OPERATING MANUAL

3781B
PATTERN GENERATOR

3782B
ERROR DETECTOR

**HEWLETT
PACKARD**

MANUAL CHANGES

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.

Model No. 3781B

Serial Prefix or Number	Make Manual Changes
2219U & below	no change
2228U & below	no change
2228U	no change
2408U00486 & ABOVE	no change
2417U00516 & ABOVE	no change
2523U & ABOVE	no change
2703U	no change

Model No. 3782B

Serial Prefix or Number	Make Manual Changes
2218U & below	no change
2231U & below	no change
2310U & below	no change
2341U00491	change 1
2417U00531 & ABOVE	no change
2523U & ABOVE	no change
2703U	no change

* NEW ITEM

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.

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Model No.3781B/3782B

ERRATA

*Page 1-6:
 Add: OPTION W30 This option is available at the time of purchase and
                    gives 3 year Extended Hardware Support. It provides
                    2 additional years of return-to-HP hardware service
                    support (for 2nd and 3rd years).

Page 1-11, Synchronisation Specifications
 The specification reads as follows:

 Frame Sync:
  When framing and control bits are present in the input data, the 3782B
  will synchronise onto the frame pulses and remove them from the input
  data. Framing may be inhibited by a switch. The 3782B is designed to the
  following nominal specification for frame sync.

  DS-1

  Frame sync loss: 3 out of 8 consecutive F_T bits in error
  Multiframe sync loss: 2 consecutive F_S bits in error
  Frame sync gain: 12 consecutive F_T bits correct
  Multiframe sync gain: 12 consecutive F_S bits correct

  DS-1C

  F Frame sync loss: 3 out of 15 consecutive F bits in error
  M Frame sync loss: 2 out of $3M_1,M_2,M_3$ (011) sequences
                                 in error
  F Frame sync gain: 15 consecutive F bits correct
  M Frame sync gain: 2 consecutive M_1,M_2,M_3 (011) sequences
                                 correct

    DS-2: sync loss: same as DS-1C
          sync gain: same as DS-1C

    DS-3

    F Frame sync loss: 3 out of 15 consecutive F bits in error
    M Frame sync loss: 2 out of 3 consecutive M_5,M_6,M_7 (010)
                                 sequences in error
    F Frame sync gain: 15 consecutive F bits correct
    M Frame sync gain: 2 consecutive M_5,M_6,M_7 (010) sequences
                                 in error

CHANGE 1 (Applicable to S/N 2341U00491 & above).

Page 1-9:
3782B "DS-3 INPUT" specification.
Remove reference to "DS-3 LO" and relevant paragraphs.

Insert the following:
"DSX-3 MON: Input accepts DSX-3 waveform (auto-threshold) with up to
22dB of flat loss".

Remove "DS-3 MON" and replace with "DS-3HI MON" wording.

Page 3-3, Paragraph 3-11(B):
Change to the following:

B DS-3 DATA INPUT accepts signals and levels from the appropriate hierarchy
levels, depending on the position of the DATA INPUT switch (3). The signal
applied to the 3782B should be 44.736Mb/s with a signal format of B3ZS.
There are four positions on the DATA INPUT switch (3) controlling the
DS-3 DATA INPUT signal. The positions are DSX-3 MON, DSX-3, DS-3 HI and
DS-3 HI MON. "The input signal for DSX-3 MON should be a shaped pulse
equivalent to a DSX-3 pulse with up to 22dB of flat loss." For DSX-3,
the input signal should be standard cross-connect waveform (CCITT Rec
G703 Para 4). For DS-3 HI, the input signal should be of 11.2ns width
and 909mV amplitude. DS-3HI MON accepts the equivalent of a DS-3HI pulse
attenuated by 13.8dB. An LED above the input (2) is illuminated if data
transistions are present. Data loss is detected within 100ms. This input
uses a WECO Type 440A, 75ohms connector.

Page 3-4, Section 3-11(3):
Change the following:
DATA INPUT switch selects the appropriate interface (line code, framing
structure and bit rate) depending on where in the hierarchy the 3782b is
connected. The hierarchy levels available are DSX-1, DSX-IC, DSX-2, DSX-3
MON, DSX-3, DS3-HI, and HI MON DS-3.

Page 3-15, Section 3-57 ("Basic Functional checks") Step 13:
Remove reference to DS-3(LO).

Note: In-lid operating instructions (p/n 03781-90002) will require change
       as follows:

3782B ERROR DETECTOR

Change "DATA INPUT" paragraph to:

"DATA INPUT - "DSX-1" accepts DS-1 cross-connect waveform. "DSX-IC"
accepts DS-IC cross-connect waveform. "DSX-2" accepts DS-2 cross-connect
waveform. "DSX-3" accepts DS-3 cross-connect waveform. "DS-3 HI" accepts
DS-3HI waveform as defined in Bell Standard at DS-3 level. DSX-3 MON
accepts DSX-3 waveform with up to 22dB of attenuation. DS-3 HI MON
setting for connection to multiplexer output monitor port (DS-3HI through
13.8dB flat loss).

ERRATA (continued)

Page 3-16, Paragraph 3-57 BASIC FUNCTIONAL CHECKS
Alter the following paragraph and steps accordingly:

Step 15   Set the 3782B GATING PERIOD switch to MAN. Press the 3782B START
           pushbutton. The 3782B parameter display window reading should
           read typically between 9.7 and 9.9 x 10(-6). Wait 30 seconds
           before accepting display reading.

Step 17   Set 3781B ERROR ADD switch to CODE. Press the 3782B START push-
           button. The 3782B parameter display window reading should read
           typically between 9.7 and 9.9 x 10(-6). Wait approximately 30
           seconds before accepting display reading.

Step 19   Set 3781B ERROR ADD switch to BIN. Press the 3782B START push-
           button. The 3782B parameter display window reading should read
           typically between 9.7 and 9.9 x 10(-6). Wait approximately 60
           seconds before accepting display reading.

DESIGNED FOR
HP-IB
SYSTEMS

Programming Note

3781B, 3782B/0000-2

DECEMBER 1980

SUPERSEDES: NONE

Quick Reference Guide
for 3781B Pattern Generator
and 3782B Error Detector
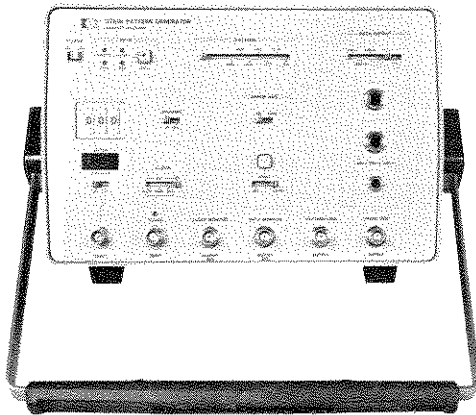
3781B Pattern Generator
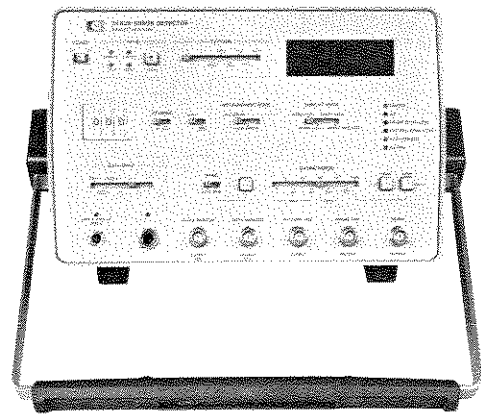
3782B Error Detector

INTRODUCTION

The Quick Reference Guide contains all the basic information required to operate the HP Models 3781B Pattern Generator and 3782B Error Detector over the Hewlett-Packard Interface Bus (HP-IB).

If more detailed information is required about the 3781B and 3782B, and HP-IB operation — refer to the Operating Manual and HP-IB Users Guide.

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LEARN

In response to a Learn Actual (LA) or Learn Remote (LR) command, the instruments output the settings of the switches and masks in a compact form. It is not necessary for the operator to know the internal format of this information, as its normal use is to allow a subsequent load instruction to reload the switches and masks with their earlier values.

Each controllable switch is allocated the bits defined in the RESPONSE CODES section (undefined bits are not necessarily output as zero). The information output signal comprises 14 bytes for the 3781B and 35 bytes for the 3782B. All slide switch codes start with zero at the left-hand side.

LOAD

In response to a load (LD) command, the instruments load the 'remote' switches and masks with data.

TRIGGER

The instruments do not respond to a device trigger.

CLEAR

Both instruments are designed to respond to the Device Clear or Selected Device Clear commands. After issuing either of these commands, the Controller must give the instruments time to react and settle. A wait of 0.5 second is recommended. (The issue of either of these commands does not affect the setting of the 3782B real-time clock.)

REMOTE/LOCAL CHANGES

The Local-to-Remote change is programmed by the Selected Device Remote Enable message (REN plus 3781B or 3782B address). The 3781B and 3782B instrument state is unchanged with all future changes affected by program codes only. Note that all front-panel functions are disabled in Remote — except the LOCAL push-button.

The Remote-to-Local change is programmed by the Go-To-Local (GTL) command or by setting the REN line false (high). In the 'remote' state, the front-panel switch settings can be changed to any position — as given in the MNEMON-ICS section. However, on going 'local', the physical position of the switch is the start position. These instruments can also be set to Local by pressing the LOCAL push-button. Note: these instruments do not respond to the LOCAL push-button, if the Local Lockout command has been issued. (This command disables the LOCAL push-button function and consequently all front-panel controls are disabled.)

SERVICE REQUEST

Both instruments are designed to issue a Service Request (SRQ) when service from the Controller is required. Programmable masks govern whether each request is generated.

It is possible for a service request to be generated before the Controller has had time to service any previous requests. In such instances, the instruments stack the requests in an orderly manner. It makes good programming sense to keep the length of this stack as short as possible by promptly responding to requests and not issuing further commands until the stack is empty. (However, it is not mandatory for the request to be serviced immediately if at all.) An instrument should not be serially polled within 20 milliseconds of a previous serial poll of that instrument.

STATUS BYTE

The instruments respond to a Serial Poll by sending their status byte. If an instrument is requesting service, bit 6 of the status byte is set. If an instrument is not requesting service, the bit is not set. For detailed information, refer to SERVICE REQUEST CODES.

PASS CONTROL

The instruments do not have the ability to take or pass control.

UNADDRESS COMMANDS

The instruments respond to the Unaddress Commands (Interface Clear — IFC true) by unlistening and untalking all Listener and Talker functions.

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MNEMONICS

3781B/3782B General Mnemonics

Mnemonic	Meaning
LD (load)	Request that the instruments load the 'remote' switches and masks with data.
CA (current answer)	3781B only. Request that the current jitter measurement display be issued in Controller format (ie., in the form "+N.NNNNENN").
	3782B only. Request that the current answer indicated by the DISPLAY MODE switch be issued.
QA (query annunciators)	3781B only. Request that the current status of the front-panel CLOCK (transitions present) LED be issued.
	3782B only. Request that the current status of the front-panel LEDs be issued (except ERRORS LED).
EC (error count)	3782B only. Request that the number of errors counted, up till the last error-second occurred, be issued.
IC (initialize clock)	3782B only. Request that the internal clock of the 3782B be initialized.
LA (learn actual)	Request that the current status of all "actual" front-panel and rear-panel switches (except push-buttons) and masks be issued. (14 bytes for 3781B and 35 bytes for 3782B.)
LR (learn remote)	Request that the current positions of all 'remote' switches and masks be issued. (14 bytes for 3781B and 35 bytes for 3782B.)
MK (mask)	The masks are programmed by quoting the mnemonic and parameter number.
QF (query firmware)	Request that the cyclic redundancy check word (CRC word) of each part of the firmware be issued.

3781B Switch Mnemonics

SWITCH NAME	MNEMONIC	PARAMETER RANGE
PATTERN	PTn	$1 \leqslant n \leqslant 10$
DATA OUTPUT	DOn	$1 \leqslant n \leqslant 6$
ZERO SUB. (VALUE)	ZVn	$0 \leqslant n \leqslant 999$
ERROR ADD (FORMAT)	EFn	$1 \leqslant n \leqslant 2$
ERROR ADD (RATE)	ERn	$1 \leqslant n \leqslant 3$
JITTER	JTn	$1 \leqslant n \leqslant 2$
CLOCK	CKn	$1 \leqslant n \leqslant 4$
FRAMING	FRn	$1 \leqslant n \leqslant 2$
ERROR ADD SINGLE SHOT	ES	

3782B Switch Mnemonics

SWITCH NAME	MNEMONIC	PARAMETER RANGE
PATTERN	PTn	$1 \leqslant n \leqslant 9$
ZERO SUB. (VALUE)	ZVn	$0 \leqslant n \leqslant 999$
DATA/DATA	DDn	$1 \leqslant n \leqslant 2$
MEASUREMENT MODE	MMn	$1 \leqslant n \leqslant 3$
DISPLAY MODE	DMn	$1 \leqslant n \leqslant 4$
DATA INPUT	DIn	$1 \leqslant n \leqslant 7$
SYNC	SYn	$1 \leqslant n \leqslant 2$
GATING PERIOD	GPn	$1 \leqslant n \leqslant 10$
BINARY/TERNARY	BTn	$1 \leqslant n \leqslant 2$
FRAMING	FRn	$1 \leqslant n \leqslant 2$
THRESHOLD	THn	$0 \leqslant n \leqslant 15$
MANUAL SYNC	MS	
START	ST	
STOP	SP	

The following switches are *not* remotely controllable

POWER (ON/OFF)
LOCAL (on front panel)
HP-IB ADDRESS (on rear-panel)
TALK ONLY/ADDRESSABLE (3782B only)
REAL-TIME CLOCK (3782B only)
LINE VOLTAGE SELECTOR

MASK DEFAULT VALUES

3781B Mask Default Values

Mask Number	Meaning	Parameter Number	Default Value
1	Issue EOI concurrent with terminator	1	2
	Do not issue EOI concurrent with terminator	2	
2	Do not SRQ on command Syntax Error	3	4
	SRQ on command Syntax Error	4	
3	Do not SRQ on command Syntax OK	5	5
	SRQ on command Syntax OK	6	
4	Do not SRQ when "LOCAL" pushbutton pressed	7	7
	SRQ when "LOCAL" pushbutton pressed.	8	

3782B Mask Default Values

Mask Number	Meaning	Parameter Number	Default Value Talk Only	Addressable
	MESSAGE SET			
1	Issue answers in Peripheral format.	1	1	2
	Issue answers in Controller format.	2		
2	Do not issue answer at end of Gating Period.	3	4	3
	Issue answer at end of Gating Period only if rear-panel RESULT PRINT THRESHOLD switch is satisfied.	4		
3	Do not issue general control messages.	5	6	5
	Issue general control messages.	6		
4	Issue four answers at end of Gating Period. (see Note 2).	7	see Note 1	8
	Issue just the answer indicated by DISPLAY MODE switch at end of Gating Period.	8		
5	Do not prefix messages with Time.	9	see Note 1	9
	Prefix messages with Time.	10		
6	Use (.) as message terminator.	11	see Note 1	12
	Use CR/LF as message terminator.	12		
7	Issue EOI concurrent with terminator.	13	see Note 1	14
	Do not issue EOI concurrent with terminator.	14		
8	Do not issue Error-Second messages.	15	see Note 1	15
	Issue Error-Second messages.	16		
9	Do not prefix Error-Rate answers in Controller format with status of "< 100 ERRORS" LED.	17	17	17
	Prefix Error-Rate answers in Controller format with status of "< 100 ERRORS" LED (see Note 3)	18		
	SERVICE REQUEST SET			
10	Do not SRQ when Error-Second occurs.	19	19	19
	SRQ when Error-Second occurs.	20		
11	Do not SRQ on command errors.	21	21	22
	SRQ on command errors.	22		

3782B Mask Default Values (continued)

Mask Number	Meaning	Parameter Number	Default Value Talk Only	Default Value Addressable
12	Do not SRQ at end of normal Gating Period.	23	23	23
	SRQ at end of normal Gating Period only if rear-panel RESULT PRINT THESHOLD switch is satisfied (see Note 4).	24		
13	Do not SRQ if Gating Period ends because of data integrity loss.	25	25	25
	SRQ if Gating Period ends because of data integrity loss.	26		
14	Do not SRQ if Gating Period ends because of an invalid switch movement.	27	27	27
	SRQ is Gating Period ends because of an invalid switch movement.	28		
15	Do not SRQ on command Syntax Error.	29	29	30
	SRQ on command Syntax Error.	30		
16	Do not SRQ on command Syntax OK.	31	31	31
	SRQ on command Syntax OK.	32		
17	Do not SRQ on loss/gain of data integrity.	33	33	33
	SRQ on loss/gain of data integrity.	34		
18	Do not SRQ after each 24-hour period elapsed on internal clock.	35	35	35
	SRQ after each 24-hour period elapsed on internal clock;	36		
19	Do not SRQ when "LOCAL" pushbutton pressed.	37	37	37
	SRQ when "LOCAL" pushbutton pressed.	38		
	RESTART SET			
20	Automatically restart repetitive gating.	39	39	40
	Automatically restart repetitive gating unless rear panel RESULT PRINT THRESHOLD switch satisfied.	40		
21	Do not restart gating following loss/gain of data integrity.	41	42	42
	Automatically restart gating following loss/gain of data integrity.	42		
22	Do not hold-off automatic restart until output buffer empty.	43	44	44
	Hold-off automatic restart until output buffer empty.	44		
23	Do not hold-off automatic restart until SRQ buffer empty.	45	46	46
	Hold-off automatic restart until SRQ buffer empty.	46		

Note 1: Talk Only values of Masks 4 thru 8 are controlled by bits 0 thru 4 respectively, of the rear-panel HP-IB ADDRESS switch. Position "1" of the switch selects the *even* value of parameter number.

Note 2: When the GATING PERIOD switch is set to SECONDS, EXTERNAL, or MANUAL and the BINARY INPUTS are used, only three answers are issued.

Note 3: If the "<100 ERRORS" annunciator is OFF, Error-Rate answers are prefixed with character "0". If annunciator is ON, answers are prefixed with character "1". If Mask 5 is set to prefix messages with Time, the Time message comes before the "<100 ERRORS" annunciator character.

Note 4: "NORMAL END" means a non-abortive end, with the GATING PERIOD switch set to SECONDS, CLKS, or EXTERNAL.

