Service Manual

HP 3324A Synthesized Function/Sweep Generator

SERIAL NUMBERS

This manual applies to instruments with serial numbers 3009G00511 and above, and 3023A..... and above. Be sure to examine the manual changes supplement in Appendix A for changes which apply to your instrument, and record these changes in the manual. If your instrument has a lower serial number, refer to Appendix D which contains backdating information for earlier instruments.

HEWLETT PACKARD

HP Part No. 03324-90001
Printed in Federal Republic of Germany October 1990

Edition 1

Notice

Subject Matter Notice

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Printing History

New editions are complete revisions of the manual. Update packages, which are issued between editions, contain additional and replacement pages to be merged into the manual by the customer. The date on the title page and back cover of the manual only changes when a new edition is published. When an edition is reprinted, all the prior updates to the edition are incorporated. No information is incorporated into a new edition unless it appears in a prior update.

Edition 1   October 1990   03324-90001   E1090

Safety

This product has been designed and tested according to International Safety Requirements. To ensure safe operation and to keep the product safe, heed the symbols, warnings and cautions contained in this section.

Operational Safety

The following general safety precautions must be observed during all phases of operation, service, and repair of this product. 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 product. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements.

DO NOT operate the product in an explosive atmosphere or in the presence of flammable gases or fumes.

Keep away from live circuits: Operating personnel must not remove equipment covers or shields. Procedures involving the removal of covers or shields are for use by service-trained personnel only. Under certain conditions, dangerous voltages may exist even with the equipment switched off.

To avoid dangerous electrical shock, DO NOT perform procedures involving cover or shield removal unless you are qualified to do so.

DO NOT operate damaged equipment: Whenever it is possible that the safety protection features built into this product have been impaired, either through physical damage, excessive moisture, or any other reason, REMOVE POWER and do not use the product until safe operation can be verified by service-trained personnel. If necessary, return the product to a Hewlett-Packard Sales and Service Office for service and repair to ensure that safety features are maintained.

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 equipment: Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the product. Return the product to a Hewlett-Packard Sales and Service Office for service and repair to ensure that safety features are maintained.

Safety Symbols

The apparatus will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect the apparatus against damage.

Indicates dangerous voltages.

Earth terminal.

Protective earth.

ATTENTION
Static Sensitive

Affixed to a product containing static sensitive devices - use anti-static handling procedures to prevent electrostatic discharge damage to components

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Warning

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

Caution

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

How to Use this Manual

Manual Overview

This manual shows how to service the HP 3324A. Brief operation and configuration information is provided where necessary, but you should refer to the "Operating and Programming Manual" for more specific information.

What is in this manual?

Chapter 1: *General Information*
Gives a brief description of the instrument, its features and how to use them. It lists available options and accessories, and also provides specification details.

Chapter 2: *Installation*
Contains information and procedures required to install the HP 3324A instrument and it's options. Preparation for use with storing and shipping requirements are also described

Chapter 3: *Adjustments*
Describes procedures for setting up the instrument after repair or board exchange, to meet performance requirements.

Chapter 4: *Replaceable Parts*
Lists the part numbers for all user replaceble parts in the instrument. The chapter also contains ordering information for exchange items.

Chapter 5: *Service*
Contains information and procedures to aid in fault isolation and repair of the HP 3324A instrument. The chapter provides an outline theory of operation.

Appendix A: *Manual Changes*
Contains information required to correct or update this manual.

Appendix B: *Component Level Information Package*
A list of the additional component-level reference documentation contained in the CLIP. Insert the CLIP here if you order it.

Appendix C: *Performance Tests*
Describes performance tests and the recommended test equipment for testing and servicing the HP 3324A. Blank Test Records are included which you are free to copy without written permission from Hewlett-Packard.

Appendix D: *Backdating Changes*
Contains information required to adapt the manual for instruments with a serial number lower than that shown on the title page.

Limited Warranty

Warranty

This Hewlett-Packard instrument product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, HP will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by HP. Buyer shall prepay shipping charges to HP and HP shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to HP from another country.

HP warrants that its software and firmware designated by HP for use with an instrument will execute its programming instructions when properly installed on that instrument. HP does not warrant that the operation of the instrument, software, or firmware will be uninterrupted or error free.

Limitation of Warranty

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

No other warranty is expressed or implied. HP specifically disclaims the implied warranties of Merchantibility and Fitness for a Particular Purpose.

Exclusive Remedies

The remedies provided herein are Buyer's sole and exclusive remedies. HP shall not be liable for any direct, indirect, special, incidental, or consequential damages, whether based on contract, tort, or any other legal theory.

Assistance

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

Certification

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

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General Information

Introduction

The HP 3324A Synthesized Function/Sweep Generator is a multi-task generator. which can be used as:

- **a reference source** : Produces a sinewave of a specified frequency, amplitude, DC offset and phase.
- **a function generator** : Produces various waveforms at a specified frequency, amplitude, DC offset and phase.
- **a sweep generator** : Produces logarithmic and linear frequency sweeps.

Detailed descriptions, operating information and programming information for the HP 3324A, are contained in the HP 3324A Operating and Programming Manual 03324-90011.

Safety

The Model HP 3324A is a Safety Class 1 instrument (instrument with an exposed metal chassis that is directly connected to earth via the power supply cable).

Before operation, the instrument and manual, including the red safety page, should be reviewed for safety markings and instructions. These must then be followed to ensure safe operation and to maintain the instrument in safe condition.

Power is supplied to some of the HP 3324A circuits at any time that the instrument is connected to the AC power source.

To disconnect from the line power, disconnect the power cord either at the rear power-inlet or at the AC line-power source (receptacle). One of these must be accessible at all times. If the instrument is installed in a cabinet, it must be disconnected from the line power by means of the system's line-power switch.

Warning

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

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

- **If this instrument is to be energized via an autotransformer for voltage reduction, ensure that the Common terminal is connected to the grounded pole of the power source.**
- **The power cable plug shall only be inserted into a socket outlet provided with a protective ground contact. The protective action must not be negated by the use of an extension cord without a protective conductor.**

- **Before switching on the instrument, the protective ground terminal of the instrument must be connected to a protective conductor. This is verified by using the power cord which is supplied with the instrument.**
- **Intentional interruption of the protective ground connection is prohibited.**

Description

For a more comprehensive description of the HP 3324A instrument, you should refer to the *HP 3324A Operating and Programming Manual*

Operating Concept

The HP 3324A has been designed so that it can be used in either of two modes:

a. Local Mode: Using the front panel to initiate operations.

b. Remote Mode: Using an external computer as the controller.

Local Mode

The HP 3324A functions needed to operate the instrument are contained in four main menus. Parameter, Waveform, Sweep and Utilities.

Remote Mode

Remote mode is used to control the HP 3324A by an external computer and instrument operations can therefore be performed by a series of programmable commands.

Brief Operating Hints

To obtain the menu that you require, press the relevant hardkey. The position of the cursor, which is not shown as a line, is shown by blinking of the display. For example, if the cursor is on "FREQ" in the Parameter menu, then "FREQ" will blink. When data is being entered, the position of the cursor is shown by a line.

To move around the menu use the [⇐], [⇒], [⇑] and [⇓] keys to move the cursor one position. To move to the extremes use the [◀◀] and [▶▶] keys.

Options

This section gives a tabular list of the options available for the HP 3324A. More comprehensive explanation of the options, is provided in the *HP 3324A Operating and Programming Manual.* These options are available when the instrument is first ordered, by specifying the option number, some options are available for fitting later, by ordering the option part number given in the Replaceable Parts List.

Table 1-1. Options Available

Option	Description
#001	High-Stability Frequency Reference
#002	High-Voltage Output
#003	Automatic Phase Calibration, Slave
#004	Automatic Phase Calibration, Master
#907	Front Handle Kit (p/n 5062-3989)
#908	Rack Mount Flange Kit (p/n 5062-3977)
#909	Rack Mount Flange and Front Handle Combination Kit (p/n 5062-3983)
#910	Set of Operating/Programming and Service Manuals (contains #915 and #916)
#915	Service Manual (p/n 03324-90001)
#916	Additional Operating and Programming Manual (p/n 03324-90011)
#W30	Three year "Return-to-HP" Repair Service
#W32	Three year "Return-to-HP" Calibration Service

Note

Automatic phase calibration between two 3324A requires that one instrument has option 003 installed and the other has option 004 installed.

Tools and Test Equipment

Table C.1 gives a complete list of the recommended test equipment for servicing the HP 3324A. Table 3.1 summarises the equipment required for the adjustment procedures.

Specifications

All specifications apply after a 30 minute warm-up period, and are valid from 0°C to 55°C ambient temperature. All specifications describe the warranted performance, except for:

- Main Signal Output
- Squarewave Characteristics (also in Option 002)
- Auxiliary Inputs
- Auxiliary Outputs
- HP-IB Control
- General Characteristics

which describe the typical performance.

Waveforms

Sine, square, triangle, negative and positive ramps, DC and TTL clock.

Frequency

Range

Sine:	1 mHz - 21 MHz
Square:	1 mHz - 11 MHz
Triangle:	1 mHz - 11 KHz
Ramps:	1 mHz - 11 KHz
Auxiliary TTL clock:	1 mHz - 60 MHz

Resolution:
1 mHz, upto 999.999 999 KHz
100 mHz, from 1 MHz upto 21.000 000 0 MHz

Accuracy:
±5 ppm of selected value, from 20°C to 30°C, at time of calibration with standard frequency reference.

Stability:
±5 ppm/year, from 20°C to 30°C, standard (see also option 001, high-stability frequency reference).

Warm-up Time:
20 minutes to within specified accuracy.

Main Signal Output (Supplementary)

Impedance:
50Ω±1Ω, 0–10 KHz

Return Loss:
> 20 dB, 10 KHz to 20 MHz, except > 10 dB for
> 3 V, 5 MHz to 20 MHz.

Floating:
Chassis ground to circuit ground: Max. 42 V peak (AC + DC)
Max. external voltage, circuit ground to signal output: ±10 V

Connector:
BNC, switchable between front and rear panel.

Amplitude

(All waveforms without DC offset, except auxiliary TTL clock).

Range:
1 mV to 10 V(p-p), amplitude can also be set up in **rms** and **dBm.**

Function	peak-to-peak	rms	dBm (50Ω)
Sine			
min.	1.000 mV	0.354 mV	−56.02
max.	10.00 V	3.536 V	+23.98
Square			
min.	1.000 mV	0.500 mV	−53.01
max.	10.00 V	5.000 V	+26.99
Triangle/ Ramps			
min.	1.000 mV	0.289 mV	−57.78
max.	10.00 V	2.887 V	+22.22

Resolution:
4 digits (0.03% of full range).

Accuracy: Accuracy specifications are given for 0 V DC offset. With DC offset, increase all sinewave tolerances by 0.2 dB and all function tolerances by 2%.

Sinewave:

	0.001 Hz to 100 KHz	>100 KHz to 10 MHz	>10 MHz to 20 MHz
+23.98 to 13.52 dBm	±0.2 dB	±0.4 dB	±0.4 dB
<+13.52 to −16.02 dBm	±0.2 dB	±0.6 dB	±0.6 dB
<−16.02 to −56.02 dBm	±0.2 dB	±0.6 dB	±0.9 dB

Squarewave:

	0.001 Hz to 100 KHz	>100 KHz to 10 MHz
10 V(p-p) to 3 V(p-p)	±1.5%	±5%
<3 V(p-p) to 1 mV(p-p)	±2.2%	±10%

Triangle:

	0.001 Hz to 2 KHz	>2 KHz to 10 KHz
10 V(p-p) to 3 V(p-p)	±1.5%	±5.0%
<3 V(p-p) to 1 mV(p-p)	±2.7%	±6.2%

Ramps:

	0.001 Hz to 500 Hz	>500 Hz to 10 KHz
10 V(p-p) to 3 V(p-p)	±1.5%	±10.0%
<3 V(p-p) to 1 mV(p-p)	±2.7%	±11.2%

Supplementary Range Information: The 1 mV to 10 V (p-p) output range of the HP 3324A consists of 8 internal output ranges

AC Function Only	DC Offset Only	AC Function and DC Offset		
Amplitude Range (p-p)	**DC Level (+ or -)**	**Amplitude Range (p-p)**	**Max. DC (+ or -)**	**Min. DC (+ or -)**
1.000 mV to 2.999 mV	1.000 mV to 1.499 mV			
3.000 mV to 9.999 mV	1.500 mV to 4.999 mV	1.000 mV to 3.333 mV	4.500 mV 3.333 mV	0.001 mV 0.001 mV
10.00 mV to 29.99 mV	5.000 mV to 14.99 mV	3.334 mV to 9.999 mV	14.99 mV 11.66 mV	0.001 mV 0.001 mV
30.00 mV to 99.99 mV	15.00 mV to 49.99 mV	10.00 mV to 33.33 mV	45.00 mV 33.33 mV	0.010 mV 0.010 mV
100.0 mV to 299.9 mV	50.00 mV to 149.99 mV	33.34 mV to 99.99 mV	149.9 mV 116.6 mV	0.010 mV 0.010 mV
300.0 mV to 999.9 mV	150.00 mV to 499.9 mV	100 mV to 333.3 mV	450.0 mV 333.3 mV	0.100 mV 0.100 mV
1.000 V to 2.999 V	500.0 mV to 1.499 V	333.4 mV to 999.9 mV	1.499 V 1.166 V	0.100 mV 0.100 mV
3.000 V to 10.00 V	1.500 V to 5.000 V	1.000 V to 9.998 V	4.500 V 1.000 mV	1.000 mV 1.000 mV

Sinewave Spectral Purity

Phase Noise:
−50 dBc for a 30 KHz band centered on a 20 MHz carrier (excluding ±1 Hz about the carrier).

Spurious:
All non-harmonically related output signals will be more than 55 dB below the carrier, (−50 dBc with DC offset), or less than −85 dBm, whichever is the greater.

Sinewave Harmonic Distortion:
Harmonically related signals will be less than the following levels relative to the fundamental:

Frequency Range	Harmonic Level
0.1 Hz - 199 KHz	−60 dBc
200 KHz - 1.99 MHz	−40 dBc
2 MHz - 14.9 MHz	−30 dBc
15 MHz - 20 MHz	−25 dBc

Squarewave Characteristics (Supplementary)

Rise/Fall Time:
(10% to 90% of p-p output voltage): ≤20 ns

Overshoot:
5% of peak-to-peak amplitude at full output.

Symmetry:
≤0.02% of period +3 ns.

Triangle/Ramp Characteristics

Linearity:
(10% to 90%, 10 KHz): ±0.05% of full peak-to-peak output voltage for each range.

Ramp Retrace Time:
(10% to 90%): ≤3 μs

Period Variation for Alternate Ramp Cycles:
≤1% of period.

DC Offset

Range:
DC only (no AC signal): 0 to ±5 V / 50Ω
DC + AC: Maximum DC offset ±4.5 V on highest range; decreasing to ±4.5 mV on lowest range. Refer to "Supplementary range information" in the Amplitude specifications.

Resolution:
4 digits

Accuracy:
DC only: ±0.015 mV to ±50 mV, depends on offset chosen, ±0.02 mV.
DC + AC, upto 1 MHz: ±0.06 mV to ±60 mV, depends on AC output level; ±0.2 mV to ±120 mV for ramps to 10 KHz.
DC + AC, from 1 MHz to 20 MHz: ±15 mV to ±150 mV, depends on AC output level.

Phase Offset

Range:
719.9° with respect to arbitrary starting phase or assigned zero phase. For squarewave frequencies below 25 KHz, phase changes greater than 25° may result in a phase shift of ±180° from the desired amount.

Resolution:
0.1°

Increment Accuracy:
±0.5°

Stability:
±1.0° of phase/°C

Frequency Sweep

Sweep Sequence Modes:
Single, continuous.

Sweep Function Modes: Multi-Interval:
Upto 50 **different** intervals can be sequenced and repeated in any order in a sequence which can contain upto 100 intervals.
Frequency-switching-time between intervals (to within 1 Hz):
$\leq$12 ms for a 100 KHz step.
$\leq$27 ms for a 1 MHz step.
$\leq$72 ms for a 20 MHz step.

Multi-Marker:
Upto 9 marker frequencies can be set if a standard sweep (no Multi-Interval) is performed. Reaching a marker frequency generates a high-to-low transition at the marker output. Time between start- and marker-frequencies, succeeding marker frequencies, and marker- and stop-frequencies are $\leq$1.5 ms.

Linear Sweep (settable for each interval):
Sweep time: 0.01 s to 10^5 s
Maximum sweep width: full frequency range of the main signal output for the waveform in use.
Minimum sweep width: 0 Hz
One marker frequency can be set in each interval.

Logarithmic Sweep (settable for each interval):
Sweep time: 0.1 s to 10^5 s
Maximum sweep width: full frequency range of the main signal output for the waveform in use.
Minimum start frequency: 1 Hz
Minimum sweep width: 1 decade

Phase Continuity:
Sweep is phase continuous over the full frequency range of the main output for all sweep modes.

Auxiliary Inputs (Supplementary)

Reference Input
For phase locking the HP 3324A to an external frequency reference.
Signal from 0 dBm to 20 dBm into 50Ω
Reference signal must be a sub-harmonic of 10 MHz from 1 MHz to 10 MHz.
Connector: rear panel BNC. With option 001 this input must be connected to the 10 MHz oven output.

Auxiliary Outputs (Supplementary)

SYNC Output:
1 mHz to 21 MHz phase synchronous squarewave with the same frequency as the main signal output, or 1 mHz to 60 MHz **Auxiliary TTL Clock** (main signal output switched off).
Output impedance: 50Ω
Output levels: high level > 1.2 V, low level < 0.2 V
Connector: BNC, front and rear panels.
Note: Level doubles into open input.

Auxiliary Frequency Output:
Squarewave.
Frequency range: 21 MHz to 60 MHz
Output impedance: 50Ω
Amplitude: 0 dBm
Connector: rear panel BNC.

X-axis Drive Output:
(0 – 100 s sweeps only).
The ramp is proportional to the entire sweep time, including each individual interval sweep time and the switching times between intervals.
Load impedance: > 10 KΩ
Output level: 0 to +10 V
Connector: rear panel BNC.

Z-axis Blank Output:
TTL compatible voltage levels capable of sinking current from a positive source. Current 200 mA, voltage 45 V, power dissipation max. 1 W.
Connector: rear panel BNC.

Sweep Marker Output:
High to low transitions at selected marker frequencies. TTL and CMOS compatible output levels. Pulsewidth in Multi-Marker mode: 1 ms.
Connector: rear panel BNC.
Fan out: 4

1 MHz Reference Output
1 MHz squarewave for phase locking additional instruments to the HP 3324A.
Output impedance: 50Ω
Output amplitude: 0 dBm
Connector: rear panel BNC.

HP-IB Control (Supplementary)

Frequency Switching Time (to within 1 Hz, exclusive of programming time):
≤10 ms for a 100 KHz step.
≤25 ms for a 1 MHz step.
≤70 ms for a 20 MHz step.

Phase Switching Time (to within 90° of phase lock, exclusive of programming time):
≤15 ms

Amplitude Switching Time (to within amplitude specification, exclusive of programming time):
<30 ms

Interface functions:
SH1, AH1, T6, L3, SR1, RL1. PP0, DC1, DT0, C0, E2

Option 001 High-Stability Frequency Reference

Aging Rate:
±5 x 10^{-8}/week after 72 hours continuous operation.
±1 x 10^{-7}/month after 15 days continuous operation.

Warm-up Time:
Reference will be within ±1 x 10^{-7} of final value 15 minutes after turn-on at 25°C, for an off time of less than 24 hours.

10 MHz Oven Output:
10 MHz squarewave for phase-locking additional instruments to the HP 3324A.
Output impedance: 50Ω
Output level: >4.5 dBm
Connector: rear panel BNC.

Option 002 High-Voltage Output

Frequency range:
1 mHz to 1 MHz

Amplitude:
4 mV to 40 V(p-p) in 8 ranges, 4–12–40 sequence into 500Ω, < 500 pF load. Ranges are four times the standard instrument ranges, without DC offset.
Accuracy: ±2% of full output for each range at 2 KHz.
Flatness: ±10% relative to programmed amplitude.

Sinewave Harmonic Distortion:
Harmonically related signals will be less than the following levels (relative to the fundamental full output into 500Ω, 500 pF load):

Frequency Range	Harmonic Level
10 Hz – 199 KHz	−60 dBc
200 KHz – 1 MHz	−40 dBc

Squarewave Rise/Fall Time:
(Supplementary)
≤125 ns, 10% to 90% of peak-to-peak output voltage with 500Ω, 500 pF load.

Squarewave Overshoot:
(Supplementary)
≤10% of peak-to-peak output voltage with 500Ω, 500 pF load.

Output Impedance:
< 3Ω at DC, < 10Ω at 1 MHz.

DC Offset:
Range: 4 times the specified range of the standard instrument.
Accuracy: ±(1% of full output voltage for each range + 25 mV).

Maximum Output Current:
±40 mA peak.

Options 003 & 004 Automatic Phase Calibration Options

The Automatic Phase Calibration options 003 (slave) and 004 (master) provide automatic phase calibration between two HP 3324As without external measuring instruments. Option 003 has to be installed in one HP 3324A, option 004 has to be installed in the other instrument. Adjustment factors for different cable delays between master/slave and 3324A/device-under-test can be entered in the UTILity menu.

Phase Error

The phase error is measured between the main signal outputs on the rear panel with either unequal or equal amplitudes and without DC offset. Phase is defined as the difference in rising edge to rising edge (measured with AC-coupled zero-crossing-points as reference points) for sine and squarewaves.

	Sine/Sine			
	3 - 10 V(p-p)		0.3 - 10 V(p-p)	
Frequency Range	Typical	Specified	Typical	Specified
1 mHz - 100 Hz	±1.5°	±2°	±1.5°	±2°
> 100 Hz - 1 MHz	±1°	±1.5°	±1°	±1.5°
> 1 MHz - 10 MHz	±1°	±2°	±1°	±3.5°
> 10 MHz - 21 MHz	±2.6°	±4°	±2.6°	±7°

	Square/Square			
	3 - 10 V(p-p)		0.3 - 10 V(p-p)	
Frequency Range	Typical	Specified	Typical	Specified
1 mHz - 100 Hz	±1°	±1.5°	±1°	±1.5°
> 100 Hz - 1 MHz	±0.4°	±1°	±0.4°	±1°
> 1 MHz - 10 MHz	±1.2°	±2°	±1.2°	±3°

General Characteristics (Supplementary)

Operating Environment:
Temperature: 0°C to 55°C, if not otherwise stated.
Relative humidity: 95%, 0°C to 40°C
Storage temperature: −40°C to +75°C

Power:
100/120/220/240 V, ±10%; 48 to 66 Hz,; 100 VA max.
Standby 20 VA max.

Weight:
11 kg net, 16.5 kg shipping

Dimensions:
132.6 mm high x 425.5 mm wide x 497.5 mm deep
(5.25 ins. high x 16.75 ins. wide x 19.625 ins. deep).

Instrument Cooling

The HP 3324A is equipped with a cooling fan mounted inside the rear panel. The instrument should be mounted so that air can freely circulate through it. When operating the HP 3324A, choose a location that provides at least 75 mm (3 inches) of clearance at the rear, and at least 25 mm (1 inch) of clearance at each side. Failure to provide adequate air clearance will result in excessive internal temperature, reducing instrument reliability.

Installation

Introduction

This chapter provides installation instructions for the HP 3324A and for retro-fitted options of the instrument. It also includes information about initial inspection and damage claims, preparation for use, packaging, storage and shipment.

Safety Considerations

Refer to safety advice contained in the front matter of this manual before commencing any installation task.

The Model HP 3324A is a Safety Class 1 instrument (instrument with an exposed metal chassis that is directly connected to earth via the power supply cable). The symbol used to indicate a protective earth terminal in the instrument is ⏚ .

Before operation, the instrument and manual, should be reviewed for safety markings and instructions. These must then be followed to ensure safe operation and to maintain the instrument in safe condition.

Warning

Service instructions are for use by service-trained personnel only. To avoid electric shock, do not perform any servicing unless qualified to do so.

Maintenence and adjustment procedures described are sometimes performed with power applied to the instrument whilst covers are removed for access. Any procedures that can be performed without power applied should be done without power.

To disconnect from the line power, disconnect the power cord either at the rear power-inlet or at the AC line-power source (receptacle). One of these must be accessible at all times. If the instrument is installed in a cabinet, it must be disconnected from the line power by means of the system line-power switch.

Capacitors inside the instrument may still be charged even if the instrument has been disconnected from a supply source.

Initial Inspection

Inspect the shipping container for damage. If the container or cushioning is damaged, it should be kept until the contents of the shipment have been checked for completeness and the instrument has been verified both mechanically and electrically.

Warning

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

Procedures for checking the operation of the instrument are given in Chapter 3 *Performance Tests.* If the contents are incomplete, mechanical damage or defect is apparent, or if an instrument does not pass the operator checks, notify the nearest Hewlett-Packard office. Keep the shipping materials for inspection by the carrier. The HP office will arrange for repair or replacement without awaiting settlement.

Preparation

Power Requirements

Caution

Before applying AC line power to the HP 3324A, ensure that the voltage selector on the HP 3324A bottom panel is set for the proper line voltage and that the correct line fuse is installed in the fuse holder. Procedures for changing the line voltage selector and fuse are contained in the following section "Line Voltage Selection".

The HP 3324A can operate from any single-phase AC power source supplying 100 V, 120 V, 220 V or 240 V in the frequency range from 48 to 66 Hz (see Table 2-1). The maximum power consumption is 100 VA with all options installed.

Table 2-1. Line Voltage Ranges

Selector Voltage	AC Voltage Range
100	90 - 108 V
120	108 - 126 V
220	198 - 231 V
240	216 - 252 V

Line Voltage Selection

Caution BEFORE SWITCHING ON THE INSTRUMENT, make sure that the instrument is set to the local line voltage and the correct line fuse is installed in the fuse holder.

The line voltage selector is set at the factory to correspond to the most commonly used line voltage of the country of destination. The line voltage selected for the HP 3324A is indicated by the switches on the bottom panel (underneath). Refer to Table 2-1 for the line voltage ranges and Table 2-2 to set the line voltage and select the appropriate fuse.

Table 2-2. Line Voltage and Fuse Selection

Line Voltage	Fuse Type	HP Part Number
100 V / 120 V	T 750 mA, 250 V	2110-0360
220 V / 240 V	T 375 mA, 250 V	2110-0421

To change the line voltage and fuse:

1. Remove the power cord.
2. To check or replace the fuse, press the fuse holder in slightly, using a screw driver, and turn it to release the catch. Pull out the fuse holder.
3. To re install the fuse, insert a fuse with the proper rating into the fuse holder, place it back into position, and push in and turn, using a screw driver.
4. To change the line voltage, turn the instrument onto its back, so that the voltage selector switches are situated in the top right of the instrument.
5. Then using a screwdriver, move the switches into the position required for the voltage to be used, as shown in Figure 2-1.

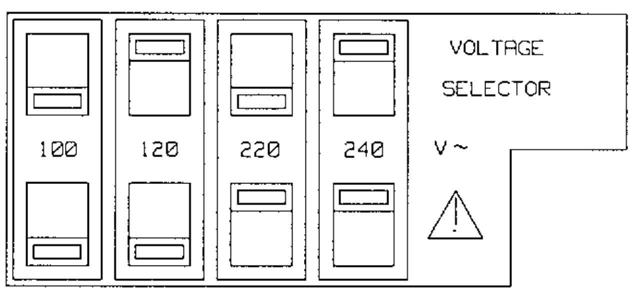

Figure 2-1. Voltage Selection Possibilities

Power Cable

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

Warning

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

- **If this instrument is to be energized via an auto transformer for voltage reduction, ensure that the Common terminal is connected to the grounded pole of the power source.**
- **The power cable plug shall only be inserted into a socket outlet provided with a protective ground contact. The protective action must not be negated by the use of an extension cord without a protective conductor.**
- **Before switching on the instrument, the protective ground terminal of the instrument must be connected to a protective conductor. This is verified by using the power cord which is supplied with the instrument.**
- **Intentional interruption of the protective ground connection is prohibited.**

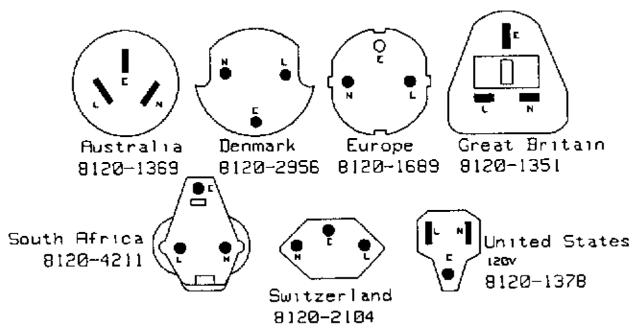

Figure 2-2. Power Cables - Plug Identification

The following work should be carried out by a qualified electrician - all local electrical codes being strictly observed. If the plug on the cable does not fit the power outlet, or the cable is to be attached to a terminal block, cut the cable at the plug end and re-wire it.

The color coding used in the cable will depend on the cable supplied. If a new plug is to be connected, it should meet local safety requirements and include the following features:

- Adequate load-carrying capacity (see table of specifications in Chapter 1).
- Ground connection.
- Cable clamp.

HP-IB Connector

The rear panel HP-IB connector (Figure 2-3), is compatible with the connector on Cable Assemblies 10833A, B, C and D. If a cable is to be locally manufactured. use male connector. HP part number 1251-0293.

HP-IB Logic Levels

The HP 3324A HP-IB lines use standard TTL logic, the levels being as follows:

- True = Low = digital ground or 0V dc to 0.4V dc,
- False = High = open or 2.5V dc to 5V dc.

All HP-IB lines have LOW assertion states. High states are held at 3.0V dc by pull-ups within the instrument. When a line functions as an input, approximately 3.2 mA of current is required to pull it low through a closure to digital ground. When a line functions as an output, it will sink up to 48 mA in the low state and approximately 0.6 mA in the high state.

Note Isolation, the HP-IB line screens are not isolated from ground.

