



Installation and Start-Up Manual

HP 2250
Measurement and Control

HP 2250 Measurement and Control Processor Installation and Start-Up Manual



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Roseville Division
8000 Foothills Boulevard
Roseville, California 95678

MANUAL PART NO. 02250-90012
Printed in U.S.A.
July 1982

PRINTING HISTORY

The Printing History below identifies the Edition of this Manual and any Updates that are included. Periodically, update packages are distributed which contain replacement pages to be merged into the manual, including an updated copy of this Printing History page. Also, the update may contain write-in instructions.

Each reprinting of this manual will incorporate all past updates; however, no new information will be added. Thus, the reprinted copy will be identical in content to prior printings of the same edition with its user-inserted update information. New editions of this manual will contain new information, as well as all updates.

To determine what manual edition and update is compatible with your current software revision code, refer to the appropriate Software Numbering Catalog, Software Product Catalog, or Diagnostic Configurator Manual.

First edition	March 1981
Update 1	March 1982
Update 2	July 1982
Reprint (incorporating updates 1 and 2)	July 1982

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SAFETY CONSIDERATIONS

GENERAL - This product and relation documentation must be reviewed for familiarization with safety markings and instructions before operation.

SAFETY SYMBOLS



Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect the product against damage.



Indicates hazardous voltages.



Indicates earth (ground) terminal (sometimes used in manual to indicate circuit common connected to grounded chassis).

WARNING

The **WARNING** sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in injury. Do not proceed beyond a **WARNING** sign until the indicated conditions are fully understood and met.

CAUTION

The **CAUTION** sign denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond a **CAUTION** sign until the indicated conditions are fully understood and met.

CAUTION

STATIC SENSITIVE DEVICES

When any two materials make contact, their surfaces are crushed on the atomic level and electrons pass back and forth between the objects. On separation, one surface comes away with excess electrons (negatively charged) while the other is electron deficient (positively charged). The level of charge that is developed depends upon the type of material. Insulators can easily build up static charges in excess of 20,000 volts. A person working at a bench or walking across a

floor can build up a charge of many thousands of volts. The amount of static voltage developed depends on the rate of generation of the charge and the capacitance of the body holding the charge. If the discharge happens to go through a semiconductor device and the transient current pulse is not effectively diverted by protection circuitry, the resulting current flow through the device can raise the temperature of internal junctions to their melting points. MOS structures are also susceptible to dielectric damage due to high fields. *The resulting damage can range from complete destruction to latent degradation.* Small geometry semiconductor devices are especially susceptible to damage by static discharge.

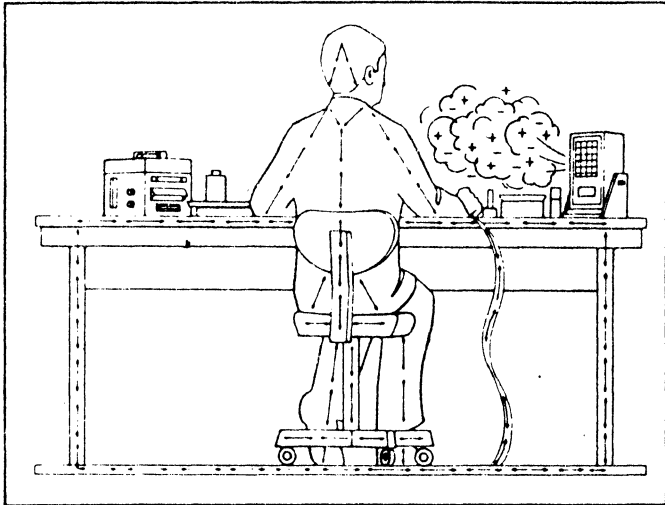
The basic concept of static protection for electronic components is the prevention of static build-up where possible and the quick removal of already existing charges. The means by which these charges are removed depend on whether the charged object is a conductor or an insulator. If the charged object is a conductor such as a metal tray or a person's body, grounding it will dissipate the charge. However, if the item to be discharged is an insulator such as a plastic box/tray or a person's clothing, ionized air must be used.

Effective anti-static systems must offer start-to-finish protection for the products that are intended to be protected. This means protection during initial production, in-plant transfer, packaging, shipment, unpacking and *ultimate use.* Methods and materials are in use today that provide this type of protection. The following procedures are recommended:

1. All semiconductor devices should be kept in "antistatic" plastic carriers. Made of transparent plastics coated with a special "antistatic" material which might wear off with excessive use, these inexpensive carriers are designed for short term service and should be discarded after a period of usage. *They should be checked periodically to see if they hold a static charge greater than 500 volts in which case they are rejected or recoated.* A 3M Model 703 static meter or equivalent can be used to measure static voltage, and if needed, carriers (and other non-conductive surfaces) can be recoated with "Staticide" (from Analytical Chemical Laboratory of Elk Grove Village, Ill.) to make them "antistatic."
2. Antistatic carriers holding finished devices are stored in transparent static shielding bags made by 3M Company. Made of a special three-layer material (nickle/polyester/polyethylene) that is "antistatic" inside and highly conductive outside, they provide a Faraday cage-like shielding which protects devices inside. "Antistatic" carriers which contain semiconductor devices should be kept in these shielding bags during storage or in transit.

Individual devices should only be handled in a static safeguarded work station.

3. A typical static safeguarded work station is shown below including grounded conductive table top, wrist strap, and floor mat to discharge conductors as well as ionized air blowers to remove charge from nonconductors (clothes). Chairs should be metallic or made of conductive materials with a grounding strap or conductive rollers.



SAFETY EARTH GROUND - This is a safety class I product and is provided with a protective earthing terminal. An uninterrupted safety earth ground must be provided from the main power source to the product input wiring terminals, power cord, or supplied power cord set. Whenever it is likely that the protection has been impaired, the product must be made inoperative and be secured against any unintended operation.

BEFORE APPLYING POWER - Verify that the product is configured to match the available main power source per the input power configuration instructions provided in this manual.

If this product is to be energized via an auto-transformer (for voltage reduction) make sure the common terminal is connected to the earth terminal of the main power source.

SERVICING

WARNING

Any servicing, adjustment, maintenance, or repair of this product must be performed only by qualified personnel.

Adjustments described in this manual may be performed with power supplied to the product while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.

Capacitors inside this product may still be charged even when disconnected from its power source.

To avoid a fire hazard, only fuses with the required current rating and of the specified type (normal blow, time delay, etc.) are to be used for replacement.

WARNING

EYE HAZARD

Eye protection must be worn when removing or inserting integrated circuits held in place with retaining clips.

INPUT POWER DISTRIBUTION

HP 2250 Measurement & Control Systems are provided with a heavy duty on/off power switch. The power switch controls ac power for all devices in a single bay. Specifically, power is switched for the power supply and the cooling fans on the HP 2104 Processor Unit and HP 2251 Measurement & Control Unit.

An electrical ratings label is located on the outside of each cabinet that requires ac input power. HP 2250 systems do not have an integral circuit breaker. They should be connected to a circuit that has a breaker that exceeds the maximum amperage requirements of the system including all the cabinets.

NOTE

Input power wiring must be provided to the cabinet power switch box. This wiring should exceed both the voltage and current specified by the electrical ratings label. In addition, safety precautions require that the input power wiring be kept physically separated from any other wiring entering or inside the cabinet. The recommended method of meeting this requirement is by locating the input power wiring inside flexible conduit directly to the power switch box. All wiring should also meet the requirements specified by local electrical codes.

NOTE

All wiring installation and changes should be done with AC power off and only by a qualified electrician.

INPUT WIRING SPECIFICATIONS

The following specifications describe the ac power wiring:

Maximum voltage rating: 300 Volts AC

Maximum current carrying: 10 Amps

Maximum operating temperature: 65 degrees C

Maximum number of power cords per switch for power supplies and/or cooling fans: 4

Maximum number of cabinets powered by one power switch: 1

INPUT POWER WIRING

Refer to the wiring diagram attached to the power switch when using the following instructions. AC input power wiring should be attached to the cabinet as follows:

- 1) Remove the switch box cover by loosening the two screws.
- 2) Route the input wiring through the switch box knockout and clamp the flexible conduit or wiring so as to provide substantial strain relief to the wiring.

3) Attach spade lugs to the voltage, or "hot," neutral and ground lines.

4) The ground wire should be attached to the ground post inside the switch box. The ground post has a label with the ground symbol next to it. Loosen the two nuts on the ground post and place the ground lug from the input power wiring underneath the nuts. Retighten the two nuts securely.

5) The hot side of the switch is the side with the brown wire from the power supply cable. Attach the hot side of the input power wiring to the empty screw terminal on that side of the switch. Securely tighten the switch.

6) Attach the neutral side of the input power wiring to the empty screw terminal on the other side of the power switch. The other screw terminal on that side of the switch has a blue wire connected to it from the power supply. Securely tighten the screw terminal.

7) Being careful to not snag any wiring, replace the switch cover and tighten the two retaining screws.

8) Before applying ac power to the system, verify that the power supply and cooling fan voltage settings are correct for the voltage being applied.

ADDING ADDITIONAL POWER CORDS TO THE SYSTEM POWER SWITCH

When it is necessary to add additional power supplies or measurement & control units to the system, they may also be switched by the cabinet power switch. Refer to the wiring diagram while using the following instructions to add power cables to the switch:

1) Disconnect AC power at the circuit breaker or some point in the circuit prior to the 2250 system.

2) Remove the covers from the set screw connectors by twisting their cap while holding the wiring stationary. Loosen the set screw and remove the wiring.

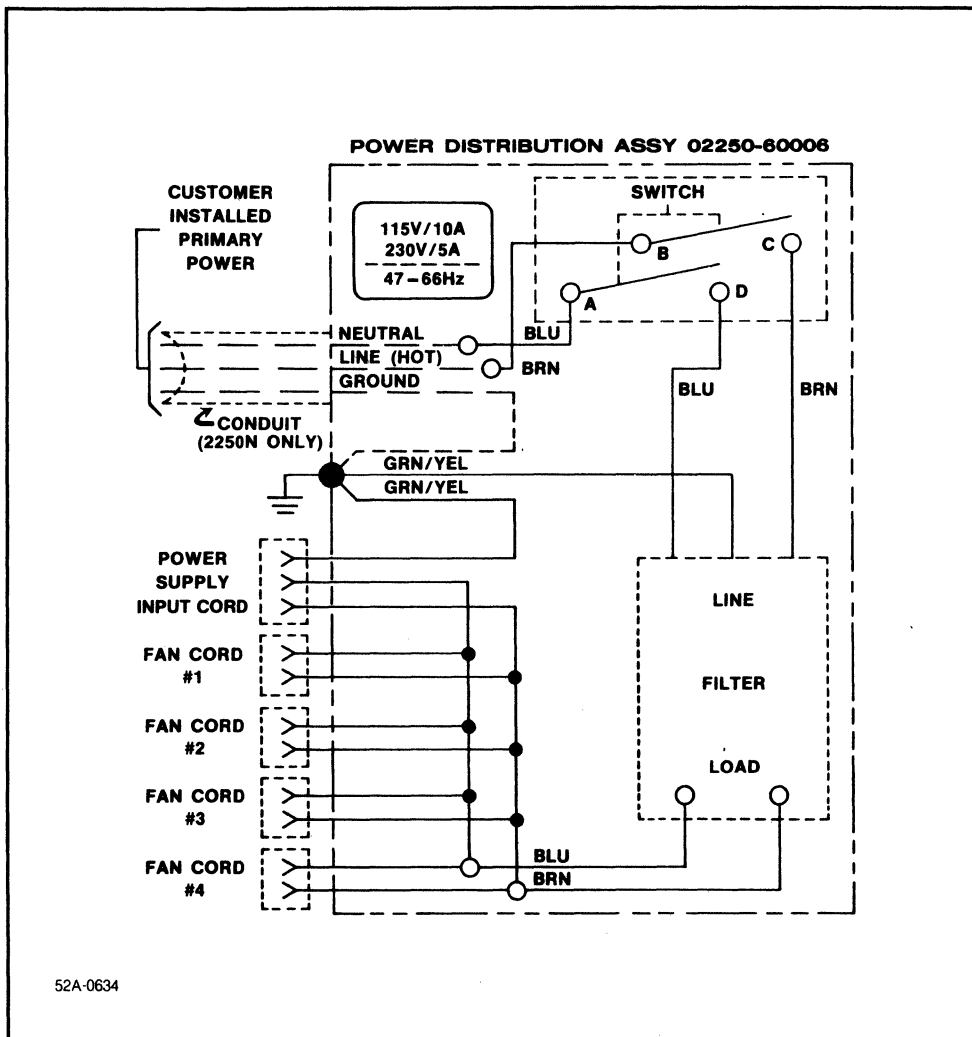
3) The fan cords have no polarity and therefore their cables can be arbitrarily added to the set screw connectors. The power supply cable has the following polarity — hot = brown, neutral = blue. Attach the brown wire to the bundle of cables that include the black wire to the switch. Add the blue wire to the bundle of cables that include the white wire to the switch.

4) Reinsert the wires into the metal sleeve and securely tighten the set screw. Reattach the plastic cap and tighten.

5) Being careful to not snag any wiring, replace the switch cover and tighten the two retaining screws.

6) Before applying the ac power to the system, verify that the power supply and cooling fan voltage settings are correct for the voltage being applied.

AC POWER WIRING



PREFACE

This manual provides installation and start-up information for the HP 2250 Measurement and Control Processor hardware. Information is included for cabinets, card frames, and printed circuit cards.

The manual is divided into four sections and one appendix as follows:

Section I -- Introduction

Describes the HP 2250 and its components.

Section II -- Installation

Provides unpacking instructions and installation procedures including mechanical and electrical requirements, and environmental considerations.

Section III -- Start-Up Procedure

Provides information required to start the system.

Section IV -- Service

Instructions are provided for performing self-tests and diagnostics, and removing and replacing assemblies.

Appendix A -- Field Wiring Practices

Contains general field wiring information which may be applied to any automation system or measurement and control system.

Additional information for the HP 2250 is included in the following manuals:

- a. HP 2250 Measurement and Control Processor Programmer's Manual, part no. 25580-90001.

- b. HP 2250 Measurement and Control Processor System Introduction Manual, part no. 02250-90011.
- c. HP 2250 Measurement and Control Processor Hardware Reference Manual, part no. 02250-90001.
- d. HP 25581A Automation Library Manual, part no. 25581-90001.
- e. HP 25582A Automation Library for Desktop Computers, part no. 25582-90001.
- f. HP 2250 Measurement and Control Processor Diagnostic and Verification Manual, part no. 25595-90001.

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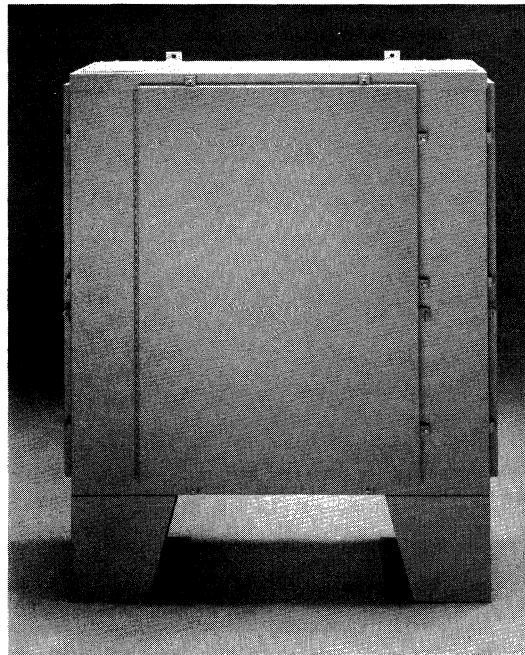
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A Field Wiring Practices



HP-2250R
Rack-mounted for
laboratory, control room,
and light industrial
applications.
It is shown here with an
HP 1000 Model 45
Computer System.



HP 2250N
NEMA-12 sealed enclosure
for factory floor application.

2250-1H

Figure 1-1. HP 2250 Measurement and Control Processors

SECTION I INTRODUCTION

1.1 INTRODUCTION TO THE MODEL 2250

This manual covers installation and start-up instructions for the HP 2250 Measurement and Control Processor.

The HP 2250 is designed for computer controlled automation tasks including data acquisition, data reduction, engineering unit conversions, data comparisons for decision making, execution of control algorithms, control actions and updates, and alarm task scheduling.

When using the HP 2250 for data acquisition, you may do the following: detect discrete input signals such as the on or off state of a switch; measure continuously variable input signals such as temperature, pressure, speed, or voltage; set up discrete output signals such as the "on" or "off" state of an output relay; and generate continuously variable output signals such as valve position or current.

HP 2250 Measurement and Control Processors, shown in figure 1-1, are mounted in cabinets or racks and consist of an HP 2104 Processor Unit, one or more (up to eight) HP 2251 Measurement and Control Units (MCUs), and up to eight function cards (per MCU) to measure and control external analog and digital devices. The function cards provide the capability for up to 2048 channels of measurement and control.

1.2 HP 2250 CONFIGURATIONS

Figure 1-2 shows the components for the different system configurations of the HP 2250. Digital and analog function cards perform I/O for the system. These function cards are installed in the HP 2251 Measurement and Control Unit (MCU). Digital and analog signal conditioning modules are mounted on the function cards to tailor the function card for interfacing to the different types of external sensors and actuators. The HP 2104 Processor Unit consists of a card frame and several cards which control the operation of the HP 2250.

Introduction

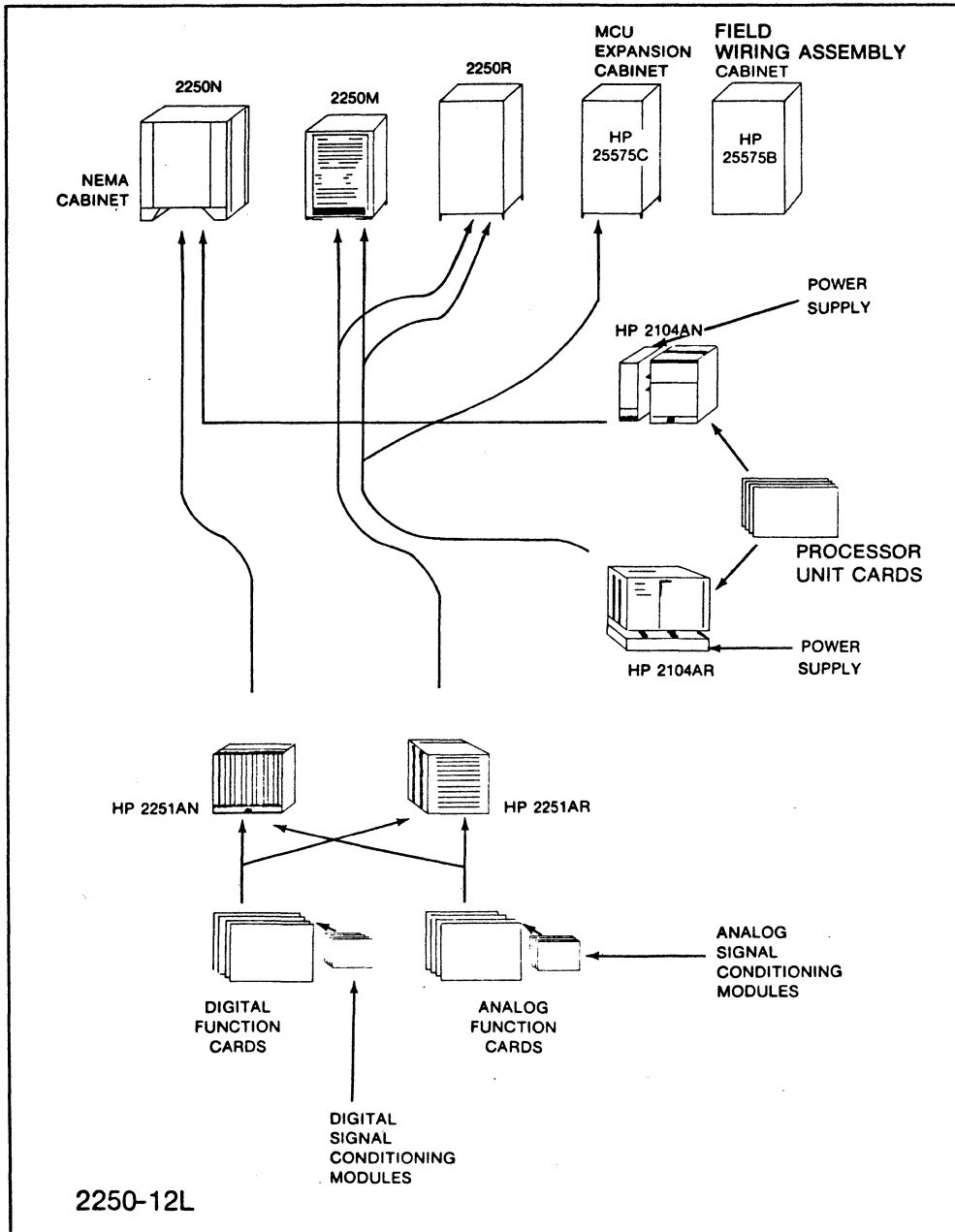


Figure 1-2. HP 2250 Components

Different combinations of the HP 2104 and HP 2251 comprise the several system configurations of the HP 2250.

The different system configurations (shown in figure 1-3) are as follows:

HP 2250M MEASUREMENT AND CONTROL PROCESSOR

The HP 2250M is a complete measurement and control system in a small, mobile cabinet. The HP 2250M contains an HP 2104 Processor Unit, one HP 2251 Measurement and Control Unit, and provision for mounting up to ten field wiring assemblies (FWAs).

Options: -010 HP 12013A Battery Backup

-015 230 volt, 50 Hz operation

HP 2250N MEASUREMENT AND CONTROL PROCESSOR

The HP 2250N is a measurement and control processor in an industrial NEMA-12 cabinet. The HP 2250N contains an HP 2104 Processor Unit, nine additional card slots for adding an HP 2103LK Board Computer, up to two HP 2251 Measurement and Control Units (one required), and up to 40 field wiring assemblies (FWAs).

NOTE

NEMA stands for the National Electrical Manufacturer's Association, which defines standards for electrical equipment, including cabinets. A NEMA Type 12 cabinet, such as is used to house the HP 2250N, is defined as being moisture resistant, and dust resistant. In addition, the cabinet is designed to provide the necessary cooling surface for the heat from electronic components, up to 50 degrees C external temperature.

Options:

-010 HP 12013A Battery Backup

-015 230V, 50 Hz operation.

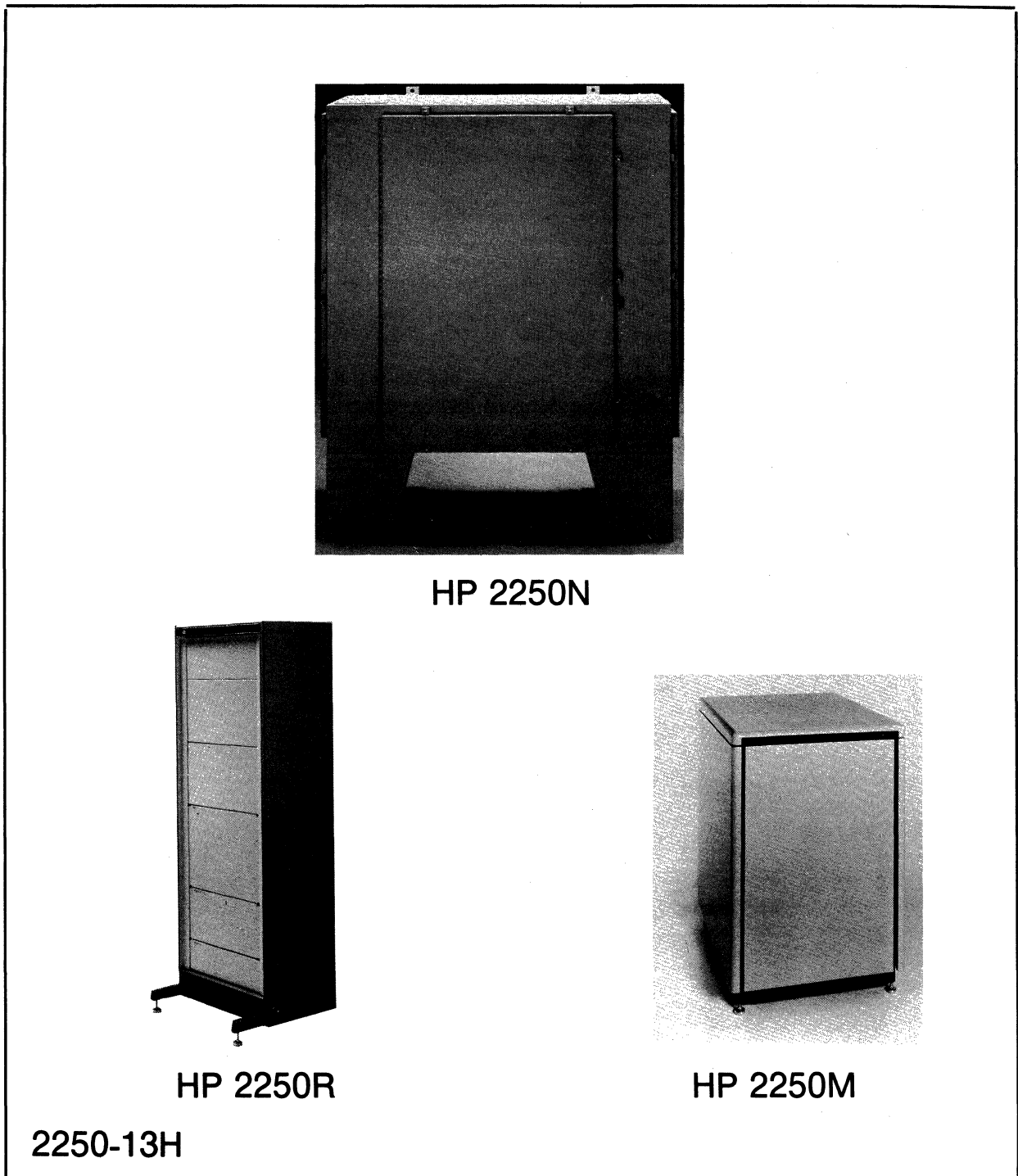


Figure 1-3. HP 2250 System Configurations

HP 2250R MEASUREMENT AND CONTROL PROCESSOR

The HP 2250R is a measurement and control processor in an upright, standard 19-inch cabinet. The HP 2250R contains an HP 2104 Processor Unit, and provision for two (one required) HP 2251 Measurement and Control Units, and up to 20 FWAs. This model can be expanded (using additional cabinets) to mount up to six more (eight total) HP 2251AR Measurement and Control Units (MCUs) and up to 135 more (195 total) FWAs.

Options:

- 001 One additional HP 25575B cabinet with space for 45 FWAs.
Total capacity: Two MCUs, 16 function cards, 65 FWAs.
- 002 Two additional HP 25575B cabinets, each with space for 45 FWAs.
One additional HP 25575C cabinet, with space for one power supply, three MCUs, and 20 FWAs.
Total capacity: Five MCUs, 40 function cards, 130 FWAs.
- 003 Three additional HP 25575B cabinets, each with space for 45 FWAs.
Two additional HP 25575C cabinets, each with space for one power supply, three MCUs, and 20 FWAs.
Total capacity: Eight MCUs, 64 function cards, 195 FWAs.
- 010 HP 12013A Battery Backup
- 015 230 volt, 50 Hz operation
- 016 Same as option -002, except with 230 volt, 50 Hz operation (option -015).
- 017 Same as option -003, except with 230 volt, 50 Hz operation (option -015).

1.2.1 HP 2251AN/AR Measurement and Control Unit

There are two models of the HP 2251 Measurement and Control Unit (MCU):

HP 2251AN Measurement and Control Unit:

Designed for mounting in a NEMA enclosure, for use with the HP 2250N.

HP 2251AR Measurement and Control Unit:

Designed for rack mounting in cabinets, for use with the HP 2250M and HP 2250R.

The two models of the MCU are shown in Section II, figures 2-20 and 2-21. Each MCU consists of a function card frame and a backplane wiring assembly. The function card frame contains a Backplane Interface (BIF) card (part number 25574-60001) and up to eight function cards. The types of function cards available are:

- HP 25501A 16-Channel High-Speed Analog Input
- HP 25502A 32-Channel High-Level Multiplexer
- HP 25503A 32-Channel Low-Level Multiplexer
- HP 25504A 16-Channel Relay Multiplexer
- HP 25510A 4-Channel Voltage/Current Analog Output
- HP 25511A 32-Point Digital Input
- HP 25512A 4-Channel Counter
- HP 25513A 32-Point Digital Output
- HP 25514A 16-Point Relay Output
- HP 25515A 4-Channel Pulse Output
- HP 25516A 16-Point Digital Multifunction

Signal conditioning modules, which are small printed circuit assemblies, are mounted on the function cards in order to tailor the function card for interfacing to many types of actuators and sensors. The different types of signal conditioning modules (SCMs) are as follows:

- HP 25531B/C/D/E/K/L One-Point Non-Isolated Digital Input
- HP 25533B/C/D/E/F/G/H/I One-Point Isolated Digital Input
- HP 25535B/C/D/E/K/L Four-Point Non-Isolated Digital Input
- HP 25537B/C/D/E/F/G/H/I Four-Point Isolated Digital Input
- HP 25539A/B/G/H/I 4-Channel Relay Arc Suppression
- HP 25543A Four-Channel Isolated Output
- HP 25544A/B/C Four-Channel Non-Isolated Output
- HP 25545A Two-Channel Solid State Relay Output

From one to eight MCUs are included in a HP 2250 system, depending on the configuration and application.

1.2.2 HP 2104AN/AR Processor Unit

The HP 2104 Processor Unit performs task processing, and data computation and conversion for the HP 2250 system. Briefly, it compiles and executes requests from the controller (host computer system), and converts measurement and control data resulting from these requests. For a complete description of the HP 2104, see the HP 2250 Measurement and Control Processor Hardware Reference Manual, part number 02250-90001.

As with the MCU, the processor unit has two models:

HP 2104AN Processor Unit:

Designed for mounting in a NEMA enclosure, for use with the HP 2250N.

HP 2104AR Processor Unit:

Designed for rack mounting in cabinets, for use with the HP 2250M and HP 2250R.

The two models of the HP 2104 are shown in Section II, figures 2-7 and 2-10. Each unit consists of a card frame, a backplane wiring assembly, an HP 12035A Power Supply, and the following cards:

- HP 12001D Processor
- HP 12070B RAM/ROM/STACK (RRACK) Memory
- HP 12071A Measurement and Control Interface (MCI)
- HP 12009A HP-IB Interface

Optional cards for the processor unit are:

- HP 12013A Battery Backup
- HP 37203L HP-IB Modem



SECTION II INSTALLATION

2.1 INTRODUCTION

This section provides complete installation instructions for the HP 2250 Measurement and Control Processor. To assist you, an installation check list is provided in table 2-1.

Information on installing cabinets and card frames is included. (Card frame installation is necessary for addition, replacement, or when being installed in customer cabinets.)

Instructions for the removal and replacement of printed circuit cards are also contained.

Site preparation is also briefly discussed. Further information is provided in the HP 2250 Measurement and Control Processor Site Preparation Manual, part no. 02250-90010.

Installation of the HP 2250, excluding field wiring, will usually be performed by Hewlett-Packard engineers under certain contractual agreements. In those cases where installation is to be performed by the user, Hewlett-Packard engineers are available for consultation on both site preparation and installation. For details on Hewlett-Packard assistance available to you, check with your local HP Sales and Service Office listed at the rear of this manual.

Information on general field wiring practices for measurement and control systems is provided in Appendix A of this manual.

Installation

Table 2-1. Installation Check List

1.0 SITE PREPARATION	
Environmental	OK? _____
Power Requirements	OK? _____
Cooling Requirments	OK? _____
Mounting Considerations	OK? _____
Weight Considerations	OK? _____
Access Space	OK? _____
2.0 UNPACKING AND INSPECTION	
Manual Updating Required?	YES _____
	DONE? _____
	NO _____
Equipment Inventory	OK? _____
3.0 INITIAL SWITCH SETTINGS	
Internal Switch and Jumper Settings	OK? _____
Line Voltage Selection	OK? _____
Select Codes	OK? _____
HP-IB Address	OK? _____

Table 2-1. Installation Check List (Continued)

4.0 INSTALLATION		
NEMA Cabinet	OK?	_____
Rack Cabinet	OK?	_____
HP 2104	OK?	_____
HP 2251	OK?	_____
SCMs	OK?	_____
Function Cards	OK?	_____
Power Supply	OK?	_____
Cables (Power and Control)	OK?	_____
5.0 START UP		
Power Supply Check	OK?	_____
Self-Test	OK?	_____
6.0 FIELD WIRING INSTALLATION	COMP?	_____

2.2 SITE PREPARATION

Site preparation for the HP 2250 includes environmental limitations, power requirements, and mounting or location considerations. These points are covered in the following paragraphs. For more extensive information on site preparation, refer to the HP 2250 Site Preparation Manual (part no. 02250-90010), which may be obtained through your local Hewlett-Packard Sales and Service Office.

2.2.1 Environmental Limitations

Environmental limitations for operating and non-operating conditions are specified in table 2-2.

As noted in Section I, the HP 2250N Measurement and Control Processor is designed for applications where the environmental conditions are moderately severe. It complies with the NEMA-12 specification including dust and dirt protection, water damage, and physical damage. The complete NEMA 12 specification will be found in the National Electrical Manufacturer's Association Publication No. (IS 1.1). (NEMA are initials standing for the National Electrical Manufacturers Association.)

2.2.2 Power Requirements

HP 2250 systems are shipped with the power supply set to operate from a single-phase power source of 86 VAC to 127 VAC or 195 VAC to 253 VAC as specified in the purchase order. Information on changing from 115 VAC operation to 230 VAC operation is in Section III in the paragraph titled "115/230 VAC Reconfiguration."

Various safety codes require that the equipment chassis, panels, and housings be grounded to protect operating and service personnel. A grounded three-conductor female power outlet must be made available to satisfy this requirement.

The HP 2250 operating input power ratings to the mainframe with one HP 12035A Power Supply installed are presented in table 2-3.

Table 2-2. Environmental Limitations

<p>AMBIENT TEMPERATURE</p> <p>Laboratory and Non-NEMA Industrial Systems:</p> <p>Operating: 0 - 40 degrees C (32 - 104 degrees F)</p> <p>Nonoperating: -40 - 75 degrees C (-40 - 167 degrees F)</p> <p>NEMA Cabinet Industrial Systems:</p> <p>Operating: 0 - 50 degrees C (32 - 122 degrees F)</p> <p>Nonoperating: -40 - 75 degrees C (-40 - 167 degrees F)</p>	
<p>ALTITUDE</p> <p>Nonoperating: 15,300 metres (50,000 ft)</p> <p>Operating: 4,600 metres (15,000 ft)</p>	
<p>RELATIVE HUMIDITY</p> <p>Up to 95% at 50 degrees C (122 degrees F), without condensation</p>	

Installation

Table 2-3. Mainframe Power Requirements

VOLTAGE (range switch selected)	
115 VAC (nominal):	range 86-127 VAC at 47-66 Hz
230 VAC (nominal):	range 195-253 VAC at 47-66 Hz
POWER	
Input:	800 Watts, max.
POWER SUPPLY INPUT FUSE	
115 VAC range:	7A, 3AG
230 VAC range:	3.5A, 3AG

Note that the HP 2104 Processor Unit is shipped with one HP 12035A Power Supply. This power supply will power the processor unit and up to two HP 2251 Measurement and Control Units (MCUs). If more MCUs are added, one additional power supply must be added for each three MCUs.

Electrical safety codes require that instrument chassis, panels, and housings be grounded to protect operating and service personnel against accidental shock. A grounded three-conductor power outlet must be used to satisfy this requirement.

The equipment is supplied with a power cord, HP part no. 8120-1378, for 115 VAC single-phase power outlets in the U.S.A. and certain other countries. Other power cords with ground connectors are available from Hewlett-Packard, consult with your local HP Sales and Service Office (listed at the back of this manual) if there is any question about which one to order. Power cords available from Hewlett-Packard are shown in figure 2-1.

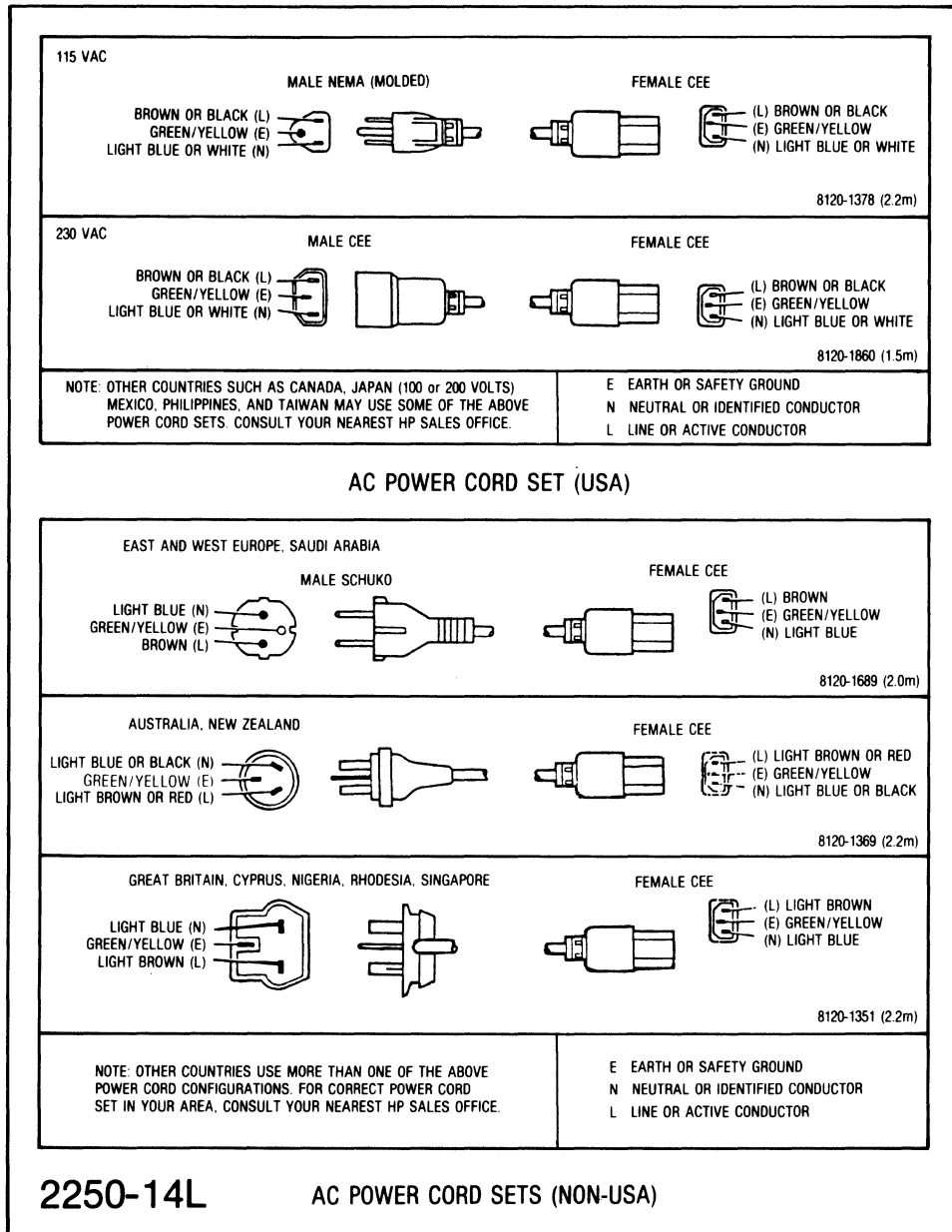


Figure 2-1. Available Power Cords

2.2.3 AC Power and External Ground

The power source used to supply ac power must be checked to ensure that it furnishes the proper voltage at which the HP 2250 is set. The outlet and its associated wiring and fuses (or circuit breakers) must be capable of carrying the current specified on the label of the power supply.

