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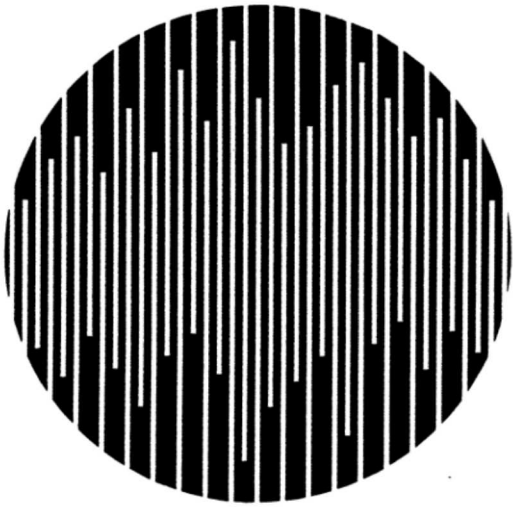
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Modicon
IBM Host Based Devices
User's Guide

890 USE 102 00 Version 2.0



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Modicon
IBM Host Based Devices
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April 1996

AEG SCHNEIDER AUTOMATION
Modicon • Square D • Telemecanique

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Chapter 1
Introducing the Host Based Devices

- ☐ Modicon Host Based Devices
- ☐ An Application Overview
- ☐ The SA85 and SM85 Adapters
- ☐ The AT−984 and MC−984 Controllers
- ☐ Modbus Plus Message Routing
- ☐ Modbus Plus Transactions
- ☐ Paths in Host Based Controllers
- ☐ Modbus Data Access Commands
- ☐ More Programming Information

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1.1 Modicon Host Based Devices

This book describes the installation and functions of four adapters for Modbus Plus networking in host compulters using IBM AT or Micro Channel bus architecture. The four adapters are:

- The SA85 Modbus Plus Network Adapter (part numbers AM−SA85−000, −002), which establishes an IBM−AT or compatible host as a Modbus Plus node
- The SM85 Modbus Plus Network Adapter (part number AM−SM85−000), which establishes an IBM PS/2 host as a Modbus Plus node
- The AT−984 Programmable Controller (part numbers AM−0984−AT0, −AT2, −AT4), which provides 984 control capability for an IBM−AT or compatible host, in addition to establishing the host as a Modbus Plus node
- The MC−984 Programmable Controller (part number AM−0984−MC0), which provides 984 control capability on a board for an IBM PS/2 host, in addition to establishing the host as a Modbus Plus node.

The AT−984 and SA85 are to be installed in an IBM AT−compatible motherboard. The MC−984 and the SM85 are to be installed in an IBM PS/2 motherboard. Each device occupies one slot in the host computer's motherboard. Up to two Modicon devices can be installed within a single host.

AT−Based Products for Single and Dual Cable Networks
Two kinds of AT−based versions are available. AM−SA85−000 and AM−0984−AT0 connect to a Modbus Plus network that uses a single cable between nodes. AM−SA85−002, AM−0984−AT2, and AM−0984−AT4 connect to a dual−cable network.

Available Software
Application packages supported by the host based devices include Modicon MODSOFT programming software, Modcom III communications library software, and third party packages. Contact Modicon for information about application software for your system.

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1.1.1 Distribution Software

The AT−based devices (SA85 and AT−984) include a set of software programs on 5.25−inch and 3.5−inch diskettes. The Micro Channel based devices (SM85 and MC−984) include software on 3.5−inch diskettes. Your diskettes contain:

- Device drivers for DOS and OS/2 that allow you to customize the presence of each device in your host computer
- Setup programs used by the Micro Channel devices to define the host interface
- A library of C language functions for Modicon's NetBIOS implementation, containing a subset of IBM NetBIOS for Modbus Plus networking
- A diagnostic utility that allows you to monitor Modbus Plus network activity and record error statistics from remote nodes
- A set of sample programs that demonstrate methods of Modbus Plus network addressing and data transfers. In addition to the executable files, C source code is supplied to illustrate how the communications library functions can be used in your application programs.

