Chapter Thirteen
Compact 984 Controllers and A120 I/O

This chapter gives an overview of the Compact Series of 984 controllers. A brief explanation of the I/O series (A120) used with the compact controller is also given. Descriptions are included in this chapter for the following items:

984-120, 130 and 145 Controllers

A120 Series Power Supplies

I/O Housings and Configurations

General Overview

Compact 984 controllers offer the same high performance, flexibility and programming language as the larger, chassis and slot-mount controllers. The Compact 984 utilizes the same instruction set for developing user logic, along with standard Modbus and Modbus Plus communication capabilities.

The Compact 984 Controllers share the following processor architecture with all other controllers in the 984 family:

A memory section that stores user logic, state RAM, and system overhead in battery-backed CMOS Ram. The system executive resides in non-volatile EPROM.

A CPU section that solves the user logic program based on the current input values in state RAM, then updates the output values in state RAM.

A I/O processing section that directs the flow of signals from input modules to state RAM, and provides a path over which output signals from the CPU's logic solve are sent to the output modules.

A communications section that provides one or more port interfaces. These interfaces allow the controller to communicate with programming panels such as the P230, hand-held diagnostic tools and other master devices, as well as additional controllers and other nodes on a Modbus (or Modbus Plus) network.

The following figure illustrates, in block diagram form, the architecture of the Compact 984.

Figure 13-1 Compact 984 Architecture - Block Diagram

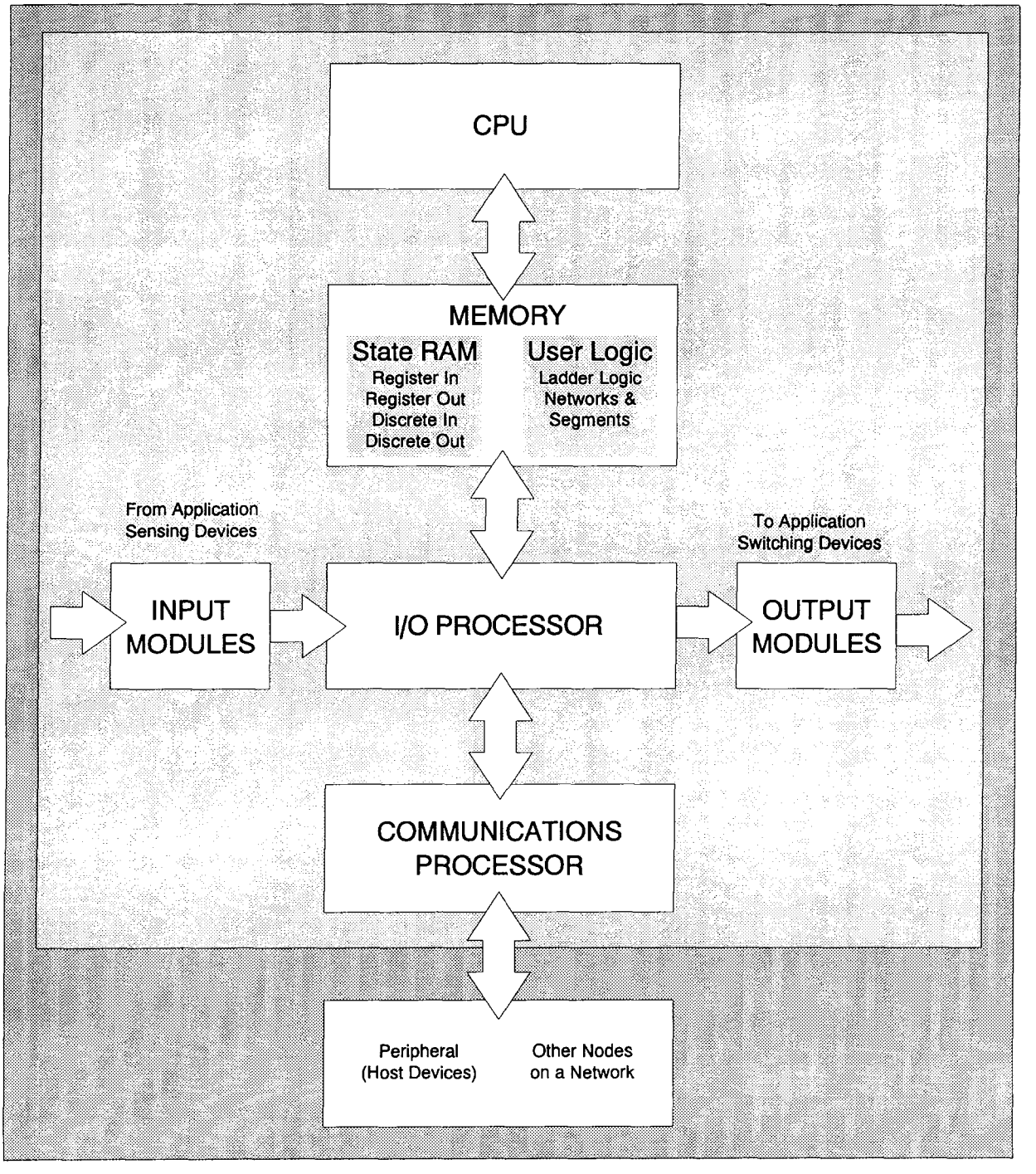
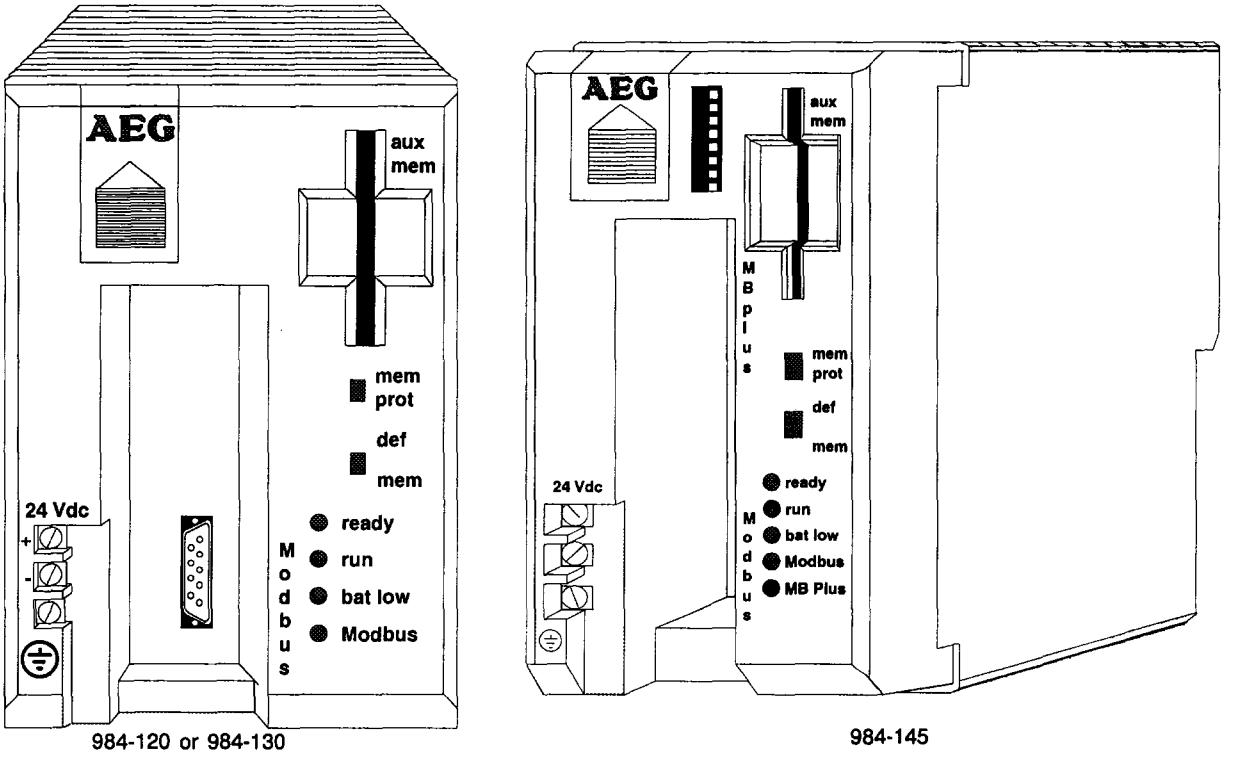


