Service Manual

MODEL HP 3325B
Synthesizer/Function Generator

Serial Numbers
All

HEWLETT PACKARD

HP Part Number 03325-90003
Microfiche Part Number 03325-90203
Printed in U.S.A.

Print Date: March 1990

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

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

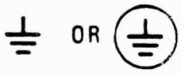
Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting.

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).

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.

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

LIST OF TABLES

LIST OF ILLUSTRATIONS

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.

SECTION V
ADJUSTMENTS

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

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 ..... Ø kHz
Bandwidth ... RBW 30 Hz ..... 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

VBW 10 Hz

Center Freq 5K
1 meg INPUT
RBW 30 HZ
VBW 10 HZ

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 (I) 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).

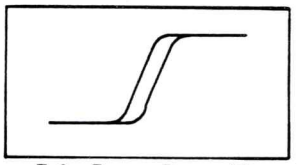


Figure 5-1. Ramp Reset Waveform.

5-19. Amplitude Flatness.

Equipment Required:

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

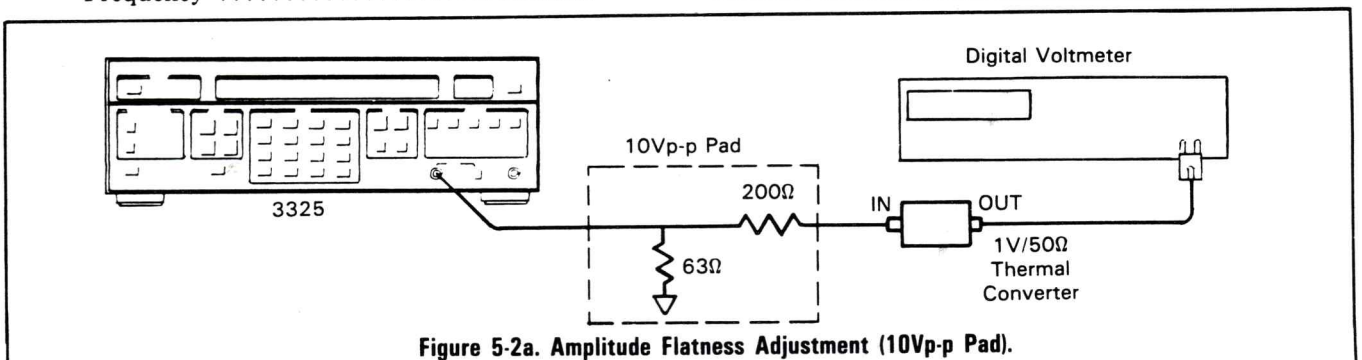


Figure 5-2a. Amplitude Flatness Adjustment (10Vp-p Pad).

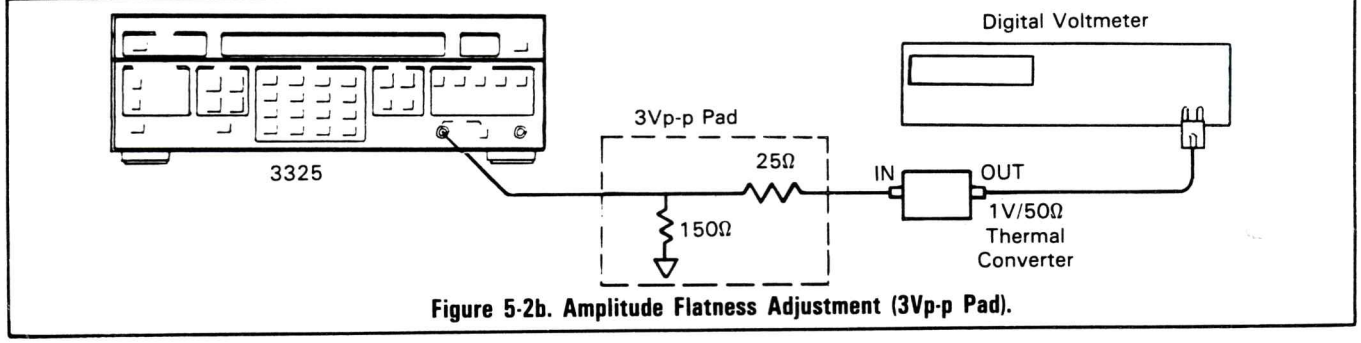
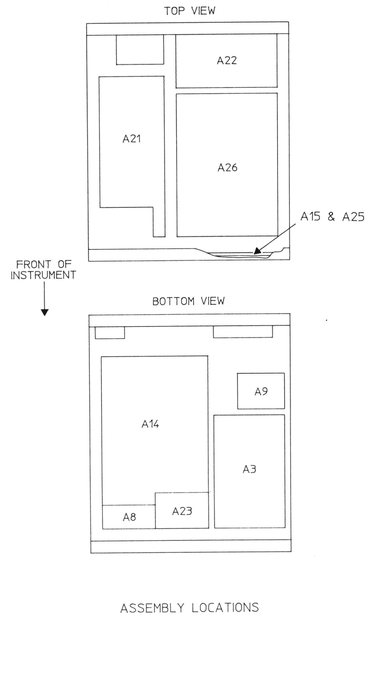
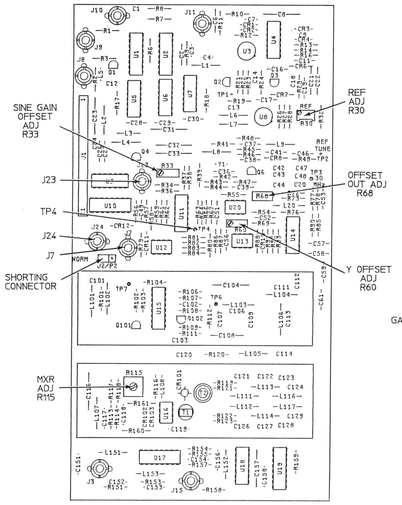
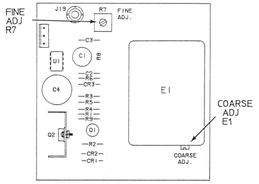
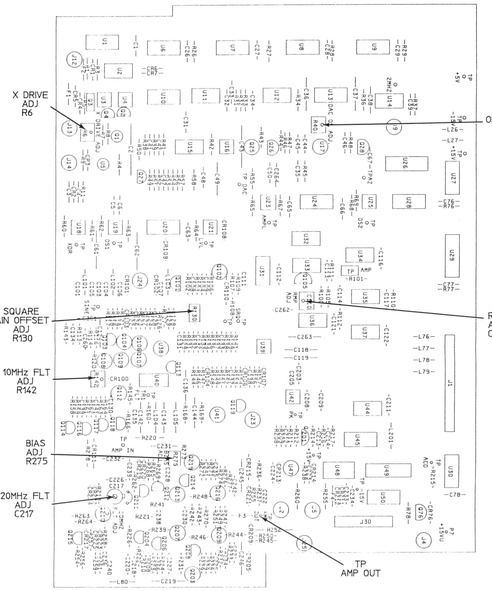


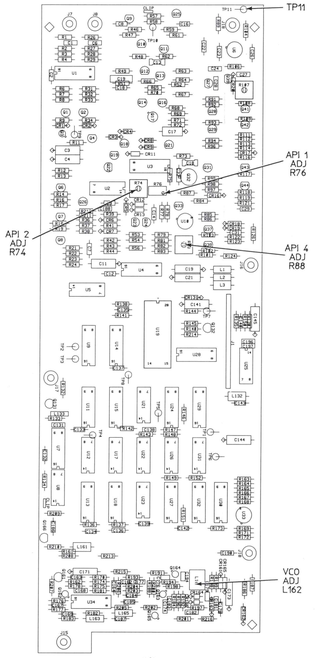
Figure 5-2b. Amplitude Flatness Adjustment (3Vp-p Pad).











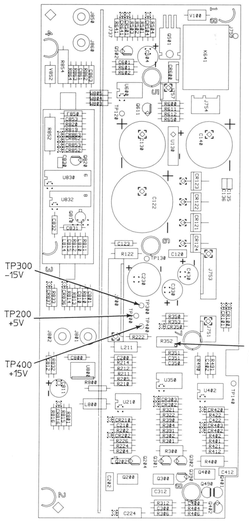


Figure 5-3. Location of Adjustments.

SECTION VI
REPLACEABLE PARTS

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

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

DESIGNATORS

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

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
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 1.688K .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

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
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	

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
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

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
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

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
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	

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
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

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
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

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
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

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
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	

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
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

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
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	B159-0005	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	SMC10VB221BX11MPT
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	SMC10VB221BX11MPT
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	SMC10VB221BX11MPT
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	SMC10VB221BX11MPT
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	SMC10VB221BX11MPT
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

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
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	

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
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

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
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	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	
	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

See introduction to this section for ordering information

* Indicates factory selected values

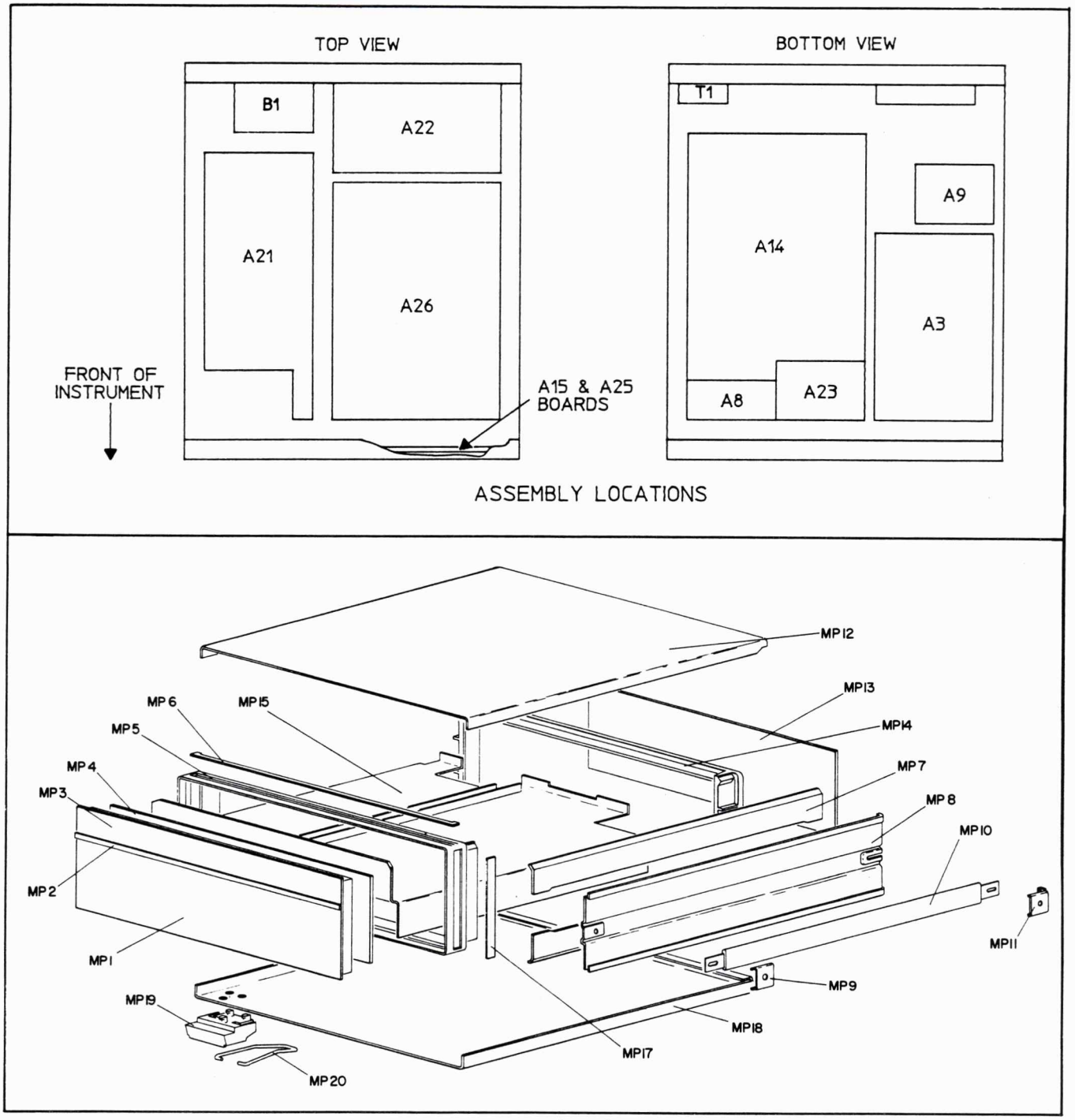


Figure 6-1. Location of Parts.

SECTION VII
MANUAL BACKDATING

TABLE OF CONTENTS

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

TABLE OF CONTENTS

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.

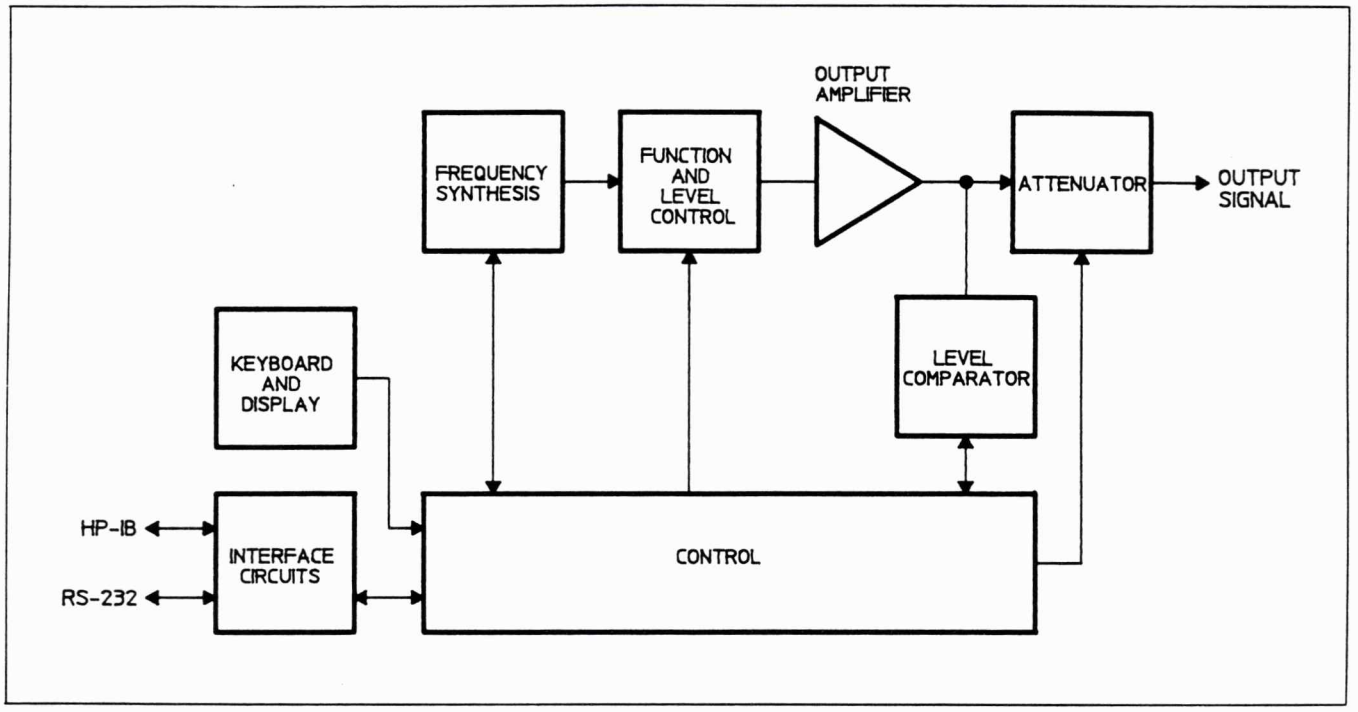


Figure 8-1. Simplified Block Diagram.

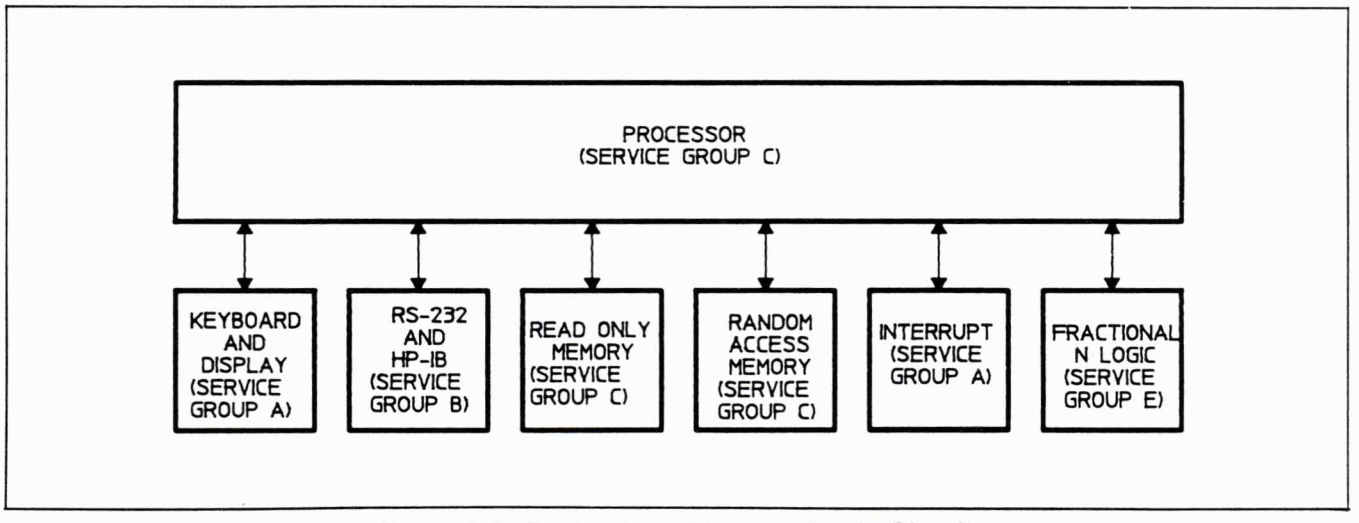


Figure 8-2. Basic Block Diagram, Logic Circuits.

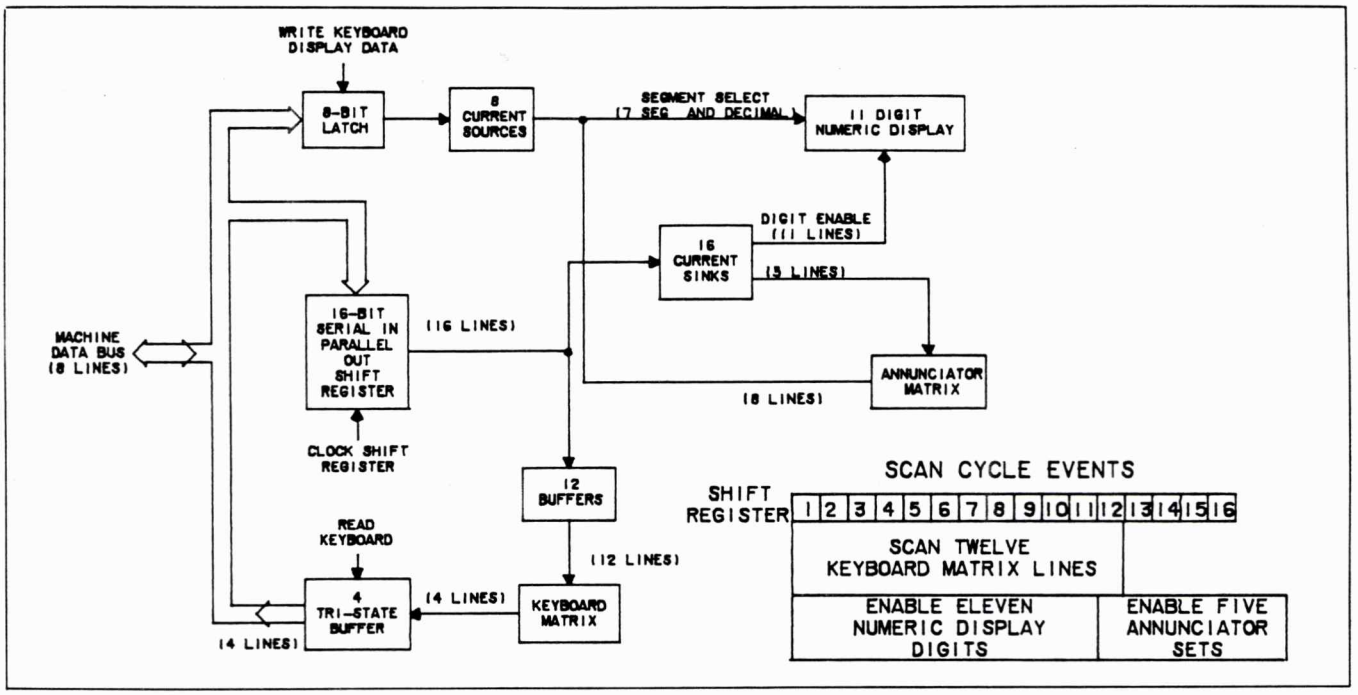


Figure 8-3. Keyboard and Display Block Diagram.

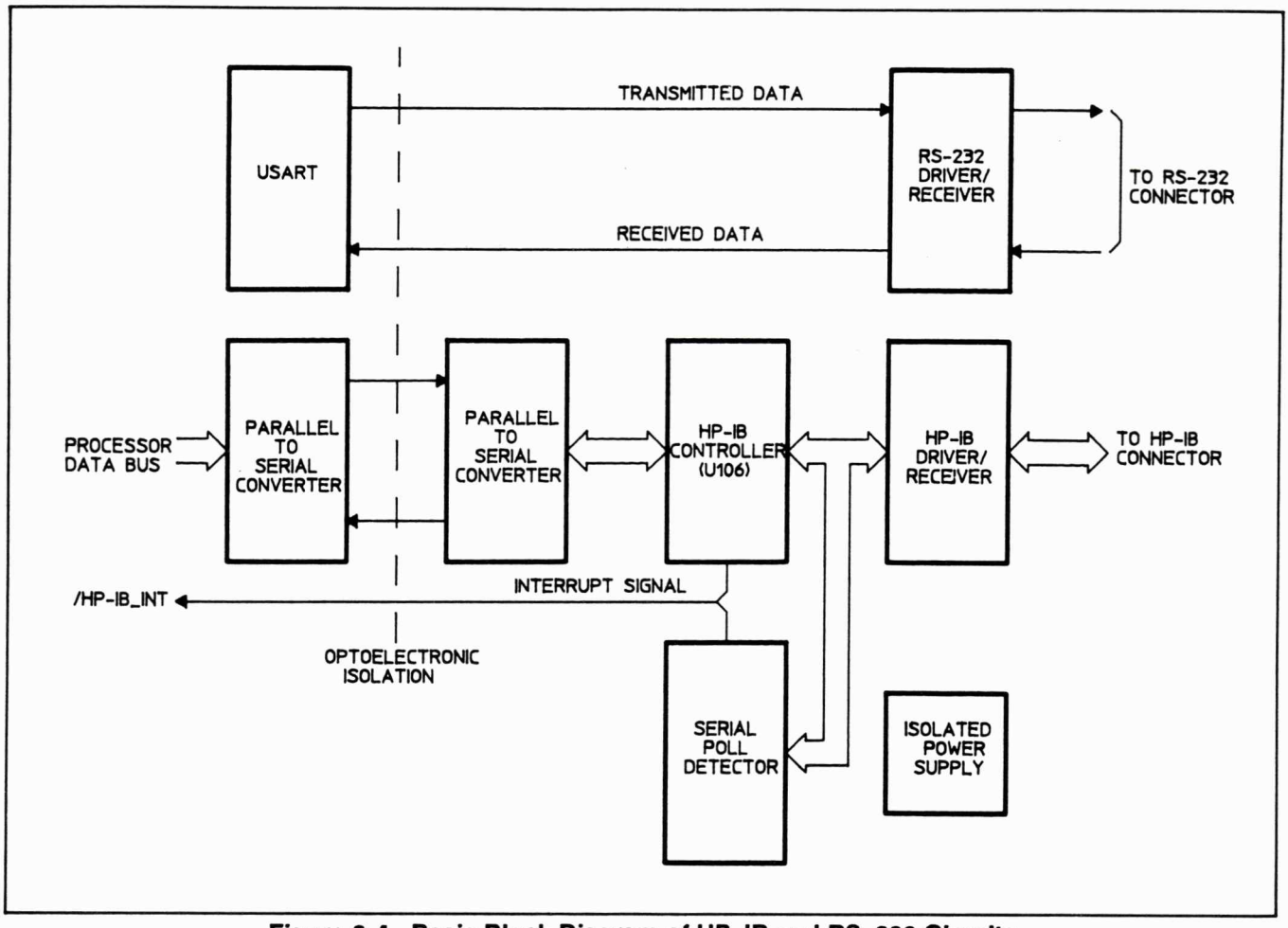


Figure 8-4. Basis Block Diagram of HP–IB and RS–232 Circuits.

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

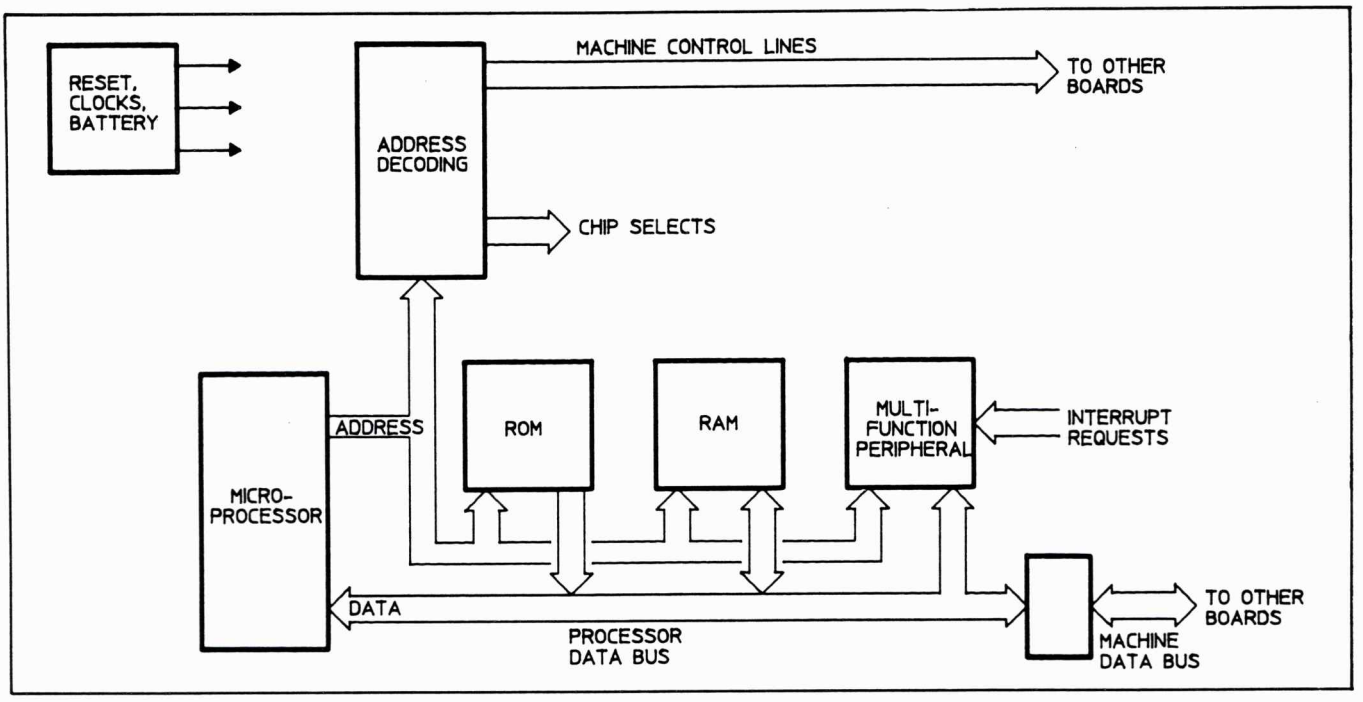


Figure 8-5. Basic Block Diagram of Control Circuits.

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.

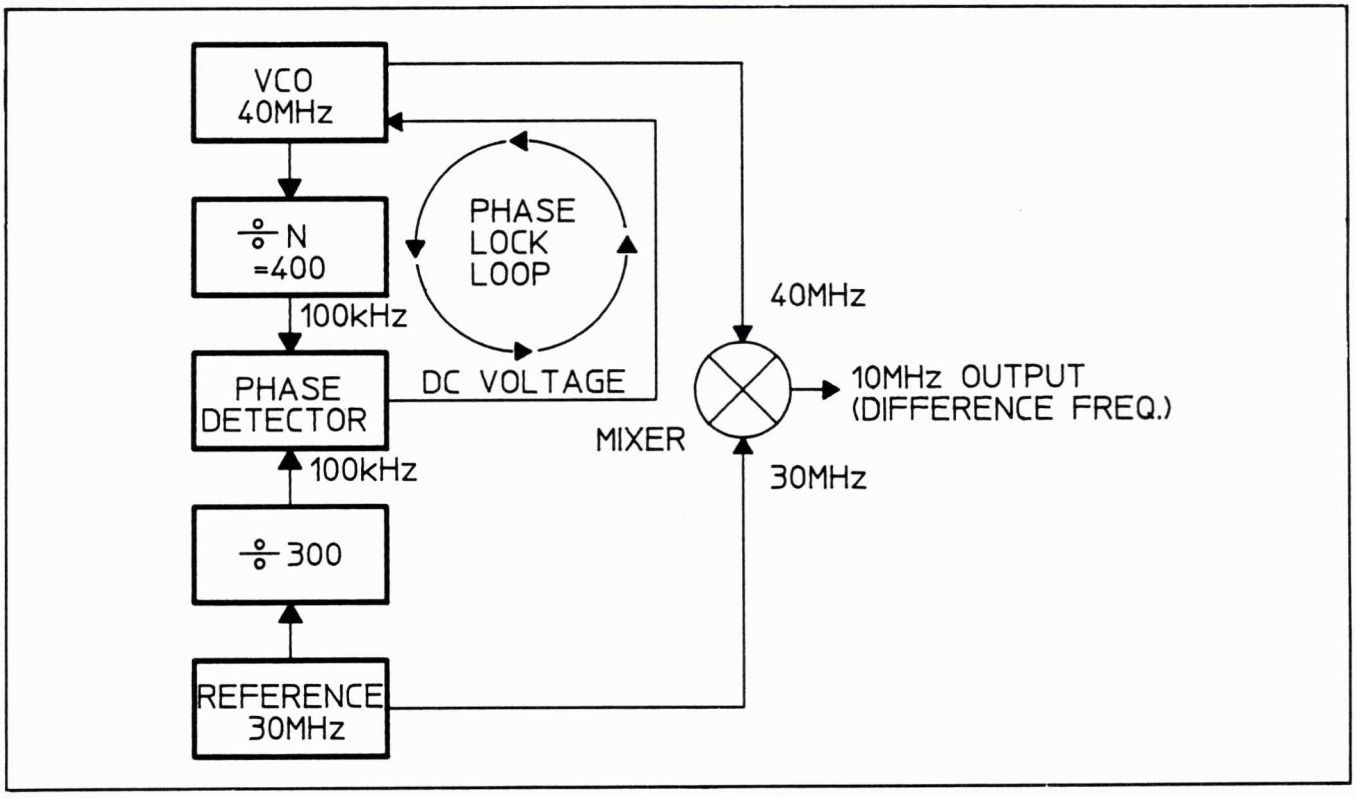


Figure 8-6. Phase Lock Loop.