Your diskettes have a PACKING.LST text file that lists all of the programs.

1.1.2 Information Text Files

Any recently updated information about the installation of your host based device is contained in a text file on your diskettes. The file names are README.DOC (DOS) and READ.ME (OS/2).

Use your operating system's TYPE command to view the file applicable to your system, or use your PRINT or COPY (to LPT1:) commands to print a hard copy. You should review the file before installing your host based device.

1.1.3 Source Code Files

Your diskettes contain the function library NETLIB.C, and the full source code for your set of sample programs. You can print a hard copy of these files to use as a reference in coding your application.

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1.2 An Application Overview

Each host based device is a peer node on the Modbus Plus network, handling the network token in its assigned address sequence. Host applications can send and receive data messages, retrieve network statistics, and access the network's global database. In addition to its network functions, each 984 controller can control industrial processes through its remote input/output port, using a stored program of ladder logic instructions.

Both single–cable and dual–cable networks are supported by AT–based devices.

Figure 1 shows typical connections for the host based devices.

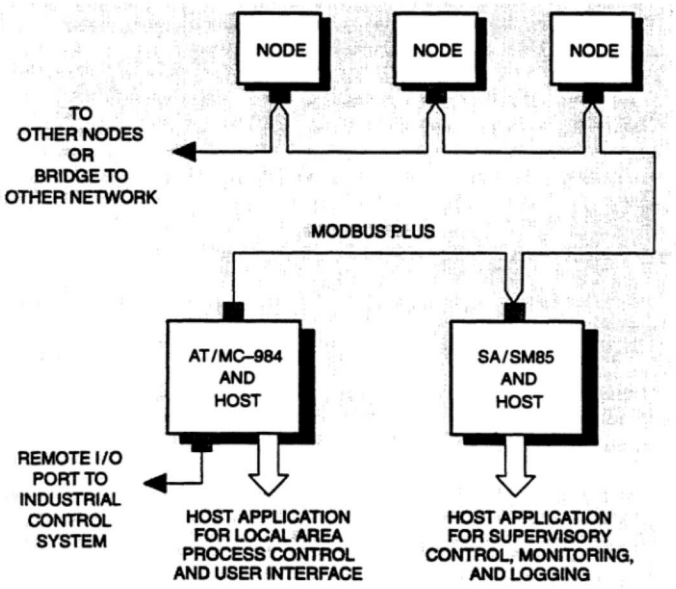


Figure 1 Application Overview

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1.3 The SA85 and SM85 Adapters

The SA85 Modbus Plus Network Adapter connects an IBM AT or compatible host to the network. It is a half–size circuit board that plugs into the host motherboard's standard 8–bit option bus. Single– and dual–cable network models are available.

The SM85 Modbus Plus Network Adapter connects an IBM PS/2 or compatible host to the network. It is a full–size circuit board that plugs into the host motherboard's Micro Channel bus.

Each adapter is provided with a C library that applies Modicon's implementation of NetBIOS commands to Modbus Plus networking. DOS and OS/2 drivers are also included to interface each adapter to the host application.

1.3.1 Network Adapter Applications

User applications running in the host computer can access the network adapter to read/write data at nodes on the local network, and at nodes on remote networks through bridges. The host application can also program network nodes remotely, retrieve statistics, and read/write data directly to the network's global database. Typical applications include:

- Control, monitoring, and reporting of remote processes
- Program load/record/verify operations
- User interfaces
- Bridging between Modbus Plus and other types of networks
- Testing and debugging of application programs
- Running network diagnostic programs.

Standard Modicon Modbus commands originated from 984 controller nodes can be addressed to a network adapter, and given to tasks running in the host. Examples include:

- Running a data logging task in the host, accessed by 984 controllers and other nodes on the network
- Providing virtual registers for remote 984 controllers.