Figure 13-2 Compact 984 Controllers



CPU User Memory Options

Compact 984 Controllers are available in three models with different user memory sizes:

The 984-120 CPU with 1.5K of user memory and one Modbus communication port.

The 984-130 CPU with 4K of user memory and one Modbus communication port.

The 984-145 CPU with 8K of user memory, one Modbus and one Modbus Plus communication ports.

➤ **NOTE** User memory is the amount of memory space (one word is comprised of 16 bits) provided for user logic and for the system overhead. It is safe to assume that approximately 1K of user memory is allocated to system overhead and the remainder is available for user application logic.

An additional 2048 (16-bit) words are provided for state RAM - up to 1920 words can be used for register/analog inputs, outputs and internal data storage. Up to 2048 bits can be used for discrete inputs, outputs and internal coils.

All three Compact 984 models provide up to 256 points of local I/O. The following table summarizes the specifications for each of the three controllers.

Table 13-1. Compact 984 Specifications Summary

Controller Model	Memory Size	I/O Capacity A120 Series	Number of I/O Drops	Racks / Drop	Communications Interface(s)
984-120	1.5K	256 Discrete Points 64 Register Words	1 Local	4 Maximum	1 Modbus Port
984-130	4.0K	256 Discrete Points 64 Register Words	1 Local	4 Maximum	1 Modbus Port
983-145	8.0K	256 Discrete Points 64 Register Words	1 Local	4 Maximum	1 Modbus Port 1 Modbus Plus Port

The 984-120 (1.5K controller) and the 984-130 (4K controller) have identical front panels which incorporate the following features:

- One Modbus communication interface
- EEPROM auxiliary memory socket
- Two slide switches for memory protection and communication parameter selection
- Four indicators
- Three terminal connections for 24 VDC.

The 984-145 (8K controller) has all the same features as the 984-120 and 984-130 and includes:

- One Modbus Plus communication interface.
- One LED Indicator for Modbus Plus port activity
- One set of DIP switches for Modbus Plus parameter selection.

Refer to Figure 5-2 for the location of the features described above.

Auxiliary Memory Upload-Download Capabilities

All Compact 984 Controllers include an auxiliary memory socket for a credit-card sized EEPROM card. This card can store system configuration and user logic. This data may be read by the controller when the card is inserted in the socket, the Memory Protect slide switch is in the OFF position, and the controller is put through a power-up sequence. For more detailed information on the use of the EEPROM card for storing/loading programs, refer to the Compact 984 Controller User Guide.

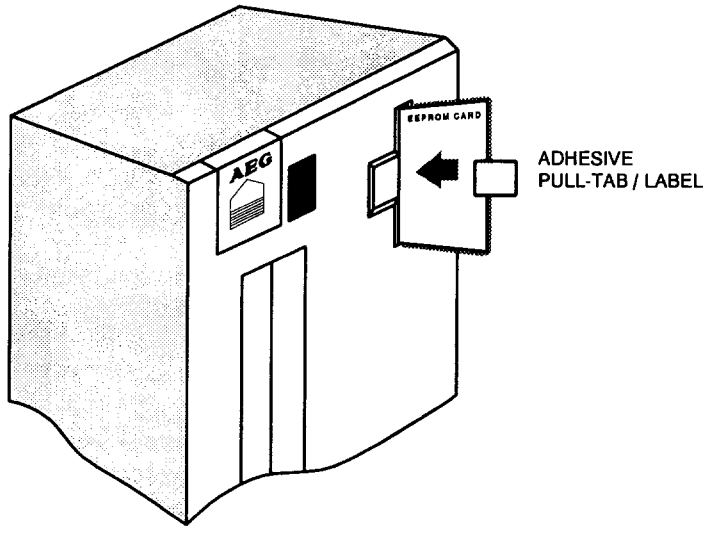
➤➤ **CAUTION AN EEPROM card may inserted into or removed from the socket only when the controller power source is OFF. Insertion or removal of the card when the controller is powered up can damage the EEPROM.**

There are two model EEPROM cards available;

- Part Number AS-MEEP-000 (32K auxiliary memory)
- Part Number AS-MEEP-001 (8K auxiliary memory)

The 8K card can be used to store programs that use under 4K words of memory. The card should be inserted in the socket with the label side facing the communication port(s) and the arrow on the label pointing into the socket. Refer to the following graphic.

Figure 13-3 Compact 984 Auxiliary Memory EEPROM Card Insertion



Slide Switches

The slide switches located on the front panel perform the memory protect function and communication parameter selection.