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.

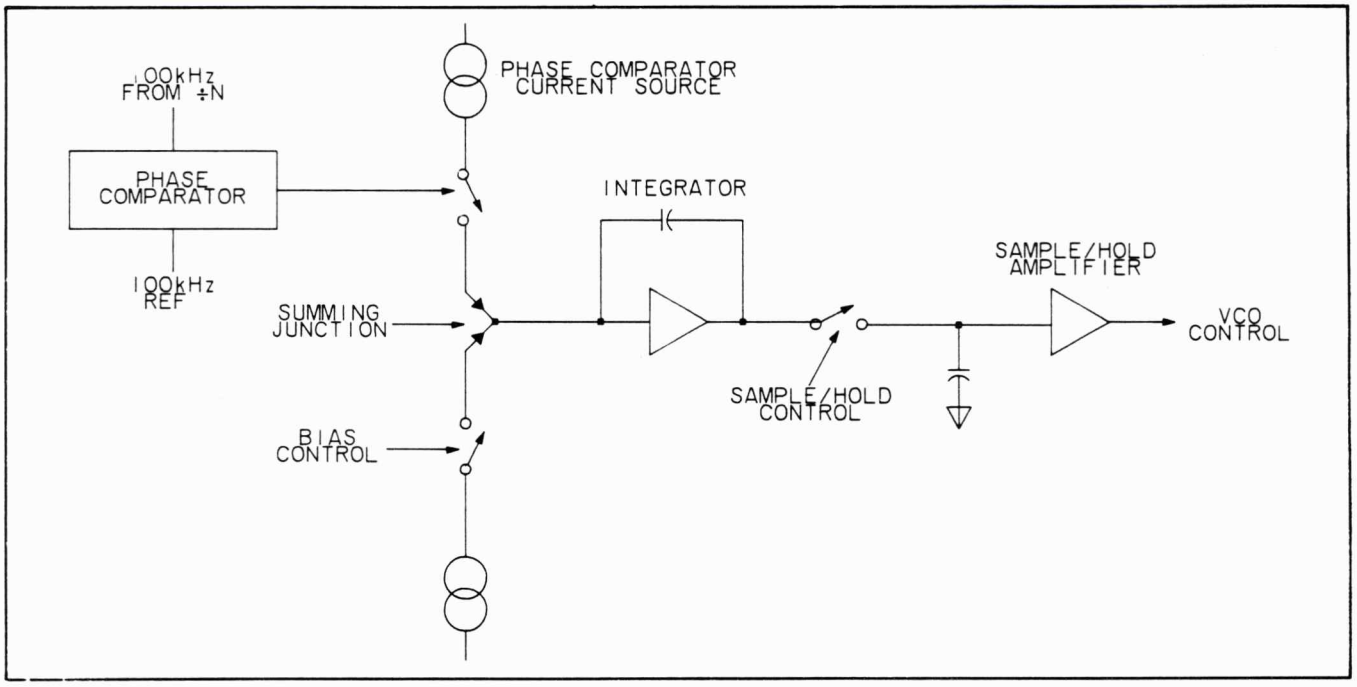


Figure 8-7. Phase Detector.

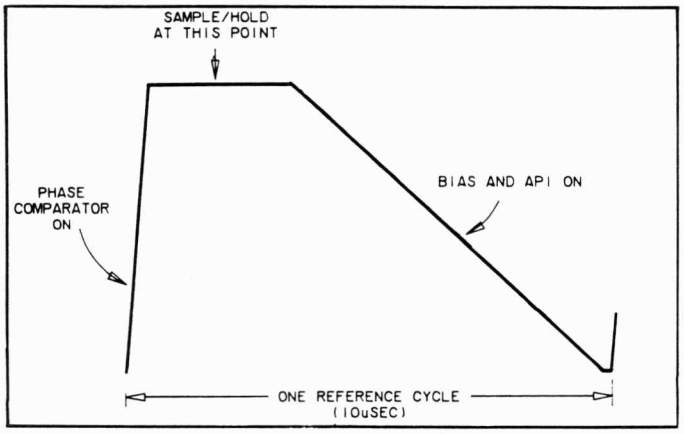


Figure 8-8. Integrator Output.

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

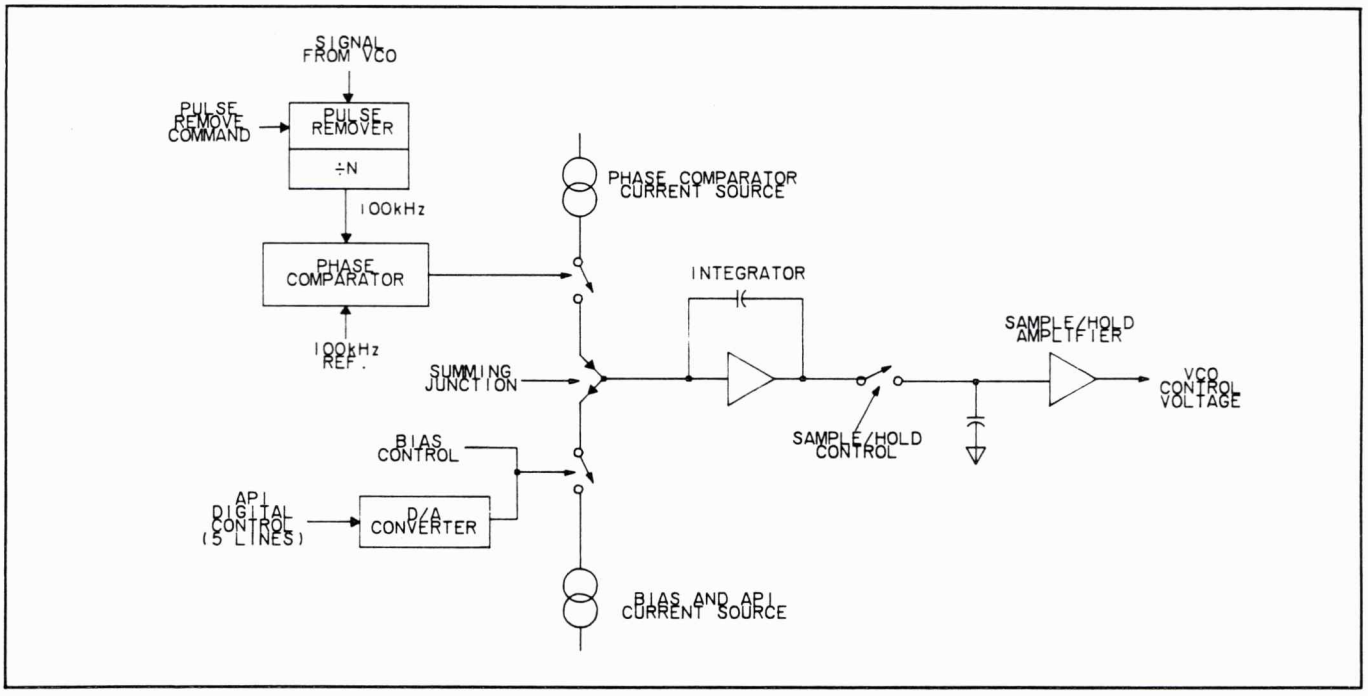


Figure 8-9. Addition of DAC and Pulse Remove Blocks.

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

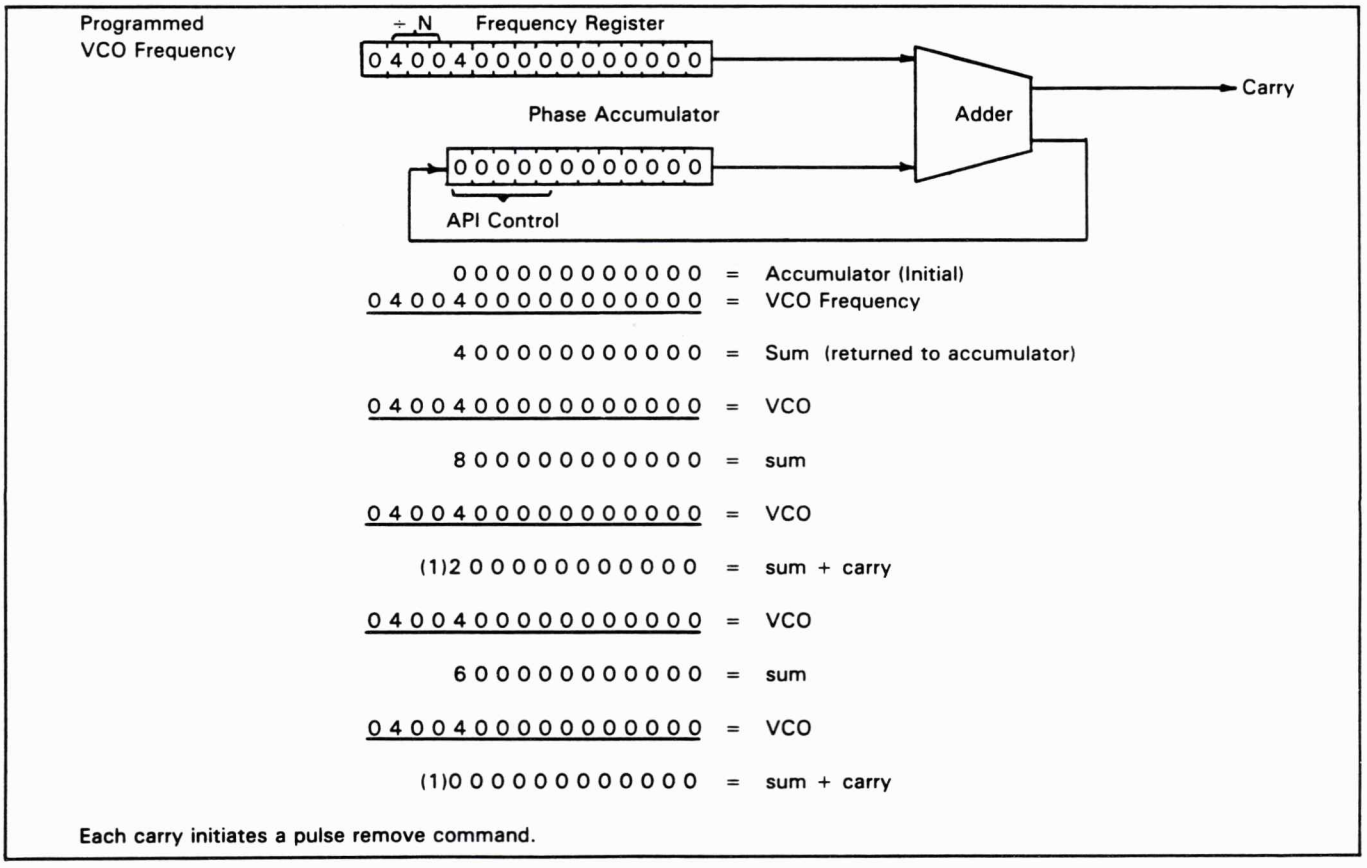


Figure 8-10. Phase Accumulation.

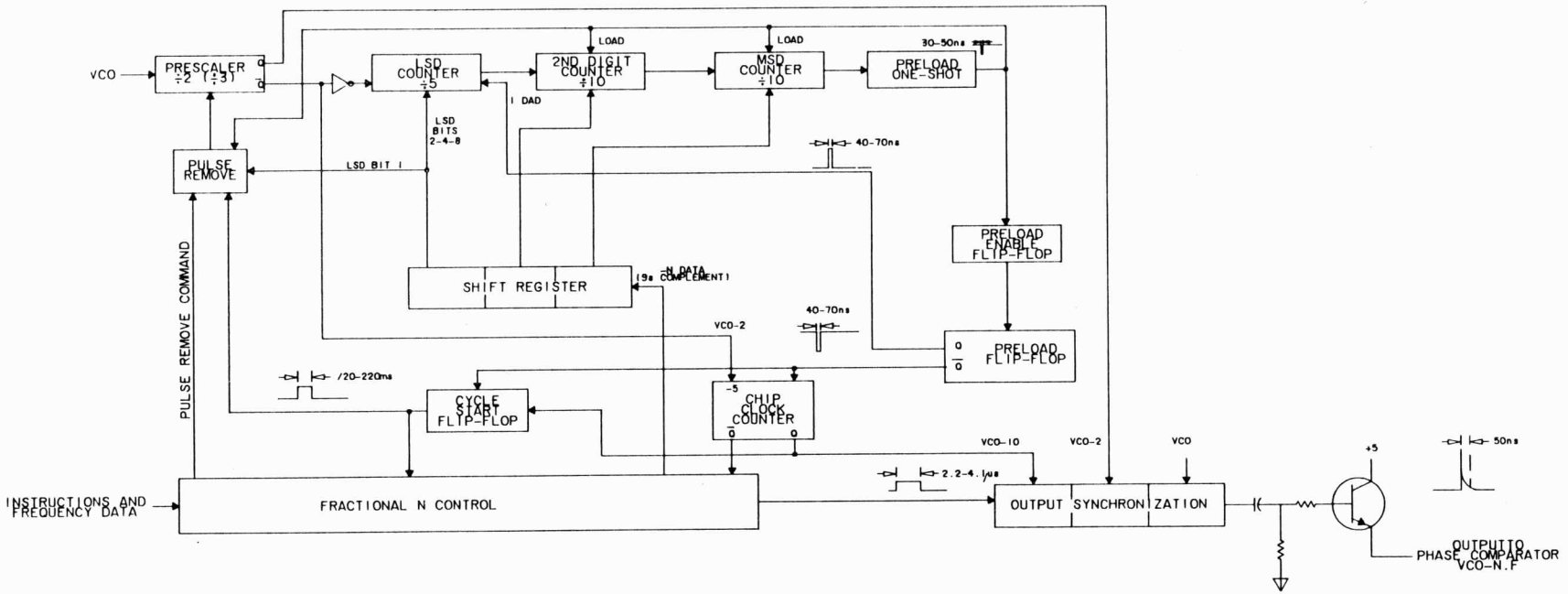


Figure 8-11. Divide by N Counter.

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

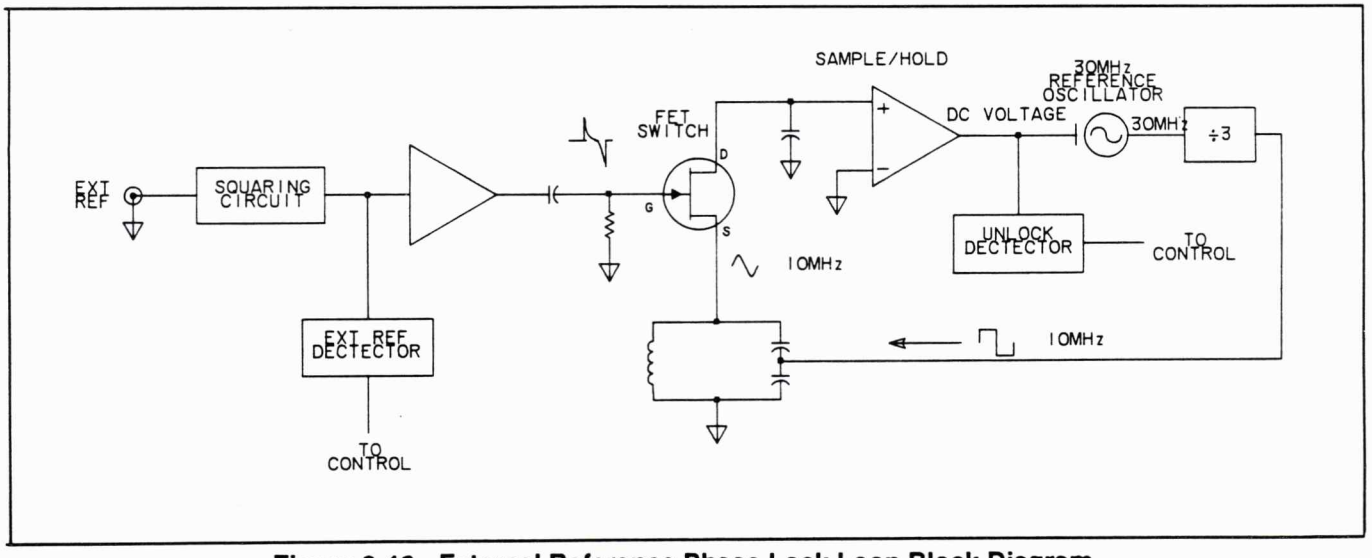


Figure 8-12. External Reference Phase Lock Loop Block Diagram.

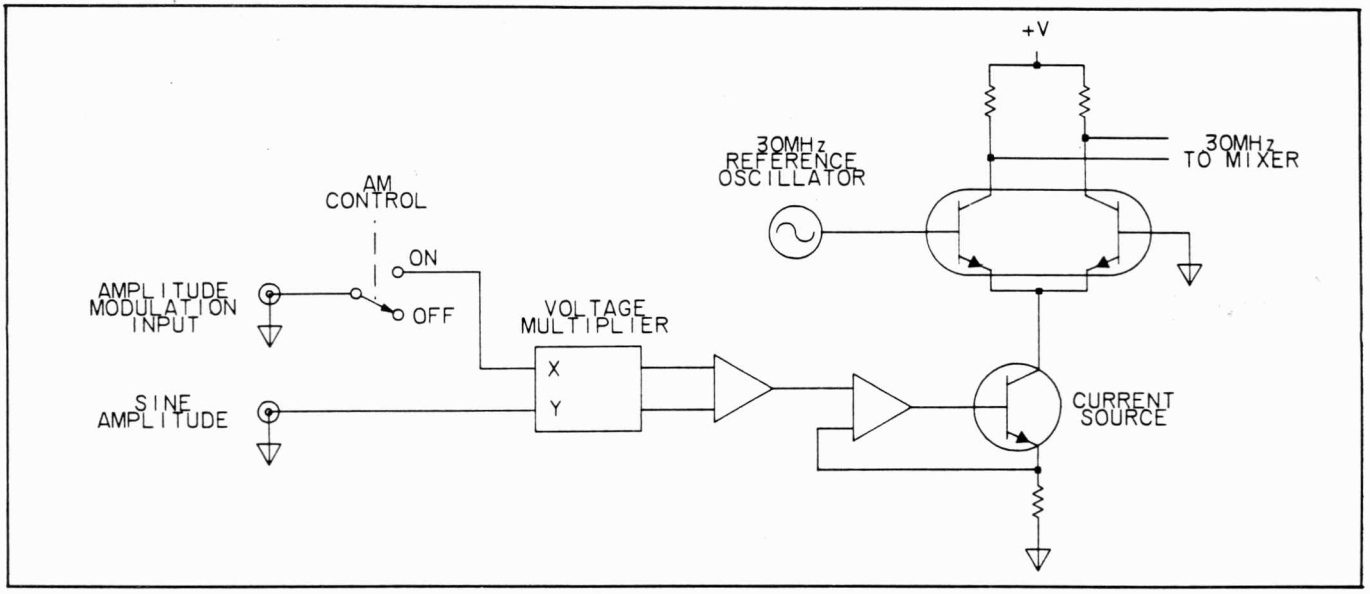


Figure 8-13. Level Control and Amplitude Modulation.

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_o) 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.

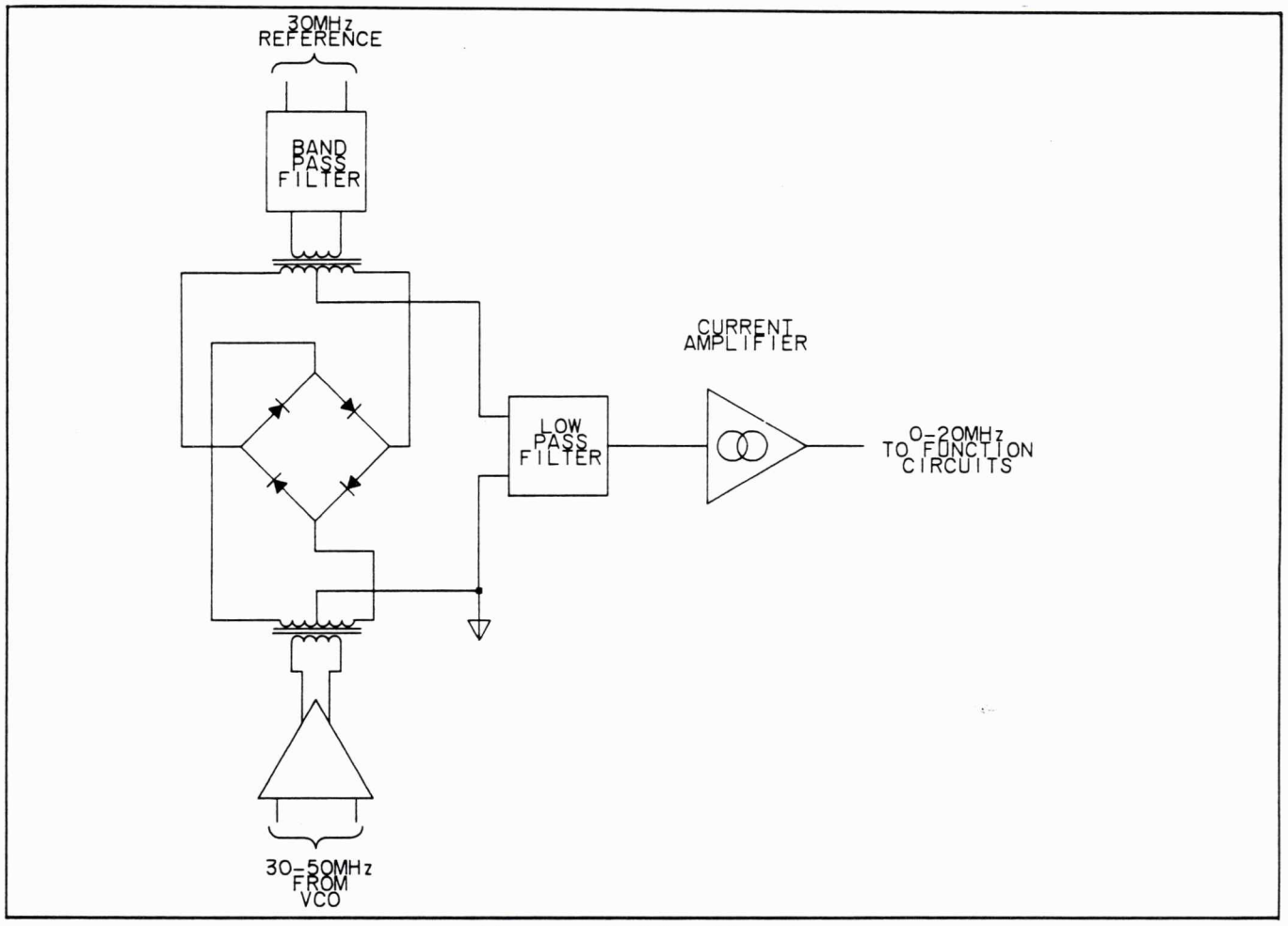


Figure 8-14. Mixer Diagram.

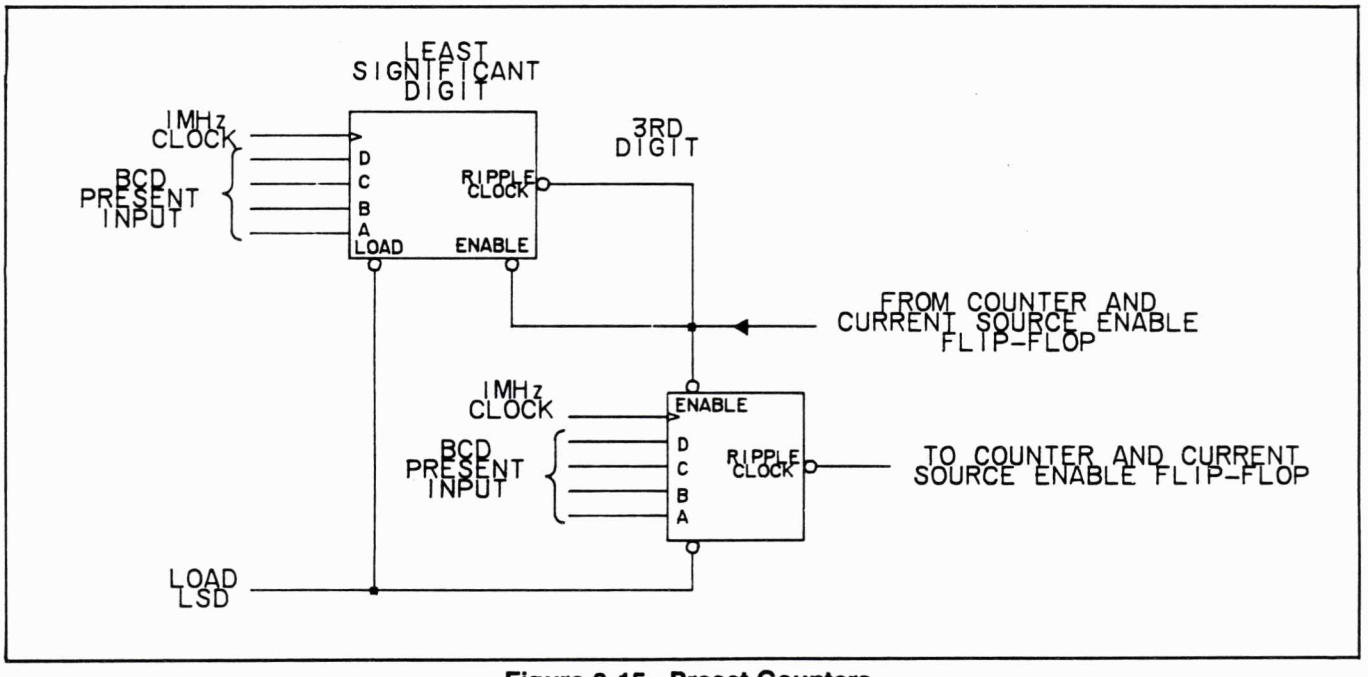


Figure 8-15. Preset Counters.

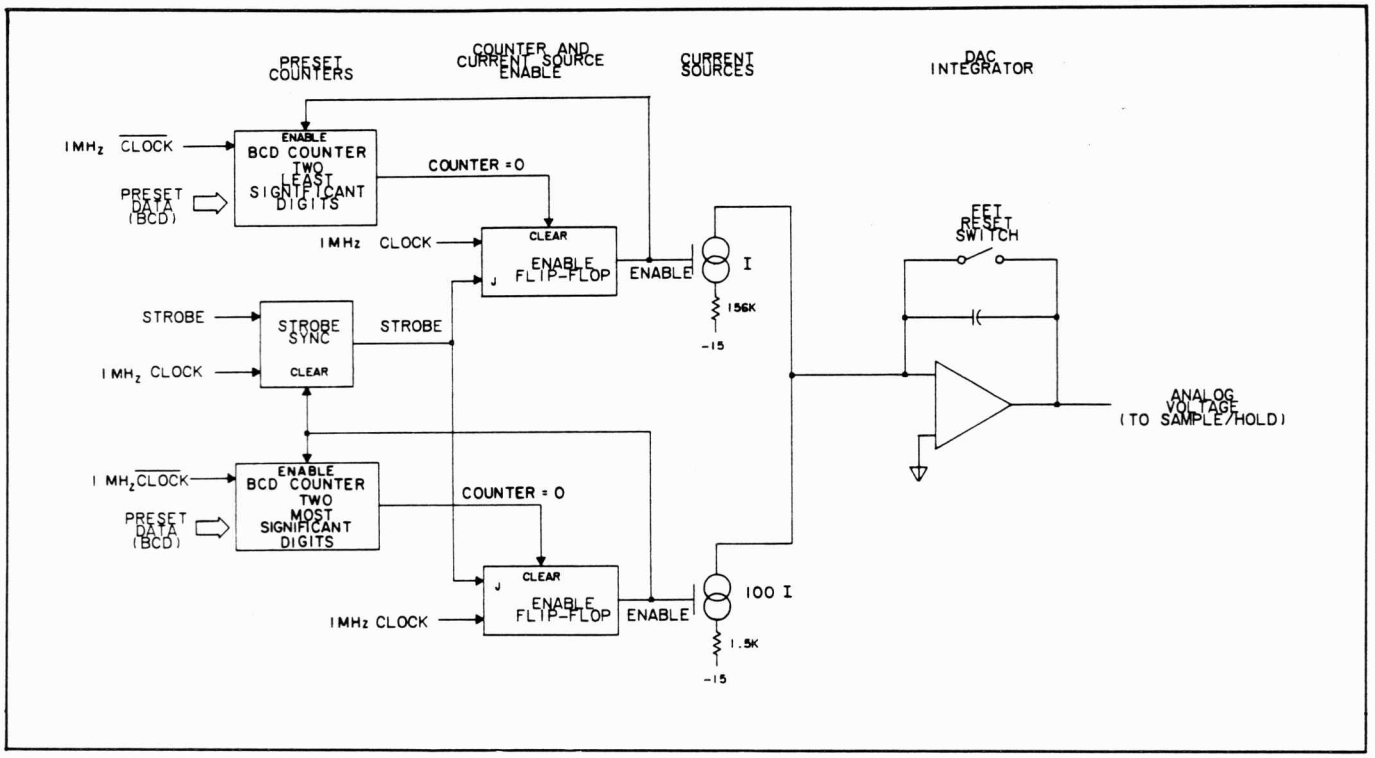


Figure 8-16. Digital-to-Analog Converter.