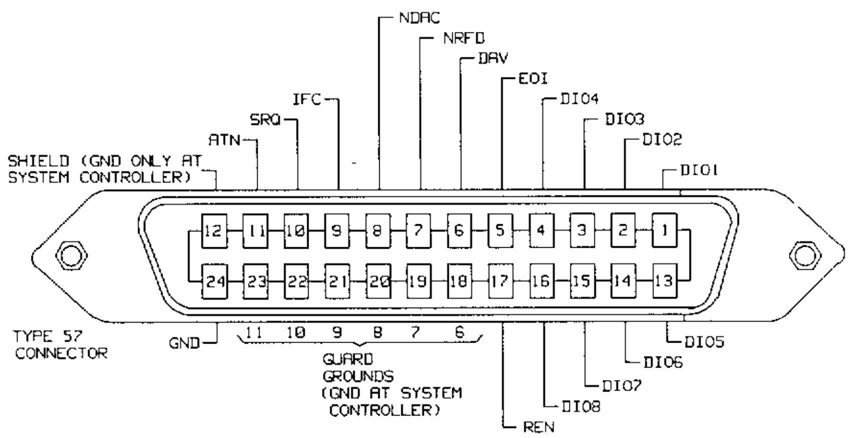

Figure 2-3. HP-IB Connector

Humidity

The HP 3324A may be operated in environments with humidity up to 95% (0°C to +40°C). However, the HP 3324A should be protected from temperatures or temperature changes which cause condensation within the instrument.

Note At output amplitudes of <50 mV in extreme environmental conditions, it is recommended that a double shielded BNC cable is used. For example, use HP p/n 5180-2459 (1.22 m, RG58V Triax, 50Ω).

Instrument Cooling

The HP 3324A is equipped with a cooling fan mounted inside the rear panel. The instrument should be mounted so that air can freely circulate through it. When operating the HP 3324A, choose a location that provides at least 75 mm (3 inches) of clearance at the rear, and at least 25 mm (1 inch) of clearance at each side. Failure to provide adequate air clearance will result in excessive internal temperature, that may reduce instrument reliability.

Installation of Options

Basic dismantling for access to HP 3324A

To gain access proceed as follows:

1. Switch OFF the instrument and remove the power cord.
2. Remove the four rear feet.
3. Remove the strap handle.
4. Remove the top cover.

Installing the High Stability Frequency Reference (#001)

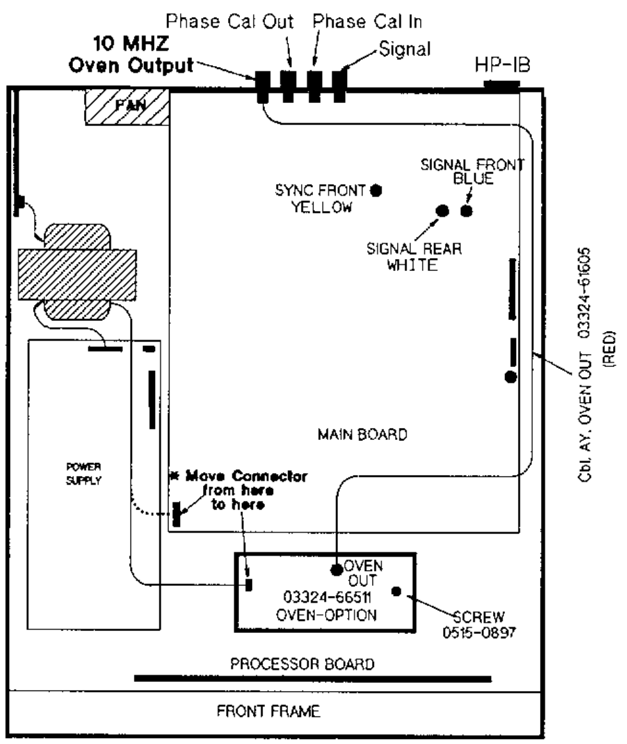

Figure 2-4. Frequency Reference Option Installation

1. Dismantle the HP 3324A for access, as described at the start of this section.

2. The oven assembly (A9) clips onto the pillars at the front of the instrument and is secured by a screw in one of the pillars.
3. Fit the BNC connector of the supplied cable to the rear panel in the aperture for 10MHz Oven Output, as shown in Fig 2.5.

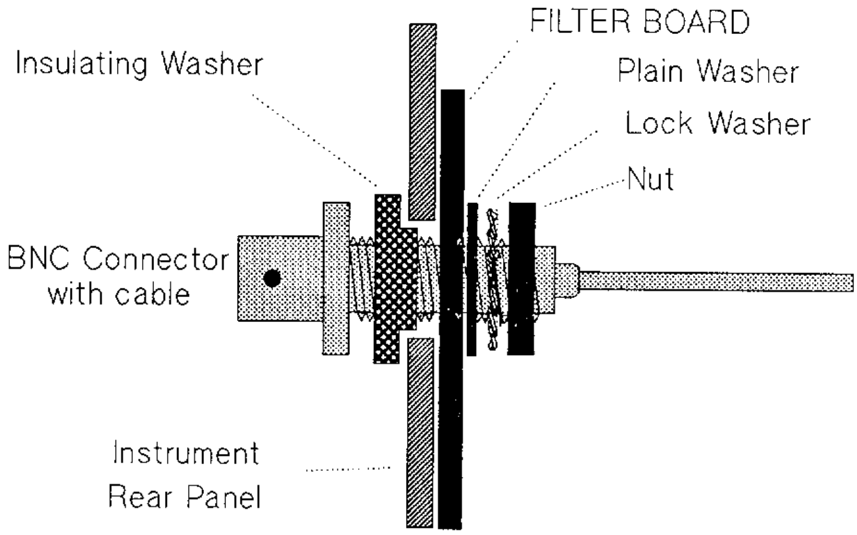

Figure 2-5. Installation of BNC Connector

4. Connect the other (red shrink tubing) end of the cable to the "oven out" SMB connector on the oven board.
5. Remove the power supply connector from connector J3 in the left-hand corner of the main board (it is only *parked* there) and connect it to the crystal oven.
6. Insert a jumper between the first two posts of J3 (nearest edge of board) from where the power lead was removed. This jumper allows the instrument to recognize that it has the oven option fitted.
7. Re-assemble the HP 3324A.
8. Fit the new identity plate to rear of instrument.

Installing the High Voltage Output Option (#002)

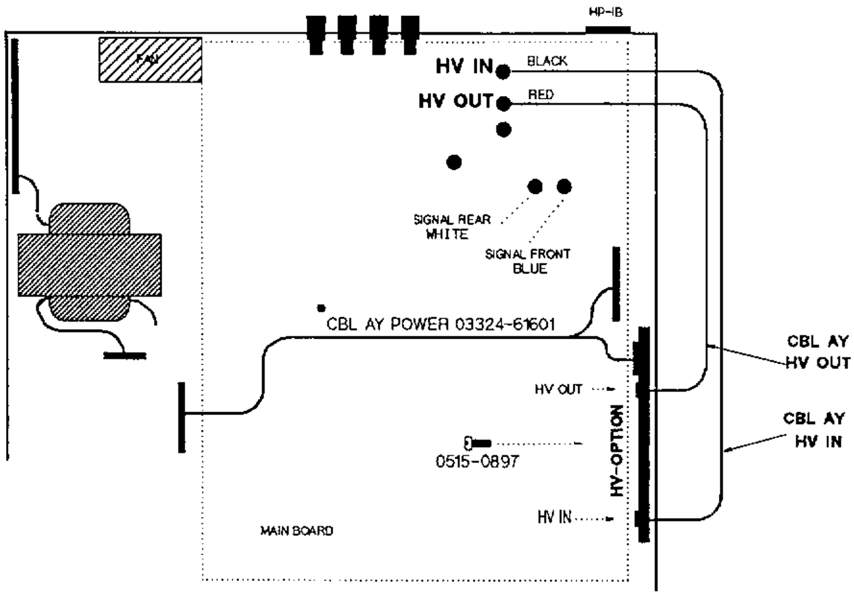

Figure 2-6. High Voltage Output installation

1. Dismantle the HP 3324A for access as described at the beginning of this section.
2. The HV board (A11) clips onto four standoff pillars and is secured by a screw to one of the pillars at the right-hand side panel, towards the front of the instrument.
3. Connect the cable with **BLACK** sleeving to the *HV IN* socket at the rear middle of the main board
4. Connect the cable with **RED** sleeving to the *HV OUT* socket at the rear middle of the main board in front of *HV IN*.
5. Remove the 5-wire connector from J1000 on the main synthesizer board and connect it to the HV board.
6. Re-assemble the HP 3324A.
7. Fit the new identity plate to rear of instrument.

Installing the Phase Calibration Option (#003/#004)

Note The cables delivered with options #003/#004 are a set matched to the boards supplied. Each set **MUST** be used to install the board with which it is supplied, as described in the following procedure. The cable sets, including the external BNC cables, are **NOT** interchangeable.

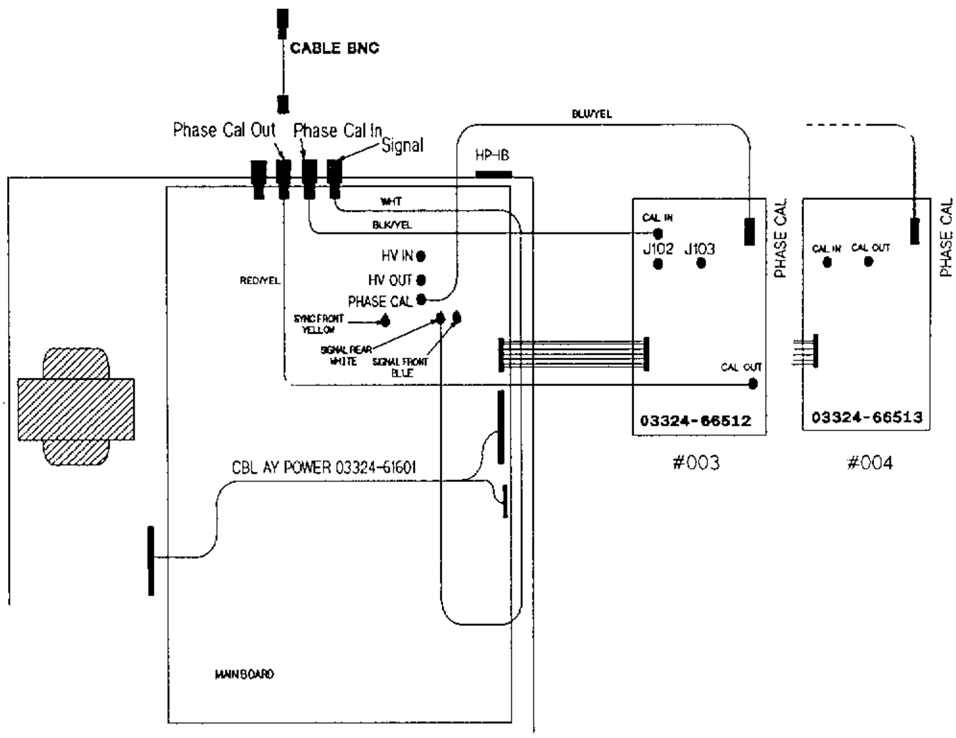

Figure 2-7. Phase Calibration Option installation

1. Dismantle the HP 3324A for access as described at the beginning of this section.
2. The phase calibration board is clipped to four standoff pillars and is attached by a screw to one of the pillars. The board is situated at the righthand side-panel towards the rear of the instrument.
3. Replace the existing signal cable between the main board and rear connector SIGNAL REAR (white sleeve), with the newly supplied cable.
4. Connect the Phase Cal cable from the new board (blue/yellow sleeve) to the Phase Cal SMB connector on the main board.
5. Install the BNC end of the black/yellow sleeved cable into the PHASE CAL IN hole of the instrument rear panel. Refer to Fig 2.5.
6. Connect the SMB end of the black/yellow sleeved cable to the CAL IN connector on the option board. Refer to Fig 2.5.
7. Install the BNC end of the red/yellow sleeved cable into the PHASE CAL OUT hole of the instrument rear panel. Refer to Fig 2.5

8. Connect the SMB end of the red/yellow sleeved cable to the CAL OUT connector on the option board. Refer to Fig 2.5.
9. Connect the flat power cable from the option board to the main board.
10. Connect the supplied BNC ended cable to the PHASE CAL OUT rear panel socket. The other end connects to the PHASE CAL IN socket on the other HP 3324A.

Shipment and Packing

Claims and Repackaging

If physical damage is evident or if the instrument does not meet specification when received, notify the carrier and the nearest Hewlett-Packard Service Office. The Sales/Service Office will arrange for repair or replacement of the unit without waiting for settlement of the claim against the carrier.

Storage and Shipment

The instrument can be stored or shipped at temperatures between −40°C and +75°C. The instrument should be protected from temperature extremes which may cause condensation within it.

Return Shipments to HP

If the instrument is to be shipped to a Hewlett-Packard Sales/Service Office, attach a tag showing owner, return address, model number and full serial number and the type of service required.

The original shipping carton and packing material may be re-usable, but the Hewlett-Packard Sales/Service Office will also provide information and recommendations on materials to be used if the original packing is no longer available or reusable. General instructions for repacking are as follows:

1. Wrap instrument in heavy paper or plastic.
2. Use strong shipping container. A double wall carton made of 350-pound test material is adequate.
3. Use enough shock-absorbing material (3 to 4 inch layer) around all sides of the instrument to provide a firm cushion and prevent movement inside container. Protect control panel with cardboard.
4. Seal shipping container securely.
5. Mark shipping container FRAGILE to encourage careful handling.
6. In any correspondence, refer to instrument by model number and serial number.

3

Adjustments

Introduction

This chapter describes adjustment procedures for the HP 3324A instrument. Most of the procedures are carried out with discrete connections to the individual items of test equipment; however, some tests involve pre-loading setup values for Digital to Analog Converters (DACs) within the instrument using a computer, operating over the HP-IB interface. A computer capable of communicating over the HP-IB bus system is an essential pre-requisite for these adjustment procedures.

In some cases, adjustments should ONLY be carried out AFTER a related procedure has been successfully performed. Where this is necessary, a suitable note is present in the text.

Note Whenever power is switched OFF for any reason. Ensure that a warming up time of 30 minutes is allowed before continuing with tests and adjustments.

Equipment Required

Equipment required for the adjustment procedures is listed below. Any equipment which satisfies the critical specifications given in the table, may be substituted for recommended models.

Table 3-1. Recommended Test Equipment (Adjustments)

Instrument	Critical Specifications	Recommended Model
Digitizing Oscilloscope	Vertical Bandwidth: 1 GHz with random repetitive sampling technique	HP 54111D
Electronic Counter	Frequency measurement Time Interval Average A to B Frequency Range: to 100 MHz Resolution: 11 digits	HP 5370B
AC/DC Digital Voltmeter	AC Function (True RMS) Ranges: 10 mV to 1000 V Bandwidth: 1 Hz to 1 kHz Resolution: 4.5 digits minimum DC Functions Ranges: 10 mV to 1000 V	HP 3458A

Table 3-1. Recommended Test Equipment (Adjustments) (continued)

Instrument	Critical Specifications	Recommended Model
Thermal Converter	Input Impedance: 50Ω Input Voltage: 3 Vrms Frequency: 2 kHz to 20 MHz Frequency Response: ±0.05 dB 2 kHz to 20 MHz	HP 11049A/Ballantine Model 1395A-1 with cable 12577A Opt. 10 Ballantine Labs, Inc. P.O. Box 97 Boonton, NJ 07005
Spectrum Analyzer	Frequency Range: 20 Hz to 40.1 MHz Spurious Responses: 100 dB below reference	HP 3585B
Adapter	BNC female to dual banana plug	HP 1251-2277
Computer	Command unit Capable of issuing HP-IB commands as part of BASIC language, program entries	HP 9*** type

Adjustment Procedures

The adjustment procedures described below for the HP 3324A, are presented in four basic groups.

Group	Tests
Group 1	Softkey check, Power supplies, Frequency, VCO, Amplitude level and Gain
Group 2	Spurious, Mixer and Harmonics
Group 3	Overshoot, Flatness, Jitter and X-drive
Group 4	Options: ■ Frequency Reference ■ High voltage output ■ Phase calibration

Default setting

To ensure that the instrument is in a known state, always select the default parameter settings at the start of each procedure. To set the instrument to its default state:

- Press (Local)
- Press (Util), the display shows *Set Default*
- Press (Select)

Refer to the Operating and Programming Manual for a list of the default parameter settings.

Equipment Set-up

The HP 3324A is connected to test equipment as shown in the test set-up figures in the text. Instructions on how to gain access to the HP 3324A are given in the "Troubleshooting" section of Chapter 5 under "General Fault Finding".

Most adjustments given in this chapter refer to the main synthesizer board A6. For convenience, the area where adjustments are to be made and where monitor points are located, is illustrated within an outline of board A6.

Group 1 Adjustments

Keyboard and power

Softkey functional check

1. Press [Local].
2. Press [Util], *Set Default* is displayed.
3. Press up arrow [▲] one or more times until "Selft:std/all" is displayed.
4. Press the right arrow [▶] to place cursor on "all"
5. Press [Select].
6. Watch the green LED above the OUTPUT connector. It should illuminate and then extinguish.
7. As soon as the LED goes out, press and hold [Wave Form] until *Waveform* is displayed.
8. Release the key, the display goes blank. Press the key again and the display reads *Waveform.*
9. Now press each key in turn from left to right and top to bottom of the control panel.
10. The display should correctly identify each key as it is depressed and released.
11. Press [Signal on off] last of all to end the test.

Note

When self test is selected, an instruction *Do self test* is placed in RAM. This instruction is deleted from RAM at the end of self test as part of a general reset. If the instrument is switched off whilst self test is running no reset takes place. This means that when the HP 3324A is switched on again, *Do self test* is still valid and active. The display could be blank unless a key is depressed, leading to a false conclusion that the instrument is faulty.

Therefore always ensure that this test is ended or aborted correctly by pressing [Signal on off].

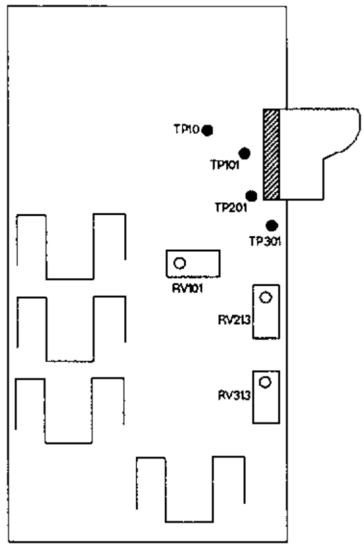

Figure 3-1. Adjustment area 1

+5V Power supply

Refer to adjustment area 1

1. Set DEFAULT state.
2. Connect DVM to Test Point **TP101** and ground clip to **TP10.**
3. Adjust **RV101** to obtain a reading of 5.02 V. Specification requirement is +5.02 ±0.01V.

+15V Power supply

Refer to adjustment area 1

1. Set DEFAULT state.
2. Connect DVM to Test Point **TP201** and ground clip to **TP10.**
3. Adjust **RV213** to obtain a reading of 15.00 V. Specification requirement is +15.0 ±0.02V.

−15V Power supply

Refer to adjustment area 1.

1. Set DEFAULT state.
2. Connect DVM to Test Point **TP301** and ground clip to **TP10.**
3. Adjust **RV313** to obtain a reading of −15.00 V. Specification requirement is −15.00 ±0.02V.

Frequency

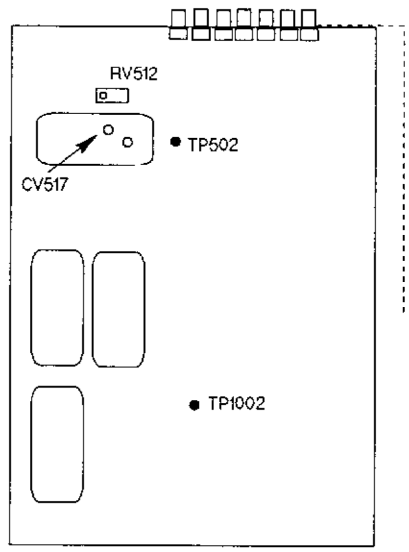

Figure 3-2. Adjustment area 2

Frequency amplitude

Refer to adjustment area 2.

1. Set DEFAULT state.
2. Connect DVM to Test Point **TP502** and ground clip to **TP1002.**
3. A typical reading should be about 5.2 V. Adjust **CV517** to achieve a maximum reading. The range of adjustment is approximately 120mV.

Frequency accuracy

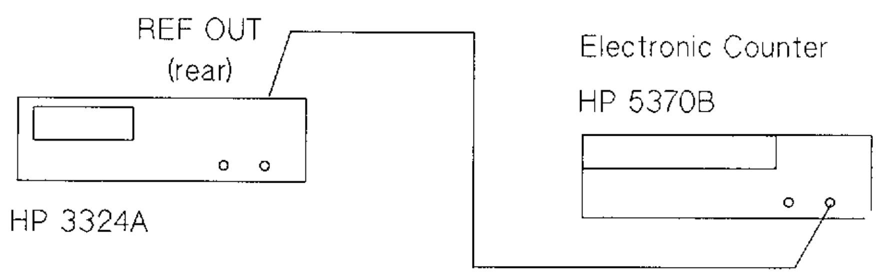

Figure 3-3. Test Setup for Frequency Accuracy

Refer to adjustment area 2.

1. Set DEFAULT state.
2. Adjust **RV512** to obtain a frequency reading of 1 MHz. Specification requirement is ±3Hz.

VCO Adjustment

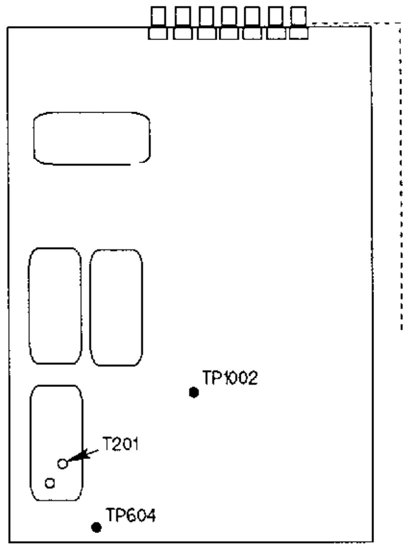

Figure 3-4. Adjustment area 3

Refer to adjustment area 3.

1. Set DEFAULT state.
2. Press (Wave Form) and use the cursor keys to highlight *Aux*.
3. Press (Select).
4. Press (Freq) and enter 60 MHz.
5. Connect DVM to Test Point **TP604** and ground clip to **TP1002.**
6. Adjust **T201** to obtain −6.0 V. Specification requirement is ±0.1V

Note The screwdriver used to adjust T201 will have a slight affect on the adjustment. Re-check the reading after screwdriver is removed.

Amplitude

The amplitude adjustment is done in three stages; negative and positive amplitude settings, followed by a mid-point (zero) check

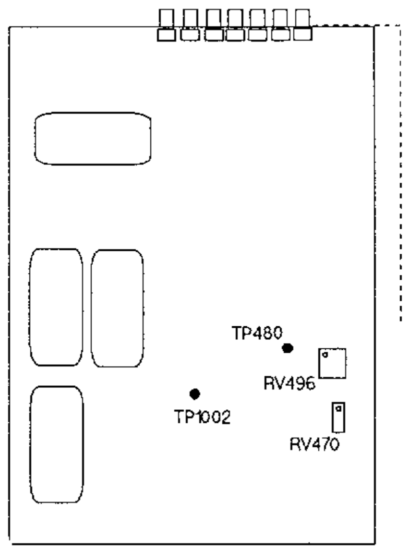

Figure 3-5. Adjustment area 4

Negative setting

Refer to adjustment area 4.

1. Press (Local).
2. Press (Util), *Set Default* is displayed.
3. Press up arrow (▲) one or more times until "HP-IB Address" is displayed.
4. Alter the address if necessary, to read "17".
5. Press (Enter).
6. Set DEFAULT.
7. Using the computer, send the following command string to the instrument:

   `OUTPUT 717;"DAC⊔Ø,ØE−3VO"`
   where 7 is the select code, 17 is the instrument bus address and ⊔ represents a significant space between characters.
8. Connect DVM to **TP480** and ground clip to **TP1002.**
9. Adjust **RV470** to obtain a reading of −10.04 V. Specification requirement is ±0.002V.
10. Leave DVM connected.

Positive setting

Refer to adjustment area 4.

1. Using the computer, send the following command string to the instrument:

   `OUTPUT 717;"DAC⊔Ø,1ØE−3VO"`
   where 7 is the select code, 17 is the instrument bus address and ⊔ represents a significant space between characters.
2. Adjust **RV496** to obtain a reading of +10.04 V. Specification requirement is ±0.002V.
3. Leave DVM connected.

Amplitude check

Refer to adjustment area 4.

1. Using the computer, send the following command string to the instrument:

   OUTPUT 717;"DAC␣0,5E−3VO"
   where 7 is the select code, 17 is the instrument bus address and ␣ represents a significant space between characters.

2. Check that DVM reads zero ±0.005V.

Gain

There are three adjustments to make and they **must** be done in the order given. If any adjustment is made, all three adjustments must be repeated in order until no further adjustment is required.

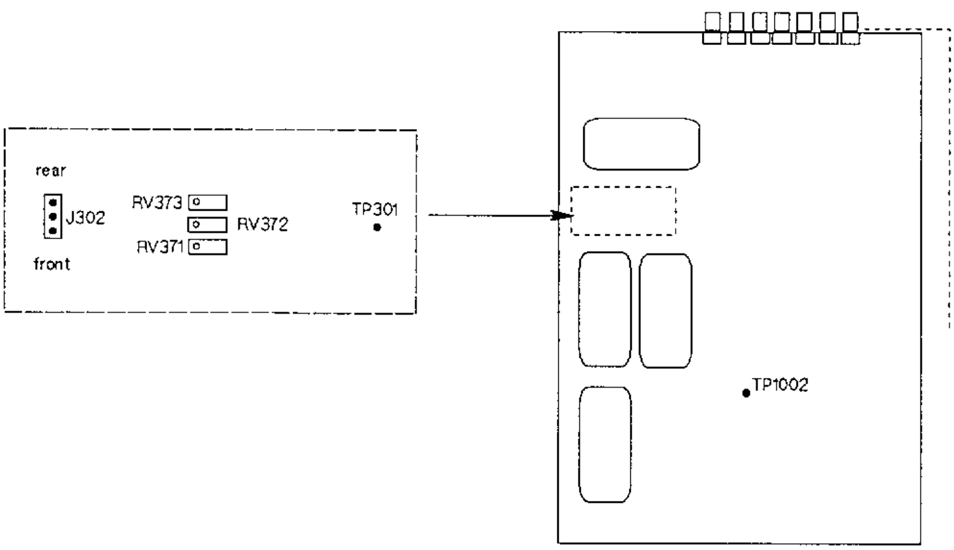

Figure 3-6. Adjustment area 5

Gain adjustment 1

Refer to adjustment area 5

1. Set DEFAULT.
2. Check that jumper **J302** is set to its front position.
3. Connect DVM to **TP301** and ground clip to **TP1002.**
4. Using the computer, send the following command string to the instrument:
   OUTPUT 717;"DAC␣3,10E−3VO"
   where 7 is the select code, 17 is the instrument bus address and ␣ represents a significant space between characters.
5. Move the jumper on **J302** to its rear position.
6. Adjust **RV373** to obtain a reading of zero volts. Specification requirement is ±0.005V.
7. Move the jumper on **J302** to its front position.
8. Leave DVM connected.

Gain adjustment 2

Refer to adjustment area 5.

1. Using the computer, send the following command string to the instrument:
   `OUTPUT 717;"DAC␣3,ØE-3VO"`
   where 7 is the select code, 17 is the instrument bus address and ␣ represents a significant space between characters.
2. Adjust **RV371** to obtain a reading of 0.015V. Specification requirement is ±0.005V
3. Leave DVM connected.

Gain adjustment 3

Refer to adjustment area 5.

1. Leave jumper **J302** in front position.
2. Using the computer, send the following command string to the instrument:
   `OUTPUT 717;"DAC␣3,1ØE-3VO"`
   where 7 is the select code, 17 is the instrument bus address and ␣ represents a significant space between characters.
3. Adjust **RV372** to obtain a reading of 6.525V. Specification requirement is ±0.025V
4. Disconnect the DVM.

Group 2 Adjustments

Spurious adjustments

There are five adjustments to make. The readings are made using a spectrum analyzer.

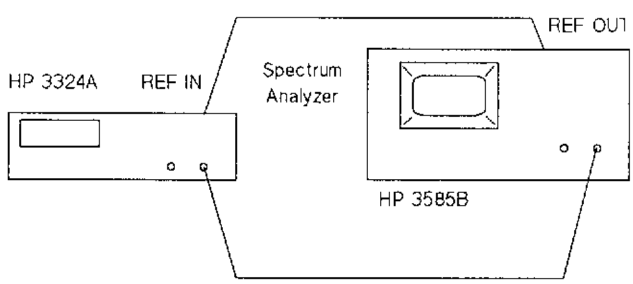

Figure 3-7. Test Setup for Spurious Measurements

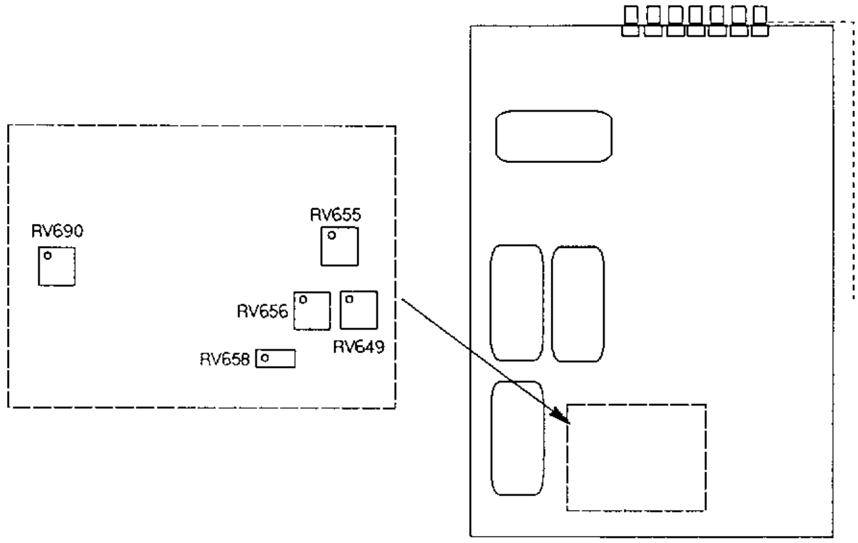

Figure 3-8. Adjustment area 6

Refer to adjustment area 6.

1. Check that *ext Ref.* is lit on the instrument display.
2. Set DEFAULT
3. Press (Freq) and enter 1 MHz.
4. Press (Ampl) and set *10V p-p.*
5. Set output to ON.
6. Measure the 1 MHz carrier amplitude on the spectrum analyzer with a 3Hz bandwidth.

