HEWLETT PACKARD

Operating and Service Manual

Model 3325A Synthesizer/Function Generator

May 1984

Part Number 03325-90002

HEWLETT PACKARD

OPERATING AND SERVICE MANUAL

MODEL 3325A
SYNTHESIZER/FUNCTION GENERATOR

Serial Numbers: All

IMPORTANT NOTICE

This manual applies to all instruments. Earlier versions of the 3325A, however, may differ in design from the instruments this revision documents directly. Design and documentations changes are identified by a Δ symbol. The delta symbols refer servicing personnel to the backdating section (Section VII) where specific information regarding the change is presented.

WARNING

To prevent potential fire or shock hazard, do not expose equipment to rain or moisture.

Manual Part No. 03325-90002

Microfiche Part No. 03325-90052

P.O. Box 69, Marysville, Washington 98270

Printed: May 1984

Notice

Hewlett-Packard to Agilent Technologies Transition

This manual may contain references to HP or Hewlett-Packard. Please note that Hewlett-Packard's former test and measurement, semiconductor products and chemical analysis businesses are now part of Agilent Technologies. To reduce potential confusion, the only change to product numbers and names has been in the company name prefix: where a product name/number was HP XXXX the current name/number is now Agilent XXXX. For example, model number HP8648 is now model number Agilent 8648.

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HEWLETT PACKARD

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Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

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This Hewlett-Packard product is warranted against defects in material and workmanship for a period of one year from date of shipment [,except that in the case of certain components listed in Section I of this manual, the warranty shall be for the specified period] . During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

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MSI

SUPERSEDES:
None

HP 3325A Synthesizer/Function Generator

Serial Numbers: 2512A21906 and above

New Attenuator Assembly

Situation:

A new Attenuator Assembly (A23, HP p/n 03325-66523) is now used in the HP 3325A. This is Revision C for the A23 assembly. The primary change effected by this revision is the replacement of the relays K1, K2, K3, and K4. This revision improves the reliability of the A23 assembly.

Repair Strategy:

Units in warranty: All units in warranty with a defective A23 board **(with yellow Printac relays)** should have the old A23 assembly replaced with the new revision board. The new relays are **not** interchangeable with the old type. This is a warranty-only-on-failure situation.

Units not in warranty: For units not in warranty it is recommended that the A23 assembly (Revs A or B) be replaced with the new Revision C board. This is not a required strategy and is **not** covered as warranty always.

All units: The attenuator board should be "clean handled" to prevent contamination of the relay contacts. If this precatuion is not taken, the dc accuracy at low amplitudes may be compromised. Special handling for this board is discussed in more detail in the HP 3325A Service Manual (page 8-L-2 of P/N 03325-90002).

Reference Designator	Part Number	Description
A23C1, 2, 15–17	0160-6506	Cap-Fxd, 0.1uf, 20%, 50V
A23C3, 7–14	0160-3558	Cap-Fxd, 0.1uf, 20%, 50V
A23J1–4	1251-2969	Connector-Phono, single phone jack
A23J30	1251-5064	Connector, 14-pin M post type
A23K1–4	0490-1548	Relay EMR 4C, 12V
A23R1–2	0699-0065	Res-Fxd, 51.01Ω, 0.25%, 0.5W
A23R3	0699-0273	Res-Fxd, 2.15kΩ, 0.1%, 0.125W
A23R4	0699-0274	Res-Fxd, 350Ω, 0.1%,0.125W
A23R5	0698-8258	Res-Fxd, 247.5Ω, 0.1%, 0.25W
A23R6–7	0698-7984	Res-Fxd, 61.1Ω, 0.1%, 0.5W
A23R8	0698-0066	Res-Fxd, 66.7Ω, 0.25%, 0.25W
A23R9–10	0698-7448	Res-Fxd, 100Ω, 0.1%, 0.25W

Parts List for 03325-66523 Rev. C

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SECTION III
OPERATION

3-1. INTRODUCTION.

3-2. This section of the manual contains instructions for manual operation and HP-IB (Hewlett-Packard Interface Bus) programming. The HP-IB information includes the basic concepts of the interface bus operation, with which you may already be familiar. Use Table 3-1 to locate the information you need for your particular situation.

Table 3-1. Operating Information.

Paragraph	Content
3-3	PANEL FEATURES (Figure 1-1)
3-5	POWER/WARMUP
3-8	INITIAL CONDITIONS
3-10	SELF TEST
3-12	FRONT/REAR SIGNAL OUTPUT
3-14	SYNC OUTPUT
3-16	EXTERNAL REFERENCE INPUT
3-18	10 MHz OVEN OPTION 001
3-20	MANUAL PROGRAMMING
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3-26	Function Selection
3-28	Frequency Entry
3-30	Frequency Limits
3-32	Frequency Display and Resolution
3-34	Auxiliary Output (Sine Function Only)
3-36	Amplitude Entry
	Table 3-2, Amplitude Limits of AC Functions
3-39	Amplitude Calibration
3-41	High Voltage Output Option 002
	Table 3-3, High Voltage Output Amplitudes
3-43	DC Offset
	Table 3-4 and Figure 3-2, Maximum DC Offset
3-46	Phase Entry
3-49	Frequency Sweep
3-55	Sweep Marker
3-58	Sweep X Drive Output
3-60	Sweep Z Blank Output
3-62	Amplitude Modulation
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3-70	Store and Recall
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3-83	General HP-IB Description
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	Table 3-5, General Interface Management Lines
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3-95	HP-IB Work Sheet
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Paragraph	Content
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	Table 3-8, Interface Functions
3-103	Developing an HP-IB Program
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3-109	Placing the 3325A in Remote
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	Table 3-9, Summary of 3325A Programming, ASCII Characters
	Table 3-10, Programming Codes
3-113	3325A Data Message Formats
3-115	Data Transfer Mode
3-118	Programming Data Transfer Mode
3-120	Programming Entry Parameters
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	Amplitude
	Offset
	Phase
	Sweep Start Frequency
	Sweep Stop Frequency
	Sweep Marker Frequency
	Sweep Time
3-122	Programming Waveform Function
3-124	Programming Binary (ON or OFF) Function
	High Voltage Output (Option 002)
	Amplitude Modulation
	Phase Modulation
3-126	Programming Selection Functions
	Rear Output/Front Output
	Linear Sweep/Logarithmic Sweep
	Data Transfer Mode
3-128	Programming Execution Functions
	Assign Zero Phase Reference
	Perform Amplitude Calibration
	Start Single Sweep
	Start Continuous Sweep
	Perform Self Test
3-130	Programming Amplitude Units Conversion
3-132	Programming Storage Registers
3-134	Service Requests
3-136	Serial Poll
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3-140	Busy Flag
3-142	Sweep Flag
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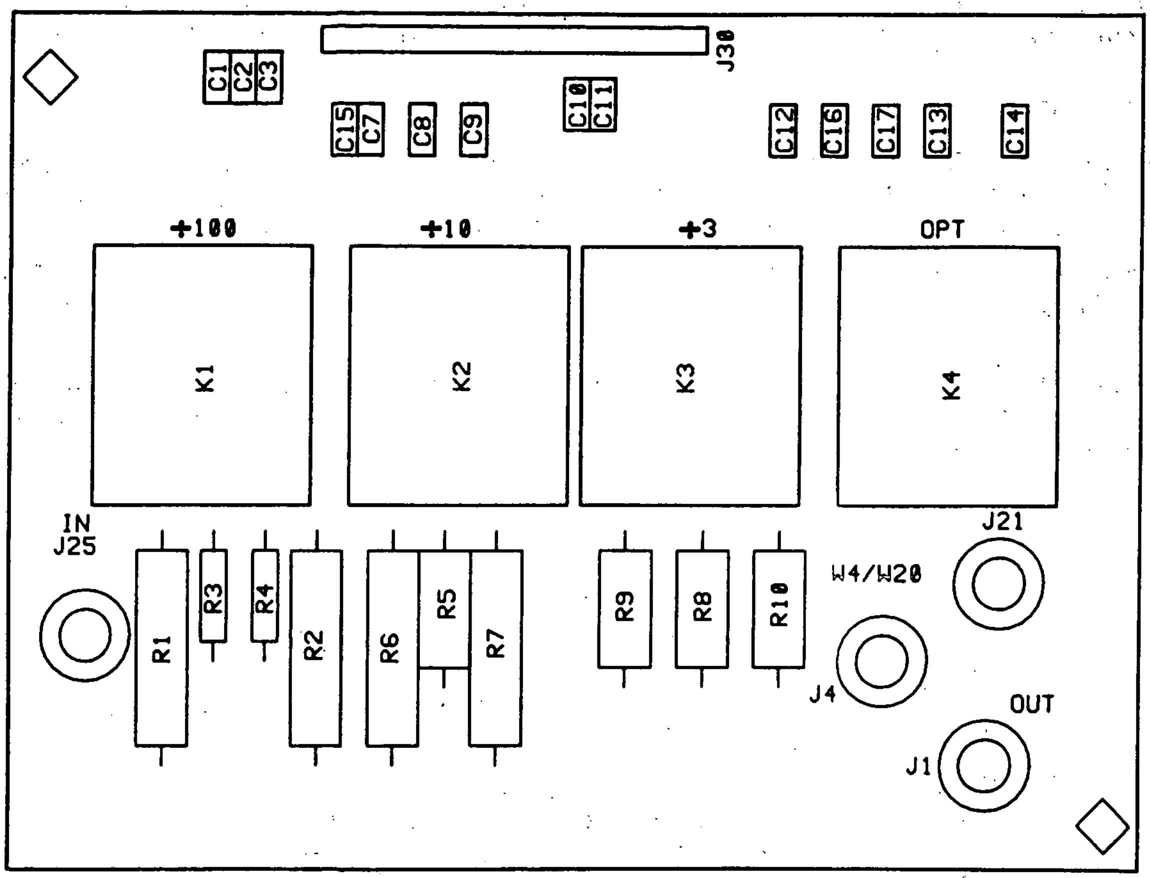
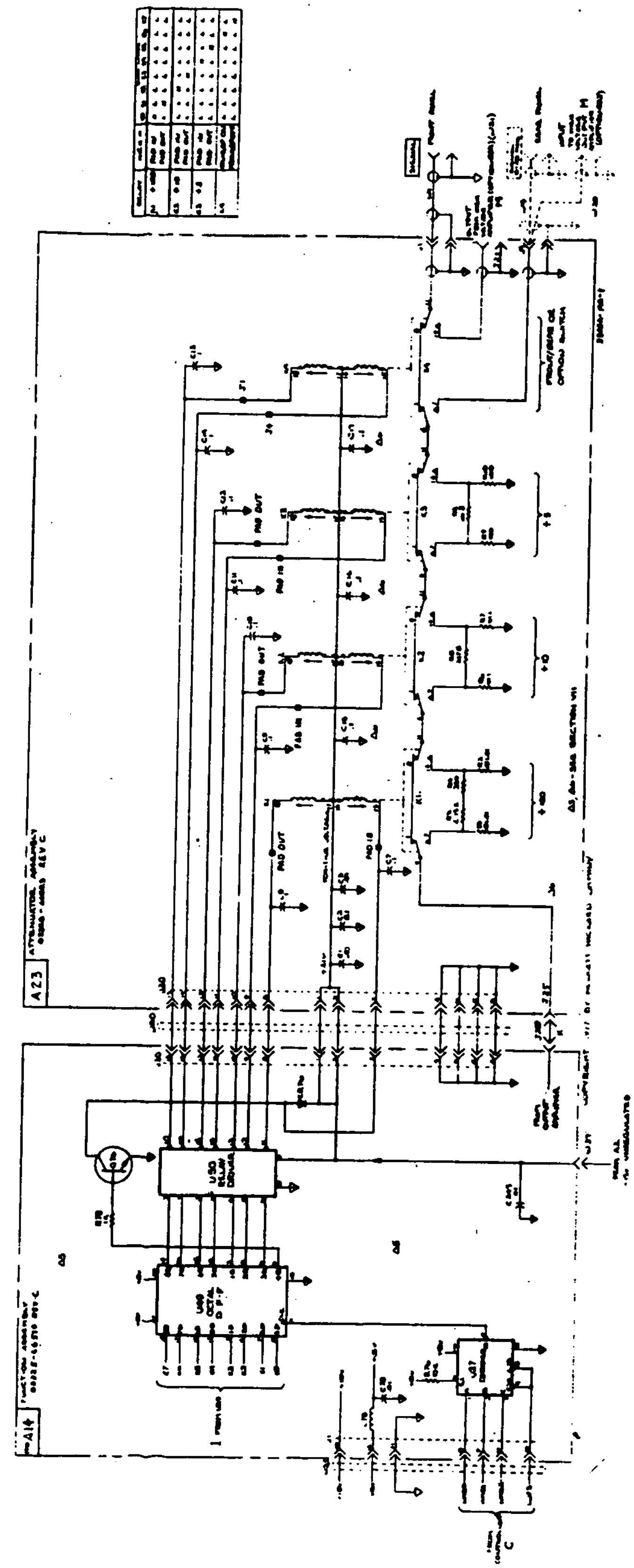
3-146	Interrogating Program Errors
3-148	Interrogating Entry Parameters
3-150	Interrogating Function (Waveform)
3-152	Interrogating Miscellaneous Parameters
3-154	Using the Interrogate Capability
3-156	3325A Programming Procedure

Appendices

A-3	META MESSAGES BLOCK DIAGRAMMED
B-3	PROGRAMMING THE MODEL 3325A with the 9825A CALCULATOR



Component Locator for 03325-66523 Rev. C



Schematic for 03325-66523 Rev. C

MANUAL CHANGES

Model Number: HP 3325A
Manual Print Date: May 1984
Manual Part Number: 03325-90002

New or Revised Item

This supplement contains important information for correcting manual errors and for updating the manual for instruments containing improvements made after printing of the manual.

To use this supplement:

1. Make all Manual ADDENDA and ERRATA changes.
2. Make all additional changes that pertain to your instrument serial number.

ERRATA

Page 1-2, Table 1-1.
In the area below SIGNAL CHARACTERISTICS, find the sine wave phase noise specification. Change the ≥ sign to ≤. It should read:

Phase Noise: ≤−60 dB.

In the area below AMPLITUDE, find the attenuator accuracy specification. For the first attenuator range, change 20 kHz to 20 MHz. It should read:

.001 Hz to 20 MHz
Attenuator Range 1

Page 1-4, Table 1-2.
In the area following AUXILIARY INPUTS, find the amplitude modulation frequency range specification. Change 500 kHz to 400 kHz. It should read:

Modulation frequency range: DC to 400 kHz

Page 2-2, Figure 2-1.

Change 1.0 Amp fuse (100/120V line voltages) to HP p/n 2110-0732.

Change 0.5 Amp fuse (220/240V line voltages) to HP p/n 2110-0733.

NOTE The above change indicates correct fuses. Using the originally specified fuses can cause permanent damage to the power supply assembly and the power transformer. For more information, refer to the related HP Product Safety Service Note, HP 3325A-19B-S (May 1986).

Page 2-3, Figure 2-2.
Change part number 8120-1351 to 5041-5807.
Change part number 8120-1369 to 5041-5808.
Change part number 8120-1689 to 5041-5809.
Change part number 8120-1348 to 5041-5819.
Change part number 8120-0698 to 5041-5806.

Page 4-5, Paragraph 4-27.
In step d, delete the 2 MHz and 200 kHz checks.
Between steps e and f, insert the following:

Set the HP 3325A to the following frequencies and verify that all harmonics are below the specified levels, relative to the fundamental.

2 MHz	−40 dB
200 kHz	−60 dB

Page 4-6, Paragraph 4-27.
In step i, change 50Ω input to high impedance input.

Page 4-11, Table 4-2.
For the Sine Wave Signal Source, change 1 MHz to 100 kHz. It should read:

Frequency Range: 100 kHz to 21 MHz

For the AC Voltmeter, change 2[Hz to 20 Hz. It should read:

Frequency Range: 20 Hz - 1 MHz

Page 4-13, Paragraph 4-38.
In step d, delete the 2 MHz and 200 kHz checks.
Between steps e and f, insert the following:

Set the HP 3325A to the following frequencies and verify that all harmonics are below the specified levels, relative to the fundamental.

2 MHz	−40 dB
200 kHz	−60 dB

In step i, change 50Ω input to high impedance input.

Page 4-15, Paragraph 4-44.
Change the amplitude modulation envelope distortion specification to:

−30 dB to 80% modulation to at 1 kHz, 0 Vdc offset.

In step c, change the modulation signal source frequency from 10 kHz to 1 kHz.

Page 4-16, Paragraph 4-44.
In step d, change the 10 kHz sideband frequency to 1 kHz.

Page 4-27, Paragraph 4-66.
Delete step n and replace it with:

n. For each delay (x), subtract the calculated voltage (y') from the measured voltage (y). Find the largest positive voltage difference ($+V_{max}$) and the largest negative difference ($-V_{max}$). Using the following formula, compute the % linearity.

$$\% \text{ LINEARITY} = \frac{|+V_{max}| + |-V_{max}|}{8 \text{ Volts}} \times 100\%$$

Performance Test Record, page 2, paragraph 4-51.
For square wave symmetry, change the > sign to <. It should read:

Square Wave Symmetry < 3.2 ns

Page 5-2, Adjustment 5-8.
Change step g to read:

Connect digital voltmeter to HP 3325A Signal Output using a 50Ω feedthrough termination.

In step h, change +10.000V to +5.000V.

In step i, change −9.985 and −10.015 to −4.98 and −5.02 respectively.

After step i, add step j. It should read:

j. Re-check steps **d** and **e**.

Page 5-2, Adjustment 5-9.
In step d, change +9.5V and +10.5V to +9.4V and 11.0V respectively.

Page 6-8, Table 6-3 (Replaceable Parts List).
Add the following part:

A5CR4 1990-0533 LED

Page 6-21, Table 6-3 (Replaceable Parts List).
Add an asterisk (*) after A21C33.

Add the following parts:

A21C33* 0160-4819 C-F 2200 pF 5% 100V
A21C33* 0160-4571 C-F 0.1 μF 50V

Page 6-22, Table 6-3 (Replaceable Parts List).
Change the reference designator A21J3 to A21U3.

Page 6-27, Table 6-3 (Replaceable Parts List).

Change fuse F1 to HP p/n 2110-0732 (1.0 Amp, fast-acting)

Change fuse F1* to HP p/n 2110-0733 (0.5 Amp, fast-acting)

NOTE The above change indicates correct fuses. Using the originally specified fuses can cause permanent damage to the power supply assembly and the power transformer. For more information, refer to the related HP Product Safety Service Note, HP 3325A-19B-S (May 1986).

Page 8-F-5/8-F-6, Figure 8-39 (schematic).
At resistor A of U3, change pin 5 to pin 15.

Delete TP9 from its present location. Draw a test point on the other side of CR3 (anode side) and label it TP9.

At VCO ÷ N.F. FROM A21 Q131, change the group label H to E.

At 100 KHZ FROM REF DIVIDERS FROM A3 Q1, change the group label F to G.

At FROM FRAC N CHIP U19, change the group label H to E.

Page 8-G-3/8-G-4, Figure 8-40 (schematic).
On U5, change the pin label from pin 15 to pin 14.

Page 8-H-3/8-H-4, Figure 8-41.
On the component locator, to the right of L105, change reference designator C111 to C114.

On the schematic, near U15 pin 12, change the voltage level of +7.2V to +2V.

Page 8-K-5/8-K-6, Figure 8-44 (schematic).
In the OUTPUT AMPLIFIER block, near Q216, change reference designator R272 to R277.

Between the base of Q219 and R271, draw a resistor. Label it R272, 22 Ω.

At the base of Q207, change reference designator R231 to R239.

At U42, draw two additional pins connected to +15V1. Label the pins 5 and 6.

CHANGE 1. For all instruments.

Page 6-4, Replaceable Parts List.
Change the part number for A2 S2 to 3101-2828.

Page 6-5, Replaceable Parts List.
Change the part number for A3 CR8 to 0122-0162. This is a direct replacement for the discontinued part.

Page 6-7, Replaceable Parts List.
Change the part number for A3 U7 to 1820-3633. This is a direct replacement for the discontinued part.

Page 6-9, Replaceable Parts List.
Delete A5 MP3.

Increase the quantity for A5 MP2 to 18.

Page 6-11, Replaceable Parts List.
Change the part number for A6 J1 to 1200-0588 (socket) and 1200-0523 (locking clamp). Order both parts when replacing J1.

Page 6-17, Replaceable Parts List.
Change the part number and description of A14 J31 to:
1258-4822 Connector-header PLZD

Page 6-18, Replaceable Parts List.
Change the part number for A14 Q207 to 1854-1114.
Change the part number for A14 Q213 to 1853-0625.

NOTE If you need to replace Q207 (1854-0233) or Q213 (1853-0440), replace the defective part with the same part number, or replace both Q207 and Q213 with the new part numbers.

For A14 R7, change the part number to 0757-0488 and the value to 909k 1%.
For A14 R8, change the part number to 0757-0288 and the value to 9.09k 1%.

Page 6-22, Replaceable Parts List.
Change the part number for A21 CR164 and CR166 to 0122-0162. This is a direct replacement for the discontinued part.

Page 6-26, Replaceable Parts List.
Change the part number for A23 R1 and R2 to 0699-2087.
Change the part number for A23 R4 to 0699-2101.
Change the part number for A23 R5 to 0699-2100.
Change the part number for A23 R6 and R7 to 0699-2088.
Change the part number for A23 R8 to 0699-2089.
Change the part number for A23 R9 and R10 to 0699-2094.

Page 6-27, Replaceable Parts List.
Change the part number for B1 to 3160-0525.
Change the part number for C2 through C5 to 5061-8021.
Change the part number for MP25 to 1400-0997.
Change the part number for MP26 to 5041-5816.
Change the part number for W3 and W4 to 03325-61631.
Add the following part:
E1 9100-3875 Power Connector

Page 6-28, Replaceable Parts List.
Change the part number for W5, W7 through W11, and W35 to 03325-61631.

Page 8-N-3/8-N-4, Figure 8-48 (schematic).
Change the value of R7 to 909k.
Change the value of R8 to 9.09k.

CHANGE 2. Applies to instruments serial-prefixed 2512A and greater.

Instruments serial-prefixed 2512A and greater have both English and metric hardware. Earlier instruments have all English hardware.

Page 1-5, Paragraph 1-20 (Accessories Available).

Add metric accessories, as shown:

Number	Description
11048C	50 Ohm Feedthrough Termination
11356A	Ground Isolator
03325-80001	Oven Board Assy. (converts instrument to Option 001)
03325-80002	High Voltage Option (converts instrument to Option 002)
5061-0077	Rack Mount Flange Kit (English) (Option 908)
5061-9677	Rack Mount Flange Kit (Metric) (Option 908)
5061-0083	Rack Mount Flange/Front Handle Kit (English) (Option 909)
5061-9683	Rack Mount Flange/Front Handle Kit (Metric) (Option 909)
5061-0089	Front Handle Kit (English) (Option 907)
5061-9689	Front Handle Kit (Metric) (Option 907)

Page 2-4, Paragraph 2-29 (Rack Mounting).

Update as follows:

a. Rack mounting without handles (Option 908); use HP Rack Mount Flange Kit 5061-0077 (English) or 5061-9677 (Metric).

b. Rack mounting with handles (Option 909); use HP Rack Mount Flange/Front Handle Kit 5061-0083 (English) or 5061-9683 (Metric).

Pages 6-27 and 6-28, Table 6-3 (Replaceable Parts List).
Update to include metric parts, as shown:

Ref.	HP P/N	Description	Qty
MP04	03325-00201	Front Sub-Panel (English)	1
MP04	03325-00211	Front Sub-Panel (Metric)	1
MP05	5020-8803	Front Frame (English)	1
MP05	5021-5803	Front Frame (Metric)	1
MP07	5020-8837	Corner Strut (English)	4
MP07	5021-5837	Corner Strut (Metric)	4
MP9	5040-7219	Strap Hdl Cap, front (English)	2
MP9	5041-6819	Strap Hdl Cap, front (Metric)	2
MP11	5040-7220	Strap Hdl Cap, rear (English)	2
MP11	5041-6820	Strap Hdl Cap, rear (Metric)	2
MP12	5060-8804	Top Cover (English)	1
MP12	5061-9435	Top Cover (Metric)	1
MP14	5020-8804	Rear Casting (English)	1
MP14	5021-5804	Rear Casting (Metric)	1
MP18	5060-9847	Bottom Cover (English)	1
MP18	5061-9447	Bottom Cover (Metric)	1
	7121-2527	Caution Label	1
	2360-0114	Screw, sub-panel/front frame (English)	4
	0515-0889	Screw, sub-panel/front frame (Metric)	4
	2680-0172	Screw, strap handles (English)	4
	0515-1132	Screw, strap handles (Metric)	4
	2510-0192	Screw, corner struts to front/rear frame (English)	16
	0515-1331	Screw, corner struts to front/rear frame (Metric)	16

CHANGE 3. Applies to instruments with serial numbers 2512A20063 and greater.

Page 6-5, Replaceable Parts List.
Change the part number for A3 J1 to 1252-1477.

Page 6-11, Replaceable Parts List.
Change the part number for A6 J2, J3, and J4 to 1252-1477.

Page 6-17, Replaceable Parts List.
Change the part number for A14 J6 to 1252-1477.
Change the part number for A14 J30 to 1251-5922.

Page 6-22, Replaceable Parts List.
Change the part number for A21 J1 to 1252-1477.

Page 6-26, Replaceable Parts List.
Change the part number for A23 J30 to 1251-5922.

Page 6-28, Replaceable Parts List.
Change the part number for W30 to 03325-61626.
Change the part number for W31, W32, and W33 to 03325-61625.

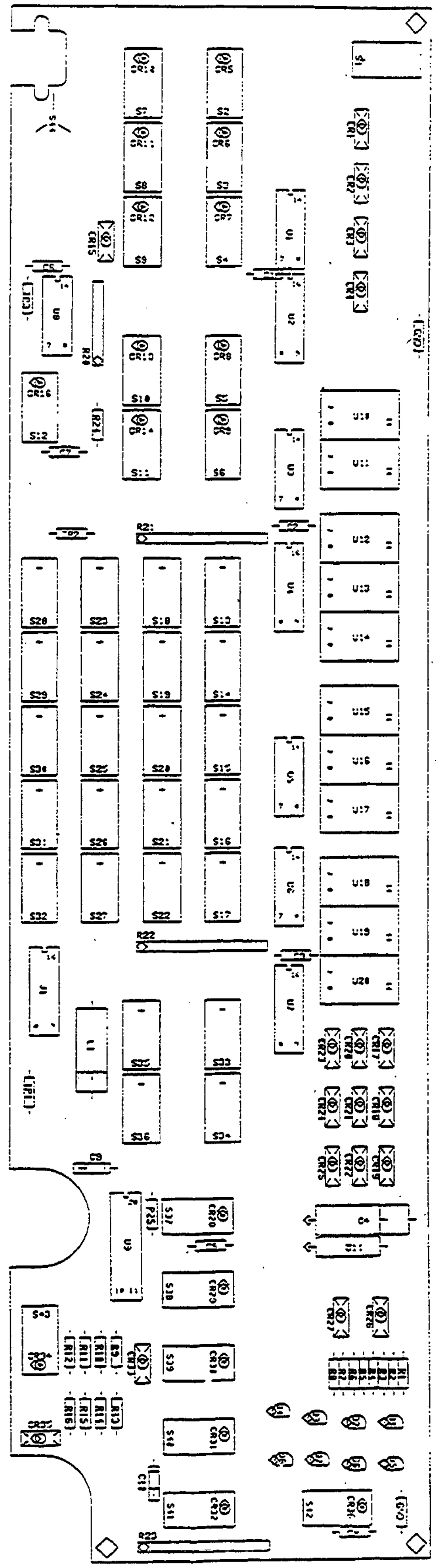


Figure 1, A5 Rev E Component Locator

CHANGE 4. Applies to instruments with serial numbers 2512A20826 and greater.

Instruments in this range have the new Rev D Keyboard Assembly, A5 (HP p/n 03325-66505). This is a direct replacement for the Rev C Keyboard Assembly.

Page 6-9, Replaceable Parts List. Add the following parts:

A5R24	0683-1025	R-F 1k 5% 1/4W
A5R25	0683-1025	R-F 1k 5% 1/4W

Page 6-10, Replaceable Parts List.
For the A5 Jumper, change the part from a cut jumper to a 0Ω resistor. The part number is 8159-0005.

Page 8-A-7/8-A-8, Figure 8-30.
Photocopy Figure 1, A5 Rev E Component Locator, and paste it over the A5 Rev C component locator.

Page 8-A-7/8-A-8, Figure 8-30.
Make the following changes to the schematic:

- Add a 1 kΩ resistor between U9 pin 1 and +5V. Label it R25.
- Redraw TP1, 2, and 3 as 0Ω resistors.
- Relabel the C7 reference designator, C2.
- Relabel the C2 reference designator, C7.
- Add a 1 kΩ resistor between U3 pin 9/U6 pin 9 and R20/C7. Label it R24.
- Remove CR26 from its present location and redraw it as shown in Figure 2.

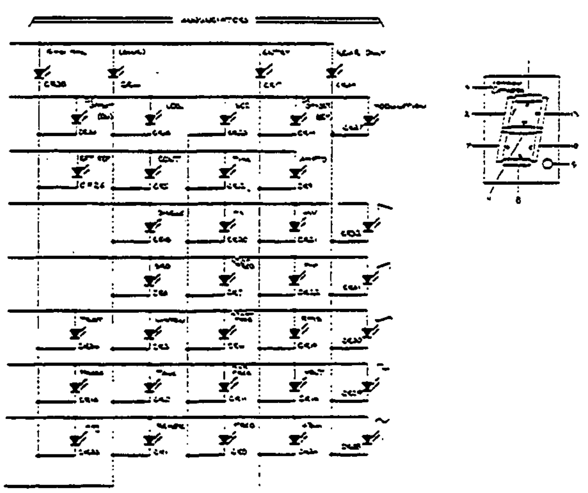


Figure 2, A5 Rev C Schematic (partial)

CHANGE 5. Applies to instruments with serial numbers 2512A21906 and greater.

Instruments in this range have the new Rev C Attenuator Assembly, A23 (HP p/n 03325-66523).

Page 6-26, Replaceable Parts List.
Change the part numbers for A23 K1, K2, K3, and K4 to HP p/n 0490-1548.

Page 8-L-3/8-L-4, Figure 8-45.
Photocopy Figure 3, A23 component locator Rev C, and paste it over the A23 Rev B component locator.

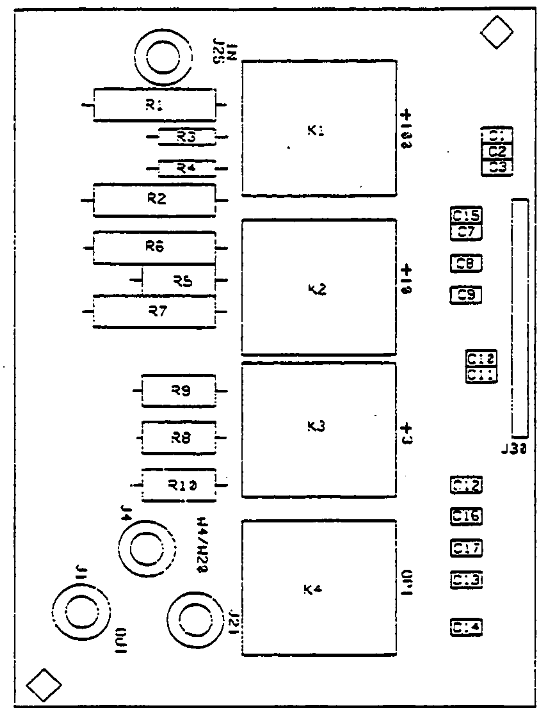


Figure 3, A23 Rev C Component Locator

Page 8-L-3/8-L-4, Figure 8-45.
On the schematic, make the following pin number changes to K1, K2, K3, and K4:

- Change pin 1 to pin 14.
- Change pin 2 to pin 8
- Change pin 3 to pin 11.
- Change pin 4 to pin 15.
- Change pin 5 to pin 16 and pin 17.
- Change pin 6 to pin 1.
- Pin 7 remains the same.
- Change pin 8 to pin 4.

CHANGE 6. Applies to instruments with serial numbers 2512A22784 and greater.

Instruments in this range have the new Rev D Fractional-N Assembly, A21 (HP p/n 03325-66521).

Page 6-22, Replaceable Parts List.

Change the reference designator for J17A to J17.

Change the reference designator for J17B to J7.

Change the reference designator for J18B to J18.

Page 8-D-7/8-D-8, Figure 8-37.
Photocopy the A21 Rev D component locator (see Figure 4) and paste it over the A21 Rev C component locator. On the schematic, change J18B to J18.

Page 8-E-3/8-E-4, Figure 8-38.
Photocopy the A21 Rev D component locator (see Figure 4) and paste it over the A21 Rev C component locator. On the schematic, change J17B to J7.

Page 8-F-5/8-F-6, Figure 8-39.
Photocopy the A21 Rev D component locator (see Figure 4) and paste it over the A21 Rev C component locator. On the schematic, change J17A to J17.

CHANGE 7. Applies to instruments with serial numbers 2512A23514 and greater.

Page 6-8, Replaceable Parts List.
Change the part number for A5 CR1 through CR4 and CR17 through CR27 to 1990-1121.

CHANGE 8. Applies to instruments with serial numbers 2512A23728 and greater.

Instruments in this range have the new Rev E Keyboard Assembly, A5 (HP p/n 03325-66505).

Page 6-8, Replaceable Parts List.
Change the part number for CR5 through CR16 and CR28 through CR36 to 1990-1169.

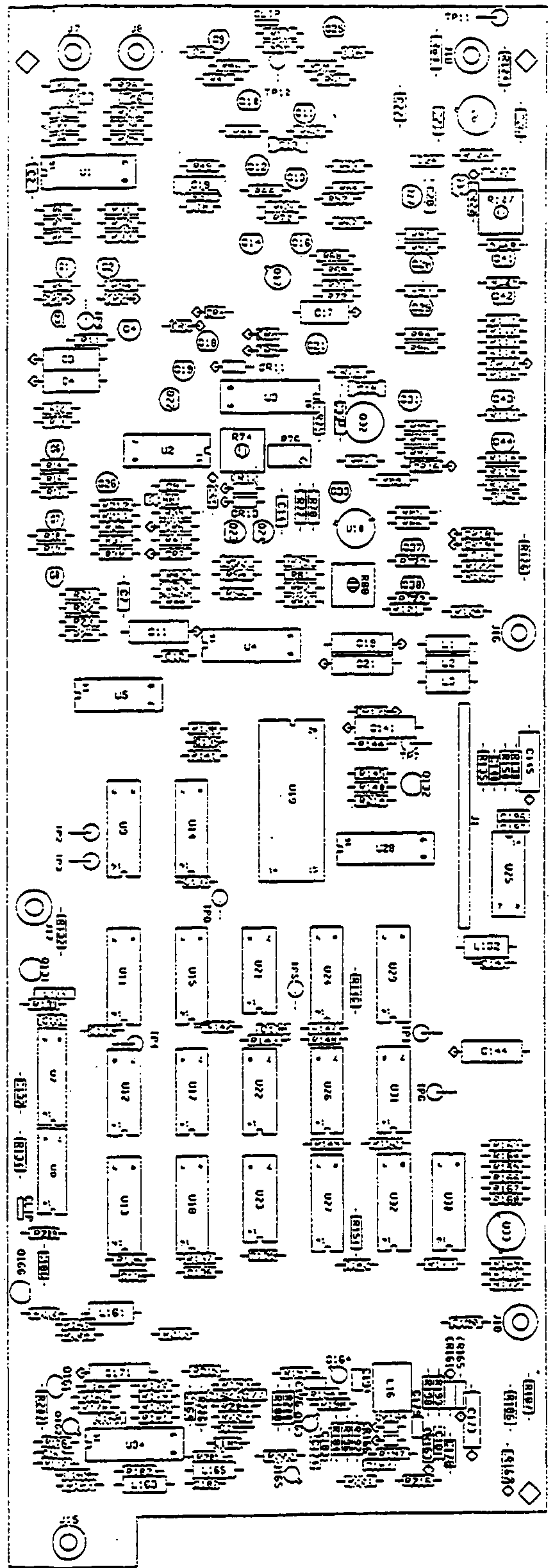


Figure 4, A21 Rev D Component Locator

CHANGE 9. Applies to instruments with serial numbers 2652A23808 and greater.

Instruments in this range have a newer Control Assembly, A16 (HP p/n 03325-66516). This is a direct replacement for the old A6 assembly (HP p/n 03325-66506). The A16 assembly has a different layout, and most parts have different component locators.

Replaceable Parts List, Table 6-3.

Add pages 6-33 through 6-37.

This is the replaceable parts list for the A16 Assembly.

Page 8-7, Paragraph 8-20.

Change the first line to read:

> The 3325A Read Only Memory (ROM) is selected by signals from the ROM Control Register.

Section 8-B.

Add pages 8-B-0 and 8-B-14a through 8-B-14d.

These pages contain the procedures and signatures for SA Test 3, revised for the A16 assembly.

Add page 8-B-15/16.

This page include the component locator and schematic for the A16 assembly (03325-66516 rev B), Service Group B.

Section 8-C.

Add pages 8-C-0 and 8-C-38a through 8-C-48e.

These pages contain the procedures and signatures for SA Test 0, SA Test 1, and SA Test 2, revised for the A16 assembly.

Add pages 8-C-49/50 and 8-C-51/52.

These pages includes the component locator and schematics for the A16 assembly (03325-66516 rev B), Service Group C.

CHANGE 10. Applies to instruments with serial numbers 2652A25183 and greater.

Page 6-3, Replaceable Parts List.
Delete A2 C19 and change the part number and value of A2 C5 and C8 to HP p/n 0180-3373, 2200 μF.

Page 8-O-3/8-O-4, Component Locator and Schematic.
Delete C19 from the component locator and schematic.

On the schematic, change the value of C5 and C8 to 2200 μF.

CHANGE 11. Applies to instruments with serial numbers 2652A25655 and greater.

Page 6-27, Replaceable Parts List.
Change the part number of T1 to HP p/n 9100-4696.

Page 6-28, Replaceable Parts List.
Delete W26 and change the part number of W28 to HP p/n 03325-61615.

HEWLETT PACKARD

OPERATING AND SERVICE MANUAL

MODEL 3325A
SYNTHESIZER/FUNCTION GENERATOR

Serial Numbers: All

IMPORTANT NOTICE

This manual applies to all instruments. Earlier versions of the 3325A, however, may differ in design from the instruments this revision documents directly. Design and documentations changes are identified by a Δ symbol. The delta symbols refer servicing personnel to the backdating section (Section VII) where specific information regarding the change is presented.

WARNING

To prevent potential fire or shock hazard, do not expose equipment to rain or moisture.

Manual Part No. 03325-90002

Microfiche Part No. 03325-90052

P.O. Box 69, Marysville, Washington 98270

Printed: May 1984

The product related to this manual is no longer in production at Hewlett Packard Co. As a service to our customers, we are supplying you with a photocopy of the original document.

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 that 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

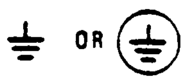
Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting.

SAFETY SYMBOLS

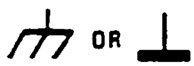
General Definitions of Safety Symbols Used On Equipment or In Manuals.


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).

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

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

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

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SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. The Operating and Service Manual contains information required to install, operate, test, adjust, and service the Hewlett-Packard Model 3325A Synthesizer/Function Generator. The Operating Manual supplement is a copy of the first three sections of the Operating and Service Manual, plus the Operational Verification procedures from Section IV. The supplement should be kept with the instrument for use by the operator. The part numbers of both the Operating and Service Manual and the Operating Manual supplement are shown on the title pages.

1-3. Also shown on the title page of this manual is a Microfiche part number. This number can be used to order 4 × 6 inch transparencies of the Operating and Service Manual. Each Microfiche contains up to 96 photo-duplicates of the manual pages. The Microfiche package includes the latest Manual Changes supplement as well as pertinent Service Notes.

