HP64000
Logic Development System

Installation
& Configuration
Reference Manual

**HEWLETT
PACKARD**

Model 64000 Reference Manuals

The following block diagram shows the documentation scheme for the IP Model 64000 Logic Development System. The interconnecting arrows show the recommended progression through the manuals as a way of gaining familiarity with the system.

Manual Map

```
                          System Overview
                               and
                          System Software
                         Reference Manuals

                Software                     Analysis
                Development                  and
   System                                    Debug


  Installation          Editor Manual         Measurement System
      and                                     Reference Manual
  Configuration
     Manual
                          HP64000            Emulator/Analyzer      Processor-dependent
                        Host Pascal          Reference Manual       Supplement
  Tape Drive          Reference Manual
  Reference                                                        (where applicable)
  Manual
                       Compiler Reference    User-definable Emulator
                          Manual             and ROM Emulator
  Flexible Disc                              Reference Manuals
     Drive
  Reference            Processor-dependent   Inverse Assembler
  Manual               Supplement            Reference Manual


                       Assembler Linker      Logic State/          General Purpose
                       Reference Manual       Software Analyzer     Preprocessor
                                             Reference             Reference Manual
                                             Manual
                       Processor-dependent
                       Supplement            Logic Timing          Processor-dependent   User-definable
                                             Analyzer              Interface Module       Interface Module
                                             Reference             Manual
                       User-definable        Manual
                       Assembler
                       Reference Manual


                       PROM Programmer
                       Reference Manual
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Printing History

Each new edition of this manual incorporates all material updated since the previous edition. Manual change sheets are issued between editions, allowing you to correct or insert information in the current edition.

The part number on the back cover changes only when each new edition is published. Minor corrections or additions may be made as the manual is reprinted between editions.

First Printing . . . . June 1982

Manual Conventions

The manual conventions and syntax conventions used in this book are presented below. For a full understanding of information in this manual, review the following conventions.

underlining | Where it is necessary to distinguish user input from computer output, the input is underlined.

Dashed line key symbols indicate a soft key on the keyboard. The physical labels for the soft keys appear on the CRT display. In text, the soft key label will appear within the symbol.

Solid outlined key symbols are used in text to represent labeled keys on the keyboard.

[   ] | Parameters enclosed in square brackets are optional. Several parameters stacked inside a set of brackets indicate an either/or situation. You may select any one or none of the parameters.

The use of square brackets implies that a default value exists.

Example:

$$\begin{bmatrix} A \\ B \end{bmatrix}$$

This indicates A or B may be selected.

{   } | Braces specify that the parameter enclosed is required information. When several parameters are stacked within a set of braces, you must select one and only one of the parameters.

Example:

$$\begin{Bmatrix} A \\ B \\ C \end{Bmatrix}$$

This example says one and only one of A, B, or C must be selected.

Choice of one and only one when several elements are enclosed.

Manual Conventions (Cont'd)

[   ]   Stacked square brackets indicate that enclosed parameters are
[   ]   optional and may be selected in any single occurrence, any
                 combination, or may be omitted.

        Example:

           [A]
           [B]
           [C]

        A and/or B and/or C may be selected, or this option may be omitted.

<   >   Angle brackets denote frequently used syntax elements which are
                 predefined.

lower-case   Key words (soft key commands) are lower-case in the Model 64000.
bold type   These key words will always be represented in text with **lower-case
                 bold type.**

        Example:

           edit <FILE>

=>   Arrow indicated "is defined as."

. . .   An ellipsis indicates a previous bracketed element can be repeated.

UPPER-CASE   Literal information which is supplied in a command is represented in
                 text with upper case type.

Syntax symbols   Indicates symbols are used for definition purposes and do not appear
in color   on the CRT display.

Installation & Configuration
Reference Manual

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Chapter **1**

General

</div>

Introduction

This manual contains information for system configuration, site selection, installation, and checkout of the Model 64000 Logic Development System. As an aid in quickly locating specific information, the contents of this manual are briefly summarized as follows:

Chapter 1 provides information concerning site selection responsibilities, environmental requirements, and receiving inspection.

Chapter 2 provides installation and checkout procedures for Development Stations (Models 64100A and 64110A).

Chapter 3 provides interconnection and checkout information for clustered configurations of the 64000 System.

Chapter 4 provides information for the installation and checkout of a development station in a stand-alone configuration.

Chapter 5 provides installation instructions for systems that utilize the HP-IB (Hewlett-Packard Interface Bus).

Chapter 6 provides installation procedures for 64000 systems utilizing the RS-232-C standard interface for data communication equipment.

Use of this manual will vary between users, depending on their specific configuration. For example, a user with multiple development stations, plus peripherals, would be interested primarily in the following:

a. Chapter 1 - General Information
b. Chapter 2 - Development Stations
c. Chapter 3 - Cluster Configurations

Whereas, a customer who has ordered a single, stand-alone development station would be interested primarily in the following:

a. Chapter 1 - General Information
b. Chapter 2 - Development Stations
c. Chapter 4 - Stand-alone Configuration

NOTE

Customers installing a hard disc to a station should also refer to Chapter 3, "Cluster Configuration".

Chapter 5 would be required reading for stand-alone configurations having interconnections to other HP-IB interface devices.

Chapter 6 would be required reading only for those stand-alone or cluster systems that have serial communication connections.

Site Selection Responsibilities

Customer

It is the customer's responsibility to provide adequate space,electrical power, and air conditioning to ensure that the selected site will be suitable for HP installed equipment. Hewlett-Packard retains the right to refuse to maintain supplied equipment if the area is deemed inadequate.

The customer is also responsible for unpacking, inventory, and placement of equipment on the selected site; all necessary information is provided in this chapter.

NOTE

The Model 64000 generates, uses, and can radiate radio frequency energy. If it is not installed and used in accordance with the Operating and Service Manuals, it may cause interference to radio communications. As temporarily permitted by regulation, it has not been tested for compliance with the limits for class A computing devices pursuant to subpart J of part 15 of FCC rules which are designed to provide reasonable protection against such interference. Operation of this equipment in a residential area is likely to cause interference in which case the user, at his own expense, will be required to take whatever measures may be required to correct the interference.

Customer Engineer

When HP installs the system, the CE (Customer Engineer) will contact the customer to schedule a date for system installation after the delivery date has been verified.

On the installation date, the CE will visually inspect all system components, install the system, and run diagnostic programs to verify system operation.

Space Requirements

Space requirements for system components are shown in figure 1-1.

NOTE

Outline dimensions listed in Figure 1-1 are for general information. If dimensions are required for building special enclosures, contact your HP Field Engineer.
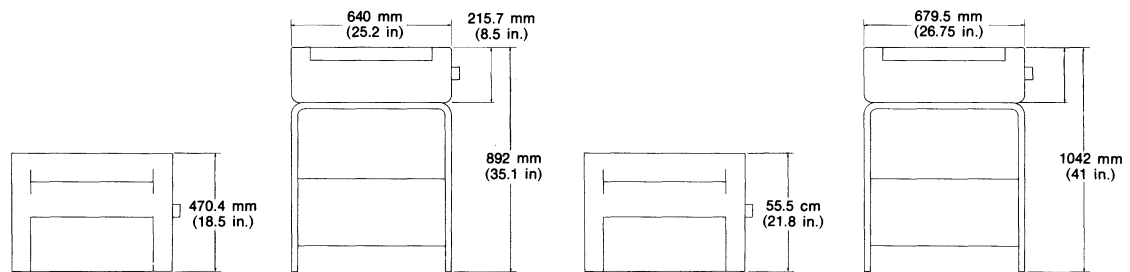
1. HP Model 2631B/G Line Printer

   Clearance Requirements

   a. Front and Rear - Adequate for operator access.

   b. Side - 76 mm (3 in.)

2. HP Model 2608 Opt 046 Line Printer

   Clearance Requirements

   a. Front and Rear - Adequate for operator access.

   b. Left Side - 203 mm (8 in.) minimum.

Figure 1-1. Space Requirements

427 mm
(16.7 in.)

428 mm
(16.9 in.)

105 mm
(4.1 in.)

55.3 cm
(21.8 in.)

79.1 cm
(31.1 in.)

71.8 cm
(28.3 in.)
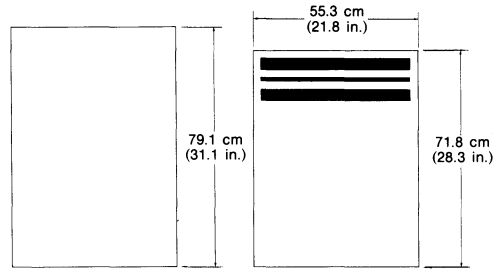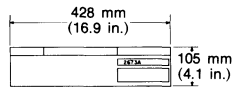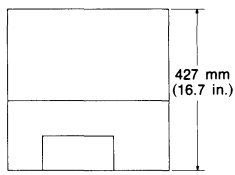
3. Model 2673A Graphics Printer

Clearance Requirements

a. Front and Rear - adequate for operator access.

4. HP Model 7906 Opt 102 Disc Drive

Clearance Requirements

a. Rear - 500 mm (20 in.) minimum from any object or barrier.

499 mm
(19.65 in.)

813 mm
(32.0 in.)

826 mm
(32.5 in.)

354 mm
(14.0 in.)

740 mm
(29.1 in.)

720 mm
(28.4 in.)
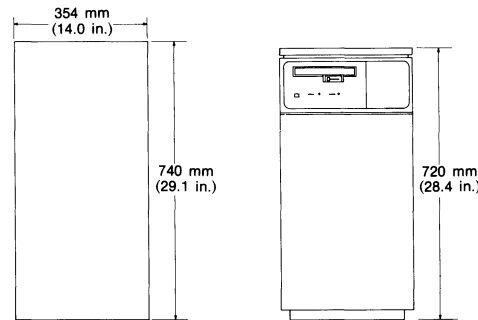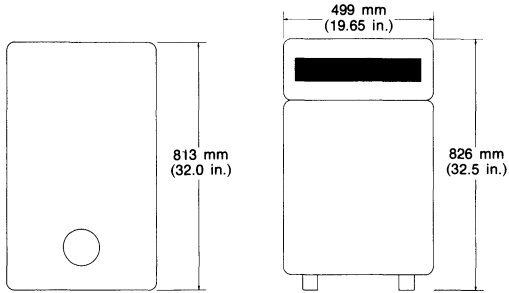
5. HP Model 7920/7925 Opt 102 Disc Drive

Clearance Requirements

a. Rear - 500 mm (20 in.) minimum from any object or barrier.

6. Model 7908P/7911P/7912P Disc Drives

Clearance Requirements

a. Rear - 500 mm (20 in.) minimum from any object or barrier.

476 mm
(18.7 in.)

425 mm
(16.7 in.)

130 mm
(5.1 in.)
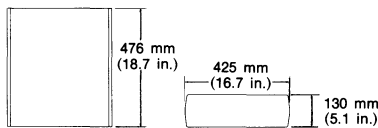
7. Model 9134A Opt 010 Disc Drive

Clearance Requirements

a. Front and Rear - adequate for operator access.

Figure 1-1. Space Requirements (Cont'd)

8. Model 64100A Development Station

Clearance Requirements

a. Front and Rear - Adequate for operator access

b. Sides - 203 mm (8 in.) min.

NOTE

Dimensions are in millimetres and (inches).

724 mm
(28-1/2 in.)

489 mm
(19-1/4 in.)

324 mm
(28-1/2 in.)

343 mm
(13-1/2 in.)

508 mm
(20 in.)
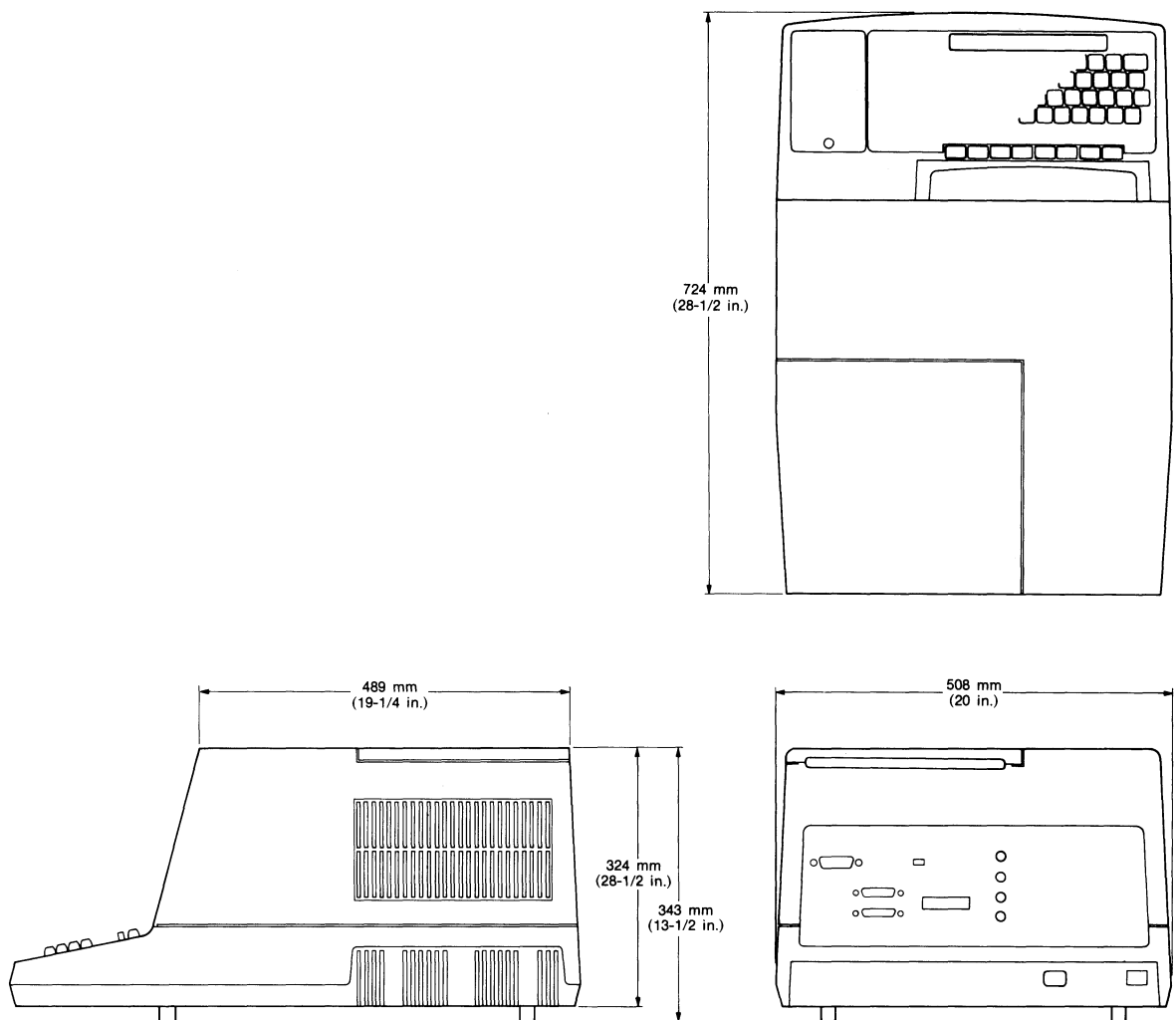
Figure 1-1. Space Requirements (Cont'd)

9. Model 64110A Development Station

Clearance Requirements

a. Front and Rear - Adequate for operator access.

b. Sides - 203 mm (8 in.) min.

NOTE

Dimensions are in millimetres and (inches).
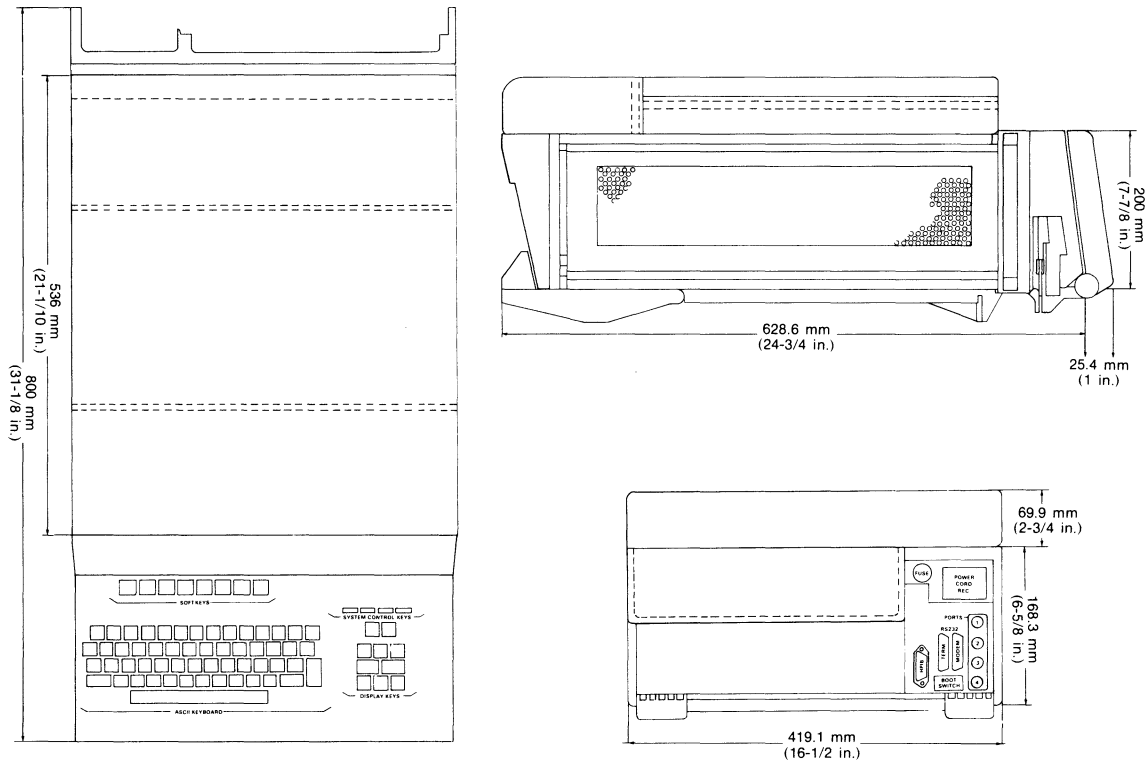
NOTE

Dimensions are for general information only. If dimensions are required for building special enclosures, contact your HP field engineer.

Figure 1-1. Space Requirements (Cont'd)

Power and Environmental Requirements

Power and environmental requirements are listed in table 1-1.

Table 1-1. Power and Environmental Requirements

Product	Max Current		Heat Dissipation	Weight	Power Cable	Bus Cable
	110 V	220 V				
64100A Station _____units_____	7.2A	3.6A	495 kcal/hr	36.5 kg (80.5 lb)	2.2 m (7ft)	2 m (6ft)
64110A Station _____units_____	6.0A	3.0A	495 kcal/hr	23.6 kg (52 lb)	2.2 m (7ft)	2 m (6ft)
7906M (Opt 102) Disc Drive _____units_____	8.0A	4.5A	640 kcal/hr	154 kg (340 lb)	2.2 m (7ft)	2 m (6ft)
7906S Disc Drive _____units_____	5.45A	2.73A	438 kcal/hr	138 kg (303 lb)	2.2 m (7ft)	2 m (6ft)
7908P Disc Drive _____units_____	4.0A	2.0A	345 kcal/hr	72.5 kg (160 lb)	2.2 m (7ft)	2 m (6ft)
7908P (Opt 140) Disc Drive _____units_____	3.5A	1.8A	345 kcal/hr	72.5 kg (160 lb)	2.2 m (7ft)	2 m (6ft)
7911P (Opt 140) Disc Drive _____units_____	7.0A	3.5A	600 kcal/hr	85.4 kg (188 lb)	2.2 m (7ft)	2 m (6ft)
7912P (Opt 140) Disc Drive _____units_____	7.0A	3.5A	600 kcal/hr	85.4 kg (188 lb)	2.2 m (7ft)	2 m (6ft)

Table 1-1. Power and Environmental Requirements (Cont'd)

Product	Max Current 110 V	220 V	Heat Dissipation	Weight	Power Cable	Bus Cable
7920M (Opt 102) Disc Drive _____units_____	7.4A	4.3A	700 kcal/hr	159 kg (350 lb)	2.2 m (7ft)	2 m (6ft)
7925M (Opt 102) Disc Drive _____units_____	6.7A	3.5A	540 kcal/hr	158 kg (350 lb)	2.2 m (7ft)	2 m (6ft)
9134A (Opt 010) Disc Drive _____units_____	1.15A	0.54A	79 kcal/hr	13.4kg (29.5 lb)	2.2 m (7ft)	2 m (6ft)
2608A (Opt 046) Printer _____units_____	12.5A	6.25A	1290 kcal/hr	97 kg (217 lb)	2.2 m (7ft)	2 m (6ft)
2631B/G (Opt 046) Printer _____units_____	1.8A	0.9A	230 kcal/hr	23 kg (51 lb)	2.2 m (7ft)	2 m (6ft)
2673A Printer _____units_____	1.0A	0.5A	120 kcal/hr	8.3 kg (18 lb)	2.2 m (7ft)	2 m (6ft)
Total	_____A	_____A	_____kcal/hr	_____kg _____lb		

System power and environmental operating requirements are listed in table 1-2.

Table 1-2. Environmental Operating Requirements

Operating Temperature	10° C (50° F) to 40° C (104° F)
Operating Humidity	8% to 80% RH (20% to 80% RH with flexible disc) Noncondensing (max wet bulb temp - 26° C (78° F))
	Power Outlets
US, Canada, Japan	NEMA 5-15 (15 A)
UK	BS 1363 (13 A)
Australia, New Zealand	AS C112 (7-5 A)
Europe (except UK and Switzerland)	CEE 7-V11 (10/16A)
Switzerland	SEV 1011 (10 A)

Power Cords

Detachable power cords, with country-dependent plugs to match wall sockets, are supplied with each component. Figure 1-2 shows the available power plugs for various countries, ordering options, specification numbers, and HP part numbers. The green-wire ground connection on each power plug is also shown.

REF 7311-1D

WARNING
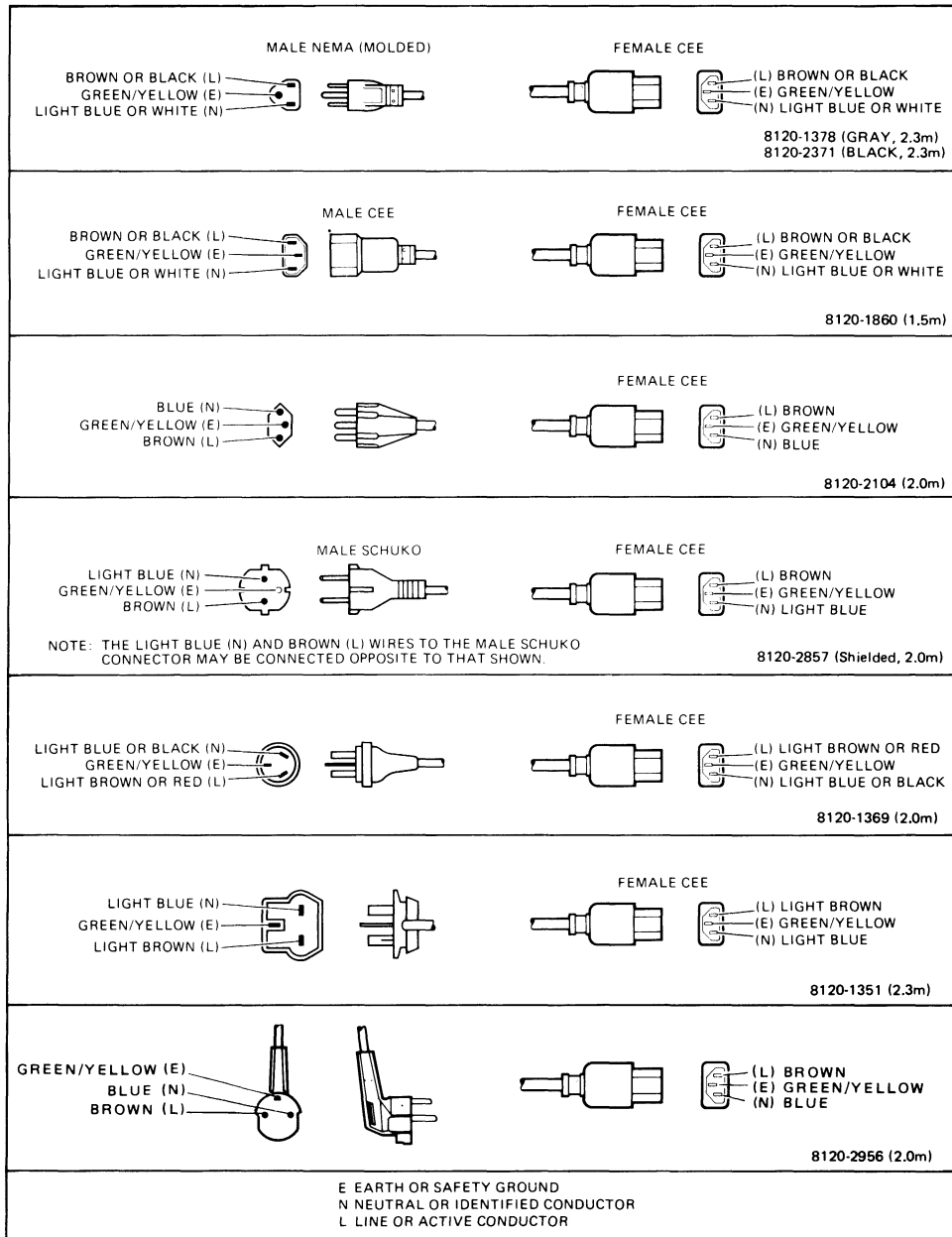
Do not use extension power cords under any circumstances.

Figure 1-2. Power Cord Sets

Grounding

Model 64000 components are equipped with three-conductor power cords which, when connected to appropriate power receptacles, ground the system. The green-wire safety ground is connected to the metal frame of each component in the system to provide a return path for fault currents due to equipment malfunctions or external faults such as lightning strikes. Do not operate the system from an ac power outlet which has no power outlet to the distribution panel where the circuit breaker is installed.

NOTE

To ensure good communications over the HP-IB interface, all power sources must be at the same ground potential.

Convenience Outlets

Power outlets for janitorial maintenance (vacuum cleaners, floor buffers, etc.) must be wired on a separate circuit breaker from the Model 64000. If these precautions are not taken, operation of such equipment will induce noise transients on the system power lines, which can cause abnormal operation of the system.

