Service Manual

MODEL HP 3325B Synthesizer/Function Generator

Serial Numbers
All

HEWLETT PACKARD

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8600 Soper Hill Road, Everett, WA 98205-1298

SAFETY SYMBOLS

General Definitions of Safety Symbols Used On Equipment or In Manuals.

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

Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 volts must be so marked).

Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating equipment.

Low-noise or noiseless, clean ground (earth) terminal. Used for a signal common, as well as providing protection against electrical shock in case of a fault. A terminal marked with this symbol must be connected to ground in the manner described in the installation (operating) manual, and before operating the equipment.

Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.

Alternating current (power line).

Direct current (power line).

Alternating or direct current (power line).

WARNING The WARNING sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in injury or death to personnel.

CAUTION The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which,if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.

NOTE: The NOTE sign denotes important information. It calls attention to procedure, practice, condition or the like, which is essential to highlight.

Error Codes 1-13

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WARNING

Maintenance described herein is performed with power supplied to the instrument, and protective covers removed. Such maintenance should be performed only by service-trained personnel who are aware of the hazards involved (for example, fire and electrical shock). Where maintenance can be performed without power applied, the power should be removed.

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SECTION V
ADJUSTMENTS

5-1. INTRODUCTION.

5-2. This section contains the procedures required to adjust the HP 3325B to meet its specifications. These adjustments should be used following repairs or if performance tests indicate a deficiency.

NOTE

Table 8-3 lists the adjustment procedures that must be performed after repair of certain circuits.

5-3. EQUIPMENT REQUIRED.

5-4. Each adjustment procedure lists the test equipment required to perform that adjustment. All test equipment required for adjustments is itemized in Table 5-1. Any equipment that satisfies the critical specifications given in the table may be substituted for the recommended model.

Table 5-1. Test Equipment Required for Adjustments

Equipment	Critical Specifications	Recommended Model
AC/DC Digital Voltmeter	AC Function: 1 V Range Accuracy: ±.5% Resolution: 4 digits DC Function: Ranges: 0.1V, 1V, 10V, 100V Accuracy: ±0.05% Resolution: 4 1/2 digits	HP 3455A/3478A
Low Frequency Spectrum Analyzer	Frequency Range: 1 kHz – 50 kHz Amplitude Accuracy: ±0.5 dB Spurious Responses: 80 dB below ref.	HP 3580A/3585A
Resistor	1 kΩ	HP Part No. 0683-1025
Electronic Counter	Frequency measurement: to 20 MHz Accuracy: ±2 counts Resolution: 8 digits	HP 5328A with Opt. 010, 040, and 041/5328B with Opt. 010
Analog Oscilloscope	Vertical: 2 channel Bandwidth: dc to 100 MHz Deflection: 5 mV to 5 V/div div Horizontal: Main and Delayed Sweeps Main: 50 ns to 0.5 s/div Delayed: 50 ns to 20 ms/div	HP 1740A/TEK 2245
Frequency Standard (for Option 001 only)	Frequency: 5 MHz Accuracy: 1×10^{-9}	HP 105B
10:1 Oscilloscope Probe	Impedance: 1 MΩ, 12 pF	HP 10041A/10040A
50-ohm Load	Accuracy: ± 0.2% Power Rating: 1W	HP 11048C
Adapter	BNC-to-dual banana plug	HP 1251-2277
High Frequency Spectrum Analyzer	Frequency Range: 1 kHz - 80 MHz Amplitude Accuracy: ±.5 dB	HP 141T/8552B/8553B/8566A/8568A
Thermal Converter	Input Impedance: 50Ω, Input Voltage: 1Vrms, Frequency: 1kHz to 20MHz, Frequency Response: ±0.05dB	HP 11050A/Ballantine Model 1395A-1 with cable 12577A Opt 10 PO Box 97 Booton, NJ 07005
Resistor	200Ω 1% 1/8W	HP 0757-0407
Resistor	50Ω 1% 0.5W	HP 0698-5965
Resistor	13Ω 1% 1/8W	HP 0757-0380
Resistor	25Ω 5% 1/4W	HP 0683-2505
Resistor	150Ω 1% 1/8W	HP 0757-0284

5-5. ADJUSTMENT PROCEDURES.

5-6. The Power Supply and the D/A Converter Gain and Offset adjustment must be performed before any of the others are made. It is recommended that all adjustments be performed in the order given. Location of all adjustments is shown on Figure 5-3 at the end on this section. Remove the top and bottom covers to gain access to all adjustments.

NOTE

The metal stiffener channel on the deck between the printed circuit boards may be used as circuit ground for all measurements.

5-7 Power Supply.

Equipment Required: dc digital voltmeter

WARNING

AC power line voltage is exposed at the rear panel and on the power supply assembly.

a. Connect a dc digital voltmeter between the –15V test point on the Power Supply assembly, A22, and ground.

b. Adjust the –15V ADJ (A22R352) for a voltmeter reading of –14.970 to –15.030 V.

c. Measure the voltages at the +15V test point and +5V test point on A22. The reading should be +14.970V to +15.030V and +5.010V to +5.070V respectively. If not, readjust the –15V ADJ control to bring all three voltages within tolerance. These voltages may be adjusted out of tolerance by Paragraph 5-8 Step f, but it is not a cause for concern.

5-8. D/A Converter Gain and Offset.

Equipment Required:

digital voltmeter (HP 3478A)
50 ohm load (HP 11048C)

a. Connect the 50 ohm load directly to the 3325 Main Signal output connector on the front panel. Connect the digital voltmeter to the 50 ohm load.

b. Place the 3325 in Special Test Mode 51 by pressing the following keys:

Shift Deg mVrms Self Test 5 1

c. Press the 0 key to set the 3325 to 0 Vdc.

d. Adjust DAC OFFSET ADJ (A14R40) for a voltmeter reading of less than 5 mVdc. Press the 0 key again to verify. Readjust A14R40 if necessary.

e. Press the . (decimal) key to set the 3325 to +5 Vdc.

f. Adjust –15V ADJ (A22R352) for a voltmeter reading of +4.985 Vdc to +5.015 Vdc. Press the . (decimal) key again to verify. Readjust –15V ADJ if necessary.

g. Press the – (minus) key to set the 3325 to –5 Vdc. Verify that the voltmeter reading is between –5.015 Vdc and –4.985 Vdc.

h. Repeat Steps c through g until all readings are within the tolerances.

i. Press the Local key to exit Special Test Mode 51. Two numbers are displayed for a moment. Both numbers should be within the +20 to –20 range. If they are not, DC Offset Accuracy may not meet all specifications.

5-9. Voltage Controlled Oscillator (VCO Frequency).

Equipment Required: dc digital voltmeter

a. Connect a dc digital voltmeter to test point A21TP11.

b. Set the 3325 frequency to 60 MHz.

c. With a non-conductive tool, adjust VCO ADJ (A21L162) through the hole in the metal cover for a voltmeter reading of –2.990V to –3.010V.

d. Set the frequency to 1 kHz. Voltmeter reading should be between +9.4V and +11.0V.

5-10. Analog Phase Interpolation (API).

Equipment Required:

low frequency spectrum analyzer
resistor 1 kΩ

a. Set 3325 as follows:

Function .... Sine
Frequency .... 5.003 MHz

b. Connect the low frequency spectrum analyzer input through a 1kΩ series resistor to A21TP11.

c. Set spectrum analyzer controls as follows:

Start Frequency .... 0 kHz
Bandwidth .... 30 Hz
Frequency Span .... 1 kHz/div
Display Smoothing .... Max
Sweep Time/Div .... 200 sec
Input Sensitivity .... 10 mV
Amplitude Reference .... Normal
Amplitude Mode .... 10 dB/div
Sweep Mode .... Manual

d. Adjust the spectrum analyzer manual vernier control to place the display marker at the peak of the API spur which appears at 3 kHz (3 display divisions).

e. Adjust the API 1 ADJ (A21R76) to reduce the spur to a minimum.

f. Change the 3325 frequency to 5 000 300 Hz.

g. Adjust API 2 ADJ (A21R74) to reduce the spur to a minimum.

h. Change the 3325 frequency to 5 000 003 Hz.

i. Adjust API 4 ADJ (A21R88) to reduce the spur to a minimum.

j. Set the 3325 to 5.003 MHz and readjust API 1 ADJ (A21R76) to its minimum value. Also check the harmonic distortion performance test.

5-11. 30 MHz Reference Oscillator.

Equipment Required: electronic counter

NOTE

The instrument must have been ON for at least 20 minutes before performing this adjustment.

a. If the instrument has the Option 001 High Stability Frequency Reference installed, the rear panel connection from "10 MHz Oven Output" to "Ext Ref In" must be disconnected.

b. Connect an electronic counter to the 3325 signal output, using 50-ohm input termination.

c. Set the 3325 as follows:

Function .... Sine
Frequency .... 20 MHz
Amplitude .... 10 Vp-p

d. Adjust the counter to measure frequency (20 MHz).

e. Adjust REF ADJ (A3R30) for a counter display of 20.000 000 MHz.

5-12. Option 001 High Stability Frequency Reference.

Equipment Required:

oscilloscope, 2 channel
quartz frequency standard, 5 MHz

NOTE

The rear panel "10 MHz Oven Output" must be connected to "Ext Ref In".

a. This procedure is for instruments with the Option 001 High Stability Frequency Reference. The instrument must have been connected to ac power in either STANDBY (⏻) or ON (|) for at least 30 minutes before attempting this adjustment. To minimize subsequent drift, the instrument should be connected to ac power for at least 12 hours before attempting this adjustment.

b. Connect the frequency standard 5 MHz output to one vertical channel of the oscilloscope and trigger the sweep from this channel.

c. Set the 3325 as follows:

Function .... Sine
Frequency .... 5 MHz
Amplitude .... 10 Vp-p

d. Connect the 3325 signal output to the second channel of the oscilloscope.

e. Adjust FINE ADJ (A9R7) to stop the 3325 signal on the oscilloscope display. (The frequency standard signal must be stationary and the 3325 signal as near stationary as possible.)

f. If FINE ADJ does not have enough range, proceed with Step g.

g. Adjust FINE ADJ to mechanical center.

h. Remove the screw from the Coarse Frequency adjustment in the end of the temperature controlled oven assembly (A9E1).

i. Using a non-conductive tool, adjust COARSE ADJ to stop the 3325 signal on the oscillope (as near stationary as possible).

j. Replace the screw in the Oven assembly and repeat Step e.

5-13. Amplitude Modulator.

Equipment Required:

oscilloscope
10:1 oscilloscope probe

a. On the rear panel, connect the MOD SOURCE output to the AMPTD MOD input.

b. Using a 10:1 probe, connect the oscilloscope to A3TP4. Set the oscilloscope input to ac coupled and the sweep to 5 ms/div.

c. Place the 3325 in Special Test Mode 52 by pressing the following keys:

Shift Deg mVrms Self Test 5 2

d. Adjust Y-OFFSET ADJ (A3R60) to null out the square wave signal on the display. Change the oscilloscope vertical gain as necessary to observe the signal.

e. Ground the oscilloscope input and zero the trace on the center line. Set the input to dc coupled.

f. Adjust OFFSET OUT ADJ (A3R68) to return the oscilloscope trace to the center line (0 Vdc). Readjust OFFSET OUT ADJ, if necessary, to maintain the null.

g. Press the Local key to exit Special Test Mode 52. The message ARB CLEARED is displayed to indicate that the Modulation Source Arb memory has been set to the default value by this special test.

5-14. Sine Wave Gain-Offset.

Equipment Required: none

a. Place the 3325 in Special Test Mode 53 by pressing the following keys:

Shift Deg mVrms Self Test 5 3

b. Repeatedly adjust SINE GAIN-OFFSET ADJ (A3R33) and press the Amptd Cal key until the number on the left side of the display reads between −10 and +10.

c. The number on the right side of the display should read between 0.8200 and 1.000. If it is not within this range, troubleshoot the sine wave amplitude control and amplifier gains.

d. Press the Local key to exit this special test. Two numbers are displayed for a moment. Both numbers should be in the +60 to −60 range. If they are not, the DC Offset accuracy with the sine wave function enabled may not meet all specifications.

5-15. Square Wave Gain-Offset.

Equipment Required: none

a. Place the 3325 in Special Test Mode 54 by pressing the following keys:

Shift Deg mVrms Self Test 5 4

b. Repeatedly adjust SQUARE GAIN-OFFSET ADJ (A14R130) and press the Amptd Cal key until the number on the left side of the display reads between −10 and +10.

c. The number on the right side of the display should read between 0.8200 and 1.000. If it is not within this range, troubleshoot the square wave amplitude control and amplifier gains.

d. Press the Local key to exit this special test. Two numbers are displayed for a moment. Both numbers should be in the +60 to −60 range. If they are not, the DC Offset accuracy with the square wave function enabled may not meet all specifications.

5-16. X Drive

Equipment Required: dc digital voltmeter

a. Connect a dc digital voltmeter to 3325 rear panel X Drive output.

b. Set the 3325 as follows:

Function .... Sine
Amplitude .... 10 Vp-p
Sweep Start Freq .... 1 MHz
Sweep Stop Freq .... 10 MHz
Sweep Marker Freq .... 5 MHz
Sweep Time .... 0.999 sec

c. Press RESET/START key to reset sweep to start conditions.

d. Digital voltmeter reading should be less than 20 mV.

e. Adjust X DRIVE ADJ (A14R6) to mechanical center.

f. Press the RESET/START key once to initiate a single sweep. At the end of the sweep the digital voltmeter reading should be +10.450V to +10.550V.

g. If the reading is less than +10.450V, adjust X DRIVE ADJ (A14R6) slightly clockwise; and if reading is greater than +10.550V, adjust it slightly counter-clockwise.

NOTE

The voltmeter reading will not respond to adjustment of X DRIVE ADJ (A14R6). The effect of this adjustment can be observed only after another single sweep. Following the end of a sweep, the X Drive output voltage will drift downward at ≤ 1 mV per second.

h. Press RESET/START twice to initiate another sweep. If necessary, readjust X DRIVE ADJ (A14R6) by turning clockwise to increase voltage and counter-clockwise to decrease voltage.

i. Repeat Steps g and h until proper voltage (+10.450 to +10.550 V) is measured immediately following the end of a sweep.

5-17. Amplifier Bias .

Equipment Required: high frequency spectrum analyzer

a. With the 3325 in its turn-on condition, set the frequency to 10 MHz, function to square wave, and amplitude to .999 Vp-p.

b. Adjust the spectrum analyzer as follows:

Center Frequency	50 MHz
Bandwidth	300 kHz
Scan Width	0-100 MHz
Input Attenuation	40 dB
Video Filter	10 kHz
Scan Time	10 msec/div
Log Reference Level	+ 10dBm,10dBLOG
Vernier	−5 dBm
Scan Mode	INT
Scan Trigger	AUTO

c. Connect the 3325 signal output to the spectrum analyzer input. Do not use a 50 Ω feed through termination.

d. The spectrum analyzer should display the high level odd harmonics and low level even harmonics of the 10 MHz square wave.

e. Adjust BIAS ADJ (A14R275) to minimize the 20 MHz second harmonic. It should dip sharply to >34 dB below the fundamental.

5-18. Ramp Stability.

Equipment Required: oscilloscope, with delayed sweep

a. Connect the 3325 Main Signal output connector to the oscilloscope vertical input. (Do NOT use a 10:1 probe.) If the oscilloscope is an HP 1740A, set the input switch to the 50-ohm position. If your oscilloscope does not have a 50-ohm input, use a 50-ohm load at the input.

b. Set the 3325 as follows:

Function	Positive Slope Ramp
Frequency	100 Hz
Amplitude	10 Vp-p

c. Set the oscilloscope as follows:

Vertical	2V/div
Main Sweep	2ms/div
Delayed Sweep	20μS/div
Trigger	Negative
Delay	Mid Screen
Display	A or B (Do not use ALT or CHOP)

d. Set the oscilloscope to delayed sweep. Adjust the delay to see the ramp reset jitter and read the positive ramp jitter in microseconds.

e. Press the Negative Ramp function on the 3325.

f. Change the trigger on the oscilloscope to positive and note the negative ramp jitter in microseconds.

g. Bump the 3325 frequency to 99.999999Hz and read the ramp jitter in microseconds.

h. If any of the above readings exceed 60μs, adjust RAMP ADJ (A14C110) to reduce the jitter.

i. Repeat the ramp jitter measurements of Steps d and f, adjusting RAMP ADJ as necessary to reduce the jitter to 60μs or for the best compromise between the two.

NOTE

If ramp jitter cannot be adjusted satisfactorily, troubleshoot the ramp generating circuitry (Service Group J).

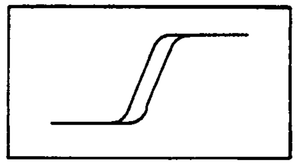

Figure 5-1. Ramp Reset Waveform.

5-19. Amplitude Flatness.

Equipment Required:

1 Vrms 50Ω thermal converter
digital voltmeter
resistors 200Ω 1% 1/8W, 13Ω 1% 1/8W, 150Ω 1% 1/4W, 50Ω 1% 1/2W, 25Ω 5% 1/4W

a. Set the 3325 as follows:

Function	Sine
Amplitude	10Vp-p
Frequency	1kHz

b. Connect the 3325 signal output (through the 10Vp-p pad and thermal converter) to the digital voltmeter (see Figure 5-2a).

CAUTION

Insure that the input voltage to the thermal converter does not exceed 1Vrms. Also for best results, allow the thermal converter time to settle and adjust to surrounding temperatures.

c. Note and record the dc voltage reading on the voltmeter. This is the flatness reference voltage.

d. Set the 3325 frequency to 20 MHz. Using a nonconductive tool, adjust 20 MHz FLT ADJ (A14C217) to obtain the same reading as recorded in Step c.

e. Set the 3325 to 10 MHz. Adjust 10 MHz FLT ADJ (A14R142) to obtain the same reading as recorded in Step c. Repeat Step d, adjusting as necessary.

f. Set the 3325 to 16MHz. The voltmeter reading should be within ±0.15mV of the reference recorded in step c. If not, decrease padding capacitor A14C101 using the capacitors shown in Table 5-2. Repeat steps d and e.

g. Set the 3325 to 20MHz. Bump the frequency down to 1MHz in 1MHz steps. Note the dc voltage at each frequency and insure that it is within ±0.15mV of the reference recorded in step c.

h. If the dc voltage measured in the 19-21MHz range is out of tolerance, increase or decrease the value of A14C103 as necessary, using the values shown in Table 5-2. If A14C103 is changed, repeat steps d and g.

i. Set the 3325 amplitude to 3.0Vp-p.

j. Replace the 10Vp-p pad with the 3.0Vp-p pad (Figure 5-2b). Repeat steps d and g. If a voltage measured in step g is out of tolerance, repeat the amplitude flatness adjustment with the 3325 at both 10Vp-p and 3Vp-p until all voltages are within tolerance.

CAUTION

Insure that the input voltage to the thermal converter does not exceed 1Vrms.

5-20. Mixer Spurious Signal.

Equipment Required: high frequency spectrum analyzer

a. Set the 3325 as follows:

Function .... Sine
Amplitude 0.999Vp-p
Frequency 20MHz

b. Set the spectrum analyzer as follows:

Center Frequency 10MHz
Bandwidth 30kHz
Scan Width 2MHz/div
Input Attenuator 10dB
Scan Time 20ms/div
Log Ref Level 0dB
Vernier .... −10dB
Scale .... 10dB log
Video Filter 10kHz
Scan Mode .... Int
Scan Trigger .... Auto

c. Connect the 3325 signal output to the spectrum analyzer's 50Ω input.

d. The 2:1 mixer spur should occur at 10 MHz. Using a non-conductive tool, adjust MXR ADJ (A3R115) until the 2:1 spur is at a minimum. Check the VCO/2 spur at 5 MHz.

e. Using the modify keys, bump the frequency from 20MHz to 11MHz in 1MHz steps. Observe the spectrum analyzer for spurious responses. At 18MHz, check for the 3:2 spur at 6MHz. Note that in all cases, all spurious responses should be > 70dB below the desired signal.

Table 5-2. Padding Values.

A14C101	A14C103
68pf -hp- p/n 0140-0192 75pf -hp- p/n 0160-2202 82pf*-hp- p/n 0160-0145	130pf -hp- p/n 0140-0195 140pf*-hp- p/n 0140-0217 150pf -hp- p/n 0140-0196
*Loaded Value	

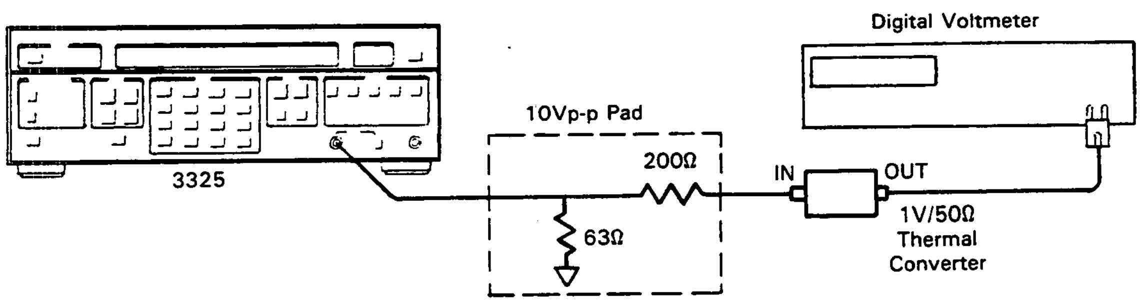

Figure 5-2a. Amplitude Flatness Adjustment (10Vp-p Pad).

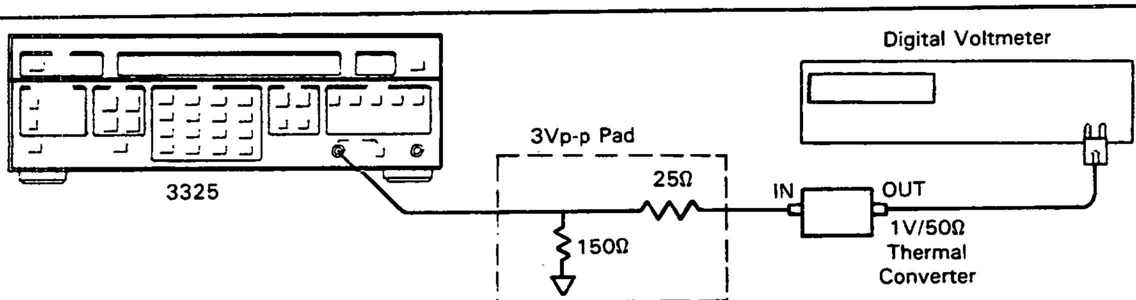

Figure 5-2b. Amplitude Flatness Adjustment (3Vp-p Pad).

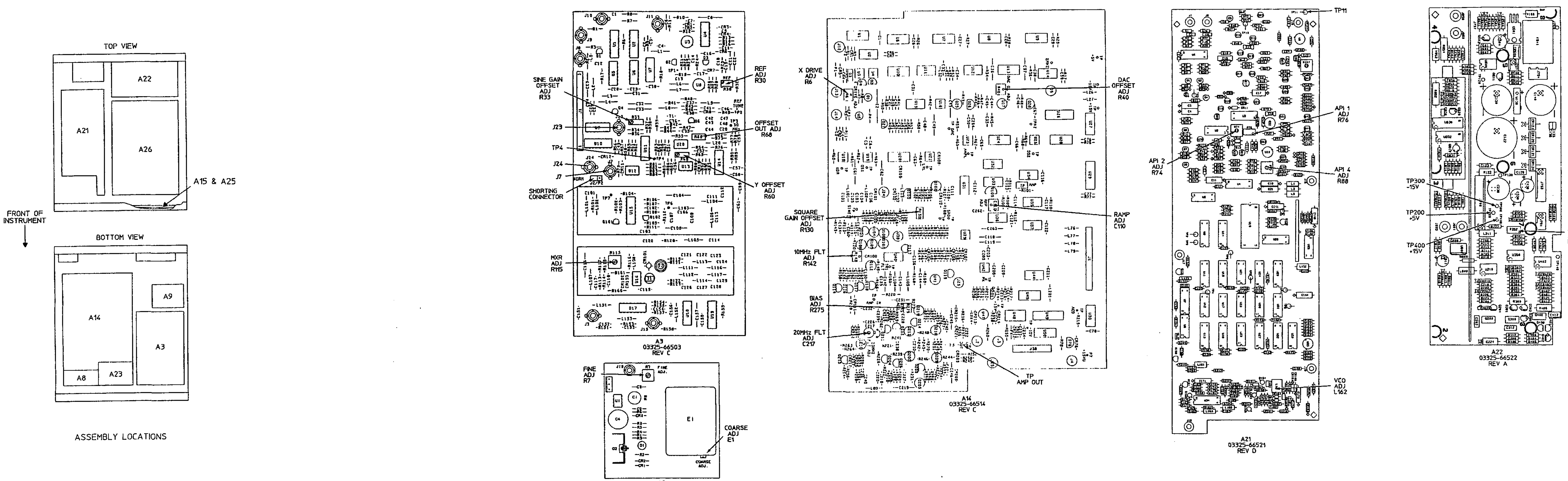

Figure 5-3. Location of Adjustments.

Section VI
Replaceable Parts

SECTION VI
REPLACEABLE PARTS

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SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-3 lists parts in alphanumeric order of their reference designators and indicates the description, -hp- part number of each part, together with any applicable notes, and provides the following:

a. Total quantity used in the instrument (Qty column). The total quantity of a part is given the first time the part number appears.

b. Description of the part. (See List of Abbreviations in Table 6-1.)

c. Code for manufacturer of the part. (See List of Manufacturers in Table 6-2.)

d. Manufacturer's part number.

6-3. Miscellaneous parts are listed in Table 6-3 following their respective assemblies. General miscellaneous parts are listed at the conclusion of Table 6-3.

6-4. ORDERING INFORMATION.

6-5. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Field Office. (See List of Office Locations at the end of this manual.) Identify parts by their Hewlett-Packard part numbers. Include instrument model and serial numbers.

6-6. NON–LISTED PARTS.

6-7. To obtain a part that is not listed, include:

a. Instrument model number.
b. Instrument serial number.
c. Description of the part.
d. Function and location of the part.

6-8. PROPRIETARY PARTS.

6-9. Items marked by a dagger (†) in the reference designator column are available only for repair and service of Hewlett-Packard instruments.

6-10. PRINTED CIRCUIT ASSEMBLIES.

6-11. Printed circuit assemblies are listed in Table 6-3.

Table 6-1. List of Abbreviations.

ABBREVIATIONS

Ag	silver
Al	aluminum
A	ampere(s)
Au	gold
C	capacitor
cer	ceramic
coef	coefficient
com	common
comp	composition
conn	connection
dep	deposited
DPDT	double-pole double-throw
DPST	double-pole single-throw
elect	electrolytic
encap	encapsulated
F	farad(s)
FET	field effect transistor
fxd	fixed
GaAs	gallium arsenide
GHz	gigahertz = 10^{+9} hertz
gd	guard(ed)
Ge	germanium
gnd	ground(ed)
H	henry(ies)
Hg	mercury
Hz	hertz (cycle(s) per second)
ID	inside diameter
impg	impregnated
incd	incandescent
ins	insulation(ed)
kΩ	kilohm(s) = 10^{+3} ohms
kHz	kilohertz = 10^{+3} hertz
L	inductor
lin	linear taper
log	logarithmic taper
mA	milliampere(s) = 10^{-3} amperes
MHz	megahertz = 10^{+6} hertz
MΩ	megohm(s) = 10^{+6} ohms
met flm	metal film
mfr	manufacturer
ms	millisecond
mtg	mounting
mV	millivolt(s) = 10^{-3} volts
μF	microfarad(s)
μs	microsecond(s)
μV	microvolt(s) = 10^{-6} volts
my	Mylar®
nA	nanoampere(s) = 10^{-9} amperes
NC	normally closed
Ne	neon
NO	normally open
NPO	negative positive zero (zero temperature coefficient)
ns	nanosecond(s) = 10^{-9} seconds
nsr	not separately replaceable
Ω	ohm(s)
obd	order by description
OD	outside diameter
p	peak
pA	picoampere(s)
pc	printed circuit
pF	picofarad(s) 10^{-12} farads
piv	peak inverse voltage
p/o	part of
pos	position(s)
poly	polystyrene
pot	potentiometer
p-p	peak-to-peak
ppm	parts per million
prec	precision (temperature coeffient, long term stability and/or tolerance)
R	resistor
Rh	rhodium
rms	root-mean-square
rot	rotary
Se	selenium
sect	section(s)
Si	silicon
sl	slide
SPDT	single-pole double-throw
SPST	single-pole single-throw
Ta	tantalum
TC	temperature coefficient
TiO_2	titanium dioxide
tog	toggle
tol	tolerance
trim	trimmer
TSTR	transistor
V	volt(s)
vacw	alternating current working voltage
var	variable
vdcw	direct current working voltage
W	watt(s)
w/	with
wiv	working inverse voltage
w/o	without
ww	wirewound
*	optimum value selected at factory, average value shown (part may be omitted)
**	no standard type number assigned selected or special type

® Dupont de Nemours

DESIGNATORS

A	assembly
B	motor
BT	battery
C	capacitor
CR	diode
DL	delay line
DS	lamp
E	misc electronic part
F	fuse
FL	filter
HR	heater
IC	integrated circuit
J	jack
K	relay
L	inductor
M	meter
MP	mechanical part
P	plug
Q	transistor
QCR	transistor-diode
R	resistor
RT	thermistor
S	switch
T	transformer
TB	terminal board
TC	thermocouple
TP	test point
TS	terminal strip
U	microcircuit
V	vacuum tube, neon bulb, photocell, etc
W	cable
X	socket
XDS	lampholder
XF	fuseholder
Y	crystal
Z	network

Table 6-2. List of Manufacturers.

Mfr. No.	Manufacturer Name	Address
28480	HEWLETT-PACKARD CO	PALO ALTO, CA 94304
00493P01	UNITED CHEMI-CON INC	ROSEMONT, IL 60018
00746P01	ROHM CORP	IRVINE, CA 92714
01136P01	ELCO INDUSTRIES INC	ROCKFORD, IL 61101
01452P01	SANGAMO WESTON INC	PICKENS, SC 29671
01468P01	STETTNER & CO	FRANKLIN PARK, IL 60131
01698P01	TEXAS INSTRUMENTS INC	BEAVERTON, OR 97005
01887P01	FERROXCUBE CORP	CANOGA PARK, CA 91304
02010P01	AVX CORP	MYRTLE BEACH, SC 29577
02037P01	MOTOROLA INC	BELLEVUE, WA 98005
02123P01	EG & G INC	SAN DIEGO, CA 98123
02237P01	FAIRCHILD SEMICONDUCTOR CORP	BELLEVUE, WA 98005
02367P01	CORNELL-DUBILIER ELECTRONICS	NEW BEDFORD, MA 02741-9990
02995P01	MEPCO/CENTRALAB INC	WEST PALM BEACH, FL 33407
03273P01	GOWANDA ELECTRONICS CORP	GOWANDA, NY 14070
03316P01	SPECIALITY CONNECTOR CO	FRANKLIN, IN 46131
03334P01	NV PHILIPS ELCOMA	SMITHFIELD, RI 02917
03406P01	NATIONAL SEMICONDUCTOR CORP	BELLEVUE, WA 98004
03418P01	MOLEX INC	DOWNERS, IL 60515
03744P01	BOURNS INC	RIVERSIDE, CA 92507
03923P01	SIEMENS CORP	ISELIN, NJ 08830
04200P01	SPRAGUE ELECTRIC CO	VANCOUVER, WA 98684
04309P01	UNIVERSAL INSTRUMENTS CORP	CONKLIN, NY 13748
04568P01	BECKMAN INDUSTRIAL CORP	FULLERTON, CA 92634
05176P01	AMERICAN SHIZUKI CORP	OGALLALA, NE 69153
05524P01	DALE ELECTRONICS INC	YANKTON, SD 57078
05826P01	AMER PRCN IND INC	EAST AURORA, NY 14052
08113P01	KAHGAN ELECTRONICS CORP	HEMPSTEAD, NY 11550
09538P01	TUSONIX	TUCSON, AZ 85740-7144
09939P01	MURATA ERIE NORTH AMERICA INC	STATE COLLEGE, PA 16801
L1359D01	PRIEBE ELECTRONICS	REDMOND, WA 98052

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A3	**03325-66503**	**0**	**1**	**PC ASSY-SIG-SCE**	**28480**	**03325-66503**
A3C1	0160-6506	3	4	C-F .1UF 20% 50V CERMLr	09939P01	RPE121-978Z5U104M50V
A3C2	0160-3847	9	34	CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A3C3-C4	0160-0362	7	2	CAPACITOR-FXD 510PF +-5% 300VDC MICA	01452P01	
A3C6	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A3C7	0160-2204	0	1	CAPACITOR-FXD 100PF +-5% 300VDC MICA	01452P01	D153F101J
A3C8	0180-0228	6	1	CAPACITOR-FXD 22UF+-10% 15VDC TA	04200P01	150D226X9015B2-DYS
A3C9	0160-6506	3		C-F .1UF 20% 50V CERMLr	09939P01	RPE121-978Z5U104M50V
A3C11	0160-0174	9	1	CAPACITOR-FXD .47UF +80-20% 50VDC CER	04200P01	2C37Z5U474Z050A
A3C12	0140-0191	8	1	CAPACITOR-FXD 56PF +-5% 300VDC MICA	02367P01	CD15ED560J03C
A3C13	0140-0199	6	1	CAPACITOR-FXD 240PF +-5% 300VDC MICA	02367P01	
A3C14	0160-6874	8	1	C-F 20PF 5% 500V CERTBr	09538P01	301 089 COG0 200J
A3C16-17	0160-3847	9		CAPACITOR-FXD..01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A3C18	0140-0204	4	1	CAPACITOR-FXD 47PF +-5% 500VDC MICA	02367P01	
A3C19	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A3C20	0160-6867	9	2	C-F 6.2PF % 500V CERTBr	09538P01	301 089 COH0 629C
A3C21-22	0180-0197	8	2	CAPACITOR-FXD 2.2UF+-10% 20VDC TA	04200P01	150D225X9020A2-DYS
A3C23	0180-1746	5	7	CAPACITOR-FXD 15UF+-10% 20VDC TA	04200P01	150D156X9020B2-DYS
A3C24	0160-6506	3		C-F .1UF 20% 50V CERMLr	09939P01	RPE121-978Z5U104M50V
A3C26-29	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A3C31	0180-0229	7	1	CAPACITOR-FXD 33UF+-10% 10VDC TA	04200P01	150D336X9010B2-DYS
A3C32-33	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	04200P01	150D156X9020B2-DYS
A3C34	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A3C36-39	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A3C41	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A3C42	0160-3520	5	1	CAPACITOR-FXD 75PF +-1% 100VDC MICA	01452P01	
A3C43	0160-6869	1	1	C-F 7.5PF --% 500V CERTBr	09538P01	301 089 COH0 759C
A3C44	0160-6870	4	1	C-F 8.2PF --% 500V CERTBr	09538P01	301 089 COH0 829C
A3C46	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A3C47	0160-3085	7	1	CAPACITOR-FXD 510PF +-1% 300VDC MICA	01452P01	
A3C48	0160-2199	2	1	CAPACITOR-FXD 30PF +-5% 300VDC MICA	01452P01	
A3C49	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A3C51-53	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A3C56	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A3C57-58	0160-6849	7		C-F 22F 5% 500V CERTBr	09538P01	301 089 COG0 220J
A3C59	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A3C61	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A3C101	0160-6506	3		C-F .1UF 20% 50V CERMLr	09939P01	RPE121-978Z5U104M50V
A3C102-103	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A3C104	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	04200P01	150D156X9020B2-DYS
A3C106	0160-6867	9		C-F 6.2PF % 500V CERTBr	09538P01	301 089 COH0 629C
A3C107	0160-6850	0	1	C-F 24F 5% 500V CERTBr	09538P01	301 089 COG0 240J
A3C108	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	04200P01	150D156X9020B2-DYS
A3C109	0160-2293	7	1	CAPACITOR-FXD 51.5PF +-1% 500VDC MICA	02367P01	
A3C111	0160-2263	1	1	CAPACITOR-FXD 18PF +-5% 500VDC CER 0+-30	01468P01	
A3C112	0160-2372	3	1	CAPACITOR-FXD 47PF +-2% 300VDC MICA	02367P01	
A3C113	0160-6872	6	1	C-F 13PF 5% 500V CERTBr	09538P01	301 089 COG0 130J
A3C114	0160-2372	3		CAPACITOR-FXD 47PF +-2% 300VDC MICA	02367P01	
A3C116	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	04200P01	150D156X9020B2-DYS
A3C117-119	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A3C120	0160-6861	3	3	C-F 3PF --% 500V CERTBr	09538P01	301 089 COJ0 309C
A3C121	0140-0190	7	4	CAPACITOR-FXD 39PF +-5% 300VDC MICA	02367P01	
A3C122	0160-6866	8	2	C-F 5.6PF --% 500V CERTBr	09538P01	301 089 COH0 569C
A3C123	0140-0190	7		CAPACITOR-FXD 39PF +-5% 300VDC MICA	02367P01	
A3C124	0160-6861	3		C-F 3PF --% 500V CERTBr	09538P01	301 089 COJ0 309C
A3C126	0140-0190	7		CAPACITOR-FXD 39PF +-5% 300VDC MICA	02367P01	
A3C127	0160-6866	8		C-F 5.6PF --% 500V CERTBr	09538P01	301 089 COH0 569C
A3C128	0140-0190	7		CAPACITOR-FXD 39PF +-5% 300VDC MICA	02367P01	
A3C129	0160-6861	3		C-F 3PF --% 500V CERTBr	09538P01	301 089 COJ0 309C
A3C151-154	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A3C156	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A3C157	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	04200P01	150D156X9020B2-DYS
A3C158	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A3CR1-2	1901-0040	1	2	DIODE-SWITCHING 30V 50MA 2NS DO-35	02237P01	
A3CR3-4	1901-0518	8	4	DIODE-SCHOTTKY SM SIG	28480	1901-0518
A3CR6	1902-3149	9	1	DIODE-ZNR 9.09V 5% DO-35 PD=.4W	02037P01	

* Indicates factory selected values

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A3CR7	1902-3030	7	1	DIODE-ZNR 3.01V 5% DO-7 PD=.4W TC=-.067%	02037P01	
A3CR8	0122-0162	5	1	DIODE-VVC 29PF 10% BVR=30V	03334P01	
A3CR10	1902-0025	4	1	DIODE-ZNR 10V 5% DO-35 PD=.4W TC=+.06%	02037P01	
A3CR11-12	1901-0518	8		DIODE-SCHOTTKY SM SIG	28480	1901-0518
A3CR101	1906-0207	2	1	DIODE-MATCHED	28480	1906-0207
A3CR102-103	1901-0535	9	2	DIODE-SCHOTTKY SM SIG	28480	1901-0535
A3J1	1252-2407	1	1	CON-HEADER 21 CONT	L1359D01	LCW-121-08-G-S-295
A3J2	1251-4822	6	1	CONN-POST TYPE .100-PIN-SPCG 3-CONT	03418P01	22-03-2031
A3J3	1251-2969	8	9	CONNECTOR-PHONO SINGLE PHONO JACK; DIP	03418P01	15-24-0503
A3J7-11	1251-2969	8		CONNECTOR-PHONO SINGLE PHONO JACK; DIP	03418P01	15-24-0503
A3J15	1251-2969	8		CONNECTOR-PHONO SINGLE PHONO JACK; DIP	03418P01	15-24-0503
A3J23-24	1251-2969	8		CONNECTOR-PHONO SINGLE PHONO JACK; DIP	03418P01	15-24-0503
A3L1	9100-3551	5	1	INDUCTOR RF-CH-MLD 1UH 5% .166DX.385LG	03273P01	15M101J
A3L2	9100-1791	1	1	CORE-FERRITE CHOKE-WIDEBAND;IMP:>360	01887P01	VK200-19/4B
A3L3-4	9140-0210	1	5	INDUCTOR RF-CH-MLD 100UH 5% .166DX.385LG	05826P01	1537-76
A3L5	9170-0894	0	1	CORE-SHIELDING BEAD	01887P01	56-590-65/4A6
A3L5	7175-0057	5	1	RESISTOR-ZERO OHMS SOLID TINNED COPPER	04309P01	
A3L6-7	9140-0210	1		INDUCTOR RF-CH-MLD 100UH 5% .166DX.385LG	05826P01	1537-76
A3L8	9100-3560	6	1	INDUCTOR RF-CH-MLD 5.6UH 5% .166DX.385LG	03273P01	15M561J
A3L9	9140-0253	2	1	INDUCTOR RF-CH-MLD 300NH 1% .166DX.385LG	03273P01	15M300F-1
A3L20	9100-1629	4	1	INDUCTOR RF-CH-MLD 47UH 5% .166DX.385LG	05826P01	1537-60
A3L101-102	9100-1791	1		CORE-FERRITE CHOKE-WIDEBAND;IMP:>360	01887P01	VK200-19/4B
A3L103	9140-0265	6	2	INDUCTOR RF-CH-MLD 1.6UH 5% .166DX.385LG	28480	9140-0265
A3L104	9100-3552	6	1	INDUCTOR RF-CH-MLD 1.5UH 5% .166DX.385LG	03273P01	15M151J
A3L105	9140-0349	7	1	INDUCTOR RF-CH-MLD 1.1UH 5% .166DX.385LG	03273P01	15M111J
A3L106	9140-0265	6		INDUCTOR RF-CH-MLD 1.6UH 5% .166DX.385LG	28480	9140-0265
A3L107	9100-0539	3	2	INDUCTOR RF-CH-MLD 10UH 5% .156DX.375LG	03273P01	15M102J
A3L108	9140-0142	8	1	INDUCTOR RF-CH-MLD 2.2UH 10% .105DX.26LG	05826P01	1025-28
A3L111-112	9100-3315	9	2	INDUCTOR RF-CH-MLD 820NH 5% .166DX.385LG	03273P01	15M820J
A3L113-114	9100-3546	8	4	INDUCTOR RF-CH-MLD 1.3UH 5% .155DX.375LG	03273P01	15M131J-1
A3L116-117	9100-3546	8		INDUCTOR RF-CH-MLD 1.3UH 5% .155DX.375LG	03273P01	15M131J-1
A3L151	9100-1791	1		CORE-FERRITE CHOKE-WIDEBAND;IMP:>360	01887P01	VK200-19/4B
A3L152	9100-0539	3		INDUCTOR RF-CH-MLD 10UH 5% .156DX.375LG	03273P01	15M102J
A3L153	9140-0210	1		INDUCTOR RF-CH-MLD 100UH 5% .166DX.385LG	05826P01	1537-76
A3Q1	1853-0448	0	1	TRANSISTOR PNP SI TO-92 PD=625MW	02037P01	
A3Q2	1855-0081	1	1	TRANSISTOR J-FET N-CHAN D-MODE SI	02037P01	SPF819
A3Q3	1853-0640	4	1	XTR SML1PNP	02237P01	S44446
A3Q4	1854-0092	2	1	TRANSISTOR NPN SI PD=200MW FT=600MHZ	02037P01	
A3Q6	1854-0215	1	1	TRANSISTOR NPN SI PD=350MW FT=300MHZ	02037P01	
A3Q101-102	1853-0640	4		XTR SML1PNP	02237P01	S44446
A3R1	0683-4705	8	7	RESISTOR 47 5% .25W CF TC=0-400	00746P01	R-25J
A3R2	0698-3432	7	1	RESISTOR 26.1 1% .125W F TC=0+-100	02995P01	SFR25H
A3R3	0757-0398	4	1	RESISTOR 75 1% .125W F TC=0+-100	02995P01	SFR25H
A3R6	0683-2225	3	5	RESISTOR 2.2K 5% .25W CF TC=0-400	00746P01	R-25J
A3R7	0698-3439	4	2	RESISTOR 178 1% .125W F TC=0+-100	02995P01	SFR25H
A3R8	0757-0397	3	5	RESISTOR 68.1 1% .125W F TC=0+-100	02995P01	SFR25H
A3R9	0683-4715	0	3	RESISTOR 470 5% .25W CF TC=0-400	00746P01	R-25J
A3R10	0757-0401	0	1	RESISTOR 100 1% .125W F TC=0+-100	02995P01	SFR25H
A3R11	0757-0397	3		RESISTOR 68.1 1% .125W F TC=0+-100	02995P01	SFR25H
A3R12	0683-1245	5	1	RESISTOR 120K 5% .25W CF TC=0-800	00746P01	R-25J
A3R13	0683-4725	2	1	RESISTOR 4.7K 5% .25W CF TC=0-400	00746P01	R-25J
A3R14	0683-1025	9	11	RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J
A3R16	0683-1025	9		RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J
A3R17	0683-2225	3		RESISTOR 2.2K 5% .25W CF TC=0-400	00746P01	R-25J
A3R18	0757-0442	9	3	RESISTOR 10K 1% .125W F TC=0+-100	02995P01	SFR25H
A3R19	0683-1045	3	1	RESISTOR 100K 5% .25W CF TC=0-400	00746P01	R-25J
A3R21	0683-1025	9		RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J
A3R22	0757-0279	0	3	RESISTOR 3.16K 1% .125W F TC=0+-100	02995P01	SFR25H
A3R23	0757-0438	3	1	RESISTOR 5.11K 1% .125W F TC=0+-100	02995P01	SFR25H
A3R24	0683-2225	3		RESISTOR 2.2K 5% .25W CF TC=0-400	00746P01	R-25J
A3R26	0757-0283	6	1	RESISTOR 2K 1% .125W F TC=0+-100	02995P01	SFR25H
A3R27	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	02995P01	SFR25H
A3R28	0698-4490	9	1	RESISTOR 29.4K 1% .125W F TC=0+-100	05524P01	CMF-55-1, T-1
A3R29	0698-3154	0	1	RESISTOR 4.22K 1% .125W F TC=0+-100	02995P01	SFR25H
A3R30	2100-3789	4	2	RESISTOR-TRMR 20K 10% C TOP-ADJ 17-TRN	04568P01	68WR20K

See introduction to this section for ordering information

* Indicates factory selected values

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A3R32	0683-1025	9		RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J
A3R33	2100-3789	4		RESISTOR-TRMR 20K 10% C TOP-ADJ 17-TRN	04568P01	68WR20K
A3R34	0699-0191	1	1	RESISTOR 1.686K .1% .125W F TC=0+-25	02995P01	5033R
A3R36	0699-0189	7	1	RESISTOR 259.6 .1% .125W F TC=0+-25	02995P01	5033R
A3R37	0683-7535	8	1	RESISTOR 75K 5% .25W CF TC=0-400	00746P01	R-25J
A3R38	0698-0084	9	1	RESISTOR 2.15K 1% .125W F TC=0+-100	02995P01	SFR25H
A3R39	0757-0274	5	1	RESISTOR 1.21K 1% .125W F TC=0+-100	02995P01	SFR25H
A3R41	0683-1025	9		RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J
A3R42	0757-0407	6	2	RESISTOR 200 1% .125W F TC=0+-100	02995P01	SFR25H
A3R43-44	0698-3155	1	2	RESISTOR 4.64K 1% .125W F TC=0+-100	02995P01	SFR25H
A3R45-46	0698-3156	2	4	RESISTOR 14.7K 1% .125W F TC=0+-100	02995P01	SFR25H
A3R47	0683-4705	8		RESISTOR 47 5% .25W CF TC=0-400	00746P01	R-25J
A3R48	0683-4715	0		RESISTOR 470 5% .25W CF TC=0-400	00746P01	R-25J
A3R49	0683-1035	1	1	RESISTOR 10K 5% .25W CF TC=0-400	00746P01	R-25J
A3R54	0757-0453	2	1	RESISTOR 30.1K 1% .125W F TC=0+-100	02995P01	SFR25H
A3R55	0698-3279	0	3	RESISTOR 4.99K 1% .125W F TC=0+-100	02995P01	SFR25H
A3R56	0683-1025	9		RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J
A3R57	0698-3279	0		RESISTOR 4.99K 1% .125W F TC=0+-100	02995P01	SFR25H
A3R58	0699-0192	2	1	RESISTOR 3.894K .1% .125W F TC=0+-25	02995P01	5033R
A3R59	0683-1025	9		RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J
A3R60	2100-3286	6	1	RESISTOR-TRMR 10K 10% C TOP-ADJ 17-TRN	04568P01	67WR
A3R61	0683-4705	8		RESISTOR 47 5% .25W CF TC=0-400	00746P01	R-25J
A3R62	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	02995P01	SFR25H
A3R63	0698-3156	2		RESISTOR 14.7K 1% .125W F TC=0+-100	02995P01	SFR25H
A3R64	0698-4437	4	1	RESISTOR 2.94K 1% .125W F TC=0+-100	05524P01	CMF-55-1, T-1
A3R66	0757-0436	1	1	RESISTOR 4.32K 1% .125W F TC=0+-100	02995P01	SFR25H
A3R67	0698-4478	3	1	RESISTOR 10.7K 1% .125W F TC=0+-100	05524P01	CMF-55-1, T-1
A3R68	2100-3207	1	1	RESISTOR-TRMR 5K 10% C SIDE-ADJ 1-TRN	03744P01	3386X-Y46-502
A3R69	0698-3136	8	1	RESISTOR 17.8K 1% .125W F TC=0+-100	02995P01	SFR25H
A3R70	0698-3497	4	1	RESISTOR 6.04K 1% .125W F TC=0+-100	02995P01	SFR25H
A3R72	0683-4705	8		RESISTOR 47 5% .25W CF TC=0-400	00746P01	R-25J
A3R73	0698-3442	9	1	RESISTOR 237 1% .125W F TC=0+-100	02995P01	SFR25H
A3R76	0683-4705	8		RESISTOR 47 5% .25W CF TC=0-400	00746P01	R-25J
A3R77-78	0698-4402	3	4	RESISTOR 97.6 1% .125W F TC=0+-100	05524P01	CMF-55-1, T-1
A3R79	0698-3279	0		RESISTOR 4.99K 1% .125W F TC=0+-100	02995P01	SFR25H
A3R80-81	0698-3581	7		RESISTOR 13.7K 1% .125W F TC=0+-100	02995P01	SFR25H
A3R82-84	0757-0273	4	3	RESISTOR 3.01K 1% .125W F TC=0+-100	02995P01	SFR25H
A3R85	0698-4402	3		RESISTOR 97.6 1% .125W F TC=0+-100	05524P01	CMF-55-1, T-1
A3R86	0698-3157	3	1	RESISTOR 19.6K 1% .125W F TC=0+-100	02995P01	SFR25H
A3R87	0683-1025	9		RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J
A3R88	0683-2225	3		RESISTOR 2.2K 5% .25W CF TC=0-400	00746P01	R-25J
A3R90	0698-4402	3		RESISTOR 97.6 1% .125W F TC=0+-100	05524P01	CMF-55-1, T-1
A3R91	0698-4467	0	1	RESISTOR 1.05K 1% .125W F TC=0+-100	05524P01	CMF-55-1, T-1
A3R92	0683-1025	9		RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J
A3R93	0683-4705	8		RESISTOR 47 5% .25W CF TC=0-400	00746P01	R-25J
A3R101	0683-4715	0		RESISTOR 470 5% .25W CF TC=0-400	00746P01	R-25J
A3R102	0757-0291	6	1	RESISTOR 24.9 1% .125W F TC=0+-100	02995P01	SFR25H
A3R103	0683-3325	6	1	RESISTOR 3.3K 5% .25W CF TC=0-400	00746P01	R-25J
A3R104	0757-0399	5	1	RESISTOR 82.5 1% .125W F TC=0+-100	02995P01	SFR25H
A3R106	0698-4435	2	1	RESISTOR 2.49K 1% .125W F TC=0+-100	05524P01	CMF-55-1, T-1
A3R107	0698-3156	2		RESISTOR 14.7K 1% .125W F TC=0+-100	02995P01	SFR25H
A3R108	0698-4037	0	1	RESISTOR 46.4 1% .125W F TC=0+-100	02995P01	SFR25H
A3R109	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	02995P01	SFR25H
A3R111	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	02995P01	SFR25H
A3R112	0757-0407	6		RESISTOR 200 1% .125W F TC=0+-100	02995P01	SFR25H
A3R113-114	0698-3444	1	4	RESISTOR 316 1% .125W F TC=0+-100	02995P01	SFR25H
A3R115	2100-0568	1	1	RESISTOR-TRMR 100 10% C TOP-ADJ 1-TRN	03744P01	3386P-Y46-101
A3R116	0757-0381	5	1	RESISTOR 15 1% .125W F TC=0+-100	02995P01	SFR25H
A3R117-118	0698-3444	1		RESISTOR 316 1% .125W F TC=0+-100	02995P01	SFR25H
A3R119	0757-0275	6	2	RESISTOR 113 1% .125W F TC=0+-100	02995P01	SFR25H
A3R120	0698-3440	7	1	RESISTOR 196 1% .125W F TC=0+-100	02995P01	SFR25H
A3R121-122	0757-0397	3		RESISTOR 68.1 1% .125W F TC=0+-100	02995P01	SFR25H
A3R123	0757-0275	6		RESISTOR 113 1% .125W F TC=0+-100	02995P01	SFR25H
A3R151	0757-0397	3		RESISTOR 68.1 1% .125W F TC=0+-100	02995P01	SFR25H
A3R153-154	0683-1025	9		RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J

* Indicates factory selected values

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A3R156	0683-1015	7	1	RESISTOR 100 5% .25W CF TC=0-400	00746P01	R-25J
A3R157	0683-4705	8		RESISTOR 47 5% .25W CF TC=0-400	00746P01	R-25J
A3R158	0698-3439	4		RESISTOR 178 1% .125W F TC=0+-100	02995P01	SFR25H
A3R159	0683-2225	3		RESISTOR 2.2K 5% .25W CF TC=0-400	00746P01	R-25J
A3R160-161	0757-0276	7	2	RESISTOR 61.9 1% .125W F TC=0+-100	02995P01	SFR25H
A3T1	9100-4038	5	1	TRANSFORMER BEAD CORE; WITH CT PRI % SEC	28480	9100-4038
A3T2	08552-6044	1	1	XFM	NEW DIV%	
A3TP1-4	1251-0600	0	6	CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	03418P01	16-06-0034
A3TP6-7	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	03418P01	16-06-0034
A3U1	1820-1991	1	1	IC CNTR TTL LS DECD DUAL 4-BIT	02237P01	
A3U2	1820-0629	0	2	IC FF TTL S J-K NEG-EDGE-TRIG	01698P01	
A3U3	1820-0321	9	1	IC COMPARATOR GP TO-99 PKG	02237P01	
A3U4	1820-1199	1	1	IC INV TTL LS HEX 1-INP	01698P01	
A3U5	1820-0693	8	1	IC FF TTL S D-TYPE POS-EDGE-TRIG	01698P01	
A3U6	1820-0683	6	1	IC INV TTL S HEX 1-INP	01698P01	
A3U7	1820-3633	2	1	ICD ALS 74ALS1004 HX INV P14	01698P01	
A3U8	1826-0043	4	1	IC OP AMP GP TO-99 PKG	03406P01	
A3U9	1820-1568	8	1	IC BFR TTL LS BUS QUAD	01698P01	
A3U10	1820-1195	7	1	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01698P01	
A3U11	1826-0437	0	1	IC MULTIPLIER 14-DIP-C PKG	02037P01	
A3U12	1826-0476	7	1	ANALOG SWITCH SPDT 8 -DIP-P	01698P01	
A3U13	1826-0547	3	1	IC OP AMP LOW-BIAS-H-IMPD DUAL 8-DIP-P	01698P01	
A3U14	1858-0063	5	1	TRANSISTOR ARRAY 14-PIN PLSTC DIP	04550P03	
A3U15	1858-0040	8	1	TRANSISTOR ARRAY 16-PIN PLSTC DIP	04550P03	
A3U16	1858-0059	9	1	TRANSISTOR ARRAY 8-PIN PLSTC DIP	28480	1858-0059
A3U17	1820-0802	1	1	IC GATE ECL NOR QUAD 2-INP	02037P01	
A3U18	1820-1322	2	1	IC GATE TTL S NOR QUAD 2-INP	01698P01	
A3U19	1820-0629	0		IC FF TTL S J-K NEG-EDGE-TRIG	01698P01	
A3U20	1820-0216	1	1	IC OP AMP GP 8-DIP-P PKG	02237P01	
A3W2	1258-0141	8	1	CON-JUMPER REM .025P	02946P01	65474-004
A3Y1	0410-1115	1	1	CRYSTAL-QUARTZ 30.00000 MHZ	03747P01	
	3050-0080	6	4	WASHER-FL NM NO. 5 .13-IN-ID .25-IN-OD	04757P01	3482-12
	2190-0363	3	2	WASHER-FL NM NO. 2 .09-IN-ID .15-IN-OD	04757P01	2-1185108
	03325-20601	3	3	MCHD SHLD-TOP	28480	03325-20601
	03325-20602	4	3	MCHD SHLD-BTM	28480	03325-20602
A8	**03325-66508**	**5**	**1**	**PC ASSY-HI VOLT**	**28480**	**03325-66508**
A8C1-2	0160-2055	9	2	CAPACITOR-FXD .01UF +80-20% 100VDC CER	09538P01	805-504 Y5V 103Z
A8C3-4	0180-2803	7	2	CAPACITOR-FXD 1000UF+50-10% 50VDC AL	28480	0180-2803
A8C5-6	0180-2822	0	2	CAPACITOR-FXD 10UF+50-10% 50VDC AL	04200P01	510D056
A8C7-8	0160-2257	3	1	CAPACITOR-FXD 10PF +-5% 500VDC CER 0+-60	01468P01	
A8C11	0160-3847	9	1	CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A8C12-13	0160-6861	3	3	C-F 3PF --% 500V CERTBr	09538P01	301 089 COJ0 309C
A8C14-15	0180-0210	6	2	CAPACITOR-FXD 3.3UF+-20% 15VDC TA	04200P01	150D335X0015A2-DYS
A8C16-17	0160-6506	3	6	C-F .1UF 20% 50V CERMLr	09939P01	RPE121-978Z5U104M50V
A8C18	0180-2825	3	2	CAPACITOR-FXD 22UF+50-10% 50VDC AL	04200P01	510D057
A8C21	0180-2825	3		CAPACITOR-FXD 22UF+50-10% 50VDC AL	04200P01	510D057
A8C22-25	0160-6506	3		C-F .1UF 20% 50V CERMLr	09939P01	RPE121-978Z5U104M50V
A8CR1-2	1902-3205	8	3	DIODE-ZNR 15V 5% DO-35 PD=.4W TC=+.057%	02037P01	
A8CR3-5	1901-0040	1	9	DIODE-SWITCHING 30V 50MA 2NS DO-35	02237P01	
A8CR6	1902-3205	8		DIODE-ZNR 15V 5% DO-35 PD=.4W TC=+.057%	02037P01	
A8CR7	1902-0244	9	1	DIODE-ZNR 30V 5% PD=1W IR=5UA	02037P01	
A8CR8	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	02237P01	
A8CR11-15	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	02237P01	
A8CR16-17	1901-0050	3	2	DIODE-SWITCHING 80V 200MA 2NS DO-35	02237P01	
A8F1	2110-0343	1	1	FUSE .25A 125V NTD .281X.093	04703P01	275.250
A8H1-2	0340-0564	3	2	INSULATOR-XSTR THRM-CNDCT	05447P01	7403-09FR-51
A8H3	1205-0298	5	1	HEAT SINK PLSTC-PWR-CS	02608P01	6030D
A8J20-21	1251-2969	8	2	CONNECTOR-PHONO SINGLE PHONO JACK; DIP	03418P01	15-24-0503
A8P1	1251-4246	8	1	CONN-POST TYPE .156-PIN-SPCG 3-CONT	03418P01	09-65-1031
A8Q1	1854-0475	5	1	TRANSISTOR-DUAL NPN PD=750MW	04550P02	
A8Q1	1205-0011	0	1	HEAT SINK TO-5/TO-39-CS	05792P01	TXBF-032-025B
A8Q2	1854-0215	1	1	TRANSISTOR NPN SI PD=350MW FT=300MHZ	02037P01	
A8Q3	1853-0036	2	1	TRANSISTOR PNP SI PD=310MW FT=250MHZ	02037P01	
A8Q4	1853-0042	0	1	TRANSISTOR PNP SI PD=310MW FT=200MHZ	02037P01	
A8Q5-6	1854-0215	1	1	TRANSISTOR NPN SI PD=350MW FT=300MHZ	02037P01	
A8Q7-8	1853-0020	4	1	TRANSISTOR PNP SI PD=300MW FT=150MHZ	02037P01	

* Indicates factory selected values

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A8Q11	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	02037P01	
A8Q12	1853-0042	0	1	TRANSISTOR PNP SI PD=310MW FT=200MHZ	02037P01	
A8Q13	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	02037P01	
A8Q14	1854-0692	8	1	TRANSISTOR NPN SI PD=15W FT=50MHZ	02037P01	
A8Q15	1853-0367	2	1	TRANSISTOR PNP SI PD=15W FT=50MHZ	02037P01	
A8R1	0698-3279	0	2	RESISTOR 4.99K 1% .125W F TC=0+-100	02995P01	SFR25H
A8R2	0757-0458	7	1	RESISTOR 51.1K 1% .125W F TC=0+-100	02995P01	SFR25H
A8R3-4	0757-0283	6	4	RESISTOR 2K 1% .125W F TC=0+-100	02995P01	SFR25H
A8R5-6	0683-4705	8	4	RESISTOR 47 5% .25W CF TC=0-400	00746P01	R-25J
A8R7	0698-3279	0		RESISTOR 4.99K 1% .125W F TC=0+-100	02995P01	SFR25H
A8R8	0698-3223	4	1	RESISTOR 1.24K 1% .125W F TC=0+-100	02995P01	SFR25H
A8R11	0698-4449	8	1	RESISTOR 309 1% .125W F TC=0+-100	05524P01	CMF-55-1, T-1
A8R12-13	0698-6360	6	2	RESISTOR 10K .1% .125W F TC=0+-25	02995P01	5033R
A8R14-15	0698-4453	4	2	RESISTOR 402 1% .125W F TC=0+-100	05524P01	CMF-55-1, T-1
A8R16-17	0683-1015	7	2	RESISTOR 100 5% .25W CF TC=0-400	00746P01	R-25J
A8R18	0683-1045	3	1	RESISTOR 100K 5% .25W CF TC=0-400	00746P01	R-25J
A8R21	0757-0273	4	2	RESISTOR 3.01K 1% .125W F TC=0+-100	02995P01	SFR25H
A8R22	0698-4498	7	1	RESISTOR 53.6K 1% .125W F TC=0+-100	05524P01	CMF-55-1, T-1
A8R23	0757-0273	4		RESISTOR 3.01K 1% .125W F TC=0+-100	02995P01	SFR25H
A8R24-25	0683-4705	8		RESISTOR 47 5% .25W CF TC=0-400	00746P01	R-25J
A8R26-27	0683-3305	2	2	RESISTOR 33 5% .25W CF TC=0-400	00746P01	R-25J
A8R28	0683-0365	8	2	RESISTOR 3.6 5% .25W CF TC=0-400	00746P01	R-25J
A8R31	0757-0283	6		RESISTOR 2K 1% .125W F TC=0+-100	02995P01	SFR25H
A8R32-33	0757-0472	5	2	RESISTOR 200K 1% .125W F TC=0+-100	02995P01	SFR25H
A8R34	0757-0283	6		RESISTOR 2K 1% .125W F TC=0+-100	02995P01	SFR25H
A8R35	0683-0365	8		RESISTOR 3.6 5% .25W CF TC=0-400	00746P01	R-25J
A8R36-37	0683-0565	0	2	RESISTOR 5.6 5% .25W CF TC=0-400	00746P01	R-25J
A8R38	0683-2205	9	1	RESISTOR 22 5% .25W CF TC=0-400	00746P01	R-25J
A8TP1-7	1251-0600	0	7	CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	03418P01	16-06-0034
A8U1	1906-0096	7	1	DIODE-FW BRDG 200V 2A	02037P01	SDA296-002
A8U2	1826-0464	3	1	IC V RGLTR-FXD-POS 14.4/15.6V TO-220 PKG	02037P01	
A8U3	1826-0214	1	1	IC V RGLTR-FXD-NEG 14.4/15.6V TO-220 PKG	02037P01	
	2200-0111	2	1	SCREW-MACH 4-40 .5-IN-LG PAN-HD-POZI	01136P01	
	2260-0009	3	1	NUT-HEX-W/LKWR 4-40-THD .094-IN-THK	04604P01	
	7121-4611	2	1	LABEL-INFORMATION .15-IN-WD .6-IN-LG	09479P01	L01003
A9	**03325-66509**	**6**	**1**	**PC ASSY-OVEN**	**28480**	**03325-66509**
A9C1	0180-0692	8	1	CAPACITOR-FXD 220UF+50-10% 35VDC AL	00493P01	SL35VB221T12X25
A9C2-3	0160-3847	9	2	CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A9C4	0180-0693	9	1	CAPACITOR-FXD 1000UF+50-10% 25VDC AL	00493P01	SL25VB102T16X35
A9CR1-2	1901-0049	0	2	DIODE-PWR RECT 50V 750MA DO-29	02037P01	
A9CR3	1902-0049	2	1	DIODE-ZNR 6.19V 5% DO-35 PD=.4W	02037P01	
A9E1	0960-0465	7	1	OSC OCXO 10MHZ VCONT TTL * 15V	02532P01	OSC 73-52
A9H1	0340-0564	3	1	INSULATOR-XSTR THRM-CNDCT	05447P01	7403-09FR-51
A9H3	1205-0298	5	1	HEAT SINK PLSTC-PWR-CS	02608P01	6030D
A9H4	2190-0556	6	1	WASHER-LK HLCL NO. 4 .115-IN-ID	28480	2190-0556
A9H5-6	2200-0103	2	2	SCREW-MACH 4-40 .25-IN-LG PAN-HD-POZI	01136P01	
A9H7	2200-0141	8	1	SCREW-MACH 4-40 .312-IN-LG PAN-HD-POZI	01125P01	4322
A9H8	2260-0001	5	1	NUT-HEX-DBL-CHAM 4-40-THD .094-IN-THK	28480	2260-0001
A9H9-12	2360-0113	2	4	SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	01136P01	
A9H13	3050-0105	6	1	WASHER-FL MTLC NO. 4 .125-IN-ID	04821P01	
A9H15	3050-0604	0	1	WASHER-FL MTLC 7/16 IN .5-IN-ID	05313P01	5710-94-16
A9H16-17	3050-0716	5	2	WASHER-FL MTLC NO. 5 .128-IN-ID	04420P01	NAS620-C5
A9J1	1251-4246	8	1	CONN-POST TYPE .156-PIN-SPCG 3-CONT	03418P01	09-65-1031
A9J19	1251-2969	8	1	CONNECTOR-PHONO SINGLE PHONO JACK; DIP	03418P01	15-24-0503
A9Q1	1854-0053	5	1	TRANSISTOR NPN 2N2218 SI TO-5 PD=800MW	02037P01	
A9Q2	1853-0450	4	1	TRANSISTOR PNP SI TO-220AB PD=60W	02037P01	SJE1980
A9R1	0683-1025	9	1	RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J
A9R2	0683-1035	1	1	RESISTOR 10K 5% .25W CF TC=0-400	00746P01	R-25J
A9R3	0683-3325	6	1	RESISTOR 3.3K 5% .25W CF TC=0-400	00746P01	R-25J
A9R4	0757-0290	5	1	RESISTOR 6.19K 1% .125W F TC=0+-100	02995P01	SFR25H
A9R5	0698-3498	5	1	RESISTOR 8.66K 1% .125W F TC=0+-100	02995P01	SFR25H
A9R6	0698-3274	5	1	RESISTOR 10K 1% .125W F TC=0+-25	02995P01	5033R
A9R7	2100-3252	6	1	RESISTOR-TRMR 5K 10% C TOP-ADJ 1-TRN	03744P01	3386P-Y46-502
A9R8	0683-1015	7	1	RESISTOR 100 5% .25W CF TC=0-400	00746P01	R-25J
A9R9	0683-2025	1	1	RESISTOR 2K 5% .25W CF TC=0-400	00746P01	R-25J
A9U1	1820-0216	1	1	IC OP AMP GP 8-DIP-P PKG	02237P01	

See introduction to this section for ordering information

* Indicates factory selected values

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
	3050-0440	2	1	WASHER-SHLDR NO. 4 .115-IN-ID .2-IN-OD	05313P01	5607-45
	7121-4611	2	1	LABEL-INFORMATION .15-IN-WD .6-IN-LG	09479P01	L01003
				Options 001 and 002 Miscellaneous Parts		
J3	1250-1499	5	1	ADAPTER-COAX RTANG M-BNC F-BNC	05769P01	58-905-0019-910
W19	03325-61610	0	1	CBL-ASM CXL MRCA/MRCA 305MM BL	L1287D01	
W20	03325-61605	3	1	CBL-ASM CXL MRCA/MRCA 305MM BK	L1287D01	
W21	03325-61621	3	1	CBL-ASM CXL MRCA/MRCA 216MM BL	L1287D01	
W29	03325-61616	6	1	CBL-ASM DSC FHSG/FHSG 440MM ML	10549P01	
	2360-0113	2	4	SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	01136P01	
	1400-0611	0	3	CLAMP-FL-CA 1-WD	04726P01	3484-1000
	3050-0716	5	2	WASHER-FL MTLC NO. 5 .128-IN-ID	04420P01	NAS620-C5
	2200-0103	2	2	SCREW-MACH 4-40 .25-IN-LG PAN-HD-POZI	01136P01	
	00310-48801	0	2	MOLD WSHR-SH D-SHAPE	28480	00310-48801
	03325-00601	1	1	SHTF SHLD-R.F. AL	28480	03325-00601
	7120-6712	6	1	LABEL-WARNING .5-IN-WD 1-IN-LG MYLAR	03211D01	
	7120-6797	7	1	LABEL-INFORMATION .35-IN-WD .75-IN-LG	03211D01	
	7120-8376	2	1	LBL-ID "OPTION 002" 9x30 AGMY	05507P01	
	7120-8377	3	1	LBL-ID "OPTION 001" 9x30 AGMY	05507P01	
	1250-1558	7	1	ADAPTER-COAX STR F-BNC F-RCA-PHONO	03316P01	29JJ126-3
A12	**03325-66512**	**1**	**1**	**HPIB PC BOARD**	**28480**	**03325-66512**
A14	**03325-66514**	**3**	**1**	**PC ASSY-FUNCTION**	**28480**	**03325-66514**
A14C1	0180-1701	2	1	CAPACITOR-FXD 6.8UF+-20% 6VDC TA	04200P01	150D685X0006A2-DYS
A14C2	0160-3560	3	1	CAPACITOR-FXD 1UF +-2% 100VDC MET-POLYC	05176P01	HEW-249
A14C3	0160-3847	9	44	CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A14C4	0160-4532	1	5	CAPACITOR-FXD 1000PF +-20% 50VDC CER	02010P01	SA105C102MAA
A14C5-6	0180-1746	5	10	CAPACITOR-FXD 15UF+-10% 20VDC TA	04200P01	150D156X9020B2-DYS
A14C26-28	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A14C29	0160-4571	8	17	CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A14C31-32	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A14C33	0160-3466	8	4	CAPACITOR-FXD 100PF +-10% 1KVDC CER	09538P01	838-546 X5E 101K
A14C34	0160-4532	1		CAPACITOR-FXD 1000PF +-20% 50VDC CER	02010P01	SA105C102MAA
A14C35	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A14C36-37	0160-0162	5	2	CAPACITOR-FXD .022UF +-10% 200VDC POLYE	05176P01	HEW-238M
A14C38-39	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A14C41-42	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A14C43	0160-4137	2	1	CAPACITOR-FXD .01UF +-1% 100VDC POLYSTY	05176P01	863UW
A14C44-45	0160-0128	3	1	CAPACITOR-FXD 2.2UF +-20% 50VDC CER	04200P01	3C37Z5U225M050A
A14C46	0160-5335	4	3	CAPACITOR-FXD 1UF +-10% 100VDC MET-POLYE	02995P01	719A1GG105PK101SB
A14C47	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A14C48	0180-0210	6	2	CAPACITOR-FXD 3.3UF+-20% 15VDC TA	04200P01	150D335X0015A2-DYS
A14C49	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	04200P01	150D156X9020B2-DYS
A14C50	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A14C61-62	0160-5335	4		CAPACITOR-FXD 1UF +-10% 100VDC MET-POLYE	02995P01	719A1GG105PK101SB
A14C63	0160-5306	9	3	CAPACITOR-FXD .1UF +-10% 100VDC	02995P01	719A1CA104PK101SA
A14C65-66	0160-5306	9		CAPACITOR-FXD .1UF +-10% 100VDC	02995P01	719A1CA104PK101SA
A14C76	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A14C77-78	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A14C101+	0160-0145	4	1	CAPACITOR-FXD 82PF +-2% 100VDC MICA	02367P01	
A14C103+	0140-0217	9	1	CAPACITOR-FXD 140PF +-2% 300VDC MICA	01452P01	
A14C104	0160-3084	6	1	CAPACITOR-FXD 60PF +-2% 500VDC MICA	01452P01	
A14C105	0160-2306	3	1	CAPACITOR-FXD 27PF +-5% 300VDC MICA	01452P01	
A14C106	0160-2201	7	1	CAPACITOR-FXD 51PF +-5% 300VDC MICA	01452P01	
A14C107	0140-0196	3	1	CAPACITOR-FXD 150PF +-5% 300VDC MICA	02367P01	
A14C108-109	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A14C110	0121-0105	4	1	CAPACITOR-V TRMR-CER 9-35PF 200V PC-MTG	01468P01	304324 9/35PF N650
A14C111	0160-6865	7	3	C-F 5.1PF –% 500V CERTBr	09538P01	301 089 COH0 519C
A14C112-113	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A14C114	0160-4532	1		CAPACITOR-FXD 1000PF +-20% 50VDC CER	02010P01	SA105C102MAA
A14C116-117	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A14C118-119	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	04200P01	150D156X9020B2-DYS
A14C121-122	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA

* Indicates factory selected values

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A14C124	0160-0299	9	1	CAPACITOR-FXD 1800PF +-10% 200VDC POLYE	05176P01	HEW-238M
A14C126-129	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A14C130	0160-6859	9		C-F 2PF --% 500V CERTBr	09538P01	301 089 COK0 209C
A14C130	0160-2240	4	1	CAPACITOR-FXD 2PF +-.25PF 500VDC CER	01468P01	
A14C131-132	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A14C133	0160-6865	7		C-F 5.1PF --% 500V CERTBr	09538P01	301 089 COH0 519C
A14C134	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A14C135	0160-2240	4		CAPACITOR-FXD 2PF +-.25PF 500VDC CER	01468P01	
A14C136	0160-6520	1	1	C-F 1UF --% 50V CERMLr	09939P01	RPE113-90125U105Z50V
A14C137-138	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A14C139	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A14C141	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A14C142	0160-0156	7	1	CAPACITOR-FXD 3900PF +-10% 200VDC POLYE	05176P01	HEW-238M
A14C143	0160-0301	4	1	CAPACITOR-FXD .012UF +-10% 200VDC POLYE	05176P01	HEW-238M
A14C144	0160-2414	4	1	CAPACITOR-FXD .022UF +-5% 200VDC POLYE	05176P01	HEW-238M
A14C203	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A14C205	0160-3466	8		CAPACITOR-FXD 100PF +-10% 1KVDC CER	09538P01	838-546 X5E 101K
A14C208-209	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A14C211-212	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A14C213-214	0160-4532	1		CAPACITOR-FXD 1000PF +-20% 50VDC CER	02010P01	SA105C102MAA
A14C217	0121-0452	4	1	CAPACITOR-V TRMR-AIR 1.3-5.4PF 175V	04670P01	187-0103-028
A14C218	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A14C219	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	04200P01	150D156X9020B2-DYS
A14C220	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A14C221	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A14C222	0160-6865	7		C-F 5.1PF --% 500V CERTBr	09538P01	301 089 COH0 519C
A14C223-225	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A14C226	0160-2240	4		CAPACITOR-FXD 2PF +-.25PF 500VDC CER	01468P01	
A14C227-230	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A14C231	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	04200P01	150D156X9020B2-DYS
A14C232	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A14C233	0180-0210	6		CAPACITOR-FXD 3.3UF+-20% 15VDC TA	04200P01	150D335X0015A2-DYS
A14C234-235	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A14C236	0160-3466	8		CAPACITOR-FXD 100PF +-10% 1KVDC CER	09538P01	838-546 X5E 101K
A14C238	0160-2055	9	1	CAPACITOR-FXD .01UF +80-20% 100VDC CER	09538P01	805-504 Y5V 103Z
A14C239	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A14C240	0160-3466	8		CAPACITOR-FXD 100PF +-10% 1KVDC CER	09538P01	838-546 X5E 101K
A14C241-242	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A14C245-246	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	04200P01	150D156X9020B2-DYS
A14C260-262	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A14C263	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	04200P01	150D156X9020B2-DYS
A14C264	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A14CR1	1902-0041	4	1	DIODE-ZNR 5.11V 5% DO-35 PD=.4W	02037P01	
A14CR2-3	1901-0040	1	18	DIODE-SWITCHING 30V 50MA 2NS DO-35	02237P01	
A14CR4	1901-0050	3	5	DIODE-SWITCHING 80V 200MA 2NS DO-35	02237P01	
A14CR5	1902-3345	7	1	DIODE-ZNR 51.1V 5% DO-35 PD=.4W	02037P01	
A14CR6-7	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	02237P01	
A14CR76	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	02237P01	
A14CR101-104	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	02237P01	
A14CR106-107	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	02237P01	
A14CR108-109	1901-0535	9	1	DIODE-SCHOTTKY SM SIG	28480	1901-0535
A14CR110-111	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	02237P01	
A14CR205	1902-0631	8	1	DIODE-ZNR 1N5351B 14V 5% PD=5W TC=+75%	02037P01	
A14CR208-210	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	02237P01	
A14CR211-212	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	02237P01	
A14CR213	1902-3149	9	1	DIODE-ZNR 9.09V 5% DO-35 PD=.4W	02037P01	
A14CR214	1902-3030	7	1	DIODE-ZNR 3.01V 5% DO-7 PD=.4W TC=-.067%	02037P01	
A14CR215	1902-0631	8		DIODE-ZNR 1N5351B 14V 5% PD=5W TC=+75%	02037P01	
A14CR217	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	02237P01	
A14CR219-221	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	02237P01	
A14CR222-225	1901-0535	9	1	DIODE-SCHOTTKY SM SIG	28480	1901-0535
A14F1-F3	2110-0343	1	3	FUSE .25A 125V NTD .281X.093	04703P01	275.250
A14F4	2110-0301	1	1	FUSE .125A 125V .281X.093	04703P01	275.125
A14HJ31	1258-0141	8	1	CON-JUMPER REM .025P	02946P01	65474-004
A14J1	1252-2407	1	1	CON-HEADER 21 CONT	L1359D01	LCW-121-08-G-S-295

* Indicates factory selected values

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A14J2	1251-2969	8	10	CONNECTOR-PHONO SINGLE PHONO JACK; DIP	03418P01	15-24-0503
A14J4-J5	1251-2969	8		CONNECTOR-PHONO SINGLE PHONO JACK; DIP	03418P01	15-24-0503
A14J6	8159-0005	0	1	RESISTOR-ZERO OHMS 22 AWG LEAD DIA	03123P01	106
A14J9	1251-2969	8		CONNECTOR-PHONO SINGLE PHONO JACK; DIP	03418P01	15-24-0503
A14J12-14	1251-2969	8		CONNECTOR-PHONO SINGLE PHONO JACK; DIP	03418P01	15-24-0503
A14J23-25	1251-2969	8		CONNECTOR-PHONO SINGLE PHONO JACK; DIP	03418P01	15-24-0503
A14J30	1251-5922	9	1	CONN-POST TYPE .100-PIN-SPCG 14-CONT	03418P01	22-10-2141
A14J30	1252-2406	0		CON-HEADER 14 CONT	L1359D01	LCW-114-08-G-S-295
A14J31	1251-4822	6	1	CONN-POST TYPE .100-PIN-SPCG 3-CONT	03418P01	22-03-2031
A14L26-27	9100-1791	1	1	CORE-FERRITE CHOKE-WIDEBAND; 290 nH 20% .23DX .375LG	0887P01	VK200-19/4B
A14L76-79	9100-1791	1		CORE-FERRITE CHOKE-WIDEBAND;290 nH 20% .23DX .375LG	0887P01	VK200-19/4B
A14L80	9100-0539	3	1	INDUCTOR RF-CH-MLD 10UH 5% .156DX.375LG	03273P01	15M102J
A14L101-102	9140-0456	7	2	INDUCTOR RF-CH-MLD 470NH 2% .166DX.385LG	03273P01	15M470G
A14L103	9100-2486	3	1	INDUCTOR RF-CH-MLD 330NH 5% .166DX.385LG	03273P01	15M330J
A14L104	9100-1622	7	1	INDUCTOR RF-CH-MLD 24UH 5% .166DX.385LG	05826P01	1537-46
A14L105	9100-1628	3	1	INDUCTOR RF-CH-MLD 43UH 5% .166DX.385LG	05826P01	1537-58
A14L201	9100-1791	1		CORE-FERRITE CHOKE-WIDEBAND; 290 nH 20% .23DX .375LG	01887P01	VK200-19/4B
A14L204	9170-0894	0	2	CORE-SHIELDING BEAD	01887P01	56-590-65/4A6
A14L211	9170-0894	0		CORE-SHIELDING BEAD	01887P01	56-590-65/4A6
A14Q1	1855-0092	4	1	TRANSISTOR J-FET N-CHAN D-MODE TO-18 SI	04550P02	
A14Q2	1855-0625	9	1	XTR SML1JFETP SI XXXXXXX P92	02883P01	
A14Q3	1854-0692	8	1	TRANSISTOR NPN SI PD=15W FT=50MHZ	02037P01	
A14Q4	1855-0625	9		XTR SML1JFETP SI XXXXXXX P92	02883P01	
A14Q25	1855-0410	0	1	TRANSISTOR J-FET N-CHAN D-MODE TO-18 SI	03406P01	
A14Q26	1853-0020	4	1	TRANSISTOR PNP SI PD=300MW FT=150MHZ	02037P01	
A14Q27	1853-0066	8	1	TRANSISTOR PNP SI TO-92 PD=625MW	02237P01	
A14Q28	1854-0215	1	1	TRANSISTOR NPN SI PD=350MW FT=300MHZ	02037P01	
A14Q76	1854-0087	5	1	TRANSISTOR NPN SI PD=360MW FT=75MHZ	04200P01	
A14Q101	1854-0795	2	1	TRANSISTOR NPN SI TO-92 PD=625MW	02037P01	
A14Q102	1853-0405	9	1	TRANSISTOR PNP SI PD=300MW FT=850MHZ	02037P01	
A14Q103	1853-0640	4	1	XTR SML1PNP	02237P01	S44446
A14Q104	1854-0404	0	1	TRANSISTOR NPN SI TO-18 PD=360MW	02037P01	
A14Q105	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	02037P01	
A14Q106	1854-0560	9	1	TRANSISTOR NPN SI DARL PD=310MW	02037P01	
A14Q107	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	02037P01	
A14Q108-109	1853-0083	9	1	TRANSISTOR-DUAL PNP PD=600MW	02237P01	
A14Q112	1854-0314	1	1	TRANSISTOR NPN SI PD=310MW FT=200MHZ	02037P01	
A14Q113	1854-0560	9		TRANSISTOR NPN SI DARL PD=310MW	02037P01	
A14Q114	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	02037P01	
A14Q116-117	1853-0066	8		TRANSISTOR PNP SI TO-92 PD=625MW	02237P01	
A14Q118	1855-0081	1	1	TRANSISTOR J-FET N-CHAN D-MODE SI	02037P01	SPF819
A14Q119	1854-0560	9		TRANSISTOR NPN SI DARL PD=310MW	02037P01	
A14Q201	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	02037P01	
A14Q203	1854-0233	3	1	TRANSISTOR NPN 2N3866 SI TO-39 PD=1W	02037P01	
A14Q203	1205-0033	6	1	HEAT SINK TO-5/TO-39-CS	02123P01	207-CB
A14Q204	1854-1139	0	1	XTR SML1NPN	02037P01	SPS8028RL
A14Q204	1205-0018	7	1	HEAT SINK TO-18-CS	02123P01	203-CB
A14Q206	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	02037P01	
A14Q207	1854-1114	1	1	XTR SML1NPN SI XXXXXXX B39	02037P01	SRF5342
A14Q207	1205-0033	6	1	HEAT SINK TO-5/TO-39-CS	02123P01	207-CB
A14Q208	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	02037P01	
A14Q209	1853-0440	2	1	TRANSISTOR PNP SI TO-39 PD=5W FT=500MHZ	02037P01	
A14Q209	1205-0033	6	1	HEAT SINK TO-5/TO-39-CS	02123P01	207-CB
A14Q210	1854-0357	2	1	TRANSISTOR-DUAL NPN PD=360MW	02037P01	
A14Q210	1205-0011	0	1	HEAT SINK TO-5/TO-39-CS	05792P01	TXBF-032-025B
A14Q211	1853-0448	0	1	TRANSISTOR PNP SI TO-92 PD=625MW	02037P01	
A14Q211	1205-0018	7	1	HEAT SINK TO-18-CS	02123P01	203-CB
A14Q212	1853-0036	2	1	TRANSISTOR PNP SI PD=310MW FT=250MHZ	02037P01	
A14Q213	1853-0625	5	1	XTR SML1PNP SI XXXXXXX B39	02037P01	SRF5343
A14Q213	1205-0033	6	1	HEAT SINK TO-5/TO-39-CS	02123P01	207-CB
A14Q214	1853-0020	4		TRANSISTOR PNP SI PD=300MW FT=150MHZ	02037P01	
A14Q215	1854-0215	1		TRANSISTOR NPN SI PD=350MW FT=300MHZ	02037P01	
A14Q216	1854-0784	9	1	TRANSISTOR NPN 2N3866A SI TO-39 PD=5W	02037P01	
A14Q216	1205-0033	6	1	HEAT SINK TO-5/TO-39-CS	02123P01	207-CB
A14Q219	1853-0440	2		TRANSISTOR PNP SI TO-39 PD=5W FT=500MHZ	02037P01	

* Indicates factory selected values

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A14Q219	1205-0033	6		HEAT SINK TO-5/TO-39-CS	02123P01	207-CB
A14R1	0683-2215	1	1	RESISTOR 220 5% .25W CF TC=0-400	00746P01	R-25J
A14R3	0698-3155	1	1	RESISTOR 4.64K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R4	0757-0439	4	1	RESISTOR 6.81K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R5	0683-2225	3	13	RESISTOR 2.2K 5% .25W CF TC=0-400	00746P01	R-25J
A14R6	2100-3253	7	1	RESISTOR-TRMR 50K 10% C TOP-ADJ 1-TRN	03744P01	3386P-Y46-503
A14R7	0757-0488	3	1	RESISTOR 909K 1% .125W F TC=0+-100	02995P01	5033R
A14R8	0757-0288	1	1	RESISTOR 9.09K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R9	0757-0410	1	2	RESISTOR 301 1% .125W F TC=0+-100	02995P01	SFR25H
A14R11	0757-0410	1		RESISTOR 301 1% .125W F TC=0+-100	02995P01	SFR25H
A14R26-29	0683-2225	3		RESISTOR 2.2K 5% .25W CF TC=0-400	00746P01	R-25J
A14R31-32	0683-1035	1	6	RESISTOR 10K 5% .25W CF TC=0-400	00746P01	R-25J
A14R33	0683-1025	9	10	RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J
A14R34	0683-5635	5	1	RESISTOR 56K 5% .25W CF TC=0-400	00746P01	R-25J
A14R36	0683-2235	5	3	RESISTOR 22K 5% .25W CF TC=0-400	00746P01	R-25J
A14R37	0683-2225	3		RESISTOR 2.2K 5% .25W CF TC=0-400	00746P01	R-25J
A14R38	0757-0289	2	2	RESISTOR 13.3K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R39	0757-0442	9	6	RESISTOR 10K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R40	2100-3214	0	1	RESISTOR-TRMR 100K 10% C TOP-ADJ 1-TRN	03744P01	3386P-Y46-104
A14R41	0757-0289	2		RESISTOR 13.3K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R42	0699-0124	0	1	RESISTOR 10.2K .1% .125W F TC=0+-25	02995P01	5033R
A14R43	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R44	0757-0441	8	1	RESISTOR 8.25K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R45	0683-4705	8	11	RESISTOR 47 5% .25W CF TC=0-400	00746P01	R-25J
A14R46	0683-1025	9		RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J
A14R48	0683-4725	2	1	RESISTOR 4.7K 5% .25W CF TC=0-400	00746P01	R-25J
A14R49	0757-0438	3	7	RESISTOR 5.11K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R50	0683-2225	3		RESISTOR 2.2K 5% .25W CF TC=0-400	00746P01	R-25J
A14R51	0757-0279	0	2	RESISTOR 3.16K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R52	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R53	0698-6347	9	1	RESISTOR 1.5K .1% .125W F TC=0+-25	02995P01	5033R
A14R54	0698-6936	2	1	RESISTOR 156K .5% .125W F TC=0+-50	02995P01	5033R
A14R55	0757-0280	3	7	RESISTOR 1K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R56	0757-0449	6	3	RESISTOR 20K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R57	0699-0121	7	1	RESISTOR 2.05M 1% .125W F TC=0+-100	06118P01	MK2
A14R58	0699-0122	8	1	RESISTOR 4.8K .1% .125W F TC=0+-25	02995P01	5033R
A14R60	0683-1015	7	5	RESISTOR 100 5% .25W CF TC=0-400	00746P01	R-25J
A14R61	0683-1025	9		RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J
A14R62	0683-1015	7		RESISTOR 100 5% .25W CF TC=0-400	00746P01	R-25J
A14R63-64	0683-1025	9		RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J
A14R65	0683-1015	7		RESISTOR 100 5% .25W CF TC=0-400	00746P01	R-25J
A14R67-68	0683-1025	9		RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J
A14R69	0683-1015	7		RESISTOR 100 5% .25W CF TC=0-400	00746P01	R-25J
A14R76	0683-1035	1		RESISTOR 10K 5% .25W CF TC=0-400	00746P01	R-25J
A14R77	0683-2225	3		RESISTOR 2.2K 5% .25W CF TC=0-400	00746P01	R-25J
A14R78	0683-1025	9		RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J
A14R100-101	0683-2225	3		RESISTOR 2.2K 5% .25W CF TC=0-400	00746P01	R-25J
A14R102	0683-4705	8		RESISTOR 47 5% .25W CF TC=0-400	00746P01	R-25J
A14R103	0757-0273	4	2	RESISTOR 3.01K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R104	0757-0283	6	2	RESISTOR 2K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R105	0757-0398	4	1	RESISTOR 75 1% .125W F TC=0+-100	02995P01	SFR25H
A14R106	0683-1515	2	1	RESISTOR 150 5% .25W CF TC=0-400	00746P01	R-25J
A14R107	0757-0400	9	1	RESISTOR 90.9 1% .125W F TC=0+-100	02995P01	SFR25H
A14R108	0698-4427	2	1	RESISTOR 1.65K 1% .125W F TC=0+-100	05524P01	CMF-55-1, T-1
A14R109	0757-0420	3	1	RESISTOR 750 1% .125W F TC=0+-100	02995P01	SFR25H
A14R110-111	0683-2225	3		RESISTOR 2.2K 5% .25W CF TC=0-400	00746P01	R-25J
A14R112	0683-7505	2	1	RESISTOR 75 5% .25W CF TC=0-400	00746P01	R-25J
A14R113	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R114	0698-6317	3	1	RESISTOR 500 .1% .125W F TC=0+-25	05524P01	CMF-55-1, T-9
A14R116	0698-6317	3	1	RESISTOR 500 .1% .125W F TC=0+-25	05524P01	CMF-55-1, T-9
A14R117-118	0698-4123	5	2	RESISTOR 499 1% .125W F TC=0+-100	02995P01	SFR25H
A14R119	0698-4435	2	1	RESISTOR 2.49K 1% .125W F TC=0+-100	05524P01	CMF-55-1, T-1
A14R121	0683-2225	3		RESISTOR 2.2K 5% .25W CF TC=0-400	00746P01	R-25J
A14R122-124	0698-6360	6	3	RESISTOR 10K .1% .125W F TC=0+-25	02995P01	5033R
A14R126	0698-6320	8	1	RESISTOR 5K .1% .125W F TC=0+-25	05524P01	CMF-55-1, T-9

* Indicates factory selected values

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A14R127	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	02995P01	5033R
A14R128	0698-6321	9	1	RESISTOR 9.9K .1% .125W F TC=0+-25	05524P01	CMF-55-1, T-9
A14R129	0698-3279	0	3	RESISTOR 4.99K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R130	2100-3212	8	1	RESISTOR-TRMR 200 10% C TOP-ADJ 1-TRN	03744P01	3386P-Y46-201
A14R131	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R132	0698-3179	9	1	RESISTOR 2.55K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R133	0683-4705	8		RESISTOR 47 5% .25W CF TC=0-400	00746P01	R-25J
A14R134	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R136	0698-3557	7	1	RESISTOR 806 1% .125W F TC=0+-100	02995P01	SFR25H
A14R137	0757-0416	7	1	RESISTOR 511 1% .125W F TC=0+-100	02995P01	SFR25H
A14R138-139	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R141	0698-4453	4	1	RESISTOR 402 1% .125W F TC=0+-100	05524P01	CMF-55-1, T-1
A14R142	2100-3409	5		RESISTOR-TRMR 20 10% C TOP-ADJ 1-TRN	03744P01	3386P-Y46-200
A14R143	0698-4037	0	1	RESISTOR 46.4 1% .125W F TC=0+-100	02995P01	SFR25H
A14R144	0698-3279	0		RESISTOR 4.99K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R145	0683-4705	8		RESISTOR 47 5% .25W CF TC=0-400	00746P01	R-25J
A14R146	0698-3279	0		RESISTOR 4.99K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R147	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R148	0698-6619	8	1	RESISTOR 15K .1% .125W F TC=0+-25	02995P01	5033R
A14R149	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	02995P01	5033R
A14R151	0698-8607	8	1	RESISTOR 4.5K .1% .125W F TC=0+-25	02995P01	5033R
A14R152	0699-0123	9	1	RESISTOR 6.75K .1% .125W F TC=0+-25	02995P01	5033R
A14R153	0683-1035	1		RESISTOR 10K 5% .25W CF TC=0-400	00746P01	R-25J
A14R154	0683-4705	8		RESISTOR 47 5% .25W CF TC=0-400	00746P01	R-25J
A14R156	0683-1035	1		RESISTOR 10K 5% .25W CF TC=0-400	00746P01	R-25J
A14R157	0683-4705	8		RESISTOR 47 5% .25W CF TC=0-400	00746P01	R-25J
A14R158-159	0757-0449	6		RESISTOR 20K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R160	0683-1055	5	1	RESISTOR 1M 5% .25W CF TC=0-800	00746P01	R-25J
A14R161	0757-0273	4		RESISTOR 3.01K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R162	0698-4475	0	1	RESISTOR 9.76K 1% .125W F TC=0+-100	05524P01	CMF-55-1, T-1
A14R163	0683-3935	4	1	RESISTOR 39K 5% .25W CF TC=0-400	00746P01	R-25J
A14R164	0698-4382	8	1	RESISTOR 52.3 1% .125W F TC=0+-100	05524P01	CMF-55-1, T-1
A14R166	0757-0401	0	2	RESISTOR 100 1% .125W F TC=0+-100	02995P01	SFR25H
A14R168	0683-6815	5	1	RESISTOR 680 5% .25W CF TC=0-400	00746P01	R-25J
A14R169	0683-1015	7		RESISTOR 100 5% .25W CF TC=0-400	00746P01	R-25J
A14R208-209	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R211	0683-4735	4	1	RESISTOR 47K 5% .25W CF TC=0-400	00746P01	R-25J
A14R212	0683-1025	9		RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J
A14R214	0683-1025	9		RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J
A14R215	0683-1035	1		RESISTOR 10K 5% .25W CF TC=0-400	00746P01	R-25J
A14R216-217	0683-2235	5		RESISTOR 22K 5% .25W CF TC=0-400	00746P01	R-25J
A14R218	0683-2205	9	6	RESISTOR 22 5% .25W CF TC=0-400	00746P01	R-25J
A14R220	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	02995P01	SFR25H
A14R221	0698-6320	8		RESISTOR 5K .1% .125W F TC=0+-25	05524P01	CMF-55-1, T-9
A14R222-223	0683-4705	8		RESISTOR 47 5% .25W CF TC=0-400	00746P01	R-25J
A14R224	0757-0276	7	1	RESISTOR 61.9 1% .125W F TC=0+-100	02995P01	SFR25H
A14R226	0757-0437	2	1	RESISTOR 4.75K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R228	0757-0405	4	2	RESISTOR 162 1% .125W F TC=0+-100	02995P01	SFR25H
A14R229	0683-2205	9		RESISTOR 22 5% .25W CF TC=0-400	00746P01	R-25J
A14R231	0757-0277	8	2	RESISTOR 49.9 1% .125W F TC=0+-100	02995P01	SFR25H
A14R232	0757-0317	7	2	RESISTOR 1.33K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R233	0683-1205	7	2	RESISTOR 12 5% .25W CF TC=0-400	00746P01	R-25J
A14R234	0683-0395	4	2	RESISTOR 3.9 5% .25W CF TC=0-400	00746P01	R-25J
A14R236-237	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R238	0683-1045	3	1	RESISTOR 100K 5% .25W CF TC=0-400	00746P01	R-25J
A14R239	0683-4705	8		RESISTOR 47 5% .25W CF TC=0-400	00746P01	R-25J
A14R241	0683-4705	8		RESISTOR 47 5% .25W CF TC=0-400	00746P01	R-25J
A14R242-243	0687-4701	2	4	RESISTOR 47 10% .5W CC TC=0+412	01607P01	EB4701
A14R244	0757-0465	6	2	RESISTOR 100K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R245	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R246	0683-2205	9		RESISTOR 22 5% .25W CF TC=0-400	00746P01	R-25J
A14R247	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R248	0683-2205	9		RESISTOR 22 5% .25W CF TC=0-400	00746P01	R-25J
A14R249	0683-0275	9	2	RESISTOR 2.7 5% .25W CF TC=0-400	00746P01	R-25J
A14R250	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	02995P01	SFR25H

See introduction to this section for ordering information

* Indicates factory selected values

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A14R251	0683-0275	9		RESISTOR 2.7 5% .25W CF TC=0-400	00746P01	R-25J
A14R252	0699-0064	7	1	RESISTOR 50 .1% .5W F TC=0+-25	02995P01	5053R
A14R253	0687-4701	2		RESISTOR 47 10% .5W CC TC=0+412	01607P01	EB4701
A14R254	0757-0402	1	1	RESISTOR 110 1% .125W F TC=0+-100	02995P01	SFR25H
A14R255-256	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R257	0757-0283	6		RESISTOR 2K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R258	0683-2205	9		RESISTOR 22 5% .25W CF TC=0-400	00746P01	R-25J
A14R259	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R260	0687-4701	2		RESISTOR 47 10% .5W CC TC=0+412	01607P01	EB4701
A14R261	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R262	0683-4705	8	1	RESISTOR 47 5% .25W CF TC=0-400	00746P01	R-25J
A14R263-264	0683-0685	5	2	RESISTOR 6.8 5% .25W CF TC=0-400	00746P01	R-25J
A14R265	0698-4388	4	1	RESISTOR 63.4 1% .125W F TC=0+-100	05524P01	CMF-55-1, T-1
A14R266	0698-4450	1	1	RESISTOR 324 1% .125W F TC=0+-100	05524P01	CMF-55-1, T-1
A14R268	0683-4705	8		RESISTOR 47 5% .25W CF TC=0-400	00746P01	R-25J
A14R269	0757-0346	2	1	RESISTOR 10 1% .125W F TC=0+-100	05524P01	CMF-55-1, T-1
A14R270	0698-3492	9	1	RESISTOR 2.67K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R271	0757-0405	4		RESISTOR 162 1% .125W F TC=0+-100	02995P01	SFR25H
A14R272	0683-2205	9		RESISTOR 22 5% .25W CF TC=0-400	00746P01	R-25J
A14R273	0757-0277	8		RESISTOR 49.9 1% .125W F TC=0+-100	02995P01	SFR25H
A14R274	0757-0317	7		RESISTOR 1.33K 1% .125W F TC=0+-100	02995P01	SFR25H
A14R275	2100-3409	5	2	RESISTOR-TRMR 20 10% C TOP-ADJ 1-TRN	03744P01	3386P-Y46-200
A14R276	0683-0395	4		RESISTOR 3.9 5% .25W CF TC=0-400	00746P01	R-25J
A14R277	0683-1205	7		RESISTOR 12 5% .25W CF TC=0-400	00746P01	R-25J
A14R278	0757-0200	7	1	RESISTOR 5.62K 1% .125W F TC=0+-100	02995P01	SFR25H
A14TP1-19	1251-0600	0	19	CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	03418P01	16-06-0034
A14U1	1820-1196	8	2	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01698P01	
A14U2	1820-1197	9	1	IC GATE TTL LS NAND QUAD 2-INP	01698P01	
A14U3-4	1826-0476	7	2	ANALOG SWITCH SPDT 8 -DIP-P	01698P01	
A14U5	1826-0304	0	1	IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG	03406P01	
A14U6	1820-1278	7	1	IC CNTR TTL LS BIN UP/DOWN SYNCHRO	01698P01	
A14U7	1820-1279	8	3	IC CNTR TTL LS DECD UP/DOWN SYNCHRO	01698P01	
A14U8-9	1820-1279	8		IC CNTR TTL LS DECD UP/DOWN SYNCHRO	01698P01	
A14U10	1820-1282	3	1	IC FF TTL LS J-K BAR POS-EDGE-TRIG	01698P01	
A14U11-12	1820-1112	8	4	IC FF TTL LS D-TYPE POS-EDGE-TRIG	01698P01	
A14U13	1820-1423	4	2	IC MV TTL LS MONOSTBL RETRIG DUAL	01698P01	
A14U14	1820-0693	8	3	IC FF TTL S D-TYPE POS-EDGE-TRIG	01698P01	
A14U15	1821-0001	4	1	TRANSISTOR ARRAY 14-PIN PLSTC DIP	02037P01	
A14U16-17	1826-0304	0		IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG	03406P01	
A14U18-19	1826-0208	3	5	IC OP AMP GP 8-DIP-P PKG	03406P01	
A14U20	1826-0416	5	2	ANALOG SWITCH 4 SPST 16 -CBRZ/SDR	03406P01	
A14U21	1826-0208	3		IC OP AMP GP 8-DIP-P PKG	03406P01	
A14U23	1826-0208	3		IC OP AMP GP 8-DIP-P PKG	03406P01	
A14U24	1826-0416	5		ANALOG SWITCH 4 SPST 16 -CBRZ/SDR	03406P01	
A14U25	1826-0208	3		IC OP AMP GP 8-DIP-P PKG	03406P01	
A14U26	1820-1730	6	3	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01698P01	
A14U27	1820-1216	3	1	IC DCDR TTL LS 3-TO-8-LINE 3-INP	01698P01	
A14U28	1820-1196	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01698P01	
A14U29	1820-1730	6		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01698P01	
A14U30	1820-1641	8	1	IC DRVR TTL LS BUS HEX 1-INP	01698P01	
A14U31	1820-1199	1	2	IC INV TTL LS HEX 1-INP	01698P01	
A14U32	1820-1442	7	1	IC CNTR TTL LS DECD ASYNCHRO	01698P01	
A14U33	1820-0693	8		IC FF TTL S D-TYPE POS-EDGE-TRIG	01698P01	
A14U34	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01698P01	
A14U35	1820-0693	8		IC FF TTL S D-TYPE POS-EDGE-TRIG	01698P01	
A14U36	1820-0694	9	1	IC GATE TTL S EXCL-OR QUAD 2-INP	01698P01	
A14U37	1820-1202	7	1	IC GATE TTL LS NAND TPL 3-INP	01698P01	
A14U38	1826-0111	7	1	IC OP AMP GP DUAL TO-99 PKG	02037P01	
A14U39	1826-0879	4	1	IC LINEAR		
A14U40	1858-0063	5	1	TRANSISTOR ARRAY 14-PIN PLSTC DIP	04550P03	
A14U41	1826-0111	7		IC OP AMP GP DUAL TO-99 PKG	02037P01	
A14U42	1826-0026	3	1	IC COMPARATOR PRCN TO-99 PKG	03406P01	
A14U44	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01698P01	
A14U45	1820-1423	4		IC MV TTL LS MONOSTBL RETRIG DUAL	01698P01	
A14U47	1820-0321	9	1	IC COMPARATOR GP TO-99 PKG	02237P01	

See introduction to this section for ordering information

* Indicates factory selected values

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A14U48	1820-1199	1		IC INV TTL LS HEX 1-INP	01698P01	
A14U49	1820-1730	6		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01698P01	
A14U50	1858-0047	5	1	TRANSISTOR ARRAY 16-PIN PLSTC DIP	04200P01	
A14W1-W2	1460-1336	4	2	WIREFORM CU BRT-TIN	04426P03	
	4330-0496	3	4	INSULATOR-BEAD GLASS	01167P01	KG12
	4330-0952	6	1	INSULATOR-BEAD CERAMIC	03344P01	10-215A
	7121-4611	2	1	LABEL-INFORMATION .15-IN-WD .6-IN-LG	09479P01	L01003
A15	**03325-66515**	**4**	**1**	**PC ASSY DISPLAY DRIVER**	**28480**	**03325-66515**
A15C100-101	0160-3847	9	2	CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A15C102-103	0160-4571	8	5	CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A15C107-109	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A15C110-121	0180-0229	7	12	CAPACITOR-FXD 33UF+-10% 10VDC TA	04200P01	150D336X9010B2-DYS
A15J100	T-46639	4	1	CON-HEADER-21C	03418P01	22-12-2214
A15J110	1251-7745	8	1	CONN-POST TYPE .100-PIN-SPCG 2-CONT	03418P01	22-12-2024
A15L1	9100-3334	2	1	INDUCTOR 25UH 10% .3D	05829P01	ES-2638
A15MP110-120	03325-40001	9	11	SPACER-LED	28480	03325-40001
A15Q101-102	1858-0076	0	2	TRANSISTOR ARRAY 14-PIN PLSTC TO-116	02037P01	
A15R100-107	0683-1035	1	8	RESISTOR 10K 5% .25W CF TC=0-400	00746P01	R-25J
A15R110-117	0683-4705	8	8	RESISTOR 47 5% .25W CF TC=0-400	00746P01	R-25J
A15R120-127	0683-2705	4	8	RESISTOR 27 5% .25W CF TC=0-400	00746P01	R-25J
A15R130-133	0683-2035	3	4	RESISTOR 20K 5% .25W CF TC=0-400	00746P01	R-25J
A15RN101	1810-0162	5	1	NETWORK-RES 14-DIP 4.7K OHM X 13	02483P01	760-1-R4.7K
A15RN103	1810-0903	2	1	R-N DIP 2.4KX8 2%	03744P01	4116B-0B0-242
A15U100	1820-3318	0	1	IC FF TTL ALS D-TYPE POS-EDGE-TRIG COM	01698P01	
A15U101	1820-3145	1	1	IC DRVR TTL ALS BUS OCTL	01698P01	
A15U102-103	1820-1433	6	2	IC SHF-RGTR TTL LS R-S SERIAL-IN PRL-OUT	01698P01	
A15U104-106	1858-0047	5	3	TRANSISTOR ARRAY 16-PIN PLSTC DIP	04200P01	
A15U107-108	1820-1200	5	2	IC INV TTL LS HEX	01698P01	
A15U110-120	1990-1235	5	11	LED-DISPLAY-SOLID STATE	28480	1990-1235
A15XU110-120	T-48012	1	11	IC SOCKET - 14 CONTACTS	28480	T-48012
	1200-0638	7	11	SOCKET-IC 14-CONT DIP DIP-SLDR	02414P01	DILB14P-308T
A21	**03325-66521**	**2**	**1**	**PC ASSY-FFS D/A**	**28480**	**03325-66521**
A21C1	0160-6638	2	3	C-F 56PF 5% 300V MICAs	08113P01	HP15560J3ST
A21C2	0160-3847	9	28	CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A21C3	0180-1861	5	3	CAPACITOR-FXD 27UF+-10% 10VDC TA	04200P01	150D276X9010B2-DYS
A21C4	0180-1746	5	6	CAPACITOR-FXD 15UF+-10% 20VDC TA	04200P01	150D156X9020B2-DYS
A21C6	0160-6638	2		C-F 56PF 5% 300V MICAs	08113P01	HP15560J3ST
A21C7	0160-4571	8	5	CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A21C8-9	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A21C10	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A21C11	0180-1861	5		CAPACITOR-FXD 27UF+-10% 10VDC TA	04200P01	150D276X9010B2-DYS
A21C12	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A21C13	0160-6865	7	1	C-F 5.1PF –% 500V CERTBr	09538P01	301 089 COH0 519C
A21C14	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A21C15	0160-2222	2	1	CAPACITOR-FXD 1500PF +-5% 300VDC MICA	01452P01	
A21C16	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A21C17	0160-4461	5	1	CAPACITOR-FXD 150PF +-2.5% 630VDC POLYP	03923P01	
A21C18	0160-2257	3	1	CAPACITOR-FXD 10PF +-5% 500VDC CER 0+-60	01468P01	
A21C19	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	04200P01	150D156X9020B2-DYS
A21C21	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	04200P01	150D156X9020B2-DYS
A21C22	0160-5306	9	1	CAPACITOR-FXD .1UF +-10% 100VDC	02995P01	719A1CA104PK101SA
A21C23	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A21C24	0140-0149	6	1	CAPACITOR-FXD 470PF +-5% 300VDC MICA	01452P01	
A21C26	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A21C27	0160-2243	7	1	CAPACITOR-FXD 2.7PF +-.25PF 500VDC CER	01468P01	
A21C28	0160-2208	4	1	CAPACITOR-FXD 330PF +-5% 300VDC MICA	01452P01	
A21C29	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A21C31	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A21C32	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A21C33*	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A21C33*	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A21C33+	0160-4819	7	1	CAPACITOR-FXD 2200PF +-5% 100VDC CER	02010P01	SA301A222JAA

* Indicates factory selected values

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A21C131	0160-6638	2		C-F 56PF 5% 300V MICAs	08113P01	HP15560J3ST
A21C132-133	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A21C134	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A21C135-137	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A21C138	0140-0206	6	1	CAPACITOR-FXD 270PF +-5% 500VDC MICA	02367P01	
A21C139-140	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A21C141	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	04200P01	150D156X9020B2-DYS
A21C142-143	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A21C144	0180-1861	5		CAPACITOR-FXD 27UF+-10% 10VDC TA	04200P01	150D276X9010B2-DYS
A21C145	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	04200P01	150D156X9020B2-DYS
A21C162	0160-6505	2	2	C-F .01UF 20% 100V CERMLr	09939P01	RPE121-978X7R103M100V
A21C163-164	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A21C167	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A21C168	0160-6662	2	3	C-F 100PF 5% 300V MICAc	08113P01	HP15101J3ST
A21C169	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A21C171	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	04200P01	150D156X9020B2-DYS
A21C173	0180-0228	6	1	CAPACITOR-FXD 22UF+-10% 15VDC TA	04200P01	150D226X9015B2-DYS
A21C174	0160-6662	2		C-F 100PF 5% 300V MICAc	08113P01	HP15101J3ST
A21C176	0160-6519	8	1	C-F 470PF 20% 100V CERMLr	09939P01	RPE121-978X7R471M100V
A21C177	0160-6505	2		C-F .01UF 20% 100V CERMLr	09939P01	RPE121-978X7R103M100V
A21C178	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A21C179	0160-6522	3	1	C-F 1000PF 5% 100V CERMLr	09939P01	RPE121-978C0G102J100V
A21C181	0160-6662	2		C-F 100PF 5% 300V MICAc	08113P01	HP15101J3ST
A21C182	0160-4441	1	1	CAPACITOR-FXD .47UF +-10% 50VDC CER	02010P01	SR305C474KAA
A21C183	0160-6688	2	2	C-F 1UF 20% 50V CERMLr	09939P01	RPE113-907Z5U105M50V
A21C184-187	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A21C188	0160-6688	2		C-F 1UF 20% 50V CERMLr	09939P01	RPE113-907Z5U105M50V
A21C190	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A21C195	0160-3876			C-F 47PF +-20% 200 VDC CER		
A21C196-197	0160-4283	9	1	CAPACITOR-FXD 100PF +-5% 200VDC CER	09939P01	RPE110C0G101J200V
A21CR1-2	1901-0040	1	8	DIODE-SWITCHING 30V 50MA 2NS DO-35	02237P01	
A21CR3-4	1901-0518	8	7	DIODE-SCHOTTKY SM SIG	28480	1901-0518
A21CR5	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	02237P01	
A21CR6-7	1902-0777	3	2	DIODE-ZNR 1N825 6.2V 5% DO-7 PD=.4W	02037P01	
A21CR8-9	1901-0518	8		DIODE-SCHOTTKY SM SIG	28480	1901-0518
A21CR11-13	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	02237P01	
A21CR16	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	02237P01	
A21CR17	1902-3054	5	1	DIODE-ZNR 3.65V 5% DO-35 PD=.4W	02037P01	
A21CR18-19	1902-0064	1		DIODE-ZNR 7.5V 5% DO-35 PD=.4W TC=+.05%	02037P01	
A21CR20	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	02237P01	
A21CR131	1902-3030	7	1	DIODE-ZNR 3.01V 5% DO-7 PD=.4W TC=-.067%	02037P01	
A21CR161	1901-0518	8		DIODE-SCHOTTKY SM SIG	28480	1901-0518
A21CR162	1901-0040	1	1	DIODE-SWITCHING 30V 50MA 2NS DO-35	02237P01	
A21CR163	1901-0518	8		DIODE-SCHOTTKY SM SIG	28480	1901-0518
A21CR164	0122-0162	5	1	DIODE-VVC 29PF 10% BVR=30V	03334P01	
A21CR165	1901-0518	8		DIODE-SCHOTTKY SM SIG	28480	1901-0518
A21CR166	0122-0162	5		DIODE-VVC 29PF 10% BVR=30V	03334P01	
A21H24	9222-0731	5	1	6 x 20 METALIZED BAG	04726P01	2100
A21J1	1252-2407	1	1	CON-HEADER 21 CONT	L1359D01	LCW-121-08-G-S-295
A21J7-8	1251-2969	8		CONNECTOR-PHONO SINGLE PHONO JACK; DIP	03418P01	15-24-0503
A21J15-18A	1251-2969	8		CONNECTOR-PHONO SINGLE PHONO JACK; DIP	03418P01	15-24-0503
A21L1-2	9100-1622	7	2	INDUCTOR RF-CH-MLD 24UH 5% .166DX.385LG	05826P01	1537-46
A21L3	9100-1791	1	1	CORE-FERRITE CHOKE-WIDEBAND;IMP:>360	01887P01	VK200-19/4B
A21L132	9100-1791	1		CORE-FERRITE CHOKE-WIDEBAND;IMP:>360	01887P01	VK200-19/4B
A21L133L133	9170-0894	0	1	CORE-SHIELDING BEAD	01887P01	56-590-65/4A6
A21L133	7175-0057	5	1	RESISTOR-ZERO OHMS SOLID TINNED COPPER	04309P01	
A21L161	9100-1791	1		CORE-FERRITE CHOKE-WIDEBAND;IMP:>360	01887P01	VK200-19/4B
A21L162	9140-0460	3	1	COIL-VAR 351NH-429NH Q=120 PC-MTG	08123P01	HP.39T
A21L163	9100-0539	3	1	INDUCTOR RF-CH-MLD 10UH 5% .156DX.375LG	03273P01	15M102J
A21L165	9140-0349	7	1	INDUCTOR RF-CH-MLD 1.1UH 5% .166DX.385LG	03273P01	15M111J
A21Q1-2	1853-0639	1	6	XTR	02037P01	SPS7848RL
A21Q3	1854-0345	8	1	TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	02037P01	
A21Q4	1853-0639	1		XTR	02037P01	SPS7848RL
A21Q6-8	1853-0640	4	9	XTR SML1PNP	02237P01	S44446
A21Q9	1854-1140	3	9	XTR SML1NPN	02037P01	SPS212RLRA

* Indicates factory selected values

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A21Q10	1853-0640	4		XTR SML1PNP	02237P01	S44446
A21Q11	1854-1140	3		XTR SML1NPN	02037P01	SPS212RLRA
A21Q12	1853-0640	4		XTR SML1PNP	02237P01	S44446
A21Q13-14	1854-1140	3		XTR SML1NPN	02037P01	SPS212RLRA
A21Q16	1854-1140	3		XTR SML1NPN	02037P01	SPS212RLRA
A21Q17	1855-0308	5	1	TRANSISTOR-JFET DUAL N-CHAN D-MODE SI	02883P01	
A21Q18-19	1855-0081	1	1	TRANSISTOR J-FET N-CHAN D-MODE SI	02037P01	SPF819
A21Q21	1855-0689	5	1	XTR SML1JFET	02037P01	
A21Q22-24	1854-1028	6	5	TRANSISTOR NPN SI PD=350MW FT=300MHZ	02037P01	
A21Q25	1853-0640	4		XTR SML1PNP	02237P01	S44446
A21Q26	1854-1028	6		TRANSISTOR NPN SI PD=350MW FT=300MHZ	02037P01	
A21Q27	1855-0081	1		TRANSISTOR J-FET N-CHAN D-MODE SI	02037P01	SPF819
A21Q28-29	1854-1140	3		XTR SML1NPN	02037P01	SPS212RLRA
A21Q31	1853-0640	4		XTR SML1PNP	02237P01	S44446
A21Q33	1855-0689	5		XTR SML1JFET	02037P01	
A21Q37	1854-1028	6		TRANSISTOR NPN SI PD=350MW FT=300MHZ	02037P01	
A21Q38	1853-0569	6	1	TRANSISTOR PNP SI PD=310MW FT=40MHZ	02037P01	
A21Q39	1855-0081	1		TRANSISTOR J-FET N-CHAN D-MODE SI	02037P01	SPF819
A21Q41-42	1854-1140	3		XTR SML1NPN	02037P01	SPS212RLRA
A21Q43-44	1853-0640	4		XTR SML1PNP	02237P01	S44446
A21Q131	1853-0639	1		XTR	02037P01	SPS7848RL
A21Q132	1854-1024	2	1	TRANSISTOR NPN SI PD=300MW FT=200MHZ	02037P01	
A21Q161	1853-0639	1		XTR	02037P01	SPS7848RL
A21Q162-165	1854-0345	8		TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	02037P01	
A21Q166	1853-0639	1		XTR	02037P01	SPS7848RL
A21R1	0757-0395	1	2	RESISTOR 56.2 1% .125W F TC=0+-100	02995P01	SFR25H
A21R2-3	0757-0419	0	3	RESISTOR 681 1% .125W F TC=0+-100	02995P01	SFR25H
A21R4	0683-4705	8	14	RESISTOR 47 5% .25W CF TC=0-400	00746P01	R-25J
A21R6	0757-0421	4	3	RESISTOR 825 1% .125W F TC=0+-100	02995P01	SFR25H
A21R7	0683-4715	0	3	RESISTOR 470 5% .25W CF TC=0-400	00746P01	R-25J
A21R8	0683-4705	8		RESISTOR 47 5% .25W CF TC=0-400	00746P01	R-25J
A21R9	0698-3440	7	2	RESISTOR 196 1% .125W F TC=0+-100	02995P01	SFR25H
A21R11	0683-2205	9	3	RESISTOR 22 5% .25W CF TC=0-400	00746P01	R-25J
A21R12-13	0757-0438	3	3	RESISTOR 5.11K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R14	0757-0418	9	2	RESISTOR 619 1% .125W F TC=0+-100	02995P01	SFR25H
A21R16	0757-0440	7	1	RESISTOR 7.5K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R17	0698-3152	8	1	RESISTOR 3.48K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R18	0757-0444	1	2	RESISTOR 12.1K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R19	0757-0278	9	1	RESISTOR 1.78K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R21	0683-4705	8		RESISTOR 47 5% .25W CF TC=0-400	00746P01	R-25J
A21R22	0683-1525	4	3	RESISTOR 1.5K 5% .25W CF TC=0-400	00746P01	R-25J
A21R23	0683-6815	5	2	RESISTOR 680 5% .25W CF TC=0-400	00746P01	R-25J
A21R24	0683-1825	7	1	RESISTOR 1.8K 5% .25W CF TC=0-400	00746P01	R-25J
A21R26	0757-0395	1		RESISTOR 56.2 1% .125W F TC=0+-100	02995P01	SFR25H
A21R27-28	0757-0317	7	2	RESISTOR 1.33K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R29	0683-4705	8		RESISTOR 47 5% .25W CF TC=0-400	00746P01	R-25J
A21R31	0683-3325	6	4	RESISTOR 3.3K 5% .25W CF TC=0-400	00746P01	R-25J
A21R32	0683-4715	0		RESISTOR 470 5% .25W CF TC=0-400	00746P01	R-25J
A21R33	0683-4705	8		RESISTOR 47 5% .25W CF TC=0-400	00746P01	R-25J
A21R34	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R36	0757-0280	3	8	RESISTOR 1K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R37	0698-3153	9	3	RESISTOR 3.83K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R38	0698-0083	8	6	RESISTOR 1.96K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R39	0757-0401	0	9	RESISTOR 100 1% .125W F TC=0+-100	02995P01	SFR25H
A21R41	0683-6815	5		RESISTOR 680 5% .25W CF TC=0-400	00746P01	R-25J
A21R42-43	0698-3153	9		RESISTOR 3.83K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R44	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R46	0683-1015	7	9	RESISTOR 100 5% .25W CF TC=0-400	00746P01	R-25J
A21R47	0683-3325	6		RESISTOR 3.3K 5% .25W CF TC=0-400	00746P01	R-25J
A21R48	0683-1015	7		RESISTOR 100 5% .25W CF TC=0-400	00746P01	R-25J
A21R49	0698-3443	0	1	RESISTOR 287 1% .125W F TC=0+-100	02995P01	SFR25H
A21R51	0757-0418	9		RESISTOR 619 1% .125W F TC=0+-100	02995P01	SFR25H
A21R52	0757-0444	1		RESISTOR 12.1K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R53-54	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R56	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0+-100	02995P01	SFR25H

See introduction to this section for ordering information

* Indicates factory selected values

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A21R57	0683-5105	4	1	RESISTOR 51 5% .25W CF TC=0-400	00746P01	R-25J
A21R58	0683-4715	0		RESISTOR 470 5% .25W CF TC=0-400	00746P01	R-25J
A21R59	0683-1015	7		RESISTOR 100 5% .25W CF TC=0-400	00746P01	R-25J
A21R61	0683-1035	1	12	RESISTOR 10K 5% .25W CF TC=0-400	00746P01	R-25J
A21R62	0683-1015	7		RESISTOR 100 5% .25W CF TC=0-400	00746P01	R-25J
A21R63	0757-0419	0		RESISTOR 681 1% .125W F TC=0+-100	02995P01	SFR25H
A21R64	0698-0084	9	1	RESISTOR 2.15K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R65	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	02995P01	SFR25H
A21R66	0683-4705	8		RESISTOR 47 5% .25W CF TC=0-400	00746P01	R-25J
A21R67	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R68-69	0698-3156	2	2	RESISTOR 14.7K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R70	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	02995P01	SFR25H
A21R71	0698-4207	6	1	RESISTOR 44.2K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R72	0683-1025	9	11	RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J
A21R73	0683-4705	8		RESISTOR 47 5% .25W CF TC=0-400	00746P01	R-25J
A21R74	2100-3211	7	1	RESISTOR-TRMR 1K 10% C TOP-ADJ 1-TRN	03744P01	3386P-Y46-102
A21R75	0757-0442	9	4	RESISTOR 10K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R76	2100-3096	6	1	RESISTOR-TRMR 50K 10% C TOP-ADJ 17-TRN	04568P01	67WR
A21R77	0683-1065	7	1	RESISTOR 10M 5% .25W CC TC=-900/+1100	01607P01	CB1065
A21R78	0757-0488	3	1	RESISTOR 909K 1% .125W F TC=0+-100	02995P01	5033R
A21R79	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	02995P01	SFR25H
A21R81	0683-1035	1		RESISTOR 10K 5% .25W CF TC=0-400	00746P01	R-25J
A21R82	0683-5625	3	1	RESISTOR 5.6K 5% .25W CF TC=0-400	00746P01	R-25J
A21R83	0683-2025	1	1	RESISTOR 2K 5% .25W CF TC=0-400	00746P01	R-25J
A21R84	0757-0289	2	1	RESISTOR 13.3K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R86	0757-0439	4	4	RESISTOR 6.81K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R87	0683-4705	8		RESISTOR 47 5% .25W CF TC=0-400	00746P01	R-25J
A21R88	2100-3383	4	1	RESISTOR-TRMR 50 10% C TOP-ADJ 1-TRN	03744P01	3386P-Y46-500
A21R89	0683-4705	8		RESISTOR 47 5% .25W CF TC=0-400	00746P01	R-25J
A21R91	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R92	0683-1025	9		RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J
A21R93-94	0683-1015	7		RESISTOR 100 5% .25W CF TC=0-400	00746P01	R-25J
A21R96	0757-0421	4		RESISTOR 825 1% .125W F TC=0+-100	02995P01	SFR25H
A21R97-98	0683-2225	3	4	RESISTOR 2.2K 5% .25W CF TC=0-400	00746P01	R-25J
A21R99	0698-3154	0	1	RESISTOR 4.22K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R101	0683-1025	9		RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J
A21R102	0683-2225	3		RESISTOR 2.2K 5% .25W CF TC=0-400	00746P01	R-25J
A21R103	0683-4705	8		RESISTOR 47 5% .25W CF TC=0-400	00746P01	R-25J
A21R104	0683-2235	5	1	RESISTOR 22K 5% .25W CF TC=0-400	00746P01	R-25J
A21R106	0683-1035	1		RESISTOR 10K 5% .25W CF TC=0-400	00746P01	R-25J
A21R107	2100-0567	0	1	RESISTOR-TRMR 2K 10% C TOP-ADJ 1-TRN	03744P01	3386P-Y46-202
A21R108	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R109	0683-1015	7		RESISTOR 100 5% .25W CF TC=0-400	00746P01	R-25J
A21R111	0683-1015	7		RESISTOR 100 5% .25W CF TC=0-400	00746P01	R-25J
A21R112	0757-0421	4		RESISTOR 825 1% .125W F TC=0+-100	02995P01	SFR25H
A21R113-114	0757-0416	7	3	RESISTOR 511 1% .125W F TC=0+-100	02995P01	SFR25H
A21R116	0683-4705	8		RESISTOR 47 5% .25W CF TC=0-400	00746P01	R-25J
A21R117	0757-0439	4		RESISTOR 6.81K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R118	0683-1025	9		RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J
A21R119	0683-1835	9	1	RESISTOR 18K 5% .25W CF TC=0-400	00746P01	R-25J
A21R121	0683-1025	9		RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J
A21R122	0698-3162	0	1	RESISTOR 46.4K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R123	0757-0465	6	1	RESISTOR 100K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R124	0683-1525	4		RESISTOR 1.5K 5% .25W CF TC=0-400	00746P01	R-25J
A21R126	0683-1025	9		RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J
A21R130	0683-2225	3		RESISTOR 2.2K 5% .25W CF TC=0-400	00746P01	R-25J
A21R132	0757-0398	4	1	RESISTOR 75 1% .125W F TC=0+-100	02995P01	SFR25H
A21R133	0698-3432	7	1	RESISTOR 26.1 1% .125W F TC=0+-100	02995P01	SFR25H
A21R134	0683-1035	1		RESISTOR 10K 5% .25W CF TC=0-400	00746P01	R-25J
A21R135	0683-2205	9		RESISTOR 22 5% .25W CF TC=0-400	00746P01	R-25J
A21R136	0683-1025	9		RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J
A21R137	0683-1035	1		RESISTOR 10K 5% .25W CF TC=0-400	00746P01	R-25J
A21R138	0698-4443	2	1	RESISTOR 4.53K 1% .125W F TC=0+-100	05524P01	CMF-55-1, T-1
A21R140	0683-1035	1		RESISTOR 10K 5% .25W CF TC=0-400	00746P01	R-25J
A21R141	0698-4422	7	1	RESISTOR 1.27K 1% .125W F TC=0+-100	05524P01	CMF-55-1, T-1