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SERVICE REQUEST CODES

3781B Service Request Codes

Code			Meaning	Controlling Mask Number
Octal	Decimal	Hex		
001	1	01	NEUTRAL — ALL OK	
100	64	40	Command Syntax Error In Line	2
101	65	41	Command Syntax of Line OK	3
102	66	4B	"LOCAL" push-button pressed	4

3782B Service Request Codes

Code			Meaning	Controlling Mask Number
Octal	Decimal	Hex		
001	1	01	NEUTRAL — ALL OK	
100	64	40	An Error-Second has occurred.	10
101	65	41	Cannot start — "ERROR 1" displayed.	11
102	66	42	Cannot start — "ERROR 2" displayed.	11
103	67	43	Cannot start — "ERROR 3" displayed.	11
104	68	44	Cannot start — "ERROR 4" displayed.	11
105	69	45	End of Gating Period — Normal.	12
106	70	46	End of Gating Period — Data Integrity Loss.	13
107	71	47	End of Gating Period — Invalid Switch Movement.	14
110	72	48	Command Syntax Error in Line.	15
111	73	49	Command Syntax of Line OK.	16
112	74	4A	Data Loss has occurred.	17
113	75	4B	AIS has occurred.	17
114	76	4C	Frame Sync Loss has occurred.	17
115	77	4D	Pattern Sync Loss has occurred.	17
116	78	4E	Data integrity regained.	17
117	79	4F	A further 24-hours has elapsed on internal real-time clock.	18
120	80	50	"LOCAL" pushbutton pressed.	19

RESPONSE CODES

3781B Response Codes

Switch	Byte Number	BITS
PATTERN	1	0-3
DATA OUTPUT	8	0-2
ZERO SUB. (HUNDREDS)	3	0-3
ZERO SUB. (TENS)	4	0-3
ZERO SUB. (UNITS)	5	0-3
ERROR ADD (FORMAT)	9	0
ERROR ADD (RATE)	10	0-1
JITTER	7	0
CLOCK	6	0-1
FRAMING	2	0
MASKS (1→4)	11→14	0

3782B Response Codes

Switch	Byte Number	BITS
PATTERN	1	0-3
ZERO SUB. (HUNDREDS)	3	0-3
ZERO SUB. (TENS)	4	0-3
ZERO SUB. (UNITS)	5	0-3
DATA/$\overline{\text{DATA}}$	2	1
MEASUREMENT MODE	7	0-1
DISPLAY MODE	9	0-1
DATA INPUT	6	0-2
SYNC	11	0
GATING PERIOD	10	0-3
BINARY/TERNARY INPUT	6	4
FRAMING	2	0
RESULT PRINT THRESHOLD	12	0-2,4
REAL-TIME CLOCK	8	0
MASKS (1→23)	13→35	0

OUTPUT MESSAGES

(3782B only)

Message	Controlling Mask (s)
An Answer	1,2,4
ERROR SECOND	8
"NO ANSWER" (in response to CA, when no answer available — Peripheral format)	1
"+9.9999E + 99" (in response to CA, when no answer available — Controller format)	1
"< 100 ERRORS"	1,2,4
"START"	3
"STOP"	3
"RESTART"	3
"DATA LOSS"	3
"AIS"	3
"FRAME LOSS"	3
"PATTERN LOSS"	3
"RECOVERY"	3
"RUN ABORT"	3
"DAY N"	3
"POWER ON"	3
TIME (as prefix to message)	5

RESULT-PRINT THRESHOLD

(3782B only)

Switch Position	Description
0≤N≤13	Threshold satisfied only if ERROR RATE is worse than 1 0E-N
N = 14	Threshold satisfied only if one or more errors have occurred
N = 15	Threshold always satisfied.

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OPERATING MANUAL

3781B
PATTERN GENERATOR
and
3782B
ERROR DETECTOR
(Including Options 001, 061 and 062)

SERIAL NUMBERS

This manual applies directly to instruments with serial numbers prefixed 2020U.

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

WARNING

READ THE FOLLOWING NOTES BEFORE INSTALLING OR SERVICING THE INSTRUMENT.

1. IF THIS INSTRUMENT IS TO BE ENERGIZED VIA AN AUTO-TRANSFORMER MAKE SURE THAT THE COMMON TERMINAL OF THE AUTO-TRANSFORMER IS CONNECTED TO THE NEUTRAL POLE OF THE POWER SOURCE.

2. THE INSTRUMENT MUST ONLY BE USED WITH THE MAINS CABLE PROVIDED. IF THIS IS NOT SUITABLE, CONTACT YOUR NEAREST HP SERVICE OFFICE. THE MAINS PLUG SHALL ONLY BE INSERTED IN A SOCKET OUTLET PROVIDED WITH A PROTECTIVE EARTH CONTACT. THE PROTECTIVE ACTION MUST NOT BE NEGATED BY THE USE OF AN EXTENSION CORD (POWER CABLE) WITHOUT A PROTECTIVE CONDUCTOR (GROUNDING).

3. THE SERVICE INFORMATION FOUND IN THIS MANUAL IS OFTEN USED WITH POWER SUPPLIED TO AND PROTECTIVE COVERS REMOVED FROM THE INSTRUMENT. ENERGY AVAILABLE AT MANY POINTS MAY, IF CONTACTED, RESULT IN PERSONAL INJURY.

4. BEFORE SWITCHING ON THIS INSTRUMENT:

    (a) Make sure the instrument input voltage selector is set to the voltage of the power source.

    (b) Ensure that all devices connected to this instrument are connected to the protective (earth) ground.

    (c) Ensure that the line power (mains) plug is connected to a three-conductor line power outlet that has a protective (earth) ground. (Grounding one conductor of a two-conductor outlet is not sufficient).

    (d) Check that the instrument fuse(s) is of the correct type and rating.

5. SERVICING INFORMATION:

    (a) This manual contains information, cautions, and warnings which must be followed to ensure safe operation and to retain the instrument in safe condition. Service and adjustments should be performed only by qualified service personnel.

    (b) Any adjustment, maintenance, and repair of the opened instrument under voltage should be avoided as much as possible and, when inevitable, should be carried out only by a skilled person who is aware of the hazard involved.

    (c) Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.

    (d) Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation.

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Figure 1-1 3781B Pattern Generator and 3782B Error Detector

SECTION I

GENERAL INFORMATION

1-1 INTRODUCTION

1-2 This Operating Manual contains information required to install, check and operate the Hewlett-Packard Models 3781B Pattern Generator and 3782B Error Detector. Figure 1-1 shows the 3781B, 3782B and accessories supplied.

1-3 Supplied with the instruments are separate Service Manuals — for use by the maintenance engineer. This Operating Manual should be kept with the instrument for use by the operator. Additional copies of 3781B/3782B publications may be ordered through your nearest Hewlett-Packard Office.

1-4 On the title page of this manual, below the manual part number, is a Microfiche part number. This number can be used to order this manual in 4 x 6-inch microfilm transparencies, each transparency contains up to 96 photo-duplicates of the manual pages. The Microfiche package also includes the latest Manual Changes supplement as well as all pertinent Service Notes.

1-5 SPECIFICATIONS

1-6 Instrument specifications are listed in Table 1-1. These specifications are performance standards or limits, against which the instrument is tested.

1-7 SAFETY CONSIDERATIONS

1-8 The HP Models 3781B Pattern Generator and 3782B Error Detector are Safety Class 1 (IEC) instruments. These instruments have been designed according to international safety standards. The instruments and manuals should be reviewed for safety markings and instructions before operation.

1-9 This manual contains information, cautions and warnings which must be followed by the user to ensure safe operation and retain the instruments in a safe condition.

⚠ Refer to Service Manual: This symbol on the instrument means the user must refer to the instrument's Service Manual to protect the instrument from damage.

⏚ Protective Earth Ground: Indicates protective earth ground terminal of the ac power source or the instrument. All exposed metal surfaces on the instrument *must* connect to a protective earth ground terminal.

⏚ Frame or Chassis Terminal: This symbol identifies a terminal that is normally common to all exposed metal surfaces on the instrument.

WARNING

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

CAUTION

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

1-10 INSTRUMENTS COVERED BY MANUAL

1-11 Attached to the rear-panel of the instrument is a serial number plate. The serial number plate has a four-digit serial prefix, a reference letter denoting country of origin (U = United Kingdom) and a five-digit serial number. The serial prefix is the same for all identical instruments, it changes only when a change is made to the instrument. The serial number is unique to each instrument.
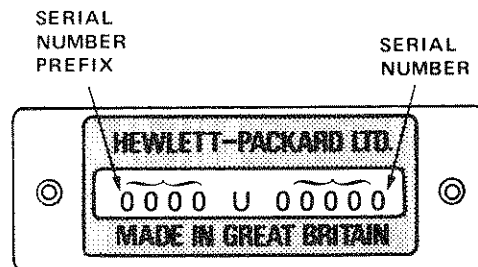
Figure 1-2 Serial Number Plate

1-12 The contents of this manual apply directly to all instruments with a serial number prefix listed under SERIAL NUMBERS on the title page. 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 that the instrument is different from those described in this manual. The Service Manuals for these instruments are supplied with a blue Manual Changes supplement, which contains the change information that documents the differences and explains how to adapt these manuals to the newer instruments.

1-13 In addition to change information, the Manual Changes supplement may contain information for correcting errors in the manuals. To keep this manual as current and as accurate as possible, Hewlett-Packard recommends that you periodically request the latest Manual Changes supplement — quoting this manuals print date and part number (both of which appear on the title page). Complementary copies of the supplement are available from Hewlett-Packard.

1-14 For information concerning a serial number prefix which is not listed on the title page or in a Manual Changes supplement, contact your nearest Hewlett-Packard Office.

1-15 DESCRIPTION

1-16 The HP Models 3781B Pattern Generator and 3782B Error Detector comprise an error performance measurement system dedicated to the testing and evaluation of digital transmission terminal and link equipment up to and including DS-3 level (44.736Mb/s) in the BELL digital hierarchy.

1-17 Both instruments are microprocessor based and HP-IB* compatible thus allowing operational simplicity and measurement flexibility. (*HP-IB — Hewlett-Packard Interface Bus — is Hewlett-Packard's implementation of IEEE Standard 488-1978.)

1-18 The 3781B and 3782B operate at the DS-1, DS-1C, DS-2 and DS-3 levels in the digital hierarchy. The 3781B also contains jitter modulation as a standard feature. At the DS-3 level, four different configurations are provided, enabling the instruments to interface at all locations in the DS-3 network.

DS-3 (HI)   — the waveform found at the DS-3 multiplexer output.

DSX-3   — the standard waveform found at the cross-connect bay.

DS-3 (MON) — which is the same signal as DS-3 (HI) but with 13.8dB flat loss (ie., the 3782B input has 13.8dB flat gain).

DS-3 (LO)   — which is equivalent to a DSX-3 signal having passed through approximately 450 feet of Type 728A Cable. (This simulates the distorted signal found at the input to the receiving equipment in a DS-3 System.)

1-19 At the other hierarchy levels, the instruments may be connected at the standard cross-connect bay. In addition, the instruments can operate at any bit rate in the range 1kb/s to 50Mb/s using external clock and, binary clock and data interfaces in ECL format.

1-20 The 3781B/3782B system measures binary errors, code errors and parity errors in a digital system.

1-21 Binary Errors

1-22 The 3781B transmits a digital pattern at the selected rate with correct framing structure (if required), appropriate ternary coding and interface voltage levels automatically applied. Simultaneously, the 3782B compares the output from the system under test with a separate internally-generated error-free pattern (identical to the 3781B pattern). This comparison is made at the binary level after any interface ternary coding and frame structure have been removed. Differences between the two patterns are counted over a selected gating period and displayed in one of four modes — error rate (error ratio), error count, error seconds or error free seconds. (Figure 1-3 shows binary error detection.)

BIT PATTERN IN   =   10010010
BIT PATTERN OUT =   10000110
INDUCED ERRORS —   ... E. E .. (binary errors)

∴ 3782B displays — Error Rate : 1 in 4 bits
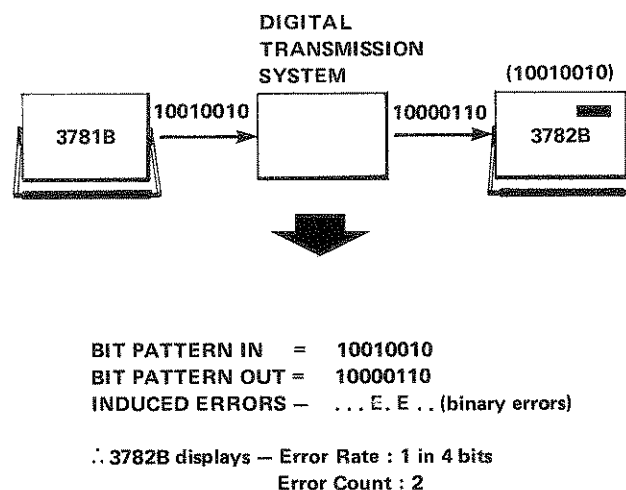   Error Count : 2

Figure 1-3 Binary Errors

1-23 Code Errors

1-24 The 3782B monitors interface or line-coded information for code errors. These errors are detected during decoding into binary data and counted and displayed in the same way as binary errors.

1-25 Binary information is nearly always coded before it reaches the digital transmission line. In the BELL System, the codes are:

Transmission Line	Code
T1, T1C	AMI (Alternate Mark Inversion)
T2	B6ZS (Bi-polar with 6 Zero Substitution)
T3	B3ZS (Bi-polar with 3 Zero Substitution)

The 3782B detects violations in the following manner:
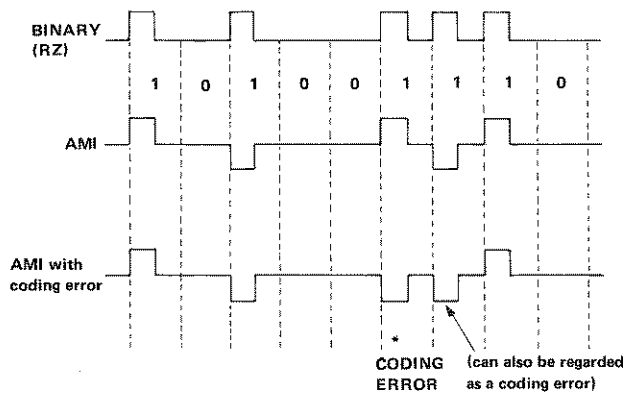
Figure 1-4 Code Errors

Figure 1-4 shows that code errors may not be an accurate measure of the error performance of a digital transmission system.

1-26 Parity Errors

1-27 At the DS-3 level in the BELL System digital hierarchy, two frame bits are used to indicate the link performance. The digital sum of the *information bits* in one frame is used to set *two frame bits* in the following frame to either 11 or 00 (depending on whether the digital sum was even or odd respectively). At the receiving end of the link, the digital sum of the received information bits can be re-calculated and compared to the value indicated by the corresponding parity bits in the following frame. A difference causes a parity error, ie., the maximum parity error rate is 1 per frame.

1-28 The measurement of parity errors does not require the use of a 3781B Pattern Generator and can be made on live traffic at the DS-3 level. This allows the 3782B to become an in-service measuring instrument for maintenance and surveillance -- especially when used in conjunction with its HP-IB capability.

1-29 Jitter Modulation

1-30 The 3781B has the built-in facility of applying a controlled amount of jitter to the output bit stream (using a simple external modulating signal source). This is displayed as jitter amplitude (in bits peak-to-peak) on a 4-digit LED display which flashes when the jitter is out-of-range. The frequency and amplitude of jitter depends on the frequency and amplitude respectively of the modulating signal. The resultant effect of the jittered data stream on the transmission system can be measured by the 3782B in terms of error performance.

1-31 This feature is particularly useful in simulating real traffic conditions since jitter tends to accumulate as a function of the length of a digital link due to the action of digital regenerators. Jitter impairments also become more noticeable as the bit rate increases. The jitter modulation facility thus allows the jitter tolerance of PCM equipment to be tested.

1-32 PRBS Zero Substitution

1-33 This allows the PRBS to be gated *off* for a number of clock periods determined by the setting of the PRBS ZERO SUBSTITUTION switch. Gating occurs every sequence following the PRBS trigger pulse. By measuring the error performance, using PRBS patterns with zero substitution, the pattern sensitive parts of a system can be examined -- for example, regenerator clock recovery circuits.

1-34 Programmability

1-35 The Pattern Generator and Error Detector are completely programmable via the Hewlett-Packard Interface Bus (HP-IB). This, coupled with the diversity of measurements the Pattern Generator/Error Detector combination can make, makes the instruments ideal for 'systems' applications.

1-36 HEWLETT-PACKARD INTERFACE BUS (HP-IB)

1-37 Compatibility

1-38 The extent to which the instruments are compatible with the HP-IB is given by the following list of interface functions:

Pattern Generator: SH1, AH1, T6, L4, SR1, RL1, DC1
Error Detector: SH1, AH1, T5, L4, SR1, RL1, DC1

1-39 The instruments interface with the HP-IB via open-collector TTL circuitry. An explanation of the implementation code may be found in IEEE Standard 488 "IEEE Standard and Digital Interface for Programmable Instrumentation", or the identical ANSI Standard MC1.1.

1-40 For more detailed information relating to program-mable control of these instruments, refer to HP-IB MODES OF OPERATION (Paragraph 3-16).

1-41 Selecting the HP-IB Address

1-42 The HP-IB ADDRESS switches are located on the rear-panels of the 3781B and 3782B. The switches represent a five-digit binary number. This number represents the talk and listen address characters which an HP-IB Controller can generate, Table 2-2 (in Section II) shows all HP-IB talk and listen addresses. Also refer to HP-IB ADDRESS SEL-ECTION (Paragraph 2-12).

1-43 HP-IB Controllers

1-44 The HP-IB interface enables the 3781B and 3782B to be used with any HP-IB compatible Computing Controller or Computer for automatic 'systems' applications.

1-45 Printer

1-46 An HP-IB compatible Printer may be connected to the 3782B for either the 'Talk Only' or 'Addressable' modes.

1-47 Real-Time Clock

1-48 The 3782B has a built-in, crystal-controlled, real-time clock. This permits peripheral devices to receive timed messages from the 3782B.

1-49 DEFINITION OF TERMS

1-50 The following paragraphs give brief definitions of terms which relate to the functions of the instrument and are commonly used in this manual.