Isolation Transformers

Switching heavy electrical machinery loads or operating certain types of equipment near the system can cause problems, even though the source is on a different circuit breaker. In some cases, it is mandatory to provide a separate circuit and circuit breaker for the system directly from the main building power. In extreme cases of severe electrical noise, it may be necessary to install an isolation transformer.

Power Line Noise

Power from a typical ac power line is inherently noisy, and fluctuations can be caused by:

a. utility power company switching
b. circuit breakers tripping
c. air conditioning equipment
d. electrical welders
e. elevators
f. copying machines
g. start-up of large electric motors

Even though you cannot control or prevent disruptions from the first two items, remember to avoid connecting 64000 System components on the same circuit breaker with any of the equipment named above.

Telephone

A telephone should be located near the system so that a customer or HP Service Engineer can discuss a servicing problem while working on the unit.

Receiving the Model 64000

NOTE

Hewlett-Packard personnel are not authorized to accept or sign for delivery of Hewlett-Packard equipment for the customer. Accepting delivery is the responsibility of the customer.

Inspecting the Shipment

The main components (Development Stations, Disc, and Printer) of the 64000 System arrive in separate cartons from different Hewlett-Packard divisions.

NOTE

Disc Models 7906, 7920, and 7925 require unique installation procedures that must be performed by an HP Service Representative.

Before unpacking the system, it is extremely important that you verify the packing list for any discrepancies, and visually inspect the shipment for damage. Only one packing list will accompany each shipment. It will be in an envelope attached to the outside of one of the cartons. Check the shipment against the packing list. If there are missing items, you must notify the carrier immediately for determination of those items.

Inspecting for Shipping Damage

Before unpacking the system, you should visually inspect all shipping crates and boxes for damage.

If there is external damage to the Model 64000 component case as a result of mishandling during shipment (damaged crates, stains, etc.), the carrier is liable for repair and/or replacement of any parts. The customer should also immediately open all cabinets and make a visual inspection of all internal parts. If there is internal damage, the carrier is also liable for repair and/or replacement of those parts.

Internal damage (within a cabinet) may be discovered after the shipment has been unpacked. On the premise that there was no damage to the shipping container, HP is liable for repair and/or replacement of any parts. You must notify the local HP Customer Engineer so the part can be replaced immediately under warranty.

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CAUTION
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Weight of most system components require two persons to lift them from the shipping containers.

Unpacking the Model 64000 Components

When unpacking components, retain all packing materials and hardware for future use. Remove units from the shipping cartons; remove all packing material from around units.

After unpacking all units, verify that serial numbers listed on shipping documents and identification tags (located on the back of each unit) agree.

If for any reason, it becomes necessary to reship one of the units, repack it in the original packing material and shipping carton.

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Chapter **2**

Development Stations

</div>

Introduction

The two development stations, 64100A and 64110A, may be configured either in a cluster or as stand-alone stations, as suitable for particular design and/or analysis needs. The 64100A has an optional flexible disc or tape cartridge for local mass storage. To operate as a stand-alone station, the 64100A must have the flexible disc option or tape drive installed. Any combination of the two stations (with any combination of local mass-storage units in the 64100A) may be configured in a cluster with a hard disc. Each cluster is limited to a maximum of six stations, one of which must have local mass storage to load system software.

This chapter discusses the physical aspects of the development stations, along with the performance verification (PV) routines.
Topics discussed are:

- Power Requirements

- Card Cage and Card Slots

- Internal Bus Configurations

- Control Source Switch Settings

- Performance Verification

For general operating instructions, refer to the System Software Reference Manual.

Development Station Power Requirements

Before connecting development stations to the power source, verify that sufficient operating power is available as follows:

64100A	110/220 Vac +/−15%, 48-66 Hz, single phase; 675 VA/7.20 A maximum at 110 Vac
64110A	110/220 Vac +/−15%, 48-66 Hz, single phase; 550 VA/6.00 A maximum at 110 Vac

Make sure each component in the system is configured for the correct voltage.

Model 64100A Card Cage

General Information

The card cage cover is located at the top right-rear corner of the development station (see figure 2-1). Remove the cover by loosening the two hold-down screws and lifting it from the back.
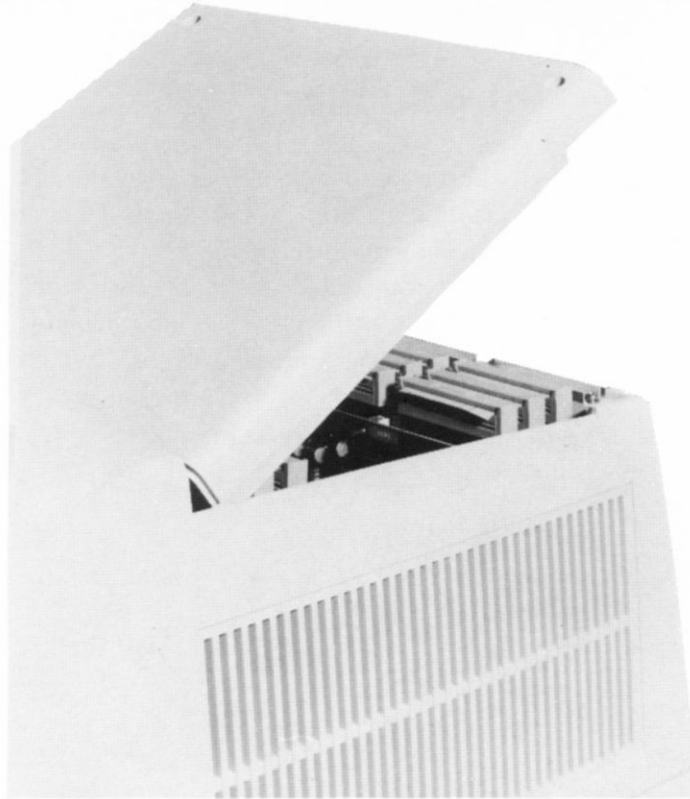
Figure 2-1. Model 64100A Card Cage Access

Model 64100A Card Slots

There are 13 card slots. The first three slots have cards installed at the factory. These cards must be installed in the order given below for the system to operate. The three required cards (plus the one option card) are:

    slot A - I/O Card
    slot B - Display Control Card
    slot C - CPU Card
    slot 0 - Local Mass Storage Controller Card.

There are ten option slots, numbered 0 through 9, that accomodate cards for specific configurations. When installing option cards ensure that the current requirements do not exceed the limits of the power supply (see tables 2-1 and 2-2).

Model 64100A Card Installation

To install one of the option cards, hold the edge of the card as shown in figure 2-2 (with component side toward the front of the development station). Slide the card down into the card cage. Align the connector on the bottom of the card with the socket on the motherboard, and apply enough pressure to seat the card into the socket.

The cards interface to the system through the mother board. For convenience, a label is located near the card slots in the card cage. As cards are inserted into the card cage, mark the card name on the label. The label may be erased and the card name changed as the card cage is reconfigured.
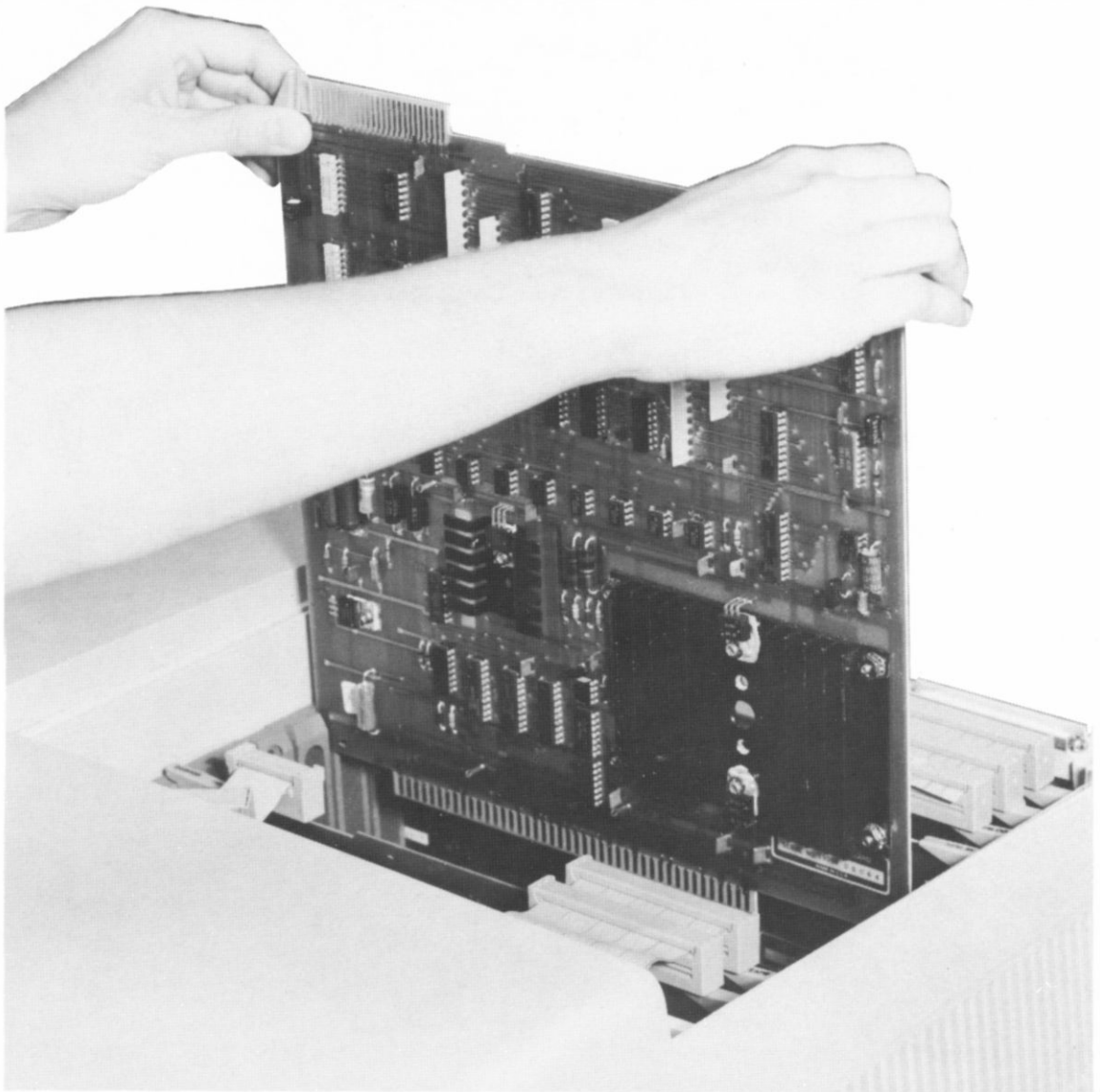
Figure 2-2. Model 64100A Card Installation

Model 64110A Card Cage

General Information

The card cage of the 64110A is accessed through the rear of the instrument (see figure 2-3).
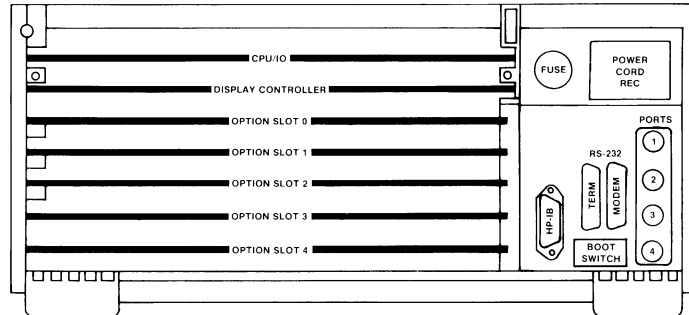
Figure 2-3. Model 64110A Card Cage Access

Model 64110A Card Slots

There are seven card slots (see figure 2-3). The top two slots contain the CPU & Input/Output card and the Display Control card which are installed at the factory. The two cards must be installed in the slots shown for the 64110A to operate properly.

There are five option slots, numbered 0 through 4, that accommodate cards for specific configurations. When installing option cards ensure that the current requirements do not exceed the limits of the power supply (see tables 2-1 and 2-2).

Model 64110A Card Installation

To install one of the option cards, insert the card as shown in figure 2-4 (with component side toward the top of the development station). Slide the card into the card cage through the rear of the instrument. Align the connector on the bottom of the card with the socket on the motherboard and apply enough pressure to seat the card in the socket.
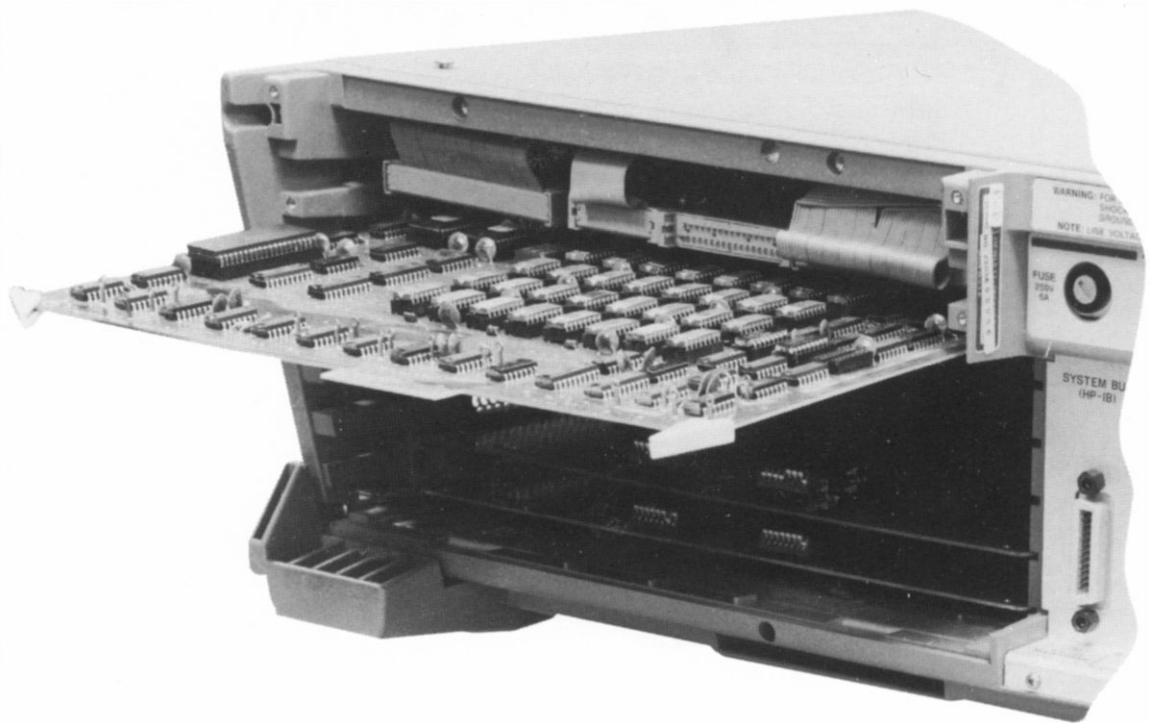
Figure 2-4. Model 64110A Card Installation

The cards interface to the system through the motherboard. For convenience, a label is located near the card slots in the card cage. As cards are inserted into the card cage, mark the card names on the labels. Labels may be erased and the card names changed as the card cage is reconfigured.

Power/Slot Requirements

Hardware subsystems installed in a 64000 Logic Development Station must not exceed the available current and card cage slots as listed in table 2-1. To ensure that the hardware selected for a single station can be accommodated, add the requirements of the hardware for each of the three columns shown in table 2-2. Then compare the total requirements against the available current/slots listed in table 2-1. Be sure that the station requirements do not exceed the maximum available.

NOTE

The total available current listed in table 2-1 indicates the current available for option cards that may be installed in slots 0 through 9 (Model 64100A) or in slots 0 through 4 (Model 64110A). The current requirements for the basic cards (installed at the factory) and other miscellaneous mainframe requirements have been deducted from the total power supply output prior to those listed in table 2-1. It should also be noted that when using table 2-2, the numbers for currents and slots listed for an Option represent the sum of the requirements of the base product (e.g., 64XXXS) plus that of the particular option.

Table 2-1. Available Development Station Currents & Slots

Model No.	Description	+5 V Cur.	–3/5 V Cur.	No. of Slots
64100A	Logic Development Station (All newly ordered units)	40.00	40.00	10
64110A	Logic Development Station	24.30	35.00	5
64100A	Logic Development Station S/N Prefix 2136 and below	19.00	10.00	10

CAUTION

Each time the option cards are reconfigured, total loading of the cards must be recalculated to ensure that current limits of the power supplies are not exceeded.

Table 2-2. Required Current/Slots
for Development Station Options

Model No.	Description	+5 V Cur.	-3/5 V Cur.	No. of Slots
*64032A	16k-word Host RAM Exp.	0.38	0.00	1

*NOTE: Used only with stations shipped prior to
March 1983. For additional information contact
the nearest HP Sales Representative.

Model No.	Description	+5 V Cur.	-3/5 V Cur.	No. of Slots
64100A	Logic Development Station			
Opt 041	Dual 5 1/4 in. Flexible Disc Unit	2.00	0.00	1
64110A	Logic Development Station			
64151A	Emul Mem Controller	1.54	0.00	1
64152B	32k-byte Emul Memory	1.20	0.00	1
64153B	16k-byte Emul Memory	1.00	0.00	1
64154B	8k-byte Emul Memory	1.00	0.00	1
64155A	Wide Emul Mem Controller	3.80	0.00	1
64161A	128k-byte Emul Memory	1.63	0.00	1
64162A	64k-byte Emul Memory	1.63	0.00	1
64163A	32k-byte Emul Memory	1.63	0.00	1
64152S	32k Emul Mem Subsys (64151A Controller)	3.40	0.00	2
Opt 011	64k Emul Mem Subsys (64151A Controller)	3.40	0.00	2
64156S	32k Emul Mem Subsys (64155A Controller)	5.40	0.00	2
Opt 011	64k Emul Mem Subsys (64155A Controller)	5.40	0.00	2
012	128k Emul Mem Subsys (64155A Controller)	5.40	0.00	2
013	256k Emul Mem Subsys (64155A Controller)	7.00	0.00	3
014	512k Emul Mem Subsys (64155A Controller)	10.2	0.00	5
015	1024k Emul Mem Subsys (64155A Controller)	16.4	0.00	9

Table 2-2. Required Current/Slots
for Development Station Options (Cont'd)

Model No.	Description	+5 V Cur.	-3/5 V Cur.	No. of Slots
64191S	6805U/R Emul Subsystem	2.3	0.00	1
64193S	6805P Emulator Subsystem	2.3	0.00	1
64202S	8080 Emulator Subsystem	4.93	0.00	1
64203S	8085 Emulator Subsystem	5.46	0.00	1
64212S	6800 Emulator Subsystem	6.25	0.00	1
64213S	6802 Emulator Subsystem	6.50	0.00	1
64215S	6809 Emulator Subsystem	6.80	0.00	1
64216S	6809E Emulator Subsystem	4.90	0.00	1
64222S	8086 Emulator Subsystem	6.20	0.00	1
64226S	8088 Emulator Subsystem	6.20	0.00	1
64232S	Z8001 Emulator Subsystem	6.10	0.00	1
64233S	Z8002 Emulator Subsystem	6.10	0.00	1
64242S	68000 Emulator Subsystem	6.10	0.00	1
64252S	Z80A Emulator Subsystem	5.81	0.00	1
64256S	6801/03 Emul Subsystem	8.40	0.00	1
64262S	8048 Emulator Subsystem	4.90	0.00	2
64272S	ROM Emulator Subsystem	4.90	0.00	1
64300A	40-Ch Emulation Analyzer	3.60	0.50	1
64302A	48-Ch Emulation Analyzer	3.70	0.40	1
*64500S	PROM Programmer Subsystem	1.12	0.00	1
64600S	200 MHz Timing Analysis; 8 channels	5.04	6.74	2
Opt 010	Expand to 16 channels	8.68	10.28	3
64601A	Timing Analysis Control	1.40	3.20	1
64602A	8-Ch Timing Card	3.60	3.30	1
64604A	8-Ch Timing Probe	0.04	0.24	0
64620S	Logic State Anal; 20-Ch	5.20	7.20	2
Opt 010	Expand to 40-Ch	7.00	6.30	2
011	Expand to 60-Ch	10.40	8.80	3
012	Expand to 80-Ch	12.20	7.90	3
013	Expand to 100-Ch	15.60	10.40	4
014	Expand to 120-Ch	17.40	9.50	4

Table 2-2. Required Current/Slots
for Development Station Options (Cont'd)

Model No.	Description	+5 V Cur.	-3/5 V Cur.	No. of Slots
64621A	Logic State Anal Contrl	1.80	4.70	1
64622A	40-Ch Logic State card	5.20	1.60	1
64623A	20-Ch Logic State card	3.40	2.50	1
64630S	GP Probe Set; Clock and 20-Ch	0.20	0.61	0
Opt 010	Expand to 40-Ch of Data	0.34	0.96	0
011	Expand to 60-Ch of Data	0.48	1.31	0
012	Expand to 80-Ch of Data	0.62	1.66	0
013	Expand to 100-Ch of Data	0.76	2.01	0
014	Expand to 120-Ch of Data	0.90	2.36	0
64635A	20-Ch State Data Probe	0.14	0.35	0
64636A	State Clock Probe	0.06	0.26	
64650A	GP Preprocessor Pod	1.80	2.60	0
**64655A	8085 Interface Kit	0.00	0.00	0
64670A	68000 Interface Kit	0.00	0.00	0
64680A	Z8001 Interface Kit	0.00	0.00	0
64681A	Z8002 Interface Kit	0.00	0.00	0
64683A	Z80 Interface Kit	0.00	0.00	0
***64941A	Dual 5 1/4 in. Flexible Disc Unit	2.00	0.00	1

*NOTE: Only available in 64100A. Difference between PROM
modules negligible; therefore, individual modules
and options are not listed.

**NOTE: Current requirements for interface kits are all
equal and are included in Model 64650A total.

***NOTE: Only applicable in 64100A. Slots and Currents are
accounted for in the 64110A which always has Dual
Flexible Discs installed.

Internal Bus Configuration

General

Depending on the station configuration, different internal bus cables may be required. Although cards and bus cables are usually installed at the factory (specific customer configuration), restructuring a configuration in the field may require additional bus cables. A list of available bus cables along with a brief description of those cables required for specific configurations follows:

    Rear Panel Bus (Model 64100A only - factory installed)
    Local Mass Storage Transport Bus
    Prom Programmer Bus (Model 64100A only)
    Input/Output Bus (factory installed)
    Emulation Memory Bus
    Emulation Bus
    Intermodule Bus (IMB)
    State Bus
    Timing Bus

Emulation Buses

Cards within the Emulation Memory Subsystem are connected by the Emulation Memory
Bus Cable, while the Emulation Bus Cables connect the Emulation Memory Control Card,
Emulation Control Card, and the Emulation Bus Analyzer Card. Two Emulation Bus Cables
are required. A typical cable interconnection is as follows:

EMULATION
MEMORY
BUS

EMULATION BUS
(1 BUS-2 CABLES)

COMPONENT SIDE