The memory protect switch has two functions;

Allowing an operator using a program panel to enter/edit user logic and configuration data.

Indicate whether the controller should read the configuration and user logic from an EEPROM auxiliary memory card on power-up.

To enable either of these functions, the switch must be in the OFF position.

The communication parameter switch is used to specify whether the communication parameters for the Modbus port are determined by the default settings, or through the configuration (memory) settings.

The default settings are;

- 9600 Baud
- Even Parity
- RTU Mode
- 1 Stop Bit
- 8 Data Bits
- Port Address 1

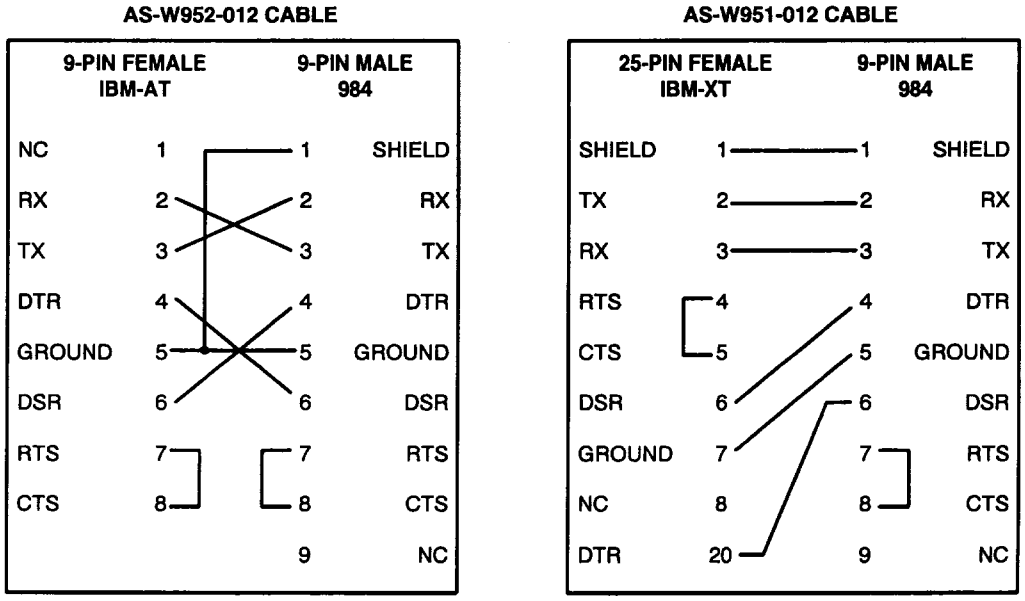
➤ **NOTE** When connecting a program panel to the controller for the first time, the program panel communication parameters must be set to correspond with the controller defaults.

➤ **NOTE** The comm parameter slide switch on the Compact 984-145 has a different function than on the 984-120/130. This is due to the Modbus Plus capability of the 984-145. Refer to the section of this chapter titled Modbus Plus Hardware on the Compact 984-145 for more information on the function of this switch.

Modbus Communication Interface

All Compact 984 Controllers include a 9-pin RS-232C connector that supports Modbus communications protocol. Modbus protocol can be used for programming or data transfer. The controller responds to transactions initiated by a host device connected to the Modbus port. The host device can be an XT type, AT type, or P230 computer. In addition the P965 Data Access Panel and multi-controller (master-slave) communication networks are supported. The pinouts for this port are as shown in the following graphic.

Figure 13-4 Compact 984 Modbus Port Cable Pinouts



TX: Transmitted Data
RX: Received Data
RTS: Request to Send
DSR: Data Set Ready
DTR: Data Terminal Ready
CD: Carrier Detect
CTS: Clear to Send
NC: No Connection

LED Indicators

The following table summarizes the LED indicators for all Compact 984 Controllers.

Table 13-2 Compact 984 Auxiliary Memory EEPROM Card Insertion

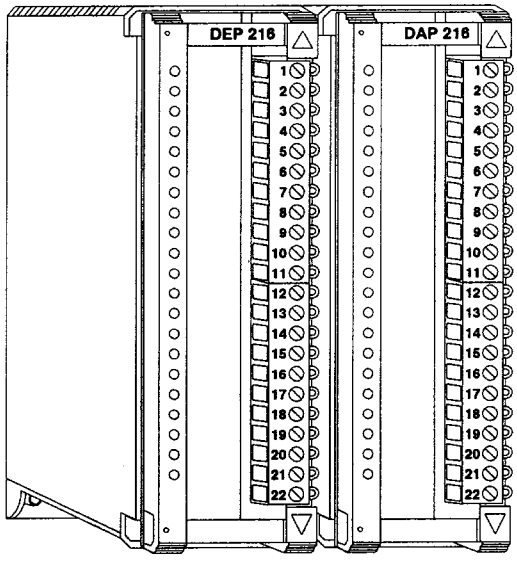
LED Label	Indication (When On)
ready (green)	Controller has passed power-up diagnostics, on whenever health status is good.
run (green)	Controller has started and is solving logic.
battery low (red)	Battery needs replacing, 14 day hold-up from time of initial indication.
Modbus (green)	Communications are active on the Modbus port.
MB Plus (green) *	**Six flashes/second:** Normal, the node is successfully receiving and passing the token. **One flash/second:** The node is off-line. **Two flashes, OFF for two seconds:** The node is hearing the token being passed to other nodes, but is not receiving the token. **Three flashes, OFF for 1.7 seconds:** The node is not hearing any other nodes, can't find another node to pass the token to. **Four Flashes, OFF for 1.4 seconds:** The node has heard a valid message from another node that is using the same address as itself.

* Refer to the section of this chapter titled Modbus Plus Hardware on the 984-145 Controller for more information regarding the flashing patterns on this LED.