1-51 AMI

1-52 Alternate Mark Inversion (often called "bi-polar" coding) is a form of ternary data in which data "marks" (normally representing '1's) are alternatively positive and negative. The main advantages of this basic code are that the average dc potential on the line is zero and, that this code can be used to detect if one data bit has been changed during transmission (as two consecutive bits would then have the same polarity). (See Figure 1-5.)
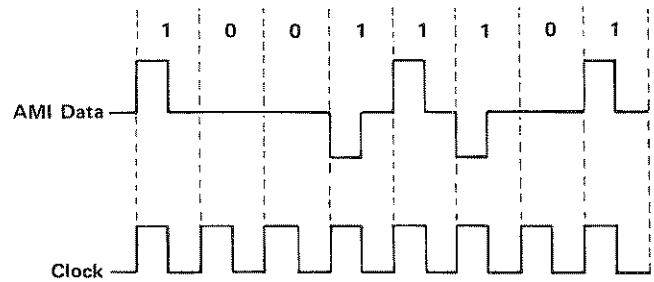
Figure 1-5 AMI Data/Clock

1-53 BER

1-54 Bit Error Rate (or Bit Error Ratio) is the ratio of the number of errors detected to the total number of clock periods measured over a selected gating period.

1-55 Binary Data

1-56 Data 'ones' and 'zeros' are represented by a two-level signal (see RZ and NRZ).

1-57 RZ

1-58 Return-to-Zero data is at the 'one' level for the dura-tion of the clock mark and returns to 'zero' for the duration of the clock space. This is the format used for ternary data interface in the 3781B/3782B. (See Figure 1-6.)
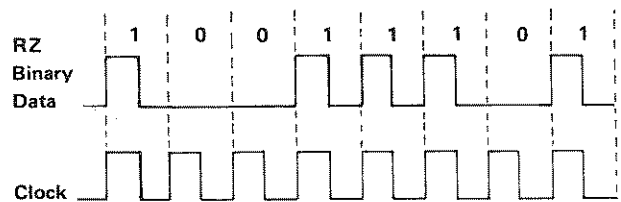
Figure 1-6 RZ Data/Clock

1-59 NRZ

1-60 Non-Return-to-Zero data remains at the 'one' level for the whole clock period. The data level is continuous be-tween consecutive 'ones'. This is the format used for binary data interfaces in the 3781B/3782B. (SeeFigure 1-7.)
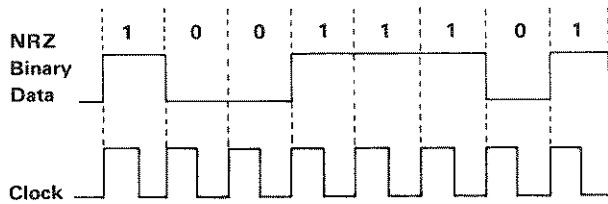
Figure 1-7 NRZ Data/Clock

1-61 Bi-polar Violations

1-62 Bi-polar violations are violations of the AMI coding rule in which two consecutive marks have the same polarity. A bi-polar violation is normally designated 'V'. (See Figure 1-8).
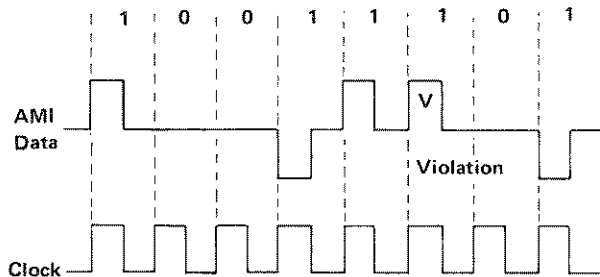
Figure 1-8 Bi-polar Violation

1-63 Codes

1-64 Refinements of the AMI code in which long sequences of zeros are eliminated by substituting a fixed pattern for the sequence of zeros. The substitution allows the clock signal to be more easily recovered from the data when long runs of zeros occur. The codes referred to in this manual are B3ZS and B6ZS.

1-65 B3ZS

1-66 Bi-polar with 3-Zeros Substitution is a pseudo-ternary code in which a specific pattern is substituted for each block of three consecutive zeros in the data stream. The substituted code is either "00V" or "B0V" (where "V" is a bi-polar violation and "B" is an extra bi-polar mark). The choice depends on the number of marks ("n") since the last "V" — as they must alternate in polarity in order to maintain the average dc content at zero. Hence, "00V" is used when "n" is odd and "B0V" when "n" is even.

1-67 B6ZS

1-68 Bi-polar with 6-Zeros Substitution — similar to B3ZS, but the substitution is made for each block of six consecutive zeros in the data stream. In this case, the substitution is always "0VB0VB" where "V" is a bi-polar violation and "B" is an extra bi-polar mark. Since two "V"s are introduced of opposing polarity, the average dc content is maintained at zero.

1-69 Delayed Data

1-70 As applied to these instruments, delayed data is data which is delayed by 22 bits from normal data.

1-71 Error Add

1-72 Binary data bits changed to produce an error without increasing the sequence length. The errors introduced take the form of the complement of 1 data bit in each 10^5 bits or single-shot errors.

1-73 Coded data bits are changed to produce a code error without increasing the sequence length or the binary error rate. The errors introduced take the form of a positive mark changed to a negative mark or vice-versa. This results in code errors. The 3782B measures code errors as defined below:

AMI — two consecutive marks of the same polarity ie., a bi-polar violation ("V").
B3ZS — 000, 1V and 010V.
B6ZS — 0V0, 1V0, 1V1 and 000000.

1-74 PRBS

1-75 A PRBS (Pseudo Random Binary Sequence) is a repetitive sequence $2^n - 1$ bits long generated by an n-stage shift register with modula-two gating. For example, a 9-stage shift register produces a sequence $2^9 - 1$ (or 511) bits long.

1-76 Recovered Clock

1-77 The Error Detector clock signal is recovered from the ternary input data.

1-78 Ternary Data

1-79 "One" and "zero" are represented by a three-level signal. Ternary data is a general term which includes AMI and the codes described in this section. All of these are more correctly described as "pseudo-ternary" codes, as positive and negative marks mean the same thing.

1-80 Word

1-81 A repetitive fixed sequence.

1-82 Synchronization

1-83 In order to function correctly, the 3782B Error Detector must have:

bit synchronization	— recovered clock from input data or correctly phased external clock and binary data.
pattern synchronization	— the reference pattern must be in phase with the input data pattern.
frame synchronization	— the framing bits must be correctly detected in order to separate the pattern data bits from the composite frame.

1-84 Zero Substitution

1-85 Zeros are substituted for part of the PRBS without increasing the sequence length. The zeros overwrite a section of the pattern. (See Figure 1-9.)
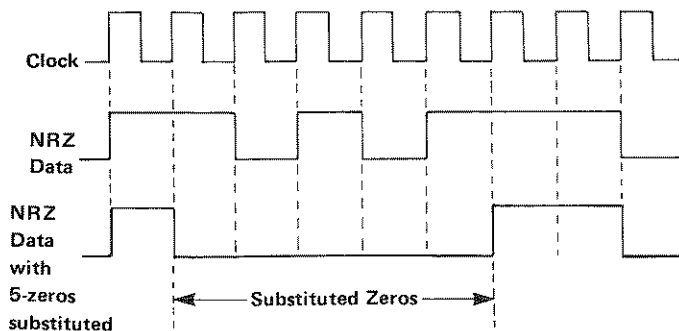
Figure 1-9 Zero Substitution

1-86 OPTIONS

1-87 **Option 001** (3781B Only) provides four DSX-3 outputs on the rear panel (via BNC connectors). With this option, the front-panel WECO Type 440A connectors are also replaced by BNC connectors.

1-88 **Option 061** Basic Rack Mount Kit. If this kit was not ordered with the original shipment and is now desired, it can be ordered from your nearest Hewlett-Packard Office. (03771-20056 for 3781B and 3782B.)

1-89 **Option 062** Rack Mount Kit enables front-panel control of some rear-panel switches and inputs/outputs. (Consequently, the 3781B and 3782B Option 062 Rack Mount Kits have different part numbers.)

3781B Option 062 enables the four rear-panel DSX-3 OUTPUTS (Option 001) to be accessed from the front panel.

3782B Option 062 enables the rear-panel BINARY/TERNARY and REAL-TIME CLOCK switches and the BINARY CLOCK, BINARY DATA and EXTERNAL GATING INPUTS to be accessed from the front panel.

These rack mount kits can be ordered from your nearest Hewlett-Packard Office. (03781-20042 for 3781B and 03782-20041 for 3782B.)

1-90 ACCESSORIES SUPPLIED

1-91 Figure 1-1 shows the HP Models 3781B, 3782B and the accessories supplied. The accessories supplied comprise: comprise:

> Storage Covers (which house In-lid Instructions)
> Power Cables
> Extender Boards (one per instrument)

1-92 ELECTRICAL EQUIPMENT AVAILABLE

1-93 HP-IB Controllers

1-94 The 3781B Pattern Generator and 3782B Error Detector have an HP-IB interface and can be used with any HP-IB Computing Controller or Computer for automatic 'systems' applications.

1-95 Printer

1-96 An HP-IB compatible Printer (eg., HP Model 5150A Option 001) can be connected to the 3782B to provide a hard-copy print-out of measurement results.

1-97 Cartridge Tape Unit

1-98 The HP Model 9875A Cartridge Tape Unit can be connected, via the HP-IB, to the 3782B to collect result data.

Table 1-1 Specifications

Except where otherwise indicated, the following parameters are warranted performance specifications. Parameters described as "typical" or "nominal" are supplemental characteristics which provide a useful indication of typical, but non-warranted, performance characteristics.

3781B Pattern Generator

DATA OUTPUTS

DSX-1, DSX-1C, DSX-2, and DS-3 compatible ternary outputs, and ECL compatible binary outputs.

DSX-1 Output —Bell standard cross-connect waveform meeting CCITT Rec. G.703 para. 1 (see Page 1-13).

Bit Rate: 1.544 Mb/s (tolerance — see Internal Clock).
Data Structure: max of 14 consecutive zeros permitted regardless of pattern selection.
Format: coded AMI.
Impedance: nominal 110Ω balanced to GND.
Connector: WECO type 310A.
Amplitude: 3V ± 0.3V pk.
+ve/−ve Amplitude Unbalance: less than ± 0.15V.
Width (at half amplitude): 324 ns ± 30 ns.
+ve/−ve Width Unbalance: less than ± 15 ns.
Transition Times (10% to 90%): < 80 ns.
Trailing Edge Overshoot: 10% to 30% of pulse amplitude, decaying to < 10% of base line-to-peak value in < 400 ns.

DSX-1C Output —Bell standard cross-connect waveform of nominally rectangular shape (see Page 1-13).

Bit Rate: 3.152 Mb/s (tolerance — see Internal Clock).
Width (at half amplitude): 159 ns ± 20 ns.
Transition Times (20% to 80%): < 50 ns.

Other specifications same as DSX-1 Output.

DSX-2 Output —Bell standard cross-connect waveform meeting CCITT Rec. G.703 para. 2 (see Page 1-13).

Bit Rate: 6.312 Mb/s (tolerance — see Internal Clock).
Format: coded B6ZS.
Impedance: nominal 110Ω balanced to GND.
Connector: WECO type 310A.
Shape: meets Bell standard mask.

DS-3 — Bell standard interface waveforms available on two separate outputs.

DS-3 Output

Bit Rate: 44.736 Mb/s (tolerance — see Internal Clock).
Format: coded B3ZS.
Impedance: nominal 75Ω unbalanced to GND.
Connector: WECO type 440A.
Amplitude: 3 switch-selectable settings HI, DSX-3, LO.

DS-3 HI: amplitude, 909mV ± 1 dB pk; width (at half amplitude), 11.2 ns ± 1.1 ns; transition times, 4.5 ns ± 1.5 ns; overshoot/undershoot, < 10% of pulse amplitude.
DSX-3: Bell standard cross-connect waveform meeting CCITT Rec. G.703 para. 4 (see Page 1-13) , corresponds to DS-3 HI signal passed through equivalent of 450 ft of WECO type 728A cable.
DS-3L0: corresponds to DSX-3 signal passed through equivalent of a further 450 ft of WECO type 728A cable.

Delayed DS-3 Output

Delay: 22 bits.

Other specifications same as DS-3 Output.

Data Monitor Output

Data: same as DSX-1, DSX-1C, DSX-2, DS-3 Outputs, but preceding them by 4 bits.
Format: binary NRZ with framing bits.
Impedance: nominal low unbalanced to GND.
Connector: BNC.
Amplitude: nominal ECL levels.
External Load: 50Ω into −2V, dc coupled; 50Ω into GND, ac coupled.
Protection: 100 mA fuse.

CLOCK

Internal Clock

Frequency: four crystal-controlled clocks at 1.544 MHz (DS-1), 3.152 MHz (DS-1C), 6.312 MHz (DS-2) and 44.736 MHz (DS-3).
Accuracy: setting tolerance better than ± 3 ppm at ambient temperature.
Stability: typically better than ± 12 ppm, 0°C to 55°C; typically better than ± 5 ppm/year aging.

External Clock

Frequency: 1 kHz to 50 MHz.
Impedance: nominal 75Ω unbalanced.
Connector: BNC.
Termination: GND or −2V, nominal levels.
Triggering: 8 ns min. pulse width, choice of AUTO, GND or ECL nominal thresholds.
Sensitivity: better than 500 mV pk-pk.
Amplitude: 5V pk-pk max. within limits of ± 5V.
Indicator: LED illuminated if clock transitions present.

Clock Monitor Output

Source: internal or external clock.
Format: continuous.
Impedance: nominal low unbalanced to GND.
Connector: BNC.
Amplitude: nominal ECL levels.
External Load: 50Ω into −2V, dc coupled; 50Ω into GND, ac coupled.
Protection: 100 mA fuse.

PATTERNS

PRBS

Polynomials: $2^9 - 1$ to CCITT Rec. V.52 ($D^9 + D^5 + 1 = 0$); $2^{15} - 1$ to CCITT Rec. 0.151 ($D^{15} + D^{14} + 1 = 0$); $2^{20} - 1$ to Bell standards ($D^{20} + D^{17} + 1 = 0$).

WORD

Fixed Patterns: 0000, 1000, 1010, 1100, 1111; 17/15 (17 ones, 15 zeros), AIS — Alarm Indication Signal (all ones without-framing bits).

Zero Substitution (PRBS only)

Sequence can be gated off for a number of clock periods, variable over the range 0 to 999 in unit steps. Gating occurs every sequence 6 bits after the PRBS trigger pulse, when viewed at the Data Monitor Output.

Framing

Framing and control bits are added to the output pattern according to the bit rate selected (DS-1, DS-1C, DS-2 or DS-3). Framing may be inhibited by a switch.

Zero Limit

When the DS-1 or DS-1C bit rates are selected, the max. run length of zeros in the output pattern is limited to 14.

Error Add

Binary or code errors are added as an error rate of 10^{-5} or a single error via a pushbutton switch.

Notes.   (a) binary errors are inserted after parity generation in the case of DS-3 framing thus causing a parity error.

       (b) AMI code errors do not cause binary errors (ie. the +ve mark changes to —ve mark and vice-versa).

       (c) binary or code errors do not violate the 14 zero limit rule which may result in a modified added error rate.

JITTER MODULATION

Timing jitter can be added to the clock and data output signals by applying an external modulating source. The typical jitter amplitude/frequency response available is shown below for constant modulation input amplitude.
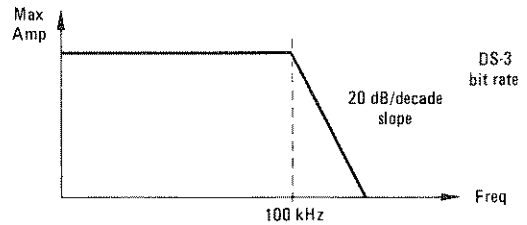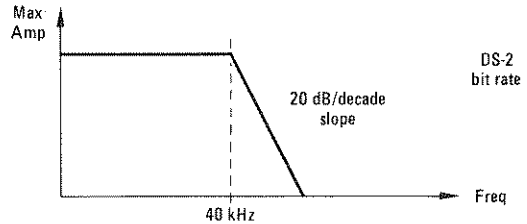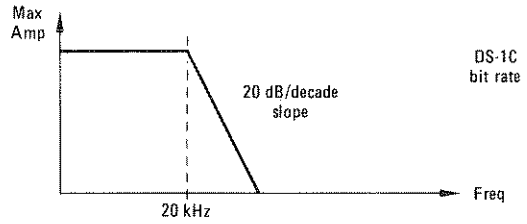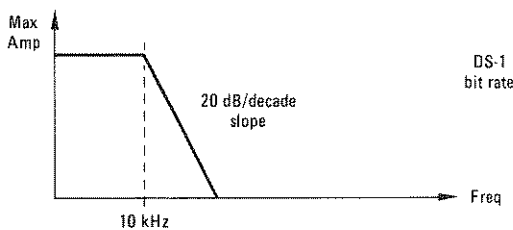
Jitter Modulation Input

Frequency Range: dc to 5% of bit rate (DS-1, DS-1C, DS-2); dc to 2.5% of bit rate (DS-3).
Impedance: nominal 50Ω unbalanced to GND.
Connector: BNC.
Sensitivity: nominal 2 bits/V (pk-pk figures at 5 Hz for DS-1, DS-1C, DS-2); nominal 4 bits/V (pk-pk figures at 5 Hz for DS-3).
Display: AB.CD LED display of pk-pk jitter (bits); flashes when out of range; valid for periodic modulating frequencies down to 5 Hz; accurate to ± 5% ± 0.1 bits.
Jitter Output Amplitude: 10.10 bits pk-pk max. (DS-1, DS-1C, DS-2); 20.20 bits pk-pk max. (DS-3).

TRIGGER OUTPUTS

Pattern Trigger Output

Format: one pulse every PRBS or WORD.
Position (with respect to Data Monitor Output): for DS-2 and DS-3, nominally coincident with bit preceding longest run of zeros in PRBS, or with 2nd bit of 4-bit WORD, or with 9th zero in 17/15 pattern; for DS-1 and DS-1C, nominally 15 bits before equivalent DS-2 and DS-3 position.
Impedance: nominal 50Ω unbalanced to GND.
Connector: BNC.
Amplitude: min.1V pk.
Width: one clock period, except with zero substitution when width stretched to approx. that of zero block.
Protection: open/short circuit protected; ± 5V max. short term voltage.

Frame Trigger Output

Format: one pulse per frame.
Position (delayed by 4 bits with respect to Data Monitor Output): for DS-1C, DS-2, DS-3, nominally 4 bits before M_1 position; for DS-1, nominally 4 bits before F_T bit in frame 1 of the multiframe.
Width: one clock period.

Other specifications same as Pattern Trigger Output.

HP-IB FACILITIES

General

Mode: "ADDRESSABLE" only.
LOCAL Switch: allows switching from "remote" to "local" control, except when the controller has issued a "local lockout" command.
Flags: Local, Remote, Listen, Talk, SRQ.
Implementation: SH1 (complete capability);
AH1 (complete capability);
T6 (basic talker, serial poll, unaddress if MLA);
TE∅ (no capability);
L4 (basic listener, unaddress if MTA);
LE∅ (no capability);
SR1 (complete capability);
RL1 (complete capability);
PP∅ (no capability);
DC1 (complete capability);
DT∅ (no capability);
C∅ (no capability).

