HEWLETT PACKARD

OPERATING AND SERVICE MANUAL

37201A

HP-IB EXTENDER

SERIAL NUMBERS

This manual applies directly to instruments with serial numbers prefixed 2014U.

With changes described in Section VII, this manual also applies to instruments with serial numbers prefixed 1925U, 1914U, and 1840U.

For additional important information about serial numbers, see INSTRUMENTS COVERED BY MANUAL in Section I.

Manual Part Number 37201-90001
Microfiche Part Number 37201-90026

Printed: February 1980

HP Computer Museum
www.hpmuseum.net

For research and education purposes only.

LIST OF CONTENTS

SECTION I INTRODUCTION

Paragraph		Page
1-1	INTRODUCTION	1-1
1-5	SPECIFICATIONS	1-1
1-7	SAFETY CONSIDERATIONS	1-1
1-9	INSTRUMENTS COVERED BY MANUAL	1-1
1-14	DESCRIPTION	1-2
1-29	ACCESSORIES SUPPLIED	1-4
1-31	ACCESSORIES AVAILABLE	1-4
1-33	EQUIPMENT NOT SUPPLIED BUT MAY BE REQUIRED	1-4
1-45	RECOMMENDED TEST EQUIPMENT	1-5

Table		
1-1	Operating Characteristics	1-1
1-2	HP-IB Capability (for non-transparent) functions	1-3
1-3	Logic Levels	1-4
1-4	Accessories Available	1-4
1-5	Recommended Test Equipment	1-5

Figure		
1-1	Model 37201A HP-IB Extender and Accessories	1-0
1-2	Dual Twisted-Pair Operation	1-2
1-3	Modem Operation	1-3

SECTION II INSTALLATION

Paragraph		Page
2-1	INTRODUCTION	2-1
2-3	INITIAL INSPECTION	2-1
2-5	PREPARATION FOR USE	2-1
2-18	FUNCTION AND DATA MEDIUM SWITCH SELECTION	2-4
2-35	MATING CONNECTORS	2-5
2-43	SYSTEM CONFIGURATIONS	2-7
2-71	STORAGE AND SHIPMENT	2-11

Table		
2-1	Power Cable Colour Codes	2-3
2-2	Function Switch Settings	2-4
2-3	HP-IB Interconnecting Cables	2-5

Figure		
2-1	Line Selector	2-2
2-2	Power Receptacle	2-2
2-3	Handle and Rack Mounting Variations	2-3
2-4	Function and Data Medium Switches	2-4
2-5	Doubling Bit Rate	2-5
2-6	Modem Connector	2-5
2-7	Dialler Connector	2-6
2-8	HP-IB Connector	2-7
2-9	Talk Only to Listen Only Configuration	2-8
2-10	Dual Twisted-Pair Configuration	2-8
2-11	Telephone Line Configuration (Dedicated Line)	2-9
2-12	Telephone Line Configuration (Multi-Point)	2-10
2-13	Telephone Line Configuration (Dialled Line)	2-11

SECTION III OPERATION

Paragraph		Page
3-1	INTRODUCTION	3-1
3-3	OPERATING CHARACTERISTICS	3-1
3-36	FRONT AND REAR PANEL FEATURES	3-5
3-38	INTERNAL PRESET SWITCHES	3-6
3-60	SIMPLIFIED BASIC OPERATING INFORMATION	3-9
3-65	ADDRESSED INSTRUCTIONS TO THE HP-IB EXTENDER	3-9
3-87	SERVICE REQUEST AND SERIAL-POLLING THE EXTENDER	3-12
3-91	ADDRESSING THE 37201A to TALK	3-12
3-94	DIFFICULTIES SOMETIMES INTRO-DUCED BY HP-IB EXTENTION	3-13
3-117	MAKING A DIALLED CONNECTION	3-15
3-129	EXAMPLE PROGRAMS FOR THE HP-IB EXTENDER	3-16
3-151	SYSTEM TROUBLESHOOTING	3-20
3-158	TWISTED PAIR CONFIGURED SYSTEM	3-21
3-160	LEASED-LINE FULL-DUPLEX DATA LINK (Using Asynchronous Modems)	3-22
3-162	LEASED-LINE FULL-DUPLEX DATA LINK (Using Synchronous Modems)	3-23
3-164	SWITCHED NETWORK USING MANUAL OR AUTOMATIC DIALLING	3-24
3-166	MULTI-POINT SYSTEM	3-25
3-168	ADDITIONAL CHECKS	3-25
3-171	37201A SELF TEST	3-26

Table		
3-1	Device Addresses	3-7
3-2	Dialling Character Set	3-10
3-3	Summary of Addressed Instructions and Talk String	3-11

LIST OF CONTENTS (continued)

Figure

3-1 Simplified Functional Operation 3-1
3-2 General Configuration for Multi-Point Operations 3-3
3-3 37201A HP-IB Extender Front Panel Features 3-5
3-4 37201A HP-IB Extender Rear Panel Features 3-6
3-5 Function Switches and Data Medium Switch 3-6
3-6 Program Example 1 3-17
3-7 Program Example 2 3-19
3-8 Program Example 3 3-20
3-9 Troubleshooting A Twisted Pair Configured System 3-21
3-10 Twisted Pair Connector 3-22
3-11 Troubleshooting a Leased-Line Full Duplex Data Link 3-22
3-12 Remote Modem Loopback Configuration 3-23
3-13 Full-Duplex Switched Data Link (Using Modem and Auto-Dialler) 3-24
3-14 Multi-Point System 3-25

SECTION IV PERFORMANCE TESTS

Paragraph Page

4-1 INTRODUCTION 4-1
4-5 SELF TEST 4-2
4-6 RS232C/V.24, RS366/V.25 OUTPUT TEST 4-2
4-7 RS232C/V.24, RS366/V.25 INPUT TEST 4-3
4-8 TWISTED-PAIR INPUT/OUTPUT TEST 4-4
4-9 DATA MEDIUM SWITCH TEST 4-5
4-10 FUNCTION SWITCH TEST 4-5
4-11 CLOCK FREQUENCY TEST 4-6

Figure

4-1 Connector Pin Numbers 4-2
4-2 Connector Pin Numbers 4-3
4-3 Connector Pin Numbers 4-4

SECTION V ADJUSTMENTS

Paragraph Page

5-1 INTRODUCTION 5-1
5-3 POWER SUPPLY ADJUSTMENT 5-1

SECTION VI REPLACEABLE PARTS

Paragraph Page

6-1 INTRODUCTION 6-1
6-3 ABBREVIATIONS 6-1
6-5 REPLACEABLE PARTS LIST 6-1
6-7 ORDERING INFORMATION 6-1
6-10 DIRECT MAIL ORDER SYSTEM 6-1

Table

6-1 Reference Designations and Abbreviatons 6-2
6-2 Replaceable Parts 6-4
6-3 Manufacturer Code List 6-8

SECTION VII MANUAL CHANGES

Paragraph Page

7-1 INTRODUCTION 7-1
7-3 MANUAL CHANGES 7-1
7-6 MANUAL CHANGE INSTRUCTIONS 7-1

Table

7-1 Manual Change by Serial Number 7-1

SECTION VIII SERVICE

Paragraph Page

8-1 INTRODUCTION 8-1
8-4 TROUBLESHOOTING 8-1
8-9 SAFETY REQUIREMENTS 8-1
8-11 RECOMMENDED TEST EQUIPMENT 8-1
8-13 LOGIC SYMBOLS 8-1
8-24 THEORY OF OPERATION 8-5

Figure

8-1 Indicator Symbols 8-2
8-2 Simplified Block Diagram 8-5
8-3 Block Diagram 8-6

GENERAL SERVICE SHEET G1 DESK TOP COMPUTER DIAGNOSTICS

Paragraph Page

G1-1 INTRODUCTION 8-8
G1-3 EQUIPMENT REQUIRED 8-8
G1-6 DESCRIPTION 8-8
G1-8 PROCEDURE 8-8
G1-13 WIRING THE INTERFACE 8-9
G1-14 WIRING THE RS232C/V.24, RS336/V.25 PLUGS 8-12
G1-16 WIRING THE TWISTED PAIR PLUG 8-12

LIST OF CONTENTS (continued)

Figure

G1-1 98032A Interface 8-9
G1-2 98032A Rear Housing & Configuration Board 8-10
G1-3 Configuration Board 8-10
G1-4 Edge Connector & Hood 8-11
G1-5 RS232C/V.24, RS366/V.25 Wiring for Loopback Tests 8-12

GENERAL SERVICE SHEET G2 SELF-TEST

Paragraph **Page**

G2-1 INTRODUCTION 8-13
G2-4 SELF-TEST 8-13
G2-13 DATA MEDIUM SWITCH TEST 8-13
G2-14 FUNCTION SWITCH TEST 8-14
G2-15 RS232C/V.24, RS366/V.25 OUTPUT TEST 8-14
G2-16 RS232C/V.24, RS366/V.25 INPUT TEST 8-15
G2-17 TWISTED PAIR INPUT & OUTPUT TEST 8-15

Figure

G2-1 Connector Pin Numbers 8-14

GENERAL SERVICE SHEET G3

Paragraph **Page**

G3-1 INTRODUCTION 8-16
G3-3 PROCESSOR SECTION TROUBLE-SHOOTING 8-16
G3-6 SERIAL SECTION TROUBLE-SHOOTING 8-17
G3-9 HP-IB SECTION TROUBLE-SHOOTING 8-17

PROCESSOR SECTION SERVICE SHEET 100

Paragraph **Page**

A100-1 INTRODUCTION 8-20
A100-3 DESCRIPTION 8-20
A100-19 TROUBLESHOOTING 8-21

Figure

A100-1 Processor Section Block Diagram 8-20
A100-2 Component Location – Section 100 8-25
A100-3 Schematic Diagram – Section 100 8-25

HP-IB SECTION SERVICE SHEET 200

Paragraph **Page**

A200-1 INTRODUCTION 8-26
A200-3 DESCRIPTION 8-26
A200-14 TROUBLESHOOTING 8-26

Figure

A200-1 HP-IB Section Block Diagram 8-26
A200-2 Component Location – Section 200 8-26
A200-3 Schematic Diagram – Section 200 8-27

SERIAL SECTION SERVICE SHEET 300

Paragraph **Page**

A300-1 INTRODUCTION 8-28
A300-3 DESCRIPTION 8-28
A300-26 TROUBLESHOOTING 8-29

Figure

A300-1 Serial Section Block Diagram 8-28
A300-2 Connector Pin Numbers 8-30
A300-3 Line Coder Waveforms 8-32
A300-4 Component Location – Section 300 8-33
A300-5 Schematic Diagram – Section 300 8-33

POWER SUPPLY SECTION SERVICE SHEET 400

Paragraph **Page**

A400-1 INTRODUCTION 8-34
A400-3 DESCRIPTION 8-34
A400-5 TROUBLESHOOTING 8-34

Figure

A400-1 Q404 Collector Waveform 8-34
A400-2 Component Location – Section 400 8-35
A400-3 Schematic Diagram – Section 400 8-35

APPENDIX A GLOSSARY OF TERMS

Page

A-1

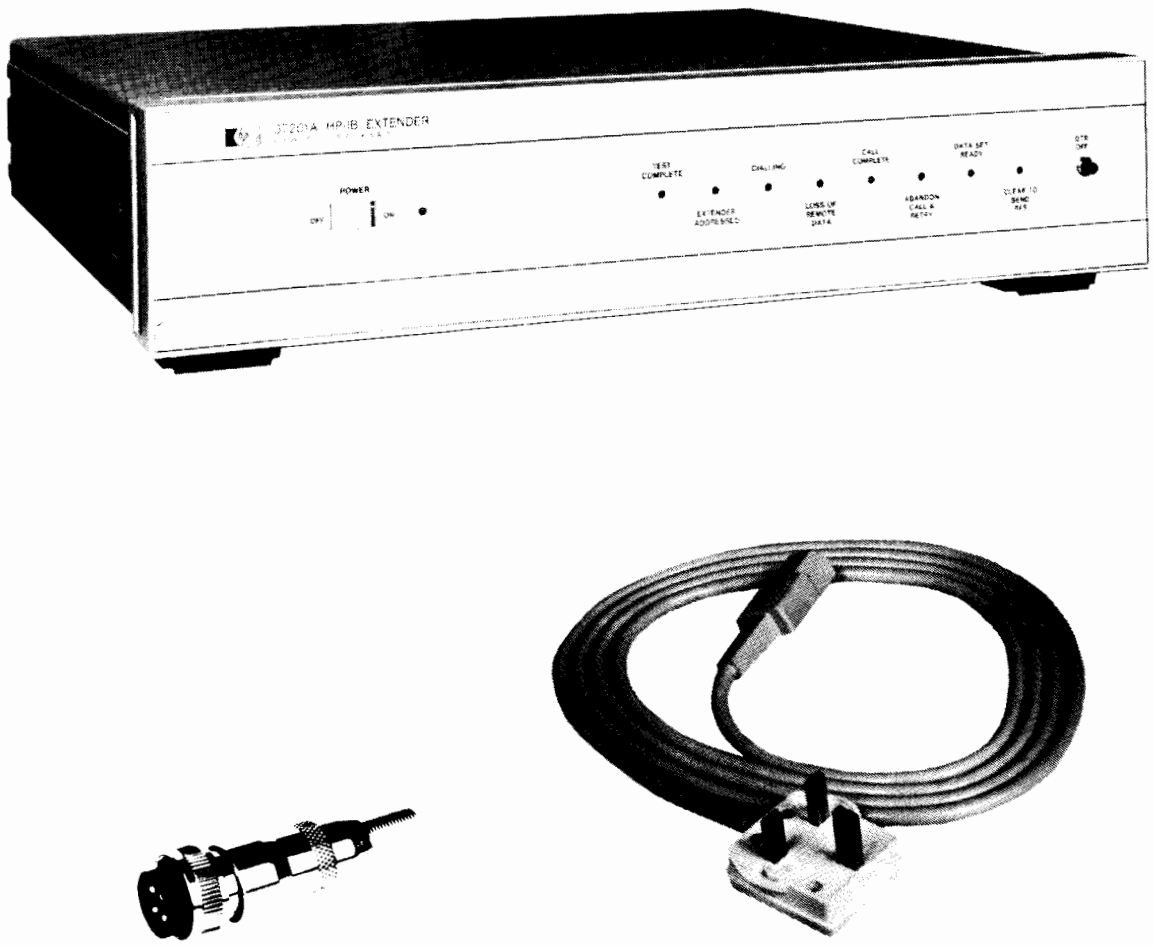


Figure 1-1 Model 37201A HP-IB Extender and Accessories

SECTION I

GENERAL INFORMATION

1-1 INTRODUCTION

1-2 This Operating and Service Manual contains information required to install, operate, test, adjust and service the Hewlett-Packard Model 37201A HP-IB Extender. Figure 1-1 shows the 37201A and the accessories supplied.

1-3 This section of the manual describes the instrument and includes information on identification, accessories, specifications, safety and other basic information.

1-4 Listed on the title page of this manual is a microfiche part number. This number can be used to order 4 x 6 inch microfilm transparencies of the manual. Each microfiche contains up to 96 photo duplicates of the manual pages. The microfiche package also includes the latest Manual Changes supplement.

1-5 SPECIFICATIONS

1-6 Instrument operating characteristics are listed in Table 1-1.

1-7 SAFETY CONSIDERATIONS

1-8 This Safety Class 1 instrument (provided with a protective earth terminal) has been designed and tested according to international safety standards. Information with regard to safety is presented at appropriate places throughout the manual.

1-9 INSTRUMENTS COVERED BY MANUAL

1-10 Attached to the instrument is a serial number plate. The serial number is in the form: 0000U00000. It is in two parts; the first four digits and the letter are the serial prefix and the last five digits are the suffix. The prefix is the same for all identical instruments; it changes only when a change is made to the instrument. The suffix, however, is assigned sequentially and is different for each instrument. The contents of this manual apply to instruments with the serial number prefix listed under SERIAL NUMBERS on the title page.

1-11 An instrument manufactured after the printing of this manual may have a serial number prefix that is not listed on the title page. This unlisted serial number prefix indicates the instrument is different from those described in this manual. The manual for this newer instrument is accompanied by a Manual Changes supplement. This supplement contains 'change information' that explains how to adapt the manual to the newer instrument.

1-12 In addition to change information, the supplement may contain information for correcting errors in the manual. To keep this manual as current and accurate as possible, Hewlett-Packard recommends that you periodically request the latest Manual Changes supplement. The supplement for this manual is identified with the manual print date and part number, both of which appear on the manual title page. Complimentary copies of the supplement are available from Hewlett-Packard.

1-13 For information concerning a serial number prefix that is not listed on the title page or in the Manual Changes supplement, contact your nearest Hewlett-Packard office.

Table 1-1 Operating Characteristics

HP-IB Data Rates

Nominal Transfer Rates*

Twin-pair cable interface: 775 data bytes/s.

Synchronous Modem interface: 744 data bytes/s at 19.2k bits/s and pro-rata at lower serial data rates.

Asynchronous Modem interface: 38 data bytes/s at 1200 bits/s and pro-rata at lower data rates.

*** Assumes continuous data byte transfer between two devices on short error-free link.**

Serial Data Rate

Twin pair cable operation: 20k bit/s fixed.

Asynchronous modem operation: 150, 300, 600, 1200 bit/s.

Synchronous modem operation: up to 19.2k bit/s.

Twin Pair Cable Interface

Range: 1000 metres.

Cable type: twin twisted pair with separate shields (recommended type HP8120-1187).

Longitudinal Isolation: provides rejection of common-mode interference.

Modem Interface

Compatible with EIA RS-232C and CCITT V.24.

Auto Dialler Interface

Compatible with EIA RS-366 and CCITT V. 25.

General

Power requirements: 100/120/220/240Vac, +10 −13%; 48 to 66Hz; 30VA max.

Operating temperature: 0 to +55°C.

Dimensions: 89mm high, 426mm wide, 356mm deep.

Weight: 5.7kg (12.5lb), net. 8.8kg (19.5lb), shipping.

1-14 DESCRIPTION

1-15 The 37201A HP-IB Extender enables the distance between groups of instruments interfaced by the Hewlett-Packard Interface Bus (HP-IB) to be extended beyond the limits imposed by direct HP-IB cabling. Functional operation of a programmed HP-IB system will usually be identical, with and without the 37201A's, except that the limited speed of the 37201A's and particularly of any associated modems may reduce the interface's speed of operation. Many instruments are inherently slow, in which case no significant difference will be noticed.

Note: HP-IB is Hewlett-Packard's implementation of IEEE Std. 488-1978 "Standard Digital Interface for Programmable Instrumentation".

1-16 By using the 37201A HP-IB Extenders and a dual twisted-pair cable, transmission distances of up to 1000 metres are attainable (see Figure 1-2). Alternatively, two 37201A's can be used in conjunction with two suitable modems and a telephone line (see Figure 1-3).

1-17 One 37201A HP-IB Extender converts the parallel-bit format of the HP-IB into serial-bit format for transmission to the other 37201A which then converts the serial information back to parallel-bit form for the instruments at its end. With the exception of Parallel Poll and Pass Control, the entire range of HP-IB functions may be extended to the remote site.

1-18 A pair of HP-IB Extenders communicate with each other using a 'private' protocol which is separate and distinct from the HP-IB protocol. Data is assembled into variable-length 'packets' or blocks for bit-serial transmission at one end, and broken down again at the other end. For the detection of transmission errors all packets of data include a block-parity check. The parity is checked by the receiving 37201A and, if correct, an acknowledgement is sent to the originating 37201A, allowing it to send more data. If the parity is incorrect, the received packet is discarded and no acknowledgement is sent.

1-19 The HP-IB Extenders provide a 'transparent' interface (HP-IB operation usually identical to operating without 37201A's) between local and remote instruments. Extenders do not usually require program control since they do not need to be under the command of a controller to carry out their basic function.

1-20 A number of 'non-transparent' functions are provided, however, which enable the HP-IB controller to control certain subsidiary functions and to monitor the operation of the Extender. For these purposes the Local Extender may be addressed, in its own right, to talk and listen. It can also Request Service and be Serial-Polled. The Local Extender may be addressed for several reasons including; passing a telephone number to an Automatic Dialler when dialling a remote site under automatic program control; and calling one of a number of remote Extenders connected via modems to a common dedicated Multi-Point telephone circuit (remote Extenders cannot be HP-IB addressed, but they can be Multi-Point addressed by the local Extender).

1-21 The maximum number of instruments that can be connected to a single 37201A is 14, including a controller. A complete system therefore, could consist of up to 14 instruments including the controller, plus a 37201A at the local end, and another 14 instruments, plus a 37201A at the remote end. Alternatively, a simple system comprising, a Talk-Only device, a Listen-Only device and no Controller may be extended.

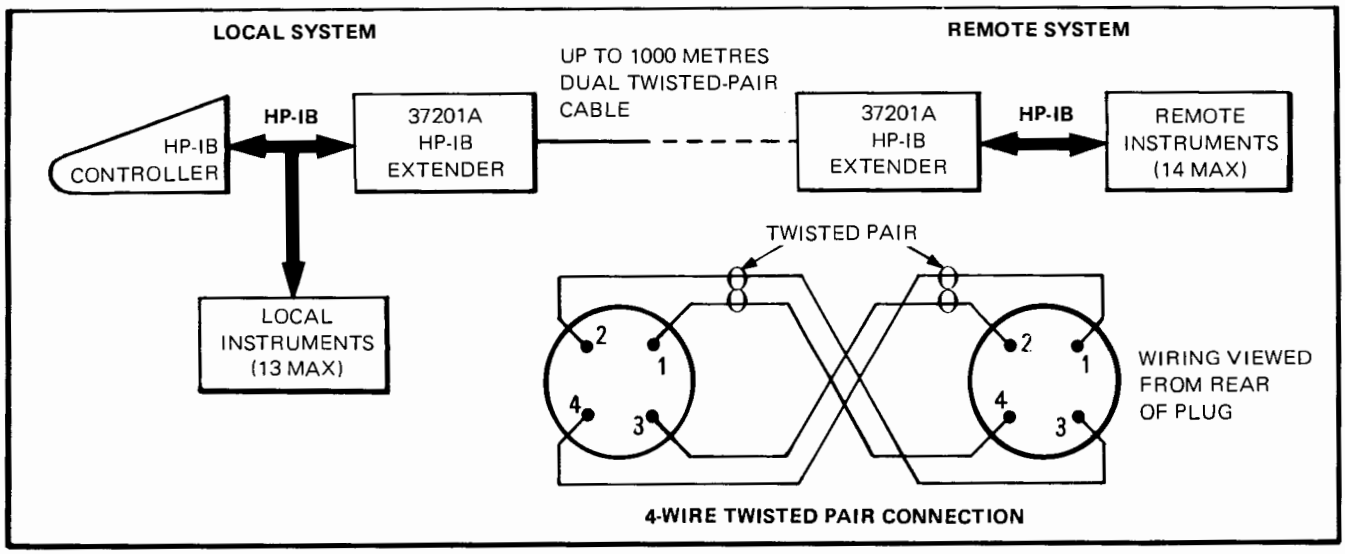


Figure 1-2 Dual Twisted-Pair Operation

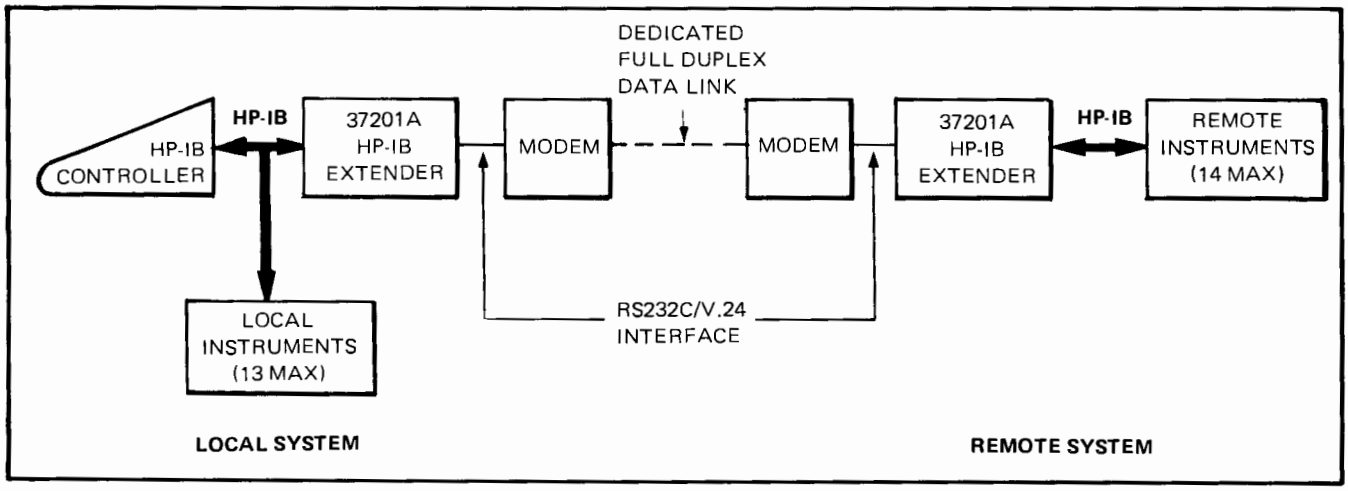


Figure 1-3 Modem Operation

1-22 HP-IB Operation

1-23 The 37201A HP-IB Bus Extender, in addition to providing a "transparent" interface between HP-IB instruments, may be addressed by a suitable controller as a normal HP-IB device (see Paragraph 1-20). Table 1-2 lists the 37201A capabilties as an HP-IB device.

1-24 Information regarding HP-IB address selection will be found in Section II. Section III contains HP-IB programming information.

Table 1-2 HP-IB Capability (for non-transparent functions)

IEEE 488–1975 Code	Capability
SH1	Source Handshake
AH1	Acceptor Handshake
T6	Basic Talker, can be Serial Polled (responds with Status Byte), does not talk if addressed to listen.
L4	Basic Listener, does not listen if addressed to talk.
TEØ	Not an Extended Talker
LEØ	Not an Extended Listener
SR1	Service Requester
RLØ	Cannot be placed in Local or Remote control
PPØ	Cannot be Parallel Polled
DCØ	No response to Device Clear
DTØ	No response to Device Trigger
C	Not applicable
E1	Open collector bus drivers

1-25 Transmission Modes

1-26 The 37201A has the following three basic modes of operation which are selected by an internal switch:

Dual Twisted Pair – This position is selected when the 37201A is used with a dual twisted-pair cable to communicate with another 37201A over distances up to 1000 metres. The signalling rate is fixed at 20KBits per second.

Synchronous Modem – Positions marked 'SYNC MODEM' are selected when the 37201A is used in conjunction with a synchronous modem, in which case the exact speed is determined by the modem clock. The three switch positions cover clock speeds up to 19200 Bits per second.

Asynchronous– Positions marked 'ASYNC MODEM' select various bit rates of 150, 300, 600 or 1200 Bits per second for transmitting data in conjunction with an asynchronous modem. A wire link inside the 37201A enables the bit rates to be doubled giving a maximum rate of 2400 Bits per second (see paragraph 2-31).

1-27 Logic Levels

1-28 Logic Levels associated with the 37201A HP-IB Extender are listed in Table 1-3.

Table 1-3 Logic Levels

Connector	Logic Levels
HP-IB	TTL Compatible True <+0.8V False >+2.0V
RS232C/V.24	Data mark <–3V Data space >+3V Control & Timing On >+3V Off <–3V
RS366/V.25	Digit lines binary 1 <–3V binary 0 >+3V Control lines On >+3V Off <–3V

1-29 ACCESSORIES SUPPLIED

1-30 Supplied with the 37201A is a four contact connector – HP Part Number 1251-3764 (Switchcraft 2504M) – to mate with the rear panel TWISTED-PAIR CABLE connector. A power cord appropriate to the country of destination (see Section II) is also supplied.

1-31 ACCESSORIES AVAILABLE

1-32 Table 1-4 lists accessories available from Hewlett-Packard which can be used in assembling an Extended HP-IB System.

Table 1-4 Accessories Available

Description	HP Part Number
Twisted-Pair cable; two twisted-pair with shield (Belden type 8723) – Specify length.	8120-1187
HP-IB Cables	
1 metre	10631A
2 metre	10631B
4 metre	10631C
0.5 metre	10631D
Twisted-Pair Connector (Switchcraft 2504M)	1251-3764
Bus Extender to Modem or Dialler cable, 3 feet	10235-61606
10 feet	01645-61605

1-33 EQUIPMENT NOT SUPPLIED BUT MAY BE REQUIRED

1-34 The following paragraphs describe equipment which may be required for assembling an Extended HP-IB System, but not supplied with the 37201A.

1-35 Modems (Data Sets)

1-36 The 37201A is designed to operate with either, 150, 300, 600 or 1200 bps asynchronous, or up to 19200 bps synchronous full-duplex modems which are EIA RS232C or CCITT V.24 compatible.

1-37 In the United States, either a Bell Model 103 or a Bell Model 113A/B is recommended for use on direct dial networks. When the Bell 113A/B Data Set is used, a 113A must be used at the Originate (Local) end of the link and a 113B used at the Answer Only (Remote) end of the link. The 37201A disconnects the line at the remote site by turning Data Terminal Ready (DTR circuit CD 108/2) OFF to effect disconnection. The 37201A will also work with any of the available disconnect options on the Bell 103 Data Set. Since the 37201A does not act upon Received Line Signal Detector (circuit CF 109), when a Bell 103 is used the option of turning Clear to Send (CTS circuit CB 106) OFF with loss of carrier is recommend though not essential.

1-38 For higher speed telephone network operation the following Hewlett-Packard full-duplex synchronous modems are recommended.

37210T 4800 bps (2400 bps Fallback)

Note 1: If this modem is used on the switched network in the USA, two DATA ACCESS ARRANGEMENTS and two separate dial up lines are required to give full duplex operation. Auto answer is not possible.

Note 2: Option 005 on the 37210A Modem gives a remote digital or analog loopback at the remote modem, which is particularly valuable when carrying out remote system diagnostics.

37220T 9600 bps (4800 bps Fallback)

Note: The 37220B is for operation on leased lines only.

1-39 Regulations regarding the connecting of equipment to the telephone network vary from country to country. Check with the local PTT before connecting modems etc to the telephone network.

1-40 Dialler

1-41 The 37201A is designed to operate with RS366 or V.25 compatible Automatic Dial Equipment. In the USA a Bell Model 801A or 801C Automatic Calling Unit is recommended for use with the Bell 103 Data Set.

1-42 The 37201A disconnects a dialled up line at the Originate (Local) end by turning both Call Request (circuit CRQ, 202), to the Automatic Calling Unit and Data Terminal Ready (DTR, circuit CD, 108/2) to the Data Set OFF. The 37201A can operate with Bell 801 Automatic Calling Units which use either of the two Call Termination options available. However, the option not to stop the Abandon Call and Retry (circuit ACR, 205) Timer when Data Set Status (circuit DSS, COS, 204) goes ON, is recommended when the 37201A is to be used in an Automatic System where there is to be no operator intervention.

1-43 Dual Twisted-Pair Cable

1-44 For Twisted-Pair operation up to 1000 metres, Beldon cable type 8723 (HP part number 8120-1187) is recommended. Other suitable Twisted-Pair Cable may be used. However, for long distances any cable selected should have the two pairs shielded from each other.

1-45 RECOMMENDED TEST EQUIPMENT

1-46 Equipment required to maintain the 37201A is listed in Table 1-5. Other equipment may be substituted if it meets or exceeds the critical specifications listed in the table.

Table 1-5 Recommended Test Equipment

Instrument	Critical Specifications	Recommended Model	Use*
Digital Multimeter	±0.1V at ±12V	hp 3476A/B	APT
Oscilloscope and plug-ins	50MHz Bandwidth	hp 180C/1801A/1821A	PT
Frequency Counter	±10ppm at 5MHz	hp 5301A	PT
Signature Analyzer	Unique	hp 5004A	T
Desk Top Computer	Unique	hp 9825A	T
String & Advanced Programming ROM	Unique	hp 98210A	T
General I/O & Extended I/O ROM	Unique	hp 98213A	T
16 Bit Interface	Unique	hp 98032A (Std)	T
Connector Edge	Unique	hp 1251-0333	T
Connector/Cable Hood	Unique	hp 1251-5765	T
Diagnostic Tape	Unique	hp 37201-18100	T
RS232C/V.24, RS366/V.25 Connector (2 off)†	Unique	hp 1251-0063	T
Connector/Cable Hood (2 off)†	Unique	hp 1251-0392	T
Twisted-Pair Connector†	Unique	hp 1251-3764	T

* A = adjustments P = Performance Tests T = Troubleshooting

† For Serial Section I/O tests if required

SECTION II

INSTALLATION

2-1 INTRODUCTION

2-2 This section contains information and instructions required to install the 37201A HP-IB Extender. This section also includes information about initial inspection, operating environment and storage and shipment.

2-3 INITIAL INSPECTION

2-4 Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the instrument has been checked both mechanically and electrically. The contents of the shipment should be as shown in Figure 1-1. Procedures for checking electrical performances are given in Section IV. If the contents of the shipment are incomplete, if there is mechanical damage or defect, or if the instrument does not pass the Performance Tests, notify the nearest Hewlett-Packard office. If the shipping container is damaged, or the cushioning material shows signs of stress, notify the carrier as well as the Hewlett-Packard office. Keep the shipping material for carrier's inspection. The Hewlett-Packard office will arrange for repair or replacement at HP Option without waiting for claim settlement.

2-5 PREPARATION FOR USE

2-6 Power Requirements

2-7 The 37201A HP-IB Extender requires a power source of 100, 120, 220, or 240V ac +10 −13% at 48 to 66Hz single phase. Power consumption is less than 50VA.

CAUTION

Before connecting this instrument to a power outlet, ensure the voltage selector is correctly set for the voltage of the power source and a fuse of the correct rating is fitted.

2-8 A timed fuse of 500mA (2110-0202) is required for 100/120V operation, and 250mA (2110-0201) is required for 220/240V operation.

2-9 Power Cable

2-10 In accordance with the international safety standards, this instrument is equipped with a three-wire power cable. When connected to an appropriate ac power receptacle, this cable grounds the instrument cabinet. The type of power cable supplied with the instrument depends on the country of destination. Figure 2-2 illustrates the standard power plugs commonly used. The number shown below each plug is the HP Part Number of the power cord equipped with that plug. If the appropriate power cord is not included with the instrument, notify the nearest Hewlett-Packard office and a replacement will be provided.

2-11 The colour codes used in each power cable are given in Table 2-1.

2-12 Operating Environment

2-13 **Temperature:** The instrument may be operated in temperatures from $0^{o}C$ to $+55^{o}C$.

2-14 **Humidity:** The instrument should be protected from extreme temperature changes which may cause condensation within the instrument.

2-15 **Altitude:** The instrument may be operated at altitudes up to 4600 metres (15,000 feet).

2-16 Rack Mounting

2-17 Rack Mounting kits are available, with or without front handles and can be purchased through your nearest Hewlett-Packard office (see Figure 2-3).

Rack Mount kit (for use without handles)	HP 5061-0074
Rack Mount kit (for use with handles)	HP 5061-0075

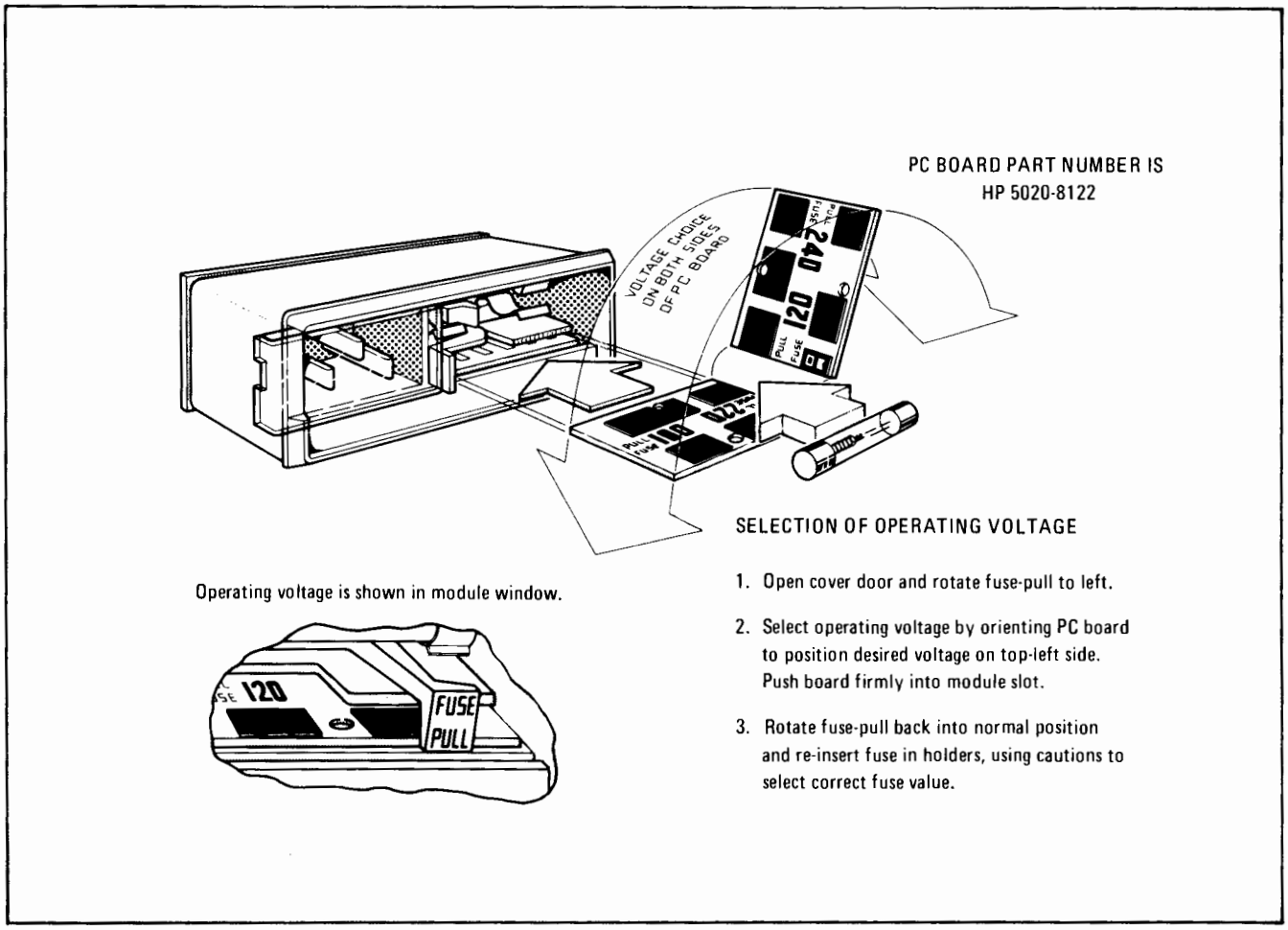


Figure 2-1 Line Selector

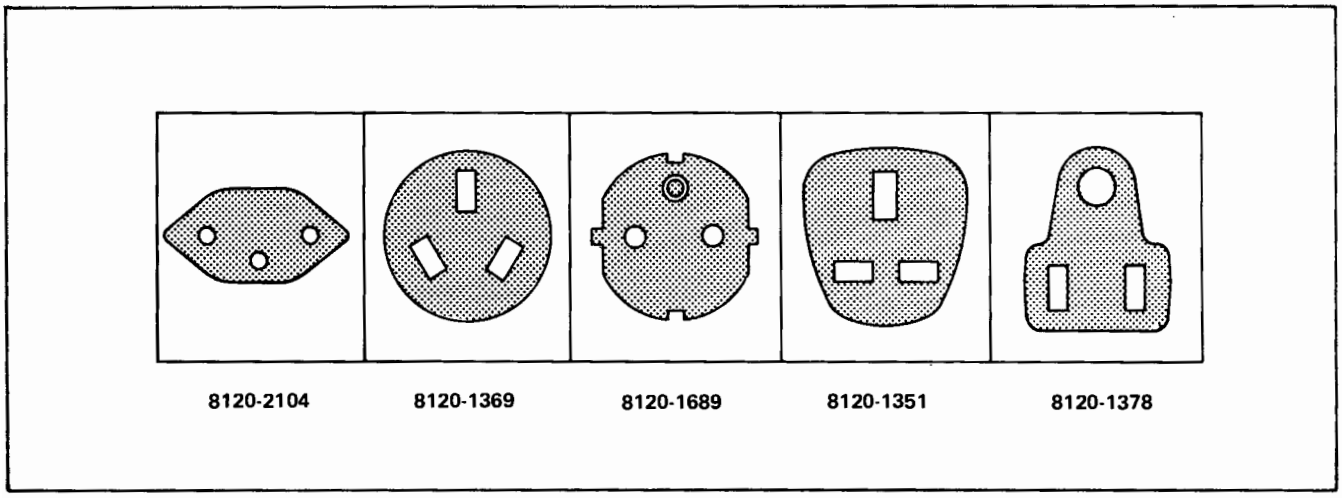


Figure 2-2 Power Receptacle

Table 2-1 Power Cable Colour Codes

Supply	Cable Type				
	8120-2104	8120-1369	8120-1689	8120-1351	8120-1378
Line	Brown	Red	Brown	Brown	Black
Neutral	Blue	Black	Blue	Blue	White
Ground	Green/Yellow	Green	Green/Yellow	Green/Yellow	Green/Yellow

WARNING

To avoid the possibility of injury or death, the following precautions must be followed before the instrument is switched on:

(a) Note that the protection provided by grounding the instrument cabinet may be lost if any power cable other than the three-pronged type supplied is used to couple the ac line voltage to the instrument.

(b) If this instrument is to be energized via an auto-transformer to reduce or increase the line voltage, make sure that the common terminal is connected to the neutral pole of the power source.

(c) The power cable plug shall only be inserted into a socket outlet provided with a protective earth contact. The protective action must not be negated by the use of an extension cord without a protective conductor (grounding).

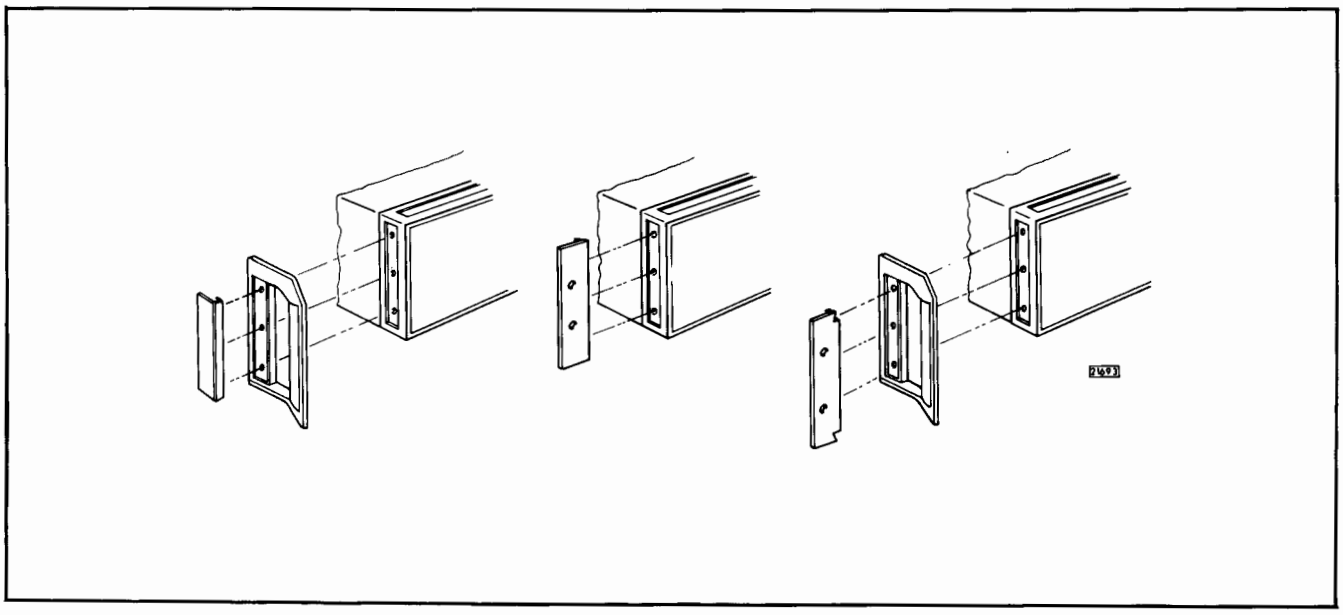


Figure 2-3 Handle and Rack Mounting Variations

2-18 FUNCTION AND DATA MEDIUM SWITCH SELECTION

2-19 FUNCTION SWITCHES

2-20 The FUNCTION SWITCHES are formed by two six-section "DIP" switches mounted inside the instrument (see Figure 2-4).

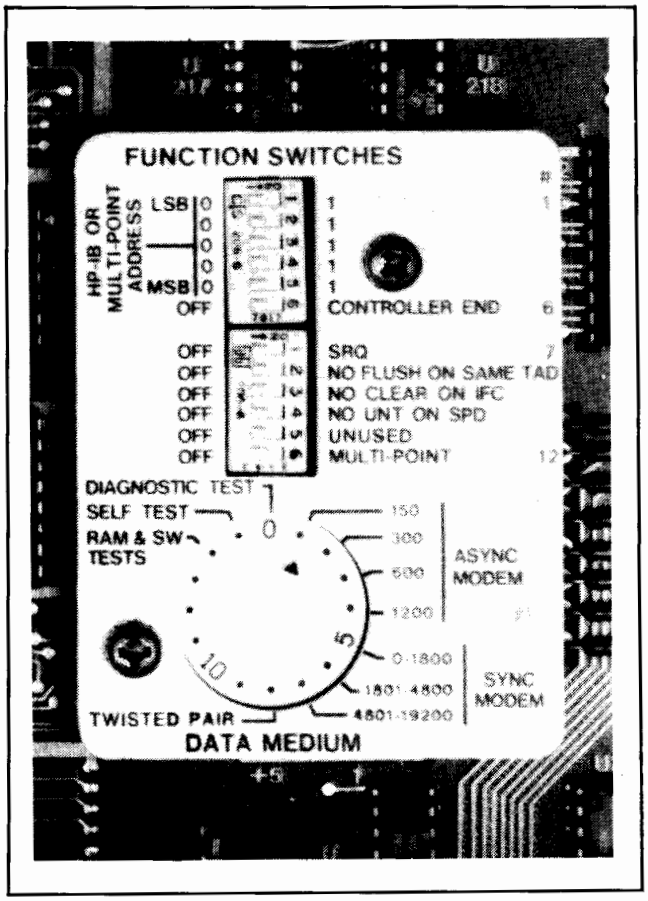


Figure 2-4 Function and Data Medium Switches

Switches 1 through 5 set either the HP-IB address or the Multi-Point address depending on the mode of operation. When the 37201A is operating in the remote mode, switches 1 through 5 are "don't care", unless it is a remote Multi-Point station.

Note: Refer to Glossary of Terms for explanations of 'Local' and 'Remote'.

2-21 Switches 6 through 12 are normally factory preset to the OFF position. Switch positions can however, vary with the mode of operation – see Table 2-2 and Section III, Paragraph 3-38.

Table 2-2 Function Switch Settings

Switch No.	Operating Mode		
	Controller Local	Remote	Remote Multi-Point
1	Set to desired HP-IB Address	Don't Care	Set to desired Multi-Point Address
2			
3			
4			
5			
6	ON	OFF	OFF
7	† Normally OFF	OFF	OFF
8	†	OFF	OFF
9	†	OFF	OFF
10	†	OFF	OFF
11	OFF	OFF	OFF
12	OFF	OFF	ON

† See Section III Paragraph 3-40.

2-22 HP-IB Address Selection

2-23 The instrument HP-IB "talk" and "listen" addresses are selected by switches 1 through 5. The switches are normally factory pre-set to device address octal 21/decimal 17, corresponding to ASCII talk and listen addresses of 'Q' and '1' respectively. The talk and listen addresses may be changed by setting the switches to any value between octal 0 and octal 36. Octal 37 should not be used as this corresponds to the HP-IB Unlisten command.

2-24 The instrument is connected to the HP-IB by connecting an HP-IB interface cable to the connector on the rear panel of the instrument. Each end of the cable has both a male and female "piggyback" connector which simplifies interconnection of instruments and cables by allowing connectors to be stacked. Up to 14 instruments can be connected to a 37201A in this way.

2-25 To achieve interface design performance, restrictions are placed on the HP-IB system cable lengths. When interconnecting an HP-IB system, the following rules should be observed.

(1) The total HP-IB cable length used must be less than or equal to 20 metres (65.6 feet).

(2) The total HP-IB cable length used must be less than or equal to 2 metres (6.5 feet) times the total number of devices connected to the Bus.

2-26 A list of HP-IB interconnecting cables available is given in Table 2-3.

Table 2-3 HP-IB Interconnecting Cables

Length	Accessory Number
1 metre	10631A
2 metres	10631B
4 metres	10631C
0.5 metres	10631D

2-27 Multi-Point Address Selection

2-28 When operating in a Multi-Point system, each remote 37201A has a unique Multi-Point address, which has no connection with HP-IB addresses (see paragraphs 3-23 and 3-43). The Multi-Point address is set by switches 1 through 5 (Figure 2-4) and can be set to any value between octal 0 and octal 36.

2-29 DATA MEDIUM SWITCH

2-30 The DATA MEDIUM switch selects the Data-Link medium which the 37201A will use for communication. Local and remote 37201A's must have the same setting. The switch also has three Test positions described in Section III Paragraph 3-58.

2-31 Switch positions marked 'ASYNC MODEM' select various Bit rates between 150 and 1200 Bits per second when transmitting data in conjunction with an asynchronous modem. A wire link inside the 37201A enables the bit rates to be doubled giving a maximum rate of 2400 Bits per second (see Figure 2-5).

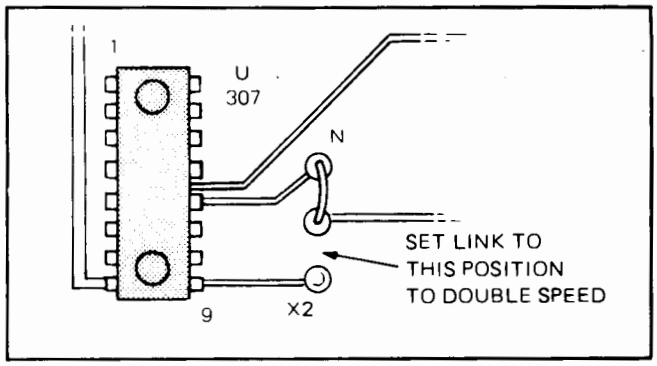


Figure 2-5 Doubling Bit Rate

2-32 Switch positions marked 'SYNC MODEM' are selected when the 37201A is used in conjunction with a synchronous modem, in which case the exact speed is determined by the modem clock. The three switch positions cover clock speeds up to 19200 Bits per second.

2-33 The 'TWISTED PAIR' position is selected when the 37201A is used with a twisted-pair cable to communicate with another 37201A over distances up to 1000 metres. The signalling rate is fixed at 20K Bits per second.

2-34 All other switch positions are unused.

2-35 MATING CONNECTORS

2-36 Modem RS232C/V.24 Connector.

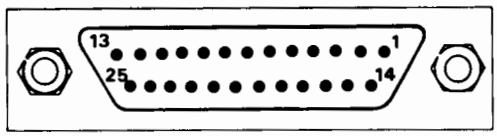
2-37 Figure 2-6 shows the MODEM RS232C/V.24 connector pin allocation and signal names. A description of the signals on this connector follows:

RS232C Pin 2 (TRANSMITTED-DATA) is the serial output data from the HP-IB Extender to the modem.

RS232C Pin 3 (RECEIVED-DATA) is the serial input data from the modem, to the HP-IB Extender.

RS232C Pin 4 (REQUEST-TO-SEND) is a signal line from the HP-IB Extender to the modem and is always ON, except before dialling, after disconnection and at an unaddressed multi-point station.

MODEM (RS232C/V.24)



Pin	Description	RS232C	V.24
1	Protective Ground	AA	101
2	Transmitted Data	BA	103
3	Received Data	BB	104
4	Request to Send	CA	105
5	Clear to Send (Ready For Sending)	CB	106
6	Data Set Ready	CC	107
7	Signal Ground	AB	102
8	Receive Line Signal Detect	CF	109
9	NC		
10	NC		
11	Link-selected with 37201A		
12	NC		
13	NC		
14	NC		
15	Transmit Clock	DB	114
16	NC		
17	Receive Clock	DD	115
18	NC		
19	NC		
20	Data Terminal Ready	CD	108/2
21	NC		
22	NC		
23	Data Signal Rate Select	CH	111
24	NC		
25	NC		

Figure 2-6 Modem Connector

RS232C Pin 5 (CLEAR-TO-SEND – also called READY-FOR-SENDING) and RS232C Pin 6 (DATA-SET-READY) are signal lines from the modem to the HP-IB Extender. The logic state of the lines is set by the modem and is examined by the HP-IB Extender to determine when a call is established. Front panel CLEAR TO SEND and DATA SET READY indicators

provide a visual indication of the state of these modem lines.

RS232C Pin 7 (SIGNAL GROUND).

RS232C Pin 8 (RECEIVER-LINE-SIGNAL-DETECT) is a signal line from the modem to the HP-IB Extender. This is internally connected but not used.

RS232C Pin 11 (SPARE) is a spare line from the HP-IB Extender to the modem. The logic state of this line may be set ON or OFF by an internal wire link, if required. The link (W301) should be present for ON and omitted for OFF.

RS232C Pin 15 (TRANSMIT-CLOCK) is the line which carries the modem transmit clock to the HP-IB Extender for synchronous operation. The modem clock rate determines the transmit bit rate of the HP-IB Extender.

RS232C Pin 17 (RECEIVE-CLOCK) is the line which carries the modem receive clock to the HP-IB Extender for synchronous operation.

RS232C Pin 20 (DATA-TERMINAL-READY). This line from the HP-IB Extender to the modem is always ON, except when disconnecting from a dialled call at either end, in which case it momentarily goes OFF until DATA SET READY goes OFF; or alternatively, may be forced OFF for as long as the front panel "DTR OFF" switch is depressed.

RS232C Pin 23 (DATA-SIGNAL-RATE-SELECT) is the signal line from the HP-IB Extender to the modem which is sometimes required to select the bit rate in the modem. The logic state of this line is dependent on the type of modem used and is determined by a wire link inside the instrument. The link (W300) should be present for ON and omitted for OFF.

2-38 Dialler RS366/V.25 Connector

2-39 Figure 2-7 shows the Auto Dialler RS366 connector pin allocation and signal names. A description of the signals on this connector follows:

RS366 Pin 2 (DIGIT-PRESENT) is a signal line from the HP-IB Extender to the Dialler, and is ON when the four NB data lines are valid.

RS366 Pin 3 (ABANDON-CALL-AND-RETRY) is a signal from the Dialler to the HP-IB Extender which indicates that a call attempt has been unsuccessful. The state of the signal is made available to the HP-IB controller in the Extender's HP-IB status-byte so that the controller may take action to terminate the call by disconnecting.

RS366 Pin 4 (CALL-REQUEST) is a signal line from the HP-IB Extender to the Dialler. This line is turned ON each time the dialler is commanded to dial by the 37201A.

RS366 Pin 5 (PRESENT-NEXT-DIGIT) is a signal line from the Dialler to the HP-IB Extender, which is turned ON when the Dialler is ready to receive a digit from the HP-IB Extender.

RS366 Pin 6 (POWER-INDICATION) is a signal line from the Dialler to the HP-IB Extender which is set ON when the Dialler power is on.

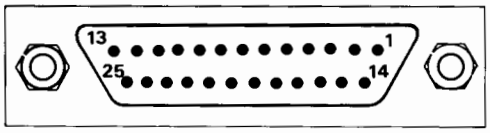
RS366 Pin 7 (SIGNAL GROUND).

RS366 Pin 13 (CALL-ORIGINATION-STATUS) is a signal line from the Dialler to the HP-IB Extender, which is set ON when the distant station is connected. It is also called DISTANT STATION CONNECTED, and sometimes DATA SET STATUS.

RS366 Pins 14 to 17 (NB1, NB2, NB4 and NB8) are lines from the HP-IB Extender to the Dialler. The HP-IB Extender places the Digit to be dialled on these lines in a negative-true four bit code (see Table 3-2).

RS366 Pin 22 (DATA LINE OCCUPIED) is a signal which indicates that the telephone channel connected to the Dialler is in use.

DIALLER (RS366/V.25)



Pin	Description	RS366	V.25
1	Protective Ground		
2	Digit Present	DPR	211
3	Abandon Call and Retry	ACR	205
4	Call Request	CRQ	202
5	Present Next Digit	PND	210
6	Power Indication	PWI	213
7	Signal Ground		
8	NC		
9	NC		
10	NC		
11	NC		
12	NC		
13	Call Origination Status (Distant Station Connected)	COS	204
14	NB 1	NB1	206
15	NB 2	NB2	207
16	NB 4	NB4	208
17	NB 8	NB8	209
18	NC		
19	NC		
20	NC		
21	NC		
22	Data Line Occupied	DLO	203
23	NC		
24	NC		
25	NC		

Figure 2-7 Dialler Connector

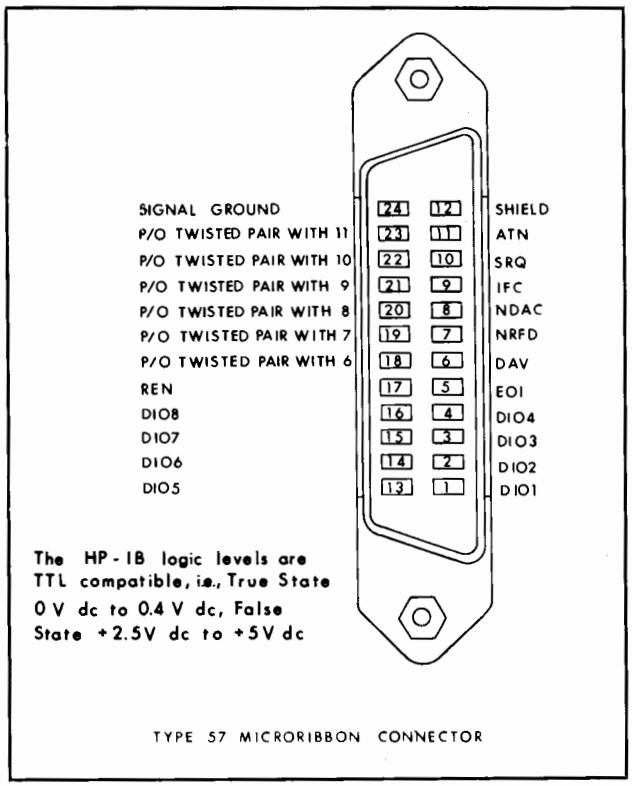


Figure 2-8 HP-IB Connector

2-40 HP-IB Connector

2-41 Figure 2-8 shows the HP-IB connector pin allocation and signal names. A description of the signals on this connector follows:

HP-IB Pins 1-4 (DI01 – DI04)
and
HP-IB Pins 13-16 (DI05 – DI08) are the Data Input/Output lines of the HP-IB.

HP-IB Pin 5 (EOI). This line is used to indicate the end of a multiple byte message, and is also used for parallel polling.

HP-IB Pin 6 (DAV). This line is used in the "Handshake" sequence, and is set low true by the source to indicate the data on DI01 – DI08 is valid.

HP-IB Pin 7 (NRFD). This line is used in the "Handshake" sequence and is set low true after the DAV line goes true to indicate that an accepting instrument is Not Ready For Data until the present data is accepted.

HP-IB Pin 8 (NDAC). This line is used in the "Handshake" sequence and is held low true by an accepting instrument until the Data on the DI01 – DI08 lines is accepted, when it goes high.

HP-IB Pin 9 (IFC). This is the "Interface Clear" line. When the system controller sets IFC low true all HP-IB instruments are unaddressed.

HP-IB Pin 10 (SRQ). This is the "Service Request" line and is set low true by any instrument requiring service.

HP-IB Pin 11 (ATN). This is the "Attention" line which is pulled low true to set the HP-IB in the Command mode.

HP-IB Pin 12 (SHIELD) is the ground to chassis pin at the HP-IB connector.

2-42 For further information on the HP-IB, refer to the "Condensed Description of the Hewlett-Packard Interface Bus" HP Part Number 59401-90030.

2-43 SYSTEM CONFIGURATIONS

2-44 The following paragraphs describe various system configurations in which the 37201A may be used. Connection between local and remote 37201A's will either be via a dual twisted-pair cable or via a telephone line (dedicated or dialled).

2-45 Talk-Only to Listen-Only Configuration

2-46 Figure 2-9 shows how two 37201A's can be connected to extend the operating distance (up to 1000 metres) between a basic talker and listener on the HP-IB. Details of accessories required are given in Section 1.

Note: Talk-Only and Listen-Only systems may also be extended using modems as described in this section.

2-47 **Function Switches:** Switches 1 to 5 (see Figure 2-4) are not used and should be left at the Factory settings. On one 37201A, set switch 6 to ON and on the other 37201A, set switch 6 to OFF. All other Function Switches should normally be set to the OFF position. A full explanation of Function Switch settings is given in Section 3.

2-48 **Data Medium Switch:** The Data Medium Switch should be set to the TWISTED PAIR position (see Figure 2-4) on both 37201A's.

2-49 Functional operation of the talker and listener on the HP-IB will not be affected by the inclusion of the 37201A's.

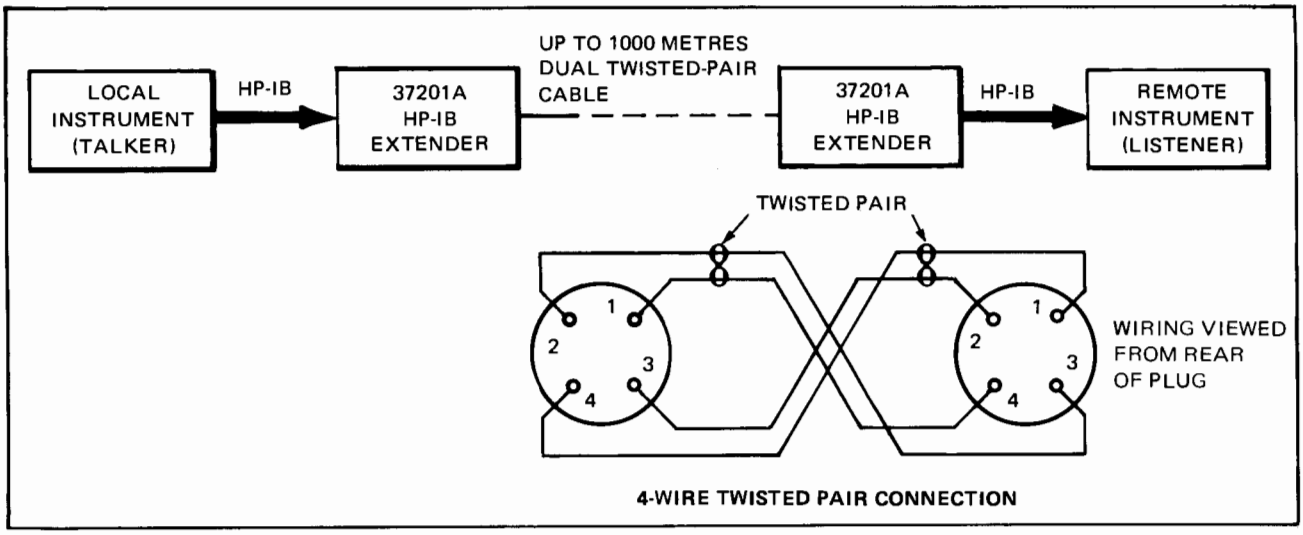


Figure 2-9 Talk Only to Listen Only Configuration

WARNING

When the twisted-pair cable is used in an out of doors environment, do not remove or connect the twisted-pair cable from or to the HP-IB Extenders during an electrical storm. To do so as lightning strikes the twisted-pair cable could result in a lethal electrical shock!

2-50 Dual Twisted-Pair Configuration

2-51 Figure 2-10 shows how two 37201A's can extend the operating distance between instruments on the HP-IB by using up to 1000 metres of Dual Twisted-Pair cable. Up to 14 instruments can be connected to the 37201A at the remote end, and up to 13 instruments plus a controller at the local end. Details of accessories required are given in Section 1.

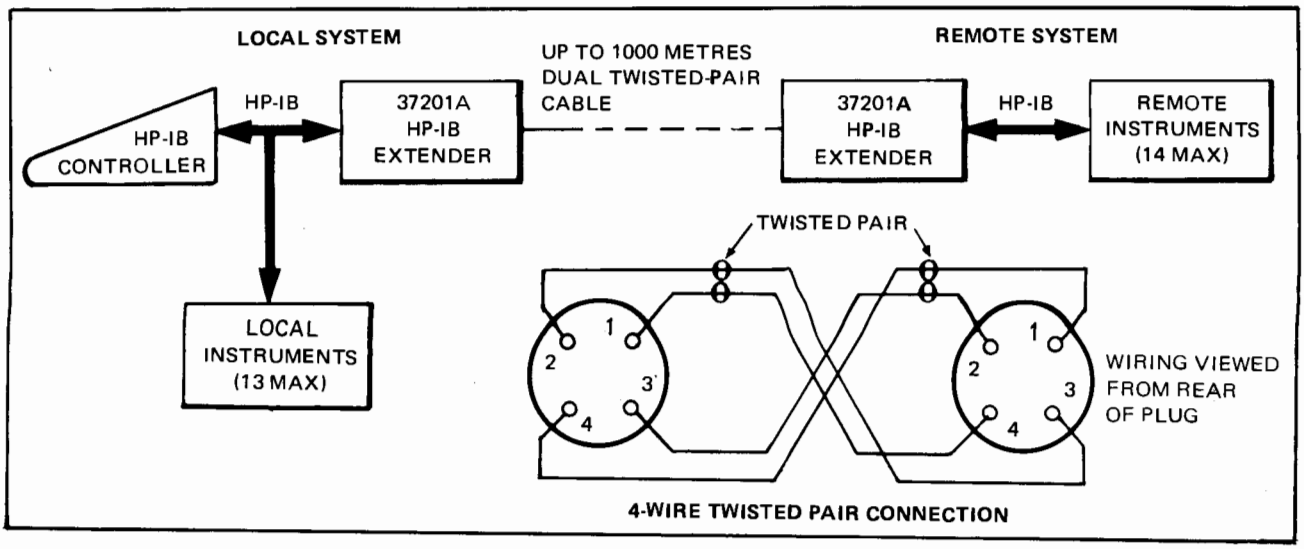


Figure 2-10 Dual Twisted-Pair Configuration

WARNING

When the twisted-pair cable is used in an out of doors environment, do not remove or connect the twisted-pair cable from or to the HP-IB Extenders during an electrical storm. To do so as lightning strikes the twisted-pair cable could result in a lethal electrical shock!

2-52 **Function Switches:** On the local 37201A, set switches 1 through 5 (see Figure 2-4) for the desired HP-IB address (see Paragraph 2-22) so that it can be addressed, if necessary, to execute one of its non-transparent functions. *Even if these functions are not used, the local 37201A must be set to an address different from all other addresses in the whole extended system.* At the remote 37201A, switches 1 through 5 have no meaning and can be left at the factory settings. On the local 37201A, set switch 6 to ON and on the remote 37201A, set switch 6 to OFF. All other Function switches should normally be set to the OFF position. A full explanation of Function Switch settings is given in Section 3.