Spurious 100 kHz

1. Press (Freq) and enter 1 MHz.
2. Measure with the 3Hz bandwidth, the spurious trace at 0.900 000MHz.
3. Adjust **RV690** to obtain a minimum reading, typically a level of −90 dBc below the carrier. Specification limit is −70 dBc.

Spurious 10 kHz

1. Press (Freq) and set 1.010 000 MHz.
2. Measure the spurious at 1.000 000 MHz.
3. Adjust **RV658** to obtain a minimum reading, typically a level of −80 dBc below the carrier Specification limit is −60 dBc.

Spurious 1 kHz

1. Press (Freq) and set 1.001 000 MHz.
2. Measure the spurious at 0.991 000 MHz.
3. Adjust **RV656** to obtain a minimum reading, typically a level of −80 dBc below the carrier Specification limit is −60 dBc.

Spurious 100 Hz

1. Press (Freq) and set 1.000 100 MHz.
2. Measure the spurious at 0.990 100 MHz.
3. Adjust **RV655** to obtain a minimum reading, typicallv a level of −80 dBc below the carrier. Specification limit is −60 dBc.

Spurious 10 Hz

1. Press (Freq) and set 1.000 010 MHz.
2. Measure the spurious at 0.990 010 MHz.
3. Adjust **RV649** to obtain a minimum reading, typically a level of −90 dBc below the carrier. Specification limit is −70 dBc.

Mixer

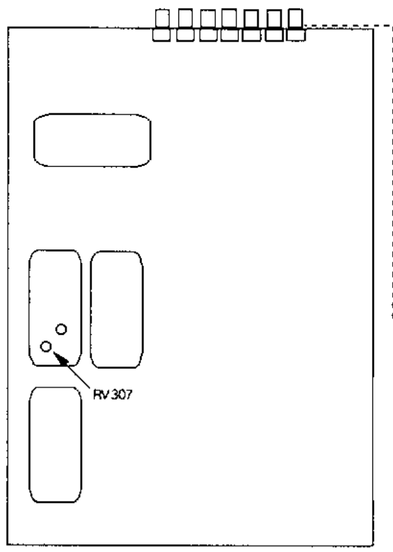

Figure 3-9. Adjustment area 7

The test setup is the same as that used for the spurious adjustments.

Refer to adjustment area 7

1. Set DEFAULT.
2. Press (Freq) and set 13.5 MHz.
3. Press (Ampl) and set *10V p-p* and set Output to ON.
4. Measure the DUT carrier amplitude with the spectrum analyzer bandwidth of 10 Hz at 13.5 MHz.
5. Measure the mixer spurious trace with the spectrum analyzer set at 16.5 MHz.

6. Adjust **RV307** to obtain a minimum reading, typically a level of −70 dBc to −80 dBc below the carrier. Specification limit is −70 dBc.

Note The adjustment on RV307 is flat and may be clockwise or counter clockwise

Harmonics

There are two adjustments to make and they are mutually dependent. This means you should loop back to the first adjustment and ensure that, if any further adjustment is necessary, the adjustments are repeated in order until no further adjustment is required.

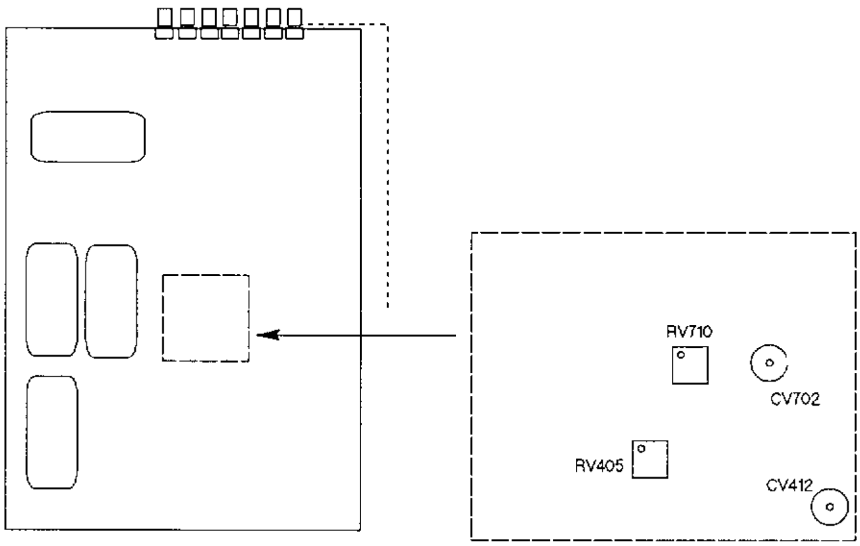

Figure 3-10. Adjustment area 8

Harmonics adjust

Refer to adjustment area 8.

1. Set DEFAULT.
2. Press (Freq) and set *2 MHz.*
3. Press (Ampl) and set *10V p-p.* Switch Output to ON.
4. Measure the DUT carrier with the spectrum analyzer at 2 MHz.
5. Measure the Harmonics at 4 MHz
6. Adjust **RV710** to obtain minimum harmonics level, typically a level of −55 dBc below the carrier. Specification limit is −42 dBc.

Harmonics re-adjust

Refer to adjustment area 8.

1. Press (Freq) and set *15 MHz.*
2. Measure the DUT carrier with the spectrum analyzer at 15 MHz.

3. Measure the Harmonics at 30 MHz.
4. Re-adjust **RV710** if necessary, to obtain a minimum reading, typically −37 dBc below the carrier. Specification limit is −30 dBc.

Group 3 Adjustments

Overshoot

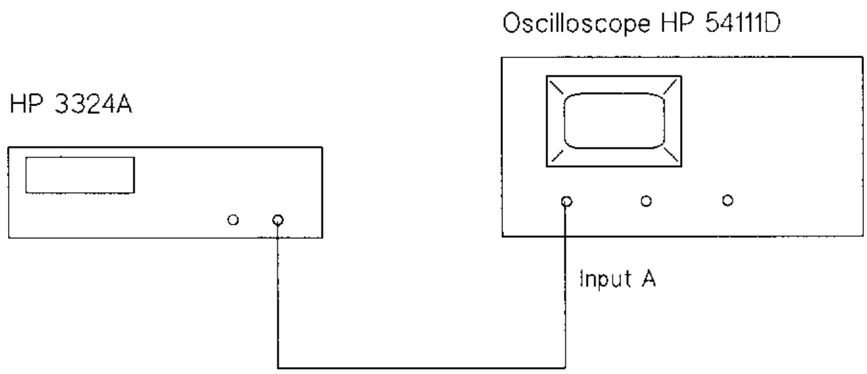

Figure 3-11. Test Setup for Overshoot

Refer to adjustment area 8.

This check is not an adjustment, but a preliminary setting for the amplitude accuracy adjustment which follows.

1. Connect oscilloscope to the SIGNAL output of the instrument.
2. Set DEFAULT.
3. Press [Wave Form] and highlight square wave.
4. Press [Select].
5. Press [Freq] and set 1.2 MHz.
6. Press [Ampl] and set 2.99V p-p. Set Output to ON.
7. Look on the oscilloscope for a smooth pulse response.
8. Adjust **CV702** to 0% overshoot. Specification limit is ±4%.

Amplitude accuracy

There are two adjustments to make and they are mutually dependent. This means you should return to the first adjustment after a test sequence and ensure that, if any further adjustment is necessary, the adjustments are repeated in order until no further adjustment is required.

Amplitude adjustment 1

Refer to adjustment area 8

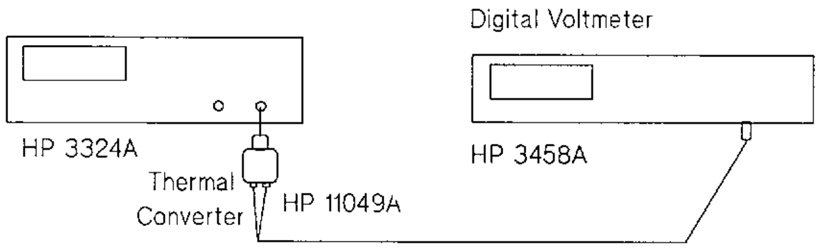

Figure 3-12. Test Setup for Amplitude Accuracy

1. Set DEFAULT.
2. Press (Freq) and set to *1 kHz.*
3. Press (Ampl) and set to *6V p-p.*
4. Press (Ampl Cal) and switch Output ON
5. Connect the HP 11049A thermal converter directly to the HP 3324 output.
6. Connect the DVM to the converter.
7. Wait one (1) minute and record the DVM reading as a reference voltage, V_O dc at 1 kHz.

Note

Do not exceed the rated voltage of the thermal converter. Any overload or high voltage transient may overload the thermal element.

The maximum voltage that can be measured with this setup is 18 dBm (6V p-p or 1.7V rms)

8. Press (Freq) and set to 10 MHz.
9. Adjust **RV405** to obtain the same DVM reading as in step 7.

Amplitude adjustment 2

Refer to adjustment area 8.

1. Press (Freq) and set to 20.5 MHz.
2. Adjust **CV702** to obtain the same DVM reading as in step 7 of Adjustment 1.
3. Repeat adjustment 1 and 2 again until no further adjustment is needed.
4. Check overshoot again.

Jitter

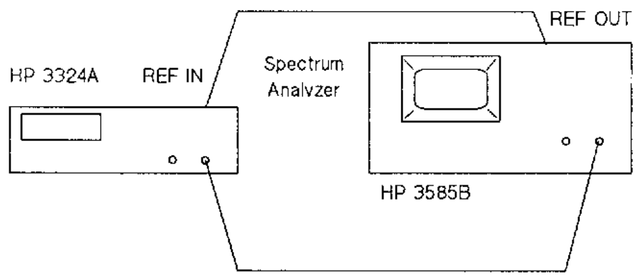

Figure 3-13. Test Setup for Jitter

Refer to adjustment area 8.

1. Set DEFAULT.
2. Press (Wave Form) and highlight the ramp up symbol.
3. Press (Select).
4. Press (Freq) and set to *98 Hz.*
5. Press (Ampl) and set to *10V p-p.* Set Output to ON.
6. Observing the spectrum analyzer, measure the fundamental wave at 98 Hz using the 3 Hz bandwidth.
7. Observing the spectrum analyzer, measure the wave at 147 Hz.
8. Adjust **CV412** for a minimum value, typically −62 dBc. Specification limit is −55 dBc.

X-drive

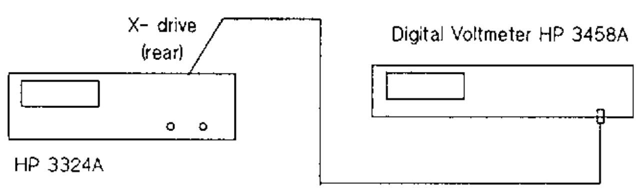

Figure 3-14. Test Setup for X-drive

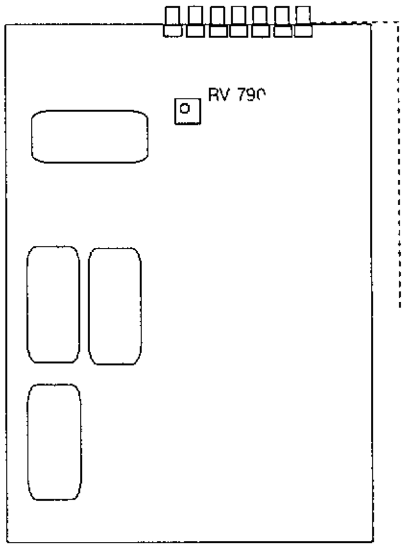

Figure 3-15. Adjustment Area 9

Refer to adjustment area 9.

1. Set DEFAULT.
2. Press (Sweep), highlight *Single* so that it starts to blink.
3. Press (Select), highlight *Interval* so that it starts to blink.
4. Highlight *sweep time* so that it starts to blink, and enter 0.999.
5. Press (s) to select seconds.
6. Press (Reset).
7. Press (Start).
8. Measure the X-drive output.
9. Adjust **RV 790** to provide an output of 10.8V ±0.1 V.

Note

Turning RV 790 counter clockwise, increases output level and turning clockwise reduces output level.

Whilst adjusting there will be no response on the DVM. You will see the result of adjustment on the next sweep run.

---

10. Repeat steps 6 to 9 until the specification is met.

Group 4 Adjustments

Frequency Reference (Option 001)

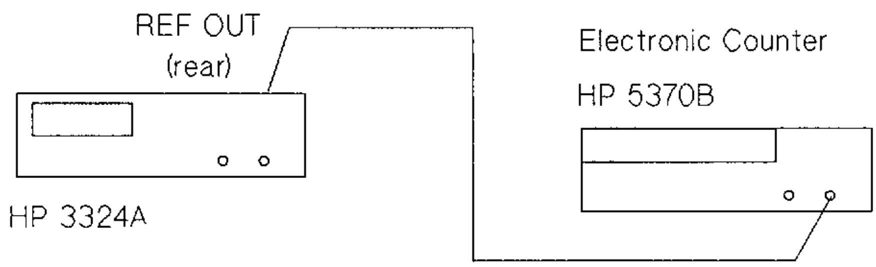

Figure 3-16. Test Setup for Frequency Reference Opt. 001

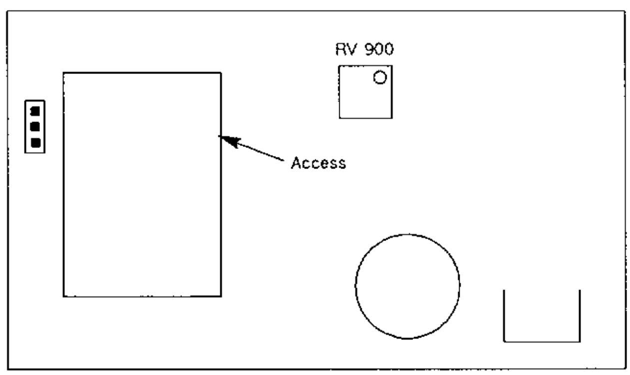

Figure 3-17. Adjustment Area 10

Note The oven must be allowed to warm up for at least one (1) hour before any adjustment is made.

Refer to adjustment area 10.

1. Adjust RV 900 to obtain a reading of 10 MHz ±0.3 Hz.
2. If a reading within the specification limits cannot be achieved:

a. Make a note of the range of adjustment given by RV 900.
b. Set RV 900 to its central position.
c. Remove the cover screw and adjust internal control screw (coarse adjustment which is approx half inch (12mm) inside the aperture) so that the frequency is brought closer to 10 MHz and within RV 900 range.

3. Repeat steps 1 and 2 until specification is met.
4. Re-fit the adjustment cover screw.

High Voltage (Option 002)

There are no adjustments to make.

Phase Calibration, Slave (Option 003)

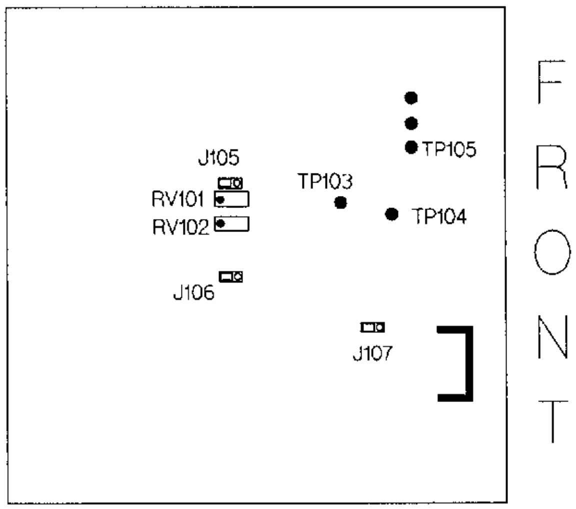

Figure 3-18. Adjustment Area 11.

Refer to adjustment area 11.

1. Set the HP 3324A to:
   - DC
   - Offset 0V
   - Signal On

Note The above setting is only necessary when the rear Backload bridging jumper is fitted.

---

2. Set jumper **J107** to it's rear position to start the test oscillator circuit.

Threshold adjustment oscillator 1

Refer to adjustment area 11.

1. Set jumper **J105** to it's front position.
2. Connect the oscilloscope and a 1:1 probe to **TP105,** common to **TP103.**
3. Turn **RV101** until the test square wave Amplitude 2V, can be seen.
4. Back off **RV101** slowly in the opposite direction until the test trace disappears (no glitch).
5. Turn **RV101** slowly back again until the pulse is starting (a small regular mark starting to break upwards to become the square wave again). This point is the threshold.
6. Move jumper **J105** back to it's normal rear position.

Threshold adjustment oscillator 2

Refer to adjustment area 11.

1. Set jumper **J106** to it's front position.
2. Connect the oscilloscope and a 1:1 probe to **TP104,** common to **TP103.**
3. Turn **RV102** until the test square wave Amplitude 2V, can be seen.
4. Back off **RV102** slowly in the opposite direction until the test trace disappears (no glitch).
5. Turn **RV102** slowly back again until the pulse is starting (a small regular mark starting to break upwards to become the square wave again). This point is the threshold.
6. Move jumper **J106** back to it's normal rear position.
7. Move jumper **J107** back to it's normal front position to disconnect the test oscillator.

Phase Calibration, Master (Option 004)

There are no adjustments to make on this board.

4

Replaceable Parts

Introduction

This section contains parts and ordering information for the
HP 3324A Synthesized Function/Sweep Generator.

Table 4-1 identifies those parts that can be returned to Hewlett-Packard as exchange items

Those components of major assemblies that are easily accessible for replacement, are listed in Table 4-2 with the assembly to which they are related.

Figure 4-1 identifies the mechanical parts of the instrument which are listed in Table 4-2.

Repair philosophy is to board level, therefore individual components for sub-assemblies are not listed. However Appendix A to this manual contains details of an information pack which contains a full parts listing for those customers who require it.

Replaceable Parts List

The organization of table 4-2, which lists replaceable parts, is as follows:

- Chassis mounted parts in alphanumeric order by reference designator.
- Electrical assemblies and their replaceable parts in alphanumeric order by reference designator.

Note An electrical assembly is a cable or a printed circuit board and its components.

The information given for each part consists of the following:

- Reference designator
- Description of part
- Hewlett-Packard part number

Reference Designators

Reference designators are alphanumeric names for parts.

1. A1 = electrical assembly number 1
2. MP1 = mechanical part number 1
3. A5F2 = fuse 2 on electrical assembly number 5

Ordering Information

To order a part listed in the tables, quote the Hewlett-Packard part number, quantity required, and address the order to your nearest Hewlett-Packard office as listed.

You may want to order a part that is not listed as replaceable. In this case, Include the instrument model number, instrument serial number (very important), with a description and function of the part.

Exchange Assemblies

Exchange assemblies are listed in a separate table; table 4-1. These exchange assemblies have a part number in the form xxxxx-695xx, whereas new part numbers are xxxxx665xx. Before ordering an exchange part, it is advisable to contact your local office or repair organization for current procedures and availability.

Note Exchange orders require return of the defective part

Direct Mail Order System

Within the USA, Hewlett-Packard can supply parts through direct mail order. The advantages are as follows:

- Direct ordering and shipment from Hewlett-Packard Parts Center in Mountain View, California.
- No maximum or minimum on any mail order (there is a minimum order for parts ordered through local Hewlett-Packard offices when orders require billing and invoicing).
- Prepaid transportation (there is a small handling charge for each order).
- No invoices - to provide these advantages, check or money order must accompany each order. Mail order forms and specific ordering information are available through your local Hewlett-Packard offices.

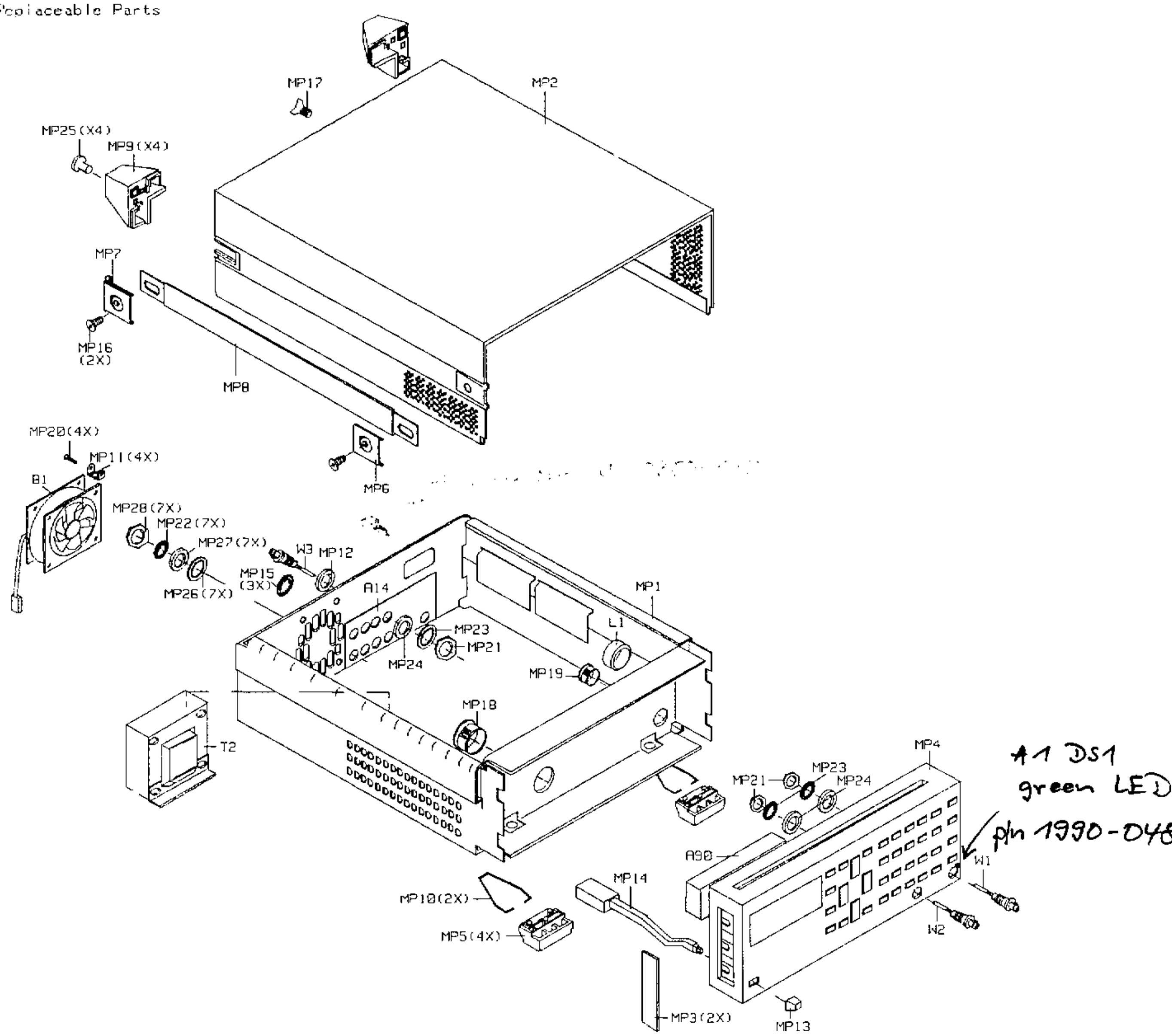

Figure 4-1. Mechanical Parts

HP 3324A Exchangeable parts

Table 4-1. Exchangeable Items

Part Number	Description	Replacement
03324-66501	Keyboard Assy.	see 03324-68701 below
03324-00201	Panel Front	see 03324-68701 below
03324-40501	Front Frame	see 03324-68701 below
03324-41901	Keypad Rubber	see 03324-68701 below
03324-48101	Window	see 03324-68701 below
	Front Panel Kit, MP4 (first 5 items)	**03324-68701**
03324-66504	CPU Bd Assy, A4	03324-69504 (exchange)
03324-66506	Signal Source Bd Assy, A6	03324-69506 (exchange)
03324-66512	PC Bd Assy, OPT 003	comp repair or 03324-68713
03324-66513	PC Bd Assy, OPT 004	comp repair or 03324-68714
03324-66514	RFI Bd Assy, A14	throw away item
03324-66590	Display Assy	throw away item

HP 3324A Replaceable Parts

Table 4-2. Replaceable Parts

Ref Designator	Description	Part Number
B1	Fan	3160-0477
L1	Toroid core	9170-0887
T2	Power transformer	9100-4783
MP1	Chassis, main	03324-60101
MP2	Cover	03324-04102
MP3	Side Trim	5001-0539
MP4	Front Panel Kit	03324-68701
MP5	Foot	5041-8801
MP6	Strap Handle, front	5041-8819
MP7	Strap Handle, rear	5041-8820
MP8	Strap Handle, 497.8	5062-3704
MP9	Foot Rear	5041-8821
MP10	Tilt Stand	1460-1345
MP11	Nut Sheet-spec	1535-5036
MP12	Insulator	5040-0702
MP13	Key	5041-0531
MP14	Push rod	5040-7023
MP15	Button plug, stl	6960-0002
MP16	Screw M5x12 FH 90	0515-0956
MP17	Screw-mach. M3x0.5	0515-0912
MP18	Grommet snap, bush	0340-0592
MP19	Grommet snap, bush	0400-0087
MP20	Screw TPG 8-18	0624-0400
MP21	Nut Hex 318-32T	2950-0001
MP22	Lock washer INT1	2190-0054
MP23	Lock washer INT3	2190-0016
MP24	Washer Brs. .375 I	3050-0067
MP25	Screw M3.5x0.6x12	0515-0892
MP26	Insulator	3050-1291
MP27	Washer	3050-0604
MP28	Nut Hex	2950-0054
MP29	Screw M3X0.5 8mm	0515-0897 — Securing Screw
MP30	CE-Label	7121-5585 — Manual Change 2
A2	Board Assy, Power Supply	03324-66502
F1	Fuse, 5A subminiature	2110-0699
K401	Relay, reed	0490-1598
A4	Board Assy, Microcomputer	03324-66504
BT100	Battery 3V	1420-0298
U400	ROM 1	03324-13700
U401	ROM 2	03324-13701
A6	Board Assy, Signal Source	03324-66506
K50-55	Relay 3A 5V	0490-1548
K54	Relay RG1T12	0490-1665

Table 4-2. Replaceable Parts (continued)

Ref Designator	Description	Part Number
A10	Board Assy Power Inlet	03324-66510
F1	Fuse, .375A 250V	2110-0421
F1	Fuse, .75A 250 V	2110-0360
MP1	Cap, Fuseholder	2110-0565
MP2	Holder, fuse	2110-0642
S1,S2	Switch-slide	3101-2769
A9	Board Assy Crystal Oven Opt #1	03324-66509
A11	Board Assy High Voltage Opt #2	03324-66511
A12	Board Assy Cal, Slave Opt #3	03324-66512
A13	Board Assy Cal, Master Opt #4	03324-66513
W1	Cable assy, Sig Front	03324-61613
W2	Cable assy, Sync Front	03324-61603
W3	Cable assy, Sig Rear	03324-61606
W4	Cable assy, PWR SS	03324-61621 01
W5	Cable assy, PWR UC	03324-61622 02
W6	Cable assy, SC Display	03324-61617

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Service

Introduction

This chapter contains service information for the HP 3324A Synthesized Function/Sweep Generator. The information includes theory of operation supported by block diagrams, details of error conditions and messages, and trouble shooting procedures.

A full set of drawings, circuit diagrams and parts lists are provided in a separate package, not part of this manual. Appendix B contains details of the information pack.

Performance tests can be found in Appendix C and adjustment procedures are provided in Chapter 3.

This chapter is arranged as follows:

Theory of Operation	A general description supported by block diagrams, that identifies the main functional blocks of the instrument
Troubleshooting	This section describes self-test, error messages and troubleshooting
Removal & Refitting	Removal and refitting procedures for sub-assemblies.

Theory of Operation

Figure 5-1 illustrates a simplified block diagram of the instrument. In response to inputs from the keyboard, or programming inputs from the interface circuits, the control circuits set the frequency, signal level, and output attenuation.

The frequency synthesizer circuit generates a sine wave at a frequency determined by digital information from the control circuits. The sine wave is applied to the function generator circuits where both the output function and signal level are determined, again by digital control.

The signal level from the output is checked by a level comparator to determine if level correction is needed, thus providing an automatic amplitude calibration. Attenuator range is selected by control circuits to provide (in conjunction with level control) the desired output-signal amplitude.

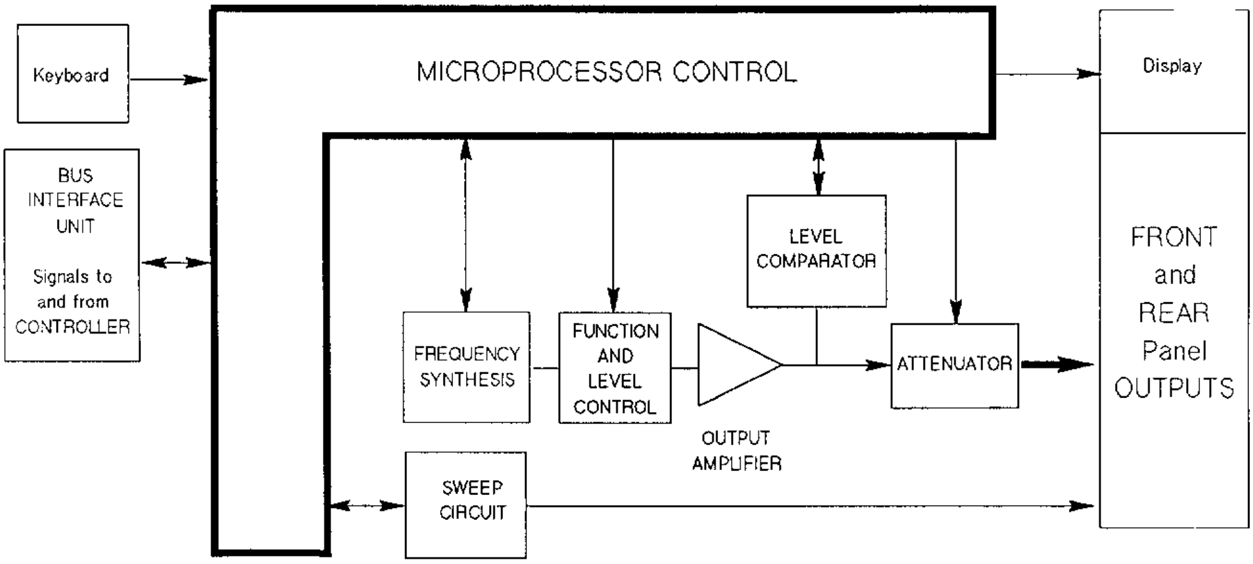


Figure 5-1. HP 3324A Simplified Block Diagram

Power Supplies

Power Inlet Board, A10

The power input board provides line filtering via dual inductor T1 and capacitors C1/C2. This filtering protects the instrument from interference which may be present on the mains voltage supply lines. The filter also reduces any RF emissions which may be generated by the instrument. Line select switches S1 and S2 are set to vary the size of transformer primary winding, according to the requirements of the mains AC supply level.

