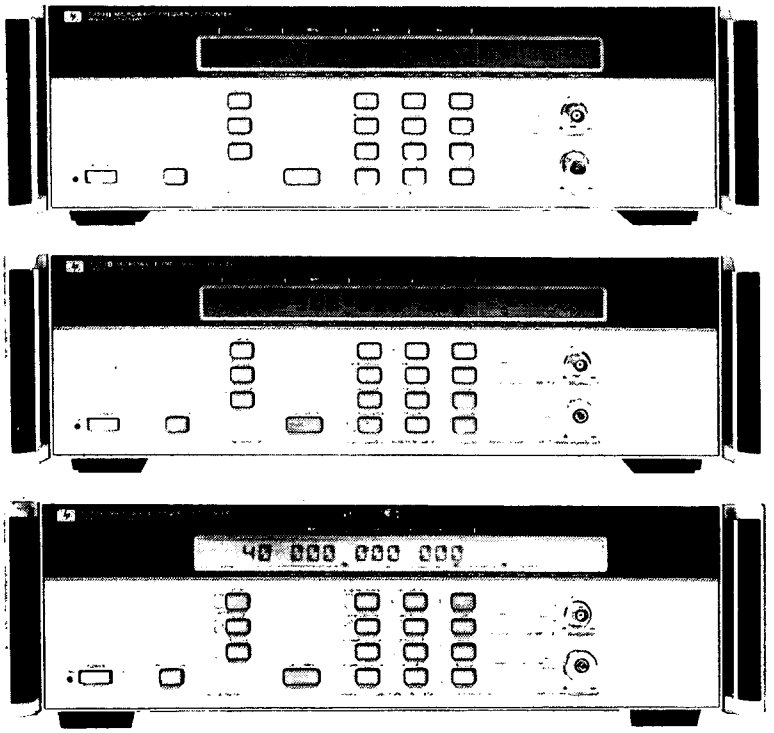
SERVICE MANUAL

DESIGNED FOR HP-IB SYSTEMS

5350B
5351B
5352B
Microwave Frequency Counters



HEWLETT PACKARD

HP 5350B/5351B/5352B

CERTIFICATION

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

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, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

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

HP 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, or 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 MERCHANTABILITY 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.

PL-05 aat *

HEWLETT PACKARD

SERVICE MANUAL

HP 5350B, 5351B and 5352B Microwave Frequency Counters

SERIAL NUMBERS

This manual applies directly to instruments with serial numbers prefixed 2713A, unless accompanied by a Manual Change Sheet indicating otherwise.

For additional information about serial numbers, refer to INSTRUMENT AND MANUAL IDENTIFICATION in Section I.

IMPORTANT NOTICE

The operating and service information for this instrument is contained in two manuals, as follows:

HP 5350B/5351B/5352B Operating and Programming Manual (HP P/N 05350-90025):

I	General Information
II	Installation
III	Operation And Programming
IV	Performance Tests

HP 5350B/5351B/5352B Service Manual (HP P/N 05350-90021):

IV	Performance Tests (duplicate)
V	Adjustments
VI	Replaceable Parts
VII	Manual Changes
VIII	Service

5301 STEVENS CREEK BOULEVARD, SANTA CLARA, CA 95051-7299

MANUAL PART NUMBER 05350-90021
Microfiche Part Number 05350-90022

Printed: MAY 1987

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PREFACE

This manual contains the information required by the user to effectively service and maintain the Hewlett-Packard Model 5350B, 5351B and 5352B Microwave Frequency Counters. The organization of this manual is designed to make quick reference of information easy, while still providing the overall depth of detail required by operating and service personnel.

The manual is divided into five sections, each relating to a specific topic. Each section is as self-contained as possible. Some sections provide learning and working information and will be used frequently. Other sections are dedicated to general and introductory types of information and are intended to be used only for reference. Where applicable, photos, illustrations, and diagrams are arranged to fold out from the manual to allow access to related information throughout the manual.

In limiting the depth of coverage in this manual, a certain amount of previous knowledge on the part of the reader is assumed. A variety of additional related documentation is available. The materials listed below provide in-depth coverage of specific areas of interest, and should be used to supplement this manual.

HP 5350B/5351B/5352B OPERATING AND PROGRAMMING MANUAL	05350-90025
AN 200 FUNDAMENTALS OF ELECTRONIC COUNTERS	5952-7506
AN 200-1 FUNDAMENTALS OF MICROWAVE FREQUENCY COUNTERS	5952-7484
LOGIC SYMBOLOGY	5951-6116
HP-IB TUTORIAL	59300-90007

IMPORTANT NOTICE

This manual includes *Table 1-1, Model 5350B/5351B/5352B Specifications,* on page xvi, and *Table 1-5, Recommended Test Equipment,* on page xviii. These tables are duplicates of those in the HP 5350B/5351B/5352B Operating and Programming Manual, and are included in this manual for ease of reference.

SAFETY CONSIDERATIONS

GENERAL

This product and related documentation must be reviewed for familiarization with safety markings and instructions before operation.

This product is a Safety Class I instrument (provided with a protective earth terminal).

BEFORE APPLYING POWER

Verify that the product is set to match the available line voltage and the correct fuse is installed. Refer to Section II, Installation.

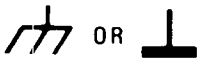
SAFETY EARTH GROUND

An uninterruptible safety earth ground must be provided from the mains power source to the product input wiring terminals or supplied power cable.

SAFETY SYMBOLS

Instruction manual symbol; the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual.

Indicates hazardous voltages.



Indicates terminal is connected to chassis when such connection is not apparent.

Alternating current.

Direct current.

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 personal injury. 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 product. Do not proceed beyond a **CAUTION** sign until the indicated conditions are fully understood and met.

SAFETY INFORMATION

WARNING

Any interruption of the protective grounding conductor (inside or outside the instrument) or disconnecting the protective earth terminal will cause a potential shock hazard that could result in personal injury. (Grounding one conductor of a two conductor outlet is not sufficient protection.)

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

If this instrument is to be energized via an autotransformer (for voltage reduction) make sure the common terminal is connected to the earthed pole terminal (neutral) of the power source.

