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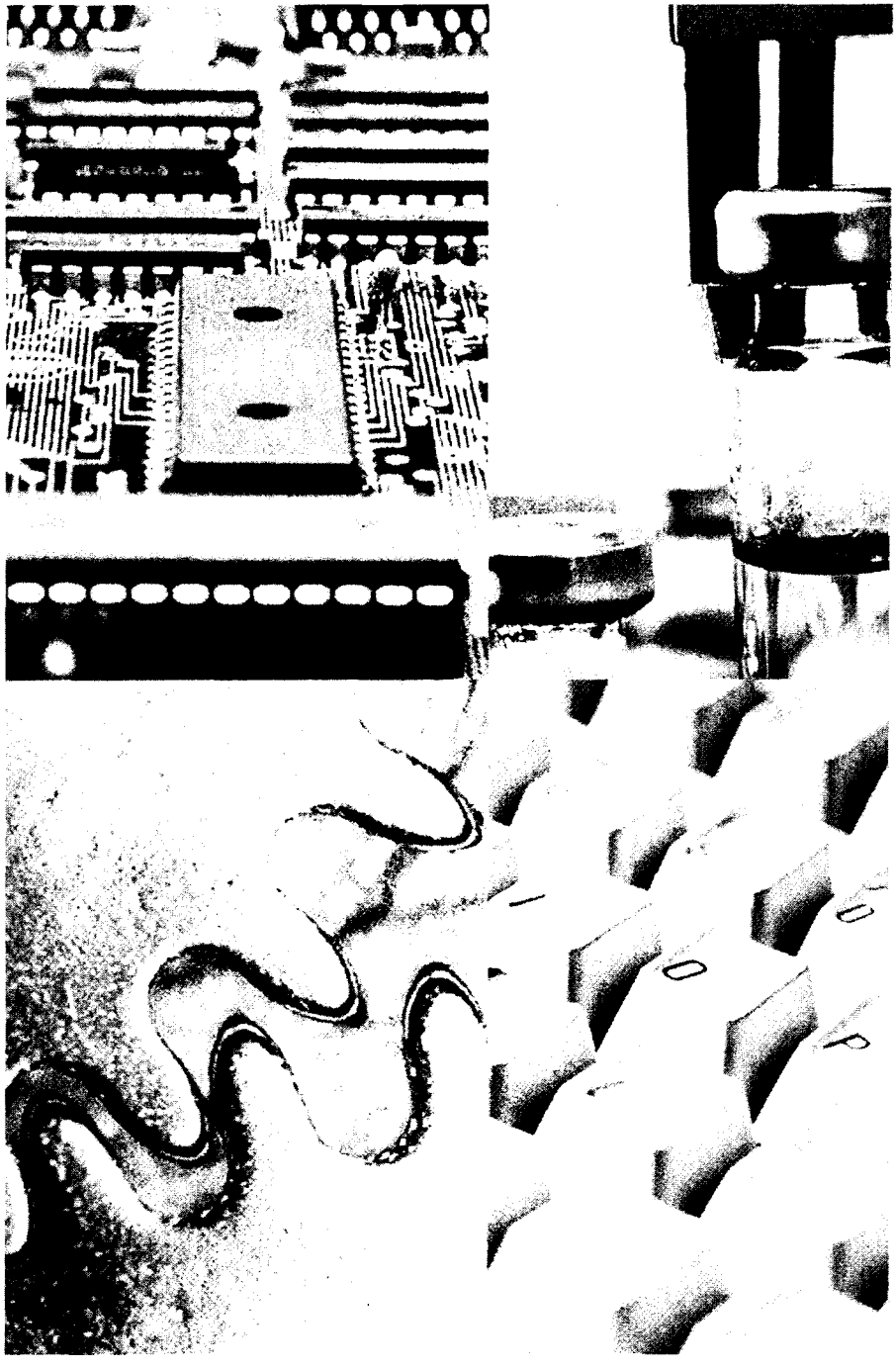
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Modicon S985 Modbus Plus Network Adapters Installation and Programming Manual

GM-S985-001 Rev. C



GROUPE SCHNEIDER

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Modicon S985 Modbus Plus Network Adapters Installation and Programming Manual

GM-S985-001 Rev. C

June, 1992

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Chapter 1
The S985 Modbus Plus Network Adapters

- Establishing/Expanding Modbus Plus Capabilities in 984 Controllers
- The S985 Network Adapters
- S985 Hardware and Software Compatibility
- Using Two S985 Cards in a Chassis Mount Controller
- Using Two S985 Cards in a Slot Mount Controller

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1.1 Establishing and Expanding Modbus Plus Capabilities in 984 Controllers

The S985 Network Adapters are option modules for the 984A/B/X chassis mount Controllers and the 984-685/-785 slot mount Controllers. They are designed to provide these controllers with dual-port (redundant) Modbus Plus network communication capabilities. In the case of the A, B, and X Controllers—which were designed before the advent of Modbus Plus—the S985 option provides an access point to the Modbus Plus network. In the case of the -685 and -785 Controllers—which currently have on-board Modbus Plus ports—the S985 option allows you to expand Modbus Plus networking capabilities with dual-port redundancy and with the ability to establish additional node addresses (on the same or on different Modbus Plus networks) within a single controller.

1.1.1 Establishing a Node Address on Modbus Plus

Modbus Plus is a local area network designed for industrial control applications that enables devices such as the programmable controllers, host computers, and other industrial automation devices to communicate as peers in a work environment. Modbus Plus uses a proprietary protocol that delivers high performance intercommunication at a data transfer rate of 1 Mbit/s.

A Modbus Plus network can comprise one or more communication sections; multiple sections on a network are linked by RR85 Repeaters. A section can support up to 32 peer devices—or *nodes*—and a network can support up to 64 nodes across all its sections:

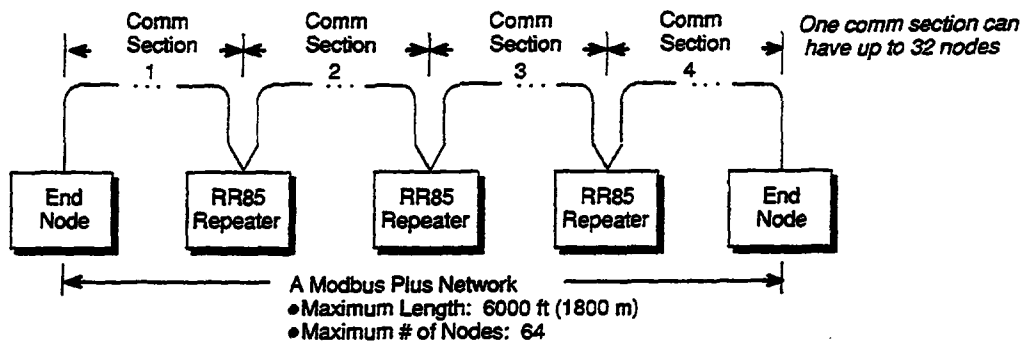


Figure 1 Linear Configuration of One Modbus Plus Network

Each node functions as a peer on a logical ring, gaining access to the network upon receipt of a token frame. The token is a bit grouping that is passed in a rotating address sequence from one node to the next. While an individual node holds the token, it may initiate data read/write and statistical transactions with other nodes; when the node passes its token, it may write to a global database that is maintained by all nodes on the network. Use of this global database allows rapid updating of alarms, set points, and other data.

Each node within a single network must have a unique address number in the range 1 ... 64. The node address of a 984 controller is specified using a set of DIP switches provided on the S985 board (and, in the case of slot mount controllers with built-in Modbus Plus capabilities, on the controller modules themselves). For a detailed description of node addressing, see Chapter 3.

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Separate Modbus Plus networks can be interconnected via BP85 Bridge Plus devices:

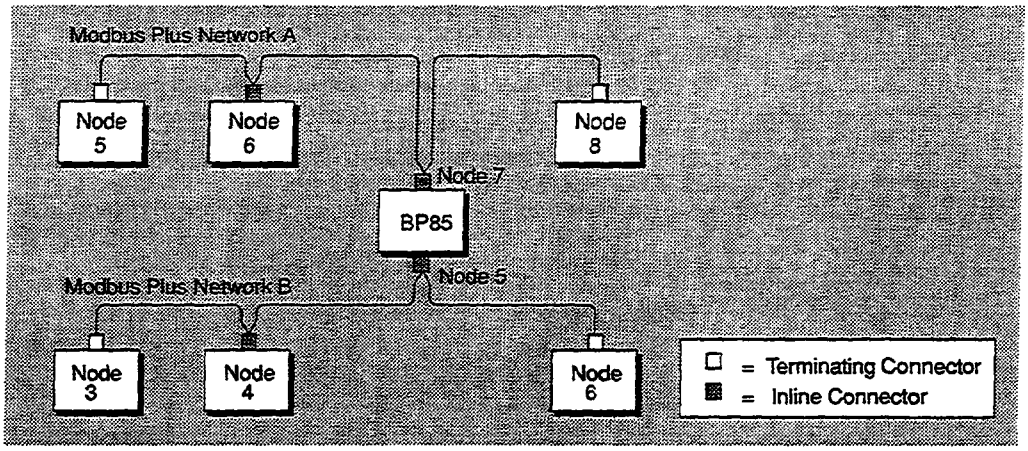


Figure 2 Multiple Networks Linked by Bridge Plus

1.1.2 S985 Software Requirement

A programmable controller with Modbus Plus capability may initiate network communication using a ladder logic function called MSTR. MSTR allows you to specify the type of communications transaction you want to carry out and to define the routing path on which the transaction will take place. The functional capabilities of the MSTR block are described in detail in Chapter 4.

The MSTR block is provided as a *loadable* software package (SW-AP9X-MBP) for use in a 984A/B/X Programmable Controller with the S985 Adapter. It is available on 3.5 inch and 5.25 inch diskette (PG-DIBM-225) for a P230 or suitable Personal Computer used as a programming panel and on P190 tape (PG-T984-225). S985 hardware and software must be ordered separately.

The MSTR block is part of the *standard* Executive package in the 984-685/-785 Programmable Controllers.

☞ **Note** In order to thoroughly understand Modbus Plus theory of operations, to be able to plan the layout of the total network, and to meet all the requirements of the network cable installation, refer to ***Modicon Modbus Plus Network Planning and Installation Guide*** (GM-MBPL-001).

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1.2 The S985 Network Adapters

The S985 dual-port Modbus Plus Adapter cards are provided in two form factors—the AM-S985-0X2 for 984A/B/X chassis mount Controllers, and the AM-S985-800 for 984-685 and 984-785 slot mount Controllers.

1.2.1 Hardware Overview

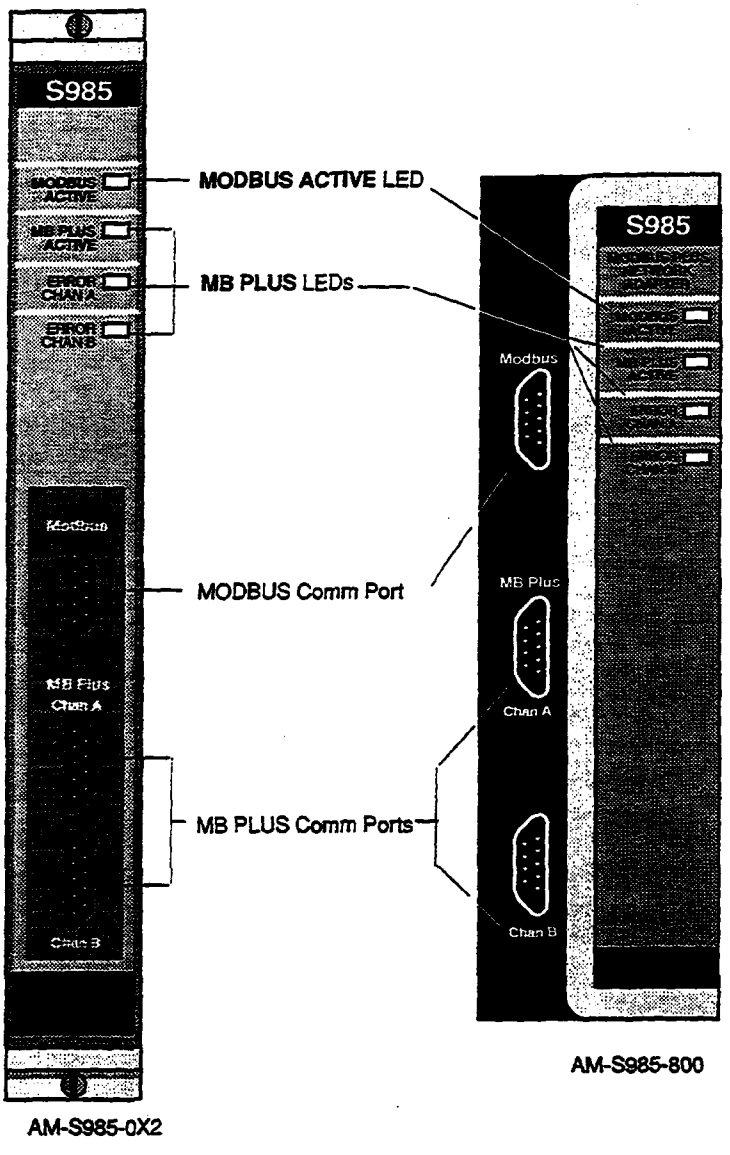


Figure 3 The S985 Option Modules—A Front View

An AM-S985-0X2 module can be inserted in a single option slot in a seven-slot or four-slot chassis. Both the chassis configurations can support either one or two S985 cards, with the potential for redundant node addresses on one or both of the cards.