The transformer has five secondary windings as follows:

Table 5-1.

Ac output	Terminal numbers	Destination
24V centre tapped	J1/1, 2, 3	To High Voltage board (if fitted)
17V centre tapped	J1/4, 5, 6	Raw to ±15V ±12V regulators and to relay supplies
7V center tapped	J1/8, 9, 10	To 5V regulator for A6 sig source board ICs
8V	J1/11, J1/12	to 5V regulator for microprocessor board ICs
17V	J3	Supply to Crystal Oven frequency reference (if fitted)

Power Supply Board, A2

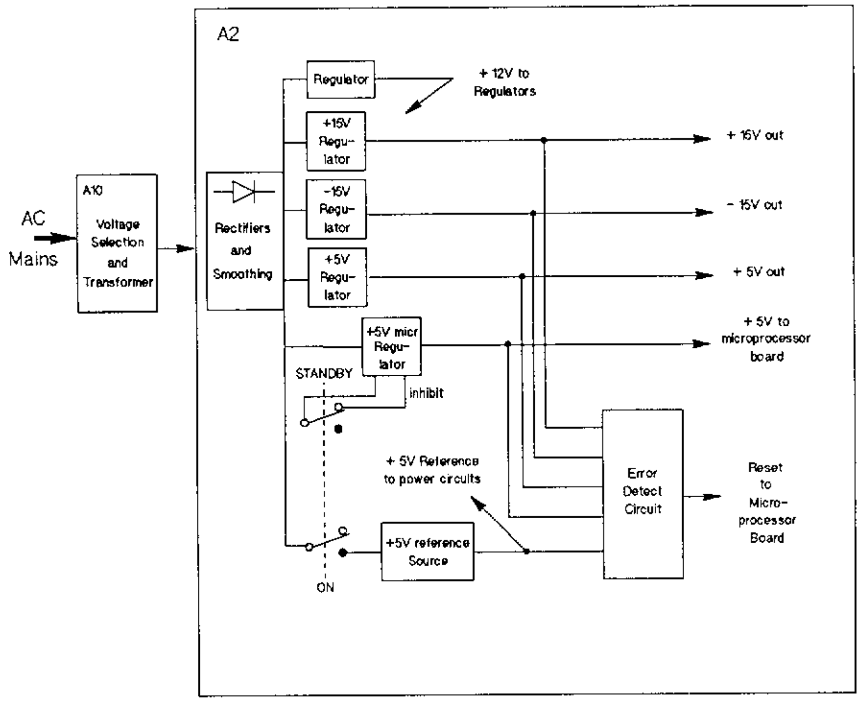


Figure 5-2. Power Supplies Block Diagram

The four main regulators (+5V, +5V μP, +15 V and −15 V) are voltage and current controlled; each regulator (not the +5V μP) having a voltage sense connection. If the voltage at the load is too low, this sense voltage feedback enables the regulator to adjust its output to the correct voltage. Should the output current increase excessively (e.g. short circuit), the voltage drop across the current sensing resistance causes the active device in the current sensing circuit to limit the current through the series pass regulator. All regulators have current foldback characteristic.

Regulator description

The 15V regulators are identical and the other two regulator circuits have similar features. The +15V regulator circuit is described here with appropriate references to elements of the other circuits which differ.

Voltage sense. The actual load voltage delivered to the Signal Source Board is returned to the regulator as a *Voltage Sense* input to Operational amplifier U203B via J2/2. RV213 provides +15V adjustment by modifying this sense input to U203B which in turn controls the base of transistor Q202. Q202 is used to regulate the power transistor Q201.

In the +5V regulator U101A provides voltage control, in the +5V microprocessor supply, U401A provides voltage control. As there is no external volt sense input to the +5V microprocessor supply, a bleed or bootstrap resistor ensures that, during the initial power-up stage, U401A is sufficiently unbalanced to allow the voltage to rise up to within it's normal control value.

Current sense. Current sensing is provided by a monolithic transistor array U202. The sensing is done by parallel elements U202D and U202E. If the current rises above the allowable limit, U202C is switched to allow a voltage rise to decrease and correct the current being drawn. In extreme over current conditions U202C shuts down the power transistor Q201. U202B provides foldback protection.

In the +5V regulator U101B provides current control, and R112 defines the foldback characteristic. In the +5V microprocessor supply, U401BA provides current control with RA401 providing the foldback characteristic.

Fault detection

The power supplies are also monitored by a common detector circuit (U260) which applies and holds a reset signal to the microprocessor circuits during power-up and whenever an "out of limits" power supply condition occurs.

Local supplies

There is a separate 12V regulator circuit (U250 & U350) to supply the operational amplifiers in the regulator circuits.

A 5V reference supply used by the regulators, is present when the power switch is set to ON.

Fan control

The DC fan runs from an unregulated source which is interrupted by a relay contact when the +5V microprocessor supply is not present.

Standby

When the instrument is switched to STANDBY, the four main regulators are disabled. The two 15V regulators and the +5V regulator are disabled by the absence of the +5V ref, and the +5V microprocessor board supply is disabled by a direct inhibit applied by the STANDBY switch.

Power is still available to the Crystal Oven Reference and High Voltage Amplifier boards if they are fitted (Options 001 and 002). These boards have their own supplies and regulators via a separate AC supply from the transformer.

Adjustment

There are three voltage adjustments possible:

- RV101 for the +5 V regulator.
- RV213 for the +15 V regulator.
- RV313 for the −15 V regulator.

There is no adjustment for the +5V microprocessor board supply.

Microprocessor Board, A4

The microprocessor board maintains all control and communication for the HP 3324A instrument.

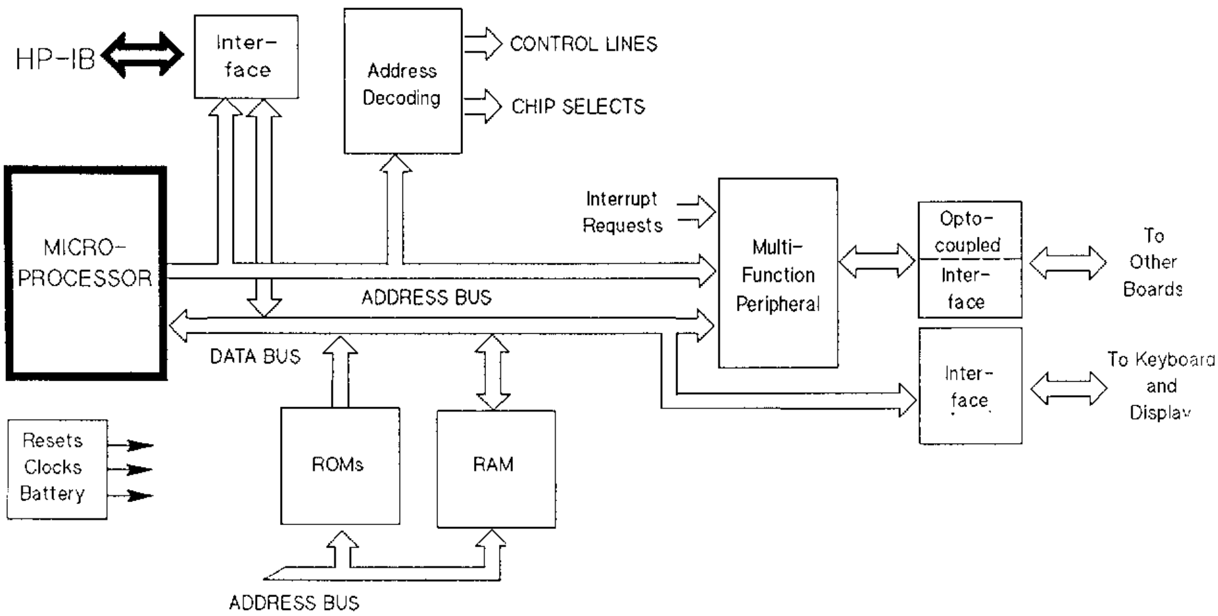


Figure 5-3. Microprocessor Board Block Diagram

General Description

The MPU works in asynchronous mode and depends on its peripherals to generate DTACK (Data acknowledge) when they are communicating with the MPU. The MPU inserts wait periods of one clock cycle or more, until it recognizes DTACK.

There are six main circuits associated with the MPU as follows:

- Timing
- Address decoding
- Memory, ROM and RAM
- Multi-function peripheral
- HP-IB interface
- Keyboard/display interface

Timing

The main clock drive is obtained from a 8.375 MHz crystal oscillator Y100, directly connected to the MPU. A secondary clock of 4.1875 MHz is derived by U111.

Reset is produced under two circumstances by U102. At power on and also if the monitor circuit of the power supply board detects a power supply deviation.

There is only one interrupt source for the MPU, the multi-function peripheral IC U300. During the interrupt acknowledge cycle, an 8-bit vector number is sent on the data bus to the MPU. The MPU uses this number to generate a 32-bit address from which the required program routine must be fetched.

Addressing

Address and Data Bus

The 68008 microprocessor has a 20-bit address bus capable of addressing up to 1 Mbyte. There is a 32-bit internal data bus, but the external bus to the instrument is only 8-bit wide.

The address decoder divides the 1 Mbyte address space into two 512 kbyte blocks by the A19 address line. The address demultiplexer device U101 further divides one of the 512k blocks into 64k areas. A detailed address map is provided in Table 5-2.

Table 5-2. HP 3324A Address Map

Address	r/w	Function	Comment
00000 to 1FFFF	r	EPROM	see Fig. 5-4
20000 to 3FFFF	r	Reserved for EPROM expansion	
40001		GPIP General Purpose I/O Register	MC 68901
40003		AER Active Edge Register	
40005		DDR Data Direction Register	
40007		IERA Interrupt Enable Register A	
40009		IERB Interrupt Enable Register B	
4000B		IPRA Interrupt Pending Register A	
4000D		IPRB Interrupt Pending Register B	
4000F		ISRA Interrupt In-Service Register A	
40011		ISRB Interrupt In-Service Register B	

Table 5-2. HP 3324A Address Map (continued)

Address	r/w	Function	Comment
40013		IMRA Interrupt Mask Register A	MC 68901
40015		IMRB Interrupt Mask Register B	
40017	r/w	VR Vector Register	MFP
40019		TACR Timer A Control Register	
4001B		TBCR Timer B Control Register	Multi-
4001D		TCDCR Timers C and D Control Register	
4001F		TADR Timer A Data Register	Function
40021		TBDR Timer B Data Register	
40023		TCDR Timer C Data Register	Peripheral
40025		TDDR Timer D Data Register	
40027		SCR Synchronous Character Register	
40029		UCR USART Control Register	
4002B		RSR Receiver Status Register	
4002D		TSR Transmitter Status Register	
4002F		UDR USART Data Register	
40030			
to		not used	
4FFFF			
50001	r/w	KBR Key Board Register	KBR
50002			Key Board
to		not used	
5FFFF			Register

Table 5-2. HP 3324A Address Map (continued)

Address	r/w	Function	Comment
60001	w	DR Display Register	DR
60002			Display
to		not used	
6FFFF			Register
70001	r	Int Status 0	
70001	w	Int Mask 0	
70003	r	Int Status 1	
70003	w	Int Mask 1	HPIB
70005	r	Address Status	
70005	w		
70007	r	Bus Status	
70007	w	Auxiliary Cmd	TMS 9914A
70009	r		
70009	w	Address	GPIB
7000B	r		
7000B	w	Serial Poll	General
7000D	r	Cmd Pass Thru	Purpose
7000D	w	Parallel Poll	Interface
7000F	r	Data In	Bus
7000F	w	Data Out	Controller
70010			
to		not used	
7FFFF			
80000			
to		not used	
F7FFF			
F8000			RAM
to	r/w	Static RAM 32KByte	
FFFFF			

Memory, ROM and RAM

The HP 3324A's firmware is contained either in two 64kbyte ROMs or in one 128kbyte ROM.

Caution If you need to replace the firmware, refer to the ROM configuration information given at the beginning of the "General Fault Finding" section in the "Troubleshooting" part of this chapter.

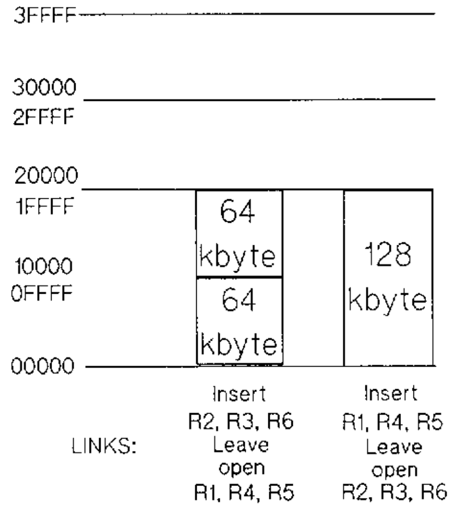


Figure 5-4. Possible ROM address maps

All current settings and values are stored in the RAM whilst the instrument is in use. The 32kbyte RAM device is provided with battery backup so that stored settings may be recovered after power off.

Multi-function peripheral

The MFP handles all interrupts and generates a vectored interrupt acknowledgement cycle to the processor. The MFP has 16 interrupt sources, eight internal and eight external. The internal sources are four timer interrupts, two receiver interrupts and two transmitter interrupts. The external sources are keyboard interrupt, HPIB-controller interrupt, device interrupt and phase calibration interrupt.

I/O pins

MFP Pins which are not used as interrupt pins are used as general purpose input or output pins. One input polls the display ready signal and two inputs read the jumpers J300 and J302. The last pin is an output pin to switch the Signal LED.

Timers

There are four timers (A-D) available. The timer clock (approximate 1.6MHz) is generated by the pulse width generator U301.

Serial interface

The serial interface clock is generated by the pulse width generator (approximate 800KHz). It forms the interface to the device bus and uses the pulse width generator clock. The interface operates in asynchronous mode.

Device interface

Opto couplers are used to isolate the other boards from the MFP.

Pulse width generator. The purpose of the pulse width generator is to transfer the clock with the data pulses over the same opto-coupler. The FLIP-FLOP U111B changes serial data bits into short or long pulses for transmission, a low bit equates to a short pulse and a high bit to a long pulse.

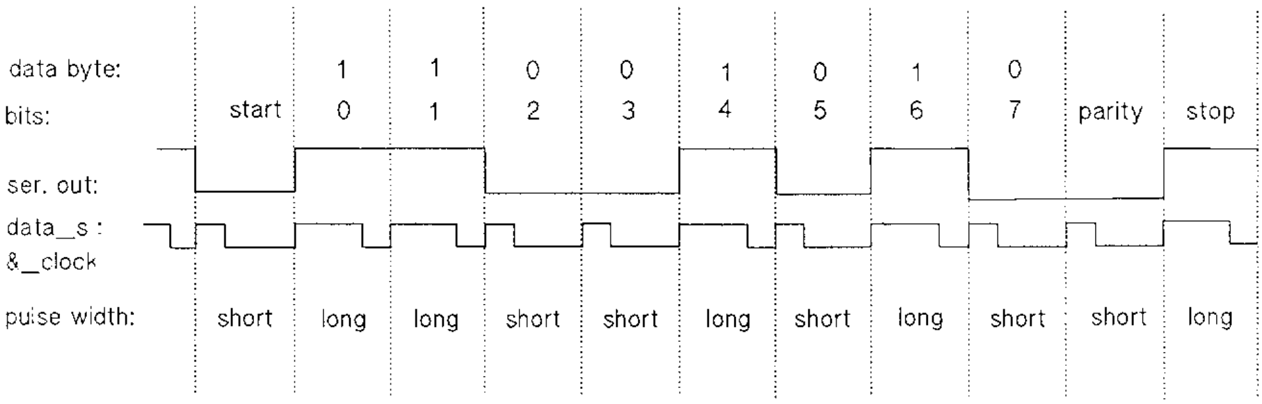


Figure 5-5. Pulse width timing

Pulse to clock generator. The clock is generated by the received data_s_&_clock signal. Low to high transition triggers the re triggerable monostable U603A to generate the clock.

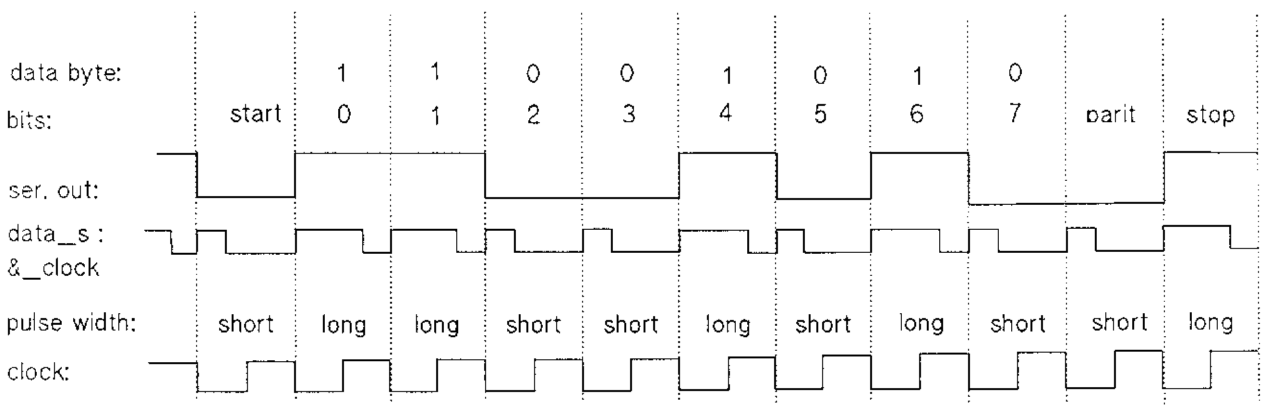


Figure 5-6. Clock Generating Timing

Load and clock shift register. The shift registers are clocked by the rising edge of the clock signal, so the pulse width specifies, whether a low or high bit is clocked in.

If the parity bit is low, the address register is loaded, if not (without parity) the stop bit is always high and the data register is loaded.

Bit 7 of the address shift register disables the output of the data write shift register with a read access. The data read shift register is loaded by a read or a write access. The strobe signal is generated by a re triggerable monostable.

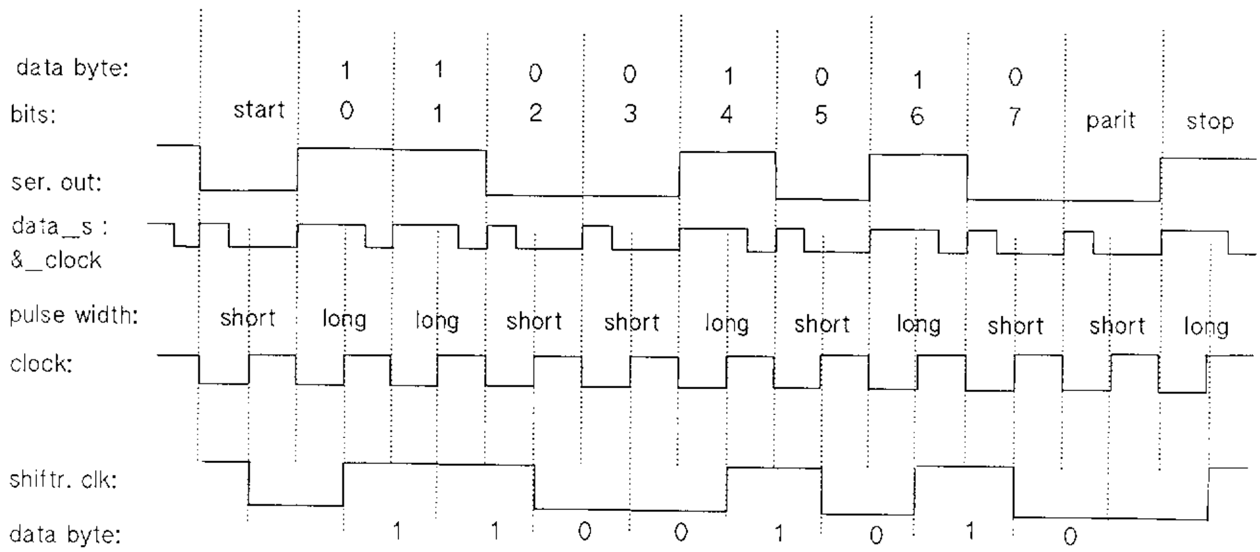


Figure 5-7. Shift Register Clock Timing

Keyboard and Display

Keyboard

The keyboard is directly driven from the microprocessor board. It is arranged as an 8 x 6 matrix. This key matrix is stimulated with data from an octal D-type flip-flop by 6 open-collector-output drivers.

In the idle state the six output pins are low, so that when a key is pressed, an interrupt is generated by the NAND-gate. The firmware then scans the key matrix using the six outputs and determines the pressed key by reading the eight input-buffer lines.

Display

The display module contains its own driver logic.

Fault finding. From the matrix grouping, it should be possible to decide whether an apparent keyboard failure is common to a group of keys, this signifies a logic circuit problem; or if it is isolated to a particular key, this indicates a possible switch or connector fault.

Monitoring at connector J10 should establish whether a display fault lies within the module or the driver circuits on the microprocessor board

HP-IB Interface

The GPIB controller with two bus transceivers, controls the HP-IB. The HP-IB address can only be changed from the keyboard as follows:

1. Press (Util)
2. Press (▲) until the current address is displayed.
3. Key in the new address
4. Press (Enter)

Signal Source Board, A6

The Signal Source Board generates all required signals for the HP 3324A in response to instructions from the microprocessor board. The main circuit areas are as follows:

- Microprocessor Interface and timer
- Fractional N circuit
- Voltage Controlled Oscillator
- Mixer and Pre-amplifier
- Reference Oscillator
- Shape Generators
- Output Amplifier
- Digital to Analog Converter
- X-drive, Markers etc.

Microprocessor Interface

The microprocessor interface operates in asynchronous mode, with the data bus operating via a transceiver chip. Main control signals are derived on the microprocessor board by the address decoder. These control signals are used to clock data lines into 3 to 8 decoders which generate enables. Further controls are derived from the full 8 way data bus via octal Flip-Flops.

Fraction N Control

The fraction N control performs several important functions for the HP 3324A.

- It calculates the ÷N and pulse remove data for the phase lock loop in the frequency synthesis circuits(the next section describes frequency synthesis). This information is updated every 10 μs.
- It increments or decrements the output frequency during a sweep function and outputs a sweep limit flag at the marker frequency during a sweep up.

Voltage Controlled Oscillator (VCO)

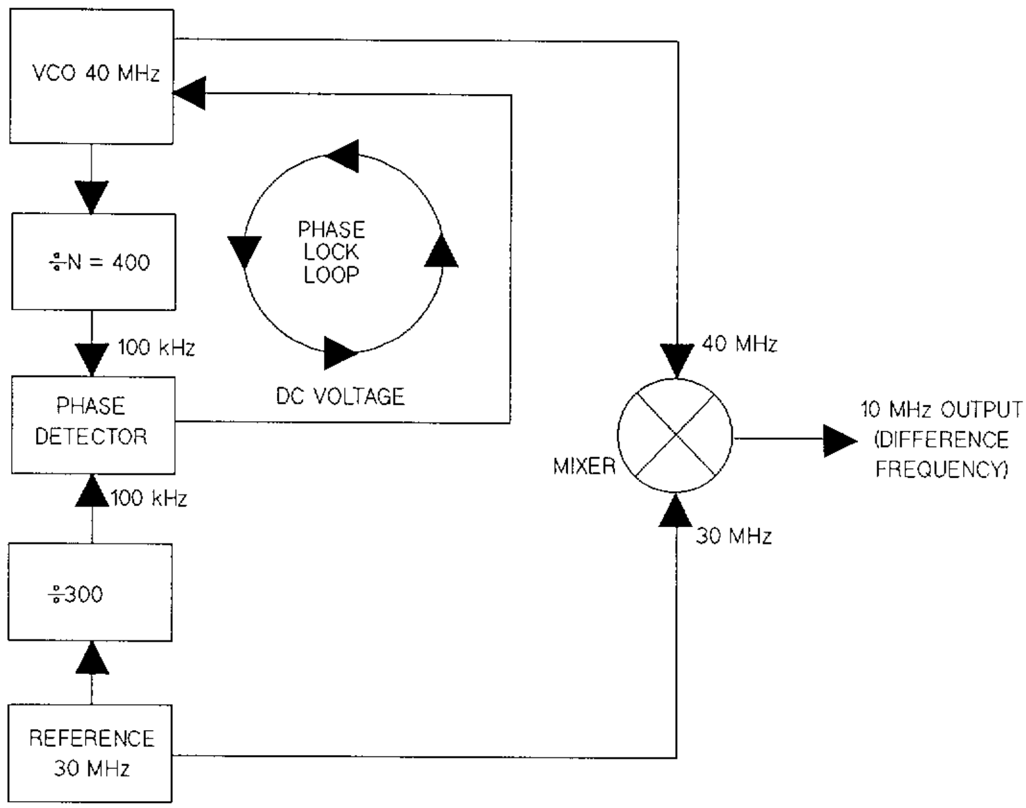


Figure 5-8. Phase Lock Loop

In the following description it is assumed that the desired output is an even 10 MHz.

The frequency of the VCO in Figure 5-8 is controlled by the DC voltage from the phase detector. This DC voltage reflects any phase change between the two detector input signals. Therefore, if the VCO frequency changes, the phase detector output changes to correct the VCO - a Phase Lock Loop (PLL).

If the output is to change from 10 MHz to 20 MHz, it is necessary to change the ÷N number from 400 to 500. This changes the divided VCO input to the phase detector to 80 kHz. The phase detector then uses the phase difference between its two inputs to change the VCO frequency to 50 MHz. This returns the phase detector input to 100 kHz, and the loop is again phase locked. The ÷N number is determined by the control circuits in response to the controller.

The HP 3324A sine wave frequency range is from 0 to 20 MHz; thus the VCO frequency range is 30 MHz to 50 MHz. This means that the ÷N number must be a 3-digit number between 300 and 500. For example, if ÷N is 398, the VCO frequency is adjusted to 39.8 MHz (398 × 100 kHz) and the output is 9.8 MHz.

Mixer

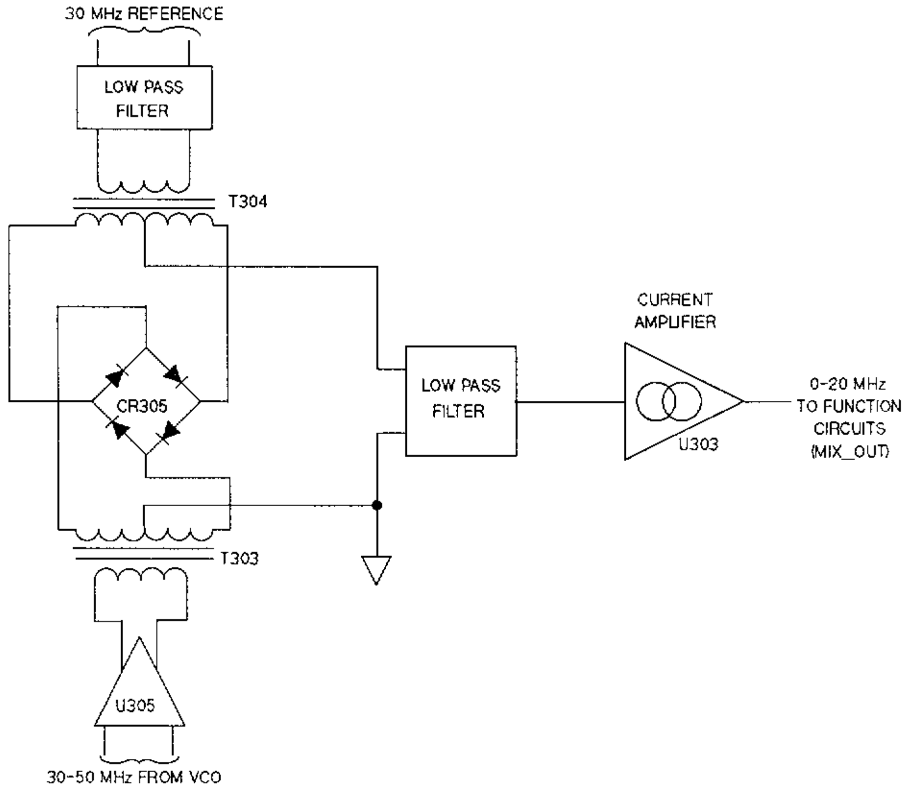


Figure 5-9. Mixer Diagram

The 30 MHz reference (MIX_30MHZ) is passed through a low-pass filter and mixed with the 30-50 MHz signal from the VCO in a diode mixing circuit. The mixing circuit output is applied to a low pass filter to remove all but the difference frequency, which is amplified by a current amplifier. This signal is then passed to the Function circuits.

Reference Oscillator

The reference oscillator is a 30 MHz crystal-controlled oscillator that can be synchronized to an external reference signal of 10 MHz or a sub harmonic of 10 MHz (minimum 1 MHz).

