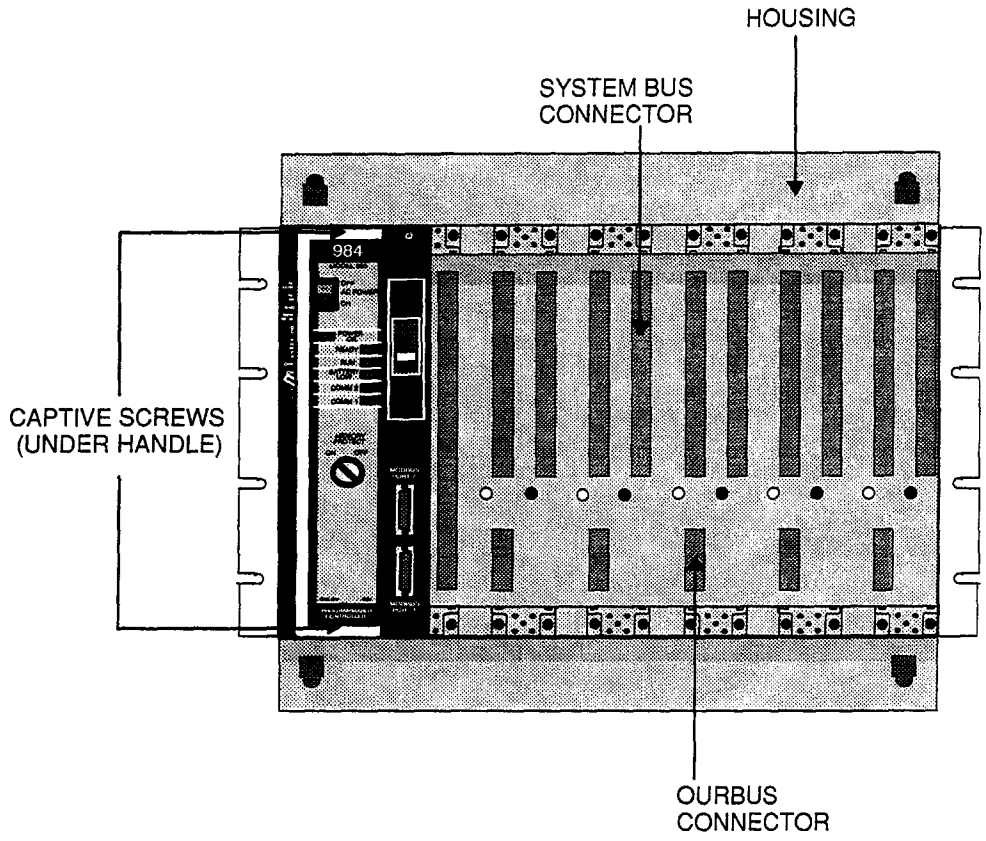


Figure 11 984–780/785 Controller in Primary Housing (H819–209)

The amount of I/O modules that may be mounted in the local drop depends on the number of slots used by options. The 19 inch primary housing, for example, requires two slots for the controller module and an additional slot for the RIOP, leaving room for four I/O modules.

The total amount of local I/O that can be serviced is 1024 I/O points (512 Input and 512 Output).

Modules configured to the 984–780/785 Controller's remote I/O system will be housed in standard 800 series enclosures; i.e., seven/eleven slot (19" to 27") housings. Nominally, each RI/O drop would utilize one P810 auxiliary power supply and a J890 I/O adapter module (J892 if ASCII is required). The total amount of Remote I/O that can be serviced is also 1024 I/O points (512 Input and 512 Output) per drop for a total of 8192 input and 8192 output.

Captive screws secure all I/O modules and auxiliary power supplies in the housings. Key pin protection is available. The modules are convection cooled. Detailed functional descriptions follow.

Power Supply Function (AC and DC)

The power supply resident in the controller module provides 40 Watts of power for local I/O purposes and 7.5 Watts for the CPU totaling 47.5 Watts of 4.3 VDC and 5 VDC power available for the CPU and I/O modules in the primary housing.

As shown in Figure 12, the 984–780/785 runs on 115 or 230VAC (47 to 63 Hertz) and/or 24VDC. The AC input, primary power variable is selected by means of a customer installed jumper. The primary power input connector is located at the front, left side of the module and shown on the drawing as "115V operation jumper." Once connected, AC POWER is switched ON/OFF with a front panel rocker switch.

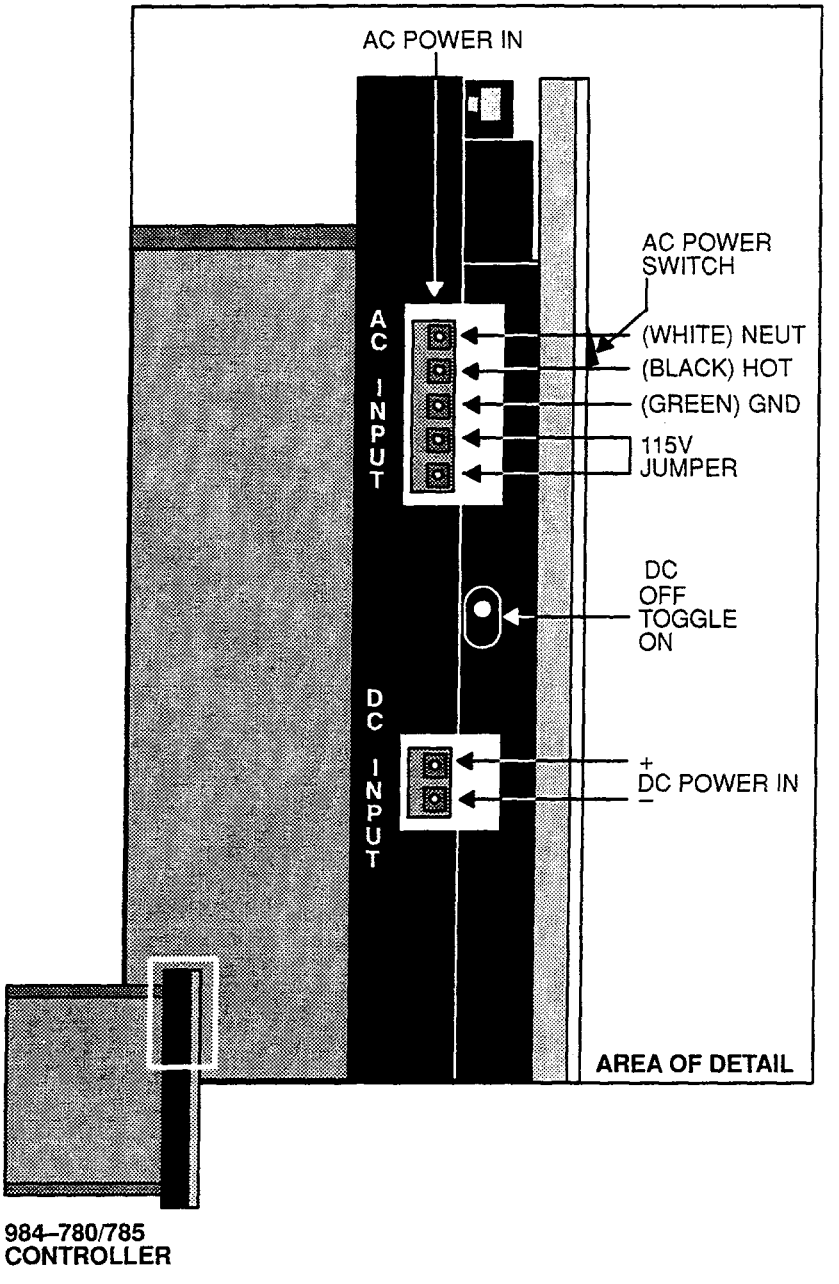


Figure 12 984 780/785 Power Supply Connections

The CPU will also operate on 24VDC, either continuously as its only source or from a power supply or battery as part of a backup power supply system. Note the DC prima. power input connector for customer supplied 24VDC power. Once connected, an auto–switching DC backup feature is enabled by setting the DC toggle switch (shown) to ON.

Memory Function

An internal, complementary metal oxide semiconductor (CMOS) random access memory (RAM) cartridge provides 16K words of available user logic. An optional state RAM memory can be provided to add up to 9999 words of register space.

Figure 13 shows the 984–780/785 CPU board from the module's right side. The Executive and RAM cartridge plug–in daughter boards are shown through the user access port in the module's case (cover not shown). The port parameter selection switches for DIP mode are shown at the bottom of the drawing. Access to the DIP switch is through the bottom of the module casing.

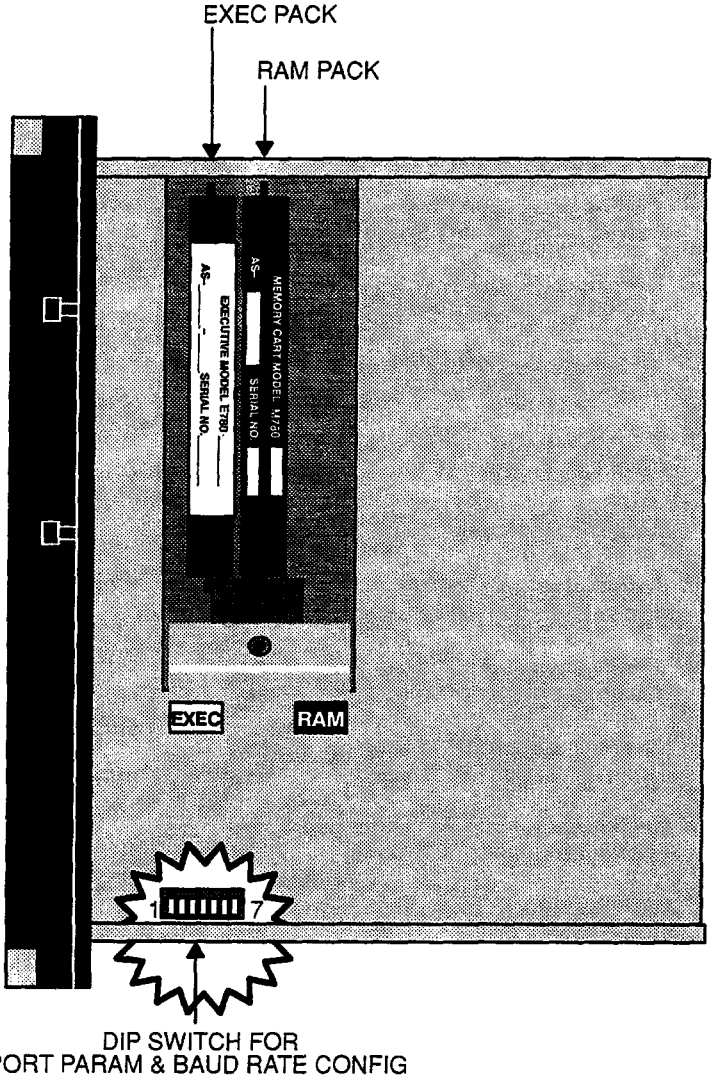


Figure 13 984–780/785 CPU Board – Right Side View (PROM Access Cover Removed)

User memory is protected for up to one year by the CPU's lithium backup battery which has a five–year shelf life.

A manually operated memory–protect key switch prevents accidental access to the user's program. The operating key may be removed to limit access to designated personnel.

Central Processing Unit (CPU) Function

The 984–780/785's 16–bit CPU, which is fully compatible with the Modicon 984 controller instruction set, solves user logic at a nominal rate of 1.5 ms per thousand nodes of user logic.

For special applications, a time–of–day clock is provided. The clock shares power with the CPU's backup battery. The module is shipped with the battery installed and the clock running.

An external run–status indicator monitors the module's activity. The 984–780/785 CPU has an Amber READY light on the front bezel. When ON, this light indicates that the processor has passed power–up diagnostics, is healthy and ready to be configured.

Remote Input/Output (RI/O) Processor Option

In addition to the local I/O drop, the separate RI/O processor used with 800 series I/O will support up to 31 RI/O drops; each drop can be configured to the maximum I/O allowance.

The 984–780/785's RIOP (S908) is designed to support RI/O up to 5,000 feet away (this distance can be increased depending upon the cable selection and certain other customer application considerations).

The 5000 foot distance allows wide latitudes in system layout and installation. Substantial economies can be realized using planned layouts. In addition, plan to keep the drops and subsequent attenuation losses within the system's 35 dB dynamic range.

The 984–780/785 Controller also supports up to 32 remote ASCII ports; two ports per J892 drop interface.

Communications Processing Function

The Model 780/785 has two built–in Modbus ports for data transfer and remote programming. Through these ports, communication processing on the CPU board links the controller to multiple supervisory and programming devices such as a host computer or Modicon's P190 CRT programmer. The two integral Modbus ports permit a 984–780/785 user to schedule more than one Modbus service per scan. [The Model 785 has one Modbus port and one Modbus Plus port.]

Mainframe Status Indicators

Status indicators on the CPU are:

POWER OK Green LED: Generated by power supply to indicate input power OK and voltage outputs OK.

READY Amber LED: Controller passed power–up diagnostics. Remains ON in Unconfigured, Stopped and Run states as long as health status is OK. Indicator is OFF when an error condition is detected by diagnostics.

RUN Green LED: Controller was started and is solving logic.

BATTERY LOW Red LED: When ON, battery needs to be replaced (14 day holdup from initial indication).

COMM 2 Green LED: When ON, communication processor has unit address and communications are in progress.

COMM 1 Green LED: When ON, communication processor has unit address and communications are in progress.

Mainframe Controls

There are two front panel controls available to the user; the first is an AC POWER ON/ OFF switch; the second is a MEMORY PROTECT key switch with removable key.

In addition, behind the backup battery cover, there is a toggle switch enabling the configuration of Modbus port 1 as set in the DIP switches mounted on the bottom of the CPU board. Finally, there is a DC backup power enabling switch (ON/OFF) at the left side of the module (under handle).

Figure 14 is a front view of the 984–780/785 system module. Table 2 shows 984–780/785 system, end–user part numbers.

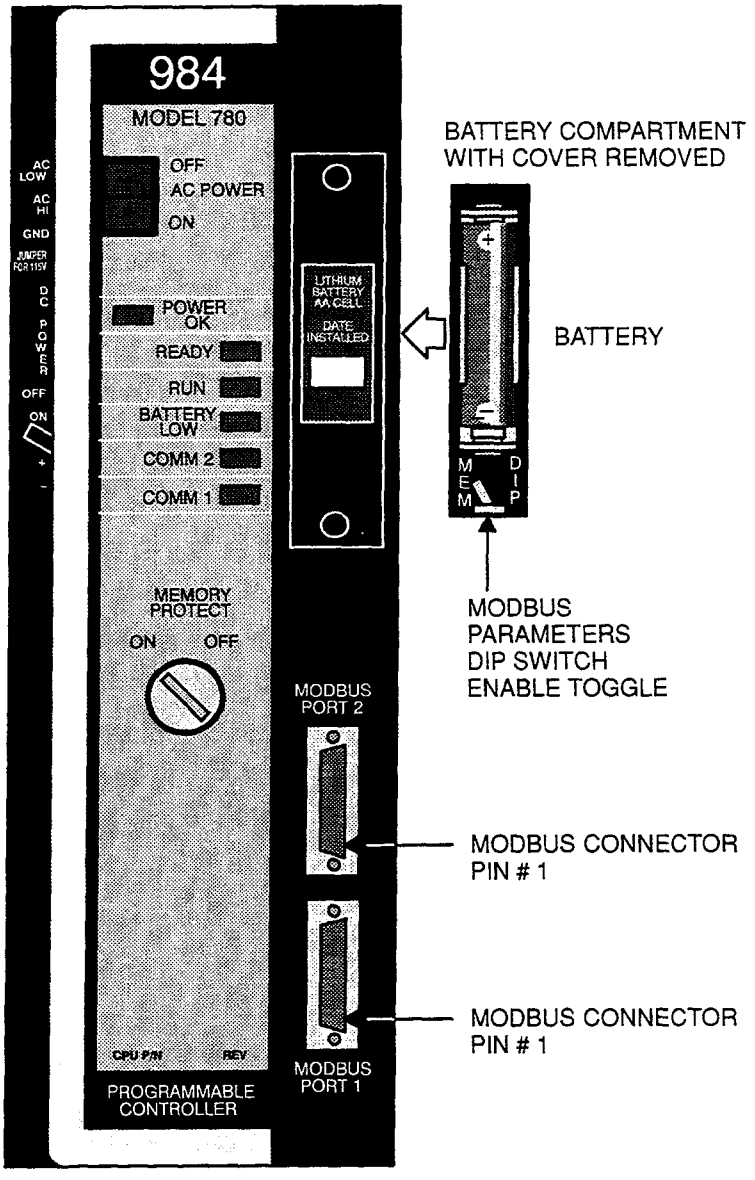


Figure 14 984–780/785 – Front Panel

Table 2 Model 780/785 Controllers – Modicon End–User Part Numbers

PART NUMBER	DESCRIPTION
Hardware	
PC–0984–780/785	CPU/PS (w/o exec cartridge)
AS–E780–902	Standard 984 Executive Cartridge
AS–E780–904	Enhanced 984 Executive Cartridge (for 780)
AS–E785–904	Enhanced 984 Executive Cartridge (for 785)
AS–M780–032	32K Memory Cartridge (for 780)
AS–M785–032	32K Memory Cartridge (for 785)
AS–S908–110	S908 RI/O Module (single cable)
AS–S908–120	S908 RI/O Module (dual cable)
AS–E908–006	Executive Cartridge for S908 (6 drops)
AS–E908–031	Executive Cartridge for S908 (31 drops)
Housings	
AS–H819–209	Primary 19" Housing w/ systems bus
AS–H827–209	Primary 27" Housing w/ systems bus
Cables	
AS–W954–006	Modem to 984–X80
AS–W955–012	IBM PC/XT to 984–X80
AS–W955–025	IBM PC/XT to 984–X80
AS–W956–012	IBM PC/AT to 984–X80
AS–W956–025	IBM PC/AT to 984–X80
AS–W953–006	P190 to 984–X80
AS–W953–012	P190 to 984–X80
AS–W953–025	P190 to 984–X80
AS–W801–0xx	Housing interconnect signal cable
AS–W802–012	Housing interconnect power cable
AS–W804–0xx	Housing interconnect aux power cable
AS–W808–0xx	Housing interconnect power cable
Software Tapes and Disc Support for P190 and IBM	
SW–PR9T–0TB	Programming Support Module – P190
SW–DO9T–0TB	Documentor Support Module – P190
SW–CS9T–0TB	Controller Support Module – P190
SW–PR9D–1DB	Programming Support Module – IBM
SW–D09D–1DB	Documentor Support Module – IBM
SW–CS9D–1DB	Controller Support module – IBM

Chapter 3
Planning Your Controller and Local I/O Installation

This chapter describes planning considerations for installing your 984 slot–mount controller with local I/O.

Planning

Overview

Your 984 controller is designed to work with your Modicon P190 Programmer or IBM Personal Computer; Modicon 800 series housings, interfaces and I/O modules; and Modicon 984 software to provide an automated control system characterized by high reliability and ease of operation.

The site planner must also consider the peripheral equipment (such as a P190 Programmer, CRT monitor, or printer) when preparing an installation plan for the site. Refer to the appropriate Modicon publications for site preparation procedures for related equipment.

Space Requirements

For the primary module housing, allow 12–inch clearance to the left so installer can see power supply connectors. Allow 6 inches on the top and side of the housing for convection cooling in vertical mounting situations. Allow 12–inch clearance at the bottom of the controller for cable access.

For all other housings, allow 6 inches on the top and sides of each housing for unobstructed cooling airflow in vertical mounting situations.

Also consider installation and physical access for removal of the modules as well as subsequent service including the connection and detachment of signal and power cables when required.

Primary Power Lines

Since power cable is cheaper than coaxial cable, the important economic considerations in planning the placement of the controller are convenient access for service and the amount of coaxial cable required, as opposed to how close the primary AC power source is to the installation.

Ideally, the power lines should be dedicated to the controller installation to minimize problems that sometimes arise when sharing AC power with electrically noisy equipment.

Finally, plan to install a service loop and a cable restraint as the primary power cable as the connector is not locked in place.

Environmental Requirements

In planning for your controller installation, consideration should be given to the environment around the controller. Although designed for a harsh industrial environment and able to withstand factors that would harm other types of electronic equipment, problems can be avoided by not placing the controller and its related equipment in an operating area where there is high ambient temperature, acidic atmosphere, vibration, dust, and dirt if it can be avoided.