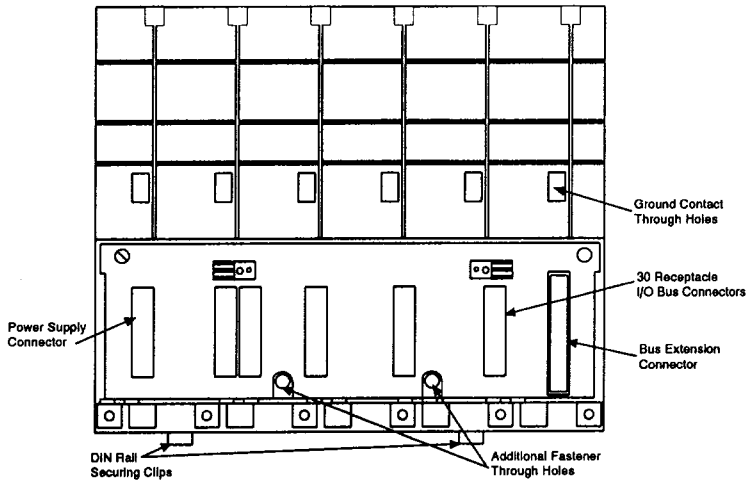
A120 I/O Support

The Compact 984 Controllers use the A120 series I/O modules. A120

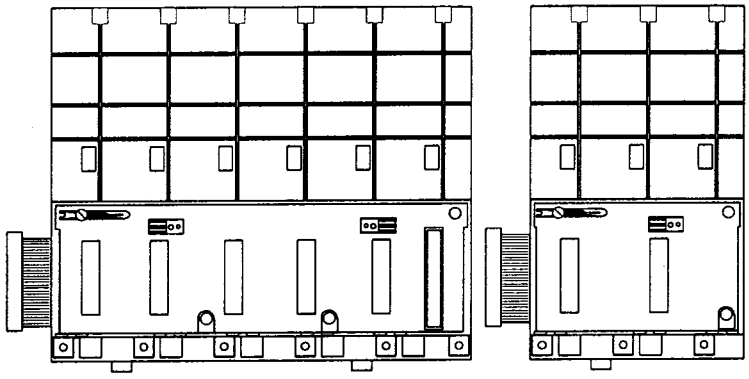
Figure 13-5 A120 I/O Modules and Housings



Typical A120 I/O Modules



A120 Primary Backplane
P.N. DTA 200



A120 Secondary Backplanes
P.N. DTA 201 & DTA 202

I/O modules are available in densities of four, eight and sixteen discrete I/O points; four analog input I/O channels; and two analog output channels.

Each module uses a standardized pair of screw-type terminal blocks that facilitate easy access and easy field wiring. Terminal blocks may be removed and modules replaced without disturbing the field wiring. A tool (Part No. AS-0TBP-000) for removing the terminal blocks is shipped with the Compact 984 Controller.

The following table lists the types of A120 I/O modules available. For more detailed information on these modules, refer to the Compact 984 Controller User Guide, Appendix B.

Table 13-3 A120 I/O Modules

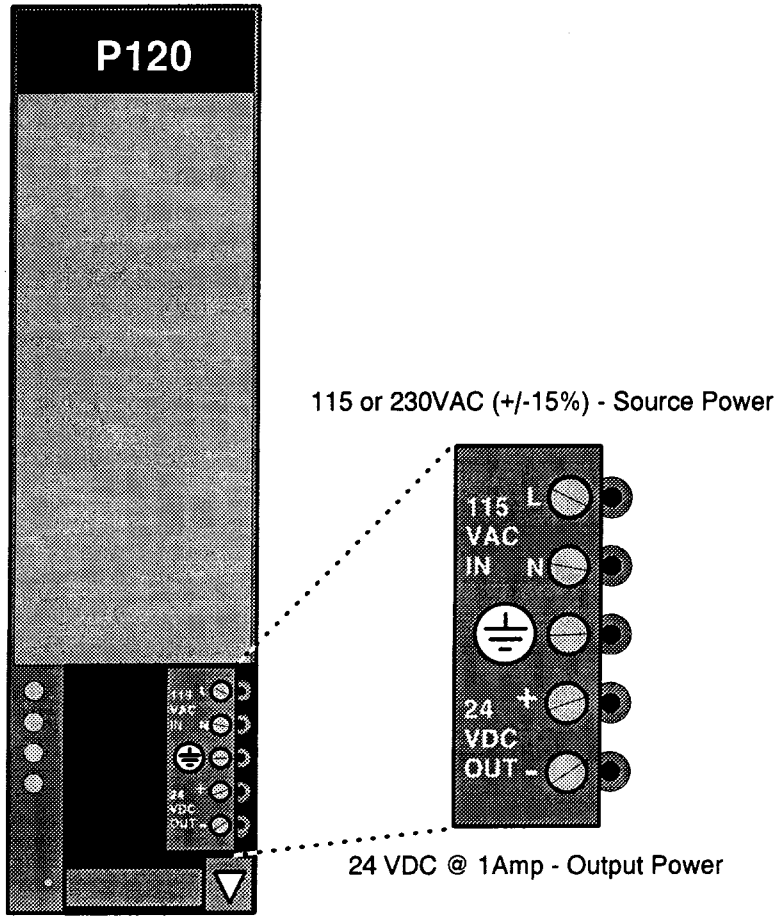
Discrete Input Modules	Part Number
8 Point 230 VAC	AS-BDEP-208
8 Point 115 VAC	AS-BDEP-209
16 Point 24 VDC (isolated)	AS-BDEP-216
16 Point 24 VDC (non-isolated)	AS-BDEO-216
16 Point 24 VDC Fast-Response	AS-BDEP-220
Discrete Output Modules	**Part Number**
4 Point Relay	AS-BDAP-204
8 Point Relay	AS-BDAP-208
8 Point 115 VAC	AS-BDAP-209
16 Point 24 VDC (isolated)	AS-BDAP-216
Discrete Combination Modules	**Part Number**
8 Point 24 VDC in / 4 Point Relay out	AS-BDAP-212
8 Point 24 VDC in / 8 Point 24 VDC out	AS-BDAP-220
Analog Input Modules	**Part Number**
4 Channel +/- 500 mV RTD	AS-BADU-204
4 Channel +/- 10 V / +/- 20 mA	AS-BADU-205
Analog Output Modules	**Part Number**
2 Channel +/- 1V, +/- 10 V, +/- 20 mA	AS-BDAU-202
Intelligent Modules	**Part Number**
1 Channel High Speed Counter/Positioning Module	AS-BZAE-201
Special Modules	**Part Number**
Blank Module with terminals for pre-wiring a slot	AS-BNUL-200
Connection multiplexer for <50V, <6A	AS-BNUL-202
16 Point input simulator for DEP 216 Module	AS-BSIM-216
2 Potentiometer, 1 meter analog simulator	AS-BSIM-203
Other Accessories	**Part Number**
Terminal block removal tool (included with controller)	AS-OTBP-000
8 toggle switch simulator for 24 VDC input modules	AS-OSIM-011

Power Supplies

The compact 984 Controllers have a built-in power supply that provides 5 VDC across the I/O bus to all I/O modules in the system. This voltage satisfies the internal power requirements for the electronics on all system modules. As many as 18 A120 I/O modules can be supported by the internal power supply.