See introduction to this section for ordering information

* Indicates factory selected values

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A21R142	0683-1025	9		RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J
A21R143	0683-1015	7		RESISTOR 100 5% .25W CF TC=0-400	00746P01	R-25J
A21R144	0683-3325	6		RESISTOR 3.3K 5% .25W CF TC=0-400	00746P01	R-25J
A21R145	0683-1025	9		RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J
A21R146-147	0683-1035	1		RESISTOR 10K 5% .25W CF TC=0-400	00746P01	R-25J
A21R148	0683-7515	4	1	RESISTOR 750 5% .25W CF TC=0-400	00746P01	R-25J
A21R149	0683-1035	1		RESISTOR 10K 5% .25W CF TC=0-400	00746P01	R-25J
A21R150	0683-3325	6		RESISTOR 3.3K 5% .25W CF TC=0-400	00746P01	R-25J
A21R151-152	0683-1035	1		RESISTOR 10K 5% .25W CF TC=0-400	00746P01	R-25J
A21R161	0683-2415	3	1	RESISTOR 240 5% .25W CF TC=0-400	00746P01	R-25J
A21R162	0699-2054	9	1	R-F 100 OHM 1% 1/20W HF04 T0	05524P01	CMF-50-21
A21R163	0683-1045	3	3	RESISTOR 100K 5% .25W CF TC=0-400	00746P01	R-25J
A21R164	0683-4735	4	2	RESISTOR 47K 5% .25W CF TC=0-400	00746P01	R-25J
A21R165	0683-1045	3		RESISTOR 100K 5% .25W CF TC=0-400	00746P01	R-25J
A21R166	0683-4735	4		RESISTOR 47K 5% .25W CF TC=0-400	00746P01	R-25J
A21R167	0683-4725	2	1	RESISTOR 4.7K 5% .25W CF TC=0-400*	00746P01	R-25J
A21R168	0683-1035	1		RESISTOR 10K 5% .25W CF TC=0-400	00746P01	R-25J
A21R169	0698-3518	0	1	RESISTOR 7.32K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R170	0683-2425	5	1	RESISTOR 2.4K 5% .25W CF TC=0-400	00746P01	R-25J
A21R171	0757-1094	9	1	RESISTOR 1.47K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R172	0683-1025	9		RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J
A21R173	0683-1045	3		RESISTOR 100K 5% .25W CF TC=0-400	00746P01	R-25J
A21R174	0683-5125	8	1	RESISTOR 5.1K 5% .25W CF TC=0-400	00746P01	R-25J
A21R176	0683-4705	8		RESISTOR 47 5% .25W CF TC=0-400	00746P01	R-25J
A21R177	0757-0417	8	1	RESISTOR 562 1% .125W F TC=0+-100	02995P01	SFR25H
A21R178	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	02995P01	SFR25H
A21R179	0683-3915	0	3	RESISTOR 390 5% .25W CF TC=0-400	00746P01	R-25J
A21R181	0683-3915	0		RESISTOR 390 5% .25W CF TC=0-400	00746P01	R-25J
A21R182	0683-1525	4		RESISTOR 1.5K 5% .25W CF TC=0-400	00746P01	R-25J
A21R183	0683-1025	9		RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J
A21R184	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R186	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	02995P01	SFR25H
A21R187	0698-4123	5	1	RESISTOR 499 1% .125W F TC=0+-100	02995P01	SFR25H
A21R188	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R189	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	02995P01	SFR25H
A21R191	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R192	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R193	0698-3279	0	2	RESISTOR 4.99K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R194	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	02995P01	SFR25H
A21R196	0757-0452	1	1	RESISTOR 27.4K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R197	0698-3440	7		RESISTOR 196 1% .125W F TC=0+-100	02995P01	SFR25H
A21R198	0698-4474	9	1	RESISTOR 8.45K 1% .125W F TC=0+-100	05524P01	CMF-55-1, T-1
A21R199	0757-0439	4		RESISTOR 6.81K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R200	0757-0394	0	1	RESISTOR 51.1 1% .125W F TC=0+-100	02995P01	SFR25H
A21R201	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R202	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	02995P01	SFR25H
A21R203	0698-3279	0		RESISTOR 4.99K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R204	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R205	0757-0283	6	1	RESISTOR 2K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R206	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R207	0683-3315	4	1	RESISTOR 330 5% .25W CF TC=0-400	00746P01	R-25J
A21R208	0683-4325	8	1	RESISTOR 4.3K 5% .25W CF TC=0-400	00746P01	R-25J
A21R209	0683-3915	0		RESISTOR 390 5% .25W CF TC=0-400	00746P01	R-25J
A21R210-211	0683-4705	8		RESISTOR 47 5% .25W CF TC=0-400	00746P01	R-25J
A21R212	0757-0439	4		RESISTOR 6.81K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R213	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	02995P01	SFR25H
A21R214	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	02995P01	SFR25H
A21R215	0683-2205	9		RESISTOR 22 5% .25W CF TC=0-400	00746P01	R-25J
A21R216	0757-0279	0	1	RESISTOR 3.16K 1% .125W F TC=0+-100	02995P01	SFR25H
A21TP1-11	1251-0600	0	11	CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	03418P01	16-06-0034
A21U1	1820-0817	8	1	IC FF ECL D-M/S DUAL	02037P01	
A21U2	1821-0001	4	1	TRANSISTOR ARRAY 14-PIN PLSTC DIP	02037P01	
A21U3	1810-0294	4	1	NETWORK-RESISTOR 16 PIN DIP; RES	28480	1810-0294
A21U4	1820-1196	8	3	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01698P01	
A21U5	1820-1112	8	1	IC FF TTL LS D-TYPE POS-EDGE-TRIG	01698P01	

* Indicates factory selected values

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Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A21U6	1826-0021	8	1	IC OP AMP GP TO-99 PKG	03406P01	
A21U7	1820-0629	0	8	IC FF TTL S J-K NEG-EDGE-TRIG	01698P01	
A21U8	1820-0697	2	1	IC DRVR TTL S NAND LINE DUAL 4-INP	01698P01	
A21U9	1820-1279	8	2	IC CNTR TTL LS DECD UP/DOWN SYNCHRO	01698P01	
A21U10	1826-0043	4	1	IC OP AMP GP TO-99 PKG	03406P01	
A21U11	1820-1279	8		IC CNTR TTL LS DECD UP/DOWN SYNCHRO	01698P01	
A21U12	1820-0681	4	3	IC GATE TTL S NAND QUAD 2-INP	01698P01	
A21U13	1820-0629	0		IC FF TTL S J-K NEG-EDGE-TRIG	01698P01	
A21U14-15	1820-1196	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01698P01	
A21U17	1820-1322	2	1	IC GATE TTL S NOR QUAD 2-INP	01698P01	
A21U18	1820-0629	0		IC FF TTL S J-K NEG-EDGE-TRIG	01698P01	
A21U19	1820-2004	9	1	IC MISC NMOS	28480	1820-2004
A21U21	1820-0683	6	1	IC INV TTL S HEX 1-INP	01698P01	
A21U22-23	1820-0681	4		IC GATE TTL S NAND QUAD 2-INP	01698P01	
A21U24	1820-0629	0		IC FF TTL S J-K NEG-EDGE-TRIG	01698P01	
A21U25-26	1820-0693	8	2	IC FF TTL S D-TYPE POS-EDGE-TRIG	01698P01	
A21U27	1820-0629	0		IC FF TTL S J-K NEG-EDGE-TRIG	01698P01	
A21U28	1820-1641	8	1	IC DRVR TTL LS BUS HEX 1-INP	01698P01	
A21U29-30	1820-0629	0		IC FF TTL S J-K NEG-EDGE-TRIG	01698P01	
A21U31	1820-1144	6	1	IC GATE TTL LS NOR QUAD 2-INP	01698P01	
A21U32	1820-0629	0		IC FF TTL S J-K NEG-EDGE-TRIG	01698P01	
A21U33	1826-0111	7	1	IC OP AMP GP DUAL TO-99 PKG	02037P01	
A21U34	1820-0802	1	1	IC GATE ECL NOR QUAD 2-INP	02037P01	
A21W1-2	1460-1336	4	2	WIREFORM CU BRT-TIN	04426P03	
	4330-0496	3	4	INSULATOR-BEAD GLASS	01167P01	KG12
	7121-4611	2	1	LABEL-INFORMATION .15-IN-WD .6-IN-LG	09479P01	L01003
	03325-20601	3	3	MCHD SHLD-TOP	28480	03325-20601
	03325-20602	4	3	MCHD SHLD-BTM	28480	03325-20602
A22	**03325-66522**	**3**	**1**	**PC-ASSY-PWR-SPLY**	**28480**	**03325-66522**
A22C120	0160-6520	1	4	C-F 1UF --% 50V CERMLr	09939P01	RPE113-90125U105Z50V
A22C122	0180-4046	4	1	C-F 10000UF 20% 20V ALUMEr	08709P01	ECES1EU103R
A22C123	0160-4835	7	5	CAPACITOR-FXD .1UF +-10% 50VDC CER	02010P01	SA305C104KAA
A22C130	0180-3761	8	2	C-F 2200UF 20% 50V ALUMEr	08709P01	ECE-S1HU222E
A22C135	0160-6506	3	3	C-F .1UF 20% 50V CERMLr	09939P01	RPE121-978Z5U104M50V
A22C136	0160-6506	3		C-F .1UF 20% 50V CERMLr	09939P01	RPE121-978Z5U104M50V
A22C140	0180-3761	8		C-F 2200UF 20% 50V ALUMEr	08709P01	ECE-S1HU222E
A22C200	0160-3847	9	9	CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A22C202	0160-6520	1		C-F 1UF --% 50V CERMLr	09939P01	RPE113-90125U105Z50V
A22C224	0180-1701	2	1	CAPACITOR-FXD 6.8UF+-20% 6VDC TA	04200P01	150D685X0006A2-DYS
A22C230	0180-3008	6	1	CAPACITOR-FXD 470UF+50-10% 35VDC AL	04200P01	502D477F035EG1D
A22C300	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A22C312	0160-6520	1		C-F 1UF --% 50V CERMLr	09939P01	RPE113-90125U105Z50V
A22C330	0180-0423	3	1	CAPACITOR-FXD 100UF+50-10% 25VDC AL	00493P01	SL25VB101T10X16
A22C351	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A22C400	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A22C412	0160-6520	1		C-F 1UF --% 50V CERMLr	09939P01	RPE113-90125U105Z50V
A22C422	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A22C430	0180-0423	3		CAPACITOR-FXD 100UF+50-10% 25VDC AL	00493P01	SL25VB101T10X16
A22C601	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	02010P01	SA305C104KAA
A22C800	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	02010P01	SA305C104KAA
A22C801	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A22C810	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A22C811	0180-3883	5	1	C-F 22UF --% 50V ALUMEr	04200P01	510D073
A22C812	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	02010P01	SA305C104KAA
A22C815	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A22C830	0160-6506	3		C-F .1UF 20% 50V CERMLr	09939P01	RPE121-978Z5U104M50V
A22C831	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	02010P01	SA305C104KAA
A22C832	0160-3847	9	1	CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A22C853	0160-4801	7	1	CAPACITOR-FXD 100PF +-5% 100VDC CER	02010P01	SA101A101JAA
A22C861	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A22C863	0160-4787	8	1	CAPACITOR-FXD 22PF +-5% 100VDC CER 0+-30	02010P01	SA106A220JAA
A22CR100-101	1901-0050	3	2	DIODE-SWITCHING 80V 200MA 2NS DO-35	02237P01	
A22CR121-124	1901-0662	3	1	DIODE-PWR RECT 100V 6A	02037P01	
A22CR202	1901-0518	8	11	DIODE-SCHOTTKY SM SIG	28480	1901-0518

See introduction to this section for ordering information

* Indicates factory selected values

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A22CR210	1902-0025	4	1	DIODE-ZNR 10V 5% DO-35 PD=.4W TC=+.06%	02037P01	
A22CR302-303	1901-0040	1	5	DIODE-SWITCHING 30V 50MA 2NS DO-35	02237P01	
A22CR350	1902-0777	3	1	DIODE-ZNR 1N825 6.2V 5% DO-7 PD=.4W	02037P01	
A22CR402-403	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	02237P01	
A22CR420	1901-0518	8		DIODE-SCHOTTKY SM SIG	28480	1901-0518
A22CR501	1901-0518	8		DIODE-SCHOTTKY SM SIG	28480	1901-0518
A22CR504	1901-0518	8		DIODE-SCHOTTKY SM SIG	28480	1901-0518
A22CR600	1884-0266	5	1	THYRISTOR-SCR 2N6400 TO-220AB VRRM=50	02037P01	
A22CR641	1901-0518	8		DIODE-SCHOTTKY SM SIG	28480	1901-0518
A22CR816	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	02237P01	
A22CR836-837	1901-0518	8		DIODE-SCHOTTKY SM SIG	28480	1901-0518
A22CR852-853	1901-0518	8		DIODE-SCHOTTKY SM SIG	28480	1901-0518
A22CR862-863	1901-0518	8		DIODE-SCHOTTKY SM SIG	28480	1901-0518
A22F850	2110-0343	1	1	FUSE .25A 125V NTD .281X.093	04703P01	275.250
A22J700	T-48100	8	1	CON HEADER 10 PIN 09-72-2101	28480	T-48100
A22J737	1251-0600	0	14	CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	03418P01	16-06-0034
A22J751	1251-8510	7	1	CONN-POST TYPE .156-PIN-SPCG 3-CONT	03418P01	09-72-2031
A22J753	1252-0023	3	1	CONN-POST TYPE .156-PIN-SPCG 6-CONT	03418P01	09-72-2061
A22J754	1251-4780	5	1	CONN-UTIL MT-LK 2-CKT 2-CONT	01380P01	350786-1
A22J757	1251-8981	6	1	CONN-POST TYPE .156-PIN-SPCG 2-CONT	03418P01	09-72-2021
A22J759	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	03418P01	16-06-0034
A22J801-802	1251-2969	8	4	CONNECTOR-PHONO SINGLE PHONO JACK; DIP	03418P01	15-24-0503
A22J850	1251-2969	8		CONNECTOR-PHONO SINGLE PHONO JACK; DIP	03418P01	15-24-0503
A22J860	1251-2969	8		CONNECTOR-PHONO SINGLE PHONO JACK; DIP	03418P01	15-24-0503
A22K641	0490-0745	9	1	RELAY 1C 6VDC-COIL 2A 115VAC	02367P01	603-6V
A22L211	9100-3807	4	1	INDUCTOR RF-CH-MLD 110NH 5% .166DX.385LG	03273P01	15M110J
A22L800	9100-0539	3	1	INDUCTOR RF-CH-MLD 10UH 5% .156DX.375LG	03273P01	15M102J
A22MP501	0340-0564	3	1	INSULATOR-XSTR THRM-CNDCT	05447P01	7403-09FR-51
A22MP502	0340-0620	2	1	INSULAROR-XSTR THRM-CNDCT	05447P01	7403-09FR-54
A22Q200	03325-66911	4	1	TRANSISTOR ASSY; XTR PNP SI PD = 3.5W	11108P01	
A22Q202	1854-0692	8	1	TRANSISTOR NPN SI PD=15W FT=50MHZ	02037P01	
A22Q204	1854-1024	2	1	TRANSISTOR NPN SI PD=300MW FT=200MHZ	02037P01	
A22Q300	03325-66912	5	1	TRANSISTOR ASSY	11108P01	
A22Q301	1854-1141	4	1	XTR SML1NPN	02037P01	SPS234RLRA
A22Q302	1853-0640	4	4	XTR SML1PNP	02237P01	S44446
A22Q390	1853-0640	4		XTR SML1PNP	02237P01	S44446
A22Q400	03325-66913	6	1	TRANSISTOR ASSY;XTR PNP SI TO-220AB PD=60W	11108P01	
A22Q401	1853-0640	4		XTR SML1PNP	02237P01	S44446
A22Q402	1854-1028	6	2	TRANSISTOR NPN SI PD=350MW FT=300MHZ	02037P01	
A22Q490	1854-1028	6		TRANSISTOR NPN SI PD=350MW FT=300MHZ	02037P01	
A22Q501	1853-0450	4	1	TRANSISTOR PNP SI TO-220AB PD=60W	02037P01	SJE1980
A22Q502	1853-0641	5	1	XTR SML1PNP	02237P01	S44445
A22Q611	1853-0640	4		XTR SML1PNP	02237P01	S44446
A22Q810	1853-0075	9	1	TRANSISTOR-DUAL PNP PD=400MW	02037P01	
A22Q820	1854-1139	0	1	XTR SML1NPN	02037P01	SPS8028RL
A22R122	0686-5115	2	1	RESISTOR 510 5% .5W CC TC=0+529	01607P01	EB5115
A22R202	0683-4715	0	2	RESISTOR 470 5% .25W CF TC=0-400	00746P01	R-25J
A22R204	0683-2705	4	4	RESISTOR 27 5% .25W CF TC=0-400	00746P01	R-25J
A22R205	0683-5125	8	1	RESISTOR 5.1K 5% .25W CF TC=0-400	00746P01	R-25J
A22R210	0683-1525	4	2	RESISTOR 1.5K 5% .25W CF TC=0-400	00746P01	R-25J
A22R211	0757-0404	3	1	RESISTOR 130 1% .125W F TC=0+-100	02995P01	SFR25H
A22R212	0757-0460	1	1	RESISTOR 61.9K 1% .125W F TC=0+-100	02995P01	SFR25H
A22R214	0757-0441	8	1	RESISTOR 8.25K 1% .125W F TC=0+-100	02995P01	SFR25H
A22R222	0683-1015	7	5	RESISTOR 100 5% .25W CF TC=0-400	00746P01	R-25J
A22R224	0698-6320	8	4	RESISTOR 5K .1% .125W F TC=0+-25	05524P01	CMF-55-1, T-9
A22R226	0698-6619	8	1	RESISTOR 15K .1% .125W F TC=0+-25	02995P01	5033R
A22R300	0811-2546	4	1	RESISTOR .56 5% .5W PW TC=0+-300	02499P01	SP-20
A22R301	0757-0283	6	4	RESISTOR 2K 1% .125W F TC=0+-100	02995P01	SFR25H
A22R302	0757-0283	6		RESISTOR 2K 1% .125W F TC=0+-100	02995P01	SFR25H
A22R304	0683-2035	3	5	RESISTOR 20K 5% .25W CF TC=0-400	00746P01	R-25J
A22R306	0683-1025	9	3	RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J
A22R312	0683-3925	2	1	RESISTOR 3.9K 5% .25W CF TC=0-400	00746P01	R-25J
A22R321	0683-1015	7		RESISTOR 100 5% .25W CF TC=0-400	00746P01	R-25J
A22R322	0698-6360	6	2	RESISTOR 10K .1% .125W F TC=0+-25	02995P01	5033R
A22R350	0698-3512	4	1	RESISTOR 1.18K 1% .125W F TC=0+-100	02995P01	SFR25H

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See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A22R351	0698-8191	5	1	RESISTOR 12.5K .1% .125W F TC=0+-25	05524P01	CMF-55-1, T-9
A22R352	2100-3296	8	1	RESISTOR-TRMR 1K 10% C TOP-ADJ 17-TRN	04568P01	67WR
A22R353	0698-8060	7	1	RESISTOR 8.64K .1% .125W F TC=0+-25	02995P01	5033R
A22R390	0683-1035	1	1	RESISTOR 10K 5% .25W CF TC=0-400	00746P01	R-25J
A22R391	0683-4725	2	1	RESISTOR 4.7K 5% .25W CF TC=0-400	00746P01	R-25J
A22R400	0811-0548	2	1	RESISTOR .47 5% .5W PW TC=0+-300	02499P01	SP-20
A22R401-402	0757-0280	3	4	RESISTOR 1K 1% .125W F TC=0+-100	02995P01	SFR25H
A22R404	0683-2035	3		RESISTOR 20K 5% .25W CF TC=0-400	00746P01	R-25J
A22R406	0683-4715	0		RESISTOR 470 5% .25W CF TC=0-400	00746P01	R-25J
A22R412	0683-1025	9		RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J
A22R421	0683-1015	7		RESISTOR 100 5% .25W CF TC=0-400	00746P01	R-25J
A22R422	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	02995P01	5033R
A22R490	0683-1045	3	1	RESISTOR 100K 5% .25W CF TC=0-400	00746P01	R-25J
A22R491	0683-2035	3		RESISTOR 20K 5% .25W CF TC=0-400	00746P01	R-25J
A22R501	0683-3025	3	1	RESISTOR 3K 5% .25W CF TC=0-400	00746P01	R-25J
A22R502	0683-1525	4		RESISTOR 1.5K 5% .25W CF TC=0-400	00746P01	R-25J
A22R503	0683-1015	7		RESISTOR 100 5% .25W CF TC=0-400	00746P01	R-25J
A22R504	0683-1005	5	1	RESISTOR 10 5% .25W CF TC=0-400	00746P01	R-25J
A22R600	0683-1015	7		RESISTOR 100 5% .25W CF TC=0-400	00746P01	R-25J
A22R601	0698-6320	8		RESISTOR 5K .1% .125W F TC=0+-25	05524P01	CMF-55-1, T-9
A22R602	0698-4487	4	1	RESISTOR 25.5K 1% .125W F TC=0+-100	05524P01	CMF-55-1, T-1
A22R611	0757-0283	6		RESISTOR 2K 1% .125W F TC=0+-100	02995P01	SFR25H
A22R612	0757-0283	6		RESISTOR 2K 1% .125W F TC=0+-100	02995P01	SFR25H
A22R650	0683-1025	9		RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J
A22R800	0683-2035	3		RESISTOR 20K 5% .25W CF TC=0-400	00746P01	R-25J
A22R801	0698-6320	8		RESISTOR 5K .1% .125W F TC=0+-25	05524P01	CMF-55-1, T-9
A22R810	0698-3262	1	1	RESISTOR 40.2 1% .125W F TC=0+-100	02995P01	SFR25H
A22R811-812	0683-2705	4		RESISTOR 27 5% .25W CF TC=0-400	00746P01	R-25J
A22R813	0683-2035	3		RESISTOR 20K 5% .25W CF TC=0-400	00746P01	R-25J
A22R814	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	02995P01	SFR25H
A22R815	0698-6320	8		RESISTOR 5K .1% .125W F TC=0+-25	05524P01	CMF-55-1, T-9
A22R816	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	02995P01	SFR25H
A22R819	0698-3132	4	1	RESISTOR 261 1% .125W F TC=0+-100	02995P01	SFR25H
A22R820	0757-0407	6	1	RESISTOR 200 1% .125W F TC=0+-100	02995P01	SFR25H
A22R832	0698-3447	4	1	RESISTOR 422 1% .125W F TC=0+-100	02995P01	SFR25H
A22R833	0683-2705	4		RESISTOR 27 5% .25W CF TC=0-400	00746P01	R-25J
A22R852	0698-3609	0	2	RESISTOR 22 5% 2W MO TC=0+-200	02499P01	GS-3
A22R854	0698-3609	0		RESISTOR 22 5% 2W MO TC=0+-200	02499P01	GS-3
A22R862	0698-4399	7	1	RESISTOR 88.7 1% .125W F TC=0+-100	05524P01	CMF-55-1, T-1
A22R863	0757-0397	3	1	RESISTOR 68.1 1% .125W F TC=0+-100	02995P01	SFR25H
A22R864	0698-4399	7	1	RESISTOR 88.7 1% .125W F TC=0+-100	05524P01	CMF-55-1, T-1
A22TP200	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	03418P01	16-06-0034
A22TP300	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	03418P01	16-06-0034
A22TP400	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	03418P01	16-06-0034
A22U130	1906-0096	7	1	DIODE-FW BRDG 200V 2A	02037P01	SDA296-002
A22U210	1826-0346	0	3	IC OP AMP GP DUAL 8-DIP-P PKG	03406P01	
A22U350	1826-0346	0		IC OP AMP GP DUAL 8-DIP-P PKG	03406P01	
A22U402	1826-0346	0		IC OP AMP GP DUAL 8-DIP-P PKG	03406P01	
A22U600	1826-0468	7	1	IC COMPARATOR GP 8-DIP-P PKG	02037P01	
A22U800	1826-1586	2	1	ICL VREG 2935	03406P01	
A22U830	T-55426	6	1	ICD 74F3037N	02910P01	
A22U832	1820-2692	1	1	IC GATE TTL F EXCL-OR QUAD 2-INP	02237P01	
A22V100	1970-0052	0	1	TUBE-ELECTRON SURGE V PTCTR	03923P01	B1-C90/20
A22V852	1970-0052	0		TUBE-ELECTRON SURGE V PTCTR	03923P01	B1-C90/20
A22W803-805	8159-0005	0	3	RESISTOR-ZERO OHMS 22 AWG LEAD DIA	03123P01	106
A22XQ200B-C	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	03418P01	16-06-0034
A22XQ200E	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	03418P01	16-06-0034
A22XQ300B-C	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	03418P01	16-06-0034
A22XQ300E	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	03418P01	16-06-0034
A22XQ400B-C	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	03418P01	16-06-0034
A22XQ400E	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	03418P01	16-06-0034
A22XQ501A	3050-0440	2	1	WASHER-SHLDR NO. 4 .115-IN-ID .2-IN-OD	05313P01	5607-45
A22XQ501B	2200-0143	0	1	SCREW-MACH 4-40 .375-IN-LG PAN-HD-POZI	01136P01	
A22XQ501C	2260-0009	3	1	NUT-HEX-W/LKWR 4-40-THD .094-IN-THK	04604P01	
	0400-0163	6	0	GROMMET-CHAN PLAIN .109-IN-GRV-WD	02201P01	PGS-2

See introduction to this section for ordering information

* Indicates factory selected values

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A23	**03325-66523**	**4**	**1**	**PC ASSY-ATTEN**	**28480**	**03325-66523**
A23C1-3	0160-6506	3		C-F .1UF 20% 50V CERMLr	09939P01	RPE121-978Z5U104M50V
A23C7-17	0160-6506	3		C-F .1UF 20% 50V CERMLr	09939P01	RPE121-978Z5U104M50V
A23J3-4	1251-2969	8		CONNECTOR-PHONO SINGLE PHONO JACK; DIP	03418P01	15-24-0503
A23J21	1251-2969	8	4	CONNECTOR-PHONO SINGLE PHONO JACK; DIP	03418P01	15-24-0503
A23J25	1251-2969	8		CONNECTOR-PHONO SINGLE PHONO JACK; DIP	03418P01	15-24-0503
A23J30	1252-2406	0	1	CON-HEADER 14 CONT	L1359D01	LCW-114-08-G-S-295
A23K1-K4	0490-1548	2	1	REL EMR 4C 12V 25	01850P01	RG2ET-L2-12V-H10
A23R1-2	0699-2087	8	1	R-F 51.01 O .25% 1/2W HF12 T2	05524P01	CMF-65-63
A23R3	0699-0273	0	1	RESISTOR 2.15K .1% .125W F TC=0+-25	02995P01	5033R
A23R4	0699-2101	7	1	R-F 350 OHM .1% 1/8W HF06 T9	05524P01	CMF-55-101
A23R5	0699-2100	6	1	R-F 247.5 O .1% 1/4W HF08 T9	05524P01	CMF-60-79
A23R6	0699-2088	9	1	R-F 61.1 OH .1% 1/2W HF12 T2	05524P01	CMF-65-63
A23R7	0699-2088	9		R-F 61.1 OH .1% 1/2W HF12 T2	05524P01	CMF-65-63
A23R8	0699-2089	0	1	R-F 66.7 OH .25% 1/4W HF08 T2	05524P01	CMF-60-79
A23R9-10	0699-2094	7	2	R-F 100 OHM .1% 1/4W HF08 T9	05524P01	CMF-60-79
	7121-4611	2	1	LABEL-INFORMATION .15-IN-WD .6-IN-LG	09479P01	L01003
A25	**03325-66525**	**6**	**1**	**PC-ASSY-KEYBD**	**28480**	**03325-66525**
A25DS200-207	1990-1169	4	40	OPT LED	28480	1990-1169
A25DS210-217	1990-1169	4		OPT LED	28480	1990-1169
A25DS220-227	1990-1169	4		OPT LED	28480	1990-1169
A25DS230-237	1990-1169	4		OPT LED	28480	1990-1169
A25DS240-247	1990-1169	4		OPT LED	28480	1990-1169
A26	**03325-66526**	**7**	**1**	**PC ASSY-CONTROLLER**	**28480**	**03325-66526**
A26B1	1420-0278	7	1	BATTERY 2.9V .72A-HR LI/S-DIOX W-FLEX	08891P01	B9511
A26C1	0160-3847	9	21	CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A26C2	0160-4835	7	22	CAPACITOR-FXD .1UF +-10% 50VDC CER	02010P01	SA305C104KAA
A26C3-4	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A26C5-7	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	02010P01	SA305C104KAA
A26C8	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A26C9-13	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	02010P01	SA305C104KAA
A26C14	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A26C26-27	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	02010P01	SA305C104KAA
A26C29-31	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	02010P01	SA305C104KAA
A26C33	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A26C34	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	02010P01	SA305C104KAA
A26C38	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	02010P01	SA305C104KAA
A26C40	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	02010P01	SA305C104KAA
A26C71-73	0180-4026	0	7	C-F 220UF 10V 20% ALUMEr	00493P01	SMC10VB2218X11MPT
A26C81-82	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A26C83	0180-1746	5	1	CAPACITOR-FXD 15UF+-10% 20VDC TA	04200P01	150D156X9020B2-DYS
A26C85	0180-4026	0		C-F 220UF 10V 20% ALUMEr	00493P01	SMC10VB2218X11MPT
A26C86-87	0180-0692	8	2	CAPACITOR-FXD 220UF+50-10% 35VDC AL	00493P01	SL35VB221T12X25
A26C95	0180-3882	4	1	C-F 22UF 20% 25V TADPDr	12340P01	T361C226M025AS C-8310
A26C97	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A26C99-100	0160-4571	8	21	CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A26C101	0180-4026	0		C-F 220UF 10V 20% ALUMEr	00493P01	SMC10VB2218X11MPT
A26C103	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A26C104	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A26C106	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A26C108-109	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A26C112	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A26C113	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A26C119	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A26C120-121	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A26C123	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A26C125	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A26C127	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A26C132	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA

See introduction to this section for ordering information

* Indicates factory selected values

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A26C135	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A26C136	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A26C162-164	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A26C170	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A26C171-175	0180-3812	0	5	C-F 15UF 20% 20V TADPDr	01760P01	202L2002156MC
A26C194	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A26C195	0180-2826	4	1	CAPACITOR-FXD 1000UF+50-10% 16VDC AL	04200P01	502D108F016EK1K
A26C199	0180-4026	0		C-F 220UF 10V 20% ALUMEr	00493P01	SMC10VB2218X11MPT
A26C201	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	02010P01	SA305C104KAA
A26C202	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A26C204	0160-4820	0	2	CAPACITOR-FXD 1800PF +-5% 100VDC CER	02010P01	SA301A182JAA
A26C206	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	02010P01	SA305C104KAA
A26C209-210	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A26C211-212	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	02010P01	SA305C104KAA
A26C214	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A26C215	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	02010P01	SA305C104KAA
A26C216	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	02010P01	SA105C103KAA
A26C217-218	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A26C220	0160-4820	0		CAPACITOR-FXD 1800PF +-5% 100VDC CER	02010P01	SA301A182JAA
A26C221	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A26C233	0180-3883	5	2	C-F 22UF --% 50V ALUMEr	04200P01	510D073
A26C234	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A26C235	0180-3883	5		C-F 22UF --% 50V ALUMEr	04200P01	510D073
A26C236	0160-4571	8		CAPACITOR-FXD .1UF +80-20% 50VDC CER	02010P01	SA105E104ZAA
A26C250	0180-4026	0		C-F 220UF 10V 20% ALUMEr	00493P01	SMC10VB2218X11MPT
A26CR2-3	1901-0518	8	3	DIODE-SCHOTTKY SM SIG	28480	1901-0518
A26CR4	1901-0050	3	9	DIODE-SWITCHING 80V 200MA 2NS DO-35	02237P01	
A26CR5-6	1902-0964	0		DIODE-ZNR 18V 5% DO-35 PD=.4W TC=+.09%	02037P01	
A26CR141-144	1990-0486	6	4	LED-LAMP LUM-INT=2MCD IF=25MA-MAX BVR=5V	28480	1990-0486
A26CR171-176	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	02237P01	
A26CR177-178	1902-0964	0	4	DIODE-ZNR 18V 5% DO-35 PD=.4W TC=+.09%	02037P01	
A26CR204-205	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	02237P01	
A26CR206	1901-0518	8		DIODE-SCHOTTKY SM SIG	28480	1901-0518
A26J1	1200-0588	6	1	SOCKET-IC 16-CONT DIP-SLDR	04152P01	CA-16S-10SD
A26J2-4	1252-2407	1		CON-HEADER 21 CONT	L1359D01	LCW-121-08-G-S-295
A26J5	T-48100	8	1	CON HEADER 10 PIN 09-72-2101	28480	T-48100
A26J10	1252-2407	1	4	CON-HEADER 21 CONT	L1359D01	LCW-121-08-G-S-295
A26J100	1251-8831	5	1	CONN-POST TYPE .100-PIN-SPCG 40-CONT	04726P02	3432-6302
A26J150	1251-4245	7	1	CONN-POST TYPE .156-PIN-SPCG 2-CONT	03418P01	09-65-1021
A26J202	1251-2969	8	1	CONNECTOR-PHONO SINGLE PHONO JACK; DIP	03418P01	15-24-0503
A26L1	9100-3334	2	1	INDUCTOR 25UH 10% .3D	05829P01	ES-2638
A26Q2	1854-1139	0	1	XTR SML1NPN	02037P01	SPS8028RL
A26Q3	1853-0398	9	1	TRANSISTOR PNP SI PD=15W FT=65MHZ	02037P01	
A26Q4	1854-1028	6	2	TRANSISTOR NPN SI PD=350MW FT=300MHZ	02037P01	
A26Q81	1853-0563	0	1	XTR SML1PNP SI 2N3906 TXXXX	02037P01	
A26Q151	1854-1028	6		TRANSISTOR NPN SI PD=350MW FT=300MHZ	02037P01	
A26R1	0683-1825	7	25	RESISTOR 1.8K 5% .25W CF TC=0-400	00746P01	R-25J
A26R2	0683-1825	7		RESISTOR 1.8K 5% .25W CF TC=0-400	00746P01	R-25J
A26R3	0683-4725	2	2	RESISTOR 4.7K 5% .25W CF TC=0-400	00746P01	R-25J
A26R5-6	0683-1825	7		RESISTOR 1.8K 5% .25W CF TC=0-400	00746P01	R-25J
A26R7	0683-4725	2		RESISTOR 4.7K 5% .25W CF TC=0-400	00746P01	R-25J
A26R8	0683-1825	7		RESISTOR 1.8K 5% .25W CF TC=0-400	00746P01	R-25J
A26R10	0683-1015	7	11	RESISTOR 100 5% .25W CF TC=0-400	00746P01	R-25J
A26R12	0683-1825	7		RESISTOR 1.8K 5% .25W CF TC=0-400	00746P01	R-25J
A26R15	0683-2215	1	4	RESISTOR 220 5% .25W CF TC=0-400	00746P01	R-25J
A26R16	0683-1035	1	5	RESISTOR 10K 5% .25W CF TC=0-400	00746P01	R-25J
A26R17-18	0683-1025	9	7	RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J
A26R31	0683-1015	7		RESISTOR 100 5% .25W CF TC=0-400	00746P01	R-25J
A26R37	0683-1825	7		RESISTOR 1.8K 5% .25W CF TC=0-400	00746P01	R-25J
A26R42	0683-1015	7		RESISTOR 100 5% .25W CF TC=0-400	00746P01	R-25J
A26R81	0698-4424	9	2	RESISTOR 1.4K 1% .125W F TC=0+-100	05524P01	CMF-55-1, T-1
A26R82	0698-3495	2	1	RESISTOR 866 1% .125W F TC=0+-100	02995P01	SFR25H
A26R83	0757-0281	4	2	RESISTOR 2.74K 1% .125W F TC=0+-100	02995P01	SFR25H
A26R84-85	0683-1825	7		RESISTOR 1.8K 5% .25W CF TC=0-400	00746P01	R-25J
A26R86	0683-7515	4	1	RESISTOR 750 5% .25W CF TC=0-400	00746P01	R-25J

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Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A26R87	0757-0281	4		RESISTOR 2.74K 1% .125W F TC=0+-100	02995P01	SFR25H
A26R88	0698-4424	9		RESISTOR 1.4K 1% .125W F TC=0+-100	05524P01	CMF-55-1, T-1
A26R89	0683-1025	9		RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J
A26R98-102	0683-1825	7		RESISTOR 1.8K 5% .25W CF TC=0-400	00746P01	R-25J
A26R103-104	0683-1035	1		RESISTOR 10K 5% .25W CF TC=0-400	00746P01	R-25J
A26R105-110	0683-4315	6	9	RESISTOR 430 5% .25W CF TC=0-400	00746P01	R-25J
A26R111-113	0683-1825	7		RESISTOR 1.8K 5% .25W CF TC=0-400	00746P01	R-25J
A26R114	0683-1015	7		RESISTOR 100 5% .25W CF TC=0-400	00746P01	R-25J
A26R115-116	0683-1825	7		RESISTOR 1.8K 5% .25W CF TC=0-400	00746P01	R-25J
A26R117-118	0683-4315	6		RESISTOR 430 5% .25W CF TC=0-400	00746P01	R-25J
A26R119-120	0683-1825	7		RESISTOR 1.8K 5% .25W CF TC=0-400	00746P01	R-25J
A26R121-123	0683-1015	7		RESISTOR 100 5% .25W CF TC=0-400	00746P01	R-25J
A26R124	0683-1825	7		RESISTOR 1.8K 5% .25W CF TC=0-400	00746P01	R-25J
A26R134	0683-1015	7		RESISTOR 100 5% .25W CF TC=0-400	00746P01	R-25J
A26R141-144	0683-1025	9		RESISTOR 1K 5% .25W CF TC=0-400	00746P01	R-25J
A26R150	0683-1825	7		RESISTOR 1.8K 5% .25W CF TC=0-400	00746P01	R-25J
A26R151-152	0683-1035	1		RESISTOR 10K 5% .25W CF TC=0-400	00746P01	R-25J
A26R153	0683-4315	6		RESISTOR 430 5% .25W CF TC=0-400	00746P01	R-25J
A26R170	0683-0475	1	1	RESISTOR 4.7 5% .25W CF TC=0-400	00746P01	R-25J
A26R171	0683-2215	1		RESISTOR 220 5% .25W CF TC=0-400	00746P01	R-25J
A26R173	0683-2215	1		RESISTOR 220 5% .25W CF TC=0-400	00746P01	R-25J
A26R175	0683-2215	1		RESISTOR 220 5% .25W CF TC=0-400	00746P01	R-25J
A26R186	0683-1015	7		RESISTOR 100 5% .25W CF TC=0-400	00746P01	R-25J
A26R197	0683-1825	7		RESISTOR 1.8K 5% .25W CF TC=0-400	00746P01	R-25J
A26R201	0683-1825	7		RESISTOR 1.8K 5% .25W CF TC=0-400	00746P01	R-25J
A26R202	0683-1015	7		RESISTOR 100 5% .25W CF TC=0-400	00746P01	R-25J
A26R203	0683-1825	7		RESISTOR 1.8K 5% .25W CF TC=0-400	00746P01	R-25J
A26R204-205	0698-6320	8	4	RESISTOR 5K .1% .125W F TC=0+-25	05524P01	CMF-55-1, T-9
A26R206	0698-7848	7	2	RESISTOR 1.25K .1% .125W F TC=0+-25	02995P01	5033R
A26R207	0683-1015	7		RESISTOR 100 5% .25W CF TC=0-400	00746P01	R-25J
A26R208	0698-7848	7		RESISTOR 1.25K .1% .125W F TC=0+-25	02995P01	5033R
A26R209	0698-4439	6	1	RESISTOR 3.24K 1% .125W F TC=0+-100	05524P01	CMF-55-1, T-1
A26R210	0698-6320	8		RESISTOR 5K .1% .125W F TC=0+-25	05524P01	CMF-55-1, T-9
A26R217	0698-6320	8		RESISTOR 5K .1% .125W F TC=0+-25	05524P01	CMF-55-1, T-9
A26R234	0698-3457	6	1	RESISTOR 316K 1% .125W F TC=0+-100	02995P01	SFR25H
A26R257	0837-0349	5	1	VTSP	03923P01	Q63100-P2390-C990
A26RN2-4	1810-0162	5	5	NETWORK-RES 14-DIP 4.7K OHM X 13	02483P01	760-1-R4.7K
A26RN130-131	1810-0162	5		NETWORK-RES 14-DIP 4.7K OHM X 13	02483P01	760-1-R4.7K
A26SW100	3101-2747	5	1	SW—RKR DIP ASSY	04990P01	90B08S
A26TP0-8	1460-2201	4	9	RDL TEST POINT	28480	1460-2201
A26U1	1820-4570	8	1	ICM MPU 68000 10 NMOS 16B P64	02037P01	
A26U2	03325-60301	4	1	ICM EPROM AM27512-25DC	28480	03325-60301
A26U3	03325-60302	5	1	ICM EPROM AM27512-25DC	28480	03325-60302
A26U6-7	1818-4228	5	2	ICM SRAM 62256 32KX8 150NS P28	06347P01	HM62256LP-15SL
A26U10	1820-4581	1	1	ICM MSUP 68901 NMOS MFP P48	02037P01	
A26U14	1820-2096	9	1	IC CNTR TTL LS BIN DUAL 4-BIT	01698P01	
A26U26	1820-2657	8	3	IC GATE TTL ALS OR QUAD 2-INP	01698P01	
A26U27	1820-3608	1	1	ICD AS 74AS04 HX INV P14	01698P01	
A26U29	1820-3731	1	1	ICD AS 74AS10 TR 3NAND P14	01698P01	
A26U30	1820-2657	8		IC GATE TTL ALS OR QUAD 2-INP	01698P01	
A26U31	1820-3100	8	3	IC DCDR TTL ALS BIN 3-TO-8-LINE 3-INP	01698P01	
A26U32	1820-1199	1	1	IC INV TTL LS HEX 1-INP	01698P01	
A26U33-34	1820-3100	8		IC DCDR TTL ALS BIN 3-TO-8-LINE 3-INP	01698P01	
A26U38	1820-3465	8	3	IC FF TTL ALS D-TYPE POS-EDGE-TRIG COM	01698P01	
A26U39	1820-2635	2	2	IC GATE TTL ALS AND QUAD 2-INP	01698P01	
A26U41	1820-3121	3	2	IC TRANSCEIVER TTL ALS BUS OCTL	01698P01	
A26U81-82	1826-1245	0	2	ICL VREG 7702	01698P01	
A26U98	1820-2691	0	1	IC FF TTL F D-TYPE POS-EDGE-TRIG	02237P01	
A26U99	1813-0143	8	1	OSC CLK 19.6608MHZ .05% TTL5V	09235P01	F1114-19.6608MHZ
A26U100	1820-3294	1	1	IC FF TTL ALS D-TYPE POS-EDGE-TRIG COM	01698P01	
A26U102	1820-3106	4	1	IC COMPTR TTL ALS MAGTD 8-BIT	01698P01	
A26U103	1820-3431	8	1	IC TRANSCEIVER TTL S INSTR-BUS IEEE-488	03406P01	
A26U104	1820-3513	7	1	IC TRANSCEIVER TTL S INSTR-BUS IEEE-488	03406P01	
A26U105	1820-2488	3	2	IC FF TTL ALS D-TYPE POS-EDGE-TRIG	01698P01	
A26U106	1820-2548	6	1	IC-GENERAL PURPOSE INTERFACE BUS ADAPTER	01698P01	

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Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A26U107-108	1820-3465	8		IC FF TTL ALS D-TYPE POS-EDGE-TRIG COM	01698P01	
A26U109	1820-2656	7	1	IC GATE TTL ALS NAND QUAD 2-INP	01698P01	
A26U110	1820-2739	7	1	IC GATE TTL ALS NOR QUAD 2-INP	01698P01	
A26U112	1820-2635	2		IC GATE TTL ALS AND QUAD 2-INP	01698P01	
A26U113	1820-2634	1	3	IC INV TTL ALS HEX	01698P01	
A26U117	1820-3104	2	2	IC SHF-RGTR TTL ALS MULTI-MODE	01698P01	
A26U119	1813-0174	5	1	OSC CLK 4MHZ .01% TTL 5V	02483P01	MX040-2
A26U120	1820-2634	1		IC INV TTL ALS HEX	01698P01	
A26U121	1820-2657	8		IC GATE TTL ALS OR QUAD 2-INP	01698P01	
A26U123	1820-3104	2		IC SHF-RGTR TTL ALS MULTI-MODE	01698P01	
A26U125	1820-2488	3		IC FF TTL ALS D-TYPE POS-EDGE-TRIG	01698P01	
A26U127	1990-0429	7	1	OPTO-ISOLATOR LED-IC GATE IF=10MA-MAX	28480	1990-0429
A26U130-132	1990-0461	7	3	OPTO-ISOLATOR LED-IC GATE IF=10MA-MAX	28480	1990-0461
A26U135-136	1820-4578	6	2	ICD ALS 74ALS465 OC BUF P20	01698P01	
A26U138	1906-0096	7	1	DIODE-FW BRDG 200V 2A	02037P01	SDA296-002
A26U150	1826-1586	2	1	ICL VREG 2935	03406P01	
A26U151	1990-0577	6	1	OPTO-ISOLATOR LED-PDIO/XSTR IF=50MA-MAX	28480	1990-0577
A26U170	T-55430	2	1	LT1081CN	10858P01	LT1081CN
A26U201-202	1820-3378	2	2	IC LCH TTL ALS D-TYPE NEG-EDGE-TRIG OCTL	03406P01	
A26U203-204	1820-3505	7	3	IC CNTR TTL ALS DECD UP/DOWN SYNCHRO	01698P01	
A26U206	1820-3505	7		IC CNTR TTL ALS DECD UP/DOWN SYNCHRO	01698P01	
A26U207	1818-3183	2	1	IC CMOS 65536 (64K) STAT RAM 150-NS 3-S	06347P01	
A26U208	1826-0838	5	1	D/A 10-BIT 16-PLASTIC CMOS	03285P01	
A26U209	1826-0550	8	1	D/A 8-BIT 16-PLASTIC BPLR	02237P01	
A26U210	1820-3121	3		IC TRANSCEIVER TTL ALS BUS OCTL	01698P01	
A26U211-212	1820-3318	0	2	IC FF TTL ALS D-TYPE POS-EDGE-TRIG COM	01698P01	
A26U214	1820-1202	7	1	IC GATE TTL LS NAND TPL 3-INP	01698P01	
A26U216	1820-2634	1		IC INV TTL ALS HEX	01698P01	
A26U217	1826-0522	4	1	IC OP AMP LOW-BIAS-H-IMPD QUAD 14-DIP-P	01698P01	
A26U218	1826-0544	0	1	IC V RGLTR-V-REF-FXD 2.5V 8-DIP-C PKG	02037P01	
A26V101	1970-0076	8	1	TUBE-ELECTRON SURGE V PTCTR	03923P01	SP350
A26XU2-3	1200-0567	1	2	SOCKET-IC 28-CONT DIP DIP-SLDR	02414P01	DILB28P-308T
A26XU150	1205-0298	5	1	HEAT SINK PLSTC-PWR-CS	02608P01	6030D
A26XU151	1205-0338	4	1	HEAT SINK SGL PLSTC-PWR-CS	02608P01	6106B-14
				CHASSIS AND MISCELLANEOUS PARTS		
A3	03325-66503	0	1	PC ASSY-SIG-SCE	28480	03325-66503
A8	03325-66508	5	1	PC ASSY-HI VOLT	28480	03325-66508
A9	03325-66509	6	1	PC ASSY-OVEN	28480	03325-66509
A12	03325-66512	1	1	HPIB PC BOARD	28480	03325-66512
A14	03325-66514	3	1	PC ASSY-FUNCTION	28480	03325-66514
A15	03325-66515	4	1	PC ASSY DISPLAY DRIVER	28480	03325-66515
A21	03325-66521	2	1	PC ASSY-FFS D/A	28480	03325-66521
A22	03325-66522	3	1	PC-ASSY-PWR-SPLY	28480	03325-66522
A23	03325-66523	4	1	PC ASSY-ATTEN	28480	03325-66523
A25	03325-66525	6	1	PC-ASSY-KEYBD	28480	03325-66525
A26	03325-66526	7	1	PC ASSY-CONTROLLER	28480	03325-66526
	0340-0564	3	1	INSULATOR-XSTR THRM-CNDCT	05447P01	7403-09FR-51
B2	03325-68501	2	1	FAN ASSY	28480	03325-68501
C2-7	5061-8021	6	6	CBL-ASM	L1774D01	
C291-292	0150-0012	3	2	CAPACITOR-FXD .01UF +-20% 1KVDC CER	09538P01	818-584 Z5U 103M
CB1	03325-61901	2	1	CIRCUIT BREAKER ASSY.	28480	03325-61901
F1	2110-0733	3	1	FUSE .5 AMP 250V NTD UL .5	07379P01	SS2-500MA
F1	2110-0732	2		FUSE 1 AMP 250V NTD UL .5	07379P01	SS2-1A
FL1	03325-60501	6	1	ASSY. LINE MOD	10549P01	
J1-14	1250-1558	7	13	ADAPTER-COAX STR F-BNC F-RCA-PHONO	03316P01	29JJ126-3
J15	1251-8598	1	1	CONNECTOR-ELASTOMERIC SPONGE RUBBER	09922P01	HL
MP1	03325-64322	7	1	PNL-DRS II ALLM	28480	03325-64322
MP3	03325-00222	2	1	SHTF PNL-DRS SUB AL	28480	03325-00222
MP4	03325-00221	1	1	SHTF PNL-FRT SUB AL	28480	03325-00221
MP5	5021-5803	2	1	CSTG-FRAME-FRONT II	28480	5021-5803
MP6	5040-7202	9	1	MOLD TRIM TOP II	28480	5040-7202
MP7	5021-5837	2	4	CSTG-CORNER STRUT	28480	5021-5837
MP8	5060-9880	5	2	SHTF CVR-SIDE II ALV	28480	5060-9880
MP9	5040-7219	8	2	STRAP HDL CAP-FR	28480	5040-7219
MP10	5060-9804	3	2	STRAP HDL 18IN	28480	5060-9804

* Indicates factory selected values

See introduction to this section for ordering information

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
MP11	5040-7220	1	2	STRAP HDL CAP-R	28480	5040-7220
MP12	5061-9435	8	1	SHTF CVR-TOP II ALV	28480	5061-9435
MP13	03325-00203	9	1	SHTF ASSY-REAR PNL ALSK	28480	03325-00203
MP14	5021-5804	3	1	CSTG-FRAME-REAR	28480	5021-5804
MP15	03325-66603	1	1	SHTF FRM-MAIN AL	28480	03325-66603
MP17	5001-0439	8	2	TRIM-VYNL II	28480	5001-0439
MP18	5061-9447	2	1	SHTF CVR-BTTM II ALV	28480	5061-9447
MP19	5040-7201	8	4	MOLD FOOT II	28480	5040-7201
MP20	1460-1345	5	2	TILT STAND SST	05502P01	
MP22	5001-3907	1	2	STMP CLIP-COMPONENT	28480	5001-3907
MP23	3150-0387	8	1	FILTER-AIR NYLON 3.129-IN-WD 3.129-IN-LG	00728P01	
MP24-26	1205-0338	4	3	HEAT SINK SGL PLSTC-PWR-CS	02608P01	6106B-14
MP27	03325-44301	0	1	KEYPAD, ELASTOMERIC LEFT	28480	03325-44301
MP28	03325-44302	1	1	KEYPAD, ELASTOMERIC CENTER	28480	03325-44302
MP29	03325-44303	2	1	KEYPAD, ELASTOMERIC RIGHT	28480	03325-44303
S1	T-46637	2	1	PWR SWITCH 3101-2988	11052P01	132AW10XXJ
T1	T-46605	4	1	PWR XMFR	28480	T-46605
W1	03325-61602	0	1	CBL-ASM SIGNAL	L1287D01	
W2	03325-61617	5	1	CBL-ASM 2 SYNC	L1287D01	
W3	03325-61624	6	1	CBL-ASM CXL MRCA/MRCA 305MM BK	10549P01	
W4	03325-61625	7	1	CBL-ASM CXL MRCA/MRCA 216MM BK	10549P01	
W5	03325-61626	8	1	CBL-ASM FLX FHDR/FHDR 50MM WH	L0011D01	
W6	03325-61627	9	1	CBL-ASM CXL MRCA/MRCA 216MM BK	10549P01	
W7	03325-61641	7	1	POWER CABLE - ASSY	11108P01	
W8	03325-61642	8	1	CBL-ASM RS-232	06925P01	
W9	03325-61643	9	1	CBL-ASM HP-IB	10047P01	
W10	03325-61644	0	1	CBL-ASM CXL MRCA	28480	03325-61644
W11	03325-61646	2	1	FRONT PANEL FLT-RBN CBL	L0011D01	
W12	03325-61604	2	1	CBL-ASM CXL Z BLK	L1287D01	
W13	03325-61619	9	1	CBL-ASM CXL MKR	L1287D01	
W14	03325-61620	2	1	CBL-ASM CXL X DRIVE	L1287D01	
W15	03325-61647	3	1	CBL-ASM DSC FCRP POWER SWITCH	L2276P01	
W16	03325-61607	7	1	CBL-ASM CXL MRCA/MRCA 305MM BK 16 PHM	L1287D01	
W17	03325-61608	6	1	CBL-ASM PD	L1287D01	
W18	03325-61609	7	1	CBL-ASM S & H	L1287D01	
W19	03325-61610	0	3	CBL-ASM OVEN	L0011D01	
W23	03325-61603	1	1	CBL-ASM ALC	L1287D01	
W24	03325-61618	8	1	CBL-ASM MXR	L1287D01	
W25	03325-61623	5	1	CBL-ASM OUT	L1287D01	
W35	03325-61631	5	1	CBL-ASM CXL	10549P01	
	8150-4517	9	1	JMPR 22GA WHTBLKGRA 175MM 8x8	10549P01	
	8150-4510	2	1	JMPR 22GA WHTGRA 75MM 8x8	10549P01	
	8150-4507	7	1	JMPR 22GA GRNYEL 125MM 8x8	10549P01	
	8150-4520	4	1	JMPR 22GA WHTBRNGRA 200MM 8x8	10549P01	
	8150-4556	6	1	JMPR 18GA GRNYEL 100MM 8x8	10549P01	
	2360-0113	2	58	SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	01136P01	
	00310-48801	0	22	MOLD WSHR-SH D-SHAPE	28480	00310-48801
	0515-1331	5	16	SCR-MCH M4.0 6MMLG FHPZ SST *	01125P01	
	2190-0020	9	12	WASHER-LK HLCL NO. 5 .128-IN-ID	04757P01	
	2200-0093	9	12	SCREW-MACH 4-40 1.25-IN-LG PAN-HD-POZI	01125P01	
	2200-0101	0	11	SCREW-MACH 4-40 .188-IN-LG PAN-HD-POZI	01136P01	
	3050-0604	0	9	WASHER-FL MTLC 7/16 IN .5-IN-ID	05313P01	5710-94-16
	0624-0208	4	9	SCREW-TPG 6-32 .5-IN-LG PAN-HD-POZI STL	01136P01	
	2200-0103	2	8	SCREW-MACH 4-40 .25-IN-LG PAN-HD-POZI	01136P01	
	1400-0249	0	8	CABLE TIE .062-.625-DIA .091-WD NYL	04225P01	TY-23M-8
	2190-0918	4	6	WASHER-LK HLCL NO. 6 .141-IN-ID	04604P01	
	0624-0077	5	6	SCREW-TPG 4-40 .312-IN-LG PAN-HD-POZI	01136P01	
	3050-0066	8	4	WASHER-FL MTLC NO. 6 .147-IN-ID	04604P01	1451
	3050-0071	5	4	WASHER-FL MTLC NO. 8 .169-IN-ID	04604P01	
	3050-0681	3	4	WASHER-FL NM NO. 8 .172-IN-ID .375-IN-OD	04604P01	%104321 (1M/BAG) BLACK?
	0515-1132	4	4	SCREW-MACH M5 X 0.8 10MM-LG	09908P01	
	2360-0123	4	4	SCREW-MACH 6-32 .625-IN-LG PAN-HD-POZI	01136P01	
	2360-0127	8	4	SCREW-MACH 6-32 .875-IN-LG PAN-HD-POZI	01136P01	
	2510-0067	4	4	SCREW-MACH 8-32 2-IN-LG PAN-HD-POZI	01136P01	

See introduction to this section for ordering information

* Indicates factory selected values

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
	0590-0167	1	4	NUT-THUMB 6-32-THD BRS	04604P01	8070-NP (PAK 1M/BAG)
	2260-0009	3	4	NUT-HEX-W/LKWR 4-40-THD .094-IN-THK	04604P01	
	2420-0001	5	4	NUT-HEX-W/LKWR 6-32-THD .109-IN-THK	04604P01	
	2580-0003	5	4	NUT-HEX-W/LKWR 8-32-THD .125-IN-THK	07296D01	
	5040-8313	5	4	MOLD WSHR-SH D-SHAPE	06617P01	
	3050-0222	8	3	WASHER-FL MTLC NO. 4 .125-IN-ID	07296D01	
For chassis mounted transistors →	3050-1161	6	3	WASHER-SHLDR NO. 4 .115-IN-ID .24-IN-OD	05313P01	5607-150
	2200-0111	2	3	SCREW-MACH 4-40 .5-IN-LG PAN-HD-POZI	01136P01	
	2260-0003	7	3	NUT-HEX-PLSTC LKG 4-40-THD .141-IN-THK	07296D01	
	1400-0611	0	3	CLAMP-FL-CA 1-WD	04726P01	3484-1000
	2190-0586	2	2	WASHER-LK HLCL 4.0 MM 4.1-MM-ID	06691D01	
	0360-1089	1	2	TERMINAL-SLDR LUG PL-MTG FOR-%1/2-SCR	04880P01	379-500-1
	0380-0643	3	2	STANDOFF-HEX .255-IN-LG 6-32-THD	02685P01	
	1252-0699	9	2	SCR-JCK 4-40 SUBMIN D STLZN	02121P01	ST6979M.250-0.187-36
	9282-0906	2	2	MISC-CABLE PROTECTOR	L1805P01	
	0340-0564	3	2	INSULATOR-XSTR THRM-CNDCT	05447P01	7403-09FR-51
	03325-90003	6	1	SERVICE MANUAL	28480	03325-90003
	7100-1293	6	1	STMP CVR-XFRMR	08391P01	
	6960-0027	3	1	PLUG-HOLE FL-HD FOR .625-D-HOLE NYL	28480	6960-0027
	03325-90014	9	1	OP MANUAL	28480	03325-90014
	7120-8539	9	1	LABEL-WARNING 1.3-IN-WD 1.6-IN-LG VINYL	03211D01	
	7121-2527	5	1	LBL-WRNG "CAUTION METRIC %	03211D01	
	7124-2083	4	1	LABEL-WARNING 1-IN-WD 3.5-IN-LG PPR	01486P01	
	8120-3962	3	1	LJPR 22GA GRA 450MM DxD	10549P01	
	0340-0915	8	1	INSULATOR-XSTR THRM-CNDCT	05447P01	7403-09FR-53
	0890-0100	8	0	TUBING-HS .093-D/.046-RCVD .02-WALL	02145P01	RNF-100-3/32-WHT
	0890-0765	1	0	TUBING-HS .187-D/.093-RCVD .02-WALL	02145P01	RNF-100-3/16-WHT
	0890-0012	1	0	SLEEVING-FLEX .04-ID NEMA-3 .016-WALL	28480	0890-0012

* Indicates factory selected values

See introduction to this section for ordering information

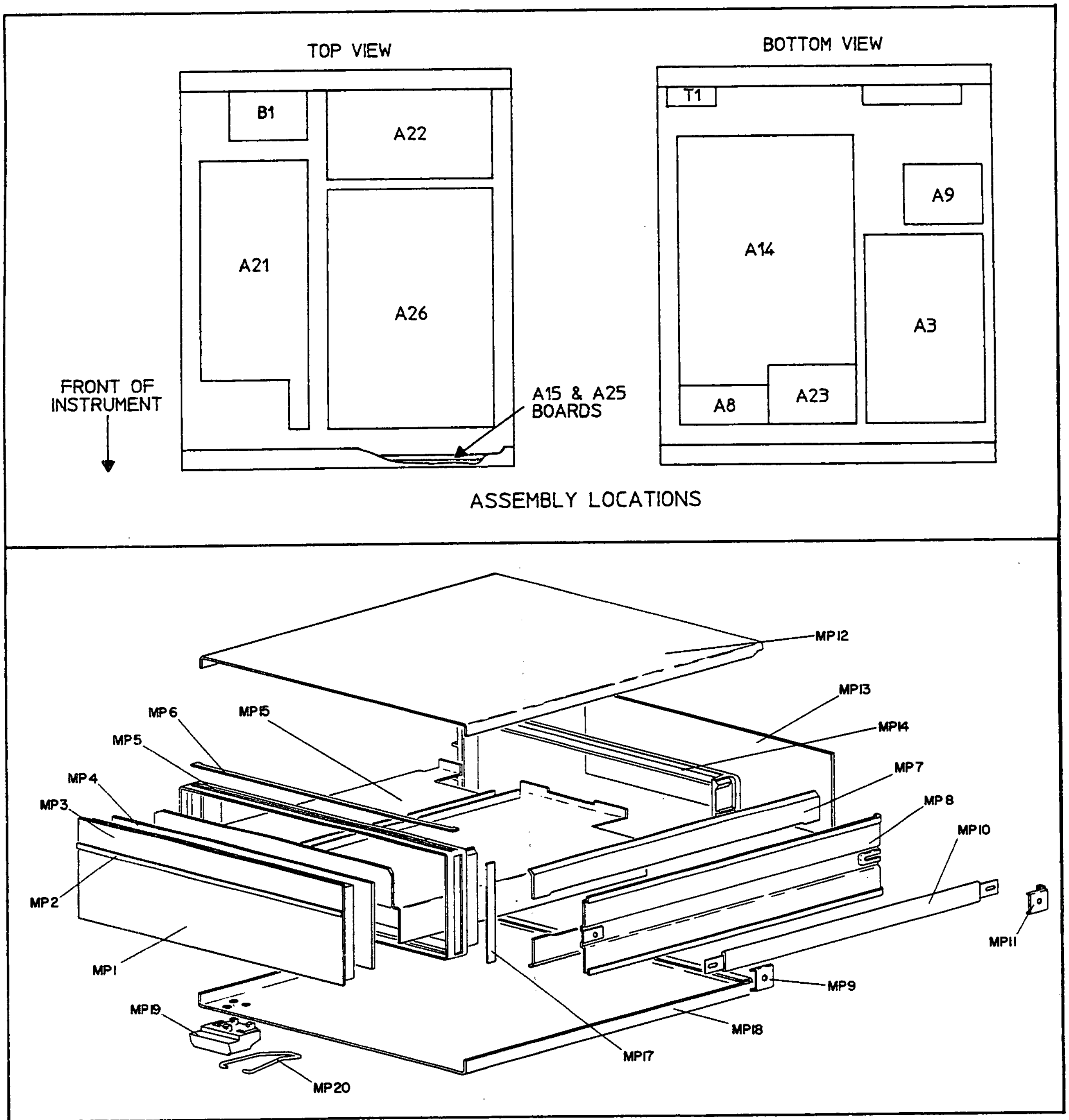

Figure 6-1. Location of Parts.

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3325B UPDATED CABLE LIST

HP 3325B Cable P/N Change Sheet   Rev 03   (10/95)
De Arbogast A100 T-335-2038

REF DES	PART NUMBER/ LABEL	CON	OLD LABEL	CABLE LENGTH	CABLE COLOR	CONNECTION FROM	TO
W1	8120-2587	RCA	1 SIGNAL	216mm	BK	A23J1	FP-SIGNAL
W2	8120-4492	RCA	2 SYNC	305mm	BK	A14J2	FP-SYNC
W3	8120-4494	RCA	3AUX IN	660mm	BK	A3J3	A22J801
W4	03325-61644	RCA	4 EXT LVL	460mm	BK	A23J4	RP-MISG OUT
W5	8120=4494	RCA	5 R SYNC	460mm	BK	A14J5	A22J802
W6	03325-61644	RCA	BUNDLE	7Cables	BK	BUNDLE	BUNDLE
W7	03325-61644	RCA	7 A-M	460mm	BK	A3J7	RP-AMP MOD II
W8	03325-61644	RCA	8 100kHz	460mm	BK	A3J8	A21J8
W9	03325-61644	RCA	9 2MHz	305mm	BK	A3J9	A14J9
W10	03325-61644	RCA	10 1MHz	305mm	BK	A3J10	RP-REF OUT
W11	03325-61644	RCA	11 EXT REF	305mm	BK	A3J11	RP-EXT REF II
W12	8120-4492	RCA	12 Z BLANK	305MM	BK	A14J12	RP-Z BLANK
W13	8120-4492	RCA	13 MKR	305mm	BK	A14J13	RP-MKR OUT
W14	8120-4492	RCA	14 XDRIVE	305mm	BK	A14J14	RP-X DRIVE
W15	8120-4891	RCA	15 VTO	153mm	BK	A3J15	A21J15
W16	8120-4492	RCA	16 PH MOD	305mm	BK	A21J16	RP-PH MOD IN
W17	8120-2587	RCA	17 PD	216mm	BK	A21J7	A21J17
W18	8120-4492	RCA	18 S&H	305mm	BK	A21J18	A21J18A
W19	8120-4492	RCA	19 OVEN	305mm	BK	A9J19	PR-10MHz OUT
W20	8120-2587	RCA	20 HIV 1	216mm	BK	A8J20	A23J4
W21	8120-2587	RCA	21 HIV 2	216mm	BK	A8J21	A23J21
W22	03325-61641	DSC	10P A22/26	280mm	ML	A22J700	A26J5
W23	8120-4492	RCA	23 ALC	305mm	BK	A3J23	A14J23
W24	8120-4492	RCA	24 MXR	305mm	BK	A3J24	A14J24
W25	8120-2844	RCA	25 OUT	102mm	BK	A14J25	A23J25
W26	8120-4492	RCA	26 MOD OUT	305mm	BK	A26J202	M SRC OUT
W27	8120-2587	RCA	27 SYNC OUT	216mm	BK	A22J850	RP-F SYNC
W28	8120-2587	RCA	28 AUX OUT	216mm	BK	A22J860	RP-AUX OUT
W29	03325-61616	DSC	3P A9/22	440mm	ML	A9P1	A22J751
W30	03325-61626	FLX	14P A14/23	50mm	WH	A14J30	A23J30
W31	03325-61646	FLX	21P A15/26	240mm	WH	A15J100	A26J10
W32	03336-61625	FLX	21P A3/26	127mm	WH	A3J1	A26J3
W33	03336-61625	FLX	21P A14/26	127mm	WH	A14J1	A26J2
W34	03336-61625	FLX	21P A21/26	127mm	WH	A21J1	A26J4

Section VII
Manual Backdating

SECTION VII
MANUAL BACKDATING

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SECTION VII
MANUAL BACKDATING

7-1. Introduction.

7-2. The revision of this manual applies directly to all instruments. Earlier versions of this instrument, however, differ in design and appearance from those currently being produced. The information in this section documents the earlier instrument configurations and associated servicing procedures. Also included is information on recommended modifications for improvements to earlier instruments.

7-3. Manual Changes Supplement

7-4. As Hewlett-Packard continues to improve the performance of the HP 3325B, corrections and modifications to the manual may be required. Required changes are documented by a yellow Manual Changes supplement and/or revised pages. To keep the manual up-to-date, periodically request the most recent supplement, available from the nearest Hewlett-Packard office (see sales and support offices listing at the back of this manual).

Section VIII
Service: Theory of Operation

SECTION VIII
SERVICE

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LIST OF ILLUSTRATIONS

LIST OF TABLES

WARNING

These servicing instructions are for use by trained service personnel only. To avoid electrical shock, do not perform any servicing other than that contained in the operating instructions unless you are qualified to do so.

SECTION VIII
SERVICE

8-1. INTRODUCTION.

8-2. This section contains information required to service the Model 3325 Synthesizer/Function Generator. This includes the theory of operation, block diagrams, troubleshooting procedures, and schematic diagrams. Most of the service information is divided into service groups, which are identified alphabetically. Each service group contains the schematic diagram, troubleshooting, and other pertinent information for a specific area of the instrument. A foldout functional block diagram follows Service Group O. The following circuits are included in the service groups:

Assembly	Circuit	Service Group
A3	VCO Buffer	D
A3	30 MHz Reference and Dividers	G
A3	Mixer	H
A8	High Voltage Output Opt 002	M
A9	High Stability Frequency Reference Opt 001	M
A12	Rear Panel Interface	B
A14	D/A Converter and Sample/Hold	I
A14	Function Circuits	J
A14	Output Amplifier and Level Comparator	K
A14	Relay Drivers	L
A14	Sweep Drive Circuits	N
A15	Display Driver	A
A21	Voltage Controlled Oscillator	D
A21	÷ NF Counter	E
A21	Fractional N Analog Circuits	F
A22	Fast Sync Converter	K
A22	Power Supplies	O
A23	Attenuator	L
A25	Keyboard	A
A26	Interface Circuits	B
A26	Control Circuits	C
A26	Modulation Source	N

Signature analysis information begins with Paragraph 8-139.

8-3. BASIS THEORY.

8-4. A simplified block diagram of the HP 3325B circuits is shown in Figure 8-1. In response to programming inputs from the keyboard or the interface circuits, the control circuits set the frequency, signal level, and output attenuation. The frequency synthesis circuits generate a sine wave at a frequency determined by digital information from the control circuits. This sine wave is applied to the function circuits where both the output function and signal level are determined, again by digital control. The signal level from the output amplifier can be tested in the level comparator to determine if a level correction is needed, thus providing an automatic amplitude calibration. If amplitude problems are encountered, it is important to disable this auto calibration. See section 8-114. Attenuator range is selected by the control circuits to provide (in conjunction with level control) the desired output signal amplitude. Program parameter data stored in the control circuits is transferred to the display when that parameter entry prefix key is pressed or the parameter prefix is programmed on the interface circuits.

8-5. THEORY OF OPERATION.

8-6. The following theory is a general description of each of the circuit blocks in the 3325 . A foldout functional block diagram of the 3325 follows Service Group O. Additional information on individual circuits may be found within the service groups. Figure 8-2 is a basic block diagram of the logic circuits, which interface with the processor (and with each other through the processor) to control the operation of the instrument. The Machine Data Bus, which consists of eight parallel lines labeled MD0 through MD7, is the principal means of data exchange between the control circuits and other parts of the instrument.

8-7. Keyboard and Display (Service Group A).

8-8. **Keyboard Scan.** Figure 8-3 is a block diagram of the Keyboard and Display circuits. To determine if a key has been pressed, a single high bit is shifted into the first position of the 16-bit register, and the four-line output of the keyboard matrix is read onto the machine data bus by the Read Keyboard clock signal. The high bit is then shifted one position in the register and the keyboard matrix output is read again. This process is repeated through the twelve input lines to the matrix. The high input bit is inverted by the keyboard buffers. A low level on one of the four matrix output lines indicates that a key has been pressed, and the control circuits initiate the proper action. After a low level has been detected, the control circuits look for a high level from the same key before the same action can be repeated. In other words, if the 5 key has been pressed, only one 5 will be processed even though the key is held through more than one keyboard scan cycle.

8-9. **Numeric Display.** The same high bit that is shifted through the 16-bit shift register to scan the keyboard enables one of the eleven numeric display digits in each of the first eleven positions of the register. When a digit is enabled, eight bits of data (parallel) from the Machine Data Bus are entered in the 8-bit latch by a Write Keyboard Display Data clock signal. Each low bit in this data enables one of the eight current sources, which supplies current to the proper segment (or decimal point) of the enabled digit.

8-10. Annunciator Matrix. In each of the last five positions of the 16-bit shift register, the high bit that is being shifted through enables one of five sets of annunciators. Then another set of eight data bits is entered into the 8-bit latch. Each low bit in this data set also turns on one of the eight current sources, which supplies current to the proper annunciator.

8-11. Scan Cycle. Approximately 14 milliseconds are required for a complete scan of the Keyboard and Display. During each scan cycle, the events shown in Figure 8-3 happen concurrently.

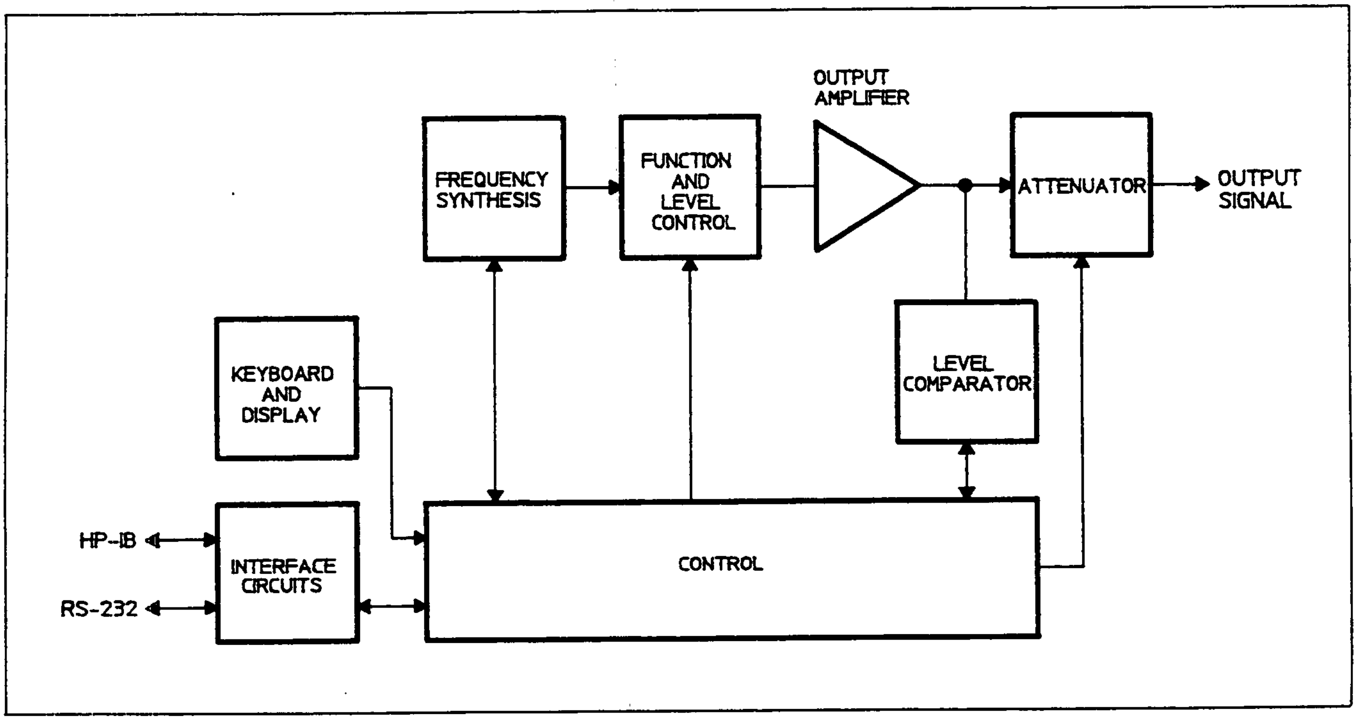


Figure 8-1. Simplified Block Diagram.

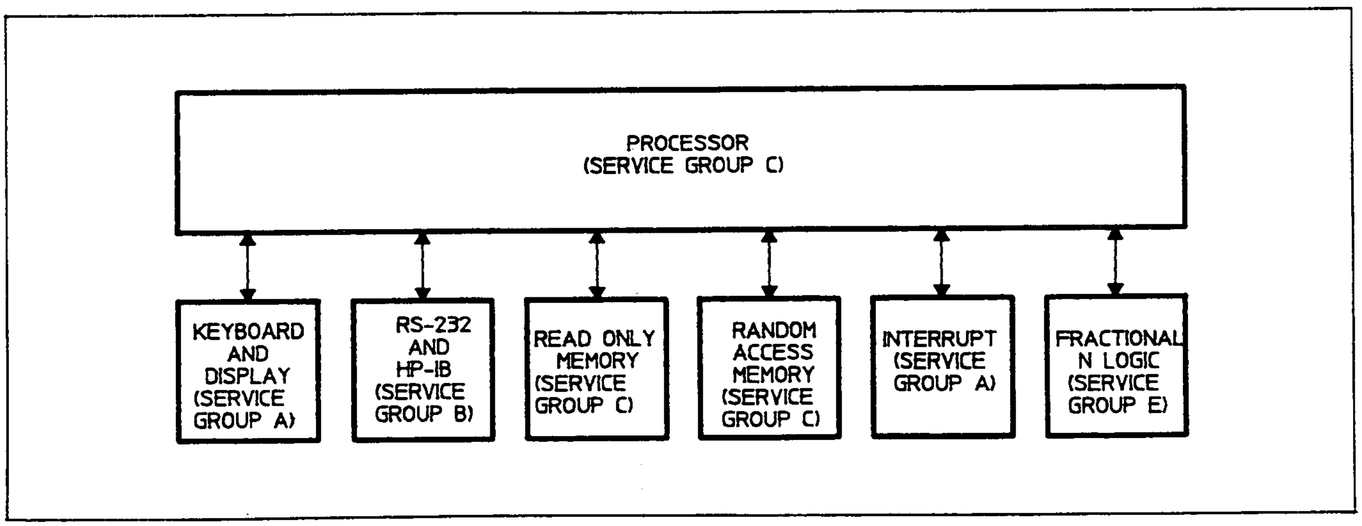


Figure 8-2. Basic Block Diagram, Logic Circuits.

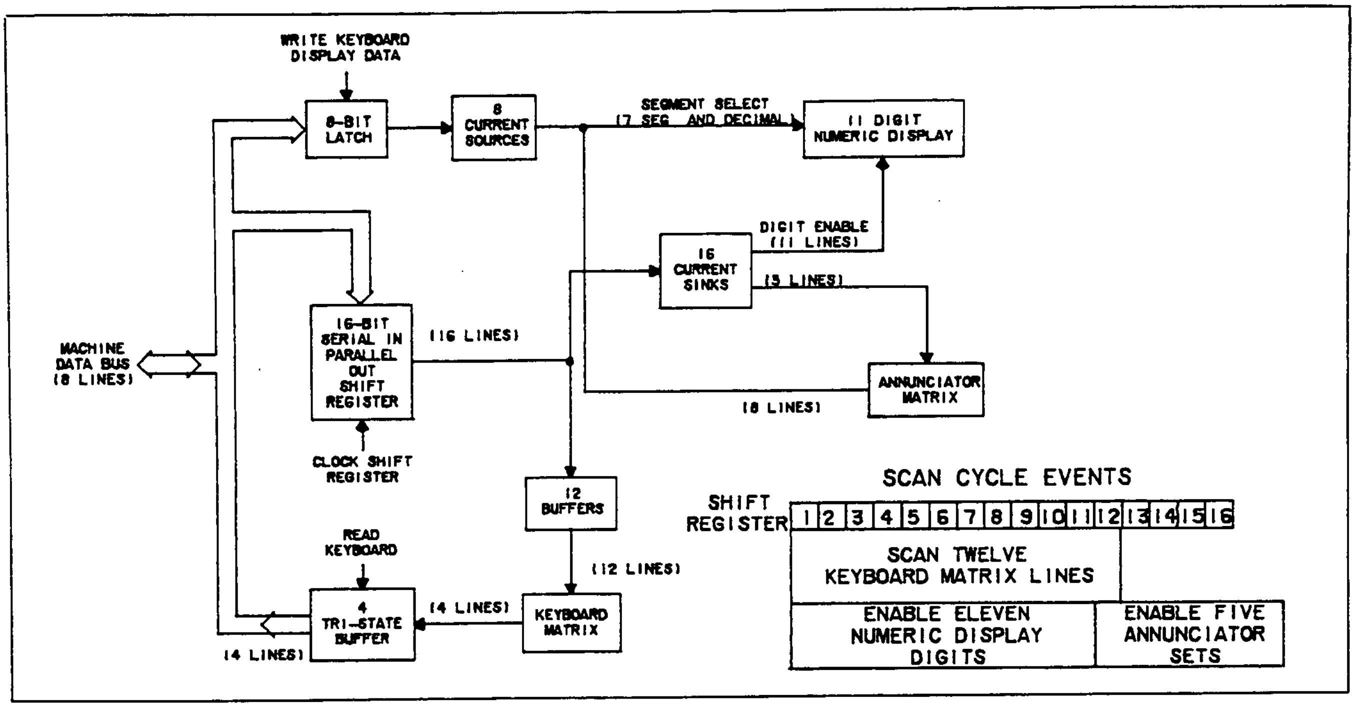


Figure 8-3. Keyboard and Display Block Diagram.

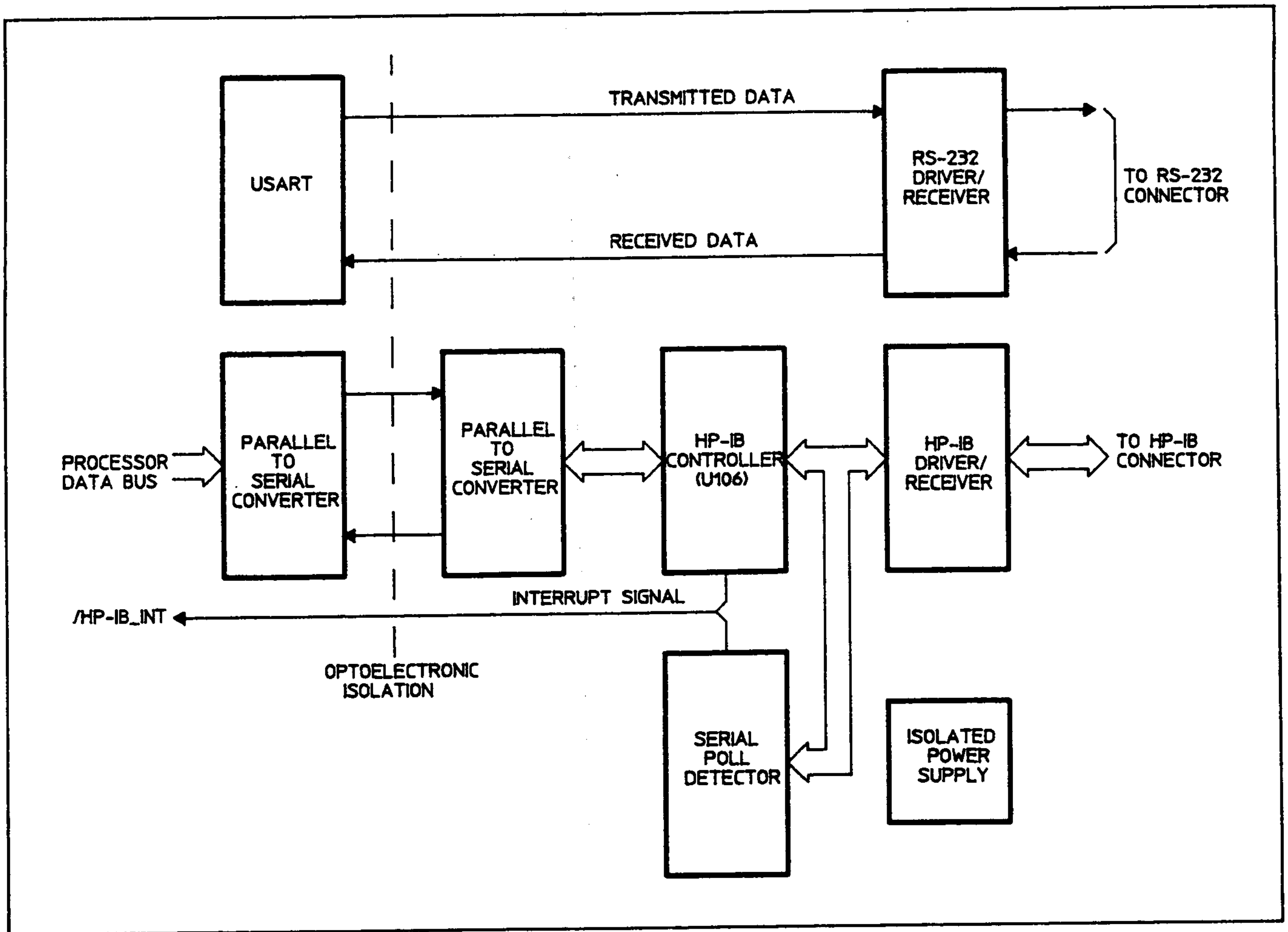


Figure 8-4. Basis Block Diagram of HP-IB and RS-232 Circuits.

8-12. HP-IB/RS-232 Circuits (Service Group B).

8-13. The HP-IB/RS-232 Circuits include the following:

- Isolated Power Supply
- Optoelectronic Isolation Interface
- HP-IB Controller
- Serial Poll Detector
- RS-232 Drivers and Receivers

Figure 8-4 is a basic block diagram of the HP-IB and RS-232 circuits.

8-14. Isolated Power Supply: Voltage regulator U150 provides +5 volt power to the isolated circuits. Optocoupler U151 and transistor Q151 disable the +5 volt supply when the HP 3325B is switched to standby.

8-15. Isolation Interface: The Isolation Interface circuits consist of shift registers U123, U125, U108, and U117 and of optocouplers U131 and U132. To transfer data from the processor to the HP-IB controller, U123 is parallel loaded with data, and the SHIFT signal is activated. SHIFTCLK (from /SHIFTCS) is clocked 8 times to shift the data through U131. Next U123 is loaded with the address of a register in the HP-IB controller, and the data is shifted 4 more times. The data is now in U117, and the register address is in U108. The SHIFT signal is deactivated, and the next SHIFTCLK writes the data to the HP-IB controller.

8-16. To transfer data from the HP-IB controller to the processor, U123 is parallel loaded with the register address, and the SHIFT signal is activated. SHIFTCLK is clocked 4 times to shift the data through U131 and into U108. The SHIFT signal is deactivated, and the next SHIFTCLK signal reads from the HP-IB controller and parallel loads U117. Data is clocked 8 times to move it through optocoupler U132 and into U123. The processor reads the data from U123.

8-17. HP-IB controller: U106 manages the HP-IB protocol. U103 and U104 buffer the HP-IB lines. When the HP 3325B is requested to listen or talk, or to transfer data in or out, the HP-IB controller interrupts the processor by activating HPIB_INT.

8-18. Serial Poll Detector: The Serial Poll Detector interrupts the processor when a serial poll occurs on the bus. This is necessary to maintain compatibility with the HP 3325A. U102 detects Serial Poll Enable and disables HP–IB commands (Serial Poll Enable and Serial Poll

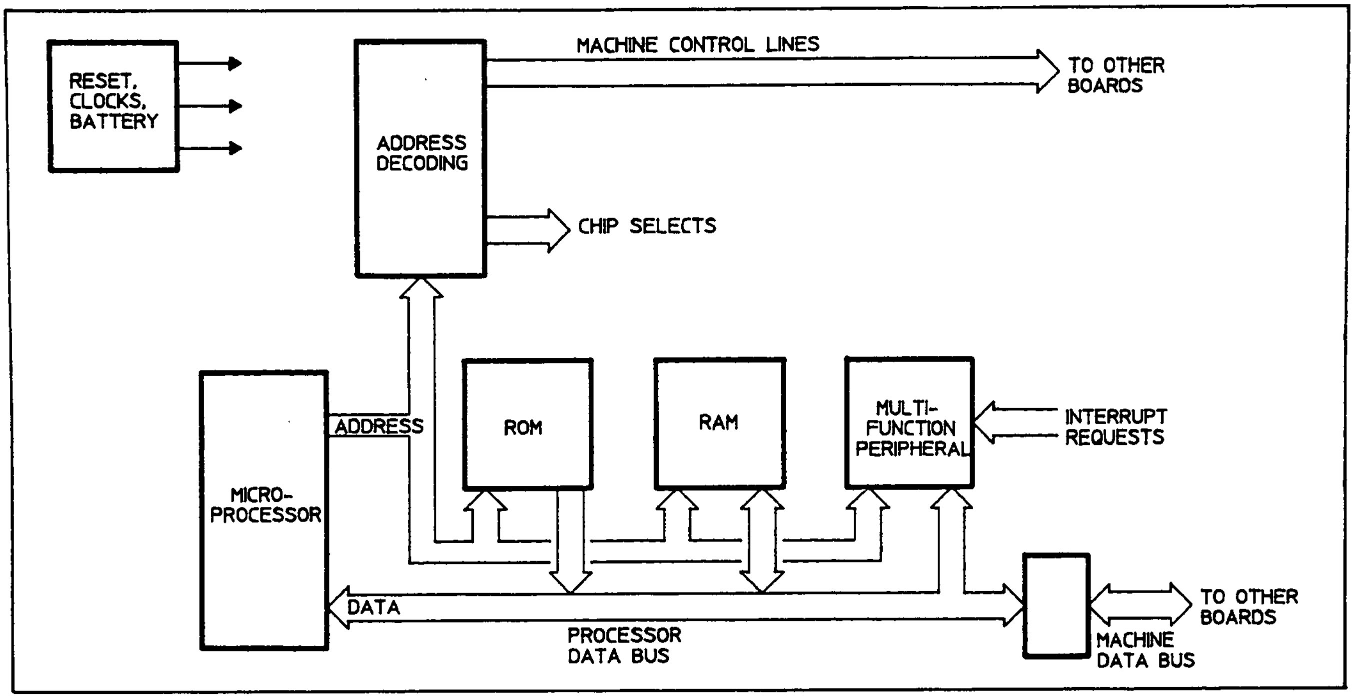


Figure 8-5. Basic Block Diagram of Control Circuits.

Disable). Serial Poll Enable sets U105A, and Serial Poll Disable clears it. When the serial poll byte is output to the HP-IB, U105B generates an interrupt to the processor.

8-19. RS-232 Driver/Receiver: The RS-232 Driver/ Receiver (U170) translates TTL levels into RS-232 voltage levels. U170 contains charge-pump circuits that generate ± 10 volt supplies from the + 5 volt supply.

8-20. Control Circuits (Service Group C).

8-21. The Control Circuits include the following:

- Microprocessor (Processor)
- Read Only Memory (ROM)
- Random Access Memory (RAM)
- Multi-Function Peripheral (MFP)
- Address Decoding
- Reset
- Clock

Figure 8-5 is a basic block diagram of the control circuits.

8-22. ROM and RAM circuits: The ROMs, U2 and U3, contain instructions that are read by the processor, U1. The RAMs, U6 and U7, provide storage for instrument state and other data.

8-23. Clock circuits: U99 generates a 19.6608 MHz clock. U98A divides this signal by 2 to make CLK10, which is used by the processor. U14A divides /CLK10 by 4 and by 16 to generate clock signals used by the MFP, U10 and by the Bus Error Detector, U14B.

8-24. Reset circuits: During power-up, U82 activates /RESET until the + 5 volt supply stays above + 4.85 volts for at least 2 seconds. When the supply is below 3.5 volts, U81 and Q81 activate /BTRY_ENABLE and transistors Q3 and Q4 function as a switch that opens to disconnect the non-volatile RAM supply (+ 5VB) from the + 5 volt supply. Q2 is a switch that prevents the RAMs from being enabled when /BTRY_ENABLE is activated. During normal operation, both /RESET and /BTRY_ENABLE should be deactivated and + 5VB should be greater than + 4.5 volts. The processor can also activate /RESET if it is unable to execute instructions.

8-25. Address Decoding circuits: The processor outputs an address to the address bus at the beginning of each read or write cycle. AB21, the most significant address signal used, selects between the MFP and all other devices. When the MFP is not selected, U31 decodes address signals AB18 thru AB20 to select either ROM, RAM, machine data bus, or some other device. When the machine data bus is selected (/MDBS is activated), U33 and U34 further decode the address and activate one of the machine control lines. The MFP internally generates the Data Transfer Acknowledge (DTACK) signal that tells the processor when the read or write operation is complete. U14B generates a bus error timeout signal if DTACK did not occur. Read and write operations to everything else are terminated by the EEDTACK signal from U38.

8-26. Multi-Function Peripheral (MFP): This integrated circuit contains the following functional circuits:

An interrupt controller. All interrupts are prioritized by the MFP. The MFP activates /IRQ to interrupt the processor.

A Universal Synchronous/Asynchronous Receiver-Transmitter (USART). The USART is used for RS-232 communication.

Timer/counter A (1 of 4). This timer/counter divides the CLK2.5 clock to generate a periodic interrupt for the processor. The interrupt occurs at an 1800 Hz rate and signals the processor to scan the keyboard and update the digital-to-analog converters on the A14 assembly.

Timer/counter B. This timer/counter is used to time discrete sweep dwells.

Timer/counter C. This timer/counter generates the MODCLK signal for the modulation source.

Timer/counter D. This timer/counter generates the BAUD_CLOCK signal for the USART. The frequency of BAUD_CLOCK is 16 times the baud rate.

Eight Input/output pins. MODLOAD and SLC are output pins. HPIB_DATA is an input pin and /HPIB_INT and /SLF are interrupt inputs.

8-27 Fractional N Control. The Fractional N Control (see Service Group E) performs several functions vital to control of the HP 3325B.

a. It calculates the ÷ N and Pulse Remove data for the phase lock loop in the frequency synthesis circuits. (Explanation of the HP 3325B frequency synthesis begins with Paragraph 8-28.) This information is updated every 10 microseconds.

b. It increments or decrements the output frequency during a sweep function and outputs a Sweep Limit Flag when the start or stop frequency is reached. It also outputs a Sweep Limit Flag at the marker frequency during a sweep up.

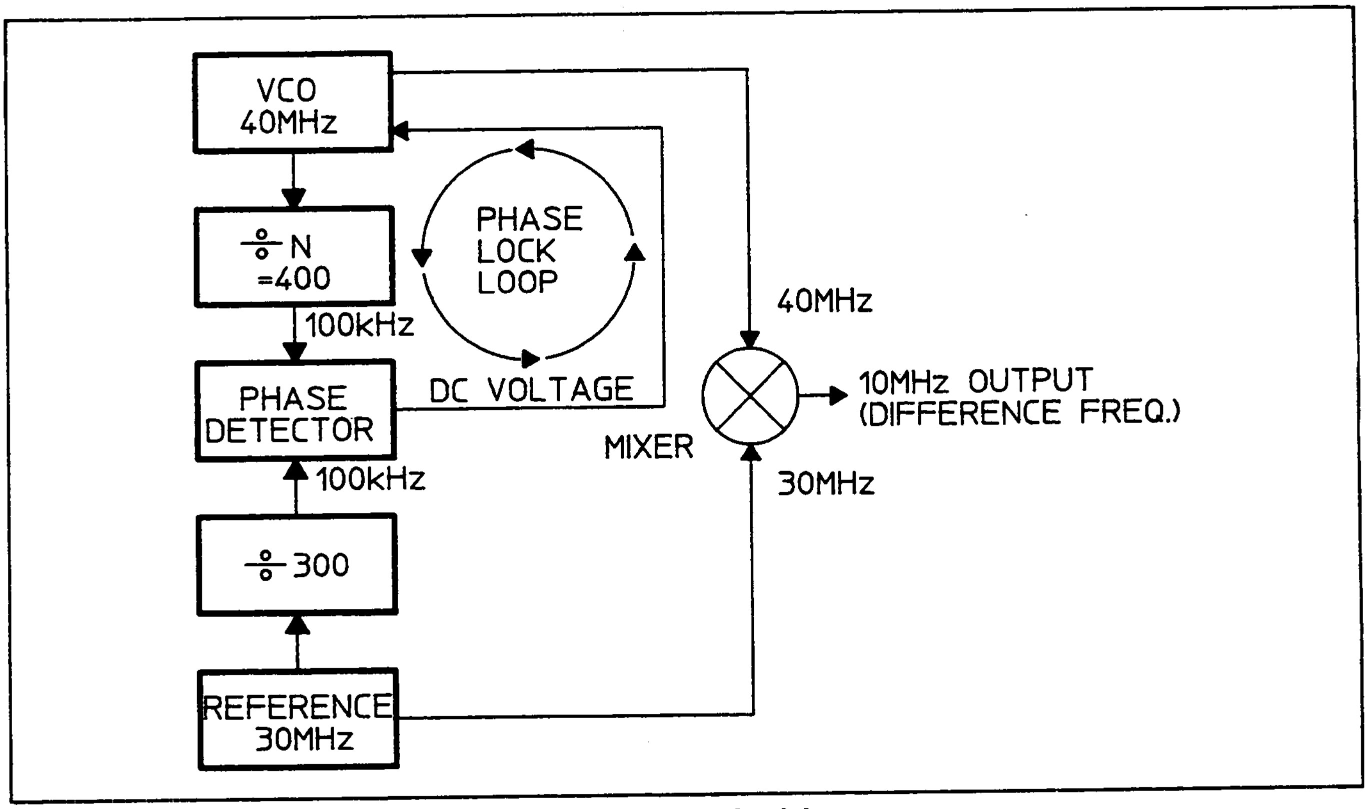


Figure 8-6. Phase Lock Loop.

8-28. Frequency Synthesis.

8-29. The Frequency Synthesis circuits are found in Service Group D, Voltage Controlled Oscillator; Service Group E, Fractional N Counter; and Service Group F, Fractional N Analog.

8-30. How does the HP 3325B generate a given frequency? Assume that the output desired is an even 10 MHz. A method for obtaining this frequency is illustrated in Figure 8-6. Basically, the HP 3325B uses this method.

8-31. The frequency of the VCO (Voltage Controlled Oscillator), in Figure 8-6, is controlled by the dc voltage out of the phase detector. This dc voltage reflects any phase change between the two detector input signals. Consequently, if the VCO frequency changes, the phase detector output changes to correct the VCO. This is known as a phase lock loop (PLL).

8-32. If we want to change the output from 10 MHz to 20 MHz, it is necessary merely to change the ÷ N number from 400 to 500. This obviously changes the divided VCO input to the phase detector to 80 kHz. The phase detector then uses the phase difference between its two inputs to change the VCO frequency to 50 MHz. This returns the phase detector input to 100 kHz, and the loop is again phase locked. It takes the 3325 about 50 milliseconds to make this change. The ÷ N number is determined by control circuits in response to front panel or remote programming.

8-33. The 3325B sine wave frequency range is essentially from zero to 20 MHz; consequently, the VCO frequency range is normally 30 MHz to 50 MHz. This dictates that the ÷ N number be a 3-digit integer between 300 and 500 (÷ N can be only three digits in the 3325A). For example, if ÷ N is 398, the VCO frequency is adjusted to 39.8 MHz (398 x 100 kHz) and the output is 9.8 MHz.

8-34. Now let us look at a more detailed diagram of the phase detector block (Figure 8-7). The control voltage to the VCO is the output of a Sample/Hold amplifier which samples the integrator output at the proper time and at regular intervals. Ideally, this voltage would be exactly the same at each sampling time and the VCO frequency would remain constant. Let us assume that this is true, and that the ÷ N number is 400. In this case, the output of the phase comparator would be a series of pulses of equal width. Each pulse turns on a current source which causes a given amount of charge to be placed on the integrator. At a specified time this voltage is stored on the Sample/Hold amplifier capacitor (Figure 8-7). The integrator output is illustrated in Figure 8-8. The charge slope is much greater than the discharge slope because the phase comparator current source has about ten times the magnitude of the bias current source.

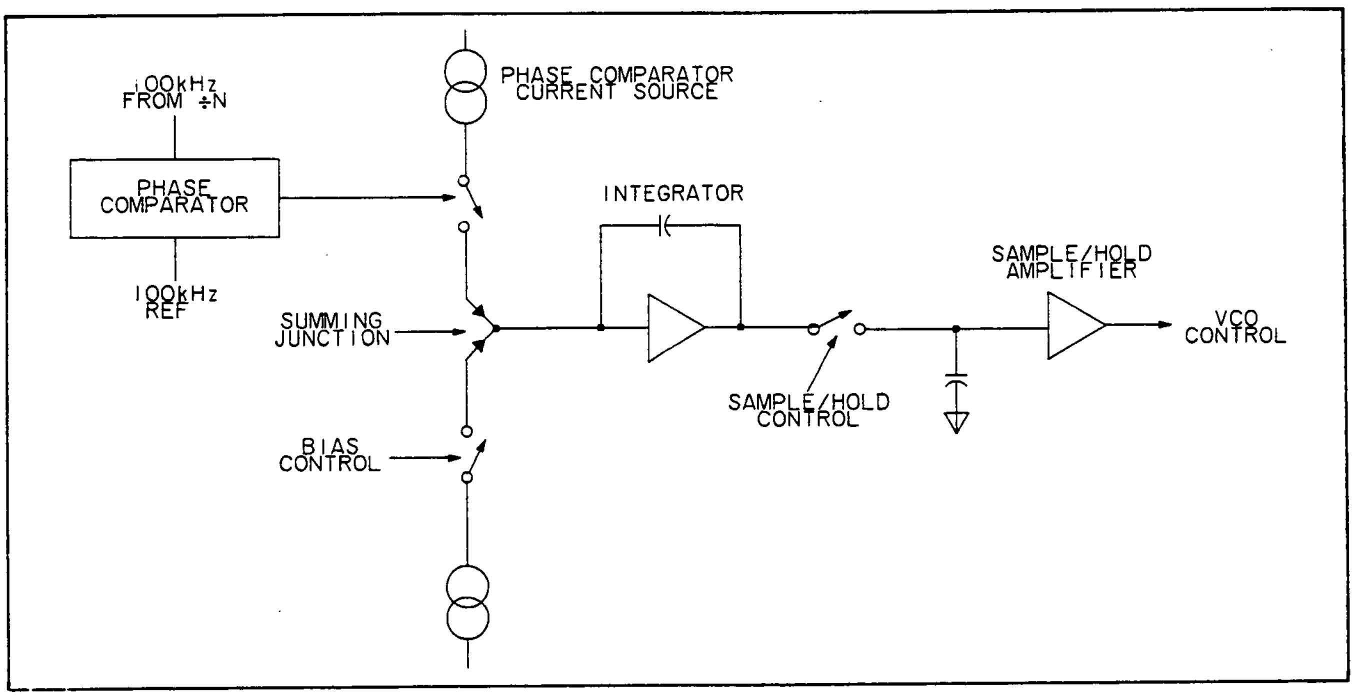


Figure 8-7. Phase Detector.

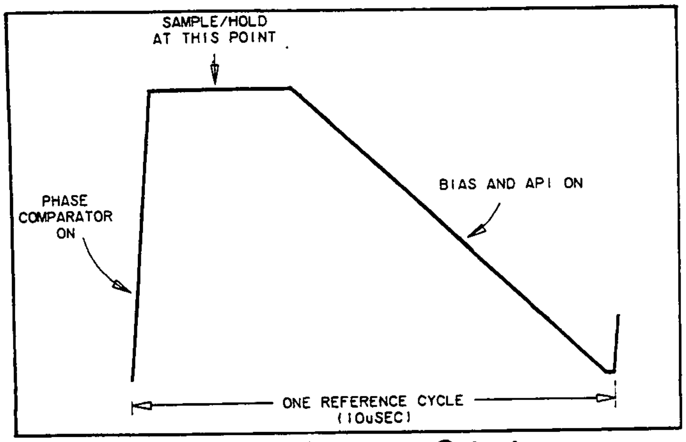


Figure 8-8. Integrator Output.

8-35. Immediately after a sample, the bias current source is turned on to discharge the integrator capacitor to the level it held before the phase comparator current was allowed to charge it. If this were not done, the charge would continue to accumulate to the limit permitted by the power supplies and remain at that level (nullifying the entire PLL scheme). The bias current is controlled by a pulse from the fractional N control IC.

8-36. Up to this point, we have considered only the situation where ÷ N is a whole number consisting of three digits. Now suppose an output of 10.04 MHz is desired. This would require the VCO frequency to be 40.04 MHz and the ÷ N number to be 400.4. (The number 400.4 is referred to as ÷ N.F. The number 400 is represented by N, and the fraction .4 may be called F, or the fractional N.) Since the existing phase lock system will not allow ÷ N to be four digits, some additional circuits are needed to make the VCO operate at a frequency of 40.04 MHz, and at the same time provide a signal to the phase comparator equal to 100 kHz. Two of these circuits are the digital-to-analog converter (DAC) and pulse remove blocks added in Figure 8-9.

8-37. If the VCO operated at 40.04 MHz and ÷ N were 400, then the divided VCO signal to the phase comparator would be 100.1 kHz and would be compared to the 100.0 kHz reference. This would result in an increasing phase comparator charge current to the integrator. To compensate for this increased charge, the discharge current from the bias source is adjusted by means of Analog Phase Interpolation (API) information from the fractional N control IC. The phase (frequency) difference between 40.04 MHz and 40.00 MHz is accumulated digitally in the control IC and applied through five lines to a digital-to-analog converter. The D/A output current is subtracted from the bias current to discharge the integrator to the proper level during each sampling period, effectively cancelling the increased charge from the phase comparator.

8-38. Only part of the problem is solved, however, because if the PLL were to continue operating in this manner, the phase comparator output would continue to increase beyond practical limits. To prevent this, a "pulse remove" technique is used. In effect, the accumulated phase difference (in the Control IC) causes the ÷ N counter to count one extra cycle (÷ 401) each time the phase accumulator passes through unity. This has the effect of "removing" a cycle of VCO frequency, and the divided signal to the phase comparator is now an average of 100 kHz.

8-39. To accumulate the phase difference, the twelve least significant digits in a "frequency register" (contained in the Fractional N control IC) are added to

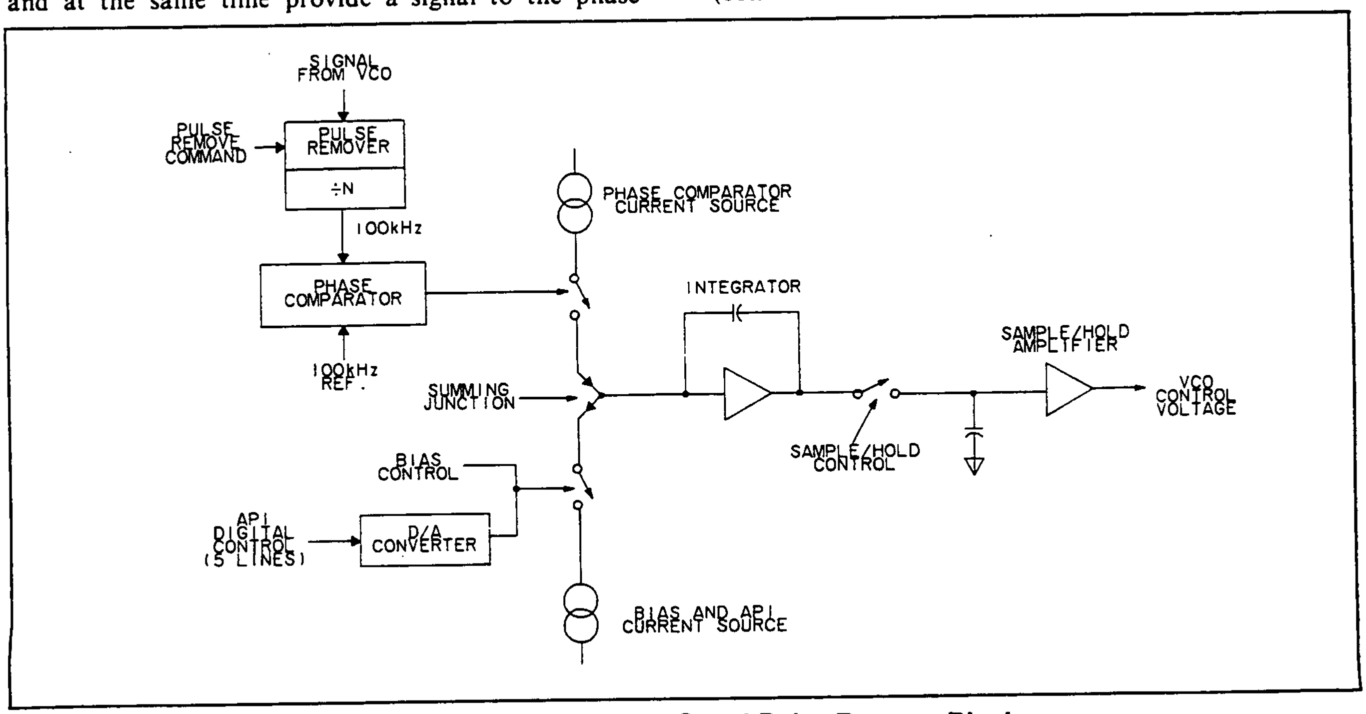


Figure 8-9. Addition of DAC and Pulse Remove Blocks.

the twelve digits in the phase accumulator, and the sum is stored again in the accumulator. This addition takes place every 10 microseconds (once for each cycle of the 100 kHZ reference). Figure 8-10 illustrates this process for the example we are using.

8-40. This example has used a fractional N of .4. If the output frequency were 10.004 MHz instead of 10.04 MHz, the fractional part would be .04, and both the phase comparator output and the phase accumulator content would increase at one-tenth the previous rate. As another example, if the output frequency were 10.09 MHz, the fractional N would be .9, and a pulse remove command would be required for 9 out of every 10 reference cycles.

8-41. Fractional N Counter. The ÷ N (Fractional N) counter consists basically of three presettable counters in series, shown in Figure 8-11. The counters for the two most significant digits (of the 3-digit ÷ N number) are decade counters. The least significant digit counter consists of a ÷ 5 counter and a ÷ 2 prescaler which can be made to divide by three as necessary. Presettable counters are used because ÷ N must be variable, as explained below.

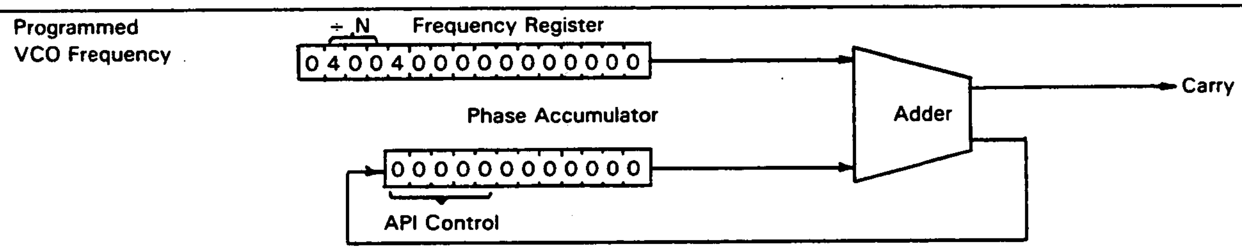
8-42. The preset number that is loaded into the counter is BCD (binary coded decimal) form is the 9's complement of the ÷ N number. N is determined by the first three digits of the VCO frequency.

	Example 1	Example 2
Sine wave output	10 000 000.0 Hz	100 000.0 Hz
Reference frequency	30 000 000.0 Hz	30 000 000.0 Hz
VCO frequency	40 000 000.0 Hz	30 100 000.0 Hz
÷N	40 0	30 1

To determine the 9's complement, ÷N is subtracted from 999 in the fractional N control IC.

	999	999
÷N	400	301
9's complement	599	698

8-43. The ÷ N counter begins at the preset number (599 in example 1), counts to 999 and then reloads the same number unless a new frequency has been programmed. One output pulse occurs for each time the counters reach 999; consequently, if 400 VCO cycles (599 to 999) are counted for every output pulse, VCO has been divided by 400. The output pulse is derived from the bias pulse issued by the fractional N control IC. To provide the proper stable phase relationship to the VCO signal, this



0 0 0 0 0 0 0 0 0 0 0 0 = Accumulator (Initial)
0 4 0 0 4 0 0 0 0 0 0 0 0 0 0 0 = VCO Frequency

4 0 0 0 0 0 0 0 0 0 0 0 = Sum (returned to accumulator)

0 4 0 0 4 0 0 0 0 0 0 0 0 0 0 0 = VCO

8 0 0 0 0 0 0 0 0 0 0 0 = sum

0 4 0 0 4 0 0 0 0 0 0 0 0 0 0 0 = VCO

(1)2 0 0 0 0 0 0 0 0 0 0 0 = sum + carry

0 4 0 0 4 0 0 0 0 0 0 0 0 0 0 0 = VCO

6 0 0 0 0 0 0 0 0 0 0 0 = sum

0 4 0 0 4 0 0 0 0 0 0 0 0 0 0 0 = VCO

(1)0 0 0 0 0 0 0 0 0 0 0 0 = sum + carry

Each carry initiates a pulse remove command.

Figure 8-10. Phase Accumulation.

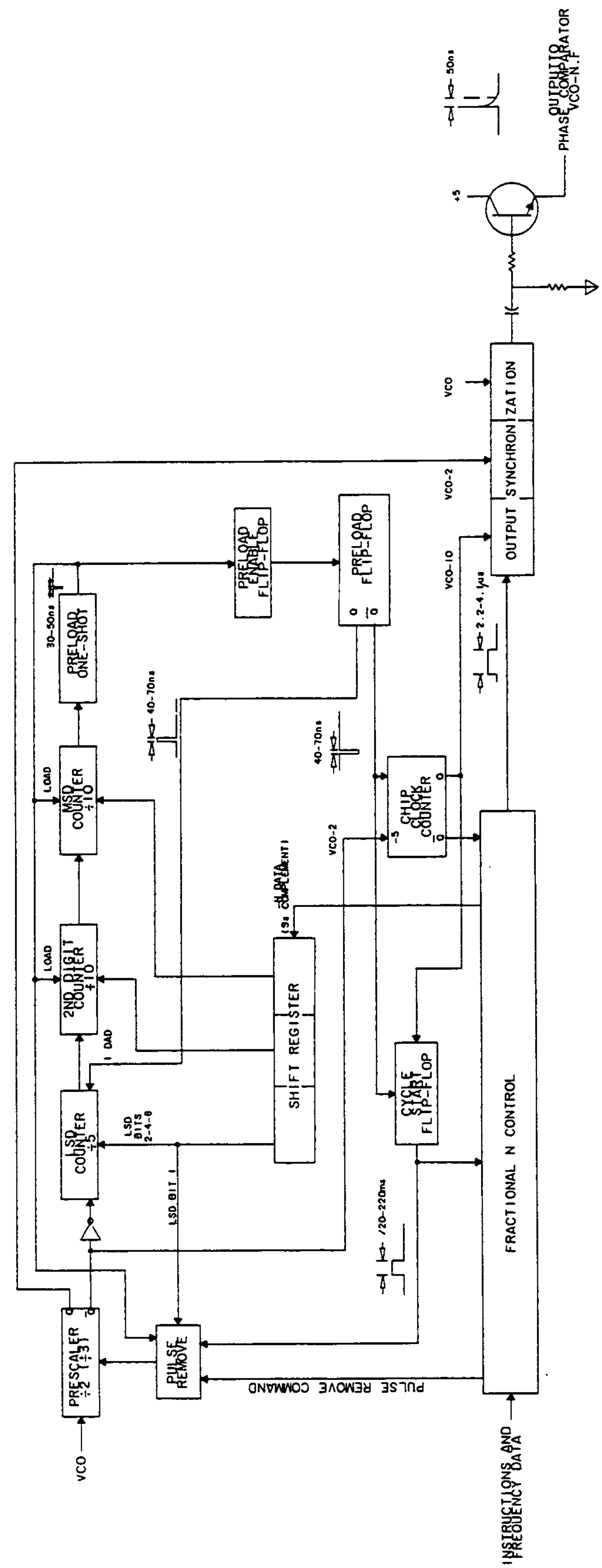


Figure 8-11. Divide by N Counter.

pulse is clocked first by VCO ÷ 10, then VCO ÷ 2, and finally by VCO.

8-44 In example 2, ÷ N is 301, so the counter must count 301 VCO cycles during each reference period. Normally only an even number of cycles could be counted because the least significant digit ÷ 5 counter is counting VCO ÷ 2 from the prescaler. Therefore, in order to count an odd number, the prescaler is forced to count one additional pulse during each reference period. To accomplish this, the pulse remove circuits are enabled when the least significant (BCD) bit of the least significant digit of the preset number is even, as is the case in example 2 (decimal 8 = binary 1000). Then the negative-going pulse from the preload one-shot changes the prescaler to ÷ 3 for one cycle. The pulse remove action associated with fractional N is independent of and in addition to the odd number count.

8-45. The chip clock counter output (Figure 8-11) is the prescaler output divided by five. The $\overline{Q}$ output from this counter goes to the fractional N control IC and is used to clock data in and out of the four shift registers within the IC. The counter Q output is used in the ÷ N.F counter output synchronization and to clock the cycle start flip-flop.

8-46. The cycle start flip-flop is set by the $\overline{Q}$ output from the preload flip-flop and is cleared by the next trailing edge of the chip clock signal. A cycle start pulse occurs at the time the ÷ N least significant digit is preloaded, which is once every reference period. Cycle start is used to initiate operations within the fractional N control IC. It is also used to set the pulse remove circuit when ÷ N is an odd number.

8-47. Reference Circuits (Service Group G).

8-48. Reference Oscillator. The Reference Oscillator is a 30 MHz crystal-controlled oscillator that can be synchronized to an external reference signal of 10 MHz or subharmonic of 10 MHz (minimum 1 MHz).

8-49. External Reference Phase Lock Loop. Figure 8-12 is a block diagram of the External Reference Phase Lock Loop. The external reference input is sent thorugh a squaring circuit, amplified, and then differentiated to provide a narrow positive pulse to the gate of a FET switch. This turns the switch on momentarily, sampling the instantaneous voltage of the sine wave at the FET switch source. This voltage is stored on the capacitor at the input of a Sample/Hold amplifier. The resulting dc output voltage from the S/H amplifier is applied to a varactor in the 30 MHz oscillator circuit to adjust the oscillator frequency.

8-50. When the 30 MHz oscillator is in phase with the external reference, the FET switch will sample the sine wave at exactly the same point each time and the S/H amplifier output voltage will remain constant. But if there is a change in phase relationship, the amplifier output voltage will change, correcting the oscillator frequency and restoring phase lock.

8-51. External Reference Detector. Whenever an external reference input is present, a detector circuit provides a logical "1" signal to the control circuits. This causes the front panel EXT REF indicator to light.

8-52. Unlock Detector. When the external reference loop is phase locked, the Sample/Hold amplifier output is a steady dc voltage. However, if the loop is not locked, this voltage will vary. The unlock detector is triggered by this varying voltage to provide a logical "1" to the control circuits. During an "unlock" condition, the front panel EXT REF indicator will flash on and off.

8-53. 30 MHz Reference Amplitude. Sine wave output amplitude and amplitude modulation are controlled by varying the amplitude of the 30 MHz Reference. Figure

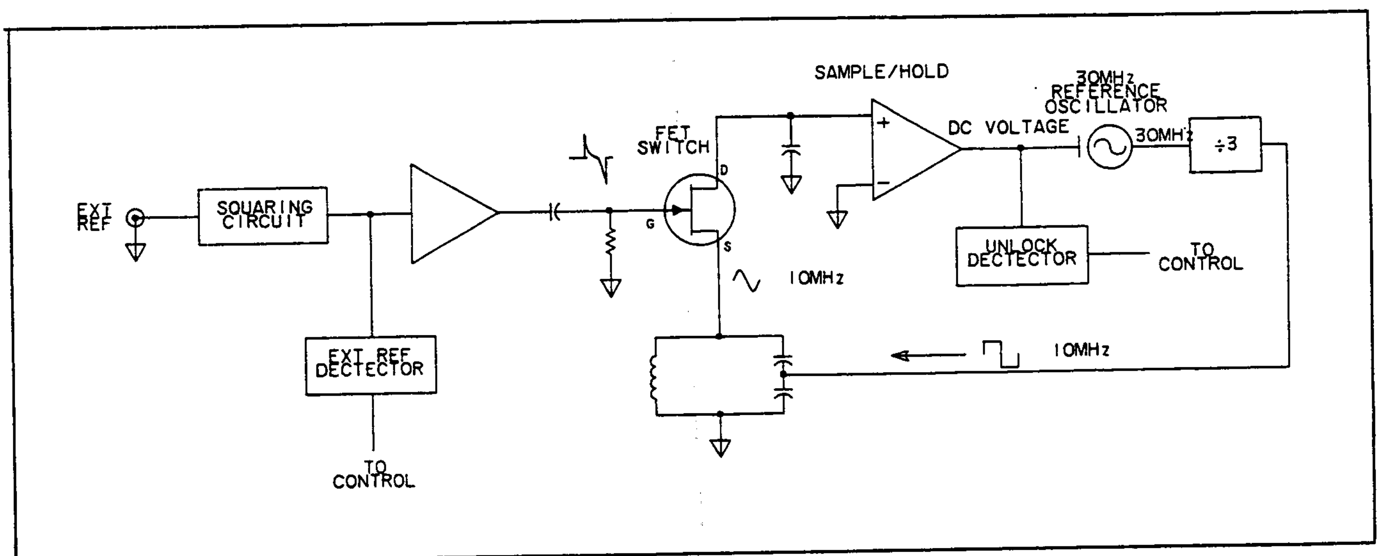


Figure 8-12. External Reference Phase Lock Loop Block Diagram.

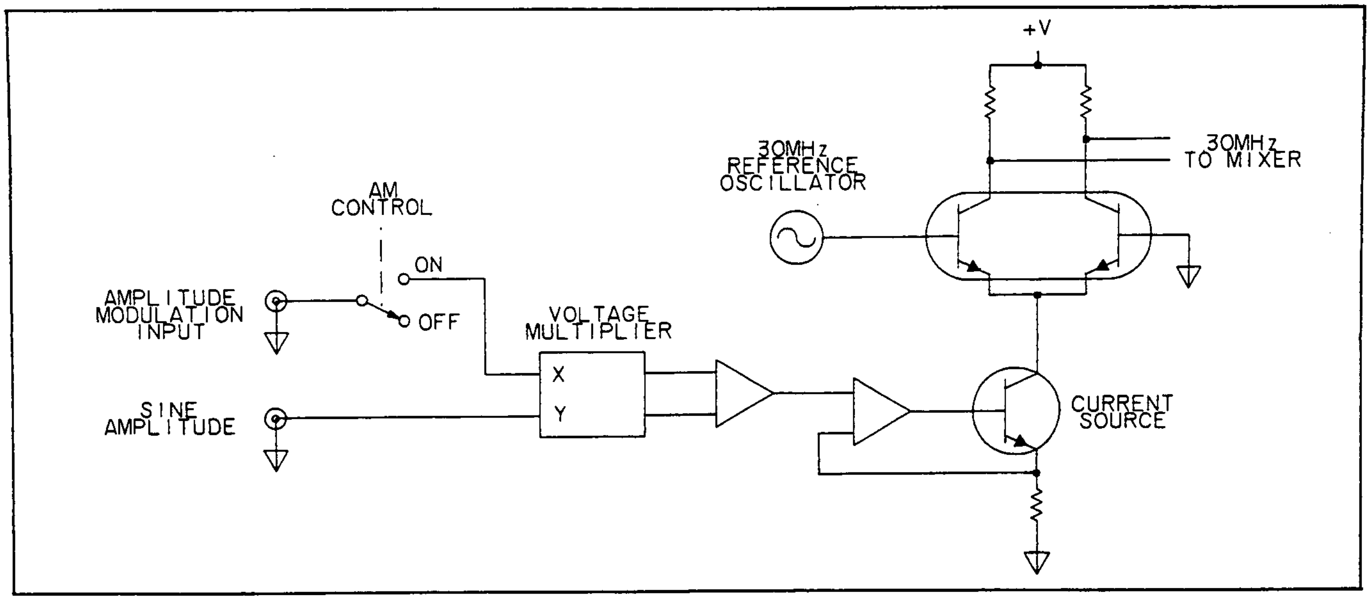


Figure 8-13. Level Control and Amplitude Modulation.

8-13 is a simplified diagram of the level control and amplitude modulation circuits. The reference signal amplitude is varied by controlling the current available from the current source (Figure 8-13), which in turn is controlled by the Sine Amplitude signal and/or the Amplitude Modulation input signal. When the AM Control switch is OFF, the X input to the voltage multiplier is constant, and the output level is controlled by the Sine Amplitude only. When the AM switch is ON, however, both the X and Y inputs influence the output. The output of the multiplier (V_0) is normally equal to .1XY, but because the multiplier output is connected to an operational amplifier input, this voltage cannot be measured. Use of the voltage multiplier in this circuit makes it possible to change the 3325 output (carrier) amplitude without affecting the percent of modulation, or to change the percent of modulation without affecting the carrier level. The output of the Level Control and Amplitude Modulation circuit goes to the Mixer, covered in Service Group H.

8-54. Reference Dividers. The 30 MHz Reference frequency is reduced through a series of dividers to provide the following signals:

10 MHz to the External Reference PLL
2 MHz to the D/A Converter (Service Group I)
1 MHz rear panel reference output
100 kHz reference to the Fractional N Phase Comparator (Service Group F)

For phase stability, the 100 kHz output is clocked first by 10 MHz, then by the 30 MHz reference signal. The 100 kHz signal is then differentiated to provide a narrow pulse to the Fractional N Phase Comparator.

8-55. Mixer (Service Group H).

8-56. The Mixer circuits are diagrammed in Figure 8-14. The 30 MHz reference is passed through a low pass filter and mixed with the 30-50 MHz signal from the VCO in a diode mixing circuit. The mixing circuit output is applied to a low pass filter to remove all but the difference frequency, which is amplified by a current amplifier. This signal then goes to the Function circuits (Paragraph 8-59).

8-57. D/A Converter (Service Group I).

8-58. The Digital-to-Analog (D/A) Converter supplies the analog voltages which control signal amplitude, dc offset, level comparator reference voltage, sweep X drive output, and correct for dc offset error. In addition, it supplies an auto zero voltage to its own current sources.

8-59. Preset Counters. Each of the four Preset Counters is a BCD counter that can be pre-loaded with a 4-digit binary number and then enabled to count from that point. In this application, they are set to count down. The counters are connected in two pairs, as illustrated by the least significant pair in Figure 8-15. Both counters are loaded at the same time, then the Least Significant Digit (LCD) Counter is enabled by the Counter and Current Source Enable Flip-Flop; and at the same time, the LSD Current Source is enabled to supply current to the DAC Integrator (see Figure 8-16). When the LSD Counter reaches zero, its Ripple Clock output enables the 3rd Digit Counter to count one clock pulse. If the preset number in the 3rd Digit Counter was greater than one, the LSD Counter continues to count, supplying an enable pulse to the 3rd Digit Counter each time it reaches zero. When the 3rd Digit Counter reaches zero, its Ripple Clock output changes the state of the Counter and Current Source flip-flop, disabling the LSD Counter and the Current Source.

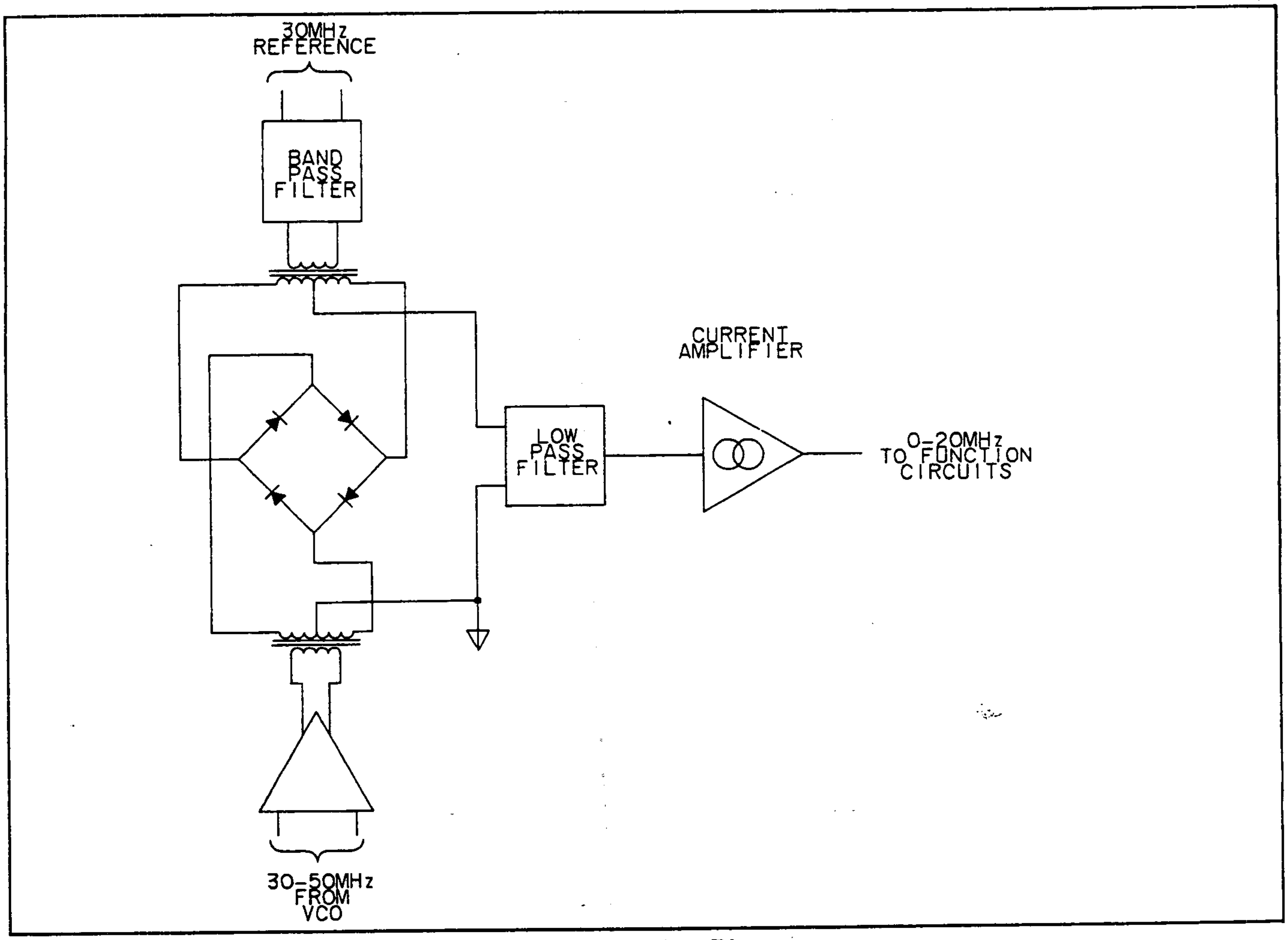


Figure 8-14. Mixer Diagram.

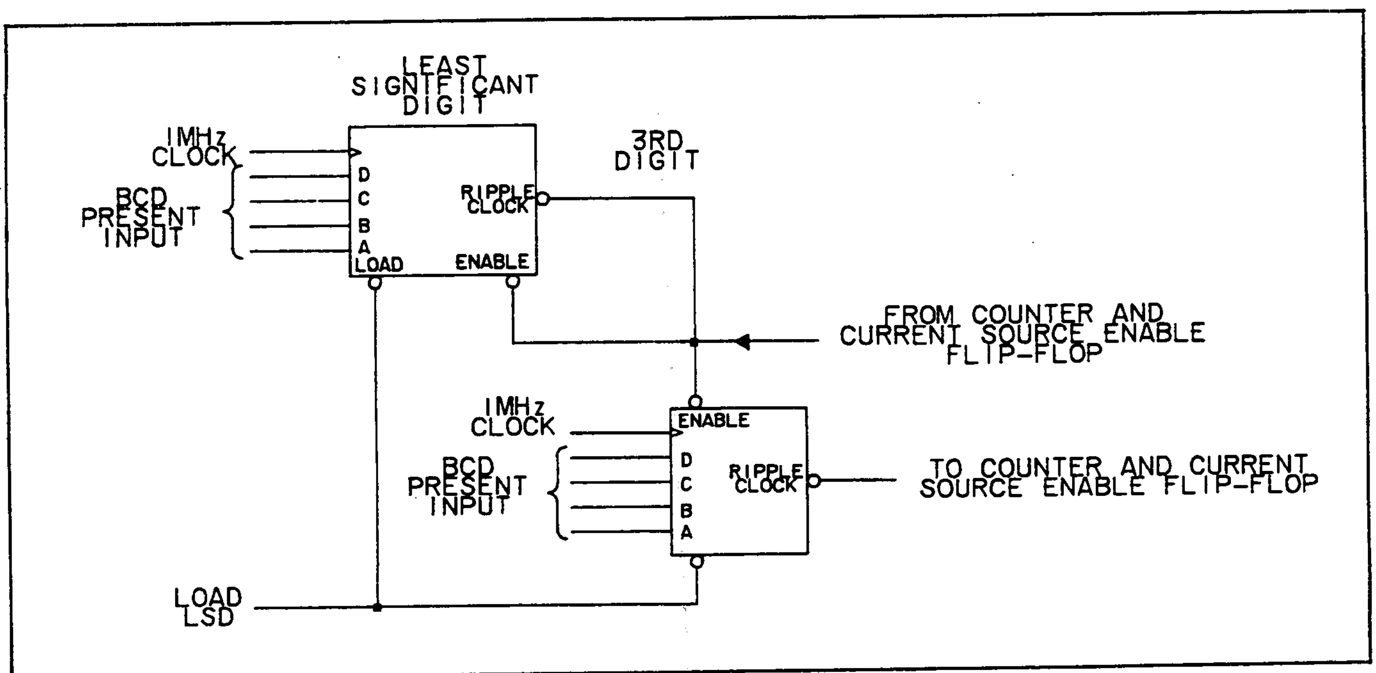


Figure 8-15. Preset Counters.