Mounting Hardware Requirements

After deciding on the final location of the controller, its associated equipment and cables, you should plan for related mounting hardware. This would include such items as: nut and bolt combinations, flat and star washers, housings, mounting boards, mounting racks, taps, splitters, terminators, and connectors.

Housing Installation Options

As shown in Figures 15 and 16, after the controller has been installed in its housing, it can be panel– or rack–mounted.

Panel or Bulkhead Mounting

As shown in Figure 15, the housing has keyholes at the top and bottom of the housing for bulkhead mounting purposes. The keyholes are sized for 5/16–inch bolts. The recommended ground point is also shown.

Mounting bolts are NOT provided. The recommended mounting bolts are 0.312–24 UNF–2B (insert or tapped) stainless steel (#8–13–SS). After the mounting bolts have been attached to the vertical mounting surface, the controller housing is hung on them by setting the keyhole slots over the mounting bolts which are then tightened to secure the housing in place.

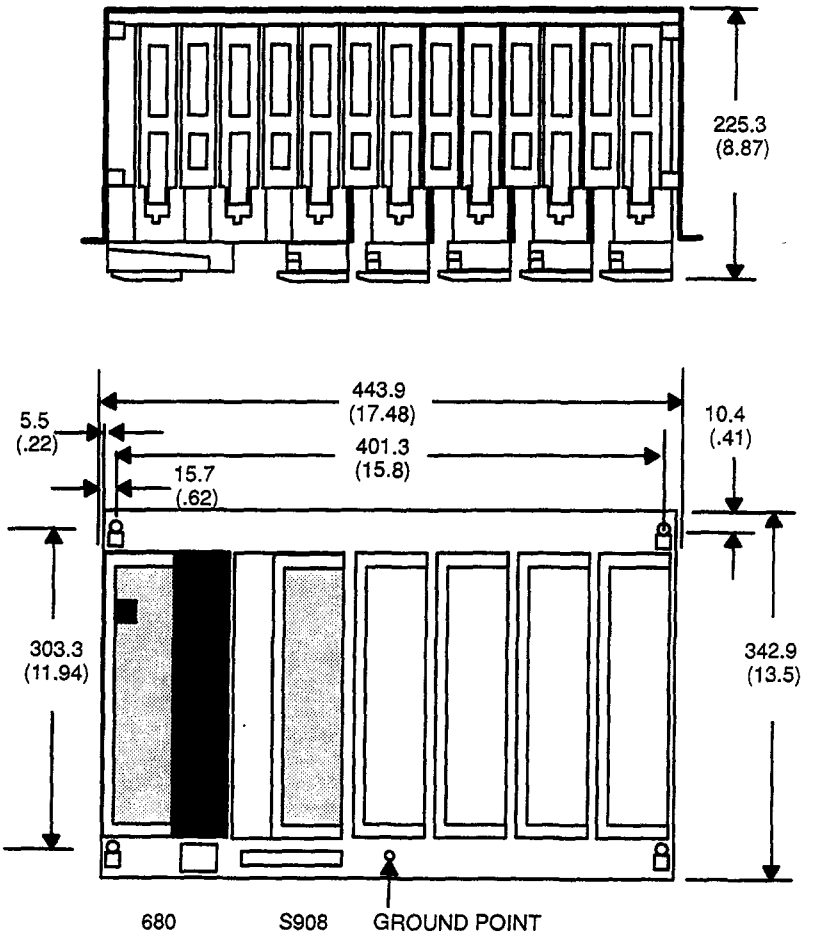


Figure 15 H819 Housing Panel/Bulkhead Mounting Dimensions

Rack Mounting

The H819 Module Housings can be mounted in a 19–inch standard (EIA) rack. Hardware for installing the rack–mount adaptor mounting flange kit is supplied but not for installing the in the rack.

Figure 16 shows dimensions for rack mounting RI/O housing. The following hardware is required for rack mounting each housing:

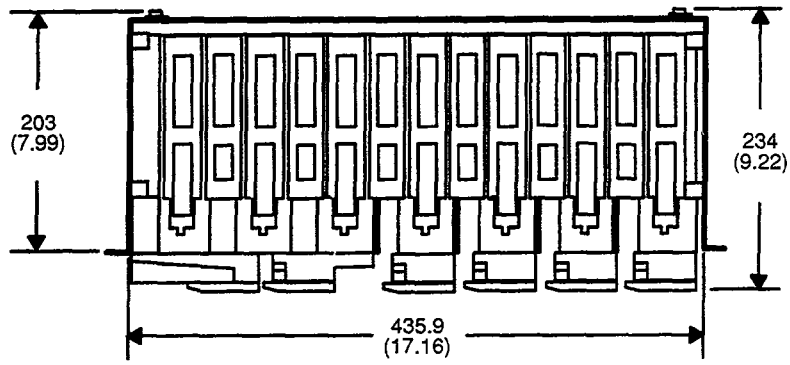
- (1) 19–inch Standard (EIA) rack
- (1) pair of rack mounting flanges
- (8) #10–32, Pan Head Machine Screws to mount the housing to the NEMA rack
- (8) #10–32 Flat Lock Nuts if mounting holes in rack's side rails rails are not threaded.

- (8) #8–32 Pan Head Machine Screws (supplied) to attach rack mount flanges to ends of housing
- (8) 1/4 bolts (supplied) to attach back of rack mount flanges back of housing

Other special mounting hardware may be required depending upon the installation site.

Some planning considerations common to rack mounting for 800 series I/O housings are:

- Between housings, allow 12 inches below the primary housing for cable breakout and six inches between the other housings in the drop for ventilation.
- The length of each cable connecting the primary housing and its immediate secondary housing (same drop) must not exceed six feet; the sum of the lengths for each cable type in the 800 I/O drop must not exceed twenty feet.



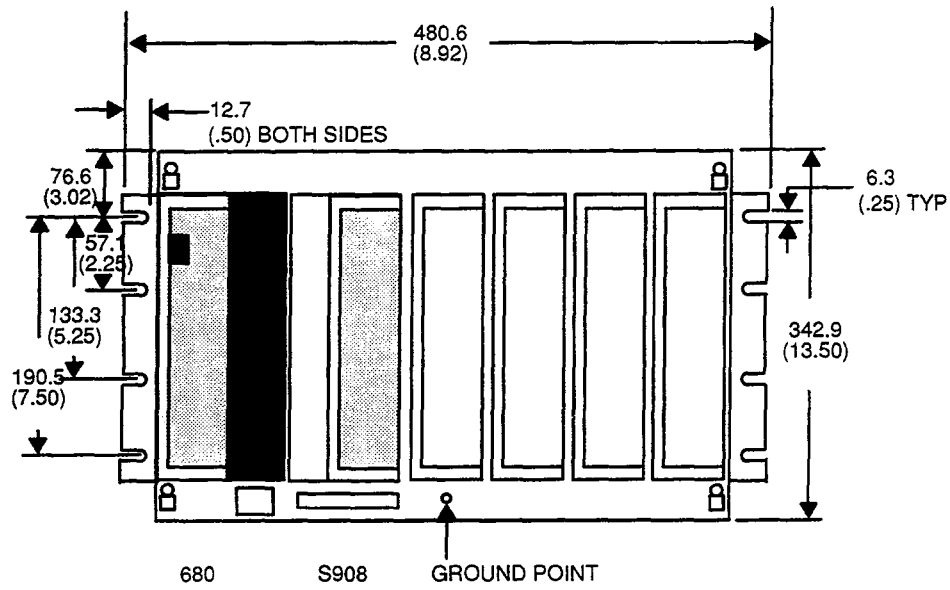


Figure 16 H819 Housing Rack Mounting Dimensions

The modular chassis will fit in a 12–inch deep standard NEMA enclosure should this be required (e.g., an acidic atmosphere in the factory).

Since the only cooling available to the controller is derived from natural convection air flow, some provision for added cooling will have to be provided if the controller is placed within a NEMA enclosure. This might require fan–driven filtered air in addition to the NEMA enclosure.

Grounding Your Installation

For grounding purposes, Modicon recommends that your controller housing(s) be mounted on a suitably finished metal mounting plate capable of supporting its weight along with the other modules in the installation. An aluminum mounting plate with a chromate finish such as IRIDITE, ALODINE or OAKITE No.36 would meet the requirement. This type of installation provides both a low frequency (AC) safety ground path and a low impedance shield path for EMI/RFI.

If a metal mounting plate (the preferred method) is not feasible, Modicon recommends that all controller housings within each drop be interconnected by a flat braided copper ground strap with a minimum width of one inch. Grounding braid should not be "daisy chained," but rather, each housing should have its own individual braid run to a common ground point. The ground strap should be kept short and installed without loops and bends. Use stainless steel hardware including a flat washer to secure the braid strap to the housing.

Regardless of the method of ground interconnection, Modicon recommends the entire installation be grounded by a one inch wide (min) flat, braided copper strap installed between the the primary housing ground connection point and a suitable factory ground. The bulkhead and rack mounting illustrations show the housing's recommended ground connection point.

Primary Power Cable (AC/DC)

The 115/230 AC power cable must have three insulated leads of Number 14 AWG stranded copper to insert in the plug–in power cable connector: color code (standard) for the AC cable is white for AC neutral, black for AC hot, and green for factory or earth ground. The European color code is light blue instead of white for neutral, brown instead of black for the hot wire, and green/yellow instead of green for ground.

☞ **Note** Factory and earth grounds often have different potentials; e.g., building steel versus grounding rods.

Your DC input source must be capable of providing 24VDC + 15%, at 10A for the turn–on surge and 3.5A continuous.

Figure 17 shows the detail for your primary power (AC/DC) cable connectors. For AC power, use AWG 14 stranded, 3–wire power cord and make your connection to the jack which comes premounted to primary power terminal strip. The 115 VAC jumper illustrated is customer installable. Use No. 14 AWG stranded copper wire for the jumper. For DC primary power input, use AWG 14 also. The CPU's DC input should come on a separate line directly from the power source and not involve your I/O.

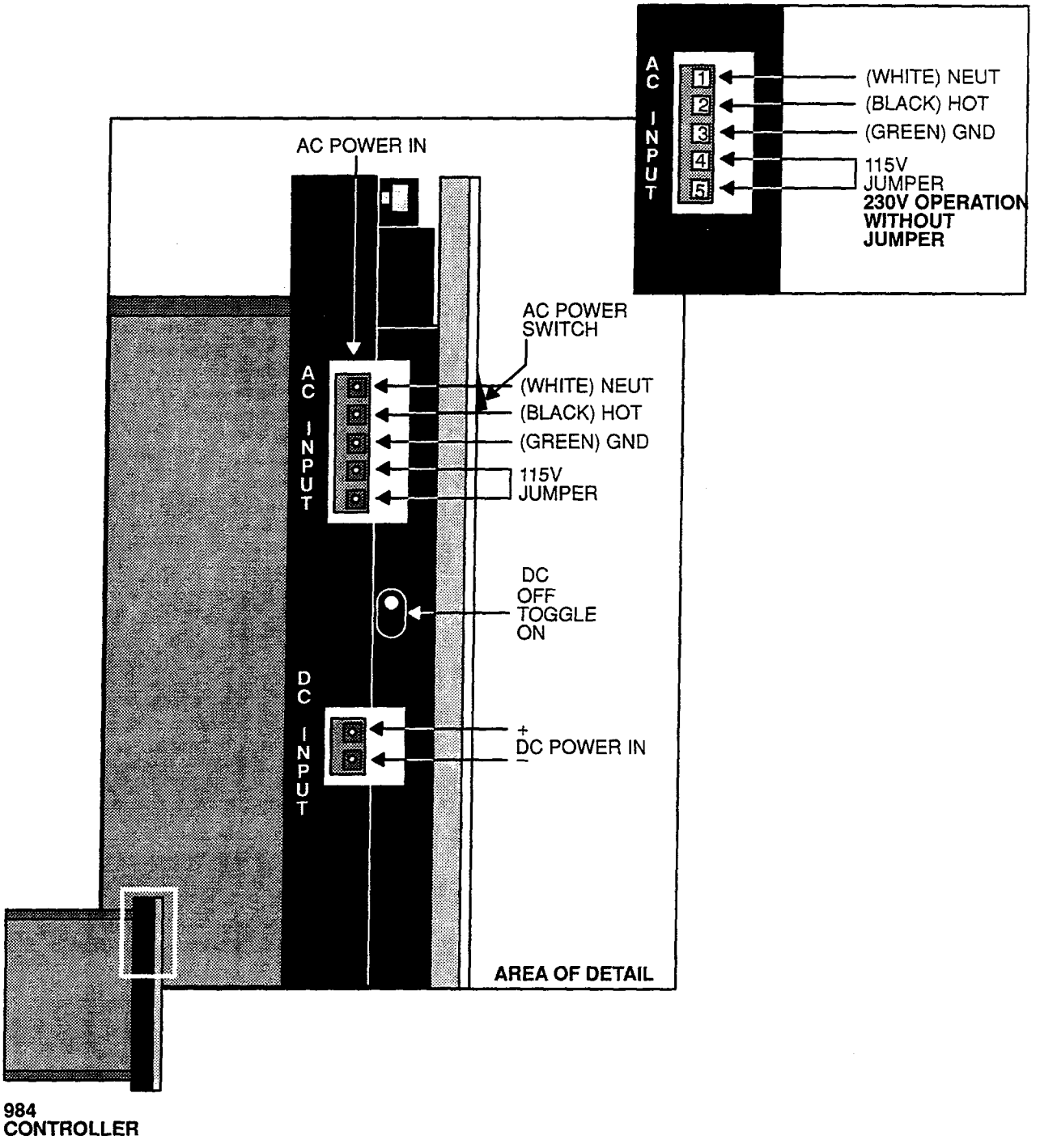


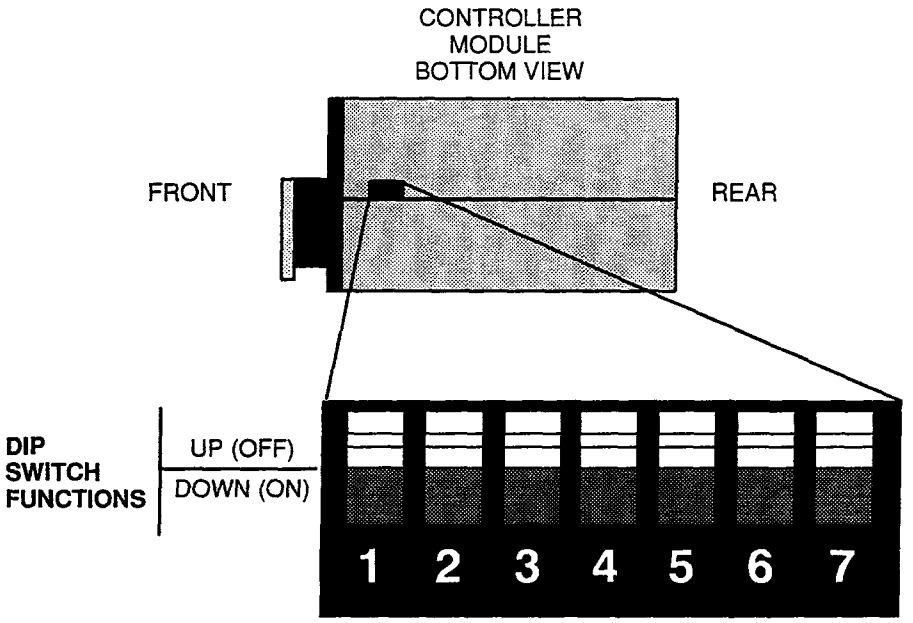
Figure 17 984–680/685–780/785 Primary Power Input Connections

How to Configure Modbus 1, Port 1 Manually

Modbus Ports 1 and 2 are software configurable. A through–the–chassis, user accessible DIP switch has been provided to manually configure Modbus Port 1 on the 984 CPU. The second port is software configurable only.

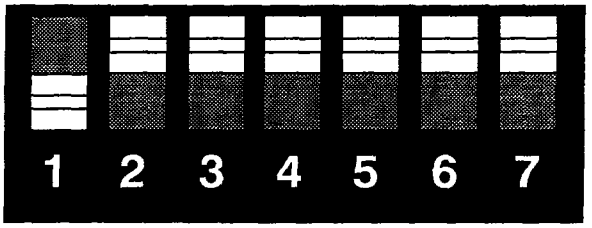
The DIP switch presettings are enabled (even while operational) using a toggle switch located on the controller module behind the battery cover (shown on Figures 7 and 14).

DIP switch settings for Modbus Port 1 are shown in Figure 18. Baud rate settings for DIP switches 1, 2, and 3 are given in Table 3.



SWITCH FUNCTION

SWITCH NO.	DOWN	UP
1	BAUD SELECT	BAUD SELECT
2	BAUD SELECT	BAUD SELECT
3	BAUD SELECT	BAUD SELECT
4	NO PARITY	PARITY
5	ODD PARITY	EVEN PARITY
6	2 STOP BITS	1 STOP BIT
7	ASCII (7 DATA BITS)	RTU (8 DATA BITS)



DEFAULT SETTINGS:
9600 BAUD, EVEN/PARITY, RTU

Figure 18 DIP Switch Settings for Modbus Port 1

☞ **Note** Unsupported switch combinations are: 2 stop bits with RTU and parity; 1 stop bit with ASCII and no parity.

☞ **Note** When the MEM/DIP enable toggle is returned to MEM position, Port 1 comm parameters and link address return to original memory configured values.

☞ **Note** Although certain production units may contain an 8–position DIP switch, only the first seven are used.

Table 3 DIP Switch Baud Rate Settings (Left to Right)

Baud	Switch #1	Switch #2	Switch #3
19,200	up	up	up
9,600	down	up	up
4,800	up	down	up
2,400	down	down	up
1,200	up	up	down
600	down	up	down
300	up	down	down
150	down	down	down

Chapter 4
Installing Your Controller and Local I/O

This chapter contains installation instructions for your 984 controller with local I/O. If you will be installing remote I/O, proceed through Chapters 5 and 6 after completing Chapter 4.

Installation Procedure with Local I/O

Warning ENSURE THAT YOUR ELECTRICAL SERVICE IS PROPERLY GROUNDED AND IN ACCORDANCE WITH THE ELECTRICAL CODE FOR YOUR AREA. INSTALLATION AND MAINTENANCE SHOULD BE PERFORMED BY A QUALIFIED PERSON IN CONFORMANCE WITH LOCAL CODE AND THE NATIONAL ELECTRICAL CODE, ANSI/NFPA PUBLICATION NO. 70.

Procedure Controller/Local I/O Installation

Step 1 Remove any modules presently installed in your primary and local I/O expansion housings and install cable troughs as required by your plan.

Step 2 Mount all housings for local drop on desired surface, taking care to observe system ground requirements.

Step 3 Starting with the primary housing, connect the W808 power cable(s), W804 Aux Power Cable(s) and W801 signal cable(s) from one housing to another through the I/O drop (in accordance with your installation plan). See Figure 19.

Step 4 If you are changing your exec pack or RAM pack, open port on right side of CPU module chassis, install new pack(s) and resecure port.

For each prom cartridge, note serial number., revision level and release date information for future reference.

Caution Exec pack goes in left connector and RAM pack in right. Observe slot in jack for orientation.

Step 5 Set the DIP Switches for Modbus Port 1 if required (see DIP Switch settings in Figure 18 and Table 3 in Chapter 3).

Step 6 Open battery cover and verify that the toggle switch that selects DIP or MEMORY for Modbus Port 1 parameter sourcing is in the desired position.