An AM-S985-800 module can be inserted in a single slot in a primary housing. This slot mount configuration can support either one or two S985 cards—with the potential for redundant node addresses on one or both of the cards—along with the native Modbus Plus address.

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1.2.2 S985 Module Comm Ports

Both S985 Modbus Plus Network Adapter models have two nine-pin D-connector Modbus Plus ports, which can be used to establish *redundant* connectivity to a single Modbus Plus network. These ports handle identical versions of all inbound and outbound network transactions, and they can keep track of the program and data paths used for these transactions.

The S985 Adapters also each have one nine-pin *Modbus* serial port (see Appendix A for pinouts). A bridge mode capability inherent in the S985 permits a Modbus master device connected to this Modbus port to access nodes on the Modbus Plus network. It also allows a Modbus master device to access the *local* 984 controller directly—without having to go out to the Modbus Plus network.

1.2.3 S985 Module LEDs

The four LEDs on the front panel display the status of the comm ports:

MODBUS ACTIVE
This green LED flashes for a split second at powerup to indicate that the S985 has passed its confidence tests. It stays ON steadily for the duration of any message reception on the Modbus port; if the message packet received is bad, the LED still goes ON but the S985 does not respond.

If the S985 detects an error condition that prevents communication at either of its ports, it shuts off the ports and flashes an error code pattern on the **MODBUS ACTIVE** LED.

☞ **Note** The programmable controller must be power cycled in order to reset the S985.

MB PLUS ACTIVE
This green LED also indicates the current communication status at the Modbus Plus port by flashing one of the following repetitive patterns:

- **Six flashes/s**—The node is on the network, handling messages and tokens normally.
- **One flash/s**—The node is offline just after being powered up or after exiting the *four-flash* mode (described below); the node monitors the network and builds a table of active and token-holding nodes. It remains in this state for 5 s, then attempts to go back into the normal operating state.
- **Two flashes, then OFF for 2 s**—The node is offline because it hears the token being passed among other nodes but is not receiving the token. Check the network link for an open or short circuit or a defective termination.
- **Three flashes, then OFF for 1.7 s**—The node is offline because it is not hearing any other nodes; it periodically claims the token but cannot find a peer to which it can pass it. Check the network link for an open or short circuit or a defective termination.
- **Four flashes, then OFF for 1.4 s**—The node is offline because it has received a message from another node with its node address (duplicate addresses are illegal!); the node remains in this state as long as it hears the duplicate address. If the duplicate address is not heard for five seconds, the node's LED changes two a *one-flash* pattern.

ERROR CHAN A and ERROR CHAN B
If an S985 detects an error condition on either of its two redundant Modbus Plus connections, the LED for the problematic channel flashes.

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1.3 S985 Hardware and Software Compatibility

An S985 Modbus Plus Network Adapter card is compatible with any Remote I/O Processor that functions in the associated controller type and with several other controller option cards provided that the cards are updated to current revision levels. When two S985 cards are used in a controller, certain additional usability restrictions may occur as described below.

1.3.1 Controller Executive Requirements

An S985 module requires that the Executive PROMs in the host 984 controller be at the most current revision level. The 984-685/-785 slot mount Controllers are shipped with the proper PROMs already installed; Executive cartridges at the proper revision level are linked to the S985-0X2 boards and shipped for installation in currently fielded 984A and 984B chassis mount Controllers. If you add a second S985-0X2 card to a controller 984A or 984B configuration that currently contains one S985-0X2, verify the minimum revision levels of your components with Modicon Customer Service.

If you are installing an S985-0X2 card in a currently fielded 984X Controller, you must upgrade the S929 Multioption Processor before you can connect to the Modbus Plus network. To arrange an S929 upgrade, contact Modicon Order Entry at 1-800-468-5342 or at 1-(508)-975-5001.

1.3.2 Power Supply Requirements

There are no power supply restrictions on the use of S985-800 cards in a 984-685/-785 slot mount Controller. The power supply requirements for the S985-0X2 card in a chassis mount controller are determined by the overall number of option modules used in the chassis.

For a 984A or 984B Controller in a seven-slot chassis, a P930 Power Supply module can handle the power requirements of a basic configuration (C921 Comm Processor, C916-100 or C924 CPU, S908 RIO Processor, and M907 or M909 Memory) along with an optional S978 Dual Modbus Modem and one S985-0X2 Modbus Plus Adapter. If your 984A or 984B Controller includes two S985-0X2 cards or an S985-0X2 with any other option module except the S978, use a P933 Power Supply. A P933 can support any three chassis mount option modules as well as the basic controller configuration.

For a 984X Controller in a four-slot chassis, a P930 power supply module can support the basic configuration (S929 Multioption Processor and C916-120 CPU) along with any two chassis mount option modules, including one or two S985-0X2 cards.

1.3.3 Using Modbus Plus Adapters with Coprocessor Option Modules

There are no constraints on the use of one or two S985-0X2 Modbus Plus Adapters with a C986 Coprocessor in a chassis mount controller.

There are no constraints on the use of one S985-800 Modbus Plus Adapter with either one or two C996 Coprocessors in a 984-685/-785 slot mount Controller. The only constraint on the use of the C996 with S985-800 cards occurs when the C996 uses Modbus communications—in this case, a second S985-800 option card cannot be used.

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straint on the use of the C996 with S985-800 cards occurs when the C996 uses Modbus communications—in this case, a second S985-800 option card cannot be used.

To assure compatibility between S985 and coprocessor modules in a controller configuration, the PROM combination on the appropriate coprocessor module should be at the most current revision—for current information contact Customer Support at 1-800-468-5342 or at 1-(508)-975-5001.

1.3.4 Using Modbus Plus with Other Networks

S985 option modules may be used in conjunction with Modbus, Modbus II, or MAP option modules.

One or two S985s may be used together with a Modbus network modem in both the chassis mount and slot mount controller configurations without any conflicts between devices or networking operations.

One S985 card may be used together with an S975 Modbus II Network Adapter or an S980 MAP Network Adapter in a controller configuration as long as the jumper settings on the S985 card are set for a single S985 (see Figure 4 for the chassis mount location and Figure 5 for the slot mount location). Two S985s cannot coexist with an S975 or an S980 in the same controller configuration.

1.3.5 Using Modbus Plus in a Hot Standby System

When two programmable controllers are connected in a Hot Standby system, Modbus Plus sees each controller as a separate address on the network, even though the two address switch settings are the same. Because Modbus Plus treats the two Hot Standby controllers as distinct nodes on the network, the application is able to interrogate either controller independently in order to acquire statistics. If switchover occurs, the node addresses of the primary and standby controllers are exchanged, thereby maintaining addressing consistency within the application.

When switchover occurs, the ring collapses and needs to be reconstituted. Reconstitution can take more than 12 s, and therefore you should not allow the application to time out for a delay longer than this—because of other latencies, the minimum timeout should be $\geq$ 15 s.

The two 984 controllers in the Hot Standby system must be identically configured. Therefore, if you are using S985 adapters with each controller, the Modbus Plus Addressing DIP switches on both units must be set to the same node address—in the address range 1 ... 64 (see Chapter NO TAG for details). The network will treat each controller as a separately addressed node offset from the other by 32 addresses. The primary controller is always treated as the address physically set by the DIP switches, and the standby controller is always seen as the node offset by $\pm$32.

For example, if you set the DIP switches on the two S985s to address 6, Modbus Plus will treat the primary controller as node 6 and the standby controller as node 38. If, on the other hand, you set the DIP switches on the two S985s to address 38, Modbus Plus will treat the primary controller as node 38 and the standby controller as node 6.

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Caution **If you are using Hot Standby controllers in a Modbus Plus network, remember that not only the address assigned via DIP switches to the primary controller must be reserved, but that the 32-address offset for position for the standby controller must also be reserved. Assigning the offset address to any other physical node on the network will result in duplicate addresses, which are illegal on Modbus Plus.**

The two Hot Standby controllers must be running before they are physically connected to a Modbus Plus network.

Caution **If a switchover occurs during a Modbus Plus transmission to the primary controller, as many as two Modbus Plus messages could be lost—the Hot Standby application should be written to take this into consideration. (The *old* primary is no longer on the network, and the *new* primary did not get the message.)**

There is a 4 ms delay between the programmable controller and the S985 due to the bus structure. As a result, it is possible for both the primary and secondary controllers to be momentarily at the primary address during switchover. The error `Invalid Address` or `Invalid Command` may be seen on an attached programming panel using a PS path.

To assure compatibility with the S985, the PROM combination on the S911 Hot Standby modules should be at the current revision level—for current information contact Customer Support at 1-800-468-5342 or at 1-(508)-975-5001.

1.3.6 Downloading Executive Firmware to NVRAM via an S985

Some 984 programmable controllers, including the E984-685 and the E984-785, store their Executive firmware in an upgradable portion of nonvolatile memory (NVRAM) resident in the controller. This firmware can be upgraded via a software upgrade utility provided through Modicon Customer Service. The utility can download firmware over Modbus or Modbus Plus. The utility cannot, however, download across the controller's backplane—this means that if you download Executive firmware through an S985-800 Adapter, you can upgrade firmware to remote controllers on the Modbus Plus network but you cannot upgrade the host controller through its S985.

Contact Customer Service for more information about this NVRAM utility.

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1.4 Using Two S985-0X2 Cards in a Chassis Mount Controller

If two S985-0X2 cards are installed in available option slots in the same chassis mount controller, the following potential advantages accrue:

- The controller can act as a central database accessible by two separate Modbus Plus networks
- The controller can establish redundant connections the Modbus Plus network(s)
- The controller can support up to eight active MSTR elements at the same time—all on the same network or four on each of two networks
- The controller can support two Modbus-to-Modbus Plus bridge connections

1.4.1 Using the Jumper Block to Indicate Device Addresses

An S985-0X2 is shipped with a jumper block installed (see Figure 4) to determine the buffer space it can use for transactions. Leave this jumper in position if you are using only one S985 with the host controller. Remove the jumper in one of the two units if you are using two S985s with the host controller—if the jumper has been removed from one of the S985s, the host controller does not support a Modbus II option card.

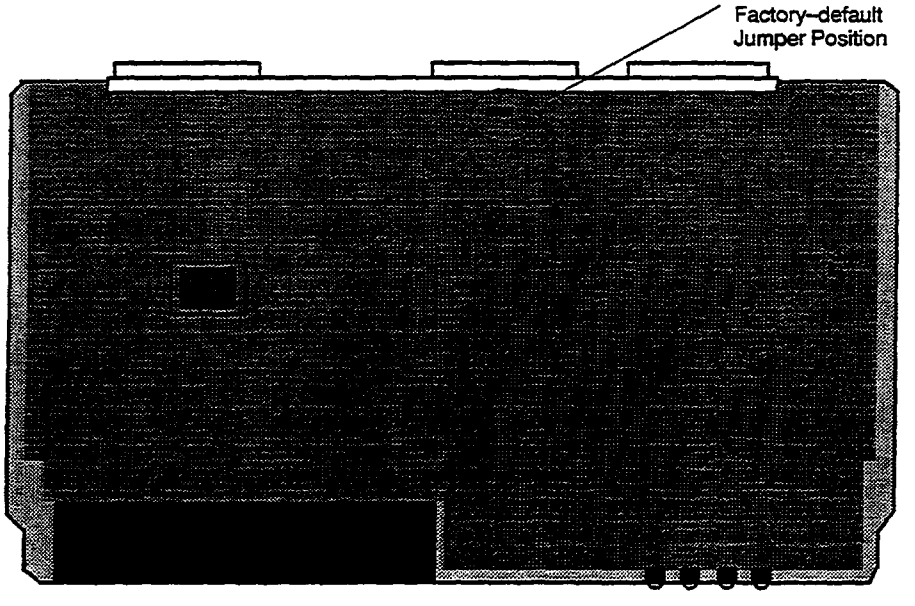


Figure 4 Location of the Jumper Block on the S985-0X2 Card

1.4.2 Addressing the Two Modbus Plus Nodes

The two S985-0X2 cards must have different Modbus Plus node addresses if the two devices are to act as nodes on the same network. The two cards may have the same or different Modbus Plus node addresses if they are connected to two different networks. For more node addressing details, refer to Section 3.2.

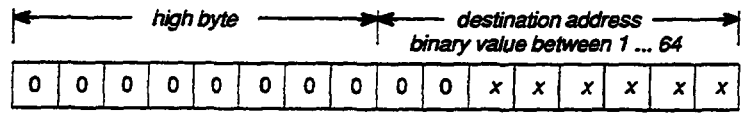
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1.4.3 Identifying Two Modbus Plus Nodes in an MSTR Control Block

In your ladder logic program, a loadable MSTR instruction transfers blocks of 4*x* registers from the controller's state RAM into one of the two S985 destination nodes on the Modbus Plus network. The address of the destination node is defined by a routing path in the MSTR control block.

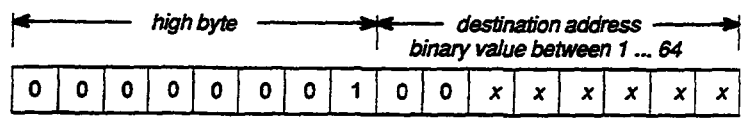
The top node in the MSTR function block is the first of nine consecutive 4*x* registers in the MSTR *control block*. The fifth register in the control block is the *routing register*—e.g., if the register displayed in the top node of the MSTR block is 400001, then the routing 1 register would be 400005. The value in the high byte of this register determines which of the two S985-0X2 cards is the destination node for a particular Modbus Plus transaction.