OF CARD

EMULATION
MEMORY CARDS

EMULATION BUS
ANALYZER

EMULATOR
CONTROL CARD

EMULATION MEMORY
CONTROL CARD
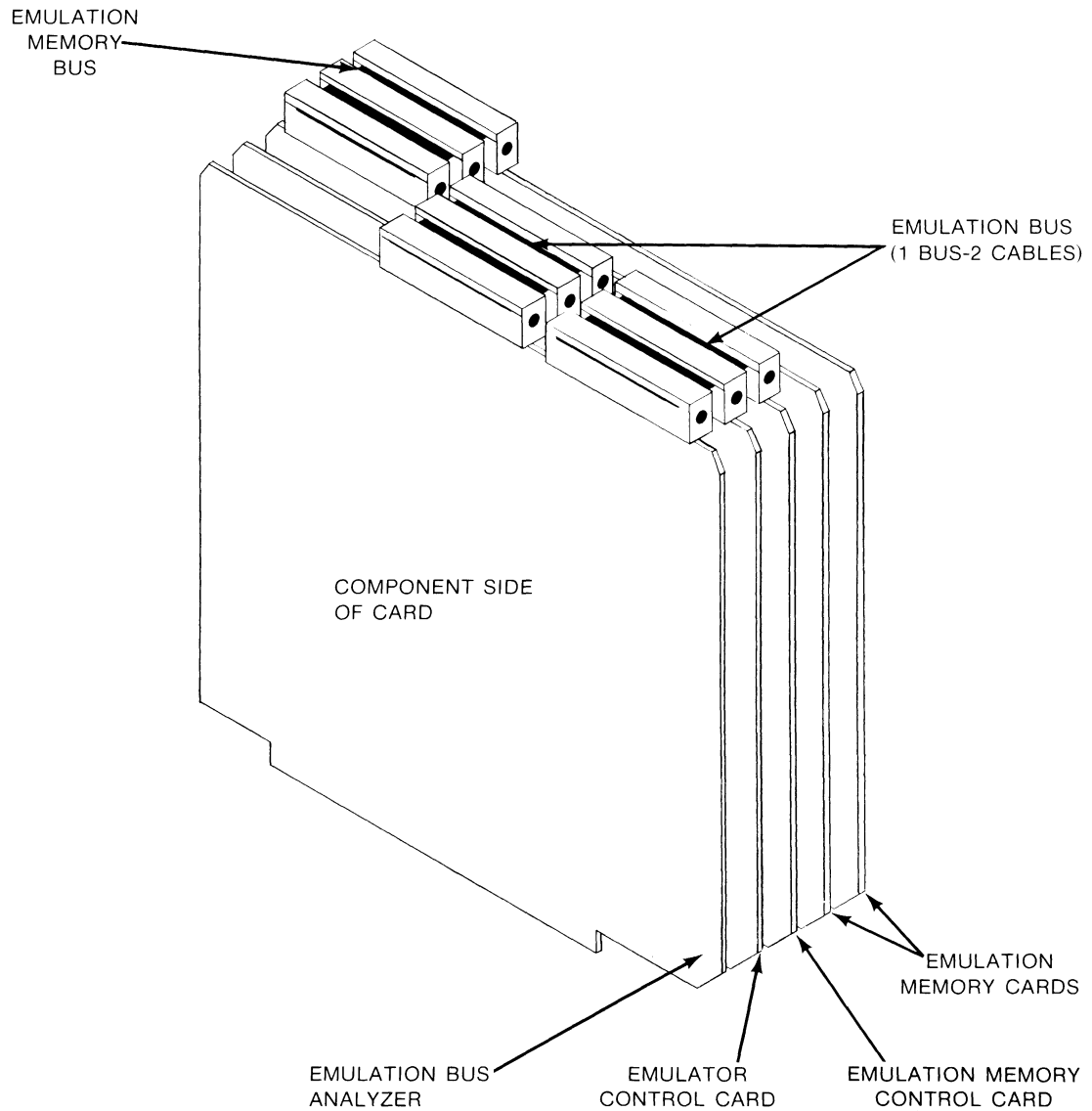
Emulation pod cables are routed to the outside of the 64100A development station through
three slots located at the back of the top cover and the rear panel. Emulation pod cables are
routed out the rear of the 64110A. Emulation pod cable lengths are determined at the factory
and shipped at maximum length.

State/Timing/IMB Buses

Cards for the State Analyzer are connected by a cable referred to as the State Analysis Bus Cable. This cable connects all cards within one analysis subsystem.

Cards for the Timing Analyzer are connected by a cable referred to as the Timing Bus Cable.

For interactive measurements with other modules, such as two Logic State Analyzers, a Timing Analyzer, or an Emulation Bus Analyzer, the Intermodule Bus (IMB) is implemented by way of the Intermodule Bus Cable. All cards have an edge connector for the IMB cable; however, only the connectors on the State and Timing Control Cards, and Emulation Bus Analyzer are functional. The connectors on the Data Acquisition Cards (both State and Timing) only provide mechanical support for the cable.

A typical cable interconnection is as follows:
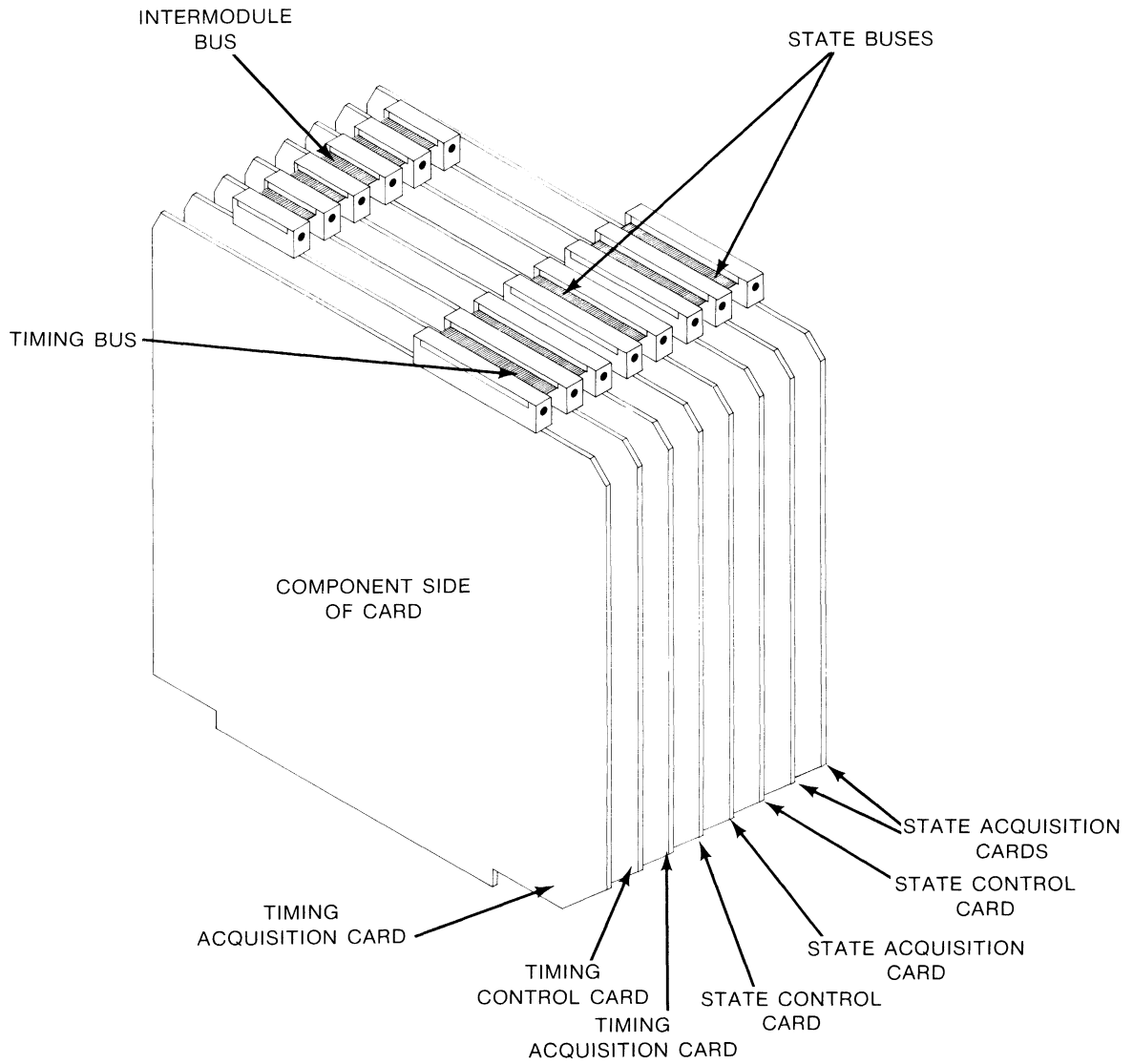
NOTE

For a specific bus configuration refer to the Operating or
Service Manual that pertains to the particular Option(s).

Control Source Switches

There are four methods of booting up the development station. The position of the boot-up switch (located on the rear panel) determines the function of the system control source. This switch function is the two leftmost bits of the switch under the label CONTROL (CONT) SOURCE.

Figure 2-5 shows the rear-panel system control source switches. Refer to table 2-3 for boot-up switch positions.

MODEL 64100A

MODEL 64110A
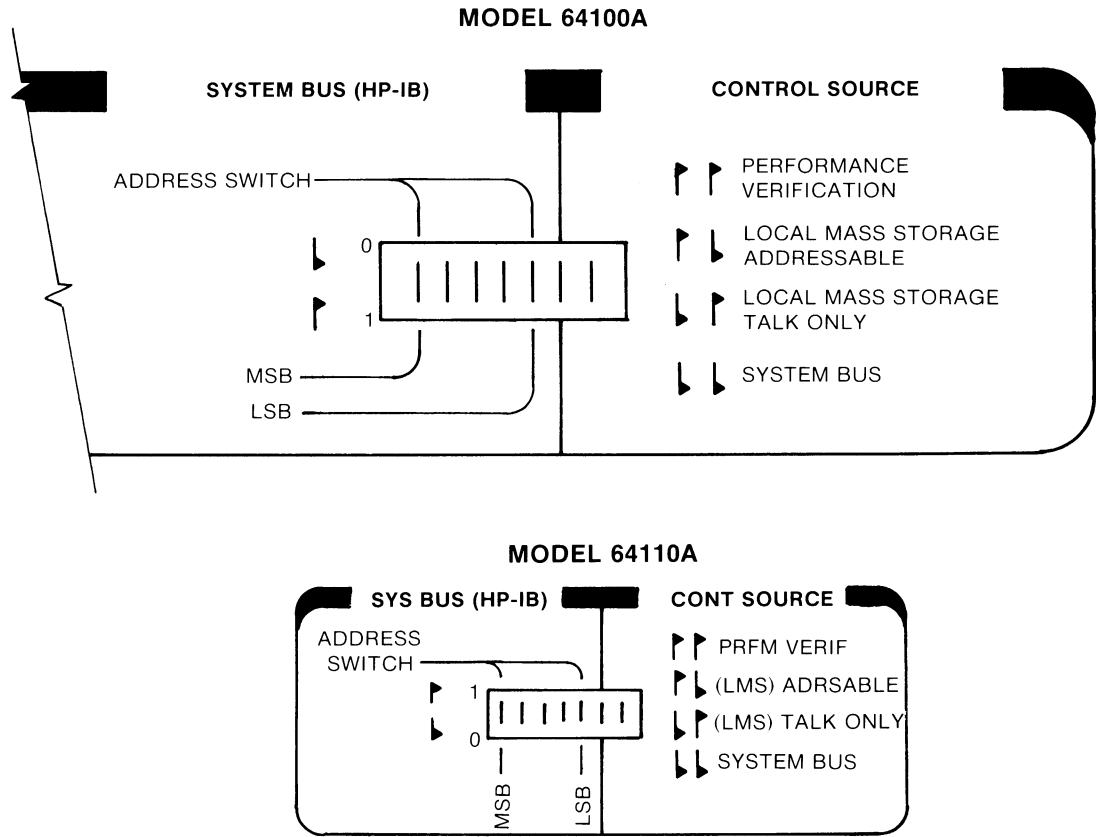
Figure 2-5. System Control Source

Table 2-3. System Control Source Switch Settings

Bit Position	Value	Function	Resulting Action
↑ ↑	11	PERFORMANCE VERIFICATION	In this mode, an internal performance verification is run on the development station.
↑ ↓	10	LOCAL MASS STORAGE ADDRESSABLE	In this mode, the development station is set to load the operating system (software) from the local mass storage unit. If operating as a "stand-alone" system, station will be "addressable" on the HP-IB bus.
↓ ↑	01	LOCAL MASS STORAGE TALK ONLY	In this mode, the station is set to load the operating system (software) from the local mass storage unit. If operating as a "stand-alone", the station will be "talk only" on HP-IB.
↓ ↓	00	SYSTEM BUS	If the operating system has been loaded onto the bus disc, the development station must be set to this mode for normal operation.

Performance Verification

Development Station

There are two methods of performing the Performance Verification tests. One method is to set the SYSTEM CONTROL SOURCE switches on the rear panel of the instrument for PERFORMANCE VERIFICATION (11). Turn the development station power ON. There will a loud beep the instant that power is switched on. Several additional beeps will be heard and a display pattern shown in figure 2-6 will become visible.
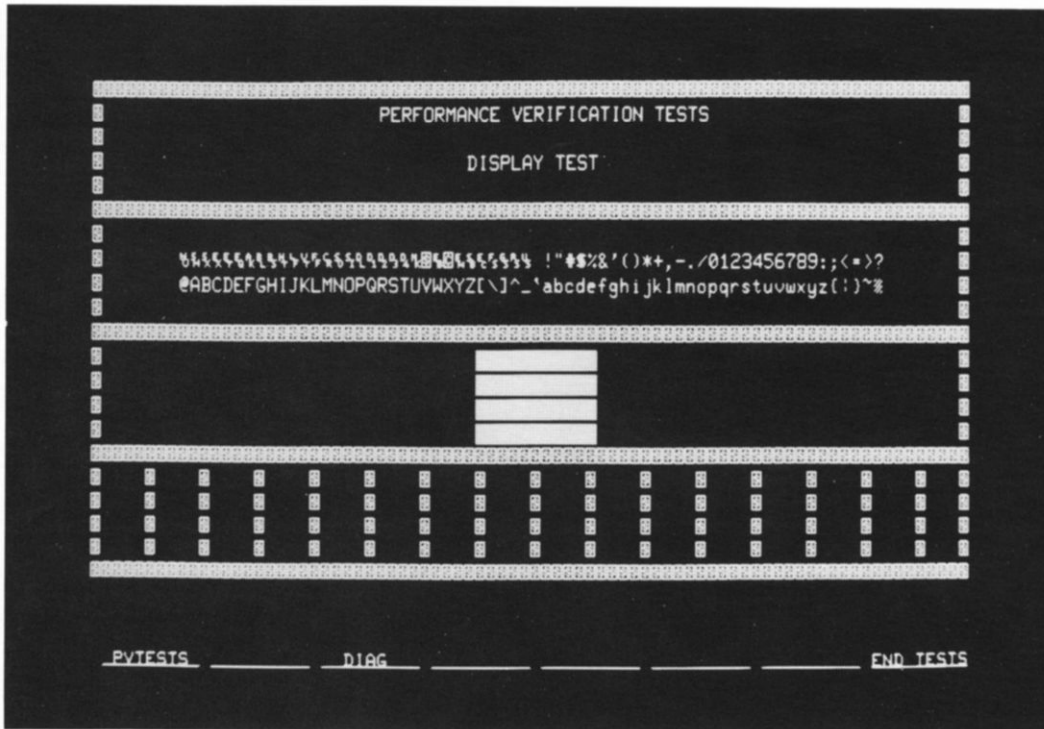
Figure 2-6. Display Test

To accomplish the Performance Verification Tests proceed as follows:

a. After Performance Verification Display Test pattern is displayed on CRT, soft key label line will display:

| pv tests | | | diag | | | | | | | | | | | end tests |

b. Press soft key | pv tests |. Soft key label line will display:

| next test | | start | | cycle | | display | | end tests | | | | | | |
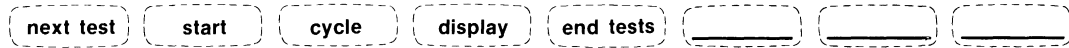
c. Press soft key | cycle |. The station will begin cycling through a number of Performance Verification tests which will be identified on the CRT. Some tests require more time than others, especially the RAM TEST and the RS232 TEST. Allow enough time for the station to complete each test.

d. After the station has cycled through the PV Tests several times, note the listings in the right-most column on the display labelled #FAIL. Only zeros should be displayed. If any test indicates that a failure has occurred, refer to the Service Overview Manual for instructions.

After a station has been initiated (booted), the other method for accomplishing PV Tests does not require the use of the SYSTEM CONTROL SOURCE switches on the rear panel of the instrument. Regardless of the settings of the SYSTEM CONTROL SOURCE switches (whether in Local Mass Storage or System Bus), the PV Tests may be run as follows:

a. Cycle AC input power to the development station OFF and then back to ON. The station will now perform a self test which will be displayed on the CRT when completed.

b. After the self test has been completed, press keyboard [CNTRL] and [RESET] keys simultaneously. Performance Verification Display Test pattern will appear on the CRT and the soft key label line will display:

| pv tests | | | diag | | | | | | | | | | | end tests |
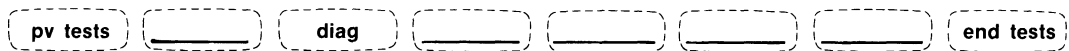
c. Accomplish steps b, c, and d as outline above for the PV Tests method using the rear panel PERFORMANCE VERIFICATION switches.

Chapter **3**

Clustered Configurations

Introduction

The cluster-based 64000 Development System typically consists of at least one development station with a local mass-storage unit installed, a compatible HP hard disc, and a printer. The system may be expanded to accommodate larger design teams or multiple design efforts by adding up to five more development stations in a daisy chain configuration.

This chapter discusses the development station as a master controller in a cluster system along with the associated discs and printer. Topics discussed are:

- Master Controller Configuration

- System Bus

- Disc Installation

- Disc Initialization

- Printer Installation

- Adding Development Stations

Master Controller Configuration

General
The Master Controller has responsibility for initializing the bus at power up, bus error recovery, and resistive line termination. Prior to connecting the Master Controller to the System Bus, accomplish the Performance Verification routine described in Chapter 2.

In a clustered system with only one development station, the station must be configured as the master controller.

NOTE

In a multistation development system, only the end development station can be designated as the master controller.

In any power-up sequence of a multistation system, the master controller must be turned on and must be left on whenever system operation is desired.

NOTE

If it becomes necessary to perform maintenance on the master controller station, reconfigure another development station as master and move it to one end of the bus. Make sure the original master controller is removed from the bus.

Model 64100A Master Controller

On the rear panel of the instrument is a set of switches labelled "MASTER" and "SLAVE" (see figure 3-1). When all switches are engaged at the top of the switch row, the station is configured as the Master Controller. When all switches are engaged at the bottom of the switch row, the station is configured as a slave station.
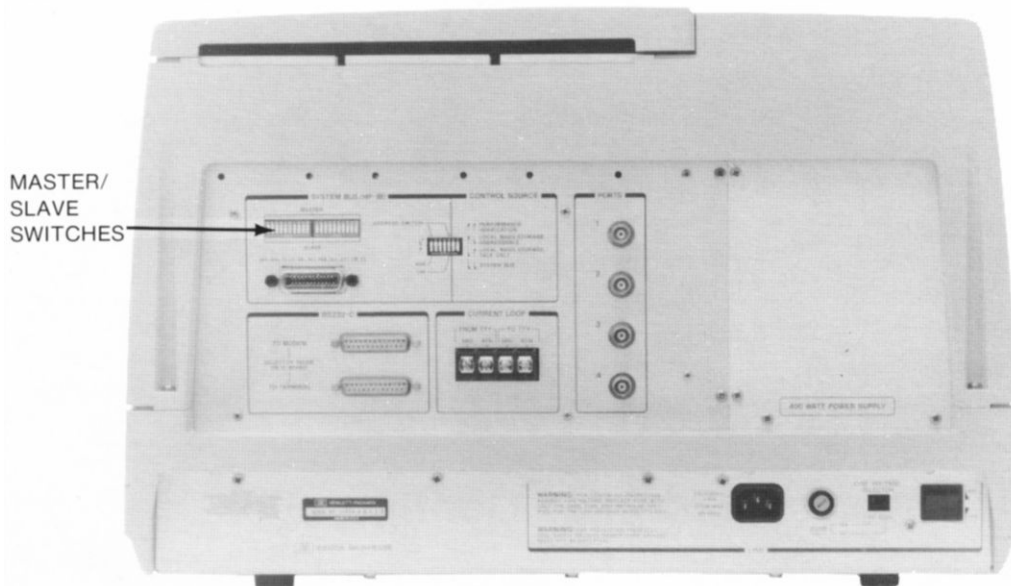
Figure 3-1. Rear Panel MASTER/SLAVE Switches

Model 64110A Master Controller

On the CPU/IO card in the 64110A are two IC sockets labelled MASTER and NORMAL (see figure 3-2). Associated with these sockets is a set (2) of moveable resistor networks that are used to designate the station as either a Master Controller or as a slave station. When the two resistor networks are plugged into the IC socket labelled MASTER, the station is configured as a Master Controller. When the two resistor networks are plugged into the IC socket labelled NORMAL, the station is configured as a slave station.
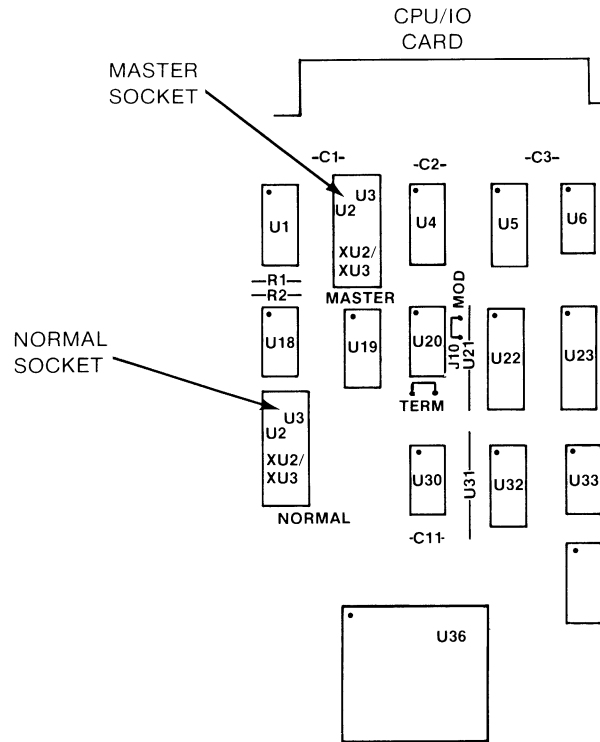
Figure 3-2. CPU/IO Card MASTER/SLAVE IC Sockets

System Bus

General Interconnect Information

The System Bus connector (figure 3-3) provides the necessary interface between the station and other components in the system. Maximum distance for the interconnection is 20 metres (65 ft), except in systems with only one development station and one hard disc drive, in which case the maximum distance is 18 metres (59 ft).

Each 64000 Development Station and some Hard Disc Drives are supplied with a two-metre cable (see 64000 System Selection and Configuration Guide). A 64000 system printer is not supplied with a cable. Additional HP-IB cables are available in lengths from one-half to four metres for customers who require special configurations (see table 3-1).

Table 3-1. HP-IB Cables

Model No.	Description
10833A	1-Metre HP-IB Cable, shielded
10833B	2-Metre HP-IB Cable, shielded
10833C	4-Metre HP-IB Cable, shielded
10833D	0.5 Metre HP-IB Cable, shielded

MODEL 64110A   **MODEL 64100A**

SYSTEM BUS
CONNECTOR
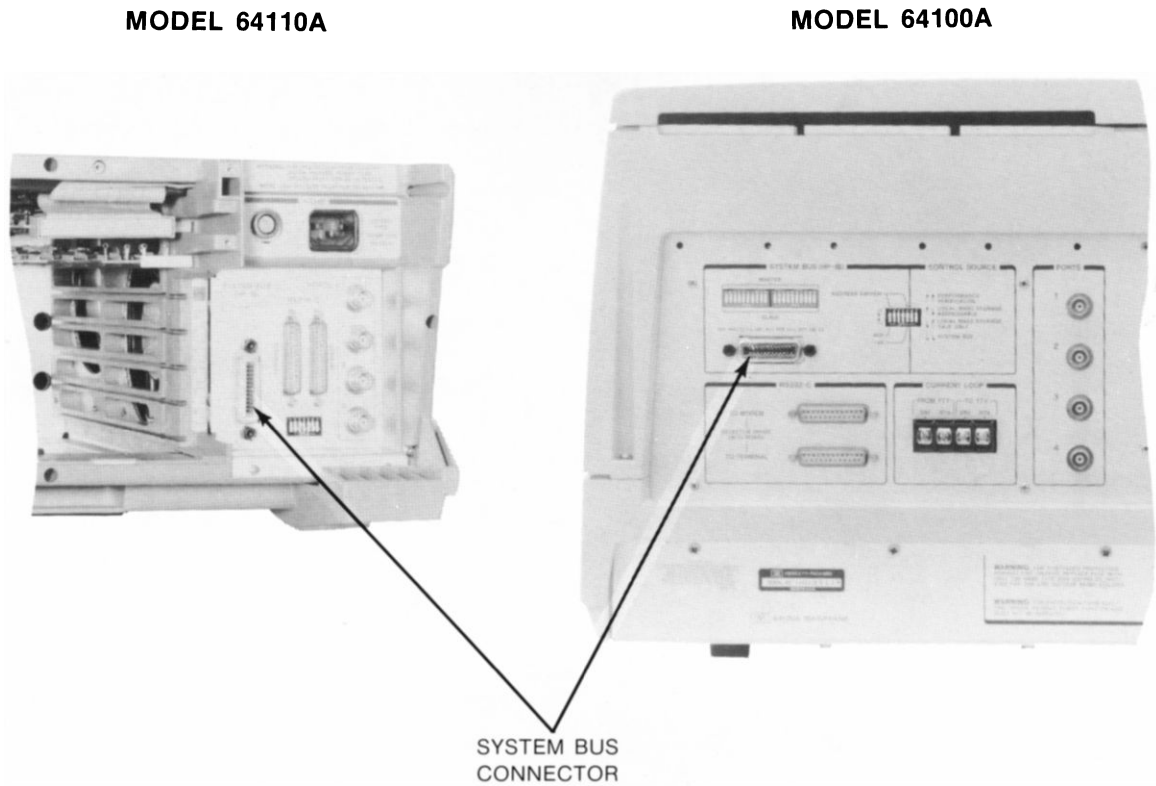
Figure 3-3. System Bus Connector

NOTE

Although the cable(s) used to interconnect instruments in a clustered 64000 System are HP-IB cables, do not interpret the System Bus as being an HP-IB bus. When operating in a cluster, only those items specified for the Model 64000 Logic Development System may be connected to this bus. For information concerning HP-IB, refer to Chapter 5 in this manual.

Bus Connections

Figure 3-4 shows the standard bus connection. In order for these components to communicate with one another, each must have its own unique address. In a cluster configuration there can be no more than two interface cables connected at one point. Star connections (3 cables connected at one point) are not allowed in the Model 64000.
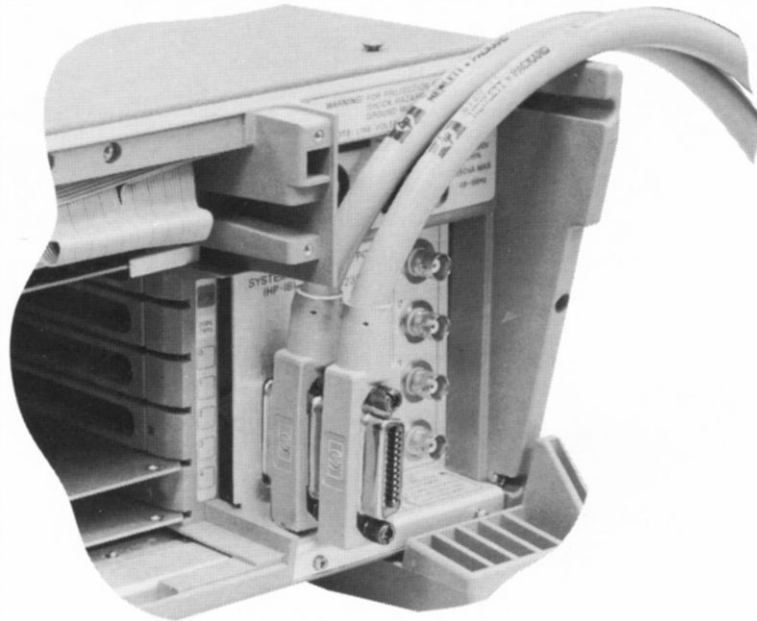
Figure 3-4. Standard Bus Connections

Bus Addressing

The ADDRESS SWITCH on the rear panel provides a unique identifier for each component in the system. This allows efficient intercommunications between components.

The main system hard disc must always have a System Bus (HP-IB) address setting of 0. The printer must have an address of 1. Each development station must have a unique address setting from 2 through 7. Table 3-2 gives the address settings for the development station(s).

Table 3-2. Development Station Address Switch Setting

Address	MSB				LSB	
0	0	0	0	0	0	
1	0	0	0	0	1	
2	0	0	0	1	0	
3	0	0	0	1	1	Valid
4	0	0	1	0	0	Development
5	0	0	1	0	1	Station
6	0	0	1	1	0	Addresses
7	0	0	1	1	1	

For cluster systems having more than one disc, the second (or more) disc may be assigned any address within the range of 2 through 7. If a printer is not included within the cluster, the address range for the second disc is 1 through 7.

Disc Installation

General

A 64000 System hard disc provides high-speed storage capacity for system software and user files. It may be connected to any number of development stations (1 to 6) and a printer to form a shared data base cluster.

Disc Models 7908P, 7911P, and 7912P have an integrated streaming tape unit for backup. These discs may be mixed on the same cluster. However, since each disc drive takes up one of the eight available System Bus addresses, any added disc requires giving up (potentially) an additional development station or the printer.

Disc Models 7906M, 7920M, and 7925M discs are from Hewlett-Packard's Multi-Access Controller (MAC) family. These discs may be mixed with each other on a cluster, but they may not reside on a cluster with a Model 7908P, 7911P, or 7912P. The MAC discs may share the disc controller (so that only one System Bus address is used), thus allowing the maximum of six stations and a printer with up to eight disc drive units.

Disc Model 9134A Option 010 is a 5 1/4-inch, 4.86 Mbyte Winchester disc. It may function as the bus disc for a small cluster or for expanding single station storage. The 9134A/Opt 010 cannot be mixed with the Models 7908P, 7911P, and 7912P. Each additional 9134A/Opt 010 takes up one available bus address.

Software Requirements

When a system is configured with a hard disc, software is required for initialization and formatting. Software is supplied by either tape cartridge or flexible disc media. The software supplied is described in the following paragraphs.

Tape Cartridge. Depending on system configuration, a minimum of three cartridge tapes will be supplied. The tapes will be labelled as follows:

a. OP SYSTEM
   1 of

This tape is required for hard disc intialization and formatting.

b. OP SYSTEM
   2 of

This tape contains operating system utilities.

c. OP SYSTEM
   3 of

This tape contains additional operating system utilities.

The three tapes must be booted in numerical order for hard disc formatting. If additional tapes are supplied, they may be down-loaded in any numerical order.

Flexible Disc. A minimum of three flexible discs are supplied for an operating system. The discs are labelled as follows:

a. OP SYSTEM
   1 of

This disc is used to initialize and format a hard disc.

b. OP SYSTEM
   2 of

This disc contains operating system utilities.

c. OP SYSTEM
   3 of

This disc contains additional system utilities.

The three flexible discs must be booted in numerical order for hard disc formatting. If additional discs are supplied, they may be downloaded in any numerical order.

Disc Interconnection

To connect a disc to the system proceed as follows:

a. Disconnect disc from primary power source (LINE).

b. Verify that the disc drive voltage selection is set for the correct line voltage and that the correct size fuse is installed.

c. Set disc HP-IB address selector (and UNIT SELECT for MAC discs) to address 0.

NOTE

For systems having more than one 7908P, 7911P, 7912P, or 9134A/Opt 010 disc installed, the second disc address may be any bus address in the range of 2 through 7. If a line printer is not included as part of the system, the second disc address may be any bus address in the range of 1 through 7.

d. Using an HP-IB cable, connect the disc to the 64000 System Bus at the development station configured as the Master Controller. See figure 3-4 for standard bus connection.

e. Apply primary power to disc.

f. Allow approximately 30 to 60 seconds for the disc to come up to operating speed and complete self test (if provided). If disc fails self test, refer to the Disc Installation Manual.

Disc Initialization

NOTE

Disc intialization and system software load can only be accomplished from a development station set as master controller and with a tape or flexible disc drive unit installed.

To complete formatting and loading of the hard disc, proceed as follows:

a. Set CONTROL SOURCE switches on rear panel of master controller station to either LOCAL MASS STORAGE position.

NOTE

Ensure that all other development stations in the cluster are turned OFF.

b. Install OP SYSTEM Tape #1 or Flexible Disc #1 into the master controller media transport (tape drive or flexible disc drive).

c. Apply LINE power to master controller station.

d. After boot operation, the development station CRT will display:

```
                    SYSTEM DISC UTILITY


   If soft fix is run the printer (if any) should remain on.

   format......Format the disc

   test........Test the disc

   fmt&tst.....Format the disc and test. Mark defective tracks

   soft fix....Fix file linkages

   diag........Perform disc self test

   menu........Redisplay this menu


   STATUS:Awaiting selection _____

        format   test   fmt&tst   soft fix   diag   menu _____ end
```
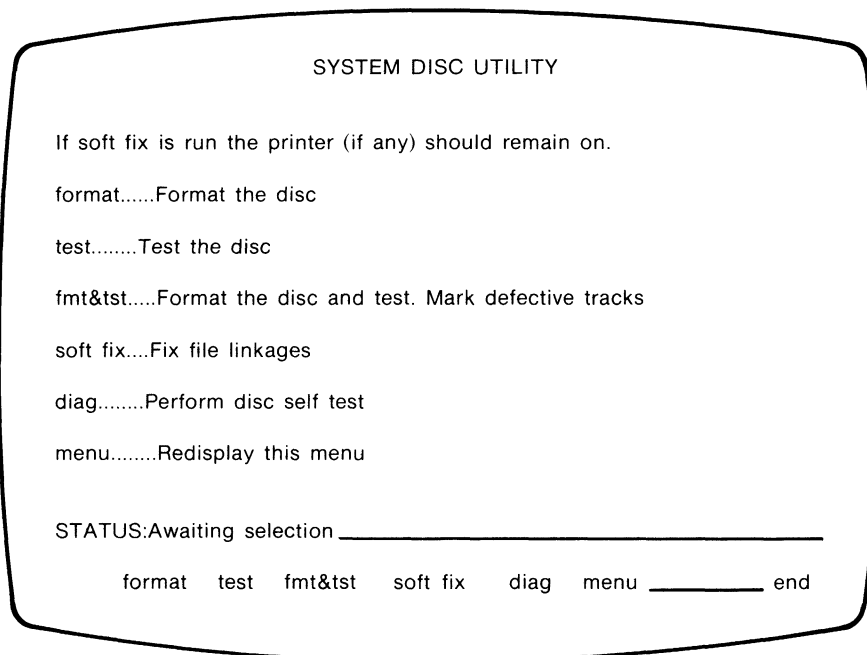
e. Press ⌈fmt & test⌋ soft key. After several moments the CRT display will appear similar to the following:

```
ADRS        DEVICE, CURRENT SYSTEM BUS CONFIGURATION
  0         7908 DISC MEMORY, UNIT=0
            WITH TAPE OPTION, UNIT=1
  1         2608 PRINTER
  7         THIS 64000




STATUS: Selecting Disc Operation_____
7908 DISC DRIVE AT ADDRESS 0 UNIT 0              NOT PREVIOUSLY
                                                FORMATTED
WARNING FORMATTING causes the permanent loss of all information now stored
in the disc memory. DO YOU WANT TO FORMAT?


     no    _____  _____  _____  _____  _____  _____    yes
```
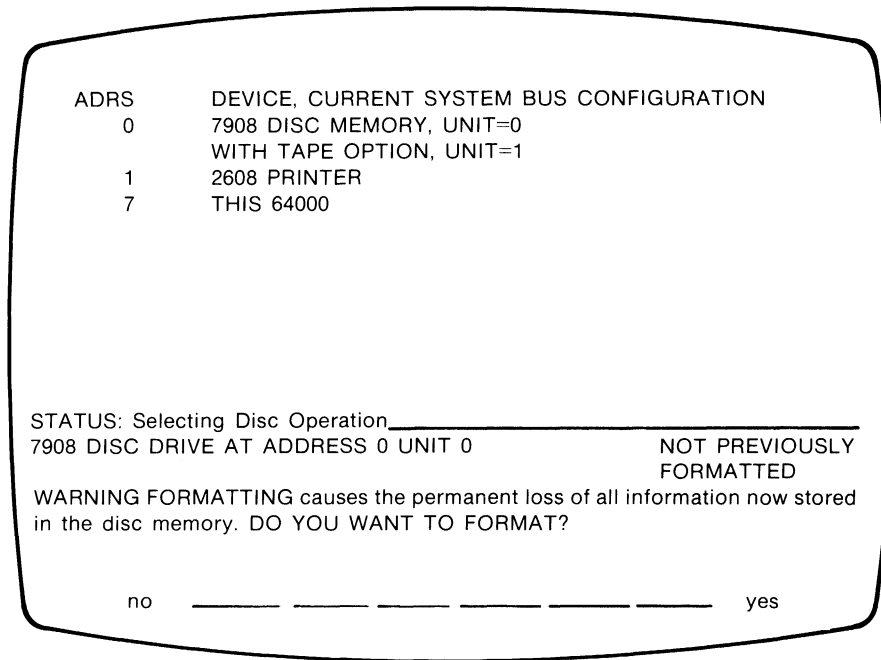
f. Press [**yes**] soft key. The system will now format all bus disc tracks. The system

writes a file directory and builds a free list of available pages for future file storage. The progress of the disc formatting procedure will be displayed on the CRT STATUS line. For example:

STATUS: Formatting tracks

.

.

.

STATUS: Testing disc

.

.

.

STATUS: Building free list

.

.

This formatting procedure takes approximately 30 minutes to complete (dependent upon particular bus disc model).
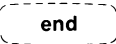
NOTE

For test, format, soft fix, and diag utilities refer to the Service
Overview Manual.

g. After the free list is built and the disc verified, the CRT soft key line will again display:

| format | test | fmt&tst | soft fix | diag | menu | | end |
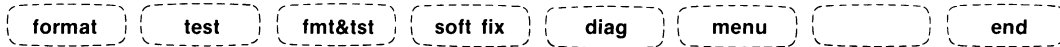
This allows the user to select additional tests or diagnostics.

h. If no further tests or diagnostics are required, press the [end] soft key. The

system will now request for optional software. The CRT will display the following:

```
                    System software load is complete

To load any optional software insert the tape (disc)