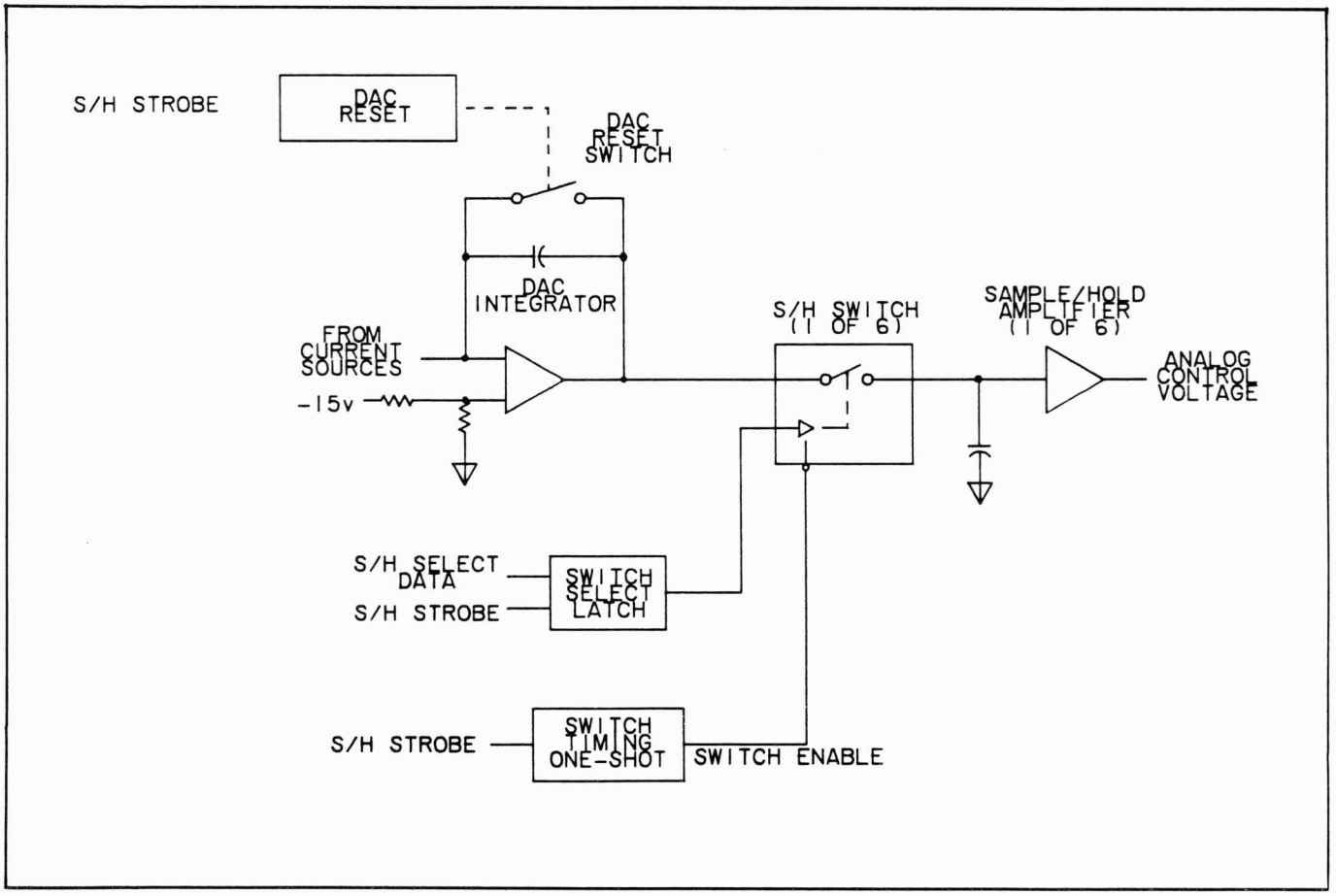


Figure 8-17. DAC Sample/Hold.

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.

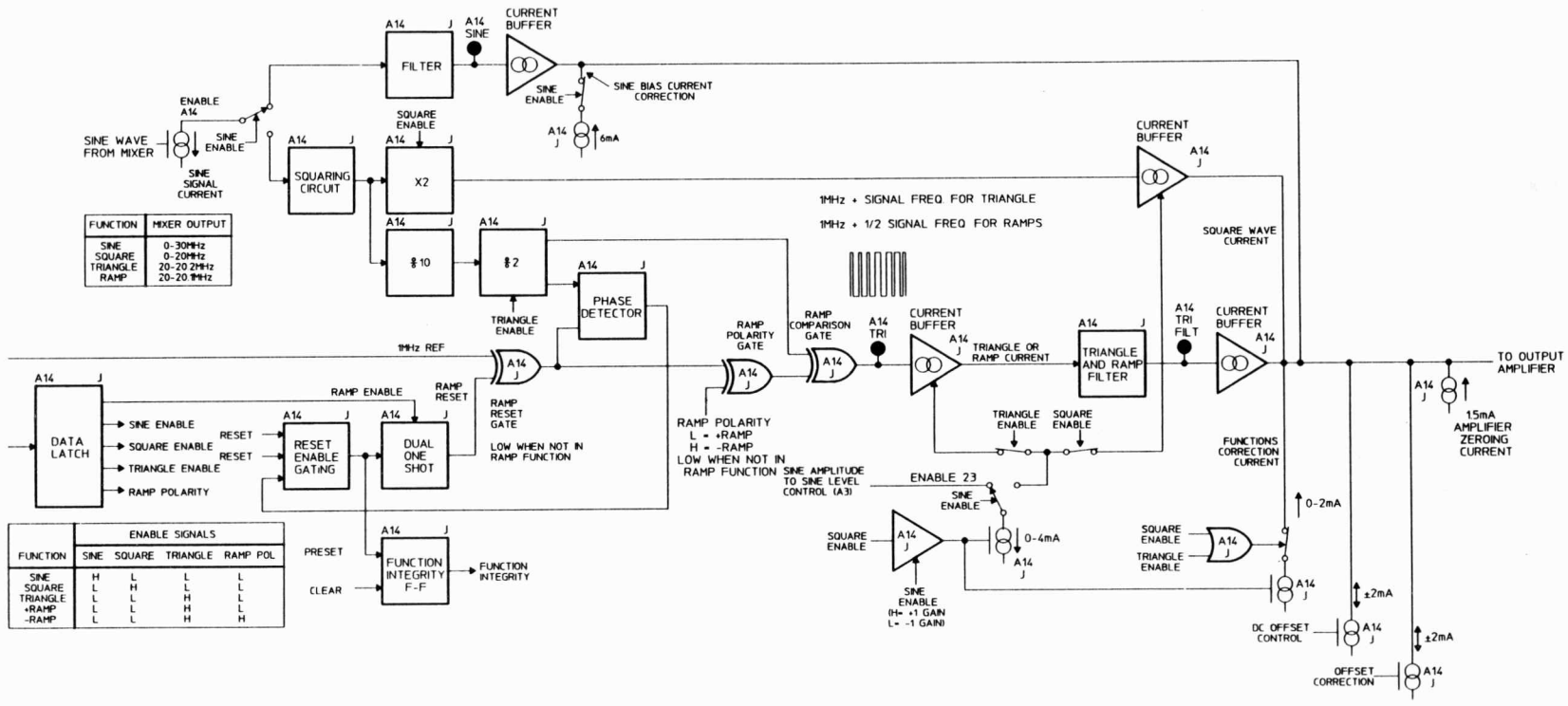
8-68. The triangle output frequency is the difference between the 1 MHz reference and the input frequency (from the mixer) divided by twenty. Consequently, the input frequency must be 20 MHz + (20 x output). To produce the maximum triangle output frequency of 10 kHz, for example, the input must be 20.2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



FUNCTION	MIXER OUTPUT
SINE	0-30MHz
SQUARE	0-20MHz
TRIANGLE	20-20.2MHz
RAMP	20-20.1MHz

FUNCTION	ENABLE SIGNALS			
	SINE	SQUARE	TRIANGLE	RAMP POL
SINE	H	L	L	L
SQUARE	L	H	L	L
TRIANGLE	L	L	H	L
+RAMP	L	L	H	L
-RAMP	L	L	H	H

Figure 8-18. Enable Signals for Function Switching.

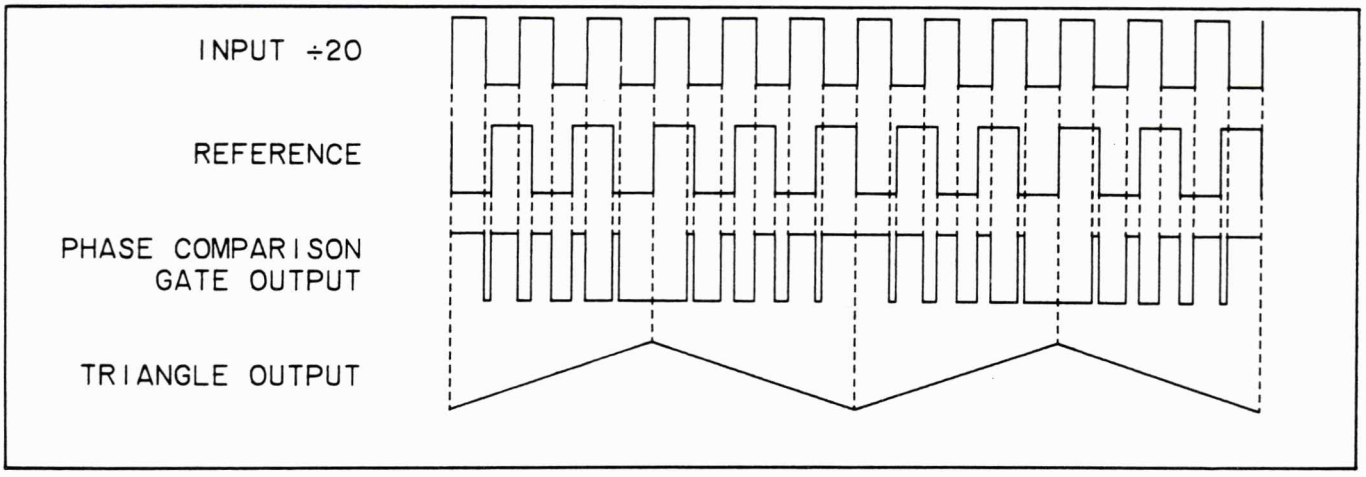


Figure 8-19. Simplified Illustration of Triangle Generation.

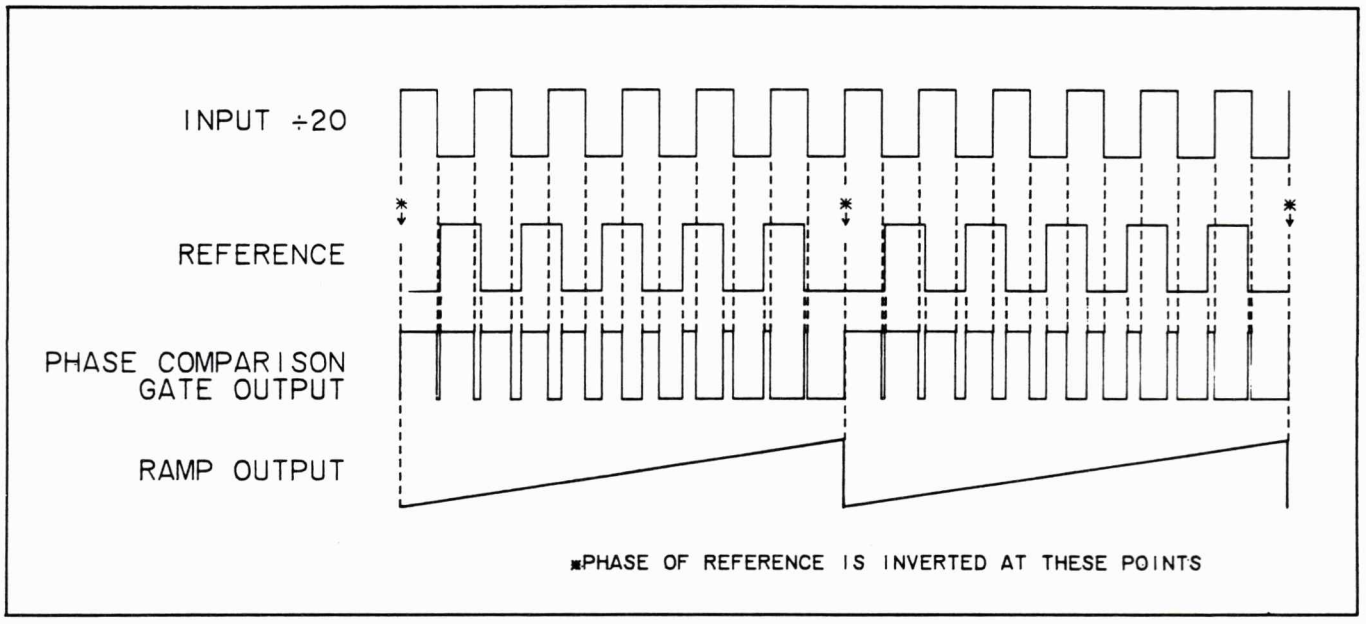


Figure 8-20. Simplified Illustration of Ramp Generation.

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.

FAST™ is a trademark of Fairchild Semiconductor Corporation.

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)		Maximum Offset (+ or −)	Minimum Offset (+ or −)	DC Only (+ or −)
			AC Only (No Offset)	AC (With Offset)			
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

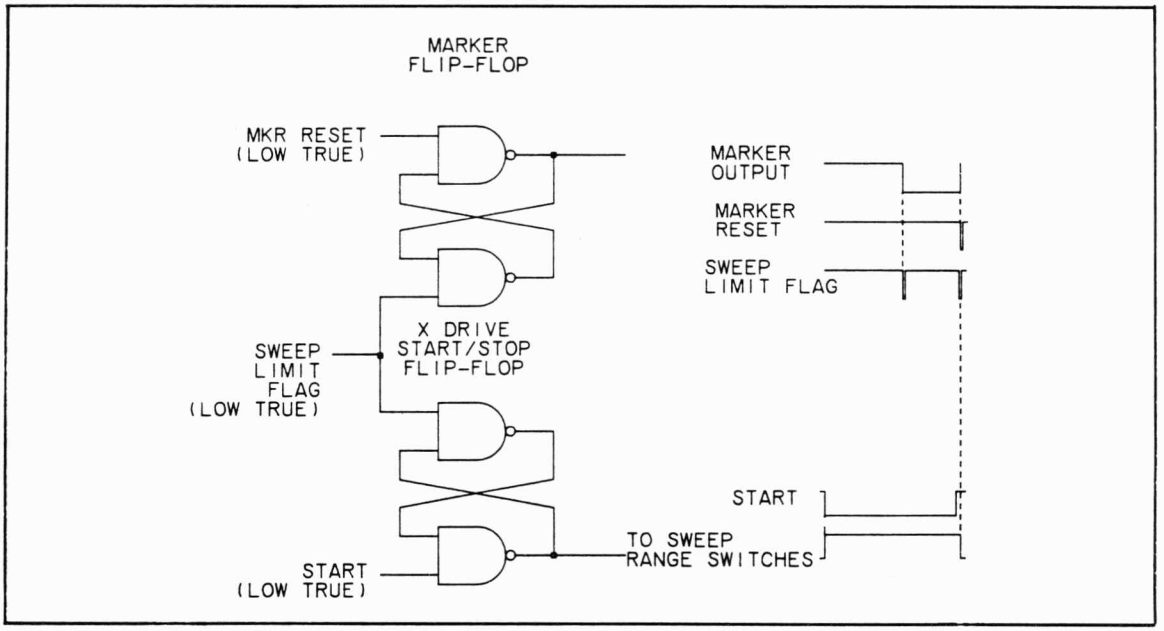


Figure 8-21. Marker and X Drive Start-Stop Flip-Flops.

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

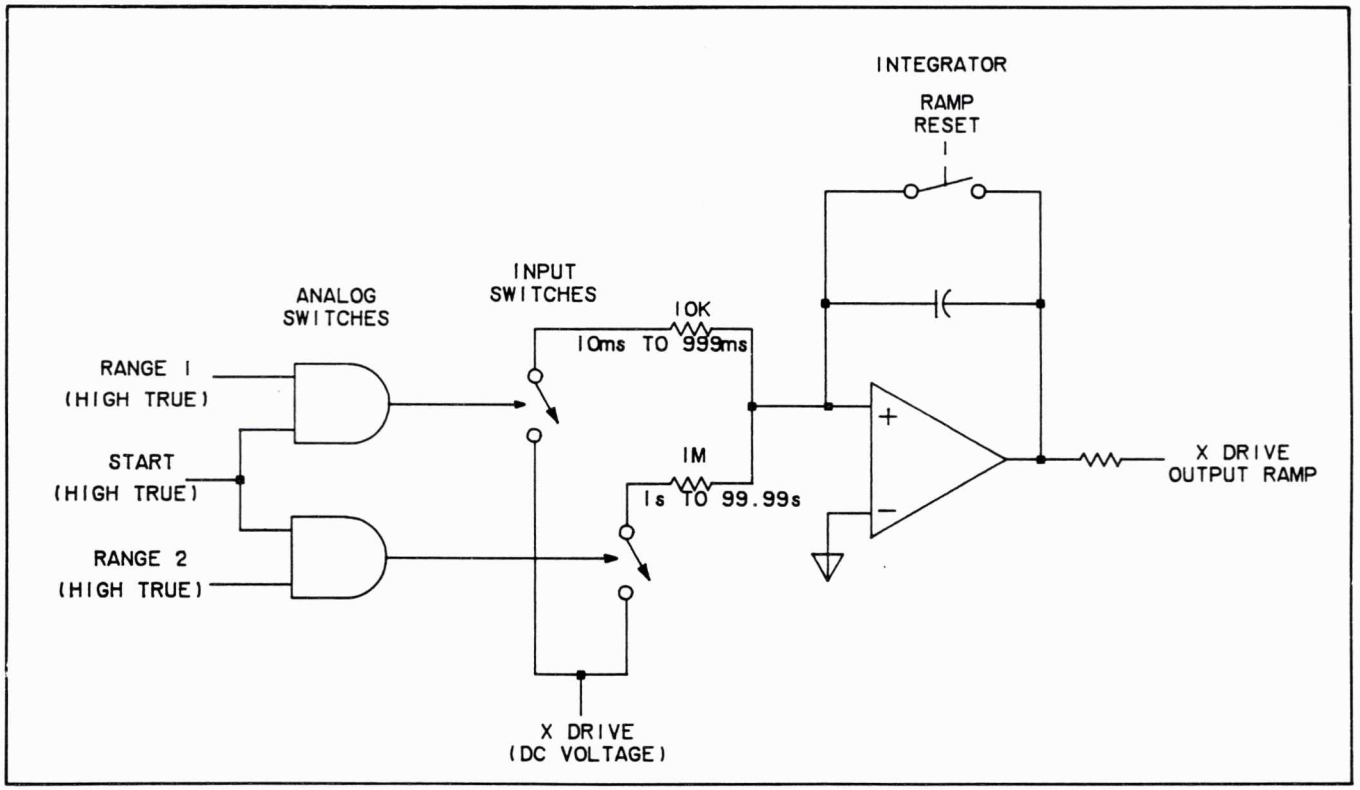


Figure 8-22. X Drive Ramp Output.

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.

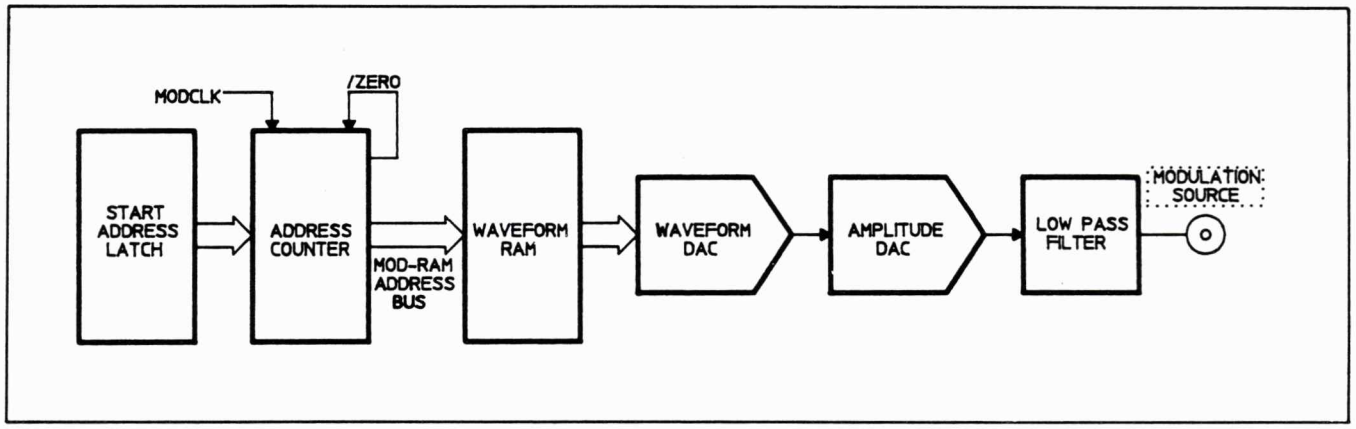


Figure 8-23. Modulation Source Block Diagram.

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.

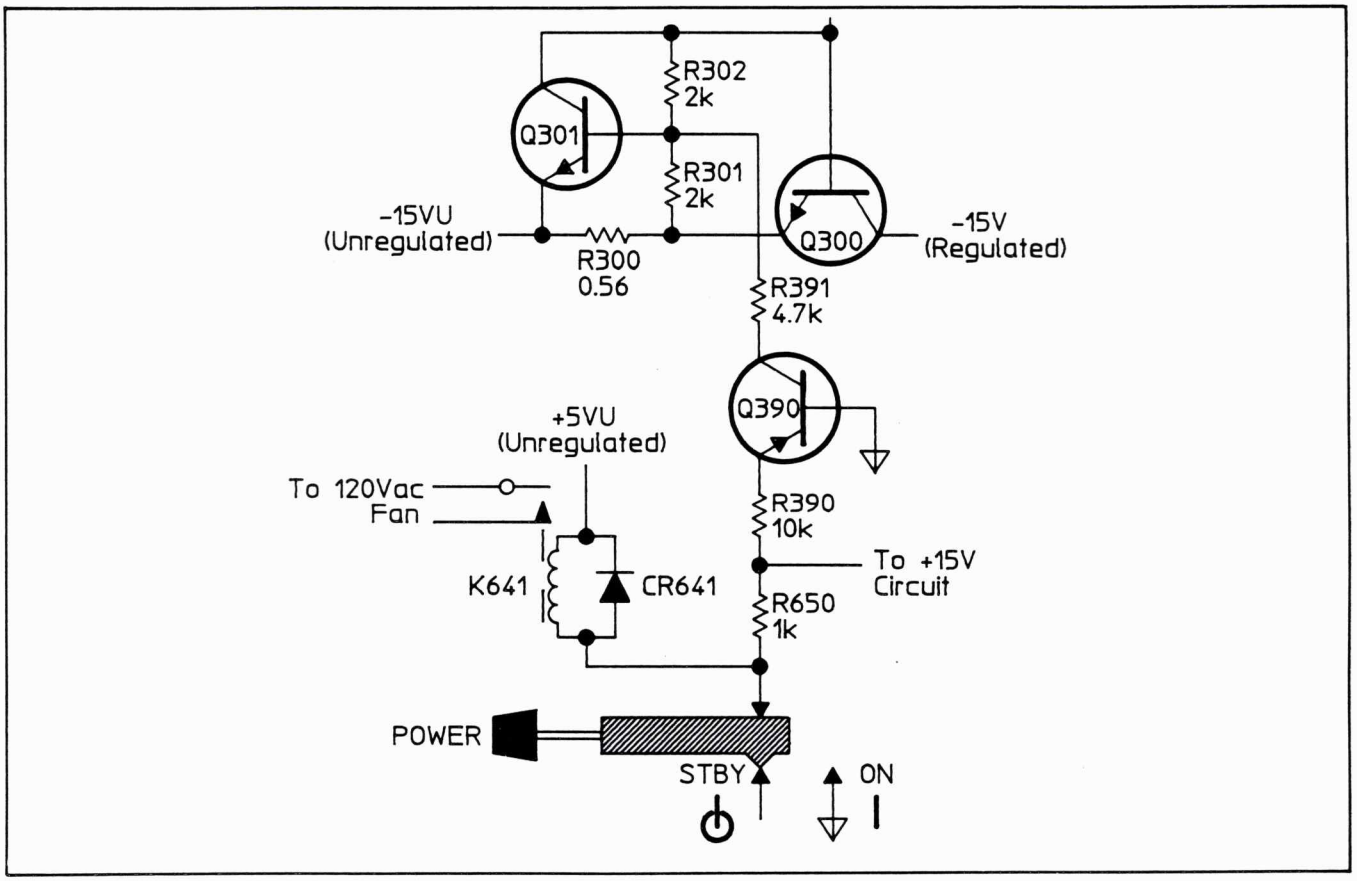


Figure 8-24. Power Supply Standby/On Circuit.

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.

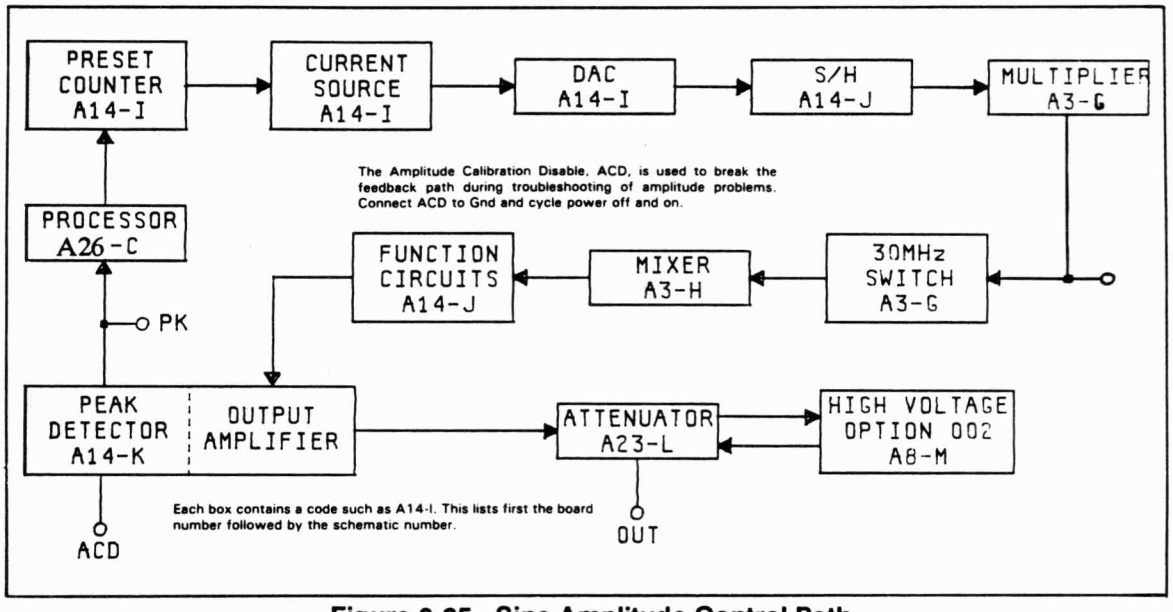


Figure 8-25. Sine Amplitude Control Path.

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.

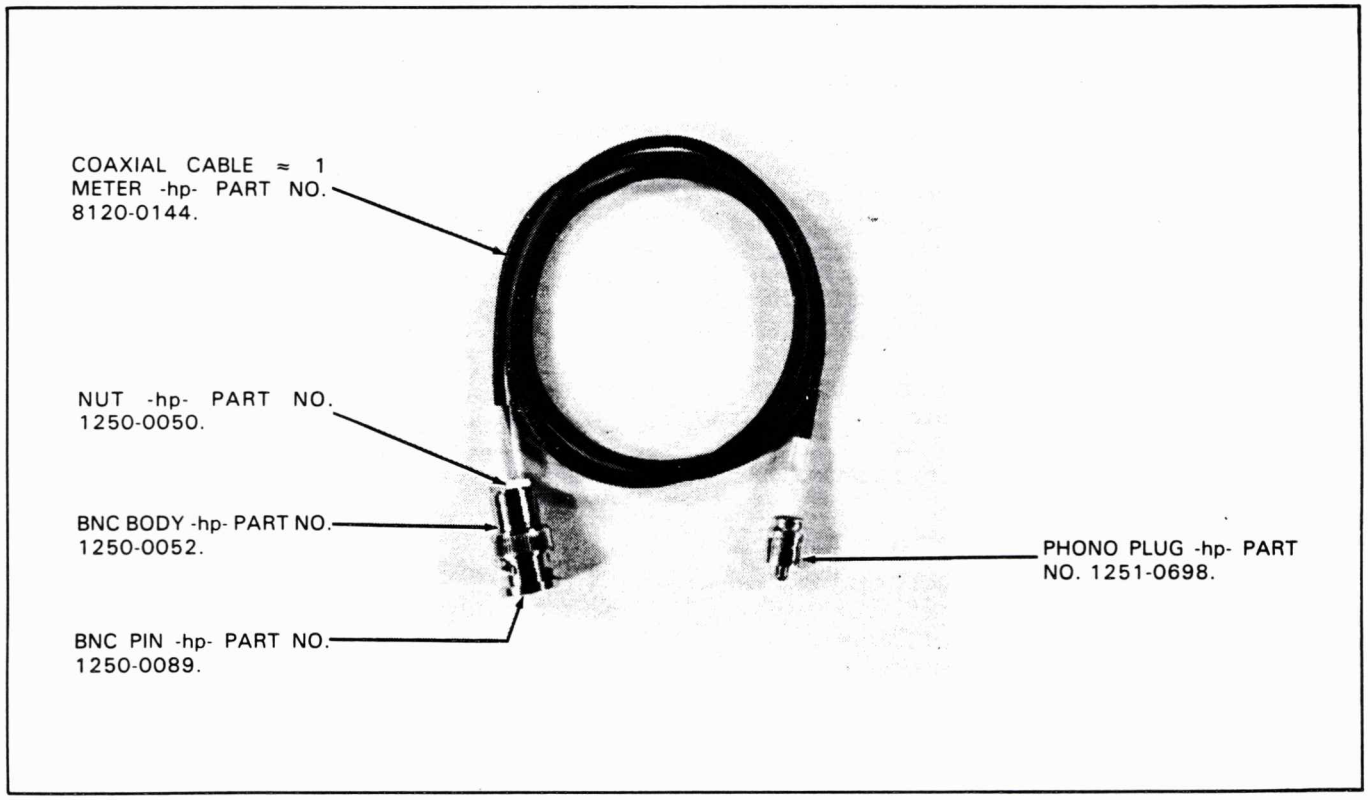


Figure 8-26. Adapter Cable.