Controlling Masks

To permit flexibility in the use of the 3781B, some operating parameters are governed by "masks". At power-on, these masks are given default values which may be overwritten in the local and remote states. Full details are given in the 3781B/3782B HP-IB Users Guide or Operating Manual.

ADDRESSABLE Mode

Scope: used when 3781B operates with an external controller; allows control of all switches except Power, Line Voltage Selection, Local and HP-IB Address.
Functions: overwrite a slide-switch or pushbutton; request the current jitter amplitude display; request the current external clock status; request the current switch positions and masks; load the switch positions and masks; "local lockout" facility; power-on reset; service requests controllable by masks.

3782B Error Detector

DATA INPUTS

DSX-1, DSX-1C, DSX-2, and DS-3 compatible ternary inputs and ECL compatible binary inputs (rear panel).

DSX-1 Input — Bell standard cross-connect waveform meeting CCITT Rec. G.703 para. 1 (see Page 1-13).

Bit rate: 1.544 Mb/s ± 50 ppm.
Data Structure: max of 14 consecutive zeros permitted regardless of input pattern.
Format: coded AMI.
Polarity: DATA or $\overline{\text{DATA}}$, switched at binary level.
Impedance: nominal 110Ω balanced to GND.
Connector: WECO type 310A.
Triggering: fixed level.
Sensitivity: accepts Bell standard cross-connect waveform.
Indicator: LED illuminated if data transitions present.

DSX-1C Input — Bell standard cross-connect waveform of nominally rectangular shape (see Page 1-13).

Bit Rate: 3.152 Mb/s ± 50 ppm.

Other specifications same as DSX-1.

DSX-2 Input — Bell standard cross-connect waveform meeting CCITT Rec. G.703 para. 2 (see Page 1-13).

Bit Rate: 6.312 Mb/s ± 30 ppm.
Format: coded B6ZS.
Polarity: DATA or $\overline{\text{DATA}}$ switched at binary level.
Impedance: nominal 110Ω balanced to GND.
Connector: WECO type 310A.
Triggering: fixed level with equalization.
Sensitivity: accepts Bell standard cross-connect waveform.
Indicator: LED illuminated if data transitions present.

DS-3 Input — Bell standard interface waveforms.

Bit Rate: 44.736 Mb/s ± 20 ppm.
Format: coded B3ZS.
Polarity: DATA or $\overline{\text{DATA}}$ switched at binary level.
Impedance: nominal 75Ω unbalanced to GND.
Connector: WECO type 440A.
Triggering: fixed level with or without equalization as appropriate (see below).
Sensitivity: 4 selectable settings HI, DSX-3, LO, MON.
DS-3 HI: amplitude, 909mV ± 1 dB pk; width (at half amplitude), 11.2 ns ± 1.1 ns; transition times, 4.5 ns ± 1.5 ns; overshoot/undershoot, < 10% of pulse amplitude.
DSX-3: Bell standard cross-connect waveform meeting CCITT Rec. G.703 para. 4 (see Page 1-13), corresponds to DS-3 HI signal passed through equivalent of 450 ft of WECO type 728A cable.
DS-3LO: corresponds to DSX-3 signal passed through equivalent of a further 450 ft of WECO type 728A cable.
DS-3 MON: same as DS-3HI, but with 13.8 dB of attenuation.
Indicator: LED illuminated if data transitions present.

Ternary Data Input Jitter Tolerance

The DSX-1, DSX-1C, DSX-2, and DS-3 data inputs operate without error in the presence of a signal with a jitter content within the nominal mask shown below.
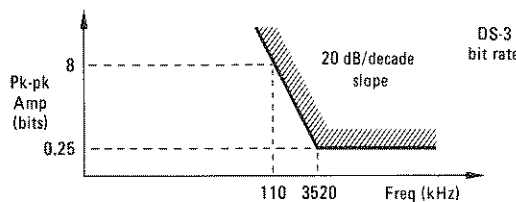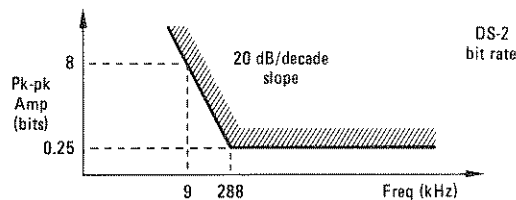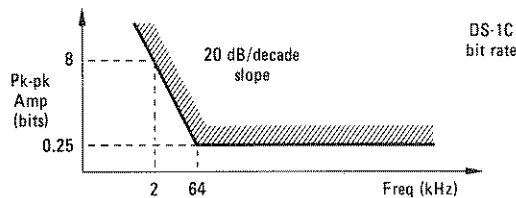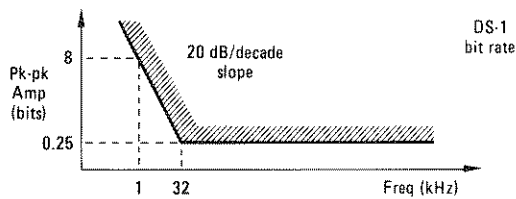
Binary Data Input (rear panel, switch selected)

Bit Rate: 1 kb/s to 50 Mb/s.
Format: binary NRZ.
Polarity: DATA or $\overline{DATA}$ switch.
Impedance: nominal 50Ω unbalanced.
Connector: BNC.
Termination: nominal −2V.
Amplitude: nominal ECL levels.
Protection: 100 mA fuse.

DATA OUTPUTS

Data Monitor Output

Source: decoded ternary, or binary, input data.
Format: binary NRZ without framing bits.
Impedance: nominal low unbalanced to GND.

Connector: BNC.
Amplitude: nominal ECL levels.
External Load : 50Ω into −2V, dc coupled; 50Ω into GND, ac coupled.
Protection: 100 mA fuse.

CLOCK

Recovered Clock

Frequency: recovered from ternary data inputs at 1.544 MHz (DS-1), 3.152 MHz (DS-1C), 6.312 MHz (DS-2) and 44.736 MHz (DS-3).

Binary Clock Input (rear panel, switch selected)

Frequency: 1 kHz to 50 MHz.
Impedance: nominal 50Ω unbalanced.
Connector: BNC.
Termination: nominal −2V.
Amplitude: nominal ECL levels.

Clock Monitor Output

Source: recovered clock from Ternary Data Inputs or rear-panel Binary Clock Input.
Format: continuous or gated when using framing.
Impedance: nominal low unbalanced to GND.
Connector: BNC.
Amplitude: nominal ECL levels.
Duty Cycle: nominal 50% on recovered clock.
External Load: 50Ω into −2V, dc coupled; 50Ω into GND, ac coupled.
Protection: 100 mA fuse.

PATTERNS

PRBS

Polynomials: $2^9 - 1$ to CCITT Rec. V.52 ($D^9 + D^5 + 1 = 0$); $2^{15} - 1$ to CCITT Rec. 0.151 ($D^{15} + D^{14} + 1 = 0$); $2^{20} - 1$ to Bell standards ($D^{20} + D^{17} + 1 = 0$).

WORD

Fixed Patterns: 0000, 1000, 1010, 1100, 1111; 17/15 (17 ones, 15 zeros).

Zero Substitution (PRBS only)

Sequence can be gated off for a number of clock periods, variable over the range 0 to 999 in unit steps. Gating occurs every sequence following the PRBS trigger. For unambiguous synchronization, the zero block should be limited to 250 zeros on $2^9 - 1$ PRBS. The display will flash repeatedly as a warning if 250 or more zeros are selected with this pattern.

Zero Limit

When the DS-1 or DS-1C bit rates are selected, the max. run length of zeros in the reference pattern is limited to 14.

SYNCHRONIZATION

Manual or automatic (for bit rate > 30 kb/s) are provided.

Frame Sync

When framing and control bits are present in the input data, the 3782B will synchronize onto the frame pulses and remove them from the input data. Framing may be inhibited by a switch.

DS-1 Frame Sync Loss: 3 out of 8 F_T bits in error.
    Multiframe Sync Loss. 2 consecutive F_S bits in error.
    Frame Sync Gain: 12 correct F_T bits.
    Multiframe Sync Gain: 12 correct F_S bits.
DS-1C F Frame Sync Loss. 3 out of 15 F bits in error.
    M Frame Sync Loss: 2 out of 3 M_1, M_2, M_3 (011) sequences in error.
    F Frame Sync Gain: 15 consecutive F bits correct.
    M Frame Sync Gain: 2 consecutive M_1, M_2, M_3 (011) sequences correct.
DS-2 Sync Loss: same as DS-1C.
    Sync Gain: same as DS-1C.
DS-3 F Frame Sync Loss: 3 out of 15 F bits in error.
    M Frame Sync Loss: 2 out of 3 M_5, M_6, M_7 (010) sequences in error.
    F Frame Sync Gain. 15 consecutive F bits correct.
    M Frame Sync Gain: 2 consecutive M_5, M_6, M_7 (010) sequences correct.

Pattern Sync

Sync Loss: > 1000 errors in 30,000 clock periods.
Sync Gain. < 10 errors in 300 clock periods.

TRIGGER OUTPUTS

Pattern Trigger Output

Format: one pulse every PRBS or WORD.
Position (with respect to Data Monitor Output): nominally 10 bits before longest run of zeros in PRBS, or nominally coincident with start of 4-bit WORD, or with 17th one in 17/15 pattern.
Impedance: nominal 50Ω unbalanced to GND.
Connector: BNC.
Amplitude: min. 1Vpk.
Width: one clock period, except with zero substitution when width stretched to approx. that of zero block.
Protection: open/short circuit protected; ± 5V max. short term voltage.

Frame Trigger Output

Format: one pulse per frame.
Position (with respect to Ternary Data Input): for DS-1, nominally 11 bits after last F_S bit in frame 12 of multiframe; for DS-1C, DS-2, nominally 12 bits after M_4 bit; for DS-3, nominally 12 bits after M_1 bit.
Width: one clock period.
Other specifications same as Pattern Trigger Output.

MEASUREMENTS

Binary Errors

Closed loop bit-by-bit detection at binary level.

Code Errors

Code violation detection as follows:
AMI: bipolar violations are code errors.
B6ZS: 0V0, 1V0, 1V1, 00V1 and 000000 are code errors (000 000V1 and 000 000V0 are counted as single code errors).
B3ZS: 1V, 000 and 010V are code errors.

Parity Errors (DS-3 only)

Parity errors occur when parity bits in one frame are not equal to the digital sum of the data bits in the previous frame.

DISPLAY MODES

Error Rate

Method: totalizes errors over selected gating period and automatically scales the answer.
Internal Gating: 10^6, 10^8, 10^{10} clock periods or 1, 10, 10^2, 10^3, 10^4 seconds, repetitive.
Manual Gating: START and STOP pushbutton switches.
External Gating: ECL compatible rear panel BNC input, high level enables count, nominal 50Ω unbalanced impedance with nominal −2V termination and 100 mA fuse protection.
Display: A.B 10^{-mn} LED.
Range: mn = 1 to 19 with automatic scaling.
Accuracy: indication given if measurement results is based on < 100 errors.

Note: Internal seconds, manual and external gating periods can be used only for Ternary Data Inputs. Other switch settings are flagged by an Error Code.

Error Count

Method: totalizes errors over selected gating period.
Gating: same as Error Rate.
Display: 5 digit LED with leading zero blanking.
Range. when count exceeds 99999, display automatically changes to A.B 10^{mn} with automatic round-up to a max count of 9.9×10^{19}

Error Seconds

Method: totalizes the number of seconds which contain one or more errors.
Gating: same as Error Rate.
Display: same as Error Count.
Range: same as Error Count.

Error Free Seconds

Method: totalizes the number of seconds during which no errors occur.
Gating: same as Error Rate.
Display. same as Error Count.
Range: same as Error Count.

Error Codes

1. Error Rate display not permitted for Binary Inputs when Gating Period set to 1, 10, 10^2, 10^3, 10^4 seconds, external or manual.
2. Parity Error measurements not permitted for DSX-1, DSX-1C or DSX-2 Data Inputs.
3. Parity Error measurements not permitted for DS-3 Data Inputs without framing.
4. Code Error measurements not permitted for Binary Inputs.

5. Code "31" not permitted for HP-IB address.
6. Talk Only mode not permitted when controller connected.
7. Power interrupt and measurement restarted.

Real-Time Clock

When rear panel switch set to VIEW/SET, local time can be viewed or set on the display in hours and minutes.

Display: HH MM.
Setting: START pushbutton sets Hours; STOP pushbutton sets Minutes; hold activated by depressing both pushbuttons, which also sets Seconds to zero.
Accuracy: setting tolerance better than ± 3 ppm at ambient temperature.
Stability: typically better than ± 12 ppm, 0°C to 55°C, typically better than ± 5 ppm/year aging.

LED Flags

Gating: indicates measurement in progress.
Errors: indicates errors being detected; each error pulse stretched to approx 500 ms.
Pattern Sync Loss: indicates local reference pattern has lost sync; LED remains lit for at least 500 ms.
Frame Sync Loss: indicates loss of frame alignment; LED remains lit for at least 500 ms.
AIS: indicates < 3 zeros in 3438 ones; LED remains lit for at least 500 ms.
< 100 Errors: indicates Error Rate result based on < 100 errors.

OTHER OUTPUTS

Error Output

Format: one pulse per error.
Impedance: nominal 50Ω unbalanced to GND.
Connector: BNC.
Amplitude: min 1V pk-pk about GND.
Protection: open/short circuit protected; ± 5V max short-term voltage.

HP-IB FACILITIES

General

Modes: "ADDRESSABLE" or "TALK ONLY", switch-selected (rear panel).
LOCAL Switch: allows switching from "remote" to "local" control except when the controller has issued a "local lockout" command.
Flags: Local, Remote, Listen, Talk, SRQ.
Implementation: SH1 (complete capability);
AH1 (complete capability);
T5 (basic talker, serial poll, talk only mode, unaddress if MLA);
TE0 (no capability);
L4 (basic listener, unaddress if MTA);
LE0 (no capability);
SR1 (complete capability);
RL1 (complete capability);
PP0 (no capability);
DC1 (complete capability);
DT0 (no capability);
C0 (no capability).

Controlling Masks

To permit flexibility in the use of the 3782B, many of the important operating parameters are governed by "masks". At power-on, these masks are given default values which may be overwritten in the local and remote states of the "ADDRESSABLE" mode. In the "TALK ONLY" mode, five of the masks are controlled by the five parts of the HP-IB Address switch. Full details are given in the 3781B/3782B HP-IB Users Guide or Operating Manual.

ADDRESSABLE Mode

Scope: used when 3782B operates with an external controller; allows control of all switches except Power, Line Voltage Selection, Local, HP-IB Address, ADDRESSABLE/TALK ONLY and Real Time Clock.
Functions: overwrite a slide-switch or pushbutton; request the current display answer; request the flag information (except Errors); initialise the internal real-time clock; request the current switch positions and masks; load the switch positions and masks; "local lockout" facility; power-on reset; service requests controllable by masks.

TALK ONLY Mode

Scope: used when 3782B operates without an external controller.
Function: provides output messages to a peripheral such as 5150A Thermal Printer or 9875A Cartridge Tape Unit connected in "LISTEN ONLY" mode.

Result Print Threshold Switch

Function: governs whether results are issued (TALK ONLY and ADDRESSABLE modes), a service request is generated and another gating period started automatically (ADDRESSABLE mode only).
Switch Positions: N = 15 threshold always satisfied; N = 14 threshold satisfied only if one or more errors have occurred; $0 \leqslant N \leqslant 13$ threshold satisfied only if error rate is worse than 1.0×10^{-N}.

General (3781B and 3782B)

Power Supply

Input Voltages: 115V −22%, +10%; 230V −18%, +10%.
Frequency: ac 48 to 66 Hz.
Consumption: approx. 150 VA, each.

Dimensions

Width: 335 mm (13.2 in).
Height: 195 mm (7.7 in).
Depth: 475 mm (18.7 in).

Weight

Net: 11 kg (24.2 lb).
Shipping: 13.5 kg (29.7 lb).

Environment

Operating Temperature Range: 0°C to 55°C.
Storage Temperature Range: −40°C to 75°C.

Bell standard cross-connect waveforms
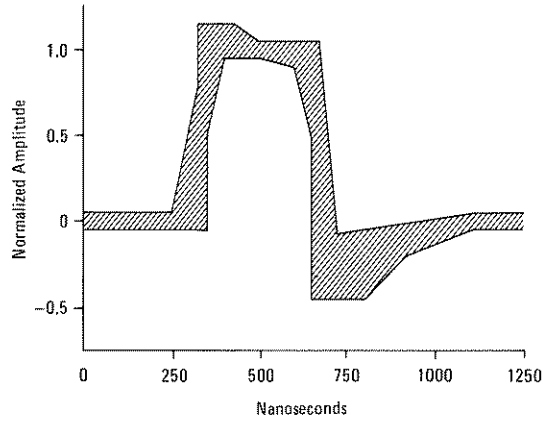
DSX-1 Isolated Pulse Template
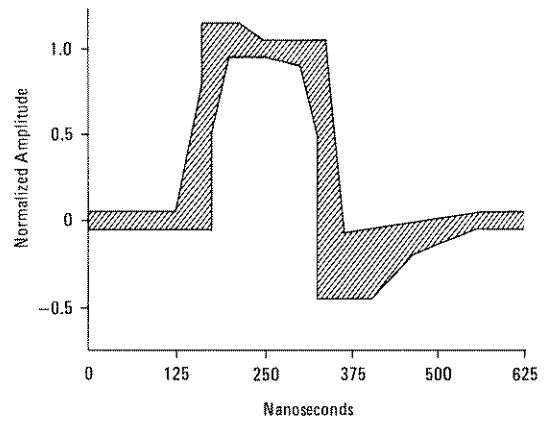
DSX-1C Isolated Pulse Template
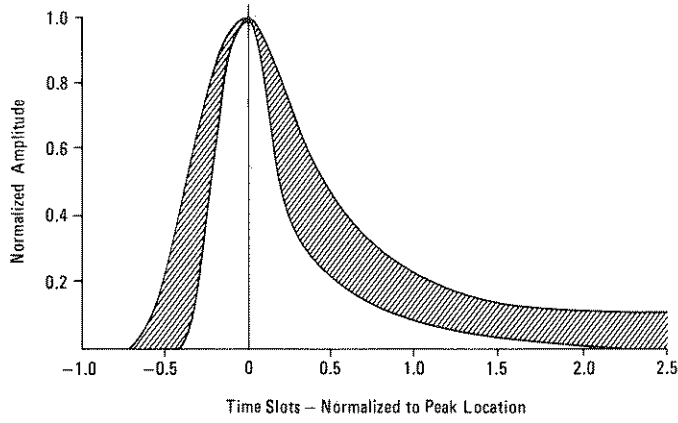
DSX-2 Isolated Pulse Template
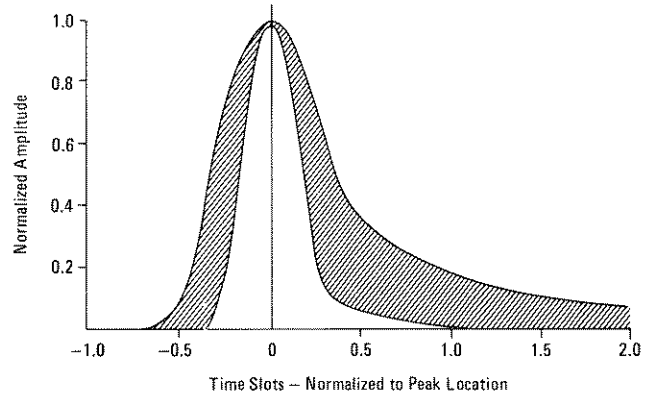
DSX-3 Isolated Pulse Template

SECTION II

INSTALLATION

2-1 INTRODUCTION

2-2 This section contains information and instructions required to prepare the 3781B and 3782B for use. Included in this section are the initial inspection procedures, power and grounding requirements, fuse selection procedure, installation information and instructions on repacking for shipment.