An external 24 VDC (1A minimum) source must be connected to the Compact 984 to power the system. If the environment is all AC, the AS-P120-000 Power Supply may be used to convert the AC source to 24 VDC. The following graphic shows the P120 Power Supply and the wiring connections associated with it.

Figure 13-6 P120 Power Supply Wiring



➤ **NOTE** Some A120 I/O modules also require an external 24 VDC supply, others may require an external 115 or 230 VAC supply.

The P120 is an isolated power supply for the Compact 984 CPU when installed in an all AC voltage environment. The unit accepts input voltage at either 115 or 230 VAC (+/- 15%). The output is rated at 24 VDC - 1 Amp continuous. The P120 is designed to be inserted in any available I/O slot in the DTA 200 backplane. It does not make any connection to the bus in the backplane.

The P120 has internal over voltage protection, preventing the output voltage from exceeding 35 VDC should the supply lose regulation. If an over voltage condition is sensed, the P120 shuts down and will not restart until the AC input power source has been turned off for a minimum of 5 minutes. The P120 also has internal over current protection which permits the unit to be safely transitioned into a short circuit condition for a period no greater than 5 minutes.

The P120 has one green LED, which when ON, indicates the unit is supplying DC power within specification (+/- 5%).

Compact 984 controllers and their associated A120 I/O modules reside in backplane housings that mount on DIN EN50 022 carrier rails. A DIN rail can be attached to a flat surface or hung on an EIA rack or in a NEMA enclosure. The DIN rail also provides the functional ground point for the Compact 984 system. Refer to the Compact 984 Programmable Controller User Guide, Chapter Four, for more detailed information on mounting dimensions for DIN rails.

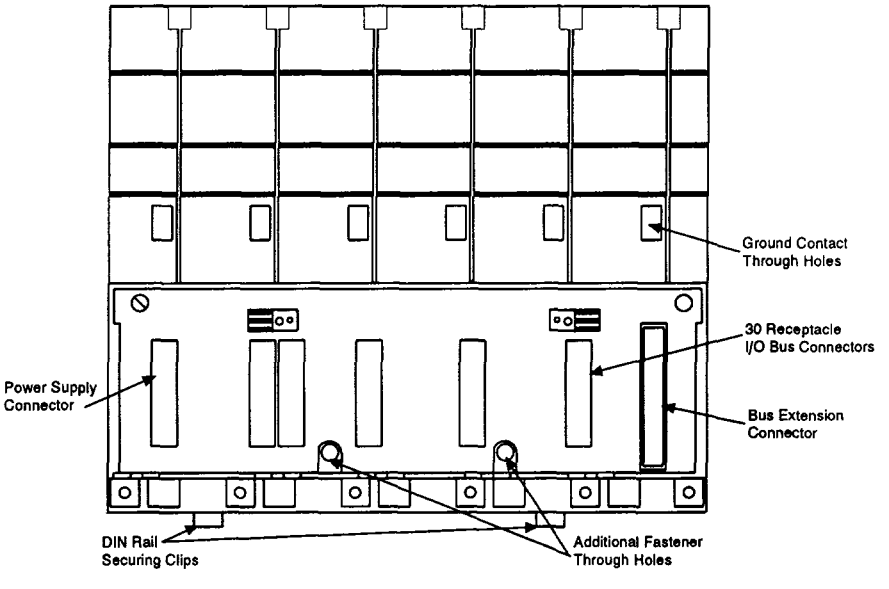
DTA Backplanes

Three types of backplanes are available;

- DTA 200 Primary Backplane (5 Slots)
- DTA 201 Secondary Backplane (5 Slots)
- DTA 202 Secondary Backpane (2 Slots)

DTA 200 Primary Backplane As a minimum the system must have one DTA 200 primary backplane. The Compact 984 CPU resides in the two left-most slots. It plugs into a 30-pin power supply connector and two 30-receptacle connectors. Three additional 30-receptacle slots are available for A120 I/O modules or option modules such as the P120 Power Supply. Only one DTA 200 backplane is used in a drop. The following graphic shows the DTA 200 and the location of the connectors described above..

Figure 13-7 DTA Primary Backplane

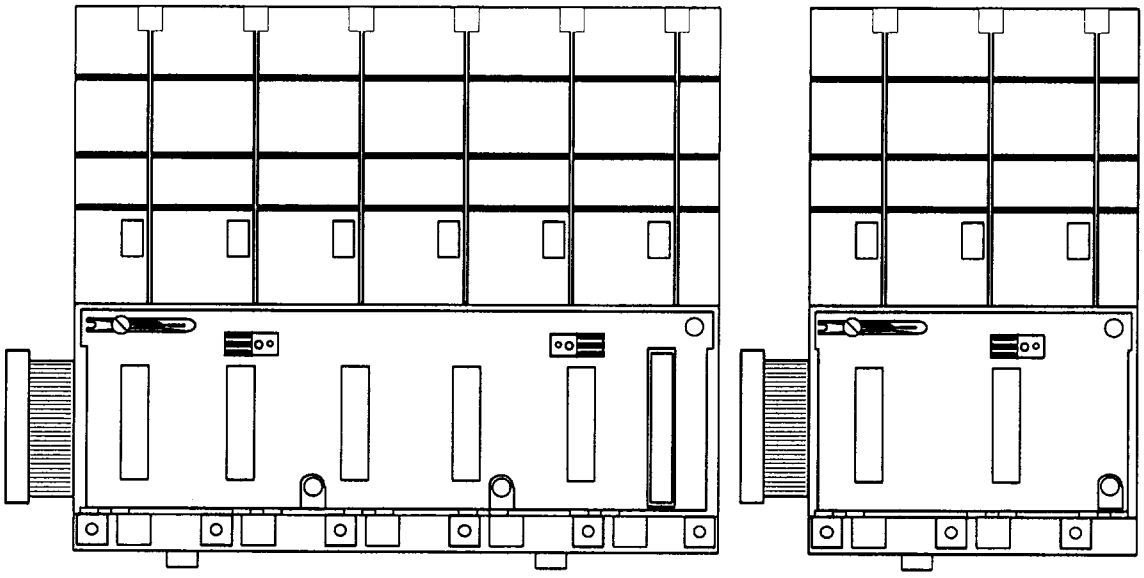


The previous graphic also shows the securing clips, which are used to lock the backplane onto the DIN rail mounting system. On the right side of the backplane is a 30-pin I/O bus extension connector that allows the system to connect to a secondary backplane (DTA 201 or DTA 202). Six through-holes provide spaces through which mounted modules may make contact with functional ground on the DIN rail.