Instructions for adjustments while covers are removed and for servicing are for use by service-trained personnel only. To avoid dangerous electric shock, do not perform such adjustments or servicing unless qualified to do so.

For continued protection against fire, replace the line fuse(s) only with 250V fuse(s) of the same current rating and type (for example, normal blow, time delay). Do not use repaired fuses or short circuited fuseholders.

When measuring power line signals, be extremely careful and always use a step-down isolation transformer whose output voltage is compatible with the input measurement capabilities of this product. This product's front and rear panels are typically at earth ground, so **NEVER TRY TO MEASURE AC POWER LINE SIGNALS WITHOUT AN ISOLATION TRANSFORMER.**

SAFETY CONSIDERATIONS

CAUTION

LINE VOLTAGE SELECTION

BEFORE CONNECTING POWER TO THE INSTRUMENT, make sure that the line voltage selector card (in the rear panel power module) is set to the correct voltage level for the ac voltage being applied, and that the correct fuse is installed. Refer to Section II, Installation.

MAXIMUM INPUT SIGNAL POWER

TO PREVENT DAMAGE TO THE INSTRUMENT, make sure that signals applied to the input do not exceed the input damage level specified for the instrument. Refer to Section I, Specifications.

ELECTROSTATIC DISCHARGE

Electronic components and assemblies can be permanently degraded or damaged by electrostatic discharge. Use the following precautions:

ENSURE that static-sensitive devices or assemblies are serviced at static-safe work stations providing proper grounding for service personnel.

ENSURE that static-sensitive devices or assemblies are stored in static-shielding containers.

DO NOT wear clothing subject to static charge buildup, such as wool or synthetic materials.

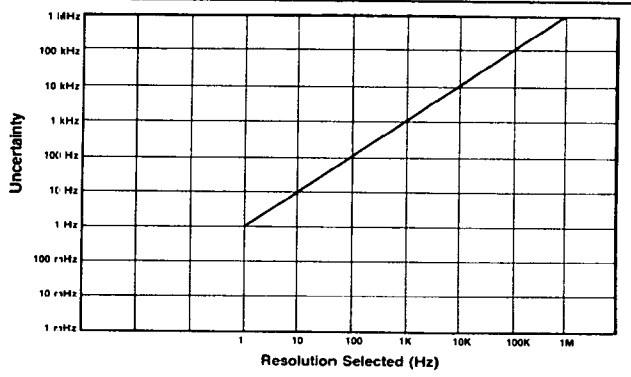
DO NOT handle components or assemblies in carpeted areas.

DO NOT remove a component or assembly from its static-shielding protection until you are ready to install it.

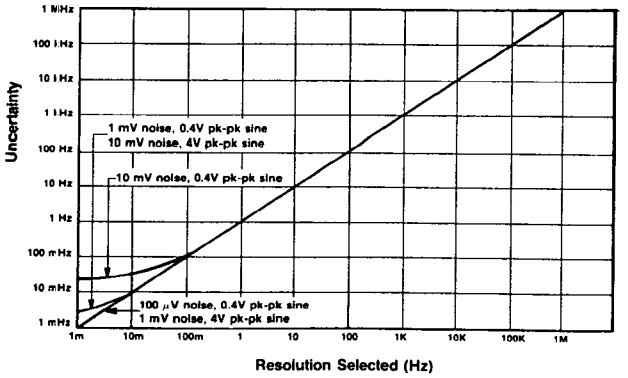
AVOID touching component leads. (Handle by the packaging only.)

Table 1-1. Model 5350B/5351B/5352B Specifications

INPUT CHARACTERISTICS			
INPUT 1:	**HP 5350B**	**HP 5351B**	**HP 5352B**
Frequency Range:	500 MHz - 20.0 GHz	500 MHz - 26.5 GHz	500 MHz - 40 GHz
Sensitivity: Full Operating Environment 500 MHz to 12.4 GHz 12.4 GHz to 20.0 GHz 20.0 GHz to 26.5 GHz 26.5 GHz to 40 GHz @ 25°C (typical) 500 MHz to 12.4 GHz 12.4 GHz to 20.0 GHz 20.0 GHz to 26.5 GHz 26.5 GHz to 40 GHz	 -32 dBm -27 dBm N/A -40 dBm -35 dBm N/A	 -32 dBm -27 dBm -16 dBm -40 dBm -35 dBm -28 dBm N/A	 -25 dBm -25 dBm -25 dBm dBm = 0.741 f(GHz) -44.6 -30 dBm -30 dBm -30 dBm dBm = 0.741 f(GHz) -49.6
Maximum Input:	+7 dBm	+7 dBm	+7 dBm
Damage Level:	+25 dBm, peak	+25 dBm, peak	+25 dBm, Peak
Impedance:	50Ω nominal	50Ω nominal	50Ω nominal
Connector:	Precision Type N female	APC-3.5 male with collar, SMA compatible	
SWR: 500 MHz - 10 GHz 10 GHz - 20 GHz 20 GHz - 26.5 GHz 26.5 GHz - 40 GHz	 <2:1 typical <3:1 typical N/A N/A	 <2:1 typical <3:1 typical <3:1 typical N/A	 <2:1 typical <3:1 typical <3:1 typical <3.5:1 typical
Coupling:	dc to 50Ω termination, ac to instrument		
Accuracy:	±1 LSD ±time base error × frequency (See Graphs 1,2,3)		
Residual Stability:	When counter and source use common 10 MHz time base or counter uses external higher stability time base, .3 LSD rms typical for resolution 1 Hz - 1 kHz at 25°C; HP 5352B only .7 LSD typical 26.5 - 40 GHz; LSD = least significant digit.		
Resolution:	Selectable 1 Hz to 1 MHz		

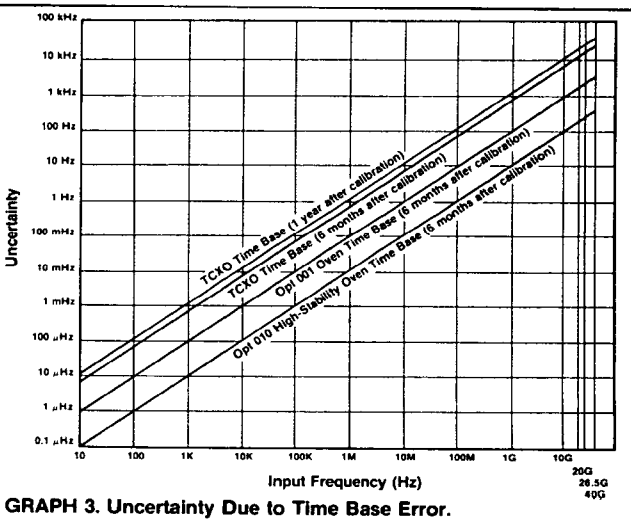


GRAPH 1. Input 1 Uncertainty Due to Resolution Selected.