External Reference Phase Lock Loop

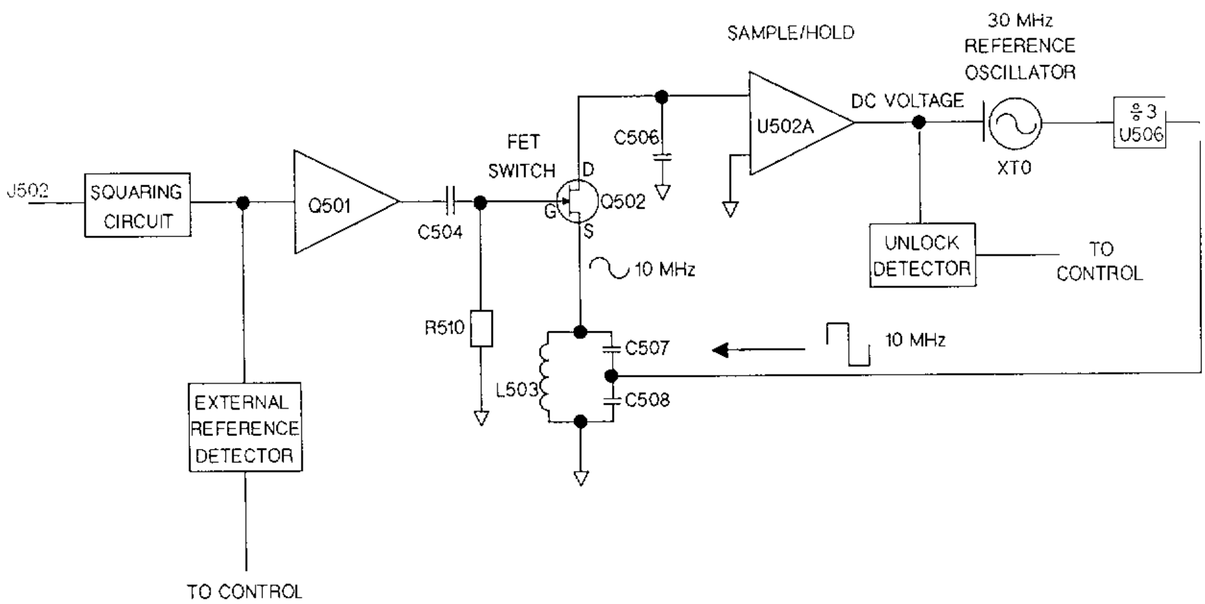


Figure 5-10. External Reference Phase Lock Loop Block Diagram

The external reference input is passed through a squaring circuit, amplified, and then differentiated to provide a narrow positive pulse to the gate of a FET switch. The FET is momentarily switched on sampling the instantaneous voltage of the sine wave at the FET source. This voltage is stored at the input of a Sample/Hold amplifier. The resulting DC output voltage is applied to a varactor in the 30 MHz oscillator circuit to adjust the oscillator circuit.

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

Reference Dividers

The 30 MHz reference frequency is reduced through a series of dividers to provide the following signals:

- 1 MHz to the external reference PLL
- 2 MHz to the DAC (on the signal source board)
- 100 kHz reference to the Fractional N Phase Comparator (on the signal source board).

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

Shape Generators

These circuits provide the correct current to the operational output amplifier for each function. They include a number of current sources and the circuits necessary to generate (from the sine wave) the square wave, triangular wave and the ramp function. Function switching is achieved by the various enable signals.

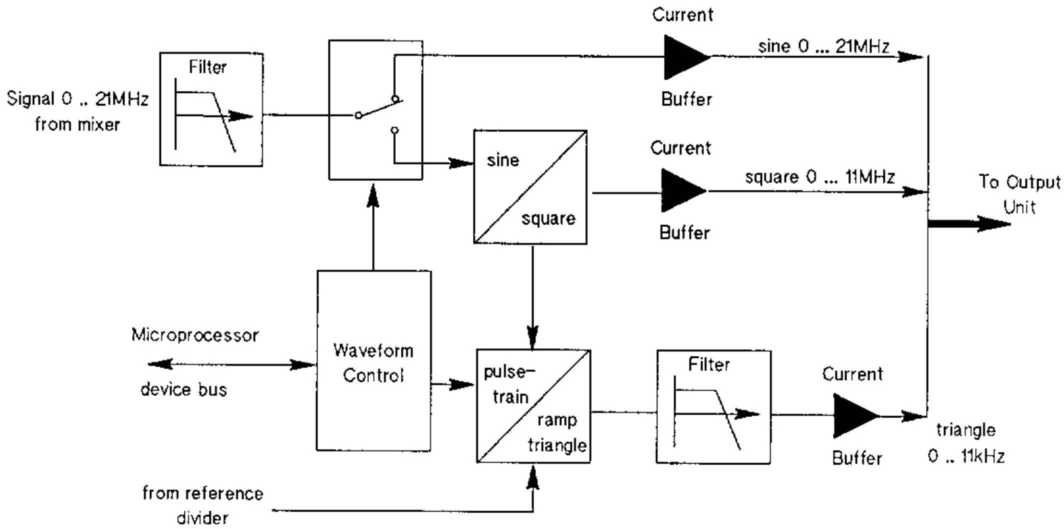


Figure 5-11. Function Generator Block Diagram

Sine Wave

The sine wave from the mixer (MIX_OUT) is passed through a current amplifier (Q401), to the output amplifier (FUNC_OUT). Sine wave amplitude is controlled by the level control circuits (see section *Amplitude and Offset Control*). However, the level control current is supplied from the amplitude control current source in this section - SINE_AMP.

Square Wave

The sine wave from the mixer is passed through a squaring circuit and then divided by U409A to produce the square wave output. Thus, in the square wave function, the sine wave must be twice the output frequency, and the maximum output frequency is 10 MHz.

Triangular Wave

To generate a triangular wave, the sine wave is first passed through the squaring circuit and then divided by 20. The result is a square wave with a frequency of 1 MHz plus the programmed output frequency. This signal is phase compared to a 1 MHz reference by an exclusive OR-gate. Because the output of this gate is high when one, and only one input is high, the gate output is a series of pulses. The width of these pulses varies in proportion to the phase difference between the two gate input signals. Figure 5-12 shows a simplified illustration of this. The output from the above gate drives a current amplifier that inverts the signal. The resultant current pulse signal is passed through a filter which shapes the triangle.

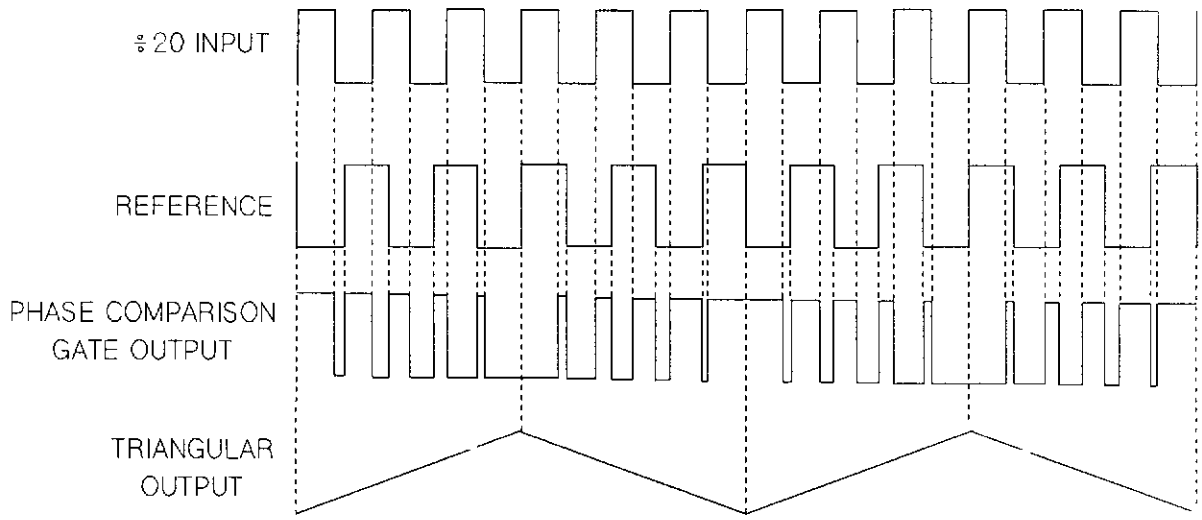


Figure 5-12. Simplified Illustration of Triangular Generation

Ramp Generation

A ramp output is generated in a similar manner to the triangular wave. However, when the phase difference between the 1 MHz reference and the ÷20 input has advanced beyond 180°, the reference is inverted by the ramp reset circuits.

The phase difference is only allowed to advance 180° instead of 360° as in the generation of the triangular wave. Thus, the frequency of the U406C ÷20 input must be 1 MHz plus one-half the output frequency. It follows that the input frequency must be ×20 the ÷20 input.

Function Integrity Flag (INT_FLAG)

INT_FLAG tells the microprocessor which reset method (analog or digital) is being used. This information is used by the microprocessor in setting the correct reference level for the output level comparator.

Ramps are reset by the digital phase detector at frequencies below 100 Hz, and by the analog output level comparator at frequencies of 100 Hz and higher.

If the ramp is being set by the digital phase detector (U407), the detector output sets the function integrity flip-flop and thus sets INT_FLAG to the microprocessor high. If the ramp is being reset by the analog level comparator at the output amplifier (U705 on the control board) via +RAMP_RS and −RAMP_RS, then this analog reset signal prevents the function integrity flip-flop from being set.

Amplitude and Offset Control

The voltage output of the output amplifier is proportional to the current into its summing junction. Thus, the signal amplitude can be controlled, by, varying the amount of current available from the current source which supplies the various functions. The amplitude control signal (AC_AMPL) is a DC analog voltage from a DAC (see section *Digital/Analog Converter*).

Because the square, triangular and ramp signals are generated by switching the uni polar amplitude control current on and off, the entire signal is above ground. These signals are centered about ground by a compensating current equal to one-half the signal amplitude; this current is known as the Functions Correction Current. After calibration, additional DC offset correction is added by the control circuits; this current is known as Offset Correction.

Positive or negative DC offset can be programmed either with or without an AC signal. The offset current source is controlled by a DC analog voltage from the DAC.

Output Amplifier

The output amplifier is an inverting operational amplifier designed for wide frequency response and low distortion. Its output stage is current protected by a 0.25 A fuse (F701). It is voltage protected by two zener diodes connected to the +15 V and −15 V supplies. The output resistance is 50 Ω.

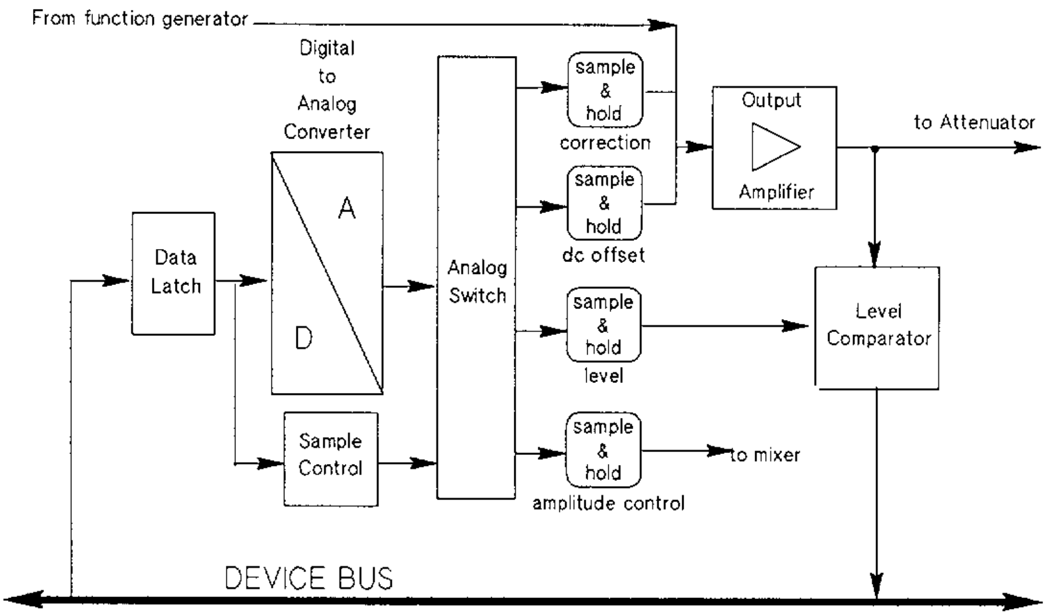


Figure 5-13. Output Unit Block Diagram

Level Comparator and AMPTD CAL

During the amplitude calibration process (AMPTD CAL), the level comparator is used to determine the offset and signal amplitude errors of the HP 3324A output. To determine the DC offset in the amplifier output, the microprocessor sets the signal amplitude to zero, and varies the voltage of the comparator's LVL input. The microprocessor then sets the signal amplitude to 8 Vp-p (with full attenuation) and proceeds to determine both the positive and negative peak voltages in a similar manner. AC calibration is done at a frequency of 1kHz.

From this information the microprocessor computes the straight-line equations for the DC offset versus programmed amplitude and for output amplitude versus programmed amplitude. Calibration FAIL codes occur if the signal could not be adequately measured. The calibration constants are then reset to default values. Calibration FAIL codes occur if the signal has been successfully measured, but, the microprocessor determined that the calibration values were outside of the recommended limits. In this case, the calibration values are left unaltered.

The level comparator is also used to reset both the positive and negative going ramps for frequencies of 100 Hz and higher.

Sync Comparator and Driver

The output waveform (FUNC_OUT) is one input to the sync comparator (U701) the other is the DC offset voltage level (DC_OS). If no DC offset has been programmed, the DC Offset voltage will be zero and the comparator output will change at zero volts. The result is a SYNC square wave with a transition at zero volts crossing of the output signal. Thus a SYNC signal transition will occur whenever the output signal crosses the DC Offset voltage and an offset has been programmed. The SYNC signal is then passed via buffer circuits to the front and rear panels.

Attenuator Relays and Drivers

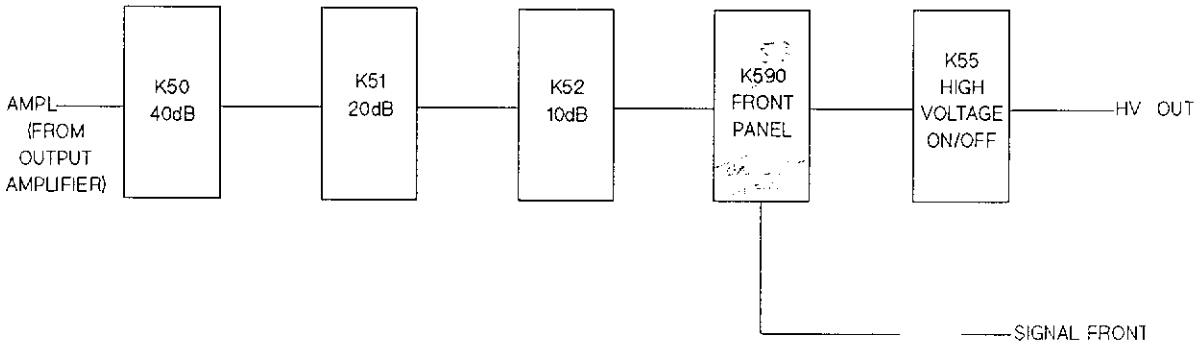


Figure 5-14. Attenuator Relays

All the relays are dual HF relays except for K54, which is a single HF relay. Because latching relays are used, continuous current is not required. Therefore the drivers are turned off by the microprocessor, after a relay has been switched.

Digital/Analog Converter (DAC)

Digital data is clocked into up/down counters U473 to U476. thus the number clocked in represents a controlled time period for the counters to count down. The output data stream is applied to a sample and hold circuit and applied via controlled switching, as an analog output to the appropriate output connector.

Sweep Drive Circuits

The sweep drive circuits provide three output signals

- Z_BLANK
- MARKER_TTL
- X_DRIVE

These signals can be used in oscilloscope, plotter and similar applications.

Z_BLANK

The Z_BLANK output voltage levels are TTL compatible. The signal goes low at the beginning of a single sweep. It goes high at the end of the sweep and remains high until the beginning of another sweep. During continuous sweep Z_BLANK is low during sweep up and high during sweep down.

The Z_BLANK output circuit is capable of sinking current through a relay. The maximum ratings are:

- maximum current sink 200 mA fused at 2.5 A
- allowable voltage range 0 V to +45 V DC
- maximum power 1W (voltage at output x current).

MARKER_TTL Output

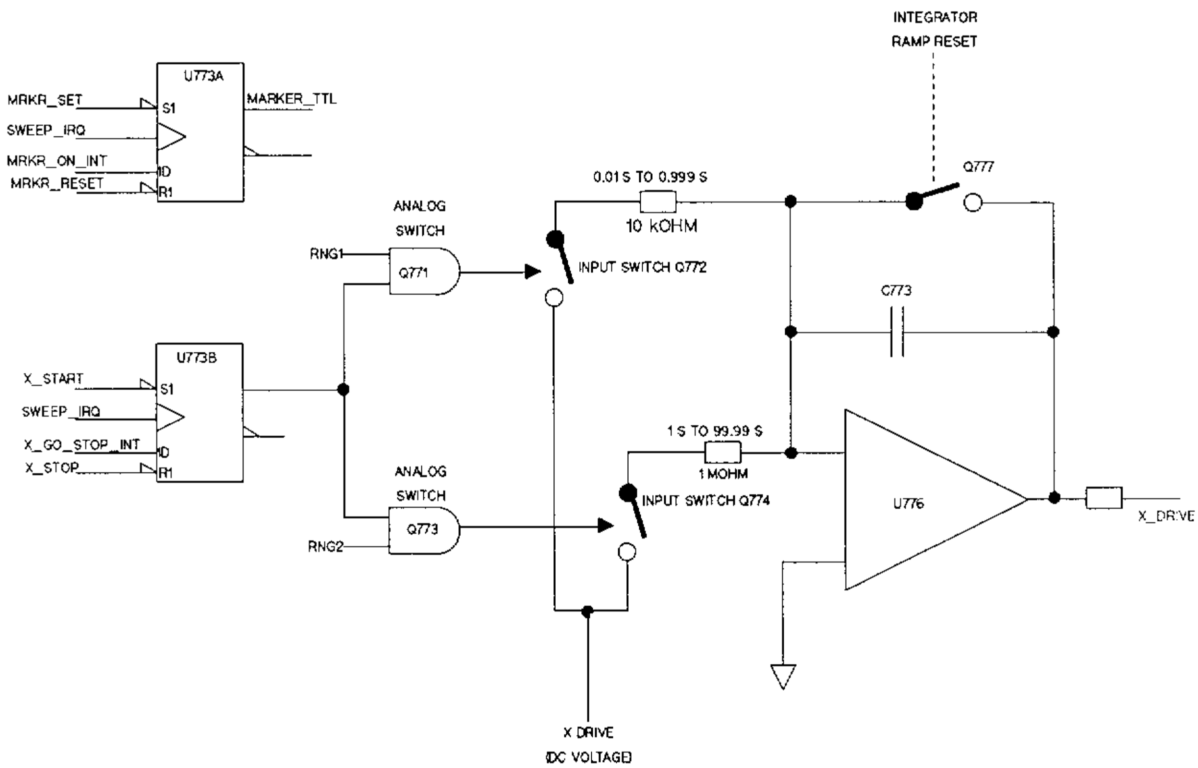


Figure 5-15. MARKER_TTL and X-DRIVE Circuits

A MARKER_TTL output pulse occurs only during linear sweep up during either single or continuous sweep. The flip-flop (U773A) producing this output is shown in Figure 5-15. The output is preset high by MRKR_SET going low at the start of a sweep and cleared by the MRKR_RESET input going low. When both MRKR_SET and MRKR_RESET are inactive (high) the output is set high by MARK_ON_INT going high at the rising edge of SWEEP_IRQ. The truth table is given in Table 5-3.

Table 5-3. Marker Flip-Flop Truth Table

MRKR_SET	MRKR_RESET	SWEEP_IRQ	MRKR_ON_INT	Output
L	H	X	X	H
H	L	X	X	L
L	L	X	X	H*
H	H	▲	H	H
H	H	▲	L	L
H	H	L	X	Qo

* this configuration is non-stable. ▲ rising edge

X_DRIVE

The output of the X-DRIVE Start/Stop flip-flop (U773B) is preset high by X_START going low at the start of a sweep and cleared by the X_STOP input going low. When both X_START and X_STOP are inactive (high) the output is set high by X_GO_STOP_INT going high at the rising edge of SWEEP_IRQ. The truth table is given in Table 5-4.

Table 5-4. X Drive Start/Stop Flip/flop Truth Table

X_START	X_STOP	SWEEP_IRQ	X_GO_STOP_INT	OUTPUT
L	H	X	X	H
H	L	X	X	L
L	L	X	X	H*
H	H	▲	H	H
H	H	▲	L	L
H	H	L	X	Qo

* this configuration is non-stable. ▲ rising edge

The X_START signal remains low until just before the end of the sweep. This prevents the SWEEP_IRQ pulse that sets the marker flip-flop from also changing the output of the X-drive flip-flop. The marker frequency and stop frequency points must be separated by approximately 400 μs to allow enough time between the two sweep-limit flags to return the START signal high and process the information for the stop frequency.

Depending on which range signal (RNG1/RNG2) is high, the high output from the Start/Stop flip-flop (U773B) is used to turn on one of two analog switches. RNG1 is high for sweep times of 0.01 s to 0.999 s; RNG2 is high for sweep times of 1 s to 99.99 s. As illustrated in Figure 5-15, each analog switch turns on a switch for the duration of the sweep. This provides current to an integrator whose output is the X_DRIVE ramp. The value of the current to the integrator depends upon the X_DRIVE analog voltage and the resistance in the integrator input circuit. These resistances are fixed at 9.1 kΩ for RNG1 and 925 kΩ for RNG2. The X_DRIVE voltage is supplied by the Digital-to-Analog Converter (DAC) and the Sample/Hold circuits. This voltage is calculated by the control circuits to provide the necessary current to increase the X_DRIVE output ramp from 0 V to +10 V during the sweep time selected.

Following a single sweep, the X_DRIVE ramp remains at 10 V until reset prior to the start of another sweep. During continuous sweep, the ramp is reset at the start of sweep down. The reset switch is a FET (Q777) connected across the integrator capacitor (C773). The ramp reset pulse is initiated at the correct time by the control circuits.

High Stability Frequency Reference Option 001, A9

The Crystal Oven (Frequency Reference) Board has its own +15 V dc regulator circuit to supply the crystal module. The crystal is temperature controlled, with an internal adjustment screw. Access to the adjustment is reached via a cover screw. A 10 MHz output signal is supplied to the rear panel of the instrument via an impedance matching circuit.

High Voltage Output Option 002, A11

The high voltage output amplifier is non-inverting and has a gain of two. It has been designed to operate over a bandwidth of 0 to 1 MHz. The output is current protected by a 0.25 A fuse, and voltage protected by diodes at the +30 V and −30 V supplies. Output resistance is zero. The +30 V and −30 V regulators which supply power to this amplifier are part of the option. Input power for these supplies is from a separate winding on the instrument power transformer; thus these supplies are active any time AC power is supplied to the instrument.

Phase Calibration Option 003 (Slave), A12

When (Phase Cal) is selected on the slave instrument, the main output signal is removed from the front or rear output and re-directed to the A12 board. If high voltage output is selected K101 switches the signal through an attenuator. If the frequency is < 100 Hz then the frequency is set to 100 Hz for phase calibration.

A TTL signal is sent to the master instrument from CAL OUT and the master responds by re-directing its output signal to the PHASE CAL IN input on the slave instrument.

The two output signals are then phase-compared on the A12 board. The phase comparator circuits produce a pulse train from U105B which has a duty cycle of 50% when the signals are exactly 180° out of phase. The microprocessor adjusts the slave's frequency until this is achieved and then adds an adjustment factor to obtain 0° phase difference. For each measure/adjust iteration K102 is used to swap the signal paths through the comparator circuits on A12. This ensures that any timing differences between the components are averaged.

The CAL OUT signal to the master is then removed and the main signal output returns to normal. The output signals from the rear output connectors of the two instruments are now in phase.

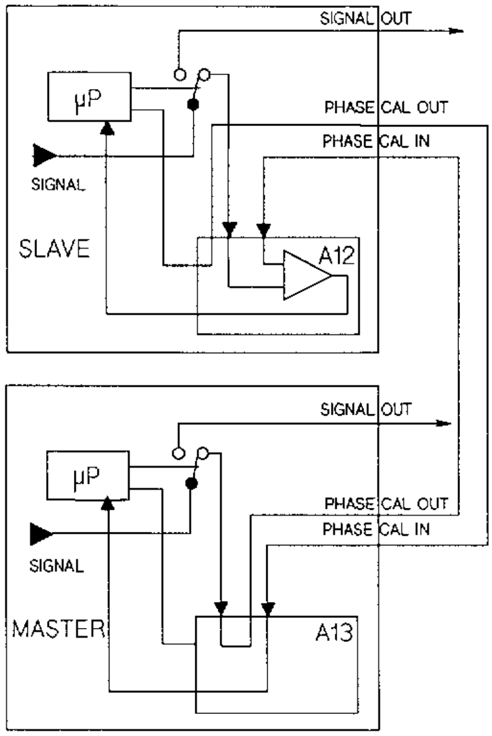


Figure 5-16. Phase Calibration, simplified block diagram

Phase Calibration Option 004 (Master), A13

When a TTL signal is received at the CAL IN input on A13 from the slave instrument, the master microprocessor is interrupted. The main output signal is removed from the front or rear output and re-directed to the A13 board. If high voltage output is selected K201 switches the signal through an attenuator. If the frequency is < 100 Hz then the frequency is set to 100 Hz for phase calibration. The output signal leaves A13 from CAL OUT and connects to the slave via PHASE CAL OUT on the master and PHASE CAL IN on the slave.

When the CAL IN signal is removed, the microprocessor returns the instrument to normal operation. The main signal output via the rear connector is now in phase with the slave instrument's output.

Troubleshooting

Self Test

The instrument always carries out a self-test after it is switched on. A standard self-test can also be started by a remote controller or from the keyboard, and an extended self-test is available from the keyboard.

Standard self-test: Manual selection

- Press [Local] key
- Press [Utils] key
- Press the [▲] key successively until *self test std/all* is displayed
- Press the [▶] key so that the underline is below *std*
- Press [Select]

The instrument enters a shortened self-test routine, during which *HP 3324A self test* is displayed. When the test ends, the instrument is placed in the standard reset condition.

Standard self-test: Remote selection

- Using the computer, send the following command string to the instrument:

  `OUTPUT 717;"TE"`
  where 7 is the instrument code, and 17 is the instrument bus address

Extended self-test

The extended self-test is only available from the keyboard. The extended self-test consists of the full "switch-on" self-test followed by an interactive keyboard test.

- Press [Local] key
- Press [Utils] key
- Press the [▲] key successively until *self test std/all* is displayed
- Press the [▶] key so that the underline is below *all*
- Press [Select]

The instrument first lights all possible displays on the panel. After a pause the display goes blank and then, *LED ON* is displayed. The green led above the output socket should be illuminated. When it extinguishes, *LED OFF* is displayed.

After completing the "switch-on" self-test, the interactive keyboard test starts. *Keyboard Test* followed by *Press any key* are displayed. As soon as you press a key the display blanks and the instrument is waiting for you to press another key.

Note If no key is depressed the test aborts after a short time delay.

As each key is pressed in turn, the display identifies it. You may test all keys.

Press "Signal On/Off" to end the manual test.

The instrument then exercises each relay whilst the display identifies the relay.

At the end of the test, the instrument retains its previous parameter settings.

Note Do not switch off the instrument whilst self test is running. Always press (Signal On/Off) to end the test correctly.

Fault Reporting on the Frontpanel

Note The following self-test errors apply to ROM software revision 3.12

Memory Test

RAM-TEST FAILED	RAM failure.
ROM-TEST FAILED	ROM failure.
MEMORY LOST	Corrupt data settings found, all data reset to default values

MFP Test

ERROR MFP U	Multi-function peripheral IC failed USART test.

Device bus Test

ERROR DB TRANS	Device bus transmitter failure.
ERROR DB REC	Device bus receiver failure.
ERROR DB READ	Device bus data read failed.
ERROR DB W-R	Device bus data write/read compare failed.

Display Test

DIS1-TEST FAILED	Display Busy line-test failed (J10(13)DISRDY).
DIS2-TEST FAILED	Display Busy line-test failed (J10(13)DISRDY).

DAC Test

DAC-TEST ERR 1	USART (device bus) test failed.
DAC-TEST ERR 2	DAC active signal still low 1 ms after starting D-to-A coversion.
DAC-TEST ERR 3	DAC counter test failed

Keyboard Test

KEY1-TEST FAILED	General error message, followed by more detailed message:
ERR KEYB1 I	Interrupt busy line-test failed.
ERR KEYB1 K	Input line active (key pressed).
ERR KEYB1 IK	Interrupt busy line-test failed and input line active.
ERR KEYB1 KK	Two or more lines are busy (more than one key pressed).
ERR KEYB1 I KK	Interrupt busy line-test failed and two or more lines active

Fractional-N IC Test

FRCN-ERR R/W (1)	Write and read of Fractional-N registers failed.
FRCN-ERR R/W (2)	Write and read using another value failed.
FRCN-ERR ADD (1)	Fractional-N adder failed
FRCN-ERR ADD (2)	Fractional-N adder failed with different values.
FRCN-ERR SWE (1)	Fractional-N sweep-limit output interrupt failed.

VCO Test

VCO-ERR 30MHZ	VCO unlocked at 30 MHz.
VCO-ERR 60MHZ	VCO unlocked at 60 MHz.

Sweep-timer Test

SW-TM-IRQ FAILED	Sweep-timer interrupt request failed.
SW-TIM-ERR CLOCK	Sweep-timer clock failed.

Offset Test

OFFS-TEST FAILED	Offset DAC test failed.

Amplitude Calibration Test

AC fail - 1	Level flip-flop defect.
AC fail - 2	Low level not achieved.
AC fail - 3	Stuck at low level.
AC fail - 4	High level not achieved.
AC fail - 5	Stuck at high level.
AC fail - 6	Output range 1 - 10 V cannot be achieved with the calculated calibration factors.
AC fail - 7	DC failed.

Fault Reporting on the Controller

The instrument's fault status is available to the controller using the ISE system error query. The failure number returned is coded as follows:

System Failure Number	System Failure Description
1	Amplitude calibration failed
2	Phase calibration failed
3	External reference unlocked
4	Main oscillator unlocked
>4	Self-test failed

To decode the self-test failure (failure number > 4), subtract 5 from it and treat the result as a set of binary fault-flags:

Bit	Self-test Failure Description
0	Memory test failed (ROM=signature test)
1	MFP (MC 68901) Test failed
2	Device bus test failed
3	Display test failed (display handshake)
4	DAC test failed (analog voltage generation)
5	Fractional-N IC test failed
6	VCO test failed
7	Sweep timer test failed
8	Offset test failed

General Fault Finding

ATTENTION
Static Sensitive

The HP 3324A boards have CMOS components that are susceptible to damage by static electricity discharge. Ensure standard ESD grounding precautions are used whilst you are working on the instrument.

Access

To remove the top cover proceed as follows:

- Switch off the instrument and disconnect the mains power cable.
- Remove the two carrying handle screws and the handle.
- Remove the four rear feet from the instrument.
- Remove the single central fixing screw on the top rear edge of the cover.
- The top cover can now be lifted clear of the instrument case. Procedures for removing and refitting the sub-assemblies are given later in this chapter.