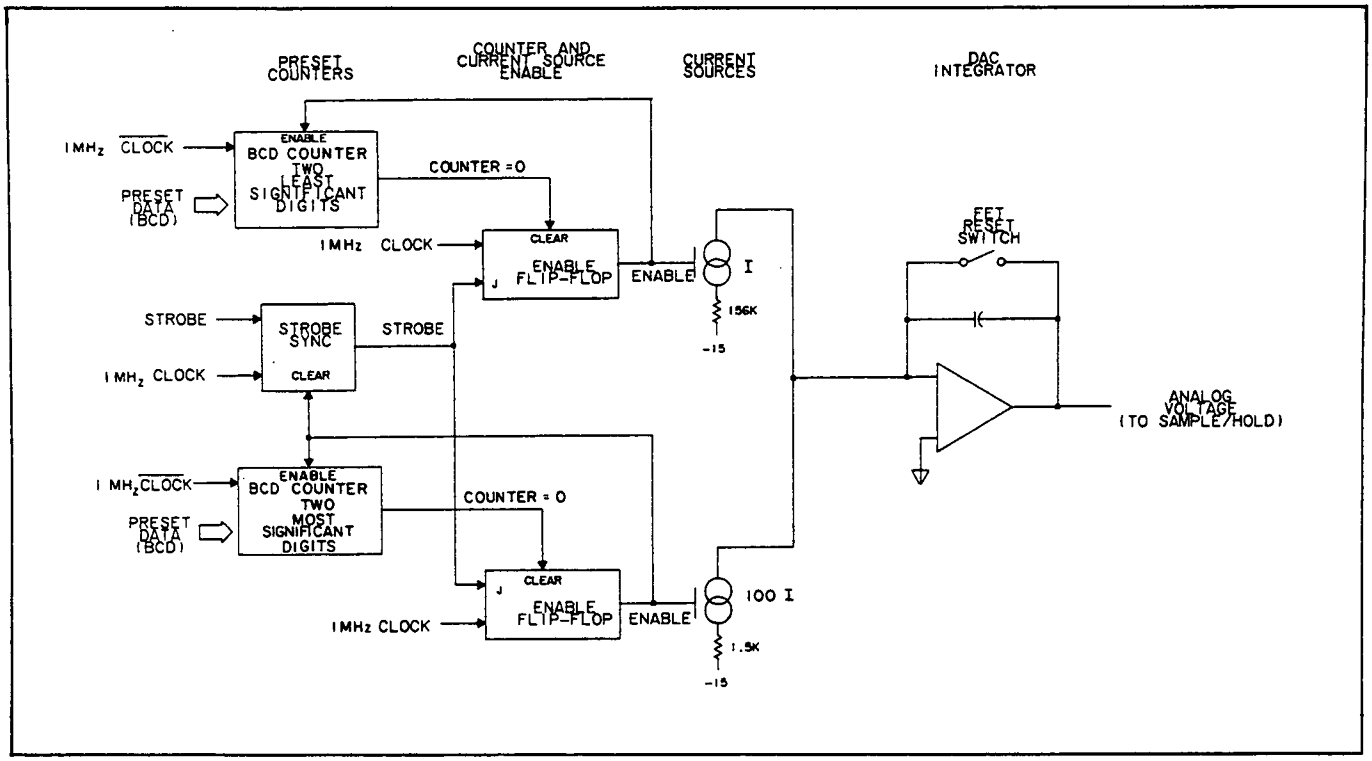


Figure 8-16. Digital-to-Analog Converter.

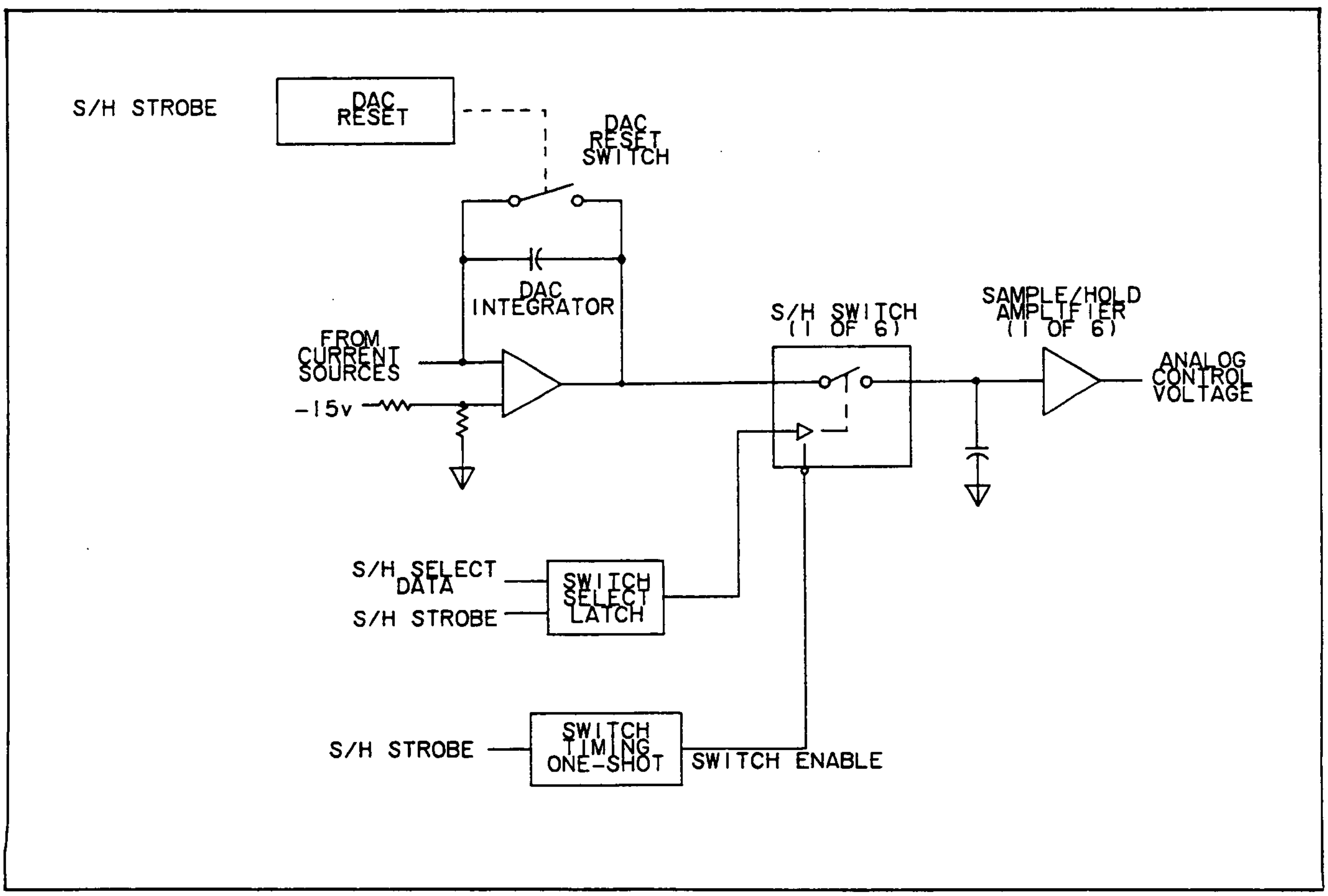


Figure 8-17. DAC Sample/Hold.

8-60. 4-Digit D/A Conversion. A simplified diagram of the D/A Converter is shown in Figure 8-16. The D/A Converter (DAC) Integrator output voltage is proportional to the four digits of BCD information that is loaded into the Preset Counters. The two current sources are enabled to supply constant current to the DAC Integrator for the length of time required for the Preset Counters to count down from the preset number to zero. The current resulting from the two most significant digits is proportionally 100 times that from the two least significant digits. For example, if the 4-digit preset number were 5555, the enable time would be the same for both current sources, but the current ratio would be 100 to 1.

8-61. DAC Sample / Hold Circuits. After the Preset Counters have finished counting and the current sources are disabled, the DAC Integrator output voltage must be transferred to the proper Sample / Hold Amplifier. Figure 8-17 is a simplified diagram of the DAC Sample/Hold circuits. The data that designates one of the six Sample/Hold Amplifiers is clocked into the latch by the S/H Strobe pulse. The S/H Strobe pulse also triggers a switch timing one-shot which enables the switches to close long enough to transfer the DAC Integrator voltage to the capacitor at the input to the S/H Amplifier.

8-62. DAC Reset. After the integrator output voltage has been transferred to the proper Sample / Hold Amplifier, the integrator is reset to zero by closing a FET switch across the integrator capacitor. The closing of this switch is timed by a one-shot which is triggered by the S/H Strobe pulse.

8-63. Function Circuits (Service Group J).

8-64. This section of the instrument provides the proper current to the operational output amplifier for each function. It includes a number of current sources, and the circuits which develop the square wave, triangle, and ramp functions from the sine wave. Function switching is accomplished by the enable signals shown in the block diagram, Figure 8-18.

8-65. Sine Wave. In sine function, the sine wave from the mixer passes through a current amplifier to the output amplifier. Sine wave amplitude is actually controlled in the level control circuits (see Paragraph 8-73), but the level control current is supplied from the amplitude control current source in this section.

8-66. Square Wave. The sine wave input is sent through a squaring circuit and then divided by two to produce the square wave output. Consequently, in the square wave function, the sine wave must be twice the output frequency, and the maximum output frequency is 10 MHz.

8-67. Triangle. To generate a triangle wave, the sine wave input is first put through the squaring circuit, then divided by 20 (÷10 and ÷2). The result is a square wave whose frequency is 1 MHz plus the programmed output frequency. This signal is phase compared to a 1 MHz reference in an exclusive OR gate. Because the output of the gate is high when one and only one input is high, the gate output is a series of pulses whose width varies in proportion to the phase difference between the two gate input signals. Figure 8-19 is a simplified illustration of this. The gate output drives a current amplifier (which inverts the signal) and the resulting current pulse signal is sent through a filter which shapes the triangle.

8-68. The triangle output frequency is the difference between the 1 MHz reference and the input frequency (from the mixer) divided by twenty. Consequently, the input frequency must be 20 MHz + (20 x output). To produce the maximum triangle output frequency of 10 kHz, for example, the input must be 20.2 MHz.

Output frequency	=	10 000 Hz
Reference	=	1 000 000 Hz
		1 010 000 Hz
	×	20
Input frequency	=	20 200 000 Hz

8-69. Positive and Negative Ramp. A ramp output is generated in the same manner as the triangle, except that when the phase difference between the 1 MHz reference and the input ÷20 has advanced 180°, the reference is inverted by the ramp reset circuits (Figure 8-18). Figure 8-20 illustrates the ramp generation process. Because the phase difference is allowed to advance only 180° instead of 360° as in triangle generation, the frequency of the "input ÷ 20" signal to the phase comparison gate must be 1 Mhz plus one-half the output frequency. For the maximum ramp output frequency of 10 kHz:

Output frequency	=	10 000 Hz
÷2	=	5 000 Hz
Reference	=	1 000 000 Hz
		1 005 000 Hz
	×	20
Input frequency	=	20 100 000 Hz

8-70. Ramp reset may be initiated either by the phase detector output (Figure 8-18) or by a + or − ramp reset signal from peak detectors at the output amplifier. Each reset pulse causes the reference signal to be inverted at the output of the ramp reset gate.

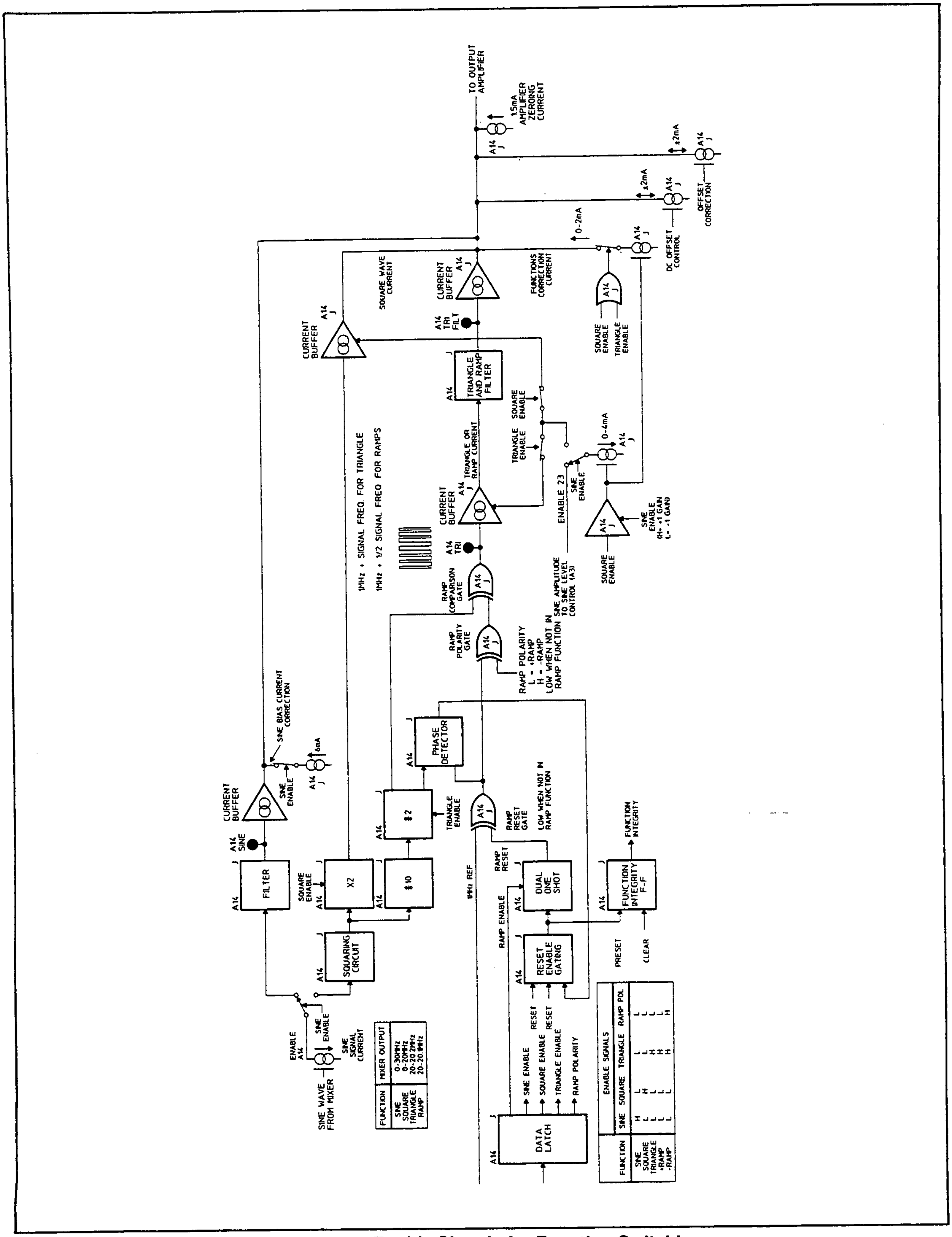


Figure 8-18. Enable Signals for Function Switching.

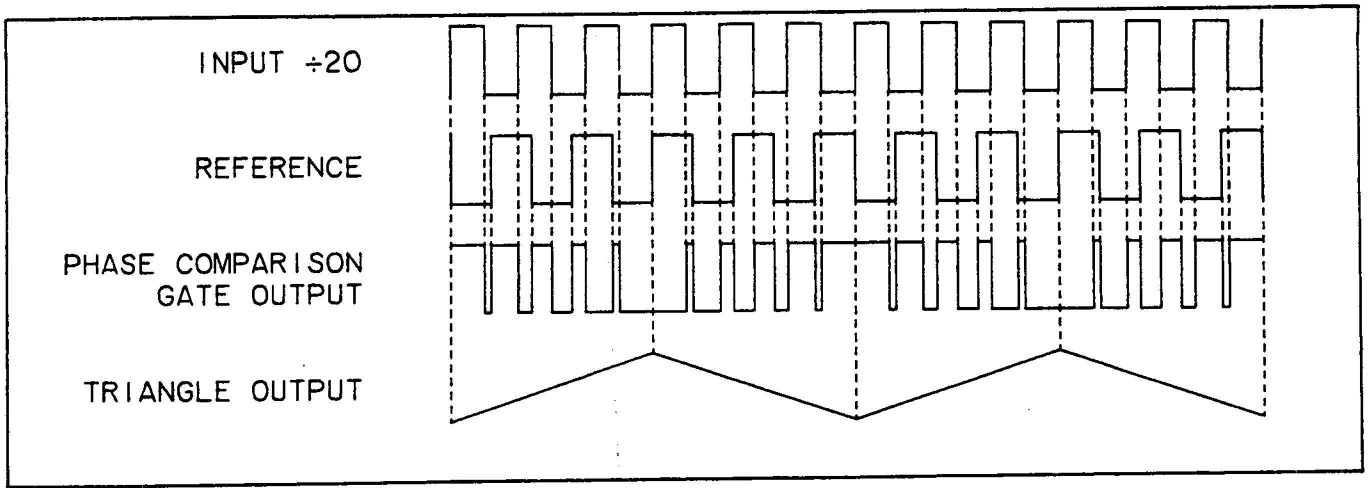


Figure 8-19. Simplified Illustration of Triangle Generation.

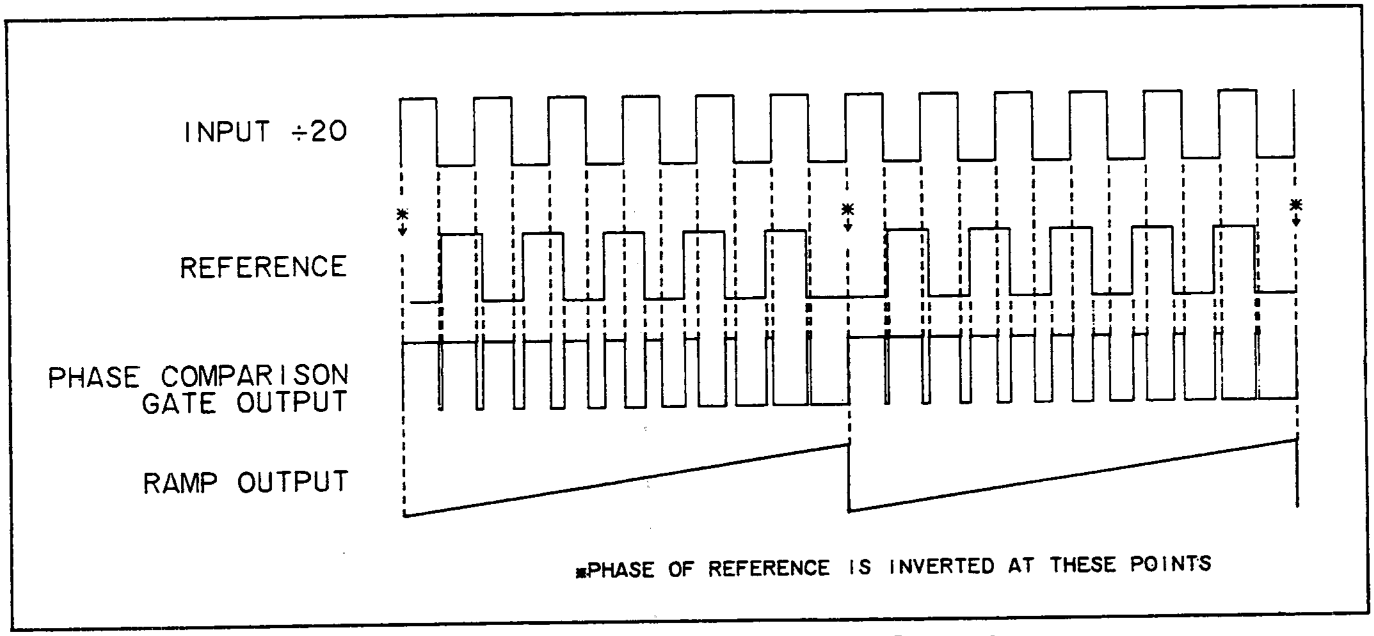


Figure 8-20. Simplified Illustration of Ramp Generation.

8-71. Ramp polarity is determined by the ramp polarity gate. If negative ramp is programmed, the reference signal is inverted by this gate.

8-72. **Function Integrity Flag.** If the ramp is being reset by the digital Phase Detector, the detector output sets the Function Integrity Flip-Flop, and the Function Integrity Flag (MD2) to the processor is high. If the ramp is being reset by the analog Level Comparator at the amplifier output (see Paragraph 8-78), the analog reset signal prevents the Function Integrity Flip-Flop from being set. The controller may reset the Function Integrity Flip-Flop. The Function Integrity Flag tells the processor which ramp reset method (analog or digital) is being used. This information is used by the processor in setting the correct reference level for the output Level Comparator. Ramps are reset by the digital Phase Detector at frequencies below 100 Hz, and by the analog output Level Comparator at frequencies of 100 Hz and higher.

8-73. **Amplitude and Offset Control.** The voltage output of the output amplifier is proportional to the current into its input summing junction. Consequently, signal amplitude can be controlled by varying the amount of current available from the current source which supplies the various functions. The amplitude control signal is a dc analog voltage from a D/A converter (see Paragraph 8-57) which receives its digital input from the controller.

8-74. Because the square wave, triangle, and ramp signals are generated by switching the unipolar amplitude control current source on and off, the entire signal is above ground. These signals are centered about ground by a compensating current equal to one-half the signal amplitude. This current is labeled Functions Correction Current in Figure 8-18. After calibration, additional dc offset correction is added by the control circuits. This current is labeled Offset Correction in Figure 8-18.

8-75. Positive or negative dc offset can be programmed either with or without an ac signal. The offset current source is also controlled by a dc analog voltage from the D/A converter. The dc offset correction current source is also controlled by the D/A converter. The offset correction voltage is calculated from the results of the AMPTD CAL routine (see Paragraph 8-78).

8-76. Output Amplifier (Service Group K).

8-77. The Output Amplifier is an inverting operational amplifier that is designed for wide frequency response and low distortion. Its output stage is protected against excessive current by a 0.125 A fuse and against excessive voltage by diodes connected to the + and - 15 V supplies. Output resistance is 50 ohms.

8-78. Level Comparator and AMPTD CAL. During the amplitude calibration process (AMPTD CAL), the Level Comparator is used to determine the offset and signal amplitude errors of the 3325 output. To do this, the processor sets the signal amplitude to zero and varies the voltage of the "Level" input to the comparator to determine the dc offset in the amplifier output. The processor then sets the signal amplitude to 8 Vpp (with full attenuation) and proceeds to determine both the positive and negative peak voltages in a similar manner. From this information the processor computes the straight-line equations for the dc offset versus programmed amplitude and for the output amplitude versus programmed amplitude. Calibration FAIL codes 021 through 025 occur if the signal could not be adequately measured. The calibration constants then are reset to default values. Calibration FAIL codes 026 through 029 occur if the signal is successfully measured, but the processor determined that the calibration values were outside of recommended limits. In this case, the calibration values are left untouched.

8-79. The Level Comparator is also used to reset both the positive and negative-going ramps for frequencies of 100 Hz and higher. The "Level" voltage is set by the processor to the peak ramp voltage programmed. When the ramp and "Level" voltages are equal, a Ramp Reset pulse is generated by a one-shot and used to toggle a Ramp Reset flip-flop (see schematic in Service Group J). The ramp is then reset as explained in Paragraph 8-69.If the "Level" voltage is set incorrectly, the digital phase detector causes the ramp to be reset, and the Functional Integrity Flag to the processor to be high (see Paragraph 8-72). The processor then adjusts the "Level" voltage until the Level Comparator output resets the Function Integrity Flag, indicating that the ramp is being reset by the Level Comparator. This ramp "loop level" process is disabled when the frequency is being swept or modulation is enabled.

8-80. Sync Comparator and Driver. The amplifier output waveform is one input to the Sync Comparator and the other input is the DC Offset voltage level. If no dc offset has been programmed, the DC Offset voltage is zero and the comparator output changes at zero volts. This results in a Sync square wave whose transition occurs at zero volts crossing of the output signal. It follows, then, that the Sync signal transition occurs whenever the output signal crosses the DC Offset voltage, when an offset has been programmed. The Sync signal then is passed through buffer circuits to the front panel. The Sync signal is also passed through the FAST™ Sync Converter to the rear panel.

8-81. FAST Sync Converter. The FAST Sync Converter circuit on the Power Supply assembly combines the 19 to 60 MHz auxiliary signal generated on the A3 assembly with the 0 to 21 MHz sync signal generated on the A14 assembly. Only one of these inputs are active. The exclusive-or gating allows the active signal to pass through to the FAST Sync Output. A 0.25A fuse protects the FAST Sync circuitry from excessive current.

8-82. Q810 and Q820 act as amplifier and level shifter for the ac coupled 0.6 Vpp auxiliary signal. The resulting TTL signal is sent to U832 where it is gated with the TTL sync signal from the output amplifier. U830 is a 30Ω totem pole line driver capable of driving a standard 50Ω cable. The fast rise times normally require precise terminations, but the RC filter at the output slows the edges just enough to prevent undesirable reflections (e.g., ringing and double triggering) with open circuit terminations. Placing a 50Ω load on the output further improves reflection problems, but it decreases the signal amplitude to a level that may be just below valid TTL levels.

8-83. Attenuator (Service Group L).

8-84. Relay Drivers. Refer to the schematic diagram in Service Group L. Relay selection data is provided by the lines labeled K0 through K7 and is stored in the D flip-flops of A14U49. This information is obtained from the Machine Data Bus through A14U29 (see Service Group I). Seven of the relay driver circuits are contained in one integrated circuit package, and the eighth is a discrete transistor circuit. Current through the relay coils is limited by the Q77, Q78 circuit. Because latching relays are used, continuous current is not required. Therefore, after a relay has been switched, the driver can be turned off by the K0-K7 information. The D flip-flops are clocked at the proper time by a signal that is also decoded in A14U27 from the Machine Bus data.

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8-85. Attenuators Relays and Pads. Relay K1, K2, and K3 control the output signals attenuation. Table 8-1 shows the voltage ranges, both with and without dc offset and the relays and attenuation factors involved. The output relay, K4, switches the output to the front or rear panel in a standard instrument and switches the High Voltage amplifier in or out in Option 002 instruments.

Table 8-1. Attenuation and Voltage Ranges.

Range	Attenuation Factor	Attenuator Relay In	Amplitude (Peak-to-Peak, 50 Ω) AC Only (No Offset)	Amplitude (Peak-to-Peak, 50 Ω) AC (With Offset)	Maximum Offset (+ or −)	Minimum Offset (+ or −)	DC Only (+ or −)
1	1	None	10.00 V to 3.000 V	9.998 V to 1.000 V	0.001 V to 4.500 V	1.000 mV	4.500 V to 1.500 V
2	3	K3	2.999 V to 1.000 V	999.9 mV to 333.4 mV	1.166 V to 1.499 V	0.100 mV	1.499 V to 0.500 V
3	10	K2	999.9 mV to 300.0 mV	333.3 mV to 100.0 mV	333.3 mV to 450.0 mV	0.100 mV	499.9 mV to 150.0 mV
4	30	K2, K3	299.9 mV to 100.0 mV	99.99 mV to 33.34 mV	116.6 mV to 149.9 mV	0.010 mV	149.9 mV to 50.00 mV
5	100	K1	99.99 mV to 30.00 mV	33.33 mV to 10.00 mV	33.33 mV to 45.00 mV	0.010 mV	49.99 mV to 15.00 mV
6	300	K1, K3	29.99 mV to 10.00 mV	9.999 mV to 3.334 mV	11.66 mV to 14.99 mV	0.001 mV	14.99 mV to 5.000 mV
7	1000	K1, K2	9.999 mV to 3.000 mV	3.333 mV to 1.000 mV	3.333 mV to 4.500 mV	0.001 mV	4.999 mV to 1.500 mV
8	3000	K1,K2,K3	2.999 mV to 1.000 mV				1.499 mV to 0.001 mV

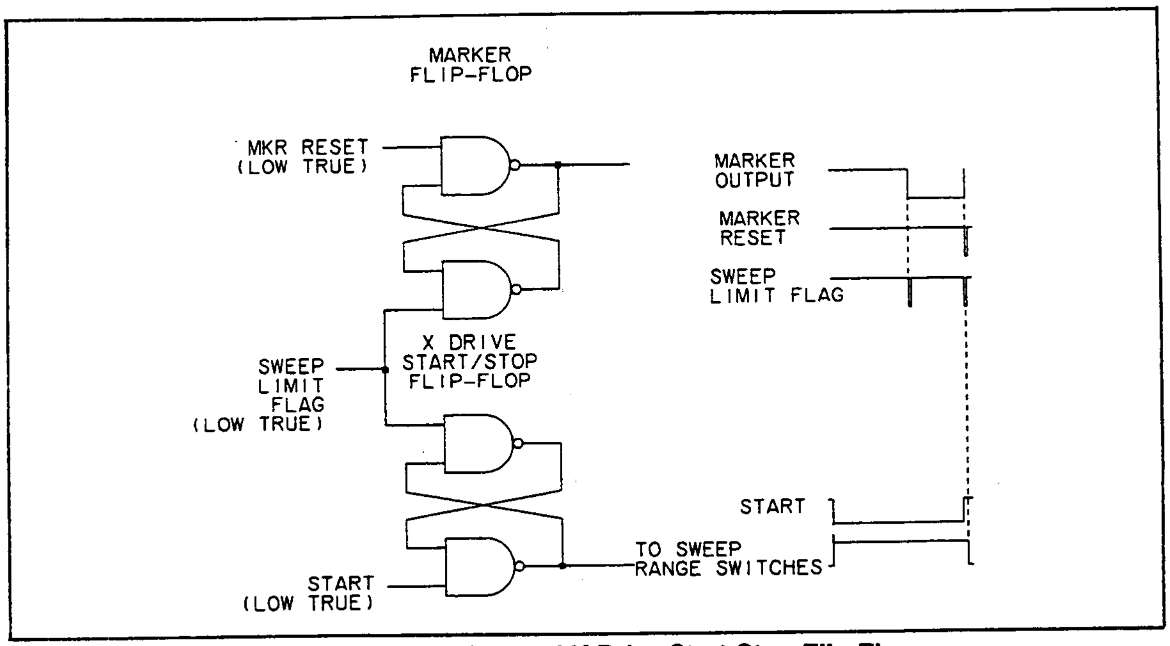


Figure 8-21. Marker and X Drive Start-Stop Flip-Flops.

8-86. Crystal Oven Option 001 (Service Group M).

8-87. AC power for the Crystal Oven is supplied by a separate winding on the instrument power transformer. Consequently, power is supplied to this assembly at any time ac power is applied to the instrument. A +15 V regulator provides dc power to the Crystal Oven. The oven output frequency is 10 MHz. It is capacitively coupled to the rear panel output connector.

8-88. High Voltage Output Option 002 (Service Group M).

8-89. The High Voltage Output Amplifier is non-inverting and has a gain of two. It is designed for operation over a bandwidth of 0 to 1 MHz. The output is current-protected by a 0.25 A fuse, and voltage-protected by diodes to the + and - 30 V supplies. Output resistance is essentially zero. Plus and minus 30 V regulators which supply power for this amplifier are a part of the option. Input power for these supplies is provided from a separate winding on the instrument power transformer; consequently, these supplies are on at any time ac power is connected to the instrument.

8-90. Sweep Drive Circuits (Service Group N).

8-91. The Sweep Drive Circuits provide three output signals that can be used in oscilloscope, plotter, and similar applications: Z Blank, Marker, and X Drive.

8-92. Z Blank. The Z Blank output voltage levels are TTL compatible. This signal goes low at the start of a linear or log single sweep, high at the end of the sweep, and remains high until the start of another sweep. For continuous sweep, Z Blank is low during sweep up and high during sweep down. The Z Blank output circuit is capable of sinking current through a relay or other device. The maximum ratings are:

Maximum current sink: 200 mA, fused at .25 A
Allowable voltage range: 0 V to +45 V dc
Maximum power (voltage at output x current): 1 W

8-93. Marker Output. A Marker output pulse occurs only during linear sweep up, either single or continuous sweep. The NAND gate flip-flop that produces this output is shown in Figure 8-21. The output is high at the start of a sweep up, then the Sweep Limit Flag input goes low at the Marker frequency, changing the flip-flop output to low. Immediately following a sweep up, the Marker Reset input goes low, resetting the flip-flop output to high.

8-94. X Drive. The output of the X Drive Start/Stop flip-flop (Figure 8-22) is set high by the low true Start signal and is returned to low by the Sweep Limit Flag pulse that occurs at the end of the sweep. The Start signal remains low until just before the end of sweep to prevent the Sweep Limit Flag pulse that sets the Marker flip-flop from also changing the X Drive flip-flop. The marker frequency and stop frequency points must be separated by approximately 400 microseconds to allow time

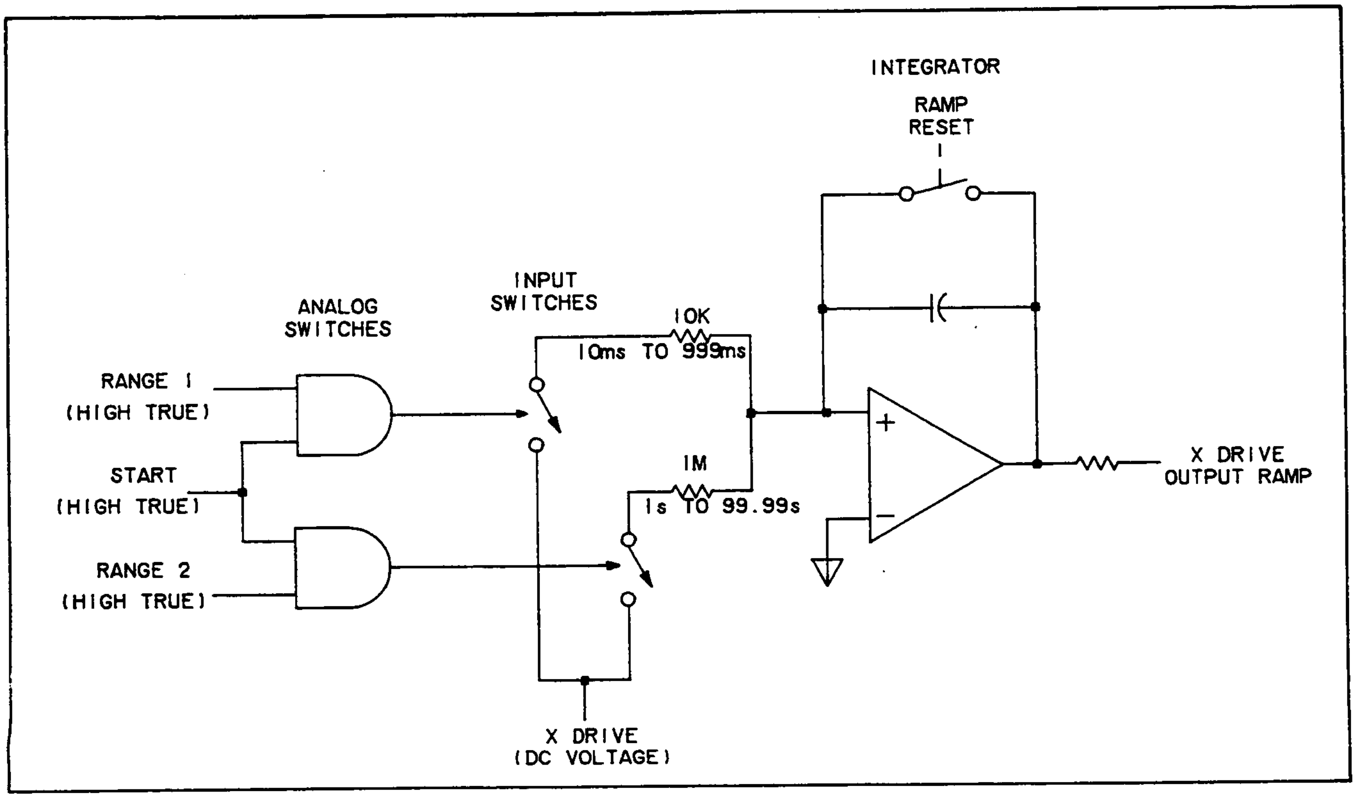


Figure 8-22. X Drive Ramp Output.

between the two Sweep Limit Flags for the control circuits and Fractional N IC to return the Start signal to high and process the information for the stop frequency.

8-95. The high output from the Start/Stop flip-flop is used to turn on one of two analog switches, depending upon which Range signal is high. Range 1 is high for sweep times of 0.01 second to 0.999 second, and Range 2 is high for times of 1 second to 99.99 seconds. As illustrated in Figure 8-22, each analog switch turns on a switch for the duration of the sweep, providing current to an integrator whose output is the X Drive ramp. The value of the current to the integrator depends upon the X Drive analog voltage and the resistance in the integrator input circuit. The resistances are fixed at 10 kΩ for Range 1 and 1 MΩ for Range 2. The value of the X Drive voltage is supplied from the Digital-to-Analog Converter (DAC) and Sample/Hold circuits (see Paragraph 8-57) and is calculated by the control circuits to provide the proper current to increase the X Drive Output Ramp from 0V to +10V during the sweep time selected.

8-96. Following a single sweep, the X Drive ramp remains essentially at 10V until reset prior to the start of another sweep. (This voltage will drift downward less than 10 mV/sec.) During continuous sweep, the ramp is reset at the start of sweep down. The reset switch is a FET connected across the integrator capacitor. The Ramp Reset pulse is initiated at the proper time by the control circuits.

8-97. Modulation Source Circuits (Service Group N)

8-98. The modulation source signal is generated by an 8-bit Digital-to-Analog Converter (DAC) from a waveform stored in the Modulation Waveform RAM. Figure 8-23 is a block diagram of these circuits.

8-99. Address Counter: U203, U204, and U206 form a 12-bit down counter that sequences through the addresses, and thus through the waveform stored in RAM U207. Each MODCLK clock cycle causes this counter to decrement. When the counter reaches 0, the /ZERO signal causes the counter to be re-loaded with the address stored in the Start Address Latches, U201 and U202. The Start Address Latch value determines the length of the waveform.

8-100. Digital-to-Analog Converters: DAC U209 converts the 8-bit waveform data into an analog current that is converted to a voltage by operational amplifiers U217A and U217B. U208 is a multiplying DAC that controls the amplitude. It multiplies the waveform by the amplitude value that U212 latched on to.

8-101. Loading the Waveform into RAM: The processor first activates MODLOAD, then writes the waveform into RAM. The processor address goes directly through the Start Address Latch and the RAM address counter in this mode. The highest address must be written last to initialize the Start Address Latch.

8-102. Modulation Source Frequency: Since the MODCLK signal is generated by dividing the processor clock by an integer, it can create only a limited set of frequencies (unlike the Fractional-N circuits on the A21 assembly). To overcome this limitation when sine waves are selected, the waveform RAM is loaded with more than 1 cycle of the waveform. For example, since multiples of 1 kHz are not available, 1 kHz sine waves are created by writing 10 cycles of a sine wave into 3072 points of the RAM, and clocking the system at 307200 Hz, which is available.

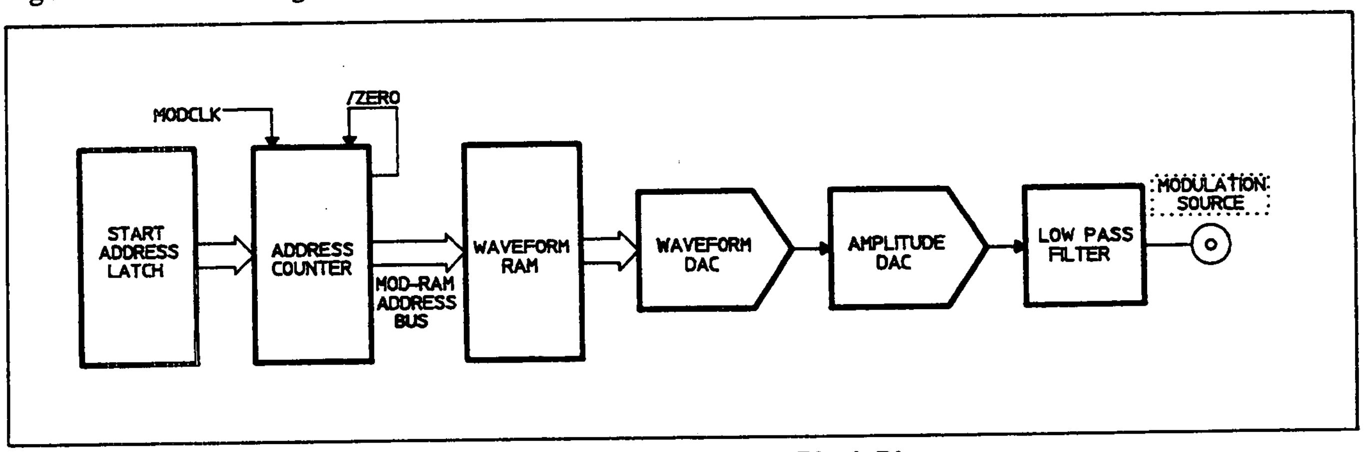


Figure 8-23. Modulation Source Block Diagram.

8-103. Power Supplies (Service Group O).

8-104. All three regulators, +5V, +15 and -15V (shown in the schematic diagram is Service Group O), are voltage and current controlled. Each regulator has a voltage sense connection. If the voltage at the load is too low, for example, this sense voltage feedback causes the regulator to adjust its output to the correct voltage. If the output current increases excessively (because of a short circuit, for example) the voltage drop across the current sensing resistance causes the active device in the current sensing circuit to limit the current through the series pass regulator.

8-105. When the front panel POWER switch is in the STANDBY (⏻) position, the three main power supply regulators are disabled. Power to the FAST Sync converter and Interface circuits is also disabled. However, power is still applied to the Oven Assembly (Option 001) and the High Voltage Output Amplifier (Option 002). These circuits have their own regulators, which are active at any time ac power is connected to the instrument.

8-106. When the POWER switch is in the STANDBY (⏻) position, as shown in the simplified schematic of Figure 8-24, a positive voltage is applied through the relay coil, K641, to the emitter of Q390. This biases Q390 into conduction. The current is limited by resistors R650, R390, and R391 so that the relay is not activated. Q301 is biased on by the current through Q390 to the point where it behaves in the same manner as it would if there was excessive current through the sensing resistor, R300. This causes the series pass regulator, Q300, to be turned off, disabling the -15V regulator. Because the +15V and -15V regulators are referenced to the -15V supply, they are also disabled.

8-107. When the POWER switch is set to ON (I), the emitter of Q390 is grounded which turns it off. Consequently, the -15V supply is not disabled. Also when the POWER switch is set to ON (I), relay K641 is activated which turns on the fan.

8-108. An over-voltage protection circuit in the unregulated +5V supply prevents the voltage from becoming high enough to damage the supply circuits. This circuit consists of an SCR (CR600) that is triggered if voltage across R601 becomes too great. (Refer to the Power Supply schematic, Service Group O.) When the SCR is triggered, it pulls current through the coil of the Relay Circuit Breaker (CB1) which disconnects the line voltage from the power supply. The Over Voltage Reset button on the rear panel must be pressed when this happens. Severe over voltages may cause the fuse to open as well.

8-109. The only voltage adjustment is R352 in the -15V regulator. This control also adjusts the +5V and +15V outputs because they are referenced to the -15V supply.

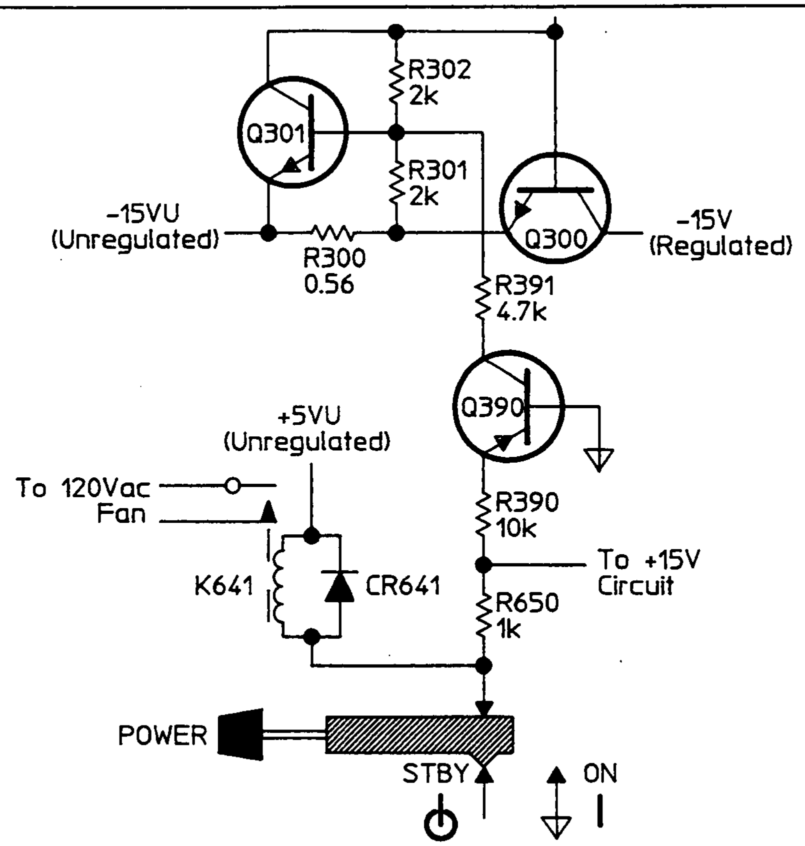


Figure 8-24. Power Supply Standby/On Circuit.

8-110. SINE AMPLITUDE CONTROL PATH.

8-111. Amplitude Control Circuitry.

8-112. The control of sine output amplitude involves a large amount of circuitry. The circuitry used is shown in Figure 8-25. Each block in this figure indicates the circuit board and schematic appropriate to that function. The process begins with the processor loading a number into the preset counters. For the length of time that it takes for these counters to count to zero, a current source is on and is charging up an integrator in the DAC. When the current source turns off, the integrator voltage is sampled and held. This D.C. voltage goes through a gain stage and a multiplier chip and establishes the bias on the 30MHz switch. This controls the level of the 30MHz reference signal to the mixer. From the mixer, a 0-20MHz signal is supplied to the function circuits, the output amplifier, the attenuator, and on to the instrument output. Through all these stages the signal's amplitude is controlled by the D.C. voltage to the 30MHz switch.

8-113. As seen in Figure 8-25, there exists a feedback path through the processor. Using a peak detector, the processor is able to sample the D.C. offsets and amplitude of the signal at the output of the Output Amplifier and compensate for errors by loading adjusted numbers into the Preset Counters.

8-114. Auto Calibration Disable (ACD).

8-115. When servicing the amplitude control path, it is imperative that the feedback path be eliminated before *troubleshooting begins.* This is performed by tying the ACD test point (on A14) to ground. This breaks the loop by preventing the processor from performing subsequent Auto Calibrations. *After tying ACD to ground, cycle power off, then on,* to erase from RAM all previous Auto Cal information.

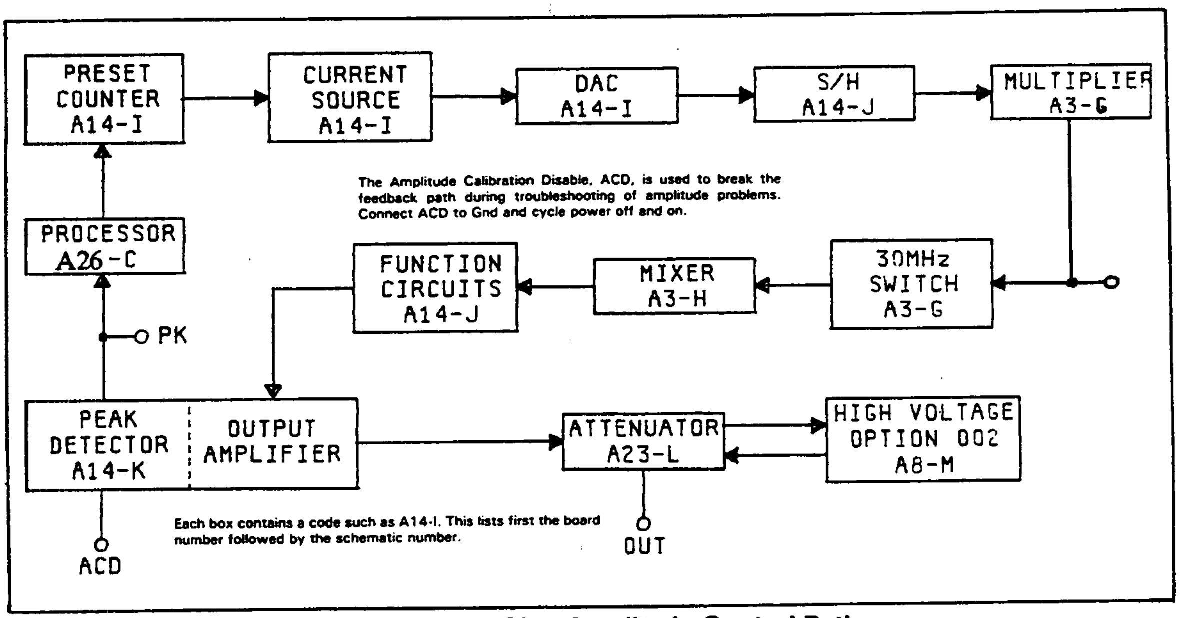


Figure 8-25. Sine Amplitude Control Path.

Section VIII
Service & Troubleshooting Information

8-116. SERVICING INFORMATION.

8-117. Power Line Voltage Selection.

8-118. The line voltage selected for the HP 3325B is indicated on the line voltage selector. Instructions for setting the line voltage and changing the fuse are contained in the *HP 3325B Installation Manual.*

8-119. Fan Filter.

8-120. The fan filter must be inspected frequently and cleaned or replaced as necessary to permit the free flow of air through the instrument. To clean the fan filter, remove the four nuts that secure the filter retainer, remove the filter, flush with soapy water, rinse clean, and air dry.

8-121. Adapter Cable.

8-122. An adapter cable may be made as shown in Figure 8-26 that will aid in adjusting and troubleshooting the instrument. This cable has a phono plug at one end to connect to the phono jacks used as signal connectors on the printed circuit board. The BNC connector at the other end connects to the input of an oscilloscope or other test equipment.

8-123. TROUBLESHOOTING INFORMATION.

8-124. Service information is organized into service groups, which include schematic diagrams, block diagrams and troubleshooting information for specific areas of the instrument. Paragraph 8-2 contains an index of the circuits and the service groups in which they can be found.

8-125. Test Equipment Required.

8-126. Table 8-2 lists the test equipment needed to troubleshoot the HP 3325B. Any equipment that meets or exceeds the critical specifications may be substituted for the recommended model.

8-127. Adjustments Required After Repair.

8-128. Following repair of some circuits, certain adjustment procedures must be performed to assure proper operation of the instrument. These adjustments are shown in Table 8-3.

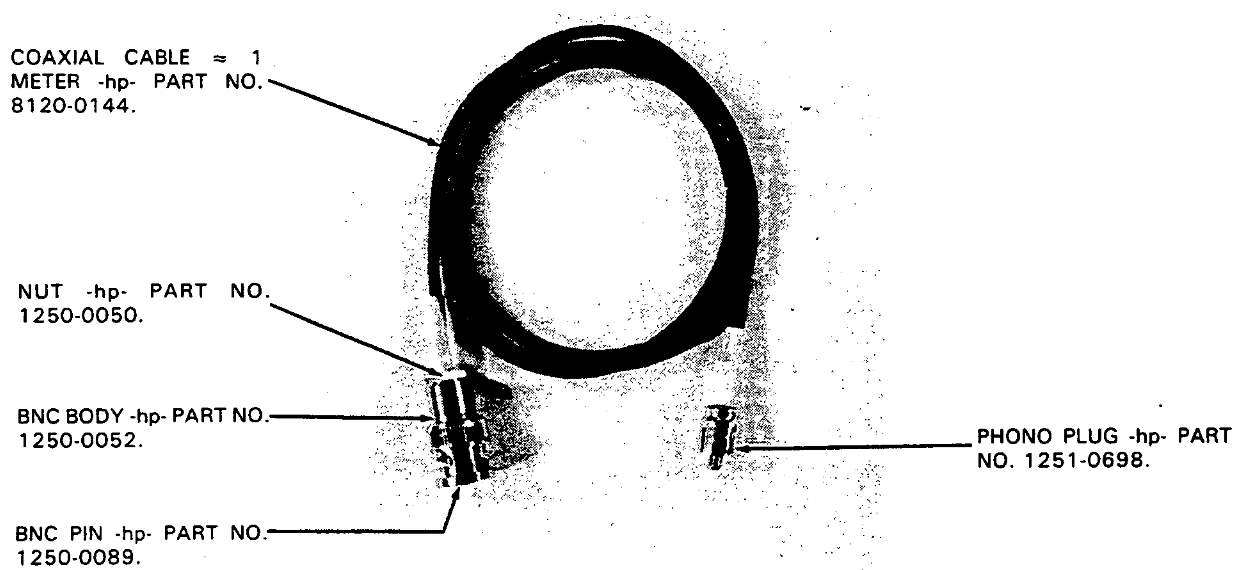


Figure 8-26. Adapter Cable.

Table 8-2. Test Equipment for Troubleshooting.

Instrument	Critical Specifications	Recommended Model	Use
Signature Analyzer	Signature: 4-digit hexadecimal Characters: 0 thru 9,A,C,F,H,P,U Threshold: Logic 1: +2.2 V Logic 0: +0.5 V Clock Frequency: ≥ 1.5 MHz	HP 5004A/5006A	Logic Circuit Troubleshooting
Pulse Generator	Pulse Rate: 500 kHz Pulse Width: ≤ 1 μs DC Offset: 1 V	HP 3312A	Logic Circuit Troubleshooting
Digital Multimeter 4 Digit	DC Function Ranges: 0.1 to 100V Accuracy: ±0.05% AC Function Ranges: .1 to 100 V Accuracy: ±0.5% Ohmmeter Ranges: 100 Ω to 1 MΩ Accuracy: ±1%	HP 3455A/3478A	General Troubleshooting
Analog Oscilloscope 2 channel	Vertical Bandwidth: dc to 100 MHz Deflection: 0.01V to 5 V/div Horizontal Main Sweep: 50 ns to 0.5 s/div Delayed Sweep: 50 ns to 20 ms/div	HP 1740A/TEK 2245	General Troubleshooting
Electronic Counter	Frequency Measurement: to 20 MHz Accuracy: ± 2 counts Resolution: 8 digits	HP 5328A/5328B	÷ N Counter Troubleshooting
Oscilloscope Probe	Division Ratio: 10 to 1 Impedance: 1 MΩ, 12 pF	HP 10041A/10040A	General Troubleshooting
50-ohm Thruput Termination	Accuracy: ±0.2% Power Rating: 1W	HP 11048C	General Troubleshooting

8-129. Orientation of Components.

8-130. A square pad or outline is used on the printed circuit board to aid in orientation of certain components for replacement and in identification of connections.

Component	Square Pad Identifies
Integrated Circuit	Pin 1
Transistor	Emitter
FET Transistor	Source
Diode	Cathode
Electrolytic Capacitor	Positive Connection

8-131. Mnemonic Dictionary.

8-132. Most of the logic and data signals in the HP 3325B are identified on the schematic diagrams by a mnemonic, which is essentially an abbreviation of the signal name. Table 8-4 is a dictionary of the mnemonics used for the HP 3325B. All mnemonics are active high unless preceded by a / (slash) which indicates active low. Some schematics may use mnemonics that begin with **L** or **H** to designate active low or active high. Therefore **/WFS** is equivalent to **LWFS**.

8-133. Basic Troubleshooting Procedures.

8-134. Make sure all cables and connectors are firmly seated and that the ribbon cables from A26 to A21, A3, and A14 are properly aligned in their connectors. Look for burned or loose components. Also make sure the microcircuit packages that are mounted in sockets are firmly seated.

8-135. The flowchart of Figure 8-27 may be used to help isolate the trouble. Some symptoms that are identifiable from the display, outputs, or response to inputs or entries are given in Table 8-5, along with suggested areas to begin troubleshooting.

8-136. Primitive Power On Tests.

8-137. At power-on, the processor runs low-level self tests. Any error found during these tests are indicated by flashing LEDs on the Control assembly.

8-138. If the instrument did not respond normally at power-on, remove the top cover and watch LEDs CR141 through CR144 on the Control assembly as the POWER switch is set to the ON (I) position. As the tests are running, the LEDs sequence through the test codes. When a failure occurs, the LEDs blink OFF and ON ten times with the error code. Use Table 8-6 to interpret the error message.

8-139. Front Panel Special Functions.

8-140. From the front panel, the HP 3325B can perform self tests, display information, and set instrument states. These special functions are accessed by pressing **Shift, Deg, Self Test** followed by two digits. The self tests may isolate a problem to a circuit. The displayed information includes calibration values, installed options, switch settings, revision codes, elapsed time on, and instrument serial number. Adjustment and calibration modes can be enabled, and calibration modes and values can be cleared. Table 8-7 lists the front panel special functions.

8-141. Special Functions 60 through 66.

8-142. Special Functions 60 through 66 display the calibration values (correction factors) that control output level and dc offset. These constants are used to compute the DAC AMPL and OS1 test point values. These values are sent to the D/A converter to obtain the correct signal output. When you select one of these special functions, numbers appear in the format for the equation of a straight line, $y = A + Bx$ (A is the offset and B is the slope). On the display, the number for A appears on the left side and the number for B appears on the right side.

8-143. Initiating these special functions may help identify impending failures. These calibration constants are useful when used in conjunction with fail codes 021 to 029. If the instrument displays any of these fail codes, either a bad adjustment was made or a failure occurred in the functionally related circuitry.

8-144. Prior to initiating Special Function 60 to 66, the function being measured must be internally calibrated to obtain valid numbers. To internally calibrate a function you can simply enable that function, or you can run the internal self tests (Shift, Self Test) to calibrate all functions.

8-145. If fail codes 021 through 025 occur, the HP 3325B could not finish its calibration and the calibration constants were reset to their default values. In other words, the constants obtained by running Special Functions 60 to 66 will be at their default values (see Tables 8-8 and 8-9).

8-146. If fail codes 026 through 029 occur, the calibration constants were not reset to their default values. However, consider it a warning that the instrument may not meet all of its specifications or may have a marginal failure. Use Table 8-8 for the enabled function if either FAIL 026 or FAIL 027 occurs. Use Table 8-9 for the enabled function if FAIL 028 or 029 occurs.

Table 8-3. Adjustment Required After Repair.

Circuit Repaired	Service Group	Adjustments Required	Para. No.
Keyboard	A	None	
HP-IB/RS-232	B	None	
Control	C	None	
Voltage Controlled Oscillator	D	Voltage Controlled Oscillator	5-9
VCO Buffer	D	None	
÷N.F.Counter	E	None	
Fractional N Analog	F	Analog Phase Interpolation	5-10
30 MHz Oscillator	G	30 MHz Reference Oscillator	5-11
Sine Amplitude &	G	Amplitude Modulator	5-13
Amplitude Modulation		Sine Wave Gain-Offset	5-14
Mixer	H	Mixer Spurious Signal	5-20
D/A Converter & Sample/Hold	I	D/A Converter Gain and Offset	5-8
Function	J	Square wave Gain-Offset	5-14
		Ramp Stability	5-18
Ramp Gating	J	Ramp Stability	5-18
Output Amplifier	K	Amplifier Bias	5-17
		Amplitude Flatness	5-19
High Stability Reference	M	High Stability Frequency Reference	5-12
Sweep Range	N	X Drive	5-16
X Drive Integrator	N	X Drive	5-16
Power Supply	O	Power Supply	5-7

8-147. Performance Test Troubleshooting Guide.

8-148. If a performance test fails, an adjustment and/or circuit repair may be necessary to correct the problem. Some of the possible causes of failure are listed in Table 8-10. This is not an exhaustive list, it is only a guide that may assist you in isolating the problem to either a Service Group or an assembly. The table assumes there are no error codes occurring and that only a performance specification is out of range.

8-149. Logic Troubleshooting by Signature Analysis.

8-150. Because of the increased complexity of the logic circuits used to control many instruments, malfunctions in these circuits may be very difficult to locate. The concept of Signature Analysis is based on the fact that at a particular point in a circuit, the data pulses are predictable under specifically programmed conditions. An instrument such as the HP 5006A Signature Analyzer compresses the data at a given point during a controlled time span (window) and displays the resulting four-character signature. This signature indicates whether the correct data was present at the measurement point, and this information can be used to locate a defective component.

8-151. Signature Analysis does have its limitations. If a component connected to a bus fails, Signature Analysis may not run, or if it does run, all components on that bus may have incorrect signatures. Therefore, if Signature Analysis can not isolate the faulty component, use schematics, signal flow diagrams, and an oscilloscope to troubleshoot.

8-152. Three Signature Analysis (SA) tests are available for troubleshooting the Control assembly and the digital sections of other assemblies.

Kernel SA Test: Checks processor, address bus, and address decoding. Use this test to troubleshoot the Control assembly when the Primitive Power On Tests fail.

SA0 Test: Provides stable signatures for the processor data bus, chip select signals, machine data bus, machine control write signals, HP-IB circuits, function circuits, keyboard and display circuits. The processor, ROM, and address bus must be working for this test to run.

SA1 Test: Checks machine control read signals. The processor, ROM, and address bus must be working for this test to run.

8-153. Before starting a Signature Analysis test, check the Primitive Power On Tests (see Paragraph 8-136). Set up procedures and signatures are located in every Service Group that troubleshoots with Signature Analysis.

Table 8-4. Mnemonic Dictionary.

Mnemonic	Definition
+5VB	Non-volatile RAM Power Supply
+5V1	Isolated HP-IB Power Supply
AB1 through AB23	Processor Address Bus
AS	Address Strobe
ATN	HP-IB Attention
BAUD_CLOCK	Baud Rate *16 Clock
BERR	Bus Error
BTRY_ENABLE	Battery Enable
CE	Chip Enable
CLK.6	0.61440 MHz Clock
CLK2.5	2.45760 MHz Clock
CLK10	9.83040 MHz Clock
CSR	Clock Shift Register on Front Panel
DAV	HP-IB Data Valid
DB0 through DB15	Processor Data Bus
DIO1 through DIO8	HP-IB Data
DTR	RS-232 Data Terminal Ready
EC	External Clock to N.F IC
EEDTACK	Everything Else Data Transfer Acknowledge
EOI	HP-IB End-or-Identify
HPIBCS	HP-IB Chip Select
HPIB_DATA	Serial Data from HP-IB circuits
HPIB_INT	HP-IB Interrupt
IAC	Interrupt Acknowledge Bus Cycle
IFC	HP-IB Interface Clear
INV	Instruction Valid to N.F IC
IRQ	Interrupt Request from MFP to Processor
LDS	Lower Byte Data Strobe
LOAD_CNT	Load Max Count into Mod Source Addr Counter
LREAD	Lower Byte Read Strobe
LWRITE	Lower Byte Write Strobe
MA0 through MA11	Mod Source RAM Address Bus
MAN_RESET	Manual Reset
MD0 through MD7	Machine Data Bus 0-7
MDBS	Machine Data Bus Select
MFPCS	Multi-Function Peripheral Chip Select
MFPDTACK	MFP Data Transfer Acknowledge
MISCCS	Miscellaneous Latch Chip Select
MODAMPCS	Mod Source Amplitude Latch Chip Select
MODCLK	Modulation Source Clock
MODLOAD	Mod Source Load RAM
MODRAMCS	Mod Source RAM Chip Select
NDAC	HP-IB Not Data Accepted
NRFD	HP-IB Not Ready for Data
PMC	Phase Modulation Control
PR/W	Processor Read, not Write
PW/R	Processor Write, not Read
R/W	Read, not Write
RAD	Read Arithmetic Data from N.F IC
RAMCS	RAM Chip Select
REN	HP-IB Remote Enable
RESET	Power-on Reset
RESET_HPIB	HP-IB Reset
RFF	Read Function Flags
RKB	Read Keyboard Data
ROMCS	ROM Chip Select
RPBSW	Read Processor Board Switches
RPSW0 through RPBSW7	Rear Panel Switch Data Bus
RRPSW	Read Rear Panel Switches
RSS	Read Signal Source Data
RX	RS-232 Received data
SD0 through SD7	HP-IB Shifted Data Bus
SHIFT	HP-IB Shift Enable
SHIFTCLK	HP-IB Shift Clock
SHIFTCS	HP-IB Shift Clock Chip Select
SI	RS-232 Serial Data In
SLC	Sweep Limit Control to N.F
SLF	Sweep Limit Flag from N.F
SO	RS-232 Serial Data Out
SRQ	HP-IB Service Request
STBY	Standby
TX	RS-232 Transmitted Data
UDS	Upper Byte Data Strobe
UREAD	Upper Byte Read Strobe
UWRITE	Upper Byte Write Strobe
W/R	Write, not Read
WFD	Write Function Data to A14
WFS	Write Function Select to A14
WKD	Write Keyboard Data
WSS	Write Signal Source Data to A3
ZERO	Mod Source Addr Count = Zero

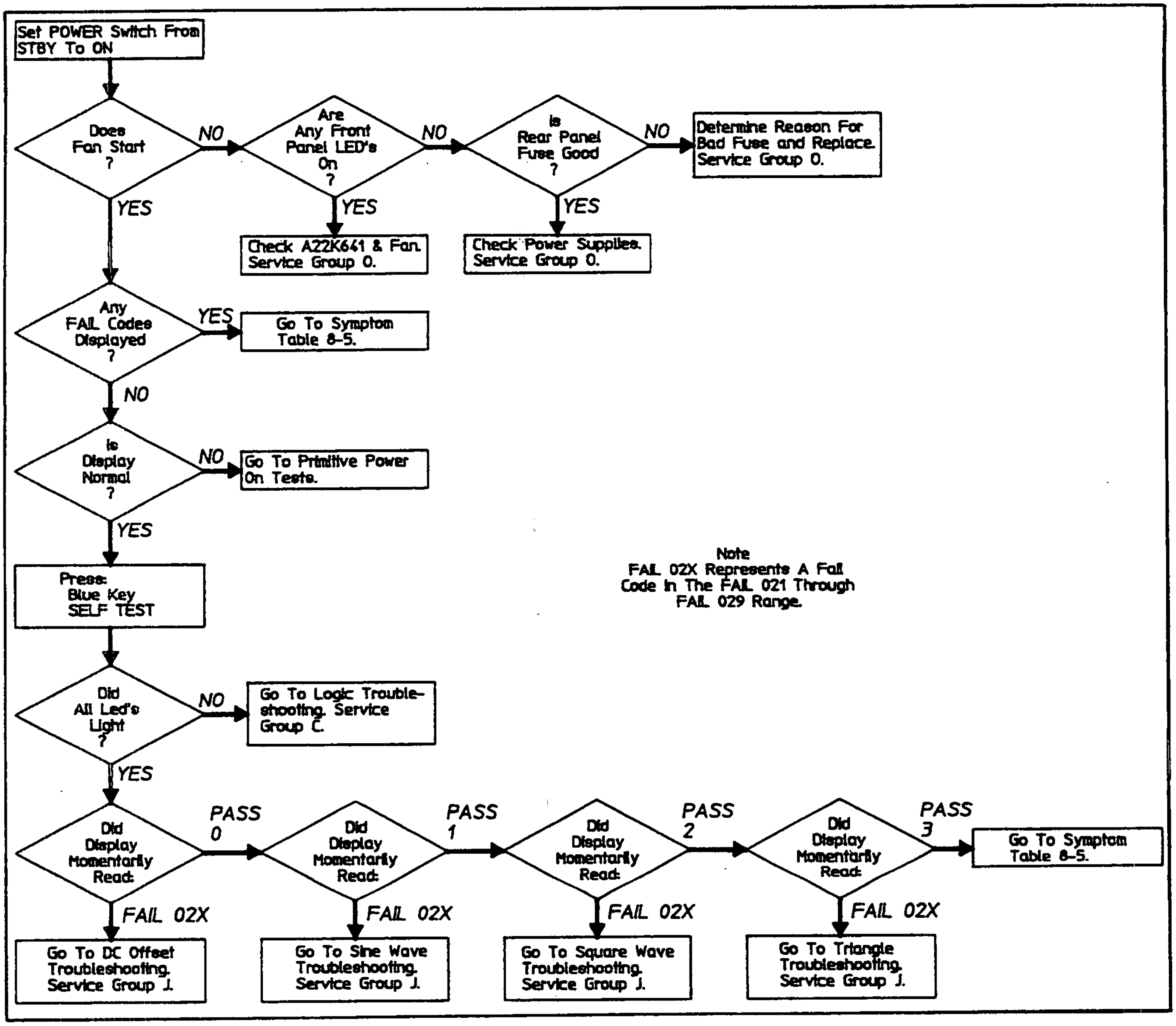


Figure 8-27. Basic Troubleshooting Procedure.

Table 8-5. Trouble Symptoms.

Symptoms	Troubleshooting Procedures
Display or Keyboard switch problems	Service Group A
No AUX output or incorrect frequency (Sine Function 21-60 MHz); front panel output normal.	Service Group D
Amplitude Modulation does not respond properly.	Service Group G
Phase Modulation does not respond properly.	Service Group F
Output amplitude incorrect for all functions.	Service Group L
No front panel display or annunciators.	If power supply voltages are correct (see Service Group O) go to Service Group C; if not, troubleshoot power supply, Service Group O.
Abnormal display characters (partial characters or all segments stay on), no response to front panel entries.	Service Group C
Display appears normal, but no response to front panel entries.	Service Group C
Instrument accepts entries but has no signal or sync outputs.	Service Group K
No signal output; sync output correct.	Service Group L
Will not sweep frequency.	Service Group E
X Drive, Z Blank, or Marker signals incorrect.	Service Group N
When External Reference or Option 001 is connected to rear panel REF IN, front panel EXT REF annunciator does not light or flashes on and off.	Service Group G
Output frequency incorrect.	Service Group G
Control problems, or instrument "locks up" and will not accept entries	Service Group C SA0 or SA1
Cannot perform SA0 or SA1	Service Group C Kernel SA Test
Display reads FAIL 010 (DAC range error)	Service Group K, J
Display reads FAIL 011 (bad checksum, low byte of ROM)	Service Group C
Display reads FAIL 012 (bad checksum, high byte of ROM)	Service Group C
Display reads FAIL 013 (machine data bus line stuck low)	Service Group C
Display reads FAIL 014 (Keyboard shift register test failed)	Service Group A, C
Display reads FAIL 021 (signal too big during calibration)	Service Group K, J
Display reads FAIL 022 (signal too small during calibration)	Service Group K, J
Display reads FAIL 023 (dc offset too positive during calibration)	Service Group K, J
Display reads FAIL 024 (dc offset too negative during calibration)	Service Group K, J
Display reads FAIL 025 (unstable/noisy calibration)	Service Group K, J
Display reads FAIL 026 (calibration factor out of range: ac gain offset)	Service Group K, J
Display reads FAIL 027 (calibration factor out of range: c gain slope)	Service Group K, J
Display reads FAIL 028 (calibration factor out of range: dc offset)	Service Group K, J
Display reads FAIL 029 (calibration factor out of range: dc slope)	Service Group K, J
Display reads FAIL 030 (external eference unlocked)	Service Group G
Display reads FAIL 031 (oscillator unlocked, voltage too low)	Service Group D
Display reads FAIL 032 (oscillator unlocked, voltage too high)	Service Group D
Display reads FAIL 031 or 032 but oscillator circuits check good.	Service Group C SA0 Test
Display reads FAIL 033 (HP-IB isolation circuits test failed self test)	Service Group B
Display reads FAIL 034 (HP-IB IC failed self test)	Service Group B
Display reads FAIL 035 (RS-232 test failed loop-back test)	Service Group B
Display reads FAIL 036 (memory lost; dead battery)	Service Group C
Display reads FAIL 037 (unexpected interrupt)	Service Group C
Display reads FAIL 038 (sweep-limit-flag signal failed self test)	Service Group E
Display reads FAIL 039 (Fractional-N IC failed self test)	Service Group E
Display reads FAIL 040 (modulation source failed self test)	Service Group N
Display reads FAIL 041 (function-integrity-flag flip-flop always set)	Service Group J

Error Codes

Table 8-6. Primitive Power On Test Error Messages.

CR144	CR143	CR142	CR141	Indicates ...
○	○	○	○	All leds are turned on at start of testing.
☼	☼	☼	☼	Unknown problem, unable to test.
●	●	○	●	Running Low-byte and High-byte RAM tests. These tests write to and read from U6 and U7 on the Control assembly.
●	●	☼	●	Low-byte RAM test failed. After blinking the LEDs, the test loops repeatedly for troubleshooting. On the Control assembly, check U6, U81, Q81, Q2, Q3, and Q4.
●	●	☼	☼	High-byte RAM test failed. After blinking the LEDs, the test loops repeatedly for troubleshooting. On the Control assembly, check U7.
●	○	●	●	Running long RAM test. This test writes to and reads from all RAM addresses.
●	☼	●	●	Failed long RAM test. After blinking the LEDs, the test loops repeatedly for troubleshooting. On the Control assembly, check U6 and U7.
●	○	●	○	Running ROM checksum test.
●	☼	●	☼	Low-byte ROM failed checksum. After blinking the LEDs, testing continues with the next test. On the Control assembly, check U2.
●	☼	☼	●	High-byte ROM failed checksum. After blinking the LEDs, testing continues with the next test. On the Control assembly, check U3.
●	○	○	○	Running MFP IC test. This test writes to and reads from U10 on the Control assembly.
●	☼	☼	☼	MFP IC test failed because incorrect data was received from U10. After blinking the LEDs, the test loops repeatedly for troubleshooting. On the Control assembly, check U10.
☼	●	●	●	MFP IC test failed because no response was received from U10. After blinking the LEDs, the test loops repeatedly for troubleshooting. On the Control assembly, check U10.
○	●	●	○	Running machine data bus test. This test does a read from the machine data bus.
☼	●	●	☼	Machine data bus test failed because a line was stuck low. After blinking the LEDs, testing continues with the next test. Set the power switch to STBY and unplug J1, J2, J3, J4, and J10 on the Control assembly. Ground the STBY test point to re-run the test. If the test fails, check U41 on the Control assembly. If the test passes, plug in one connector at a time and re-run the test to determine the assembly causing this test to fail.
○	●	○	●	Running Keyboard test. This test writes to and reads from the Keyboard assembly.
☼	●	☼	●	Keyboard test failed. After blinking the LEDs, testing continues with the next test. Set the power switch to STBY and unplug J10 on the Control assembly. Check the A15 assembly.
○	●	○	○	Running digital signature analysis test. On the Control assembly, return SA0 and SA1 on switch S100 to the NORMAL position and cycle power.
○	○	●	○	Special boot mode. On the Control assembly, return SPCO on switch S100 to the NORMAL position and cycle power.
○	○	○	●	Primitive power-on tests complete, initializing software.
●	●	●	●	Normal operation.

○=ON ●=OFF ☼=BLINKING

Table 8-7. Front Panel Special Functions.

To select a Special Function, press **Shift**, **Deg**, **Self Test** followed by two digits corresponding to the Special Function.

SPECIAL FUNCTION	DESCRIPTION
00	Self test. Same as pressing Shift, Self Test. Turns all front panel LEDs on, then off, then does amplitude calibrations on Sine, Square, and Triangle waveforms.
11	Power-on self test. Re-runs the power-on self tests. Same as running SPECIAL 12, 13, and 14. A successful test will not display any PASS indicators. Power must be cycled after running this test to restore HP-IB operation.
12	HP-IB circuits test. Writes data through the serial isolation path, then reads it back. Tests for stuck /HPIB_INT signal. Power must be cycled after running this test to restore HP-IB operation.
13	Fractional-N integrated circuit test. Writes data to A21 U19, executes a sweep, and reads data back. Tests for stuck SLC signal. Power must be cycled after running this test to restore operation.
14	Modulation Source test. Writes data to the modulation source waveform RAM, then reads it back. Modulation source function and amplitude must be reprogrammed after this test to restore operation.
20	Keyboard test. Lights all front panel LEDs. Pressing any key turns off one LED while the key is pressed. Press **Local** several times to quit.
21	HP-IB connector pins test. Front panel display continuously lists any HP-IB signals that are low. Disconnect all other HP-IB devices, and connect one HP-IB cable before starting this test. Short each pin of the HP-IB connector to pin 24, one at a time, while watching the display. **Pn 1** should appear when pin 1 is connected to pin 24. All pins should respond except pins 10, 12, and 18 through 24. Because the HP-IB is isolated, pins must be shorted to pin 24, not chassis or earth ground. Press **Local** to quit and cycle power to restore HP-IB operation.
22	RS-232 loop-back test. On the A26 Assembly, connect R173 to R175 at the ends nearest connector J100 before running this test. This test transmits several characters and expects to receive them back.
30	Displays (and output to HP-IB or RS232) the software revision code. The revision code is 4 digits, two for the year since 1960 and two for the week.
31	Displays the options installed.
32	Displays the elapsed time on in hours (also see Special Function 98).
34	Displays the rear panel switch setting as a value from 0 to 255. (The switch values are binary. Pin 1 in the up position represents 1.)
35	Displays the Control assembly switch setting as a value from 0 to 255. (The switch values are binary. Pin 1 in the NORMAL position represents 1.)
36	Displays the serial number (see the ZSER command).
50	Clears calibration values.
51	DC adjustment mode. Press local to quit.
52	Amplitude modulation adjustment mode (clears ARB waveform). Press local to quit.
53	Sine wave adjustment mode. Press local to quit.
54	Square wave adjustment mode. Press local to quit.
60	Displays calibration value for dc offset.
61	Displays calibration values for sine wave gain (as A, B in the equation $y = A + Bx$).
62	Displays calibration values for sine wave offset.
63	Displays calibration values for square wave gain.
64	Displays calibration values for square wave offset.
65	Displays calibration values for triangle wave gain.
66	Displays calibration values for triangle wave offset.
85	Restores normal calibration mode (CALM0).
95	Enables calibration mode 1 (CALM1). Calibrates all functions, then inhibits further calibration.
98	Displays **CLEAr Hr?**. The elapsed time counter is reset to 0 only if **Clear** is pressed.

Table 8-8. Typical Values for Amplitude Gain Corrections. (default values are shown in parentheses)

Special Test	Offset(A1)	Slope(B1)
61, Sine Wave	0±80 (0)	0.91±0.08 (0.8)
63, Square Wave	0±80 (0)	0.91±0.08 (0.8)
65, Triangle Wave	0±80 (0)	0.91±0.08 (0.8)

Table 8-9. Typical Values for Residual DC Corrections. (default values are shown in parentheses)

Special Test	Offset(A2)	Slope(B2)
60, DC Only	0±800 (0)	0.00 (0.00)
62, Sine wave	0±800 (0)	0±0.1 (0.00)
64, Square wave	0±800 (0)	-0.05±0.1 (0.00)
66, Triangle wave	0±800 (0)	-0.05±0.1 (0.00)

NOTE

Default values have no dc offset correction and the amplitudes are approximately 5% to 20% below normal. These values are obtained in one of three ways:

1. *By performing an ACAL disable (affects all functions).*
2. *If a FAIL 021-025 occurs for the particular function.*
3. *By turning on the HP 3325B without activating the function of concern.*

Table 8-10. Performance Test Troubleshooting Guide

Performance Test	Possible Cause of Failure
Harmonic Distortion	Suspect A3, A14, or A21.
Spurious Signals: Mixer Spurs	Check adjustment 5-20. If still bad, refer to Service Group H.
Fractional N Spurs	Check adjustment 5-10. If still bad, refer to Service Group F.
Integrated Phase Noise	Suspect A21.
AM Envelope Distortion	Check adjustments 5-13 and 5-14. If still bad, refer to Service Group G.
Square Wave Rise Time and Aberrations	Check adjustment 5-17. If still bad, refer to Service Group K.
Ramp Retrace Time	Refer to Service Group J.
Sync Output	Refer to Service Group K.
Square Wave Symmetry	Check adjustment 5-15. If still bad, refer to Service Group J.
Frequency Accuracy	Check adjustment 5-15. If still bad, refer to Service Group G.
Phase Increment Accuracy	Refer to Service Group F.
Phase Modulation Linearity	Refer to Service Groups E and F.
Amplitude Accuracy:	
Sine (< 100 kHz)	Check adjustments 5-13 and 5-14. If still bad, refer to Service Groups G, I, and J. Suspect the DAC (A14), amplitude control (A14), or sine amplitude and AM circuitry (A3).
Sine (> 100 kHz)	Check adjustment 5-17. If still bad, refer to Service Groups H and J. Suspect the 20 MHz LPF (A3) or the sine amplitude filter (A14).
Square, Triangle, Ramps	Check adjustment 5-15. If still bad, refer to Service Group J.
DC Offset Accuracy (DC only)	Check adjustment 5-8. If still bad, refer to Service Groups I, L, and O. Suspect the DAC (A14), attenuator (A23), or power supply (A22).
DC Offset Accuracy with AC Functions: Sine	Refer to Service Group H.
Square, Triangle, Ramps	Refer to Service Group J.
	Note: Having the mixer adjust more than 1/2 turn clockwise from stop can put the sine wave dc offset out of spec. It may be necessary to find the best compromise between the 2:1 spur and the amount of DC offset.
Triangle Linearity	Refer to Service Group J. Suspect the triangle filter circuitry.
X-Drive Linearity	Check adjustment 5-16. If still bad, refer to Service Group N.
Ramp Period Variation	Check adjustment 5-18. If still bad, refer to Service Group J.

GENERAL SCHEMATIC NOTES

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.

2. COMPONENT VALUES ARE SHOWN AS FOLLOWS UNLESS OTHERWISE NOTED.
   - RESISTANCE IN OHMS
   - CAPACITANCE IN MICROFARADS
   - INDUCTANCE IN MILLIHENRYS

3. DENOTES EARTH GROUND. USED FOR TERMINALS WITH NO LESS THAN A NO. 18 GAUGE WIRE CONNECTED BETWEEN TERMINAL AND EARTH GROUND TERMINAL OR AC POWER RECEPTACLE.

4. DENOTES FRAME GROUND. USED FOR TERMINALS WHICH ARE PERMANENTLY CONNECTED WITHIN APPROXIMATELY 0.1 OHM OF EARTH GROUND.

5. DENOTES GROUND ON PRINTED CIRCUIT ASSEMBLY. (PERMANENTLY CONNECTED TO FRAME GROUND)

   DENOTES ISOLATED (I) OR SIGNAL(S) CIRCUIT GROUND.

   DENOTES ANALOG CIRCUIT GROUND.

   DENOTES DIGITAL CIRCUIT GROUND.

   DENOTES HP-IB AND RS-232 BUS GROUND.

6. DENOTES ASSEMBLY.

7. DENOTES MAIN SIGNAL PATH.

8. DENOTES FEEDBACK PATH.

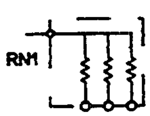
9. DENOTES FRONT PANEL MARKING.

10. DENOTES REAR PANEL MARKING.

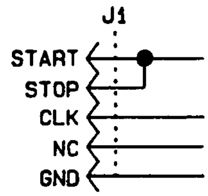
11. DENOTES SCREWDRIVER ADJUST

12. * AVERAGE VALUE SHOWN, OPTIMUM VALUE SELECTED AT FACTORY. THE VALUE OF THESE COMPONENTS MAY VARY FROM ONE INSTRUMENT TO ANOTHER. THE METHOD OF SELECTING THESE COMPONENTS IS DESCRIBED IN SECTION V OF THIS MANUAL.

13. ALL RELAYS ARE SHOWN DEENERGIZED.

14. 

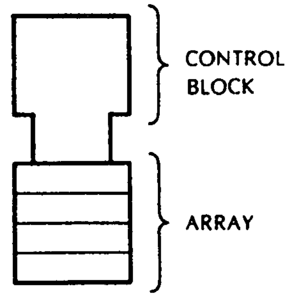
DENOTES RESISTOR PACK

15. 

DENOTES SIGNATURE ANALYSIS TESTING POINTS

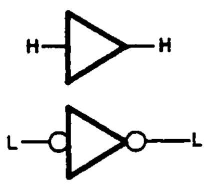
16. CONTROL BLOCK IS USED WHEN AN ARRAY OF RELATED LOGIC ELEMENTS SHARE COMMON CONTROL LINES

LOGIC ELEMENTS WITH COMMON CONTROL BLOCK

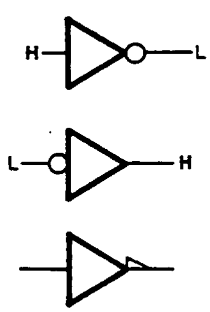


17. WAVEFORMS AND AC VOLTAGE MEASUREMENTS WERE MADE WITH RESPECT TO CHASSIS GROUND USING AN OSCILLOSCOPE WITH A 10:1 PROBE. THE VOLTAGE LEVELS SHOWN FOR THE WAVEFORMS ARE ACTUAL VOLTAGE LEVELS AND ARE NOT TO BE CONFUSED WITH OSCILLOSCOPE SETTING. THE VOLTAGE LEVELS SHOWN ARE NOMINAL AND MAY VARY FROM ONE INSTRUMENT TO ANOTHER. A VARIATION OF ±10% IN MEASUREMENTS SHOULD BE ALLOWED. ALL WAVEFORMS SHOWN WERE AC-COUPLED UNLESS OTHERWISE NOTED. DC VOLTAGE LEVELS OF WAVEFORM TEST POINTS ARE INDICATED SEPARATELY.

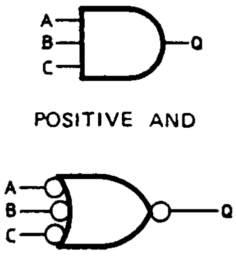
18. DC VOLTAGE LEVELS WERE MEASURED WITH RESPECT TO CIRCUIT GROUND USING A DVM. THE VOLTAGE LEVELS SHOWN ARE NOMINAL AND MAY VARY FROM ONE INSTRUMENT TO ANOTHER DUE TO CHANGE IN TRANSISTOR CHARACTERISTICS. A VARIATION OF ±10% SHOULD BE ALLOWED.



DENOTES BUFFER



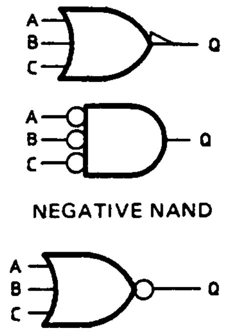
DENOTES INVERTER



POSITIVE AND

NEGATIVE OR

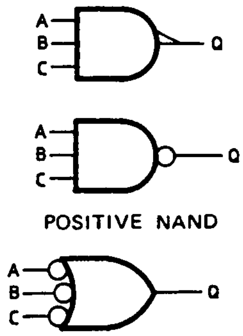
A	B	C	Q
L	L	L	L
L	L	H	L
L	H	L	L
L	H	H	L
H	L	L	L
H	L	H	L
H	H	L	L
H	H	H	H



NEGATIVE NAND

POSITIVE NOR

A	B	C	Q
L	L	L	H
L	L	H	L
L	H	L	L
L	H	H	L
H	L	L	L
H	L	H	L
H	H	L	L
H	H	H	L



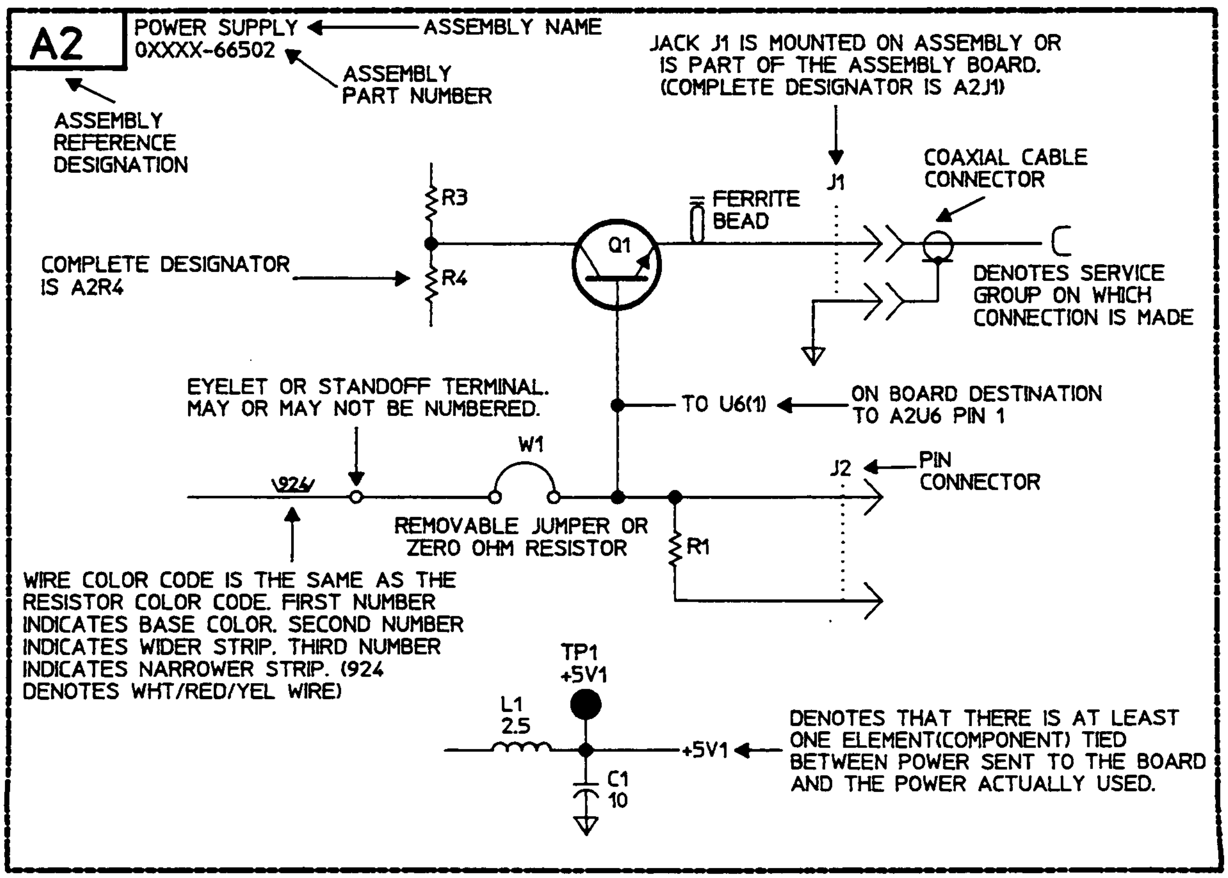
POSITIVE NAND

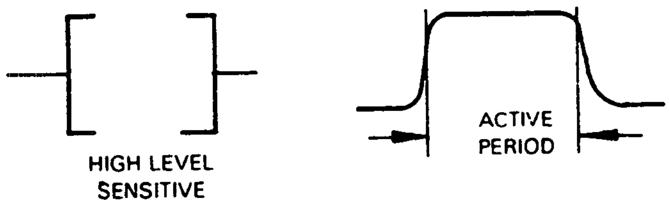
NEGATIVE NOR

A	B	C	Q
L	L	L	H
L	L	H	H
L	H	L	H
L	H	H	H
H	L	L	H
H	L	H	H
H	H	L	H
H	H	H	L

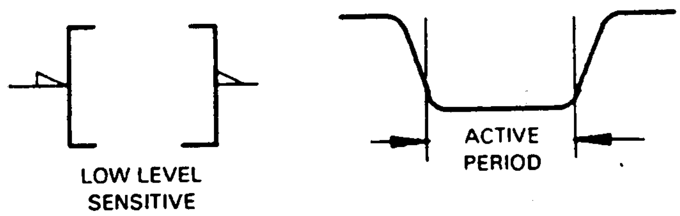
EXCLUSIVE OR GATE

A	B	Q
L	L	L
L	H	H
H	L	H
H	H	L

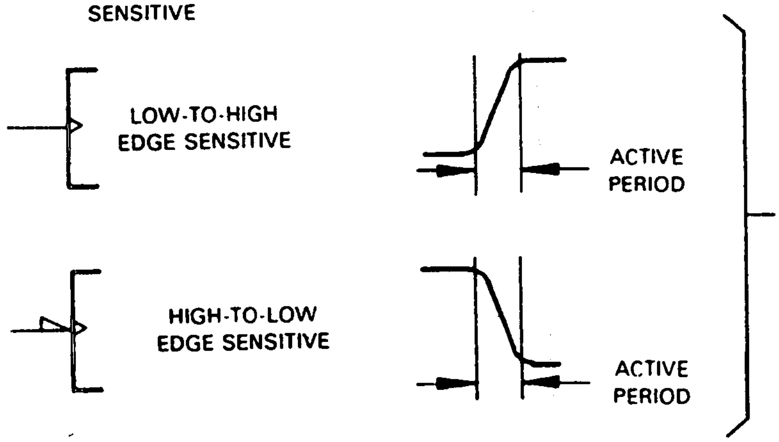




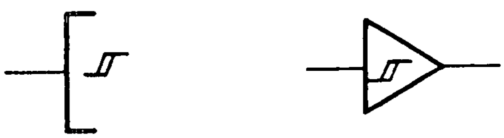
ACTIVE HIGH inputs and outputs - Indicated by the absence of the polarity indicator (▷).



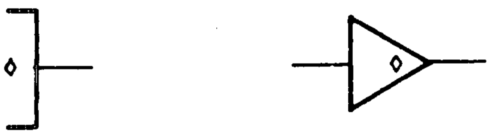
ACTIVE LOW inputs and outputs - Indicated by the presence of the polarity indicator (▷).



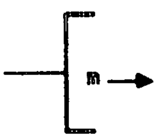
EDGE SENSITIVE (Dynamic) inputs - Indicated by the presence of the dynamic indicator symbol (>).



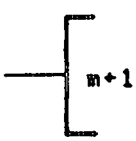
BI-THRESHOLD (Hysteresis) input (⎍) - Input takes on internal high state when external signal exceeds high threshold value State is maintained until external signal falls below a lower threshold value.



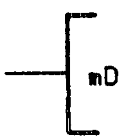
OPEN COLLECTOR output (◊) - Forms a part of a distributed connector.



SHIFT RIGHT (Down) input of register. m may be other qualifiers or dependency notation.



COUNT UP input of a counter. m may be other qualifiers or dependency notation.



DATA input m may be other qualifiers or dependency notation

Qualifying Symbols

Service Group A
Keyboard, A25 and
Display, A15

SERVICE GROUP A: KEYBOARD, A25 and DISPLAY, A15.

Troubleshooting Information.

A stuck key is often noticeable by its "lack of play". The following troubleshooting hints are intended to help determine whether a problem on the Keyboard assembly is due to a malfunctioning key or a component failure.

Check the 1.67 kHz clock signal at A15U102 pin 8. The 1.67 kHz clock is the rate at which a logic "1", supplied by MD4 of the machine data bus, is shifted through registers U102 and U103.

Check A15U103 pin 13 for a 5V pulse every 10.2 ms. A 5V pulse on this pin at a 10.2 ms rate indicates that shift registers U102 and U103 are functioning properly.

To check for stuck keys, press **Shift, Deg, Self Test, 2, 0**. This front panel special function lights all front panel LEDs. If a key is stuck in the on position, the corresponding LED will not be lit. If all LEDs are lit, press one key at a time and look for the corresponding LED to turn off while the key is pressed. Press **Local** several (4 or 5) times to quit.

Check the machine data bus lines at the input and output of A15U100 for logic level transitions. The same level present at the input and its corresponding output indicates a problem with U100.

Signature Analysis Test 0 can be used to troubleshoot stuck keys. This test can also troubleshoot an incorrect display, inoperative keyboard, or FAIL 014.

Removal of Keyboard and Display Assemblies.

Disconnect the signal and sync output cables from the front panel.

Remove the plastic trim strips from the top and the bottom of the front frame by prying up with a small screw driver or similar tool in one of the slots near either end of the strips.

Remove the 2 screws from the top of the frame (beneath the trim strip) and the 3 corresponding screws from the bottom side of the front frame.

Push the keyboard assembly forward from the front frame.

NOTE

The Keyboard and Display assemblies do not need to be disassembled any further to perform the SA0 test. All signatures are available on the circuit side of the Display assembly.

To change a part on the Display assembly, remove the 7 screws that hold it in place. Disconnect J100 (ribbon cable to Control assembly) and J110 (cable to power switch). Be careful to keep the connectors clean.

NOTE

When attaching the Display assembly to the Keyboard assembly, be sure to reconnect the cables to J100 and J110. Also make sure the wire fingers in the foam connector are facing the pads on both assemblies.

To change a part on the Keyboard assembly, first remove the Display assembly, then remove the 13 screws holding the assembly to the front panel.

Signature Analysis Test 0.

The SA0 test can be used to troubleshoot an incorrect display, inoperative keyboard, stuck keys, or a FAIL 014.

Set the POWER switch to STANDBY (⏻), then connect the Signature Analyzer as follows:

Gnd:		A26 TP0 (GND)
Start:	+ slope	A26 TP3 (S/A START STOP)
Stop:	+ slope	A26 TP3 (S/A START STOP)
Clock:	– slope	A26 U39 Pin 1 (/EEDTACK)

Remove the front panel assembly and lay it face down so that no keys are pressed.

Set A26SW100 pin 1 to the **SA0** position. Check that A26SW100 pin 2 (SA1) is in the **NORMAL** position.

Set the POWER switch to ON (I). A26 CR141, CR142, CR144 should be on. CR143 should be off. If the front panel display is operational, the front panel LEDs will be on in a random pattern.

Check for a +5V signature of HF3A.

If the +5V signature or the A26 LEDs are incorrect, troubleshoot the A26 assembly using the Kernel SA test. If they are correct, troubleshoot the Display assembly using this SA test. Use the Test Signal Flow Diagram to help you determine the order to check the signatures and facilitate troubleshooting.

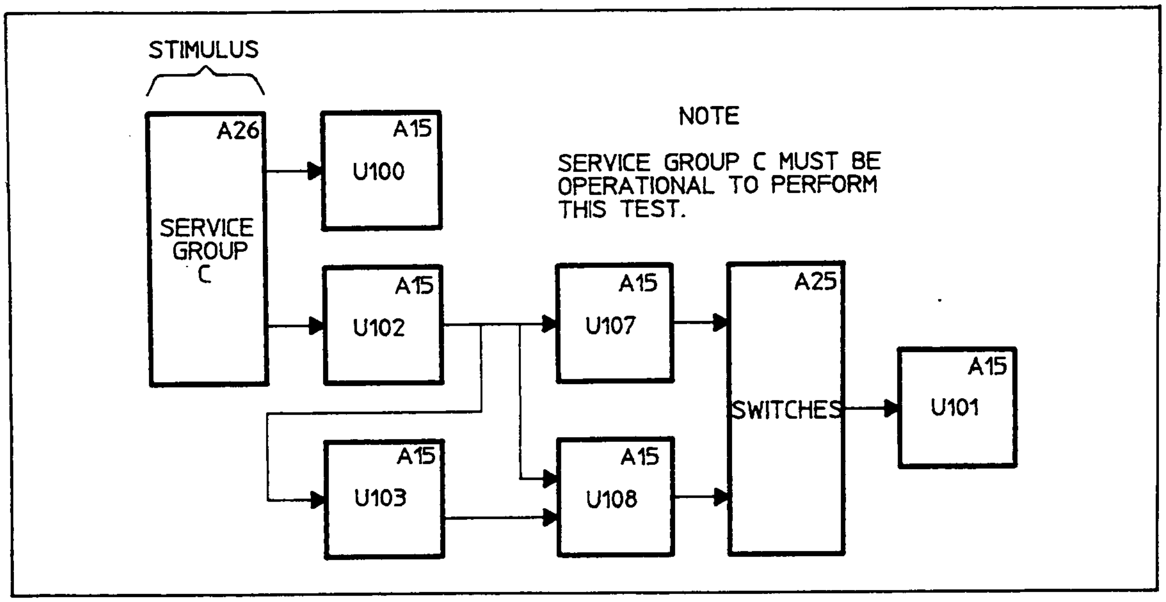
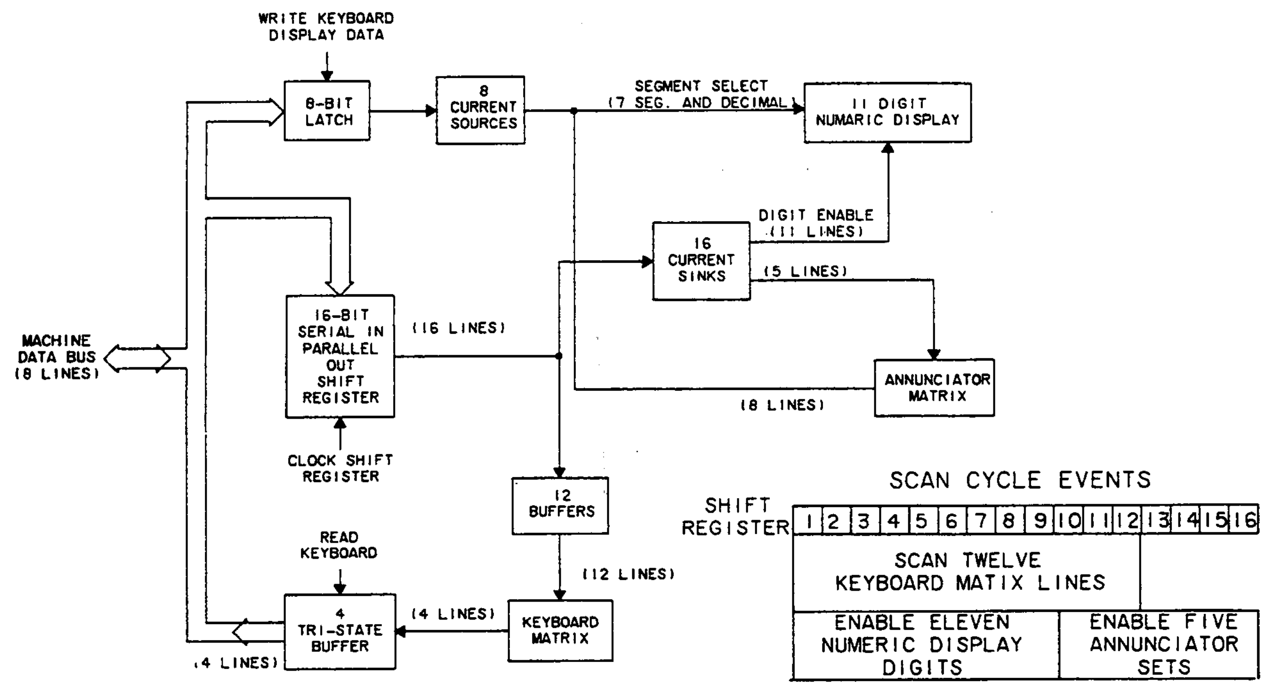


Figure 8-A-1. A15 and A25 Assembly SA0 Test Signal Flow Diagram.

Table 8-A-1. A15 Assembly Signatures.
(The dash indicates an unstable signature.)

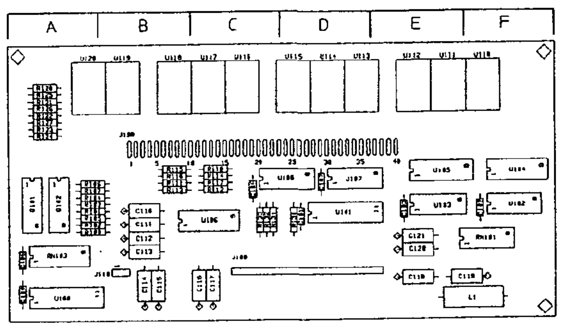
Pin	U100	U101	U102	U103
1	HF3A	HF3A	9F9A	8F97
2	F72U	0000	9F9A	8F97
3	7F6P	0795	50AH	50AH
4	9F9A	0000	8F97	8F97
5	1C15	6057	50AH	50AH
6	F72U	0000	8F97	8F97
7	7F6P	2354	0000	0000
8	9F9A	8F97	2HFH	2HFH
9	1C15	7F6P	HF3A	HF3A
10	0000	0000	50AH	50AH
11	U105	HF3A	8F97	8F97
12	F72U	9F9A	50AH	50AH
13	7F6P	HF3A	8F97	8F97
14	2354	–	HF3A	HF3A
15	1C15	HF3A		
16	F72U	–		
17	6057	HF3A		
18	0795	–		
19	1C15	HF3A		
20	HF3A	HF3A		



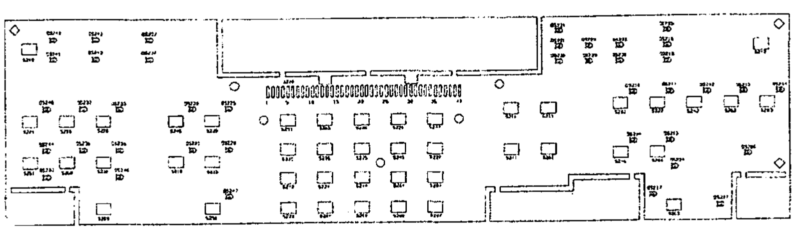
Keyboard and Display Block Diagram

A15 Component Locations

Designator	Board Location	Designator	Board Location	Designator	Board Location	Designator	Board Location	Designator	Board Location
C100	A	C119	F	R107	A	R127	A	U110	F
C101	D	C120	E	R110	C	R130	D	U111	E
C102	F	C121	E	R111	B	R131	C	U112	E
C103	E	J100	C	R112	C	R132	C	U113	D
C107	D	J110	B	R113	B	R133	C	U114	D
C108	C	J199	B	R114	C	RN101	F	U115	D
C109	A	L1	F	R115	B	RN103	A	U116	C
C110	B	Q101	A	R116	B	U100	A	U117	C
C111	B	Q102	A	R117	C	U101	D	U118	B
C112	B	R100	A	R120	A	U102	F	U119	B
C113	B	R101	A	R121	A	U103	E	U120	A
C114	B	R102	A	R122	A	U104	F		
C115	B	R103	A	R123	A	U105	E		
C116	C	R104	A	R124	A	U106	C		
C117	C	R105	A	R125	A	U107	D		
C118	E	R106	A	R126	A	U108	D		



A15
03325-66515



A25
03325-66525

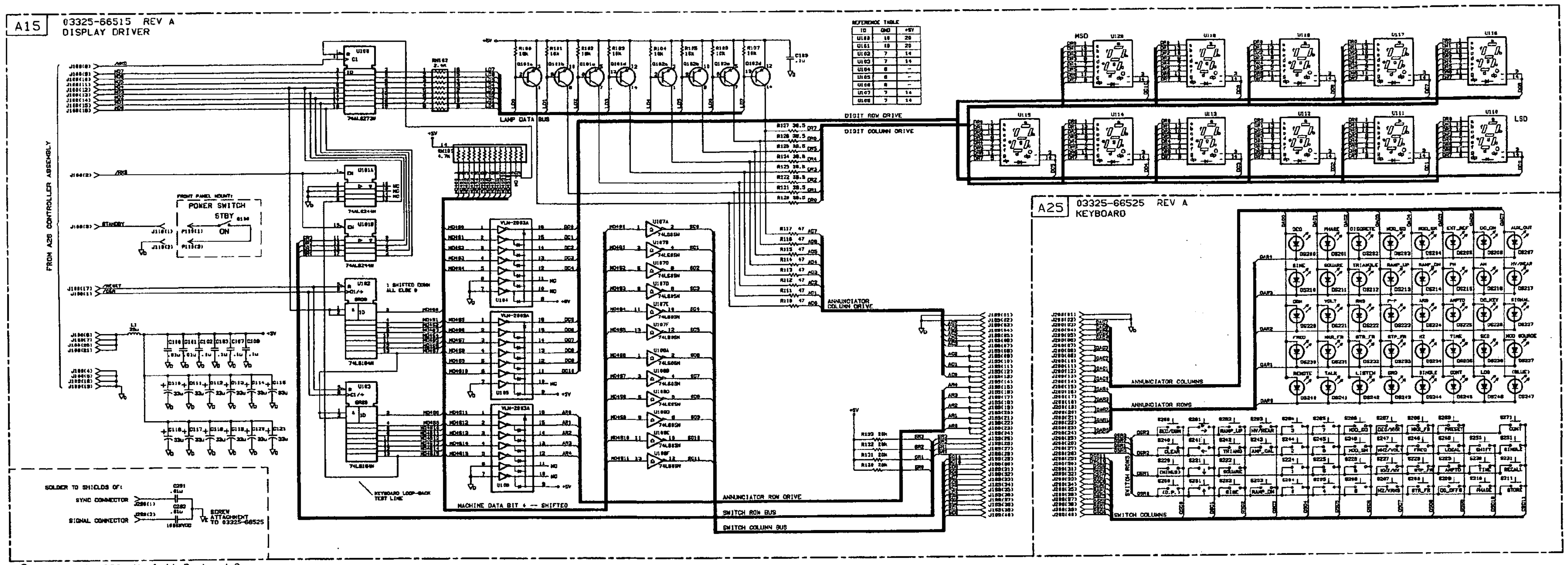


Figure 8-A-2. Keyboard, A25 and Display, A15.

Service Group B
Interface Circuits, A26, A12

SERVICE GROUP B: INTERFACE CIRCUITS, A26.

Troubleshooting Information.

Two Signature Analysis tests are available for troubleshooting the HP-IB and RS-232 circuits. These SA tests can be used to troubleshoot an inoperative HP-IB, RS-232, FAIL 033, or FAIL 034. Before starting a Signature Analysis test, use the following steps to help you isolate the problem.

a. Check that the +5V isolated supply on the A26 assembly is present.

b. Check U119 pin 8 for a 4 MHz clock signal.

c. For HP-IB interface problems, select Special Function 21. This special function lists, on the front panel, any HP-IB signals that are low. Disconnect the HP 3325B from all HP-IB devices. Connect one HP-IB cable to the HP 3325B. Press **Shift, Deg, Self Test, 2, 1** to start the test. Using the disconnected end of the HP-IB cable, connect one pin at a time to pin 24 while watching the display. Pn 1 should appear when pin 1 is connected to pin 24. All pins should respond except pins 10, 12, and 18 through 24. Because the HP-IB is isolated, pins must be shorted to pin 24, not chassis or earth ground. Press Local to quit and cycle power to restore HP-IB operation.

d. For RS-232 interface problems, select Special Function 22. This special function transmits several characters and expects to receive them back. Disconnect the HP 3325B from all RS-232 devices. Connect R173 to R175 at the ends nearest connector J100 on the A26 assembly, or connect pin 2 to pin 3 on the RS-232 connector. Press **Shift, Deg, Self Test, 2, 2** to start the test.

e. Check the serial isolation path by selecting Special Function 12 (press **Shift, Deg, Self Test, 1, 2**). This special function writes data through the serial isolation path, then reads it back. It tests for a stuck /HPIB_INT signal. Power must be cycled after running this test to restore operation.

f. If FAIL 033 occurs, troubleshoot the HP-IB optical isolation circuits with Signature Analysis Test 0.

g. If FAIL 034 occurs, troubleshoot the HP-IB IC (U106) with Signature Analysis Test 0.

h. If FAIL 035 occurs, troubleshoot the RS-232 optical isolator loop.

Signature Analysis Test 0.

Set the POWER switch to STANDBY (⏻), then connect the Signature Analyzer as follows:

Gnd:		A26 TP0 (GND)
Start:	+ slope	A26 TP3 (S/A START STOP)
Stop:	+ slope	A26 TP3 (S/A START STOP)
Clock:	- slope	A26 U39 Pin 1 (/EEDTACK)

Remove any HP-IB or RS-232 cables. Connect D-Ground to B-Ground by shorting A26V101.

Set A26SW100 pin 1 to the **SA0** position. Check that A26SW100 pin 2 (SA1) is in the **NORMAL** position.

Set the POWER switch to ON (I). A26 CR141, CR142, and CR144 should be on. CR143 should be off. If the front panel display is operational, the front panel LEDs will be on in a random pattern.

Check for a +5V signature of HF3A.

If the +5V signature or the A26 LEDs are incorrect, troubleshoot the A26 assembly using the Kernel SA test in Service Group C. If they are correct, troubleshoot using this SA test. Use the Test Signal Flow Diagram (Figure 8-B-1) to help you determine the order to check the signatures and facilitate troubleshooting.

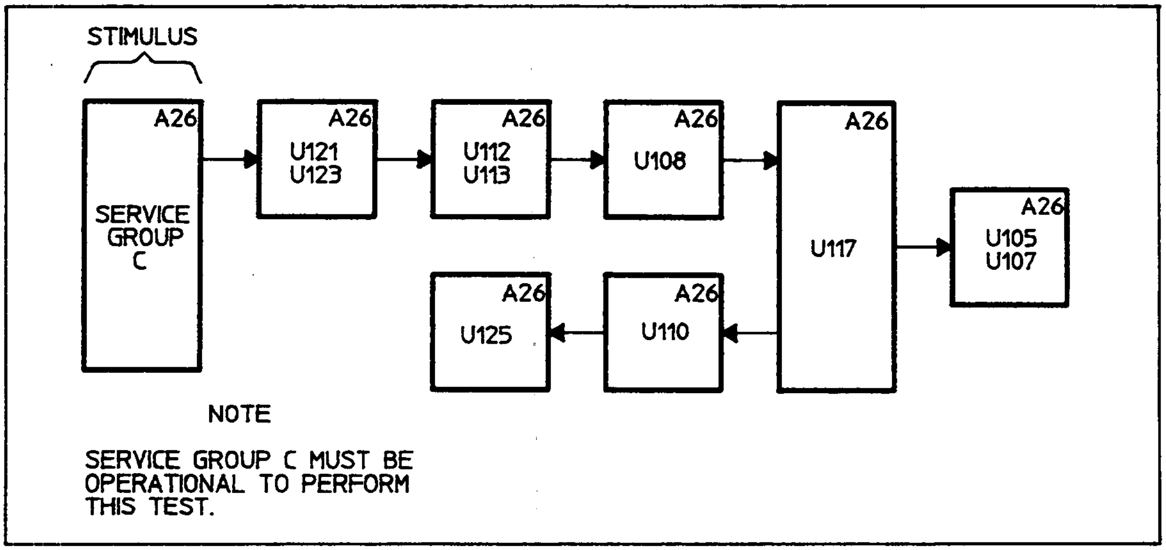


Figure 8-B-1. A26 Assembly SA0 Test Signal Flow Diagram.

Table 8-B-1. A26 Assembly SA0 Signatures.
(The dash indicates an unstable signature.)

Pin	U105	U107	U108	U110	U112	U113	U117	U121	U123	U125
1	5U4H	HF3A	HF3A	A3AA	1U02	1U02	1U02	HU69	6CP1	HF3A
2	HF3A	5U4H	HF3A	7U90	C7HC	F338	1U02	H2U1	HF3A	1U6F
3	HF3A	C2F6	HF3A	5F83	1471	6CP1	1U02	HU69	HF3A	C7HC
4	HF3A	6PUF	HF3A	U2CU	F338	C7HC	C2F6	6CP1	UU65	HF3A
5	0000	8377	HF3A	F338	006F	006F	C2F6	H2U1	4508	C5H3
6	HF3A	C2F6	HF56	1706	0000	HF56	C2F6	6CP1	F173	69P9
7	0000	5U4H	5F83	0000	0000	0000	C2F6	0000	429F	0000
8	HF3A	0000	0000	0000	F338	HF3A	5FU4	HF3A	HF56	–
9	0000	A3AA	1471	1U02	HF56	0000	HF3A	0PFC	HF3A	–
10	HF3A	8377	55AH	F338	F338	1U02	0000	HU69	0000	–
11	0000	6PUF	5F83	U2CU	HF3A	F338	H2F5	6CP1	0000	–
12	0000	5U4H	8F27	F338	HF3A	0000	C7HC	H2U1	68C2	–
13	8377	C2F6	55AH	PHCH	HF3A	HF3A	6PUF	6CP1	U8C2	–
14	HF3A	6PUF	8F27	HF3A	HF3A	HF3A	6PUF	HF3A	7U4F	HF3A
15		8377	H2F5				6PUF		3AC1	
16		HF3A	HF3A				6PUF		A71H	
17							1706		–	
18							0000		–	
19							0000		HF3A	
20							HF3A		HF3A	

Signature Analysis Test 1.

Set the POWER switch to STANDBY (⏻), then connect the Signature Analyzer as follows:

Gnd:		A26 TP0 (GND)
Start:	+ slope	A26 TP3 (S/A START STOP)
Stop:	+ slope	A26 TP3 (S/A START STOP)
Clock:	- slope	A26 U39 Pin 1 (/EEDTACK)

Remove any HP-IB or RS-232 cables. Connect D-Ground to B-Ground by shorting A26V101.

Set A26SW100 pin 2 to the **SA1** position. Check that A26SW100 pin 1 (SA0) is in the **NORMAL** position.

Set the POWER switch to ON (I). A26 CR141, CR142, and CR144 should be on. CR143 should be off. All front panel LEDs should be off.

Check for a +5V signature of 5456.

If the +5V signature or the A26 LEDs are incorrect, troubleshoot the A26 assembly using the Kernel SA test in Service Group C. If they are correct, troubleshoot using this SA test. Use the Test Signal Flow Diagram (Figure 8-B-2) to help you determine the order to check the signatures and facilitate troubleshooting.

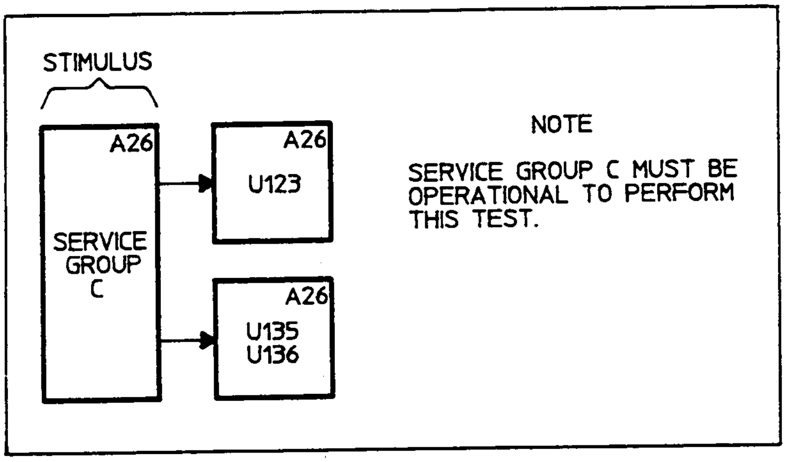
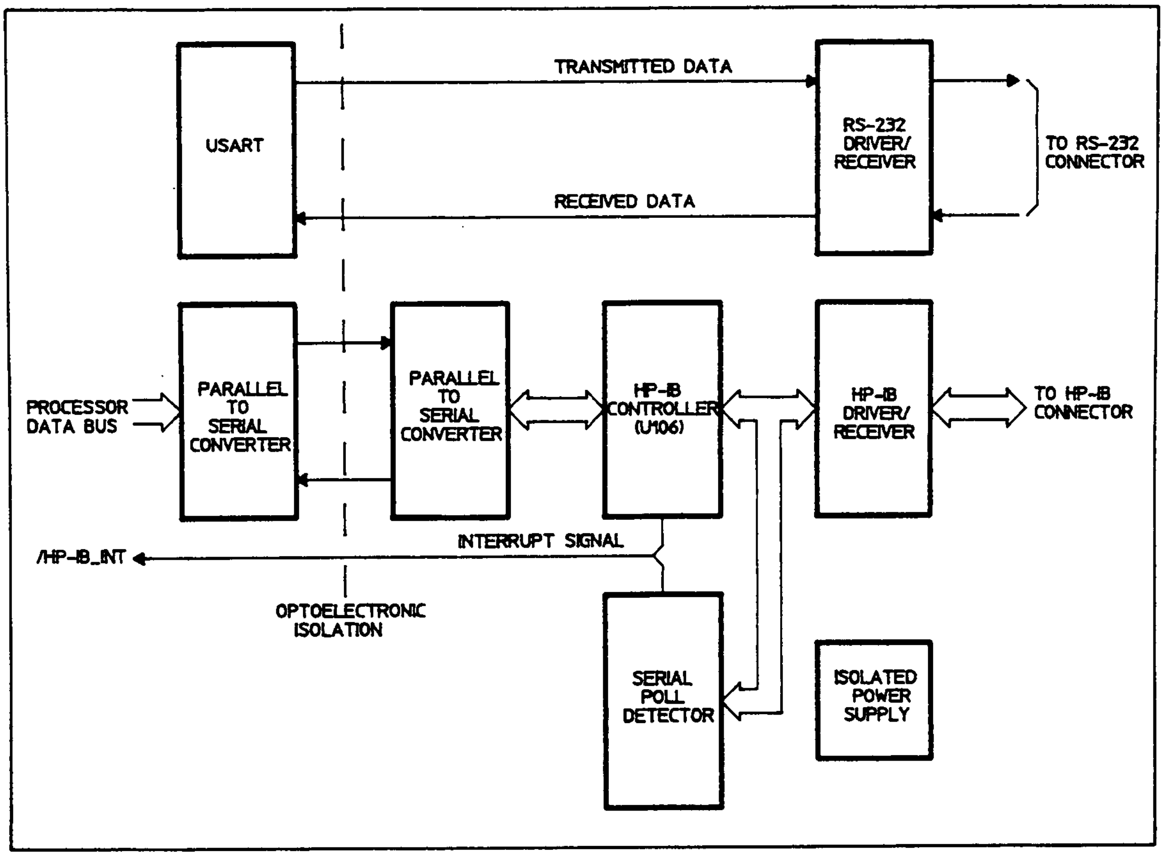


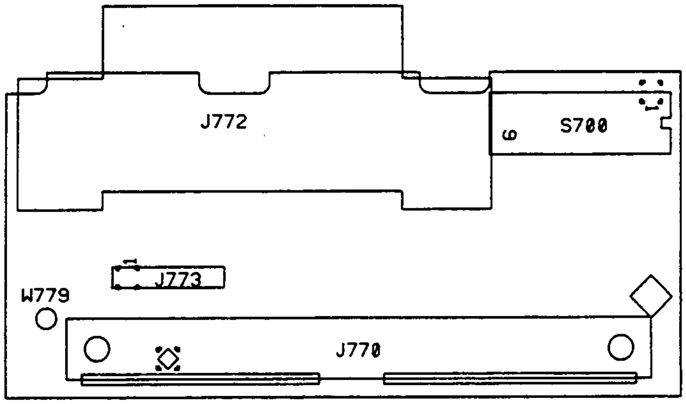
Figure 8-B-2. A26 Assembly SA1 Test Signal Flow Diagram:

Table 8-B-2. A26 Assembly SA1 Signatures.
(The dash indicates an unstable signature.)

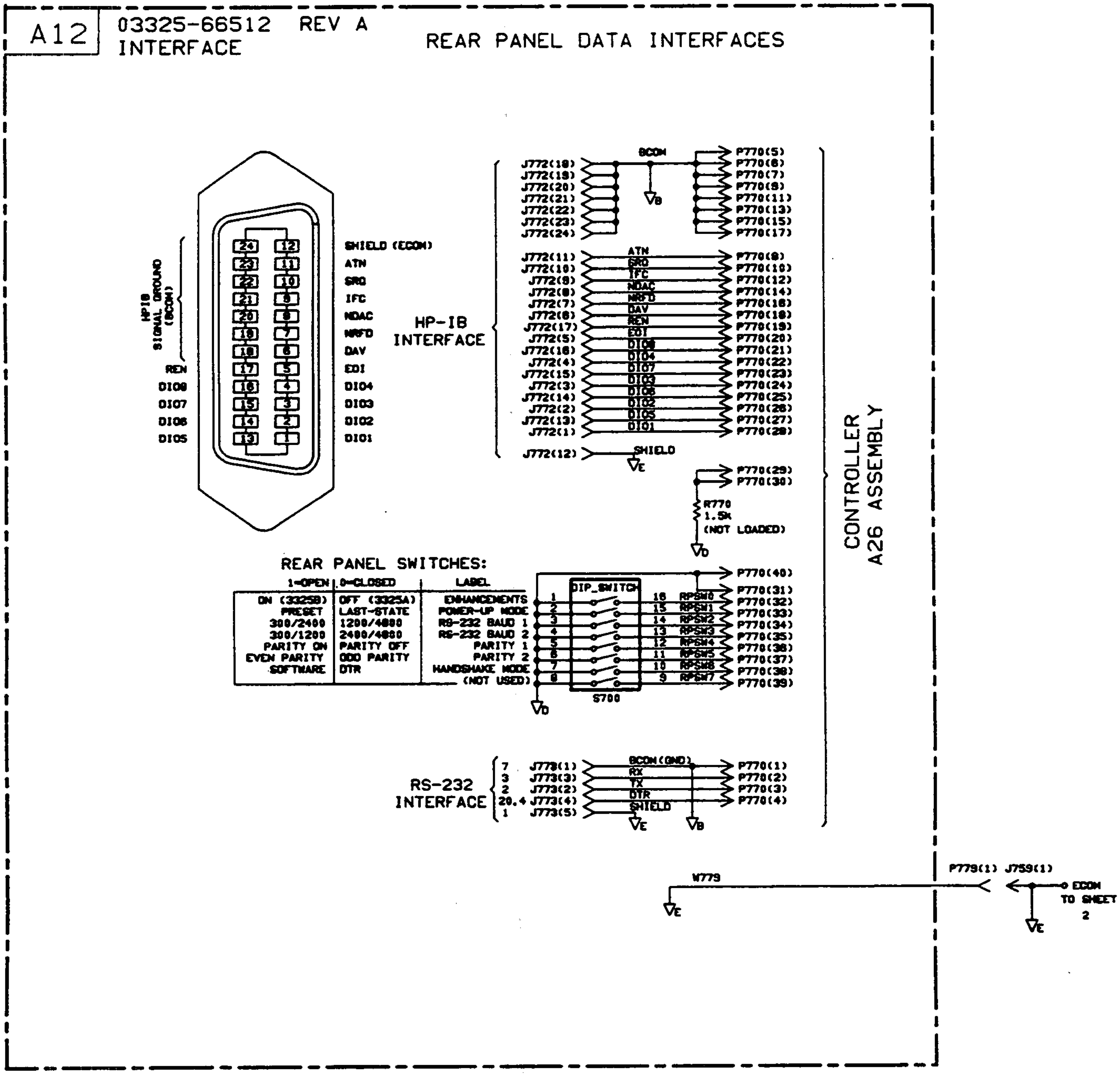
Pin	U123	U135	U136
1	5456	0000	0000
2	5456	–	–
3	5456	–	–
4	–	–	–
5	–	–	–
6	–	–	–
7	–	–	–
8	0000	–	–
9	5456	–	–
10	0000	0000	0000
11	0000	–	–
12	5456	–	–
13	–	–	–
14	–	–	–
15	–	–	–
16	–	–	–
17	0000	–	–
18	–	–	–
19	5456	F3C1	UH28
20	5456	5456	5456

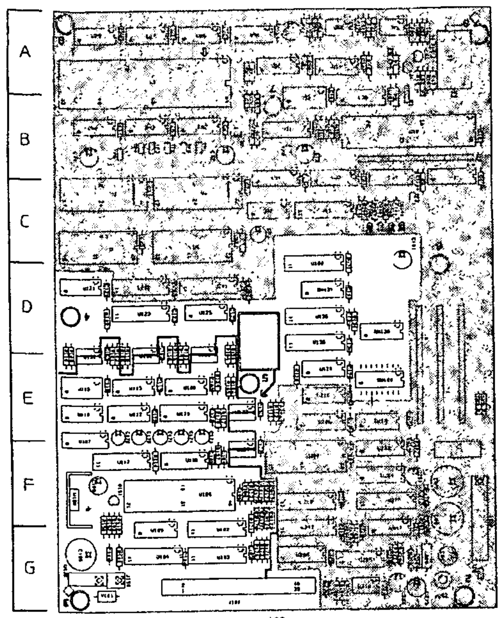


Basic Block Diagram of HP-IB and RS-232 Circuits.