Have a qualified electrician check the power source with an ac voltmeter to ensure that the required single-phase voltage is present. If the processor power supply is set for 115-volt operation, the line voltage must be in the range of 86 to 127 volts ac (rms); for 230-volt operation, the line voltage must be in the range of 195 to 253 volts ac (rms).

If the line voltage is in the correct range, have the electrician check the power source to ensure that it is wired correctly with respect to ac high potential, ac neutral, and ground. Correct any improper wiring of the source. Observe local electrical codes.

For safety reasons, it is mandatory that a connection be made between the chassis and earth ground. The ground wire in the power cord usually provides this connection through the power outlet.

2.2.4 Cooling Requirements

Cooling requirements of the HP 2250 differ according to the particular model. In general, where the equipment is operating in a moderate environment, such as light industrial facilities or laboratories, you do not have to supply additional cooling if there is a free flow of air around the equipment.

The HP 2104 and HP 2251 are equipped with fans. The direction of air flow from the fans is into the card frame. If the cabinet has a plenum opening for air flow, it should be kept free of obstructions to the air flow. NEMA-type cabinets which are sealed against dust should have free flow around them for convection cooling.

2.3 UNPACKING AND INSPECTION

When the Hewlett-Packard shipment arrives, check the carrier's shipping papers against the received container or containers for the correct number. Inspect the shipping containers immediately for any evidence of mishandling during transit. If any container is damaged, or if any container is waterstained, request that the carrier's agent be present when it is opened.

Open the shipping container marked "MANUALS AND ACCESSORIES." One of the items in this package is a list of equipment supplied. Compare this list against the purchase order to verify that the shipment is correct. If incorrect, contact the nearest Hewlett-Packard Sales Office.

Unpack the shipping container(s) and inspect each item for external damage. Look for damage such as broken controls and connectors, dented corners, bent panels, scratches, and loose components. Check also the rigid foam-plastic cushioning (if used) for signs of deformation which could be indicative of rough handling during transit with consequential damage.

If visual examination reveals any damage to the equipment or accessories, follow the claims procedure given in the paragraph below. Retain the shipping container(s) and packing material for examination in the settlement of claims or for future reuse.

2.3.1 Claims Procedure

If the shipment is incomplete or if the equipment is damaged or fails to operate satisfactorily, notify the nearest Hewlett-Packard Sales and Service Office. If damage occurred in transit, also notify the carrier. Hewlett-Packard will arrange for replacement or repair of damaged equipment without waiting for settlement of claims against the carrier. In the event of damage in transit, retain the shipping container(s) and packing material for inspection.

2.3.2 Repackaging for Shipment

CAUTION

When a battery backup card is installed in a processor unit that is to be shipped by airplane, the batteries must be discharged before shipment. This can be done by letting the batteries discharge through memory for 75 minutes. Also, if the battery card is shipped by itself it must be discharged before shipment. Also note that the batteries can be damaged if the board is placed on a conducting surface that might short the batteries.

The same containers and material used in factory packaging can be used for reshipping the equipment, or if they have been discarded, the containers and packing material may be obtained from Hewlett-Packard Sales and Service Offices. The cartons used should be double walled and constructed of material rated for pressures of 2.41 MPa (350 psi). Containers for cards should be of anti-static material of the same type in which the card was shipped.

When shipping any equipment back to the factory, first attach a tag to it specifying your return address and the type of service required. Also identify the equipment by model number and serial number. Wrap the equipment in heavy paper or sheet plastic.

Use sufficient absorbing material on all sides of the unit to provide a firm cushion which will prevent any movement of the unit inside the container. Use particular care to protect the corners of the unit and the front and rear panels.

Seal the shipping container securely and mark it "FRAGILE" on all six sides.

In any subsequent correspondence with Hewlett-Packard concerning this equipment, always refer to it by model number and serial number.

2.3.3 Manual Inventory and Updating

Check to ensure that all manuals listed on the list of materials have been received.

Before beginning installation, perform any updating that may be required for the installation and start-up manual (this manual). Updating instructions (if any) are provided in a "Manual Update Notice."

2.3.4 Equipment Inventory

The HP 2250 model number, serial number, and option number are written on an identification label affixed to the inside of the front door. If the 220 VAC option has been ordered, it is identified by the three digit number, 015, written on the identification label.

2.4 INSTALLATION PROCEDURES

2.4.1 Tools

No installation tools other than ordinary hand tools are required.

2.4.2 Test Equipment

An ac voltmeter is required to verify the adequacy of the ac power outlet; required specifications are given in table 2-4.

Table 2-4. AC Voltmeter Specifications

INSTRUMENT	CRITICAL SPECIFICATIONS	RECOMMENDED MODEL
Digital Voltmeter	At least four-digit readout. Capable of measuring ac line voltage to +/- 1.0%. Voltage range must be from 80 to 130 VAC (standard) or 190 to 260 VAC (option 015).	HP 34730A 4-digit display, or equivalent.

2.4.3 NEMA Cabinet Installation

The HP 2250N system NEMA-type cabinet (see figure 2-2) may be mounted on a wall of the building or bolted to the floor. The recommended size of the mounting bolts is 12 mm (1/2 inch). The dimensions of the HP 2250N NEMA cabinet are shown in figure 2-3.

When the cabinet is mounted on the wall, the normal distance from the floor to the top holes is approximately 1.5 metres (61.25 inches) if the cabinet feet are removed. This provides a normal height for access to the equipment; however, other heights are permissible (leaving the feet on the cabinet, for example, would add 12 inches). The mounting hole locations for wall mounting is shown in figure 2-4.

The floor-mounted installation has the advantage of allowing convection cooling of a greater surface area than possible with wall mounting. The recommended size of bolts for mounting the frames is 12 mm (1/2-inch). Floor mount hole locations are shown in figure 2-5.

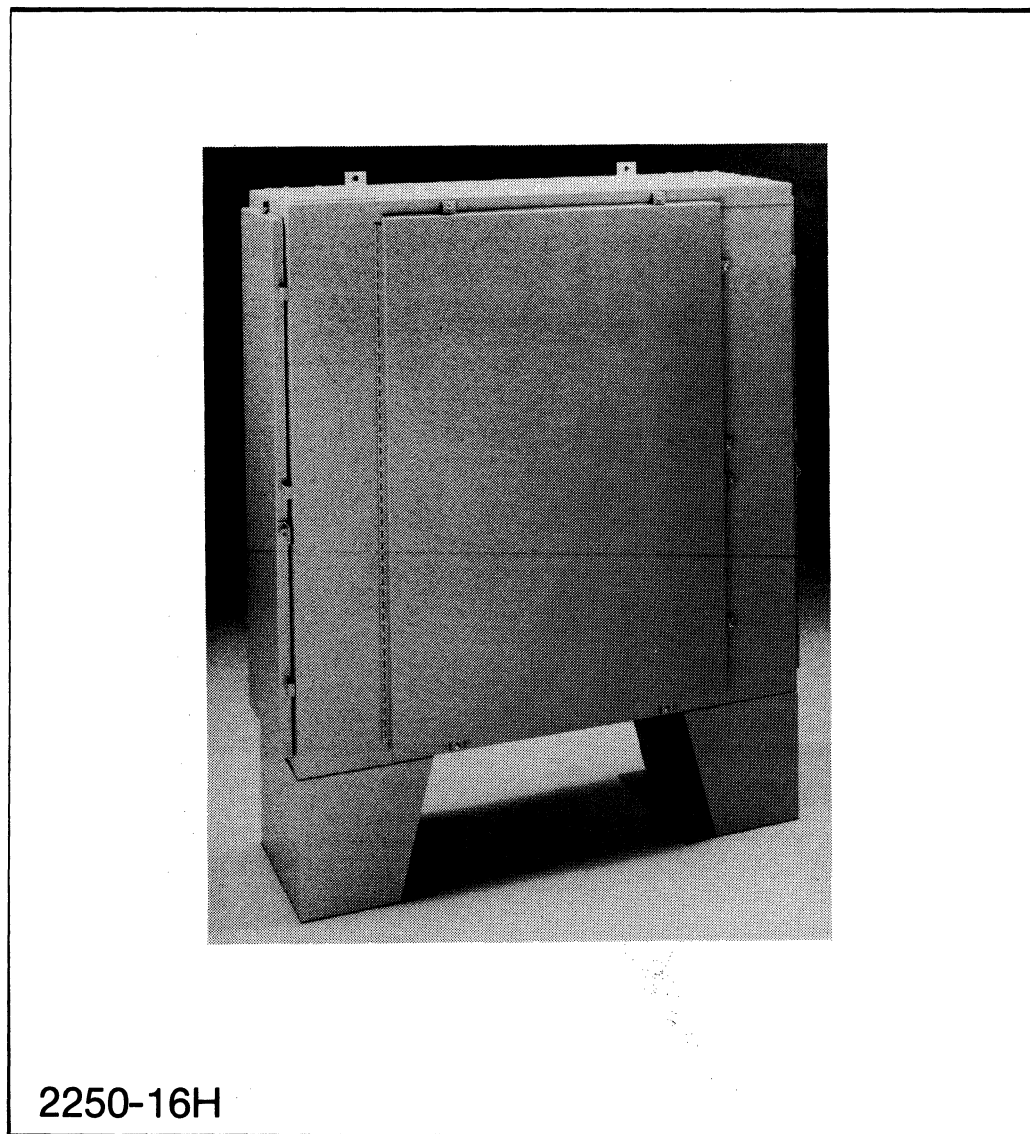


Figure 2-2. NEMA Cabinet

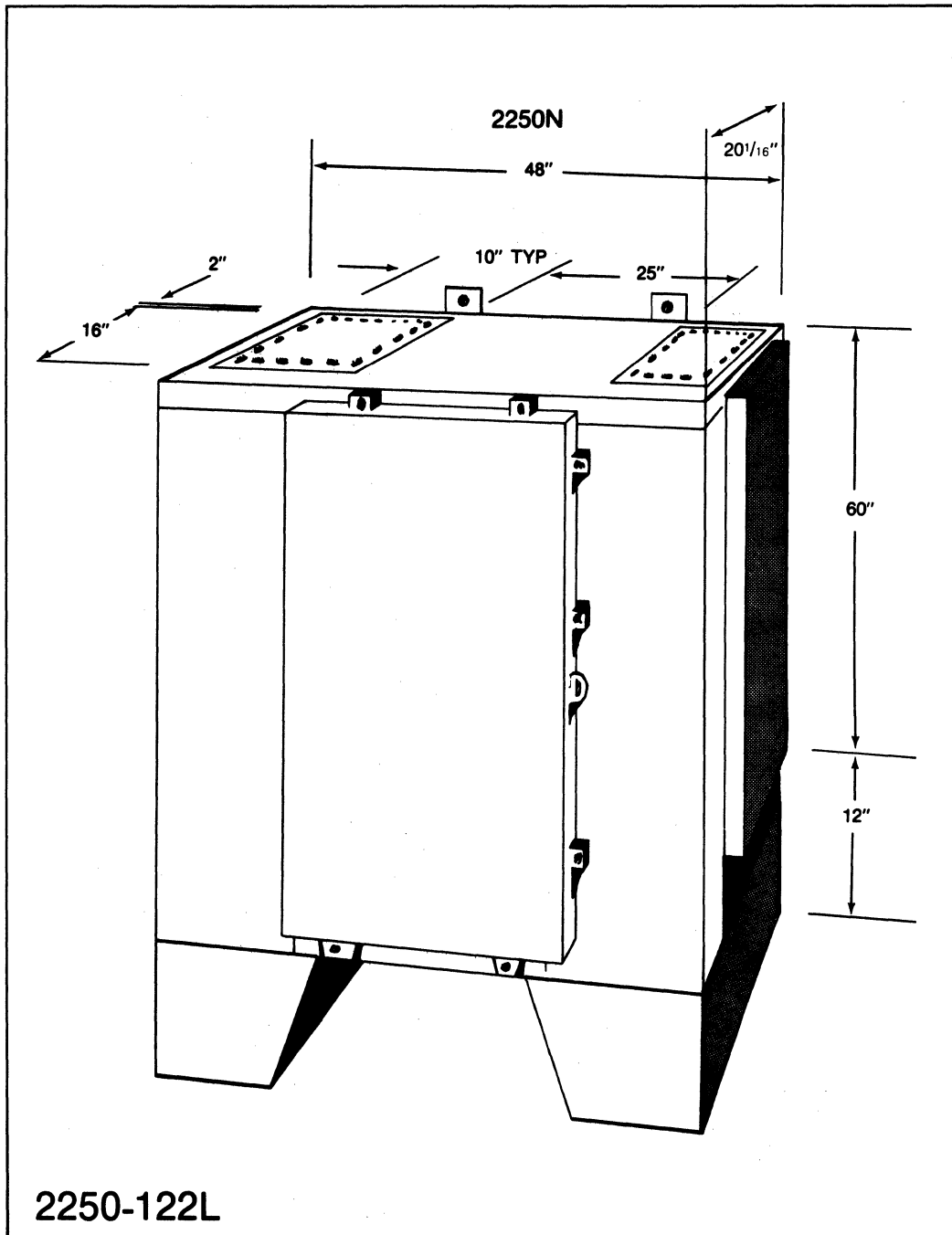


Figure 2-3. NEMA Cabinet Dimensions

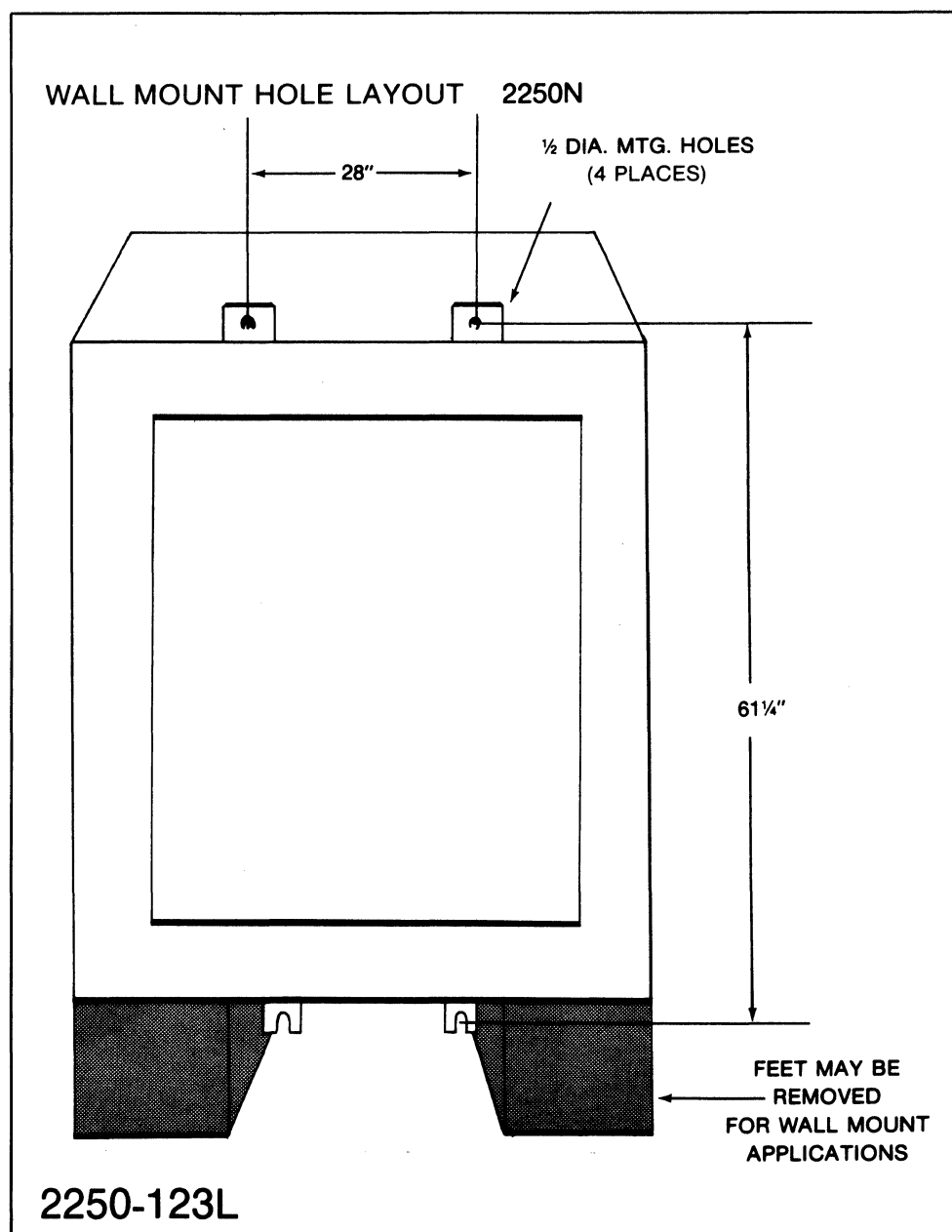


Figure 2-4. NEMA Cabinet Wall Mounting Hole Locations

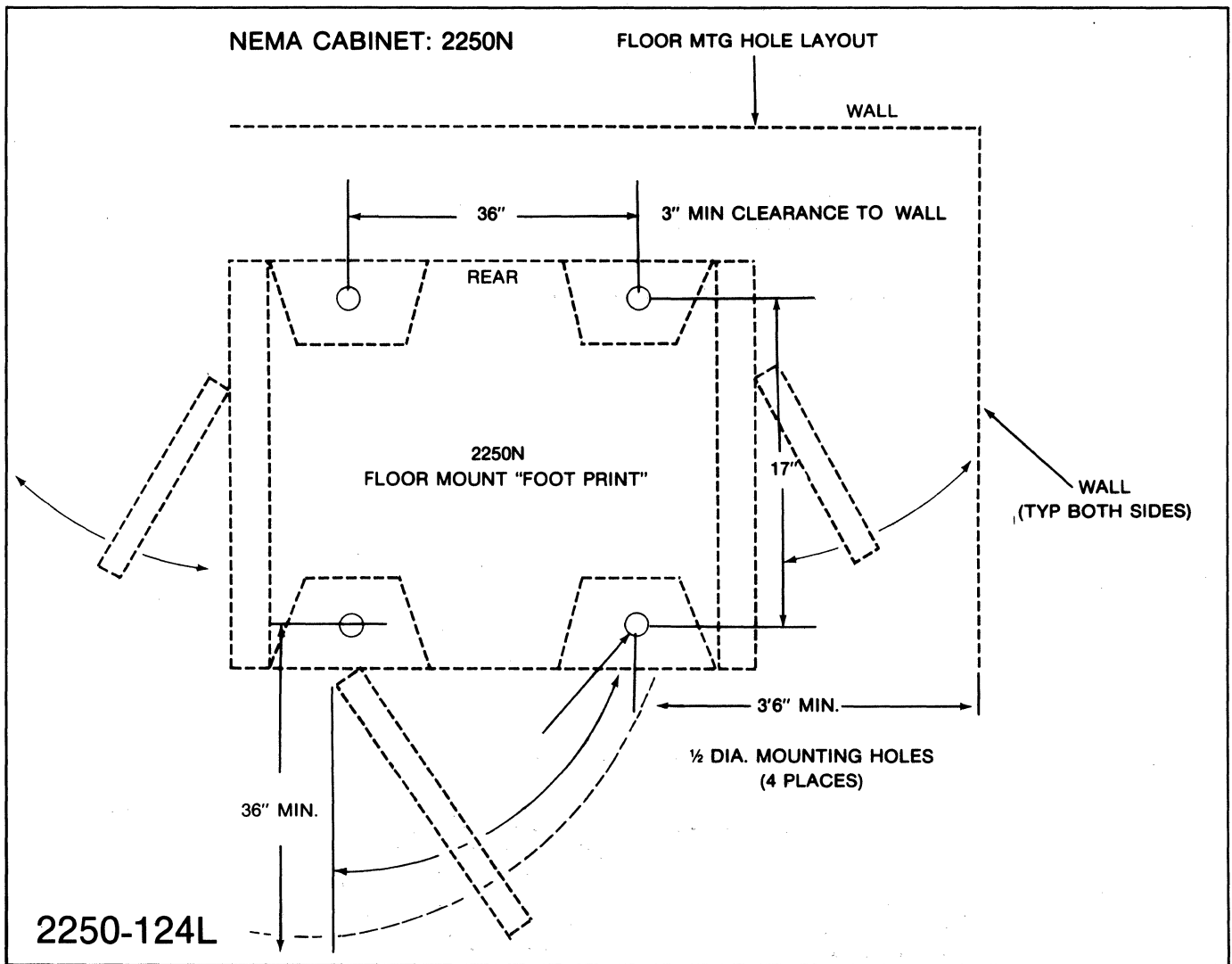


Figure 2-5. NEMA Cabinet Floor Mounting Hole Locations

2.4.4 Rack Cabinet Installation

The installation of rack cabinets (see figure 2-6) requires only that the mounting floor be capable of supporting the weight of the cabinet and its equipment, and that the environmental considerations (see table 2-2) have been met. In addition, leave sufficient room around the cabinet for maintenance and cleaning. Note that forklifts should not be used to lift cabinets.

2.4.5 HP 2104AN Mounting

The HP 2104AN Processor Unit (see figure 2-7) consists of a card frame and a power supply, both of which can be installed in a NEMA cabinet. Panel-mounting hardware consists of mounting flanges on the rear of the card frames which bolt onto the rear panel, or wall, of the NEMA cabinet. The dimensions of the HP 2104AN are shown in figure 2-8, and the mounting hole layout is shown in figure 2-9.

2.4.6 HP 2104AR Mounting

The HP 2104AR Processor Unit (see figure 2-10) consists of rack-mounted card frames which can be installed in standard 19-inch rack cabinets. The fans direct air into the frames from the left sides. The mounting hardware consists of mounting flanges on the front of the frames to bolt to the rack.

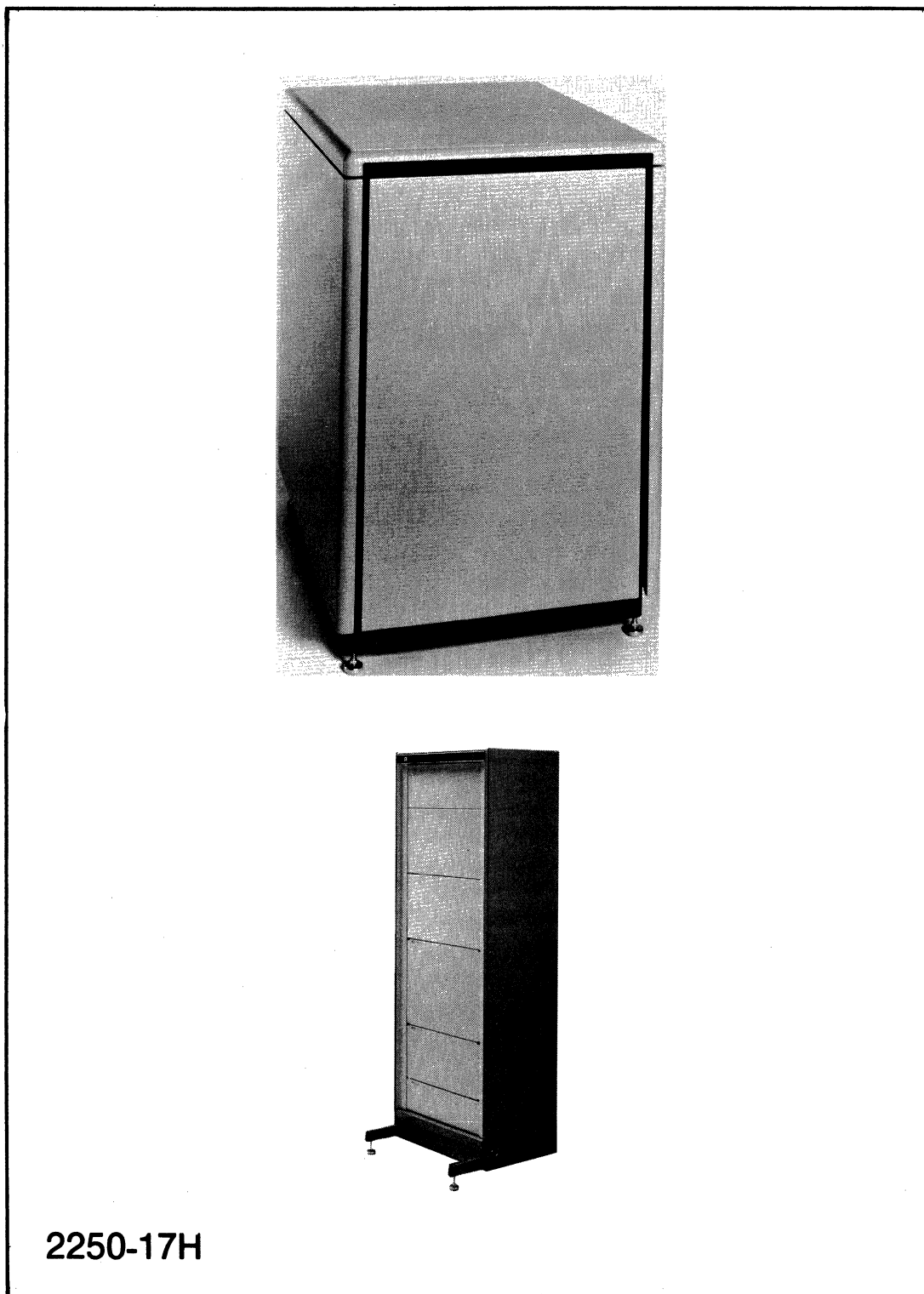
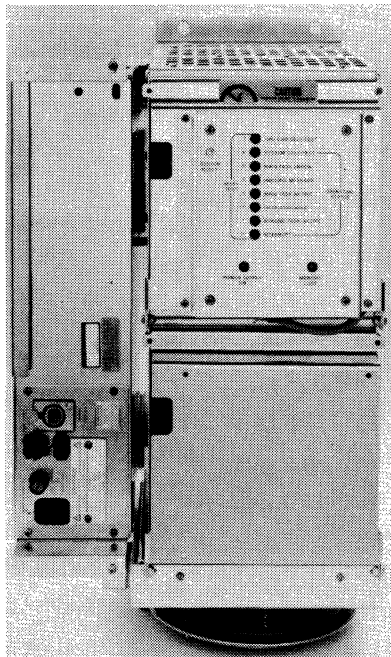
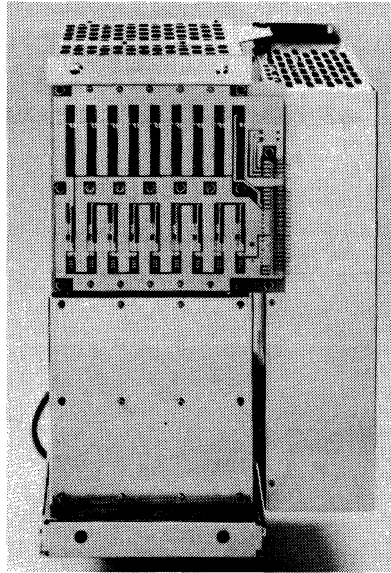


Figure 2-6. Rack Cabinets



2250-18H

Figure 2-7. HP 2104AN Processor Unit

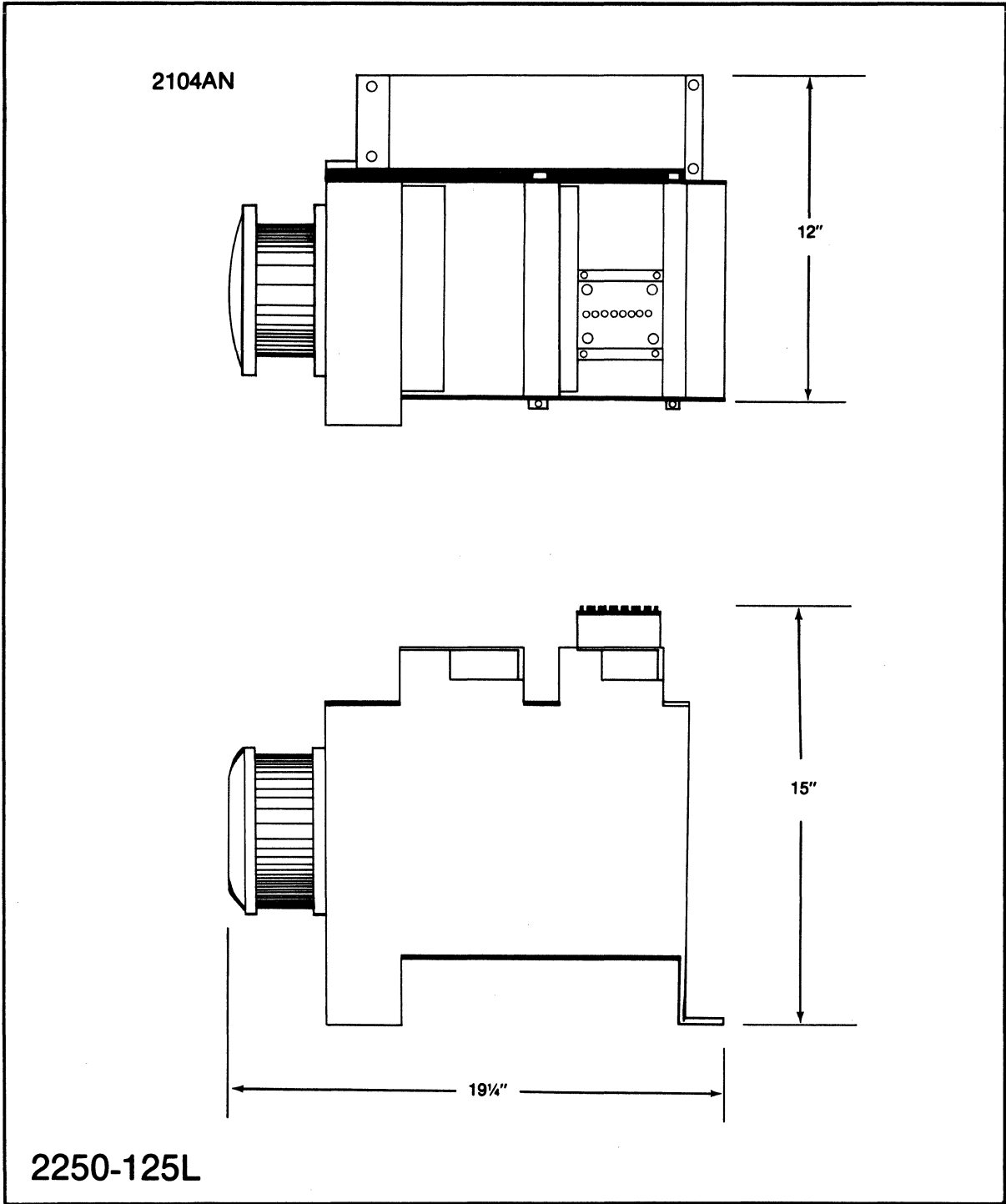


Figure 2-8. HP 2104AN Processor Unit Dimensions

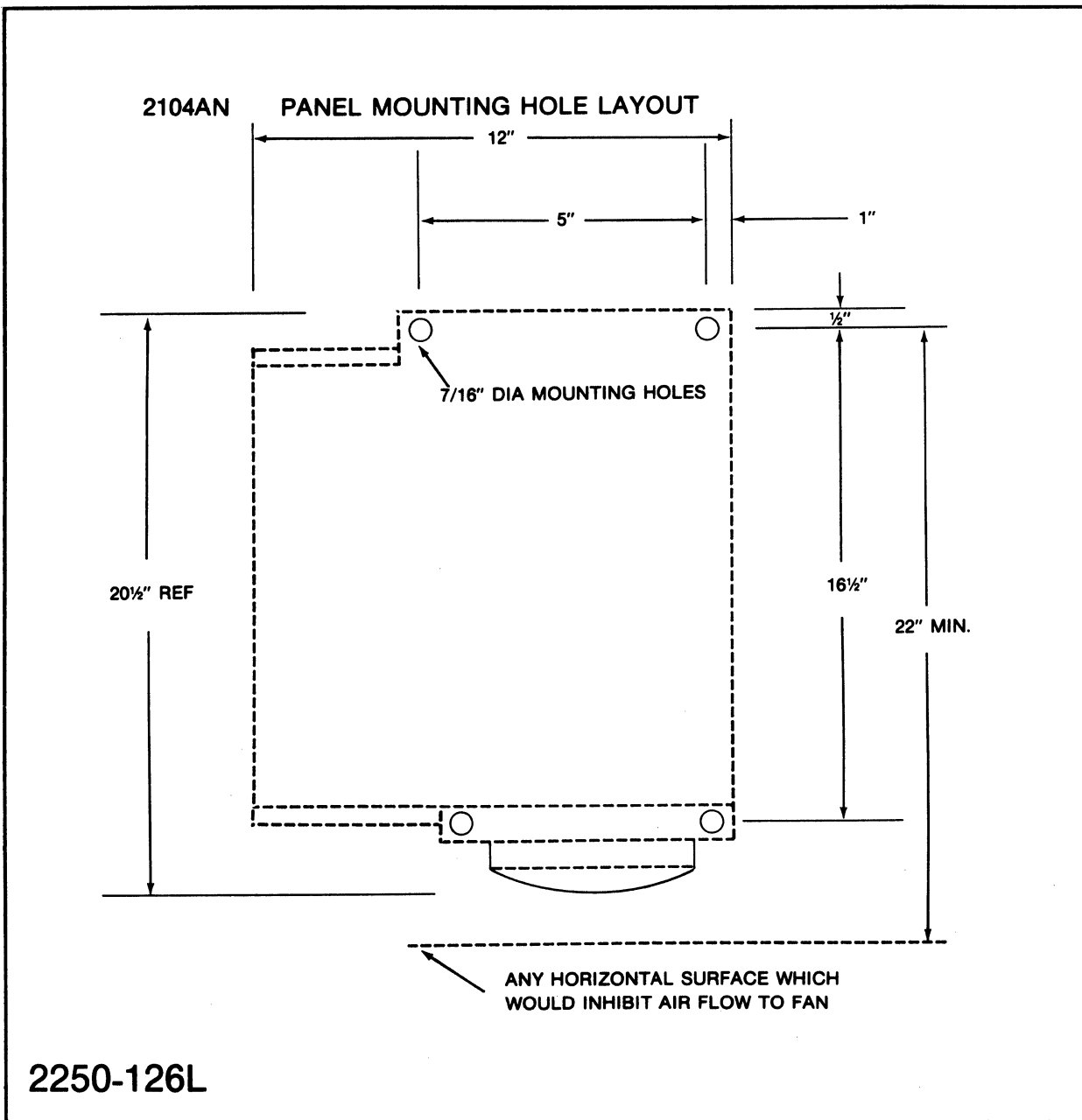
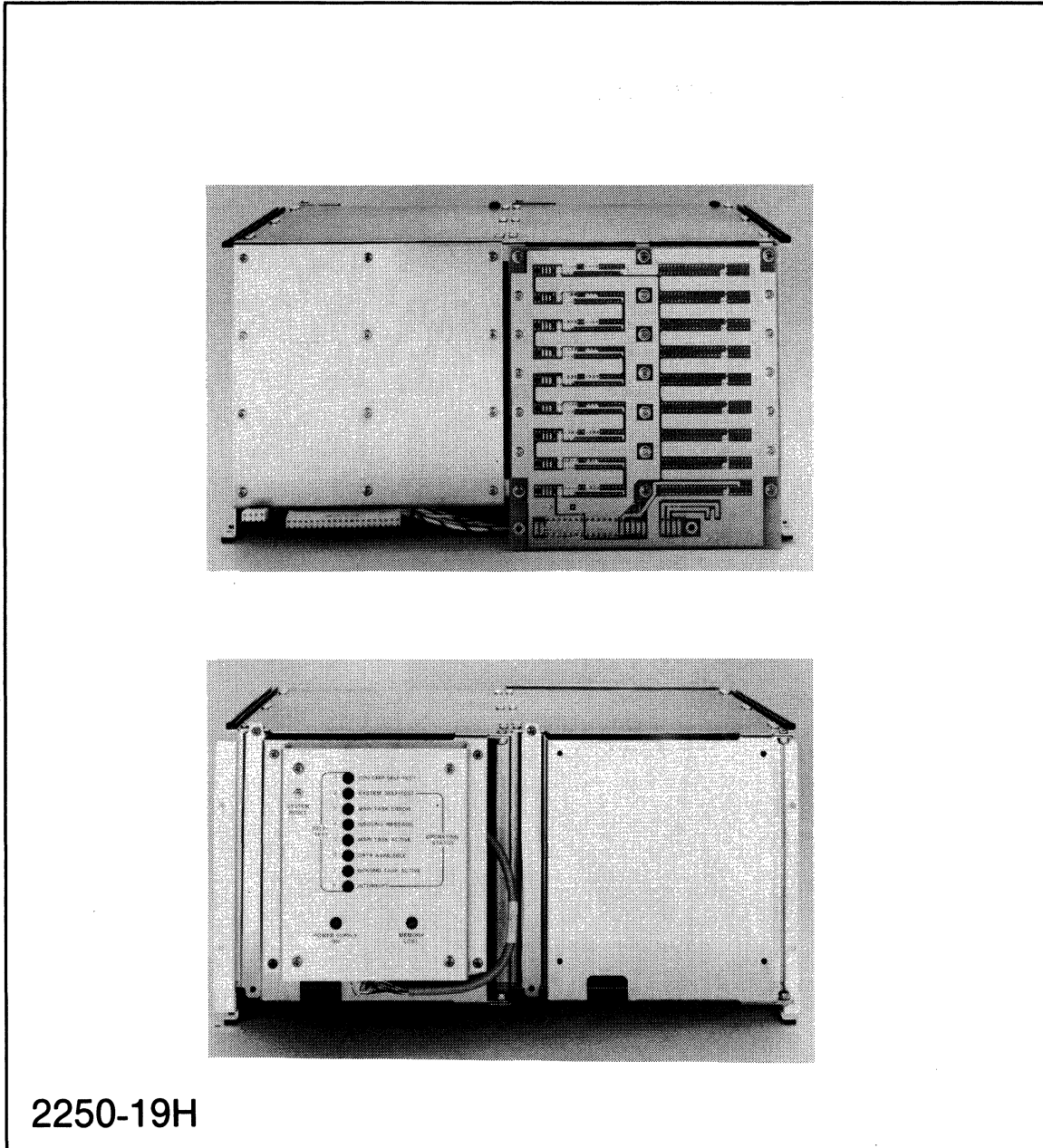


Figure 2-9. HP 2104AN Processor Unit Mounting Hole Layout



2250-19H

Figure 2-10. HP 2104AR Processor Unit

2.5 HP 2104 PROCESSOR UNIT CARD INSTALLATION

Processor unit cards are shipped installed and should not require access by the customer under normal conditions. There may be times, however, when access is necessary and therefore installation instructions are presented in the following paragraphs.