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1.4 The AT–984 and MC–984 Controllers

In addition to their Modbus Plus network functions, the AT–984 and MC–984 boards offer standard 984 control capabilities. Both boards provide the following ladder logic programming elements and logic instructions. For more details on these instructions, see the *984 Controller Systems Manual.*

Standard Programming Elements

Symbol	Meaning
⊣ ⊢	Normally open (N.O.) contact
⊣\⊢	Normally closed (N.C.) contact
⊣↑⊢	Positive transitional (P.T.) contact
⊣↓⊢	Negative transitional (N.T.) contact
–( )–	Normal coil
–(L)–	Latched (memory-retentive) coil

Instruction Set

Type	Instruction	Meaning
Counters and Timers	UCTR	Counts up from 0 to a preset value
	DCTR	Counts down from a preset value to 0
	T1.0	Timer that measures in seconds
	T0.1	Timer that measures in tenths of a second
	T.01	Timer that measures in hundredths of a second
Calculations	ADD	Adds top node value to middle node value
	SUB	Subtracts middle node value from top node value
	MUL	Multiplies top node value by middle node value
	DIV	Divides top node value by middle node value
	EMTH	Lets you select from a library of 38 enhanced math operations, including floating point operations and extra integer math operations such as square root
DX Move	R→T	Moves register values to a table
	T→R	Moves table values to a register
	T→T	Moves a specified set of values from one table to another table
	BLKM	Moves a specified block of data
	TBLK	Moves a block of data from a table to another specified block area
	BLKT	Moves a block of registers to specified locations in a table
	FIN	First–in operation to a queue
	FOUT	First–out operation to a queue
	SRCH	Performs a table search

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Type	Instruction	Meaning
DX Move (continued)	READ	Reads an ASCII input device message to the PLC memory
	WRIT	Writes a message from the controller to an ASCII output device
DX Matrix	AND	Logically ANDs the contents of two matrices
	OR	Performs logical inclusive OR of the contents of two matrices
	XOR	Performs logical exclusive OR of the contents of two matrices
	COMP	Performs the logical complement of values in a source matrix
	CMPR	Logically compares the values in two matrices
	MBIT	Performs a logical bit modify operation
	SENS	Performs a logical bit sensing operation
	BROT	Performs a logical bit rotate operation
System health	STAT	Displays a group of status registers describing the health of the RIO network
Closed loop control	PID2	Performs a specified proportional–integral–derivative function
Modbus Plus Networking	MSTR	Specifies a function from a menu of networking operations
Skip nodes	SKP	Skips a specified number of networks in a ladder logic program
Drum sequencing	SCIF	Emulates a mechanical tenor drum, letting you perform sequential control and input comparison operations
Subroutine/interrupt support	JSR	Jumps from scheduled logic scan to a ladder logic subroutine
	LAB	Labels the entry point in a ladder logic network where the subroutine or interrupt logic begins
	RET	Returns the logic scan from the subroutine or interrupt logic to its previous position in the logic program

Software loadable instructions may also be added to an AT−984 or MC−984:

Loadable Instructions

Instruction	Meaning
FN*xx*	Allows you to develop your own custom loadable function blocks
DRUM and ICMP	Simplifies implementation of sequential step oriented logic and other software loadable functions. See the manual noted above for a list of instructions applicable to this and other 984 controllers.

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1.5 Modbus Plus Message Routing

Each device establishes its host as a node on the Modbus Plus network. Each node is assigned a unique address between 1 and 64 on its network. Multiple networks can be joined through Bridge Plus devices.

1.5.1 Modbus Plus Routing Paths

Nodes address each other using a routing path field of five bytes. The path is imbedded in the Modbus Plus message frame as sent from the originating node. The five bytes of routing allow destination nodes to be addressed up to four networks away from the originating node. The routing bytes are used by each type of device in a specific way, as illustrated below and on the next page.