1-4. Additional copies of the Operating and Service Manual, Operating Information Supplement, or Service Notes can be ordered through your nearest Hewlett-Packard Sales and Service Office. (A list of these offices is provided at the end of this manual.)

1-5. INSTRUMENT DESCRIPTION.

1-6. The Model 3325A Synthesizer/Function Generator produces the following signals at a minimum frequency of 1 μHz and maximum frequency of:

Sine wave	20 MHz
Square wave	10 MHz
Triangle	10 kHz
Positive slope ramp	10 kHz
Negative slope ramp	10 kHz

Frequency may be selected with up to eleven digits of resolution. Output amplitude is 1 mV to 10 V peak-to-peak. The output level may also be selected or displayed in V rms or in dBm (50 ohms). Any function may be dc offset up to ±4.5 V, or the output may be dc only up to ±5 V. An optional high voltage output produces up to 40 V p-p into ≥500 ohms load.

1-7. Frequency sweep of all functions is provided in linear or log sweep, at sweep times of 10 milliseconds to 99.99 seconds for linear sweep. Maximum time for log sweep is 99.99 seconds and minimum time is 2 seconds for single log sweep and 0.1 second for continuous log sweep. Single linear sweep may be up or down, while continuous sweep is up/down/up, etc., in the linear mode and up/up, etc., in log mode.

1-8. The Model 3325A is fully programmable through the rear panel Hewlett-Packard Interface Bus (HP-IB) connector. A device such as a programmable calculator is capable of remotely controlling the 3325A. Interface information is given in Section II of this manual, and programming information is in Section III.

1-9. SPECIFICATIONS.

1-10. Instrument specifications are listed in Table 1-1. These specifications are the performance standards or limits against which the instrument is tested. Any changes in specifications due to manufacturing, design or traceability to the U.S. National Bureau of Standards are included in Table 1-1 of this manual and/or the Manual Changes Supplement.

1-11. SUPPLEMENTAL OPERATING INFORMATION.

1-12. Table 1-2 contains information describing general operating characteristics of the 3325A. This information is supplemental operating information and is not to be considered as specifications.

1-13. REMOTE CONTROL.

1-14. Table 1-3 lists the HP-IB interface capabilities of the Model 3325A in conformity with IEEE Standard 488-1978, "Standard Digital Interface for Programmable Instrumentation". HP-IB response times are given in Table 1-4.

1-15. OPTIONS.

1-16. The following options extend the frequency stability and output amplitude capabilities of the Model 3325A:

Option 001	High Stability Frequency Reference
Option 002	High Voltage Output

The following options indicate the line voltage to which the instrument was set at the factory:

Option 100	Nominal 100 V ac
Option 120	Nominal 120 V ac
Option 220	Nominal 220 V ac
Option 240	Nominal 240 V ac

Table 1-1. Specifications.

FUNCTIONS AND FREQUENCIES

Sine Wave:
Signal Output (Front or Rear Panel):
0.000 001 Hz to 20 999 999.999 Hz

Auxiliary Output (Rear Panel):
21 000 000.000 Hz to 60 999 999.999 Hz
Underrange to 19 000 000.001 Hz

Square Wave: 0.000 001 Hz to 10 999 999.999 Hz

Triangle: 0.000 001 Hz to 10 999.999 999 Hz

Positive and Negative Slope Ramp:
0.000 001 Hz to 10 999.999 999 Hz

FREQUENCY RESOLUTION

1 μHz for frequencies below 100 kHz
1 mHz for frequencies 100 kHz and higher

FREQUENCY ACCURACY (Standard Instrument)

$\pm 5 \times 10^{-6}$ of selected value (20° to 30°C)

FREQUENCY STABILITY (Standard Instrument)

$\pm 5 \times 10^{-6}$ per year (20° to 30°C)

SIGNAL CHARACTERISTICS

Sine Wave:
Harmonic Distortion relative to the amplitude of the fundamental frequency at full output on each range

Fundamental Frequency	No Harmonic Greater Than
0.1 Hz to 50 kHz	−65 dB
50 kHz to 200 kHz	−60 dB
200 kHz to 2 MHz	−40 dB
2 MHz to 15 MHz	−30 dB
15 MHz to 20 MHz	−25 dB

Spurious: All non-harmonically related output signals will be more than 70dB below the carrier (-60dB with DC offset), or less than -90dBm, whichever is greater.

Phase Noise: ≥ -60dB (Option 001 Only) for a 30kHz band centered on a 20MHz carrier (excluding ± 1Hz about the carrier).

Square Wave:
Rise/Fall Time: ≤ 20 nanoseconds, 10% to 90% at full output

Symmetry: ≤ .02% of period + 3 nanoseconds

Overshoot: ≤ 5% of peak to peak amplitude at full output

Triangle:

Linearity, 10% to 90%, best fit straight line: ± 0.05% of full p-p output for each range

Ramps (Positive or Negative Slope):

Linearity, 10% to 90%, best fit straight line: ± 0.05% of full p-p output for each range

Retrace Time: ≤ 3 microseconds, 90% to 10%

Ramp Period Variation: < ± 1% of period, maximum

AMPLITUDE

Amplitude Accuracy with no Attenuation (Attenuator range 1) into 50 ohm Load. (No D.C. offset)

Function and frequency range	Tolerance relative to programmed amplitude
Sine Wave .001 Hz to 100 kHz	± 0.1 dB
Square Wave .001 Hz to 100 kHz	± 1.0%
Triangle .001 Hz to 2 kHz 2 kHz to 10 kHz	 ± 1.5% ± 5%
Ramps .001 Hz to 500 Hz 500 Hz to 10 kHz	 ± 1.5% ± 10%

Flatness with no attenuation (Attenuator Range 1) into a 50 Ohm load	Tolerance relative to programmed amplitude at 1 kHz
Sine Wave 100 kHz to 20 MHz	± 0.3 dB
Square Wave 100 kHz to 10 MHz	± 10%

Amplitude accuracy with D.C. offset and no attenuation (Range 1) into a 50 ohm load.	Tolerance relative to programmed amplitude.
Sine Wave .001 Hz to 100 kHz	± 0.3 dB
Square .001 Hz to 100 kHz	± 3%
Triangle .001 Hz to 2 kHz 2 kHz to 10 kHz	 ± 4% ± 6%
Ramps .001 Hz to 500 Hz 500 Hz to 10 kHz	 ± 4% ± 11%

Attenuator Accuracy (these errors are additive with the amplitude accuracy errors)	Tolerance relative to programmed amplitude.
.001 Hz to 20 kHz Attenuator Range 1	No Error
.001 Hz to 100 kHz Attenuator ranges 2 through 8	± 0.1 dB
100 kHz to 10 MHz Attenuator ranges 2 through 8	± 0.2 dB
10 MHz to 20 MHz Attenuator ranges 2 through 4 Attenuator ranges 5 through 8	 ± 0.2 dB ± 0.5 dB

Table 1-1. Specifications (Cont'd).

Accuracy of DC Offset (into 50 ohms):

DC Only (No AC Function): ± 0.4% of full peak output for each range*

*Except lowest attenuator range where accuracy is ± 20 μV.

DC + AC, ≤ 1 MHz: ± 1.2%, Ramps ± 2.4%

DC + AC, > 1 MHz: ± 3%

AMPLITUDE MODULATION (of Sine Function only)

Modulation Envelope Distortion: − 30 dB to 80% modulation at 1 kHz, 0 V dc Offset

PHASE OFFSET

Range: ± 719.9° with respect to arbitrary starting phase, or assigned zero phase

Resolution: 0.1°
Stability: ± 1° phase/°C
Increment Accuracy: ± 0.2°

PHASE MODULATION

Linearity (Sine Function): ± 0.5%, best fit straight line

SYNC OUTPUT

Output Levels into 50 ohms:
Square wave with V_{high} ≥ + 1.2V, V_{low} ≤ + 0.2V

X DRIVE OUTPUT

Amplitude: 0 to + 10 V dc linear ramp proportional to sweep frequency (sweep up only)

Linearity, 10% to 90%, best fit straight line: ± 0.1% of final value. Specified for all linear sweep widths which are integral multiples of the minimum sweep width for each function and sweep time.

OPTION 001

HIGH STABILITY FREQUENCY REFERENCE

Ambient Stability: ± 5 × 10^{-8} (0° to 55°C referenced to + 30°C)

Aging Rate: ± 5 × 10^{-8} per week (after 72 hours continuous operation)
± 1 × 10^{-7} per month (after 15 days continuous operation)

OPTION 002

HIGH VOLTAGE OUTPUT

Frequency Range:
Sine and Square Wave: 1 μHz to 1 MHz
Triangle and Ramps: 1 μHz to 10 kHz

Amplitude:

Range: 4mVp-p to 40Vp-p (≥ 500Ω, < 500pF load) maximum output current, ± 40mA

Accuracy (at 2 kHz): ± 2% of full output for each range

Flatness: ± 10% of programmed amplitude

DC Offset:
Range: 4 times the range of the standard instrument

Accuracy: ± (1% + 25 mV) of full output for each range

Signal Characteristics:
Sine Wave Harmonic Distortion (relative to the fundamental frequency at full output into ≥ 500 ohms, < 500 pF)

Fundamental Frequency	No Harmonic Greater Than
10 Hz to 50 kHz	−65 dB
50 kHz to 200 kHz	−60 dB
200 kHz to 1 MHz	−40 dB

Square Wave:

Rise/Fall Time: ≤ 125 nanoseconds, 10% to 90% at full output with ≥ 500 ohm, < 500pF load

Overshoot: < 10% of peak amplitude with ≥ 500 ohm, < 500 pF load

Table 1-2 Supplemental Information

MAIN SIGNAL OUTPUT

50 Ω Impedance

BNC Connector, switchable to front or rear panel (not switchable with Option 002)

May be floated a maximum of ± 42 V peak (ac + dc) from chassis (earth) ground

Amplitude Ranges:
All AC Functions (with no dc offset):

Range No.	Attenuation Factor	Amplitude (Peak-to-Peak)
1	1	10.00 V to 3.000 V
2	3	2.999 V to 1.000 V
3	10	999.9 mV to 300.0 mV
4	30	299.9 mV to 100.0 mV
5	100	99.99 mV to 30.00 mV
6	300	29.99 mV to 10.00 mV
7	1000	9.999 mV to 3.000 mV
8	3000	2.999 mV to 1.000 mV

DC Offset Only:

Range No.	Attenuation Factor	Amplitude (Peak-to-Peak)
1	1	5.000 V to 1.500 V
2	3	1.499 V to 500.0 mV
3	10	499.9 mV to 150.0 mV
4	30	149.9 mV to 50.00 mV
5	100	49.99 mV to 15.00 mV
6	300	14.99 mV to 5.000 mV
7	1000	4.999 mV to 1.500 mV
8	3000	1.499 mV to 1.000 mV

Table 1-2. Supplemental Information (Cont'd).

AC Function with DC Offset:

Range No.	Attenuation Factor	AC Function Amplitude (p-p)	Maximum DC (+ or −)	Min. DC (+ or −)
1	1	9.998 V to 1.000 V	1.000 mV to 4.500 V	1.000 mV
2	3	999.9 mV to 333.4 mV	1.166 V to 1.499 V	0.100 mV
3	10	333.3 mV to 100.0 mV	333.3 mV to 450.0 mV	0.100 mV
4	30	99.99 mV to 33.34 mV	116.6 mV to 149.9 mV	0.010 mV
5	100	33.33 mV to 10.00 mV	33.33 mV to 45.00 mV	0.010 mV
6	300	9.999 mV to 3.334 mV	11.66 mV to 14.99 mV	0.001 mV
7	1000	3.333 mV to 1.000 mV	3.333 mV to 4.500 mV	0.001 mV

High Voltage Output Option 002:
Amplitude and Ranges: 4 times the standard instrument amplitudes

Output Impedance: <2 Ω at DC to <10 Ω at 1 MHz

Square Wave Settling Time: <1 μs to settle to within .05% of final value for frequencies of 10 Hz to 500 kHz, tested at full output with no load

FREQUENCY SWEEP

Sweep Time:
Linear Sweep: 0.01 second to 99.99 seconds (single or continuous)

Log Sweep:
Single Sweep: 2 seconds to 99.99 seconds
Continuous Sweep: 0.1 second to 99.99 seconds

Maximum Sweep Width: 1 Hz to maximum frequency of the function selected

Minimum Sweep Width (Linear):

	Minimum Sweep Width	
Function	Sweep Time 0.01 second	Sweep Time 99.99 seconds
Sine	0.1 mHz	999.9 mHz
Square	0.05 mHz	499.5 mHz
Triangle	0.005 mHz	49.95 mHz
Ramps	0.01 mHz	99.99 mHz

Minimum Sweep Width (Log): 1 decade

Phase Continuity: Sweep is phase continuous over the full frequency range

WARMUP TIME

Standard Instrument: 20 minutes to within specified accuracy

Option 001 High Stability Frequency Reference:
Reference will be within ±1 × 10^{-7} of final value 15 minutes after turn-on at 25°C for an off time of less than 24 hours

AUXILIARY INPUTS (May be floated a maximum of ±42 V peak (ac + dc) from chassis (earth) ground)

Reference: For phase-locking the 3325A to an external frequency reference of 10 MHz or a subharmonic of 10 MHz down to 1 MHz. Level must be 0 dBm to +20 dBm into 50 ohms. Rear panel BNC connector.

Amplitude Modulation Input (Sine Function Only):

Modulation depth at full output for each range: 0 to 100%

Modulation frequency range: DC to 500 kHz (0 to 21 MHz carrier frequency)

Sensitivity: 5 V peak for 100% modulation

Input Impedance: 10 kΩ

Connector: Rear panel BNC

Phase Modulation:
Modulation Frequency Range: DC to 5 kHz

Modulation Depth

Function	Depth (+ or −)
Sine	850°
Square	425°
Triangle	42.5°
Ramps	85°

Input Impedance: 20 kΩ

Connector: Rear panel BNC

AUXILIARY OUTPUTS (May be floated a maximum of ±42 V peak (ac + dc) from chassis (earth) ground)

Auxiliary Frequency Output (ac coupled output):

Frequency Range: 21 MHz to 60.999 999 999 MHz, with underrange coverage to 19.000 000 001 MHz

Amplitude: 0 dBm

Output Impedance: 50 ohms

Connector: Rear panel BNC

1 MHz Reference Output (for phase-locking other instruments to 3325A):

Amplitude: 0 dBm

Output Impedance: 50 ohms

Connector: Rear panel BNC

Marker Output (Linear sweep only):

Levels: High to Low TTL compatible voltage transition at selected marker frequency, sweep up only.

Connector: Rear panel BNC

Table 1-2. Supplemental Information (Cont'd).

X Drive Output (Sweep up only):
Amplitude: 0 to + 10 V linear ramp proportional to sweep frequency

Connector: Rear panel BNC

Z Blank Output:
Levels (TTL compatible voltage levels):
Linear Sweep:
Single: Low at start of sweep, High at stop. Remains High until start of next sweep.

Continuous: Low during sweep up, High during sweep down.

Log Sweep:
Single: Low at start of sweep, High at stop. Remains High until start of next sweep.

Continuous: Low during sweep. Goes High momentarily at stop frequency.

10 MHz Oven Reference Output, Option 001, for phase locking the 3325A to the optional high stability frequency reference:

Amplitude: 0 dBm, 50 ohms

Connector: Rear panel BNC. Must be connected to the rear panel EXT REF IN connector.

REMOTE CONTROL

Hewlett-Packard Interface Bus (HP-IB) Control: (HP-IB is Hewlett-Packard Company's implementation of IEEE Standard 488-1978). Time shown is in addition to programming time.

Frequency Switching and Settling Time:*

<10 ms to within 1 Hz of final value for 100 kHz span

<25 ms to within 1 Hz of final value for 1 MHz span

<70 ms to within 1 Hz of final value for 20 MHz span

Phase Switching and Settling Time:*
< 15 ms to within 90° of phase lock for 20 MHz frequency change

Amplitude Switching Time:*
<30 ms to within amplitude specifications

*Times shown are in addition to programming time

GENERAL

Operating Environment:

Temperature: 0° to 55°C
Relative Humidity: <95%, 0° to 40°C
Altitude: ≤ 15,000 ft.

Storage Temperature: −50° to +75°C
Storage Altitude: ≤50,000 ft.

Power Requirements:

100/120/220/240V+5%,−10%,48 to 66 Hz
60 VA, 100 VA with all options, 10 VA standby

Dimensions in millimeters and (inches):

132.6 (5¼) high × 425.5 (16¾) wide × 497.8 (19-5/8) deep

Weight in kilograms and (lbs):

Net weight: 9(20)
Shipping Weight: 14.5 (32)

The following accessory options are also available for the Model 3325A:

Option 907	Front Handle Assembly
Option 908	Rack Mount Flange Kit
Option 909	Rack Mount Flange Kit/Front Handle Assembly
Option 910	Additional Operating and Service Manual

1-17. ACCESSORIES SUPPLIED.

1-18. A special connector is supplied with the High Stability Frequency Reference Option 001 for connecting the rear panel Reference Output to the Reference Input. This connector is Part No. 1250-1499.

1-19. ACCESSORIES AVAILABLE.

1-20. The following accessories are available for use with the Model 3325A:

Number	Description
11048C	50 ohm Feedthru Termination
11356A	Ground Isolator
03325-80001	Oven Board Assy. (Converts 3325A to Option 001)
03325-80002	High Voltage Option (Converts 3325A to Option 002)
5061-0077	Rack Mount Flange Kit (Option 908)
5061-0083	Rack Mount Flange/Front Handle Kit (Option 909)
5061-0089	Front Handle Kit (Option 907)

1-21. INSTRUMENT AND MANUAL IDENTIFICATION.

1-22. The instrument serial number is located on the rear panel. Hewlett-Packard uses a two-section serial number consisting of a four-digit prefix and a five-digit suffix. A letter between the prefix and suffix identifies the country in which the instrument was manufactured (A = USA, G = West Germany, J = Japan, U = United Kingdom). All correspondence with Hewlett-Packard concerning this instrument should include the complete serial number.

1-23. The serial number prefix is the same for all identical instruments and changes only when a change is made to the instrument. The suffix is assigned sequentially and is different for each instrument. If the serial number of your instrument is lower than the serial number on the title page of this manual, refer to Section VII, MANUAL CHANGES, for the information that will adapt this manual to your instrument. This is especially important if the serial prefix of your instrument is different than the one shown on the title page of this manual. An instrument manufactured after the printing of this manual may differ in some respect from the information in this manual. In this case, a yellow Manual Changes supplement included with the manual explains how to adapt the manual to your instrument.

1-24. SAFETY CONSIDERATIONS.

1-25. To ensure safe operation and to retain the instrument in a safe condition, this Operating and Service Manual contains information, cautions and warnings which must be adhered to by the user or service personnel.

Table 1-3. HP-IB Interface Capability.

Code	Function
SH1	Source handshake capability
AH1	Acceptor handshake capability
T6	Basic talker; Serial poll; Unaddressed to talk if addressed to listen
L3	Basic listener; Listen only; Unaddressed to listen if addressed to talk
SR1	Service Request capability
RL1	Remote/Local capability
PPØ	No parallel poll capability
DC1	Device Clear capability
DTØ	No device trigger capability
CØ	No controller capability
E1	Open collector bus drivers

1-26. The symbol ⚠ appearing on the front or rear panel of the 3325A is an international symbol meaning "refer to the Operating and Service Manual". The symbol identifies important instructions required to prevent damage to the instrument. To ensure the safety of the operating and maintenance personnel and retain the safe operating condition of the instrument, these instructions must be adhered to.

1-27. RECOMMENDED TEST EQUIPMENT.

1-28. Equipment required to maintain the Model 3325A is listed in Table 1-5. Other equipment can be substituted if it meets or exceeds the critical specifications listed in the table.

Table 1-4. HP-IB Response Times.

Function	Mnemonic	Input Data Transfer Time	Device Time	Output Data Transfer Time
Function (Waveform) 1 Digit	FU	450–500 µs 225–250 µs	1600 ms 2.8 ms	450–500 µs 225–250 µs
Frequency ≤ 11 Digits + Decimal Delimiters	FR HZ, KH, or MH	450–500 µs 225–250 µs each 450–500 µs	7.0 ms 2.8 ms each 12.5 ms	450–500 µs 225–250 µs each 450–500 µs
Amplitude ≤ 4 Digits + Decimal Delimiters	AM VO or MV VR or MR DB	450–500 µs 225–250 µs each 450–500 µs 450–500 µs 450–500 µs	6.8 ms 2.8 ms each 90 ms 130 ms 250 ms	450–500 µs 225–250 µs each 450–500 µs 450–500 µs 450–500 µs
DC Offset ≤ 4 Digits + Decimal Delimiters	OF VO or MV	450–500 µs 225–250 µs each 450–500 µs	6.8 ms 2.8 ms each 82 ms	450–500 µs 225–250 µs each 450–500 µs
Phase ≤ 4 Digits + Decimal Delimiter	PH DE	450–500 µs 225–250 µs each 450–500 µs	5 ms 2.8 ms each 28 ms	450–500 µs 225–250 µs each 450–500 µs
Sweep Start Frequency ≤ 11 Digits + Decimal Delimiters	ST HZ, KH, or MH	450–500 µs 225–250 µs each 450–500 µs	7.0 ms 2.8 ms each 10.3 ms	450–500 µs 225–250 µs each 450–500 µs
Sweep Stop Frequency ≤ 11 Digits + Decimal Delimiters	SP HZ, KH or MH	450–500 µs 225–250 µs each 450–500 µs	7.0 ms 2.8 ms each 10.3 ms	450–500 µs 225–250 µs each 450–500 µs
Sweep Marker Frequency ≤ 11 Digits + Decimal Delimiters	MF HZ, KH or MH	450–500 µs 225–250 µs each 450–500 µs	7.0 ms 2.8 ms each 10.3 ms	450–500 µs 225–250 µs each 450–500 µs
Sweep Time ≤ 4 Digits + Decimal Delimiter	T1 SE	450–500 µs 225–250 µs each 450–500 µs	5.5 ms 2.8 ms each 7.0 ms	450–500 µs 225–250 µs each 450–500 µs
Store	SR	450–500 µs	11 ms	
Recall	RE	450–500 µs	1700 ms	
Assign Zero Phase	AP	450–500 µs	5.2 ms	
Amptd Cal	AC	450–500 µs	1500 ms	
Start Single Sweep	SS	450–500 µs	300 ms	
Start Continuous Sweep	SC	450–500 µs	300 ms	
Interrogate (Add Parameter Mnemonic Time)	I	225–250 µs	3 ms	
Mask Service Request	MS	450–500 µs	4.5 ms	
High Voltage Output	HV	450–500 µs	48 ms	
Rear/Front Output	RF	450–500 µs	44.5 ms	
Self Test	TE	450–500 µs	10,000 ms	
Sweep Mode	SM	450–500 µs	4.5 ms	
Data Transfer Mode	MD	450–500 µs	4.5 ms	
Interrogate Function	IFU	675–750 µs	1603 ms	
Interrogate Error	IER	675–750 µs	11.5 ms	
Universal Commands		~225 µs per byte		
Amplitude Modulation	MA	450–500 µs	7.0 ms	
Phase Modulation	MP	450–500 µs	7.0 ms	

Table 1-5. Recommended Test Equipment.

Instrument	Critical Specifications	Required For: Oper. Ver.	Perf. Tests	Adjust-ments	Trouble-shooting	Recommended Model
Oscilloscope	Vertical Bandwidth: dc to 100 MHz Deflection: 0.01 V to 10V/div Horizontal Sweep: 0.05 μs to 1 s/div x10 Magnification Delayed Sweep	X	X	X	X	-hp- 1740A
Electronic Counter	Frequency Measurement Frequency Range: to 20 MHz Resolution: 8 digits Accuracy: ±2 counts Time Interval Average A to B Resolution: 0.1 ns	X	X	X		-hp- 5328A with Opt 01 and 040 or 041
Digital Voltmeter	DC Function Ranges: .1 V, 1 V, 10 V, 100 V Accuracy: ±.2% Resolution: 4½ digits AC Function Ranges: 1 V, 10 V, 100 V Accuracy: ±.5% Resolution: 4 digits			X	X	-hp- 3466A
	DC Function Ranges: .1 V, 1 V, 10 V, 100 V Accuracy: ±.05% Resolution: 6 digits AC Function: True RMS Ranges: 1 V, 10 V, 100 V Accuracy: ±.2% Resolution: 6 digits Crest Factor: 4:1	X	X	X		-hp- 3455A
50-ohm Load	Accuracy: ±.2% Power Rating: 1 W	X	X	X	X	-hp- 11048C
High Frequency Spectrum Analyzer	Frequency Range: 1 kHz to 100 MHz Amplitude Accuracy: ±.5 dB	X	X	X		-hp- 141T/8552B/8553B/ 8566A/8568A
Low Frequency Spectrum Analyzer	Frequency Range: 20Hz-50kHz Amplitude Accuracy: ±.5 dB Spurious Responses: 80 dB below reference	X	X	X		-hp- 3580A/3585A
Sine Wave Signal Source	Frequency: 1 kHz Amplitude: 1 V rams into 20 kΩ			X		-hp- 204C
	Frequency Range:		X			-hp- 3335A 1 MHz-20 MHz Amplitude Range: to +7.0 dBm Output Impedance: 50 Ω Phase Noise (Integrated): 9.9 MHz: < −63 dB 20 MHz: < −70 dB Spurious: >75 dB below fundamental
Double Balanced Mixer	Impedance: 50Ω Frequency: to 20 MHz		X			-hp- 10534A or 10514A
1 MHz Low Pass Filter	Cut-off Frequency: 1 MHz Stopband Atten: 50 dB by 4 MHz Stopband Freq: 4 MHz-80 MHz		X			F882 1MHz Low Pass Filter, Impedance 50Ω, C Shape Factor, Metal Can, BNC's Allen Avionics, Inc. 224 E. Second St. Mineola, NY 11501
15 kHz Noise Equivalent Filter	Consisting of: Resistor: 10 kΩ ±1% Capacitor: 1600 pF ±5%		X			-hp- 0757-0340 -hp- 0160-2223

Table 1-5. Recommended Test Equipment (Cont'd).

Instrument	Critical Specifications	Required For: Oper. Ver.	Perf. Tests	Adjust-ments	Trouble-shooting	Recommended Model
AC Voltmeter	Ranges: 0.1 V to 1 V Frequency Range:20 Hz-1 MHz Input Impedance: ≥1 MΩ Meter: Log scale Acc (100 Hz to 10 kHz): ±1%		X			-hp- 400 FL
Resistor	1 kΩ ±5%			X		-hp- 0683-1025
Oscilloscope Probe	Division Ratio: 10 to 1 Impedance: 1 MΩ, 12 pF			X	X	-hp- 10041A
DC Power Supply	Volts: 0-10 V Amps: 10 mA Floating output		X	X		-hp- 6214A
Frequency Standard (Required for Option 001 Only)	Frequency: 5 MHz Accuracy: 1 × 10^{-9}			X		-hp- 105B
Calculator (Required for automatic testing)	HP-IB Control Capability	X	X			-hp- 9825A with 98034A Interface, General I/O ROM, Extended I/O ROM
System Voltmeter	DC Voltage: 0 to ±10 V Sample/Hold Measurement External Trigger: Low True TTL Edge Trigger Trigger Delay: selectable, 10 µs to 140 µs		X			-hp- 3437A
BNC Tee Adapter BNC-to-Triax Adapter	Male-female-female BNC-to-dual banana plug Female BNC-to-Male Triax	X X	X X X	X X		-hp- 1250-0781 -hp- 1250-2277 -hp- 1250-0595
Signature Analyzer	Signature: 4-digit hexadecimal Characters:0thru 9,A,C,F,H,P,U Threshold Logic 1: +2.2 V Logic 0: +0.5 V Clock Frequency: ≥1.5 MHz				X	-hp- 5004A
Pulse Generator	Pulse Rate: 500 kHz Pulse Width: ≤1 µs DC Offset: 1 V				X	-hp- 3312A
Resistor	56.2Ω 1% 1/8W	X	X			-hp- 0757-0395
Thermal Converter	Input Impedance: 75 Ω Input Voltage: 0.5 V rms Frequency: 2 kHz to 20 MHz Frequency Response: ±0.05 dB 2 kHz to 20 MHz		X	X		-hp- 11050A
Resistive Divider	Consisting of: Resistor: 36.5 Ω 1% ½ W Resistor: 13.7 Ω 1% ½ W		X			 -hp- 0757-0996 -hp- 0698-4998
Resistive Divider	Consisting of: Resistor: 40.2 Ω 1% ½ W Resistor: 10 Ω 1% ½ W		X			 -hp- 0698-5022 -hp- 0757-0984
Resistive Divider	Consisting of: Resistor: 30 Ω 1% ¼ W Resistor: 20 Ω 1% ¼ W		X			 -hp- 0698-7533 -hp- 0698-6296
Resistive Divider	Consisting of: Resistor: 100 kΩ 1% 1/8 W Resistor: 162 kΩ 1% 1/8 W		X			 -hp- 0757-0465 -hp- 0757-0470
Termination	50 ohm Feedthrough 1%		X			-hp- 11048C
Thermal Converter	BNC Connectors		X			-hp- 11050A

SECTION II
INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains instructions for installing and interfacing the Model 3325A Synthesizer/Function Generator. Included are initial inspection procedures, power and grounding requirements, line voltage selection, environmental requirements, installation instructions, HP—IB connection procedure, and instructions for repackaging for shipment.

2-3. INITIAL INSPECTION.

2-4. Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the instrument has been checked mechanically and electrically. This instrument was carefully inspected both mechanically and electrically before shipment. It should be free of mars and scratches and in perfect electrical order upon receipt. Procedures for checking electrical performance are given in Section IV. If there is mechanical damage or defect or if the instrument does not pass the electrical performance test, notify the nearest Hewlett-Packard Sales and Service Office listed at the rear of this manual. If the shipping container is damaged or the cushioning material shows signs of stress, notify the carrier as well as the Hewlett-Packard office. Keep the shipping material for the carrier's inspection. The warranty statement is located in the front of this manual.

2-5. PREPARATION FOR USE.

2-6. Power Requirements.

2-7. The Model 3325A requires a power source of 100, 120, 220, or 240 V ac, +5%, -10%, 48 to 66 Hz single phase. Power consumption is 100 VA maximum.

2-8. Line Voltage Selection.

CAUTION

Before connecting ac power to this instrument, make sure it is set to the line voltage of the power source. Also ensure that the common connection of the power outlet is connected to a protective earth contact.

WARNING

The line voltage selection switches are located inside the top cover of the instrument. Line voltage selection should be done by trained service personnel only. To avoid electrical shock, make sure the power cord is disconnected before removing the instrument cover.

2-9. The line voltage selection switches are set at the factory to correspond to the line voltage option ordered. This information may be found on the rear panel.

Option	Line Voltage Selected
100	100 V
120	120 V
220	220 V
240	240 V

If it is necessary to change the line voltage selection, access to the switches may be gained by removing the top cover of the 3325A. Make the desired voltage selection as shown in Figure 2-1. Be sure to observe the CAUTIONS in Figure 2-1.

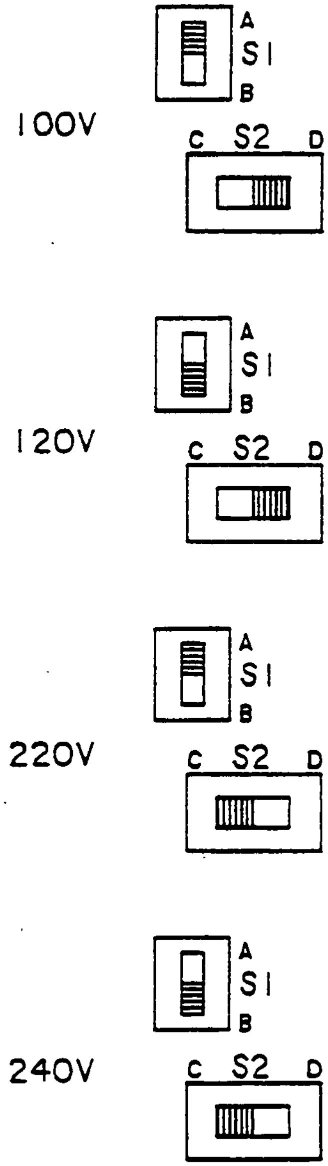
2-10. Power Cable.

2-11. In accordance with international safety standards, this instrument is equipped with a three-wire cable. When connected to an appropriate power line outlet, this cable grounds the instrument cabinet. The type of power cable shipped with each instrument depends on the country of destination. Refer to Figure 2-2 for the connector configuration and -hp- part numbers of the available power cables.

2-12. HP—IB Connections.

2-13. Interconnection data concerning the rear panel HP—IB connector is provided in Figure 2-3. This connector is compatible with the -hp- 10631 (A, B, or C) HP—IB cables. The lengths of these cables are as follows:

10631A	1 meter
10631B	2 meters
10631C	4 meters



SWITCHES VIEWED FROM REAR OF INSTRUMENT

LINE VOLTAGE	S1	S2
100V	A	D
120V	B	D
220V	A	C
240V	B	C

CAUTION

WHEN CHANGING THE LINE VOLTAGE SELECTION, MAKE SURE THE CORRECT FUSE IS INSTALLED FOR FOR THE VOLTAGE SELECTED.

LINE VOLTAGE	FUSE	-hp-PART NO.
100/120V	1A	2110-0001
220/240V	.5A	2110-0012

AFTER CHANGING LINE VOLTAGE SELECTION, BE SURE TO INDICATE ON THE REAR PANEL THE NEW VOLTAGE SELECTED.

3325A-29

Figure 2-1. Line Voltage Selection.

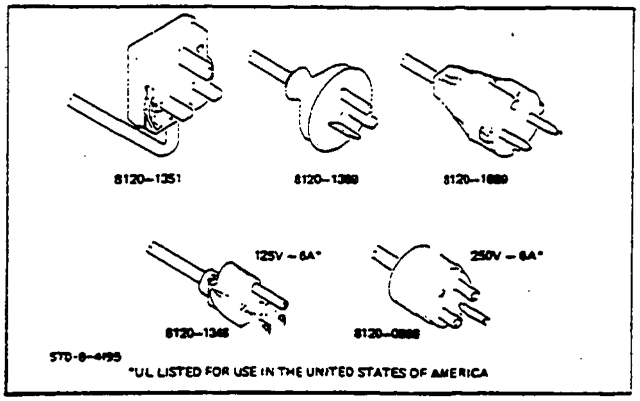


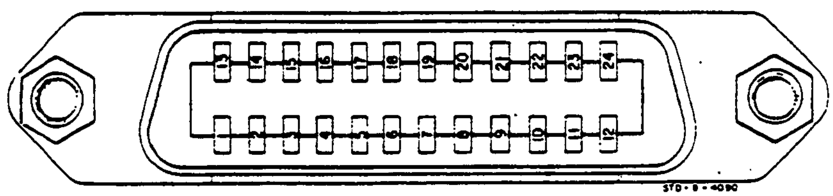
Figure 2-2. Power Cables.

Up to 15 instruments (including the controller) may be connected in an HP—IB system. The HP—IB cables have identical stacking connectors on both ends so that several cables can be connected to a single source. As a practical matter, avoid stacking more than three or four cables on any one connector. If the stack gets too large, the force on the stack can produce enough leverage to damage the connector mounting. Be sure that the connector screws are tightened firmly in place to keep it from working loose during use, and be sure to observe the CAUTION of Figure 2-3.

2-14. Cable Length Restrictions. System components can be interconnected in virtually any configuration. However, to achieve reliable system performance, proper voltage levels and timing relationships must be maintained. If the system cable is too long, the lines cannot be driven properly and the system will fail to perform. The maximum length of cable that can be used to connect a group of instruments must not exceed 2 meters (6.5 ft.) times the number of instruments to be connected, or 20 meters (65.6 ft.), whichever is less.

2-15. 3325A Listen/Talk Address.

2-16. The 3325A is normally shipped from the factory with the listen address set to ASCII character 1; talk address Q. The 3325A address switches are located inside the top cover near the center of the instrument. The possible HP—IB addresses are shown in Table 2-1. Set the five switches (marked 1 through 5) to the correct positions corresponding to the ASCII code address chosen. The 3325A may be set to a "listen only" condition by setting the switch marked LON to the "1" position. Be sure to leave the ROM switch in the "1" position. This switch is used for troubleshooting only.



PIN	LINE
1	DIO1
2	DIO2
3	DIO3
4	DIO4
13	DIO5
14	DIO6
15	DIO7
16	DIO8
5	EOI
17	REN
6	DAV
7	NRFD
8	NDAC
9	IFC
10	SRQ
11	ATN
12	SHIELD—CHASSIS GROUND
18	P/O TWISTED PAIR WITH PIN 6
19	P/O TWISTED PAIR WITH PIN 7
20	P/O TWISTED PAIR WITH PIN 8
21	P/O TWISTED PAIR WITH PIN 9
22	P/O TWISTED PAIR WITH PIN 10
23	P/O TWISTED PAIR WITH PIN 11
24	ISOLATED DIGITAL GROUND

Pins 18–24: THESE PINS ARE INTERNALLY GROUNDED

CAUTION

The 3325A contains metric threaded HP—IB cable mounting studs as opposed to English threads. Metric threaded -hp- 10631A, B, or C HP—IB cable lockscrews must be used to secure the cable to the instrument. Identification of the two types of mounting studs and lockscrews is made by their color. English threaded fasteners are colored silver and metric threaded fasteners are colored black. DO NOT mate silver and black fasteners to each other or the threads of either or both will be destroyed. Metric threaded HP-IB cable hardware illustrations and part numbers follow.

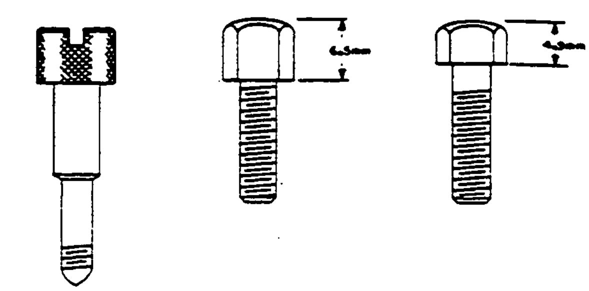


Figure 2-3. HP—IB Connector.

WARNING

Because the address switches are located inside the instrument, they should be set by trained service personnel only. To avoid electrical shock, make sure the power cord is disconnected before removing the instrument cover.

2-17. HP—IB Description.

2-18. A description of the HP-IB is provided in Section III of this manual. A study of this information is necessary if you are not familiar with the HP-IB Concept. Additional information concerning the design criteria and operation of the bus is available in IEEE Standard 488-1978 "IEEE Standard Digital Interface for Programmable Instrumentation."

2-19. Connecting Oven Option 001.

2-20. In order to use the Oven Option 001, an external connection must be made between the rear panel 10 MHz OVEN OUTPUT and the REF IN connectors. A special connector for this purpose, -hp- Part No. 1250-1499, is supplied with instruments having Option 001.

2-21. OPERATING ENVIRONMENT.

WARNING

To prevent potential electrical or fire hazard, do not expose equipment to rain or moisture.

2-22. In order for the 3325A to meet the specifications listed in Table 1-1, the operating environment must be within the following limits:

Temperature	0 to +55°C
Relative Humidity	95% at 40°C
Altitude	4600 meters (15,000 feet)

2-23. Cooling System.

2-24. The cooling fan intake and the exhaust vent are located in the rear panel. When operating the instrument, provide at least 75 mm (3 inches) of clearance at the rear, and at least 7 mm (¼ inch) on all sides of the instrument. Failure to allow adequate air circulation will result in excessive internal temperature, reducing instrument reliability.

2-25. It is imperative that the fan filter be inspected frequently and cleaned or replaced as necessary to permit the free flow of air through the instrument. To clean the filter, remove the four nuts that secure the filter retainer. Remove the filter and flush with soapy water, rinse clean, and air dry.

2-26. Bench Operation.