HP 2104 Processor Unit slot allocation and control cabling are shown in figure 2-11. The cards of the processor unit must be installed in the proper order. The cards are accessed by opening the front cover of the processor unit card frame. If there has been any field installation of cards, the order of the cards should be checked. The card slots are labelled with slot numbers.

Card order starting from Slot 0 is the following:

- Slot 0 -- HP 12013A Battery Backup Card (Optional)
- ✓ Slot 1 -- HP 12070A RRACK (RAM/ROM/Stack) Memory Card
- ✓ Slot 2 -- HP 12001D Processor Card
- ✓ Slot 3 -- HP 12071A Measurement and Control Interface (MCI) Card
- Slot 4 -- HP 12009A HP-IB Interface Card
- Slot 5 -- HP-IB Modem Card (Placed in slot next to HP-IB card)
(Optional)

To install a card, perform the preliminary setup procedures described below for the different types of cards, then slide the card into its slot with the component side up in the 2104AR and to the right in the 2104AN. Press against the two red extractor levers until the card is fully seated into its slot (see figure 2-12).

(A card is removed by grasping the two red extractor levers and pulling them toward you. The card can then be gently removed from its slot.)

The processor card must always be located in the slot just below the memory card in vertically oriented card frames, or just to the left of the memory card in horizontally oriented card frames.

The component side of the card should face up in vertically oriented card frames and to the right in horizontally oriented card frames.

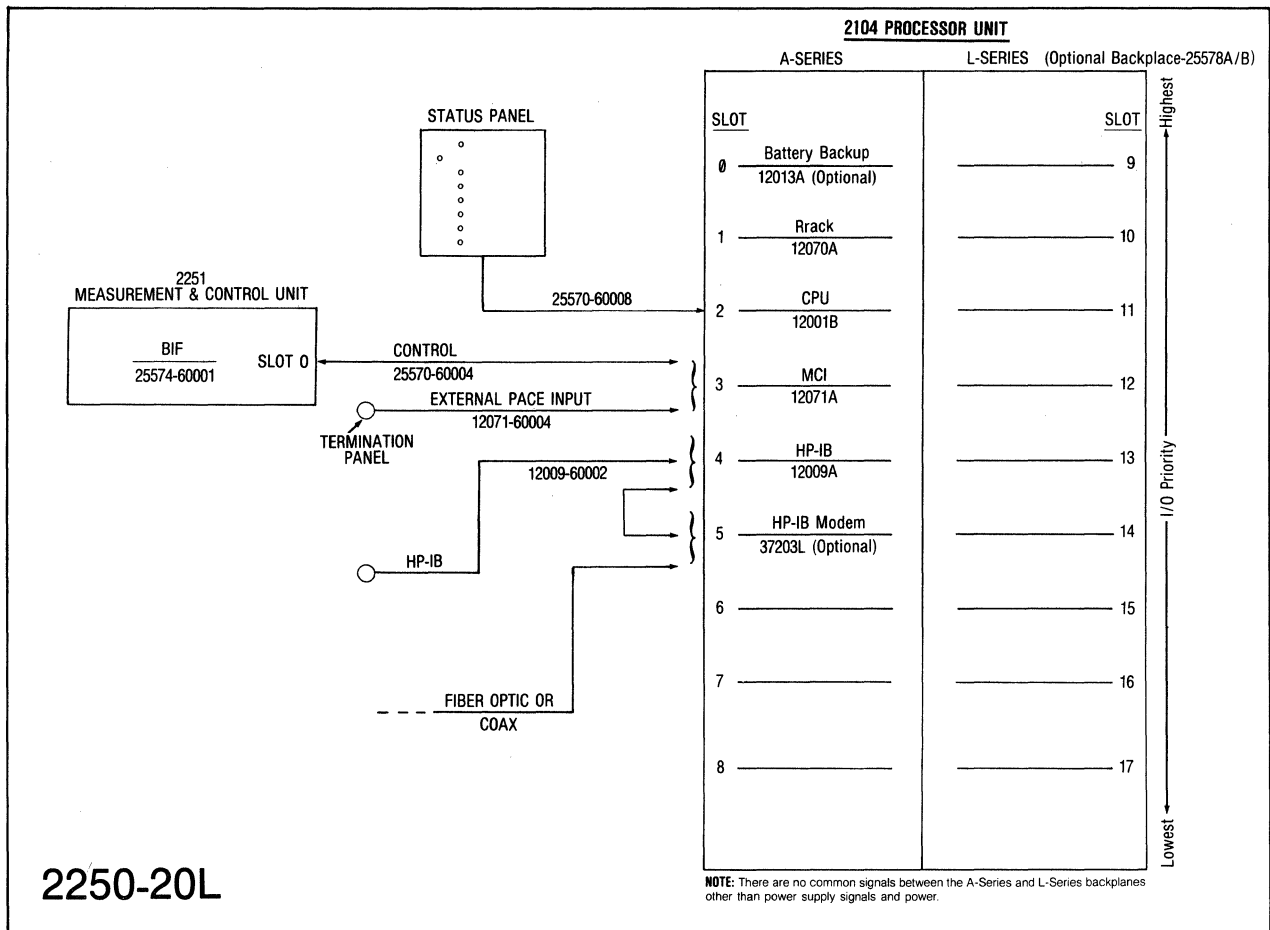
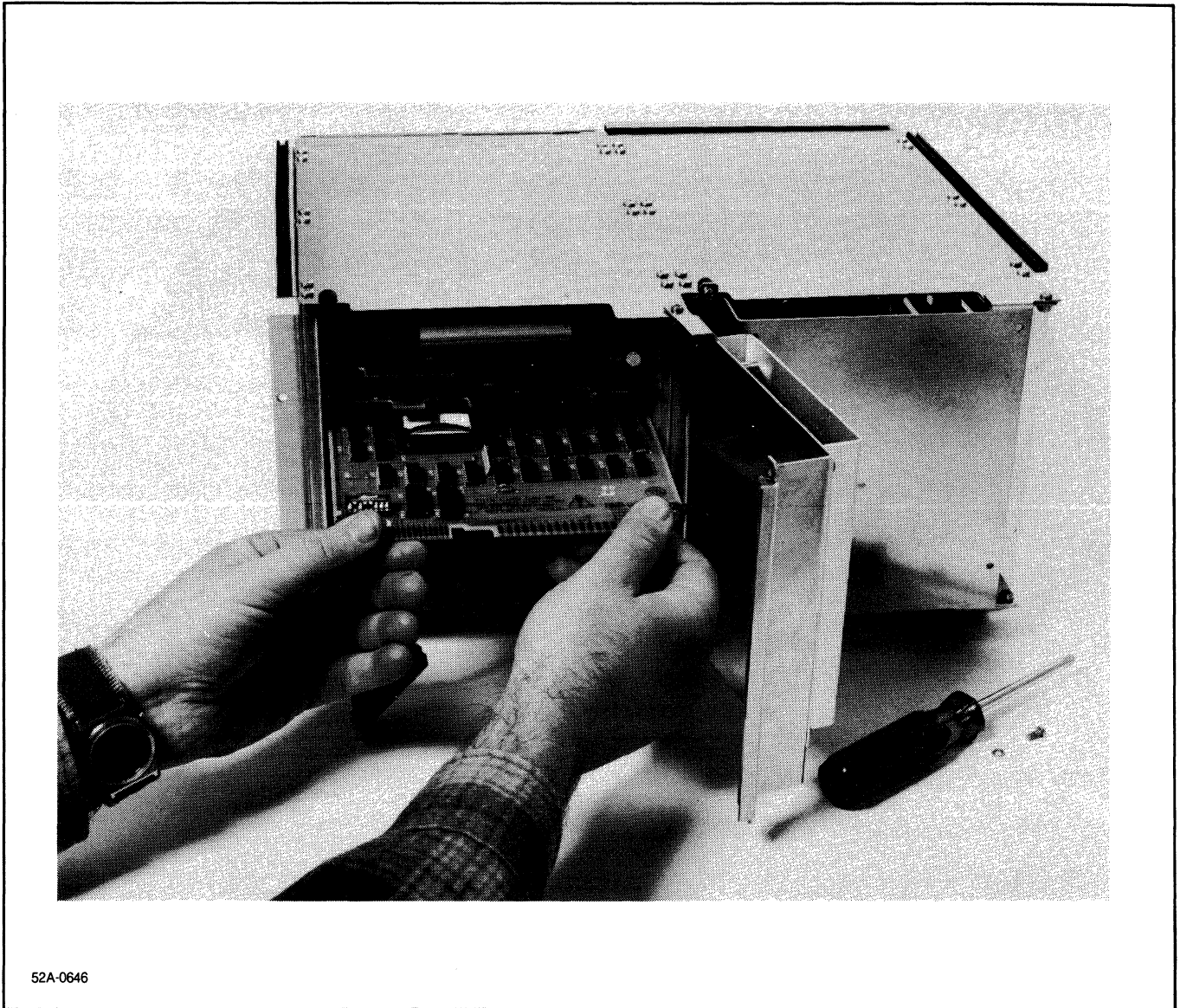


Figure 2-11. HP 2104 Processor Unit Slot Allocation and Control Cabling



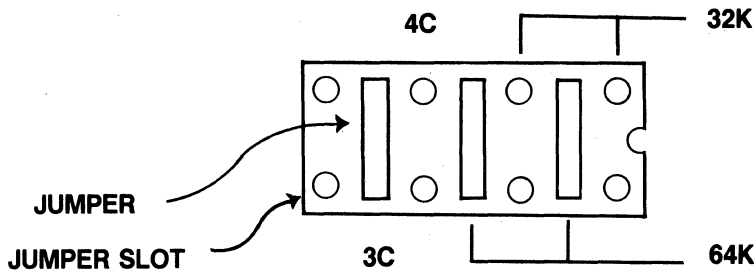
52A-0646

Figure 2-12. Installing a Card in the HP 2104 Processor Unit

2.5.1 HP 12070A MEMORY CARD INSTALLATION

To install the memory card (see figure 2-13), perform the following:

- a. Set the card down with the empty sockets up (toward you).
- b. If an HP 12013A Battery Backup card is to be installed, set the BATTERY BACKUP switch, located at the right rear corner of the memory card, to BATT. If no battery backup card is to be installed, set the BATTERY BACKUP switch to NORMAL.
- c. Set the jumpers, located at the front left section of the card, to the following pattern:



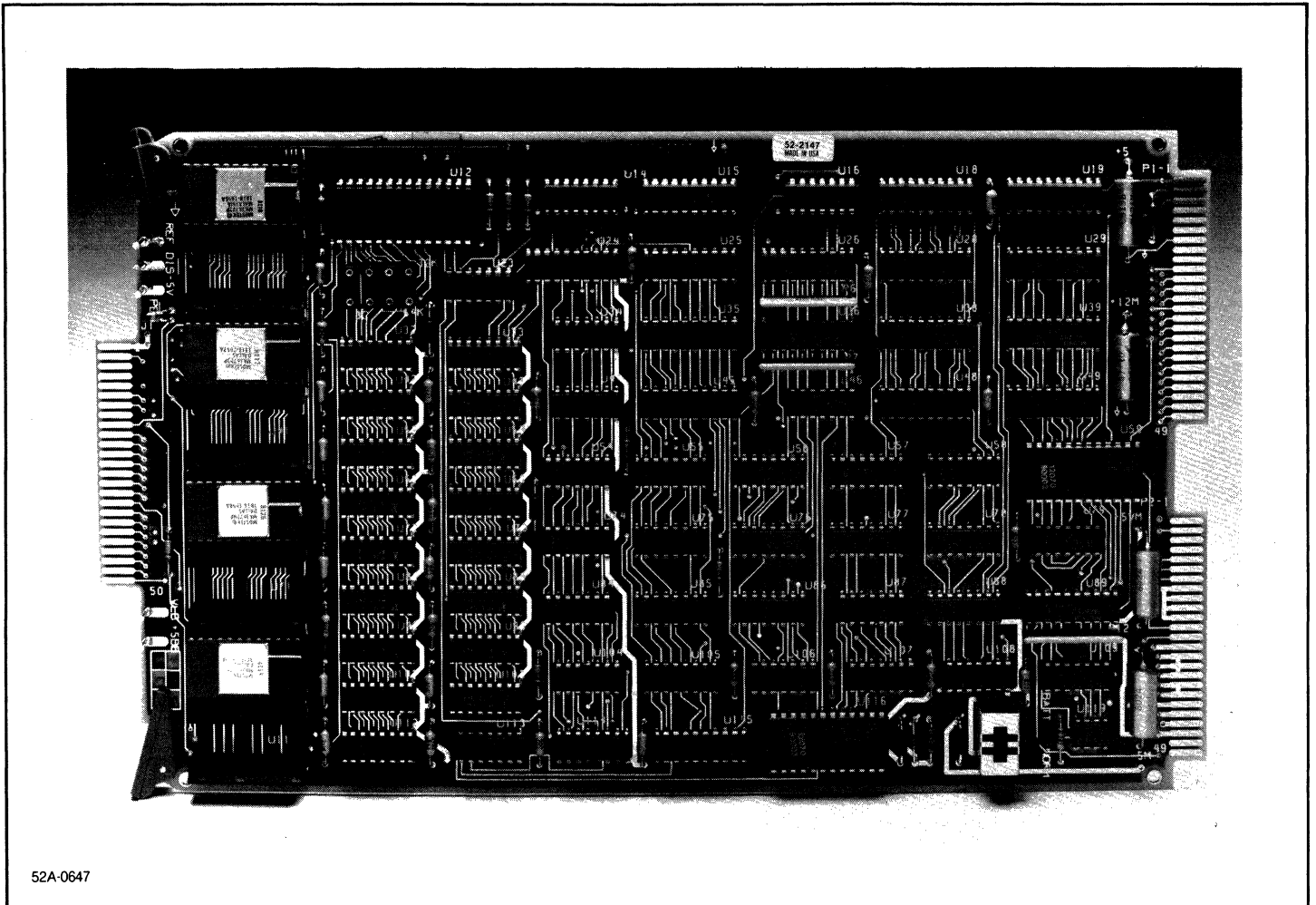
- d. Install the four Read Only Memory chips (ROMs) from the HP 25580A firmware set (MCL/50) into the appropriate sockets:

SOCKET	ROM
U11	1818-1656A
U31	1818-1657A
U61	1818-1658A
U91	1818-1659A

NOTE

Verify the polarity of the ROMs when installing by matching the cutout on the chip with the notch in the socket. The notches will be facing away.

- e. Install the memory card into slot 1 of the HP 2104 card cage. Refer to figure 2-12 and verify that the card is securely seated into the backplane.



52A-0647

Figure 2-13. HP 12070A RRACK Memory Card

2.5.2 HP 12001D PROCESSOR CARD INSTALLATION

To install the processor card (see figure 2-14), perform the following:

- a. Set switch U1, located on the front left edge of the card, as follows:

UP	-									UP	--	switch is open
DOWN	-	-	-	-	-	-	-	-	-	DOWN	--	switch is closed
		1	2	3	4	5	6	7	8			

If an HP 12013A Battery Backup card is part of the system, the switch U1-8 should be set to UP ("OPEN"). Switch U1 then should be as follows:

UP	-									UP	--	switch is open
DOWN	-	-	-	-	-	-	-	-	-	DOWN	--	switch is closed
		1	2	3	4	5	6	7	8			

- b. Install the processor card in slot 2 of the HP 2104 card cage. Refer to figure 2-12 and verify that the card is securely seated into the backplane.
- c. Attach the status panel cable, part number 25570-60008, to the front edge connector on the processor card. Check the polarity of the cable when installing. This is done by verifying that the side of the cable connector labeled "COMP SIDE" is facing toward the side of the card on which the components are located.

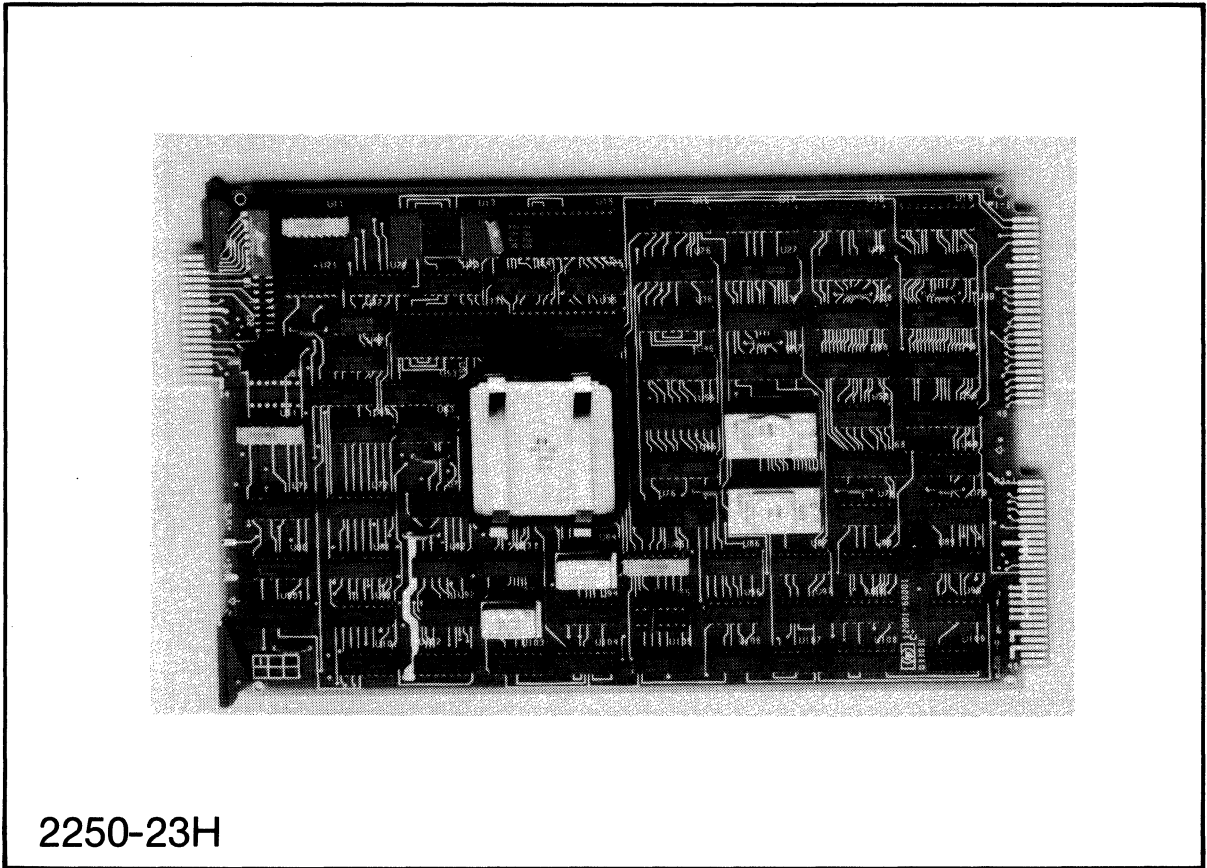


Figure 2-14. HP 12001D Processor Card

2.5.3 HP 12071A MCI Card Installation

To install the Measurement and Control Interface (MCI) card (see figure 2-15), perform the following:

- a. Set switch U1, located on the front left edge of the card, as follows:

UP		-	-		-	UP	--	switch is open
DOWN	-	-	-		-	DOWN	--	switch is closed
	1	2	3	4	5	6	7	8

- b. Install the MCI card in slot 3 of the HP 2104 card cage. Refer to figure 2-12 and verify that the card is securely seated in the backplane.
- c. The MCI card must be connected to the first MCU card cage through the MC (Measurement and Control) Bus 50-pin ribbon cable (part number 25570-60004, see figure 2-11). The cable goes from J1 on the MCI card to J11 on the BIF card, part number 25574-60001, in the MCU card cage.
- d. Connect the External Pace Input cable (part number 12071-60004) to the J2 edge connector of the MCI card. Check the polarity of the cable when installing. This is done by verifying that the cable connector side labeled "CARD SIDE" faces the side of the MCI card which contains components. External pace input connections are shown in figure 2-16.

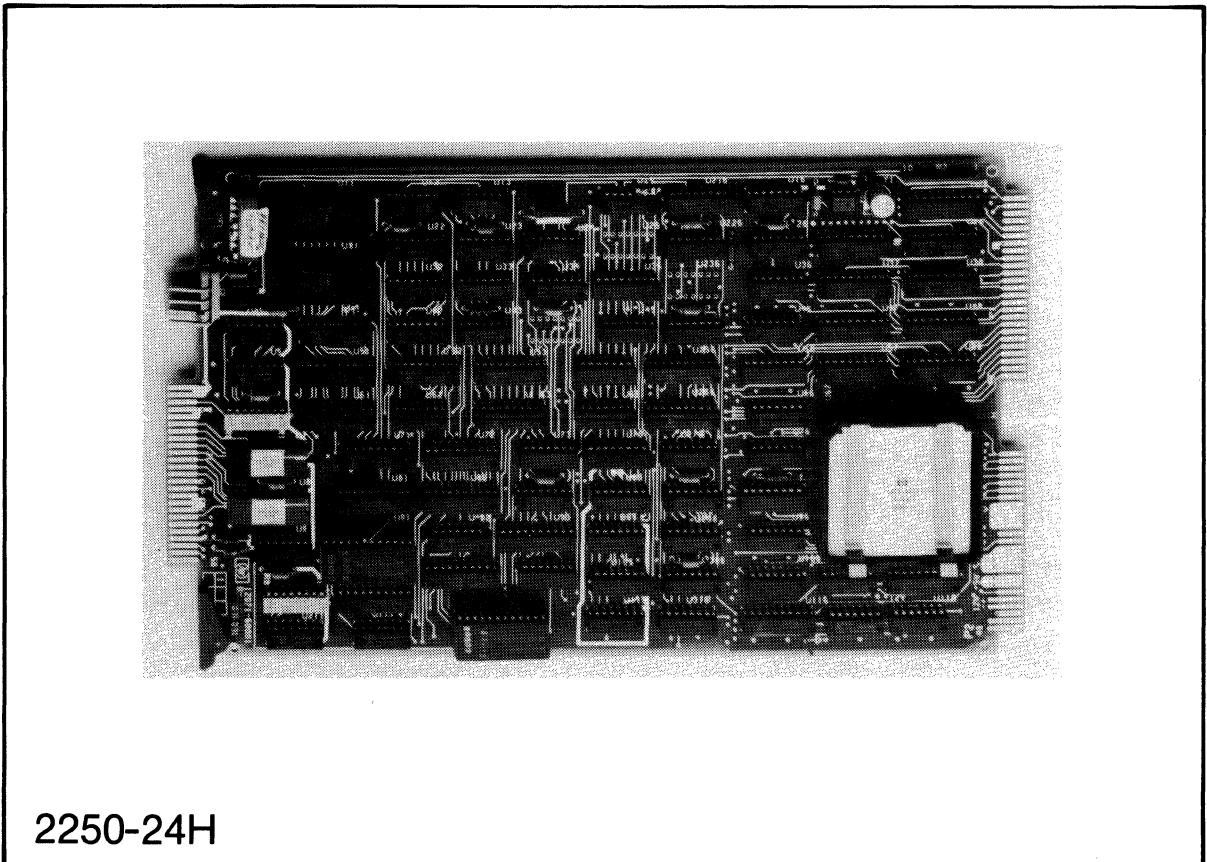


Figure 2-15. HP 12071A MCI Card

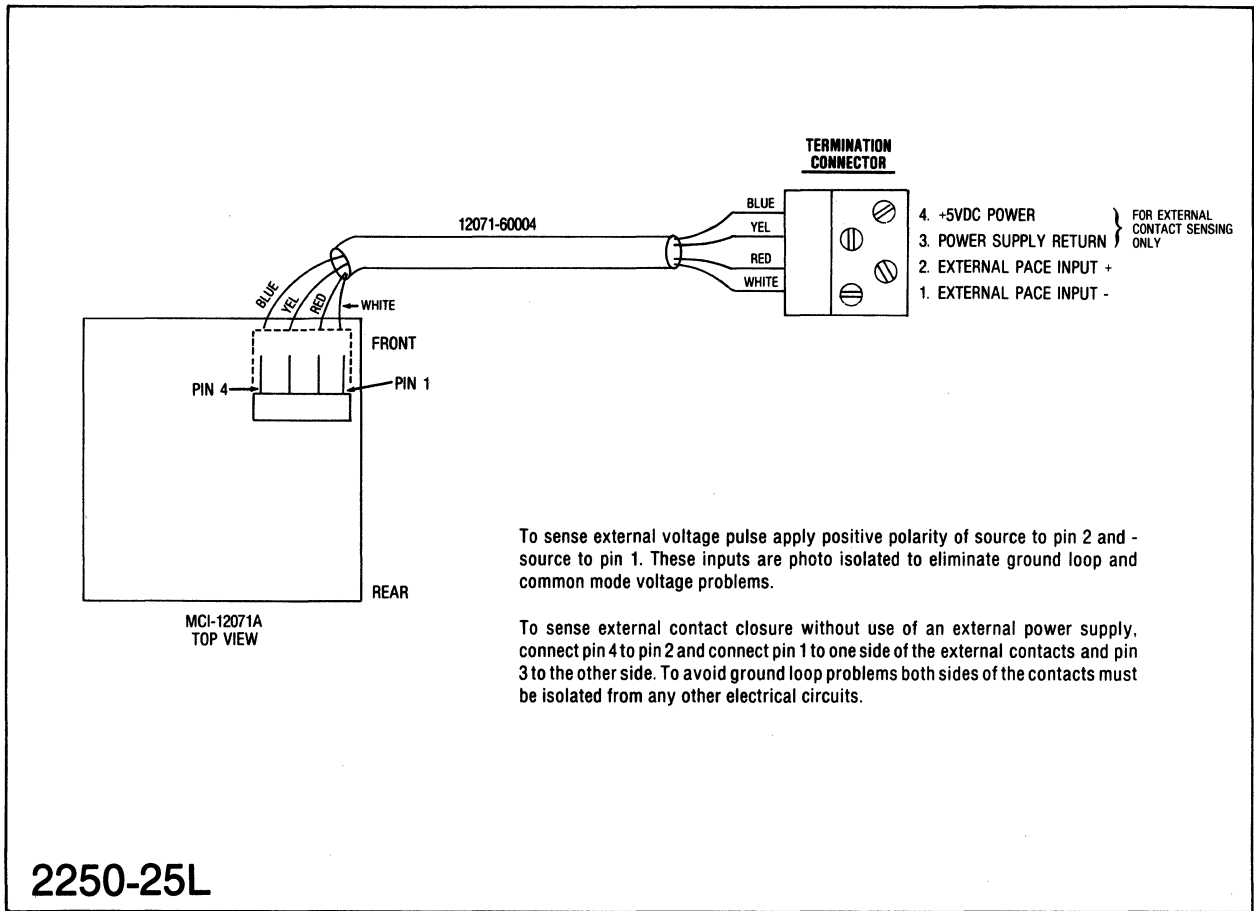


Figure 2-16. External Pace Input Connections

2.5.4 HP 12009A HP-IB Interface Card Installation

To install the HP-IB card (see figure 2-17), perform the following:

- a. Set switch U1, located on the front left edge of the card, as follows:

```

UP      - - -      UP      -- switch is open
DOWN    - - - - -  DOWN    -- switch is closed
        1 2 3 4 5 6 7 8

```

- b. Switch U16, located at the left edge toward the rear of the card, is the HP-IB address switch. This switch normally is set to address 5 as follows:

```

UP      - - -      UP      -- switch is open
DOWN    - - - - -  DOWN    -- switch is closed
        1 2 3 4 5 6 7 8

```

Because each HP-IB interface can have as many as 14 devices connected to it, each device must be set to a specific address code. The HP 2250 can be set to any one of 31 HP-IB addresses, ranging from 0 through 30. Each address is set by setting switches U16-4 through U16-8 to the appropriate binary bit positions for the particular address value desired. Switch U16-8 is the low-order bit.

An ASCII code informs the HP-IB card whether the device is to "Talk" or "Listen" for each of the address codes.

The Listen and Talk characters for each address code, the address switch settings, and the address codes in decimal and octal, are shown in table 2-5.

- c. Check that the two sockets at the front of the card are empty. If any resistor networks are plugged into these sockets, remove them.
- d. Install the HP-IB card into slot 4 of the HP 2104 card cage. Refer to figure 2-12 and verify that the card is securely seated into the backplane.
- e. Connect cable 12009-60002 to connector J2 on the card.

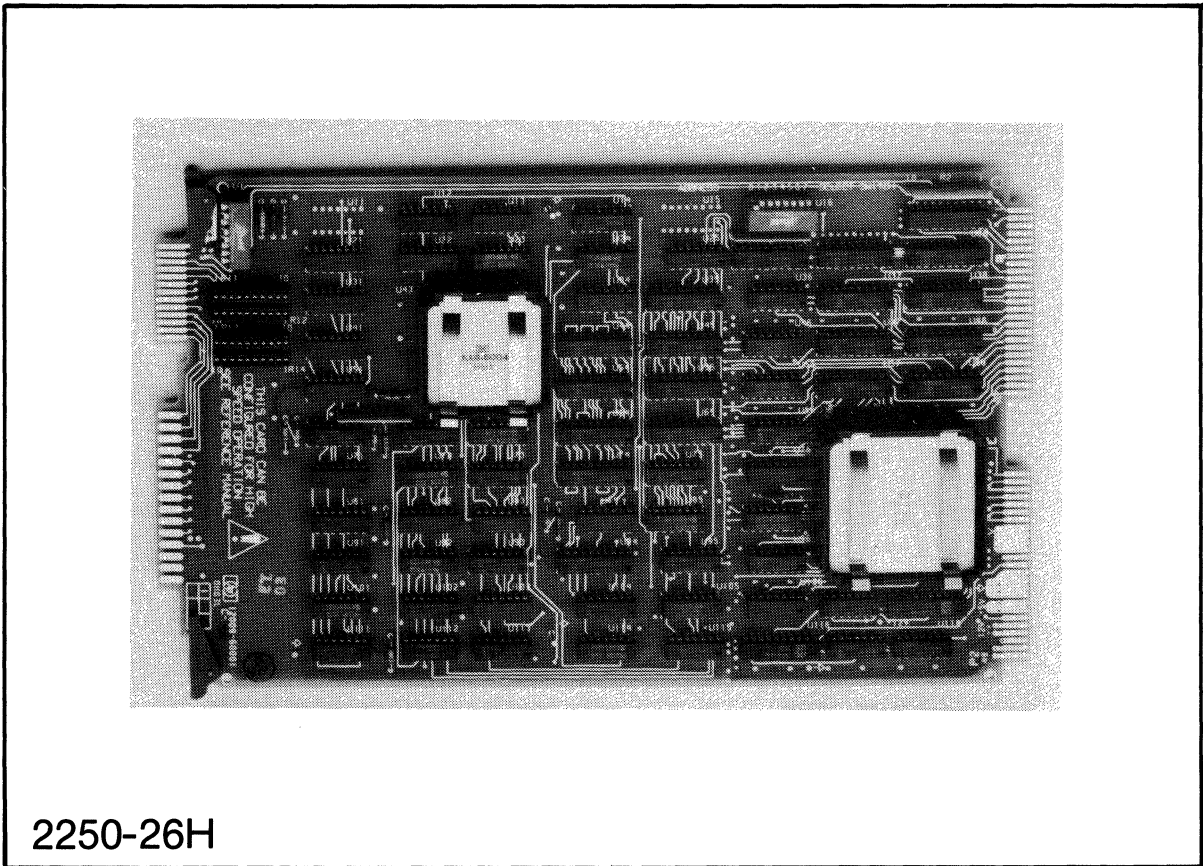


Figure 2-17. HP 12009A HP-IB Interface Card

Table 2-5. HP-IB Address Codes

ADDRESS CHARACTERS		ADDRESS SWITCH SETTINGS					ADDRESS CODES	
LISTEN	TALK	U16-4	U16-5	U16-6	U16-7	U16-8	DECIMAL	OCTAL
SP		0	0	0	0	0	0	0
!	A	0	0	0	0	1	1	1
"	B	0	0	0	1	0	2	2
	C	0	0	0	1	1	3	3
\$	D	0	0	1	0	0	4	4
NOTE: Following value (5) preset at factory.								
%	E	0	0	1	0	1	5	5
&	F	0	0	1	1	0	6	6
'	G	0	0	1	1	1	7	7
(	H	0	1	0	0	0	8	10
)	I	0	1	0	0	1	9	11
*	J	0	1	0	1	0	10	12
+	K	0	1	0	1	1	11	13
,	L	0	1	1	0	0	12	14
-	M	0	1	1	0	1	13	15
.	N	0	1	1	1	0	14	16
/	O	0	1	1	1	1	15	17
0	P	1	0	0	0	0	16	20
1	Q	1	0	0	0	1	17	21
2	R	1	0	0	1	0	18	22

Table 2-5. HP-IB Address Codes (Continued)

ADDRESS CHARACTERS		ADDRESS SWITCH SETTINGS					ADDRESS CODES	
LISTEN	TALK	U16-4	U16-5	U16-6	U16-7	U16-8	DECIMAL	OCTAL
3	S	1	0	0	1	1	19	23
4	T	1	0	1	0	0	20	24
5	U	1	0	1	0	1	21	25
6	V	1	0	1	1	0	22	26
7	W	1	0	1	1	1	23	27
8	X	1	1	0	0	0	24	30
9	Y	1	1	0	0	1	25	31
:	Z	1	1	0	1	0	26	32
;	[	1	1	0	1	1	27	33
<	\	1	1	1	0	0	28	34
=	]	1	1	1	0	1	29	35
>	^	1	1	1	1	0	30	36

2.5.5 HP 12013A Battery Backup Card Installation

To install the optional battery backup card (see figure 2-18), perform the following:

CAUTION

Do not set the battery backup card on a conductive surface or on top of another printed circuit card.

NOTE

If the battery backup card is installed in the processor unit and the memory card switch is set to NORM, the battery backup card will continually emit a beep sound every 10 seconds while power is turned on. This configuration should be avoided since it will prevent the card from sustaining memory for the rated time period when line power is removed.

- a. Set the 3-position switch, located on the right front of the card, to ON or OFF, depending on the mode desired. See below.
 1. ON enables the battery backup card to sustain processor unit memory for up to 30 minutes when the ac line power is removed. The batteries will charge when they are not actually sustaining memory.
 2. OFF prevents the battery backup card from sustaining memory but still permits charging of the batteries while line power is on.
 3. REMOTE is not used.
- b. Install the card in slot 0 of the HP 2104 card cage. Refer to figure 2-12 and verify that the card is securely seated in the backplane.

Note that the battery backup card is shipped fully discharged. Therefore, it must be charged for 14 hours to obtain the capacity to sustain memory for 30 minutes (a full charge).

If a battery backup card is installed and enabled and the line power fails or is removed, the card will emit a one-second beep every ten seconds, indicating that the card is sustaining memory. If the card does not sustain memory for the duration of the power removal, it emits a single two-second beep when power is restored.

NOTE

Corrosion may form on the battery backup card batteries when they are fully discharged. This corrosion can be removed with a cloth dampened in a mild solution of baking soda and water.

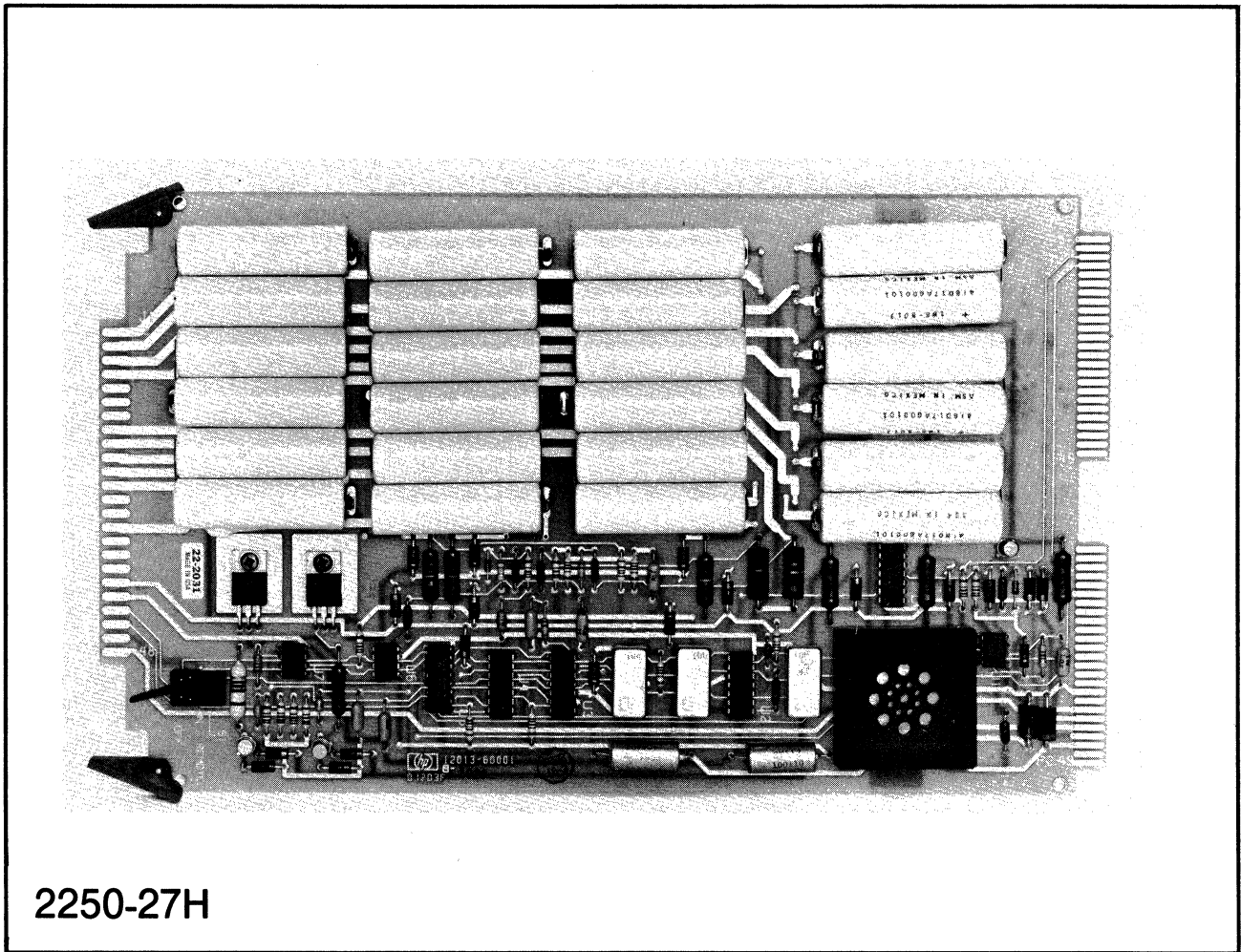


Figure 2-18. HP 12013A Battery Backup Card

2.5.6 Power Supply Installation

The power supply is mounted on the side of the processor unit in an HP 2250N (NEMA cabinet) and below the processor unit in HP 2250R or HP 2250M (rack mounted) systems. In the HP 2250N system, the power supply connects directly to the processor unit backplane. In the HP 2250R and HP 2250M systems, the power supply connects to a cable and adapter board.