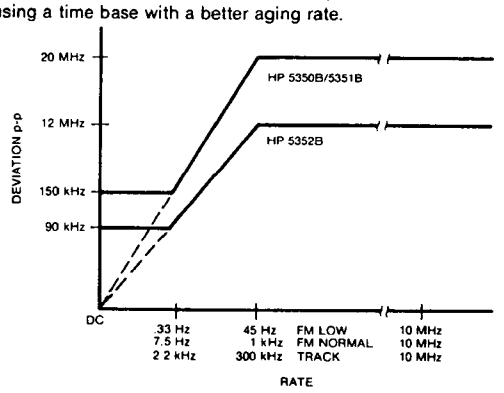


GRAPH 2. Input 2 Uncertainty Due to Trigger Error and Resolution Selected.

NOTE:
Input 1 accuracy = resolution uncertainty (Graph 1) + time base uncertainty (Graph 3).
Input 2 accuracy = resolution and trigger uncertainty (Graph 2) + time base uncertainty (Graph 3).



GRAPH 3. Uncertainty Due to Time Base Error.
Time Base Error can be reduced by calibrating the time base more frequently, or by using a time base with a better aging rate.



GRAPH 4. FM Rate Tolerance.

Table 1-1. Model 5350B/5351B/5352B Specifications (Continued)

INPUT 1: HP 5350B/5351B/5352B

Modes of Operation:
Automatic: Counter automatically acquires and displays highest level signal within sensitivity range.
Manual: Center frequency must be entered to within ± 20 MHz of input frequency; ±3 MHz worst case below 1 GHz; increases measurement and data output rate.

Automatic Amplitude Discrimination: Automatically measures the largest of all signals present, providing that signal is >6 dB (typical) above any signal within 500 MHz; > 20 dB (typical) above any signal within 500 MHz to 20 (40) GHz.

FM Tolerance (See Graph 4):
Automatic Mode: 20 MHz p-p (12 MHz, HP 5352B).
Manual Mode: 60 MHz p-p (55 MHz, HP 5352B), when center frequency is entered within ±1 MHz of input signal.
Maximum FM Rate: 10 MHz.

Tracking Speed:
Fast-Acquisition Track: 1 GHz/s.
Normal FM Rate: 1 MHz/s.
Low FM Rate: 80 kHz/s.

Acquisition Time:
Automatic Mode:
Fast-Acquisition Track: < 60 ms.
Normal FM Rate: <125 ms.
Low FM Rate: <1.25s.
Manual Mode: <20 ms

AM Tolerance: Any modulation index provided the minimum signal level is not less than the sensitivity specification.

Gate Time: For 1 Hz resolution

500 MHz-5.7 GHz	200 ms
5.7-11.3 GHz	400 ms
11.3-16.9 GHz	600 ms
16.9-22.5 GHz	800 ms
>22.5 GHz	1000 ms

INPUT 2: HP 5350B/5351B/5352B

Frequency Range: 10 Hz to 525 MHz.

Mode of Operation:
50Ω: 10 MHz to 525 MHz.
1 MΩ: 10 Hz to 80 MHz.

Sensitivity:
Full Operating Environment:
50Ω: 10 MHz to 525 MHz, 25 mV rms.
1 MΩ: 10 Hz to 80 MHz, 25 mV rms.
@ 25°C (typical):
50Ω: 10 MHz to 525 MHz, 15 mV rms.
1 MΩ: 10 Hz to 80 MHz, 15 mV rms.

Gate Time = 1/Resolution 1 ms minimum.

Resolution: selectable 1 Hz to 1 MHz.

High Resolution: 1 MΩ mode: 0.001 Hz for <100 kHz input; 0.01 Hz for < 1 MHz input; 0.1 Hz for <10 MHz input; 1 Hz for >10 MHz input: 1 second gate.

Accuracy: ± 1 LSD ±

$$\left(\frac{1.4 \times \text{Trigger Error}\,①}{\text{Gate Time}} \pm \text{Time base error}\right) \times \text{Freq.}$$

(See Graphs 1, 2, and 3)

Impedance:
Selectable: 1 MΩ nominal shunted by <70 pF or 50Ω nominal.
Coupling: ac.
Connector: Replaceable fuse, Type BNC female.
Maximum Input:
50Ω: + 10 dBm; 1 MΩ: 1V rms.
Damage Level: 50Ω or 1 MΩ
dc - 5 kHz: 250V (dc + ac peak);
>5 kHz: 5.5V rms (+28 dBm) + 1.25 × 10^6 V rms/FREQ.
Panel Label: 5.5 V rms (+ 28 dBm).

TCXO TIME BASE

Crystal Frequency: 10 MHz.
Stability:
Aging Rate: <1 × 10^{-7} per month.
Short Term: <1 × 10^{-9} for 1 s averaging time.
Temperature: <1 × 10^{-6}, 0-50°, if referenced to +25°C and set to the offset frequency.
Line Variation: <1 × 10^{-7} for 10% change from nominal.
Time Base Output: 10 MHz and 1 MHz, >2.4V square wave ac coupled into 1 kΩ: >1.5V p-p into 50Ω; available from rear panel BNC connectors whenever the instrument has ac power connected.
External Time Base: 1, 2, 5 or 10 MHz, 0.7V min. to 8V max. p-p sine wave or square wave into >1 kΩ shunted by <30 pF, via rear panel BNC connector.
External reference automatically selected when signal is present, an indicator (▼) appears in the display. TCXO power turned off, oven heater on, oscillator signal disconnected.