2-53 **Data Medium Switch:** The Data Medium Switch should be set to the TWISTED-PAIR position (see Figure 2-4) on both 37201A's.

2-54 Functional operation of the HP-IB system is usually identical, with or without the 37201A's except that the limited speed of the 37201A's may reduce the speed of operation. However, many bus instruments are inherently slow, in which case there will be no significant difference.

2-55 Telephone Line Configuration (Dedicated Line)

2-56 Figure 2-11 shows how two 37201A's can extend the operating distance between instruments on the HP-IB by using a dedicated (permanently connected) telephone line. Identical full-duplex modems are required at the local and remote locations. Details of recommended modems and accessories required are given in Section 1.

2-57 **Function Switches:** On the local 37201A, set switches 1 through 5 (see Figure 2-4) for the desired HP-IB address (see Paragraph 2-22) so that it can be addressed, if necessary, to execute one of its non-transparent functions. *Even if these functions are not used, the local 37201A must be set to an address different from all other addresses in the whole extended system.* At the remote 37201A, switches 1 through 5 have no meaning and can be left at the factory settings. On the local 37201A, set switch 6 to ON, and on the remote 37201A, set switch 6 to OFF. All other Function switches should normally be set to the OFF position. A full explanation of Function Switch settings is given in Section 3.

2-58 **Data Medium Switch:** The Data Medium Switch should be set for the type (synchronous or asynchronous) and speed of modem being used (see Paragraph 2-29). Local and remote 37201A's must have the same setting.

2-59 Functional Operation of the HP-IB system is usually identical, with or without the 37201A's, except that the limited speed of the 37201A's, and particularly of any associated modems may reduce the speed of operation. However, many bus instruments are inherently slow, in which case there will be no significant difference.

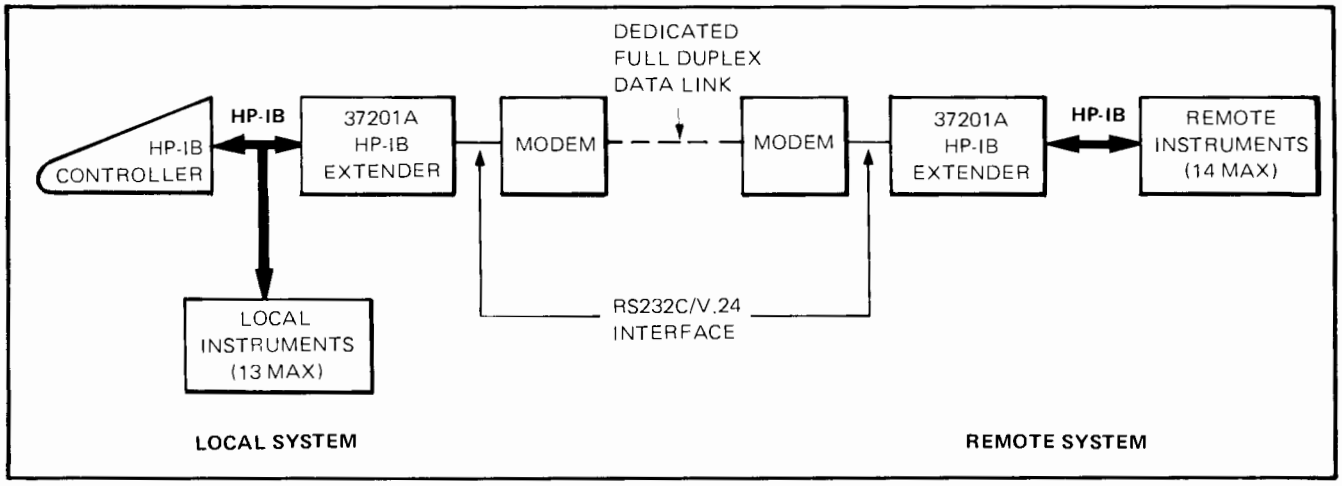


Figure 2-11 Telephone Line Configuration (Dedicated Line)

2-60 Telephone Line Configuration (Multi-Point)

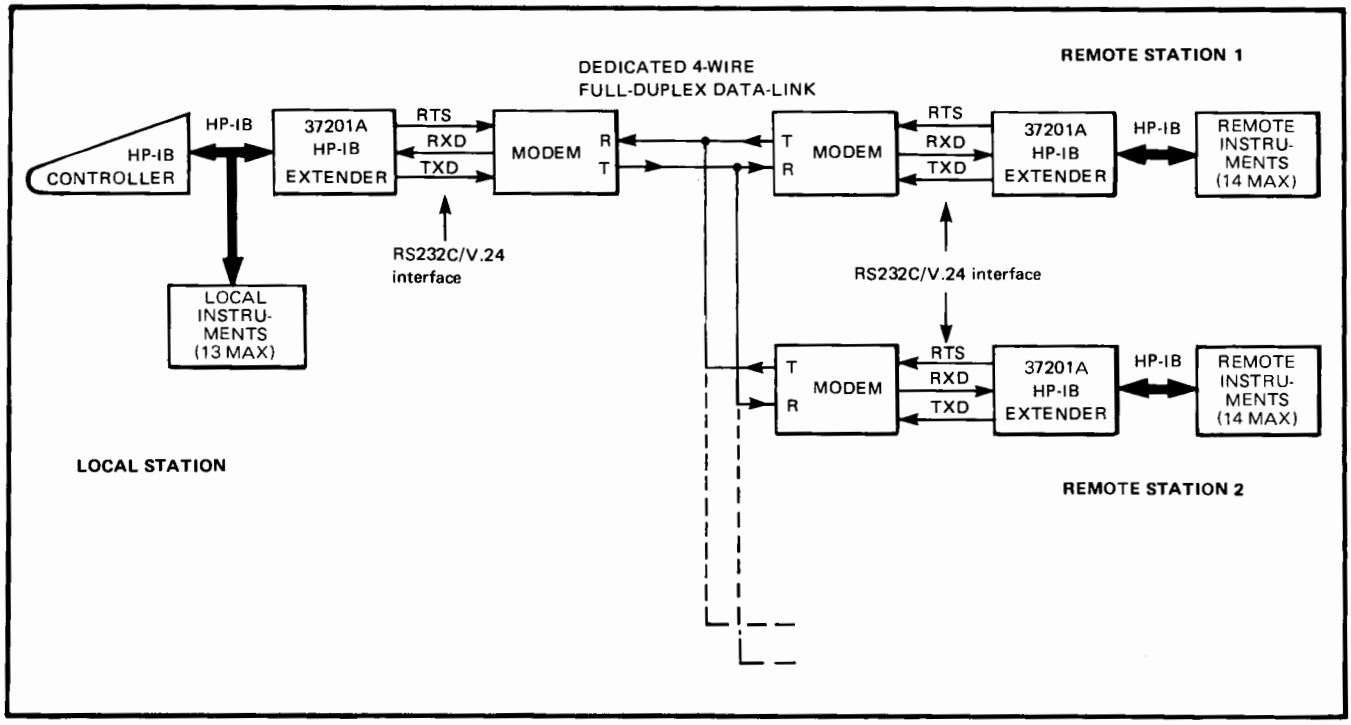


Figure 2-12 Telephone Line Configuration (Multi-Point)

2-61 Figure 2-12 shows how 37201A's can be used to allow one of a number of remote clusters of HP-IB devices to be accessed from a local station using a dedicated (permanently connected) telephone line. Identical full-duplex modems are required at the local and remote stations. The remote station modems are connected in parallel across a dedicated (leased or private) 4-wire full-duplex telephone circuit, and in turn to the local station. Details of recommended modems and accessories are given in Section 1.

2-62 **Function Switches:** On the local 37201A, set switches 1 through 5 (see Figure 2-4) for the desired HP-IB address (see Paragraph 2-22) so that it can be addressed to execute one of its non-transparent functions. *The local 37201A must be set to an address different from all other addresses in the whole extended system.* At the remote 37201A, set switches 1 through 5 to the desired Multi-Point address (see Paragraph 2-27). The Multi-Point address has no connection with HP-IB addresses. No two stations can have the same Multi-Point address. On the local 37201A, set switch 6 to ON and at the remote 37201A, set switch 6 to OFF. At each remote 37201A, set switch 12 to ON. All other Function Switches should normally be set to the OFF position. A full explanation of Function Switch settings is given in Section 3.

2-63 **Data Medium Switch:** The Data Medium Switch should be set for the type (synchronous or asynchronous) and speed of modem being used (see Paragraph 2-29). Local and remote 37201A's must have the same setting.

2-64 Modems used in a Multi-Point configuration must have the carrier controlled by the Request To Send line (RTS). Modems which have the option of having the Data Set Ready (DSR) line controlled by the Data Terminal Ready (DTR) line are preferable to ones where Data Set Ready (DSR) is held on continuously.

2-65 Functional Operation of the HP-IB system is usually identical, with or without the 37201A's, except that the limited speed of the 37201A's, and particularly of any associated modems may reduce the speed of operation. However, many bus instruments are inherently slow, in which case there will be no significant difference.

Note: It is recommended that after power-on early action should be taken by the HP-IB controller to 'Idle' the 37201A (see paragraph 3-116).

2-66 Telephone Line Configuration (Dialled Line)

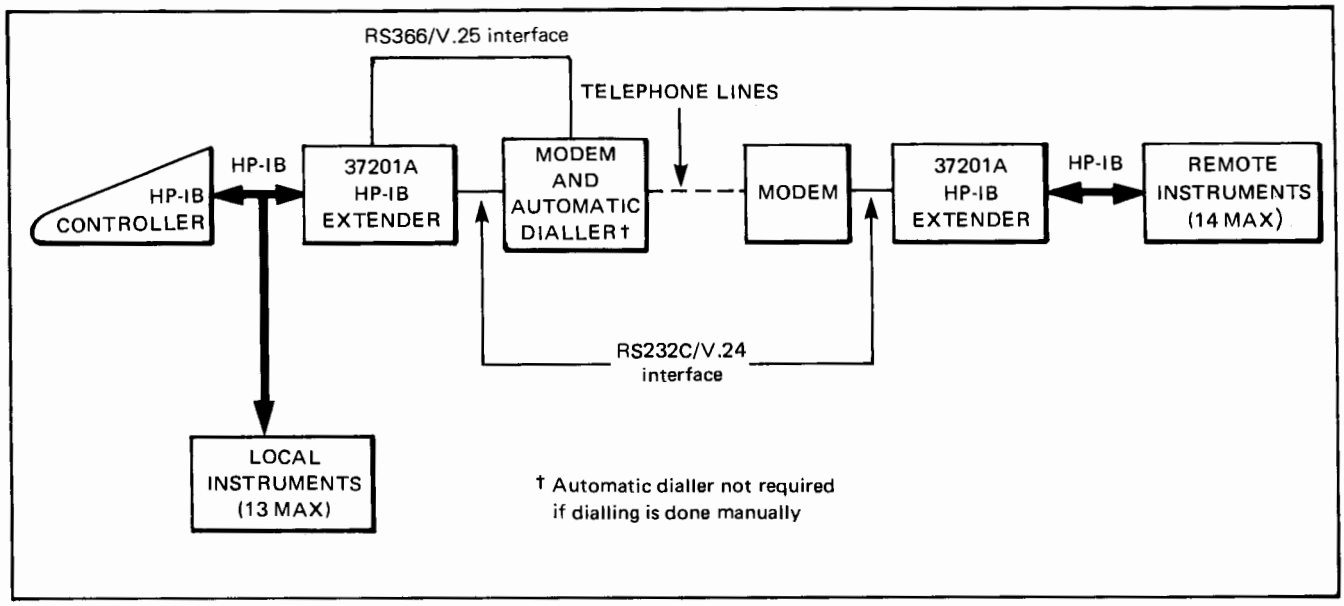


Figure 2-13 Telephone Line Configuration (Dialled Line)

2-67 Figure 2-13 shows how two 37201A's can extend the operating distance between instruments on the HP-IB using a Dial-up telephone line. Identical full-duplex modems are required at the local and remote locations. Dialling can be either manual or via an Automatic Dialler. In some countries the local telephone authorities may require the modems to be connected to the line via a protective network such as a Data Access Arrangement. Details of recommended modems, diallers and accessories required are given in Section 1.

2-68 **Function Switches:** On the local 37201A, set switches 1 through 5 (see Figure 2-4) for the desired HP-IB address (see Paragraph 2-22) so that it can be addressed, if necessary, to execute one of its non-transparent functions. *Even if these functions are not used, the local 37201A must be set to an address different from all other addresses in the whole extended system.* At the remote 37201A, switches 1 through 5 have no meaning and can be left at the factory settings. On the local 37201A, set switch 6 to ON, and on the remote 37201A, set switch 6 to OFF. All other Function switches should normally be set to the OFF position. A full explanation of Function Switch settings is given in Section 3.

2-69 **Data Medium Switch:** The Data Medium Switch should be set for the type (synchronous or asynchronous) and speed of modem being used (see Paragraph 2-29). Local and remote 37201A's must have the same setting.

2-70 Functional Operation of the HP-IB system is usually identical, with or without the 37201A's, except that the limited speed of the 37201A's, and particularly of any associated modems may reduce the speed of operation. However, many bus instruments are inherently slow, in which case there will be no significant difference.

Note: It is recommended that after power-on early action should be taken by the HP-IB controller to 'Idle' the 37201A (see paragraph 3-116).

2-71 STORAGE AND SHIPMENT

2-72 Environment

2-73 The instrument may be stored or shipped in environments within the following limits:

Temperature . . . . . .–40°C to +75°C
Altitude . . . . . .up to 15,300 metres (50,000 feet)

The instrument should also be protected from temperature extremes which could cause condensation within the instrument.

2-74 Packaging

2-75 **Original Packaging.** Containers and materials identical to those used in factory packaging are available through Hewlett-Packard offices. If the instrument is being returned to Hewlett-Packard for servicing, attach a tag indicating the type of service required, return address, model number, and full serial number. Also, mark the container 'FRAGILE' to ensure careful handling. In any correspondence, refer to the instrument by model number and full serial number.

2-76 **Other Packaging.** The following general instructions should be used for re-packing with commercially available materials:

(a) Wrap instrument in heavy paper or plastic. (If shipping to Hewlett-Packard office or service centre, attach tag indicating type of service required, return address, model number, and full serial number).

(b) Use strong shipping container. A double-wall carton made of 200-pound test material is adequate.

(c) Use a layer of shock-absorbing material 50 to 75mm (2 to 3 inch) thick around all sides of the instrument to provide firm cushioning and prevent movement inside container. Protect the control panel with cardboard.

(d) Seal shipping container securely.

(e) Mark shipping container FRAGILE to ensure careful handling.

(f) In any correspondence, refer to instrument by model number and full serial number.

SECTION III

OPERATION

3-1 INTRODUCTION

3-2 This section of the manual explains the function of the controls and indicators of the Model 37201A HP-IB Extender. Included in this section are; Operating Characteristics, difficulties introduced by an extended system, HP-IB addressed instructions, programming examples and system troubleshooting.

3-3 OPERATING CHARACTERISTICS

3-4 A basic description of the 37201A is given in Section I Paragraph 1-14 to 1-28. The following paragraphs describe some aspects of the 37201A Operating Characteristics in more detail.

3-5 Serial Transmission Protocol Between Extenders

3-6 As explained in Section I, the 37201A's communicate with each other using a 'private' protocol. While a knowledge of this protocol is not essential, the following description may help to clarify the operation of the 37201A.

3-7 The protocol between 37201A's gives protection from errors introduced into the data link by means of a system of detection and automatic re-transmission. This system also allows the bus at the receiving end of the data-link to run considerably slower than the serial byte rate without losing information. The error detection and re-transmission system reduces the chance of data-link errors causing HP-IB errors to an insignificant level.

3-8 Data taken from the HP-IB is stored in the 37201A's transmit memory buffers (see Figure 3-1). Byte pairs are used: one byte for data and one for the HP-IB management

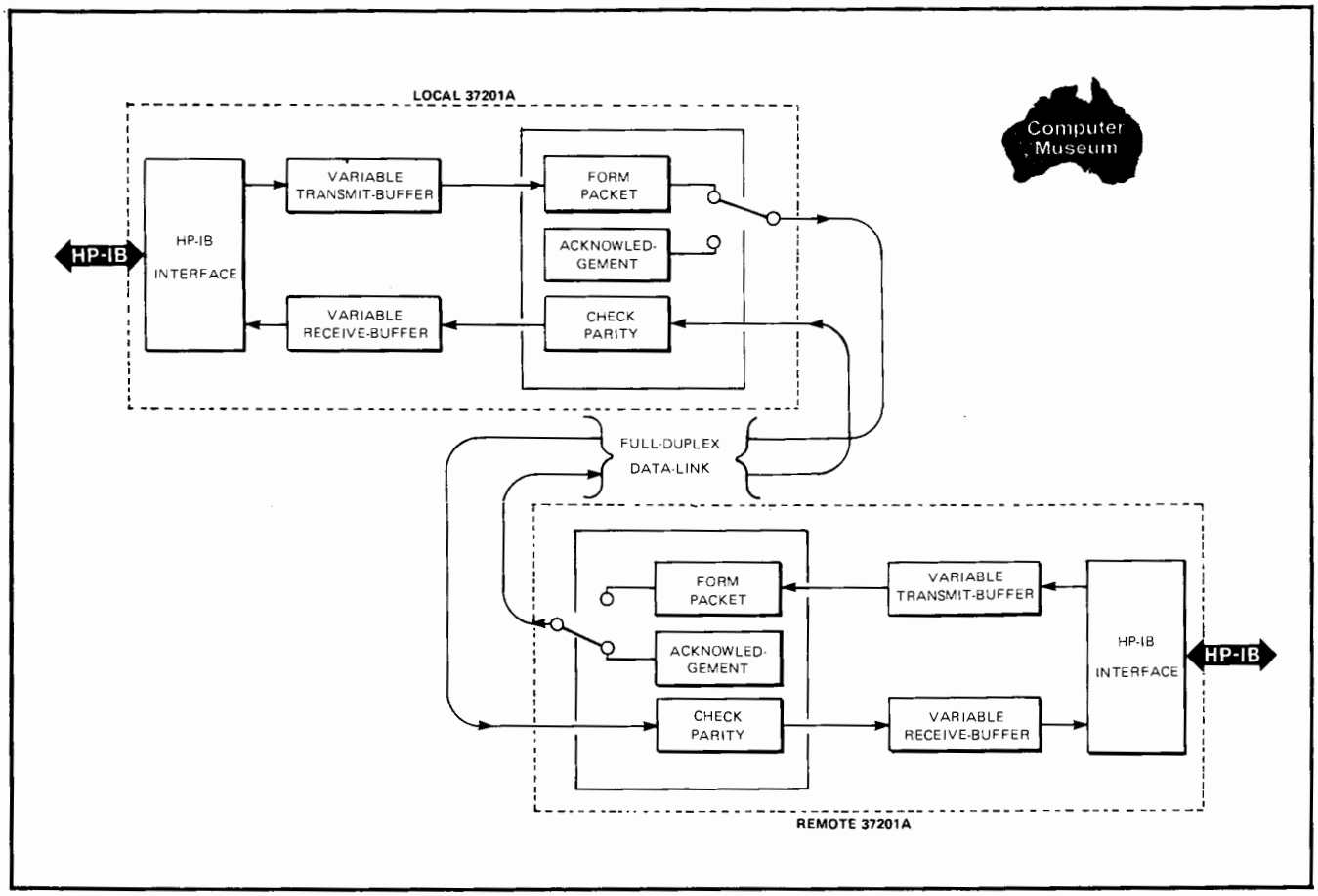


Figure 3-1 Simplified Functional Operation

lines along with certain internal functions. The serial protocol takes the data from the buffers and assembles it into variable-length transmission blocks or "packets", there being as much data in the packet as there was in the buffer, up to a maximum of 30 HP-IB Data-Bytes. Every 8-bit byte in the packet has an odd parity bit added in the 9th bit position, and the packet also has a parity byte added at the end, giving both horizontal and vertical block-parity for error detection. In addition, every byte in the asynchronous mode has a start bit (Space) and a stop bit (Mark), making 11 bits in all.

3-9 A receiving-end 37201A takes in the packet and checks its parity. If the block-parity is correct, an acknowledgement is sent to the originating 37201A allowing it to send more data, and the data within the packet is stored in a receive buffer ready to go out on to the bus. If the block-parity is incorrect, the received packet is discarded and no acknowledgement is sent. The originating 37201A repeats the packet if no acknowledgement is received within a certain time-out period. The time-out period starts at two seconds (to accommodate the maximum possible inter-continental round-trip delay) and then quickly optimises itself to suit the prevalent delay with which acknowledgements are returned.

3-10 When operating in the synchronous mode, either in the Twisted-Pair configuration or with synchronous Modems, the receiving 37201A will resynchronise its receive function after each packet. Each new packet is preceded by a sync code, and the receiving 37201A searches for this code on a bit-by-bit basis. This prevents the 37201A from permanently losing synchronisation in the event of a clock slip, since each new packet is resynchronised.

3-11 Should any device on the receive-end bus be Accepting data at a rate slower than the permissable transmit serial byte rate, no acknowledgement is sent until space becomes available in the receive buffer. This prevents destruction of data due to buffer overflow.

3-12 Loss of Remote Data: During normal operation, data is sent from the originating 37201A and an acknowledgement returned from the receive 37201A. When there is no HP-IB data to be sent, empty packets are inserted every four seconds and an acknowledgement returned, in order to test the data-link's integrity. If packets fail to be either received or acknowledged, the LOSS OF REMOTE DATA indicator on the front panel comes ON (and the appropriate bit is set in the Status-Byte and Talk-String – see Paragraph 3-87). The failure of either direction of the full-duplex data-link or of the remote 37201A, for a period greater than 8 seconds (12 seconds at 300bps and 20 seconds at 150bps asynchronous), normally results in LOSS OF REMOTE DATA becoming true on both 37201A's. If the 'Idle' instruction (Paragraph 3-67) has been used, LOSS OF REMOTE DATA ceases to indicate correctly the integrity of the physical data-link.

3-13 Transparent HP-IB Extension

3-14 'Transparent' in the context used here, means that functional operation of a programmed HP-IB system is identical with or without the 37201A's, except that the speed of operation may be limited by the 37201A's and any associated modems.

3-15 The function of "transparent" extension provided by the 37201A's is to accept data from, or source data on to, each bus on behalf of instruments at the opposite end. Each 37201A does this by Source-Handshaking on to the bus any data it has in its serial receive-buffer or by Acceptor-Handshaking any available bus data and placing it in its serial transmit-buffer. With each Data Byte a copy of the five Management lines (IFC, ATN, SRQ, EOI, REN) is also sent, but the three handshake lines (DAV, NRFD, NDAC) are not transmitted. Additionally, upon any change in one of the relevant Management lines, a new copy of all five lines is sent; the associated "data" byte being marked as a "dummy" which is discarded at the receiving end. Data to be conveyed over the full-duplex serial data-link is carried between 37201A's within the "private" protocol described in Paragraph 3-5. One necessary feature of this protocol is for the Source Handshake of a device at one end to be suspended should either the data-link or an opposite end Acceptor be unable to cope with the Source's data rate. Variable-length transmit and receive buffers provide elasticity.

3-16 When 37201A's are handling HP-IB data they do not know where the Accepting instrument(s) is/are located. Consequently all data is sent to the opposite end, irrespective of whether the addressed instrument is at the near end, and the speed of the overall bus is limited either by the slowest instrument or by the data-link.

3-17 HP-IB Function Limitations: The extension provided by 37201A's does not allow devices at the remote site (the other end from the Controller) to be Parallel-Polled. Because of distance, a response from remote devices within 200ns, as required by IEEE Std 488, is not physically possible. This function is not implemented, therefore. The other user restriction is that a Controller is not permitted to Pass Control to a device at the remote site.

3-18 Non-Transparent Functions

3-19 In addition to the ability of a pair of 37201A's to extend an existing programmed HP-IB system, usually without modification – known as the 37201A's "transparent" functions – there are also a number of "non-transparent" functions. These allow the HP-IB controller to address the local 37201A as a normal HP-IB device in order to:

(a) Modify the 37201A's behaviour (Paragraph 3-65).

(b) Pass a telephone number for control of an automatic calling (dialling) unit (Paragraph 3-24).

(c) Pass a multi-point address for raising one of a number of remote multi-point stations (Paragraph 3-21).

(d) Serial-Poll the local 37201A to receive its HP-IB status byte (Paragraph 3-87).

(e) Receive the local 37201A's 4-byte Talk-String, giving further information about its current state.

The local 37201A may also, if desired, Request Service to alert the controller of certain events. Remote 37201A's neither have an HP-IB address nor can they Request Service in their own right.

3-20 Many simple systems will have no need for the above addressed facilities, in which case these may be ignored. Care should be taken, however, that the local 37201A's address is set differently from all other devices in the whole system to avoid inadvertantly addressing the 37201A.

3-21 Multi-Point Operation

3-22 A Multi-Point (sometimes called Multi-drop) system allows one of a number of remote clusters of HP-IB devices to be accessed from a local station. As shown in Figure 3-2, the remote stations' modems are connected in parallel across a dedicated (leased or private) 4-wire full-duplex telephone circuit and in turn to the local station. The local station acts as the controlling master and can call each of the remote stations bringing them into transparent operation (one at a time only) with the local station's HP-IB devices.

The local station transmits and receives continuously, whilst remote stations receive continuously but with only the currently selected remote station transmitting at any one time. For this reason the modems must have their carrier controlled by the RS232C/V.24 Request-To-Send (RTS, circuit CA/105) line, so that when a remote 37201A is called, it can turn on the carrier and begin communicating with the local 37201A.

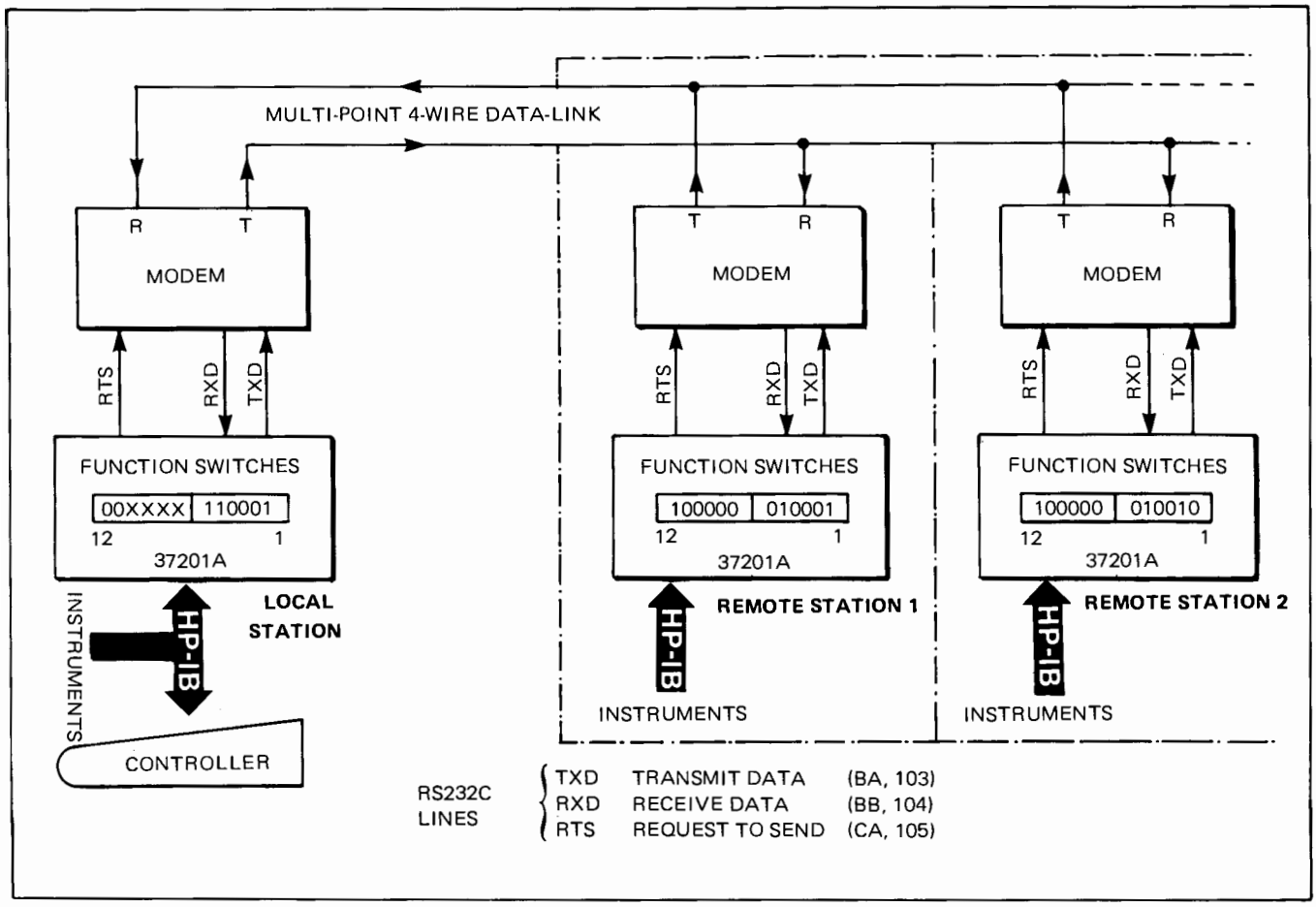


Figure 3-2 General Configuration for Multi-Point Operation

3-23 Each remote 37201A has a unique Multi-Point address, which has no connection whatsoever with HP-IB addresses, but is used by the "private" protocol between 37201A's to determine when a particular remote station should come on-line. When the controller wishes to bring a remote station on-line, it passes the station's Multi-Point address to the local 37201A as a Data-Byte in a HP-IB addressed instruction. The "private" protocol then automatically calls the remote station. The remote 37201A recognises its own Multi-Point address, then turns-on its modem's carrier and enables its data handling functions. Stations which recognise an address other than their own (i.e. all others) turn-off, if not already off. All remote 37201A's must have different Multi-Point addresses because only one station may be on-line at any one time. After a remote station has been brought on-line, transparent HP-IB transactions can proceed as in a simple two-station connection. *The Twisted-Pair connection medium cannot be used in a Multi-Point configuration.*

3-24 Automatic Dialling, Answering and Disconnection

3-25 The 37201A may be used in a system using automatic dialling over the switched telephone network. An RS366/V.25 compatible interface is provided to enable the 37201A to control suitable automatic calling (dialling) equipment. In order to dial-up a remote site, the local 37201A is addressed as an HP-IB device and sent the required telephone number as a string of HP-IB Data-Bytes which is then passed on to the automatic calling unit via the RS366/V.25 interface. The remote bus becomes transparently connected to the local bus once the dialled-up telephone channel has been established. For unattended operation, the modem at the remote site must be capable of automatically answering a telephone call.

3-26 Once the HP-IB transactions have been completed, the telephone channel must be disconnected at both ends, equivalent to putting a telephone handset "on-hook" after normal voice communication. In the 37201A, this is done by turning the Data-Terminal-Ready (DTR, circuit CD, 108/2) line to the modem OFF. Additionally, the Call-Request (circuit CRQ, 202) line to the Automatic Calling Unit is turned OFF by the local 37201A. At the local site, this disconnection is initiated either by an addressed HP-IB command to the 37201A or under the restrictions outlined in Paragraph 3-127, by using the front panel "DTR OFF" button. The remote 37201A disconnects by turning Data-Terminal-Ready OFF when no packets have been received for a period of 40 seconds with Data-Set-Ready (DSR, circuit CC, 107) still ON, indicating that the telephone channel is still connected. For unattended remote sites, this method of timed-out disconnection is essential because any switched network failure might otherwise leave the remote station isolated but still "off-hook" and therefore unable to receive any further calls since it would appear engaged.

3-27 Knowing when a String has been Sent

3-28 Due to the buffered nature of data transfer in the 37201A, it is possible for the HP-IB transactions at one end of the data-link to have been completed before all the data has been sent to the far end of the data-link. If the program in the HP-IB Controller disables the data-link in some way (e.g. by Disconnecting, Idling – see Paragraph 3-67, or by turning down a Multi Point station) immediately after sending data to the remote site, any data still in the transmit-buffer of the local 37201A will be lost.

3-29 Additionally, consider the case where some form of measurement system is separated by 37201A's and a serial data-link. It may be necessary to ensure that certain HP-IB commands have been received by the instruments at the remote site before undertaking a measurement. This could be done by having a sufficiently long wait period, but a faster and more reliable method is described below.

3-30 What is required in both of the above cases is a positive indication of when all the data in the local 37201A's buffers has reached the remote site. This is provided in the 37201A's by means of the "SRQ ON STRING SENT" function. This is enabled by means of an addressed instruction to the local 37201A, which will then Request Service (SRQ) when all the data in the buffers has been sent and acknowledged. The data-link may then be disabled or the measurement taken, as appropriate. Note that when using this function any HP-IB activity, including addressing the local 37201A itself, will put data into the buffers, so nothing must be done on the local bus in between enabling the function and the local 37201A Requesting Service.

3-31 Modem Interface Lines

3-32 When used with modems over the dial-up switched network, the 37201A will only turn ON Data-Terminal-Ready (DTR circuit CD, 108/2) if Data-Set-Ready (DSR circuit CC, 107) is OFF, and will only turn ON Request-To-Send (RTS circuit CA, 105) if both Data-Set-Ready is ON and Clear-To-Send (CTS circuit CB, 106) is OFF. This is also the case with leased (dedicated) circuit operation although normally, of course, Data-Terminal-Ready and Data-Set-Ready are not then used.

3-33 When a dialled-up connection has been established, the local 37201A will disconnect (go "on-hook") by turning Data-Terminal-Ready (and Request-To-Send) OFF in response to a "D" (disconnect) instruction (Paragraph 3-69), or by turning Data-Terminal-Ready OFF with the front-panel button (see Paragraph 3-127). The remote 37201A will automatically disconnect by turning OFF Data-Terminal-Ready (and Request-To-Send) when no data (specifically, no error-free packet) has been received for a period of 40 seconds with Data-Set-Ready still ON (DSR indicating that the line is still connected). Since the 37201A is unaware of whether the telephone data-link is leased (dedicated) or switched, this attempt at disconnection, which

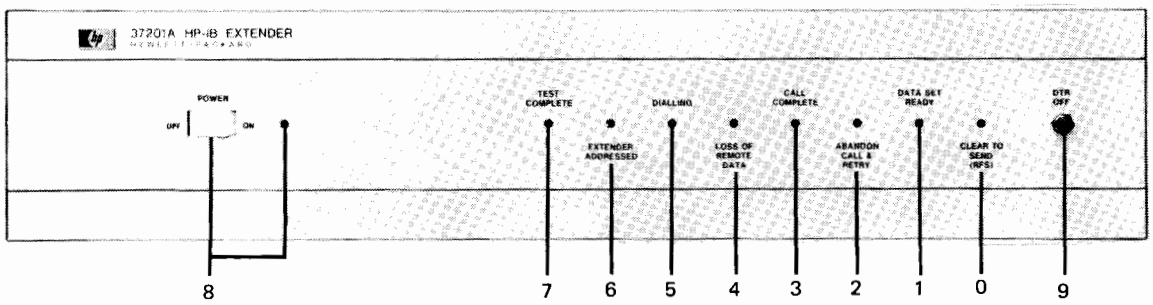
has no meaning for a leased circuit, will also occur in leased circuit operation if the data-link should be broken.

3-34 When a remote 37201A is used in Multi-Point configuration, it uses the Request-To-Send line to control the modem's carrier: the carrier being on when Request-To-Send is ON. The receive side of the remote 37201A is always enabled awaiting its own Multi-Point address so that it might respond accordingly.

3-35 A remote Multi-Point station requires Data-Set-Ready to be held ON, otherwise it will not respond to its Multi-Point address when called. In addition, a station which is currently addressed (on-line) will become unaddressed if Data-Set-Ready should go OFF. For *abnormal* circumstances, this may provide a convenient means of manually unaddressing a remote 37201A. Provided the modem puts Data-Set-Ready OFF when Data-Terminal-Ready goes OFF, pressing a remote 37201A's front-panel "DTR OFF" button will unaddress the Multi-Point station.

3-36 FRONT AND REAR PANEL FEATURES

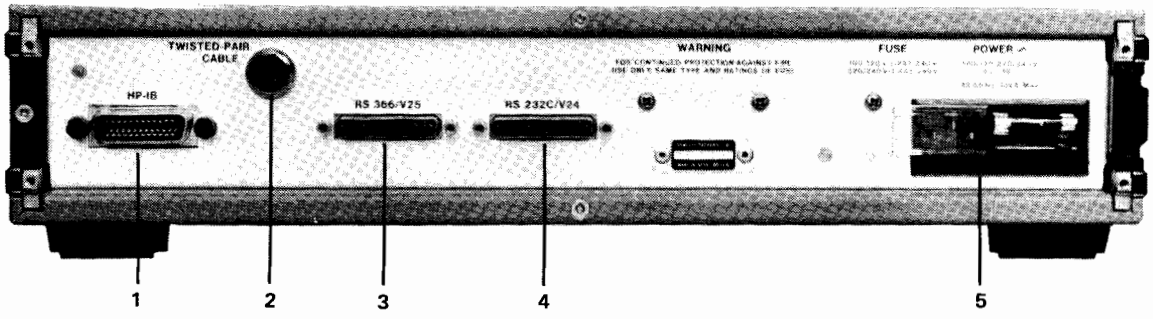
3-37 The front and rear panel features on the 37201A are described in Figure 3-3 and 3-4.



0. CLEAR TO SEND (RFS – Ready For Sending). This provides a visual indication of the state of the RS232C/V.24 modem line of the same name.
1. DATA SET READY. This provides a visual indication of the state of the RS232C/V.24 modem line of the same name.
2. ABANDON CALL & RETRY (ACR). This provides a visual indication of the state of the RS366/V.25 line of the same name. It is illuminated after a call to a remote system has been attempted by an automatic dialler, and the remote system has not responded within the time limit set by the ACR timer in the dialler. This indicator does not mean the call itself has been abandoned but serves only as an indication to the user, so that he may take action to abandon the call by sending instruction "D".
3. CALL COMPLETE. The call complete indicator comes ON 3 seconds after the DATA SET READY and CLEAR TO SEND (RFS) indicators are ON – indicating the call connection has been successful when using automatic calling.
4. LOSS OF REMOTE DATA. This gives an indication of a breakdown of communication between two 37201A HP-IB Extenders due to a failure of the full duplex transmission path, or of one of the 37201A's or associated equipment between them. In periods when no data is transmitted the 37201A's send "test" data at 4 second intervals, to test the transmission path. Should the test data fail to be received for a period of 8, 12 or 20 seconds depending on the bit rate, the LOSS OF REMOTE DATA indicator will come ON, (see Paragraph 3-12).

   Note: If the 'Idle' instruction has been sent to the local 37201A, then the LOSS OF REMOTE DATA indicator at both ends ceases to indicate correctly the integrity of the physical data-link and will come ON.
5. DIALLING. This is ON when the 37201A is used in conjunction with an automatic dialler, to dial a call to a remote system, and the call is not yet established.
6. EXTENDER ADDRESSED. This indicator comes ON when the 37201A is addressed in its own right by a HP-IB controller to perform a "non-transparent" function (see Paragraph 3-18).
7. TEST COMPLETE. This indicator shows the SELF-TEST routine has been carried out satisfactorily (position 15 on the Data Medium Switch), (see Paragraph 3-172).
8. POWER. The POWER switch, switches the ac supply ON or OFF. A power-on indicator is illuminated to give a visual indication of when the instrument is in the "power-on" condition.
9. DTR OFF (Data-Terminal-Ready). For as long as this switch is depressed, the Data-Terminal-Ready line on the RS232C/V.24 interface will be held in the OFF condition. Mainly used as a manual override to disconnect a dialled-up telephone link.

Figure 3-3 37201A HP-IB Extender Front Panel Features



1. Connector for the HP-IB; used to connect the 37201A to the HP-IB.
2. Connector for a twin twisted-pair cable; used for interconnecting 37201A's for distances up to 1000 metres.
3. RS366/V.25 connector; used for connecting the 37201A to a suitable automatic dialler. The interface conforms to EIA RS366 and CCITT V.25 recommendations for automatic calling units.
4. RS232C/V.24 connector; used for connecting the 37201A to a suitable modem. The interface conforms to EIA RS232C and CCITT V.24 recommendations for data communications equipment.
5. Power Module connection receptacle with fuse and line voltage selector. Figure 2-1 indicates the method of selecting the line voltage.

Figure 3-4 37201A HP-IB Extender Rear Panel Features

3-38 INTERNAL PRESET SWITCHES

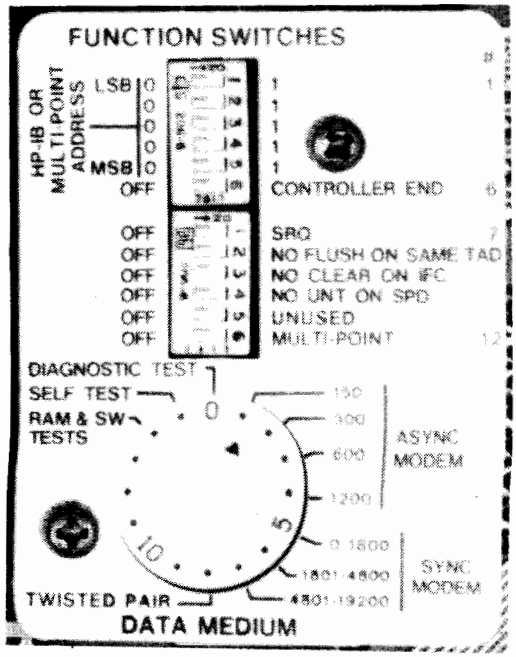


Figure 3-5 Function Switches and Data Medium Switch

3-39 The twelve FUNCTION SWITCHES and the DATA MEDIUM switch, illustrated in Figure 3-5 are located inside the 37201A. Since the positions of these switches are examined approximately every second by the 37201A's firmware, the switch positions may be altered whilst the 37201A is powered ON. Exceptions to this are the RAM AND SWITCH TEST, SELF TEST, and DIAGNOSTIC TEST; each of which will only be implemented if the 37201A is powered ON with the DATA MEDIUM switch in the appropriate position.

WARNING

Access to the Data Medium and Function Switches requires the removal of the instrument top cover which may expose hazardous potentials. Changing the settings of the Data Medium and Function Switches with power applied to the instrument should only be attempted by service trained personnel who are aware of the hazard involved.

3-40 Function Switches

3-41 These switches, numbered 1 to 12, allow the 37201A to be configured in different ways.

3-42 Function Switches 1 to 5: "HP-IB OR MULTI-POINT ADDRESS"

3-43 At the local station (i.e. the Controller end), these switches define the HP-IB address of the local 37201A so that it may be addressed, if necessary, to execute one of its non-transparent functions. *Even if these functions are not used, the local 37201A's HP-IB address must be set to a value different from all other addresses in the whole extended system.* At a remote station these switches have no meaning, except in a remote Multi-Point station where the switches define the Multi-Point address of that 37201A. Equivalent forms of device address are shown in Table 3-1. The address is normally factory preset to Listen Address of ASCII "1" (Talk Address of ASCII "Q").

3-44 Function Switch 6: "CONTROLLER END"

3-45 At the local station (i.e. the Controller end), this switch must be ON, and at remote stations it must be OFF. For simple systems comprising a Talk-Only device, a Listen-Only device and no Controller, switch 6 at the two ends should still be set differently.

Table 3-1 Device Addresses

Multi-Point Address or HP-IB Listen-Address (ASCII)	HP-IB Talk-Address (ASCII)	Device-Set Address Switches		
		Function Switches 5 4 3 2 1	Octal Code	Decimal Code
SP	@	0 0 0 0 0	00	0
!	A	0 0 0 0 1	01	1
"	B	0 0 0 1 0	02	2
#	C	0 0 0 1 1	03	3
$	D	0 0 1 0 0	04	4
%	E	0 0 1 0 1	05	5
&	F	0 0 1 1 0	06	6
'	G	0 0 1 1 1	07	7
(	H	0 1 0 0 0	10	8
)	I	0 1 0 0 1	11	9
*	J	0 1 0 1 0	12	10
+	K	0 1 0 1 1	13	11
,	L	0 1 1 0 0	14	12
-	M	0 1 1 0 1	15	13
.	N	0 1 1 1 0	16	14
/	O	0 1 1 1 1	17	15
0	P	1 0 0 0 0	20	16
1	Q	1 0 0 0 1	21	17
2	R	1 0 0 1 0	22	18
3	S	1 0 0 1 1	23	19
4	T	1 0 1 0 0	24	20
5	U	1 0 1 0 1	25	21
6	V	1 0 1 1 0	26	22
7	W	1 0 1 1 1	27	23
8	X	1 1 0 0 0	30	24
9	Y	1 1 0 0 1	31	25
:	Z	1 1 0 1 0	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

Note: Multi-Point addresses are formed by the local 37201A from the lowest five bits of the character following "M" in the Multi-Point select instruction (see Paragraph 3-84). The ASCII characters in the first column above are, however, recommended for Multi-Point address designation since they are the ones used in byte 3 of the Talk-String to indicate which Multi-Point station is currently raised.

3-46 Function Switch 7: "SRQ"

3-47 When ON, this allows the local 37201A to Request Service (SRQ) in its own right. It has no effect on the 37201A's ability to support transparently HP-IB devices which may use the Service Request function. The local 37201A can Request Service, in its own right, for four reasons described in Paragraph 3-87.

The switch should be set OFF if these functions are not needed or if there is no routine in the Controller to deal with a Service Request. In a remote 37201A the switch has no meaning, and should be set OFF.

3-48 Function Switch 8: "NO FLUSH ON SAME TAD"

3-49 This switch is usually set to OFF. When set ON in the local 37201A, it prevents the remote transmit-buffer and local receive-buffer from being "flushed" (data destroyed) each time a new Talk Address (TAD) is the same as the last Talk Address (see Paragraph 3-107). In a remote 37201A the switch has no meaning, and should be set OFF. The action of this switch may be duplicated within the body of a program by use of the pair of addressed instructions "E" (for ON) and "F" (for OFF) – see Paragraph 3-75.

3-50 Function Switch 9: "NO CLEAR ON IFC"

3-51 This switch is usually set to OFF. When set ON in the local 37201A, it prevents the local transmit-buffer and remote receive-buffer from being cleared (data destroyed) when the Interface-Clear (IFC) message is sent. The IFC message then retains its correct position in the string of data being transmitted to the remote bus, see Paragraph 3-97. In a remote 37201A the switch has no meaning, and should be set OFF.

3-52 Function Switch 10: "NO UNT ON SPD"

3-53 This switch is usually set to OFF. When set ON in the local 37201A it prevents the addition of an Untalk (UNT) command after a Serial-Poll Disable (SPD) command in transmission to the remote station (see Paragraph 3-108). In a remote 37201A the switch has no meaning, and should be set OFF. The action of this switch may be duplicated within the body of a program by use of the pair of addressed instructions "V" (for ON) and, "U" (for OFF) – see Paragraph 3-77.

3-54 Function Switch 11: "UNUSED"

3-55 This switch is not used, and should be set OFF.

3-56 Function Switch 12: "MULTI-POINT"

3-57 In the local 37201A, this switch must be set OFF. In remote 37201A's this switch should also be set OFF, unless the station is a remote member of a Multi-Point configuration, in which case it should be set ON.

3-58 Data Medium Selector Switch

3-59 This switch selects the Data-Link medium that the 37201A will use for communication. Local and remote 37201A's must have the same setting. The switch also allows selection of three test positions. Of the 16 possible switch positions only the following 11 are used:

Positions 1 to 4:

These positions select signalling rates of 150, 300, 600 or 1200bps respectively when transmitting data in conjunction with an asynchronous modem.

Positions 5 to 7:

These positions are selected when the 37201A is used in conjunction with a synchronous modem, in which case the exact speed is determined by the modem clock. The three positions cover clock speeds up to 19200bps in the following ranges:

5 up to 1800bps
6 1801 to 4800bps
7 4801 to 19200bps

Position 8:

This position is selected when the 37201A is used with the twisted-pair cable to communicate with another 37201A over distances up to 1000 metres. The signalling rate is fixed at 20kbit/s.

Positions 9, 10, 11, 12, 13:

These are not used.

Position 14:

This position selects two separate but simultaneous tests. The RAM TEST facilitates Signature-Analysis testing of the 37201A's Random Access Memory. The SWITCH TEST enables the FUNCTION SWITCHES and the DATA MEDIUM switch to be tested in conjunction with the front panel lamps.

Position 15:

This position selects the 37201A's SELF-TEST mode (see Paragraph 3-171).

Position 0:

This position selects the 37201A's desk-top computer DIAGNOSTIC TEST mode (see Section 8).

3-60 SIMPLIFIED BASIC OPERATING INFORMATION

3-61 The following paragraphs describe the basic procedures for operating the 37201A. Information on installation and other equipment used with the 37201A is given in Sections I and II.

3-62 Basic transparent operation of the 37201A usually requires only the following steps:

(a) Select the appropriate data-link medium required, on the DATA-MEDIUM switch. Both local and remote 37201A's must have the same setting.

(b) FUNCTION SWITCHES 1 to 5 define the local 37201A's HP-IB address for "non-transparent" functions. *Even if you do not wish to address the 37201A, these switches must be set to an address different from all others in the total (extended) HP-IB system.*

(c) In the local 37201A (Controller End), FUNCTION SWITCH 6 must be set ON, and in the remote end it must be set OFF. In a simple system with a Talk-Only device, a Listen-Only device and no Controller, this switch should be set differently at the two ends.

(d) In a local 37201A, FUNCTION SWITCHES 7 to 10 should usually be OFF, and FUNCTION SWITCHES 11 and 12 must always be OFF. In a remote 37201A, FUNCTION SWITCHES 1 to 5, and 12, should usually be OFF, and FUNCTION SWITCHES 6 to 11 must always be OFF.

More detailed information about the use of the FUNCTION SWITCHES and about the 37201A's addressed instructions and non-transparent functions can be found throughout this section.

3-63 Note that the 37201A cannot perform its normal function if powered-on with the DATA MEDIUM switch in any of its three test positions (positions 14, 15 and 0) even if the switch position is changed subsequently.

3-64 When the pair of 37201A's are in communication with each other, the front-panel LOSS OF REMOTE DATA lamp will go out at both ends (provided the 'Idle' instruction has not been used). This is true even if no HP-IB activity is taking place, and also if no HP-IB devices are connected. The LOSS OF REMOTE DATA indicator gives a very quick and powerful means of determining successful communication between 37201A's, even although the rest of the HP-IB system may not yet be functioning.

3-65 ADDRESSED INSTRUCTIONS TO THE HP-IB EXTENDER

3-66 A number of addressed instructions are available, which when sent to the local 37201A, enable the behaviour of the local, or both 37201A's to be controlled and modified. These are as follows:

3-67 Instructions "I" and "A"

3-68 The "I" instruction sets the local 37201A into the "Idle" mode, which means that communication with the remote station ceases, without physical disconnection of the data-link. As explained in Paragraph 3-112 and 3-113, this enables HP-IB activity either to progress at a faster rate on the local bus than the data-link rate might otherwise allow, or to continue following complete failure in the data-link or in remote station devices. The "A" instruction (Active) reverses the action of "I" and returns the system to normal extended operation. The 37201A powers-on in the Active mode.

3-69 Instruction "D"

3-70 The "D" instruction is used to "Disconnect" a switched-network telephone modem connection. It causes the RS232C/V.24 interface line Data-Terminal-Ready (and Request-To-Send) and the RS366/V.25 line Call-Request to go off in the local 37201A. The remote 37201A will also disconnect as described in Paragraph 3-26 and 3-33. Following disconnection, the local 37201A is automatically placed in the "Idle" mode.

3-71 Instruction "S"

3-72 Correct use of the "S" instruction ensures that the local 37201A has completed sending data to the remote station before the Controller disconnects a switched-network connection, Idles the local 37201A, or selects a new Multi-Point station. The "S" instruction usually follows a data-message and precedes a "D", "I" or "M" (Multi-Point) instruction. When the entire data-message has been sent and acknowledged, the local 37201A will Request Service (SRQ) (provided that FUNCTION SWITCH 7 is ON), letting the Controller know that it may now send the "D", "I", or "M" instruction.

3-73 Note that it may be advisable to carry out a Serial-Poll immediately preceding the "S" instruction to clear any existing SRQ's from other devices. As well as the Service Request, the 37201A sets Status-Byte bit-DI08 when the data-message has been sent, and this bit should be checked along with the Request Service bit (DI07) to ensure that the Service Request (SRQ) did in fact come from the 37201A. It is not satisfactory to continuously Serial-Poll the 37201A to examine Status-Byte bit-DI07, whilst ig-

noring Service Requests, since this will prevent the transmit-buffer from emptying and will make the 37201A think that the data-message has not yet been sent.

3-74 As an alternative to this procedure, it is satisfactory (although not as fast and reliable) simply to leave a long enough pause following the last data-message, before sending the "D", "I" or "M" instruction.

3-75 Instructions "F" and "E"

3-76 Instruction "E" addressed to the local 37201A, prevents the remote transmit-buffer and local receive-buffer from being "flushed" (data destroyed) every time a new Talk-Address is issued which was the same as the last. This is discussed in Paragraph 3-107. Instruction "F" reverses the action of "E" and causes these buffers to be flushed on every Talk-Address; the normal situation. FUNCTION switch 8 called NO FLUSH SAME TAD duplicates the action of "F" and "E", with "F" corresponding to OFF and "E" corresponding to ON. The 37201A powers-on as if "F" had been sent, unless FUNCTION SWITCH 8 is ON. The last action (either "E", "F", or a change in FUNCTION SWITCH 8) remains in force until the next action.

3-77 Instructions "U" and "V"

3-78 Instruction "V" addressed to the local 37201A, prevents the addition of the Untalk (UNT) command after a Serial-Poll Disable (SPD) command in transmission to the remote station. This is discussed in Paragraph 3-108. Instruction "U" reverses the action of "V" and causes the Untalk to be added following Serial-Poll-Disable; the normal situation. FUNCTION SWITCH 10 called NO UNT ON SPD duplicates the action of "U" and "V" with "U" corresponding to OFF and "V" corresponding to ON. The 37201A powers-on as if "U" had been sent, unless FUNCTION SWITCH 10 is ON. The last action (either "V", "U", or a change in FUNCTION SWITCH 10) remains in force until the next action.

3-79 Instructions "Q" and "R"

3-80 Instruction "R" addressed to the local 37201A clears the local transmit-buffer when the local 37201A recognises that there has been LOSS OF REMOTE DATA (provided that FUNCTION SWITCH 7 (SRQ) is ON). The local 37201A also requests service by sending the SRQ message. This clearing avoids handshake "hold-up" and allows further bus activity as explained in Paragraph 3-101. Instruction "Q" reverses the effect of "R". The 37201A powers-on as if "Q" had been sent.

LOSS OF REMOTE DATA is controlled by the same criteria as the front-panel lamp of the same name (see Paragraph 3-12).

3-81 Instructions "N" and "T"

3-82 Instructions "N" and "T" are used when controlling an automatic dialling unit. Valid ASCII characters following "N" and preceding "T" are used by the local 37201A to form the 4-bit digits which are sent to the dialler as the telephone number to be dialled (including control characters). As an example, the total instruction to the local 37201A might take the following form:

N 9 D 123 4567 C T

Each of the 16 possible 4-bit digits can be sent to the dialler by use of the appropriate ASCII character in the string between "N" and "T", as detailed in Table 3-2. All other ASCII characters (including spaces which may be inserted for visual convenience) between "N" and "T", are accepted and then ignored by the 37201A. Note that a "D" which may be used between "N" and "T" has nothing to do with the addressed instruction "D" used for Disconnection. Since the 37201A handles the digits singly, there is no limit to the length of the telephone number which may be dialled.

Table 3-2 Dialling Character Set

ASCII Character Sent to 37201A	RS366 Digit	V.24/25 Digit	RS366/V.25 Signal Circuit States			
			NB8	NB4	NB2	NB1
0	0	0	0	0	0	0
1	1	1	0	0	0	1
2	2	2	0	0	1	0
3	3	3	0	0	1	1
4	4	4	0	1	0	0
5	5	5	0	1	0	1
6	6	6	0	1	1	0
7	7	7	0	1	1	1
8	8	8	1	0	0	0
9	9	9	1	0	0	1
A	☆	Unassigned	1	0	1	0
B	#	Unassigned	1	0	1	1
C	EON	EON	1	1	0	0
D	Unassigned	SEP	1	1	0	1
E	Unassigned	Unassigned	1	1	1	0
F	Unassigned	Unassigned	1	1	1	1

Note: Use of EON (End Of Number) and SEP (Separation) control characters depends on the telephone equipment and dialler.

3-83 At power-on, it is advisable in an automatic dialling station, to "Idle" the local 37201A as described in Paragraph 3-116. Following a successful dialling sequence, CALL COMPLETE will come ON and the local 37201A will automatically become "Active".

3-84 Instruction "M"

3-85 Instruction "M" addressed to the local 37201A indicates that the character immediately following is to be used by the 37201A to form a Multi-Point address. The lowest five bits of the ASCII character immediately following (in the same Data-Byte string) are used by the "private" protocol as the address of the Multi-Point station to be raised. For example, the complete instruction "M3" sent to the local 37201A will result in the remote 37201A being raised which has its FUNCTION SWITCHES 5 to 1 set to 10011 (see Table 3-1). All other remote 37201A's will be automatically turned-down. ASCII characters in the left-hand column of Table 3-1 are recommended for use as Multi-Point address characters.

Note: When no remote station is currently raised, Loss of Remote Data will come ON.

3-86 The local 37201A must be "Active" before a remote station can be Multi-Point addressed. With an "Idle" 37201A the "A" instruction required to make it "Active" can be combined with the Multi-Point addressing instruction to give, for example, the instruction "AM3".

Table 3-3 Summary of Addressed Instructions and Talk String

Command	Description
*"A"	Activate
"I"	Idle
"N . . . . . T"	Dial ("N" also Idles, "T" also Activates)
"D"	Disconnect (also Idles)
"S"	Please SRQ when string has been received by remote end.
"M"	Multi-Point Address follows
"E" or switch 8 ON	Flush EXCEPT on same Talk Address as last one sent
"F" or switch 8 OFF	Flush on ALL Talk Addresses
"U" or switch 10 OFF	ADD Untalk to Serial Poll Disable
"V" or switch 10 ON	OMIT Untalk from Serial Poll Disable
*"Q"	DISABLE clear of Local Transmit Buffers on LRD and SRQ
"R"	ENABLE clear of Local Transmit Buffers on LRD and SRQ

Note: * = power on condition

TALK STRING

Byte	Bit							
	8	7	6	5	4	3	2	1
1	STRING SENT	RQS	X	LRD	CALL COMP	ACR	DSR	CTS
2	0	0	0	0	0	DLO	PWI	COS
3	0	0	1	(	Multi-Point Station Active			)
4 Set	0	"A"	"S"	"R"	(SW10, "V")	SW9	(SW8, "E")	SW7
4 Cleared		"I"		"Q"	(SW10, "U")	SW9	(SW8, "F")	SW7

3-87 SERVICE REQUEST AND SERIAL-POLLING THE EXTENDER

3-88 The local 37201A (but not a remote 37201A) can Request Service in its own right if FUNCTION SWITCH 7 (SRQ) is ON. This function is of the non-transparent category and does not affect the ability of the 37201A to support HP-IB instruments which might make use of the Service Request function themselves. When it Requests Service (sets SRQ), the 37201A sets the RQS bit (DI07) in its Status Byte in acccordance with the IEEE-488 standard. The remaining seven bits in the byte provide information about which of four possible causes gave rise to the Service Request, and some additional information. The 37201A may wish to alert the Controller for the following reasons:

(a) LOSS OF REMOTE DATA has occurred indicating a failure in the data-link or in the remote 37201A. This sets bit DI05 in the Status-Byte.

Note: LOSS OF REMOTE DATA becoming true does not cause an SRQ if the 37201A is 'Idle', as would be the case after a disconnect "D" instruction.

(b) The automatic calling unit (if in use) has turned its ABANDON CALL AND RETRY (ACR) line ON during a dialling sequence to indicate that the Controller should terminate the call attempt. This sets bit DI03 in the Status-Byte.

(c) CALL COMPLETE has occurred indicating a successful call connection following a dialling sequence. This sets bit DI04 in the Status-Byte.

(d) SRQ ON STRING SENT has occurred following an "S" instruction (see Paragraph 3-27 and 3-71 to 3-74). This sets bit DI08 in the Status-Byte.

Although the 37201A will Request Service only if FUNCTION SWITCH 7 (SRQ) is ON, the DI03, DI04 and DI05 bits in the Status-Byte will nevertheless be set appropriately even if it is OFF. DI08 (SRQ ON STRING SENT) in the Status-Byte will only be set if FUNCTION SWITCH 7 (SRQ) is ON, however.

3-89 Upon Serial-Polling the local 37201A, the RQS-bit (DI07) of the Status-Byte will be cleared in accordance with IEEE-488 standard, and the SRQ ON STRING SENT bit (DI08) will also be cleared if appropriate. The complete Status-Byte is as follows:

DI08: SRQ ON STRING SENT. This indicates that transmission of data to the remote end has been completed following an "S" instruction, if FUNCTION SWITCH 7 is ON.

DI07: RQS. Indicates the 37201A has Requested Service – as defined by IEEE-488 standard.

DI06: Not used.

DI05: LOSS OF REMOTE DATA. This indicates failure in the data-link or the remote 37201A.

DI04: CALL COMPLETE. This indicates that call connection has been successfully completed following a dialling sequence.

DI03: ABANDON CALL AND RETRY. Indicates the state of the RS366/V.25 line of the same name and that the dialler has signalled unsuccessful completion of the call attempt. The Controller's next action should be to send instruction "TD" to the local 37201A. The "T" ensures that the dialling digit string is terminated.

DI02: DATA SET READY. Indicates the state of the RS232C/V.24 line of the same name.

DI01: CLEAR TO SEND (READY FOR SENDING). Indicates the state of the RS232C/V.24 line of the same name.

3-90 In accordance with IEEE-488 standard, the local 37201A can be Serial-Polled at any time, even if there has been no Service-Request (SRQ).

3-91 ADDRESSING THE 37201A TO TALK

3-92 The local 37201A (but not a remote 37201A) may be addressed to talk in its own right. This function is of the non-transparent category and does not affect the 37201A's ability to support HP-IB instruments which Talk over the extended system.

3-93 When addressed to talk, the local 37201A will send a fixed length Talk-String of four Data-Bytes; the four bytes are not followed either by Carriage-Return or Line-Feed, but EOI is asserted along with Byte 4. The four bytes give information about the current state of the local 37201A and its interfaces, as follows.

BYTE 1: Is identical to the Status-Byte described in Paragraphs 3-87 to 3-89, and is reproduced in the Talk-String for convenience. However, unlike Serial-Polling the 37201A, neither DI07 or DI08 in this byte will be cleared.

BYTE 2: Gives information about three of the RS366/V.25 dialler control lines, (0 indicates OFF). The other five lines are unused.

- DI03: Shows the current state of the DATA LINE OCCUPIED (DLO) line.
- DI02: Shows the current state of the POWER INDICATION (PWI) line.
- DI01: Shows the current state of the CALL ORIGINATION STATUS (COS) line. Other names for this line include DISTANT STATION CONNECTED and DATA SET STATUS.

BYTE 3: Is an ASCII character indicating the last Multi-Point station successfully addressed. The byte will be one of the ASCII characters in the left-hand column of Table 3-1 unless no Multi-Point station is active, in which case the byte will be the ASCII character "?". When a remote 37201A is Multi-Point addressed by the local 37201A in response to an "M" instruction, the remote 37201A responds by returning the value of its address switches (FUNCTION SWITCHES 1-5) to the local 37201A as confirmation that it has been successfully addressed. It is an ASCII character formed from these returned five bits which the local 37201A uses as Byte 3.

BYTE 4: Gives information about the local 37201A's configuration, as defined by certain of the FUNCTION SWITCHES and addressed instructions.

- DI08: Unused.
- DI07: "1" if the 37201A is "Active", and "0" if "Idle".
- DI06: "1" if the "S" instruction has been sent and the transmit buffer is not yet empty.
- DI05: "1" if instruction "R" has been sent, and "0" if "Q" has been sent or at power-on.
- DI04: "1" if NO UNTALK ON SERIAL POLL DISABLE is selected either by a transition to ON in FUNCTION SWITCH 10 or by a "V" instruction; and "0" following a transition to OFF in the switch or a "U" instruction. At power-on the position of Function Switch 10 is read as if it had just been changed to it's current position (since only transitions in switch position are read).
- DI03: Gives the position of FUNCTION SWITCH 9 (NO CLEAR ON IFC); "1" indicates ON.
- DI02: "1" if NO FLUSH ON SAME TALK ADDRESS is selected either by a transition to ON in FUNCTION SWITCH 8 or by an "E" instruction; and "0" following a transition to OFF in the switch or an "F" instruction. At power-on the position of Function Switch 8 is read as if it had just been changed to it's current position (since only transitions in switch positions are read).
- DI01: Gives the position of FUNCTION SWITCH 7 (SRQ); "1" indicates ON.

3-94 DIFFICULTIES SOMETIMES INTRODUCED BY HP-IB EXTENSION

3-95 Extension of an HP-IB system may occasionally introduce anomalies which were not anticipated at the time when IEEE Standard 488-1975, and later standards, were created. These anomalies arise for several reasons: (a) the Standard defines transfer in parallel bytes with no communication delay or buffer-queues between devices on the Interface; (b) in some places the Standard is sufficiently loosely defined to allow designers slightly different interpretations of how their interfaces should operate; and (c) the implications of telephone data-link breakdown in an unattended system have to be considered. For most devices, particularly in simple systems, the following discussion can usually be ignored.

3-96 For all compatible devices to behave as expected, it will sometimes be necessary for the user to select one of two possible operating modes in certain features of the 37201A. The reasons for these, and what occurs in each case is explained below. Selection of operating mode is either by one of the internal hardware FUNCTION SWITCHES, or by an addressed instruction to the local 37201A. In two cases, a pair of addressed functions duplicate the ON/OFF action of a switch, and allow the operation of the 37201A to be modified within an HP-IB program as well as manually.

3-97 Interface Clear. The HP-IB Interface Clear (IFC) message is intended as an abortive means of clearing down the system to a known initial state with all talkers and listeners unaddressed. This is particularly useful if a program has produced unintended results. In such a situation it is usually unimportant whether or not messages immediately preceding IFC are lost. In its normal mode of operation, the 37201A assumes this to be the case and clears (destroys) all data in outward transmission (local-transmit and remote-receive buffers), as well as putting out the IFC message at the remote end.

It also clears all incoming data (remote-transmit and local-receive buffers), except SRQ messages in transit from the remote end, since IFC does not inhibit a device from requesting service. Buffer clearing is necessary otherwise the next bus action following the IFC might be the result of the buffer contents appearing on the bus instead of the Controller's next action.

3-98 Some HP-IB programmers may view the role of IFC as not being purely abortive and might wish to use it simply as a means of unaddressing all talkers and listeners from within the body of a program (although this is not recommended). In this case it would be unacceptable to destroy

data preceding IFC in the local-transmit and remote-receive buffers since program flow, immediately prior to the Controller sending IFC, would be unexpectedly destroyed.