If the value of the high byte in the routing 1 register is 0:



then the destination node for the Modbus Plus transaction is the S985-0X2 card with the jumper installed.

If the value of the high byte in the routing 1 register is 1:



then the destination node for the Modbus Plus transaction is the S985-0X2 card with the jumper removed.

If for any reason the destination-node address specified in the registers is incorrect, Modbus Plus function error code `F001`—`Wrong s985 Routing Requested`—is shown. For a detailed description of the entire MSTR function block, see Section NO TAG.

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1.5 Using Two S985-800 Cards in a Slot Mount Controller

If two S985-800 cards are installed in available option slots in the same 984-685/-785 slot mount controller, the following potential advantages accrue:

- The controller can act as a central database accessible by three separate Modbus Plus networks (the two connections provided by the adapter cards plus the Modbus Plus capability resident in the 984-685/-785 board itself)
- The controller can establish redundant connections on two of the three Modbus Plus networks
- The controller can support up to twelve active MSTR elements at the same time on each of one, two, or three networks
- The controller can support three Modbus-to-Modbus Plus bridge connections

1.5.1 Using the Jumper Blocks to Indicate Device Addresses

An S985-800 is shipped with jumper blocks installed in two of four possible locations (see Figure 5) to indicate the device address—i.e., the buffer space used for transactions. Leave the two jumpers in the default positions shown below if you are using only one S985 or if it is the first of two S985s used with the host controller. Move the jumpers to the alternate positions shown below if the unit is the second of two S985s used with a host controller—when the alternate jumper positions are used, the controller does not support the Modbus II option card.

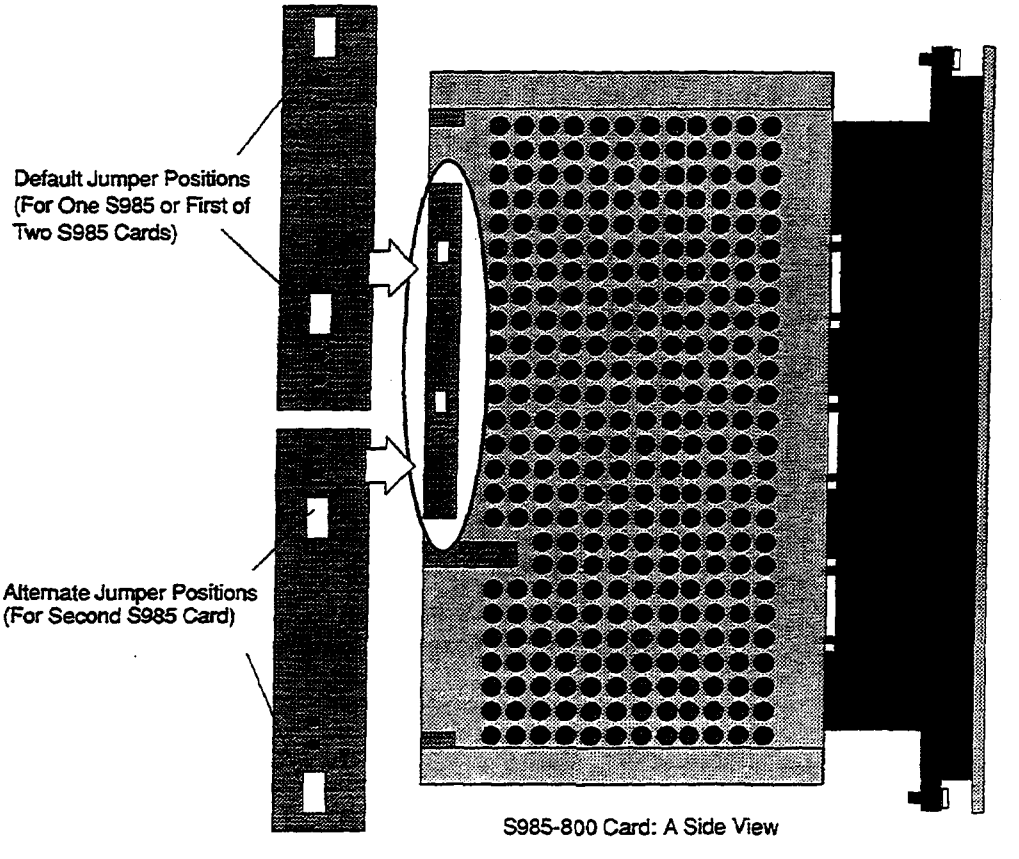


Figure 5 Two Areas of Detail Showing Alternative Jumper Positions on an S985-800 Card

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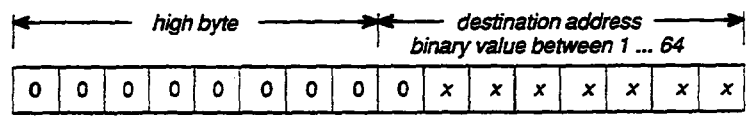
Caution The two jumper positions shown above are the only legal positions for S985-800 operations. Other positioning combinations of the two jumpers constitute illegal device addresses and prohibit the adapter from functioning properly.

1.5.2 Identifying Three Modbus Plus Nodes in an MSTR Control Block

In your ladder logic program, a standard MSTR instruction transfers blocks of 4*x* registers from the controller's state RAM into one of the three possible Modbus Plus destination nodes—the on-board Modbus Plus port on the controller itself or the dual port available on either of two possible S985-800 cards. The address of the destination node is defined by a routing path in the MSTR control block.

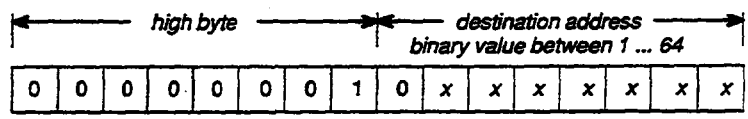
The top node in the MSTR function block is the first of nine consecutive 4*x* registers in the MSTR *control block*. The fifth register in the control block is the *routing register*—e.g., if the register displayed in the top node of the MSTR block is 400001, then the routing 1 register would be 400005. The value in the high byte of this register determines which of the two S985-800 cards is the destination node for a particular Modbus Plus transaction.

If the value of the high byte in the routing 1 register is 0:



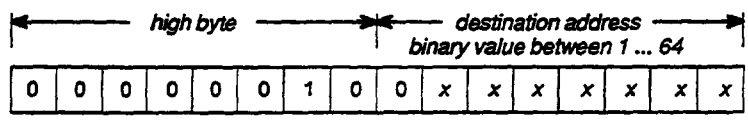
then the destination node for the Modbus Plus transaction is the on-board Modbus Plus port on the 984-685/-785 Controller.

If the value of the high byte in the routing 1 register is 1:



then the destination node for the Modbus Plus transaction is the S985-800 card with the jumpers set to the default positions (see Figure 5).

If the value of the high byte in the routing 1 register is 2:



then the destination node for the Modbus Plus transaction is the S985-800 card with the jumpers set to the alternate positions (see Figure 5).

For a detailed description of the entire MSTR function block, see Section 4.1.

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Chapter 2
S985 Communication Capabilities

- The Bridge Between Modbus and Modbus Plus
- Understanding Modbus Plus Address Routing Schemes
- Modbus Plus Communication Paths
- Modbus Plus Message Queuing

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2.1 The Bridge Between Modbus and Modbus Plus

Both versions of the S985 Modbus Plus Adapter provide a standard Modbus serial port, as shown in Chapter 1. This port acts as a bridge, allowing a Modbus master device to attach to a Modbus Plus node; the Modbus device may attach to the local (984A/B/X or 984-685/-785) Controller or to any other node on the Modbus Plus network by using the node's Modbus Plus address. The Modbus bridge mode functionality is for connection of a single Modbus Master device only.

2.1.1 Setting Modbus Port Communication Parameters

There are three communication parameters to be selected for a Modbus port:

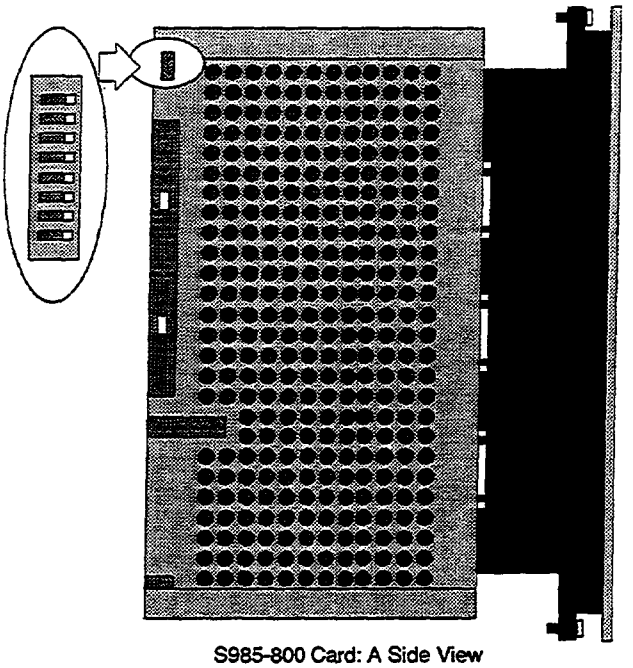
- *Communication mode*—the protocol (or bit structure) of the message transmissions. The choices are ASCII or RTU (Remote Terminal Unit). In ASCII mode a Modbus port handles messages composed of bytes containing one start bit, seven data bits, one parity bit, and two stop bits. RTU mode packs data bits more compactly to increase speed—in this mode a Modbus port handles messages composed of bytes containing eight data bits and either one parity bit and one stop bit or no parity bits and two stop bits.
- *Baud*—the data transmission speed, measured in bits/s. The default baud is 9600.
- *Parity*—a method of verifying the accuracy of a data transmission, using one bit in the message to make the sum of the 1-bits even or odd.

If you are using an S985-002 card in a 984A/B/X chassis mount Controller, the communication parameters are set in the configurator editor in panel software. If you are using just one S985 card in the controller, leave the factory-installed jumper block(s) in place and set the desired communication parameters for this card as the parameters for comm port #2. If you are using two S985 cards, adjust the jumper settings (see Section 1.4 for the S985-002 or Section 1.5 for the S985-800) on one of the cards and set the desired communication parameters for this card as the parameters as comm port #3; leave the default jumper settings intact in the other card and set its parameters as comm port #2.

The actual physical comm port(s) in the host controller will be overridden by software and cannot be used when the S985 option(s) are installed.

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If you are using an S985-800 card in a 984-685/-785 slot mount Controller, the Modbus port communication parameters are set via a DIP switch located as shown in Figure 6:



S985-800 Card: A Side View

Figure 6 DIP Switch Location for Modbus Port Parameters on an S985-800 Card

The communication parameters can be set as follows:

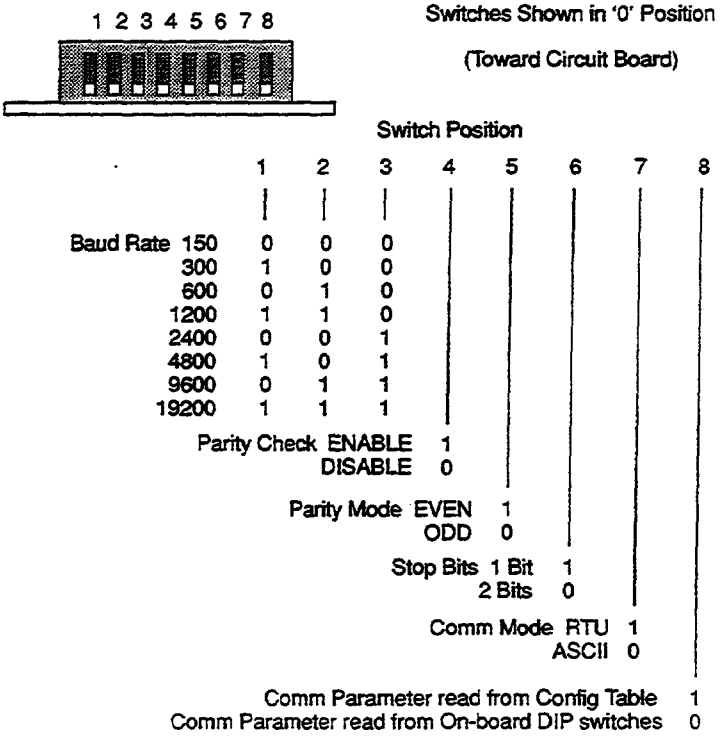


Figure 7 Modbus Port Comm Parameter Settings on the S985-800 DIP Switch

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2.1.2 Attaching to a Modbus Plus Node via Bridge Mode

When a Modbus master device is connected to the Modbus port in an S985 Adapter, . can be attached to the local (host) controller or to any other node on Modbus Plus. When you attach to the host controller, messages from the Modbus master are sent directly to the host without being routed over a Modbus Plus communication path. When you attach to any other node on the network, the message is routed through the Modbus Plus port(s) to the destination device.

☞ **Note** When you are connecting a Modbus master device to a node on Modbus Plus—including the host controller—always use the desired node's Modbus Plus address.

⚠ **Caution If you are accustomed to using Modbus master devices (such as programming panels) with Modicon programmable controllers in un-networked environments, you may be used to attaching to the local controller by addressing it as device #1—the default device address in the configurator editor. Be aware that in a Modbus Plus network environment you *must know* the Modbus Plus address of the node with which you want to communicate and you *must specify* that address correctly in the attach procedure.**

If you want to attach to a node on Modbus Plus but do not know its network address, get this information from your network supervisor before proceeding.