2-27. The instrument has plastic feet attached to the bottom panel. The front feet contain foldaway tilt stands for convenience in bench operation. The tilt stand raises the front of the instrument for easier viewing of the control panel. The plastic feet are shaped to make full-width modular instruments self-align when they are stacked. A front handle kit, -hp- Part No. 5061-0089 (Option 907), can be installed for ease of handling the instrument on the bench (see Figure 2-4). The kit is shipped with the instrument if Option 907 is also ordered. Otherwise, the front handle kit is available separately by its -hp- part number.

2-28. Rack Mounting.

2-29. The 3325A can be rack mounted in a rack having an EIA standard width of 482.6 mm (19 inches). The instrument can be rack mounted with or without a handle kit by use of the following items:

a. Rack mounting without handles: use Rack Mount Flange Kit -hp- Part No. 5061-0077 (Option 908).

b. Rack mounting with handles: use the combination Rack Mount Flange/Front Handle Kit -hp- Part No. 5061-0083 (Option 909).

NOTE

The Rack Mount Flange Kit of item a will not provide the space requirement for rack mounting when used with the bench handle assembly (-hp- Part No. 5060-9899, Option 907). To rack mount with handles, the combination kit of item b (Option 909) must be used (see Figure 2-4). If either Option 908 or 909 is ordered, the corresponding kit is shipped with the instrument. Otherwise, both kits are available separately by their -hp- part numbers.

2-30. STORAGE AND SHIPMENT.

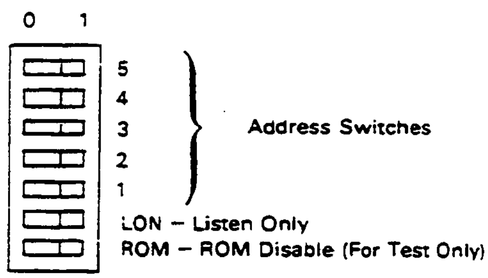
2-31. Environment.

2-32. The instrument should be stored in a clean, dry environment. The following environmental limitations apply to both storage and shipment:

Temperature	-40°C to +75°C
Relative Humidity	95% at 40°C
Altitude	15,300 meters (50,000 feet)

Table 2-1. HP—IB Addresses.

ASCII Characters: Listen Address	ASCII Characters: Talk Address	Address Switches (Binary Code) 5 4 3 2 1	Equivalent Codes (To 5-Bit Binary Switches): Octal	Decimal	Hexadecimal
SP	@	0 0 0 0 0	00	00	00
!	A	0 0 0 0 1	01	01	01
"	B	0 0 0 1 0	02	02	02
#	C	0 0 0 1 1	03	03	03
$	D	0 0 1 0 0	04	04	04
%	E	0 0 1 0 1	05	05	05
&	F	0 0 1 1 0	06	06	06
'	G	0 0 1 1 1	07	07	07
(	H	0 1 0 0 0	10	08	08
)	I	0 1 0 0 1	11	09	09
*	J	0 1 0 1 0	12	10	0A
+	K	0 1 0 1 1	13	11	0B
,	L	0 1 1 0 0	14	12	0C
-	M	0 1 1 0 1	15	13	0D
.	N	0 1 1 1 0	16	14	0E
/	O	0 1 1 1 1	17	15	0F
Ø	P	1 0 0 0 0	20	16	10
1 (Factory Selected Address)	Q	1 0 0 0 1	21	17	11
2	R	1 0 0 1 0	22	18	12
3	S	1 0 0 1 1	23	19	13
4	T	1 0 1 0 0	24	20	14
5	U	1 0 1 0 1	25	21	15
6	V	1 0 1 1 0	26	22	16
7	W	1 0 1 1 1	27	23	17
8	X	1 1 0 0 0	30	24	18
9	Y	1 1 0 0 1	31	25	19
:	Z	1 1 0 1 0	32	26	1A
;	[	1 1 0 1 1	33	27	1B
<	\	1 1 1 0 0	34	28	1C
=	]	1 1 1 0 1	35	29	1D
>	~	1 1 1 1 0	36	30	1E



NOTE: The Equivalent Codes shown correspond only to the 5-bit binary switch code. These bits are the same for both listen and talk addresses, and the sixth and seventh bits determine whether the address is listen (01) or talk (10). Some controllers distinguish between listen and talk automatically, requiring only the 5-bit code equivalent to designate a device.

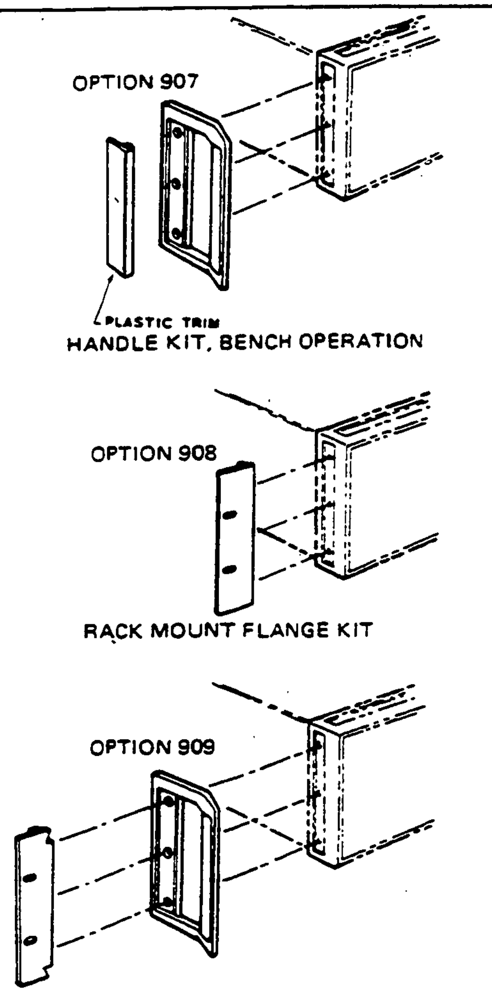


Figure 2-4. Rack Mount and Handle Kits.

2-33. Instrument Identification.

2-34. If the instrument is being returned to Hewlett-Packard for servicing, attach a tag indicating the type of service required, return address, model number, and full serial number. In any correspondence, refer to the instrument by model number and full serial number.

2-35. Packaging.

2-36. **Original Packaging.** If the original packaging has been retained, pack the instrument in the same manner as it was received. Be sure to seal the shipping container securely. Also, mark the container FRAGILE to assure careful handling.

2-37. **Other Packaging.** The following general instructions should be used for repackaging with commercially available materials.

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

b. Use a strong shipping container. A doublewall carton made of 250-pound test material is adequate.

c. Use enough shock-absorbing material (3-to-4 inch layer) around all sides of the instrument to provide firm cushion and prevent movement inside the container. Protect the control panel with cardboard.

d. Seal the shipping container securely.

e. Mark the shipping container FRAGILE to assure careful handling.

NOTE

The HP-IB is Hewlett-Packard Company's implementation of IEEE Standard 488-1978.

3-3. PANEL FEATURES.

3-4. Figure 3-1 identifies and describes the functions of the front and rear panel controls, indicators, and connectors.

3-5. POWER/WARM-UP.

3-6. The Model 3325A requires a power source of 100, 120, 220, or 240 Vac, +5% -10%, 48 to 66 Hz single phase. The selection of line voltage and fuse is described in Paragraph 2-8 and Figure 2-1.

3-7. The 3325A POWER switch has two positions, STBY and ON. Power is applied to some circuits at any time the instrument is connected to the ac power source. If the instrument has the Oven Assembly Option 001 installed, it is important that it remain connected to the power source to maintain a constant oven temperature, eliminating the need for a long warm-up period. If an instrument with the Oven Assembly has been disconnected from ac power no longer than 24 hours, a 15-minute warmup period is sufficient to bring the reference frequency to within $\pm 1 \times 10^{-7}$ of final value.

3-8. INITIAL CONDITIONS.

3-9. After the POWER switch has been set to ON, the instrument status will be as follows:

Function....................... Sine
Frequency.................... 1000 Hz
Amplitude.................. 1 mV p-p
Phase......................... 0 deg
DC Offset....................... 0 V
Front Signal Output
Sweep....................... Linear
  Start Frequency.............. 1 MHz
  Stop Frequency............. 10 MHz
  Marker Frequency............ 5 MHz
  Time......................... 1 sec

NOTES

1. If the display reads OSC FAIL the frequency synthesis circuits are not operating properly.

2. If A-CAL FAIL appears in the display momentarily after turn-on, any one of the three AMPTD CAL tests could be incorrect. Perform a SELF TEST operation to identify the failure.

3. If either of the above conditions occurs, refer the instrument to qualified service personnel for repair.

3-10. SELF TEST.

3-11. The self test operation is initiated by pressing the blue prefix key, then the SELF TEST key (AMPTD CAL). This test uses the control, ROM, and control clock circuits to perform the following checks:

LED check: Turns on all LED's for about 2 seconds
Check 1: Tests AMPTD CAL of the sine wave
Check 2: Tests AMPTD CAL of the square wave
Check 3: Tests AMPTD CAL of the triangle wave

Following each check the display indicates either PASS or FAIL for approximately one second. If all tests pass, this indicates that approximately 60% of all circuits are operating properly.

3-12. FRONT/REAR SIGNAL OUTPUT.

CAUTION

The maximum peak voltage that can be safely applied between chassis and the outer conductor of any of the 3325A input or output signal connectors is ±42 V.

3-13. The standard Model 3325A provides selectable front or rear panel 50-ohm signal outputs. The rear panel signal output is selected by pressing the REAR ONLY key. The lighted indicator in the center of this key denotes that the signal output is at the rear panel.

NOTE

The rear panel SIGNAL output is not present on instruments equipped with the High Voltage Output Option 002.

3-14. SYNC OUTPUT.

3-15. A square wave sync output is provided at BNC connectors on both the front and rear panels. This sync signal is always in phase with the output signal, with the sync transition occurring at the signal zero crossing, or when the signal crosses the dc offset voltage. The output impedance of either front or rear panel sync output is approximately 50 ohms. When connected to a 50-ohm coaxial cable that is terminated by a 50 ohm resistive load, the sync signal levels are as follows:

Low Level = < 0.2 V
High level = > 1.2 V

NOTE

If a sync output is connected to a 50-ohm coaxial cable that is terminated by a high impedance load (≥1 megohm) the voltage levels are approximately twice the values given above. However, the improper ter-

mination of the 50-ohm system will cause ringing at the positive and negative transitions of the sync signal.

3-16. EXTERNAL REFERENCE INPUT.

3-17. The 3325A may be operated with an external reference to control the standard 30 MHz internal reference oscillator frequency. The external reference level must be greater than 0 dBm (50 ohms), and the frequency must be within 10 PPM of 10 MHz or a submultiple thereof down to 1 MHz (10, 5, 3.33, 2.5, or 1 MHz). The front panel EXT REF annunciator will light to indicate that an external reference is being used. The internal reference oscillator is phase locked to the external reference, and a phase lock detector circuit causes the EXT REF light to flash if synchronization is lost.

3-18. 10 MHz OVEN OPTION 001.

3-19. Option 001 is a temperature stabilized 10 MHz oscillator which provides improved frequency stability (see specifications in Table 1-1). The output from this oscillator is at the rear panel 10 MHz OVEN OUTPUT connector. This output must be connected to the EXT REF input. A special connector, -hp- Part No. 1250-1499, is provided with Option 001 for this purpose.

3-20. MANUAL PROGRAMMING.

3-21. The following paragraphs describe the procedures for operating the 3325A from the front panel. Also included are the limits for each parameter.

3-22. Clear Display.

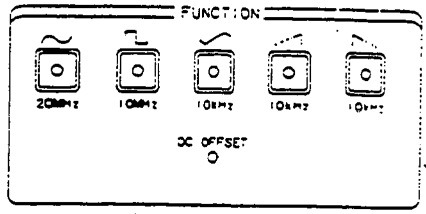
3-23. Pressing the CLEAR key (in the left column of the DATA group) clears the display to zero. This key is useful when an error is made while entering data.

3-24. Entry Errors.

3-25. The word "Error" will appear in the display for approximately one second when an error in programming occurs. The incorrect entry will not be accepted.

ASCII Numeric	Error
1	Entry parameter out of bounds (for example, Freq ≥ 61 MHz)
2	Invalid delimiter
3	Frequency too large for function (for example, Function = Triangle, Freq ≥ 11 kHz)
4	Sweep time too small or too large
5	Offset incompatible with amplitude, or amplitude incompatible with offset
6	Sweep frequency too large for function; Sweep bandwidth too small; Start frequency too small (log sweep); Start frequency greater than stop frequency (log sweep)
7	Unrecognizable mnemonic received
8	Unrecognizable data character received
9	Option does not exist (High Voltage or Rear/Front)

3-26. Function Selection.

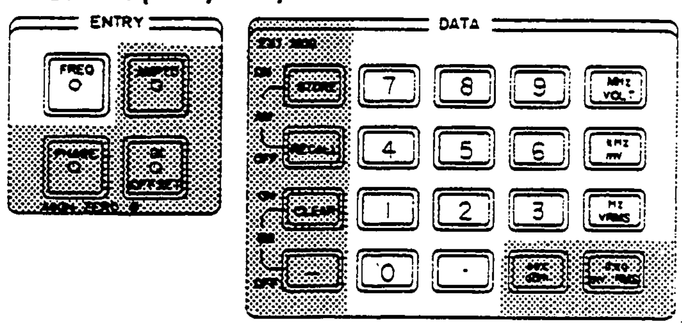


3-27. Any of the five functions may be selected by pressing the appropriate FUNCTION key. A light in the center of the key indicates the present function. Pressing the same key the second time removes the ac signal, setting the output to zero unless a dc offset has been programmed (see Paragraph 3-43). When the ac signal is removed in this way, the instrument automatically displays dc offset, and the dc offset entry key light comes on. The ac signal can be restored by pressing the FUNCTION key again. The output signal for each function is centered about zero volts unless a dc offset has been programmed.

NOTE

The standard instrument signal output must be terminated by an external 50-ohm load or sine wave distortion and square wave overshoot may result, particularly at higher frequencies.

3-28. Frequency Entry.



NOTE

A lighted indicator in the center of any entry key denotes it as the active entry parameter. For example, if the FREQ entry key indicator is on, it is not necessary to press that key before entering data.

3-29. Enter frequency by first pressing the FREQ ENTRY key, then the numerical data, followed by the data suffix (delimiter) key (Hz, kHz, MHz). Numerical data must be entered most significant digit first, entering the decimal in the proper place. The frequency parameter is stored in the 3325A when the delimiter key is pressed.

3-30. Frequency Limits.

3-31. The minimum frequency for all functions is 1 μHz. The nominal maximum frequency for each function is shown below the function select key on the front

Table 3-2. Amplitude Limits of AC Functions.

Function	Peak-to-Peak Max.	Peak-to-Peak Min.	rms Max.	rms Min.	dBm (50 Ω) Max.	dBm (50 Ω) Min.
Sine	10 V	1 mV	3.536 V	0.354 mV	+23.98	-56.02
Square	10 V	1 mV	5.000 V	0.5 mV	+26.99	-53.01
Triangle	10 V	1 mV	2.888 V	0.289 mV	+22.22	-57.78
± Ramp	10 V	1 mV	2.888 V	0.289 mV	+22.22	-57.78

panel. However, because of the overrange capability of the 3325A, the maximum frequency for each function is as shown below:

Sine wave	20 999 999.999 Hz
Square wave	10 999 999.999 Hz
Triangle	10 999.999 999 Hz
Positive slope ramp	10 999.999 999 Hz
Negative slope ramp	10 999.999 999 Hz

3-32. Frequency Display and Resolution.

3-33. Frequency is always displayed in Hz, even though the entry may have been made in kHz or MHz. For example, an entry of 1.2 MHz is displayed as 1 200 000.0 Hz. Non-significant zeroes to the right of the first digit following the decimal point are not displayed except during a "modify" condition (see Paragraph 3-68). The maximum resolution is 1 µHz for frequencies up to and including 99 999.999 999 Hz, and 1 mHz for frequencies of 100 000.000 Hz and higher.

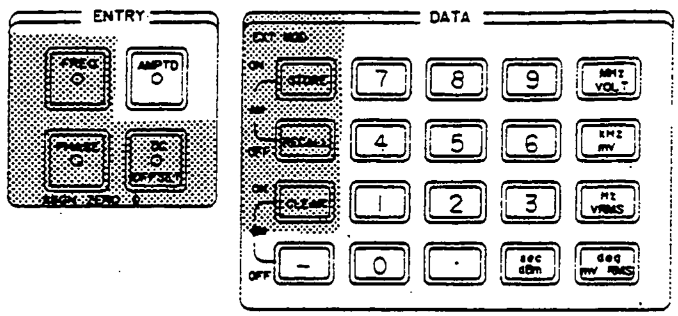
3-34. Auxiliary Output (Sine Function Only).

3-35. A rear panel auxiliary output can be used for frequencies above 19 MHz to a maximum of 60 999 999.999 Hz. The output level is a nominal 0 dBm into 50 ohms. The output automatically switches to the AUX output when frequencies of 21 000 000.000 Hz or higher are programmed. For this reason, the AUX output is labeled "21-60 MHz". Frequencies between 19 MHz and 21 MHz can be obtained at the AUX output only by first entering 21 MHz or higher, then entering the desired frequency. For example, if the desired frequency is 19.5 MHz, first enter "FREQ 21 MHz", then "19.5 MHz". Then, if a front panel SIGNAL output of 19.5 MHz (or any frequency between 19 MHz and 21 MHz) is desired, enter any frequency 19 MHz or lower, then enter 19.5 MHz.

NOTE

Only one signal output is active at one time. A lighted "21-60 MHz Rear" annunciator indicates that the rear panel AUX, 0 dBm, 21-60 MHz output is active. A lighted "Signal, Rear Only" annunciator indicates that the rear panel signal output is active. Neither light on, indicates the front panel signal output is active.

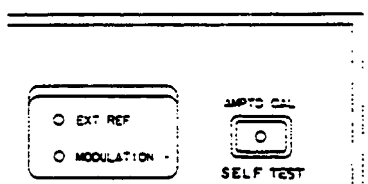
3-36. Amplitude Entry.



3-37. Amplitude is entered and displayed with 4-digit resolution. Press the AMPTD ENTRY key, then the numerical data, followed by the V, mV, Vrms, mVrms, or dBm key. The V and mV keys enter peak-to-peak value of ac functions. Maximum and minimum amplitudes for each function are shown in Table 3-2.

3-38. The 3325A will convert an amplitude value between peak-to-peak, rms, or dBm for any function. For example, if a sine wave amplitude of 10 V p-p has been entered, press the Vrms or mVrms key to display the same amplitude as 3.536 Vrms, or press the dBm key to display the value as (+)23.98 dBm.

3-39. Amplitude Calibration.



3-40. The 3325A will calibrate the output signal when the AMPTD CAL key is pressed. The output goes to less than 4 mV p-p while the calibration is in process. An amplitude and offset calibration is performed automatically whenever the function is switched and at instrument turn-on.

NOTE

If A-CAL FAIL appears in the display momentarily after an AMPTD CAL operation, the instrument should be referred to qualified service personnel for repair.

3-41. High Voltage Output Option 002.

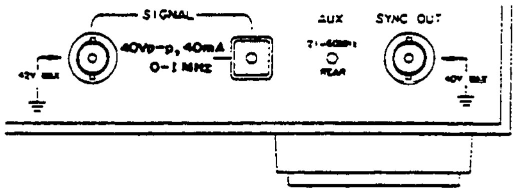


Table 3-3. High Voltage Output Amplitudes (Option 002).

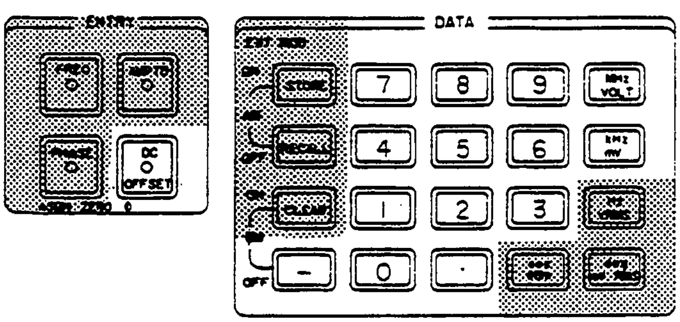
Function	Peak-to-Peak Max.	Peak-to-Peak Min.	rms Max.	rms Min.
Sine	40 V	4 mV	14.14 V	1.42 mV
Square	40 V	4 mV	20.0 V	2.0 mV
Triangle	40 V	4 mV	11.55 V	1.16 mV
± Ramp	40 V	4 mV	11.55 V	1.16 mV

3-42. The high voltage output is selected by pressing the key in the lower right corner of the front panel. This option provides a maximum output of 40 V p-p into a high impedance. The load resistance must be greater than 500 ohms or distortion will result, particularly at higher frequencies. To assure square wave overshoot <5% of peak-to-peak output, the total capacitance connected to the output should be <500 pF. The same entry procedures and display features apply as in the standard operation. Maximum and minimum amplitudes are shown in Table 3-3. Maximum frequency for sine and square wave functions is 1 MHz (10 kHz for triangle and ramps).

NOTE

The rear panel signal output is inactive (no internal signal connection) if the instrument has the High Voltage Output Option 002 installed. Instructions are given in the Operating and Service Manual, Section VIII, Service Group M, for activating the rear panel signal output in one of two ways: 1) Placing the standard/high voltage output on the rear panel only, disconnecting the front panel signal output, or 2) Disabling the high voltage output and enabling the standard front/rear output configuration.

3-43. DC Offset.



3-44. Offset Only, No AC Function. When no ac function is present, the dc voltage output may be programmed from 0mV to ±5V, with 4 digit resolution. When no ac function is present, the DC OFFSET entry prefix is automatically selected. It is necessary merely to enter the numerical data followed by the V or mV delimiter. The rms keys cannot be used to enter offset.

NOTE

When the High Voltage Output is selected (Option 002), minimum amplitude for dc only (no ac function) is 0.01 mV and maximum is 20.0 V.

3-45. Offset with AC Function. When dc offset is to be added to any ac function, there are minimum and maximum offset limits which must be observed. These limits are affected by the ac voltage and the resulting attenuator settings, which are shown in Table 3-4. Figure 3-2 is a set of graphs which show the approximate maximum dc offset permissible for a given ac peak-to-peak voltage. The following equation may be used to determine maximum offset voltage.

$$\text{Maximum dc offset} = \frac{5}{A} - \frac{\text{Amptd}}{2}$$

Where A = Attenuator factor (from Table 3-4)
Amptd = Amplitude in V p-p of the ac function

NOTES

1. If an attempt is made to enter a dc offset that is too great for the amplitude already programmed, "Error 5" will appear in the display momentarily, and the dc offset entry will not be accepted.

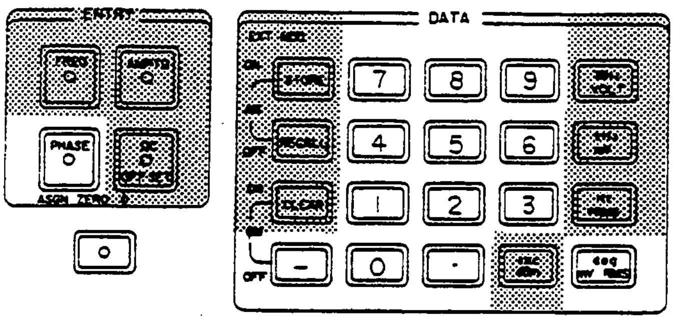
2. After a dc offset has been entered, if the amplitude (ac) is then increased beyond the level where the amplitude and offset are compatible, "Error 5" will appear in the display momentarily, and the ac amplitude entry will not be accepted.

3. The minimum and maximum permissible dc offset voltages when the High Voltage Output is selected (Option 002) may be determined by multiplying the amplitude and offset values in Table 3-4 by four. This also applies for Figure 3-2. Change the above equation (for determining maximum dc offset) to the following:

$$\text{Maximum dc offset} = \frac{20}{A} - \frac{\text{Amptd}}{2}$$

4. Resolution of a dc offset entry (with ac function) is determined by the resolution of the ac amplitude.

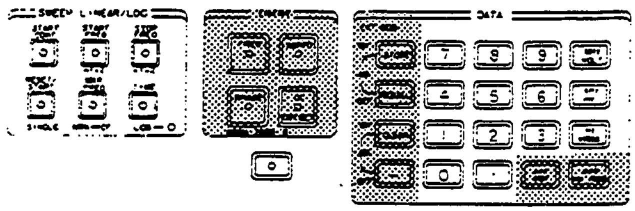
3-46. Phase Entry.



3-47. The phase of the SIGNAL output can be shifted up to ±719.9° with respect to the 1 MHz REF OUT (rear panel). Phase shift entry resolution is 0.1°. To program phase shift, press the PHASE ENTRY key, enter number of degrees of phase desired, then press the "deg" key. For a negative phase shift, press the "−" key before entering the numerical data. For square wave frequencies below 25 kHz, phase changes greater than 25° may result in a phase shift ±180° from the desired amount.

3-48. After entering a phase shift, the new phase may be assigned the zero phase position, and subsequent changes in phase referenced to that point. To assign zero phase, press the blue entry prefix key, then press ASGN ZERO Ø (PHASE) key.

3-49. Frequency Sweep.



3-50. Frequency sweep is phase continuous over the full frequency range; that is, there are no discontinuities in the output waveform. When the instrument is turned on, the sweep mode is set to linear, and the parameters are set as follows:

Start Frequency............1 000 000.0 Hz
Stop Frequency............10 000 000.0 Hz
Marker Frequency..........5 000 000.0 Hz
Time.............................1.0 sec

Table 3-4. Maximum DC Offset with any AC Function.

AC Amplitude Entry (peak-to-peak)		Maximum DC Offset (+ or −)	Minimum DC Offset Entry	Range	Attenuation Factor
1.000 mV to 3.333 mV	with with	4.500 mV 3.333 mV	0.001 mV	7	A = 1000
3.334 mV to 9.999 mV	with with	14.99 mV 11.66 mV	0.001 mV	6	A = 300
10.00 mV to 33.33 mV	with with	45.00 mV 33.33 mV	0.010 mV	5	A = 100
33.34 mV to 99.99 mV	with with	149.9 mV 116.6 mV	0.010 mV	4	A = 30
100.0 mV to 333.3 mV	with with	450.0 mV 333.3 mV	0.100 mV	3	A = 10
333.4 mV to 999.9 mV	with with	1.499 V 1.166 V	0.100 mV	2	A = 3
1.000 V to 9.998 V	with with	4.500 V 0.001 V	1.000 mV	1	A = 1

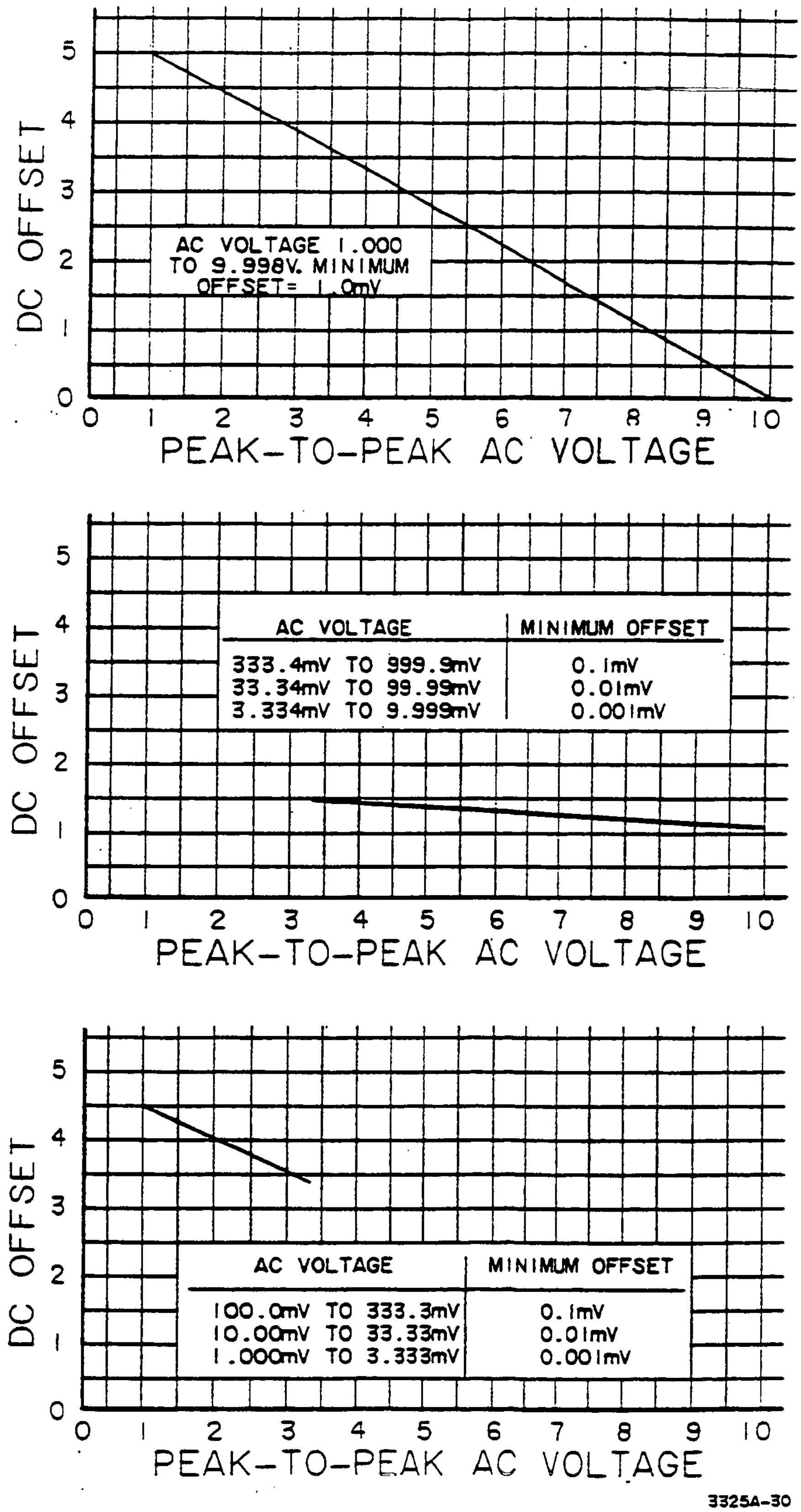
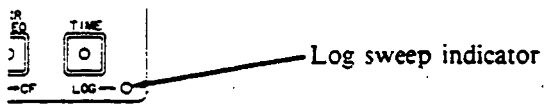


Figure 3-2. Maximum DC Offset With AC Functions.

NOTE

The Marker Frequency must be lower than Stop Frequency by a sufficient amount to permit the Marker pulse width to be approximately 400 microseconds. See Paragraph 3-55.

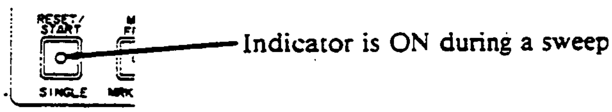
To change any of the sweep parameters, press the appropriate SWEEP entry key, then enter the desired data. To select LOG sweep, press the blue prefix key and then the LOG (TIME) key. The log indicator should light. The sweep mode is linear unless this light is on.



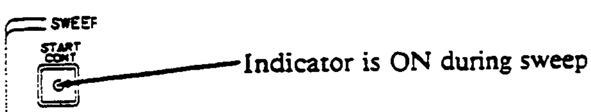
3-51. Linear Sweep. In linear mode, either CONTINUOUS or SINGLE sweep may be used. Single sweep is from START to STOP frequency, and either START or STOP may be the higher frequency. To begin a single sweep:

Press "RESET/START" key to set output and display to the start frequency selected and reset the X Drive ramp.

Press "RESET/START" key again to start the sweep.



The output frequency sweeps to the STOP frequency selected and remains there. This frequency appears in the display. Continuous sweep is up-down-up, etc., and begins when the "START CONT" key is pressed. Continuous sweep may be stopped by pressing the "START CONT" key again, or by pressing "START SINGLE", "FREQ ENTRY", or "PHASE ENTRY". The display will indicate the frequency at which the sweep stopped. The sweep will stop while any other parameter is being changed, then will restart. Pressing "AMPTD CAL", "SELF TEST", "ASSIGN ZERO Ø", or changing the function will also stop continuous sweep.



3-52. Log Sweep. In either single or continuous log sweep mode, the stop frequency must be higher than the start frequency, and sweep is up only. (Continuous sweep is start to stop, start to stop, etc.) The minimum bandwidth for log sweep is one decade. Single log sweep is a line-segmented log approximation in one-tenth decade segments, and continuous log sweep is a two-segment log approximation.

NOTE

Because of the computation time required by the control circuits in log sweep, the actual stop frequency (which is displayed at the end of a single sweep) will be higher than the selected stop frequency, but always within 0.25%. The error decreases as sweep time is increased.

3-53. Sweep Time. The maximum time per sweep (up or down) for all sweep modes is 99.99 seconds, with .01 second resolution for times ≥1 second, and .001 second resolution for times <1 second. Minimum times are as follows:

Linear sweep, single or continuous...0.010 s
Log sweep
  Single..........................2.000 s
  Continuous....................0.100 s

NOTE

In single log sweep, the sweep time is increased by the processing time required between segments. The time increase (in seconds) is approximately equal to

$$.045 \left(10 \log \frac{\text{stop frequency}}{\text{start frequency}} \right)$$

3-54. Sweep Bandwidth. The maximum sweep bandwidth is the full frequency range for the function selected, except that in log sweep, the minimum frequency is 1 Hz. The minimum bandwidth for log sweep is one decade. Minimum bandwidth for each function (linear sweep) is as follows:

Sine............(10 mHz/s) × (sweep time)
Square..........(5 mHz/s) × (sweep time)
Triangle.......(0.5 mHz/s) × (sweep time)
Ramps..........(1 mHz/s) × (sweep time)

For sweep bandwidths of less than 100 times the minimum, Bandwidth selected should be an integral multiple of the minimum. In linear sweep mode the sweep bandwidth may be multiplied or divided by two by pressing the blue prefix key and then "Δfx2" or "Δf÷2". These bandwidth modification keys do not operate in log sweep mode.

3-55. Sweep Marker.

3-56. The marker frequency may be set to any point within the sweep band up to within approximately 400 microseconds of the stop frequency. If the marker frequency is set beyond this point, the stop frequency will automatically be increased so that the marker pulse is

approximately 400 microseconds wide. The following equation may be used to determine the approximate maximum marker frequency:

$$\text{Max. marker freq.} = \text{stop freq.} - \frac{.0004 \times \text{bandwidth}}{\text{sweep time}}$$

The rear panel MARKER output is at TTL compatible voltage levels. It is High at the start of a sweep up, goes Low at the selected marker frequency, then High again at the stop frequency. No marker output is present during sweep down or during a log sweep. Set the marker frequency by pressing the "MKR FREQ" key and entering the numerical data and the frequency suffix.

3-57. The sweep band can be moved up or down to center on the marker frequency by pressing the blue prefix key and then the MKR → CF(MKR FREQ) key. This does not change the sweep bandwidth unless either the new upper or lower limit would be beyond the frequency limit for the present function.

3-58. Sweep X Drive Output.

3-59. The rear panel X DRIVE output is as follows:

Linear sweep:

Single: 0 V at start, increasing linearly to > + 10 V at stop, whether the sweep is up or down. Remains at essentially this voltage until reset prior to the start of another sweep. (Voltage will drift downward less than 10 mV/s.)

Continuous: Increases linearly from 0 V to > + 10 V during sweep up, then goes to 0 V at beginning of sweep down and remains at 0 V during sweep down.

Log sweep: Starts at 0 V and increases to > + 10 V with the sweep segments.

NOTE

The X DRIVE output has a nominal voltage of + 10.5 V at the end of a sweep. This final voltage is specified to be greater than 10.0 V to ensure compatibility with oscilloscopes having a horizontal sensitivity of 10.0 V for full-screen deflection.

X DRIVE output voltage is linear with time in both linear and log sweep modes.

3-60. Sweep Z Blank Output.

3-61. The Z BLANK output voltages are TTL compatible, and the output logic levels are as follows:

Linear sweep:

Single: Goes LOW at start of sweep, HIGH at stop, whether the sweep is up or down. Remains until start of next sweep.

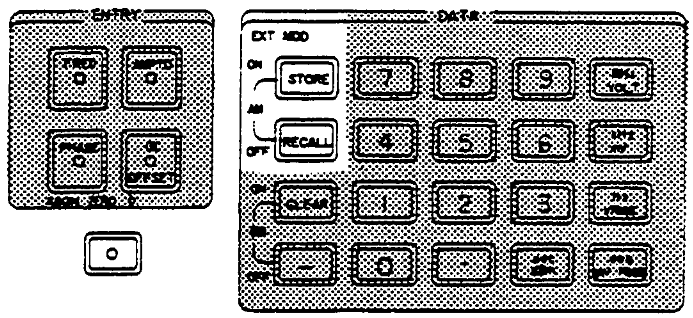
Continuous: LOW during sweep up, HIGH during sweep down.

Log sweep: Goes LOW at start frequency, HIGH at stop. In single sweep, remains HIGH until start of next sweep. In continuous sweep, is HIGH momentarily at stop frequency.

When the Z BLANK output is low, it is capable of sinking current through a relay or other device. The maximum ratings are:

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

3-62. Amplitude Modulation.

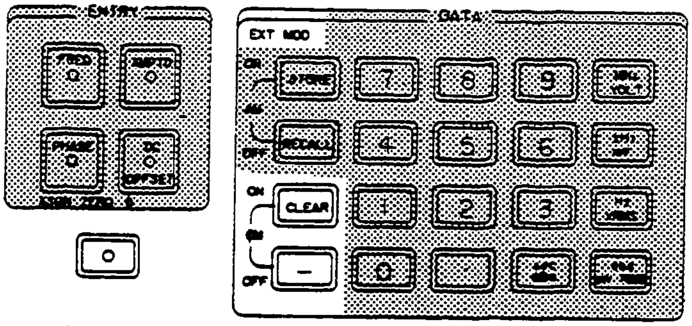


3-63. To program amplitude modulation, press the blue prefix key, then press the "AM ON" (STORE) key. To remove the modulation, press the blue key, then "AM OFF" (RECALL). The display shows "A ON" or "A OFF" momentarily to indicate the status of the amplitude modulation. The status of phase modulation (P ON or P OFF) is displayed at the same time. The modulation input must be connected to the rear panel AMPTD MOD input. The impedance of this input is 20 kΩ (10 kΩ when AM is OFF).

3-64. When amplitude modulation is programmed, the amplitude of the output signal (with no modulation) is halved; however, the display still indicates the programmed amplitude. Then, when the output (carrier) is modulated 100%, the maximum amplitude of the modulated output equals the programmed amplitude. A modulation input of approximately 5 V peak results in 100% modulation. Modulation frequency may be 0 to 50 kHz. If amplitude modulation is ON when 3325A functions other than sine wave are selected, the output may be gated, depending on the level of the modulation input. Amplitude modulation should be used only with the sine wave function, and the modulation input should not exceed ±10 V peak.

3-65. A dc voltage may be applied to the AMPTD MOD input to control the 3325A output level, or a pulse may be used to gate the output. Approximately +5 V cuts off the output signal, while approximately -5 V doubles the output. (Maximum output is 10 V p-p.) DC or pulse inputs should not exceed ±5 V peak.

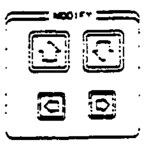
3-66. Phase Modulation.



3-67. To program phase modulation, press the blue prefix key, the the "ØM ON" (CLEAR) key, and to remove phase modulation, press the blue key, then "ØM OFF" (-). The phase modulation signal at the rear panel PHASE MOD input may be up to ±10 V peak. The input impedance is 10 kΩ. The modulating signal frequency may be dc to 5 kHz. An input of ±5 V results in the following approximate phase deviation (±170° per volt for sine function):

3325A Function	Phase Deviation
Sine	±850°
Square	±425°
Triangle	±42.5°
± Ramp	±85°

3-68. Modify Keys.