3-99 This second usage of the IFC message is also accomodated by the 37201A. When FUNCTION SWITCH 9 is set ON in the local 37201A, the local-transmit and remote-receive buffers are not cleared by IFC. The remote-transmit and local-receive buffers (except SRQ messages) are cleared, however, since they are assumed to contain data (if any) which the Controller could neither have anticipated nor wanted following the IFC. In this mode, the IFC message retains its correct relative position in the queue of data being sent to the remote site.

3-100 IFC also clears any packets of data in transit, in addition to buffer contents as described.

3-101 Buffer Clearing on LOSS OF REMOTE DATA

3-102 When Serial-Polled or addressed to give its 4-byte Talk-String, the local 37201A can supply useful information about the state of its interfaces and the data-link. This aids interpretation of system faults (even within an automatic and unattended local station), the most serious of which is likely to be a failure of the data-link resulting in complete loss of communication with the remote site. In this situation, local transmit-data may rapidly fill up the transmit-buffer. When full, the local 37201A's HP-IB handshake sequence will hold up the Source of data as its normal (and only) means of indicating inability to cope with more data.

After a period of 8 seconds (12 seconds at 300bps and 20 seconds at 150bps), the LOSS OF REMOTE DATA (LRD) bit in the Status-byte and in the Talk-String will be set to indicate failure in either the data-link or the remote 37201A.

3-103 Under such a hold-up condition, the Controller's only way of determining what has happended is by Serial-Polling the local 37201A to examine the LRD bit in the Status-Byte. If the handshake is held up, Serial-Polling is unfortunately not possible in normal operation. To accommodate this situation an additional feature, enabled by an addressed instruction "R" (and disabled by instruction "Q" – see Paragraph 3-79) clears the local transmit-buffer (data destroyed) – thus releasing the handshake and enabling a Serial-Poll or other subsequent Controller action to take place. Of course data is destroyed, but a data-link failure results in complete loss of remote control anyway. The transmit-buffer clearing happens only if LOSS OF REMOTE DATA (LRD) occurs with the SRQ switch (FUNCTION switch 7) ON and with addressed instruction "R" in force (i.e. "R" has not been cancelled by "Q" as it will be at power-on).

3-104 This clearing is also useful since it allows the Controller, to send the instruction "I" to the local 37201A which idles the extension functions allowing the local bus to continue operation even although the remote bus may have failed (see Paragraph 3-112).

3-105 Continuous Talkers

3-106 When addressed to Talk, most devices issue a finite number of Data-Bytes and then stop. Some instruments, however, have been designed to continue issuing Data-Bytes until a different Talk Address or Untalk (UNT) is sent. Should such an instrument be at the remote location, any Data-Bytes in transit to the local end when a new Talk-Address is sent might be incorrectly interpreted by the Controller or other Listener as coming from the new Talker. For this reason, normally the 37201A's automatically Flush out the remote transmit-buffer and the local receive-buffer when a Talk-Address is sent, destroying data in transit since it is neither required nor expected. Any SRQ messages in transit are not destroyed.

3-107 Most Controllers can command certain Talkers to send their sequence of Data-Bytes either by issuing a Talk and a Listen address once prior to the required string, or by issuing a new (repeat) Talk address before each new byte of the string. If the Controller is using the latter (less efficient) mode, the Flush function will clearly destroy wanted data. An alternative user-selectable mode is provided whereby the buffer Flush is prevented when an issued Talk Address is the same as the previous one. This mode is enabled by setting FUNCTION SWITCH 8 to ON in the local 37201A. Alternatively, it can be enabled by addressed instruction "E" (and disabled by instruction "F") – see Paragraph 3-75.

3-108 Talking Following Serial-Poll

3-109 Having issued a Status-Byte during a Serial-Poll and received a Serial-Poll-Disable (SPD) a few devices follow the non-recommended practice of continuing to issue Data-Bytes. This is a general bus anomaly which could cause difficulty for the 37201A, since such a device at the remote end would fill up the buffers with (probably) unwanted data. To overcome this problem, the 37201A adds the Untalk (UNT) message after every Serial-Poll-Disable (SPD) message in transit to the remote end.

3-110 If it should be desired that such a device continue issuing Data-Bytes following a Serial-Poll then an alternative user-selectable mode is provided which prevents the addition of UNT to SPD. This mode may be enabled by addressed instruction "V" (and disabled by instruction "U") – see Paragraph 3-77.

3-111 Extender's Idle Mode

3-112 If an unattended remote site or its associated data-link fails such that data cannot move or the remote handshake is held up, then the local bus will also stop almost immediately because the local 37201A must stop its handshake sequence. To avoid local instruments being disabled by a remote fault, a user-selectable mode is provided whereby the extension functions of the 37201A's are placed in an "Idle" condition. The "Idle" mode is enabled by sending the local 37201A the addressed instruction "I". To return to the normal "Active" mode of operation, the addressed instruction "A" should be sent (see Paragraph 3-67).

3-113 When Idle, the local 37201A completes the local handshake but takes no active part in bus operation. Because there is no communication with the remote site, the local bus with its 37201A in Idle mode will run very much faster (maximum at least 2400 Data-Bytes per second) than the limited speed that the data-link will otherwise allow. Use of the Idle and Active modes within a program will often enable local bus transactions to proceed at a pace unimpeded by data-link speed.

3-114 The "I" instruction also clears all buffers so that new data following a subsequent "A" (Active) instruction will not be unwittingly preceded by unwanted data. If the "Idle" instruction has been sent to the local 37201A, then the LOSS OF REMOTE DATA indicators at both ends cease to indicate correctly the integrity of the physical data-link and will turn ON.

3-115 To send an"I" instruction following a data-link failure, it will often be necessary to have first made use of the mode which clears the buffers on "LOSS OF REMOTE DATA" (see Paragraph 3-101), to guarantee that the local handshake is not held up by the failure.

3-116 Use of the "Idle" instruction may often be necessary in a system where connection is made using manual or automatic dialling or in a Multi-Point System. Since a local 37201A powers-on in the "Active" state, the 37201A in a local station will immediately attempt to communicate with a non-existent remote station (before the dialled connection has been made). After the first few HP-IB transactions (between local devices) have been made, the transmit buffer becomes full and the local bus handshake is held-up by the 37201A since it cannot cope with any more data. At this point no useful bus activity can take place (except sending IFC with FUNCTION SWITCH 9 set OFF). To avoid this type of hold-up, it is recommended that the first action taken by the Controller after system power-on is to send the "I" instruction to the 37201A. Making the "I" instruction an early action ensures that the "I" will be accepted before the transmit buffer is full and the handshake is held-up. The foregoing discussion applies equally to a Multi-Point configuration before the first station is Multi-Point-addressed and brought on-line, but the local 37201A must be "Active" before a station can be Multi-Point addressed. When using the 37201A with Automatic Calling Equipment the 37201A will be placed in the Idle mode when addressed Instruction "N" is sent and in the Active mode when "T" is sent.

3-117 MAKING A DIALLED CONNECTION

3-118 When using the 37201A on telephone channels with Modems (Data Sets), with or without Automatic Calling Equipment, certain information can be gained about the telephone equipment as the call progresses or in the event of a system failure. It is necessary to read the Talk-String from the local 37201A (see Paragraph 3-91, and example controller program, Paragraph 3-141) in order to access the required information.

3-119 Using Automatic Calling Equipment

3-120 The following points should be noted when using the 37201A with Automatic Calling Equipment (Auto-Dialler) over the RS366/V.25 interface.

3-121 Before making the call, it is advisable to check the available indicators to ensure that the 37201A, Dialler and Modem are all in the correct state to commence as follows:

OFF:	CLEAR TO SEND (CTS)	Talk-String Byte 1, DI01
	: DATA SET READY (DSR)	Talk-String Byte 1, DI02
	: ABANDON CALL & RETRY (ACR)	Talk-String Byte 1, DI03
	: CALL COMPLETE	Talk-String Byte 1, DI04
	: DIALLING	37201A Front Panel Indicator
	: CALL ORIGINATION STATUS (COS)	Talk-String Byte 2, DI01
	: DATA LINE OCCUPIED (DLO)	Talk-String Byte 2, DI03
ON:	POWER INDICATION (PWI)	Talk-String Byte 2, DI02
	: LOSS OF REMOTE DATA	Talk-String Byte 1, DI05

3-122 If an indicator that should be OFF is in fact ON, a disconnect ("D") instruction should be sent to the 37201A and the state of the indicators re-examined. The ON state of PWI indicates that power is available in the Automatic Calling Equipment. If the 37201A's DIALLING indicator is already ON, it may be necessary to assert IFC before sending the "D" instruction. In this case, it is recommended that the instruction sent should be "TD", where the "T" guarantees that the dial-string is correctly terminated (if not already terminated), allowing disconnection to follow.

Note: The RS366 CALL ORIGINATION STATUS (COS) line is sometimes referred to as Data-Set-Status or Distant-Station-Connected.

3-123 Progress of the Call

3-124 When the 37201A is HP-IB addressed and sent the number to be dialled, the "EXTENDER ADDRESSED" and "DIALLING" indicators on the front panel should come ON. These indicate that the 37201A has been correctly addressed and the dialling sequence has begun. Dialling will not proceed unless the RS366 PRESENT NEXT DIGIT (PND) line is OFF, as it normally should be at this stage. Once the automatic call has been initiated, the 37201A will not respond to further HP-IB instructions until either ACR comes ON or CALL COMPLETE comes ON. However, in the event of failure in the Dialler which might result in neither of these happening, access to the 37201A may be gained by setting IFC.

3-125 ACR coming ON indicates that the Automatic Calling Equipment has failed to establish a suitable connection as would occur, for example, if the remote site was engaged (off-hook) or the call was mis-routed. If CALL COMPLETE does not come ON after a reasonable time then either DSR or CTS from the local modem has not come ON as it should. Once a call has been established, both DLO and COS should be ON. DLO indicates that the outgoing telephone channel is in use either by the 37201A's dialler or by other equipment, and COS indicates that connection has been made to the remote site and that the dialler has passed control of the channel to the modem.

3-126 When a call is correctly answered, CALL COMPLETE comes ON within four seconds of both DSR and CTS coming ON, LOSS OF REMOTE DATA goes OFF (after a short time), and the local 37201A becomes "Active" (DI07 in Byte 4 set). If the 37201A is enabled to SRQ (FUNCTION SWITCH 7 ON), then the RQS bit (DI07) in the Status-Byte will also be set. If LOSS OF REMOTE DATA does not go OFF in a reasonable period of time, but all the other indicators appear to be correct, then the local and remote 37201A's are still not in proper communication for some reason. If the remote 37201A is functioning correctly, but LOSS OF REMOTE DATA is ON, it will disconnect by putting DTR OFF after 40 seconds.

3-127 Terminating the Connection

3-128 If a call was made using Automatic Calling Equipment via the RS366/V.25 interface on the local 37201A, it is recommended that the call is normally terminated by means of the addressed instruction "D" and not by means of the front panel "DTR OFF" button. Usually this button should only be used to terminate a manually dialled call when no general purpose HP-IB controller (e.g. Desk-top Computer) is in use on the local bus since, unlike "D", it neither "Idles" the local 37201A nor turns OFF the Call Request (circuit CRQ) line to the Automatic Calling Equipment. Following disconnection, CALL COMPLETE, DSR and CTS should go OFF, and LOSS OF REMOTE DATA come ON after a short delay. If the SRQ switch (FUNCTION SWITCH 7) is ON in the local 37201A and the "D" instruction is used to effect disconnection, the 37201A nevertheless will not Request-Service when LOSS OF REMOTE DATA goes ON since it realises that the data-link was broken intentionally.

3-129 EXAMPLE PROGRAMS FOR THE HP-IB EXTENDER

3-130 The following programs are designed to be used with an HP 9825A Desk-Top Computer fitted with an HP 98034A HP-IB Interface. In addition, the 9825A Desk-Top Computer must be fitted with both the General I/O ROM and the Extended I/O ROM. For further details, see the Operating and Programming Manual for the HP 9825A Desk-top Computer. These programs are not intended to provide a solution to any particular programming problems, but rather to illustrate certain aspects of the way 37201A's may be used.

3-131 Note that in the terminology used by HP-IB (defined by IEEE Std. 488) the eight bits in a byte are numbered from 1 to 8 (DI01 to DI08), whereas in the terminology of the 9825A Desk-Top Computer, the bits are numbered 0 to 7. Thus, for example, the RQS bit of the Status-Byte is called DI07 but the 9825A calls this bit 6.

3-132 Service Request (SRQ) Subroutine

3-133 In both Example 1 (Dialling) and Example 3 (Multi-Point), a subroutine named "WAIT.SRQ" is used to handle Service-Requests (see Paragraph 3-87) from the local 37201A itself. For this subroutine to work, the SRQ switch (FUNCTION SWITCH 7) must be set ON in the local 37201A.

3-134 The subroutine first waits for the HP-IB SRQ line to go true and then checks to see that it was the 37201A ("Extender") that caused the SRQ. The subroutine stores the Status-Byte returned from the 37201A in Variable "H", and checks that the 37201A requested service as expected. This is done by setting bits in Variable "Z" in the same positions as one or more of the required bits in the 37201A Status-Byte before the subroutine is entered. If none of the required bits are present in the 37201A Status-Byte, then the "Incorrect SRQ" message is printed, the 37201A is returned to a defined state, and the program stops. This also happens if the SRQ line goes true due to an instrument other than the local 37201A requesting service.

3-135 Example 1 — Automatic Calling (Dialling)

3-136 The object of the program is to call a remote site using an Automatic Calling Unit (Dialler), write a message to an HP-IB device at that remote site, and then disconnect the call.

3-137 Program Details

3-138 The main section of the program starts at the label "CONTINUE" on Line 13 (see Figure 3-6). After an initial attempt, the program will call the remote site again if the call was not successful (indicated by ABANDON CALL & RETRY going ON), but will stop calling after 4 unsuccessful attempts. The SRQ ON STRING SENT function is used to ensure that the data reaches the remote HP-IB device before the call is terminated.

Use of Variables:

T – Try Counter, used to count up to 4 unsuccessful attempts to call the remote site, after which the program will stop.

```
0: "Dialling example f1":
1: dev "Extender",717,"Device",701
2: 0→T
3: gto "CONTINUE"
4:
5: "NEXT.TRY":
6: cmd "Extender","D"
7: T+1→T
8: fxd 0
9: prt "Failed to call",T
10: spc 1
11: if T>=4;end
12:
13: "CONTINUE":
14: rds("Extender")→B
15: cmd "Extender","N 123 4567 C T"
16: 12→Z
17: gsb "WAIT.SRQ"
18: if bit(2,H);gto "NEXT.TRY"
19: prt "Call in progress"
20: spc 1
21: wrt "Device","Message to remote site"
22: rds("Extender")→B
23: cmd "Extender","S"
24: 128→Z
25: gsb "WAIT.SRQ"
26: cmd "Extender","D"
27: prt "Call finished"
28: spc 1
29: end
30:
31: "WAIT.SRQ":
32: if bit(7,rds(7))=0;gto -0
33: rds("Extender")→H
34: if bit(6,H)=0;gto "ERROR.SRQ"
35: if band(Z,H)#0;ret
36:
37: "ERROR.SRQ":
38: prt "Incorrect SRQ"
39: spc 1
40: cli 7
41: cmd "Extender","TD"
42: end
*19062
```

Figure 3-6 Program Example 1

B – Used to dump the Status-Byte from the 37201A when clearing the RQS bit in that Status-Byte.

Z – Variable used to hold the required bits set following the 37201A's Service-Request. The variable is set in the main body of the program and used in subroutine "WAIT.SRQ".

H – Variable holding the Status-Byte from the 37201A following a Serial-Poll.

The program first clears the RQS bit (DI07) in the Status-Byte of the local 37201A (Line 14) and then sends the number to be dialled to the 37201A. Variable "Z" has bits 2 and 3 set (Decimal 12) corresponding to both CALL COMPLETE and ABANDON CALL & RETRY. If either of these 2 bits is set in the Status-Byte when the 37201A requests service, then the SRQ is valid and the program resumes at Line 18. If neither bit is set, then an error message is printed, a Disconnect instruction is sent to the 37201A, and the program stops (Lines 37 – 42).

3-139 If ABANDON CALL & RETRY was set in the Status-Byte, then the program branches to the label "NEXT. TRY", disconnects the local 37201A from the telephone channel, increments the try counter (variable "T") and then attempts to call the remote site once again provided that less than 4 unsuccessful attempts have already been made.

3-140 If CALL COMPLETE was set in the Status-Byte, then the message is sent to the "Device" at the remote site and the program prepares to disconnect the telephone channel at the local 37201A. The program uses the SRQ ON STRING SENT function to ensure that the message has been sent before disconnecting. The program clears the RQS bit (DI07) in the Status-Byte, sends the "S" instruction to the local 37201A and sets bit 7 (Decimal 128) in Variable "Z", corresponding to the SRQ ON STRING SENT bit in the Status-Byte. The program then uses the "WAIT.SRQ" subroutine to wait for a Service-Request for SRQ ON STRING SENT. When the SRQ is received, the "Call Finished" message is printed, the local 37201A is disconnected from the telephone channel and the program stops.

3-141 Example 2 – Read and Display the Extender's Talk-String

3-142 This program (see Figure 3-7) may be used to read the Talk-String from the local 37201A, and display it in a convenient form:

Use of Variables:

K – Counter for the loop "LOOP.1" (Lines 10-24) which prints out a binary representation of each byte of the Talk-String, and hence counts from 1 to 4.

L – Limit for the loop "LOOP.1". Set equal to the number of bytes in the Desk-Top Computer's transfer-buffer after the 37201A has sent all 4 bytes of the Talk-String.

J – Counter for the loop "LOOP.2" (lines 15-19) which assembles each bit of the binary representation of each byte, and hence counts from 0 (DI01) to 7 (DI08).

P – Current byte of the Talk-String read from the buffer "Input" at the start of each pass of the loop "LOOP. 1".

N – Used to save byte-3 of the Talk-String.

A – Variable used to accumulate a number which represents the binary form of any one byte in the Talk-String.

X – Variable which, starting at 1, increases by a factor of 10 for each pass of the loop "LOOP.2". Used in the assembly of the number stored in variable "A".

3-143 The program first reads the Talk-String from the local 37201A into the buffer "Input" (Line 5), and then waits for this transfer to be completed (Line 6). When all the data has been transferred into the buffer, the buffer status is no longer negative but equal to the number of bytes in the buffer, and is stored in the limit variable "L" (Line 8).

3-144 The outer Loop "LOOP.1" (Lines 10-24) first reads a byte from the buffer (Line 11) then assembles a binary represenation of that byte ("LOOP.2" Lines 15-19) and prints the representation (Line 21). The loop counter variable "K" is also printed to show the number of each byte.

3-145 The inner "LOOP.2" (Lines 15-19) takes the byte from the Talk-String held in Variable "P" and assembles into Variable "A" a number representing the binary form of that byte. This is done by testing each bit of "P" and if a particular bit is set equal to 1, adding to "A" a relevant power of 10 held in variable "X". For example, if the byte held in "P" is equal to "00010110" binary, then the number ten thousand, one hundred and ten will be assigned to "A". The number in variable "A" is printed in leading zeros format (Line 2). An example of the output from this program is shown below.

```
1 msb 00010011
2 msb 00000000
3 msb 00111111
4 msb 00001001

Byte 3 is ?
```

```
0: "Read message example f6":
1: dev "Extender",717
2: fmt 1,f1.0," msb ",fz8.0
3: fmt 2,/,"Byte 3 is ",b,/
4: buf "Input",4,1
5: tfr "Extender","Input",4
6: if rds("Input")<0;gto -0
7: 1→K
8: rds("Input")→L
9:
10: "LOOP.1":
11: rdb("Input")→P
12: 0→A→J
13: 1→X
14:
15: "LOOP.2":
16: if bit(J,P);A+X→A
17: X*10→X
18: J+1→J
19: if J<=7;gto "LOOP.2"
20:
21: wrt 16.1,K,A
22: if K=3;P→N
23: K+1→K
24: if K<=L;gto "LOOP.1"
25:
26: wrt 16.2,N
27: end
*11037
```

Figure 3-7 Program Example 2

3-146 Program 3 — Multi-Point Operation

3-147 This program (see Figure 3-8) raises one Multi-Point station, writes a message to a device at that station and then uses the SRQ ON STRING SENT function to ensure that the whole message has been sent. A second station is then raised, lowering the first station in the process, and a number read from an instrument at that station. Both Multi-Point stations are then lowered. Since the last operation performed on the HP-IB extended to the second station was a read, it is not necessary to use the SRQ ON STRING SENT function before lowering the second station.

Use of Variables:

B — Used to dump the Status-Byte from the 37201A when clearing the RQS bit in that Status-Byte.

Z — Variable used to hold the required bits set following the 37201A Service-Request. The variable is set in the main body of the program and used in subroutine "WAIT.SRQ".

H — Variable holding the Status-Byte from the 37201A following a Serial-Poll.

In this example, the first Multi-Point Station has an address of ASCII "1" (10001) and the second Multi-Point Station has an address of ASCII "+" (01011). The address ASCII "?" (11111) has the effect of lowering either or both stations although, only one station will ever be raised at one time in a correctly configured and operating system.

3-148 The program first addresses the local 37201A instructing it to raise Station "1", and then sends a message to the "Device" at Station "1" (Lines 2 and 5). The RQS bit (DI07) in the Status-Byte of the local 37201A is then cleared (Line 6) and the 37201A is enabled to SRQ ON STRING SENT (Lines 7-9, see Paragraph 3-132). Following the SRQ, confirming that the remote 37201A has received the whole message, the Multi-Point address "+" is sent to the local 37201A. This lowers Station "1" and raises Station "+".

3-149 The HP-IB is now transparently connected from the local end through to Station "+", instead of through to Station "1" as before. A number is then read from the "Instrument" at Station "+" (Line 13), both Multi-Point Stations are then lowered (Line 14), and the program stops.

confidence that the instrument is functionally operational (see paragraph 3-171), and should be performed before commencing with the system troubleshooting. A more complete check of the 37201A is given in the Service Section of the manual and should only be carried out by service trained personnel.

```
 0: "Multi-Point example f3":
 1: dev "Extender",717,"Device",701,"Instrument",702
 2: cmd "Extender","M1"
 3: prt "Station 1 raised"
 4: spc 1
 5: wrt "Device","Message to Station 1"
 6: rds("Extender")→B
 7: cmd "Extender","S"
 8: 128→Z
 9: gsb "WAIT.SRQ"
10: cmd "Extender","M+"
11: prt "Station + raised"
12: spc 1
13: red "Instrument",A
14: cmd "Extender","M?"
15: prt "Stations lowered"
16: spc 1
17: end
18:
19: "WAIT.SRQ":
20: if bit(7,rds(7))=0;gto -0
21: rds("Extender")→H
22: if bit(6,H)=0;gto "ERROR.SRQ"
23: if band(Z,H)#0;ret
24:
25: "ERROR.SRQ":
26: prt "Incorrect SRQ"
27: spc 1
28: cli 7
29: cmd "Extender","M?"
30: end
*3589
```

Figure 3-8 Program Example 3

3-150 In the event of an incorrect SRQ being received (e.g. from another device) when the program is waiting for the local 37201A to Request-Service for SRQ ON STRING SENT (Line 20), then the "Incorrect SRQ" message will be printed (Line 26), both Multi-Point stations lowered and the program will stop.

3-151 SYSTEM TROUBLESHOOTING

3-152 The following procedures cover fault diagnosis of the different types of system configuration and are intended only as a guide to help in indicating a faulty area. Individual set-ups and equipment may vary considerably. The Self Test facility available in the 37201A gives a high degree of

3-153 The procedures assume that the system controller and HP-IB cabling to the local 37201A are operating. Also, since the 37201A is essentially transparent (see paragraph 3-13), any HP-IB data errors, such as wrong characters, introduced by any of the other bus instruments will not appear as a fault using these procedures.

3-154 INITIAL CHECKS

3-155 The following procedures use the 37201A LOSS OF REMOTE DATA indicator in isolating faults. The LOSS OF REMOTE DATA indicator can be ON for a number of reasons and does not necessarily mean there is a fault.

Before proceeding with the troubleshooting check the following points.

(a) That the local 37201A is not in the 'Idle' mode. To ensure the 37201A is in the 'Active' mode, switch the 37201A POWER switch OFF then ON. Alternatively, the Talk String Bit DI07 of Byte 4 can be examined (paragraph 3-93) and if the 37201A is in the 'Idle' mode (DI07 is 0) address the local 37201A and send the 'A' (Active) instruction (paragraph 3-67).

(b) That the internal FUNCTION and DATA MEDIUM switches are set correctly on both local and remote 37201A's.

(c) That the CONTROLLER END switch is set to ON at the local 37201A and OFF at the remote 37201A.

(d) That if the system is not configured for multipoint operation, the MULTI-POINT switch on the remote 37201A is set to OFF in order to hold the Request To Send (RTS) line on the modem ON.

3-156 Local Extender Loopback Test

3-157 The system troubleshooting procedures make use of the 37201A's ability to be loopback tested which works as follows:

Coupling together (i.e. looping back) the transmit and receiving ports of an isolated 37201A (disconnected from HP-IB and data link) results in LOSS OF REMOTE DATA going OFF. This is because the receive function of the 37201A assumes that the empty packets which it receives every four seconds come from a distant 37201A, when in fact they are from its own transmit function. The isolated 37201A should be powered OFF and ON before checking that LOSS OF REMOTE DATA goes OFF.

3-158 TWISTED PAIR CONFIGURED SYSTEM

3-159 Failure of the communication link in the twisted pair configuration will be indicated by the LOSS OF REMOTE DATA indicator coming ON. The following procedure makes use of the 37201A's loopback test described in paragraph 3-156.

PROCEDURE

1. Carry out the INITIAL CHECKS for the local 37201A (paragraph 3-155) and remove the HP-IB cable from the rear panel.

2. Disconnect the twisted pair cable from the local 37201A.

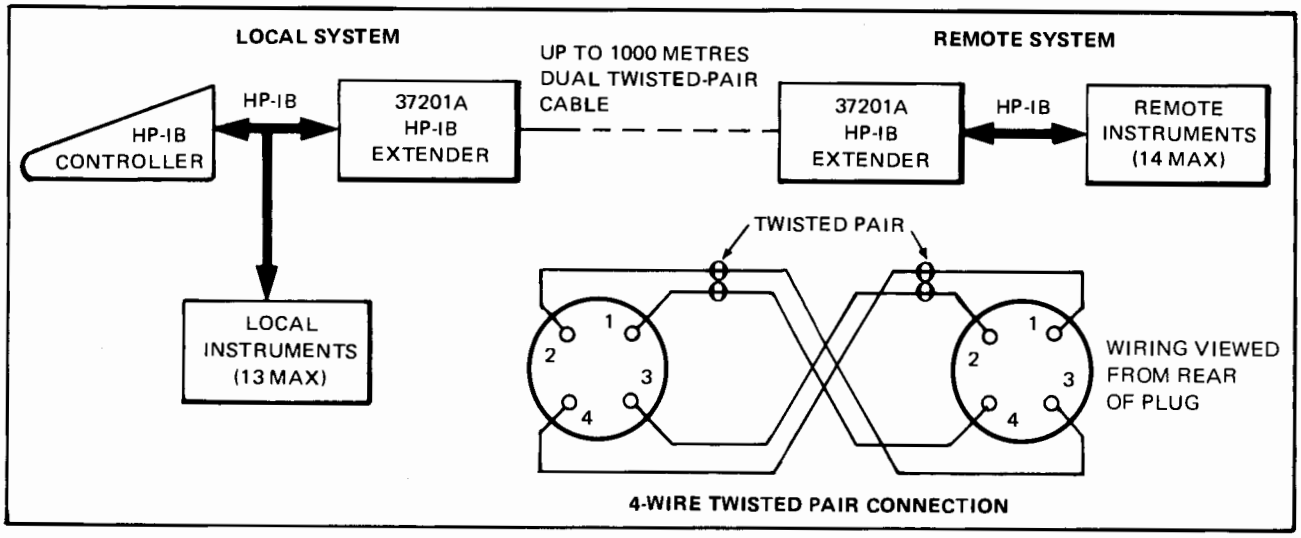


Figure 3-9 Troubleshooting A Twisted Pair Configured System

To loopback the transmit and receive signals use two wire links to connect the 37201A TWISTED PAIR rear panel connector pin 4 to pin 1 and pin 3 to pin 2 (see Figure 3-10).

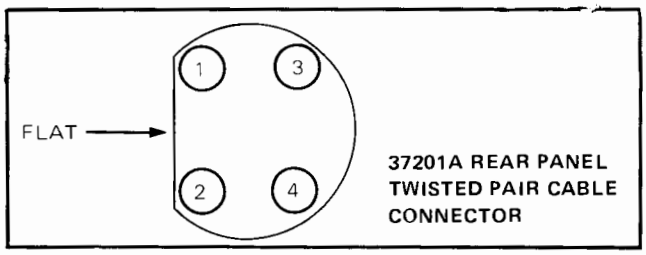


Figure 3-10 Twisted Pair Connector

3. Turn the 37201A power OFF then ON. After 4 seconds the LOSS OF REMOTE DATA indicator should go OFF. If it doesn't it can be assumed the 37201A is faulty.

4. Repeat steps 1 to 3 using the remote 37201A. If the LOSS OF REMOTE DATA indicator turns OFF, the fault can be assumed to be in the interconnecting cable – check for continuity and correct wiring of the cable.

3-160 LEASED-LINE FULL-DUPLEX DATA LINK (Using Asynchronous Modems)

3-161 Failure of the data link between the local 37201A and the remote 37201A will be indicated by the LOSS OF REMOTE DATA indicator on both 37201A's being ON. The following procedure uses the 37201A loopback test described in paragraph 3-156 to verify operation of the local and remote 37201A's.

The modems are checked using their loopback facility (if available and if local telephone authority regulations permit).

PROCEDURE

1. Carry out the initial CHECKS for the local 37201A (paragraph 3-155) and remove the HP-IB cable from the rear panel.

2. Check the local 37201A front panel indicators Data Set Ready (DSR) and Clear To Send (CTS) are ON. Alternatively, check byte 1 of the talk string (paragraph 3-91). If the DSR and CTS indicators are OFF, examine the local modem and the 37201A to modem interface.

   Note: Both DSR and CTS normally must be ON for modems to communicate. Many modems intended for dedicated (leased) operation hold DSR permanently ON unless they are powered-off or in a test mode. Due to the way the 37201A operates, DSR being permanently ON may leave DTR in an indeterminate state depending on the order devices were powered-on. This does not cause any problems since RS232C/V.24 requires only DSR, RTS and CTS to be on for communication.

   In switched-network operation using a dialled telephone channel the ON state of DSR indicates that the modem is connected to a channel, equivalent to a telephone handset being 'off-hook'. This does not imply that the distant modem is connected.

   Some modems turn CTS OFF when they are not receiving the carrier from the distant end. This (or the modem Received-Line-Signal detector) provides a simple means of determining if the distant-to-near data-link is intact, and that the modem is connected.

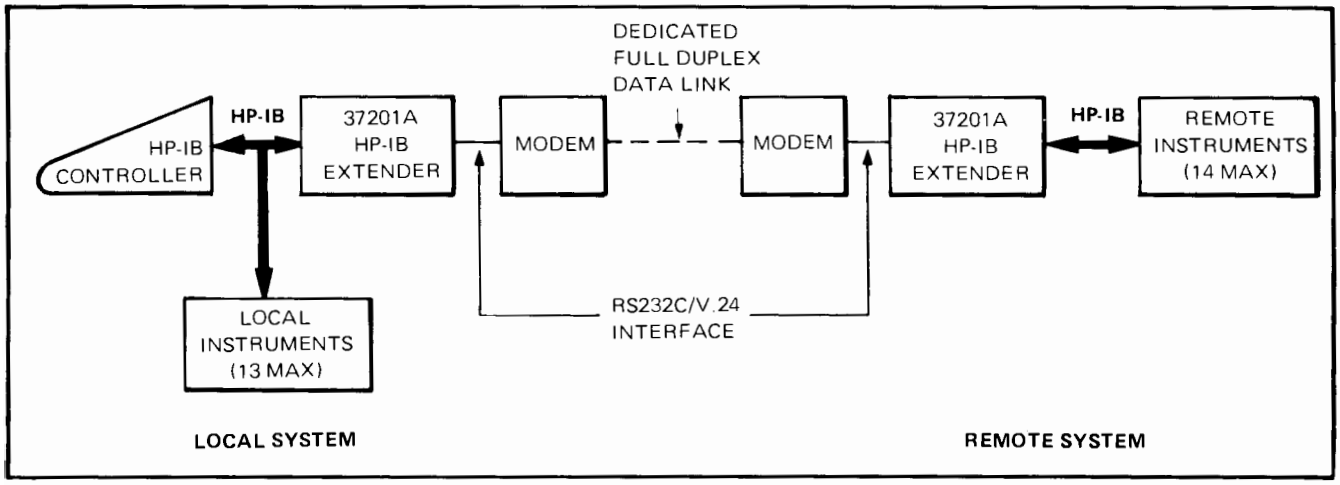


Figure 3-11 Troubleshooting a Leased-Line Full Duplex Data Link

3. Remove the local 37201A RS232C/V.24 connector and switch the local 37201A POWER switch OFF then ON. Link pin 2 (transmit) to pin 3 (receive) on the 37201A RS232C/V.24 connector. Check that the 37201A LOSS OF REMOTE DATA goes OFF after a delay of <20 seconds. This checks the local 37201A. Reconnect the RS232C/V.24 cable.

Step 4 in this procedure relies on either the modem having an analog loopback facility, or being able to manually connect the modem transmit outputs to the modem receive inputs. If the modem does not have an analog loopback facility, or the local telephone authorities do not permit disconnecting the modem transmit outputs and receive inputs, proceed to step 6.

4. If an analog loopback facility is available, set the local modem to the loopback mode and check that the local 37201A LOSS OF REMOTE DATA indicator goes OFF. If a loopback facility is not available and if it is permitted by the local telephone authority, disconnect the modem from the leased line, connect the modem transmit outputs to the modem receive inputs, and check that the local 37201A LOSS OF REMOTE DATA indicator goes OFF. This checks the local modem.

5. Repeat steps 1 through 4 at the remote end to verify the remote 37201A and modem.

6. This part of the procedure caters for modems without the loopback facility, and where connecting the modem transmit outputs to the receive inputs is not permitted. The procedure tests both modems and the data link by transferring the loopback to the RS232C/V.24 interface of the remote modem.

If the asynchronous modem has a digital loopback facility then this can be used in place of steps a and b below.

Remote Modem Connection Details:

a) Remove the remote modem to 37201A RS232C/V.24 interconnecting cable, and connect the modem Transmit line (RS232C/V.24 Pin 2) to the modem Receive line (RS232C/V.24 Pin 3) – see Figure 3-12.

b) In order to communicate, the modems must have the RTS and DTR lines (pins 4 and 20) held ON. This can be achieved by connecting both pins 4 and 20 of the remote modem's RS232C/V.24 connector to pin 11 of the remote 37201A's RS232C/V.24 connector. Pin 11 on the 37201A RS232C/V.24 connector is held ON provided the internal link W301 is present, as it is on leaving the factory. Apart from pin 11, the remote 37201A must be disconnected from the modem but powered ON.

The data from the local 37201A is now looped back at the remote modem RS232C/V.24 interface, and the LOSS OF REMOTE DATA indicator at the local 37201A should go OFF, unless there is a fault at either modem or the data link.

3-162 LEASED-LINE FULL-DUPLEX DATA LINK (Using Synchronous Modems)

3-163 The procedure for Synchronous Modems is similar to the procedure outlined in paragraph 3-160 for Asynchronous Modems. However, in the Synchronous Mode the 37201A cannot perform the loopback test (step 3) on its own, since it requires transmit and receive clocks applied to pins 15 and 17 on the RS232C/V.24 connector. Step 3 in the procedure may be avoided if step 4, which remains the same, is carried out before step 3 and if the LOSS OF REMOTE DATA indicator on the 37201A goes OFF on completion of step 4.

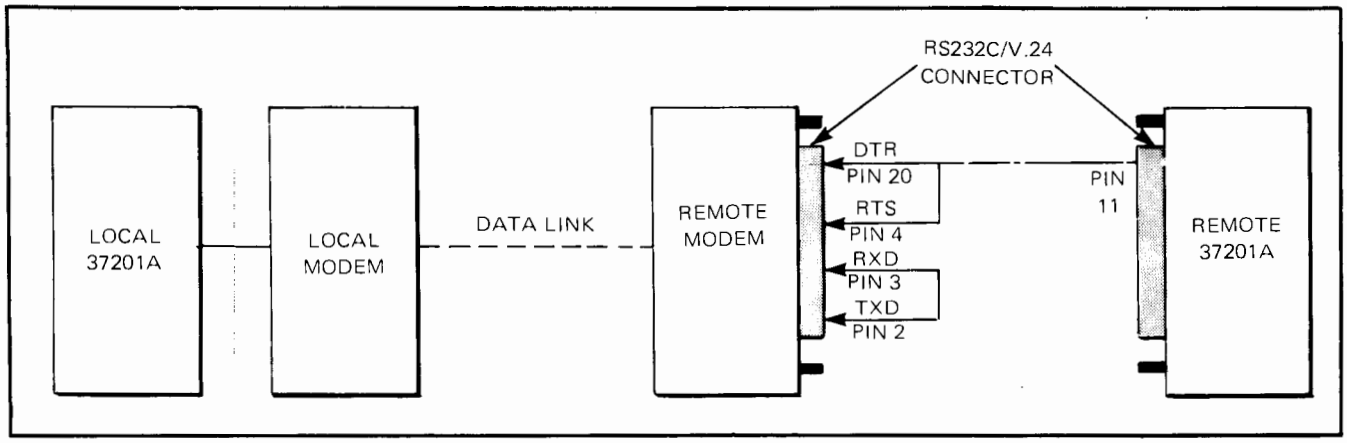


Figure 3-12 Remote Modem Loopback Configuration

3-164 SWITCHED NETWORK USING MANUAL OR AUTOMATIC DIALLING

3-165 Failure of the data link between the local and remote 37201A s will be indicated by the LOSS OF REMOTE DATA indicator being ON. The modems and the 37201A s can be checked using the procedure given in paragraph 3-160. However, before proceeding with paragraph 3-160 perform the INITIAL CHECKS in paragraph 3-153, then steps 1 and 2 below.

1. If during normal operation the remote system has been cut-off due to a telephone network failure and the LOSS OF REMOTE DATA indicator has come on, address the local 37201A, send a disconnect instruction "TD", and try to re-establish the call.

2. If the call cannot be established, or re-established and another remote station is available try dialling the alternative remote station to determine if the local equipment is working. If this is not possible, check the local 37201A and modem as outlined in paragraph 3-160.

The information contained in paragraph 3-117 to 3-128 may be useful in determining whether the failure is due to the dialling equipment.

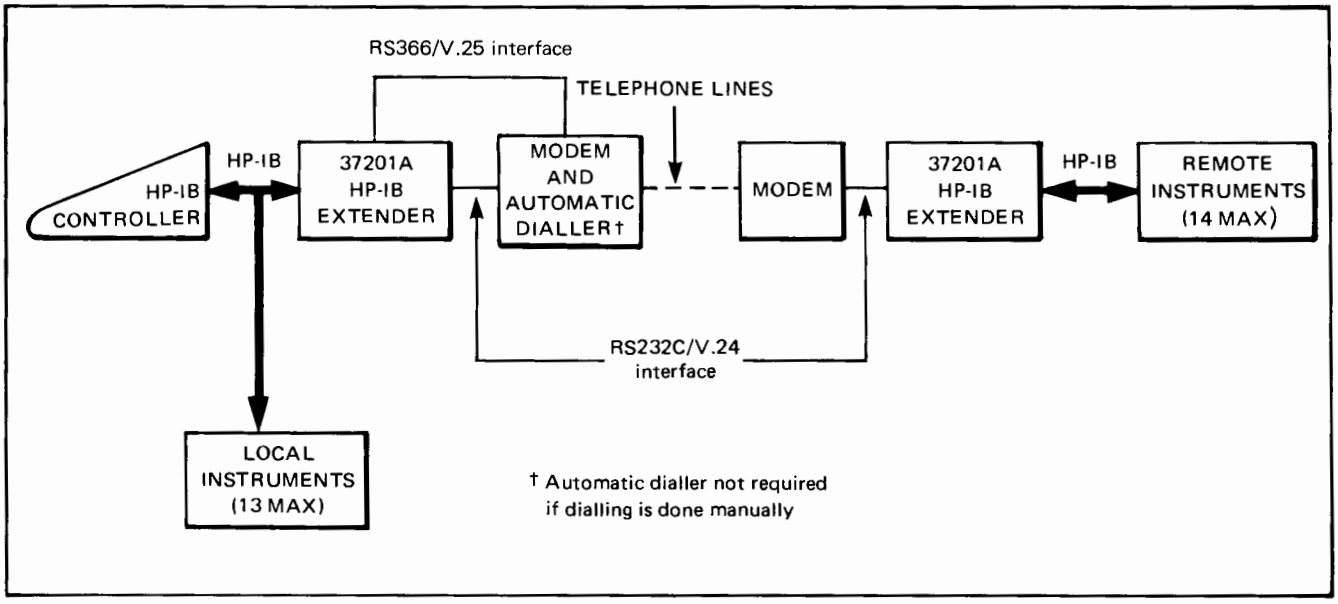


Figure 3-13 Full-Duplex Switched Data Link (Using Modem and Auto-Dialler)

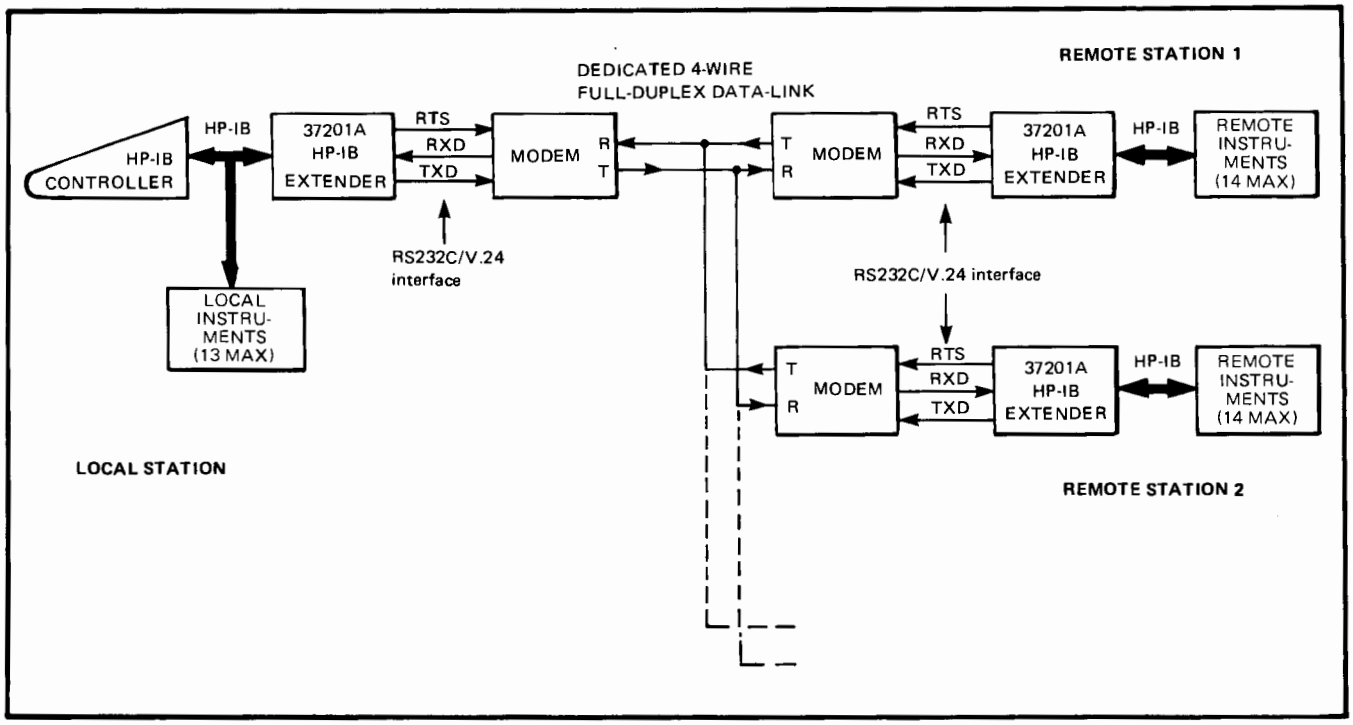


Figure 3-14 Multi-Point System

3-166 MULTI-POINT SYSTEM

3-167 When a Multi-Point station is addressed, the LOSS OF REMOTE DATA indicator should go OFF. The following procedure calls each remote station in turn, to try and isolate the fault to the local station or one of the remote stations. Once isolated to the local or a remote station, the 37201A s can be loopback tested as in step 3 paragraph 3-160, except that the remote 37201A s should have FUNCTION SWITCH 12 (MULTI-POINT) set to OFF (one at a time) for the test.

PROCEDURE

1. Check the 37201A s settings (paragraph 3-155).

2. With no Multi-Point station addressed check that the LOSS OF REMOTE DATA and DATA SET READY indicators on the local 37201A are ON. Address the local 37201A and send the Multi-Point address of the first Multi-Point station paragraph 3-84). The LOSS OF REMOTE DATA indicator should go out after a small delay depending on the speed of the modem being used (<20s for 150 bps, <12s for 300 bps, and <8s for 600 bps and greater). The 37201A CTS indicator should also be ON (depending on the type of modem in use CTS may have been ON before multi-point station 1 was called).

If the LOSS OF REMOTE DATA indicator goes OFF in step 2, then it can be assumed that the local station and remote station 1 are operating correctly. Next, call each remote station in turn and check that the LOSS OF REMOTE indicator goes OFF. If not check the modem and 37201A at that station as outlined in paragraph 3-160 or 3-162 (remember to change FUNCTION SWITCH 12 to OFF for each loopback check of remote stations).

If the LOSS OF REMOTE DATA indicator stays ON in step 2, try calling each remote station. If the LOSS OF REMOTE DATA indicator fails to go OFF for all remote stations, then the fault is in the local station or in the line. If the LOSS OF REMOTE DATA indicator goes OFF, for at least one remote station, then one or more of the other remote stations on their associated lines must be faulty.

Note: The Multi-Point station 'on line' is automatically turned down each time a different Multi-Point address is sent. By checking Byte 3 of the 'Talk String' paragraph 3-93, the address of the last Multi-Point station raised is returned as an ASCII character. Where no Multi-Point station is active an ASCII '?' is returned.

3-168 ADDITIONAL CHECKS

3-169 Sometimes a failure can occur which does not turn LOSS OF REMOTE DATA ON. This can happen if a fault causes the modem at either end to loopback, or if there is a fault on the telephone line. These faults would result in

the local 37201A communicating with itself, giving the appearance of being connected to a good link with the LOSS OF REMOTE DATA indicator staying OFF.

3-170 The following procedure uses the ability of a remote 37201A to return the value of its address switches to the local 37201A as a means of checking the integrity of the data-link and remote 37201A. If the local 37201A is sent a Multi-Point address instruction, then the remote 37201A will return the Multi-Point address set up on its FUNCTION SWITCHES even although FUNCTION SWITCH 12 (Multi-Point is OFF). A Multi-Point address instruction is sent to the local 37201A and byte 3 of the Talk-String is examined to see what address, if any, has been returned.

Note: The following procedure is not suitable for 37201A s operating in the TWISTED PAIR configuration.

1. Assuming that the remote 37201A has a Multi-Point address of ASCII "1", address the local 37201A and send the Multi-Point address instruction "M$" ($ is an arbitrary character from the first column in Table 3-1, but different from "1").

2. After a suitable pause, address the local 37201A to send its Talk-String.

Note: The length of the necessary pause between the Multi-Point address instruction to the local 37201A and addressing it for its Talk-String is dependent upon the speed selected. Recommended delays are; 8 seconds for 150bps, 4 seconds for 300bps, 2 seconds for 600bps and 1 second for 1200 bps or higher speeds. Any character (from the first column of Table 3-1) may be used in the above Multi-Point address instruction sent to the local 37201A, provided that it is neither the same as the Multi-Point address of the remote 37201A nor equal to ASCII "?" (1111).

If the ASCII character in byte 3 is '1' the remote 37201A has responded correctly and the data-link, modems and 37201As can be assumed to be functioning correctly.

If there is a loopback either at the remote modem, somewhere on the data-link or at the local modem, then the character in byte-3 will be "$", since the apparent response seen by the local 37201A is in fact its own Multi-Point calling packet to the remote station (the calling and response packets of the private 'protocol' being the same).

Any equipment beyond the local 37201A not functioning correctly will result in a "?" in byte-3, showing there has been no response.

3-171 37201A SELF TEST

3-172 In order that an individual 37201A may be tested for correct functional operation, a SELF-TEST facility has been incorporated. This enables internal firmware routines to exercise the 37201A's hardware in a manner very similar to its normal operating condition.

3-173 To perform SELF-TEST with a single 37201A, use the following procedure:

(a) Remove all connectors and the top cover from the 37201A (except the power cord) so that it is completely isolated from other equipment, and put the POWER switch OFF.

(b) Put the internal DATA MEDIUM switch to position 15 (SELF-TEST).

(c) Put the POWER switch ON.

Note: the SELF-TEST will only be implemented if the 37201A is powered-on with the DATA MEDIUM selector already in the SELF-TEST position.

(d) The 37201A should now execute its SELF-TEST routine approximately once per second.

Correct operation is indicated by two alternating states of the eight front-panel lamps. The left-hand lamp (TEST COMPLETE) should come on alone, followed by the other seven lamps alone; the sequence repeating continuously with a period of about one second. Any other behaviour (for example, if any of the lamps stay off) indicates failure, if the above procedure has been followed. The SELF-TEST function is not totally comprehensive since there is no means, for example, by which the firmware can test the RS232C/V.24, RS366/V.25 and twisted-pair drivers and receivers or the internal switches. Further tests are detailed in the SERVICE section. If the above SELF-TEST procedure indicates a fault, then the 37201A should be referred to trained service personnel.

SECTION IV

PERFORMANCE TESTS

4-1 INTRODUCTION

4-2 The specialized nature of the 37201A, and the many different modes and operating configurations possible, make a full performance verification impractical. A full performance verification would require a large variety of equipment, including another 37201A, a suitable HP-IB controller, as well as data communications equipment such as modems and auto diallers.

4-3 In view of these requirements, and since the operating characteristics of the 37201A are largely determined by its internal program, a self-test facility has been provided to simplify testing. The self-test routine checks out the complete instrument, except for: the internal Function and Data Medium switches, the Twisted-Pair, RS232C/V.24 and RS366/V.25 input/output interfaces, for which separate tests are provided. The tests in this section are very similar to those in General Service Sheet G2. Therefore if the tests in General Service Sheet G2 have been completed successfully there is no need to do the Performance Tests here.

4-4 No attempt has been made in this section to describe the full external tests, or to show how various types of system controllers generate and respond to the various bus commands and messages. However, included in Section II of this manual are examples of various installation set-ups, and in Section III, example programs are given to guide anyone who may wish to perform such external tests.

WARNING

The following tests must be performed with power supplied to the instrument, and the protective covers removed. Such maintenance should be performed only by service trained personnel who are aware of the hazards involved.

4-5 SELF TEST

DESCRIPTION

The self-test routine checks out the complete instrument, except for: the internal Function and Data Medium switches, the Twisted-Pair, RS232C/V.24 and RS366/V.25 input/output interfaces, for which separate tests are provided.

PROCEDURE

1. Remove the 37201A top cover, and any connectors from the rear panel (except the power cord).
2. Set the Data Medium switch to the Self-Test position.
3. Switch the POWER switch off then on.
4. The TEST COMPLETE lamp should flash on for about 0.6 seconds and the remaining lamps stay off. The remaining lamps should then come on for about 0.4 seconds with the TEST COMPLETE lamp off. The sequence should then repeat continuously. Any other response indicates a failure.

4-6 RS232C/V.24, RS366/V.25 OUPUT TEST

DESCRIPTION

The RS232C/V.24 and RS366/V.25 outputs are monitored using an oscilloscope, dc coupled to the output pin of the connectors, while the self-test routine is running. The routine periodically changes the state of the RS232C/V.24 and RS366/V.25 drivers enabling their outputs to be observed changing state.

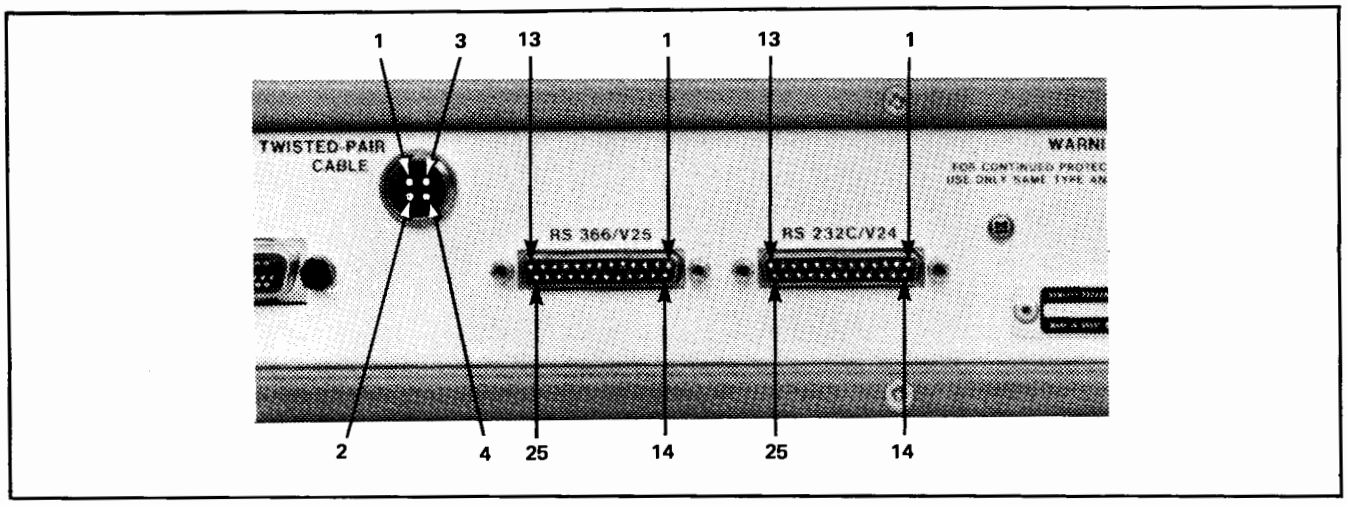


Figure 4-1 Connector Pin Numbers

PROCEDURE

1. Remove the 37201A top cover, and any connectors from the rear panel (except the power cord).
2. Set the Data Medium switch to the Self-Test position.
3. Switch the POWER switch off then on.

4. Monitor the following pins and check that pulses occur at approximately 1 second intervals. The logic levels of the pulses should be +10 ± 2V and −10 ± 2V. Note that, because the pulses are very narrow, an oscilloscope sweep speed of 1s/div and a sensitivity of 10V/div is recommended.

	Pins	
RS232C/V.24	2	
	4	
	20	– Holding the front panel DTR switch pressed should stop the pulses and set this pin low (−10 ± 2V).
RS366/V.25	2	
	4	
	14	– a positive going pulse from −10 ± 2V to +10 ± 2V
	15	– a negative going pulse from +10 ± 2V to −10 ± 2V
	16	– a positive going pulse from −10 ± 2V to +10 ± 2V
	17	– a negative going pulse from +10 ± 2V to −10 ± 2V

4-7 RS232C/V.24, RS366/V.25 INPUT TEST

DESCRIPTION

The RS232C/V.24 and RS366/V.25 inputs are checked by connecting the RS366/V.25 output (pin 2) to the various input pins in turn and monitoring the appropriate receiver outputs while the self-test routine is running. The connection from RS366/V.25 (pin 2) causes each device to change state periodically so that its TTL level outputs can be observed changing.

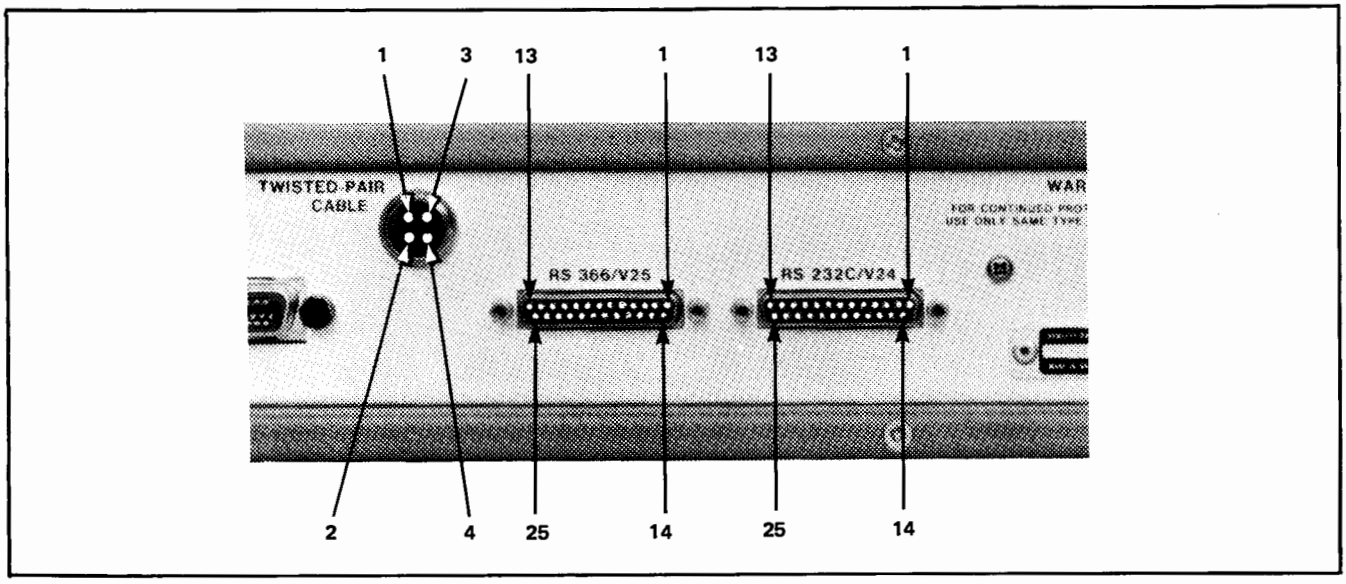


Figure 4-2 Connector Pin Numbers

PROCEDURE

1. Remove the 37201A top cover, and any connectors from the rear panel (except the power cord).

2. Set the Data Medium switch to the Self-Test position.

3. Switch the POWER switch off then on.

4. Connect RS366/V.25 pin 2 to the input pins listed below and check the corresponding receiver outputs. Note that the receiver outputs should all be within the normal TTL logic levels (0 to 0.8V and 2.8 to 5V).

Connect RS366/V.25 pin 2 to:		Monitor Receiver Output	
RS366/V.25	3	U321	(6)
	5	U321	(11)
	6	U300	(8)
	13	U300	(11)
	22	U300	(6)
RS232C/V.24	3	U320	(11)
	5	U321	(8)
	6	U321	(3)
	8	U320	(3)
	15	U320	(6)
	17	U320	(8)

4-8 TWISTED-PAIR INTPUT/OUTPUT TEST

DESCRIPTION

The twisted pair output is checked by connecting it back to the twisted pair input and observing the LOSS OF REMOTE DATA indicator on the front panel.

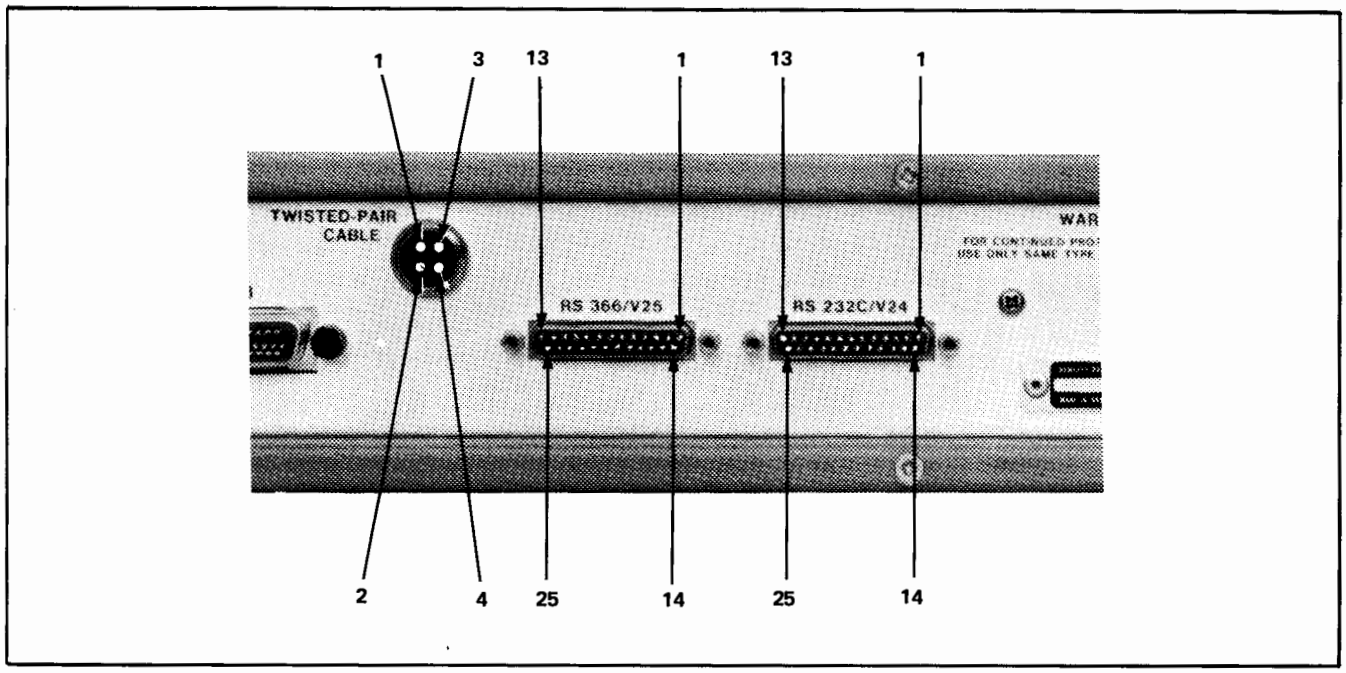


Figure 4-3 Connector Pin Numbers

PROCEDURE

1. Remove the 37201A top cover, and any connectors from the rear panel (except the power cord).
2. Set the Data Medium switch to Twisted-Pair and switch the POWER switch off then on.
3. Connect the output to the input – Pin 4 to Pin 1 and Pin 3 to Pin 2. The LOSS OF REMOTE DATA indicator on the front panel should go off within 8 seconds. When the links are removed from the connector, the LOSS OF REMOTE DATA indicator should come on again within 8 seconds.

4-9 DATA MEDIUM SWITCH TEST

DESCRIPTION

The four left hand indicators on the front panel give a binary representation of the position of the Data Medium Switch while running the Ram and Switch test.

PROCEDURE

1. Remove the 37201A top cover, and any connectors from the rear panel (except the power cord).
2. Note the Data Medium switch setting so that it can be returned there after the test is completed.
3. Set the Data Medium switch to Ram & Sw Tests. Switch the 37201A POWER switch off then on.
4. Switch the Data Medium switch through positions 0 to 15 while observing the four left hand indicators on the front panel – they should read as follows:

DATA MEDIUM SWITCH	TEST COMPLETE	EXTENDER ADDRESSED	DIALLING	LOSS OF REMOTE DATA
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
10	1	0	1	0
11	1	0	1	1
12	1	1	0	0
13	1	1	0	1
14	1	1	1	0
15	1	1	1	1

1 = indicator on 0 = indicator off

4-10 FUNCTION SWITCH TEST

DESCRIPTION

The four-right hand front panel indicators give a binary representation of the highest numbered Function switch to be on while running the Ram and Switch test.

PROCEDURE

1. Remove the 37201A top cover, and any connectors from the rear panel (except the power cord).
2. Note the settings of the twelve function switches before setting them to the left hand off position.

3. Set the Data Medium switch to Ram & Sw Tests. Switch the 37201A POWER switch off then on.

4. Switch each Function switch on in turn (in the order indicated below) while observing the four right hand front panel indicators.

FUNCTION SWITCH	CALL COMPLETE	ABANDON CALL & RETRY	DATA SET READY	CLEAR TO SEND
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
10	1	0	1	0
11	1	0	1	1
12	1	1	0	0

1 = indicator on 0 = indicator off

5. Reset both the Function and Data Medium switches to their original positions.

4-11 CLOCK FREQUENCY TEST

DESCRIPTION

The clock frequency is checked with a suitable frequency counter.

PROCEDURE

1. Remove the 37201A top cover, and any connectors from the rear panel (except the power cord).

2. Connect a suitable frequency counter to the Clock test point and monitor the frequency, it should be 960kHz ± 300Hz.

SECTION V

ADJUSTMENTS

5-1 INTRODUCTION

5-2 This section describes the only adjustment required.

WARNING

Maintenance described herein is performed with protective covers removed and power applied to the instrument. Maintenance should be performed only by service trained personnel who are aware of the hazards involved.

5-3 POWER SUPPLY ADJUSTMENT

5-4 Connect a suitable dc voltmeter to the +5V Test Point and if necessary adjust R405 to obtain a reading of +5V ± 0.05V.

SECTION VI

REPLACEABLE PARTS

6-1 INTRODUCTION

6-2 This section contains information for ordering parts. Table 6-1 lists abbreviations used in the parts list and throughout the manual. Table 6-2 lists all replaceable parts in reference designator order. Table 6-3 contains the names and addresses that correspond to the manufacturers code numbers.

6-3 ABBREVIATIONS

6-4 Table 6-1 lists all abbreviations used in the parts list, the schematics and throughout the manual. In some cases two forms of the abbreviation are used, one all in capital letters, and one partial or no capitals. This occurs because the abbreviations in the parts list are always all capitals. However, in the schematics and other parts of the manual, other abbreviation forms are used with both lower and upper case letters.

6-5 REPLACEABLE PARTS LIST

6-6 Table 6-2 is the list of replaceable parts and is organised as follows:

(a) Electrical assemblies and their components in alpha-numeric order by reference designation.
(b) Chassis-mounted parts in alpha-numeric order by reference designation.
(c) Miscellaneous parts.
(d) Illustrated parts breakdown.

The information given for each part consists of the following:

(a) The Hewlett-Packard part number.
(b) Part number check digit (CD).
(c) The total quantity (Qty) in the instrument.
(d) The description of the part.
(e) A typical manufacturer of the part in a five-digit code.
(f) The manufacturers number for that part.

The total quantity for each part is given only once – at the first appearance of the part in the list.

6-7 ORDERING INFORMATION

6-8 To order a part listed in the replaceable parts table, quote the Hewlett-Packard part number (with the check digit), indicate the quantity required, and address the order to the nearest Hewlett-Packard office. The check digit will ensure accurate and timely processing of your order.

6-9 To order a part that is not listed in the replaceable parts table, include the instrument model number, instrument serial number, the description and function of the part, and the number of parts required. Address the order to the nearest Hewlett-Packard Office.