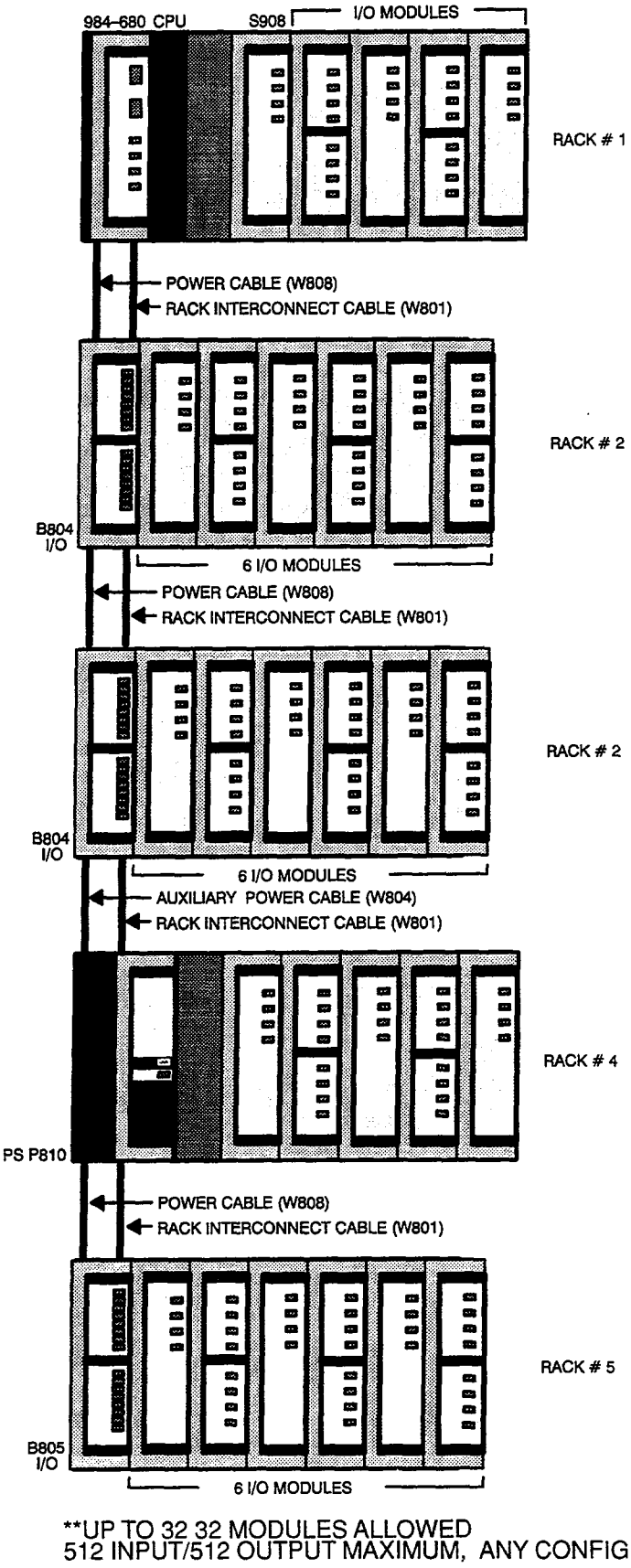


Figure 19 Typical Configuration for Local Drop

Step 7 Verify presence of DC backup battery. If your lithium battery has been supplied separately, install it in the battery compartment at this time observing correct polarity – if the BATTERY LOW indicator comes ON when the unit is energized, the polarity is wrong.

Step 8 Resecure battery cover.

Step 9 Install your controller module in Slot 1 of the primary housing, securing it with captive screws.

Step 10 Set the controller's memory protect key–switch as desired.

☞ **Note** If you won't be installing RI/O, skip Steps 11 and 12 below. If you will be using RI/O but do not wish to mount the RI/O driver at this time, it's OK to leave slot open.

Step 11 Gaining access through port in left side of RIOP chassis, make any changes regarding your RI/O Exec Pack at this time and resecure.

Step 12 Install your RIOP module in the primary housing.

Step 13 Insert Auxiliary power supply(s) in expansion housings (according to your plan).

Warning IN STEPS 14 THRU 25 BELOW, THE AC AND DC PRIMARY SOURCES SHOULD NOT BE CONNECTED (ENERGIZED) ON THE SOURCE SIDE.

Step 14 Wire your Auxiliary power supply input power terminal strip and install the 115VAC jumper (if appropriate).

Step 15 Wire your primary power cable to the Controller's input power connector and install the 115VAC jumper (if appropriate).

Step 16 Form a service loop in your AC input power cord and install a mechanical restraint.

Step 17 Plug power cord connector into the controller module's power supply jack at left side of module. DO NOT CONNECT TO PRIMARY POWER SOURCE AT THIS TIME!

Step 18 With the DC backup power enabling toggle in the OFF (up) position, wire your DC power supply input connector. DO NOT CONNECT TO PRIMARY POWER SOURCE AT THIS TIME!

Step 19 Form a service loop in DC input power cord and install a mechanical restraint.

Step 20 Plug DC power cord into DC Supply jack on left side of controller module.

Step 21 Do all field wiring, laying in cabling breakout in cable trough to left of each I/O module slot on the expansion housings and connecting it to the I/O connector.

Step 22 Install key pins in each housing slot according to plan.

Step 23 Insert planned I/O module in rightmost slot of last expansion housing in the drop and secure with captive screws.

Step 24 Working right to left, mount and secure all remaining I/O modules for each housing in the drop.

Step 25 Verify your system grounds, terminations and cable connections are according to your installation plan and that I/O status in the field side is correct for this local drop.

☞ **Note** Your controller is now ready for initial power up and check–out (if desired).

Step 26 Plug your primary power cord into its AC source and power up the controller.

Step 27 Energize your DC backup power source.

Step 28 Switch your DC enabling toggle switch to ON.

Step 29 Visually inspect installation and verify operation. The POWER ON Indicator should come up Green and the READY indicator, Amber.

Step 30 To further verify your installation, connect your P190 to controller and verify controller operation. If necessary, see Appendix D for Error Codes or who to call.

Chapter 5
Planning for Your Remote I/O Installation

This chapter describes how to plan for the installation of your controller with 800 Series Remote I/O.

Planning for 984 Controllers with 800 Series Remote I/O

Overview

The Modicon 800 series I/O modules and housings are used for remote RI/O in your 984 system. The first 800 housing of each RI/O drop requires a P810 or P884 power supply and a J890/892 RI/O adapter module. In addition to the first housing, you may install up to four more I/O housings for a total of five in each RI/O drop. However, the following constraints apply:

- The total RI/O for any single drop can not exceed 1024 points (512 Input and 512 output).
- The maximum number of modules for any given drop is 32.
- The total attenuation to any drop can not exceed 35 dB.

Consider the peripheral equipment (such as a P190 Programmer, CRT monitor or printer) when preparing your site installation plan. Refer to the appropriate Modicon publications for site preparation procedures for related equipment.

RI/O Site Location Tradeoffs

Dual Cable Since you may order and install a dual cable option in the future, you might want to consider the second cable's installation route while planning the first. At some point there might be a tradeoff between routing two cables on the same path to reduce installation costs and exposing the second cable to the same risks as the first.

CPU Location Although the 984 controller is designed to be located up to 5000 feet from its RI/O, from an economic point of view, the location of the controller should be considered in terms of the length of the communication cable, since cable length affects installation costs. Also consider access for monitoring and service including peripheral devices.

Planning Your Remote I/O Cable Installation

Modicon field experience is that the majority of failures associated with controller system installations can be traced to improper cable/connector fabrication and poor grounding practices. Precautions taken with your cable run layout, installing the cable connectors and the cable installation will pay off in performance.

Good Cable Installation Practices

Standard CATV fabrication practices are good for 984 RIO cable installations.

Ensure there is adequate strain relief (a service loop) for the trunk cable at all taps, splitters, and at all tap–to–drop cable connections to allow for expansion and contraction of cable over long runs. The rule is that there will be a 0.05% change in cable length per degree of temperature change.

For example, a cable length of 546.8 yards (500 meters) at 68°F (20°C), would vary by a foot and a half (0.5 meters) for each degree of temperature change.

Use the proper cable handling tools and avoid exceeding the minimum cable bending radius. Kinks and dents in the cable cause reflections in the transmission path and decrease the system's dynamic range. Exceeding the bending radius of the drop cable can also rupture the cable's outer conductor and lead to electro–magnetic interference (EMI) problems.

Taps and splitters and COAX are not grounded other than through the RIOP interface.

Cabling Requirements

The Remote Input/Output (RIO) system operates on a band of frequencies centered around 1.544 MHz. The communication system can use those types of cable used in Community Antenna Television (CATV) and other coaxial types as recommended. (See Appendix A for Cable Specifications.) The following guidelines apply:

- The maximum distance of any drop is 100 feet (30 meters) from the main cable. Taps should be placed as close as possible to the remote unit for ease of maintenance. In addition, the 14 dB tap attenuation makes long cable lengths more susceptible to noise interference.
- The maximum allowable dB loss between the 984 controller and any drop is 35 dB which must be taken into account when designing the system.
- Total cable length should not exceed 5,000 feet for RG–6/U cable; 8,000 feet for RG–11/U cable, or 15,000 feet for CATV cable. The maximum cable run specified includes main trunk and drop cable.

- The dB loss for the qualified cables is:

  CATV = 0.8 dB/1000 ft. (305 meters)

  RG–11/U = 2.0 dB/1000 ft/ (305 meters)

  RG–6/U = 7.0 dB/1000 ft. (305 meters)

- The dB loss for the taps and splitter is:

  Tap = 1 dB thru, 14 dB down the drop.

  Splitter = 6 dB from center to either side.

- The last tap on the RI/O trunk cable must be terminated with a 75 ohm cable terminator.

- Mixing cable types significantly increases the Voltage Standing Wave Ratio (VSWR) caused by reflections resulting from the signal moving from one type of cable to another.

- Good practices dictate using one brand of cable connector throughout your installation.

- Your RI/O coaxial cable should not be mechanically pulled during installation.

- As a general guideline, adjacent high–energy cables should not be closer than 12 inches per kilovolt. When they must cross, it should be at right angles.

RI/O Cable Topologies

The following guidelines apply to your controller's RIO communication cable installation.

A coax or CATV cable run is used to connect all I/O locations to the controller with taps or drops. Ideally, this cable run should be linear form with multi–branch (drops). Modicon strongly recommends that you use **only** Modicon Rev C taps with your installation.

Figure 20 shows which topologies can be used and which cannot.

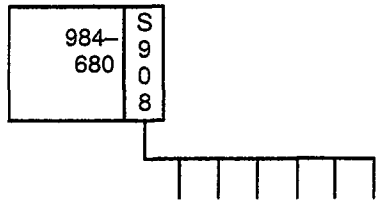
Caution **RIO Cable splitting is NOT recommended by Modicon. If you are thinking about using a split configuration, you should have a compelling need and be fully cognizant of the balancing considerations required in a split configuration. Use only one splitter and install it as close to the controller as possible. Also, the length of the cable run on either side of the splitter should be as nearly equal as possible since unbalanced lines can cause mismatches which produce undesirable effects.**

Planning Your Cable System Diagram

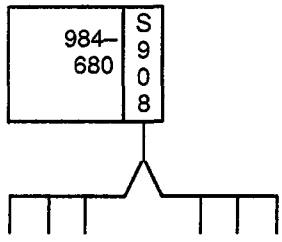
In the planning phase, the installation diagram is only a projection. However, a diagram can be very helpful during installation if it is carefully annotated with such detail as estimated cable lengths, taps, terminators, splitters, and projected cable routings.

After the installation, the layout diagram should be corrected to reflect the system as installed. At this point, the diagram becomes an important tool for maintenance, repair, and other critical plant information thereby avoiding the downtime associated with rediscovering what used to be common information.

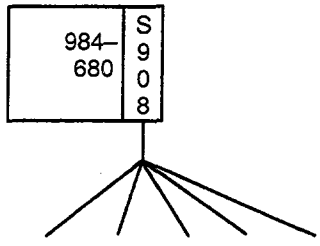
A. LINEAR CONFIGURATION
(PREFERRED)



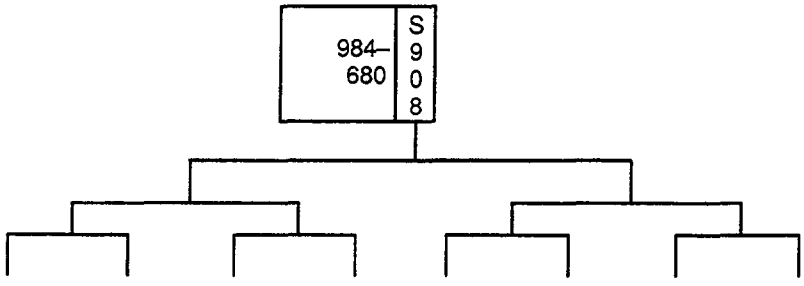
B. SPLITTER CONFIGURATION
(NOT RECOMMENDED)



C. STAR CONFIGURATION
(NOT ALLOWED)



D. TREE CONFIGURATION
(NOT ALLOWED)



E. RING CONFIGURATION
(NOT ALLOWED)

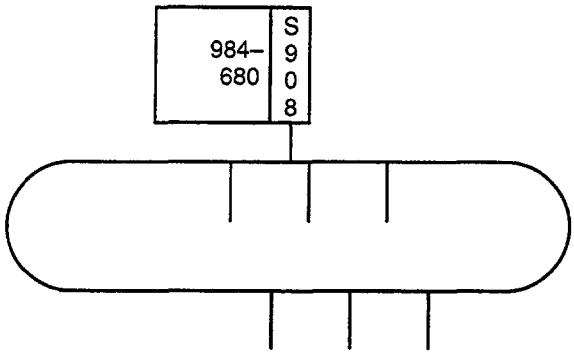


Figure 20 Recommended, Allowed, and Illegal Topologies

Drafting the Cable Diagram

Figure 21 is an example of an RIO cable diagram shown for explanatory purposes only. Calculate the theoretical losses using the data provided on cables, taps, and splitters to verify your system design before proceeding to the actual installation. Table 4 shows the calculated losses for this example.

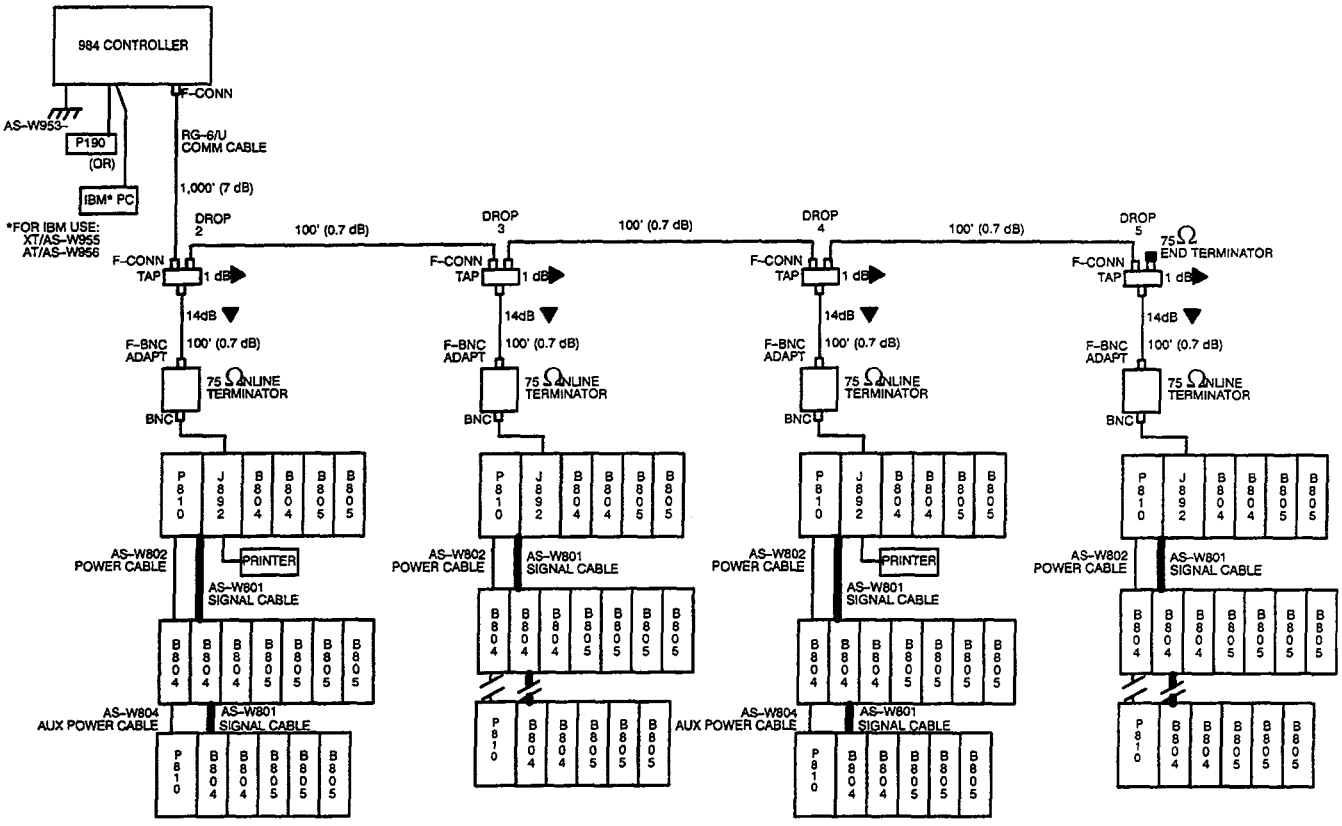


Figure 21 Example of Cable System Diagram

Table 4 Calculate Losses from Sample Cable Diagram (Figure 15)

Comm Cable	Length	Atten (dB)
To D2	1000	7.0
To D3	100	0.7
To D4	100	0.7
To D5	100	0.7
Taps		
D2→D4 @ 1 dB ea		3.0
Drop 5	Tap	14.0
	Drop Cable	0.7
	TOTAL	26.8

Grounding Your Installation

For grounding purposes, Modicon recommends that your controller housing(s) be mounted on a suitably finished metallic mounting plate capable of supporting its weight along with the other modules in the installation. An aluminum mounting plate with a chromate finish such as IRIDITE, ALODINE or OAKITE No.36 would meet the requirement. A plain metal plate with a clean surface, free of grease, oil, etc. would be the second choice. The plate should be connected to building ground either by mounting hardware or through a single heavy–gauge conductor. A metal strap is best, with braid the alternate choice. This type of installation is recommended because it provides both an AC safety ground and a low impedance path to ground for high frequency EMI/RFI interference.

If a metallic mounting plate (the preferred method) is not feasible, Modicon recommends that all controller housings within each drop be grounded by a flat, braided strap with a minimum width of 1 inch. The ground strap should be short and installed without loops and bends. Although loops and braids may be aesthetically pleasing, they increase impedance at noise frequencies. Braid should be installed as straight and flat as possible. Metal straps, the first choice for grounding and bonding, offer the lowest impedance paths at noise frequencies, but braid is more practical to use. Stranded wire should not be used for plate or chassis grounding due to its higher impedance at noise frequencies. Use stainless steel hardware, including a flat washer to secure straps and braid at connection points.

Figure 22 shows recommended and mistaken methods for equipment grounding using strap or braid and wire. In some cases, even units that are mounted on metal plates may benefit from chassis, 0–volt, or both connections as shown. Star grounding of the equipment AC ground wire (0v) may not be beneficial in all applications, but wiring as shown in (B) and (C) in an attempt to implement it is sure to cause ground loops when jumpers are added in this manner. *Remember* that star grounding is the preferred method for noise suppression and avoidance of ground current loops. Daisy–chaining should *never* be used.