OPTIONAL OVEN TIME BASE OPTION 001④

Crystal Frequency: 10 MHz.
Stability:
Aging Rate: <5 × 10^{-10}/day after 24-hour warm-up; <1 × 10^{-7}/year for continuous operation ②.
Short-Term: <1 × 10^{-10} for 1 s average.
Temperature: <7 × 10^{-9}, 0-50°C
Line Variation: <1 × 10^{-10} for 10% change from nominal.
Warm-Up: <5 × 10^{-9} of final value 10 minutes after turn-on at 25°C ②.

OPTIONAL REAR PANEL INPUTS OPTION 002③

All specifications are the same except Input 1:

Sensitivity:
Sensitivity is reduced by:
1 dBm, 500 MHz to 12.4 GHz
2 dBm, 12.4 GHz to 20.0 GHz
3 dBm, 20.0 GHz to 26.5 GHz
SWR:
500 MHz -10 GHz (<2.5:1 typical)
10 GHz - 20 GHz (<3.5:1 typical)
20 GHz - 26.5 GHz (<3.5:1 typical, 5351B)

OPTIONAL INCREASED DAMAGE LEVEL OPTION 006③

Protects Input 1 from damage by limiting high level signals. All specifications are the same except Input 1:

Damage Level

500 MHz to 6 GHz	+39 dBm (8 Watts)
6 GHz to 18 GHz	+36 dBm (4 Watts)
18 GHz to 26.5 GHz	+34.8 dBm (3 Watts)

Sensitivity:
Sensitivity is reduced by:
3 dBm, 500 MHz to 12.4 GHz
4 dBm, 12.4 GHz to 20.0 GHz
5 dBm, 20.0 GHz to 26.5 GHz
SWR:
500 MHz - 10 GHz (<2.5:1 typical)
10 GHz - 20 GHz (<3.5:1 typical)
20 GHz - 26.5 GHz (<3.5:1 typical, 5351B)

OPTIONAL HIGH STABILITY OVEN TIME BASE OPTION 010④

Crystal Frequency: 10 MHz.
Stability:
Aging Rate: <7 × 10^{-10}/week after 24 hrs; <1 × 10^{-10}/day (typical) after 30 days; <2 × 10^{-8}/year for continuous operation.
Short-Term: <1 × 10^{-10} for 1 s average.
Temperature: <7 × 10^{-9}, 0-50°C.
Line Variation: <1 × 10^{-10} for 10% change from nominal.
Warm-Up: <5 × 10^{-9} of final value 10 minutes after turn-on at 25°C ②.

GENERAL

Display: Segmented 24 character alpha-numeric LCD with 24 annunciators (backlighted); lockout (see Diagnostics).
Keyboard: Set up stored in STBY mode; lockout (see Diagnostics).
Self-Check: Tests for correct circuit operation using LO frequency divided by ten.
Diagnostics: Front panel or HP-IB selectable, Display and Keyboard Lockout, Service Diagnostics and User Information.
Data Output: Over HP-IB bus; varies with Frequency and Resolution.
Automatic Mode: 100 readings per second.
Manual Mode: 120 readings per second. (10 kHz resolution, no math functions "DUMP MODE").

Math Functions: Result = **measurement × scale + offset.**
Offset: Measurement is offset by entered value.
Scale: Measurement is multiplied by entered value.
Smooth: Displayed resolution is determined using exponential averaging; Displays only stable digits.
Sample Rate: Variable from less than 50 ms between measurements to HOLD, which holds the display indefinitely or until **Trigger** occurs.
Display Rate: 5/s, 1 kHz resolution.
Overload Indication: "OVRLOAD" A user message; External pad or signal attenuation should be used to avoid damage.

Sleep Mode: Input 1 emissions reduced to <-70 dBm typical when sleep mode or input 2 is selected.
IF Output: Rear panel BNC provides 30-110 MHz down-converted microwave signal at >-20 dBm into 50Ω, ac coupled.
HP-IB: Functions and diagnostics are programmable; address settable from front panel. Default switches on rear panel; Teach/Learn programming; IEEE 728 compatible command structure; Function subset SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT1, C0, E1.
Reset/local: returns to local control.

Operating Temperature: 0°C to 50°C.
Power Requirements: 100 VA max.
Line Select:
100 V (90-105 VAC rms; 47.5-440 Hz).
115/120 V (104-126 VAC rms; 47.5-440 Hz).
220 V (198-231 VAC rms; 47.5-66 Hz).
230/240 V (207-252 VAC rms; 47.5-66 Hz).
Accessories Furnished: Power cord, manual
Size: D/133 mmH × 407 mmW × 358 mmD (5 ¼ in. H × 16 in. W × 14 in. D).
Weight: 11 kg (24 lb)

Footnotes:

① **Trigger Error:**

$$\frac{\sqrt{e_i^2 + e_n^2}}{\text{Input Slew Rate in V/s at Trigger point}} \text{ s rms}$$

Where e_i = Effective rms noise of counter's input channel. (100 μV typical)
e_n = rms noise of the input signal for a 500 MHz bandwidth.

② For oscillator off time less than 24 hours. Final value is defined as frequency 24 hours after turn on; an indicator (▼) appears in the display until the oven reaches operating temperature.
③ Available with HP 5350B/5351B only.
④ Options 001 and 010 are mutually exclusive.