2-3 INITIAL INSPECTION

WARNING

To avoid hazardous electrical shock, do not perform electrical tests when there are signs of shipping damage to any portion of the outer enclosure (covers, panels, meters).

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 and listed in Paragraph 1-90. Procedures for checking electrical operation are given in Section IV of the Service Manuals.

If the contents of the shipment are incomplete, if there is mechanical damage or defect, notify the nearest Hewlett-

Packard Office. If the instrument does not pass the electrical performance checks given in Section IV of the Service Manual, notify the nearest Hewlett-Packard Office. If the shipping container is also damaged, or the cushioning material shows signs of stress, notify the carrier as well as the Hewlett-Packard Office. Keep the shipping materials for carrier's inspection. The Hewlett-Packard Office will arrange for repair or replacement without waiting for claim settlement.

2-5 PREPARATION FOR USE

2-6 Power Requirements ⚠

2-7 The 3781B and 3782B each requires a power source of 115V (+10%, −22%) or 230V (+10%, −18%) at a frequency between 48 to 66Hz. Total power consumption of each is less than 150VA.

CAUTION

Before connecting these instruments to a power outlet ensure that the voltage selector is correctly set for the voltage of the power source and a fuse of the correct rating is fitted.

2-8 Line Voltage Selection ⚠

2-9 Figure 2-1 provides instructions on the setting of the voltage selector. Fuse ratings for the different power source voltages are given in Table 2-1.
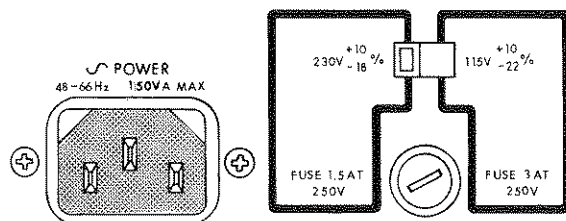
1. Remove power cord.

2. Insert screwdriver into slot of voltage selector and push to left or right (depending on supply voltage).

3. Unscrew fuse compartment end cap, fit appropriate fuse and replace end cap.

Figure 2-1 Line Voltage Selection

Table 2-1 Fuses

Nominal Line Voltage	Fuse Rating	HP Part Number
115V +10% −22%	*3A 250V (TIME DELAY)	2110-0381
230V +10% −18%	*1.5A 250V (TIME DELAY)	2110-0304

*Appropriate fuse supplied with instrument.

2-10 Power Cord

2-11 The power cord supplied with each instrument varies with the country of destination. Figure 2-2 illustrates the standard power plug and cord configurations that are commonly used. The part number shown beneath each plug is the part number of the appropriate power cord and plug.

If the appropriate power cord is not included with the instrument notify the nearest HP Sales/Service Office and a replacement will be provided.

| 8120-2104 | 8120-1369 | *8120-1689 | 8120-1351 | 8120-1378 | 8120-2956 |
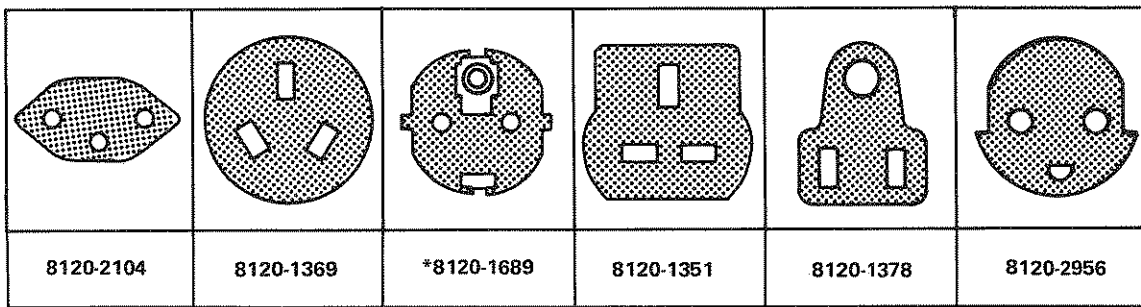
Note: In order to pass German Std. FTZ527 Power cord 8120-2857 must be fitted to the instrument.

Colour codes for each cable are: LINE-Brown, NEUTRAL-Blue, EARTH-Green/Yellow.

Figure 2-2 Power Cable and Mains Plug Part Numbers

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).

2-12 HP-IB Address Selection

2-13 The 3781B and 3782B HP-IB talk and listen address switches are located on the rear panel.

2-14 Use a pencil to set the switches to the desired HP-IB address. The switches are illustrated in Figure 2-3. The allowable HP-IB address codes are given in Table 2-2.

2-15 Interconnections

2-16 Interconnection data for the Hewlett-Packard Interface Bus (HP-IB) is provided in Figure 2-4.

2-17 Mating Connectors

2-18 Interface Connector. The HP-IB mating connector is shown in Figure 2-4. (Note that the two securing screws are metric.)

2-19 Coaxial Connectors. Coaxial mating connectors used with the Pattern Generator should be 50Ω coaxial BNC male connectors or WECO Type 310A or 440A connectors. (75Ω coaxial BNC connectors with the 3781B Option 001.)

3781B

3782B
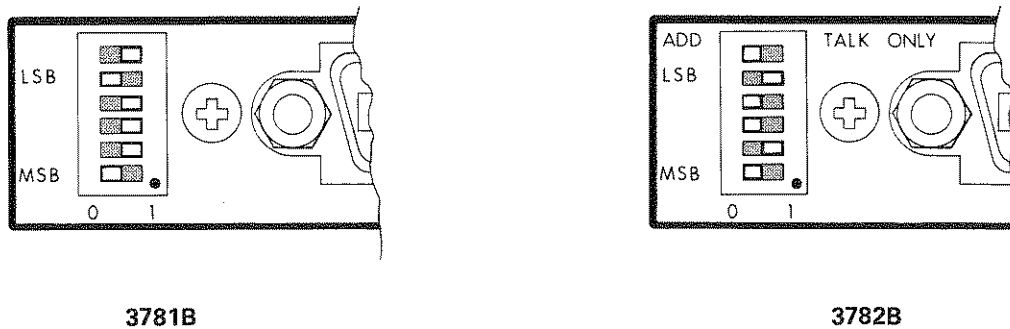
Figure 2-3 HP-IB Address Switches

Logic Levels

The Hewlett-Packard Interface Bus logic levels are TTL compatible, ie., the true (1) state is 0.0V dc to +0.4V dc and the false (0) state is +2.5V dc to +5.0V dc.

Programming and Output Data Format

Refer to Section III (Operation).

Mating Connector

HP1251-0293; Amphenol 57-30240.

Mating Cables Available

HP10631A, 1 metre (3.3ft)
HP10631B, 2 metres (6.6ft)
HP10631C, 4 metres (13.2ft)
HP10631D, 0.5 metres (1.6ft)

Cabling Restrictions

1. An HP-IB System may contain no more than 2 metres (6ft) of connecting cable per instrument.

2. The maximum accumulative length of connecting cable for any HP-IB System is 20.0 metres (65.6ft).

Figure 2-4 Hewlett-Packard Interface Bus Connection

Table 2-2 Allowable HP-IB Address Codes

Address Switches					Talk Address Character	Listen Address Character	Decimal Equivalent
A5	A4	A3	A2	A1			
0	0	0	0	0	@	SP	0
0	0	0	0	1	A	!	1
0	0	0	1	0	B	''	2
0	0	0	1	1	C	#	3
0	0	1	0	0	D	$	4
0	0	1	0	1	E	%	5
0	0	1	1	0	F	&	6
0	0	1	1	1	G	'	7
0	1	0	0	0	H	(	8
0	1	0	0	1	I	)	9
0	1	0	1	0	J	*	10
0	1	0	1	1	K	+	11
0	1	1	0	0	L	,	12
0	1	1	0	1	M	--	13
0	1	1	1	0	N	.	14
0	1	1	1	1	O	/	15
1	0	0	0	0	P	0	16
1	0	0	0	1	Q	1	17
1	0	0	1	0	R	2	18
1	0	0	1	1	S	3	19
1	0	1	0	0	T	4	20
1	0	1	0	1	U	5	21
1	0	1	1	0	V	6	22
1	0	1	1	1	W	7	23
1	1	0	0	0	X	8	24
1	1	0	0	1	Y	9	25
1	1	0	1	0	Z	:	26
1	1	0	1	1	[	;	27
1	1	1	0	0	\	$<$	28
1	1	1	0	1	]	$=$	29
1	1	1	1	0	$\cap$	$>$	30

2-20 Operating Environment

2-21 The instrument should be operated in temperatures within the range 0°C to +55°C and at altitudes up to 4,500 metres (15,000ft). At all times the instrument should be protected from temperature extremes and environments which cause condensation within the instrument.

2-22 RACK MOUNTING

2-23 A Rack Mount Kit is available for use with the 3781B and 3782B and can be purchased from your nearest Hewlett-Packard Office. For more detailed information, refer to Paragraph 1-86.

2-24 Instructions on conversion to rack mounting are included with the rack mount kit and are also reproduced in Figure 2-5 for convenience.

Inches	mm
19.000 =	482.6
18.646 =	473.61
0.344 =	8.74
8.718 =	221.44
7.234 =	183.74
1.484 =	37.69
12.300 =	312.30
17.036 =	432.54
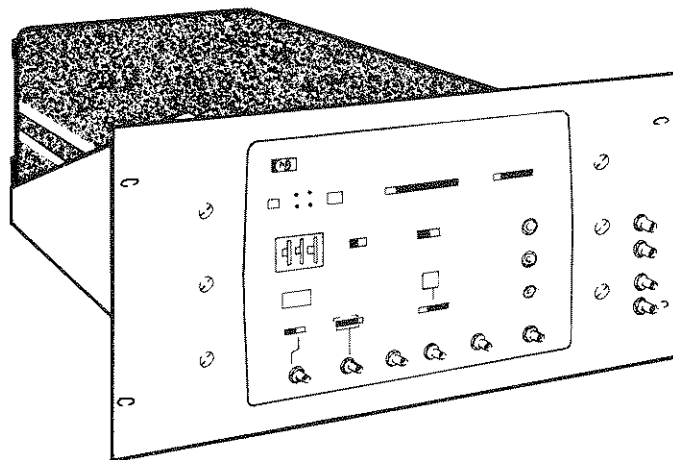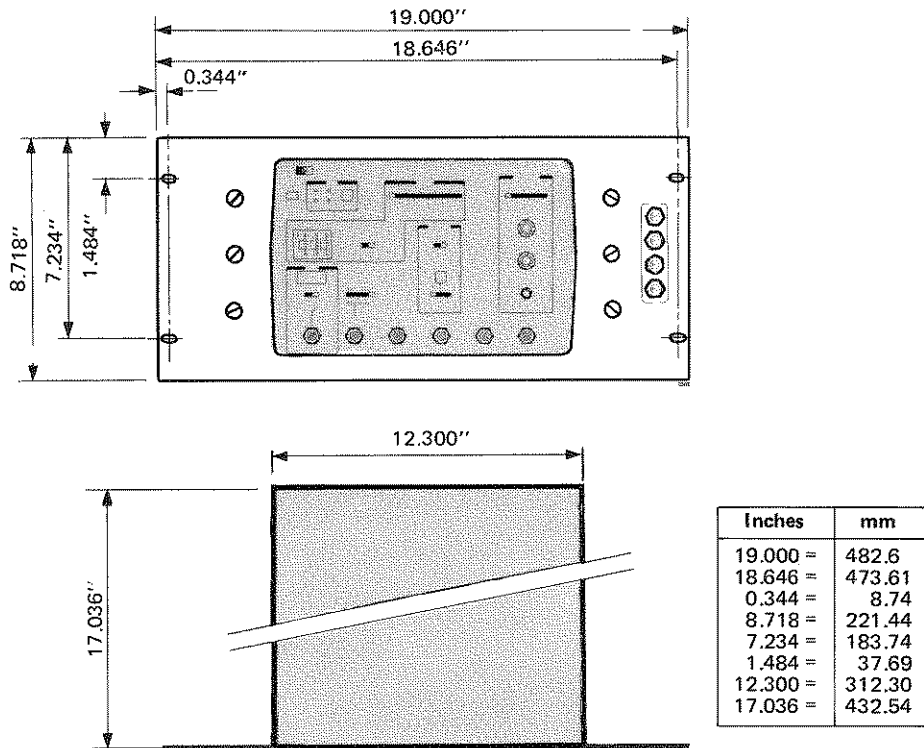
Figure 2-5 Rack Mounting (3781B)

2-25 STORAGE AND SHIPMENT

2-26 Environment

2-27 The instrument may be stored or shipped in environments within the following limits:

Temperature . . . . −40°C to +65°C
Altitude . . . . Up to 15,200 metres
(50,000 feet)

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

2-28 Repackaging for Shipment

2-29 **Tagging for Service.** If the instrument is being returned to Hewlett-Packard for service, please complete one of the blue repair tags located at the beginning of the Service Manual and attach it to the instrument.

2-30 **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.

2-31 **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 a 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 350-pound test material is adequate.

(c) Use a layer of shock-absorbing material 70 to 100 mm (3- to 4-inch) thick around all sides of the instrument to provide firm cushioning and prevent movement inside container. Protect 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 explains the functions of the controls, connectors and indicators of the HP Models 3781B Pattern Generator and 3782B Error Detector. Also included in this section is an explanation of the HP-IB functions of both instruments and a check procedure on the main functions of the instrument. At the rear of this section are instructions for maintenance of the air filters.

3-3 For convenience, the fold-out contains the key to all front-panel controls, etc.

3-4 POWER CONTROLS AND CONNECTORS

3-5 Details of setting the supply voltage and fuse selection are given in Section II.

WARNING

Before the instrument is switched on, all protective earth terminals, extension cords, auto-transformers and devices connected to it should be connected to a protective earth ground socket. Any interruption of the protective earth grounding will cause a potential shock hazard that could result in personal injury.

Only fuses with the required rated current and of specified type should be used. Do not use repaired fuses or short-circuited fuse holders. To do so could cause a shock or fire hazard.

CAUTION

Before the instrument is switched-on, it must be set to the voltage of the power source or damage to the instrument may result.

3-6 The POWER switch (5) in 3781B and (7) in 3782B controls the ac power input to the instrument.

DS-1C, DS-2 or DS-3 rates selected or 4 bits before the first F_T bit at the DS-1 rate. The amplitude of the FRAME TRIG OUTPUT is 1V pk-pk and is a 50Ω unbalanced signal.

G DSX-1, DSX-1C, DSX-2 DATA OUTPUT supplies the necessary signals and levels, depending on the position of the DATA OUTPUT switch (16), to interface with BELL System cross-connect points. For a DSX-1 output signal the frequency is 1.544MHz and for DSX-1C the frequency is 3.152MHz. For DSX-1 and DSX-1C, the format is coded AMI and the data structure allows a maximum of 14 consecutive zeros in the output — regardless of pattern selection. The output signal amplitude is 3V ± 0.3V pk at a nominal 110Ω. The connector is WECO type 310A.

H and J DS-3 and DELAYED DS-3 DATA OUTPUTS supply the necessary signals and levels, depending on the position of the DATA OUTPUT switch (16), to interface with the terminal equipment and BELL System cross-connect points. The DS-3 output signal frequency is 44.736MHz and the format is B3ZS. There are three positions on the DATA OUTPUT switch (16) controlling the DS-3 outputs. These positions are DS-3LO, DSX-3 and DS-3HI. The output signal in the DS-3 LO mode is a shaped pulse equivalent to a DSX-3 pulse passed through a further 450 ft of WECO Type 728A cable. The output signal in the DS-3 mode is the standard cross-connect waveform (CCITT Rec. G703 Para 4). In the DS-3HI mode, the output signal is a pulse of 11.2ns width and 909mV amplitude. The DELAYED DS-3 OUTPUT signal has the same characteristics as the DS-3 OUTPUT, except that the signal is delayed by 22 bits. The connectors are WECO Type 440A.

1 JITTER switch activates the jitter modulation circuitry and the amount of jitter added to the output data is displayed in the JITTER LED display (2).

2 JITTER LED display gives a 4-digit display of pk-pk jitter (bits). The display flashes when the signal is out-of-range. The display is valid for periodic modulating frequencies down to 5Hz.

3 FRAMING switch adds a framing pulse sequence, depending on the DATA OUTPUT selected, to the output pattern.

4 PRBS ZERO SUBSTITUTION switch, when used in conjunction with the PRBS modes of the PATTERN switch (12) substitutes any number of zeros (up to 999) in the PRBS. When the DS-1 or DS-1C rates are selected, the maximum run length of zeros in the output pattern is limited to 14.

3-7 3781B Pattern Generator CONTROLS, CONNECTORS AND INDICATORS

3-8 Front-Panel Description

A JITTER INPUT operates at the DS-1, DS-1C, DS-2 or DS-3 rates. The frequency range of the JITTER INPUT for the DS-1, DS-1C and DS-2 rates is dc to 5% of bit rate. The frequency range of the JITTER INPUT for the DS-3 rates is dc to 2.5% of bit rate. The maximum jitter amplitude obtainable on the DS-1, DS-1C and DS-2 signals is 10.1 bits pk-pk and the maximum jitter on the DS-3 signals is 20.2 bits pk-pk.