A12
03325-66512





A26
03325-66526

Designator	Board Location	Designator	Board Location	Designator	Board Location	Designator	Board Location	Designator	Board Location
C100	D	C173	E	R103	D	R142	C	U109	E
C101	C	C174	E	R104	F	R143	C	U110	E
C103	G	C175	E	R105	E	R144	C	U112	E
C104	G	C184	G	R106	E	R150	F	U113	E
C106	F	C185	G	R107	D	R151	D	U117	F
C108	F	C189	F	R108	D	R152	F	U119	E
C109	E	CR141	C	R109	D	R153	D	U120	E
C112	E	CR142	C	R110	D	R170	E	U121	D
C113	E	CR143	C	R111	E	R171	G	U123	D
C119	E	CR144	C	R112	E	R173	G	U125	D
C120	E	CR171	F	R113	F	R175	G	U127	F
C121	D	CR172	F	R114	D	R186	F	U130	D
C123	D	CR173	F	R115	D	R187	F	U131	D
C125	D	CR174	F	R116	D	RN130	D	U132	E
C127	F	CR175	F	R117	E	RN131	D	U135	D
C132	E	CR176	F	R118	D	SW100	E	U136	D
C135	D	CR177	F	R119	F	U100	C	U138	G
C136	D	CR178	F	R120	E	U102	G	U150	F
C162	D	J100	G	R121	C	U103	G	U151	D
C163	D	J150	G	R122	D	U104	G	U170	E
C164	F	Q151	F	R123	F	U105	G	Y101	G
C170	E	R100	G	R124	E	U106	F		
C171	E	R101	D	R134	D	U107	E		
C172	E	R102	D	R141	C	U108	F		

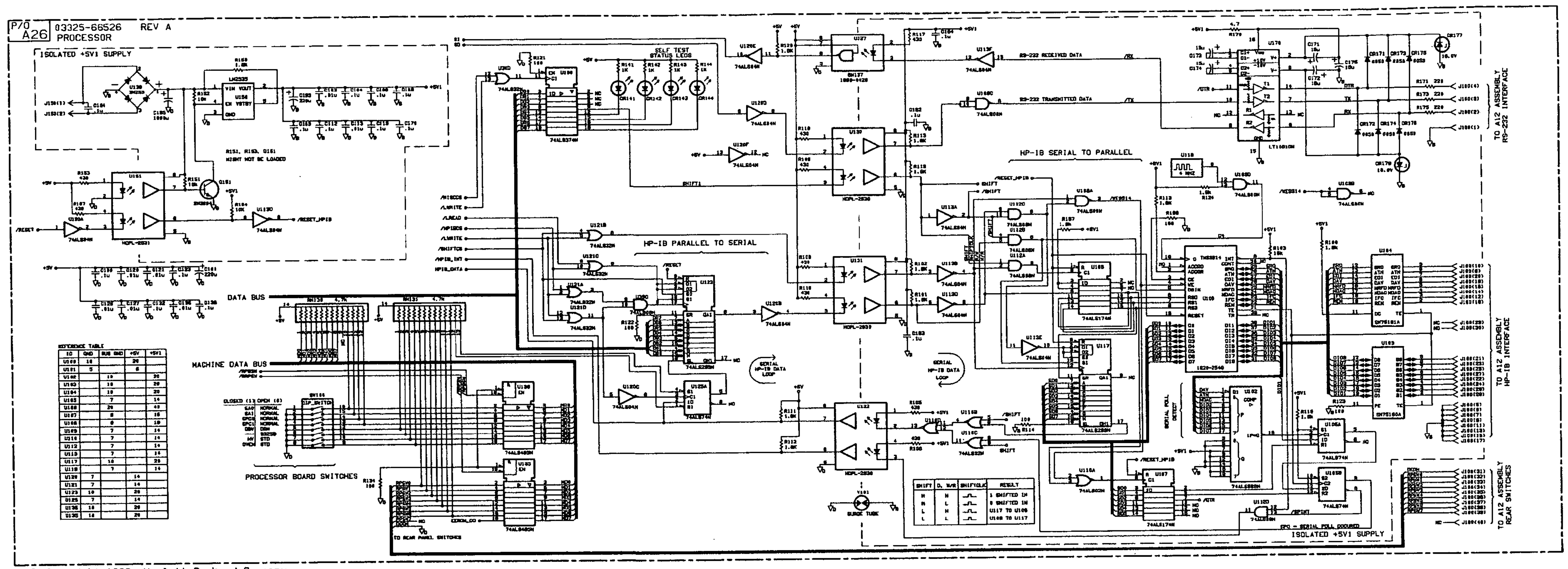


Figure 8-B-3. Interface Circuits, A26, A12

SERVICE GROUP C - CONTROL CIRCUITS, A26.

Troubleshooting Information.

Three Signature Analysis tests are available for troubleshooting the Control circuits.

Kernel SA Test: Checks microprocessor, Address Bus, and address decoding. Use this test to troubleshoot the Control assembly when the Primitive Power On tests and other SA tests fail to run.

SA0 Test: Provides stable signatures on the processor data bus, chip select signals, Machine Data Bus, and Machine Control write signals. The processor, ROM, and Address Bus must be working for this test to run.

SA1 Test: Provides stable signatures on the Machine Control read signals. The processor, ROM, and Address Bus must be working for this test to run.

Before starting a Signature Analysis test, use the following steps to help you isolate the problem.

a. On the Control assembly, watch LEDs CR141 through CR144 sequence through the test codes as the POWER switch is set to the ON (I) position. When a failure occurs, the LEDs blink OFF and ON ten times with the error code. Use Table 8-6 to interpret the error message.

b. Check that the voltages from the power supply are present on the Control assembly.

c. Check the processor clock circuitry for correct frequencies.

d. Set the POWER switch to STANDBY (⏻), then disconnect J2, J3, and J4 on the Control assembly. Set the POWER switch to ON (I). If FAIL 31, 32, 39, or FAIL 21 through 29 is displayed, then a significant portion of the processor circuitry is working, and you should start troubleshooting with SA0. If no FAIL messages are displayed, then start troubleshooting with the Kernel SA test.

KERNEL SA TEST:

Set the POWER switch to STANDBY (⏻), then connect the Signature Analyzer as follows:

Gnd:		A26 TP0 (GND)
Start:	+ slope	A26 TP3 (S/A START STOP)
Stop:	+ slope	A26 TP3 (S/A START STOP)
Clock:	+ slope	A26 TP2 (S/A CLOCK)

Connect the following A26 test points to ground (TP0):

TP4 (DB8)
TP5 (DB15)
TP7 (MFPDTACK)
TP8 (BUS DISABLE)

Connect U14 pin 2 to +5V.

Set the POWER switch to ON (I). Momentarily short A26U1 pin 5 to ground (pin 5 has an arrow pointing to it). This will cause the microprocessor to sequence through the entire address space repeatedly. Except U1, all other devices on the Data Bus are disabled.

Check for a +5V signature of A70F (it will take about 4 seconds to acquire each signature). If this is incorrect, check Data Bus lines DB0 through DB15 with an oscilloscope. DB8 and DB15 should be low, all others should be high.

Use the Test Signal Flow Diagram (Figure 8-C-1) to help you determine the order to check the signatures and facilitate troubleshooting.

NOTE

This test should run if J2, J3, and J4 are unplugged. J10 can be unplugged if TP6 (STBY) is connected to ground to turn on the power supply. This test should also run if A26U2, U3, U6, U7, and U10 are removed.

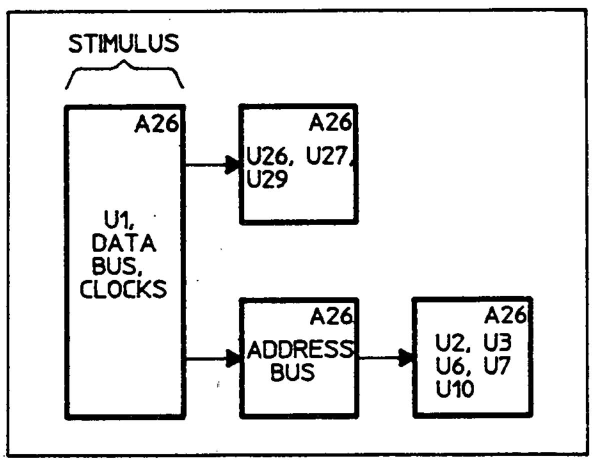


Figure 8-C-1. A26 Assembly Kernel SA Test Signal Flow Diagram.

Table 8-C-1. A26 Assembly Kernel SA Signatures.
(The dash indicates an unstable signature.)

Pin	U1	U26	U27	U29
1	A70F	0000	A70F	0000
2	A70F	0000	0000	A70F
3	A70F	0000	–	A70F
4	A70F	0000	A70F	A70F
5	A70F	0000	9P86	9P86
6	–	0000	398A	398A
7	0000	0000	0000	0000
8	0000	A70F	398A	9P86
9	A70F	0000	9P86	A70F
10	0000	A70F	0000	A70F
11	A70F	A70F	0000	398A
12	A70F	A70F	A70F	A70F
13	A70F	0000	0000	A70F
14	A70F	A70F	A70F	A70F
15	–			
16	0000			
17	A70F			
18	A70F			
19	–			
20	–			
21	–			
22	A70F			
23	A70F			
24	–			
25	–			
26	A70F			
27	A70F			
28	0000			
29	62UC			
30	HP56			
31	9344			
32	18CU			
33	9P86			
34	3951			
35	UUUU			
36	AA44			
37	H133			
38	AH0P			
39	69F8			
40	2127			
41	5CC2			
42	A214			
43	H483			
44	HFFH			
45	62UC			
46	HP56			
47	9344			
48	18CU			
49	–			
50	9P86			
51	9P5H			
52	9P5H			
53	–			
54	–			

Signature Analysis TEST 0.

Set the POWER switch to STANDBY (⏻), then connect the Signature Analyzer as follows:

Gnd:		A26 TP0 (GND)
Start:	+ slope	A26 TP3 (S/A START STOP)
Stop:	+ slope	A26 TP3 (S/A START STOP)
Clock:	− slope	A26 U39 Pin 1 (/EEDTACK)

Set A26SW100 pin 1 to the **SA0** position. Check that A26SW100 pin 2 (SA1) is in the **NORMAL** position.

Set the POWER switch to ON (⏻). A26 CR141, CR142, CR144 should be on. CR143 should be off. If the front panel display is operational, all LEDs will be on in a random pattern.

Check for a +5V signature of HF3A.

The microprocessor, ROM, and address bus must be working for this test to run. If the LEDs or the +5V signature are incorrect, troubleshoot the A26 assembly using the Kernel SA test. If they are correct, troubleshoot the A26 assembly using this SA test. Use the Test Signal Flow Diagram (Figure 8-C-2) to help you determine the order to check the signatures and facilitate troubleshooting.

NOTE

This test should run if J2, J3, and J4 are unplugged. J10 can be unplugged if TP6 (STBY) is connected to ground to turn on the power supply.

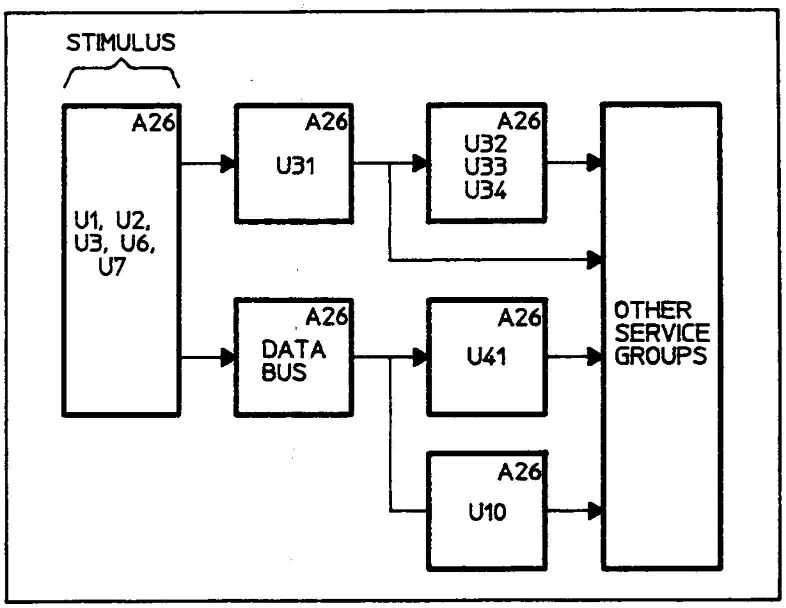


Figure 8-C-2. A26 Assembly SA0 Test Signal Flow Diagram.

Table 8-C-2. A26 Assembly SA0 Signatures.
(The dash indicates an unstable signature.)

Pin	U10	U31	U32	U33	U34	U41
1	–	–	1H05	–	–	0PFC
2	–	–	F13U	–	–	A71H
3	–	–	F13U	–	–	UU65
4	–	0000	1H05	0PFC	H2U1	3AC1
5	–	0000	P325	UHU1	UHU1	4508
6	–	HF3A	3U1U	HF3A	HF3A	7U4F
7	–	UF24	0000	HF3A	FPP9	F173
8	–	0000	H3U1	0000	0000	U8C2
9	–	HHHC	0UFC	HF3A	U105	429F
10	–	2305	HF3A	HF3A	0UFC	0000
11	–	9972	0000	HF3A	P325	7F6P
12	–	UHU1	0000	HF3A	HF3A	9F9A
13	–	HU69	HF3A	HF3A	1H05	7F6P
14	–	6CP1	HF3A	HF3A	1P3C	9F9A
15	–	0PFC		HF3A	2HFH	7F6P
16	–	HF3A		HF3A	HF3A	2354
17	–					6057
18	–					0795
19	–					UHU1
20	–					HF3A
21	–					
22	55C5					
23	1U6F					
24	–					
25	F414					
26	–					
27	–					
28	–					
29	–					
30	–					
31	–					
32	HF3A					
33	HF3A					
34	0000					
35	–					
36	–					
37	A71H					
38	UU65					
39	3AC1					
40	4508					
41	7U4F					
42	F173					
43	U8C2					
44	429F					
45	HF3A					
46	HF3A					
47	0000					
48	HF3A					

Signature Analysis Test 1.

Set the POWER switch to STANDBY (⏻), then connect the Signature Analyzer as follows:

Gnd:		A26 TP0 (GND)
Start:	+ slope	A26 TP3 (S/A START STOP)
Stop:	+ slope	A26 TP3 (S/A START STOP)
Clock:	- slope	A26 U39 Pin 1 (/EEDTACK)

Set A26SW100 pin 2 to the **SA1** position. Check that A26SW100 pin 1 (SA0) is in the NORMAL position.

Set the POWER switch to ON (I). A26 CR141, CR142, CR144 should be on. CR143 should be off. All front panel LEDs should be off.

Check for a +5V signature of 5456.

The microprocessor, ROM, and the address bus must be working for this test to run. If the LEDs or the +5V signature are incorrect, troubleshoot the A26 assembly using the Kernel SA test. If they are correct, troubleshoot the A26 assembly using this SA test. Use the Test Signal Flow Diagram (Figure 8-C-3) to help you determine the order to check the signatures and facilitate troubleshooting.

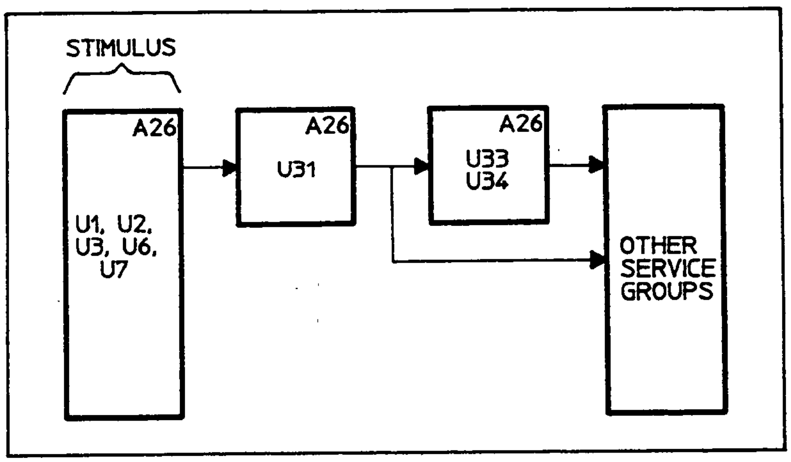
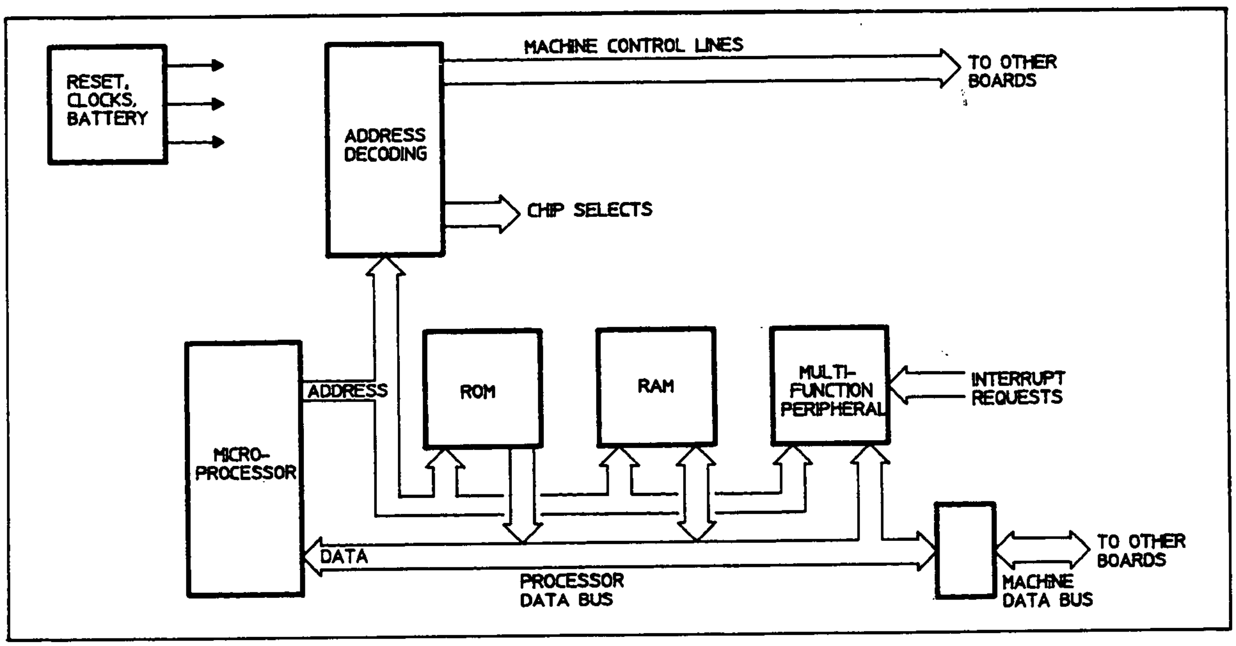


Figure 8-C-3. A26 Assembly SA1 Test Signal Flow Diagram.

Table 8-C-3. A26 Assembly SA1 Signatures.
(The dash indicates an unstable signature.)

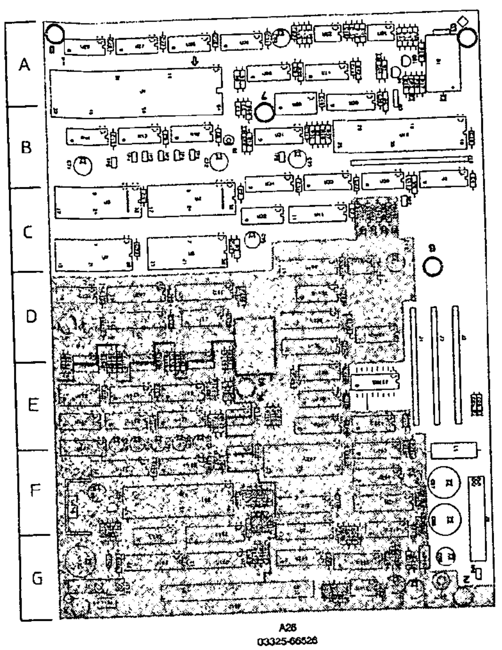
Pin	U31	U33	U34
1	–	–	–
2	–	–	–
3	–	–	–
4	0000	0000	5456
5	0000	3789	3789
6	5456	5456	5456
7	5476	7404	5456
8	0000	0000	0000
9	5456	517F	5456
10	5653	06UU	5456
11	5456	7PF1	5456
12	3789	5456	5456
13	5456	5456	5456
14	5456	UH28	5456
15	61UA	F3C1	5456
16	5456	5456	5456



Basic Block Diagram of Control Circuits

A26 Component Locations

Designator	Board Location	Designator	Board Location	Designator	Board Location	Designator	Board Location	Designator	Board Location
B1	A	C072	B	Q004	A	R087	A	U026	A
C001	B	C073	B	Q081	A	R088	A	U027	A
C002	C	C081	A	R001	A	R089	A	U029	A
C003	C	C082	A	R002	B	R098	A	U030	A
C004	B	C083	A	R003	C	R099	B	U031	B
C005	B	C085	G	R005	B	RN002	B	U032	C
C006	B	C086	F	R006	B	RN003	B	U033	B
C007	C	C087	F	R007	A	RN004	B	U034	B
C008	A	C095	C	R008	A	SW100	E	U038	B
C009	B	C097	C	R010	B	TP0	B	U039	B
C010	B	C099	C	R012	B	TP1	B	U041	C
C011	B	CR002	B	R014	F	TP2	B	U081	A
C012	A	CR003	A	R015	A	TP3	B	U082	A
C013	B	CR004	A	R016	A	TP4	B	U098	A
C014	A	CR005	E	R017	A	TP5	B	U099	B
C026	A	CR006	E	R018	A	TP6	G		
C027	A	J001	B	R031	B	TP7	C		
C029	A	J002	D	R037	B	TP8	B		
C030	A	J003	D	R042	A	U001	A		
C031	B	J004	D	R081	A	U002	C		
C033	B	J005	F	R082	A	U003	C		
C034	C	J010	B	R083	A	U006	C		
C038	A	L001	F	R084	A	U007	C		
C040	B	Q002	B	R085	A	U010	B		
C071	B	Q003	B	R086	A	U014	A		



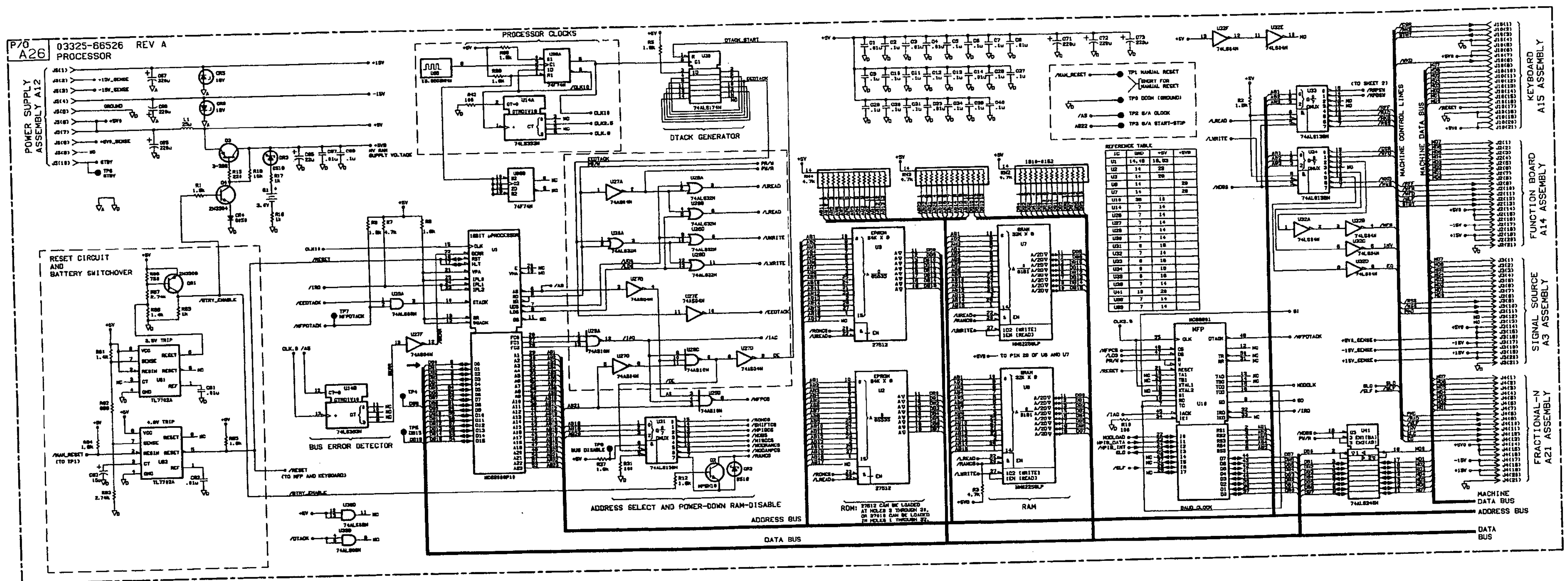


Figure 8-C-4. Control Circuits, A26.

Service Group D
VCO, A21 and
VCO Buffer, A3

SERVICE GROUP D - VOLTAGE CONTROLLED OSCILLATOR SHIELD.

The VCO circuit is covered by a shield consisting of a flat cover and an extrusion. Always set the POWER switch to STANDBY (⏻) before removing or replacing the shield. When replacing the shield, make sure the notches on the bottom edge of the extrusion are aligned to avoid shorting the signal traces on the printed circuit board to ground. Also, make sure the hole in the cover is over the VCO adjustment coil.

Voltage Controlled Oscillator Troubleshooting.

"FAIL 031" or "FAIL 032" Display Indication.

a. With an oscilloscope, check the reference pulse signal at A21U1 pin 11. This should be a very narrow pulse with an amplitude of approximately 2 V p-p at a frequency of 100 kHz.

If this signal is correct, go to Step b.

If this signal is not correct, go to Service Group G.

CAUTION

Do not allow disconnected cable connectors to contact the printed circuit boards or components, or circuits may be damaged.

b. Check the +5V, +15V, and -15V power supply voltages at the following points:

+5V ----- C33 (Service Group F)

+15V ----- C10 (Service Group F)

-15V ----- C26 (Service Group F)

Moreover, when the problem has been isolated to the functional block, the first step should be a check of the power supply voltage into the functional block.

c. Make sure the VCO oscillates at the top and bottom of its frequency range. Disconnect the cable from A21J18A (cable marked 18 S-H). This is the VCO control voltage. Measure the frequency of the signal at A21U34 pin 14 and at A21Q161 collector. The frequency should be approximately 45MHz. If the frequency is not approximately 45MHz, check varicaps CR164 and CR166.

d. Place an external dc voltage (-3V to +10V) at the VCO input and note the following frequencies at the collector of Q161 and at U34 pin 14.

DC Voltage	Frequency
−3V	60.9MHz
+5V	42.6MHz
+10V	30 MHz

If the VCO frequency is not correct, disconnect the external DC power supply and measure the DC voltages noted on the VCO schematic diagram. Voltages should be within ±10%. (Voltages are measured with A21J18A still disconnected.)

If the VCO frequencies are correct, go to step e.

e. Reconnect the cable to A21J18A. Measure the voltage levels at A21U33 pins 1 and 7. The voltage at one of these pins may be at approximately +13V, and the other at a negative voltage. (If the frequency synthesis circuits are operating correctly, both pins will be negative.

f. Connect an oscilloscope to A21TP9.

If pin 1 of A21U33 is positive, and the signal at TP9 is always positive, the trouble is probably in the Integrator, Bias, or Sample/Hold circuits. Go to Service Group F.

If pin 1 of A21U33 is positive and the signal at TP9 is mostly negative, the trouble is probably in the ÷N.F Counter circuits, Service Group E, or the Phase Comparator, Service Group F.

If pin 7 of A21U33 is positive, and the signal at TP9 is always positive, the trouble is probably in the ÷N.F Counter circuits, Service Group E, or the Phase Comparator, Service Group F.

If pin 7 of A21U33 is positive, and the signal at TP9 is mostly negative, the trouble is probably in the Integrator, Bias, or Sample/Hold circuits. Go to Service Group F.

No Rear Panel AUX Output, or Incorrect AUX Frequency (Either One-Half or Two Times the Programmed Frequency).

a. Check A3J3 for AUX output and correct AUX frequency. If the signal at A3J3 is correct, troubleshoot the FAST Sync circuitry in Service Group K. If the signal at A3J3 is not correct, go to Step b.

b. Set function to sine, frequency to 10 MHz. Measure voltage level at A3U18 pin 9. Should be a TTL high level ($\geq +2.4V$). If not, go to Step g.

c. Set frequency to 21 MHz. Voltage level at A3U18 pin 9 should be TTL low ($\leq +0.4$ V). Voltage at A3U18 pin 6 should be high. If either voltage is not correct go to Step g.

d. Set frequency to 29.999 999 999 MHz. Voltage levels should be the same as in Step c.

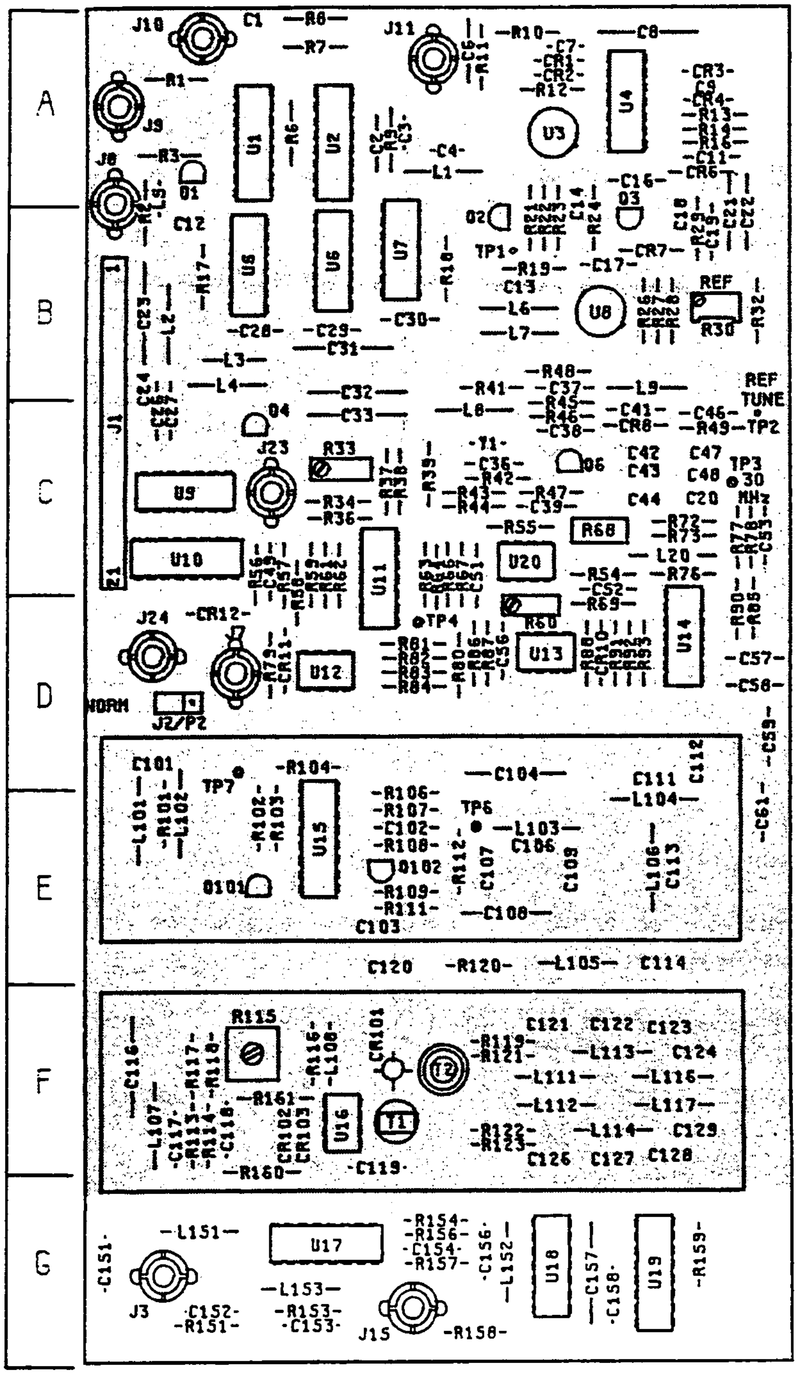
e. Set frequency to 30 MHz. Voltage at A3U18 pin 6 should be low, pin 9 should be low.

f. If all of the above levels are correct, the trouble is probably in A3U18, U19, C152, or R158.

g. If any of the above levels is incorrect, check input pins 12 and 13 of A3U10 for the presence of TTL level pulses.

If input pulses are present, A3U10 may be defective.

If input pulses are not present, go to Control Logic troubleshooting, Service Group C.



A3
03325-66503
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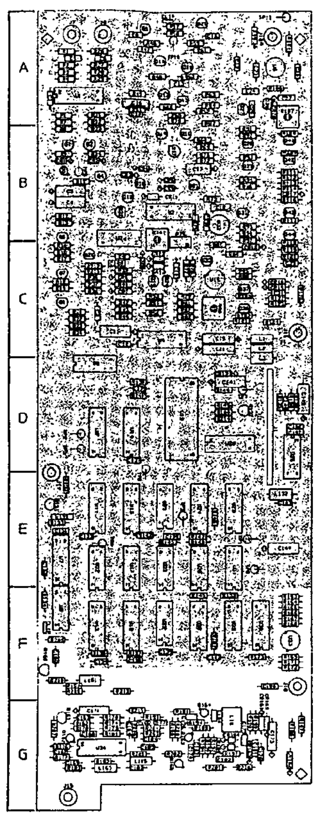
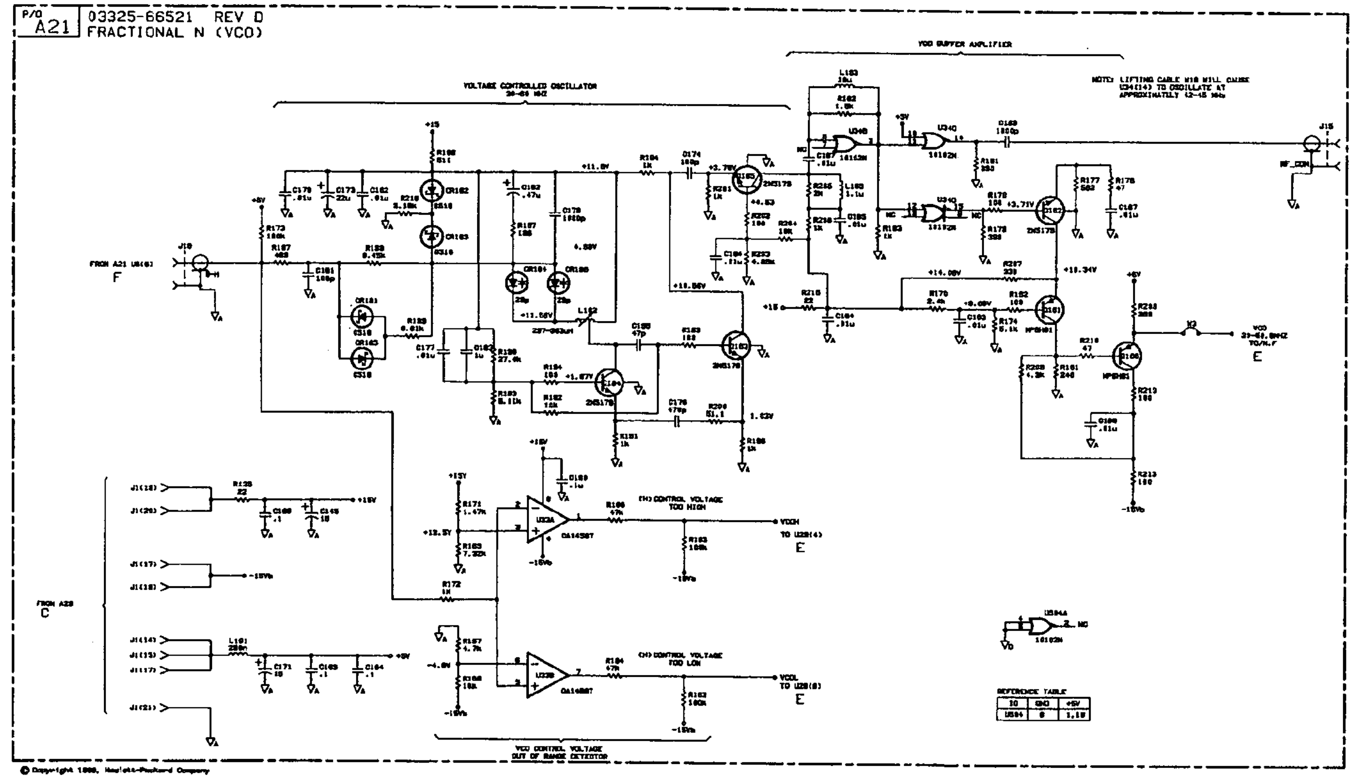


Designator	Board Location	Designator	Board Location
C162	G	R169	F
C163	G	R170	G
C164	G	R171	F
C167	G	R172	F
C168	G	R173	F
C169	G	R174	G
C171	G	R175	G
C173	G	R176	G
C174	G	R177	G
C176	G	R178	G
C177	G	R181	G
C178	G	R182	G
C179	G	R183	G
C181	G	R184	C
C182	G	R185	G
C183	G	R187	G
C184	G	R188	G
C185	G	R189	G
C186	F	R191	G
C187	G	R192	G
C190	F	R193	G
C194	G	R194	G
CR161	G	R196	G
CR162	G	R197	G
CR163	G	R198	G
CR164	G	R199	G
CR165	G	R200	G
CR166	G	R201	G
J1	D	R202	G
J18	F	R203	G
L161	F	R204	G
L162	G	R205	G
L163	G	R206	G
L165	G	R207	G
Q161	G	R208	F
Q162	G	R209	F
Q163	G	R210	F
Q164	G	R213	F
Q165	G	R215	G
Q166	F	R216	G
R161	F	U33	F
R162	G	U34	G
R163	F		
R164	F		
R165	F		
R166	F		
R167	F		
R168	F		

A21 Component Locations



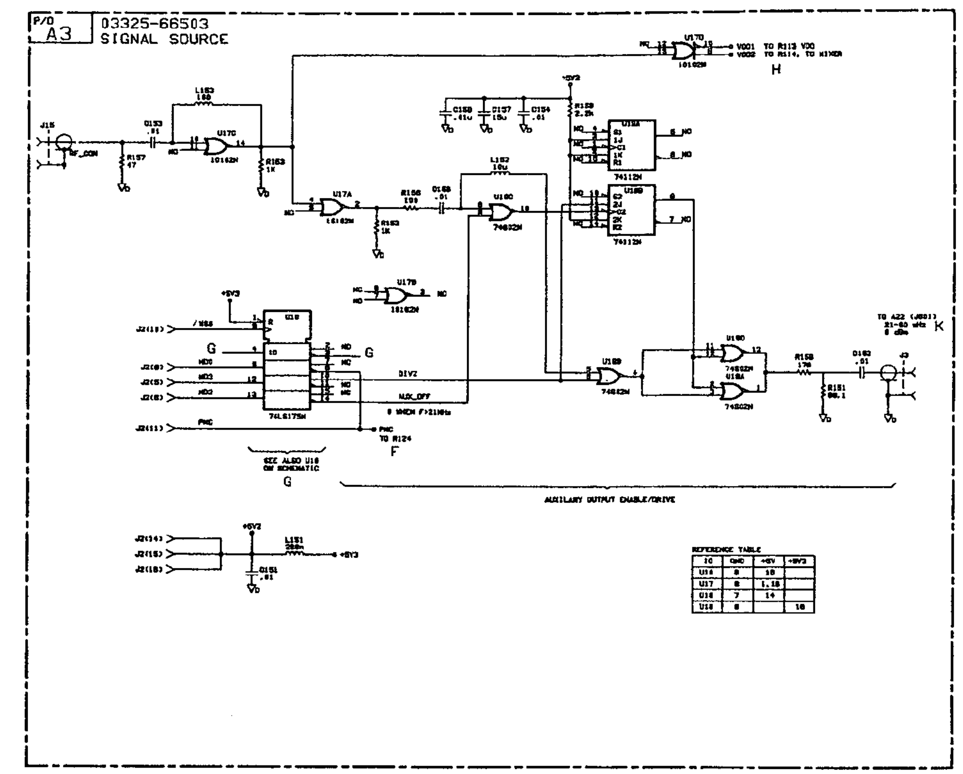


Figure 8-D-1. VCO, A21 and VCO Buffer, A3.
8-D-5/8-D-6

SERVICE GROUP E · ÷N.F COUNTER.

÷N.F Counter Troubleshooting.

CAUTION

Do not allow disconnected cable connectors to contact the printed circuit boards or components, or circuits may be damaged.

a. To check the ÷N circuitry, program the front panel for a frequency of 10MHz and disconnect cable W18 at J18A.

b. Place an external DC voltage source at the input to the VCO (-3V to +10V), and monitor the waveform at U1 pin 6. The 2Vp-p narrow pulse should begin to approach a frequency of 100kHz as the external DC control voltage is varied.

If the frequency does not approach 100kHz, troubleshoot the ÷N circuitry (step c). Note that the frequency will approach 100kHz for every N number programmed into the 3325 and with the appropriate DC level at the VCO input.

If the frequency at U1 pin 6 approaches 100kHz and the problem appears to be digitally related, check that the API current sources are getting the correct signals and that the FETs are not leaking (see Service Group F).

c. Disconnect the external power supply. Leave cable W18 disconnected at A21J18A.

d. Measure and note the frequency of the VCO signal at jumper W3. This signal should be approximately 45MHz.

e. Connect test points A21TP6 and A21TP8 to ground. This disables the ÷N Shift Register and the Pulse Remove circuits.

f. Measure the frequency at each of the following points in order, and determine the relationship to the VCO frequency at W3 (step d). Replace any defective components.

A21TP1 should be VCO ÷ 2. If not correct, check A21U32 and A21U27 for signal transitions at the input and output pins.

A21TP2 should be VCO ÷ 10. If not correct, check A21U13 and A21U18.

A21U21 pin 8 should be VCO ÷ 100. If not, check A21U9.

A21TP3 should be VCO ÷ 1000. If not correct, check A21U9, A21U11, A21U21, and A21U22.

A21TP4 should be VCO ÷ 1000. If not, check A21U12 and A21U22.

A21TP5 should be VCO ÷ 10. If not, check A21U24.

A21TP7 should be VCO ÷ 1000. If not, check A21U29.

A21Q131 collector should be VCO ÷ 1000 (very narrow pulse at approximately 2Vp-p). If not, check A21U26, A21U27, A21Q131, and A21C131.

A21U19 pins 2, 3, 4, 5, 6, 10, and 11 should be VCO ÷ 1000. If not, A21U19 is probably defective.

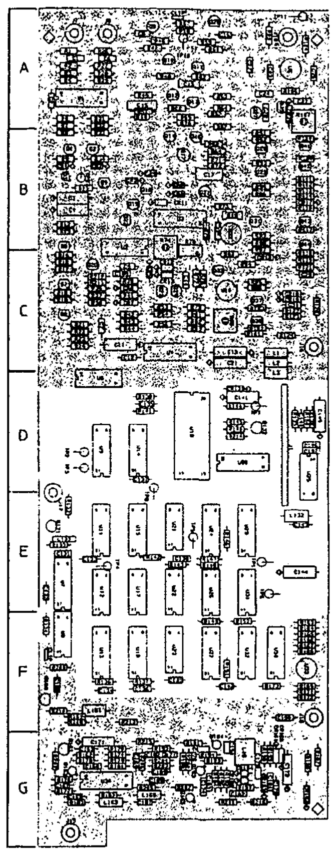
g. If all of the above signals are correct, check for the presence of input pulses at A21U19, pins 20 through 23.

h. Reconnect cable to A21J18A. Press the START CONT key and check for the presence of pulses at A21U19, pins 11, 13, 14, 15, 16, and 17.

i. Disconnect ground from A21TP6 and A21TP8. While in continuous sweep mode, check for the presence of pulses at the input pins, output pins, and clock pins of A21U14 and A21U15. If pulses appear at the input pins and clock inputs and the level at the clear inputs (pin 1) is high, replace the defective latch IC. If pulses are also present at the outputs, the gates in the ÷ 5 Counter circuit (A21U12, A21U17, A21U23) may be defective.

Designator	Board Location	Designator	Board Location
C131	E	R149	F
C132	E	R150	D
C133	E	R151	F
C134	F	R152	F
C135	D	R173	F
C136	F	R214	D
C137	D	TP01	E
C138	E	TP02	D
C139	F	TP03	D
C140	D	TP04	E
C141	D	TP05	E
C142	F	TP06	E
C143	E	TP07	D
C144	E	TP08	E
C145	D	U07	E
C196	D	U08	F
C197	D	U09	D
CR131	D	U11	E
J01	D	U12	E
J17	E	U13	F
L132	E	U14	D
L133	E	U15	E
Q131	E	U17	E
Q132	D	U18	F
R130	D	U19	D
R132	E	U21	E
R133	E	U22	E
R134	F	U23	F
R135	D	U24	E
R136	F	U25	D
R137	F	U26	E
R138	D	U27	F
R140	D	U28	D
R141	D	U29	E
R142	E	U30	F
R143	E	U31	E
R144	D	U32	F
R145	D	U34	G
R146	E		
R147	E		
R148	E		

A21 Component Locations



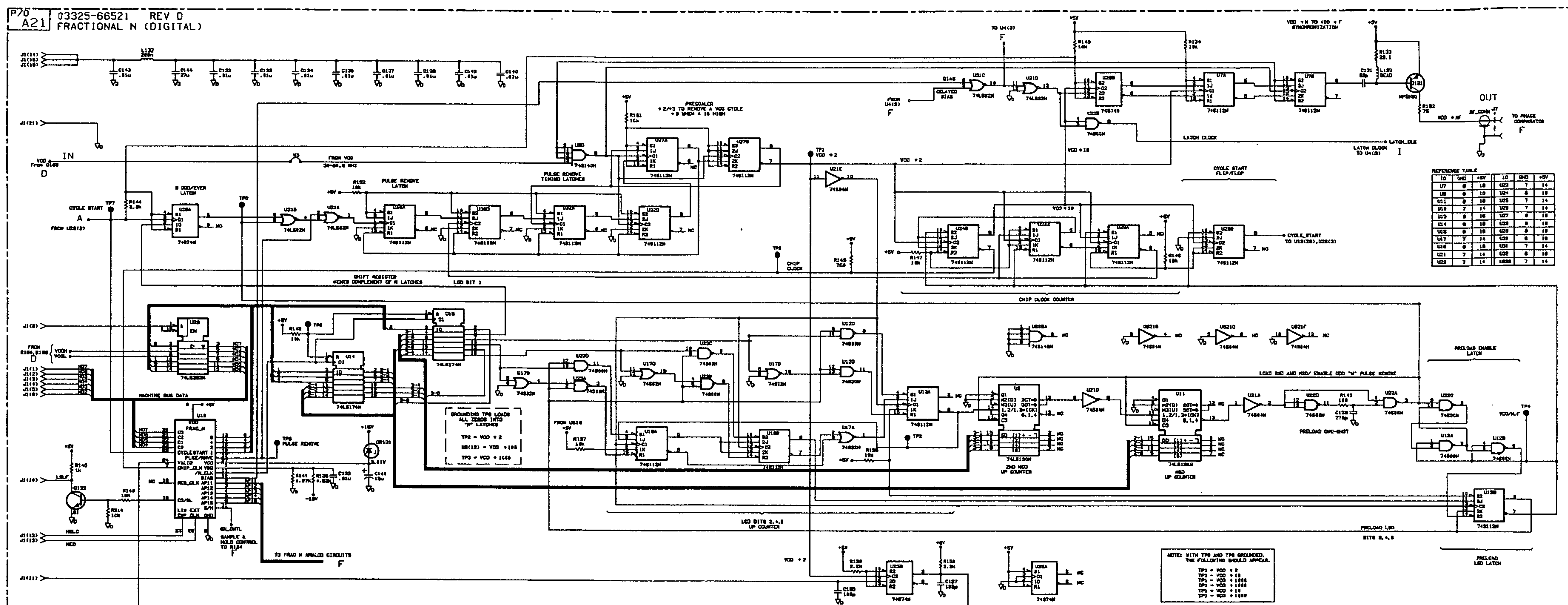


Figure 8-E-1. ÷ N.F. Counter, A21.
8-E-3/8-E-4

Service Group F
Fractional N Analog
Circuits, A21

SERVICE GROUP F · FRACTIONAL N ANALOG CIRCUITS.

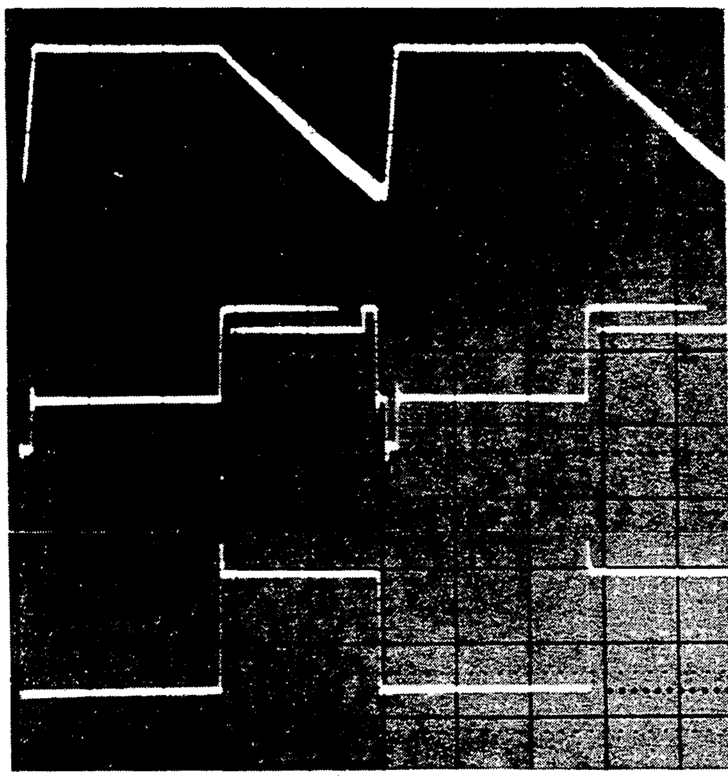
Fractional N Analog Troubleshooting.

If pin 1 of A21U33 is positive (in Service Group D Troubleshooting) and the signal at TP9 is always positive, or if pin 7 of A21U33 is positive and the signal at TP9 is mostly negative, the trouble is probably in the Integrator, Bias, or Sample/Hold circuits.

The following waveforms may be observed at the points indicated. If the Bias/API waveforms are correct, but the Integrator output is not correct, the trouble is probably in the Integrator, Current Sources, or the Sample/Hold circuit.

Set the frequency to 1 kHz, function to sine, and observe the waveform below.

a. If the Counter circuit and VCO are working correctly but the VCO is still not tuning properly, set the frequency to 1.1MHz and the amplitude to 10Vp-p and test for the correct signal at A21TP10 (see Figure 8-F-1). Make sure cable W18 is connected from the Sample and Hold output to the VCO input.



b. If the waveform at TP10 is rounded or slightly distorted, make sure the Sample/Hold FETs are not leaking.

c. If the waveform at TP10 is bad, test the integrator and Sample/Hold circuitry. Heat sink and remove A21CR4 and A21CR8 to open the phase locked loop at the integrator input. These diodes are a prime noise source especially when overheated. Install jumper W2. This jumper places a 1kΩ resistor in parallel with C17, changing the integrator to a transconductance amplifier (Eout = -1000 x Iin). While monitoring the integrator output at TP10 and the Sample/Hold output at TP11, inject various currents from -12mA to +5mA into the integrator input. An easy way to accomplish this is to use a dc power supply with a 1kΩ resistor in series with its output. Every volt from the power supply will inject 1mA into the integrator. The voltage at TP10 and TP11 should equal the power supply voltage only it will be opposite in polarity.

If the voltage at TP10 is correct but the voltage at TP11 is not, troubleshoot the Sample/Hold circuitry. Apply +5V to A21U6(3). The output voltage at TP11 should be +5V. If not, replace U6. If the voltage at TP11 is correct, momentarily short across A21C24, then apply the +5V at the junction of A21Q27 (drain) and A21Q39 (source). The voltage at TP11 should be +5V. If not, check for the presence of the Sample/Hold Control signal from the base of A21Q44 through to the gates of Q27 and Q39. This signal should be a 0.3 to 0.6μs TTL pulse at 100kHz. The pulse width is derived from the VCO frequency (VCO/10) and the repetition rate is derived from VCO/N.F.

d. If the integrator and Sample/Hold circuitry appear to be operating properly, check the following circuits in the order given to isolate the faulty sub-block.

1. Check the phase comparator output at A21TP9. The waveform should appear as shown in Figure 8-F-1 for the given conditions.
2. Measure the voltage at the junction of R41 and R39. The voltage should be -8V.
3. Check the outputs of U4 and U5 for the presence of the bias and API signals. These signals should be toggling while the 3325 is sweeping. If the signals are not present, check the operation of the Fractional N chip (U19) and check for the latch clock coming from U22 pin 6.

e. If the above circuitry is good, then the fault probably lies in the integrator or the API 1/Bias sub-block.

API Troubleshooting.

Exercise care when troubleshooting the API/Bias circuitry. The signals are small currents that are difficult to detect. Note that if the VCO locks but there are large spurious signals present at the output, diodes A21CR3, CR4, CR8, and CR9 should be checked.

f. Connect cable W18 back to the sample/hold output at J18A if not already done so.

The following steps determine if the digital programming portion or the analog portion of the A21 board is at fault.

g. Enter a frequency on the 3325 front panel of 5 000 001Hz.

For this frequency, the fractional-N counter is trying to correct the phase detector error for the 1Hz offset. Hence, the programming pattern for API 1 will repeat at a 1.0s rate, API 2 will repeat at 0.1 second rate, API 3 at a 0.01s rate, API 4 at a 0.001s rate, and API 5 at a 0.0001s rate.

h. Using an oscilloscope, check for each programming pulse at the following outputs:

API 1	U5(9)
API 2	U4(15)
API 3	U4(12)
API 4	U4(10)
API 5	U4(7)

i. If these pulses are present, then the digital section is probably good, and the fault may lie in the analog current sources. If any of the pulses are not present, check the fractional-N chip (U19) for the proper signals.

Individual API Troubleshooting.

j. Connect a spectrum analyzer through a 1kΩ series resistor to A21TP11.

k. Select the sine function on the 3325 and set the frequency to 5 000 000Hz.

l. Set the spectrum analyzer as follows to measure the signal at TP11:

Start Frequency 0kHz
Bandwidth.................................. 30Hz
Frequency Span 1kHz/div
Sweep Time/Div 200s
Input Sensitivity 10mV
Sweep Mode........................... Manual
Vertical Scale 10dB/div

The analyzer should measure a level of < -70dB. If the signal at TP11 is < -70dB, the API current sources in their OFF mode are not interfering with the phase detector output and the digital portion of the board is probably good. If the signal is not < -70dB, either the API current sources may not have turned off sufficiently or the phase detector input and output signals may be bad.

m. Set the 3325 frequency to 5 001 000Hz.

n. The spectrum analyzer should read < -70dB at TP11. If this signal is incorrect, troubleshoot the API 1 sub-block and the U19 programming signals. If the signal is good, the problem is probably not in the API 1 sub-block. Proceed to step o.

o. Set the 3325 frequency to 5 000 100Hz.

p. The spectrum analyzer should read < -70dB. This frequency tests the API 2 circuit. If the signal is incorrect, troubleshoot the API 2 sub-block and the U19 programming signals. If the signal is good, proceed to step q.

q. Set the 3325 frequency to 5 000 010Hz.

r. The spectrum analyzer should read < -70dB. This frequency tests the API 3 circuit. If the signal is incorrect, troubleshoot the API 3 sub-block and the U19 programming signals. If the signal is good, proceed to step s.

s. Set the 3325 frequency to 5 000 001Hz.

t. The spectrum analyzer should read < -70dB at TP11. This frequency tests the API 4 circuit. If the signal is incorrect, troubleshoot the API 4 sub-block and the U19 programming signals. If the signal is good, proceed to step u.

u. Set the 3325 frequency to 5 000 000.1Hz.

v. The spectrum analyzer should read < -70dB. This frequency tests the API 5 circuitry. If the level is incorrect, troubleshoot the API 5 sub-block and the U19 programming signals.

Phase Modulation Troubleshooting

If the output does not respond properly to a phase modulation input, measure dc voltages within the Phase Modulation circuit (A1Q37 and Q38) with:

Phase Modulation .... Off
Phase Modulation Input .... Open

Phase Modulation linearity problems can often be traced to A21CR18 and A21CR19.

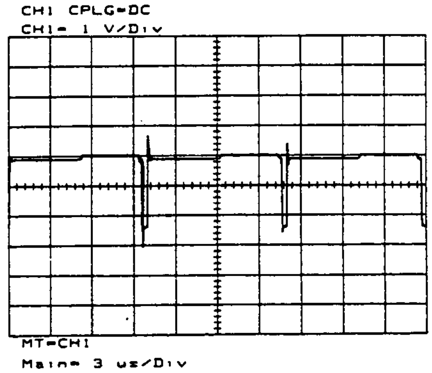
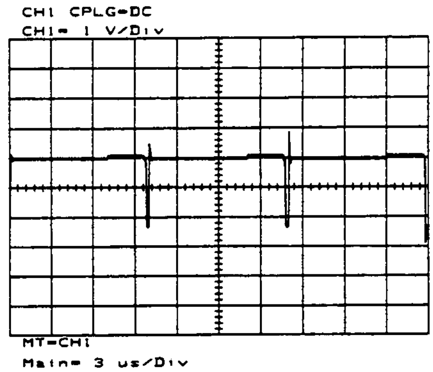
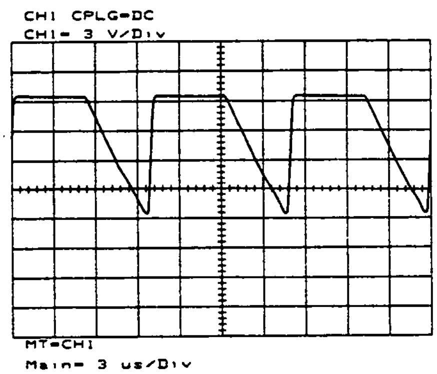
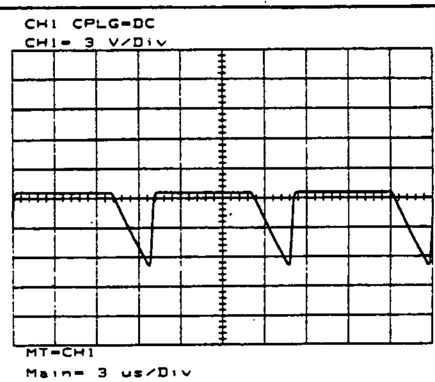
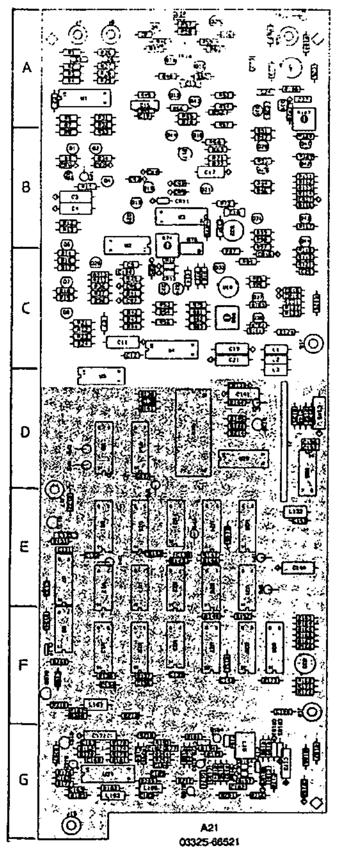
TP	HP3325 Set Up	Measurement Set Up	Important Parameters	Waveform
9	Freq 1.1 MHz Function Sine Amplitude 10Vp-p	Oscilloscope Ch1 Coupling dc Ch1 Volts/Div 1V/div Time Div. 3.00μsec Trigger Ch1	Pulse Height and Width	
9	Freq 19.9MHz Function Sine Amplitude 10Vp-p	Oscilloscope Ch1 Coupling dc Ch1 Volts/Div 1V/div Time Div. 3.00μsec Trigger Ch1	Pulse Height and Width	
10	Freq 1.1 MHz Funcion Sine Amplitude 10Vp-p	Oscilloscope Ch1 Coupling dc Ch1 Volts/div 3.0V Time Div 3.0μsec Trigger Ch1	Pulse Height and Width	
10	Freq 19.9MHz Function Sine Amplitude 10Vp-p	Oscilloscope Ch1 Coupling dc Ch1 Volts/div 3.0V Time Div 3.0μsec Trigger Ch1	Pulse Height and Width	

Figure 8-F-1. TP9 & TP10 Waveforms

A21 Component Locations

Designator	Board Location	Designator	Board Location	Designator	Board Location
C001	A	Q029	B	R079	C
C002	A	Q031	B	R081	C
C003	B	Q032	B	R082	C
C004	B	Q033	C	R083	C
C005	A	Q037	C	R084	C
C007	C	Q038	C	R085	C
C008	A	Q039	A	R086	C
C009	C	Q041	B	R087	C
C010	A	Q042	B	R088	C
C011	C	Q043	B	R089	A
C012	C	Q044	B	R091	B
C013	A	R001	A	R092	B
C014	C	R002	A	R093	B
C015	A	R003	A	R094	B
C016	A	R004	A	R096	B
C017	B	R006	A	R097	B
C018	B	R007	A	R098	B
C019	C	R008	B	R099	B
C021	C	R009	B	R101	C
C022	A	R011	B	R102	C
C023	A	R012	B	R103	C
C024	A	R013	B	R104	A
C026	A	R014	C	R106	A
C027	A	R016	C	R107	A
C028	A	R017	C	R108	B
C029	C	R018	C	R109	B
C031	C	R019	C	R111	B
C033	B	R021	C	R112	B
CR001	B	R022	C	R113	B
CR002	B	R023	C	R114	B
CR003	B	R024	C	R116	B
CR004	B	R026	A	R117	B
CR005	C	R027	A	R118	C
CR006	C	R028	A	R119	C
CR007	C	R029	A	R121	C
CR008	B	R031	A	R122	C
CR009	B	R032	A	R123	C
CR011	B	R033	B	R124	C
CR012	C	R034	B	R126	C
CR013	C	R036	C	R211	C
CR016	C	R037	C	R212	C
CR017	B	R038	C	TP09	B
CR018	C	R039	C	TP10	A
CR019	C	R041	C	TP11	A
CR020	A	R042	C	U01	A
J01	D	R043	C	U02	B
J07	A	R044	C	U03	B
J08	A	R046	A	U04	C
J18	C	R047	A	U05	D
J18A	A	R048	A	U06	A
L001	C	R049	A	U10	C
L002	C	R051	A		
Q001	B	R052	A		
Q002	B	R053	C		
Q003	B	R054	C		
Q004	B	R056	C		
Q006	B	R057	A		
Q007	C	R058	A		
Q008	C	R059	A		
Q009	A	R061	A		
Q010	A	R062	A		
Q011	A	R063	A		
Q012	A	R064	A		
Q013	A	R065	A		
Q014	B	R066	A		
Q016	B	R067	A		
Q017	B	R068	B		
Q018	B	R069	B		
Q019	B	R070	A		
Q021	B	R071	B		
Q022	B	R072	B		
Q023	C	R073	B		
Q024	C	R074	B		
Q025	A	R075	B		
Q026	C	R076	B		
Q027	A	R077	C		
Q028	B	R078	C		



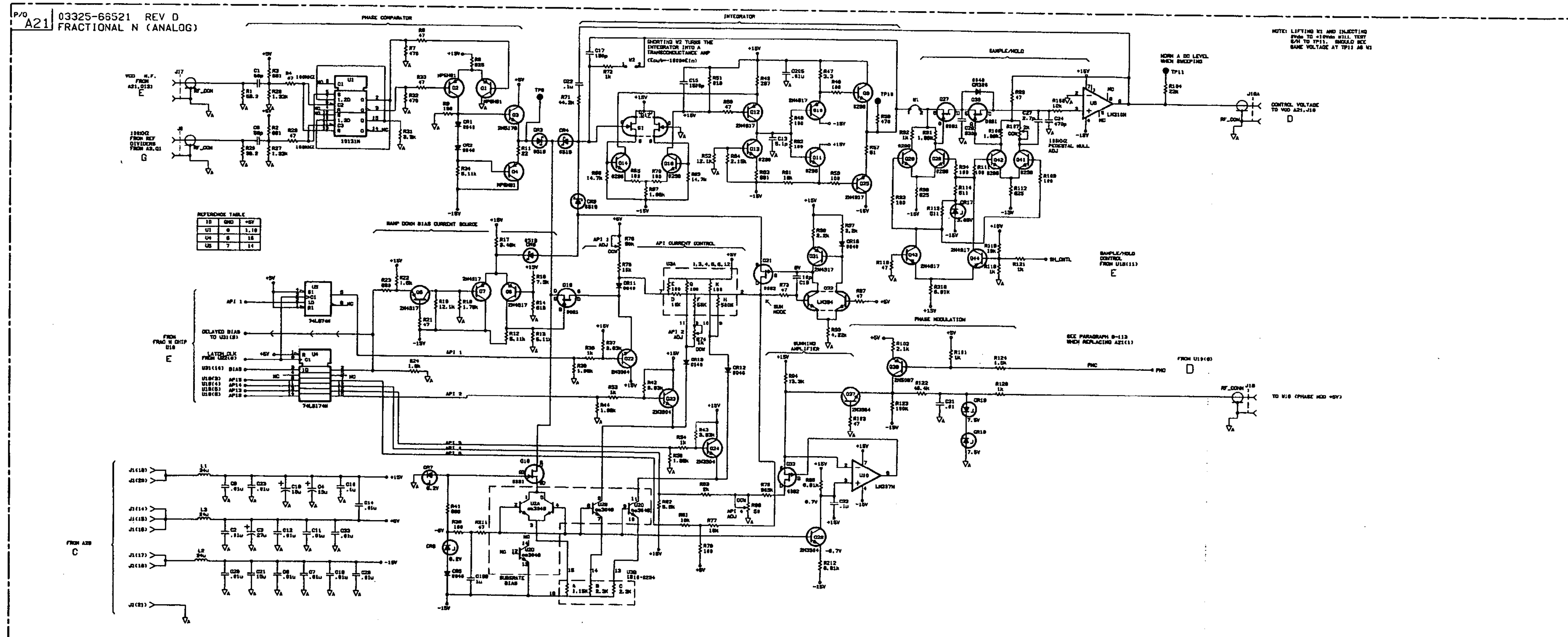


Figure 8-F-2. Fractional N Analog, A21.
8-F-5/8-F-6

Service Group G
30 MHz Reference
and Dividers, A3

SERVICE GROUP G - 30MHz REFERENCE AND DIVIDERS.

30MHz Reference Troubleshooting.

"FAIL 031" or "FAIL 032" Display Indication.

Step a of the "FAIL 031" or "FAIL 032" troubleshooting in Service Group D should be performed before procceding with the following.

a. Check frequencies at the following points in order. If the signal is incorrect at any point, troubleshoot the associated circuits.

A3TP3	30 MHz
A3U2 pins 5 and 6	10 MHz
A3U1 pin 3	1 MHz
A3U1 pin 6	2 MHz
A3J10	1 MHz
A3U1 pin 13	100 kHz
A3U5 pin 8	100 kHz
A3Q1 collector	100 kHz (narrow pulse)

If the 30MHz Oscillator is failing it could be due to heavy loading by the multiplier (A3U11). This can be checked by lifting A3R73. Oscillator failures have also been linked to A3Q6, A3Y1, and A3CR8.

CAUTION

Do not allow disconnected cable connectors to contact the printed circuit boards or components, or circuits may be damaged.

Amplitude Troubleshooting.

b. The most common cause of problems in the Sine Amplitude Control and Amplitude Modulation circuitry is the multiplier (A3U11). Problems with U11 are usually detected by incorrect voltages at A3TP4. The voltage at TP4 should be pure dc and on a working instrument (or a malfunctioning one with Auto Calibration Disabled* - ACD) will be the following levels:

* See Figure 8-K-2 (Service Group K) for ACD test point location.

Programmed Amplitude	TP4
3Vp-p	2Vdc
10Vp-p	6Vdc

Using the modify key to increase the programmed voltage by one volt at a time should cause the voltage at TP4 to increase linearly as well. Pulling cable W23 at either end should cause TP4 to reach approximately 6-8V.

c. If the voltage at TP4 is correct but the output amplitude is still incorrect, check the ac voltages on U14 pins 6 and 7. With 10Vp-p programmed, both voltage levels should be approximately 0.6Vp-p. If not and with W23 disconnected at A3J23, measure the voltage at the following points:

A3TP4	6-8Vdc
A3U11(9)	4.8Vdc

Note also that U14 is probably bad if the frequency difference between pins 6 and 7 is greater than 20% (the frequency should be approximately 30MHz on both pins).

d. If after A3U11 and/or A3U14 have been replaced and incorrect voltages are measured at TP4, the amplitude problem may be isolated via Service Groups C, J, or I.

e. If the voltages at TP4 are correct and the output amplitude is incorrect, troubleshoot the problem via Service Groups H or J.

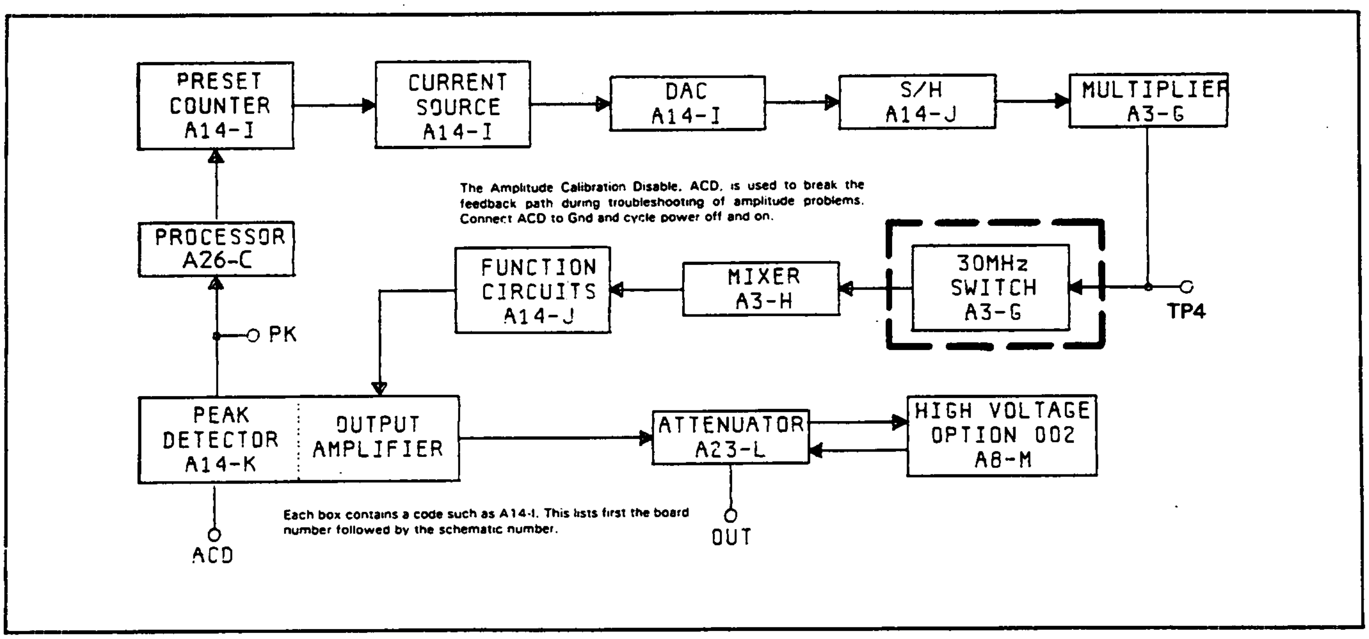
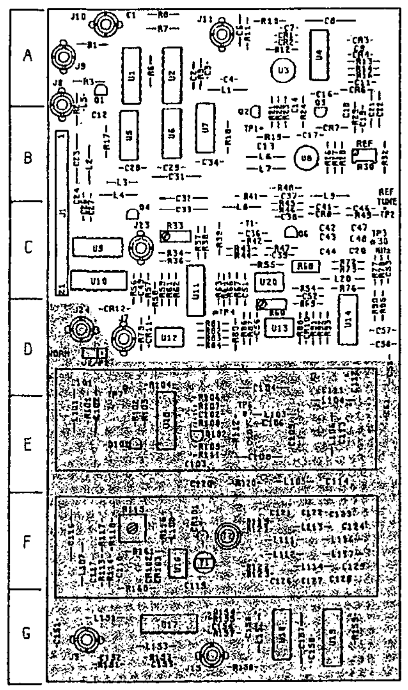


Figure 8-G-1. Sine Amplitude Control Path.

Designator	Board Location	Designator	Board Location	Designator	Board Location
C001	A	Q003	B	R093	D
C002	A	Q004	C	R104	D
C003	A	Q006	C	TP1	B
C004	A	R001	A	TP2	C
C006	A	R002	B	TP3	C
C007	A	R003	A	TP4	D
C008	A	R006	A	TP7	D
C009	A	R007	A	U01	A
C011	A	R008	A	U02	A
C012	B	R009	A	U03	A
C013	B	R010	A	U04	A
C014	A	R011	A	U05	B
C016	A	R012	A	U06	B
C017	B	R013	A	U07	B
C018	B	R014	A	U08	B
C019	B	R016	A	U09	C
C020	C	R017	B	U10	C
C021	B	R018	B	U11	C
C022	B	R019	B	U12	D
C023	B	R021	B	U13	D
C024	B	R022	B	U14	D
C026	C	R023	B	U20	C
C027	C	R024	B	Y1	C
C028	B	R026	B		
C029	B	R027	B		
C031	B	R028	B		
C032	B	R029	B		
C033	C	R030	B		
C034	B	R032	B		
C036	C	R033	C		
C037	B	R034	C		
C038	C	R036	C		
C039	C	R037	C		
C041	C	R038	C		
C042	C	R039	C		
C043	C	R041	B		
C044	C	R042	C		
C046	C	R043	C		
C047	C	R044	C		
C048	C	R045	C		
C049	C	R046	C		
C051	C	R047	C		
C052	C	R048	B		
C053	C	R049	C		
C056	D	R054	C		
C057	D	R055	C		
C058	D	R056	C		
C088	D	R057	C		
CR001	A	R058	C		
CR002	A	R059	C		
CR003	A	R060	D		
CR004	A	R061	C		
CR006	A	R062	C		
CR007	B	R063	C		
CR008	C	R064	C		
CR010	D	R066	C		
CR011	D	R067	C		
CR012	D	R068	C		
J01	C	R069	D		
J07	D	R072	C		
J08	A	R073	C		
J09	A	R076	C		
J10	A	R077	C		
J11	A	R078	C		
J23	C	R079	D		
L001	A	R080	D		
L002	B	R081	D		
L003	B	R082	D		
L004	B	R083	D		
L005	A	R084	D		
L006	B	R085	D		
L007	B	R086	D		
L008	C	R087	D		
L009	B	R088	D		
L020	C	R090	D		
Q001	A	R091	D		
Q002	B	R092	D		



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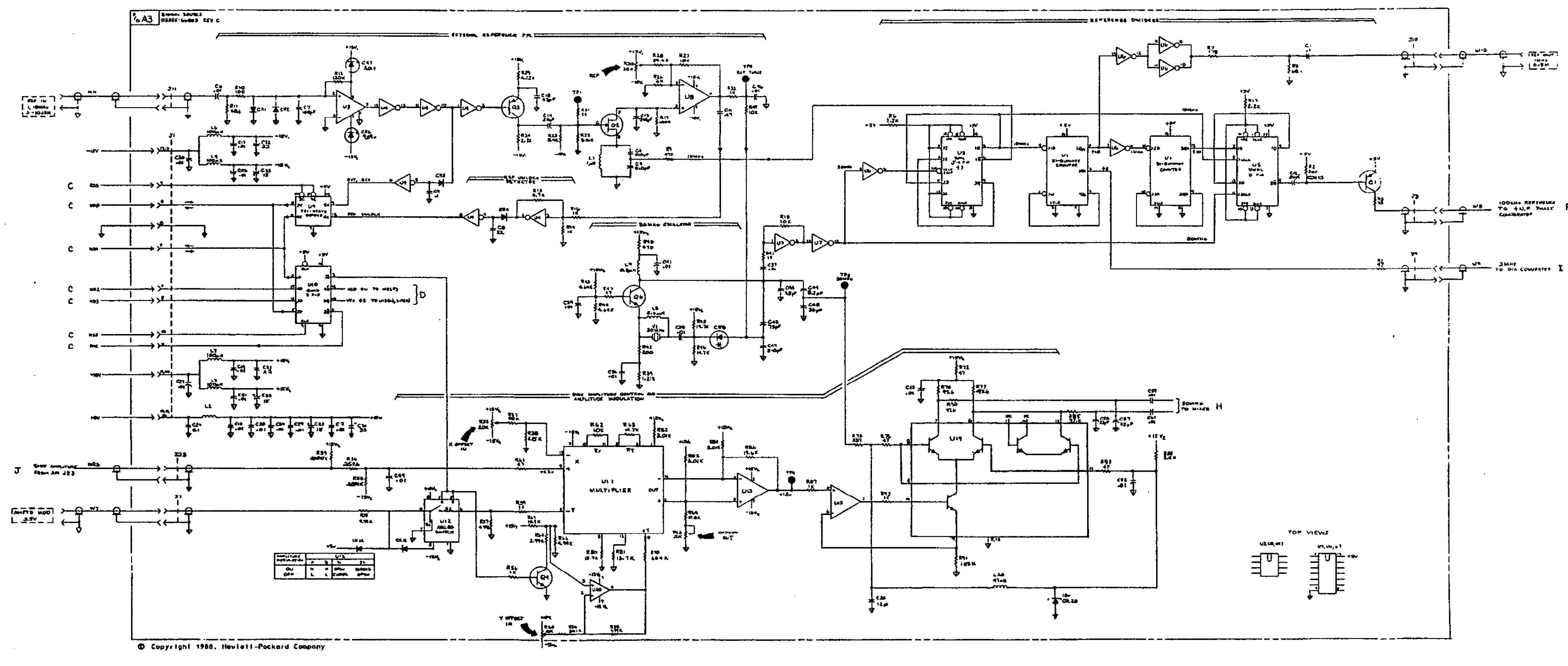

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Figure 8-G-2. 30 MHz Reference and Dividers, A3

Service Group H
Mixer, A3

SERVICE GROUP H - MIXER.

Mixer Shields.

The Mixer circuits are covered by two shields, each consisting of a flat cover and an extrusion. Always set the POWER switch to STANDBY (⏻) before removing or replacing the shields. When replacing a shield, make sure the notches on the bottom edge of the extrusion are aligned to avoid shorting the signal traces on the printed circuit board to ground. Also, when replacing the shield nearest the front of the instrument, make sure the hole in the cover is over the mixer adjustment resistor.

Mixer Troubleshooting.

Failures on this portion of the A3 board are usually linked to A3CR101, A3U16, and sometimes A3U15. A3U16 often fails because of metalization.

a. Ground the Auto Calibration Disable (ACD) test point (Service Group K – Figure 8-K-2) and cycle power. When 10 Vpp is programmed, the voltage at A3TP6 should be 100 mVpp with no dc. If this voltage in not correct, make sure that ACD is disabled and check TP6 again. If the voltage is still incorrect, the fault lies prior to TP6.

b. To check for a A3CR101 failure, turn the instrument off and measure the resistance from TP6 to ground. An ohmmeter with ≤ 1mA of current (3455A for example) is needed. The resistance should range from 198Ω to 202Ω. If the resistance measures less than 198Ω, one of the diodes in CR101 is leaky. CR101 can also be responsible for poor harmonic distortion and spurs.

c. When replacing CR101, a good technique is to use four round toothpicks to position each of the four leads into place. This enables the new CR101 to be checked for satisfactory operation before it is soldered in place. Since the orientation of CR101 often affects harmonics and spurs, rotating it 90, 180, or 270 degrees can often improve these specifications. Use care when replacing CR101. Because of its small size, it is often damaged when being soldered.

d. The waveform on the secondary windings of T1 (side closest to CR101 on schematic) can be observed on an oscilloscope. At turn-on, this waveform should be a 2Vp-p, 30MHz sine wave on both leads. Note that the waveform on T2 is not as easily observed.

e. The voltage measured at A3TP7 should be the same as A3TP6 (step a). If this is the case, A3U15 is probably good.

f. The mixer output signal leaves the A3 board and enters the A14 board as a current via cable W24. A check of this current is made as follows:

1. Connect the ACD test point (Service Group K) to ground and cycle instrument power.
2. Move the Norm/Test jumper on A3 (Service Group H) to the test position.
3. Program the front panel for a sine function at 10Vp-p.
4. Remove cable W24 from connector J24 on A3 (Service Group H).
5. Place an oscilloscope probe on J24's center connector. The signal should be close to 2.00Vp-p with 2.2Vdc.
6. Program an instrument sweep from 1kHz to 20MHz while monitoring the signal at the center connector of J24. Note that the voltages should remain the same. If they do not, check the multiplier (U11) and the differential amplifier (U14) in Service Group G.

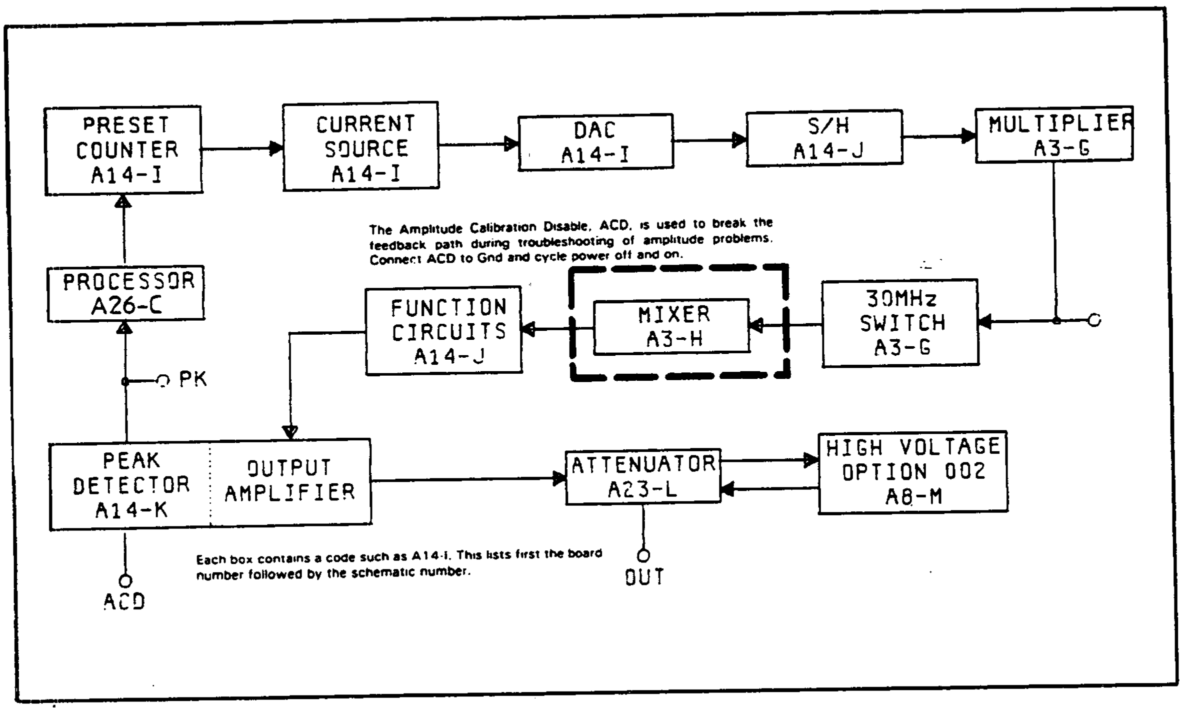
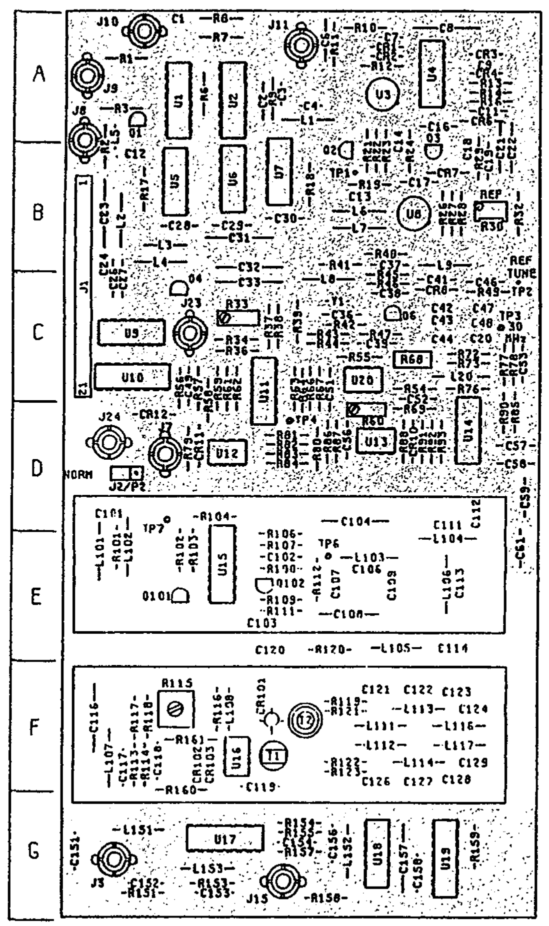


Figure 8-H-1. Sine Amplitude Control Path.

esignator	Board Location
C061	E
C101	D
C102	E
C103	E
C104	D
C106	E
C107	E
C108	E
C109	E
C111	D
C112	D
C113	E
C114	E
C116	F
C117	F
C118	F
C119	F
C120	E
C121	F
C122	F
C123	F
C124	F
C126	F
C127	F
C128	F
C129	F
CR101	F
CR102	F
CR103	F
J01	C
J24	D
L101	E
L102	E
L103	E
L104	E
L105	E
L106	E
L107	F
L108	F
L111	F
L112	F
L113	F
L114	F
L116	F
L117	F
Q101	E
Q102	E
R101	E
R102	E
R103	E
R104	D
R106	E
R107	E
R108	E
R109	E
R111	E
R112	E
R113	F
R114	F
R115	F
R116	F
R117	F
R118	F
R119	F
R120	E
R121	F
R122	F
R123	F
R160	F
R161	F
T1·	F
T2	F
TP6	E
U15	E
U16	F



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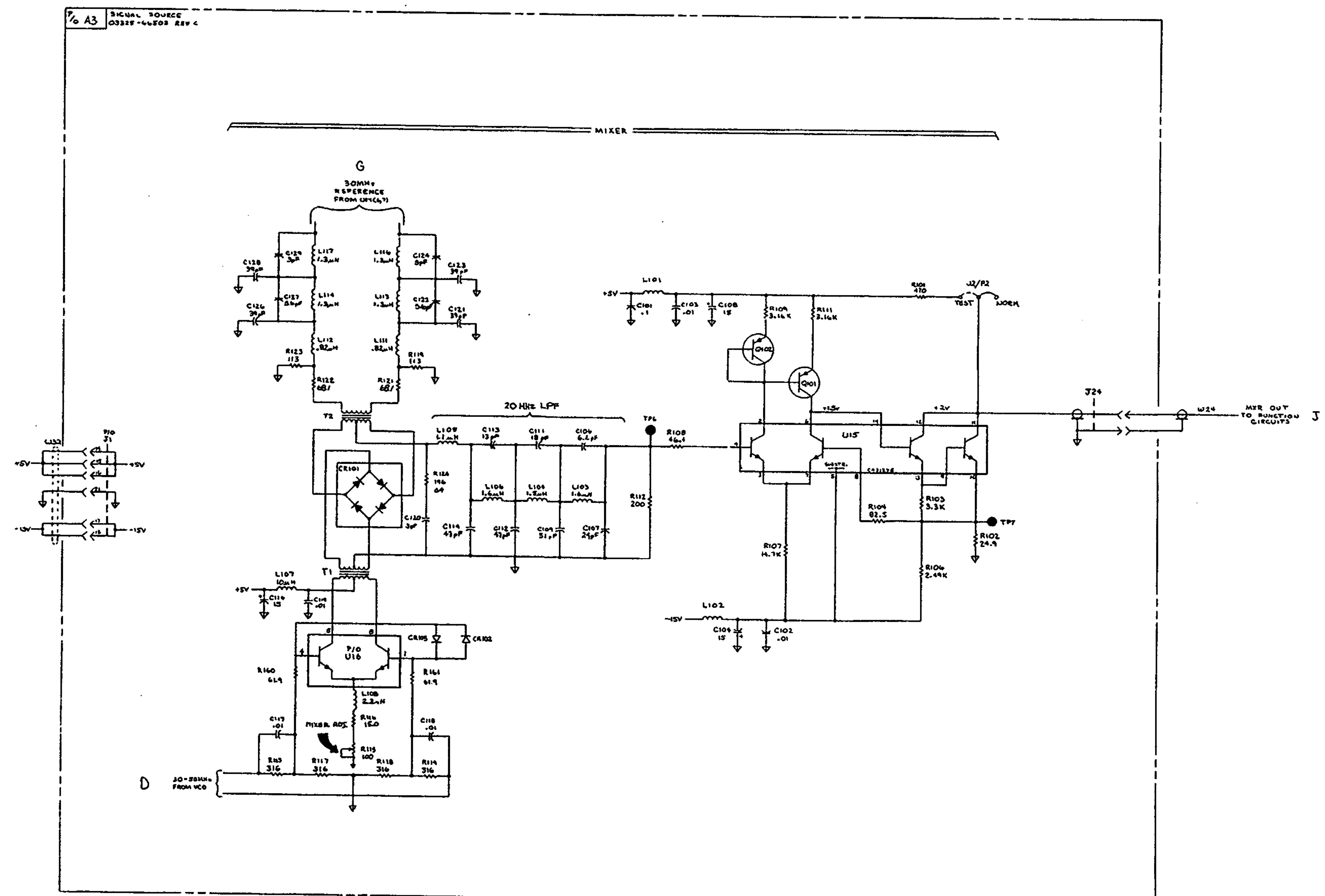


Figure 8-H-2. Mixer, A3.

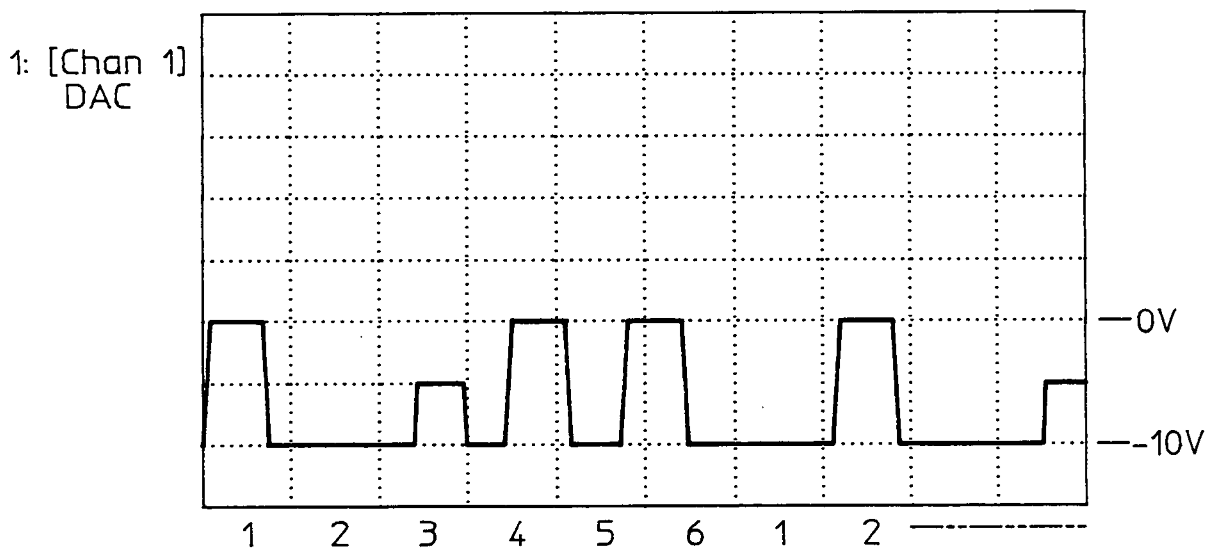
Service Group I
D/A Converter and
Sample/Hold A14

SERVICE GROUP I - D/A CONVERTER AND SAMPLE HOLD.

D/A and Sample/Hold Troubleshooting.

These circuits convert digital information (from the controller) to the analog voltages which control output level, dc offset, etc. If these control voltages appear to be incorrect (Service Groups J, K, or N) the trouble may be in the DAC counters, current source, or integrator, or in the Sample/Hold switches or amplifiers.

Observe the "DAC Integrator Out" pulse train shown below. The voltage level at each Sample/Hold output amplifier test point should be identical to the level of its corresponding pulse at the DAC test point. This pulse train occurs at instrument turn-on and with the ACD test point grounded (schematic K - Service Group K). Note that the levels have a tolerance of ± 0.02Vdc. Verification of these levels is made by again grounding the ACD test point, externally triggering an oscilloscope on the positive slope of test point AZ, and connecting the scope's input to the DAC test point.



1 =	DAC Auto Zero	(No TP) 0 Vdc
2 =	Amplitude Calibration Level	(TP + LVL) -10 Vdc
3 =	Output Amplitude	(TP AMPL) -5 Vdc
4 =	DC Offset	(TP OS2) 0 Vdc
5 =	DC Offset Correction	(TP OS1) 0 Vdc
6 =	X Drive	(TP XDR) -10 Vdc

If the level at each Sample/Hold test point is not the same as its corresponding pulse at the DAC test point, suspect problems with the analog switch, the op amp, or the Sample/Hold capacitor. The following information can also help one determine if the Sample/Hold output is good.

The DAC Auto Zero pulse is approximately 0V and the voltage out of A14U17 will vary slightly around -4.2V.

+LVL: This voltage is used during self-calibration (AMPTD CAL) at which time +LVL jumps to various levels for a period of about 1 second. At all other times, +LVL remains at approximately -10.2V.

AMPL: This voltage controls the amplitude of all functions.

Programmed Sine Amplitude	TP AMPL
2.99Vp-p	+4V
3.00Vp-p	-5V
10.00Vp-p	+6V
Sine function off	-10V

OS2: This voltage controls the D.C. offset of the output waveform.

With Sine function off:

Programmed D.C. Offset	TP OS2
+5Vdc	+10V
-5Vdc	-10V

OS1: This is the DC offset error correction voltage and is calculated during a self-calibration. This voltage should always be close to 0V.

XDR: X Drive is -10V for a one second sweep, -5V for a two second sweep and 0V for a 99 second sweep.

A potential problem with this section of the A14 board is loading of the DAC test point by a defective analog switch, Op-Amp, or Sample/Hold capacitor. To check for a loading problem, unsolder the lead nearest the DAC test point on the resistor (R55) between A14U16 pin 6 and the test point. Attach an oscilloscope probe to the unsoldered lead of the resistor and monitor the DAC pulse train. Continue to observe this pulse train while pressing the resistor lead down so that it makes contact with the point from which it was unsoldered. If any changes in the levels of the pulse train is observed, the waveform is being loaded.

The charge time and consequently the output voltage of the DAC Integrator is determined by the width of the output pulses from U10. These pulses turn on the dual current source, and the total current charges the integrator capacitor. The U10 outputs are negative-going pulses.

Pulses should be present at the input and output pins of the various IC's. The Load LSD, Load MSD, and S/H Strobe pulses should occur at a 1 kHz rate. The 2 MHz Reference (at the 2 MHz test point) is divided by 2 in U14 to provide a clock signal to the DAC circuits.

Signature Analysis Test 0.

The SA0 test can be used to troubleshoot incorrect DAC output, incorrect Main Signal output, and FAIL 021 through FAIL 029.

Set the POWER switch to STANDBY (⏻), then connect the Signature Analyzer as follows:

Gnd:		A26 TP0 (GND)
Start:	+ slope	A26 TP3 (S/A START STOP)
Stop:	+ slope	A26 TP3 (S/A START STOP)
Clock:	– slope	A26 U39 Pin 1 (/EEDTACK)

Connect A14U14 pin 1 to ground (the outer shell of A14J9 is connected to ground).

Set A26SW100 pin 1 to the **SA0** position. Check that A26SW100 pin 2 (SA1) is in the **NORMAL** position.

Set the POWER switch to ON (I). A26 CR141, CR142, and CR144 should be on. CR143 should be off. If the front panel display is operational, the front panel LEDs will be on in a random pattern.

Check for a +5V signature of HF3A.

If the +5V signature or the A26 LEDs are incorrect, troubleshoot the A26 assembly using the Kernel SA test in Service Group C. If they are correct, troubleshoot the A14 assembly using this SA test. Use the Test Signal Flow Diagram to help you determine the order to check the signatures.

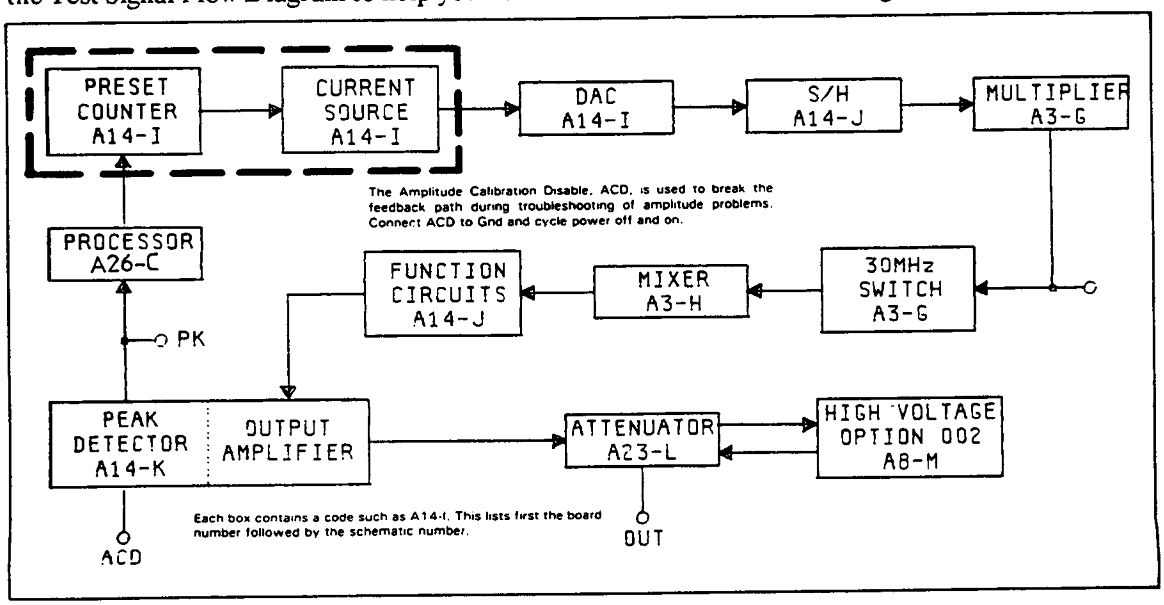


Figure 8-I-1. Sine Amplitude Control Path.

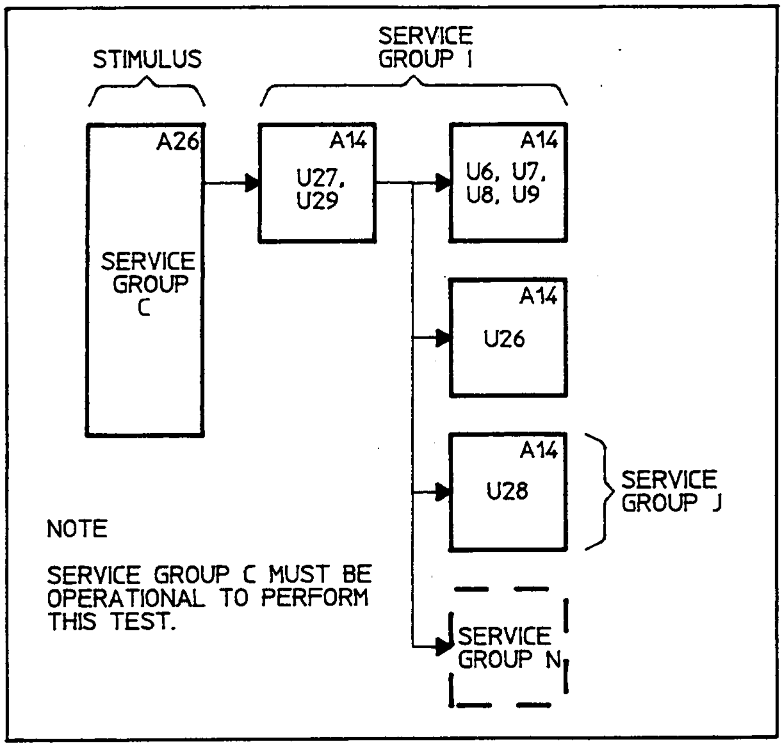
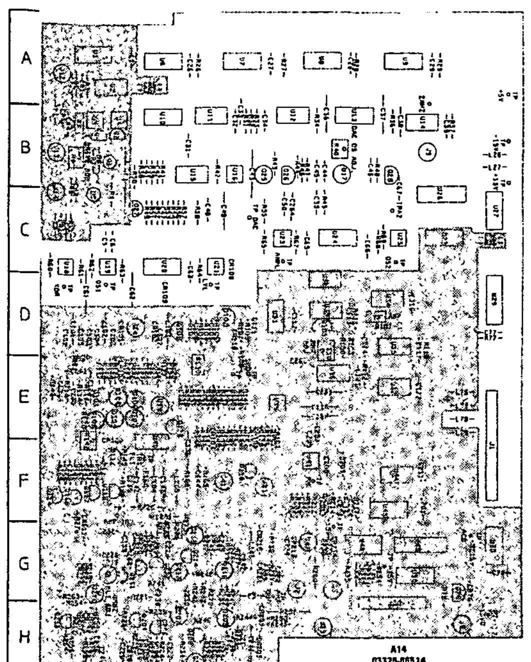


Figure 8-I-2. A14 Assembly SA0 Test Signal Flow Diagram.

Table 8-I-1. A14 Assembly Signatures.

Pin	U6	U7	U8	U9	U26	U27	U28	U29
1	9HF5	9HF5	9HF5	9HF5	HF3A	0795	HF3A	HF3A
2	0000	HF3A	FP21	FP21	1F48	6057	PA2A	41UU
3	0000	HF3A	121C	121C	41UU	2354	9HF5	9F9A
4	HF3A	HF3A	HF3A	HF3A	41UU	1H05	41UU	7F6P
5	HF3A	HF3A	HF3A	HF3A	1F48	1H05	3610	9HF5
6	0000	HF3A	121C	121C	F072	HF3A	9HF5	41UU
7	0000	HF3A	FP21	FP21	9HF5	U8P2	U6P5	9F9A
8	0000	0000	0000	0000	41UU	0000	0000	7F6P
9	9HF5	9HF5	9HF5	9HF5	1F48	HF3A	860A	9HF5
10	41UU	41UU	41UU	41UU	0000	472F	3610	0000
11	HF3A	HF3A	472F	472F	U8P2	HF3A	41UU	1P3C
12	HF3A	0000	0000	0000	1F48	CPPC	U696	9HF5
13	HF3A	HF3A	HF3A	HF3A	41UU	860A	41UU	7F6P
14	HF3A	HF3A	HF3A	HF3A	9HF5	9A2A	9HF5	2354
15	41UU	41UU	41UU	41UU	F072	HF3A	PA2A	41UU
16	HF3A	HF3A	HF3A	HF3A	F072	HF3A	HF3A	9HF5
17					9HF5			6057
18					9HF5			0795
19					F072			41UU
20					HF3A			HF3A



signator	Board Location	Designator	Board Location	Designator	Board Location	Designator	Board Location	Designator	Board Location
C005	C	C045	C	Q026	B	R048	B	U07	A
C008	C	C046	B	Q027	C	R049	C	U08	A
C026	A	C047	C	Q028	B	R050	B	U09	A
C027	A	C048	C	R005	B	R051	C	U10	B
C028	A	C049	C	R026	A	R052	C	U11	B
C029	A	C050	C	R027	A	R053	C	U12	B
C031	B	C061	D	R028	A	R054	C	U13	B
C032	B	C062	D	R029	A	R055	C	U14	B
C033	B	C063	C	R031	B	R056	C	U15	B
C034	B	C065	C	R032	B	R057	C	U16	B
C035	C	C066	C	R033	B	R058	C	U17	B
C036	B	C067	C	R034	B	R060	C	U18	C
C037	B	C076	C	R036	B	R061	C	U19	C
C037	B	C077	D	R038	B	R062	C	U20	C
C038	B	CR108	C	R039	B	R063	C	U21	C
C039	B	CR109	D	R040	B	R064	C	U23	C
C041	B	J01	F	R041	B	R065	C	U24	C
C042	B	J09	B	R042	B	R067	C	U25	C
C043	B	L026	B	R043	B	R068	C	U26	C
C043	C	L027	B	R044	B	R069	C	U27	C
C044	B	L078	E	R046	B	R112	E	U29	D
C045	B	Q025	B	R047	B	U06	A		

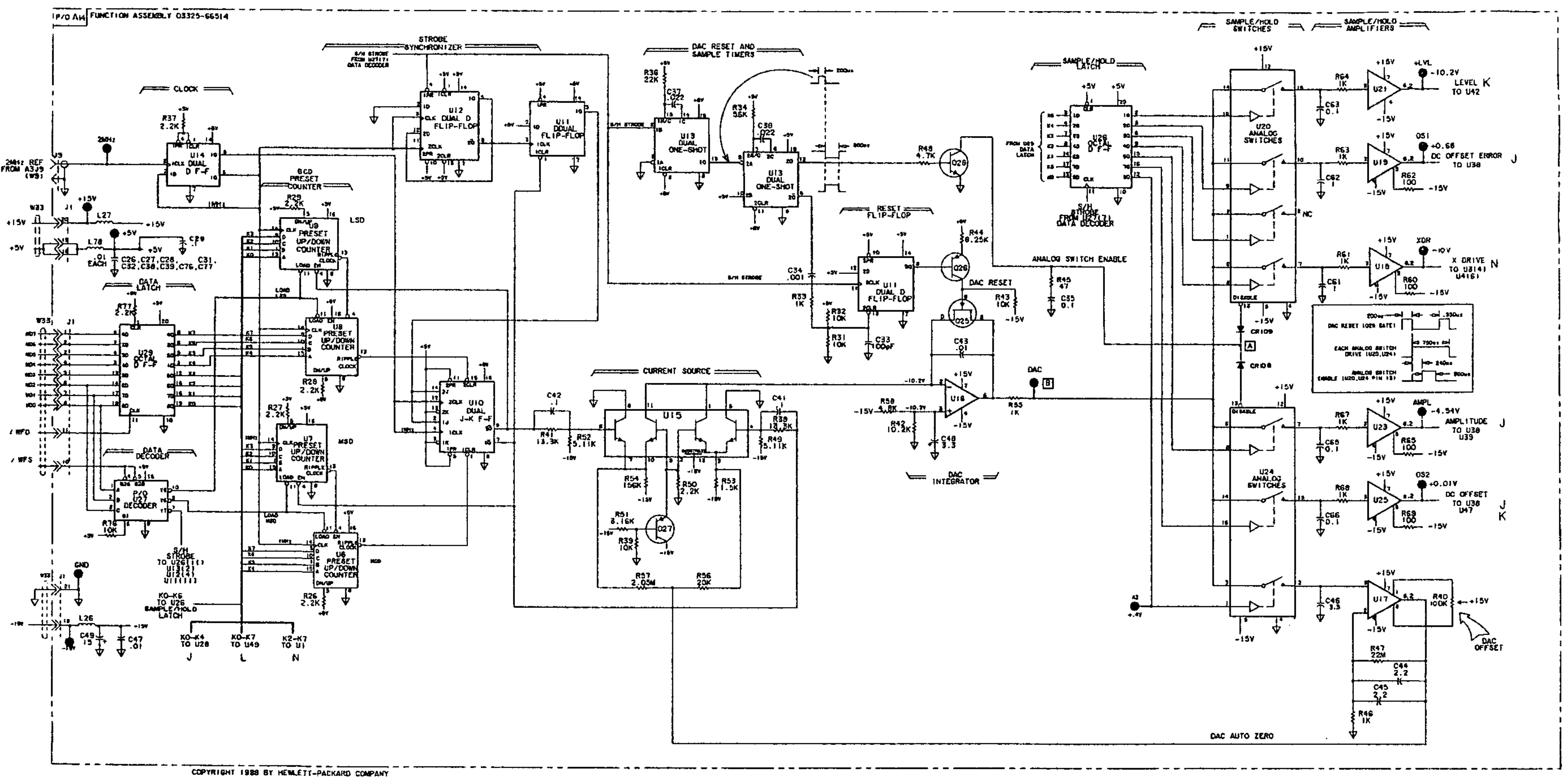


Figure 8-1-3. D/A Converter and Sample/Hold, A14.

Service Group J
Function Circuits, A14

SERVICE GROUP J - FUNCTION CIRCUITS.

Function Circuits Troubleshooting.

The A14Q112 amplifier circuit supplies sine wave current to the output amplifier. Disconnect the cable (marked "23 ALC") from A14J23 to permit maximum signal amplitude at A14 test point SINE.

CAUTION

Do not allow disconnected cable connector to contact the printed circuit boards or components, or circuits may be damaged.

The sine wave signal at test point SINE should be approximately 200 mVpp at the selected frequency.

If this signal is not correct, the trouble is ahead of the SINE test point. If the sine function is the only one not operating correctly, check the diode CR101 and the filter components in the Q112 emitter circuit.

If there is a signal at the SINE test point, check the Sine Enable voltage at U28 pin 10. This should be at a TTL high level. If not, check input and clock signals to U28 and U27. The inputs to U28 can be traced to U29, Service Group I. Signature Analysis Test 0 may be used to check U27, U28, and U29.

Be sure to reconnect cable 23 to A14J23.

Square, Triangle, and Ramp Functions.

If the sine function is operating properly, but none of the other functions is correct, the trouble is probably in the Q101, Q102 circuits or U31 inverters. Also check for the correct enable signals from U28. The table next to U28 on the schematic relates the functions to the enable signal levels. The trouble may also be in the Offset and Amplitude Control circuits.

Square Function Only.

If the square wave function only is not operating properly, observe the signal at the SQR test point on A14. This should be a TTL level square wave at the selected frequency.

If this signal is not present, check the Square Enable voltage level at U33 pin 4, which should be TTL high. If correct, check the clock input at U33 pin 3, then the U31 inverter circuits and Q101, 102. If the signal at U31 pins 5 and 9 is correct but pins 6 and 8 are always low, it is possible that U32 could be defective.

If the signal at SQR is correct, troubleshoot the U40 circuits and the Amplitude Control circuits.

If Self Tests 1 and 3 pass and Self Test 2 fails, suspect problems with A14U42 in Service Group K.

Triangle and Ramp Functions.

If the sine and square functions are correct, but the triangle and ramp functions are not operating properly, use the following procedure.

a. Connect oscilloscope to the TRI test point (on A14). Set controls as follows:

Vertical............................0.2 V/div (÷ 10 probe)
Sweep..0.1 μs/div
Trigger.....................................Int/+ slope

b. Set the 3325 as follows:

Function...Triangle
Frequency.. 1 Hz
Amplitude...................................... 10 V p-p

c. The pulse width of the TRI signal should increase and decrease at a 1 Hz rate (TTL levels).

d. Monitor pin 9 of U36 with the oscilloscope. This should be a TTL square wave, frequency 1 MHz (actually 1.000 001 MHz). If not, go to Step f.

e. The signal at pin 10 of U36 should be a TTL square wave at 1 MHz. If not, go to the 2 MHz test point and trace the signal through to U36 pin 10. U14 divides the 2 MHz reference by two. If U14 is not operating, check for a TTL high Triangle Enable at U14 pin 10.

f. If the proper signal is not present at U36 pin 9, trace the signal back through U32, which is a ÷ 10 counter. Also check for a TTL high Triangle Enable level at U33 pin 10.

g. If the digital signals are all correct the trouble may be in U40 or the Triangle and Ramp Filter circuits. Observe the signal at the TRIFILT test point. It should be a triangle or ramp (selected function) approximately 200 mV p-p. If not, check U40 output at pin 13. Measure voltages in the Q114–Q118 circuits.

Ramp Functions Only.

If only the ramp functions are not operating properly, the trouble is probably in the ramp reset circuits.

a. Connect an oscilloscope to the TRI test point (on A14). Set the controls as follows:

Vertical............................0.2 V/div (÷ 10 probe)
Sweep..0.1 μs/div
Trigger.....................................Int/+ slope

b. Set the 3325 as follows:

Function	+ Ramp
Frequency	1 Hz
Amplitude	10 V p-p

c. The width of the positive pulse should decrease to zero, then reset and repeat at a 1 Hz rate (TTL levels).

d. Change function to − Ramp. The positive pulse at the TRI test point should increase to maximum, then reset to zero and repeat at a 1 Hz rate. If the signal is the same as the correct signal in Step d, the Ramp Polarity signal from U28 pin 5 may be incorrect. This level should be high for − Ramp function and low for + Ramp.

e. If the pulse width in Step c or d increases and decreases, the pulse reset circuits are not operating, and the 3325 output signal should be a triangle, at a 0.5 Hz rate.

f. At frequencies below 100 Hz, the ramps are reset by the digital Phase Detector, U35. Check for negative-going pulses at U35 pin 6, positive-going pulses at U37 pin 8, and negative-going pulses at U37 pin 6. Each pulse should toggle the output of U34, pin 8. The Ramp Enable level at U34 pin 10 must be high.

g. At frequencies of 100 Hz and higher, ramps are reset by the ± Ramp Reset pulses generated by the Ramp Reset one-shots (U45, Service Group K) which are triggered by the Level Comparator output, U42 pin 7. These are also negative-going pulses, approximately 10 μs wide.

DC Offset and Amplitude Troubleshooting.

Problems in the Amplitude and Offset control circuits are most easily located by measuring dc voltages. The voltages shown on the schematic are measured with the instrument in the Preset state. Amplitude problems have in the past, been linked to U38, U39, and U40 failures. If the amplitude level from the DAC (see AMPL test point - Service Group I) is correct as well as the voltages at A3TP4 (Service Group G), then the amplitude control circuitry in this service group is suspect.

A dc offset in sine function only may be caused by a fault in the Q103, Q104 circuits.

If the square, triangle, and ramp functions are inoperative, or if the DC Offset (no ac function) is one-half the programmed level, the problem may be in Offset Control circuits U38B, Q106, U41B, or Q113.

The voltages at Q108 emitters should always be identical.

Clipping of the positive or negative peaks on the output waveform is sometimes caused by a fault in the D.C. Offset Current circuitry. Too much or too little offset current causes the output amplifier to saturate on either the positive or negative peaks.

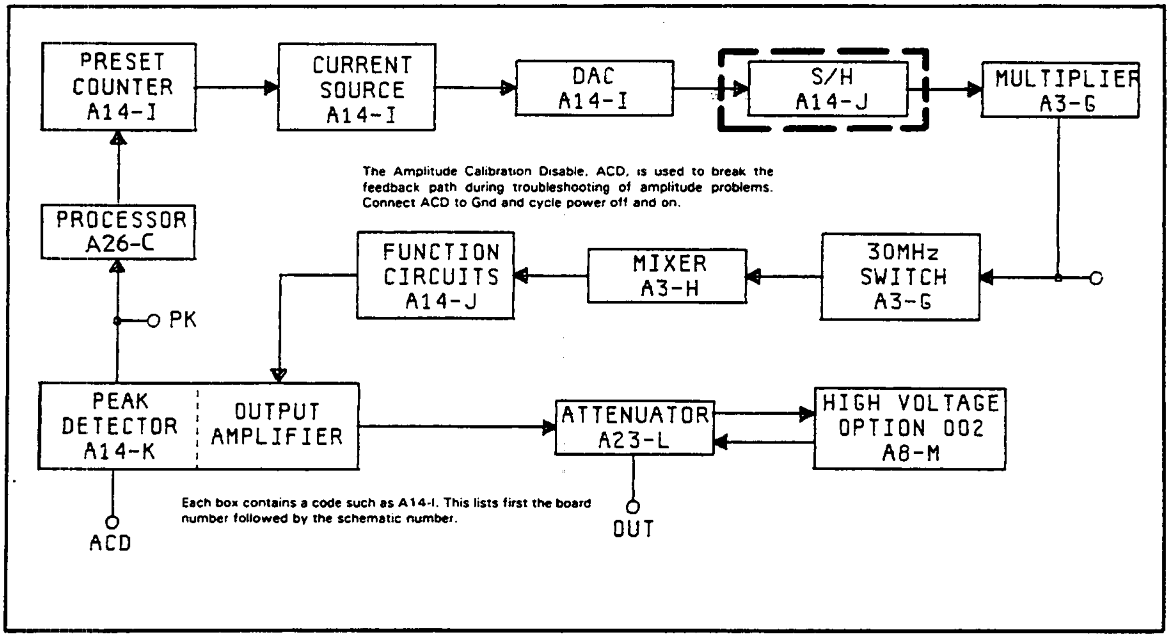


Figure 8-J-1. Sine Amplitude Control Path.

Signature Analysis Test 0.

The SA0 test can be used to troubleshoot incorrect DAC output, incorrect Main Signal output, and FAIL 021 through FAIL 029.

Set the POWER switch to STANDBY (⏻), then connect the Signature Analyzer as follows:

Gnd:		A26 TP0 (GND)
Start:	+ slope	A26 TP3 (S/A START STOP)
Stop:	+ slope	A26 TP3 (S/A START STOP)
Clock:	− slope	A26 U39 Pin 1 (/EEDTACK)

Connect A14U14 pin 1 to ground (the outer shell of A14J9 is connected to ground).

Set A26 SW100 pin 1 to the SA0 position. Check that A26SW100 pin 2 (SA1) is in the **NORMAL** position.

Set the POWER switch to ON (|). A26 CR141, CR142, and CR144 should be on. CR143 should be off. If the front panel display is operational, all front panel LEDs will be on in a random pattern.

Check for a +5V signature of HF3A.

If the +5V signature or the A26 LEDs are incorrect, troubleshoot the A26 assembly using the Kernel SA test. If they are correct, troubleshoot the A14 assembly using this SA test. Use the Test Signal Flow Diagram to help you determine the order to check the signatures.

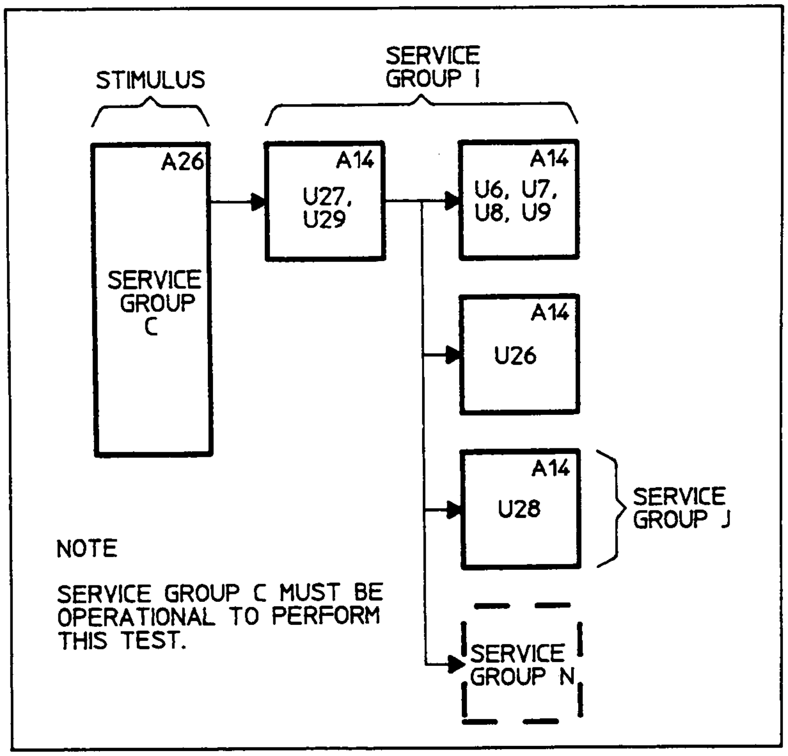


Figure 8-J-2. A14 Assembly SA0 Test Signal Flow Diagram.

Table 8-J-1. A14 Assembly Signatures.

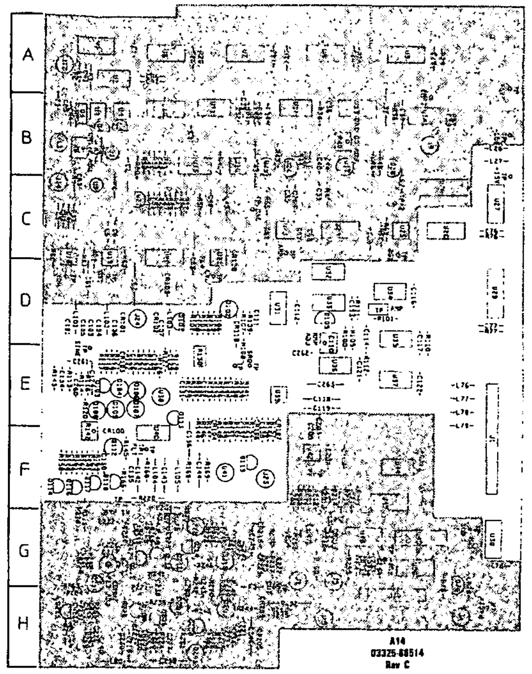
Pin	U6	U7	U8	U9	U26	U27	U28	U29
1	9HF5	9HF5	9HF5	9HF5	HF3A	0795	HF3A	HF3A
2	0000	HF3A	FP21	FP21	1F48	6057	PA2A	41UU
3	0000	HF3A	121C	121C	41UU	2354	9HF5	9F9A
4	HF3A	HF3A	HF3A	HF3A	41UU	1H05	41UU	7F6P
5	HF3A	HF3A	HF3A	HF3A	1F48	1H05	3610	9HF5
6	0000	HF3A	121C	121C	F072	HF3A	9HF5	41UU
7	0000	HF3A	FP21	FP21	9HF5	U8P2	U6P5	9F9A
8	0000	0000	0000	0000	41UU	0000	0000	7F6P
9	9HF5	9HF5	9HF5	9HF5	1F48	HF3A	860A	9HF5
10	41UU	41UU	41UU	41UU	0000	472F	3610	0000
11	HF3A	HF3A	472F	472F	U8P2	HF3A	41UU	1P3C
12	HF3A	0000	0000	0000	1F48	CPPC	U696	9HF5
13	HF3A	HF3A	HF3A	HF3A	41UU	860A	41UU	7F6P
14	HF3A	HF3A	HF3A	HF3A	9HF5	9A2A	9HF5	2354
15	41UU	41UU	41UU	41UU	F072	HF3A	PA2A	41UU
16	HF3A	HF3A	HF3A	HF3A	F072	HF3A	HF3A	9HF5
17					9HF5			6057
18					9HF5			0795
19					F072			41UU
20					HF3A			HF3A

Designator	Board Location	Designator	Board Location	Designator	Board Location	Designator	Board Location	Designator	Board Location
C076	C	C141	F	Q104	E	R123	E	R163	F
C077	D	C142	F	Q105	D	R124	E	R164	F
C101	D	C143	F	Q106	E	R126	E	R166	F
C103	D	C144	F	Q107	E	R127	E	R168	F
C104	D	C260	E	Q108	E	R128	E	R169	F
C105	D	C261	E	Q109	E	R129	E	U27	C
C106	D	C262	E	Q113	E	R130	E	U28	C
C107	D	C263	E	Q114	F	R131	E	U28	E
C108	D	CR100	F	Q116	F	R132	E	U29	D
C109	D	CR101	D	Q117	F	R133	E	U31	D
C110	D	CR102	D	Q118	F	R134	E	U32	D
C111	D	CR103	E	Q119	F	R136	E	U33	D
C112	D	CR104	F	R077	D	R137	E	U34	D
C113	D	CR106	F	R100	D	R138	E	U35	D
C114	D	CR107	F	R101	D	R139	E	U36	E
C116	D	CR109	D	R102	D	R141	E	U37	E
C117	D	CR110	D	R103	D	R142	F	U39	E
C118	E	CR111	F	R104	D	R143	E	U40	F
C119	E	J01	F	R105	D	R144	F	U41	F
C121	E	J23	F	R106	D	R145	F		
C122	E	J24	D	R107	D	R146	F		
C124	E	L026	B	R108	E	R147	F		
C126	E	L027	B	R109	D	R148	F		
C127	E	L076	E	R110	D	R149	F		
C128	E	L077	E	R111	D	R151	F		
C129	E	L078	E	R112	E	R152	F		
C130	F	L079	E	R113	E	R153	F		
C131	E	L101	D	R114	E	R154	F		
C132	E	L102	D	R116	E	R156	F		
C133	E	L103	D	R117	E	R157	F		
C134	E	L104	F	R118	E	R158	F		
C136	F	L105	F	R119	E	R159	F		
C137	F	Q101	D	R120	E	R160	F		
C138	F	Q102	D	R121	E	R161	F		
C139	F	Q103	E	R122	E	R162	F		

A14 Component Locations

Note 1: These voltage levels are useful when troubleshooting amplitude problems. Levels shown occur with the 3325 's frequency set to 1kHz, and with Auto Calibration Disable (ACD) grounded.

Programmed Amplitude (Vp-p)	TP AMP IN (0V dc offset)		TP AMP IN (2V dc offset)	
	Vp-p	DC Level	Vp-p	DC Level
1	0.16	5.17	0.06	5.1
2	0.28	5.17	0.1	5.1
3	0.16	5.17	0.14	5.1
4	0.20	5.17	0.18	5.1
5	0.24	5.17	0.22	5.1
6	0.28	5.17	0.26	5.1
7	0.32	5.17		
8	0.38	5.17		
9	0.44	5.17		
10	0.48	5.17		



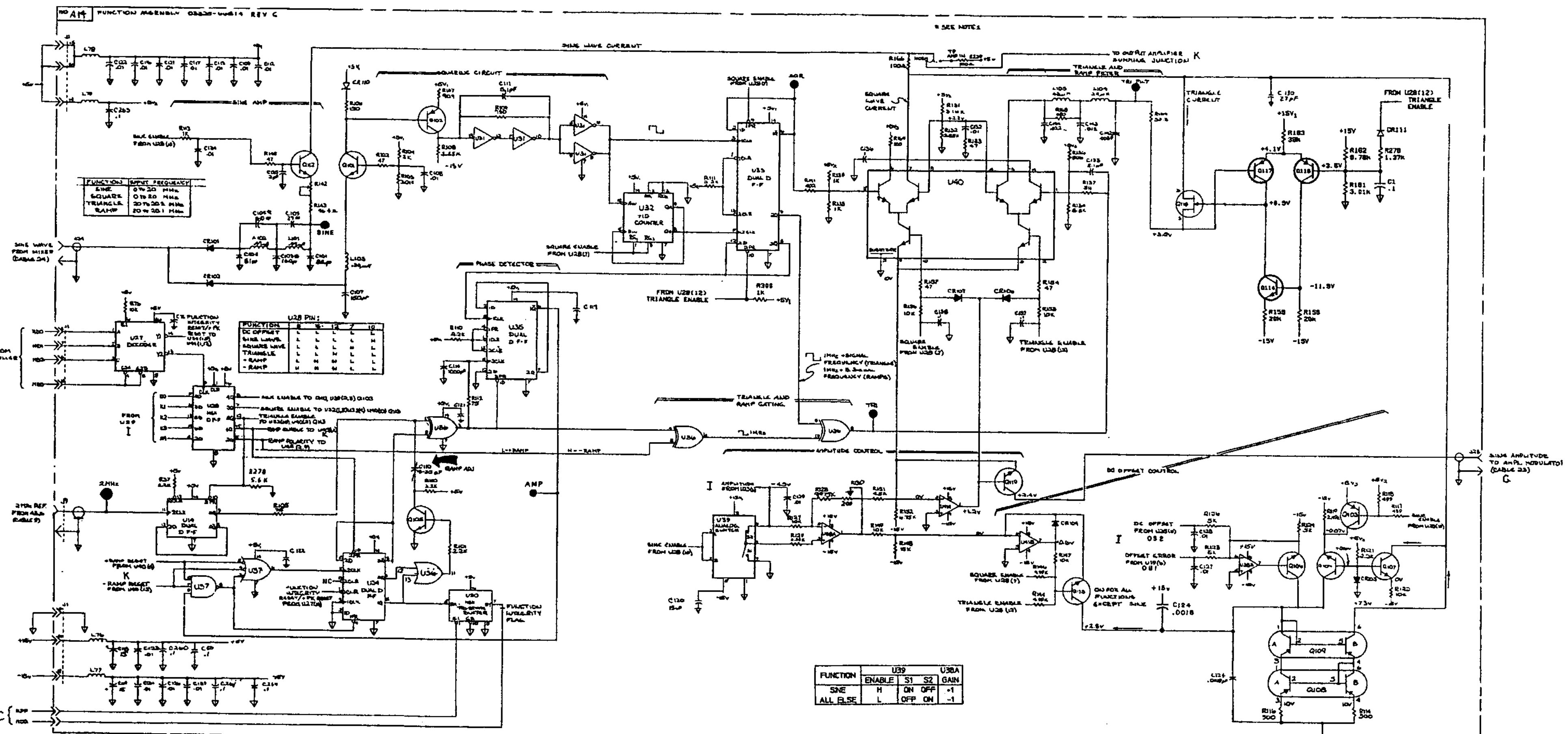


Figure 8-J-3. Function Circuits, A14.

Service Group K
Output Amplifier, A14 &
FAST Sync Converter, A22

SERVICE GROUP K · OUTPUT AMPLIFIER AND LEVEL COMPARATOR.

Output Amplifier and Level Comparator Troubleshooting.

If the instrument accepts and displays entries but there is neither a signal nor sync output, or both outputs are distorted, the trouble may be in the output amplifier circuit. Note that when troubleshooting amplifier problems, the Auto Calibration Disable (ACD) test point must be grounded and the power cycled (Figure 8-K-3). This procedure breaks the amplitude loop and makes it possible to troubleshoot the amplitude control path (see Figure 8-K-2).

a. First verify that the output amplifier is causing the problem. Look for a signal at the AMP OUT test point. If the waveform is correct, the amplifier is probably operating correctly, and the problem may be in the Attenuator, Service Group L. If the waveform is not correct, continue troubleshooting with Step b.

b. Disconnect any external equipment from the signal output.

c. Move the small shorting connector marked AMP IN (on A14) from the NORM to the opposite position.

d. Measure the dc voltage at the AMP OUT test point and at both ends of the fuse, F3. These voltages should be approximately +7.5V.

NOTE

The fuse F3 can be opened when excessive voltage is applied to the HP 3325B signal port. Therefore, it should be replaced as necessary (0.25A, HP 2110-0343).

e. Set the HP 3325B to preset conditions and check the following dc voltages.