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

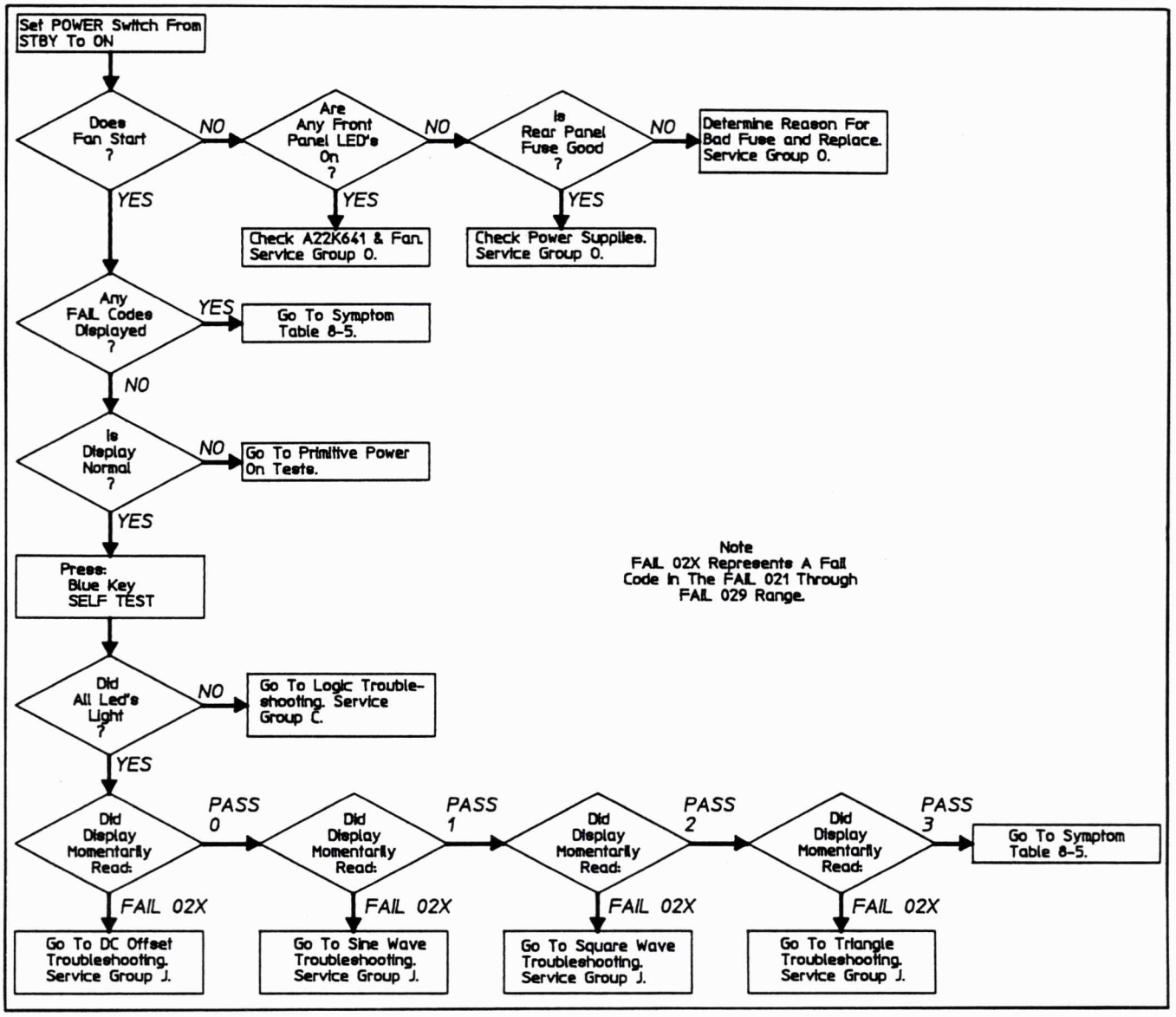


Figure 8-27. Basic Troubleshooting Procedure.

Table 8-5. Trouble Symptoms.

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

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.

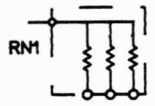
9. DENOTES FRONT PANEL MARKING.

10. DENOTES REAR PANEL MARKING.

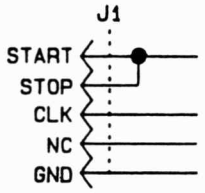
11. DENOTES SCREWDRIVER ADJUST

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.

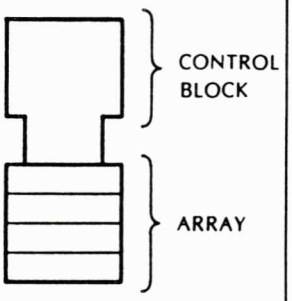
14. 

DENOTES RESISTOR PACK

15. 

DENOTES SIGNATURE ANALYSIS TESTING POINTS

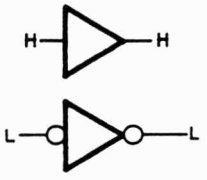
16. CONTROL BLOCK IS USED WHEN AN ARRAY OF RELATED LOGIC ELEMENTS SHARE COMMON CONTROL LINES



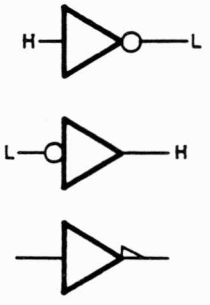
LOGIC ELEMENTS WITH COMMON CONTROL BLOCK

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.

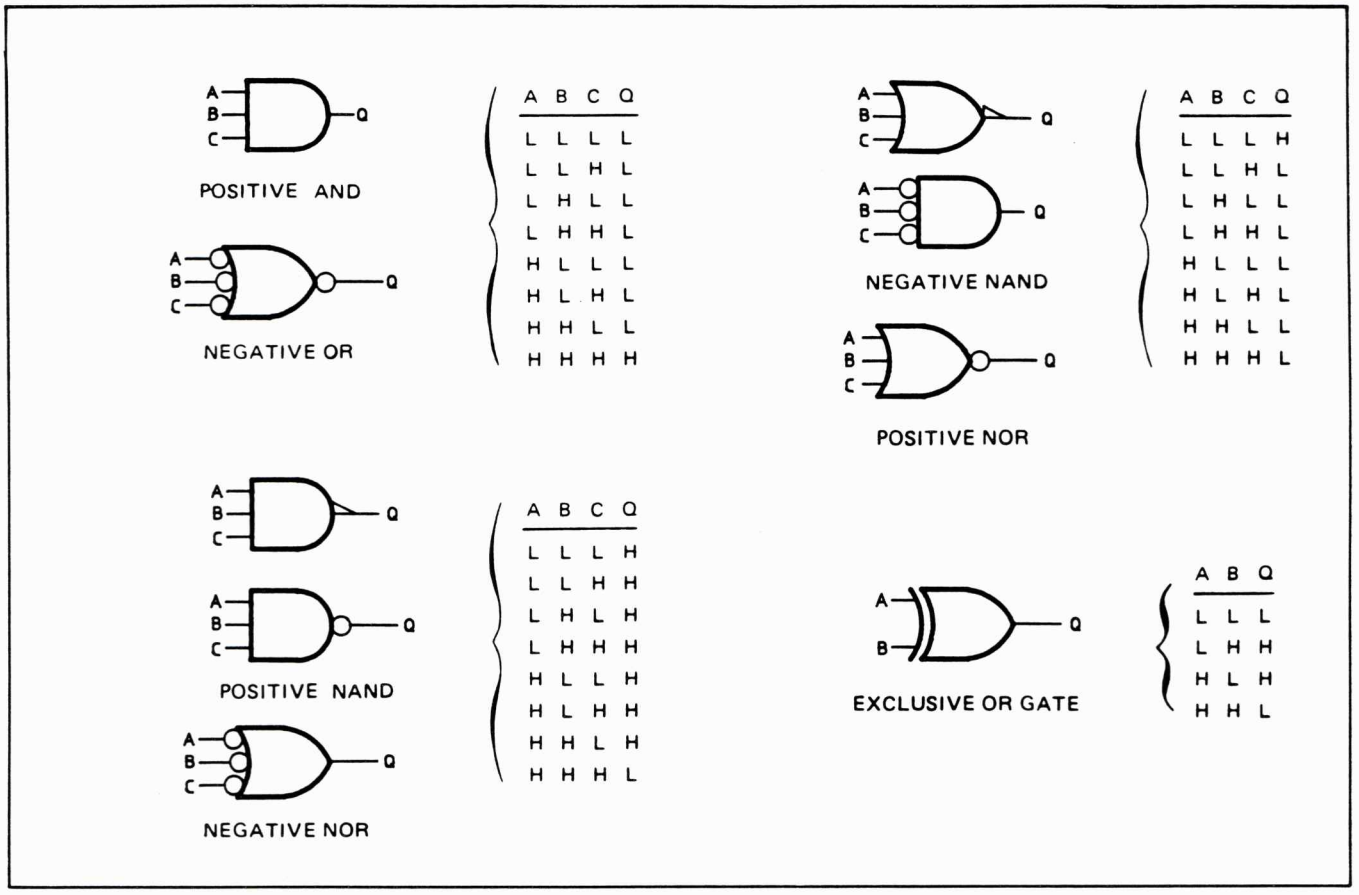
18. DC VOLTAGE LEVELS WERE MEASURED WITH RESPECT TO CIRCUIT GROUND USING A DVM. THE VOLTAGE LEVELS SHOWN ARE NOMINAL AND MAY VARY FROM ONE INSTRUMENT TO ANOTHER DUE TO CHANGE IN TRANSISTOR CHARACTERISTICS. A VARIATION OF ±10% SHOULD BE ALLOWED.

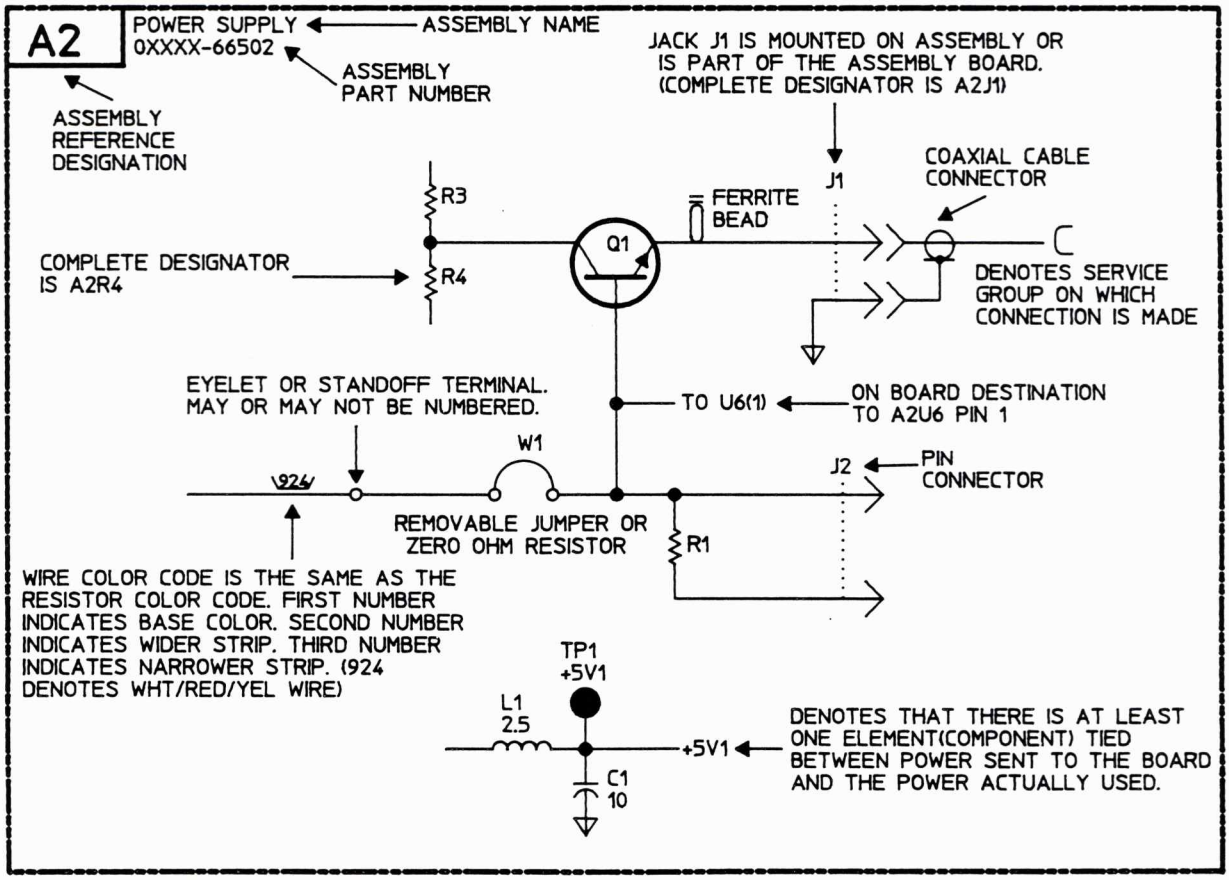


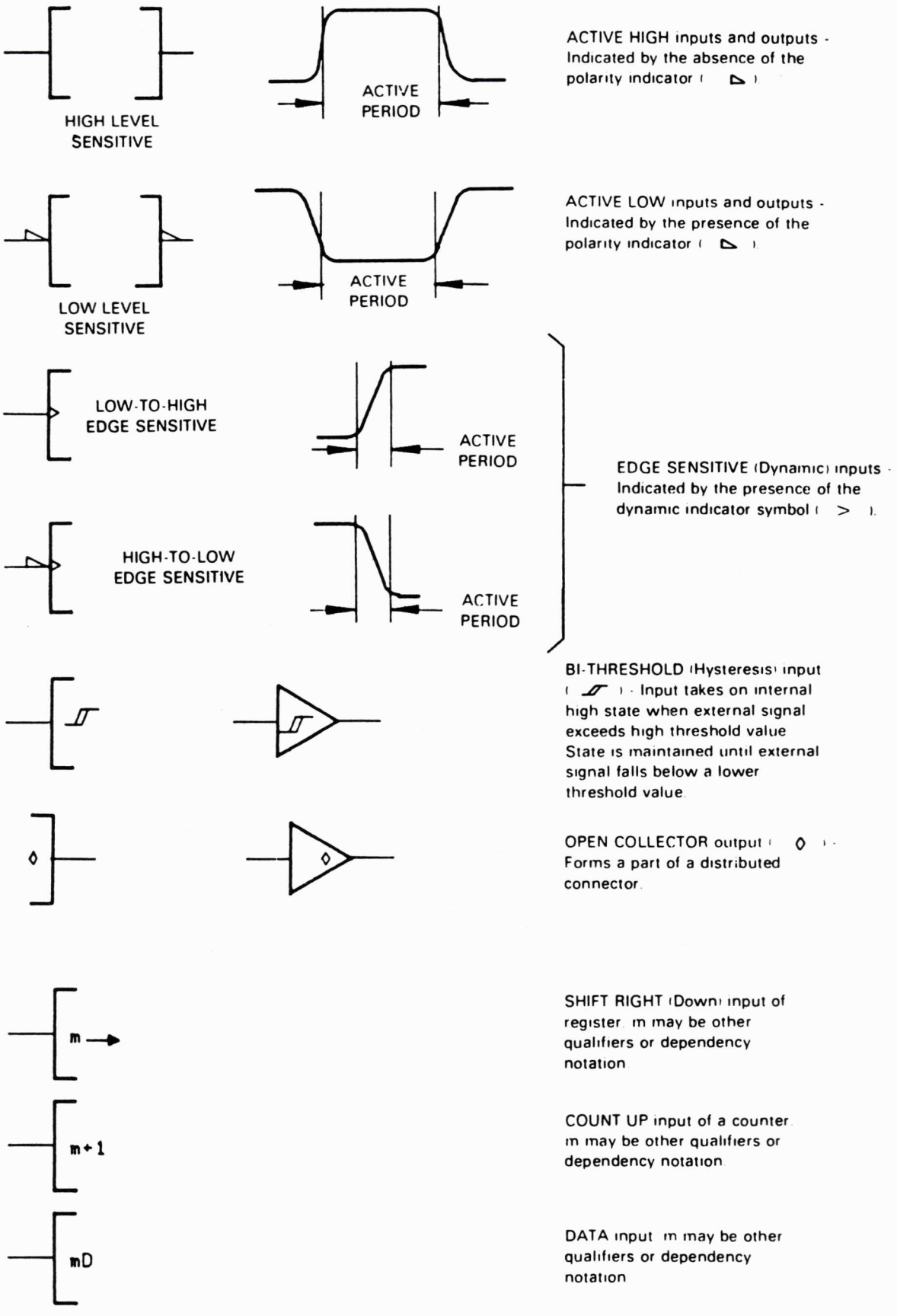
DENOTES BUFFER



DENOTES INVERTER


A
B
C
Q
POSITIVE AND
NEGATIVE OR
POSITIVE NAND
NEGATIVE NOR
POSITIVE NOR
NEGATIVE NAND
EXCLUSIVE OR GATE
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
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
A B Q
L L L
L H H
H L H
H H L


A2
POWER SUPPLY
0XXXX-66502
ASSEMBLY NAME
ASSEMBLY PART NUMBER
ASSEMBLY REFERENCE DESIGNATION
JACK J1 IS MOUNTED ON ASSEMBLY OR IS PART OF THE ASSEMBLY BOARD. (COMPLETE DESIGNATOR IS A2J1)
J1
COAXIAL CABLE CONNECTOR
R3
FERRITE BEAD
Q1
COMPLETE DESIGNATOR IS A2R4
R4
DENOTES SERVICE GROUP ON WHICH CONNECTION IS MADE
EYELET OR STANDOFF TERMINAL. MAY OR MAY NOT BE NUMBERED.
TO U6(1)
ON BOARD DESTINATION TO A2U6 PIN 1
W1
J2
PIN CONNECTOR
924
REMOVABLE JUMPER OR ZERO OHM RESISTOR
R1
WIRE COLOR CODE IS THE SAME AS THE RESISTOR COLOR CODE. FIRST NUMBER INDICATES BASE COLOR. SECOND NUMBER INDICATES WIDER STRIP. THIRD NUMBER INDICATES NARROWER STRIP. (924 DENOTES WHT/RED/YEL WIRE)
TP1
+5V1
L1
2.5
+5V1
C1
10
DENOTES THAT THERE IS AT LEAST ONE ELEMENT(COMPONENT) TIED BETWEEN POWER SENT TO THE BOARD AND THE POWER ACTUALLY USED.



Qualifying Symbols

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 (|). 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.

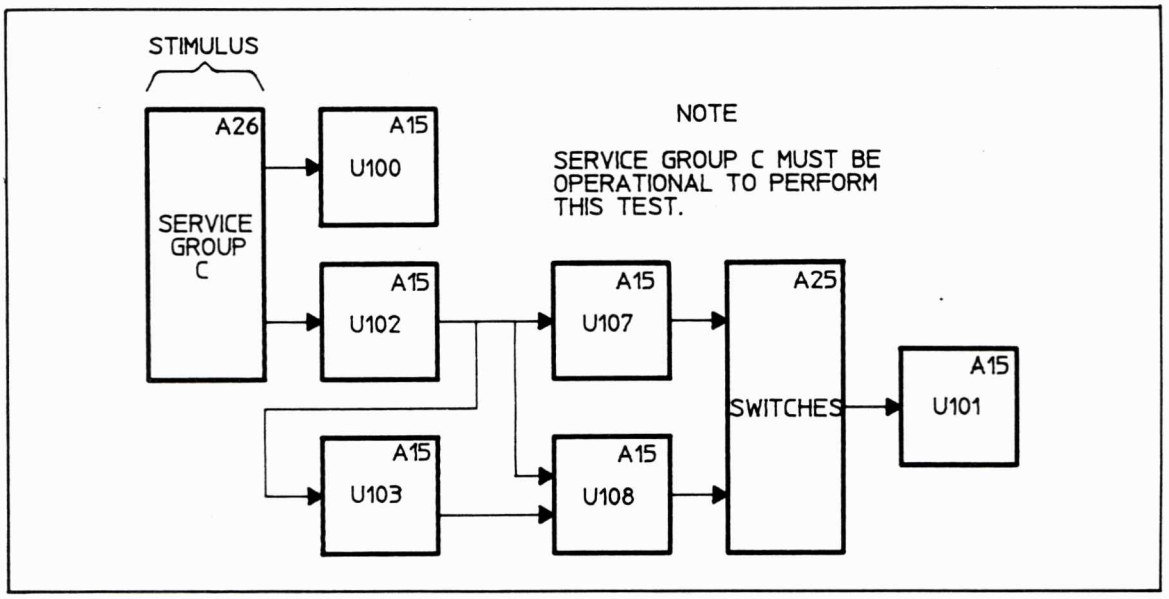
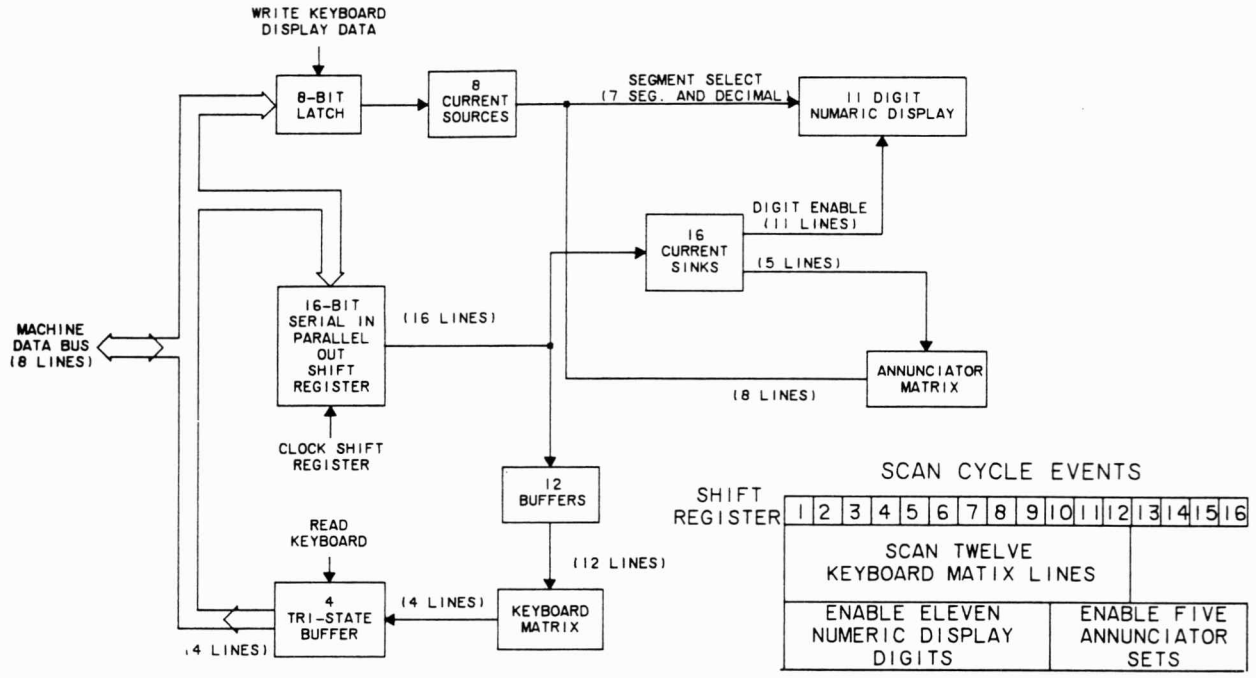


Figure 8-A-1. A15 and A25 Assembly SA0 Test Signal Flow Diagram.

Table 8-A-1. A15 Assembly Signatures.

(The dash indicates an unstable signature.)

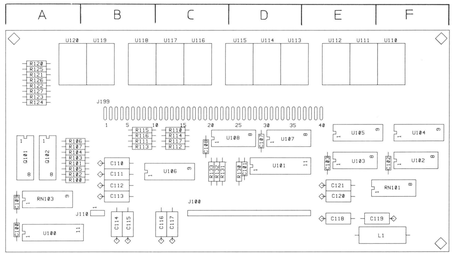
Pin	U100	U101	U102	U103
1	HF3A	HF3A	9F9A	8F97
2	F72U	0000	9F9A	8F97
3	7F6P	0795	50AH	50AH
4	9F9A	0000	8F97	8F97
5	1C15	6057	50AH	50AH
6	F72U	0000	8F97	8F97
7	7F6P	2354	0000	0000
8	9F9A	8F97	2HFH	2HFH
9	1C15	7F6P	HF3A	HF3A
10	0000	0000	50AH	50AH
11	U105	HF3A	8F97	8F97
12	F72U	9F9A	50AH	50AH
13	7F6P	HF3A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



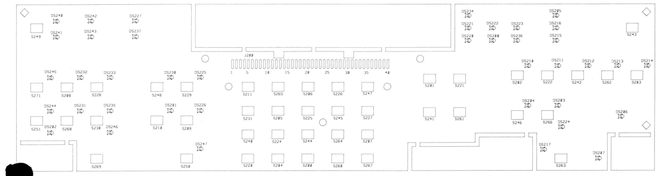
Keyboard and Display Block Diagram

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

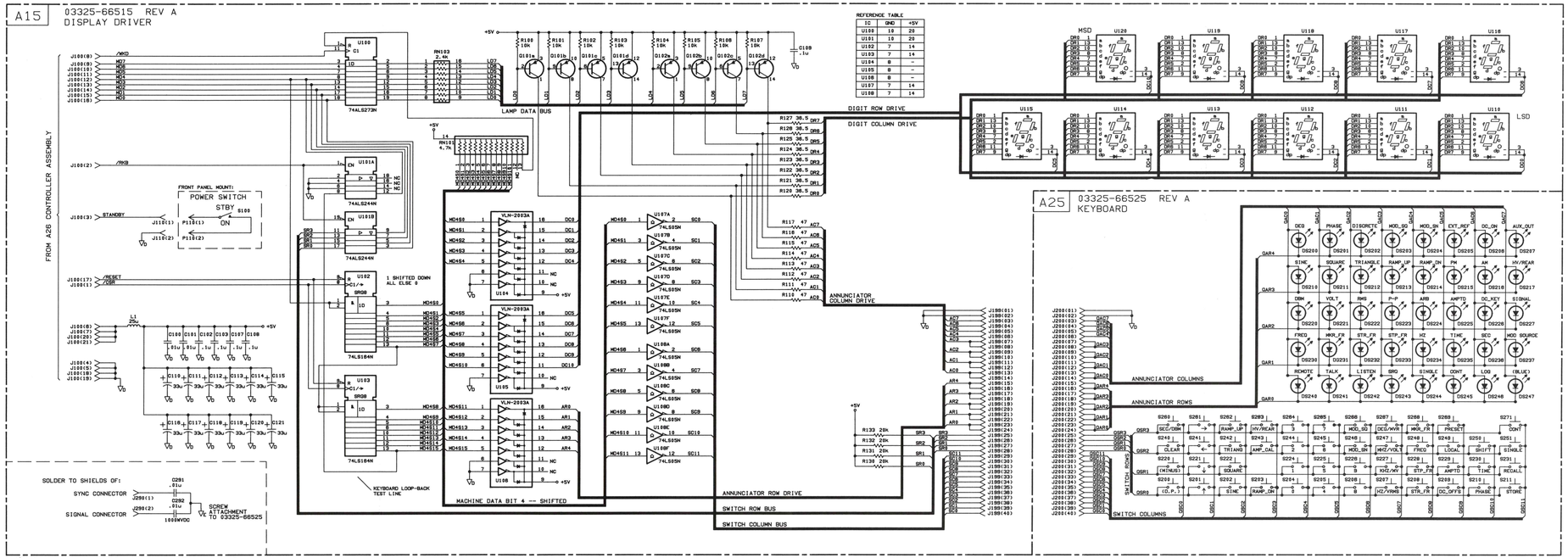


Figure 8-A-2. Keyboard, A25 and Display, A15.
8-A-5/8-A-6

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.

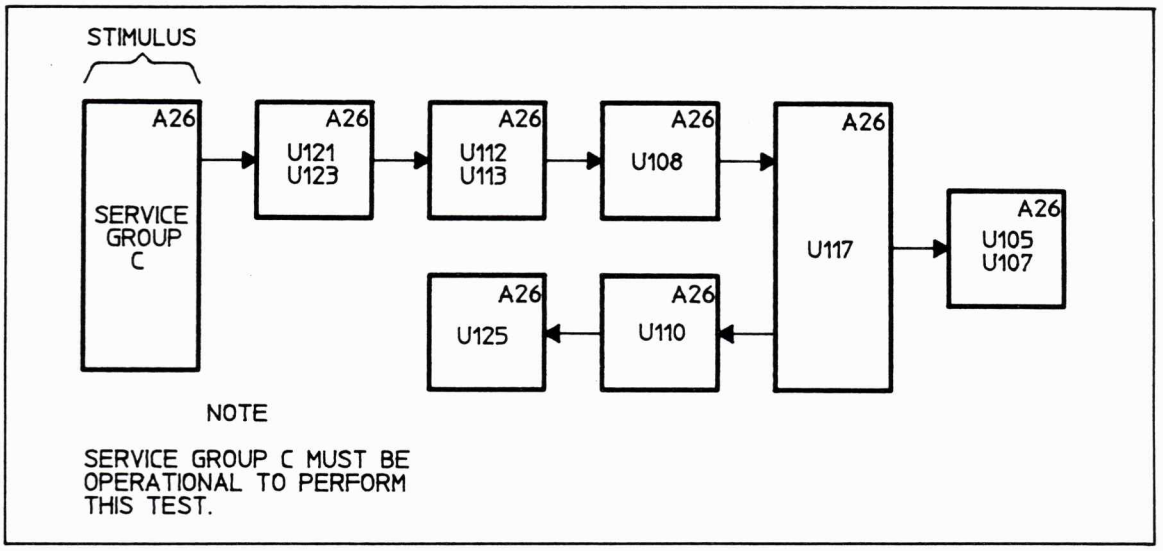


Figure 8-B-1. A26 Assembly SA0 Test Signal Flow Diagram.

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.