B CLOCK INPUT accepts an external clock input signal in the range 1kHz to 50MHz. The maximum acceptable input amplitude is 5V pk-pk within excursion limits of ± 5V. This 75Ω unbalanced input is triggered by automatic, GND or ECL threshold levels with a minimum pulse width of 8ns.

C CLOCK MONITOR OUTPUT ECL allows the clock signal to be monitored or used with binary data. It is a low-impedance output giving nominal ECL levels. The external loading should be 50Ω to −2V or 50Ω to GND ac.

D DATA MONITOR OUTPUT ECL supplies the same information as the DSX-1, DSX-1C, DSX-2 and DS-3 OUTPUTS – but in a binary NRZ format. It is a low-impedance output giving nominal ECL levels. The external loading should be 50Ω to −2V dc or 50Ω to GND ac.

E PATTERN TRIG OUTPUT supplies one pulse every PRBS or WORD. The DSX-1, DSX-1C, DSX-2 and DS-3 output signals are delayed by 4 bits from the DATA MONITOR OUTPUT. The PATTERN TRIG OUTPUT output pulse, in the DSX-2 and DS-3 modes, is in one of three positions. These positions, with respect to the DATA MONITOR OUTPUT signal, are:

(1) coincident with the bit preceding the longest run of zeros in PRBS.

(2) coincident with the 2nd bit of the 4-bit word.

(3) coincident with the 9th zero in the 17/15 pattern. The amplitude of the PATTERN TRIG OUTPUT signal is 1V pk and is a 50Ω unbalanced signal.

The DSX-1, DSX-1C TRIG OUTPUT signal is 15 bits before equivalent DS-2 or DS-3 position.

F FRAME TRIG OUTPUT supplies one pulse per frame. Its position, with respect to the DATA MONITOR OUTPUT, is 4 bits before the M_1 position when
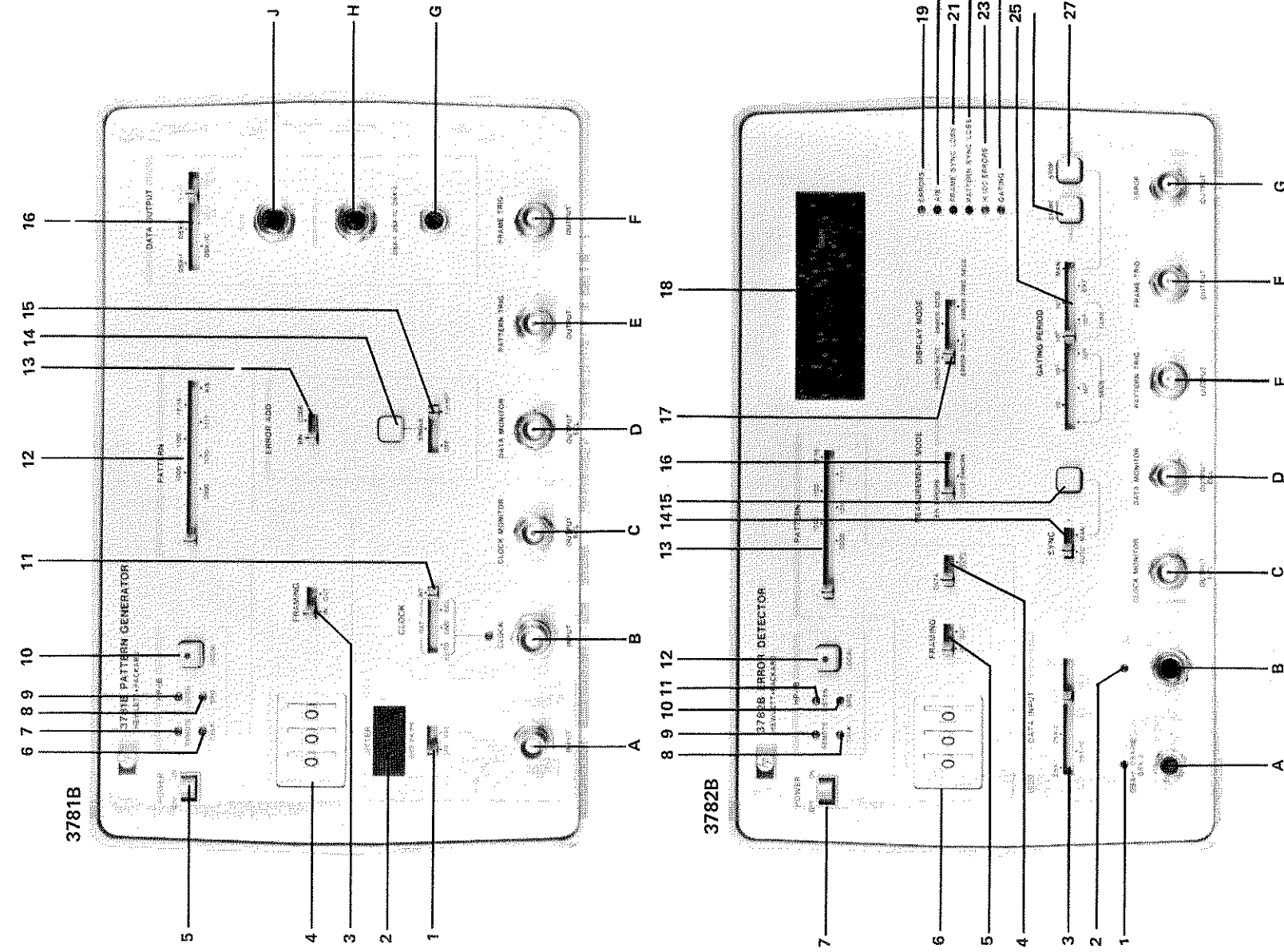

Figure 3-1 Key to Front-Panel Controls, Connectors and Indicators

5   POWER switch activates the entire instrument by controlling the ac supply.

6   TALK LED (HP-IB function) indicates that the 3781B is able to pass information over the HP-IB.

7   REMOTE LED (HP-IB function) indicates that the 3781B is being controlled from an external source.

8   SRQ LED (HP-IB function) indicates that the 3781B is requesting service from the HP-IB.

9   LISTEN LED (HP-IB function) indicates that the 3781B is listening to information from the HP-IB.

10 LOCAL switch (HP-IB function) allows the 3781B to be switched from Remote to Local control (indicated by the REMOTE and LOCAL LEDs), except when a Local Lockout signal has been issued by the Controller. The LOCAL LED indicates that the 3781B is being controlled via the front panel.

11 CLOCK switch selects which CLOCK SOURCE will be used in the 3781B. If the INT mode is selected, a clock rate dependent on the position of the DATA OUTPUT switch (16) is internally generated. For a hierarchy level of DS-1, the internally-generated clock is 1.544MHz; for DS-1C, the clock is 3.152MHz; for DS-2, the clock is 6.312MHz; for DS-3, the clock is 44.736MHz. In the EXT mode, one of three positions is available (AUTO, GND and ECL) giving a choice of input termination and trigger level. This allows the 3781B to be operated over the frequency range 1kHz to 50MHz.

12 PATTERN switch can be segmented into three groups – PRBS, 4-bit words and miscellaneous.

PRBS: the 3781B offers a choice of three PRBS modes – 2^9-1 (511 bits), $2^{15}-1$ (32767 bits) and $2^{20}-1$ (1048575 bits). The PRBS patterns are also used in conjunction with the PRBS ZERO SUBSTITUTION switch (4).

4-bit words: the 3781B offers a choice of five 4-bit words – 0000, 1000, 1010, 1100 and 1111.

miscellaneous: these patterns consist of 17/15 and AIS. 17/15 is a pattern of 17 'ones' and 15 'zeros'. AIS is a pattern of all 'ones' without framing.

13 Part of the ERROR ADD facility which selects between binary or code errors.

14 and 15 Part of the ERROR ADD facility selecting the degree of induced error in the signal. A single error, or one error in every 10^5 (100,000) clock periods may be introduced.

16 DATA OUTPUT switch selects the appropriate interface (line code, framing structure, interface voltage levels and bit rate) depending on where in the hierarchy the 3781B is connected. The hierarchy levels available are DSX-1, DSX-1C, DSX-2, DS-3 LO, DSX-3 and DS-3 HI.

3-9 Rear-Panel Description

HP-IB. The 3781B accepts and supplies information via this rear-panel socket. The HP-IB facility can control all switches except POWER and LOCAL. The REMOTE, LOCAL, TALK, LISTEN and SRQ LEDs indicate the HP-IB status of the 3781B. The 3781B is designed to operate in the addressable mode. The HP-IB address is set by the rear-panel, dual-in-line ADDRESS switch. If no Controller is connected, the setting of this switch is immaterial.

3-10 3782B Error Detector CONTROLS, CONNECTORS AND INDICATORS

3-11 Front-Panel Description

A   DSX-1, DSX-1C, DSX-2 DATA INPUT accepts signals and levels from the appropriate hierarchy levels, depending on the position of the DATA INPUT switch (3). In the DSX-1 position, the signal applied to the 3782B should be 1.544Mb/s; and in the DSX-1C position, the signal should be 3.152Mb/s. The signal format for both positions is coded AMI. In the DSX-2 position, the signal applied to the 3782B should be 6.312Mb/s with a signal format of B6ZS. For all signals, the maximum amplitude should be 5V pk within excursion limits of $\pm$ 5V. An LED above the input (1) is illuminated if data transitions are present. This input uses a WECO Type 310A, 110Ω balanced connector.

B   DS-3 DATA INPUT accepts signals and levels from the appropriate hierarchy levels, depending on the position of the DATA INPUT switch (3). The signal applied to the 3782B should be 44.736Mb/s with a signal format of B3ZS. There are four positions on the DATA INPUT switch (3) controlling the DS-3 DATA INPUT signal. The positions are DS-3 LO, DSX-3, DS-3 HI and DS-3 MON. The input signal for DS-3 LO should be a shaped pulse equivalent to a DSX-3 pulse passed through a further 450 ft of WECO Type 728A cable. For DSX-3, the input signal should be the standard cross-connect waveform (CCITT Rec G703 Para 4). For DS-3 HI, the input signal should be of 11.2ns width and 909mV amplitude. DS-3 MON accepts the equivalent of a DS-3 HI pulse attenuated by 13.8dB. An LED above the input (2) is illuminated if data transitions are present. Data loss is detected within 100ms. This input uses a WECO Type 440A, 75Ω connector.

C CLOCK MONITOR OUTPUT ECL signal is the recovered clock from the DATA INPUT signal (A) or (B), or the rear-panel BINARY CLOCK INPUT signal. This output signal is continuous except when the input signal has a frame signal superimposed. When a frame signal is present, the CLOCK MONITOR OUTPUT signal is gated off whenever a framing bit occurs.

D DATA MONITOR OUTPUT ECL supplies the same data as that accepted by the DATA INPUT (A) or (B). The format of the output signal is binary (without framing bits) and has ECL levels.

E PATTERN TRIG OUTPUT supplies one pulse every PRBS or WORD. The output pattern is related to the DATA INPUT signal (A) or (B). There is approximately 6 bits delay between the DATA INPUT signal and the PATTERN TRIG OUTPUT signal. The amplitude of the PATTERN TRIG OUTPUT signal is 1V pk and is a 50Ω unbalanced signal.

F FRAME TRIG OUTPUT supplies one pulse per frame. The position of the output pulse (with respect to the ternary input) is as follows:

DSX-1   approx 11 bits after last F_s bit
DSX-1C approx 12 bits after M_4 bit
DSX-2   approx 12 bits after M_4 bit
DS-3   approx 12 bits after M_1 bit

The amplitude of the FRAME TRIG OUTPUT signal is 1V pk and is a 50Ω unbalanced signal.

G ERROR OUTPUT supplies one pulse per error at a minimum amplitude of 1V pk-pk.

1 DSX-1, DSX-1C, DSX-2 LED illuminates if data transitions are present at the DSX-1, DSX-1C, DSX-2 DATA INPUT (A).

2 DS-3 LED illuminates if data transitions are present at the DS-3 DATA INPUT (B).

3 DATA INPUT switch selects the appropriate interface (line code, framing structure and bit rate) depending on where in the hierarchy the 3782B is connected. The hierarchy levels available are DSX-1, DSX-1C, DSX-2, DS-3LO, DSX-3, DS-3HI and MON DS-3.

4 DATA/$\overline{\text{DATA}}$ switch can invert the input data signal. Inversion occurs at the binary signal level.

5 FRAMING switch is set to IN, if the input data contains the frame pulse sequence. The Error Detector thus looks for frame synchronization before making measurements.

6 PRBS ZERO SUBSTITUTION switch, when used in conjunction with the PRBS modes of the PATTERN switch (13), substitutes any number of zeros (up to 999) in the PRBS reference pattern.

7 POWER switch activates the entire instrument by controlling the ac supply.

8 TALK LED (HP-IB function) indicates that the 3782B is able to pass information over the HP-IB.

9 REMOTE LED (HP-IB function) indicates that the 3782B is being controlled from an external source.

10 SRQ LED (HP-IB function) indicates that the 3782B is requesting service from the HP-IB.

11 LISTEN LED (HP-IB function) indicates that the 3782B is listening to information from the HP-IB.

12 LOCAL switch (HP-IB function) allows the 3782B to be switched from Remote to Local control (indicated by the REMOTE and LOCAL LEDs) except when a Local Lockout signal has been issued by the Controller. The LOCAL LED indicates that the 3782B is being controlled via the front panel.

13 PATTERN switch can be segmented into three groups – PRBS, 4-bit words and miscellaneous.

PRBS: the 3782B offers a choice of three PRBS modes – $2^9 - 1$ (511 bits), $2^{15} - 1$ (32767 bits) and $2^{20} - 1$ (1048575 bits). The PRBS patterns are also used in conjunction with the PRBS ZERO SUBSTITUTION switch (6).

4-bit words: the 3782B offers a choice of five 4-bit words – 0000, 1000, 1010, 1100 and 1111.

miscellaneous: these patterns consist of 17/15, which is a pattern of 17 'ones' and 15 'zeros'.

14 SYNC switch selects the method of detecting loss of synchronization and how a search for synchronism will be initiated. When the SYNC switch is in the AUTO mode, PATTERN SYNC and FRAME SYNC (if FRAMING switch set to IN) are monitored independently. After Pattern Sync Loss or Frame Sync Loss is detected, a search for synchronism is automatically initiated. Pattern Sync Loss will only be detected correctly if there are at least 30,000 clock periods in the selected gating period. If the 3782B is operated at low frequencies, via the BINARY CLOCK and DATA INPUTs, Frame Sync Gain may take an excessive time. However, this time can be minimized by switching to MAN SYNC. In the MAN SYNC mode, automatic sync loss detection is removed. Pressing the MAN SYNC pushbutton (15) initiates a search for synchronism. Before full synchronism is achieved, Frame Sync and Pattern Sync must be achieved.

Frame Sync must be achieved when framing and control bits are present in the input data. The 3782B synchronizes onto the frame pulses and removes them from the input data. The framing on the DSX-1, DSX-1C, DSX-2 and DS-3 signals may be disabled by the FRAMING switch (5). If frame sync loss occurs (sync loss criterion depends on frame type), the FRAME SYNC LOSS LED (21) illuminates.

Pattern Sync is monitored by the 3782B. If pattern sync loss occurs (> 1000 errors in 30,000 clock periods) the PATTERN SYNC LOSS LED (22) illuminates. Pattern sync gain is achieved when there are < 10 errors in 300 clock periods.

15 This push-button, with the SYNC switch (14) in the MANUAL mode, enables the operator to re-synchronize the 3782B.

16 MEASUREMENT MODE switch has three positions — depending on the measurement required. The measurements available are BIN ERRORS (binary errors) CODE ERRORS and PARITY ERRORS.

Binary Errors are detected by closed-loop, bit-by-bit error detection at the binary level after interface coding has been removed. Binary errors are detected in pseudo-random data sequences and fixed word patterns.

Code Errors are defined as follows:

AMI (DSX-1, DSX-1C rates) — a bi-polar violation is a code error.

B6ZS (DSX-2 rate) — 0VO, 1VO, 1V1 and 000000 are code errors, where V is a bi-polar violation.
Note that 000000V1 and 000000V0 are counted as single errors.

B3ZS (DS-3 rate) — 1V, 000 and 010V are code errors.

Code errors can be measured on live traffic as well as on patterns generated by the 3781B. However, they only have significance for the section following the previous interface encoder.

Parity Errors relate to the DS-3 rate. These errors occur when parity bits in one frame are not equal to the digital sum of the data bits in the previous frame.

17 DISPLAY MODE switch selects how the measured errors (binary, code or parity) may be displayed. Four error modes are provided — ERROR RATE, ERROR COUNT, ERROR SECS or ERROR FREE SECS. The result is displayed, by LEDs, in the parameter display window (18). Note that for each measurement over a selected gating period, any one of the four modes may be selected to show the result ie., all four calculations are made simultaneously and the processor displays the desired result.

The only exception occurs when binary inputs are used. ERROR RATE is available only when the CLOCKS gating period is selected.

18 The result display window gives an LED display of the measured errors. The five-digit LED display, with leading zero blanking, automatically changes to $A. B\ 10^{MN}$ format when a count of 99999 is exceeded. The display for error rate is formatted $A. B\ 10^{-MN}$ (where M can be blank or 1).

At the end of the gating period, the display will automatically show the measurement result that has been selected by the DISPLAY MODE switch. Any of the four measurement results can be displayed by simply setting the DISPLAY MODE switch to the appropriate position, as all four measurements are made simultaneously. This feature can be used irrespective of the selected gating period and does not affect the current measurement.

Besides displaying measurement results, the display can also be used to display the real-time clock. Also, the display will give a flashing single-digit error code, if the operator has inadvertently selected incompatible switch settings.

19 ERRORS LED, when illuminated, indicates that error pulses are being detected. Each error pulse is stretched to approximately 500ms.

20 AIS (Alarm Indication Signal) LED illuminates when *less* than 3 zeros are detected in a run of 1390 ones. The LED remains illuminated for at least 500ms.

21 FRAME SYNC LOSS LED, when illuminated, indicates a loss of framing (as defined by BELL Standards). This facility is used in conjunction with the SYNC switch (14). The LED remains illuminated for at least 500ms.

22 PATTERN SYNC LOSS LED, when illuminated, indicates that the local pattern reference has lost sync with the incoming pattern. This facility is used in conjunction with the SYNC switch (14). The LED remains illuminated for at least 500ms.

23 < 100 ERRORS LED indicates that an Error Rate measurement result has been based on less than 100 errors ie., the statistical variance in the result is greater than 10%.