Location	DC Voltage
Cathode of CR219	+12.1V
Collector of Q212	+12.9V
Base of Q212	+13.7V
Base of Q206	–13.4V
Collector of Q206	–12.8V
Collector of Q215	+6V

f. Replace the shorting connector back to the NORM position.

g. Lift R239 and R241 at their junction. Reroute the 5 kΩ feedback resistor, R221 (AMP OUT end), to the hole where R241 was removed. The power stage is no longer in the circuit and collector of Q204 is now the no load output of the high gain preamplifier.

h. For low frequency problems, examine the collector of Q204 using a high impedance oscilloscope probe. For example, program the HP 3325B for a 1 kHz, 10 Vpp sine wave. You should see a clean 20 Vpp signal (remember, the amplitude is doubled since there is no longer a 50Ω load). If there is no signal, troubleshoot the preamplifier section. Service Group J (Function circuits) should also be suspect.

i. For high frequency problems, construct the probe shown in Figure 8-K-1. Using this probe, examine the collector of Q204 with a spectrum analyzer. For example, program the HP 3325B for a 15 MHz fundamental signal (the other harmonics should still meet spec).

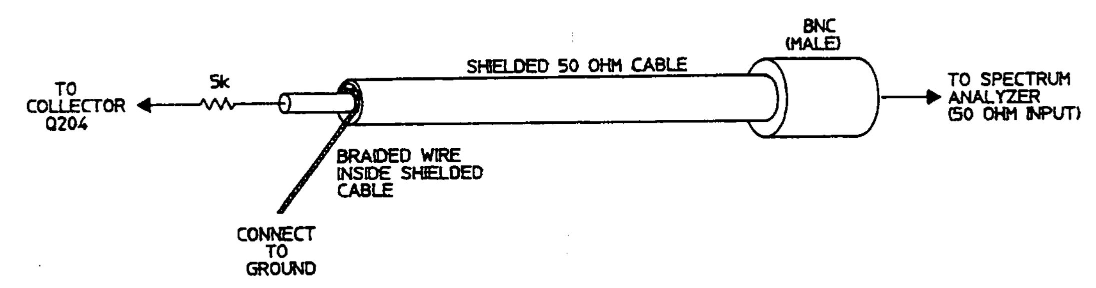


Figure 8-K-1. Gain Stage High Frequency Troubleshooting Probe.

j. Reconnect R239 and R241 (leave R221 at the junction, too).

k. Observe the junction of R249 and R251. A few millivolts of dc offset and some change in distortion (as seen on the spectrum analyzer) may exist since the 5 kΩ feedback path has been removed.

l. The signals on one half of the power stage, from the junction of R239 and R241 to the junction of R249 and R251, should be of the same magnitude but of opposite polarity from the other half. If the output signal has distortion problems on either the top or the bottom portion of the waveform, then troubleshoot the respective half of the power stage, top or bottom. Set the HP 3325B for turn-on conditions, but with zero volts dc offset and all functions off. The approximate dc voltages are as follows:

Location	DC Voltage
Emitter of Q213	+0.7V
Emitter of Q207	–0.7V
Collector of Q216	+15V
Collector of Q209	–15V

m. After troubleshooting, reroute R221 back to its original position.

NOTE

In normal operation, the gain preamplifier provides high gain, low distortion, and low noise. The power amplifier has a gain of 1 and acts as a buffer.

CIRCUIT NOTES

Q208 and Q214 are simply protection devices and are usually OFF. The power stage should still operate if they are removed.

In normal operation, the signal at the collector of Q204 should be essentially the same as the signal at the junction of R249 and R251.

If the HP 3325B does not meet accuracy specifications at 20 MHz after repair of the output amplifier and the flatness cannot be adjusted properly with the FLT adjustment (Section V, Amplitude Flatness adjustment), it may be necessary to select a different value for A14C103 (Service Group J). Increasing the value increases the output amplitude at higher frequencies, and vise versa. Note that the 20 MHz flatness adjustment (FLT) affects square wave overshoot.

No Sync Output, Signal Output Normal.

If the signal output is normal but there is no front panel sync output, check for a square wave at both ends of the fuse, F4. With no external equipment connected to the sync output, this should be a TTL level square wave.

If the signal is present at only one end of the fuse, replace the fuse (.125 A, -hp- Part No. 2110-0301).

If the fuse is good, trace the signal from U47 through U48. If any one of the five parallel inverters has failed with either the input or output at ground, the sync output will not be present.

If there is no signal at U47 output, move the small shorting connector marked AMP IN from the NORM position to the opposite position. The dc voltage at U47 pin 2 should then measure +3.75 V (one-half the voltage at the AMP OUT test point).

No FAST Sync Output, Sync Output Normal.

If the sync output at the front panel is a normal TTL signal, but there is no FAST sync output at the rear panel, check the FAST Sync Converter circuitry on the A22 assembly.

Set the main signal to 10 MHz. Verify that the sync signal is present on U382 pins 8 and 10, and on U830 pins 9, 10, and 11. Also, check the protection fuse F850.

C853 slows the edges of the FAST sync to minimize reflection problems. If there is excessive ringing the value of C853 may be adjusted slightly.

At frequencies above 21 MHz the 21 – 60 MHz Auxiliary signal drives the FAST Sync output. Check the signal through the amplifier at Q810 and Q820. The emitter of Q820 should carry a signal with valid TTL levels.

No Rear Panel AUX Output.

Step a of No Rear Panel AUX Output troubleshooting in Service Group D should be performed before proceeding with the following.

At frequencies above 21 MHz the 21 – 60 MHz auxiliary signal drives the FAST sync converter. This signal is routed to both the FAST sync output and the auxiliary output on the rear panel. If the FAST sync functions from 21 to 60 MHz, check the AUX drive circuits at A22U830 pin 16. If the FAST Sync is also bad, follow the No FAST Sync Output, Sync Output Normal troubleshooting procedures.

Level Comparator, Level Data, and Ramp Reset Troubleshooting.

The level Comparator output level (at PK test point) changes each time the amplifier output equals the "Level" voltage at U42 pin 3. These changes should be easily observed when the Amptd Cal key is pressed or when frequencies above 100 Hz are selected for triangle or ramp waves.

The Level Comparator outputs preset the Level Data Flip-Flops, which are reset as necessary by the controller.

The Ramp Reset one-shots are triggered by the Level Comparator outputs when the Ramp Enable signal is high. The level of the Ramp Polarity signal at U45 pins 2 and 9 determines whether the + Ramp or – Ramp reset one-shot is triggered.

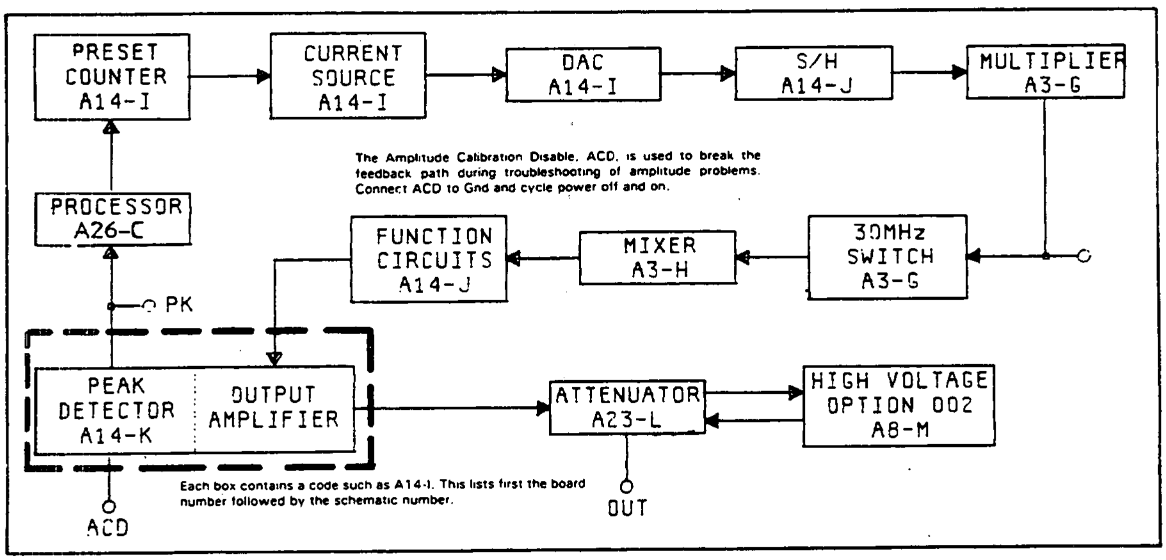
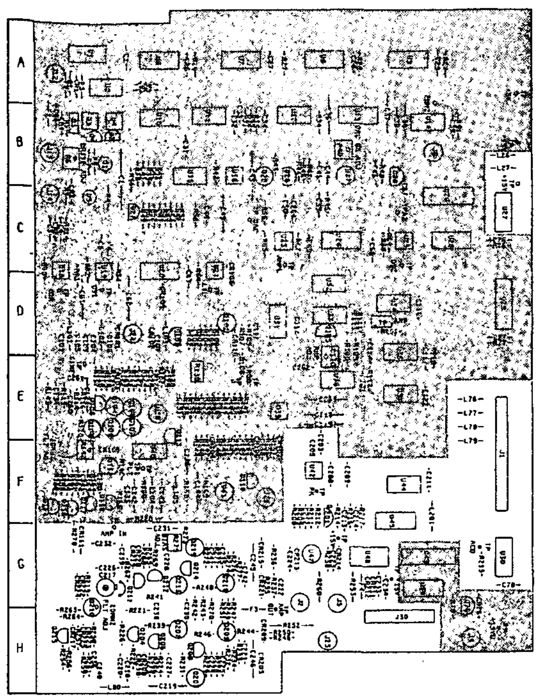


Figure 8-K-2. Sine Amplitude Control Path.

A14 Component Locations

Designator	Board Location	Designator	Board Location	Designator	Board Location	Designator	Board Location	Designator	Board Location
C078	G	CR205	H	Q204	H	R236	G	R273	G
C208	F	CR208	H	Q206	H	R237	G	R274	G
C209	F	CR209	H	Q207	H	R238	G	R275	G
C211	F	CR210	H	Q208	H	R239	H	R276	G
C212	F	CR211	G	Q209	H	R241	G	R277	G
C213	F	CR212	G	Q210	G	R242	G	R278	F
C214	F	CR213	G	Q211	G	R243	G	U27	C
C217	G	CR214	G	Q212	G	R244	H	U30	G
C218	H	CR215	G	Q213	G	R245	H	U42	F
C219	H	CR217	H	Q214	G	R246	H	U44	F
C220	H	CR219	G	Q215	H	R247	G	U45	F
C221	H	CR220	G	Q216	G	R248	G	U47	G
C222	G	CR221	G	Q219	G	R249	G	U48	G
C223	G	CR222	G	R078	G	R250	H		
C224	G	CR223	H	R208	F	R251	G		
C225	H	CR224	G	R209	F	R252	H		
C226	G	CR225	H	R211	F	R253	G		
C227	H	F3	G	R212	F	R254	H		
C228	G	F4	G	R214	F	R255	G		
C229	H	J01	F	R215	G	R256	H		
C230	G	J02	G	R216	F	R257	H		
C231	G	J05	G	R217	F	R258	H		
C232	G	J25	H	R218	G	R259	H		
C233	G	J30	H	R220	F	R260	G		
C234	G	L026	B	R221	G	R261	H		
C235	G	L027	B	R222	H	R262	G		
C236	H	L076	E	R223	H	R263	H		
C238	G	L077	E	R224	H	R264	H		
C239	G	L078	E	R226	H	R265	G		
C240	H	L079	E	R228	H	R266	H		
C241	G	L080	H	R229	H	R268	G		
C242	G	L201	F	R231	H	R269	G		
C245	G	Q076	G	R232	H	R270	G		
C246	H	Q201	F	R233	H	R271	G		
CR076	G	Q203	H	R234	H	R272	G		



A14
03325-66514
Rev C

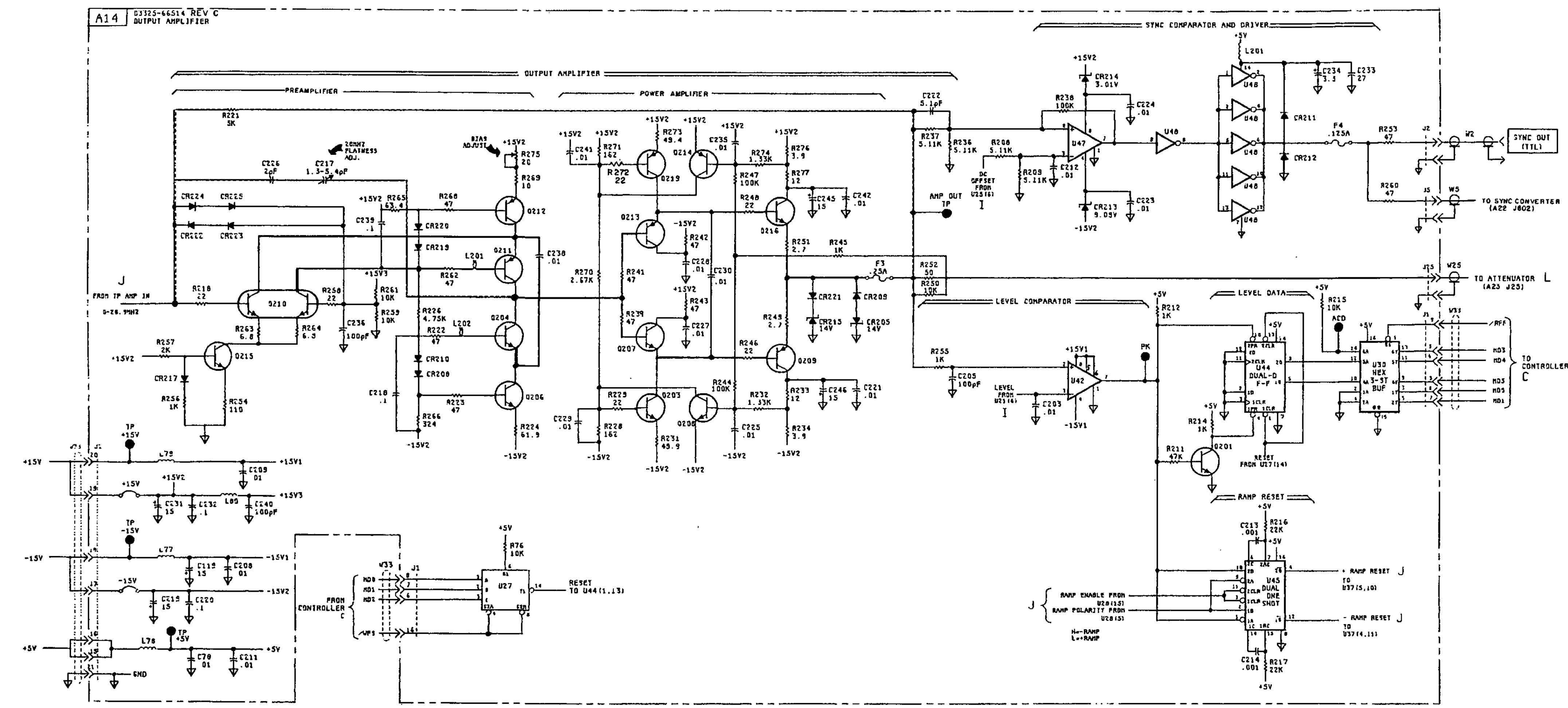
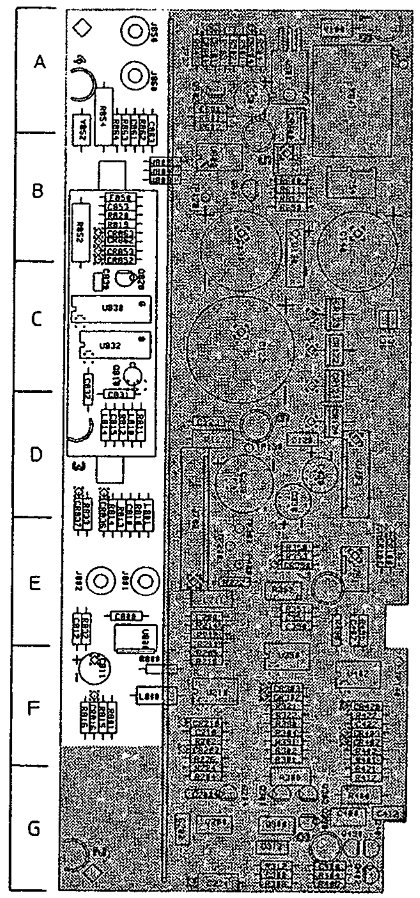


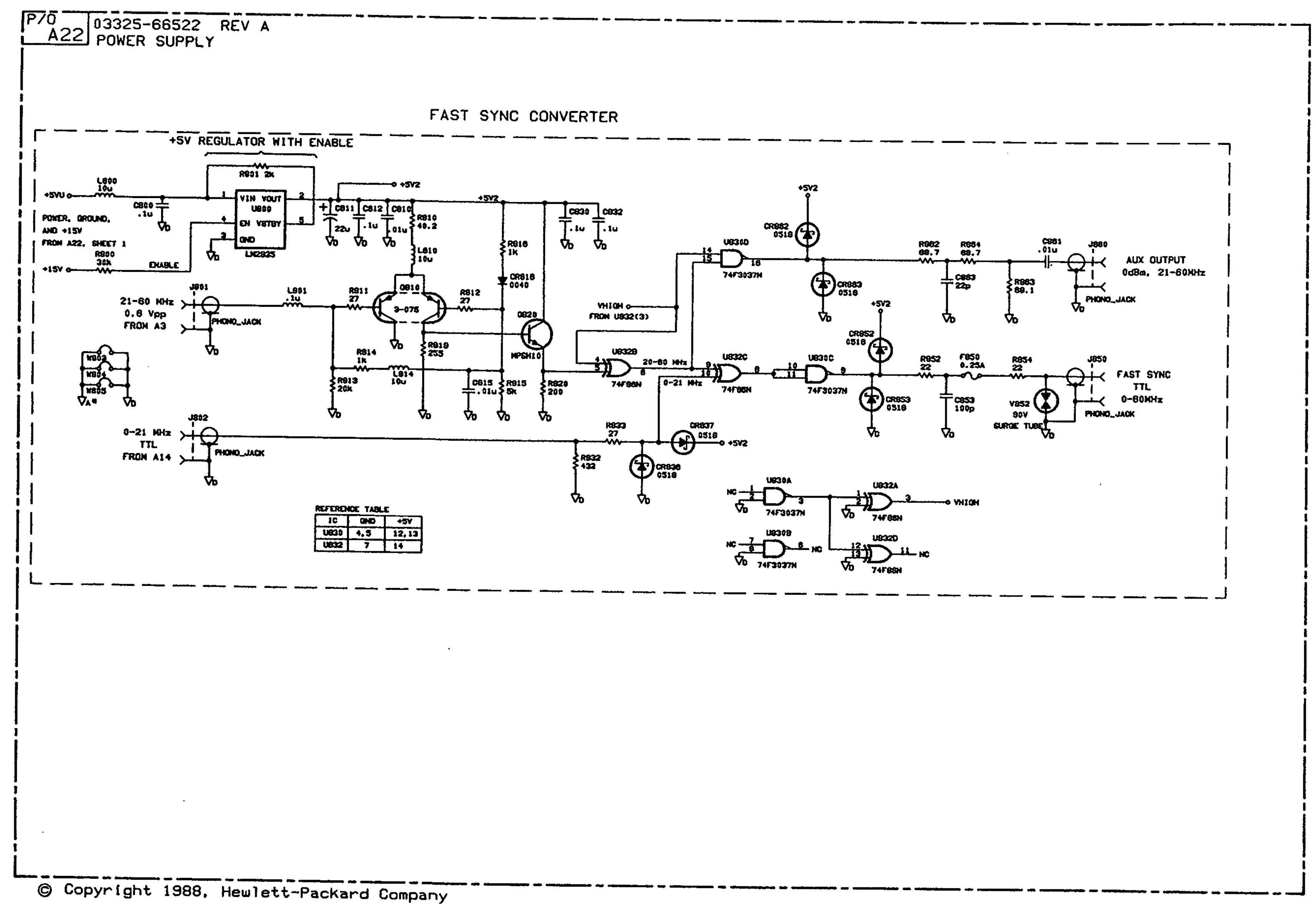
Figure 8-K-3. Output Amplifier, A14



A22
03325-66522

A22 Component Locations

Designator	Board Location	Designator	Board Location	Designator	Board Location	Designator	Board Location	Designator	Board Location
C800	E	CR836	D	L801	D	R815	F	U830	C
C810	D	CR837	D	L810	D	R816	F	U832	C
C811	F	CR852	B	L814	D	R819	B	V852	A
C812	E	CR853	B	Q810	C	R820	B	W803	B
C815	D	CR862	B	Q820	C	R832	E	W804	B
C830	C	CR863	B	R800	F	R833	D	W805	B
C831	D	F850	B	R801	F	R852	B		
C832	C	J801	E	R810	D	R854	A		
C853	B	J802	E	R811	D	R862	A		
C861	A	J850	A	R812	D	R863	A		
C863	A	J860	A	R813	D	R864	A		
CR816	F	L800	F	R814	D	U800	E		



IC	GND	+5V
U830	4,5	12,13
U832	7	14

Figure 8-K-4. FAST Sync Converter, A22.

Service Group L
Relay Drivers, A14 and
Attenuator, A23

SERVICE GROUP L - ATTENUATOR.

NOTE

Handle the A23 Attenuator circuit board ONLY by its edges. Contaminants, such as finger oil, on the circuit board surface contribute to leakage across the attenuator relays and pads.

Troubleshooting Attenuator Relays and Drivers.

Set output to:

Function . . . . DC Offset only (no AC function)
DC Offset . . . . 5 V

Press AMPTD CAL Key.

Measure the 3325 output voltage with a dc digital voltmeter. Do not use a 50-ohm load. The output level should be + 10.000 V ±0.4%. If the output voltage is incorrect by a large amount (a factor of 3, 10, or 100 for example) one of the attenuator relays may be latched in the wrong position. With the DC Offset set to 5 V, none of the attenuator pads should be in.

	No Load Output voltage will be
If ÷ 100 pad (K1) is IN	0.100 V
If ÷ 10 pad (K2) is IN	1.000 V
If ÷ 3 pad (K3) is IN	3.333 V
If ÷ 100 and ÷ 10 pads are IN	0.010 V
If ÷ 100 and ÷ 3 pads are IN	0.033 V
If ÷ 10 and ÷ 3 pads are IN	0.333 V
If K4 is in the IN position	
Instrument with High Voltage	
Option 002	20.00 V
Instrument without Option 002	
(front panel output)	0 V
(rear panel output)	10.00 V

Operation of the latching relays may be checked by momentarily grounding the appropriate test pads found on the Attenuator assembly (A23). These are labeled "IN" and "OUT" for K1, K2, and K3; and "J1" and "J4" for K4.

A small error in the output voltage may be caused by the output amplifier or by excessive contact resistance in the attenuator relays, particularly if the error is not evident on all ranges. The following table lists the eight ranges used in the DC Offset only mode, and the relays used for each range. Relay K4 is used for all ranges.

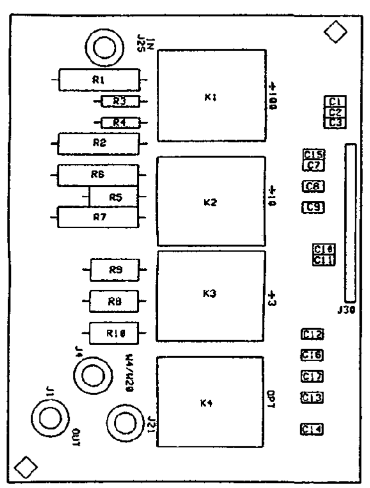
Range	DC Offset Only (No AC Function)	Attenuator Relay Pads In
1	5.000 to 1.500 V	None
2	1.499 to 0.500 V	K3
3	499.9 to 150.0 mV	K2
4	149.9 to 50.00 mV	K2, K3
5	49.99 to 15.00 mV	K1
6	14.99 to 5.000 mV	K1, K3
7	4.999 to 1.500 mV	K1, K2
8	1.499 to 1.000 mV	K1, K2, K3

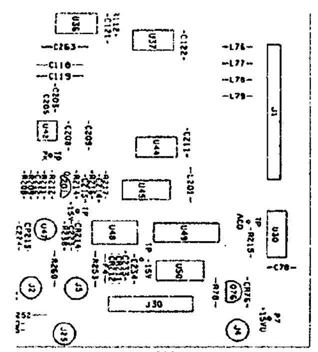
Relay drive pulses at A14U49 outputs and A14Q76 occur only in conjunction with a range change. Each relay is pulsed, regardless of its prior state. Changing the output level from 5V to 1 mV results in pulses to K1, K2, and K3 which place them in the "pad in" position. Changing from 1 mV to 5V causes all three relays to change to the "pad out" position. Pulses may be observed at the proper points by observing an oscilloscope set to a slow sweep speed while entering the above voltages. The clock pulse to U49 may also be observed during any range change. Pulses should appear at U49 inputs continually.

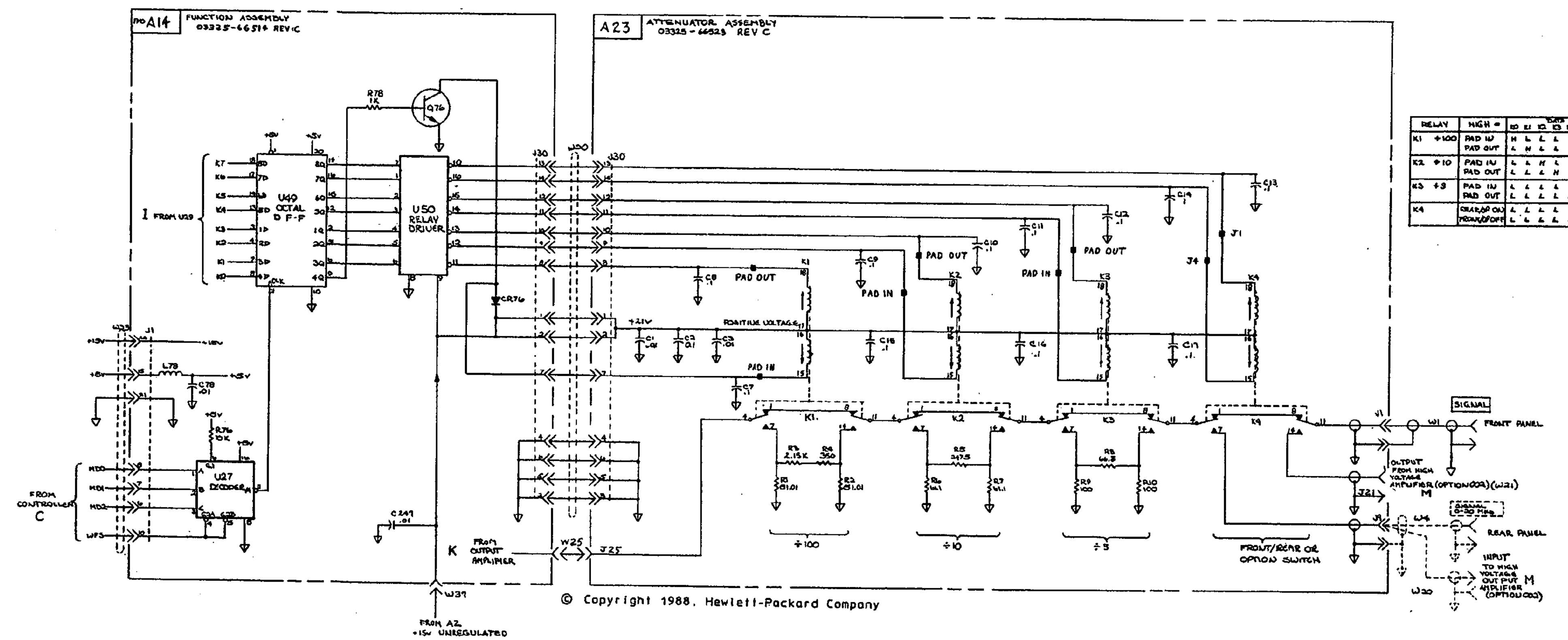
A23 Attenuator Circuit Board Cleaning.

The HP 3325B dc offset accuracy performance at the lowest attenuator ranges may be degraded by contaminants on the circuit board surface. Finger oils and dust contribute to leakage across the attenuator relays and pads. To prevent this, handle the board ONLY by its edges.

If necessary, clean the board with Freon TMS (Miller Stephenson, MS165).







RELAY	HIGH =	K0	K1	K2	K3	K4	K5	K6	K7
K1 ÷100	PAD IN	H	L	L	L	L	L	L	L
	PAD OUT	L	H	L	L	L	L	L	L
K2 ÷10	PAD IN	L	L	H	L	L	L	L	L
	PAD OUT	L	L	L	H	L	L	L	L
K3 ÷3	PAD IN	L	L	L	L	H	L	L	L
	PAD OUT	L	L	L	L	L	H	L	L
K4	REAR/OP ON	L	L	L	L	L	L	H	L
	FRONT/OP OFF	L	L	L	L	L	L	L	H

Figure 8-L-1. Relay Drivers, A14 and Attenuator, A23.

Service Group M
Options: 002
A8 and 001, A9

SERVICE GROUP M - OPTIONS: HIGH VOLTAGE OUTPUT (OPT. 002) AND HIGH STABILITY REFERENCE (OPT. 001).

High Voltage Output Amplifier Troubleshooting.

Before servicing the A8 assembly, be sure that it is being used within its limits of operation:

Frequency Range: 0 - 1MHz
Output Load: 500Ω minimum

If the standard output is normal but there is no high voltage output, move the small shorting connector marked AMP IN (on A14) from the NORM position to the opposite position. Measure the dc voltage at A8TP5 and at both ends of A8F1. This voltage should be approximately +15 V.

If voltage is present at only one end of A8F1, replace the fuse (.25 A, -hp- Part No. 2110-0343).

If the fuse is good, return the shorting connector to the NORM position. Disconnect the cable (marked 20 HI V1) from A8J20. Measure dc voltages with the circuit as shown on the schematic. Voltages should be within ± 10%.

On the A26 assembly, check that SW100 pin 7 is in the HV position. This indicates to the processor that the High Voltage option is installed and the processor then allows voltages greater than 10 Vpp to be programmed.

Note that the A8 assembly has its own +30V power supply.

Be sure to reconnect the cable to U8J20 after troubleshooting.

REAR PANEL OUTPUT WITH OPTION 002.

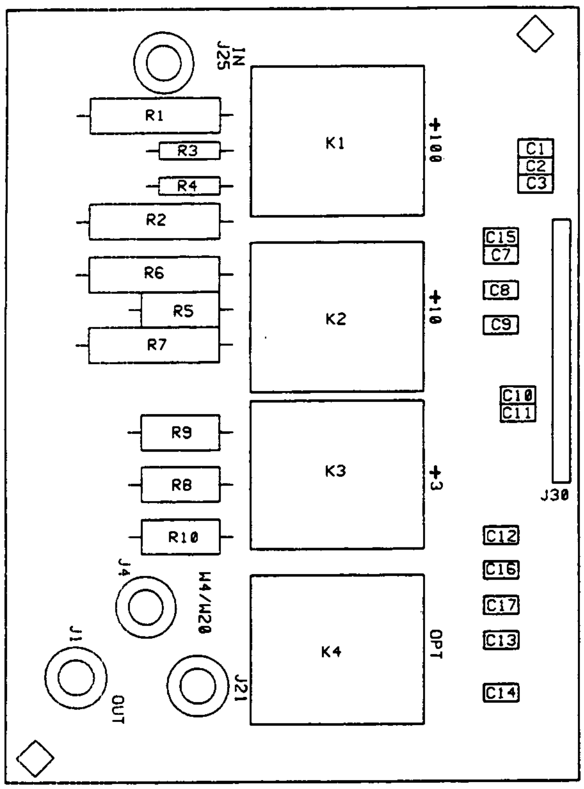
Normally, instruments having the High Voltage Output Option 002 are shipped from the factory with the signal output at the front panel. The signal output can be changed to the rear panel by reconnecting Cables 1 and 4.

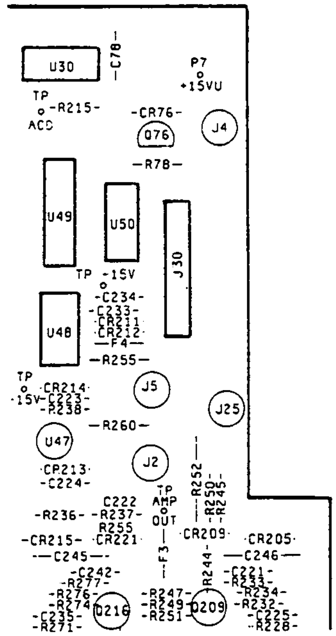
a. Disconnect Cable 1 (to the front panel signal output) from the attenuator assembly J1 OUT.

b. Disconnect Cable 4 (to rear panel signal output) from the connector on A14 labeled "4 DUMMY", and connect it to J1 OUT on the attenuator assembly. It may be necessary to cut a cable tie to reach J1.

c. Connect Cable 1 to the "4 DUMMY" connector.

d. The standard and high voltage outputs will now appear at the rear panel SIGNAL connector.





CHANGING OPTION 002 TO STANDARD (FRONT/REAR) OUTPUT.

Use the following procedure to change an instrument with High Voltage Output Option 002 to the standard instrument Front/Rear signal output configuration. The High Voltage output will then not be available at either the front or rear panel.

a. Disconnect the cable (marked 20 HI V1) from A23 J4.

b. Disconnect the cable (marked 21 HI V2) from A23 J21.

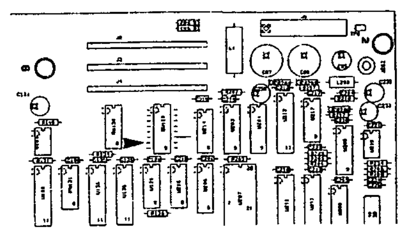
c. Disconnect the cable (marked 4 REAR/EXT LVL) from A14 4/DUMMY and connect it to A23 J4.

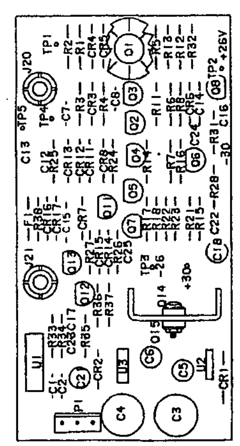
d. Connect the cable marked 20 HI V1 to A14 4/DUMMY.

e. Secure the cable marked 21 HI V2 in a position that does not allow the connector to touch the printed circuit board or any component.

f. Move A26 SW100 pin 7 from the HV position to the STD position.

g. Attach a tag or other identification to the front panel to indicate that the high voltage output has been disabled and that the standard signal is available at the front or rear panel (switchable).





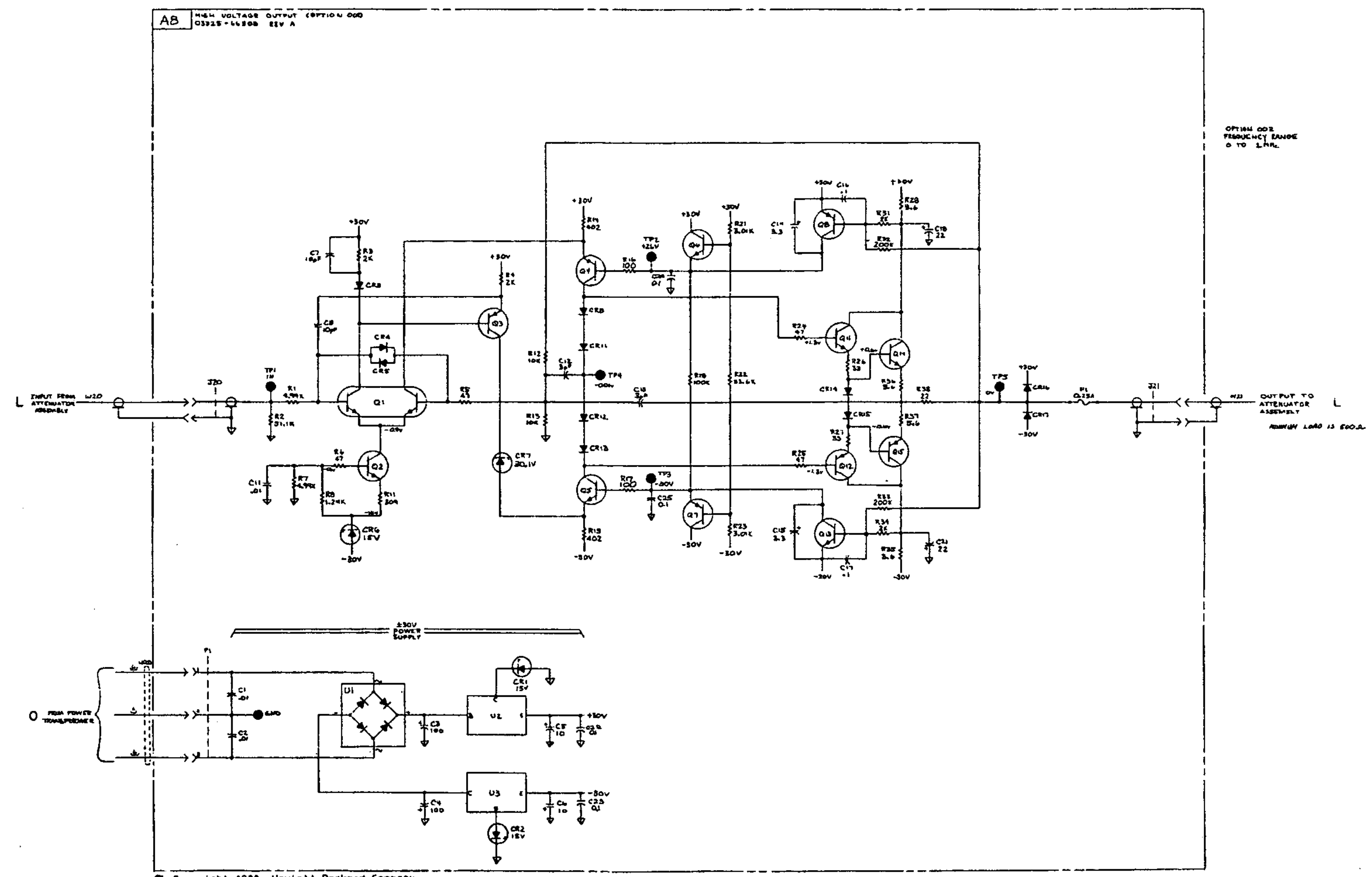
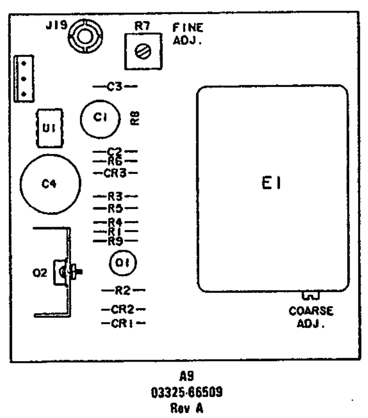


Figure 8-M-1. High Voltage Output Option 002, A8.



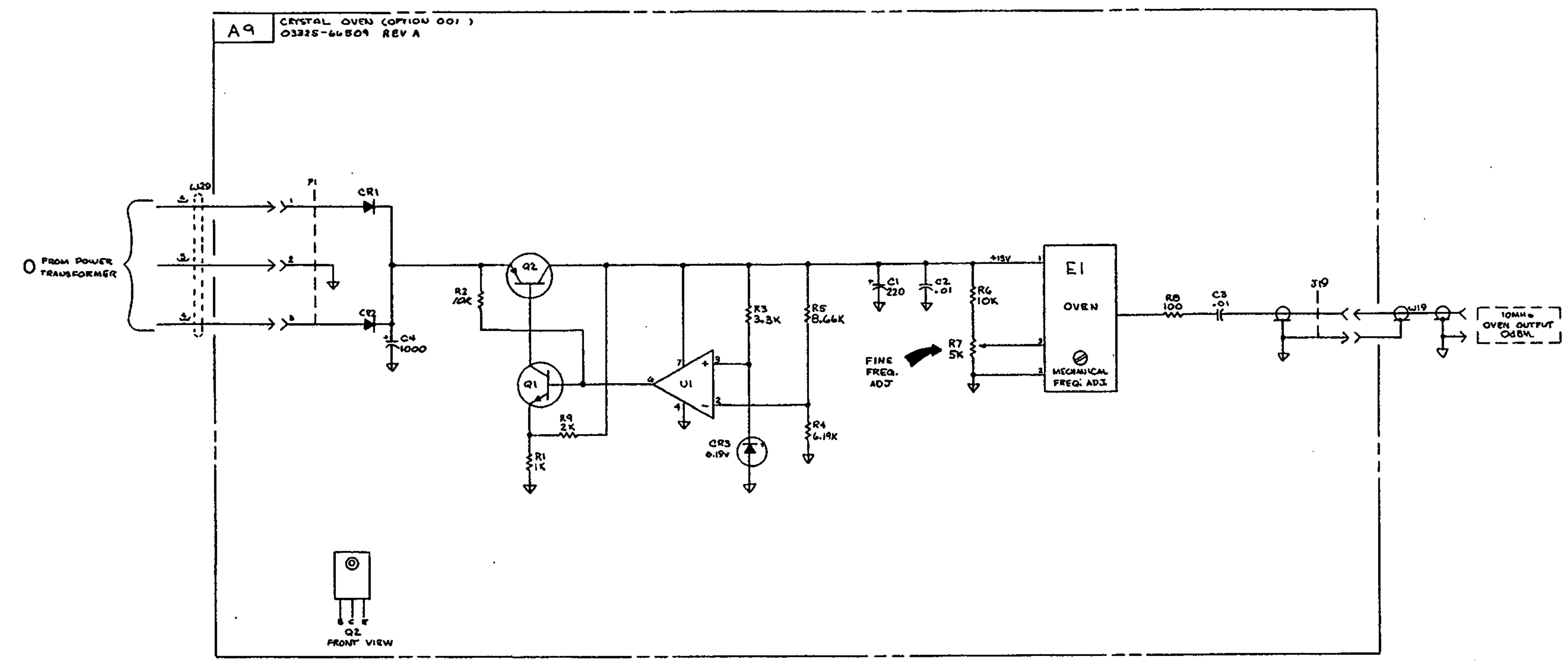


Figure 8-M-2. High Stability Reference Option 001, A9.

Service Group N
Sweep Drive, A14 and
Modulation Source, A26

SERVICE GROUP N - SWEEP DRIVE and MODULATION SOURCE CIRCUITS, A14 and A26.

Troubleshooting The Sweep Drive Circuits.

To determine whether only one or both X Drive ranges are bad, monitor the X Drive output with an oscilloscope.

a. Set sweep time to .999 sec. Press START CONT key. X Drive output should go from 0 V to > +10 V during sweep up, and remain at 0 V during sweep down.

b. Set sweep time to 1 sec. The oscilloscope display should be as described in Step a.

c. Check the voltage at the XDR test point (on A14). This voltage should change from −10.0 V to −0.1 V when the sweep time is changed from 1 sec to .999 sec.

d. If neither output is correct in Steps a and b, first troubleshoot the X Drive Integrator circuit. The ramp reset pulse at the gate of A14Q1 should be as indicated on the schematic, with the negative-going edge of the pulse occurring at the end of a sweep up (in continuous sweep). Also check for the Ramp Reset pulse at A14U1 pin 12. If no pulse is present, go to the Logic troubleshooting, Service Group C.

e. Setting the sweep time to .999 sec checks Range 1, while a time of 1 sec checks Range 2. If only one range is inoperative, compare the voltage at U4 pin 4 (Range 1) or U3 pin 6 (Range 2) to the voltage at the XDR test point.

.999 sec = −0.1 V
1 sec = −10.0 V

If these voltages are correct, the Sweep Range Switches are working, and the trouble is probably in the X Drive Integrator.

f. If either of the voltages in Step e is not correct, check for the Range 1 level at U4 pin 2, or the Range 2 level at U3 pin 2 and 3. One of these should be TTL high and the other low, depending upon the range of the sweep time selected.

g. The Start output from the X Drive Start/Stop Flip-Flop should be high during a sweep up and low during sweep down. The L Start level at U2 pin 2 and U1 pin 15 should go low at the beginning of a sweep up and high just before the end of sweep up.

Z Blank Output.

With the 3325 in continuous sweep (linear mode) the Z Blank output should be at a TTL low level during sweep up, high during sweep down. Check for this signal at both ends of A14F1. If the fuse is bad, replace with -hp- P/N 2110-0343, 0.25A. The signal should be inverted at the base of Q3.

Marker Output.

The Marker output operates only during a linear sweep up. It is high at the start of a sweep up, goes low at the selected marker frequency, then high again at the stop frequency. Check for this signal at both ends of A14F2. If the fuse is bad, replace with -hp- Part No. 2110-0343, .25 A.

If the fuse is good, check for the presence of the Sweep Limit Flag at U2 pin 5, and the Marker Reset pulse at U2 pin 1. Both should be negative-going pulses. Sweep Limit Flag should occur at the selected marker frequency and at the end of sweep up. The Marker Reset pulse should occur immediately after the end of sweep up.

Troubleshooting the Modulation Source Circuits.

The analog circuits can be checked with an oscilloscope. Press the Instr Preset key, then select MOD SOURCE sine wave. Set MOD SOURCE amplitude to 10V.

Check for a 1 kHz, 10 Vpp sine wave at the Modulation Source output. On A26U217, check pin 14 for a 15.4 Vpp sine wave and pin 1 for a 20 Vpp sine wave. Also check U218 pin 2 for a voltage of 2.5 Vdc.

Check the digital section of the modulation source with Signature Analysis Test 0.

Signature Analysis Test 0.

The SA0 test can be used to troubleshoot incorrect signals from the X-Drive, Marker, Z-blank, or Modulation Source outputs, and FAIL 040.

Set the POWER switch to STANDBY (⏻), then connect the Signature Analyzer as follows:

Gnd:		A26 TP0 (GND)
Start:	+ slope	A26 TP3 (S/A START STOP)
Stop:	+ slope	A26 TP3 (S/A START STOP)
Clock:	– slope	A26 U39 Pin 1 (/EEDTACK)

Set A26SW100 pin 1 to the **SA0** position. Check that A26SW100 pin 2 (SA1) is in the **NORMAL** position.

Set the POWER switch to ON (I). A26 CR141, CR142, CR144 should be on. CR143 should be off. If the front panel display is operational, the front panel LEDs will be on in a random pattern.

Check for a +5V signature of HF3A.

If the +5V signature or the A26 LEDs are incorrect, troubleshoot the A26 assembly using the Kernel SA test in Service Group C. If they are correct, troubleshoot the A14 and A26 assembly using this SA test. Use the Test Signal Flow Diagram to help you determine the order to check the signatures.

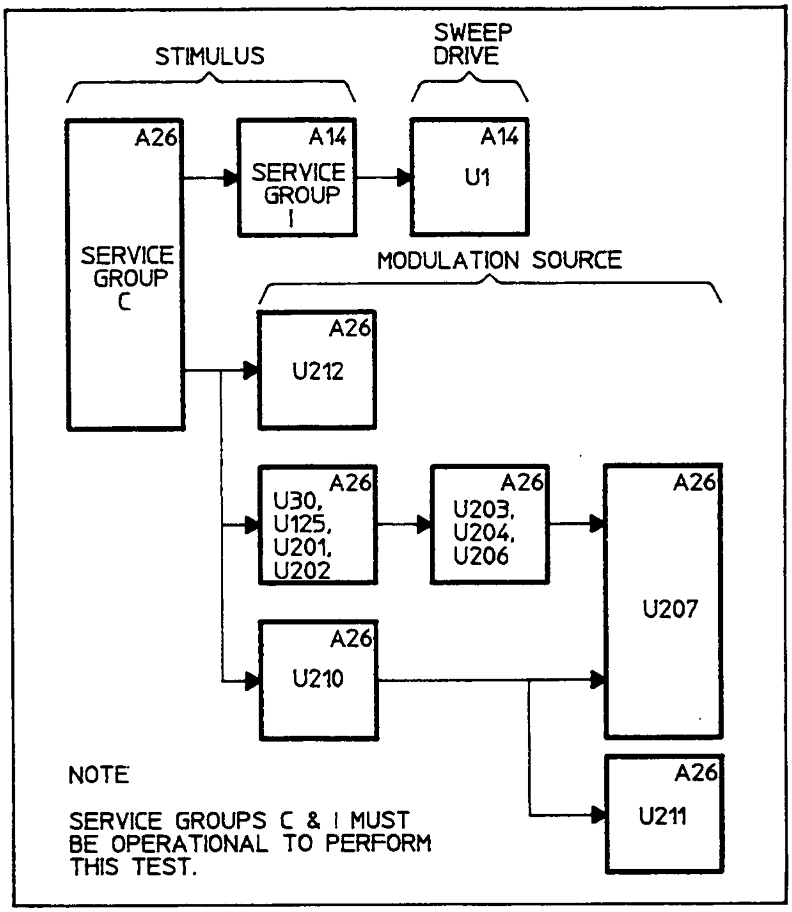


Figure 8-N-1. A14 and A26 Assembly SA0 Test Signal Flow Diagram.

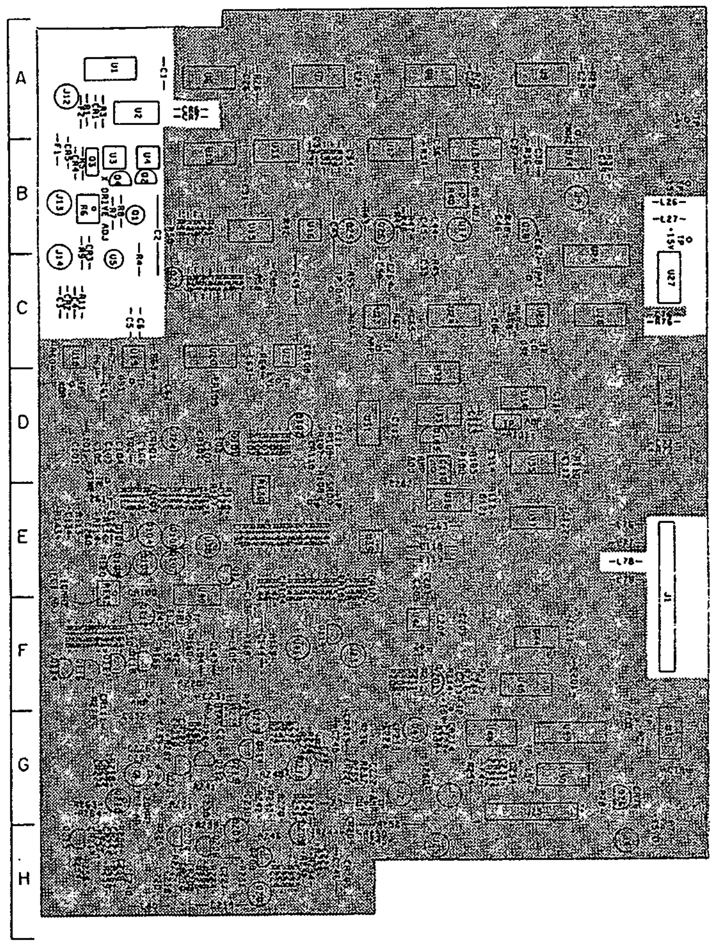
Table 8-N-1. A14 and A26 Assembly Signatures.

(The dash indicates an unstable signature.)

Pin	A14 U1	A26 U30	A26 U125	A26 U201	A26 U202	A26 U203
1	HF3A	–	–	0000	0000	0000
2	21C0	–	–	89PU	89PU	0000
3	41UU	–	–	–	–	89PU
4	41UU	HHHC	–	–	–	0000
5	21C0	H2U1	–	0000	0000	HF3A
6	41UU	HHHC	–	89PU	89PU	89PU
7	21C0	0000	0000	–	–	0000
8	0000	2305	0000	–	–	0000
9	CPPC	H2U1	HF3A	0000	0000	0000
10	UH8A	2305	HF3A	0000	0000	89PU
11	9HF5	–	0000	UU3U	UU3U	2305
12	UH8A	–	89PU	89PU	0000	55H5
13	9HF5	–	HF3A	–	–	HF3A
14	9HF5	HF3A	HF3A	–	–	HF3A
15	UH8A			0000	0000	89PU
16	HF3A			89PU	0000	HF3A
17				–	–	
18				–	–	
19				0000	0000	
20				HF3A	HF3A	

Table 8-N-1. A14 and A26 Assembly Signatures (Cont).
(The dash indicates an unstable signature)

Pin	A26 U204	A26 U206	A26 U207	A26 U210	A26 U211	A26 U212
1	0000	0000	HF3A	55C5	HF3A	HF3A
2	0000	0000	0000	A71H	0000	UU5U
3	89PU	89PU	0000	UU65	–	A71H
4	HF3A	HF3A	89PU	3AC1	–	UU65
5	HF3A	HF3A	0000	4508	0000	2365
6	89PU	89PU	89PU	7U4F	0000	UU5U
7	0000	0000	0000	F173	–	3AC1
8	0000	0000	89PU	U8C2	–	4508
9	0000	0000	0000	429F	0000	2365
10	89PU	89PU	89PU	0000	0000	0000
11	2305	2305	–	–	0000	HHHC
12	55H5	55H5	–	–	0000	UU5U
13	HF3A	HF3A	–	–	–	7U4F
14	HF3A	HF3A	0000	–	–	F173
15	89PU	89PU	–	–	0000	2365
16	HF3A	HF3A	–	–	0000	UU5U
17			–	–	–	U8C2
18			–	–	–	429F
19			–	2305	0000	2365
20			0000	HF3A	HF3A	HF3A
21			89PU			
22			55C5			
23			0000			
24			0000			
25			89PU			
26			HF3A			
27			2305			
28			HF3A			



A14
03325-66514
Rev C

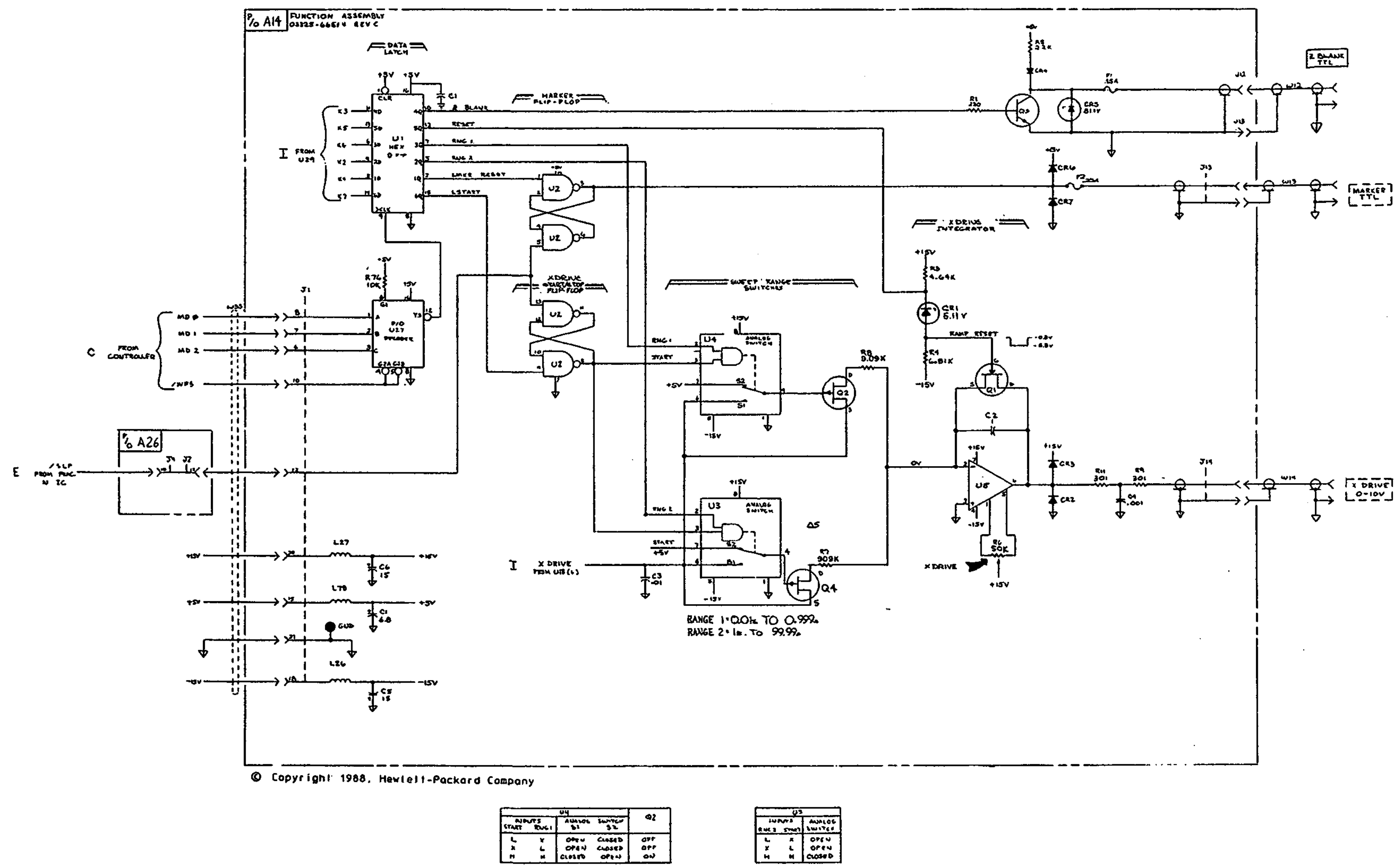
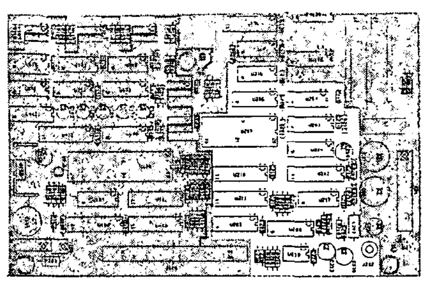


Figure 8-N-2. Sweep Drive, A14.



A26
03325-66525

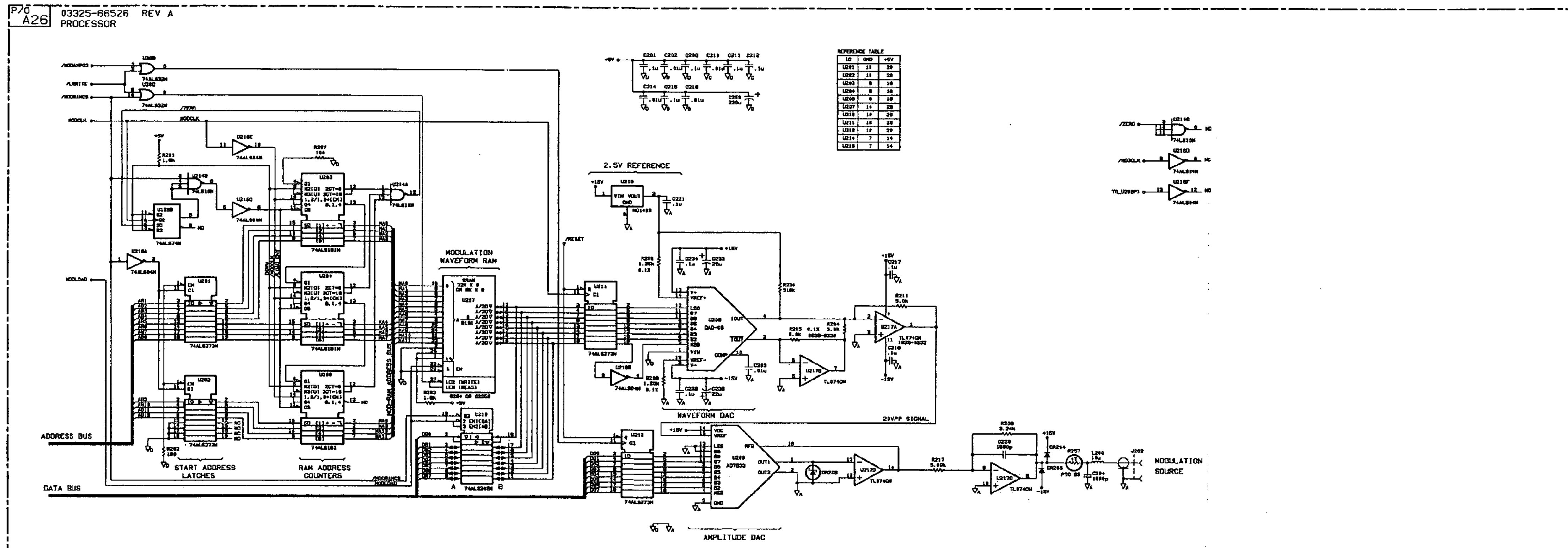


Figure 8-N-3. Modulation Source, A26.

SERVICE GROUP O - POWER SUPPLIES.

Power Supply Troubleshooting.

WARNING

Service procedures described in this section are performed with the protective covers removed and power applied. Hazardous voltage and energy available at many points can, if contacted, result in personal injury.

To determine if the trouble is in the regulators or if some other circuit is pulling down a power supply voltage, set the POWER switch to STANDBY (⏻) and then disconnect the cable from A22J700. Disconnecting the cable from A22J100 removes the power to the other circuit boards and disables the power supplies. Ground A22 J700 pin 10, to enable the power supplies, and set the POWER switch to ON (I).

The three power supply voltages (–15V, +15, and +5V) are routed from A22 J700 through a cable to A26 J5. The power supply voltages then are routed from J2, J3, J4, and J10 through ribbon cables to the other assemblies.

If the power supply voltages are not within ±1V of the correct value with the cable removed, troubleshoot the regulator circuits, using the dc voltages noted on the schematic. Note that all supplies are referenced to -15V. Therefore, if this supply is bad, the +5V and +15V supplies will be off as well.

If the power supply voltages are correct with the cable disconnected, set the POWER switch to STANDBY (⏻) and disconnect the ribbon cables from A26 J2, J3, J4, and J10. Reconnect the cable to A22J700. On the Control assembly, connect the STBY test point (TP6) to ground (TP0) to enable the power supplies, and set the POWER switch to ON (I). If power supply voltages are again incorrect, the problem is on the A26 assembly (Service Group B and C). If power supply voltages are correct with the A26 assembly connected and the other assemblies disconnected, replace the cables one at a time until you locate the assembly causing the problem. Troubleshoot the faulty assembly.

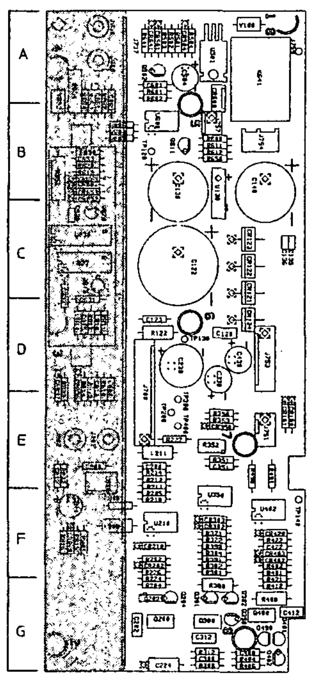
CAUTION

The ribbon cables must be removed and reinserted carefully to prevent damage. Make sure that the cable contacts are aligned properly with the connector contacts.

NOTE

When replacing Q200, Q300, or Q400, make sure the insulator is in place correctly.

Designator	Board Location	Designator	Board Location	Designator	Board Location	Designator	Board Location
C120	D	CR403	F	Q810	C	R650	B
C122	C	CR420	F	Q820	C	R800	F
C123	D	CR501	A	R122	D	R801	F
C130	B	CR504	A	R202	F	R810	D
C135	C	CR600	A	R205	F	R811	D
C136	C	CR641	A	R210	F	R812	D
C140	B	CR816	F	R211	E	R813	D
C200	E	CR836	D	R212	E	R814	D
C202	G	CR837	D	R214	E	R815	F
C224	G	CR852	B	R222	E	R816	F
C230	D	CR853	B	R224	F	R819	B
C300	G	CR862	B	R226	F	R820	B
C312	G	CR863	B	R300	G	R832	E
C330	D	F850	B	R301	F	R833	D
C340	D	J700	D	R302	F	R852	B
C351	E	J737	A	R304	F	R854	A
C400	G	J751	E	R306	G	R862	A
C412	G	J753	D	R312	G	R863	A
C422	F	J754	B	R321	F	R864	A
C430	D	J757	B	R322	F	TP120	B
C504	A	J759	A	R350	E	TP130	D
C601	A	J801	E	R351	E	TP140	F
C800	E	J802	E	R352	E	TP200	E
C810	D	J850	A	R353	E	TP300	E
C811	F	J860	A	R390	F	TP400	E
C812	E	K641	A	R391	F	U130	B
C815	D	L211	E	R400	G	U210	F
C830	C	L800	F	R401	F	U350	F
C831	D	L801	D	R402	F	U402	F
C832	C	L810	D	R404	G	U600	B
C853	B	L814	D	R406	G	U800	E
C861	A	Q200	G	R421	F	U830	C
C863	A	Q202	G	R422	F	U832	C
CR100	E	Q204	G	R490	E	V100	A
CR101	E	Q300	G	R491	E	V852	A
CR121	C	Q301	G	R501	A	W803	B
CR122	C	Q302	G	R502	A	W804	B
CR123	C	Q390	G	R503	A	W805	B
CR124	D	Q400	G	R504	A		
CR202	F	Q401	G	R600	B		
CR210	F	Q402	G	R601	A		
CR302	F	Q490	G	R602	A		
CR303	F	Q501	A	R611	B		
CR350	E	Q502	A	R612	B		
CR402	F	Q611	B	R641	A		



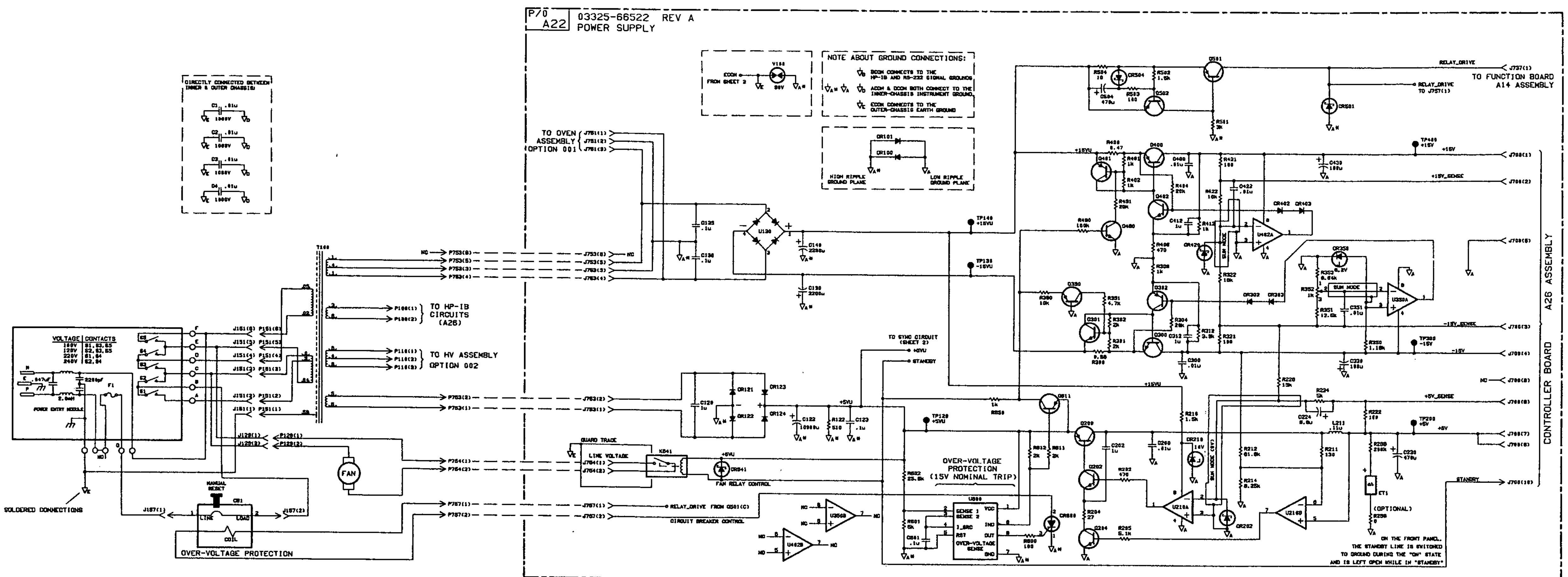


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Figure 8-O-1. Power Supplies, A22.

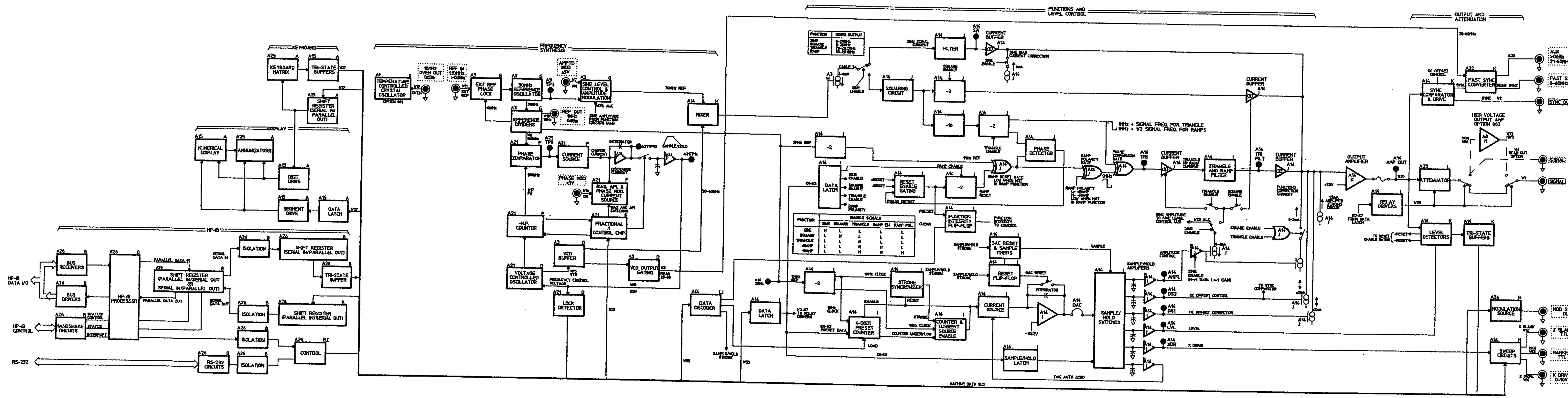

Figure 8-P-1. Functional Block Diagram
8-P-1/8-P-2

Hewlett-Packard Sales and Service Offices

To obtain Servicing information or to order replacement parts, contact the nearest Hewlett-Packard Sales and Service Office listed in HP Catalog, or contact the nearest regional office listed below:

In the United States
California
P.O. Box 4230
1421 South Manhattan Avenue
Fullerton 92631

Georgia
P.O. Box 105005
2000 South Park Place
Atlanta 30339

Illinois
5201 Tollview Drive
Rolling Meadows 60008

New Jersey
W. 120 Century Road
Paramus 07652

In Canada
Hewlett-Packard (Canada) Ltd.
17500 South Service Road
Trans-Canada Highway
Kirkland, Quebec H9J 2M5

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Case Postale 365
CH-1217 Meyrin

In All Other Locations
Hewlett-Packard Inter-Americas
3155 Porter Drive
Palo Alto, California 94304

SERVICE NOTE

SUPERSEDES: None

HP 3325B Synthesizer/Function Generator

Serial Numbers: 0000A00100 / 2847A06410

High Line and Low Line Fuse Change

Parts Required:

HP Part No.	Description	Line Operation
2110-0876	Fuse 1.5A 250V non time delay	(100/120V operation)
2110-0877	Fuse 750mA 250V non time delay	(220/240V operation)
03325-80401	Label- rear panel fuse label	

Situation:

Both high and low line fuses are being increased in value to eliminate nuisance fuse blowing at power-up (due to a large inrush current that occurs during the first cycle of applied line voltage). This problem occurs most frequently at high line settings (220/240V).

Ignore this Service Note if you are not experiencing this problem.

Continued

DATE: 09 March 1992

ADMINISTRATIVE INFORMATION

SERVICE NOTE CLASSIFICATION: **MODIFICATION RECOMMENDED**			
ACTION CATEGORY:	☐ IMMEDIATELY ■ ON SPECIFIED FAILURE ☐ AGREEABLE TIME	STANDARDS: LABOR:	
LOCATION CATEGORY:	■ CUSTOMER INSTALLABLE ☐ ON-SITE ☐ HP LOCATION	SERVICE INVENTORY: ☐ RETURN ☐ SCRAP ☐ SEE TEXT	USED PARTS: ☐ RETURN ☐ SCRAP ☐ SEE TEXT
AVAILABILITY:	PRODUCT'S SUPPORT LIFE	RESPONSIBLE ENTITY: A100	UNTIL: 09 March 1994
AUTHOR: DAA	ENTITY: A100	ADDITIONAL INFORMATION:	

HEWLETT PACKARD

Solution/Action:

Remove the power cord from the 3325B. Replace the line fuse with the appropriate value (listed above) and apply the fuse label over the incorrect silked screened label on the rear panel.

Make documentation corrections in the 3325B manuals as follows:

Manual Part No.	Page	Correction
Operating Manual 03325-90014	1-2 1-35,37 1-41,42	Change the fuse values on the rear panel diagram.
Installation Man. 03325-90006	4-3 4-4	Change fuse values in Table 4-2. Figure 4-1 change rear panel fuse label.
Service Manual 03325-90003	6-25	Table 6-3 Change p/n and description of F1. Add Label p/n to end of list.

3325AB

3325A relay replacement on A23 board

PCO# A1-02489
Ser# 2512A21906
SN# 3325A-22

* 03325-66523 PC Attenuator Board Assembly
  Rev.C has been layed out for new relays

* 0490-1141 replaced by 0490-1548
  yellow printac relay > Aromat RG2ET-L2-12V-H10

* RETURN LOSS SPEC at 20MHz not met using Printac relays

* SUPPORT ISSUE: to repl 0490-1141 order 03325-66523 Rev.C

....

3325A D/A Offset Adj

D/A Converter Offset adjust doesn't work (sinewave ampl accuracy out of spec)

D/A Converter Offset Adjust:

1. Adjust A14R40 for a "zero" reading
   Press "ampl cal" key

2. Re-check for a zero reading at the AMP OUT test point.
   (this voltage may drift above 5mV after an AMPL CAL is performed).
   Re-adjust A14R40 to get a "zero"reading

3. Press AMPL CAL key again

4. Repeat step 2 (until a zero reading is maintained)

....

3325A OSCILLATOR, ACAL failures

The "OSC FAIL" and "ACAL FAIL" USUALLY can be traced to either of the following PC board assemblies:

A21 board (change FracN Chip- in socket)

A3 board (check the 30 MHz signal freq and level)

The 3325A has had a history of intermittent failures due to defective phono cables (or at least poor connections on the phono coax cables). Check them all thoroughly for continuity and good, clean connections.

....

3325A/B Phase Noise

Here are LSID's comments regarding the HP 3325A/B Phase Noise issue, commonly referred to as "low frequency jitter".

Typical Customer complaints:

1. "Unacceptable Jitter": frequency range- 10 kHz to .01 Hz.

   Unit is failing its Phase Noise Spec due to the fact that the customer was unable to obtain a viewable oscilloscope display of the 3325B output sinewave while triggering the scope from a frequency standard (standard was also phase locked to the 3325B).

2. The 3325A/B Frequency Accuracy appears to be Out of Spec in the range below 100 Hz, relating to measurements taken with a frequency counter.

   3325B Frequency Accuracy Spec: +/- 5 ppm

Hewlett-Packard reply:

1. HP 3325A/B Phase Noise is NOT SPECIFIED for standard instruments. It is specified ONLY for Option 001 instruments.

Phase Noise Spec: (Opt. 001 only)	=/< -60 dBc for a 30 kHz band centered on a 20 MHz carrier excluding +/-1 Hz about the carrier.

   The 60 dB represents a 1000 to 1 ratio. This will be approx. the same as the average cycle to cycle VARIATION in PERIOD. In other words, a 1 Hz sinewave (period = 1000ms) typically may have individual periods between 999 and 1001 milli-seconds. This variation would relate to a counter reading error of +/-1000 ppm (1s +/- 1ms) when measuring a 1 Hz signal using a one second gate

   NOTE: the key thing to remember here is that, in the presence of phase noise, one cannot measure the nominal frequency accuracy by averaging a SMALL number of periods (ie 10 or 100 periods). Nominal and instantaneous frequency are seldom, if ever, the same. They are related to each other by phase noise.

   Therefore, to measure nominal frequency in the presence of phase noise, one must average the frequency reading over a number of periods corresponding to the RATIO of the resolution required to the EFFECTIVE phase noise.

   In this case, with a 60 dBc phase noise spec and a (roughly) 120 dBc (1 ppm) desired freq. resolution, the measurement time is about 3000 times the period. For ease of measurement and added resolution, a 10,000 period gate time is recommended.

   example: 1 Hz measurement

period x 10,000 = gate time setting

(1sec) x 10,000 = 10,000 sec gate time

Recognizing that many counters do not have a 10,000 second gate time option, it may be necessary to use a shorter gate time and take the average of 100 or more readings to obtain the true nominal frequency of the device under test.

2. HP 3325B frequency measurements, taken with an HP 5345A frequency counter at the factory, VERIFIED the frequency accuracy spec of +/- 5 ppm in the range in question. Close attention was paid to to proper gate time settings, as per the above example. Ten readings were taken and averaged for each decade frequency from 1000 Hz to .1 Hz, using a gate time setting of 10 seconds.
   50 readings were averaged at 1000 sec gate time for the .01 Hz measurement.

3. I suggest that the Customer again measure his 3325B frequency accuracy, following the above example. I believe he was measuring instantaneous frequency instead of the true nominal frequency. I do not believe that his unit is faulty, only his method of measurement.

....

3325B Noise on AC LINE

Problem: Noise riding on sine wave.

There is no spec involved for the noise that you are seeing riding on the AC Sine Wave. I assume that there is a defect, probably located on the A21 board.

I need some additional information from you:

1. What is the 3325B output frequency when the noise is present?

2. Can you find out what the frequency of the noise, itself, is? Is it low or high frequency noise?

3. I suspect that this noise is due to some API defect. Set the 3325B output frequency to 100 kHz (APIs are off). Is the noise still present? Then reduce the output frequency to 1 kHz; if the noise re-appears, the APIs are suspect. You may also be experiencing low frequency noise.

   View the output signal using an HP 3585A/B Spectrum Analyzer tc determine the noise frequency.

....

3325A: replacing A6 with A16

HP 3325A

HP 3336A/B/C

Instructions for replacing the 66506 with a 03325-66516 processor board.

** See Service Note 3325A-21 **

* See the 03325-90002 Service Manual Change Sheet for A16 *
(schematic, parts list and troubleshooting information)

The 03325-66516 PC board is a direct replacement for the old A6 boards (66506) used in both the 3325A and the 3336A/B/C instruments. The board you receive from stock is set up to operate in the 3325A.

Step 1. Replace old 66506 with the 03325-66516 board; replace the eleven screws.

NOTE: there are two holes near the power connector (P5). Install a screw in the more distant hole. The other hole should remain empty.

Step 2. Set the A16 switches as follows:

* S1 (near J4): set to desired HP-IB address (default address is 17. Switch pos 1-8 are 10001000)

* S2 (near U15): all eight switches must be OFF (toward U10)

Step 3. Power-up 3325A (display will show 1000 Hz).

NOTE: If display does not show 1000 Hz, check the cable to the front panel. If this cable is REVERSED, the fan will turn on EVEN WHEN the power switch is in the STANDBY mode. Check integrity of all other cables.

....

HP 3325A/B low frequency jitter fixes

1. Problem: ripple on triangle or ramp output

   Cure: cable 03325-61641 (A22 to A26); twist the blue and purple leads together; twist the red and orange leads together.

2. Problem: lf sinewave jitter.

   Cure: * replace power supply regulation transistors.
   * tighten all screws securing PC boards (especially A14)
   * perform "RAM Stability Adjustment" (A14C110 cap)

....

3325A/B: FracN Socket

The FracN tin plated socket p/n 1200-0567 (MP19) was replaced with gold plated socket p/n 1200-1255 on the 03325-66521 PC board.

Reason for the change: Reliability requires the use of gold plated sockets foı gold plated IC's and the socket is needed because the FRAC-N chip requires a capacitor fix between the IC legs.

....

3325B: transformer wire insulation

PROBLEM: power transformer metal edge is abraiding the wire insulation.

LSID will add an additional layer of insulation, (2" piece) p/n 0890-1386, to the wiring harness of the Primary Transformer, 9100-4724, that is used on the 3325B. This extra layer will prevent any abrasion of the wiring insulation from sharp edges that might exist on the transformer body. The added heat-shrink tubing extends over the end of the connector to ensure the total wire coverage.

-	P/N	Desc.	Qty	Ref Desig	MDC
Add:	0890-1386	(HS tubing)	.2	MP300	3A

....

3325B Flatness Test Failures:

Cause: too much capacitance...change A14C103 from 140 pF to 130 pF.
0140-0217 to 0140-0195.

....

3325A: low frequency distortion

Causes of low freq. distortion:

1. 100 Hz dist: bad crimp on pow.sup. cable 03325-61641 pin 3 (15V sense lead). Replace cable and connector 1251-5347)

2. A3CR101 may be in backwards.

3. Distortion is to be checked at FULL OUTPUT.

4. Check A2 in line related.

5. Check A14 output amplifier.

6. Check A21 APIs and VCO.

....

3325A DC Offset drift

Older 3325A units will drift out of calibration within 6 months cal period due to:

1. Improper adjustment of DC Offset: very sensitive to temperature; should make adj with the covers on.

2. Bad attenuator relays: tap relays while monitoring DC offset to locate defective contacts

....

HP 3325B Harmonic Distortion Failure

Problem: fails HD at 12.4 kHz (2nd harm.) and 18.6 kHz (3rd harm.).

Cure: a 10 DB decrease in HD can be gained be roughing the contact surface of the top metal shield (03325-40602) on the A21 board to provide better shielding.

....

HP 3325A/B Triangle Linearity Test Failures

Problem: fails spec.

Cause: A14C142, C143, C144 were found to be unreliable caps (tolerance fluctuates). Replace the caps, being very careful not to apply excessive heat which would change their value.

Parts Needed:	A14C142	0160-0156
	A14C143	0160-2189
	A14C144	0160-2414

....

3325AB STE/9000 Phase Increment Accuracy Test repeatability

I have found the HP 3325A_B Phase increment repeatability to be very poor.

This affects the results of the HP 3325A/B Phase Increment Accuracy Test
I found that both the STE/9000 solution and the Manual solution have poor repeatability.

Attached are some of my investigation notes.
==

Problem verified:

1. Tested the HP3325A and HP3325B using both the

   HP3335A and HP8663A as the Sources using the HP 3325A_B STE/9000 Solution. Found the test to have poor repeatability.
   - The HP3335A is more repeatable.

2. Ran the HP 3336C and HP3324A Phase Increment Accy test software using both an HP 3325A and an HP 3325B.
   Used both the HP3335A and HP8663A ETE.

   Same results as with the HP3325A_B software.
   NOTE: Tested the HP3336C and found it to be repeatable with both the HP8663A and HP 3335A.

3. Manually, performed the test using an HP 54120T scope, with the HP 8663A then the HP3335A as the scope trigger, and the UUT as the measurement channel input.

Found that the Repeatability was just as bad as the counter method used in the Automated Procedure. I did not notice appreciable difference between using the HP 3335A and the HP 8663A.

So far it seems that the source of the repeability error is the HP 3325A/B design.

Noticed that changing form 1 to 10 to 100 degrees in this order gave the most repeatable results. going from 100 to 0 then back to 100 gave the greatest variation in results.

Solution:

This bug has been fixed by averaging the measurement. This will decrease the measurement uncertainty to a reasonable level.

Attached is the run results for the Phase Increment accuracy test. The test was done with the 3325B as the UUT, and either 3335A or 3325A as the synthesizer. Different combinations of sine wave and square waves were used. As the results show, the best, most repeatable results were obtained from using a 3335 as the synthesizer and using the sine wave function of the UUT and synthesizer. All data is taken with averaging enabled
With old counter (5328)
3335 with 3325 (both sine waves) .550238 Ave diff 0.1526 Max diff 0.4965

With old counter: (5328)
3325 (sine) with 3325 (sine) 0.87290 ave diff 0.247843 Max diff 0.792

....

3325B: Performance Test Additions

HP 3325B Performance Test Requirements

The Hewlett-Packard Lake Stevens Instrument Division recommends that the following tests be performed to meet the requirements of a FULL PERFORMANCE TEST of instrument specifications:

1. Perform all Performance Tests, as stated in the HP 3325B Installation Manual.

2. The following additional tests that should be performed are located within the Operational Verification Test section of the same manual:

   2.1. Amplitude Flatness Check
   2.2. Sine Wave Verification

3. The Operational Verification Record data sheets for the above tests are located in the "operational verification record" in the Installation Manual.

....

3325A/B A21R107 Spur Adjustment Procedure

Note: The following adjustment procedure (using different test equipment) appears in the 3336A/B/C Service Manual para. 5-16 "API Spur Adj.".

Use the following procedure on the 3325A/B ONLY when SPUR failures occur.

API Pedestal Height

Step 1. 3325 set up: Preset
Freq to 20MHz
Ampl to 7dBm

Step 2. Connect the 3585A/B 10MHz Ref Output to the 3325 Ext Ref In.

Step 3. Connect the 3325 50 ohm output to the 50 ohm input on the 3585A/B

Step 4. 3585A/B set up: Preset

Center Freq to	20MHz
Freq Span to	500kHz
CF Step Size to	100kHz
Res BW to	3Hz
Step	Up or Down

Step 5. Adjust A21R107 to minimize the 100kHz sidebands. These should appear 100kHz away from the 20MHz ref.

Note: A21R107 may have to be misadjusted, initially, to be able to see the 100kHz sidebands.

Step 6. Test Limits: the 100kHz sidebands should adjust to at least 70 dB below the 20MHz ref. (cust spec).

....

3325B A14R130 DAC adjustment procedure

Note: this adj. procedure optimizes the DAC range on the 3325B internal calibration routine. Perform this procedure ONLY when internal cal failures occur (failures dealing with Square Wave gain and DC Offset).

Step 1. Run the 3325B SQUARE WAVE ADJUST TEST (special test #54)

1.1. Press: Shift
Deg/mV RMS
Self Test
5
4

The 3325B will then turn on the Sq Wave function, set the amplitude, perform a Cal., and display the Amplitude Cal Factors.

Step 2. Adjust A14R130 until the left-hand number in the 3325B display reads between -10 and +10 (after pressing the AMPTD CAL key). The other number should also remain within the test limits.

```
                  Test Limits: -10 to +10     gain offset (left side)
                               0.83 to 0.97  gain slope (right side)
```

Step 3. Press the LOCAL key to exit Special Test #54.
Two numbers will be displayed. They indicate
the DC Offset Error (in mV) for DC settings of
-4.5V and +4.5V with a square wave amplitude
of 1V p-p. Both numbers should typically be +50mV.

****

HP 3325A A14R130 Adjustment Procedure:

Note: this adj. procedure optimizes the DAC range on the 3325A. Perform this procedure ONLY when internal cal failures occur (failures dealing with square wave gain and DC offset).

```
3325A Setup: Signal Mode: squarewave
             Frequency:   1 kHz
             Amplitude:   1 volt p-p
             DC Offset:   1 millivolt
```

1. Connect 3325A output , through a 50 ohm load, to a 3455A voltmeter (set for fast rms readings).
2. Adjust A14R130 for a 500 millivolt reading on the 3455A (550 mv if 3455A is an option 001 voltmeter).
3. End of procedure.

....

3325A: power transformer change

The old power transformer (9100-4099) was replaced with 9100-4696. This new transformer does NOT come with leads for connection to the Option 002 board. You must solder the free end of cable 03325-61645 (Opt 002 PS cable) to the 3 open terminals on the power transformer (center terminal to ground).

See PCO A1-03837. The old cable, connecting A8 to the power transformer, was part of the power transformer (W28 on A8 schematic). P/N 03325-61645 is used on both 3325A and 3325B. When replacing T1 (9100-4099) on old 3325A Option 002 units, you must also order cable 03325-61645 and clip off the three separate connectors on one end and then solder these leads to the power transformer as follows:

T1 terminal 1: white/brown/grey lead
T1 terminal 2: black lead
T1 terminal 3: white/yellow/grey lead

The 6 pin connector, which connects the power transformer leads to the A2P3 connector, often discolors due to long term heating. To replace this connector, order: 1251-2993 plastic housing (qty 1)
1251-2992 pins (qty 6)

The plastic 2 pin plug (blue wires to HPIB (A6), part number is: 1251-4145

The 10 pin plug, connecting the transformer leads to the A2P2 connector, is:

1251-3389 10 pin plug

....

3325A/B

Problem: Hi Voltage output (opt002) dies at >800kHz.

Cause: Low value 100uF filter cap on -30 volt supply
(100uF 50V 0180-2803)

....

3325B UPDATED CABLE LIST

HP 3325B Cable P/N Change Sheet Rev 03 (10/95)
De Arbogast A100 T-335-2038

REF DES	PART NUMBER/ LABEL	CON	OLD LABEL	CABLE LENGTH	CABLE COLOR	CONNECTION FROM	TO
W1	8120-2587	RCA	1 SIGNAL	216mm	BK	A23J1	FP-SIGNAL
W2	8120-4492	RCA	2 SYNC	305mm	BK	A14J2	FP-SYNC
W3	8120-4494	RCA	3AUX IN	660mm	BK	A3J3	A22J801
W4	03325-61644	RCA	4 EXT LVL	460mm	BK	A23J4	RP-MISG OUT
W5	8120=4494	RCA	5 R SYNC	460mm	BK	A14J5	A22J802
W6	03325-61644	RCA	BUNDLE	7Cables	BK	BUNDLE	BUNDLE
W7	03325-61644	RCA	7 A-M	460mm	BK	A3J7	RP-AMP MOD II
W8	03325-61644	RCA	8 100kHz	460mm	BK	A3J8	A21J8
W9	03325-61644	RCA	9 2MHz	305mm	BK	A3J9	A14J9
W10	03325-61644	RCA	10 1MHz	305mm	BK	A3J10	RP-REF OUT
W11	03325-61644	RCA	11 EXT REF	305mm	BK	A3J11	RP-EXT REF II
W12	8120-4492	RCA	12 Z BLANK	305MM	BK	A14J12	RP-Z BLANK
W13	8120-4492	RCA	13 MKR	305mm	BK	A14J13	RP-MKR OUT
W14	8120-4492	RCA	14 XDRIVE	305mm	BK	A14J14	RP-X DRIVE
W15	8120-4891	RCA	15 VTO	153mm	BK	A3J15	A21J15
W16	8120-4492	RCA	16 PH MOD	305mm	BK	A21J16	RP-PH MOD IN
W17	8120-2587	RCA	17 PD	216mm	BK	A21J7	A21J17
W18	8120-4492	RCA	18 S&H	305mm	BK	A21J18	A21J18A
W19	8120-4492	RCA	19 OVEN	305mm	BK	A9J19	PR-10MHz OUT
W20	8120-2587	RCA	20 HIV 1	216mm	BK	A8J20	A23J4
W21	8120-2587	RCA	21 HIV 2	216mm	BK	A8J21	A23J21
W22	03325-61641	DSC	10P A22/26	280mm	ML	A22J700	A26J5
W23	8120-4492	RCA	23 ALC	305mm	BK	A3J23	A14J23
W24	8120-4492	RCA	24 MXR	305mm	BK	A3J24	A14J24
W25	8120-2844	RCA	25 OUT	102mm	BK	A14J25	A23J25
W26	8120-4492	RCA	26 MOD OUT	305mm	BK	A26J202	M SRC OUT
W27	8120-2587	RCA	27 SYNC OUT	216mm	BK	A22J850	RP-F SYNC
W28	8120-2587	RCA	28 AUX OUT	216mm	BK	A22J860	RP-AUX OUT
W29	03325-61616	DSC	3P A9/22	440mm	ML	A9P1	A22J751
W30	03325-61626	FLX	14P A14/23	50mm	WH	A14J30	A23J30
W31	03325-61646	FLX	21P A15/26	240mm	WH	A15J100	A26J10
W32	03336-61625	FLX	21P A3/26	127mm	WH	A3J1	A26J3
W33	03336-61625	FLX	21P A14/26	127mm	WH	A14J1	A26J2
W34	03336-61625	FLX	21P A21/26	127mm	WH	A21J1	A26J4

W35	03325-61643	RBN	40P A12/26	300mm	GY	A12J770	A26J100
W36	03325-61647	DSC	2P PWR SW	175mm	BK	A15J110	FP-S100
W37	03325-61642	DSC	4P A12/RP	55mm	ML	A12J773	RP-RS232
W38	03325-61645	SHL	3P A8/T100	410mm	GY	A8P1	T100
W39	8120-3962	LD	1P A14/22	450mm	GR	A14P7	A22J737
W6	8120-2491		HPIB 3325A				

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HP 3325B Cable P/N Change Sheet Rev 03 (10/95)
De Arbogast A100 T-335-2038

REF DES	PART NUMBER/ LABEL	SCHEMAT PAGES	A&W DRAWING	OPT	("*" USED IN) 25B	25A	36ABC
W1	8120-2587	8L3	F108 PF109		*	*	
W2	8120-4492	8K7	F108 PF109		*	*	*
W3	8120-4494	8D5 8K9	F67,68,101		*		
W4	03325-61644	8L3	F19,20,36,37	002	*		
W5	8120-4494	8K7 8K9	F35,98		*		
W6	03325-61644	BUNDLE	F12		*		
W7	03325-61644	8G2	F17,18,40		*		
W8	03325-61644	8F2 8G3	F40,93		*		
W9	03325-61644	8G3 8J7	F33,34,40		*		
W10	03325-61644	8H3	F19,20,40		*		
W11	03325-61644	8G2	F19,20,40		*		
W12	8120-4492	8N5	F48-51		*	*	*
W13	8120-4492	8N5	F48-51	001	*	*	*
W14	8120-4492	8N5	F48-51	002	*	*	*
W15	8120-4891	8D5	F68,68,103	002	*	*	*
W16	8120-4492	8F5	F92		*	*	
W17	8120-2587	8E3 8F5	F104		*	*	*
W18	8120-4492	8D5 8F5	F104		*	*	*
W19	8120-4492	8M5	F75		*	*	*
W20	8120-2587	8L3 8M3	F81	002	*	*	
W21	8120-2587	8L1 8M3	F81	002	*	*	
W22	03325-61641	8C9 803	F97		*		
W23	8120-4492	8G3 8J7	F62-65		*	*	*
W24	8120-4492	8H3 8H7	F62-65		*	*	*
W25	8120-2844	8K7 8L3	F69		*		
W26	8120-4492	8N7	F89-91		*		
W27	8120-2587	8K9	F41-45,88		*		
W28	8120-2587	8K9	F41-45,88		*		
W29	03325-61616	8M5 803	F73,74,102	001	*	*	*
W30	03325-61626	8L3	F60,61		*	*	
W31	03325-61646	8A5 8C9	F107 PF104		*		
W32	03336-61625	8C9D5GH3	F56,57,95	002	*	*	*
W33	03336-61625	8C9I5J7N	F58,59,94		*	*	*
W34	03336-61625	8DE1C9F5	F96		*	*	*
W35	03325-61643	8B6 8B7	F99		*		
W36	03325-61647	8A5	PF89,92		*		
W37	03325-61642	8B6	PF28,29,37		*		
W38	03325-61645	8M3 803	F79,80	002	*	*	
W39	8120-3962	8L3 803	F15,16,38,39		*	*	*
W6	8120-2491	3325A only	HPIB & conn.			*	

....

3325A/B

3325A/B

The 3325B A14 COMPONENT LAYOUT DIAGRAM is INCORRECT.

Change reference designator CR213 to CR214
Change reference designator CR214 to CR213

InterOffice Service Memo

"File" 3325B
Per BA

GREGORY,TIM / HP2411/01 - HPDESK print.

Message.   Dated: 02/01/88 at 1630.
Subject: INTRODUCING...
Sender: Inga BOLES / HPA100/20   Contents: 2.

Part 1.

FROM: Inga BOLES / HPA100/20

TO: Hassan BENSLIMAN / HP8400/20
Peter BURBAGE / HP8006/OA
Mike BURCHER / HP9062/RB
Hank CHMAJ / HP2613/00
Erwin DILLARD / HP3112/02
Pat DUFFY / HP2403/XX
Bill EYLER / HP2403/01
Albert GFROERER / HP8370/00
Bill GODLESKI / HP4401/HP
Tim GREGORY / HP2411/01
Fang-Ta HSU / HPD400/01
Irvin JONES / HP3112/02
Mike KEENAN / HP2451/01
Soren LARSEN / HP9300/XX
Max MAXIN / HP3185/01
Jim PURI / HP3185/XX
Ron SLOTA / HP4401/XX
Werner SPAETH / HP8370/00
John WALTON / HP8006/OA
Kirby WRIGHT / HP2451/01

CC: De ARBOGAST / HPA100/30
Merl AVENELL / HPA100/20
Karen BARTZ / HPA100/20
Kenneth FELDHAUS / HPA100/20
Claudine GOVIER / HPA100/20
Joe HEBERT / HPA100/20
Leeroy KIND / HPA100/20
Marshall LOLLIS / HPA100/20
Kelly NG / HPA100/20
Randy OMEL / HPA100/20
Rick VANNESS / HPA100/20
Sam WILKIE / HPA100/20

Part 2.

THE FOLLOWING ARTICLE WILL APPEAR IN THE MARCH 1988 ISSUE OF CUSTOMER SUPPORT NEWS, AND IS ALSO THE COVER FEATURE.

Q: "Why did we wait so long to tell you about it?"
A: 'Division private' secrecy was kept until the CPL date so that the sales of the 3325A would be affected as little as possible by news of the 3325B. It is anticipated that this late release of information will not have a great affect on you or the customers. The following article will tell you why and answer any questions you may have.

Introducing the HP 3325B--The Best is Now Better!

(Data/Pulse/Function Generators)

Inga Boles/LSID

The HP 3325B (0-21 MHz) Synthesizer/Function Generator is replacing the HP 3325A as Lake Stevens Instrument Division's solution for the low frequency synthesizer marketplace. However, the 3325B is better than a replacement. Its added operation, application, and service capabilities (while maintaining the low price of the A-version) make this more than a "B" product, it's an A+!

Product Description

The feature set of the 3325B is a superset of the 3325A features and is as follows:

* Non-volatile memory. It will hold 10 instrument state storage registers, the HP-IB address, elapsed time on, serial number, discrete sweep table, and modulation source arbitrary waveform. Units can now be set to "wake up" in the same state as it was when power was disconnected.

* Modulation source. A second source of sine, square and arbitrary waveforms provides a signal which may be used to modulate the main signal.

* RS-232 interface. This serial interface offers an alternative to the HP-IB. Both are standard in the 3325B.

* 60 MHz sync. The frequency range of the rear panel sync output has been extended to 60 MHz.

* Discrete sweep. A sequence of up to 100 linear sweeps or frequency steps provides the ability to create custom sweep patterns.

* Front panel conveniences. A preset key, frequency entry increment and decrement, the use of the left arrow key as a backspace, and the ability to set the HP-IB address from the front panel have been added. Also, the new elastomeric ("flubber") keypad will enhance durability and reliability.

* Circuit breaker. An over-voltage protection circuit provides added reliability and reduces maintenance.

* Extended self-tests and diagnostics. Hardware failure codes have been added and the error codes have been expanded. "Primitive power-on tests" and "special tests" have been added. The SA tests have been revamped and extended. All of this should reduce repair times by quickly isolating failures to the functional sub-circuit level!

Compatibility

The 3325B enhancements were designed to improve upon the capabilities of the 3325A while maintaining backwards compatibility. Even the options have the same numbers, prices and specifications.

In most cases the new features do not cause compatibility problems. In those few cases where the 3325B enhancements may cause a conflict, complete backwards compatibility is achieved by turning off the enhancements switch on the rear panel (or over the bus). In addition, HP-IB programs which were written for the 3325A can be used on the 3325B without modification.

Service Strategy

Hardware

A mixed repair strategy will be used for the 3325B. Component level repair will be used for nine of the eleven assemblies. One assembly will participate in SMR's exchange program, and one will be a "throw-away" board due to its low cost. Table 1, shows a list of the assemblies, several of which were "recycled" from the 3325A. Those assemblies which were re-designed or added can not be retrofitted backwards to the A models.

Table 1. HP 3325B PC assemblies

Strategy	Description	P/N
C	*A3, Signal Source	03325-66503
	*A8, HV Output (Opt 2)	03325-66508
	*A9, Xtl Oven (Opt 1)	03325-66509
	A15, Numeric Display	03325-66515
	*A21, FFS D/A	03325-66521
	A22, Power Supply	03325-66522
	*A23, Attenuator	03325-66523
	A25, Front Panel	03325-66525
	A26, Controller	03325-66526
E	*A14, Function assy	03325-66514 (03325-69514)+
T	A12, HP-IB/RS232	03325-66512

where, C = component level
E = exchange program
T = throw-away
* = also used in 3325A
+ = exchange part number

Calibration

Several contributions have been achieved which streamline calibration. The operational verification and performance tests for the 3325B are the same as those for the 3325A, thus current SCAT1 systems can provide immediate support! The only exception is that the square wave overshoot test has been corrected. The adjustments have been revised to take advantage of the built-in modulation source and front panel special functions. By using these built-in capabilities, we have reduced the amount of required adjustment equipment by two pieces.

Reducing MTTR

The MTTR is anticipated to be reduced (from approximately 4.5 hours for the 3325A) to less than three hours within one year after first shipments for the 3325B. This significant reduction in time will be achieved via the leveraged hardware, strong diagnostics, and service manual enhancements.

Diagnostics

The new controller board provides multiple levels of tests and troubleshooting aids. The Primitive Power-on Tests are automatically performed each time the instrument is turned on. Failures are reported by blinking LEDs on the A26 (controller) assembly. Front panel Special Functions can be performed by entering a two digit code. The Signature Analysis tests have been rewritten and expanded to include the keyboard, control, interface, DAC, function, sweep drive and modulation source circuits. Finally, when a hardware failure is detected, the 3325B will display FAIL xxx (example, FAIL 013 indicates that a machine data bus line is stuck low).

Documentation

There are three manuals available for the 3325B...Operation, Installation, and Service. To receive your copies you will need to order the following:

Operation Manual (P/N 03325-90014). This manual includes specifications, remote and manual operation guidelines, and a general information section.

Installation Manual (P/N 03325-90006). This manual includes specifications, operation verification tests, performance tests, and installation information.

Service Manual (P/N 03325-90003). This manual includes the theory of operation, RPL, adjustments, service information, troubleshooting procedures, schematics, component locators, and block diagram. All sections have been updated to reflect new hardware and to correct errors for those assemblies which have been recycled. The troubleshooting procedures have been extended. The service information section has been greatly enhanced and now includes a "performance test troubleshooting guide" which can also apply to the 3325A!

Note: For those who may not have an urgent need, the above manuals will be mailed by approximately Q4 '88 to participants in the subscription service program.

Training

The 3325B should be repaired by those technicians who have had previous training for the 3325A or who have had sufficient 3325A repair experience. A self-paced service training course which concentrates on the differences from the 3325A will be available by September, 1988. Prior data from the 3325A shows the failure rates to be very low (<6%). We expect the faiure rates for the 3325B to be similarly low or lower.

Summary

Shipments began in February, 1988. The 3325B should be an even stronger customer choice for low frequency synthesizers than the 3325A. This will be achieved by the expanded feature set, improved serviceability and reliability, and maintaining the same low price as its predecessor.

An article describing the support life plan for the 3325A will appear in a future issue of Customer Support News.

HEWLETT PACKARD

HP 3325B
Operating Manual

Warranty

The information contained in this document is subject to change without notice.

Hewlett-Packard makes no warranty of any kind with regard to this material, including, but not limited to, the implied warranties or merchantability and fitness for a particular purpose.

Hewlett-Packard shall not be liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance, or use of this material.

Safety Summary

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements. This is a Safety Class 1 instrument.

Ground the Instrument

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three-conductor ac power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable meet International Electrotechnical Commission (IEC) safety standards.

Do Not Operate in an Explosive Atmosphere

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

Keep Away from Live Circuits

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

Do Not Service or Adjust Alone

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

Do Not Substitute Parts or Modify Instrument

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Hewlett-Packard Sales and Service Office for service and repair to ensure the safety features are maintained.

Dangerous Procedure Warnings

Warnings accompany potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

Cleaning

To prevent electricial shock, disconnect this product from mains before cleaning. Only use a dry cloth or one slightly dampened with water to clean external parts. DO NOT attempt to clean internally!

Safety Symbols

The following safety symbols are used throughout this manual and in the instrument. Familiarize yourself with each symbol and its meaning before operating this instrument.

General Definitions of Safety Symbols Used on Equipment or in Manuals

Instruction manual symbol. The product is marked with this symbol when it is necessary for the user to refer to the instruction manual to protect against damage to the instrument.

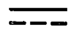
Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 volts must be so marked).

Protective ground (earth) terminal. Used to identify any terminal which is intended for connection to an external protective conductor for protection against electrical shock in case of a fault, or to the terminal of a protective ground (earth) electrode.

Low-noise or noiseless, clean ground (earth) terminal. Used for a signal common, as well as providing protection against electrical shock in case of a fault. A terminal marked with this symbol must be connected to ground in the manner described in the installation (operating) manual, and before operating the equipment.

Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.

Alternating current (power line).



Direct current (power line).

Alternating or direct current (power line).

Warning

The warning sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which if not correctly performed or adhered to, could result in injury or death to personnel.

Caution

The caution sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product or the user's data.

Hewlett-Packard
8600 Soper Hill Road
Everett, Washington 98205-1298

Printed in U.S.A

Operating Manual
HP 3325B
Synthesizer/Function Generator

Serial Numbers
All

HEWLETT
PACKARD

HP Part Number 03325-90035
Printed in U.S.A.

Print Date: January 1997

8600 Soper Hill Road, Everett, WA 98205-1298

Warning

To prevent potential fire or shock hazard, do not expose equipment to rain or moisture.

Herstellerbescheinigung

Hiermit wird bescheinigt, daß das Gerät/System

HP 3325B SYNTHESIZER/FUNCTION GENERATOR

in Übereinstimmung mit den Bestimmungen von Postverfügung 1046/84 funkentstört ist.

Der Deutschen Bundespost wurde das Inverkehrbringen dieses Gerätes/Systems angezeigt und die Berechtigung zur Überprüfung der Serie auf Einhaltung der Bestimmungen eingeräumt

Zusatzinformation für Meß- und Testgeräte

Werden Meß- und Testgeräte mit ungeschirmten Kabeln und/oder in offenen Meßaufbauten verwendet, so ist vom Betreiber sicherzustellen, daß die Funk-Entstörbestimmungen unter Betriebsbedingungen an seiner Grundstücksgrenze eingehalten werden.

Manufacturer's declaration

This is to certify that the equipment

HP 3325B SYNTHESIZER/FUNCTION GENERATOR

is in accordance with the Radio Interference Requirements of Directive FTZ 1046/1984. The German Bundespost was notified that this equipment was put into circulation, the right to check the series for compliance with the requirements was granted.

Additional Information for Test- and Measurement Equipment

If Test- and Measurement is operated with unscreened cables and/or used for measurements on open set-ups, the user has to assure that under operating conditions the Radio Interference Limits are still at the border of his premises.

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WARRANTY

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SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements. This is a Safety Class 1 instrument.

GROUND THE INSTRUMENT

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three-conductor ac power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable meet International Electrotechnical Commission (IEC) safety standards.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

DO NOT SERVICE OR ADJUST ALONE

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Hewlett-Packard Sales and Service Office for service and repair to ensure the safety features are maintained.

DANGEROUS PROCEDURE WARNINGS

Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

Warning

Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting.

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SAFETY SYMBOLS

General Definitions of Safety Symbols Used On Equipment or In Manuals.

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

Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 volts must be so marked.)

OR

Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating equipment.

Low-noise or noiseless, clean ground (earth) terminal. Used for a signal common, as well as providing protection against electrical shock in case of a fault. A terminal marked with this symbol must be connected to ground in the manner described in the installation (operating) manual, and before operating the equipment.

OR

Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.

Alternating current (power line.)

Direct current (power line.)

Alternating or direct current (power line.)

Warning — **The WARNING sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which if not correctly performed or adhered to, could result in injury or death to personnel.**

Caution — The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.

Note — The NOTE sign denotes important information. It calls attention to procedure, practice, condition or the like, which is essential to highlight.

Table of Contents

Table of Contents, continued

Introduction

This operating manual contains information necessary to operate the Hewlett-Packard Model 3325B Synthesizer/Function Generator. This covers direct operation via the front panel as well as remote operation via the HP-IB or RS-232 interface. Also included with the HP 3325B is an installation manual that provides information and procedures to install and check the performance of the HP 3325B as well as a service manual to adjust, and service the HP 3325B.

- Operation Manual (Chapters 1, 2, 3)
- Installation Manual (Chapter 4, includes perfomance tests)
- Service Manual (Sections 5, 6, 7, 8)

This operating manual is divided into three chapters:

1. Operation and Reference
2. Remote Operation
3. General Information

The HP part number of this operating manual is listed on the title page along with the microfiche part number. The Microfiche part number can be used to order 4 × 6 microfilm transparencies of the operating manual. Each microfiche package also includes the latest manual change supplements for the operating manual.

Chapter 1

Operation and Reference

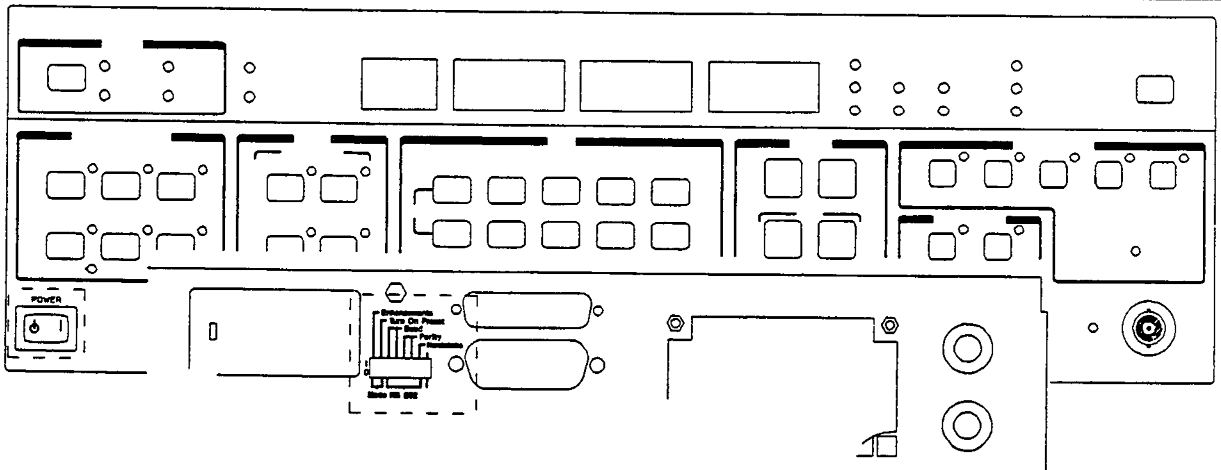
Chapter 1

Operation and Reference

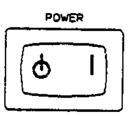
This chapter contains a description of the manual operation of the HP 3325B Synthesizer/Function Generator. The subdivisions in this chapter describe each major function of the HP 3325B. Chapter 2, "HP 3325B Remote Operation" contains a complete list of commands used for remote operation of the HP 3325B with a computer. Figure 1-1 identifies and describes the front and rear-panel controls, connectors, and indicators.

Caution *Prior to operating the HP 3325B, check that the fuse rating and line voltage setting are correct for the local ac power source. The Power Requirements section in "HP 3325B Installation" contains information for setting the line voltage and selecting the fuse.*

HP 3325B Turn-On and Warm-Up

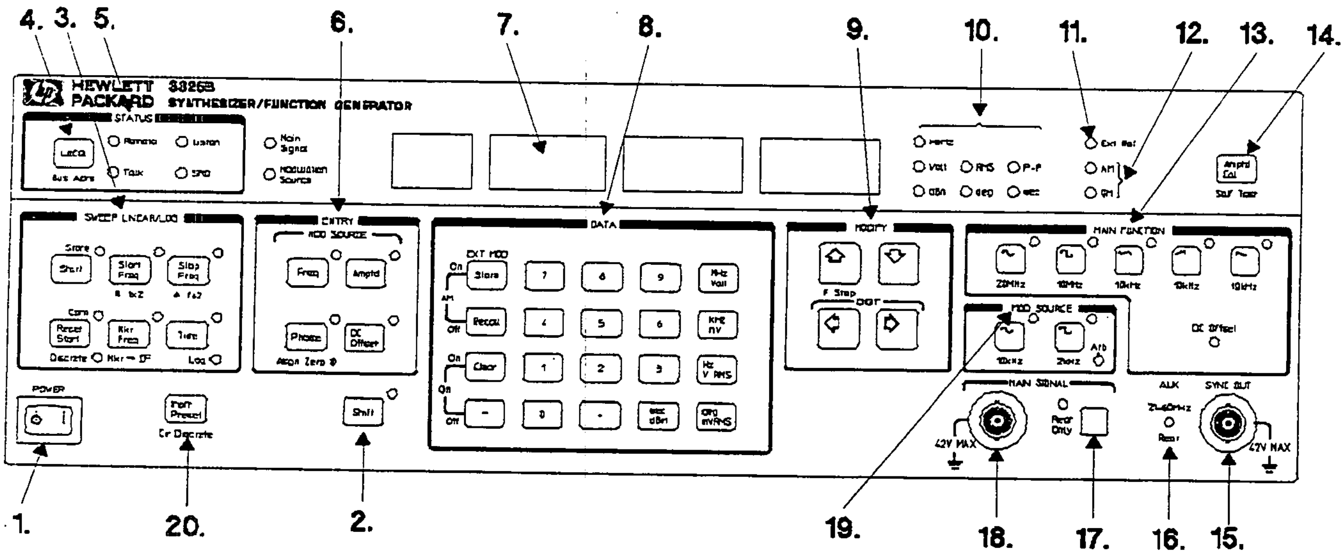


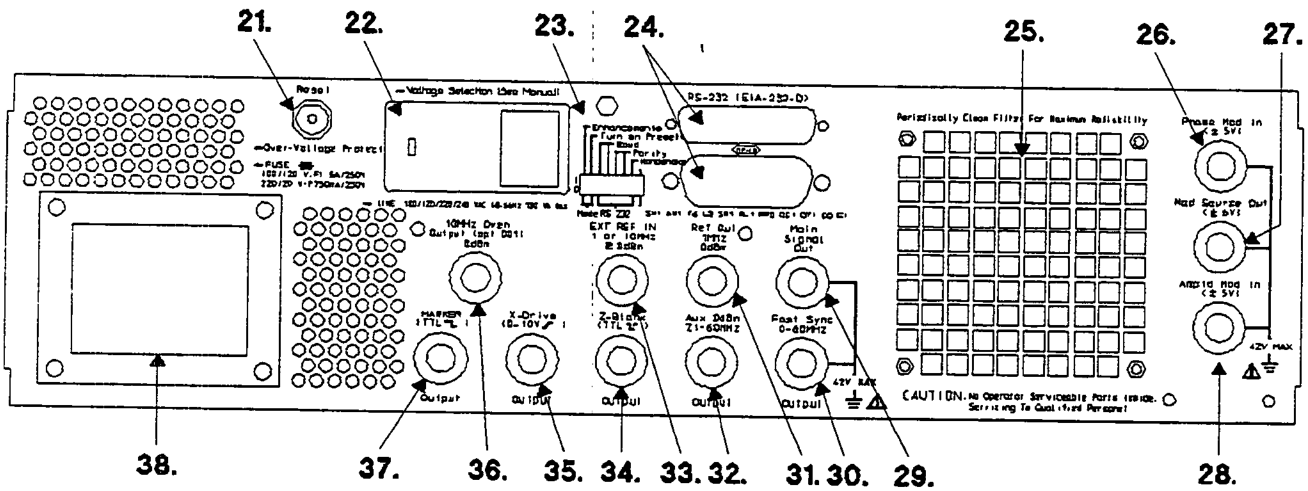
Turn-On and Power-Up Self Tests



Turn on the HP 3325B by pressing the I-side of the power switch. When turned on, power is applied to all of the HP 3325B circuits and the display shows "3325" followed by a list of the installed options. Then the HP 3325B initiates a series of self tests and calibrates internal circuits. When the ⏻-side of the Power key is pressed, the HP 3325B is placed in standby.

Note If Fail appears in the display, the HP 3325B has sensed a circuit failure or an amplitude calibration failure. If the Fail message appears in the display, send the instrument to qualified service personnel for repair.





1. **Power switch:** In the standby (⏻) position, power is applied to the oven (option 001), the HP-IB interface circuits external to the isolation barrier, and the high voltage output circuits (option 002), in addition to the power supply circuits.
2. **Blue [Shift] key**: Press the [Shift] key to access the key function labeled in blue.
3. **Sweep Linear/Log key group**: These are entry prefix keys for the sweep parameters, and the sweep start keys. When preceded by the [Shift] key, the sweep parameter keys control sweep modification functions and linear/log/discrete selection.
4. **[Local] key**: Returns HP 3325B from remote control to front-panel control unless local lockout has been programmed. When preceded by the [Shift] key, the HP 3325B HP-IB address is displayed.
5. **Status indicator group**: The indicators show the HP 3325B HP-IB status: Remote, Addressed to Listen, Addressed to Talk, and Request Service (SRQ).
6. **Entry key group**: These are the entry prefix keys for the main and modulation source signal parameters.
7. **Display**: Displays the value of the entry parameter selected, error codes, and self test results.
8. **Data key group**: This group includes the numeric data keys, the data suffix keys, the [Store] and [Recall] keys, and the entry [Clear] key. When preceded by the [Shift] key, the keys in the left column control the modulation functions.
9. **Modify Group**: The horizontal arrow keys select the digit to modify (indicated by the flashing digit), and the vertical arrow keys increment or decrement the digit. Preceding the up-arrow with the [Shift] key selects the frequency step parameter for display and modification.
10. **Units Indicators**: The indicators display the units of the value represented by the numeric display.

11. **Ext Ref Indicator**: The Ext Ref Indicator illuminates if an external reference or option 001 (internal 10 MHz oven reference) is connected to the rear-panel Ref In connector. The indicator flashes if the internal oscillator is not phase-locked to the external reference.
12. **Modulation Indicators**: The modulation indicators illuminate if amplitude or phase modulation is enabled.
13. **Main Function key group**: These keys select the main signal output function or dc-only.
14. **[Amptd Cal] key**: This key calibrates the amplitude and offset of the output signal. When preceded by the [Shift] key, it initiates an instrument self test.
15. **Sync Out**: A square wave synchronized output signal is available at this connector and rear-panel Fast Sync connector. This signal is synchronized with the output signal crossover point (zero volts or dc offset voltage). The front-panel sync output functions for frequencies below 21 MHz.

Caution *The maximum peak voltage that can be safely applied between chassis and outer conductor of any of the HP 3325B input or output signal connectors is ±42V.*

---

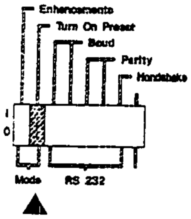
16. **Aux 21-60 MHz Rear indicator**: This indicator illuminates when the rear-panel Aux output is active.
17. **[Rear Only] key**: In standard instruments, this key switches the signal output from front-panel to rear-panel. The rear-panel output is active when the adjacent indicator illuminates. In instruments with the high voltage option (002), this key switches from normal to high voltage output. The adjacent indicator illuminates when the high voltage output is enabled. The key is labeled "40 V_{pp}, 40 mA, 0-1 MHz" for option 002. In option 002 instruments, no rear-panel signal output is provided.
18. **Main Signal output**: Standard output impedance is 50Ω. High voltage output option 002 output impedance is nominally < 1Ω at dc and < 10Ω at 1 MHz. Load impedance must be at least 500Ω. Standard and high-voltage outputs are fuse-protected.

Note If the standard instrument signal output is not terminated by an external 50Ω load, undesirable distortion may result, particularly at higher frequencies. Similar conditions may result if the high voltage output (option 002) is terminated by less than 500Ω.

---

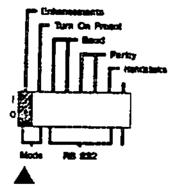
19. **Modulation Source key group**: These keys select the modulation signal function.
20. **[Instr Preset] key**: This key restores the HP 3325B to a predefined state (see table 1-1). When preceded by the [Shift] key, Instr Preset clears the discrete frequency sweep segments from memory.
21. **Circuit Breaker Reset Button:** Disconnects power supply from power line when the line voltage exceeds upper limit. See the Installation Manual for information on resetting the breaker and voltage limits.
22. **Voltage selection vs fuse used:** This module contains the line fuse and configures the HP 3325B for local line voltages. Refer to the HP 3325B Installation Manual for line fuse selection and line voltage configuration.
23. **Mode/RS-232 switch**: These switches enable the HP 3325B enhancements, turn-on configuration, and RS-232 characteristics.
24. **HP-IB/RS-232 connectors**: Remote control of the HP 3325B by an external controller is accomplished through these connectors.
25. **Fan Filter:** See "Instrument Cooling" in the Installation Manual for information concerning the fan and its filter.
26. **Phase Mod In**: Input connector for a phase modulating signal of ±5V maximum peak voltage.
27. **Mod Source Out**: Output connector for the internal modulation source.
28. **Amptd Mod In**: Input connector for an amplitude modulating signal of ±5V maximum peak voltage.
29. **Main Signal Out**: The output signal is switched to this connector by the front-panel [Rear Only] key. Instruments with the high voltage option 002 cannot switch the main signal to the rear-panel connector.
30. **Fast Sync**: A square wave synchronizing output signal is available at this connector. This signal is synchronized to (changes state at) the output signal crossover point (zero volts or dc offset voltage) and operates from 0 to 60 MHZ.
31. **Ref Out**: A 1 MHz signal from the HP 3325B reference circuits is available at this connector.
32. **Aux 0 dBm**: A signal is available at this output for frequencies between 19 MHz and 59 999 999.999 Hz.
33. **Ext Ref In**: This external frequency reference may be used to phase-lock the internal 30 MHz oscillator.
34. **Z-Blank**: A TTL-compatible output is present during a sweep operation.
35. **X-Drive**: This output ramps from 0V to 10V during a sweep-up.
36. **10 MHz Oven Output**: This signal is present only in instruments with option 001. Normally it is connected to the Ext Ref In connector (item 33) with a special connector (HP Part No. 1250-1499) supplied with option 001.
37. **Marker**: This TTL-compatible output goes low at the selected marker frequency during a sweep up, and high at completion of the sweep.
38. **Power Transformer**

Turn-On State



The initial state of the HP 3325B at power up is dependent upon the setting of the rear-panel Turn-On Preset switch. With the Turn-On Preset switch in the up (1) position, the turn-on state is the preset state described in "The Preset State and the Instr Preset Key." With the Turn-On Preset switch in the down (0) position (and the Enhancements switch in the up (1) position), the setup state in effect when power is removed is used as the turn-on state.

Enhancement Mode



Enhanced mode refers to the HP 3325A features that were improved to create the HP 3325B. In this mode all stored information is retained in nonvolatile memory. Stored information may be erased by overwriting the information in memory or by applying power with the green [Instr Preset] key depressed (memory clear).

HP 3325A (Compatibility) Mode

In this mode, stored information cannot be recalled after the power switch is set to the standby position.

Note See table 3-2 for a comparison of compatible and enhanced features.

Power-Down State/Turn-On Preset

The last operating state prior to removing power is also retained in nonvolatile memory. This operating state is restored by pressing the [Recall] key followed by the [−] (minus) key.

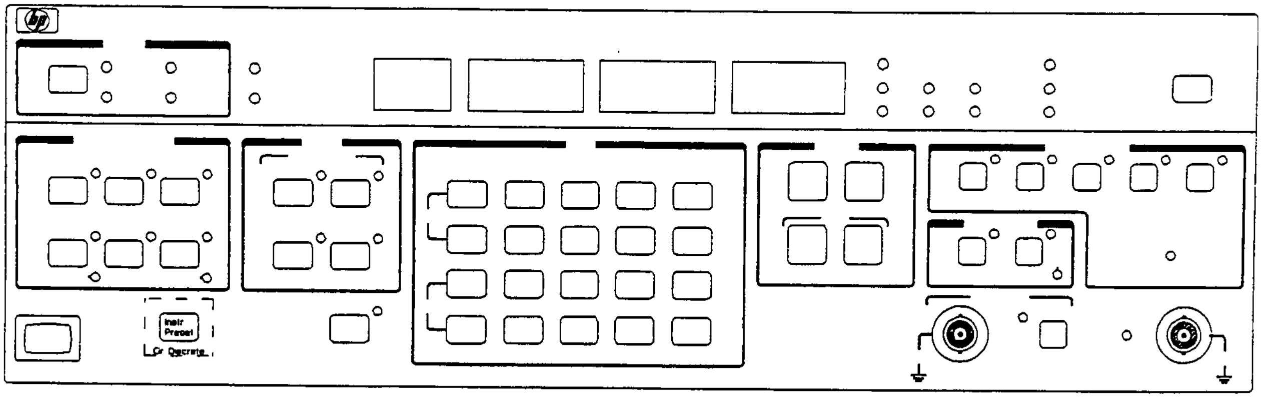
The setup state stored in the power-down memory can be selected as the turn-on state through the use of the Enhancements and Turn-On Preset switches. To allow the HP 3325B to restore the power-down state, set the Enhancements switch to the up (1) position, and the Turn-On Preset switch to the down position (0). Restoring the power-down state at turn-on is disabled by setting the Turn-On Preset switch in the up (1) position.

Warm-Up

Warm-up time is the amount of time the HP 3325B is connected to power. The HP 3325B without the high stability frequency reference (option 001) requires 30 minutes of warm-up time to meet all specifications. The HP 3325B with option 001 requires 15 minutes of warm-up time to meet frequency specifications if power is disconnected for less than 24 hours. If power is disconnected from the HP 3325B with option 001 for more than 24 hours, up to 72 hours of warm-up time may be required to meet frequency specifications. The HP 3325B with option 001 requires 30 minutes of warm-up to meet other specifications.

Note Moving the power switch from the I position to the (⏻) position places the HP 3325B in standby. In standby, power is removed from all circuits except those that should be kept warm to minimize warm-up time.

The Preset State and the Instrument Preset Key



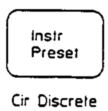


Table 1-1 lists the *preset state* of the HP 3325B. This is a predefined state selected by pressing the green [Instr Preset] key. It is also the active state at power-up if the rear-panel Turn-On Preset switch is in the up (1) position. Instrument preset provides a convenient starting state for establishing an instrument setup. Instrument preset does not erase instrument states, modulation source ARB waveforms, or the discrete sweep table in internal memory.

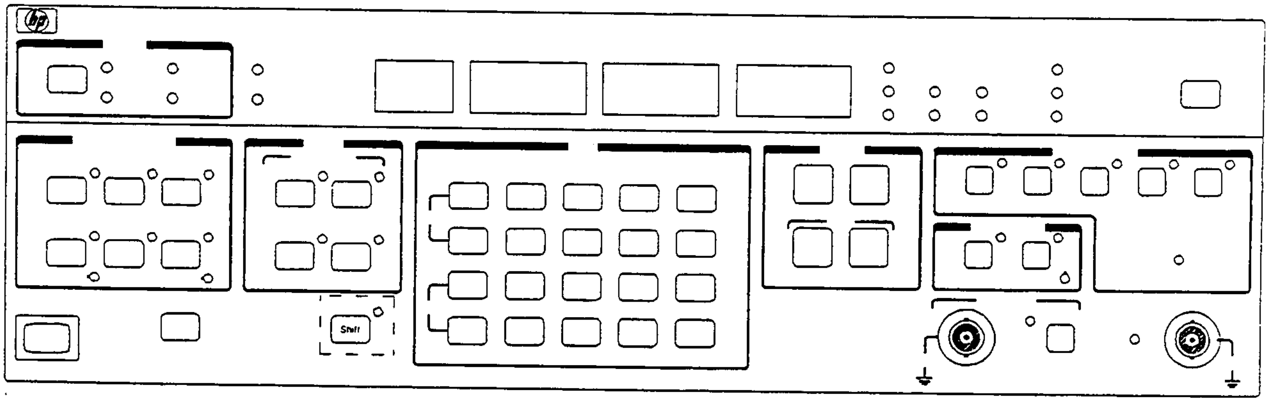
Table 1-1. HP 3325B Preset State

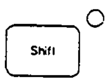
Key Group	Parameter	Preset State/Value
Status	Local	No effect
	Bus Adrs	No effect
Function	Sine wave	Enabled
Entry	Freq	1 kHz
	Amptd	0.001 V_{pp}
	Phase	0°
	DC Offset	0V
	Assign Zero Φ	–
	Mod Source Freq	1 kHz
	Mod Source Amptd	0.1 V_{pp}
Sweep Linear/Log	Sweep	Off
	Start Freq	1 MHz
	Stop Freq	10 MHz
	Mkr Freq	5 MHz
	Time	1 second
	Discrete Sweep/Log Sweep	Off

Table 1-1. HP 3325B Preset State (Cont'd)

Key Group	Parameter	Preset State/Value
Modulation	Ext Mod AM Ext Mod ΦM	Off Off
Modify	F Step	0.0 Hz
Mod Source	Mod Source	Off
Other Keys	[Shift]	Off
Signal	High Voltage Rear-Only	Off Disabled (Front-panel output)

Shift Key

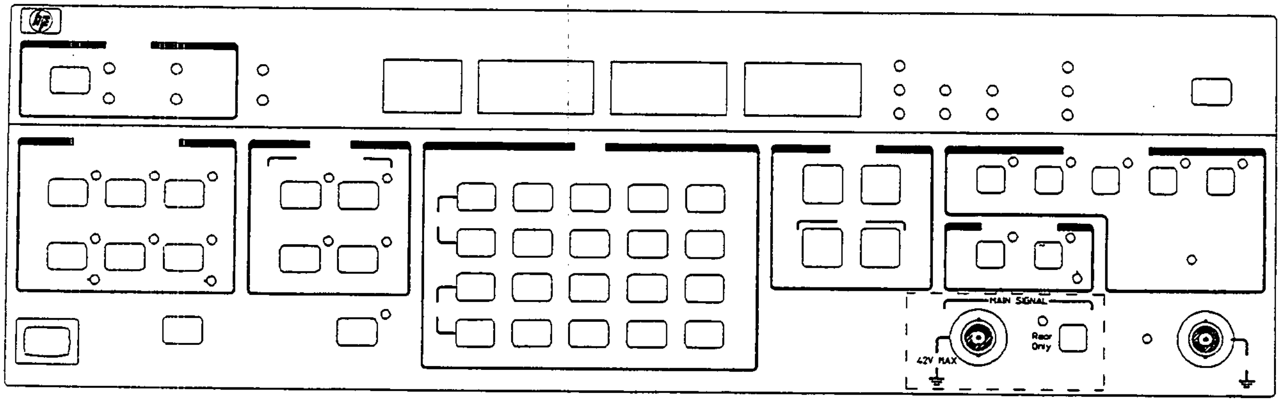




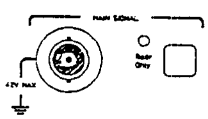
Some keys control two functions. The first function name appears on the key itself and is activated by pressing the key. If a key has another function, its name appears in blue below the key and it is activated by first pressing the blue [Shift] key. This manual may refer to shifted key names with or without reminding you to press the [Shift] key first. Always look for both names of a key when searching the front panel for a key name.