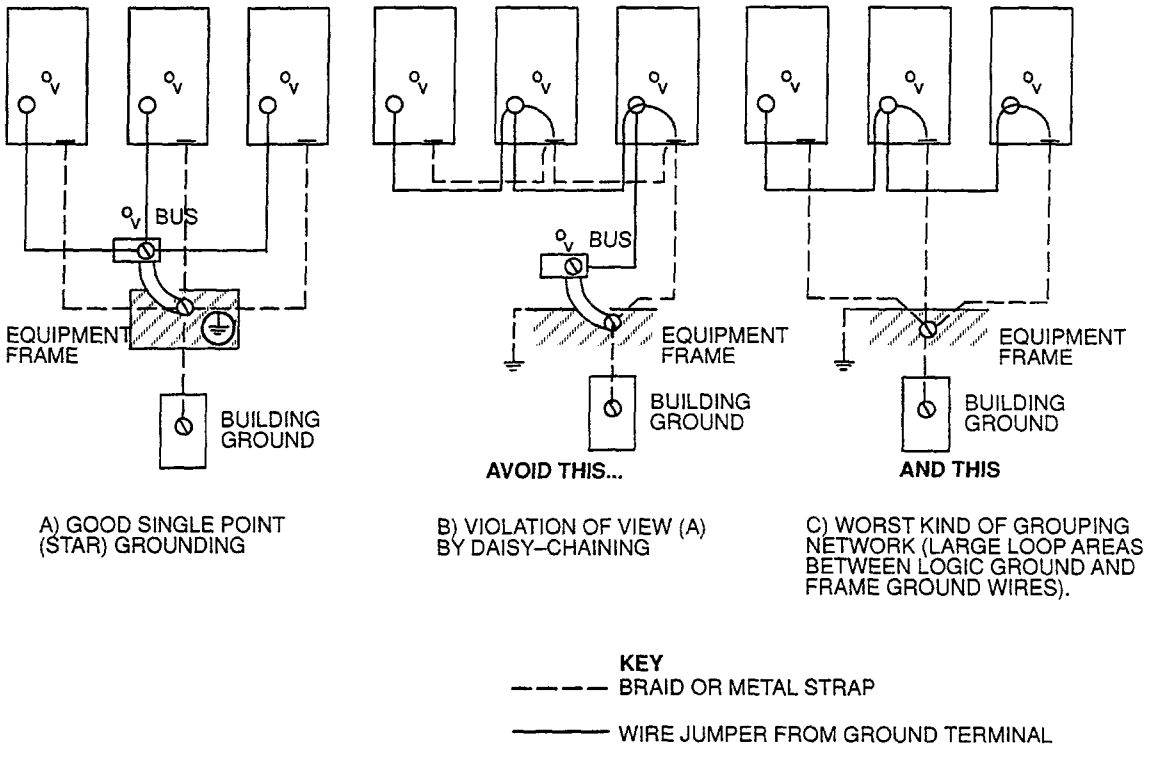
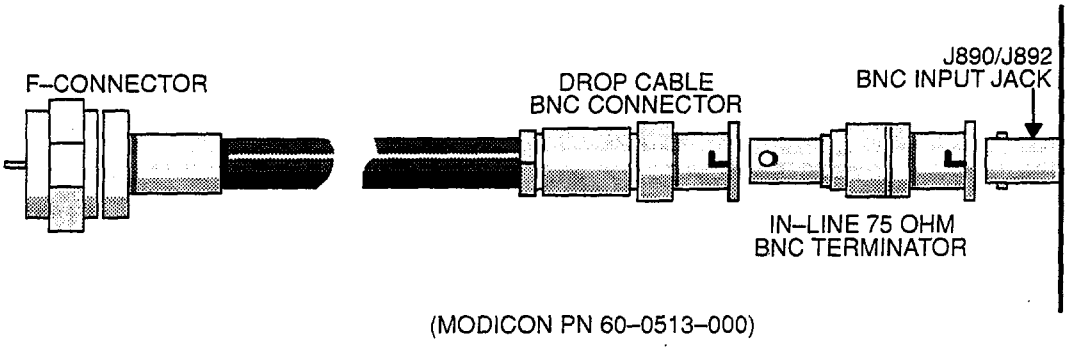


Figure 22 Centralized (Star) Grounding with Some Typical Mistakes

Drop Cable to J890/J892 Termination

The cable drop to the J890 or J892 must be loaded with a suitable type of in–line, 75 Ohm, BNC fitted termination before it is connected to the J890 or J892 input jack (BNC). This arrangement is shown in Figure 23.

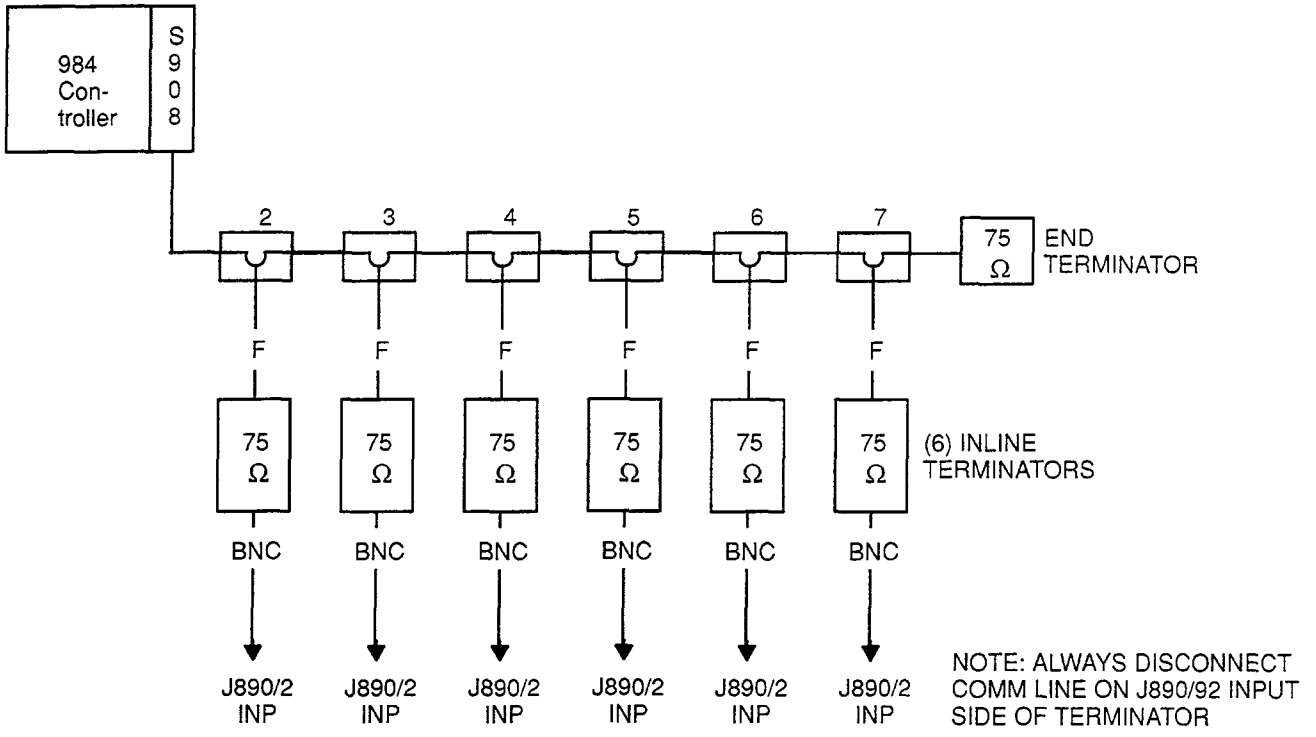
Caution **Removing the 75 Ohm terminator from the drop cable when disconnecting the J890 or J892 while the system is running can cause other I/O drops to malfunction. Instead, disconnect the cable by removing the terminator from the J890/J892 input jack.**



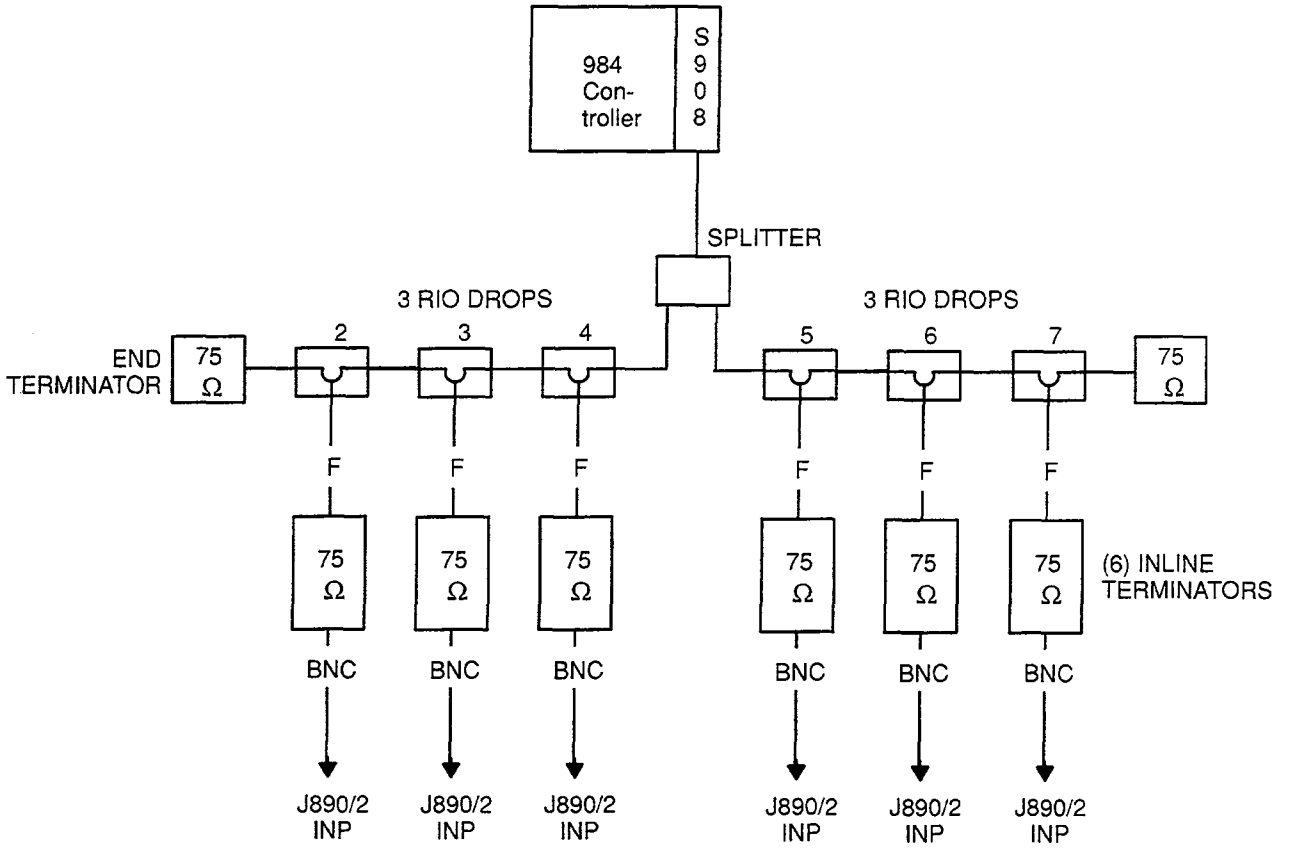
(MODICON PN 60–0513–000)

Figure 23 Drop Cable to In–Line 75 Ohm Terminator to J890/J892

Terminations for linear and splitter topologies are shown in Figure 24.



A. LINEAR NETWORK TERMINATIONS



B. SPLIT NETWORK TERMINATIONS

Figure 24 Terminating Linear and Splitter Networks

Chapter 6
Installing Your Remote I/O

This chapter provides installation procedures for your Remote I/O subsystems. The procedures cover the following installation areas:

- Panel/Bulkhead Mounting
- Rack Mounting
- Field Wiring
- I/O Module
- Power Supply
- Remote I/O Adapter System Configuration
- Remote I/O Cable

Mounting Your 800 Series Remote I/O Housings

The 984 series housings can be panel/bulkhead on a vertical, metal surface or rack–mounted in a 19–inch NEMA rack. Some planning considerations are common to both panel/bulkhead mounting and rack mounting for 800 series I/O housings.

Between housings, allow 12 inches below the primary housing for cable breakout and six inches between the other housings in the drop for ventilation.

The length of each cable connecting the primary housing and its immediate secondary housing (same drop) must not exceed six feet; the sum of the lengths for each cable type in the 800 I/O drop must not exceed twenty feet.

Panel/Bulkhead Mounting

The 800 I/O sub–system can be mounted on any vertical, grounded, metal surface capable of supporting its weight. It is also designed to mount in a NEMA panel.

Mounting hardware is not supplied for the RI/O Housings. It is recommended that (4) 1/4–20 bolts 7/8" long and 1/4–20 inserts be used for a metal wall mount surface or NEMA panel. Special mounting hardware may be required depending upon the installation site.

Rack Mounting

The H819 Module Housings can be mounted in a 19–inch standard (EIA) rack. If you want to rack mount your housing(s), you must order the conversion kit; i.e., a pair of mounting flanges and related hardware (supplied). The following hardware is also required (but not supplied) for rack mounting each housing:

- (1) 19–inch Standard (EIA) rack
- (8) 1/4 bolts (supplied) to attach back of rack mount flanges back of housing

Other special mounting hardware may be required depending upon the installation site.

Panel/Bulkhead Mounting

As shown in Figure 25, the housing has keyholes at the top and bottom of the housing for bulkhead mounting purposes. The keyholes are sized for 5/16–inch bolts. The recommended ground point is also shown.

Procedure **Panel/Bulkhead Mounting Installation**

Step 1 Install and ground your bulkhead mounting surface for Drop 2.

Step 2 Layout your drop based on your Remote I/O configuration diagram and installation plan.

Step 3 Install 1/4 inch inserts into the panel or metal mounting surface for your primary housing as shown in Figures 25 and 26.

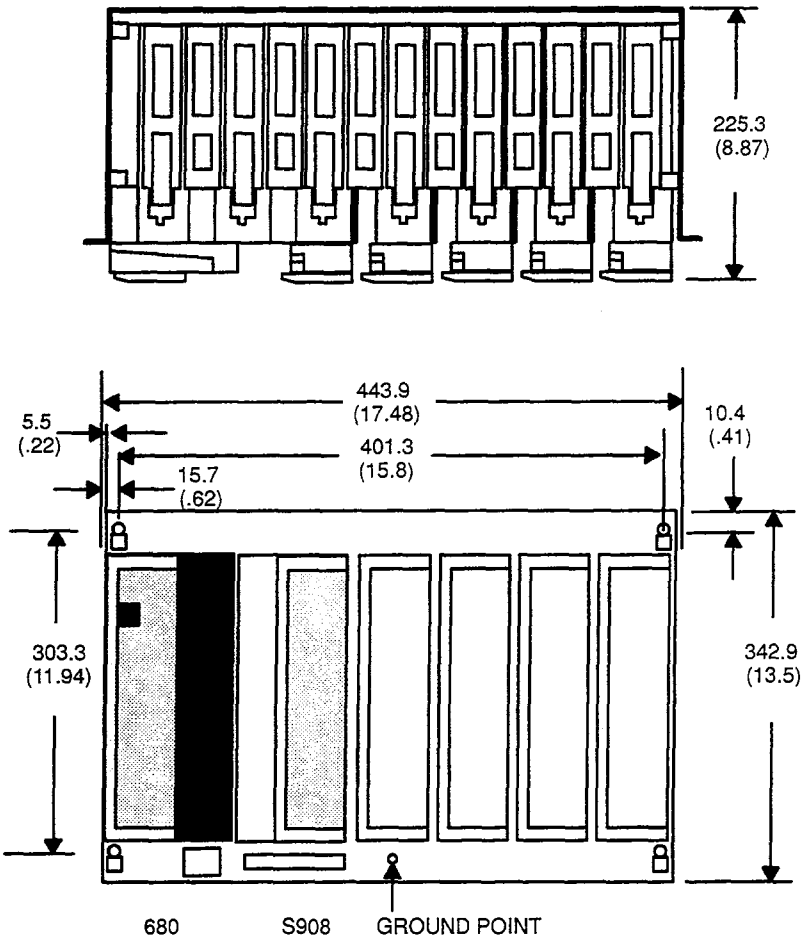


Figure 25 Remote I/O H819 Panel/Bulkhead Mounting Dimensions

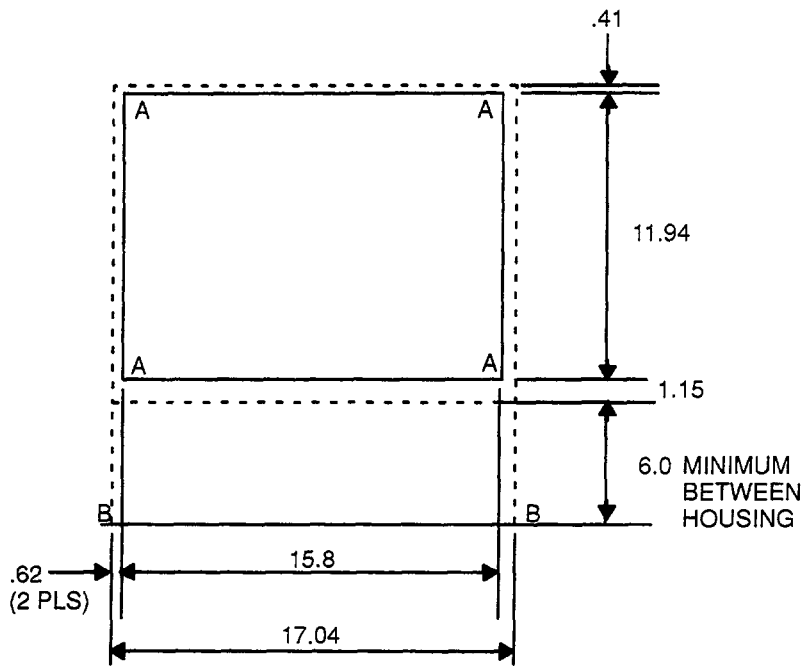


Figure 26 H819 Remote I/O Housing Footprint

Step 4 As shown in Figure 27, attach the primary housing to its mounting surface by inserting the required number of 1/4–inch bolts. (H819 requires four bolts in the housing's mounting flange.) Also install cable troughs for your Remote I/O module slots.

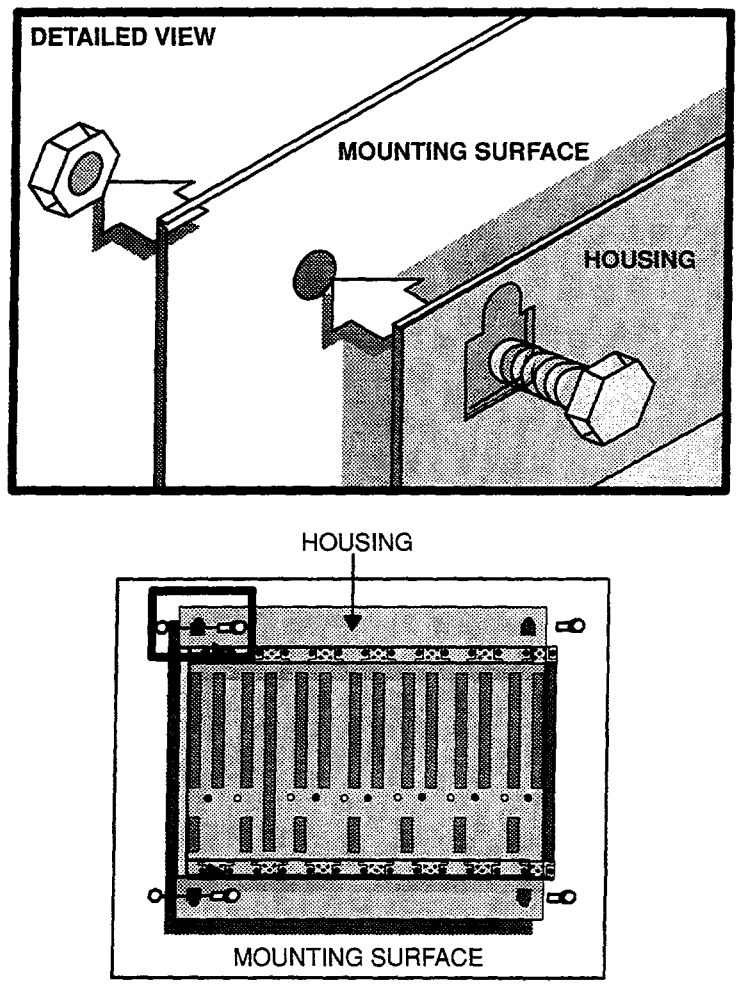


Figure 27 Attach Housing to Mounting Surface

Step 5 Repeat Steps (3) and (4) above for each housing in Drop 2.

Step 6 Using appropriate lengths, connect your W801 signal cable and W802 power cable (use W804 auxiliary power cable when required) between the signal and power connector ports at the top and bottom of each housing as shown in Figure 28.