Table 1-5. Recommended Test Equipment

Instrument	Required Characteristics	Use*	Recommended Model
Oscilloscope	275 MHz bandwidth Delayed sweep capability	T,A	HP 1725A
Oscilloscope Probe (2 required)	High impedance (10:1) Minimal capacitance (8-10 pF)	T,A	HP 10017A
Active Probe	≥350 MHz 100:1 divide capability	T	HP 1120A
High Impedance Oscilloscope Probe	10MΩ or greater	T	HP 10014A
Storage Oscilloscope	100 MHz bandwidth Storage capability	T	HP 1744A
Sweep Oscillator	.01-20 GHz [26.5 GHz] Frequency Modulation capability 20 MHz p-p	OV,P	HP 8350B mainframe/ HP 83595A plug-in
Synthesized Signal Generator	10 MHz to 2.6 GHz 5% Amplitude Modulation 200 kHz FM p-p -40 dBm to +10 dBm	T,A	HP 8660C mainframe/ HP 86603A plug-in/ HP 86632B plug-in
Synthesizer Sweeper	10 MHz to 26.5 GHz	A	HP 8340B
Synthesizer	2 GHz to 26.5 GHz 1 Hz accuracy +4 dBm output	P	HP 8673B
Synthesizer	10 Hz to 10 MHz -20 dBm to +5 dBm	OV,P	HP 3325A
Millimeter-wave Source Module	+5 dBm -15 dBc harmonic and subharmonic suppression	OV,P	HP 83554A
Spectrum Analyzer	RF inputs from 1 MHz to 500 MHz	T,P	HP 8565A
Digital Voltmeter	4 ½ digit AC/DC	T,A	HP 3466A
Variable Transformer	120V/240V	T	Allied Electronics P/N 927-6010(120V) P/N 927-6120(240V)
Signature Analyzer	TTL compatible QUAL mode required	T	HP 5005B
Power Meter	50 MHz to 40 GHz	A,OV,P	HP 436A
Power Sensor	50 MHz to 26.5 GHz -30 to +10 dBm	A,OV,P	HP 8485A
Power Sensor	26.5-40 GHz -30 to +10 dBm	OV,P	HP R8486A

*T = Troubleshooting
A = Adjustments
OV = Operation Verification
P = Full Performance Testing

Table 1-5. Recommended Test Equipment (Continued)

Instrument	Required Characteristics	Use*	Recommended Model
Frequency Counter	9-digit resolution	A	HP 5384A
Waveguide Attenuator	26.5-40 GHz	P	HP R382A
Amplifier	13.5-20 GHz +17 dBm output minimum 12 dB gain minimum	P	HP 8349B (Option 002)
Waveguide Directional Coupler	26.5-40 GHz 10 dB coupling	P	HP R752C
Waveguide-to-Coax Adapter	UG599/U to APC 3.5 female	P	Maury U230A
Power Supply	480 mA @ 20V	T	HP 6216A
Sampling Voltmeter	±3% accuracy at 10 MHz	T	HP 3406A
Controller	IEEE-488 Interface compatible BASIC compatible	T,OV,P	HP-85B HP 82937A Interface HP 82936A ROM Drawer HP 82903A 16K Memory Module Advanced Programming ROM HP P/N 00085-15005
Power Splitter	DC to 26.5 GHz	OV,P	HP 11667B
50Ω Termination	DC to 26.5 GHz	P	HP 909D
50Ω Feedthrough Termination	BNC male to BNC female	OV,P	HP 10100C
Step Attenuator	DC to 26.5 GHz	OV,P	HP 8495D
Fixed Attenuator	10 dB ±1 dB	P	HP 8493C (Option 010, Option 890)
Fixed Attenuator	20 dB Attenuation	A	HP 8491A Option 20
Extender Boards (2 required)	50 pin (2 X 25)	T	HP P/N 5060-0175
Extender Cable	SMB male to SMB female	T	HP P/N 05350-60102
IF Test Cable	90° SMB female to BNC male	T	HP P/N 05350-60121
LO Test Cable	90° SMB male to BNC male	T	HP P/N 05350-60120
HP-IB Verification Tape	Rev. H or later	T,OV,P	HP P/N 59300-10002

*T = Troubleshooting
A = Adjustments
OV = Operation Verification
P = Full Performance Testing

SECTION IV
PERFORMANCE TESTS

4-1. INTRODUCTION

4-2. This section contains procedures for testing the electrical performance of the HP 5350B, 5351B and 5352B Microwave Frequency Counters, using the specifications listed in *Table 1-1* as performance standards. All test procedures in this section apply to all three models unless otherwise indicated. Specifications which apply only to an individual model are indicated in the following procedures by being enclosed in brackets, [ ].

4-3. OPERATION VERIFICATION

4-4. The Operation Verification procedure, beginning at paragraph 4-17, is an abbreviated series of tests that may be performed to give a high degree of confidence that the instrument is operating properly without performing the complete Performance Test. An Operation Verification should be useful for incoming inspection, routine maintenance, and after instrument repair.

4-5. PERFORMANCE TEST

4-6. The complete Performance Test procedures begin at paragraph 4-30. All tests can be performed without access to the inside of the instrument.

4-7. HP-IB VERIFICATION

4-8. An HP-IB verification program, described in paragraph 4-24, exercises the instrument through the majority of its command set via the HP-IB interface. The program is written for an HP-85B as the controller. If the instrument successfully completes all phases of the verification program, there is a very high probability that the HP-IB interface and the counter are working properly. The HP-IB program is available on a cassette, HP Part No. 59300-10002 (Revision H or later).

4-9. EQUIPMENT REQUIRED

4-10. The equipment required for all test procedures in this section is listed in *Table 1-5*. Any equipment that satisfies the required characteristics given in the table may be substituted for the recommended models.

4-11. CALIBRATION CYCLE

4-12. The HP 5350B/51B/52B requires periodic verification of operation. Depending on the use and environmental conditions, the counter should be checked using the Operation Verification procedure at least once every year. A full calibration procedure, including adjustments and a full Performance Test, should be performed at least once every 6 months for instruments equipped with the standard TCXO timebase, at least once a year for instruments equipped with the Option 001 Oven Oscillator Timebase, and once every 5 years for instruments equipped with the Option 010 High Stability Timebase, in order to maintain kHz accuracy of the HP 5350B/51B/52B.

4-13. TEST RECORD

4-14. Results of the operation verification should be recorded on a copy of the Operation Verification Record, *Table 4-3*, located at the end of the procedure. Results of the Performance Tests should be recorded on a copy of the Performance Test Record, *Table 4-4*, located at the end of this section.

4-15. OPTION TEST SPECIFICATIONS

4-16. The Operation Verification and Performance Tests described in this section are intended for testing of the standard HP 5350B/51B/52B. If Option 002 (Rear Panel Inputs) or Option 006 (Limiter) is installed in the 5350B or 5351B, the sensitivity specifications of the counter will be different from the standard instrument. An HP 5350B or 5351B equipped with either, or both, options should be tested using the same procedures as for the standard instrument, using the option specifications listed in Section I as performance standards. Refer to *Table 1-1, Specifications*, and Section III, paragraphs 3-47 and 3-49, for information on Option 002 and 006 specifications.