3-69. The numerical data of any parameter may be changed by use of the MODIFY keys. First press the prefix key of the parameter to be modified, placing the information in the display. Next, press the ⇦ or ⇨ key to move the bright digit cursor to the digit you want to modify. Then press the ⇧ or ⇩ key momentarily to increase or decrease the value of that digit by 1. If the modify key is held, the digit will continue to increment or decrement after a slight delay. As the modified digit passes 9 (incrementing) or 0 (decrementing) the digit to its left will increment or decrement.

3-70. Store and Recall.

3-71. An entire program may be stored in any one of 10 registers by pressing the "STORE 0-9" key, then the register number. This stores all the information that is in the current program memory. Other programs may then be entered. All stored information is lost when power is removed from these circuits by setting the POWER switch to STBY or disconnecting ac power from the instrument.

NOTE

Any phase information stored is invalid when recalled because the instrument performs an amplitude calibration on RECALL. Phase relationship between the output signal and the reference is not maintained when AMPTD CAL occurs.

3-72. OPERATOR'S CHECKS.

3-73. The following checks provide the operator with a means of determining whether the instrument is operational. They are not intended to verify any specifications. If the instrument fails any of these checks, it should be referred to qualified service personnel for repair.

3-74. Self Test.

3-75. Press the blue prefix key, then SELF TEST (AMPTD CAL). All the front panel display and annunciator LED's should light for approximately two seconds, then the instrument performs an automatic calibration of the sine, square, and triangle functions and the display indicates momentarily whether each test passed or failed. The dc offset is also checked in these tests.

NOTE

If the display reads OSC FAIL at any time, the frequency synthesis circuits are not functioning properly. Refer the instrument to qualified service personnel for repair.

3-76. Output Checks.

3-77. An oscilloscope (-hp- 1740A or equivalent) is required for these checks. Connect the 3325A output through a 50-ohm feedthru termination (-hp- 11048C) to the oscilloscope input (input dc coupled), or set the 1740A input switch to 50 ohms.

FUNCTIONS

a. Make the following 3325A keyboard selections:

FUNCTION .... Sine
FREQUENCY .... 2 kHz
AMPLITUDE .... 10 V p-p

b. Set the oscilloscope controls as follows:

Vertical .... .5 V/div
Horizontal .... 0.5 ms/div
Trigger .... Auto

c. Adjust oscilloscope controls for a stable display, which should show a sine wave approximately two divisions peak-to-peak and one cycle per division.

d. Select square wave, triangle, positive slope ramp, and negative slope ramp and verify that each function indicates the same frequency and peak-to-peak amplitude.

AMPLITUDE AND DC OFFSET

e. Set the 3325A as follows:

FUNCTION......................Square
FREQUENCY......................2 kHz
AMPLITUDE....................10 V p-p

f. Set the oscilloscope controls as follows:

Vertical.........................2 V/div
Horizontal....................0.5 ms/div
Trigger...........................Auto

g. Oscilloscope display should show one square wave per division, 5 divisions peak-to-peak vertical. This checks the output with no attenuation. Actual display will depend greatly upon the accuracy of the oscilloscope amplifiers and display.

h. Change 3325A amplitude to 1 V p-p, and change oscilloscope vertical to .2 V/div. Oscilloscope display should again be 5 divisions peak-to-peak. This checks the ÷3 attenuator section.

i. Change 3325A amplitude to 500 mV p-p, and change oscilloscope vertical to .1 V/div. Oscilloscope display should be 5 divisions peak-to-peak. This checks the ÷10 attenuator section.

j. Change 3325A amplitude to 50 mV p-p, and change oscilloscope vertical to .01 V/div. The square wave display should be 5 divisions peak-to-peak. This checks the ÷100 attenuator section.

k. Press the 3325A SQUARE WAVE FUNCTION key to remove the square wave output. The indicator in the DC OFFSET Entry key should light and the 3325A display should show 0.0 mV.

l. Set the oscilloscope vertical control to 2 V/div. Ground the input and set the trace to the center line. Set input to dc coupled.

m. Enter 5 V offset in the 3325A. The oscilloscope trace should be 2.5 divisions above the center line. Enter −5 V offset in the 3325A. The oscilloscope trace should go to 2.5 divisions below the center line.

n. Enter 0 V offset in the 3325A. Trace should be on the center line.

FREQUENCY

o. Set the 3325A as follows:

FUNCTION.........................Sine
FREQUENCY....................100 Hz
AMPLITUDE..................10 V p-p

p. Set the oscilloscope controls as follows:

Vertical..........................2 V/div
Horizontal.......................1 ms/div

q. Oscilloscope display should show one cycle of sine wave, which should be free of any apparent irregularities.

r. Enter 20 MHz in the 3325A. Change oscilloscope horizontal to .05 μs/div. Oscilloscope should display one cycle of sine wave per division.

HIGH VOLTAGE OUTPUT (OPTION 002)

s. Remove the 50-ohm feedthru termination between the 3325A output and the oscilloscope input. Press the key in the lower right corner of the 3325A front panel to select the High Voltage output.

t. Set the 3325A as follows:

FUNCTION.........................Sine
FREQUENCY......................2 kHz
AMPLITUDE...................40 V p-p

u. Set the oscilloscope controls as follows:

Vertical........................10 V/div
Horizontal....................0.5 ms/div

v. The oscilloscope display should show a sine wave four divisions peak-to-peak, one cycle per division. This checks the high voltage output amplifier.

3-78. OPERATOR'S MAINTENANCE.

3-79. Maintenance by the operator is limited to cleaning or replacing the rear panel fan filter, or replacing the ac line fuse on the rear panel. Generally, if the ac line fuse requires replacement there is a failure within the instrument, which should be referred to qualified service personnel. Disconnect the ac line cord before replacing the fuse. Be sure to use the correct replacement fuse:

Nominal Line Voltage	Fuse	-hp- Part No.
100/120 V	1 A	2110-0001
220/240 V	0.5 A	2110-0012

3-80. The fan filter should be inspected frequently and cleaned or replaced as necessary to allow free flow of air. To remove the filter, disconnect ac power from the instrument and remove the four nuts that secure the filter retainer. Remove the filter and wash thoroughly with soapy water, rinse clean, and air dry.

3-81. HP-IB OPERATION.

3-82. The Model 3325A is remotely controlled by means of the Hewlett-Packard Interface Bus (HP-IB).

The following information gives a general description of the HP-IB and defines the terms, concepts, and messages used in an HP-IB system. It also lists the capabilities and requirements for programming the 3325A. Program examples using a specific Hewlett-Packard calculator as the system controller may be found in the Supplemental Programming Information, Appendix 3-A at the rear of this section.

NOTE

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

3-83. General HP-IB Description.

3-84. The HP-IB is a parallel bus of 16 active signal lines grouped into three sets according to function, to interconnect up to 15 instruments. Figure 3-3 is a diagram of the interface connections and bus structure.

3-85. Eight signal lines form the first set and are termed "data" lines. The data lines carry coded messages which represent addresses, program data, measurements, and status bytes. The same data lines are used for input and output messages in bit-parallel, byte-serial form. Normally, a seven-bit ASCII code represents each piece (byte) of data, leaving the eighth bit available for parity checking.

3-86. Data transfer is controlled by means of an interlocked "handshake" technique which permits data transfer (asynchronously) at the rate of the slowest device participating in that particular conversation. The three data byte transfer control lines which implement the handshake form the second set of lines.

3-87. The remaining five general interface management lines form the third set and are used in such ways as activating all the connected devices at once, clearing the interface, etc. Table 3-5 defines each of the management lines.

3-88. Definition of HP-IB Terms and Concepts.

Byte - A unit of information consisting of eight binary digits (bits).

Device - Any unit that is compatible with the IEEE Standard 488-1978.

Device Dependent - 1. An action a device performs in response to information sent on the HP-IB. The action is characteristic of an individual device and may vary from device to device. 2. The data required to communicate with a particular device.

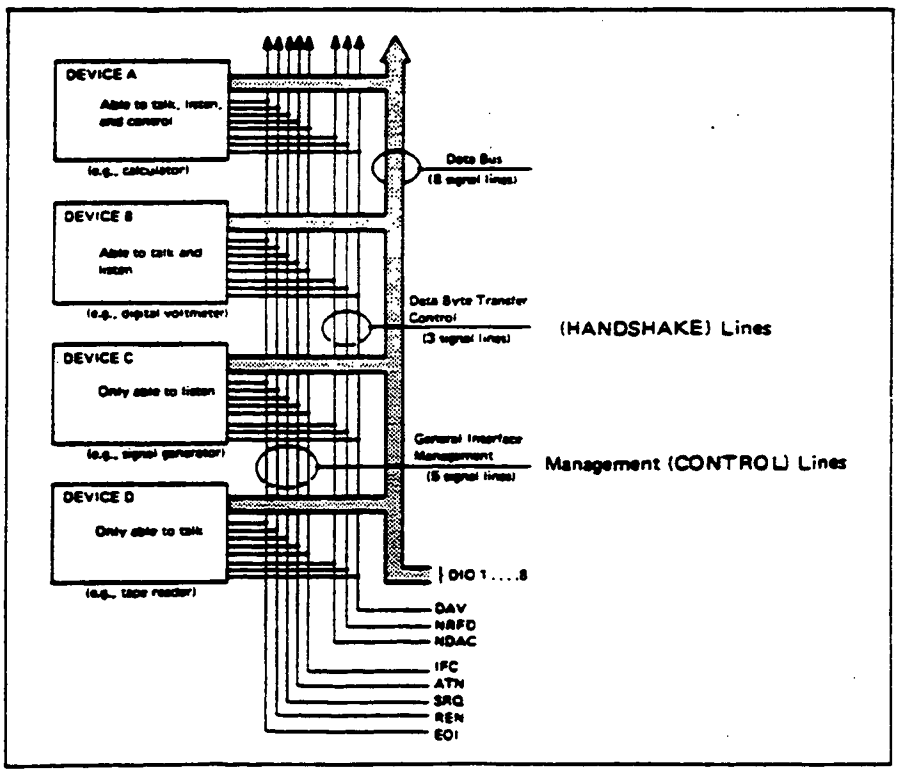


Figure 3-3. Interface Connections and Bus Structure.

Table 3-5. General Interface Management Lines.

Name	Mnemonic	Description
Attention	ATN	Enables a device to interpret data on the bus as a controller command (command mode) or data transfer (Data Mode).
Interface Clear	IFC	Initializes the HP-IB system to an idle state (no activity on the bus.)
Service Request	SRQ	Alerts the controller to a need for communication.
Remote Enable	REN	Places instruments under remote program control.
End Or Identify	EOI	Indicates last data transmission during a data transfer sequence; used with ATN to poll devices for their status.

Operator - The person that operates either the system or any device in the system.

Address - The characters sent by a controller to specify which device will send information on the bus and which device(s) will receive information. A device may also have its address fixed so that it may only receive information (listen only) or only send information (talk only).

Polling - Polling is a means by which a controller can identify a device that needs interaction with it. The controller may poll devices for their operational condition one at a time, which is termed a serial poll, or as groups of devices simultaneously, which is termed a parallel poll.

3-89. Basic Device Communication Capability.

3-90. Devices which communicate along the interface bus fall into three basic categories.

Talkers - Devices which send information on the bus when they have been addressed.

Listeners - Devices which receive information sent on the bus when they have been addressed.

Controllers - Devices that can specify the talker and listener(s) for an information transfer. The controller can be an active controller or a system controller. The active controller is defined as the current controlling device on the bus. The system controller can take control of the bus even if it is not the active controller. Each system can have only one system controller, even if several controllers have system control capability.

3-91. Message Definitions.

3-92. Information is transferred on the HP-IB from one device to one or more other devices in quantities called "messages". Some of the messages consist of two basic parts, the address portion and the information portion. Others are general messages to all devices. Messages can be classified into twelve types, which are referred to as "meta messages". These are defined in Table 3-6. A block diagram presentation of meta messages and their implementation will be found in Appendix A-3 at the rear of this section.

NOTE

The meta message in itself is not a program code or an HP-IB command. It is only intended as a tool to translate a program written as an algorithm into the controller's code.

3-93. 3325A Response to Messages.

3-94. The 3325A is capable of implementing only those messages indicated in Table 3-7. In order for those messages to be implemented, certain bus actions are required, which are shown in the Interface Functions column.

3-95. HP-IB Work Sheet.

3-96. A work sheet is provided at the end of this section for listing the address and message capabilities of each instrument in your HP-IB system. When this sheet is filled out, it will provide a summary of the system capabilities.

3-97. HP-IB Addressing.

3-98. Certain messages require that a specific talker and listener be designated. Each instrument on the bus has its own distinctive listen and/or talk address which distinguishes it from other devices. The 3325A receives programming instructions when addressed to listen. When addressed to talk, it will respond to the instructions it received prior to being addressed to talk, such as an interrogation or serial poll.

3-99. Addressing usually takes the form of "universal unlisten, device talk, device(s) listen". The universal unlisten command removes all listeners from the bus, allowing only the listener(s) designated by the device(s) listen parameter to receive information. The information is sent by the talker designated by the device talk parameter. The system controller may designate itself as either talker or listener.

3-100. 3325A REMOTE PROGRAMMING.

3-101. 3325A HP-IB Capabilities.

3-102. Table 3-8 lists the HP-IB capabilities of the 3325A, which are compatible with IEEE Standard 488-1978.

Table 3-6. Definition of Meta Messages.

Message	Definition	Message	Definition
Data	The actual information (binary bytes) which is sent from a talker to one or more listeners. The information or data can be in a numeric form or a string of characters.	Status Byte	A byte that represents the status of a single device. One bit indicates whether the device sent the required service message and the remaining 7 bits indicate operational conditions defined by the device. This byte is sent from the talking device in response to a "Serial Poll" operation performed by a controller.
Trigger	The trigger message causes the listening device(s) to perform a device-dependent action.	Status Bit	A byte that represents the operational conditions of a group of devices on the bus. Each device responds on a particular bit of the byte thus identifying a device dependent condition. This bit is typically sent by devices in response to a parallel poll operation. The status bit message can also be used by a controller to specify the particular bit and logic level that a device will respond with when a parallel poll operation is performed. Thus, more than one device may respond on the same bit.
Clear	A clear message will cause a device(s) to return to a predefined device-dependent state.	Pass Control	This message transfers the bus management responsibilities from the active controller to another controller.
Remote	The remote message causes the listening device(s) to switch from local front panel control, to remote program control. This message remains in effect so that devices subsequently addressed to listen will go into remote operation.	Abort	The system controller sends the abort message to unconditionally assume control of the bus from the active controller. The message will terminate all bus communications but does not implement the clear message.
Local	This message clears the remote message from the listening device(s) and returns the device(s) to local front panel control.		
Local Lockout	The local lockout message is implemented to prevent the device operator from manually inhibiting remote program control.		
Clear Lockout and Set Local	This message causes all devices to be removed from the local lockout mode and revert to local. It will also clear the remote message for all devices.		
Require Service	A device can send this message at any time to signify that it needs some type of interaction with the controller. The message is cleared by the device's status byte message if it no longer requires service.		

3-103. Developing an HP-IB Program.

3-104. Basically, the 3325A is programmed remotely in the same manner as it is programmed manually. The sequence in which the various parameters are programmed is not important. At the end of this section (III) there is a summary of the HP-IB Programming Codes. This chart may be removed from the manual and/or copied to be used as a programming reference.

NOTE

It may be necessary to refer to some paragraphs on manual operation for descriptions of certain signals and requirements.

3-105. Several steps are needed to develop an HP-IB program.

a. Completely define the operation(s) the system is required to perform.

b. Write the program in flowchart or algorithm form. (An algorithm may be defined as a fixed step-by-step procedure for finding a solution to a problem.) Use the key words for meta messages shown in Table 3-6 in developing the program. The twelve key words are repeated here for reference.

Data
*Trigger
Clear
Remote
Local
Local Lockout
Clear Lockout and Set Local
Require Service

Table 3-7. 3325A Implementation of Messages.

Message	Implementation*	Interface Functions** Sender	Interface Functions** Receiver	3325A Response
Data	SR	T, SH	L^n, AH	Will send or receive as instructed
Trigger	NA			
Clear	R	ID-LIST C, SH ALL C, SH	DC^n, L, AH DC, AH	Device Clear sets 3325A to initial turn-on conditions. See Para. 3-8.
Remote	R	Remote Enable ID-LIST, C_s, SH	RL^n, L, AH RL, AH	Goes to Remote. Can be set to Local by LOCAL key.
Local	R	C_s, SH	RL^n, AH	Goes to Local.
Local Lockout	R	C, SH	RL, AH	Goes to Remote. Cannot be set to Local by LOCAL key.
Clear Lockout and Set Local	R	C, SH C_s	RL	Goes to Local from Local Lockout.
Require Service	S		C	Sets SRQ True.
Status Byte	S	SR^n	L^n, AH	Sends byte which indicates if service required and reason.
Status Bit	NA			
Pass Control	NA			
Abort	R	C_s		Unaddress

*S = Send Only
R = Receive Only
SR = Send and Receive
NA = Not Applicable

**SH = Source Handshake
AH = Acceptor Handshake
T = Talker (includes TE = Extended Talker)
L = Listener (includes LE = Extended Listener)
SR = Service Request
RL = Remote/Local
PP = Parallel Poll
DC = Device Clear
DT = Device Trigger
C = Any Controller
C_N = A specific controller (for example, C_A, C_B)
C_s = The System Controller
X^n = Indicates replication n times

Status Byte
*Status Bit
*Pass Control
Abort

*Not implemented by the 3325A

NOTE

The meta message in itself is not a program code or an HP-IB command. It is only intended as a tool to translate a program written as an algorithm into the controller's code.

Table 3-8. Interface Functions.

Code	Function
SH1	Source handshake capability
AH1	Acceptor handshake capability
T6	Basic talker; Serial Poll; Unaddressed to talk if addressed to listen
L3	Basic listener; Listen Only; Unaddressed to listen if addressed to talk
SR1	Service Request capability
RL1	Remote/Local capability
PP0	No parallel poll capability
DC1	Device clear capability
DT0	No device trigger capability
C0	No controller capability
E1	Open collector bus drivers

c. Define the operation in program codes that the instrument can use. Each instrument has its own set of program codes which are ASCII characters. The 3325A program codes are shown beginning with Paragraph 3-120 or Table 3-9.

d. Convert the program into the controller's language. The conversion information is supplied with each controller. For example, the -hp- 9825A Calculator Extended I/O Manual provides a chart for program code conversion.

NOTE

Examples for controlling the 3325A with a specific Hewlett-Packard calculator are provided in the Supplemental Programming Information, Appendix B-3 at the rear of this section.

3-106. Block diagrams and explanations of the meta messages that apply to the 3325A are shown in Appendix A-3 at the rear of this section.

3-107. Universal and Addressed Commands.

3-108. The 3325A will respond to the following universal and addressed commands, which are sent in the command mode (ATN true).

Mnemonic	Command	ASCII Code
Universal:		
*DCL	Device Clear	DC4
LLO	Local Lockout	DC1
MLA	My Listen Address	(selectable)
MTA	My Talk Address	(selectable)
SPD	Serial Poll Disable	EM
SPE	Serial Poll Enable	CAN
UNL	Unlisten	?
UNT	Untalk	–
Addressed:		
GTL	Go to Local	SOH
*SDC	Selected Device Clear	EOT

*DCL and SDC commands set the 3325A to its initial turn-on conditions (see Paragraph 3-8) and cause an AMPTD CAL operation. Any data in the HP-IB input buffer is lost. The storage registers, SRQ masking, and the status byte are not affected.

3-109. Placing the 3325A in Remote.

3-110. The 3325A will go to Remote when ATN is true, REN is true, and it receives its listen address.

3-111. The 3325A Address.

3-112. The 3325A address is normally set at the factory to:

	ASCII Character	5-Bit Octal	(5-Bit Octal Equivalent) Decimal	Hexadecimal
Listen	1	21	17	11
Talk	Q	21	17	11

The 3325A can be made to display its address in decimal code by pressing the blue prefix key and the BUS ADRS (LOCAL) key.

NOTES

1. All programming is shown in ASCII code.

2. Table 3-9 is a summary of the 3325A program data messages and program times. Table 3-10 lists program codes in binary, octal, decimal, and hexadecimal. At the end of this section (III) there is also a summary of the HP-IB programming codes. This chart may be removed from the manual and/or copied to be used as a programming reference.

3. The following front panel key actions cannot be remotely programmed:

Modify group
Sweep bandwidth × 2
Sweep bandwidth ÷ 2
Set sweep center frequency to marker frequency
Display bus address
Clear display

4. The 3325A must be set to REMOTE and addressed to LISTEN before it will accept device dependent data messages.

3-113. 3325A Data Message Formats.

3-114. The following are valid programming strings (data messages) for the 3325A:

Mnemonic, Data, Delimiter, EOS
Mnemonic, Data, EOS
Mnemonic, EOS
I, Mnemonic, EOS

Where I is the ASCII character I and EOS is the end-of-string character, which is required for Data Transfer Mode 2 (see following paragraphs). Valid EOS characters are:

LF = Line Feed = 12 octal
* = Asterisk = 52 octal

Table 3-9. Summary of 3325A Programming (ASCII Characters).**

Parameter or Operation	Mnemonics ASCII Code	Data	ASCII Code	Delimiters	Approximate Programming Time*
Data Transfer Mode Data Mode 1 Data Mode 2	 =MD =MD	 1 2		NA	MD=4.5 ms
Function	=FU	0=DC Only 1=Sine 2=Square 3=Triangle 4=Positive Ramp 5=Negative Ramp		NA	FU=1500 ms
Frequency	=FR	≤ 11 Digits and Decimal	HZ=Hertz KH=Kilohertz MH=Megahertz		FR=7.0 ms Each digit or decimal=2.8 ms HZ, KH, or MH=12.5 ms
Amplitude	=AM	≤ 4 Digits and Decimal. Also − sign if negative dBm. + sign is valid but not required.	VO=Volts (p-p) MV=Millivolts (p-p) VR=Volts rms MR=Millivolts rms DB=dBm		AM=6.8 ms Each digit, decimal or decimal=2.8 ms VO or MV=90 ms VR or MR=130 ms DB=250 ms
DC Offset	=OF	≤ 4 Digits and Decimal. Also − sign if negative dc offset. + sign is valid but not required.	VO=Volts MV=Millivolts		OF=6.8 ms Each digit, decimal, or − sign=2.8 ms VO or MV=82 ms
Phase	=PH	≤ 4 Digits − minus sign	DE=Degrees		PH=5 ms; DE=28 ms Each digit and − sign=2.8 ms
Sweep Start Frequency Sweep Stop Frequency Sweep Marker Frequency	=ST =SP =MF	≤ 11 Digits and Decimal	HZ=Hertz KH=Kilohertz MH=Megahertz		ST, SP, or MF=7.0 ms Each digit or decimal=2.8 ms HZ, KH, or MH=10.3 ms
Sweep Time	=TI	≤ 4 Digits and Decimal	SE=Seconds		TI=5.5 ms; SE=7.0 ms Each digit and decimal=2.8 ms
Sweep Mode Linear Logarithmic	=SM	 1 2		NA	SM=4.5 ms
Rear or Front Panel Output Front Panel Rear Panel	=RF	 1 2		NA	RF=44.5 ms
Store Program Recall Program	=SR =RE	1 Digit, 0-9		NA	SR=11 ms; RE=1700 ms
Execution Functions Assign Zero Phase Perform Auto-Cal Start Single Sweep Start Continuous Sweep Perform Self-Test	 =AP =AC =SS =SC =TE	NA NA		NA NA	 AP=5.2 ms AC=1500 ms SS=300 ms SC=300 ms TE=10,000 ms
Interrogate Program Error	=IER	NA		NA	IER=11.5 ms
Interrogate Entry Parameters Frequency Amplitude Offset Phase Sweep Start Frequency Sweep Stop Frequency Sweep Marker Frequency Sweep Time	 =IFR =IAM =IOF =IPH =IST =ISP =IMF =ITI	NA		NA	 IFR=10 ms IAM=9.8 ms IOF=9.8 ms IPH=8 ms IST=10 ms ISP=10 ms IMF=10 ms ITI=8.5 ms
Interrogate Function	=IFU	NA		NA	IFU=1603 ms
Mask Service Requests	=MS	See Para. 3-144		NA	MS=4.5 ms
Binary (ON/OFF) Functions High Voltage Output Amplitude Modulation Phase Modulation	 =HV =MA =MP	 OFF=0 ON=1		NA	HV=48 ms MA=7.0 ms MP=7.0 ms

*Program times are in addition to the data transfer time of 225 to 250 µs per byte.
**See Note 2 following Paragraph 3-112.

Table 3-10. Programming Codes.

Instruction	ASCII Characters	Binary Code	Octal Code	Decimal Code	Hexadecimal Code
Entry					
Frequency	F	1000110	106	70	46
	R	1010010	122	82	52
Amplitude	A	1000001	101	65	41
	M	1001101	115	77	4D
Offset	O	1001111	117	79	4F
	F	1000110	106	70	46
Phase	P	1010000	120	80	50
	H	1001000	110	72	48
Sweep					
Start Frequency	S	1010011	123	83	53
	T	1010100	124	84	54
Stop Frequency	S	1010011	123	83	53
	P	1010000	120	80	50
Marker Frequency	M	1001101	115	77	4D
	F	1000110	106	70	46
Time	T	1010100	124	84	54
	I	1001001	111	73	49
Start Continuous	S	1010011	123	83	53
	C	1000011	103	67	43
Start Single (must be sent twice)	S	1010011	123	83	53
	S	1010011	123	83	53
Sweep Mode	S	1010011	123	83	53
	M	1001101	115	77	4D
Numerical Data					
0	0	0110000	060	48	30
1	1	0110001	061	49	31
2	2	0110010	062	50	32
3	3	0110011	063	51	33
4	4	0110100	064	52	34
5	5	0110101	065	53	35
6	6	0110110	066	54	36
7	7	0110111	067	55	37
8	8	0111000	070	56	38
9	9	0111001	071	57	39
. (decimal)	.	0101110	056	46	2E
− (minus)	−	0101101	055	45	2D
Data Suffix (Delimiter)					
Hertz	H	1001000	110	72	48
	Z	1011010	132	90	5A
Kilohertz	K	1001011	113	75	4B
	H	1001000	110	72	48
Megahertz	M	1001101	115	77	4D
	H	1001000	110	72	4A
Volts (p-p or dc)	V	1010110	126	86	56
	O	1001111	117	79	4F
Millivolts (p-p or dc)	M	1001101	115	77	4D
	V	1010110	126	86	56
Volts rms	V	1010110	126	86	56
	R	1010010	122	82	52
Millivolts rms	M	1001101	115	77	4D
	R	1010010	122	82	52
dBm	D	1000100	104	68	44
	B	1000010	102	66	42
Degrees	D	1000100	104	68	44
	E	1000101	105	69	45
Seconds	S	1010011	123	83	53
	E	1000101	105	69	45
Store	S	1010011	123	83	53
	R	1010010	122	82	52
Recall	R	1010010	122	82	52
	E	1000101	105	69	45

Table 3-10. Programming Codes (Cont'd).

Instruction	ASCII Characters	Binary Code	Octal Code	Decimal Code	Hexadecimal Code
High Voltage Output	H V	1 0 0 1 0 0 0 1 0 1 0 1 1 0	110 126	72 86	48 56
Modulation-Amplitude	M A	1 0 0 1 1 0 1 1 0 0 0 0 0 1	115 101	77 65	4D 41
Modulation-Phase	M P	1 0 0 1 1 0 1 1 0 1 0 0 0 0	115 120	77 80	4D 50
Rear or Front Output	R F	1 0 1 0 0 1 0 1 0 0 0 1 1 0	122 106	82 70	52 46
Data Transfer Mode	M D	1 0 0 1 1 0 1 1 0 0 0 1 0 0	115 104	77 68	4D 44
Assign Zero Phase Reference	A P	1 0 0 0 0 0 1 1 0 1 0 0 0 0	101 120	65 80	41 50
Perform Auto Cal.	A C	1 0 0 0 0 0 1 1 0 0 0 0 1 1	101 103	65 67	41 43
Perform Self Test	T E	1 0 1 0 1 0 0 1 0 0 0 1 0 1	124 105	84 69	54 45
Mask SRQ	M S	1 0 0 1 1 0 1 1 0 1 0 0 1 1	115 123	77 83	4D 53
Interrogate (Parameter)	I	1 0 0 1 0 0 1	111	73	49
Interrogate Error	I E R	1 0 0 1 0 0 1 1 0 0 0 1 0 1 1 0 1 0 0 1 0	111 105 122	73 69 82	49 45 52
EOS (End of String) Line Feed Asterisk	 LF *	 0 0 0 1 0 1 0 0 1 0 1 0 1 0	 12 52	 10 42	 A 2A

All spaces (40 octal), carriage returns (15 octal), commas (54 octal), and all lower case alphabetics are ignored by the 3325A.

NOTE

A program string may program one parameter or all parameters. For example, the string "FU2FR10KHAM3VO" programs the following:

FU2 = Square wave function
FR10KH = 10 kHz
AM3VO = 3 V p-p

The EOS character should follow the complete string, or a maximum of 48 characters (see Paragraphs 3-115 through 3-118).

3-115. Data Transfer Mode.

3-116. The 3325A accepts data from the HP-IB in either of two modes. If speed of communication is a critical factor on your HP-IB system, Mode 2 is preferable. The characteristics of the two modes are:

Data Mode 1. The 3325A turns on in Data Mode 1. In this mode, each device dependent character (byte) is processed when received. Line feeds and Asterisks (EOS characters) are ignored. No other device dependent data communications are permitted on the bus until the entire 3325A program string has been accepted and all but the last character processed.

Data Mode 2. Device dependent characters are accepted and stored in an internal buffer and not processed until the EOS character is received or the buffer is filled (48 bytes). Consequently, other communications on the bus are permitted after the program string has been accepted (at the rate of approximately 150 to 200 microseconds per character). If the program string contains 48 characters or more, the 3325A will hold up the bus while it processes the 48 characters before accepting and storing the rest of the string. Because the instrument turns on in Data Mode 1, Mode 2 must be programmed remotely. It will then remain in Mode 2 until Mode 1 is programmed or until the POWER switch is set to STBY.

3-117. While the 3325A is processing data it will accept and respond to universal commands. For this reason, when operating in Mode 2, the controller can send a program string (48 characters or less) to the 3325A, and

while this data is being processed the controller can unaddress the 3325A to listen and then communicate with another device. However, if the string is more than 48 characters, the bus will be held up until the first 48 characters have been processed and the remaining characters accepted. In order for the bus to be used during 3325A processing time for communication between other devices, a program string greater than 48 characters should be divided and an EOS character sent after (or at a convenient place before) the 48th byte. The remaining program can then constitute a second string. While the 3325A is processing input information, a "Busy" flag is set in the status byte (see Paragraph 3-136). This flag can be used to determine when the 3325A has finished processing.

NOTE

The 3325A will handshake bus communications even though the POWER switch is set to STBY. This will not interfere with the operation of the bus unless it was set to STBY while addressed to talk. Before it is set to STBY, make sure it is not addressed to talk, or else disconnect the HP-IB cable from the 3325A. The addressed to talk condition can be cleared by an IFC command, even when the 3325A is in Standby.

3-118. Programming Data Transfer Mode.

3-119. Instructions for programming Data Transfer Mode are included in Paragraph 3-126.

3-120. Programming Entry Parameters.

3-121. The 3325A entry parameters are:

Frequency
Amplitude
Offset
Phase
Sweep Start Frequency
Sweep Stop Frequency
Sweep Marker Frequency
Sweep Time

The programming syntax for these parameters is:

Mnemonic, Data, Delimiter, EOS

NOTE

All program codes are shown in ASCII characters.

Valid mnemonics:

FR = Frequency
AM = Amplitude
OF = Offset
PH = Phase
ST = Sweep Start Frequency
SP = Sweep Stop Frequency
MF = Sweep Marker Frequency
TI = Sweep Time

Valid data:

0 thru 9 = ASCII numerics (if too many digits are sent, the extra digits will be ignored or rounded)

+ = ASCII plus sign (plus sign is accepted but not required)

− = ASCII minus sign (minus sign will be ignored if sent for parameters that cannot be negative)

. = ASCII decimal (floating decimal entries not valid)

Valid delimiters:

HZ = Hertz
KH = Kilohertz
MH = Megahertz
VO = Volts (peak-to-peak or dc)
MV = Millivolts (peak-to-peak or dc)
VR = Volts rms
MR = Millivolts rms
DB = dBm
DE = Degrees
SE = Seconds

NOTE

When operating in Data Mode 1, an EOS character is not required. When in Mode 2, the EOS character should not be sent until the end of the program string (or after 48 bytes; see Paragraph 3-117).

3-122. Programming Waveform Function.

3-123. The selectable functions are:

DC only
Sine wave
Square wave
Triangle wave
Positive Slope Ramp
Negative Slope Ramp

The programming syntax for selecting function is:

Mnemonic, Data, EOS

Valid mnemonic:

FU = Function

Valid data:

- 0 = Function off (dc only)
- 1 = Sine
- 2 = Square
- 3 = Triangle
- 4 = Positive Slope Ramp
- 5 = Negative Slope Ramp

3-124. Programming Binary (On or Off) Functions.

3-125. The programmable binary functions are:

High Voltage Output (Option 002)
Amplitude Modulation
Phase Modulation

The programming syntax for binary functions is:

Mnemonic, Data, EOS

Valid mnemonics:

HV = High Voltage Output (If the 3325A receives the HV mnemonic but does not have the high voltage option, SRQ (if enabled) and an error code will be generated. See Paragraph 3-134.)
MA = Modulation – Amplitude
MP = Modulation – Phase

Valid data:

- 0 = Off
- 1 = On

NOTE

The rear panel signal output is inactive (no internal signal connection) if the instrument has the High Voltage Output Option 002 installed. Instructions are given in the Operating and Service Manual, Section VIII, Service Group M, for activating the rear panel signal output in one of two ways: 1) Placing the standard/high voltage output on the rear panel only, disconnecting the front panel signal output, or 2) Disabling the high voltage output and enabling the standard front/rear output configuration.

3-126. Programming Selection Functions.

NOTE

The selection functions are similar to binary functions, but instead of ON or OFF states, selection is made between two mutually exclusive operations.

3-127. The programmable selection functions are:

Rear Output/Front Output
Linear Sweep/Logarithmic Sweep
Data Transfer Mode

The programming syntax for the selection functions is:

Mnemonic, Data, EOS

Valid mnemonics:

RF = Rear or Front Output
SM = Sweep Mode
MD = Data Transfer Mode

Valid data for RF is:

1 = Select Rear Output

2 = Select Front Output (If the 3325A receives the RF mnemonic but does not have rear output capability (Option 002, for example) SRQ (if enabled) and an error code will be generated. See Paragraph 3-134.)

Valid data for SM is:

1 = Linear Sweep (The 3325A turns on in Linear Sweep function. This function need not be programmed except to change from Linear to Log Sweep or to return to Linear.)

2 = Logarithmic Sweep

Valid data for MD is:

1 = Data Mode 1 (The 3325A turns on in Data Mode 1. This function need not be programmed if it is desired to remain in Data Mode 1.)
2 = Data Mode 2

3-128. Programming Execution Functions.

3-129. The programmable execution functions are:

Assign Zero Phase Reference
Perform Amplitude Calibration
Start Single Sweep
Start Continuous Sweep
Perform Self Test

The programming syntax for execution functions is:

Mnemonic, EOS

Valid mnemonics:

AP = Assign Zero Phase Reference
AC = Perform Amplitude Calibration
SS = Start Single Sweep

SC = Start Continuous Sweep
TE = Perform Self Test

NOTES

1. The Start Single mnemonic must be sent twice (SSSS). The first SS sets the output (and display) to the start frequency, and the second SS starts the sweep.

2. While the 3325A is in Continuous Sweep mode, if it receives the mnemonics SC, SS, FR, PH, AC, AP, or TE, it will stop sweeping. It must receive SC again in order to resume continuous sweeping; or if a single sweep is to be programmed, SSSS is required.

3. The "Busy" flag (bit 7 in the status byte, see Paragraph 3-138) will be "1" for the duration of a Self Test operation. After Self Test, the 3325A returns to the previously programmed conditions, except that if a sweep was in progress the sweep will remain stopped.

3-130. Programming Amplitude Units Conversion.

3-131. The programming syntax for converting amplitude units (Vp-p, Vrms, dBm) is:

Mnemonic, Delimiter, EOS

Mnemonic = AM = Amplitude

Delimiter = The units to which you want to convert:

VO = Vp-p
MV = mVp-p
VR = Vrms
MR = mVrms
DB = dBm

Example: If amplitude was programmed in Vp-p, it may be converted to dBm by programming "AMDB". If amplitude was the last parameter programmed and is shown in the display, only the delimiter "DB" needs to be programmed.

3-132. Programming Storage Registers.

3-133. The data that will be stored includes the current program of Entry Parameters, Function (Waveform), Binary Functions, and Selection Functions. The storage register functions are:

- Store Data in Register N
- Recall Data from Register N

The programming syntax for storage register functions is:

Mnemonic, Data, EOS

Valid mnemonics:

SR = Store
RE = Recall

Valid data:

Ø thru 9 = ASCII numerics specifying register number

NOTES

1. If no data has been stored in a register, the recall command for that register will be ignored.

2. An amplitude calibration is performed when a register is recalled.

3. The numeric value for the phase is stored, but the phase of the output is not changed when the register is recalled. (Phase may need to be reprogrammed.)

4. DCL (Device Clear) and SDC (Selected Device Clear) commands do not affect the storage registers.

3-134. Service Requests.

3-135. The 3325A will set the SRQ line true for any of the following reasons, if enabled by the SRQ mask (see Paragraph 3-144):

Program String Error
Sweep Started or Sweep Stopped
System Failure (Possible component problem)
  Failed Self Test
  Failed Amplitude Calibration
  External Reference Unlocked
  Main Oscillator Unlocked

3-136. Serial Poll.

3-137. When the system controller determines that the SRQ line is true, it may conduct either a Serial Poll or a Parallel Poll to determine which device(s) initiated the Service Request, and the reason(s) for the request. The 3325A responds to a Serial Poll, which is conducted in the following manner:

Controller places ATN true (command mode)
Controller sends Serial Poll Enable (SPE) on lines DIO1–8 (ASCII CAN, binary code ×0011000)

Controller sends 3325A Talk address, controller Listen address
Controller places ATN false (data mode)
3325A responds by sending status byte on DIO1–8
Controller places ATN true (after each device has been polled)
Controller sends Serial Poll Disable (SPD) on DIO1–8 (ASCII EM, binary code ×0011001)

Serial Poll Disable clears the SRQ message originated by the 3325A, resetting bits 0 through 3 and bit 6 in the status byte.

NOTE

Some of the above Serial Poll operations are performed automatically by some controllers in response to certain programming statements. Refer to the programming instructions for your particular controller.

3-138. Status Byte.

3-139. A status byte consists of one 8-bit byte on the HP-IB data lines. A "1" in bit 6 indicates that the 3325A did request service (placed SRQ true), and a "0" in bit 6 indicates that it did not request service. The 3325A status byte contains the following information:

```
7 6 5 4 3 2 1 0   Status byte bits
(8 7 6 5 4 3 2 1  DIO lines)
F R F x S S S S   F = Flag; R = Request Service:
                  S = Status
```

- Bit 0: 1 = Program String Error
- Bit 1: 1 = Sweep Stopped
- Bit 2: 1 = Sweep Started
- Bit 3: 1 = System Failure (possible component failure), includes:
  - Failed Self Test
  - Failed Amptd Cal
  - Ext Ref Unlocked
  - Main Osc Unlocked
- Bit 5: Sweep Flag. 1 = Sweep in Progress. Does not cause SRQ.
- Bit 6: RQS Message. 1 = Service Request.
- Bit 7: Busy Flag. 1 = 3325A busy processing data. Does not cause SRQ.

3-140. Busy Flag.

3-141. The Busy Flag (status byte bit 7) is high (1) while the 3325A is processing data. This bit can be monitored by the controller to determine when the 3325A is ready for more data.

3-142. Sweep Flag.