☞ **Note** Once you have completed the connection, remember to log out of the programming panel—the process of making the connection uses a Program Master (PM) path that will not be released until you log out.

2.1.3 Addressing Ranges on Modbus Plus

A single Modbus Plus network can have up to 64 addressable nodes, each with a unique address in the range 1 ... 64 (see Figure 15 in Chapter 3 for address settings). The Modbus master device connected to the Modbus port on the S985 can attach to any one of these nodes using *direct attach address* routing, simply by specifying the correct address in the range 1 ... 64.

Multiple networks can be joined by via two or three Modbus Plus connections in a single controller or via BP85 Bridge Plus devices. When networks are joined, nodes across the multiple networks can be addressed. In these cases, you will require an addressing capability outside the 1 ... 64 range. Two address routing strategies, *explicit* and *implicit attach address* routing, are available in Modbus Plus. These routing techniques are described in the following section.

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2.2 Understanding Modbus Plus Address Routing Schemes

Modbus devices use addresses of one byte in the range 1 ... 255. Modbus Plus devices are addressed in the range 1 ... 64, with five consecutive routing bytes contained in each message. When a Modbus message is received at the Modbus port on an S985 Adapter, the single-byte address contained in the message is converted into a five-byte routing path for Modbus Plus. The five bytes of routing are imbedded in a Modbus Plus message frame as it is sent from the originating node.

2.2.1 Destination Device Requirements

The structure of the Modbus Plus routing address is determined by the type of device at the destination node:

- If you are initiating a transaction with another 984 controller, the last (rightmost) nonzero byte in the routing scheme is the destination node address
- If you are initiating a transaction with a network adapter in a non-controller node—e.g., an SA85—the next to the last nonzero byte is the destination node address, and the last nonzero byte is the task # (range: 1 ... 8)
- If you are initiating a transaction with a single slave on a Bridge MUX port, the next to the last nonzero byte is the Bridge MUX node address, and the last nonzero byte is the desired MUX port # (range: 1 ... 4)
- If you are initiating a transaction with a slave device on a Modbus network connected to a Bridge MUX, the second from the last nonzero byte is the node address of the MUX, the next to the last nonzero byte is the desired MUX port # (range: 1 ... 4), and the last nonzero byte is the desired Modbus slave address (range: 1 ... 247)

Any leading nonzero bytes ahead of the address bytes described above are Bridge Plus node addresses.

Assume, for example, that your routing path is to a controller two networks removed from the originating 984. The message is routed first to a BP85 Bridge Plus at node address 25. The bridge forwards the message to node 20, a BP85 Bridge Plus device on the second network. Node 20 forwards the message to the destination controller node address 12 on the third network. The zero-content bytes in the fourth and fifth routing bytes specify that further routing beyond the third byte is not required:

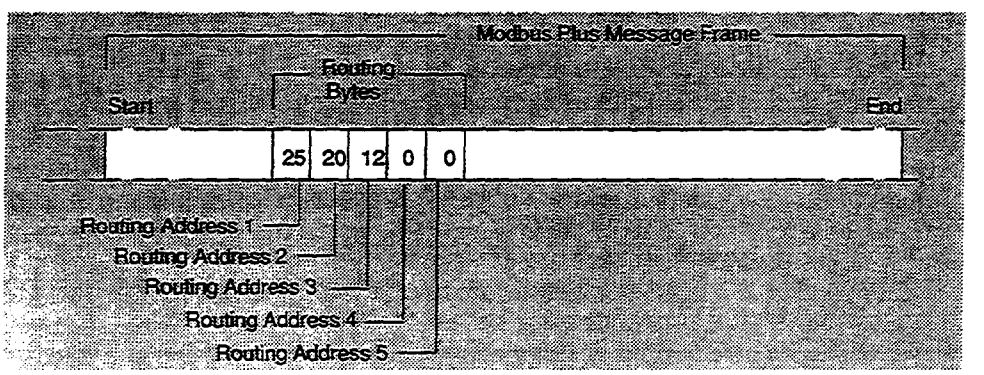


Figure 8 An Example of a Message Frame Routing Path

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☞ **Note** The routing address scheme must be developed as part of an overall network planning process—for details, see ***Modbus Plus Network Planning and Installation Guide***, GM-MBPL-001.

2.2.2 Bridge Mode Addressing

The manner in which Modbus Plus converts a Modbus message using bridge mode is determined by the range of the Modbus address (1 ... 255):

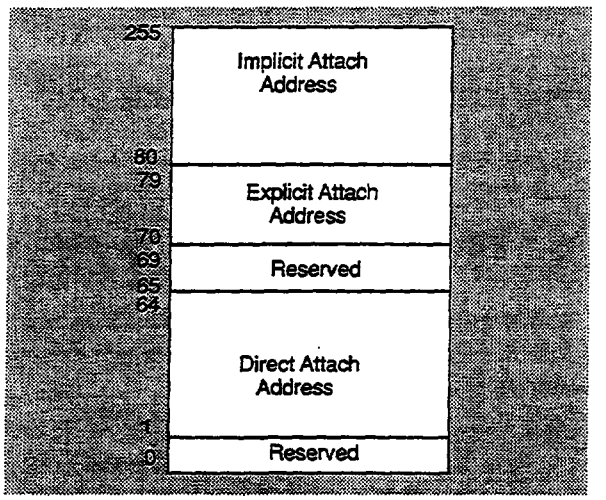


Figure 9 Modbus-to-Modbus Plus Address Conversion

If the address range in the Modbus message is between 1 ... 64, the message is routed to the corresponding Modbus Plus node address on the local network. This routing procedure is called *direct attach address*. Direct attach address routing implies that a nonzero value exists in only routing address 1 in the Modbus Plus message frame; it does not allow you to send the incoming Modbus message beyond the local network.

If the address range in the Modbus message is between 70 ... 79, the S985 initiates an *explicit attach address* procedure which compares the Modbus address to an address table stored in the controller. Up to 10 addresses in the range 70 ... 79 become pointers to the table, which contains up to 10 stored routing paths for Modbus Plus. Each routing path is five bytes in length. The routing path pointed to by each address is applied to the corresponding message. Explicit attach address routing implies that nonzero values may exist in any or all routing addresses in the Modbus Plus message frame; it allows you to send incoming Modbus messages through as many as four BP85 Bridge Plus devices across as many as five Modbus Plus networks—for details, see ***Modbus Plus Network Planning and Installation Guide***, GM-MBPL-001.

☞ **Note** Within the controller, the routing path table is programmed in a group of 4*x* registers located immediately after the Timer Register in User Logic.

If the address range in the Modbus message is between 80 ... 255, the S985 initiates an *implicit attach address* procedure which divides the address by 10 and uses the quotient and remainder as the first and second bytes, respectively, in a routing path. Implicit attach address routing implies that there may be nonzero values in routing addresses 1 and 2 in the Modbus Plus message frame; it allows you to send incoming Modbus messages through one BP85 Bridge Plus device across up to two Modbus Plus networks.

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2.3 Modbus Plus Communication Paths

With multiple devices processing messages asynchronously on a Modbus Plus network, it becomes possible for an individual device to have several concurrent transactions in process. The S985 opens a communication path when a transaction begins, keeps it open during the transaction, and closes it when the transaction terminates. When the path is closed, it becomes available for another transaction.

2.3.1 Four Types of Communication Paths

An S985 Modbus Plus Adapter maintains four types of communication paths:

- *Data master paths*—For *read* and *write data* or *get* and *clear remote statistics* operations originated by a MSTR block in a 984 controller going to a destination device on the network. An S985 Modbus Plus Adapter allows the controller to support up to *five* data master paths—paths DM01 ... DM04 for processing up to four concurrent MSTR blocks, and path DM05 that may be used for data master transactions via the Modbus port. Design your application to use a maximum of four MSTR data master paths at any one time.
- *Data slave paths*—For data reads and writes received by the S985 from the network, which are then passed to the controller. An S985 allows the controller to support up to *four* data slave (DS) paths, and therefore handle up to four concurrent transactions over the Modbus Plus network.
- *Program master paths*—For sending programming commands from the host controller to the Modbus Plus network. Program master paths can handle all Modbus commands—i.e., function codes. When a Modbus master is connected to the Modbus port on the S985 card, it may be used for either programming or monitoring functions. An S985 supports *one* program master (PM) path.
- *Program slave paths*—For accepting programming commands received by the S985 from the network via the S985 Modbus Plus port. An S985 supports *one* program slave (PS) path.

Both the origination and destination devices open and maintain paths until the transaction completes. If the transaction passes through one or more Bridge Plus devices to access a destination across multiple networks, each bridge opens and maintains a path at each of its two network ports. Thus a logical path is maintained between the origination and destination devices until the transaction is finished.

All paths are independent of one another, and activity on one path does not affect the performance of the other paths.

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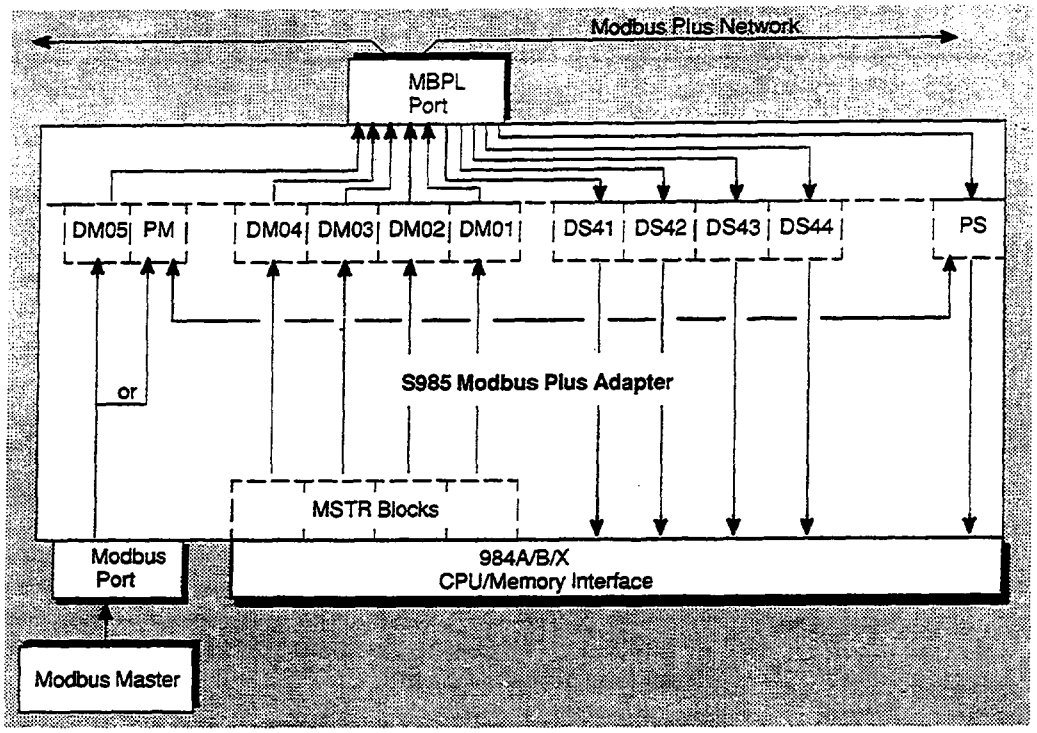


Figure 10 S985 Interface to a Modbus Plus Network

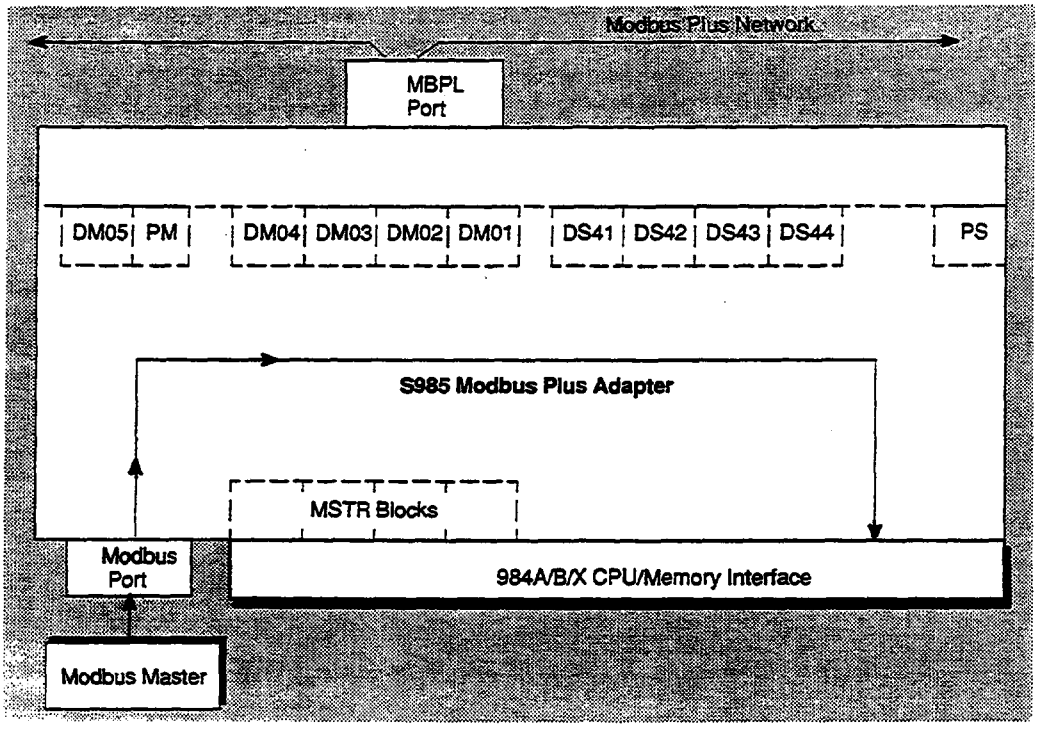


Figure 11 Direct Communication with the Local Controller via the S985 Modbus Port

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2.4 Modbus Plus Message Queueing

If all data slave paths are currently active in a device, the device queues additional transactions. These transactions remain queued until a data slave path becomes available, and then individual transactions are removed from the queue and given available paths. Queueing effects the timing in your application—the data response is not returned to your application until a full path (from origin to destination) is available.