NOTE

The following operation verification and performance test procedures require measurement of the actual input sensitivity of the 5350B/5351B/5352B. The actual sensitivity MUST be measured as follows:

1. Before measuring, be sure to calibrate the power meter according to the frequency calibration data provided on the power sensor to be used in the test.

2. To measure actual sensitivity, decrease the input level to the counter until it stops counting, then slowly increase the input level until the counter measures the input properly (as defined by the particular procedure being performed).

4-17. OPERATION VERIFICATION PROCEDURE

4-18. Power-Up Self Test

a. Before connecting the power cord and switching on the instrument, be sure that the line voltage selector is properly set, the correct fuse is installed, and all safety precautions have been observed.

b. Set the POWER switch to the ON position and verify the Power-Up Self Test routine, as follows:

1. Immediately after switching the power on, the counter performs a display test in which all segments of the liquid crystal display are turned on. The display should remain in this state for about three seconds. Check that no segments are missing.

2. If any of the internal tests fail, the results of the first test failing will be displayed after the display test. Pressing the RESET/LOCAL key will display the next test, if any, failing. When all failing tests have been displayed, the HP-IB address will be displayed for about two seconds. If all tests pass, the HP-IB address will be displayed immediately after the display test.

3. After the HP-IB address is displayed, the counter should go into the measurement mode last selected (if the counter had previously been left in Standby), or into the Auto mode with FM Rate/Track set to NORMAL (if AC power had previously been disconnected from the counter).

4. If a FAIL message is displayed during the Power-Up Self Test, refer to troubleshooting procedures in Section VIII, Service, for information about specific diagnostic failures.

c. Enter results of the Power-Up Self Test on the Operation Verification Record (*Table 4-3*).

4-19. INPUT 2, Gating and Counting Check

a. Set the counter to the INPUT 2, 50Ω impedance mode by pressing the 50Ω key.

b. Connect the rear panel 10MHZ OUT BNC to the front panel INPUT 2. Verify that the instrument displays: 10 000 000 (±1 Hz).

c. Enter results on the Operation Verification Record.

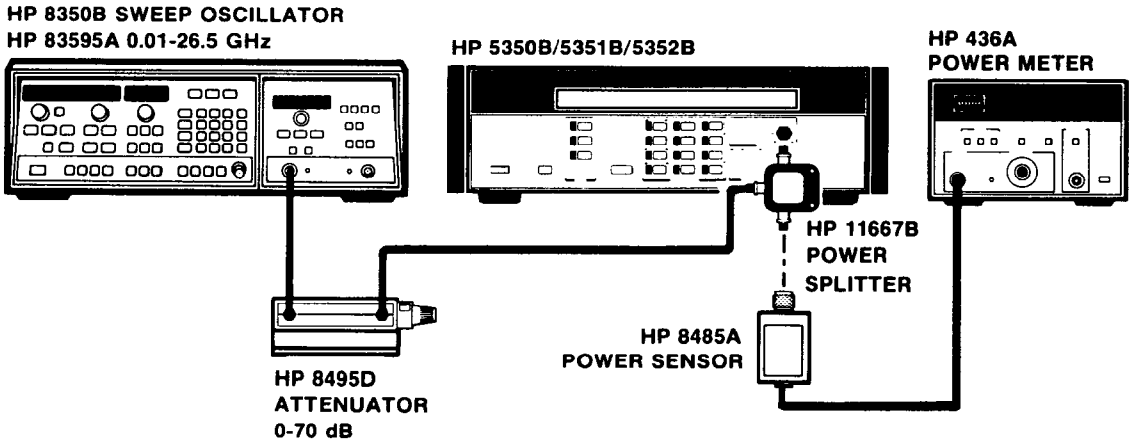
4-20. INPUT 2, 10 Hz-525 MHz Input Sensitivity Test

4-21. The following test is in two parts, Setup 1 for 50 MHz to 525 MHz, and Setup 2 for 10 Hz to 20 MHz.

Specification: 50Ω: 10 MHz-525 MHz, 25 mV rms
1MΩ: 10 Hz-80 MHz, 25 mV rms

Description: The counter is set to the 10 MHz-525 MHz range, 50Ω impedance, and a 25 mV rms (-19.3 dBm) signal is applied to INPUT 2. The test generator is set to selected frequencies and the 5350B/51B/52B is checked for proper counting. The counter is next set for 1MΩ impedance, a 25 mV rms (-19.3 dBm) 80 MHz signal is applied to INPUT 2 through a 50Ω feedthrough, and the counter is checked for proper counting. The test setup is changed to Setup 2 to test the 10 Hz-20 MHz range.

Setup 1: INPUT 2, 50 MHz-525 MHz



a. Set the counter to the 10 MHz-525 MHz range, 50Ω impedance, by pressing the 50Ω key.

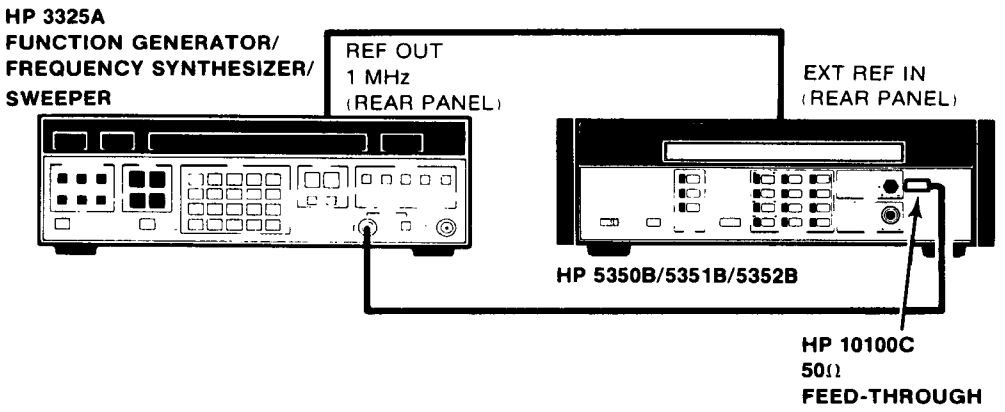
b. Set the 8350B to 50 MHz, and the 83595A and 8495D for an output level of 25 mV rms (-19.3 dBm) as measured on the 436A Power Meter. Measure actual sensitivity and verify that the 5350B/51B/52B counts properly at 50 MHz, 100 MHz, 250 MHz, and 525 MHz. (Note that exact frequencies may not be achieved due to the frequency stability characteristics of the 8350B source.) Enter the results in the Operation Verification Record (*Table 4-3*).

c. Insert a 50Ω feedthrough between the 11667B power splitter and INPUT 2 of the counter. Press the 1MΩ key on the counter to select the 1MΩ impedance, 10 Hz-80 MHz input.

d. Set the 8350B to 80 MHz, and set the 83595A for a level of 25 mV rms (-19.3 dBm) as measured on the 436A Power Meter.

e. Verify that the 5350B/51B/52B counts properly at 80 MHz at 25 mV rms, and enter the result in the Operation Verification Record.