3-143. The Sweep Flag (bit 5 of the status byte) is high (1) while the 3325A is in the process of sweeping. This bit can be monitored by the controller to determine when the end of a sweep occurs.

3-144. Masking or Enabling Service Requests.

3-145. Bits 3 through 0 in the status byte can be masked so that the corresponding conditions will not cause a service request. However, a "1" will still appear in the status byte if the condition exists, and can be cleared only by a serial poll. At instrument turn-on all SRQ conditions are masked. The programming syntax for masking and enabling SRQ conditions is:

Mnemonic, Data, EOS

Mnemonic = MS

Valid Data is shown in Table 3-11.

3-146. Interrogating Program Errors.

3-147. The "Program Error" service request may result from the following Errors:

ASCII Numeric	Error
1	Entry parameter out of bounds (for example, Freq ≥ 61 MHz)
2	Invalid delimiter
3	Frequency too large for function (for example, Function = Triangle, Freq ≥ 11 kHz)
4	Sweep time too small or too large
5	Offset incompatible with amplitude, or amplitude incompatible with offset
6	Sweep frequency too large for function; Sweep bandwidth too small; Start frequency too small (log sweep); Start frequency greater than stop frequency (log sweep)
7	Unrecognizable mnemonic received
8	Unrecognizable data character received
9	Option does not exist (High Voltage or Rear/Front)

Table 3-11. SRQ Mask/Enable Data.

ASCII Character	Bits 3 thru 0	System Fail Bit 3	Sweep Start Bit 2	Sweep Stop Bit 1	Program Error Bit 0
@	*0000	Mask	Mask	Mask	Mask
A	0001	Mask	Mask	Mask	Enable
B	0010	Mask	Mask	Enable	Mask
C	0011	Mask	Mask	Enable	Enable
D	0100	Mask	Enable	Mask	Mask
E	0101	Mask	Enable	Mask	Enable
F	0110	Mask	Enable	Enable	Mask
G	0111	Mask	Enable	Enable	Enable
H	1000	Enable	Mask	Mask	Mask
I	1001	Enable	Mask	Mask	Enable
J	1010	Enable	Mask	Enable	Mask
K	1011	Enable	Mask	Enable	Enable
L	1100	Enable	Enable	Mask	Mask
M	1101	Enable	Enable	Mask	Enable
N	1110	Enable	Enable	Enable	Mask
O	1111	Enable	Enable	Enable	Enable

*Initial turn-on conditions

The programming syntax for interrogating error is:

Mnemonic, EOS

Mnemonic = IER

After receiving IER, the 3325A will send back the following the next time it is addressed to talk:

Mnemonic, Data, CR (ASCII carriage return), LF & EOI (ASCII line feed with EOI sent simultaneously)

Mnemonic = ER

Data = The ASCII numeric corresponding to the first error that occurred (see list above).

If no error occurred, the code returned is Ø. When more than one error has occurred, only the code for the first error will be returned. After interrogation, the error code is set to zero until the next error occurs.

3-148. Interrogating Entry Parameters.

3-149. Each entry parameter can be interrogated by the controller to determine its value. The programming syntax for interrogating entry parameters is:

I, Mnemonic, EOI

I = the ASCII character I and indicates interrogation desired.

Valid mnemonics (parameter to be interrogated):

FR = Frequency
AM = Amplitude
OF = Offset
PH = Phase
ST = Sweep Start Frequency
SP = Sweep Stop Frequency
MF = Sweep Marker Frequency
TI = Sweep Time

After receiving a parameter interrogation, the 3325A will send back the following the next time it is addressed to talk:

Mnemonic, Data, Delimiter, CR (ASCII Carriage Return), LF & EOI (ASCII Line Feed with EOI sent simultaneously)

Mnemonic = The mnemonic of the parameter being interrogated

Data = 11 digits of ASCII numerics equal to the value of the specified parameter plus decimal point. If the value is negative, the first digit is a minus sign.

Delimiter = The data suffix mnemonic denoting the parameter value (see Paragraph 3-120)

NOTE

Only one parameter can be interrogated by each interrogation message.

3-150. Interrogating Function (Waveform).

3-151. The 3325A may be interrogated by the controller to determine the current function programmed. The programming syntax for interrogating function is:

I, Mnemonic, EOS

I = The ASCII character I and indicates interrogation desired

Mnemonic = FU = Function

After receiving IFU, the 3325A will send back the following the next time it is addressed to talk:

Mnemonic, Data, CR (ASCII Carriage Return), LF & EOI (ASCII Line Feed with EOI sent simultaneously)

Mnemonic = FU

Data = One ASCII numeric indicating function as follows:

0 = DC Only (Offset)
1 = Sine
2 = Square
3 = Triangle
4 = Positive Slope Ramp
5 = Negative Slope Ramp

3-152. Interrogating Miscellaneous Parameters.

3-153. The other parameters shown below can be interrogated by the controller to determine their present state. The programming syntax is:

I, Mnemonic, EOS

I = The ASCII character I and indicates interrogation desired

Valid Mnemonics (parameter to be interrogated):

SM = Sweep Mode
RF = Rear or Front Output*
HV = High Voltage Output*
MA = Amplitude Modulation
MP = Phase Modulation

*Rear/Front output and High Voltage Output (Option 002) are mutually exclusive. If either RF or HV is interrogated, the mnemonic and data returned will indicate the actual capability of the instrument and its state. For example, if the High Voltage option is present and OFF, HV0 will be returned in response to either IRF or IHV.

After receiving an interrogation, the 3325A will send back the following the next time it is addressed to talk:

Mnemonic, Data, CR (ASCII Carriage Return), LF & EOI (ASCII Line Feed with EOI sent simultaneously)

Mnemonic = The mnemonic of the parameter being interrogated

Data = 1 ASCII digit specifying the state of the parameter. This is the same digit that would be used to program the parameter to that state.

3-154. Using the Interrogate Capability.

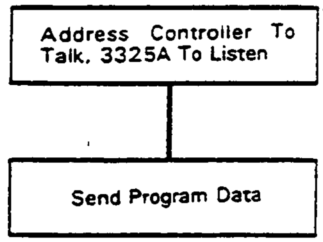
3-155. When the 3325A is changed from local to remote operation or vice versa, it retains its currently programmed state until this program is changed by the operator or controller. This feature can be useful in setting up a program string for HP-IB programming. For example, using the 3325A in local, the operator can determine experimentally the parameters required to perform the operation or test desired. Then the 3325A can be placed in remote and its function and entry parameters interrogated. Each item can be stored by the controller and then combined to form the 3325A program string to be incorporated into the total HP-IB program.

3-156. 3325A Programming Procedure.

3-157. The following examples are given to illustrate the basic procedure for developing a program. Program examples are shown in Appendix B-3, using the -hp- Model 9825A Calculator as the system controller. Appendix A-3 diagrams the required messages.

Example 1:
Address controller to talk, 3325A to listen

Send Program Data



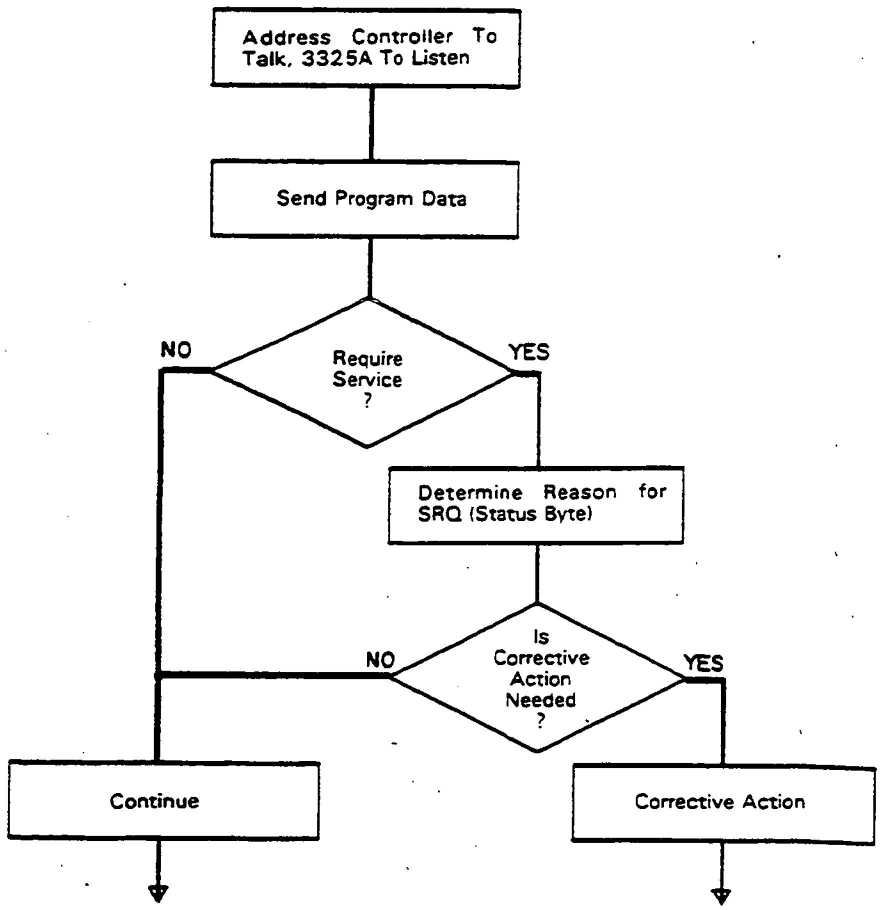
Example 2:
Address controller to talk, 3325A to listen

Send Program Data

Check for Require Service message

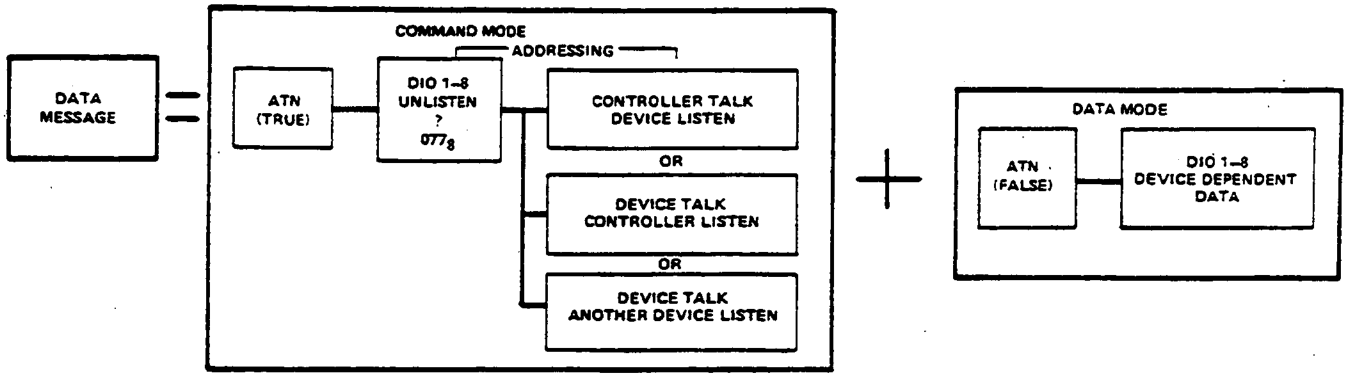
If yes, determine reason from 3325A Status Byte

Take corrective action if necessary



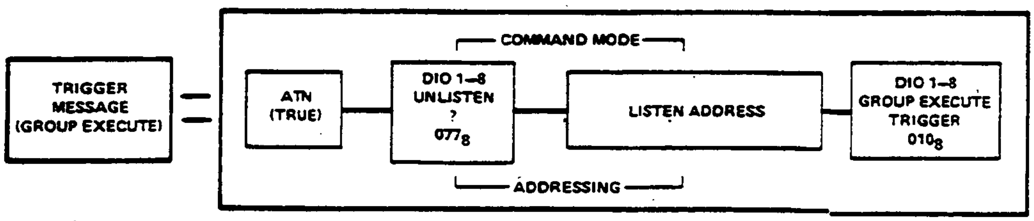
APPENDIX A
SECTION III
META MESSAGES
BLOCK DIAGRAMMED

DATA MESSAGE — The Data message is the actual information that is sent from a talker to one or more listeners. This action requires the controller to first enter the command mode to set up the talker and listener(s) for the transfer of data. The information is then transferred in the data mode.



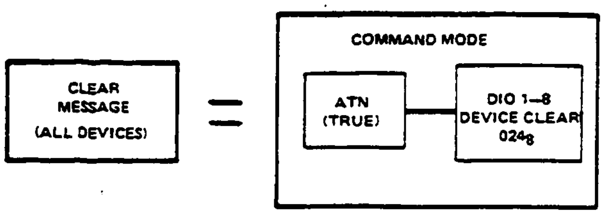
TRIGGER — The Trigger message causes all addressed instruments with this capability to execute some predefined function simultaneously.

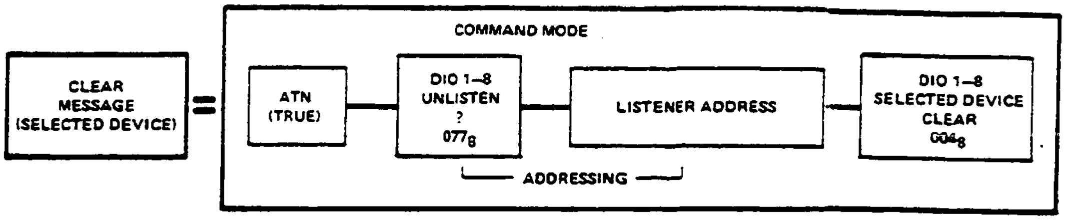
The 3325A does not have Trigger capability.



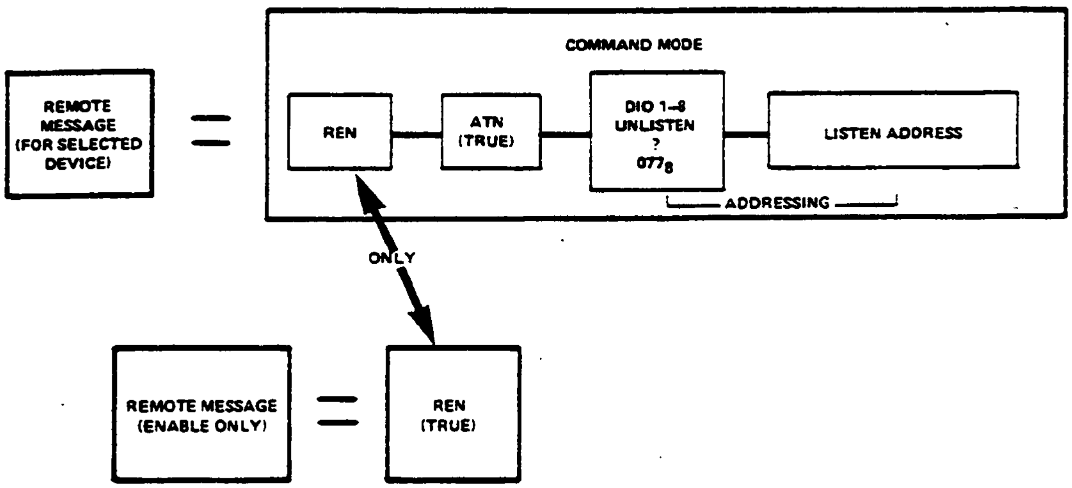
REN MUST BE TRUE BEFORE EXECUTING THE TRIGGER MESSAGE.

CLEAR — The Clear message may be implemented for addressed devices or for all devices on the bus capable of responding. In both cases the controller places the bus in the command mode to execute the message.

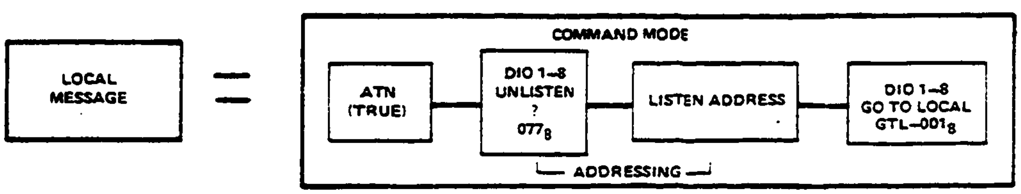




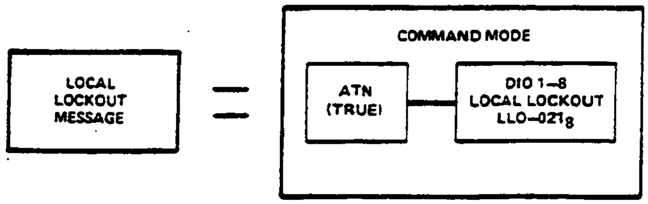
REMOTE — Only the system controller can place the device into the Remote operating condition. To implement the Remote message, the controller must set the REN line true. The HP-IB is then in the Remote Enable mode. The controller then sends the listen addresses of those devices that are to be placed in the Remote operating condition. Some instruments have been designed to enter the Remote mode as soon as REN is true.



LOCAL — The Local message will remove addressed devices from the Remote operating mode to local (front panel) control. The controller must place the HP-IB into the command mode and address to listen all devices that are to be returned to local. The Local message does not remove the HP-IB from the Remote mode, only the listening devices.

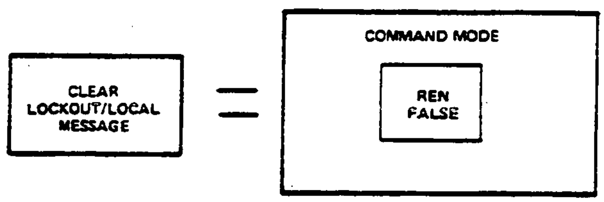


LOCAL LOCKOUT — The Local Lockout message prevents the operator from placing the instrument into local control from the front panel. The controller must be in the command mode to send the Local Lockout message.

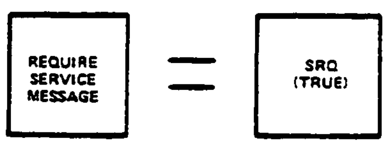


REN MUST BE TRUE BEFORE EXECUTING THE LOCAL LOCKOUT MESSAGE.

CLEAR LOCKOUT AND SET LOCAL — This message removes all devices from the Local Lockout mode and causes them to revert to local control. Because the REN line is set false, the HP-IB is in the local mode.

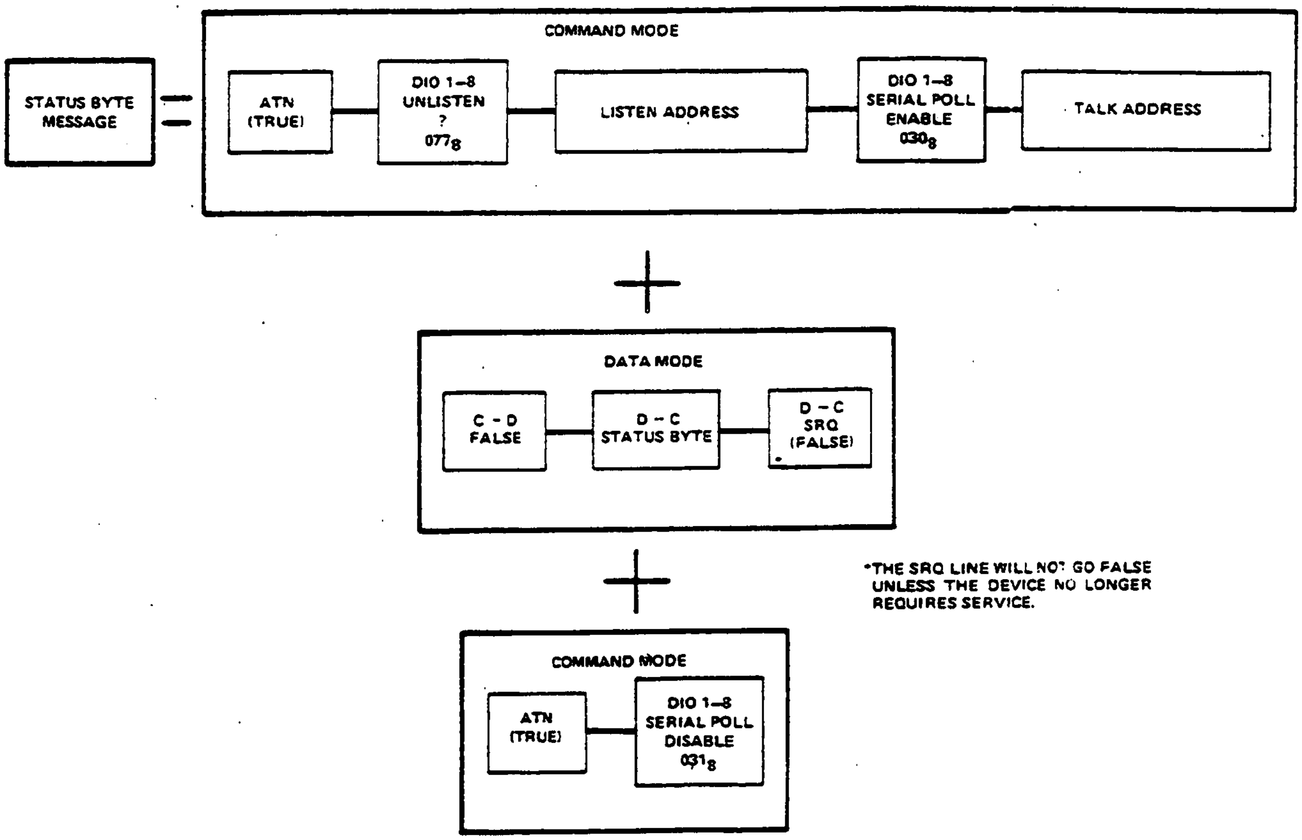


REQUIRE SERVICE — The Require Service message is implemented by a device setting the SRQ line true. The Require Service message and, therefore, the SRQ line is held true until a poll is conducted by the controller to determine the cause of the request for service, or until the device no longer needs service.

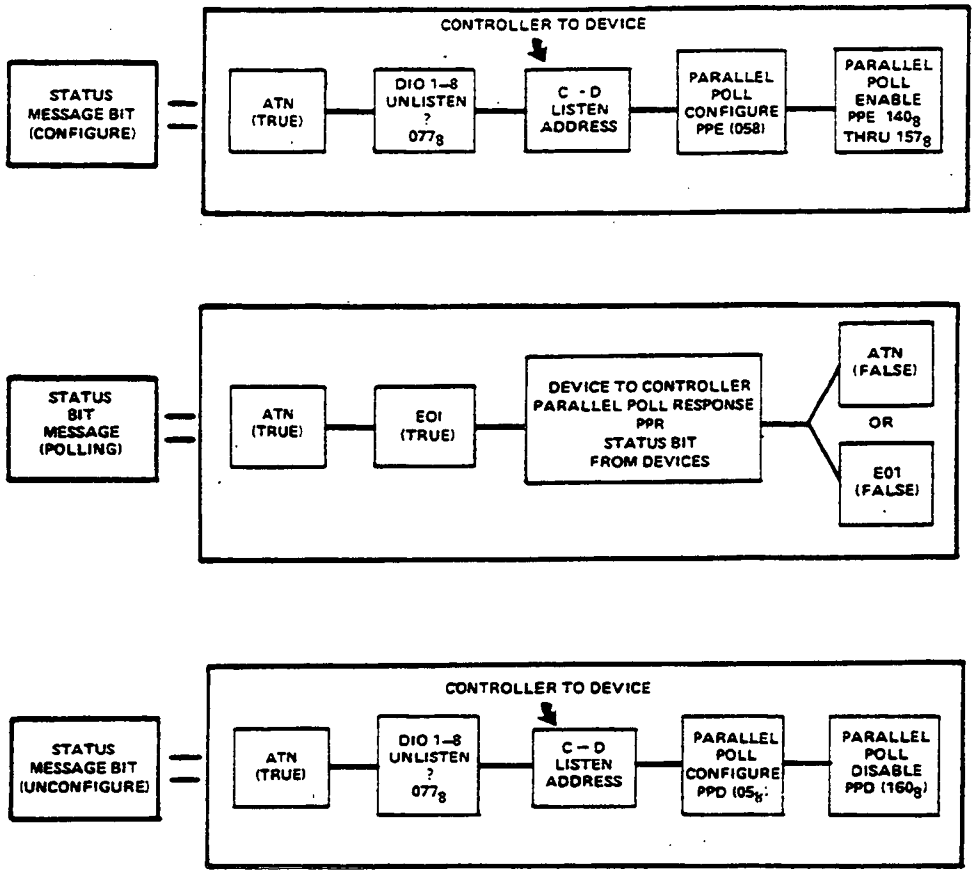


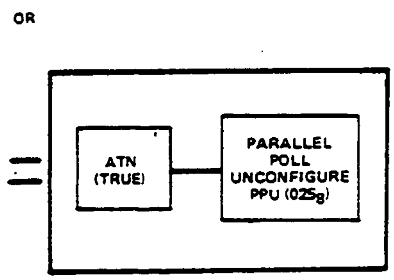
*REFER TO THE STATUS BYTE MESSAGE FOR THE SPECIFICATIONS REQUIRED TO FORCE SRQ FALSE.

STATUS BYTE — The Status Byte message represents the operational status of a single instrument during a Serial Poll. A controller usually Serial Polls devices in response to a Require Service message. The controller requests device status from one device at a time. The status information byte (8 bits) sent by the device will tell whether that device needed service and why. A device will stop requesting service upon being Serial Polled, or if it no longer needs service. The controller initiates the message by placing the bus into the command mode, sending the Serial Poll Enable command, and addressing the specific devices to be polled, one at a time. The device then sends its Status Byte and clears the SRQ line provided the cause for the require Service message is no longer present. The controller then places the bus in the command mode to terminate the message with a Serial Poll Disable command.



STATUS BIT — The Status Bit message is sent by a device to the controller to indicate its operational status in response to a Parallel Poll. Parallel Polling consists of the controller requesting one bit of status from each device simultaneously. The Parallel Poll may consist of three types of operations: Configuring, Polling, and Unconfiguring. In Configuring, the controller assigns each device a logic level and bit (on the bus data lines) for a poll response. During polling, each device responds on its assigned data line with the appropriate logic level. In Unconfiguring, the controller negates the bit and level assignments for all or selected devices. Several devices may be assigned to the same bit and level, causing their response bits to be logically ORed or ANDed.

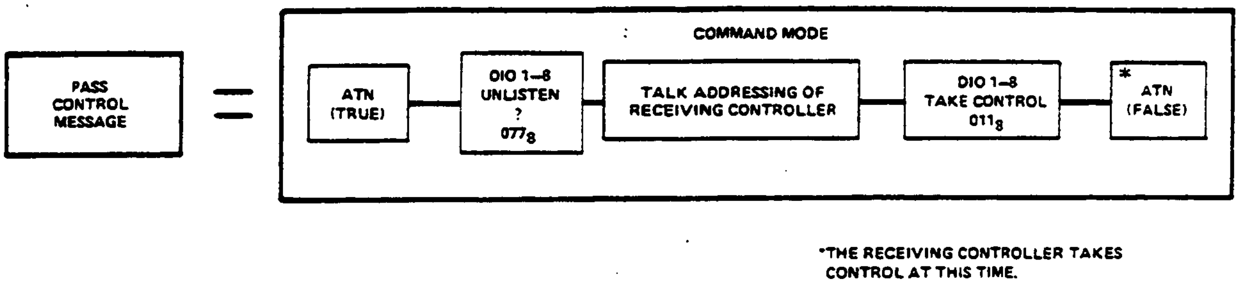




PPE ASSIGNS THE LOGIC LEVEL AND DATA LINE OF A DEVICE(S) RESPONSE. 140_8 THRU 147_8 ASSIGN THE LOW (TRUE) LEVEL AND 150_8 THRU 1507_8 ASSIGNS THE HIGH (FALSE) LEVEL. 140_8 AND 150_8 ASSIGNS BIT 2^0 (DATA LINE 1), 141_8 AND 157_8 WHICH ASSIGN BIT 2^7 AND IS THE LAST POSSIBLE ASSIGNMENT.

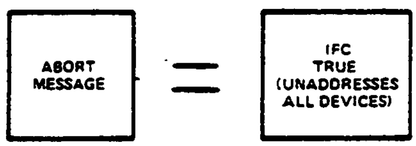
The 3325A does not respond to Parallel Poll.

PASS CONTROL — The Pass Control message transfers bus management responsibilities from the active controller to another controller. In order to pass control, the active controller must enter the command mode, send the talk address, and the HP-IB characters for talk control.



The 3325A does not respond to the Pass Control message.

ABORT —The system Controller implements the Abort Message to regain control of the HP-IB from the active controller.

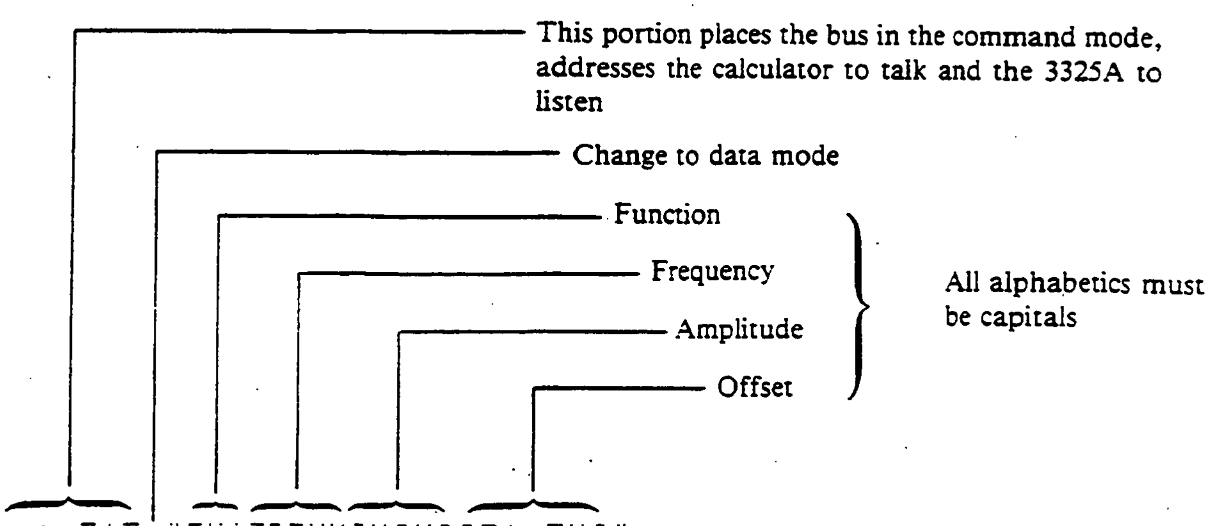


APPENDIX B
SECTION III
PROGRAMMING THE MODEL 3325A with the MODEL 9825A CALCULATOR

The following basic examples are provided to assis the operator in developing programs for the Model 3325A in an HP-IB system which uses the -hp- Model 9825A Calculator as the system controller. The calculator must be equipped with a General I/O ROM and an HP-IB Interface set to select code 7. The calculator (controller) normally holds the REN line true, unless the "lcl 7" (local) command is sent. REN may be returned to the true state by the "rem 7" (remote) command.

Example 1: This is a basic program statement which accomplishes the following:

Address the controller to talk
Address the 3325A to listen
Sent Program Data:
  Function: Sine
  Frequency: 5 kHz
  Amplitude: 3 Vp-p
  Offset: +1.5 V




```
0: wrt 717,"FU1FR5KHAM3VOOF1.5VO"
```

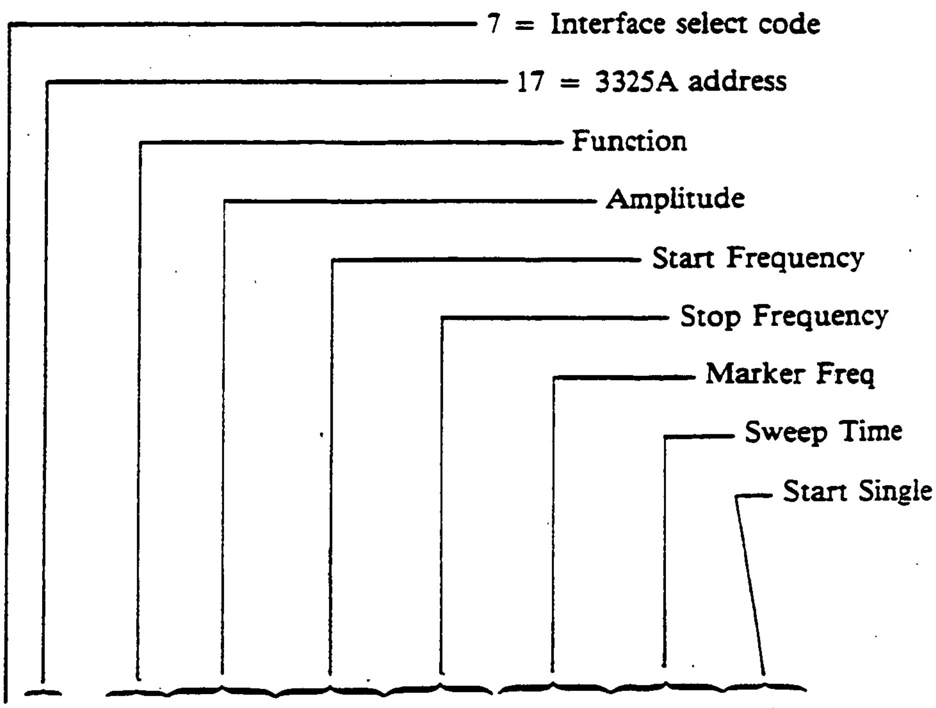
The last parameter programmed can be changed without sending the parameter mnemonic. For example, following the program string above, the offset (OF) may be changed to 1 V by sending "1VO".

Example: 2: This program sets up sweep parameters and initiates a single sweep.

Address the controller to talk
Address the 3325A to listen
Send Program Data:
- Function: Sine
- Amplitude: 3 Vrms
- Start Frequency: 1 kHz
- Stop Frequency: 10 kHz
- Marker Frequency: 5 kHz
- Sweep Time: 2 seconds
- Start Single Sweep

NOTE

To start a single sweep the mnemonic "SS" must be sent twice. The first "SS" sets the 3325A to the Start frequency, and the second "SS" starts the sweep.




```
0: wrt 717,"FU1AM3VRST1KHSP10KHMF5KHTI2SESSSS"
```

Example 3: This example checks the "Require Service" status of the 3325A and if it did request service, determines the reason.

```
0: wrt 717,"MSOF
 U3AM3VOST1KHSP1
 5KHMF5KHTI5SESC
 "
1: wait 1000
2: rds(717)→S
3: if bit(6,S)=1
 ;prt "Request
 Service";gsb 5
4: dsp "PROCEED
 WITH PROGRAM";
 stp
5: if bit(0,S)=1
 ;prt "Program
 Error";wrt 717,
 "IER";red 717,E
6: if E=1;prt
 "Parameter out
 of Bounds"
7: if E=2;prt
 "Invalid Delimi
 ter"
8: if E=3;prt
 "Freq too large
 for Function"
9: if E=4;prt
 "Sweep Time
 Invalid"
10: if E=5;prt
 "Offset & Amptd
 Incompatible"
11: if E=6;prt
 "Sweep Paramete
 r Error"
12: if E=7;prt
 "Unrecognizable
 Mnemonic"
13: if E=8;prt
 "Unrecognizable
 Data Char"
14: if E=9;prt
 "Option Does
 Not Exist"
```

1. Enables all service request conditions.

2. Program data contains an error. Stop frequency (SP15KH) is too large for triangle function (FU3).

3. Wait statement allows time for sweep to start before reading status.

4. Read status byte from the 3325A and place in the calculator variable "S".

5 If bit 6 of the status byte = 1, the 3325A did request service. Go to subroutine to determine the reason.

6. Programming continues at this point if the 3325A did not request service or upon returning from the subroutine.

7. If service request resulted from a program string error, interrogate the 3325A to determine the error code and place in the calculator variable "E".

8. Determine the nature of the program error.

```
15: if bit(1,
 S)=1;prt "Sweep
  Stopped"
16: if bit(2,
 S)=1;prt "Sweep
  Started"
17: if bit(3,
 S)=1;prt "Syste
 m Failure"
18: if bit(5,
 S)=1;prt "Sweep
 ing"
19: if bit(7,
 S)=1;prt "Busy"          (9)
20: ret                   (10)
```

```
Request Service
Program Error             (11)
Sweep Parameter
Error
```

```
Request Service
Sweep Started             (12)
Sweeping
```

9. Determine other reason for service request and if "Sweeping" or "Busy" flags were true.

10. Return from subroutine.

11. Printer records the results of the serial poll.

12. If the program string were corrected to make all data valid, this printout would result from the above program.

Example 4: The 3325A can be set up manually to the optimum parameters needed for the test to be performed, then the calculator can interrogate the 3325A to determine and record these parameters. This example program interrogates:

Function: IFU
Frequency: IFR
Amplitude: IAM
DC Offset: IOF

```
0: wrt 717,"IFU"
 ;red 717,W;fxd
 6
1: prt "Function
  =",W
```

Line Ø Write statement interrogates Function; read statement addresses 3325A to talk, calculator to listen, and places data in variable W; "fxd 6" fixes six decimal places.

Line 1 Because only numerical data can be placed in the variables, print statements may include in quotes the parameter interrogated.

```
2: wrt 717,"IFR"
 ;red 717,F
3: prt "Frequenc
 y =",F,"Hz"
4: wrt 717,"IAM"
 ;red 717,A
5: prt "Amplitud
 e =",A
6: wrt 717,"IOF"
 ;red 717,O
7: prt "Offset
 =",O,"V"
```

Lines 2 - 7 Other parameters are interrogated. Amplitude data acquired by this program does not indicate the units programmed. Frequency is always returned in Hz and DC Offset in Volts.

```
Function =
        1.000000
Frequency =
     1000.000000
Hz
Amplitude =
       22.310000
Offset =
        0.001000
V
```

This printout results from the above program.

If the calculator is equipped with a String Variable ROM, the interrogate program may be changed to the following. Because string variables accept both alpha and numeric characters, the resulting printout includes the mnemonics and delimiters (units).

```
0: dim W$[50],
 F$[50],A$[50],
 O$[50]                  (1)
1: wrt 717,"IFU"
 ;red 717,W$;
 prt W$
2: wrt 717,"IFR"
 ;red 717,F$;
 prt F$
3: wrt 717,"IAM"
 ;red 717,A$;
 prt A$
4: wrt 717,"IOF"
 ;red 717,O$;
 prt O$
```

1. Dimension a string variable for each parameter you want to interrogate. The dimension number (in brackets) is the number of spaces assigned to the variable.

```
FU1
FR00001000.000HZ
AM00000022.310DB         (2)
OF00000.001000VO
```

2. This printout results when string variables are used.

Example 5: The 3325A can be made to sweep amplitude (in steps) if a for/next statement is used in the calculator program. It is recommended that the upper and lower amplitude limits selected be on the same range because irregularities in the sweep will occur if the attenuator relays are switched.

```
0: wrt 717,"FU1F
 R1KHOF0VOAM3VO"
1: for I=3 to
 10 by .1;wrt
 717,I,"VO"
2: next I
3: for I=10 to
 3 by -.1;wrt
 717,I,"VO"
4: next I
5: gto 1
```

Line 0 DC Offset (OF0VO) is programmed to zero because any offset would be incompatible with the 10 V maximum amplitude of this sweep.

Line 1 The sweep limits (3 to 10) are on the same range. The sweep increment is in .1 V steps. Because amplitude was the last parameter programmed, the write statement does not require the "AM" mnemonic.

Line 2 The calculator returns to Line 1 until I = 10, then proceeds to Line 3.

Line 3 The sweep decrement is also in .1 V steps.

Line 5 Return to Line 1 to continue sweeping.

The sweep speed is determined by calculator and 3325A data transfer and processing times. If a slower sweep time is desired, wait statements may be added before the "next I" statements.