To run the system just loaded, connect all peripherals and additional HP 64000s
then set the rear panel "SYSTEM CONTROL SOURCE" switches to the "SYSTEM
BUS" mode
```
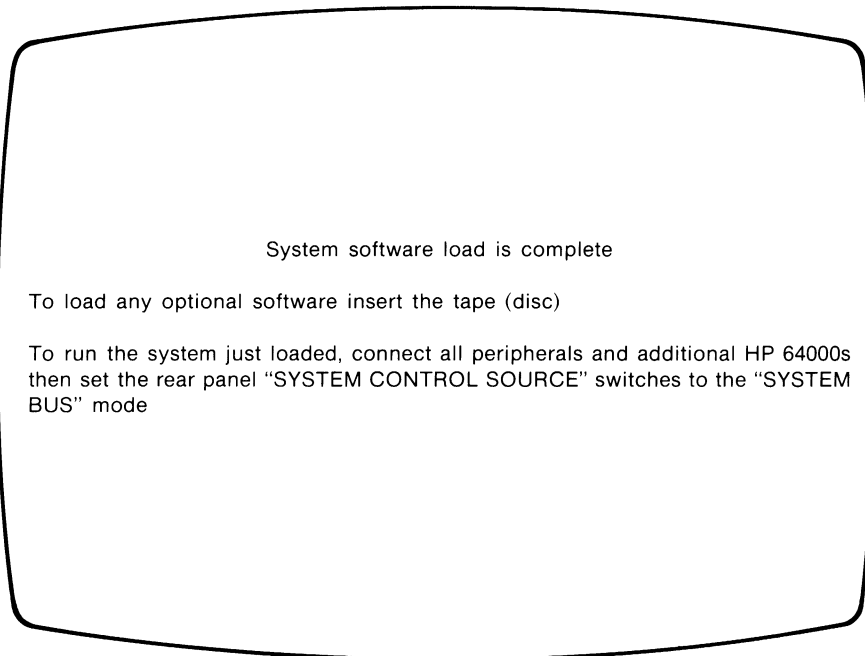
i. Remove OP SYSTEM tape or flexible disc #1 from the media transport. Insert OP
SYSTEM tape or flexible disc #2 into the media transport. The system will
automatically boot the system utility programs.

j. Continue inserting additional tapes or flexible discs in numerical order into the media
transport. After all tapes (flexible discs) have been booted, set the rear panel "SYSTEM
CONTROL SOURCE" switches to the "SYSTEM BUS" mode of operation. The system
is now operational.

Printers

General
For hard-copy output, three options are available. Depending on the required performance and hard-copy load, the choices range from a portable thermal printer to a high-speed printer.

Only a single printer may be configured on the System Bus; additional RS-232-C printers may be connected to individual stations to provide local output.

Printer Interconnection
To connect a printer to the system proceed as follows:

a. Disconnect line printer from primary power source.

b. Verify that the printer voltage selection is set for the correct line voltage and that the proper size fuse is installed.

c. Set line printer HP-IB address selector to address 1.

d. If the system printer has Listen Always (LA) and Service Request (SRQ) switches, ensure that the switches are set to OFF (0) positions.

e. Using an HP-IB cable connect printer to 64000 System Bus at one development station (or at the bus disc). See figure 3-4 for standard bus connection. (Note: Master Controller station must be on one end of System Bus.)

f. Apply primary power to line printer.

g. Initiate printer self test. If printer fails self test refer to the Printer Installation Manual.

h. Set line printer for ON LINE operation.

Adding Development Stations

When adding development stations, set the first station in the cluster string to act as master controller; set up all other stations as slave stations as follows:

a. Set station to slave configuration as follows:

(1). Model 64100A:

(a). Set MASTER/SLAVE switches on rear panel of instrument to SLAVE positions.

(2). Model 64110A:

NOTE

The 64110A is shipped from the factory with the resistor networks installed in the NORMAL IC socket. If the resistor networks have not been moved to the MASTER IC socket, step a below is not necessary.

(a). Plug resistor networks into NORMAL IC socket on CPU/IO card.

b. Run development station performance verification (see Chapter 2).

c. Set SYSTEM (SYS) BUS (HP-IB) ADDRESS SWITCH (rear panel of instrument) to next appropriate address.

d. Connect System Bus cable to next component (see figures 3-3 and 3-4).

NOTE

The master controller station must be on one end of the entire bus system (refer to "System Bus" in this chapter).

e. Turn slave station power ON.

f.   Simultaneously press [SHIFT] and [RESET] keyboard keys on the master controller
station.

NOTE

The display should show the System Bus configuration with
the new station recognized by address. If a "DEVICE NOT
RECOGNIZED" message is issued for the particular address,
rerun the Performance Verification. If the problem still exists,
contact the appropriate service personnel.

g.   When all development stations are on line, the entire system is operational.

Chapter **4**

Stand-alone Configuration

Introduction

General

The two development stations, Model 64100A and Model 64110A, may be configured either in a cluster or as stand-alone stations, suitable for a particular design and/or analysis needs. The 64110A has integral dual 5 1/4-inch flexible disc drives installed as standard equipment. The 64100A has an optional dual flexible disc or tape cartridge unit for local mass storage. To operate as a stand-alone station, the 64100A must have the flexible disc option installed.

The minimum 64000 System consists of the Model 64110A Development Station with application modules in a stand-alone configuration. This configuration is designed primarily for those users who want emulation, software development, or software and hardware analysis in a portable, programmable system along with the capability to expand by adding various options to their systems.

Stand-alone Operation

Boot-up Operation

To boot-up either the Model 64100A or 64110A proceed as follows:

a. Accomplish Performance Verification function as described in Chapter 2.

b. Set CONTROL SOURCE switches on rear panel of station to either LOCAL MASS STORAGE ADDRESSABLE or LOCAL MASS STORAGE TALK ONLY position (see figure 2-5).

NOTE

Selection of either LMS ADDRESSABLE or LMS TALK ONLY will depend on HP-IB requirements (see Chapter 5). If there are no HP-IB requirements either LMS selection will function properly for stand-alone operation.

c. Install OPERATING SYSTEM floppy #2, furnished with the software, into station as follows:

(1)Install Operating System disc into flexible drive LU=0 (see Chapter 3 for description of software furnished).

(2)Install additional flexible disc(s) (system option(s)) into flexible drive LU=1.

d. Apply power to the unit. The station will automatically boot and perform a self-test program. The CRT will display

Self-test Completed

at the end of the program. The station is now available for use.

For specific operations - state analysis, timing analysis, or emulation - refer to the appropriate Reference Manual. For HP-IB operation refer to Chapter 5 in this manual.

NOTE

The user may configure his own set of bootable flexible discs. Refer to the Flexible Disc Drive Reference Manual for instructions.

HP-IB

Introduction

General

As a stand-alone station, the 64000 has the capability of being remotely controlled over the Hewlett-Packard Interface Bus (HP-IB). HP-IB is Hewlett-Packard's implementation of IEEE Standard 488 (1978), Digital Interface for Programmable Instrumentation. As a stand-alone instrument, the 64000 does not act as a controller.

The Hewlett-Packard Interface Bus is a general purpose digital interface system that simplifies the design and integration of instruments and computers into systems. For the user who is not familiar with the Hewlett-Packard Interface Bus refer to Appendix A for a brief introduction.

This chapter discusses the development station in an HP-IB environment. Topics discussed are:

- 64000 HP-IB Interface Capabilities
- HP-IB Interface Connection
- HP-IB Address Selection
- Remote Operation - Measurement Functions
- Command Files
- Output to the HP-IB
- File Input
- Remote Operation of the Display
- Programmable Service Request
- Status Report
- Parity
- Device Clear

Model 64000 HP-IB Interface Capabilities

Interface functions are predefined capabilities which are designed into an HP-IB device. The following list of bus functions indicate the interface capabilities of a stand-alone 64000 station:

Code	Interface Function
SH1	Complete source handshake
AH1	Complete acceptor handshake
T1	Complete talker including: basic talker, serial poll, and talk only mode.
L2	Complete listener; no "listen only"
SR1	Programmable service request and serial polling capability
RL2	Remote/local - no "local lockout"
PP0	No parallel polling capability
DC1	Device clear capability
DT0	No group execute trigger
C0	No controller capability

NOTE

Ensure that the 64000 station is configured as a SLAVE station when operating in an HP-IB environment. It is not designed to function as an HP-IB Master Controller. As indicated previously (Chapter 3), the 64110A is shipped from the factory configured as a SLAVE station. If the resistor networks have been moved, reconfigure the station for SLAVE operation.

Interface Connections

HP-IB System Interface Connection

The 64000 is connected to the interface bus by connecting an HP-IB interface cable to the rear-panel SYSTEM BUS (HP-IB) connector. As many as 15 instruments can be connected to the same interface bus.

The connector, mounting, and cabling specifications of the interface define a flexible cabling system for interconnecting HP-IB devices. Devices can be interconnected in STAR, LINEAR, or in a mixed configuration (see figure 5-1).

NOTE

Although there is no restriction to the way cables may be connected together, it is recommended that no more than 3 to 4 piggy-back connectors be stacked together on one device. The resulting configuration can exert great force on the device's panel where the connector is mounted and could cause mechanical damage.

STAR or LINEAR
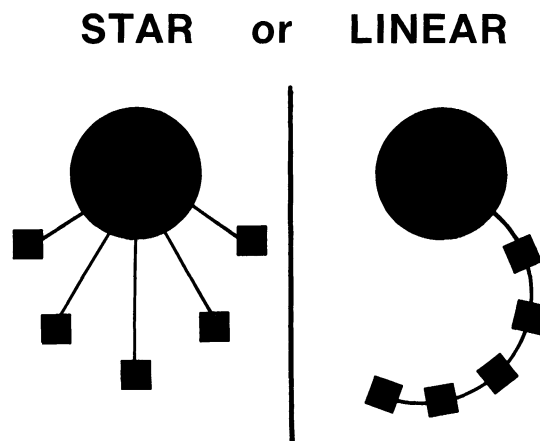
Figure 5-1. Cabling Configurations

HP-IB Address Selection

Every device on an HP-IB system has at least one address which is used by the active controller in the COMMAND MODE to specify who talks (by way of a Talk Address) and who listens (by way of Listen Addresses). The address for a 64000 station is selected by setting the five SYSTEM BUS (HP-IB) ADDRESS SWITCHes, located on the rear panel, to the desired address. The decimal equivalent of the 5-bit address selected by the switches determine the station's address on the interface and can be from 0 thru 29 inclusive (see table 5-1).

In addition to setting the HP-IB ADDRESS switches, the user must also set the CONTROL SOURCE switches on the rear panel of the station to either LOCAL MASS STORAGE ADDRESSABLE or LOCAL MASS STORAGE TALK ONLY positions. When the CONTROL SOURCE switches are set for LOCAL MASS STORAGE ADDRESSABLE, the station can be addressed by an active controller to function as either a talker or a listener. When the CONTROL SOURCE switches are set for LOCAL MASS STORAGE TALK ONLY, the station functions as a talker only.

NOTE

Two address codes are used to tell every device to UNTALK (-) or UNLISTEN (?). Therefore, device address 31 (decimal value) as listed in table 5-1 is illegal. In addition, address 30 is used for the identify sequence. Therefore, the maximum usable address set totals 30 (zero base, or addresses 0 through 29).

Table 5-1. Talk/Listen Addresses

| Addr Switch No. | | | | | Addr Characters | | Octal | Decimal |
| MSB | | | | LSB | | | Value | Value |
5	4	3	2	1	Talk	Listen		
0	0	0	0	0	@	SP	00	00
0	0	0	0	1	A	!	01	01
0	0	0	1	0	B	"	02	02
0	0	0	1	1	C	#	03	03
0	0	1	0	0	D	$	04	04
0	0	1	0	1	E	%	05	05
0	0	1	1	0	F	&	06	06
0	0	1	1	1	G	'	07	07
0	1	0	0	0	H	(	10	08
0	1	0	0	1	I	)	11	09
0	1	0	1	0	J	*	12	10
0	1	0	1	1	K	+	13	11
0	1	1	0	0	L	,	14	12
0	1	1	0	1	M	_	15	13
0	1	1	1	0	N	.	16	14
0	1	1	1	1	O	/	17	15
1	0	0	0	0	P	0	20	16
1	0	0	0	1	Q	1	21	17
1	0	0	1	0	R	2	22	18
1	0	0	1	1	S	3	23	19
1	0	1	0	0	T	4	24	20
1	0	1	0	1	U	5	25	21
1	0	1	1	0	V	6	26	22
1	0	1	1	1	W	7	27	23
1	1	0	0	0	X	8	30	24
1	1	0	0	1	Y	9	31	25
1	1	0	1	0	Z	:	32	26
1	1	0	1	1	[	;	33	27
1	1	1	0	0	\	<	34	28
1	1	1	0	1	]	=	35	29
1	1	1	1	0	<	>	36	30
1	1	1	1	1	-	?	37	31

Remote Operation - Measurement Functions

General

When the station is operating standalone with a flexible disc, the rear panel HP-IB port is freed for HP-IB protocol and the commands:

copy <FILE> to hpib

and

copy hpib to <FILE>

are permitted. In addition, transmitting any normal 64000 command over the bus system will result in that command being executed just as if it had been typed in. All commands transmitted must be terminated with an ASCII line feed (0AH).

Normal error messages displayed in keyboard operation are displayed under HP-IB operation.

Command Files

It is also possible to evoke command files over the HP-IB system. Command files are source files, created in the 64000 edit mode or by using the log command, consisting of valid system commands to be executed in sequence. Command files provide a convenient method of passing parameters and a method of structuring a series of commands to be evoked with a minimum of key strokes (refer to the System Software Reference Manual for Command File Syntax).

If insufficient parameters are passed when a command file is called, an error message will be issued and the command file call will be aborted. In normal keyboard operation, this error results in prompts for the missing parameters.

If a command file call is in progress at the time the HP-IB goes remote, the command file will run unless an error is encountered (i.e. wrong number of parameters passed). In this instance, the result depends on the exact timing of the events. The command file may retain control until all parameters have been defined and then run, or it may terminate (abort) as described above.

Outputs to the HP-IB

The monitor command:

copy <FILE> to printer

will result in the ASCII output of the selected file. If the file is non-ASCII, e.g., link_com, it will be translated before output. The output will be formatted in such a manner that an ASCII printer will print the result. The last character transmitted will be an ASCII form feed (0CH). The EOI signal (pin 5 of the HP-IB connector) will be set on this character. If the file is to be returned to the 64000, the last byte (0CH) should not be sent since it is not part of the file.

The monitor command:

copy <FILE> to hpib

will result in the identical output of ASCII files that occurred under the command:

copy <FILE> to printer

Non-ASCII files will be available in internal 64000 formats. The last byte transmitted in non-ASCII files will be a 0. The EOI signal will be set on this character. This byte (0) is part of the file and must be sent back to the 64000 if the file is returned.

Outputs from the 64000 are transmitted at approximately 4.5K bytes/sec. If a disc access is required, the output transmission rate will be reduced.

File Input

The monitor command:

copy hpib to <FILE>

will cause the HP-IB data to be written to the designated <FILE>. The file formats are the same as those for output files (see above). Each line in a text file must be terminated with an ASCII line feed (0AH). Carriage returns may be sent with the line feed, but they have no effect on the file contents.

Lines which exceed 240 characters in length will be separated into multiple records internally. No data will be lost.

Non-text files must be in proper 64000 internal format. Each record begins with a length word which must contain the length of the preceding record in the high order byte and the length of the current record in the low order byte. The file is terminated by a zero length record which must be present for this mode to terminate normally.

The <FILE> input must be terminated by one of three special conditions:

a. End or Identify (EOI) line must be set.

b. Transmission of ASCII End of Text character (03H).

c. Transmission of ASCII End of Transmission character (04H).

NOTE

End or Identify (EOI) and one of the terminating characters
(03H or 04H) is also acceptable.

Inputs to the 64000 are received at approximately 4K bytes/sec. If a disc access is required, the input rate will be reduced.

When in remote operation, all keyboard keys are inoperative, except for the reset key.

Remote Operation of the Display

The 64000 station display may be operated remotely by sending an ASCII escape character (1BH) followed by the letter "D" and a two-byte offset. The 16-bit value (two bytes) of the offset must lie between 0 and 19*80-1 (19 lines by 80 columns in the display area).

All characters transmitted after the escape character, letter "D", and offset will be written directly on the display beginning at the offset specified. All eight bits of the character transmitted are sent to the display; therefore, display enhancements may be used.

NOTE

If text is being transmitted with parity checks, the parity bit
will transform those characters into enhancement characters.
Enhancement characters are as follows:

1 0 U I X X B X

where:
    U = 1 for underlining.
    I = 1 for inverse video.
    B = 1 for blinking.
    Any combination of the above is valid.

Input which overflows the screen buffer will be sent to the command buffer. Although this will garble the next command sent over the HP-IB, this method of handling the overflow allows the user to see what overflowed and what needs to be done to correct it.

An ASCII End of Text character (03H) will terminate the remote operation of the display.

Sending an ASCII escape character (1BH) followed by the letter "B" will cause the station beeper to beep.

Programmable Service Request

Service requested can be programmed using the ASCII escape character (1BH) followed by the letter "M" and a mask byte. The bits within the mask byte are as follows:

bit	condition
0	awaiting command
1	command error
2	trace complete

A "1" in a given bit position enables the corresponding function to cause a service request. A "0" disables the function request. At power-on, the default condition is all bits set to "0" (no service request).

Status Report

Transmitting an ASCII escape character (1BH) followed by an "S" will request a status report. A byte will be returned indicating which service request functions have become active since the last status report. The bits in this byte are the same as those in the mask byte listed above in the service request paragraph.

Parity