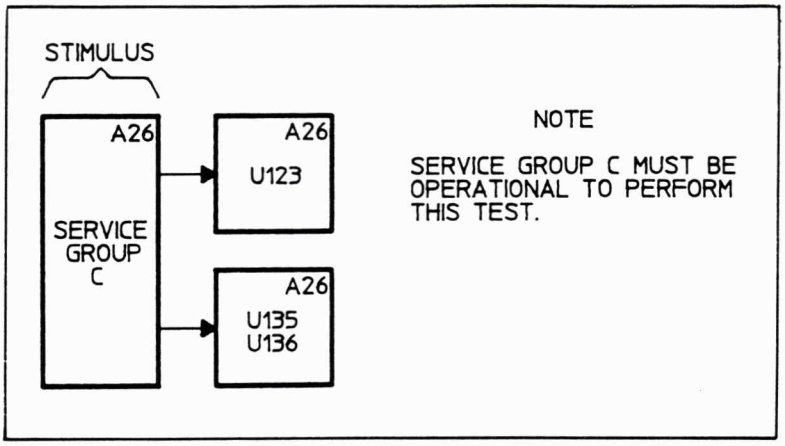
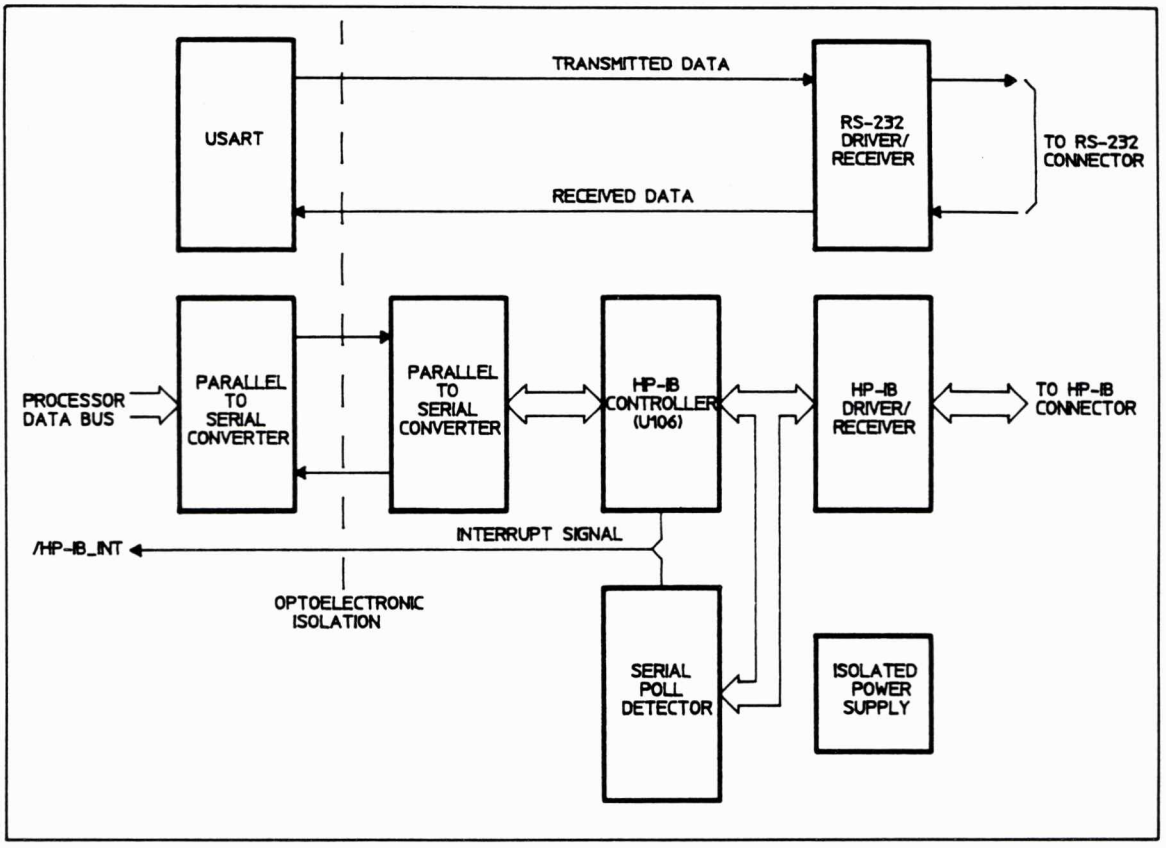


Figure 8-B-2. A26 Assembly SA1 Test Signal Flow Diagram:

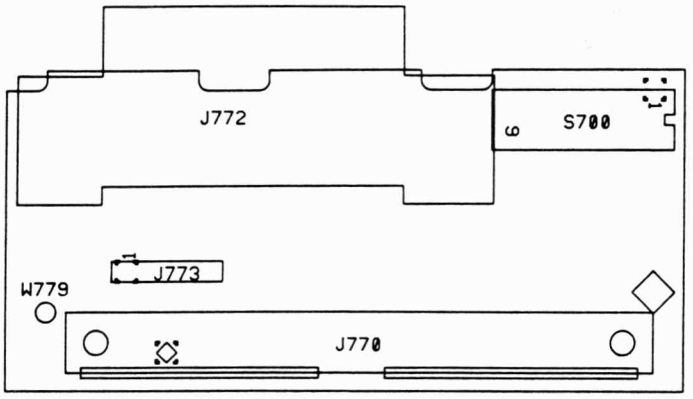
Table 8-B-2. A26 Assembly SA1 Signatures.

(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

A12 03325-66512 REV A
INTERFACE

REAR PANEL DATA INTERFACES

HP-IB INTERFACE

SHIELD (ECOM)
ATN
SRQ
IFC
NDAC
NRFD
DAV
EOI
DIO4
DIO3
DIO2
DIO1
REN
DIO8
DIO7
DIO6
DIO5
HP IB SIGNAL GROUND (ECOM)

J772(18) J772(19) J772(20) J772(21) J772(22) J772(23) J772(24) → ECOM → P770(5) P770(6) P770(7) P770(9) P770(11) P770(13) P770(15) P770(17)

J772(11) ATN → P770(8)
J772(10) SRQ → P770(10)
J772(9) IFC → P770(12)
J772(8) NDAC → P770(14)
J772(7) NRFD → P770(16)
J772(6) DAV → P770(18)
J772(17) REN → P770(19)
J772(5) EOI → P770(20)
J772(16) DIO8 → P770(21)
J772(4) DIO4 → P770(22)
J772(15) DIO7 → P770(23)
J772(3) DIO3 → P770(24)
J772(14) DIO6 → P770(25)
J772(2) DIO2 → P770(26)
J772(13) DIO5 → P770(27)
J772(1) DIO1 → P770(28)

J772(12) → SHIELD

P770(29) P770(30)
R770 1.5K (NOT LOADED)

REAR PANEL SWITCHES:

1=OPEN	0=CLOSED	LABEL
ON (3325B)	OFF (3325A)	ENHANCEMENTS
PRESET	LAST-STATE	POWER-UP MODE
300/2400	1200/4800	RS-232 BAUD 1
300/1200	2400/4800	RS-232 BAUD 2
PARITY ON	PARITY OFF	PARITY 1
EVEN PARITY	ODD PARITY	PARITY 2
SOFTWARE	DTR	HANDSHAKE MODE
		(NOT USED)

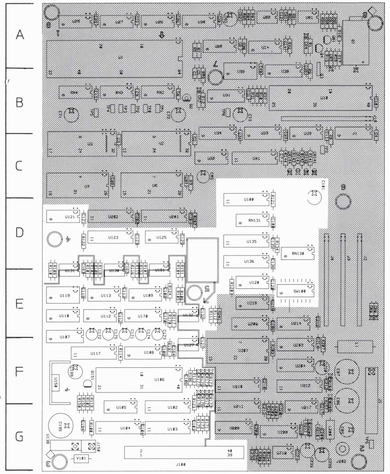
DIP_SWITCH S700
1 RPSW0 → P770(31)
2 RPSW1 → P770(32)
3 RPSW2 → P770(33)
4 RPSW3 → P770(34)
5 RPSW4 → P770(35)
6 RPSW5 → P770(36)
7 RPSW6 → P770(37)
8 RPSW7 → P770(38)
P770(40) P770(39)

RS-232 INTERFACE

7 J773(1) BCOM (GND) → P770(1)
3 J773(3) RX → P770(2)
2 J773(2) TX → P770(3)
20,4 J773(4) DTR → P770(4)
1 J773(5) SHIELD

CONTROLLER A26 ASSEMBLY

W779 → P779(1) J759(1) → ECOM TO SHEET 2



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	R103	F	R143	C	U110	E
C103	G	C175	E	R105	E	R144	C	U112	E
C104	G	C194	G	R106	E	R150	F	U113	E
C106	F	C195	G	R107	D	R151	D	U117	F
C108	F	C199	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	CR142	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	R197	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	V101	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.

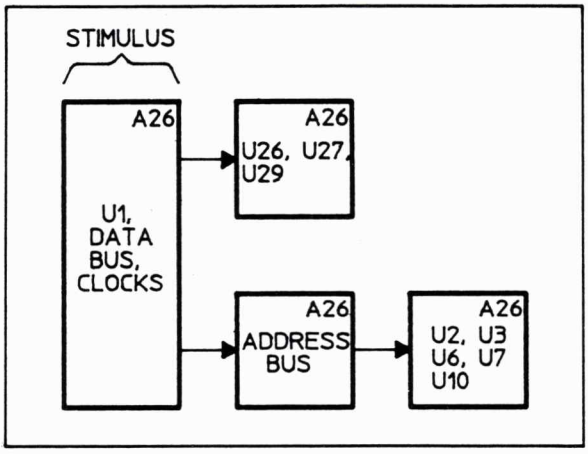


Figure 8-C-1. A26 Assembly Kernel SA Test Signal Flow Diagram.

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.

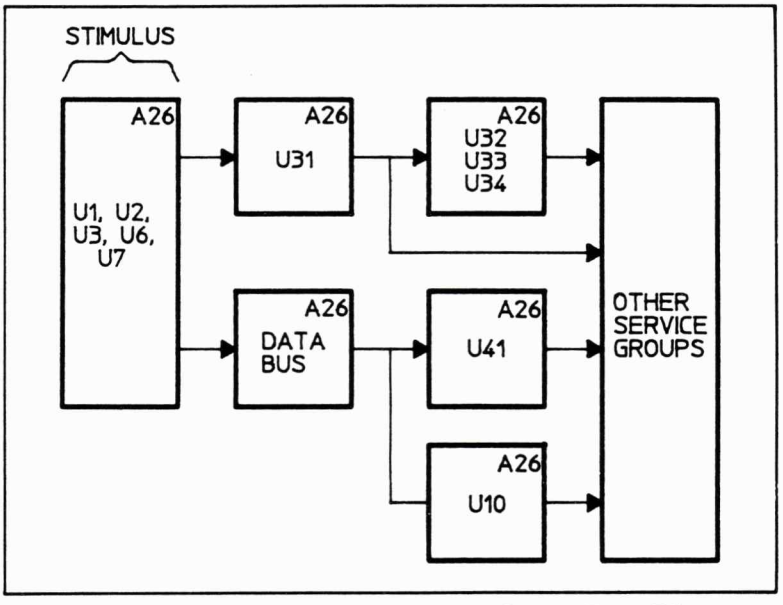


Figure 8-C-2. A26 Assembly SA0 Test Signal Flow Diagram.

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.

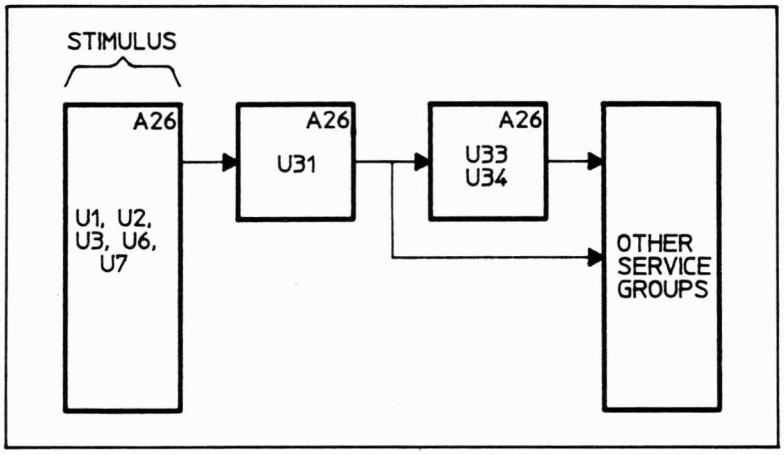
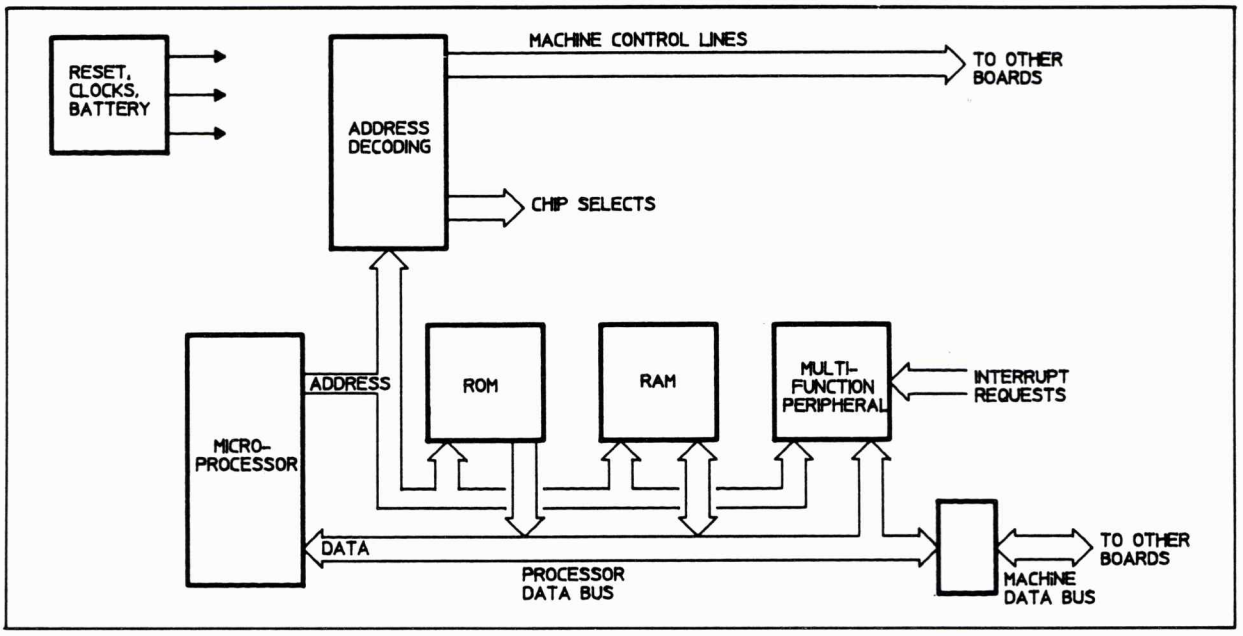


Figure 8-C-3. A26 Assembly SA1 Test Signal Flow Diagram.

Table 8-C-3. A26 Assembly SA1 Signatures.

(The dash indicates an unstable signature.)

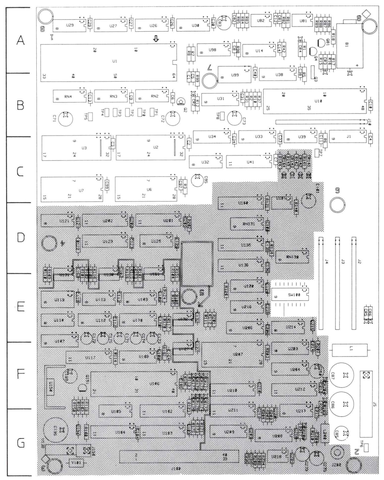
Pin	U31	U33	U34
1	–	–	–
2	–	–	–
3	–	–	–
4	0000	0000	5456
5	0000	3789	3789
6	5456	5456	5456
7	5476	7404	5456
8	0000	0000	0000
9	5456	517F	5456
10	5653	06UU	5456
11	5456	7PF1	5456
12	3789	5456	5456
13	5456	5456	5456
14	5456	UH28	5456
15	61UA	F3C1	5456
16	5456	5456	5456



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		



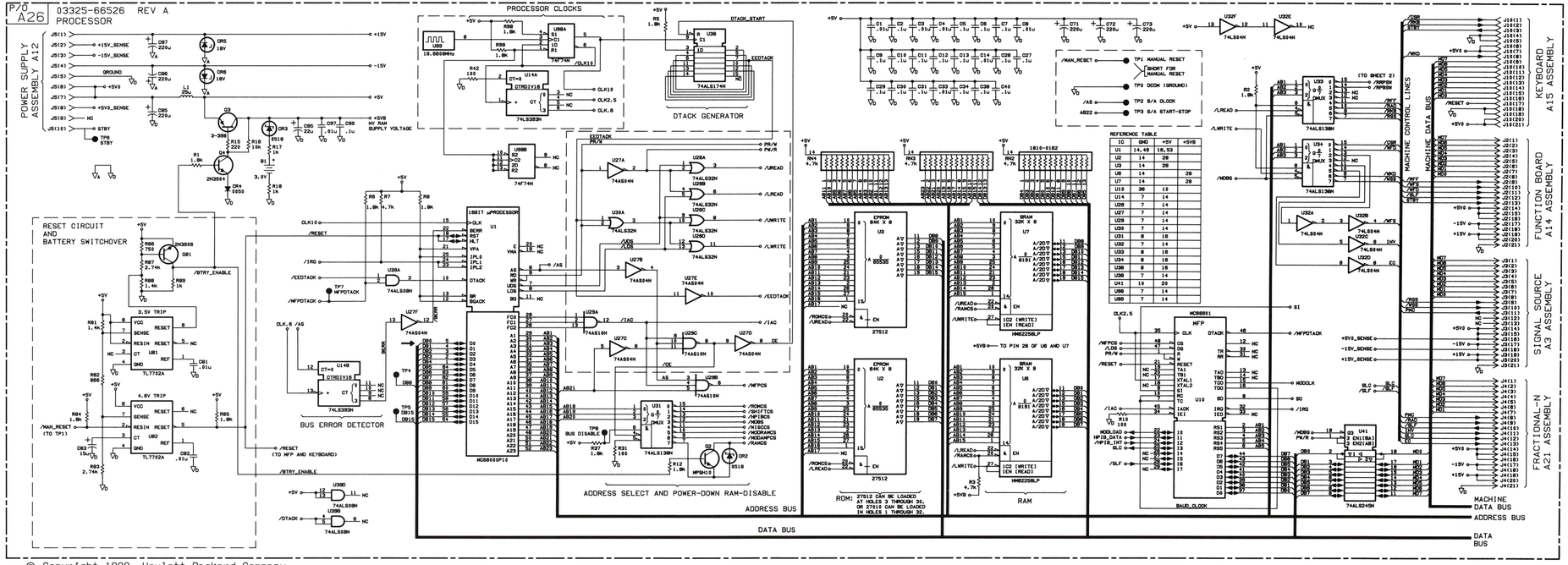


Figure 8-C-4. Control Circuits, A26.

SERVICE GROUP D - 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 ($\geq +2.4$V). 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.

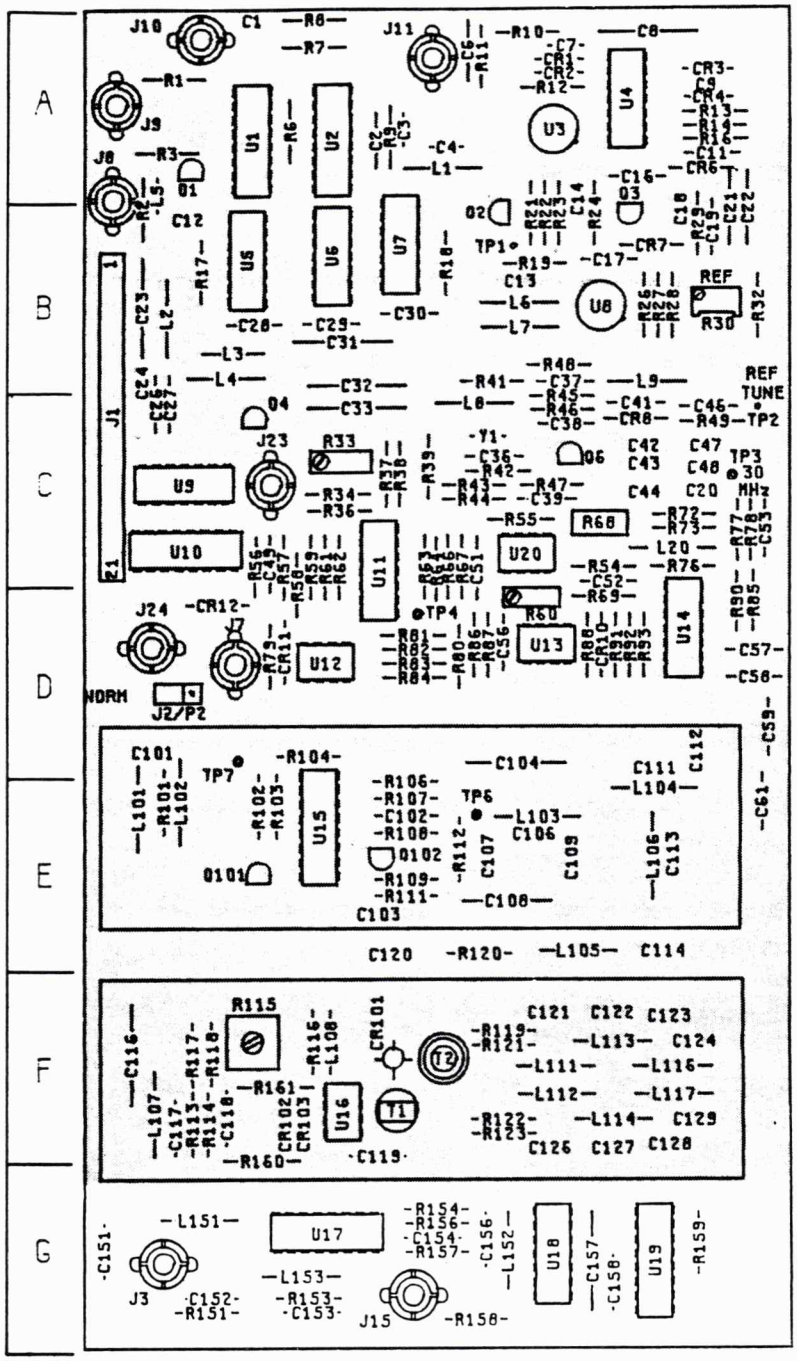
e. Set frequency to 30 MHz. Voltage at A3U18 pin 6 should be low, pin 9 should be low.

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

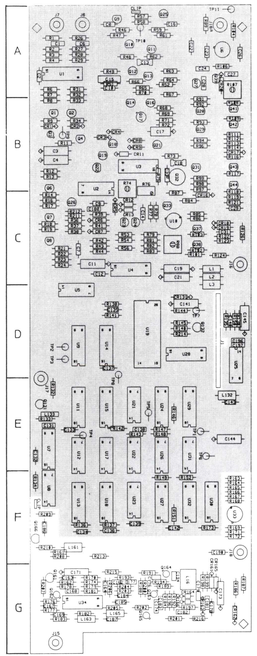
g. If any of the above levels is incorrect, check input pins 12 and 13 of A3U10 for the presence of TTL level pulses.

If input pulses are present, A3U10 may be defective.

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

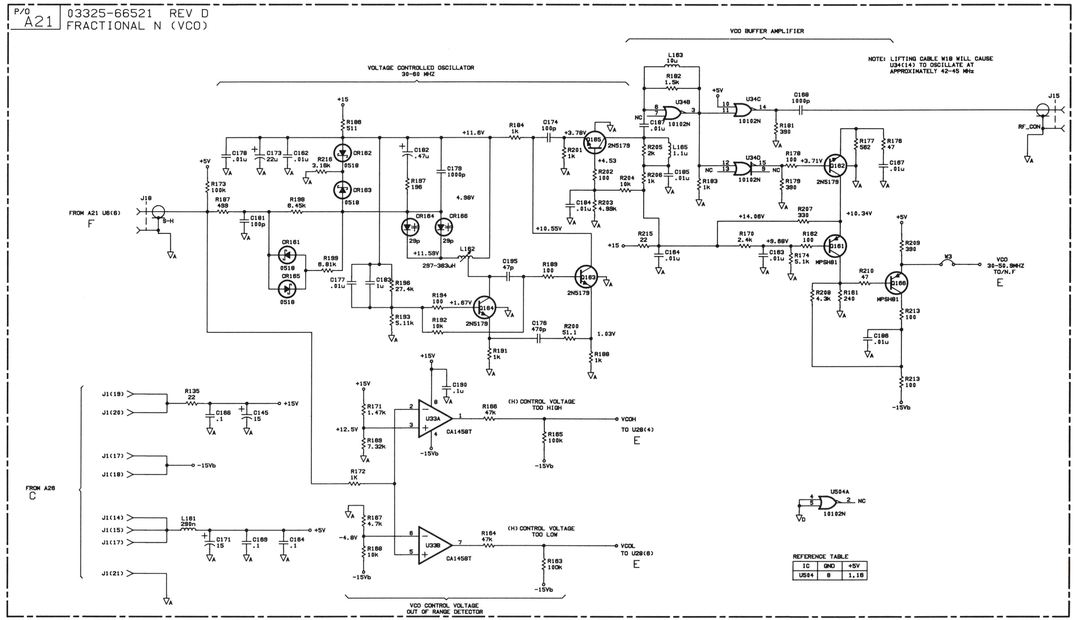


A3
03325-66503
Rev C



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	G
C182	G	R186	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



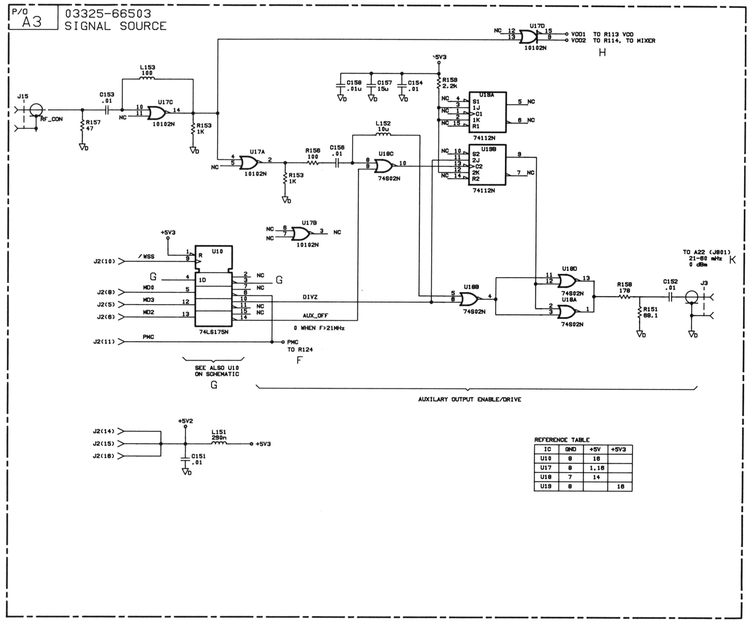


Figure 8-D-1. VCO, A21 and VCO Buffer, A3.

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.

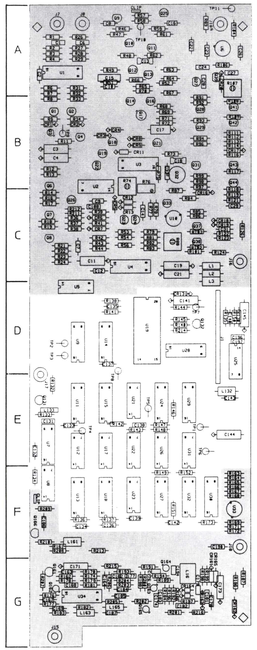
g. If all of the above signals are correct, check for the presence of input pulses at A21U19, pins 20 through 23.

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



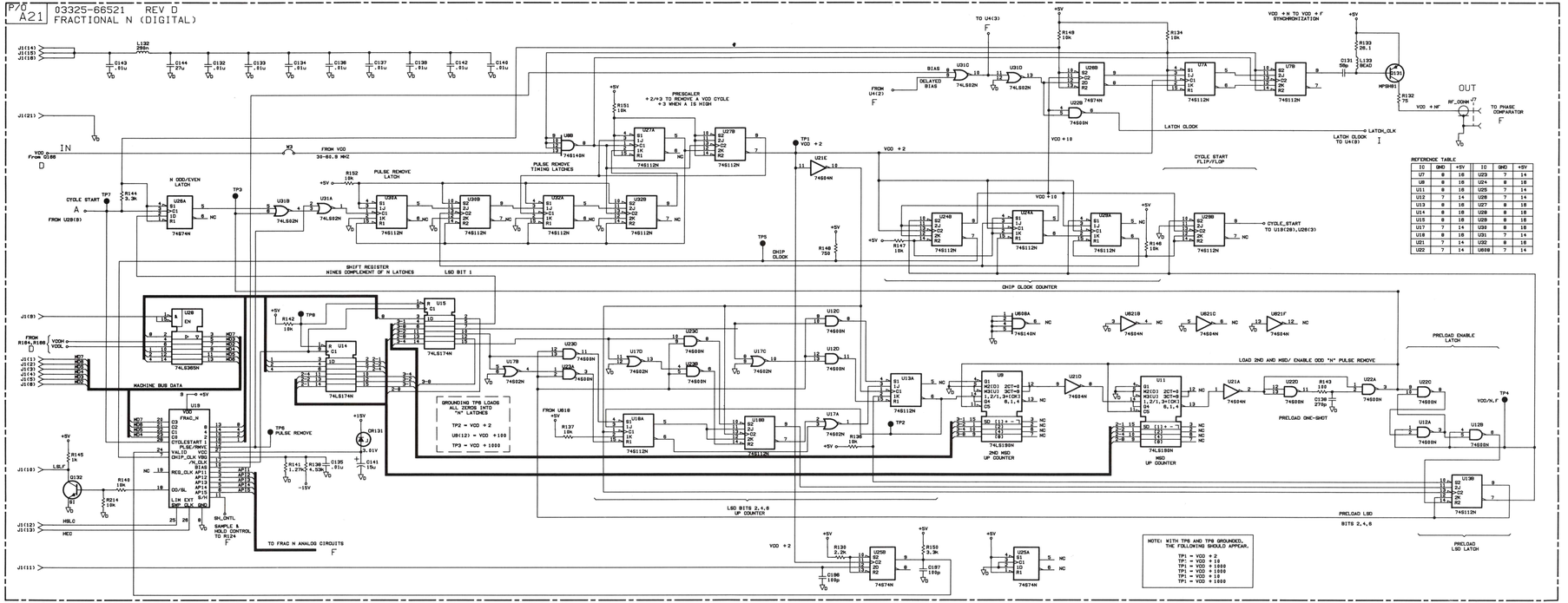


Figure 8-E-1. ÷ N.F. Counter, A21.
8-E-3/8-E-4

SERVICE GROUP F - FRACTIONAL N ANALOG CIRCUITS.