Caution The HP 3324A firmware is either contained in two 24-pin 64kbyte ROMs, or in one 28-pin 128kbyte ROM. If you replace the instrument's firmware with a different type of ROM-set to that originally fitted, you MUST reconfigure the links R1 - R6, otherwise the instrument will not run and the ROM(s) may be damaged.

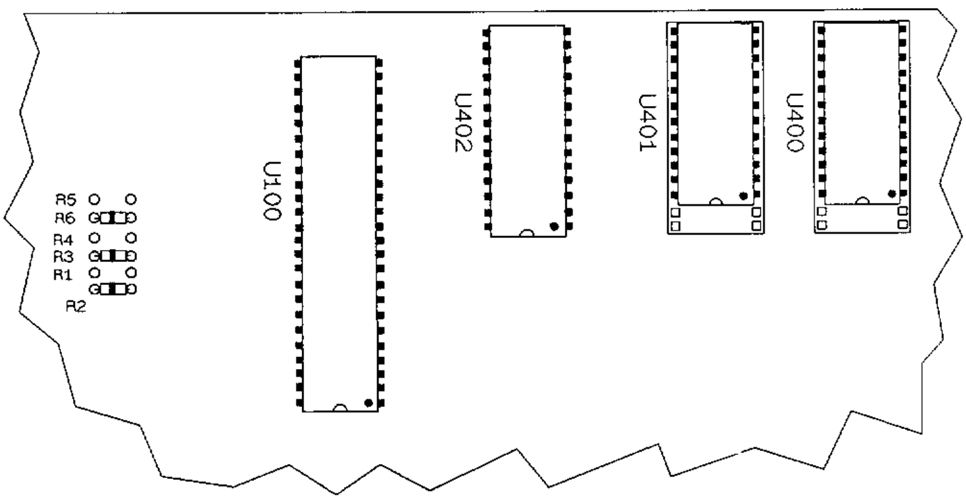


Figure 5-17. Twin 64kbyte ROM firmware configuration

Figure 5-17 shows the twin ROM configuration. Note that pin 1 of each ROM is fitted to pin 3 of each 28-pin IC socket and links R2, R3 and R6 are made.

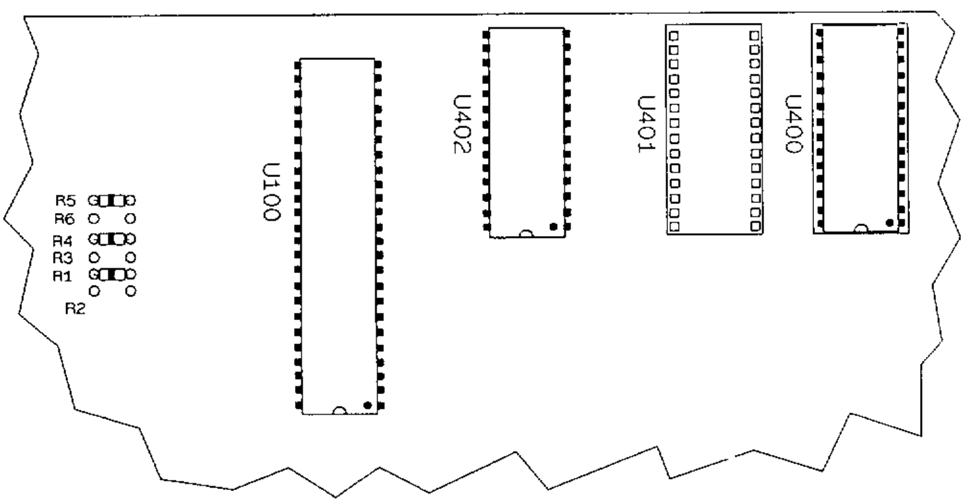


Figure 5-18. Single 128kbyte ROM firmware configuration

Figure 5-17 shows the single ROM configuration. Note that IC socket U401 is unused and links R1, R4 and R5 are made.

Make sure all boards, cables and connectors are firmly seated and that flat cables are properly aligned in their connectors. Ensure that integrated circuit packages that are not soldered to the circuit boards, such as the microprocessor and ROMs, are securely mounted in their sockets. Look for overheated components (brown burn marks).

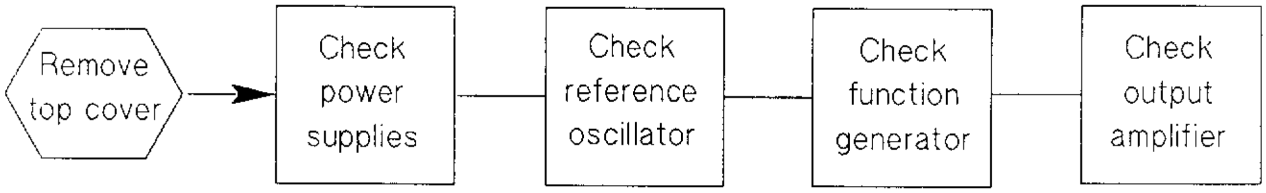
Note the error message(s) provided by the self test routines.

Diagnosis

Symptoms	Possible Trouble Area
No front panel display	Check power supplies and connections from the microprocessor board
Display or keyboard faults	Keyboard
Abnormal display (partial characters etc.	Microprocessor board
Display is normal but no response to keyboard	Microprocessor board
Control problems or instrument locks up	Microprocessor board
Instrument accepts manual but not programmed instructions	HP-IB interface/connections, or controller
Instrument accepts inputs but has no signal or sync outputs	Output amplifier
Output amplitude incorrect for all	Output amplifier
No signal out but sync output correct	Attenuators
Instrument will not sweep	÷N circuit
X-drive, marker etc incorrect	Sweep circuits & X-drive integrator
When ext ref or opt 001 connected to REF IN, *Ext ref* does not light or flashes	30 MHz oscillator, sine modulator
Output frequency incorrect	30 MHz oscillator, sine modulator
No AUX OUT or incorrect	VCO
Display reads *Osc Fail*	VCO
Osc Fail lights but VCO ok.	Microprocessor board

Fault Finding Checks

Checkout the signal board in the following order



Power Supply Check

Test and adjustment procedures for the power supplies are given in Chapter 5 *Adjustments.* If a low voltage reading cannot be corrected with the appropriate potentiometer, check the no-load voltage by disconnecting the supply cables to other parts of the instrument.

Check the +5V microprocessor supply as follows:

1. Connect the DVM to **TP403** with the common to **TP402** (ground).
2. Check that the reading is +5V to +5.1V.
3. There is no adjustment. Should the voltage be below +5V, disconnect the microprocessor board and check the +5V again without a load.

Reference Oscillator Check

1. Connect *Ref Out* to the input channel of the oscilloscope.
2. Measure the instrument output as 1MHz into 50Ω. Amplitude should be approx. 700mV.

If this check passes, do the PLL check:

PLL Check

The PLL circuit requires two equal inputs of 100 kHz, one is the reference signal and one is generated by the FRAC-N chip. These can be checked as follows:

1. Set the oscilloscope to AC input 0.2V per division.
2. Using a 1:1 probe, measure 100kHz approx 620mV amplitude at pins 5 (ref) and 6 of U603 (See Figure 5-19).

The waveforms must be identical, with no glitches etc.

Functional Generator Check

This check may be carried out by isolating the circuits using the jumpers on the circuit board provided for this purpose.

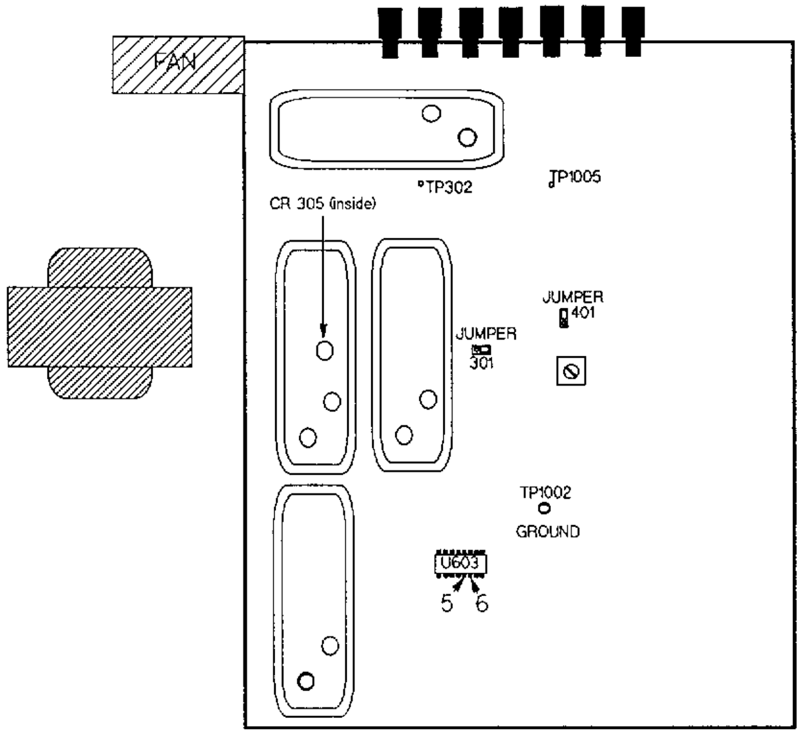


Figure 5-19. Component and Monitor Positions

1. Set the instrument output to SINE WAVE 1kHz 10 V AMPLITUDE.
2. Set **J301** to it's left (test) position to isolate the function generator circuit.
3. Measure the input signal (now isolated) at **J301** with the scope set to 1V AC input. You should see a 1kHz sine wave with a 1.8V offset.
4. Set **J301** to it's right (normal) position.
5. Move **J401** to it's front (test) position and measure the sine wave again. You should see the same waveform amplitude (400mV) with an offset of 5V.
6. Replace **J401** in it's rear (normal) position.

Amplifier Check

The previous checks ensure that the correct signal is entering the output amplifier. Possible causes of a missing amplifier output measured at the front panel are as follows:

- Mixer diode CR305 is blown. This results in no sine or triangular output. The component is a matched diode. Monitor it with the oscilloscope, between **TP302** and TP1005 (ground) for a 20 MHz signal.
- An over limit signal has been applied to the external input and fuse **F701** has blown.

Both the above components are very delicate and may only be replaced by a skilled technician.

Caution

Replacement components can be damaged during pre-forming.

Damage can be caused to the board and adjacent components by using an incorrectly rated soldering iron.

CR305 is under a screening cover that can only be removed after the Signal Source Board A6 has been removed.

For the reasons stated above, **HP recommend board exchange, rather than field repair.**

Removal and refitting procedures

Once the instrument top cover is removed, all sub-assemblies and boards of the HP 3324A are accessible.

Tools

The following tools are needed to dismantle the instrument:

- A medium sized posidrive type screwdriver (not philips type).
- A small to medium size flat bladed screwdriver.
- A 1/2 inch (13mm) box wrench.
- Pliers.
- Container for small parts such as loose screws.

All circuit boards are fitted into the case in the same manner. The boards have slotted holes which fit over support pillars, the board is then pushed to one side about 1/4 inch (0.5cm) so that the pillars support the board and are engaged securely in the narrow slot of the hole.

Caution

Whenever you move a board, make sure it is refitted correctly to **ALL** it's support pillars.

Removing the Power Supply Board, A2

Caution

If you are exchanging/replacing the A2 board, or the cable connecting it to the Signal Source board A6, you must check that the connector A2J2 is correctly fitted for use with your cable. Early instruments have a cable-bundle connecting A2 and A6; later instruments have a ribbon-cable.Figure 5-20 shows the two possibilities:

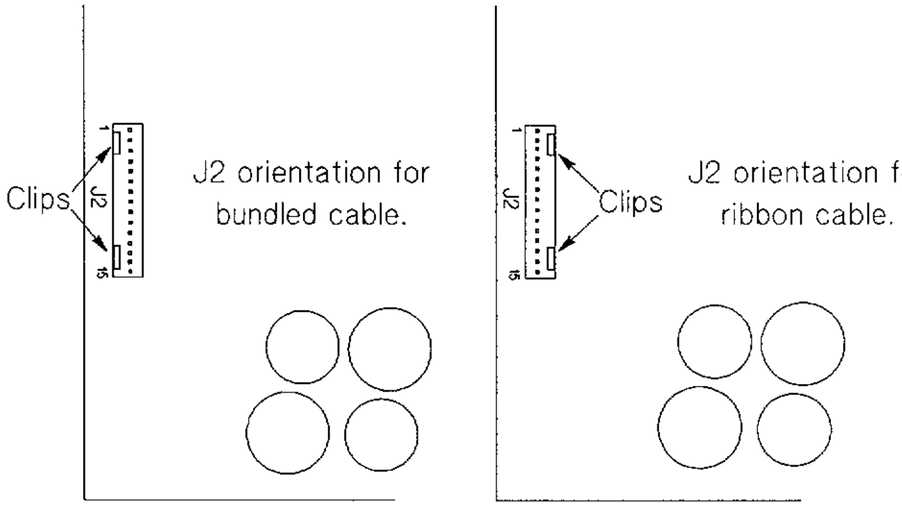


Figure 5-20. Connector A2J2 orientation.

If necessary, remove connector J2 and re-solder it to the board with the correct orientation.

1. Make sure that the power cable has been removed from the instrument.
2. Remove the four cable connectors.
3. Set the STANDBY switch to on and using the flat blade screwdriver, carefully prise the switch operating rod away from the white front-end of the switch (insert the blade and twist).
4. Remove the single fixing screw at the front right corner of the board.
5. Slide the board rearwards until it is free from the support pillars.
6. Lift the board rear end first so that the board can be brought out clear of the instrument.
7. Refit is the reverse procedure, taking care to engage the switch operating rod in the front panel hole first and ensuring that it is clipped securely to the switch after the board has been fitted to it's support pillars.

Removing the Microprocessor Board, A4

1. Remove the four cable connectors.
2. Remove the single fixing screw at the right hand bottom corner of the board.
3. Slide the board to the left until it is free from the support pillars.
4. Lift the board out clear of the instrument.
5. Refit is the reverse procedure.

Removing the Signal Source Board, A6

1. Remove the ribbon cable connector from the microprocessor board.
2. Remove the board power supply cable from the power supply board but leave the cable connected to the board.
3. Note the colour and positions of the miniature coax SMC connectors on the board and then disconnect them.
4. Remove the fixing nuts, lock washer, plain washer and insulating washer from each BNC connector of the rear panel bottom row.
5. Remove four fixing screws from the rear edge of the board and one screw from the front edge.
6. Slide the board forwards until it is free from the support pillars.
7. Lift the board front end first so that the board can be brought out clear of the instrument

Refitting is slightly different:

1. Engage the rear BNC connectors in their rear panel holes as the board is carefully slotted onto **ALL** support pillars.

Note Take care to ensure that the power supply ribbon-cable is correctly located under the board. Early instruments have a bundle of cables fitted instead of a ribbon-cable, this runs over the top of the board.(See also "Removing the Power Supply Board A2").

2. Fit washers and nut in the correct order to the BNC connectors and fully tighten

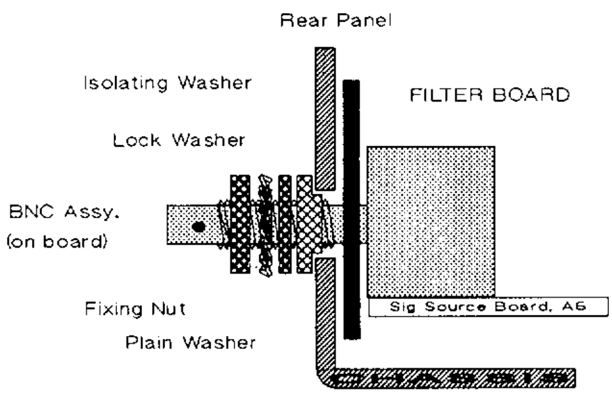


Figure 5-21. Lower set of BNC Connectors

3. Fit board fixing screws (five).
4. Connect all cables and route them neatly.

Removing Option Boards

The same principle should be adopted for removing option boards. Each is secured by one fixing screw only. Make sure that you note the location and sleeve color of each cable before removing it from a board. Refer to the installation instructions given in Chapter 2 if necessary.

A

Manual Changes

Introduction

This appendix contains information for correcting errors and updating this manual.

At the time of print there are no changes.

HEWLETT PACKARD

MANUAL CHANGES July, 98

Manual for Model Number	3324A
Manual printed on	October 1990
Manual Part Number	03324-90001

Make all ERRATA corrections.

Check the following table for your instrument serial prefix/serial number/EDC and make the listed changes to your manual

New Item

Serial Prefix or Serial Number	Manual Changes
ERRATA	
3009G00806	1
3009G02706	2

INDEX OF MANUAL CHANGES

MANUAL CHANGE	FRAME
ERRATA	
1	W4,5
2	MP30

ERRATA

On Page 1-9, General Information (Specifications)

Frequency Sweep
.
.
Linear Sweep (settable for each interval)
.
.
ADD: Minimum sweep rate: 0.2 Hz/sec.

On Page 2-9, Installation
step 6: change to read:

...Refer to Fig. 2.7

On Page 2-10, Installation
step 8: change to read:

...Refer to Fig. 2.7

On Page 4-1, Replaceable Parts, change to read:

Introduction
.
.
Repair philosophy .... However Appendix B ....

Performance Test

Triangle Linearity

Page 12-37 in the 03324-90011 Manual
Page C-26 in the 03324-90001 Manual

step 13:
change to read:
.
.
.
$y=a_1x+a_o$

step 14:
change to read:

For each delay (x), subtract the calculated voltage (y') from the measured voltage (y) [$y-y' = \Delta y$]. Find the largest positive or negative voltage difference (Δy max). Using the following Formular, computer the % linearity:

% linearity = ($|\Delta_y$ max | / 4 Volt) x 100%

Performance Test

Amplitude Accuracy

Page 12-24 and 12-49, in the 03324-90011 Manual

Page C-18 and C-39, in the 03324-90001 Manual

step 32, or Test Record List

change to read:

Amplitude 1 V New Limits!
DC Oddset 1 mV

Test	Freq	Function	Minimum	Maximum
13	99.9Hz	Square	0.958 V	1.042 V
15	99.9Hz	Triangle	0.953 V	1.047 V
18	99.9Hz	+ Ramp	0.953 V	1.047 V
19	99.9Hz	- Ramp	0.953 V	1.047 V
21	1kHz	Square	0.958 V	1.042 V
22	2kHz	Triangle	0.953 V	1.047 V
23	500Hz	+ Ramp	0.953 V	1.047 V
24	500Hz	- Ramp	0.953 V	1.047 V
25	100kHz	Square	0.880 V	1.120 V
26	10kHz	Triangle	0.918 V	1.082 V
27	10kHz	+ Ramp	0.868 V	1.132 V
28	10kHz	- Ramp	0.868 V	1.132 V

Specifications

page 1-8 in the 03324-90001 manual

DC Offset

change to read:
Accuracy:

a) DC only:

DC Offset Range	Accuracy
1.5000 V to 5.0000 V	+/- 50 mV
0.5000 V to 1.4999 V	+/- 17 mV
0.0150 V to 0.4999 V	+/- 5 mV
0.0500 V to 0.1499 V	+/- 1.7 mv
0.0150 V to 0.0499 V	+/- 0.52 mV
0.0050 V to 0.0149 V	+/- 0.19 mV
0.0015 V to 0.0049 V	+/- 0.07 mV
0.0005 V to 0.0014 V	+/- 0.037 mV

The accuracy given to each range is the same for each value in this range.

b) DC + AC, → < 1 MHz:

Sinewave + Squarewave

Amplitude Range	Accuracy
1.0000 V to 10.0000 V	+/- 60 mV
0.3000 V to 0.0000 V	+/- 20 mV
0.1000 V to 0.2999 V	+/- 6 mV
0.0300 V to 0.0999 V	+/- 2 mV
0.0100 V to 0.0299 V	+/- 0.6 mV
0.0030 V to 0.0099 V	+/- 0.2 mV
0.0010 V to 0.0029 V	+/- 0.06 mV

The accuracy given to each range is the same for each value in this range

Ramp + Triangle, upto 11 kHz

Amplitude Range	Accurancy
1.0000 V to 10.0000 V	+7- 120 mV
0.3000 V to 0.9999 V	+/- 40 mV
0.1000 V to 0.2999 V	+/- 12 mV
0.0300 V to 0.0999 V	+/- 4 mV
0.0100 V to 0.0299 V	+/- 1.2 mV
0.0030 V to 0.0099 V	+/- 0.4 mV
0.0010 V to 0.0029 V	+/- 0.12 mV

The accuracy given to each range is the same for each value in this range.

c) DC + AC, → < 1 MKz

Sinewave up to 21 MHz

Squarewave up to 11 MHz

Amplitude Range	Accuracy
1.0000 V to 10.0000 V	+/- 150 mV
0.3000 V to 0.9999 V	+/- 48 mV
0.1000 V to 0.2999 V	+/- 15 mV
0.0300 V to 0.0999 V	+/- 4.8 mV
0.0100 V to 0.0299 V	+/- 1.5 mV
0.0030 V to 0.0099 V	+/- 0.49 mV
0.0010 V to 0.0029 V	+/- 0.15 mV

The accurancy given to each range is the same for each value in this range.

Section: General Information

Add: on page 1-3, after "Tools and Test Equipment:

<u>Recalibration, cleaning and lubrication</u>

The Performance Tests should be performed at 12-month intervals, if necessary using the adjustment procedure described in Chapter 3 in this manual should any of the performance tests fail.
At the same intervals the instrument should be inspected mechanically and for cleanliness. Dust is best removed with a small vacuum cleaner or finebrush. Accumulation of dirt on the front panel or covers can be removed with a soft cloth if necessary slightly moistened with water.

The instrument requires no lubrication.

on page 1-14, General Characteristics

add: Calibration cycle: 12 months recommended

page 3-7, Adjustments

Amplitude

Negative setting

change to read:

step 9: ... Specification requirement is -10V +/- 0.2V.

Positive setting

change to read:

step 2: ... Specification requirement is 10V +/- 0.2V.

page Contents-4, Table of Contents

add after line "General Fault Finding":

Access - Cover Removal 5-27

page 5-27, General Fault Finding:

change the heading "Access" to read:

Access - Cover Removal

page 5-32, Service

removal and refitting procedure

add: Cover removal is described on page 5-27, Access - Cover Removal.

page 4-1, Replaceable Parts

Introduction

change to read:

... However Appendix B to this manual is reserved for an optional information package, CLIP p/n 03324-90031, which contains a full parts listing and schematics for those customers who require it.

In Table 4-2, Page 4-5, add the following lines after the linebegining "MP28":

MP29	Screw M M3X0.58 mm	0515-0897
	Securing screw for board assemblies.	

Page 1-14 add:

Declaration of Conformity

(similar to ISO/IEC Guide 22)

Manufacturer: Hewlett-Packard GmbH
Boeblingen Instruments Division
Herrenberger Str. 130
D-71034 Boeblingen Germany

We declare that the product

HP 3324A Function/Sweep Generator

conforms to the following standards:

Safety: IEC 348 (1978)

EMC: EN 55011 (1991)/CISPR 11 Group1, Class B
EN 50082-1 (1991)
IEC 801-2 ESD: 4kV cd, 8kV ad
IEC 801-3 Radiated Immunity: 3V/m
IEC 801-4 Fast Transients: 0.5kV, 1kV

Supplementary Information:

During the measurements against EN 55011, the I/O ports were terminated with their nominal impedance, the HP-IB connection was terminated with the cable HP 10833B. When the product is connected to other devices, the user must ensure that the connecting cables and the other devices are adequately shielded to prevent radiation.

Boeblingen, 29th April 1993
Robert Hofgaertner
Quality Assurance Manager

Page C-17, Performance Tests

change to read:

.

.

Test	Frequenz	Function	Minimum	Maximum
25	101kHz	Square	2.850 V	3.150 V

.

.

Page C-38 Test Record

Amplitude: 3 V (p-p)
change to read:

.

.	Min	Measured	Max
Square, 101kHz	2.850 V	-------	3.150 V

.

.

page 1-14 Operating Environment:
add errata:
Altitude up to 2000m
Installation Category II
Pollution Degree 2
Warning: To prevent electrical shock, disconnent the HP model 3324A from mains before cleaning. Use a dry cloth or one slightly dampened with water to clean the external case parts. Do not attempt to clean internally.

===

! CHANGE TO NEW SERIAL NUMBER FORMAT !

last serial number old format	3009G02755
first serial number new format	DE30202756

===

MANUAL CHANGE 1

On Page 4-6, change the Table of Replaceable Parts to read:

W4	03324-61601	CBL AY PWR SS
W5	03324-61602	CBL AY PWR UC

MANUAL CHANGE 2

On Page 4-4 Repl.Parts, Table 4-2 add:

MP30	7121-5585	Ce-Label

B

Component Level Information Package

Introduction

The component level information package (CLIP) contains:

1. Circuit schematics for each electrical assembly.
2. Parts list for each electrical assembly.
3. Component layout and locator table for each electrical assembly.

The CLIP for the HP 3324A must be ordered seperately.

C

Performance Tests

Introduction

The procedures in this appendix test the performance of the instrument. The complete specifications to which the HP 3324A is tested are given in Chapter 1 and in each test. All tests can be performed without access to the interior of the instrument.

Test Equipment

Equipment required for the performance tests is listed in Table C-1. Recommended Test Equipment. Any equipment which satisfies the critical specifications given in the table may be substituted for recommended models.

Test Record

Results of the performance tests may be tabulated in the Test Records provided at the end of this chapter. It is recommended that you fill out the Test Record and refer to it while doing the test. Since the test limits and set-up information are printed on the Test Record for easy reference, the record can also be used as an abbreviated test procedure (if you are familiar with test procedures). The Test Record can also be used as a permanent record and may be reproduced without written permission from Hewlett-Packard.

Instrument Specification

Specifications are the performance characteristics of the instrument which are certified. These specifications, listed in Chapter 1, are the performance standards or limits against which the HP 3324A can be tested.

Any changes in the specifications due to manufacturing changes, design, or traceable to the National Bureau of Standards will be covered in a manual change supplement or revised manual. The specifications listed here supersede any previously published.

Performance Tests

The following are the performance tests for the HP 3324A:

Harmonic Distortion
Spurious Signal
Integrated Phase Noise
Ramp Retrace Time
Frequency Accuracy
Phase Increment Accuracy
Amplitude Accuracy
DC Offset Accuracy
DC Offset Accuracy with AC Functions
Triangle Linearity
Ramp Period Variation
Automatic Phase Calibration

Table C-1. Recommended Test Equipment

Instrument	Critical Specifications	Recommended Model
Analog Oscilloscope	Vertical Bandwidth: DC to 275 MHz Deflection: 0.01 to 5 V/div Horizontal Sweep: 10 ns to 0.5 s/div x10 Magnification Delayed Sweep	HP 1725A
Digitizing Oscilloscope	Vertical Bandwidth: 1 GHz with random repetitive sampling technique Timebase accuracy:0.002%	HP 54111D
Electronic Counter	Frequency measurement Time Interval Average A to B Frequency Range: to 100 MHz Resolution: 11 digits	HP 5370B
AC/DC Digital Voltmeter	AC Function (True RMS) Ranges: 10 mV to 1000 V Bandwidth: 1 Hz to 10 MHz Resolution: 4.5 digits minimum DC Functions Ranges: 10 mV to 1000 V	HP 3458A
50Ω Feedthru Termination	Accuracy: ±1% Power Rating: 2 W	HP 10100C
Spectrum Analyzer	Frequency Range: 20 Hz to 40.1 MHz Spurious Responses: 80 dB below reference	HP 3585B
Double Balanced Mixer	Impedance: 50Ω Frequency Range: 1 – 20 MHz	HP 10534A
1 MHz Low Pass Filter	Cut-off Frequency: 1 MHz Stopband Atten: 50 dB by 4 MHz Stopband Freq: 4 – 80 MHz	Model J903, TTE Inc. 2214 S. Benny Ave. Los Angeles, CA 90064

Table C-1. Recommended Test Equipment (continued)

Instrument	Critical Specifications	Recommended Model
15 kHz Filter	Consisting of: Resistor: 10 KΩ 1% Capacitor: 1600 pF 5%	
AC Voltmeter	Ranges: 0.1 to 1 V Frequency Range: 20 Hz – 1 MHz Input Impedance: ≥1 MΩ Meter: Log scale Acc (100 Hz to 10 kHz): ±1%	HP 400FL/3400A
Sinewave Signal Source	Frequency: 20 kHz Amplitude: 10 V(p-p) into 50Ω	HP 3324A/3325B
DC Power Supply	Volts: 0 to ±5 V Amps: 10 mA Floating Output	HP 6214A/6214B
Thermal Converter	Input Impedance: 50Ω Input Voltage: 3 Vrms Frequency: 2 kHz to 20 MHz Frequency Response: ±0.05 dB 2 kHz to 20 MHz	HP 11049A/Ballantine Model 1395A-1 with cable 12577A Opt. 10 Ballantine Labs, Inc. P.O. Box 97 Boonton, NJ 07005
High-Speed DC Digital Voltmeter	DC Voltage: 0 to ±10 V External Trigger: Low True TTL Edge Trigger Trigger Delay: Selectable 10 to 140 μs	HP 3437A
Resistors:	20Ω 1/4 W 1% 30Ω 1/4 W 1% 50Ω 1/8 W 1% (475Ω 2 W 1%)	
Capacitor:	300 pF 5%	
BNC-to-Triax Adapter	Female BNC to Male Triax	HP 1250-0595
Adapter	BNC female to dual banana plug BNC Tee	HP 1251-2277 HP 1250-0781

Harmonic Distortion

This procedure tests the harmonic distortion of the HP 3324A sine wave output.

Specifications

Harmonic distortion (relative to fundamental)

Fundamental Frequency	No Harmonic Greater Than
0.1 Hz to 199 kHz	−60 dB
200 kHz to 1.99 MHz	−40 dB
2 to 14.9 MHz	−30 dB
15 to 20 MHz	−25 dB

Equipment Required

Spectrum Analyzer
50Ω Feedthru Termination
Resistor 475Ω 2W 1%
Resistor 50Ω 1/8W 1%
Capacitor 300 pF 5%

Procedure

1. Set the HP 3324A output as follows:

High-voltage	Output Off
Function	Sine
Frequency	20 MHz
Amplitude	999 mV(p-p)

2. Connect the signal output to the spectrum analyzer 50Ω input.
3. Set the spectrum analyzer controls to display the fundamental and at least four harmonics. Verify that all harmonics are at least 25 dB below the fundamental.
4. Set the HP 3324A to 15 MHz and verify that all harmonics are at least 25 dB below the fundamental.
5. Set the HP 3324A to the following frequencies and verify the specified levels, relative to the fundamental.