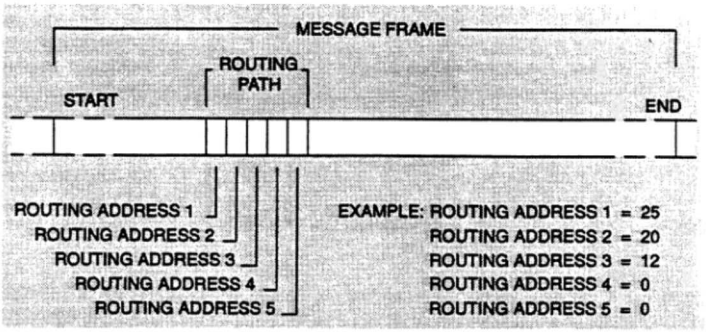


Figure 2 Message Frame Routing Path

The example in Figure 2 shows routing to a controller through three networks that are joined by a pair of Bridge Plus devices. Using the routing bytes in the example, the message will be sent first to node 25, a Bridge Plus on the local network. That bridge forwards the message to a second Bridge Plus at node address 20 on the second network. The second bridge forwards the message to its final destination, a controller at node address 12 on the third network. The zero contents of bytes 4 and 5 specify that no further routing will occur.

The routing path contents are specific to the type of device at the destination. Routing path methods for various networked devices are outlined below. For further details about message routing paths, see your *Modbus Planning and Installation Guide.*

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1.5.2 Routing to Programmable Controllers

For 984 programmable controllers, including the AT−984 and MC−984, the last nonzero byte in the routing specifies the network node address of the controller (range: 1 ... 64). For example, the path 5.0.0.0.0 specifies a controller node at address 5 on the local network (the network to which the host is attached).

1.5.3 Routing to Network Adapters

For host−based network adapters such as the SA85 and SM85, the bytes up to and including the adapter's own node address specify the routing to the adapter (e.g., through Bridge Plus devices). The byte immediately following the adapter's node address specifies an internal path or task (range: 1 ... 8) to which the message is to be assigned.

Any remaining bytes after the task byte are available to the user for custom application within the host program (range: 0 ... 255). The adapter does not check the contents of bytes following the task byte.

For example, if an adapter is at node address 35 on the local network, the path 35.8.200.0.0 specifies routing to path 8 in that adapter, with the value 200 used for further application in the host program.

1.5.4 Routing to Bridge Multiplexers

For BM85 bridge multiplexers, the routing field contents are specific to the slave device configuration at the multiplexer's Modbus port. Either a single slave device or a network of slave devices can be connected at the port.

A single slave device at a multiplexer's Modbus port is addressed using two bytes. The next−to−last nonzero byte addresses the multiplexer node (range: 1 ... 64). The last nonzero byte specifies the port (range: 1 ... 4) to which the slave device is attached. Specifying the port automatically addresses the device at that port. For example, if a BM85 is at node address 25 on the local network, 25.1.0.0.0 routes a message to the single slave device at the multiplexer's port 1.

A networked slave device at the multiplexer's port is addressed using three bytes. The third−from−last nonzero byte addresses the multiplexer node (range: 1 ... 64). The next−to−last nonzero byte specifies the port (range: 1 ... 4) to which the network is attached. The last nonzero byte specifies the Modbus address of the slave device (range: 1 ... 247). For example, 25.2.200.0.0 routes a message to multiplexer node address 25, port 2, slave device 200.

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1.6 Modbus Plus Transactions

With multiple node devices processing messages asynchronously on the network, an individual device might have several concurrent transactions in process. Each device has multiple internal paths of various types to allow concurrent processing of transactions. It opens a path when a transaction begins, keeps it open during processing of the transaction, and closes it when the transaction terminates. When the path is closed, it becomes available to another transaction.