6-10 DIRECT MAIL ORDER SYSTEM

6-11 Within the USA, Hewlett-Packard can supply parts through a direct mail order system. Advantages of using the system are as follows:

(a) Direct ordering and shipment from the HP Parts Centre in Mountain View, California.

(b) No maximum or minimum on any mail order (there is a minimum order amount for parts ordered through a local HP office when the orders require billing and invoicing).

(c) Prepaid transportation (there is a small handling charge for each order).

(d) No invoices – to provide these advantages, a cheque or money order must accompany each order.

6-12 Mail Order forms and specific ordering information are available through your local HP office. Addresses and phone numbers are located at the back of this manual.

Table 6-1 Reference Designations and Abbreviations

REFERENCE DESIGNATIONS

A . . . . . assembly
AT . . attenuator; isolator; termination
B . . . . . fan; motor
BT . . . . . battery
C . . . . . capacitor
CP . . . . . coupler
CR . . . . . diode; diode thyristor; varactor
DC . . . directional coupler
DL . . . . . delay line
DS . . . . . annunciator; signaling device (audible or visual); lamp; LED
E . . . . . miscellaneous electrical part
F . . . . . fuse
FL . . . . . filter
H . . . . . hardware
HY . . . . . circulator
J . . . electrical connector (stationary portion); jack
K . . . . . relay
L . . . . . coil; inductor
M . . . . . meter
MP . . . . . miscellaneous mechanical part
P . . . electrical connector (movable portion); plug
Q . . . . . transistor: SCR; triode thyristor
R . . . . . resistor
RT . . . . . thermistor
S . . . . . switch
T . . . . . transformer
TB . . . . . terminal board
TC . . . . . thermocouple
TP . . . . . test point
U . . . . . integrated circuit; microcircuit
V . . . . . electron tube
VR . . . . voltage regulator; breakdown diode
W . . . . cable; transmission path; wire
X . . . . . socket
Y . . . . crystal unit (piezoelectric or quartz)
Z . . . . tuned cavity; tuned circuit

ABBREVIATIONS

A . . . . . ampere
ac . . . . alternating current
ACCESS . . . . . accessory
ADJ . . . . . adjustment
A/D . . . . analog-to-digital
AF . . . . . audio frequency
AFC . . . . . automatic frequency control
AGC . . . . . automatic gain control
AL . . . . . aluminum
ALC . . . . . automatic level control
AM . . . amplitude modulation
AMPL . . . . . amplifier
APC . . . . automatic phase control
ASSY . . . . . assembly
AUX . . . . . auxiliary
avg . . . . . average
AWG . . . . American wire gauge
BAL . . . . . balance
BCD . . . . . binary coded decimal
BD . . . . . board
BE CU . . . . . beryllium copper
BFO . . . . . beat frequency oscillator
BH . . . . . binder head
BKDN . . . . . breakdown
BP . . . . . bandpass
BPF . . . . . bandpass filter
BRS . . . . . brass
BWO . . . . . backward-wave oscillator
CAL . . . . . calibrate
ccw . . counter-clockwise
CER . . . . . ceramic
CHAN . . . . . channel
cm . . . . . centimeter
CMO . . cabinet mount only
COAX . . . . . coaxial
COEF . . . . . coefficient
COM . . . . . common
COMP . . . . . composition
COMPL . . . . . complete
CONN . . . . . connector
CP . . . . . cadmium plate
CRT . . . cathode-ray tube
CTL . . . . complementary transistor logic
CW . . . . . continuous wave
cw . . . . . clockwise
cm . . . . . centimeter
D/A . . . . digital-to-analog
dB . . . . . decibel
dBm . . . . decibel referred to 1 mW
dc . . . . . direct current
deg . . degree (temperature interval or difference)
° . . . . . degree (plane angle)
°C . . . . . degree Celsius (centigrade)
°F . . . . degree Fahrenheit
°K . . . . . degree Kelvin
DEPC . . deposited carbon
DET . . . . . detector
diam . . . . . diameter
DIA . . . diameter (used in parts list)
DIFF AMPL . . differential amplifier
div . . . . . division
DPDT . . . . . double-pole, double-throw
DR . . . . . drive
DSB . . . . double sideband
DTL . . . . diode transistor logic
DVM . . . digital voltmeter
ECL . . . . emitter coupled logic
EMF . . electromotive force
EDP . . . . . electronic data processing
ELECT . . . . . electrolytic
ENCAP . . . . encapsulated
EXT . . . . . external
F . . . . . farad
FET . . . . . field-effect transistor
F/F . . . . . flip-flop
FH . . . . . flat head
FIL H . . . . . fillister head
FM . . frequency modulation
FP . . . . . front panel
FREQ . . . . . frequency
FXD . . . . . fixed
g . . . . . gram
GE . . . . . germanium
GHz . . . . . gigahertz
GL . . . . . glass
GRD . . . . . ground(ed)
H . . . . . henry
h . . . . . hour
HET . . . . . heterodyne
HEX . . . . . hexagonal
HD . . . . . head
HDW . . . . . hardware
HF . . . . . high frequency
HG . . . . . mercury
HI . . . . . high
HP . . . . . Hewlett-Packard
HPF . . . . . high pass filter
HR . . . . . hour (used in parts list)
HV . . . . . high voltage
Hz . . . . . Hertz
IC . . . . integrated circuit
ID . . . . . inside diameter
IF . . . . . intermediate frequency
IMPG . . . . . impregnated
in . . . . . inch
INCD . . . . . incandescent
INCL . . . . . include(s)
INP . . . . . input
INS . . . . . insulation
INT . . . . . internal
kg . . . . . kilogram
kHz . . . . . kilohertz
kΩ . . . . . kilohm
kV . . . . . kilovolt
lb . . . . . pound
LC . . . . . inductance-capacitance
LED . . light-emitting diode
LF . . . . . low frequency
LG . . . . . long
LH . . . . . left hand
LIM . . . . . limit
LIN . . . linear taper (used in parts list)
lin . . . . . linear
LK WASH . . . lock washer
LO . . . low; local oscillator
LOG . . . . logarithmic taper (used in parts list)
log . . . . . logrithm(ic)
LPF . . . . . low pass filter
LV . . . . . low voltage
m . . . . . meter (distance)
mA . . . . . milliampere
MAX . . . . . maximum
MΩ . . . . . megohm
MEG . . . . meg (10^6) (used in parts list)
MET FLM . . . . metal film
MET OX . . metallic oxide
MF . . . medium frequency; microfarad (used in parts list)
MFR . . . . . manufacturer
mg . . . . . milligram
MHz . . . . . megahertz
mH . . . . . millihenry
mho . . . . . mho
MIN . . . . . minimum
min . . . . . minute (time)
. . .' . . . . . minute (plane angle)
MINAT . . . . . miniature
mm . . . . . millimeter
MOD . . . . . modulator
MOM . . . . . momentary
MOS . . . . . metal-oxide semiconductor
ms . . . . . millisecond
MTG . . . . . mounting
MTR . . . meter (indicating device)
mV . . . . . millivolt
mVac . . . . . millivolt, ac
mVdc . . . . . millivolt, dc
mVpk . . . . millivolt, peak

NOTE

All abbreviations in the parts list will be in upper-case.

Table 6-1 Reference Designations and Abbreviations (continued)

mVp-p . . . millivolt, peak-to-peak
mVrms . . . . millivolt, rms
mW . . . . . milliwatt
MUX . . . . . multiplex
MY . . . . . mylar
μA . . . . . microampere
μF . . . . . microfarad
μH . . . . . microhenry
μmho . . . . . micromho
μs . . . . . microsecond
μV . . . . . microvolt
μVac . . . . . microvolt, ac
μVdc . . . . . microvolt, dc
μVpk . . . microvolt, peak
μVp-p . . . microvolt, peak-to-peak
μVrms . . . . microvolt, rms
μW . . . . . microwatt
nA . . . . . nanoampere
NC . . . . . no connection
N/C . . . . normally closed
NE . . . . . neon
NEG . . . . . negative
nF . . . . . nanofarad
NI PL . . . . . nickel plate
N/O . . . . . normally open
NOM . . . . . nominal
NORM . . . . . normal
NPN . . . negative-positive-negative
NPO . . . . negative-positive zero (zero temperature coefficient)
NRFR . . not recommended for field replacement
NSR . . . . . not separately replaceable
ns . . . . . nanosecond
nW . . . . . nanowatt
OBD . . . order by description
OD . . . . . outside diameter
OH . . . . . oval head
OP AMPL . . . operational amplifier
OPT . . . . . option
OSC . . . . . oscillator
OX . . . . . oxide
oz . . . . . ounce
Ω . . . . . ohm
P . . . . peak (used in parts list)
PAM . . . . pulse-amplitude modulation
PC . . . . . printed circuit
PCM . . pulse-code modulation; pulse-count modulation
PDM . . . . . pulse-duration modulation
pF . . . . . picofarad
PH BRZ phosphor bronze
PHL . . . . . Phillips
PIN . . . positive-intrinsic-negative
PIV . . . . . peak inverse voltage
pk . . . . . peak
PL . . . . . phase lock
PLO . . . . . phase lock oscillator
PM . . . . phase modulation
PNP . . . positive-negative-positive
P/O . . . . . part of
POLY . . . . . polystyrene
PORC . . . . . porcelain
POS . . positive; position(s) (used in parts list)
POSN . . . . . position
POT . . . . . potentiometer
p-p . . . . . peak-to-peak
PP . . . peak-to-peak (used in parts list)
PPM . . . . . pulse-position modulation
PREAMPL . . . preamplifier
PRF . . . . pulse-repetition frequency
PRR . . . . pulse repetition rate
ps . . . . . picosecond
PT . . . . . point
PTM . . . . . pulse-time modulation
PWM . . . . . pulse-width modulation
PWV . . . . . peak working voltage
RC . . . . . resistance-capacitance
RECT . . . . . rectifier
REF . . . . . reference
REG . . . . . regulated
REPL . . . . . replaceable
RF . . . . . radio frequency
RFI . . . . radio frequency interference
RH . . . . round head; right hand
RLC . . . . . resistance-inductance-capacitance
RMO . . . rack mount only
rms . . . . root-mean-square
RND . . . . . round
ROM . . read-only memory
R&P . . . . . rack and panel
RWV . . . reverse working voltage
S . . . scattering parameter
s . . . . . second (time)
. . . " . second (plane angle)
S-B . . . . . slow-blow (fuse) (used in parts list)
SCR . . . silicon controlled rectifier; screw
SE . . . . . selenium
SECT . . . . . sections
SEMICON . . . . . semiconductor
SHF . . . . . superhigh frequency
SI . . . . . silicon
SIL . . . . . silver
SL . . . . . slide
SNR . . signal-to-noise ratio
SPDT . . . . . single-pole, double-throw
SPG . . . . . spring
SR . . . . . split ring
SPST . . . . . single-pole, single-throw
SSB . . . . . single sideband
SST . . . . . stainless steel
STL . . . . . steel
SQ . . . . . square
SWR . . standing-wave ratio
SYNC . . . . . synchronize
T . . timed (slow-blow fuse)
TA . . . . . tantalum
TC . . . . . temperature compensating
TD . . . . . time delay
TERM . . . . . terminal
TFT . . thin-film transistor
TGL . . . . . toggle
THD . . . . . thread
THRU . . . . . through
TI . . . . . titanium
TOL . . . . . tolerance
TRIM . . . . . trimmer
TSTR . . . . . transistor
TTL . . transistor-transistor logic
TV . . . . . television
TVI television interference
TWT . . traveling wave tube
U . . . . . micro (10^{-6}) (used in parts list)
UF . . . microfarad (used in parts list)
UHF . . ultrahigh frequency
UNREG . . . . unregulated
V . . . . . volt
VA . . . . . voltampere
Vac . . . . . volts, ac
VAR . . . . . variable
VCO . . . voltage-controlled oscillator
Vdc . . . . . volts, dc
VDCW . . volts, dc, working (used in parts list)
V(F) . . . . . volts, filtered
VFO . . variable-frequency oscillator
VHF . . . . . very-high frequency
Vpk . . . . . volts, peak
Vp-p . . volts, peak-to-peak
Vrms . . . . . volts, rms
VSWR . . . voltage standing wave ratio
VTO . . . . . voltage-tuned oscillator
VTVM . . . . vacuum-tube voltmeter
V(X) . . . . . volts, switched
W . . . . . watt
W/ . . . . . with
WIV . . . . working inverse voltage
WW . . . . . wirewound
W/O . . . . . without
YIG . . yttrium-iron-garnet
Z_o . . . . . characteristic impedance

NOTE

All abbreviations in the parts list will be in upper-case.

MULTIPLIERS

Abbreviation	Prefix	Multiple
T	tera	10^{12}
G	giga	10^{9}
M	mega	10^{6}
k	kilo	10^{3}
da	deka	10
d	deci	10^{-1}
c	centi	10^{-2}
m	milli	10^{-3}
μ	micro	10^{-6}
n	nano	10^{-9}
p	pico	10^{-12}
f	femto	10^{-15}
a	atto	10^{-18}

Table 6-2 Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1	37201-60020	6	2	BOARD ASSEMBLY	28480	37201-60020
A1C100	0180-0474	4	1	CAPACITOR-FXD 15UF+-10% 20VDC TA	28480	0180-0474
A1C300	0160-3878	6	10	CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A1C301	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A1C302	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A1C303	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A1C304	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A1C305	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A1C306	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A1C307	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A1C308	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A1C309	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A1C310	0160-0574	3	1	CAPACITOR-FXD .022UF +-20% 100VDC CER	28480	0160-0574
A1C400	0180-2373	6	2	CAPACITOR-FXD 580UF+150-10% 35VDC AL	28480	0180-2373
A1C401	0160-3486	2	6	CAPACITOR-FXD .47UF +80-20% 50VDC CER	28480	0160-3486
A1C402	0160-3486	2		CAPACITOR-FXD .47UF +80-20% 50VDC CER	28480	0160-3486
A1C403	0180-2662	6	1	CAPACITOR-FXD 10UF+-10% 10VDC TA	25088	D4R7G81A10K
A1C404	0180-2373	6		CAPACITOR-FXD 580UF+150-10% 35VDC AL	28480	0180-2373
A1C405	0160-3486	2		CAPACITOR-FXD .47UF +80-20% 50VDC CER	28480	0160-3486
A1C406	0160-3486	2		CAPACITOR-FXD .47UF +80-20% 50VDC CER	28480	0160-3486
A1C407	0180-1948	9	2	CAPACITOR-FXD 1500UF+75-10% 40VDC AL	56289	39D158G040HP4
A1C408	0180-1948	9		CAPACITOR-FXD 1500UF+75-10% 40VDC AL	56289	39D158G040HP4
A1C409	0180-0097	7	1	CAPACITOR-FXD 47UF+-10% 35VDC TA	56289	150D476X9035B2
A1C410	0160-3486	2		CAPACITOR-FXD .47UF +80-20% 50VDC CER	28480	0160-3486
A1C411	0180-0159	2	1	CAPACITOR-FXD 220UF+-20% 10VDC TA	56289	150D227X001082
A1C413	0160-3486	2		CAPACITOR-FXD .47UF +80-20% 50VDC CER	28480	0160-3486
A1C414	0160-0576	5	13	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C415	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C416	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C417	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C418	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C419	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C420	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C421	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C422	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C423	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C424	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C425	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C426	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1CR400	1884-0066	3	1	THYRISTOR-SCR 2N4443 VRRM=400	04713	2N4443
A1CR401	1906-0096	7	2	DIODE-FW BRDG 200V 2A	04713	MDA202
A1CR402	1906-0096	7		DIODE-FW BRDG 200V 2A	04713	MDA202
A1CR403	1901-0200	5	4	DIODE-PWR RECT 100V 1.5A	28480	1901-0200
A1CR404	1901-0200	5		DIODE-PWR RECT 100V 1.5A	28480	1901-0200
A1CR405	1901-0200	5		DIODE-PWR RECT 100V 1.5A	28480	1901-0200
A1CR406	1901-0200	5		DIODE-PWR RECT 100V 1.5A	28480	1901-0200
A1CR407	1902-3048	7	1	DIODE-ZNR 3.48V 5% DO-7 PD=.4W TC=-.058%	28480	1902-3048
A1CR408	1902-0041	4	1	DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC=-.009%	28480	1902-0041
A1CR409	1901-0040	1	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR410	1901-0663	4	1	DIODE-PWR RECT 50V 3A 500NS	13327	N83000
A1CR411	1902-0049	2	1	DIODE-ZNR 6.19V 5% DO-7 PD=.4W TC=+.022%	28480	1902-0049
A1CR412	1902-3139	7	1	DIODE-ZNR 8.25V 5% DO-7 PD=.4W TC=+.053%	28480	1902-3139
A1DB200	1990-0486	6	8	LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4684
A1DB201	1990-0486	6		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4684
A1DB202	1990-0486	6		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4684
A1DB203	1990-0486	6		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4684
A1DB204	1990-0486	6		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4684
A1DB205	1990-0486	6		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4684
A1DB206	1990-0486	6		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4684
A1DB207	1990-0486	6		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4684
A1DB400	1990-0485	5	1	LED-VISIBLE LUM-INT=800UCD IF=30MA-MAX	28480	5082-4984
A1F400	2110-0003	0	1	FUSE 3A 250V FAST-BLO 1.25X.25 UL IEC	75915	312003
A1F401	2110-0012	1	2	FUSE .5A 250V FAST-BLO 1.25X.25 UL IEC	28480	2110-0012
A1F402	2110-0012	1		FUSE .5A 250V FAST-BLO 1.25X.25 UL IEC	28480	2110-0012
A1L400	03760-70080	4	1	TOROID ASSEMBLY	28480	03760-70080
A1MP20	37201-00024	4	1	HEAT SINK	28480	37201-00024
A1MP21	37201-00025	5	1	LEGEND PLATE	28480	37201-00025
A1Q400	1854-0071	7	2	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q401	1853-0020	4	1	TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A1Q402	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q403	1854-0589	2	1	TRANSISTOR NPN SI TO-3 PD=200W FT=2MHZ	04713	MJ3772
A1Q404	1854-0039	7	1	TRANSISTOR NPN 2N30538 SI TO-39 PD=1W	01928	2N30538

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-2 Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1Q405	1853-0010	2	1	TRANSISTOR PNP SI TO-18 PD=360MW	28480	1853-0010
A1R100	0757-0442	9	4	RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A1R101	1810-0055	5	1	NETWORK-RES 9-PIN-SIP .15-PIN-SPCG	28480	1810-0055
A1R102	0757-0420	3	3	RESISTOR 750 1% .125W F TC=0+-100	24546	C4-1/8-T0-751-F
A1R103	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A1R104	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A1R105	0698-3431	6	2	RESISTOR 23.7 1% .125W F TC=0+-100	03888	PME55-1/8-T0-23R7-F
A1R106	0698-3431	6		RESISTOR 23.7 1% .125W F TC=0+-100	03888	PME55-1/8-T0-23R7-F
A1R107	0757-0420	3		RESISTOR 750 1% .125W F TC=0+-100	24546	C4-1/8-T0-751-F
A1R108	0698-3151	7	3	RESISTOR 2.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2871-F
A1R109	0698-3151	7		RESISTOR 2.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2871-F
A1R110	0698-3151	7		RESISTOR 2.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2871-F
A1R111	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A1R112	0757-0420	3		RESISTOR 750 1% .125W F TC=0+-100	24546	C4-1/8-T0-751-F
A1R113	0757-0280		1	RESISTOR 1K 1% .125W F TC=0+-100	2M627	CRB14
A1R200	0698-3442	9	10	RESISTOR 237 1% .125W F TC=0+-100	24546	C4-1/8-T0-237R-F
A1R201	0698-3442	9		RESISTOR 237 1% .125W F TC=0+-100	24546	C4-1/8-T0-237R-F
A1R202	0698-3442	9		RESISTOR 237 1% .125W F TC=0+-100	24546	C4-1/8-T0-237R-F
A1R203	0698-3442	9		RESISTOR 237 1% .125W F TC=0+-100	24546	C4-1/8-T0-237R-F
A1R204	0698-3442	9		RESISTOR 237 1% .125W F TC=0+-100	24546	C4-1/8-T0-237R-F
A1R205	0698-3442	9		RESISTOR 237 1% .125W F TC=0+-100	24546	C4-1/8-T0-237R-F
A1R206	0698-3442	9		RESISTOR 237 1% .125W F TC=0+-100	24546	C4-1/8-T0-237R-F
A1R207	0698-3442	9		RESISTOR 237 1% .125W F TC=0+-100	24546	C4-1/8-T0-237R-F
A1R208	0757-0438	3	1	RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A1R209	0757-0280	3	6	RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A1R300	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A1R301	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A1R302	0698-3435	0	2	RESISTOR 38.3 1% .125W F TC=0+-100	24546	C4-1/8-T0-38R3-F
A1R303	0698-3435	0		RESISTOR 38.3 1% .125W F TC=0+-100	24546	C4-1/8-T0-38R3-F
A1R304	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A1R305	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A1R306	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A1R307	0757-0398	4	1	RESISTOR 75 1% .125W F TC=0+-100	24546	C4-1/8-T0-75R0-F
A1R400	0698-3442	9		RESISTOR 237 1% .125W F TC=0+-100	24546	C4-1/8-T0-237R-F
A1R401	0757-0418	9	1	RESISTOR 619 1% .125W F TC=0+-100	24546	C4-1/8-T0-619R-F
A1R402	0698-3132	4	1	RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A1R403	0698-3447	4	1	RESISTOR 422 1% .125W F TC=0+-100	24546	C4-1/8-T0-422R-F
A1R404	0698-3444	1	1	RESISTOR 316 1% .125W F TC=0+-100	24546	C4-1/8-T0-316R-F
A1R405	2100-3212	8	1	RESISTOR-TRMR 200 10% C TOP-ADJ 1-TRN	28480	2100-3212
A1R406	0698-4037	0	1	RESISTOR 46.4 1% .125W F TC=0+-100	24546	C4-1/8-T0-46R4-F
A1R407	0690-6811	6	1	RESISTOR 680 10% 1W CC TC=0+529	01121	GB6811
A1R408	0757-0199	3	1	RESISTOR 21.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2152-F
A1R409	0757-0279	0	1	RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A1R410	0698-3442	9		RESISTOR 237 1% .125W F TC=0+-100	24546	C4-1/8-T0-237R-F
A1R411	0757-0180	2	1	RESISTOR 31.6 1% .125W F TC=0+-100	28480	0757-0180
A1R412	0757-0283	6	1	RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-F
A1R413	0757-0401	0	1	RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A1R414	0757-0407	6	2	RESISTOR 200 1% .125W F TC=0+-100	24546	C4-1/8-T0-201-F
A1R415	0757-0407	6		RESISTOR 200 1% .125W F TC=0+-100	24546	C4-1/8-T0-201-F
A1S200	3100-3260	7	1	SWITCH, ROTARY SPECIAL PCB	28480	3100-3260
A1S201	3101-2097	8	2	SWITCH, SLIDE 6-1A-NS	28480	3101-2097
A1S202	3101-2097	8		SWITCH, SLIDE 6-1A-NS	28480	3101-2097
A1T300	37201-80002	6	1	TRANSFORMER, CORE PCT	28480	37201-80002
A1TL400	37201-20021		1	PC BOARD TEST	28480	37201-20021
A1U100	1820-1918	2	4	IC BFR TTL LS LINE DRVR OCTL	01295	SN74LS241N
A1U101	1820-1480	3	1	IC MICPROC NMOS 8-BIT	04713	MC6800L
A1U103	5090-0983		1	IC, PROM	28480	5090-0863
A1U105	5090-0984		1	IC, PROM	28480	5090-0865
A1U107	5090-0985		1	IC, PROM	28480	5090-0867
A1U110	1820-1918	2		IC BFR TTL LS LINE DRVR OCTL	01295	SN74LS241N
A1U109	5090-0986		1	IC PROM		
A1U111	1820-2036	7	1	IC DRVR NMOS CLOCK DRVR	04713	MC6875P
A1U112	1818-0643	3	2	IC NMOS 4K RAM STAT 450-NS 3-S	34649	P2114L
A1U113	1818-0643	3		IC NMOS 4K RAM STAT 450-NS 3-S	34649	P2114L
A1U114	1820-1216	3	2	IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A1U115	1820-1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A1U116	1820-1206	1	1	IC GATE TTL LS NOR TPL 3-INP	01295	SN74LS27N
A1U117	1820-1197	9	4	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A1U118	1820-2165	3	3	IC SW TTL BUS TPL	04713	MC6881P/MC3449P
A1U119	1820-2165	3		IC SW TTL BUS TPL	04713	MC6881P/MC3449P
A1U120	1820-2165	3		IC SW TTL BUS TPL	04713	MC6881P/MC3449P

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-2 Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1U121	1820-1199	1	3	IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A1U122	1820-1918	2		IC BFR TTL LS LINE DRVR OCTL	01295	SN74LS241N
A1U200	1820-1481	4	5	IC PIA NMOS	04713	MC6821L
A1U201	1820-1481	4		IC PIA NMOS	04713	MC6821L
A1U202	1820-1481	4		IC PIA NMOS	04713	MC6821L
A1U203	1820-1481	4		IC PIA NMOS	04713	MC6821L
A1U204	1820-1689	4	4	IC UART TTL QUAD	04713	MC3446P
A1U205	1820-1689	4		IC UART TTL QUAD	04713	MC3446P
A1U206	1820-1689	4		IC UART TTL QUAD	04713	MC3446P
A1U207	1820-1689	4		IC UART TTL QUAD	04713	MC3446P
A1U208	1820-1112	8	3	IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74N
A1U209	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A1U210	1820-1201	6	1	IC GATE TTL LS AND QUAD 2-INP	01295	SN74LS08N
A1U211	1820-1199	1		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A1U212	1820-1918	2		IC BFR TTL LS LINE DRVR OCTL	01295	SN74LS241N
A1U213	1820-1207	2	1	IC GATE TTL LS NAND 8-INP	01295	SN74LS30N
A1U214	1820-1991	1	4	IC CNTR TTL LS DECD DUAL 4-BIT	01295	SN74LS390N
A1U215	1820-1991	1		IC CNTR TTL LS DECD DUAL 4-BIT	01295	SN74LS390N
A1U216	1820-1991	1		IC CNTR TTL LS DECD DUAL 4-BIT	01295	SN74LS390N
A1U217	1820-1427	8	2	IC DCDR TTL LS 2-TO-4-LINE DUAL 2-INP	01295	SN74LS156N
A1U218	1820-1427	8		IC DCDR TTL LS 2-TO-4-LINE DUAL 2-INP	01295	SN74LS156N
A1U300	1820-0990	8	4	IC RCVR DTL NAND LINE QUAD	04713	MC1489AL
A1U301	1820-1470	1	4	IC MUXR/DATA-SEL TTL LS 2-TO-1-LINE QUAD	01295	SN74LS157N
A1U302	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A1U303	1820-1212	9	1	IC FF TTL LS J-K NEG-EDGE-TRIG	01295	SN74LS112N
A1U304	1820-1435	8	2	IC CNTR TTL LS BIN UP/DOWN SYNCHRO	01295	SN74LS669N
A1U305	1820-1435	8		IC CNTR TTL LS BIN UP/DOWN SYNCHRO	01295	SN74LS669N
A1U306	1820-1144	6	1	IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A1U307	1820-1195	7	1	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A1U308	1820-1989	7	1	IC CNTR TTL LS BIN DUAL 4-BIT	07263	74LS393PC
A1U309	1820-1199	1		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A1U310	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74N
A1U311	1820-1470	1		IC MUXR/DATA-SEL TTL LS 2-TO-1-LINE QUAD	01295	SN74LS157N
A1U312	1820-1470	1		IC MUXR/DATA-SEL TTL LS 2-TO-1-LINE QUAD	01295	SN74LS157N
A1U313	1820-1481	4		IC PIA NMOS	04713	MC6821L
A1U314	1820-1690		1	IC ASYNCHRONOUS COMMUNICATIONS INTERFACE	04713	NC6850L
A1U315	1820-1310	8	1	IC RCVR TTL LINE RCVR DUAL	01295	SN751088N
A1U316	1820-1110	6	1	IC DRVR TTL LINE DRVR DUAL	01295	SN75110AN
A1U317	1820-0509	5	3	IC DRVR DTL LINE DRVR QUAD	04713	MC1488L
A1U318	1820-0509	5		IC DRVR DTL LINE DRVR QUAD	04713	MC1488L
A1U319	1820-0509	5		IC DRVR DTL LINE DRVR QUAD	04713	MC1488L
A1U320	1820-0990	8		IC RCVR DTL NAND LINE QUAD	04713	MC1489AL
A1U321	1820-0990	8		IC RCVR DTL NAND LINE QUAD	04713	MC1489AL
A1U322	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74N
A1U323	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A1U324	1820-1470	1		IC MUXR/DATA-SEL TTL LS 2-TO-1-LINE QUAD	01295	SN74LS157N
A1U325	1820-1991	1		IC CNTR TTL LS DECD DUAL 4-BIT	01295	SN74LS390N
A1U326	1820-2175	5	1	IC MICPROC-ACCESS NMOS	04713	MC6852CP
A1U400	1820-0990	8		IC RCVR DTL NAND LINE QUAD	04713	MC1489AL
A1U401	1826-0147	9	2	IC 7812 V RGLTR TO-220	04713	MC7812CP
A1U402	1826-0147	9		IC 7812 V RGLTR TO-220	04713	MC7812CP
A1U403	1826-0445	0	1	IC 7905 V RGLTR TO-220	07263	UA7905UC
A1U404	1826-0026	3	1	COMPARATOR PRCN TO-99	04713	MLM311G
A1XA400	1251-0472		1	CONNECTOR PC EDGE 6-CON/ROW 2-ROWS	23880	SCM6D/7-1HP
A1Y100	0410-1197	9	1	CRYSTAL, 3.840 MHZ	28480	0410-1197
MISC	1200-0541			SOCKET-IC 24-CONT DIP DIP-SLDR	09922	DK824P-108
	1200-0507			SOCKET-IC 24-CONT DIP-SLDR	06776	0002811
A1	37201-60020	6		BOARD ASSEMBLY	28480	37201-60020
C1	0160-3561	4	1	CAPACITOR-FXD 1000PF/1000PF +100-0%	28480	0160-3561
E1	0960-0444	2	1	LINE MODULE, UNFILTERED	28480	0960-0444
F1	2110-0201	0	1	FUSE .25A 250V SLO-BLO 1.25X.25 UL IEC	75915	313.250
F1	2110-0202	1	1	FUSE .5A 250V SLO-BLO 1.25X.25 UL IEC	75915	313.500
MP1	37201-00026	2	1	FRONT PANEL	28480	37201-00026
MP2	37201-00027	0	1	SUB-PANEL	28480	37201-00027
MP3	5020-8801	4	1	FRONT FRAME, UPPER	28480	5020-8801
MP4	5040-7202	9	1	TRIM, TOP	28480	5040-7202
MP5	5020-8830	9	2	SIDE STRUT	28480	5020-8830
MP6	5040-7219	8	1	STRAP, HANDLE, CAP-FRONT	28480	5040-7219
MP7	5060-9833	8	1	TOP COVER	28480	5060-9833
MP8	5060-9874	7	1	COVER, SIDE	28480	5060-9874
MP9	5060-9905	5	1	COVER, SIDE, PERFORATED	28480	5060-9905
MP10	5060-9845	2	1	COVER, BOTTOM	28480	5060-9845
MP11	5060-9802	1	1		28480	5060-9802
MP12	5040-7201	8	4	FOOT(STANDARD)	28480	5040-7201
MP13	37201-00023	3	1	REAR PANEL	28480	37201-00023
MP14	5020-8802	5	1	REAR FRAME, UPPER	28480	5020-8802
MP15	5040-7220	1	1	STRAP, HANDLE, CAP-REAR	28480	5040-7220

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-2 Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
MP16	37201-20026	8	3	STRUT	28480	37201-20026
MP17	5001-0438	7	2	TRIM STRIP, SIDE	28480	5001-0438
MP18	4040-1083	1	2		28480	4040-1083
MP19	37201-20027	9	2	TRANSFORMER SUPPORT	28480	37201-20027
S1	3101-2369	7	1	SWITCH, ROCKER DPDT-NS	28480	3101-2369
S2	3101-0183	6	1	SWITCH, PUSHBUTTONM SPDT NOM-25A BLK-BTN	82289	913
T1	37201-80001	5	1	TRANSFORMER ASSEMBLY	28480	37201-80001
W1	37201-60031	9	1	POWER CABLE	28480	37201-60031
W2	37201-60011	5	1	CONNECTOR-4-WIRE ASSEMBLY	28480	37201-60011
W3	37201-60032	0	1	COAX CABLE ASSEMBLY	28480	37201-60032
				MISCELLANEOUS		
	1251-0064		2	CONNECTOR 25 PIN (RS232C)	28480	1251-0064
	1251-0064			CONNECTOR 25 PIN (RS366)	28480	1251-0064
	1251-3283		1	CONNECTOR 24 PIN (HP-IB)	28480	1251-3283

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-3 Manufacturer Code List

MFR No.	Manufacturer Name	Address		Zip Code
01121	ALLEN-BRADLEY CO	MILWAUKEE	WI	53204
01295	TEXAS INSTRU INC SEMICOND CMPNT DIV	DALLAS	TX	75222
0192B	RCA CORP SOLID STATE DIV	SOMERVILLE	NJ	08876
03888	KDI PYROFILM CORP	WHIPPANY	NJ	07981
04713	MOTOROLA SEMICONDUCTOR PRODUCTS	PHOENIX	AZ	85062
07263	FAIRCHILD SEMICONDUCTOR DIV	MOUNTAIN VIEW	CA	94042
13327	SOLITRON DEVICES INC (DIODES)	TAPPAN	NY	10983
24546	CORNING GLASS WORKS (BRADFORD)	BRADFORD	PA	16701
25088	SIEMENS CORP	ISELIN	NJ	08830
28480	HEWLETT-PACKARD CO CORPORATE HQ	PALO ALTO	CA	94304
34649	INTEL CORP	MOUNTAIN VIEW	CA	95051
56289	SPRAGUE ELECTRIC CO	NORTH ADAMS	MA	01247
75915	LITTELFUSE INC	DES PLAINES	IL	60016
82389	SWITCHCRAFT INC	CHICAGO		
23880	STANFORD APPLIED ENGINEERING INC	SANTA CLARA	CA	
09922	BURNDY CORP	NORWALK	CT	
2M627	R-OHM CORPORATION	IRVINE	CA	
06776	ROBINSON NUGENT INC	NEW ALBANY	IN	

SECTION VII

MANUAL CHANGES

7-1 INTRODUCTION

7-2 This section contains information for adapting this manual to instruments for which the content does not apply directly.

7-3 MANUAL CHANGES

7-4 To adapt this manual to your instrument, refer to Table 7-1 and make all the manual changes listed opposite your instrument serial number. Perform these changes in the sequence listed.

7-5 If your instrument serial number is not listed on the title page of this manual or in Table 7-1 below, it may be documented in a Blue MANUAL CHANGES supplement. For additional information about serial number coverage refer to INSTRUMENTS COVERED BY MANUAL in Section I.

Table 7-1 Manual Changes By Serial Number

Serial Prefix or Number	Make Manual Changes
1925U	NONE*
1914U-Numbers 00270 and above	A
1914U-Numbers up to 00269	A, B

Serial Prefix or Number	Make Manual Changes
1840U-Numbers 00142 and above	A, B, C
1840U-Numbers up to 00141	A, B, C, D

*Change to PC Board layout to accommodate another instrument.

7-6 MANUAL CHANGE INSTRUCTIONS

CHANGE A

Page 8-25, Figure A100-2 and A100-3.
Add Component Location and Schematic Diagram, Figures 7-1 and 7-2.
Delete Component Location and Schematic Diagram, Figures A100-2 and A100-3.

Page 8-23, Signature List.
Add Signature List page 7-3 and 7-4.
Delete Signature List page 8-23 and 8-24.

CHANGE B

Page 6-5, Table 6-2, Replaceable Parts.
Delete A1R113 Part Number 0757-0280, RESISTOR 1K.

Page 7-5 , Figure 7-2 Schematic Diagram, Section 100.
Delete A1R113, 1K and join U111 pin 1 to pin 2.

CHANGE C

Page 8-25, Figure A100-2 Component Location.
Add Component Location Figure 7-3.
Delete Existing component location.

Page 6-5, Table 6-2 Replaceable Parts.
Add: A1U102 Part Number 5090-0944 IC PROM
A1U104 Part Number 5090-0946 IC PROM
A1U106 Part Number 5090-0866 IC PROM
A1U108 Part Number 5090-0868 IC PROM
Change A1U103 from 5090-0983 to 5090-0945
A1U105 from 5090-0984 to 5090-0865
A1U107 from 5090-0985 to 5090-0867
Delete. A1U109 Part Number 5090-0986

Note: Instruments with serial prefix 1914U may be fitted with either fuseable link ROMs or erasable PROMs. In order to identify which type is fitted check the component location Figure 7-1 to see where the ROM SELECTOR LINKS are fitted. The ROM stock numbers are different for the different types of ROM but the instrument operation and signatures remain unchanged. The only difference is in the ROM select lines (see schematic diagram Figure 7-2). For replacement purposes, fuseable link ROMs must be replaced with fuseable link ROMs. To change to EPROMs requires all ROMs in the instrument to be changed. The reverse is also true.

Page 8-23/24, Signature List.
Add Signature List pages 7-9 and 7-10.
Delete existing Signature List.

CHANGE D

Page 6-6, Table 6-2 Replaceable Parts.

Change MP1 Part Number 37201-00026 to 37201-00022.
MP2 Part Number 37201-00027 to 37201-00020.

Page 6-7, Table 6-2 Replaceable Parts.
Add under S2, Part Number 3101-0851 CAP-PUSHBUTTON BLACK.
Change S2 Part Number 3101-0183 to 3101-2369.

SIGNATURE LIST

The following signatures were taken with the test link in the SA Test position. Before taking signatures, switch the 37201A Power off and then on to provide a reset – this is a precaution to ensure correct signatures.

Before making any signature checks, check the +5V signature is 755U and the 0V line is 0000.

MPU ADDRESS

U101

Pin		Pin	
9	C113	32	–
10	7050	31	–
11	0772	30	–
12	C4C3	29	–
13	AA08	28	–
14	7211	27	–
15	A3C1	26	–
16	7707	25	NOT USED
17	577A	24	0000
18	HH86	23	1180
19	89F1	22	PCF3
20	AC99	21	–

SELECTORS

U114

Pin		Pin	
1	AA08	16	+V
2	7211	15	C2P5
3	A3C1	14	4P70
4	1180	13	A614
5	0000	12	9260
6	89F1	11	87HF
7	8ACC	10	FU61
8	GND	9	8U44

U115

Pin		Pin	
1	89F1	16	+V
2	AC99	15	048A
3	PCF3	14	A39A
4	0000	13	0H59
5	B clock	12	599H
6	1180	11	9970
7	0U2U	10	U94A
8	GND	9	8H41

BUFFERS

U121

Pin		Pin	
1	HIGH	14	HIGH
2	LOW	13	HIGH
3	1180	12	LOW
4	64HU	11	LOW
5	B clock	10	HIGH
6	B clock	9	755U
7	LOW	8	0000

3 I/P NOR

U116

Pin		Pin	
1	LOW		
2	LOW	13	HIGH
3	B clock	12	LOW
4	LOW	11	B clock
5	LOW	10	1180
6	755U	9	89F1
7	LOW	8	P17F

3 I/P NAND

U117

Pin		Pin	
2	LOW	13	NOT USED
3	HIGH	12	NOT USED
4	LOW	11	NOT USED
5	P17F	10	64HU
6	HIGH	9	89F1
7	LOW	8	U0UF

ROM DATA BUS SIGNATURES

All ROM's connected as for processor troubleshooting (Check 1) at U102.

U102

Pin		Pin	
8	–	17	8889
9	30H3	16	20P8
10	CF94	15	20UP
11	864F	14	4FU4
12	GND	13	538H

INDIVIDUAL ROM SIGNATURES FOR PROCESSOR TROUBLESHOOTING (Check 4).

Pin	U102	U103	U104	U105	U106	U107	U108
9	62H4	5556	H0P3	A277	U64U	HU67	2HHU
10	P15H	C908	PC74	1018	5400	0F12	APH7
11	A04F	3UHA	U20U	FH2U	U45A	76A2	98HF
12	GND	GND	GND	GND	GND	GND	GND
13	3UU6	AHPC	74UP	660U	P16F	5523	61P5
14	263F	924P	9943	219A	1H63	P43C	9824
15	H886	0CH2	F6UU	1A68	4U71	UA6A	9447
16	5200	HH50	145H	425A	2577	4A9F	83F0
17	U2P6	420P	49U5	1FU5	9HP0	5641	P146

The above signatures were taken for instruments with serial prefix 1840U, refer to the current change sheet to ensure the signatures have not changed.

The above listed ROM signatures were for ROM's with the following stock numbers:

U102 – 5090-0944 or 5090-0976
U103 – 5090-0945 or 5090-0977
U104 – 5090-0946 or 5090-0978
U105 – 5090-0947 or 5090-0979
U106 – 5090-0866 or 5090-0980
U107 – 5090-0867 or 5090-0981
U108 – 5090-0869 or 5090-0982

RAM TEST SIGNATURES (CHECK 2)

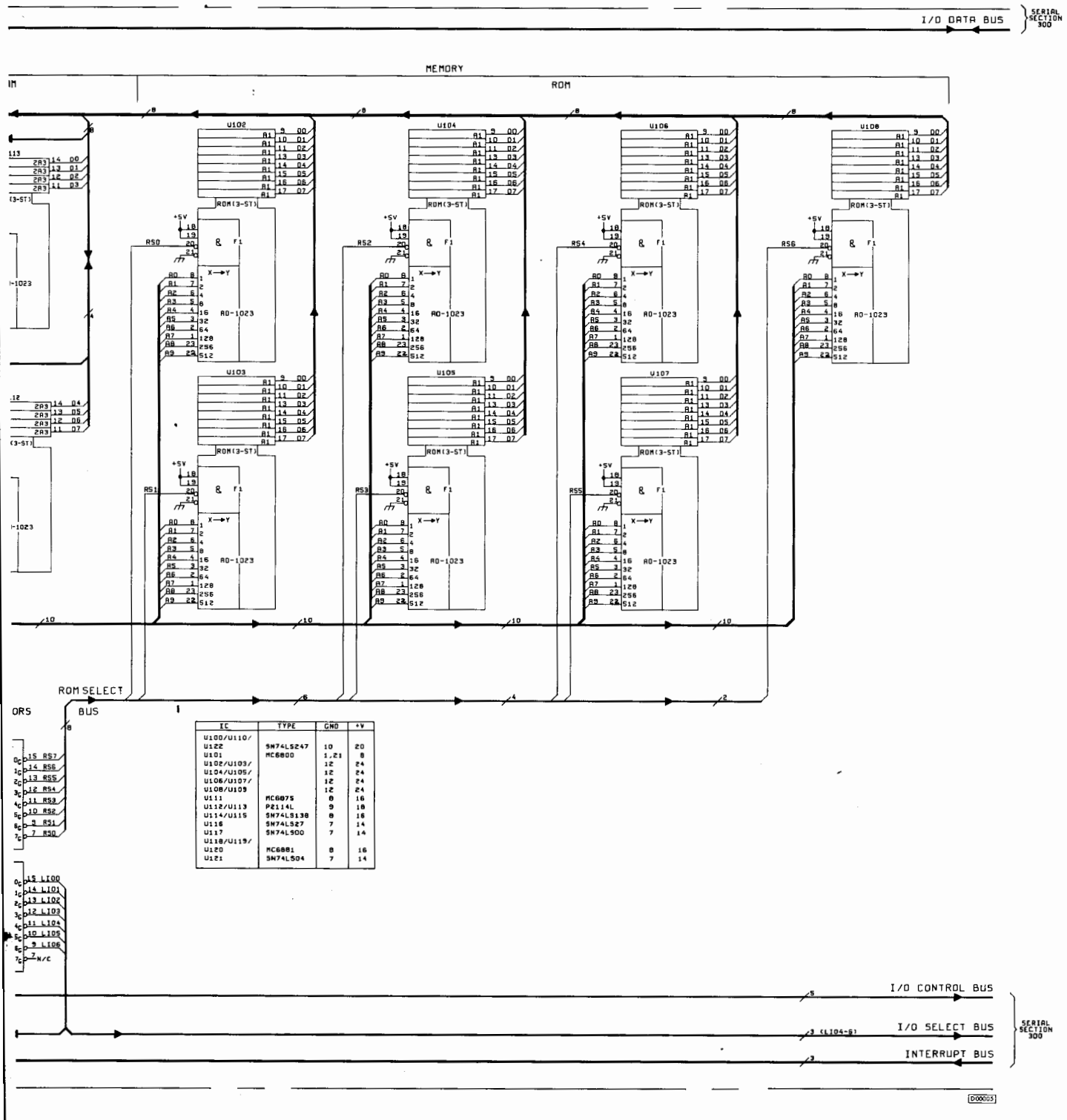
The following signatures were taken with the test link in the normal position. Before taking signatures, switch the 37201A Power off then on.

Check the +5V line signature is 69C4 and the 0V line is 0000. Note the +5V signature is different with the test link in the normal position.

U102				U101				U113/112 ADDRS			
Pin		Pin		Pin		Pin		Pin		Pin	
1	–	17	P7C6	5	6F7F	36	–	1	–	18	–
9	6C59	16	P357	6	–	35	–	2	415H	17	7141
10	UAHU	15	4F07	7	–	34	A32U	3	C39C	16	HA26
11	2372	14	P19C	8	HIGH	33	–	4	3C84	15	53H2
12	GND	13	25HA	9	A612	32	–	5	A612	14	*
								6	A7H1	13	*
								7	56H0	12	*
								8	8943	11	*
								9	LOW	10	A32U

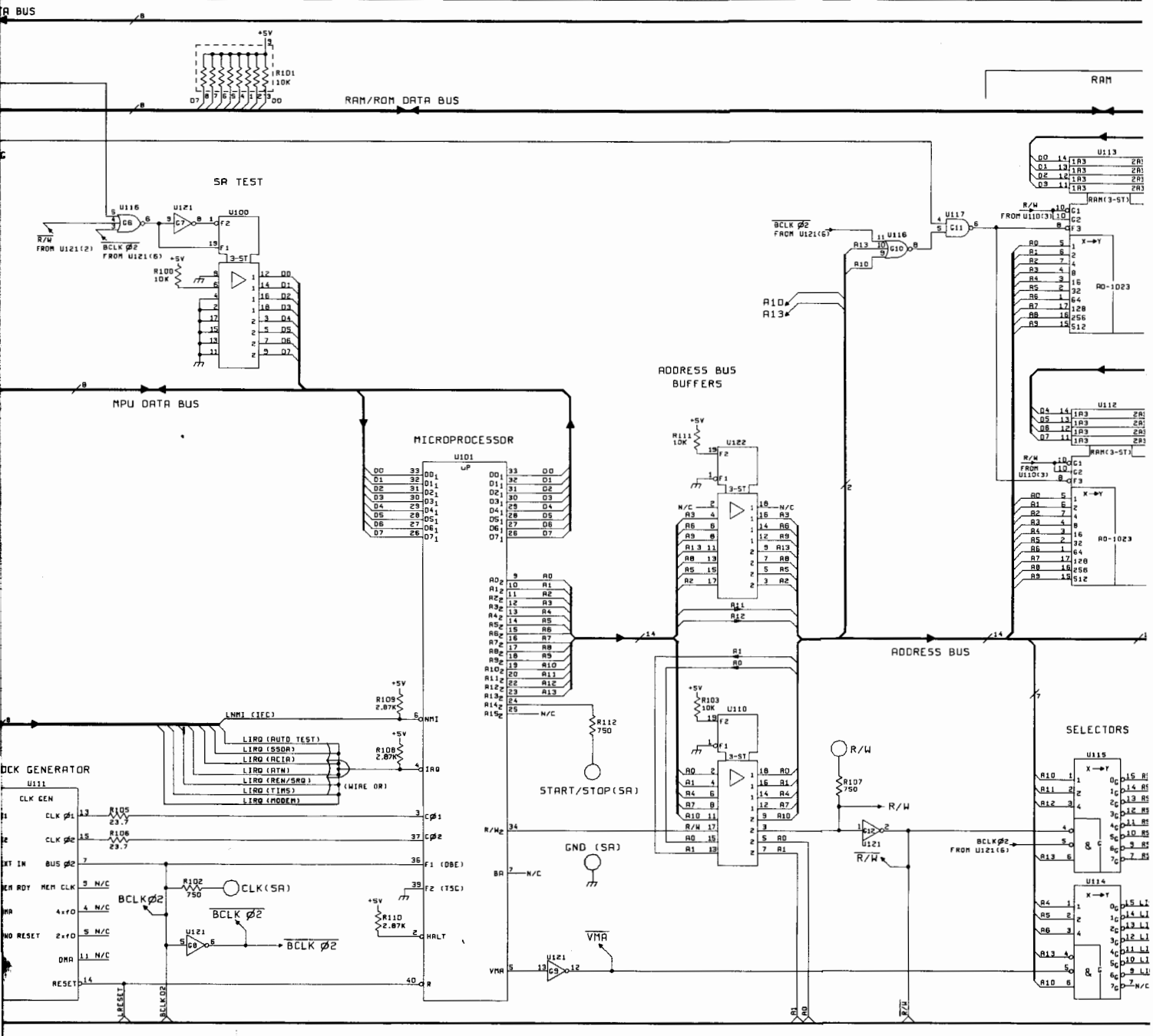
U116				U121			
Pin		Pin		Pin		Pin	
1	LOW	14	HIGH	1	A32U	14	HIGH
2	05F8	13	LOW	2	FA9C	13	6F7F
3	B clock	12	6F7F	3	0U2P	12	05F8
4	FA9C	11	B clock	4	669A	11	HIGH
5	HIGH	10	0U2P	5	B clock	10	LOW
6	LOW	9	0U2P	6	B clock	9	LOW
7	LOW	8	669A	7	LOW	8	HIGH

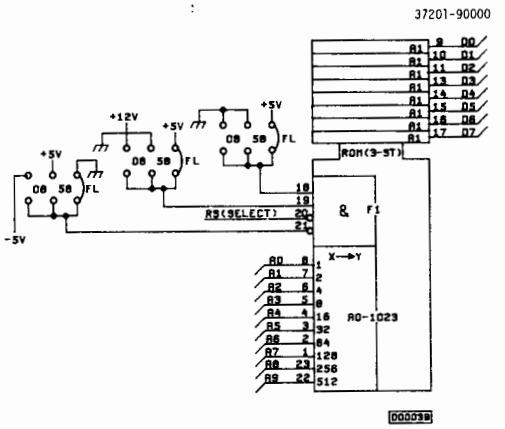
* The signatures at these pins have been measured at U102 so there is no need to repeat the check at this point. U102 was chosen purely from a convenience point of view.



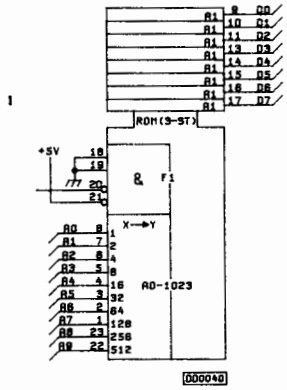
IC	TYPE	GND	+V
U100/U110/ U122	SN74LS247	10	20
U101	MC6800	1,21	8
U102/U103/ U104/U105/ U106/U107/ U108/U109		12	24
U111	MC6875	0	16
U112/U113	P2114L	9	18
U114/U115	SN74LS138	8	16
U116	SN74LS27	7	14
U117	SN74LS00	7	14
U118/U119/ U120	MC6881	8	16
U121	SN74LS04	7	14

(Figure A100-3 Schematic Diagram — Section 100)
Figure 7-2 Schematic Diagram


RAM/ROM DATA BUS
RAM
SA TEST
MPU DATA BUS
MICROPROCESSOR
ADDRESS BUS BUFFERS
ADDRESS BUS
SELECTORS
START/STOP(SA)
GND (SA)
CLK(SA)
BCLK Ø2
VMA
R/W
RESET
HALT
NMI
IRQ
(WIRE OR)
LIRQ (AUTO TEST)
LIRQ (SSDA)
LIRQ (ACIA)
LIRQ (ATN)
LIRQ (REN/SRQ)
LIRQ (TIMS)
LIRQ (MODEM)
CLK GEN
A0-1023
RAM(3-ST)



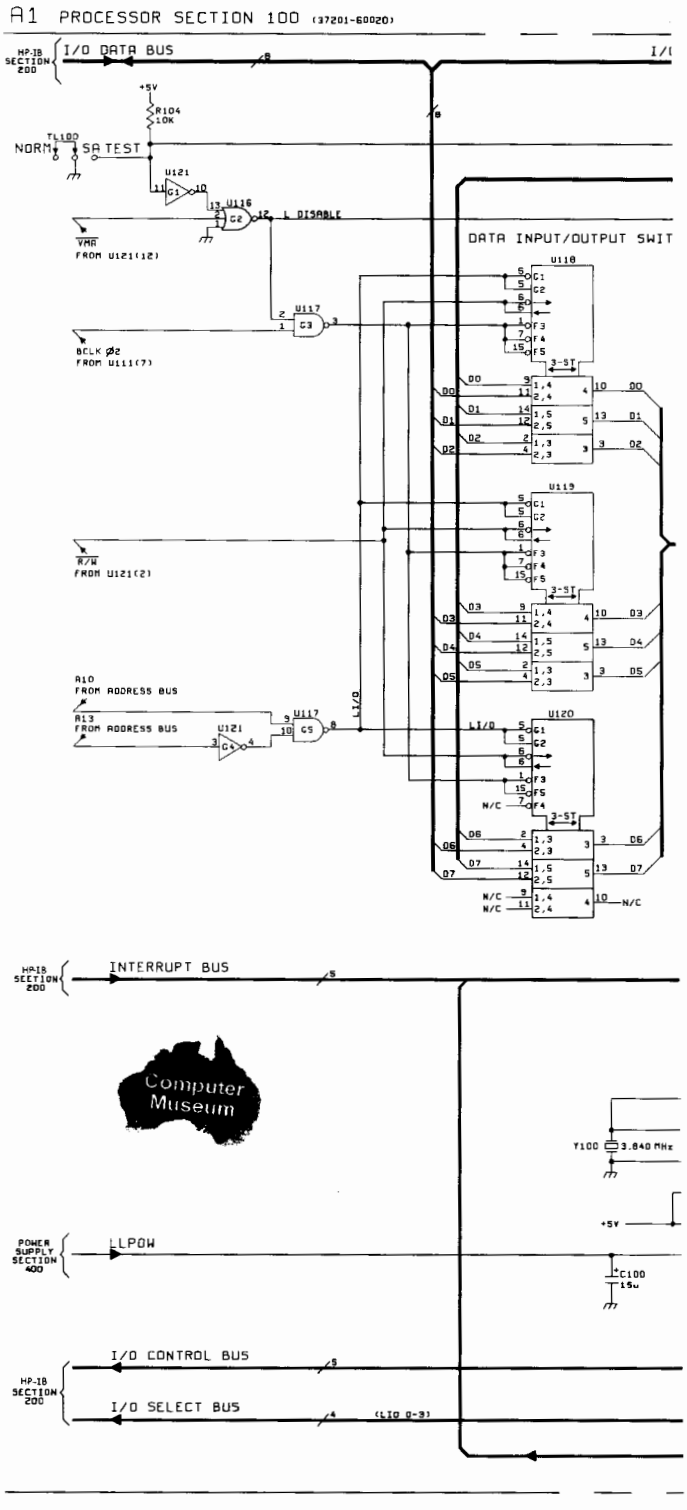
ROM's U102 – U108 shown as connected for fuseable link ROMS

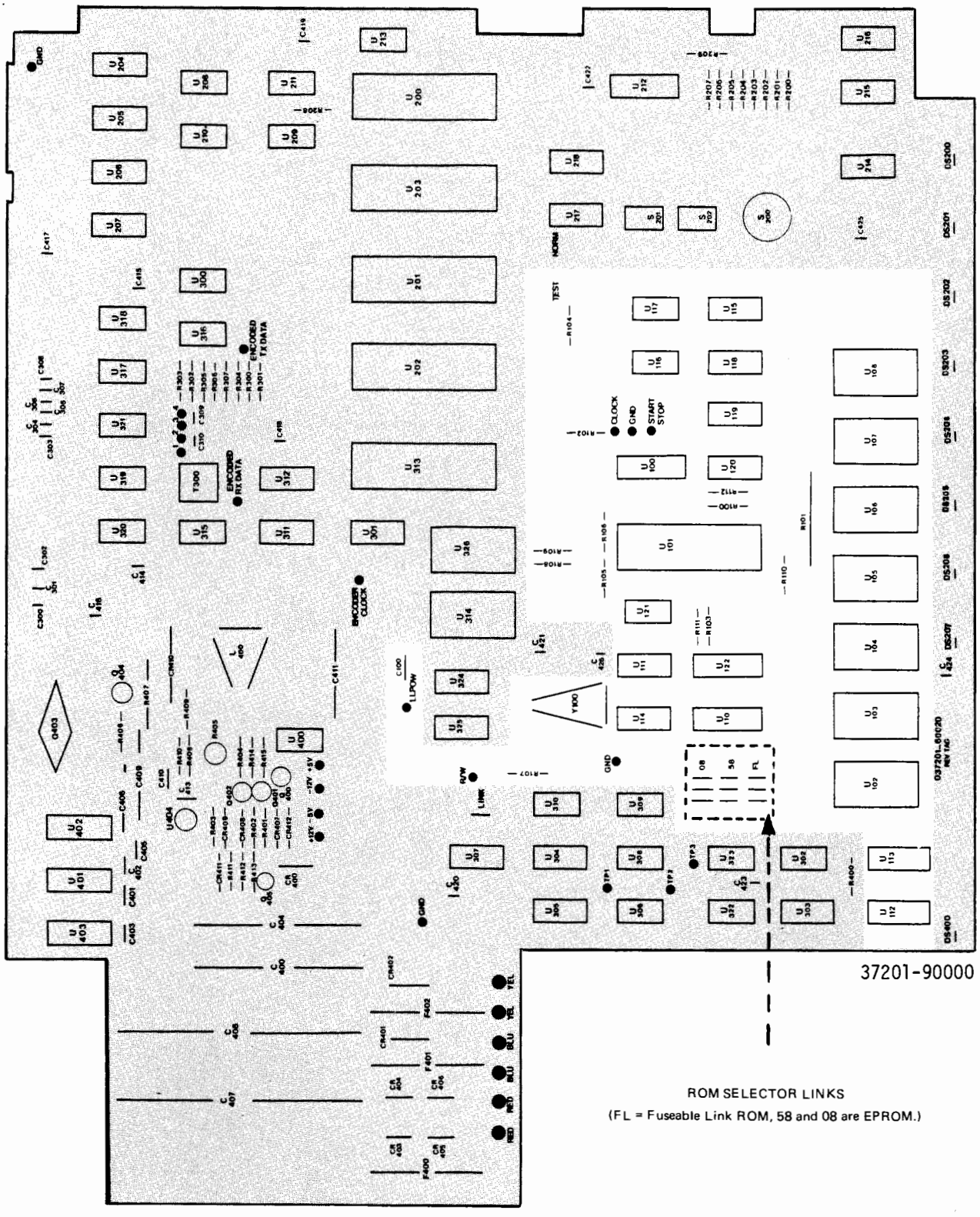


ROM's U102 – U108 drawn as wired for EPROM (linked at 58 position)

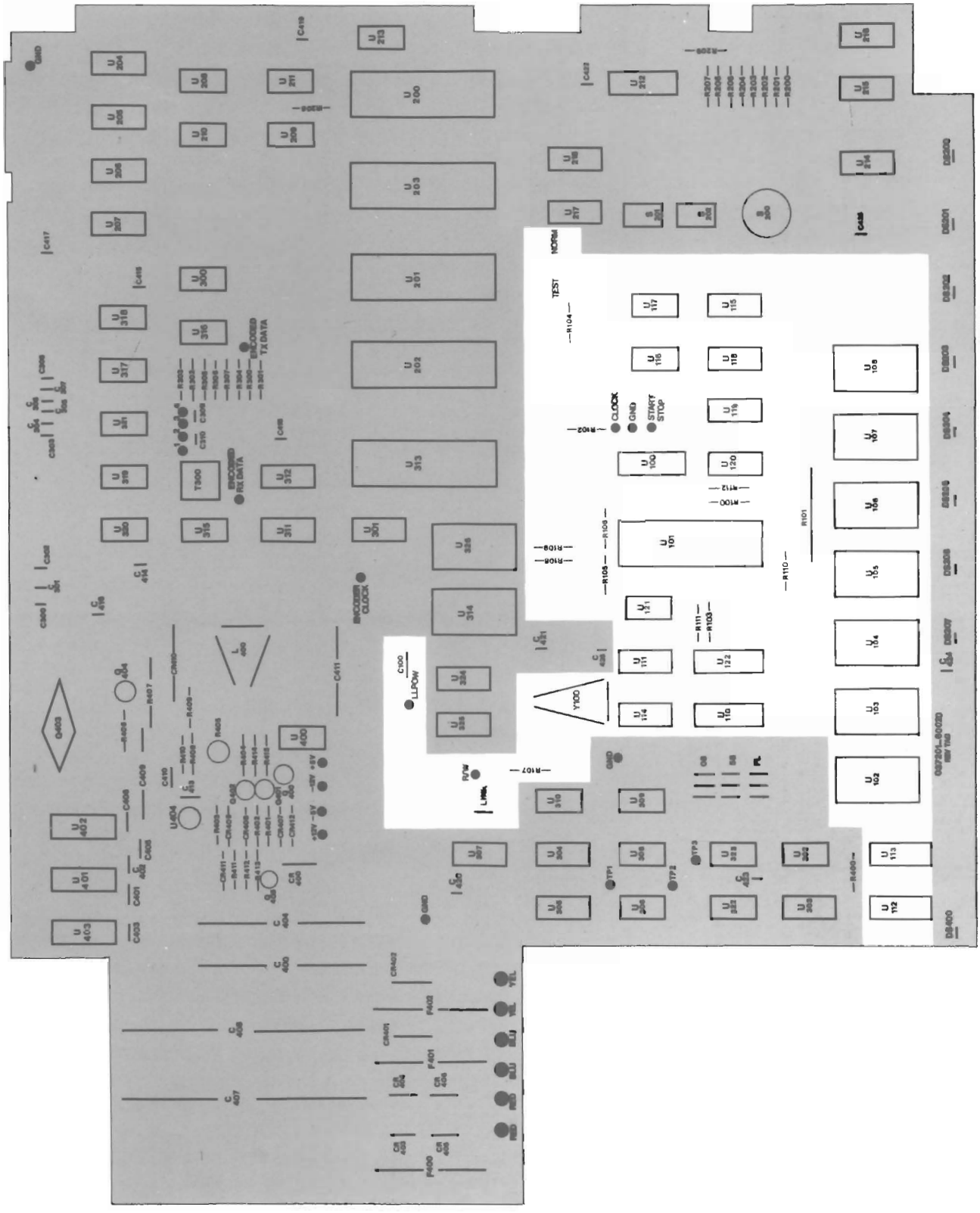
Valid for EPROM stock numbers:

U102	5090-0976	U106	5090-0980
U103	5090-0977	U107	5090-0981
U104	5090-0978	U108	5090-0982
U105	5090-0979		





(Figure A100-2 Component Location — Section 100)
Figure 7-1 Component Location



(Figure A100-2 Component Location Section 100)

Figure 7-3 Component Location

SIGNATURE LIST

The following signatures were taken with the test link in the SA Test position. Before taking signatures, switch the 37201A Power off and then on to provide a reset – this is a precaution to ensure correct signatures.

Before making any signature checks, check the +5V signature is 755U and the 0V line is 0000.

MPU ADDRESS

U101

Pin		Pin	
9	C113	32	–
10	7050	31	–
11	0772	30	–
12	C4C3	29	–
13	AA08	28	–
14	7211	27	–
15	A3C1	26	–
16	7707	25	NOT USED
17	577A	24	0000
18	HH86	23	1180
19	89F1	22	PCF3
20	AC99	21	–

SELECTORS

U114

Pin		Pin	
1	AA08	16	+V
2	7211	15	C2P5
3	A3C1	14	4P70
4	1180	13	A614
5	0000	12	9260
6	89F1	11	87HF
7	8ACC	10	FU61
8	GND	9	8U44

U115

Pin		Pin	
1	89F1	16	+V
2	AC99	15	048A
3	PCF3	14	A39A
4	0000	13	0H59
5	B clock	12	599H
6	1180	11	9970
7	0U2U	10	U94A
8	GND	9	8H41

BUFFERS

U121

Pin		Pin	
1	HIGH	14	HIGH
2	LOW	13	HIGH
3	1180	12	LOW
4	64HU	11	LOW
5	B clock	10	HIGH
6	B clock	9	755U
7	LOW	8	0000

3 I/P NOR

U116

Pin		Pin	
1	LOW		
2	LOW	13	HIGH
3	B clock	12	LOW
4	LOW	11	B clock
5	LOW	10	1180
6	755U	9	89F1
7	LOW	8	P17F

3 I/P NAND

U117

Pin		Pin	
2	LOW	13	NOT USED
3	HIGH	12	NOT USED
4	LOW	11	NOT USED
5	P17F	10	64HU
6	HIGH	9	89F1
7	LOW	8	U0UF

ROM DATA BUS SIGNATURES

All ROM's connected as for processor troubleshooting (Check 1) at U102.

U102

Pin		Pin	
8	–	17	8889
9	30H3	16	20P8
10	CF94	15	20UP
11	864F	14	4FU4
12	GND	13	538H

INDIVIDUAL ROM SIGNATURES FOR PROCESSOR TROUBLESHOOTING (Check 4).

Pin	U102	U103	U104	U105	U106	U107	U108
9	62H4	5556	H0P3	A277	U64U	HU67	2HHU
10	P15H	C908	PC74	1018	5400	0F12	APH7
11	A04F	3UHA	U20U	FH2U	U45A	76A2	98HF
12	GND	GND	GND	GND	GND	GND	GND
13	3UU6	AHPC	74UP	660U	PI6F	5523	61P5
14	263F	924P	9943	219A	1H63	P43C	9824
15	H886	0CH2	F6UU	1A68	4U71	UA6A	9447
16	5200	HH50	145H	425A	2577	4A9F	83F0
17	U2P6	420P	49U5	1FU5	9HP0	5641	P146

The above signatures were taken for instruments with serial prefix 1840U, refer to the current change sheet to ensure the signatures have not changed.

The above listed ROM signatures were for ROM's with the following stock numbers:

U102 – 5090-0944 U106 – 5090-0866
U103 – 5090-0945 U107 – 5090-0867
U104 – 5090-0946 U108 – 5090-0868
U105 – 5090-0865

RAM TEST SIGNATURES (CHECK 2)

The following signatures were taken with the test link in the normal position. Before taking signatures, switch the 37201A Power off then on.

Check the +5V line signatre is 69C4 and the 0V line is 0000. Note the +5V signature is different with the test link in the normal position.