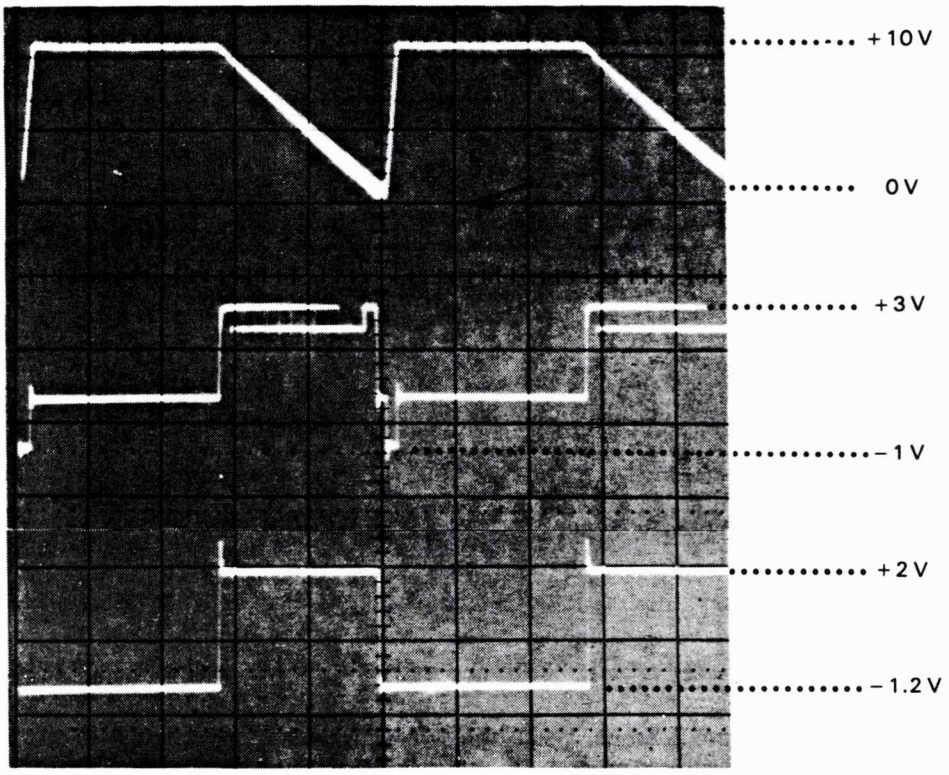
Fractional N Analog Troubleshooting.

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.

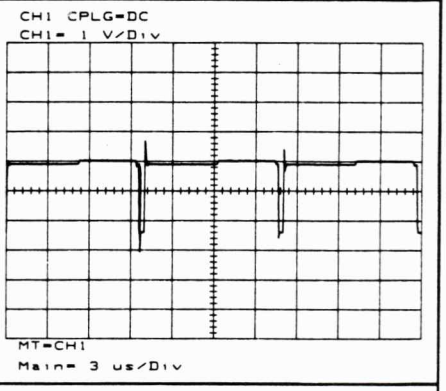
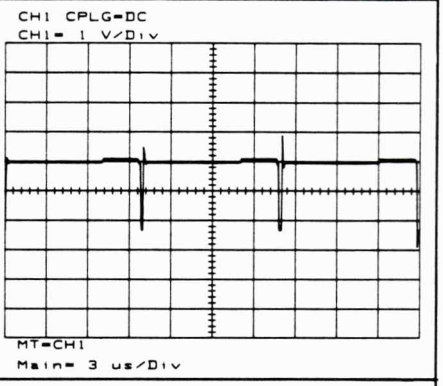
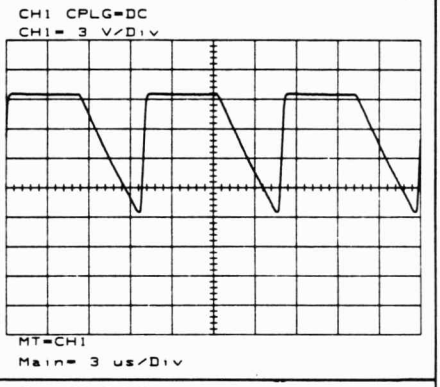
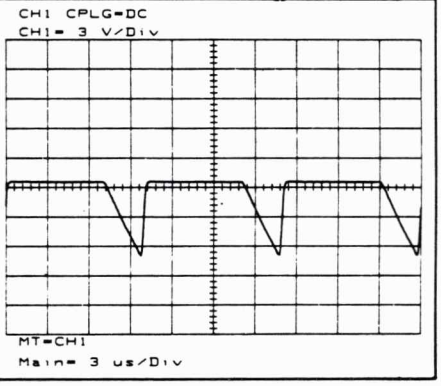
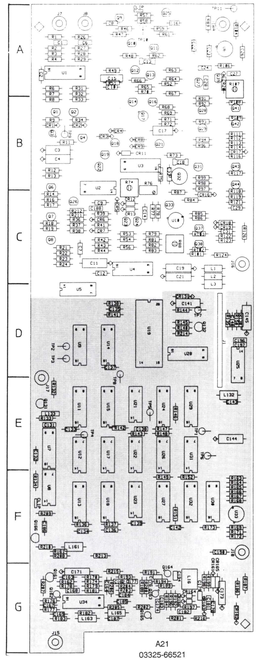
TP	HP3325 Set Up	Measurement Set Up	Important Parameters	Waveform
9	Freq 1.1 MHz Function Sine Amplitude 10Vp-p	Oscilloscope Ch1 Coupling dc Ch1 Volts/Div 1V/div Time Div. 3.00μsec Trigger Ch1	Pulse Height and Width	
9	Freq 19.9MHz Function Sine Amplitude 10Vp-p	Oscilloscope Ch1 Coupling dc Ch1 Volts/Div 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
C006	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	R045	A	U04	C
J16	C	R047	A	U05	A
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		



A21
03325-66521

P/O A21 03325-66521 REV D
FRACTIONAL N (ANALOG)

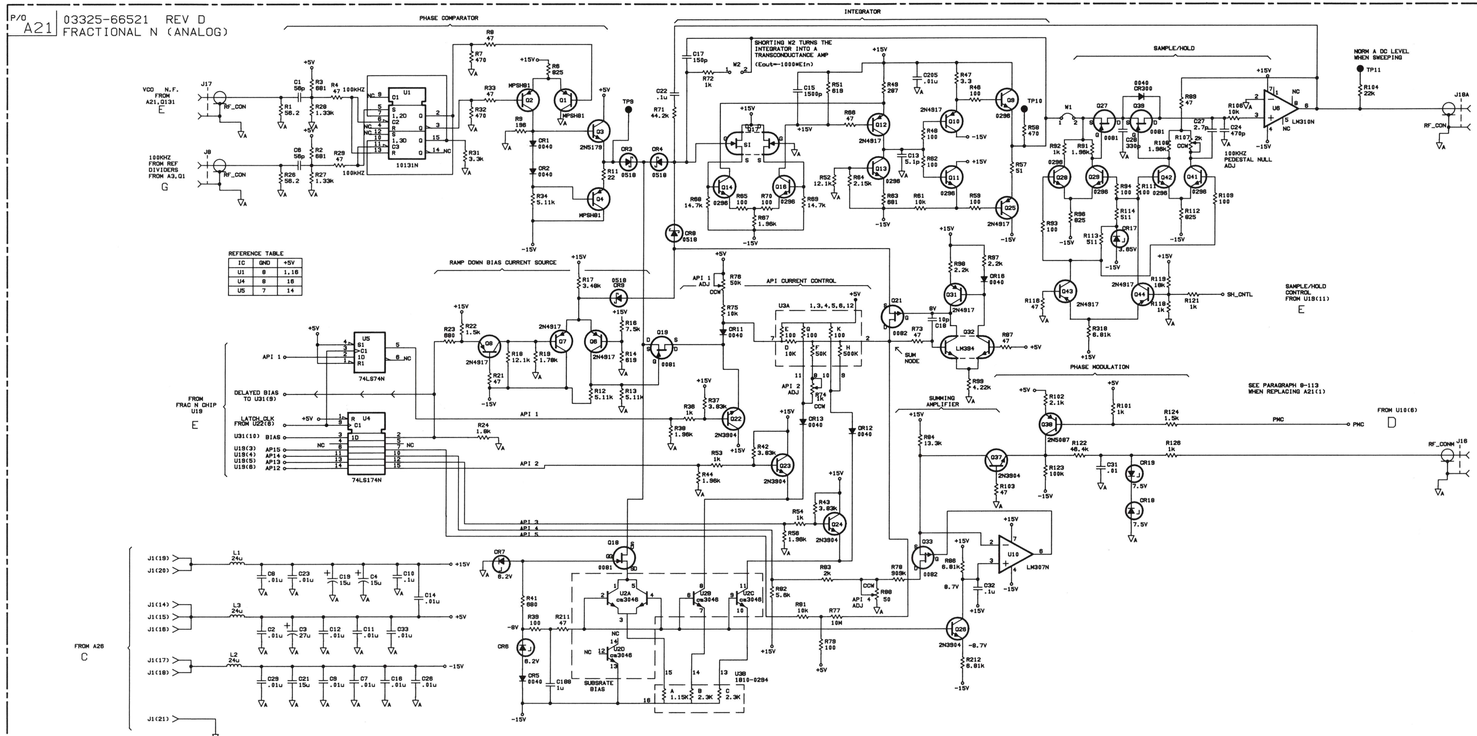


Figure 8-F-2. Fractional N Analog, A21.

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 proceeding 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 linearily 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.

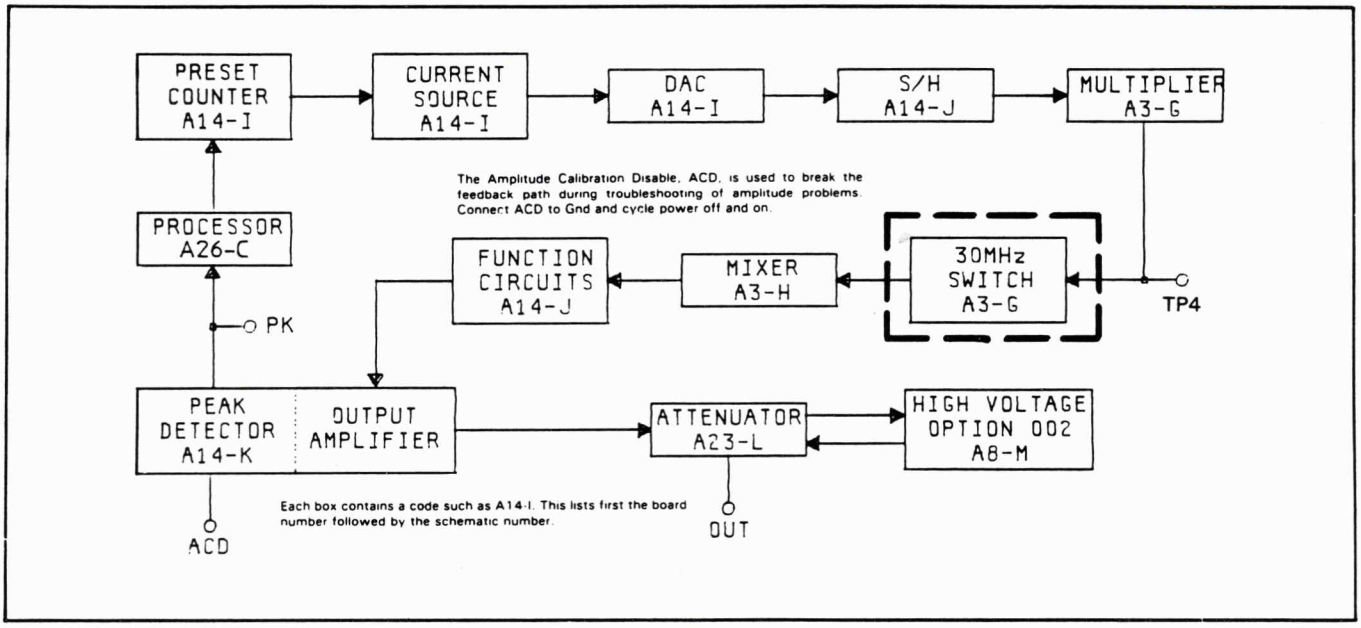
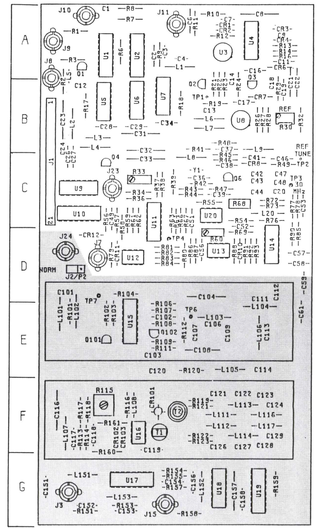


Figure 8-G-1. Sine Amplitude Control Path.

Designator	Board Location
C001	A
C002	A
C003	A
C004	A
C006	A
C007	A
C008	A
C009	A
C011	A
C012	B
C013	B
C014	A
C016	A
C017	B
C018	B
C019	B
C020	C
C021	B
C022	B
C023	B
C024	B
C026	C
C027	C
C028	B
C029	B
C031	B
C032	B
C033	C
C034	B
C036	C
C037	B
C038	C
C039	C
C041	C
C042	C
C043	B
C044	C
C046	C
C047	C
C048	C
C049	C
C051	C
C052	C
C053	C
C056	D
C057	D
C058	D
C059	D
CR001	A
CR002	A
CR003	A
CR004	A
CR006	A
CR007	B
CR008	C
CR010	D
CR011	D
CR012	D
J01	C
J07	D
J08	A
J09	A
J10	A
J11	A
J23	C
L001	A
L002	B
L003	B
L004	B
L005	A
L006	B
L007	B
L008	C
L009	B
L020	C
Q001	A
Q002	B
Q003	B
Q004	C
Q006	C
R001	A
R002	B
R003	A
R006	A
R007	A
R008	A
R009	A
R010	A
R011	A
R012	A
R013	A
R014	A
R016	A
R017	B
R018	B
R019	B
R021	B
R022	B
R023	B
R024	B
R026	B
R027	B
R028	B
R029	B
R030	B
R032	B
R033	C
R034	C
R036	C
R037	C
R038	C
R039	C
R041	B
R042	C
R043	C
R044	C
R045	C
R046	C
R047	C
R048	B
R049	C
R054	C
R055	C
R056	C
R057	C
R058	C
R059	C
R060	D
R061	C
R062	C
R063	C
R064	C
R066	C
R067	C
R068	C
R069	D
R072	C
R073	C
R076	C
R077	C
R078	C
R079	D
R080	D
R081	D
R082	D
R083	D
R084	D
R085	D
R086	D
R087	D
R088	D
R090	D
R091	D
R092	D
R093	D
R104	D
TP1	B
TP2	C
TP3	C
TP4	D
TP7	D
U01	A
U02	A
U03	A
U04	A
U05	B
U06	B
U07	B
U08	B
U09	C
U10	C
U11	C
U12	D
U13	D
U14	D
U20	C
Y1	C



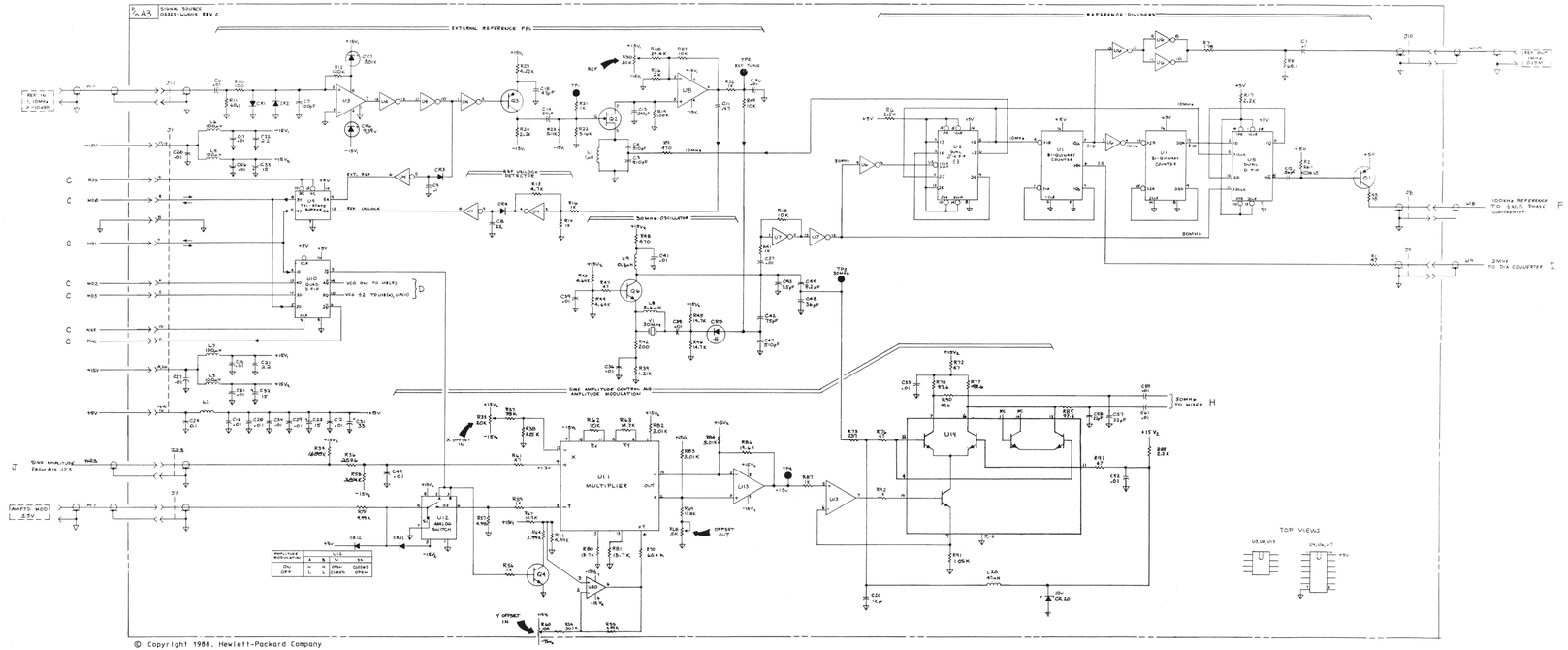


Figure 8-G-2. 30 MHz Reference and Dividers, A3.

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.

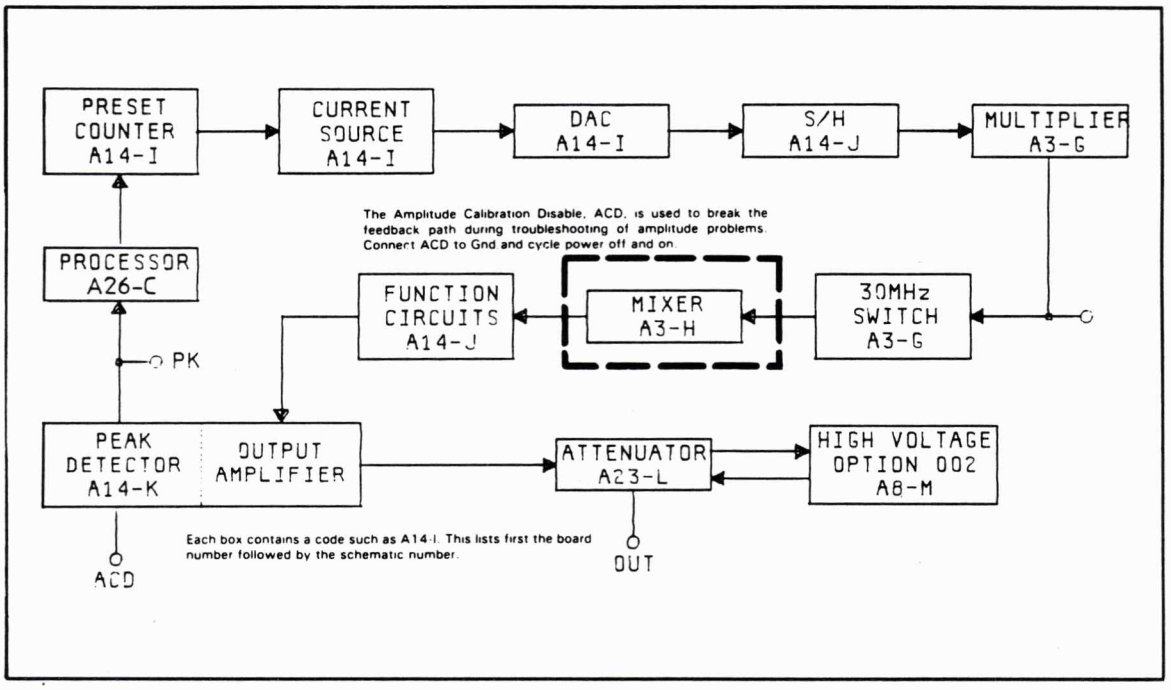
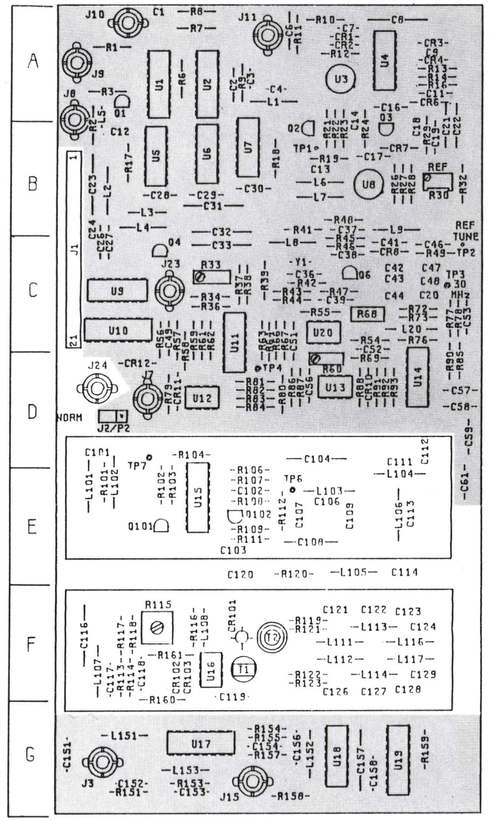


Figure 8-H-1. Sine Amplitude Control Path.

Designator	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



A3
03325-66503
Rev C

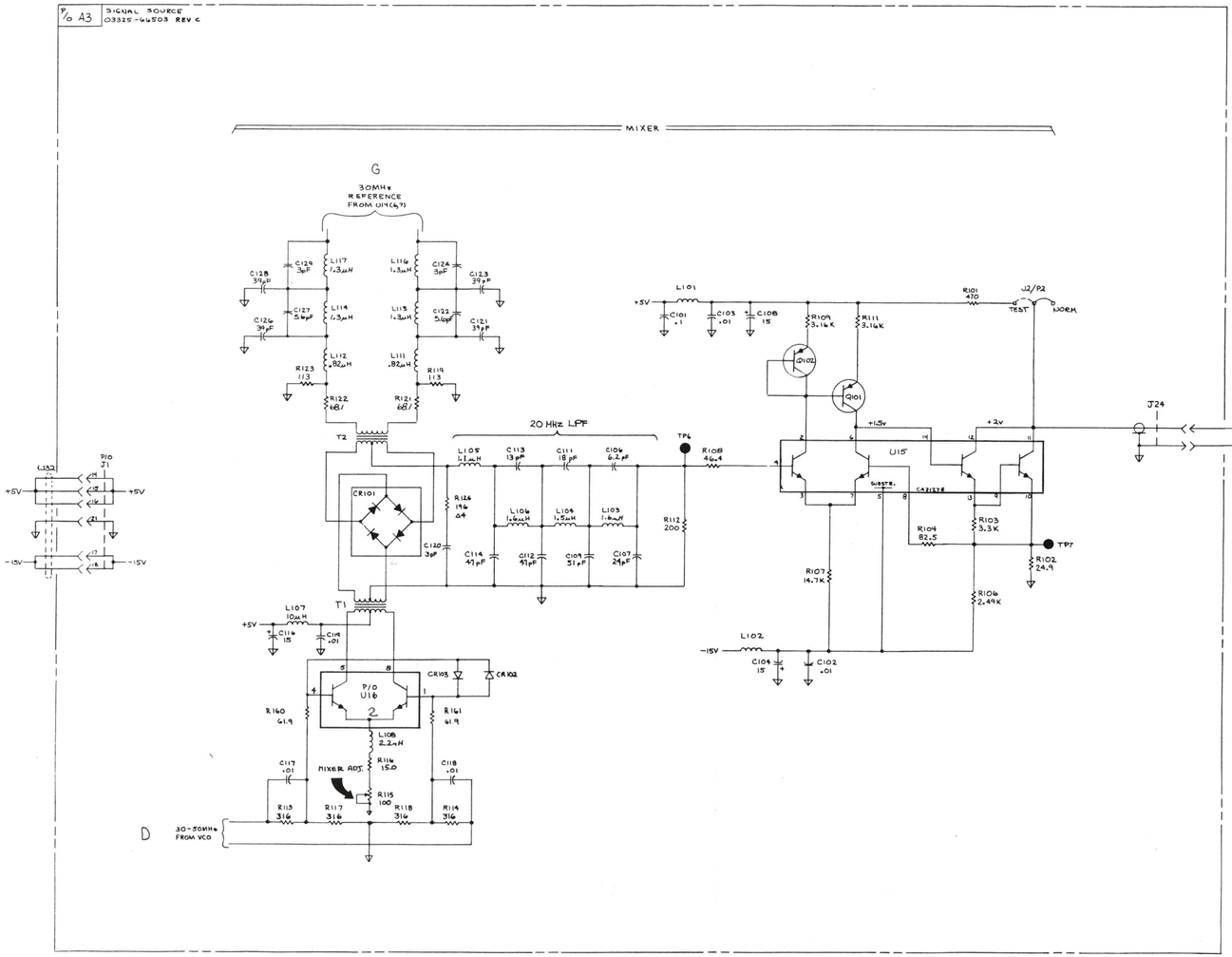


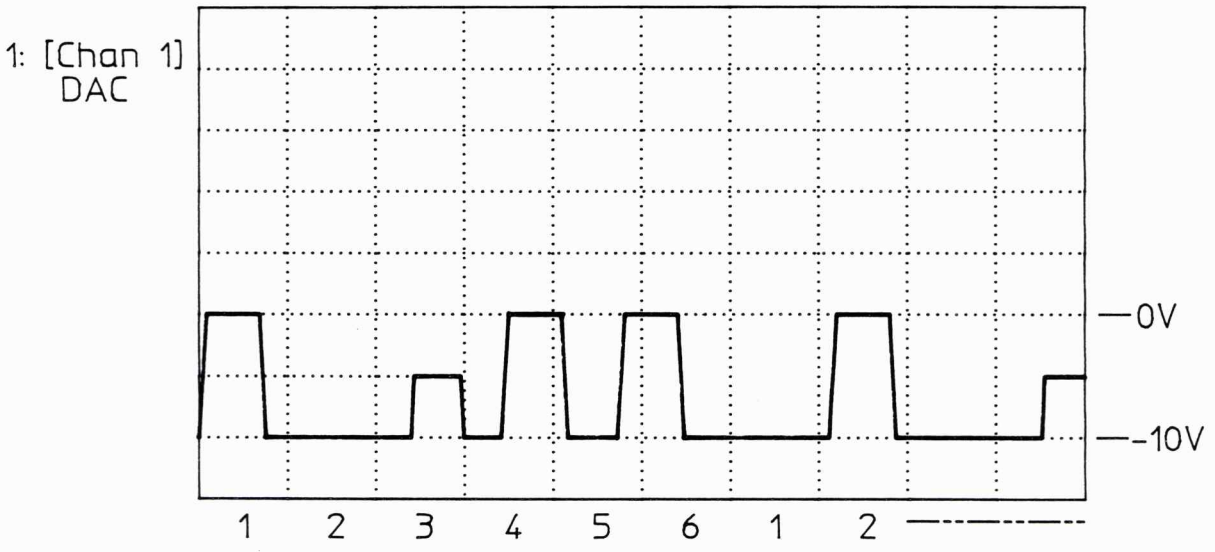
Figure 8-H-2. Mixer, A3.

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.

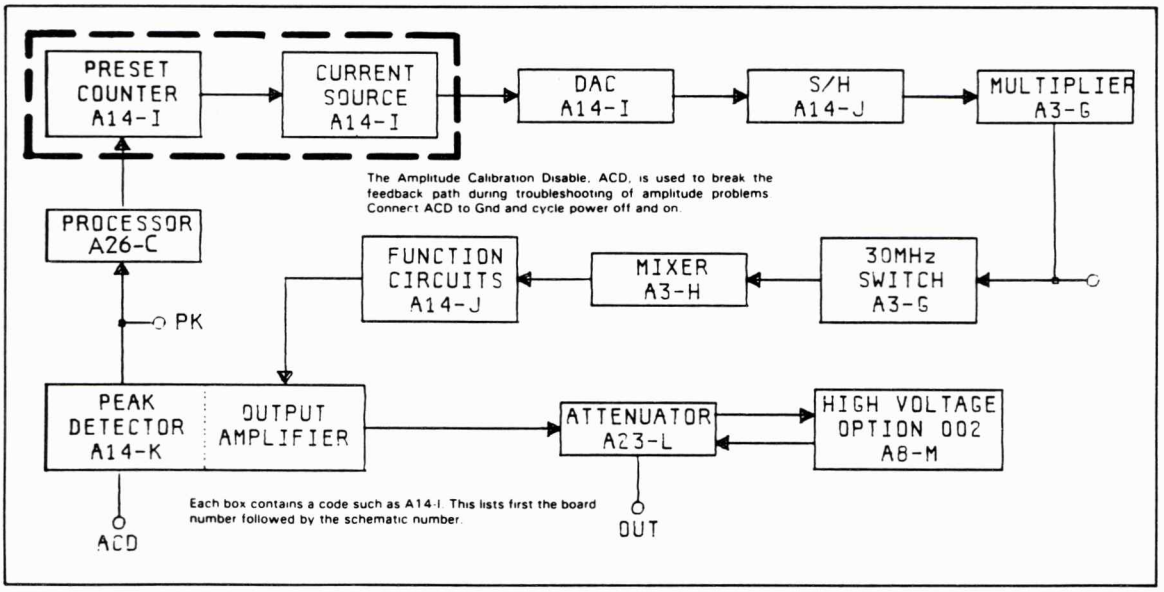


Figure 8-I-1. Sine Amplitude Control Path.