MODEL 3325A SYNTHESIZER/FUNCTION GENERATOR HP-IB PROGRAMMING CODE (ASCII Characters)

FUnction

DC only	Ø
Sine	1
Square	2
Triangle	3
Positive Ramp	4
Negative Ramp	5

FRequency

Hz	HZ
kHz	KH
MHz	MH

AMplitude

Volts p-p	VO
mVp-p	MV
Vrms	VR
mVrms	MR
dBm	DB

DC OFfset

Volts	VO
mV	MV

PHase

Degrees	DE

Sweep STart Frequency

Sweep StoP Frequency

Sweep Marker Frequency

Sweep TIme

Seconds	SE

Sweep Mode

Linear	1
Logarithmic	2

StoRe Program Ø – 9

REcall Program Ø – 9

Rear or Front Panel Output

Front	1
Rear	2

Execution Functions

- Assign Zero Phase
- Perform Amptd Cal
- Start Single*
- Start Continuous
- Perform Self TEst

High Voltage Output

On	1
Off	Ø

Amplitude Modulation – MA

On	1
Off	Ø

Phase Modulation – MP

On	1
Off	Ø

Data

Ø	Ø
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
–	–
.(Decimal)	.

Interrogate Operations

Function	IFU
Frequency	IFR
Amplitude	IAM
Offset	IOF
Phase	IPH
Swp Start Freq	IST
Swp Stop Freq	ISP
Swp Mkr Freq	IMF
Sweep Time	ITI
Sweep Mode	ISM
Rear/Front Out	IRF
High Volt Out	IHV
Error	IER
Program Mode	IMD
Amptd Mode	IMA
Phase Mode	IMP

Error Codes (See Paragraph 3-146)

1. Entry parameter out of bounds
2. Invalid delimiter
3. Frequency too large for function
4. Sweep time too small or too large
5. Offset and amplitude incompatible
6. Sweep frequency or bandwidth error
7. Unrecognizable mnemonic
8. Unrecognizable data character
9. Option does not exist

*Start Single code must be sent twice "SSSS". The first "SS" resets the sweep to start conditions and the second "SS" starts the sweep.

HP-IB IMPLEMENTATION WORKSHEET

DEVICE IDENTIFICATION														
ADDRESS	LISTEN													
	TALK													
	DECIMAL													
MESSAGE						DEVICE IMPLEMENTATION*								
DATA														
TRIGGER														
CLEAR														
LOCAL														
REMOTE														
LOCAL LOCKOUT														
CLEAR LOCKOUT AND SET LOCAL														
REQUIRE SERVICE														
STATUS BYTE														
STATUS BIT														
PASS CONTROL														
ABORT														

*S=SEND ONLY R=RECEIVE ONLY SR=SEND AND RECEIVE N=NOT IMPLEMENTED

SECTION IV
PERFORMANCE TESTS

4-1. INTRODUCTION.

4-2. This section contains tests which are in-cabinet procedures to determine whether the instrument is operating properly. In the Operating and Service Manual two sets of procedures are provided:

a. Operational Verification procedures which are recommended for incoming inspection and general after-repair tests.

b. Performance Tests which compare the instrument operation to the specifications listed in Table 1-1.

The Operating Supplement contains only the Operational Verification Procedures.

4-3. CALCULATOR-CONTROLLED TEST.

4-4. The only calculator-controlled test in these procedures tests the HP-IB interface circuits for proper operation. All input and output lines are tested. The program used for this test is written specifically for the -hp- Model 9825A Calculator but may be adapted to other controllers. The calculator prints the test results. This test is recommended for both the Operational Verification Checks and the Performance Tests.

4-5. OPERATIONAL VERIFICATION.

4-6. The following procedures are recommended for incoming inspection and for testing the instrument after repair. Additional tests to be performed following repair of certain circuits are indicated in Section VIII. An Operational Verification Record is located at the end of this section. For ease of recording the test data at various times, copies of the blank Operational Verification Record may be made without written permission from Hewlett-Packard.

4-7. Operational Verification includes the following procedures:

Par. No.	Test
4-10	Self Test
4-12	Sine Wave Verification
4-14	Square Wave Verification
4-16	Triangle and Ramp Verification
4-18	Amplitude Flatness Check
4-20	Sync Output Check
4-22	Frequency Accuracy
4-24	Output Level and Attenuator Check
4-26	Harmonic Distortion Test
4-28	Close-in Spurious Signal Test
4-30	HP-IB Interface Test

4-8. Required Test Equipment.

4-9. A list of test equipment required for the Operational Verification procedures is given in Table 4-1. Any equipment that satisfies the critical specifications given in the table may be substituted for the recommended model.

4-10. Self Test.

4-11. This test uses the control, ROM, and control clock circuits to verify operation of these and other circuits. The following front panel indications result from this test.

LED check: Turns on all LED's for about two seconds

The following messages are displayed for about one second:

OSC FAIL - displayed only if the VCO is not controlled (displayed continuously after test)

PASS or FAIL 1 - tests AMPTD CAL of sine wave

PASS or FAIL 2 - tests AMPTD CAL of square wave

PASS or FAIL 3 - tests AMPTD CAL of triangle

Press the blue entry prefix key, then press SELF TEST (AMPTD CAL) key. All LED's should light, and the display should not indicate any failures.

4-12. Sine Wave Verification.

4-13. This procedure visually checks the sine wave output for the correct frequency and any visible irregularities.

Equipment Required: Oscilloscope (-hp- Model 1740A)

a. Connect the 3325A signal output to the oscilloscope vertical input. If the oscilloscope is an -hp- Model 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 (-hp- Model 11048C 50-ohm Feedthru Termination) at the input.

b. Set the 3325A as follows:

High Voltage Output (Option 002) . . . . . Off
Function . . . . Sine
Frequency . . . . 20 MHz
Amplitude . . . . 10 V p-p

Table 4-1. Test Equipment Required for Operational Verification.

Instrument	Critical Specifications	Recommended Model
Oscilloscope	Vertical: Bandwidth: dc to 100 MHz Deflection: 1 V to 5 V/div Horizontal: Sweep: .05μs to 1 s/div External Sweep Input	-hp- 1740A
Electronic Counter	Frequency measurement to 20 MHz Accuracy: ±2 counts Resolution: 8 digits	-hp- 5328A with Opt. 040 or 041
DC Digital Voltmeter	Ranges: 0.1 V to 100 V Resolution: 6 digits Accuracy: ±0.1%	-hp- 3455A
50-ohm load	Accuracy: ±0.2% Power Rating: 1 W	-hp- 11048C
High Frequency Spectrum Analyzer	Frequency Range: 1 MHz to 80 MHz Amplitude Accuracy: ±0.5 dB Noise: >70 dB below reference	-hp- 141T/8552B/8553B/ 8566A/8568A
Low frequency Spectrum Analyzer	Frequency Range: 100 Hz to 50 kHz Amplitude Range: 2 m V to 20 V Noise: >80 dB below input reference or −140 dBv	-hp- 3580A/3585A
Resistor	56.2Ω 1/8W 1.0%	-hp- 0757-0395
Adapter	BNC female-to-dual banana plug	-hp- 1250-2277
Calculator	HP-IB Control Capability	-hp- 9825A with 98034A Interface, General I/O ROM, Extended I/O ROM
Resistor	470Ω 2W 5%	-hp- 0698-3634

c. Set the oscilloscope vertical control to 2 V/div, horizontal to .05 μs/div.

d. The oscilloscope should display one cycle per division, approximately five divisions peak-to-peak.

e. Change 3325A frequency to 1 MHz.

f. Change oscilloscope horizontal control to .1 μs/div.

g. The oscilloscope should display one sine wave having no visible irregularities.

High Voltage Output (Option 002)

h. Set the oscilloscope vertical control to 5 V/div.

i. Set the oscilloscope input switch to 1 MΩ dc coupled position (or disconnect external 50-ohm load).

j. Press 3325A High Voltage Output key (lower right corner of front panel).

k. Change 3325A amplitude to 40 V p-p. The oscilloscope should display one sine wave approximately eight divisions peak-to-peak having no visible irregularities.

l. Press the High Voltage Output key again to turn the option off.

4-14. Square Wave Verification.

4-15. This procedure checks the square wave output for frequency, rise time, and abberrations.

Equipment Required: Oscilloscope (-hp- Model 1740A)

a. Connect the 3325A signal output to the oscilloscope vertical input. If the oscilloscope is an -hp- Model 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 (-hp- Model 11048C 50-ohm Feedthru Termination) at the input.

b. Set the 3325A as follows:

High Voltage Output (Option 002) ..... Off
Function .... Square
Frequency .... 1 MHz
Amplitude .... 10 V p-p

c. Set the oscilloscope vertical control to 2 V/div, horizontal to .2 μs/div. The oscilloscope should display two square waves, approximately five divisions peak-to-peak.

d. Switch the oscilloscope vertical control to 1 V/div. so that the abberrations (overshoot and ringing) can be measured. Aberration excursion should be less than 500 mV (½ div.).

e. Repeat Step d at 2 kHz and .1 ms/div.

f. Adjust the oscilloscope vertical and horizontal controls so that the square wave rise time between the 10% and 90% points can be measured. Rise time should be less than 20 nanoseconds.

4-16. Triangle and Ramp Verification.

4-17. This procedure checks the triangle and ramp output signals for frequency, shape, and ramp retrace time.

Equipment Required: Oscilloscope (-hp- Model 1740A)

a. Connect the 3325A signal output to the oscilloscope vertical input. If the oscilloscope is an -hp- Model 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 (-hp- Model 11048C 50-ohm Feedthru Termination) at the input.

b. Set the 3325A as follows:

High Voltage Output (Option 002) ..... Off
Function .... Triangle
Frequency .... 10 kHz
Amplitude .... 10 V p-p

c. Set the oscilloscope vertical control to 2 V/div, horizontal to .1 ms/div. The oscilloscope should display one triangle wave per division, approximately five divisions peak-to-peak.

d. Change the 3325A function to positive slope ramp. The display should be one ramp per division, approximately five divisions peak-to-peak.

e. Change 3325A function to negative slope ramp. The display should be one ramp per division, approximately five divisions peak-to-peak.

f. Change the oscilloscope horizontal and vertical controls so that the ramp retrace time from the 90% to 10% points can be measured. Retrace time should be less than 3 μs.

g. Change 3325A function to positive slope ramp and repeat Step f.

h. Change 3325A function to triangle.

i. Set oscilloscope vertical control to 2 V/div, horizontal to 10 μs/div. The oscilloscope should display one triangle wave with no visible irregularities in either slope.

4-18. Amplitude Flatness Check.

4-19. This procedure provides a visual check of the sine wave amplitude flatness.

Equipment Required: Oscilloscope (-hp- Model 1740A)

a. Connect the 3325A signal output to the oscilloscope vertical input. If the oscilloscope is an -hp- Model 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 (-hp- Model 11048C 50-ohm Feedthru Termination) at the input.

b. Set the 3325A as follows:

High Voltage Output (Option 002) ..... Off
Function .... Sine
Frequency .... 2 kHz
Amplitude .... 10 V p-p
Sweep Start Freq .... 0 Hz
Sweep Stop Freq .... 20 MHz
Sweep Marker Freq .... 5 MHz
Sweep Time .... .01 sec

c. Connect the 3325A X-Drive output to the oscilloscope's channel B input. Connect the 3325A signal output to the oscilloscope's channel A input.

* d. Set the oscilloscope as follows:

Display .... A vs B
Channel A Sensitivity 1V/div
(uncal - adjust for full vertical deflection)
Channel B Sensitivity 0.5V/div
(uncal - adjust for full horizontal sweep)

* Settings may vary from one oscilloscope to another. Note that whichever scope is used, it should be operated in a "X-Y" mode, with the 3325A X-Drive output driving the horizontal (X) sweep and the signal output driving the scope's vertical (Y) channel.

e. Press the 3325A START CONT key.

f. The oscilloscope display should show a sweep that is essentially flat, dropping no more than 3.5%. Any D.C. variations should be ignored, taking the peak-to-peak reading for flatness comparison.

4-20. Sync Output Check.

4-21. This test verifies the sync output signal levels.

Equipment Required: Oscilloscope (-hp- Model 1740A)

a. Connect the 3325A sync output to the oscilloscope vertical input. If the oscilloscope is an -hp- Model 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 (-hp- Model 11048C 50-ohm Feedthru Termination) at the input.

b. Set the 3325A function to sine, frequency to 20 MHz.

c. Adjust the oscilloscope controls to measure the high and low voltage levels of the sine square wave. The high level should be greater than +1.2 V and the low level should be less than +0.2 V.

4-22. Frequency Accuracy.

4-23. This test compares the accuracy of the 3325A output signal to the specification in Table 1-1: $\pm 5 \times 10^{-6}$ of selected frequency.

Equipment Required: Electronic Counter (-hp- Model 5328A, calibrated within three months or with an accurate 10 MHz external reference input)

a. Connect the 3325A signal output to the electronic counter channel A input with a 50 Ω load. Allow 3325A and counter to warm up for 20 minutes.

b. Set the 3325A output as follows:

Function ....Sine
Frequency ....20 MHz
Amplitude ....0.99 V P-P
DC Offset ....0 V

c. Set the counter to count the frequency of the A input with 0.1Hz resolution, and adjust for stable triggering. Electronic counter should indicate 20 000 000.0Hz ±100Hz.

d. Change 3325A function to square wave. Frequency automatically changes to 10 MHz. Electronic counter should indicate 10 000 000.0 Hz ±50 Hz.

e. Change 3325A function to triangle. Frequency automatically changes to 10kHz. Move the counter input to the sync output of the 3325A. Set the counter to average 1000 periods. Electronic counter should indicate 100 000.00ns ±0.5ns.

f. Change 3325A function to positive slope ramp. Electronic counter should indicate 100,000 ns ± .5 ns.

4-24. Output Level and Attenuator Check.

4-25. This procedure checks the output level and the attenuator by using the "dc only" function.

Equipment Required:
DC Digital Voltmeter (-hp- Model 3455A)
50-ohm Feedthru Termination (-hp- Model 11048C)

a. Connect the 3325A signal output through a 50-ohm feedthru termination to a dc digital voltmeter input.

b. If the instrument has High Voltage Output Option 002, make sure the High Voltage Output is Off (High Voltage indicator light in the center of the "SIGNAL" key in the lower right corner of the front panel if Off).

c. Press whichever function key is presently active, indicated by a lighted indicator in the center of the key. This removes the ac output. The indicator in the center of the DC OFFSET key should light.

d. Set the 3325A dc offset to -5 V, then press the AMPTD CAL key.

e. The dc digital voltmeter reading should be -4.980V to -5.020V.

f. Change 3325A dc offset to (+)5 V. Digital voltmeter reading should be +4.980 V to +5.020 V.

g. Change 3325A dc offset to the following voltages. The voltmeter readings should be within the tolerances shown.

DC Offset	Tolerances
±1.499 V	±1.49300 to 1.50499 V
±499.9 mV	±0.49790 to 0.50190 V
±149.9 mV	±0.14930 to 0.15050 V
±49.99 mV	±0.04979 to 0.05019 V
±14.99 mV	±0.01493 to 0.01505 V
±4.999 mV	±0.004979 to 0.005019 V
±1.499 mV	±0.001479 to 0.001519 V

High Voltage Output Option 002 DC Offset

h. Remove the 50-ohm feedthru termination and connect the 3325A output directly to the digital voltmeter input.

i. Press the "SIGNAL" key in the lower right corner of the 3325A front panel to select High Voltage Output (Option 002). Lighted indicator in the center of this key indicates High Voltage Output is on.

j. Set 3325A dc offset to 20 V. Digital voltmeter reading should be +19.775 V to +20.225 V.

k. Set 3325A dc offset to −20 V. Digital voltmeter reading should be −19.775 V to −20.225 V.

4-26. Harmonic Distortion Test.

4-27. This procedure tests the harmonic distortion of the 3325A sine wave output against the following specifications from Table 1-1.

Harmonic Distortion (relative to fundamental)

Fundamental Frequency	No Harmonic Greater Than
0.1 Hz to 50 kHz	−65 dB
50 kHz to 200 kHz	−60 dB
200 kHz to 2 MHz	−40 dB
2 MHz to 15 MHz	−30 dB
15 MHz to 20 MHz	−25 dB

Equipment Required:
- High Frequency Spectrum Analyzer (-hp- Model 141T/8552B/8553B/8566A/8568A)
- Low Frequency Spectrum Analyzer (-hp- Model 3580A/ 3585A)
- 50-ohm Feedthru Termination (-hp- Model 11048C)
- Resistor 470Ω 2W 5% (-hp- 0698-3634)
- Resistor 56.2Ω 1/8W 1% (-hp- 0757-0395)

a. Set the 3325A output as follows:

High Voltage Output (Option 002) .....Off
Function ....Sine
Frequency ....20 MHz
Amplitude 999mVp-p

b. Connect the 3325A signal output to the high frequency spectrum analyzer's 50 ohm input.

c. Set the spectrum analyzer controls to display the fundamental and at least four harmonics. Verify that all harmonics are 25dB below the fundamental.

d. Set the 3325A to the following frequencies and verify that all harmonics are below the specified levels, relative to the fundamental.

15 MHz	−30 dB
2 MHz	−40 dB
200 kHz	−60 dB

e. Disconnect the 3325A from the high frequency spectrum analyzer and connect it to the low frequency spectrum analyzer's 50 ohm input.

f. Set the 3325A frequency to 50kHz and the amplitude to 9.99mVp-p.

g. Set the spectrum analyzer controls to display the fundamental and at least three harmonics. (It may be necessary to decrease the analyzer's video bandwidth to separate the harmonics from the noise floor.) Verify that all harmonics are at least 65dB below the fundamental.

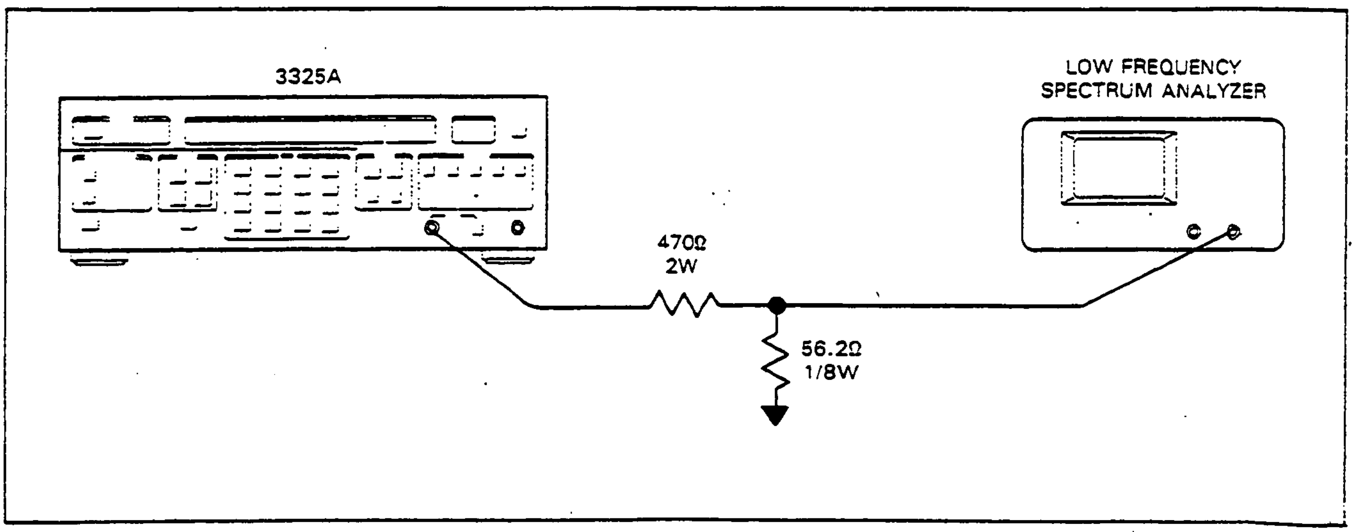


Figure 4-1. Harmonic Distortion Verification (High Voltage Output).

h. Set the 3325A to the following frequencies and verify that all harmonics are 65dB below the fundamental.

10kHz

1kHz

100Hz

High Voltage Output (Option 2)

i. Connect the 3325A signal output to the low frequency spectrum analyzer's 50Ω input. (See Figure 4-1.)

j. Press the "high voltage output" key on the 3325A. Set the amplitude to 40Vp-p and the frequency to 100Hz.

k. Set the spectrum analyzer controls to display the fundamental and at least three harmonics. Verify that all harmonics are 65dB below the fundamental.

l. Set the 3325A to the following frequencies and verify that their harmonics are below the specified levels, relative to the fundamental.

10kHz	-65dB
200kHz	-60dB
1MHz	-40dB

m. Press the high voltage output key to deactivate the high voltage output.

4-28. Close-In Spurious Signal Test.

4-29. This procedure tests the sine wave output for spurious signals which may be generated by the 3325A frequency synthesis circuits. The spurious signals must be more than 70 dB lower than the fundamental signal.

Equipment Required: Spectrum Analyzer (-hp-3585A/ 8566A/8568A)

a. Set the 3325A as follows:

High Voltage Output (Option 002) . . . . . Off
Function . . . . Sine
Frequency 20.001MHz
Amplitude . . . . -2.99dBm
DC Offset . . . . 0 V

b. Connect the 3325A signal output to the spectrum analyzer's 50 ohm input.

c. Set the spectrum analyzer controls for a center frequency of 20.001MHz, a resolution bandwidth of 30Hz, a 100Hz/div frequency span, with the fundamental referenced to the top of the display graticule.

d. Set the spectrum analyzer center frequency to 20.002, 20.003, and 20.004MHz, verifying in each case that all spurious signals are more than 70dB below the fundamental.

4-30. HP-IB Interface Test.

4-31. The following calculator program tests the operation of the 3325A HP-IB interface circuits. The program is written for an -hp- Model 9825A calculator but may be adapted for other controllers.

Equipment Required:
-hp- Model 9825A Calculator equipped with:
98034A HP-IB Interface (set to select code 7)
Any combination of ROM's that includes a General I/O ROM and an Extended I/O ROM

a. Connect the calculator interface cable to the 3325A rear panel HP-IB connector. It is recommended that no other equipment be connected to this HP-IB during this test.

b. Enter the program into the calculator.

c. Press RUN. Tests 4 through 7 in this program require the operator to press CONTINUE if the test passes, or 1 CONTINUE if the test fails. If the Test 4 question (SRQ LIGHT ON?, 1 = NO) does not appear in the calculator display within 30 seconds after start of the program (RUN), the 3325A and calculator are not interfacing properly. The calculator may display an error indication that will identify the problem. If not, the 3325A HP-IB circuits are probably not operating correctly.

PROGRAM FLOWCHART

Instrument Returns To Known Conditions After Self Test

Test 1 – Did Frequency Go To 1000 Hz?

Test 2 – Interrogate Frequency

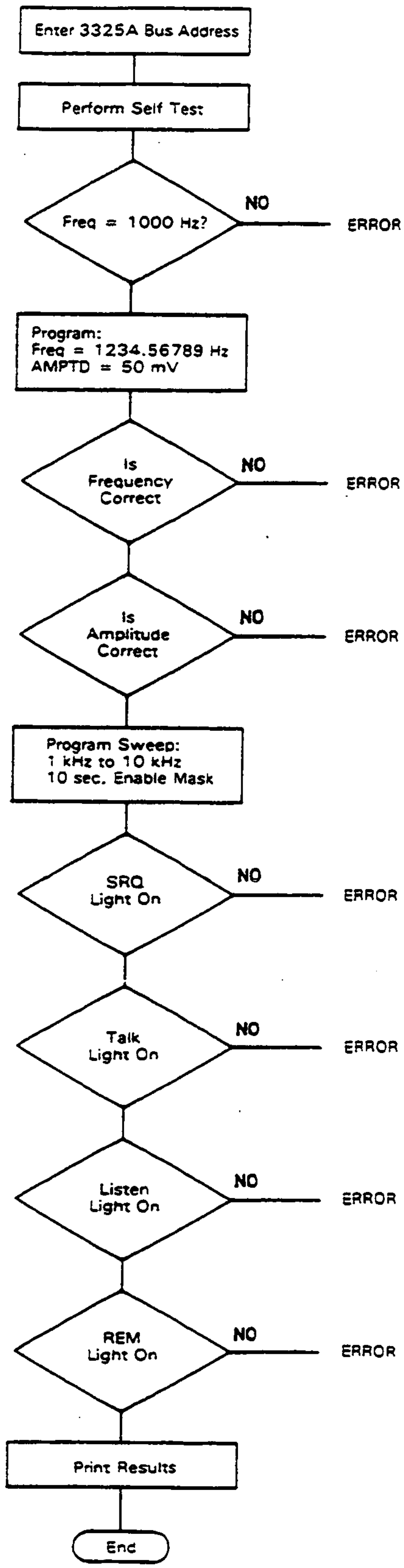
Test 3 – Interrogate Amplitude

Test 4 – Test SRQ Circuits

Test 5 – Test Talk Circuits

Test 6 – Test Listen Circuits

Test 7 – Test Remote Circuits



```
0:  fmt ;csv;0→r1→r2→r3→r4→r5→r6→r7
1:  prt "****************"
2:  prt "3325A"
3:  prt "HP-IB TEST"
4:  prt "**************"
5:  beep;ent "3325A BUS ADDRESS?,cont=717",A
6:  if flg13;717→A
7:  clr A                                  ← Clear the 3325A to Turn-on State
8:  rem 7                                  ← Set HP-IB Remote Enable (Select Code 7)
9:
10:  "TEST 1":
11:  wrt A,"TE"                            ← Perform Self Test
12:  wrt A,"IFR"                           ← Interrogate Frequency
13:  red A,F                               ← Read 3325A Frequency
14:  if F#1000;1→r1                        ← Compare Frequency to 1000 Hz
15:
16:  "TEST 2,3 SETUP":
17:  wrt A,"FR1234.567890HZ AM50MV"        ← Set Freq to 1234.567890 Hz, Amptd to 50mV
18:  wrt A,"SR3"                           ← Store Settings in Register 3
19:  clr A                                 ← Clear the 3325A
20:  wrt A,"RE3"                           ← Recall Settings in Register 3
21:
22:  "TEST 2":
23:  wrt A,"IFR"                           ← Interrogate Frequency
24:  red A,G                               ← Read Frequency
25:  if G#1234.56789;1→r2                  ← Compare to Frequency Stored
26:
27:  "TEST3":
28:  wrt A,"IAM"                           ← Interrogate Amplitude
29:  red A,H                               ← Read Amplitude
30:  if H#.05;1→r3                         ← Compare to Amplitude Stored
31:
```

```
32: "TEST 4":
33: wrt A,"ST1KH SP10KH SM1 TI10SE MSF SSSS" — Lin Sweep 1—10kHz, Enable SRQ Mask
34: cli 7;lcl 7 ——— Clear Interface, Interface to Local
35: beep;ent "SRQ LIGHT ON?,1=NO",r4 ——— Did 3325A Initiate SRQ?
36:
37: "TEST 5":
38: rds(A)→S ——— Read Status into Variable 5
39: rem 7 ——— Set Remote Enable
40: red A,S ——— Read from the 3325A
41: beep;ent "TALK LIGHT ON?,1=NO",r5 ——— Did 3325A respond to Talk Command?
42:
43: "TEST6":
44: wrt A;lcl 7 ——— Write to the 3325A, Interface to Local
45: beep;ent "LISTEN LIGHT ON?,1=NO",r6 ——— Did 3325A respond to Listen Command?
46:
47: "TEST 7":
48: rem 7;wrt A;cli 7 ——— Remote Interface, Write to 3325A, Clear Interface
49: beep;ent "REMOTE LIGHT ON:,1=NO",r7 ——— Did the 3325A Respond to Remote?
50:
51: spc ;prt "**************"
52: prt "TEST RESULTS:"
53: spc ;1→I;fxd 0
54: if rI=0;prt "TEST",I,"      PASS"
55: if rI=1;prt "TEST",I,"             FAIL"
56: if (I+1→I)<=7;jmp -2
57: prt "*****************";spc 3
    (lines 51–57) ——— Print Results of Tests
58: ent "Repeat test?,1=Yes",C;if C=1;gto 0 ——— Self Contained Program may be Linked or Used as a Subroutine
59: end
*24386
```

Variables used in this Test Program:

A	Address of 3325A (defaults to 717)
F	Frequency read from 3325A in test #1
G	Frequency read from 3325A in test #2
H	Amplitude read from 3325A in test #3
I	Counter used to print test results
r1-r7	Test results (0=Pass, 1=Fail)
S	Status read from 3325A in test #5

Samples of Program Printouts:

```
****************
3325A
HP-IB TEST
*************

*************
TEST RESULTS:

TEST            1
     PASS
TEST            2
     PASS
TEST            3
     PASS
TEST            4
          FAIL
TEST            5
     PASS
TEST            6
     PASS
TEST            7
     PASS
****************
```

```
****************
3325A
HP-IB TEST
*************

*************
TEST RESULTS:

TEST            1
     PASS
TEST            2
     PASS
TEST            3
     PASS
TEST            4
     PASS
TEST            5
     PASS
TEST            6
     PASS
TEST            7
     PASS
****************
```

4-32. PERFORMANCE TESTS.

4-33. The following procedures compare the instrument operation to its specifications, listed in Table 1-1. A Performance Test Record is located at the end of this section. This Test Record lists all of the tested specifications and the acceptable limits. For ease of recording data at various times, copies of the blank Performance Test Record may be made without written permission from Hewlett-Packard.

4-34. The Performance Tests include the following:

Par No.	Test
4-37	Harmonic Distortion
4-39	Spurious Signal Tests
4-41	Integrated Phase Noise
4-43	Amplitude Modulation Envelope Distortion
4-45	Square Wave Rise Time and Aberrations
4-47	Ramp Retrace Time
4-49	Sync Output
4-51	Square Wave Symmetry
4-53	Frequency Accuracy
4-55	Phase Increment Accuracy
4-57	Phase Modulation Linearity
4-59	Amplitude Accuracy
4-61	DC Offset Accuracy (DC Only)
4-63	DC Offset Accuracy with AC Functions
4-65	Triangle Linearity
4-67	X Drive Linearity
4-69	Ramp Period Variation
4-71	HP-IB Interface Test

Table 4-2. Test Equipment Required For Performance Tests.

Instrument	Critical Specifications	Recommended Model
High Frequency Spectrum Analyzer	Frequency Range: 1 kHz to 80 MHz Amplitude Accuracy: ±0.5 dB Noise: > 70 dB below reference	-hp- 141T/8552B/8553B/ 8566A/8568A
50-ohm Load	Accuracy: ±0.2% Power Rating: 1 W	-hp- Model 11048C
Resistor	56.2Ω 1/8W 1.0%	-hp- 0757-0395
Low Frequency Spectrum Analyzer	Frequency Range: 20Hz to 50kHz Amplitude Accuracy: ± 0.5dB Spurious Responses: 80dB below reference	-hp-3580A/3585A
Sine Wave Signal Source	Frequency Range: 1 MHz to 21 MHz Amplitude Range: to + 13.01 dBm Output Impedance: 50Ω Phase Noise (Integrated): 9.9 MHz: < −63 dB 20 MHz: < −70 dB Spurious: > 75 dB below fundamental	-hp- 3335A
Double Balanced Mixer	Impedance: 50 Ω Frequency Range: 1 MHz-20 MHz	-hp- 10534A
AC/DC Digital Voltmeter	AC function (True RMS) Ranges: 1 V to 100 V Accuracy: ±0.2% Resolution: 6 digits Crest Factor: 4:1 DC Function Ranges: 0.1 V to 100 V Accuracy: ±0.05% Resolution: 6 digits	-hp- 3455A
1 MHz Low Pass Filter	Cut-off Frequency: 1 MHz Stopband Atten: 50 dB by 4 MHz Stopband Freq: 4 MHz-80 MHz	F882 1MHz LPF Allen Avionics, Inc. 224 E Second St. Mineola, NY 11501
15 kHz Filter	Consisting of: Resistor: 10 kΩ 1% Capacitor: 1600 pF 5%	 -hp- 0757-0340 -hp- 0160-2223
Resistor	470Ω 2W 5%	-hp- 0698-3634
AC Voltmeter	Ranges: 0.1 V to 1 V Frequency Range: 2] Hz-1 MHz Input Impedance: ≥ 1 MΩ Meter: Log scale Acc (100 Hz to 10 kHz): ± 1%	-hp- 400FL
Sine Wave Signal Source	Frequency: 10 kHz Amplitude: 1 V rms into 20 kΩ Distortion: −60 dB	-hp- 204C

Table 4-2. Test Equipment Required For Performance Tests (Cont'd).

Instrument	Critical Specifications	Recommended Model
Oscilloscope	Vertical: Bandwidth: dc to 100 MHz Deflection: 1 V to 5 V/div Horizontal: Sweep: 0.05 μs to 1 s/div x 10 magnification	-hp- 1740A
Electronic Counter	Frequency measurement Frequency Range: to 20 MHz Resolution: 8 digits Accuracy: ± 2 counts Time Interval Average A to B Resolution: 0.01 ns	-hp- 5328A With Option 040 or 041
DC Power Supply	Volts: 0 to ±5 V Amps: 10 mA Floating Output	-hp- 6214A
Thermal Converter	Input Impedance: 50 Ω Input Voltage: 1 V rms Frequency: 2 kHz to 20 MHz Frequency Response: ±0.05 dB 2 kHz to 20 MHz	-hp- 11050A
Resistive Divider	Consisting of: 2 Resistors: 61.11 Ω .1% 1/4 W 2 Resistors: 36.55 Ω .1% 1/8 W	 -hp- 0699-0090 -hp- 0698-7169
Resistive Divider	Capacitor: 300 pF 5% Consisting of: 3 Resistors: 1330 Ω .1% 1/4 W Resistor: 43Ω .1% 1/8 W	-hp- 0160-2207 -hp- 0698-7453 -hp- 0698-8264
High-Speed DC Digital Voltmeter	DC Voltage: 0 to ± 10 V External Trigger: Low True TTL Edge Trigger Trigger Delay: Selectable 10 μs to 140 μs	-hp- 3437A
BNC-to-Triax Adapter	50 ohm	-hp- 1250-0595 Adapter or 11172A RF Cable
Resistive Divider − 2.5	Consisting of: Resistor: 30 Ω 1% 1/4 W Resistor: 20 Ω 1% 1/4 W	 -hp- 0698-7533 -hp- 0698-6296
Resistive Divider ÷ 2.6	Consisting of: Resistor: 100 kΩ 1% 1/8 W Resistor: 162 kΩ 1% 1/8 W	 -hp- 0757-0465 -hp- 0757-0470
Calculator	HP-IB Control Capability	-hp- 9825A with 98034A Interface, General I/O ROM, Extended I/O ROM
Adapter	Female BNC-to-Dual Banana Plug BNC Tee	-hp- 1250-2277 -hp- 1250-0781
Step Attenuator	0-12dB: 1dB steps	-hp- 355C

4-35. Equipment Required.

4-36. The test equipment required for the Performance Tests is listed in Table 4-2. Any equipment that satisfies the critical specifications given in the table may be substituted for the recommended model.

4-37. Harmonic Distortion Test.

4-38. This procedure tests the harmonic distortion of the 3325A sine wave output against the following specifications from Table 1-1.

Harmonic Distortion (relative to fundamental)

Fundamental Frequency	No Harmonic Greater Than
0.1 Hz to 50 kHz	−65 dB
50 kHz to 200 kHz	−60 dB
200 kHz to 2 MHz	−40 dB
2 MHz to 15 MHz	−30 dB
15 MHz to 20 MHz	−25 dB

Equipment Required:
- High Frequency Spectrum Analyzer (-hp- Model 141T/8552B/8553B/8566A/8568A)
- Low Frequency Spectrum Analyzer (-hp- Model 3580A/3585A)
- 50-ohm Feedthru Termination (-hp- Model 11048C)
- Resistor 470Ω 2W 5% (-hp- 0698-3634)
- Resistor 56.2Ω 1/8W 1% (-hp- 0757-0395)

a. Set the 3325A output as follows:

High Voltage Output (Option 002) .....Off
Function ....Sine
Frequency ....20 MHz
Amplitude 999mVp-p

b. Connect the 3325A signal output to the high frequency spectrum analyzer's 50 ohm input.

c. Set the spectrum analyzer controls to display the fundamental and at least four harmonics. Verify that all harmonics are 25dB below the fundamental.

d. Set the 3325A to the following frequencies and verify that all harmonics are below the specified levels, relative to the fundamental.

15 MHz	−30 dB
2 MHz	−40 dB
200 kHz	−60 dB

e. Disconnect the 3325A from the high frequency spectrum analyzer and connect it to the low frequency spectrum analyzer's 50 ohm input.

f. Set the 3325A frequency to 50kHz and the amplitude to 9.99mVp-p.

g. Set the spectrum analyzer controls to display the fundamental and at least three harmonics. (It may be necessary to decrease the analyzer's video bandwidth to separate the harmonics from the noise floor.) Verify that all harmonics are a least 65dB below the fundamental.

h. Set the 3325A to the following frequencies and verify that all harmonics are 65dB below the fundamental.

10kHz
1kHz
100Hz

High Voltage Output (Option 2)

i. Connect the 3325A signal output to the low frequency spectrum analyzer's 50Ω input. (See Figure 4-1.)

j. Press the "high voltage output" key on the 3325A. Set the amplitude to 40Vp-p and the frequency to 100Hz.

k. Set the spectrum analyzer controls to display the fundamental and at least three harmonics. Verify that all harmonics are 65dB below the fundamental.

l. Set the 3325A to the following frequencies and verify that their harmonics are below the specified level, relative to the fundamental.

10kHz	-65dB
200kHz	-60dB
1MHz	-40dB

m. Press the high voltage output key to deactivate the high voltage output.

4-39. Spurious Signal Tests.

4-40. This procedure tests the 3325A sine wave output for spurious signals. Circuits within the 3325A may generate repetitive frequencies that are not harmonically related to the fundamental output frequency. All spurious signals must be more than 70dB below the fundamental signal or less than -90dBm, whichever is greater.

Equipment Required:
- Spectrum Analyzer (-hp- Model 3585A/8566A/8568A)

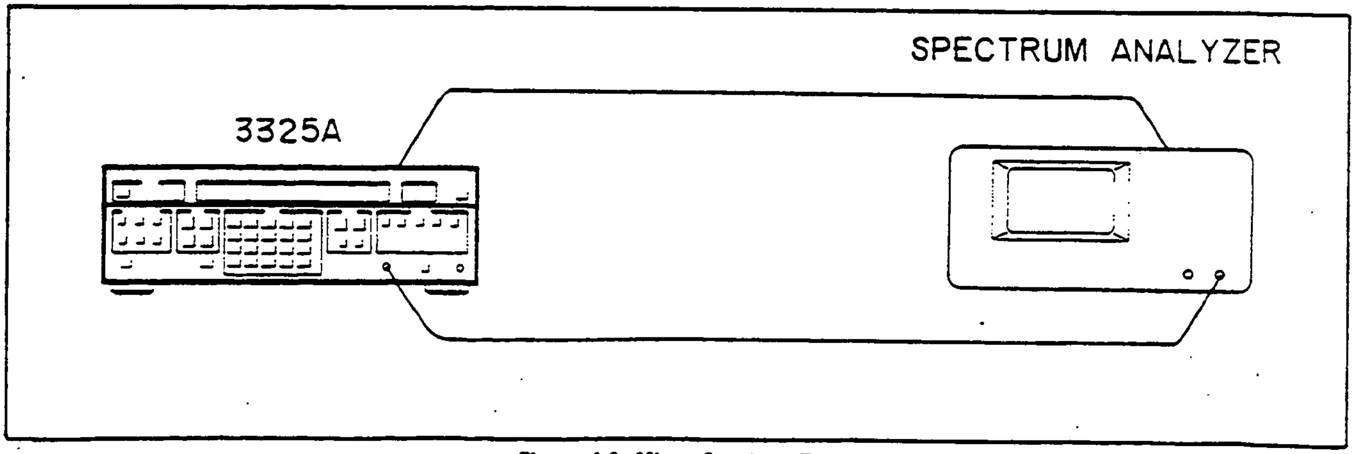


Figure 4-2. Mixer Spurious Test

Mixer Spurious Test

a. Connect the 3325A signal output to the spectrum analyzer 50 ohm (RF) input and the 3325A EXT REF input to the analyzer's 10MHz reference output. (See Figure 4-2.)

b. Set the 3325A as follows:

Function .... Sine
Amplitude .... -20dBm
Frequency 2.001MHz

c. Set the analyzer controls as follows:

Center Frequency 2.001MHz
Frequency Span 1kHz
Video BW 100Hz
Resolution BW 30Hz

d. Adjust the spectrum analyzer to reference the fundamental to the top display graticule.

e. Without changing the reference level, change the spectrum analyzer center frequency to 27.999MHz to display the 2:1 mixer spur. Verify that this spur is at least 70dB below the fundamental.

f. Change the spectrum analyzer center frequency to 25.998MHz to display the 3:2 mixer spur. Verify that this spur is at least 70dB below the fundamental.

g. In a similar manner, change the 3325A's frequency and the spectrum analyzer center frequency to the following frequencies. For each setting, verify that all spurious signals are 70dB below the fundamental.