Setup 2: INPUT 2, 10 Hz-20 MHz



a. 5350B/51B/52B settings are the same as in the 80 MHz test (INPUT 2, 1MΩ).

b. Connect the 3325A to INPUT 2 of the counter via a 50Ω feedthrough. Set the 3325A for an output of 25 mV rms (-19.3 dBm) at 10 Hz.

c. Verify that the counter counts properly at 10 Hz, 50 kHz, 1 MHz, 10 MHz, and 20 MHz. Enter results in the Operation Verification Record.

4-22. INPUT 1, 500 MHz-20 GHz [26.5 GHz, 40 GHz] Input Sensitivity Test

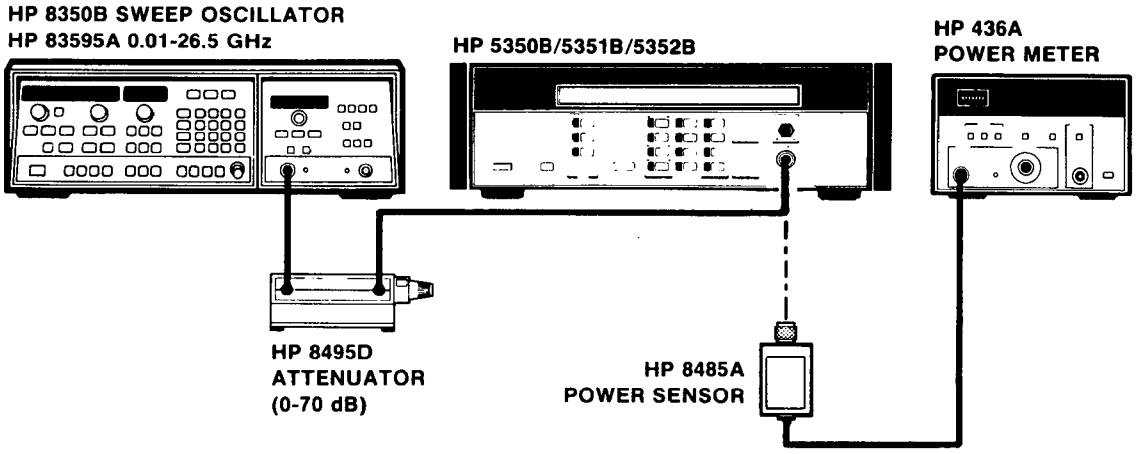
4-23. The following test is in two parts, Setup 1 for 500 MHz to 20 [26.5] GHz, and Setup 2 for 26.5 GHz to 40 GHz [5352B only].

Specifications:

5350B sensitivity	=	-32 dBm, 500 MHz-12.4 GHz
	=	-27 dBm, 12.4 GHz-20 GHz
5351B sensitivity	=	-32 dBm, 500 MHz-12.4 GHz
	=	-27 dBm, 12.4 GHz-20 GHz
	=	-16 dBm, 20 GHz-26.5 GHz
5352B sensitivity	=	-25 dBm, 500 MHz-26.5 GHz
	=	0.741 × freq. in GHz - 44.6 dBm, for frequencies greater than 26.5 GHz. (-15 dBm at 40 GHz)

Description: The counter is set to the 500 MHz-20 GHz [26.5 GHz, 40 GHz] range and the appropriate input signal is applied to INPUT 1. The generator is set to selected frequencies and levels appropriate to the model being tested, and the actual sensitivity of the HP 5350B/51B/52B is measured up to 20 GHz [26.5 GHz, 5351B/5352B]. Setup 2 is used to measure the actual sensitivity of the 5352B at selected frequencies up to 40 GHz.

Setup 1: 500 MHz-20 GHz [26.5 GHz]



a. Set the counter to INPUT 1, Automatic mode by pressing the AUTO key.

b. Connect the equipment as shown in Setup 1.

c. Set the 8350B to 500 MHz, and set the 83595A and 8495D for -32 dBm [-25 dBm, 5352B], as measured on the 436A.

d. Measure the actual sensitivity at 500 MHz, 1 GHz, 5 GHz, and 12.4 GHz. (Verify the signal level with the 436A Power Meter at each of these frequencies.) Enter the actual sensitivity result in the Operation Verification Record.