24 GATING LED indicates that a measurement is in process.

25 GATING PERIOD switch selects the measurement gating period either in SECONDS, number of CLOCKS, MANUALLY or EXTERNALLY operated.

26 START push-button initiates a gating period, when the GATING PERIOD switch (25) is in the MAN mode. When the rear-panel REAL TIME CLOCK switch is set to VIEW/SET, the START push-button is used to set HOURS on the local time display.

27 STOP push-buttons terminates a gating period, when the GATING PERIOD switch (25) is in the MAN mode. When the rear-panel REAL TIME CLOCK switch is set to VIEW/SET, the STOP push-button is used to set MINUTES on the local time display.

When the REAL TIME CLOCK switch set to VIEW/SET, pressing both push-buttons (25) and (26) simultaneously holds the clock display with the seconds count at zero — ready for initialization when the push-buttons are released.

3-12 Rear-Panel Description

BINARY DATA INPUT is an alternative data input to the 3782B, via the rear-panel BIN/TERNARY switch. The frequency range available is 1kb/s to 50Mb/s with a binary, ECL, NRZ format.

BINARY CLOCK INPUT is used to supply clock to the 3782B via the rear-panel BIN/TERNARY switch (when the BINARY DATA INPUT is used). The clock rate should be in the range 1kHz to 50MHz, with an ECL format.

EXT GATING INPUT. When the GATING PERIOD switch (25) is set to EXT, a high ECL logic level applied to the EXT GATING INPUT will initiate a gating period while a low ECL logic level will terminate the gating period.

HP-IB. The 3782B accepts and supplies information via this rear-panel socket. The HP-IB facility can control all switches except POWER and LOCAL. The REMOTE, LOCAL, TALK, LISTEN and SRQ LEDs indicate the HP-IB status of the 3782B.

The 3782B is designed to operate in two distinct modes — "Talk Only" and "Addressable". The HP-IB address is set by the rear-panel, dual-in-line ADDRESS switch. The "Talk Only" mode allows the measurement results to be output to a peripheral device (such as a Printer or Cassette Recorder) connected in a "Listen" mode.

BIN/TERNARY switch allows data to be input either in ternary format at the four hierarchy levels [via the front-panel inputs (A) or (B)] or alternatively via the BINARY CLOCK and DATA INPUTs on the rear panel.

RESULT PRINT THRESHOLD switch. At the end of each gating period, this switch (in conjunction with some software masks — see Section 3-31) governs whether measurement results are issued via the HP-IB connector. If the value set on the switch is 15 — threshold always satisfied (always prints). If set to 14 — threshold satisfied if one or more errors have occurred. If set to a value N (where $0 \leqslant N \leqslant 13$) the answer will only be issued if the measured error rate during that gating period was worse than 1.0×10^{-N}.

REAL TIME CLOCK switch. When set to VIEW/SET, local time can be set via the STOP (27) and START (26) push-buttons and viewed on the parameter display (18). If a measurement is in progress, it will not be affected by setting the clock. When set to the NORMAL position, the parameter display and STOP and START push-buttons return to their normal functions, however, the processor continues to calculate the local time.

3-13 SWITCH-ON PROCEDURE

3-14 The 3781B and 3782B each require ac power supply of 115V (+10%, −22%) or 230V (+10%, −18%) at 48 to 66Hz and each consume less than 150VA.

WARNING

Before the instrument is switched on, all protective earth terminals, extension cords, auto-transformers and devices connected to it should be connected to a protective earth grounded socket. Any interruption of the protective earth grounding will cause a potential shock hazard that could result in personal injury.

Only fuses with the rated current and specified type should be used. Do not use repaired fuses or short-circuited fuseholders. To do so could cause a shock or fire hazard.

CAUTION

Before the instrument is switched on, it must be set to the voltage of the power source or damage to the instrument may result.

Fuses: 220/240V — 1.5AT (slow-blow)
hp 2110-0304
100/120V — 3AT (slow-blow)
hp 2110-0381

3-15 The instruments are ready for operation immediately after switch-on.

3-16 HP-IB MODES OF OPERATION

3-17 The 3781B is designed to operate in the Addressable mode and the 3782B is designed to operate in two distinct modes — Talk Only and Addressable. The HP-IB address is set by the rear-panel dual-in-line ADDRESS switch.

3-18 Operation in the Talk Only Mode (3782B only).

3-19 This is the simplest mode of operation and the mode used if no Controller is connected to the HP-IB. The front-panel controls are responsive and actively control the instrument. The 3782B automatically outputs messages relevant to its operation. For example, if an HP Model 5150A Option 001 Thermal Printer were connected to the 3782B it could be used to print-out measurement results. The 3782B rear-panel HP-IB ADDRESS switch must be set to Talk Only and any peripheral must be set to Listen Only. In this mode, the five HP-IB ADDRESS switches on the 3782B are used instead to control the format of the OUT-PUT messages. They should normally all be set to the "1" position.

3-20 Operation in the Addressable Mode

3-21 The addressable mode of operation is more easily understood by imagining the concept that two front panels exist.

    1. The 'actual' front panel.

    2. A 'remote' front panel.

3-22 The instruments can be used to perform measurements under one of two modes of operation.

    1. Under 'local' control — where the 'actual' front panel is responsive and used to control the instrument.

    2. Under 'remote' control — where the 'remote' front panel is used to control the instrument and the 'actual' front panel is inoperative.

3-23 Programming codes sent by the Controller are used to set-up the 'remote' front panel. (At power-on, the instrument assumes the local state.) On going remote, the 'remote' front panel is initialized with the current switch settings of the 'actual' front panel.

3-24 PRINCIPAL FEATURES OF HP-IB OPERATION

    1. Ability to overwrite a switch or push-button position by remote control.

    2. Output results in one or all of the four display modes.

    3. Flexibility and operational simplicity achieved using pre-programmed control masks.

    4. HP-IB Bus Extenders and suitable modems may be used to increase the distance between instruments.

    5. The current positions of all front and rear-panel switches (except push-buttons) or all remote switches and masks be issued.

3-25 IMPLEMENTATION OF HP-IB

3781B:

SH1	complete capability
AH1	complete capability
T6	basic talker, serial poll, unaddress is MLA
TE0	no capability
L4	basic listener, unaddress is MTA
LE0	no capability
SR1	complete capability
RL1	complete capability
PP0	no capability
DC1	complete capability
DT0	no capability
C0	no capability

3782B:

SH1	complete capability
AH1	complete capability
T5	basic talker, serial poll, talk only mode, unaddress if MLA
TE0	no capability
L4	basic listener, unaddress if MTA
LE0	no capability
SR1	complete capability
RL1	complete capability
PP0	no capability
DC1	complete capability
DT0	no capability
C0	no capability

3-26 REPERTOIRE OF REMOTE COMMANDS

3-27 The 'remote' commands require a code to be sent to the instruments from the HP-IB Controller. The format of this code is a two-character, upper or lower case mnemonic which specifies the action needed or the switch to be set. Sometimes the switch mnemonic is followed by a parameter which indicates the new position of the switch. For slide switches, this number is the position of the switch — starting with '1' at the left-hand side (see Figure 3-2).

'1'   '2'   '3'   '4'

Figure 3-2 Slide Switch Position Numbering

3-28 For rear-panel toggle switches, the "up" position has code '1' and the "down" position has code '2'.

3-29 Successive commands may be separated by a comma (,) semi-colon (;) colon (:) or space ( ). Commands may be sent either whilst gating or not gating. If commands contained in Paragraph 3-30 (1) or (2) are received whilst under 'local' control, they will be accepted but ignored.

3-30 The following remote commands are available:

1. Over-write a switch or push-button on the 'remote' front panel. Tables 3-1 and 3-2 give the switch mnemonics.

Table 3-1 3781B Switch Mnemonics

SWITCH NAME	MNEMONIC	PARAMETER RANGE
PATTERN	PTn	$1 \leqslant n \leqslant 10$
DATA OUTPUT	DOn	$1 \leqslant n \leqslant 6$
ZERO SUB. (VALUE)	ZVn	$0 \leqslant n \leqslant 999$
ERROR ADD (FORMAT)	EFn	$1 \leqslant n \leqslant 2$
ERROR ADD (RATE)	ERn	$1 \leqslant n \leqslant 3$
JITTER	JTn	$1 \leqslant n \leqslant 2$
CLOCK	CKn	$1 \leqslant n \leqslant 4$
FRAMING	FRn	$1 \leqslant n \leqslant 2$
ERROR ADD SINGLE SHOT	ES	

Table 3-2 3782B Switch Mnemonics

SWITCH NAME	MNEMONIC	PARAMETER RANGE
PATTERN	PTn	$1 \leqslant n \leqslant 9$
ZERO SUB. (VALUE)	ZVn	$0 \leqslant n \leqslant 999$
DATA/$\overline{\text{DATA}}$	DDn	$1 \leqslant n \leqslant 2$
MEASUREMENT MODE	MMn	$1 \leqslant n \leqslant 3$
DISPLAY MODE	DMn	$1 \leqslant n \leqslant 4$
DATA INPUT	DIn	$1 \leqslant n \leqslant 7$
SYNC	SYn	$1 \leqslant n \leqslant 2$
GATING PERIOD	GPn	$1 \leqslant n \leqslant 10$
BINARY/TERNARY	BTn	$1 \leqslant n \leqslant 2$
FRAMING	FRn	$1 \leqslant n \leqslant 2$
THRESHOLD	THn	$0 \leqslant n \leqslant 15$
MANUAL SYNC	MS	
START	ST	
STOP	SP	

The following switches are *not* remotely controllable:

POWER (ON/OFF)
LOCAL (on front panel)
HP-IB ADDRESS (on rear-panel)
TALK ONLY/ADDRESSABLE (3782B only)
REAL-TIME CLOCK (3782B only)
LINE VOLTAGE SELECTOR

2. Request that the instruments load the 'remote' switches and masks with data. The mnemonic is LD (load).

3. 3781B only. Request that the current jitter measurement display be issued in Controller format (ie in the form "+N.NNNNE+NN"). If the current display is blank, an out-of-range answer ("+9.9999E+99") is sent to the Controller. (The jitter measurement display takes a few seconds to stabilize after movement of the DATA OUTPUT, JITTER or CLOCK switches). The mnemonic is CA (current answer).

4. 3781B only. Request that the current status of the front-panel CLOCK TRANSITIONS PRESENT annunciator (LED) be issued. A single-byte reply is given.

    Byte = 0, when LED is OFF.
    Byte = 1, when LED is ON.

    The mnemonic is QA (query annunciator).

5. 3782B only. Request that the current answer indicated by the DISPLAY MODE switch be issued. This command provides answers in addition to those provided by Masks 2 and 4 and can also provide answers while the instrument is gating. (For information on Masks, see Paragraph 3-31). Mask 1 controls the format — either in Controller format ("N.NNNNE±NN") or Peripheral format, in which case, one of the following will be sent, depending on the position of the DISPLAY MODE switch.

    1. ER N.NE-N
       < 100 ERRORS (sometimes)
    2. EC NNNNN
    3. ES NNNNN
    4. FS NNNNN

    If the current display is blank, or is used to display an erroneous switch position, an out-of-range answer ("+9.9999E + 99") is sent in Controller format or the message "NO ANSWER" is sent in Peripheral format.
    The mnemonic is CA (current answer).

6. 3782B only. Request that the number of errors counted, up till the last error-second occurred, be issued. This command provides answers in addition to those provided by Mask 8. Mask 1 permits selection between Controller format and Peripheral format "EC (NNNNN)".
    The mnemonic is EC (error count).

7. 3782B only. Request that the current status of the front panel annunciators (LED's) is issued (except the ERRORS annunciator). A single byte reply is given. The meaning of each bit is given in Table 3-3.

Table 3-3 Bit Significance

BIT	MEANING
0	AIS
1	FSL (Frame Sync Loss)
2	PSL (Pattern Sync Loss)
3	*not used*
4	< 100 Errors
5	Gating
6	DSX-1, DSX-1C, DSX-2
7	DS-3

If any bit = 0, the appropriate LED is OFF.
If any bit = 1, the appropriate LED is ON.
The mnemonic is QA (query annunciators).

8. 3782B only. Request that the internal clock of the 3782B be initialized. This command must be followed by a six-digit parameter. (The clock is set to the desired time by six digits.) For example, IC 235958 will set the clock to 23 hours, 59 minutes, 58 seconds.
    The mnemonic is IC (initialize clock).

9. Request that the current status of all 'actual' front-panel and rear-panel switches (except push-buttons) and masks be issued. Fourteen bytes of data are output for the 3781B and thirty-five bytes of data are output for the 3782B in response to this command.
    The mnemonic is LA (learn actual).

10. Request that the current positions of all 'remote' switches and masks be issued. Fourteen bytes of data are output for the 3781B and thirty-five bytes of data are output for the 3782B in response to this command.
    The mnemonic is LR (learn remote).

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11. Issue a signal to set 'Local Lockout'.

12. Issue a signal to clear 'Local Lockout". (Note: it is implicit in HP-IB protocol that this command will also cause the instrument to go 'local'.)

13. Issue an HP-IB signal to cause the instruments to completely clear themselves and return to the power-on state (using Device Clear or Selected Device Clear). *It is recommended that every program used to remotely control these instruments starts with either of these commands.* After issuing either of these commands, the Controller must give the instruments time to react and settle. A wait of 0.5 second is recommended. The issue of either of these com-

mands does not affect the setting of the 3782B real-time clock.

3-31 CONTROLLING MASKS

3-32 To permit flexibility in the use of these instruments many of the important operating parameters are governed by Masks. At power-on, these masks are given default values – as specified in Tables 3-4 and 3-5. These default values may be overwritten at any time for the 3781B or, in the 'local' and 'remote' states of the Addressable mode for the 3782B. (For the 3782B only, in the Talk Only mode, five of the masks are controlled by the five rear-panel HP-IB ADDRESS switches.) **The masks are programmed by the mnemonic MK followed by the parameter number.**

Table 3-4 3781B Mask Default Values

Mask Number	Meaning	Parameter Number	Default Value
1	Issue EOI concurrent with terminator	1	2
	Do not issue EOI concurrent with terminator	2	
2	Do not SRQ on command Syntax Error	3	4
	SRQ on command Syntax Error	4	
3	Do not SRQ on command Syntax OK	5	5
	SRQ on command Syntax OK	6	
4	Do not SRQ when "LOCAL" pushbutton pressed	7	7
	SRQ when "LOCAL" pushbutton pressed.	8	

Table 3-5 3782B Mask Default Values

Mask Number	Meaning	Parameter Number	Default Value Talk Only	Addressable
1	**MESSAGE SET** Issue answers in Peripheral format.	1	1	2
	Issue answers in Controller format.	2		
2	Do not issue answer at end of Gating Period.	3	4	3
	Issue answer at end of Gating Period only if rear-panel RESULT PRINT THRESHOLD switch is satisfied.	4		
3	Do not issue general control messages.	5	6	5
	Issue general control messages.	6		
4	Issue four answers at end of Gating Period. (see Note 2).	7	see Note 1	8
	Issue just the answer indicated by DISPLAY MODE switch at end of Gating Period.	8		
5	Do not prefix messages with Time.	9	see Note 1	9
	Prefix messages with Time.	10		
6	Use (,) as message terminator.	11	see Note 1	12
	Use CR/LF as message terminator.	12		

Table 3-5 3782B Mask Default Values (continued)

Mask Number	Meaning	Parameter Number	Default Value Talk Only	Addressable
7	Issue EOI concurrent with terminator.	13	see Note 1	14
	Do not issue EOI concurrent with terminator.	14		
8	Do not issue Error-Second messages.	15	see Note 1	15
	Issue Error-Second messages.	16		
9	Do not prefix Error-Rate answers in Controller format with status of "<100 ERRORS" LED.	17	17	17
	Prefix Error-Rate answers in Controller format with status of "<100 ERRORS" LED (see Note 3)	18		
	SERVICE REQUEST SET			
10	Do not SRQ when Error-Second occurs.	19	19	19
	SRQ when Error-Second occurs.	20		
11	Do not SRQ on command errors.	21	21	22
	SRQ on command errors.	22		
12	Do not SRQ at end of normal Gating Period.	23	23	23
	SRQ at end of normal Gating Period only if rear-panel RESULT PRINT THESHOLD switch is satisfied (see Note 4).	24		
13	Do not SRQ if Gating Period ends because of data integrity loss.	25	25	25
	SRQ if Gating Period ends because of data integrity loss.	26		
14	Do not SRQ if Gating Period ends because of an invalid switch movement.	27	27	27
	SRQ is Gating Period ends because of an invalid switch movement.	28		
15	Do not SRQ on command Syntax Error.	29	29	30
	SRQ on command Syntax Error.	30		
16	Do not SRQ on command Syntax OK.	31	31	31
	SRQ on command Syntax OK.	32		
17	Do not SRQ on loss/gain of data integrity.	33	33	33
	SRQ on loss/gain of data integrity.	34		
18	Do not SRQ after each 24-hour period elapsed on internal clock.	35	35	35
	SRQ after each 24-hour period elapsed on internal clock;	36		
19	Do not SRQ when "LOCAL" pushbutton pressed.	37	37	37
	SRQ when "LOCAL" pushbutton pressed.	38		
	RESTART SET			
20	Automatically restart repetitive gating.	39	39	40
	Automatically restart repetitive gating unless rear panel RESULT PRINT THRESHOLD switch satisfied.	40		
21	Do not restart gating following loss/gain of data integrity.	41	42	42
	Automatically restart gating following loss/gain of data integrity.	42		
22	Do not hold-off automatic restart until output buffer empty.	43	44	44
	Hold-off automatic restart until output buffer empty.	44		
23	Do not hold-off automatic restart until SRQ buffer empty.	45	46	46
	Hold-off automatic restart until SRQ buffer empty.	46		

★ Notes 1 to 4 are given on Page 3-12.

Note 1: Talk Only values of Masks 4 thru 8 are controlled by bits 0 thru 4 respectively, of the rear-panel HP-IB ADDRESS switch. Position "1" of the switch selects the *even* value of parameter number.

Note 2: When the GATING PERIOD switch is set to SECONDS, EXTERNAL, or MANUAL and the BINARY INPUTS are used, only three answers are issued.

Note 3: If the "<100 ERRORS" annunciator is OFF, Error-Rate answers are prefixed with character "0". If annunciator is ON, answers are prefixed with character "1". If Mask 5 is set to prefix messages with Time, the Time message comes before the "<100 ERRORS" annunciator character.

Note 4: "NORMAL END" means a non-abortive end, with the GATING PERIOD switch set to SECONDS, CLKS, or EXTERNAL.