U102

Pin		Pin	
1	–	17	P7C6
9	6C59	16	P357
10	UAHU	15	4F07
11	2372	14	P19C
12	GND	13	25HA

U101

Pin		Pin	
5	6F7F	36	–
6	–	35	–
7	–	34	A32U
8	HIGH	33	–
9	A612	32	–

U113/112 ADDRS

Pin		Pin	
1	–	18	–
2	415H	17	7141
3	C39C	16	HA26
4	3C84	15	53H2
5	A612	14	*
6	A7H1	13	*
7	56H0	12	*
8	8943	11	*
9	LOW	10	A32U

U116

Pin		Pin	
1	LOW	14	HIGH
2	05F8	13	LOW
3	B clock	12	6F7F
4	FA9C	11	B clock
5	HIGH	10	0U2P
6	LOW	9	0U2P
7	LOW	8	669A

U121

Pin		Pin	
1	A32U	14	HIGH
2	FA9C	13	6F7F
3	0U2P	12	05F8
4	669A	11	HIGH
5	B clock	10	LOW
6	B clock	9	LOW
7	LOW	8	HIGH

* The signatures at these pins have been measured at U102 so there is no need to repeat the check at this point. U102 was chosen purely from a convenience point of view.

SECTION VIII

SERVICE

8-1. INTRODUCTION

8-2. This section of the manual contains the information required to repair the 37201A HP-IB Extender. All the circuitry is contained on one printed circuit board, but for ease of documentation the instrument is divided into four sections. The sections are: Processor Section 100, HP-IB Section 200, Serial Section 300 and Power Supply Section 400. Detailed information i.e. circuit descriptions, schematic diagrams, component locations and troubleshooting information pertaining to each section is contained respectively in Section Service Sheets 100, 200, 300 and 400.

8-3. By way of an introduction to the hardware, an overall general theory of operation is presented in Paragraph 8-24.

8-4. TROUBLESHOOTING

8-5. Three different methods of troubleshooting the 37201A have been devised viz. Desk Top Computer Diagnostics, Self-Test, and Signature Analysis, contained respectively in General Service Sheets G1, G2 and G3.

8-6. An HP 9825A Desk Top Computer program to assist troubleshooting the 37201A is available on an HP Tape Cartridge. Where possible this program should be used first when troubleshooting. Normally it will isolate the fault to a specific area, often to within a few components. Having located the area of the fault, reference should be made to the appropriate Section Service Sheet. Full details of the equipment required, procedure etc. are given in General Service Sheet G1.

8-7. General Service Sheet G2 describes how most of the instrument is checked by the self-test procedure, and how to check the remainder not covered by the self-test procedure. (The checks described are similar to the Performance Tests in Section IV of this manual.) Occasionally, the self-test routine will show the instrument to be faulty but will not indicate the precise location of the fault. If the fault cannot be located to at least one of the Service Sections, then proceed to General Service Sheet G3.

8-8. If either the Desk Top Computer program or the self-test procedure indicate that the instrument is faulty without indicating the precise location, the procedure in General Service Sheet G3 should be performed. General Service Sheet G3 uses signature analysis and other more traditional methods to locate the fault.

8-9. SAFETY REQUIREMENTS

8-10. This section contains information and warnings which must be followed for your protection and to avoid damage to the equipment.

WARNING

Procedures described in this section are performed with protective covers removed and power supplied to the instrument. Servicing should only be performed by trained personnel who are aware of the hazard involved.

8-11. RECOMMENDED TEST EQUIPMENT

8-12. Test equipment required to maintain the 37201A is listed in Table 1-5. Any equipment that satisfies the critical specifications given in the table may be substituted for the recommended models. In order to run the Desk Top Computer Diagnostic Program, a special 16 bit I/O has to be constructed, full details are in General Service Sheet G1.

8-13. LOGIC SYMBOLS

8-14. The logic symbols used in this manual are based on the American National Standard ANSI Y32.14-1973, "Graphic Symbols for Logic Diagrams (Two-State Devices)".

8-15. Qualifiers

8-16. Qualifiers are that portion of a logic symbol that denotes its logic function. The following qualifiers are used in this manual:

&	–	AND.
◄►	–	Bilateral Switch: A binary controlled circuit which acts as an on/off switch to analog or binary signals flowing in both directions.
X→Y	–	Coder: Input code (X) is converted to output code (Y) per weighted values.
mCNTR	–	COUNTER with modulus m.
RAM	–	RANDOM ACCESS MEMORY.
ROM	–	READ ONLY MEMORY.

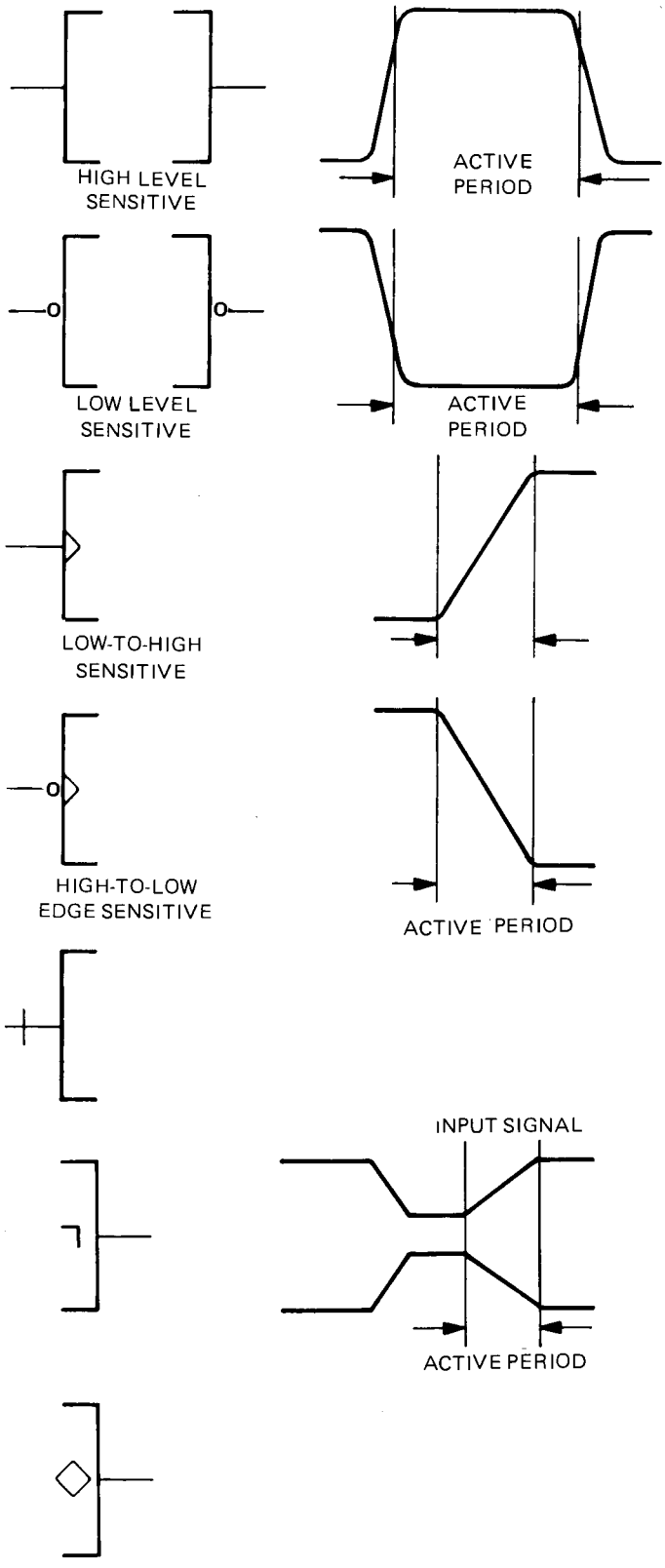


Figure 8-1 Indicator Symbols

+m – COUNT UP INPUT (m is replaced with a number indicating number of shifts or counts).

MUX – MULTIPLEXER.

3-ST – THREE STATE OUTPUT: 3 state label is used with F notation to symbolize devices that have an output disconnect ability.

T – Toggle Input.

X/Y – Signal Level Converter: Input levels are different from output levels.

 – Indicates that hysteresis exists in the device.

8-17. Indicator Symbols

Indicator Symbols identify the active state or level of a symbol's input or output (see Figure 8-1).

8-18. Dependency Notation

8-19. Dependency notation is the technique for defining input/output and input/input relationships without showing all the elements and interconnections involved. Logic relationships between inputs and outputs are shown in this manual by using the following notation:

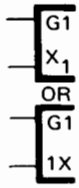
mAm – Address Dependency: The m prefix should be replaced with a number that differentiates between several address inputs, indicates dependency or indicates demultiplexing and multiplexing of address inputs/outputs. The "m" suffix indicates the number of cells that can be addressed.

Gm – Gate (AND) Dependency: The G input gates those inputs or outputs labelled with the same identifier m. The m is replaced with a number.

Cm – Control Dependency: This is used only with D type Flip-Flops and indicates that the basic function of the Flip-Flop is controlled by inputs with the same identifier. The m is replaced with a number.

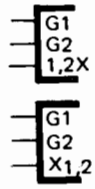
Fm – Free Dependency: This is an input that acts as a connect switch when active and a disconnect when inactive. Used for 3-state logic.

– The input that controls or gates other inputs is labelled with a "C" or a "G", followed by an identifying number. The controlled or gated input or output is labelled with the same number. In this example, "1" is controlled by "G1".



– When the controlled or gated input or output already has a functional label (X is used here), that level will be prefixed or subscripted by the identifying number.

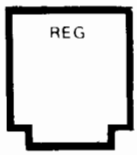
– If a particular device has only one gating or control input then the identifying number may be eliminated and the relationship shown with a subscript.



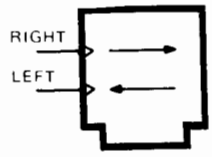
– If the input or output is affected by more than one gate or control input, then the identifying numbers of each gate or control input will appear in the prefix or subscript separated by commas. In this example "X" is controlled by "G1" and "G2".

8-20. Control Blocks

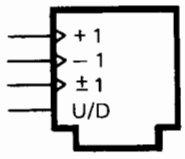
8-21. Control Blocks are used with complex logic to show when common control signals are applied to a group of functionally separate units. Typical examples of control blocks follow.



– Register control block: This symbol used with an associated array of flip-flop symbols to provide a point of placement for common function lines, such as a common clear.



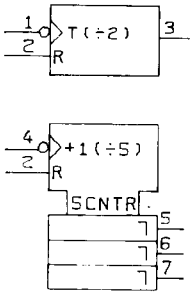
– Shift register control block: These symbols are used with an array of flip-flop symbols to form a shift register. An active transition at the inputs causes left or right shifting as indicated.



– Counter Control Block: The symbol is used with an array of flip-flops or other circuits serving as a binary or decade counter. An active transition at the +1 or −1 inputs causes the counter to increment one count upward or downward, respectively. An active transition at the ±1 input causes the counter to increment one count upward or downward depending on the input at an up/down control.

8-22. Complex Logic Devices

8-23. The basic symbols can be combined in various ways to represent the operation of complex logic devices. The following examples are taken from the schematic diagrams in this manual.

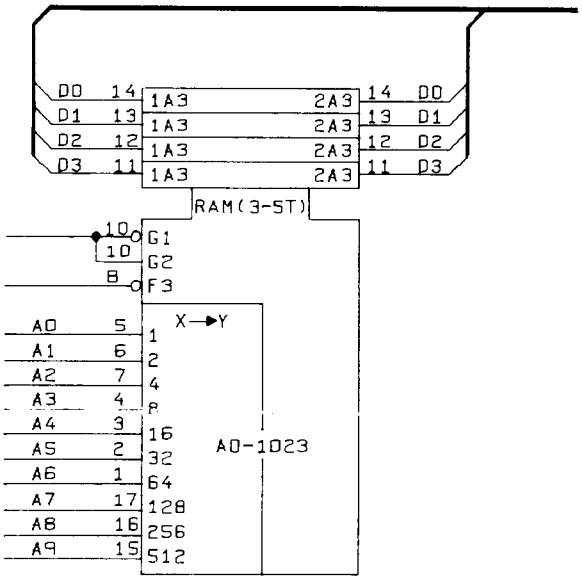


— **Presettable Decade Counter (÷2, ÷5 option).** This counter has a "÷2" and a "÷5" function. Each function has a block containing those lines which will select the function of the device.

The ÷2 operation is enabled on the negative going transition of the signal present on the T (Toggle) input.

The ÷5 operation is enabled on the negative going transition of the signal present on the +1 (÷5) input.

A high on R will reset all outputs regardless of the other inputs.



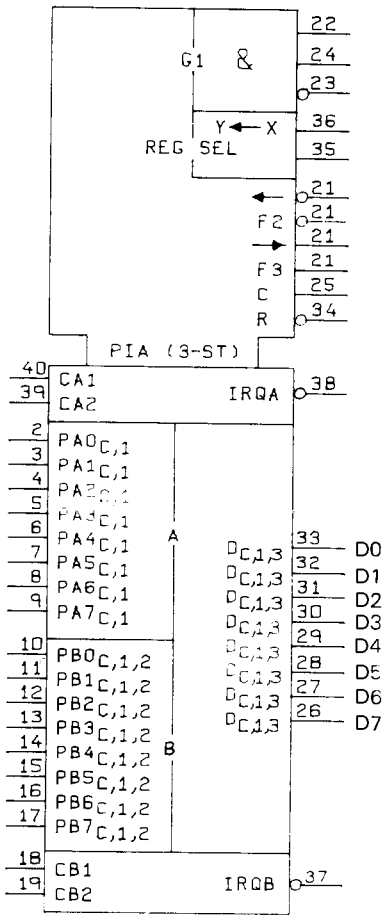
RAM (With identical input/output pins).
Random Access Memory with possible access to 1024 locations. Address selection is determined by the 10 address input codes in the lower left corner of the control block. These address codes are weighted to correspond to the possible address (A0-1023).

G1 and G2 are the read and write enables. A low on Pin 10 will enable G1 or the Read Function. A high on Pin 10 will enable G2 or the Write Function. F3 is the three-state enable line. A high on Pin 8 will enable data to be read and written.

The input lines are noted in the upper left portion of the symbol. "3" indicates that these inputs are enabled when there is a high on F3. 1A indicates that information will be read into the chip when G1 is enabled at the memory location addressed.

The output lines are noted in the upper right portion of the symbol. "3" indicates that these outputs are enabled by a high on F3. "2" indicates that information will be written out of the chip when G2 is enabled at the memory location addressed.

(Note: The input/output pins are identical. This is indicated by signal line bundling).



Peripheral Interface Adapter (PIA).
The Peripheral Interface Adapter is the input/output data interface between the MC6800 Microprocessing Unit (MPU) and the peripheral circuits.

Before any data transfer can take place via the PIA, it must receive its Chip Select Code on Pins 22, 24 and 23 (G1). Data is transferred on the enable pulse (C).

The bi-directional data lines (D0 to D7) transfer data between the MPU and the PIA. Data transfer on D0 to D7 is

dependent on; the chip select code (G1); the enable pulse (C) and the state of the read/write line (Pin 21). The "3" in this case has been used to indicate that D0 to D7 will be in the output mode when F3 is high.

Note: The arrows on the read/write line (Pin 21) are used to indicate when data is read from the MPU into the PIA (←) or out of the PIA to the MPU (→).

The PIA provides two 8-bit bi-directional data buses (PA0 to PA7 and PB0 to PB7) for interfacing to peripheral devices.

PA0 to PA7 can be programmed to act as inputs or outputs by the MPU. Data transfer (input or output) is dependant on C, G1 and the setting of an internal Data Direction Register.

PB0 to PB7 are the same as PA0 to PA7 except that the output buffers are 3-state. The "2" indicates that PB0 to PB7 will be in the output mode when F2 is low.

REG SEL (Pins 35, 36) – used to select various registers inside the PIA.

IRQA and IRQB are active low interrupt lines which are connected to the MPU.

CA1 and CB1 are interrupt inputs which when set high will set the corresponding IRQA or IRQB line low.

CA2 and CB2 can be used as an interrupt input or a peripheral control output (controlled by an internal register).

A low on the R line will reset all internal registers to zero; configure PA0-PA7, PB0-PB7, CA2 and CB2 as inputs and disable all interrupts.

8-24. THEORY OF OPERATION

8-25. Introduction

8-26. The following description is concerned only with the hardware aspect of the instrument, not the controlling software functions. To obtain a better understanding of the software operating characteristics, refer to Section I Paragraph 1-14 and Section III Paragraph 3-3, also Paragraph 3-151 which outlines probable causes of operational failure in a systems environment.

8-27. A description of the 37201A appears in Section I, but essentially the 37201A converts bit-parallel HP-IB data into a form suitable for transmission over a serial data link, or from serial format back into the bit-parallel HP-IB format.

8-28. Figure 8-2 is a simplified block diagram of the 37201A. Data from the HP-IB is passed via the microprocessor's bi-directional data bus to either the ACIA (Asynchronous Communications Interface Adapter) for transmission by an asynchronous modem, or SSDA (Synchronous Serial Data Adapter) for transmission by a synchronous modem or a twisted-pair cable. The microprocessor controls all the data handling and routing operations. Program instructions for the microprocessor are stored in the read-only section of the memory. The modem/dialler PIA (Peripheral Interface Adapter) handles the control lines to and from the Dialler (RS366/V.25) interface and to and from the Modem (RS232C/V.24) interface.

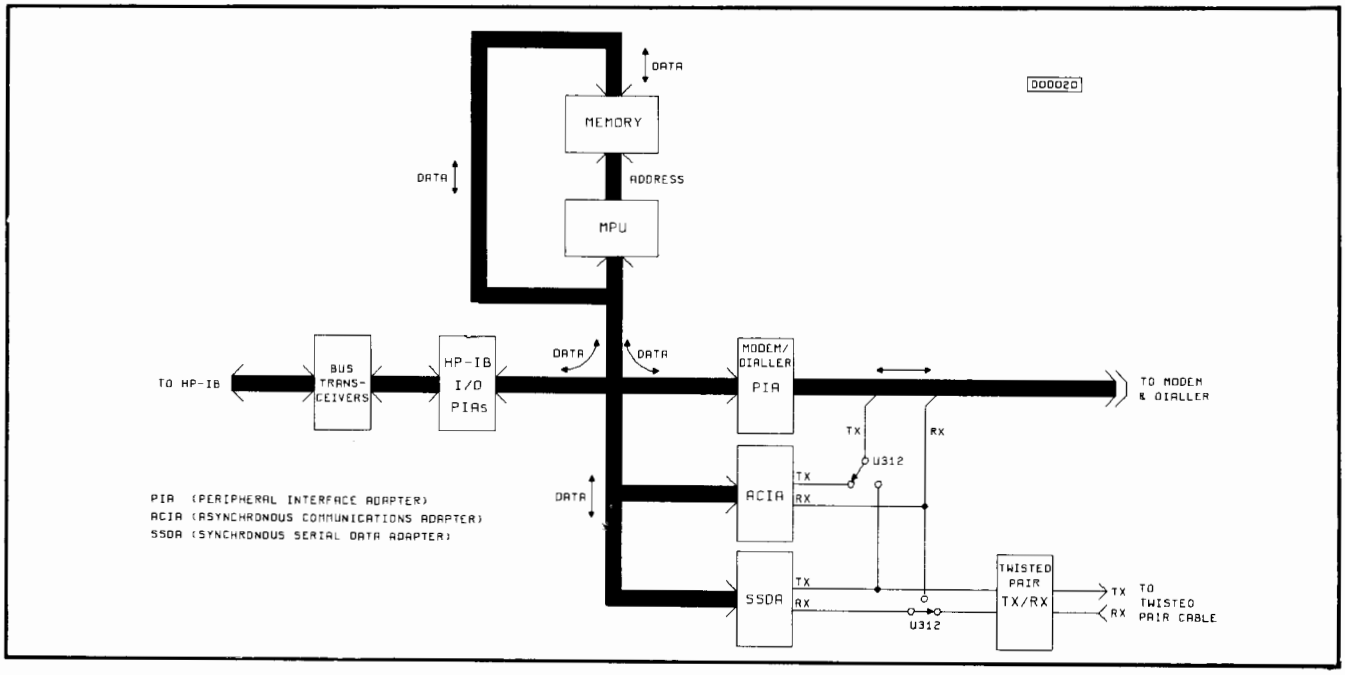


Figure 8-2 Simplified Block Diagram

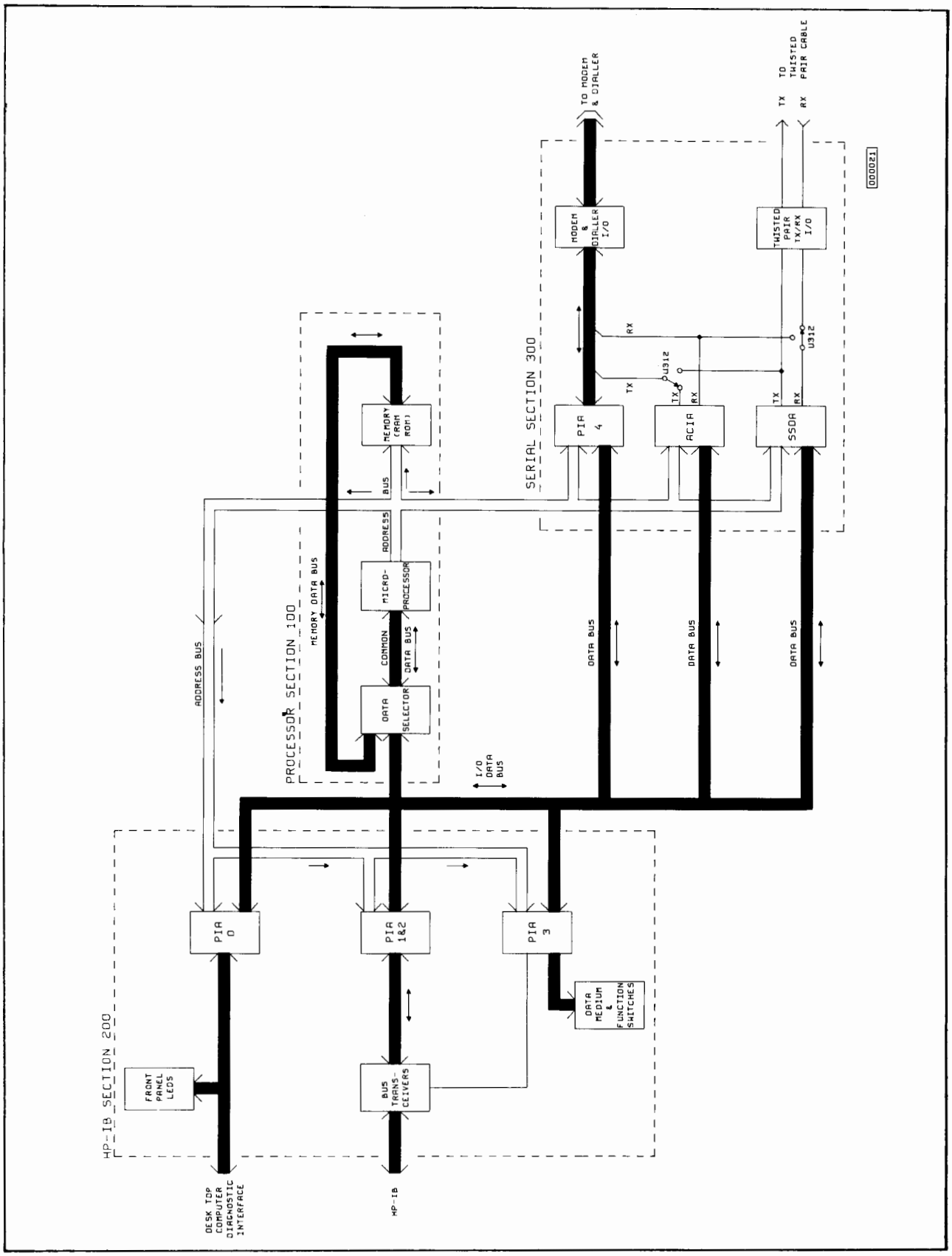


Figure 8-3 Block Diagram

8-29. Description

8-30. Figure 8-3 is a more detailed block diagram than Figure 8-2 which in addition shows the three main sections into which the instrument is divided. The microprocessor, under program control, examines the HP-IB management lines (IFC, ATN, SRQ, EOI, REN) and the handshake lines (DAV, NRFD, NDAC) and transfers data from the HP-IB into a transmit buffer (an assigned series of RAM locations). The present state of the HP-IB management lines is copied and placed beside each data byte. If the management lines change in the absence of data, a copy of the management lines is placed beside a 'dummy' data byte. Should the buffer become full, the microprocessor will hold up the handshake routine, preventing any further transfer of data until the buffer starts to empty. The contents of the transmit buffer are assembled into 'packets' for transmission via the ACIA or SSDA (depending on the transmission mode selected) where the data is converted into serial format. Serial data received by either the ACIA or SSDA is converted into parallel data bytes and loaded into a receive buffer (a further series of RAM locations). The ACIA or SSDA informs the microprocessor by means of an interrupt when it is ready to transmit or receive more data.

8-31. When the microprocessor receives an interrupt, it performs a polling routine accessing each device in turn to find out which device caused the interrupt. In the case of either the ACIA or SSDA causing the interrupt, the microprocessor examines the status of the device to determine whether it is ready to transmit or whether it is ready to receive.

8-32. The parallel input/output data to and from the HP-IB is transferred via three PIA's, PIA1, PIA2 and PIA3. The direction of data flow is determined by the microprocessor, under program control. PIA1 handles the HP-IB management control and handshake lines, PIA2 handles the HP-IB data lines, PIA3 controls the switching of the bus transceivers depending on whether the 37201A is a listener or a talker on the HP-IB.

8-33. PIA0 is the interface between the microprocessor and the front panel display, and a HP 9825A Desk Top Computer input/output connector which allows troubleshooting routines to be transferred into the read/write memory where they are accessable to the microprocessor.

8-34. The microprocessor examines the internal switches via PIA3 at regular intervals and responds to any changes made to the switch settings, except when the Data Medium switch is set to one of its test positions when the 37201A has to be powered off then on for the microprocessor to run the test programs.

8-35. The input/output data bus and the memory data bus are routed to the microprocessor via a data selector which controls both the selection between buses and the direction of the flow.

8-36. Communication with modem control lines and any automatic dialling equipment (when used) is carried out via PIA4. The ACIA converts the byte-parallel data to serial format for transmission via an asynchronous modem, or vice versa, while the SSDA does the same for synchronous modems and twisted-pair cable transmissions. PIA4 also controls the switching between the ACIA and the SSDA, which is shown in Figure 8-2 and 8-3 for the sake of simplicity as being mechanical although it is in fact part of a multiplexing integrated circuit chip.

GENERAL SERVICE SHEET G1

DESK TOP COMPUTER DIAGNOSTICS

G1-1. INTRODUCTION

G1-2. The Desk Top Computer Diagnostic Tape can aid troubleshooting the 37201A by indicating the general area within which the trouble lies. This service sheet contains details of what is required in order to run the diagnostic tape. If the diagnostic tape is not available, an alternative method of troubleshooting is contained in General Service Sheet G2.

G1-3. EQUIPMENT REQUIRED

G1-4. Equipment required to run the diagnostic tape is as follows:

	Item	Type
	Desk Top Computer	HP 9825A
	String & Advanced Programming ROM	HP 98210A
	General I/O & Extended I/O ROM	HP 98213A
	16 Bit Interface	HP 98032A (Std)
	Connector Edge	HP 1251-0333
	Connector/Cable Hood	HP 1251-5765
	Diagnostic Tape	HP 37201-18100
For Serial Section I/O tests if required	RS232C/V.24, RS366/V.25 Connector (2 off)	HP 1251-0063
	Connector/Cable Hood (2 off)	HP 1251-0392
	Twisted-Pair Connector	HP 1251-3764

G1-5. The 16-Bit Interface needs links set, the edge connector has to be wired to the free end of the cable, the RS232C/V.24 and RS366/V.25 connectors have to be wired to each other, and the twisted-pair connector has to have links fitted. Details will be found in paragraphs G1-13, G1-14 and G1-16.

G1-6. DESCRIPTION

G1-7. The diagnostic program consists of a control program and three sub programs, one for each section of the instrument, Processor, HP-IB, and Serial sections. Each program transfers a series of data files into the 37201A memory. The files are run as individual short microprocessor programs each of which tests some part of the 37201A and passes the result back to the desk top computer.

G1-8. PROCEDURE

G1-9. If the 37201A is faulty and the diagnostic program is available, disconnect all cables except the power cord from the 37201A, insert the diagnostic tape cartridge into the 9825A Desk Top Computer and switch the power off, then on. The tape should then run and give instructions etc. regarding connection to the 37201A.

G1-10. Should a fault occur on either the 37201A data bus, address bus, control lines, or interrupt lines as listed below, the 9825A will be unable to transfer the data files and the 9825A will print out "Basic Failure" with instructions to run tests from the beginning. As a precaution the interface between the 9825A and the 37201A should be checked, the 37201A power should be switched off then on and the program re-run. If the "Basic Failure" print out reappears, refer to General Service Sheet G2. If a failure is indicated in a particular area, refer to the appropriate service sheet.

G1-11. A fault in any of the following areas will prevent the diagnostic program being run successfully.

Processor Section 100.

1. A fault which holds almost any line in the Processor Section high or low is likely to prevent transfer of the program.

HP-IB Section 200.

1. A fault on the following desk top computer interface components: U212, U213, U210 (G3), U211 (G1, G2), U200 Pins 18, 19, 10 to 17, 26 to 33, 21, 23, 25, 34, 35, 36, 38.

2. A fault on the other PIA's, U201, U202, U203 data bus pins 26 to 33, interrupt pins 37, 38, or control line pins 21, 23, 25, 34, 35, 36.

Serial Section 300.

1. A fault on U313 data bus pins 26 to 33, interrupt pins 37, 38, 39, or control line pins 21, 23, 25, 34, 35.

2. A fault on U314 data bus pins 15 to 22, or control line pins 7, 9, 11, 13, 14.

3. A fault on U326 data bus pins 15 to 22, or control line pins 7, 9, 11, 13, 14.

G1-12. The diagnostic program will not recognise a fault on the following:

HP-IB Section 200

Divide by 10^6 circuit (U214, U215, U216), Switch De-

code Logic (all of U217, part of U218, S201, S202 and part of S200).

Serial Section 300

PIA U313 pins 40, 15, 19, 10, 11, 12, 13, and 2 to 9.

Incorrect clock frequencies will also be undetected.

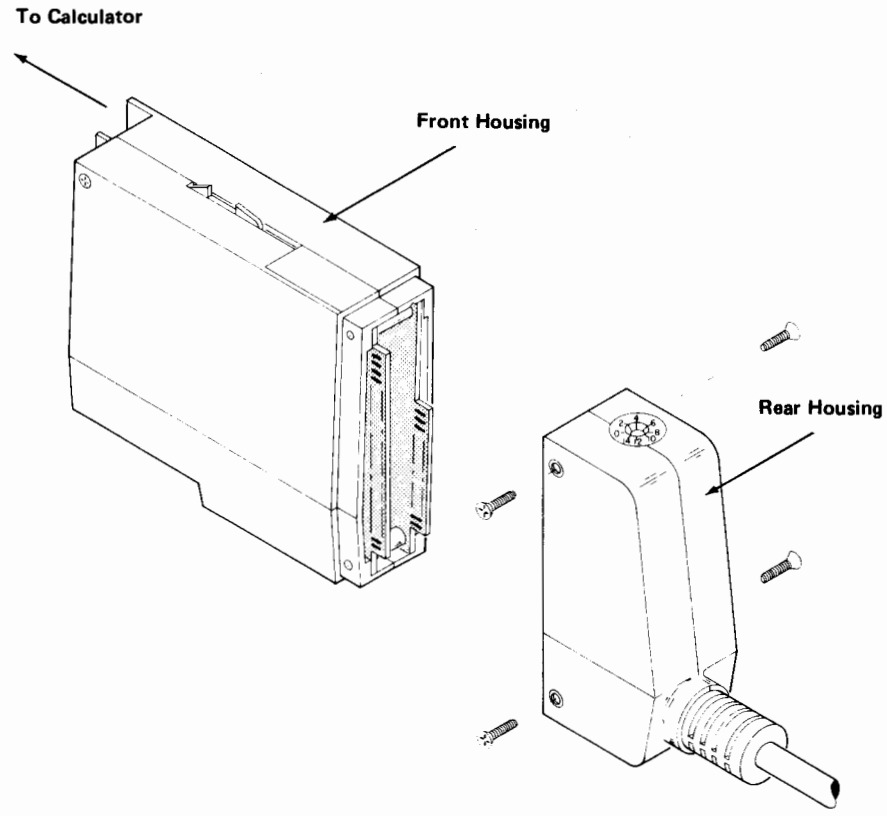


Figure G1-1 98032A Interface

G1-13. WIRING THE INTERFACE

1. Remove the four screws in the rear housing of the 98032, and separate both front and rear parts as shown in Figure G1-1.

2. Split the rear housing by removing the two remaining screws in the rear housing, as shown in Figure G1-2.

3. Install jumpers across the holes provided in position E and position 5, as shown in Figure G1-3. THERE SHOULD BE NO LINKS IN ANY OTHER POSITIONS.

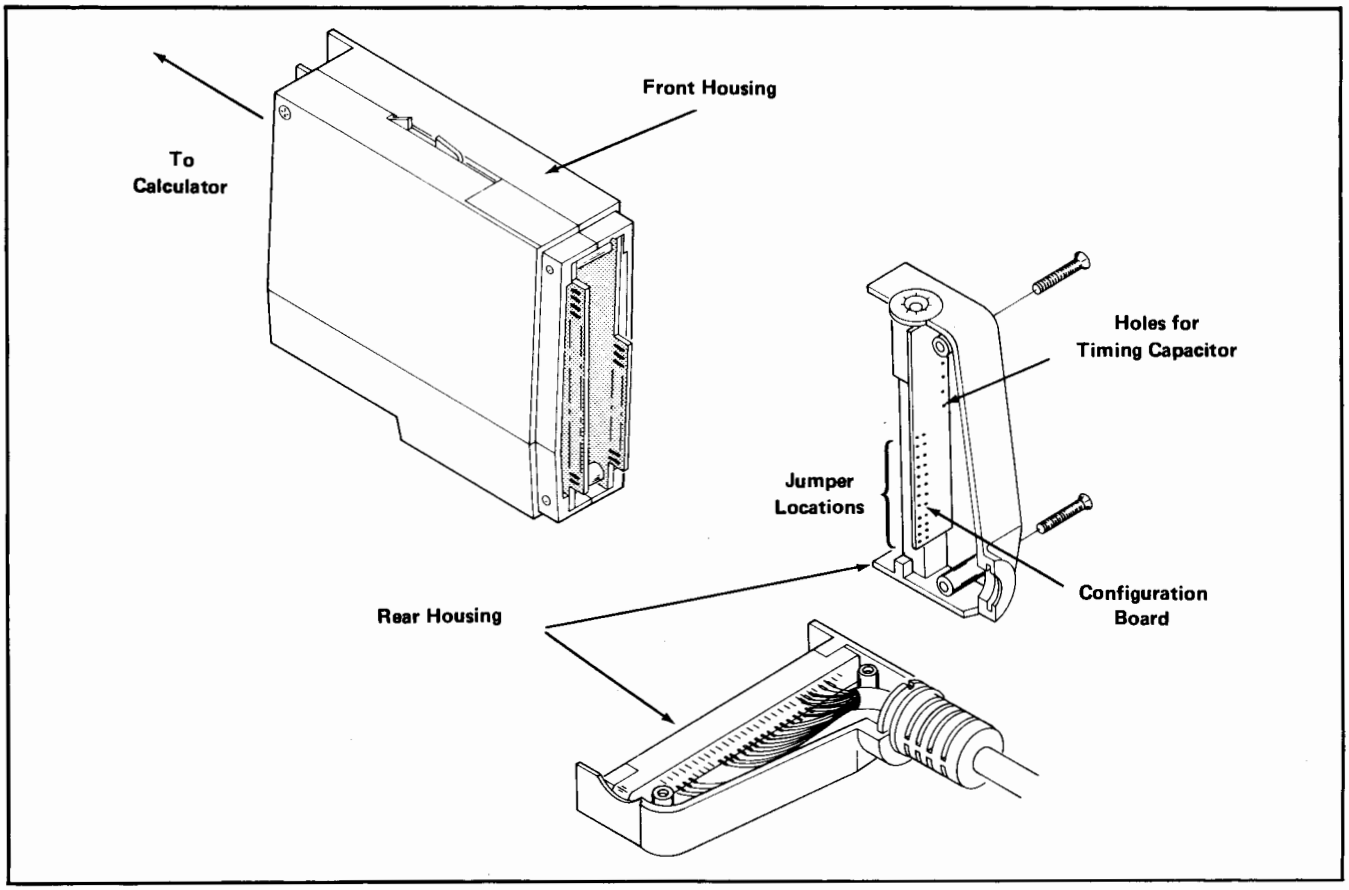


Figure G1-2 98032A Rear Housing & Configuration Board

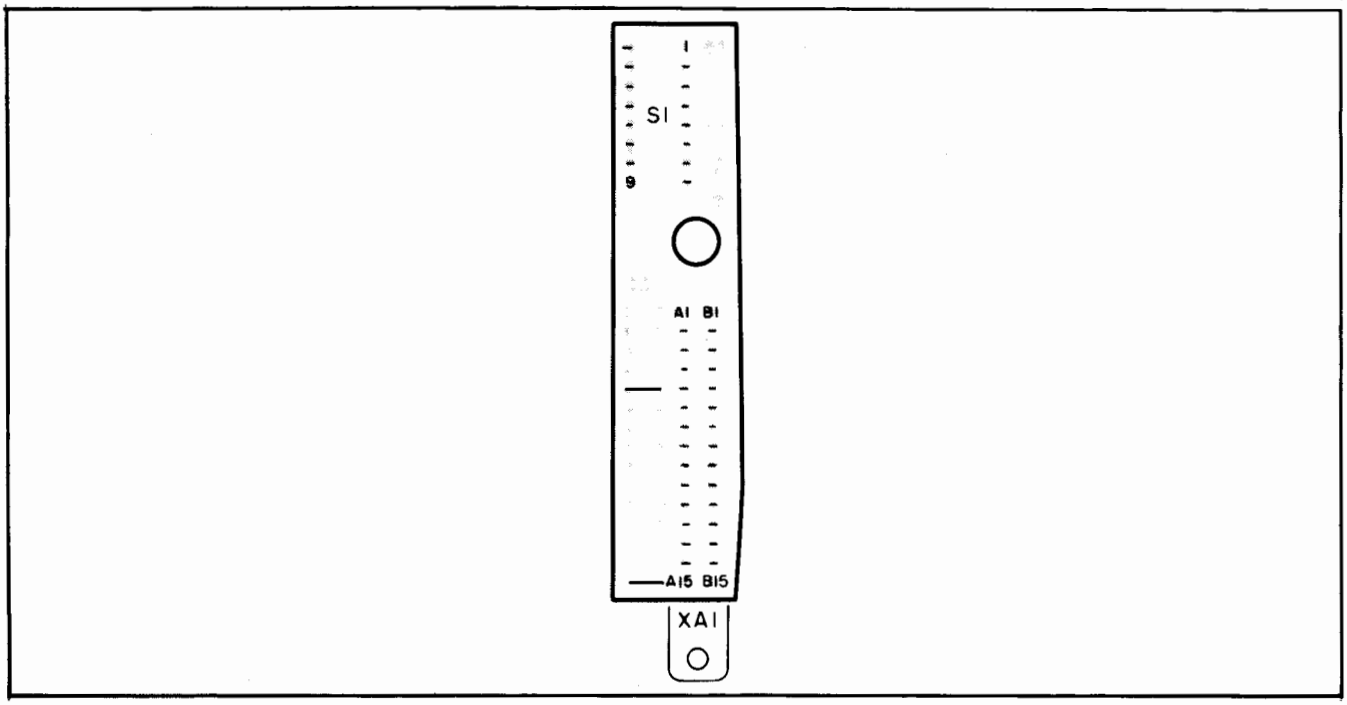


Figure G1-3 Configuration Board

4. Connect the following wires to the edge connector as follows, and cut back the remaining wires.

Connector Pin	Wire	(37201A) Ref	Signal Name 98032 Ref
1	GREY	(PFLG)	PFLG
2	GREY-WHITE	(PCTL)	PCTL
3	VIO	(TO 7)	DI7
4	BLUE	(TO 6)	DI6
5	GREEN	(TO 5)	DI5
6	YELLOW	(TO 4)	DI4
7	ORANGE	(TO 3)	DI3
8	RED	(TO 2)	DI2
9	BROWN	(TO 1)	DI1
10	BLACK	(TO Ø)	DIØ
A	SCREEN, WH-BLK-GRN, WH-BLK-BLUE, WH-BLK-ORN – GND		
B	WH-BLK-GRY	(PSTS)	PSTS
C	WH-VIO	(TI 7)	DO7
D	WH-BL	(TI 6)	DO6
E	WH-GRN	(TI 5)	DO5
F	WH-YEL	(TI 4)	DO4
H	WH-ORN	(TI 3)	DO3
J	WH-RED	(TI 2)	DO2
K	WH-BRN	(TI 1)	DO1
L	WH-BLK	(TI Ø)	DOØ

5. Mate the edge connector with the Hood as shown in Figure G1-4.

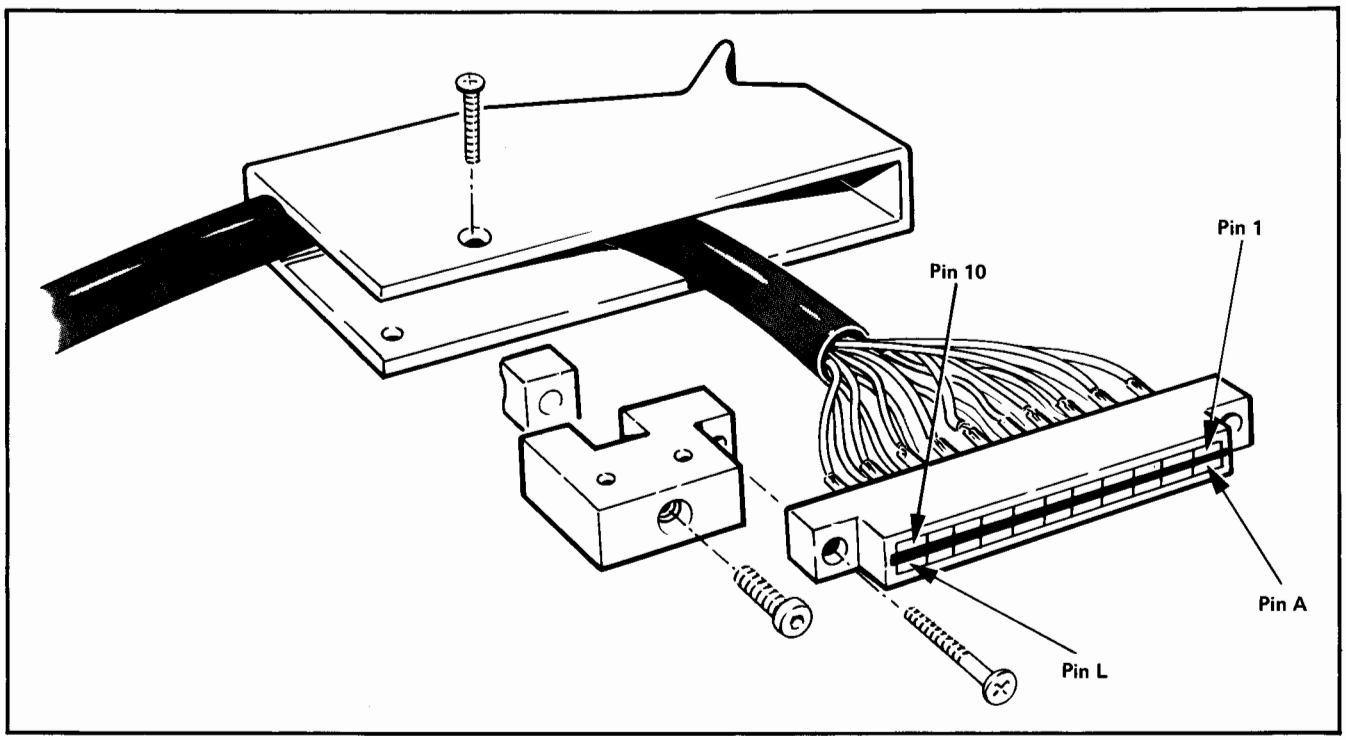


Figure G1-4 Edge Connector & Hood

G1-14. WIRING THE RS232C/V.24, RS366/V.25 PLUGS

G1-15. Connect the plugs together as shown in Figure G1-5.

G1-16. WIRING THE TWISTED PAIR PLUG

G1-17. Connect pin 4 to pin 1 and pin 3 to pin 2, refer to Figure G1-5.

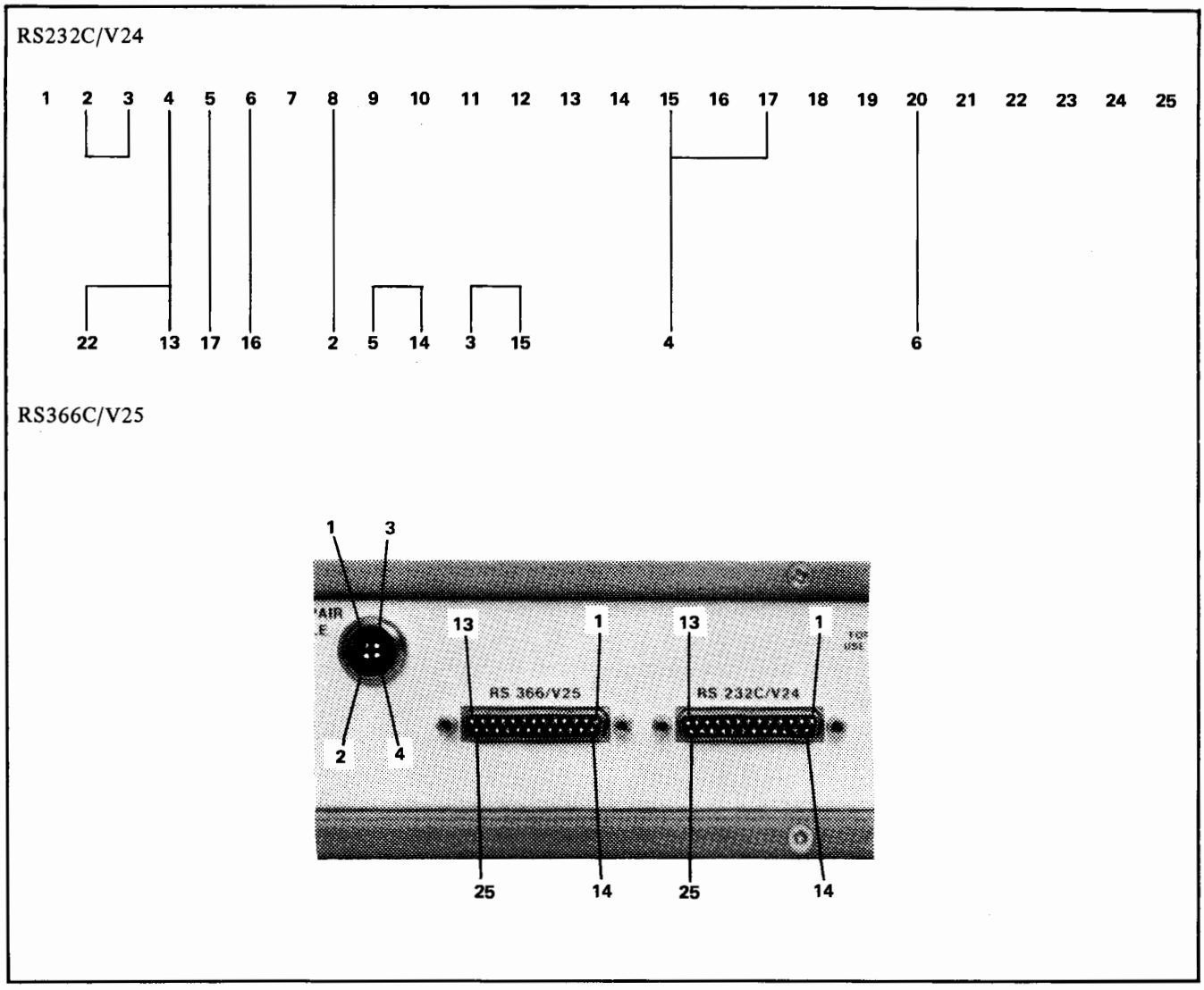


Figure G1-5 RS232C/V.24, RS366/V.25 Wiring for Loopback Tests

GENERAL SERVICE SHEET G2

SELF-TEST

G2-1. INTRODUCTION

G2-2. The tests in this service sheet are to determine if the instrument is faulty, and if so, where the fault is. The tests in this General Service Sheet are similar to the Performance Tests in Section IV of this manual.

G2-3. The self test routine built-in to the 37201A, tests most of the instrument. The switches and their decoding logic, and the drivers and receivers for the Twisted Pair, RS232C/V.24 and RS366/V.25 connectors, are tested separately. Although the self test routine is not principally intended for troubleshooting, some information can be obtained from the state of the front panel lamps. The accuracy of the information obtained in this way is not totally reliable, but is included here as an aid to finding roughly the area of the fault.

G2-4. SELF-TEST

G2-5. Procedure:

1. Remove the 37201A top cover, and all connectors from the rear panel (except the power cord).
2. Set the Data Medium switch to the Self Test position.
3. Switch the POWER switch off then on.
4. The TEST COMPLETE lamp should flash on for about 0.6 seconds and the remaining lamps stay off. The remaining lamps should then come on for about 0.4 seconds, and the TEST COMPLETE lamp stay off. The sequence should then repeat continuously.
5. The POWER lamp should be on continuously. If it is not, either there is a power failure, a power supply failure, or the LED is faulty.

G2-6. If the sequence in step 4 is not present, the instrument may be presumed to be faulty.

G2-7. Failure of either the EXTENDER ADDRESSED, DIALLING, or LOSS OF REMOTE DATA lamps to light, indicates that the fault is probably in the HP-IB Section 200.

G2-8. Failure of either the CALL COMPLETE, or ABAND-ON CALL & RETRY lamps to light, indicates that the fault is probably in the Serial Section 300.

G2-9 Failure of the DATA SET READY lamp to light is usually indicative of a RAM failure (Processor Section 100) and failure of the CLEAR TO SEND (RFS) lamp to light is usually indicative of a ROM or associated logic failure (also Section 100).

G2-10 A clock or power supply failure will also stop the flashing sequence. The supply rails may be monitored with a suitable DVM at their respective test points. The clock frequency can be monitored at the CLOCK test point or at U111 pins 13 and 15.

G2-11 The self-test program requires in addition to the normal processor clocks, the slow timing clock input at U203 pin 19 from the Divide by 10^6 circuit. Check that this clock is present. If it is not, refer to the HP-IB Section Service Sheet 200.

G2-12 If the self test routine above indicates a fault but the area of the fault is uncertain, refer to General Service Sheet G3.

G2-13 DATA MEDIUM SWITCH TEST

This test can be disregarded if it has been carried out in the Performance Tests.

Description:

The four left hand indicators on the front panel should give a binary representation of the position of the Data Medium switch when the Ram & Sw Test is running – if they do not, refer to Section Service Sheet 200.

Procedure:

1. Remove the 37201A top cover, and any connectors from the rear panel (except the power cord).
2. Note the Data Medium switch setting so that it can be returned there after the test is completed.

3. Set the Data Medium switch to Ram & Sw Tests. Switch the 37201A POWER switch off then on again.

4. Switch the Data Medium switch through positions 0 to 15 while observing the four left hand indicators on the front panel – they should read as follows:

Data Medium Switch	Test Complete	Extender Addressed	Dialling	Loss Of Remote Data
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
10	1	0	1	0
11	1	0	1	1
12	1	1	0	0
13	1	1	0	1
14	1	1	1	0
15	1	1	1	1

1 = indicator on 0 = indicator off

G2-14 FUNCTION SWITCH TEST

This test can be disregarded if it has been carried out in the Performance Tests.

Description:

The four right hand front panel indicators should give a binary representation of the highest number Function switch that is on when the Ram & Sw Test is running – if they do not, refer to Section Service Sheet 200.

Procedure:

1. Remove the 37201A top cover, and any connectors from the rear panel (except the power cord).

2. Note the settings of the Data Medium switch and twelve Function switches before setting the Function switches to the left hand off position.

3. Set the Data Medium switch to Ram & Sw Tests. Switch the 37201A POWER switch off then on again.

4. Switch each Function switch on in turn in the order indicated below while observing the four right hand front panel indicators.

Function Switch	Call Complete	Abandon Call & Retry	Data Set Ready	Clear To Send
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
10	1	0	1	0
11	1	0	1	1
12	1	1	0	0

5. Reset both the Function and Data Medium switches to their original positions.

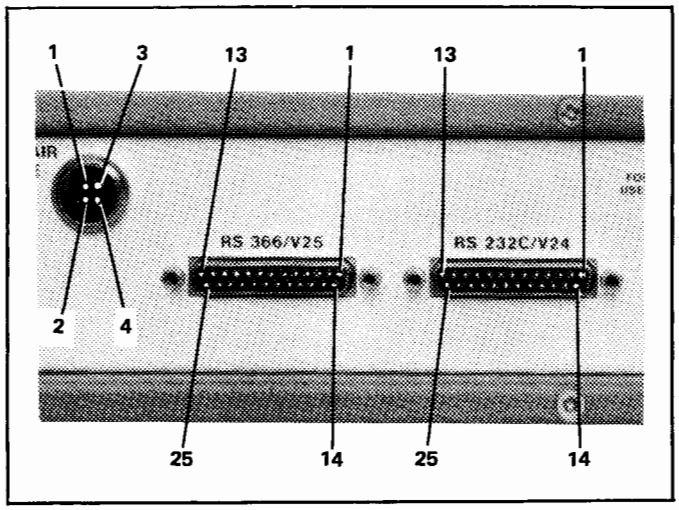


Figure G2-1 Connector Pin Numbers

G2-15 RS232C/V.24, RS366/V.25 OUTPUT TEST

This test can be disregarded if it has been carried out in the Performance Tests.

Description:

The RS232C/V.24 and RS366/V.25 outputs are monitored using an oscilloscope, dc coupled to the output pins of the connectors, while the self-test routine is running. The routine periodically changes the state of the RS232C/V.24 and RS366/V.25 drivers enabling their outputs to be observed changing state. If faulty, refer to Section Service Sheet 300.

Procedure:

1. Remove the 37201A top cover, and any connectors from the rear panel (except the power cord).
2. Set the Data Medium switch to the Self-Test position.
3. Switch the POWER switch off then on.
4. Monitor with an oscilloscope dc coupled to the following pins and check that pulses occur at approximately 1 second intervals. The logic levels of the pulses should be +10 ± 2V and −10 ± 2V. Note that, because the pulses are very narrow, an oscilloscope sweep speed of 1s/div and a sensitivity of 10V/div is recommended.

	Pins	
RS232C/V.24	2	
	4	
	20	– Holding the front panel DTR switch pressed should stop the pulses and set this pin low −10 ± 2V.
RS366/V.25	2	
	4	
	14	– a positive going pulse from −10 ± 2V to +10 ± 2V
	15	– a negative going pulse from +10 ± 2V to −10 ± 2V.
	16	– a positive going pulse from −10 ± 2V to +10 ± 2V.
	17	– a negative going pulse from +10 ± 2V to −10 ± 2V.

G2-16 RS232C/V.24, RS366/V.25 INPUT TEST

This test can be disregarded if it has been carried out in the Performance Tests.

Description:

The RS232C/V.24 and RS366/V.25 inputs are checked by connecting the RS366/V.25 output (pin 2) to the various input pins in turn and monitoring the appropriate receiver outputs while the self-test routine is running. The connection from RS366/V.25 (pin 2) causes each receiver to change state periodically so that its TTL level (0 to 0.8V and 2.8 to 5V) outputs can be observed changing state. If faulty, refer to Section Service Sheet 300.

Procedure:

1. Remove the 37201A top cover, and any connectors from the rear panel (except the power cord).
2. Set the Data Medium switch to the Self-Test position.
3. Switch the POWER switch off then on.
4. Connect RS366/V.25 pin 2 to the input pins listed below and check the corresponding receiver outputs. Note that the receiver outputs should all be within the normal TTL logic levels (0V to 4V ± 1V).

Connect RS366/V.25 pin 2 to:		Monitor Receiver Output	
RS366/V.25	3	U321	(6)
	5	U321	(11)
	6	U300	(8)
	13	U300	(11)
	22	U300	(6)
RS232C/V.24	3	U320	(11)
	5	U321	(8)
	6	U321	(3)
	8	U320	(3)
	15	U320	(6)
	17	U320	(8)

G2-17 TWISTED PAIR INPUT & OUTPUT TEST

This test can be disregarded if it has been carried out in the Performance Tests.

Description:

The twisted pair output is checked by connecting it back to the twisted pair input and observing the LOSS OF REMOTE DATA indicator on the front panel. If faulty, refer to Section Service Sheet 300.

Procedure:

1. Remove the 37201A top cover, and any connectors from the rear panel (except the power cord).
2. Set the Data Medium switch to Twisted Pair and switch the POWER switch off and then on.
3. Connect the output to the input – Pin 4 to Pin 1 and Pin 3 to Pin 2. The LOSS OF REMOTE DATA indicator on the front panel should go off within 8 seconds. When the links are removed from the connector, the LOSS OF REMOTE DATA indicator should come on again within 8 seconds.

GENERAL SERVICE SHEET G3

G3-1 INTRODUCTION

G3-2 This service sheet is divided into three parts: Processor Section Troubleshooting, Serial Section Troubleshooting and HP-IB Section Troubleshooting. If the preceding tests have indicated the area of the fault, go straight to the appropriate section. If the area of trouble is unknown, perform the following – in the order given.

G3-3 PROCESSOR SECTION TROUBLESHOOTING

G3-4 Equipment Required

G3-5 An hp 5004A Signature Analyzer (SA) is required for the following checks. Connect the SA as follows:

SA CLOCK probe	CLOCK test point
SA START probe	START/STOP test point
SA STOP probe	START/STOP test point
SA GND probe	GND test point
SA Logic probe ground	GND test point

SA Controls:

LINE switch	IN
START switch	IN
STOP switch	OUT
CLOCK switch	IN
HOLD switch	OUT
SELF TEST switch	OUT

Check 1

Set the test link TL100 to the SA TEST position and check that the SA Gate lamp is flashing – if not proceed to the Processor Section Service Sheet 100. Check the signatures on the RAM/ROM data bus and at selector U114 against these given below. Correct signatures indicate that the microprocessor U101 and the memory appear to be operational – proceed to Check 2. If a signature is faulty, proceed to the Processor Section Service Sheet 100.

Switch the 37201A Power switch off then on before taking signatures.

Check +5V signature is 755U and 0V signature is 0000.

RAM/ROM DATA BUS – SA TEST SIGNATURES (with test link in SA TEST).

U103

PIN		PIN	
8	–	17	8889
9	30H3	16	20P8
10	CF94	15	20UP
11	864F	14	4FU4
12	GND	13	538H

SELECTOR SIGNATURES
(with test link in SA TEST)

U114

1	AA08	16	+5 VOLTS
2	7211	15	C2P5
3	A3C1	14	4P70
4	1180	13	A614
5	0000	12	9260
6	89F1	11	87HF
7	8ACC	10	FU61
8	GND	9	8U44

Important Note: Any change to the instrument software is likely to affect the ROM signatures above (U102). Check with the current manual change sheet to ensure the signatures listed here are not affected. To obtain the correct signatures, a short ground lead on the SA Logic Probe is essential.

Check 2

With the test link TL1 in the NORM (normal) position, set the 37201A Data Medium switch to Ram & Sw Tests, switch the 37201A POWER switch off then on. This runs a program to exercise the RAM, enabling it to be tested using Signature Analysis. Monitor the signatures on the RAM/ROM data bus. If all the signatures are correct, and Check 1 was correct, the Processor section is almost certain to be functioning correctly and the fault lies elsewhere. Proceed to the Serial Section Troubleshooting G3-6. If a signature is faulty, refer to the Processor Section Service Sheet 100.

RAM/ROM DATA BUS – RAM TEST SIGNATURES (with test link in normal position, Data Medium Switch at Ram & Sw Test, and instrument switched off then on).

Check that +5V signature is 69C4.

U103

PIN		PIN	
8	–	17	P7C6
9	6C59	16	P357
10	UAHU	15	4F07
11	2372	14	P19C
12	GND	13	25HA

If a faulty signature appears in Check 2, switch the 37201A off then on and recheck the signature. This is a precaution; if the logic probe should accidentally short against another ROM pin the program will jump and incorrect but stable signatures will result.

Important Note: Any change to the instrument software is likely to affect the signatures, check with the current manual change sheet to ensure the signatures listed here are not affected.

G3-6 SERIAL SECTION TROUBLESHOOTING

G3-7 The I/O drivers and receivers for the RS232C/V.24 and RS366/V.25 interfaces should be checked as outlined in the RS232C/V.24, RS366/V.25 INPUT/OUTPUT checks in General Service Sheet G2.

G3-8 Set the Data Medium switch Diagnostic Test, and switch the 37201A Power switch off then on.

Check 1 (Line Encoder)

Connect an oscilloscope to the Encoded Tx Data test point. A TTL level squarewave (0 to 4V ± 1V) with a period of about 100μs should be displayed. Short U309 pin 11 to ground and the squarewave frequency should double – if it does not, refer to the Serial Section Service Sheet 300.

Check 2 (Line Decoder & Clock Extraction)

Connect the oscilloscope to U310 pin 8 and check for a TTL level squarewave at the same frequency as the one at the Encoder Clock test point (20kHz).

Connect the oscilloscope to U310 pin 5 and check for a continuous logic 1 voltage level (4V ± 1V). Short U309 pin 11 to ground and check that the oscilloscope voltage level falls to a continuous logic 0 – if it does not, refer to the Serial Section Service Sheet 300.

Check 3

Connect an oscilloscope to U312 pin 9. Switch the Data Medium switch to position 150, switch the 37201A Power off and then on. Single pulses approximately 6.7ms wide, at TTL levels, spaced at approximately 70ms intervals should be shown on the oscilloscope. Switch the Data Medium switch to the 300 position and check that the pulse repetition rate doubles. Repeat for the 600 and 1200 switch positions, each time checking that the pulse repetition rate doubles. Short bursts of data should also occur – typically at 2 second intervals for a switch setting of 1200 (3 secs for 600, 5 secs for 300, 8 secs for 150). If faulty, refer to Section Service Sheet 300.

Check 4 Loopback Test (Data Medium Switch at 150, 300, 600 or 1200 – Async Modem)

Connect a suitable jumper wire between RS232C/V.24 pin 2 and pin 3, after a short delay (<30 secs depending on switch settings) the LOSS OF REMOTE DATA indicator should extinguish. Remove the jumper wire and the LOSS OF REMOTE DATA should come on again after a short delay (<30 secs depending on switch settings). If faulty, refer to Section Service Sheet 300.

Note: This check does not guarantee the ACIA (U314) is functioning correctly but provides a confidence level check.

Check 5.

Set the Data Medium switch to the Self Test position and switch the 37201A Power switch off then on. Connect the oscilloscope to U326 pins 6, 4, 2 and 3 and check that these outputs switch from high to low. Note the Tx and Rx data (pins 6 and 2) will be narrow pulses. The waveform repetition period will be approximately 1 second.

More detailed tests are given under the Serial Section Service Sheet 300.

G3-9 HP-IB SECTION TROUBLESHOOTING

G3-10 The information contained in this section is the same as that in the HP-IB Section Service Sheet 200 and should be used in conjunction with the Section 200 Schematic Diagram.

G3-11 Most of the HP-IB Section is checked by the self-test program but Notes 1 to 4 following should be read carefully as they list the areas not checked and also some points which may prevent incorrect fault diagnosis.

G3-12 Switch the Data Medium switch to Self-Test and the Power switch off then on. The program now running exercises most of the lines in the HP-IB Section, allowing

each IC in turn to be checked with a suitable logic probe. (The Signature Analyzer probe is suitable.) Ground the probe carefully to avoid pick-up.

Note 1: The following are not exercised by the self-test program: U210(8), U213(8), U203(4, 5, 6), lines connected to +5V or ground, U201(38), unconnected PIA CA or CB inputs/IRQ outputs.
A complete check of the Switch Decode Logic, the U200 PB outputs, or of U212 is not possible in the self-test mode. Also, because the self-test program uses the front panel LEDs to indicate failures, a stuck line associated with the LEDs e.g. a U200 PB output or a U212 output, does not necessarily mean that one of those components is faulty. These circuits can all be checked conclusively by performing the Data Medium and Function switch tests in General Service Sheet G2.

Note 2: When the Data Medium switch is set to Ram & Sw Tests and all the Function switches are set to the right hand On position, the following are exercised: U217, U218 inputs and outputs, U203 pins 2, 3, 7, 8, 9 (pins 4, 5 and 6 are normally high in this condition).

Note 3: A line stuck at logic 0 on the PIA data bus may cause the PIA PA or PB lines to stick but the remaining data bus lines will be exercised. If the Processor Section Checks 1 and 2 have been performed successfully, there will be no stuck lines on the Processor or RAM/ROM data buses.

Note 4: If a fault occurs in the Divide by 10^6 circuit (U214 though U216) the self-test program will not run because the program requires this circuit for timing.

PROCESSOR SECTION SERVICE SHEET 100

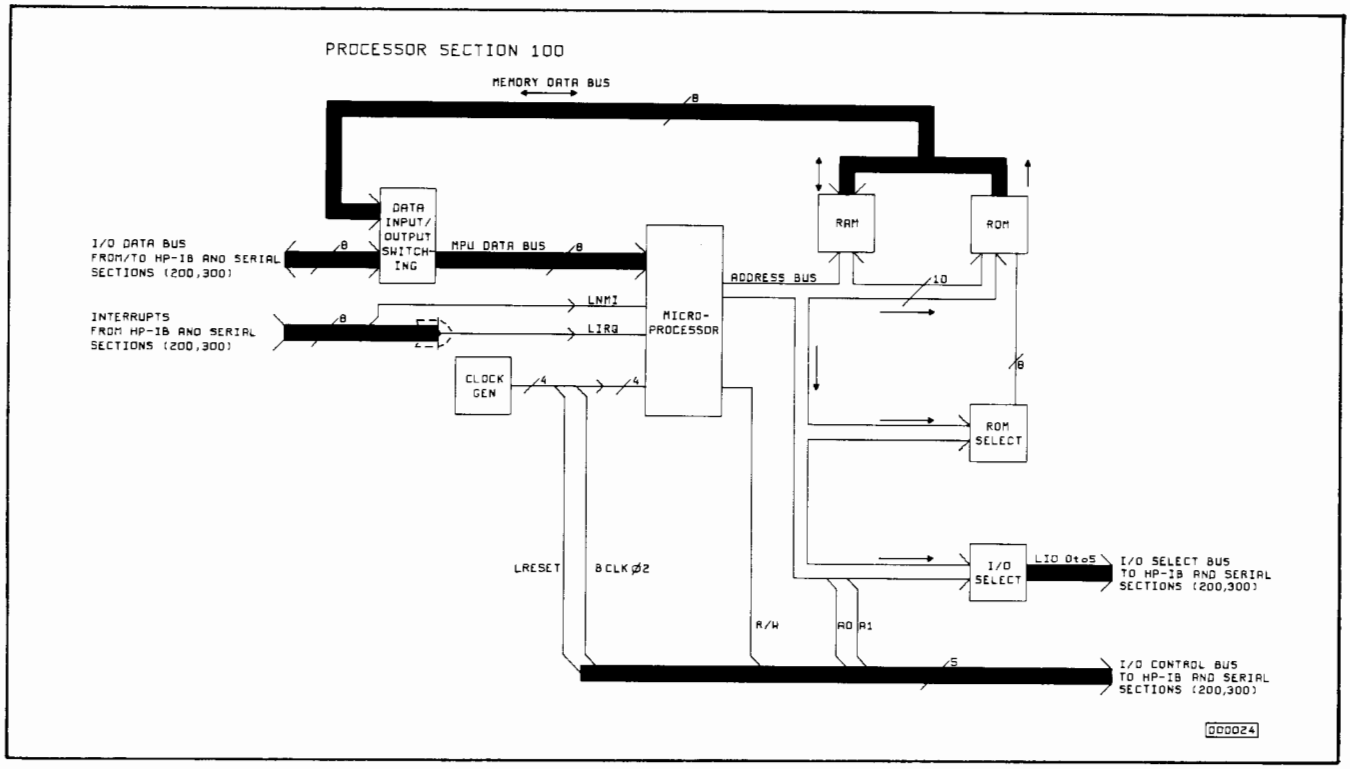


Figure A100-1 Processor Section Block Diagram

A100-1 INTRODUCTION

A100-2 The processor section comprises the microprocessor, and the memory containing the program information necessary to carry out nearly all functions of the 37201A HP-IB Extender.