Both the originating and destination devices open paths for a mutual transaction, and maintain the paths until the transaction completes. If the transaction passes through Bridge Plus devices to a destination on another network, each bridge opens and maintains a path at each of its two network ports. Thus a logical path is established between the originating and destination devices, and maintained until the transaction is finished. When the transaction is completed, all of the paths it has used will be freed.

1.6.1 Path Types

Each Modbus Plus device contains the following types of paths:

Data Master (DM) Path This type of path is opened for data reads and writes, and for get and clear remote statistics, as they are originated in the device. DM paths are identified by a path value in the range 01...08 hexadecimal in programming functions that require the specification of a path.

Data Slave (DS) Path This type of path is opened for data reads and writes as they are received by the device. DS paths are identified in the range 41...48 hexadecimal.

Program Master (PM) Path This type of path is opened for programming commands as they are originated in the device. PM paths are identified in the range 81...88 hexadecimal.

Program Slave (PS) Path This type of path is opened for programming commands as they are received by the device. PS paths are identified in the range C1...C8 hexadecimal.

Each path is independent of the others. Activity in one path does not affect the performance of the other paths.

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1.6.2 Path Quantities

The following paths are available in the Modbus Plus host based devices:

	Controllers	BM85	BP85	SA85/SM85
Data Master	8*	4	8	8
Data Slave	4	4	8	8
Program Master	8	4	8	8
Program Slave	1	4	8	8

* Because the host based controllers have a *virtual network adapter* capability built in, their path quantities are different from other types of 984 controllers – see Section 1.7.

1.6.3 Queueing

If all DS paths are active in a device, new incoming transactions will be queued. Transactions will remain queued until a path is available, and will then be removed from the queue and given the path. A final data response will not be returned to the originating application until a full path is available from origin to destination.

When the destination node removes a transaction from its queue, it will wait for the network token and then will request the command again from the originating node. The originator will retransmit the command while the destination retains the token. This process occurs transparently, eliminating the need for polling between the origin and destination devices in the application.

BP85 Bridge Plus Queueing Messages which must pass through multiple bridges will be queued (if necessary) within the first bridge, but will not be queued within any subsequent bridges. An attempt to queue in a second bridge will return an error code, which can be tested by the application program in the originating node. This prevents unpredictable delays from queueing across several networks. The originating application can determine how to proceed with outstanding tasks, rather than having to wait through multiple levels of queueing. Tasks that are currently in progress can be allowed to continue, or can be aborted in favor of a higher priority task.

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1.7 Paths in Host Based Controllers

The AT−984 and MC−984 controllers can communicate with other nodes over the Modbus Plus network, and with the host application. These controllers also have a built−in *virtual network adapter* that allows the host application to communicate directly to the network without passing through the controller's holding registers.

1.7.1 Paths Between the Controller and Network

Four controller DM paths are available for MSTR blocks in a ladder logic program. The controller can initiate communication with other nodes using the MSTR. As a path becomes available, it will be given to a waiting MSTR. The controller can also use MSTRs to read/write global data and get/clear network statistics in its peer processor, without the need for a path.

Other nodes on the Modbus Plus network can communicate with the controller over as many as four concurrent DS paths. The nodes can use the single PS path to remotely program the controller.

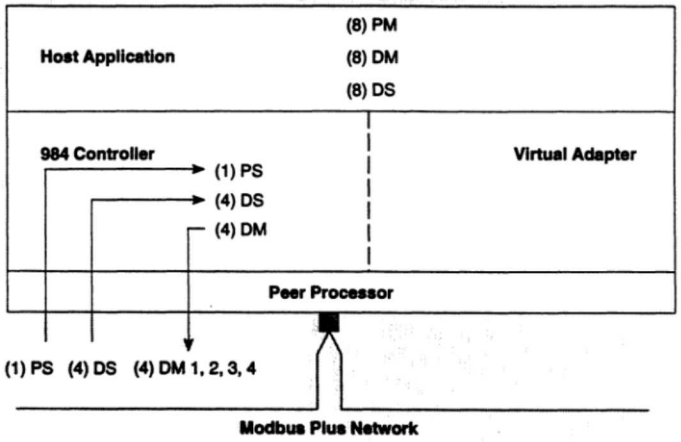


Figure 3 Paths Between the Controller and Network

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1.7.2 Paths Between the Host and Network