The indicator adjacent to the [Shift] key illuminates when the [Shift] key is pressed to indicate that the shifted key names may be selected.

Main Signal Output



Main Signal Output Connectors



The Main Signal is available at one of two BNC connectors located on the front and rear panels. The front-panel [Rear Only] key selects which of these two connectors has the main signal output. The active connector is indicated by the rear-only indicator; an illuminated rear-only indicator denotes that the rear-panel output is active.

Both outputs share the same ground and may be floated up to ±42 volts peak relative to earth ground.

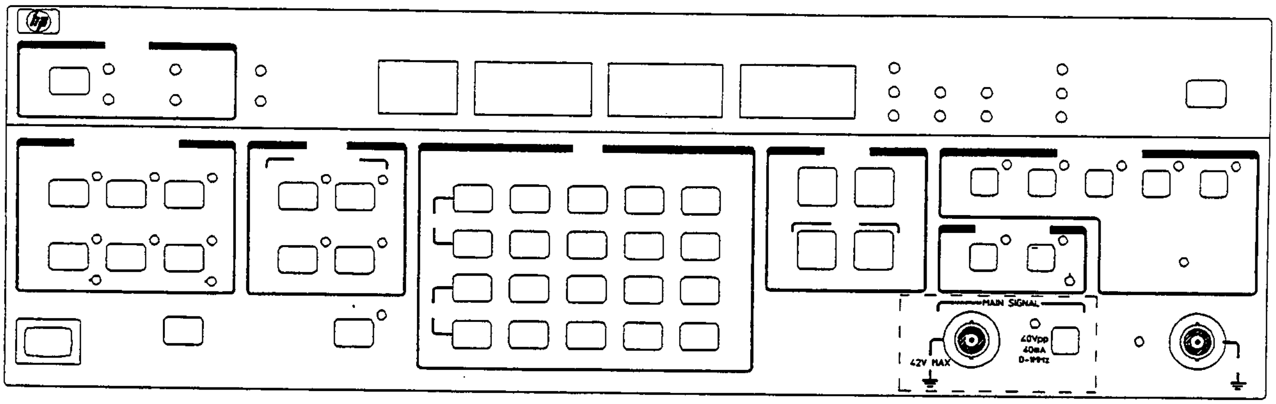
Caution *The maximum peak voltage (ac + dc) that can be safely applied between chassis and the outer conductor of the HP 3325B input and output connectors is ±42 volts peak.*

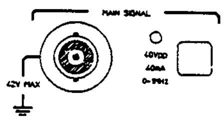
Note When the high voltage option (option 002) is installed, the key by the Main Signal output connector (labeled "40 V_{pp}, 40 mA, 0-1 MHz") controls the high voltage amplifier. On these instruments, the rear-panel Main Signal output connector is inactive.

The specifications for the Main Signal output impedance and return loss are:

Impedance:	50Ω ±1Ω from 0 to 10 kHz
Return Loss:	20 dB 10 kHz to 20 MHz except > 10 dB for > 3V, 5 MHz to 20 MHz
High Voltage (option 002):	< 2Ω at dc < 10Ω at 1 MHz

The High Voltage Option (option 002)





On instruments with the High Voltage Option (option 002)installed, the [40 V_{pp}] key enables or disables the high voltage output. The 40 V_{pp} indicator illuminates when the high voltage output is enabled. The high voltage option increases the available output voltage range to a maximum value of 40 V_{pp} (into a high impedance). Enabling the high voltage option reduces the maximum output frequency for the sine and square waves to 1 MHz, and decreases the output impedance (see Main Signal output). The output signal momentarily drops to zero volts when internal attenuator settings change.

Note

The rear-panel signal output is inactive (no internal signal connection) if the HP 3325B has the high voltage output (option 002) installed. Instructions in the Service Manual describe activation of the rear-panel signal output in one of two ways:

1. Disconnecting the front-panel signal output and placing the standard/high voltage output on the rear panel only, or

2. Disabling the high voltage output and enabling the standard front/rear output.

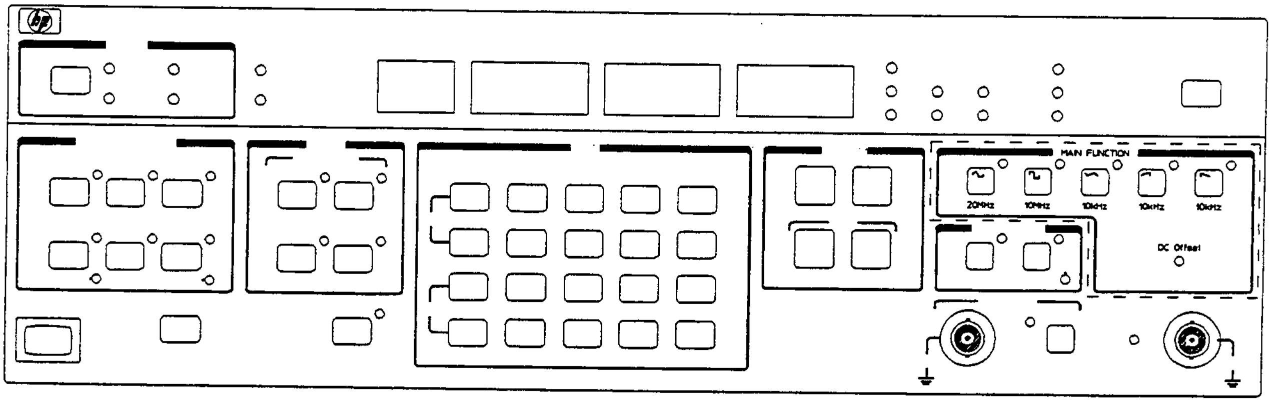
If one of these modifications is required, arrange for the work to be done by qualified service personnel.

The HP 3325B specifications apply when the external load resistance is > 500Ω and the total capacitance is < 500 pF. The same entry procedures and display features apply as for the standard configuration. Maximum and minimum amplitudes are listed in table 1-2.

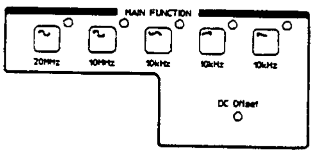
Table 1-2. High Voltage Amplitudes (option 002)

	V_{pp}		V_{rms}	
Function	**Max.**	**Min.**	**Max.**	**Min.**
Sine	40V	4 mV	14.14V	1.42 mV
Square	40V	4 mV	20.0V	2.0 mV
Triangle	40V	4 mV	11.55V	1.16 mV
± Ramp	40V	4 mV	11.55V	1.16 mV

Selecting the Output Function



The Main Function Keys and Indicators

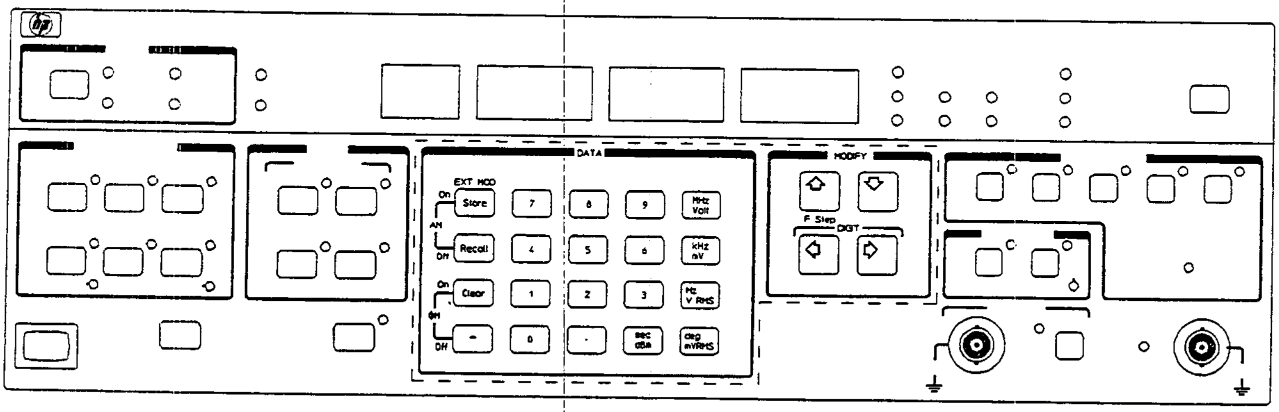


Pressing one of the five Main Function keys selects the function output of the HP 3325B. The indicator adjacent to a function key illuminates when that function is selected. Pressing the function key for the selected function a second time removes the ac component of the signal leaving only the selected dc offset (if any is entered). Removing the ac signal in this way, automatically displays dc offset and illuminates the dc offset entry indicator. Pressing the disabled function key again restores the ac signal. Unless a dc offset is entered, the output signal for each function is centered about zero volts.

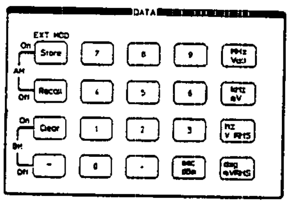
The DC Offset indicator illuminates when a non-zero dc offset exists.

Note — The standard instrument signal output must be terminated by an external 50Ω load or sine wave distortion and square wave overshoot may result, particularly at the higher frequencies (> 1 MHz). All specifications apply with a 50Ω load connected to the HP 3325B main signal output except where indicated (table 3-1, Specifications).

Data Entry And Modification



The Data Keys



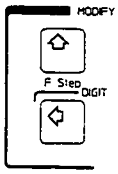
Entering setup values with the numeric keypad is a simple three step process:

1. Select a parameter to change.
2. Enter the desired value (most significant digit first).
3. End the entry with a units key.

For example, to change the output amplitude to 1 V_{rms}, press the [Amptd] (amplitude) key to display the current amplitude value. Press the [1] key in the numeric keypad, and press the [Hz / V RMS] units key to end the entry. For the example, the V_{rms} units from the [Hz / V RMS] units key is assigned to the data value. The HP 3325B assigns the units to the data value that corresponds to the parameter being changed. If an entered value exceeds the HP 3325B range limits, the HP 3325B ignores the entered value and displays an error message (refer to table 1-4). To cancel an incomplete data entry, press any key that requires the display for data entry (see table 1-3).

Table 1-3. Parameters Accepting Data Entry

Amptd	Mod Source Freq
Bus Adrs	Phase
DC Offset	Start Freq
F Step	Stop Freq
Freq	Store
Mkr Freq	Recall
Mod Source Amptd	Time



The value entered with the Data keys may be edited during data entry with the left-arrow key in the Modify key group. Each time the left-arrow key is pressed, the least-significant digit or decimal point is removed from the display. After the incorrect digits are removed from the display value, data entry can continue.

Clear Display

Pressing the [Clear] key (in the left column of the Data key group) clears the display to zero. This key is useful when an error is made while entering data.

Error Messages

If an attempt is made to enter or modify operating parameters beyond the HP 3325B capabilities, the new input is ignored and an error message and code is displayed. Table 1-4 lists the error messages and explanations of the errors.

Table 1-4. Error Messages

Error Code	Description
100	The value entered for the selected parameter exceeds the valid limits
200	The units key selected is improper for the selected parameter
201	The units key selected is improper for the selected parameter with high voltage option
300	The frequency entered is too high for the waveform function selected
400	The sweep time entered is too large for the frequency span (sweep span is too small)
401	The sweep time is too small for the frequency span.
500	Amplitude and dc offset values are incompatible
501	The dc offset is too large for amplitude
502	The amplitude is too large for the dc offset
503	Amplitude is too small
600	Sweep frequency improper
601	Sweep frequency too large for function
602	Sweep bandwidth too small
603	Log sweep start frequency too small
604	Log sweep stop frequency less than start frequency
605	Discrete sweep segment is empty
700	Unknown command
701	Illegal query
751	Key ignored front-panel key pressed while the HP 3325B is in remote (press LOCAL key)

Table 1-4. Error Messages (Cont'd)

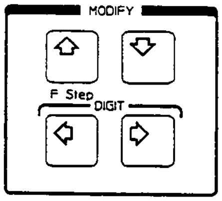
Error Code	Description
752	Key ignored front-panel key pressed while the HP 3325B is in local lockout
753	Feature disabled in compatibility mode
754	Attempt to recall a memory register that has not been stored since power up
755	Amplitude modulation not allowed on selected function
756	Modulation source arbitrary waveform memory register is empty
757	Too many modulation source arbitrary waveform points
758	Firmware (program) failure
800	A remote HP-IB or RS-232 command has a syntax error
801	Illegal digit for selection item
802	Illegal binary data block header
803	Illegal string, string overflow
810	RS-232 overrun – characters lost
811	RS-232 parity error
812	RS-232 frame error
900	Option not installed
-CAL-	Calibration in progress
PASS	A self test is successful
FAIL	A self test is unsuccessful – refer the HP 3325B to qualified service personnel for repair

Viewing Setup Parameters

Pressing a front-panel key which accepts data entry (such as the [Freq] or [Amptd] key) displays the current value of a setup parameter. Table 1-3 lists the front-panel keys which accept data entries. Pressing one of these keys does not alter the current setup values.

The units of the displayed parameter are indicated by an illuminated indicator at the right of the display. The indicators at the left of the display indicate whether the display value is associated with the Main Signal or the Modulation Source.

Modifying Parameter Values



The arrow keys in the Modify key group are used to modify the display value. The right and left-arrow keys select the digit for modification as indicated by the flashing digit. Pressing the right-arrow key selects the next least significant digit for modification; pressing the left-arrow key selects the next most significant digit for modification. To extinguish the flashing digit, press a right or left-arrow key until the flashing digit moves off the display.

The flashing digit is the least significant digit that is modified with the up- and down-arrow keys. The up-arrow key increments the value of the display, while the down-arrow decrements the value of the display. The up-and down-arrows modify the display value until the boundary limit is reached.

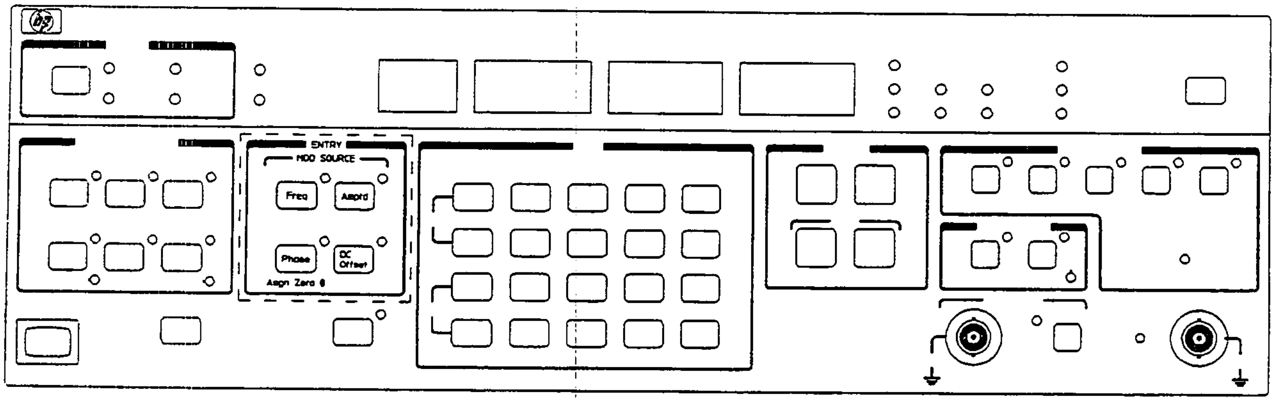
Frequency Step

The frequency step is how much change in the frequency parameter occurs when the up or down-arrow keys are pressed. The [F Step] (Frequency Step) key enables display, entry, or modification of the frequency step parameter. The [F Step] key is selected by pressing the blue [Shift] key prior to the up-arrow key. The displayed frequency value is changed with the numeric keypad and units keys, or modified with the modify controls. The MHz, kHz, and Hz units allow convenient entry of frequency values. During frequency step entry, the Hz units indicator is illuminated but the Frequency Entry indicator is extinguished.

The up-arrow and down-arrow keys increment and decrement the display by the F Step value when all the following are true:

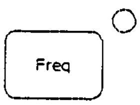
1. The frequency step is non-zero (in the case of the main signal) or less than frequency resolution (for the modulation source)
2. A main signal or modulation source frequency value is displayed, and
3. No flashing digits appear in the display

The Entry Keys



Note An illuminated indicator adjacent to an entry key denotes it as the active entry parameter. For example, if the [Freq] entry key indicator is illuminated, it is not necessary to press that key before entering data.

Frequency



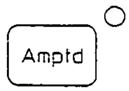
The [Freq] (Frequency) key enables display, entry, or modification of the frequency of the signal output. The indicator adjacent to the [Freq] key illuminates when the output frequency value is displayed. Frequency values are displayed in Hertz and changed with the numeric keypad and units keys or modified with the modify controls. The MHz, kHz, and Hz units allow convenient entry of frequency values.

Resolution of the frequency entry is 1 μHz for frequencies below 100 kHz, and 1 mHz for 100 kHz and above. At 100 kHz and above, 1 μHz resolution is possible through the use of the F Step parameter. Also, as a modify key is used to cross above the 100 kHz boundary, any μHz resolution value is maintained but not displayed. Frequency ranges are dependent upon the function selected and high voltage option (see table 1-5). During a frequency change, the main output signal is phase-continuous; that is, there are no phase discontinuities in the output waveform.

Table 1-5. Frequency Limits

Function	Main Signal
Sine	0 → 20 999 999.999 Hz
Square	0 → 10 999 999.999 Hz
Triangle, Ramps	0 → 10 999.999 999 Hz

Amplitude



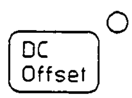
The [Amptd] (amplitude) key enables display, entry, or modification of the amplitude of the signal output. The indicator adjacent to the [Amptd] key illuminates when an amplitude value is displayed. The displayed amplitude value is changed with the numeric keypad and units keys, or modified with the Modify keys. The Volt, mV, V RMS, mV RMS, and dBm units allow convenient entry of amplitude values. Amplitude values are displayed in Volts rms, Volts peak-to-peak (V_{pp}), or dBm as denoted by the indicators at the right of the display. The amplitude range is dependent upon selection of dc offset and the high voltage option (see table 1-6). The output signal is momentarily set at zero volts when internal attenuator settings change.

The HP 3325B units keys convert amplitude values to V_{pp}, V_{rms}, or dBm for any function. For example, if a sine wave amplitude of 10 V_{pp} is displayed, pressing the [V_{rms}] or [mV_{rms}] key displays the same amplitude as 3.536 V_{rms}, while pressing the [dBm] key displays the value as 23.98 dBm. When changing from one function to another, the last amplitude displayed is held constant.

Table 1-6. Amplitude Limits of AC Functions

	V_{pp}		V_{rms}		dBm (50Ω)	
Function	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**
Sine	10V	1 mV	3.536V	0.354 mV	+23.98	−56.02
Square	10V	1 mV	5.000V	0.5 mV	+26.99	−53.01
Triangle	10V	1 mV	2.887V	0.289 mV	+22.22	−57.78
±Ramp	10V	1 mV	2.887V	0.289 mV	+22.22	−57.78

DC Offset



The [DC Offset] key enables display, entry, or modification of the dc offset of the signal output. The indicator adjacent to the [DC Offset] key illuminates when a dc offset value is displayed. The displayed dc offset value is changed with the numeric keypad and [Volt] or [mV] units key, or modified with the modify controls. The dc offset range is dependent upon amplitude and the high voltage option. Figure 1-2, and table 1-7 and 1-8 list the maximum output of the HP 3325B. The output signal momentarily drops to zero volts when internal attenuator settings change.

The DC Offset indicator in Main Function key block illuminates when a non-zero dc offset value exists.

AC with DC Offset

When dc offset is added to any ac function, there are minimum and maximum offset limits which must be observed. These limits are affected by the ac voltage and internal attenuator settings, listed in table 1-7. Figure 1-2 contains a set of graphs which show the approximate maximum dc offset permissible for a given ac peak-to-peak voltage. Resolution of a dc offset entry (with ac function) is determined by the resolution of the ac amplitude. The following equation may be used to determine maximum offset voltage:

Maximum dc offset = (5 ÷ A) − (Amptd ÷ 2)

Where A = Attenuation factor (from table 1-7)
Amptd = Amplitude in V_{pp} of the ac function.

If a dc offset too large for the amplitude already programmed is entered or if the ac amplitude is increased beyond the level where the amplitude and offset are compatible, an error code between 500 and 503 appears in the display momentarily and the entry value is not accepted. The display then indicates the nearest acceptable value.

Table 1-7. Maximum DC Offset with any AC Functions

AC Amplitude Entry (peak-to-peak)		Maximum DC Offset (+ or −)	Minimum DC Offset Entry	Range	Attenuation Factor
1.000 mV	with	4.500 mV			
to			0.001 mV	7	A = 1000
3.333 mV	with	3.333 mV			
3.334 mV	with	14.99 mV			
to			0.001 mV	6	A = 300
9.999 mV	with	11.66 mV			
10.00 mV	with	45.00 mV			
to			0.010 mV	5	A = 100
33.33 mV	with	33.33 mV			
33.34 mV	with	149.9 mV			
to			0.010 mV	4	A = 30
99.99 mV	with	116.6 mV			
100.0 mV	with	450.0 mV			
to			0.100 V	3	A = 10
333.3 mV	with	333.3 mV			
333.4 mV	with	1.499V			
to			0.100 V	2	A = 3
999.9 mV	with	1.166 mV			
1.000 V	with	4.500 V			
to			1.000 mV	1	A = 1
9.998 mV	with	0.001 mV			

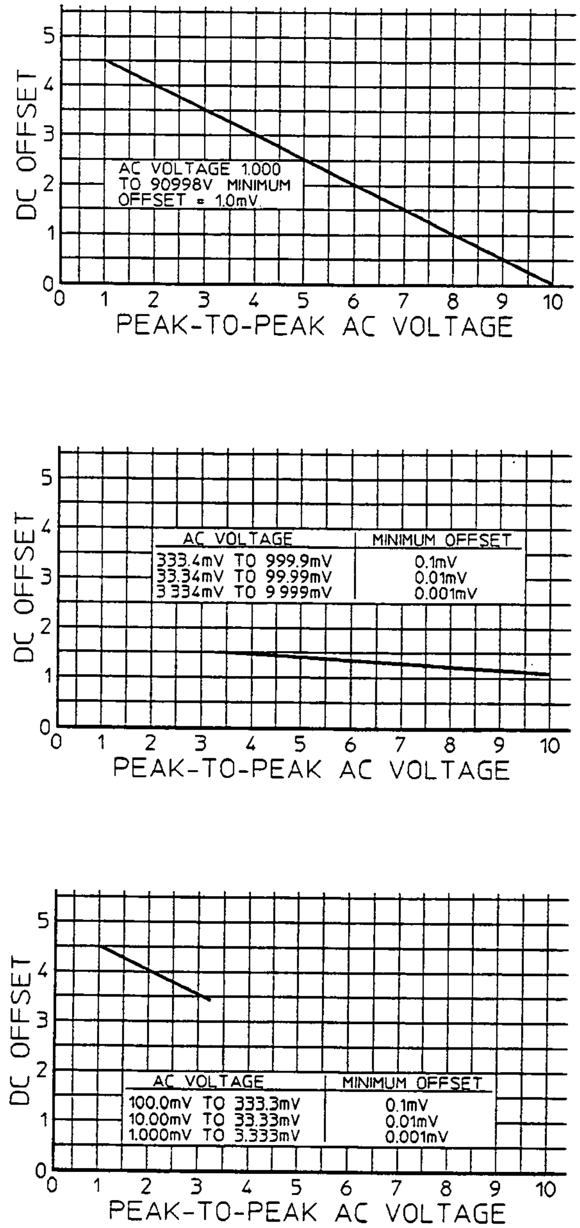


Figure 1-1. Maximum DC Offset with any AC Functions

DC Only

When the Main Function selections are disabled (all indicators extinguished), the HP 3325B automatically displays the DC Offset value and selects the [DC Offset] key for entry of DC Offset values. Without an ac function selected, the dc voltage output ranges from 0 mV to ± 5V, with four-digit resolution.

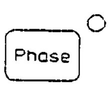
High Voltage Option

With the high voltage option enabled, the dc offset range is ±20 volts (ac + dc peak value or dc only). DC offset with the high voltage option is dependent on the ac amplitude. With the high voltage output (option 002) selected, the minimum and maximum permissible dc offset voltages may be determined by multiplying the amplitude and offset values in table 1-7 (and figure 1-2) by 4. The equation for determining maximum dc offset is:

Maximum dc Offset = (20 ÷ A) − (Amptd ÷ 2)
Where A = Attenuator factor (from table 1-7)
Amptd = Amplitude in V_{pp} of the ac function.

Note When the high voltage output is selected, minimum amplitude for dc only (no ac function) is 0.01 mV and maximum is 20.0V.

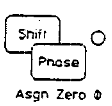
Phase



The [Phase] key enables display, entry, or modification for the phase of the Main Signal. The indicator adjacent to [Phase] key illuminates when a phase value is displayed. The displayed phase value is changed with the entry keys and [Deg] (degrees) units key, or modified with the modify controls. The phase display range is ±719.9° with a resolution of 0.1°. Phase values of ±1440° entered with the entry keys are accepted and the value is displayed modulo 720. For square wave frequencies below 25 kHz, phase changes greater than 25° may result in a phase shift ±180° from the desired amount.

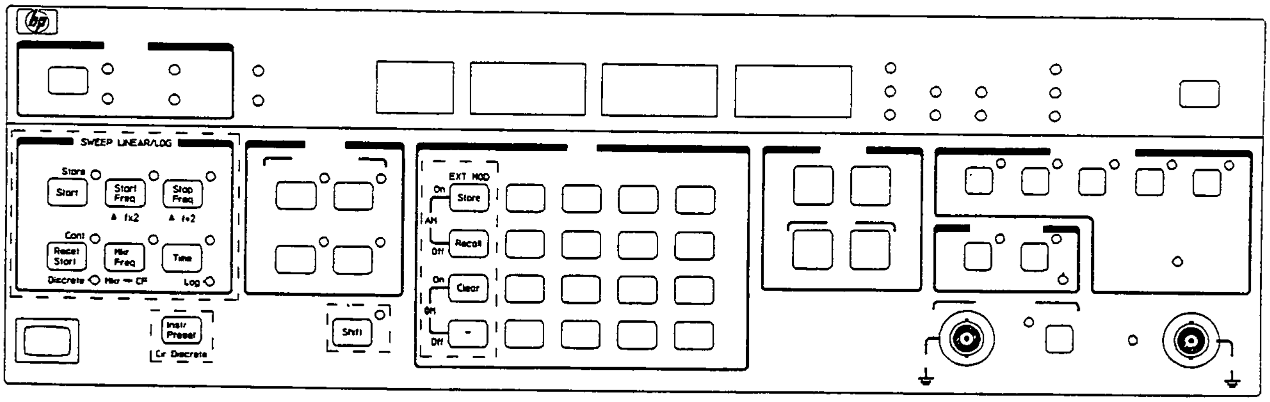
After entering a phase shift, the new phase may be assigned the zero-phase position; subsequent changes in phase are with reference to that value. To assign zero phase, press the blue [Shift] key followed by [Asgn Zero Φ] key.

Asgn Zero Φ



The [Asgn Zero Φ] (Assign Zero phase) key assigns a reference of zero degrees to the existing phase parameter of the Main Signal without changing the phase of the output waveforms. Subsequent changes in phase are with respect to that value. The [Asgn Zero Φ] key is selected by pressing the blue [Shift] key prior to the [Phase] key.

Frequency Sweeps



Introduction to Sweeps

The HP 3325B performs three kinds of sweeps: linear, log, and discrete. Linear sweeps of any function have sweep-time limits of 10 ms to 1000s and may be single or continuous. Single linear sweeps may be either up or down in frequency. Continuous sweeps move back and forth between the start and stop frequency in an up/down/up/down. . . fashion. The marker functions only during up-sweeps.

Log sweep times range from 1s to 1000s for single sweeps and from 0.1s to 1000s for continuous sweeps. Single log sweeps are up-only; they always start at the start frequency and sweep up to the stop frequency. The marker does not function during log sweeps.

Discrete sweeps allow the creation of custom sweep patterns. A discrete sweep consists of up to 100 linear sweeps or frequency steps (called segments). Each segment has four parameters: start frequency, stop frequency, sweep time, and marker frequency, which may be entered from the front panel or down-loaded from a computer. The marker functions as specified for each segment whether the sweep is up or down.

Single or continuous frequency sweeps are selectable with the [Start] and [Reset/Start] keys. Sweep parameters are entered with the [Start Freq] (start frequency), [Stop Freq] (stop frequency), and [Time] keys. The [Mkr → CF] (marker into center frequency), [Δf × 2], and [Δf ÷ 2] keys allow convenient modification of the sweep parameters. The [Mkr Freq] (marker frequency) key allows the rear-panel TTL level marker output signal to be specified.

Linear sweeps are phase-continuous over the full frequency range of the main output signal; that is, there are no phase discontinuities in the swept output waveform. When the HP 3325B is turned on, the sweep is off, the sweep mode is set to linear, and the parameters are set as follows:

Start Frequency	1 000 000.0 Hz
Stop Frequency	10 000 000.0 Hz
Marker Frequency	5 000 000.0 Hz
Time	1s

Note The marker frequency should be lower than the stop frequency by a sufficient amount to permit the marker pulse width to be approximately 400 μs.

To change any of the sweep parameters, press the appropriate Sweep Linear/Log entry key, then enter the desired data. To select log sweep, press the blue [Shift] key followed by the [Log] (Time) key to illuminate the log indicator. The sweep mode is linear unless the log or discrete indicators are illuminated. To select discrete sweep, press the [Shift] key and then the [Discrete] key. When a discrete sweep is selected, the discrete indicator is illuminated.

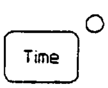
Start Frequency

The [Start Freq] (start frequency) key enables display, entry, or modification of the sweep start frequency for the main signal. The indicator adjacent to the [Start Freq] key illuminates when a start frequency value is displayed. The displayed frequency value may be changed with the entry and units keys, or with the modify keys. The MHz, kHz, and Hz units allow convenient entry of frequency values. Frequency resolution is 1 μHz for frequencies below 100 kHz and 1 mHz for frequencies above 100 kHz. The upper frequency limit is established by the function selected.

Stop Frequency

The [Stop Freq] (stop frequency) key enables display, entry, or modification of the sweep stop frequency of the main signal. The indicator adjacent to the [Stop Freq] key illuminates when a stop frequency value is displayed. The displayed frequency value is changed with the entry and units keys, or with the modify keys. The MHz, kHz, and Hz units allow convenient entry of frequency values. Frequency resolution is 1 μHz for frequencies below 100 kHz and 1 mHz for frequencies above 100 kHz. The upper frequency limit is established by the Main Function selected.

Time



The [Time] key enables display, entry, or modification of the sweep time for the Main Signal. The indicator adjacent to the [Time] key illuminates when a time value is displayed. The displayed time value is changed with the entry and units keys, or modified with the modify keys. The [SEC] units key ends entry of numeric values.

The maximum time per sweep (up or down) for all sweep modes is 1000 seconds, with a resolution of 0.01s for times $\geq$ 1s, and 0.001s for times < 1s.

Note The X-Drive output functions only when sweep time is < 100s. See the discussion, later in this chapter, on the marker, Z-blank, and X-drive rear-panel connectors.

Minimum times are:

Single Linear Sweep	0.010s
Continuous Linear Sweep	0.010s
Single Log Sweep	1.000s
Continuous Log Sweep	0.100s

Note When the enhancements are turned off, single log-sweep sweep time is increased by the processing time required between segments. The time increase (in seconds) is approximately equal to:

Time Increase = 0.045[10 log(stop freq. ÷ start freq.)]

Marker Frequency

[Mkr Freq]

The marker is a TTL-compatible signal on a rear-panel connector that goes low at the specified marker frequency during linear up-sweeps. It may also be used with discrete sweeps where it operates while sweeping up or down.

The [Mkr Freq] (marker frequency) key enables display, entry, or modification of the sweep marker frequency. The indicator adjacent to the [Mkr Freq] key illuminates when the marker frequency value is displayed. The displayed frequency value is changed with the entry and units keys, or with the modify keys. The MHz, kHz, and Hz units allow convenient entry of frequency values. Frequency resolution is 1 μHz for frequencies below 100 kHz and 1 mHz for frequencies above 100 kHz.

For a marker signal to be generated, the marker frequency may be set to any point within the sweep band to within approximately 400 μs of the stop frequency. If the marker frequency is set beyond this point, the stop frequency is automatically increased so that the marker pulse is approximately 400 μs wide. The following equation may be used to determine the approximate maximum marker frequency:

Max marker freq. = stop freq. − (0.0004 × bandwidth ÷ sweep time)

Note The marker signal is not generated on the down-sweep of a continuous sweep. See the discussion, later in this chapter, on the marker, Z-blank, and X-drive rear-panel outputs.

Mkr → CF

[Shift] [Mkr Freq]
Mkr → CF

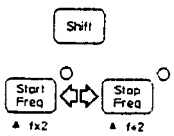
The [Mkr→CF] (marker into center frequency) key centers the sweep band on the frequency value of the marker parameter. The [Mkr→CF] key is selected by pressing the blue [Shift] key followed by the [Mkr Freq] key.

Reset/Start Sweep

The [Reset/Start] key performs three functions for the sweep operations:

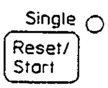
1. If a continuous or single sweep is in progress, Reset/Start cancels the sweep. When a sweep is stopped, the current frequency appears in the display.
2. For single sweeps, the first press of the [Reset/Start] key resets the sweep to the start of the sweep.
3. After a single sweep is reset, pressing the [Reset/Start] key again starts the frequency sweep.

Δf×2, Δf÷2 (Modify Bandwidth)



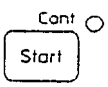
In linear sweep mode, the [Δf×2] and [Δf÷2] keys may be used to double or halve the sweep bandwidth. If either the new sweep start or stop frequency exceeds the frequency limits, an error message is displayed. These two keys have no effect on discrete sweeps.

Single Sweep



The [Reset/Start] key resets the sweep the first time it is pressed. A single sweep starts the second time the [Reset/Start] key is pressed. An illuminated *Single* indicator denotes that a single linear sweep is in progress. A single sweep sweeps from the start frequency to the stop frequency over the specified sweep time.

Continuous Sweep



The [Start] key initiates a continuous (repetitive) sweep. The Cont indicator adjacent to [Start] key illuminates when a continuous sweep is in progress. Continuous sweeps move back and forth between the start and stop frequencies in an up/down/up/down. . . fashion. If the marker is active, it functions only during the up-sweep. Sweep parameters should be entered before starting a continuous sweep. See previous discussion on start and stop frequencies and sweep time.

Linear Frequency Sweeps

In linear mode, either continuous or single sweeps are available. Single sweep is from the start to stop frequency, where either the start or stop frequency may be the higher value.

To begin a single sweep:

1. Press [Reset/Start] to set output and display to the start frequency selected and reset the X-Drive ramp.
2. Press [Reset/Start] again to start the sweep.

The output signal frequency sweeps to the selected stop frequency and remains there. This frequency appears in the display.

Continuous linear sweeps alternate between up and down-sweeps. A continuous sweep begins when the [Start] key is pressed. The Cont indicator illuminates while the continuous sweep is active. Continuous sweeps may be stopped by pressing the [Start] key or by pressing [Reset/Start], [Freq], or [Phase] keys. With enhancements turned off, the sweep may stop when other parameters are changed. With enhancements turned on, the sweep does not stop for parameter changes that do not affect the sweep (i.e., amplitude or offset changes do not cause the sweep to stop). Pressing [Amptd Cal], [Self Test], [Asgn Zero Φ], or changing the function stops a continuous sweep. When a sweep stops, the display indicates the frequency at which the sweep stopped.

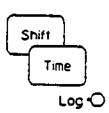
Linear Sweep Bandwidth

The maximum bandwidth is the full frequency range for the function selected. The minimum bandwidth for each function is as follows:

Sine	(10 mHz/s) × (sweep time)
Square	(5 mHz/s) × (sweep time)
Triangle	(0.5 mHz/s) × (sweep time)
Ramps	(1 mHz/s) × (sweep time)

For sweep bandwidths of less than 100 times the minimum bandwidth, bandwidth selected should be an integral multiple of the minimum bandwidth or sweep-time errors and stop-frequency errors will occur.

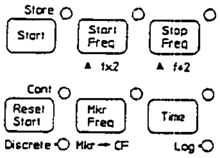
Log Frequency Sweep



In either single or continuous log sweep mode, the stop frequency must be higher than the start frequency and the sweep is up-only (continuous log sweep is a repetitive start-to-stop sweep, only). The minimum bandwidth for log sweep is one decade. Single log sweep is a line-segmented log approximation in one-tenth decade segments, and continuous log sweep is a two-segment-per-decade log approximation.

Note For narrow-band log sweeps, the actual stop frequency may be higher than the selected stop frequency. The error decreases as sweep time is increased. This error is minimized by activating enhancements.

Discrete Frequency Sweep



Discrete sweeps consist of up to 100 linear sweeps (called segments) combined to form a custom sweep pattern. Parameters for each sweep segment consist of start frequency, stop frequency, sweep time, and marker frequency. These parameters are entered by programming a standard linear sweep and storing it into a discrete sweep segment as described in *Storing Discrete Sweep Segments*.

To perform a discrete frequency sweep, the HP 3325B sequences through the segment entries, performing the designated sweeps and skipping blank entries. The sequence is always from segment 00 to 99. For single sweep operation, the HP 3325B sequences through the elements each time the sweep is reset and started with the [Reset/Start] key. For continuous sweeps, the HP 3325B sequences through the segments repeatedly.

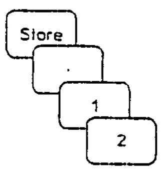
Clearing All Discrete Sweep Elements

The [Clr Discrete] (clear discrete) key empties all discrete sweep segments in nonvolatile memory. This should be done before entering new parameters. The [Clr Discrete] key is activated by pressing the blue [Shift] key and then the green [Instr Preset] key.

Storing Discrete Sweep Segments

Discrete sweep entries may be made whether the discrete sweep is active or not. Each sweep segment is a linear sweep; it may be considered a frequency step if the start frequency is the same as the stop frequency. The entries are saved in nonvolatile memory.

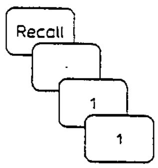
To store a discrete sweep segment:



1. Enter the start and stop frequencies, sweep time, and (optionally) the marker frequency as you would for any linear sweep.
2. Press the [Store] key.
3. Press the [.] key in the data group.
4. Enter a two-digit number by pressing numeric keys in the data group. Numbers between 1 and 9 should be preceded with a 0 (zero). No units or other terminating keystrokes are required. This number is the entry number in the discrete sweep segment list, the order of which determines the pattern of the discrete sweep. Segments may be saved in any order but are always executed sequentially from 00 to 99.

Discrete sweep segment entries may also be made by down-loading the parameters from a computer through one of the rear-panel interface connectors. In some cases, this is the preferred method of setting up discrete sweeps; especially if more than one pattern is used on a regular basis. See Chapter 2, Remote Operation, for more information.

Recalling Discrete Sweep Segments

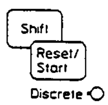


Discrete sweep parameters for any segment (start, stop, and marker frequency and sweep time) may be examined by recalling the discrete sweep segment entry and then pressing the key corresponding to the parameter of interest. To recall a discrete sweep segment:

1. Press the [Recall] key.
2. Press the [.] key.
3. Enter a two-digit number by pressing numeric keys in the data group. Numbers between 1 and 9 should be preceded by a 0 (zero). No units or other terminating keystrokes are required. This number is the entry number in the discrete sweep segment list, the order of which determines the pattern of the discrete sweep. If an empty segment is recalled the message "Error 605" is displayed.

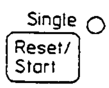
The key sequence [Recall], [.], [1], [1] recalls the linear sweep segment previously stored in segment 11.

Enabling Discrete Sweeps



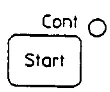
The [Discrete] key enables and disables discrete frequency sweeps. The [Discrete] key is activated by pressing the blue [Shift] key and then pressing the [Reset/Start] key. The Discrete indicator illuminates when a discrete frequency sweep is enabled.

Single Discrete Sweeps



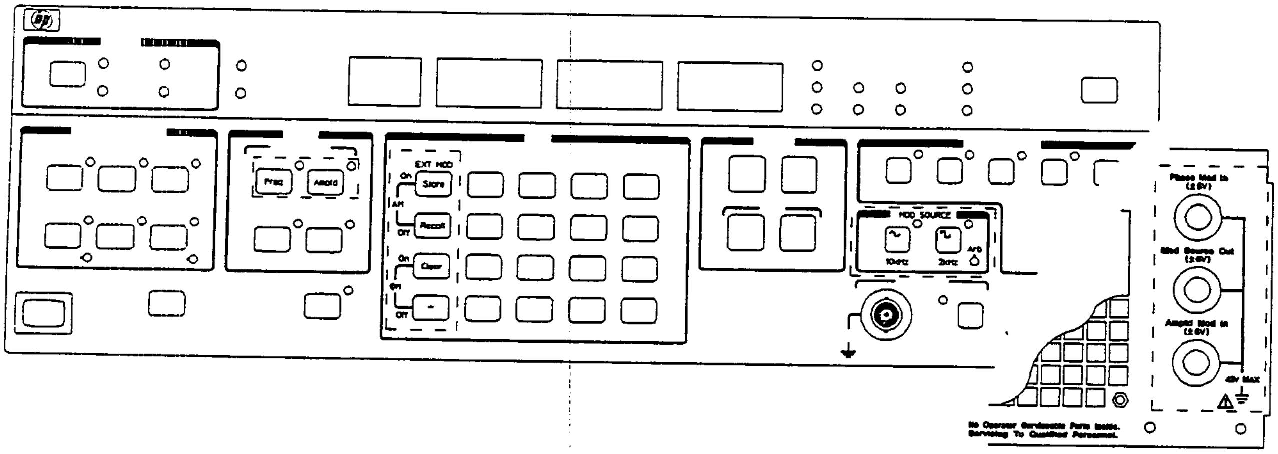
The [Reset/Start] key initiates a single discrete frequency sweep. The indicator adjacent to [Reset/Start] key illuminates when a single sweep is in progress. The [Reset/Start] key initiates a sweep from discrete frequency sweep segment 00 to 99, skipping empty segments. Pressing the [Reset/Start] key during a sweep stops the sweep and displays the present frequency. Pressing [Reset/Start] again resets the frequency to the start frequency of the first sweep segment.

Continuous Discrete Sweeps



When discrete sweep is selected, pressing the [Start] key initiates a continuous discrete frequency sweep. The indicator adjacent to [Start] key illuminates when a continuous sweep is in progress. Continuous discrete sweeps sequence through the segment table from 00 to 99, starting again at 00, repetitively. Pressing [Start] while a sweep is in progress stops the sweep.

Modulation

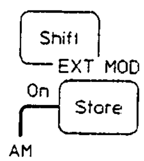


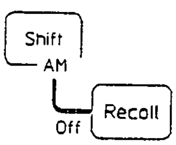
Introduction

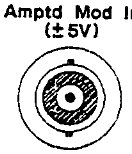
The Main Signal may be amplitude or phase-modulated by a signal connected to either of the two corresponding rear-panel connectors (Amptd Mod In or Phase Mod In). The signal may originate from another signal generator or the internal modulation source may provide the signal. After the connections are made to the rear-panel connectors, modulation of the Main Signal is controlled by the operator.

The Mod Source keys provide an independent sine wave, square wave, or arbitrary waveform signal through the rear-panel Mod Source Out connector. This signal may be used to modulate the Main Signal by connecting it to the rear-panel modulation input connector(s) and pressing the appropriate front-panel keys to activate modulation and control the Mod Source signal.

Amplitude Modulation





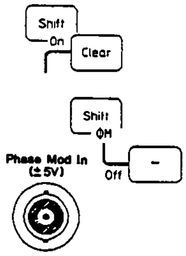


Amplitude modulation of the Main Signal is enabled by pressing the [AM On] ([Shift] [Store]) key which illuminates the AM indicator. Amplitude modulation is disabled by pressing the [AM Off] ([Shift] [Recall]) key which extinguishes the AM indicator, or by presetting the HP 3325B. The modulating signal is applied to the HP 3325B through the rear-panel Amptd Mod In connectors.

When amplitude modulation is enabled, the value entered for the amplitude of the Main Signal is the maximum value possible, or 100% modulation value. When no modulating signal is present or that signal is 0V, the amplitude of the Main Signal is half the entered value. (0V is considered to be 50% modulation.) A modulation input of approximately 5 V_{pk} results in 100% modulation. Modulation frequency may range from 0 to 400 kHz. If amplitude modulation is on when functions other than sine wave are selected, the output may be gated, depending on the level of the modulation input. Amplitude modulation should only by used with the sine wave function, and the modulation input should not exceed ±10 V_{pk}.

A dc voltage may be applied to the Amptd Mod input to control the HP 3325B output level, or a pulse may be used to gate the output. Approximately +5V cuts off the output signal, while approximately −5V doubles the output (maximum input is 10 V_{pp}). DC or pulse inputs should not exceed ±5 V_{pk}. The impedance of the Amptd Mod input is 10 kΩ (5 kΩ when AM is off).

Phase Modulation

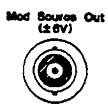


The [ΦM] (phase modulation) keys in the data group enable and disable phase modulation of the Main Signal. Phase modulation is enabled by pressing the [ΦM On] ([Shift] [Clear]) key, which illuminates the ΦM modulation indicator. Phase modulation is disabled by pressing the [ΦM Off] ([Shift] [−]) key, which extinguishes the ΦM modulation indicator, or by presetting the HP 3325B. The modulating signal is applied to the HP 3325B through the rear-panel Phase Mod In connector.

The phase modulation signal at the rear-panel Phase Mod Input connector should not exceed ±10 V_{pk}. The input impedance is 40 kΩ. The modulation signal frequency may be dc to 5 kHz. An input of ±5V results in the following approximate phase deviation (±170° per volt for the sine function):

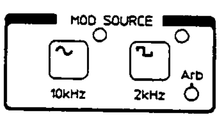
HP 3325B Function	Phase Deviation
Sine	±850°
Square	±425°
Triangle	±42.5°
±Ramp	±85°

Modulation Source

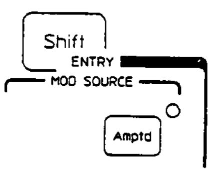


The modulation source provides a second independent signal source, available at the rear-panel Mod Source Out connector. This signal may be used to modulate the main signal by connecting the mod source out connector to the (amplitude or phase) input modulation connector(s) and then controlling main signal modulation and the mod source signal.

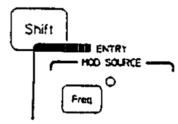
Note The Mod Source output signal should be connected to the Phase or Amplitude Modulation input connector with a BNC coaxial connector at the rear panel. There is no internal connection.



The modulation source is enabled by pressing the Mod Source sine wave or square wave key. The modulation source is disabled by pressing the Mod Source sine wave or square wave key adjacent to the illuminated Mod Source indicator to extinguish that indicator.



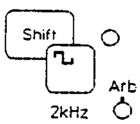
The Mod Source amplitude is entered by pressing the [Shift] key followed by the [Amptd] key. The Modulation Source indicator to the left of the display illuminates to indicate the display contains a modulation source value. Valid modulation source amplitudes range from 0.1 to 12 V_{pp} with 0.1V resolution. Amplitudes may be entered in either V_{pp} or V_{rms}.



The Mod Source Frequency is entered by pressing the [Shift] key followed by the [Freq] key. The Modulation Source indicator illuminates to indicate the display contains a modulation source value. The sine wave frequency values range from 0.1 Hz to 10 kHz with 2-digit resolution. The square wave frequency values range from 0.1 Hz to 2 kHz with 2-digit resolution. The modulation signal is momentarily disabled during modulation frequency changes.

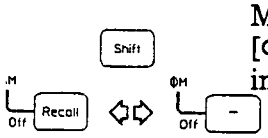
The Modulation Source is a free-running signal which is not phase-locked to the Main Signal output or External Reference input. It has no DC offset or phase parameters. The Modulation Source output is intended to drive high impedance inputs and should not be terminated in 50Ω. It may be connected to both modulation inputs at the same time but the extra loading may draw the output signal voltage down.

Arbitrary Waveforms



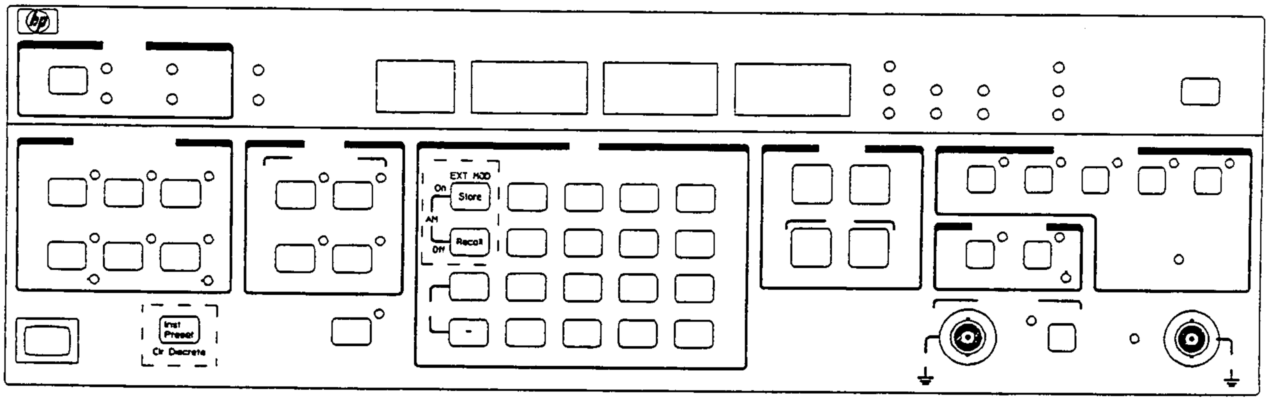
The modulation source may be programmed as an arbitrary waveform source by a computer via HP-IB or RS-232. Once programmed, the waveform is retained in nonvolatile memory and may be initiated from the front panel. Select the arbitrary waveform with the [Shift] Mod Source square wave key which illuminates the Arb indicator. The repetition rate of the arbitrary waveform is set with the [Shift] [Freq] key. Repetition rates range from 0.1 Hz to 10 kHz (the HP 3325B adjusts the value to compatible internal frequencies). The default waveform is dc (after memory is cleared).

Disabling Modulation



Modulation is disabled by pressing the [AM Off] ([Shift] [Recall]) key or [ΦM Off] ([Shift] [−]) key. The extinguished AM or ΦM modulation indicators provide a visual indication that modulation inputs are disabled.

Storing/Recalling Instrument States



Storing Instrument States

The [Store] key, followed by a digit from 0 to 9, saves the current operating state in internal memory. The digit following the [Store] key specifies the memory location for storing the operating state. If two operating states are saved in the same memory location, the operating state saved first is overwritten. These states are not cleared by instrument preset; they are cleared by a memory clear (power up while pressing the preset key).

Note Any phase information stored is invalid when recalled because the instrument performs an amplitude calibration on Recall. The phase relationship between the output signal and the reference is not maintained when an amplitude calibration occurs.

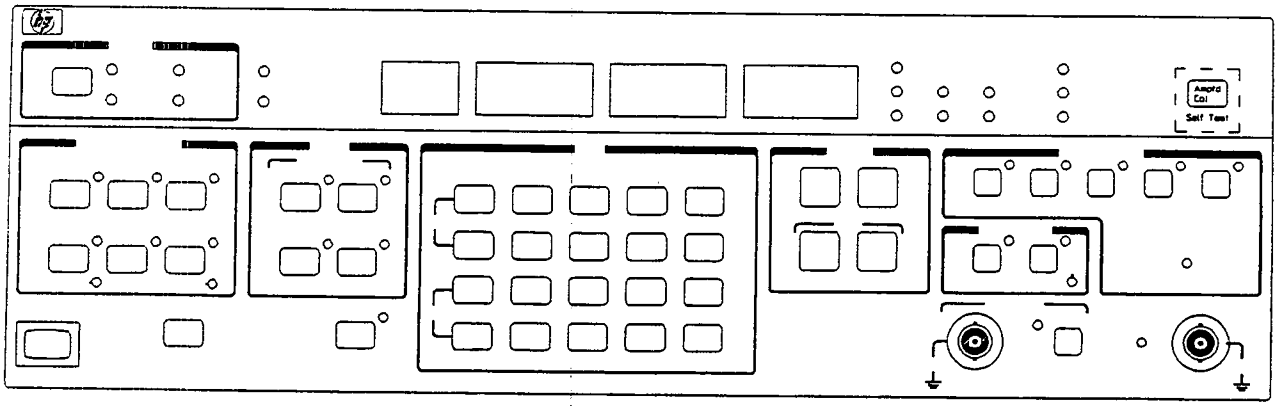
Recalling Instrument States

The [Recall] key, followed by a digit from 0 to 9, recalls an operating state saved in internal memory. The digits 0 to 9 select the memory location for the recall operation. Pressing [Recall] [−] recalls the state of the instrument just before it was last powered down.

Memory Clear

Applying power to the HP 3325B with the green [Inst Preset] key depressed replaces the contents of all nonvolatile memory registers with the instrument preset state. All saved operating states (including power-down) are replaced with the instrument preset state, discrete frequency sweep elements are cleared, the arbitrary waveform registers are set to dc, the HP-IB address is set to 17, and the message "Fail 36" is displayed.

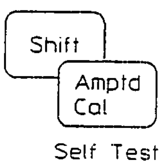
Calibration and Self Test



Amplitude Calibration

The [Amptd Cal] key initiates a calibration of the output signal each time the key is pressed. The Main Signal output amplitude changes to less than 4 mVpp while the calibration is in progress. An amplitude and offset calibration is performed automatically whenever the function is changed and at instrument turn-on.

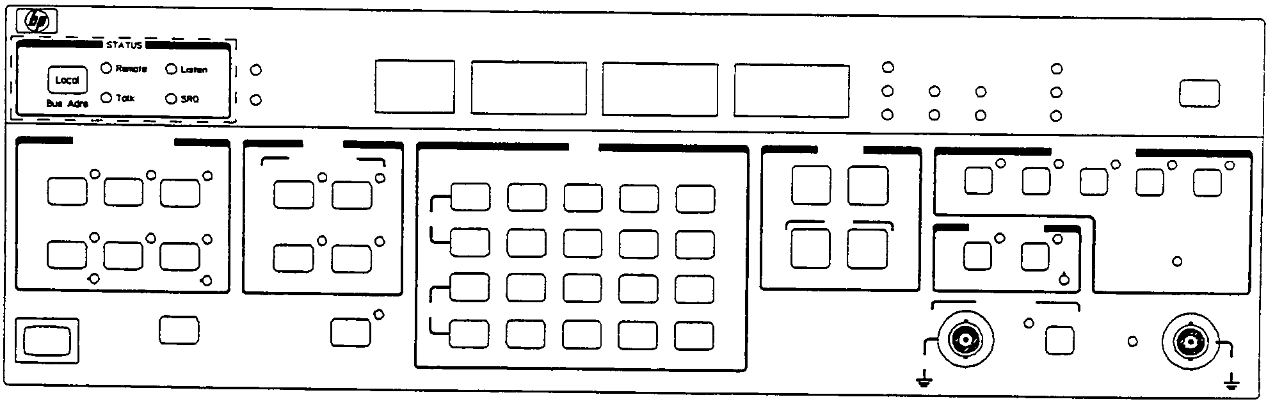
Self Test



A self test is initiated by pressing the blue [Shift] key prior to the [Amptd Cal] ([Self Test]) key. During a self test, all indicators and display segments briefly illuminate, -CAL- is displayed, and a series of internal tests is initiated. After each internal test, Pass or Fail and a number is displayed to indicate the test results. During a self test, the outputs are disabled.

Note If the message "Fail 21" through "Fail 29" is displayed momentarily after a self test, the HP 3325B should be sent to qualified service personnel for repair.

The HP-IB Status Keys/Indicators/Connector



The HP-IB (Hewlett-Packard Interface Bus) key and status indicators are used during remote operation. An overview of the HP-IB and a description of the HP 3325B HP-IB characteristics and commands is contained in Chapter 2.

Local

Local

The [Local] key removes the HP 3325B from remote (HP-IB or RS-232) operation if local lockout is not in effect. Remote operation is indicated by the illuminated Remote indicator.

○ Remote

The Remote indicator illuminates when the HP 3325B is operating under remote control. While in remote (and local lockout is not in effect), only the [Local] key is recognized.

○ Listen

The Listen indicator illuminates when the HP 3325B is addressed to listen over the HP-IB.

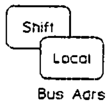
○ Talk

The Talk indicator illuminates when the HP 3325B is addressed to talk over the HP-IB.

○ SRQ

The SRQ (service request) indicator illuminates when the HP 3325B has requested service (HP-IB only).

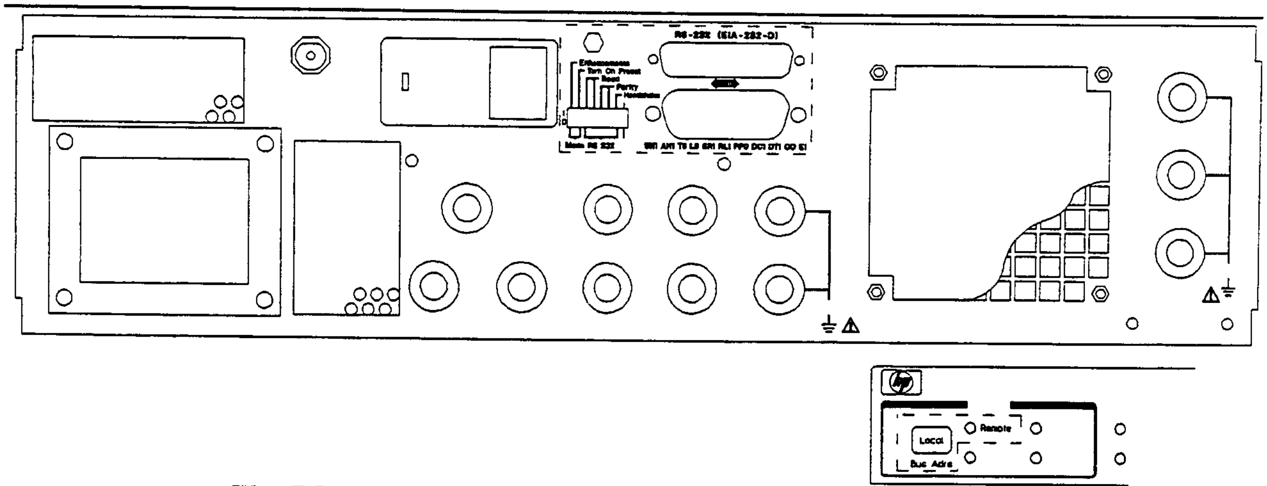
Bus Address



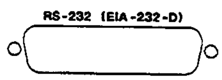
The [Bus Adrs] (bus address) key enables display or entry of the HP-IB address. The [Bus Adrs] key is selected by pressing the blue [Shift] key prior to the [Local] key. After selection of the [Bus Adrs] key, the HP-IB address is entered with the data entry keys or changed with the modify keys. For address values entered with the data entry keys, pressing any units key sets the address. The HP-IB address is an integer in the range of 0 to 31 and is retained in nonvolatile memory. Entering an address value of 31 places the HP 3325B in the listen-only mode and the HP 3325B displays LO rather than the address value.

The HP 3325B is connected to other HP-IB devices through the rear-panel HP-IB connector.

The RS-232 Switches/Indicators/Connector

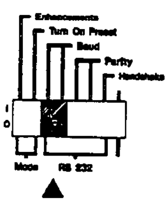


The RS-232 serial interface provides an alternate method (to the HP-IB) of remotely controlling the HP 3325B. Chapter 2 provides an overview of remote operation and contains a complete list of the remote operation commands.



The 25-pin female connector is configured as Data Terminal Equipment (DTE). Chapter 2 contains a description of the characteristics of the connectors. Five of the small switches on the rear panel configure the HP 3325B for operation with the serial RS-232 communications link.

Baud Rate



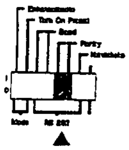
The Baud switches (switches 3 and 4) control the transmission speed (baud rate) of the RS-232 serial interface. Table 1-8 lists the available baud rates and switch settings for them. Whenever the baud switches are changed, the new rate value is displayed. For example, when switch 3 and 4 are placed in the down position, the HP 3325B displays "bAUd = 4800".

Table 1-8. RS-232 Baud Rate

Rate	Switch 3	Switch 4	Display Message
300*	up	up	bAUd = 300
1200	up	down	bAUd = 1200
2400	down	up	bAUd = 2400
4800	down	down	bAUd = 4800

* *Factory setting*

Word Length/Parity



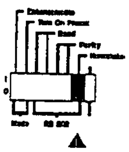
The Parity switches (switches 5 and 6) control the parity and word length of the serial data exchanged with the host computer. Table 1-9 lists the available word lengths and parity and corresponding switch settings. Whenever the parity switches are changed, the new parity value is displayed.

Table 1-9. RS-232 Word Length and Parity

Word Length	Parity	Switch 5	Switch 6
7 data bits *	Even	up	up
7 data bits	Odd	up	down
8 data bits	None	down	up
7 data bits	Zero	down	down

* *Factory setting*

Handshaking



The Handshake switch (switch 7) sets the handshaking characteristics used to communicate with host computer. Table 1-10 lists the handshaking available and corresponding switch settings. Whenever the Handshake switch is changed, the new handshaking characteristics are displayed.

Table 1-10. RS-232 Handshaking

Handshaking	Switch 7	Display Message
Software (Xon/Xoff) *	up	HAnd = Soft
Hardware (DTR/RTS)	down	HAnd = dtr

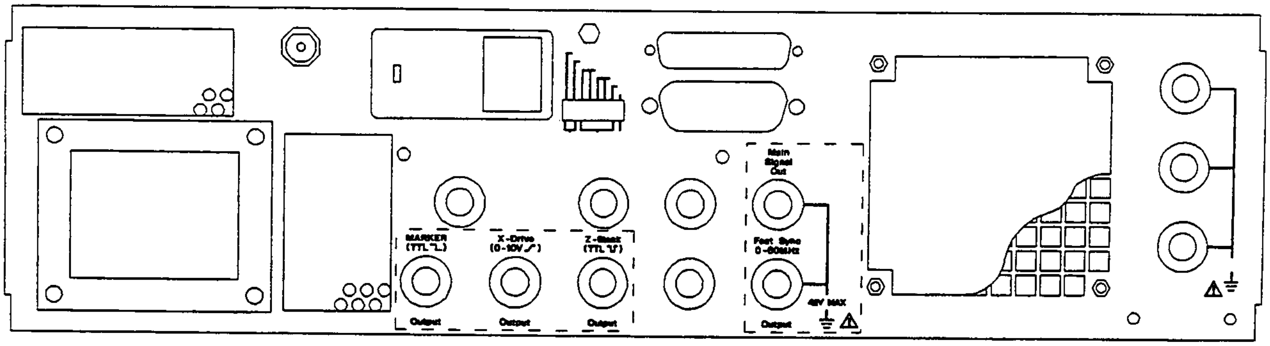
* *Factory setting*

RS-232 Local/Remote

The [Local] key removes the HP 3325B from remote (HP-IB or RS-232) operation if local lockout is not in effect. Remote operation is indicated by the illuminated Remote indicator.

The Remote indicator illuminates when the HP 3325B is operating under HP-IB or RS-232 control. While in remote (and local lockout is not in effect), only the [Local] key is recognized.

Marker / Z-Blank (Pen Lift) / X-Drive Outputs



The Marker, Z-Blank, and X-Drive connectors provide outputs to drive an analog plotter or oscilloscope display during sweep operation.

Marker

The rear-panel Marker connector provides a TTL-level signal indicating when the sweep frequency reaches the value entered for the marker frequency.

Single/Continuous Linear Sweep

During a sweep up, the marker signal starts at a high level at the start frequency, drops to a low level at the selected marker frequency, and returns to the high level at the stop frequency. The marker output is disabled during a sweep down. If the marker value entered is out of the sweep span, no marker transition occurs.

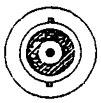
Log Sweep

The marker is disabled during log sweeps.

Discrete Sweep

For discrete frequency sweeps, the marker goes to a high value at the start of each frequency segment, drops to a low level at the selected marker frequency and remains low until the start of the next sweep segment. Each of the sweep segments may have a different marker frequency. (See the discussion on discrete sweeps, earlier in this chapter, under Frequency Sweeps.) If the marker value entered is out of the sweep span of the segment, the marker output stays high during the duration of the sweep segment. The marker functions for up or down-sweeps when executing discrete sweeps. If the start, stop, and marker frequency parameters of a segment are equal, the marker output is low during the segment sweep time.

Z-Blank



The Z-Blank output drops low at the start of sweep and remains low until the end of a sweep. At the end of a sweep, the Z-Blank output signal goes to a high level and remains high until another sweep segment is initiated. The Z-Blank connector is located on the rear panel and the output is TTL-compatible. The Z-Blank low level is capable of sinking current from a positive voltage source through a pen-lift circuit or other device. When this output is low the maximum Z-Blank ratings are:

Maximum current sink: 200 mA
Allowable voltage range: 0 to +42V dc
Maximum power (voltage at output × current): 1 W

Single Linear Sweep

Z-Blank drops to a low level at the start of sweep and remains low until the end of a sweep. At the end, the Z-Blank output goes to a high level and remains high until the sweep is restarted.

Continuous Linear Sweep

Z-Blank drops to a low level during the sweep up, and goes to a high level for the sweep down.

Single Log Sweep

Z-Blank drops to a low level at the start frequency, and goes to a high level at the stop frequency and remains high until the sweep is restarted.

Continuous Log Sweep

Z-Blank drops to a low level at the start frequency, and momentarily goes to a high level at the stop frequency.

Discrete Frequency Sweep

Z-Blank drops low at the start of the first segment and stays low until the end of the last segment, when it returns to a high level. During continuous sweeps, Z-Blank remains high for approximately 400 μs.

X-Drive

During sweep operation, the rear-panel X-Drive connector provides a 0 to > 10 volt linear ramp proportional to the sweep time (ramps up). For sweep times of 100 seconds or more the X-drive output stays at 0 volts.

Note The X-Drive output has a nominal voltage of just over 10 volts at the end of a sweep to ensure compatibility with oscilloscopes with a horizontal sensitivity of 10 volts for full-screen deflection.

Single Linear Sweep

During a sweep, X-Drive Out increases linearly from 0 to > 10 volts from the start frequency to the stop frequency. At the end of a sweep, the output remains at approximately 10 volts until reset for the start of the next sweep. (Voltage drifts downward less than 10 mV/s.)

Continuous Linear Sweep

During the up sweep, X-Drive output signal increases linearly from 0 to > 10 volts. The output drops to 0 volts at the start of the down sweep and remains there during the down sweep.

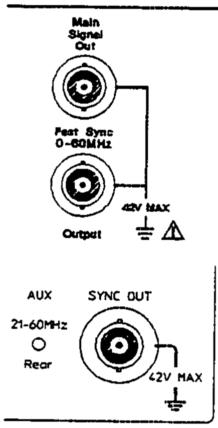
Log Sweep

X-Drive increases linearly from 0 to > 10 volts with the sweep segments.

Discrete Frequency Sweep

The X-Drive output is disabled during discrete sweeps.

Synchronization Outputs



A square wave with the frequency and phase of the main signal output is available at the front-panel Sync (synchronous) Out and rear-panel Fast Sync connectors. The Sync transition occurs at the signal zero-crossing or when the signal crosses the dc offset voltage.

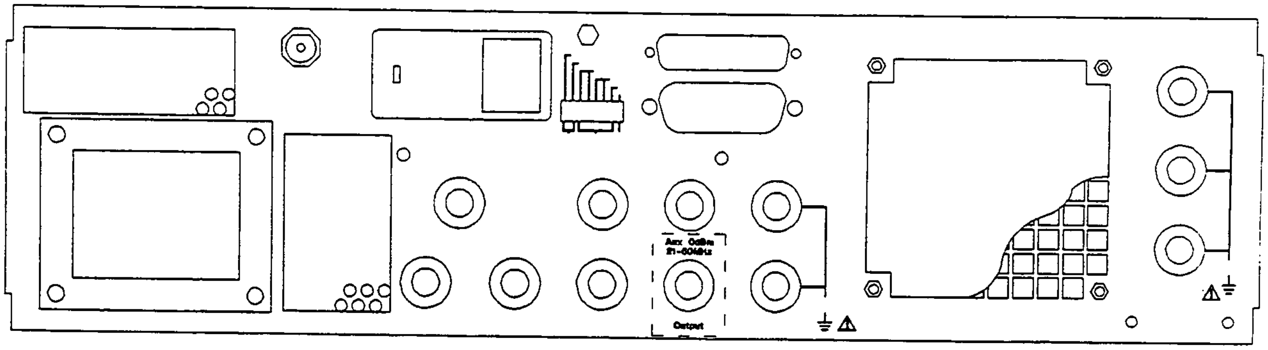
The output impedance of Sync Out is approximately 50Ω with a frequency range matching the main signal output. When the Sync Out output is terminated in a 50Ω resistive load, the output levels are:

Front Sync	Rear Fast Sync
Low level < +0.2V	Low level < +0.5V
High level > +1.2V	High level > +1.5V

Note When the Sync output is connected to a high impedance load (≥ 1 MΩ), the voltage levels are approximately twice the values listed. Improper termination of a 50Ω system may cause ringing at the signal positive and negative transitions. It may be terminated into larger impedances, if necessary to drive TTL circuits to 60 MHz.

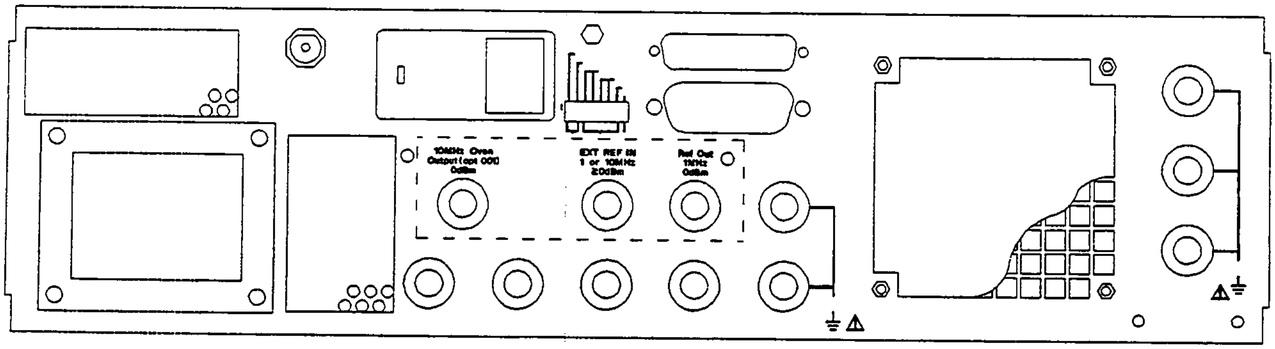
The rear-panel Fast Sync output impedance is approximately 50Ω with a frequency range extended to 60 MHz. The output levels for the Fast Sync connector may fall below the TTL minimums when terminated into 50Ω.

AUX 0 dBm 21−60 MHz Output (Extended Frequency)

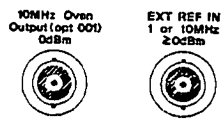


The rear-panel Aux 0 dBm 21−60 MHz connector supplies a signal when the HP 3325B frequency is set above 21 MHz. Once active, the frequency of this output ranges from 19 MHz to a maximum of 60 999 999.999 Hz. Frequencies below 19 MHz reactivate the main signal output connector. The auxiliary output is ac-coupled with a level approximately 0 dBm into 50Ω.

External Reference or Oven-Stabilized Frequency Option



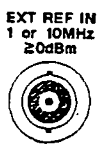
10 MHz Oven Output (High-Stability Frequency Reference)



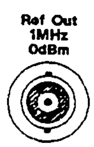
The 10 MHz oven output signal is available at a connector on the rear panel if the high-stability frequency reference (option 001) is installed. It is a 10 MHz temperature-stabilized crystal oscillator which connects to the HP 3325B frequency reference input by connecting the 10 MHz oven output connector to the External Ref In connector with a BNC-to-BNC adapter (HP part number 1250-1499). The 10 MHz oven signal has a level greater than 0 dBm (50Ω). The output signal is present whenever the HP 3325B is connected to a power source.

To reduce the warmup time and obtain maximum performance from an HP 3325B equipped with option 001, leave the HP 3325B connected to a power source. Power is supplied to option 001 whenever the HP 3325B is connected to a power source. An HP 3325B with option 001 requires 15 minutes of warmup time to meet frequency specifications if power is disconnected for less than 24 hours. If power is disconnected for more than 24 hours, the HP 3325B may require up to 72 hours of warmup time to meet frequency specifications.

External Frequency Reference



The External Ref In connector phase-locks the HP 3325B to external frequency references. Phase-locking to an external frequency reference transfers the external reference's frequency accuracy and aging rate to the HP 3325B. The level of the frequency reference must be from 0 dBm to +20 dBm (50Ω). The frequency must be 10 MHz (±10 ppm) or a subharmonic down to 1 MHz (e.g., 1, 2, 3.33, 5, or 10 MHz). The front-panel Ext Ref indicator illuminates when the HP 3325B is connected to an external frequency reference. The Ext Ref indicator blinks if the HP 3325B is unable to synchronize to the reference. The 10 MHz oven output normally connects to the External Ref In connector if the high stability frequency reference (option 001) is installed.



The Ref Out 1 MHz connector supplies a 1 MHz square wave derived from the frequency reference of the HP 3325B. The square wave has a level greater than 0 dBm (50Ω) and can be used to phase-lock an analyzer or other instrumentation to the frequency reference of the HP 3325B.

Chapter 2

Remote Operation

Chapter 2

Remote Operation

This chapter contains two sections:

1. General information concerning the operation of the selected interface (either HP-IB or RS-232)
2. Interface commands specific to the HP 3325B.

The first is an overview of the Hewlett-Packard Interface Bus (HP-IB) and its relationship to the HP 3325B as well as a general description of the RS-232 interface. Both contain information that is general interface information, only; i.e., commands that might be used with any instrument.

The second section contains descriptions of commands used specifically for the HP 3325B.

Remote Operation via HP-IB

Description of the HP-IB

The HP-IB is a bus structure that links the HP 3325B to desktop computers, minicomputers, and other HP-IB controlled instruments to form automated measurement systems. The HP-IB is Hewlett-Packard's implementation of the IEEE Standard 488-1978 and ANSI Standard MC 1.1.

All of the active HP-IB interface circuits are contained within the various HP-IB controlled devices. The interconnecting cable is entirely passive and its role is limited to connecting the devices in parallel so that data can be transferred from one device to another.

Every participating device must be able to perform at least one of the following roles: talker, listener, or controller. A talker transmits data to other devices called listeners. Most devices can be both a talker and listener, but not at the same time. A controller manages the operation of the bus system by designating which device is to talk and which devices are to listen at any given time. The HP 3325B can be either a talker or a listener.

The full flexibility and power of the HP-IB is realized when a controller is added to the system. An HP-IB controller participates in the measurement by being programmed to automate, monitor, and coordinate instrument operation as well as process the measurement results. There may be more than one controller on the bus but only one can be active at a time. (Changing the active controller is accomplished with the *pass control* bus message.) One (and only one) of the controllers should be hard-wired as the *system controller*.

Capabilities of the HP-IB

Number of Interconnected Devices

Up to 15 devices, maximum, may be on one contiguous bus.

Interconnection Path/Maximum Cable Length

Star or linear bus network. Total transmission path length = 2 meters times number of devices, or 20 meters, whichever is less, with a maximum of 3 meters separating any two devices.

Message Transfer Method

Byte-serial, 8 bit-parallel, asynchronous data transfer using a 3-wire handshake.

Data Transfer Rate

One megabyte per second (maximum) over limited distances; actual data rate depends upon the capability of the slowest device involved in the transmission.

Address Capability

Primary addresses: 31 talk, 31 listen; secondary (2-byte) addresses: 961 talk, 961 listen. 1 talker and 14 listeners, maximum, at one time. The HP 3325B has only primary address capability. Table 2-2 lists the talk and listen HP-IB addresses.

Multiple Controller Capability

In systems with more than one controller, only one controller can be active at a time. The active controller can pass control to another controller but only the system controller can assume unconditional control. Only one system controller is allowed per system.

Interface Circuits

Driver and receiver circuits are TTL compatible.

Bus Structure

The HP-IB signal lines consist of eight data lines (DIO1−DIO8), five bus management lines, (explained in following text), and three handshake lines. This is shown in figure 2-1.

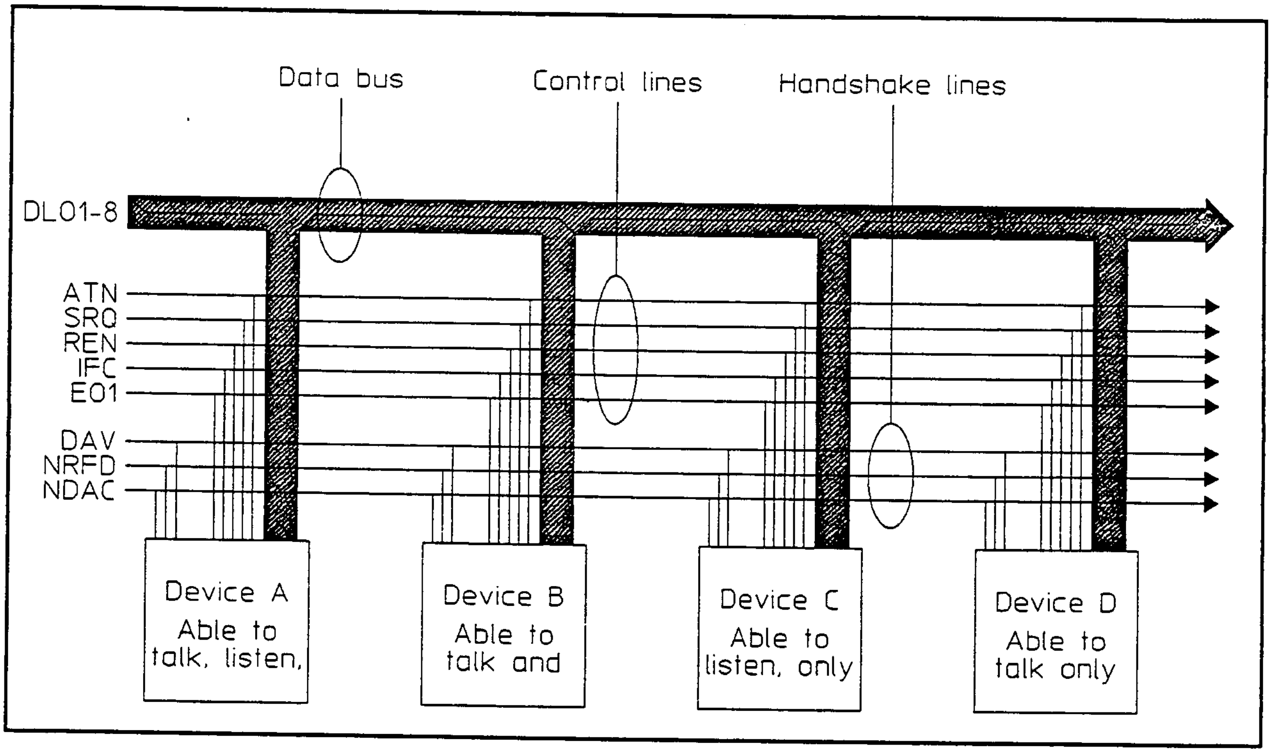


Figure 2-1. HP-IB Structure

HP-IB Management (Control) Lines

ATN — Attention. This line is used by the active controller to define how information on the data lines should be interpreted by other devices on the bus.

When ATN is low (true) the HP-IB is in the *command mode* and the data lines should be interpreted as *bus commands* (see "Bus Commands" later in this chapter). In the command mode the controller is active and all other devices are waiting for instructions. Also, devices on the HP-IB are addressed or unaddressed as listeners or talkers while the bus is in command mode.

When ATN is false the HP-IB is in *data mode* and the data lines should be interpreted as device-dependent commands. In the *data mode*, data and instructions are transferred between devices on the HP-IB. Instructions transferred to the instrument are called *device-dependent commands*. All the commands specifically for the HP 3325B fall into this category. The HP 3325B device-dependent commands configure the HP 3325B, initiate measurements, initiate data transfers, or define error-reporting conditions. These device-dependent commands are meaningless for other instruments. The HP 3325B device-dependent commands are listed later in this chapter under the heading "HP 3325B Remote Operation Command Set."

SRQ — Service Request. This line is set low (true) by any instrument requiring service. The controller should be programmed to respond to most service requests by polling the devices on the bus to determine which one initiated the request. The HP 3325B responds to a serial poll by putting its status byte on the data lines.

REN — Remote Enable. The system controller must set REN low and then address specific device(s) to listen before they can operate under remote control.

IFC — Interface Clear. Only the *system controller* can activate the IFC line. When IFC is set true (low), all devices on the bus become inactive.

EOI — End Or Identify. This line is used to indicate the end of a multiple-byte transfer sequence (in the *data mode*) or by the controller, in conjunction with ATN, to execute a parallel poll.

HP 3325B HP-IB Capability

The HP 3325B interfaces to the HP-IB as defined by IEEE Standard 488-1978. The interface functional subset which the HP 3325B implements is specified in table 2-1.

Table 2-1. HP 3325B HP-IB Capability

Code	Function
SH1	Complete source handshake capability
AH1	Complete acceptor handshake capability
T6	Basic talker; serial poll; unaddressed to talk if addressed to listen; no talk-only
L3	Basic listener; unaddressed to listen if addressed to talk; listen-only
SR1	Complete service request capability
RL1	Complete remote/local capability
PP0	No parallel poll capability
DC1	Device clear capability
DT1	Device trigger capability
C0	No controller capability
E1	Driver electronics – open collector

Talk/Listen Addresses

Each HP-IB device has at least one talk and one listen address unless the device is either totally transparent or is a talk-only or listen-only device. Device addresses are used by the active controller in the *command mode* (ATN true) to specify the talker (via a talk address) and the listener(s) (via listen addresses). Only one device may be addressed to talk at a time.

The address of a device is usually preset at the factory but may be set to another value during system configuration. In the binary representation of the address, the device address is the decimal equivalent of the five least-significant bits of the address. (On HP-IB devices with selector switches, these are the five address switches.) The address can be from 0 to 31, inclusive. The sixth and seventh bits determine if the address is a talk or listen address, respectively. High-level HP-IB controllers typically configure these two bits automatically. Table 2-2 lists the HP-IB addresses if a controller requires the talk and listen addresses.

Table 2-2. HP-IB Addresses

Device Address	Binary Address	Address Characters Talk	Address Characters Listen
0	0000 0000	@	Space
1	0000 0001	A	!
2	0000 0010	B	"
3	0000 0011	C	#
4	0000 0100	D	$
5	0000 0101	E	%
6	0000 0110	F	&
7	0000 0111	G	'
8	0000 1000	H	(
9	0000 1001	I	)
10	0000 1010	J	*
11	0000 1011	K	+
12	0000 1100	L	,
13	0000 1101	M	-
14	0000 1110	N	.
15	0000 1111	O	/
16	0001 0000	P	0
17	0001 0001	Q	1 (HP 3325B default address)
18	0001 0010	R	2
19	0001 0011	S	3
20	0001 0100	T	4
21	0001 0101	U	5 (typically the controller)
22	0001 0110	V	6
23	0001 0111	W	7
24	0001 1000	X	8
25	0001 1001	Y	9
26	0001 1010	Z	:
27	0001 1011	[	;
28	0001 1100	\	<
29	0001 1101	]	=
30	0001 1110	^	>

The talk and listen addresses fall within the printable ASCII character set. When a device receives one of these characters while ATN is true, it becomes addressed. The ASCII character "?" (ASCII 31) unaddresses all devices while ATN is true. The device address (set from the HP 3325B front panel) is used by HP-IB controllers, most of which automatically send the talk and listen address characters.

Viewing the HP 3325B HP-IB Address

The HP-IB address is stored in a nonvolatile memory location(there are no address switches). The address appears in the display when you press [Bus Adrs] key ([Shift] [Local]). The address message is removed from the display by pressing another key that requires the display.

Changing the HP-IB Address

Every device on the HP-IB must have a unique address. The HP 3325B address can be set at any address between 0 and 31, inclusive, and is stored in internal nonvolatile memory. When selecting an address, remember that the controller also has an address (usually 21).
To change the HP-IB address:

1. Press the blue [Shift] key followed by the [Local] key in the HP-IB Status block to display the HP-IB address.
2. Enter the address with the data entry keys or change it with the arrow keys.
3. Press any units key to enter the new address.

Notes

An address entry of 31 sets the HP 3325B to *listen only* and the message "Addr. = LO" appears in the display.

If you enter an address greater than 31, the message "Error 100" appears in the display (entry parameter out of range).

The HP-IB address is reset to 17 after a memory clear operation (hold down the Preset key and cycle power).

Bus Commands

The HP-IB interface system operates in one of two modes, controlled by the ATN bus management line: *command mode* (ATN true) or data mode (ATN false). (If an HP controller is used, the bus management lines are configured automatically and all necessary command strings are issued.)

Bus commands are issued while the HP-IB is in the command mode. These commands may instruct the instrument's HP-IB interface to control the instrument (like Clear or Trigger) but are more often used for bus management (Remote, Local, Polls, Service Request, Abort interface activity, or Pass Control). Bus commands are issued through the use of one of the five bus management lines or through the eight-bit data bus. The bus commands and the HP 3325B responses to them are described in the following:

Abort

The *abort* command (interface clear – IFC true) halts all HP-IB activity. The system controller assumes unconditional control of the bus. The HP 3325B responds by becoming unaddressed.

Clear

The clear command causes all devices addressed to listen to reconfigure themselves to a predefined device-dependent condition. The HP 3325B responds to the clear command (both the device clear, DCL, and selective device clear, SDC) by clearing the interface command buffer of any pending commands, clearing the error register, and resetting the instrument to the Preset state.

Clear Lockout/Set Local

The clear lockout/set local command removes all devices from the local lockout mode and returns the HP 3325B to local (front panel) control. The HP-IB is in the local mode because the REN bus management line is set false.

Local

The *local* command clears the remote command from the listening device and returns the listening device to local (front panel) control. If local lockout is not in effect, the HP 3325B responds by returning to front panel control. The Remote indicator on the front panel extinguishes if the HP 3325B is in Remote prior to the Local command.

Local Lockout

The *local lockout* command disables the Local front panel key to avoid operator interference. The HP 3325B front panel is locked out.

Parallel Poll

The *parallel poll* command is a controller operation used to obtain information from the devices under its control. The HP 3325B does not respond to this bus command.

Pass Control

The *pass control* command shifts system control from one controller to another. The HP 3325B does not respond to this command.

Remote

The *remote* command directs an instrument to take instructions from the HP-IB instead of the instrument's front panel. To implement the remote command, the controller must set the REN bus management line true. When the HP 3325B accepts the remote command, the Remote front panel indicator illuminates and the front panel is disabled except for the Local key which can return control of the instrument to the front panel if pressed. If the *local lockout* message is also issued, the mode cannot be changed from remote to local via the front panel [Local] key.

Serial Poll

The *serial poll* is issued by the active controller along with a specific address. If the address matches the address setting of the HP 3325B, it responds by putting its status byte on the data lines for the controller to read. The HP 3325B status byte consists of eight bits indicating the states of several operating parameters (refer to "The Status Byte").

Service Request

The *service request* (SRQ) bus management line is used by a device to indicate a need for attention from the controller. When the HP 3325B requires service (as is determined by the setting of the status byte mask) it issues an SRQ (pulls the SRQ line low), sets bit 6 of the status byte (see the "Status Byte"), and illuminates the front panel SRQ indicator. The SRQ is cleared by executing a serial poll of the HP 3325B. Bit 6, the require-service bit, is sometimes referred to as the status bit in connection with a poll. Bits 0, 1, 2, and 3 in the status byte may initiate an SRQ, depending on the setting of the status byte mask. The status byte may be masked to select which of the four bits cause the HP 3325B to issue the SRQ.

Trigger

The *group execute trigger* (GET) or *selective device trigger* (SDT) command causes all addressed instruments with HP-IB trigger capability to execute a predefined function simultaneously. The HP 3325B responds to the HP-IB trigger command by starting a single sweep, providing the HP 3325B is in the enhancements mode and the sweep was reset using the RSW command.

Masking The Status Byte

The HP 3325B MS and ESTB commands specify which bits in the status byte are enabled (to generate an SRQ). These commands are described under the HP 3325B Remote Control Command Set. Table 2-3 describes the HP 3325B status byte and lists the decimal value of each bit position.

The Status Byte

The status byte is an eight-bit word transmitted by the HP 3325B in response to a serial poll. The state of each bit indicates the status of an internal HP 3325B function. Table 2-3 describes the HP 3325B status byte bit positions and the events and conditions that set and reset each bit. A status bit is enabled (set) when the condition it represents changes from false to true. When a bit is enabled, bit 6 is also set and an SRQ is generated if the Boolean AND of the status byte and the status byte mask is not equal to zero. See the MS command and table 2-3 for more information on masking the status byte.

Table 2-3. HP 3325B Status Byte

Bit	Value	Description
B0	1	**ERR.** Program or front panel entry error. Use IER or ERR? to query for error number. Set when an error occurs. Cleared by a serial poll, QSTB?, or power on. Not cleared by HP-IB clear, *RST, ERR?, or IER commands.
B1	2	**STOP.** Sweep stopped; set by completion of a single sweep or by and command that stops a single sweep. Cleared by a serial poll, QSTB?, or starting a sweep. Not cleared by the HP-IB clear command, *RST command, or a single sweep reset.
B2	4	**START.** Sweep started. Set when a dingle or continuous sweep starts. Cleared by serial poll, QSTB?, completion of a single sweep, or any command that stops a sweep.
B3	8	**FAIL.** Hardware failure. Set by Self Test failure, Calibration failure, External Reference Unlock, Oscillator Unlocked, or Memory Lost conditions. Cleared by power-on, serial poll, and QSTB?. Not cleared by HP-IB clear or *RST.
B4	16	**Bit 4.** Always zero.
B5	32	**SWEEP.** Set when a sweep is in progress, clear when a sweep is not in progress. Cannot be configured to cause SRQ.
B6	64	**Require Service.** Set when the HP 3325B requires service (sent an SRQ). Its main function is to identify the instrument as having requested service when it is polled by the controller. It is set by the occurrence of an event which sets the ERR, STOP, START, or FAIL bits (if they are not masked; see the MS command and table 2-34). Cleared by a serial poll or QSTB? command, an HP-IB clear command, a *RST (reset) command, when the HP 3325B is preset (front panel), or when power is cycled. NOTE: this status bit is not set if one of the bits which sets it is set but masked, and is then unmasked. Recommend you poll after changing the mask.
B7	128	**BUSY.** Set while a command is being executed, clear when instrument is not busy. Cannot be configured to enable SRQ.

Remote Operation via RS-232 Interface

Description of the RS-232 Interface

The RS-232 interface provides a serial data communications link between the HP 3325B and controllers such as desktop computers.

Note	The RS-232C interface can be used when it is not possible or feasible to use the HP-IB. Never try to use both the RS-232 interface and HP-IB at the same time.

Serial data communication differs from the HP-IB in that serial data is transmitted one bit at a time while the HP-IB moves a byte (eight bits) at a time. The serial data format is shown in figure 2-2.

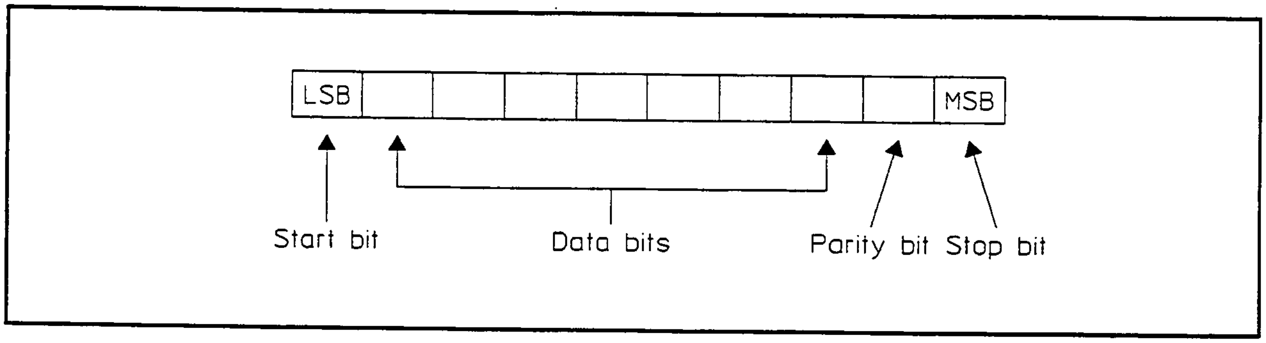


Figure 2-2. Serial Word Conifiguration

The HP 3325B RS-232 interface implements a subset of the signals defined in ANSI/EIA-232-D-1986 and CCITT V.24. The connector is a standard 25-pin female connector configured as Data Terminal Equipment (DTE). The HP 3325B sends and receives ASCII characters using an asynchronous format.

Table 2-4. RS-232 Connector Pin Assignments

Pin No.	Signal Name and Description
1	**Shield:** Connected to the HP 3325B chassis.
2	**BA or TXD (transmit data):** Bit-serial data transmitted from the HP 3325B.
3	**BB or RXD (receive data):** Bit-serial data received by the HP 3325B.
4	**CA or RTS (request to send):** An output from the HP 3325B that is usually +10V. If **hardware handshaking** is enabled, this signal changes to −10V when the HP 3325B buffer has room for less than 128 characters.
7	**AB or Signal Ground:** The reference potential for other signals. Note: *to prevent ground loops, the HP 3325B RS-232 interface circuits are isolated from earth ground and from signal ground.*
20	**CD or DTR (data terminal ready):** An output from the HP 3325B that is usually +10V. If **hardware handshaking** is enabled, this signal changes to −10V when the HP 3325B buffer has room for less than 128 characters.
	No other pins are connected.

The Cable

A standard printer cable should be used to connect the HP 3325B to another DTE device such as a computer or terminal. The printer cable switches the receive and send connections, as is necessary when a DTE device is connected to another DTE device. Use an HP 13242G to connect the HP 3325B to a controller with a 25-pin connector. Use an HP 24542G to connect to a 9-pin male connector as may be found on a serial interface in a desktop computer. Use an HP 92221P to connect to a 9-pin female connector as may be found on HP Series 9000/300 computers.

A standard modem cable should be used to connect the HP 3325B to a modem (HP 13242N).

Setting The Switches

Seven switches on the RS-232C rear panel determine the interface's baud rate, active handshake, and parity. All switches are set to the up position at the factory. New settings are recognized immediately displayed on the front panel when a switch setting is changed. The switch settings are defined in the following pages.

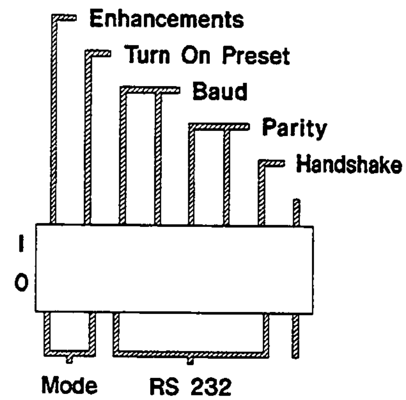


Figure 2-3. Rear-panel RS-232 switches

Mode Settings

Switches 1 and 2 select the enhancements/compatibility setting and the power-on state of the HP 3325B. These two switches are not directly tied to remote operation of the HP 3325B. They are explained here, in the remote control chapter, for the sake of completeness. They are explained again in Chapter 3, General Information.

Enhancements – Switch 1 determines the enhancement setting. Enhancements refers to capabilities that are improved on or added to those of the HP 3325A. When the enhancement mode is off, the HP 3325B is in the compatible mode. The enhancements mode may also be controlled with the ENH command as described later in this chapter.

Turn-On Preset – Switch 2 determines the turn-on settings. The choice is between the instrument preset state or the state of the instrument when it was last turned off.

Table 2-5. Mode Settings: switches 1 and 2

	Up	Down
Switch 1 – Enhancements	on	off
Switch 2 – Turn-on state	Preset	Turn-off state*

** Requires that enhancements be on*

Baud Rate

Four different baud rates are available. These are selected by changing rear panel switches numbers three and four as shown in table 2-6. When a switch is changed the new baud rate is displayed on the front panel.

Table 2-6. Baud Rate Selection: switches 3 and 4

Baud Rate	Switch 3	Switch 4
300	up	up
1200	up	down
2400	down	up
4800	down	down

Word Length and Parity

Word length and parity are selected by setting switches five and six as shown in table 2-7.

Table 2-7. Switch settings for word length and parity: switches 5 and 6

Description	Switch 5	Switch 6
7 data bits, 1 parity bit, even parity	up	up
7 data bits, 1 parity bit, odd parity	up	down
8 data bits, no parity	down	up
7 data bits, 1 parity bit, parity bit always 0 (zero)	down	down

Handshake Selection

Handshaking, or receive pacing, is performed by the HP 3325B to prevent its character buffer from overflowing. Data is lost if it is sent to the HP 3325B when its data buffer is full. The data buffer can hold 256 characters. The handshaking may be accomplished with one of two different methods, selected with switch 7: *software handshake* or the *hardware handshake*.

When *software handshaking* is selected, the HP 3325B sends the Xoff character (decimal 19 or DC3) when there is room for less than 128 characters in its buffer. After sending Xoff the HP 3325B processes characters until there is room for 256 characters, when it sends the Xon character (decimal 17 or DC1) to indicate that it is ready for more characters.

The *hardware handshake* performs the same function using hardware connections to signal its readiness for data. Both the RTS (request to send) and DTR (data terminal ready) lines become false (−10V) when there is room for less than 128 characters in the character buffer. This handshake is not recommended when the HP 3325B is connected to a modem since dropping the DTR line may cause the modem to disconnect.

The HP 3325B uses receive handshaking, only. It does not respond when it receives the Xoff character and no hardware connection is made which would signal it to stop sending data. All data sequences sent by the HP 3325B are short enough that transmit pacing should not be necessary.

Table 2-8. Setting the Handshake: switch 7

Handshake description	Switch 7
Software (Xon/Xoff)	up
Hardware (DTR/RTS)	down

Remote and Local Functions

The first character of a remote command puts the HP 3325B in *Remote Mode* which causes the Remote LED to illuminate. The Talk and Listen LEDs are not used when using the RS-232 interface for remote control. When the HP 3325B receives the "LCL" command or the [Local] front-panel key is pressed, the HP 3325B returns to front-panel control.

Other remote-control commands that are useful for RS-232 operation are ECHO, RMT, *RST, and QSTB. These are described in more detail later in the chapter.

Note The RS-232 interface does not alert the controlling computer when the instrument issues a service request (SRQ), as the HP-IB does. We recommend checking the status byte periodically with the QSTB? command when the RS-232 interface is used for remote control.

HP 3325B Remote Operation Command Set

The commands for operating the HP 3325B with a computer controller are listed here. Some of these commands correspond to front-panel keystrokes; the rest are remote-only commands. Remote commands corresponding to front panel keys are described in Chapter 1.

The HP-IB Remote status light, located in the HP-IB Status block on the left side of the front panel, indicates whether the instrument is currently operating under *local* (front panel control) or *remote* control. Remote operation is accomplished only via commands transmitted through one of the two interface connectors located on the rear panel.

Note The Remote indicator on the HP 3325B can be used for a quick operational check of the remote interface. If you are using the HP-IB interface, refer to the controller operating manual for a description of the HP-IB Remote message. If you are using the RS-232 interface, send the RMT command. When this message is sent to the HP 3325B, the Remote indicator should illuminate. If this does not occur, check the cabling, the HP 3325B HP-IB address and the syntax of the controller statement (for HP-IB), or the baud rate, word length and parity settings (for RS-232).

Changing from local control to remote control does not alter the current operating state. Changing from local to remote control may be accomplished by issuing a remote command such as REMOTE (HP-IB) or RMT (RS-232).

Changing the HP 3325B from remote control to local control causes the HP 3325B to return to front panel control without changing the operating state. This may be accomplished by either pressing the [Local] key (if local lockout is not in effect), or by issuing a command remote command such as LOCAL (an HP-IB bus message) or LCL (an RS-232 command).

Command Syntax

The following conventions apply to the HP 3325B HP-IB commands:

- The HP 3325B accepts data in 7-bit ASCII code and ignores the 8th (parity) bit.
- All spaces and lower case alphabetic characters are ignored by the HP 3325B; they may be used to improve program readability.
- Under HP-IB control, two data transfer modes are available. Refer to the MD command for more detail. An asterisk or line feed is required to terminate a command string in data transfer mode 2.
- A semicolon can be used to separate commands (recommended but not required).
- Range values may be in integer, real, or exponential form. For positive values, only the first eleven digits of the mantissa are used. For negative values, only the first ten digits of the mantissa are used. Leading zeros before the decimal point are ignored.

The HP 3325B uses the following forms for remote commands:

Command Form	Example	Example Description
<mnemonic>	AC	Amplitude Calibrate
<mnemonic> <data>	FU2	Square wave function select
<mnemonic> <rangedata> <suffix>	AM1.2VO	Amplitude of 1.2 V_{pp}
<mnemonic>?	FR?	Interrogate frequency
<mnemonic>	IFR	Interrogate frequency

where:

- **<mnemonic>** is the HP-IB mnemonic
- **<suffix>** is an alphabetic code for units, function, or mode
- **<data>** is a numeric code for a function or mode
- **<range data>** is the value for an entry parameter
- ? is used to interrogate the HP 3325B.

A program string for the HP 3325B may contain multiple HP-IB commands such as

"FU2 FR 1 MH AM 2 VO FR?"

Interrogating The HP 3325B For Setup Parameters

The value of a setup parameter is read over the HP-IB by sending the parameter HP-IB mnemonic followed by a question mark (?). For example, sending the mnemonic FR? sets up the HP 3325B to respond with the frequency value. HP-IB data is transmitted when the HP 3325B is addressed to talk. RS-232 data is transmitted 100 ms after the interrogation. Each interrogation response ends with the carriage return (ASCII 13) and line feed (ASCII 10) characters. Each interrogation may include command mnemonic and suffix, depending on the setting of the HEAD command.

Remote Operation via RS-232 Interface

Setup parameters include frequency, amplitude, offset, phase, sweep start frequency, sweep stop frequency, sweep marker frequency, sweep time, modulation source frequency, and modulation source amplitude.The current value for a setup parameter is displayed on the HP 3325B front panel if the corresponding HP-IB mnemonic is sent without data and a suffix. For example, sending the mnemonic AM displays the amplitude value but does not change the amplitude value.

The units for the displayed value of a setup parameter change to new units if the corresponding command mnemonic and new suffix are sent without data. For example, sending the mnemonic AM DB displays the current amplitude value in dBm. Sending the AM DB command does not change the amplitude value.

Note If the display is disabled with the DSP0 command, the requested value is not displayed.

Command Reference

Syntax Drawing Rules

All characters in circles or ovals are terminal symbols and must be sent exactly as shown. Items in boxes are *non-terminal* symbols; descriptions of these items are given following the syntax drawings. Spaces and lower case letters are ignored; they can be inserted to improve readability.

The *Response Format* tables specify what is returned by the instrument in response to a

query. All responses are terminated with <carriage return> and <line feed> with the HP-IB EOI (bus management line) active. The "#" symbol represents one digit.

Definitions

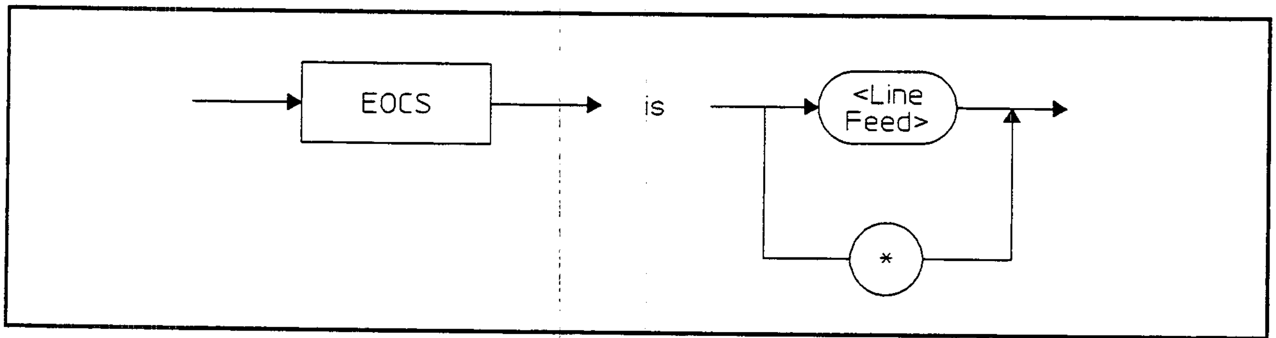


Figure 2-4. Definition of EOCS

The End-Of-Command-String character is used in Data Transfer Mode 2 (see the MD command). In data transfer mode 2, device-dependent commands are accepted and stored in an internal buffer and are not processed until the End-Of-Command-String (EOCS) character is received or the buffer is filled (48 bytes).

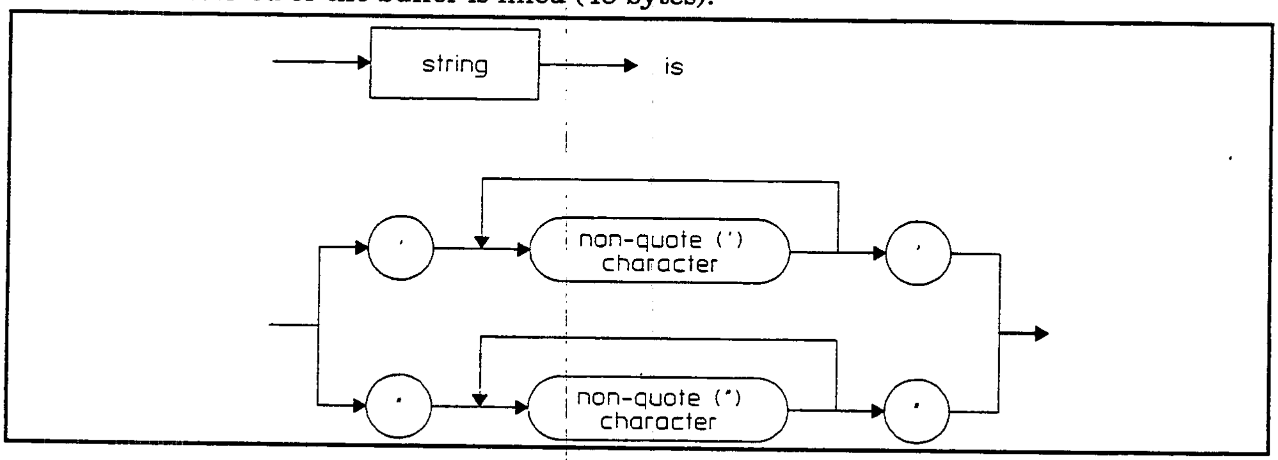


Figure 2-5. Definition of "String"

Strings can not include the End-Of-Command-String characters (* or <line feed>).

AC; Amplitude Calibration Command

The AC command performs an amplitude calibration. If calibration is not successful, the FAIL bit of the status register is set.

Command Availability

	AC
HP 3325B	Yes
HP 3325A	Yes

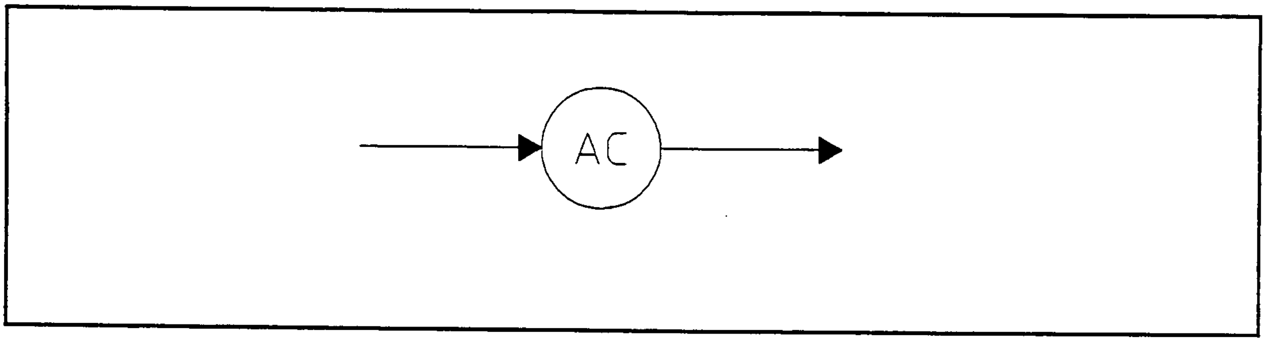


Figure 2-6. AC Syntax Diagram

AM; Amplitude Command

The AM command sets the amplitude of the main signal. Sending AM with no value or units displays the current amplitude. Sending AM and units without any value causes the current amplitude to be displayed in the new units. Issuing IAM or AM? causes the instrument to output its current amplitude. See MOAM to set the amplitude of the modulation source.

Instrument Preset value: 1.0 mV_{pp}

Command Availability

	AM	IAM	AM?	DV
HP 3325B	Yes	Yes	Yes	Yes
HP 3325A	Yes	Yes	No	No

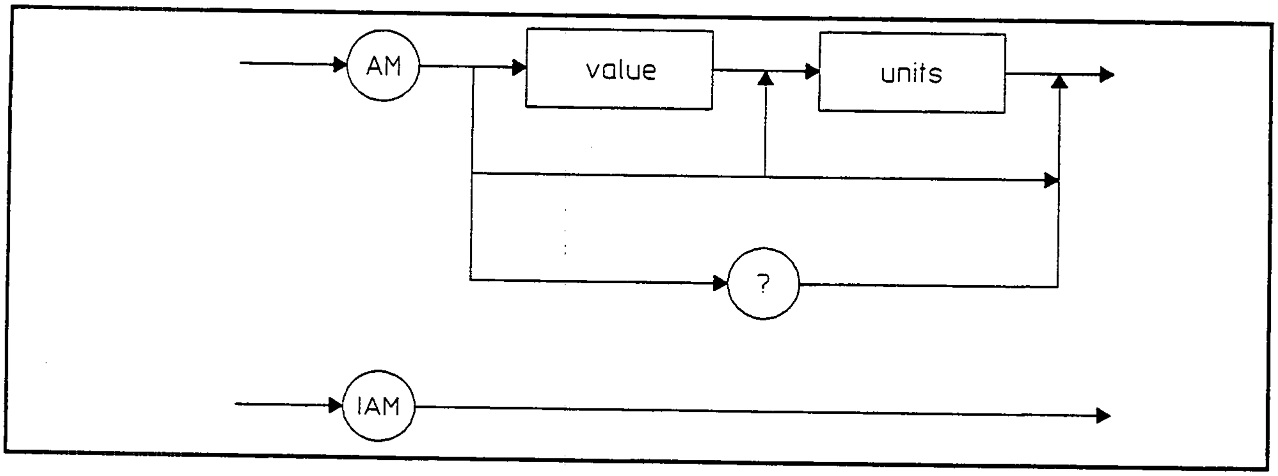


Figure 2-7. AM Syntax Diagram

Table 2-9. AM "value" Restrictions Given "units"

Value range	Units	Description	High Voltage"
0.001 →10.0 0.004 → 40.0	VO	V_{pp} On	Off
1.0 → 10000.0 4.0 → 40000.0	MV	mV_{pp} On	Off
0.000354 →3.53 0.00142 → 14.1	VR	V_{rms} On	Off
0.354 → 3530.0 1.42 → 14100.0	MR	mV_{rms} On	Off
−56.02 → 23.98 Illegal	DB	dBm	Off
−69.01 →10.97 −56.97 → 23.01	DV	dBV_{rms} On	Off

Table 2-10. AM? and IAM Response Format

Current Units	HEAD-on response	HEAD-off response
VO or MV	AM#####.######VO	#####.######
VR or MR	AM#####.######VR	#####.######
DB or DV	AM−#######.###DB	−#######.###
DB or DV (special)	AM−#######.###DV	−#######.###

AP; Assign Zero Phase Command

The AP command assigns the current phase value to zero; subsequent changes in phase are referenced to that point.

Command Availability

	AP
HP 3325B	Yes
HP 3325A	Yes

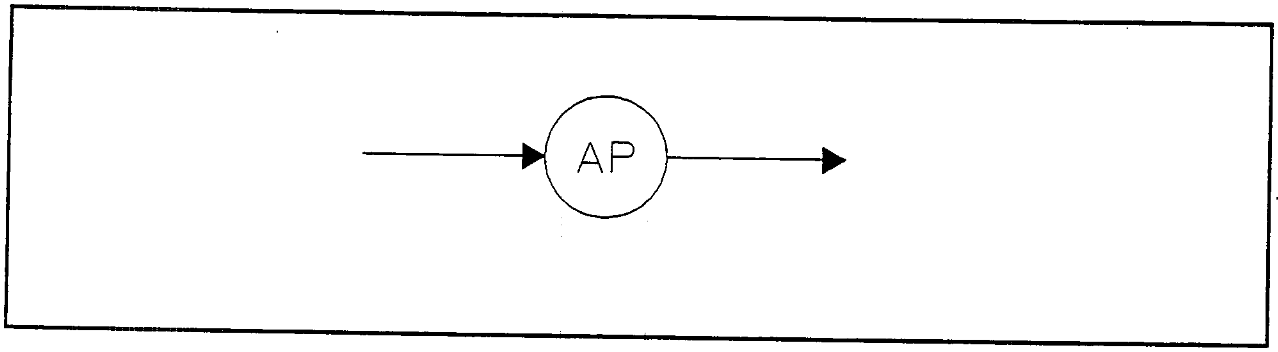


Figure 2-8. AP Syntax Diagram

CALM; Calibration Mode Command

The CALM command allows all functions to be calibrated once. In this mode, function changes are faster.

Instrument Power-on value: 0

Instrument Preset, HP-IB clear value: not changed.

Command Availability

	CALM
HP 3325B	Yes
HP 3325A	No

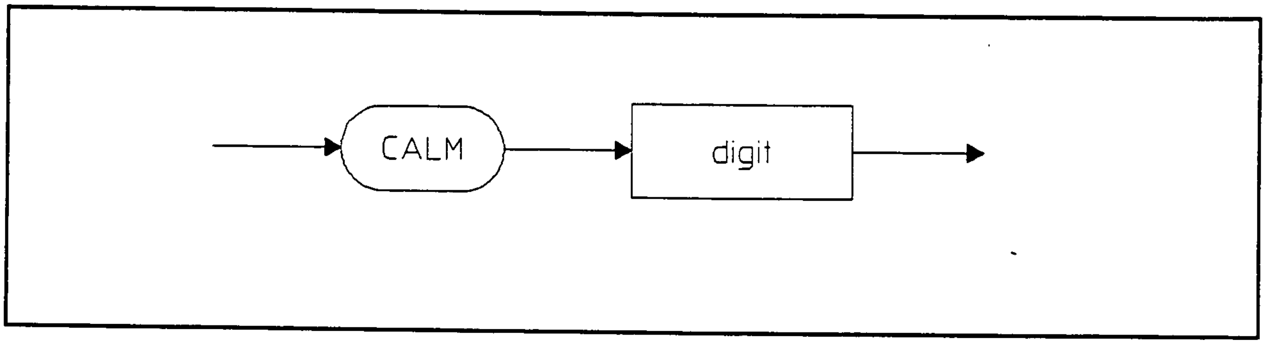


Figure 2-9. CALM Syntax Diagram

Digit	Meaning
0	Perform an Amplitude Calibration whenever the waveform function is changed.
1	Perform an Amplitude Calibration on all functions immediately, do not re-calibrate when waveform function is changed.

DCLR; Discrete Sweep Table Clear Command

The DCLR command clears all previously stored discrete sweep vectors.

Command Availability

	DCLR
HP 3325B	Yes
HP 3325A	No

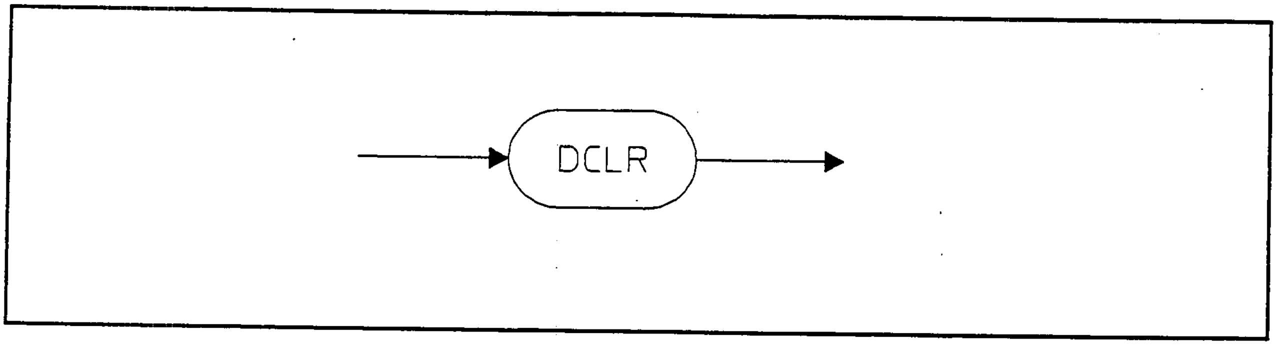


Figure 2-10. DCLR Syntax Diagram

DISP; Display On/Off Command

The DISP command and allows the display to be turned off. "DISP OFF" is displayed until the display is turned back on.

Instrument Power-on value: On

Instrument Preset, HP-IB clear value: not changed.

Command Availability

	DISP
HP 3325B	Yes
HP 3325A	No

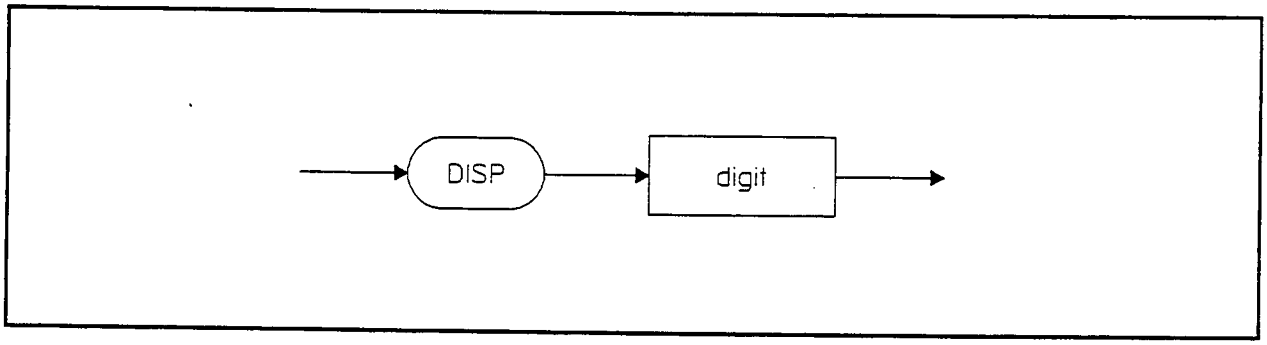


Figure 2-11. DISP Syntax Diagram

digit	Meaning
0	Display off.
1	Display on.

DRCL and DSTO; Discrete Sweep Store and Recall Commands

DRCL recalls the discrete sweep vector number specified by the two digits. Start frequency, stop frequency, marker frequency, and sweep time values are overwritten with the recalled values.

DSTO saves the current start frequency, stop frequency, marker frequency, and sweep time values in the discrete sweep vector number specified by the two digits.

Command Availability

	DRCL	DSTO
HP 3325B	Yes	Yes
HP 3325A	No	No

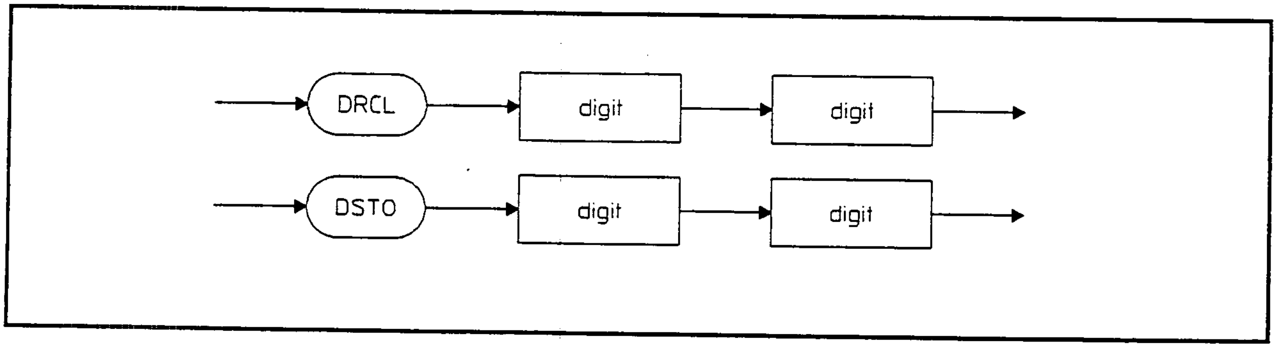


Figure 2-12. DRCL and DSTO Syntax Diagrams

DSP; Display String Command

The DSP command allows a message to be put in the instrument's display. Some alphabetic characters may be hard to distinguish when displayed in the 7-segment numeric displays.

Command Availability

	DSP
HP 3325B	Yes
HP 3325A	No

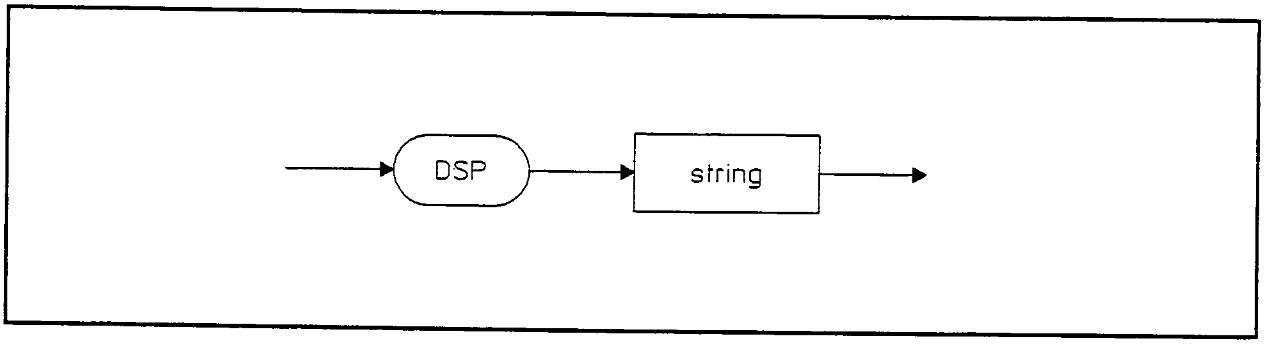


Figure 2-13. DSP Syntax Diagram

ECHO; RS-232 Echo-Control Command

The ECHO command enables echoing of in-bound RS-232 characters. This is useful when using a full-duplex terminal to program the HP 3325B. The carriage return character is echoed as <carriage return> and <line feed>.

Instrument Preset, HP-IB clear value: not changed

Instrument Power-on value: 0

Command Availability

	ECHO
HP 3325B	Yes
HP 3325A	No

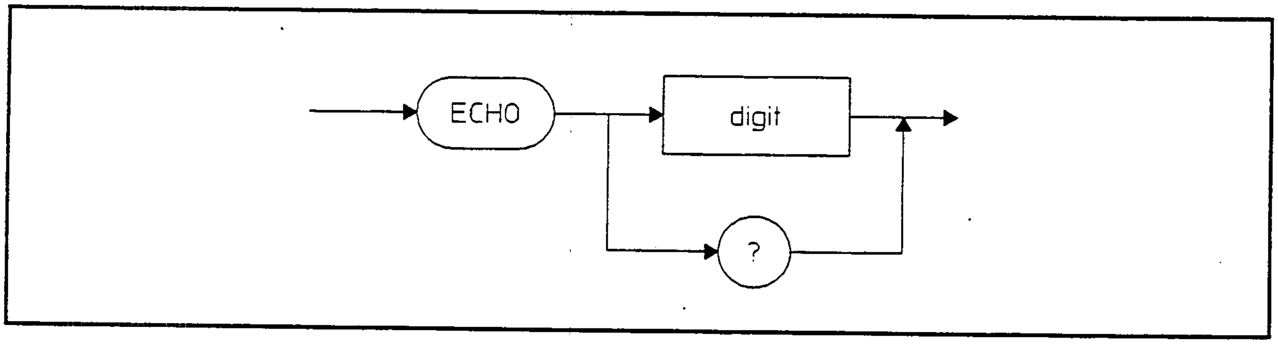


Figure 2-14. ECHO Syntax Diagram

digit	Meaning
0	Do not echo characters.
1	Echo characters.

Table 2-11. ECHO? Response Format

HEAD-on response	HEAD-off response
ECHO#	#

ENH; Enhancements Control Command

The ENH command selects between the *enhancements* mode and the *compatibility* mode. In the *enhancements* mode, new features of the HP 3325B are enabled. In the *compatibility* mode, some new features are disabled, but only those which may cause compatibility problems. Refer to Chapter 3, General Information, for a description of the differences in the two settings.

Instrument Preset, HP-IB clear value: not changed

Instrument Power-on value: rear-panel switch setting

Command Availability

	ENH
HP 3325B	Yes
HP 3325A	No

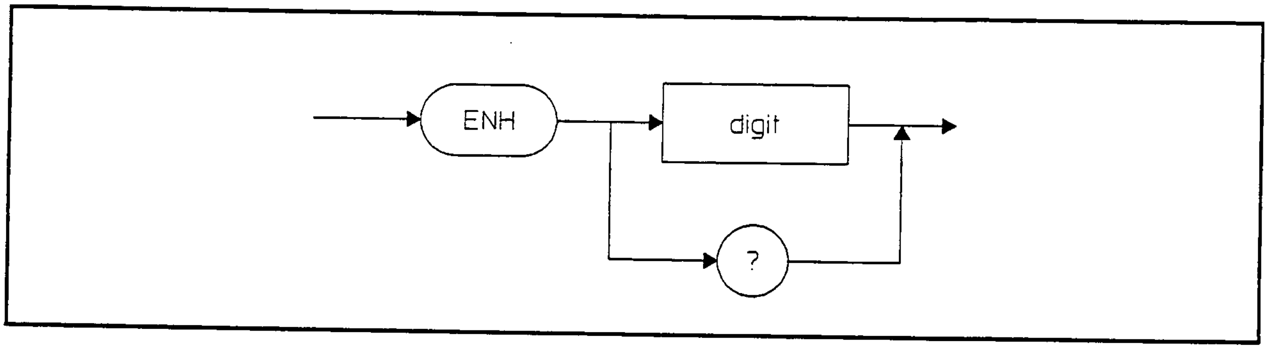


Figure 2-15. ENH Syntax Diagram

digit	Meaning
0	Select the compatibility mode.
1	Select the Enhancements mode.

Table 2-12. ENH? Response Format

HEAD-on response	HEAD-off response
ENH#	#

ERR? and IER; Error Query

These commands query the instrument for the most recent error code. The IER query returns a one-digit code. The ERR? query returns a three-digit code, the first digit of which is the same as the IER query; the other two digits provide more detail as described in table 2-51 later in this chapter. If no error occurred, 0 is returned. Issuing either command clears both error codes to 0.

Instrument Power-on: Clears any errors.

Instrument Preset, HP-IB Clear: Clears any errors.

Command Availability

	ERR?	IER
HP 3325B	Yes	Yes
HP 3325A	No	Yes

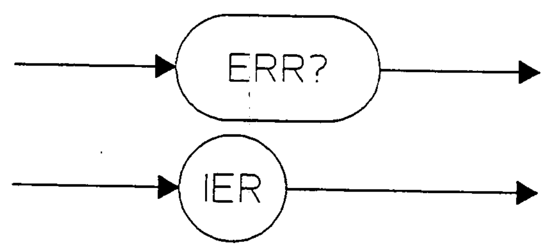


Figure 2-16. ERR Syntax Diagram

Table 2-13. ERR? and IER Response Formats

Command	HEAD-on response	HEAD-off response
ERR?	ERR###	###
IER	ER#	#

ESTB; Service Request Enable Command

The ESTB command is used to set the status byte mask. Four lists in the status byte are capable of causing a service request (SRQ). When they are enabled (unmasked). They may be enabled or masked in any combination as defined in the table 2-34. The MS Command accomplishes the same thing using alpha characters instead of decimal characters.

In the syntax diagram of Figure 2-17, **value** is a decimal number whose binary (base 2) equivalent represents the bits of the Status Register. The range of **value** is 0 thru 15.