BP85 Bridge Plus Queueing Messages that must pass through multiple bridges will be queued (if necessary) within the first bridge, but will not be queued within any subsequent bridges in the transaction path. Figure 12 shows an example.

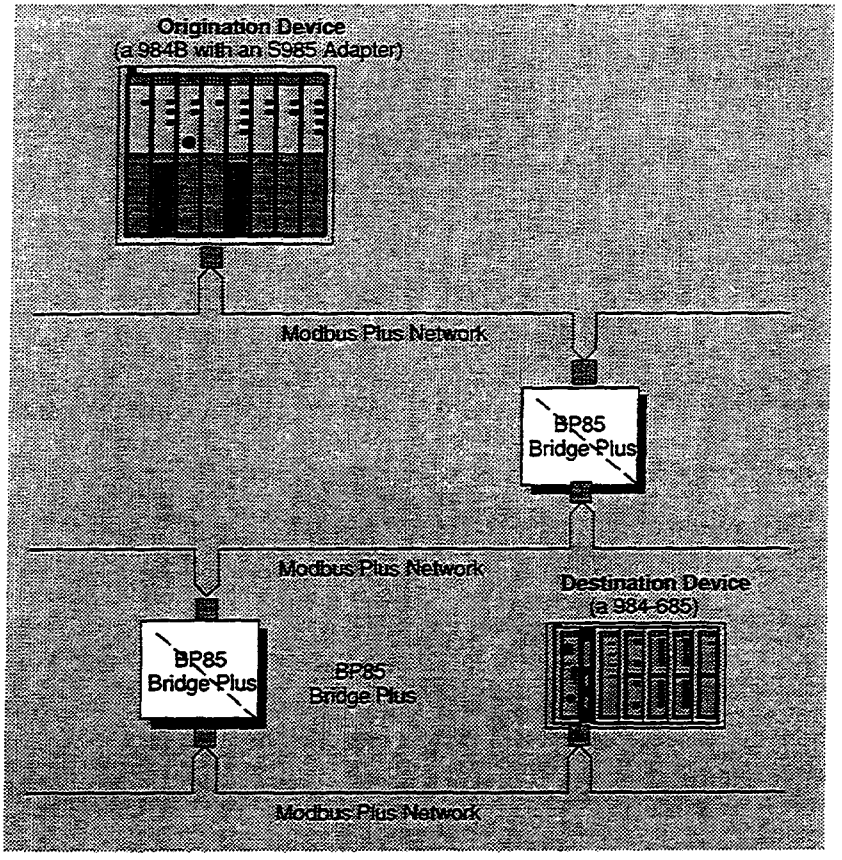


Figure 12 BP85 Bridge Plus Queueing

A message from the (origination) 984B Controller must pass through two Bridge Plus devices to reach the (destination) 984-685 Controller. If a path is not available in the first bridge, the message is queued and given a path when one is available. If the second bridge does not have a path when it receives the message, the message is not queued. An error code is returned from the bridge and can be tested by the application program in the originating controller.

Transactions are handled in this way to prevent excessive delays between requests and responses. This situation is caused by having large message loadings on the bridge, and it should occur only rarely.

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Chapter 3
Installing an S985 Adapter in a 984 Controller

- System Executive Requirements for Modbus Plus
- Setting the Modbus Plus Node Address
- S985 Hardware Installation
- S985 Software Loadable Installation
- MSTR Opcode Assignment Considerations
- Attaching the Modbus Plus Node Identification Label

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3.1 System Executive Requirements for Modbus Plus

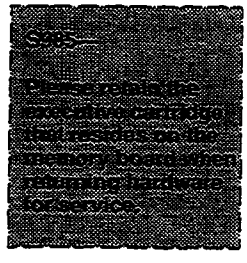
The first step in the installation procedure is to make sure that the system executive in the 984 controller is compatible with the S985 Modbus Plus Adapter module.

3.1.1 Executive Compatibility Requirements

If you plan to use an S985 Adapter in a 984 controller that does not currently contain another S985, the system executive in that controller may need to be upgraded, depending on the controller type. If you plan to install a second S985 Adapter in a 984 controller that currently contains one S985, you may also need to upgrade your system executive.

☞ **Note** Make sure that the system executive cartridge you are using is appropriate for the model of 984 controller and RIO processor and is at least to the minimum revision level listed on the READ-ME-FIRST sheet shipped with this document (GI-S985-RMF).

Executives that support Modbus Plus for the 984A and 984B chassis mount Controllers are shipped with the respective S985 module, and you can upgrade those controllers following the instructions given below. The new executive cartridges for the 984A and 984B Controllers are nonstandard and should be retained by you in the event that you return hardware to Modicon for service. They are shipped with a label; place the top portion of this label on the S985 board:



To establish a Modbus Plus capability in a currently installed 984X Controller, you must use an upgraded S929 Multioption Processor (model S929-005 or higher). Contact Modicon Order Entry to arrange for this upgrade.

3.1.2 Upgrading the Executive Cartridge in a 984A Controller

An *AM-S985-020* Upgrade Kit supports the S985 Modbus Plus upgrade for the 984A Controller with an S908 Remote I/O Processor; an *AM-S985-010* Upgrade Kit supports the S985 Modbus Plus upgrade for the 984A Controller with an S901 Remote I/O Processor. Both kits includes the AM-S985-000 Modbus Plus Adapter card and an appropriate S902 Executive cartridge (see GI-S985-RMF) to be installed in the M907 module.

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Installing an S902 Executive in the M907 Memory Module

Step 1 At the line power source, disable voltage to the 984A Controller.



Warning To help protect yourself and others against electric shock, open and padlock open all system power disconnect switches before making high voltage connections.

Step 2 Remove the black cover plate beneath the MEMORY PROTECT keyswitch on the M907 Memory module by unfastening the two Phillips screws at the top and bottom of the plate.

Step 3 Pull the current Executive Cartridge from its socket, then replace it with the new S902 Executive Cartridge.

Step 4 Resecure the cover plate on the M907 module with the two Phillips screws.

3.1.3 Upgrading the Executive Cartridge in a 984B Controller

An *AM-S985-040* Upgrade Kit supports a Modbus Plus upgrade for the 984B Controller with a S908 Remote I/O Processor; an *AM-S985-030* Upgrade Kit supports the S985 Modbus Plus upgrade for the 984B Controller with an S901 Remote I/O Processor. Both kits includes the AM-S985-000 Modbus Plus Adapter card and an appropriate S902 Executive cartridge (see GI-S985-RMF) to be installed in the M909 module.

Installing an S902 Executive in the M909 Memory Module

Step 1 At the line power source, disable voltage to the 984B Controller.



Warning To help protect yourself and others against electric shock, open and padlock open all system power disconnect switches before making high voltage connections.

Step 2 Remove the black cover plate beneath the MEMORY PROTECT keyswitch on the M909 Memory module by unfastening the two Phillips screws at the top and bottom of the plate.

Step 3 Pull the current Executive Cartridge from its socket, then replace it with the new S902 Executive Cartridge.

Step 4 Resecure the cover plate on the M909 module with the two Phillips screws.

3.1.4 Modbus Plus Executive Firmware Support for a 984X Controller

If you plan to upgrade a currently fielded 984X Controller (part number P1-984X-008) for Modbus Plus capability, you must upgrade the current AM-S929-00*x* Multioption Processor to an AM- S929-005 Multioption Processor as well as install the S985 Adapter module. To arrange the S929 upgrade, contact expediter from Modicon Order Entry at 1-800-468-5342 or at 1-(508)-975-5001.

If you are purchasing a new 984X Controller and you want it to contain the firmware that supports a Modbus Plus interface, the top level part number for that controller is P1-984X-108.

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3.2 Setting the Modbus Plus Node Address

After making sure that the system executive in your controller is at the most current revision level, the next step in the installation process is to specify the desired Modbus Plus network node address for the S985 card. The Modbus Plus node address is set via the DIP switches located on the card.

3.2.1 Modbus Plus Address DIP Switch Locations

The Modbus Plus node address becomes one of a possible two (in the case of the S985-0X2) or three (in the case of the S985-800) Modbus Plus network addresses provided in the host controller. The address is set via the six DIP switches. These switches are located on the S985-0X2 card as shown in Figure 13:

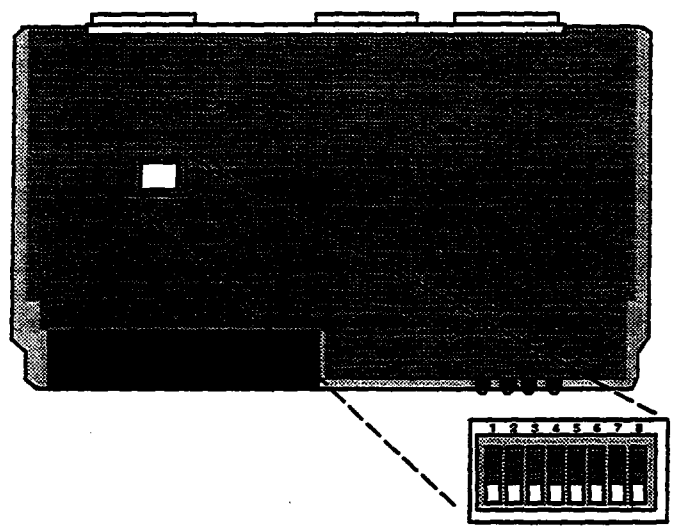


Figure 13 Location of the Modbus Plus Node Address Switches on the S985-0X2 Card

and on the S985-800 card as shown in Figure 14:

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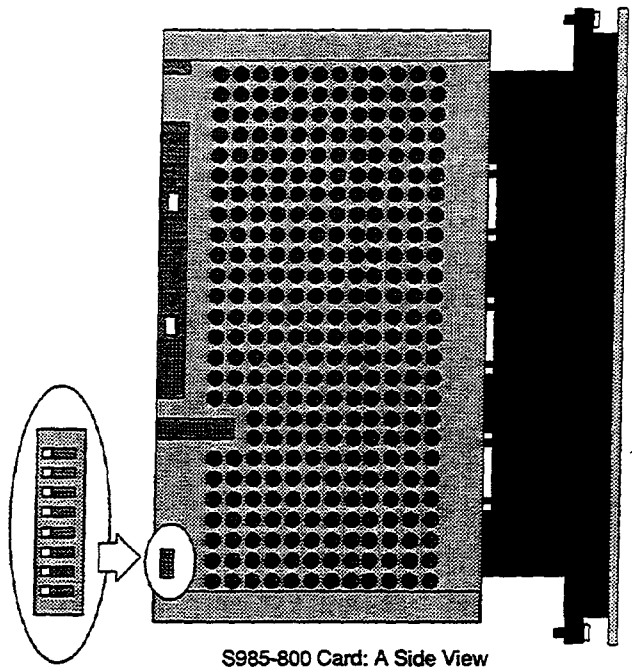
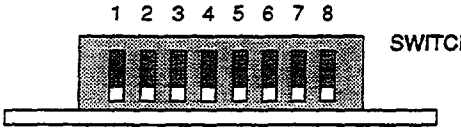


Figure 14 Location of the Modbus Plus Node Address Switches on the S985-800 Card

3.2.2 Node Address Settings

Each device on a Modbus Plus network must have a unique address in the range 1 ... 64. Using the DIP switches, set the device address to one of the positions shown in Figure 15:

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ADDRESS	SWITCH POSITION 1	2	3	4	5	6	ADDRESS	SWITCH POSITION 1	2	3	4	5	6
1	0	0	0	0	0	0	33	0	0	0	0	0	1
2	1	0	0	0	0	0	34	1	0	0	0	0	1
3	0	1	0	0	0	0	35	0	1	0	0	0	1
4	1	1	0	0	0	0	36	1	1	0	0	0	1
5	0	0	1	0	0	0	37	0	0	1	0	0	1
6	1	0	1	0	0	0	38	1	0	1	0	0	1
7	0	1	1	0	0	0	39	0	1	1	0	0	1
8	1	1	1	0	0	0	40	1	1	1	0	0	1
9	0	0	0	1	0	0	41	0	0	0	1	0	1
10	1	0	0	1	0	0	42	1	0	0	1	0	1
11	0	1	0	1	0	0	43	0	1	0	1	0	1
12	1	1	0	1	0	0	44	1	1	0	1	0	1
13	0	0	1	1	0	0	45	0	0	1	1	0	1
14	1	0	1	1	0	0	46	1	0	1	1	0	1
15	0	1	1	1	0	0	47	0	1	1	1	0	1
16	1	1	1	1	0	0	48	1	1	1	1	0	1
17	0	0	0	0	1	0	49	0	0	0	0	1	1
18	1	0	0	0	1	0	50	1	0	0	0	1	1
19	0	1	0	0	1	0	51	0	1	0	0	1	1
20	1	1	0	0	1	0	52	1	1	0	0	1	1
21	0	0	1	0	1	0	53	0	0	1	0	1	1
22	1	0	1	0	1	0	54	1	0	1	0	1	1
23	0	1	1	0	1	0	55	0	1	1	0	1	1
24	1	1	1	0	1	0	56	1	1	1	0	1	1
25	0	0	0	1	1	0	57	0	0	0	1	1	1
26	1	0	0	1	1	0	58	1	0	0	1	1	1
27	0	1	0	1	1	0	59	0	1	0	1	1	1
28	1	1	0	1	1	0	60	1	1	0	1	1	1
29	0	0	1	1	1	0	61	0	0	1	1	1	1
30	1	0	1	1	1	0	62	1	0	1	1	1	1
31	0	1	1	1	1	0	63	0	1	1	1	1	1
32	1	1	1	1	1	0	64	1	1	1	1	1	1

Figure 15 Modbus Plus Node Address Switch Settings

☞ **Note** Switches 7 and 8 are not used.