To install the power supply, refer to figure 2-19, and perform the following:

- a. Verify that the label plate indicating the power supply voltage matches that which was ordered as follows:

HP 2104 Standard	-----	115VAC~
		7A MAX
		47.5 ~ 66HZ
		FUSE: 7A

HP 2104 Option 015	-----	230VAC~
		3A MAX
		47.5 ~ 66HZ
		FUSE: 3A

- b. Slide the power supply into the two slots on the side (HP 2104AN) or below the processor unit (HP 2104AR). Ensure that the connectors at the rear of the power supply are engaged.
- c. Fasten the two screws from the holding frame to the power supply cage.
- d. Connect power cable part number 8120-1378 from the power supply to a suitable source of power.
- e. Connect cable 25572-60001 from the power supply to the backplane interface (BIF) card, located in the MCU card cage. Either connector on the BIF can be used.

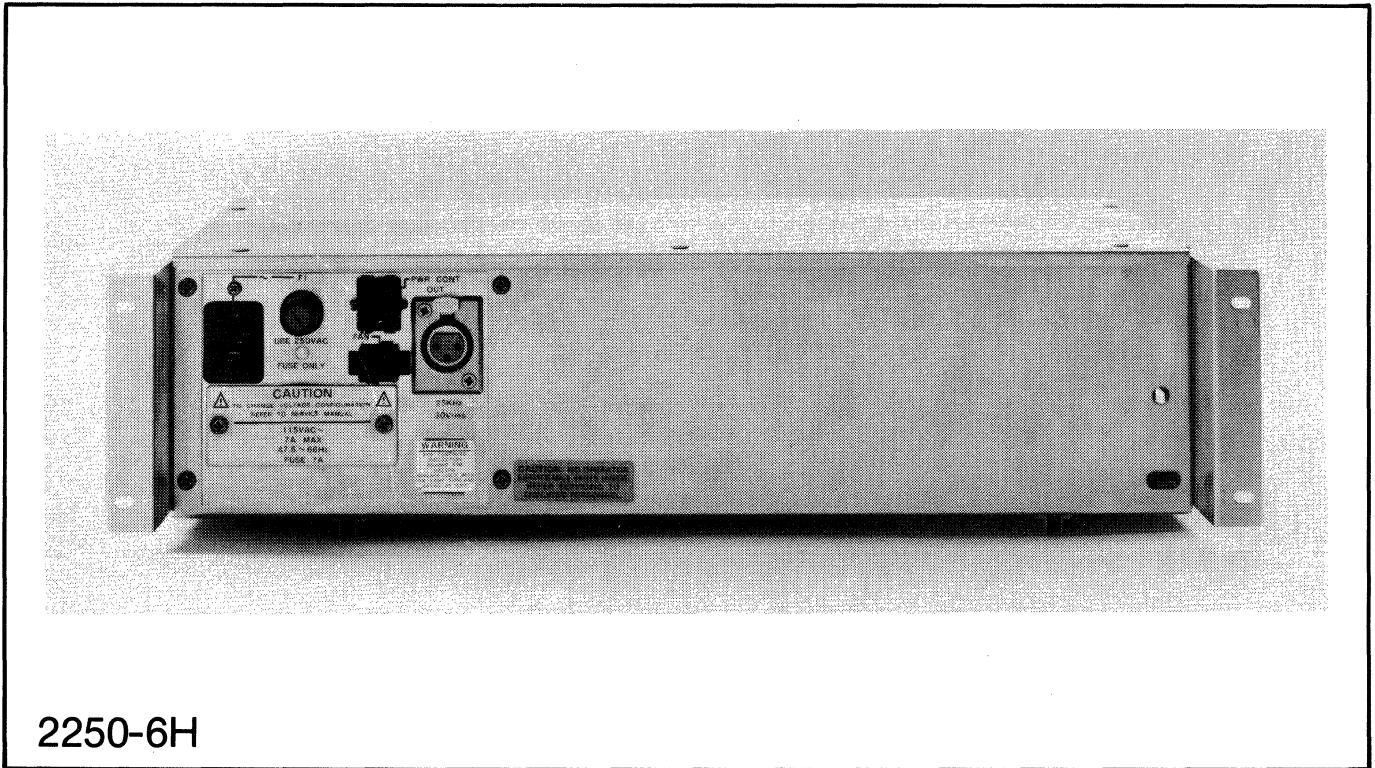


Figure 2-19. HP 12035A Power Supply

2.6 HP 2251 MEASUREMENT AND CONTROL UNIT

The HP 2251AN and HP 2251AR Measurement and Control Units (MCUs) are shown in figures 2-20 and 2-21. The MCU consists of a card cage with nine slots and a Backplane Interface (BIF) card, part number 25574-60002, which is always installed in slot number 0 of the card cage. Input/output (I/O) function cards are installed in the remaining eight slots. The mounting hole layout for the HP 2251AN (which mounts in a NEMA cabinet) is shown in figure 2-22. There may be up to eight MCUs installed in an HP 2250 system.

2.6.1 Backplane Interface Card Installation

There is one backplane interface (BIF) card (part number 25574-60002), see figure 2-23, in each MCU. As noted above, there may be up to eight MCUs in an HP 2250 system. The order of the MCUs is immaterial but each must be separately selected by number. The number is set on a rotary switch located on the BIF card.

To install the BIF card, perform the following:

- a. Set the thumbwheel switch, located on the front of the card, to 0 if the card is going to be located in the first MCU, to 1 if the card is to be located in the second MCU, 2 if the third, and so on.
- b. Insert the BIF card in slot 0 of the MCU card cage.
- c. Pull the black mounting tabs outward, away from the card. (See figure 2-24.) Push the retaining tabs up and out of the way.
- d. Push the card into the slot.
- e. Push the mounting tabs toward the card (this draws the card all the way into the slot). The tabs should lock in place.
- f. Connect the ribbon cable, part number 25570-60004, from the MCI card to the edge connector, J11, on the BIF card if the BIF card is installed in MCU number 0.
- g. If the BIF is installed in MCU number 1 or greater, connect one of the BIF-to-BIF cables 02251-60003, 02251-60004, or 02251-60009, depending on the desired length. See figure 2-25.

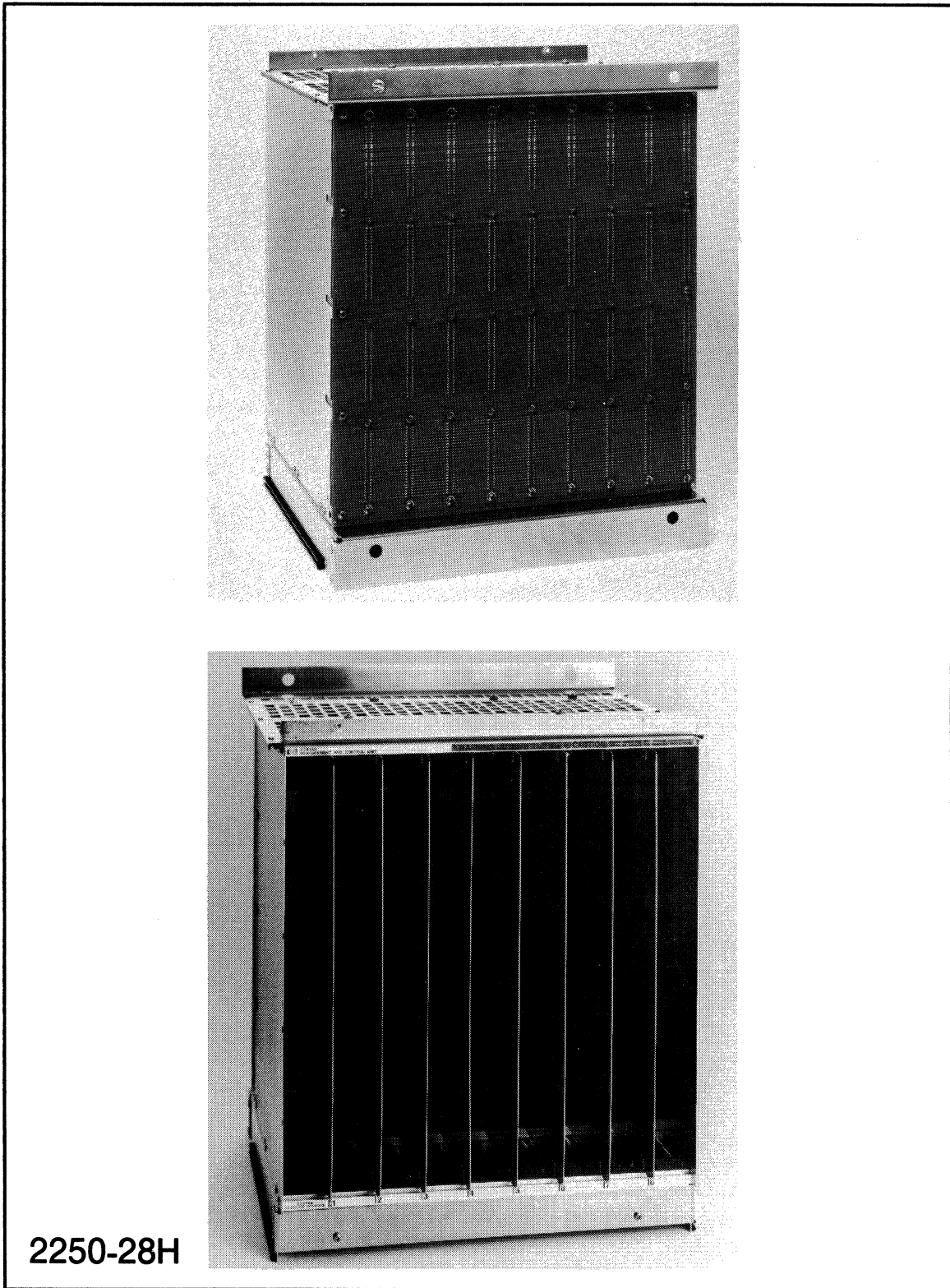


Figure 2-20. HP 2251AN Measurement and Control Unit

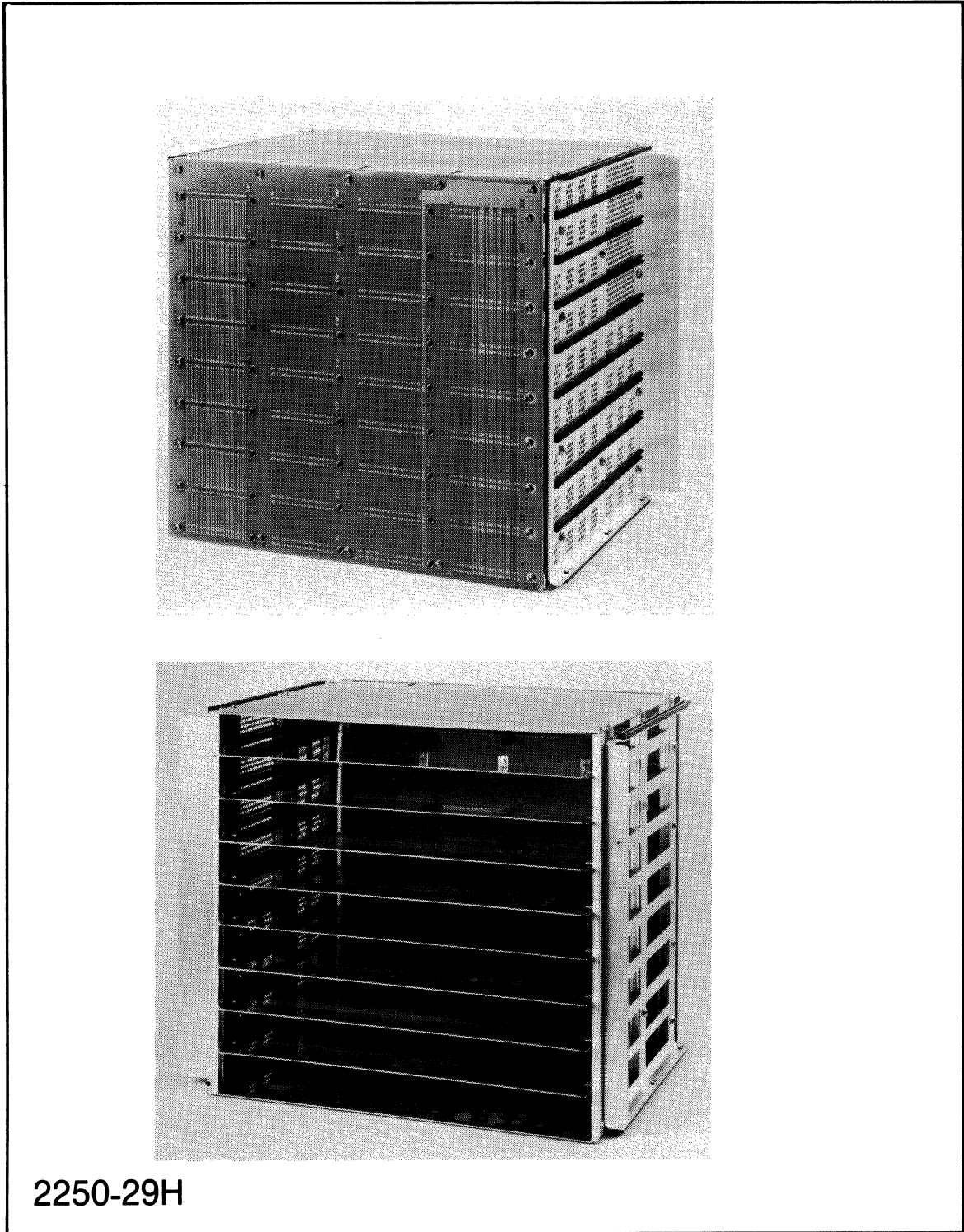


Figure 2-21. HP 2251AR Measurement and Control Unit

Installation

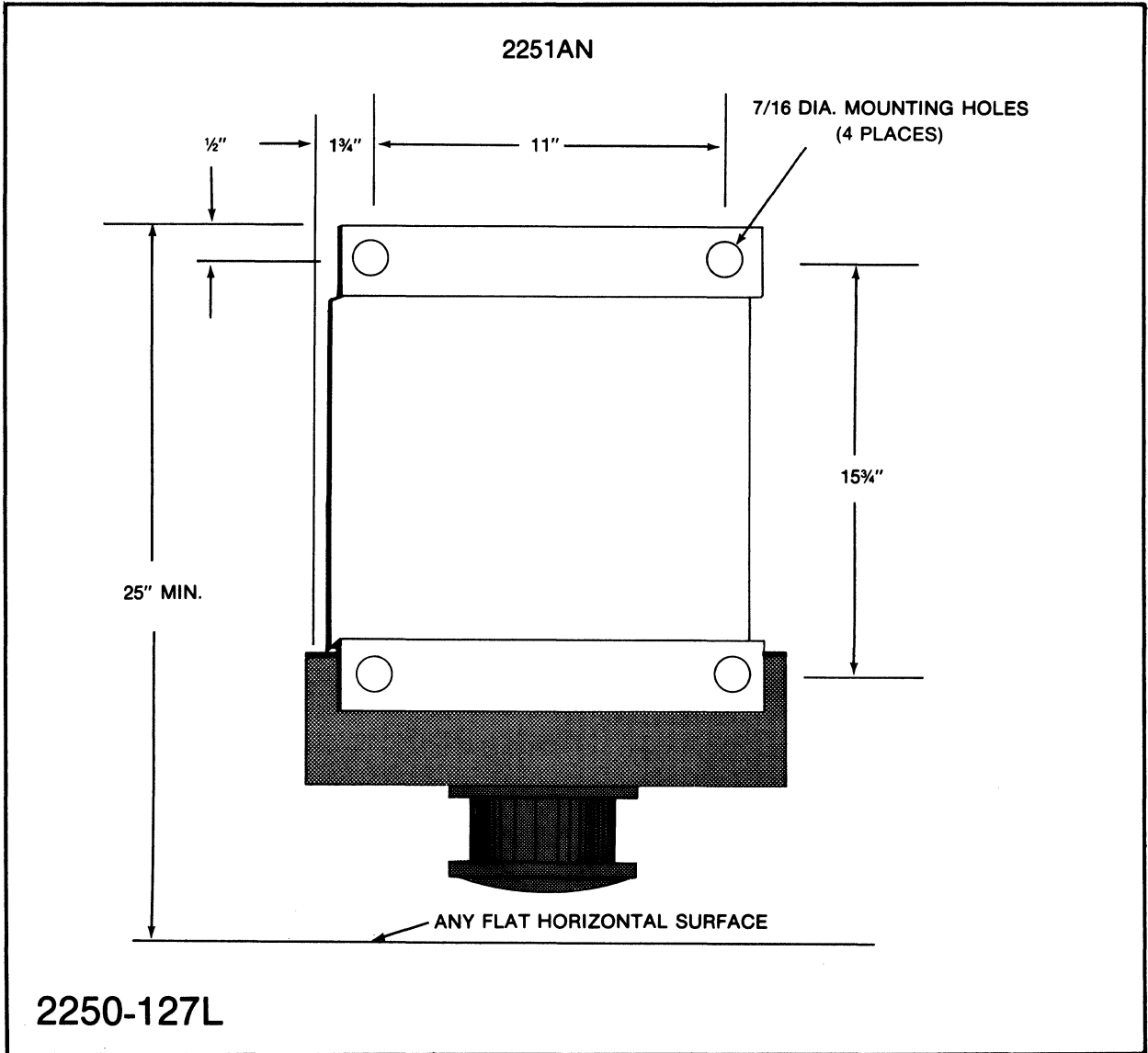


Figure 2-22. HP 2251AN Mounting Hole Layout

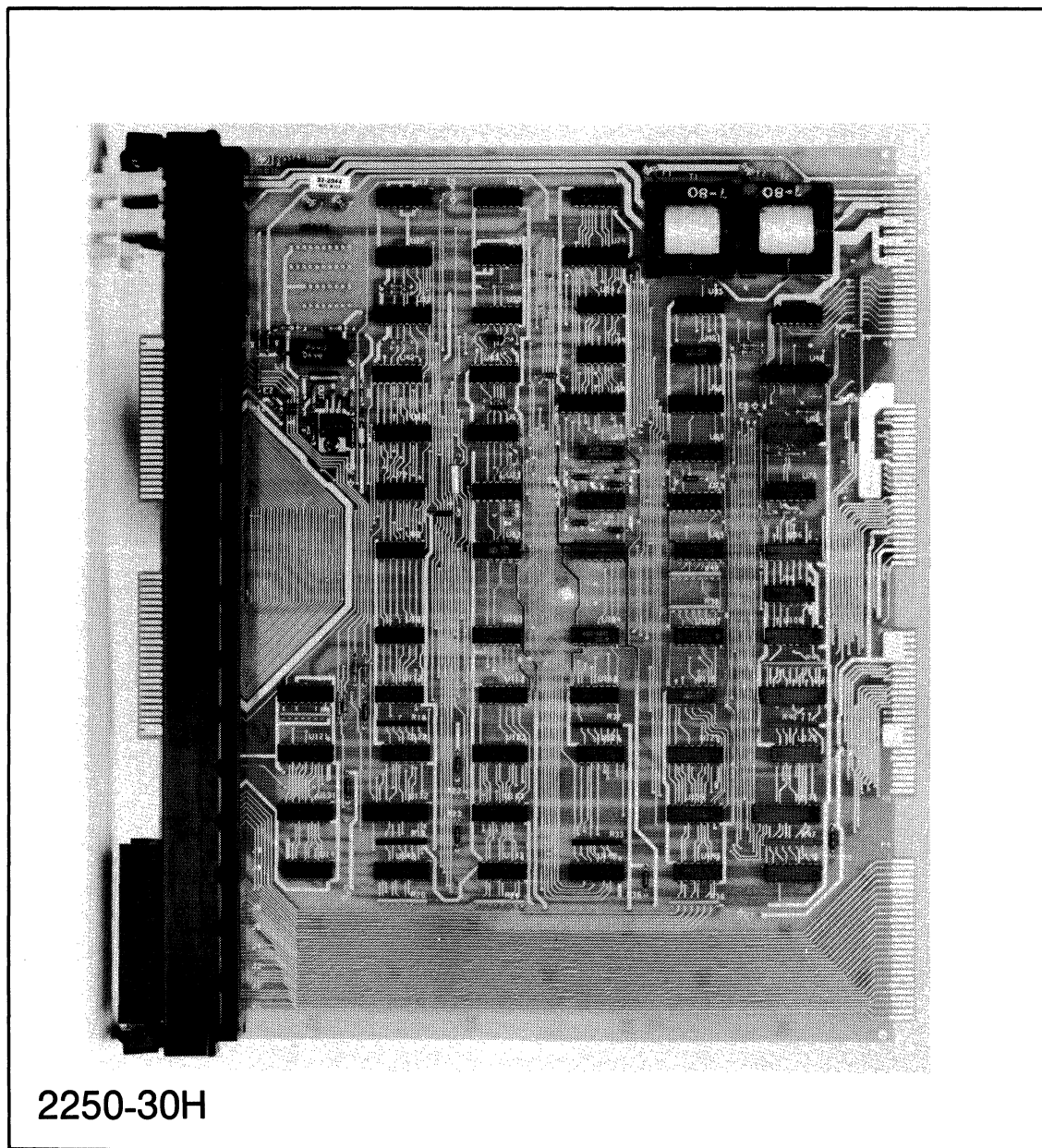


Figure 2-23. Backplane Interface Card



Figure 2-24. Installing a Card in the MCU

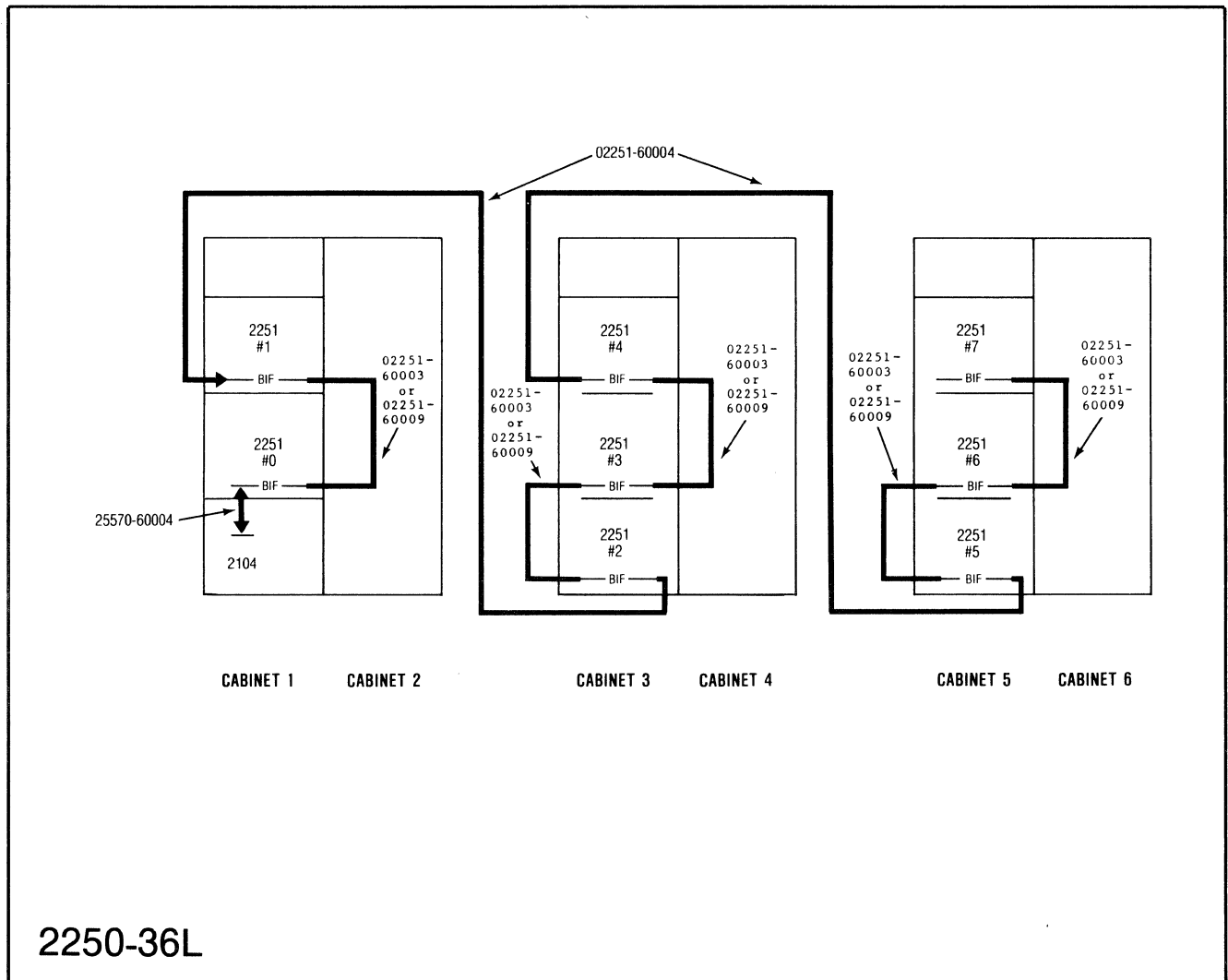


Figure 2-25. BIF-to-BIF Control Cable Layout

2.7 SIGNAL CONDITIONING MODULES

Signal Conditioning Modules (SCMs) are small printed circuit assemblies which plug onto function cards. The SCMs tailor the function cards for interfacing to many types of sensors and actuators. Several different signal conditioning modules are shown in figure 2-26. See the HP 2250 Hardware Reference Manual, part number 02250-90001, for functional descriptions of the various types of SCMs and the function cards on which they are used.

Signal conditioning modules are mounted on function cards by pressing the SCM down over the mounting posts on the function card as shown in figure 2-27. Make sure that the connection pins on the function card (see arrow) do not bend and that they fit in the corresponding holes on the SCM.

2.8 FUNCTION CARDS

Function cards are installed in the HP 2251AN or HP 2251AR MCU as described in the following paragraphs.

NOTE

Make sure that the appropriate signal conditioning modules are installed on any function card before it is installed in the MCU. See the preceding paragraphs for this procedure.

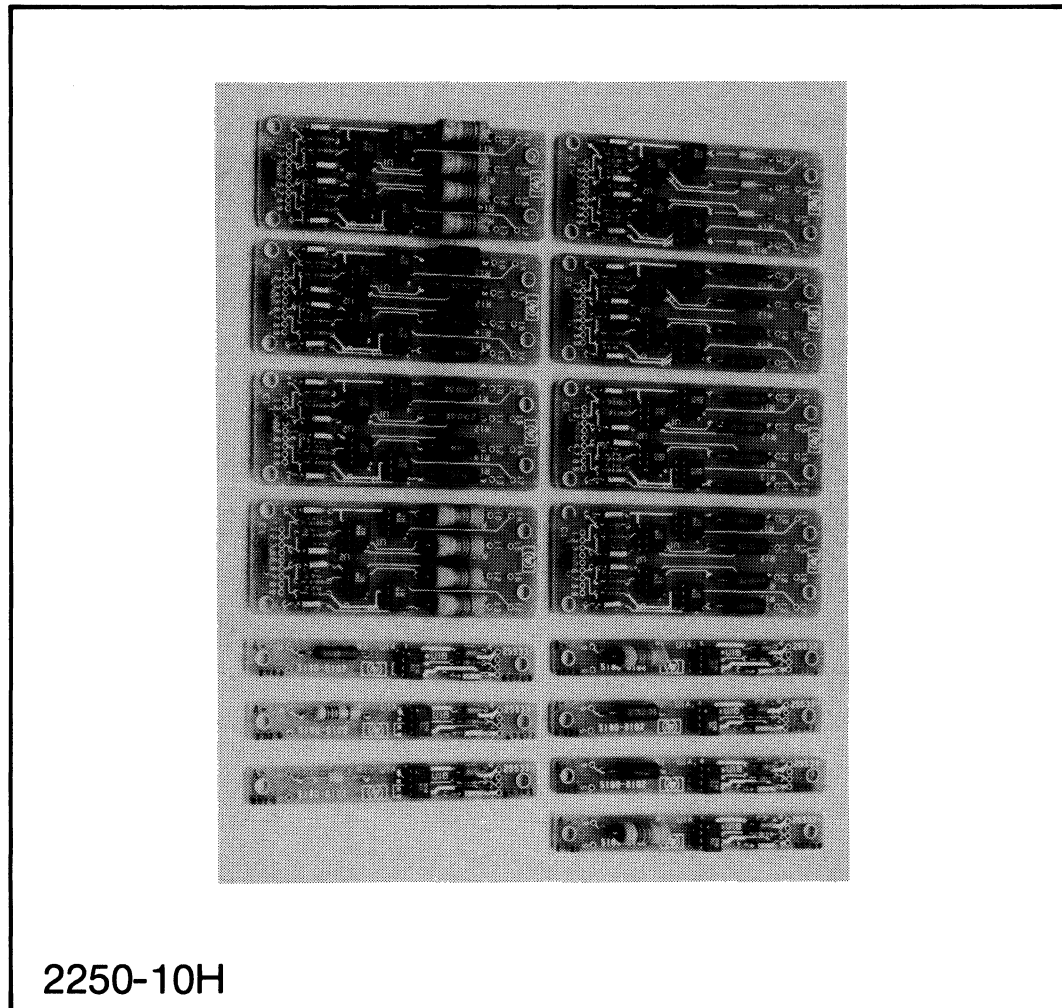


Figure 2-26. Signal Conditioning Modules

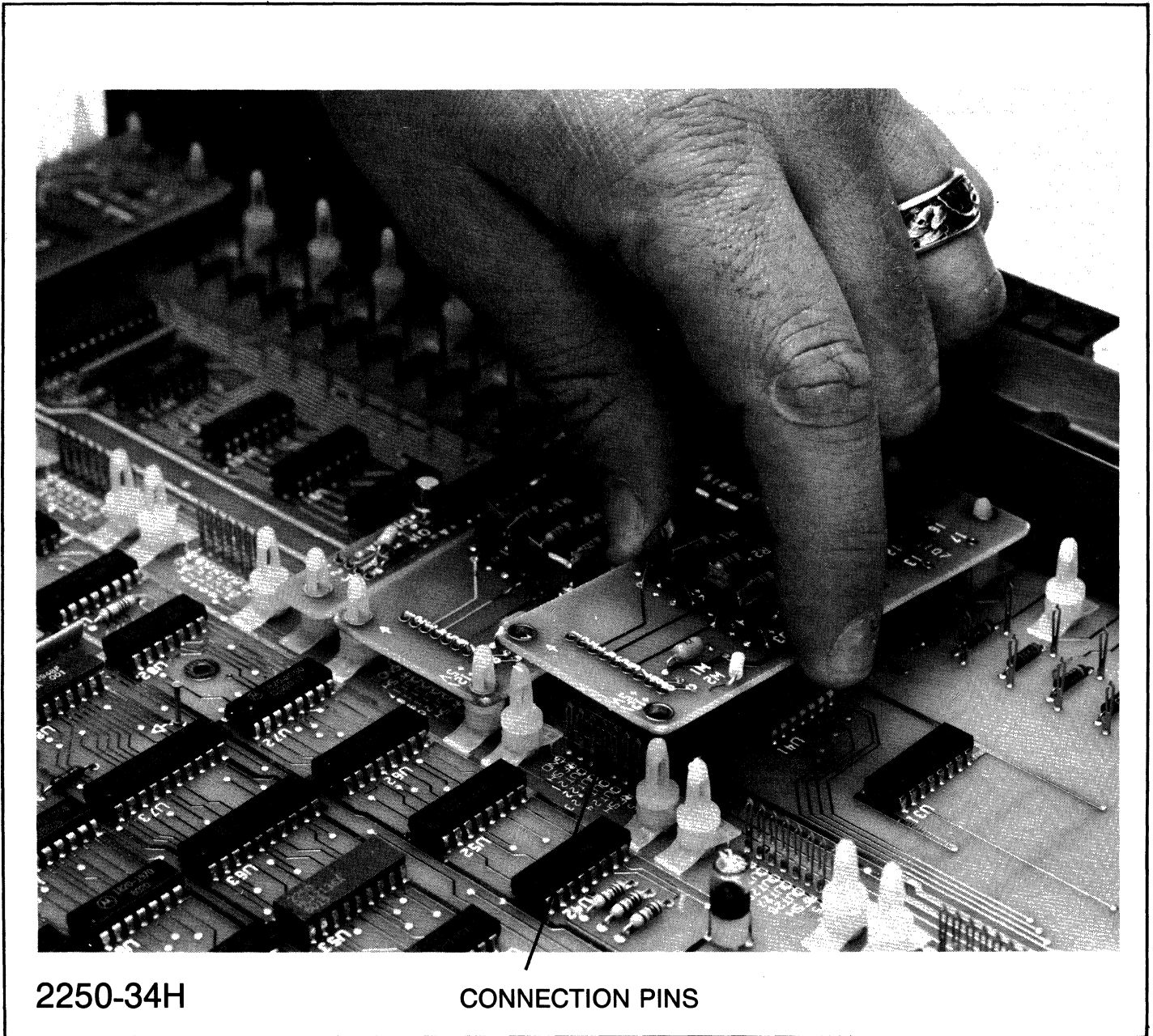


Figure 2-27. Installing an SCM on a Function Card

As noted, the MCU consists of a card cage with nine slots (numbered 0 through 8) and a backplane interface (BIF) card, which is always installed in slot number 0 of the card cage. Thus, the card cage contains eight slots for I/O (function) cards. (Slot number 0 is not an I/O slot and must contain a BIF card.)

NOTE

Each function card is classified as digital or analog. The classification is only descriptive, not functional. For example, the HP 25510A 4-Channel Voltage/Current Analog Output card is functionally analog, but is descriptively digital.

2.8.1 Function Card Mounting Considerations

The two descriptive classifications of cards are placed in the I/O slots in a specific order. Cards classified as digital are placed from the highest numbered I/O slot to the lowest numbered slot. Cards classified as analog are placed from the lowest numbered I/O slot to the highest numbered slot. An exception is the HP 25501A 16-Channel High-Speed Analog Input card, which is always placed in the lowest-numbered slot. Mounting considerations for digital and analog function cards are shown in figure 2-28.

SLOT NO.	DIGITAL CARD
8 7 6 5 4 3 2	25514A 16-CHANNEL RELAY OUTPUT 25513A 32-CHANNEL DIGITAL OUTPUT 25516A 16-CHANNEL DIGITAL MULTIFUNCTION 25511A 32-CHANNEL DIGITAL INPUT 25512A 4-CHANNEL COUNTER 25515A 4-CHANNEL PULSE OUTPUT 25510A 4-CHANNEL V/I ANALOG OUTPUT
SLOT NO.	ANALOG CARD
1 2 3 4	25501A 16-CHANNEL HS ANALOG INPUT 32-CHANNEL LOW-LEVEL MUX 16-CHANNEL RELAY MUX 32 CHANNEL HIGH-LEVEL MUX

Figure 2-28. Typical Function Card Mounting Order

2.8.1.1 General Placement Rules

Digital cards are placed in MCU card cages (as shown in figure 2-28), starting from slot number 8 of the first MCU frame and proceeding to slot 7, then slot 6, etc. When this frame is full, proceed to slot number 8 of the next highest frame. Repeat until all cards are installed.

For analog function cards, the first HP 25501A 16-Channel High-Speed Analog Input card is placed in slot number 1 of the lowest I/O frame. The remaining analog cards are placed in slots 2, 3, 4, etc., until the frame is full. If necessary, proceed to the next I/O frame. Repeat as necessary.

Note that an HP 25503 low level multiplexer card must not be placed directly next to an HP 25510 analog output card; at least one slot must intervene.

Figure 2-29 shows some function card configurations.

2.8.2 FUNCTION CARD INSTALLATION

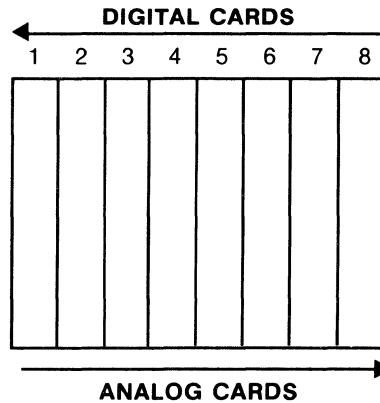
To install a function card in the MCU card cage, refer to figure 2-24, and perform the following:

- a. Ensure that the appropriate SCMs are mounted on the card (see the paragraph "SIGNAL CONDITIONING MODULES").
- b. Determine if the card is a digital or analog function card.
- c. If the card is an HP 25510 analog output card, set each channel for bipolar voltage, unipolar voltage, or current output, as appropriate. Since the card comes from the factory calibrated for bipolar voltage output, recalibrate it if you are using a different output mode.
- d. Insert the card in the correct slot in the MCU card cage.
- e. Pull the black mounting tabs outward, away from the card (see figure 2-24). Push the retaining tabs up and out of the way.
- f. Push the card into the slot.
- g. Push the mounting tabs toward the card (this draws the card all the way into the slot). The tabs should lock in place.