The host application can communicate with the peer processor, and therefore with Modbus Plus network nodes, using PM and DM paths through the virtual adapter. Eight PM paths and four DM paths are available for this purpose. This type of communication is timed to occur at the controller's end–of–scan.

Eight host DM paths are present, but paths 1 ... 4 are used only by the controller. DM paths 5 ... 8 may be used directly from the host to the network. Paths in the range 1 ... 4 will be mapped to paths in the range 5 ... 8. If more than four paths are used, the additional paths will be queued until a path 5 ... 8 becomes available.

The host application can read or clear network statistics in the peer processor. It cannot read or write global data directly to the network, but can access holding registers in the controller's logic program that are used for storing the global data.

Remote nodes cannot initiate communications directly with the host application. They can read and write controller registers, which are accessible to the host.

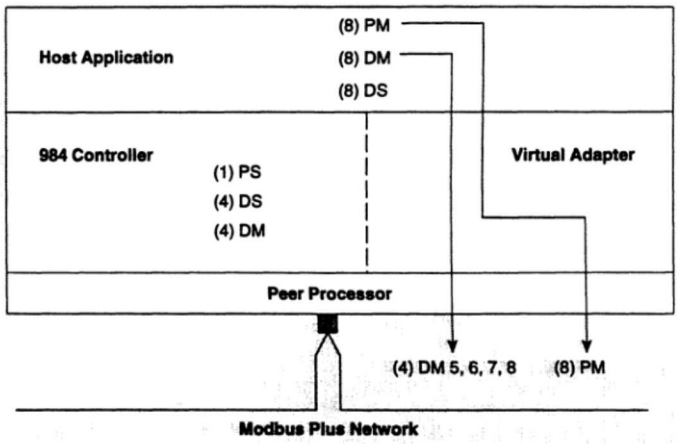


Figure 4 Paths Between the Host and Network

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1.7.3 Paths Between the Host and Controller

The host computer contains eight PM paths, while the controller has one PS path. The host may have any one of its PM paths logged into the 984 at a time.

Eight DM paths are available in the host, while the controller has four DS paths. The host can communicate with the 984 using up to four concurrent DM paths. Any additional host DM tasks will be queued. The host addresses the controller by using its network address in the first byte of the routing path (see Figure 2).

Four controller DM paths are available for MSTR blocks in a ladder logic program. The controller can communicate with its host over these paths, using the host's DS paths. As a path becomes available, it will be given to a waiting MSTR.

The controller addresses its host by using the first two bytes in the routing path (see Figure 2). Routing byte 1 is the Modbus Plus network node address for the local controller. Routing byte 2 is a host DS path number, which can be used to direct the message to an application task (range 1 ... 8) running in the host.

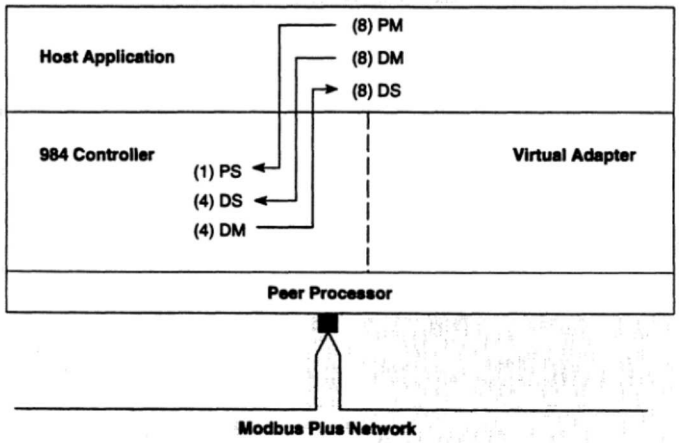


Figure 5 Paths Between the Host and Controller

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1.8 Modbus Data Access Commands