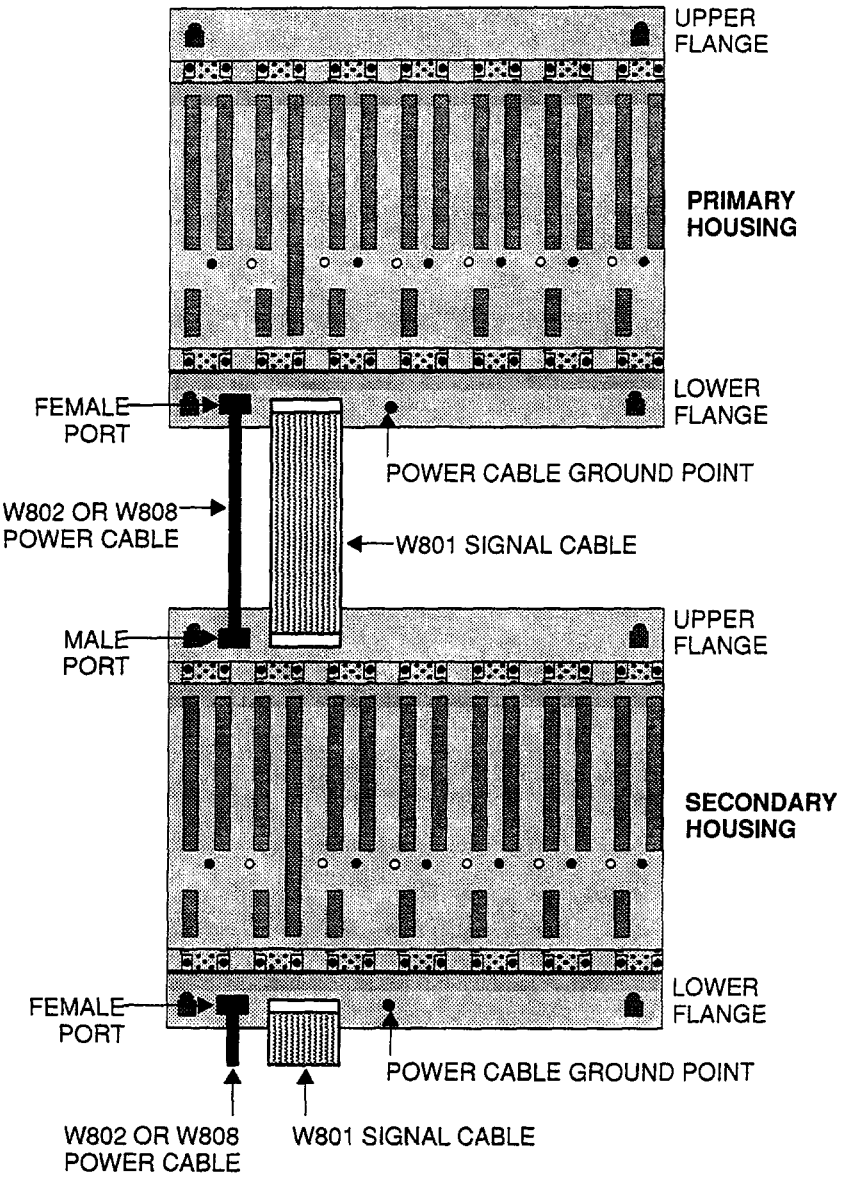


Figure 28 Connecting Cables within Each Drop

Step 7 Ground all W802 power cables to each housing's ground point in the drop as shown in Figure 28. The grounding lug requires a #10 machine screw.

Step 8 Repeat Steps (1) thru (7) above for all remaining Remote I/O drops.

Rack Mounting

The H819 Module Housings can be mounted in a 19–inch standard (EIA) rack. This requires installing a rack adaptor mounting flange kit. Figure 29 shows the housing's rack mounting dimensions.

The following hardware is required for rack mounting each housing:

- (1) Rack mounting adaptor kit which includes: a pair of rack mounting flanges; (8) #8–32 Pan Head Machine Screws (supplied) to attach rack mount flanges to ends of housing; (8) 1/4 bolts (supplied) to attach flange kit to back of housing.
- (8) #10–32, Pan Head Machine Screws to mount the housing with flange adaptor to NEMA rack.
- (8) #10–32 Flat Lock Nuts if mounting holes in rack's side rails rails are not threaded.

Other special mounting hardware may be required depending upon the installation site.

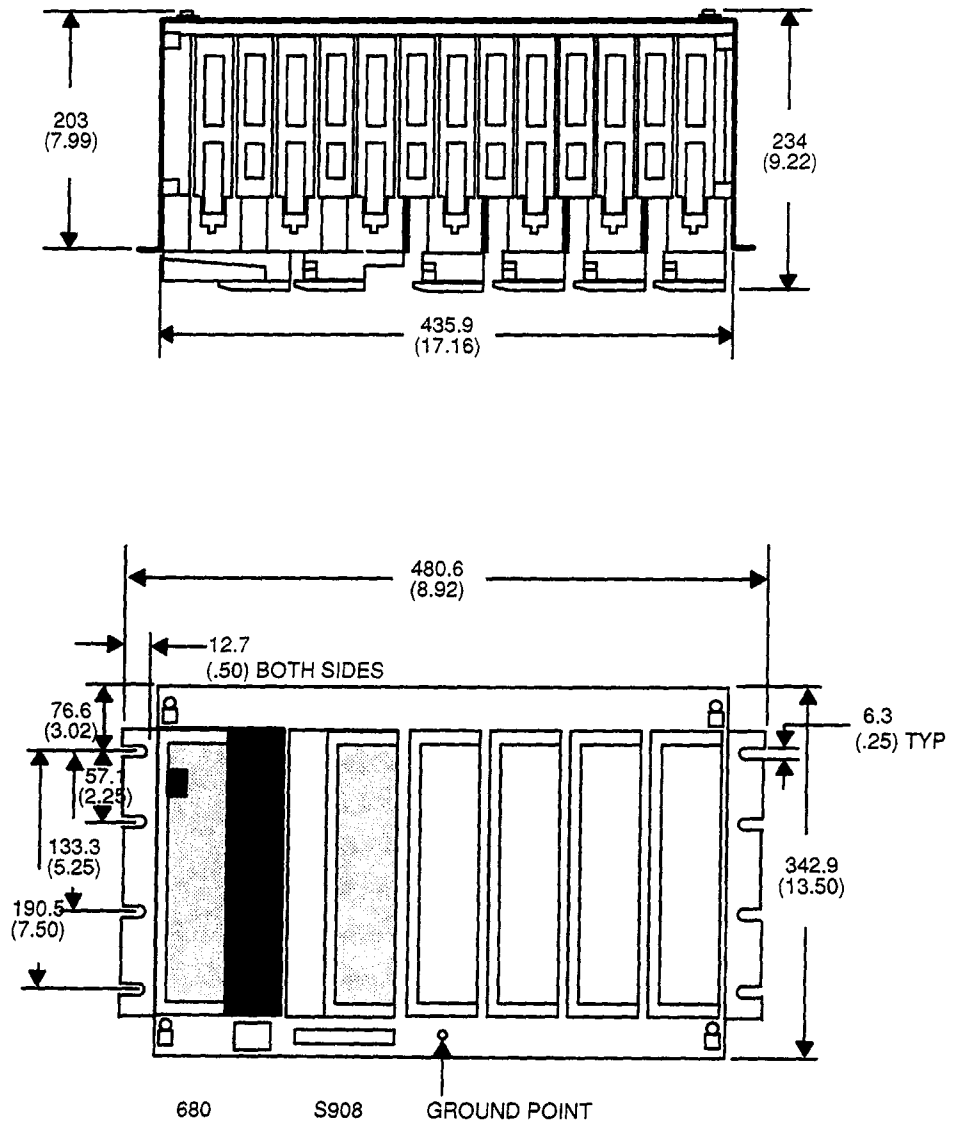


Figure 29 H819 Rack Mount Dimensions

Procedure Rack Mounting Installation

Step 1 At Drop 2, using #8–32 mounting hardware shown in Figure 30, replace the primary housing's two end plates with rack mounting flanges.

Step 2 Use 1/4–inch bolts (supplied) attach each flange to the housing's back panel.

Step 3 When the rack mount flange is installed, ensure that contact with the back plate of the housing is a good ground.

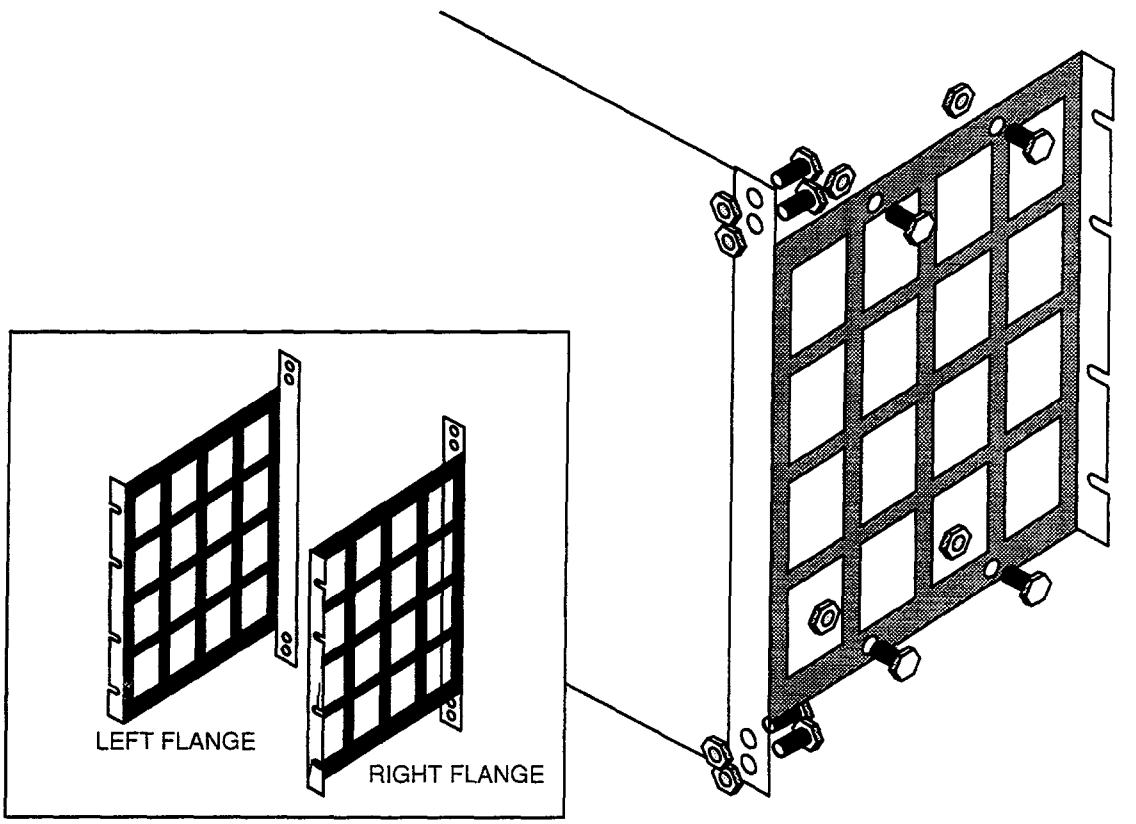


Figure 30 Attaching Rack Mounting Flange to Housing

Step 4 To attach the module housing to the rack as shown in Figure 31, lift the empty module housing to its mount position in the rack and insert the mounting screws. Use #10–32 pan head screws to attach the module housing to the rack. Install cable troughs for all Remote I/O modules.

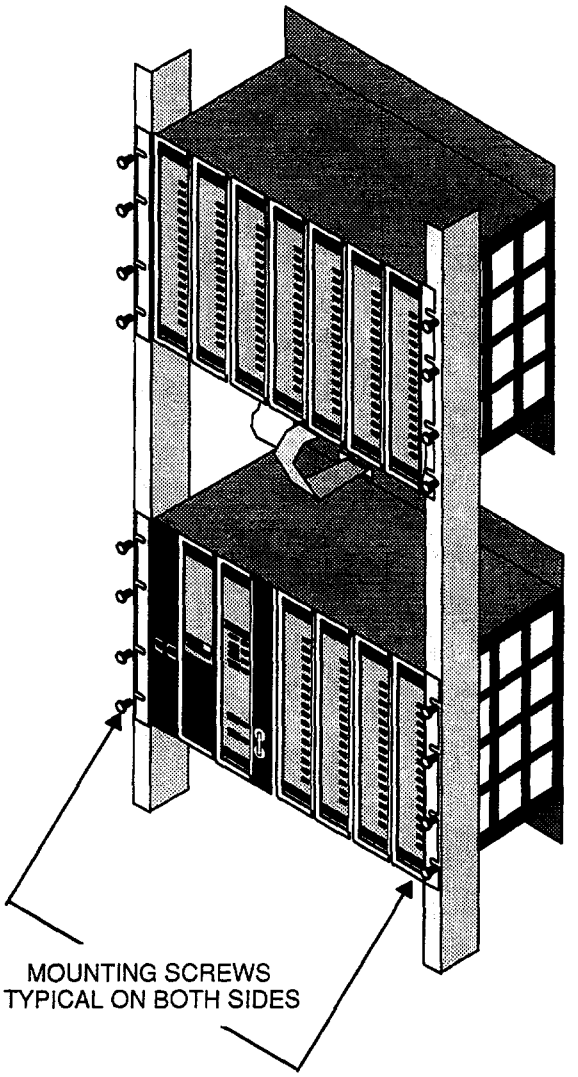


Figure 31 Rack Mounting Your Housing

Step 5 Repeat Steps (1) thru (4) above for all remaining housings within Drop 2.

Step 6 Using appropriate lengths, connect your W801 signal cable and W802 power cable (use W808 auxiliary power cable when required) between the signal and power connector ports at the top and bottom of each housing within the drop as shown in Figure 28.

Step 7 Ground each W802 power cable to the housing's ground point shown earlier in Figure 28. The grounding lug requires a #10 machine screw.

Step 8 Ground your rack for Drop 2 to the best possible ground following good practices as outlined in Chapter 5, *Planning Your Remote I/O Installation.*

Step 9 Repeat Steps (1) thru (8) above for all remaining drops according to plan.

Connecting Your Field Wiring

Field wiring should be in place before the I/O modules are inserted into the racks. During installation, the slot to the left of the slot being wired must be empty.

As shown in Figure 32, field wiring is routed through the wire trough to the terminal block. There are 20 field wiring terminal screws on each terminal block. User field wiring crosses from the left side into the wire connectors. Each terminal can accept as many as four #22 AWG wires, as many as two #14 AWG wires, or a single #12 AWG wire. The wires can be solid or stranded.

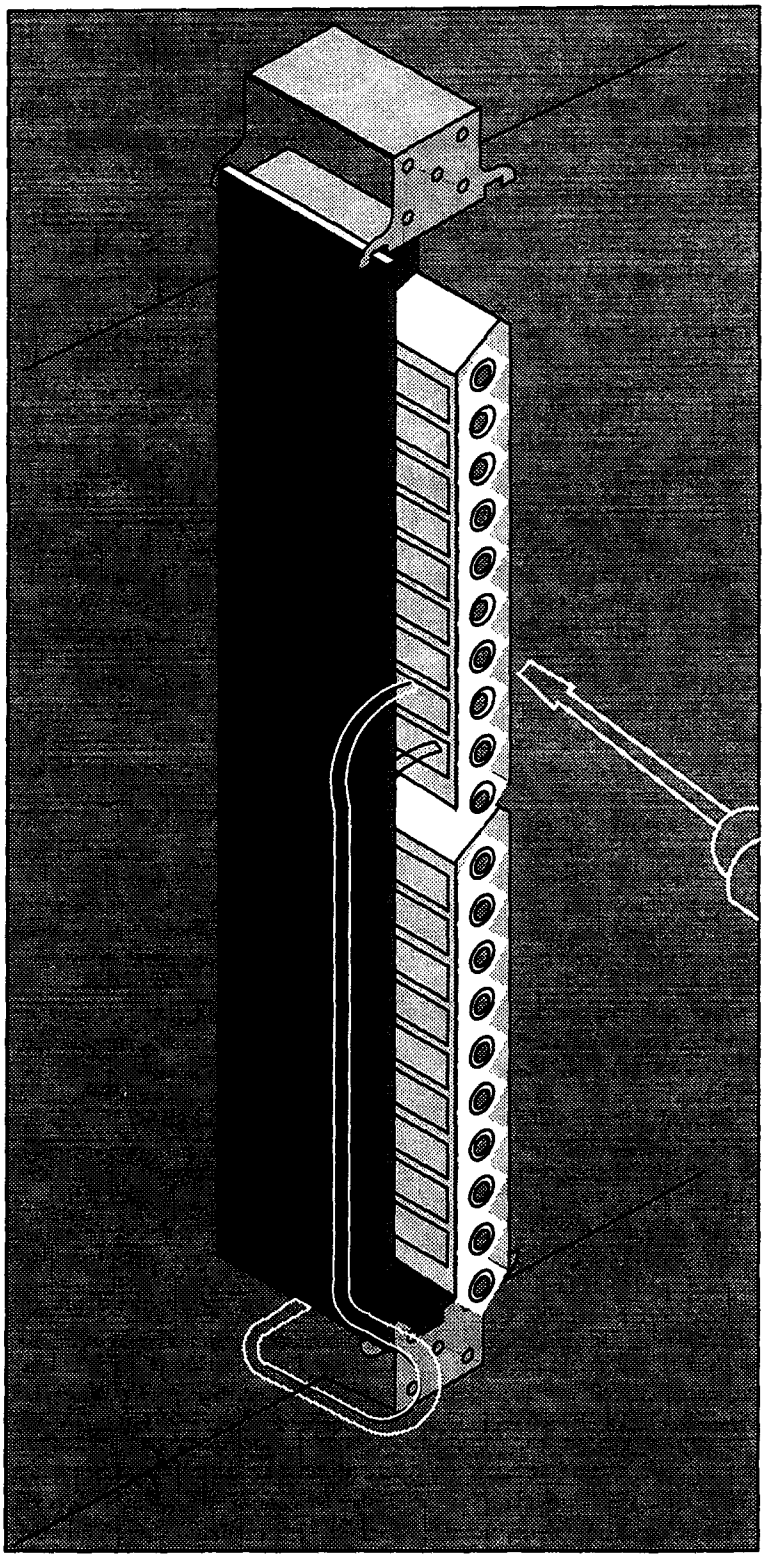


Figure 32 Field Wiring to Terminal Strip

Procedure **Connecting Your Field Wiring**

Step 1 If you already have a Power Supply installed, ensure that it is OFF and will remain OFF.

Step 2 Bring field wiring to last housing in Drop 2.

Step 3 Fan–out your cable breakout and lay it in the cable trough for rightmost I/O module slot on housing.

Step 4 Open the wire connectors by turning the recessed terminal screws counter–clockwise.

Step 5 Insert the field wires into the wire connectors and tighten the terminal screws.

Step 6 Repeat Steps (3) thru (5) for each slot in last housing.

Step 7 Repeat Steps (1) thru (6) above for each housing in Drop 2.

Step 8 Repeat Steps (1) thru (7) above for each remaining drop.

Power Supply Installation

Your 800 series remote I/O power supply (P810) module goes in the first slot of the primary housing in each drop. The power supply passes power to the I/O modules within its housing via backplane connectors and from housing to housing within the drop via a W802 power cable(s) The W804 Auxiliary power cable is used to send switching signals (IOcontrollerH) into a housing that has its own auxiliary power supply.

As shown in Figure 33, the power supply module is secured to the housing by two captive screws located behind the handle.

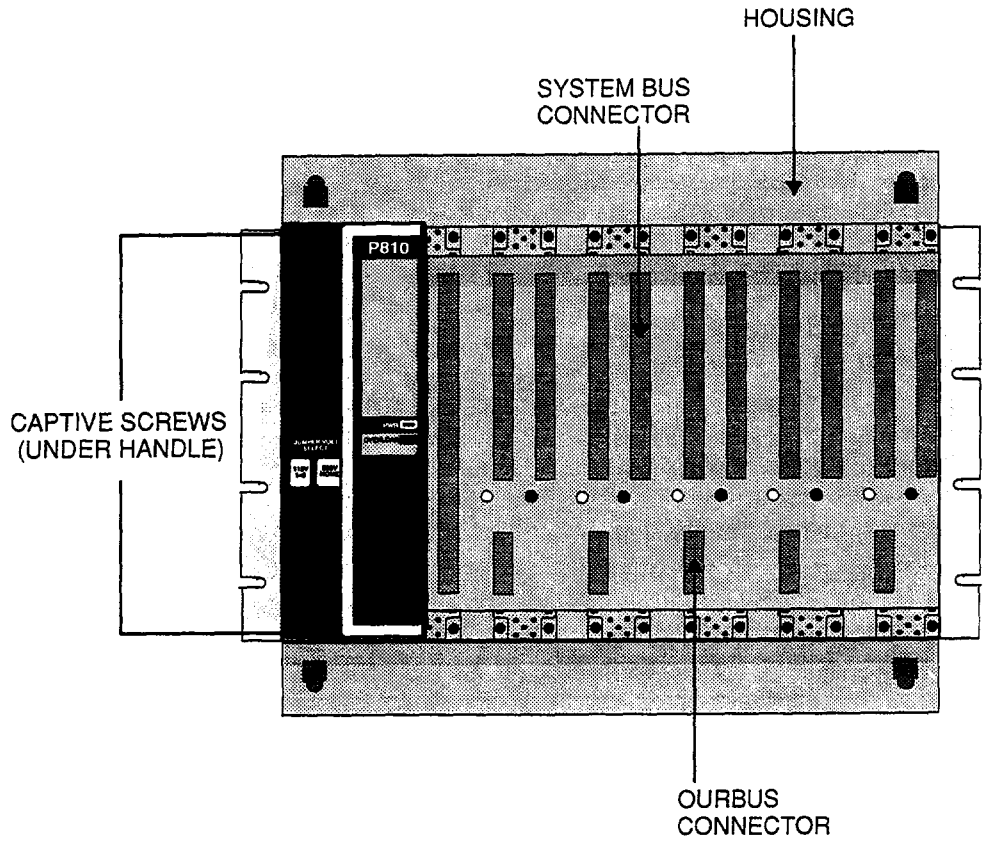


Figure 33 P810 Power Supply Insertion

Procedure Power Supply Installation and Wiring

Warning BE SURE THE MAIN POWER TO THE INSTALLATION IS OFF AND WILL REMAIN OFF BEFORE WIRING POWER SUPPLY

Step 1 Install your P810 in Drop 2.