14.9 MHz	−30 dB
2 MHz	−30 dB
1.99 MHz	−40 dB
200 kHz	−40 dB

6. Set the HP 3324A frequency to 50 kHz and the amplitude to 9.99 mV(p-p).
7. Set the spectrum analyzer controls to display the fundamental and at least three harmonics. (It may be necessary to decrease the video bandwidth to separate the

harmonics from the noise floor.) Verify that all harmonics are at least 60 dB below the fundamental.

8. Set the HP 3324A to the following frequencies and verify that all harmonics are 60 dB below the fundamental.
   - 10 kHz
   - 1 kHz
   - 100 Hz

High-Voltage Output (Option 002)

Continued from the previous procedure.

1. Connect the HP 3324A signal output to the analyzer high-impedance input as shown in Figure C-1.

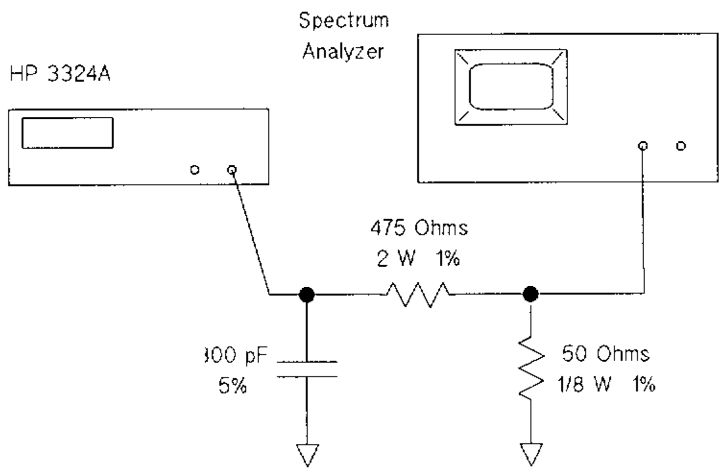


Figure C-1. Harmonic Distortion Verification Test Set-Up (High-Voltage Output)

2. Select the high-voltage output on the HP 3324A. Set the amplitude to 40 V(p-p) and the frequency to 100 Hz.
3. Set the spectrum analyzer controls to display the fundamental and at least three harmonics. Verify that all harmonics are 60 dB below the fundamental.
4. Set the HP 3324A to the following frequencies and verify that their harmonics are below the specified level, relative to the fundamental.

10 kHz	−60 dB
100 kHz	−60 dB
200 kHz	−40 dB
1 MHz	−40 dB

5. Turn off the high-voltage output.

Spurious Signal

This procedure tests the HP 3324A sine wave output for spurious signals. Circuits within the HP 3324A may generate repetitive frequencies that are not harmonically related to the fundamental output frequency.

Specifications

All spurious signals must be more than 55 dB below the fundamental signal or less than −85 dBm, whichever is greater.

Equipment Required

Spectrum Analyzer

Mixer Spurious Procedure

1. Connect the HP 3324A signal output to the spectrum analyzer 50Ω (RF) input and the HP 3324A EXT REF input to the analyzer 10 MHz reference output, as shown in Figure C-2.

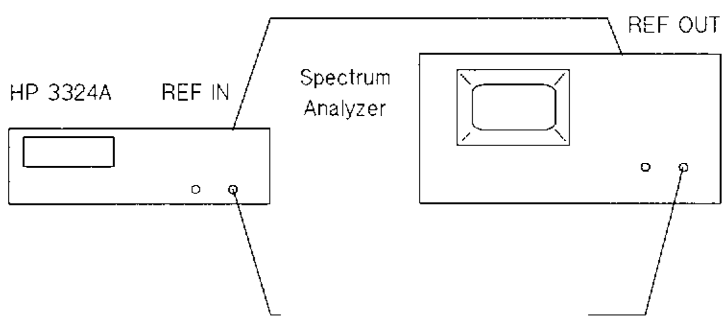


Figure C-2. Mixer Spurious Test Set-Up

2. Set the HP 3324A as follows:

Function	Sine
Frequency	2.001 MHz
Amplitude	63.24 mV(p-p)

3. Set the analyzer controls as follows:

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

4. Adjust the spectrum analyzer to reference the fundamental to the top display graticule.
5. Without changing the reference level, change the spectrum analyzer center frequency to 27.999 MHz to display the 2:1 mixer spur. Verify that this spur is at least 55 dB below the fundamental.

6. Change the spectrum analyzer center frequency to 25.998 MHz to display the 3:2 mixer spur. Verify that this spur is at least 55 dB below the fundamental.
7. In a similar manner, change the HP 3324A frequency and the spectrum analyzer center frequency to the following frequencies. For each setting, verify that all spurious signals are 55 dB below the fundamental.

HP 3324A	Spectrum Analyzer Center Frequency	
	2:1 Spur	3:2 Spur
4.100 MHz	25.9 MHz	21.8 MHz
6.100 MHz	23.9 MHz	17.8 MHz
8.100 MHz	21.9 MHz	13.8 MHz
10.100 MHz	19.9 MHz	9.8 MHz
12.100 MHz	17.9 MHz	5.8 MHz
14.100 MHz	15.9 MHz	1.8 MHz
16.100 MHz	13.9 MHz	2.2 MHz
18.100 MHz	11.9 MHz	6.2 MHz
20.100 MHz	9.9 MHz	10.2 MHz

Close-in Spurious (Fractional N Spurs) Procedure

This procedure continues from the previous one.

1. Set the HP 3324A to 5.001 MHz and the amplitude to 448.3 mV(p-p).
2. Set the spectrum analyzer controls as follows:

Center Frequency	5.001 MHz
Frequency Span	1 kHz
Video BW	100 Hz
Resolution BW	30 Hz

3. Adjust the spectrum analyzer to reference the fundamental to the top display graticule.
4. Without changing the reference level, change the spectrum analyzer center frequency to 5.002 MHz to display the API 1 spur. It may be necessary to decrease the video bandwidth to optimize the display resolution.
5. All spurious (non-harmonic) signals should be at least 55 dB below the fundamental.
6. Without changing the reference level, set the HP 3324A frequency and the spectrum analyzer center frequency to the frequencies listed in the following table. For each setting, verify that all spurious signals are at least 55 dB below the fundamental.

HP 3324A	Spectrum Analyzer Center Frequency
5.0001 MHz	5.0011 MHz
5.00001 MHz	5.00101 MHz
5.000001 MHz	5.001001 MHz
20.001 MHz	20.002 MHz
20.001 MHz	20.003 MHz
20.001 MHz	20.004 MHz
20.001 MHz	20.005 MHz

Integrated Phase Noise

This procedure tests the HP 3324A integrated phase noise.

Specifications

−50 dB for a 30 kHz band centered on a 20 MHz carrier (excluding ±1 Hz about the carrier).

Equipment Required

Frequency Synthesizer
Double Balanced Mixer
50Ω Feedthru Termination
AC/DC Digital Voltmeter
AC Voltmeter
15 kHz Noise Equivalent Filter
1 MHz Low Pass Filter

Procedure

1. Connect the equipment as shown in Figure C-3, connecting the 15 kHz noise equivalent filter output to the AC voltmeter. Phase lock the HP 3324A and the signal generator together.

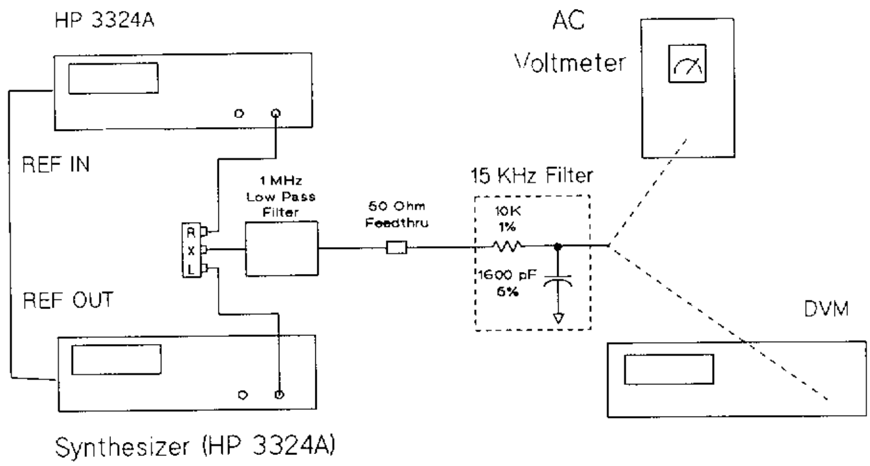


Figure C-3. Integrated Phase Noise Test Set-Up

2. Set the HP 3324A as follows:

Function	Sine
Frequency	19.901 MHz
Amplitude	632 mV(p-p)

3. Set the synthesizer (reference) as follows:

Frequency	19.9 MHz
Amplitude	1.416 V(p-p)

4. Record the AC voltmeter reading (dB scale).
5. Change the HP 3324A frequency to 19.9 MHz.
6. Connect the 15 kHz filter output to the digital voltmeter.
7. Press the HP 3324A (Phase) key. Using the modify keys, adjust the output phase for a minimum reading on the digital voltmeter.
8. Disconnect the 15 kHz filter output from the digital voltmeter and connect it to the AC voltmeter.
9. Record the AC voltmeter reading (dB scale) and subtract it from the reading recorded in step 4. The difference should be −44 dB or below. Add −6 dB to this number and enter on the Performance Test Record. The 6 dB is a correction factor compensating for the folding action of the mixer.

Note

Frequencies used minimize the phase noise contribution of the frequency synthesizer.

Ramp Retrace Time

This procedure tests the HP 3324A retrace time of the positive and negative slope ramps.

Specifications

≤3 μs 90% to 10%

Equipment Required

Digitizing Oscilloscope

Procedure

1. Connect the HP 3324A signal output to the oscilloscope vertical input. (If your oscilloscope does not have a 50Ω input, use a 50Ω feedthru termination at the input.)
2. Set the HP 3324A as follows:

High-Voltage Output	Off
Function	Positive Slope Ramp
Frequency	10 kHz
Amplitude	10 V(p-p)

3. 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. (Use the δt mode.)
4. Change the HP 3324A function to a negative slope ramp and repeat step 3 for the rising edge from the 10% to 90% points.

Frequency Accuracy

This procedure compares the accuracy of the HP 3324A output signal to the specification.

Specifications

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

Equipment Required

Electronic counter (calibrated within three months or with an accurate 10 MHz external reference input)

Procedure

1. Connect the HP 3324A signal output to the electronic counter channel A input with a 50Ω feedthru termination. Allow the HP 3324A to warm up for 20 minutes and the counters frequency reference to warm up for its specified period.
2. Set the HP 3324A output as follows:

High-Voltage Output	Off
Function	Sine
Frequency	20 MHz
Amplitude	0.99 V(p-p)
DC Offset	0 V

3. Set the counter to count the frequency of the A input with 0.1 Hz resolution, and adjust for stable triggering. The electronic counter should indicate 20,000,000.00 Hz ±100 Hz.
4. Change the HP 3324A frequency 10 MHz. Change the function to a square wave. The electronic counter should indicate 10,000,000.00 Hz ±50 Hz.
5. Change the HP 3324A frequency 10 kHz. Change the function to a triangle. Set the counter to average 1000 periods. The electronic counter should indicate 100,000.00 ns ±0.5 ns.
6. Change the HP 3324A function to a positive slope ramp. The electronic counter should indicate 100.000.00 ns ±0.5 ns.

Phase Increment Accuracy

This procedure compares the phase increment accuracy to the specification.

Specifications

±0.5°

Equipment Required

Frequency Synthesizer
Electronic Counter

Procedure

1. Connect the equipment as shown in Figure C-4.

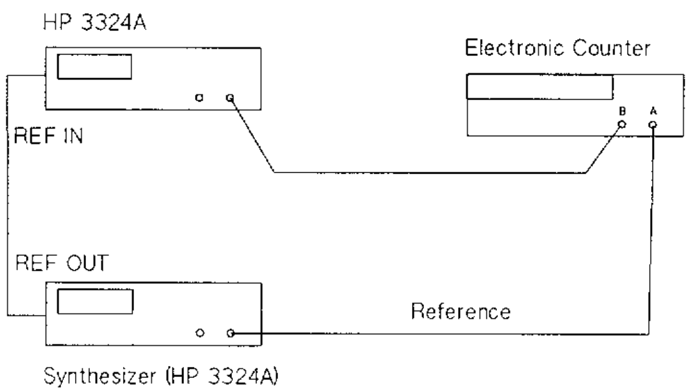


Figure C-4. Phase Increment Accuracy Test Set-Up

2. Set the HP 3324A as follows:

High-Voltage Output	Off
Function	Sine
Frequency	100 kHz
Amplitude	13 dBm

3. Set the synthesizer as follows:

Frequency	0.1 MHz
Amplitude	13 dBm

4. Set the counter as follows:

Function	Time Interval Avg A to B
Frequency	
Resolution, N	10^5
Inputs	50Ω, separate
Slope A and B	Positive
Sample Rate	Maximum

5. Press the HP 3324A [Phase] key to display phase. Using the modify keys, adjust the phase until the counter reads approximately 200 ns. Press the blue [Shift] key, and then the [Assign Phase 0] key.
6. Set the counter sample rate to hold, then reset the counter. Record the counter reading (to 2 decimal places) on the Performance Test Record in the space for Zero Phase Time Interval. This is the phase difference (in nanoseconds) between the HP 3324A output and the reference signal.
7. Set the HP 3324A phase to $-1°$.
8. Reset the counter. Record the counter reading (to 2 decimal places) in the space for 1° Increment Time Interval.
9. Determine the time difference between the counter readings in steps 8 and 6, and record in the Time Difference column. The difference should be $\pm 0.5°$.
10. Set the HP 3324A phase to $-10°$.
11. Reset the counter. Record the counter reading in the space for 10° Increment Time Interval.
12. Enter the time difference between the Zero Phase Time Interval and the reading in step 11 in the Time Difference column. This should be between $\pm 0.5°$
13. Set the HP 3324A phase to $-100°$.
14. Reset the counter. Record the counter reading in the space for 100° Increment Time Interval.
15. Enter the time difference between the Zero Phase Time Interval and the reading in step 14 in the Time Difference column. This should be between $\pm 0.5°$.

Amplitude Accuracy

This procedure tests the amplitude accuracy of the HP 3324A AC function output signals.

Specifications

See Chapter 1

Equipment Required

AC/DC Digital Voltmeter
High Speed Digital DC Voltmeter
50Ω, 0 – 12 dB (1 dB/step) Attenuator
50Ω Feedthru Termination
Thermal Converter
Analog Oscilloscope
Resistor 475Ω 2 W 1%
Resistor 50Ω 1/8 W 1%
Capacitor 300 pF 5%

Note For each new setting of the amplitude, press (Ampl Cal) to perform an amplitude calibration.

Amplitude Accuracy at Frequencies upto 100 kHz Procedure

1. **Sine wave Test.** Connect the HP 3324A signal output through a 50Ω feedthru termination to the AC digital voltmeter input.
2. Set the HP 3324A as follows:

High-Voltage Output	Off
Function	Sine
Frequency	100 Hz
Amplitude	3.536 Vrms (10 V(p-p))
DC Offset	0 V

3. Press the (Ampl Cal) key.
4. Read the AC voltmeter. Change the HP 3324A frequency to 1 kHz and 100 kHz and repeat. Verify that all three voltmeter readings are between 3.455 and 3.617 Vrms (±0.2 dB).
5. Change the HP 3324A amplitude to 1.061 Vrms (3 V(p-p)) and take AC voltage readings for 100 Hz, 1 kHz and 100 kHz as above. Verify that all three voltmeter readings are between 1.037 and 1.085 Vrms (±0.2 dB).
6. Change the HP 3324A amplitude to 0.3536 Vrms (1 V(p-p)) and set the DC offset to 1 mV. Set the HP 3324A frequency to 100 Hz, 1 kHz and 100 kHz, and read the AC voltage. Verify that all three readings are between 0.3370 and 0.3702 Vrms (±0.4 dB).
7. **Function Test.** Set up the equipment as shown in Figure C-5.

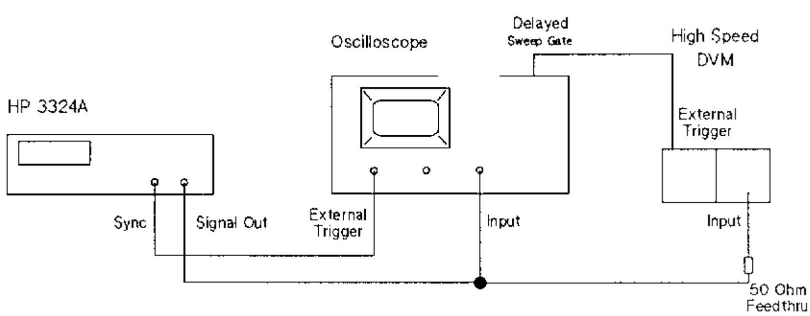


Figure C-5. Function Amplitude Accuracy Test Set-Up

8. Set the HP 3324A as follows:

High-Voltage Option	Off
Function	Square
Frequency	99.9 Hz
Amplitude	10 V(p-p)
DC Offset	0 V

9. Set the oscilloscope as follows:

Display	A or B
Vertical Sensitivity	2 V/div
Trigger	Ext
Main Sweep	1 ms/div
Delayed Sweep	5 μs/div

10. Set the voltmeter as follows:

Range	10 V
Trigger	Ext
Delay	0 s
Coupling	DC, 1 MΩ

11. 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.
12. Press (Ampl Cal) on the HP 3324A.
13. Read the positive peak voltage of the attenuated waveform on the voltmeter. If the reading is not stable, alternatively press hold, then ext to repeat readings. Change the oscilloscope delay to read the negative peak. Add the two readings to obtain volts peak-to-peak. Verify that the sum is between 9.85 and 10.15 V.
14. Change the HP 3324A function to a triangle.
15. Adjust the oscilloscope delay to read the positive peak voltage on the high-speed digital voltmeter. Adjust the delay to read the negative peak on the voltmeter. Verify that the sum of the absolute values of the positive and negative peak voltages is between 9.85 and 10.15 V.
16. Change the HP 3324A function to a positive ramp.
17. Place the intensified spot on the positive peak. Alternatively press hold, then ext to repeat readings. Record the most positive reading.
18. Adjust the delay and read the negative peak. Ramp jitter should be visible on all ramp readings (the high-speed voltmeter will hold the readings). Verify that the sum of the absolute values of the positive and negative peaks is between 9.85 and 10.15 V.
19. Change the HP 3324A function to a negative ramp. Change the oscilloscope trigger to positive and take the negative ramp reading as above.
20. Change the HP 3324A function to a square wave and the frequency to 1 kHz. Set the oscilloscope as follows:

Main Sweep	100 μs/div
Delayed Sweep	0.05 μs/div

21. Read the positive peak; push the negative trigger and read the negative peak. Verify that the sum of the absolute values is between 9.85 and 10.15 V.
22. Change the HP 3324A function to a triangle and the frequency to 2 kHz. Set the oscilloscope main sweep to 50 μs/div. Adjust the delay and position. Set the positive and negative trigger to read the peaks. Verify that the sum is between 9.85 and 10.15 V.

23. Change the HP 3324A function to a positive ramp and the frequency to 500 Hz. Set the oscilloscope main sweep to 0.2 ms/div (adjust the sweep vernier to return the peaks to the center screen). Verify that the voltage is between 9.85 and 10.15 V

24. Change the HP 3324A function to a negative ramp. Verify that the voltage is between 9.85 and 10.15 V.

25. Change the HP 3324A function to square and the frequency to 101 kHz. Return the oscilloscope sweep vernier to calibrate and set the main sweep to 0.5 μs/div and magnify to off. Read the positive and negative peak voltages in the center of the screen. By pressing positive/negative trigger, verify that the voltage is between 9.50 and 10.50 V

26. Change the HP 3324A frequency to 10 kHz and the function to triangle . Set the oscilloscope main sweep to 10 μs/div and press magnify. Verify that the voltage is between 9.50 and 10.50 V.

27. Change the HP 3324A function to a positive ramp. Set the oscilloscope main sweep to 10 μs/div. Adjust the delay to read the highest peak. Verify that the voltage is between 9 and 11 V.

28. Change the HP 3324A function to a negative ramp. Verify a voltage of between 9 and 11 V.

29. Change the HP 3324A amplitude to 3 V(p-p), and press (Ampl Cal). Set the HP 3324A frequency to 99.9 Hz and the function to square wave.

30. Repeat tests 9 through 28. Test limits are as follows:

Test	Frequency	Function	Minimum	Maximum
13	99.9 Hz	Square	2.955 V	3.045 V
15	99.9 Hz	Triangle	2.955 V	3.045 V
18	99.9 Hz	+ Ramp	2.955 V	3.045 V
19	99.9 Hz	− Ramp	2.955 V	3.045 V
21	1 kHz	Square	2.955 V	3.045 V
22	2 kHz	Triangle	2.955 V	3.045 V
23	500 Hz	+ Ramp	2.955 V	3.045 V
24	500 Hz	− Ramp	2.955 V	3.045 V
25	101 kHz	Square	2.700 V	3.300 V
26	10 kHz	Triangle	2.850 V	3.150 V
27	10 kHz	+ Ramp	2.700 V	3.300 V
28	10 kHz	− Ramp	2.700 V	3.300 V

31. Change the HP 3324A amplitude to 1 V(p-p), press (Ampl Cal) and set the DC offset to 1 mV. Set the frequency to 99.9 Hz and the function to square. Set the oscilloscope's vertical sensitivity to 0.05 V/div for all 1 V(p-p) tests.

32. Repeat tests 9 through 28. Test limits are as follows:

Test	Frequency	Function	Minimum	Maximum
13	99.9 Hz	Square	0.978 V	1.022 V
15	99.9 Hz	Triangle	0.973 V	1.027 V
18	99.9 Hz	+ Ramp	0.973 V	1.027 V
19	99.9 Hz	− Ramp	0.973 V	1.027 V
21	1 kHz	Square	0.978 V	1.022 V
22	2 kHz	Triangle	0.973 V	1.027 V
23	500 Hz	+ Ramp	0.973 V	1.027 V
24	500 Hz	− Ramp	0.973 V	1.027 V
25	100 kHz	Square	0.900 V	1.100 V
26	10 kHz	Triangle	0.938 V	1.062 V
27	10 kHz	+ Ramp	0.888 V	1.112 V
28	10 kHz	− Ramp	0.888 V	1.112 V

High-Voltage Output (Option 002)

Amplitude Accuracy for Frequencies to 100 kHz

This procedure continues from the previous one.

1. **Sine wave Test.** Connect the HP 3324A signal output to the AC voltmeter with a 6-foot cable. Connect a 500Ω, 300 pF load (at either end) in parallel with the line.
2. Select the high-voltage output on the HP 3324A. "HIGH-VOLT" is shown in the display.
3. Set the HP 3324A function to a sine wave, the frequency to 2 kHz, and the amplitude to 14.14 Vrms (40 V(p-p)). Press [Ampl Cal]. The AC voltmeter reading should be between 13.86 and 14.42 Vrms.
4. **High-Voltage Function Test.** Connect the equipment as shown in Figure C-6.

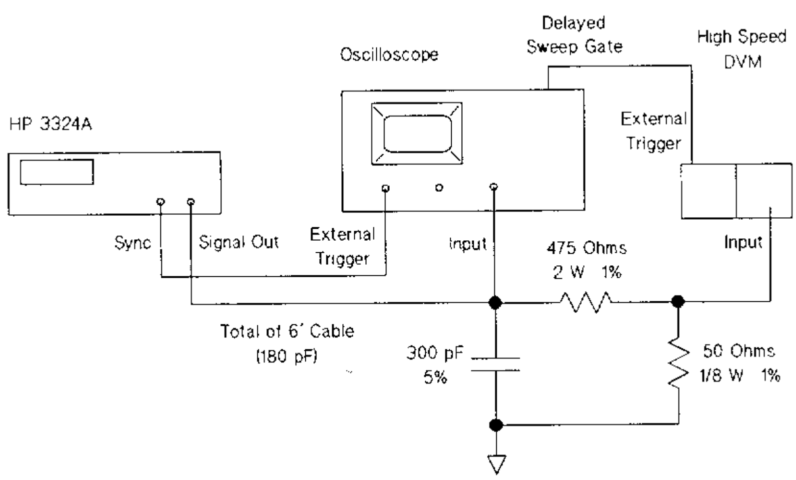


Figure C-6. Function Amplitude Accuracy Test Set-Up (High-Voltage Output)

5. The voltage divider shown in Figure C-6 is built into a small metal box with 2 BNC connectors. Parts used are:

   R3, 475Ω 2 W 1%
   R4, 50Ω 1/8 W 2%
   C1, 300 pF 5%

   Connect the tap to the input of the high-speed voltmeter, as shown in Figure C-6.

6. Set the HP 3324A frequency to 2 kHz and the amplitude to 40 V(p-p). Set the voltmeter to the 1 V range and external trigger. Set the oscilloscope as follows:

Vertical Sensitivity	2 V/div
Trigger	External
Main Sweep	20 μs/div
Delayed Sweep	0.05 μs/div
Delay	615
Magnify	×10

7. Set the HP 3324A to square wave and read the peak voltages on the voltmeter. Verify that the sum of the voltages is between 3.466 and 3.607 V(p-p).
8. Change the HP 3324A function to triangle, and read the peak voltages. The sum should be between 3.466 and 3.607 V(p-p).
9. Change the HP 3324A function to positive ramp. Change the oscilloscope main sweep to 0.1 ms/div and delay to 500. Verify a sum voltage of 3.466 to 3.607 V(p-p). Repeat for a negative ramp by changing the oscilloscope trigger to positive.

Amplitude Flatness (Frequencies above 100 kHz)

1. Set the HP 3324A as follows:

Function	Sine
Frequency	1 kHz
DC Offset	0 V
Amplitude	10 dBm

2. Connect the HP 3324A signal output via a 50Ω (±0.2Ω) feedthru to the DVM input. Set the DVM to measure AC voltage.
3. Press [Ampl] followed by [Ampl Cal]. Wait 2 seconds and record the voltmeter reading as V_0rms.
4. Connect the equipment as shown in Figure C-7 (the thermal converter should be connected directly to the HP 3324A), and set the DVM to measure DC voltage.

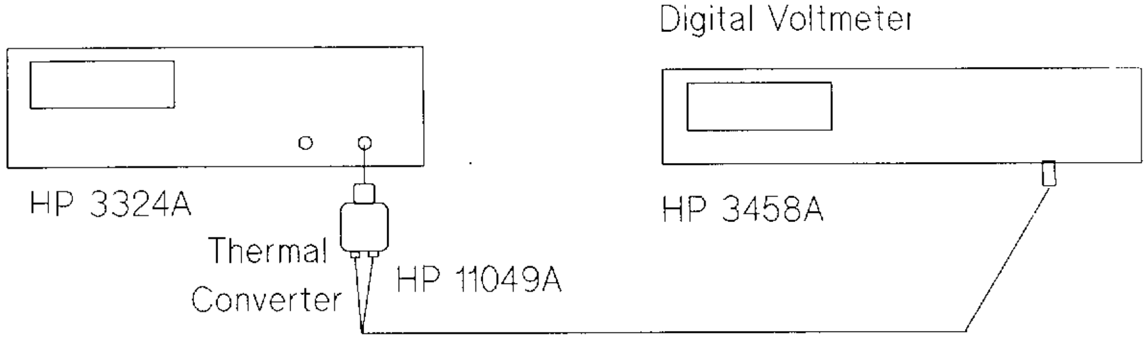


Figure C-7. Amplitude Flatness Test Set-Up

Note

Do not exceed the rated voltage of the thermal converter. Any overload or high voltage transient may destroy the thermo element.
The maximum voltage that can be measured with this setup is 18 dBm (6 V(p-p) or 1.7 Vrms). The minimum voltage is 8 dBm (2 V(p-p) or 0.57 Vrms).

5. Wait 3 minutes and record the DVM reading as V_0dc.
6. Set the 3324A frequency to 101 kHz, 500 kHz, 1 MHz, 5 MHz, 10 MHz, 15MHz, and 20 MHz, and record the voltmeter reading (Vmeas) at each frequency. In each case allow the thermal converter 10 seconds to stabilize.
7. Calculate the amplitude accuracy using the following equation:

$$Ampl.(dBm) = 20log_{10}\left(\frac{V_0rms}{0.223607\sqrt{V_0dc}}\right) + 20log_{10}\left(\sqrt{Vmeas}\right)$$

8. Verify that all results are within 9.4 dBm and 10.6 dBm (accuracy = ±0.6 dB).
9. Change the HP 3324A frequency to 1 kHz and the amplitude to 18 dBm.
10. Repeat steps 2 to 7 and verify that all results are within 17.6 and 18.4 dBm (accuracy = ±0.4 dB).
11. Disconnect the thermal converter from the HP 3324A output.
12. **Square wave flatness.** accuracy Set the HP 3324A as follows:

High-Voltage Output	Off
Function	Square
Frequency	1 kHz
Amplitude	10 V(p-p)
DC Offset	0 V

13. Connect the HP 3324A signal output to an oscilloscope with a 50Ω feedthru termination. Set the oscilloscope as follows:

Vertical Sensitivity	2 V/div
Time/div	0.1 ms

14. Use the modify keys to increase the HP 3324A frequency from 1 kHz to 10.001 MHz in 2 MHz steps. Two lines will appear on the oscilloscope. Verify that they remain within 0.5 of a major division of 5 divisions apart for all 11 frequencies.

High-Voltage Output (Option 002)

Amplitude Flatness above 100 kHz

This procedure continues from the previous one

1. Connect the HP 3324A output to an oscilloscope with a 500Ω, 300pF load (load attached at either end). The cable capacitance (30 pF/foot) must be included in the 300 pF. The HV divider (Figure C-6) may be used with 6 feet of cable.
2. Set the oscilloscope as follows:

Vertical Sensitivity	10 V/div
Time/div	1 ms

3. Set the HP 3324A to 40 V(p-p) sine wave and 1 kHz. Adjust the oscilloscope intensity and focus for a sharp trace.
4. Use the modify keys to increase the HP 3324A frequency from 1 kHz to 1.001 MHz in 200 kHz steps. Verify that the width of the bright region of the screen is 4 ±0.4 divisions for all frequencies.

DC Offset Accuracy (DC Only)

This procedure tests the HP 3324A DC offset accuracy when no AC function output is present.