3325A Frequency	Spectrum Analyzer Center Frequency 2:1 Spur	3:2 Spur
4.100MHz	25.9MHz	21.8MHz
6.100MHz	23.9MHz	17.8MHz
8.100MHz	21.9MHz	13.8MHz
10.100MHz	19.9MHz	9.8MHz
12.100MHz	17.9MHz	5.8MHz
14.100MHz	15.9MHz	1.8MHz
16.100MHz	13.9MHz	2.2MHz
18.100MHz	11.9MHz	6.2MHz
20.100MHz	9.9MHz	10.2MHz

Close-in Spurious Test
(Fractional N Spurs)

h. Set the 3325A frequency to 5.001MHz and the amplitude to -2.99dBm.

i. Set the spectrum analyzer controls as follows:

Center Frequency 5.001MHz
Frequency Span 1kHz
Video BW 100Hz
Resolution BW 30Hz

j. Adjust the spectrum analyzer to reference the fundamental to the top display graticule.

k. Without changing the reference level, change the spectrum analyzer center frequency to 5.002MHz to display the API 1 spur. It may be necessary to decrease the analyzer's video bandwidth to optimize the display resolution.

l. All spurious (non-harmonic) signals should be at least 70dB below the fundamental.

m. Without changing the reference level, set the 3325A frequency and the spectrum analyzer center frequency to the frequencies listed below. For each setting, verify that all spurious signals are at least 70dB below the fundamental.

3325A Frequency	Spectrum Analyzer Center Frequency
5.0001MHz	5.0011MHz
5.00001MHz	5.00101MHz
5.000001MHz	5.001001MHz
20.001MHz	20.002MHz
20.001MHz	20.003MHz
20.001MHz	20.004MHz
20.001MHz	20.005MHz

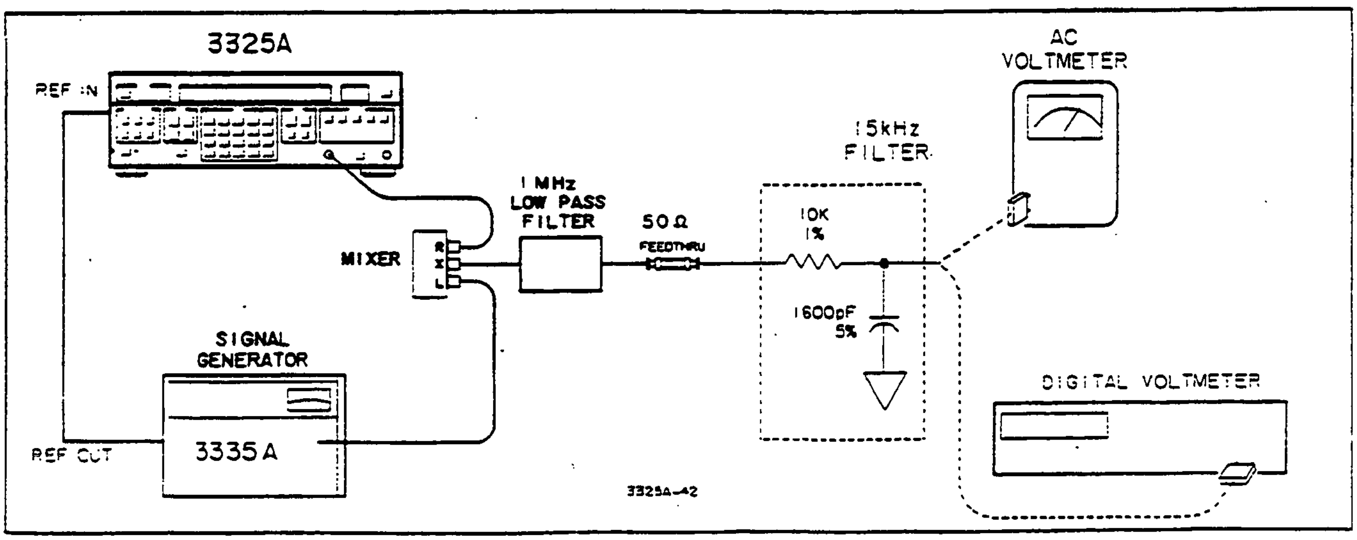


Figure 4-3. Integrated Phase Noise Test

4-41. Integrated Phase Noise Test.

4-42. This test compares the integrated phase noise to the specification in Table 1-1, which is:

> −60 dB for a 30 kHz band centered on a 20 MHz carrier (excluding ±1 Hz about the carrier).

Equipment Required:
- Sine wave signal source (-hp- Model 3335A)
- Mixer (-hp- Model 10534A)
- 50-ohm load (-hp- Model 11048C)
- DC digital voltmeter (-hp- Model 3455A)
- AC voltmeter (-hp- Model 400 FL)
- 15 kHz noise equivalent filter consisting of:
  - Resistor: 10 kΩ ±1% (-hp- Part No. 0757-0340)
  - Capacitor: 1600 pF ±5% (-hp- Part No. 0160-2223) See Figure 4-3
- 1MHz Low Pass Filter (Model F882 - Allen Avionics)

a. Connect the equipment as shown in Figure 4-3, connecting the 15kHz noise equivalent filter output to the ac voltmeter. Phase lock the 3325A and the signal generator together.

b. Set the 3325A as follows:

Function .... Sine
Frequency .... 19.901 MHz
Amplitude .... 0 dBm

c. Set the sine wave signal source (reference) as follows:

Frequency .... 19.9 MHz
Amplitude .... +7.00 dBm

d. Record the ac voltmeter reading (dB scale).

e. Change 3325A frequency to 19.9 MHz.

f. Connect the 15 kHz filter output to the dc digital voltmeter.

g. Press the 3325A PHASE entry key. Using the MODIFY keys, adjust the 3325A output phase for a minimum reading on the digital voltmeter.

h. Disconnect the 15 kHz filter output from the digital voltmeter and connect it to the ac voltmeter.

i. Record the ac voltmeter reading (dB scale) and subtract it from the reading recorded in Step d. The difference should be −54 dB or greater. Add −6 dB to this number and enter on the performance test card. The 6 dB is a correction factor compensating for the folding action of the mixer.

NOTE

Frequencies used minimize the phase noise contribution of the 3335A.

4-43. Amplitude Modulation Envelope Distortion Test.

4-44. This procedure tests the 3325A against the amplitude modulation envelope distortion specification in Table 1-1:

> −30 dB to 80% modulation at 10 kHz, 0 V dc offset

Equipment Required:
- Sine wave signal source (-hp- Model 204C)
- Spectrum Analyzer (-hp- Model 141T/3585A/8552B/8553B/8566A)

a. Connect the equipment as shown in Figure 4-4.

b. Set the 3325A output as follows:

Function .... Sine
Frequency .... 1 MHz
Amplitude .... 3 Vp-p
DC Offset .... 0 V
High Voltage Output (Option 002) ..... Off
AM .... On

c. Set the modulating signal source frequency to 10 kHz and adjust the level to produce 80% modulation of the 3325A output. 80% modulation is indicated by

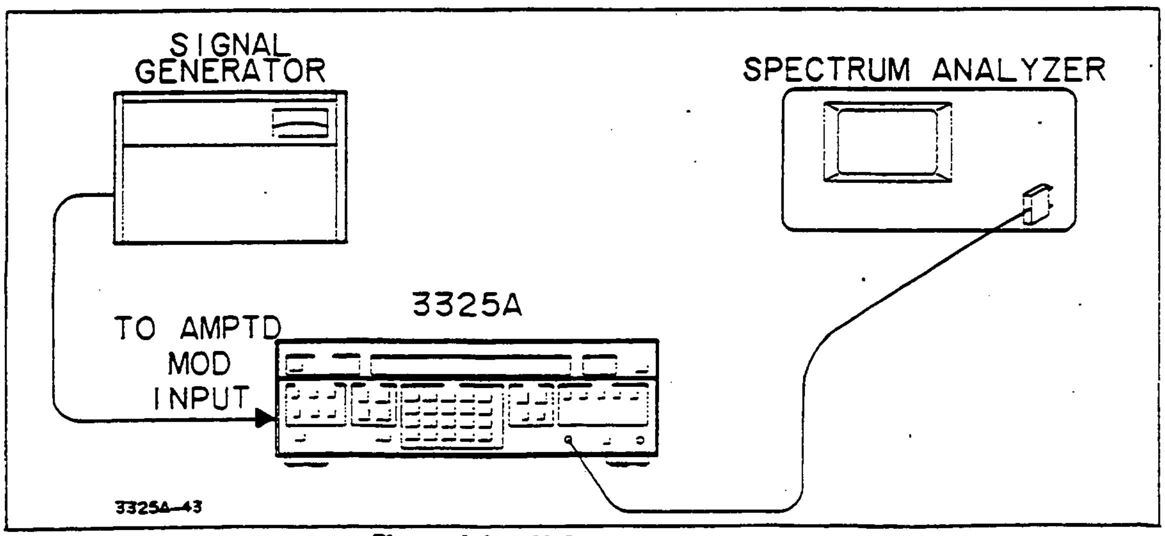


Figure 4-4. AM Envelope Distortion

modulation sidebands being 8.0 dB down from the carrier, as viewed on the 2 dB/div display of the spectrum analyzer.

d. Adjust the spectrum analyzer to display the fundamental frequency, the 10 kHz sideband frequency, and at least 4 harmonics of the sidebands. All harmonics should be at least 30 dB lower than the modulation sidebands.

4-45. Square Wave Rise Time and Abberations.

4-46. This procedure compares the 3325A square wave output to its rise/fall time and overshoot specifications in Table 1-1.

Rise and Fall Time: <20 ns, 10% to 90% at full output
Overshoot: <5% of p-p amplitude at full output

Equipment Required: Oscilloscope (-hp- Model 1740A)

a. Connect the 3325A signal output to the oscilloscope vertical input. If the oscilloscope is an -hp- Model 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 (-hp- Model 11048C 50-ohm feedthru termination) at the input.

b. Set the 3325A as follows:

High Voltage Output (Option 002) ..... Off
Function .... Square
Frequency .... 1 MHz
Amplitude .... 10 V p-p

c. Adjust the oscilloscope vertical and horizontal controls so that the square wave rise time between the 10% and 90% points can be measured. Rise time should be less than 20 nanoseconds.

d. Adjust the oscilloscope to measure the square wave fall time between the 90% and 10% points. Fall time should be less than 20 nanoseconds.

e. Expand the oscilloscope vertical display and adjust controls so that the overshoot can be measured. Overshoot should be less than 500 mV at positive and negative peaks.

4-47. Ramp Retrace Time.

4-48. This test compares the retrace time of the positive and negative slope ramps to the specifications in Table 1-1:

<3 μs 90% to 10%

Equipment Required: Oscilloscope (-hp- Model 1740A)

a. Connect the 3325A signal output to the oscilloscope vertical input. If the oscilloscope is an -hp- Model 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 (-hp- Model 11048C 50-ohm feedthru termination) at the input.

b. Set the 3325A as follows:

High Voltage Output (Option 002) ..... Off
Function .... Positive Slope Ramp
Frequency .... 10 kHz
Amplitude .... 10 V p-p

c. Adjust the oscilloscope vertical and horizontal controls so that the ramp retrace time from the 90% to 10% points can be measured. Retrace time should be less than 3 μs.

d. Change function to negative slope ramp and repeat Step c.

4-49. Sync Output Test.

4-50. This procedure checks the voltage levels of the sync output square wave:

$V_{high} > +1.2V$; $V_{low} < +0.2V$ into 50 ohms

Equipment Required: Oscilloscope (-hp- Model 1740A)

a. Connect the 3325A sync output to the oscilloscope vertical input. If the oscilloscope is an -hp- Model 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 (-hp- Model 11048C 50-ohm Feedthru Termination).

b. Set the 3325A function to sine, frequency to 20 MHz.

c. Adjust the oscilloscope controls to measure the high and low levels of the sync square wave. The high level should be greater than +1.2 V and the low level should be less than +0.2 V.

4-51. Square Wave Symmetry.

4-52. This procedure checks the symmetry of the square wave signal output to the specification in Table 1-1:

0.02% of period + 3 nanoseconds

Equipment Required: Electronic counter (-hp- Model 5328A)

a. Connect the 3325A signal output to both inputs of the electronic counter, using a BNC tee (see Figure 4-5).

b. Set the 3325A output as follows:

Function .... Square
Frequency .... 1 MHz
Amplitude .... 1 V rms
DC Offset .... 0 V

c. Adjust the electronic counter to measure time interval average A to B, with Slope A +, Slope B −. Note the reading.

d. Change Slope A to −, Slope B to +. Reading should be equal to the reading in Step c ± < 3.2 ns.

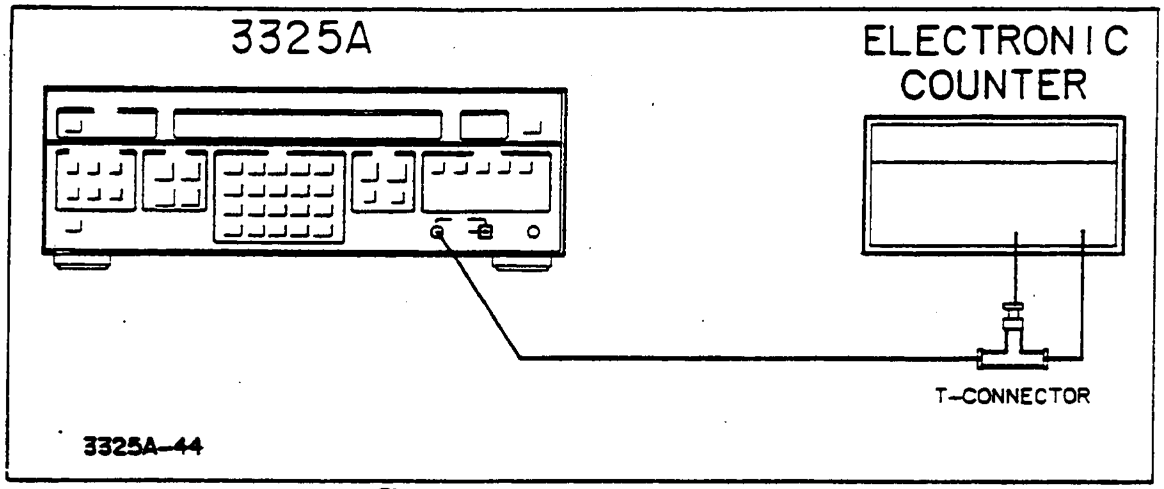


Figure 4-5. Square Wave Symmetry.

4-53. Frequency Accuracy.

4-54. This test compares the accuracy of the 3325A output signal to the specification in Table 1-1:

$\pm 5 \times 10^{-6}$ of selected frequency

Equipment Required: Electronic Counter (-hp- Model 5328A, calibrated within three months or with an accurate 10 MHz external reference input)

a. Connect the 3325A signal output to the electronic counter channel A input with a 50 Ω load. Allow 3325A and counter to warm up for 20 minutes.

b. Set the 3325A output as follows:

Function .... Sine
Frequency .... 20 MHz
Amplitude 0.99Vp-p
DC Offset .... 0 V

c. Set the counter to count the frequency of the A input with 0.1Hz resolution, and adjust for stable triggering. Electronic counter should indicate 20 000 000.0Hz ± 100Hz.

d. Change 3325A function to square wave. Frequency automatically changes to 10 MHz. Electronic counter should indicate 10 000 000.0 Hz ± 50 Hz.

e. Change the 3325A function to triangle. Frequency automatically changes to 10kHz. Move the counter input to the sync output of the 3325A. Set the counter to average 1000 periods. Electronic counter should indicate 100 000.00ns ± 0.5ns.

f. Change 3325A function to positive slope ramp. Electronic counter should indicate 100,000 ns ± .5 ns.

4-55. Phase Increment Accuracy.

4-56. This test compares the phase increment accuracy of the 3325A to the specification in Table 1-1:

±0.2°

Equipment Required:
Sine wave signal source (-hp- Model 3335A)
Electronic Counter (-hp- Model 5328A)

a. Connect the equipment as shown in Figure 4-7.

b. Set the 3325A as follows:

High Voltage Output (Option 002) ..... Off
Function .... Sine
Frequency .... 100 kHz
Amplitude .... 13 dBm

c. Set the sine wave signal source (3335A) as follows:

Frequency .... 0.1 MHz
Amplitude .... 13 dBm

d. Set the electronic counter (5328A) as follows:

Function .... Time Interval Avg. A to B
Frequency Resolution, N .... 10^5
Inputs .... 50 Ω, Separate
Slope A and B .... Positive
Sample Rate .... Maximum

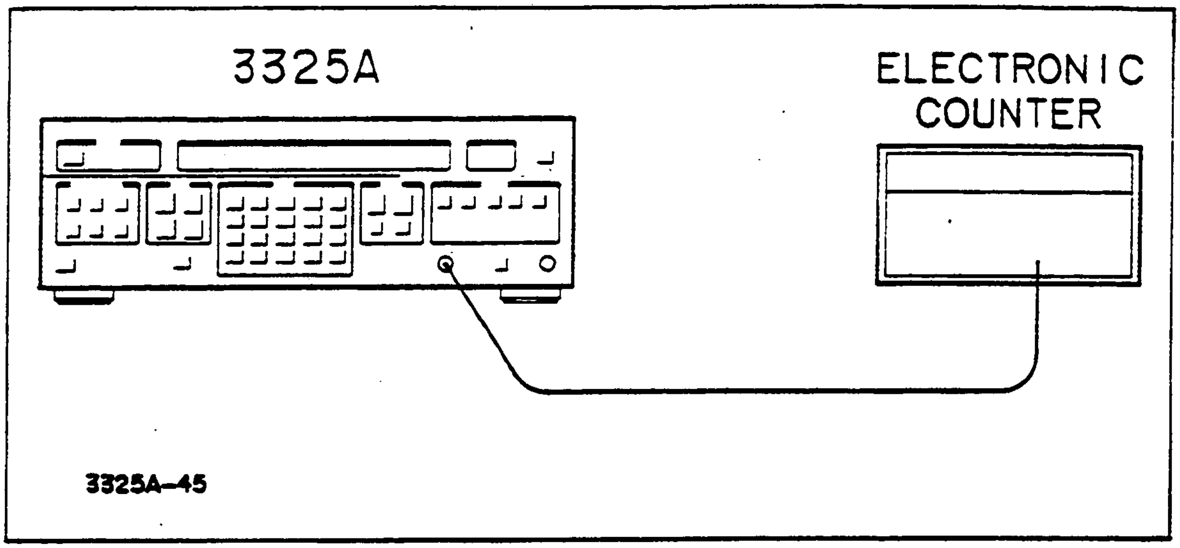


Figure 4-6. Frequency Accuracy.

e. Press the 3325A PHASE entry key to display phase. Using the Modify keys, adjust the phase until the counter reads approximately 200 nanoseconds. Press the 3325A blue entry prefix key, then ASGN ZERO PHASE.

f. Set the electronic counter sample rate to HOLD. Press RESET. Record the counter reading (to 2 decimal places) on the Performance Test Record in the space for "Zero Phase Time Interval". This is the phase difference (in nanoseconds) between the 3325A output and the reference signal.

g. Set the 3325A phase to −1°.

h. Press the electronic counter RESET. Record the counter reading (to 2 decimal places) in the space for "1° Increment Time Interval".

i. Determine the time difference between the counter readings in Step h and Step f, and record in the "Time Difference" column. The difference should be from 22.22 ns to 33.34 ns.

j. Set the 3325A phase to −10°.

k. Press the electronic counter RESET. Record the counter reading to the space for "10° Increment Time Interval".

l. Enter the time difference between the "Zero Phase Time Interval" and the reading in Step k in the "Time Difference" column. This should be from 272.22 ns to 283.34 ns.

m. Set the 3325A phase to −100°.

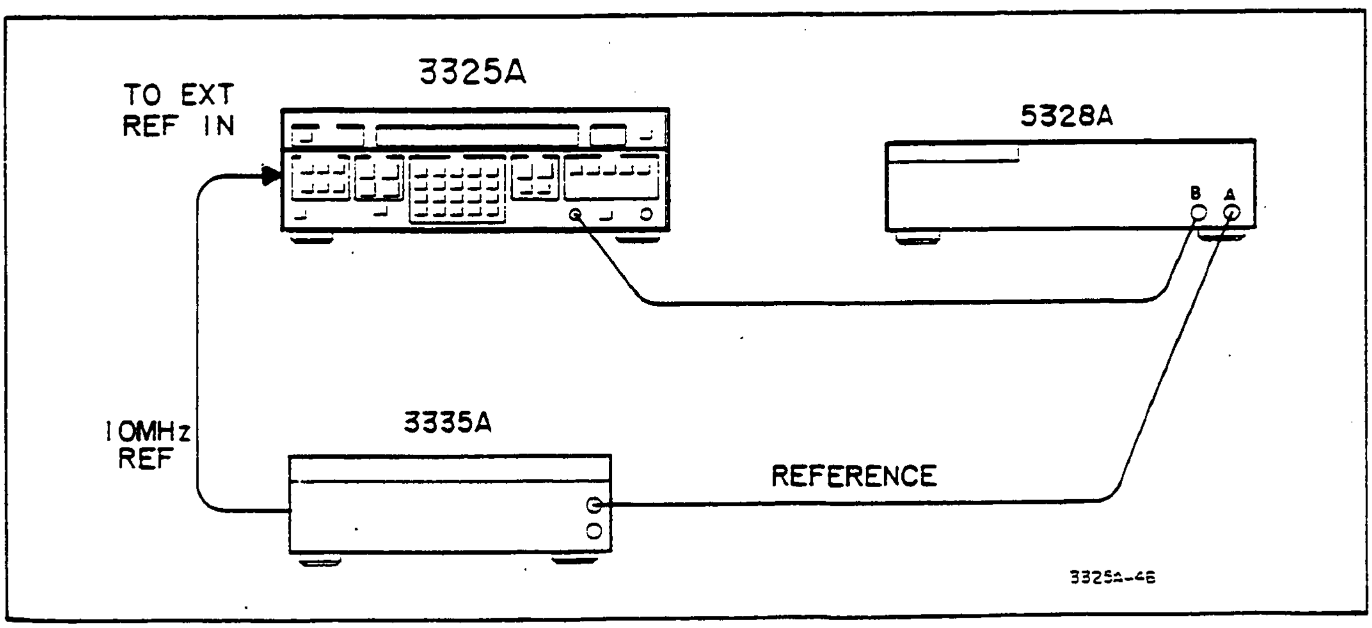


Figure 4-7. Phase Increment Accuracy.

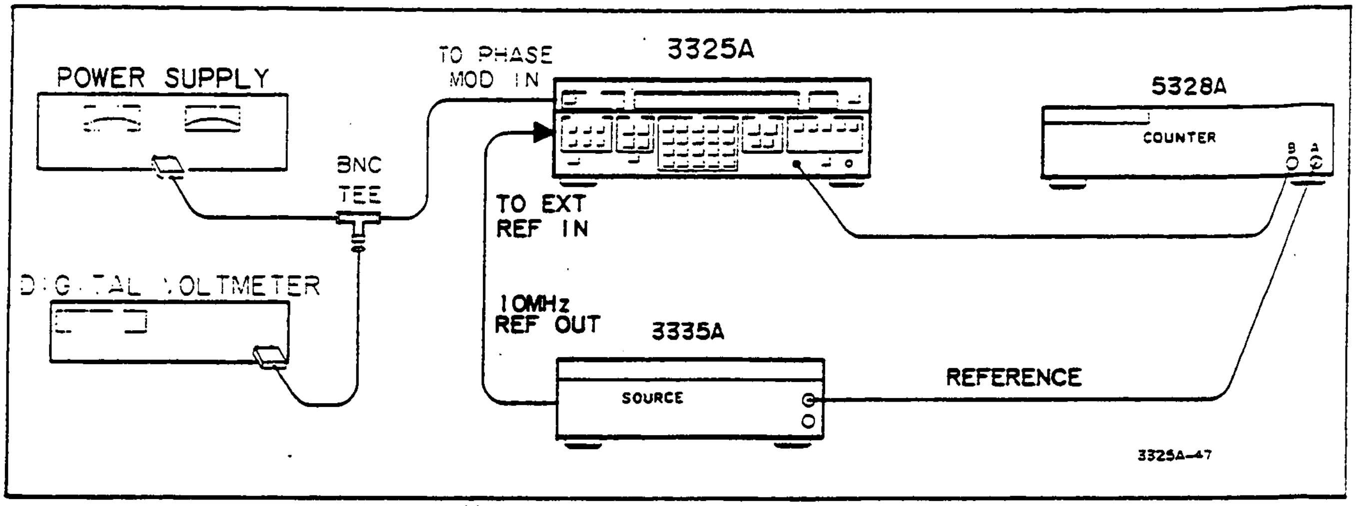


Figure 4-8. Phase Modulation Linearity.

n. Press the electronic counter RESET. Record the counter reading in the space for "100° Increment Time Interval".

o. Enter the time difference between the "Zero Phase Time Interval" and the reading in Step n in the "Time Difference" column. It should be from 2722.22 ns to 2783.34 ns.

4-57. Phase Modulation Linearity.

4-58. This procedure tests the phase modulation linearity. The specification in Table 1-1 is:

±0.5%, best fit straight line

Equipment Required:
Sine wave signal source (-hp- Model 3335A)
Electronic counter (-hp- Model 5328A)
DC power supply (-hp- Model 6214A)
Digital voltmeter (-hp- Model 3455A)

a. Connect the equipment as shown in Figure 4-8.

b. Set the 3325A as follows:

High Voltage Output (Option 002) ..... Off
Function .... Sine
Frequency 100kHz
Amplitude .... 13 dBm
Phase Modulation .... On

c. Set the sine wave signal source (3335A) as follows:

Frequency 100kHz
Amplitude .... 13 dBm

d. Set the electronic counter (5328A) as follows:

Function ...... Time Interval Avg. A and B
Frequency Resolution, N .... 10^5
Inputs .... 50 Ω, Separate
Slope A and B .... Positive
Sample Rate .... Maximum

e. Using the digital voltmeter to monitor the dc power supply output, set the dc voltage as near −5.0000 V as possible.

f. Press the 3325A PHASE entry key to display phase. Using the Modify keys, adjust the phase until the counter reads approximately 200 nanoseconds. Record the counter reading as a reference for the following steps.

g. As soon as possible after recording the counter reading, note the digital voltmeter reading and record on the Performance Test Record in the "DVM Reading, x_1" space.

h. Press the 3325A blue prefix key, then ASGN ZERO PHASE.

i. Change the dc power supply output to −4.0000 V.

j. Using the Modify keys, adjust the 3325A phase to return the counter reading to the value recorded in Step f.

k. Record the digital voltmeter reading in the "DVM Reading, x_2" space.

l. The 3325A display indicates the phase change resulting from the 1 V change in modulating voltage. Record the phase display in the "Phase Difference, 2" space (positive value).

m. Press the 3325A blue prefix key, then ASGN ZERO PHASE.

n. Change the power supply output to the following voltages and repeat Steps j through m for each. Record the dvm readings and phase differences in the appropriate spaces on the Performance Test Record.

DC Voltage	DVM Reading	Phase Difference
−3.0000 V	x_3	3
−2.0000 V	x_4	4
−1.0000 V	x_5	5
0.0000 V	x_6	6
+1.0000 V	x_7	7
+2.0000 V	x_8	8
+3.0000 V	x_9	9
+4.0000 V	x_{10}	10
+5.0000 V	x_{11}	11

o. Enter the cumulative phase change in the "Cumulative Phase" column. That is, enter the "2" Phase Difference in the y_2 space, then add the "y_2" and "3" values and enter in the y_3 space. Add the "y_3" and "4" values and enter in y_4, etc.

p. On the Performance Test Record, multiply each x value by the corresponding y value and enter in the "x times y" column.

q. Total the "DVM Reading" column and enter in the Σx space. Total the "Cumulative Phase" values and enter in the Σy space. Total the "x times y" values and enter in the Σxy space.

r. Square each x value and enter in the "x^2" column. Total this column and enter in the Σx^2 space.

s. Square the Σx value and enter in the $(\Sigma x)^2$ space.

t. Multiply the Σx value by the Σy value and enter in the $\Sigma x \Sigma y$ space.

u. The equation for determining the "best fit straight line" specification for each y value is:

$$y = a_1 x + a_0$$

Where: $a_1 x$ and a_0 are constants to be calculated from data taken previously

Where: x is the value of the modulating voltage, recorded as x_1 through x_{11}

v. First determine the value of a_1 using the following equation:

$$a_1 = \frac{\Sigma xy - \frac{\Sigma x \Sigma y}{n}}{\Sigma x^2 - (\Sigma x)^2/n}$$

Where: Σx, Σy, Σxy, $\Sigma x \Sigma y$, Σx^2, and $(\Sigma x)^2$ are the previously calculated values entered on the Performance Test Record

n = 11 (the number of points to be calculated)

w. Determine the value of a_0 using the equation:

$$a_0 = \frac{\Sigma y}{n} - a_1 \frac{\Sigma x}{n}$$

x. Calculate each value for y using the equation: $y = a_1 x + a_0$. Enter each result on the Performance Test Record in the "Best Fit Straight Line Values" column, (y_1 through (y_{11}).

y. Determine the test limits for each y value by increasing and decreasing the calculated (y) values by 0.5% of the (y_{11}) value. Enter in the Maximum and Minimum columns.

z. Transfer the y_1 through y_{11} "Cumulative Phase" entries to the "Measured Cumulative Phase" column. Each value should be within the calculated limits.

4-59. Amplitude Accuracy.

4-60. This procedure tests the amplitude of the 3325A ac function output signals against the accuracy specifications in Table 1-1.

Equipment Required:

AC/DC digital voltmeter (-hp- Model 3455A, average converter opt. 001 preferred)

AC: Accuracy sufficient to verify a 1% specification to 100 kHz.

DC: Resolution, 1 microvolt.

High speed DC voltmeter (-hp- Model 3437A). At least 3½-digit resolution, 1½ microsec. or faster settling time.

50-Ohm step attenuator (-hp- Model 355C)

50-Ohm feedthru termination (-hp- Model 11048C)

Thermal converter (-hp- Model 11050A)

Oscilloscope (-hp- Model 1740A) Must have delayed sweep of .05 microsec/div and delayed sweep gate output.

Components:

Resistor 36.55 ohm 0.1% 0.125W 2 ea 0698-7169
Resistor 61.11 ohm 0.1% 0.25W 2 ea 0699-0090
Resistor 43ohm* 0.1% 0.125W 1 ea 0698-8264
Resistor 1330ohm* 0.1% 0.25W 3 ea 0698-7453
Capacitor 300 pF* 5% 1 ea 0160-2207

*Used only to test High Voltage (option 002).

Amplitude Accuracy at Frequencies up to 100 kHz

a. Sine Wave Test. Connect the 3325A signal output through a 50 ohm feedthrough termination to the AC digital voltmeter input.

b. Set the 3325A as follows:

High Voltage Output (Option 002)	Off
Function	Sine
Frequency	100 Hz
Amplitude	3.536 V_{RMS}(10 Vp-p)
DC Offset	0 V

c. Press AMPTD CAL key.

d. Read AC Voltmeter. Change 3325A frequency to 1 kHz and 100 kHz and repeat. Verify that all three voltmeter readings are between 3.495 V_{RMS} and 3.577 V_{RMS} (±0.1 dB).

e. Change 3325A amplitude to 1.061 V_{RMS} (3 Vp-p) and take ac voltage readings for 100 Hz, 1 kHz and 100 kHz as above. Verify that all three voltmeter readings are between 1.048 V_{RMS} and 1.073 V_{RMS} (±0.1 dB).

f. Change 3325A amplitude to .3536 V_{RMS} and set dc offset to 1 mV. Set 3325A frequency to (100 Hz, 1 kHz, and 100 kHz and read ac voltage. Verify that all three readings are between .3411 V_{RMS} and .3660 V_{RMS} (±0.3 dB).

g. Function Test. Connect 3325A sync output to external trigger input of oscilloscope. Connect 3325A signal output to the voltage divider of Figure 4-10(A). Connect the voltage divider output to oscilloscope vertical input and to high speed voltmeter input. Connect delayed sweep gate from oscilloscope to external trigger input of high speed voltmeter. See Figure 4-9 A.

h. Set the 3325A as follows:

High Voltage Output (Option 2)	OFF
DC Offset	0 V
Amplitude	10 Vp-p
Frequency	99.9 Hz
Function	Square

i. Set the oscilloscope as follows:

Display	A or B
Vertical Sensitivity	.5 volts/div
Trigger	Ext
Main Sweep	1 msec/div
Delayed Sweep	5 μsec/div
Delay	250

j. Set the 3437A voltmeter as follows:

Range	1.0 V
Trigger	Ext
Delay	0 sec
Coupling	DC 1MΩ

k. One cycle of the square wave should fill the screen of the oscilloscope, and the sample time for the voltmeter should be seen as the intensified spot of the delayed sweep.

l. Press AMPTD CAL on the 3325A.

m. Read positive peak voltage of attenuated waveform on voltmeter. If the reading is not stable, press hold, then ext. alternatively to repeat readings. Change oscilloscope delay to 750 and read negative peak. Add the two readings to obtain volts peak to peak. Verify that sum is between 3.661 volts and 3.735 volts.

n. Change 3325A function to Triangle. Change oscilloscope to:

Vertical Sensitivity	.2 volts/div
Vertical Position	9 o'clock
Main Sweep	.5 msec/div
Delay	500
Magnify	X10
Delayed Sweep	1 μsec/div

o. Adjust oscilloscope delay to place the intensified spot on peak of triangle and read positive peak voltage on 3437A. Press neg trigger, move vertical position knob of CR0 to 3 o'clock and adjust intensified spot to read negative peak on the 3437A. Verify that sum of positive and negative peak voltages is between 3.643 and 3.754 volts.

p. Change 3325A function to pos ramp. Change oscilloscope to:

Trigger	pos
Main Sweep	2 msec/div

Place spot on positive peak, press hold, then ext, then hold a few times on the 3437A and record most positive reading.

q. Move vertical position knob to 3 o'clock, adjust delay and read negative peak. Ramp jitter should be visible on all ramp readings (the 3437A will hold the readings). Verify that sum of pos and neg peaks is between 3.643 and 3.754 volts.

r. Change 3325A function to neg ramp. Change CRO trigger to pos and take neg ramp reading as above.

s. Change 3325A function to square and frequency to 1 kHz. Set CR0 as follows:

Main Sweep	50 μsec/div
Delayed Sweep	.05 μsec/div

Read positive peak; push neg trigger and read negative peak. Verify that sum is between 3.661 and 3.735 volts.

t. Change 3325A function to triangle and frequency to 2 kHz. Set CRO main sweep to 20 μsec/div and delay to 610. Adjust delay and position and set pos and neg trigger to read peaks. Verify Vp-p to be between 3.643 and 3.754 volts.

u. Change 3325 function to pos ramp and frequency to 500 Hz. Set main sweep of CRO to .2 msec/div and adjust sweep vernier to return peaks to center screen (trigger must be neg to see jitter at this point). Verify Vpp to be between 3.643 and 3.754 volts.

v. Change 3325A function to neg ramp and CRO trigger to pos. Verify Vpp of 3.643 to 3.754 volts.

w. Change 3325A frequency to 100 kHz and function to square. Return CRO sweep vernier to calibrate and set main sweep to .5 μsec/div and magnify to off. Read pos and neg peak voltages in the center of the screen. By pressing pos/neg trigger. Verify Vpp of 3.661 to 3.735 volts.

x. Change 3325A function to triangle (frequency will go to 10 kHz). Set CRO main sweep to 5 μsec/div and press magnify. Verify Vpp of 3.513 to 3.883 volts.

y. Change 3325A function to pos ramp. Set cro main sweep to 20 μsec/div. Adjust delay to set end of intensified spot on highest peak. Verify Vpp of 3.328 to 3.996 volts.

z. Change 3325A function to neg ramp. Verify Vpp of 3.328 to 3.996 volts.

aa. Change 3325A amplitude to 3Vp-p, and remove the voltage divider from the circuit. Reconnect the 3325A signal output to the oscilloscope and voltmeter through the 50 ohm feedthru termination. Set the 3325A frequency to 99.9Hz and the function to square.

bb. Repeat tests i through z. New test limits are as follows:

Test	Frequency	Function	Minimum	Maximum
m	99.9 Hz	Square	2.970 V	3.030 V
o	99.9 Hz	Triangle	2.955 V	3.045 V
q	99.9 Hz	Pos Ramp	2.955 V	3.045 V
r	99.9 Hz	Neg Ramp	2.955 V	3.045 V
s	1 kHz	Square	2.970 V	3.030 V
t	2 kHz	Triangle	2.955 V	3.045 V
u	500 Hz	Pos Ramp	2.955 V	3.045 V
v	500 Hz	Neg Ramp	2.955 V	3.045 V
w	100 kHz	Square	2.970 V	3.030 V
x	10 kHz	Triangle	2.850 V	3.150 V
y	10 kHz	Pos Ramp	2.700 V	3.300 V
z	10 kHz	Neg Ramp	2.700 V	3.300 V

cc. Change 3325A amplitude to 1 Vpp, and set dc offset to 1 mV. Set frequency to 99.9 Hz and function to square. Set CRO vertical sensitivity to .05 volts/div for all 1 Vpp tests.

dd. Repeat tests i through z. New test limits are as follows:

Test	Frequency	Function	Minimum	Maximum
m	99.9 Hz	Square	.970	1.030
o	99.9 Hz	Triangle	.960	1.040
q	99.9 Hz	Pos Ramp	.960	1.040
r	99.9 Hz	Neg Ramp	.960	1.040
s	1 kHz	Square	.970	1.030
t	2 kHz	Triangle	.960	1.040
u	500 Hz	Pos Ramp	.960	1.040
v	500 Hz	Neg Ramp	.960	1.040
w	100 kHz	Square	.970	1.030
x	10 kHz	Triangle	.940	1.060
y	10 kHz	Pos Ramp	.890	1.110
z	10 kHz	Neg Ramp	.890	1.110

High Voltage Output Amplitude Accuracy For Frequencies To 100 kHz
(For Instruments with High Voltage Option 002)

ee. Sine Wave Test. Connect 3325A signal output to the AC voltmeter via a 6 ft. cable. Connect a 500 Ω, 300 pF load (at either end) in parallel with the line.

ff. Press the 3325 high voltage key near the 3325A output connector. A LED in the key indicates that the high voltage output is on.

gg. Set 3325A function to sine, frequency to 2 kHz, and amplitude to 14.14 V_{RMS} (40 Vpp). Press AMPTD CAL key. The AC voltmeter reading should be 13.86 to 14.42 V_{RMS}.

hh. High Voltage Function Test. Connect 3325A signal output to CRO and voltage divider via a 6 ft. cable. Trigger CRO on 3325A sync output. Trigger high speed DC voltmeter on delayed sweep gate from CRO See Figure 4-9B.

ii. The voltage divider shown in Figure 4- 9B is built into a small metal box with 2 BNC connectors. Parts used are:

R3, 443 ohm, consists of 3 parallel 1330 ohm resistors, each 0.1%, 0.25 watt, -hp- Part Number 0698-7453

R4, 43 ohm, 0.1%, 0.125 watt, -hp- Part No. 0698-8264

C1, 300 pF, 5%, -hp- Part Number 0160-2207

Connect the tap to the input of high speed DC voltmeter as shown in Figure 4-9B.

jj. Set 3325A frequency to 2 kHz and amplitude to 40 Vpp. Set DC voltmeter to 1V range and ext trigger. Set oscilloscope as follows:

Vertical Sensitivity	2 volts/div
Vertical Position	8 o'clock
Trigger	Ext
Main Sweep	20 μsec/div
Delayed Sweep	.05 μsec/div
Delay	615
Magnify	X10

kk. Set 3325A to square wave and read positive peak on DC voltmeter. Switch CRO to neg trigger, take vertical position to 4 o'clock, and read neg peak. Verify that peak to peak voltage is between 3.466 and 3.607 volts.

ll. Change 3325A function to triangle, and read peak voltages. Vpp should be 3.466 to 3.607 volts.

mm. Change 3325A to pos ramp. Change CRO main sweep to .1 msec/div and delay to 500. Verify Vpp of 3.466 to 3.607 volts. Repeat for neg ramp by changing CRO trigger to pos.