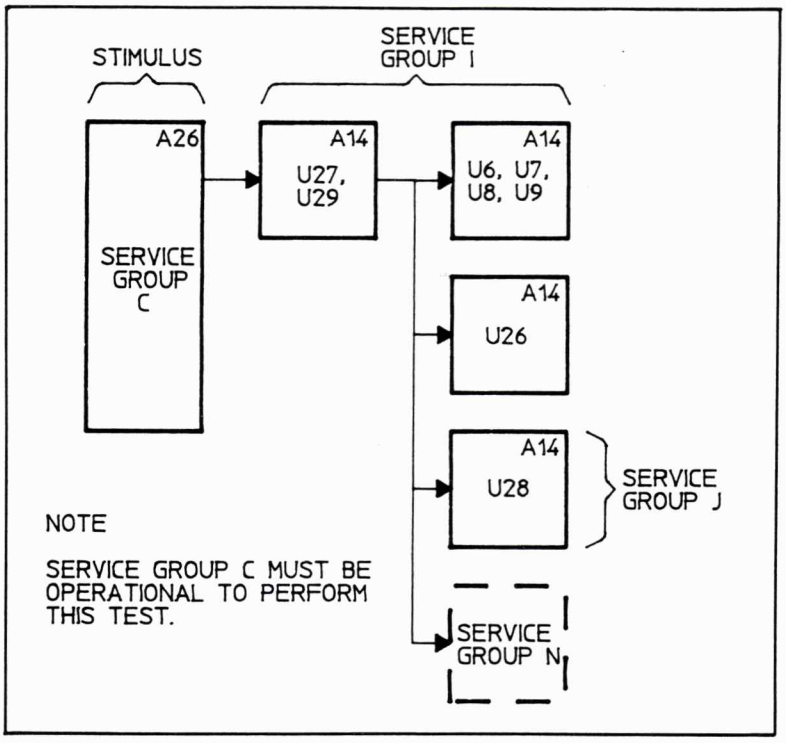
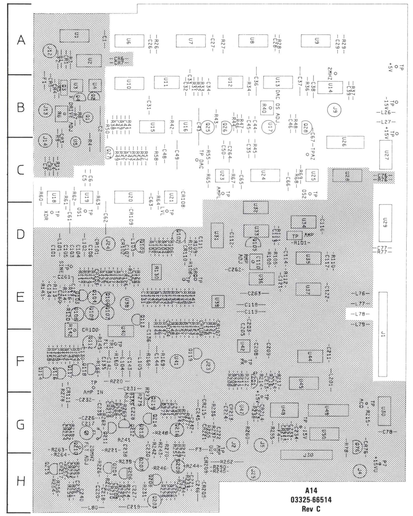


Figure 8-I-2. A14 Assembly SA0 Test Signal Flow Diagram.

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



Designator	Board Location	Designator	Board Location	Designator	Board Location	Designator	Board Location	Designator	Board Location
C005	C	C045	C	Q026	B	R048	B	U07	A
C006	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	R006	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	U05	A		

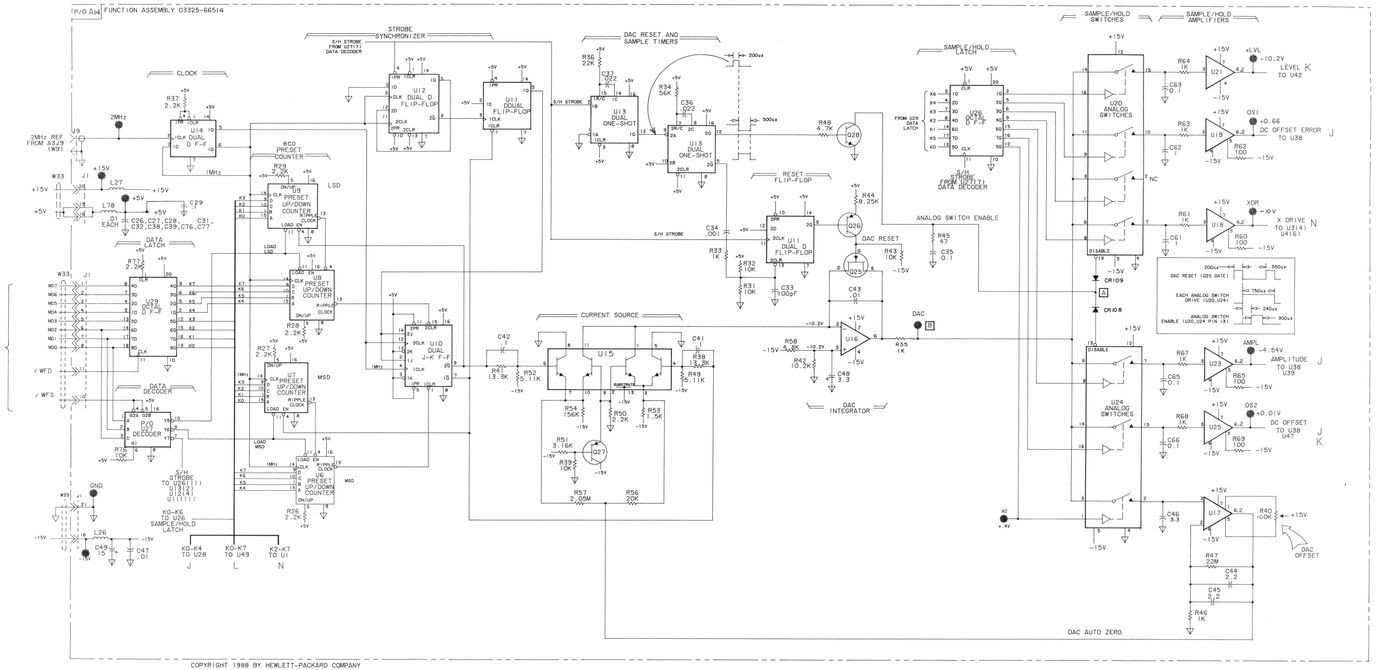


Figure 8-1-3. D/A Converter and Sample/Hold, A14.

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.

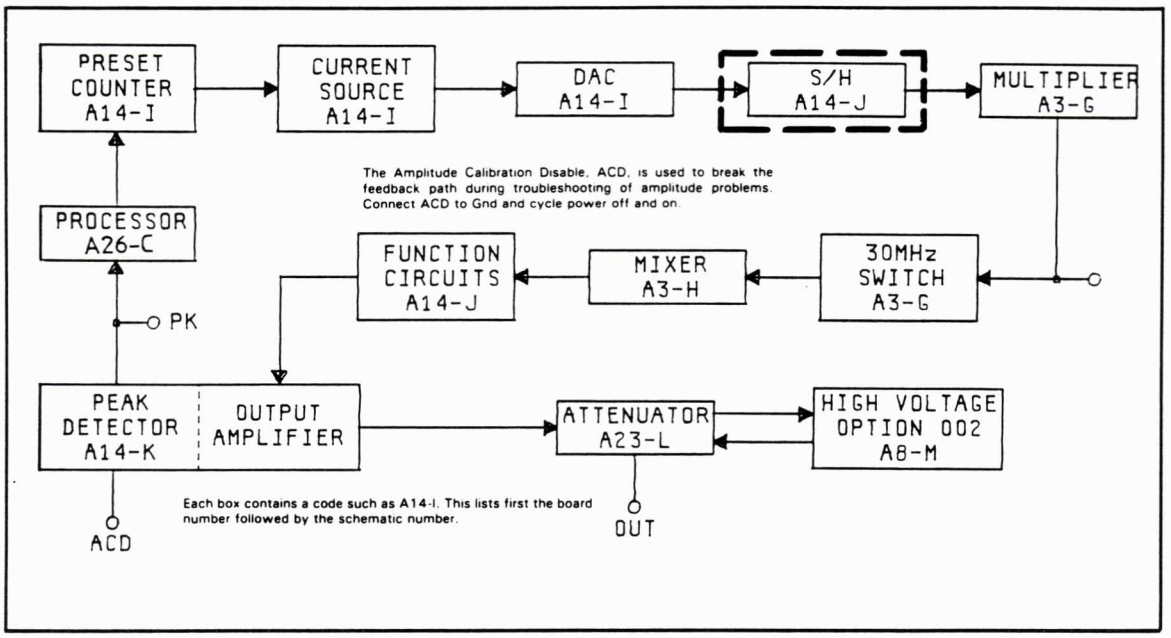


Figure 8-J-1. Sine Amplitude Control Path.

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 (I). 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.

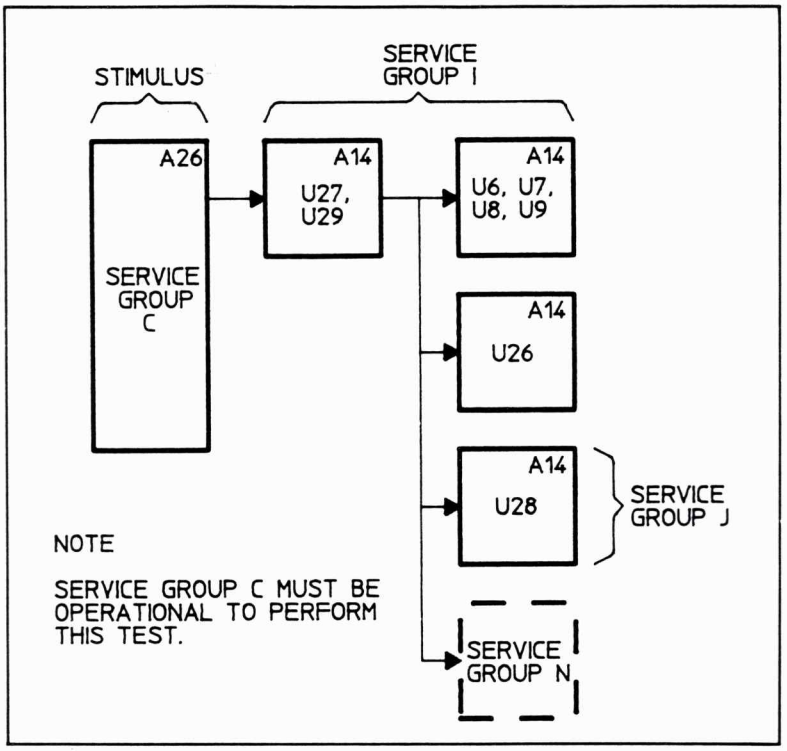


Figure 8-J-2. A14 Assembly SA0 Test Signal Flow Diagram.

Table 8-J-1. A14 Assembly Signatures.

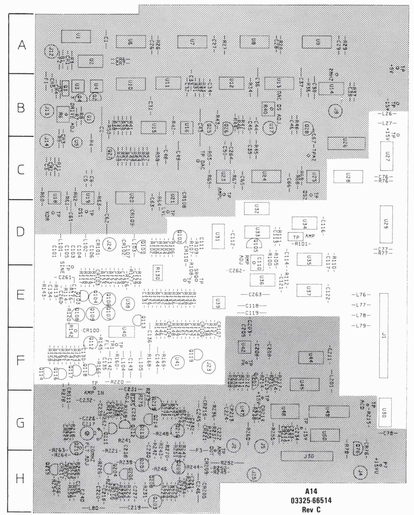
Pin	U6	U7	U8	U9	U26	U27	U28	U29
1	9HF5	9HF5	9HF5	9HF5	HF3A	0795	HF3A	HF3A
2	0000	HF3A	FP21	FP21	1F48	6057	PA2A	41UU
3	0000	HF3A	121C	121C	41UU	2354	9HF5	9F9A
4	HF3A	HF3A	HF3A	HF3A	41UU	1H05	41UU	7F6P
5	HF3A	HF3A	HF3A	HF3A	1F48	1H05	3610	9HF5
6	0000	HF3A	121C	121C	F072	HF3A	9HF5	41UU
7	0000	HF3A	FP21	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		



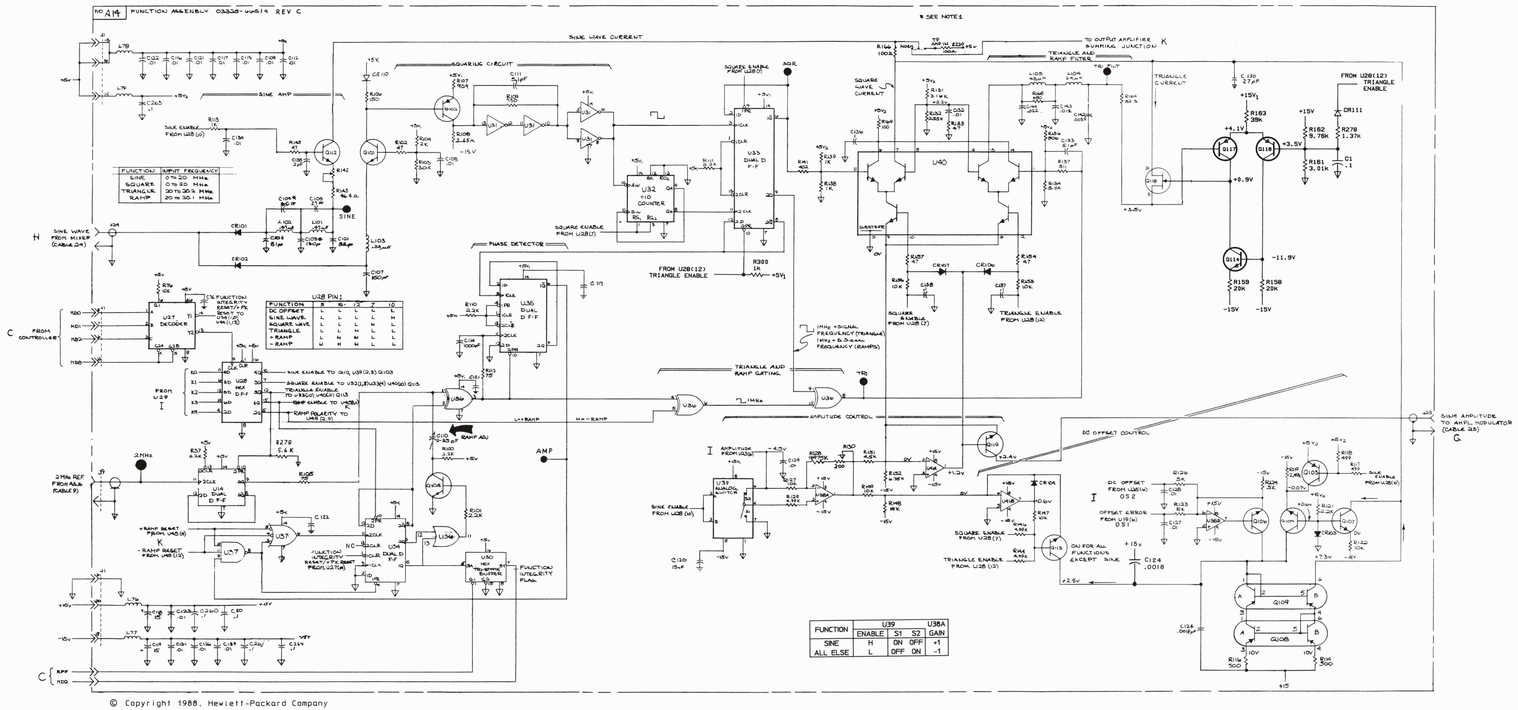


Figure 8-J-3. Function Circuits, A14.
8-J-7/8-J-8

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).

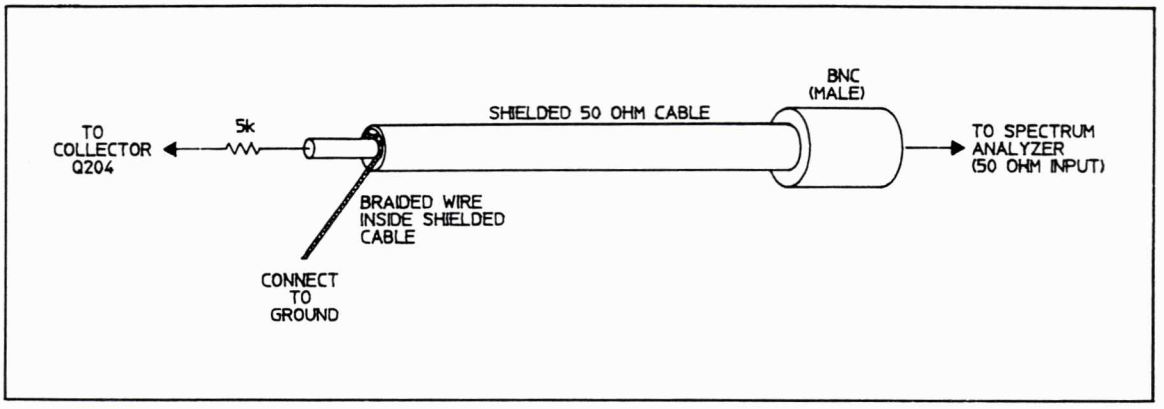


Figure 8-K-1. Gain Stage High Frequency Troubleshooting Probe.

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.

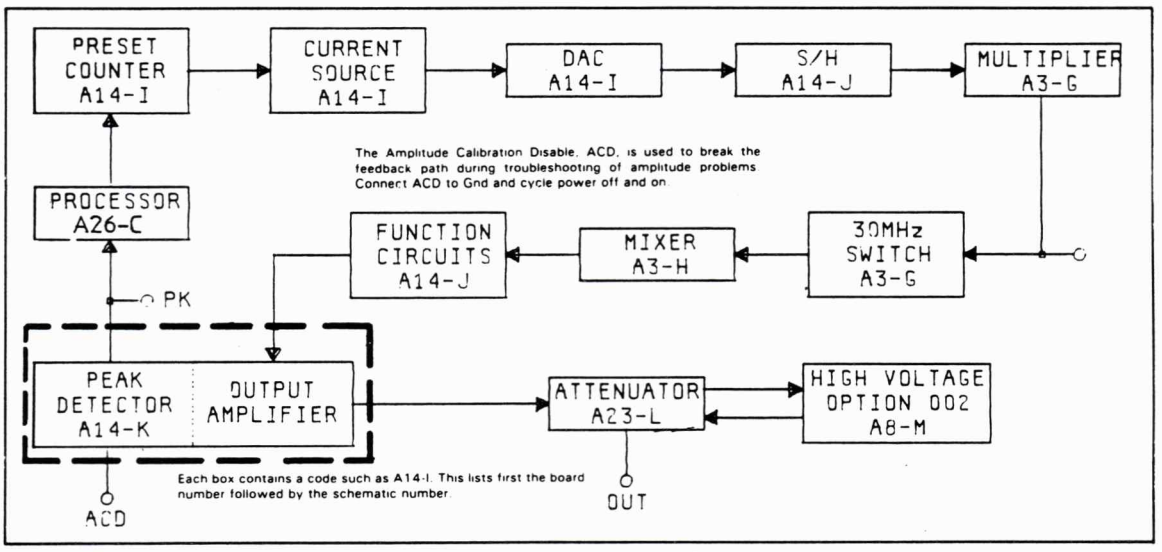
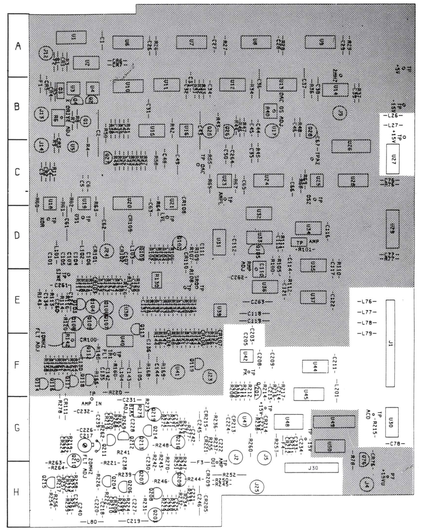


Figure 8-K-2. Sine Amplitude Control Path.

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

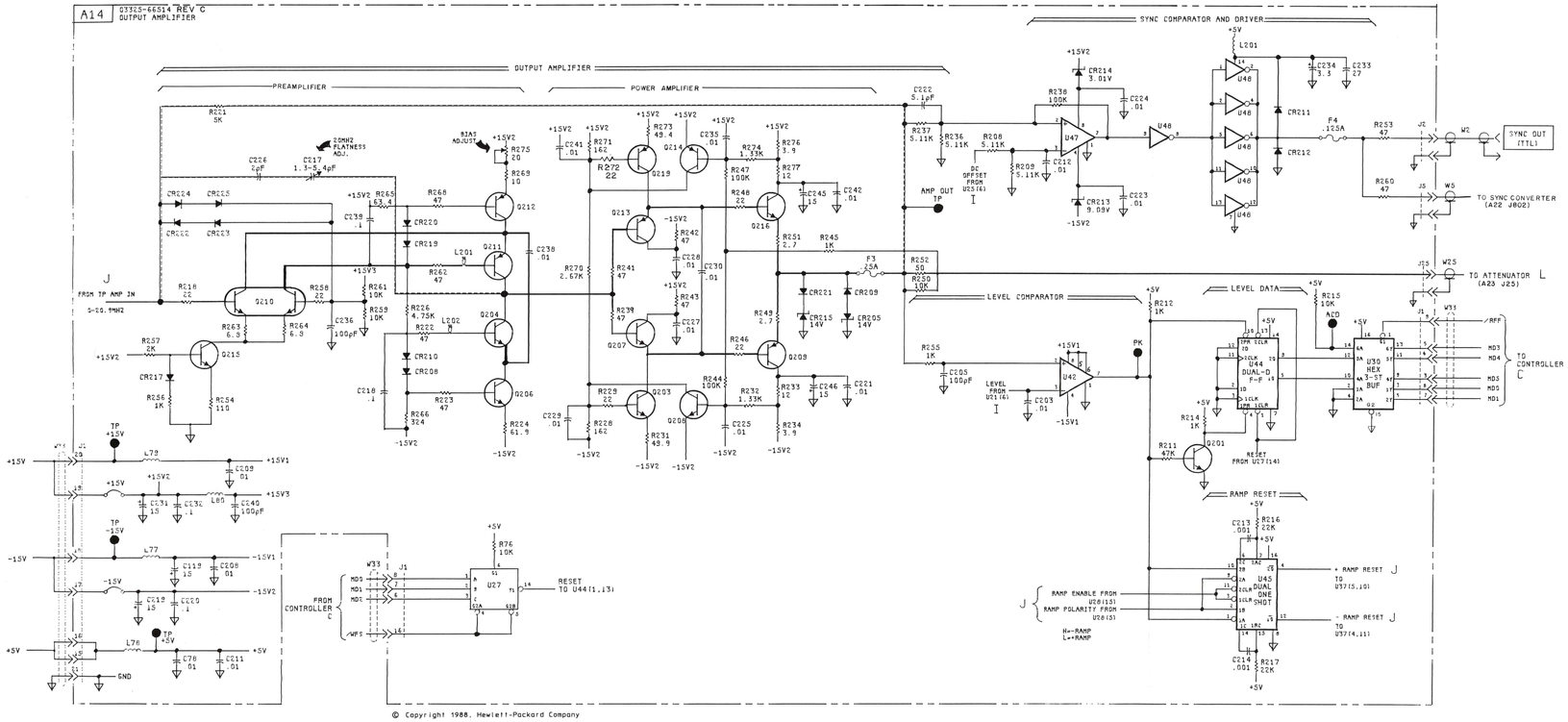
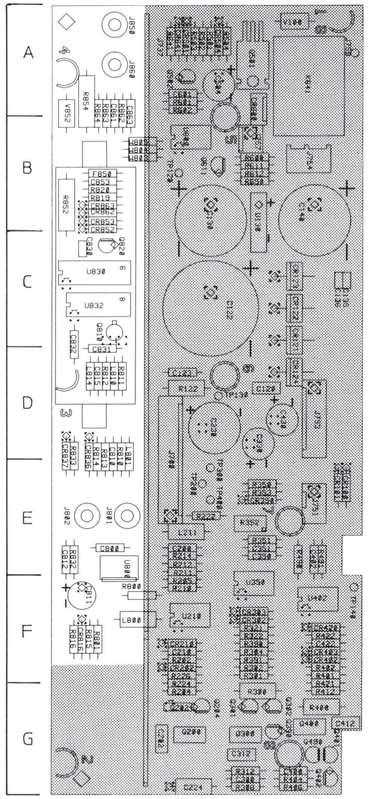


Figure 8-K-3. Output Amplifier, A14.



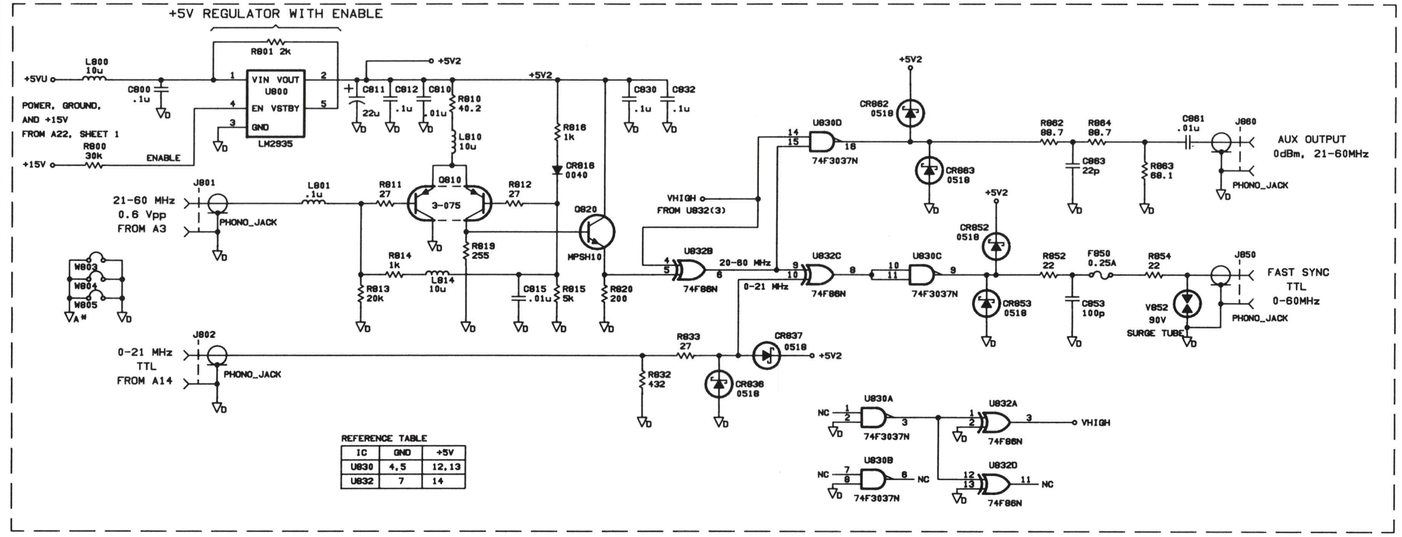
A22
03325-66522

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		

P/O A22 03325-66522 REV A
POWER SUPPLY

FAST SYNC CONVERTER



REFERENCE TABLE

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

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

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.

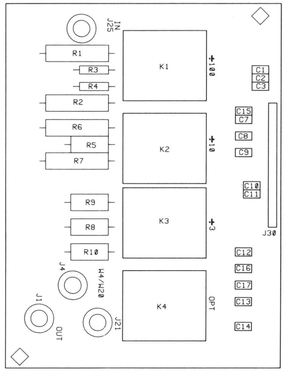
Range	DC Offset Only (No AC Function)	Attenuator Relay Pads In
1	5.000 to 1.500 V	None
2	1.499 to 0.500 V	K3
3	499.9 to 150.0 mV	K2
4	149.9 to 50.00 mV	K2, K3
5	49.99 to 15.00 mV	K1
6	14.99 to 5.000 mV	K1, K3
7	4.999 to 1.500 mV	K1, K2
8	1.499 to 1.000 mV	K1, K2, K3

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.

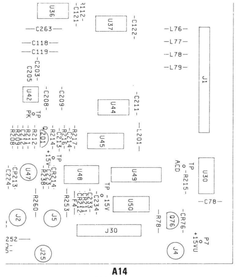
A23 Attenuator Circuit Board Cleaning.

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.

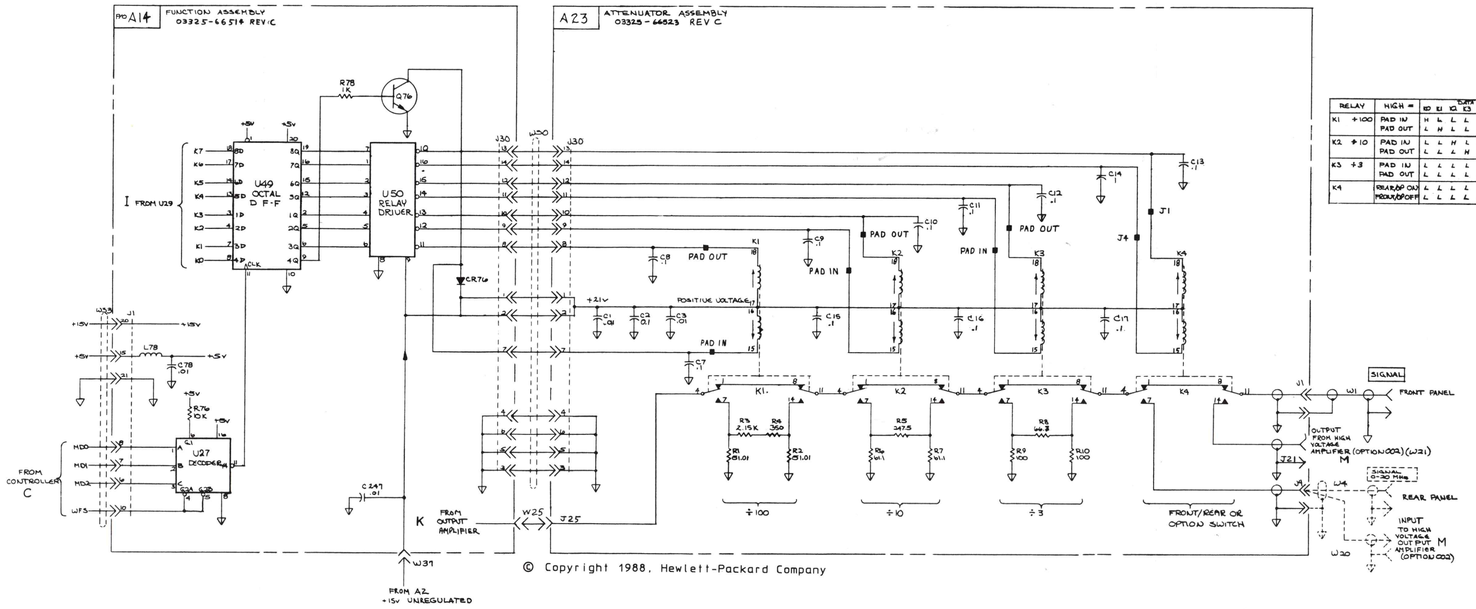
If necessary, clean the board with Freon TMS (Miller Stephenson, MS165).