Instrument Power-on value: 0 (all masked)

Instrument Preset, HP-IB-clear value: not changed

Command Availability

	ESTB	ESTB?
HP 3325B	Yes	Yes
HP 3325A	No	No

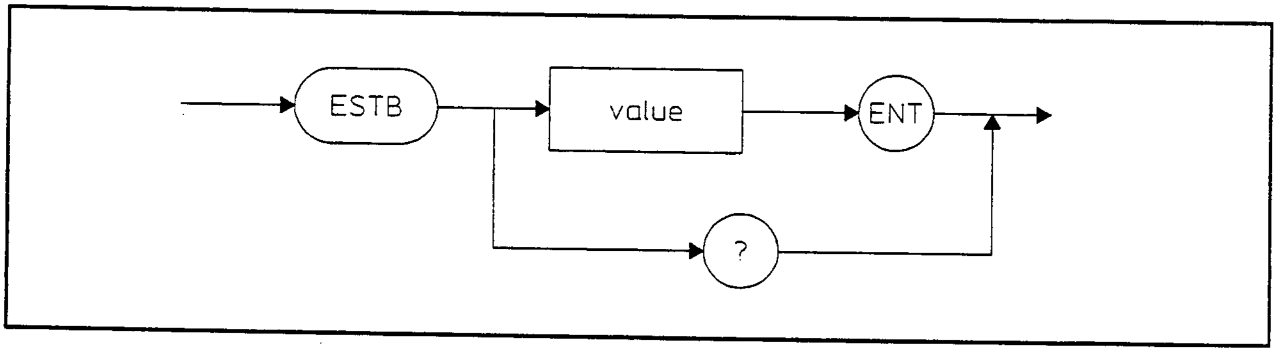


Figure 2-17. ESTB Syntax Diagram

Table 2-14. Status-Register Bits that can be enabled to cause SRQ

Bit	Value	Name	Description
0	1	ERR	Program or keyboard entry error.
1	2	STOP	Sweep stopped.
2	4	START	Sweep started.
3	8	FAIL	Hardware failure.

Table 2-15. ESTB? Response Format

HEAD-on response	HEAD-off response
ESTB###ENT	###

EXTR?; External Reference Locked Query

The EXTR? query returns 1 if the reference oscillator is locked to an external input, 0 if not.

Command Availability

	EXTR
HP 3325B	Yes
HP 3325A	No

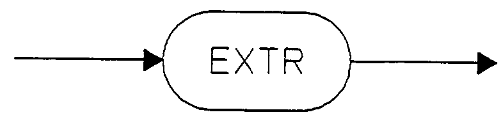


Figure 2-18. EXTR? Syntax Diagram

Table 2-16. EXTR? Response Format

HEAD-on response	HEAD-off response
EXTR#	#

FR; Frequency Command

The FR command sets the frequency. Sending FR with no value or units displays the current frequency. IFR and FR? cause the instrument to output its current frequency. See MOFR to set the frequency of the modulation source.

Instrument Preset value: 1000.0 Hz

Command Availability:

	FR	IFR	FR?
HP 3325B	Yes	Yes	Yes
HP 3325A	Yes	Yes	No

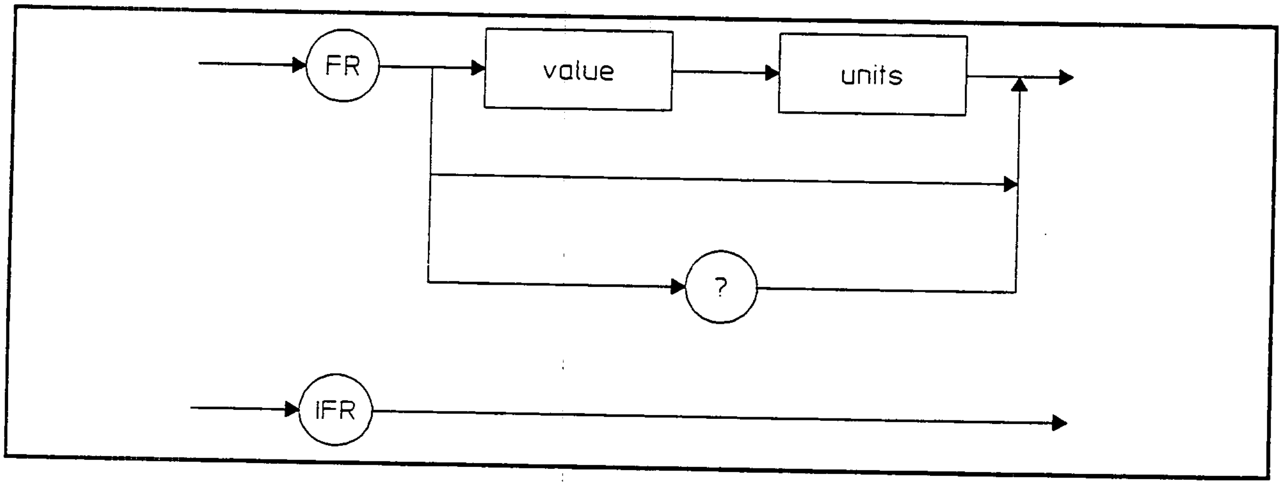


Figure 2-19. FR Syntax Diagram

Table 2-17. FR "value" Restrictions Given "units"

Units	Description	Range Restrictions for "value" (sine)
HZ	Hertz	0.0 → 60999999.999
KH	kHz	0.0 → 60999.999999
MH	MHz	0.0 → 60.999999

Table 2-18. FR? and IFR Response Format

μHz programmed	HEAD-on response	HEAD-off response
No	FR########.###HZ	########.###
Yes	FR#####.######HZ	#####.######

FU; Waveform Function Command

The FU command selects the waveform function for the main signal output.

Instrument Preset value: 1

Command Availability

	FU	IFU	FU?
HP 3325B	Yes	Yes	Yes
HP 3325A	Yes	Yes	No

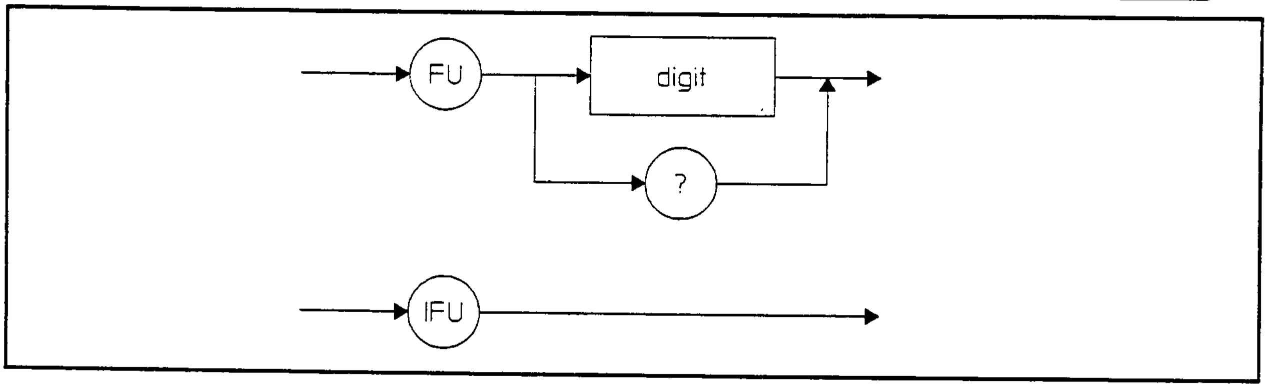


Figure 2-20. FU Syntax Diagram

Table 2-19. Waveform Selections for "digit"

digit	Waveform
0	Selects DC only.
1	Selects Sine wave
2	Selects Square wave.
3	Selects Triangle wave.
4	Selects Positive ramp.
5	Selects Negative ramp.

Table 2-20. FU? and IFU Response Format

HEAD-on response	HEAD-off response
FU#	#

HEAD; Response Header Control Command

The HEAD command enables or disables the alpha header (and units suffix) for query responses. With HEAD on, the response can be used to re-program the item. With HEAD off, only the numerics are sent which can make it easier to read into a numeric variable in a program.

Instrument Power-on value: 1.

Instrument Preset, HP-IB clear value: not changed.

Command Availability:

	HEAD
HP 3325B	Yes
HP 3325A	No

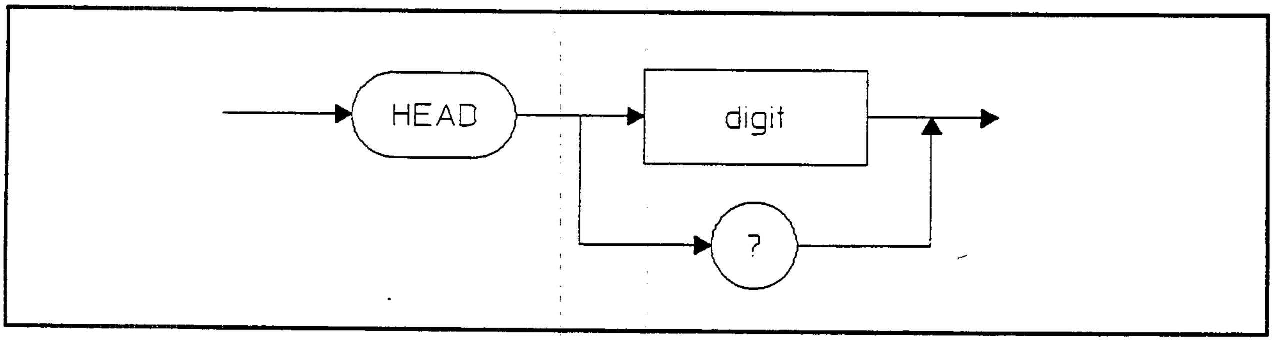


Figure 2-21. HEAD Syntax Diagram

"Digit"	Mode
0	Selects header OFF mode.
1	Selects header ON mode.

Table 2-21. HEAD? Response Format

HEAD-on response	HEAD-off response
HEAD#	#

HV; High Voltage Output Command

The HV command controls the High Voltage amplifier option for the main signal output.

Instrument Preset value: 1.

Command Availability

	HV	IHV	HV?
HP 3325B	Yes	Yes	Yes
HP 3325A	Yes	Yes	No

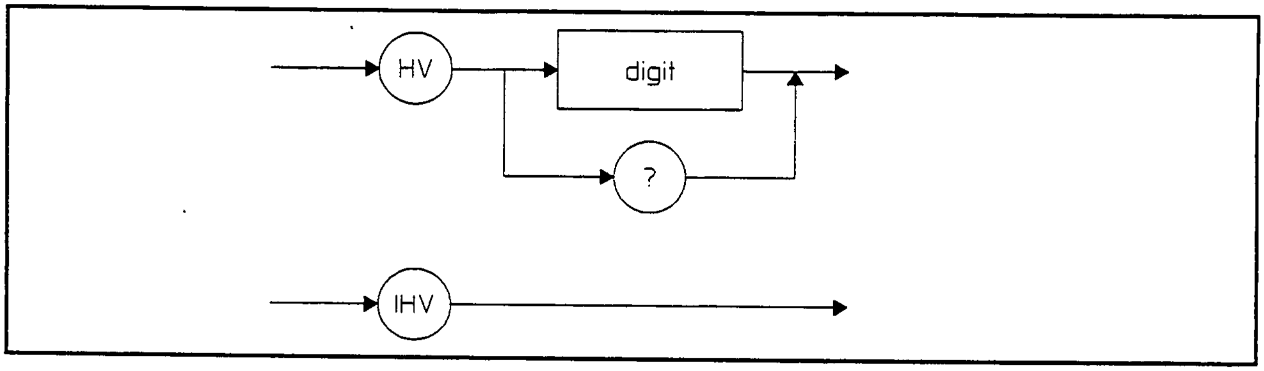


Figure 2-22. HV Syntax Diagram

digit	Meaning
0	Disable the high voltage amplifier.
1	Enable the high voltage amplifier.

Table 2-22. HV? and IHV Response Format

Option installed	HEAD-on response	HEAD-off response
Yes	HV#	#
No	RF#	#

ID?, *IDN?; Identification Query

This query returns the instrument manufacturer, model number, serial number, and firmware revision code.

Note — In data transfer mode 2, an asterisk terminates a command string. Therefore use IDN?, without an asterisk, in data transfer mode 2.

Command Availability

	*IDN?	ID?
HP 3325B	Yes	Yes
HP 3325A	No	No

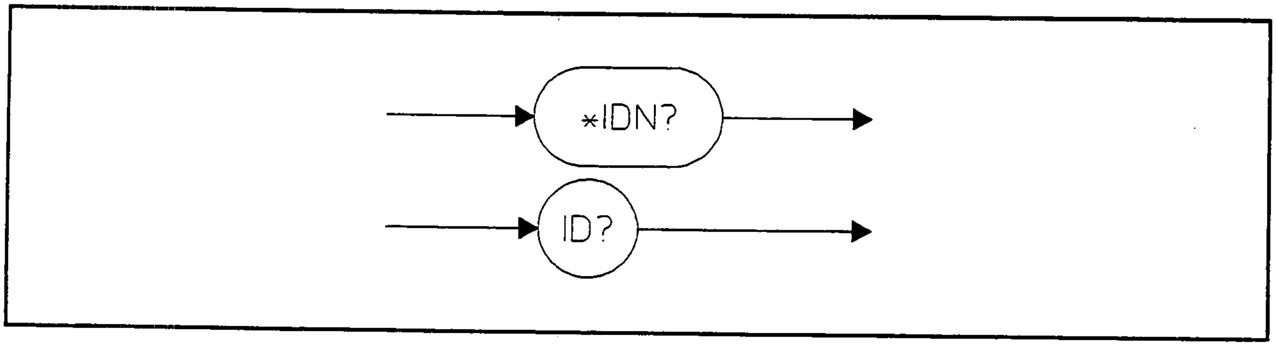


Figure 2-23. ID? and *IDN? Syntax Diagrams

Table 2-23. ID? and *IDN? Response Format

ID? response	*IDN? response
HP3325B	HEWLETT-PACKARD,3325B,2800A00000,2800

LCL; Local Command

The LCL command places the instrument in *local mode* and clears any local lockout. This command has the same effect as the HP-IB *local* bus command but can be issued when using the RS-232 interface.

Command Availability

	LCL
HP 3325B	Yes
HP 3325A	No

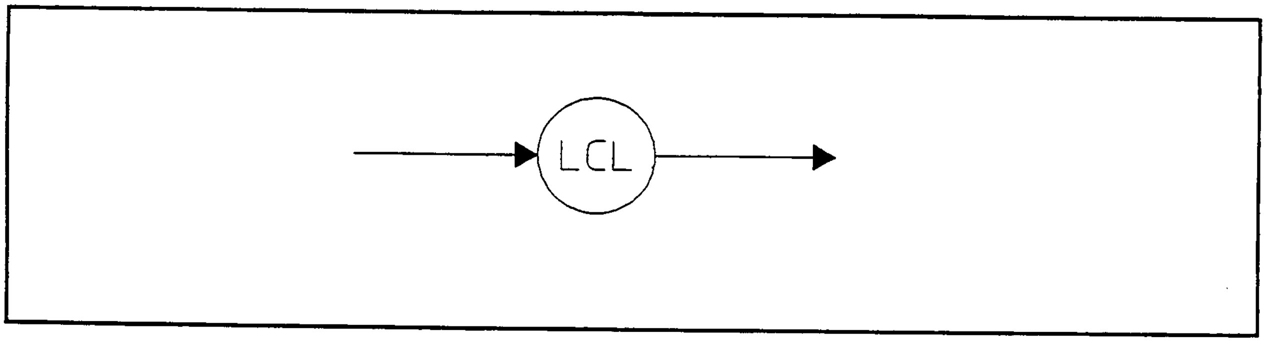


Figure 2-24. LCL Syntax Diagram

MA; Amplitude Modulation Command

The MA command enables and disables amplitude modulation of the main signal output. Amplitude modulation is only valid for sine waves.

Note	If MA is enabled and no signal is applied to the AMPTD MOD input, the main signal amplitude is one half of its programmed value since 0 Volts corresponds to 50% modulation.

Instrument Preset value: 0.

Command Availability

	MA	IMA	MA?
HP 3325B	Yes	Yes	Yes
HP 3325A	Yes	Yes	No

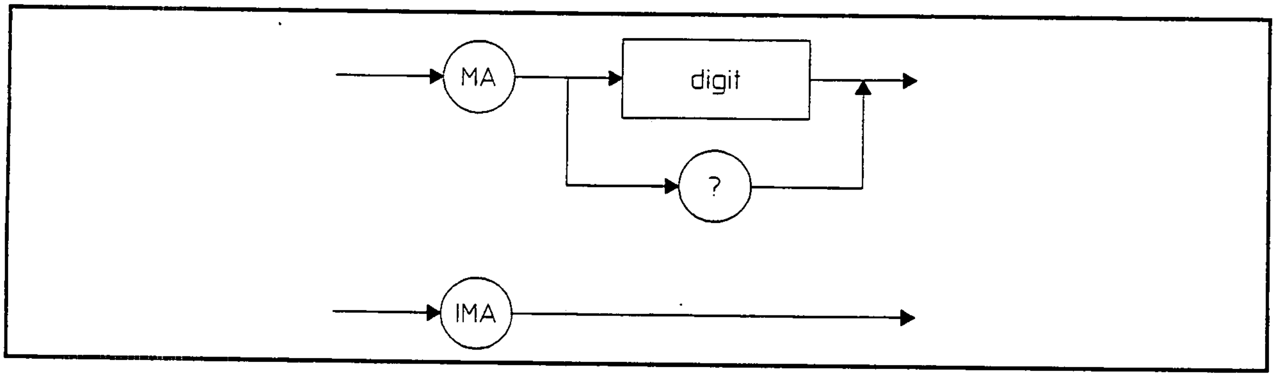


Figure 2-25. MA Syntax Diagram

"Digit	Meaning
0	Disable amplitude modulation.
1	Enable amplitude modulation.

Table 2-24. MA? and IMA Response Format

HEAD-on response	HEAD-off response
MA#	#

MD; Data Transfer Mode Command

The MD command selects the HP-IB data transfer mode. (This command has no effect when the RS-232 interface is used.) In mode 1, each device-dependent character is processed when received. No other communications are permitted on the bus until the entire HP 3325B program string has been accepted and all but the last character processed. In mode 2, device-dependent characters are accepted and stored in an internal buffer; they are not processed until the End-Of-Command-String (EOCS) character is received or the buffer is filled (48 bytes). Valid EOCS characters are the <line feed> character (ASCII decimal 10) or the asterisk (*) character (ASCII decimal 42).

Instrument Power-on, HP-IB Clear value: 1.

Instrument Preset value: not changed.

Command Availability

	MD	MD?
HP 3325B	Yes	Yes
HP 3325A	Yes	No

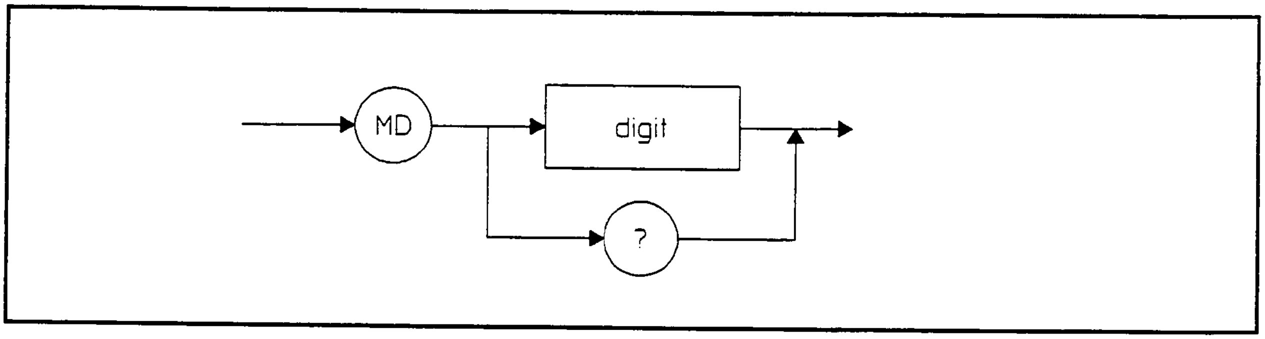


Figure 2-26. MD Syntax Diagram

Digit"	Meaning
1	Each character processed when received.
2	Characters buffered, EOCS starts processing.

Table 2-25. MD? and IMD Response Format

HEAD-on response	HEAD-off response
MD#	#

MF; Marker Frequency Command

The MF command sets the marker frequency. Sending MF with no value or units displays the current frequency. IMF and MF? cause the instrument to output its current frequency.

Instrument Preset value: 5.0 MHz

Command Availability

	MF	IMF	MF?
HP 3325B	Yes	Yes	Yes
HP 3325A	Yes	Yes	No

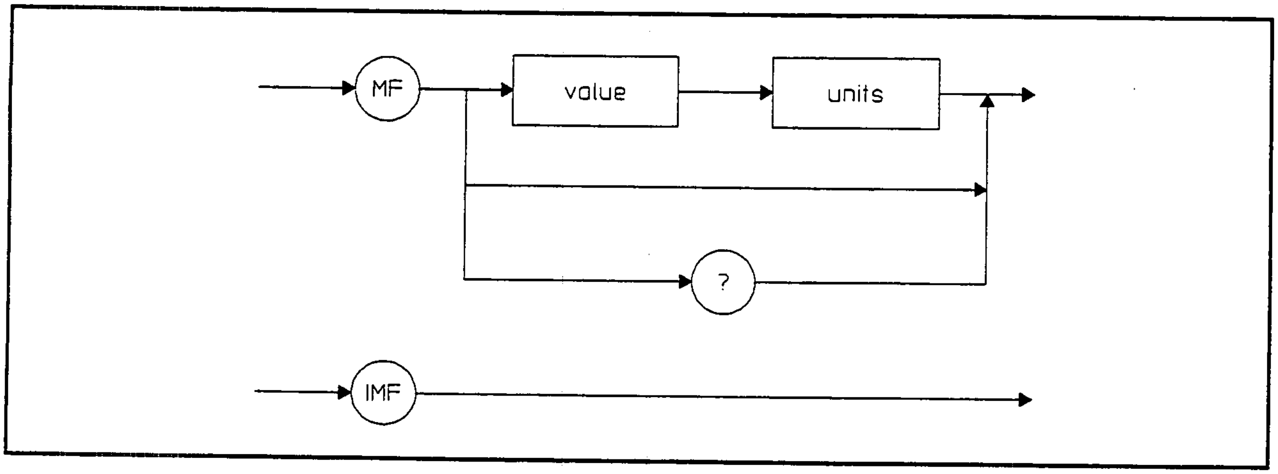


Figure 2-27. MF Syntax Diagram

Table 2-26. MF "value" Restrictions Given "units"

"Units"	Description	Range Restrictions for "value"
HZ	Hertz	0.0 → 20999999.999
KH	kilo-Hz	0.0 → 20999.999999
MH	mega-Hz	0.0 → 20.999999999

Table 2-27. MF? and IMF Response Format

μ Hz programmed	HEAD-on response	HEAD-off response
No	MF########.###HZ	########.###
Yes	MF#####.######HZ	#####.######

MOAM; Modulation Source Amplitude Command

The MOAM command sets the amplitude of the modulation signal. Sending MOAM with no value or units displays the current amplitude. Sending MOAM and units without any value displays the current amplitude in the new units. MOAM? causes the instrument to output the current amplitude.

Instrument Preset value: 0.1 Vpp

Command Availability

	MOAM	MOAM?
HP 3325B	Yes	Yes
HP 3325A	No	No

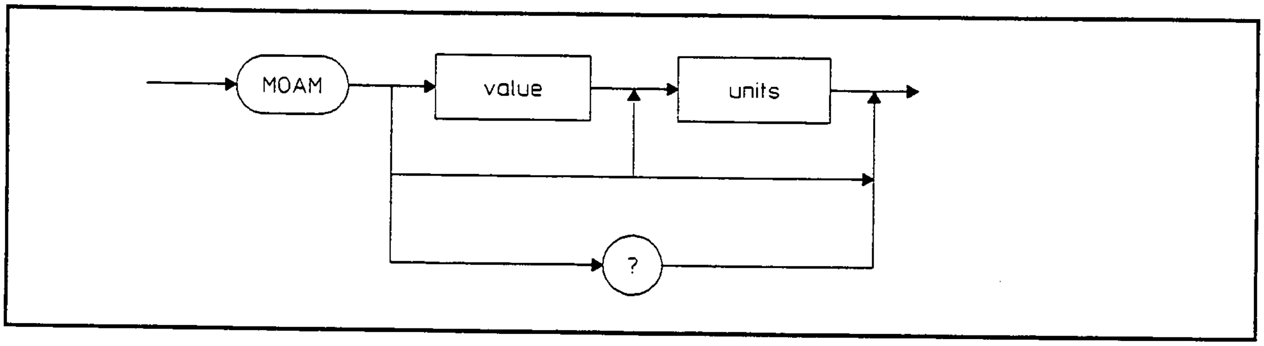


Figure 2-28. MOAM Syntax Diagram

Table 2-28. MOAM "value" Restrictions Given "units"

value range	units	Description
VO	V_{pp}	0.0 → 12.0
MV	mV_{pp}	0.0 → 12000.0
VR	V_{rms}	0.0 → 4.2
MR	mV_{rms}	0.0 → 4200.0

Table 2-29. MOAM? Response Format

Current Units	HEAD-on response	HEAD-off response
VO or MV	MOAM#####.######VO	#####.######
VR or MR	MOAM#####.######VR	#####.######

MOAR; Write Modulation Source Arbitrary Waveform Data

The MOAR command defines an arbitrary waveform for the modulation source. From 1 to 4096 waveform sample points can be programmed. A value of 0 corresponds to 0.0 volts, and +1.0 corresponds to full scale which is half the MOAM voltage (since MOAM is in peak-to-peak). Issuing this command turns the modulation source off, so it should be followed with a MOFU3 command.

When using arbitrary waveforms, the MOFR command sets the frequency at which the entire waveform block is repeated. Only certain discrete frequencies are available and these depend on the number of entries in the waveform. The HP 3325B selects a frequency as near as possible to the value entered with the MOFR command.

Command Availability

	MOAR
HP 3325B	Yes
HP 3325A	No

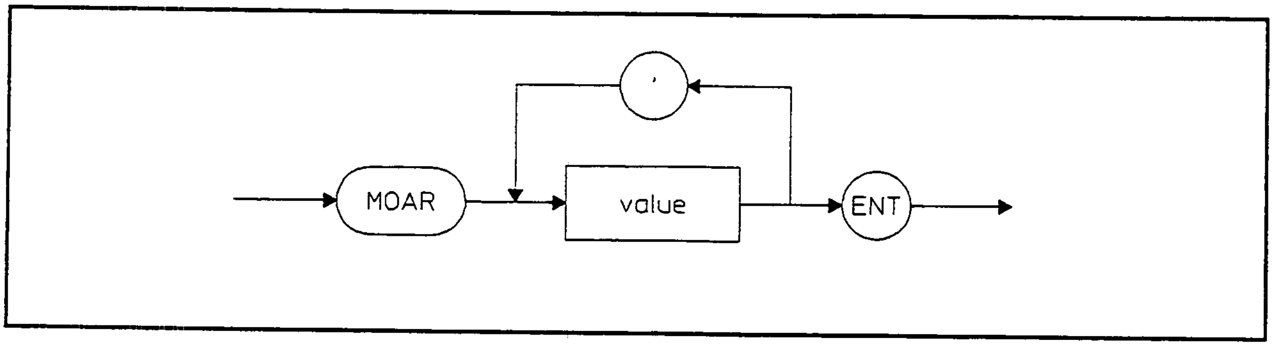
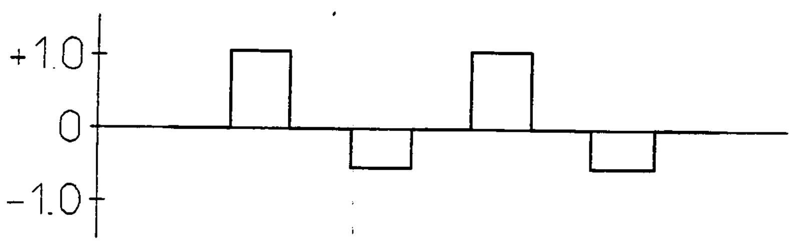


Figure 2-29. MOAR Syntax Diagram

Where *value* is a waveform sample whose value ranges from −1.0 to +1.0.

Example:

MOAR 1,0,- 0.4,0 ENT results in the following waveform:



MOFR; Modulation Source Frequency Command

The MOFR command sets the modulation source frequency. Sending MOFR with no value or units displays the current frequency. Issuing MOFR? causes the instrument to output its current frequency.

Notes	Only two digits of frequency resolution are available.
	The timebase is not locked to the main signal or an external reference input.
	Programming the frequency causes the signal to turn off momentarily.

Instrument Preset value: 1000.0 Hz

Command Availability

	MOFR	MOFR?
HP 3325B	Yes	Yes
HP 3325A	No	No

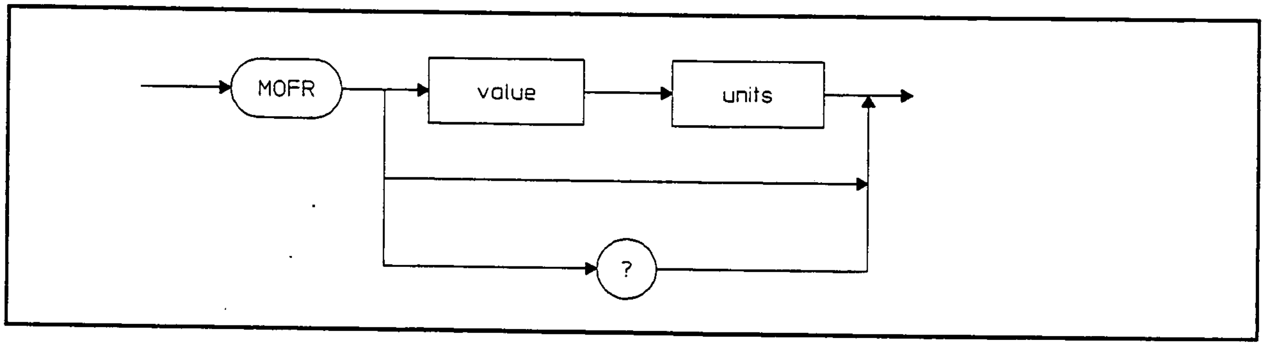


Figure 2-30. MOFR Syntax Diagram

Table 2-30. MOFR "value" Restrictions Given "units"

Value Range	Units	Description
0.0 → 10000.0	HZ	Hertz
0.0 → 10.0	KH	kilo-Hz
0.0 → 0.01	MH	mega-Hz

Table 2-31. MOFR? Response Format

HEAD-on response	HEAD-off response
MOFR########.###HZ	########.###

MOFU; Modulation Source Waveform Function Command

The MOFU command selects the waveform function for the modulation source output.

Instrument Preset value: 0.

Command Availability

	MOFR	MOFR?
HP 3325B	Yes	Yes
HP 3325A	No	No

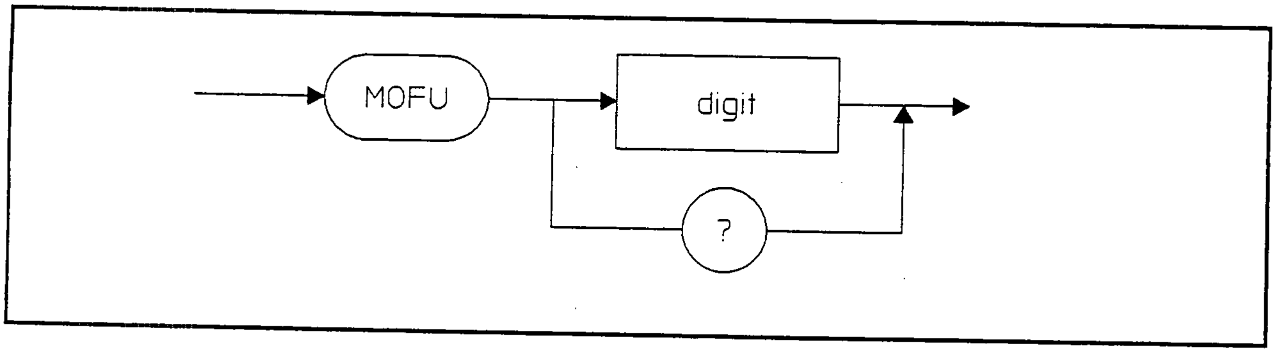


Figure 2-31. MORU Syntax Diagram

"Digit"	Waveform
0	All functions off.
1	Selects Sine wave.
2	Selects Square wave.
3	Selects Arbitrary wave.

Table 2-32. MOFU? Response Format

HEAD-on response	HEAD-off response
MOFU#	#

MP; Phase Modulation Command

The MP command enables and disables phase modulation of the main signal output.

Instrument Preset value: 0.

Command Availability

	MP	IMP	MP?
HP 3325B	Yes	Yes	Yes
HP 3325A	Yes	Yes	No

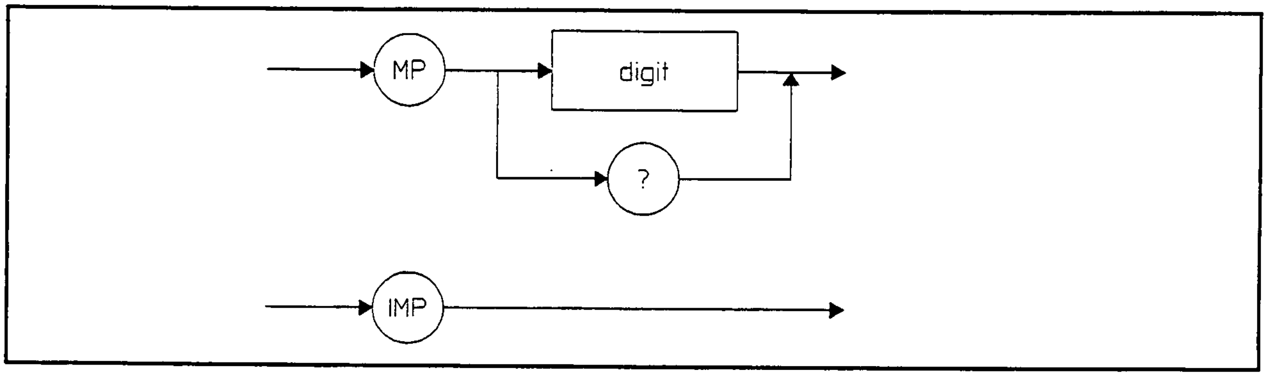


Figure 2-32. MP Syntax Diagram

"Digit"	Meaning
0	Disable phase modulation.
1	Enable phase modulation.

Table 2-33. MP? and IMP Response Format

HEAD-on response	HEAD-off response
MP#	#

MS; Status Byte Mask Command

The MS command is used to set the status byte mask. Four lists in the status byte are capable of causing a service request (SRQ) when they are enabled (unmasked). They may be enabled or masked in any combination as defined in table 2-34. The ESTB command accomplishes the same thing using decimal numbers instead of alphabetic characters.

Instrument Power-on value: @ (no bits enabled).

Instrument Preset, HP-IB Clear value: not changed.

Command Availability

	MS
HP 3325B	Yes
HP 3325A	Yes

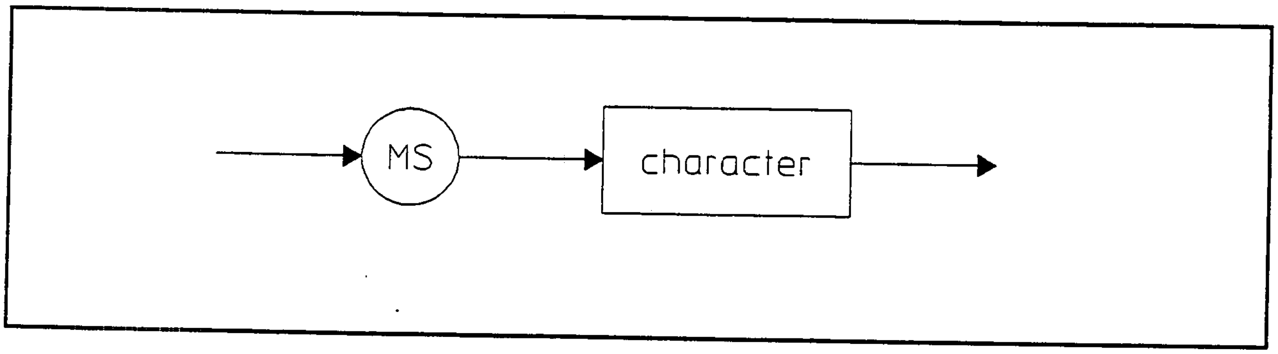


Figure 2-33. MS Syntax Diagram

Table 2-34. Status Byte Mask Characters

"character"	Status Bits: FAIL	START	STOP	ERR
@	Mask	Mask	Mask	Mask
A	Mask	Mask	Mask	ENABLE
B	Mask	Mask	ENABLE	Mask
C	Mask	Mask	ENABLE	ENABLE
D	Mask	ENABLE	Mask	Mask
E	Mask	ENABLE	Mask	ENABLE
F	Mask	ENABLE	ENABLE	Mask
G	Mask	ENABLE	ENABLE	ENABLE
H	ENABLE	Mask	Mask	Mask
I	ENABLE	Mask	Mask	ENABLE
J	ENABLE	Mask	ENABLE	Mask
K	ENABLE	Mask	ENABLE	ENABLE
L	ENABLE	ENABLE	Mask	Mask
M	ENABLE	ENABLE	Mask	ENABLE
N	ENABLE	ENABLE	ENABLE	Mask
O	ENABLE	ENABLE	ENABLE	ENABLE

OF; DC Offset Command

The OF command sets the DC offset of the main signal. Sending OF with no value or units displays the current offset. When programming DC offset with an AC function, the DC offset range is further restricted by the AM setting and the resulting attenuator range. See the discussion in Chapter 1 under the heading "AC with DC Offset."

Instrument Preset value: 0.0 V_{pp}

Command Availability

	OF	IOF	OF?
HP 3325B	Yes	Yes	Yes
HP 3325A	Yes	Yes	No

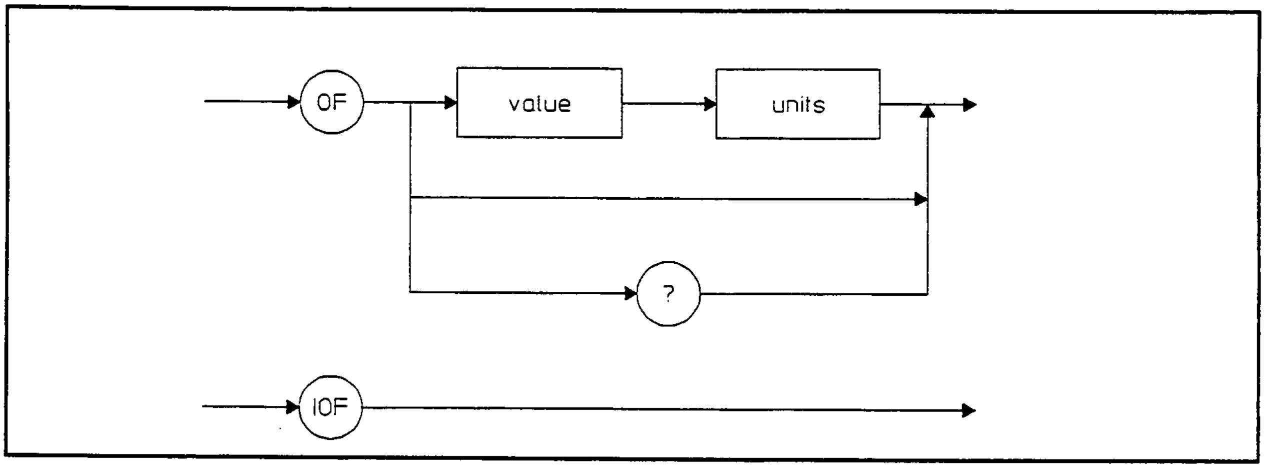


Figure 2-34. OF Syntax Diagram

Table 2-35. OF "value" Restrictions Given "units"

Units	Description	High Voltage	Value Range(DC only)
VO	Volts	Off	−5.0 → 5.0
		On	−20.0 → 20.0
MV	mVolts	Off	−5000.0 → 5000.0
		On	−20000.0 → 20000.0

Table 2-36. OF? and IOF Response Format

Current Units	HEAD-on response	HEAD-off response
VO or MV	OF#####.######VO	#####.######

OPT?; Option Query Command

The OPT? query returns a list of the options installed in the instrument.

Command Availability

	OPT?
HP 3325B	Yes
HP 3325A	No

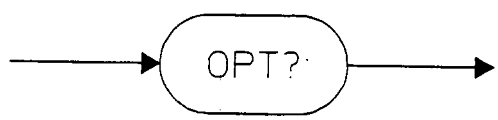


Figure 2-35. OPT? Syntax Diagram

Table 2-37. OPT? Response Format

Options installed	HEAD-on response	HEAD-off response
none	OPT0,0	0,0
Oven	OPT1,0	1,0
High Voltage	OPT0,2	0,2
Oven and High V.	OPT1,2	1,2

PH; Phase Command

The PH command sets the phase of the main signal. Sending PH with no value or units displays the current phase. Values outside the −720 to +720 range are treated as (value modulus 720).

Instrument Preset value: 0.0 Degrees

Command Availability

	PH	IPH	PH?
HP 3325B	Yes	Yes	Yes
HP 3325A	Yes	Yes	No

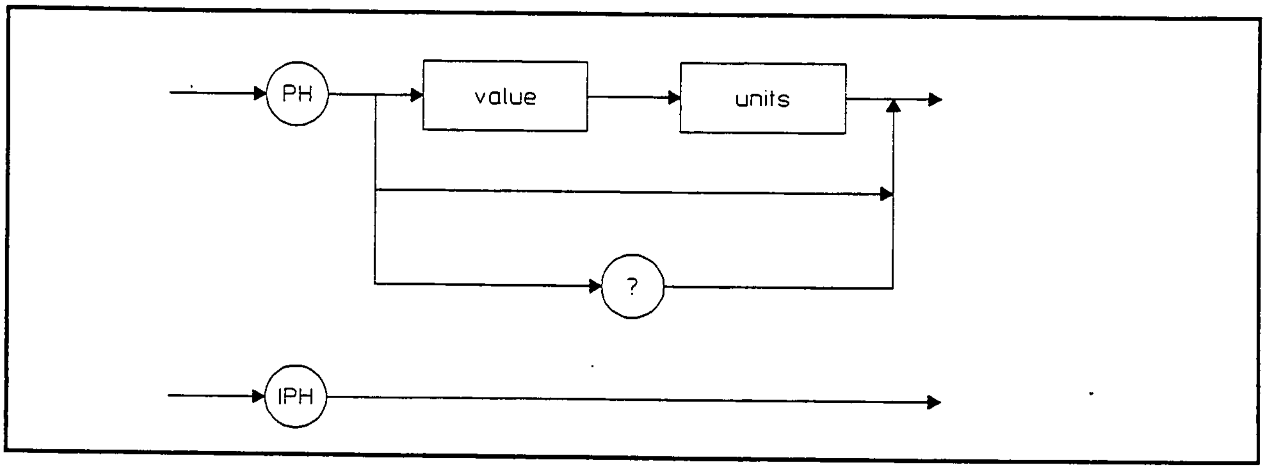


Figure 2-36. PH Syntax Diagram

Table 2-38. PH "value" Restrictions Given "units"

"Units"	Description	Range Restrictions for "value"
DE	Degrees	−720.0 → 720.0

Table 2-39. IPH and PH? Response Format

HEAD-on response	HEAD-off response
PH########.###DE	########.###

QSTB; Query Status Byte (RS-232)

The QSTB? query command is used to upload the *status byte* over the RS-232 interface. The HP 3325B responds to this command by returning the contents of the status register in the form of an integer value ranging from 0 to 255. This integer, when converted to binary (base 2), represents the bits of the Status Register. This command reads the same register as the HP-IB *serial poll* and clears the ERR, STOP, START, FAIL and RQS bits of the status byte.

Command Availability

	QSTB?
HP 3325B	Yes
HP 3325A	No

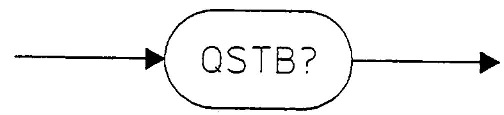


Figure 2-37. QSTB? Syntax Diagram

Table 2-40. Status Register Bit Coding

Bit	Value	Name	Description
0	1	ERR	Program or keyboard entry error.
1	2	STOP	Sweep stopped.
2	4	START	Sweep started.
3	8	FAIL	Hardware failure.
4	16	BIT4	Always zero.
5	32	SWEEP	Sweep in progress.
6	64	RQS	This corresponds to the HP-IB SRQ signal.
7	128	BUSY	Set while a command is being executed.

Table 2-41. QSTB? Response Format

HEAD-on response	HEAD-off response
QSTB###	###

RE; Recall State Command

The RE command recalls an instrument setup state from 1 of 11 memory locations. Locations 0 through 9 are programmed with the SR command. Location "–" is always the state when power is turned off.

Command Availability

	RE0 thru RE9	RE–
HP 3325B	Yes	Yes
HP 3325A	Yes	No

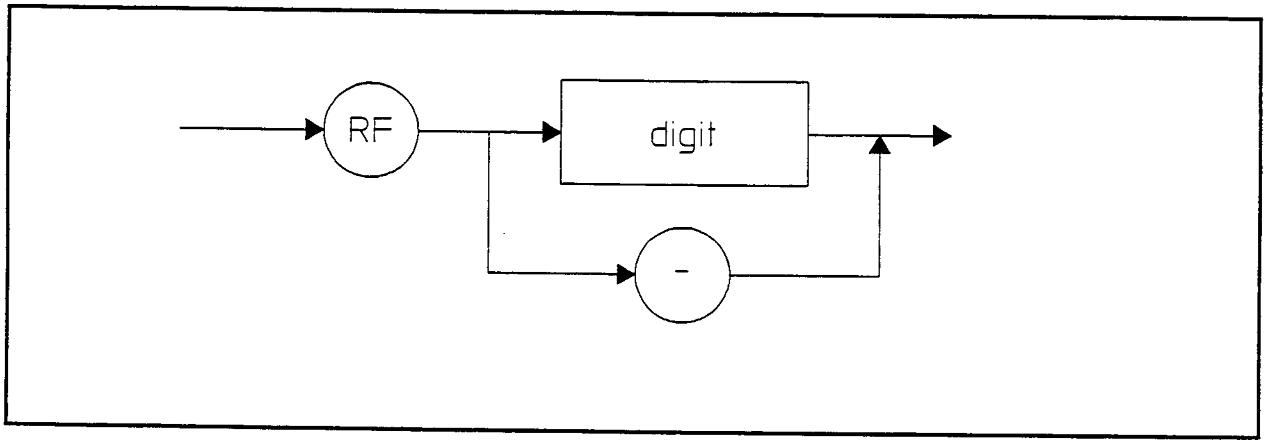


Figure 2-38. RE Syntax Diagram

"Digit"	Meaning
0 → 9	Recalls state in location 0 thru 9.
– (minus sign)	Recalls state at power-down.–

RF; Rear or Front Signal Output Command

The RF command determines whether the main signal is present at the rear or front BNC connector.

Instrument Preset value: 1 (front).

Command Availability

	RF	IRF	RF?
HP 3325B	Yes	Yes	Yes
HP 3325A	Yes	Yes	No

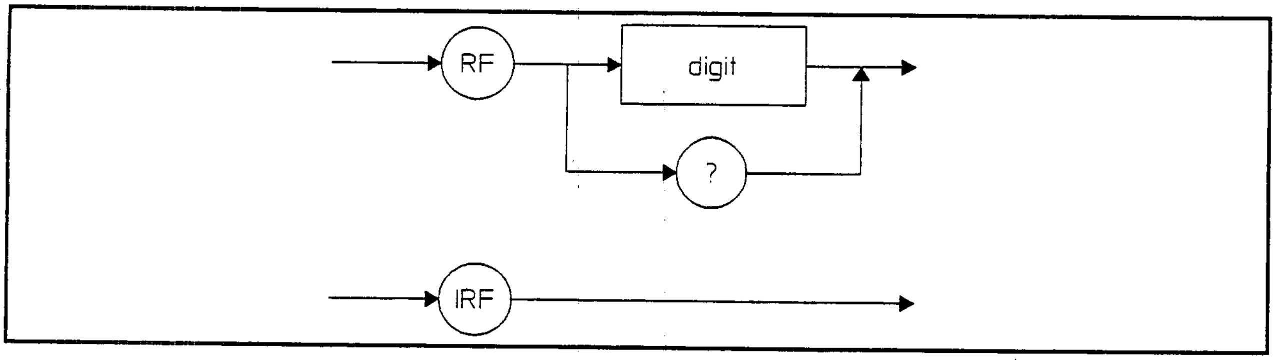


Figure 2-39. RF Syntax Diagram

"Digit"	Meaning
1	Front panel output.
2	Rear panel output.

Table 2-42. RF? and IRF Response Format

HV option	HEAD-on response	HEAD-off response
no	RF#	#
yes	HV#	#

RMT; Remote (with Local-Lockout) Command

The RMT command places the instrument in *remote* with *local lockout* mode. This command has the same effect as the HP-IB Local Lockout bus command but can be programmed using the RS-232 interface.

Command Availability

	RMT
HP 3325B	Yes
HP 3325A	No

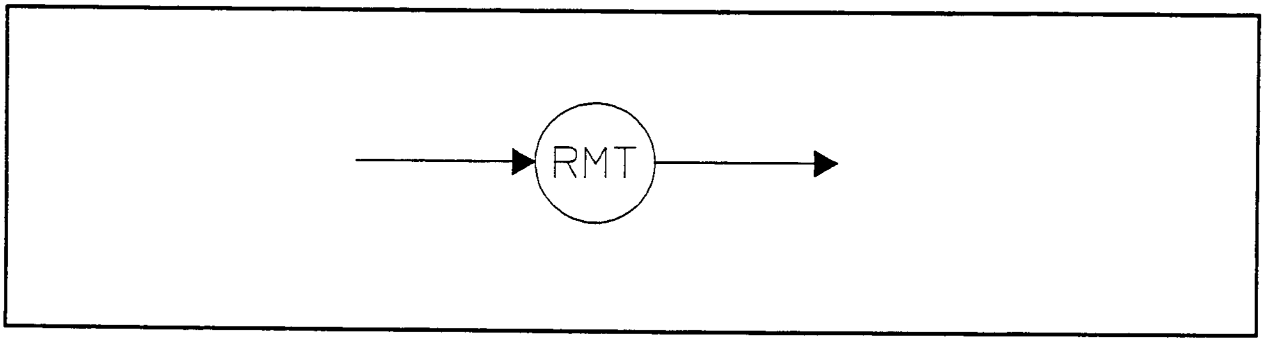


Figure 2-40. RMT Syntax Diagram

*RST; Reset Command

The *RST command resets the HP 3325B to the state in table 2-43. This command has the same effect as pressing the Instrument Preset key on the front panel and is similar to the HP-IB Device Clear command. *RST does not change the data transfer mode as does the Device Clear command.

Note In data transfer mode 2, an asterisk terminates a command string. Therefore use RST, without an asterisk, in data transfer mode 2.

Command Availability

	*RST
HP 3325B	Yes
HP 3325A	No

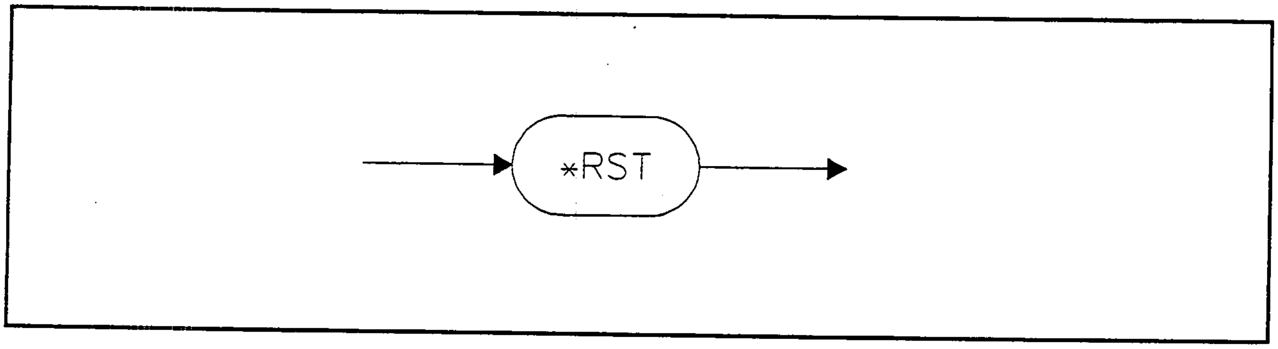


Figure 2-41. *RST Syntax Diagram

Table 2-43. Reset State

Item	Reset Value
Function	Sine
Frequency	1000.0 Hz
Amplitude	1.0 mV_{pp}
Offset	0.0 V
Phase	0.0°
Mod Source Function	Off
Mod Source Frequency	1000.0 Hz
Mod Source Amplitude	0.1 V_{pp}
Start Frequency	1.0 MHz
Stop Frequency	10.0 MHz
Marker Frequency	5 MHz
Sweep Time	1.0 Sec
High voltage	Off
Front/Rear output	Front
Amplitude Modulation	Off
Phase Modulation	Off
Sweep Mode	Linear
Status Byte (bits cleared)	0, 1, 2, 3, & 6

The *RST command does not alter:

- The 10 state storage registers
- HP-IB address
- HP-IB data transfer mode
- Status byte mask
- Enhancement/compatibility mode
- Calibration mode
- Head on/off
- Display on/off
- Echo on/off
- Discrete sweep table
- Modulation source arbitrary waveform data
- Serial number and elapsed time clock

RSW; Reset Single Sweep Command

The RSW command places the instrument in the sweep reset state. The output frequency returns to the Start Frequency and the next SS command starts a single sweep.

Command Availability

	RSW
HP 3325B	Yes
HP 3325A	No

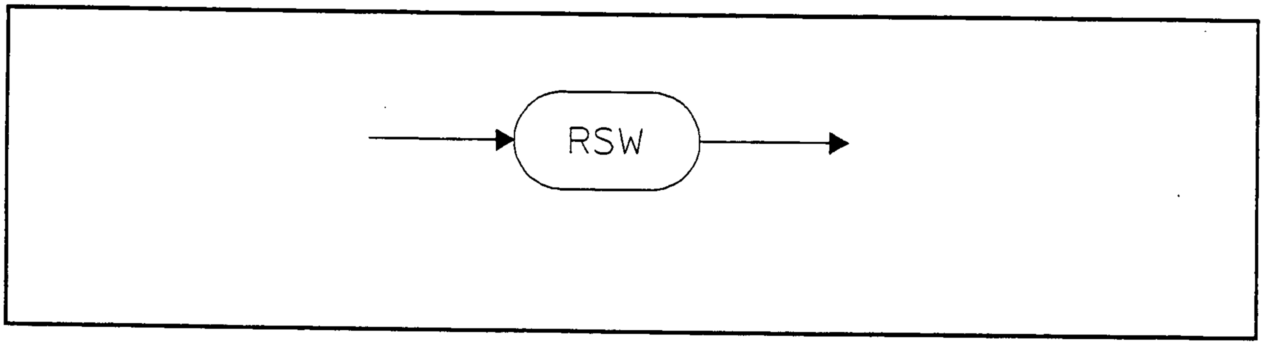


Figure 2-42. RSW Syntax Diagram

SC; Start Continuous Sweep Command

The SC command starts a continuous sweep. If the instrument is already sweeping, this command stops the sweep and does not restart it. FR can be used to stop a sweep.

Command Availability

	SC
HP 3325B	Yes
HP 3325A	Yes

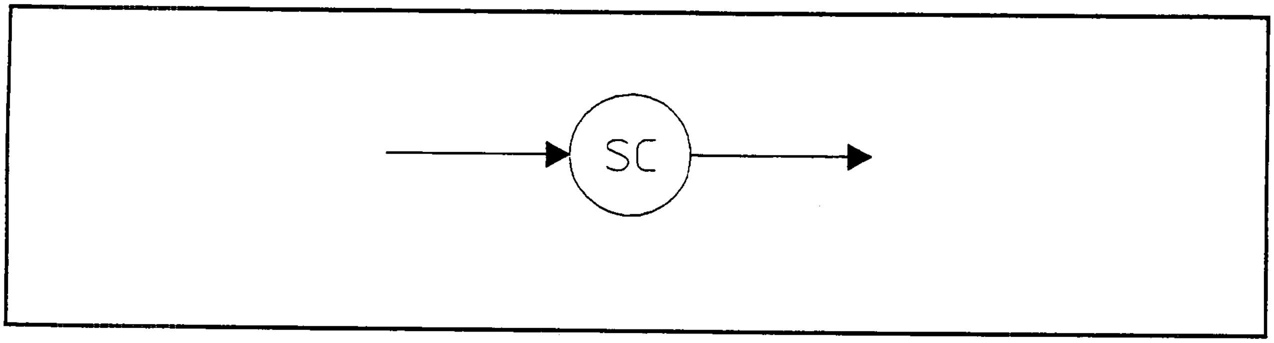


Figure 2-43. SC Syntax Diagram

SM; Sweep Mode Command

The SM command selects the sweep mode.

Instrument Preset value: 1.

Command Availability

	SM	ISM	SM?	SM3
HP 3325B	Yes	Yes	Yes	Yes
HP 3325A	Yes	Yes	No	No

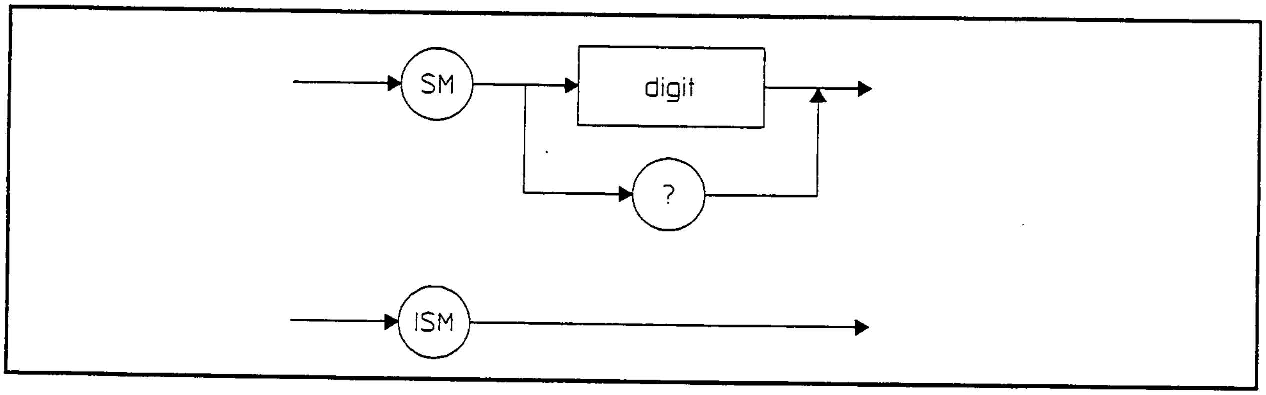


Figure 2-44. SM Syntax Diagram

"Digit"	Waveform
1	Selects Linear sweep mode.
2	Selects Logarithmic sweep mode.
3	Selects Discrete sweep mode.

Table 2-44. SM? and ISM Response Format

HEAD-on response	HEAD-off response
SM#	#

SP; Sweep Stop Frequency Command

The SP command sets the sweep stop frequency.

Instrument Preset value: 10.0 MHz

Command Availability

	SP	ISP	SP?
HP 3325B	Yes	Yes	Yes
HP 3325A	Yes	Yes	No

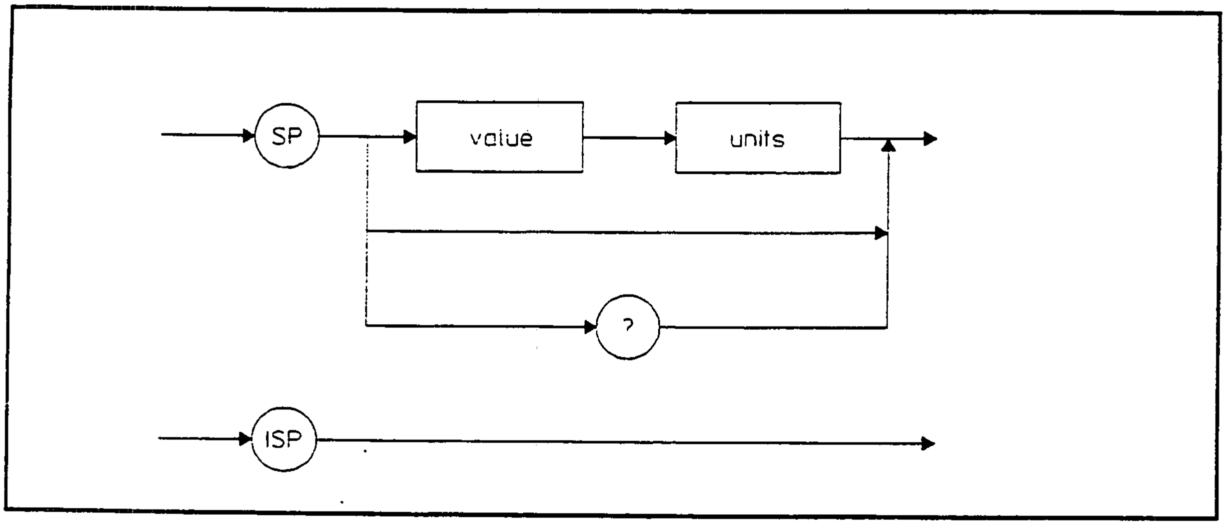


Figure 2-45. SP Syntax Diagram

Table 2-45. SP "value" Restrictions Given "units"

Value Range	Units	Description
0.0 → 20999999.999	HZ	Hertz
0.0 → 20999.9999990	KH	kilo-Hz
0.0 → 20.999999999	MH	mega-Hz

Table 2-46. SP? and ISP Response Format

μ Hz programmed	HEAD-on response	HEAD-off response
no	SP########.###HZ	########.###
yes	SP#####.######HZ	#####.######

SR; Store State Command

The SR command stores the current instrument setup state in one of 10 memory locations.

Command Availability

	SR
HP 3325B	Yes
HP 3325A	Yes

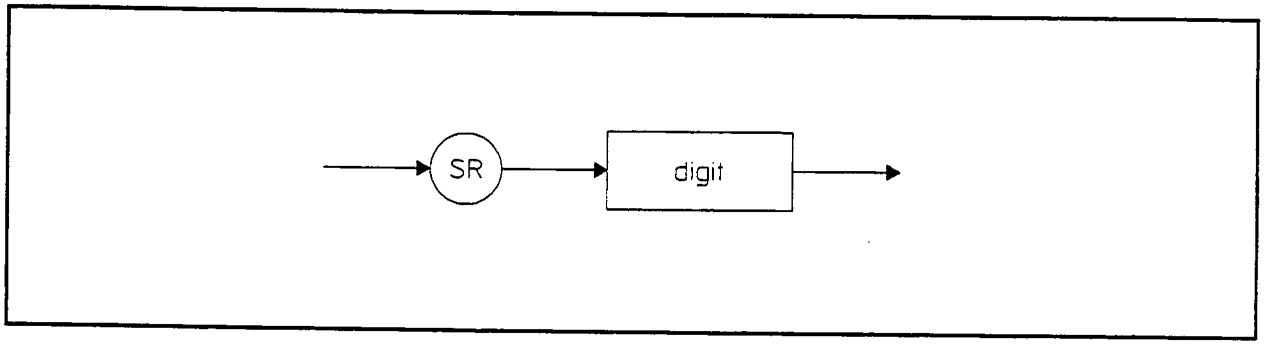


Figure 2-46. SR Syntax Diagram

"Digit"	Meaning
0 → 9	Stores state in location 0 thru 9.

SS; Start Single Sweep Command

The effect of the SS command depends on the state of the instrument. If the instrument is not sweeping and not in the sweep-reset state, then the SS command puts the instrument in the sweep-reset state at the sweep Start Frequency. If the instrument is already in the sweep-reset state, this command starts a single sweep. If the instrument is sweeping, this command stops the sweep and does not restart it.

Single sweeps can be started using the HP-IB Group Execute Trigger command. Before using the GET command, the HP 3325B must be in the enhancements mode and the sweep must be reset using the RSW command.

Command Availability

	SS
HP 3325B	Yes
HP 3325A	Yes

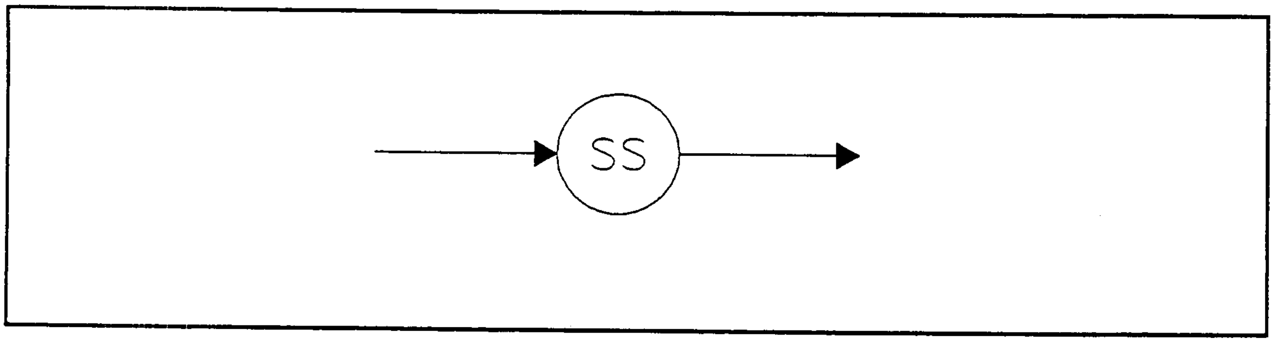


Figure 2-47. SS Syntax Diagram

ST; Sweep Start Frequency Command

The ST command sets the sweep start frequency.

Start Frequency Preset value: 1.0 MHz

Command Availability

	ST	IST	ST?
HP 3325B	Yes	Yes	Yes
HP 3325A	Yes	Yes	No

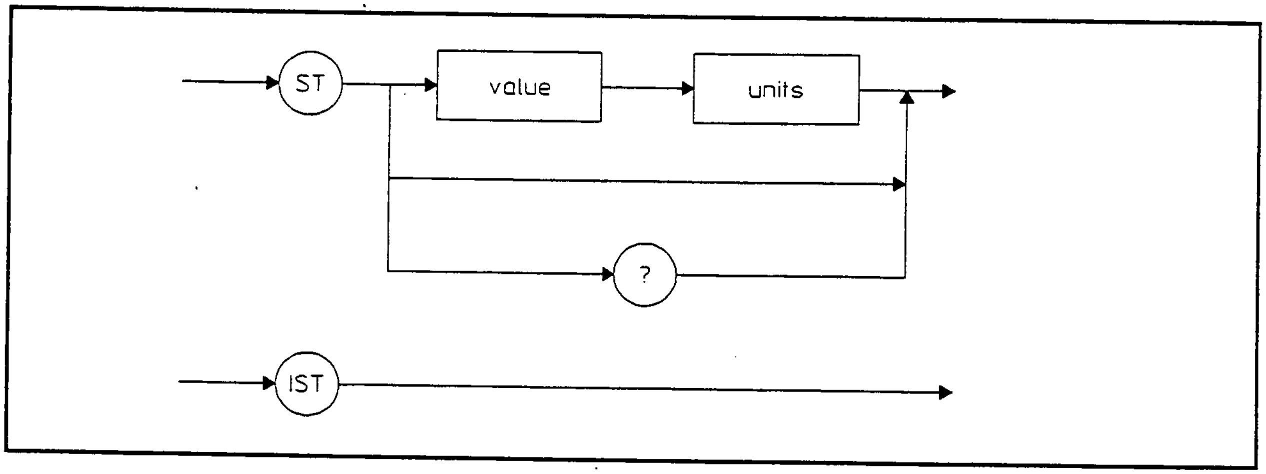


Figure 2-48. ST Syntax Diagram

Table 2-47. ST "value" Restrictions Given "units"

value range	units	Description
0.0 → 20999999.999	HZ	Hertz
0.0 → 20999.999999	KH	kilo-Hz
0.0 → 20.999999999	MH	mega-Hz

Table 2-48. ST? and IST Response Format

μHz programmed	HEAD-on response	HEAD-off response
no	ST########.###HZ	########.###
yes	ST#####.######HZ	#####.######

TI; Sweep Time Command

The TI command sets the sweep time. Sending TI with no value or units displays the current sweep time. ITI and TI? cause the instrument to output its current sweep time.

Instrument Preset value: 1.0 Sec

Command Availability

	TI	ITI	TI?
HP 3325B	Yes	Yes	Yes
HP 3325A	Yes	Yes	No

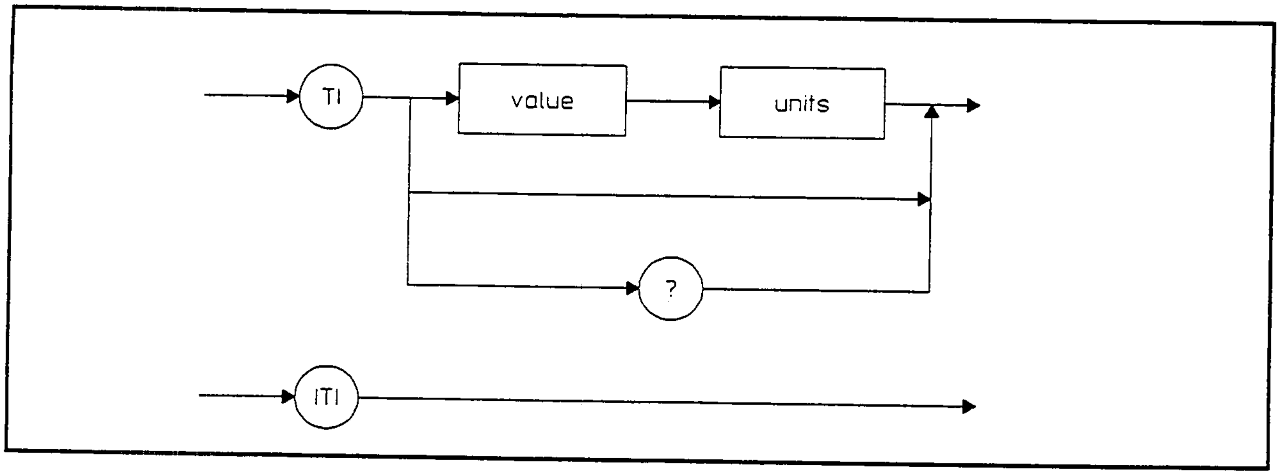


Figure 2-49. TI Syntax Diagram

Table 2-49. TI "value" Restrictions Given "units"

"Units"	Description	Range Restrictions for "value"
SE	Seconds	0.0 → 1000

Table 2-50. TI? and ITI Response Format

HEAD-on response	HEAD-off response
TI#######.###SE	#######.###

Table 2-51. Error Messages

Code	Description
FAIL 010	Hardware failure, DAC range
FAIL 011	Bad checksum, low byte of ROM
FAIL 012	Bad checksum, high byte of ROM
FAIL 013	Machine data bus line stuck low
FAIL 014	Keyboard shift register test failed
FAIL 021	Signal too big during calibration
FAIL 022	Signal too small during calibration
FAIL 023	DC offset too positive during cal
FAIL 024	DC offset too negative during cal
FAIL 025	Unstable/ noisy calibration
FAIL 026	Calibration factor out of range: AC gain offset
FAIL 027	Calibration factor out of range: AC gain slope
FAIL 028	Calibration factor out of range: DC offset
FAIL 029	Calibration factor out of range: DC slope
FAIL 030	External ref unlocked
FAIL 031	Oscillator unlocked, VCO voltage too low
FAIL 032	Oscillator unlocked, VCO voltage too high
FAIL 033	HP-IB isolation circuits test failed self test
FAIL 034	HP-IB IC failed self test
FAIL 035	RS-232 test failed loop-back test
FAIL 036	Memory lost (battery dead)
FAIL 037	Unexpected interrupt
FAIL 038	Sweep-limit-flag signal failed self test
FAIL 039	Fractional-N IC failed self test
FAIL 040	Modulation Source failed self test
FAIL 041	Function-integrity-flag flip-flop always set
Error 100	Entry parameter out of bounds
Error 200	Invalid units suffix for entry
Error 201	Invalid units suffix with high voltage
Error 300	Frequency too large for function
Error 400	Sweep time too large (same as sweep rate too small)
Error 401	Sweep time too small
Error 500	Amplitude/offset incompatible
Error 501	Offset too big for amplitude
Error 502	Amplitude too big for offset
Error 503	Amplitude too small

Table 2-51. Error Messages (con't)

Code	Description
Error 600	Sweep frequency improper
Error 601	Sweep frequency too large for function
Error 602	Sweep bandwidth too small
Error 603	Log sweep start freq too small
Error 604	Log sweep stop frequency less than start frequency
Error 605	Discrete sweep element is empty
Error 700	Unknown command
Error 701	Illegal query
Error 751	Key ignored – in remote (press LOCAL)*
Error 752	Key ignored – local lockout*
Error 753	Feature disabled in compatibility mode
Error 754	Attempt to recall a register that has not been stored since power up. (Use enhancements mode)*
Error 755	Amplitude modulation not allowed on selected function (warning only)*
Error 756	Modulation source arbitrary waveform is empty
Error 757	Too many modulation source arbitrary waveform points
Error 758	Firmware failure
Error 759	Error while running XRUN routine
Error 800	Illegal character received
Error 801	Illegal digit for selection item
Error 802	Illegal binary data block header
Error 803	Illegal string, string overflow
Error 810	RS-232 overrun – characters lost
Error 811	RS-232 parity error
Error 812	RS-232 frame error
Error 900	Option not installed

* *These errors do not set the ERR bit in the status byte.*

HP 3325A Compatibility

For compatibility with existing programs, the HP 3325B supports all of the HP 3325A Synthesizer/Function Generator remote commands. Table 2-52 lists the HP 3325B mnemonics alphabetically and shows compatibility of each with the HP 3325A.

Table 2-52. Remote Command Compatibility

HP 3325B Command	HP 3325A Compatible?	Description
*	yes	End-of-string character
AC	yes	Amplitude Calibrate
AM	yes	Amplitude
AP	yes	Assign zero phase
CALM	no	Calibration mode
DB	yes	dBm (suffix)
DCLR	no	Discrete sweep clear
DE	yes	Degrees (suffix)
DISP	no	Display on/off
DRCL	no	Discrete sweep recall
DSP	no	Display string
DSTO	no	Discrete sweep store
DV	no	dBV_{rms} (suffix)
E	no	Exponent character
ECHO	no	Echo; for RS-232
ENH	no	Enhancements on
ENT	no	Enter, no units (suffix)
ER	yes	Error query, 1-digit code
ERR	no	Error query, 3-digit code
ESTB	no	Stat register mask (same as MS)
EXTR	no	Ext Ref query
FR	yes	Frequency
FU	yes	Function select
HEAD	no	Header on/off
HV	yes	High voltage
HZ	yes	Hertz (suffix)
ID	no	Identify, short
*IDN	no	Identify, long
KH	yes	Kilohertz (suffix)
LCL	no	Local, clear lockout (RS-232)
MA	yes	Amplitude modulation
MD	yes	Data transfer mode
MF	yes	Sweep marker frequency
MH	yes	Megahertz (suffix)
MOAM	no	Mod S amp
MOAR	no	Write arbitrary waveform

Table 2-52. Remote Command Compatibility (con't)

HP 3325B Command	HP 3325A Compatible?	Description
MOFR	no	Mod S frequency
MOFU	no	Mod S function
MP	yes	Phase modulation
MR	yes	mV_{rms} (suffix)
MS	yes	Status register mask (same as ESTB)
MV	yes	mV_{pp} (suffix)
OF	yes	DC offset entry
OPT	no	Option query
PH	yes	Phase entry
QSTB	no	Status register query
RE	yes	Recall state
RF	yes	Rear or front output selection
RMT	no	Remote with lockout (RS-232)
*RST	no	Reset (preset)
RSW	no	Reset single sweep
SC	yes	Start continuous sweep
SE	yes	Seconds (suffix)
SM	yes	Sweep mode selection
SP	yes	Sweep stop frequency entry
SR	yes	Store state selection
SS	yes	Start a single sweep
ST	yes	Sweep start frequency
TI	yes	Sweep time
VO	yes	V_{pp} (suffix)
VR	yes	V_{rms} (suffix)

Writing Compatible Programs

Backward Compatible with the HP 3325A

- Use only the two-letter HP 3325B command mnemonics such as FR. The three and four-letter mnemonics such as MOFR are not available on the HP 3325A.
- Do not separate commands with a semicolon.
- Use a leading **I** to interrogate setup parameters instead of a trailing **?**.
- Do not send values in scientific notation.

Programming Practices Compatible with IEEE 488.2

- Separate commands with a semicolon or line feed
- Use a trailing **?** to interrogate setup parameters instead of a leading **I**.
- Do not use data transfer mode 2.

Example Programs

HP-IB Interface Example Program

```
30  !
40  ! HP-BASIC Program to control the HP 3325B synthesizer.
50  !
60   ASSIGN @Hp3325 to 717            ! Select code and bus address
70                                    ! usually 7 and 17
80   !
90   OUTPUT @Hp3325;"RST"             !  reset the HP 3325B
100  !
110  Stat-SPOLL (@Hp3325)             ! read status register
120  IF BIT(Stat,0) or BIT(Stat,3) then print "3325B has an error"
130  !
140  OUTPUT @Hp3325;"FR 123 KH; AM 1 V0"  ! program freq and amptd
150  OUTPUT @Hp3325;"FR?"             ! ask for frequency
160  ENTER @Hp3325;Freq               ! read it back
170  PRINT "Frequency in Hz = ";Freq
180  !
190  LOCAL @Hp3325                    ! return front panel to local control
200  !
210  PRINT "Program done."
220  END
```

RS-232 Interface Example Program for HP-Vectra or IBM/PC

```
10   'HP Vectra BASIC program to control the HP 3325B Synthesizer
20   '
30   'First open a communications file to the HP 3325B
40   'change COM1 to COM2 if needed.
50   OPEN "COM1:" AS #1
60   'OPEN defaults to 300 baud, 7 bits, parity EVEN
70   '
80   PRINT #1, "RST"                  ' send reset
90   PRINT #1, "HEAD 0"               ' turn off heading in HP 3325B responses
100  '
110  PRINT #1,"QSTB?"                 ' ask for status register
120  INPUT #1, STAT                   ' read response from HP 3325B
130  IF (STAT and (1+8)0) then print "3325B has an error"
140  '
150  PRINT "Programming frequency and amplitude"
160  PRINT #1, "FR 123.4 KH; AM 1 VO"
170  PRINT #1, "FR?"                  ' ask for frequency
180  INPUT #1, FREQ                   ' read it back
190  PRINT "Frequency in Hz = ";FREQ
200  '
210  PRINT #!, "LCL"                  ' return front panel to local control
220  '
230  PRINT "Program done"
240  END
```

RS-232 Interface Example Program for HP Series 300

```
30   !
40   ! HP-BASIC Program to control the HP 3325B synthesizer using either
50   ! a HP98644, HP98626, or the build-in serial interface in
60   ! a Series-200 or Series-300 computer.
70   !
80   ! The connecting cable depends on the RS232 interface:
90   !    HP98644A interface:    use 13242G cable (25 pin M to 25 pin M).
100  !    Built-in interface:  use 92221P cable (9 pin M to 25 pin M).
110  !
120  ASSIGN @Hp3325 to 9             ! Select code for the serial interface,
130                                  ! usually 9 or 10
140  !
160  GOSUB Initialize_card
170  !
190  OUTPUT @Hp3325;"RST"            ! reset the HP 3325B
200  !
210  OUTPUT @Hp3325;"QSTB?"          ! ask for status register
220  ENTER @Hp3325;Stat              ! read status from HP 3325B
240  IF Bit(Stat,0) OR BIT(Stat,3) then print "3325B has an error"
250  !
260  OUTPUT @Hp3325;"FR 123 KH; AM 1 V0"         ! program freq and amptd
270  OUTPUT @Hp3325;"FR?"            ! ask for frequency
280  ENTER @Hp3325;Freq              ! read it back
290  PRINT "Frequency in Hz = ";Freq
300  !
310  OUTPUT @Hp3325;"LCL"            ! retrun front panel to local control
320  !
330  PRINT "Program done."
340  STOP
350  !
360  ! ------------------------------------------------------------
370 Initialize_card:    !
380  !
390  Isc=SC(@Hp3325)                 ! Get Interface select code
400  !
410  Reset_=0
420  Baud=3
430  Parity_=4
440  !
450  ! ALL the RS232 switches on the HP 3325B rear panel should be
460  ! up.  This sets baud=300, parity ON, parity EVEN
470  !
480  CONTROL Isc,Reset_;1            ! reset the card
490  CONTROL Isc,Baud;300            ! set baud rate
500  CONTROL Isc,Parity_;16+8+0+2    ! set parity
510 RETURN
520 END
```

HP 3325B HP-IB and RS-232 Programming Codes:

Commands:

Code	Function	Code	Function
AC	Amplitude Cal	MF	Sweep marker frequency
AM	Amplitude	MOAM	Modulation Source amplitude
AP	Assign zero phase	MOAR	Write arb waveform
CALM	Calibration mode (0-1)	MOFR	Modulation Source frequency
DCLR	Discrete sweep clear	MOFU	Modulation Source function (0-3)
DISP	Display (0-1)	MP	Phase modulation (0-1)
DRCL	Discrete sweep recall (00-99)	MS	Status reg. mask (also ESTB) (@,A-0)
DSP	Display a string (' ')	OF	DC Offset
DSTO	Discrete sweep store (00-99)	OPT?	Option query
ECHO	Echo for RS-232 (0-1)	PH	Phase
ENH	Enhancements mode (0-1)	QSTB?	Status register query
IER	Error query (1 digit)	RE	Recallstate (– , 0-9)
ERR?	Error query (3 digit)	RF	Rear or front output (2-1)
ESTB	Status reg. mask (also MS) (0-15)	RMT	Remote with lockout
EXTR?	Ext Ref query	*RST	Reset (Preset)
FR	Frequency	RSW	Reset single sweep
FU	Function Select (0-5)	SC	Start continuous sweep
HEAD	Query Header Enabled (0-1)	SM	Sweep mode (1-3)
HV	High voltage (0-1)	SP	Sweep stop frequency
ID?	Model Identify (short)	SR	Store state (0-9)
*IDN?	Model Identify (long)	SS	Reset or Start single sweep
LCL	Local, clear lockout	ST	Sweep start frequency
MA	Amplitude modulation (0-1)	TE	Self Test
MD	Data transfer mode (1-2)	TI	Sweep time

Note that most commands may be followed by a question mark (?) to interrogate the related parameter.

* Only bits 0 to 3 may enable an SRQ.

Commands, Continued

Data		Suffix			
0 to 9	Digits	Hz	Hertz	dB	dBm
E	Exponent character	KH	KHz	DV	dBvrms
'xyz'	Alpha-numeric string	MH	MHz	DE	Degrees
–	minus sign	MR	milli-Volts RMS	SE	Seconds
.	Decimal point	MV	milli-Volts p-p	ENT	Enter, no units
		VO	Volts p-p	*	EOS character
		VR	Volts RMS		

Status Byte			
Bit	**Value**	**Name**	**Description**
0	1	ERR*	Program or keyboard entry error
1	2	STOP*	Sweep stopped
2	4	START*	Sweep started
3	8	FAIL*	Hardware failure
5	32	SWEEP	Sweeping
6	64	RQS	Requested service
7	128	BUSY	HP 3325 is busy

* Only bits 0 to 3 may enable an SRQ.

Bits which can be enabled to generate an SRQ and the arguments for MS and ESTB:

Arguments	Fail	Start	Stop	ERR
@, 0	Mask	Mask	Mask	Mask
A, 1	Mask	Mask	Mask	ENABLE
B, 2	Mask	Mask	ENABLE	Mask
C, 3	Mask	Mask	ENABLE	ENABLE
D, 4	Mask	ENABLE	Mask	Mask
E, 5	Mask	ENABLE	Mask	ENABLE
F, 6	Mask	ENABLE	ENABLE	Mask
G, 7	Mask	ENABLE	ENABLE	ENABLE
H, 8	ENABLE	Mask	Mask	Mask
I, 9	ENABLE	Mask	Mask	ENABLE
J, 10	ENABLE	Mask	ENABLE	Mask
K, 11	ENABLE	Mask	ENABLE	ENABLE
L, 12	ENABLE	Enable	Mask	Mask
M, 13	ENABLE	Enable	Mask	ENABLE
N, 14	ENABLE	Enable	ENABLE	Mask
O, 15	ENABLE	Enable	ENABLE	ENABLE

(Example: MSI or ESTB9ENT cause an SRQ to be generated when an Error of Failure occurs. ESTB? returns the byte value of the mask.)

Hardware Failure Codes

Fail	010	DAC range error
Fail	011	bad checksum, low byte of ROM
Fail	012	bad checksum, high byte of ROM
Fail	013	machine data bus line stuck low
Fail	014	keyboard shift register test failed
Fail	021	signal too big during calibration
Fail	022	signal too small during calibration
Fail	023	DC offset too positive during cal
Fail	024	DC offset too negative during cal
Fail	025	unstable/noisy calibration
Fail	026	calibration factor out of range: AC gain offset
Fail	027	calibration factor out of range: AC gain slope
Fail	028	calibration factor out of range: DC offset
Fail	029	calibration factor out of range: DC slope
Fail	030	external ref unlocked
Fail	031	oscillator unlocked, VCO voltage too low
Fail	032	oscillator unlocked, VCO voltage too high
Fail	033	HP-IB isolation circuits failed self test
Fail	034	HP-IB IC failed self test
Fail	035	RS232 test failed loop-back test
Fail	036	memory lost (battery dead)
Fail	037	unexpected interrupt
Fail	038	sweep-limit-flag signal failed self test
Fail	039	Fractional-N IC failed self test
Fail	040	Modulation Source failed self test
Fail	041	function-integrity-flag flip-flop always set

Programming Error Codes

Error	100	entry parameter out of bounds
Error	200	invalid units delimiter for entry
Error	201	invalid units delimiter with high voltage
Error	300	frequency too large for function
Error	400	sweep time too large, sweep rate too small
Error	401	sweep time too small
Error	500	amplitude/offset incompatible
Error	501	offset too big for amplitude
Error	502	amplitude too big for offset
Error	503	amplitude too small for offset
Error	600	sweep frequency
Error	601	sweep frequency too large for function
Error	602	sweep bandwidth too small
Error	603	log sweep start freq too small
Error	604	log sweep stop < start freq
Error	605	discrete sweep element is empty
Error	700	unknown command
Error	701	illegal query
Error	751	key ignored -- in remote (press LOCAL)
Error	752	key ignored -- local lockout
Error	753	feature disable in compatibility mode
Error	754	attempt to recall a register that has not been stored since power up (use enhancements mode)
Error	755	amplitude modulation not allowed on selected function (warning only)
Error	756	modulation source arbitrary wave form is empty
Error	757	too many modulation source arbitrary waveform points
Error	758	firmware failure
Error	800	illegal character received
Error	801	illegal digit for selection item
Error	802	illegal binary data block header
Error	803	illegal string, string overflow
Error	810	RS232 overrun -- characters lost
Error	811	RS232 parity error
Error	812	RS232 frame error
Error	900	option not installed

Chapter 3

General Information

Chapter 3

General Information

Introduction

This chapter contains general information about the HP 3325B, including its performance specifications, safety considerations, instrument description, available options, supplied accessories, and available accessories.

Specifications

Instrument specifications are listed in table 3-1. The specifications are the performance standards or limits against which the instrument is tested.

Safety Considerations

This product is a safety class 1 instrument (provided with a protective earth terminal). The instrument and manual should be reviewed for safety markings, instructions, cautions, and warnings to ensure safe operation.

The connector shells listed below are common to one another and floating with respect to earth ground.

1. Main Signal (front and rear)
2. Sync Out
3. Mod Source Out
4. Ref. Out
5. 10 MHz Oven Output
6. Marker
7. X-Drive
8. Z-Blank
9. Aux. 0 dBm
10. Fast Sync
11. Ext. Ref In
12. Phase Mod In
13. Amptd Mod In

For operator protection, the maximum float voltage is 42V peak from earth ground.

This manual may have a yellow *manual change supplement* with it. This supplement contains information to correct errors and incorporate new information to keep the manual current. The supplement for this manual is identified by the manual print date and part number, both of which appear on the manual title page. Complimentary copies of the supplement are available from Hewlett-Packard.

Instrument Description

The HP 3325B Synthesizer/Function Generator produces sine wave, square wave, triangle waveforms, and positive and negative ramp waveforms from 1 μHz to a maximum frequency of 20 Mhz for sine wave and 10 Mhz for square wave and 10 kHz for the triangle and ramp functions. (The .999 extensions are assumed.) Frequency resolution is 1 μHz or eleven digits. Output amplitude is 1 mV_{pp} to 10 V_{pp}. The output amplitude level may be entered or displayed in V_{rms} or dBm (50Ω) as well as V_{pp}. Any function may have a dc offset of up to ±4.5V or the output may be dc-only up to ±5V. An optional high voltage output produces up to 40 V_{pp} into a load ≥ 500Ω, ≤ 500 pF.

The HP 3325B performs linear or log frequency sweeps in any of its waveforms at sweep times of 10 ms to 1000s for linear sweeps. Log sweep times are from 1s to 1000s for single sweeps and from 0.1s to 1000s for continuous sweeps. The direction of a single linear sweep may be up or down. A continuous sweep moves back and forth between the start and stop frequencies in an up/down/up/down/. . . fashion. Log sweeps always start at the start frequency and sweep up to the stop frequency. *Discrete sweep* is a feature which allows creation of custom sweep patterns.

The HP 3325B is fully programmable through two separate computer interface connectors located on the rear panel. They are the Hewlett-Packard Interface Bus (HP-IB) and an RS-232 serial interface. A desktop computer can be configured and programmed to remotely operate the HP 3325B with either of these two interfaces. Interface information is in Chapter 2, Remote Operation.

New or Enhanced Features of the HP 3325B

The feature set of the HP 3325B is a superset of the HP 3325A features. The additional features and improvements are summarized in the following:

- Non-volatile memory added: battery backup provides power to the memory when the power switch is in the standby position or when the instrument is disconnected from line voltage.
- Modulation source added: a second source of sine wave, square wave, and arbitrary waveforms provides a signal which may be used to modulate the main signal. The output connector for this source is on the rear panel between the two modulation input connectors.
- RS-232 interface added: this serial interface offers an alternative to the HP-IB. Additional remote operation commands have been added to the command set to allow it to be used in the same manner as the HP-IB (i.e.; emulate the HP-IB bus commands).
- Frequency range of the rear-panel sync output extended to 60 MHz.
- Discrete sweep added: a sequence of up to 100 linear sweeps or frequency steps (called segments) offers the ability to create custom sweep patterns. Each segment is composed of a start frequency, stop frequency, sweep time, and marker frequency. Refer to Chapter 1, Operation and Reference, for more information on this feature.
- Additional front-panel conveniences such as a preset key, frequency entry increment and decrement (defined by a new F STEP key), and the use of the left-arrow key as a backspace during parameter entries.
- Over-voltage circuit breaker added: an over-voltage protection circuit provides added reliability and reduces maintenance.
- Extended self-test and diagnostic capabilities to reduce maintenance.

Compatibility with the HP 3325A

The HP 3325B enhancements were designed to improve upon the capabilities of the HP 3325A without sacrificing compatibility. In most cases the new features do not cause compatibility problems. Complete backward compatibility is achieved by turning off the enhancements switch (on the rear panel). This feature is also programmable. Table 3-2 shows a comparison of the HP 3325A features that have been enhanced and are controlled by the enhancements switch.

Table 3-2. Comparison of compatible and enhanced features relative to HP 3325A

Compatibility Mode	Enhancement Mode
Store/recall registers cleared when power is turned off.	Store/recall registers are non-volatile.
Programming times compatible with the HP 3325A.	Some items program faster.
Amplitude calibration time compatible with the HP 3325A.	Calibration is faster.
Frequency, time, and phase entries are truncated.	All entries are rounded.
Amplitude or offset entries stop a sweep.	Amplitude and offset values can be changed while sweeping without stopping the sweep.
Actual sweep time can vary significantly from value entered for very narrow-band sweeps.	Actual sweep time value deviates less from value entered.
Actual sweep stop-frequency can vary from value entered for very narrow-band sweeps.	Actual sweep stop-frequency value deviates less from entered value.
Continuous log sweeps always cover an integer number of decades.	Partial decades possible.
Log sweep momentarily pauses between sweeps.	Pause time between log sweep segments minimized.

Options

Table 3-3 lists the options available for the HP 3325B. These options are available when the instrument is ordered by specifying the option number, or are available for later installation by ordering the HP part number.

Table 3-3. Options

HP 3325B Option	HP Part Number	Description
001	03325-88801	High Stability Frequency Reference
002	03325-88802	High Voltage Output
907	5062-3989	Front Handle Kit
908	5062-3977	Rack Flange Kit
909	5062-3983	Rack Mount Flange Kit with Handles
910	--	Extra Manual Set

Accessories Supplied

Table 3-4 lists the accessories supplied with the HP 3325B. Additional Operating and Service manuals may be ordered through your HP Sales and Service Office.

Table 3-4. Accessories Supplied

Description	Quantity	HP Part Number
Operating Manual	1 ea.	03325-90015
Installation Manual	1 ea.	03325-90007
Service Manual	1 ea.	03325-90005

Accessories Available

Table 3-5 lists the accessories available for the HP 3325B. These accessories may be obtained through your HP Sales and Service Office.

Table 3-5. Accessories Available

Accessory	HP Part Number
Ground Isolator	15507A
50Ω Feed-Thru Termination	11048C
Transit Case	9211-2655

Table 3-1. Specifications

Frequency

Range:

Sine: 1μHz to 20.999 999 999 MHz

Square: 1μHz to 10.999 999 999 MHz

Triangle/Ramps: 1μHz to 10.999 999 999 kHz

Resolution:

1μHz, <100 kHz

1mHz ≥ 100 kHz (1μHz available, not displayed)

Accuracy:

$+5 \times 10^{-6}$/year, 20°C to 30°C, at time of calibration, (Standard Instrument)

Stability:

$\pm 5 \times 10^{-6}$/year, 20°C to 30°C, standard (See also option 001, high stability frequency reference)

Warm-up Time:

20 minutes to within specified accuracy.

Main Signal Output (all waveforms)

Impedance:

50Ω ± 1Ω, 0-10 kHz

Return Loss:

>20 dB, 10 kHz to 20 MHz, except >10 dB for >3V, 5 MHz to 20 MHz

Connector:

BNC; switchable to front or rear panel, non-switchable with option 002 except by internal cable change.

Floating:

Output may be floated up to 42V peak (ac + dc)

Amplitude (all waveforms)

Resolution:

0.03% of full range or 0.01 dB (4 digits).

Range:

1 mV to 10 Vpp in 8 amplitude ranges, 1-3-10 sequence. Ranges are 1 mV – 2.999 mV, 3 mV – 9.999 mV, 10 mV – 29.99 mV, 30 mV – 99.99 mV, .1V – .2999V, .3V – .9999V, 1V – 2.999V, 3V – 10V, (without dc offset).

Function	Peak to Peak	rms	dBm(50Ω)
Sine			
minimum	1.000 mV	0.354 mV	– 56.02
maximum	10.00V	3.536V	+23.98
Square			
minimum	1.000 mV	0.500 mV	– 53.01
maximum	10.00V	5.000V	+26.99
Triangle/Ramps			
minimum	1.000 mV	0.289 mV	– 57.78
maximum	10.00V	2.887V	+22.22

Accuracy: (with 0 Vdc offset)

Sine:

<table>
<tr><th>.001 Hz</th><th>100 kHz</th><th>10 MHz</th><th>20 MHz</th></tr>
<tr><td>+23.98 dBm</td><td>± .1dB</td><td colspan="2">± .4 dB</td></tr>
<tr><td>+13.52 dBm
– 16.02 dBm</td><td rowspan="2">± .2 dB</td><td rowspan="2">± .6 dB</td><td>± .6 dB</td></tr>
<tr><td>– 56.02</td><td>± .9 dB</td></tr>
</table>

Square Wave:

<table>
<tr><th>.001 Hz</th><th>100 kHz</th><th>10 MHz</th></tr>
<tr><td>10 Vpp</td><td>± 1.0%</td><td>± 11.1%</td></tr>
<tr><td>3 Vpp
1 mVpp</td><td>± 2.2%</td><td>± 13.6%</td></tr>
</table>

Triangle:

<table>
<tr><th>.001 Hz</th><th>2 kHz</th><th>10 kHz</th></tr>
<tr><td>10 Vpp</td><td>± 1.5%</td><td>± 5.0%</td></tr>
<tr><td>3 Vpp
1 mVpp</td><td>± 2.7%</td><td>± 6.2%</td></tr>
</table>

Ramps:

<table>
<tr><th>.001 Hz</th><th>500 Hz</th><th>10 kHz</th></tr>
<tr><td>10 Vpp</td><td>± 1.5%</td><td>± 10%</td></tr>
<tr><td>3 Vpp
1 mVpp</td><td>± 2.7%</td><td>± 11.2%</td></tr>
</table>

With dc offset, increase all sinewave tolerances by .2 dB and all function tolerances by 2%.

Table 3-1. Specifications, Continued

Sinewave Spectral Purity

Phase Noise:

– 60 dBc for a 30 kHz band centered on a 20 MHz carrier (excluding ± 1 Hz about the carrier) with option 001 installed.

Spurious:

All non-harmonically related output signals will be more than 70 dB below the carrier (– 60 dBc with dc offset), or less than – 90 dBm, whichever is greater.

Waveform Characteristics

Sinewave Harmonic Distortion:

Harmonically related signals will be less than the following levels relative to the fundamental:

Frequency Range	Harmonic Level
.1 Hz to 50 kHz	– 65 dBc
50 kHz to 200 kHz	– 60 dBc
200 kHz to 2 MHz	– 40 dBc
2 MHz to 15 MHz	– 30 dBc
15 MHz to 20 MHz	– 25 dBc

Squarewave Characteristics:

Rice/fall time: ≤ 20 ns 10% to 90%, at full output.

Overshoot: ≤ 5% of peak to peak amplitude, at full output.at 1 MHz.

Settling time: < 1μs to settle to within .05 of final value, tested at full output with no load, 10 Hz to 500 kHz.

Symmetry: ≤ .02% of period + 3 ns.

Triangle/Ramp Characteristics:

Triangle/ramp linearity (10% to 90%, 10 kHz): ± .05% of full p-p output for each range.

Ramp retrace time: ≤ 3 μs, 90% to 10%.

Period variation for alternate ramp cycles ≤ 1% of period.

DC Offset

Range:

DC only (no ac signal): 0 to ± 5.0 V/50Ω

DC + AC: Maximum dc offset ± 4.5V highest range; decreasing to ± 4.5mV lowest range.

Resolution: 4 digits

Accuracy:

DC only: ± .02 mV to ± 20 mV, depends offset chosen.

DC + AC, to 1 MHz: ± .06 mV to ± 60mV depends on ac output level, ± .2 mV to ± 120 mV for ramps to 10 kHz.

DC + AC, 1 MHz to 20 MHz: ± 15 mV to ± 150 mV, depends on AC output level.

Phase Offset

Range:

± 719 .9° with respect to arbitrary starting phase, or assigned zero phase.

Resolution: 0.1°

Increment Accuracy: ± 0.2°

Stability: ± 1.0 degree of phase/°C

Sinewave Amplitude Modulation

Modulation Depth (at full output for each range):

0-100%

Modulation Frequency Range:

DC to 400 kHz (0-21 MHz carrier frequency)

Envelope Distortion:

– 30 dB to 80% modulation at 1 kHz, 0 Vdc offset

Sensitivity:

± 5V peak for 100% modulaiton

Input Impedance: 10kΩ

Connector: Rear panel BNC

Table 3-1. Specifications, Continued

Phase Modulation

Sine Function Range:
± 850°, ± 5V input
Sine Function-Linearity:
± 0.5%, best fit straight line
Squarewave Range: ± 425°
Triangle Range: ± 42.5°
Positive and Negative Ramps: ± 85°
Modulation Frequency Range: DC – 5 kHz
Input Impedance: >40kΩ
Connector: Rear panel BNC

Frequency Sweep

Sweep Time:
Linear: 0.01s to 1000s
Logarithmic: 1s to 1000s single, 0.1s to 1000s continuous
Maximum Sweep Width:
Full frequency range of the main signal output for the wave form in use except minimum log start frequency is 1 Hz.
Minimum Sweep Width:

Function	Minimum sweep width	
	Sweep time .01 sec.	Sweep time 99.9 sec.
Sine	.1 mHz	999.9 mHz
Square	.05 mHz	499.5 mHz
Triangle	.005 mHz	49.95 mHz
Ramps	.01 mHz	99.99 mHz

Minimum log sweep width is 1 decade.
Phase Continuity:
Sweep is phase continuous over the full frequency range of the main output.
Discrete Sweep:
Number of segments: 100 maximum (Start and stop frequencies settalbe for each segment)
Time/segment: 0.01s to 1000s, 0.01s resolution.

Modulation Source:

Frequency Range: Sine 0.1 Hz-10 kHz, Square 0.1 Hz-2 kHz
Frequency Resolution: 2 digits
Frequency Accuracy: Typically 0.1% (Sinewave)
Amplitude Range: 0.1 Vpp to 12 Vpp
Amplitude Resolution: 0.1V
Amplitude Accuracy: Typically ± 200 mV
Impedance: Designed to drive ≥ 10 kΩ loads
Sinewave Purity: Typically better than – 34 dBc
Standard Waveforms: Sine, Square
Arbitrary Waveforms: Vertical resolution 256 points, horizontal resolution 4096 points, 300,000 samples/sec, 10 kHz maximum.
Output Location: Rear Panel BNC

Table 3-1. Specifications, Continued

Auxiliary Outputs

Auxiliary Frequency Output:

Frequency Range: 21 MHz to 60.999.999 99 MHz, underrange coverage to 19.000 000 001 MHz, frequency selectior from front panel.

Amplitude: 0 dBm; output impedance: 50

Connector: Rear panel BNC

Sync Output:

Square wave with $V_{high} \geq 1.2V$ $V_{low} \leq 0.2V$ into 50Ω. Frequency range is the same as the main signal output for front pane sync and DC – 60 MHz for rear panel sync

Output impedance: 50Ω

Connector: BNC front and rear panels.

X-Axis Drive: (0-100s sweeps only)

0 to +10 Vdc linear ramp proportional to sweep frequency; linearity, 10-90%, ±.1% of final value (applies for sweep widths which are integer multiples of the minimum sweep width).

Connector: Rear panel BNC

Sweep Marker Output:

High to low TTL compatible voltage transition at keyboard selected marker frequency. (Linear sweep only.)

Connector: Rear panel BNC

Z-Axis Blank Output:

TTL compatible voltage levels capable of sinking current from a positive source. Current 200 mA, voltage 45V, power dissipation 1 watt maximum.

1 MHz Reference Output:

0 dBm output for phase-locking additional instruments to the HP 3325B.

Connector: Rear panel BNC

10 MHz Oven Output:

0 dBm internal high stability frequency reference output for phase-locking HP 3325B or other instruments (option 001 only).

Connector: Rear panel BNC

Auxiliary Inputs

Reference Input:

For phase-locking HP 3325B to an external frequency reference. Signal from 0 dBm to +20 dBm into 50Ω. Reference signal must be a subharmonic of 10 MHz from 1 MHz to 10 MHz.

Connector: Rear panel BNC. With option 001 this input may be jumpered to the 10 MHz reference output.

Amplitude Modulation Input:

See modulation specifications

Phase Modulation Input:

See modulation specifications.

Remote Control

Frequency Switching Time (to within 1 Hz exclusive of programming time):

≤ 10 ms for 100 kHz step; ≤ 25 msec for 1 MHz step; ≤ 70 msec for 20 MHz step.

Phase Switching Time (to within 90° of phase lock exclusive of programming time:

<30 ms.

HP-IB Interface Functions:

SH1, AH1, T6, L3, SR1, RL1, PP0, DC1, DT1, C0, E1

RS-232 Interface:

Subset of ANSI/EIA-232-D-1986, CCITT V.24

Type: DTE, 25 pin female "D" connector

Baud Rate: 300-4800

Table 3-1. Specifications, Continued

Option 001 High Stability Frequency Reference

Aging Rate:

± 5 x 10^{-8}/week, after 72 hours continuous operation; ± 1 x 10^{-7} mo., after 15 days continuous operation.

Warm-up Time:

Reference will be within ± 1 x 10^{-7} of final value 15 minutes after turn-on at 25°C for an off time of less than 24 hours.

Option 002 High Voltage Output

Frequency Range: 1μHz to 1 MHz

Amplitude:

Range: 4.00 mV to 40.00 Vpp in 8 ranges, 4-12-40 sequence, into 500Ω <500 pF load. Ranges are four times the standard instrument ranges, without dc offset.

Accuracy: ± 2% of full output for each range at 2 kHz.

Flatness: ± 10% relative to programmed amplitude.

Sinewave Distortion:

Harmonically related signals will be less than the following levels (relative to the fundamental full output into 500Ω, load):

10 Hz-50 kHz: − 65 dB

50 kHz-200 kHz: − 60 dB

200 kHz-1 MHz: − 40 dB

Square Wave Rise/Fall Time:

± 125 ns, 10% to 90% at full output, with 500Ω, 500 pF load.

Output Impedance:

<2Ω at dc, <10Ω at 1 MHz

DC Offset:

Range: 4 times the specified range of the standard instrument.

Accuracy: ± (1% of full output for each range + 25mV).

Maximum Output Current:

± 20 mA peak

General

Operating Environment:

Temperature: 0°C to 55°C

Relative Humidity: 95%, 0°C to 40°C

Altitude: ≤ 15,000 ft.

Acoustic Noise Emission:

LpA <70 dB (sound pressure level)
operator position
normal operation per ISO 7779

Power:

100/120/220/240V, +5%, − 10%; 48 to 66 Hz;
90 VA, 120 VA with all options

Weight:

9 kg (20 lbs) net; 14.5 kg (32 lbs) shipping

Dimensions:

133.4 mm high x 425.5 mm wide x 498.5 mm deep
(5 1/4" H x 16 3/4" W x 19 5/8" D)

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Hewlett-Packard Sales and Service Offices

To obtain Servicing information or to order replacement parts, contact the nearest Hewlett-Packard Sales and Service Office listed in HP Catalog, or contact the nearest regional office listed below:

In the United States
California
P.O. Box 4230
1421 South Manhattan Avenue
Fullerton 92631

Georgia
P.O. Box 105005
2000 South Park Place
Atlanta 30339

Illinois
5201 Tollview Drive
Rolling Meadows 60008

New Jersey
W. 120 Century Road
Paramus 07652

In Canada
Hewlett-Packard (Canada) Ltd.
17500 South Service Road
Trans-Canada Highway
Kirkland, Quebec H9J 2M5

In France
Hewlett-Packard France
F-91947 Les Ulis Cedex
Orsay

In German Federal Republic
Hewlett-Packard GmbH
Vertriebszentrale Frankfurt
Berner Strasse 117
Postfach 560 140
D-6000 Frankfurt 56

In Great Britain
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King Street Lane
Winnersh, Wokingham
Berkshire RG11 5AR

In Other European Countries
Switzerland
Hewlett-Packard (Schweiz) AG
7, rue du Bois-du-Lan
Case Postale 365
CH-1217 Meyrin

In All Other Locations
Hewlett-Packard Inter-Americas
3155 Porter Drive
Palo Alto, California 94304

HEWLETT PACKARD

HP 3325B Installation Manual

Warranty

The information contained in this document is subject to change without notice.

Hewlett-Packard makes no warranty of any kind with regard to this material, including, but not limited to, the implied warranties or merchantability and fitness for a particular purpose.

Hewlett-Packard shall not be liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance, or use of this material.

Safety Summary

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements. This is a Safety Class 1 instrument.

Ground the Instrument

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three-conductor ac power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable meet International Electrotechnical Commission (IEC) safety standards.

Do Not Operate in an Explosive Atmosphere

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

Keep Away from Live Circuits

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

Do Not Service or Adjust Alone

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

Do Not Substitute Parts or Modify Instrument

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Hewlett-Packard Sales and Service Office for service and repair to ensure the safety features are maintained.

Dangerous Procedure Warnings

Warnings accompany potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

Safety Symbols

The following safety symbols are used throughout this manual and in the instrument. Familiarize yourself with each symbol and its meaning before operating this instrument.

General Definitions of Safety Symbols Used on Equipment or in Manuals

Instruction manual symbol. The product is marked with this symbol when it is necessary for the user to refer to the instruction manual to protect against damage to the instrument.

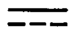
Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 volts must be so marked).

Protective ground (earth) terminal. Used to identify any terminal which is intended for connection to an external protective conductor for protection against electrical shock in case of a fault, or to the terminal of a protective ground (earth) electrode.

Low-noise or noiseless, clean ground (earth) terminal. Used for a signal common, as well as providing protection against electrical shock in case of a fault. A terminal marked with this symbol must be connected to ground in the manner described in the installation (operating) manual, and before operating the equipment.

Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.

Alternating current (power line).



Direct current (power line).

Alternating or direct current (power line).

Warning

The warning sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which if not correctly performed or adhered to, could result in injury or death to personnel.

Caution

The caution sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product or the user's data.

Hewlett-Packard
8600 Soper Hill Road
Everett, Washington 98205-1298

Printed in U.S.A

Installation Manual
HP 3325B
Synthesizer/Function Generator

Serial Numbers
All

HEWLETT
PACKARD

HP Part Number: 03325-90007
Microfiche Part Number: 03325-90207
Printed in U.S.A.

Print Date: December 1991

8600 Soper Hill Road, Everett, WA 98205-1298

Warning

To prevent potential fire or shock hazard, do not expose equipment to rain or moisture.

HEWLETT PACKARD

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and the calibration facilities of other International Standards Organization Members.

WARRANTY

This Hewlett-Packard product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by HP. Buyer shall prepay shipping charges to -hp- and -hp- shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to -hp- from another country.

HP software and firmware products which are designated by HP for use with a hardware product, when properly installed on the hardware product, are warranted not to fail to execute their programing instructions due to defects in materials and workmanship. If HP receives notice of such defects during their warranty period, HP shall repair or replace software media and firmware which do not execute their programming instructions due to such defects. HP does not warrant that the operation of the software, firmware or hardware shall be uninterrupted or error free.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HEWLETT-PACKARD SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HEWLETT-PACKARD SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

HEWLETT PACKARD

SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements. This is a Safety Class 1 instrument.

GROUND THE INSTRUMENT

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three-conductor ac power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable meet International Electrotechnical Commission (IEC) safety standards.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

DO NOT SERVICE OR ADJUST ALONE

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Hewlett-Packard Sales and Service Office for service and repair to ensure the safety features are maintained.

DANGEROUS PROCEDURE WARNINGS

Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

Warning **Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting.**

HEWLETT PACKARD

SAFETY SYMBOLS

General Definitions of Safety Symbols Used On Equipment or In Manuals.

⚠	Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the instrument.
ϟ	Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 volts must be so marked.)
⏚ OR (⏚)	Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating equipment.
(⏚)	Low-noise or noiseless, clean ground (earth) terminal. Used for a signal common, as well as providing protection against electrical shock in case of a fault. A terminal marked with this symbol must be connected to ground in the manner described in the installation (operating) manual, and before operating the equipment.
⊥ OR ⊥	Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.
∼	Alternating current (power line.)
⎓	Direct current (power line.)
≂	Alternating or direct current (power line.)

Warning — **The WARNING sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which if not correctly performed or adhered to, could result in injury or death to personnel.**

Caution — The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.

Note — The NOTE sign denotes important information. It calls attention to procedure, practice, condition or the like, which is essential to highlight.

Table of Contents

Chapter4

HP 3325B Installation

This section contains instructions for installing and interfacing the HP 3325B Synthesizer/Function Generator as well as tests to verify performance. Included are initial inspection procedures, power and grounding requirements, operating environment, available accessories and options, installation instructions, interfacing procedures, and instructions for repacking and shipping.

There are two sets of tests: the first, operational verification, is a subset of the second, performance tests, an exhaustive test of the HP 3325B specifications. The operational verification is typically used as an incoming inspection tool upon initial receipt. The performance tests are used just before shipping from the factory, after any service work, and when a full calibration is performed.

General Installation Information

Initial Inspection

The HP 3325B was carefully inspected both mechanically and electrically before shipment. It should be free of mars or scratches and in perfect electrical order upon receipt. To assure that this is the case, perform the following steps:

- Inspect the HP 3325B for physical damage incurred in transit. If the HP 3325B was damaged in transit, file a claim with the carrier.

Warning ***The integrity of the protective earth ground may be interrupted if the HP 3325B is mechanically damaged. Under no circumstances should the HP 3325B be connected to power if it is damaged.***

- Check for supplied accessories (listed in Chapter 3 of the Operating Manual).

Inspection will be completed after testing the electrical performance using the Operational Verification tests which appear later in this document. Also included in this document is the Performance Test. This is a very detailed test procedure designed to verify that the HP 3325B meets all the performance specifications.

Power Requirements

Caution *Before applying ac line power to the HP 3325B, ensure the voltage selector on the HP 3325B rear panel is set for the proper line voltage and the correct line fuse is installed in the fuse holder. Procedures for changing the line voltage selector and fuse are contained in the following section for "Line Voltage Selection."*

The HP 3325B can operate from any single phase ac power source supplying 100V, 120V, 220V or 240V in the frequency range from 47 to 66 Hz (see table 4-1). With all options installed, power consumption is less than 100 VA.

Table 4-1. Line Voltage Ranges

Selector Voltage	AC Voltage Range
100	90-108V
120	108-126V
220	198-231V
240	216-252V

Line Voltage Selection

The line voltage selector is set at the factory to correspond to the most commonly used line voltage of the country of destination. The line voltage selected for the HP 3325B is indicated on the line voltage selector (refer to figure 4-1). Refer to table 4-2 for the line voltage ranges and table 4-3 to set the line voltage and select the appropriate fuse. To change the line voltage and fuse:

1. Remove the power cord.
2. Pry open the power selector cover on the rear panel with a small screwdriver (see figure 4-1).
3. To check or replace the fuse, pull the white fuse holder out of the power selector and remove the fuse from the fuse holder.
4. To reinstall the fuse, insert a fuse with the proper rating into the fuse holder. The white arrow on the fuse holder handle should point toward the top of the instrument. Push the fuse holder into the power selector.
5. To change the line voltage, remove the cylindrical line voltage selector.

Caution *Remove line voltage selector to change voltage. Rotating the selector without removing the cylinder could damage the module.*

6. Reinstall the cylindrical line voltage selector and ensure the required voltage label is facing out of the power selector. The cylinder is keyed so that it can not be installed backwards.
7. Close the power selector by pushing the side catches in (toward the center of the cover) and then pressing down firmly on the cover.
8. Check that the correct line voltage appears through the window in the power selector cover.

Table 4-2. Line Voltage and Fuse Selection

Line Setting	Fuse Type	HP Part Number
100V/120V	1.5A 250V Quick-Acting (F)	2110-0876
220V/240V	750 mA 250V Quick-Acting (F)	2110-0877

Over-Voltage Protect Circuit Breaker

In addition to the current protection provided by the line fuse, the HP 3325B is protected by an over-voltage circuit breaker. This device disconnects the power supply from the main power connector when the line voltage exceeds the upper limit. The reset switch, located on the rear panel (figure 4-1), pops out when this occurs. If this occurs:

1. Turn the power switch to STANDBY (⏻) and disconnect the power cord.
2. Check the setting of the line-voltage selector, as described earlier in this chapter, to be sure that it matches the power connected to the HP 3325B.

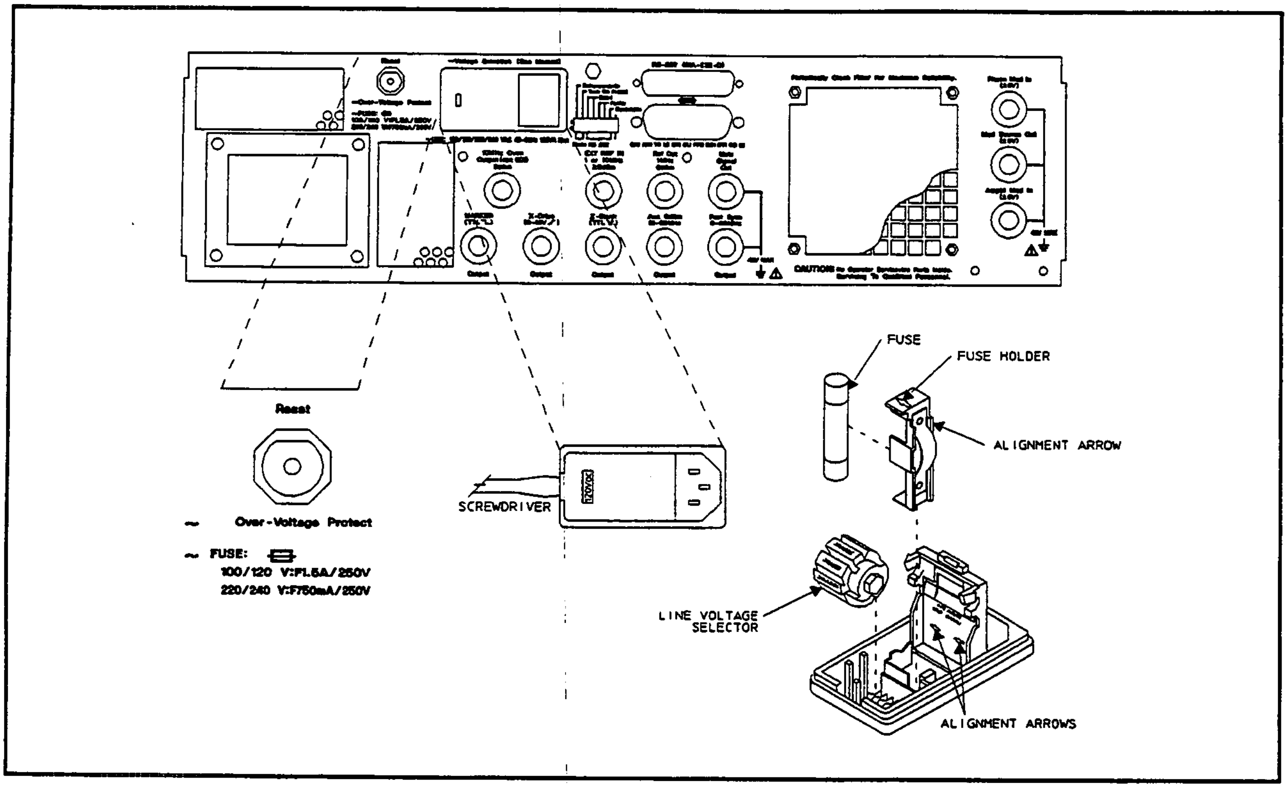


Figure 4-1. Line Voltage Selection, Fuse Replacement, and Circuit Breaker

3. Reset the circuit breaker by pushing the reset switch on the rear panel.
4. Reconnect the power cord and turn the power switch on.

If the circuit breaker pops out when power is restored and the line voltage level is within the limits described in table 4-1, send the HP 3325B to a qualified service facility for repair.

Warning ***Line voltages should be measured by a qualified service person who is aware of the hazards involved.***

If the circuit breaker does not open and the HP 3325B does not operate, remove power and check line fuse.

Power Cable and Grounding Requirements

The HP 3325B is equipped with a three-conductor power cord which, when plugged into an appropriate receptacle, grounds the HP 3325B cabinet. The type of power cable plug shipped with each instrument depends on the country of destination. Refer to figure 4-2 for the part number of the power cable and plug configurations available.

Warning ***The power cable plug must be inserted into an outlet provided with a protective earth terminal. Defeating the protection of the grounded instrument cabinet can subject the operator to lethal voltages.***

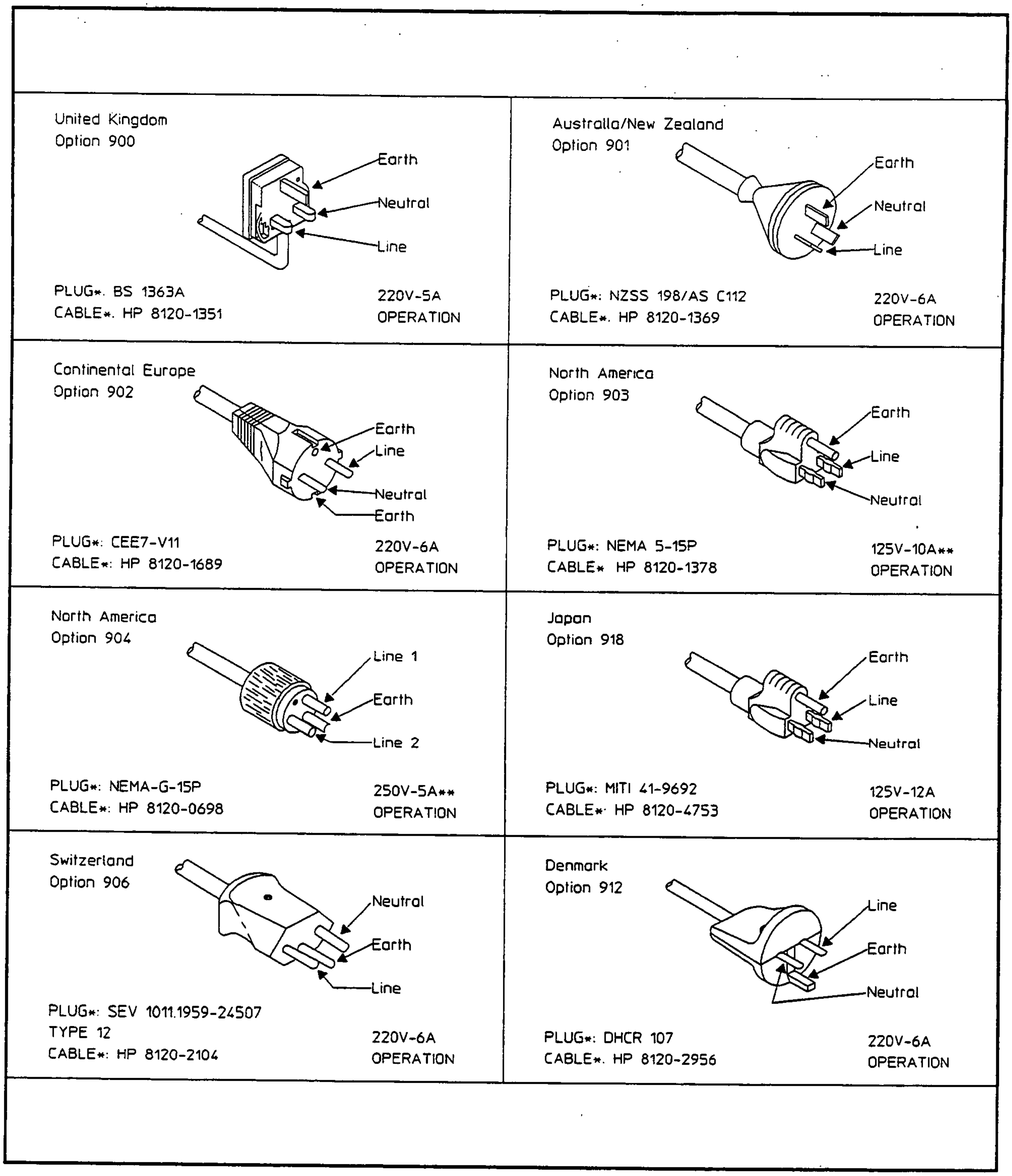


Figure 4-2. Power Cables

* The number shown for the plug is the industry identifier for the plug only. The number shown for the cable is an HP part number for a complete cable including the plug.

** UL listed for use in the United States of America.

Operating Environment

The following summarizes the HP 3325B operating environment ranges. In order for the HP 3325B to meet specifications, the operating environment must be within these limits.

Warning ***The HP 3325B is not designed for outdoor use. To prevent potential fire or shock hazard, do not expose the HP 3325B to rain or other excessive moisture.***

Temperature

The HP 3325B may be operated in temperatures from 0°C to 55°C.

Humidity

The HP 3325B may be operated in environments with humidity up to 95% (0°C to +40°C). However, the HP 3325B should be protected from temperatures or temperature changes which cause condensation within the instrument.

Altitude

The HP 3325B may be operated at altitudes up to 4572 meters (15,000 feet).

Instrument Cooling

The HP 3325B is equipped with a cooling fan mounted on the rear panel. The HP 3325B should be mounted so that air can freely circulate through it. When operating the HP 3325B, choose a location that provides at least 75 mm (3 inches) of clearance at the rear, and at least 25 mm (1 inch) of clearance at each side. Failure to provide adequate air clearance will result in excessive internal temperature, reducing instrument reliability. The filter for the cooling fan can be cleaned without removing it. The filter (HP part number 3150-0387) should be cleaned with a vacuum cleaner every thirty days.

Installation

The HP 3325B is shipped with plastic feet in place, ready for use as a portable bench instrument. The plastic feet are shaped to make full width modular instruments self-align when they are stacked. The clearances provided by the plastic feet in bench stacking and the filler strip in rack mounting allow air passage across the top and bottom cabinet surfaces.

A front handle kit can be installed for ease of handling the HP 3325B on the bench. The part number for the front handle kit is listed in table 3-3 of the *HP 3325B Operating Manual*.

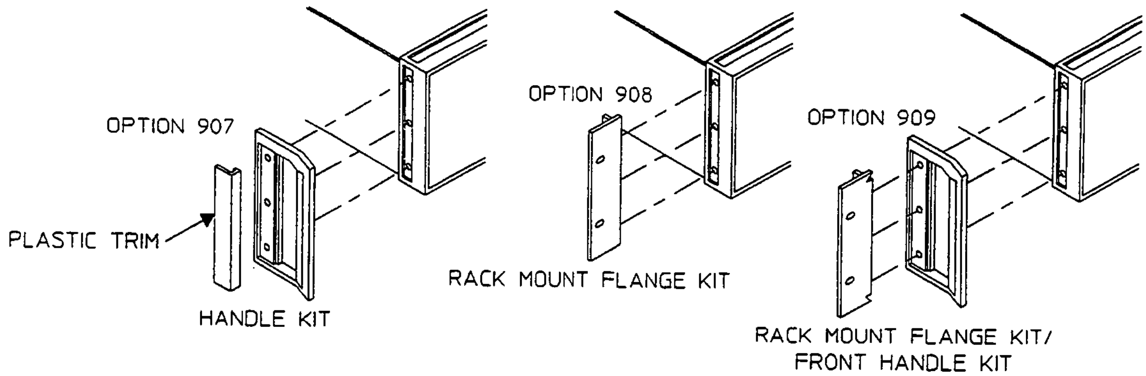


Figure 4-3. Rack Mount and Handle Kits

Option 908 (rack mount flange kit) and 909 (rack mount flange kit with handles) enable the HP 3325B to be mounted in an equipment cabinet. The rack mount for the HP 3325B is EIA standard width of 482.6 mm (19 inches). To install the HP 3325B in an equipment cabinet:

- If installed, remove the plastic trim (see figure 4-3) and front handles from the HP 3325B.
- Remove the plastic feet from the bottom of the HP 3325B.
- Install the rack flange kit with or without handles according to instructions included with the kit. (Kit part numbers are listed in figure 3-3 of the HP 3325B Operation Manual.)

Note The rack mount flange kit of Option 908 will not provide the space requirement for rack mounting when used with the front handle kit of Option 907. If front handles are not available, use the combination kit of Option 909 to rack mount with handles. If Option 907 front handles are available, use Rack Mount Flange Kit, HP part number 5062-4072 to add rack mounting.

- Install an instrument support rail on each side of the instrument cabinet. (The instrument support rails, used to support the weight of the instrument, are included with HP instrument cabinets.)
- Lift the HP 3325B to its position in the cabinet on top of the instrument support rails.
- Using the appropriate screws, fasten the HP 3325B rack mount flanges to the front of the instrument cabinet.

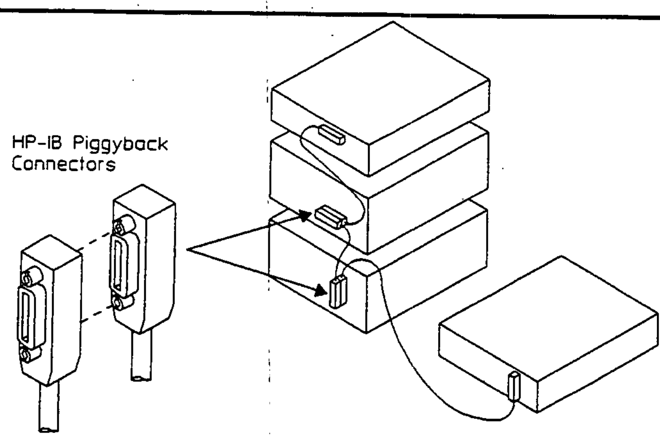


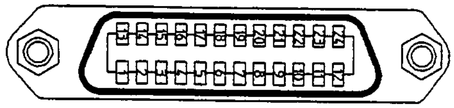
Figure 4-4. Typical HP-IB System Interconnection

HP-IB System Interface Connections

The HP 3325B instrument is compatible with the Hewlett-Packard Interface Bus (HP-IB). The HP-IB is Hewlett-Packard's implementation of IEEE Standard 4881978 and ANSI Standard MC 1.1. The HP 3325B is connected to the HP-IB by connecting an HP-IB interface cable to the connector located on the rear panel. Figure 4-4 illustrates a typical HP-IB system interconnection.