Step 2 Remove protective cover plate from power connector.

Step 3 Wire AC input connector as shown in Figure 34.

Step 4 The P810 is shipped from the factory wired for 115 VAC operation; i.e., 1 & 2 jumpered. Ensure this is the case. To wire for 230 VAC operation, remove the jumper.

Note To wire a P800, see Figure 35. To wire a P884, see Figure 36.

Step 5 Reinstall protective cover.

Step 6 Repeat Steps (1) thru (4) above for each remaining drop.

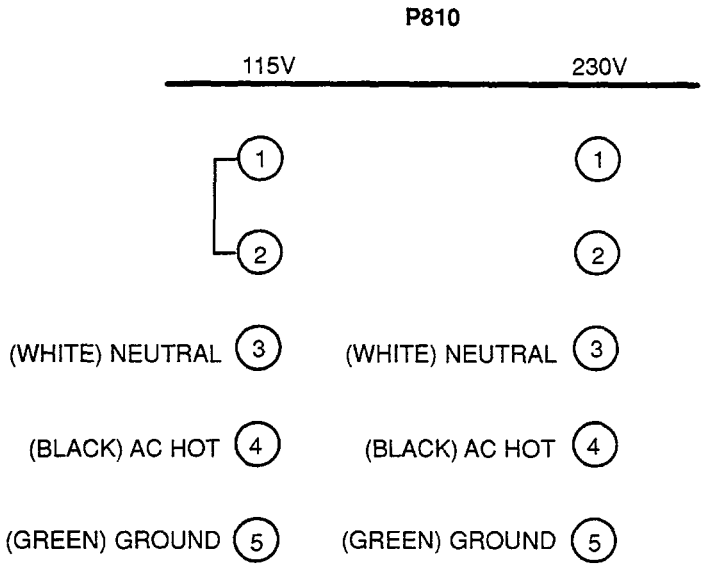


Figure 34 P810 Power Supply Terminal Strip

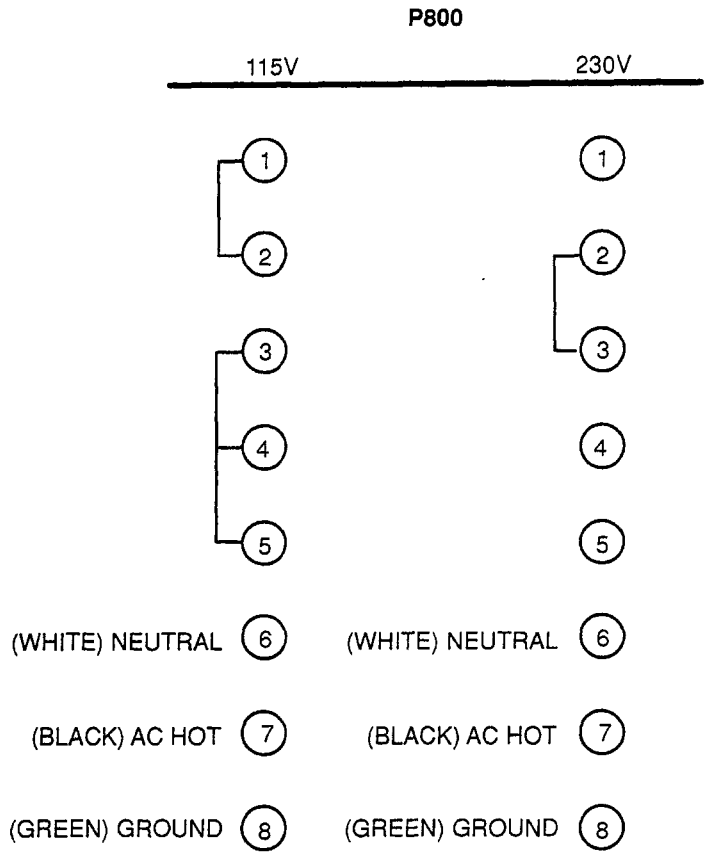


Figure 35 P800 Power Supply Terminal Strip

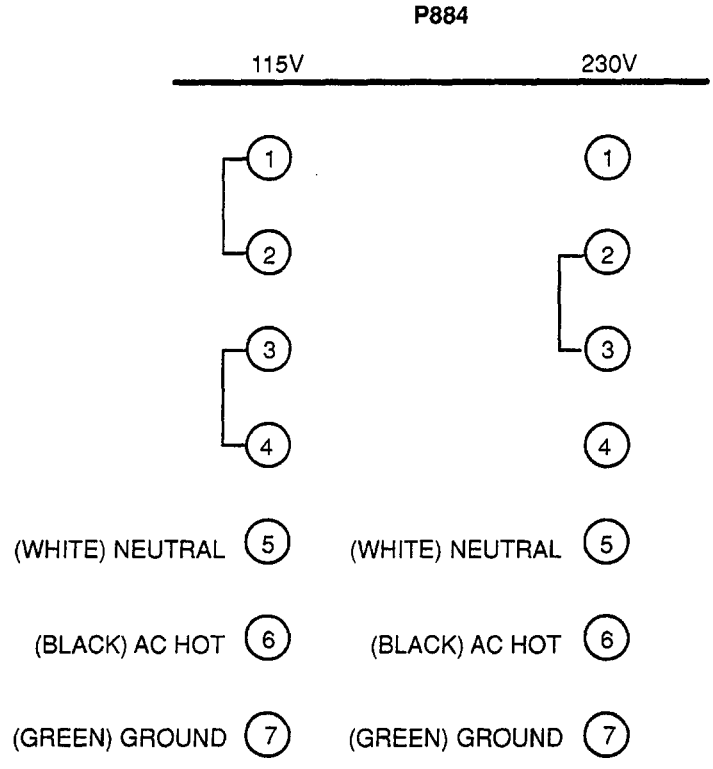


Figure 36 P884 Power Supply Terminal Strip

AC Input Power Wiring

The AC power source connects to the terminal block located on the P810 Power Supply's front panel (under protective terminal cover plate).

Ideally, the power line should be dedicated to the controller installation to minimize problems that sometimes arise when sharing AC power with electrically noisy equipment.

The AC power cable must have three insulated leads of Number 14 AWG stranded copper to insert in the plug–in power cable connector: color code (standard) for the AC cable is white for AC neutral, black for AC hot, and green for factory or earth ground. The European color code is light blue instead of white for neutral, brown instead of black for the hot wire, and green/yellow instead of green for ground.

☞ **Note** Factory and earth grounds often have different potentials; e.g., building steel versus grounding rods.

Your P810 Power Supply operates on 115V/230VAC input. Your installation instructions and the power supply labeling show the customer installable jumper used for a specified input voltage. Information for input wiring on the P800 and P884 power supplies is also shown.

I/O Module Insertion

The I/O modules insert into designated slots. They connect to each other within the housing by way of the backplane connectors. The I/O connectors mounted on the I/O modules mate with the terminal block connectors mounted on the housing. Each module has two captive screws which secure it to the housing. Figure 37 shows the I/O module insertion.

Procedure **I/O Module Installation**

Step 1 At Drop 2, insert key pins in last housing according to plan.

Step 2 Insert last I/O Module in rightmost slot of last housing in Drop 2.

Step 3 Secure I/O module with captive screws.

Step 4 Working right to left, repeat Steps (2) and (3) above for all remaining I/O slots in last housing.

Step 5 Repeat Steps (1) thru (4) above for all housings in Drop 2.

Step 6 Repeat Steps (1) thru (5) above for all remaining drops.

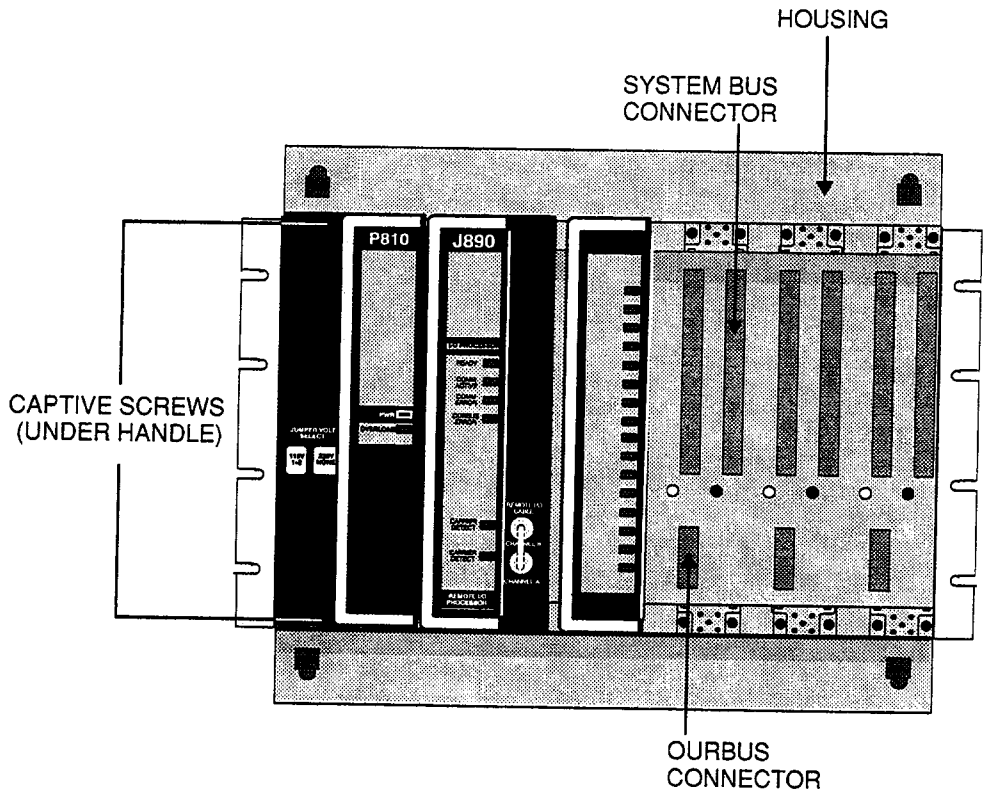


Figure 37 984 800 Series I/O Module Installation

Warning 800 SERIES I/O MODULES MUST NOT BE REMOVED AND REPLACED (HOT–SWAPPED) WHILE THE POWER SUPPLY MODULE IS ENERGIZED [ON].

Your S908 RIOP Installation Options

RI/O Interface Another type of exec cartridge exists for the remote I/O interface. Depending on which cartridge has been installed, the RI/O drop limit is either 6 or 31.

Your RI/O exec cartridge installation is accomplished through an access panel in the left side of the RIOP module's chassis.

Caution MODICON cannot endorse Splitter networks as good practice and recommends that they not be used!

☞ **Note** If you installed your S908 Remote I/OP in the Local installation procedure, skip the installation procedure below.

Procedure **Setup and Mount S908 Remote I/O Processor in 680 Primary Housing**

Step 1 Open access port in S908 and ensure correct Executive Cartridge is securely installed as shown in Figure 38.

Step 2 Secure access port.

Step 3 Install S908 in primary second slot of controller enclosure.

Step 4 Secure module with captive screws.

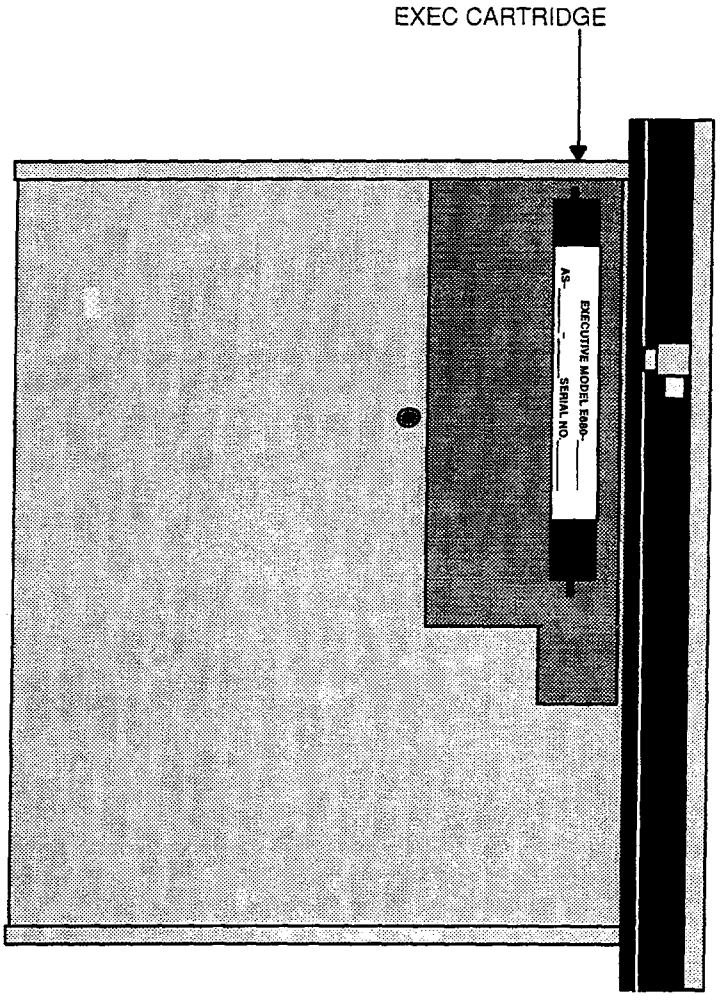


Figure 38 S908 Exec Pack Installation

Remote I/O Cable

When you pull your I/O cable, take special care not to place excessive stress on the cable. Where possible, avoid crossing high voltage lines (high energy) except at right angles. To the extent possible, good practice dictates that you: avoid running cable near large motors, inductors or devices such as welding machines; in high temperature areas; through areas where the cable covering could be eroded by chemical contaminants. Plan to install your Remote I/O F–connectors after cable has been installed and cut to fit.

The following procedure is recommended for installing F–connectors on your coax cable.

Procedure **F–Connector Installation**

Step 1 As shown in Figure 39, score the cable jacket and, taking care not to cut the braided shield underneath, expose the braid. Separate (comb out) the braid. Fold it back against the jacket and evenly distribute it around the cable jacket.

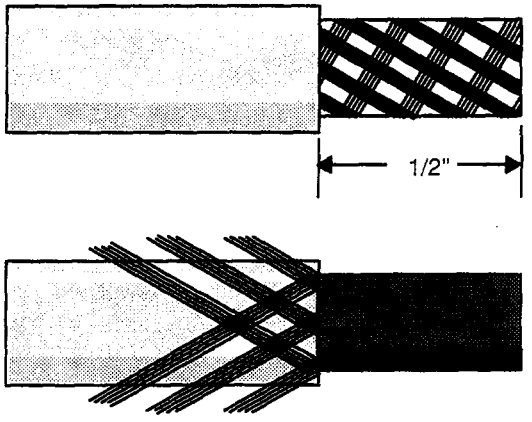


Figure 39 Preparing COAX Shield Prior to Connector Installation

Step 2 As shown in Figure 40, cut through the exposed bonded foil and dielectric and remove without damaging center conductor.

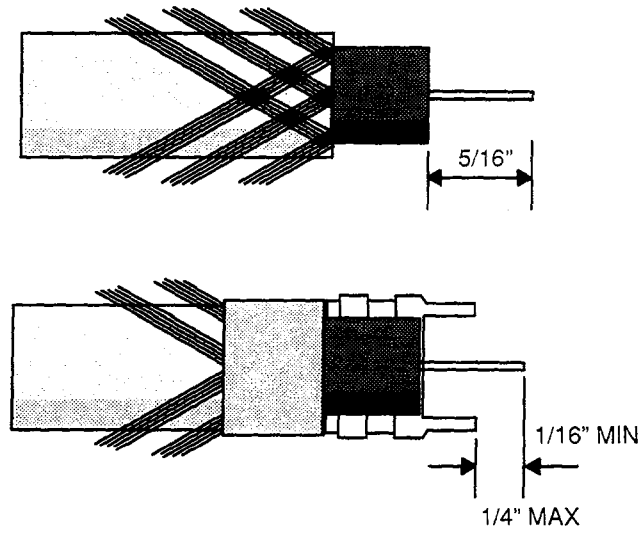


Figure 40 Trimming Dielectric and Installing Connector

Step 3 As shown in Figure 40 above, insert the cable into the F–connector until dielectric is flush with inside shoulder of the connector. The center conductor should protrude about 1/8" beyond the connector shell.

Step 4 Crimp connector and trim excess braid.

Caution Once the coaxial cable F–connector is firmly attached, it is imperative that these connections not be stressed by excessive cable tension.

Procedure Remote I/O Cable Installation for Linear Hookup

Step 1 Pull cable from CPU to Drop 2.

Step 2 Make up cable connectors as required.

Step 3 Mount Remote I/O cable on S908 Remote I/OP at Drop 1.

Step 4 Attach cable to Tap at Drop 2.

Step 5 Mount 75 ohm In–Line termination to J89X.

Step 6 Connect tap and Remote I/O Adaptor input termination with short length of coax.

Step 7 Dress and secure Remote I/O cable at Drop 2 according to plan.

Step 8 Pull cable from Drop 2 to Drop 3.

Step 9 Make up cable connectors as required.

Step 10 Connect Remote I/O cable to tap at Drop 2.

Step 11 Connect Remote I/O cable to tap at Drop 3.

Step 12 Mount 75 ohm In–Line termination to J89x input at Drop 3.

Step 13 Connect tap to in–line termination.

Step 14 Dress and secure Remote I/O cable at Drop 3 according to plan.

Step 15 Repeat Steps (8) thru (14) above for each remaining Drop in Remote I/O system.

Step 16 Connect 75 ohm End termination to outgoing port on last tap on network.

Verify Your Remote I/O Installation

☞ **Note** Your controller Remote I/O system is ready for initial power up and check–out.

Procedure **Verifying the Remote I/O Installation**

Step 1 Visually inspect installation at Drop 2.

Step 2 Energize your Remote I/O power supply and J89X Remote I/OP adaptor at Drop 2.

Step 3 Visually inspect installation and verify operation. Your P810 Power Supply POWER ON Indicator and your J89X READY Indicator should both come up Green.

Step 4 Connect P190 to controller and verify controller operation. If necessary, see Appendix B for Cable Checkout information and/or Appendix C for Error Codes and other related information.

Step 5 Repeat Steps 1 thru 4 above for all remaining drops.

Appendix A
984–680/685 Specifications

This appendix covers the following specifications for the 984–680 and 685 controllers:

- ELECTRICAL CHARACTERISTICS
- CIRCUIT CHARACTERISTICS
- ENVIRONMENTAL CHARACTERISTICS
- PHYSICAL CHARACTERISTICS
- BUILT–IN POWER SUPPLY
- EXTERNAL POWER ISSUES

Mainframe Specifications

Electrical Characteristics

Indicators	READY, Amber LED:	Controller passed power–up diagnostics. Remains ON in Unconfigured, Stopped, and Start states as long as health status OK.
	POWER OK, Green LED:	Generated by power supply to indicate input power OK and voltage outputs OK.
	RUN, Green LED:	Controller has started and is solving logic.
	BATTERY LOW, Red LED:	Battery needs replacing.
	MODBUS 2, Green LED:	Comm process has unit address and communications in progress.
	MODBUS 1, Green LED:	Comm process has unit address and communications in progress.
Static Discharge	15kV to all surfaces	
Time–of–Day Clock	+ 1 sec/day @ 25°C + 3 sec/day @0–40°C + 8 sec/day @0–60°C	
Magnetic	20 Gauss field inside Helmholtz Coil, 0.25 to 8 pps	
Agency Approval	Meets applicable agency safety requirements	

Circuit Characteristics

Scan	3ms/K words (680) 2ms/K words (685)
Throughput	<10ms for 64 I/O points
Local I/O	512 bit in/ 512 bits out 1 Discrete point = 1 bit 1 Analog point = 16 bits

Circuit Characteristics (continued)

RI/O per Drop	Each drop same as local
Total I/O	Local I/O • 512 bits in/ 512 bits out • < 1024 Discrete I/O • < 32 Analog In/ 32 Out 31 Remote Drops • 15872 bits in/ 15872 bits out • < 2048 Discrete I/O • < 1920 Analog I/O
Memory	User Logic: 8 – 16K Words Registers: 1920
Holdup	32ms for CPU
Power Consumption	5 W
Surge Withstand	Per IEEE 472–1974, ANSI C37.90a

Environmental Characteristics

Temperature	Operating: 0° → 60°C Storage: –40° → +80°C
Humidity	0–95% Non–condensing
Max Wet Bulb	Non–operating: Non–condensing Operating: 85°F
Altitude	10,000 feet max
Shock	+ 10g's, 11ms, 3 pulses per axis
Vibration (Operating)	5Hz to 50Hz @ .005 in D.A.,30 min/axis 50Hz to 500Hz @ .625 g's, 30 min/axis
Vibration (Non–operating)	10Hz to 50Hz @ .029 g's/Hz 50Hz to 300Hz @ .029 g's/Hz, –8dB/octave

Physical Characteristics

Dimensions

WxHxD (in.)	3.1 x 10.5 x 8
WxHxD (mm)	79 x 266 x 203
Weight	6 lbs.