FUNCTION CARD CONFIGURATION: GENERALIZED PLACEMENT RULE

DIGITAL PRIORITY	
25514A	16CH RELAY OUTPUT
25513A	32CH DIG OUTPUT
25516A	MULTIFUNCTION
25511A	32CH DIG INPUT
25512A	COUNTER
25515A	PULSE OUTPUT
25510A	4CH V/I DAC

ANALOG PRIORITY	
25501A	16CH ADC
25503A	32CH LL MUX
25504A	16CH RELAY MUX
25502A	32CH HL MUX



EXAMPLE 1:	PRODUCTS	DESCRIPTION	QTY
	2251AR	I/O FRAME	2
	22501A	16CH ADC	2
	25502A	32CH HL MUX	3
	25503A	32CH LL MUX	3
	25504A	16CH RLY MUX	3
	25510A	4CH V/I DAC	2
	25511A	32CH DIG IN	1

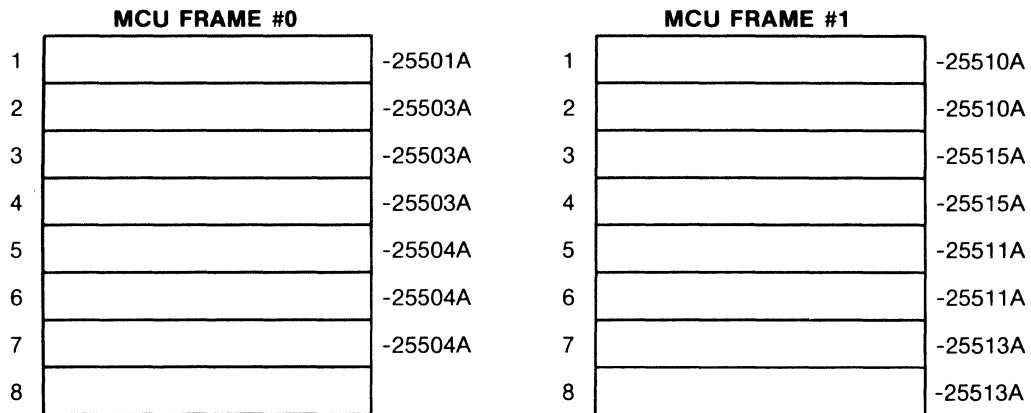
MCU FRAME #0	
1	-25501A
2	-25503A
3	-25503A
4	-25503A
5	-25504A
6	-25504A
7	-25504A
8	-25502A

MCU FRAME #1	
1	-25501A
2	-25502A
3	-25502A
4	
5	
6	-25510A
7	-25510A
8	-25511A

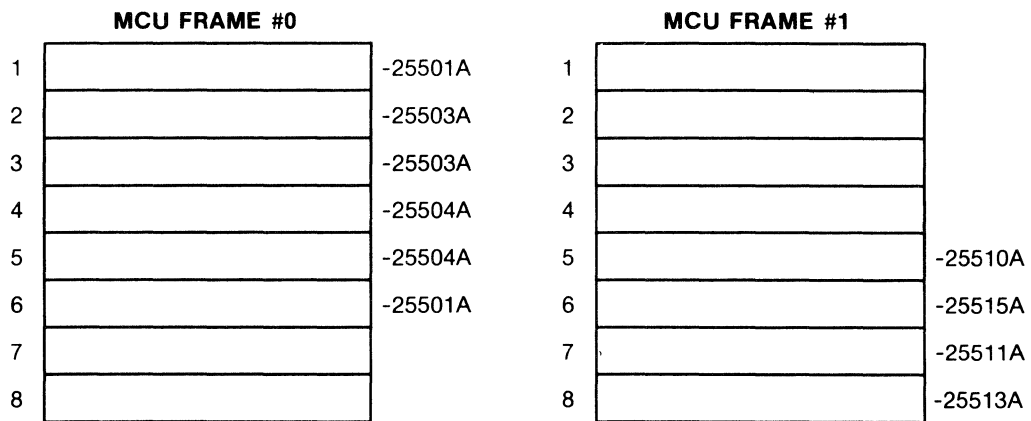
52A-0648

Figure 2-29. Function Card Configuration Examples (Sheet 1 of 3)

EXAMPLE 2:	PRODUCTS	DESCRIPTION	QTY
	2251AR	I/O FRAME	2
	22501A	16CH ADC	1
	25503A	32CH LL MUX	3
	25504A	16CH RLY MUX	3
	25510A	4CH V/I DAC	2
	25511A	32CH DIG IN	2
	25513A	32CH DIG OUT	2
	25515A	PULSE OUTPUT	2



EXAMPLE 3:	PRODUCTS	DESCRIPTION	QTY
	2251AR	I/O FRAME	2
	22501A	16CH ADC	2
	25503A	32CH LL MUX	2
	25504A	16CH RLY MUX	2
	25510A	4CH V/I DAC	1
	25511A	32CH DIG IN	1
	25513A	32CH DIG OUT	1
	25515A	PULSE OUTPUT	1

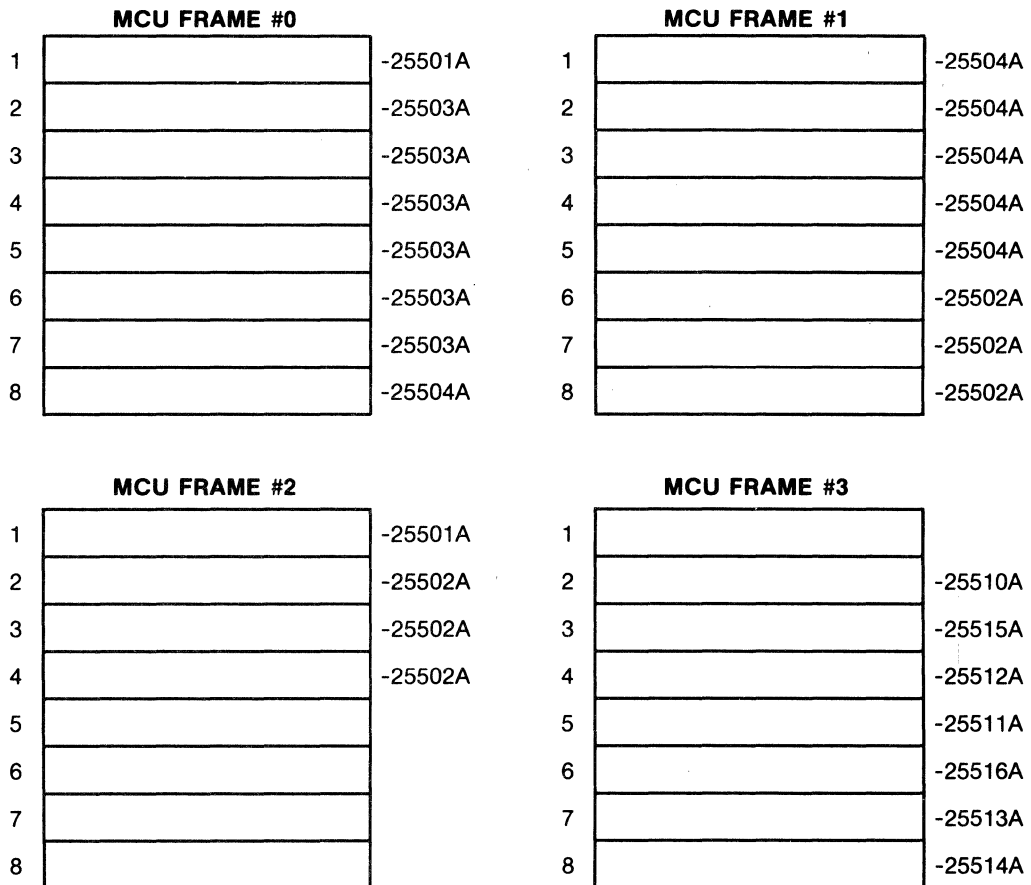


2250-33L2

Figure 2-29. Function Card Configuration Examples (Sheet 2 of 3)

EXAMPLE 4:

<u>PRODUCTS</u>	<u>DESCRIPTION</u>	<u>QTY</u>
2251AR	I/O FRAME	4
22501A	16CH ADC	2
25502A	32CH HL MUX	6
25503A	32CH LL MUX	6
25504A	16CH RLY MUX	6
25510A	4CH V/I DAC	1
25511A	32CH DIG IN	1
25512A	COUNTER	1
25513A	32CH DIG OUT	1
25514A	16CH RLY OUT	1
25515A	PULSE OUTPUT	1
25516A	MULTIFUNCTION	1



2250-33L3

Figure 2-29. Function Card Configuration Examples (Sheet 3 of 3)

2.9 CONTROL AND POWER CABLING

Figure 2-30 shows a maximum HP 2250 system, that is, one HP 2104 processor unit and eight HP 2251 measurement and control units (MCUs). Note that the processor unit and two MCUs are powered by the original power supply, and one additional power supply is required for each additional three MCUs.

Control and power cables are shown in figure 2-30. Power cabling is from each power supply to the processor unit and MCUs.

2.10 INPUT/OUTPUT CABLING

All function cards have from one to four 36-pin input/output (I/O) connector modules, A1 through A4, located on the front edge of the card. Corresponding connectors, P1, P2, P3, and P4, on the opposite edge of the card connect to the MCU backplane.

Each I/O connector module connects to an I/O field wiring cable assembly. Figure 2-31 demonstrates the connector modules and the cable assemblies. Eight 4-wire cables are connected to each connector module. The other end of each cable is terminated in a field wiring screw termination block. Figure 2-32 shows the cabling and a field wiring termination block assembly. External devices which are to be measured and controlled by the HP 2250 system are connected to the field wiring termination blocks.

Table 2-5A lists which cables can be used with which cards.

WARNING

CAUTION

Improper connection of field wiring to the screw terminations can create a shock or fire hazard or cause equipment failure, particularly when high voltage signals are present. Strip only the last 1/4" to 5/16" of insulation from the field wiring before connecting it to the screw terminations. DO NOT STRIP MORE THAN THIS AMOUNT. Make sure that the wires are fully inserted into the termination block.

WARNING

DO NOT use cables designed for other cards on the HP 25504 Relay Multiplexer (RLYMUX) Card. Due to differences in cable configurations between the RLYMUX card and other cards, use of a non-RLYMUX cable on a RLYMUX card could result in the routing of hazardous or even lethal voltages to terminations where they are not expected. USE ONLY SPECIFIED RLYMUX CABLES ON THE RLYMUX CARD.

Table 2-5A. Function Card Cables

Product Number	Connectors	
	Card	Field Wiring
25550A 25550B	digital digital	screw terminations unterminated
25551A 25551B	analog* analog*	screw terminations unterminated
25551C 25551D	RLYMUX RLYMUX	screw terminations unterminated
25594A 25594B	LLMUX RLYMUX	thermocouple reference thermocouple reference
* except HP 25504 RLYMUX card		

Installation

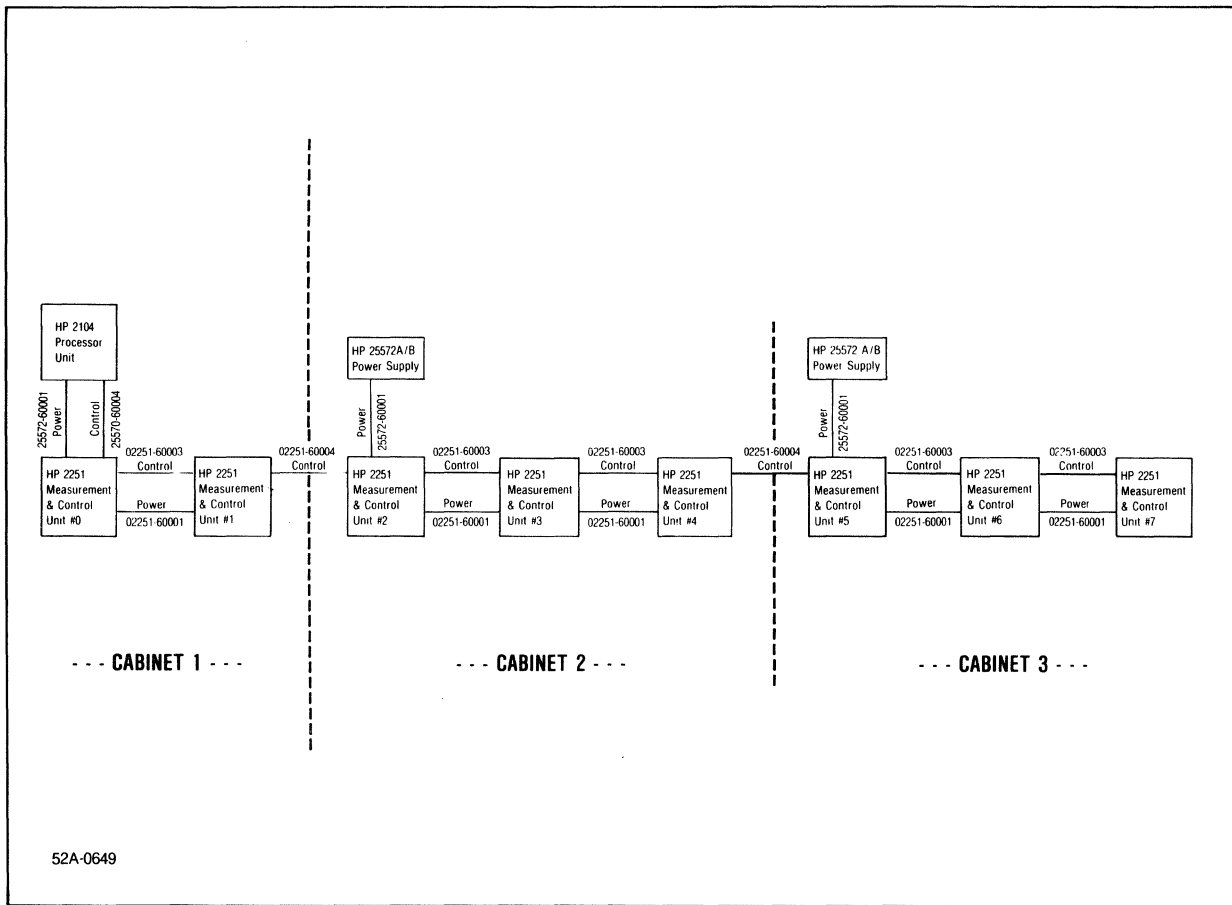


Figure 2-30. Maximum HP 2250 System

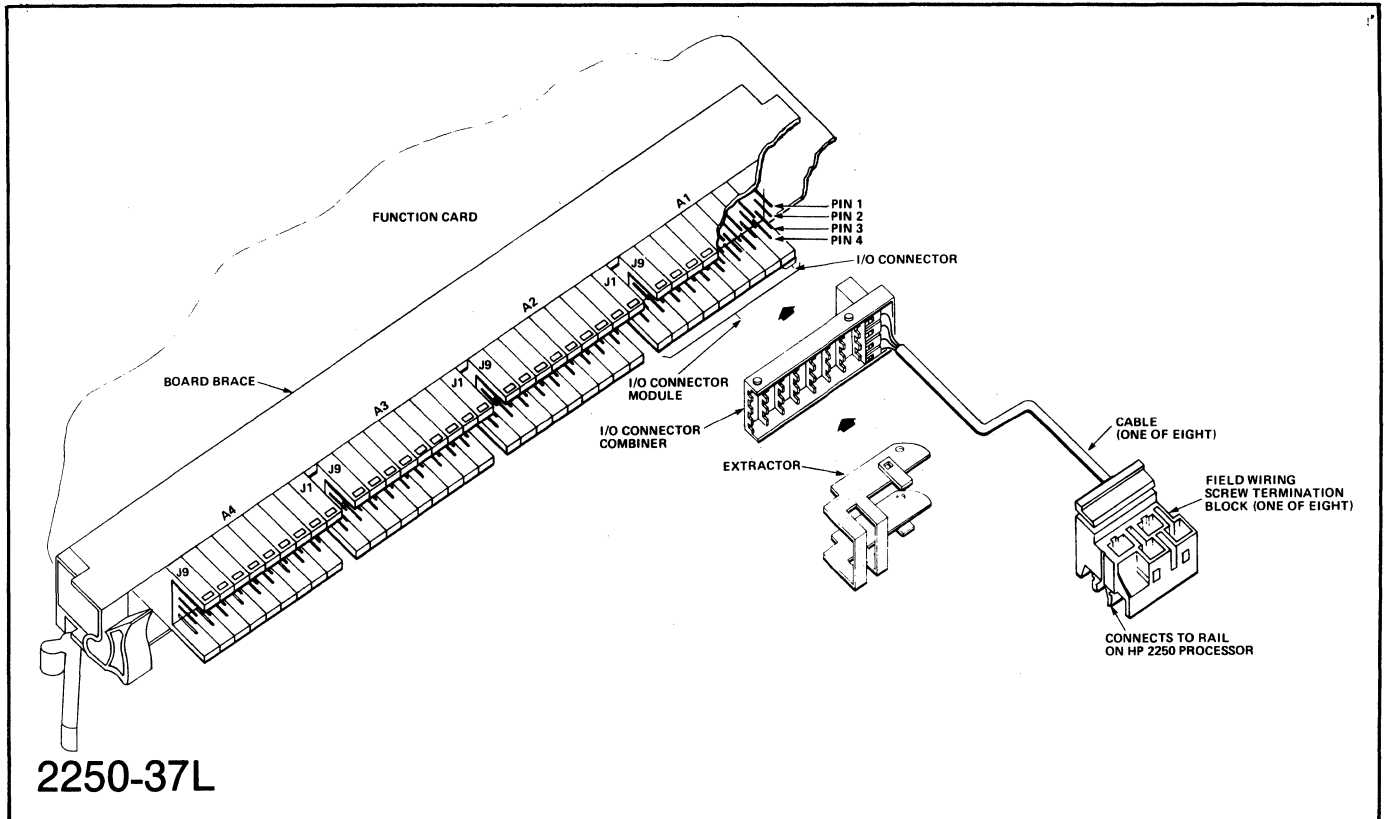
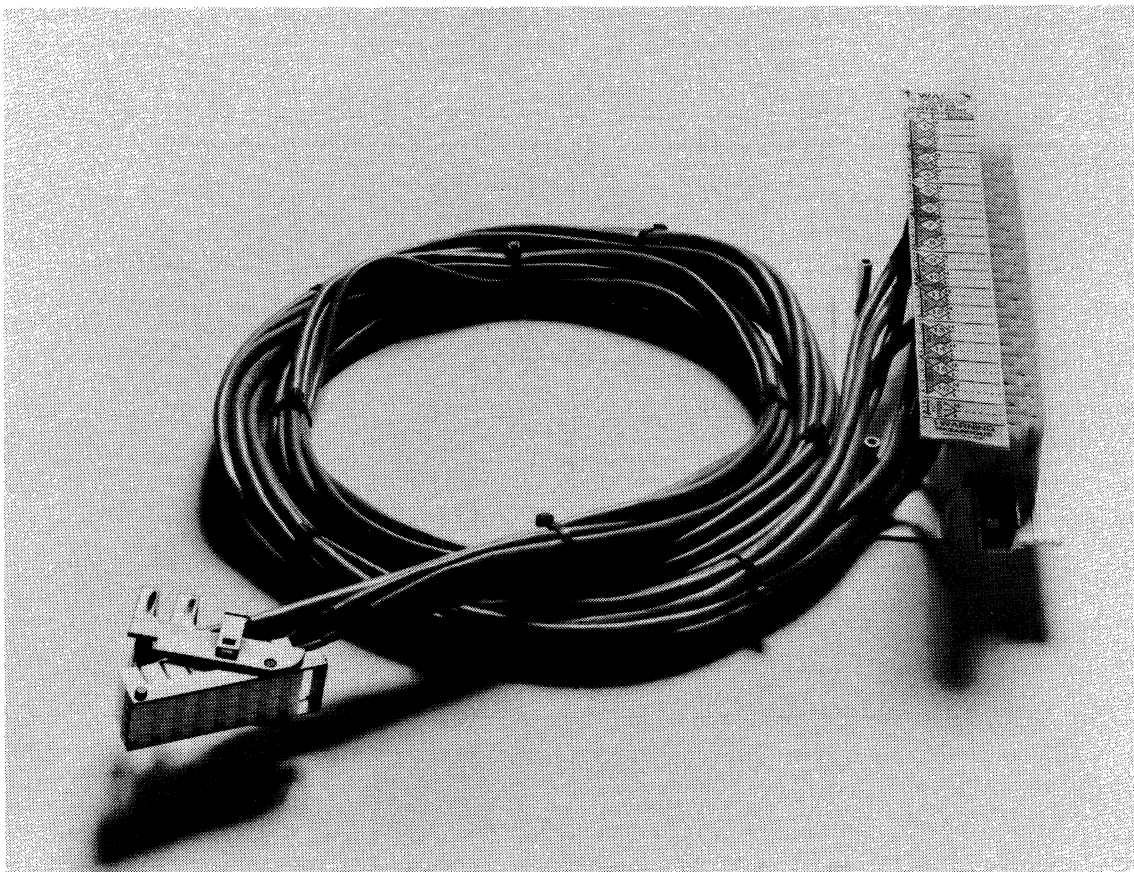


Figure 2-31. Connector Modules and Cable Assembly



2250-38H

Figure 2-32. Cabling and Field Wiring Assembly

In a system such as the HP 2250 which connects to hundreds of devices, some method must be used to record the connections. The method used with the HP 2250 is described in the following paragraphs.

Figure 2-33 shows the termination block labels for an HP 25511A 32-Point Digital Input card. The devices connected to the HP 25511A are recorded on the labels and the labels are then affixed to the termination block. The system number, MCU number, and I/O slot number also are recorded on the label (see the top of the label directly under "DIGITAL INPUT").

The cables that connect to the termination blocks are labeled with field wiring assembly (FWA) number, MCU number, and I/O slot number information. These labels are shown in figure 2-34.

The function card itself also is labeled with information that allows you to determine system number, MCU number, and slot number in which the card is installed; field wiring assembly (FWA) numbers and locations; and the types and numbers of SCMs installed on the card. A label for the HP 25511A card is shown in figure 2-35.

In summary then, cards installed when you receive your system will be labeled as follows:

- a. The card will be labeled with the MCU number and slot number in which it is installed. In addition, the numbers and types of SCMs installed on the card are recorded on the label, as are the FWAs which are connected to the card.
- b. The cables connecting the FWAs to the card are labeled to show the MCU number, slot number, and FWA numbers.
- c. The field termination block is labeled to show the MCU number and slot number to which the FWA (of which the field termination block is a part) is connected, and the types of devices which are connected to the function card through the FWA.

If you install cards in your system, label blocks are furnished with each card so that you can record the above information for each card. The labels are self-adhesive, so that, once the information is recorded on the labels, they can be removed from the sheet and attached to the card, the SCMs installed on the cards, the cables connected to the cards, and the FWAs on the end of the cables.

Figures 2-36 through 2-44 show the label blocks for all available function cards.

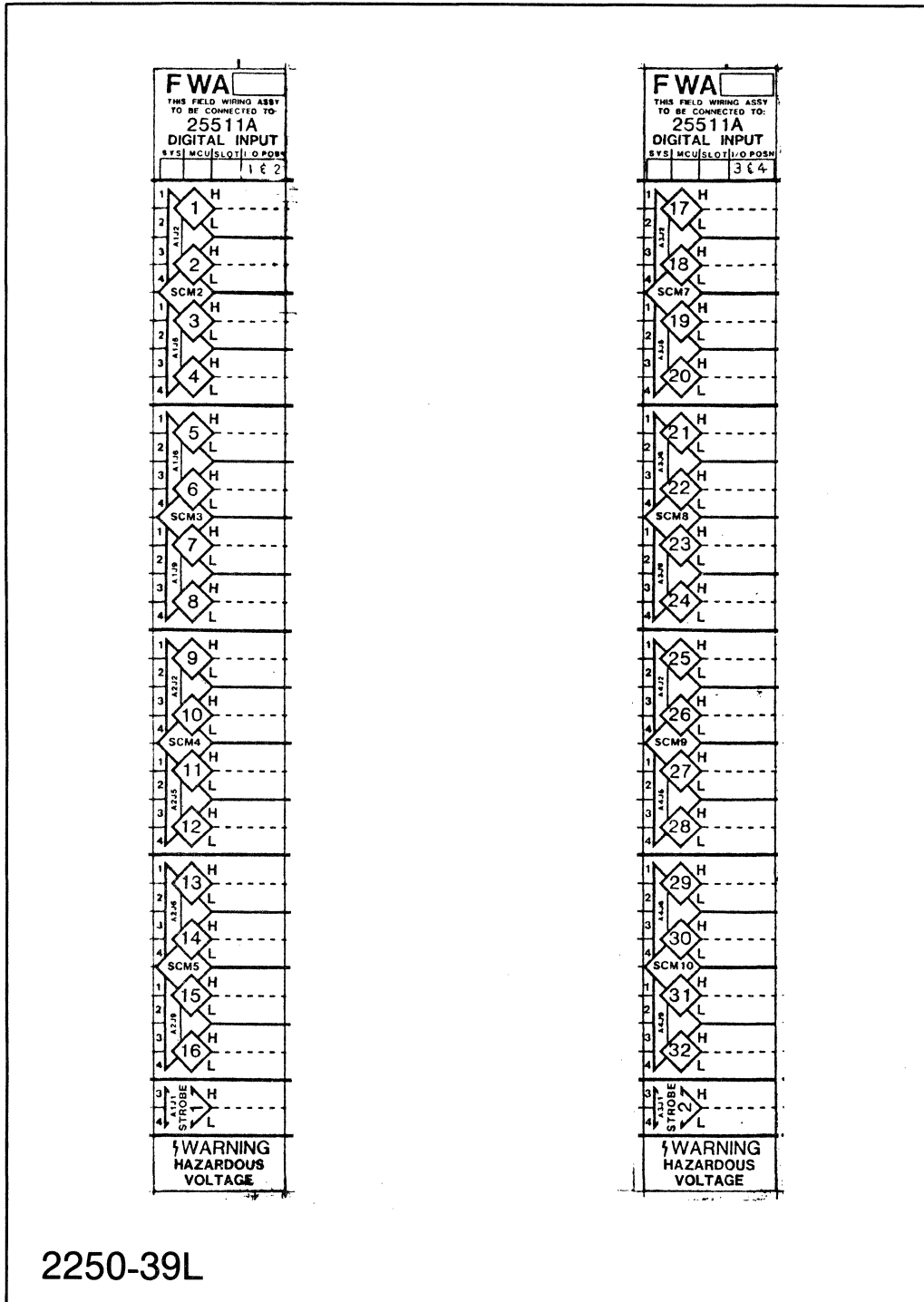


Figure 2-33. Termination Block Labels

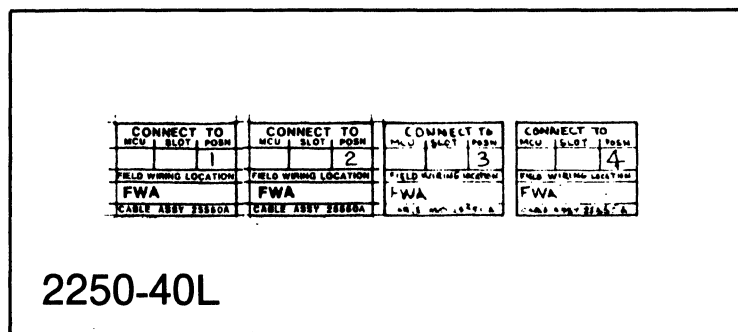


Figure 2-34. Cable Labels

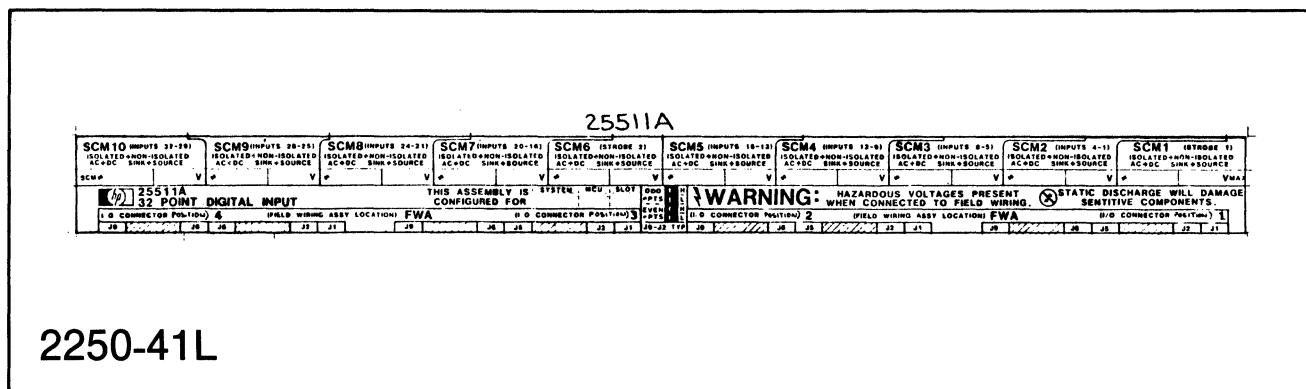
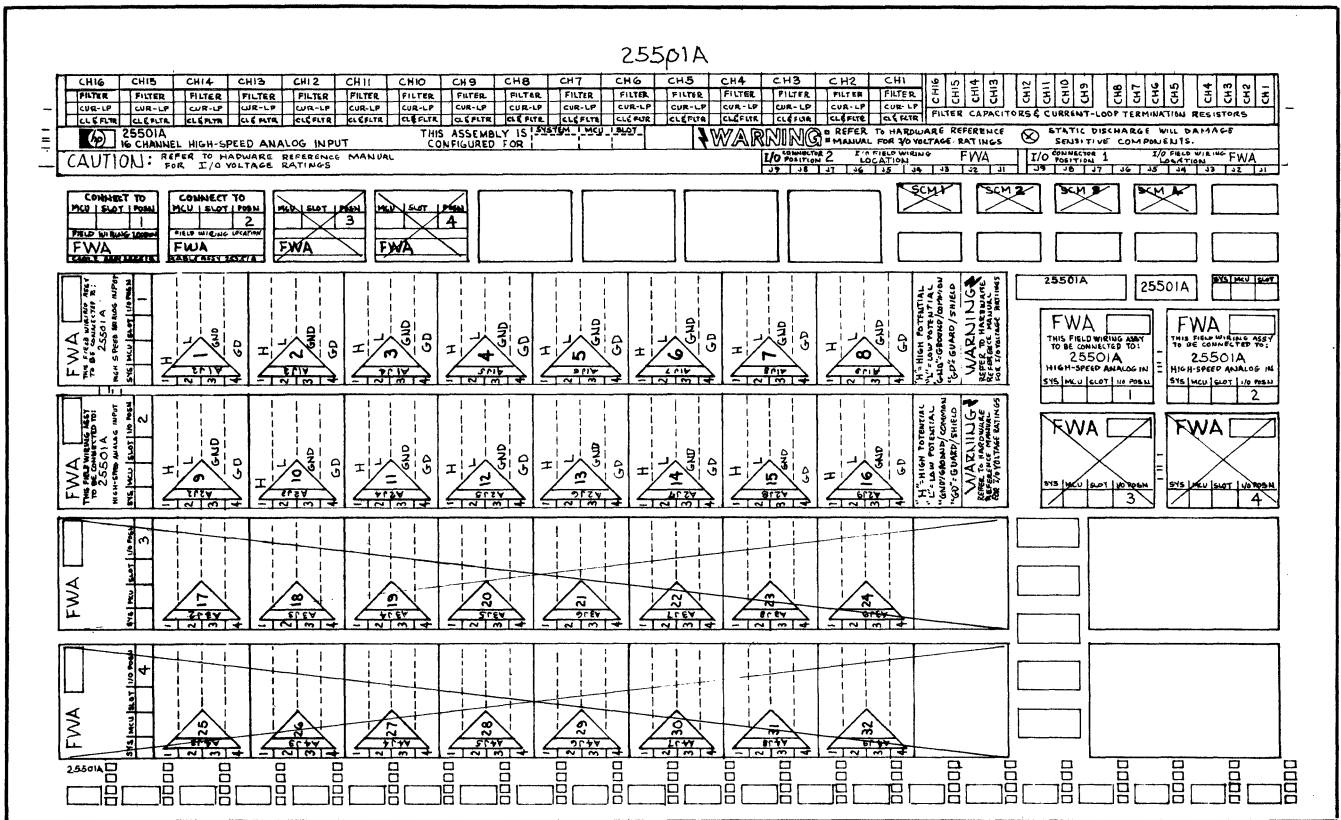