DTA 201 and DTA 202 Secondary Backplanes Up to three secondary backplanes may be used in a drop (a maximum of four - one primary and three secondary). Secondary (or extension) backplanes may be mounted to the right of the primary on a common DIN rail, or underneath the primary on another DIN rail. The secondary backplanes have either two (DTA 202) or five (DTA 201) 30-receptacle connectors for I/O or option module insertion.

Secondary backplanes contain an I/O bus extension ribbon cable with a 30-receptacle connector. This allows backplanes to be interlocked along a common DIN rail via a ground extension strap.
The DTA 202 two-slot backplane does not have a bus extension connector on the right side, therefore only one (if desired) may be used in a drop, and it must be the last one in the drop. Up to three DTA 201 backplanes may be used in a drop.

Figure 13-8 DTA 201 and DTA 202 Secondary Backplanes



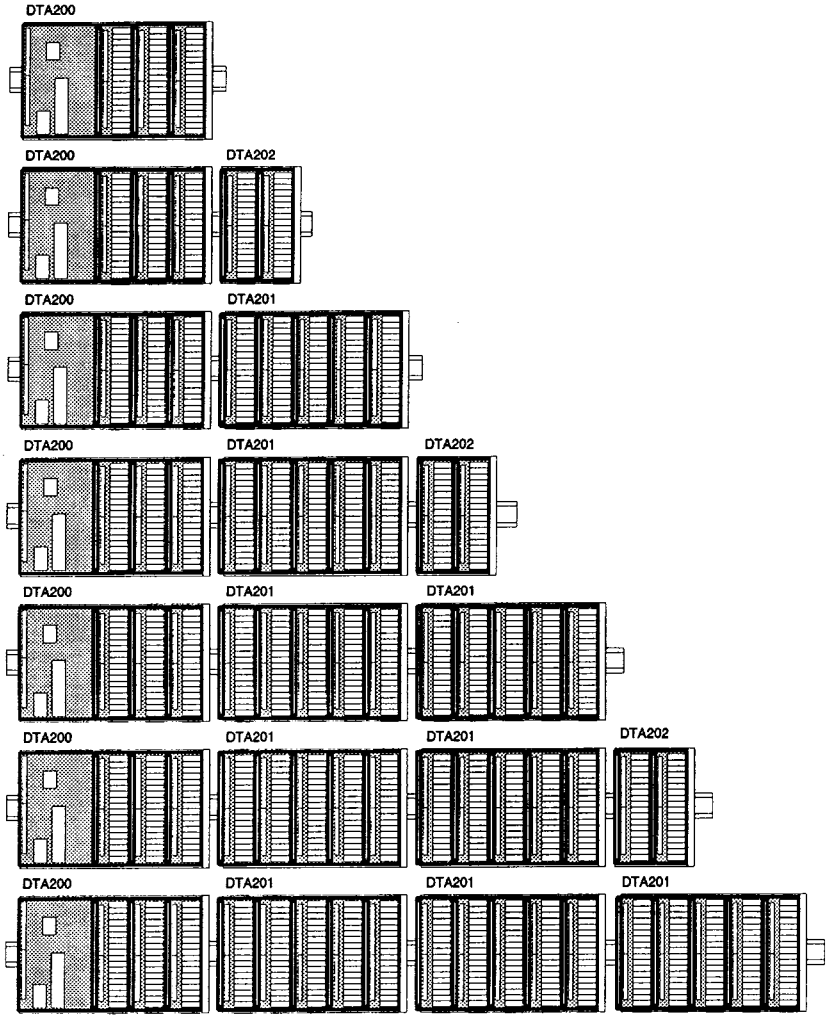
Drop Layout

Linear Layouts The left-most backplane on the DIN rail must be the DTA 200 primary backplane. Up to three secondary backplanes may be interconnected to the right of the primary. The system may use:

- One DTA 202 secondary backplane with the DTA 200
- As many as three DTA 201 secondary backplanes with the DTA 200
- One or two DTA 201 secondary backplanes together with one DTA 202 secondary backplane with the DTA 200

If a DTA 202 backplane is used, it must be the last (right-most) backplane in the drop. The following graphic illustrates the possible backplane combinations used in a linear layout.