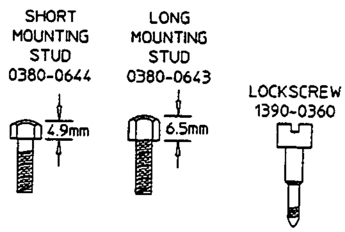
With the HP-IB system, up to 15 HP-IB compatible instruments can be interconnected. The HP 10833 HP-IB cables have identical piggy-back connectors on each end so that several cables can be connected to a single source without special adapters or switch boxes. System components and devices can be connected in virtually any configuration. There must, of course, be a path from the controller to every device operating on the bus. As a practical matter, avoid stacking more than three or four cables on any one connector. If the stack gets too long, any force on the stack can damage the connector mounting. Be sure that each connector is firmly screwed in place to keep it from working loose during use. The HP 3325B uses all the available HP-IB lines, therefore, any damaged connector pins may adversely affect HP-IB operation. Refer to figure 4-5 for a description of the HP-IB connector.

Caution *The HP 3325B contains metric threaded HP-IB cable mounting studs as opposed to English threads. Metric threaded HP 10833A, B, C ,or D HP-IB cable lockscrews must be used to secure the cable to the instrument. Identification of the two types of mounting studs and lockscrews is made by their color. English threaded fasteners are colored silver and metric threaded fasteners are colored black. DO NOT mate silver and black fasteners to each other or the threads of either or both will be destroyed. Metric threaded HP-IB cable hardware illustrations and part numbers follow.*



Caution

The HP 3325B contains metric threaded HP-IB cable mounting studs as opposed to English threads Metric threaded HP 10833A, B, C, or D HP-IB cable lockscrews must be used to secure the cable to the instrument. Identification of the two types of mounting studs and lockscrews is made by their color English threaded fasteners are colored silver and metric threaded fasteners are colored black. DO NOT mate silver and black fastners to each other or the threads of eitheror both will be destroyed Metric threaded HP-IB cable hardware illustrations and part numbers follow.



HP-IB Interconnect Cables	
Part Number	Length
10833A	1 m (3.3 ft)
10833B	2 m (6.6 ft)
10833C	4 m (13.2 ft)
10833D	0.5 m (1.6 ft)

PIN	LINE
1	D101
2	D102
3	D103
4	D104
13	D105
14	D106
15	D107
16	D108
5	D01
17	REN
6	DAV
7	NRFD
8	NDAC
9	IFC
10	SRQ
11	ATN
12	SHIELD-CHASSIS GROUND
18	P/O TWISTED PAIR WITH PIN 6
19	P/O TWISTED PAIR WITH PIN 7
20	P/O TWISTED PAIR WITH PIN 8
21	P/O TWISTED PAIR WITH PIN 9
22	P/O TWISTED PAIR WITH PIN 10
23	P/O TWISTED PAIR WITH PIN 11
24	ISOLATED DIGITAL GROUND

Figure 4-5. HP-IB Connector Information

To achieve design performance with the HP-IB, proper voltage levels and timing relationships must be maintained. If the system cable is too long, the lines cannot be driven properly and the system will fail to perform (see figure 4-5 for HP-IB cable lengths). Therefore, when interconnecting an HP-IB system, it is important to observe the following rule:

> Total cable length for the system must be less than or equal to 20 meters (65 feet) or 2 meters (6 feet) times the total number of devices connected to the bus, whichever is less.

Storage And Shipment

The HP 3325B should be stored in a clean, dry environment. The following are environmental limitations that apply to both storage and shipment:

Temperature	−40°C to +75°C
Humidity	Up to 95%
Altitude	Up to 15,300 meters (50,000 feet)

The HP 3325B should also be protected from temperatures or temperature changes which cause condensation within the instrument.

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 service, 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.

The following general instructions should be used for repacking with commercially available materials:

- Wrap the instrument in heavy paper or anti-static plastic. If shipping to a Hewlett-Packard office or service center, attach a tag to the instrument indicating type of service required, return address, model number, and full serial number.
- Use a strong shipping container. A double-wall carton made of 350-pound test material is adequate.
- Use a layer of shock absorbing material 70 to 100 mm (3 to 4 inch) thick around all sides of the HP 3325B to provide firm cushioning and prevent movement inside of the container. Protect the control panel with cardboard.

Caution *Styrene pellets in any shape should not be used as packing material. The pellets do not adequately cushion the instrument and do not prevent the instrument from shifting in the carton. The pellets also create static electricity which can damage electronic components.*

- Seal shipping container securely.
- Mark shipping container FRAGILE to ensure careful handling.
- In any correspondence, refer to the instrument by model number and full serial number.

Operational Verification

The following procedures are recommended for incoming inspection and for testing the instrument after repair. Additional tests to be performed following repair of certain circuits are indicated in Section VIII of the *HP 3325B Service Manual*. An Operational Verification Record is located at the end of this section. For ease of recording the test data at various times, copies of the blank Operational Verification Record may be made without written permission from Hewlett-Packard.

Operational Verification includes the following procedures:

- Self Test
- Sine Wave Verification
- Square Wave Verification
- Triangle and Ramp Verification
- Amplitude Flatness Check
- Sync Output Check
- Frequency Accuracy
- Output Level and Attenuator Check
- Harmonic Distortion
- Close-in Spurious Signal

Required Test Equipment

The test equipment required for Operational Verification is listed in table 4-3. Any equipment that satisfies the critical specifications given in the table may be substituted for the recommended model.

Table 4-3. Test Equipment Required for Operational Verification

Instrument	Critical Specifications	Recommended Model
Analog Oscilloscope	Vertical: Bandwidth: dc to 100 MHz Deflection: 0.01 to 5 V/div Horizontal: Sweep: 0.05 μs to 0.5 s/div × 10 Magnification Delayed Sweep	TEK 2245 HP 1740A (Alternate)
Electronic Counter	Frequency measurement to 20 MHz Accuracy: ± 2 counts Resolution: 8 digits	HP 5328A with Option 010, 040, and 041 HP 5328B with Opt. 010
DC Digital Voltmeter	Ranges: 0.1 to 100V Resolution: 5 1/2 digits Accuracy: ± 0.1%	HP 3455A/3478A

Table 4-3. Test Equipment Required for Operational Verification (Cont'd)

Instrument	Critical Specifications	Recommended model
50Ω Feedthru Termination	Accuracy: ± 0.2% Power Rating: 1W	HP 11048C
High Frequency Spectrum Analyzer	Frequency Range: 1 to 80 MHz Amplitude Accuracy: ± 0.5 dB Noise: >70 dB below reference	HP 141T/ 8552B/ 8553B/ 8566A/B/8568A/B
Low Frequency Spectrum Analyzer	Frequency Range: 100 Hz to 50 kHz Amplitude Range: 2 mV to 20V Noise: >80 dB below input reference or −140 dBv	HP 3580A/3585A/B
Resistor	470Ω 2W 5%	HP 0698-3634
Resistor	56.2Ω 1/8W 1.0%	HP 0757-0395
Adapter	BNC female-to-dual banana plug	HP 1251-2277

Self Test

This test uses the control, ROM, and control clock circuits to verify operation of these and other circuits. The following front panel indications result from this test.

LED check: Turns on all LEDs for about two seconds.

The following messages are displayed for about one second:

PASS 0 or FAIL 02*n* – tests Amptd Cal of dc offset.
PASS 1 or FAIL 02*n* – tests Amptd Cal of sine wave.
PASS 2 or FAIL 02*n* – tests Amptd Cal of square wave.
PASS 3 or FAIL 02*n* – tests Amptd Cal of triangle wave.
(*n* is a number from 0 to 9)

Press the blue [Shift] key, then press the [Amptd Cal] key. All LEDs should light, and the display should not indicate any failures.

Sine Wave Verification

This procedure visually checks the sine wave output for the correct frequency and any visible irregularities.

Equipment Required: Analog Oscilloscope

a. Connect the HP 3325B signal output to the oscilloscope vertical input. Set the input switch to the 50Ω position. If your oscilloscope does not have a 50Ω input, use a 50Ω feedthru termination at the input.

b. Set the HP 3325B as follows:

High Voltage Output (option 002)	Off
Function	Sine
Frequency	20 MHz
Amplitude	10 V_{pp}

c. Set the oscilloscope vertical control to 2 V/div, horizontal to 0.05 μs/div.

d. The oscilloscope should display one cycle per division, approximately five divisions peak-to-peak.

e. Change the HP 3325B frequency to 1 MHz.

f. Change oscilloscope horizontal control to 0.1 μs/div.

g. The oscilloscope should display one sine wave having no visible irregularities.

High Voltage Output (option 002)

h. Set the oscilloscope vertical control to 5 V/div.

i. Set the oscilloscope input switch to 1 MΩ dc coupled position (or disconnect external 50Ω feedthru termination).

j. Select the high voltage output on the HP 3325B. A LED near the key indicates that the high voltage output is on.

k. Change the amplitude to 40 V_{pp}. The oscilloscope should display one sine wave approximately eight divisions peak-to-peak having no visible irregularities.

l. Turn off the high voltage output.

Square Wave Verification

This procedure checks the square wave output for frequency, rise time, and aberrations.

Equipment Required: Analog Oscilloscope

a. Connect the HP 3325B signal output to the oscilloscope vertical input. Set the input switch to the 50Ω position. If your oscilloscope does not have a 50Ω input, use a 50Ω feedthru termination at the input.

b. Set the HP 3325B as follows:

High Voltage Output (option 002)	Off
Function	Square
Frequency	1 MHz
Amplitude	10 V_{pp}

c. Set the oscilloscope vertical control to 2 V/div, horizontal to 0.2 μs/div. The oscilloscope should display two square waves, approximately five divisions peak-to-peak.

d. Switch the oscilloscope vertical control to 1 V/div, so that the aberrations (overshoot and ringing) can be measured. Aberration excursion should be less than 500 mV (1/2 div).

e. Repeat step d at 2 kHz and 0.1 ms/div.

f. Adjust the oscilloscope vertical and horizontal controls so that the square wave rise time between the 10% and 90% points can be measured. Rise time should be less than 20 ns.

Triangle and Ramp Verification

This procedure checks the triangle and ramp output signals for frequency, shape, and ramp retrace time.

Equipment Required: Analog Oscilloscope

a. Connect the HP 3325B signal output to the oscilloscope vertical input. Set the input switch to the 50Ω position. If your oscilloscope does not have a 50Ω input, use a 50Ω feedthru termination at the input.

b. Set the HP 3325B as follows:

High Voltage Output (option 002)	Off
Function	Triangle
Frequency	10 kHz
Amplitude	10 V_{pp}

c. Set the oscilloscope vertical control to 2 V/div, horizontal to 0.1 ms/div. The oscilloscope should display one triangle wave per division, approximately five divisions peak-to-peak.

d. Change the HP 3325B function to positive slope ramp. The display should be one ramp per division, approximately five divisions peak-to-peak.

e. Change the function to negative slope ramp. The display should be one ramp per division, approximately five divisions peak-to-peak.

f. Change the oscilloscope horizontal and vertical controls so that the ramp retrace time from the 90% to 10% points can be measured. Retrace time should be less than 3 μs.

g. Change the HP 3325B function to positive slope ramp and repeat step f.

h. Change the function to triangle.

i. Set oscilloscope vertical control to 2 V/div, horizontal to 10 μs/div. The oscilloscope should display one triangle wave with no visible irregularities in either slope.

Amplitude Flatness Check

This procedure provides a visual check of the sine wave amplitude flatness.

Equipment Required: Analog Oscilloscope

a. Connect the HP 3325B signal output to the oscilloscope vertical input. Set the input switch to the 50Ω position. If your oscilloscope does not have a 50Ω input, use a 50Ω feedthru termination at the input.

b. Set the HP 3325B as follows:

High Voltage Output (option 002)	Off
Function	Sine
Frequency	2 kHz
Amplitude	10 V_{pp}
Sweep Start Freq	0 Hz
Sweep Stop Freq	20 MHz
Sweep Marker Freq	5 MHz
Sweep Time	0.01 sec

c. Connect the HP 3325B X-Drive output to the oscilloscope channel B input. Connect the signal output to the oscilloscope channel A input.

*d. Set the oscilloscope as follows:

Display	A vs B
Channel A Sensitivity (uncal – adjust for full vertical deflection)	1 V/div
Channel B Sensitivity (uncal – adjust for full horizontal sweep)	0.5 V/div

**Settings may vary from one oscilloscope to another. Note that whichever oscilloscope is used, it should be operated in a X-Y mode with the HP 3325B X-Drive output driving the horizontal (X) channel and the signal output driving the vertical (Y) channel.*

e. Press the HP 3325B [Start Cont] key.

f. The oscilloscope display should show a sweep that is essentially flat, dropping no more than 3.5%. Any dc variations should be ignored, taking the peak-to-peak reading for flatness comparison.

Sync Output Check

This test verifies the sync output signal levels.

Equipment Required: Analog Oscilloscope

a. Connect the HP 3325B sync output to the oscilloscope vertical input. Set the input switch to the 50Ω position. If your oscilloscope does not have a 50Ω input, use a 50Ω feedthru termination at the input.

b. Set the HP 3325B function to sine, frequency to 20 MHz.

c. Adjust the oscilloscope controls to measure the high and low voltage levels of the sync square wave. The high level should be greater than +1.2V and the low level should be less than +0.2V.

Frequency Accuracy

This test compares the accuracy of the HP 3325B output signal to the following specification:

$\pm 5 \times 10^{-6}$ of selected frequency (20°C to 30°C).

Equipment Required: Electronic Counter (calibrated within three months or with an accurate 10 MHz external reference input)

a. Connect the HP 3325B signal output to the electronic counter channel A input with a 50Ω feedthru termination. Allow HP 3325B to warm up for 20 minutes and the counter to warm up for its specified period.

b. Set the HP 3325B output as follows:

Function	Sine
Frequency	20 MHz
Amplitude	0.99 V_{pp}
DC Offset	0V

c. Set the counter to count the frequency of the A input with 0.1 Hz resolution, and adjust for stable triggering. Electronic counter should indicate 20 000 000.0 Hz ±100 Hz.

d. Change the HP 3325B function to square wave. Frequency automatically changes to 10 MHz. Electronic counter should indicate 10 000 000.0 Hz ±50 Hz.

e. Change the function to triangle. Frequency automatically changes to 10 kHz. Move the counter input to the sync output of the HP 3325B. Set the counter to average 1000 periods. Electronic counter should indicate 100 000.00 ns ±0.5 ns.

f. Change the function to positive slope ramp. Electronic counter should indicate 100 000.00 ns ±0.5 ns.

Output Level and Attenuator Check

This procedure checks the output level and the attenuator by using the "dc only" function.

Equipment Required: DC Digital Voltmeter
50Ω Feedthru Termination

a. Connect the HP 3325B signal output directly to a 50Ω feedthru termination and then with a cable to the voltmeter input.

b. If the instrument has high voltage output (option 002), make sure the high voltage output is off (high voltage indicator light in the lower right corner of the front panel is off).

c. Press whichever function key is presently active, indicated by a lighted indicator beside the key. This removes the ac output. The indicator beside the [DC Offset] key should light.

d. Set the HP 3325B dc offset to −5V, then press the [Amptd Cal] key.

e. The voltmeter reading should be −4.980 to −5.020 V.

f. Change the HP 3325B dc offset to +5V. Voltmeter reading should be +4.980 to +5.020 V.

g. Change the HP 3325B dc offset to the following voltages. The voltmeter reading should be within the tolerances shown.

DC Offset	Tolerances
±1.499V	±1.49300 to 1.50499 V
±499.9 mV	±0.49790 to 0.50190 V
±149.9 mV	±0.14930 t o 0.15050 V
±49.99 mV	±0.04979 to 0.05019 V
±14.99 mV	±0.01493 to 0.01505 V
±4.999 mV	±0.004979 to 0.005019 V
±1.499 mV	±0.001479 to 0.001519 V

High Voltage Output (option 002) DC Offset

h. Remove the 50Ω feedthru termination and connect the HP 3325B output directly to the voltmeter input.

i. Select high voltage output on the HP 3325B. A LED near the key indicates that high voltage output is on.

j. Set the HP 3325B dc offset to 20V. Voltmeter reading should be +19.775 to +20.225 V.

k. Set the HP 3325B dc offset to −20V. Voltmeter reading should be −19.775 to −20.225 V.

Harmonic Distortion

This procedure tests the harmonic distortion of the HP 3325B sine wave output to the following specifications:

Harmonic Distortion (relative to fundamental)

Fundamental Frequency	No Harmonic Greater Than
0.1 Hz to 50 kHz	−65 dB
50 to 200 kHz	−60 dB
200 kHz to 2 MHz	−40 dB
2 to 15 MHz	−30 dB
15 to 20 MHz	−25 dB

Equipment Required: High Frequency Spectrum Analyzer
Low Frequency Spectrum Analyzer
50Ω Feedthru Termination
Resistor 470Ω 2W 5%
Resistor 56.2Ω 1/8W 1%

a. Set the HP 3325B output as follows:

High Voltage Output (option 002)	Off
Function	Sine
Frequency	20 MHz
Amplitude	999 mV_{pp}

b. Connect the HP 3325B signal output to the high frequency spectrum analyzer 50Ω input.

c. Set the spectrum analyzer controls to display the fundamental and at least four harmonics. Verify that all harmonics are 25 dB below the fundamental.

d. Set the HP 3325B to 15 MHz and verify that all harmonics are at least 30 dB below the fundamental.

e. Disconnect the HP 3325B from the high frequency spectrum analyzer and connect it to the low frequency spectrum analyzer 50Ω input. Set the HP 3325B to the following frequencies and verify the specified levels, relative to the fundamental.

2 MHz	−40 dB
200 kHz	−60 dB

f. Set the HP 3325B frequency to 50 kHz and the amplitude to 9.99 mV_{pp}.

g. Set the spectrum analyzer controls to display the fundamental and at least three harmonics. (It may be necessary to decrease the video bandwidth to separate the harmonics from the noise floor.) Verify that all harmonics are at least 65 dB below the fundamental.

h. Set the HP 3325B to the following frequencies and verify that all harmonics are 65 dB below the fundamental.

10 kHz
1 kHz
100 Hz

High Voltage Output (option 002)

i. Connect the HP 3325B signal output to the low frequency spectrum analyzer high impedance input (see figure 4-6).

j. Select the high voltage output on the HP 3325B. Set the amplitude to 40 V_{pp} and the frequency to 100 Hz.

k. Set the spectrum analyzer controls to display the fundamental and at least three harmonics. Verify that all harmonics are 65 dB below the fundamental.

l. Set the HP 3325B to the following frequencies and verify that their harmonics are below the specified levels, relative to the fundamental.

10 kHz	−65 dB
200 kHz	−60 dB
1 MHz	−40 dB

m. Turn off the high voltage output.

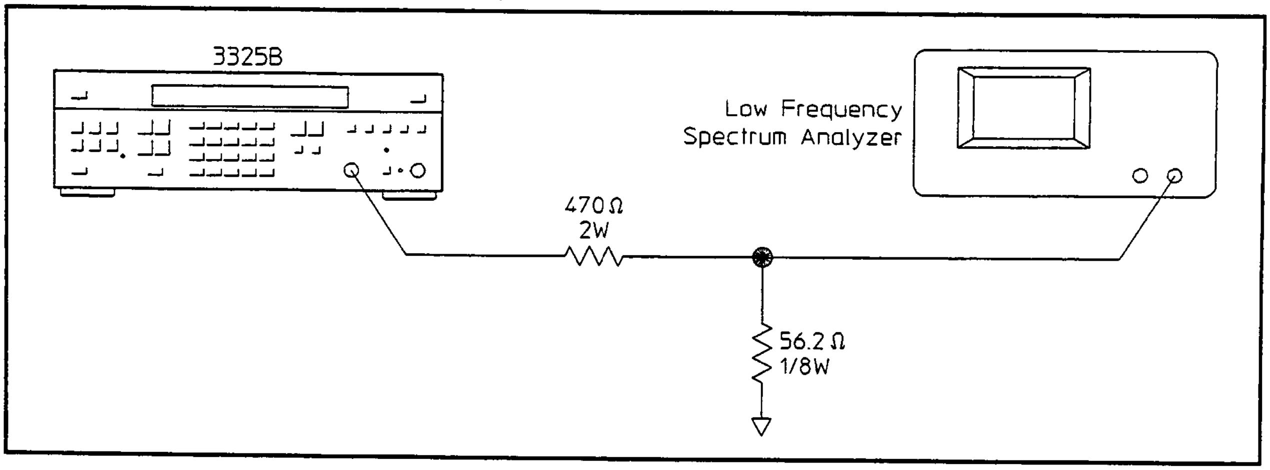


Figure 4-6. Harmonic Distortion Verification (High Voltage Output).

Close-In Spurious Signal

This procedure tests the sine wave output for spurious signals which may be generated by the HP 3325B frequency synthesis circuits. The spurious signals must be more than 70 dB lower than the fundamental signal.

Equipment Required: Spectrum Analyzer

a. Set the HP 3325B as follows:

High Voltage Output (option 002)	Off
Function	Sine
Frequency	20.001 MHz
Amplitude	−2.99 dBm
DC Offset	0V

b. Connect the HP 3325B signal output to the spectrum analyzer 50Ω input.

c. Set the spectrum analyzer controls for a center frequency of 20.001 MHz, a resolution bandwidth of 30 Hz, a frequency span of 100 Hz/div, and the fundamental referenced to the top of the display graticule.

d. Set the spectrum analyzer center frequency to 20.002, 20.003, and 20.004 MHz, verifying in each case that all spurious signals are more than 70 dB below the fundamental.

Performance Tests

The following procedures compare the instrument operation to its specifications listed in Appendix A. Performance Test Records are located at the end of this section. These test records lists all of the tested specifications and acceptable limits. For ease of recording data at various times, copies of the blank Performance Test Records may be made without written permission from Hewlett-Packard.

The Performance Tests include the following:

- Harmonic Distortion
- Spurious Signal
- Integrated Phase Noise
- Amplitude Modulation Envelope Distortion
- Square Wave Rise Time and Aberrations
- Ramp Retrace Time
- Sync Output
- Square Wave Symmetry
- Frequency Accuracy
- Phase Increment Accuracy
- Phase Modulation Linearity
- Amplitude Accuracy
- DC Offset Accuracy (DC Only)
- DC Offset Accuracy with AC Functions
- Triangle Linearity
- X Drive Linearity
- Ramp Period Variation

Required Test Equipment

The test equipment required for the Performance Tests is listed in table 4-4. Any equipment that satisfies the critical specifications given in the table may be substituted for the recommended model.

Table 4-4. Test Equipment Required for Performance Tests.

Instrument	Critical Specifications	Recommended Model
Analog Oscilloscope	Vertical Bandwidth: dc to 100 MHz Deflection: 0.01 to 5 V/div Horizontal Sweep: 0.05 μs to 0.5 s/div ×10 Magnification Delayed Sweep	TEK 2245 HP 1740A (alternate)
Sampling Oscilloscope	Vertical Deflection: 2 mV/div Horizontal Sweep: 10 ps to 50 μs/div Transient response Aberrations: < +0.5%, − 3% Vpp first 5 ns following step transition < ±1% pp after 5 ms	TEK 7603* with 7T11/ 7S11 and S-1
Electronic Counter	Frequency measurement Frequency Range: to 20 MHz Resolution: 8 digits Accuracy: ± 2 counts Time Interval Average A to B Resolution: 0.01 ns	HP 5328B with Opt. 010 HP 5328A with Option 010, 040, and 041
AC/DC Digital Voltmeter	AC Function (True RMS) Ranges: 1 to 100 V Accuracy : ± 0.2% Resolution: 5 1/2 digits Crest Factor: 4:1 DC Functions Ranges: 0.1 to 100 V Accuracy: ± 0.05% Resolution: 6 digits	HP 3455A /3478A
50Ω Feedthru Termination	Accuracy: ± 0.2% Power Rating: 1W	HP 11048C
High Frequency Spectrum Analyzer	Frequency Range: 1 kHz to 80 MHz Amplitude Accuracy: ± 0.5 dB Noise: > 70 dB below reference	HP 8552B/8553B/ 8566A/B/8568A/B HP 141T (alternate)
Low Frequency Spectrum Analyzer	Frequency Range: 20 Hz to 50 kHz Amplitude Accuracy: ± 0.5 dB Spurious Responses: 80 dB below reference	HP 3580A/3585A/B

(*) This equipment is only necessary to perform the Square Wave Rise Time and Aberrations test.

Table 4-4. Test Equipment Required for Performance Tests. (Cont'd)

Instrument	Critical Specifications	Recommended Model
Frequency Synthesizer	Frequency Range: 100 kHz to 21 MHz Amplitude Range: to +13.01 dBm Output Impedance: 50Ω Phase Noise (Integrated): 9.9 MHz: < − 63 dB 20 MHz: < − 70 dB Spurious: > 75 dB below fundamental	HP 3335A
Double Balanced Mixer	Impedance: 50Ω Frequency Range: 1 – 20 MHz	ZP10514 Mini-Circuits PO Box 350166 Brooklyn, NY 11235-0003
1 MHz Low Pass Filter	Cut-off Frequency: 1 MHz Stopband Atten: 50 dB by 4 MHz Stopband Freq: 4 – 80 MHz	Model J903 TTE Inc. 12016 115th Avenue NE Kirkland, WA 98034
15 kHz Filter	Consisting of: Resistor: 10 kΩ 1% Capacitor: 1600 pF 5%	 HP 0757-0340 HP 0160-2223
AC Voltmeter	Ranges: 0.1 to 1 V Frequency Range: 20 Hz – 1 MHz Input Impedance: ≥1 MΩ Meter: Log scale Acc (100 Hz to 10 kHz): ±1%	HP 3400A HP 400FL (alternate)
Sine Wave Signal Source	Frequency: 10 kHz Amplitude: 1 Vrms into 20 kΩ Distortion: −60 dB	HP 3325A/B/3336A HP 204C (alternate)
DC Power Supply	Volts: 0 to ±5 V Amps: 10 mA Floating Output	HP 6214A/6214B/C
Thermal Converter	Input Impedance: 50Ω Input Voltage: 1 Vrms Frequency: 2 kHz to 20 MHz Frequency Response: ±0.05 dB 2 kHz to 20 MHz	HP 11050A/Ballantine Model 1395A-1 with cable 12577A Opt. 10 Ballantine Labs, Inc. P. O. Box 97 Boonton, NJ 07005
Resistive Divider	Consisting of: 2 Resistors: 61.11Ω 0.1% 1/4W 2 Resistors: 36.55Ω 0.1% 1/8W	 HP 0699-0090 HP 0698-7169
Resistive Divider	Consisting of: Capacitor: 300 pF 5% 3 Resistors: 1330Ω 0.1% 1/4W Resistor: 43Ω 0.1% 1/8W	 HP 0160-2207 HP 0698-7453 HP 0698-8264

Table 4-4. Test Equipment Required for Performance Tests. (Cont'd)

Instrument	Critical Specifications	Recommended Model
High-Speed DC Digital Voltmeter	DC Voltage: 0 to ±10 V External Trigger: Low True TTL Edge Trigger Trigger Delay: Selectable 10 to 140 μs	HP 3437A
BNC-to-Triax Adapter	Female BNC to Male Triax	HP 1250-0595
Resistive Divider ÷ 2.5	Consisting of: Resistor: 30Ω 1% 1/4W Resistor: 20Ω 1% 1/4W	 HP 0698-7533 HP 0698-6296
Resistive Divider ÷ 2.6	Consisting of: Resistor: 100 kΩ 1% 1/8W Resistor: 162 kΩ 1% 1/8W	 HP 0757-0465 HP 0757-0470
Resistor	470Ω 2W 5%	HP 0698-3634
Resistor	56.2Ω 1/8W 1.0%	HP 0757-0395
Adapter	BNC female to dual banana plug BNC Tee	HP 1251-2277 HP 1250-0781
Step Attenuator	0 – 12 dB; 1 dB steps 0 – 40 dB	HP 355C HP 355D*

(*) This equipment is only necessary to perform the Square Wave Rise Time and Aberrations test.

Harmonic Distortion

This procedure tests the harmonic distortion of the HP 3325B sine wave output to the following specifications:

Harmonic Distortion (relative to fundamental)

Fundamental Frequency	No Harmonic Greater Than
0.1 Hz to 50 kHz	−65 dB
50 to 200 kHz	−60 dB
200 kHz to 2 MHz	−40 dB
2 to 15 MHz	−30 dB
15 to 20 MHz	−25 dB

Equipment Required:
- High Frequency Spectrum Analyzer
- Low Frequency Spectrum Analyzer
- 50Ω Feedthru Termination
- Resistor 470Ω 2W 5%
- Resistor 56.2Ω 1/8W 1%

a. Set the HP 3325B output as follows:

High Voltage Output (option 002)	Off
Function	Sine
Frequency	20 MHz
Amplitude	999 mV_{pp}

b. Connect the signal output to the high frequency spectrum analyzer 50Ω input.

c. Set the spectrum analyzer controls to display the fundamental and at least four harmonics. Verify that all harmonics are 25 dB below the fundamental.

d. Set the HP 3325B to 15 MHz and verify that all harmonics are at least 30 dB below the fundamental.

e. Disconnect the HP 3325B from the high frequency spectrum analyzer and connect it to the low frequency spectrum analyzer 50Ω input. Set the HP 3325B to the following frequencies and verify the specified levels, relative to the fundamental.

2 MHz	−40 dB
200 kHz	−60 dB

f. Set the HP 3325B frequency to 50 kHz and the amplitude to 9.99 mV_{pp}.

g. Set the spectrum analyzer controls to display the fundamental and at least three harmonics. (It may be necessary to decrease the video bandwidth to separate the harmonics from the noise floor.) Verify that all harmonics are at least 65 dB below the fundamental.

h. Set the HP 3325B to the following frequencies and verify that all harmonics are 65 dB below the fundamental.

10 kHz
1 kHz
100 Hz

High Voltage Output (option 002)

i. Connect the HP 3325B signal output to the low frequency spectrum analyzer high impedance input (see figure 4-6).

j. Select the high voltage output on the HP 3325B. Set the amplitude to 40 V_{pp} and the frequency to 100 Hz.

k. Set the spectrum analyzer controls to display the fundamental and at least three harmonics. Verify that all harmonics are 65 dB below the fundamental.

l. Set the HP 3325B to the following frequencies and verify that their harmonics are below the specified level, relative to the fundamental.

10 kHz	−65 dB
200 kHz	−60 dB
1 MHz	−40 dB

m. Turn off the high voltage output.

Spurious Signal

This procedure tests the HP 3325B sine wave output for spurious signals. Circuits within the HP 3325B may generate repetitive frequencies that are not harmonically related to the fundamental output frequency. All spurious signals must be more than 70 dB below the fundamental signal or less than −90 dBm, whichever is greater.

Equipment Required: Spectrum Analyzer

Mixer Spurious

a. Connect the HP 3325B signal output to the spectrum analyzer 50Ω (RF) input and the HP 3325B EXT REF input to the analyzer 10 MHz reference output (see figure 4-7).

b. Set the HP 3325B as follows:

Function	Sine
Amplitude	−20 dBm
Frequency	2.001 MHz

c. Set the analyzer controls as follows:

Center Frequency	2.001 MHz
Frequency Span	1 kHz
Video BW	100 Hz
Resolution BW	30 Hz

d. Adjust the spectrum analyzer to reference the fundamental to the top display graticule.

e. Without changing the reference level, change the spectrum analyzer center frequency to 27.999 MHz to display the 2:1 mixer spur. Verify that this spur is at least 70 dB below the fundamental.

f. Change the spectrum analyzer center frequency to 25.998 MHz to display the 3:2 mixer spur. Verify that this spur is at least 70 dB below the fundamental.

g. In a similar manner, change the HP 3325B frequency and the spectrum analyzer center frequency to the following frequencies. For each setting, verify that all spurious signals are 70 dB below the fundamental.

HP 3325B	Spectrum Analyzer Center Frequency	
	2:1 Spur	3:2 Spur
4.100 MHz	25.9 MHz	21.8 MHz
6.100 MHz	23.9 MHz	17.8 MHz
8.100 MHz	21.9 MHz	13.8 MHz
10.100 MHz	19.9 MHz	9.8 MHz
12.100 MHz	17.9 MHz	5.8 MHz
14.100 MHz	15.9 MHz	1.8 MHz
16.100 MHz	13.9 MHz	2.2 MHz
18.100 MHz	11.9 MHz	6.2 MHz
20.100 MHz	9.9 MHz	10.2 MHz

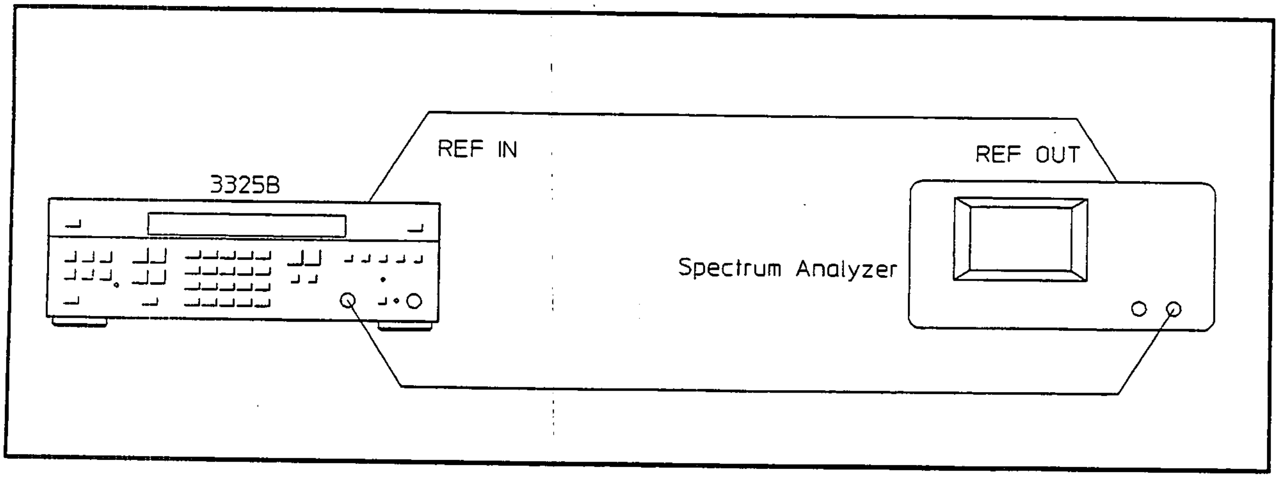


Figure 4-7. Mixer Spurious.

Close-in Spurious (Fractional N Spurs)

h. Set the HP 3325B frequency to 5.001 MHz and the amplitude to −2.99 dBm.

i. Set the spectrum analyzer controls as follows:

Center Frequency	5.001 MHz
Frequency Span	1 kHz
Video BW	100 Hz
Resolution BW	30 Hz

j. Adjust the spectrum analyzer to reference the fundamental to the top display graticule.

k. Without changing the reference level, change the spectrum analyzer center frequency to 5.002 MHz to display the API 1 spur. It may be necessary to decrease the video bandwidth to optimize the display resolution.

l. All spurious (non-harmonic) signals should be at least 70 dB below the fundamental.

m. Without changing the reference level, set the HP 3325B frequency and the spectrum analyzer center frequency to the frequencies listed below. For each setting, verify that all spurious signals are at least 70 dB below the fundamental.

HP 3325B	Spectrum Analyzer Center Frequency
5.0001 MHz	5.0011 MHz
5.00001 MHz	5.00101 MHz
5.000001 MHz	5.001001 MHz
20.001 MHz	20.002 MHz
20.001 MHz	20.003 MHz
20.001 MHz	20.004 MHz
20.001 MHz	20.005 MHz

Integrated Phase Noise

This test compares the HP 3325B integrated phase noise to the following specification:

−60 dB for a 30 kHz band centered on a 20 MHz carrier (excluding ±1 Hz about the carrier).

Equipment Required:
- Frequency Synthesizer
- Double Balanced Mixer
- 50Ω Feedthru Termination
- AC/DC Digital Voltmeter
- AC Voltmeter
- 15 kHz noise equivalent filter consisting of:
  - Resistor: 10 kΩ ± 1%
  - Capacitor: 1600 pF ± 5% (see figure 4-8)
- 1 MHz Low Pass Filter

a. Connect the equipment as shown in figure 4-8, connecting the 15 kHz noise equivalent filter output to the ac voltmeter. Phase lock the HP 3325B and the signal generator together.

b. Set the HP 3325B as follows:

Function	Sine
Frequency	19.901 MHz
Amplitude	0 dBm

c. Set the synthesizer (reference) as follows:

Frequency	19.9 MHz
Amplitude	+7.00 dBm

d. Record the ac voltmeter reading (dB scale).

e. Change the HP 3325B frequency to 19.9 MHz.

f. Connect the 15 kHz filter output to the digital voltmeter.

g. Press the HP 3325B [Phase] key. Using the modify keys, adjust the output phase for a minimum reading on the digital voltmeter.

h. Disconnect the 15 kHz filter output from the digital voltmeter and connect it to the ac voltmeter.

i. Record the ac voltmeter reading (dB scale) and subtract it from the reading recorded in step d. The difference should be −54 dB or greater. Add −6 dB to this number and enter on the Performance Test Record. The 6 dB is a correction factor compensating for the folding action of the mixer.

NOTE Frequencies used minimize the phase noise contribution of the frequency synthesizer.

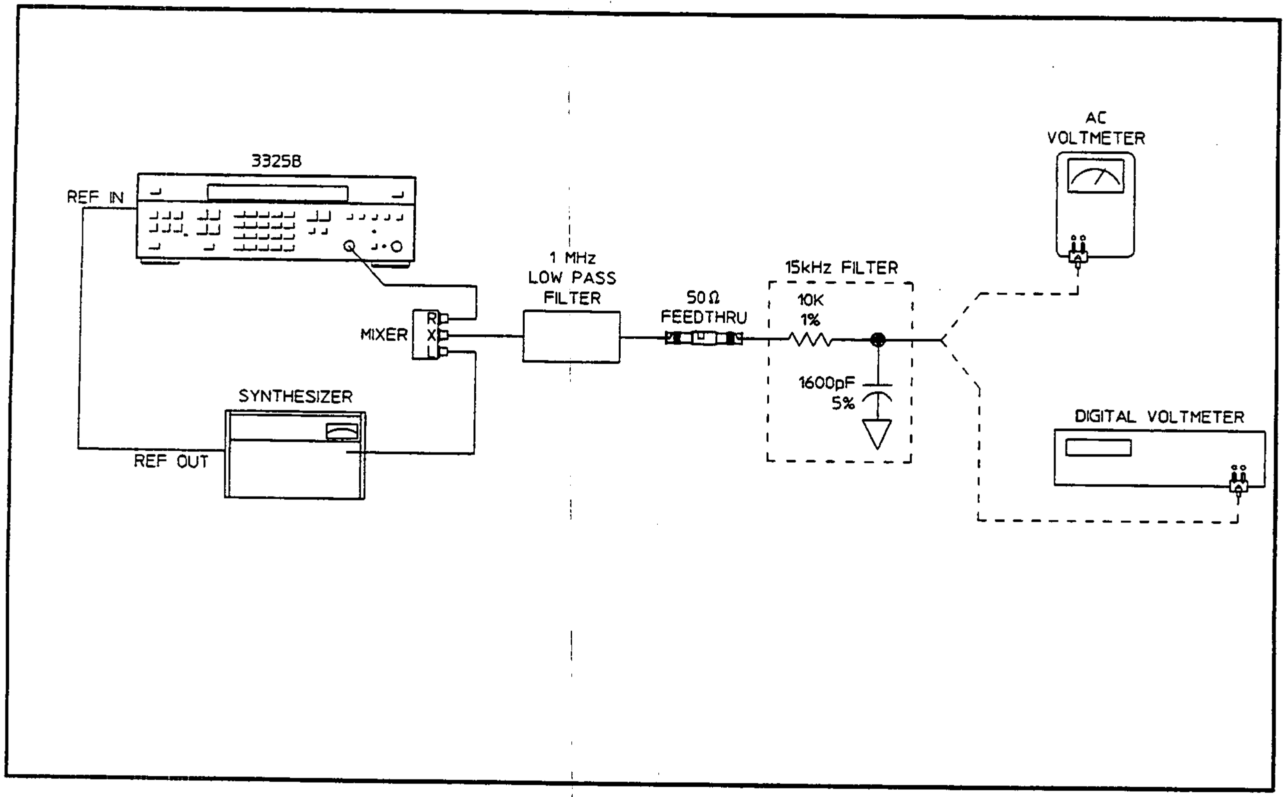


Figure 4-8. Integrated Phase Noise.

Amplitude Modulation Envelope Distortion

This procedure tests the HP 3325B amplitude modulation envelope distortion to the following specification:

−30 dB to 80% modulation at 1 kHz, 0V dc offset

Equipment Required: Sine Wave Signal Source
Spectrum Analyzer

a. Connect the equipment as shown in figure 4-9.

b. Set the HP 3325B output as follows:

Function	Sine
Frequency	1 MHz
Amplitude	3 V_{pp}
DC Offset	0V
High Voltage Output (option 002)	Off
AM	On

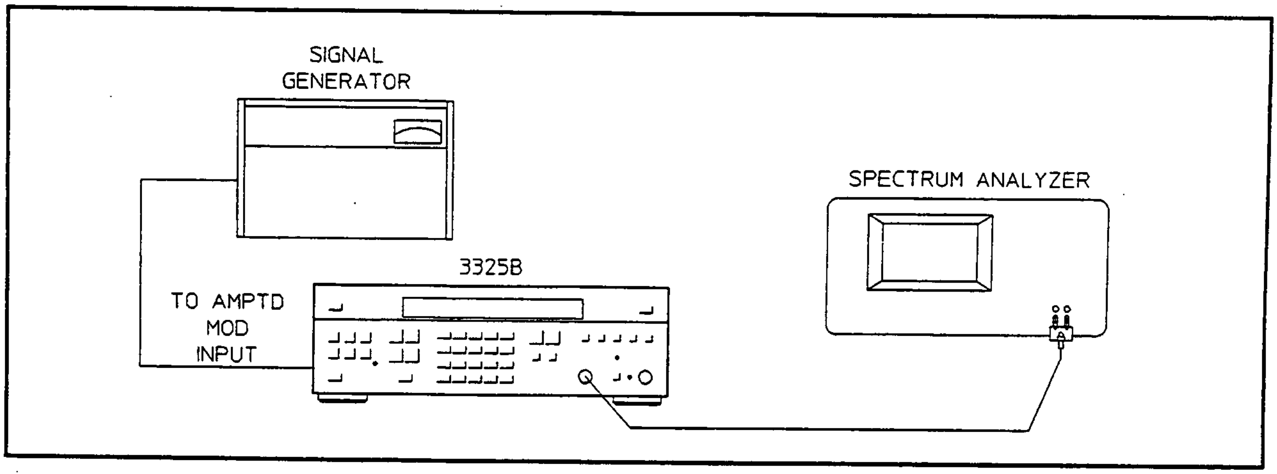


Figure 4-9. AM Envelope Distortion.

c. Set the modulating signal source frequency to 1 kHz and adjust the level to produce 80% modulation of the HP 3325B output. This is indicated by modulation sidebands being 8.0 dB down from the carrier, as viewed on the 2 dB/div display of the spectrum analyzer.

d. Adjust the spectrum analyzer to display the fundamental frequency, the 1 kHz sideband frequency, and at least 4 harmonics of the sidebands. All harmonics should be at least 30 dB lower than the modulation sidebands.

Square Wave Rise Time and Aberrations

This procedure compares the HP 3325B square wave output to its rise/fall time and overshoot specifications.

Rise and Fall Time: ≤20 ns, 10% to 90% at full output

Overshoot: ≤5% of peak-to-peak amplitude at full output

Equipment Required: Sampling Oscilloscope
40 dB Attenuator

a. Connect the HP 3325B signal output to the attenuator input and the attenuator output to the oscilloscope input. Set the attenuator for 40 dB attenuation.

b. Set the HP 3325B as follows:

High Voltage Output (option 002)	Off
Function	Square
Frequency	1 MHz
Amplitude	10 V_{pp}

c. Adjust the oscilloscope vertical and horizontal controls so that the square wave rise time between the 10% and 90% points can be measured. Rise time should be less than 20 ns.

d. Adjust the oscilloscope vertical and horizontal controls so that the square wave fall time between the 10% and 90% points can be measured. Fall time should be less than 20 ns.

e. Adjust the oscilloscope vertical and horizontal controls so that the square wave overshoot can be measured. Overshoot should be less than 500 mV at positive and negative peaks.

Ramp Retrace Time

This test compares the HP 3325B retrace time of the positive and negative slope ramps to the following specification:

$\leq 3\ \mu s$ 90% to 10%

Equipment Required: Analog Oscilloscope

a. Connect the HP 3325B signal output to the oscilloscope vertical input. Set the input switch to the 50Ω position. If your oscilloscope does not have a 50Ω input, use a 50Ω feedthru termination at the input.

b. Set the HP 3325B as follows:

High Voltage Output (option 002)	Off
Function	Positive Slope Ramp
Frequency	10 kHz
Amplitude	10 V_{pp}

c. Adjust the oscilloscope vertical and horizontal controls so that the ramp retrace time from the 90% to 10% points can be measured. Retrace time should be less than 3 μs.

d. Change function to negative slope ramp and repeat step c.

Sync Output

This procedure checks the voltage levels of the square wave on the HP 3325B front and rear panel sync outputs to the following specifications:

$V_{high} > +1.2V$; $V_{low} < +0.2V$ into 50Ω

Equipment Required: Analog Oscilloscope

a. Connect the HP 3325B front sync output to the oscilloscope vertical input. Set the input switch to the 50Ω position. If your oscilloscope does not have a 50Ω input, use a 50Ω feedthru termination at the input.

b. Set the HP 3325B function to sine, frequency to 20 MHz.

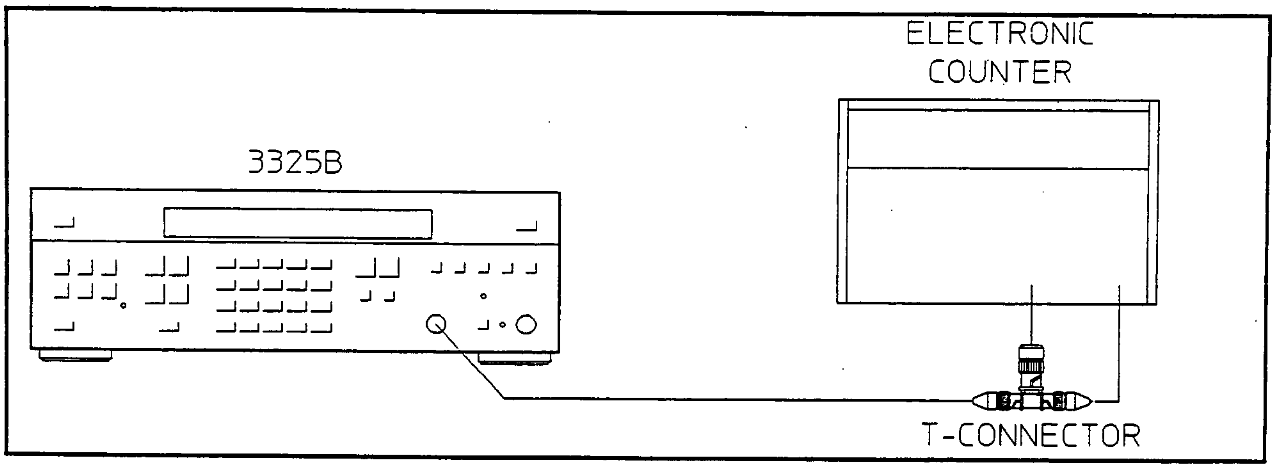


Figure 4-10. Square Wave Symmetry.

c. Adjust the oscilloscope controls to measure the high and low levels of the sync square wave. The high level should be greater than +1.2V and the low level should be less than +0.2V.

d. Repeat the measurment for the rear panel FAST ™ sync out. The high level should be greater than +0.5V and the low level less than +0.5V.

Square Wave Symmetry

This procedure checks the symmetry of the HP 3325B square wave signal output to the following specification:

≤0.02% of period +3 nanoseconds

Equipment Required: Electronic Counter

a. Connect the HP 3325B signal output to both inputs of the electronic counter, using a BNC tee (see figure 4-10).

b. Set the HP 3325B output as follows:

Function	Square
Frequency	1 MHz
Amplitude	1 Vrms
DC Offset	0V

c. Adjust the electronic counter to measure time interval average A to B, with Slope A +, Slope B –. Note the reading.

d. Change Slope A to –, Slope B to +. Reading should be equal to the reading in step c ± < 3.2 ns.

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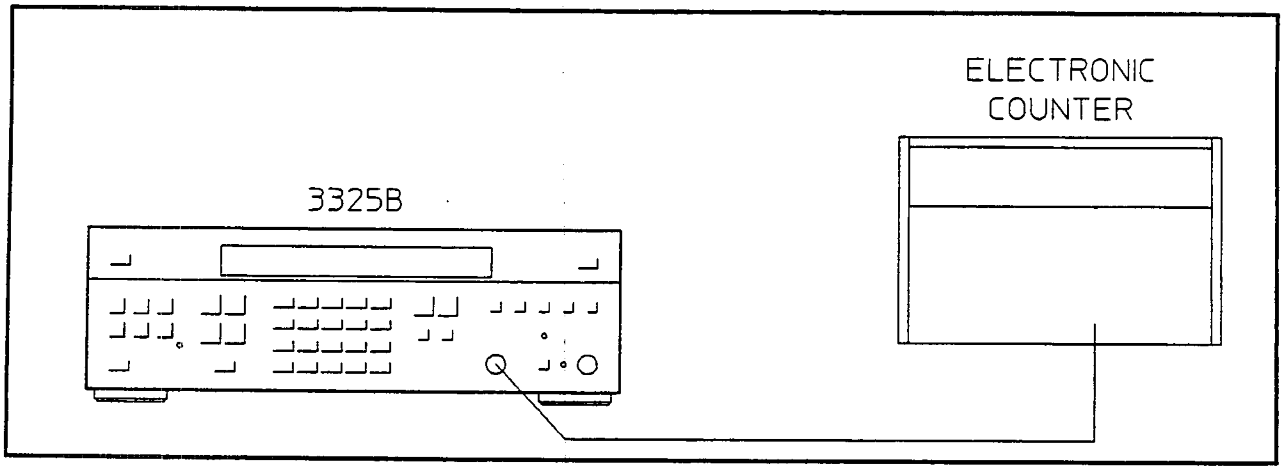

Figure 4-11. Frequency Accuracy.

Frequency Accuracy

This test compares the accuracy of the HP 3325B output signal to the following specifications:

$\pm 5 \times 10^{-6}$ of selected frequency (20°C to 30°C)

Equipment Required: Electronic Counter (calibrated within three months or with an accurate 10 MHz external reference input)

a. Connect the HP 3325B signal output to the electronic counter channel A input with a 50Ω feedthru termination. Allow the HP 3325B to warm up for 20 minutes and the counter's frequency reference to warm up for its specified period.

b. Set the HP 3325B output as follows:

Function	Sine
Frequency	20 MHz
Amplitude	0.99 V_{pp}
DC Offset	0V

c. Set the counter to count the frequency of the A input with 0.1 Hz resolution, and adjust for stable triggering. Electronic counter should indicate 20 000 000.00 Hz ±100 Hz.

d. Change the HP 3325B function to square wave. Frequency automatically changes to 10 MHz. Electronic counter should indicate 10 000 000.0 Hz ±50 Hz.

e. Change the HP 3325B function to triangle. Frequency automatically changes to 10 kHz. Move the counter input to the sync output of the HP 3325B. Set the counter to average 1000 periods. Electronic counter should indicate 100 000.00 ns ±0.5 ns.

f. Change the HP 3325B function to positive slope ramp. Electronic counter should indicate 100 000.00 ns ±0.5 ns.

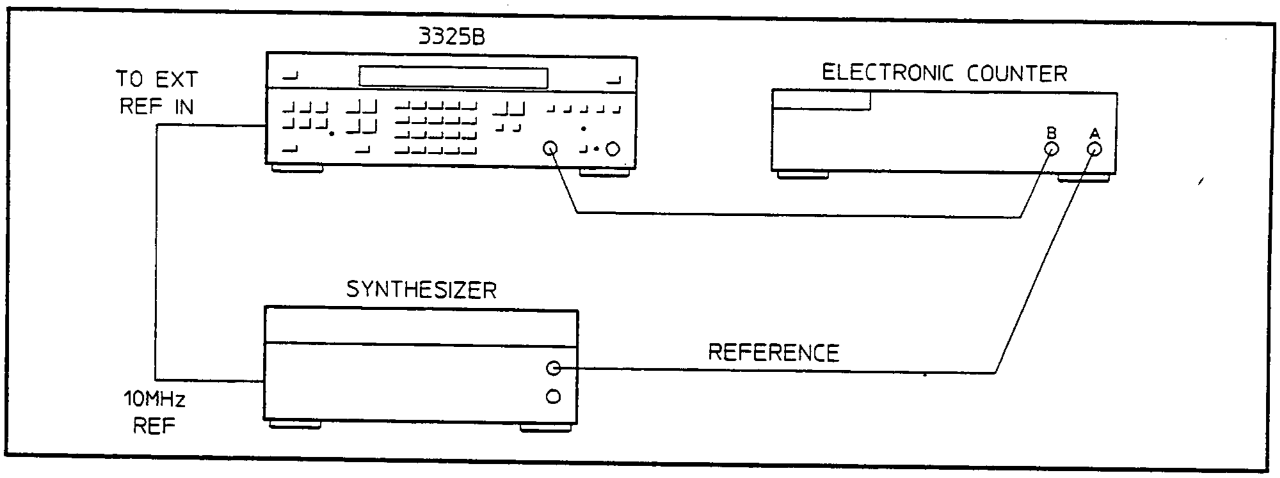

Figure 4-12. Phase Increment Accuracy.

Phase Increment Accuracy

This test compares the HP 3325B phase increment accuracy to the following specification:

±0.2°

Equipment Required: Frequency Synthesizer
Electronic Counter

a. Connect the equipment as shown in figure 4-12.

b. Set the HP 3325B as follows:

High Voltage Output (option 002)	Off
Function	Sine
Frequency	100 kHz
Amplitude	13 dBm

c. Set the synthesizer as follows:

Frequency	0.1 MHz
Amplitude	13 dBm

d. Set the counter as follows:

Function	Time Interval Avg A to B
Frequency Resolution, N	10^5
Inputs	50Ω, Separate
Slope A and B	Positive
Sample Rate	Maximum

e. Press the HP 3325B [Phase] key to display phase. Using the modify keys, adjust the phase until the counter reads approximately 200 ns. Press the blue [Shift] key, then the [Asgn Zero Φ] key.

f. Set the counter sample rate to hold, then reset the counter. Record the counter reading (to 2 decimal places) on the Performance Test Record in the space for *Zero Phase Time Interval*. This is the phase difference (in nanoseconds) between the HP 3325B output and the reference signal.

g. Set the HP 3325B phase to −1°.

h. Reset the counter. Record the counter reading (to 2 decimal places) in the space for *1° Increment Time Interval*.

i. Determine the time difference between the counter readings in steps h and f, and record in the *Time Difference* column. The difference should be from 22.22 to 33.34 ns.

j. Set the HP 3325B phase to −10°.

k. Reset the counter. Record the counter reading in the space for *10° Increment Time Interval*.

l. Enter the time difference between the *Zero Phase Time Interval* and the reading in step k in the *Time Difference* column. This should be from 272.22 to 283.34 ns.

m. Set the HP 3325B phase to −100°.

n. Reset the counter. Record the counter reading in the space for *100° Incremental Time Interval*.

o. Enter the time difference between the *Zero Phase Time Interval* and the reading in step n in the *Time Difference* column. It should be from 2772.22 to 2783.34 ns.

Phase Modulation Linearity

This procedure compares the HP 3325B phase modulation linearity to the following specification:

±0.5%, best fit straight line

Equipment Required: Frequency Synthesizer
Electronic Counter
DC Power Supply
Digital Voltmeter

a. Connect the equipment as shown in figure 4-13.

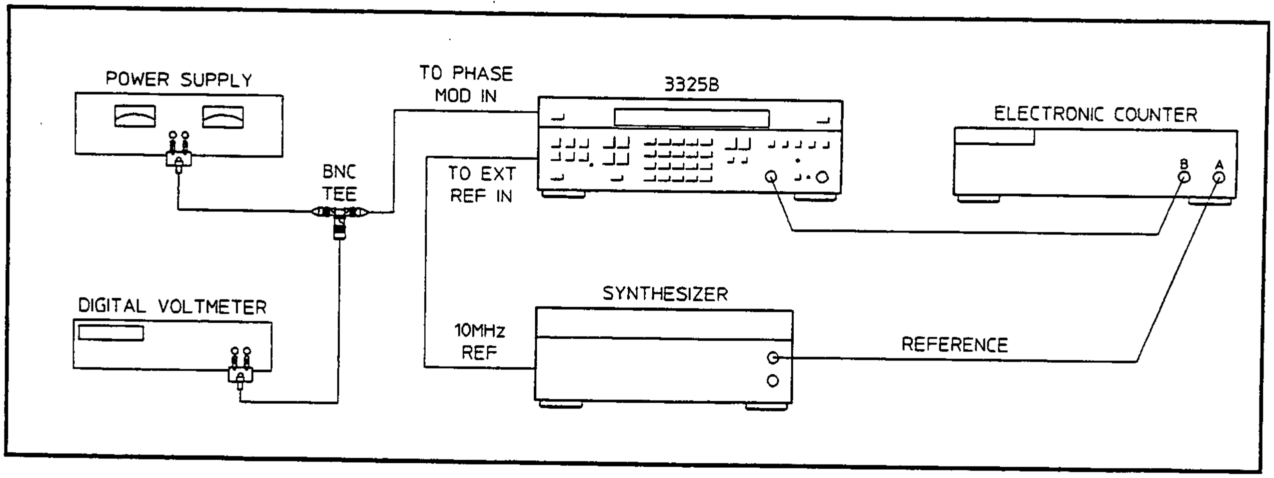

Figure 4-13. Phase Modulation Linearity.

b. Set the HP 3325B as follows:

High Voltage Output (option 002)	Off
Function	Sine
Frequency	100 kHz
Amplitude	13 dBm
Phase Modulation	On

c. Set the synthesizer as follows:

Frequency	100 kHz
Amplitude	13 dBm

d. Set the electronic counter as follows:

Function	Time Interval Avg A to B
Frequency Resolution, N	10^5
Inputs	50Ω, Separate
Slope A and B	Positive
Sample Rate	Maximum

e. Using the voltmeter to monitor the dc power supply output, set the dc voltage as near −5.0000V as possible.

f. Press the HP 3325B [Phase] key to display phase. Using the modify keys, adjust the phase until the counter reads approximately 200 ns. Record the counter reading as a reference for the following steps.

g. As soon as possible after recording the counter reading, note the voltmeter reading and record on the Performance Test Record in the *DVM Reading, x_1* space.

h. Press the HP 3325B blue [Shift] key, then the [Asgn Zero Φ] key.

i. Change the dc power supply output to −4.0000V.

j. Using the modify keys, adjust the HP 3325B phase to return the counter reading to the value recorded in step f.

k. Record the voltmeter reading in the *DVM Reading, x_2* space.

l. The HP 3325B display indicates the phase change resulting from the 1V change in modulating voltage. Record the phase display in the *Phase Difference, 2* space (positive value).

m. Press the HP 3325B blue [Shift] key, then the [Asgn Zero Φ] key.

n. Change the power supply output to the following voltages and repeat steps j through m for each. Record the DVM reading and phase differences in the appropriate spaces on the Performance Test Record.

DC Voltage	DVM Reading	Phase Difference
−3.0000V	x_3	3
−2.0000V	x_4	4
−1.0000V	x_5	5
0.0000V	x_6	6
+1.0000V	x_7	7
+2.0000V	x_8	8
+3.0000V	x_9	9
+4.0000V	x_{10}	10
+5.0000V	x_{11}	11

o. Enter the cumulative phase change in the *Cumulative Phase* column. That is, enter the *2 Phase Difference* in the y_2 space, then add the y_2 and *3* values and enter in the y_3 space. Add the y_3 and *4* values and enter in y_4, and so on.

p. On the Performance Test Record, multiply each x value by the corresponding y value and enter in the *x times y* column.

q. Total the *DVM Reading* column and enter in the Σx space. Total the *Cumulative Phase* values and enter in the Σy space. Total the *x times y* values and enter in the Σxy space.

r. Square each x value and enter in the x^2 column. Total this column and enter in the Σx^2 space.

s. Square the Σx value and enter in the $(\Sigma x)^2$ space.

t. Multiply the Σx value by the Σy value and enter in the $\Sigma x \Sigma y$ space.

u. The equation for determining the best fit line specification for each y value is:

$y = a_1 x + a_0$

Where: $a_1 x$ and a_0 are constants to be calculated from data taken previously

Where: x is the value of the modulating voltage, recorded as x_1 through x_{11}

v. First determine the value of a_1 using the following equation:

$$a_1 = \frac{\Sigma xy - \frac{\Sigma x \Sigma y}{n}}{\Sigma x^2 - \frac{(\Sigma x)^2}{n}}$$

Where: Σx, Σy, Σxy, $\Sigma x \Sigma y$, Σx^2, and $(\Sigma x)^2$ are the previously calculated values entered on the Performance Test Record

Where: $n = 11$ (the number of points to be calculated)

w. Determine the value of a_0 using the equation:

$$a_0 = \frac{\Sigma y}{n} - a_1 \frac{\Sigma x}{n}$$

x. Calculate each value for y using the equation: $y = a_1x + a_0$. Enter each result on the Performance Test Record in the *Best Fit Straight Line Values* column, (y_1) through (y_{11}).

y. Determine the test limits for each y value by increasing and decreasing the calculated (y) values by 0.5% of the (y_{11}) value. Enter in the Maximum and Minimum columns.

z. Transfer the y_1 through y_{11} *Cumulative Phase* entries to the *Measured Cumulative Phase* column. Each value should be within the calculated limits.

Amplitude Accuracy

This procedure tests the amplitude accuracy of the HP 3325B ac function output signals to the specifications listed in Appendix A:

Equipment Required: AC/DC Digital Voltmeter
- AC: Accuracy sufficient to verify a 1% specification to 100 kHz
- DC: Resolution, 1 µv

High Speed Digital DC Voltmeter
- At least 3 1/2 digit resolution, 1 1/2 µs or faster settling time.

50Ω, 0-12 dB (1 dB/step) Attenuator
50Ω Feedthru Termination
Thermal Converter
Analog Oscilloscope
- Must have delayed sweep of 0.05 µs/div and delayed sweep gate output.

Components:
- 2 Resistors 36.55Ω 0.1% 0.125W
- 2 Resistors 61.11Ω 0.1% 0.25W
- Resistor 43Ω * 0.1% 0.125W
- 3 Resistors 1330Ω * 0.1% 0.25W
- Capacitor 300 pF * 5%

**Used only to test High Voltage (option 002)*

Amplitude Accuracy at Frequencies up to 100 kHz

a. Sine Wave Test. Connect the HP 3325B signal output through a 50Ω feedthru termination to the ac digital voltmeter input.

b. Set the HP 3325B as follows:

High Voltage Output (option 002)	Off
Function	Sine
Frequency	100 Hz
Amplitude	3.536 Vrms (10 V_{pp})
DC Offset	0V

c. Press the [Amptd Cal] key.

d. Read ac voltmeter. Change the HP 3325B frequency to 1 kHz and 100 kHz and repeat. Verify that all three voltmeter reading are between 3.495 and 3.577 Vrms (23.98 dBm ± 0.1 dB).

e. Change the HP 3325B amplitude to 1.061 Vrms (3 V_{pp}) and take ac voltage readings for 100 Hz, 1 kHz and 100 kHz as above. Verify that all three voltmeter readings are between 1.048 and 1.073 Vrms (13.52 dBm ± 0.1 dB).

f. Change the HP 3325B amplitude to 0.3536 Vrms and set dc offset to 1 mV. Set the HP 3325B frequency to 100 Hz, 1 kHz and 100 kHz and read ac voltage. Verify that all three readings are between 0.3411 and 0.3660 Vrms (3.98 dBm ± 0.3 dB).

g. Function Test. Connect the HP 3325B sync output to external trigger input of oscilloscope. Connect the HP 3325B signal output to the voltage divider of figure 4-14A. Connect the voltage divider output to oscilloscope vertical input and to high speed voltmeter input. Connect delayed sweep gate from oscilloscope to external trigger input of high speed voltmeter (see figure 4-14A).

h. Set the HP 3325B as follows:

High Voltage Output (option 002)	Off
DC Offset	0V
Amplitude	10 V_{pp}
Frequency	99.9 Hz
Function	Square

i. Set the oscilloscope as follows:

Display	A or B
Vertical Sensitivity	0.5 V/div
Trigger	Ext
Main Sweep	1 ms/div
Delayed Sweep	5 μs/div
Delay	250

j. Set the voltmeter as follows:

Range	1.0V
Trigger	Ext
Delay	0s
Coupling	DC, 1 MΩ

k. One cycle of the square wave should fill the screen of the oscilloscope, and the sample time for the voltmeter should be seen as the intensified spot of the delayed sweep.

l. Press [Amptd Cal] on the HP 3325B.

m. Read positive peak voltage of attenuated waveform on voltmeter. If the reading is not stable, alternately press hold, then ext to repeat readings. Change oscilloscope delay to 750 and read negative peak. Add the two readings to obtain volts peak-to-peak. Verify that sum is between 3.661 and 3.735 V.

n. Change the HP 3325B function to triangle. Change oscilloscope to:

Vertical Sensitivity	0.2 V/div
Vertical Position	9 o'clock
Main Sweep	0.5 ms/div
Delay	500
Magnify	X10
Delayed Sweep	1 μs/div

o. Adjust oscilloscope delay to place the intensified spot on peak of triangle and read positive peak voltage on the high speed digital voltmeter. Press negative trigger, move vertical position knob of oscilloscope to 3 o'clock and adjust intensified spot to read negative peak on the voltmeter. Verify that sum of positive and negative peak voltage is between 3.643 and 3.754 V.

p. Change the HP 3325B function to positive ramp. Change oscilloscope to:

Trigger	positive
Main Sweep	2 ms/div

Place intensified spot on positive peak. Alternately press hold, then ext to repeat readings. Record the most positive reading.

q. Move vertical position knob to 3 o'clock, adjust delay and read negative peak. Ramp jitter should be visible on all ramp readings (the high speed digital voltmeter will hold the readings). Verify that sum of positive and negative peaks is between 3.643 and 3.754 V.

r. Change the HP 3325B function to negative ramp. Change oscilloscope trigger to positive and take negative ramp reading as above.

s. Change the HP 3325B function to square and frequency to 1 kHz. Set oscilloscope as follows:

Main Sweep	50 μs/div
Delayed Sweep	0.05 μs/div

Read positive peak; push negative trigger and read negative peak. Verify that sum is between 3.661 and 3.735 V.

t. Change the HP 3325B function to triangle and frequency to 2 kHz. Set oscilloscope main sweep to 20 μs/div and delay to 610. Adjust delay and position. Set positive and negative trigger to read peaks. Verify voltage to be between 3.643 and 3.754 V_{pp}.

u. Change the HP 3325B function to positive ramp and frequency to 500 Hz. Set main sweep of oscilloscope to 0.2 ms/div and adjust sweep vernier to return peaks to center screen (trigger must be negative to see jitter at this point). Verify voltage to be between 3.643 and 3.754 V_{pp}.

v. Change the HP 3325B function to negative ramp and oscilloscope trigger to positive. Verify voltage of 3.643 to 3.754 V_{pp}.

w. Change HP 3325B frequency to 100 kHz and function to square. Return oscilloscope sweep vernier to calibrate and set main sweep to 0.5 μs/div and magnify to off. Read positive and negative peak voltages in the center of the screen. By pressing positive/negative trigger, verify voltage of 3.661 to 3.735 V_{pp}.

x. Change the HP 3325B function to triangle (frequency will go to 10 kHz). Set oscilloscope main sweep to 5 μs/div and press magnify. Verify voltage of 3.513 to 3.883 V_{pp}.

y. Change the HP 3325B function to positive ramp. Set oscilloscope main sweep to 20 μs/div. Adjust delay to set end of intensified spot on highest peak. Verify voltage of 3.328 to 3.996 V_{pp}.

z. Change the HP 3325B function to negative ramp. Verify voltage of 3.328 to 3.996 V_{pp}.

aa. Change the HP 3325B amplitude to 3 V_{pp}, and remove the voltage divider from the circuit. Reconnect the HP 3325B signal output to the oscilloscope and voltmeter through the 50Ω feedthru termination. Set the HP 3325B frequency to 99.9 Hz and the function to square.

bb. Repeat tests i through z. Test limits are as follows:

Test	Frequency	Function	Minimum	Maximum
m	99.9 Hz	Square	2.970V	3.030V
o	99.9 Hz	Triangle	2.955V	3.045V
q	99.9 Hz	+ Ramp	2.955V	3.045V
r	99.9 Hz	– Ramp	2.955V	3.045V
s	1 kHz	Square	2.970V	3.030V
t	2 kHz	Triangle	2.955V	3.045V
u	500 Hz	+ Ramp	2.955V	3.045V
v	500 Hz	– Ramp	2.955V	3.045V
w	100 kHz	Square	2.970V	3.030V
x	10 kHz	Triangle	2.850V	3.150V
y	10 kHz	+ Ramp	2.700V	3.300V
z	10 kHz	– Ramp	2.700V	3.300V

cc. Change the HP 3325B amplitude to 1 V_{pp}, and set dc offset to 1 mV. Set frequency to 99.9 Hz and function to square. Set oscilloscope vertical sensitivity to 0.05 V/div for all 1 V_{pp} tests.

dd. Repeat tests i through z. Test limits are as follows:

Test	Frequency	Function	Minimum	Maximum
m	99.9 Hz	Square	0.970V	1.030V
o	99.9 Hz	Triangle	0.960V	1.040V
q	99.9 Hz	+ Ramp	0.960V	1.040V
r	99.9 Hz	– Ramp	0.960V	1.040V
s	1 kHz	Square	0.970V	1.030V
t	2 kHz	Triangle	0.960V	1.040V
u	500 Hz	+ Ramp	0.960V	1.040V
v	500 Hz	– Ramp	0.960V	1.040V
w	100 kHz	Square	0.970V	1.030V
x	10 kHz	Triangle	0.940V	1.060V
y	10 kHz	+ Ramp	0.890V	1.110V
z	10 kHz	– Ramp	0.890V	1.110V

High Voltage Output Amplitude Accuracy for Frequencies to 100 kHz (for instruments with high voltage option 002)

ee. Sine Wave Test. Connect the HP 3325B signal output to the ac voltmeter with a 6 foot cable. Connect a 500Ω, 300 pF load (at either end) in parallel with the line.

ff. Select the high voltage output on the HP 3325B. A LED near the key indicates that the high voltage output is on.

gg. Set the HP 3325B function to sine, frequency to 2 kHz, and amplitude to 14.14 Vrms (40 V_{pp}). Press [Amptd Cal]. The ac voltmeter reading should be 13.86 to 14.42 Vrms.

hh. High Voltage Function Test. Connect the HP 3325B signal output to oscilloscope and voltage divider with a 6 foot cable. Trigger oscilloscope on HP 3325B sync output. Trigger high speed voltmeter on delayed sweep gate from oscilloscope (see figure 4-14B).

ii. The voltage divider shown in figure 4-14B is built into a small metal box with 2 BNC connectors. Parts used are:

R3, 443Ω consists of 3 parallel 1330Ω resistors, each 0.1%, 0.25W
R4, 43Ω, 0.1%, 0.125W
C1, 300 pF, 5%
Connect the tap to the input of high speed voltmeter as shown in figure 4-14B.

jj. Set the HP 3325B frequency to 2 kHz and amplitude to 40 V_{pp}. Set voltmeter to 1V range and external trigger. Set oscilloscope as follows:

Vertical Sensitivity	2 V/div
Vertical Position	8 o'clock
Trigger	External
Main Sweep	20 μs/div
Delayed Sweep	0.05 μs/div
Delay	615
Magnify	× 10

kk. Set the HP 3325B to square wave and read positive peak on voltmeter. Switch oscilloscope to negative trigger, vertical position to 4 o'clock, and read negative peak. Verify that voltage is between 3.466 and 3.607 V_{pp}.

ll. Change the HP 3325B function to triangle, and read peak voltages. Voltage should be 3.466 to 3.607 V_{pp}.

mm. Change the HP 3325B to positive ramp. Change oscilloscope main sweep to 0.1 ms/div and delay to 500. Verify voltage of 3.466 to 3.607 V_{pp}. Repeat for negative ramp by changing oscilloscope trigger to positive.

Amplitude Flatness: (Frequencies above 100 kHz)

nn. Set the HP 3325B as follows:

High Voltage Output (option 002)	Off
Function	Sine
Frequency	1 kHz
Amplitude	3 V_{pp}

oo. Set the 50Ω attenuator to 3 dB and connect to signal output. Connect 1 V_{rms} thermal converter to attenuator output. Connect voltmeter with microvolt resolution to thermal converter output (see figure 4-14C).

pp. Press the HP 3325B [Amptd Cal] key. Record the voltmeter reading in the 3V sine wave 1 kHz reference space on the Performance Test Record.

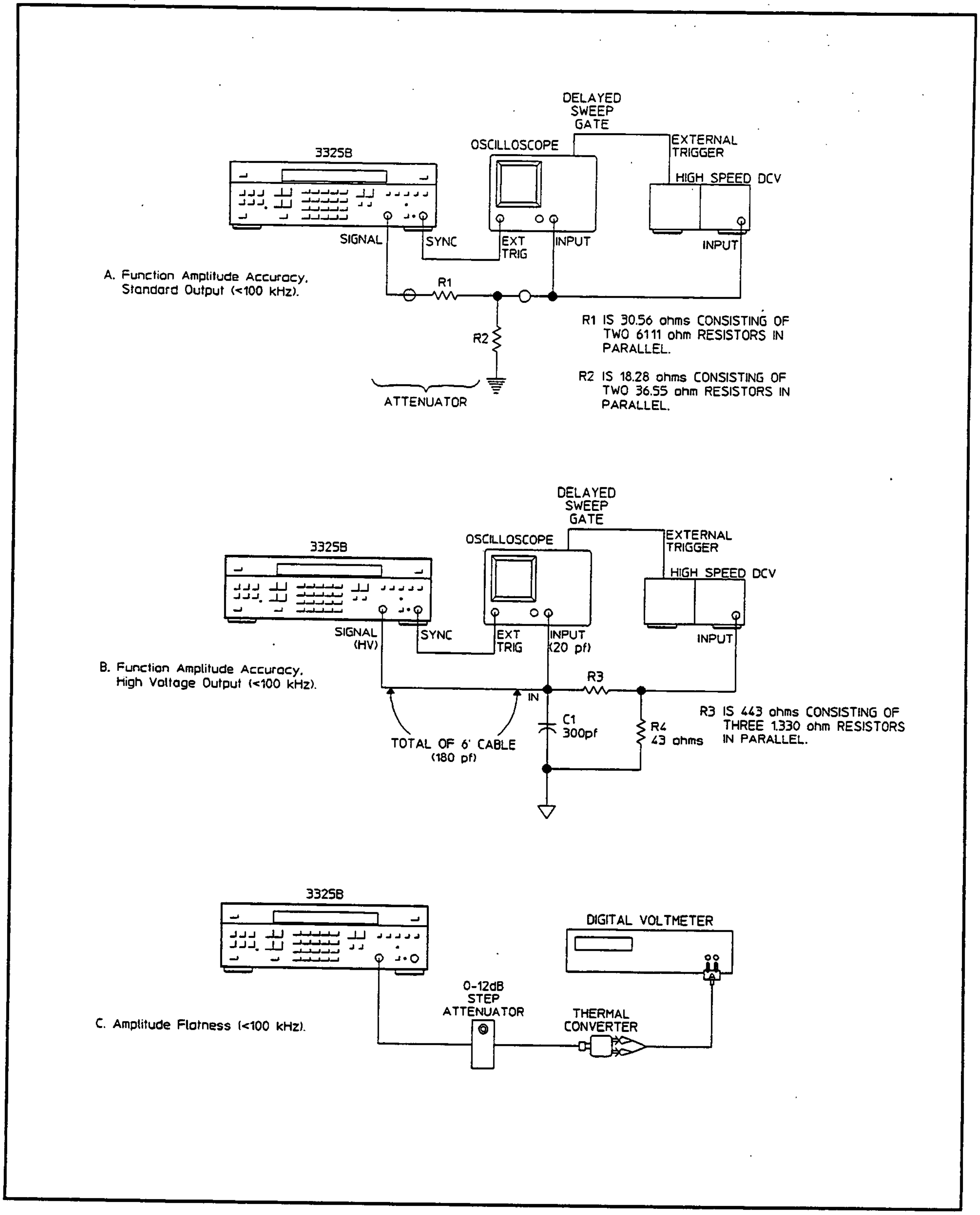

Figure 4-14. Amplitude Accuracy and Flatness.

qq. Use the modify keys to increase the frequency in 2 MHz steps from 1 kHz to 20.001 MHz, recording the voltmeter reading at each frequency. In each case, allow the thermal converter several seconds to stabilize.

rr. Verify that all flatness readings are within ±6.6% of the 1 kHz reference reading.

ss. Change attenuator to 12 dB. Change the HP 3325B amplitude to 10 V_{pp}. Repeat steps pp and qq for 10 V_{pp}. Verify that all readings are within 6.3% of the 1 kHz reference.

tt. Disconnect the thermal converter from the HP 3325B output.

uu. Square wave flatness. Set the HP 3325B as follows:

High Voltage Output (option 002)	Off
Function	Square
Frequency	1 kHz
Amplitude	10 V_{pp}

vv. Connect the HP 3325B signal output to an oscilloscope with a 50Ω feedthru termination. Set the oscilloscope as follows:

Vertical Sensitivity	2 V/div
Time/Div	0.1 ms

ww. Use the modify keys to increase the HP 3325B frequency from 1 kHz to 10.001 MHz in 2 MHz steps. Two lines will appear on the oscilloscope. Verify that they remain within 1/2 major division of 5 divisions apart for all 11 frequencies.

High Voltage Output (option 002)
Amplitude Flatness above 100 kHz

xx. Connect the HP 3325B output to an oscilloscope with a 500Ω, 500 pF load (load attached at either end). Cable capacitance (30 pF/foot) must be included in the 500 pF.
The HV divider (figure 4-14B) may be used with 6 feet of cable.

yy. Set the oscilloscope as follows:

Vertical Sensitivity	10 V/div
Time/Div	1 ms

zz. Set the HP 3325B to 40 Vpp sine wave and 1 kHz. Adjust oscilloscope intensity and focus for a sharp trace.

aaa. Use the modify keys to increase the HP 3325B frequency from 1 kHz to 1.001 MHz in 200 kHz steps. Verify that the width of the bright region of the screen is 4 ±0.4 divisions for all 11 frequencies.

DC Offset Accuracy (DC Only)

This procedure tests the HP 3325B dc offset accuracy when no ac function output is present to the following specifications:

±0.4% of full range*

* *Except lowest attenuator range where accuracy is ±20 μV*

Equipment Required: DC Digital Voltmeter with 5 digit resolution, capable of measuring > 20V for high voltage output (option 002)
50Ω Feedthru Termination

a. Connect the HP 3325B signal output directly to the 50Ω feedthru termination and then with a cable to the dc digital voltmeter input (see figure 4-15A).

b. Press whichever function key is presently active, indicated by a lighted indicator beside the key. This removes the ac output. The indicator beside the [DC Offset] key should light.

c. Set the HP 3325B dc offset to 5V, then press [Amptd Cal].

d. The voltmeter reading should be +4.980 to +5.020 V.

e. Change the HP 3325B dc offset to −5V. Voltmeter reading should be −4.980 to −5.020 V.

Attenuator Test

f. Set the dc offset to the positive and negative voltages shown below. The digital voltmeter reading should be within the tolerances shown for each voltage.

DC Offset	Tolerances
±1.499V	±1.49300 to 1.50499 V
±499.9 mV	±0.49790 to 0.50190 V
±149.9 mV	±0.14930 to 0.15050 V
±49.99 mV	±0.04979 to 0.05019 V
±14.99 mV	±0.01493 to 0.01505 V
±4.999 mV	±0.004979 to 0.005019 V
±1.499 mV	±0.001479 to 0.001519 V

High Voltage Output (option 002) DC Offset

g. Remove the 50Ω feedthru termination and connect the HP 3325B output directly to the voltmeter input.

h. Select the high voltage output on the HP 3325B. A LED near the key indicates that the high voltage output is on.

i. Set the HP 3325B dc offset to 20V. Voltmeter reading should be +19.775 to 20.225 V.

j. Set the HP 3325B dc offset to −20V. Voltmeter reading should be −19.775 to −20.225 V

DC Offset Accuracy with AC Functions

This procedure compares the HP 3325B dc offset with ac functions accuracy to the following specifications:

DC + AC, ≤ 1 MHz: ±1.2%, Ramps ±2.4%
DC + AC, > 1 MHz: ±3%

Equipment Required: DC Digital Voltmeter
50Ω Feedthru Termination

a. Connect the equipment as shown in figure 4-15A. Set the voltmeter to measure dc voltage.

b. Set the HP 3325B output as follows:

High Voltage Output (option 002)	Off
Function	Sine
Frequency	20.999 999 999 MHz
Amplitude	1 V_{pp}
DC Offset	+4.5V

c. Press [Amptd Cal]. After amplitude calibration (approximately 2 seconds) the voltmeter reading should be +4.350 to +4.650 Vdc.

d. Change the dc offset to −4.5V. Voltmeter reading should be −4.350 to −4.650 Vdc.

e. Change the HP 3325B frequency to 999.9 kHz. The voltmeter reading should be −4.440 to −4.560 Vdc.

f. Change the HP 3325B dc offset to +4.5V. The voltmeter reading should be +4.440 to +4.560 Vdc.

g. Set the HP 3325B function to square. The voltmeter reading should be +4.440 to +4.560 Vdc.

h. Change the HP 3325B dc offset to −4.5V. The voltmeter reading should be −4.440 to −4.560 Vdc.

i. Change the HP 3325B frequency to 9.9999 MHz. The voltmeter reading should be −4.350 to −4.650 V.

j. Set the HP 3325B function to triangle, frequency to 9.9 kHz. The voltmeter reading should be −4.440 to −4.560 V.

k. Set the function to positive ramp. The voltmeter reading should be −4.380 to −4.620 V.

Triangle Linearity

This procedure tests the linearity of the HP 3325B triangle wave output to the following specifications:

±0.05% of full output, 10% to 90%, best fit straight line

Because the triangle and ramp outputs are generated by the same circuits, this procedure effectively tests the ramp linearity also.

Equipment Required: High-Speed DC Digital Voltmeter (This procedure is written to use the high speed and delay capabilities of the HP 3437A)
Resistive Divider, ÷ 2.5, consisting of:
30Ω ±1% 1/4W
20Ω ±1% 1/4W
BNC-to-Triax Adapter

a. Connect the HP 3325B and the high-speed voltmeter through the divider as shown in figure 4-15B.

b. Set the HP 3325B as follows:

High Voltage Output (option 002)	Off
Function	Triangle
Frequency	10 kHz
Amplitude	10 V_{pp}

c. Set the voltmeter as follows:

Range	1V
Number of Readings	1
Trigger	External

NOTE The HP 3437A triggers on the negative going edge of the HP 3325B sync square wave.

d. Set the voltmeter delay to 0.00003 (seconds). Record the voltmeter reading on the Performance Test Record under *Positive Slope Measurement, (10%)* y_1. This is the 10% point on the positive slope of the triangle (see figure 4-15C).

e. Measure the voltage at each 10% segment point by setting the voltmeter delay to the following. Enter on the Performance Test Record in the appropriate spaces under *Positive Slope Measurement*.

Delay	Percent of Slope
0.000035	20
0.00004	30
0.000045	40
0.00005	50
0.000055	60
0.00006	70
0.000065	80
0.00007	90

f. Measure the voltage at each 10% segment point on the negative slope by setting the voltmeter delay to the following. Enter the reading on the Performance Test Record in the appropriate spaces under *Negative Slope Measurement*.

Delay	Percent of Slope
0.00008	90
0.000085	80
0.00009	70
0.000095	60
0.0001	50
0.000105	40
0.00011	30
0.000115	20
0.00012	10

g. Algebraically add the voltages recorded in the *Positive Slope Measurement* column and enter the total in the Σy space.

h. Multiply Σy by 45 (which is Σx) and enter the result in the $\Sigma x \Sigma y$ space.

i. Multiply each y value by the corresponding x value and enter in the *x times y* column. Total these values and enter in the Σxy space.

j. The equation for determining the best fit straight line specification for each y value is:

$$y = a_1 x + a_0$$

Where: a_1 and a_0 are constants to be calculated from data taken previously.

NOTE: Calculate the values of a_1 and a_0 to at least five decimal places.

k. First determine the value of a_1 using the following equation:

$$a_1 = \frac{\Sigma xy - \frac{\Sigma x \Sigma y}{n}}{\Sigma x^2 - \frac{(\Sigma x)^2}{n}}$$

Where: Σx, Σy, Σxy, $\Sigma x \Sigma y$, Σx^2, and $(\Sigma x)^2$ are the previously calculated values entered on the Performance Test Record.

Where: $n = 9$ (the number of points to be calculated)

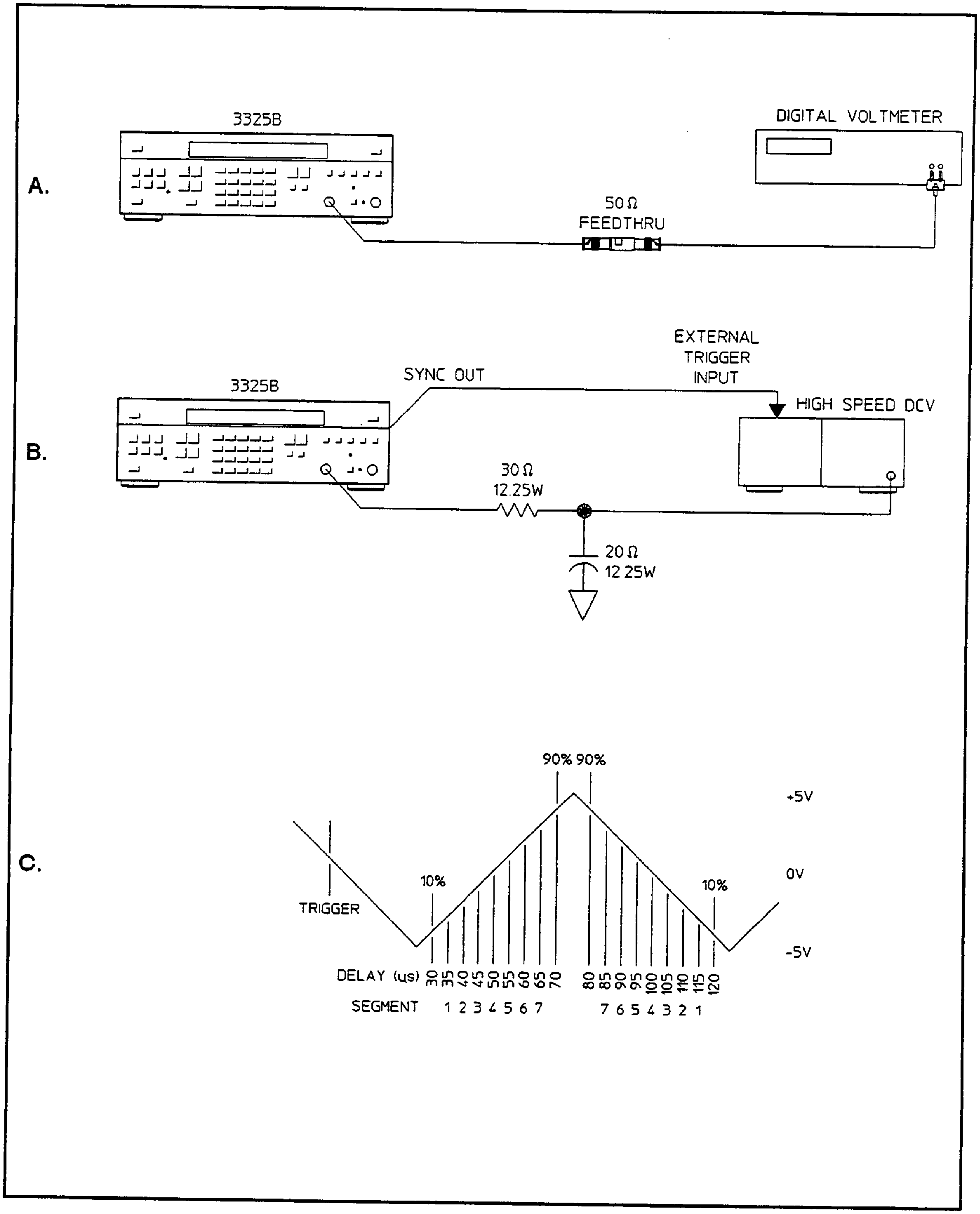

Figure 4-15. DC Offset and Triangle Linearity.

l. Determine the value of a_0 using the equation:

$$a_0 = \frac{\Sigma y}{n} - a_1 \frac{\Sigma x}{n}$$

m. Calculate the best fit straight line value for each point (y_1 through y_9) using the equation:

$y = a_1 x = a_0$

Enter each result on the Performance Test Record in the *Best Fit Straight Line* column.

n. For each delay (x), subtract the calculated voltage (y') from the measured voltage (y). Find the largest positive voltage difference ($+V_{max}$) and the largest negative difference ($-V_{max}$). Using the following formula, compute the % linearity.

$$\% \text{ LINEARITY} = \frac{|+V_{max}| + |-V_{max}|}{8 \text{ Volts}} \times 100\%$$

o. Algebraically add the voltages recorded in the *Negative Slope Measurement* column and enter the total in the Σy space.

p. Repeat steps h through n to determine the best fit straight line values and tolerances for the negative slope. The voltages measured and recorded in the *Negative Slope Measurement* column should be within the calculated tolerances.

X Drive Linearity

This procedure tests the linearity of the HP 3325B rear panel X Drive output to the following specifications: for all linear sweep widths which are integral multiples of the minimum sweep width for each function and sweep time:

±0.1% of final value, 10% to 90%, best fit straight line.

Equipment Required: High-Speed DC Digital Voltmeter (This procedure is written to use the high speed and delay capabilities of the HP 3437A)
Resistive Divider, ÷ ~2.6, consisting of:
100 kΩ 1% 1/8W
162 kΩ 1% 1/8W
DC Power Supply
BNC-to-Triax Adapter

a. Connect the equipment as shown in figure 4-16A.

b. Set the HP 3325B as follows:

High Voltage Output (option 002)	Off
Function	Sine
Amplitude	10 V_{pp}
Sweep Start Frequency	1 MHz
Sweep Stop Frequency	10 MHz
Sweep Marker Frequency	4 MHz
Sweep Time	0.01s

c. Press the HP 3325B [Start Cont] key.

d. Set the voltmeter as follows:

Range	1V
Number of Readings	1
Trigger	External

NOTE The HP 3437A triggers on the negative going edge of the Z Blank signal, which occurs at the start of a sweep up.

e. Set the voltmeter delay to 0.001 (seconds). Adjust the dc power supply for a voltmeter reading of −1.600V. Record the voltmeter reading on the Performance Test Record under *X Drive Ramp Measurement, (10%),* y_1. This is the 10% point on the X Drive ramp (see figure 4-16B).

f. Measure the voltage at each 10% segment point by setting the voltmeter delay to the following. Enter on the Performance Test Record in the appropriate spaces under *X Drive Ramp Measurement.*

Delay	Percent of Ramp
0.002	20
0.003	30
0.004	40
0.005	50
0.006	60
0.007	70
0.008	80
0.009	90

g. Algebraically add the voltages recorded in the *X Drive Ramp Measurement* column and enter the total in the Σy space.

h. Multiply Σy by 45 (which is Σx) and enter the result in the $\Sigma x \Sigma y$ space.

i. Multiply each y value by the corresponding x value and enter in the *x times y* column. Total these values and enter in the Σxy space.

j. The equation for determining the best fit straight line specification for each y value is:

$$y = a_1 x + a_0$$

Where: a_1 and a_0 are constants to be calculated from data taken previously.

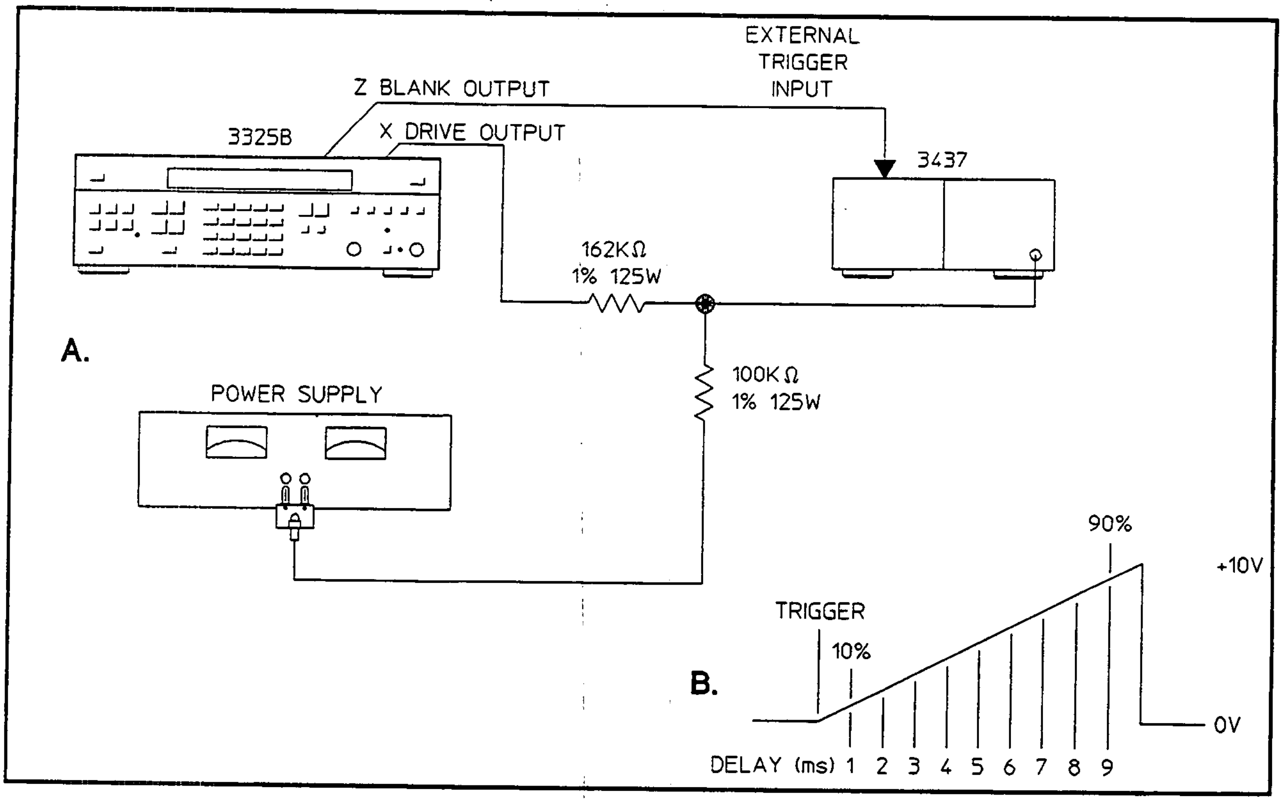

Figure 4-16. X Drive Linearity

NOTE Calculate the values of a_1 and a_0 to at least five decimal places.

---

k. First determine the value of a_1 using the following equation:

$$a_1 = \frac{\Sigma xy - \dfrac{\Sigma x \Sigma y}{n}}{\Sigma x^2 - \dfrac{(\Sigma x)^2}{n}}$$

Where: Σx, Σy, Σxy, $\Sigma x \Sigma y$, Σx^2, and $(\Sigma x)^2$ are the previously calculated values entered on the Performance Test Record.

Where: $n = 9$ (the number of points to be calculated)

l. Determine the value of a_0 using the equation:

$$a_0 = \frac{\Sigma y}{n} - a_1 \frac{\Sigma x}{n}$$

m. Calculate the best fit straight line value for each point (y_1 through y_9) using the equation:

$$y = a_1x + a_0$$

Enter each result on the Performance Test Record in the *Best Fit Straight Line* column.

n. Determine the minimum and maximum allowable voltages at each point by subtracting and adding 0.004V to the voltage calculated in step m (10.5V ÷ 2.6 × 0.1%). Enter these voltage limits on the Performance Test Record under *Minimum* and *Maximum*. The voltage measured and recorded in the *X Drive Ramp Measurement* column should be within these calculated tolerances.

NOTE The HP 3325B X Drive maximum voltage (100%) is set at the factory to +10.5V.

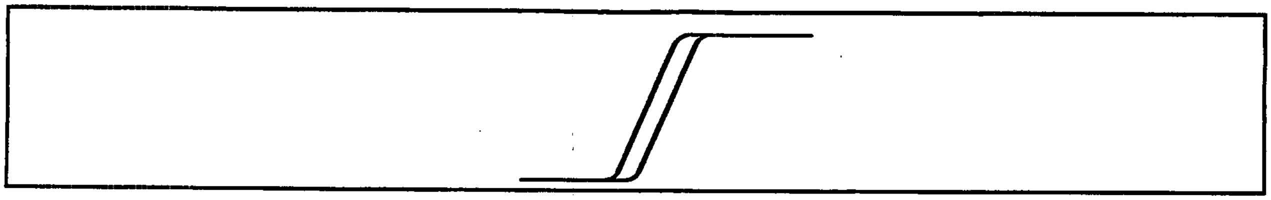

Figure 4-17. Ramp Period Variation.

Ramp Period Variation

This procedure tests the variation between alternate cycles of the HP 3325B positive and negative slope ramps to the following specification:

< ±1% of period, maximum

Equipment Required: Analog Oscilloscope, with delayed sweep

a. Connect the HP 3325B signal output to the oscilloscope vertical input. (Do NOT use a 10:1 probe.) Set the input switch to the 50Ω position. If your oscilloscope does not have a 50Ω input, use a 50Ω feedthru termination at the input.

b. Set the HP 3325B as follows:

Function	Negative Slope Ramp
Frequency	100 Hz
Amplitude	10 V_{pp}

c. Set the oscilloscope as follows:

Vertical	2 V/div
Main sweep	2.0 ms/div
Delayed sweep	20 μs/div
Trigger	Positive

d. With the oscilloscope horizontal controls set to main sweep, adjust the intensified portion of the trace to the reset (positive going) portion of the ramp.

e. Set the horizontal controls to delayed sweep and position the ramp reset portion near the center of the display.

f. The reset portion should show more than one line, as in figure 4-17. The lines should not be separated by more than ten divisions on the display.

g. Change the HP 3325B function to positive slope ramp and set oscilloscope trigger to negative to verify the positive ramp.

h. Increase the HP 3325B frequency to 99.999999 Hz to check the low frequency ramps. Verify that ramp period variations do not exceed ten divisions.

Operational Verification Record

Calibration Entity and Address____

____

Test Performed By____

Test Date____

Serial Number____

Operational Verfication Record

Self Test		
		Passed:
Sine Wave Verification		
Step d	20 MHz: Frequency and Amplitude	Passed:
Step g	Signal Purity	Passed:
	High Voltage Output (1 MHz)	Passed:
Square Wave Verification		
Step c	Frequency and Amplitude	Passed:
Steps d and e	Aberrations	Passed:
Step f	Rise Time	Passed:
Triangle and Ramp Verification		
Step c	Triangle Freq. and Amptd.	Passed:
Step d	+ Ramp Freq. and Amptd.	Passed:
Step e	– Ramp Freq. and Amptd.	Passed:
Step f	– Ramp Retrace Time	Passed:
Step g	+ Ramp Retrace Time	Passed:
Step i	Triangle Linearity	Passed:
Amplitude Flatness		
Measured Value		Passed:
Sync Output Check		
Measured Value		**Specification**
High: ______________		>+ 1.2V
Low: ______________		< 0.2V

Frequency Accuracy			
Measurement		**Measured Value**	**Specification**
Step c	Sine 20 MHz	______________	± 100 Hz
Step d	Square 10 MHz	______________	± 50 Hz
Step e	Triangle 10 kHz (100,00 ns)	______________	± .5 ns
Step f	Ramp 10 kHz (100,000 ns)	______________	± .5 ns

Operational Verfication Record, Continued

Output Level and Attenuator Check (DC Offset Only)

Entry	Minimum	Measured Value	Maximum
– 5V	– 5.020V	________	– 4.980V
(+)5V	+ 4.980V	________	+ 5.020V
* (±) 1.499V	(±) 1.49300V	________	(±) 1.50499V
499.9 mV	+ 0.49790V	________	+ 05.0190V
149.9 mV	+ 0.14930V	________	+ 0.15050V
49.99 mV	+ 0.04979V	________	+ 0.05019V
14.99 mV	+ 0.01493V	________	+ 0.01505V
4.999 mV	+ 0.04979V	________	+ 0.005019V
1.499 mV	+ 0.001479V	________	+ 0.001519V

* All entries and limits are ±

High Voltage Output (Option 002)

Entry	Minimum	Measured Value	Maximum
20V	+ 19.775V	________	+ 20.225V
– 20V	– 20.225V	________	– 19.775V

Harmonic Distortion

Entry	Measured Value	All Harmonics Below:
20 MHz	________	– 25 dB
15 MHz	________	– 30 dB
2 MHz	________	– 40 dB
200 kHz	________	– 60 dB
50 kHz	________	– 65 dB
10 kHz	________	– 65 dB
1 kHz	________	– 65 dB
100 Hz	________	– 65 dB

High Voltage Output (Option 002)

Entry	Measured Value	All Harmonics Below:
100 Hz	________	– 65 dB
10 kHz	________	– 65 dB
200 kHz	________	– 60 dB
1 MHz	________	– 40 dB

Close-In Spurious Signal Test

Measurement	Passed:

Performance Test Record

Calibration Entity and Address____

____

Test Performed By____

Report Number ____

Customer____

Trace Number____

Installed Options____

Test Date____

Temperature____

Humidity____

Power Line Frequency____

Trace Number:________________Report Number:______________Test Date:__/__/__

Test Equipment:

Low Frequency Spectrum Analyzer

Model____

Trace Number____

Calibration Due Date____

High Frequency Spectrum Analyzer

Model____

Trace Number____

Calibration Due Date____

Digital Multimeter

Model____

Trace Number____

Calibration Due Date____

High Speed DC Digital Voltmeter

Model____

Trace Number____

Calibration Due Date____

Frequency Counter

Model____

Trace Number____

Calibration Due Date____

Trace Number:__________________Report Number:_______________Test Date:___/___/___

Sampling Oscilloscope

Model____

Trace Number____

Calibration Due Date_____________________________________

Analog Oscilloscope

Model____

Trace Number____

Calibration Due Date_____________________________________

Frequency Synthesizer

Model____

Trace Number____

Calibration Due Date_____________________________________

Feedthrough Termination

Model____

Trace Number____

Calibration Due Date_____________________________________

Thermal Converter

Model____

Trace Number____

Calibration Due Date_____________________________________

Trace Number:__________________Report Number:________________Test Date:___/___/___

Sinewave Signal Source

Model____

Trace Number____

Calibration Due Date____________________________________

Step Attenuator (1)

Model____

Trace Number____

Calibration Due Date____________________________________

Step Attenuator (2)

Model____

Trace Number____

Calibration Due Date____________________________________

DC Power Supply

Model____

Trace Number____

Calibration Due Date____________________________________

Performance Test Record

Harmonic Distortion		
Fundamental Frequency	**Measured Value**	**Specification**
20 MHz	______	– 25 dB
15 MHz	______	– 30 dB
2 MHz	______	– 40 dB
200 kHz	______	– 60 dB
50 kHz	______	– 65 dB
10 kHz	______	– 65 dB
1 kHz	______	– 65 dB
100 Hz	______	– 65 dB

High Voltage Output (Option 002)		
Fundamental Frequency	**Measured Value**	**Specification**
100 Hz	______	– 65 dB
10 kHz	______	– 65 dB
200 kHz	______	– 60 dB
1 MHz	______	– 40 dB

Spurious Signal			
Mixer Spurious (2:1 spur/3:2 spur)			
Frequency	**2:1 spur**	**3:2 spur**	**Specification**
4.100 MHz	______	______	≤ 70 dB
6.100 MHz	______	______	≤ 70 dB
8.100 MHz	______	______	≤ 70 dB
10.100 MHz	______	______	≤ 70 dB
12.100 MHz	______	______	≤ 70 dB
14.100 MHz	______	______	≤ 70 dB
16.100 MHz	______	______	≤ 70 dB
18.100 MHz	______	______	≤ 70 dB
20100 MHz	______	______	≤ 70 dB

Close-in Spurious		
Frequency	**Measured Value**	**Specification**
5.0001 MHz	______	≤ 70 dB
5.00001 MHz	______	≤ 70 dB
5.000001 MHz	______	≤ 70 dB
20.001 MHz	______	≤ 70 dB

Integrated Phase Noise		
Frequency	**Measured Value**	**Specification**
19.901 MHz	______	≤ 60 dB

Performance Test Record, Continued

Amplitude Modulation Envelope Distortion		
Frequency	**Measured Value**	**Specification**
	________	≤ 30 dB

Square Wave Rise Time and Aberrations		
Measurement	**Measured Value**	**Specification**
Rise Time	________	< 20 ns
Fall Time	________	< 20 ns
Overshoot, Positive Peak	________	< 500 mV
Overshoot, Negative Peak	________	< 500 mV

Ramp Retrace Time		
Measurement	**Measured Value**	**Specification**
+ Ramp	________	< 3 μs
− Ramp	________	< 3 μs

Sync Output		
Measurement	**Measured Value**	**Specification**
V_{high}	________	> + 1.2V
V_{low}	________	< + 0.2V
	________	

Square Wave Symmetry		
Measurement	**Measured Value**	**Specification**
	________	< 3.2 ns

Frequency Accuracy		
Measurement	**Measured Value**	**Specification**
Sine, 20 MHz	________	± 100 Hz
Square, 10 MHz	________	± 50 Hz
Triangle, 10 kHz (100,00 ns)	________	± .5 ns
Ramp, 10 kHz (100,000 ns)	________	± .5 ns

Phase Increment Accuracy			
Measurement	**Minimum**	**Time Difference**	**Maximum**
Zero Phase Time Interval ________			
1° Increment Time Interval ________	22.22 ns	________	33.34 ns
10° Increment Time Interval ________	272.22 ns	________	283.34 ns
100° Increment Time Interval ________	2772.22 ns	________	2783.34 ns

Phase Modulation Linearity				
DVM Reading	**Phase Difference**	**Cumulative Phase**	**x times y**	**x^2**
x1 ______	1 0	y1 0	0	______
x2 ______	2 ______	y2 ______	______	______
x3 ______	3 ______	y3 ______	______	______
x4 ______	4 ______	y4 ______	______	______
x5 ______	5 ______	y5 ______	______	______
x6 ______	6 ______	y6 ______	______	______
x7 ______	7 ______	y7 ______	______	______
x8 ______	8 ______	y8 ______	______	______
x9 ______	9 ______	y9 ______	______	______
x10 ______	10 ______	y10 ______	______	______
x11 ______	11 ______	y11 ______	______	______
Σx ______		Σy ______	Σxy ______	Σx^2 ______
$(\Sigma x)^2$ ______		$\Sigma x \Sigma y$ ______		

Best Fit Straight Line Phase	Minimum Limit	Measured Cumulative Phase	Maximum Limit
(y1) ______	y1 0	______	______
(y2) ______	y2 ______	______	______
(y3) ______	y3 ______	______	______
(y4) ______	y4 ______	______	______
(y5) ______	y5 ______	______	______
(y6) ______	y6 ______	______	______
(y7) ______	y7 ______	______	______
(y8) ______	y8 ______	______	______
(y9) ______	y9 ______	______	______
(y10) ______	y10 ______	______	______
(y11) ______	y11 ______	______	______

Specification: $\pm$ 0.5% of $(y_{11}) = \pm$ ______ °

Amplitude Accuracy

Sine Wave Test			
Entry	**Minimum**	**Measured**	**Maximum**
Amplitude: 3.536 Vrms			
Sine, 100 Hz	3.495V	________	3.577V
Sine, 1 kHz	3.495V	________	3.577V
Sine, 100 kHz	3.495V	________	3.577V
Amplitude: 1.061 Vrms			
Sine, 100 Hz	1.048V	________	1.073V
Sine, 1 kHz	1.048V	________	1.073V
Sine, 100 kHz	1.048V	________	1.073V
Amplitude: 0.3536 Vrms			
DC, 1 mV			
Sine, 100 Hz	0.3411V	________	0.3660V
Sine, 1 kHz	0.3411V	________	0.3660V
Sine, 100 kHz	0.3411V	________	0.3660V

Function Test			
Entry	**Minimum**	**Measured**	**Maximum**
Amplitude: 10 Vpp			
Square, 99.9 Hz	3.661V	________	3.735V
Triangle, 99.9 Hz	3.643V	________	3.754V
Pos Ramp, 99.9 Hz	3.643V	________	3.754V
Neg Ramp, 99.9 Hz	3.643V	________	3.754V
Square, 1 kHz	3.661V	________	3.735V
Triangle, 2 kHz	3.643V	________	3.754V
Pos Ramp, 500 Hz	3.643V	________	3.754V
Neg Ramp, 500 Hz	3.643V	________	3.754V
Square, 100 kHz	3.661V	________	3.735V
Triangle, 10 kHz	3.513V	________	3.883V
Pos Ramp, 10 kHz	3.328V	________	3.996V
Neg Ramp, 10 kHz	3.328V	________	3.996V

Amplitude Accuracy, Continued

Entry	Minimum	Measured	Maximum
Amplitude: 3 Vpp			
Square, 99.9 Hz	2.970V	______	3.030V
Triangle, 99.9 Hz	2.955V	______	3.045V
Pos Ramp, 99.9 Hz	2.955V	______	3.045V
Neg Ramp, 99.9 Hz	2.955V	______	3.045V
Square, 1 kHz	2.970V	______	3.030V
Triangle, 2 kHz	2.955V	______	3.045V
Pos Ramp, 500 Hz	2.955V	______	3.045V
Neg Ramp, 500 Hz	2.955V	______	3.045V
Square, 100 kHz	2.970V	______	3.030V
Triangle, 10 kHz	2.850V	______	3.150V
Pos Ramp, 10 kHz	2.700V	______	3.300V
Neg Ramp, 10 kHz	2.700V	______	3.300V
Amplitude: 1 Vpp **DC: 1 mV**			
Square, 99.9 Hz	0.970V	______	1.030V
Triangle, 99.9 Hz	0.960V	______	1.040V
Pos Ramp, 99.9 Hz	0.960V	______	1.040V
Neg Ramp, 99.9 Hz	0.960V	______	1.040V
Square, 1 kHz	0.970V	______	1.030V
Triangle, 2 kHz	0.960V	______	1.040V
Pos Ramp, 500 Hz	0.960V	______	1.040V
Neg Ramp, 500 Hz	0.960V	______	1.040V
Square, 100 kHz	0.970V	______	1.030V
Triangle, 10 kHz	0.940V	______	1.060V
Pos Ramp, 10 kHz	0.890V	______	1.110V
Neg Ramp, 10 kHz	0.890V	______	1.110V

Amplitude Accuracy, Continued

High Voltage (Option 002) Sinewave Test			
Entry	**Minimum**	**Measured**	**Maximum**
Amplitude: 14.14 Vrms			
Sine, 2 kHz	13.86V	________	14.42V

High Voltage (Option 002) Function Test			
Entry	**Minimum**	**Measured**	**Maximum**
Amplitude: 40 Vpp			
Square, 2 kHz	3.466V	________	3.607V
Triangle, 2 kHz	3.466V	________	3.607V
Pos Ramp, 2 kHz	3.466V	________	3.607V
Neg Ramp, 2 kHz	3.466V	________	3.607V

Amplitude Flatness

Measurement	Minimum	Measured Value	Maximum
Sine, 3 Vpp, 1 kHz (Reference)		____________ = Y	
Allowable tolerance (± 6.6%)	0.934Y	____________	1.066Y
2.001 MHz	0.934Y	____________	1.066Y
4.001 MHz	0.934Y	____________	1.066Y
6.001 MHz	0.934Y	____________	1.066Y
8.001 MHz	0.934Y	____________	1.066Y
10.001 MHz	0.934Y	____________	1.066Y
12.001 MHz	0.934Y	____________	1.066Y
14.001 MHz	0.934Y	____________	1.066Y
16.001 MHz	0.934Y	____________	1.066Y
18.001 MHz	0.934Y	____________	1.066Y
20.001 MHz	0.934Y	____________	1.066Y
Sine, 10 Vpp, 1 kHz (Reference)		____________ = Y	
Allowable tolerance (± 6.3%)	0.937Y	____________	1.063Y
2.001 MHz	0.934Y	____________	1.066Y
4.001 MHz	0.934Y	____________	1.066Y
6.001 MHz	0.934Y	____________	1.066Y
8.001 MHz	0.934Y	____________	1.066Y
10.001 MHz	0.934Y	____________	1.066Y
12.001 MHz	0.934Y	____________	1.066Y
14.001 MHz	0.934Y	____________	1.066Y
16.001 MHz	0.934Y	____________	1.066Y
18.001 MHz	0.934Y	____________	1.066Y
20.001 MHz	0.934Y	____________	1.066Y
Square, 10 Vpp	Pass:____________	Fail:____________ (check one)	
High Voltage (Option 002) Flatness			
Sine, 40 Vpp	Pass:____________	Fail:____________ (check one)	

DC Offset Accuracy (DC Only)

Entry	Minimum	Measured Value	Maximum
5V	+ 4.980V		+ 5.020V
– 5V	– 5.020V		+ 4.980V
– 1.499V	– 1.50499V		– 1.49300V
1.499V	+ 1.49300V		+ 1.50499V
499.9 mV	+ 0.49790V		+ 05.0190V
– 499.9 mV	– 05.0190V		– 0.49790V
– 149.9 mV	– 0.15050V		– 0.14930V
149.9 mV	+ 0.14930V		+ 0.15050V
49.99 mV	+ 0.04979V		+ 0.05019V
– 49.99 mV	– 0.05019V		– 0.04979V
– 14.99 mV	– 0.01505V		– 0.01493V
14.99 mV	+ 0.01493V		+ 0.01505V
4.999 mV	+ 0.004979V		+ 0.005019V
– 4.999 mV	– 0.005019V		– 0.004979V
– 1.499 mV	– 0.001519V		– 0.001479V
1.499 mV	+ 0.001479V		+ 0.001519V

High Voltage Output (Option 002)

Entry	Minimum	Measured Value	Maximum
20V	+ 19.775V		+ 20.225V
– 20V	– 20.225V		– 19.775V

DC Offset Accuracy with AC Functions

Entry	Minimum	Measured Value	Maximum
Sine 20.999 999 999 MHz			
4.5V	+ 4.350V		+ 4.650V
– 4.5V	– 4.650V		– 4.350V
Sine 999.9 kHz			
– 4.5V	– 4.560V		– 4.440V
4.5V	+ 4.440V		+ 4.560V
Square 999.9 kHz			
4.5V	+ 4.440V		+ 4.560V
– 4.5V	– 4.560V		– 4.440V
Square 9.9999 MHz			
– 4.5V	– 4.650V		– 4.350V
Triangle 9.9 kHz			
– 4.5V	– 4.440V		– 4.560V
Ramp 9.9 kHz			
– 4.5V	– 4.380V		– 4.620V

Triangle Linearity

x Values	Positive Slope Measurement		x times y	Calculated Best Fit Straight Line		Tolerances Minimum	Tolerances Maximum
x1 = 1	(10%) y1	______	______	(y1)	______	______	______
x2 = 2	(20%) y2	______	______	(y2)	______	______	______
x3 = 3	(30%) y3	______	______	(y3)	______	______	______
x4 = 4	(40%) y4	______	______	(y4)	______	______	______
x5 = 5	(50%) y5	______	______	(y5)	______	______	______
x6 = 6	(60%) y6	______	______	(y6)	______	______	______
x7 = 7	(70%) y7	______	______	(y7)	______	______	______
x8 = 8	(80%) y8	______	______	(y8)	______	______	______
x9 = 9	(90%) y9	______	______	(y9)	______	______	______
$\Sigma x = 45$	Σy	______	Σxy ______				
$(\Sigma x)^2 = 2025$	$\Sigma x \Sigma y$	______					
$(\Sigma x)^2 = 285$							

x Values	Negative Slope Measurement		x times y	Calculated Best Fit Straight Line		Tolerances Minimum	Tolerances Maximum
x9 = 9	(90%) y9	______	______	(y9)	______	______	______
x8 = 8	(80%) y8	______	______	(y8)	______	______	______
x7 = 7	(70%) y7	______	______	(y7)	______	______	______
x6 = 6	(60%) y6	______	______	(y6)	______	______	______
x5 = 5	(50%) y5	______	______	(y5)	______	______	______
x4 = 4	(40%) y4	______	______	(y4)	______	______	______
x3 = 3	(30%) y3	______	______	(y3)	______	______	______
x2 = 2	(20%) y2	______	______	(y2)	______	______	______
x1 = 1	(10%) y1	______	______	(y1)	______	______	______
$\Sigma x = 45$	Σy	______	Σxy ______				
$(\Sigma x)^2 = 2025$	$\Sigma x \Sigma y$	______					
$(\Sigma x)^2 = 285$							

X Drive Linearity

x Values	Positive Slope Measurement		x times y	Calculated Best Fit Straight Line		Tolerances Minimum	Tolerances Maximum
$x_1 = 1$	(10%) y_1			(y_1)			
$x_2 = 2$	(20%) y_2			(y_2)			
$x_3 = 3$	(30%) y_3			(y_3)			
$x_4 = 4$	(40%) y_4			(y_4)			
$x_5 = 5$	(50%) y_5			(y_5)			
$x_6 = 6$	(60%) y_6			(y_6)			
$x_7 = 7$	(70%) y_7			(y_7)			
$x_8 = 8$	(80%) y_8			(y_8)			
$x_9 = 9$	(90%) y_9			(y_9)			
$\Sigma x = 45$	Σy		Σxy				
$(\Sigma x)^2 = 2025$	$\Sigma x \Sigma y$						
$(\Sigma x)^2 = 285$							

Ramp Period Variation

Measurement	Measured Value	Specification
Negative Slope Ramp, 100 Hz		$< \pm 100\,\mu s$
Positive Slope Ramp, 100 Hz		$< \pm 100\,\mu s$
Positive Slope Ramp, 99.9 Hz		$< \pm 100\,\mu s$

Appendix A

Specifications

■ Frequency

Range:

Sine: 1 μHz to 20.999 999 999 MHz

Square: 1 μHz to 10.999 999 999 MHz

Triangle/Ramps: 1 μHz to 10.999 999 999 kHz

Resolution:

1 μHz, < 100 kHz

1 mHz ≥ 100 kHz (1 μHz available, not displayed)

Accuracy:

± 5 x 10^{-6} of selected value, 20 °C to 30 °C, at time of calibration, (Standard Instrument)

Stability:

± 5 x 10^{-6}/year, 20 °C to 30 °C, standard (See also option 001, high stability frequency reference)

Warm-up Time:

20 minutes to within specified accuracy.

■ Main Signal Output (all waveforms)

Impedance:

50Ω ± 1Ω, 0-10 kHz

Return Loss:

> 20 dB, 10 kHz to 20 MHz, except > 10 dB for > 3V, 5 MHz to 20 MHz

Connector:

BNC; switchable for front or rear panel, non-switchable with option 002 except by internal cable change.

Floating:

Output may be floated up to 42V peak (ac + dc)

■ Amplitude (all waveforms)

Resolution:

0.03% of full range or 0.01 dB (4 digits).

Range:

1 mV to 10 Vpp in 8 amplitude ranges, 1-3-10 sequence. Ranges are 1 mV -2.999 mV, 3 mV -9.999 mV, 10 mV -29.99 mV, 30 mV -99.99 mV, .1V -.2999V, .3V -.9999V, 1V -2.999V, 3V -10V, (without dc offset).

Function	peak to peak	rms	dBm (50Ω)
Sine			
minimum	1.000 mV	0.354 mV	- 56.02
maximum	10.00V	3.536V	+ 23.98
Square			
minimum	1.000 mV	0.500 mV	- 53.01
maximum	10.00V	5.000V	+ 26.99
Triangle/Ramps			
minimum	1.000 mV	0.289 mV	- 57.78
maximum	10.00V	2.887V	+ 22.22

Accuracy: (with 0 Vdc offset)

Sine:			
.001 Hz	100 kHz	10 MHz	20 MHz
+ 23.98 dBm	± .1 dB	± .4 dB	
+ 13.52 dBm	± .2 dB	± .6 dB	± .6 dB
- 16.02 dBm			
- 56.02 dBm			± .9 dB

Square Wave:		
.001 Hz	100 kHz	10 MHz
10 Vpp	± 1.0%	± 11.1%
3 Vpp		
1 mVpp	± 2.2%	± 13.6%

Triangle:		
.001 Hz	2 kHz	10 kHz
10 Vpp	± 1.5%	± 5.0%
3 Vpp 1 mVpp	± 2.7%	± 6.2%

Ramps:		
.001 Hz	500 Hz	10 kHz
10 Vpp	± 1.5%	± 10%
3 Vpp 1 mVpp	± 10%	± 11.2%

With dc offset, increase all sinewave tolerances by .2 dB and all function tolerances by 2%.

■ Sinewave Spectral Purity

Phase Noise:

- 60 dBc for a 30 kHz band centered on a 20 MHz carrier (excluding ± 1 Hz about the carrier) with option 001 installed.

Spurious:

All non-harmonically related output signals will be more than 70 dB below the carrier (- 60 dBc with dc offset), or less than - 90 dBm, whichever is greater.

■ Waveform Characteristics

Sinewave Harmonic Distortion:

Harmonically related signals will be less than the following levels relative to the fundamental:

Frequency Range	Harmonic Level
.1 Hz to 50 kHz	- 65 dBc
50 kHz to 200 kHz	- 60 dBc
200 kHz to 2 MHz	- 40 dBc
2 MHz to 15 MHz	- 30 dBc
15 MHz to 20 MHz	- 25 dBc

Squarewave Characteristics:

Rise/fall time: ≤ 20 ns 10% to 90%, at full output.

Overshoot: ≤ 5% of peak to peak amplitude, at full output.at 1 MHz.

Settling time: < 1 μs to settle to within .05% of final value, tested at full output with no load, 10 Hz to 500 kHz.

Symmetry: ≤ .02% of period + 3 ns.

Triangle/Ramp Characteristics:

Triangle/ramp linearity (10% to 90%, 10 kHz): ± .05% of full p-p output for each range.

Ramp retrace time: ≤ 3 μs, 90% to 10%.

Period variation for alternate ramp cycles: ≤ 1% of period.

■ DC Offset

Range:

DC only (no ac signal): 0 to ± 5.0V/50Ω

DC + AC: Maximum dc offset ± 4.5V on highest range; decreasing to ± 4.5 mV on lowest range.

Resolution: 4 digits

Accuracy:

DC only: ± .02 mV to ± 20 mV, depends on offset chosen.

DC + AC, to 1 MHz: ± .06 mV to ± 60 mV, depends on ac output level, ± .2 mV to ± 120 mV for ramps to 10 kHz.

DC + AC, 1 MHz to 20 MHz: ± 15 mV to ± 150 mV, depends on ac output level.

■ Phase Offset

Range:

± 719.9° with respect to arbitrary starting phase, or assigned zero phase.

Resolution: 0.1°

Increment Accuracy: ± 0.2°

Stability: ± 1.0 degree of phase/°C

Sinewave Amplitude Modulation

Modulation Depth (at full output for each range):

0-100%

Modulation Frequency Range:

DC to 400 kHz (0-21 MHz carrier frequency)

Envelope Distortion:

- 30 dB to 80% modulation at 1 kHz, 0 Vdc offset.

Sensitivity:

± 5V peak for 100% modulation

Input Impedance: 10 kΩ

Connector: Rear panel BNC

Phase Modulation

Sine Function Range:

± 850°, ± 5V input

Sine Function-Linearity:

± 0.5%, best fit straight line

Squarewave Range: ± 425°

Triangle Range: ± 42.5°

Positive and Negative Ramps: ± 85°

Modulation Frequency Range: dc - 5 kHz

Input Impedance: >40 kΩ

Connector: Rear panel BNC

Frequency Sweep

Sweep Time:

Linear: 0.01s to 1000s

Logarithmic: 1s to 1000s single, 0.1s to 1000s continuous

Maximum Sweep Width:

Full frequency range of the main signal output for the waveform in use except minimum log start frequency is 1 Hz.

Minimum Sweep Width:

Function	Minimum sweep width	
	Sweep time .01 sec.	Sweep time 99.9 sec.
Sine:	.1 mHz	999.9 mHz
Square	.05 mHz	499.5 mHz
Triangle:	.005 mHz	49.95 mHz
Ramps:	.01 mHz	99.99 mHz

Minimum log sweep width is 1 decade.

Phase Continuity:

Sweep is phase continuous over the full frequency range of the main output.

Discrete Sweep:

Number of segments: 100 maximum (Start and stop frequencies set table for each segment)

Time/segment: 0.01s to 1000s, 0.01s resolution

Modulation Source:

Frequency Range: Sine 0.1 Hz - 10 kHz, Square 0.1 Hz - 2 kHz

Frequency Resolution: 2 digits

Frequency Accuracy: Typically 0.1% (Sinewave)

Amplitude Range: 0.1 Vpp to 12 Vpp

Amplitude Resolution: 0.1V

Amplitude Accuracy: Typically ± 200 mV

Impedance: Designed to drive ≥ 10 kΩ loads

Sinewave Purity: Typically better than - 34 dBc

Standard Waveforms: Sine, Square

Arbitrary Waveforms: Vertical resolution 256 points, horizontal resolution 4096 points, 300,000 samples/sec, 10 kHz maximum.

Output Location: Rear Panel BNC

Auxiliary Outputs

Auxiliary Frequency Output:

Frequency Range: 21 MHz to 60.999 999 999 MHz, under range coverage to 19.000 000 001 MHz, frequency selection from front panel.

Amplitude: 0dBm; output impedance: 50Ω

Connector: Rear panel BNC

Sync Output:

Square wave with $V_{high} \geq 1.2V$, $V_{low} \leq 0.2V$ into 50Ω. Frequency range is the same as the main signal output for front panel sync and dc -60 MHz for rear panel sync.

Output impedance: 50Ω

Connector: BNC front and rear panels.

X-Axis Drive:

(0-100s sweeps only)

0 to + 10 Vdc linear ramp proportional to sweep frequency; linearity, 10 - 90%, ±.1% of final value (applies for sweep widths which are integer multiples of the minimum sweep width).

Connector: Rear panel BNC.

Sweep Marker Output:

High to low TTL compatible voltage transition at keyboard selected marker frequency. (Linear sweep only.)

Connector: Rear panel BNC

Z-Axis Blank Output:

TTL compatible voltage levels capable of sinking current from a positive source. Current 200 mA, voltage 45V, power dissipation 1 watt maximum.

1 MHz Reference Output:

0 dBm output for phase-locking additional instruments to the HP 3325B.

Connector: Rear panel BNC.

10 MHz Oven Output:

0 dBm internal high stability frequency reference output for phase-locking HP 3325B or other instruments (option 001 only).

Connector: Rear panel BNC.

Auxiliary Inputs

Reference Input:

For phase-locking HP 3325B to an external frequency reference. Signal from 0 dBm to +20 dBm into 50Ω. Reference signal must be a subharmonic of 10 MHz from 1 MHz to 10 MHz.

Connector: Rear panel BNC. With option 001 this input may be jumpered to the 10 MHz reference output.

Amplitude Modulation Input:

See modulation specifications

Phase Modulation Input:

See modulation specifications

Remote Control

Frequency Switching Time (to within 1 Hz exclusive of programming time:

≤ 10 ms for 100 kHz step; ≤ 25 msec for 1 MHz step; ≤ 70 msec for 20 MHz step.

Phase Switching Time (to within 90° of phase lock exclusive of programming time:
≤ 15 msec.

Amplitude Switching Time (to within amplitude specifications, exclusive of programming time):
<30 ms.

HP-IB Interface Functions:

SH1, AH1, T6, L3, SR1, RL1, PP0, DC1, DT1, C0, E1

RS-232 Interface:

Subset of ANSI/EIA-232D-1986, CCITT V.24

Type: DTE, 25 pin female "D" connector

Baud Rate: 300-4800

Option 001 High Stability Frequency Reference

Aging Rate:

± 5 x 10^{-8}/week, after 72 hours continuous operation; ± 1 x 10^{-7} mo., after 15 days continuous operation.

Warm-up time:

Reference will be within ± 1 x 10^{-7} of final value 15 minutes after turn-on at 25 °C for on off time of less that 24 hours.

Option 002 High Voltage Output

Frequency Range: 1 μHz to 1 MHz

Amplitude:

Range: 4.00 mV to 40.00 Vpp in 8 ranges, 4-12-40 sequence, into 500Ω <500 pF load. Ranges are four times the standard instrument ranges, without dc offset.

Accuracy: ± 2% of full output for each range at 2 kHz.

Flatness: ± 10% relative to programmed amplitude.

Sinewave Distortion:

Harmonically related signals will be less than the following levels (relative to the fundamental full output into 500Ω, load):

10 Hz - 50 kHz: - 65 dB

50 kHz - 200 kHz: - 60 dB

200 kHz - 1 MHz: - 40 dB

Square Wave Rise/Fall Time:

± 125 ns, 10% to 90% at full output, with 500Ω, 500 pF load.

Square Wave Overshoot:

± 10% of peak to peak amplitude with 500Ω, 500 pF load.

Output Impedance:

<2Ω at dc, <10Ω at 1 MHz

DC Offset:

Range: 4 times the specified range of the standard instrument.

Accuracy: ± (1% of full output for each range + 25 mV).

Maximum Output Current:

± 20 mA peak

General

Operating Environment:

Temperature: 0 °C to 55 °C

Relative Humidity: 95%, 0 °C to 40 °C

Altitude: ≤ 15,000 ft.

Acoustic Noise Emission:

LpA <70 dB (sound pressure level)
operator position
normal operation
per ISO 7779

Power:

100/120/220/240V, + 5%, - 10%; 48 to 66 Hz; 90 VA, 120 VA with all options

Weight:

9 kg (20lbs) net ; 14.5 kg (32 lbs) shipping

Dimensions:

133.4 mm high x 425.5 mm wide x 498.5 mm deep (5 1/4 inch H x 16 3/4 inch W x 19 5/8 inch D)

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