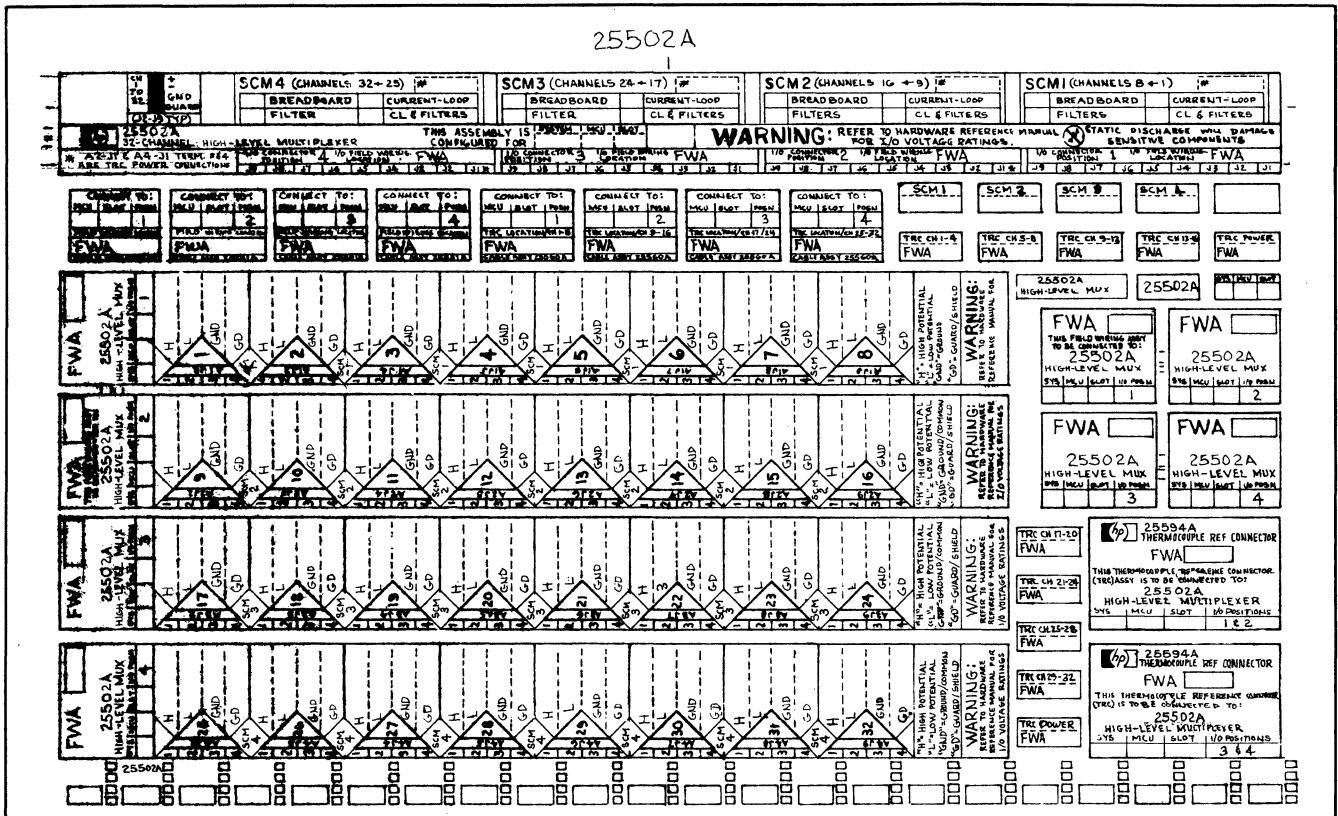
Figure 2-35. Function Card Label

Installation



2250-42L

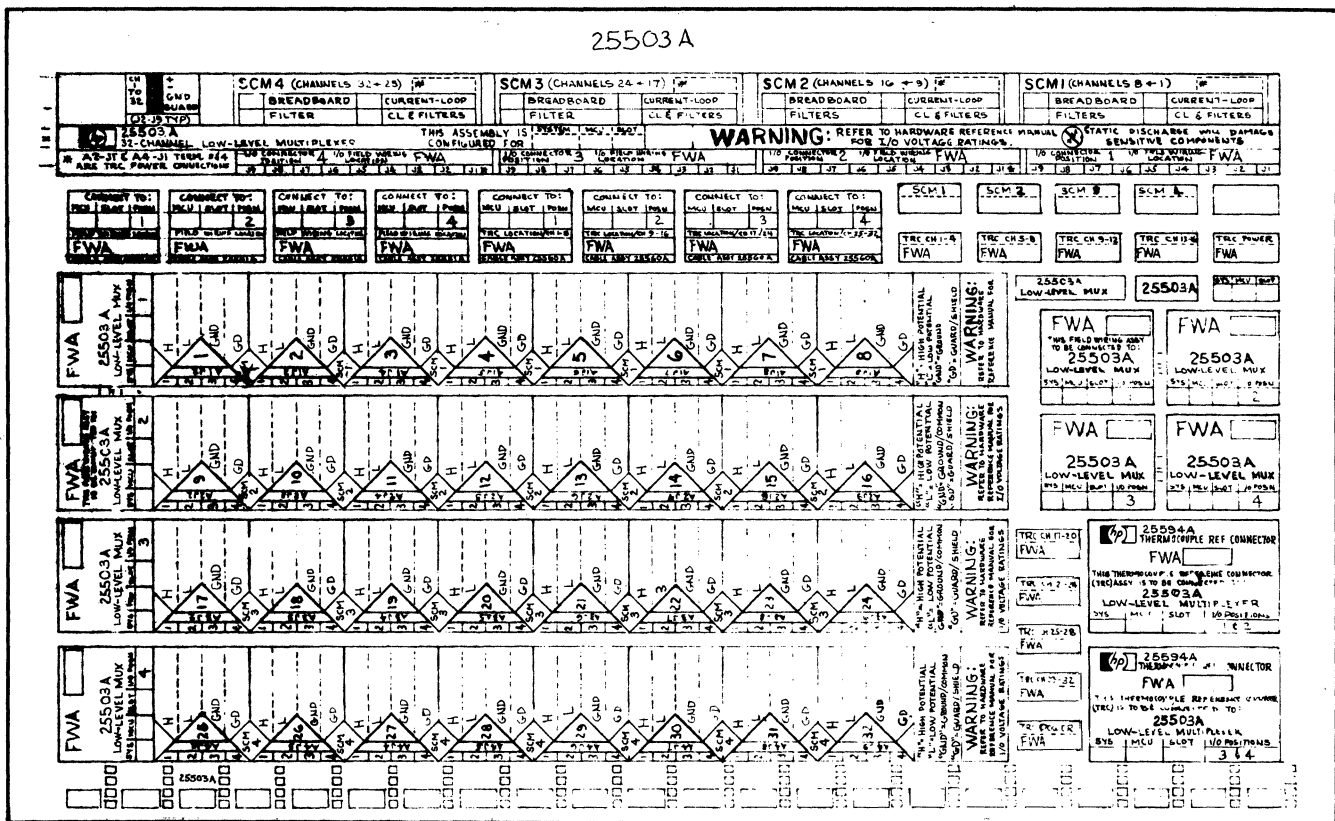
Figure 2-36. HP 25501A Label Block



2250-43L

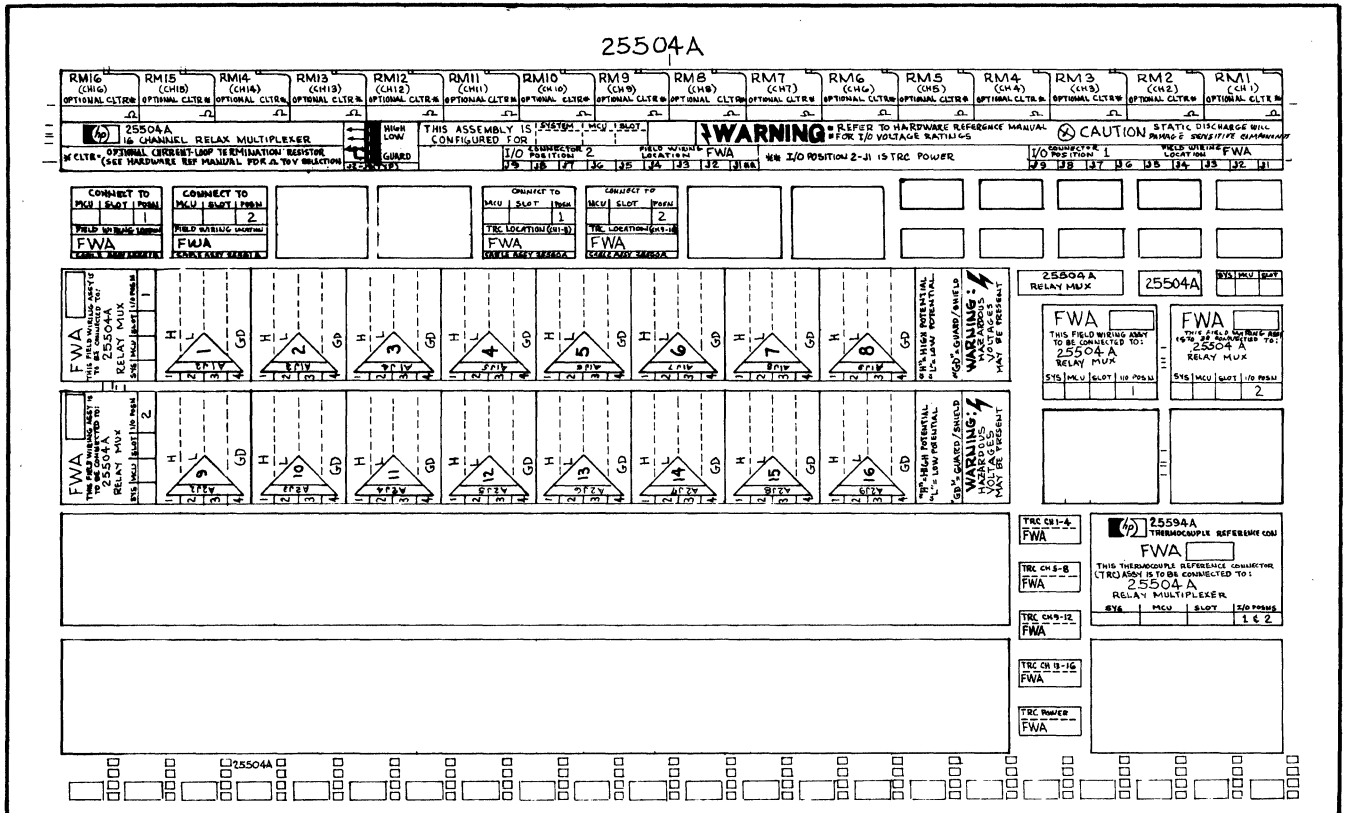
Figure 2-37. HP 25502A Label Block

Installation



2250-44L

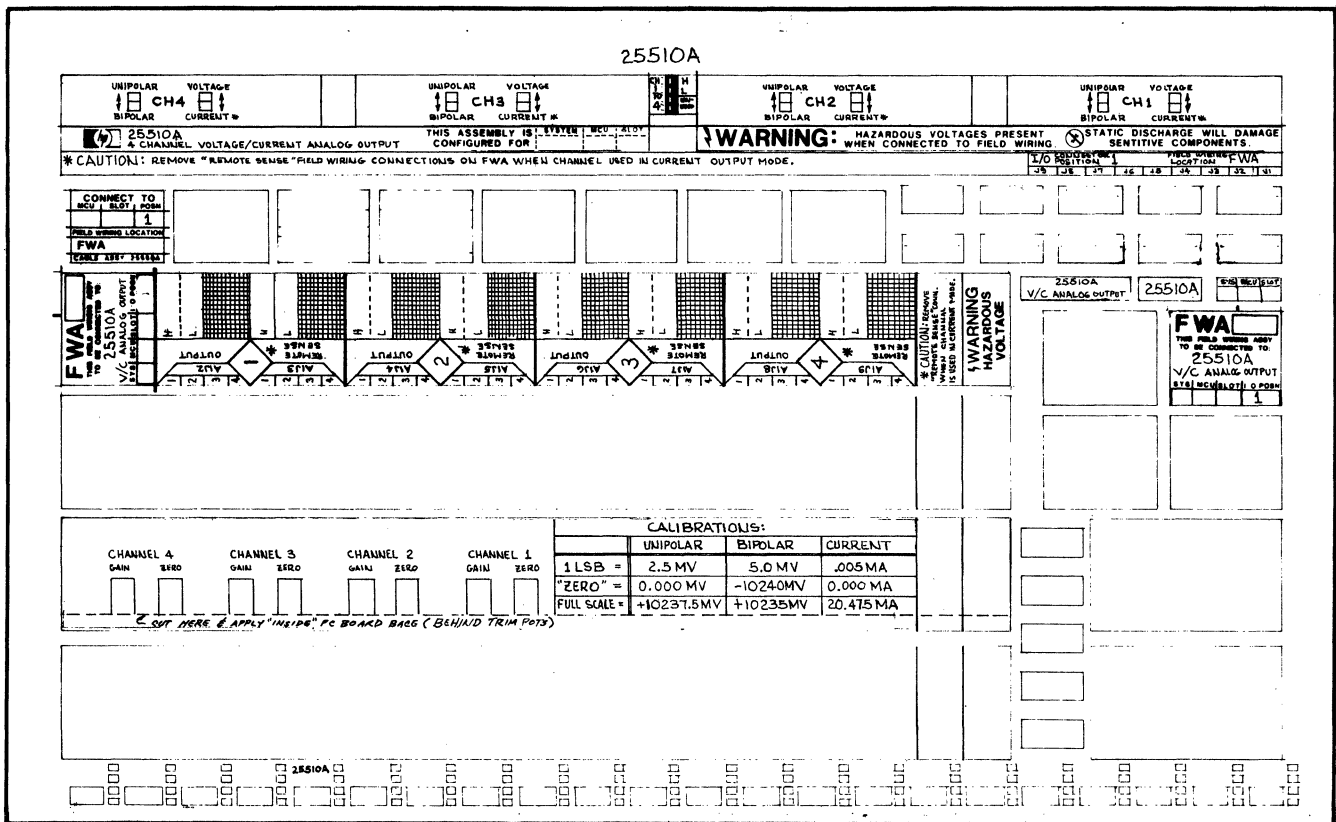
Figure 2-38. HP 25503A Label Block



2250-45L

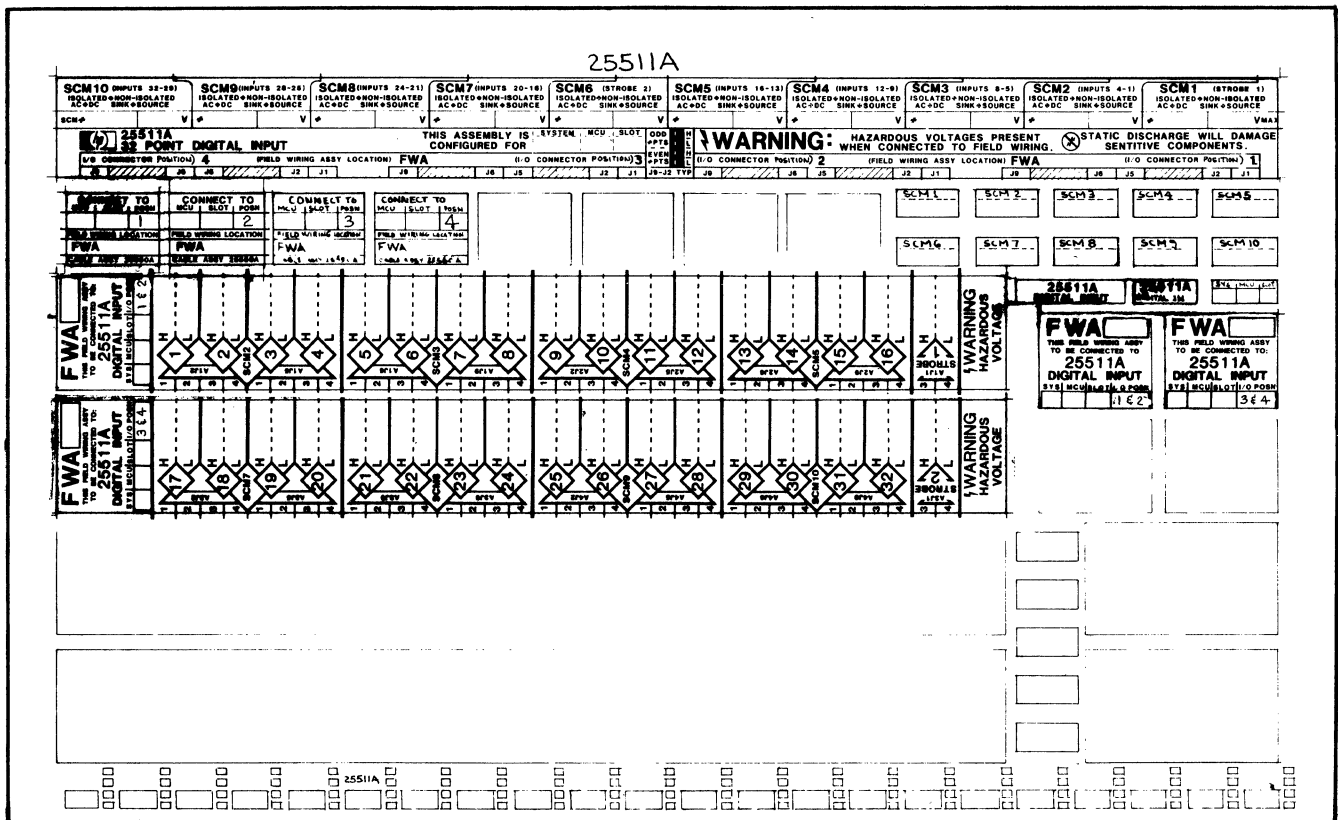
Figure 2-39. HP 25504A Label Block

Installation



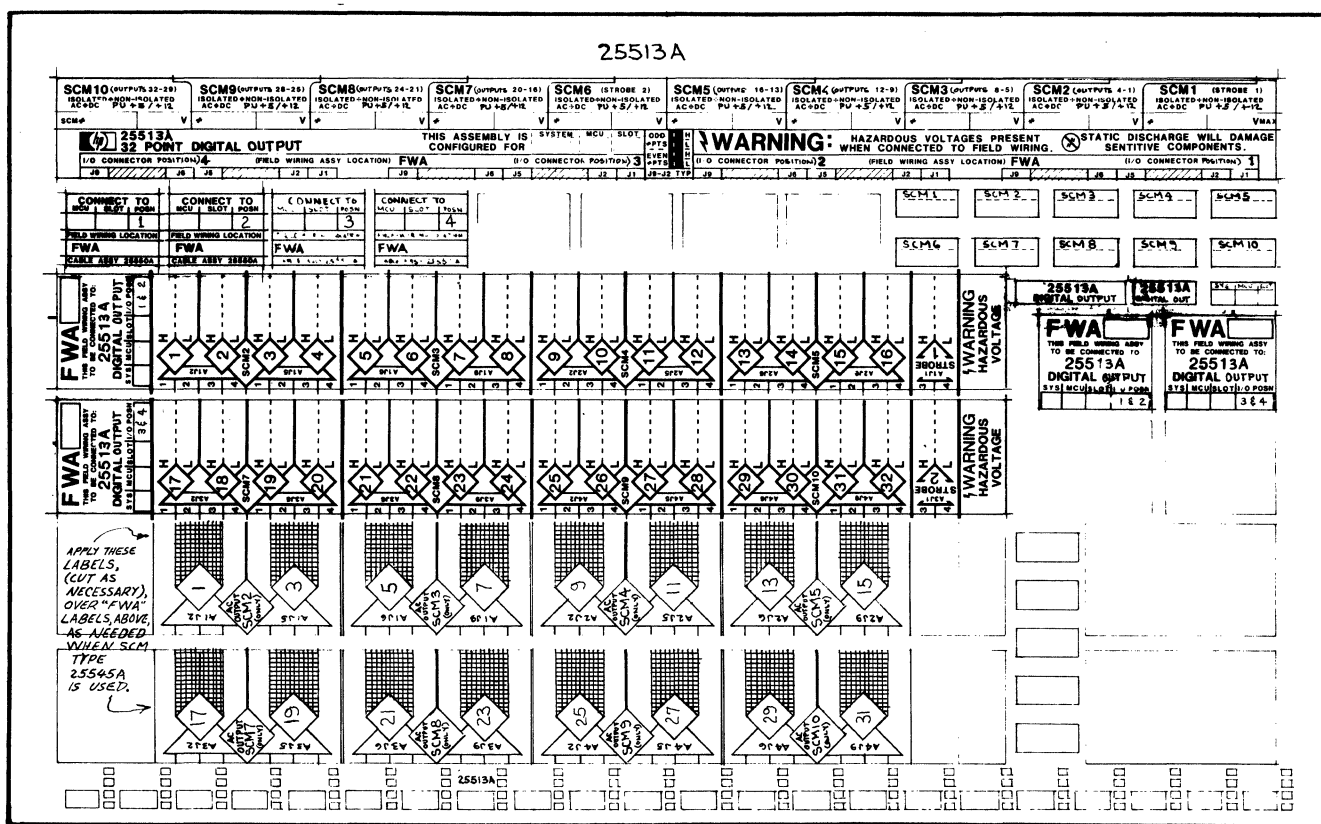
2250-46L

Figure 2-40. HP 25510A Label Block



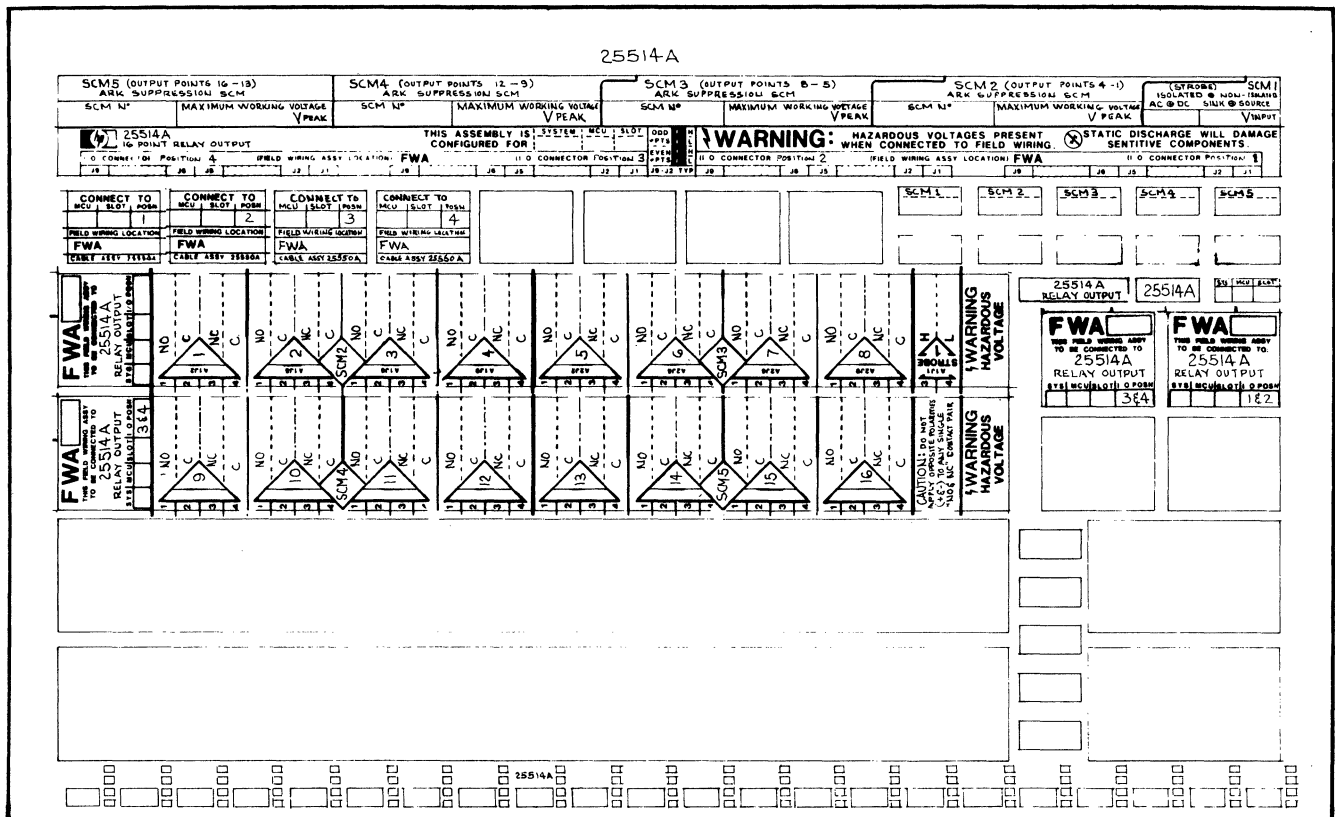
2250-47L

Figure 2-41. HP 25511A Label Block



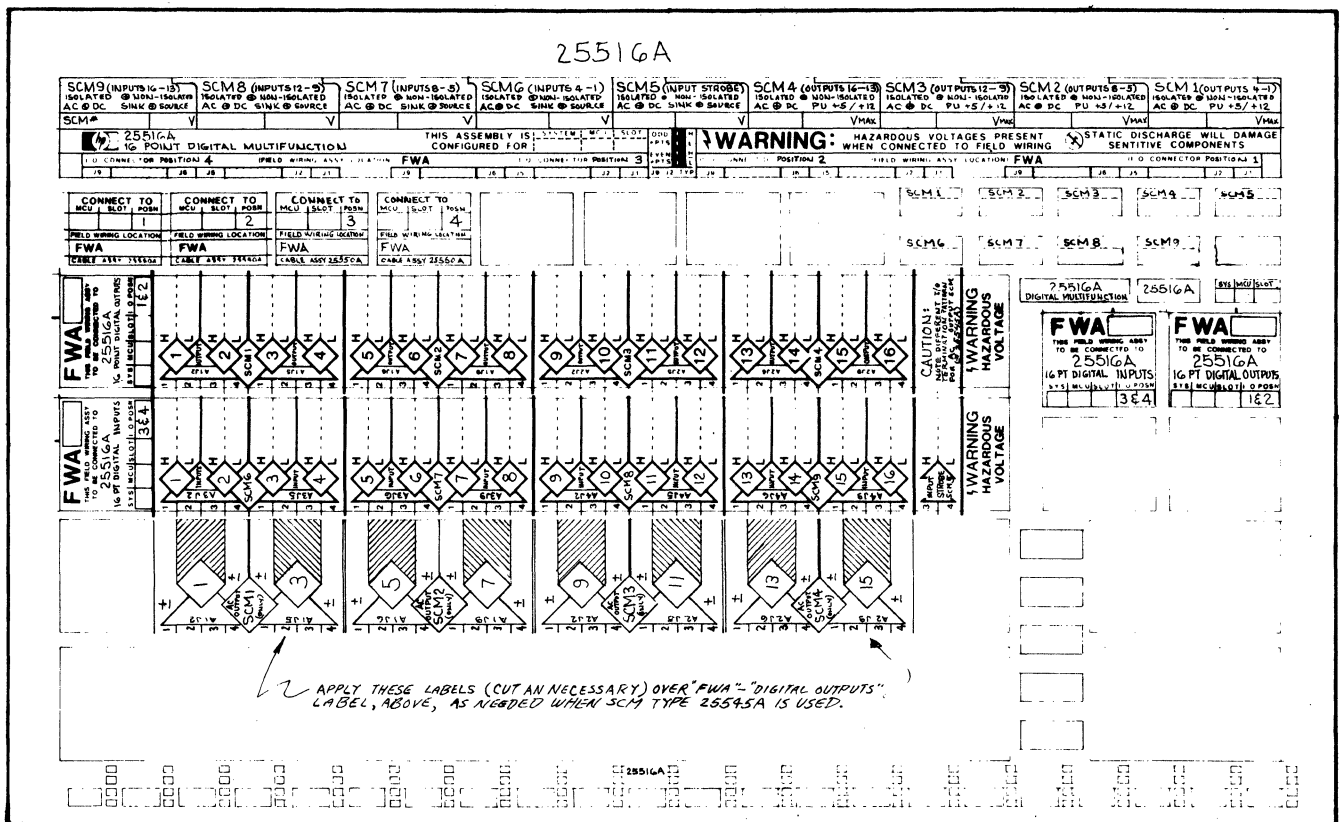
2250-48L

Figure 2-42. HP 25513A Label Block



2250-49L

Figure 2-43. HP 25514A Label Block



2250-50L

Figure 2-44. HP 25516A Label Block

Tables 2-6 through 2-14 contain I/O connector module pin assignments for the function cards. Pins 1 and 2 of connector J1 on each of the cards is connected to an identifying resistor. Each resistor value is unique and is used by the HP 25590 Diagnostic Interface Unit as a card identifier.

The remaining pins are used to connect external points or channels to the card.

Table 2-6. HP 25501A I/O Connector Module Pin Assignments

CONNECTOR	PINS	CONNECTION		CONNECTOR	PINS	CONNECTION
A1J1	1,2	ID Resistor		A2J1	1,2	ID Resistor
A1J1	3	Ground		A2J1	3	Ground
A1J2	1,2,3	Channel 1		A2J2	1,2,3	Channel 9
A1J3	1,2,3	Channel 2		A2J3	1,2,3	Channel 10
A1J4	1,2,3	Channel 3		A2J4	1,2,3	Channel 11
A1J5	1,2,3	Channel 4		A2J5	1,2,3	Channel 12
A1J6	1,2,3	Channel 5		A2J6	1,2,3	Channel 13
A1J7	1,2,3	Channel 6		A2J7	1,2,3	Channel 14
A1J8	1,2,3	Channel 7		A2J8	1,2,3	Channel 15
A1J9	1,2,3	Channel 8		A2J9	1,2,3	Channel 16

Note that Pins 1, 2, and 3 of J2 through J9 in each connector have the following connections: Pin 1 (+ Input), Pin 2 (- Input), and Pin 3 (Ground).

Installation

Table 2-7. HP 25502A I/O Connector Module Pin Assignments

CONNECTOR	PINS	CONNECTION		CONNECTOR	PINS	CONNECTION
A1J1	1,2	ID Resistor		A3J1	1,2	ID Resistor
A1J1	3	Ground		A3J1	3	Ground
A1J1	4	Not used		A3J1	4	Not used
A1J2	1,2,3	Channel 1		A3J2	1,2,3	Channel 17
A1J3	1,2,3	Channel 2		A3J3	1,2,3	Channel 18
A1J4	1,2,3	Channel 3		A3J4	1,2,3	Channel 19
A1J5	1,2,3	Channel 4		A3J5	1,2,3	Channel 20
A1J6	1,2,3	Channel 5		A3J6	1,2,3	Channel 21
A1J7	1,2,3	Channel 6		A3J7	1,2,3	Channel 22
A1J8	1,2,3	Channel 7		A3J8	1,2,3	Channel 23
A1J9	1,2,3	Channel 8		A3J9	1,2,3	Channel 24
A2J1	1,2	ID Resistor		A4J1	1,2	ID Resistor
A2J1	3	Ground		A4J1	3	Ground
A2J1	4	Not used		A4J1	4	Not used
A2J2	1,2,3	Channel 9		A4J2	1,2,3	Channel 25
A2J3	1,2,3	Channel 10		A4J3	1,2,3	Channel 26
A2J4	1,2,3	Channel 11		A4J4	1,2,3	Channel 27
A2J5	1,2,3	Channel 12		A4J5	1,2,3	Channel 28
A2J6	1,2,3	Channel 13		A4J6	1,2,3	Channel 29
A2J7	1,2,3	Channel 14		A4J7	1,2,3	Channel 30
A2J8	1,2,3	Channel 15		A4J8	1,2,3	Channel 31
A2J9	1,2,3	Channel 16		A4J9	1,2,3	Channel 32
<p>Note that Pins 1, 2, and 3, of J2 through J9 in each connector have the following connections: Pin 1 (+ input), Pin 2 (- Input), and Pin 3 (Ground).</p>						

Table 2-8. HP 25503A I/O Connector Module Pin Assignments

CONNECTOR	PINS	CONNECTION	CONNECTOR	PINS	CONNECTION
A1J1	1,2	ID Resistor	A3J1	1,2	ID Resistor
A1J1	2	Ground	A3J1	2	Ground
A1J1	3	Thermocouple Supply (+)	A3J1	3	Thermocouple Supply (+)
A1J1	4	Thermocouple Supply (-)	A3J1	4	Thermocouple Supply (-)
A1J2	1,2,3	Channel 1	A3J2	1,2,3	Channel 17
A1J3	1,2,3	Channel 2	A3J3	1,2,3	Channel 18
A1J4	1,2,3	Channel 3	A3J4	1,2,3	Channel 19
A1J5	1,2,3	Channel 4	A3J5	1,2,3	Channel 20
A1J6	1,2,3	Channel 5	A3J6	1,2,3	Channel 21
A1J7	1,2,3	Channel 6	A3J7	1,2,3	Channel 22
A1J8	1,2,3	Channel 7	A3J8	1,2,3	Channel 23
A1J9	1,2,3	Channel 8	A3J9	1,2,3	Channel 24
A2J1	1,2	ID Resistor	A4J1	1,2	ID Resistor
A2J1	2	Ground	A4J1	2	Ground
A2J1	3	Thermocouple Supply (+)	A4J1	3	Thermocouple Supply (+)
A2J1	4	Thermocouple Supply (-)	A4J1	4	Thermocouple Supply (-)
A2J2	1,2,3	Channel 9	A4J2	1,2,3	Channel 25
A2J3	1,2,3	Channel 10	A4J3	1,2,3	Channel 26
A2J4	1,2,3	Channel 11	A4J4	1,2,3	Channel 27
A2J5	1,2,3	Channel 12	A4J5	1,2,3	Channel 28
A2J6	1,2,3	Channel 13	A4J6	1,2,3	Channel 29
A2J7	1,2,3	Channel 14	A4J7	1,2,3	Channel 30
A2J8	1,2,3	Channel 15	A4J8	1,2,3	Channel 31
A2J9	1,2,3	Channel 16	A4J9	1,2,3	Channel 32
<p>Note that pins 1, 2, and 3 of J2 through J9 in each connector have the following connections: Pin 1 (+ input), Pin 2 (- Input), and Pin 3 (Ground).</p>					

Table 2-9. HP 25504A I/O Connector Module Pin Assignments

CONNECTOR	PINS	CONNECTION		CONNECTOR	PINS	CONNECTION
A1J1	1,2	ID Resistor		A3J1	1,2	ID Resistor
A1J1	2	Ground		A3J1	2	Ground
A1J1	3	Thermocouple		A3J1	3	Thermocouple
A1J1	4	Supply (+)		A3J1	4	Supply (+)
A1J1	4	Thermocouple		A3J1	4	Thermocouple
A1J1	4	Supply (-)		A3J1	4	Supply (-)
A1J2	1-4	Channel 1		A3J2	1-4	Channel 9
A1J3	1-4	Card guard		A3J3	1-4	Card guard
A1J4	1-4	Channel 2		A3J4	1-4	Channel 10
A1J5	1-4	Card guard		A3J5	1-4	Card guard
A1J6	1-4	Channel 3		A3J6	1-4	Channel 11
A1J7	1-4	Card guard		A3J7	1-4	Card guard
A1J8	1-4	Channel 4		A3J8	1-4	Channel 12
A1J9	1-4	Card guard		A3J9	1-4	Card guard
A2J1	1-4	Card guard		A4J1	1-4	Card guard
A2J2	1-4	Channel 5		A4J2	1-4	Channel 13
A2J3	1-4	Card guard		A4J3	1-4	Card guard
A2J4	1-4	Channel 6		A4J4	1-4	Channel 14
A2J5	1-4	Card guard		A4J5	1-4	Card guard
A2J6	1-4	Channel 7		A4J6	1-4	Channel 15
A2J7	1-4	Card guard		A4J7	1-4	Card guard
A2J8	1-4	Channel 8		A4J8	1-4	Channel 16
A2J9	1-4	Card guard		A4J9	1-4	Card guard
<p>Note that pins 1, 2, 3 and 4 of J2, J4, J6, and J8 in each connector have the following connections: Pin 1 (+ Input), Pin 2 (- Input), and Pins 3 and 4 (Guard). All other pins are connected to a card-driven guard.</p>						

Table 2-10. HP 25510A I/O Connector Module Pin Assignments

CONNECTOR	PINS	CONNECTION		CONNECTOR	PINS	CONNECTION
A1J1	1,2	ID Resistor		A1J6	1	Ch. 3, +V/I
A1J2	1	Ch. 1, +V/I		A1J6	2	Ch. 3, -V/I
A1J2	2	Ch. 1, -V/I		A1J7	1	Ch. 3, +S
A1J3	1	Ch. 1, +S		A1J7	2	Ch. 3, -S
A1J3	2	Ch. 1, -S		A1J8	1	Ch. 4, +V/I
A1J4	1	Ch. 2, +V/I		A1J8	2	Ch. 4, -V/I
A1J4	2	Ch. 2, -V/I		A1J9	1	Ch. 4, +S
A1J5	1	Ch. 2, +S		A1J9	2	Ch. 4, -S
A1J5	2	Ch. 2, -S				

Note that pin 3 of J2 through J9 is not used by the Analog Output Card. Pin 3 is not electrically connected to the card, but may be used as a connection point for the shield in the HP 25551A/B I/O Cables.

Installation

Table 2-11. HP 25511A I/O Connector Module Pin Assignments

CONNECTOR	PINS	CONNECTION	CONNECTOR	PINS	CONNECTION
A1J1	1,2	R=147 ohms	A3J1	1,2	R=147 ohms
A1J1	3	Fld. 1 Strobe	A3J1	3	Fld. 2 Strobe
A1J1	4	Strobe Gnd.	A3J1	4	Strobe Gnd.
A1J2	1	Pt. 1 +	A3J2	1	Pt. 17 +
A1J2	2	Pt. 1 -	A3J2	2	Pt. 17 -
A1J2	3	Pt. 2 +	A3J2	3	Pt. 18 +
A1J2	4	Pt. 2 -	A3J2	4	Pt. 18 -
A1J5	1	Pt. 3 +	A3J5	1	Pt. 19 +
A1J5	2	Pt. 3 -	A3J5	2	Pt. 19 -
A1J5	3	Pt. 4 +	A3J5	3	Pt. 20 +
A1J5	4	Pt. 4 -	A3J5	4	Pt. 20 -
A1J6	1	Pt. 5 +	A3J6	1	Pt. 21 +
A1J6	2	Pt. 5 -	A3J6	2	Pt. 21 -
A1J6	3	Pt. 6 +	A3J6	3	Pt. 22 +
A1J6	4	Pt. 6 -	A3J6	4	Pt. 22 -
A1J9	1	Pt. 7 +	A3J9	1	Pt. 23 +
A1J9	2	Pt. 7 -	A3J9	2	Pt. 23 -
A1J9	3	Pt. 8 +	A3J9	3	Pt. 24 +
A1J9	4	Pt. 8 -	A3J9	4	Pt. 24 -
A2J1	1,2	R=147 ohms	A4J1	1,2	R=147 ohms
A2J1	3,4	NOT USED	A4J1	3,4	NOT USED
A2J2	1	Pt. 9 +	A4J2	1	Pt. 25 +
A2J2	2	Pt. 9 -	A4J2	2	Pt. 25 -
A2J2	3	Pt. 10 +	A4J2	3	Pt. 26 +
A2J2	4	Pt. 10 -	A4J2	4	Pt. 26 -
A2J5	1	Pt. 11 +	A4J5	1	Pt. 27 +
A2J5	2	Pt. 11 -	A4J5	2	Pt. 27 -
A2J5	3	Pt. 12 +	A4J5	3	Pt. 28 +
A2J5	4	Pt. 12 -	A4J5	4	Pt. 28 -
A2J6	1	Pt. 13 +	A4J6	1	Pt. 29 +
A2J6	2	Pt. 13 -	A4J6	2	Pt. 29 -
A2J6	3	Pt. 14 +	A4J6	3	Pt. 30 +
A2J6	4	Pt. 14 -	A4J6	4	Pt. 30 -
A2J9	1	Pt. 15 +	A4J9	1	Pt. 31 +
A2J9	2	Pt. 15 -	A4J9	2	Pt. 31 -
A2J9	3	Pt. 16 +	A4J9	3	Pt. 32 +
A2J9	4	Pt. 16 -	A4J9	4	Pt. 32 -

Table 2-12. HP 25513A I/O Connector Module Pin Assignments

CONNECTOR	PINS	CONNECTION	CONNECTOR	PINS	CONNECTION
A1J1	1,2	178 ohm res	A3J1	1,2	178 ohm res
A1J1	3	Fld.1 Strobe	A3J1	3	Fld.2 Strobe
A1J1	4	Strobe Gnd.	A3J1	4	Strobe Gnd.
A1J2	1	Pt. 1 +	A3J2	1	Pt. 17 +
A1J2	2	Pt. 1 -	A3J2	2	Pt. 17 -
A1J2	3	Pt. 2 +	A3J2	3	Pt. 18 +
A1J2	4	Pt. 2 -	A3J2	4	Pt. 18 -
A1J5	1	Pt. 3 +	A3J5	1	Pt. 19 +
A1J5	2	Pt. 3 -	A3J5	2	Pt. 19 -
A1J5	3	Pt. 4 +	A3J5	3	Pt. 20 +
A1J5	4	Pt. 4 -	A3J5	4	Pt. 20 -
A1J6	1	Pt. 5 +	A3J6	1	Pt. 21 +
A1J6	2	Pt. 5 -	A3J6	2	Pt. 21 -
A1J6	3	Pt. 6 +	A3J6	3	Pt. 22 +
A1J6	4	Pt. 6 -	A3J6	4	Pt. 22 -
A1J9	1	Pt. 7 +	A3J9	1	Pt. 23 +
A1J9	2	Pt. 7 -	A3J9	2	Pt. 23 -
A1J9	3	Pt. 8 +	A3J9	3	Pt. 24 +
A1J9	4	Pt. 8 -	A3J9	4	Pt. 24 -
A2J1	1,2	R= 178 ohms	A3J1	1,2	R= 178 ohms
A2J1	3,4	NOT USED	A4J1	3,4	NOT USED
A2J2	1	Pt. 9 +	A4J2	1	Pt. 25 +
A2J2	2	Pt. 9 -	A4J2	2	Pt. 25 -
A2J2	3	Pt. 10 +	A4J2	3	Pt. 26 +
A2J2	4	Pt. 10 -	A4J2	4	Pt. 26 -
A2J5	1	Pt. 11 +	A4J5	1	Pt. 27 +
A2J5	2	Pt. 11 -	A4J5	2	Pt. 27 -
A2J5	3	Pt. 12 +	A4J5	3	Pt. 28 +
A2J5	4	Pt. 12 -	A4J5	4	Pt. 28 -
A2J6	1	Pt. 13 +	A4J6	1	Pt. 29 +
A2J6	2	Pt. 13 -	A4J6	2	Pt. 29 -
A2J6	3	Pt. 14 +	A4J6	3	Pt. 30 +
A2J6	4	Pt. 14 -	A4J6	4	Pt. 30 -
A2J9	1	Pt. 15 +	A4J9	1	Pt. 31 +
A2J9	2	Pt. 15 -	A4J9	2	Pt. 31 -
A2J9	3	Pt. 16 +	A4J9	3	Pt. 32 +
A2J9	4	Pt. 16 -	A4J9	4	Pt. 32 -

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Table 2-13. HP 25514A I/O Connector Module Pin Assignments

CONNECTOR	PINS	CONNECTION	CONNECTOR	PINS	CONNECTION
A1J1	1,2	R=196 ohm	A3J1	1,2	R=196 ohm
A1J1	3	Strobe Gnd.	A3J1	3	NOT USED
A1J1	4	Fld.1 Strobe	A4J1	4	NOT USED
A1J2	1	NO1	A3J2	1	NO9
A1J2	2	COM1	A3J2	2	COM9
A1J2	3	NC1	A3J2	3	NC9
A1J2	4	COM1	A3J2	4	COM9
A1J5	1	NO2	A3J5	1	NO10
A1J5	2	COM2	A3J5	2	COM10
A1J5	3	NC2	A3J5	3	NC10
A1J5	4	COM2	A3J5	4	COM10
A1J6	1	NO3	A3J6	1	NO11
A1J6	2	COM3	A3J6	2	COM11
A1J6	3	NC3	A3J6	3	NC11
A1J6	4	COM3	A3J6	4	COM11
A1J9	1	NO4	A3J9	1	NO12
A1J9	2	COM4	A3J9	2	COM12
A1J9	3	NC4	A3J9	3	NC12
A1J9	4	COM4	A3J9	4	COM12
A2J1	1,2	R=196 ohm	A4J1	1,2	R=196 ohm
A2J1	3,4	N.C.	A4J1	3,4	N.C.
A2J2	1	NO5	A4J2	1	NO13
A2J2	2	COM5	A4J2	2	COM13
A2J2	3	NC5	A4J2	3	NC13
A2J2	4	COM5	A4J2	4	COM13
A2J5	1	NO6	A4J5	1	NO14
A2J5	2	COM6	A4J5	2	COM14
A2J5	3	NC6	A4J5	3	NC14
A2J5	4	COM6	A4J5	4	COM14
A2J6	1	NO7	A4J6	1	NO15
A2J6	2	COM7	A4J6	2	COM15
A2J6	3	NC7	A4J6	3	NC15
A2J6	4	COM7	A4J6	4	COM15
A2J9	1	NO8	A4J9	1	NO16
A2J9	2	COM8	A4J9	2	COM16
A2J9	3	NC8	A4J9	3	NC16
A2J9	4	COM8	A4J9	4	COM16

Table 2-14. HP 25516A I/O Connector Module Pin Assignments

CONNECTOR	PINS	CONNECTION	CONNECTOR	PINS	CONNECTION
A1J1	1,2	178-ohm res.	A3J1	1,2	147-ohm res.
A1J1	3	N.C..	A3J1	3	Fld. 2 Strobe
A1J1	4	NOT USED	A3J1	4	Strobe Gnd.
A1J2	1	Out Pt. 1 +	A3J2	1	In Pt. 1 +
A1J2	2	Out Pt. 1 -	A3J2	2	In Pt. 1 -
A1J2	3	Out Pt. 2 +	A3J2	3	In Pt. 2 +
A1J2	4	Out Pt. 2 -	A3J2	4	In Pt. 2 -
A1J5	1	Out Pt. 3 +	A3J5	1	In Pt. 3 +
A1J5	2	Out Pt. 3 -	A3J5	2	In Pt. 3 -
A1J5	3	Out Pt. 4 +	A3J5	3	In Pt. 4 +
A1J5	4	Out Pt. 4 -	A3J5	4	In Pt. 4 -
A1J6	1	Out Pt. 5 +	A3J6	1	In Pt. 5 +
A1J6	2	Out Pt. 5 -	A3J6	2	In Pt. 5 -
A1J6	3	Out Pt. 6 +	A3J6	3	In Pt. 6 +
A1J6	4	Out Pt. 6 -	A3J6	4	In Pt. 6 -
A1J9	1	Out Pt. 7 +	A3J9	1	In Pt. 7 +
A1J9	2	Out Pt. 7 -	A3J9	2	In Pt. 7 -
A1J9	3	Out Pt. 8 +	A3J9	3	In Pt. 8 +
A1J9	4	Out Pt. 8 -	A3J9	4	In Pt. 8 -
A2J1	1,2	178-ohm res.	A4J1	1,2	147-ohm res.
A2J1	3,4	NOT USED	A4J1	3,4	NOT USED
A2J2	1	Out Pt. 9 +	A4J2	1	In Pt. 9 +
A2J2	2	Out Pt. 9 -	A4J2	2	In Pt. 9 -
A2J2	3	Out Pt. 10 +	A4J2	3	In Pt. 10 +
A2J2	4	Out Pt. 10 -	A4J2	4	In Pt. 10 -
A2J5	1	Out Pt. 11 +	A4J5	1	In Pt. 11 +
A2J5	2	Out Pt. 11 -	A4J5	2	In Pt. 11 -
A2J5	3	Out Pt. 12 +	A4J5	3	In Pt. 12 +
A2J5	4	Out Pt. 12 -	A4J5	4	In Pt. 12 -
A2J6	1	Out Pt. 13 +	A4J6	1	In Pt. 13 +
A2J6	2	Out Pt. 13 -	A4J6	2	In Pt. 13 -
A2J6	3	Out Pt. 14 +	A4J6	3	In Pt. 14 +
A2J6	4	Out Pt. 14 -	A4J6	4	In Pt. 14 -
A2J9	1	Out Pt. 15 +	A4J9	1	In Pt. 15 +
A2J9	2	Out Pt. 15 -	A4J9	2	In Pt. 15 -
A2J9	3	Out Pt. 16 +	A4J9	3	In Pt. 16 +
A2J9	4	Out Pt. 16 -	A4J9	4	In Pt. 16 -

2.11 THERMOCOUPLE CONNECTIONS

The HP 25594A Thermocouple Reference Connector (TRC), shown in figure 2-45, provides an accurate reference junction for thermocouple measurements. See the HP 2250 Hardware Reference Manual, part number 02250-90001, for a description of the TRC and the ranges of the thermocouples used with the TRC.