A23
03325-66523
REV C



A14
03325-66514
Rev C



RELAY	HIGH =	DATA LINES D0	D1	D2	D3	D4	D5	D6	D7
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/OPTION	L	L	L	L	L	L	H	L
	FRONT/OPTION	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.

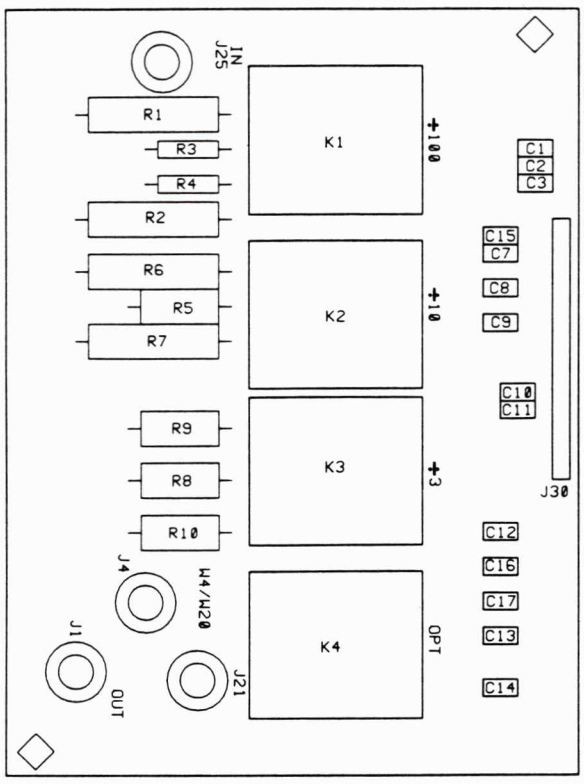
Normally, instruments having the High Voltage Output Option 002 are shipped from the factory with the signal output at the front panel. The signal output can be changed to the rear panel by reconnecting Cables 1 and 4.

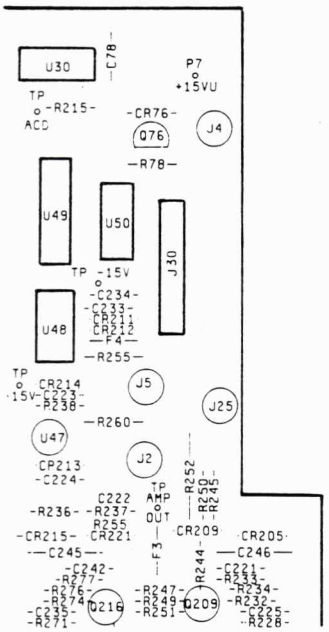
a. Disconnect Cable 1 (to the front panel signal output) from the attenuator assembly J1 OUT.

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.

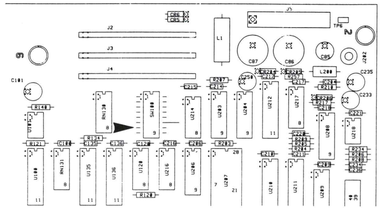
c. Disconnect the cable (marked 4 REAR/EXT LVL) from A14 4/DUMMY and connect it to A23 J4.

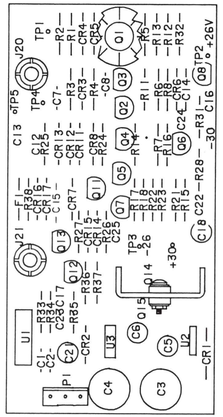
d. Connect the cable marked 20 HI V1 to A14 4/DUMMY.

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).





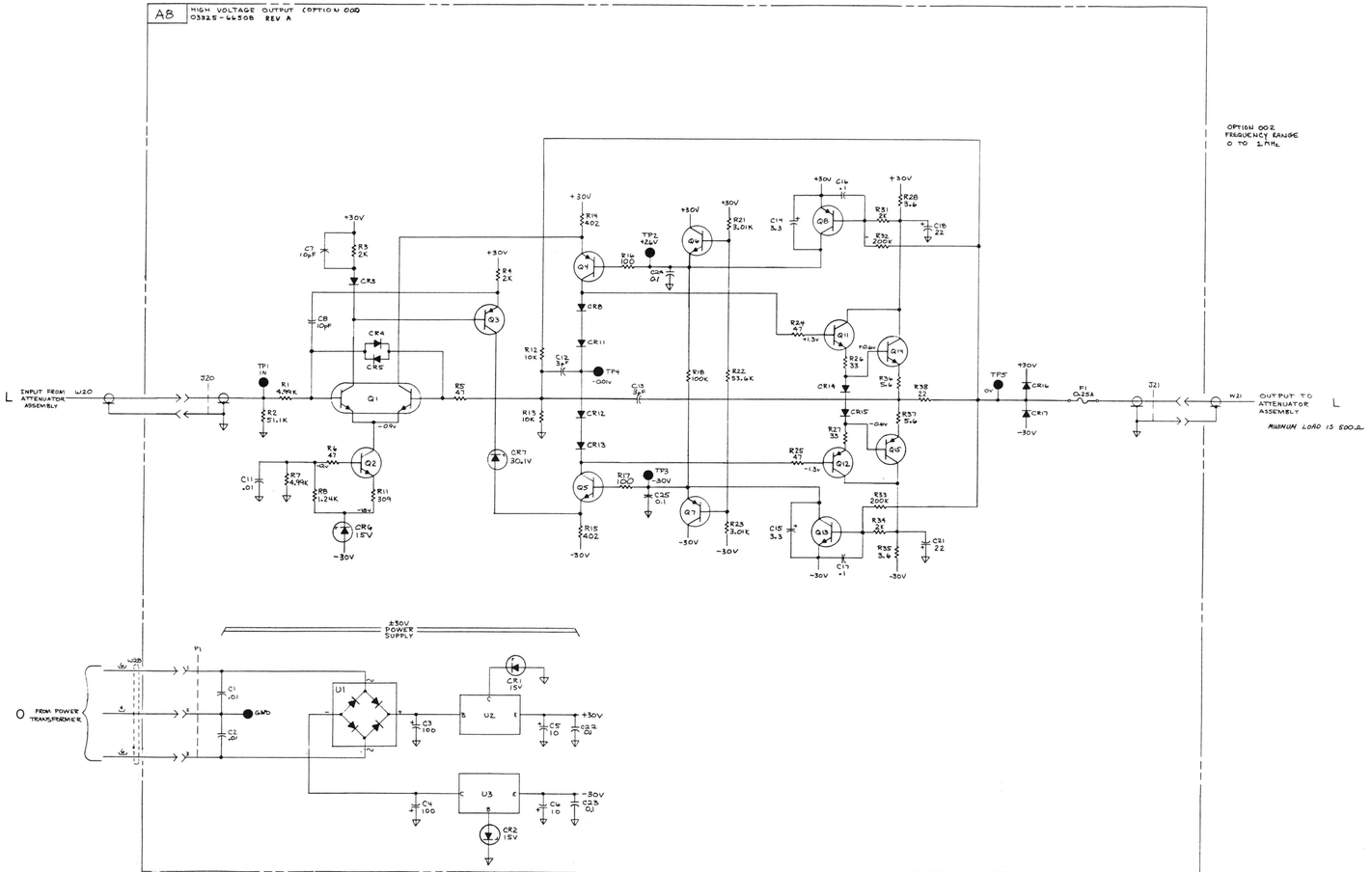
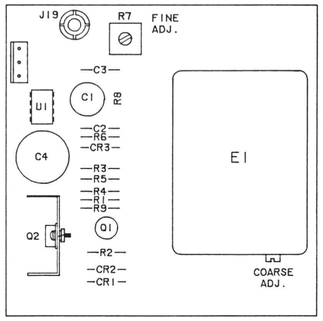


Figure 8-M-1. High Voltage Output Option 002, A8.



A9
03325-66509
Rev A

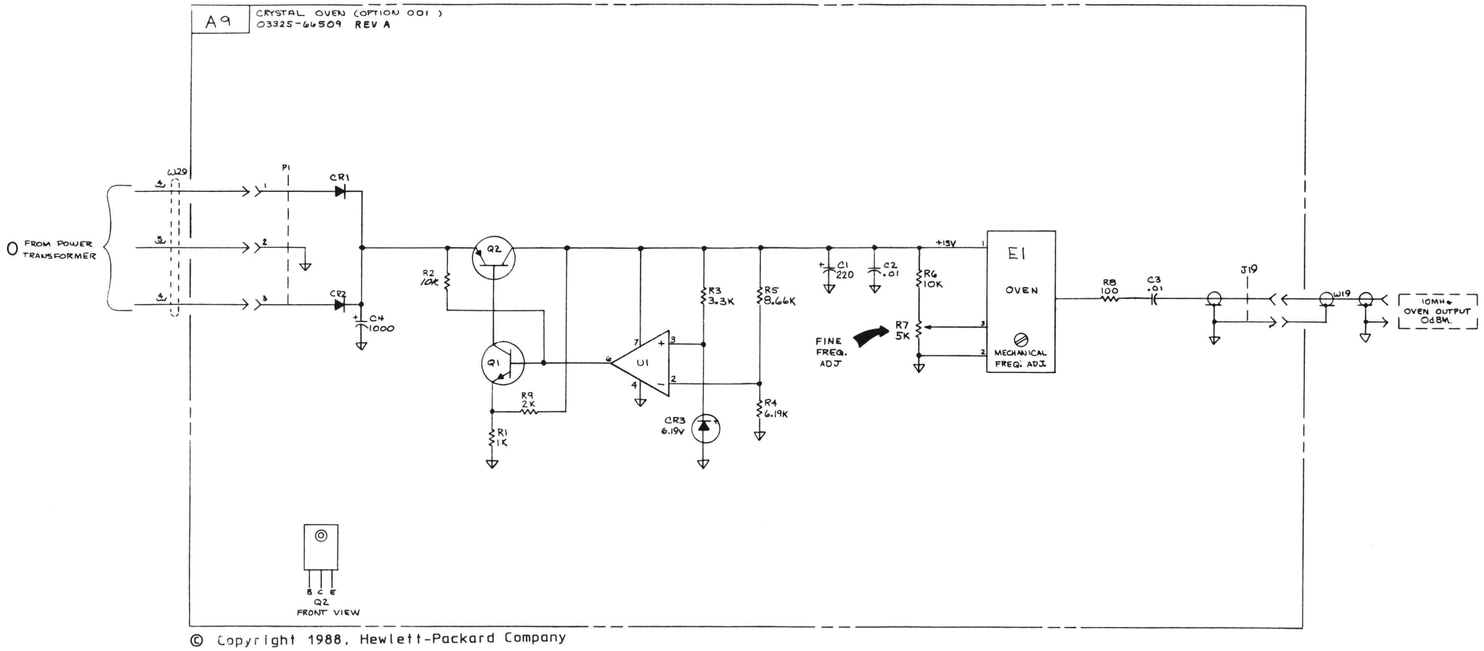


Figure 8-M-2. High Stability Reference Option 001, A9.

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.

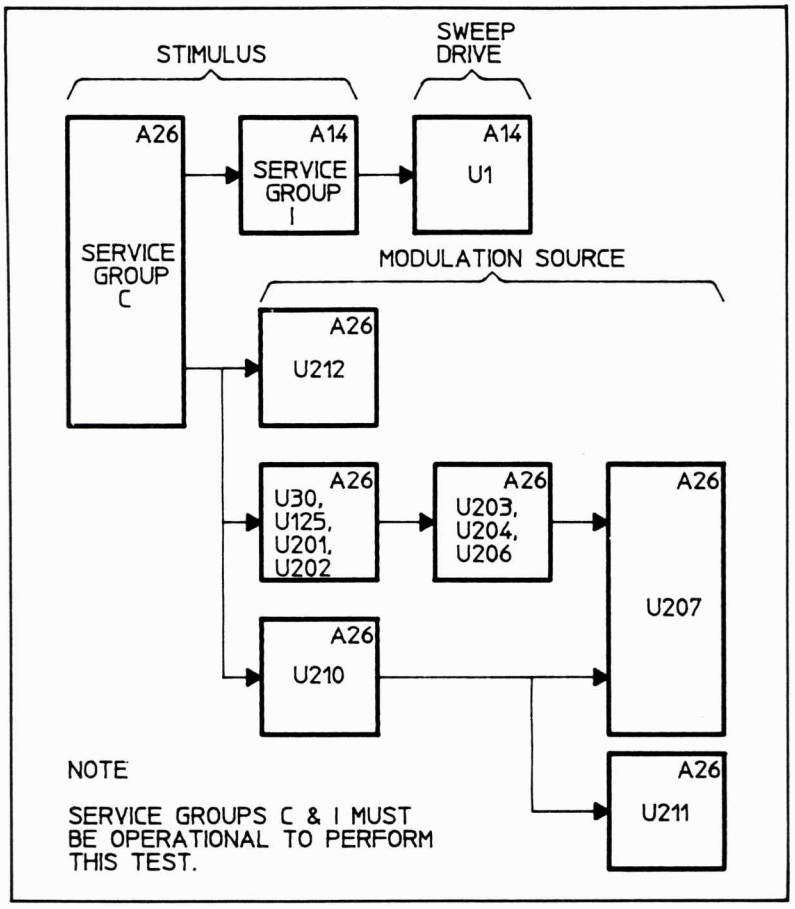


Figure 8-N-1. A14 and A26 Assembly SA0 Test Signal Flow Diagram.

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

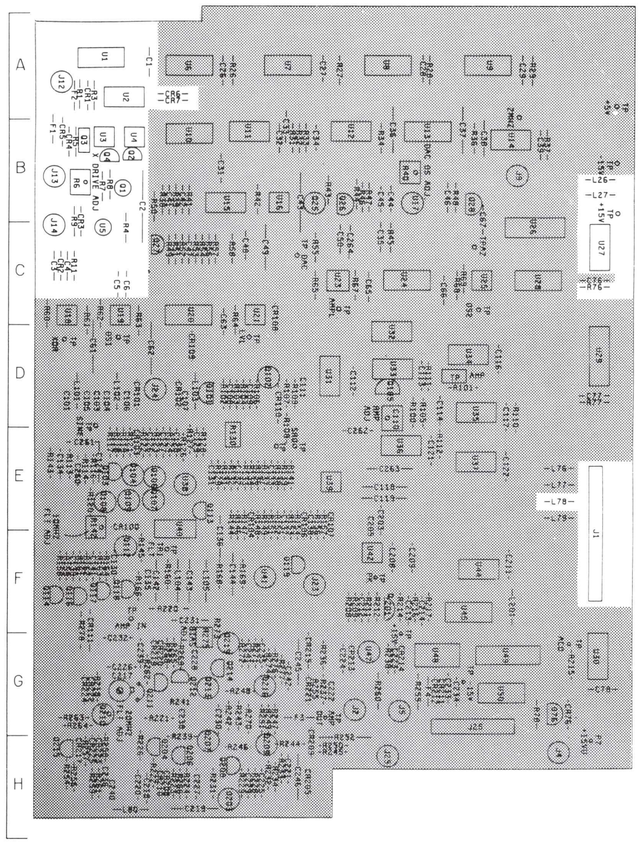
(The dash indicates an unstable signature.)

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	

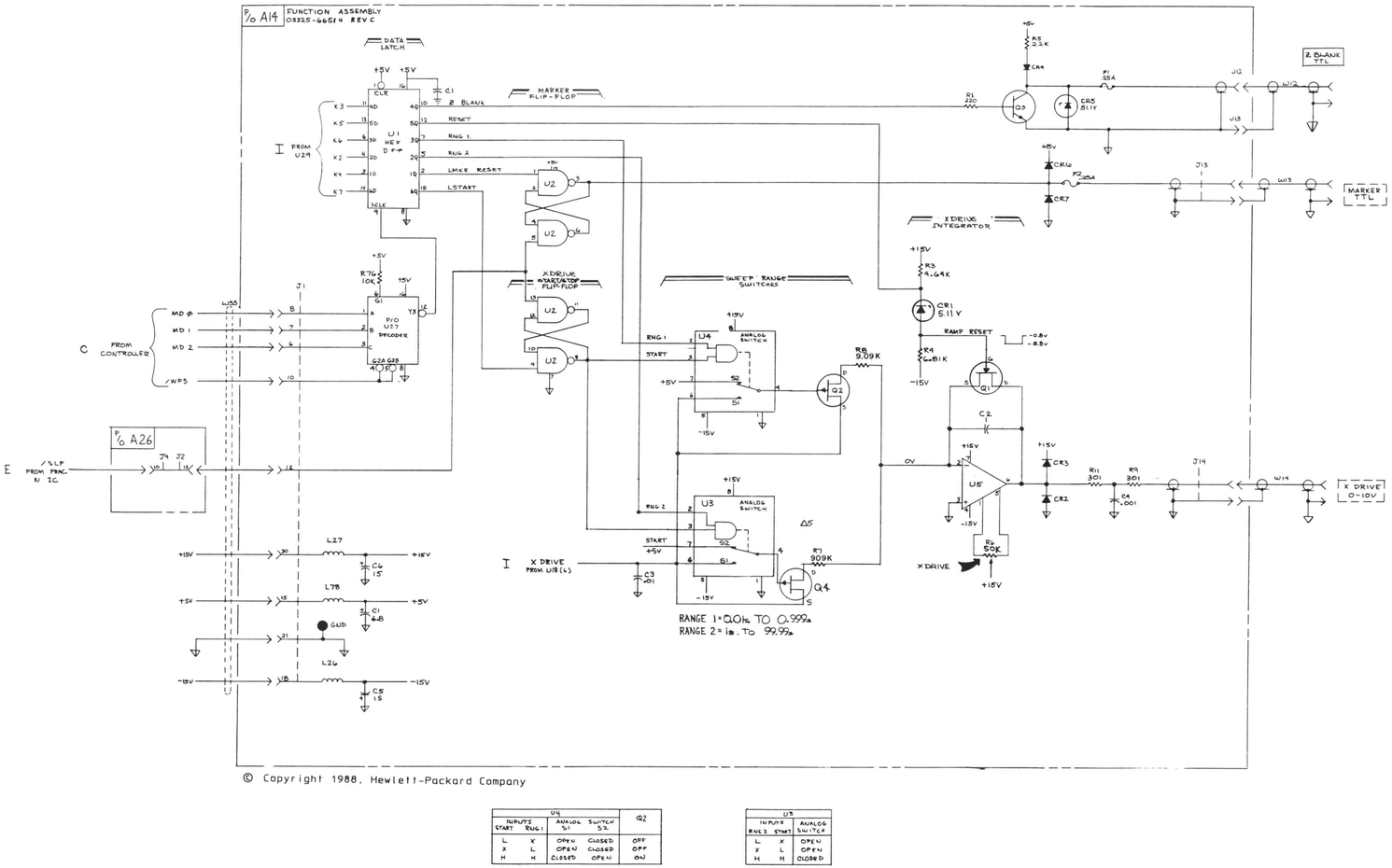
Table 8-N-1. A14 and A26 Assembly Signatures (Cont).

(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			



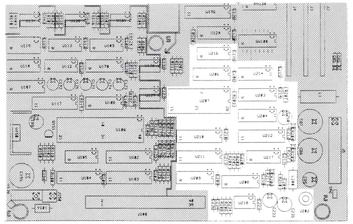
A14
03325-66514
Rev C



U4				Q2
INPUTS START	INPUTS RNG 1	ANALOG SWITCH S1	ANALOG SWITCH S2	
L	X	OPEN	CLOSED	OFF
X	L	OPEN	CLOSED	OFF
H	H	CLOSED	OPEN	ON

U3		
INPUTS RNG 2	INPUTS START	ANALOG SWITCH
L	X	OPEN
X	L	OPEN
H	H	CLOSED

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



A26
03325-66526

P70 A26 03325-66526 REV A
PROCESSOR

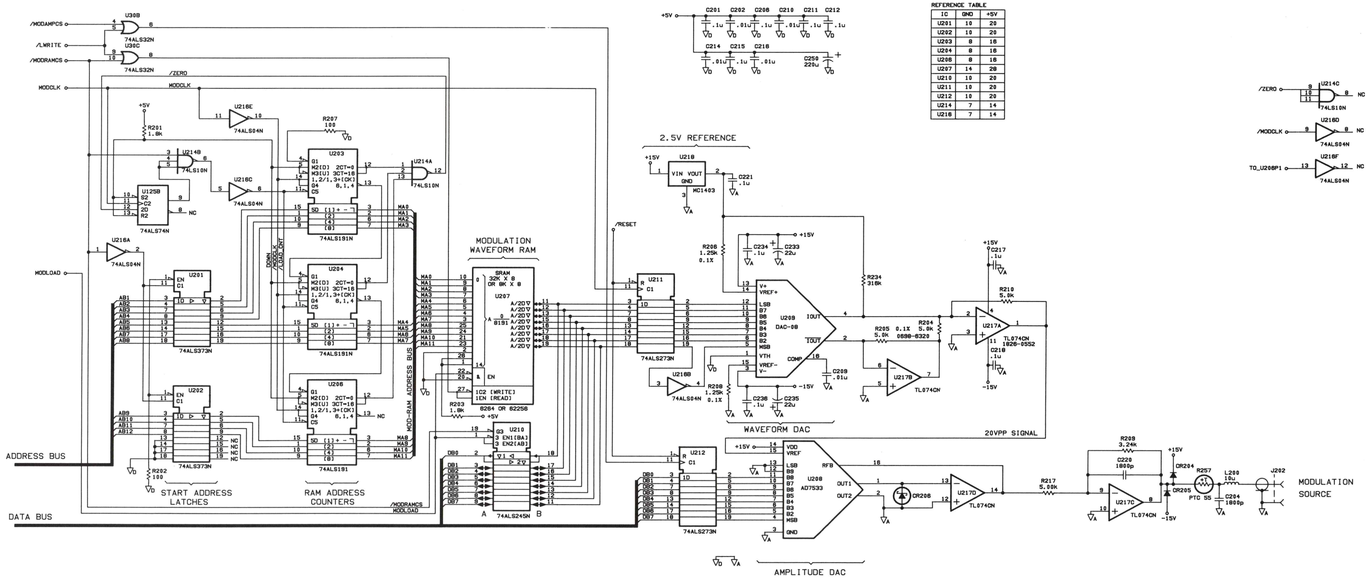


Figure 8-N-3. Modulation Source, A26.

SERVICE GROUP 0 · 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 (⏽).

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 (⏽). 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.

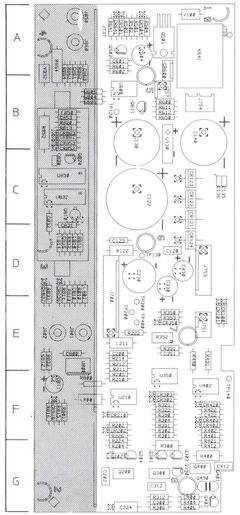
CAUTION

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



A22
03325-66522

P/O A22 03325-66522 REV A
POWER SUPPLY

DIRECTLY CONNECTED BETWEEN INNER & OUTER CHASSIS:
C1 .01u 1000V
C2 .01u 1000V
C3 .01u 1000V
C4 .01u 1000V

ECOM FROM SHEET 2
V100 85V

NOTE ABOUT GROUND CONNECTIONS:
BCOM CONNECTS TO THE HP-IB AND RS-232 SIGNAL GROUNDS.
ACOM & DCOM BOTH CONNECT TO THE INNER-CHASSIS INSTRUMENT GROUND.
ECOM CONNECTS TO THE OUTER-CHASSIS EARTH GROUND

CR101
CR100
HIGH RIPPLE GROUND PLANE
LOW RIPPLE GROUND PLANE

TO OVEN ASSEMBLY OPTION 001 J751(1) J751(2) J751(3)

T100
NC P753(6) P753(5) P753(3) P753(4)
P100(1) P100(2) TO HP-IB CIRCUITS (A26)
P110(1) P110(2) P110(3) TO HV ASSEMBLY OPTION 002
P753(2) P753(1)
P754(1) P754(2)
P757(1) P757(2)

VOLTAGE CONTACTS
100V S1,S3,S5
120V S2,S3,S5
220V S1,S4
240V S2,S4
.047uF 2200pF 2.0mH
POWER ENTRY MODULE
F1
J151(6) P151(6)
J151(5) P151(5)
J151(4) P151(4)
J151(3) P151(3)
J151(2) P151(2)
J151(1) P151(1)
J128(1) P129(1)
J128(2) P129(2)
NC1
SOLDERED CONNECTIONS
J157(1) J157(2)
MANUAL RESET
CB1
LINE LOAD
COIL
OVER-VOLTAGE PROTECTION
FAN

C135 .1u
C136 .1u
U130
C140 2200u
C139 2200u
TP140 +15VU
TP130 -15VU

J753(6) NC
J753(5)
J753(3)
J753(4)
J753(2)
J753(1)
J754(1)
J754(2)
J757(1)
J757(2)

TO SYNC CIRCUIT (SHEET 2) +5VU STANDBY
C120 1u
CR121 CR122 CR123 CR124
C122 1000u
R122 510
C123 .1u
+5VU
QUARD TRACE
LINE VOLTAGE
J754(1)
J754(2)
K841
+5VU
CR841
FAN RELAY CONTROL
RELAY_DRIVE FROM Q501(C)
CIRCUIT BREAKER CONTROL
U352B
U402B
TP120 +5VU
R602 25.5K
R601 5K
C601 .1u
U600
SENSE 1
SENSE 2
I_SRC
RST
OVER-VOLTAGE SENSE
VCC
IND
OUT
GND
R603 100
CR603
OVER-VOLTAGE PROTECTION (15V NOMINAL TRIP)
1K R659
Q611
R612 2K
R611 2K
R610 1.5K
Q200
C292 1u
Q292
R292 470
R264 27
Q264
R265 5.1K
C200 .01u
CR210
U210A
U210B
CR262
R212 81.9K
R214 0.25K
R211 130
L211 .11u
C224 0.8u
R222 100
TP200 +5V
R280 200K
C230 470u
ET1
(OPTIONAL)
STANDBY
ON THE FRONT PANEL, THE STANDBY LINE IS SWITCHED TO GROUND DURING THE "ON" STATE AND IS LEFT OPEN WHILE IN "STANDBY"

Q501
CR504 R502 1.5K
R504 10
C504 470u
R503 100
Q502
R501 3K
CR501
RELAY_DRIVE
RELAY_DRIVE TO J757(1)
J737(1) TO FUNCTION BOARD A14 ASSEMBLY

TP400 +15V
+15V
+15V_SENSE
J700(1)
J700(2)
R400 0.47
Q400
R401 1K
Q401
R402 1K
C401 .01u
C400 .01u
R421 100
C430 100u
R422 100
C422 .01u
R404 20K
Q402
R491 20K
C412 1u
R412 1K
R490 100K
Q490
R406 470
CR402 CR403
CR428
U402A
R322 10K
R308 1K
R309 0.2V 0.84K
R352 1K
R351 12.5K
C351 .01u
U352A
R350 1.18K
C330 100u
TP300 -15V
-15V
-15V_SENSE
J700(3)
J700(4)
R380 10K
Q380
R381 4.7K
Q382
R382 2K
Q381
R302 2K
R304 20K
R312 3.9K
R321 100
Q383
R301 2K
R300
C300 .01u
C312 1u
R228 15K
NC J700(8)
R224 2K
+5V_SENSE
J700(9)
J700(7)
J700(6)
J700(10)
STANDBY
SLOW MODE
FAST MODE
SLOW MODE (5V)
CONTROLLER BOARD A26 ASSEMBLY

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

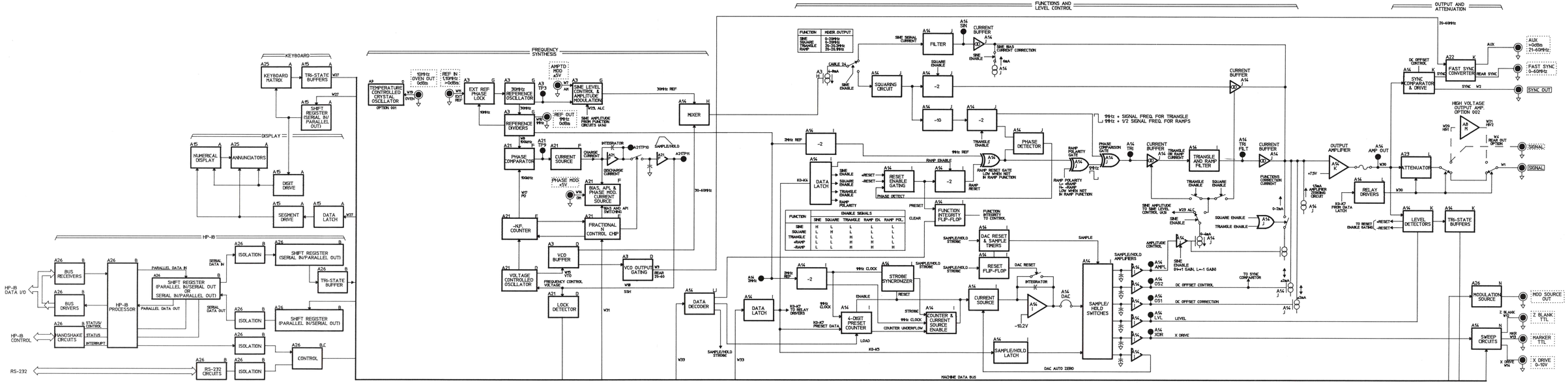


Figure 8-P-1. Functional Block Diagram.

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
Hewlett-Packard Ltd.
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 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
Hewlett-Packard Ltd.
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