Built-in Power Supply

Input Power	115 VAC + 15% 220 VAC + 15% 24 VDC + 15%
Fuse	1A, 3A Buss; not customer replaceable
Holdup	32ms for CPU from Power OK going inactive
Indicators	LED GREEN: Power OK
Output Power	40 Watts to I/O service
Output Voltage*	
V1 5VDC I/O	8.0A max
V2 4.3VDC I/O	6.0A max
V3 –5VDC I/O	0.5A max

* *When added, any combination of V1, V2, and V3 must not exceed 8.0A*

External Power Issue Specifications

AC Input Power Parameters	Peak VA = 360 Mean VA = 72
Inrush Current	10A (AC) 1.5 A (DC)
Isolation Transformer	0.5kVA (recommended)
Ext 24VDC Power Supply	70W nominal
RIOP Load	1.6A max @ 5VDC

Appendix B
984–780/785 Specifications

This appendix covers the following specifications for the 984–780 and 785 controllers:

- ELECTRICAL CHARACTERISTICS
- CIRCUIT CHARACTERISTICS
- ENVIRONMENTAL CHARACTERISTICS
- PHYSICAL CHARACTERISTICS
- BUILT–IN POWER SUPPLY
- EXTERNAL POWER ISSUES

Mainframe Specifications

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Indicators	READY, Amber LED:	Controller passed power–up diagnostics. Remains ON in Unconfigured, Stopped, and Start states as long as health status OK.
	POWER OK, Green LED:	Generated by power supply to indicate input power OK and voltage outputs OK.
	RUN, Green LED:	Controller has started and is solving logic.
	BATTERY LOW, Red LED:	Battery needs replacing.
	MODBUS 2, Green LED:	Comm process has unit address and communications in progress.
	MODBUS 1, Green LED:	Comm process has unit address and communications in progress.
Static Discharge	15kV to all surfaces	
Time–of–Day Clock	+ 1 sec/day @ 25°C + 3 sec/day @0–40°C + 8 sec/day @0–60°C	
Magnetic	20 Gauss field inside Helmholtz Coil, 0.25 to 8 pps	
Agency Approval	Meets applicable agency safety requirements	

Circuit Characteristics

Scan	1.5ms/K words (both 780 and 785)
Throughput	<10ms for 64 I/O points
Local I/O	512 bit in/ 512 bits out 1 Discrete point = 1 bit 1 Analog point = 16 bits

Circuit Characteristics (continued)

RI/O per Drop	Each drop same as local
Total I/O	Local I/O • 512 bits in/ 512 bits out (1024 TOTAL) • < 1024 Discrete I/O • < 32 Analog In/32 Out 31 Remote Drops • 15872 bits in/ 15872 bits out • < 16,384 Discrete I/O • < 2048 Analog I/O
Memory	User Logic: 16 – 32K Words Registers: 9999
Holdup	32ms for CPU
Power Consumption	5 W
Surge Withstand	Per IEEE 472–1974, ANSI C37.90a

Environmental Characteristics

Temperature	Operating: 0° → 60°C Storage: –40° → +80°C
Humidity	0–95% Non–condensing
Max Wet Bulb	Non–operating: Non–condensing Operating: 85°F
Altitude	10,000 feet max
Shock	+ 10g's, 11ms, 3 pulses per axis
Vibration (Operating)	5Hz to 50Hz @ .005 in D.A.,30 min/axis 50Hz to 500Hz @ .625 g's, 30 min/axis
Vibration (Non–operating)	10Hz to 50Hz @ .029 g's/Hz 50Hz to 300Hz @ .029 g's/Hz, –8dB/octave

Physical Characteristics

Dimensions	
WxHxD (in.)	3.1 x 10.5 x 8
WxHxD (mm)	79 x 266 x 203
Weight	6 lbs.

Built–in Power Supply

Input Power	115 VAC + 15% 220 VAC + 15% 24 VDC + 15%
Fuse	1A, 3A Buss; not customer replaceable
Holdup	32ms for CPU from Power OK going inactive
Indicators	LED GREEN: Power OK
Output Power	40 Watts to I/O service
Output Voltage*	
V1 5VDC I/O	8.0A max
V2 4.3VDC I/O	6.0A max
V3 –5VDC I/O	0.5A max

* *When added, any combination of V1, V2, and V3 must not exceed 8.0A*

External Power Issue Specifications

AC Input Power Parameters	Peak VA = 360 Mean VA = 72
Inrush Current	10A (AC) 1.5 A (DC)
Isolation Transformer	0.5kVA (recommended)
Ext 24VDC Power Supply	70W nominal
RIOP Load	1.6A max @ 5VDC

Appendix C
Cable Hardware Specifications and Cable Checkout

This appendix provides specifications for Remote I/O signal cable and related hardware, along with guidelines for checking out your RI/O cables in your 984 system.

Qualified Remote I/O Cable Manufacturers

Choose from the qualified signal connection cable manufacturers listed below. Telephone vendors for current part numbers.

Table 5 Recommended 1/2 in CATV Cable (Up to 15,000 ft)

Manufacturer: ***Times Fiber Communications*****, 358 Hall Ave., Wallingford, CT**
Telephone: (203)265–8500 Fax: (203)265–8422

Description	Minimum Bend Radius
Plain	6 in (15.24 cm)
Jacketed	6.96 in (17.68 cm)
Jacketed Messengered	6.96 in (17.68 cm)
Jacketed for Burial	7.2 in (18.29 cm)
Jacketed and Armored for Burial	8.4 in (21.33 cm)

Capacitance: 15 pfd/ft
Signal loss @ 1.554 Mz: 0.8 dB/1000 ft (305 m)

Manufacturer: ***Comm Scope Co.*****, Network Cable Division, General Instrument Corporation,**
P.O. Box 1729, 1375 Lenoir–Rhyne Blvd., Hickory, NC 28602
Telephone: (704)324–2260 (800)982–1708 Telex: 802–166 Fax: (704)324–4813

Description
Bare Cable, Aluminum Sheath Polyethylene Jacket Underground/Waterproof Waterproof with Armor

All Types Rated at:
Minimum bend radius: 8 in (20.32 cm)
Capacitance: 15.3 pfd/ft (+1.0 pfd)
Signal loss @ 1.544 MHz: 0.8 dB/1000 ft (304.8 m)

Table 6 Recommended RG–6/U Coaxial Cable (up to 5,000 ft)

Manufacturer: ***Belden Corporation*****, P.O. Box 1980, Richmond, IN 47374**
Telephone: (317)983–5200 Telex: 499–7255 in U.S., 494–5989 international
Fax: (317)983–5294

All Types Rated at:
Minimum bend radius: 3.3 in (8.25 cm)
Capacitance: 17.3 pfd/ft
Signal loss @ 1.544 MHz: 7.0 dB/1000 ft (304.8 m)

Table 7 Recommended RG–11/U Coaxial Cable (up to 8,000 ft)

Manufacturer: *Delta.Suprenant*, 172 Sterling St., Clinton, MA 01510
Telephone: (508)365–6331 Fax: (508)365–4054

Description	Bend Radius
Flame Retardant, Foamed Coax	5.0 in (12.7 cm)
Flame Retardant, Foamed with Magnetic Shielding and Moisture Barrier	7.33 in (18.62 cm)

Capacitance: 17.3 pfd/ft
Signal loss @ 1.544 MHz: 2.0 dB/1000 ft (304.8 m)

Caution Remember that for proper remote I/O operation

- **RG–6/U cable must not exceed 5000 ft (1524 m)**
- **RG–11/U cable must not exceed 8000 ft (2438.4 m)**
- **CATV cable must not exceed 15,000 ft (4572 m)**

These maximum cable lengths include the length of the trunk and the length of the cable from tap to drop.

Do not draw the cable mechanically during installation. Refer to manufacturer's specifications for correct cable tension.

Cable Connectors

For optimum system performance, we recommend that you use *only one brand of connector* consistently in RIO subsystems. Brand mixing is undesirable and can lead to unpredictable system performance.

Table 8 Recommended Line Tap

Manufacturer: Modicon

Type	Characteristics	Specifications
MA–0185–000, F–type	Insertion Loss	–01 dB (max)
	Return Loss	–18 dB (min)
	Tap Loss	–14 dB (nom)
	Frequency Range	0.1–100 MHz
	Impedance	75 Ω

Table 9 Recommended Line Splitter

Manufacturer: Modicon

Type	Characteristics	Specifications
MA–0186–000, F–type	Insertion Loss	–06 dB (max)
	Return Loss	–18 dB (min)
	Frequency Range	0.1–100 MHz
	Impedance	75 Ω

Cable Terminator

The 75 Ω cable terminator type TR–75F (or any other 1/4–W brand) is recommended. It is manufactured by:

Jerrold/RF Systems, 2200 Byberry Rd., Hatboro, PA 19040
Telephone: (215)674–4800 (800)874–0721 Fax: (215)441–0958

In–line Terminator

The 75 Ω in–line terminator (part number 60–0513–000) sold by **Modicon** is recommended. This terminator is used on the J890/J892 Processor.

The CATV to male F connector type AI–500–FM–B3 is recommended. It is manufactured by:

***L.R.C. Electronics*, 901 South Ave, P.O. Box 111, Horseheads, NY 14845**
Telephone: (607)739–3844 (800)528–5567 Telex: 5101–01 1–251 Fax: (607)739–0106

RG–6/U Male F Connector

The following male F connectors are recommended:

- GF–6–AHS/312, manufactured by

  ***Gilbert Engineering*, P.O. Box 23189, Phoenix, AZ 85064–3189 or**
  5310 West Camelback, Glendale, AZ 85301–7597
  Telephone: (602)245–1050 (800)528–5567 Fax: (602)934–5160 TWX: 910–951–1380

- **L.R.C.** F–6CH

- **Modicon** Part # 52–0331–000

- EZF 52–0400–000 with installation tool 60–0528–000 and blade pack 60–0529–000, manufactured by

  ***Raychem Corporation*, 300 Constitution Dr., Menlo Park, CA 94025**
  Telephone: (415)361–2288 TWX: 910–373–1728

RG–6/U Male BNC Connectors

The following male BNC connectors are recommended:

- **Gilbert** GA–BNC–6–AHS–312L

- **L.R.C./Augat** F–56Ch–BNC/M

- **Modicon** Part # 52–0332–000 (Use Cable Prep. Hct–775 or Gilbert G–CRT–775 Crimp Tool)

RG–11/U Male F Connector

The following RG–11 male F connectors are recommended:

- **Gilbert** GF–11–AHP/450

- **Raychem** EZF 52–0401–000 with installation tool 60–0530–000 and blade pack 60–0531–000

☞ **Note** (1) Cable length maximums are based on a system dynamic range of 35 dB. (2) Modicon taps and splitters are supplied with 75 ohm terminators and type F–56 male connectors.

Recommended Tools

The following special installation tools are recommended in addition to the standard plant electrician's tools.

Crimp tools for RG6/U:

- LRC CT–596
- Gilbert G–CRT–659
- Cablematic CR–596B
- Cable Prep HCT–659
- Gilbert G–CRT–775
- Cable Prep HCT–775

Crimp tool for RG–11/U:

- G–CRT–211

Introduction to RIO Cable Checkout

Prior to the installation of a new Remote Input/Output (RI/O) network, it is prudent to test all cable stock while it is still on the spool for center conductor continuity and short circuits between shield and center conductor.

Using a Time Domain Reflectometer (TDR), center conductor open circuits, shorts to shield, crushed points, and broken cables can be located and identified.

If a TDR is not available, an ohmmeter can be used to check for shorts and opens (continuity).

⚠ **Caution Splices are not recommended since they can add as much as 1 dB of signal loss and introduce a location where contamination can enter the cable and degrade performance.**

Once the cable has been pulled and all drops have been installed, make a visual inspection of the cable run to ensure that the cable does not have bends exceeding the minimum bend ratio of the cable manufacturer's specifications.

Watch out for sharp bends which could rub through the cable jacket. There must, of course, be some bends in the cable to allow for strain relief of taps and splitters, and to reduce impedance changes due to temperature variations stretching the cable.

Cable should not be run next to voltage sources which could induce false data on the network. Observe the recommended 12 inch separation distance per kilovolt of energy on the adjacent power cable.

Cable Checkout Test Equipment

The following is a list of test equipment that can be used to evaluate your RI/O cable network.

- A high input impedance multimeter.
- A baseband (1.544 MHz) Test Generator (LMT–1544) and Receiver (LMR–1544), or an equivalent signal generator.
- An Oscilloscope
- A Time Domain Reflectometer (TDR) with Printer.
- A dB Attenuation box.

Cable Checkout Procedures

Initial cable network testing must be done without any interface devices connected. Taps must be terminated with 75 ohm terminators to prevent undesirable reflections.

Caution **Do not overlook the possibility of high voltage being present on the shield of the cable caused by inadvertent contact with a voltage source during cable installation. Test equipment other than a high input impedance meter or an oscilloscope must not be connected to the coaxial cable if the presence of high voltage is suspected on the network.**

High Voltage Test Use the voltmeter to test for high voltages from shield to ground and from center conductor to ground. Also check between shield and center conductor.

Noise Test Excessive RI/O cable noise in your system can cause retries and/or loss of communication with remote interfaces. If you suspect such a problem, use an oscilloscope connected at the end of the cable normally attached to the PC and determine the noise level (if any) between the center conductor and shield. Any voltage determined present must not exceed 20 millivolts peak–to–peak. Any voltage present in excess of 20 mv p–p should be eliminated or reduced as much as possible. Do not proceed to other tests until this has been done. The noise source should also be identified for future reference in the event of communication problems.

Repeat this test (if necessary) for all ports on the RI/O network, i.e. trunk runs and drop cables. Sections must be terminated with a 75ohm terminator or a tap in the case of drop cables.

Post–Installation Network Integrity Test

After a main network cable has been installed, a most effective method of checking for cable flaws that may degrade system performance is based upon the use of the Time Domain Reflectometer (TDR). This test instrument will evaluate the degree of degradation and determine the approximate location of the flaw.

Set up the TDR according to the instructions contained in its operator's manual and measure the return loss of all detectable flaws along the trunk cable only.

Table 9 is a summary of transmission component losses. Figures 40 and 41 show TDR reference wave forms for use when troubleshooting transmission losses.

Table 10 Summary of Transmission Losses

Component	Path	Loss
Tap	Trunk Path	1 dB
	Trunk to Drop	14 dB
Splitter	Each Path	6 dB
1/2 in. CATV Cable		0.8 dB/1000 ft. (304 cm)*
RG–11/U		2 dB/1000 ft. (304 cm)*
RG–6/U		7 dB/1000 ft. (304 cm)*

* At 1.544 MHz.

Figure 41 illustrates the importance of using the same hardware throughout the system to avoid impedance mismatches.

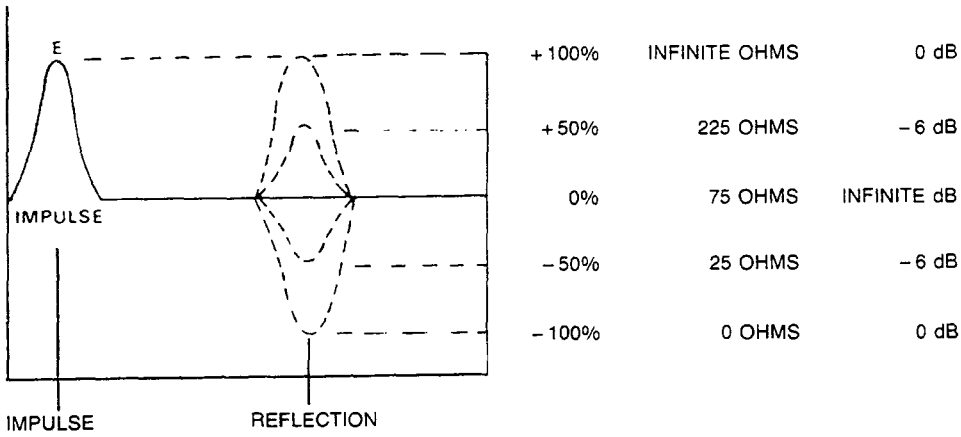


Figure 41 Pulse Reflections from Impedance Mismatch

If long sections of cable are checked, configurations with less than 20 ft. between taps could give a misleading reading on the TDR as shown in Figure 42. The indicated return loss will be the sum of the return losses from each of the taps. In this situation, consider replacing taps that are close together with barrel connectors during this test, or expand the TDR scale and check shorter lengths.

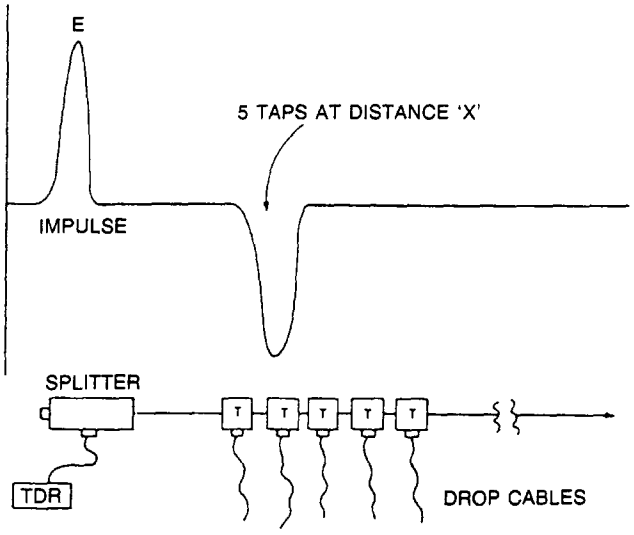


Figure 42 TDR Measurement for Closely Spaced Taps

Caution Before reconnecting I/O drops, a network profile should be recorded on the TDR printer and placed on file for future use. This record permits future comparisons to be made if the network integrity is ever suspect. Figure 43 is an actual TDR printout showing a normal profile. The "bumps" are taps spaced along the cable and should produce ever–lessening magnitudes as distance increases. Abrupt overall level shifts and "bumps" where no taps exist indicate problem areas such as squeezed spots, insulation breaks, or possibly bad splices.

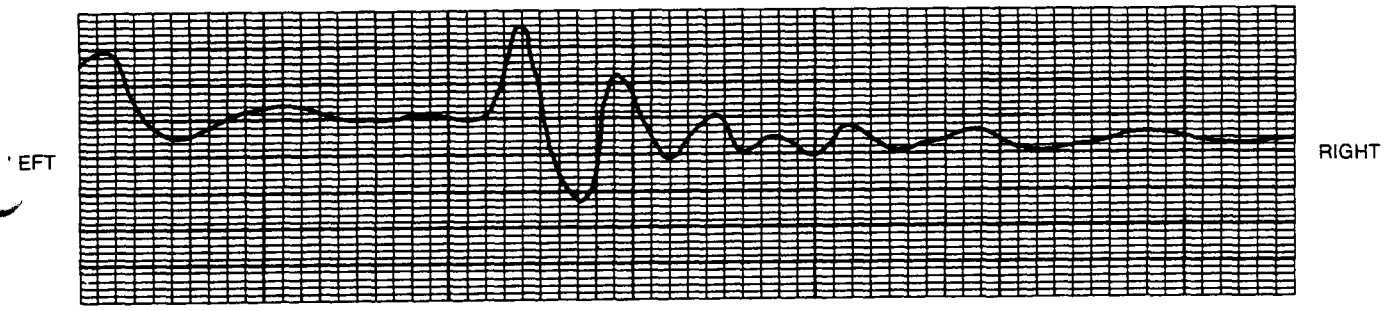


Figure 43 TDR Printout – Normal Network Profile

In Figure 44, observe that long cable runs produce a standing wave on the TDR waveform. When this occurs, the actual waveform baseline should be used for return loss measurements.