A100-3 DESCRIPTION

A100-4 Data Input/Output Switching

A100-5 The three bi-lateral switches U118, U119, U120 allow transfer of data to and from the microprocessor (U101). The switches connect the microprocessor to the memory (RAM and ROM), or to the input/output data bus. Direction of data is controlled by the read/write (R/W) line from the microprocessor. Data is transferred to the microprocessor when the R/W line of the microprocessor is high, and from the microprocessor when the R/W line of the microprocessor is low. The selection between the input/output data bus and the memory is determined by the state of LI/O. When LI/O is low the input/output data bus is connected to the microprocessor, this coincides with the selector (U114) being enabled. The state of the LI/O line is governed by the microprocessor address lines A10 and A13. U118, U119, U120 inputs F3, F4 and F5 force all the data pins to a high impedance condition when either BCLK Ø2 (from U111) is low or when L DISABLE is low which is when VMA is high, or when TL100 (SA TEST) is in the test position.

A100-6 Microprocessor

A100-7 The microprocessor (U101) has a bi-directional 8 bit data bus, a one way 16 bit address bus, 8 control inputs including a 2 phase clock, and 3 control outputs.

A100-8 At switch on, the microprocessor is set to a defined start address. To fetch a program instruction from memory, the microprocessor places the address of the memory location on one of its internal address registers, then transfers the contents of the register to the address bus. The instruction at that address in memory is transferred to the microprocessor via the data bus, and stored in another register of the microprocessor. The microprocessor then proceeds to the next memory location unless the last instruction sends it elsewhere.

A100-9 The following describes the microprocessor control inputs:

(a) RESET. This is low true, and ensures the proper 'start up' of the microprocessor; it is controlled by the reset output of the clock generator (U111).

(b) HALT. This is low true, and in this instrument is not used.

(c) NMI. The Non Maskable Interrupt is low true, and connected to the HP-IB IFC line via PIA1. The microprocessor responds immediately to IFC when this line is pulled low.

(d) IRQ. The Interrupt Request line is low true. The microprocessor responds accordingly when this line is pulled low. Six IRQ lines, from the PIAs, the SSDA, and ACIA are wire-ORed together. When the IRQ line goes low, the microprocessor performs a read operation on each peripheral device via the data bus, to see which device has requested interrupt servicing. A priority is assigned to each interrupt line.

(e) CLKØ1 and CLKØ2. Are two phases of the clock, data transfer takes place during the Ø2 clock cycle.

(f) DBE. The Data Bus Enable is high true and enables the data bus.

(g) TSC. The Three State Control line is high true, and in this instrument not used.

A100-10 The following describe the microprocessor control outputs:

(a) (R/W). The Read/Write line is high for read operations, and low for write operations.

(b) VMA. The Valid Memory Address is high true and indicates when a valid memory address is present on the address bus.

(c) BA. The Bus Available is high true, and in this instrument not used.

A100-11 Memory

A100-12 The memory is made up of a READ ONLY MEMORY (ROM), and a static RANDOM ACCESS MEMORY (RAM). The ROM stores the programs necessary for the operation of the 37201A. The RAM functions as a temporary memory store for the microprocessor. The read/write line, when high enables the micrprocessor to read information from the RAM or ROM. The read/write line, when low, enables the microprocessor to write information into the RAM.

A100-13 Selectors

A100-14 The memory selector and the I/O selector (U115 and U114) are 3-8 line decoders with low true outputs. The ROM, or I/O device selected depends on the address on the address bus. Gates G10 and G11 select the RAM.

A100-15 Clock Generator

A100-16 The clock generator (U111) supplies a non overlapping clock (Ø1 and Ø2) and a separate BCLKØ2 in phase with CLKØ2 to enable the microprocessor data bus via DBE as well as various other circuitry. A power on reset (PWO RESET) detects line and power-on transients to pull the RESET output low.

A100-17 S.A. Test

A100-18 Setting TL100 to S.A. Test forces the NO-OP code (0000 0010) on to the microprocessor data bus via U100. L DISABLE at G2 output is true, deselecting the F3 inputs on the RAM memory, and the F3, F4 and F5 inputs on the bi-lateral switches U118, U119, U120. The NO-OP code on the microprocessor data bus forces the microprocessor to cycle through the memory addresses.

A100-19 TROUBLESHOOTING

A100-20 The troubleshooting here is self contained, it repeats some of the checks performed in the General Troubleshooting section, these may be omitted at the technicians discretion.

A100-21 An HP 5004A Signature Analyzer (SA) is required for some checks, and should be connected as follows:

SA CLOCK probe	CLOCK test point
SA START probe	START/STOP test point
SA STOP probe	START/STOP test point
SA GND probe	GND test point
SA Logic probe ground	GND test point
SA Controls:	
LINE switch	IN
START switch	IN
STOP switch	OUT
CLOCK switch	IN
HOLD switch	OUT
SELF TEST switch	OUT

A100-22 For convenience, the signature list on Pages 8-23 and 8-24 is also printed on a separate sheet and kept in the pocket on the inside back cover of this manual.

Check 1 – ROM Signatures

Set the test link TL100 to the SA Test position and check that the S.A. 'GATE' indicator is flashing – if not, proceed to Check 6. Monitor the signatures on the ROM data bus at U103, and at selector U115 and check them against the signature list. Correct signatures indicate that the micropro-

cessor (U101) and the ROM (U103, 5, 7 & 9) appear to be functioning correctly – proceed to Check 2. If the signatures are incorrect – proceed to Check 3.

Check 2 – RAM Signatures

This check tests the operation of the RAM under program control. Set the test link TL100 to the Normal position. Set the Data Medium switch to the Ram & Sw Tests position. Switch the 37201A POWER switch off then on. Monitor the signatures on the RAM/ROM data bus listed under Ram Test Signatures U103 in the signature list. If all the signatures are Correct, and check 1 was correct, the Processor Section is almost certain to be functioning correctly and the fault lies elsewhere. If a signature is incorrect in Check 2 and Check 1 is correct – monitor the remaining signatures listed under Ram Test Signatures. The fault is probably in the area of the RAMs U112 and U113 or U117, U118, U119 or U120. Use the schematic diagram in conunction with the signatures to try and locate the fault.

Note: If a faulty signature appears in Check 2, switch the 37201A off then on and recheck the signature. This is a precaution; if the logic probe should accidentally short against another ROM pin, the program will jump, and incorrect but stable sigantures will result.

Check 3

Incorrect ROM signatures could be due to either a faulty microprocessor, a faulty ROM, or a fault on the ROM data bus or ROM selector. The microprocessor address bus signatures should be checked against the signature list. If these signatures are incorrect – proceed to Check 6. If the signatures are correct – proceed with Check 4.

Check 4

First check the signatures at the ROM selector (U115) outputs against the signature list. If these are correct – connect a link between ground and U115 pin 6, thereby setting all the U115 outputs high, deselecting all the ROM's. Connect another link between ground and each of the U115 output pins in turn, thereby selecting each ROM in turn.

If all the signatures taken in Check 1 were incorrect, it will probably only be necessary to monitor DØ (U103 pin 9) while each ROM in turn is enabled (all the ROM data outputs are in parallel). The faulty ROM should show an incorrect signature when checked against the Individual ROM signature list. If only one signature in Check 1 was incorrect, and the incorrect signature does not correspond to the signature for +5V or GND, connect the Signature Analyzer to the faulty data line (on U103) and enable each ROM in turn. If the signature does correspond to either the signature for +5V or GND – proceed to Check 5.

Check 5

There is a possibility that circuitry other than the ROM's (such as U118, U119, U120 or RAM's U112 and U113) is faulty. Connect a link between GND and U115 pin 6 and see if the fault disappears, if it does, the fault is in the RAM or ROM area – enable each ROM in turn as described in Check 4, and enable the two RAM's by connecting U117 pin 6 (G11 output) to GND. The fact that the fault does not disappear when U115 pin 6 is grounded, does not prove conclusively that the fault is elsewhere, it is only an indication.

Check 6

Ensure that the clock frequency is 0.96MHz and that there are clock signals present on all the clock generator output pins (U111 pins 13, 15, and 17).

Check 7

Signatures for the NAND, NOR gates and the buffers are included in the signature list to help find faults not covered in the preceding procedure. They should be used in conjunction with the schematic diagram in the way waveforms are used on an analogue schematic diagram. Additional signatures for U116 and U121 are listed under Ram Test Signatures on the list, this is because the gates are exercised differently in this mode. Check with the current change sheet that the signatures have not changed.

SIGNATURE LIST

(For serial prefixes below 1925U see Section VII)

The following signatures were taken with the test link in the SA Test position. Before taking signatures, switch the 37201A Power off and then on to provide a reset – this is a precaution to ensure correct signatures.

Before making any signature checks, check the +5V signature is 755U and the 0V line is 0000.

MPU ADDRESS

U101

Pin		Pin	
9	C113	32	–
10	7050	31	–
11	0772	30	–
12	C4C3	29	–
13	AA08	28	–
14	7211	27	–
15	A3C1	26	–
16	7707	25	NOT USED
17	577A	24	0000
18	HH86	23	1180
19	89F1	22	PCF3
20	AC99	21	–

SELECTORS

U114

Pin		Pin	
1	AA08	16	+V
2	7211	15	C2P5
3	A3C1	14	4P70
4	1180	13	A614
5	0000	12	9260
6	89F1	11	87HF
7	8ACC	10	FU61
8	GND	9	8U44

U115

Pin		Pin	
1	0000	16	755U
2	AC99	15	H24U
3	PCF3	14	755U
4	0000	13	219C
5	B clock	12	755U
6	1180	11	1565
7	755U	10	755U
8	0000	9	U731

BUFFERS

U121

Pin		Pin	
1	HIGH	14	HIGH
2	LOW	13	HIGH
3	1180	12	LOW
4	64HU	11	LOW
5	B clock	10	HIGH
6	B clock	9	755U
7	LOW	8	0000

3 I/P NOR

U116

Pin		Pin	
1	LOW		
2	LOW	13	HIGH
3	B clock	12	LOW
4	LOW	11	B clock
5	LOW	10	1180
6	755U	9	89F1
7	LOW	8	P17F

3 I/P NAND

U117

Pin		Pin	
2	LOW	13	NOT USED
3	HIGH	12	NOT USED
4	LOW	11	NOT USED
5	P17F	10	64HU
6	HIGH	9	89F1
7	LOW	8	U0UF

ROM DATA BUS SIGNATURES

All ROM's connected as for processor troubleshooting (Check 1) at U103.

U102

Pin		Pin	
8	–	17	8889
9	30H3	16	20P8
10	CF94	15	20UP
11	864F	14	4FU4
12	GND	13	538H

INDIVIDUAL ROM SIGNATURES FOR PROCESSOR TROUBLESHOOTING (Check 4).

Pin	U103	U105	U107	U109
9	3FH9	439P	946A	C236
10	U066	A73P	9F51	P7P0
11	07PC	7108	11C5	P52H
12	0000	0000	0000	0000
13	HP8H	6U71	FP48	U942
14	CP3P	A2A5	1F78	U504
15	68CP	7F6C	10HP	313H
16	94FU	H8C6	FUU5	F23P
17	5120	33P4	U1C4	FPPH

The above signatures were taken for instruments with serial prefix 1925U, refer to the current change sheet to ensure the signatures have not changed.

The above listed ROM signatures were for ROM's with the following stock numbers:

U103 – 5090-0983 U107 – 5090-0985
U105 – 5090-0984 U109 – 5090-0986

RAM TEST SIGNATURES (CHECK 2)

The following signatures were taken with the test link in the normal position. Before taking signatures, switch the 37201A Power off then on.

Check the +5V line signature is 69C4 and the 0V line is 0000. Note the +5V signature is different with the test link in the normal position.

U103

Pin		Pin	
1	–	17	P7C6
9	6C59	16	P357
10	UAHU	15	4F07
11	2372	14	P19C
12	GND	13	25HA

U101

Pin		Pin	
5	6F7F	36	–
6	–	35	–
7	–	34	A32U
8	HIGH	33	–
9	A612	32	–

U113/112 ADDRS

Pin		Pin	
1	–	18	–
2	415H	17	7141
3	C39C	16	HA26
4	3C84	15	53H2
5	A612	14	*
6	A7H1	13	*
7	56H0	12	*
8	8943	11	*
9	LOW	10	A32U

U116

Pin		Pin	
1	LOW	14	HIGH
2	05F8	13	LOW
3	B clock	12	6F7F
4	FA9C	11	B clock
5	HIGH	10	0U2P
6	LOW	9	0U2P
7	LOW	8	669A

U121

Pin		Pin	
1	A32U	14	HIGH
2	FA9C	13	6F7F
3	0U2P	12	05F8
4	669A	11	HIGH
5	B clock	10	LOW
6	B clock	9	LOW
7	LOW	8	HIGH

* The signatures at these pins have been measured at U103 so there is no need to repeat the check at this point. U103 was chosen purely from a convenience point of view.

HP-IB SECTION SERVICE SHEET 200

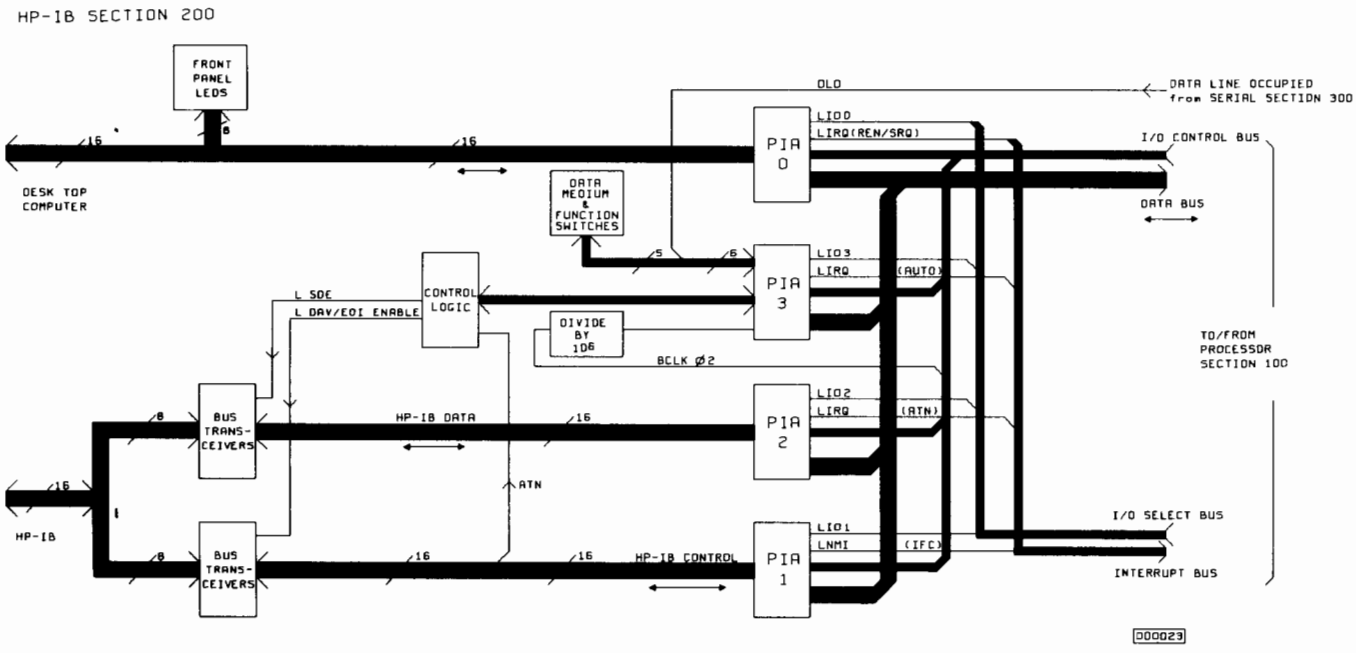
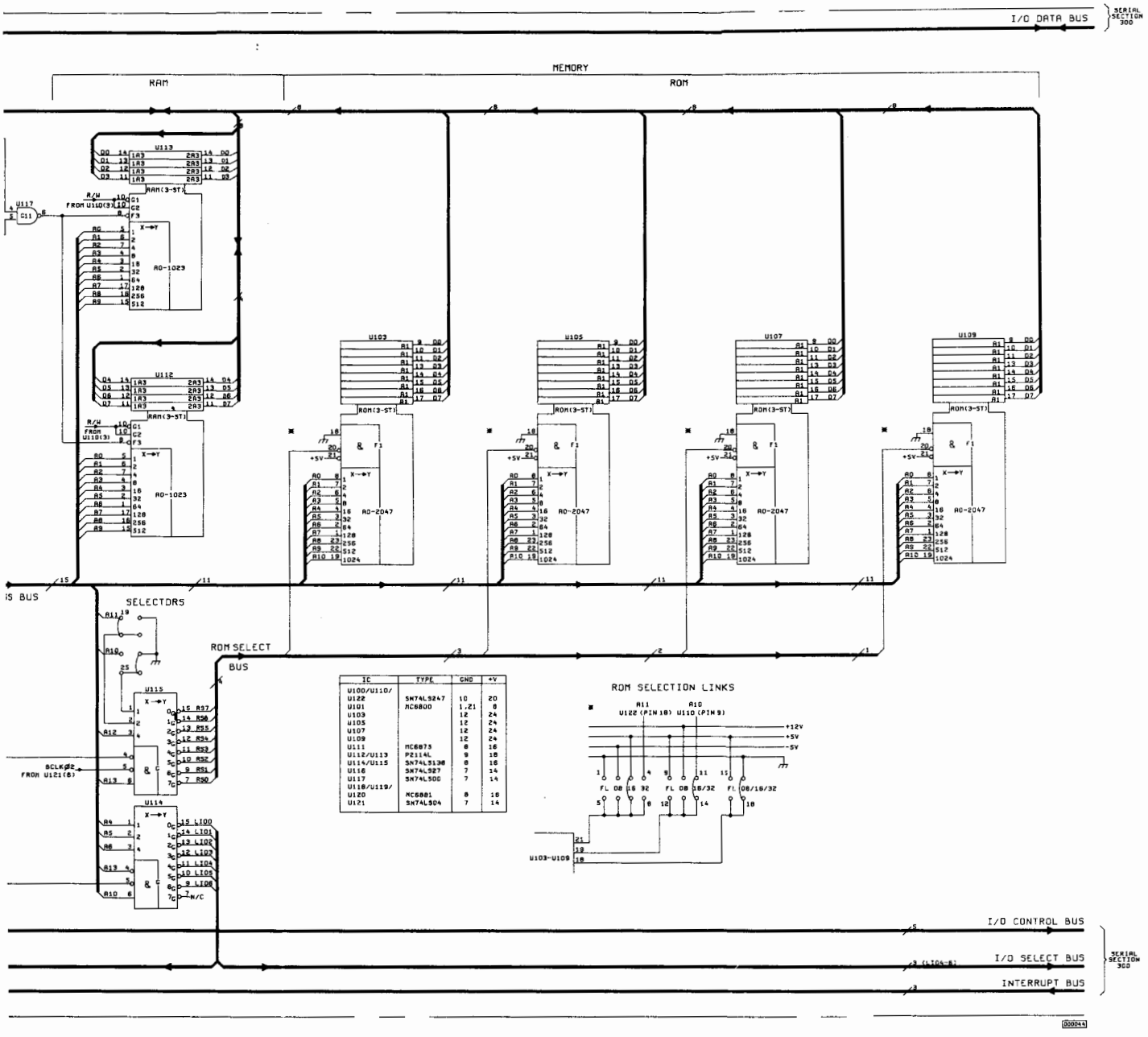


Figure A200-1 HP-IB Section Block Diagram

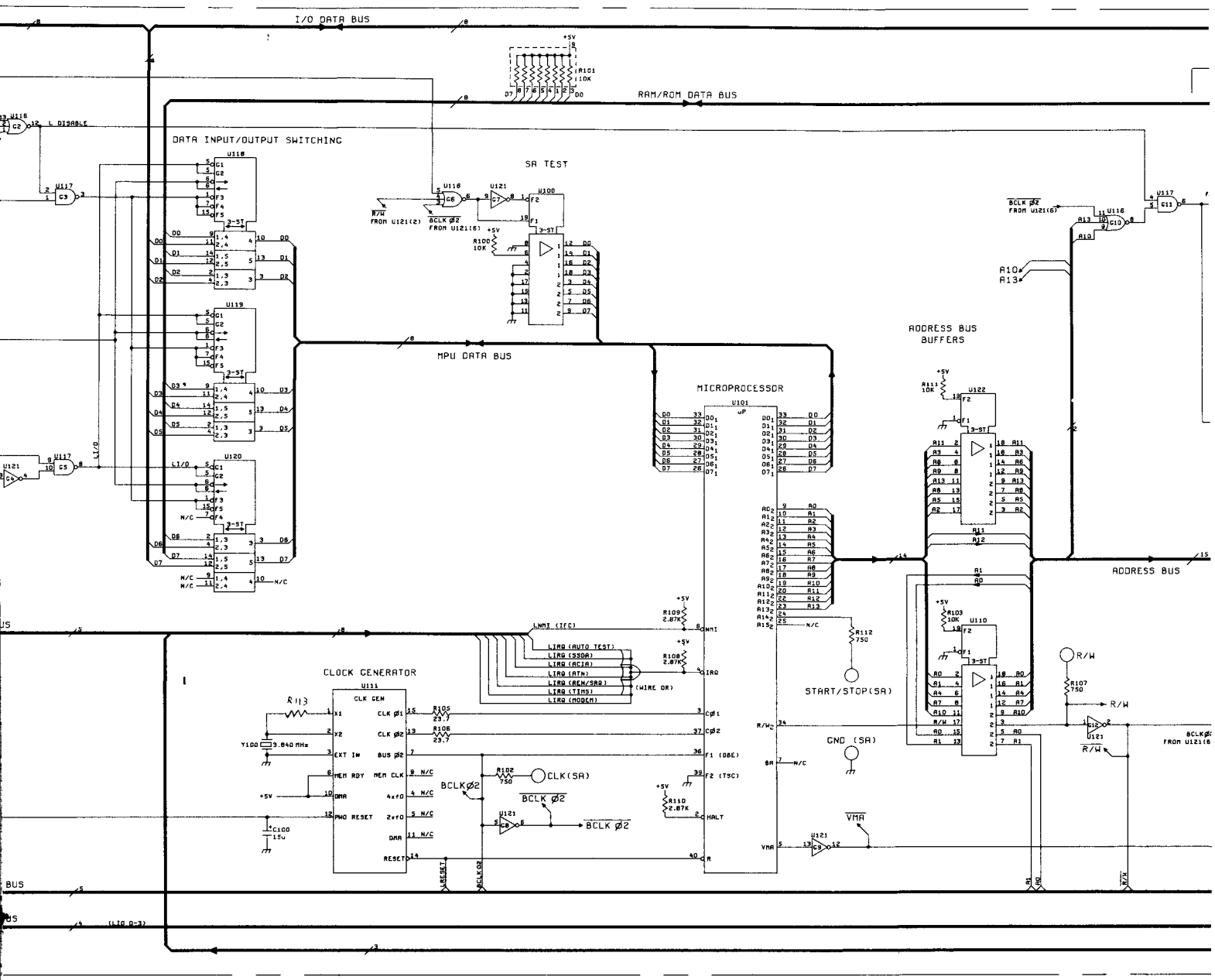
Figure A100-2 Component Location – Section 100
Figure A100-3 Schematic Diagram – Section 100



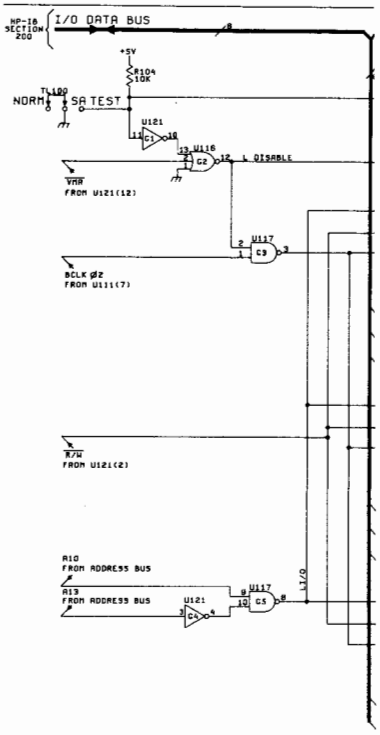
IC	TYPE	GND	+V
U100/U110/ U122	SN74LS247	10	20
U101	MC6800	1,21	8
U103		12	24
U105		12	24
U107		12	24
U109		12	24
U111	MC6875	8	16
U112/U113	P2114L	9	18
U114/U115	SN74LS138	8	16
U116	SN74LS27	7	14
U117	SN74LS00	7	14
U118/U119/ U120	MC6881	8	16
U121	SN74L304	7	14

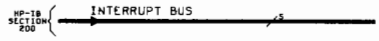
Figure A100-3 Schematic Diagram — Section 100

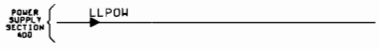
TION 100 (37201-60020)

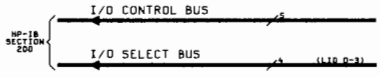


A1 PROCESSOR SECTION 100 (37201-60020)









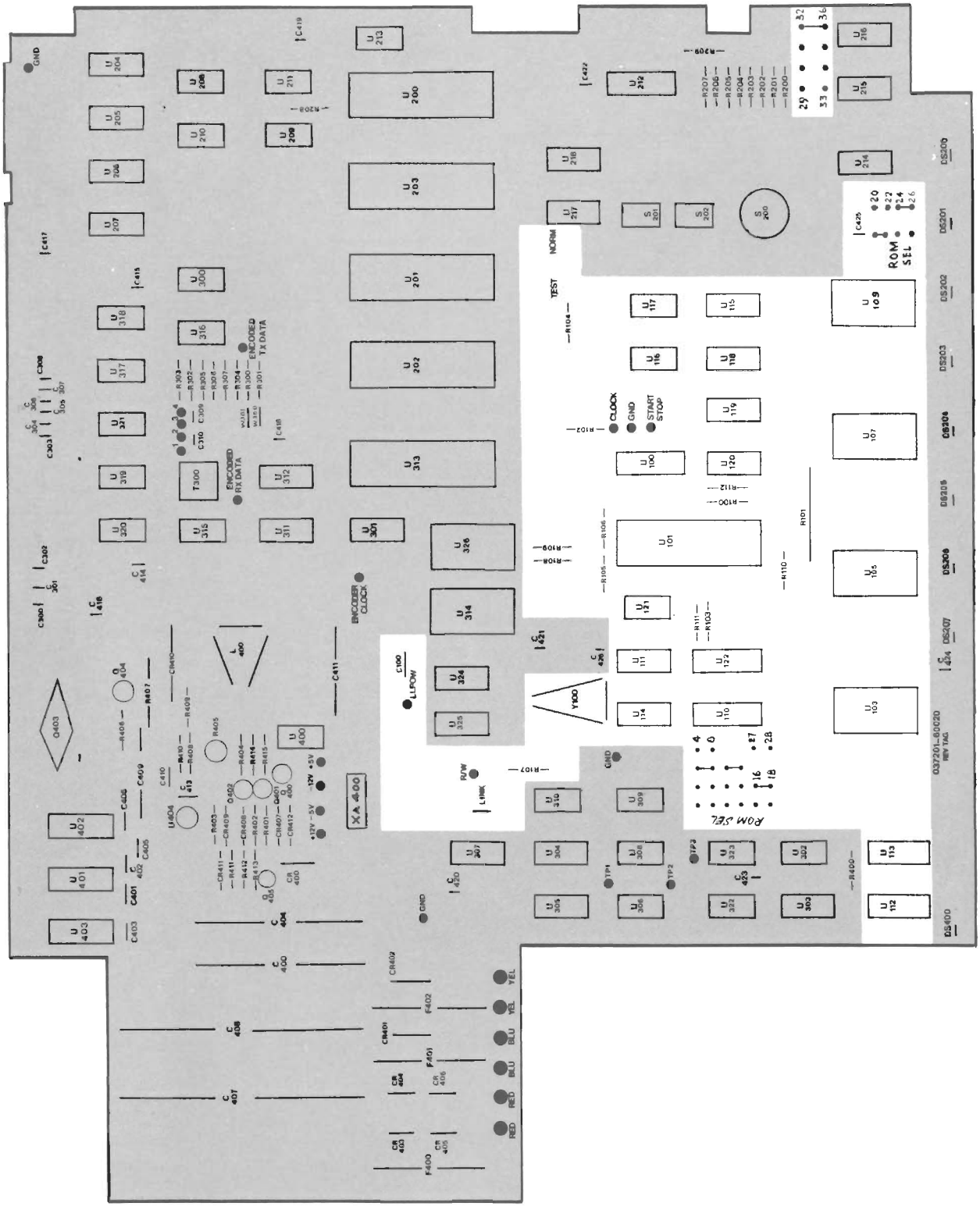


Figure A100-2 Component Location — Section 100

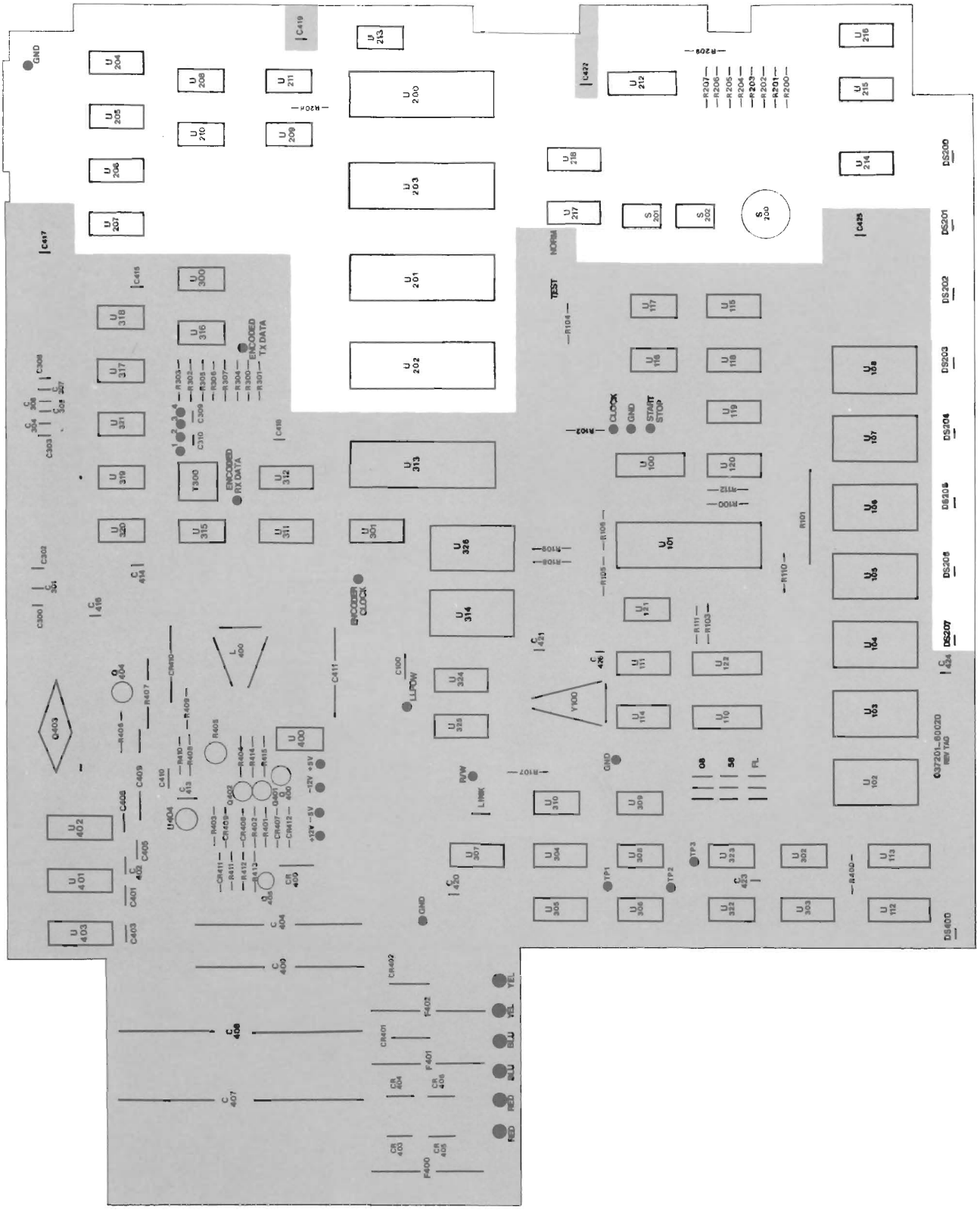


Figure A200-2 Component Location — Section 200

A200-1 INTRODUCTION

A200-2 The HP-IB section provides an interface between the Processor section and (a) the HP-IB, (b) a desk-top computer when running the diagnostics program, (c) the front panel lamps and (d) the internal switches.

A200-3 DESCRIPTION

A200-4 Bus Transceivers

A200-5 The bus transceivers (U204-U207) control the flow of HP-IB information to and from PIA1 and PIA2. The HP-IB data lines DI01-DI08 are routed via U206, U207. Data transfer from PIA2 to the HP-IB can only take place when LSDE is low. The HP-IB control and handshake lines are routed via U204, U205.

A200-6 Control Logic

A200-7 One requirement of instruments that talk on the HP-IB is that they remove data from the bus within 200ns of ATN going true. The control logic is incorporated in this instrument in order to meet this constraint which is beyond the capability of the microprocessor. The two flip-flops FF1 and FF2 detect glitches on the ATN line and cause LSDE to go high, which allows data transfer one way only, from the HP-IB to PIA2. Further communication is delayed by L-INHIBIT going low which inhibits the handshake lines NRFD and NDAC. DAV and EOI are also inhibited by LDAV/EOI being high. When the microprocessor catches up with the random logic, it resets FF1 and FF2, removing the inhibit from the handshake lines.

A200-8 Divide by 10^6

A200-9 The divide by 10^6 circuit divides the 960kHz clock to give an output pulse at 1 second intervals (1.04 seconds). This pulse is used to pull the interrupt input CB2 on PIA3.

A200-10 Switch Decode Logic

A200-11 The switch decode logic comprises, two 3 to 8 line decoders U217 and U218, two 6 position dual-in-line switches S201 and S202 and the 4 bit binary encoded Data Medium Switch S200. The two decoders U217, U218 are permanently enabled. The inputs to the decoders are connected in parallel and strobed, in binary sequence, by PIA3 – outputs PA5, PA6 and PA7. The output lines of U217 and U218 are connected to the three switches S200, S201 and S202. The switches are connected in a wired-OR configuration to PA0 and PA1 inputs of PIA3. PIA3 reads the switches by comparing the co-incident binary number on PA5, PA6 and PA7 when the decoder output line associated with a closed switch goes low.

A200-12 Peripheral Interface Adaptors (PIA s)

A200-13 PIA1 and PIA2 are used to interface the 37201A to the HP-IB. PIA3 is used to read the switches, configure the control logic and generate a recurring interrupt. (The precise timing of the interrupt (1.04 seconds) is set by the divide by 10^6.) PIA0 is used to provide an interface between a suitable desk top computer (such as the HP 9825A) and the 37201A, for troubleshooting/diagnostic programs; it also interfaces the microprocessor to the front panel LED indicators. The PIAs are addressable from the microprocessor via the I/O Select bus. A bi-directional data bus allows the transfer of information to and from the microprocessor. All the interrupt lines except LNMI are wire-ORed and taken to the microprocessor. Each interrupt output (IRQA and IRQB) has two internal flag bits to allow the microprocessor to identify which interrupt line has been pulled. When an interrupt occurs the microprocessor carries out a polling routine to determine which interrupt flag is set, and if more than one interrupt occurs, the microprocessor services the interrupts on a priority basis. The following is a brief description of the PIA lines:

D_0-D_7 –

These are bi-directional data lines. The data lines remain in a high impedance mode unless the PIA is addressed by the Microprocessor.

RESET (R) –

This line is low active and is used as a power on reset in the 37201A to initialise all the PIA s. PA0-PA7, PB0-PB7, CA2, CB2 are all configured as inputs and all interrupts are disabled.

CLOCK (C) –

Provides timing, all timing is referenced to either the leading or trailing edge of the clock input.

READ/WRITE (R/W) –

This line controls the transfer of data to and from the data bus. When the line is high the microprocessor reads data from the PIA, and when the line is low, writes data into the PIA. Note the Data Bus buffers are only enabled when the PIA is addressed, and a clock pulse is present.

REG SEL (A0, A1) –

These lines are used to address the internal registers of the PIA which affect the control, output and data direction.

PIA Address Lines (G1)

These three address lines are used to select a PIA. The condition for selection is, pins 22 and 24 must be high with pin 23 low.

IRQA, IRQB –

These are interrupt lines to the microprocessor, and may be connected in a wire-OR configuration, they are low true.

CA1, CB1 –

These are the interrupt inputs, which when set high and enabled will pull their corresponding IRQA, or IRQB line low.

CA2, CB2 –

May be programmed to act as an interrupt input, or a peripheral control output. As an output it is TTL compatible. The lines are programmed by their respective internal control registers (Control Reg. B for CB2).

PA0-PA7 –

Peripheral data lines which may be programmed by the microprocessor to act as either inputs or outputs. During a read operation the data on all the lines programmed as inputs appears directly on the corresponding microprocessor Data Bus lines.

PB0-PB7 –

These lines are the same as for PA0-PA7 except they have 3-state buffers on the output. (Capable of driving 1 TTL load with 1-1.5mA).

A200-14 TROUBLESHOOTING

A200-15 The information contained in this paragraph is the same as that in the HP-IB Section Troubleshooting in General Service Sheet G3.

A200-16 Most of the HP-IB Section is checked by the self-test program but Notes 1 to 4 following should be read carefully as they list the areas not checked and also some points which may prevent incorrect fault diagnosis.

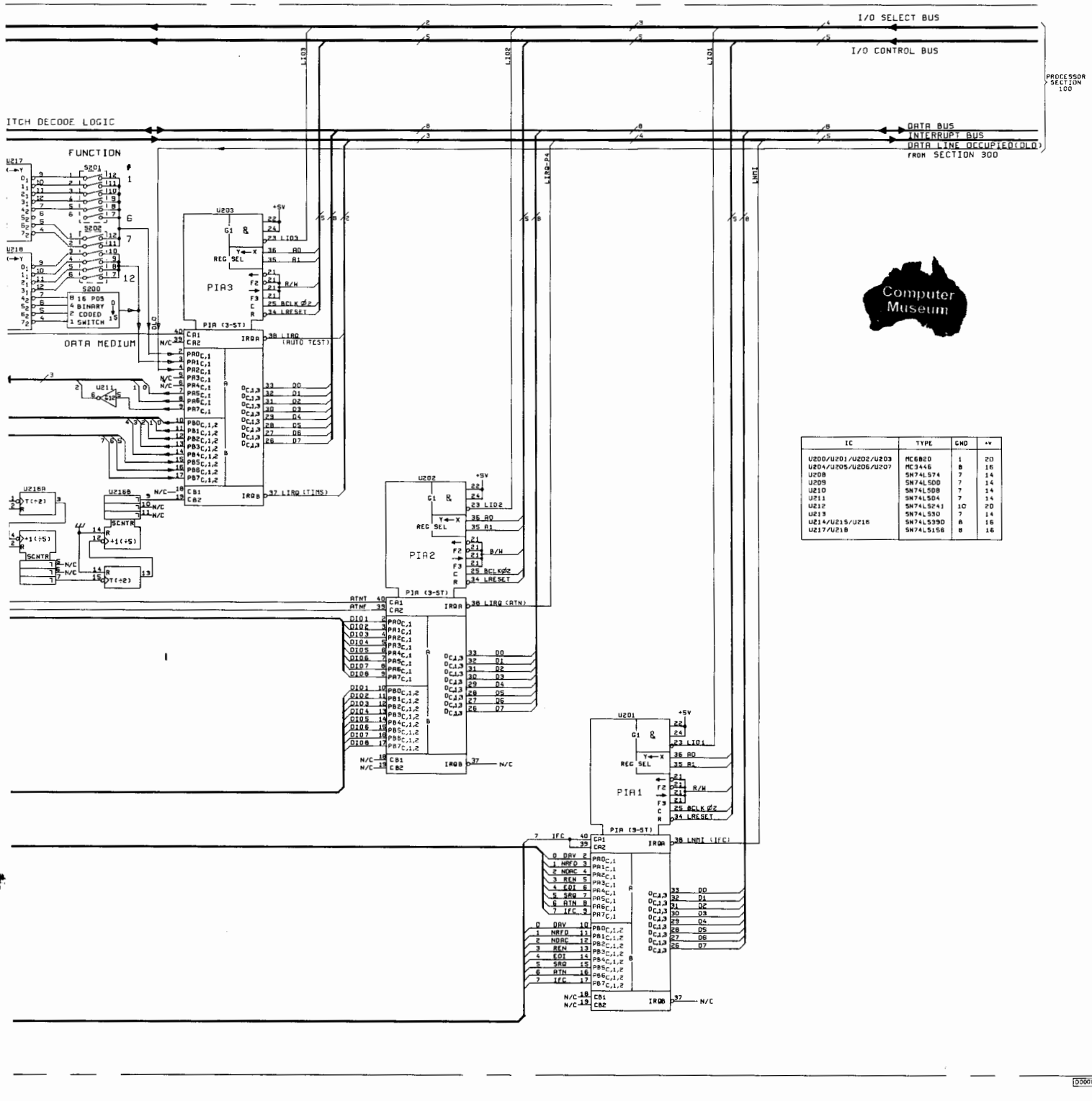
A200-17 Switch the Data Medium switch to Self-Test and the Power switch off then on. The program now running exercises most of the lines in the HP-IB Section, allowing each IC in turn to be checked with a suitable logic probe. (The Signature Analyzer probe is suitable.) Ground the probe carefully to avoid pick-up.

Note 1: The following are not exercised by the self-test program: U210(8), U213(8), U203(4, 5, 6), lines connected to +5V or ground, U201(38), unconnected PIA CA or CB inputs/IRQ outputs.
A complete check of the Switch Decode Logic, the U200 PB outputs, or of U212 is not possible in the self-test mode. Also, because the self-test program uses the front panel LEDs to indicate failures, a stuck line associated with the LEDs e.g. a U200 PB output or a U212 output, does not necessarily mean that one of these components is faulty. These circuits can all be checked conclusively by performing the Data Medium and Function switch tests in General Service Sheet G2.

Note 2: When the Data Medium switch is set to Ram & Sw Tests and all the Function switches are set to the right hand On position, the following are exercised: U217, U218 inputs and outputs, U203 pins 2, 3, 7, 8, 9 (pins 4, 5 and 6 are normally high in this condition).

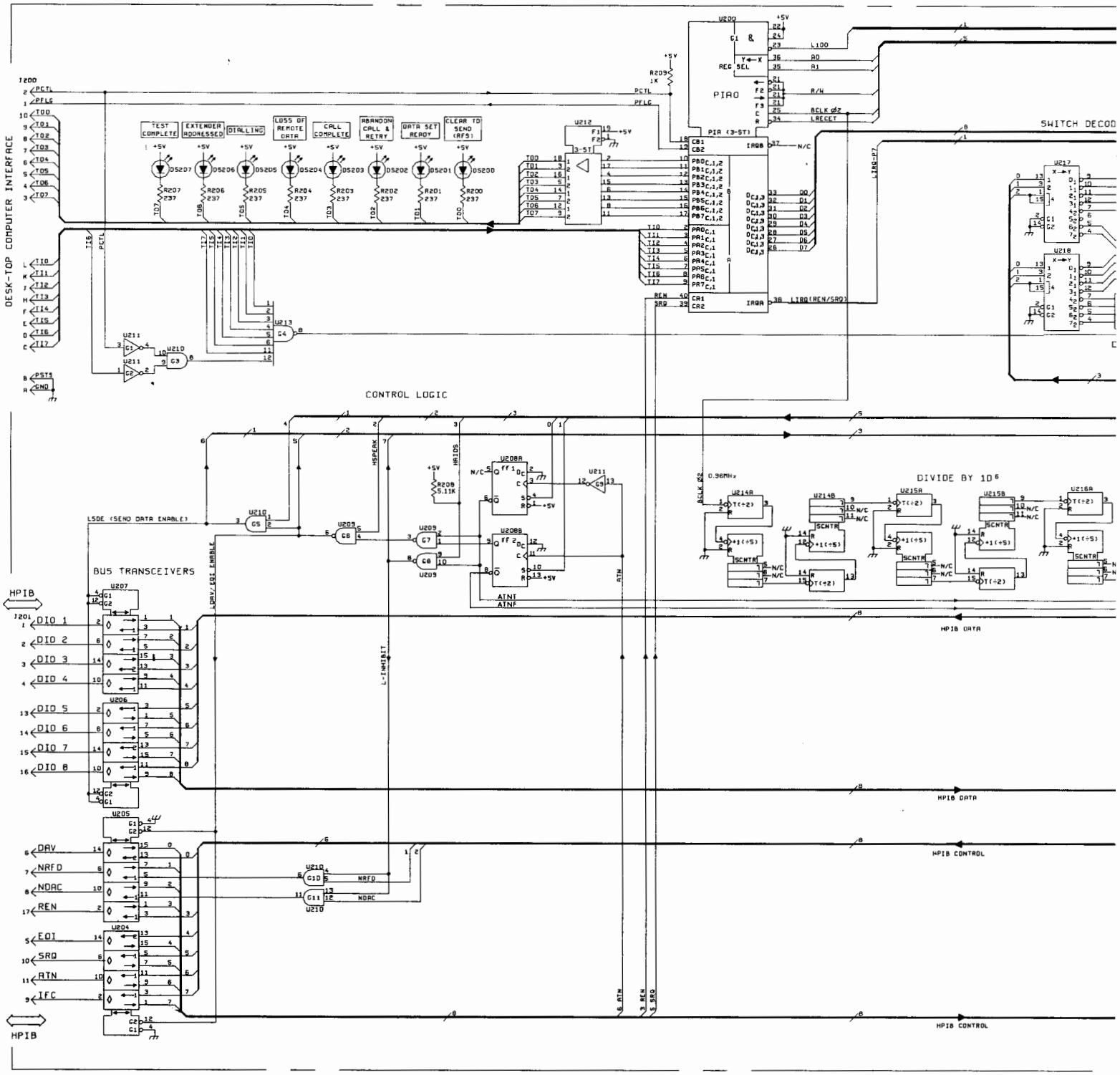
Note 3: A line stuck at logic 0 on the PIA data bus may cause the PIA PA or PB lines to stick but the remaining data bus lines will be exercised. If the Processor Section Checks 1 and 2 have been performed successfully, there will be no stuck lines on the Processor or RAM/ROM data buses.

Note 4: If a fault occurs in the Divide by 10^6 circuit (U214 through U216) the self-test program will not run because the program requires this circuit for timing.



IC	TYPE	GND	+V
U200/U201/U202/U203	MC6820	1	20
U204/U205/U206/U207	MC3446	8	16
U208	SN74LS74	7	14
U209	SN74LS00	7	14
U210	SN74LS08	7	14
U211	SN74LS04	7	14
U212	SN74LS241	10	20
U213	SN74LS30	7	14
U214/U215/U216	SN74LS390	8	16
U217/U218	SN74LS156	8	16

Figure A200-3 Schematic Diagram — Section 200


A1 HP-IB SECTION 200 (37201-60020)
DESK-TOP COMPUTER INTERFACE
SWITCH DECOD
TEST COMPLETE
EXTENDED ADDRESSED
DIALLING
LOSS OF REMOTE DATA
CALL COMPLETE
ABANDON CALL & RETRY
DATA SET READY
CLEAR TO SEND (RFS)
PIA0
PIA (3-ST)
CONTROL LOGIC
BUS TRANSCEIVERS
DIVIDE BY 10^6
0.96MHz
LSDE (SEND DATA ENABLE)
HPIB DATA
HPIB CONTROL
HPIB
DIO 1
DIO 2
DIO 3
DIO 4
DIO 5
DIO 6
DIO 7
DIO 8
DAV
NRFD
NDAC
REN
EOI
SRQ
ATN
IFC

A300-1 INTRODUCTION

A300-2 The Serial Section converts the parallel data into serial format suitable for transmission via a modem or over a twisted pair cable. The converse is also carried out, converting serial data to parallel. In addition, the Serial Section also provides a suitable interface for an autodialler.

A300-3 DESCRIPTION

A300-4 Peripheral Interface Adapter (PIA)

A300-5 This PIA handles the control lines to and from the autodialler interface. It handles the control lines to and from the Modem (RS232C/V.24) and the internal switching between synchronous and asynchronous data. Details of the PIA I/O and control lines can be found in the HP-IB Section Service Sheet 200.

A300-6 Asynchronous Communications Interface Adaptor (ACIA)

A300-7 The ACIA is used to convert the parallel data from the data bus into asynchronous serial data for transmission via a suitable modem. The bit rate or speed at which data is transmitted can be selected from four speeds between 150 bits per second and 1200bps. Details of the ACIA I/O and control lines can be found in paragraph A300-24.

A300-8 Synchronous Serial Data Adaptor (SSDA)

A300-9 The SSDA converts the parallel data from the data bus into synchronous serial data for transmission via a synchronous modem or a twisted pair cable. The transmission speed is 20kbits for a twisted pair cable. For a modem it is dependent on the modem clock rate. Details of the SSDA I/O and control lines can be found in paragraph A300-25.

A300-10 Line Encoder

A300-11 The line encoder converts the serial data, synchronised to the encoder clock, into a data stream with a spectrum suitable for transmission over ac coupled paths. Figure A300-3, gives waveforms for a continuous logic 1 input and a continuous logic 0 input to the line encoder.

A300-12 Dual Line Driver

A300-13 The dual line-driver U316 provides a balanced output suitable for driving a twisted pair cable up to 1000 meters in length.

A300-14 Line Receiver

A300-15 The line receiver U315 is connected to a balanced transformer input. The overall configuration makes the receiver immune to dc voltages on the line and provides a high level of common mode rejection minimising the effects of line noise.

A300-16 Line Decoder and Clock Extractor

A300-17 This circuit extracts the clock from the incoming data stream and decodes the data. A 960kHz clock from the Processor Section (100) is divided by U305 and U308B to run at the same nominal frequency as the Encoder Clock. The clock from the transmitting 37201A will not however be in exact synchronism with the clock at the receiving 37201A. Synchronisation of clocks is achieved with down counter U305 and divider U308B. The carry output pulse from U305 pin 15 reloads the data on the D_C data input lines, from which U305 decrements. FF8, FF9 and G11 detect a clock component in the data stream and produce an output pulse at G11 output which forces the counter U305 to reload and divider U308B to reset, synchronising the counter and divider to the incoming data clock. The data is decoded by the circuitry at FF3 and FF6.

A300-18 Switching

A300-19 Switching is controlled by PIA5 (U313), and multiplexers U301, U311, U312 and U324. Simplified block diagram Figure A300-1 shows the individual switch sections without the control lines from PIA5 (U313).

A300-20 Clock Divider (Sync Data)

A300-21 This divides the 960kHz clock by 48 to provide a clock for the Line Encoder and the SSDA transmit clock when the 37201A is used in the Twisted-Pair mode.

A300-22 Clock Divider (Async Data)

A300-23 The async clock divider divides the 960kHz clock to provide one output at 19200Hz (U325 pin 7) and another at 9600Hz (U325 pin 3). The clock rate selected by multiplexer U324 is used as the Tx and Rx clock for the ACIA. The data rate transmitted by the ACIA is determined by a further internal division of this clock by 16 or 64 to provide the total of four possible asynchronous rates.

A300-24 Asynchronous Communications Interface Adapter (ACIA)

D_0-D_7 –

These are bi-directional data lines. The data lines are not driven unless the ACIA is addressed by the microprocessor.

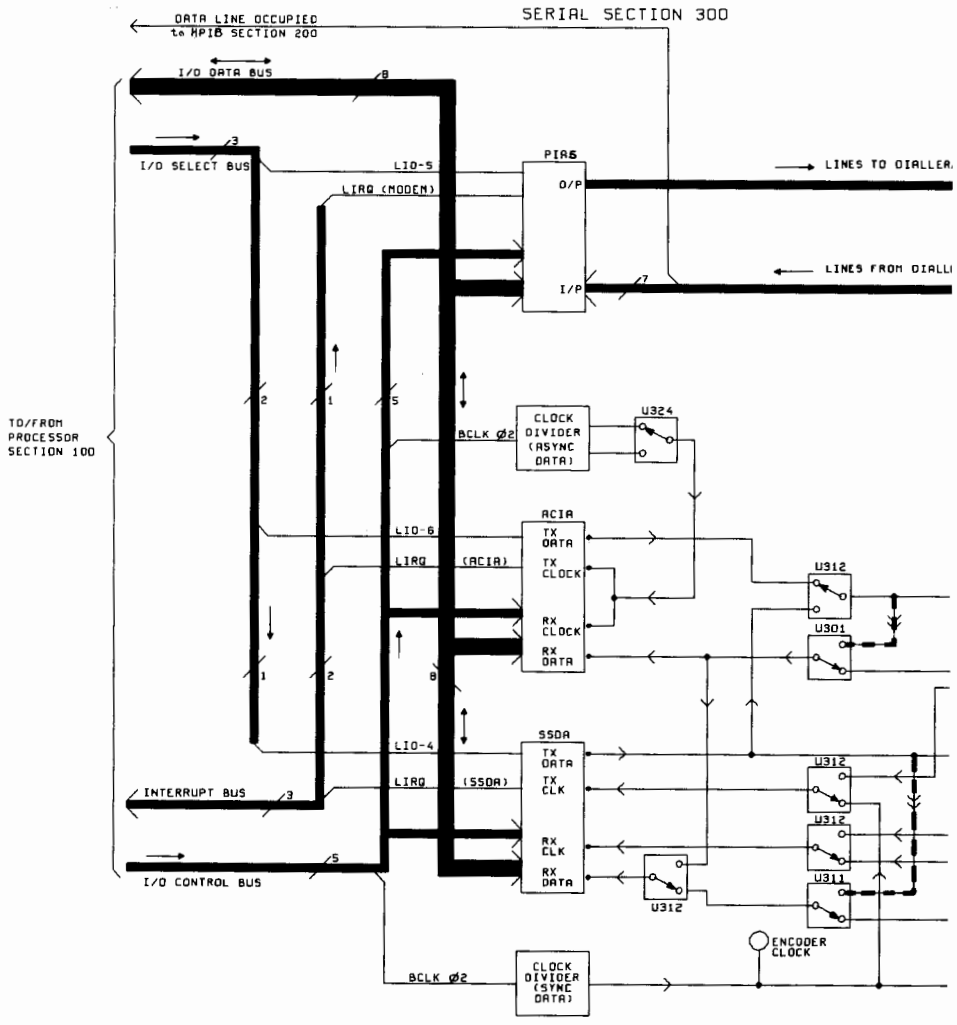
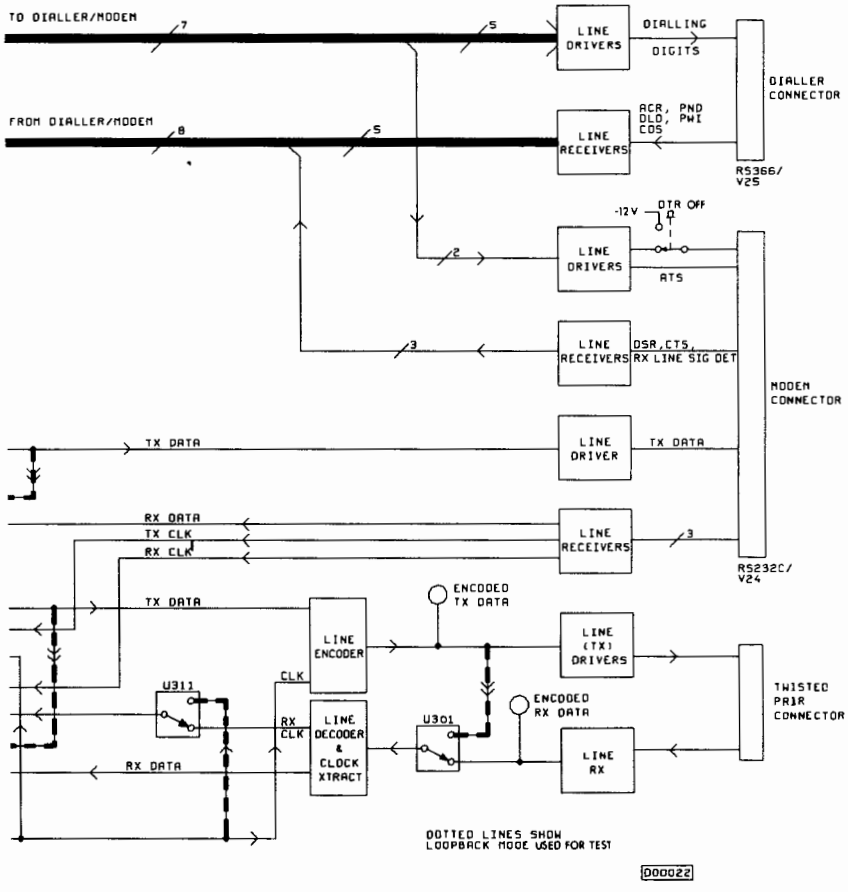


Figure A300-1 Serial Section

SERVICE SHEET 300



ection Block Diagram

CLOCK (C3) –

Uses the microprocessor BCLK Ø2.

READ/WRITE (R/W) –

This line controls the transfer of data to and from the data bus. When the line is high the microprocessor reads from the ACIA and when the line is low the microprocessor writes data into the ACIA.

REG SEL (A0) –

This line is used in conjunction with the Read/Write line to select internal registers within the ACIA.

ACIA Address Lines (G1)

These three lines are used to select the ACIA. The condition for selection is pins 8 and 10 must be high, with pin 9 low.

IRQ –

This is the interrupt line to the microprocessor and is wire-ORed with the PIAs and SSDA interrupt lines, it is low true.

TRANS DATA (Pin 6)

This is the transmit data output.

TRANS CLOCK (C4) –

Is internally divided by 16 or 64 and used to clock the transmit data.

RX DATA (Pin 2)

This is the received data input.

RX CLOCK (C5) –

Is internally divided by 16 or 64 and is the receive clock input used for synchronising the received data.

A300-25 Synchronous Serial Data Adapter (SSDA)

D_0-D_7 –

These are bi-directional data lines. The data lines are not driven unless the SSDA is addressed by the microprocessor.

RESET (R) –

This line is low true, and resets both the transmit and receive sections.

CLOCK (C3) –

Uses the microprocessor clock BCLK Ø2.

READ/WRITE (R/W) –

This line controls the transfer of data to and from the data bus. When the line is high the microprocessor reads from the SSDA and when the line is low the microprocessor writes data into the SSDA.

REGISTER SELECT (REG SEL) –

This line is used in conjunction with the Read/Write line to select internal registers within the SSDA.

CHIP SELECT (G1) –

This is the select line for the SSDA, and is low true to select the SSDA.

IRQ –

This is the interrupt line to the microprocessor and is wire-ORed with the PIAs and ACIA interrupt lines. It is low true.

TRANS DATA (Tx) –

This is the transmit data output.

TRANS CLOCK (C4) –

This is used to clock the transmit data.

RX DATA (Rx) –

This is the received data input.

RX CLOCK (C5) –

This is the receive clock input used for clocking in the received data.

A300-26 TROUBLESHOOTING

A300-27 The troubleshooting in this section is self contained and repeats some of the checks carried out in the General Service Sheets. These checks may be omitted at the technicians discretion.

Check 1 Clock Dividers

(a) Connect a suitable counter to the Encoder Clock test point, and check the frequency is 20kHz ± 20Hz.

(b) Connect the counter to U324 pin 12. Set the Data Medium switch to 150, and switch the 37201A off then on. Check the frequency at the following switch settings:

	Data Medium Switch	Frequency
Async Modem	150	9.6kHz ± 10Hz
	300	19.2kHz ± 20Hz
	600	9.6kHz ± 10Hz
	1200	19.2kHz ± 20Hz

Check 2 PIA, ACIA, SSDA

(a) Set the Data Medium switch to Self-Test and switch the 37201A off then on. Use an oscilloscope or logic probe to check for transitions on U313, U314 and U326 with the following exceptions:

On PIA5 (U313) there is no transition on pins 6, 7, 8, 9, 10, 11, 18, 20, 22, 24, 34 and 40.

On ACIA (U314) there is no transition on pins 1, 5, 8, 12, 10, 23, 24.

On the SSDA (U326) there is no transition on pins 1, 5, 8, 9, 12, 23, 24.

Check 3 RS232C/V.24 and RS366/V.25 Input/Output

The input/output drivers are not tested by the Self-Test mode.

RS366/V.25 output drivers can be monitored using a suitable oscilloscope dc coupled to the RS366/V.25 output pins, the RS232C/V.24 output drivers can be monitored similarly.

(a) To monitor the RS232C/V.24 and RS366/V.25 outputs, set the Data Medium switch to Self-Test, switch the Power off then on, then check for transitions approximately every second at the following pins. The logic levels should be +10 ± 2V and −10 ± 2V. Note that, because the transitions are very narrow, an oscilloscope sweep speed of 1s/div and a sensitivity of 10V/div is recommended.

	Pins	
RS232C/V.24	2	
	4	
	20	– Holding the front panel DTR switch pressed should stop the pulses and set this pin low (−10 ± 2V).
RS366/V.25	2	
	4	
	14	– a positive going pulse from −10 ± 2V to +10 ± 2V.
	15	– a negative going pulse from +10 ± 2V to −10 ± 2V.
	16	– a positive going pulse from −10 ± 2V to +10 ± 2V.
	17	– a negative going pulse from +10 ± 2V to −10 ± 2V.

(b) Connect RS366/V.25 pin 2 in turn to each input pin listed below and check that the corresponding receiver output shows transitions. Note that the receiver outputs should all be within the normal TTL logic levels (0V to 4V ± 1V). A suitable logic probe, or the Signature Analyzer probe may be used in place of the oscilloscope.

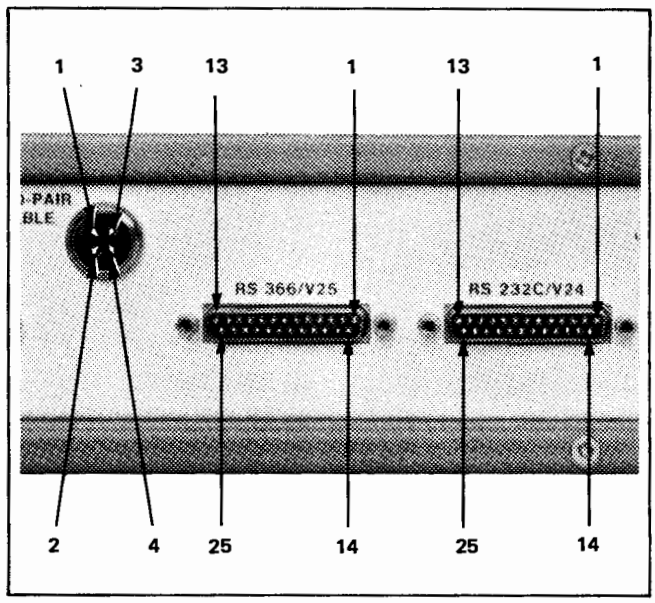


Figure A300-2 Connector Pin Numbers

Connect RS366/V.25 pin 2 to:		Receiver Output
RS366/V.25	3	U321 (6)
	5	U321 (11)
	6	U300 (8)
	13	U300 (11)
	22	U300 (6)
RS232C/V.24	3	U320 (11)
	5	U321 (8)
	6	U321 (3)
	8	U320 (3)
	15	U320 (6)
	17	U320 (8)

Check 4 Line Encoder/Line Decoder & Clock Extractor

Set the Data Medium switch to Diagnostic Test and switch the Power off then on.

(a) Connect an oscilloscope to the Encoded Tx Data test point. A TTL level (0 to 4V ± 1V) squarewave with a period of about 100μs should be displayed. Short U309 pin 11 to ground, the squarewave period should halve – if it does not, refer to Check 4e. Remove the short from U309 pin 11.

(b) Connect the oscilloscope to U310 pin 8 and check that the TTL level squarewave is at the same frequency as the one at the Encoder Clock test point (20kHz). Connect the oscilloscope to U310 pin 5 and check for a logic 1 voltage level (4V ± 1V). Short U309 pin 11 to ground and check that the voltage level falls to logic 0 – if fautly, refer to Check 4c.

(c) Set the Data Medium switch to Diagnostic Test and switch the Power off then on. Connect the HP 5004A Signature Analyzer as follows:

SA CLOCK probe . . . . . CLOCK test point
SA GND probe . . . . . GND test point
SA Logic probe ground . . . . . GDN test point
SA START probe . . . . . ENCODED Tx DATA test point
SA STOP probe . . . . . ENCODED Tx DATA test point

SA Controls:
LINE . . . . . IN
START . . . . . IN
STOP . . . . . OUT
CLOCK . . . . . IN
HOLD . . . . . OUT
SELF-TEST . . . . . OUT

Check that the signature on the +5V test point is 59A4. With the Data Medium switch set to the Diagnostic Test position the Line Encoder output is looped back via U301 through the Line Decoder & Clock Extractor circuitry. The first signature listed below is the Line Decoder & Clock Extracter output, followed by three key signatures taken at the test points, the remainder of the list is not necessarily documented in a logical checking order but should be used with the schematic diagram if one of the first four signatures are wrong. Check with the current change sheet that the signatures have not changed.

Note: Care should be taken when connecting U309 (11) to ground – if the wrong pin is grounded, the +5V fuse may blow, or damage may result.