3.2.3 Addressing Two S985 Cards in a Chassis Mount Controller

If two S985 cards are installed in the chassis, each card may be given the same or different node addresses, depending on how the cards are connected to the Modbus Plus network(s):

- If both cards are set to the same address, the two nodes cannot be on the same Modbus Plus network
- If the two cards are set to different node addresses, they may be placed on either the same or on different Modbus Plus networks

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3.3 S985 Hardware Installation

After setting a Modbus Plus network address for the S985 card, you are ready to install the card in an available option slot with the appropriate (chassis mount or slot mount) controller.

Installing an S985 Card in a 984 Controller

Step 1 At the line power source, disable voltage to the 984 controller.



Warning To help protect yourself and others against electric shock, open and padlock open all system power disconnect switches before making high voltage connections.

Step 2 Insert the S985 in an available option slot in the chassis (for a 984A/B/X) or primary housing (for a 984-685/-785). Make sure the module is seated firmly in the backplane, and tighten the two securing screws at the top and bottom of the module.

Step 3 If you are using the redundant cable option available on the S985 card, plug the two Modbus Plus local drop cable connectors into the two nine-pin Modbus Plus D-connectors on the S985 module (see Figure 3 in Section 1.2 for connector locations). If you are not using the redundant cable option, then you can plug the one Modbus Plus local drop cable connector into either of the two nine-pin Modbus Plus D-connectors on the S985 module. Then tighten the securing screws on the D-connector(s).

☞ **Note** The unused channel LED will be lit during a single-cable operation.

☞ **Note** To facilitate future troubleshooting, always label your cable A and cable B, and always plug cable A to cable A and cable B to cable B at each node.

Step 4 If you intend to use a Modbus master device across the bridge to Modbus Plus, connect the device to the nine-pin Modbus D-shell connector on the S985 module, then tighten the two securing screws on the connector.

Step 5 Enable voltage to the 984 controller at the power source.

Result When the controller powers up, the S985 should come up operating as a peer node on the network; the **MODBUS ACTIVE** LED should flash for a split second at powerup to indicate that the S985 has passed its confidence tests. The operating status of the S985 can be determined by the light pattern flashing on the **MB PLUS ACTIVE** LED, as described in Section 1.2.3.

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3.4 Software Loadable Installation for the 984A/B/X Controllers

If you are using S985-0X2 Adapters in a 984A/B/X chassis mount controller, you must load the MSTR function to the controller's system memory. This process can be done with either a P190 Programming Panel or with a P230 or IBM-compatible Personal Computer that is running Modsoft or P190 emulation panel software.

Loading the MSTR Block with Modsoft Panel Software

☞ **Note** Modsoft must be in offline mode when it is used to install loadable software to the 984 controller.

Step 1 Insert the SW-AP9X-MBP (PG-DIBM-225) disk in drive A: of your programming panel.

Step 2 Go to the **Offline** selection on the main menu. A pulldown menu appears at ↓**Offline**. Select **Config** from the pulldown menu, then press <RETURN>. The panel then displays the configurator menu screen.

Step 3 Place the cursor on the ↓**DXFnctn** selection on the top row of the configurator menu. A pulldown menu with two selections—**Select** and **Library**—will appear. Move the cursor on the **Library** selection, then press <RETURN>.

Step 4 A pop-up screen appears at the bottom of the configurator screen, requesting `FILENAME:`. Enter the following in the pop-up screen:

```
<DRIVE:><PATH>984LODM.DAT
```

Then press <RETURN>. The system reads the contents of the disk in drive A:.

Step 5 When the contents of the disk have been read, a pop-up screen appears at the bottom of the configurator screen, requesting `Load loadable: MSTR (Y/N)`. Select `Y`, then press <RETURN>. The system loads the MSTR function to a library of loadable functions.

Step 6 Go back to the ↓**DXFnctn** pulldown menu, move the cursor on **Select**, and press <RETURN>. The system displays a screen with a list of all current loadables in the loadables library. The list is in four columns showing the name of the loadable, its opcode, its revision number, and its size—i.e., the number of bytes it will consume in the controller.

Step 7 The MSTR function should be listed on the screen with its revision number and size, but without an opcode. Place the cursor on MSTR, then press <RETURN>. A list of all currently unassigned opcodes appears on the screen—the opcodes are listed in hexadecimal format.

Step 8 Select an opcode from this list to be assigned to the MSTR function—if BF is available, choose it as the opcode.

An opcode is selected by highlighting the desired hexadecimal value, via the < ↑ > and < ↓ > keys on your keyboard, and pressing <RETURN> at the desired selection.

Step 9 After an opcode has been assigned to the MSTR function, it is available for use in ladder logic programming. To exit the loading procedure, remove the PG-DIBM-225 disk from the drive, and return to the main menu in Modsoft.

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Loading the MSTR Block with a P190

Step 1 Load the AS-T984-304 Configuration tape into the P190 tape drive. The P190 will display two new software label keys at the bottom of the screen— **984 CONFIG** and **ATTACH UNIT #**.

Step 2 Enter the controller unit number in the assembly register, then press **984 CONFIG**. The P190 will momentarily display the message: `LOADING CONFIGURATION TABLE`, then the configurator editor screen.



Caution If the P190 is attached to another Modbus port, use the unit number specified in the configurator editor.

Step 3 Press **MODULES**. Three new software label keys will appear—**LOAD MODULES**, **DELETE MODULES**, and **PREVIOUS MENU**.

Step 4 Press **LOAD MODULES**. The P190 will display the software label keys **PROCEED** and **CANCEL** and will request that you insert a loadable module tape.

Step 5 Remove the Configuration tape, insert the SW-AP9X-MBP (PG-T984-225) tape, and press **PROCEED**. The P190 will display the **LOAD PROGRAM**, **DISPLAY HELP FRAME**, and **PREVIOUS MENU** software label keys.

Step 6 If you want information on the MSTR function, enter `MSTR` in the assembly register and press **DISPLAY HELP FRAME**. To advance through multiple information screens, press **NEXT SCREEN**. To exit HELP mode, press **LOAD PROGRAM**; this loads the MSTR function into the P190. Press **DIRECTORY DISPLAY** to return to the **LOAD MODULES** display.

Step 7 Enter `MSTR` in the assembly register; as each character is struck, it is entered in the `ENTER PROGRAM NAME:` field in the configurator screen.

Step 8 Press **LOAD PROGRAM**. The P190 will display the message: `SEARCHING FOR PROGRAM: MSTR`, followed by: `LOADING PROGRAM: MSTR`. When the function has finished loading, the P190 will display the message: `LOADING OF PROGRAM COMPLETED`.

Step 9 Remove the PG-T984-225 tape from the P190 drive, then press **PREVIOUS MENU**. The P190 will display three software label keys—**LOAD MODULES**, **DELETE MODULES**, and **PREVIOUS MENU**.

Step 10 Press **PREVIOUS MENU**. The P190 will display the specified configuration.

Step 11 Press **WRITE CONFIG** to enter the new configuration into the controller's system memory. The P190 will display the message: `WRITING CONFIGURATION TABLE`, followed by a new display with the message: `984 CONFIGURATION WRITTEN` and the software label keys **984 CONFIG** and **ATTACH UNIT #**. The MSTR function is now loaded to the controller and can be used for application programming.

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Loading the MSTR Block with P190 Emulation Software

Step 1 Access the 984 Configuration Menu from the Main Menu—an Attach screen appears with the following software label keys displayed at the bottom of the screen—**PROGRAM/MONITOR** (<F1>),**984 CONFIG** (<F2>), **RETURN TO EXEC** (<F6>), and **ATTACH UNIT #** (<F8>).

Step 2 Enter the appropriate controller unit number in the assembly register, then press <F3>. The Configuration screen will appear.

☞ **Note** The controller must be stopped before proceeding.

Step 3 Press <F5>. Three new software label keys will be displayed—**LOAD MODULES**, **DELETE MODULES**, and **PREVIOUS MENU**.

Step 4 Press **LOAD MODULES** (<F1>). The panel will display a request for you to insert a loadable module disk, and the software label keys **PROCEED** and **CANCEL** will appear.

Step 5 Insert the SW-AP9X-MBP (PG-DIBM-225) disk in drive A: of your programming panel, then press **PROCEED**. The panel will display the name of the drive letter and the loadable file name—`A:984LODM.DAT`—in the center of the screen, and three software label keys—**LOAD PROGRAM**, **DISPLAY HELP FRAME**, and **PREVIOUS MENU**—appear at the bottom of the screen.

Step 6 If you want information on the MSTR function, enter `MSTR` in the assembly register and press **DISPLAY HELP FRAME**. To advance through multiple information screens, press **NEXT SCREEN**. To exit HELP mode, press **LOAD PROGRAM**.

Step 7 Enter `MSTR` in the `ENTER PROGRAM NAME:` field in the configurator screen.

Step 8 Press **LOAD PROGRAM**. The panel will display the message: `SEARCHING FOR PROGRAM: MSTR`, followed by: `LOADING PROGRAM: MSTR`. When the function has finished loading, the panel will display the message: `LOADING OF PROGRAM COMPLETED.`

Step 9 Remove the PG-DIBM-225 disk from the drive, then press **PREVIOUS MENU**. The panel will display three software label keys—**LOAD MODULES**, **DELETE MODULES**, and **PREVIOUS MENU**.

Step 10 Press **PREVIOUS MENU**. The panel will display the specified configuration.

Step 11 Press <F8> to enter the new configuration into the controller's system memory. The panel will display the message: `WRITING CONFIGURATION TABLE`, followed by a new display with the message: `984 CONFIGURATION WRITTEN`. The MSTR function is now loaded to the controller and can be used for application programming.

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3.5 MSTR Opcode Assignment Considerations

Each function block in your 984 instruction set must be assigned a unique opcode. The standard instructions resident in the system executive have hard-coded opcodes that cannot be changed. The loadable functions, however, allow a certain amount of flexibility in opcode assignment, particularly if you are using Modsoft panel software.

Therefore, if you are using an S985-0X2 card in a 984A/B/X chassis mount Controller, you may change the opcode of the loadable MSTR function to avoid potential conflicts. If you are using an S985-800 card in a 984-685/-785 slot mount Controller, MSTR is a standard function with an opcode that cannot be changed.

3.5.1 The MSTR Opcode

The opcode provided for the MSTR function is BF (hexadecimal). There may be a potential conflict between MSTR and the CKSM loadable, which has the same opcode assignment. Here is a list of the opcodes used for loadable functions in the 984A/B/X Controller types. Whenever possible, use the standard opcode assignment for loadables in your configuration:

Table 1 Standard Opcode Assignments for Loadable Functions

Opcode (Hex)	984A/B/X Loadable Function
5E	PID2
BE	MATH
DE	DMTH
FE	DRUM
1F	MBUS
3F	PEER
5F	CALL
7F	ICMP
9F	BLKT
BF	MSTR or CKSM
DF	TBLK
FF	HSBY

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3.5.2 How to Handle Opcode Conflicts

If you are loading the MSTR block to your loadable library using Modsoft and the CKSM loadable is already present and using opcode BF, you may simply choose another currently unassigned opcode and allocate it to MSTR (see the Modsoft software loadable procedure on the previous page).

If you want to load the MSTR block to the loadables table in system memory using P190 or P190 emulation software and the CKSM loadable is already present, you have two choices:

- You may delete CKSM from the loadables table using the **DELETE MODULES** utility in the software configurator. If you choose to do this, you must carefully edit your existing ladder logic and remove all CKSM blocks from the ladder.
- If your application requires that you have both the CKSM and MSTR function blocks for programming, contact Modicon Customer Service at 1-800-468-5342 to arrange an opcode modification.



Caution If you modify any loadables so that their opcodes are different from those shown in Table 1, you must use caution when porting logic to or from your controller. The opcode conflicts that can result may hang up the target controller or cause the wrong function blocks to be executed in ladder logic.

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3.6 Attaching the Modbus Plus Node Identification Label

Two Modbus Plus node identification labels are supplied with your S985 Adapter. One is used to identify the Modbus Plus network number and node address of the device; the other is a spare.

The label is designed to provide ready information to persons who will maintain the network in the future. As the last step in the installation procedure, you should enter the required information on the label and place it where it can be easily seen. It may be attached to the front bezel of the S985, to the controller chassis, or to the NEMA mounting cabinet.