The TRC has 15 input channels and 16 output channels. Input channels 1 through 15 receive independent thermocouple voltages from any type of thermocouple. Output channels 1 through 15 are used for transferring the thermocouple voltages to the inputs of the HP 25502A and HP 25503A multiplexers. Output channel 16 transfers the thermocouple reference voltage to the input of the HP 25502A or HP 25503A.

The TRC is mounted in the rack with termination blocks. A connection diagram is shown in figure 2-46.

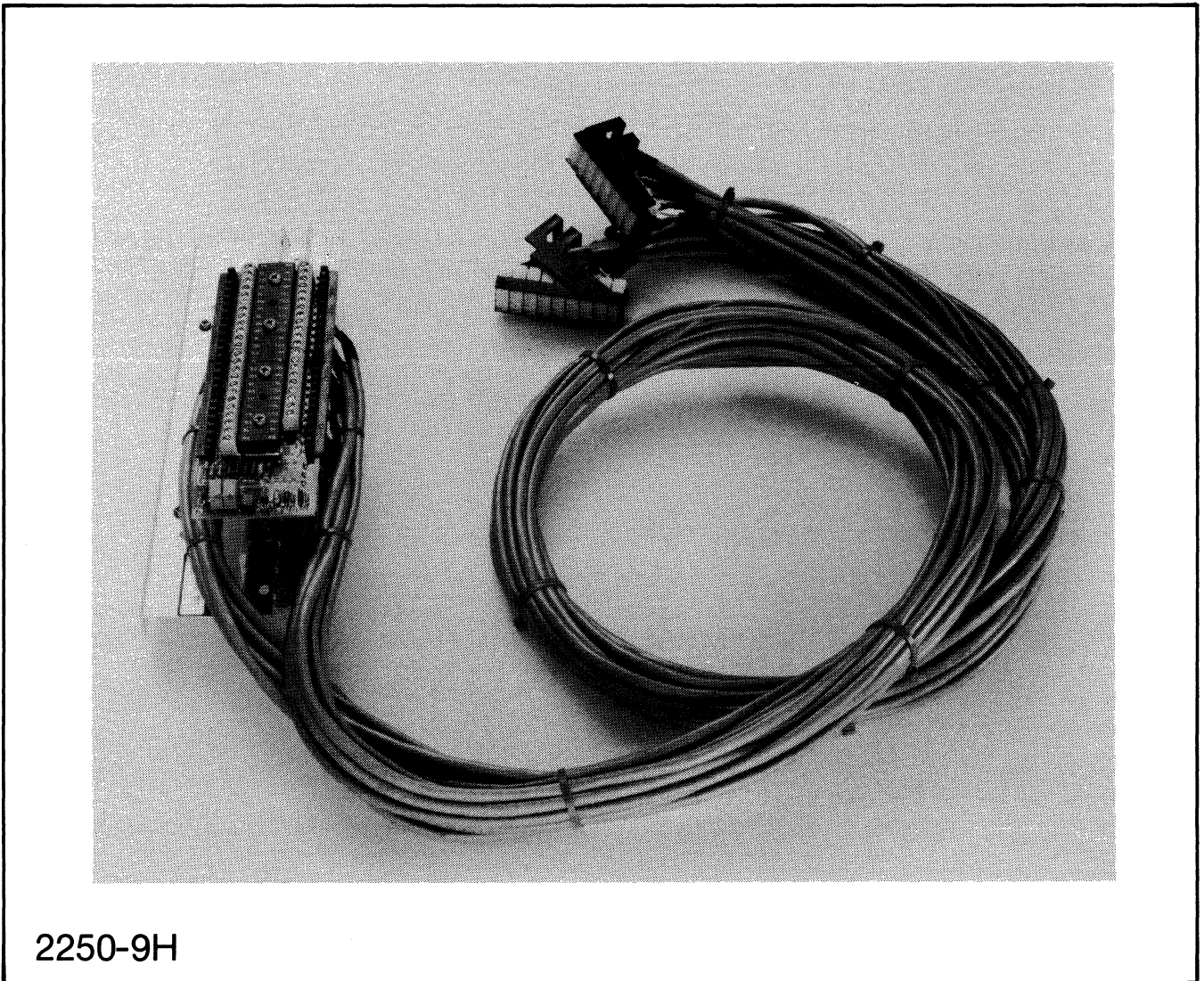


Figure 2-45. HP 25594A Thermocouple Reference Connector

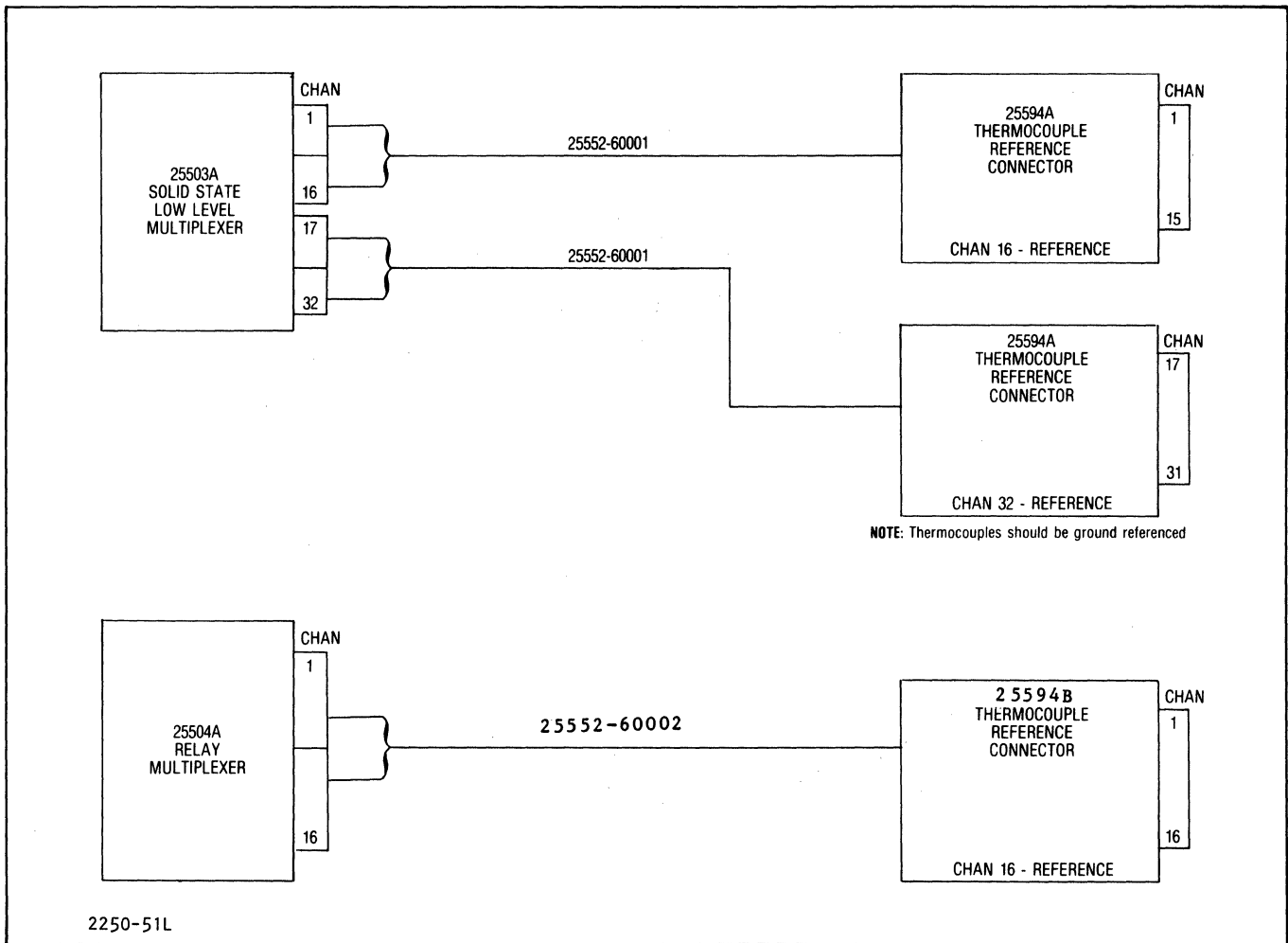


Figure 2-46. Thermocouple Connections

SECTION III

START-UP PROCEDURE

When all cables are properly connected to the HP 2250 system (see Section II), turn power on and observe the following:

- a. Facing the front panel of the power supply, look at the LEDs behind the small cutout. Both GREEN LEDs should be on. The RED LED should be off.
- b. Check that all fans (in the HP 2104 and in each HP 2251) are operating.
- c. Observe that the eight RED LEDs on the status panel are changing through various patterns. Verify that the GREEN LED on the status panel is on.
- d. Check that the GREEN LED on the HP 12070A card (slot 1) is on.
- e. On the BIF card (part number 25574-60001) in slot 0 of the HP 2251), check that the GREEN LED is on, and the RED LED is off.
- f. When the RED LEDs on the status panel have stopped moving, the following pattern should be displayed:

7	--	off
6	--	off
5	--	off
4	--	off
3	--	off
2	--	on
1	--	off
0	--	off

If the above conditions are verified, the HP 2250 should be considered operational.



SECTION IV SERVICE

4.1 INTRODUCTION

This section includes preventive maintenance, troubleshooting information for isolating malfunctions to the assembly level, procedures for removing and replacing various assemblies, backplane pin connections, and a power distribution diagram.

4.2 ELECTRICAL SAFETY

Before proceeding with any maintenance or service on equipment which requires physical contact with electrical or electronic components, be sure that either power is removed or that safety precautions are followed to protect against shock. Heed all "WARNING" signs on equipment and refer to the "SAFETY CONSIDERATIONS" page (page iii) at the front of this manual. All service work must be done by qualified personnel.

4.3 PREVENTIVE MAINTENANCE

Under normally clean operating conditions, the preventive maintenance steps given below should be performed on a semiannual basis. If the operating conditions are adverse, perform the steps as often as necessary.

CAUTION

Some of the components on the cards are susceptible to static discharge. Make sure that you do not cause a static charge to be generated when handling cards. If in doubt, wear a properly grounded anti-static strap. Refer to the "SAFETY CONSIDERATIONS" page (page iii) in the front of this manual.

- a. Clean equipment exterior and interior.
- b. Check fans for proper operation.

If the optional battery backup card is installed in the processor unit, periodically check the batteries for corrosion. Corrosion may form on the batteries when they are fully discharged. This corrosion can be removed with a cloth dampened in a mild solution of baking soda and water.

4.4 TROUBLESHOOTING

Processor unit malfunctions can be isolated to the assembly level by sequentially performing the following tests:

- a. Power supply check.
- b. Self-test.
- c. Diagnostics.

When a malfunction is encountered, replace the assembly indicated in the test procedure. (Assembly removal and replacement procedures are given in this section.) After the malfunction is corrected, contact your nearest Hewlett-Packard Sales and Service Office for instructions regarding shipment of the defective assembly.

4.5 POWER SUPPLY CHECK

To verify power supply operation, proceed as follows:

- a. Connect the power supply to the appropriate voltage (115 VAC or 230 VAC).
- b. Facing the front panel of the power supply, look at the LEDs behind the small cutout. Both GREEN LEDs should be on. The RED LED should be off.

4.6 SELF-TEST

A self-test for the HP 2250 tests the HP 2104 Processor Unit and part of each backplane interface (BIF) card in each MCU (function cards in each MCU are not tested by the self-test; they are tested by individual function card diagnostics).

The self-test consists of two test programs (Test 1 and Test 2) that automatically execute each time the processor unit is powered up and which provide a quick, convenient check of basic processor operation. (Also, the self-test can be executed by pressing the SYSTEM RESET switch on the front panel.) If either self-test program fails, the processor unit will not operate.

Test 1 is built into the CPU chip on the processor card and executes immediately upon power up. It checks logic on the processor card and checks 15 lines of the address and data buses; the sixteenth data line is checked by Test 2. On successful completion, Test 2 is started. If Test 1 detects a failure, it stops executing and all front panel LEDs remain lit. Test 1 execution time is negligible.

Test 2 is stored in ROM on the processor card and executes on successful completion of Test 1. Test 2 checks the processor unit's basic instruction set, several internal registers, and the memory. If memory was sustained by the optional battery backup card, it is checked in a non-destructive manner; otherwise, Test 2 clears memory. Test 2 checks memory by reading a memory location and complementing, storing, and comparing the data; it repeats this process for each memory location.

Test 2 also checks part of the logic on each interface card to ensure that data transfer and flag functions are processed correctly. If Test 2 detects a failure, it stops executing and the front panel LEDs indicate a failure code. (Table 4-1 describes the failure codes.) The LED indication on successful completion of Test 2 is that all LEDs are off. Test 2 execution time is about two seconds.

4.7 SELF-TEST TROUBLESHOOTING

Execute the self-test by turning on HP 2250 power. Troubles detected by the self-test are indicated by the LEDs as listed in table 4-1. When the LEDs indicate a failure of the CPU chip, processor card, or memory card, replace the CPU chip or the appropriate card as listed in the table. An I/O failure indicated by the LED display of 01111100 can be isolated to the HP-IB or MCI card by substituting these cards and rerunning the test.

4.8 DIAGNOSTICS

The HP 25595A Diagnostic Package should be used for testing when the system is initially installed or when the self-test cannot detect a system malfunction. The kernel diagnostic in the package tests the processor and memory cards and part of the I/O cards' logic; and interface diagnostics test the individual interface cards. MCU function cards are tested by function card diagnostics. Instructions for running the diagnostics are given in the HP 2250 Measurement and Control Processor Diagnostic and Verification Manual, part number 25595-90001.

4.9 MEMORY PARITY LED

Memory parity status is indicated by an LED on the front of the memory card. When the LED is lit, a memory parity error has not occurred; when the LED is off, a parity error has occurred. A parity error indication (LED off) can be cleared either by cycling the Power switch or by pressing the RESET switch on the processor card. Frequently recurring parity errors can be eliminated by replacing the memory card.

Table 4-1. Self-Test LED Error Codes

ERROR CODE	FAILURE DESCRIPTION (0=OFF, 1=ON)
LED NUMBER 7 6 5 4 3 2 1 0	
1 1 1 1 1 1 1 1	Data and address lines test
0 1 1 1 1 1 1 1 0 1 1 1 1 1 1 0 0 1 1 1 1 1 0 1 0 1 1 1 1 1 0 0	Test of CPU chip on processor card Processor card tests Memory card test I/O circuits test
0 1 1 1 1 0 1 1 0 1 1 1 1 0 1 0 0 1 1 1 1 0 0 1 0 1 1 1 1 0 0 0	Executing loader Loader error Not Used Not Used
0 1 1 1 0 1 1 1 0 1 1 1 0 1 1 0 0 1 1 1 0 1 0 1 0 1 1 1 0 1 0 0	Kernel diagnostic: CPU test in processor Kernel diagnostic: processor test Kernel diagnostic: memory test I/O test
0 1 1 1 0 0 1 1 0 1 1 1 0 0 1 0 0 1 1 1 0 0 0 1 0 1 1 1 0 0 0 0	RAM test: fill with post-inc base register function RAM test: fill with pre-dec base register function RAM test: fill base register with offset table RAM test: test base register offsets
0 1 1 0 1 1 1 1 0 1 1 0 1 1 1 0 0 1 1 0 1 1 0 1 0 1 1 0 1 1 0 0	ROM test: position check, locations 40000B-47777B ROM test: checksum test, locations 40000B-47777B ROM test: position check, locations 50000B-57777B ROM test: checksum test, locations 50000B-57777B
0 1 1 0 1 0 1 1 0 1 1 0 1 0 1 0 0 1 1 0 1 0 0 1 0 1 1 0 1 0 0 0	ROM test: position check, locations 60000B-67777B ROM test: checksum test, locations 60000B-67777B ROM test: position check, locations 70000B-77777B ROM test: checksum test, locations 70000B-77777B
0 1 1 0 0 1 1 1 0 1 1 0 0 1 1 0 0 1 1 0 0 1 0 1 0 1 1 0 0 1 0 0	No MCI card found No HP-IB card found Error when loading trap cells Initialize and last control word interrupt error
0 1 1 0 0 0 1 1 0 1 1 0 0 0 1 0 0 1 1 0 0 0 0 1 0 1 1 0 0 0 0 0	MCI card internal registers error Time of day clock error Watchdog timer error Timeout interrupt error

Table 4-1. Self-Test LED Error Codes (Continued)

ERROR CODE	FAILURE DESCRIPTION (0=OFF, 1=ON)
LED NUMBER 7 6 5 4 3 2 1 0	
0 1 0 1 1 1 1 1	BIF card error in MCU 0 (1st MCU)
0 1 0 1 1 1 1 0	BIF card error in MCU 1
0 1 0 1 1 1 0 1	BIF card error in MCU 2
0 1 0 1 1 1 0 0	BIF card error in MCU 3
0 1 0 1 1 0 1 1	BIF card error in MCU 4
0 1 0 1 1 0 1 0	BIF card error in MCU 5
0 1 0 1 1 0 0 1	BIF card error in MCU 6
0 1 0 1 1 0 0 0	BIF card error in MCU 7 (8th MCU)
0 1 0 1 0 1 1 1	BIF card address error
0 1 0 1 0 1 1 0	BIF card address error
0 1 0 1 0 1 0 1	BIF card address error
0 1 0 1 0 1 0 0	BIF card address error
0 1 0 1 0 0 1 1	BIF card address error
0 1 0 1 0 0 1 0	BIF card address error
0 1 0 1 0 0 0 1	BIF card address error
0 1 0 1 0 0 0 0	BIF card address error
0 1 0 0 1 1 1 1	HP-IB card initialization, clear error
0 1 0 0 1 1 1 0	HP-IB card, data bus error
0 1 0 0 1 1 0 1	PHI chip initialize, flush FIFOs error
0 1 0 0 1 1 0 0	Output data transfer, interrupts error
0 1 0 0 1 0 1 1	Input data transfer error
0 0 0 0 0 0 0 0	System ready
The front panel LEDs have the following meanings (when lit):	
LED NUMBER	MEANING
7	CPU CHIP SELF-TEST
6	SYSTEM SELF-TEST
5	MAIN TASK ERROR
SELF-TEST	4 INBOUND MESSAGE OPERATING STATUS
	3 MAIN TASK ACTIVE
	2 DATA AVAILABLE
	1 BCKGND TASK ACTIVE
	0 INTERRUPT

4.10 ASSEMBLY REMOVAL AND REPLACEMENT

WARNING

Heed all WARNING - HAZARDOUS VOLTAGE labels.

CAUTION

All contents of memory will be lost when the main (line) and battery voltages are both off.

The following paragraphs contain procedures for removing and replacing the various assemblies of the HP 2250. Before attempting to remove any circuit card or other assembly from an HP 2250 system, you should read Section II to become thoroughly familiar with the composition of the system. Pay special attention to the paragraphs describing HP 2104 and HP 2251 card installation; complete understanding of the installation procedures will assist you when attempting to remove like assemblies.

4.10.1 HP 2104 Processor Unit Cards

4.10.1.1 Removal

Remove a card from the processor unit as follows:

- a. Open the front door of the cabinet.
- b. Set the Power switch to OFF.
- c. Remove the two retaining screws on the processor unit cover and open the cover (see figure 4-1).
- d. If applicable, remove the cable connector from the card. Remove the card by pulling outward on the red card extractor levers (see Section II, figure 2-12).

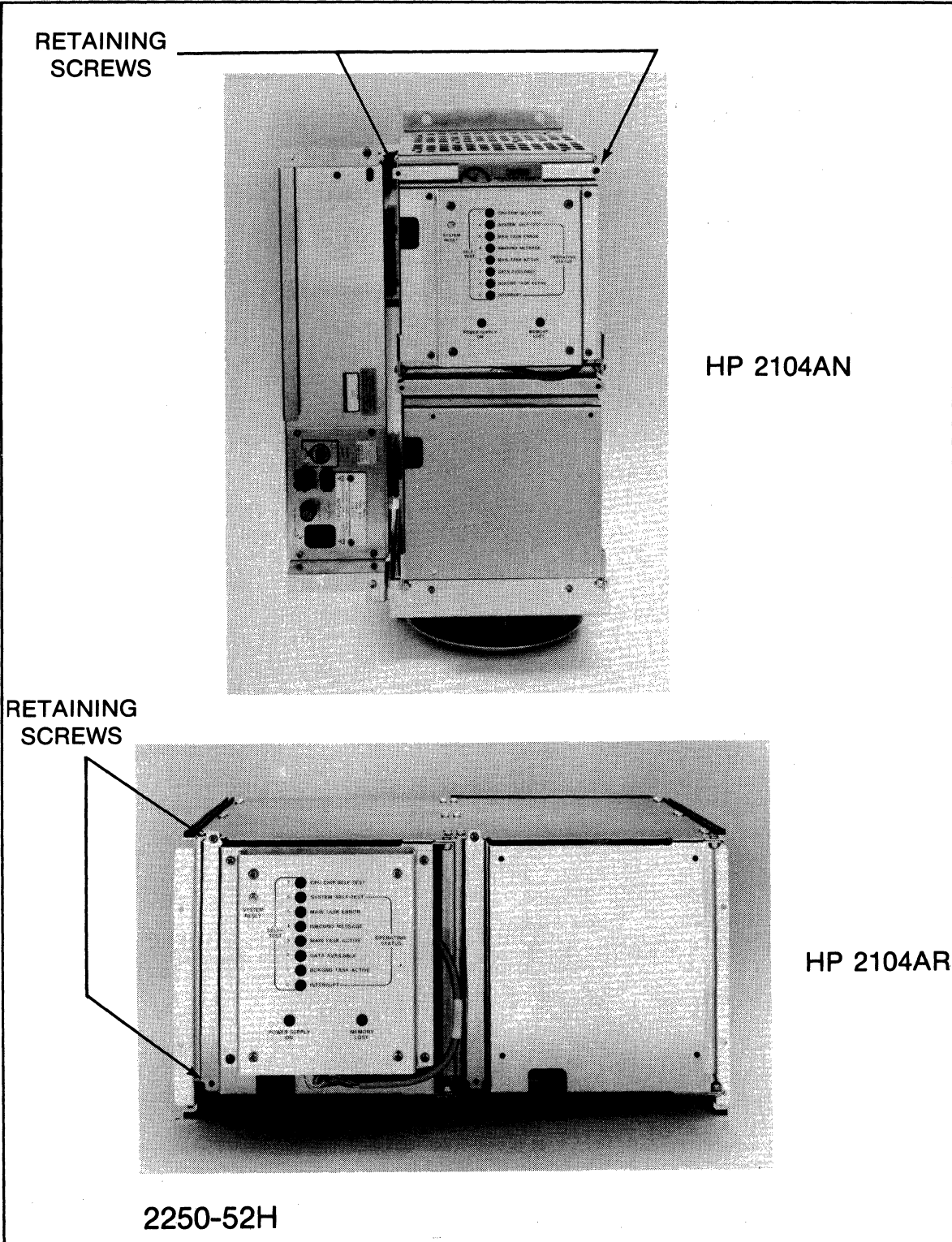


Figure 4-1. Removing the Processor Unit Card Cover

4.10.1.2 Replacement

Replace a processor unit card by reversing the removal procedure. See the appropriate installation paragraph in Section II. If a replacement card is being installed, be sure the card's switches are set properly.

4.10.2 CPU, I/O Master, and PHI Chips

WARNING

OBSERVE EYE HAZARD SAFETY PRECAUTIONS. Wear safety glasses when removing or installing the retaining clips on the CPU, I/O master, or PHI chip.

CAUTION

STATIC SENSITIVE DEVICE. Use anti-static handling procedures when removing or installing the chips.

4.10.2.1 Removal

To remove the CPU chip on the processor card, the I/O Master chip on the MCI card or HP-IB card, or the PHI chip on the HP-IB card, proceed as follows:

- a. Remove the appropriate card from the processor unit and place it on a flat surface.
- b. While pressing down on one of the retaining clips with a thumb, insert the flat blade of a screwdriver or similar instrument between the retaining clip and the side of the socket.
- c. Twist the bottom portion of the blade away from the socket to free the retaining clip (A) from the bottom edge of the socket (see figure 4-2).
- d. When the retaining clip (A) is free, lift it up and over the chip.
- e. Remove the second retaining clip by following steps b through d.
- f. Carefully tip the card on edge and remove the chip. Observe the anti-static handling precautions when handling the chip.

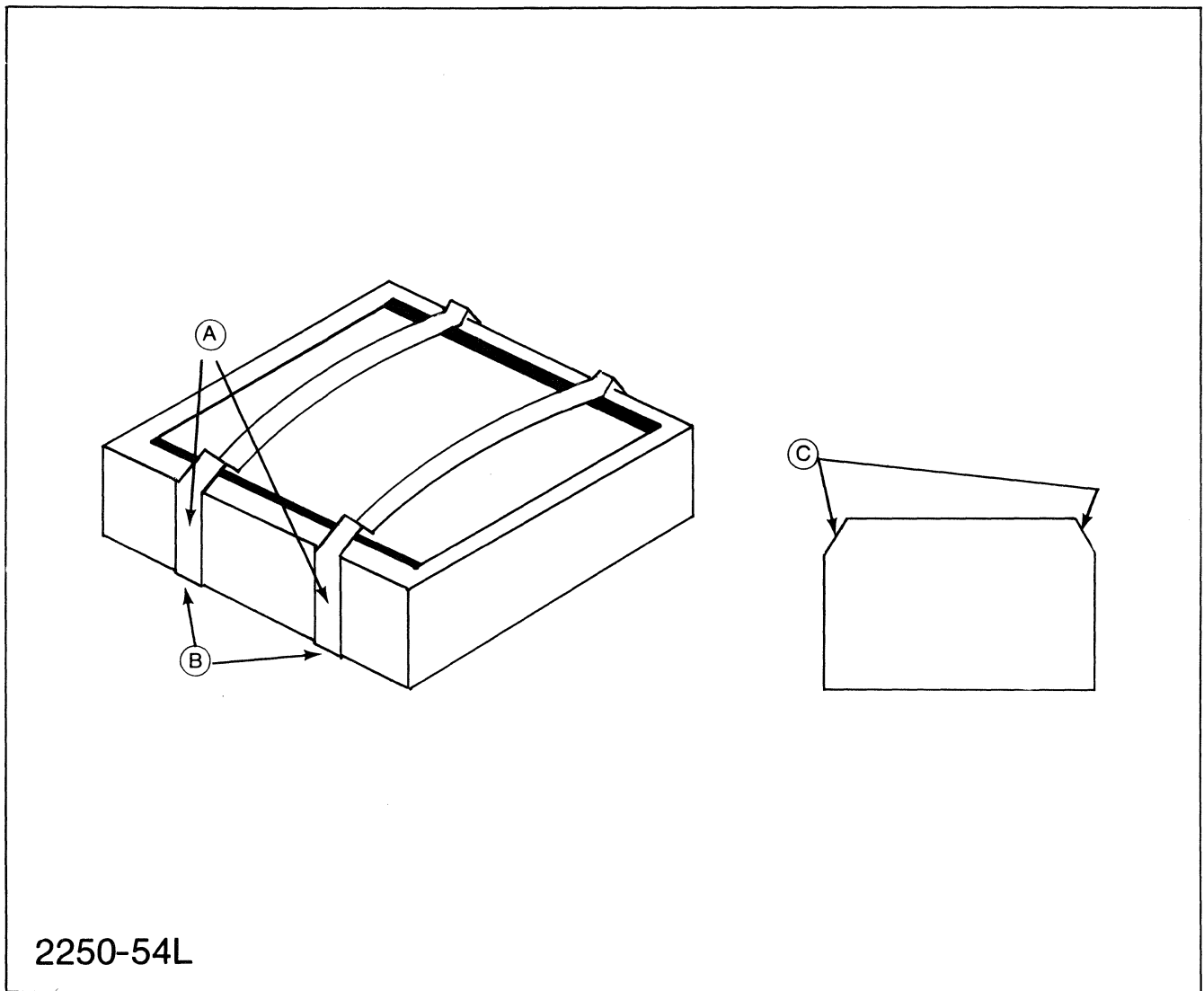


Figure 4-2. Chip Socket

4.10.2.2 Replacement

To install the CPU chip, I/O master chip, or the PHI chip, proceed as follows:

- a. Observe the anti-static handling precautions when handling the chip.
- b. Place the card on a flat surface with the component side up.
- c. Remove the retaining clips from the socket if they are in place (see figure 4-2).
- d. Place the chip in the socket, locating the two flat corners (C) of the socket facing the two flat corners of the chip. The trace side of the chip package must be on the bottom when the chip is placed in the socket.
- e. Place the retaining clips in the two places provided for them in the side of the socket.
- f. Press down with a thumb on the retaining clip (A) and press the retaining clip over the edge of the socket until it snaps under bottom edge of the socket (B).
- g. Install the second retaining clip, following steps c through f.

4.11 POWER SUPPLY

4.11.1 Removal, HP 2250N

To remove the power supply from an HP 2250N system, proceed as follows:

- a. Open the front door.
- b. Disconnect the cables from the front of the power supply.
- c. Remove the two screws securing the power supply to the HP 2104AN processor unit.
- d. Grasp the power supply and pull it out of the processor unit.

4.11.2 Removal, HP 2250M and HP 2250R

To remove the power supply from an HP 2250M or HP 2250R system, proceed as follows:

- a. Remove the front panel (HP 2250R) or open the front door (HP 2250M).
- b. Disconnect the cables from the front of the power supply.
- c. Remove the four screws holding the power supply in the rack.
- d. Grasp the power supply and pull it out of the cabinet.

4.11.3 Replacement

Replace the power supply by reversing the removal procedure.

4.11.4 Power Supply Fan

4.11.4.1 Removal

To remove the power supply fan, remove the power supply as outlined in the preceding paragraphs and proceed as follows:

- a. Remove the screws holding the top and rear panels of the power supply in place.
- b. Disconnect the power supply fan wires from the mother board.
- c. Remove the screws securing the power supply fan.
- d. Carefully lift the fan up and out of the power supply.

4.11.4.2 Replacement

Replace the power supply fan by reversing the removal procedure.

4.12 PROCESSOR UNIT BACKPLANE

4.12.1 Removal

HP 2104AN and HP2104AR processor unit backplanes are shown in figure 4-3. To remove the backplane, the HP 2104 must be removed from the system (see HP 2104 installation instructions in Section II; removal is the opposite). Once the processor unit is removed from the system, proceed as follows to remove the backplane:

- a. Remove the power supply from the side of the processor unit (HP 2104AN only, see the appropriate paragraph above.)
- b. Remove the top cover of the processor unit.
- c. Remove the screws holding the backplane in place.
- d. Carefully lift the backplane up and out of the processor unit.

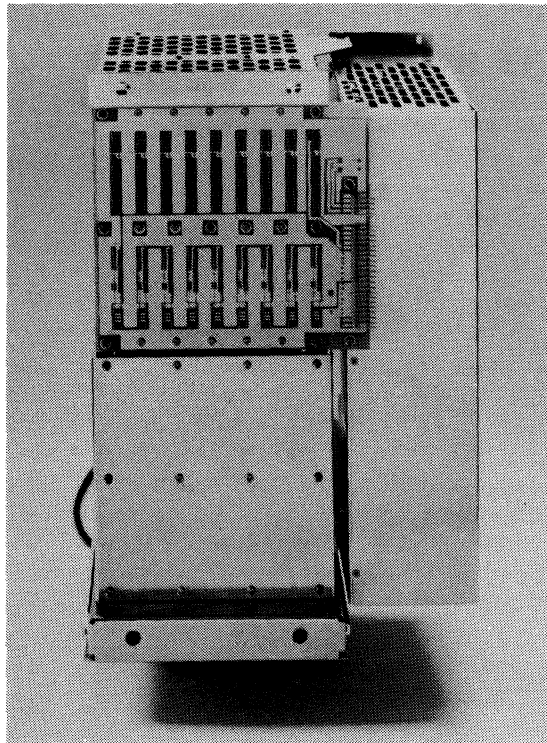
4.12.2 Replacement

Replace the backplane by reversing the removal procedure.

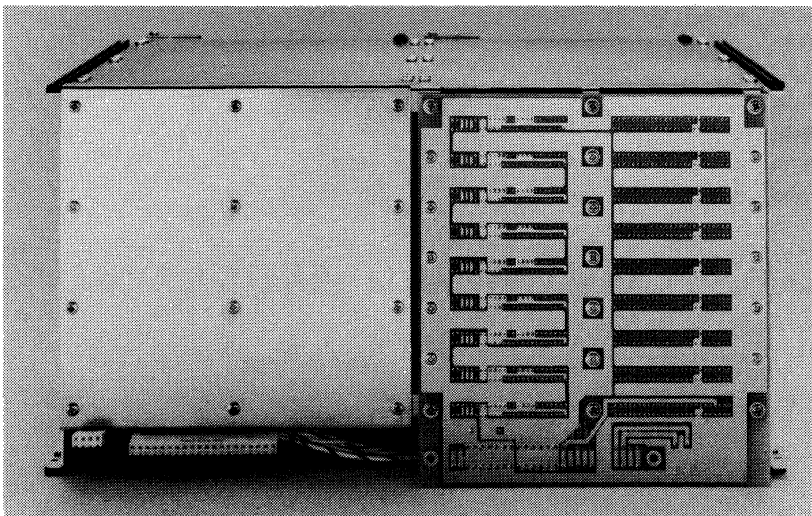
4.13 HP 2251 MEASUREMENT AND CONTROL UNIT

4.13.1 Function Card Removal

- a. Open the front door (or remove the front panel) of the cabinet.
- b. Remove any cables from the function card by grasping the release clips on the cable connector (see figure 4-4) and pulling outward on the connector.



HP 2104AN



HP 2104AR

2250-58H

Figure 4-3. Processor Unit Backplanes

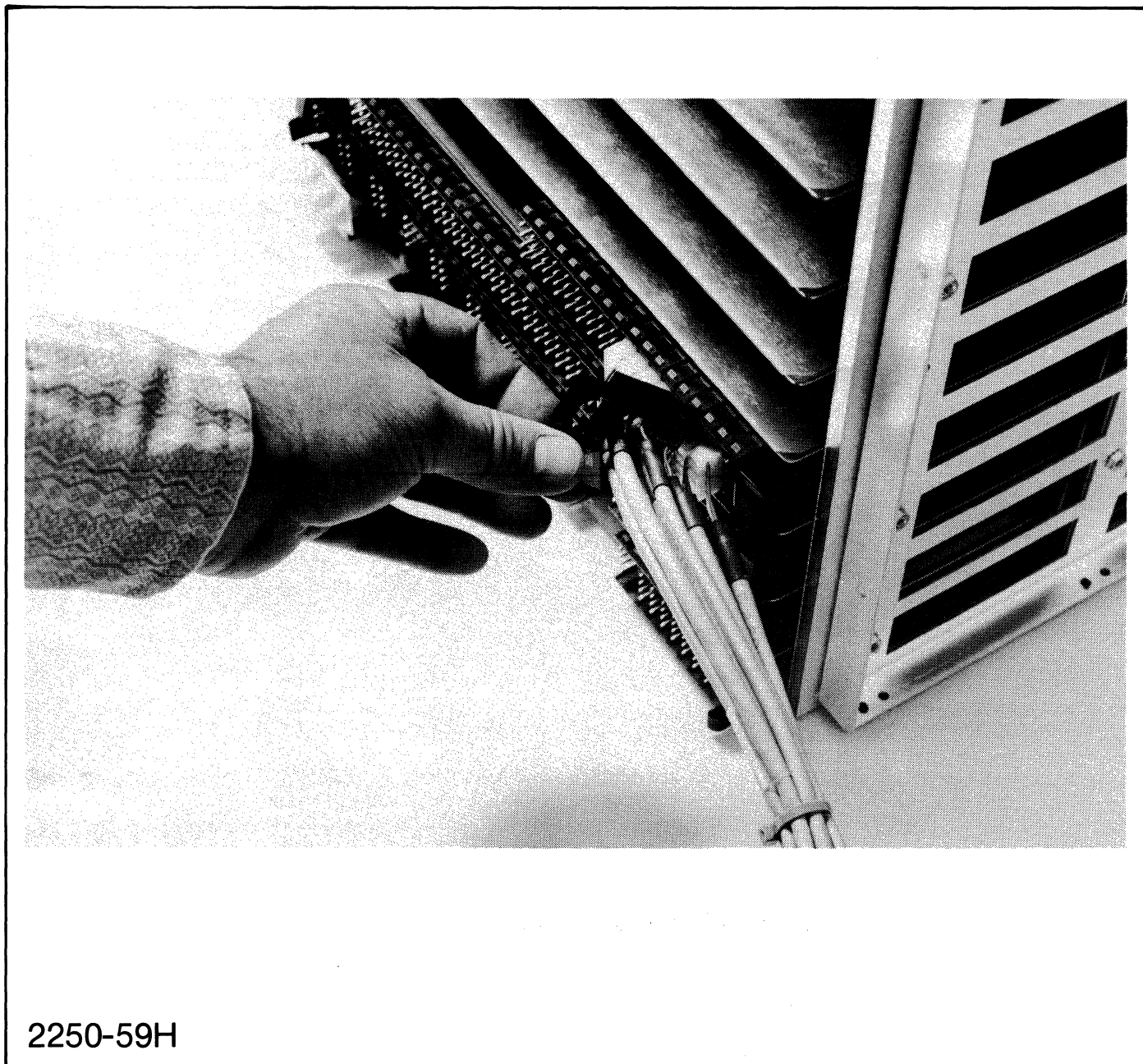


Figure 4-4. Removing Function Card Cable Connectors.