In most operating modes, the incoming datum is masked to 7 bits. Parity bits are therefore ignored. Binary input and writing to the display are exceptions. In these modes, the high order bit is significant and care must be taken to ensure that parity bits are not used.

Device Clear

The Device Clear (DC) interface function provides the station with the capability of being cleared (initialized) by the controller. The HP-IB standard Device Clear commands are used. This will cause a complete reboot except for HP-IB interface conditions, that is, the DC signal affects only station functions and does not affect other interface functions (cleared by IFC).

<div align="right">

Chapter **6**

RS-232-C

</div>

Introduction

This chapter discusses the RS-232-C interconnection of a 64000 station with external equipment. Topics discussed are:

- Mechanical Interface
- Electrical Interface
- Input/Output Card Switch Identification
- Development Station Requirements
- Copy Command Conventions
- Terminal as a Talker/Listener
- Modem as a Talker/Listener
- Current Loop Operation
- Executing Remote Monitor Commands

RS-232-C/Current Loop Communications

EIA RS-232-C Interface Standard

The RS-232-C Interface specifies a 25-pin connector as the standard interface in data communication networks, with specific pin assignments for ground, data, control, and timing circuits. The interface also specifies the mechanical and electrical requirements of an interface, within an operating range of 0 to 19,200 bps in bit-serial operation. It provides a common meeting ground, allowing interaction between many types of equipment and manufacturers, providing greater flexibility in the selection of equipment for data communication networks.

Mechanical

The signal interface between the Data Communications Equipment (DCE), usually a modem, and the Data Terminal Equipment (DTE), usually a remote terminal or data processor, is located at the RS-232-C-specified connector located between equipment. Cables less than 15 metres (50 ft) are recommended for interconnection. Longer cables may be used provided the load capacitance is suitable. The development station pin assignment shown in table 6-1 must be used. Figure 6-1 is the Development Station RS-232-C/Current Loop Schematic. Figure 6-2 is the RS-232-C/Current Loop Interface.

Electrical

Except for protective and signal grounds, all circuits carry bipolar low-voltage signals suitable for electronic circuits. All voltages are measured at the connector with respect to signal ground (pin 7) and cannot exceed +/−25 V. The significance of the bipolar signals is summarized in table 6-2, with the region between +/−3 V defined as the transition region.

While RS-232-C designates 23 circuits, the number actually in use depends upon the type of equipment connected.

Table 6-1. Development Station RS-232-C Interface Connector Pin Assignments

Signal Direction		Pin Number	Circuit	Description
Development Station	Modem			
		1	shield gnd	Protective Ground
———————▶		2	TXD	Transmitted Data
◀———————		3	RXD	Received Data
———————▶		4	RTS	Request to Send
◀———————		5	CTS	Clear to Send
		6	DSR	Data Set Ready
		7	signal gnd	Signal Ground (common return)
◀———————		8	CARDET	Carrier Detect
		9	---	unassigned
		10	---	unassigned
		11	---	unassigned
		12	---	unassigned
		13	---	unassigned
		14	---	unassigned
		15	TXCLK	Transmit clock
		16	---	unassigned
		17	RXCLK	Receive clock
		18	---	unassigned
		19	---	unassigned
———————▶		20	DTR	Data Terminal Ready
		21	---	unassigned
		22	---	unassigned
		23	---	unassigned
		24	---	unassigned
		25	---	unassigned

Figure 6-1. Development Station RS-232-C/Current Loop Schematic

MODEL 64110A   **MODEL 64100A**

RS-232-C   SERIAL I/O
CONNECTORS   PORTS

RS-232-C   TTY CURRENT   SERIAL I/O
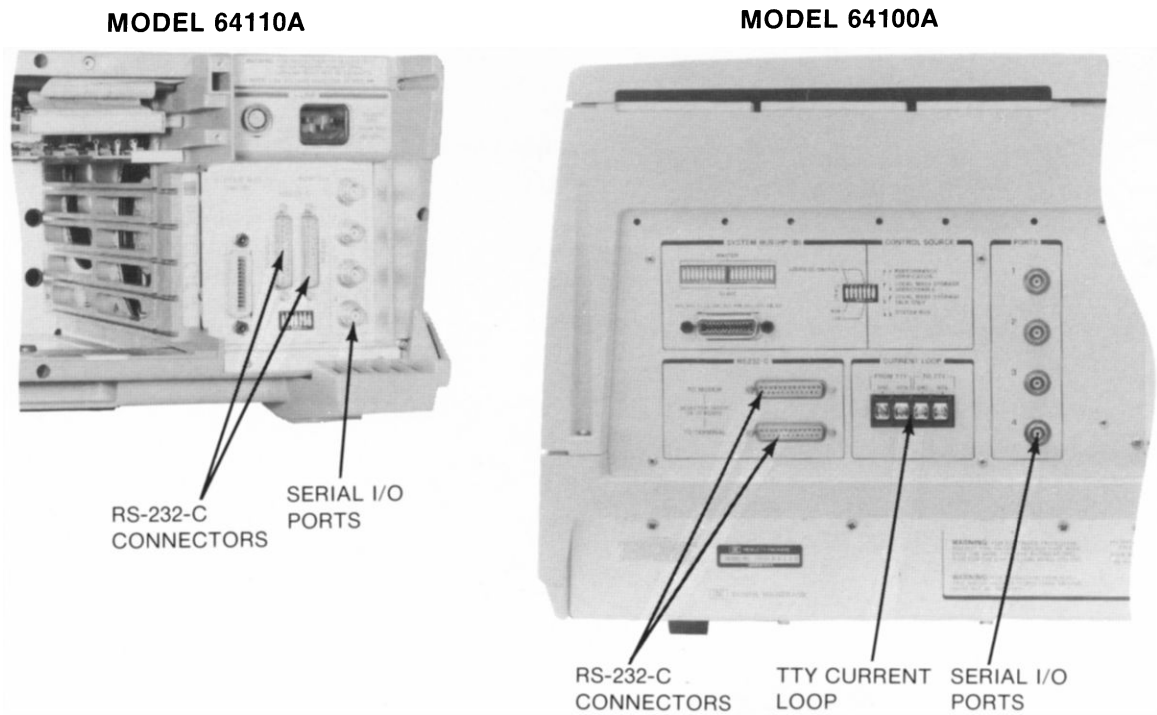CONNECTORS   LOOP   PORTS

Figure 6-2. RS-232-C/Current Loop Interface

Table 6-2. EIA RS-232-C Interface Voltages

		Negative voltage (−3 to −25)	Positive voltage (+3 to +25)
Data Circuits	Binary State	1	0
	Signal Condition	Mark	Space
Control Circuits		Off	On

RS-232-C Communication Considerations

Model 64100A

The Model 64100A provides for asynchronous serial communication between the station and external communications devices. Communication is controlled by five switches on the I/O card (first card in the card cage). Figure 6-3 shows the location of five switches. Table 6-3 shows the required switch positions to evoke the appropriate serial communications.

Switch S1 is set to either 20 mA or 60 mA depending on the Current Loop requirements.

Switch S2 provides for internal receive or transmit clock selection.

Switch S3 selects Current Loop or RS-232-C operation. Switch S4 is an 8-bit multifunction switch. Table 6-4 shows the individual bit functions and the settings required to obtain these functions.

Bits 2 thru 5 of Switch S5 control the baud rate (see table 6-5). Bit 1 controls the Request to Send (RTS) line. It determines whether the line is toggled between a one or a zero or is tied high (+12V). Bit 1 is set to zero to toggle RTS and set to 1 to tie the line high.
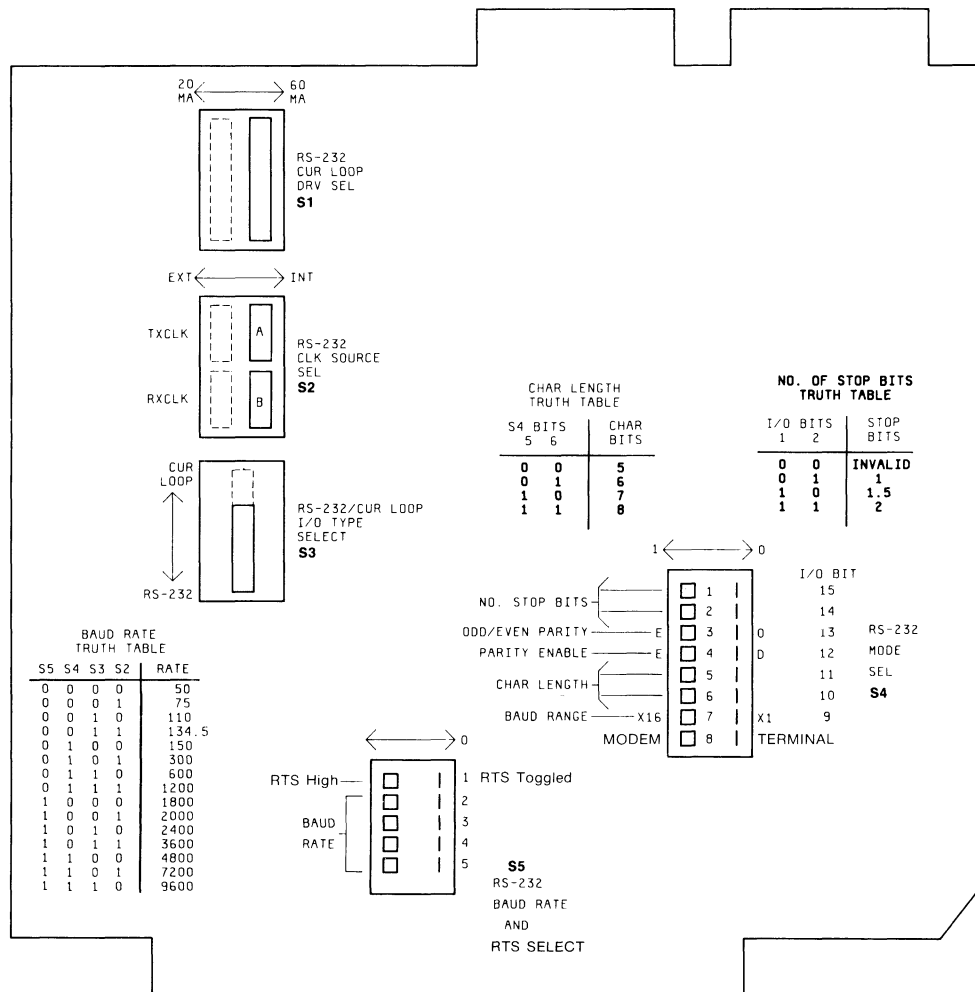
20 MA ← → 60 MA

RS-232
CUR LOOP
DRV SEL
S1

EXT ← → INT

TXCLK   A

RXCLK   B

RS-232
CLK SOURCE
SEL
S2

CUR LOOP ↑↓ RS-232

RS-232/CUR LOOP
I/O TYPE
SELECT
S3

CHAR LENGTH
TRUTH TABLE

S4 BITS 5 6		CHAR BITS
0	0	5
0	1	6
1	0	7
1	1	8

NO. OF STOP BITS
TRUTH TABLE

I/O BITS 1 2		STOP BITS
0	0	INVALID
0	1	1
1	0	1.5
1	1	2

BAUD RATE
TRUTH TABLE

S5	S4	S3	S2	RATE
0	0	0	0	50
0	0	0	1	75
0	0	1	0	110
0	0	1	1	134.5
0	1	0	0	150
0	1	0	1	300
0	1	1	0	600
0	1	1	1	1200
1	0	0	0	1800
1	0	0	1	2000
1	0	1	0	2400
1	0	1	1	3600
1	1	0	0	4800
1	1	0	1	7200
1	1	1	0	9600

1 ← → 0

I/O BIT

NO. STOP BITS — 1   15
2   14
ODD/EVEN PARITY — E   3   0   13   RS-232
PARITY ENABLE — E   4   D   12   MODE
CHAR LENGTH — 5   11   SEL
6   10   **S4**
BAUD RANGE — X16   7   X1   9
MODEM   8   TERMINAL

RTS High — 1 RTS Toggled
2
BAUD 3
RATE 4
5 **S5**
RS-232
BAUD RATE
AND
RTS SELECT

Figure 6-3. Model 64100A I/O Card Switch Identification

Table 6-3. Model 64100A I/O Switch Functions

Switch	Position	Name	Functions
S1		Current Loop Drive Select	Selects Appropriate current loop operation if
	left	20 mA	current loop selected.
	right	60 mA	
S2	left	Ext clock select	Provides clock selection.
	right	Int clock select	
S3	up	Current Loop operation	Selects current loop or RS-232C ASYNC operation.
	down	RS-232 operation	
S4	See Table 6-4	Mode Select	Selects Terminal/Modem, Stop Bit Qualifier, Parity and Character length.
S5	See Table 6-5	Baud Rate	Selects baud rate (bit 2 to 5). Selects RTS function (bit 1).

Table 6-4. Model 64100A S4 Bit Functions

Bit	Function	Comments
1 (msb) 2	# of stop bits	00 = invalid, 01 = 1 bit 10 = 1 1/2 bits 11 = 2 bits
3 4	Odd/even Parity Parity enable/ disable	1 = even, 0 = odd 1 = enable, 0 = disable
5 (msb) 6	Word (Character) Length	00 = 5 01 = 6 10 = 7 11 = 8
7 8	Clock Mode Modem/Terminal	1 or divide by 16 MODEM/TERMINAL Select

Table 6-5. Model 64100A S5 Baud Rate Selection

Baud Rate	Switch Position			
	S5 Bits			
	MSB			LSB
	5	4	3	2
50	0	0	0	0
75	0	0	0	1
110	0	0	1	0
134.5	0	0	1	1
150	0	1	0	0
300	0	1	0	1
600	0	1	1	0
1200	0	1	1	1
1800	1	0	0	0
2000	1	0	0	1
2400	1	0	1	0
3600	1	0	1	1
4800	1	1	0	0
7200	1	1	0	1
9600	1	1	1	0

Model 64110A

The Model 64110A functions similarly to the Model 64100A except for the Current Loop facility which is not provided. Like the 64100A, the 64110A provides asynchronous serial communications between the station and external communications devices. Communications is controlled by two switches on the RS-232/Flexible Disc Control card and a jumper on the CPU/IO card (see figure 6-4 for switches and jumper locations). Table 6-6 describes the switches (S1 and S2) and the jumper on the CPU/IO card.

Table 6-6. Model 64110A RS-232-C Switch Identification

Switch	Position	Name	Function
S1	See Table 6-5	Baud Rate	Selects baud rate (bits 2 to 5). Selects RTS function (bit 1). (Same function as S5 on Model 64100A I/O Card.)
S2	See Table 6-7	Mode Select	Selects Stop Bit Qualifier, Parity, Character length, and Baud Range.
J10 Jumper	Mod or Term	Modem/Terminal	When jumper installed in J10 MOD position, "To Peripheral" interconnection effective. When jumper installed in J10 TERM position, "To Modem" interconnection effective.

Table 6-7. Model 64110A S2 Bit Functions

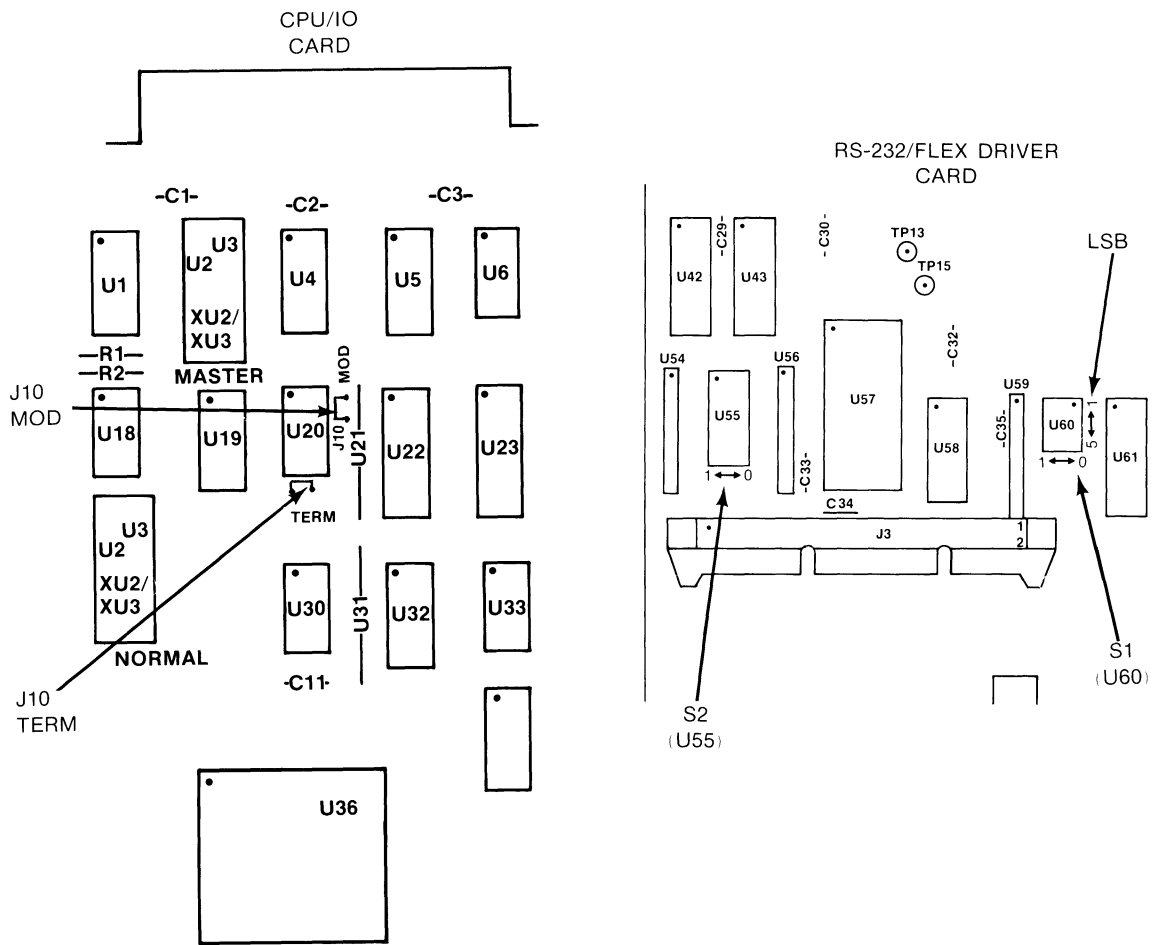| Bit	Function	Comments
1 (msb) 2	# of stop bits	00 = invalid, 01 = 1 bit 10 = 1 1/2 bits 11 = 2 bits
3 4	Odd/even Parity Parity enable/ disable	1 = even, 0 = odd 1 = enable, 0 = disable
5 (msb) 6	Word (Character) Length	00 = 5 01 = 6 10 = 7 11 = 8
7	Clock Mode	1 or divide by 16
8	No connection	

Figure 6-4. Model 64110A RS-232-C Switch Locations

Development Station RS-232-C Requirements.

The development station can receive and transmit any file type supported by the 64000 using the copy command. Source and listing files are transferred in a manner different than the other file types.

When operating at 1200 baud or below, it is not necessary that hand-shake protocol be used, as no loss of information will occur. Above 1200 baud it is mandatory that the handshake protocol be observed.

When receiving source or listing files, the station looks for a carriage return, line feed, or any combination of a carriage return and a line feed, as the end of the record.

When receiving other file types, the following sequence must be adhered to in order for the station to process the data.

   a. First byte is the number of words in the record.

   b. Record

   c. Last byte is the checksum of the data in the record (excluding the word count and the checksum).

The length of a record must be 1 to 128 bytes.

Errors encountered during RS-232-C communications will be displayed as:

   checksum=xxx, parity=xxx, size=xxx, overrun=xxx

To terminate the file, a record beginning and consisting solely of EOT (binary 4) is expected for source files or a null (binary 0) for other file types. If the system has received an end of record, no other information is received, and the system will automatically time out after 10 seconds.

Copy Command Convention

General

The copy command is used to move a file from one destination to another. When moving files through the RS-232-C link, refer to the System Software Reference Manual for Copy Command Syntax.
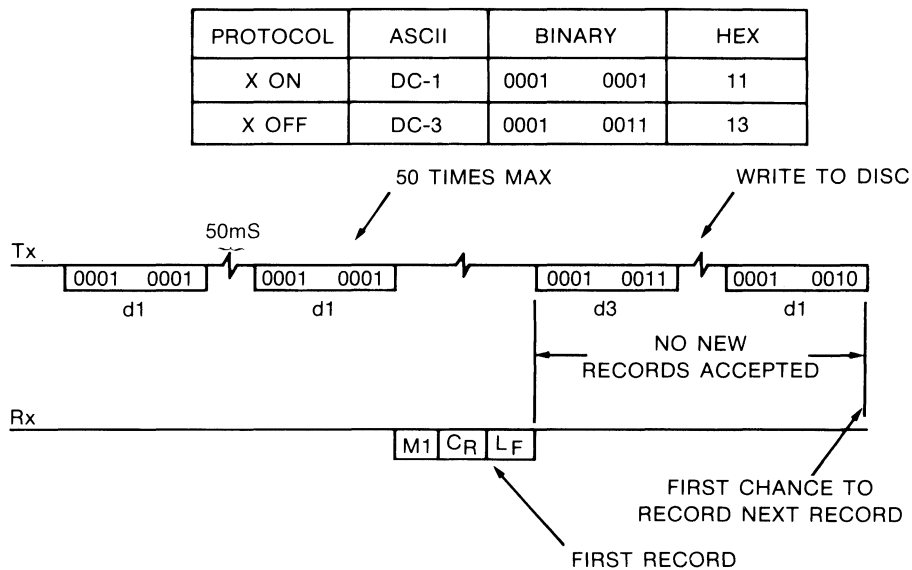
NOTE

For information concerning Terminal Mode operation on RS-232-C refer to the System Software Reference Manual.

Software Handshake Conventions

In receive mode, the 64000 will output an XON (ASCII DC-1) until data is received. Also, after each record is read, it will generate an XOFF (ASCII DC-3) while storing the record followed by an XON to signal ready. If used, this can allow the 64000 to run at maximum speed; otherwise, 1200 baud is the maximum advised speed.

In transmit mode, the 64000 will listen to the XON/XOFF convention described above. Once an XOFF is received it will wait for an XON before it continues to transmit. This convention is not necessary, and if it is not used, transmission will continue as if the receiving end.can maintain the selected baud rate. Software handshake timing is shown in figure 6-5.

PROTOCOL	ASCII	BINARY		HEX
X ON	DC-1	0001	0001	11
X OFF	DC-3	0001	0011	13

NOTE: RECEIVER TIMES OUT (AFTER 10 SECONDS). TIMER WILL BEGIN ONLY AFTER FIRST RECORD IS RECEIVED.

INITIATED COPY RS-232 TO <FILE>

Figure 6-5. Software Handshake Timing

Development Station as Terminal Talker (see figures 6-6 and 6-7).

Syntax: **copy** <FILE> to rs232

Equipment Connection:
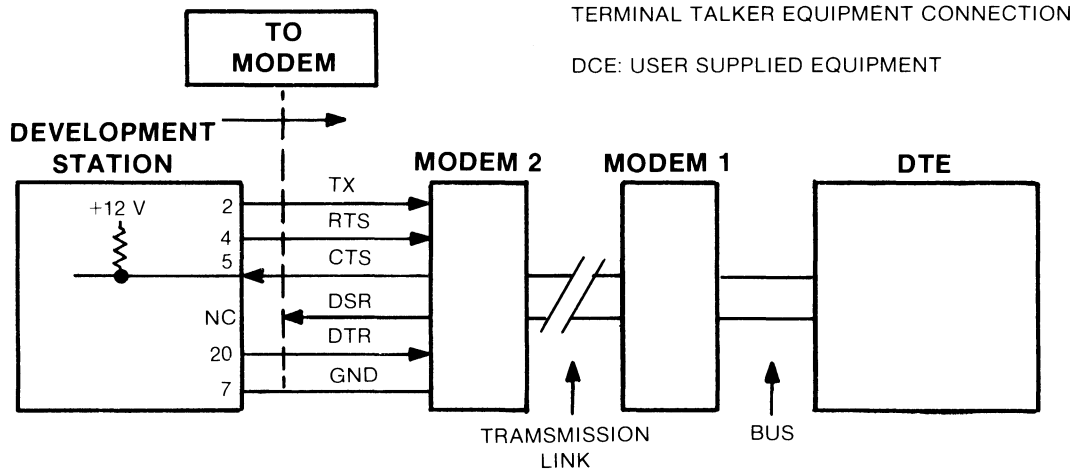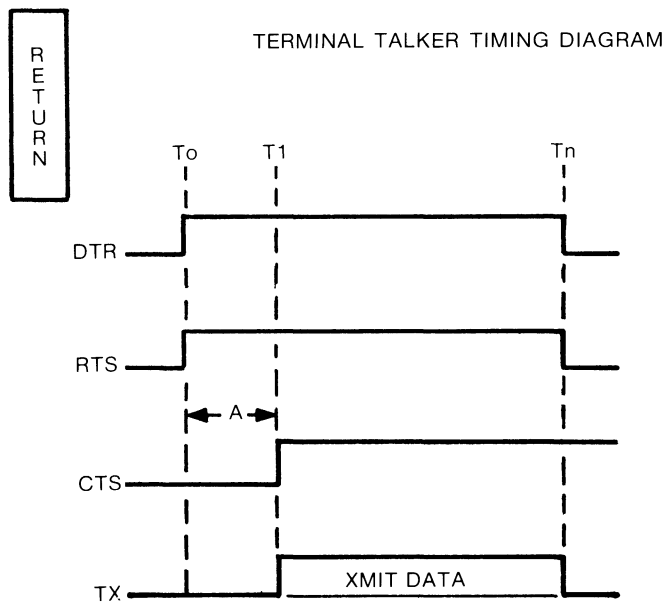

Figure 6-6. Terminal Talker Equipment Connection

Figure 6-7. Terminal Talker Timing Diagram

Sequence of Major Events

a. The modem DSR line is not connected to the development station and therefore DSR is ignored as an input.

b. When [RETURN] is pressed (T0), the RTS and DTR line goes true (+12V).

NOTE

RTS can be set true (+12V) at all times by setting Bit 1 to a logical "1" on Switch S5 (Model 64100A) or Switch 1 (Model 64110A).

c. The development station will not send data until CTS is raised true. Modem sets CTS true (T1).

NOTE

The development station TXD output (pin 2) idles in a marking state (logical "1", -12V) between transmission. In the event a CTS line is not connected to the development station, an internal pull-up circuit will bias the CTS input to +12V. This automatically results in a constant CTS true.

d. The development station transmits data; user's DTE receives data.

e. When data transmission ends (TN), RTS line goes false.

Development Station as Terminal Listener (see figures 6-8 and 6-9).

Syntax: **copy** rs232 to <FILE>

Equipment Connection:
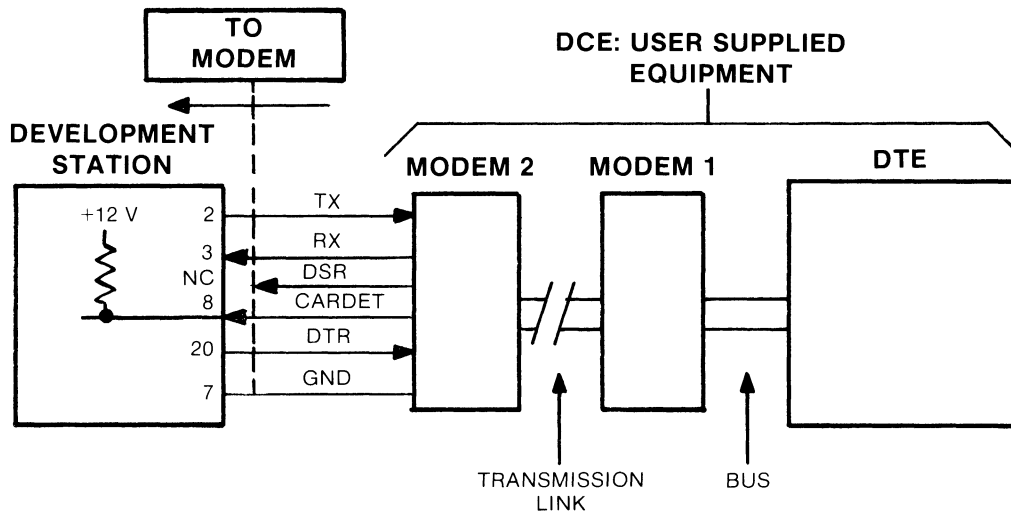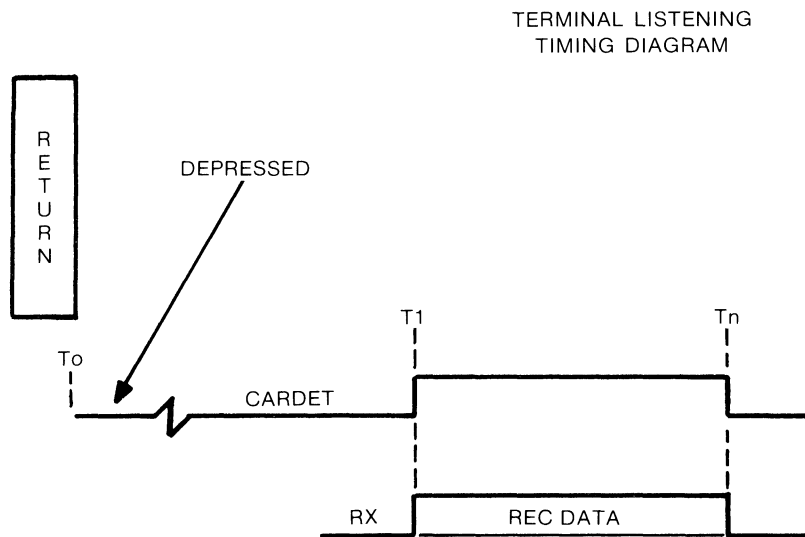

Figure 6-8. Terminal Listener Equipment Connection

Figure 6-9. Terminal Listener Timing Diagram

Sequence of Major Events

a. At T0, the [RETURN] key is pressed indicating a desire to receive data.

b. At T1, user modem 2 detects carrier and provides a CARDET true single. The development station senses CARDET. This true is required for the development station to receive data.

NOTE

If no connection to CARDET exists, an internal pull-up circuit automatically sets CARDET true (+12V). This results in the development station being in a constant state to receive data.

---

c. At the end of the received message (T1), the modem drives CARDET false and the development station input is disabled.

Development Station as Modem Talker (see figures 6-10 and 6-11).

Syntax: **copy** <FILE> to rs232
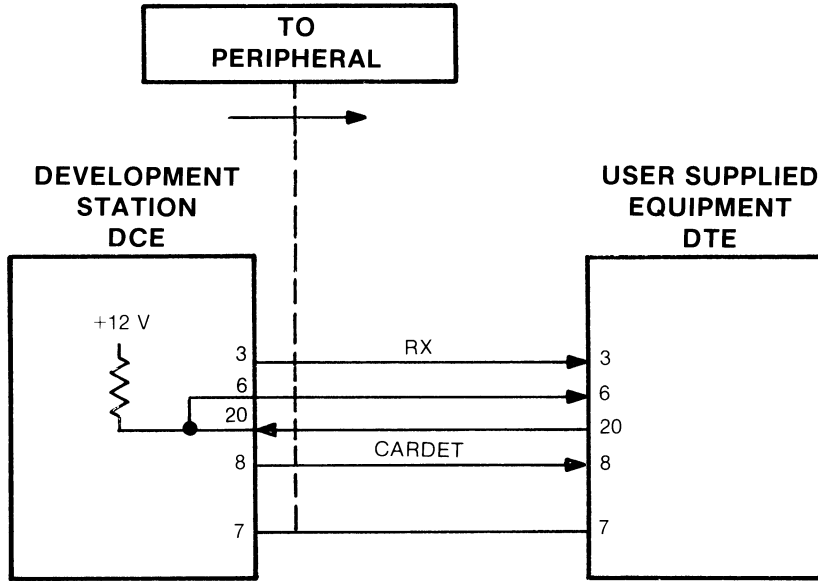
Equipment Connection:
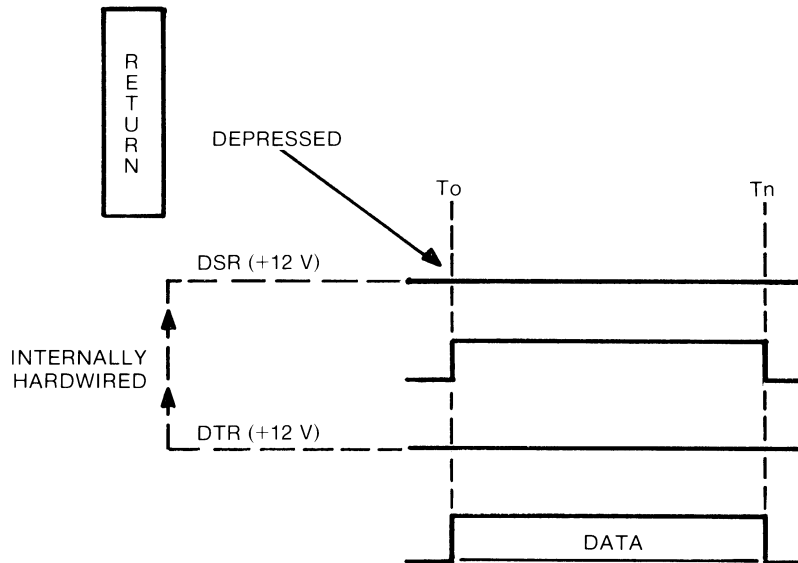

Figure 6-10. Modem Talker Equipment Connection

Figure 6-11. Modem Talker Timing Diagram

Sequence of Major Events

a. DTR is true from user's DTE. DSR is provided to the DTE by returning DTR.

NOTE

If no connection to DTR exists, DTR is set true (+12V) by an internal pull-up circuit.

---

b. When ⌈R E T U R N⌋ (T0) is pressed, a true CARDET is given the DTE.

The development station instantaneously begins data transmission which is outputted on Pin 3 (RX).

NOTE

The CARDET signal is generated by the development station. The development station requires a true DTR signal to transmit. If no connection is made to DTR, the DTR line is set true by an internal pull-up circuit.

---

c. CARDET is lowered (false) following completion of transmitted message (TN).

NOTE

The development station will place RX data (Pin 3) in a steady mark state (−12V) between messages.

Development Station as Modem Listener (see figures 6-12 and 6-13).

Syntax: **copy** rs232 to <FILE>
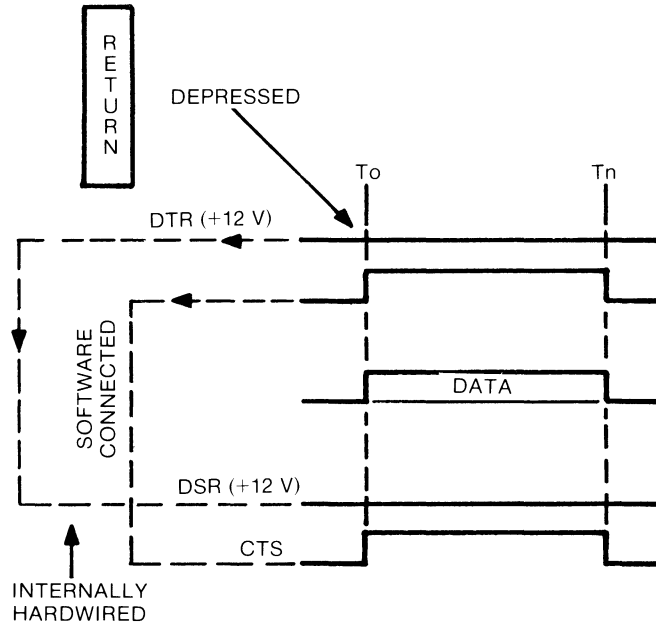
Equipment Connection:

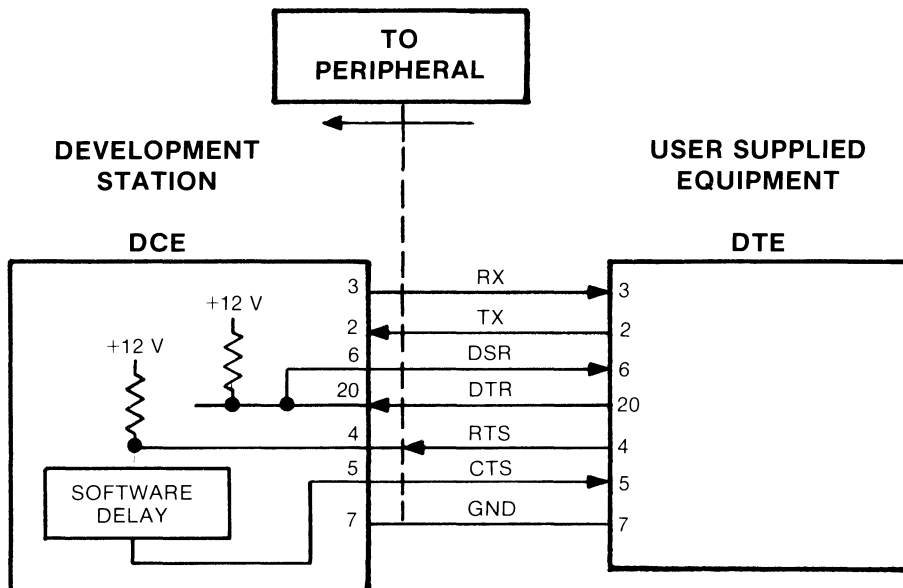

Figure 6-12. Modem Listener Equipment Connection

Figure 6-13. Modem Listener Timing Diagram

Sequence of Major Events

a.   DTE DTR line true (+12V). Development station connects DTR to DSR, effectively returning the DTE's own DTR signal as DSR. If DTR is not connected, an internal pull-up circuit will raise DSR to +12V automatically.

b.   DTE RTS signal goes true. RTS signal (T0) is received by the station and results in a software driven CTS true.

<div align="center">NOTE</div>

The RTS-CTS turn around is an automatic software function performed by the station. Duration of the RTS to CTS delay is approximately 100 ms (maximum).

If no RTS connection exists, an internal pull-up circuit will automatically result in a true CTS signal applied to the DTE.

---

c.   DTE equipment transmits and the station receives data on Pin 2.

d.   At TN, DTE RTS goes low (false) and data transmission ends. The station CTS goes low and xmit data terminates.

Current Loop Operation (Model 64100A Only)

The 64000 System operates to and from a TTY by using the same commands used in RS-232-C operation:

copy <FILE> to rs232

copy rs232 to <FILE>

The only differences are in the switch settings on the I/O card. To operate with a TTY, set S1 to 20 mA or 60 mA. Set S3 to ILOOP. Set S4 function (table 6-4), number of stop bits, parity, character length, etc., and S5 (table 6-5) to desired position.

When a current loop is used to interface a station with a computer system, the devices are usually connected by two separate electrical loops, with a constant supply of current driven through each loop. One of the loops is used to transmit data from the station to the computer while the other is used by the computer to send data to the terminal (figure 6-14). In general, the computer provides the current source required by each of the interface loops.

Conceptually, a current loop operates as follows. To transmit data to the terminal, the computer switches the current source of the appropriate loop off and on in accordance with the ones and zeros of the transmitted data. The station detects the changes in current by means of a "relay" and converts those relay signals back into usable data. The station transmits data by using a "switch" to interrupt the current flow in the loop which it uses for transmission. The computer, in turn, interprets the change in current flow as the transmitted data.
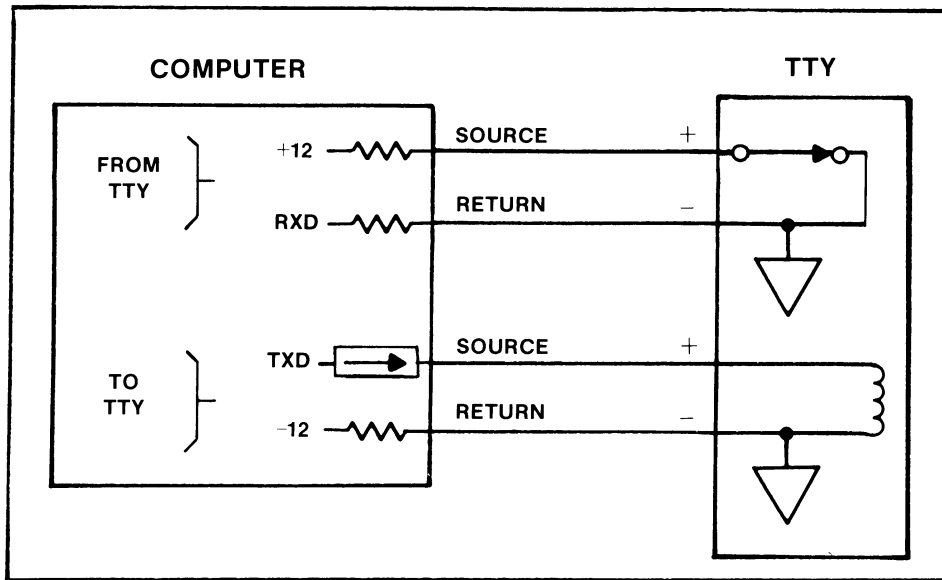

Figure 6-14. Current Loop Equipment Connection