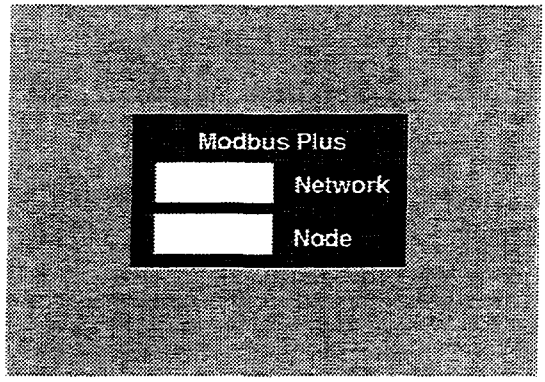


Figure 16 Modbus Plus Node Identification Label

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Chapter 4
The MSTR Loadable Function Block

- MSTR Block Overview
- MSTR Function Error Codes
- *Read* and *Write* MSTR Functions
- *Get Local Statistics* MSTR Function
- *Clear Local Statistics* MSTR Function
- *Write Global Data* MSTR Function
- *Read Global Data* MSTR Function
- *Get Remote Statistics* MSTR Function
- *Clear Remote Statistics* MSTR Function
- Network Statistics

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4.1 MSTR Block Overview

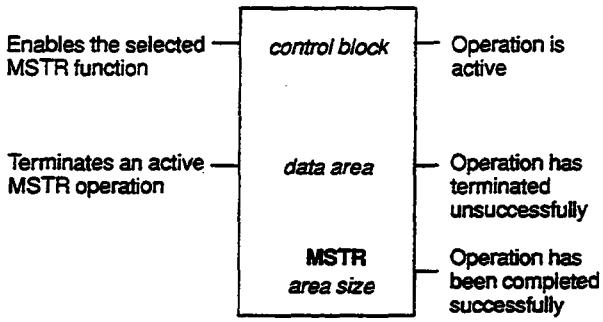
All 984 controllers that support a Modbus Plus communications capability have a special master (MSTR) instruction with which nodes on the network can initiate message transactions. The MSTR function allows you to initiate one of eight possible operations over the Modbus Plus network:

Table 2 The Eight MSTR Operations

MSTR Function	Code
Write data	1
Read data	2
Get local statistics	3
Clear local statistics	4
Write global database	5
Read global database	6
Get remote statistics	7
Clear remote statistics	8

Up to four MSTR blocks may be simultaneously active in a ladder logic program. More than four MSTR blocks may be programmed to be enabled by the logic flow—as one active MSTR block releases the resources it has been using and becomes deactivated, the next MSTR function encountered in logic may be activated.

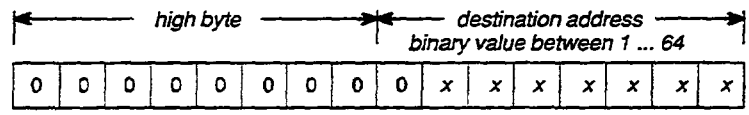
The MSTR instruction is a three-node function block:



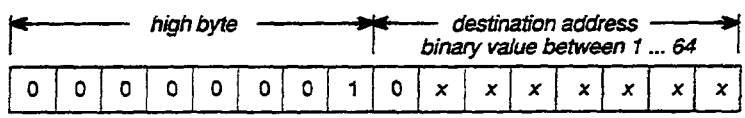
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The top node, which must be a 4*x* register, is the first of nine consecutive holding registers that form the MSTR *control block*:

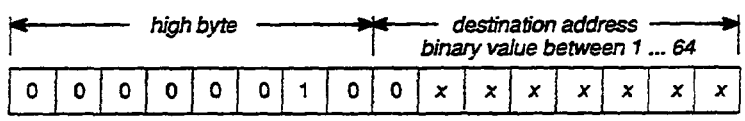
4*x*	Identifies one of the eight MSTR operations
4*x* + 1	Contains error status
4*x* + 2	Contains length
4*x* + 3	Contains MSTR function-dependent information
4*x* + 4	The Routing 1 register, used to designate the address of the destination node for a network transaction—for an S985-002 card in a chassis mount controller, a value of 0 in the high byte indicates that the MSTR function is destined for the S985 card set for controller port #2; for a 984-685/-785 slot mount Controller, a value of 0 in the high byte indicates that the MSTR function is destined for the on-board Modbus Plus port on the controller:



For two S985-002 cards in a chassis mount controller, a value of 1 in the high byte indicates that the MSTR function is destined for the second S985 card's assigned buffer space; for an S985-800 configuration in a 984-685/-785 slot mount Controller, a value of 1 in the high byte indicates that the MSTR function is destined for the S985 card set for comm port #2:



For two S985-800 cards in a 984-685/-785 Controller configuration, a value of 2 in the high byte indicates that the MSTR function is destined for the second S985 card's assigned buffer space:



With respect to the buffer space assigned to a second S985 card, the Routing 1 register uses a decimal offset of 256 between the *destination* node address and the value displayed in the register.

4*x* + 5	The Routing 2 register*
4*x* + 6	The Routing 3 register*
4*x* + 7	The Routing 4 register*
4*x* + 8	The Routing 5 register*

* For a description of routing path schemes, see Chapter 2.

The middle node, which must also be a 4*x* register, designates the first register in the *data area*. For operations that provide the communication processor with data—such as a Write operation—the *data area* is the source of the data. For operations that acquire data from the communication processor—such as a Read operation—the *data area* is the destination of the data.

The bottom node indicates that this is an MSTR function and specifies the maximum number of registers in the *data area*; *area size* must be a constant value ranging from 1 ... 100.

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4.2 MSTR Function Error Codes

If an error occurs during any one of the eight MSTR operations, a hexadecimal error code will be displayed in register 4*xxxx* + 1 in the control block. The form of the code is *Mmss*, where

- *M* represents the major code
- *m* represents the minor code
- *ss* represents a subcode

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Table 3 MSTR Function Error Codes

Hex Error Code	Meaning
1001	User-initiated abort
2001	Invalid operation type
2002	User parameter changed
2003	Invalid length
2004	Invalid offset
2005	Invalid length + offset
2006	Invalid slave device data area
2007	Invalid slave device network area
2008	Invalid slave device network routing
2009	Route equal to your own address
200A	Attempting to obtain more global data words than available
200B	Peer Cop conflict on read/write global data
200C	Bad pattern for change-of-address request
200D	Bad address for change-of-address request
30ss*	Modbus slave exception response
4001	Inconsistent Modbus slave response
5001	Inconsistent network response
6*mss***	Routing failure
F001	Selected S985 option is not present

* The *ss* subfield in error code 30ss is:

ss Hex Value	Meaning
01	Slave device does not support the requested operation
02	Nonexistent slave device registers requested
03	Invalid data value requested
04	Unassigned
05	Slave has accepted long-duration program command
06	Function can't be performed now—a long-duration command in effect
07	Slave has rejected long-duration program command
08 ... 255	Unassigned

** The *m* subfield in error code 6mss is an index into the routing information indicating where an error has been detected—a value of 0 indicates the local node, a 2 the second device on the route, etc.

The *ss* subfield in error code 6*mss* is:

ss Hex Value	Meaning
01	No response received
02	Program access denied
03	Node offline and unable to communicate
04	Exception response received
05	Router node data paths busy
06	Slave device down
07	Bad destination address
08	Invalid node type in routing path
10	Slave has rejected the command
20	Initiated transaction forgotten by slave device
40	Unexpected master output path received
80	Unexpected response received

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4.3 *Read* and *Write* MSTR Functions

An MSTR Write function transfers data from the local *master* device to a specified *slave destination* device on the network. An MSTR Read function transfers data from a specified *slave source* device to a *master destination* device on the network. Each Read function and each Write function uses one data master path and can be completed over multiple scans—remember that only four data master paths are available for MSTR functions at any one time.

4.3.1 Control Block Utilization

The contents of the nine registers in the top node of the MSTR block contain the following information when you implement a Read or Write function:

Table 4 *Read* and *Write* MSTR Functions

Control Block Register	MSTR Function	Register Content
4*xxxx*	Operation type	1 = Write 2 = Read
4*xxxx* + 1	Error status	Displays a hex value indicating an MSTR error, when relevant
4*xxxx* + 2	Length	Write = number of registers to be sent to slave Read = number of registers to be read from slave
4*xxxx* + 3	Slave device data area	Specifies starting 4*xxxx* register in the slave to be read from or written to (1 = 40001, 49 = 40049)
4*xxxx* + 4, + 5, + 6, + 7, + 8	Routing 1 ... 5, respectively	Designates the routing path address of the destination device (*see Chapter 2*)

If you attempt to program the MSTR function to Read or Write its own station address, an error will be generated in the second register of the MSTR control block. It is possible to attempt a Read/Write operation to a nonexistent register in the slave device. The slave will detect this condition and report it, which may take several scans.

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4.4 *Get Local Statistics* MSTR Function

The *Get local statistics* function obtains operational information related to the local node—where the MSTR function has been programmed. This operation takes one scan to complete and does not require a data master path.

4.4.1 Control Block Utilization

The contents of the first four registers in the top node of the MSTR block are used when you implement a Get local statistics function:

Table 5 *Get Local Statistics* MSTR Function

Control Block Register	MSTR Function	Register Content
4*xxxx*	Operation type	3
4*xxxx* + 1	Error status	Displays a hex value indicating an MSTR error, when relevant
4*xxxx* + 2	Length	Starting from *offset*, the number of words of statistics from the local processor's statistics table; the length must be > 0 ≤ the size of the data area
4*xxxx* + 3	Offset	An offset value relative to the first available word in the local processor's statistics table—if the offset is specified as 1, the function obtains statistics starting with the second word in the table
4*xxxx* + 4	Routing 1	If the local node is set for comm port #3, set the high byte to a value of 1

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4.5 *Clear Local Statistics* MSTR Function

The *Clear local statistics* function clears operational statistics relative to the local node—where the MSTR function has been programmed. This operation takes one scan to complete and does not require a data master path.

4.5.1 Control Block Utilization

The contents of the first two registers in the top node of the MSTR block are used when you implement a Clear local statistics function:

Table 6 *Clear Local Statistics* MSTR Function

Control Block Register	MSTR Function	Register Content
4*xxxx*	Operation type	4
4*xxxx* + 1	Error status	Displays a hex value indicating an MSTR error, when relevant
4*xxxx* + 4	Routing 1	If the local node is set for comm port #3, set the high byte to a value of 1

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4.6 *Write Global Data* MSTR Function

The *Write global data* function transfers data to the comm processor in the current node so that it can be sent over the network when the node passes the token to its successor. All nodes on the local network link can receive this data. This operation takes one scan to complete and does not require a data master path.

4.6.1 Control Block Utilization

The contents of the first three registers in the top node of the MSTR block are used when you implement a Write global data function:

Table 7 *Write Global Data* MSTR Function

Control Block Register	MSTR Function	Register Content
4*xxxx*	Operation type	5
4*xxxx* + 1	Error status	Displays a hex value indicating an MSTR error, when relevant
4*xxxx* + 2	Length	Specifies the number of registers from the data area to be sent to the comm processor; the value of the length must be ≤ 32 and must not exceed the size of the data area
4*xxxx* + 4	Routing 1	If the current node is set for comm port #3, set the high byte to a value of 1

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4.7 *Read Global Data* MSTR Function

The *Read global data* function gets data from the comm processor in any node on the local network link that is providing global data. This operation may require multiple scans to complete if no global data are currently available from the requested node; if global data are currently available, the operation completes in a single scan. No master path is required.

4.7.1 Control Block Utilization

The contents of the first five registers in the top node of the MSTR block are used when you implement a Read global data function:

Table 8 *Read Global Data* MSTR Function

Control Block Register	MSTR Function	Register Content
4*xxxx*	Operation type	6
4*xxxx* + 1	Error status	Displays a hex value indicating an MSTR error, when relevant
4*xxxx* + 2	Length	Specifies the number of words of global data to be requested from the comm processor designated by the routing 1 parameter; the value of the length must be > 0 ≤ 32 and must not exceed the size of the data area
4*xxxx* + 3	Available words	Contains the number of words available from the requested node; the value is automatically updated by internal software
4*xxxx* + 4	Routing 1	The low byte specifies the address of the node whose global data are to be returned (a value between 1 ... 64); if the node is set for comm port #3, set the high byte to a value of 1

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4.8 *Get Remote Statistics* MSTR Function

The *Get remote statistics* function obtains operational information relative to remote nodes on the network. This operation uses a single data master path and may require multiple scans to complete—remember that only four data master paths are available for MSTR functions at any one time.

4.8.1 Control Block Utilization

The contents of the nine registers in the top node of the MSTR block contain the following information when you implement a Get remote statistics function:

Table 9 *Get Remote Statistics* MSTR Function

Control Block Register	MSTR Function	Register Content
4*xxxx*	Operation type	7
4*xxxx* + 1	Error status	Displays a hex value indicating an MSTR error, when relevant
4*xxxx* + 2	Length	Starting from an *offset,* the number of words of statistics to be obtained from a remote node; the value of the length must be > 0 ≤ total number of statistics available (54) and must not exceed the size of the data area
4*xxxx* + 3	Offset	Specifies an offset value relative to the first available word in the statistics table; the value must not exceed the number of statistic words available
4*xxxx* + 4, + 5, + 6, + 7, + 8	Routing 1 ... 5, respectively	Designates the routing path address of the destination device (*see Chapter 2*)

☞ **Note** The remote comm processor always returns its complete statistics table when a request is made, even if the request is for less than the full table. The MSTR function then copies only the amount of words you have requested to the designated 4*xxxx* registers.