Amplitude Flatness: (Frequencies above 100 kHz)

nn. Set the 3325A as follows:

High Voltage Output (Option 2)	OFF
Function	Sine
Frequency	1 kHz
Amplitude	3 Vpp

oo. Set the 50 Ω attenuator (-hp- Model 355C) to 3 dB and connect to signal output. Connect 1 V_{RMS} thermal converter (-hp- 11050A) to attenuator output. Connect DC digital voltmeter with microvolt resolution (-hp- 3455A) to thermal converter output. See Figure 4-9C.

pp. Press 3325A AMPTD CAL key. Record the voltmeter reading in the 3 V sine wave 1 kHz reference space on the performance test record.

qq. Set the 3325A modify key to the 1MHz position and bump the frequency in 2MHz steps from 1kHz to 20.001MHz, recording the voltmeter reading at each frequency. In each case, allow the thermal converter several seconds to stabilize.

rr. Verify that all flatness readings are within ± 6.6% of the 1 kHz reference reading.

ss. Change attenuator to 12 dB. Change 3325A amplitude to 10 Vpp. Repeat steps pp and qq for 10 Vpp. Verify that all readings are within 6.3% of the 1 kHz reference.

tt. Disconnect the thermal converter from the 3325A output.

uu. Square wave flatness. Set the 3325A as follows:

High Voltage Output (Option 2)	OFF
Function	Square
Amplitude	10 Vpp
Frequency	1 kHz

vv. Connect the 3325A signal output to an oscilloscope (-hp- 1740A) with a 50Ω load. Set the oscilloscope as follows:

Vertical Sensitivity	2 volts/div
Time/Div	.1 msec

ww. Use the modify keys to bump the 3325A frequency from 1 kHz to 10.001 MHz in 2 MHz steps. Two lines will appear on the oscilloscope. Verify that they remain within ½ major division of 5 divisions apart for all 11 frequencies.

xx. High Voltage (Option 2) Amplitude Flatness above 100kHz.

yy. Connect the 3325A output to an oscilloscope (-hp- 1740A) with a 500 Ω, 500 pF load (load attached at either end). Cable capacitance (30pF/foot) must be included in the 500 pF. The HV divider (Figure 4-9B) may be used with 6 feet of cable.

zz. Set the oscilloscope as follows:

Vertical Sensitivity	10 volts/div
Time/Div	1 msec

aaa. Set the 3325A to 40 Vpp sine wave (HV option on) and 1 kHz. Adjust oscilloscope intensity and focus for a sharp trace.

bbb. Use the modify keys to bump the 3325A frequency from 1 kHz to 1.001 MHz in 200 kHz steps. Verify that the width of the bright region of the screen is 4 ± .4 divisions for all 11 frequencies.

4-61. DC Offset Accuracy (DC Only).

4-62. This procedure tests the dc offset accuracy when no ac function output is present. The dc only specification in Table 1-1 is:

±0.4% of full range*

* Except lowest attenuator range where accuracy is ±20μV

Equipment Required:

DC digital voltmeter with 5-digit resolution, capable of measuring >20 V for High Voltage Output Option 002 (-hp- Model 3455A)

50-ohm Feedthru termination (-hp- Model 11048C)

a. Connect the 3325A signal output through the 50-ohm feedthru termination to the dc digital voltmeter input (see Figure 4-11(A)).

b. Press whichever function key is presently active, indicated by a lighted indicator in the center of the key. This removes the ac output. The indicator in the center of the "DC OFFSET" entry key should light.

c. Set the 3325A dc offset to 5 V, then press the "AMPTD CAL" key.

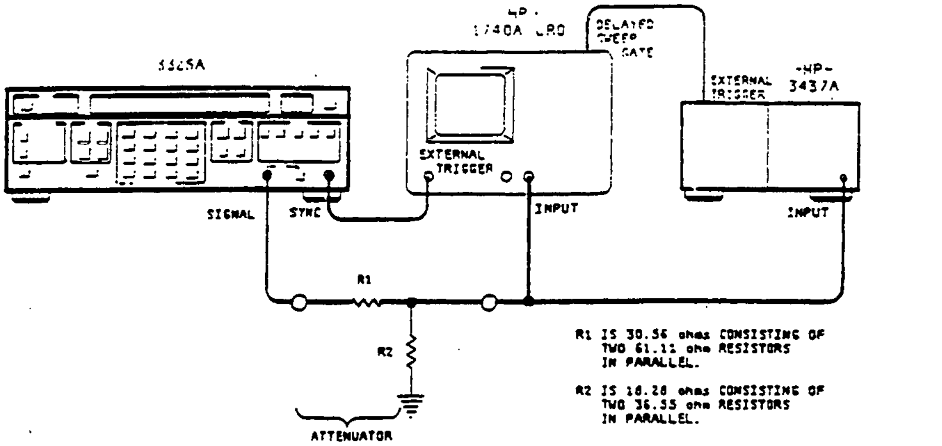
d. The dc digital voltmeter reading should be +4.980 to +5.020 V.

e. Change 3325A dc offset to −5 V. Digital voltmeter reading should be −4.980 to −5.020 V.

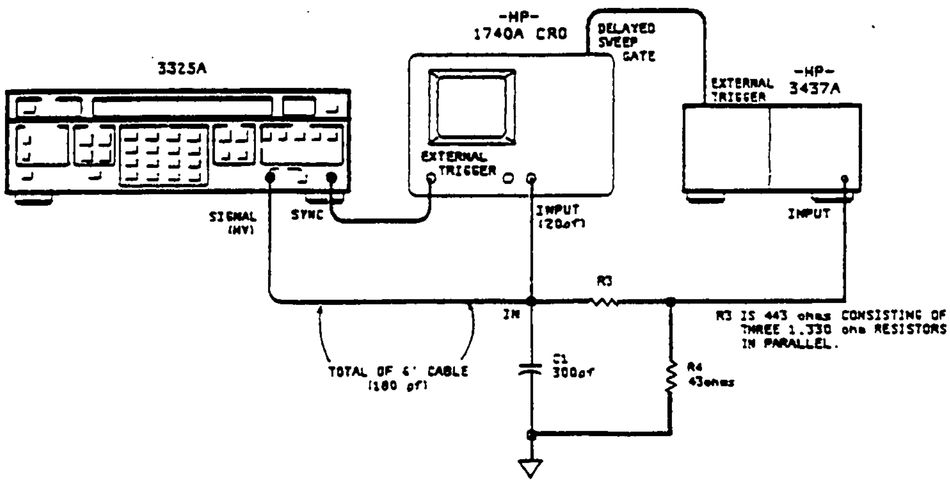
Attenuator Test

f. Set the dc offset to the positive and negative voltages shown below. The digital voltmeter reading should be within the tolerances shown for each voltage.

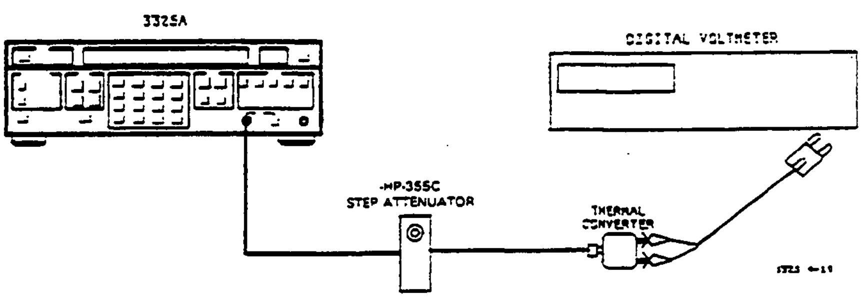
DC Offset	Tolerances
±1.499 V	±1.49300 to 1.50499 V
±499.9 mV	±0.49790 to 0.50190 V
±149.9 mV	±0.14930 to 0.15050 V
±49.99 mV	±0.04979 to 0.05019 V
±14.99 mV	±0.01493 to 0.01505 V
±4.999 mV	±0.004979 to 0.005019 V
±1.499 mV	±0.001479 to 0.001519 V



A. Function Amplitude Accuracy, Standard Output (<100 kHz)



B. Function Amplitude Accuracy, High Voltage Output (<100 kHz)



C. Amplitude Flatness (> 100 kHz)

Figure 4-9. Amplitude Accuracy and Flatness.

High Voltage Output Option 002 DC Offset

g. Remove the 50-ohm feedthru and connect the 3325A output directly to the digital voltmeter input.

h. Press the "SIGNAL" key in the lower right corner of the 3325A front panel to select High Voltage Output (Option 002). Lighted indicator in the center of this key indicates High Voltage Output is on.

i. Set 3325A dc offset to 20 V. Digital voltmeter reading should be +19.775 V to 20.225 V.

j. Set 3325A dc offset to −20 V. Digital voltmeter reading should be −19.775 V to −20.225 V.

4-63. DC Offset Accuracy with AC Functions.

4-64. The specifications for DC Offset accuracy with AC Functions given in Table 1-1 are as follows:

DC + AC, ≤1 MHz: ±1.2%, Ramps ±2.4%
DC + AC, >1 MHz: ±3%

Equipment Required:
DC Digital voltmeter (-hp- Model 3455A)
50-ohm feedthru termination (-hp- Model 11048C)

a. Connect the equipment as shown in Figure 4-10 A . Set the digital voltmeter to measure dc voltage.

b. Set the 3325A output as follows:

High Voltage Output (Option 002)	Off
Function	Sine
Frequency	20.999 999 999 MHz
Amplitude	1 V p-p
DC Offset	+4.5 V

c. Press AMPTD CAL key. After amplitude calibration (approximately 2 seconds) the digital voltmeter reading should be +4.350 to +4.650 V dc.

d. Change the dc offset to −4.5 V. Digital voltmeter reading should be −4.350 to −4.650 V dc.

e. Change the 3325A frequency to 999.9 kHz. The digital voltmeter reading should be −4.440 to −4.560 V dc.

f. Change the 3325A dc offset to (+) 4.5 V. The digital voltmeter reading should be +4.440 to +4.560 V dc.

g. Set the 3325A function to Square. The digital voltmeter reading should be +4.440 to +4.560 V dc.

h. Change the 3325A dc offset to −4.5V. The digital voltmeter reading should be −4.440 to −4.560 V dc.

i. Change the 3325A frequency to 9.9999 MHz. The digital voltmeter reading should be −4.350 to −4.650 V.

j. Set the 3325A function to Triangle, frequency to 9.9 kHz. The digital voltmeter reading should be −4.440 to −4.560 V.

k. Set the 3325A function to + Ramp. The digital voltmeter reading should be −4.380 to −4.620 V.

4-65. Triangle Linearity.

4-66. This procedure tests the linearity of the triangle wave output against the specification in Table 1-1:

±0.05% of full output, 10% to 90%, best fit straight line

Because the triangle and ramp outputs are generated by the same circuits, this procedure effectively tests the ramp linearity also.

Equipment Required:
High-speed dc digital voltmeter (This procedure is written to use the high speed and delay capabilities of the -hp- Model 3437A)
Resistive divider, ÷2.5, consisting of:
30 ohms ±1% ¼W (-hp- Part No. 0698-7533)
20 ohms ±1% ¼W (-hp- Part No. 0698-6296)
BNC-to-Triax adapter (-hp- Part No. 1250-0595 or Model 11172A RF Cable)

a. Connect the 3325A and the high-speed digital voltmeter through the divider as shown in Figure 4-10B.

b. Set the 3325A as follows:

High Voltage Output (Option 002)	Off
Function	Triangle
Frequency	10 kHz
Amplitude	10 V p-p

c. Set the digital voltmeter as follows:

Range	1 V
Number of Readings	1
Trigger	Ext

NOTE

The Model 3437A triggers on the negative-going edge of the 3325A sync square wave.

d. Set the digital voltmeter delay to .00003 (seconds). Record the digital voltmeter reading on the Performance Test Record under "Positive Slope Measurement, (10%) y_1". This is the 10% point on the positive slope of the triangle. See Figure 4-11.

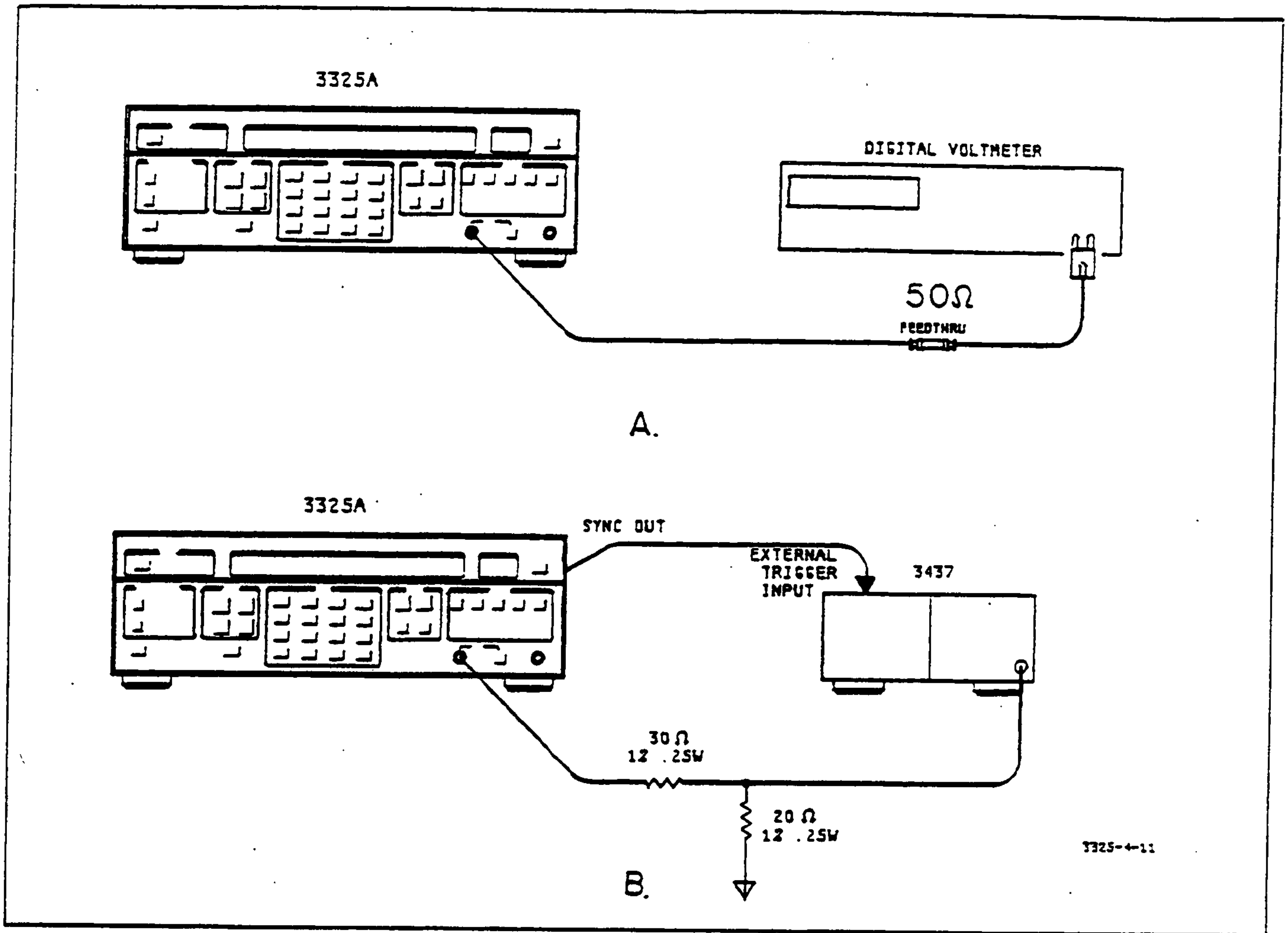


Figure 4-10. Triangle and Ramp Linearity Test.

e. Measure the voltage at each 10% segment point by setting the digital voltmeter delay to the following. Enter on the Performance Test Record in the appropriate spaces under "Positive Slope Measurement."

Delay	Percent of Slope
.000035	20
.00004	30
.000045	40
.00005	50
.000055	60
.00006	70
.000065	80
.00007	90

f. Measure the voltage at each 10% segment point on the negative slope by setting the digital voltmeter delay to the following. Enter the readings on the Performance Test Record in the appropriate spaces under "Negative Slope Measurement."

Delay	Percent of Slope
.00008	90
.000085	80
.00009	70
.000095	60
.0001	50
.000105	40
.00011	30
.000115	20
.00012	10

g. Algebraically add the voltages recorded in the "Positive Slope Measurement" column and enter the total in the "Σy" space.

h. Multiply Σy by 45 (which is Σx) and enter the result in the "$\Sigma x \Sigma y$" space.

i. Multiply each y value by the corresponding x value and enter in the "x times y" column. Total these values and enter in the "Σxy" space.

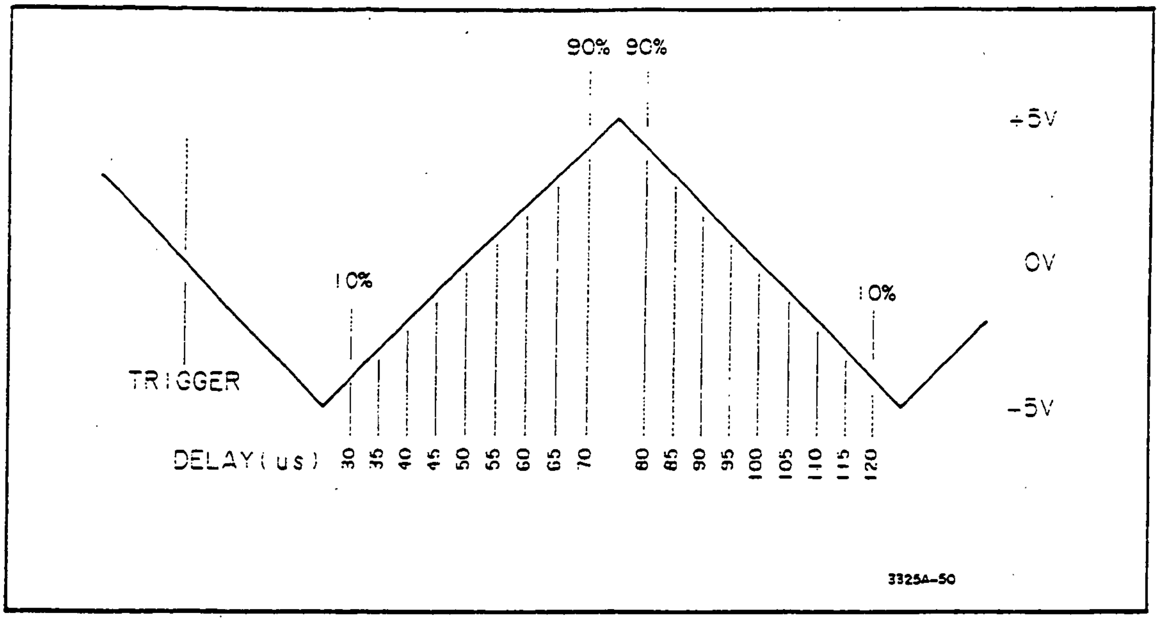


Figure 4-11. Triangle Linearity Test.

j. The equation for determining the "best fit straight line" specification for each y value is:

$$y = a_1x + a_0$$

Where: a_1 and a_0 are constants to be calculated from data taken previously.

NOTE

Calculate the values of a_1 and a_0 to at least five decimal places.

k. First determine the value of a_1 using the following equation:

$$a_1 = \frac{\Sigma xy - \frac{\Sigma x \Sigma y}{n}}{\Sigma x^2 - \frac{(\Sigma x)^2}{n}}$$

Where: Σx, Σy, Σxy, $\Sigma x \Sigma y$; Σz^2, and $(\Sigma x)^2$ are the previously calculated values entered on the Performance Test Record.

n = 9 (the number of points to be calculated)

l. Determine the value of a_0 using the equation:

$$a_0 = \frac{\Sigma y}{n} - a_1 \frac{\Sigma x}{n}$$

m. Calculate the "Best Fit Straight Line" value for each point (y_1 through y_9) using the equation:

$$y = a_1x + a_0$$

Enter each result on the Performance Test Record in the "Best Fit Straight Line" column.

n. Determine the minimum and maximum allowable voltages at each point by subtracting and adding 0.002 V to the voltages calculated in Step m (10 V ÷ 2.5 x 0.05 %). Enter these voltage limits on the Performance Test Record under "Minimum" and "Maximum". The voltages measured and recorded in the "Positive Slope Measurement" column should be within these calculated tolerances.

o. Algebraically add the voltages recorded in the "Negative Slope Measurement" column and enter the total in the "Σy" space.

p. Repeat Steps h through n to determine the "Best Fit Straight Line" values and tolerances for the negative slope. The voltages measured and recorded in the "Negative Slope Measurement" column should be within the calculated tolerances.

4-67. X Drive Linearity.

4-68. This procedure tests the linearity of the rear panel X Drive output to the specification in Table 1-1: for all linear sweep widths which are integral multiples of the minimum sweep width for each function and sweep time:

±0.1% of final value, 10% to 90%, best fit straight line.

Equipment Required:

- High-speed dc digital voltmeter (This procedure is written to use the high speed and delay capabilities of the -hp- Model 3437A)
- Resistive divider, ÷ ~2.6, consisting of:
  - 100kΩ 1% 1/8W (-hp- Part No. 0757-0465)
  - 162kΩ 1% 1/8W (-hp- Part No. 0757-0470)
- DC power supply (-hp- MOdel 6214A)
- BNC-to-Triax adapter (-hp- Part No. 1250-0595 Model 11172A RF Cable)

a. Connect the equipment as shown in Figure 4-12.

b. Set the 3325A as follows:

High Voltage Output (Option 002) ..... Off
Function .... Sine
Amplitude .... 10 V p-p
Sweep Start Frequency .... 1 MHz
Sweep Stop Frequency .... 10 MHz
Sweep Marker Frequency .... 4 MHz
Sweep Time .... 0.01 sec

c. Press 3325A START CONT key.

d. Set the digital voltmeter as follows:

Range .... 1 V
Number of Readings 1
Trigger .... Ext

NOTE

The model 3437A triggers on the negative going edge of the Z Blank signal, which occurs at the start of a sweep up.

e. Set the digital voltmeter delay to .001 (seconds). Adjust the dc power supply for a digital voltmeter reading of −1.600 V. Record the digital voltmeter reading on the Performance Test Record under "X Drive Ramp Measurement, (10%), y_1." This is the 10% point on the X Drive ramp. See Figure 4-13.

f. Measure the voltage at each 10% segment point by setting the digital voltmeter delay to the following. Enter on the Performance Test Record in the appropriate spaces under "X Drive Ramp Measurement".

Delay	Percent of Ramp
.002	20
.003	30
.004	40
.005	50
.006	60
.007	70
.008	80
.009	90

g. Algebraically add the voltages recorded in the "X Drive Ramp Measurement" column and enter the total in the "Σy" space.

h. Multiply Σy by 45 (which is Σx) and enter the result in the "$\Sigma x \Sigma y$" space.

i. Multiply each y value by the corresponding x value and enter in the "x times y" column. Total these values and enter in the "Σxy" space.

j. The equation for determining the "best fit straight line" specification for each y value is:

$$y = a_1 x + a_0$$

Where: a_1 and a_0 are constants to be calculated from data taken previously.

NOTE

Calculate the values of a_1 and a_0 to at least five decimal places.

k. First determine the value of a_1 using the following equation:

$$a_1 = \frac{\Sigma xy - \dfrac{\Sigma x \Sigma y}{n}}{\Sigma x^2 - \dfrac{(\Sigma x)^2}{n}}$$

Where: Σx, Σy, Σxy, $\Sigma x\Sigma y$, Σz^2, and $(\Sigma x)^2$ are the previously calculated values entered on the Performance Test Record.

n = 9 (the number of points to be calculated)

l. Determine the value of a_0 using the equation:

$$a_0 = \frac{\Sigma y}{n} - a_1 \frac{\Sigma x}{n}$$

m. Calculate the "Best Fit Straight Line" value for each point (y_1 through y_9) using the equation:

$$y = a_1 x + a_0$$

Enter each result on the Performance Test Record in the "Best Fit Straight Line" column.

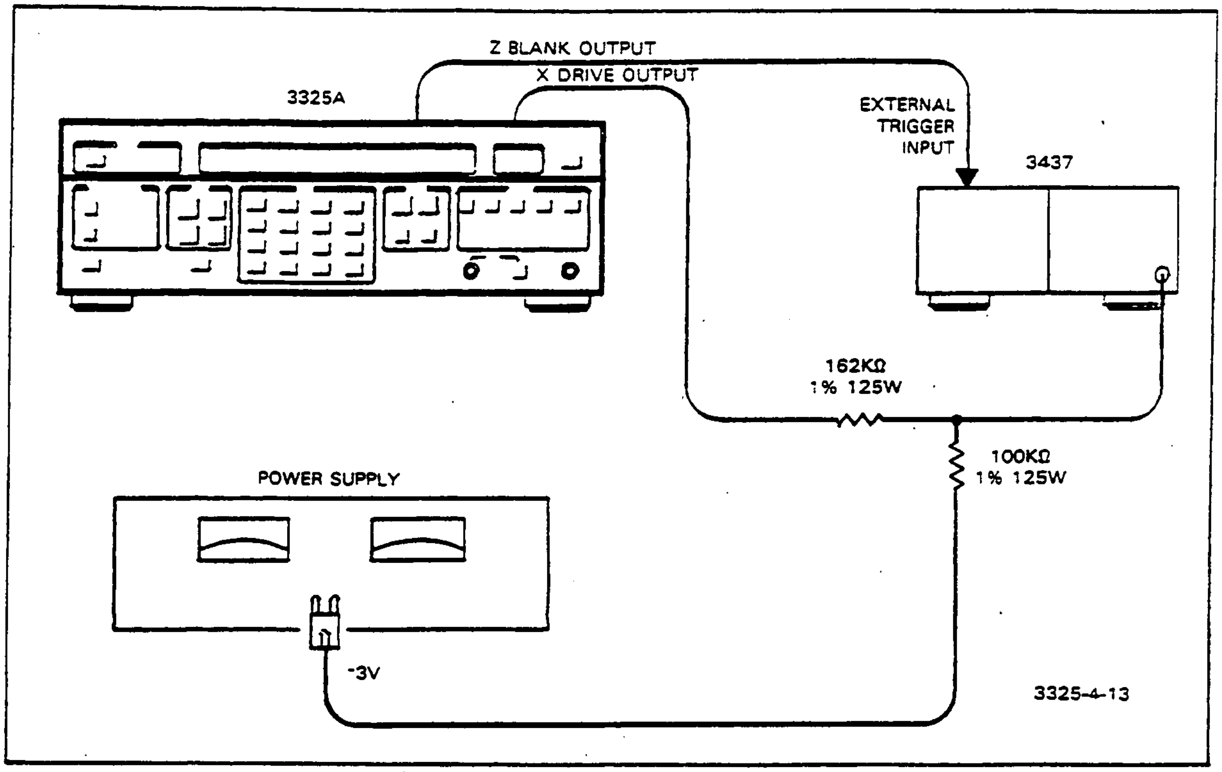


Figure 4-12. X Drive Linearity Test.

n. Determine the minimum and maximum allowable voltages at each point by subtracting and adding 0.004 V to the voltages calculated in Step m (10.5 V ÷ 2.6 x 0.1%). Enter these voltage limits on the Performance Test Record under "Minimum" and "Maximum". The voltages measured and recorded in the "X Drive Ramp Measurement" column should be within these calculated tolerances.

NOTE

The 3325A X Drive maximum voltage (100%) is set at the factory to +10.5 V..

4-69. Ramp Period Variation.

4-70. This procedure tests the variation between alternate cycles of the positive and negative slope ramps to the specification in Table 1-1: < ±1% of period, maximum.

Equipment Required: Oscilloscope, with delayed sweep (-hp- Model 1740A)

a. Connect 3325A signal output to the oscilloscope vertical input. (Do NOT use a 10:1 probe.) If the oscilloscope is an -hp- Model 1740A, set the input switch to the 50-ohm position. If your oscilloscope doesnot have a 50-ohm input, use a 50-ohm load (-hp- Model 11048C 50-ohm Feedthru Termination) at the input.

b. Set the 3325A as follows:

Function............Negative Slope Ramp
Frequency........................100 Hz
Amplitude.....................10 V p-p

c. Set the oscilloscope as follows:

Vertical.........................2 V/div
Main sweep..................2.0 ms/div
Delayed sweep................20 μs/div
Trigger.......................Positive

d. With oscilloscope horizontal controls set to main sweep, adjust the intensified portion of the trace to the reset (positive going) portion of the ramp.

e. Set the horizontal controls to delayed sweep and position the ramp reset portion near the center of the display.

f. The reset portion should show more than one line, as in Figure 4-14. The lines should not be separated by more than ten divisions on the display.

g. Change the 3325A function to positive slope ramp and set oscilloscope trigger to negative to verify the positive ramp.

h. Bump the 3325A frequency to 99.999999 Hz to check the low frequency ramps. Verify that ramp period variations do not exceed ten divisions.

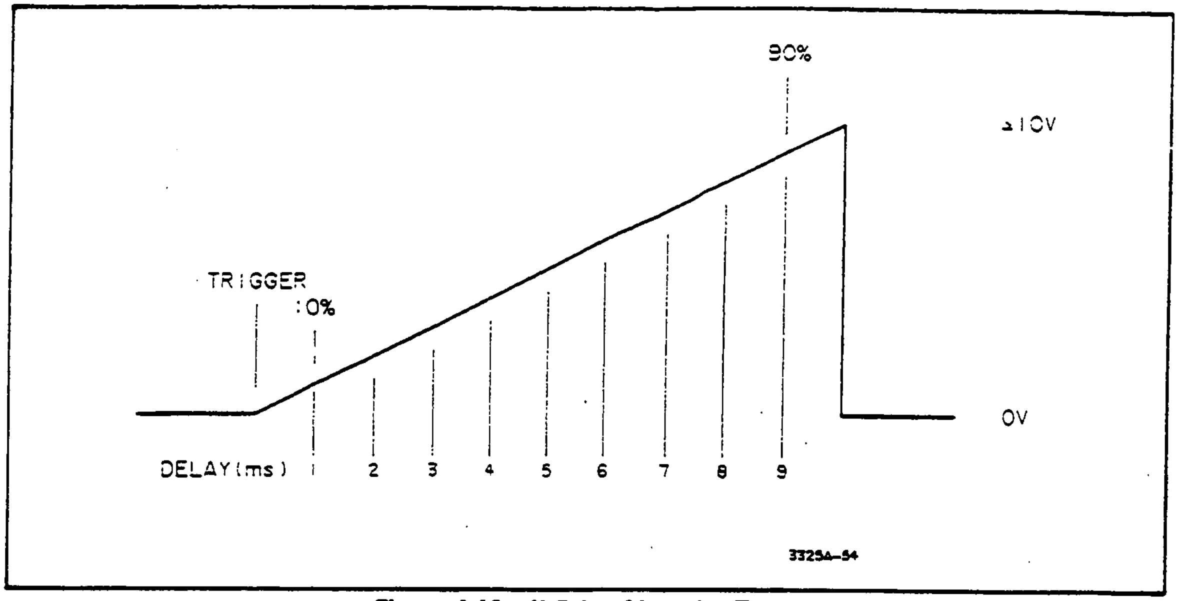


Figure 4-13. X Drive Linearity Test.

4-71. HP-IB Interface Test.

4-72. The following calculator program tests the operation of the 3325A HP-IB interface circuits. The program is written for an -hp- Model 9825A calculator but may be adapted for other controllers. The program is printed on a foldout page for your convenience.

Equipment Required:
-hp- Model 9825A Calculator equipped with:
98034A HP-IB Interface (set the select code 7)
Any combination of ROM's that includes a General I/O ROM and an Extended I/O ROM

a. Connect the calculator interface cable to the 3325A rear panel HP-IB connector. It is recommended that no other equipment be connected to this HP-IB during this test.

b. Enter the program into the calculator.

c. Press RUN. Tests 4 through 7 in this program require the operator to press CONTINUE if the test passes, or 1 CONTINUE if the test fails. If the Test 4 question (SRQ LIGHT ON?, 1 = NO) does not appear in the calculator display within 30 seconds after start of the program (RUN), the 3325A and calculator are not interfacing properly. The calculator may display an error indication that will identify the problem. If not, the 3325A HP-IB circuits are probably not operating correctly.

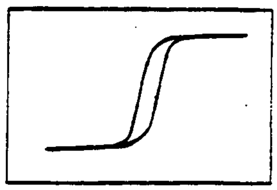


Figure 4-14. Ramp Reset Waveform.

PROGRAM FLOWCHART

Instrument Returns To Known Conditions After Self Test

Test 1 – Did Frequency Go To 1000 Hz?

Test 2 – Interrogate Frequency

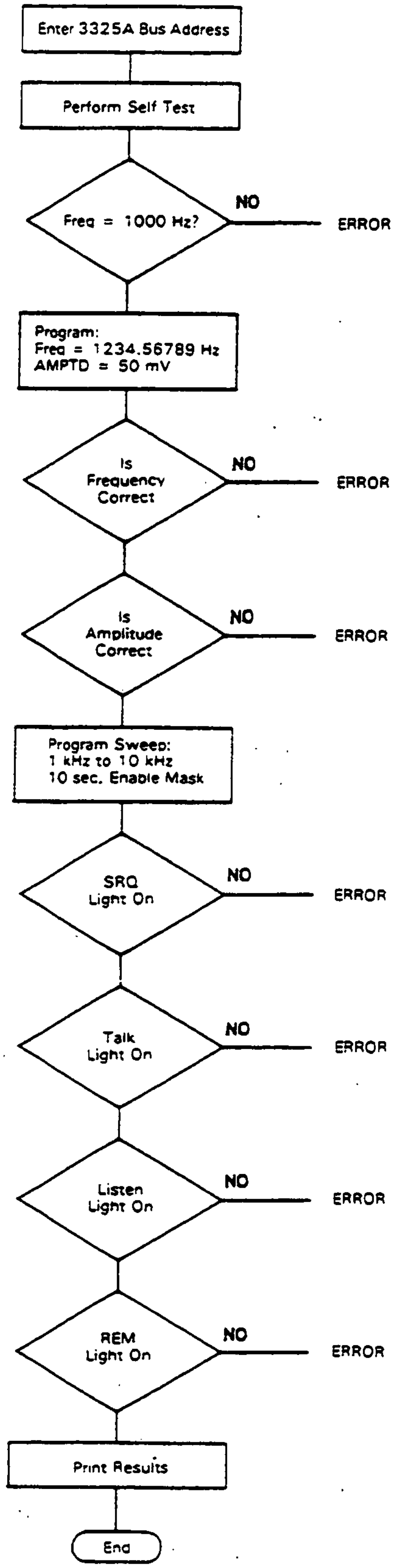
Test 3 – Interrogate Amplitude

Test 4 – Test SRQ Circuits

Test 5 – Test Talk Circuits

Test 6 – Test Listen Circuits

Test 7 – Test Remote Circuits



```
0: fmt ;csv;0→r1→r2→r3→r4→r5→r6→r7
1: prt "################"
2: prt "3325A"
3: prt "HP-IB TEST"
4: prt "##############"
5: beep;ent "3325A BUS ADDRESS?,cont=717",A
6: if flg13;717→A
7: clr A ———————— Clear the 3325A to Turn-on State
8: rem 7 ———————— Set HP-IB Remote Enable (Select Code 7)
9:
10: "TEST 1":
11: wrt A,"TE" ———————— Perform Self Test
12: wrt A,"IFR" ———————— Interrogate Frequency
13: red A,F ———————— Read 3325A Frequency
14: if F#1000;1→r1 ———————— Compare Frequency to 1000 Hz
15:
16: "TEST 2,3 SETUP":
17: wrt A,"FR1234.567890HZ AM50MV" ———————— Set Freq to 1234.567890 Hz, Amptd to 50mV
18: wrt A,"SR3" ———————— Store Settings in Register 3
19: clr A ———————— Clear the 3325A
20: wrt A,"RE3" ———————— Recall Settings in Register 3
21:
22: "TEST 2":
23: wrt A,"IFR" ———————— Interrogate Frequency
24: red A,G ———————— Read Frequency
25: if G#1234.56789;1→r2 ———————— Compare to Frequency Stored
26:
27: "TEST3":
28: wrt A,"IAM" ———————— Interrogate Amplitude
29: red A,H ———————— Read Amplitude
30: if H#.05;1→r3 ———————— Compare to Amplitude Stored
31:
32: "TEST 4":
33: wrt A,"ST1KH SP10KH SM1 TI10SE MSF SSSS" ———— Lin Sweep 1—10kHz, Enable SRQ Mask
34: cli 7;lcl 7 ———————— Clear Interface, Interface to Local
35: beep;ent "SRQ LIGHT ON?,1=NO",r4 ———————— Did 3325A Initiate SRQ?
36:
37: "TEST 5":
38: rds(A)→S ———————— Read Status into Variable 5
39: rem 7 ———————— Set Remote Enable
40: red A,S ———————— Read from the 3325A
41: beep;ent "TALK LIGHT ON?,1=NO",r5 ———————— Did 3325A respond to Talk Command?
42:
43: "TEST6":
44: wrt A;lcl 7 ———————— Write to the 3325A, Interface to Local
45: beep;ent "LISTEN LIGHT ON?,1=NO",r6 ———— Did 3325A respond to Listen Command?
46:
47: "TEST 7":
48: rem 7;wrt A;cli 7 ———————— Remote Interface, Write to 3325A, Clear Interface
49: beep;ent "REMOTE LIGHT ON:,1=NO",r7 ———————— Did the 3325A Respond to Remote?
50:
```

```
51: spc ;prt "#############"
52: prt "TEST RESULTS:"
53: spc ;1→I;fxd 0
54: if rI=0;prt "TEST",I,"     PASS"
55: if rI=1;prt "TEST",I,"          FAIL"
56: if (I+1→I)<=7;jmp -2
57: prt "###############";spc 3
58: ent "Repeat test?,1=Yes",C;if C=1;gto 0
59: end
*24386
```

Lines 51–57: Print Results of Tests

Line 58: Self Contained Program may be Linked or Used as a Subroutine

Variables used in this Test Program:

A	Address of 3325A (defaults to 717)
F	Frequency read from 3325A in test #1
G	Frequency read from 3325A in test #2
H	Amplitude read from 3325A in test #3
I	Counter used to print test results
r1-r7	Test results (0 = Pass, 1 = Fail)
S	Status read from 3325A in test #5

Samples of Program Printouts:

```
################
3325A
HP-IB TEST
#############

#############
TEST RESULTS:

TEST           1
     PASS
TEST           2
     PASS
TEST           3
     PASS
TEST           4
          FAIL
TEST           5
     PASS
TEST           6
     PASS
TEST           7
     PASS
################
```

```
################
3325A
HP-IB TEST
#############

#############
TEST RESULTS:

TEST           1
     PASS
TEST           2
     PASS
TEST           3
     PASS
TEST           4
     PASS
TEST           5
     PASS
TEST           6
     PASS
TEST           7
     PASS
################
```