The 64100A is an active device; it can supply the current requirements of both loops. The station can therefore interface successfully with a passive device, where a passive device is one that does not supply current to the loop. The connections necessary to interface the station to a passive device using current loop is shown in figure 6-15.
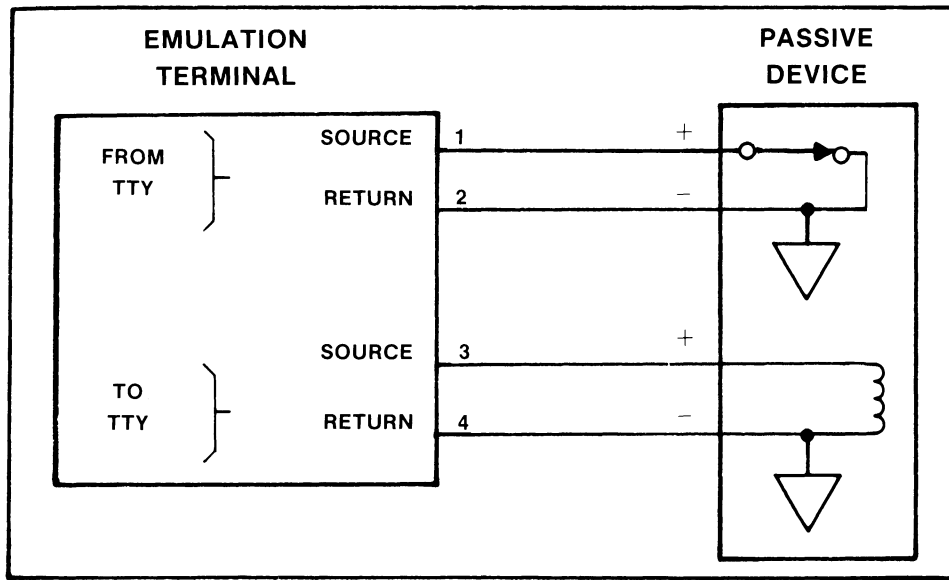
Figure 6-15. Current Loop Interface with a Passive Device

The station can also interface with another active device. In this case each device supplies current to one of the loops. Figure 6-16 shows this type of current loop.
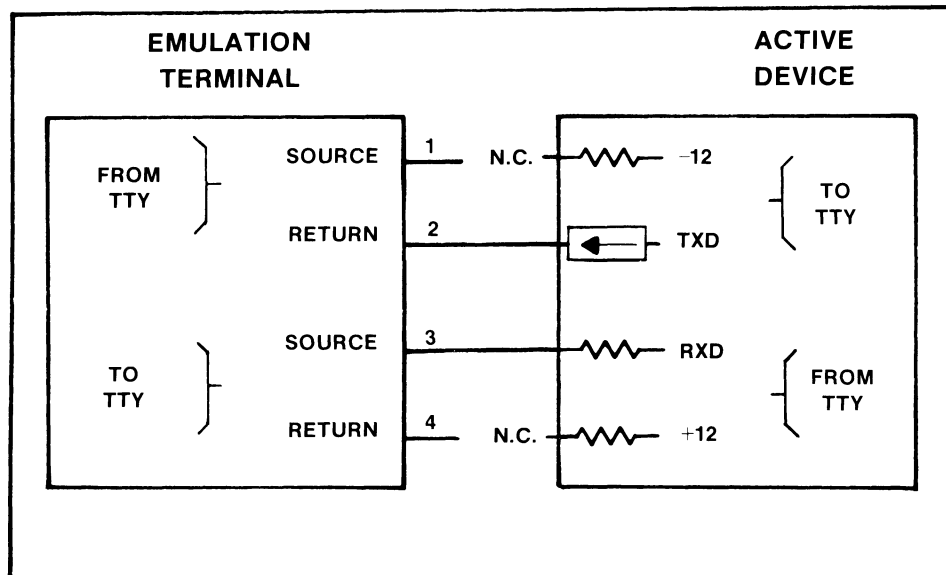

Figure 6-16. Current Loop Interface with an Active Device

Executing Remote Monitor Commands

When in Monitor mode, the operating system monitors the RS-232-C serial I/O port for monitor commands. If a command is received it will be executed, whenever possible, if it is in the proper format. There is a certain assumption that is made:

1. The serial communication link is a two-wire system. That is, only serial data transmit and serial data receive (plus ground) are used and control signals such as data terminal ready (DTR) are not used.

The serial data format assumes that an allowable monitor command is preceded by the backward slash (\). For example, to copy a file to the printer, the copy command becomes:

\copy NAME:source to printer

Note the backward slash (\) header. This command would be executed just as if it were typed in from the development station keyboard by the user. Note also that commands are executed in the order they are received.

It is possible to determine if the command was executed correctly by sending enquire (ENQ) to the system. There are two possible responses by the system to such an inquiry. These are:

1. Acknowledgement (ACK) which signals that the preceding command was successfully executed.

2. Negative acknowledgement (NAK) which signals that the preceding command was not successfully executed.

   Consider, for example, the following sequence of events: If a command is received on the serial port and is successfully executed, then an operator at the development station tries unsuccessfully to execute a Monitor command, then an ENQ is received over the serial port — the response will be NAK.

Remember, the response of ACK or NAK is to the last command. In the case of the above, the last command was the unsuccessful try at the console. Thus it is clear that when using the serial I/O port to execute Monitor commands and query the system, the individual using the serial port is responsible for determining whether the response of the system to an ENQ is valid or not.

Appendix **A**

Introduction to the HP-IB

General Information

Introduction

The Hewlett-Packard Interface Bus is a defined instrumentation interface which simplifies the integration of instruments, calculators, and computers into systems. It minimizes compatibility problems between devices and has sufficient flexibility to accommodate future products.

HP-IB applies to the interface of instrumentation systems in which the:

a. Data exchanged among the interconnected instruments is digital (as distinct from analog).

b. Number of devices that may be interconnected by one contiguous bus does not exceed 15.

c. Total transmission path lengths over the interconnecting cables does not exceed 20 metres or 2 metres per device, whichever is less (when not using a bus-extension technique).

d. Data rate across the interface on any signal line does not exceed 1 M byte/second.

The HP-IB employs a 16-line bus to interconnect up to 15 instruments. This bus is the sole communication link between the interconnected units. Each instrument on the bus is connected in parallel to the 16 lines of the bus. Eight of the lines are used to transmit data and the remaining eight are used for communication timing (handshake) and control.

Data is transmitted on the eight HP-IB data lines as a series of eight-bit characters referred to as "bytes". The meaning of each byte is arbitrary, being different for each type of instrument. Normally, a 7-bit ASCII code is used with the eighth bit available for a parity check, if desired. Data is transferred in a sequence, referred to as "HANDSHAKE". This sequence permits asynchronous communication over a wide range of data rates.

Communication between devices on the HP-IB employs the three basic functional elements listed below. Every device on the bus must be able to perform at least one of these functions:

a. LISTENER - A device capable of receiving data or commands from other instruments. Examples of this type of device are: printers, display devices, signal sources and the like.

b. TALKER - A device capable of transmitting data or commands to other instruments. Examples of this type of device are: tape readers, instruments that output data, etc.

c. CONTROLLER - A device capable of managing the various activities of the HP-IB such as addressing and so on. A calculator or computer with an appropriate I/O interface is an example of this type of device.

An HP-IB system allows only one device at a time to be an active talker. Up to 15 devices may simultaneously be listeners. Only one device at a time may be an active controller.

System Configuration

HP-IB Systems can be categorized into three types:

a. Systems with no controller - Include devices that can be set to a "Talk Only" or a "Listen Only" mode and are interconnected to operate together in a very basic system.

b. Systems with a single controller - The modes of data transfer for these systems are:

1). Direct transfer between talkers and listeners (Data Mode).

2). Transfer from a device to a controller (Data Mode).

3). Transfer from a controller to a device (Command Mode).

c. Systems with multiple controllers - The modes of data transfer for these systems are the same as those listed in subparagraph b. In addition, a method of passing control from one controller to another is required. One controller must be designated as the system controller. The system controller is the only device that can control the HP-IB lines designated IFC (Interface Clear) and REN (Remote Enable). When the system controller sets IFC low, all I/O operations cease and all talkers, listeners, and controllers are unaddressed. Control is passed to a different controller by addressing it as a talker and commanding it to "take control" (octal code 011).

Command Mode Operation

The HP-IB interface connector and bus structure are shown in figure A-1. The active controller manages all bus communications. The state of the ATN (attention) line, determined by the controller, defines how data on the eight data (DIO) lines will be interpreted by other devices on the bus. When ATN is low, the HP-IB is in the Command Mode. While in this mode, the controller is the only talker on the bus; all other devices are waiting for instructions. Instructions which may be issued by the Controller in "Command Mode" include:

a. Talker Address

   A 7-bit code transmitted on the HP-IB which enables a specific device to talk. Only one bus device at a time may act as the talker. When the controller addresses a unit to talk, the previous talker is automatically unaddressed and ceases to be a talker.

b. Listener Address

   A 7-bit code transmitted on the HP-IB which enables a specific device to listen. Several bus devices at a time may be listeners.

c. Universal Commands

   Bus devices capable of responding to these commands from the controller will do so at any time regardless of whether they are addressed. The commands are listed below:

Commands	Purpose
LLO (Local Lockout)	Disables front panel local-reset button on responding devices.
DCL (Device Clear)	Returns all devices capable of re-sponding to pre-determined states, regardless of whether they are addressed or not.
PPU (Parallel Poll unconfigured)	Sets all devices on the HP-IB to the Parallel Poll Idle State.
SPE (Serial Poll Enable)	Enables Serial Poll Mode on the bus.
SPD (Serial Poll Disable)	Disables Serial Poll Mode on the bus.

d. Addressed Commands

These commands are similar to universal commands except that they are recognized only by devices that are addressed as listeners. The addressed commands are listed below:

Commands	Purpose
SDC (Selective Device Clear)	Returns addressed devices, capable of responding, to pre-determined states.
GTL (Go to Local)	Returns responding devices to local control.
GET (Group Execute Trigger)	Initiates a simultaneous pre-programmed action by responding devices.
PPC (Parallel Poll Configure)	This command permits the DIO lines to be assigned to instruments on the bus for the purpose of responding to a parallel poll.
TCT (Take Control)	This command is given when the active controller on the bus transfers control to another instrument.

e. "Unlisten" address (command)

The UNL (Unlisten) command unaddresses all listeners that have been previously addressed to listen.

f. "Untalk" address (command)

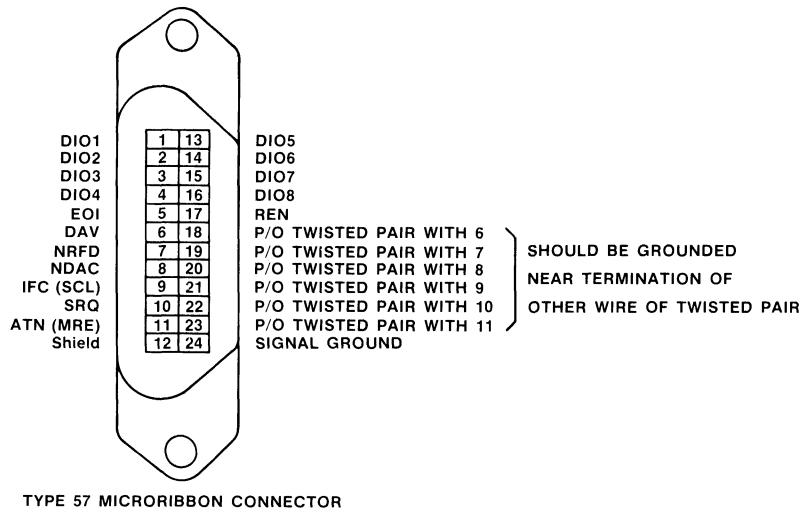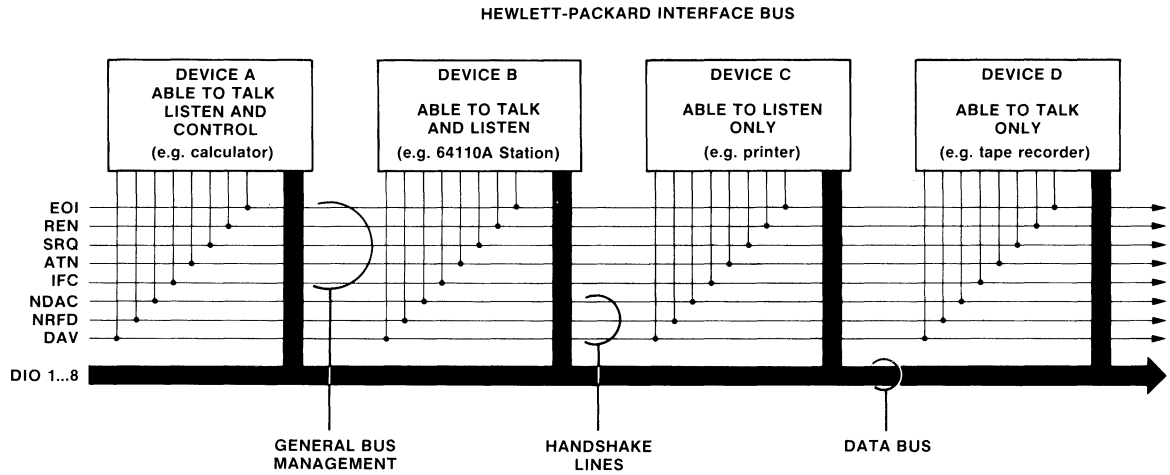The UNT (Untalk) command unaddresses any talker that had been previously addressed to talk.

HEWLETT-PACKARD INTERFACE BUS

DEVICE A	DEVICE B	DEVICE C	DEVICE D
ABLE TO TALK LISTEN AND CONTROL	ABLE TO TALK AND LISTEN	ABLE TO LISTEN ONLY	ABLE TO TALK ONLY
(e.g. calculator)	(e.g. 64110A Station)	(e.g. printer)	(e.g. tape recorder)

EOI
REN
SRQ
ATN
IFC
NDAC
NRFD
DAV

DIO 1...8

GENERAL BUS
MANAGEMENT

HANDSHAKE
LINES

DATA BUS

DIO1	1	13	DIO5
DIO2	2	14	DIO6
DIO3	3	15	DIO7
DIO4	4	16	DIO8
EOI	5	17	REN
DAV	6	18	P/O TWISTED PAIR WITH 6
NRFD	7	19	P/O TWISTED PAIR WITH 7
NDAC	8	20	P/O TWISTED PAIR WITH 8
IFC (SCL)	9	21	P/O TWISTED PAIR WITH 9
SRQ	10	22	P/O TWISTED PAIR WITH 10
ATN (MRE)	11	23	P/O TWISTED PAIR WITH 11
Shield	12	24	SIGNAL GROUND

SHOULD BE GROUNDED

NEAR TERMINATION OF

OTHER WIRE OF TWISTED PAIR

TYPE 57 MICRORIBBON CONNECTOR

Figure A-1. Interface Connector and Bus Structure

Data Mode Operation

When ATN (attention) goes high, the HP-IB is in "Data Mode". In this mode data may be transferred between devices that were addressed when the HP-IB was in "Command Mode". Messages that can be transferred in this mode include:

a. Programming Instructions

Codes are 7-bit bytes placed on the HP-IB data (DIO) lines. The meaning of each byte is device dependent and is selected by the equipment designer.

These types of messages are usually between the controller acting as the talker and a single device that has been addressed as a listener.

b. Data

Data codes are 7-bit bytes placed on the data lines. The meaning of each byte is device dependent. For meaningful communication to occur both the talker and listener must agree on the meaning of the codes they use.

Data Transfer

Each character byte transferred on the HP-IB data lines employs the three-wire (interlocked) handshake sequence using interface signal lines DAV, NRFD, and NDAC. This handshake sequence has the following characteristics:

a. Data transfer is asynchronous - data can be transferred at any rate suitable for the devices operating on the bus. The maximum data rate for any HP-IB system is 1 million bytes per second.

b. Devices with different input/output speeds can be inter-connected. Data transfer rate automatically adjusts to the slowest active device.

c. More than one device can accept data at the same time.

The data transfer or "HANDSHAKE" lines are shown in figure A-1. The mnemonics of each line have the following meanings:

a. DAV (data valid)   is used to indicate the condition (avail-
                                              ability and validity) of information on the
                                              DIO signal lines.

b. NRFD (not ready for data)

is used to indicate the condition of
readiness of device(s) to accept data.

c. NDAC (not data accepted)

is used to indicate the condition of
acceptance of data by device(s).

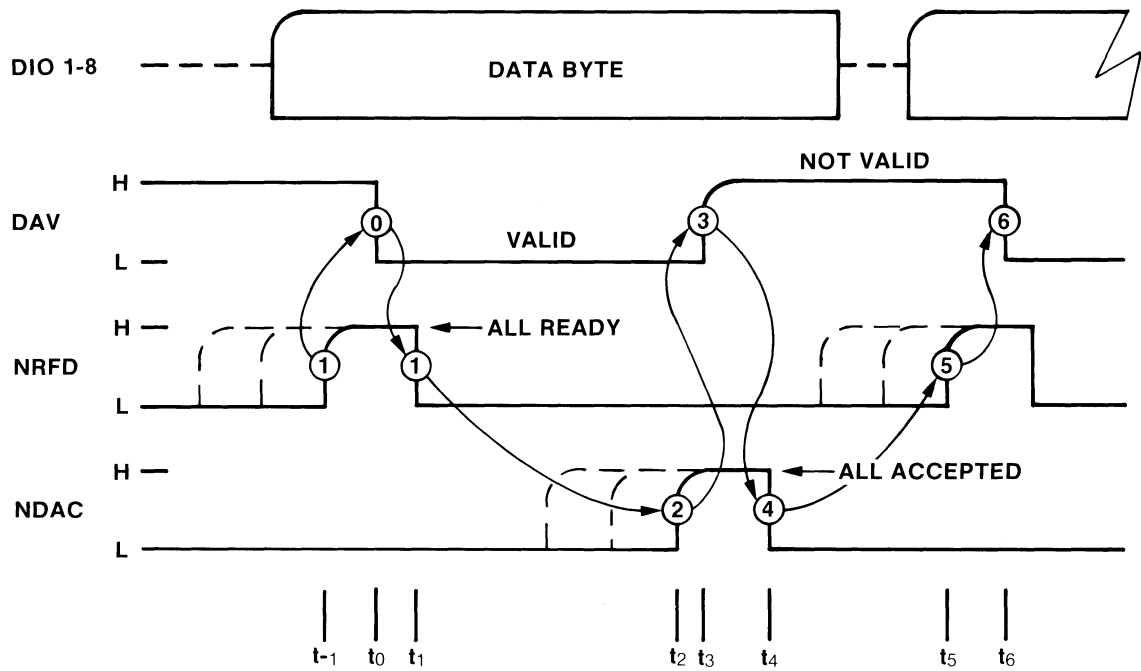The handshake timing sequence is illustrated in figure A-2.

Figure A-2. Data Byte Transfer

Other Bus Lines
Five additional HP-IB lines and their functions are:

a. ATN (Attention) - This line is used to specify how data on the DIO signal lines are to be interpreted and which devices must respond to the data.

b. IFC (Interface Clear) - This line is used to place the interface system, portions of which are contained in all interconnected devices, in a known quiescent state.

c. REN (Remote Enable) - When the system controller sets REN low, devices on the bus may be addressed to operate under remote control.

d. EOI (End or Identify) - This line is used to indicate the end of a multiple byte transfer sequence or, in conjunction with ATN, to execute a parallel polling sequence.

e. SRQ (Service Request) - Some devices that operate on the interface bus have the ability to request service from the system controller. A device may request service when it has completed a measurement, when it has detected a critical condition, or for any other reason. Service request is initiated when a device sets the HP-IB line labelled SRQ low. The controller has the option of determining when or if a service request will be serviced.

Interface Functions

A list of the available functions is given in table A-1. Every HP-IB device is able to perform at least one function on the HP-IB. Devices ignore all commands relating to functions they do not have.

Table A-1. HP-IB Interface Functions

Function	Description
SH_	The SH interface function controls the initiation of, and termination of, the transfer of a multiline message byte. This function utilizes the DAV, RFD (ready for data), and DAC (data accepted) signals to effect each message byte transfer.
AH_	The AH function provides a device with the capability to guarantee proper reception of remote multiline messages. An interlock handshake sequence between an SH function and one or more AH functions (each contained within separate devices) guarantees asynchronous transfer of each message byte.
T_ or TE_	The T interface function provides a device with the capability to send device-dependent data (including status data) over the interface to other devices. There are two alternative versions of the function: one with and one without address extension. The normal T function uses a one-byte address. The T interface with address extension (TE) uses a two-byte address. In all other respects, the capabilities of both versions are the same.
L_ or LE_	The L interface function provides a device with the capability to receive device-dependent data (including status data) over the interface from other devices. This capability exists only when the function is addressed to listen. There are two alternative versions of the function: one with and one without address extension. The normal L interface function uses a one-byte address. The L function with address extension (LE) uses a two-byte address. In all other respects, the capabilities of both versions are the same.
SR_	The SR interface function provides a device with the capability to asynchronously request service from the controller in charge of the interface.

Table A-1. HP-IB Interface Functions (Cont'd)

Function	Description
RL_	The RL interface function provides a device with the capability to select between two sources of input information. The function indicates either input information from the front-panel controls (local) or input information from the interface (remote) is to be used.
PP_	The PP interface function provides a device with the capability to present one bit of status to the controller in charge without being previously addressed to talk.
DC_	The DC interface function provides the device with the capability to be cleared (initialized) either individually or as part of a group of devices. The group may be either a subset or all addressed devices in one system.
DT_	The DT interface function provides the device with the capability to have its basic operation started either individually or as part of a group of devices. The group may be either a subset or all addressed devices in one system.
C_	The C interface function provides a device with the capability to send device addresses, universal commands, and addressed commands to other devices over the interface. It also provides the capability to conduct parallel polls to determine which device requires service.

Operating Considerations Summary

The following is a brief summary of bus operating considerations:

a. When a device capable of activating IFC is powered on during system operation, it causes the active controller on the bus to relinquish control, resulting in errors. The Controller must transmit IFC to regain active control.

b. Prior to addressing new listeners it is recommended that all old listeners be removed using the Unlisten Command (UNL).

c. Only one talker can be addressed at a time. When a new talker is addressed the former talker is automatically unaddressed.

d. The accumulative length of the HP-IB cable in any system must not exceed 20 metres (65 ft.). A system may contain no more than 2 meters of cable per device.

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