3-33 RESULT PRINT THRESHOLD SWITCH (3782B only)

3-34 At the end of each Gating Period, the rear-panel RESULT PRINT THRESHOLD switch (in conjunction with Masks 2, 12 and 20) governs whether:

    (a) answers are issued,

    (b) an SRQ is generated,

    (c) another Gating Period will start automatically.

The sixteen positions of the RESULT PRINT THRESHOLD switch govern whether the threshold is satisfied at the end of a Gating Period according to Table 3-6.

If the BINARY INPUT is used with the GATING PERIOD switch set to SECONDS, EXTERNAL or MANUAL, an ERROR RATE answer is not available and a switch setting of 0 to 13 is treated as though a switch setting of 14 had been selected.

3-35 REPERTOIRE OF MESSAGES (3782B only)

3-36 The 3782B is designed to issue a number of messages during the progress of a measurement. Each message is controlled by one or more Masks. Table 3-7 lists the messages and appropriate controlling masks.

Table 3-6 Result-Print Threshold

Switch Position	Description
$0 \leqslant N \leqslant 13$	Threshold satisfied only if ERROR RATE is worse than 1.0E-N
N = 14	Threshold satisfied only if one or more errors have occurred.
N = 15	Threshold always satisfied.

Table 3-7 Output Messages

Message	Controlling Mask(s)
An Answer	1,2,4
ERROR SECOND	8
"NO ANSWER" (in response to CA, when no answer available — Peripheral format)	1
"+9.9999E + 99" (in response to CA, when no answer available — Controller format)	1
"<100 ERRORS"	1,2,4
"START"	3
"STOP"	3
"RESTART"	3
"DATA LOSS"	3
"AIS"	3
"FRAME LOSS"	3
"PATTERN LOSS"	3
"RECOVERY"	3
"RUN ABORT"	3
"DAY N"	3
"POWER ON"	3
TIME (as prefix to message)	5

3-37 TERMINATION OF A BUFFER (3782B only)

3-38 Sometimes an instrument having an internal input buffer (eg the HP Model 9875A Cartridge Tape Unit) is used to receive the 3782B output messages. At the end of a sequence of measurements, and before powering down, any partially-filled input buffer needs to be written onto tape. This is achieved using a CR/LF code. A CR/LF will be issued if the 3782B "STOP" pushbutton is pressed (either manually or remotely) while Mask 6 is set to use the code "," as message terminator and the rear-panel REAL-TIME CLOCK switch is set to NORMAL.

3-39 SERVICE REQUESTS

3-40 Both instruments are designed to issue a service request (SRQ) when service from the Controller is required.

Programmable masks govern whether each request is generated.

3-41 It is possible for a service request to be generated before the Controller has had time to service any previous requests. In such instances, the instruments stack the requests in an orderly manner. It makes good programming sense to keep the length of this stack as short as possible by promptly responding to requests and not issuing further commands until the stack is empty. (However, it is not mandatory for the request to be serviced immediately if at all.) An instrument should not be serially polled within 20 milliseconds of a previous serial poll of that instrument.

3-42 REPERTOIRE OF SERVICE REQUESTS

3-43 Tables 3-8 and 3-9 list the service request codes that are used to indicate the reason for service. The mask number that controls each service request is also given.

Table 3-8 3781B Service Request Codes

| Code | | | Meaning | Controlling Mask Number |
Octal	Decimal	Hex		
001	1	01	NEUTRAL — ALL OK	
100	64	40	Command Syntax Error In Line	2
101	65	41	Command Syntax of Line OK	3
102	66	4R	"LOCAL" push-button pressed	4

Table 3-9 3782B Service Request Codes

| Code | | | Meaning | Controlling Mask Number |
Octal	Decimal	Hex		
001	1	01	NEUTRAL — ALL OK	
100	64	40	An Error-Second has occurred.	10
101	65	41	Cannot start — "ERROR 1" displayed.	11
102	66	42	Cannot start — "ERROR 2" displayed.	11
103	67	43	Cannot start — "ERROR 3" displayed.	11
104	68	44	Cannot start — "ERROR 4" displayed.	11
105	69	45	End of Gating Period — Normal.	12
106	70	46	End of Gating Period — Data Integrity Loss.	13
107	71	47	End of Gating Period — Invalid Switch Movement.	14
110	72	48	Command Syntax Error in Line.	15
111	73	49	Command Syntax of Line OK.	16
112	74	4A	Data Loss has occurred.	17
113	75	4B	AIS has occurred.	17
114	76	4C	Frame Sync Loss has occurred.	17
115	77	4D	Pattern Sync Loss has occurred.	17
116	78	4E	Data integrity regained.	17
117	79	4F	A further 24-hours has elapsed on internal real-time clock.	18
120	80	50	"LOCAL" pushbutton pressed.	19

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3-44 LOCAL Push-button

3-45 The LOCAL push-button is situated on the front-panel of both instruments. The function of this control is to cause either instrument to return to the "Local" state (manually controllable). The Controller can, however, issue a Local Lockout command in which case the LOCAL push-button becomes inoperative. (In the 3782B, this control is functionally inoperative in the Talk Only mode.)

3-46 Internal Real-Time Clock (3782B only)

3-47 The 3782B has a built-in, crystal-controlled, real-time clock. The instrument can be programmed to prefix messages with the time from this internal clock. The format of this message is "HH-MM-SS". Peripheral devices having no internal clock of their own (eg the HP Model 9875A Cartridge Tape Unit) can thus receive timed messages from the 3782B.

3-48 The clock can be initialized in one of three ways:

1. At device power-on, the clock is set to zero.

2. Under "Local" control (either in the Talk Only or Addressable modes) the rear-panel REAL-TIME CLOCK switch can be set to VIEW/SET. The front-panel START and STOP push-buttons now take the subsidiary roll of fast advance of Hours and Minutes respectively. The main LED display window simultaneously shows the time in hours and minutes. If both push-buttons are held down together, the internal clock is held at the current time.

3. Under "Remote" control, using the command "IC".

Initializing the clock sets the day count to '1' and (for steps 1 and 2 only) sets the seconds count to zero.

3-49 Whenever the clock rolls over, after each 24-hour period, an output message gives the day count and an SRQ is generated under control of the programmable masks. The total range of the clock is 99 days, 23 hours, 59 minutes and 59 seconds.

3-50 USING THE HP 37201A BUS EXTENDER

3-51 The HP Model 37201A Bus Extender and suitable modems may be used to increase the distance between instruments. However, these long-distance communication paths must remain connected for the entire period that the instruments are expected to function remotely. Remember, that for each "local" 37201A Bus Extender used, only one "remote" 37201A Bus Extender and HP-IB instrument cluster can be active at any one time.

3-52 DEFINITION OF 'LEARN' TRANSFER

3-53 In response to a Learn Actual (LA) or Learn Remote

(LR) command, the instruments output the settings of the switches and masks in a compact form. It is not necessary for the operator to know the internal format of this information, as its normal use is to allow a subsequent load instruction to re-load the switches and masks with their earlier values. However, Tables 3-10 and 3-11 define the structures — should a need arise to know the internal structure.

3-54 Each controllable switch is allocated the bits given in Tables 3-10 and 3-11 (undefined bits are not necessarily output as zero). Information output signal comprises 14 bytes for the 3781B and 35 bytes for the 3782B. All slide switch codes start with zero at the left-hand side.

Table 3-10 3781B Response Codes

Switch	Byte Number	BITS
PATTERN	1	0-3
DATA OUTPUT	8	0-2
ZERO SUB. (HUNDREDS)	3	0-3
ZERO SUB. (TENS)	4	0-3
ZERO SUB. (UNITS)	5	0-3
ERROR ADD (FORMAT)	9	0
ERROR ADD (RATE)	10	0-1
JITTER	7	0
CLOCK	6	0-1
FRAMING	2	0
MASKS (1→4)	11→14	0

Table 3-11 3782B Response Codes

Switch	Byte Number	BITS
PATTERN	1	0-3
ZERO SUB. (HUNDREDS)	3	0-3
ZERO SUB. (TENS)	4	0-3
ZERO SUB. (UNITS)	5	0-3
DATA/$\overline{\text{DATA}}$	2	1
MEASUREMENT MODE	7	0-1
DISPLAY MODE	9	0-1
DATA INPUT	6	0-2
SYNC	11	0
GATING PERIOD	10	0-3
BINARY/TERNARY INPUT	6	4
FRAMING	2	0
RESULT PRINT THRESHOLD	12	0-2,4
REAL-TIME CLOCK	8	0
MASKS (1→23)	13→35	0

3-55 OPERATORS CHECKS

3-56 The Operators Checks allow the operator to check the main functions of the instruments prior to use. These checks comprise Basic Functional Checks and HP-IB Functional Checks. (A complete specification check is given in Section IV of the Service Manuals.)

3-57 BASIC FUNCTIONAL CHECKS

Setting-up Procedure

1. Ensure the mains selector setting and fuse rating are correct for the power line in use (see Section II).

2. Set all 3781B front-panel switches to the left-hand side except for:

   CLOCK . . . . INT
   PRBS ZERO SUBSTITUTION 000

3. Set all 3782B front-panel switches to the left-hand side except for:

   GATING PERIOD . . . . 10^6 CLKS
   PRBS ZERO SUBSTITUTION 000

4. Set the 3782B rear-panel switches as follows:

   REAL TIME CLOCK . . . . OFF
   BINARY I/P/TERNARY I/P . . . TERNARY I/P

   RESULT PRINT THRESHOLD . . . .

   HP-IB ADDRESS . . . .

5. Connect the 3781B and 3782B to the line supply and switch on. (If instruments are already powered-up, switch off and then switch on.) Allow an initialization period of approximately 5 seconds.

6. Check that the 3782B LOCAL and TALK LEDs are illuminated and a flashing "7" is displayed in the 3782B parameter display window.

7. Press the 3782B STOP push-button and the flashing "7" will cease, leaving the parameter display window blank.

8. Connect the 3781B DSX-1, DSC-1C, DSX-2 DATA OUTPUT to the 3782B DSX-1, DSX-1C, DSX-2 DATA INPUT using a WECO Type 310A cable. The 3782B DSX-1, DSX-1C, DSX-2 DATA INPUT LED should illuminate.

9. The 3782B parameter display window should give the display "0.0". Check that the GATING LED is flashing and the <100 ERRORS LED is illuminated.

10. Check that the 3782B parameter display window reading is "0.0" with the 3781B and 3782B PATTERN switches set to $2^{15}-1$, $2^{20}-1$, 0000, 1000, 1010, 1100, 1111 and 17/15. *(Ensure the 3781B and 3782B PATTERN switches are set to identical settings.)* Check that the GATING LED is flashing and the <100 ERRORS LED is illuminated. *(Note: the 3782B SYNC LOSS LED may illuminate briefly during synchronization when the PATTERN switch settings are changed.)*

11. Set the 3781B PATTERN switch to AIS. The 3782B AIS and ERRORS LEDs should illuminate (ignore the 3782B parameter display window reading).

12. Reset the 3781B and 3782B PATTERN switches to 2^9-1. Set the 3781B ERROR ADD switch to 1 in 10^5. The 3782B parameter display window should read "1.0 10^{-5}". Check that the GATING LED is flashing and the ERRORS and <100 ERRORS LEDs are illuminated.

13. Connect the 3781B DS-3 DATA OUTPUT to the 3782B DS-3 DATA INPUT using a WECO Type 440A cable. The 3782B parameter display window should read "1.0 10^{-5}". Check that the GATING LED is flashing and the ERRORS and <100 ERRORS LEDs are illuminated. Ensure that these displays are achieved with the DATA OUTPUT/INPUT switches set to DSX-1C, DSX-2, DS-3(LO), DSX-3 and DS-3(HI). *(Ensure the 3781B DATA OUTPUT and 3782B DATA INPUT switches are set to identical settings.)* A brief synchronisation period is required after changing the switch settings.

14. With the 3781B and 3782B DATA OUTPUT/INPUT switches set to DS-3(HI), set the 3781B and 3782B PATTERN switches to 1111. The 3782B parameter display window should read "1.0 10^{-5}" with the GATING LED flashing and the ERRORS and <100 ERRORS LEDs illuminated.

15. Set the 3782B GATING PERIOD switch to MAN. Press the 3782B START push-button. The 3782B parameter display window reading should average to "1.0 10^{-5}" with the GATING and ERRORS LEDs illuminated. (Note: the 3782B display may take approximately 30 seconds to settle.)

16. Set the 3782B MEASUREMENT MODE switch to CODE ERRORS. Press the 3782B START push-button. The 3782B parameter display window should read "0.0" with the GATING and <100 ERRORS LEDs illuminated.

17. Set the 3781B ERROR ADD switch to CODE. Press the 3782B START push-button. The 3782B parameter display window reading should average to "1.0 10^{-5}" with the GATING and ERRORS LEDs illuminated. (Note: the 3782B display may take approximately 30 seconds to settle.)

18. Set the 3782B MEASUREMENT MODE switch to PARITY ERRORS. Press the 3782B START push-button. The 3782B parameter display window should read "0.0" with the GATING and <100 ERRORS LEDs illuminated.

19. Set the 3781B ERROR ADD switch to BIN. Press the 3782B START push-button. The 3782B parameter display window reading should average to "1.0 10^{-5} with the GATING and ERRORS LEDs illuminated. (Note: the 3782B display may take approximately 60 seconds to settle.)

3-58 HP-IB FUNCTIONAL CHECKS

3-59 To check that the 3782B Error Detector is functioning properly in the "Talk Only" mode (without an HP-IB Controller) perform the following set-up.

1. Perform the procedures contained in Paragraph 3-57. Only if not previously performed.

2. Set the 3782B HP-IB ADDRESS switches to the following positions (as viewed from the rear).

3. Set the 3781B and 3782B front-panel switches as contained in Paragraph 3-57 steps 2 and 3. Connect the 3781B DSX-1, DSX-1C, DSX-2 DATA OUTPUT to the 3782B DSX-1, DSX-1C, DSX-2 DATA INPUT using a WECO Type 310A cable.

4. Set the 3782B GATING PERIOD switch to MAN. Connect a suitable peripheral (eg., HP-IB compatible Thermal Printer, Cassette Recorder, etc) to the 3782B HP-IB connector and set the peripheral to "Listen Only". (In this example, an HP Model 5150A Option 001 Thermal Printer is used.)

5. Press the 3782B START push-button. Wait approximately 5 seconds and press the 3782B STOP push-button. The Thermal Printer printout should be similar to Figure 3-3 (ie, with no local time).

```
FS        5
ES        0
EC        0
<100 ERROR
ER 0.0
STOP
START
```

Figure 3-3 Error Print-out Without Time

6. Set the HP-IB ADDRESS switches to and press the 3782B START push-button. Wait approximately 5 seconds and press the 3782B STOP push-button. The Thermal Printer printout should be similar to Figure 3-4 (ie., with local time).

```
12-50-24  FS        5
12-50-24  ES        0
12-50-24  EC        0
12-50-24  <100 ERROR
12-50-24  ER 0.0
12-50-24  STOP
12-50-19  START
```

Figure 3-4 Error Print-out With Time

7. With the HP-IB ADDRESS switches set to ▢ set the 3781B ERROR ADD switch to SINGLE. Press the 3782B START push-button. Press the 3781B SINGLE push-button three times. Press the 3782B STOP push-button. A print-out similar to Figure 3-5 should be obtained.

```
00-45-01  FS       2
00-45-01  ES       3
00-45-01  EC      42
00-45-01  <100 ERROR
00-45-01  ER 5.6E-6
00-45-01  STOP
00-45-00  ES(     42)
00-44-59  ES(     28)
00-44-58  ES(     14)
00-44-56  START
```

Figure 3-5 Print Every Error Second

8. Set the HP-IB ADDRESS switches to ▢ with the GATING PERIOD switch set to MAN. Press the 3782B START push-button. Press the 3781B SINGLE push-button three times. Press the 3782B STOP push-button. A print-out similar to Figure 3-6 should be obtained.

```
14-50-48  FS      11
14-50-48  ES       7
14-50-48  EC      18
14-50-48  <100 ERROR
14-50-48  ER 1.2E-8
14-50-48  STOP
14-50-30  START
```

Figure 3-6 Print Cumulative Errors

9. Set the 3781B ERROR ADD switch to 1 in 10^5 and press the 3782B START push-button. Change the 3782B PATTERN switch mode to 1000 and a print-out similar to Figure 3-7 should be obtained.

```
00-49-17  FS       0
00-49-17  ES       2
00-49-17  EC    1447
00-49-17  ER 4.6E-4
00-49-17  RUN ABORT
00-49-17  PATTN LOSS
00-49-15  START
```

Figure 3-7 Print Pattern Loss

3-60 ERROR CODES (3782B only)

3-61 Certain combinations of switch positions are invalid. These invalid positions generate an error code which flashes in the left-hand position of the main LED display window. The significance of these codes is given in the Table 3-12.

Table 3-12 Error Code Description

Error Code	Meaning
1	ERROR RATE display not permitted for BINARY INPUTS when GATING PERIOD switch set to SECONDS, EXTERNAL or MANUAL.
2	PARITY ERROR measurements not permitted for DSX-1, DSX-1C or DSX-2 INPUTS.
3	PARITY ERROR measurements not permitted for DS-3 INPUTS without framing.
4	CODE ERROR measurements not permitted for BINARY INPUTS.
5	Code "31" not permitted for HP-IB Address.
6	'Talk Only' mode not permitted when Controller connected.
7	Instrument has suffered power interrupt and been powered-up. This code is cancelled by movement of any switch or upon receipt of a 'remote' command.

3-62 OPERATORS MAINTENANCE

3-63 Operators Maintenance consists of replacing defective fuses and cleaning the air filter. These items are discussed in the following paragraphs.

WARNING

It is important that the following maintenance procedures be executed according to the recommended schedule to retain the safety features which have been designed into the instrument.

3-64 Fuses ⚠

3-65 The ac line fuse, located at the rear of the instrument may be replaced by the operator. The ac line cord should be disconnected from the power source and the other end disconnected from the instrument. With the power cord removed, the fuse compartment may be opened. The fuse is removed by unscrewing the fuse compartment end cap. For detailed information on fuse replacement and values, refer to Section II.

3-66 Air Filter ⚠

3-67 The fan has a filter attached from the outside, for ease of cleaning and replacement. This filter should be removed and cleaned at intervals of approximately one month, depending on the environment. To service the filter, remove the four screws holding the filter to the rear panel.

WARNING

The instrument should not be operated with the air filter removed and the fan blades exposed.

3-68 Wash the filter mesh in clean soapy water, rinse thoroughly and dry before refitting, or, replace the filter with Part Number 03762-60040.

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