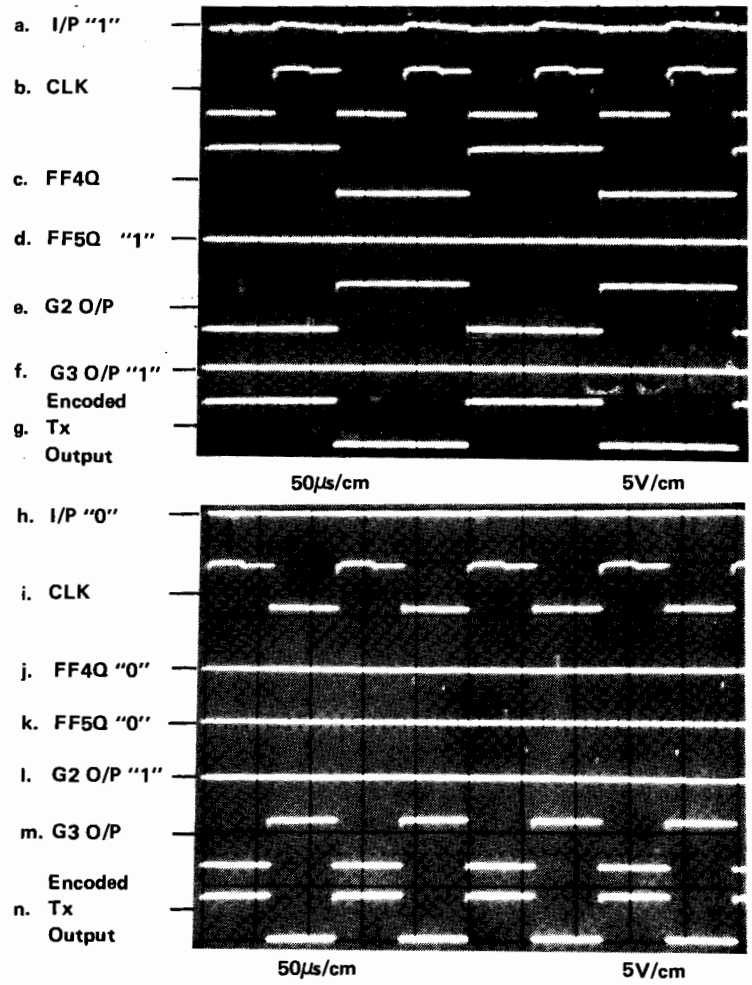
LINE DECODER & CLOCK EXTRACTOR SIGNATURES WHEN IN THE LOOPBACK MODE

	Monitor Point	Signature	Sig with U309 (11) Grounded
Output	U310 (5)	59A4 (high)	0000
Key Test Points	TP3	69C8	4AA5
	TP2	UACC	A552
	TP1	5669	9FFP
U306	U306 (13)	UACC	A552
	U306 (6)	8858	H0P4
	U306 (3)	H1UF	A3HH
	U306 (2)	UACC	A552
	U306 (1)	8858	H0P4
	U306 (9)	8858	H0P4
	U306 (8)	UACC	A552
	U306 (10)	2C47	068U
U307	U307 (7)	U576	4AA5
	U307 (14)	4F07	U07P
U323	U323 (12)	8U04	495F
	U323 (11)	AU2C	399F
	U323 (9)	301F	399F
	U323 (8)	202U	70F0
	U323 (5)	P545	7339
	U323 (4)	U576	4AA5
	U323 (6)	59A4	399F
U309	U309 (13)	AU2C	399F
	U309 (12)	U68U	0000
	U309 (3)	202U	70F0
	U309 (4)	798C	03U9
	U309 (8)	301F	399F
U308	U308 (2)	same as Test Point 302	
	U308 (4)	8U04	495F
	U308 (5)	same as Test Point 303	
U310	U310 (2)	59A4	399F
	U310 (3)	U68U	4AA5
	U310 (11)	8U04	495F
	U310 (12)	same as Test Point 303	

(d) Check the twisted-pair output at the output pins 3 and 4 with an oscilloscope (a logic probe will not work). There should be a squarewave of approximately 0.7V with respect to ground and period 100μs on both pins. Check the twisted-pair input by linking pin 4 to pin 1 and pin 3 to pin 2 and checking the Encoded Rx Data test point with the oscilloscope. The waveform should be a TTL level squarewave with a period of 100μs. Note that there will be spurious signals on the Encoded Rx Data test point if no input signal is present.

Note: With the Data Medium switch set to Twisted-Pair and the Power switched off then on, the LOSS OF REMOTE DATA indicator should extinguish when the Tx output is connected to the Rx input (pin 4 to pin 1 and pin 3 to pin 2).

e. Figure A300-3 g. and n. show the waveform at the ENCODED Tx DATA test point for both a continuous logic 1 input and a continuous logic 0 input. (When the 37201A is powered on with the Data Medium switch set to Diagnostic Test, the input to the Line Encoder is a continuous logic 1, grounding U309 pin 11 produces a continuous logic 0 at the input to the Line Encoder).



Note: All waveforms triggered from Encoded Tx Data Test Point.

Figure A300-3 Line Coder Waveforms

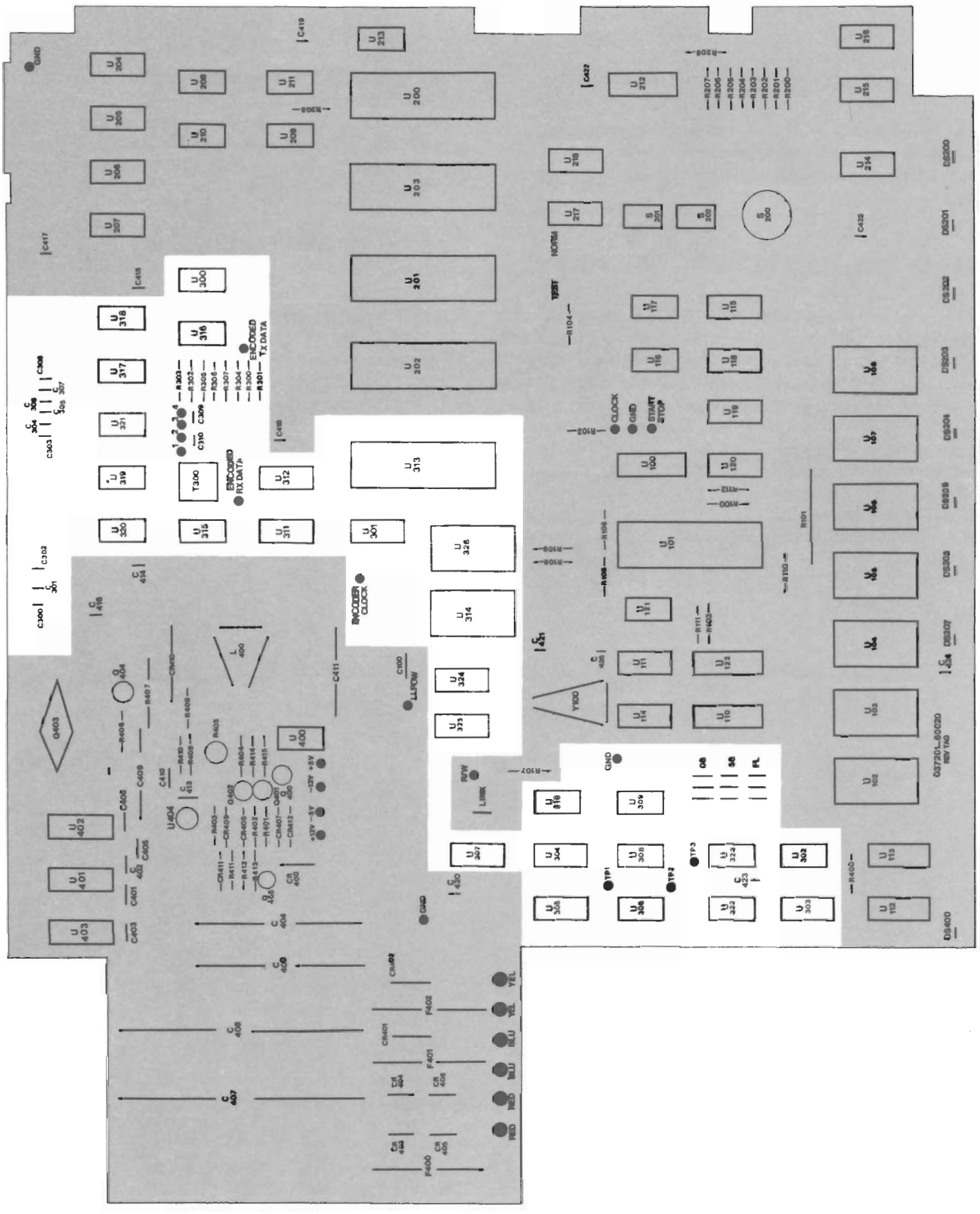
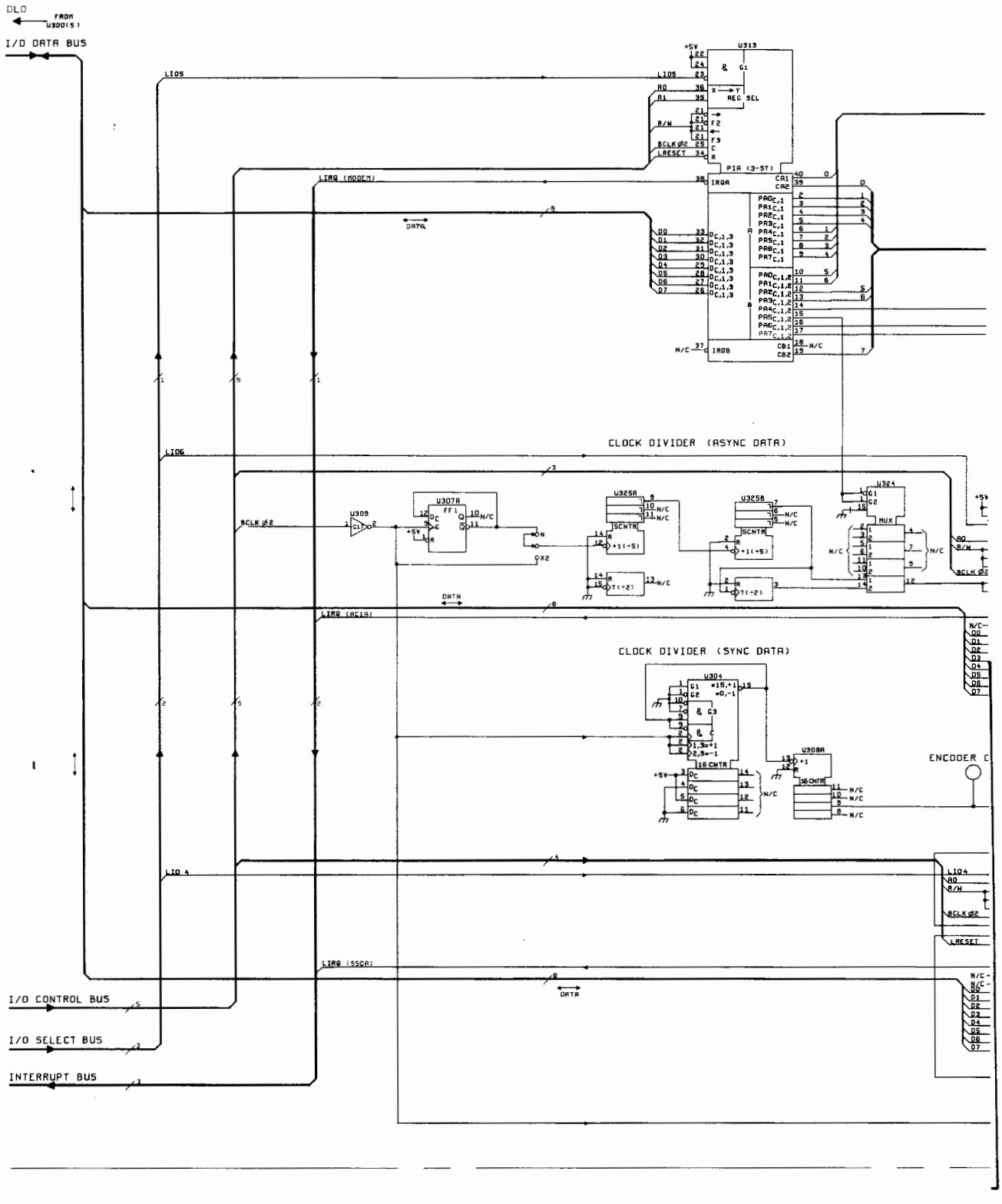
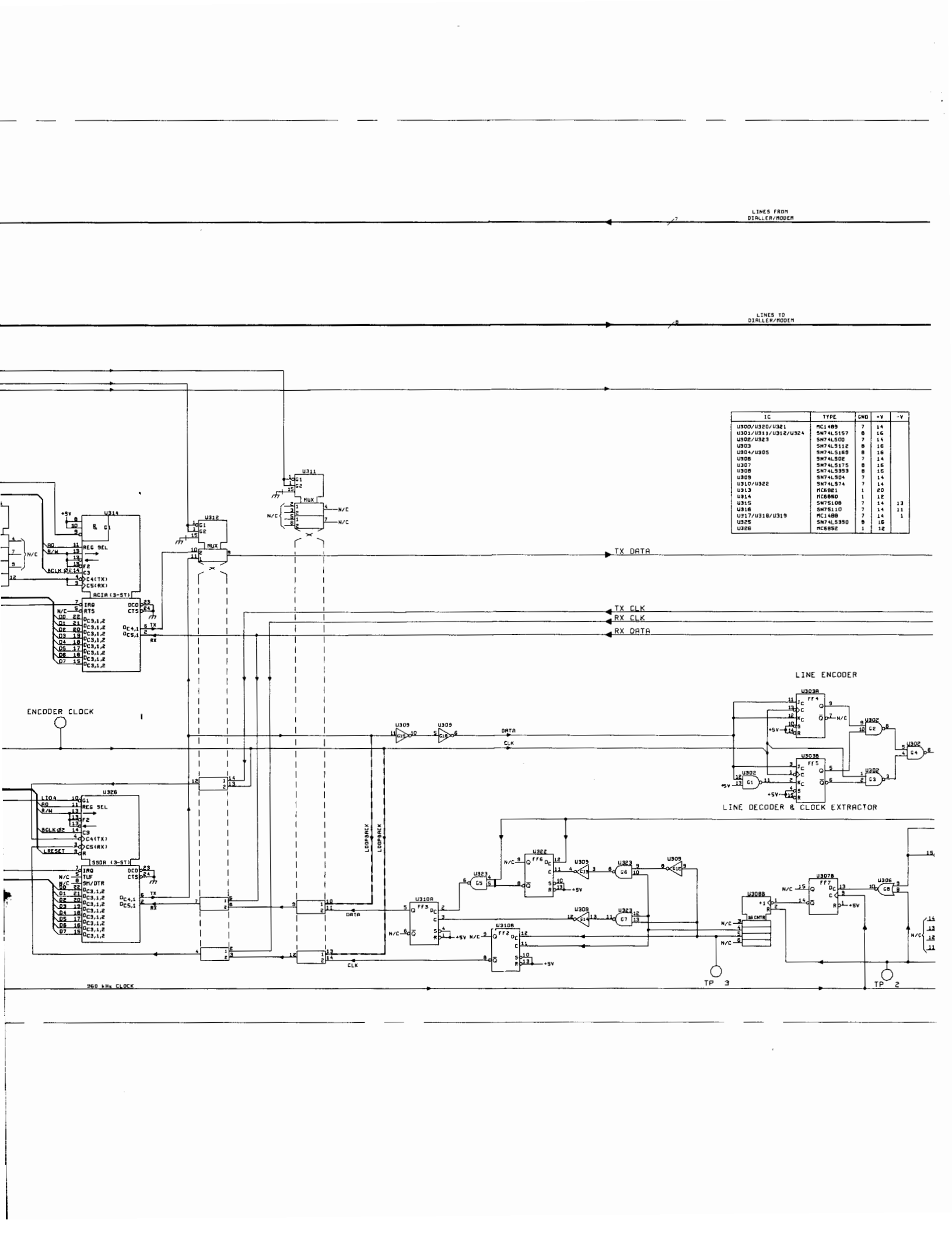


Figure A300-4 Component Location — Section 300

A1 SERIAL SECTION 300 (37201-60020)




LINES FROM DIALLER/MODEM
LINES TO DIALLER/MODEM
TX DATA
TX CLK
RX CLK
RX DATA
ENCODER CLOCK
LINE ENCODER
LINE DECODER & CLOCK EXTRACTOR
960 kHz CLOCK
TP 3
TP 2
DATA
CLK
LOOPBACK
LOOPBACK
ACIA (3-ST)
SSDR (3-ST)
REG SEL
MUX
IC TYPE GND +V -V
U300/U320/U321 MC1489 7 14
U301/U311/U312/U324 SN74LS157 8 16
U302/U323 SN74LS00 7 14
U303 SN74LS112 8 16
U304/U305 SN74LS169 8 16
U306 SN74LS02 7 14
U307 SN74LS175 8 16
U308 SN74LS353 8 16
U309 SN74LS04 7 14
U310/U322 SN74LS74 7 14
U313 MC6821 1 20
U314 MC6850 1 12
U315 SN75108 7 14 13
U316 SN75110 7 14 11
U317/U318/U319 MC1488 7 14 1
U325 SN74LS350 8 16
U326 MC6852 1 12

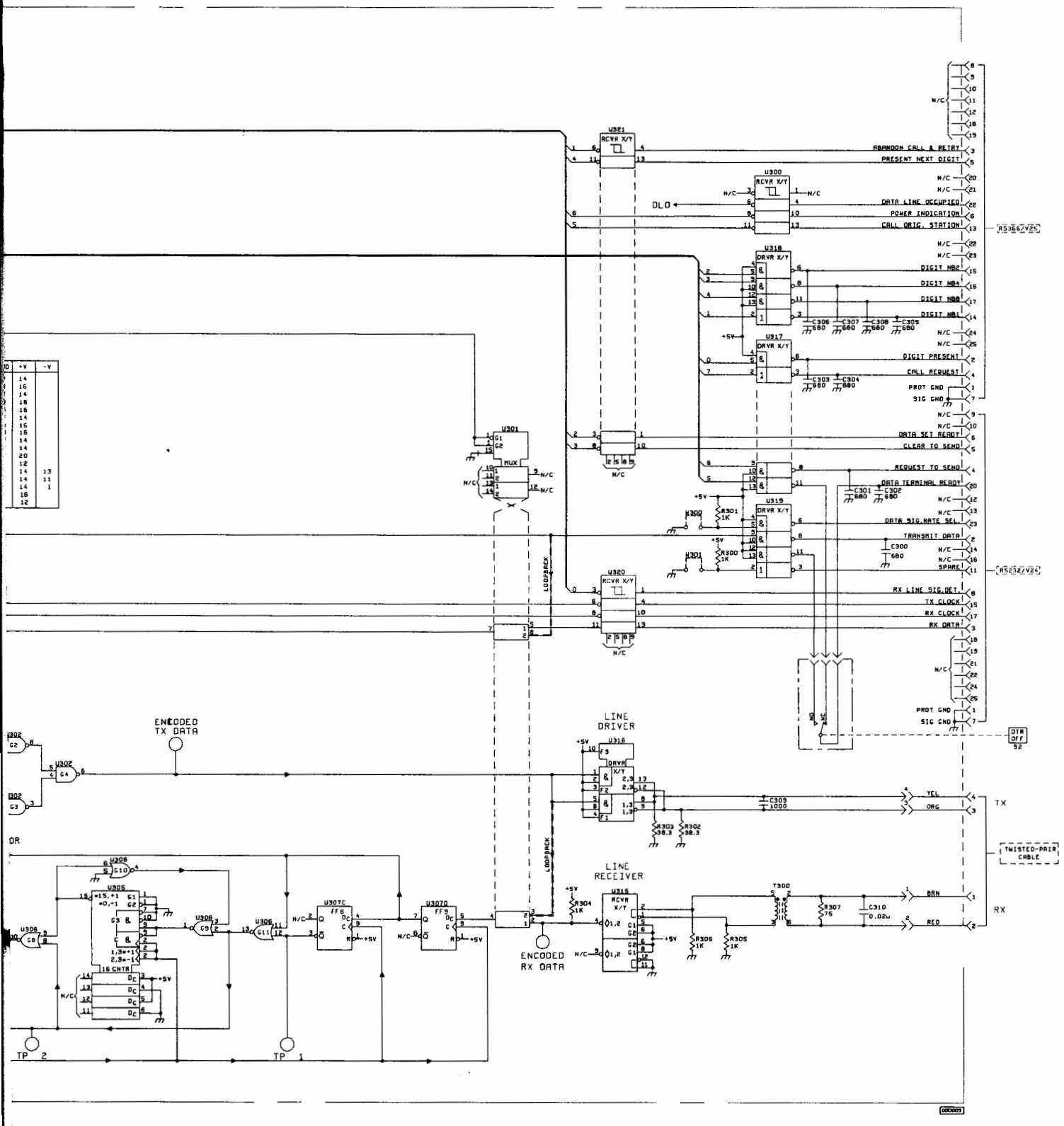


Figure A300-5 Schematic Diagram — Section 300

POWER SUPPLY SECTION SERVICE SHEET 400

A400-1 INTRODUCTION

A400-2 The +12, −12 and −5V supplies are provided by conventional series regulator integrated circuits while the +5V supply is provided by a self oscillating switching regulator.

A400-3 DESCRIPTION

A400-4 The voltage produced at Q402 collector provides the reference voltage for the input of comparator U404. The non-inverting input of the comparator is connected to the output of the regulator. For the purpose of this description only, the ground rail is regarded as the output. If the output voltage is less than the reference voltage, then switching transistors Q403 and Q404 will be switched on by the comparator. Positive feedback via R408 raises the voltage on the inverting input of the comparator above the reference voltage, holding the switching transistors on until the output voltage reaches the same level. When the output voltage does reach the same level, the comparator output falls, switching Q403 and Q404 off. Positive feedback via R408 lowers the voltage on the inverting input of the comparator below the reference voltage, holding the switching transistors off until the output voltage also drops below the reference voltage, when the comparator will switch Q403 and Q404 on again.

A400-5 TROUBLESHOOTING

A400-6 The pc board test link (TL400) allows the power supply to be isolated from the rest of the instrument, permitting no-load voltage readings to be taken, and avoiding damage to the rest of the instrument while the power supply is being repaired.

A400-7 The ac supplies for the +12V and +5V regulators are individually fused, while the −12V and −5V regulators share a common fuse.

A400-8 Voltages and waveforms are given on the schematic diagram. Figure A400-1 shows the waveform at Q404 collector.

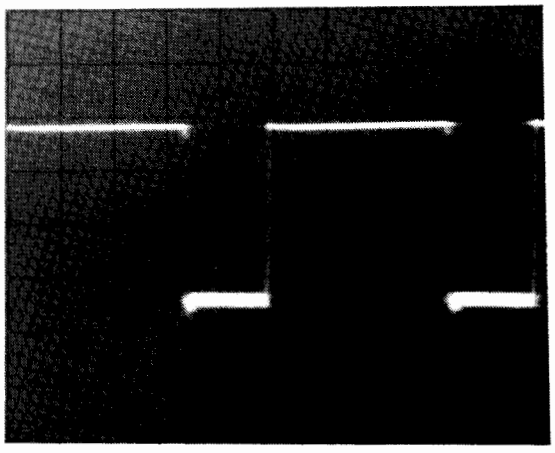


Figure A400-1 Q404 Collector Waveform

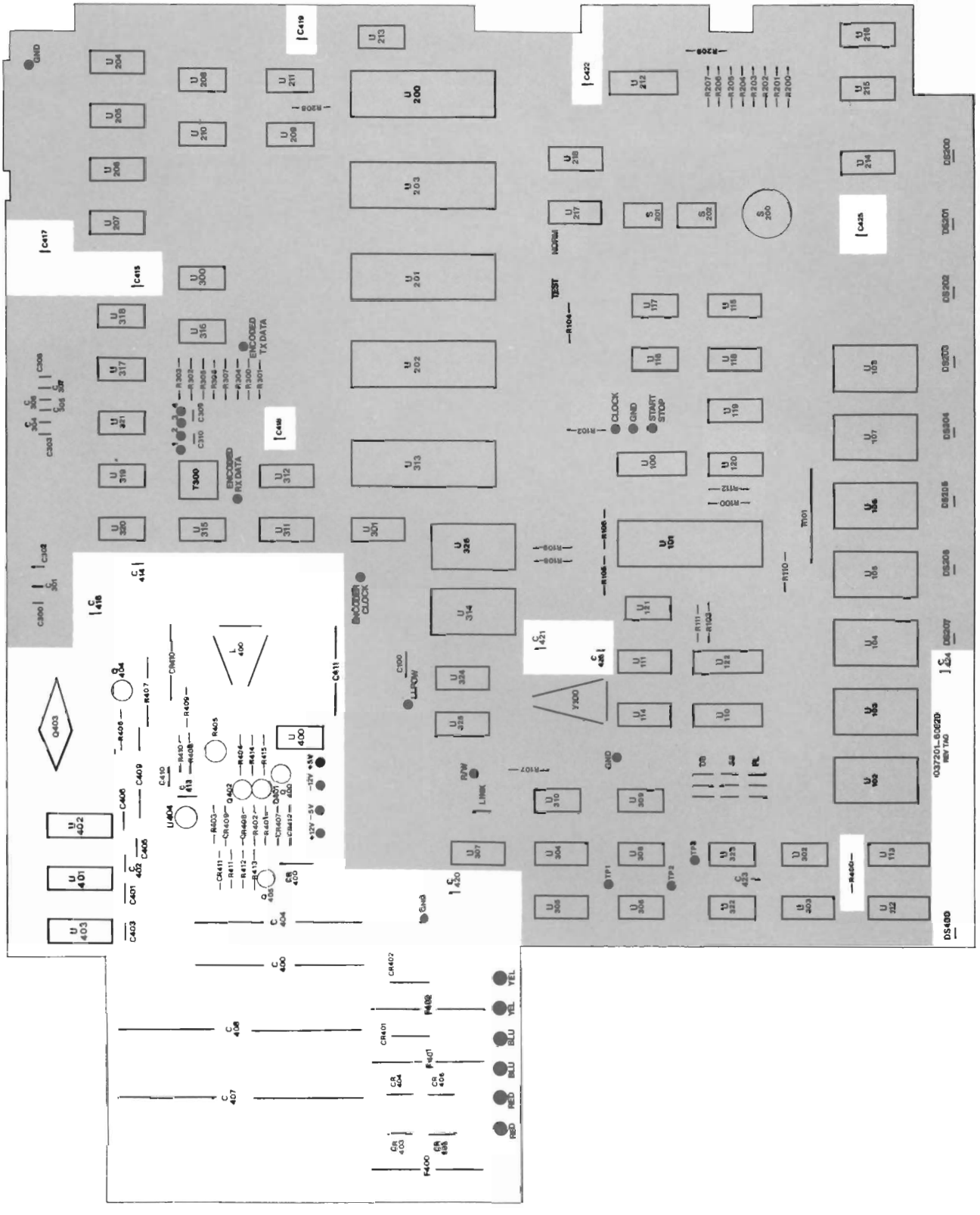
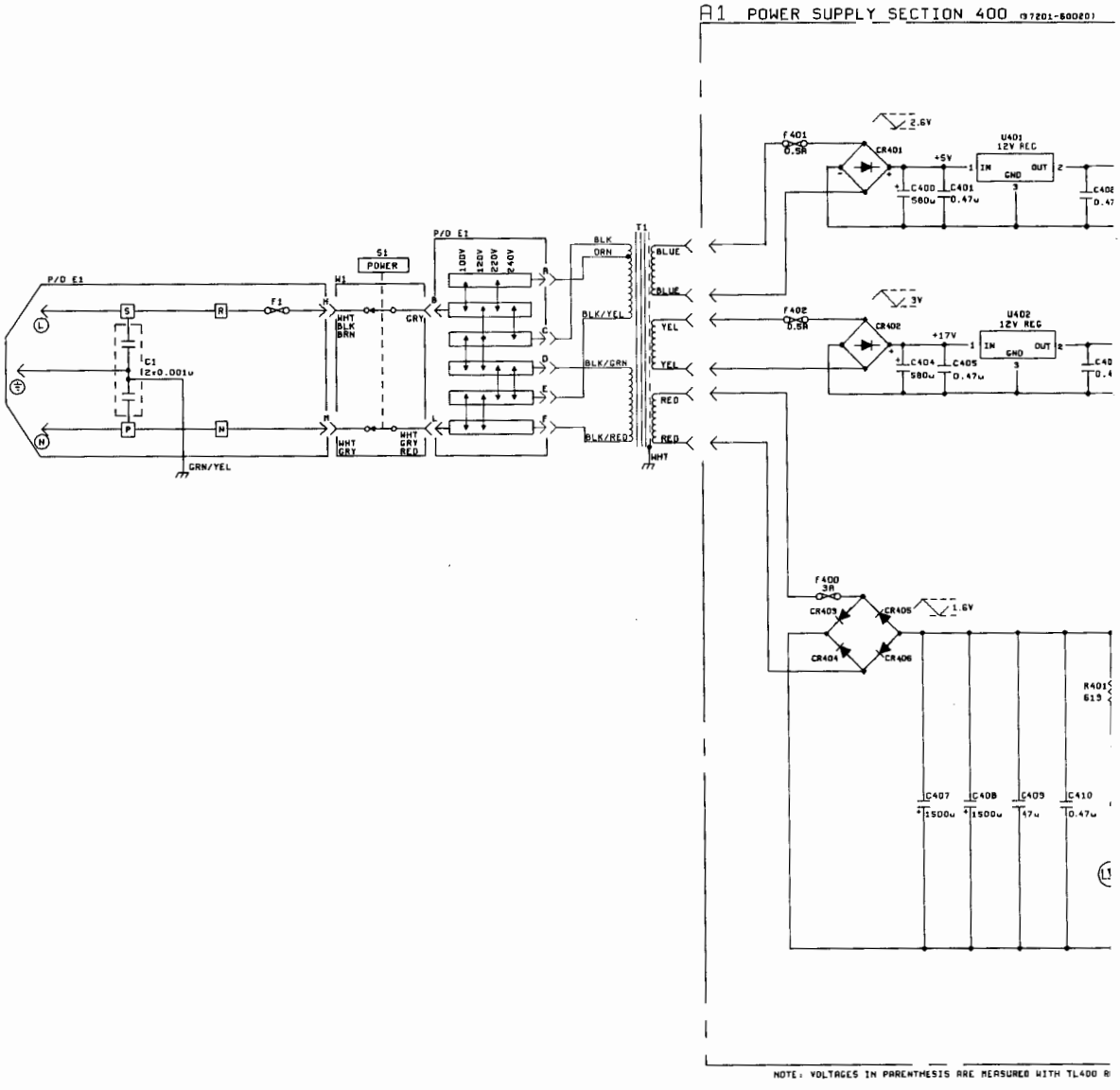


Figure A400-2 Component Location – Section 400


A1 POWER SUPPLY SECTION 400 (97201-60020)
P/O E1
S1
POWER
F1
C1
12+0.001u
GRN/YEL
T1
100V
120V
220V
240V
BLK
ORN
BLK/YEL
BLK/GRN
BLK/RED
BLUE
BLUE
YEL
YEL
RED
RED
WHT
F401
0.5A
CR401
2.6V
U401
12V REG
+5V
C400
580u
C401
0.47u
F402
0.5A
CR402
3V
U402
12V REG
+17V
C404
580u
C405
0.47u
F400
3A
CR403
CR404
CR405
CR406
1.6V
R401
619
C407
1500u
C408
1500u
C409
47u
C410
0.47u
NOTE: VOLTAGES IN PARENTHESIS ARE MEASURED WITH TL400 R

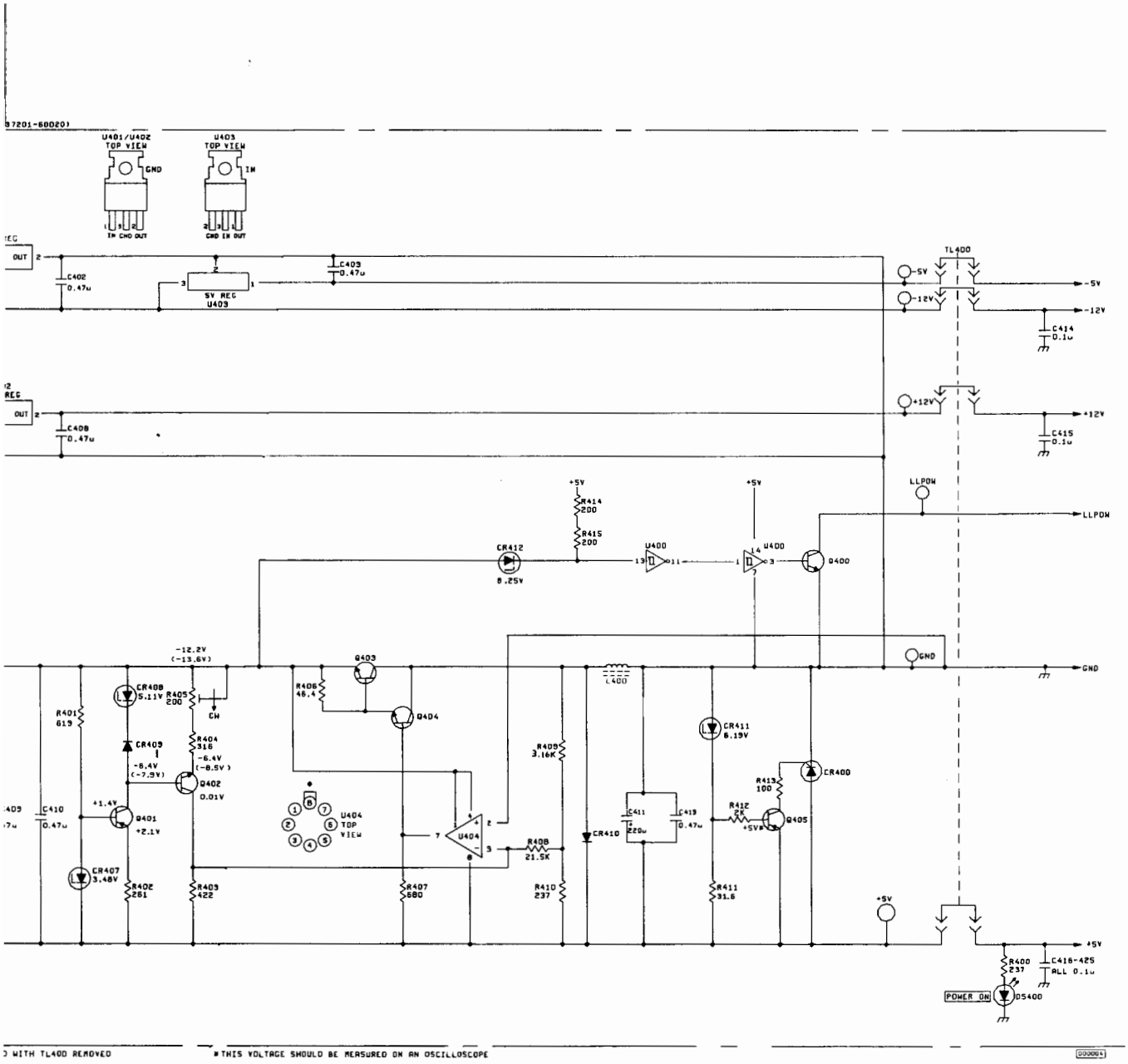


Figure A400-3 Schematic Diagram — Section 400

APPENDIX A

GLOSSARY OF TERMS

Descriptions of the following terms relate to their use in the 37201A Operating and Service Manual and should be considered advisory rather than authoritative. Terms marked "*" are general HP-IB terms, and are not confined to the 37201A.

Abandon Call & Retry	:	RS366/V.25 line from the Automatic Calling Unit (Dialler) to the 37201A and displayed on the front panel, in the Status-Byte and in the Talk-String. It indicates that the current attempt to dial-up the remote site should be abandoned.
Acceptor *	:	Device accepting Data-Bytes from the bus.
Acknowledgement	:	See Paragraph 3-9. "Private" message from the receiving 37201A to the originating 37201A confirming that a "packet" or block of data has been received with no block-parity errors.
Active	:	See Paragraph 3-111. A pair or 37201A's which have been enabled to communicate with one another (the normal situation) are said to be "Active". When not "Active" the 37201A's are "Idle". The term "Active" has nothing to do with the physical data-link. A local 37201A becomes active when it changes from the "Idle" to the "Active" mode, following an "A" instruction or automatically after certain other operations.
Address	:	Each HP-IB device has an "Address" used by the Controller to select which devices are to Source and which are to Accept Data-Bytes. As a quite separate concept, each remote 37201A in a Multi-Point system has a Multi-Point "Address" which the local 37201A uses to raise one of the remote 37201A's.
Asynchronous	:	Terms used to describe bit-serial communication in which the receive device synchronises to each individual byte by using the byte's "start" and "stop" bits, and no external clock is used.
ATN *	:	HP-IB line "Attention". Used by the Controller to indicate that the data on DI01 to DI08 is to be treated as a "Command" Byte rather than a "Data" Byte.
Automatic Answer	:	A modem used on the normal telephone switched-network which can answer a call automatically and connect itself to line has "Automatic Answer" capability. This is equivalent to lifting the telephone handset in speech operation.
Automatic Calling Equipment	:	See Paragraph 3-24 and 3-119. Also referred to as an "Auto-Dialler". Device which makes a telephone call automatically and is controlled via a standard interface which conforms to the RS366/V.25 recommendation.

Buffers	:	Byte serial memory within the 37201A used to store pending communication data. There are two principal buffers within the 37201A, one for data waiting to be transmitted over the serial data-link and one for data that has been received and is waiting to go out on to the bus.
Call Origination Status	:	RS366/V.25 line from the Automatic Calling Equipment (Dialler) to the 37201A. Indicates that the telephone connection has been established and that control of the telephone channel has been passed to the Modem. This line is sometimes referred to as "Distant Station Connected" or "Data Set Status".
Call Request	:	RS366/V.25 line to the Automatic Calling Unit (Dialler) from the 37201A. Used to indicate the 37201A wishes to initiate a call.
Carrier	:	Basic transmission frequency of a Modem which is modulated by the digital data. In a Multi-Point system, the remote station currently addressed has its carrier turned-on by the "Request To Send" line, and all other remote modems have their carriers off.
C.C.I.T.T.	:	International body responsible for the V.24 and V.25 recommendations concerning Serial Data Transmission equipment and Automatic Calling equipment respectively.
Clear To Send	:	RS232C/V.24 line from the Modem to the 37201A, displayed on the front panel, and in the Status-Byte and Talk-String. Indicates the Modem is ready to transmit data. Also called "Ready For Sending".
Command *	:	Command messages are those messages issued by the HP-IB Controller when directing bus operations. Most command messages are coded into an 8-bit byte with ATN (Attention) true, but others are uniline messages.
Common Mode Isolation	:	Ability of the 37201A Twisted-Pair input to reject an interfering signal which is common to the two lines, such as might result from induced pick-up on a long cable.
Controller *	:	HP-IB device capable of directing bus transactions, for example by assigning Listeners and Talkers using the ATN (Attention) line, and by initialising the bus system using the IFC (Interface Clear) line.
Data Line Occupied	:	RS366/V.25 line from the Automatic Calling Unit (Dialler) to the 37201A. Indicates that the telephone channel is in use either by the Calling Unit and Modem connected to the 37201A or by some other equipment.
Data Set	:	Alternative name for Modem.

Data Set Ready	:	RS232C/V.24 line from the Modem to the 37201A, displayed on the front panel, and in the Status-Byte and Talk-String. Indicates that the modem is powered ON and is not in an internal test mode. Also indicates that the Modem is connected to line when used on the switched telephone network.
Data Set Status	:	See "Call Origination Status".
Data Terminal Ready	:	See Paragraph 3-31. RS232C/V.24 line from the 37201A to the Modem. Used to control switching of the Modem to the telephone line.
Dedicated	:	A Dedicated data-link is one continuously used for a specific application. Examples are a Twisted-pair cable for use between 37201A's directly or a leased-line permanently hired from a telephone authority and used with Modems.
Diagnostic Test	:	Test mode on 37201A used in conjunction with an HP Desk-Top Computer and a suitable program cartridge to diagnose the source of a fault within a single 37201A.
Dialler	:	See "Automatic Calling Equipment".
Disconnection	:	See Paragraph 3-26 and 3-127. Act of terminating a Dialled-up telephone call. Equivalent to putting a telephone handset "On-hook".
Distant Station Connected	:	See "Call Origination Status".
E.I.A.	:	Electronic Industries Association. American body responsible for the RS232C and RS366 standards concerning Serial Data Transmission equipment and Automatic Calling equipment respectively.
EOI *	:	HP-IB line "End Or Identify". Used either to indicate the last byte in a string of Data-Bytes, or to initiate a Parallel-Poll when set true along with the ATN (Attention) line.
Firmware	:	The 37201A's internal microprocessor program permanently stored in read-only memory.
Flushing Function	:	See Paragraph 3-105.
Four-Wires	:	Serial data-link used "Full Duplex" which has 2 wires for transmitting data and 2 wires for receiving data.
Full Duplex	:	Mode of serial data transmission in which there are two separate channels, allowing transmission of data in both directions simultaneously. This may be implemented either as 2 pairs of wires or as a single pair using a multiplexing arrangement.

HP-IB *	:	Hewlett-Packard's implementation of I.E.E.E. standard 488-1978 and A.N.S.I. MC 1.1–1975: Standard Digital Interface for Programmable Instrumentation.
Handshake *	:	The process whereby digital signals effect the transfer of each Data-Byte from one device to another across the HP-IB interface using a fixed sequence of status and control signals. The HP-IB uses a Handshake involving the 3 lines DAV (Data Valid), NRFD (Not Ready For Data) and NDAC (Not Data Accepted).
Idle	:	See Paragraph 3-111.
I.E.E.E.	:	Institute of Electrical and Electronics Engineers. Body responsible for Standard 488-1978.
IFC *	:	HP-IB line "Interface Clear". Used by the Controller to initialise a bus system or to abort a current bus state and return the system to its initial state.
Instruction	:	The term used in this manual to describe device-dependant HP-IB messages sent to the local 37201A itself to modify and control its operation.
Leased Line	:	Serial data-link owned by the telephone Authority but hired by a customer for his exclusive use.
Link	:	See "Serial Data-Link".
Listen Address *	:	A member of the sub-set of bus Commands, issued by the Controller with the ATN (Attention) line true, and used to assign which device is to accept the following Data-Byte message when ATN goes false.
Listener *	:	HP-IB device which is configured to Accept, or has been addressed to Accept, Data-Bytes from the bus.
Listen-Only *	:	Applied to an HP-IB device only capable of continually accepting Data-Bytes and therefore not requiring to be addressed.
Local	:	Term used to describe the 37201A at the same end of the serial data-link as the HP-IB controller. Sometimes also used to refer to an HP-IB instrument under manual and not bus control.
Loopback	:	See Paragraph 3-156 and 3-161 parts 4 and 6. Serial test mode in which the input and output ports of a serial device are connected together so that the device receives its own transmitted data. Used to test serial devices and serial data-links, the latter by looping back at the far end.

Loss of Remote Data	:	See Paragraph 3-12. Abbreviated to LRD. Indicator on the front panel, and in the Status-Byte and the Talk-String of the 37201A. Used to show that the local and remote 37201A's are not communicating with each other correctly.
Management Lines *	:	The HP-IB General Interface Management Lines are IFC (Interface Clear), ATN (Attention), SRQ (Service Request), REN (Remote Enable) and EOI (End or Identify).
Modem	:	Device for both sending and receiving digital Serial data over long distances. Abbreviation of Modulator-Demodulator.
Multi-Drop	:	See "Multi-Point".
Multi-Point	:	See Paragraph 3-21. A communication configuration in which one local station is connected via serial data-links to many remote stations in "parallel". All remote stations receive data, but only one may transmit at a time under control of the local station.
On-Line	:	A Multi-Point Station that has been addressed, or the remote site in a dialled-up link that has been successfully called, may be said to be "On-Line".
Packet	:	See Paragraph 3-8. Block of data sent between 37201A's as the means of communication used by the "private" protocol.
Parallel-Poll *	:	The HP-IB Parallel-Poll function provides a device with the capability to present one bit of status information to the Controller without being addressed to talk. The signal lines DI01 to DI08 are used to convey the device status bits, allowing up to eight devices to unambiguously respond to a Parallel-Poll. See Paragraph 3-17 for restrictions on use of Parallel-Poll with 37201A.
Parity	:	See Paragraph 3-8. Single bit indicating whether the number of ones in a byte is odd or even. Used to detect noise-induced errors in serial transmission. Parity can be odd or even, a one or a zero parity-bit respectively being used to indicate an even number of ones in the byte excluding the parity-bit. The 37201A sets and checks the block-parity of its transmission packets both vertically and horizontally.
Pass-Control *	:	HP-IB facility allowing a Controller to relinquish control over the bus and give active control to another device. See Paragraph 3-17 for restrictions on use of Pass-Control with 37201A.
Power Indication	:	RS366/V.25 line from the Automatic Calling Unit to the 37201A. Indicates that power is available within the Automatic Calling Unit.

Present Next Digit	:	RS366/V.25 line from the Automatic Calling Unit to the 37201A. Used to indicate that the Calling Unit is ready to accept the next digit of the telephone number from the 37201A.
Private Protocol	:	The codes, commands and communication conventions used between 37201A's for performing their functions and carrying HP-IB data. This is quite distinct from the HP-IB protocol, and no part of the private protocol appears on the bus at either end of the serial data-link. Details of the protocol are unique to the requirements of the 37201A.
Raise	:	The act of causing a remote Multi-Point station to establish full communication with the local 37201A thereby enabling the two groups of HP-IB instruments to operate as one.
Remote	:	Term used to describe the 37201A and other devices at the opposite end of the serial data-link from the Controller. Sometimes also used to describe an instrument which is currently under HP-IB control rather than manual control.
REN *	:	HP-IB line Remote ENable. Used by the Controller to cause all instruments (having the function) to come under HP-IB control rather than manual control.
Request To Send	:	An RS232C/V.24 line from the 37201A to the modem used to inform the modem that the 37201A has data to send on the serial data-link. Controls the Modem's carrier in a Multi-Point system.
RS232C	:	The E.I.A. standard which defines the interchange circuits between data terminal equipment (e.g. 37201A) and data communication equipment (Modem). E.I.A. RS232C is closely equivalent to the C.C.I.T.T. V.24 standard.
RS366	:	The E.I.A. standard which defines the manner of operation of automatic calling equipment on the switched telephone network. (E.I.A. RS366 is closely equivalent to the C.C.I.T.T. V.25 standard).
RQS *	:	Abbreviation for Request Service. This is a Message sent true or false by bit DI07 in the Status-Byte of an instrument being Serial-Polled. It tells the Controller whether or not that instrument was responsible for a Service-Request message (see SRQ).
Serial Data-Link	:	A communication path through which data is passed one bit at a time, as used by a pair of 37201A's for communication.
Serial Errors	:	Bits incorrectly received due to corruptions in transmission over a serial data-link.

Self-Test	:	Test mode in the 37201A, requiring no additional equipment, in which the 37201A tests itself for correct hardware operation. (See Paragraph 3-171).
Serial-Poll *	:	HP-IB function by which the Controller obtains the status of a number of instruments. The Controller reads one Status-Byte from each of the instruments in turn.
Serial-Poll-Disable *	:	(Abbreviated SPD).
Serial-Poll-Enable *	:	(Abbreviated SPE). These command messages are sent during a Serial-Poll by the Controller. SPE causes each device responding to the Poll to enter a mode which causes it to send its Status-Byte when addressed to Talk, rather than its ordinary Talk message. SPD causes the devices to leave the Serial-Poll Mode.
Signature Analysis	:	A method of diagnosing the source of a fault in a digital logic circuit using a Signature Analyzer.
Source *	:	Device sending Data-Bytes on the bus.
SRQ *	:	HP-IB line Service ReQuest, used to carry the Service-Request message. Devices requiring service from the Controller pull this line true.
Station	:	The complete collection of equipment at one end of the data-link.
Status-Byte *	:	Single byte sent by an instrument in response to a Serial-Poll. It gives the current status of the instrument, and also indicates if that instrument has Requested Service.
String	:	A sequence of characters, usually a complete message.
Switched Network	:	The ordinary public telephone network or other dialled network.
Synchronous	:	Term used to describe bit-serial communication in which bit transfer to and from the modems is controlled by a clock. As is usually the case, modems for use with the 37201A supply the required clocks.
Talk Address *	:	A member of the sub-set of bus Commands, issued by the Controller with ATN (Attention) line true, and used to assign which device is to source the next Data-Byte message when ATN goes false.
Talk-Only*	:	Applied to an HP-IB device only capable of continually sourcing Data-Bytes and therefore not requiring to be addressed.

Talk String	:	The Talk-String is the set of 4 bytes which the 37201A sends when addressed to Talk. See Paragraph 3-91.
Time-Out	:	The failure of an expected event to occur within a given period. See Paragraph 3-9.
Transparency	:	Transparency means the ability of the 37201A's to extend a bus without need for any special setting-up instructions in the applications program.
Twisted-Pair	:	Abbreviation used to refer to one of the means of communication used between two 37201A's. Also refers to the 4-Pin rear-panel connector to which are attached the 4 wires in two pairs (each pair being twisted together and screened from the order). One pair is for transmission and one for reception.
Unlisten *	:	HP-IB multiline command message (abbreviated UNL) sent by the controller with ATN true. The command is a special listen address which cause all instruments currently addressed to listen, to become unaddressed.
Untalk*	:	HP-IB multiline message (abbreviated UNT) sent by the controller with ATN true. The command is a special talk address which causes any instrument currently addressed to talk, to become unaddressed.
V.24	:	The C.C.I.T.T. standard which defines the interchange circuits between data terminal equipment (e.g. 37201A) and data communication equipment (modem). (C.C.I.T.T. V.24 is closely equivalent to E.I.A. RS232C standard).
V.25	:	The C.C.I.T.T. standard which defines the manner of operation of Automatic Calling Equipment on the switched telephone network. (C.C.I.T.T. V.25 is closely equivalent to E.I.A. RS366 standard).

MANUAL CHANGES

MANUAL IDENTIFICATION
Model Number: 37201A
Date Printed: Feb. 1980
Part Number: 37201-90001

This supplement contains important information for correcting manual errors and for adapting the manual to instruments containing improvements made after the printing of the manual.

To use this supplement:

Make all ERRATA corrections.

Make all appropriate serial number related changes indicated in the tables below.

Serial Prefix or Number	Make Manual Changes
1925U-00667	1
2011U	2
2011U-01463	3
2232U	4
2232U-01697	5
2232U-01892	6
2232U-02531	7
2511U-02692	8*

Serial Prefix or Number	Make Manual Changes

* NEW ITEM

ERRATA

Page i Title Page

Change to read:

This manual applies directly to instruments with serial numbers prefixed 1925U. With changes described in Section VII, this manual also applies to instruments with serial numbers prefixed 1914U and 1840U.

On Page 8-24 Ram Test Signatures (Check 2) and on Signature List in back pocket of the manual:

Change to read:

The following signatures were taken with the test link in the normal position and Data Medium Switch to "Ram and SW Test".

NOTE

Manual change supplements are revised as often as necessary to keep manuals as current and accurate as possible. Hewlett-Packard recommends that you periodically request the latest edition of the supplement. Free copies are available from all HP offices. When requesting copies quote the manual identification information from your supplement or the model number and print date from the title page of the manual.

HEWLETT PACKARD

Printed in U.K.

ERRATA (continued)

Page 4-6, Paragraph 4-11 CLOCK FREQUENCY TEST
Change to read:

2. Connect a suitable frequency counter to the Clock test point and monitor the frequency, it should be 960kHz ± 450Hz.

Page 6-6 Table 6-2 Replaceable Parts
Change A1Y100 to 0410-1227

CHANGE 1

Effective on and after Serial Number 1925U-00667, ROM's U103 and U105 are changed. The ROM stock numbers are different and the signatures relating to the ROM Data Bus and new ROM's are different. A new Function Switch Legend Plate is also fitted.

A new signature list accompanies this manual change sheet. The list contains the ROM stock numbers and replaces the one in the back pocket of the manual. Change page 8-23 of the manual as appropriate.

Page 3-8, Paragraph 3-54 add the following

3-54 Function Switch 11:"ACTIVATE ON CTS"

3-55 This switch is usually set to OFF. This switch is only used when the 37201A is connected to the Anderson-Jacobson Acoustic Coupler. When set to ON, in the 37201A connected to the A-J Coupler, the 37201A will be put in the IDLE state, thus sending a continous mark, until Clear-to-Send (CTS) is raised. This idling is irrespective of whether the 37201A is a controller-end device or not. When CTS is raised the 37201A waits for approximately 2 seconds and then self activates. When CTS goes low the 37201A will 'self-idle'.

Note: *When using the feature, the 37201A should be powered OFF then ON after setting switch 11 since setting switch 11 OFF in a non-controller-end device with CTS already OFF would result in the 37201A being IDLE with no way to re-activate it since the 37201A is un-addressable.*

Page 6-5, Table 6-2, Replacement Parts:
Change Part Number A1U103 from 5090-0983 to 37201-80003.
Change Part Number A1U105 from 5090-0984 to 37201-80004.

Page 6-7, Table 6-2, Replacement Parts:
Add Part Number MP20, 37201-00042, Function Switch Legend Plate.

CHANGE 2

Effective on and after Serial Prefix 2011U a change to the circuit as shown in Figure 1. Change the schematic diagram (Figure A400-3, Section 400) as appropriate.

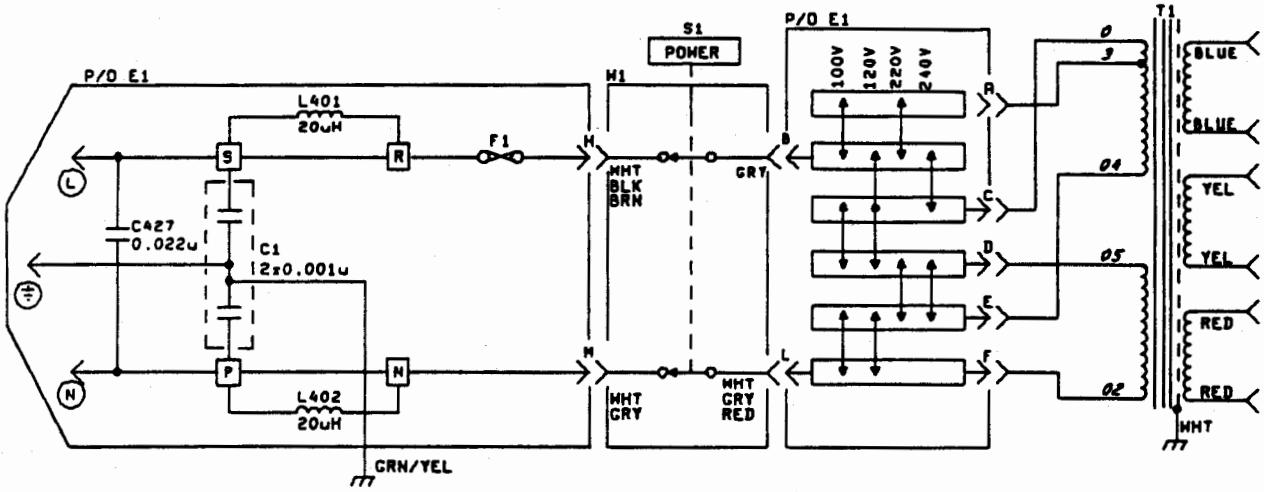


Figure 1 MAINS MODULE

Page 6-7, Table 6-2, Replacement Parts:
Add Part Number A1C427, 0160-4048 CAPACITOR-FXD 0.022μF.
Add Part Number A1L401, 9140-0470 INDUCTOR-FXD 20μH.
Add Part Number A1L402, 9140-0470 INDUCTOR-FXD 20μH.

CHANGE 3

Effective on and after Serial Number 2011U01463 A1CR403, A1CR404, A1CR405 and A1CR406 are changed.

Page 6-4, Table 6-2, Replacement Parts:
Change Part Number A1CR403 from 1901-0200 to 1901-0673
Change Part Number A1CR404 from 1901-0200 to 1901-0673
Change Part Number A1CR405 from 1901-0200 to 1901-0673
Change Part Number A1CR406 from 1901-0200 to 1901-0673

SIGNATURE LIST (FROM 1925U00667)

The following signatures were taken with the test link in the SA Test position. Before taking signatures, switch the 37201A Power off and then on to provide a reset – this is a precaution to ensure correct signatures.

Before making any signature checks, check the +5V signature is 755U and the 0V line is 0000.

MPU ADDRESS

U101

Pin		Pin	
9	C113	32	–
10	7050	31	–
11	0772	30	–
12	C4C3	29	–
13	AA08	28	–
14	7211	27	–
15	A3C1	26	–
16	7707	25	NOT USED
17	577A	24	0000
18	HH86	23	1180
19	89F1	22	PCF3
20	AC99	21	–

SELECTORS

U114

Pin		Pin	
1	AA08	16	+V
2	7211	15	C2P5
3	A3C1	14	4P70
4	1180	13	A614
5	0000	12	9260
6	89F1	11	87HF
7	8ACC	10	FU61
8	GND	9	8U44

U115

Pin		Pin	
1	0000	16	755U
2	AC99	15	H24U
3	PCF3	14	755U
4	0000	13	219C
5	B clock	12	755U
6	1180	11	1565
7	755U	10	755U
8	0000	9	U731

BUFFERS

U121

Pin		Pin	
1	HIGH	14	HIGH
2	LOW	13	HIGH
3	1180	12	LOW
4	64HU	11	LOW
5	B clock	10	HIGH
6	B clock	9	755U
7	LOW	8	0000

3 I/P NOR

U116

Pin		Pin	
1	LOW		
2	LOW	13	HIGH
3	B clock	12	LOW
4	LOW	11	B clock
5	LOW	10	1180
6	755U	9	89F1
7	LOW	8	P17F

3 I/P NAND

U117

Pin		Pin	
2	LOW	13	NOT USED
3	HIGH	12	NOT USED
4	LOW	11	NOT USED
5	P17F	10	64HU
6	HIGH	9	89F1
7	LOW	8	U0UF

ROM DATA BUS SIGNATURES

All ROM's connected as for processor troubleshooting (Check 1) at U103.

U103

Pin		Pin	
8	–	17	CHAU
9	3418	16	AH10
10	75PH	15	HH5U
11	40A9	14	8FF4
12	GND	13	FU9F

INDIVIDUAL ROM SIGNATURES FOR PROCESSOR TROUBLESHOOTING (Check 4).

Pin	U103	U105	U107	U109
9	C647	F1C7	946A	C236
10	U5CH	17AF	9F51	P7P0
11	H841	62F9	11C5	P52H
12	0000	0000	0000	0000
13	1343	160A	FP38	U942
14	1U68	C0A0	1F78	U504
15	166A	7A1P	10HP	313H
16	3378	C852	FUU5	F23P
17	266U	6P18	U1C4	FPPH

The above signatures were taken for instruments with serial number 1925U-00667 and above, refer to the current change sheet to ensure the signatures have not changed.

The above listed ROM signatures were for ROM's with the following stock numbers:

U103 -37201-80003 U107 – 5090-0985

U105 -37201-80004 U109 – 5090-0986

RAM TEST SIGNATURES (CHECK 2)

The following signatures were taken with the test link in the normal position, Data Medium switch to "RAM & SW test". Before taking signatures, switch the 37201A Power off then on.

Check the +5V line signatre is 69C4 and the 0V line is 0000. Note the +5V signature is different with the test link in the normal position.

U103

Pin		Pin	
1	–	17	P7C6
9	6C59	16	P357
10	UAHU	15	4F07
11	2372	14	P19C
12	GND	13	25HA

U101

Pin		Pin	
5	6F7F	36	–
6	–	35	–
7	–	34	A32U
8	HIGH	33	–
9	A612	32	–

U113/112 ADDRS

Pin		Pin	
1	–	18	–
2	415H	17	7141
3	C39C	16	HA26
4	3C84	15	53H2
5	A612	14	*
6	A7H1	13	*
7	56H0	12	*
8	8943	11	*
9	LOW	10	A32U

U116

Pin		Pin	
1	LOW	14	HIGH
2	05F8	13	LOW
3	B clock	12	6F7F
4	FA9C	11	B clock
5	HIGH	10	0U2P
6	LOW	9	0U2P
7	LOW	8	669A

U121

Pin		Pin	
1	A32U	14	HIGH
2	FA9C	13	6F7F
3	0U2P	12	05F8
4	669A	11	HIGH
5	B clock	10	LOW
6	B clock	9	LOW
7	LOW	8	HIGH

* The signatures at these pins have been measured at U103 so there is no need to repeat the check at this point. U103 was chosen purely from a convenience point of view.

CHANGE 4

Effective on and after Serial Prefix 2232U. A new printed circuit board, Part Number 37201-60030, is fitted.

New schematic diagrams, component location, replacement parts, circuit descriptions and signature lists, accompany this manual change sheet.

Page 2-6, Paragraph 2-37, RS232C Pin 23
Change the last sentence to read:

The logic state of this line is dependant on the type of modem used and is determined by the wire link (W300) inside the instrument.

Pages 8-17, 8-21, 8-22 and 8-24.
Change circuit reference U103 to U102.

Page 8-20, Paragraph A100-5
Change paragraph to read:

The two bi-lateral switches U124 and U125 allow the transfer of data to and from the microprocessor (U101). The switches connect the microprocessor to the memory (RAM and ROM), or to the input/output data bus. Direction of data is controlled by the read/write (R/W) line from the microprocessor. Data is transferred to the microprocessor when the R/W line of the microprocessor is high and from the microprocessor when the R/W line is low. The selection between the input/output data bus and the memory is determined by the state of the LI/O. When LI/O is low the input/output data bus is connected to the microprocessor, this coincides with the selector (U114) being enabled. The state of the LI/O line is governed by the microprocessor address lines A10 and A13. All the data pins of U124 and U125 are forced to a high impedance condition when either BCLK02 (from U111) is low or when L DISABLE is low which is when $\overline{VMA}$ is high, or when TL100 is in the SA TEST position.

Page 8-21, Paragraph A100-16
Add:

The clock generator (U111) produces a clock at four times CLK02 ($4f_o$) to be used to derive the clock signal for asynchronous data.

Page 8-21, Paragraph A100-18
Change paragraph to read:

Setting TL100 to SA Test forces the NO-OP code (0000 0010) on to the microprocessor data bus via U100. L DISABLE at G2 output is true, deselecting the F3 inputs on the RAM memory and the enable inputs on the bi-lateral switches U124 and U125. The NO-OP code on the microprocessor data bus forces the microprocessor to cycle through the memory addresses.

CHANGE 4 (continued)

Page 8-28, Paragraph A300-23
Change first sentence to read:

The asynch clock divider divides the $4f_0$ (3.84MHz) clock to provide one output at 19200Hz (U327 Pin 5) and another at 9600Hz (U327 Pin 9).