Transactions to or from programmable controller nodes are based on Modbus data access commands that are imbedded into Modbus Plus frames. These commands are recognized by controllers for reading and writing coils and registers, and for reporting status. The following Modbus commands are used:

Function Code (Decimal)	Command Name
1	Read Discrete Output Status (0*xxxx*)
2	Read Discrete Input Status (1*xxxx*)
3	Read Output Register (4*xxxx*)
4	Read Input Register (3*xxxx*)
5	Force Single Coil (0*xxxx*)
6	Preset Single Register (4*xxxx*)
7	Read Exception Status
8*	Get/Clear Network Statistics (Subfunction 21)
15	Force Multiple Coils (0*xxxx*)
16	Preset Multiple Registers (4*xxxx*)
17	Report Slave ID

* Use only subfunction 21 of function 8 for Modbus Plus networking data.

Path Requirements

All of the Modbus data access commands require a Data Master path in the initiating node. Section 1.6.2 lists the path quantities that are available in Modbus Plus devices.

Sample Programs

The sample programs on your distribution disks provide examples of how Modbus commands can be imbedded into messages to programmable controllers. The programs also show how to handle the responses from the controllers. Source code and executable files are provided.

For example, the sample program READNODE.EXE reads a controller's discrete inputs, coils, input registers, and holding registers, and displays their contents. You can examine the source file READNODE.C for programming examples.

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1.9 More Programming Information

Modbus Plus applications can be programmed using Modicon's implementation of NetBIOS commands, described in Appendixes A through C.

Instructions for running the Modbus Plus Network Diagnostic Utility program and for interpreting the network activity are contained in Appendix D.

Instructions for running the sample programs can be found in Appendix E. Your disks contain the full source code files for these programs.

For more details about using Modbus data access commands, see Appendix F.

If you would like further information about the application of your Modbus Plus network, refer to the *Modbus Plus Planning and Installation Guide*. For more information about the 984 Programmable Controller system, see the *984 Controller Systems Manual*.

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Chapter 2
The AT-984 Controller

- ☐ AT−984 Overview
- ☐ Installation Overview
- ☐ Locating the Switches
- ☐ Setting the Modbus Plus Address
- ☐ Setting the Memory Base Address
- ☐ Installing the Battery and Jumpers
- ☐ Installing the AT−984 Board
- ☐ Reading the Network Indicator
- ☐ Stopped Error Codes
- ☐ Labeling the Modbus Plus Port
- ☐ Initializing the AT−984
- ☐ AT−984 Specifications

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2.1 AT–984 Overview

The AT–984 board is a full–function 984 programmable controller designed to operate in an IBM–AT or compatible host computer. It is a full–length AT card that resides in one option slot in the host's motherboard. The host communicates directly with the controller over the AT bus. The AT–984 also acts as a Modbus Plus network node for applications running on the host PC—it can send messages generated by its host out over the Modbus Plus network.

2.1.1 984 Controller Capabilities

The AT–984 Controller contains a 16–bit word CPU, solving user logic at a rate of 1.5 ms/K words. Models AM–0984–AT0 and –AT2 provide 16K words of user memory, and support up to 7 remote drops of I/O modules. Model AM–0984–AT4 provides 32K words of user memory, and supports up to 16 remote I/O drops. All models contain an S908 Remote I/O Processor that communicates with the remote I/O system at 1.544 Mbaud.