Figure 13-9 Linear Configuration Possible Layouts

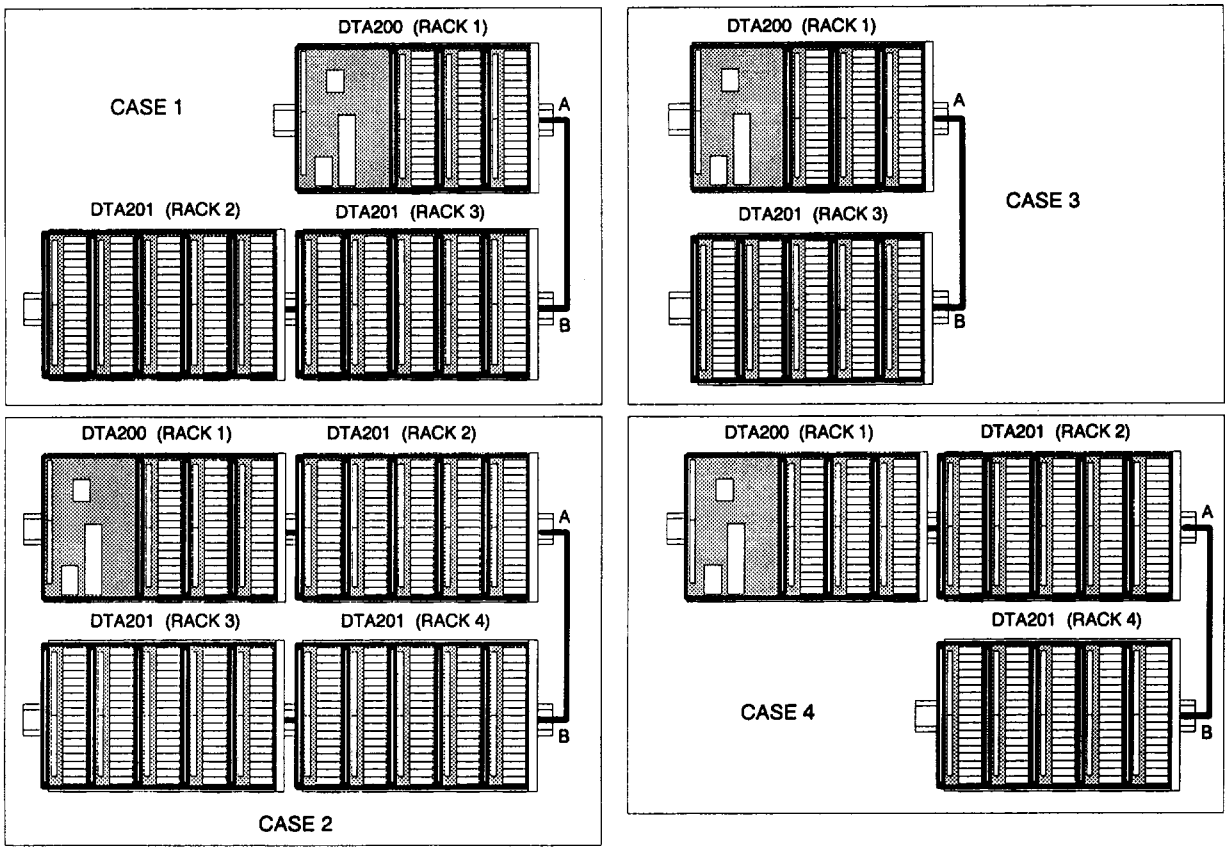


Stacked Drop Layout Backplanes in a drop may be stacked on two DIN rails and connected via a BXT 201 bus extension cable. There may be either one or two backplanes on each rail.

➤➤ **CAUTION The BXT 201 cable connectors are polarized and must be connected properly - the *A* connector *must* be attached to the top backplane, and the *B* connector *must* be attached to the bottom backplane.**

The following graphic shows the possible combinations and variations for stacked layouts.

Figure 13-10 Stacked Configuration Possible Layouts



CASE 1 A single DTA 200 Backplane over two DTA 201 backplanes; the BXT 201 runs from rack 1 to rack 3.

CASE 2 A DTA 200 backplane and one DTA 201 backplane over two DTA 201 backplanes; the BXT 201 runs from rack 2 to rack 4.

CASE 3 A single DTA 200 backplane over a single DTA 201 backplane - in this case, the BXT 201 runs from rack 1 to rack 3.

CASE 4 A DTA 200 backplane and one DTA 201 over a single DTA 201. The BXT 201 runs from rack 2 to rack 4.

➤ **NOTE** In each of the above cases, the rack number designation is the way the 984 Traffic Cop will identify each of these racks.

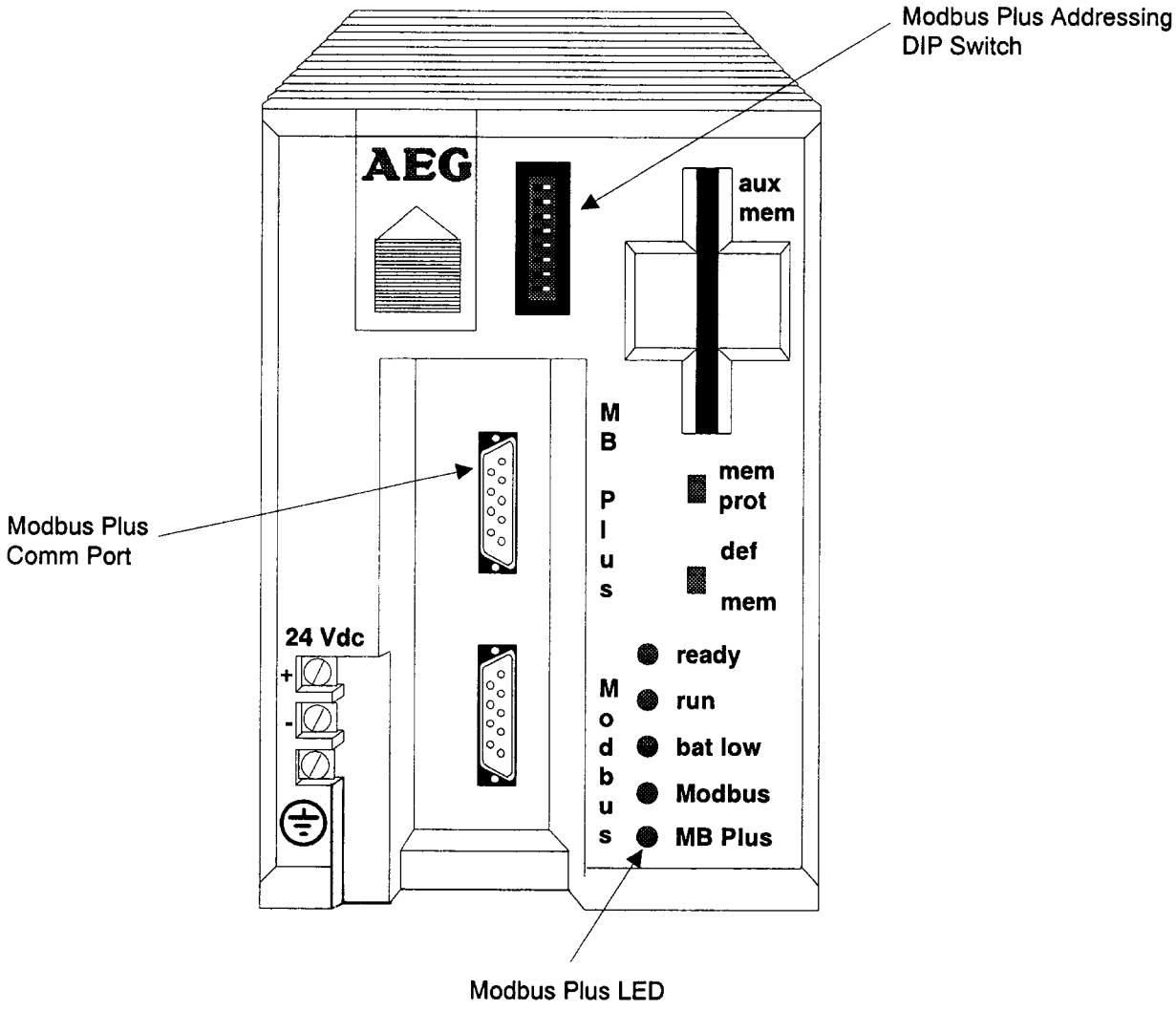
➤ **NOTE** Since the DTA 202 (two slot) secondary backplane does not have the bus extension connector on the right side, it cannot be used in a stacked configuration.