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1	37201-60030	8	1	BOARD ASSEMBLY	28480	37201-60030
A1C100	0180-0474	4	1	CAPACITOR-FXD 15UF+-10% 20VDC TA	28480	0180-0474
A1C101	0160-4547	8	1	CAPACITOR-FXD 150PF +-5% 200VDC CER	28480	0160-4547
A1C300	0160-3878	6	10	CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A1C301	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A1C302	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A1C303	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A1C304	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A1C305	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A1C306	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A1C307	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A1C308	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A1C309	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A1C310	0160-0574	3	1	CAPACITOR-FXD .022UF +-20% 100VDC CER	28480	0160-0574
A1C400	0180-2373	6	2	CAPACITOR-FXD 580UF+150-10% 35VDC AL	28480	0180-2373
A1C401	0160-3486	2	6	CAPACITOR-FXD .47UF +80-20% 50VDC CER	28480	0160-3486
A1C402	0160-3486	2		CAPACITOR-FXD .47UF +80-20% 50VDC CER	28480	0160-3486
A1C403	0180-2662	6	1	CAPACITOR-FXD 10UF+-10% 10VDC TA	25088	D4R7G81A10K
A1C404	0180-2373	6		CAPACITOR-FXD 580UF+150-10% 35VDC AL	28480	0180-2373
A1C405	0160-3486	2		CAPACITOR-FXD .47UF +80-20% 50VDC CER	28480	0160-3486
A1C406	0160-3486	2		CAPACITOR-FXD .47UF +80-20% 50VDC CER	28480	0160-3486
A1C407	0180-1948	9	2	CAPACITOR-FXD 1500UF+75-10% 40VDC AL	56289	39D158G040HP4
A1C408	0180-1948	9		CAPACITOR-FXD 1500UF+75-10% 40VDC AL	56289	39D158G040HP4
A1C409	0180-0097	7	1	CAPACITOR-FXD 47UF+-10% 35VDC TA	56289	150D476X9035S2
A1C410	0160-3486	2		CAPACITOR-FXD .47UF +80-20% 50VDC CER	28480	0160-3486
A1C411	0180-0159	2	1	CAPACITOR-FXD 220UF+-20% 10VDC TA	56289	150D227X0010B2
A1C413	0160-3486	2		CAPACITOR-FXD .47UF +80-20% 50VDC CER	28480	0160-3486
A1C414	0160-0576	5	18	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C415	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C416	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C417	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C418	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C419	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C420	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C421	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C422	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C423	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C424	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C425	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C426	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C427	0160-4048	4	1	CAPACITOR-FXD .022UF +- 20% 250V AC (RMS)	28480	0160-4048
A1C428	0160-0576	5		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-0576
A1C429	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C430	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C431	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C432	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1CR400	1884-0066	3	1	THYRISTOR-SCR 2N4443 VRRM=400	04713	2N4443
A1CR401	1906-0096	7	2	DIODE-FW BRDG 200V 2A	04713	MDA202
A1CR402	1906-0096	7		DIODE-FW BRDG 200V 2A	04713	MDA202
A1CR403	1901-0673	6	4	DIODE-PWR RECT 100V 5A 5US	28480	1901-0673
A1CR404	1901-0673	6		DIODE-PWR RECT 100V 5A 5US	28480	1901-0673
A1CR405	1901-0673	6		DIODE-PWR RECT 100V 5A 5US	28480	1901-0673
A1CR406	1901-0673	6		DIODE-PWR RECT 100V 5A 5US	28480	1901-0673
A1CR407	1902-0947	9	1	DIODE-ZNR 3.6V 5% DO-35 PD = .4W TC = .036%	28480	1902-0947
A1CR408	1902-0951	5	1	DIODE-ZNR 5.1V 5% DO - 35 PD = .4W TC = +.035%	28480	1902-0951
A1CR409	1901-0040	7	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A1CR410	1901-1086	7	1	DIODE-PWR RECT 50V 5A 200NS	28480	1901-1086
A1CR411	1902-0953	7	1	DIODE-ZNR 6.2V 5% DO-35 PD = .4W TC = +.053%	28480	1902-0953
A1CR412	1902-0956	0	1	DIODE-ZNR 8.2V 5% DO-35 PD = .4W TC = +.065%	28480	1902-0956
A1CR413	1901-0731	7		DIODE-PWR RECT 400V 1A	28480	1901-0731
A1CR414	1901-0731	7		DIODE-PWR RECT 400V 1A	28480	1901-0731
A1CR415	1901-0731	7		DIODE-PWR RECT 400V 1A	28480	1901-0731
A1CR416	1901-0731	7		DIODE-PWR RECT 400V 1A	28480	1901-0731
A1CR417	1901-0731	7		DIODE-PWR RECT 400V 1A	28480	1901-0731
A1CR418	1901-0731	7		DIODE-PWR RECT 400V 1A	28480	1901-0731
A1CR419	1901-0731	7		DIODE-PWR RECT 400V 1A	28480	1901-0731
A1CR420	1902-0976	4	1	DIODE-ZNR 14.5V PD = 5W TC = +.088% IR = 5UA	28480	1902-0976
A1DS200	1990-0486	6	8	LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4684
A1DS201	1990-0486	6		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4684
A1DS202	1990-0486	6		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4684
A1DS203	1990-0486	6		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4684
A1DS204	1990-0486	6		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4684
A1DS205	1990-0486	6		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4684
A1DS206	1990-0486	6		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4684
A1DS207	1990-0486	6		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4684
A1DS400	1990-0485	5	1	LED-VISIBLE LUM-INT=800UCD IF=30MA-MAX	28480	5082-4984
A1F400	2110-0003	0	1	FUSE 3A 250V FAST-BLO 1.25X.25 UL IEC	75915	312003
A1F401	2110-0012	1	2	FUSE .5A 250V FAST-BLO 1.25X.25 UL IEC	28480	2110-0012
A1F402	2110-0012	1		FUSE .5A 250V FAST-BLO 1.25X.25 UL IEC	28480	2110-0012
A1L100	9140-0398	6	1	INDUCTOR RF-CH-MLD 12UH 5% .166DX 385LG	28480	9140-0398
A1L400	03760-70080	4	1	TOROID ASSEMBLY	28480	03760-70080

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-3. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1L401	9140-0470	5	2	INDUCTOR RF-CH-MLD 82UH 5% .166DX 385LG	28480	9140-0470
A1L402	9140-0470	5		INDUCTOR RF-CH-MLD 82UH 5% .166DX 385LG	28480	9140-0470
A1LK201	1810-0055	5	1	NETWORK-RES 9-SIP 10.0K OHM x 8		
A1MP20	37201-00024	4	1	HEAT SINK	28480	37201-00024
A1MP21	37201-00042	6	1	LEGEND PLATE	28480	37201-00042
A1Q400	1854-0071	7	2	TRANSISTOR NPN SI PD=300MW FT=280MHZ	28480	1854-0071
A1Q401	1853-0020	4	1	TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A1Q402	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=280MHZ	28480	1854-0071
A1Q403	1854-0589	2	1	TRANSISTOR NPN SI TO-3 PD=200W FT=2MHZ	04713	MJ3772
A1Q404	1854-0039	7	1	TRANSISTOR NPN 2N3053B SI TO-39 PD=1W	01928	2N3053B
A1Q405	1853-0010	2	1	TRANSISTOR PNP SI TO-18 PD=360MW	28480	1853-0010
A1R100	0757-0442	9	6	RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A1R101	1810-0055	5	1	NETWORK-RES 9-PIN-SIP .15-PIN-SPCG	28480	1810-0055
A1R102	0757-0420	3	3	RESISTOR 750 1% .125W F TC=0+-100	24546	C4-1/8-T0-751-F
A1R103	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A1R104	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A1R105	0698-3431	6	2	RESISTOR 23.7 1% .125W F TC=0+-100	03888	PME55-1/8-T0-23R7-F
A1R106	0698-3431	6		RESISTOR 23.7 1% .125W F TC=0+-100	03888	PME55-1/8-T0-23R7-F
A1R107	0757-0420	3		RESISTOR 750 1% .125W F TC=0+-100	24546	C4-1/8-T0-751-F
A1R108	0698-3151	7	3	RESISTOR 2.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2871-F
A1R109	0698-3151	7		RESISTOR 2.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2871-F
A1R110	0698-3151	7		RESISTOR 2.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2871-F
A1R111	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A1R112	0757-0420	3		RESISTOR 750 1% .125W F TC=0+-100	24546	C4-1/8-T0-751-F
A1R113	0757-0280	3	1	RESISTOR 1K 1% .125W F TC=0+-100	2M627	CRB14
A1R200	0698-3442	9	10	RESISTOR 237 1% .125W F TC=0+-100	24546	C4-1/8-T0-237R-F
A1R201	0698-3442	9		RESISTOR 237 1% .125W F TC=0+-100	24546	C4-1/8-T0-237R-F
A1R202	0698-3442	9		RESISTOR 237 1% .125W F TC=0+-100	24546	C4-1/8-T0-237R-F
A1R203	0698-3442	9		RESISTOR 237 1% .125W F TC=0+-100	24546	C4-1/8-T0-237R-F
A1R204	0698-3442	9		RESISTOR 237 1% .125W F TC=0+-100	24546	C4-1/8-T0-237R-F
A1R205	0698-3442	9		RESISTOR 237 1% .125W F TC=0+-100	24546	C4-1/8-T0-237R-F
A1R206	0698-3442	9		RESISTOR 237 1% .125W F TC=0+-100	24546	C4-1/8-T0-237R-F
A1R207	0698-3442	9		RESISTOR 237 1% .125W F TC=0+-100	24546	C4-1/8-T0-237R-F
A1R208	0757-0438	3	1	RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A1R209	0757-0280	3	6	RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A1R300	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A1R302	0698-3435	0	2	RESISTOR 38.3 1% .125W F TC=0+-100	24546	C4-1/8-T0-38R3-F
A1R303	0698-3435	0		RESISTOR 38.3 1% .125W F TC=0+-100	24546	C4-1/8-T0-38R3-F
A1R304	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A1R305	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A1R306	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A1R307	0757-0398	4	1	RESISTOR 75 1% .125W F TC=0+-100	24546	C4-1/8-T0-75R0-F
A1R308	0757-0737	5		RESISTOR 1.62K 1% .25W FTC = 0+ – 100	28480	0757-0737
A1R400	0698-3442	9		RESISTOR 237 1% .125W F TC=0+-100	24546	C4-1/8-T0-237R-F
A1R401	0757-0418	9	1	RESISTOR 619 1% .125W F TC=0+-100	24546	C4-1/8-T0-619R-F
A1R402	0698-3132	4	1	RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A1R403	0698-3447	4	1	RESISTOR 422 1% .125W F TC=0+-100	24546	C4-1/8-T0-422R-F
A1R404	0698-3444	1	1	RESISTOR 316 1% .125W F TC=0+-100	24546	C4-1/8-T0-316R-F
A1R405	2100-3212	8	1	RESISTOR-TRMR 200 10% C TOP-ADJ 1-7RN	28480	2100-3212
A1R406	0698-4037	0	1	RESISTOR 46.4 1% .125W F TC=0+-100	24546	C4-1/8-T0-46R4-F
A1R407	0761-0039	9	1	RESISTOR 680 5% 1W MO TC = 0+ – 200	28480	0761-0039
A1R408	0757-0199	3	1	RESISTOR 21.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2152-F
A1R409	0757-0279	0	1	RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A1R410	0698-3442	9		RESISTOR 237 1% .125W F TC=0+-100	24546	C4-1/8-T0-237R-F
A1R411	0757-0180	2	1	RESISTOR 31.6 1% .125W F TC=0+-100	28480	0757-0180
A1R412	0698-5490	1	1	RESISTOR 2K 1% .125W F TC = 0+50	28480	0698-5490
A1R413	0757-0401	0	1	RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A1R414	0757-0407	6	2	RESISTOR 200 1% .125W F TC=0+-100	24546	C4-1/8-T0-201-F
A1R415	0757-0407	6		RESISTOR 200 1% .125W F TC=0+-100	24546	C4-1/8-T0-201-F
A1S200	3100-3260	7	1	SWITCH, ROTARY SPECIAL PCB	28480	3100-3260
A1S201	3101-2097	8	2	SWITCH, SLIDE 6-1A-NB	28480	3101-2097
A1S202	3101-2097	8		SWITCH, SLIDE 6-1A-NB	28480	3101-2097
A1T300	37201-80002	6	1	TRANSFORMER, CORE PCT	28480	37201-80002
A1TL400	37201-20021	3	1	PC BOARD TEST	28480	37201-20021
A1U100	1820-1918	2	4	IC BFR TTL LS LINE DRVR OCTL	01295	SN74LS241N
A1U101	1820-1480	3	1	IC MICPROC NMOS 8-BIT	04713	MC6800L
A1U102	37201-80011	7	1	IC PROM	28480	37201-80011
A1U110	1820-1918	2		IC BFR TTL LS LINE DRVR OCTL	01295	SN74LS241N
A1U111	1820-2036	7	1	IC DRVR NMOS CLOCK DRVR	04713	MC6875P
A1U112	1818-0643	3	2	IC NMOS 4K RAM STAT 450-NS 3-S	34649	P2114L
A1U113	1818-0643	3		IC NMOS 4K RAM STAT 450-NS 3-S	34649	P2114L
A1U114	1820-1216	3	2	IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A1U115	1820-1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A1U116	1820-1206	1	1	IC GATE TTL LS NOR TPL 3-INP	01295	SN74LS27N
A1U117	1820-1197	9	4	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-3. Replaceable Parts (continued)

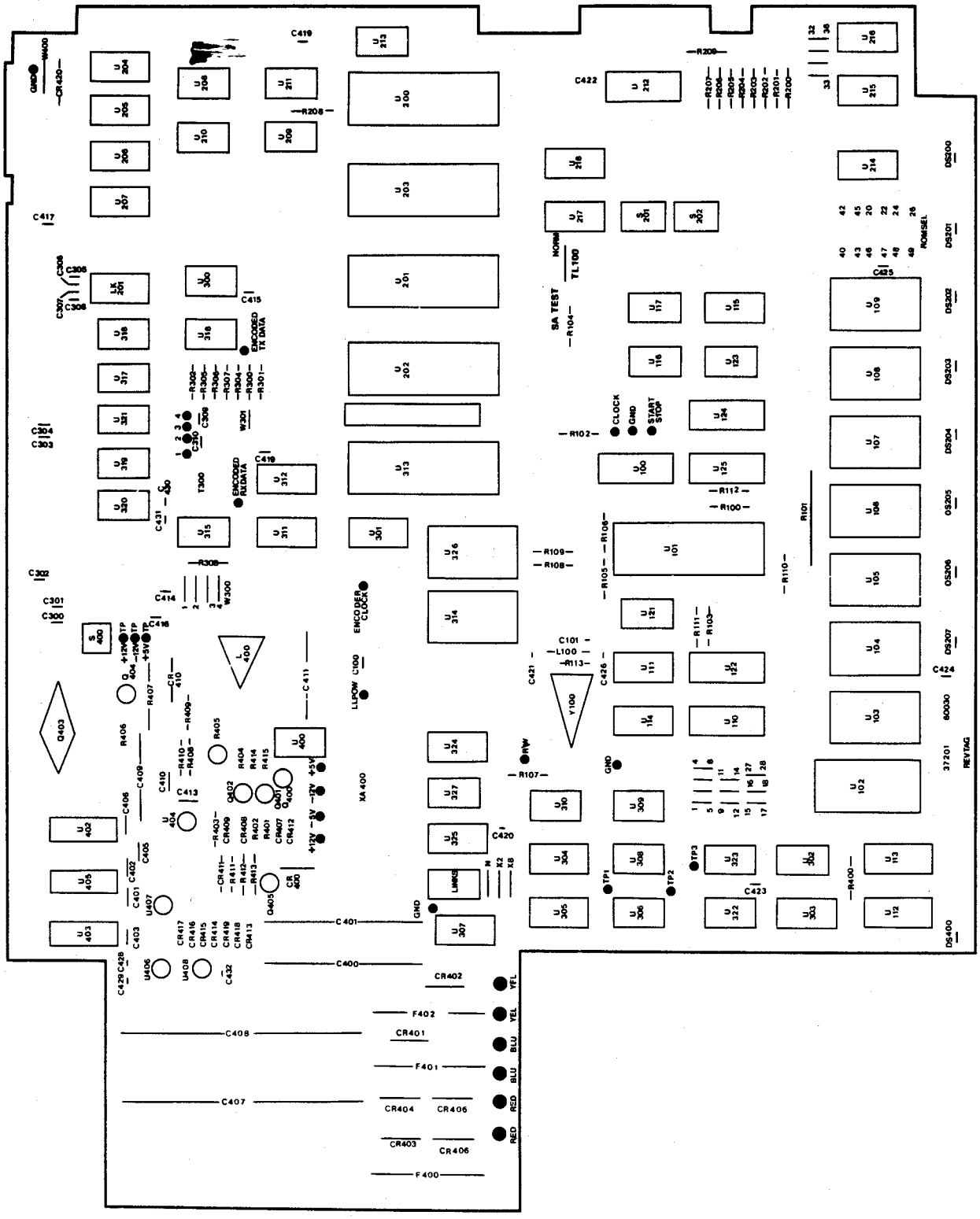
Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1U121	1820-1199	1	3	IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A1U122	1820-1918	2		IC BFR TTL LS LINE DRVR OCTL	01295	SN74LS241N
A1U123	1820-1202	7	1	IC GATE TTL LS NAND TPL 3-INP	01295	SN74LS10N
A1U124	1820-2075	4	2	IC MISC TTL LS	01295	SN74LS245N
A1U125	1820-2075	4		IC MISC TTL LS	01295	SN74LS245N
A1U200	1820-1481	4	5	IC PIA NMOS	04713	MC6821L
A1U201	1820-1481	4		IC PIA NMOS	04713	MC6821L
A1U202	1820-1481	4		IC PIA NMOS	04713	MC6821L
A1U203	1820-1481	4		IC PIA NMOS	04713	MC6821L
A1U204	1820-1649	4	4	IC UART TTL QUAD	04713	MC3446P
A1U205	1820-1649	4		IC UART TTL QUAD	04713	MC3446P
A1U206	1820-1649	4		IC UART TTL QUAD	04713	MC3446P
A1U207	1820-1649	4		IC UART TTL QUAD	04713	MC3446P
A1U208	1820-1112	8	3	IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74N
A1U209	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A1U210	1820-1201	6	1	IC GATE TTL LS AND QUAD 2-INP	01295	SN74LS08N
A1U211	1820-1199	1		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A1U212	1820-1918	2		IC BFR TTL LS LINE DRVR OCTL	01295	SN74LS241N
A1U213	1820-1207	2	1	IC GATE TTL LS NAND 8-INP	01295	SN74LS30N
A1U214	1820-1991	1	4	IC CNTR TTL LS DECD DUAL 4-BIT	01295	SN74LS390N
A1U215	1820-1991	1		IC CNTR TTL LS DECD DUAL 4-BIT	01295	SN74LS390N
A1U216	1820-1991	1		IC CNTR TTL LS DECD DUAL 4-BIT	01295	SN74LS390N
A1U217	1820-1427	8	2	IC DCDR TTL LS 2-TO-4-LINE DUAL 2-INP	01295	SN74LS156N
A1U218	1820-1427	8		IC DCDR TTL LS 2-TO-4-LINE DUAL 2-INP	01295	SN74LS156N
A1U300	1820-0990	8	4	IC RCVR DTL NAND LINE QUAD	04713	MC1489AL
A1U301	1820-1470	1	4	IC MUXR/DATA-SEL TTL LS 2-TO-1-LINE QUAD	01295	SN74LS157N
A1U302	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A1U303	1820-1212	9	1	IC FF TTL LS J-K NEG-EDGE-TRIG	01295	SN74LS112N
A1U304	1820-1435	8	2	IC CNTR TTL LS BIN UP/DOWN SYNCHRO	01295	SN74LS669N
A1U305	1820-1435	8		IC CNTR TTL LS BIN UP/DOWN SYNCHRO	01295	SN74LS669N
A1U306	1820-1144	6	1	IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A1U307	1820-1195	7	1	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A1U308	1820-2096	9	1	IC CNTR TTL LS BIN DUAL 4-BIT	01295	SN74LS393N
A1U309	1820-1199	1		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A1U310	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74N
A1U311	1820-1470	1		IC MUXR/DATA-SEL TTL LS 2-TO-1-LINE QUAD	01295	SN74LS157N
A1U312	1820-1470	1		IC MUXR/DATA-SEL TTL LS 2-TO-1-LINE QUAD	01295	SN74LS157N
A1U313	1820-1481	4		IC PIA NMOS	04713	MC6821L
A1U314	1820-1690-	7	1	IC ASYNCHRONOUS COMMUNICATIONS INTERFACE	04713	NC6850L
A1U315	1820-1310	8	1	IC RCVR TTL LINE RCVR DUAL	01295	SN75108AN
A1U316	1820-1110	6	1	IC DRVR TTL LINE DRVR DUAL	01295	SN75110AN
A1U317	1820-0509	5	3	IC DRVR DTL LINE DRVR QUAD	04713	MC1488L
A1U318	1820-0509	5		IC DRVR DTL LINE DRVR QUAD	04713	MC1488L
A1U319	1820-0509	5		IC DRVR DTL LINE DRVR QUAD	04713	MC1488L
A1U320	1820-0990	8		IC RCVR DTL NAND LINE QUAD	04713	MC1489AL
A1U321	1820-0990	8		IC RCVR DTL NAND LINE QUAD	04713	MC1489AL
A1U322	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74N
A1U323	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A1U324	1820-1470	1		IC MUXR/DATA-SEL TTL LS 2-TO-1-LINE QUAD	01295	SN74LS157N
A1U325	1820-1991	1		IC CNTR TTL LS DECD DUAL 4-BIT	01295	SN74LS390N
A1U326	1820-2175	5	1	IC MICPROC-ACCESS NMOS	04713	MC6852CP
A1U327	1820-1443	8	1	IC CNTR TTL LS BIN ASYNCHRO	01295	SN74LS293N
A1U400	1820-0990	8		IC RCVR DTL NAND LINE QUAD	04713	MC1489AL
A1U402	1826-0147	9		IC 7812 V RGLTR TO-220	04713	MC7812CP
A1U403	1826-0445	0	1	IC 7905 V RGLTR TO-220	07263	UA7905UC
A1U404	1826-0026	3	1	COMPARATOR PRCN TO-99	04713	MLM311G
A1U405	1826-0418	7	1	IC V RGLTR – FXD – NEG 12.4/11.6V TO – 220 PKG	27014	LM320T-12
A1U406	1826-0331	3	1	IC V RGLT-FXD-NEG 11.5/12.5V TO – 39 PKG	04713	XC79L17CE
A1U407	1826-0438	1	1	IC V RGLTR-FXD-POS 11.8/12.2V TO – 39 PKG	27014	LM340LAH-12
A1U408	1826-0555	3	1	IC V RGLTR-FXD-POS 4.9/5.1V TO – 92 PKG	27014	LM340LA2-5
A1XA400	1251-0472	4	1	CONNECTOR PC EDGE 6-CON/ROW 2-ROWS	23880	SCM6D/7-1HP
A1Y100	0410-1227	6	1	CRYSTAL-QUARTZ 8MHz TO-5-HLDR	28480	0140-1227
MISC	1200-0541	1		SOCKET-IC 24-CONT DIP DIP-SLDR	09922	DK824P-108
	1200-0507	9		SOCKET-IC 24-CONT DIP-SLDR	06776	0002811
A1	37201-60020	6		BOARD ASSEMBLY	28480	37201-60020
C1	0160-3561	4	1	CAPACITOR-FXD 1000PF/1000PF +100-0%	28480	0160-3561
E1	0960-0444	2	1	LINE MODULE, UNFILTERED	28480	0960-0444
F1	2110-0201	0	1	FUSE .25A 250V SLO-BLO 1.25X.25 UL IEC	75915	313.250
F1	2110-0202	1	1	FUSE .5A 250V SLO-BLO 1.25X.25 UL IEC	75915	313.500
MP1	37201-00026	2	1	FRONT PANEL	28480	37201-00026
MP2	37201-00027	0	1	SUB-PANEL	28480	37201-00027
MP3	5020-8801	4	1	FRONT FRAME, UPPER	28480	5020-8801
MP4	5040-7202	9	1	TRIM, TOP	28480	5040-7202
MP5	5020-8830	9	2	SIDE STRUT	28480	5020-8830
MP6	5040-7219	8	1	STRAP, HANDLE, CAP-FRONT	28480	5040-7219
MP7	5060-9833	8	1	TOP COVER	28480	5060-9833
MP8	5060-9874	7	1	COVER, SIDE	28480	5060-9874
MP9	5060-9905	5	1	COVER, SIDE, PERFORATED	28480	5060-9905
MP10	5060-9845	2	1	COVER, BOTTOM	28480	5060-9845

See introduction to this section for ordering information
*Indicates factory selected value

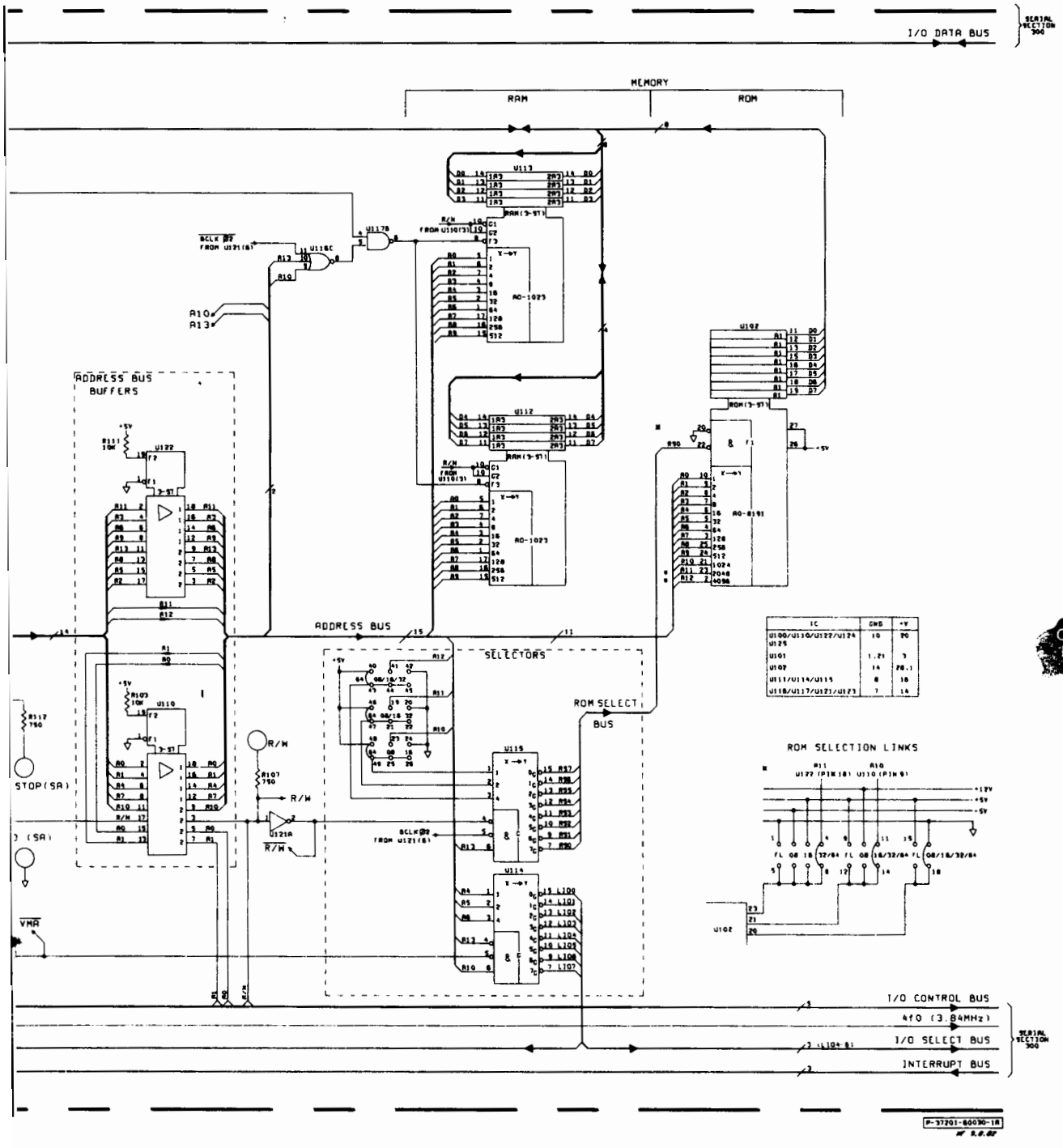
Table 6-3. Replaceable Parts (continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
MP11	5060-9802	1	1		28480	5060-9802
MP12	5040-7201	8	4	FOOT(STANDARD)	28480	5040-7201
MP13	37201-00023	3	1	REAR PANEL	28480	37201-00023
MP14	5020-8802	5	1	REAR FRAME, UPPER	28480	5020-8802
MP15	5040-7220	1	1	STRAP, HANDLE, CAP-REAR	28480	5040-7220
MP16	37201-20026	6	3	STRUT	28480	37201-20026
MP17	5001-0438	7	2	TRIM STRIP, SIDE	28480	5001-0438
MP18	4040-1083	1	2		28480	4040-1083
MP19	37201-20027	9	2	TRANSFORMER SUPPORT	28480	37201-20027
S1	3101-0183	7	1	SWITCH, ROCKER DPDT-NS	28480	3101-2369
S2	3101-1261	6	1	SWITCH, PUSHBUTTON SPDT NOM-25A BLK-BTN	B2289	913
T1	37201-80001	5	1	TRANSFORMER ASSEMBLY	28480	37201-80001
W1	37201-60031	9	1	POWER CABLE	28480	37201-60031
W2	37201-60011	5	1	CONNECTOR-4-WIRE ASSEMBLY	28480	37201-60011
W3	37201-60032	0	1	COAX CABLE ASSEMBLY	28480	37201-60032
				MISCELLANEOUS		
	1251-0084	0	2	CONNECTOR 25 PIN (RS232C)	28480	1251-0084
	1251-0084	0		CONNECTOR 25 PIN (RS366)	28480	1251-0084
	1251-3283	1	1	CONNECTOR 24 PIN (HP-IB)	28480	1251-3283
				UNUSED REFERENCE DESIGNATORS		
A1R301				NOT ASSIGNED		
A1U103				NOT ASSIGNED		
A1U104				NOT ASSIGNED		
A1U105				NOT ASSIGNED		
A1U106				NOT ASSIGNED		
A1U107				NOT ASSIGNED		
A1U108				NOT ASSIGNED		
A1U109				NOT ASSIGNED		
A1U118				NOT ASSIGNED		
A1U119				NOT ASSIGNED		
A1U120				NOT ASSIGNED		
A1U401				NOT ASSIGNED		

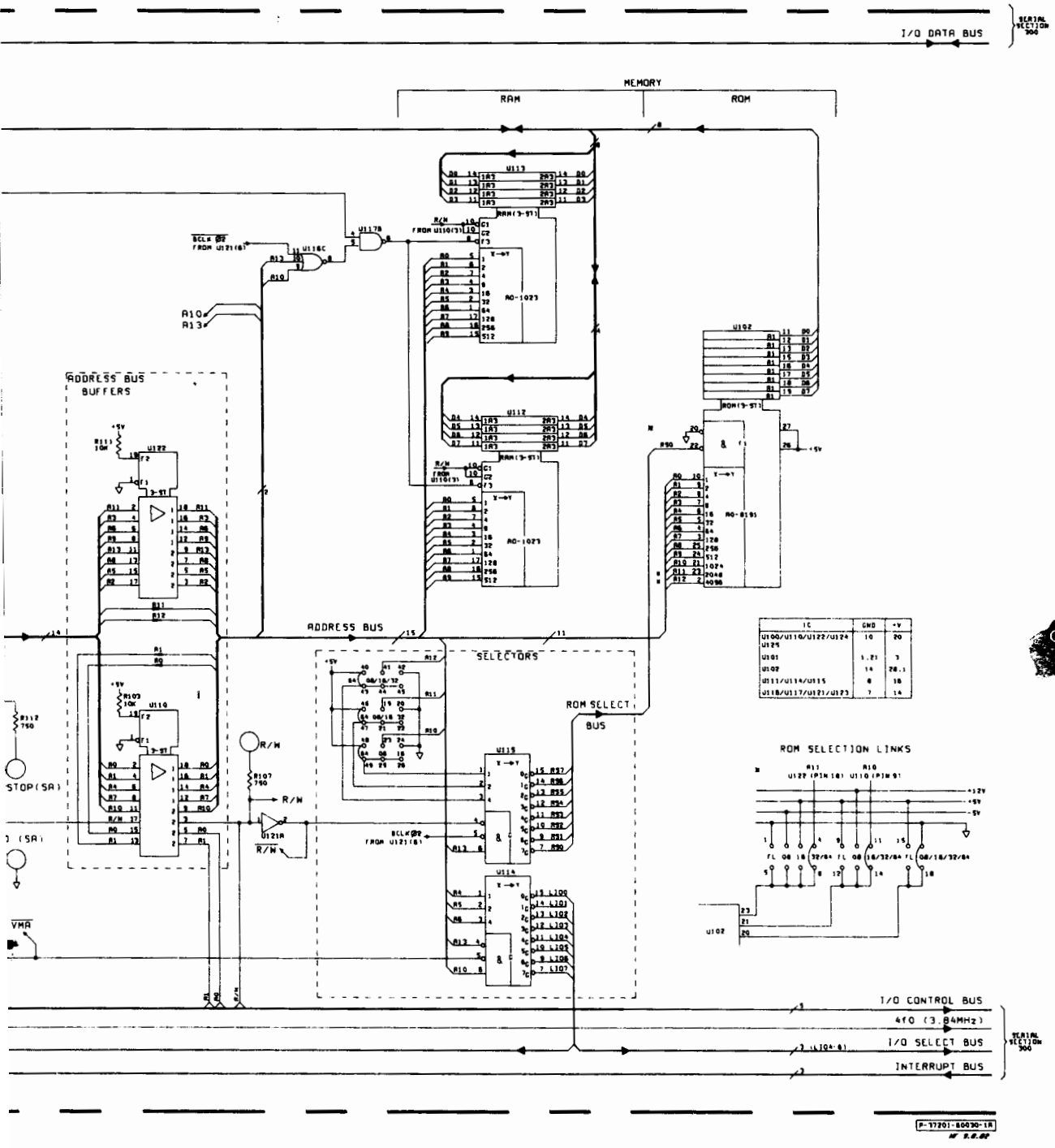
See introduction to this section for ordering information
*Indicates factory selected value



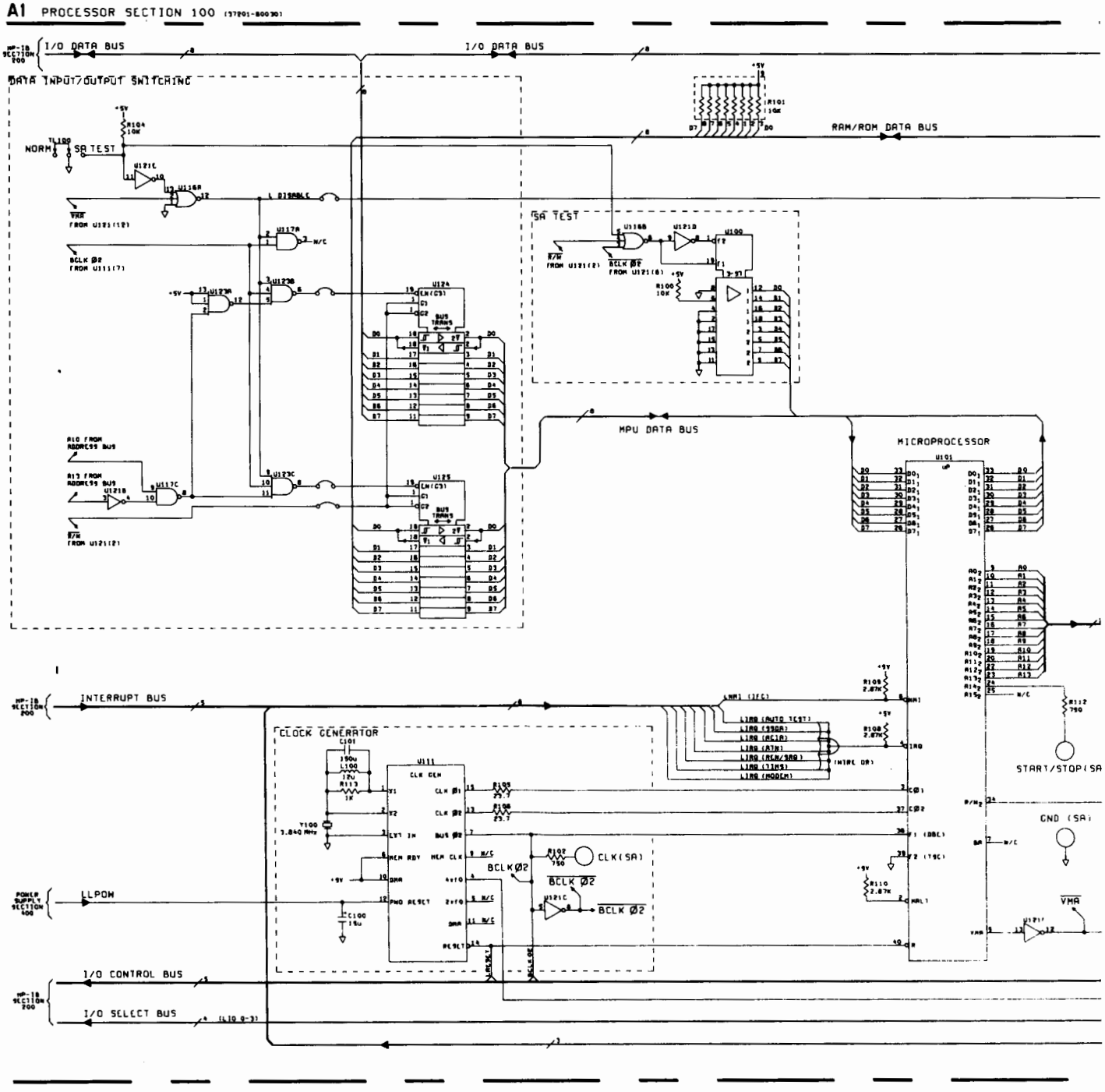
A1 Component Location (37201-60030)

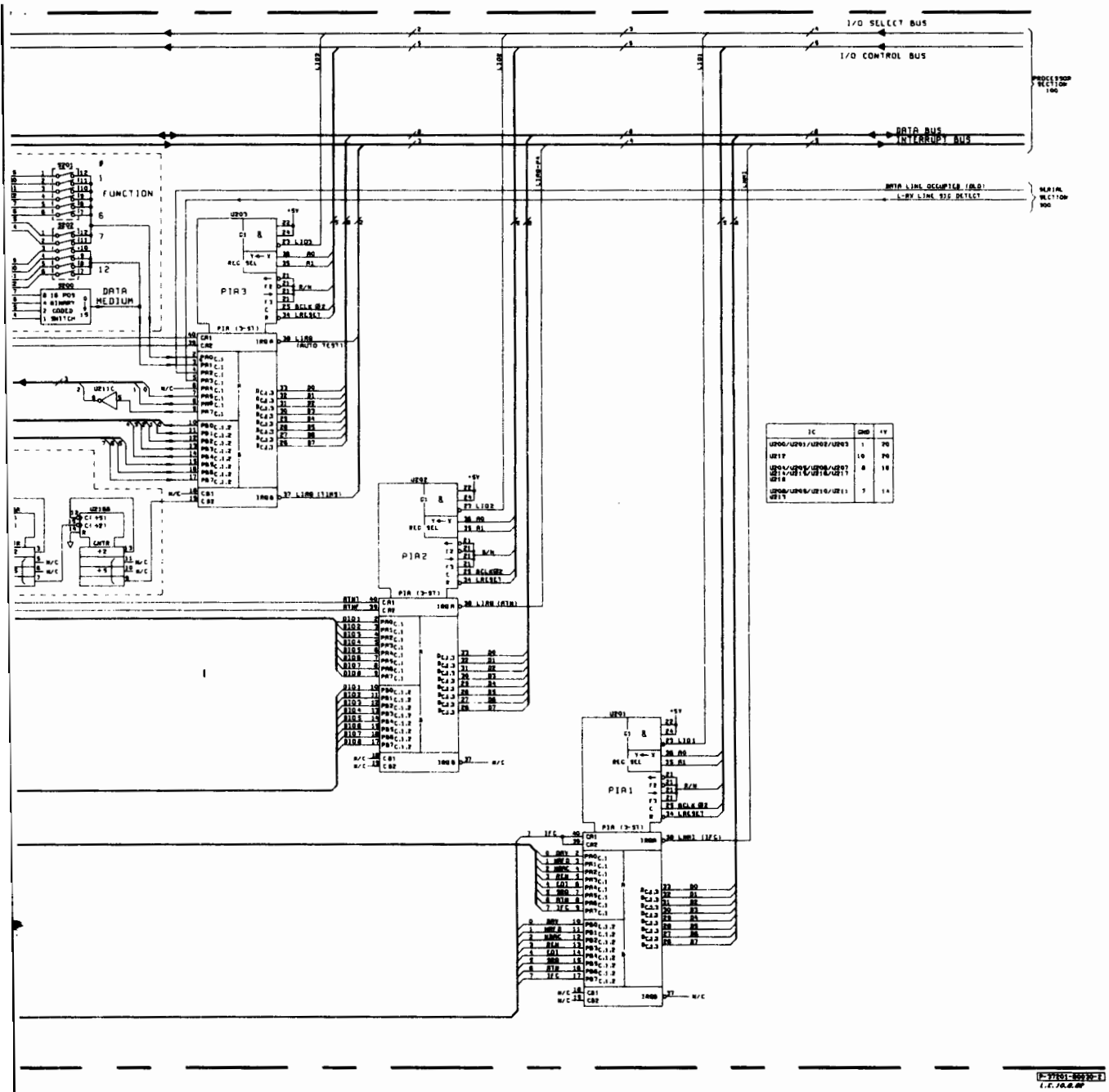


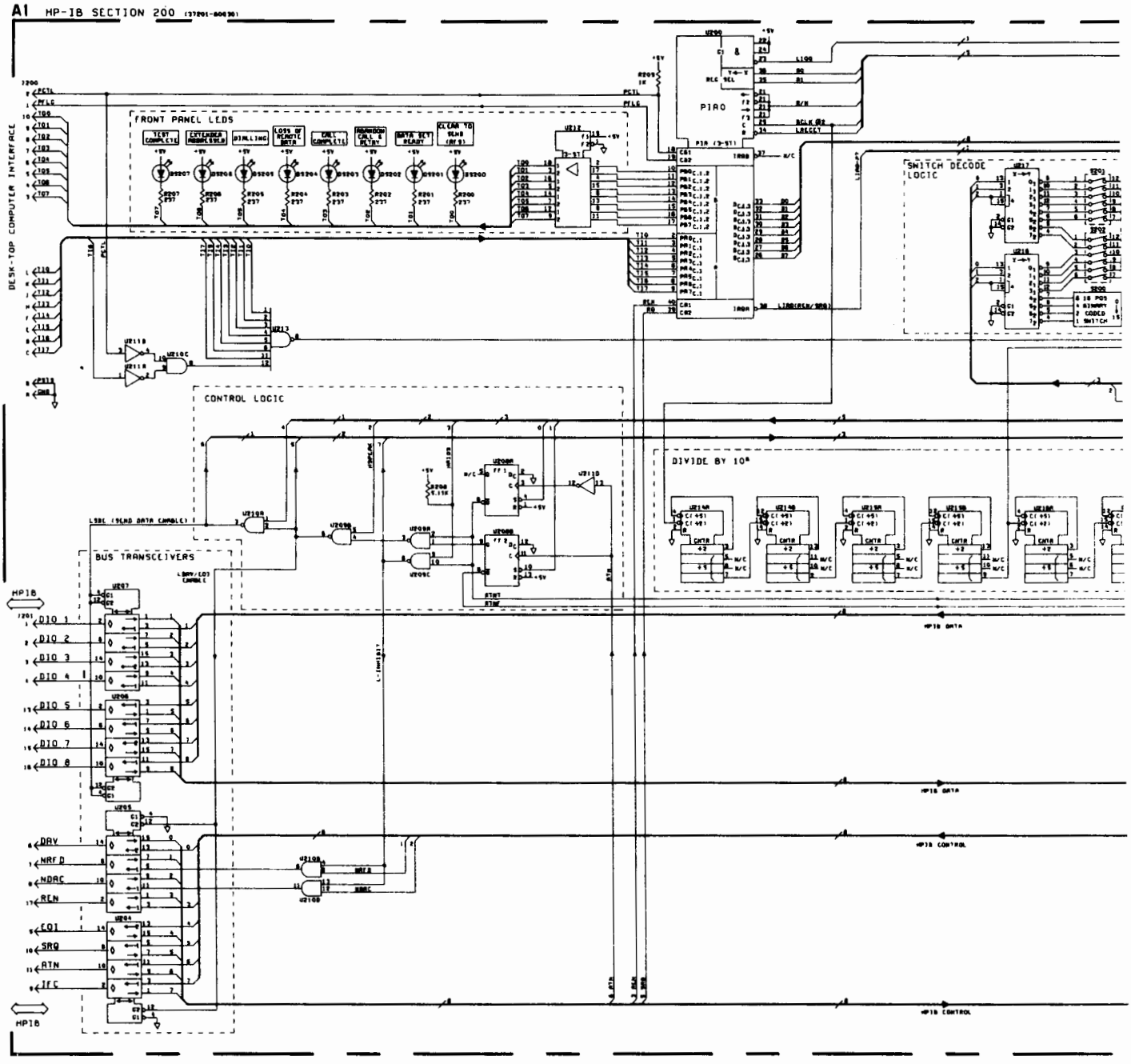
IC	CWS	+V
U100/U110/U122/U124	10	20
U125		
U101	1,21	7
U102	14	28,1
U111/U114/U115	8	16
U118/U117/U121/U123	7	14

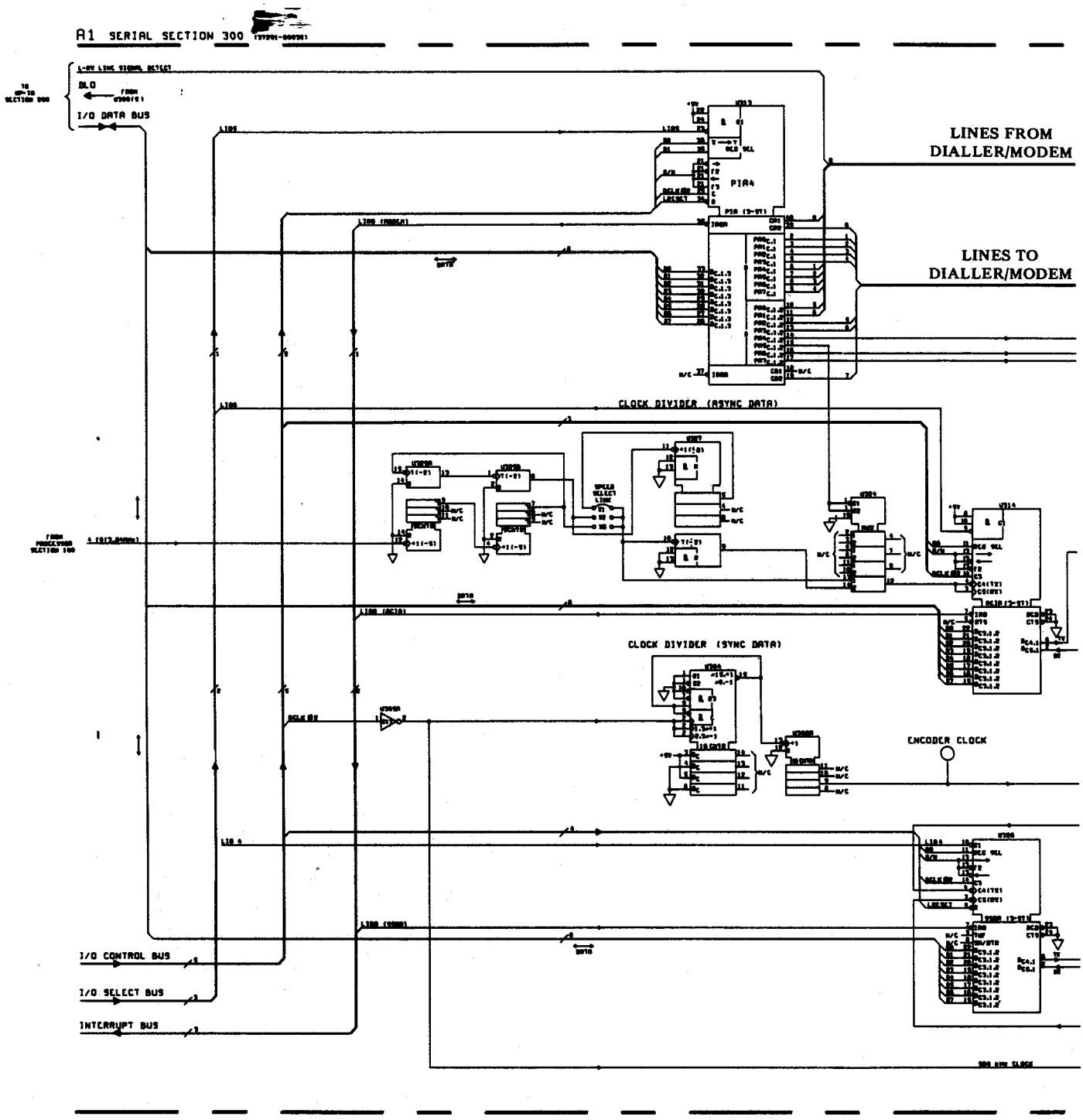


Model No. 37201A

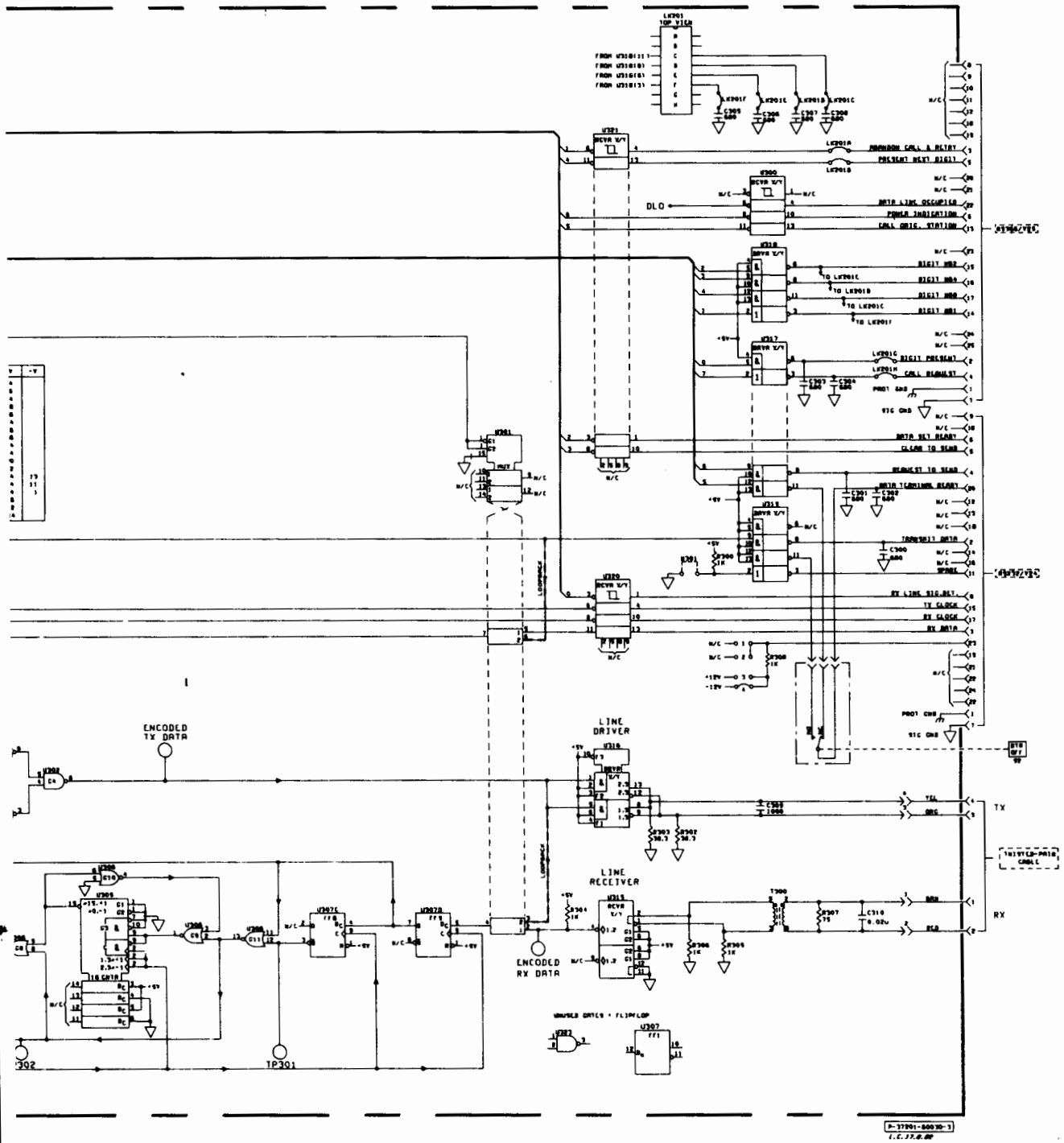



I/O SELECT BUS
I/O CONTROL BUS
DATA BUS
INTERRUPT BUS
FUNCTION
DATA MEDIUM
PIA3
PIA2
PIA1
PIA (3-ST)


A1 HP-IB SECTION 200
DESK-TOP COMPUTER INTERFACE
FRONT PANEL LEDS
SWITCH DECODE LOGIC
CONTROL LOGIC
DIVIDE BY 10^8
BUS TRANSCEIVERS
HP1B
DIO 1
DIO 2
DIO 3
DIO 4
DIO 5
DIO 6
DIO 7
DIO 8
DAV
NRFD
NDAC
REN
EOI
SRQ
ATN
IFC
HP1B DATA
HP1B CONTROL

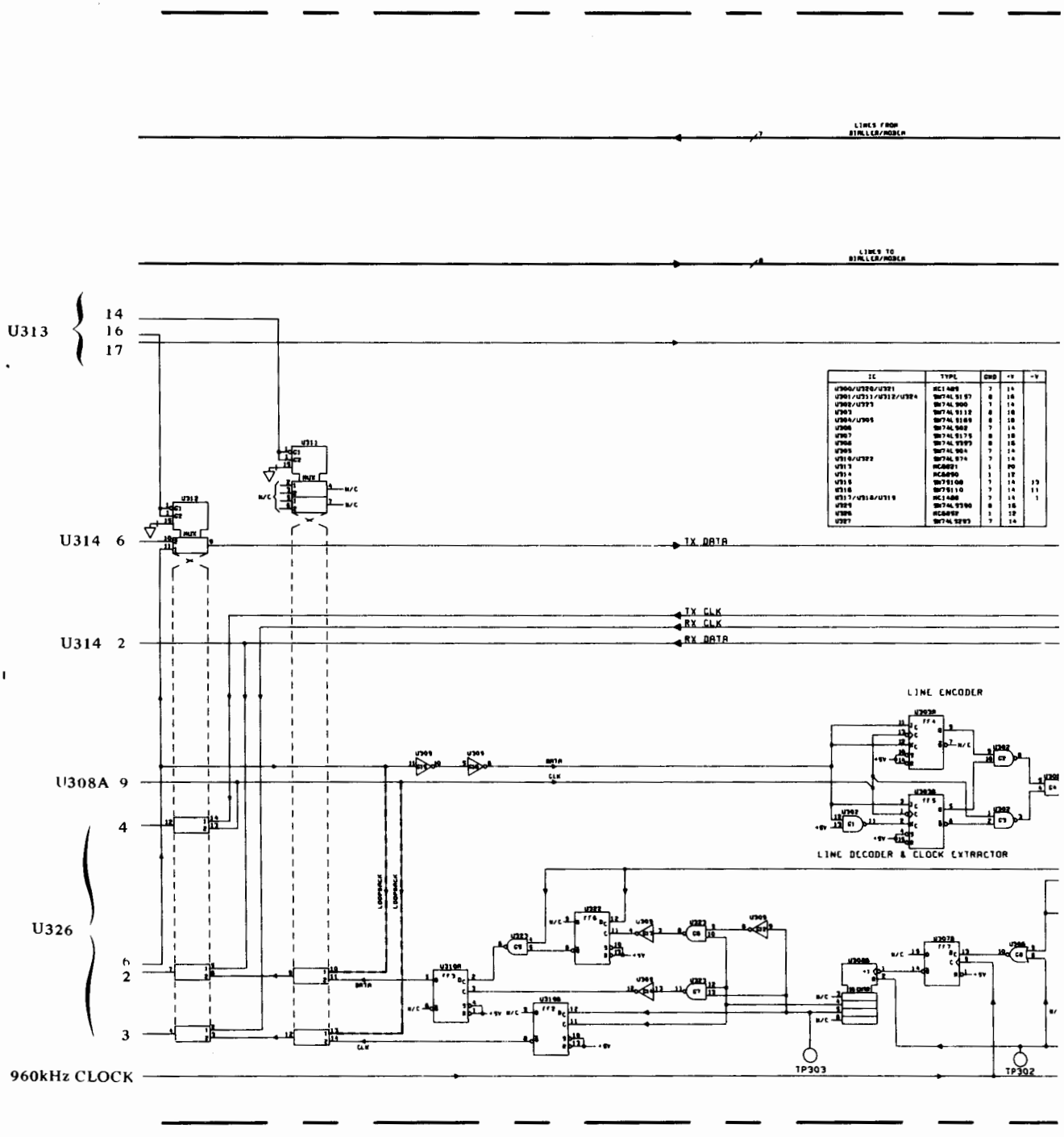


A1 Serial Section 300 - Part 1

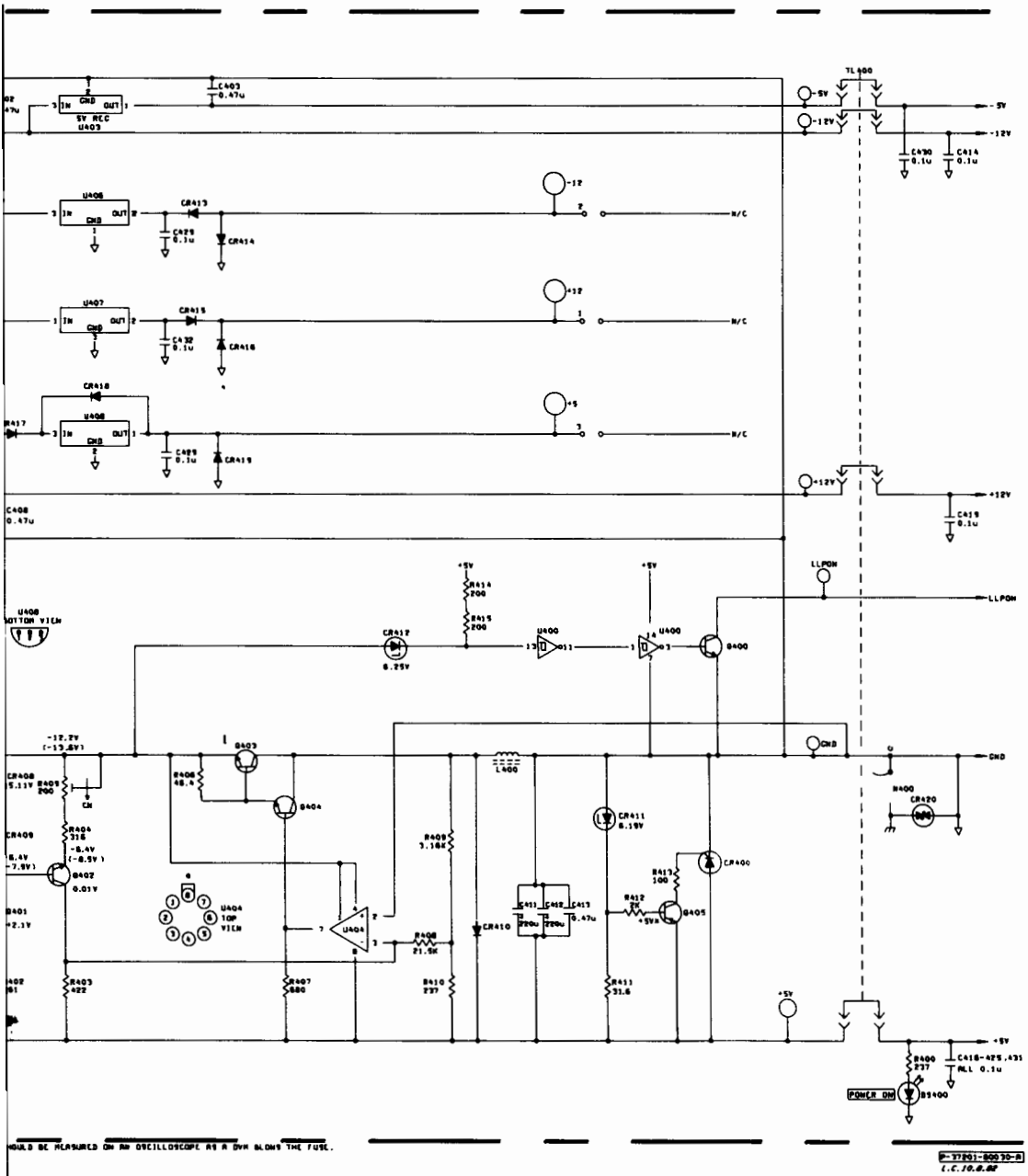


ion 300 - Part 2

Model No. 37201A



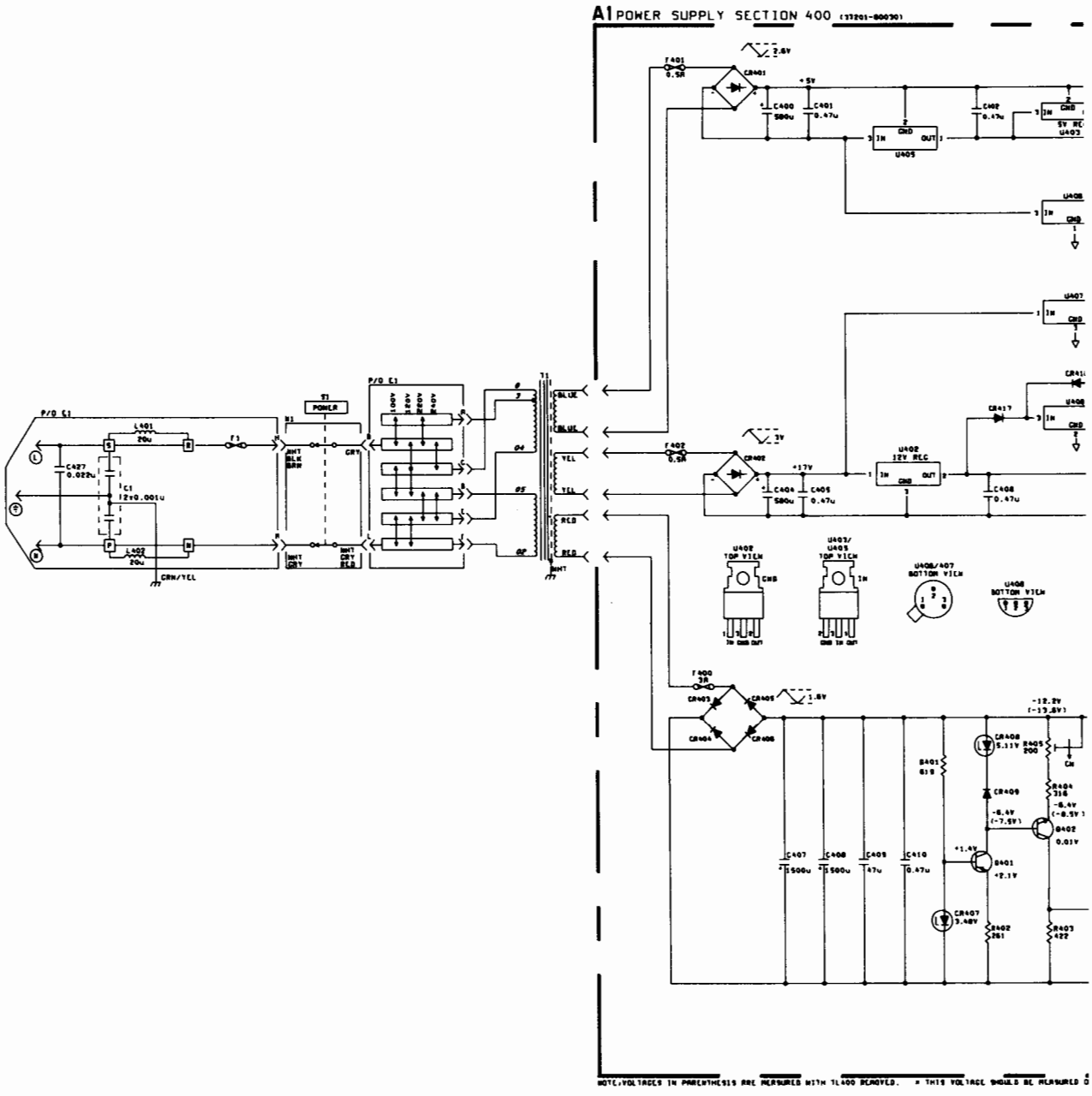
A1 Serial Section



HOULD BE MEASURED ON AN OSCILLOSCOPE AS A 3VA SLOWS THE FUSE.

P-37201-80030-A
I.C.10.0.82

Model No. 37201A



SIGNATURE LIST
(For Serial Prefix 2232U)

The following signatures were taken with the test link in the SA Test position. Before taking signatures, switch the 37201A Power off and then on to provide a reset - this is a precaution to ensure correct signatures.

Before making any signature checks, check the +5V signature is 755U and the 0V line is 0000.

MPU ADDRESS

U101

Pin		Pin	
9	C113	32	-
10	7050	31	-
11	0772	30	-
12	C4C3	29	-
13	AA08	28	-
14	7211	27	-
15	A3C1	26	-
16	7707	25	NOT USED
17	577A	24	0000
18	HH86	23	1180
19	89F1	22	PCF3
20	AC99	21	-

SELECTORS

U114

Pin		Pin	
1	AA08	16	+V
2	7211	15	C2P5
3	A3C1	14	4P70
4	1180	13	A614
5	0000	12	9260
6	89F1	11	87HF
7	8ACC	10	FU61
8	GND	9	8U44

U115

Pin		Pin	
1	0000	16	755U
2	AC99	15	H24U
3	PCF3	14	755U
4	0000	13	219C
5	B clock	12	755U
6	1180	11	1565
7	755U	10	755U
8	0000	9	U731

BUFFERS

U121

Pin		Pin	
1	HIGH	14	HIGH
2	LOW	13	HIGH
3	1180	12	LOW
4	64HU	11	LOW
5	B clock	10	HIGH
6	B clock	9	755U
7	LOW	8	0000

3I/P NOR

U116

Pin		Pin	
1	LOW	14	HIGH
2	LOW	13	HIGH
3	B clock	12	LOW
4	LOW	11	B clock
5	LOW	10	1180
6	755U	9	89F1
7	LOW	8	P17F

3I/P NAND

U117

Pin		Pin	
2	LOW	13	NOT USED
3	HIGH	12	NOT USED
4	LOW	11	NOT USED
5	P17F	10	64HU
6	HIGH	9	89F1
7	LOW	8	U0UF

ROM DATA BUS SIGNATURES

All ROMS's connected as for processor troubleshooting (Check 1) at U102.

Pin		Pin		Pin		Pin	
1	HIGH	8	0772	21	89F1	28	HIGH
2	PCF3	9	7050	20	LOW	27	HIGH
3	7707	10	C113	19	CHAU	26	HIGH
4	A3C1	11	3418	18	AH10	25	577A
5	7211	12	75PH	17	HH5U	24	HH86
6	AA08	13	40A9	16	8FF4	23	AC99
7	C4C3	14	GND	15	FU9F	22	64HU

RAM TEST SIGNATURES (CHECK 2)

The following signatures were taken with the test link in the normal position. Before taking signatures, switch the 37201A Power off then on.

Check the +5V line signature is 69C4 and the 0V line is 0000. Note the +5V signature is different with the test link in the normal position.

U102		U101		U113/112 ADDRS	
Pin		Pin		Pin	Pin
11	6C59	5	6F7F	36 -	1 -	18 -
12	UAHU	6	-	35 -	2 415H	17 7141
13	2372	7	-	34 A32U	3 C39C	16 HA26
14	GND	8	HIGH	33 -	4 3C84	15 53H2
15	25HA	9	A612	32 -	5 A612	14 *
16	P19C				6 A7H1	13 *
17	4F07				7 56H0	12 *
18	P357				8 8943	11 *
19	P7C6				9 LOW	10 A32U

U116				U121			
Pin		Pin		Pin		Pin	
1	LOW	14	HIGH	1	A32U	14	HIGH
2	05F8	13	LOW	2	FA9C	13	6F7F
3	B clock	12	6F7F	3	0U2P	12	05F8
4	FA9C	11	B clock	4	669A	11	HIGH
5	HIGH	10	0U2P	5	B clock	10	LOW
6	LOW	9	0U2P	6	B clock	9	LOW
7	LOW	8	669A	7	LOW	8	HIGH

*The signatures at these pins have been measured at U102 so there is no need to repeat the check at this point. U102 was chosen purely from a convenience point of view.

CHANGE 5

Effective on and after Serial Number 2232U-01697 there is a change to the CLOCK GENERATOR circuit.

Remove A1C101 and A1L100 and increase value of A1C100 from 15μF to 22μF.

Change Figure A100-3 Schematic Diagram - Section 100 as appropriate.

Page 6-4, Table 6-2 Replaceable Parts
Delete A1C101 and A1L100
Change A1C100 Part Number from 0180-0474 to 0180-2821 22μF, 35V CAPACITOR.

CHANGE 6

Effective on and after Serial Number 2232U-01892 there is a change to the Clock Generator circuit.

Add: A 33pF capacitor in parallel with A1R113.
Change: Figure A100-3 Schematic Diagram as appropriate.

Page 6-4, Table 6-2, Replaceable Parts:
Add: A1C101 Part Number 0160-4386 33pF Capacitor.

CHANGE 7

Effective on and after Serial Number 2232U-02531 there is a change to the Power Supply circuit.

Page 6-4, Table 6-2 Replaceable Parts:
Change: A1C402 0.47uF Capacitor to 4.7uF Capacitor, Part Number 0180-2698

Page 8-35, A400 Schematic Diagram:
Change: A1C402 to 4.7uF

*CHANGE 8

Effective from Serial Number 2511U02692 cabinet harware changes from inch to metric sizes.

Page 2-1, Paragraph 2-16/17:
Change to read:

2-16 Rack Mounting and Front Handle Kits

2-17 Rack Mounting and Front Handle Kits are available and may be purchased through your nearest Hewlett Packard office. See Figure 2-3 for the various handle and rack mounts available.

Front Handle Kit	HP 5061-9688
Rack Mount Kit (for use with handles)	HP 5061-9675
Rack Mount Kit (for use without handles)	HP 5061-9674

Page 6-6, Table 6-2 Replaceable Parts:
Change:

MP3	Front Frame, Upper	Part Number to 5021-5801
MP5	Side Strut	Part Number to 5021-5830
MP6	Strap Handle, Cap Front	Part Number to 5041-6819
MP7	Top Cover	Part Number to 5061-9433
MP9	Cover Side Perforated	Part Number to 5061-9505
MP10	Cover Bottom	Part Number to 5061-9445
MP14	Rear Frame, Upper	Part Number to 5021-5802
MP15	Strap Handle, Cap Rear	Part Number to 5041-6820