Specifications

1% of full range ±0.02 mV

Equipment Required

DC Digital Voltmeter
50Ω Feedthru Termination

Procedure

1. Connect the HP 3324A signal output directly to the 50Ω feedthru termination and then with a cable to the DC digital voltmeter input.
2. Set the output so that only the DC output is present.
3. Set the HP 3324A DC offset to 5 V, then press [Ampl Cal].
4. The voltmeter reading should be between +4.950 and +5.050 V.
5. Change the HP 3324A DC offset to −5 V. The voltmeter reading should be between −4.950 and −5.050 V.

Attenuator Test

This procedure continues from the previous one

1. Set the DC offset to the positive and negative voltages below. The digital voltmeter reading should be within the tolerances shown for each voltage.

DC Offset	Tolerances
±1.499 V	±1.48399 to 1.51401 V
±499.9 mV	±0.48488 to 0.50491 V
±149.9 mV	±0.14838 to 0.15142 V
±49.99 mV	±0.04947 to 0.05051 V
±14.99 mV	±0.01482 to 0.01516 V
±4.999 mV	±0.004929 to 0.005069 V
±1.499 mV	±0.001464 to 0.001534 V

High-Voltage Output (Option 002)

This procedure continues from the previous one.

1. Remove the 50Ω feedthru termination and connect the HP 3324A output directly to the voltmeter input.
2. Select the high-voltage output on the HP 3324A. "HIGH-VOLT" will be shown in the display.
3. Set the HP 3324A DC offset to 20 V. The voltmeter reading should be +19.775 to 20.225 V.

DC Offset Accuracy with AC Functions

This procedure tests the HP 3324A DC offset accuracy when an AC function output is present.

Specifications

DC + AC, up to 1 MHz: 1.2%
For ramps up to 10 kHz: 2.4%
DC + AC, from 1 MHz to 20 MHz: 3%

Equipment Required

DC Digital Voltmeter
50Ω Feedthru Termination

Procedure

1. Connect the equipment as shown in Figure C-8. Set the voltmeter to measure DC voltage.

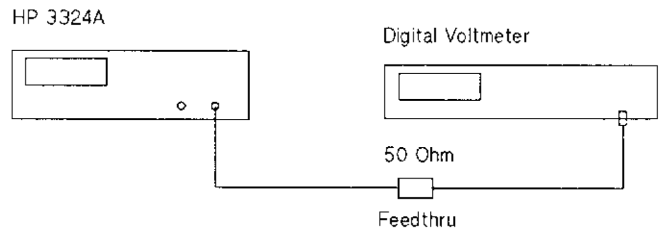


Figure C-8. DC Offset Test Set-Up

2. Set the HP 3324A output as follows:

High-Voltage Output	Off
Function	Sine
Frequency	21 MHz
Amplitude	1 V(p-p)
DC Offset	+4.5 V

3. Press [Ampl Cal]. After amplitude calibration (approximately 2 seconds) the voltmeter reading should be +4.350 to +4.650 Vdc.
4. Change the HP 3324A DC offset to −4.5 V. The voltmeter reading should be −4.350 to −4.650 Vdc.
5. Change the HP 3324A frequency to 999.9 kHz. The voltmeter reading should be −4.440 to −4.560 Vdc.
6. Change the HP 3324A DC offset to +4.5 V. The voltmeter reading should be +4.440 to +4.560 Vdc.
7. Set the HP 3324A function to square. The voltmeter reading should be +4.440 to +4.560 Vdc.
8. Change the HP 3324A DC offset to −4.5 V. The voltmeter reading should be −4.440 to −4.560 Vdc.
9. Change the HP 3324A frequency to 9.9999 MHz. The voltmeter reading should be −4.350 to −4.650 Vdc.
10. Set the HP 3324A function to triangle, frequency to 9.9 kHz. The voltmeter reading should be −4.440 to −4.560 Vdc.
11. Set the function to positive ramp. The voltmeter should be −4.380 to −4.620 V.

Triangle Linearity

This procedure tests the linearity of the HP 3324A triangle wave output. As the triangle and ramp outputs are generated by the same circuits, this procedure effectively tests the ramp linearity also.

Specifications

±0.05% of full output, 10% to 90%, best fit straight line

Equipment Required

High-speed DC Digital Voltmeter
Resistor, 20Ω 1/4 W 1%
Resistor, 30Ω 1/4 W 1%
BNC-to-Triax Adapter

Procedure

1. Connect the HP 3324A and the high-speed voltmeter through the divider as shown in Figure C-9.

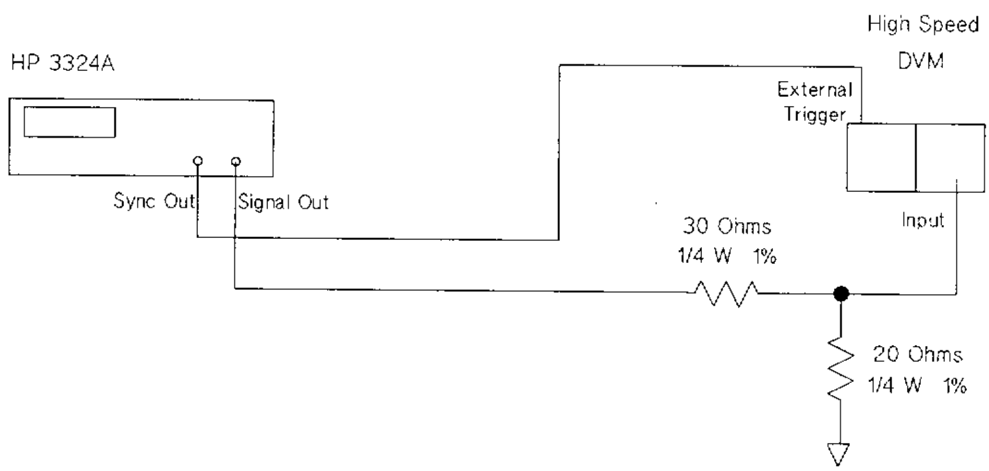


Figure C-9. Triangle Linearity Test Set-Up

2. Set the HP 3324A output as follows:

High-Voltage Output	Off
Function	Triangle
Frequency	10 kHz
Amplitude	10 V(p-p)
DC Offset	0 V

3. Set the voltmeter as follows:

Range	1 V
Number of readings	1
Trigger	External

Note The HP 3437A triggers on the negative going edge of the HP 3324A sync square wave.

4. Set the voltmeter delay to 0.00003 (seconds). Record the voltmeter reading on the Performance Test Record under *Positive Slope Measurement, (10%)*y_I. This is the 10% point on the positive slope of the triangle.
5. Measure the voltage at each 10% segment point by setting the voltmeter delay to the following. Enter on the Performance Test Record in the appropriate spaces under *Positive Slope Measurement.*

Delay	Percent of Slope
0.000035	20
0.00004	30
0.000045	40
0.00005	50
0.000055	60
0.00006	70
0.000065	80
0.00007	90

6. Measure the voltage at each 10% segment point on the negative slope by setting the voltmeter delay to the following. Enter on the Performance Test Record in the appropriate spaces under *Negative Slope Measurement.*

Delay	Percent of Slope
0.00008	90
0.000085	80
0.00009	70
0.000095	60
0.0001	50
0.000105	40
0.00011	30
0.000115	20
0.00012	10

7. Algebraically add the voltages recorded in the *Positive Slope Measurement* column and enter the total in the $\sum y$ space.
8. Multiply Σy by 45 (which is Σx) and enter the result in the $\Sigma x \Sigma y$ space.
9. 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.
10. 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 the data taken previously.

Note Calculate the values of a_1 and a_0 to at least five decimal places.

11. First determine the value of a_1 using the following equation:

$$a_1 = \frac{\Sigma xy - \frac{\Sigma x \Sigma y}{n}}{\Sigma x^2 - \frac{(\Sigma x)^2}{n}}$$

where Σx, Σy, Σxy, $\Sigma x \Sigma y$, Σx^2 , and $(\Sigma x)^2$, are the previously calculated values entered on the Performance Test Record.

where n=9 (the number of points to be calculated).

12. Determine the value of a_0 using the equation:

$$a_0 = \frac{\Sigma y}{n} - \frac{a_1 \Sigma x}{n}$$

13. 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.

14. 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.

% linearity = $((|+V_{max}| + |-V_{max}|) \div 8 \text{ volts}) \times 100\%$

15. Add the voltages recorded in the Negative Slope Measurement column algebraically and enter the total in the Σy space.

16. Repeat steps 8 through 14 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.

Ramp Period Variation

This procedure tests the variation between alternate cycles of the HP 3324A positive and negative slope ramps.

Specifications

< ±1% of period, maximum

Equipment Required

Analog Oscilloscope, with delayed sweep

Procedure

1. Connect the HP 3324A signal output to the oscilloscope vertical input. (Do NOT use a 10:1 probe.) Set the input switch to the 50Ω position. If your oscilloscope does not have a 50Ω input, use a 50Ω feedthru termination at the input.
2. Set the HP 3324A output as follows:

Function	Negative Slope Ramp
Frequency	100 Hz
Amplitude	10 V(p-p)
DC Offset	0 V

3. Set the oscilloscope as follows:

Vertical	2 V/div
Main Sweep	2.0 ms/div
Delayed Sweep	20 μs/div
Trigger	Positive

4. With the oscilloscope horizontal controls set to main sweep, adjust the intensified portion of the trace to the reset (positive going) portion of the ramp.
5. Set the horizontal controls to delayed sweep and position the ramp reset portion near the center of the display.
6. The reset portion should show more than one line, as in Figure C-9. The lines should not be separated by more than five divisions on the display.
7. Change the HP 3324A function to positive slope ramp and set the oscilloscope trigger to negative to verify the positive ramp.
8. Increase the HP 3324A frequency to 99.999999 Hz to check the low frequency ramps. Verify that ramp period variations do not exceed five divisions.

Automatic Phase Calibration (Options 003 and 004)

This procedure tests the accuracy of the phase calibration options 003 (slave) and 004 (master).

Specifications

Phase error:

	Sine/Sine			
	3 - 10 V(p-p)		0.3 - 10 V(p-p)	
Frequency Range	Typical	Specified	Typical	Specified
1 mHz - 100 Hz	±1.5°	±2°	±1.5°	±2°
> 100 Hz - 1 MHz	±1°	±1.5°	±1°	±1.5°
> 1 MHz - 10 MHz	±1°	±2°	±1°	±3.5°
> 10 MHz - 21 MHz	±2.6°	±4°	±2.6°	±7°

	Square/Square			
	3 - 10 V(p-p)		0.3 - 10 V(p-p)	
Frequency Range	Typical	Specified	Typical	Specified
1 mHz - 100 Hz	±1°	±1.5°	±1°	±1.5°
> 100 Hz - 1 MHz	±0.4°	±1°	±0.4°	±1°
> 1 MHz - 10 MHz	±1.2°	±2°	±1.2°	±3°

Equipment Required

Digitizing Oscilloscope
50Ω BNC Cables (2 off of the same length!)

Note Connect a 3324A signal to the oscilloscope and using an adder (splitter) HP 15109, check the oscilloscope inter channel accuracy and take the error into account.

Procedure

1. Connect the equipment as shown in Figure C-10.

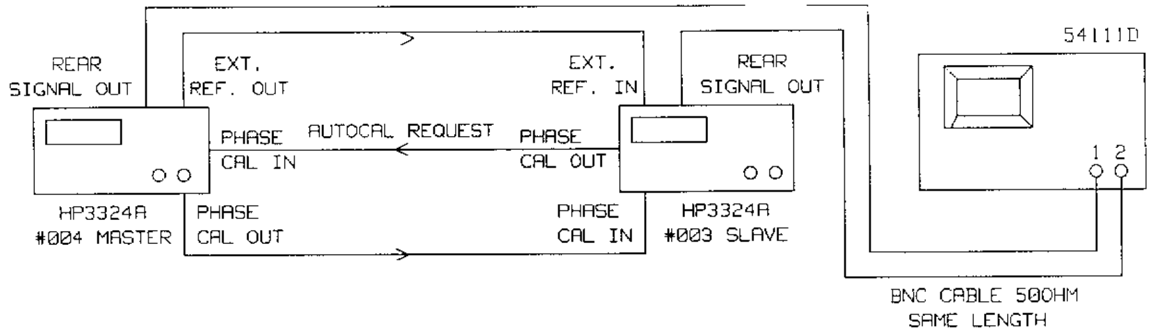


Figure C-10. Phase Calibration Test Set-Up

2. Set the two HP 3324As as follows:

Util menu	Set default
Frequency	1 MHz
Amplitude	10 V(p-p)
Waveform	Sine
Signal ON	Rear

3. Connect the two 3324As for Phase Calibration.
4. Press (Ampl Cal) on both HP 3324As.
5. Press (Phase Cal) on the "slave" instrument (the one with option 003 installed).
6. Set the oscilloscope as follows:

Trigger Source	Channel 1, Trigger Level = 0.00 V, Slope = positive
Timebase	100 ns/div, Delay = 0.0s, Delay Ref at center
Display	Repetitive, Averaging On, Number of Averages = 64, Screen = single
Channel 2	Display On, Sensitivity = 2.00 V/div, Offset = 0.00 V, Input Coupling = dc, Input Impedance = 50Ω
Channel 1	Display On, Sensitivity = 2.00 V/div, Offset = 0.00 V, Input Coupling = dc, Input Impedance = 50Ω
Delta V	V Markers On, Marker 1 Position = Channel 1, Marker 2 Position = Channel 2, Preset Levels = 50-50%, Auto Level Set
Delta t	T Markers On, Start On Pos Edge 1, Stop on Pos Edge 1

7. Press (Phase Cal) on the "slave" instrument.
8. Press (Clear Display) on the scope and wait for # Avgs = 64.
9. Press (Edge Find).
10. Check that $\delta t < 4.17$ ns.
11. Change the waveform of the two HP 3324As to square.
12. Select the Delta V menu on the scope and with preset levels at 50-50% press Auto Level Set.
13. Select the Delta T menu on the scope.
14. Press (Phase Cal) on the "slave" instrument.
15. Press (Clear Display) on the slope and wait for # Avgs = 64.

16. Press **Edge Find**.

17. Check that $\delta t < 2.78$ ns.

Note

With the above procedure the Phase Calibration at other frequencies and/or amplitudes can be measured.

Serial No: ___________________________ Report No: __________________________ Date: ___________

Test Facility :

____

____

____

____

Test Conditions :

Installed Options :

____

Ambient Temperature :

______________________°C

Relative Humidity :

______________________%

Line Frequency :

______________________Hz

Special Notes :

____

____

____

____

____

____

____

TEST RECORD: Record of equipment and conditions.

Serial No: ______________________ Report No: ______________________ Date: __________

Test Equipment Used :

Description	Model No.	Serial No.	Trace No.	Cal.Due Date
Counter				
Analog Oscilloscope				
Digital Oscilloscope				
Digital Voltmeter				
Spectrum Analyzer				
Function Generator				
DC Power Supply				
Controller				

Test Record 1

Hewlett-Packard Model **3324A**	Test Performed By
Synthesized Function/Sweep Generator	Date
Serial Number	Comments
Customer	CSO No.

Harmonic Distortion Test Pass ▢ Fail ▢

Fundamental Frequency		**Specification**
20 MHz	____________________________	−25 dB
15 MHz	____________________________	−25 dB
14.9 MHz	____________________________	−30 dB
2 MHz	____________________________	−30 dB
1.99 MHz	____________________________	−40 dB
200 kHz	____________________________	−40 dB
10 kHz	____________________________	−60 dB
1 kHz	____________________________	−60 dB
100 Hz	____________________________	−60 dB

High-Voltage Output (Option 002)

100 Hz	____________________________	−60 dB
1 kHz	____________________________	−60 dB
10 kHz	____________________________	−60 dB
200 kHz	____________________________	−40 dB
1 MHz	____________________________	−40 dB

Test Record 2

Hewlett-Packard Model **3324A**	Test Performed By
Synthesized Function/Sweep Generator	Date
Serial Number	Comments
Customer	CSO No.

Spurious Signal Test Pass ▢ Fail ▢

Mixer Spurious	2:1 spur	3:2 spur	**Specification**
2.001 MHz	_________	_________	−55 dB
4.100 MHz	_________	_________	−55 dB
6.100 MHz	_________	_________	−55 dB
8.100 MHz	_________	_________	−55 dB
10.100 MHz	_________	_________	−55 dB
12.100 MHz	_________	_________	−55 dB
14.100 MHz	_________	_________	−55 dB
16.100 MHz	_________	_________	−55 dB
18.100 MHz	_________	_________	−55 dB
20.100 MHz	_________	_________	−55 dB

Close-in-Spurious

5.0001 MHz	____________________	−55 dB
5.00001 MHz	____________________	−55 dB
5.000001 MHz	____________________	−55 dB
20.001 MHz	____________________	−55 dB
20.001 MHz	____________________	−55 dB
20.001 MHz	____________________	−55 dB
20.001 MHz	____________________	−55 dB

Test Record 3

Hewlett-Packard Model **3324A**	Test Performed By
Synthesized Function/Sweep Generator	Date
Serial Number	Comments
Customer	CSO No.

Integrated Phase Noise Test Pass ☐ Fail ☐

1st AC voltmeter reading	____________________________ dB	
2nd AC voltmeter reading	____________________________ dB	
1st reading − 2nd reading	= ____________________________ dB	
		Specification
Result − 6 dB	= ________________________	−50 dB

Ramp Retrace Time Test Pass ☐ Fail ☐

		Specification
Positive Slope Ramp	____________________________	$\leq 3\ \mu s$
Negative Slope Ramp	____________________________	$\leq 3\ \mu s$

Test Record 4

Hewlett-Packard Model **3324A**	Test Performed By
Synthesized Function/Sweep Generator	Date
Serial Number	Comments
Customer	CSO No.

Frequency Accuracy Test Pass ▢ Fail ▢

Sine, 20 MHz	______________________ ±100 Hz
Square, 10 MHz	______________________ ±50 Hz
Triangle, 10 kHz (100,000 ns)	______________________ ±0.5 ns
Ramp, 10 kHz (100,000 ns)	______________________ ±0.5 ns

Phase Increment Accuracy Test Pass ▢ Fail ▢

	Measured	Minimum	Time Difference	Maximum
Zero Phase Time Interval	__________			
1° Increment Time Interval	__________	13.89 ns	__________	41.67 ns
10° Increment Time Interval	__________	263.89 ns	__________	291.67 ns
100° Increment Time Interval	__________	2763.89 ns	__________	2791.67 ns

Test Record 5

(1 of 4)

Hewlett-Packard Model **3324A**
Synthesized Function/Sweep Generator
Serial Number
Customer

Test Performed By
Date
Comments
CSO No.

Amplitude Accuracy Test Pass ▢ Fail ▢

Sine wave Test	Minimum	Measured	Maximum
Amplitude: 3.536 Vrms			
Sine, 100 Hz:	3.455 V	________________	3.617 V
Sine, 1 kHz:	3.455 V	________________	3.617 V
Sine, 100 kHz:	3.455 V	________________	3.617 V
Amplitude: 1.061 Vrms			
Sine, 100 Hz:	1.037 V	________________	1.085 V
Sine, 1 kHz:	1.037 V	________________	1.085 V
Sine, 100 kHz:	1.037 V	________________	1.085 V
Amplitude: 0.3536 Vrms			
DC, 1 mV			
Sine, 100 Hz:	0.3370 V	________________	0.3702 V
Sine, 1 kHz:	0.3370 V	________________	0.3702 V
Sine, 100 kHz:	0.3370 V	________________	0.3702 V

Test Record 5

Amplitude Accuracy Test (continued)

Function Test	Minimum	Measured	Maximum
Amplitude: 10 V(p-p)			
Square, 99.9 Hz	9.95 V	________________	10.15 V
Triangle, 99.9 Hz	9.85 V	________________	10.15 V
Pos. Ramp, 99.9 Hz	9.85 V	________________	10.15 V
Neg. Ramp, 99.9 Hz	9.85 V	________________	10.15 V
Square, 1 kHz	9.95 V	________________	10.15 V
Triangle, 2 kHz	9.85 V	________________	10.15 V
Pos. Ramp, 500 Hz	9.85 V	________________	10.15 V
Neg. Ramp, 500 Hz	9.85 V	________________	10.15 V
Square, 101 kHz	9.50 V	________________	10.50 V
Triangle, 10 kHz	9.50 V	________________	10.50 V
Pos. Ramp, 10 kHz	9.00 V	________________	11.00 V
Neg. Ramp, 10 kHz	9.00 V	________________	11.00 V
Amplitude: 3 V(p-p)			
Square, 99.9 Hz	2.955 V	________________	3.045 V
Triangle, 99.9 Hz	2.955 V	________________	3.045 V
Pos. Ramp, 99.9 Hz	2.955 V	________________	3.045 V
Neg. Ramp, 99.9 Hz	2.955 V	________________	3.045 V
Square, 1 kHz	2.955 V	________________	3.045 V
Triangle, 2 kHz	2.955 V	________________	3.045 V
Pos. Ramp, 500 Hz	2.955 V	________________	3.045 V
Neg. Ramp, 500 Hz	2.955 V	________________	3.045 V
Square, 101 kHz	2.700 V	________________	3.300 V
Triangle, 10 kHz	2.850 V	________________	3.150 V
Pos. Ramp, 10 kHz	2.700 V	________________	3.300 V
Neg. Ramp, 10 kHz	2.700 V	________________	3.300 V

Amplitude Accuracy Test (continued)

Function Test	Minimum	Measured	Maximum
Amplitude: 1 V(p-p)			
DC: 1 mV			
Square, 99.9 Hz	0.978 V	________________	1.022 V
Triangle, 99.9 Hz	0.973 V	________________	1.027 V
Pos. Ramp, 99.9 Hz	0.973 V	________________	1.027 V
Neg. Ramp, 99.9 Hz	0.973 V	________________	1.027 V
Square, 1 kHz	0.978 V	________________	1.022 V
Triangle, 2 kHz	0.973 V	________________	1.027 V
Pos. Ramp, 500 Hz	0.973 V	________________	1.027 V
Neg. Ramp, 500 Hz	0.973 V	________________	1.027 V
Square, 101 kHz	0.900 V	________________	1.100 V
Triangle, 10 kHz	0.938 V	________________	1.062 V
Pos. Ramp, 10 kHz	0.888 V	________________	1.112 V
Neg. Ramp, 10 kHz	0.888 V	________________	1.112 V

High-Voltage Output (Option 002)

Sine wave Test	Minimum	Measured	Maximum
Amplitude: 14.14 Vrms			
Sine, 2 kHz	13.86 V	________________	14.42 V

Function Test	Minimum	Measured	Maximum
Amplitude: 40 V(p-p)			
Square, 2 kHz	3.466 V	________________	3.607 V
Triangle, 2 kHz	3.466 V	________________	3.607 V
Pos. Ramp, 2 kHz	3.466 V	________________	3.607 V
Neg. Ramp, 2 kHz	3.466 V	________________	3.607 V

Amplitude Accuracy Test (continued)

Amplitude Flatness Test	**Min.**	**Calc. Ampl.**	**Max.**
Sine, 10 dBm, 1 kHz	9.8 dBm	____________	10.2 dBm
101 kHz	9.4 dBm	____________	10.6 dBm
500 kHz	9.4 dBm	____________	10.6 dBm
1 MHz	9.4 dBm	____________	10.6 dBm
5 MHz	9.4 dBm	____________	10.6 dBm
10 kHz	9.4 dBm	____________	10.6 dBm
15 kHz	9.4 dBm	____________	10.6 dBm
20 kHz	9.4 dBm	____________	10.6 dBm
Sine, 18 dBm, 1 kHz	Min. 17.8 dBm	____________	Max. 18.2 dBm
101 kHz	17.6 dBm	____________	18.4 dBm
500 kHz	17.6 dBm	____________	18.4 dBm
1 MHz	17.6 dBm	____________	18.4 dBm
5 MHz	17.6 dBm	____________	18.4 dBm
10 kHz	17.6 dBm	____________	18.4 dBm
15 kHz	17.6 dBm	____________	18.4 dBm
20 kHz	17.6 dBm	____________	18.4 dBm
Square, 10 V(p-p)	Pass ☐		Fail ☐
High-Voltage Output (Option 002)			
Sine, 40 V(p-p)	Pass ☐		Fail ☐

Test Record 6

Hewlett-Packard Model **3324A**
Synthesized Function/Sweep Generator
Serial Number
Customer

Test Performed By
Date
Comments
CSO No.

DC Offset Accuracy Test (DC Only) Pass ▢ Fail ▢

	Minimum	Measured	Maximum
5 V	+4.950 V	________________	+5.050 V
−5 V	−4.950 V	________________	−5.050 V
1.499 V	+1.48399 V	________________	+1.51401 V
−1.499 V	−1.48399 V	________________	−1.51401 V
499.9 mV	+0.49488 V	________________	+0.50491 V
-499.9 mV	−0.49488 V	________________	−0.50491 V
149.9 mV	+0.14838 V	________________	+0.15142 V
-149.9 mV	−0.14838 V	________________	−0.15142 V
49.99 mV	+0.04947 V	________________	+0.05051 V
−49.99 mV	−0.04947 V	________________	−0.05051 V
14.99 mV	+0.01482 V	________________	+0.01516 V
-14.99 mV	−0.01482 V	________________	−0.01516 V
4.999 mV	+0.004929 V	________________	+0.005069 V
−4.999 mV	−0.004929 V	________________	−0.005069 V
1.999 mV	+0.001464 V	________________	+0.001534 V
-1.999 mV	−0.001464 V	________________	−0.001534 V

High-Voltage Output (Option 002)

20 V	+19.775 V	________________	+20.225 V
−20 V	−19.775 V	________________	−20.225 V

Test Record 7

Hewlett-Packard Model **3324A**
Synthesized Function/Sweep Generator
Serial Number
Customer

Test Performed By
Date
Comments
CSO No.

DC Offset Accuracy Test with AC Functions Pass ☐ Fail ☐

	Minimum	Measured	Maximum
Sine, 21 MHz			
4.5 V	+4.350 V	________________	+4.650 V
−4.5 V	−4.350 V	________________	−4.650 V
Sine, 999.9 kHz			
4.5 V	+4.440 V	________________	+4.560 V
−4.5 V	−4.440 V	________________	−4.560 V
Square, 999.9 kHz			
4.5 V	+4.440 V	________________	+4.560 V
−4.5 V	−4.440 V	________________	−4.560 V
Square, 9.9999 MHz			
−4.5 V	−4.350 V	________________	−4.650 V
Triangle, 9.9 kHz			
−4.5 V	−4.440 V	________________	−4.560 V
Ramp, 9.9 kHz			
-4.5 V	−4.380 V	________________	−4.620 V

Test Record 8

Hewlett-Packard Model **3324A**	Test Performed By
Synthesized Function/Sweep Generator	Date
Serial Number	Comments
Customer	CSO No.

Triangle Linearity Test Pass ▢ Fail ▢

x Values	Positive Slope Measurement	x times y	Calculated Best Fit Straight Line	Minimum Tolerance	Maximum Tolerance
$x_1 = 1$	(10%) y_1_____	_________	(y_1)________	________	________
$x_2 = 2$	(20%) y_2_____	_________	(y_2)________	________	________
$x_3 = 3$	(30%) y_3_____	_________	(y_3)________	________	________
$x_4 = 4$	(40%) y_4_____	_________	(y_4)________	________	________
$x_5 = 5$	(50%) y_5_____	_________	(y_5)________	________	________
$x_6 = 6$	(60%) y_6_____	_________	(y_6)________	________	________
$x_7 = 7$	(70%) y_7_____	_________	(y_7)________	________	________
$x_8 = 8$	(80%) y_8_____	_________	(y_8)________	________	________
$x_9 = 9$	(90%) y_9_____	_________	(y_9)________	________	________

$\Sigma x = 45$ Σy____________ Σxy_____

$(\Sigma x)^2 = 2025$ $\Sigma x \Sigma y$___________

$\Sigma x^2 = 285$

Test Record 8

Triangle Linearity Test (continued) Pass ▢ Fail ▢

x Values	Negative Slope Measurement	x times y	Calculated Best Fit Straight Line	Minimum Tolerance	Maximum Tolerance
$x_1 = 1$	(10%) y_1_____	_________	(y_1)________	________	________
$x_2 = 2$	(20%) y_2_____	_________	(y_2)________	________	________
$x_3 = 3$	(30%) y_3_____	_________	(y_3)________	________	________
$x_4 = 4$	(40%) y_4_____	_________	(y_4)________	________	________
$x_5 = 5$	(50%) y_5_____	_________	(y_5)________	________	________
$x_6 = 6$	(60%) y_6_____	_________	(y_6)________	________	________
$x_7 = 7$	(70%) y_7_____	_________	(y_7)________	________	________
$x_8 = 8$	(80%) y_8_____	_________	(y_8)________	________	________
$x_9 = 9$	(90%) y_9_____	_________	(y_9)________	________	________

$\Sigma x = 45$ Σy____________ Σxy______

$(\Sigma x)^2 = 2025$ $\Sigma x \Sigma y$___________

$\Sigma x^2 = 285$

Ramp Period Variation Test Pass ▢ Fail ▢

Negative Slope Ramp, 100 Hz	Pass ▢	Fail ▢
Positive Slope Ramp, 100 Hz	Pass ▢	Fail ▢
Positive Slope Ramp, 99.9 Hz	Pass ▢	Fail ▢

Test Record 9

Hewlett-Packard Model **3324A**	Test Performed By
Synthesized Function/Sweep Generator	Date
Serial Number	Comments
Customer	CSO No.

Automatic Phase Calibration Test Pass ▢ Fail ▢

Formula:

$\delta t = \{PER(sec.).Spec(deg.)\} / 360(deg.)$

Sine, 1 MHz	____________________	$\delta t < 4.17$ ns
Square, 1 MHz	____________________	$\delta t < 2.78$ ns

D

Backdating Changes

Introduction

This appendix contains backdating information to adapt this manual for instruments with a lower serial number than that shown on the title page. There are two series of serial numbers, a "G" series and an "A" series.

G: 2836G00510 and below
A: 2949A....

These instruments did not have the RFI filter board A14 fitted. The BNC connectors on the A6 board were fitted with capacitive washers instead of insulating washers. Therefore:

1. In Figure 4-1 delete A14.
2. In Table 4-1 delete 03324-66514 RFI Bd Assy A14.
3. In Table 4-2 replace MP26 with Capacitor Washer 0160-6777.
4. In Figure 5-21 :
   a. Delete the filter board.
   b. Replace "Isolating Washer" with "Capacitor Washer".