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4.9 *Clear Remote Statistics* MSTR Function

The *Clear remote statistics* function clears operational statistics related to a remote network node from the data area in the local node. This operation uses a single data master path and may require multiple scans to complete—remember that only four data master paths are available for MSTR functions at any one time.

4.9.1 Control Block Utilization

The contents of seven registers in the top node of the MSTR block contain the following information when you implement a Clear remote statistics function:

Table 10 ***Clear Remote Statistics*** **MSTR Function**

Control Block Register	MSTR Function	Register Content
4*xxxx*	Operation type	8
4*xxxx* + 1	Error status	Displays a hex value indicating an MSTR error, when relevant
4*xxxx* + 2 and 4*xxxx* + 3		Not used
4*xxxx* + 4, + 5, + 6, + 7, + 8	Routing 1 ... 5, respectively	Designates the routing path address of the destination device (*see Chapter 2*)

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4.10 Network Statistics

The following table presents statistics available on the Modbus Plus network. You may acquire this information by using the appropriate MSTR logic function or by using Modbus function code 8.

☞ **Note** When you issue the *Clear local* or *Clear remote statistics* functions, only words 13 ... 22 are cleared.

Table 11 Modbus Plus Network Statistics

Word	Bit	Meaning
00		Node type I.D:
	0	Unknown node type
	1	Standard controller node
	2	Bridge MUX
	3	Host
	4	Bridge Plus
	5	Peer I/O
01		Communications processor version. First release is version 1.00 and displays as 0100 hex
02		Network address for this station
03		MAC state variable:
	0	Power up state
	1	Monitor offline state
	2	Duplicate offline state
	3	Idle state
	4	Use token state
	5	Work response state
	6	Pass token state
	7	Solicit response state
	8	Check pass state
	9	Claim token state
	10	Claim response state
04		Peer status (LED code); provides status of this unit relative to the network:
	0	Monitor link operation
	32	Normal link operation
	64	Never getting token
	96	Sole station
	128	Duplicate station
05		Token pass counter; increments each time this station gets the token
06		Token rotation time in ms
07	LO	Data master failed during token ownership bit map
	HI	Program master failed during token ownership bit map
08	LO	Data master token owner work bit map
	HI	Program master token owner work bit map
09	LO	Data slave token owner work bit map
	HI	Program slave token owner work bit map

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Modbus Plus Network Statistics (continued)

Word	Byte	Meaning
10	LO	Data master/get master response transfer request bit map
	HI	Data slave/get slave command transfer request bit map
11	LO	Program master/get master rsponse transfer request bit map
	HI	Program slave/get slave command transfer request bit map
12	LO	Program master connect status bit map
	HI	Program slave automatic logout request bit map
13	LO	Pretransmit deferral error counter
	HI	Receive buffer DMA overrun error counter
14	LO	Repeated command received counter
	HI	No Try counter (nonexistent station)
15	LO	Cable A framing error
	HI	Cable B framing error
16	LO	UART error
	HI	Bad packet-length error counter
17	LO	Bad link-address error counter
	HI	Transmit buffer DMA-underrun error counter
18	LO	Bad internal packet length error counter
	HI	Bad MAC function code error counter
19	LO	Communication retry counter
	HI	Communication failed error counter
20	LO	Good receive packet success counter
	HI	No response received error counter
21	LO	Exception response received error counter
	HI	Unexpected path error counter
22	LO	Unexpected response error counter
	HI	Forgotten transaction error counter
23	LO	Active station table bit map, nodes 1 ... 8
	HI	Active station table bit map, nodes 9 ...16
24	LO	Active station table bit map, nodes 17 ... 24
	HI	Active station table bit map, nodes 25 ... 32
25	LO	Active station table bit map, nodes 33 ... 40
	HI	Active station table bit map, nodes 41 ... 48
26	LO	Active station table bit map, nodes 49 ... 56
	HI	Active station table bit map, nodes 57 ... 64
27	LO	Token station table bit map, nodes 1 ... 8
	HI	Token station table bit map, nodes 9 ... 16
28	LO	Token station table bit map, nodes 17 ... 24
	HI	Token station table bit map, nodes 25 ... 32
29	LO	Token station table bit map, nodes 33 ... 40
	HI	Token station table bit map, nodes 41 ... 48
30	LO	Token station table bit map, nodes 49 ... 56
	HI	Token station table bit map, nodes 57 ... 64

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Modbus Plus Network Statistics (continued)

Word	Byte	Meaning
31	LO	Global data present table bit map, nodes 1 ... 8
	HI	Global data present table bit map, nodes 9 ... 16
32	LO	Global data present table bit map, nodes 17 ... 24
	HI	Global data present table bit map, nodes 25 ... 32
33	LO	Global data present table bit map, nodes 33 ... 40
	HI	Global data present table bit map, nodes 41 ... 48
34	LO	Global data present table map, nodes 49 ... 56
	HI	Global data present table bit map, nodes 57 ... 64
35	LO	Receive buffer in use bit map, buffer 1 ... 8
	HI	Receive buffer in use bit map, buffer 9 ... 16
36	LO	Receive buffer in use bit map, buffer 17 ... 24
	HI	Receive buffer in use bit map, buffer 25 ... 32
37	LO	Receive buffer in use bit map, buffer 33 ... 40
	HI	Station management command processed initiation counter
38	LO	Data master output path 1 command initiation counter
	HI	Data master output path 2 command initiation counter
39	LO	Data master output path 3 command initiation counter
	HI	Data master output path 4 command initiation counter
40	LO	Data master output path 5 command initiation counter
	HI	Data master output path 6 command initiation counter
41	LO	Data master output path 7 command initiation counter
	HI	Data master output path 8 command initiation counter
42	LO	Data slave input path 41 command processed counter
	HI	Data slave input path 42 command processed counter
43	LO	Data slave input path 43 command processed counter
	HI	Data slave input path 44 command processed counter
44	LO	Data slave input path 45 command processed counter
	HI	Data slave input path 46 command processed counter
45	LO	Data slave input path 47 command processed counter
	HI	Data slave input path 48 command processed counter
46	LO	Program master output path 81 command initiation counter
	HI	Program master output path 82 command initiation counter
47	LO	Program master output path 83 command initiation counter
	HI	Program master output path 84 command initiation counter
48	LO	Program master command initiation counter
	HI	Program master output path 86 command initiation counter
49	LO	Program master output path 87 command initiation counter
	HI	Program master output path 88 command initiation counter

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Modbus Plus Network Statistics (continued)

Word	Byte	Meaning
50	LO	Program slave input path C1 command processed counter
	HI	Program slave input path C2 command processed counter
51	LO	Program slave input path C3 command processed counter
	HI	Program slave input path C4 command processed counter
52	LO	Program slave input path C5 command processed counter
	HI	Program slave input path C6 command processed counter
53	LO	Program slave input path C7 command processed counter
	HI	Program slave input path C8 command processed counter

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Appendix
Specifications

- Hardware/Software Part Numbers
- Hardware Specifications for the S985 Modbus Plus Adapter Module
- Modbus Plus Network Characteristics

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Hardware/Software Part Numbers

Adapter Modules	*AM-S985-002*, as shipped for the 984X Controller (This Modbus Plus Adapter requires a new S929 Multi-option Processor, an upgrade that must be handled by Modicon Field Support)
	AM-S985-800, as shipped for the 984-685 and 984-785 Controllers (This Modbus Plus Adapter requires that the executive software in the host programmable controller be at the most current revision level)
984A Upgrade Kits	*AM-S985-012*, includes an S902 Executive Cartridge upgrade to the M907 module suitable for a 984A Controller with an S901 RIO Processor, and the AM-S985-002 Modbus Plus Adapter
	AM-S985-022, includes an S902 Executive Cartridge upgrade to the M907 module suitable for a 984A Controller with an S908 RIO Processor, and the AM-S985-002 Modbus Plus Adapter
984B Upgrade Kits	*AM-S985-032*, includes an S902 Executive Cartridge upgrade to the M909 module for a 984B Controller with an S901 RIO Processor, and the AM-S985-002 Modbus Plus Adapter
	AM-S985-042, includes an S902 Executive Cartridge upgrade to the M909 module for a 984B Controller with an S908 RIO Processor, and the AM-S985-002 Modbus Plus Adapter
Software Loadable	*SW-AP9X-MBP*, includes MSTR function block on P190 tape, 5.25 in diskette, and 3.5 in diskette media
	This software is used in conjunction with the AM-S985-002, AM-S985-012, AM-S985-022, AM-S985-032, and AM-S985-042 packages only—it is not required for AM-S985-800 Adapters

☞ **Note** Insure that your current hardware configuration uses an S902 Executive cartridge suitable for the model of 984 controller and type of RIO processor in the chassis and that the executive has at least the minimum revision level given in the READ-ME-FIRST sheet shipped with this document (GI-S985-RMF).

☞ **Note** S985 hardware and software must be ordered separately.

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Hardware Specifications for the S985 Modbus Plus Adapter Module

Environmental

Temperature	0 ... 60 Degrees C (operating) –40 ... +80 Degrees C (storage)
Humidity	0 ... 95% (noncondensing)
Altitude	10,000 ft (maximum)

Physical

S985-002

Size (W x H x D)	1.85 in x 19.5 in x 10.13 in 47 mm x 495.3 mm x 257.3 mm
Weight	5 lb 2.27 kg

S985-800

Size (W x H x D)	2.54 in x10.46 in x 8 in 64.5 mm x 267 mm x 203 mm
Weight	5 lb 2.27 kg
Power	1.2 A unit load on the bus

Agency Standards

Designed to meet UL, CSA, and VDE standards.

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Modbus Plus Network Characteristics

Speed	1 Mbps
Network Length	1500 ft/section (max), up to four sections connected by three repeaters between any two nodes (6000 ft max)
Number of Nodes	32/link (max) 64/network (max)
Communication Medium	Single twisted shielded pair (Belden 9841)
Medium Access	Token bus
Error Checking	CRC16

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Modbus Comm Port Pinouts

The Modbus comm port on the S985 option board is a nin-pin D-shell connector identical to the Modbus ports on the 984 slot mount controllers but different from the 25-pin Modbus comm ports provided on the 984A/B/X Controllers.

Modbus Port Pinouts for IBM PCs

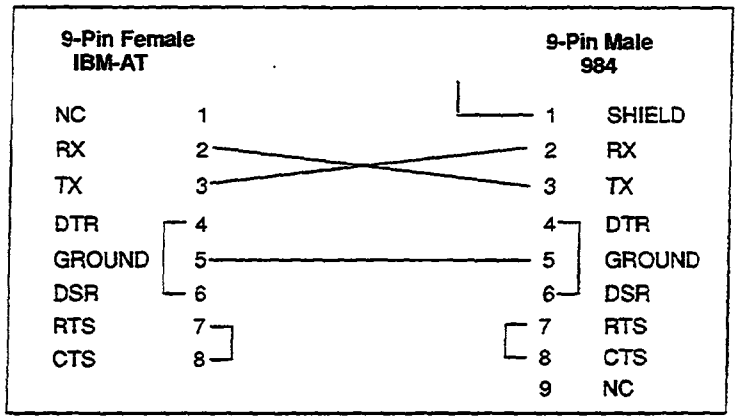


Figure 17 IBM-AT to Modbus Pinouts

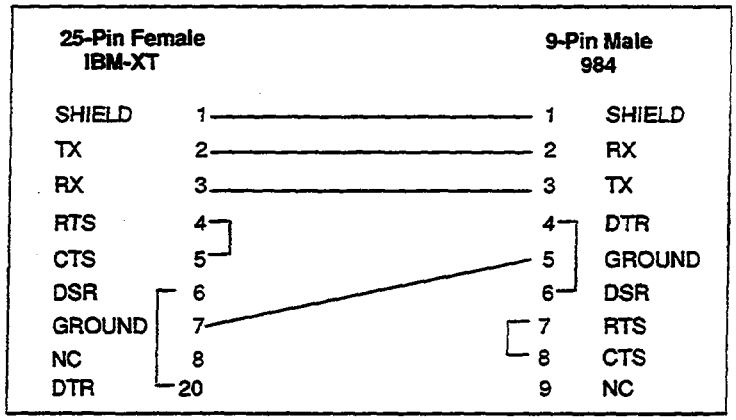


Figure 18 IBM-XT to Modbus Pinouts

TX: transmitted data
CTS: clear to send
DTR: data terminal ready
RTS: request to send
DSR: data set ready
RX: received data
NC: no connection

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Modbus Port Pinouts for P190s

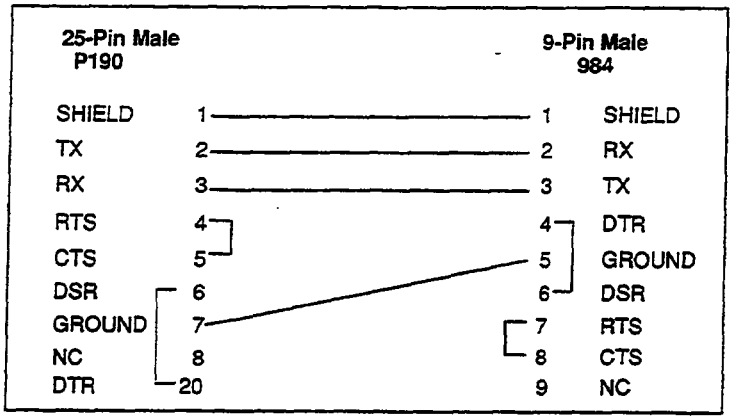


Figure 19 P190 to Modbus Pinouts

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