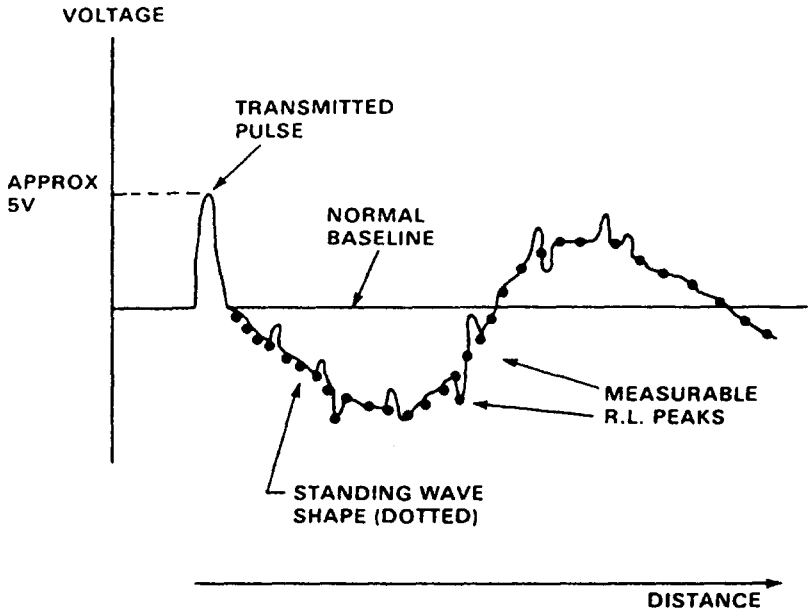


Figure 44 TDR Reading for Long Cable Run Illustrating Exaggerated Standing Wave

Transmission Loss Measurements Tests

Transmission loss measurements check cabling and in–line insertion losses against calculated losses which must be less than the maximum allowable insertion loss of 35 dB between the PC and any remote drop.

For users with a model LMT/LMR 1544, follow Procedure A. Users with a frequency generator and an oscilloscope should use Procedure B.

Procedure A Loss Measurements (LMT/LMR 1544)

Step 1 Properly terminate all drops; use RI/O units where required. All I/O installations must be powered down.

Step 2 Connect main trunk coaxial (984–680 PC end) to the LMT–1544. Energize the unit by plugging the LMT power supply into an AC voltage outlet.

Step 3 At each drop, remove the termination (I/O Unit or Resistance) and connect the LMR–1544 receiver to verify that the actual loss is not greater than the calculated loss.

Procedure B Loss Measurements (Frequency Generator and Scope)

Step 1 Properly terminate all branches either with I/O units or 75 ohm terminators.

Step 2 Connect frequency generator to the 984–680 PC end of the cable.

Step 3 Terminate the frequency generator output with 75 ohms, and adjust to 3 volts peak–to–peak @ 1.544 MHz.

Step 4 Measure the voltage across the termination of each drop. If necessary, refer to the Oscilloscope test section for proper scope attachment to the coaxial cable. Use the following formula to calculate loss for each drop. (The result must be a negative number.)

$$\text{dB loss} = 20 \log \frac{\text{V out}}{\text{V in}}$$

where: V in = frequency generator voltage
V out= drop voltage

Testing for Cable Shield–to–Ground Shorts by Meter

Test for shield–to–ground shorts with an ohmmeter as shown in Figure 45.

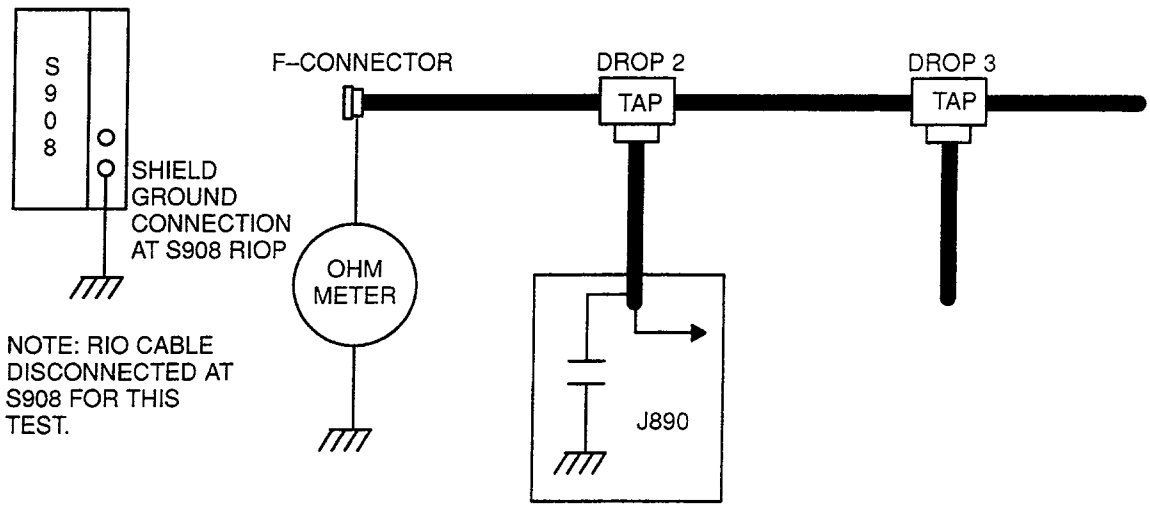


Figure 45 Measuring for Shield–to–Ground Shorts

For J890/J892 RI/O Systems, coaxial cable shields are tied to chassis at the S908 end and capacitor–coupled to chassis at the J890/J892 end.

No ground loop exists if the the meter stabilizes at very high resistance.

If the measured resistance is a very low value (in the vicinity of 1000 ohms or less): 1) check for a coaxial braid short due to worn outer insulation; 2) check comm cable at S908 end to be sure J89X BNC caps are not shorting cable shields; 3) check for a faulty isolation circuit in the RI/O units.

Procedure **Locating Resistance Faults**

Step 1 Connect ohmmeter to suspect branch.

Step 2 Systematically remove the cable from each drop and check ohmmeter reading until a substantial increase in resistance occurs. This indicates last supply's isolation circuit is faulty. Compare measured value with a recalculation.

Step 3 If all modules have been removed and the ground loop still exists, the fault is in the coaxial cable. Sections of cable must be isolated at tap connections and checked.

Oscilloscope Testing

The oscilloscope is used to view undesirable signals (such as those from EMI/RFI based noise), or signal reflections due to impedance mismatches that distort desired signals.

The oscilloscope required should have 100 Megahertz capability to assess the quality of a 984–680 PC signal train. The oscilloscope must display 100 nanoseconds per division and be capable of displaying signal levels from 50 millivolts to 200 volts peak–to–peak on AC power inputs.

Warning SUPPLY VOLTAGES ARE PRESENT THAT CAN CAUSE INJURY OR DEATH!

Use the scope to check the quality of the AC input voltage of the various system power supplies. Look for EMI/RFI noise on each of the three AC input wires to the power supplies. Although the PC system power supply is designed to offset effects of noise on the AC power input, you should use your scope to look for the presence of undesirable noise. If present, steps can be taken to trace the noise to its source for tolerable reduction or possible elimination.

If the AC voltage supply exhibits high–level ripples or spikes, use the scope to evaluate the quality of unit power supplies DC output voltage. AC ripple voltages riding on the DC must be limited to 150 millivolts.

The scope can be used to evaluate the coaxial cable signal strength and quality of the controller and the I/O output waveforms.

To couple the oscilloscope into various parts of the system, use a BNC TEE connector at the 984–680 PC output jack and RI/O driver remote interfaces. The J890/892 line taps and splitters have F–type connectors which require a short (6") F–to–BNC adapter cable to accommodate the BNC Tee connector.

An alternative to the BNC Tee connector is a gutted tap with a jumper wire between the IN and OUT ports. Short coaxial section adapters will be required to insert the tap into the coaxial line. Remove adapters and TEEs when testing is complete.

Signals should be checked at the points indicated in Figure 46 and in the order specified. The "x" indicates the last check point for a problem drop.

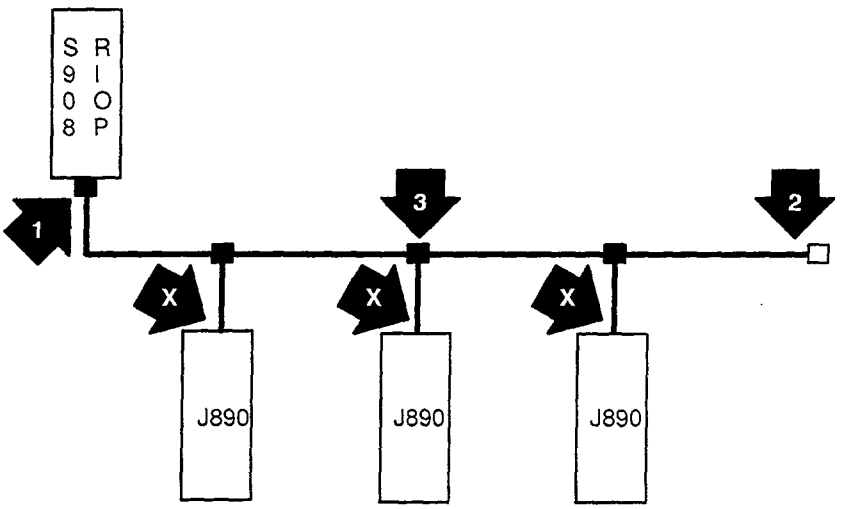


Figure 46 Scope Test Points – Typical Cable System

Troubleshooting Noise Problems

Signals should be checked for amplitude, shape and noise.

A general guideline is that the noise levels for the J89X and S908 should be less than 20 mv peak to peak.

Actual signal photo tracings examples are shown below. Although laboratory conditions are relatively noise–free, these examples do illustrate other problems that may be encountered.

Use the scope to evaluate the dB losses in long runs of cable. Check the dB loss at each tap, add them up, and compare the sum with the scope observation at the last tap in the cable line.

Also, use the scope to look for distortion due to VSWR on improperly terminated cable. Use the scope to assess the amount and nature of any EMI/RFI, suspected or actual, on the coaxial cable.

Be sure to summarize the results of these tests (when used) and add them to the data entered in the system topography drawing(s).

With the PC powered down and disconnected from the cable (or in STOP mode), the oscilloscope can be used to check random noise from sources other than those devices normally turned off and on by the controller.

Figures 47 – 51 are true tracings of pictures taken from the oscilloscope. The pictures were taken with the PC attached and communicating with remote drops.

To duplicate the setup, use the BNC TEE connector or modified tap and short adapter coaxial cable sections to attach the oscilloscope. Keep in mind that communications will be lost between the PC and RI/O when a cable is disconnected. Maximum RI/O drop holdup time is 32 milliseconds.

Analyzing Signal Shapes on an Oscilloscope

Figure 47 shows a total scan of the controller output with RI/O replies. Connect the oscilloscope probe close to the PC.

The signals of larger amplitude are the main impulse from the controller while the lower level signals are RI/O unit reply messages to the controller.

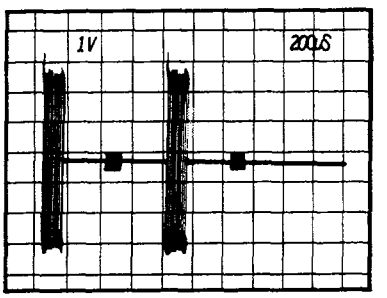


Figure 47 Normal Envelope

As shown in Figure 48, a normal signal data bit will have an amplitude of 5.0 volts peak–to–peak, measured at the source.

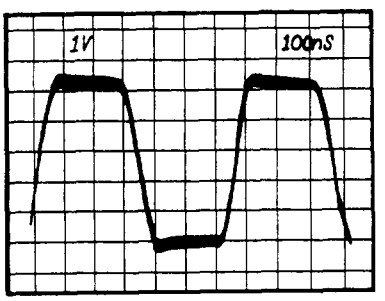


Figure 48 Normal Signal

Figure 49 illustrates a response signal that has passed through 4,000 feet of RG6/U coaxial cable. The distortion is caused by characteristics of the cable.

The same signal is displayed at two different sweep speeds; the second waveform being an expanded version of the first.

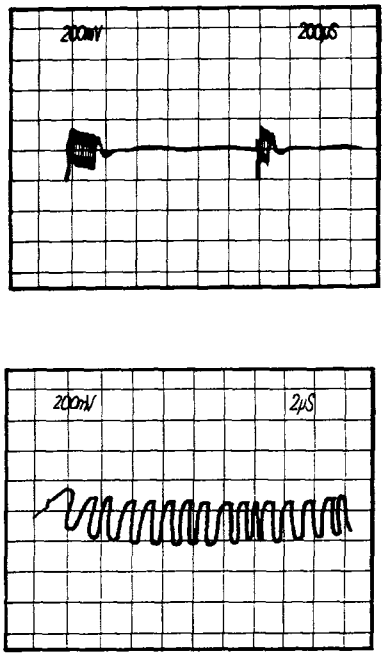


Figure 49 Cable Attenuation

Figure 50 shows a signal shape distorted by reflections from impedance mismatches. The main signal from the controller combines with the reflected signal to cause the dis tortion.

To verify a suspected reflection problem, insert a dB attenuation box in the main cable run after the tap being checked and add some dB loss (10 dB) to the network. The corrected signal should appear as a more normal square pulse if reflections are the problem.

Modicon Rev C taps are properly impedance matched to minimize reflection effects.

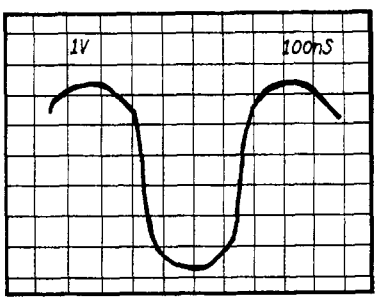


Figure 50 Impedance Mismatch

Figure 51 shows a signal distortion pattern typical of an unterminated cable.

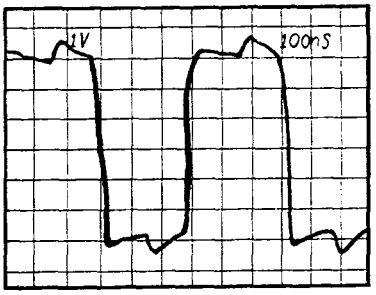


Figure 51 Unterminated Cable

Appendix D
Troubleshooting

This appendix contains troubleshooting help and Modicon telephone numbers for Customer Service and Technical Support.

☞ **Note** Early 984–680 models manufactured with C940–001 PCB's have Pin 1 floating. The PCB part number can be viewed through the perforated metal cover. The silkscreened part number on the component side (bottom left, front) is partially obscured by the chassis slide. The C940–10X part number for models presently in manufacture is on the component side, top right, rear.

Figure 52 shows Modbus cable pinouts for troubleshooting purposes.

Stopped Error Codes

Table 11 following lists stopped error codes for your 984 controller.

Table 11 Stopped Error Codes

Machine Stop Bits		Description
PCSICK	0x7FFF	Controller unhealthy
PCSTOPPED	0x8000	Controller stopped
BADTCOP	0x4000	Bad I/O traffic cop
DIMAWAR	0x2000	Controller in dim awareness
PORTIVENT	0x1000	Bad port intervention
BADSEGSCH	0x0800	Bad segment scheduler
SONNOTIST	0x0400	Son did not start segment
PDCHEKSUM	0x0200	Bad power–down checksum
NOEOLDOIO	0x0080	Watchdog expired
RTCFAILED	0x0040	Real time clock failed
BADOXUSED	0x0020	Bad coil used table
RIOFAILED	0x0010	Remote I/O option failed
NODETYPE	0x0008	Illegal node type user
ULCSUMERR	0x0004	User logic checksum error
DSCRDISAB	0x0002	Discretes disable error
BADCONFIG	0x0001	Bad configuration

Customer Service & Technical Assistance

Modicon telephone numbers are:

- To call us from anywhere in North America except from within the state of Massachusetts:

1–(800)–468–5342

- To call us from within Massachusetts or from outside North America:

1–(508)–975–5001

Customer Service – When calling the Modicon 5001 telephone number, ask for service from the list below.

When calling the 800 number, you will get a recording asking you to enter a one digit code for the type of service you want (listed below). However, this only works with a Touch–Tone™ phone. If using a dial phone, hang on and the operator will intercept after a short pause.

The service categories – and *extra digit* code responses for push–button phones – are:

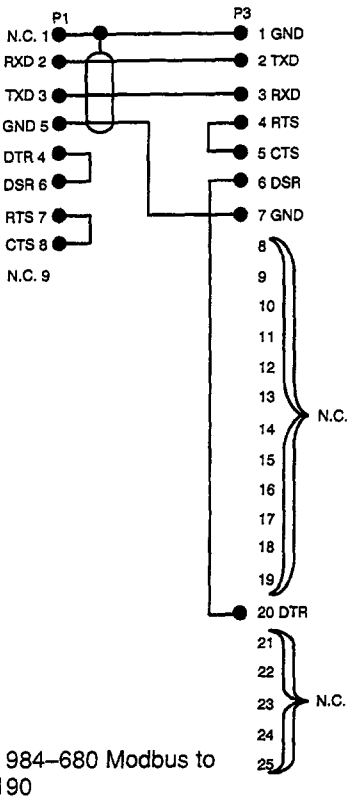
"1" – Hardware or software technical support

"2" – Order entry, buying hardware or software

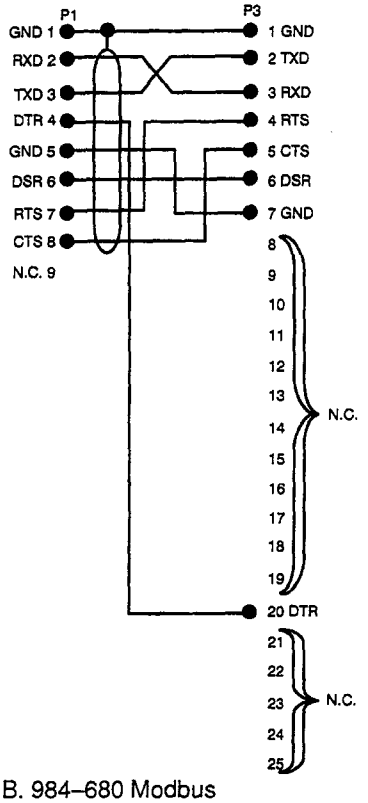
"3" – Return/exchange status inquiries

"4" – Training/course registration inquiries

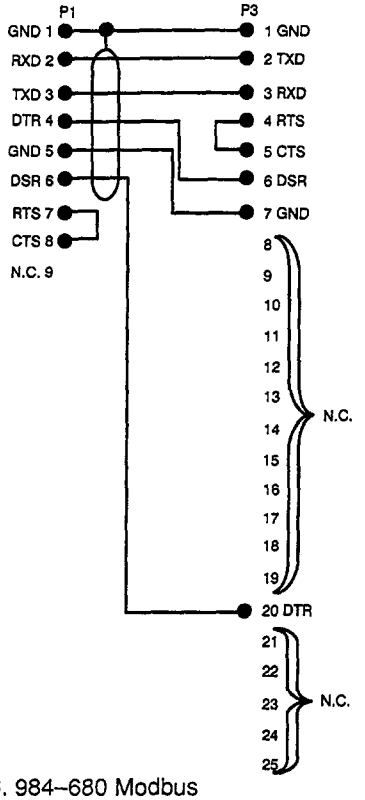
"5" – General information other than above.



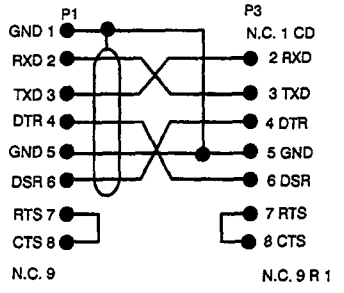
A. 984–680 Modbus to P190 (AS–W953–000)



B. 984–680 Modbus Connector to Modem (AS–W956–000)



C. 984–680 Modbus Connector to Null Modem (IBM PC/XT)



D. 984–680 Modbus to IBM AT (AS–W956–000)

Figure 52 Modbus Cable Pinouts

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