Refer to the chapter in this manual titled "System Level Specifications", for detailed instructions on mounting and installing the DTA 2XX backplanes.

Modbus Plus Hardware on the Compact 984-145

The 984-145 (8K Compact 984 Controller) has the added capability of Modbus Plus peer-to-peer networking. All of the front panel hardware on the 984-120/130 Controllers is present on the -145. In addition, the -145 provides another 9-pin comm port expressly for Modbus Plus, an addressing DIP switch to indicate the address of the controller on the Modbus Plus network, and an additional LED indicator.

Figure 13-11 The Compact 984-145 Controller (with Modbus Plus Capability)



The MB Plus LED

The MB Plus LED is a green indicator that shows the type of communication activity on the Modbus Plus port. A specific flash pattern indicates the nature of the Modbus Plus comm activity:

Six flashes per second: The normal operating state for a Modbus Plus Node. The node is successfully receiving and passing the token. All nodes on the network should be flashing this pattern.

One flash per second: The node is off-line after just being powered up, or after hearing a message from another node with the same address (duplicate addresses are not allowed). In this state, the node monitors the network and builds a table of active nodes and token-holding nodes. It remains in this state for five seconds, then attempts to go to its normal operating state.

Two flashes, then OFF for two seconds: The node is hearing the token being passed among the other nodes, but is never receiving the token. Check the network link for an open or short circuit, or defective termination.

Three flashes, then OFF for 1.7 seconds: The node is not hearing any other nodes. It is periodically claiming the token, but finding no other node to which to pass it. Check the network link for an open or short circuit, or defective termination.

Four flashes, then OFF for 1.4 seconds: The node has heard a valid message from another node that is using the same address. The node remains off-line in this state for as long as it continues to hear the duplicate address. If the duplicate address is not heard for five seconds, the node then changes to the pattern of one flash per second.

The comm parameter slide switch

The comm parameter slide switch (labeled default or mem) is used to select a bridge mode between a Modbus master device and Modbus Plus. For a detailed description of bridge mode functionality and other Modbus Plus capabilities see the chapter in this manual titled Modbus Plus Capabilities.

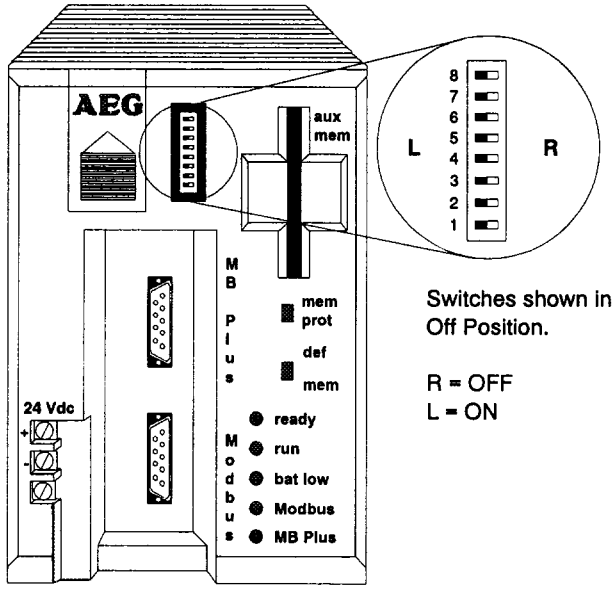
Modbus Plus Addressing DIP Switch

Each node on a Modbus Plus network must be assigned a unique address in the range 1 ... 64, using switches 1 through 6 on the addressing DIP switches. The following table defines the switch settings/addresses.

Table 13-4 Modbus Plus DIP Switch Settings (Node Address)

Address	Switch Setting 1	2	3	4	5	6
1	R	R	R	R	R	R
2	L	R	R	R	R	R
3	R	L	R	R	R	R
4	L	L	R	R	R	R
5	R	R	L	R	R	R
6	L	R	L	R	R	R
7	R	L	L	R	R	R
8	L	L	L	R	R	R
9	R	R	R	L	R	R
10	L	R	R	L	R	R
11	R	L	R	L	R	R
12	L	L	R	L	R	R
13	R	R	L	L	R	R
14	L	R	L	L	R	R
15	R	L	L	L	R	R
16	L	L	L	L	R	R
17	R	R	R	R	L	R
18	L	R	R	R	L	R
19	R	L	R	R	L	R
20	L	L	R	R	L	R
21	R	R	L	R	L	R
22	L	R	L	R	L	R
23	R	L	L	R	L	R
24	L	L	L	R	L	R
25	R	R	R	L	L	R
26	L	R	R	L	L	R
27	R	L	R	L	L	R
28	L	L	R	L	L	R
29	R	R	L	L	L	R
30	L	R	L	L	L	R
31	R	L	L	L	L	R
32	L	L	L	L	L	R

Address	Switch Setting 1	2	3	4	5	6
33	R	R	R	R	R	L
34	L	R	R	R	R	L
35	R	L	R	R	R	L
36	L	L	R	R	R	L
37	R	R	L	R	R	L
38	L	R	L	R	R	L
39	R	L	L	R	R	L
40	L	L	L	R	R	L
41	R	R	R	L	R	L
42	L	R	R	L	R	L
43	R	L	R	L	R	L
44	L	L	R	L	R	L
45	R	R	L	L	R	L
46	L	R	L	L	R	L
47	R	L	L	L	R	L
48	L	L	L	L	R	L
49	R	R	R	R	L	L
50	L	R	R	R	L	L
51	R	L	R	R	L	L
52	L	L	R	R	L	L
53	R	R	L	R	L	L
54	L	R	L	R	L	L
55	R	L	L	R	L	L
56	L	L	L	R	L	L
57	R	R	R	L	L	L
58	L	R	R	L	L	L
59	R	L	R	L	L	L
60	L	L	R	L	L	L
61	R	R	L	L	L	L
62	L	R	L	L	L	L
63	R	L	L	L	L	L
64	L	L	L	L	L	L



Switches shown in Off Position.

R = OFF
L = ON