- c. Release the locking clips on the function card (see figure 4-5A) and pull the insertion and removal tabs (top and bottom, see figure 4-5B) out from the card. Then pull the card out of its socket.

4.13.2 Function Card Replacement

Refer to the appropriate paragraph in Section II for information on replacing a function card in the MCU.

4.13.3 MCU Backplane Removal

The HP 2251AN and HP 2251AR MCU backplanes are shown in figure 4-6. Before a backplane can be removed from an MCU, the MCU must be removed from the system. Refer to the paragraphs on MCU installation in Section II before removing the MCU from the system (removal is the opposite of installation). Once the MCU is removed from the system, remove the backplane as follows:

- a. Remove all function cards from the backplane as outlined above.
- b. Remove the screws holding the backplane in place and carefully lift the backplane out of the MCU.

4.13.4 MCU Backplane Replacement

Replace the MCU backplane by reversing the removal procedure.

4.14 115/230 VAC RECONFIGURATION

The front panel of the HP 12035A Power Supply has a selector switch for configuring the processor unit to the ac line voltage to be used. (See Section II, figure 2-19).

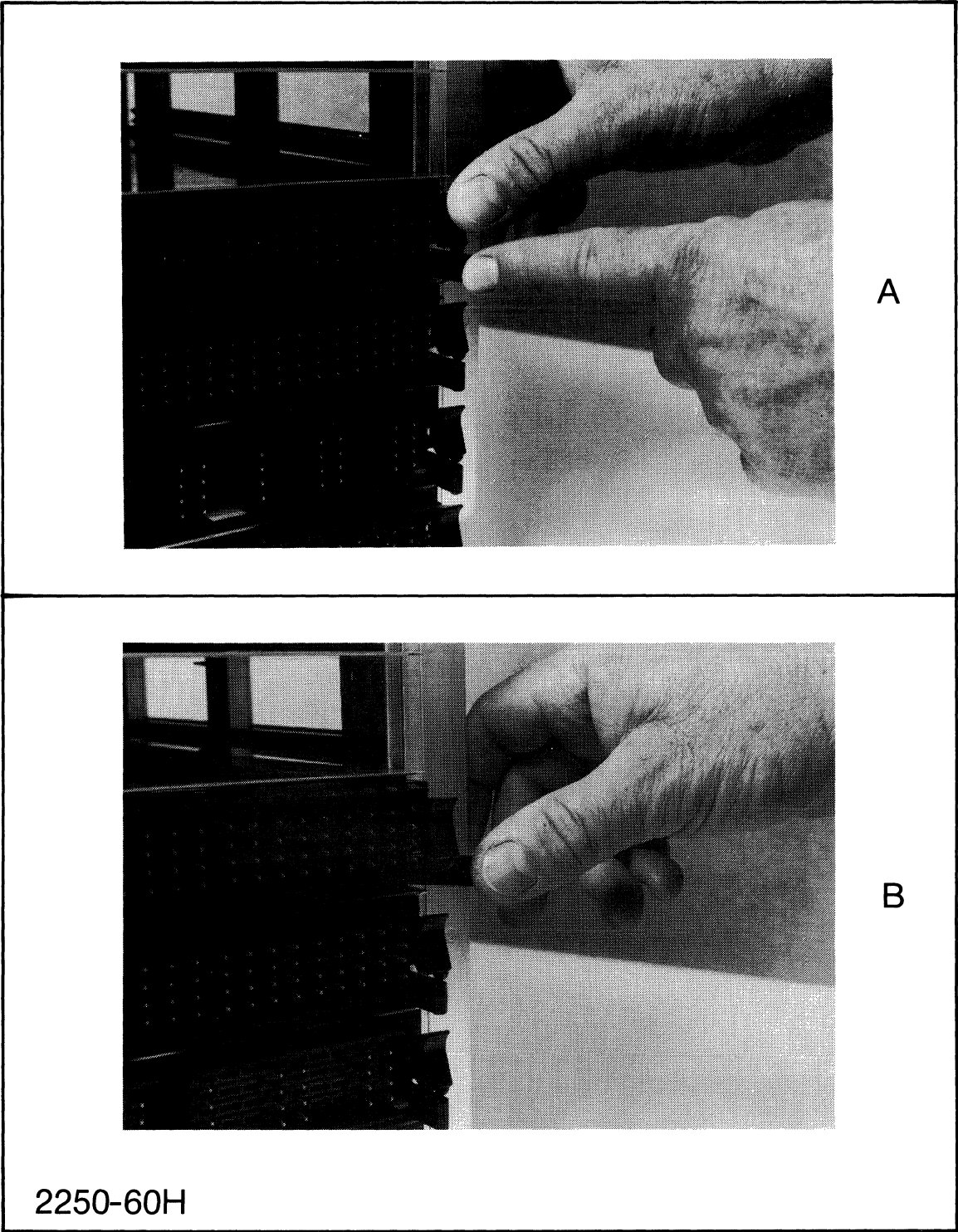
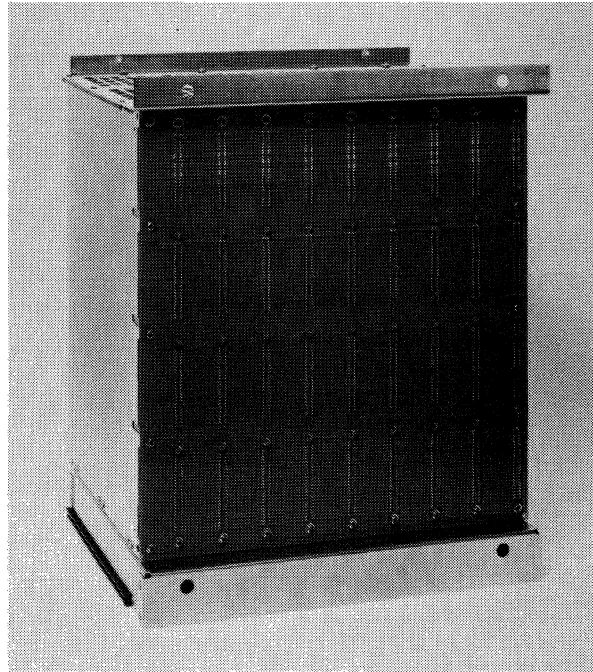
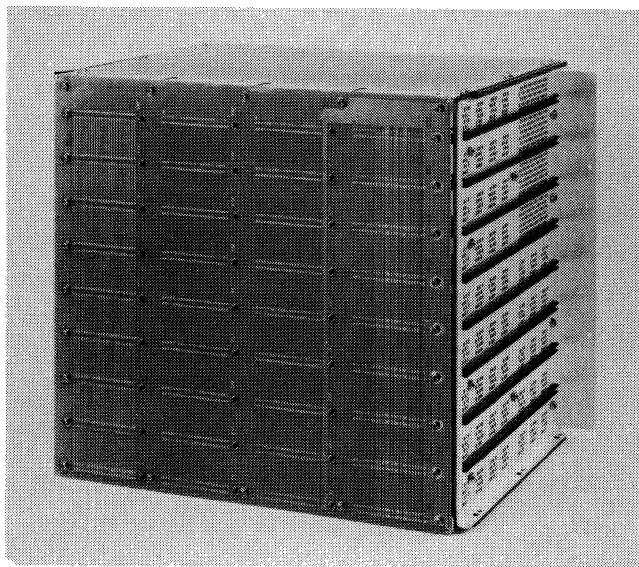


Figure 4-5. Function Card Removal



HP 2104AN



HP 2104AR

2250-61H

Figure 4-6. MCU Backplanes

The switch positions and the corresponding ac voltage ranges are as follows:

Switch Position	AC Voltage Range
115	86-127
230	195-253

If it is necessary to change the position of the line voltage selector switch, refer to figure 2-19 and proceed as follows:

CAUTION

Do not adjust the line voltage selector switch while ac power is applied to the processor unit. Before proceeding, disconnect the power cord.

- a. Remove the voltage rating tag on the power supply front panel.
- b. Insert the tip of a screwdriver (or similar tool) into the slot on the voltage selector switch. Turn the switch so that the indicated position corresponds to the line voltage to be used. Be sure the switch is firmly set in a detent.
- c. Replace the voltage rating tag so that it indicates the selected voltage. (Note that the tag has printing on both sides.)
- d. Change processor unit and MCU fans to 230 VAC fans.

4.15 POWER DISTRIBUTION DIAGRAM

There is also a power bus going from the processor unit power supply to each BIF of the MCUs. Figure 4-7 is the power distribution diagram for the HP 2250.

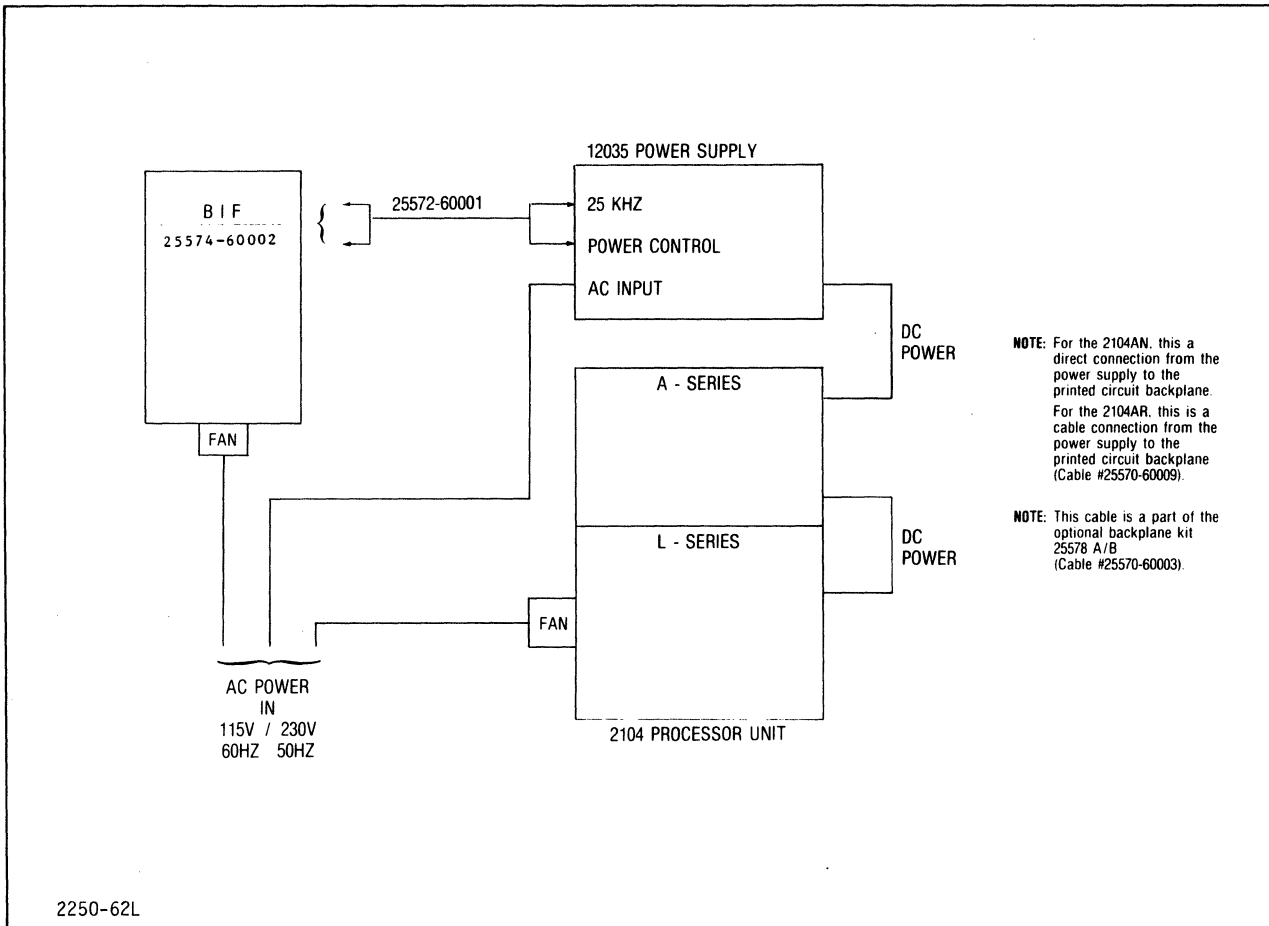


Figure 4-7. Power Distribution Diagram

APPENDIX A

FIELD WIRING PRACTICES

A.1 INTRODUCTION

This appendix contains information to assist in the external wiring between industrial and scientific processes and HP 2250 systems. It also provides cabling practices which will prevent application problems arising from installations which may comply with the local electrical code but do not meet signal and grounding requirements for measurement and control systems. This section is divided into two main areas as follows:

1. Wiring guidelines for analog and digital signal cables.
2. Grounding and shielding techniques for equipment and cables.

A.2 GUIDELINES FOR CABLE INSTALLATION

Measurement and control interfaces should be connected to external processes in such a way that the system specifications are not compromised by noise pickup, common-mode voltages, and ground loops. Analog signal cabling is considerably more critical than digital signal cabling and must be installed according to the practices described below. Analog cabling guidelines are given in table A-1.

Digital wires present fewer problems and usually can be bundled in unshielded cables without raising ground loop problems. Digital cabling guidelines are given in table A-2.

Table A-1. Guidelines for Analog External Cables

1. Avoid ground loops by eliminating current paths between separate ground points.
2. Use twisted-pair insulated shielded cable for each channel. Wrapped aluminum shielding provides better shield efficiency than braided shielding. When bundle cable is used for analog signals, use an overall shield and insulated jacket, in addition to the pair shields and insulation.
3. Use wire of small enough gauge to facilitate handling while providing strength and reasonably low resistance. Stranded 18 AWG wire with 19 strands is suitable.
4. Cable jacket should be impervious to contaminants that may be present as well as being abrasion-resistant. Minimum insulation rating should be 600 volts and a typical minimum temperature specification is 75 degrees C (167 degrees F).
5. When making connections at either end of the cables, avoid thermocouple effects caused by the junction of dissimilar metals; e.g., use only copper connectors (preferably silver plated).
6. Ground the shield only at the source end for analog inputs, at the load for analog outputs, and select a high quality ground (see discussion in text on grounding).
7. For unenclosed thermocouples, use short shielded cable between the thermocouple and reference and connect a ground to the thermocouple. The shield should be carried through any junction boxes or connectors but not grounded.
8. For enclosed thermocouples, connect the enclosure and cable shield together. Shield continues ungrounded to shielded reference junction and is grounded close to the thermocouple junction at the system side of the reference junction.
9. For enclosed bridge transducers, connect enclosure and cable shield, and ground the enclosure.
10. Avoid noise pickup; e.g., route cables so they are never close to sources of strong electrical noise (dc motors, fluorescent lights, etc.).

Table A-2. Guidelines for Digital External Cabling

1. Bundle the cables in logical groups to aid in cable tracing and repairs.
2. Keep grounds separate from analog grounds to avoid switching transient problems.
3. Use wire of sufficient size to meet specifications on switched circuits (digital output functions), yet the wire should be flexible enough to be easily handled. Stranded wire of 18AWG and 19 strands is generally suitable.
4. As a general rule, wire each ground circuit so it will converge individually to a single ground point.
5. Shielding of digital wires is usually not necessary and may be detrimental by adding digital signal-to-ground capacitance.

A.3 SOURCES OF NOISE

Noise is defined here as any electrical disturbance or spurious signal, either radiated or superimposed on conductors which may interfere with the proper operation of the measurement and control equipment. Noise sources of prime importance to measurement and control are identified below:

a. Power Frequency Noise

Power equipment and power transmission lines are the prime sources of noise at power frequency, harmonics of the power frequency, and a broad spectrum of radio frequency noise (see below). These sources include electrical power equipment, electrical distribution equipment, electrical power transmission lines, and power control equipment. Noise at the power frequency and its harmonics are coupled into data signal lines from the power lines through capacitive, inductive, and resistive coupling. This coupling exists where the data signal lines and power lines run in proximity to each other. If care is taken to properly ground the measurement and control system and signal cables, the effect of ground currents associated with the power system can be minimized. Also the coupling between the power and signal conductors should be kept as low as practical for the installation.

2. Ground Loop Noise

Ground currents flow in the neutral or common conductor of a circuit, whether it is directly connected to the earth or not (see figure A-1). Such currents are called "ground loops" which flow back into the measurement circuit via resistive or capacitive coupling, or electromagnetic inductance. These currents may be associated only with the individual circuit or circuits, or they may be earth ground currents which flow below the earth's surface. Potential differences between two earth ground rods can be over 10V peak-to-peak. Ground loop currents are usually the result of locating ground points indiscriminately throughout a chassis or system. Earthground currents may flow into a measurement system over circuits to remote transducers (see common-mode voltages below).

3. Common-Mode Noise.

An important form of noise in measurement systems is called "common-mode voltage." This noise is a result of earth currents and other potential differences. Common-mode voltages are those voltages which appear on each side of a signal line to a common reference point (see figure A-2). It can be caused by capacitive or resistive coupling, or electromagnetic inductance. The most troublesome form is caused by resistive coupling between two separate ground points. The potential difference between the ground points may be called the "common-mode generator" and is primarily at the power line frequency.

Common-mode voltages may be generated in three general areas: earth, transducer, and system. The earth generated voltage occurs where the system is connected to two different ground potentials, one at the transducer and one at the measurement and control systems as shown in figure A-2A. Transducer common-mode voltage occurs as a result of the transducer and circuit configuration, as shown in figure A-2B, where a dc voltage is applied across a resistance bridge. And, system common-mode voltage is a result of electromagnetically induced voltage in the signal lines running between the transducers and measurement and control system as shown in figure A-2C. In a system where several channels run through a conduit to the measurement area, the amount of coupling (or loop area) will be proportional to the cable length.

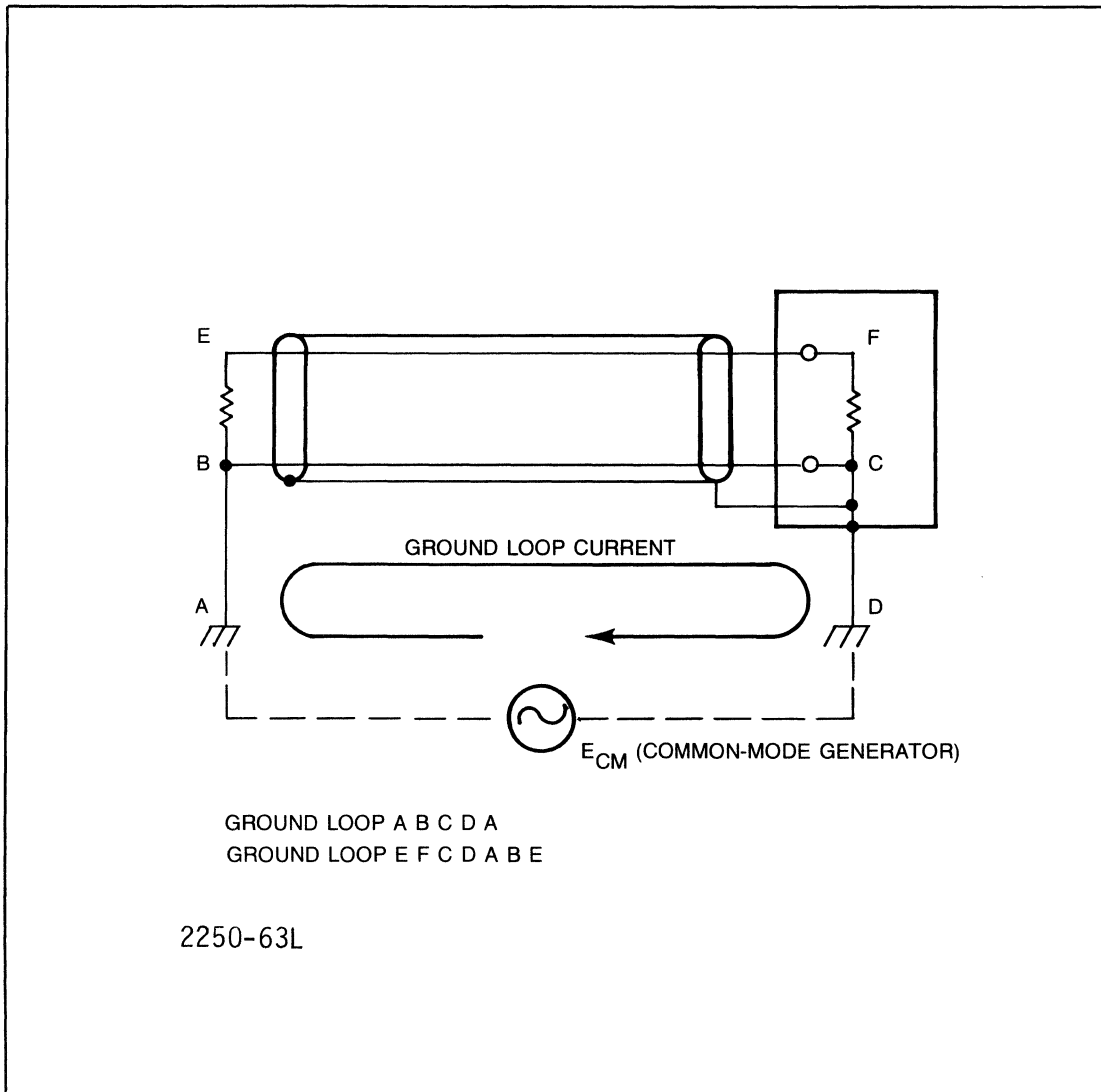


Figure A-1. Ground Loop Currents

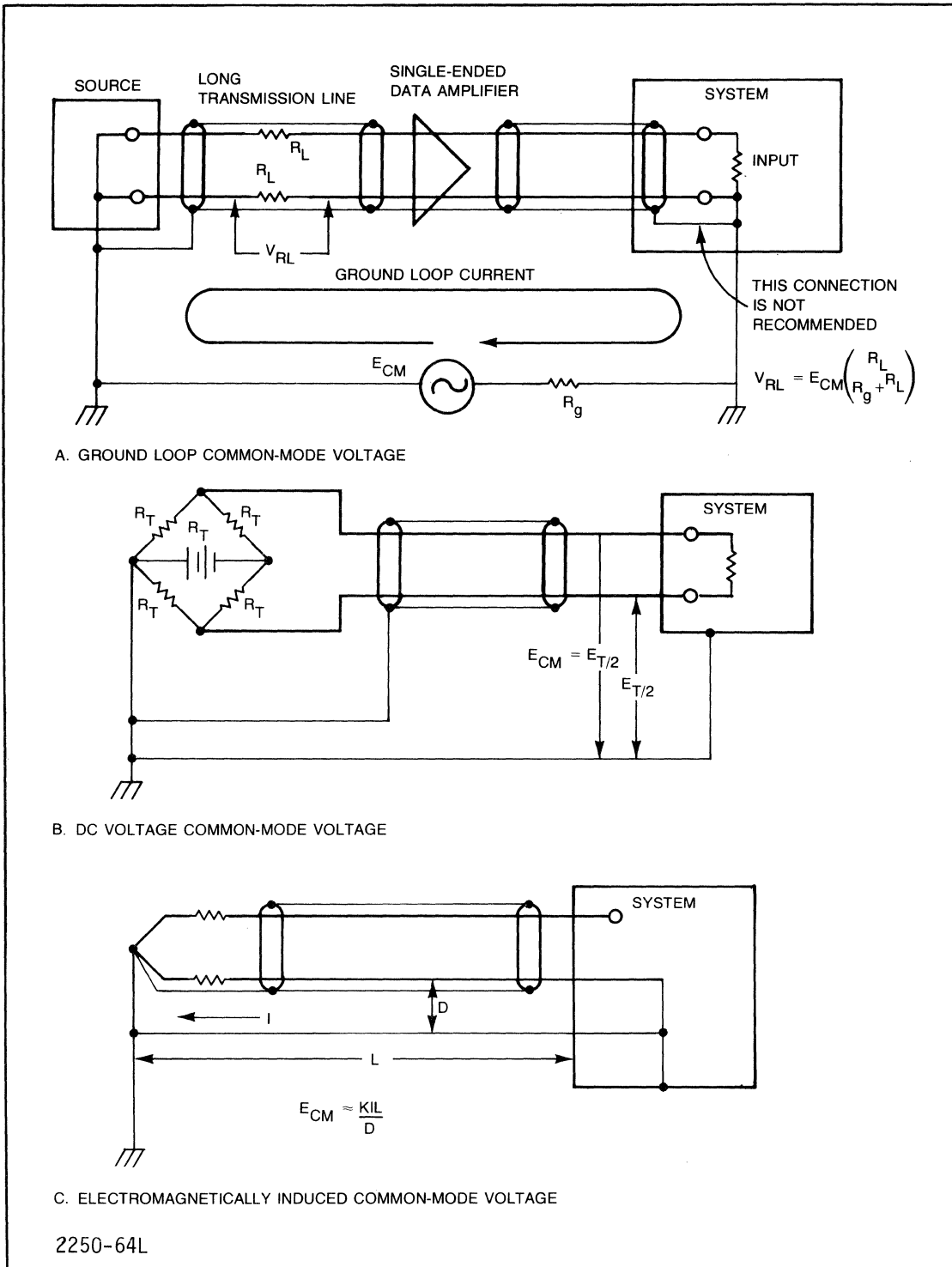


Figure A-2. Generation of Common-mode Voltages

4. Radio Frequency Noise.

Radio frequency noise should be seriously considered where there are low-level analog signals to be measured or output. The prime sources of rf noise generated through arcing and corona discharges are as follows:

- a. Electrical discharge lamps (e.g., fluorescent and mercury vapor fixtures).
- b. Some types of electrical rotating equipment.
- c. High voltage power equipment and lines.
- d. Power and control switching devices.

Arcing is probably the most prevalent cause of radio frequency noise. It occurs in electrical machinery containing brushes or slip rings, and in switchgear and motor controllers. The interference from arcing can be minimized by keeping the instrumentation separated as far as possible from the noise source.

The number of noise sources can be reduced by using inductive motors, which contain neither commutators nor slip rings, wherever possible. Also, troublesome switchgear may be modified by installing arc suppressors on the contacts, if this does not introduce a detrimental delay time on relay release.

Motor, fixture, and appliance noise may be conducted and radiated by electrical wiring more so than by direct radiation. The best way to block this path is by installing a filter in the line at the source.

Corona discharge as a source of radio frequency noise is less common than arcing. It is generated on high voltage transmission lines and in electrical equipment. Formation of corona may vary with temperature and humidity conditions and cannot be predicted with certainty.

A.4 NOISE COUPLING

Noise transfers from one circuit to another by both electromagnetic coupling and electrostatic coupling. Electromagnetic coupling, which is the basic principle of transformers and motors, induces voltage from one conductor to another in several ways as follows: in proportion to the rate-of-current change in the source, in proportion to the circuit area or inductive reactance, and inversely related to the distance between them.

Strong magnetic fields can be generated from many sources particularly where currents are high (in excess of 10 Amps) including the following:

- a. AC motors and transformers
- b. AC power lines
- c. Induction heaters
- d. High initial current circuits such as solenoids and DC voltage switches.

A.5 NOISE REDUCTION AND PREVENTION

Noise and its effects are reduced by proper grounding, shielding, and cable installation. These are discussed below.

A.5.1 Grounding

A "ground" is a term used to describe a common voltage reference point. This point is not necessarily connected to earth ground. However, an earth ground is normally used to fix the neutral point of an electrical system to the theoretically zero volts of earth ground, and to provide a low resistance current path to earth for safety of personnel.

The overall grounding of a measurement and control system should consider both the electrical power grounding and the signal circuit grounding. Ac power grounding includes all distribution and utility service as well as lighting and equipment power. Signal circuit grounding includes all electronic and electrical control circuits associated with the measurement and control system. The design of each of these grounding systems for an error free measurement and control system must receive careful consideration - both independently and with respect to each other.

A.5.1.1 Power Grounds

Primary power circuits and their grounding are standard and required by the National Electrical Code. The most important consideration is its relative location to the measurement system -- all heavy electrical equipment and primary power distribution should be placed some distance from the measurement system so that earth currents will be reasonably small. Grounding of the measurement and control system cabinet should be separate from the standard ac power equipment ground point so that ac ground currents from this equipment will not enter the system cabinet. In problem cases, an isolation transformer should be used for supplying system power to prevent ground loss between the electrical power ground point and the measurement and control ground point.

A.5.1.2 Signal Grounds

The signal ground is associated with the transmission of measurement signals or control signals. These are associated with either digital or analog signals and they should be separate. Analog signal sources are either grounded transducers such as a bonded thermocouple or ungrounded such as a strain-gage bridge transducer. In each type the maximum measurement accuracy is achieved when noise is minimized. Proper grounding is shown in figure A-3B for bonded thermocouples and in figure A-3D for ungrounded strain gages. The cable shield should be grounded at the same point which grounds the transducer or potential center point of the strain gage.

A.5.1.3 Quality of Ground

The earth connection as required by code will have little affect on reducing data acquisition system noise. The National Electrical Code specifies a metallic underground water pipe with a ground resistance of 25 ohms or less. Data acquisition systems should have ground resistance approaching or less than 5 ohms under the most dry (least moist) soil conditions. This means that additional high-quality grounds should be installed in many facilities using sensitive analog instrumentation. The connections to these grounds should be accessible for inspection.

When installing ground rods, if resistance measurements are to be made, bolt the ground wire to the rod (instead of welding) so that it can be disconnected for measurement. The resistance of a ground rod installation should be measured when it is installed and checked every two months for the first year and semi-annually thereafter.

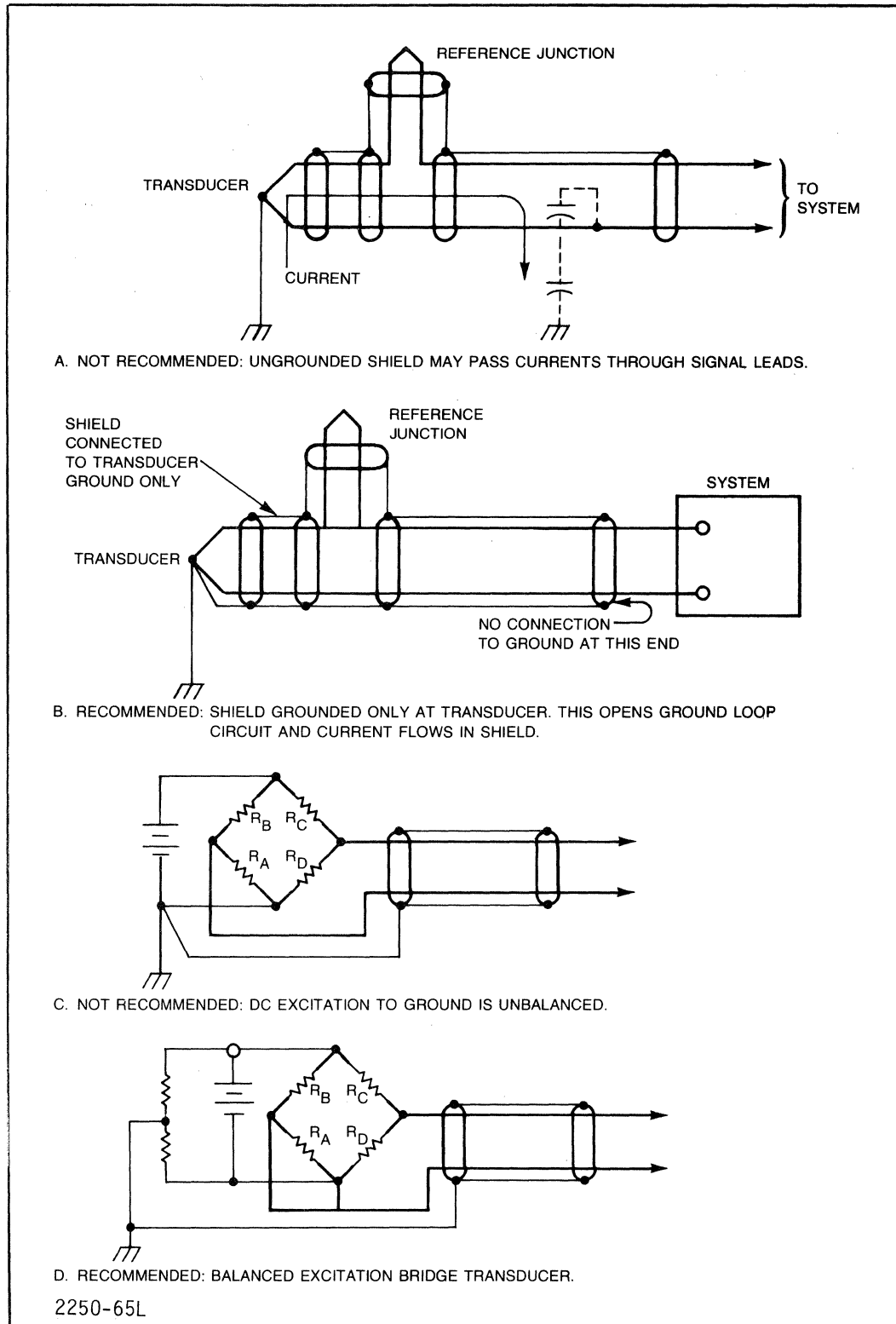


Figure A-3. Sensor Grounding Methods

Ground rod installations may take several forms. The easiest but least effective is the sledge-hammer driven rod of 8 to 10 feet in length. In poor soil conditions this type of rod is almost useless. An improved method of driving such a rod is the "chuck and anvil" method consisting of a sliding hammer and a movable anvil which can be adjusted to the remaining height above ground.

For longer ground rods, it is recommended that "jointed" rods be used.

Treatment of sandy soil provides an improvement in its grounding qualities. Use either common salt or magnesium sulphate in a water solution. However, the chemical concentration may decrease with time as ground water flow will gradually carry away the chemical. Thus maintenance is required at a frequency which is dependent upon the ground water conditions throughout the year. One method used for easy maintenance of treated soil is to form a circular trench of about a one foot depth around the ground rod to hold the solution. A second method is to sink a tile pipe around the ground rod to a depth of about two feet. The pipe is cleared of soil and filled with the solution. A removable cover on top of the pipe allows inspection and maintenance.

A.5.2 Analog Signal Cables

Each transducer should be in a metallic enclosure and the enclosure connected to the shield of a shielded cable. The enclosure (or case) is grounded and thus the shield is also grounded. Normally twisted-pair shielded cables are used wherever possible, the shielding is made continuous throughout, from transducer to system. In the instrumentation cables commonly used, shields for effective electrostatic shielding are either single-layer copper braid or copper stranded wrap. Thickness of shield is not important. Electrostatic shielding is normally all that is required.

Ground loops can exist between different process areas and between different unintentional grounds. Confirm this condition by opening all connections to the common ground and testing for open circuit between the shield and ground.

If there are strong magnetic fields to be guarded against, copper braid and aluminum shield are not effective unless the shield is much thicker than normally used for signal cables. The extra thickness may result in sufficient eddy current generation by the magnetic flux so that the flux penetration of the shield is minimal. A high permeability ferrous material, such as iron, is the best magnetic shielding material because magnetic flux will actually be absorbed in it. (If magnetic interference originates in power conductors, the best solution is to install the conductors in rigid steel conduit.)

Twisting two-wire transmission reduces the voltages induced in the line. The effectiveness of this reduction is proportional to how close the wires are brought together in the twisted configuration.

A.5.3 Digital Signal Cables

Digital signal cabling requirements are different from analog cabling due to the nature of the digital signals. Noise is actually generated by the digital switching circuits due to the fast voltage-level changes, (in analog circuits, externally generated noise must be guarded against). High speed in digital circuits is usually desirable for high system speed, yet as speed increases the noise increases.

Higher frequency components of the switching components are coupled from one wire to another by the capacitance and inductance of the circuit. Thus to reduce coupling, the capacitance between wires should be minimized by using wire which has thick insulation made of high dielectric constant material. Teflon insulation has a suitable dielectric constant for this application.

Shielded cable as used for analog circuits is not recommended for digital circuits because the relatively large capacitance per unit length of the center wires to the shield is detrimental to the switching characteristics. This capacitance must be charged and discharged as the circuit is switched, thus introducing delay time and distortion of the signal waveform.

Inductance coupling is a transformer type effect due to the proximity of wires in common cables. Pickup through inductance becomes significant when the switching or pulse currents become large. Problems associated with inductance coupling can be minimized by twisting these lines with a ground wire to reduce the magnetic field and couple some of it to ground.

To reduce noise coupling in digital circuits it is recommended that digital systems be wired in a point-to-point fashion rather than in large bundled cables. Following this procedure, where many points are located close together such as at a junction box, the wires should be fanned out from this point to their destinations with runs which are as short as possible.

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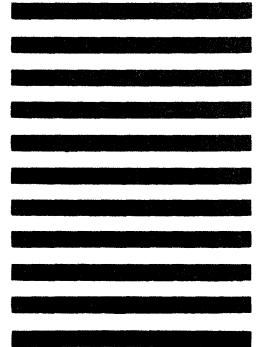
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Jin. Abdul Muis 62
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Cable: *BASTEL Tel-Aviv*
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Intercambio Mundial de Comércio S.a.r.l.
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Modern Electronic Establishment
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JEDDAH
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01/20/81



MANUAL PART NO. 02250-90012
Printed in U.S.A.
July 1982

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