The AT–984 supports drops of Modicon 800, 200, and 500 Series I/O modules. Each drop provides up to 512 bits in/ 512 bits out, with up to 2048 bits systemwide. Each drop can support one of the following types of remote I/O interface devices:

RIO Drop Interface	I/O Module Series	Remote ASCII Support
J890	800	None
J892	800	Two/drop
P890	800	None
P892	800	Two/drop
P451 with J291	200	None
P453 with J290	200	Two/drop
P451 with J291 and J540	500	None
P453 with J290 and J540	500	Two/drop

An F–connector at the rear panel of the board provides the remote I/O connection. The RIO cable system can operate with up to 32 dB total signal loss, including the losses for all cables, taps, and connectors.

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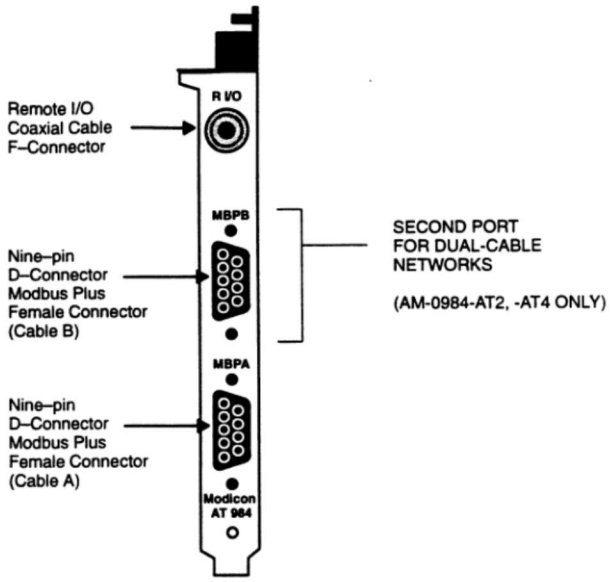


Figure 6 AT–984 Rear Panel View

2.1.2 Communications Capabilities

The AT–984 Controller communicates with its host PC over the AT bus and can communicate with other devices on a Modbus Plus network via the female nine–pin D–connector on the rear panel of the board. For dual–cable networks, the upper D–connector is for cable B (on AM–0984–AT2, AT4 only).

An AT–984 Controller is supplied with device drivers for DOS and OS/2. The drivers provide an interface to Modicon's implementation of NetBIOS commands.

2.1.3 System Planning

For further information about planning your Modbus Plus network system, see the *Modibus Plus Network Planning and Installation Guide.*

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2.2 Installation Overview

Installation of the AT−984 Controller board consists of five types of actions:

- ☐ Setting the controller's Modbus Plus address switches (see Section 2.4)
- ☐ Setting the controller's memory base address switches (see Section 2.5)
- ☐ Installing the controller's battery and setting its jumpers (see Section 2.6)
- ☐ Installing the controller board into the host and connecting it to the Modbus Plus network (see Section 2.7)
- ☐ Installing the device driver, software library, network diagnostic, and sample programs. Instructions for installing the DOS and OS/2 versions of your software are provided in separate chapters of this guide.

☞ **Note:** Before installing the AT−984, you should be familiar with methods for handling circuit boards, including methods for antistatic protection. If you are not familiar with these methods, contact Modicon for assistance.

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2.2.1 Adding or Deleting Active Nodes

If you are replacing an AT−984 as a node device on an active Modbus Plus network, you can disconnect the device's local network cable and reconnect it without powering down the devices at the network's other nodes. The network protocol will bypass the removed device, and will include it when reconnected.



Caution: If your application is dependent upon the presence of this controller node on the network, adding or deleting it as an active node can produce unpredictable results. Make sure to determine how the application will handle the network configuration before adding or deleting any node.

Before replacing an AT−984 in your application, make sure its network address switches, memory address switches, and jumpers are set correctly.

If you disconnect a node device from the network, it is not necessary to terminate its local drop connector. The connector should be left open electrically. Cover its pins to prevent damage and contamination.

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