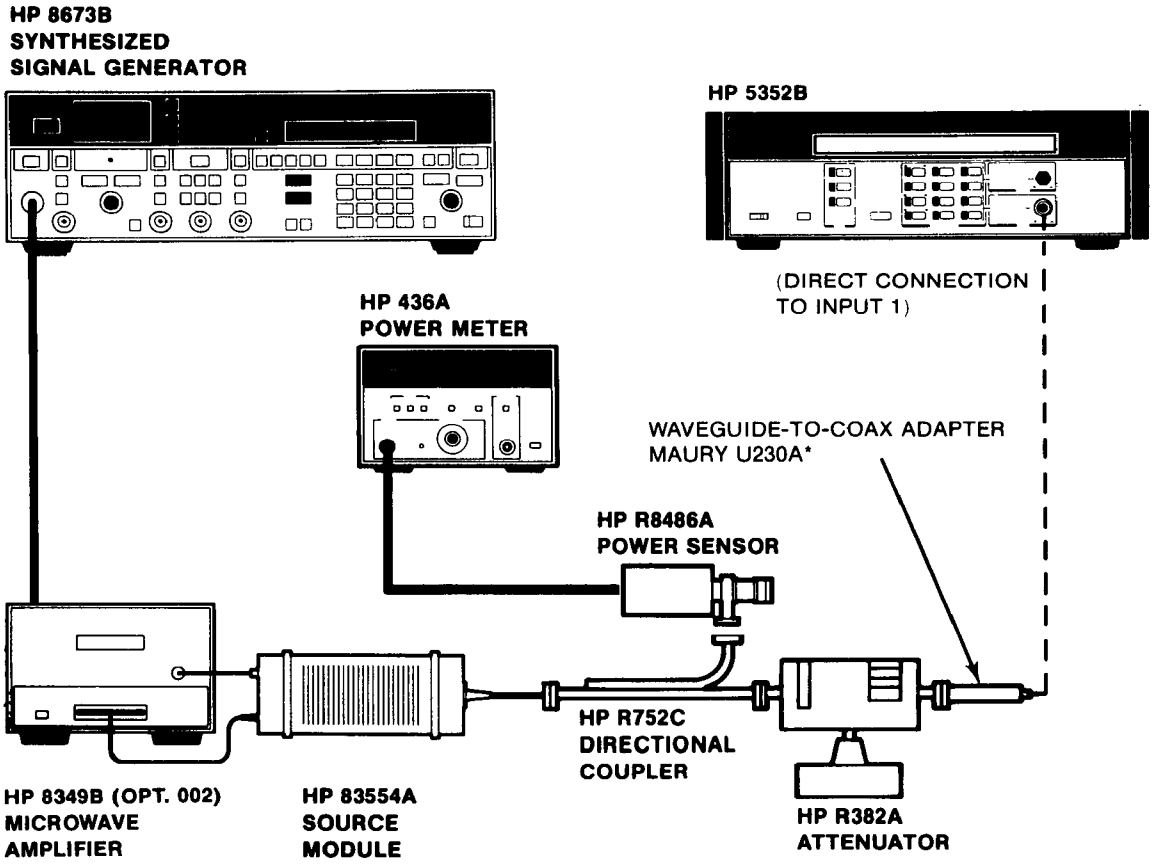
e. Set the 8350B to 18 GHz. Set the 83595A and 8495D for -27 dBm [-25 dBm, 5352B] as measured on the 436A.

f. Measure the actual sensitivity at 18 GHz and 20 GHz. (Verify the signal level with the 436A Power Meter at each of these frequencies.) Enter the actual sensitivity result in the Operation Verification Record.

g. If a 5351B is being tested, set the 83595A and 8495D for -16 dBm at 22 GHz. Measure the actual sensitivity at 22 GHz and 26.5 GHz. Enter the actual sensitivity result in the Operation Verification Record.

h. If a 5352B is being tested, leave the 83595A and 8495D set to -25 dBm at 22 GHz. Measure the actual sensitivity at 22 GHz and 26.5 GHz. Enter the actual sensitivity result in the Operation Verification Record.

Setup 2: 26.5 GHz-40 GHz [5352B]



*Available from: Maury Microwave Corporation, 8610 Helms Avenue, Cucamonga, CA 91730.

a. Set the 5352B to INPUT 1, Automatic mode by pressing the AUTO key.

b. Connect the equipment as shown in Setup 2.

c. Measure the actual sensitivity at 26.5 GHz, 30 GHz, 34 GHz, and 40 GHz, as follows:

1. Set the 8673B to 13.25 GHz, and set the level for a +17 dBm output from the 8349B Amplifier (as indicated on the 8349B front panel display).

2. Add attenuation by adjusting the R382A Precision Attenuator until the counter stops measuring, then decrease the attenuation until the counter measures the input properly.

3. Note the doubled frequency (26.5 GHz) power reading on the 436A, add +10 dB to the reading, and subtract the value of the R382A attenuator setting to obtain the sensitivity level of the counter.

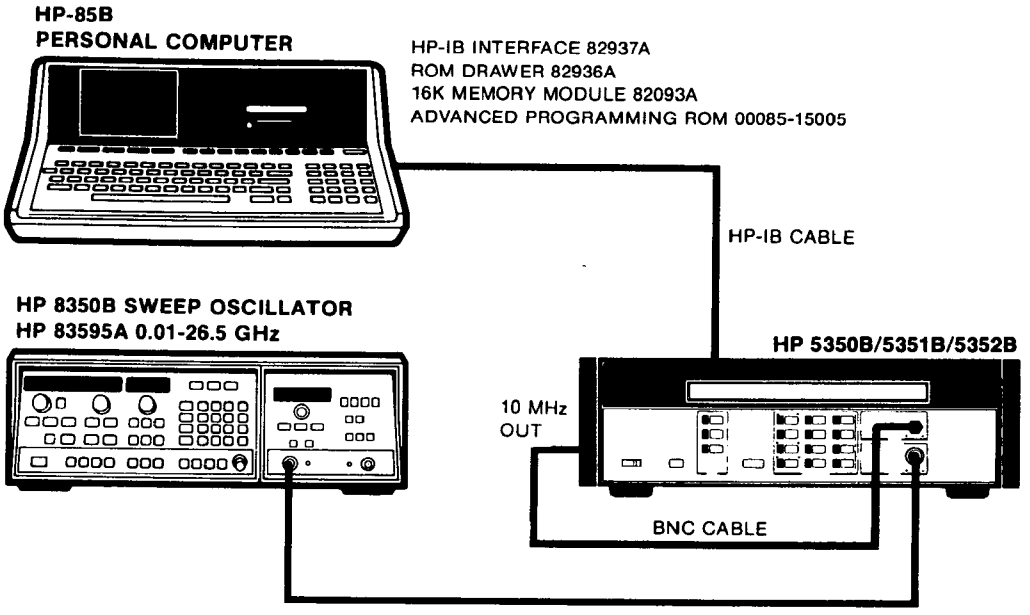
4. Repeat the above steps at 30 GHz, 34 GHz, and 40 GHz (15, 17, and 20 GHz input to the source module, respectively).

d. Enter the actual sensitivity result in the Operation Verification Record.

4-24. HP-IB VERIFICATION

4-25. The HP-85 program listed in *Table 4-1* exercises the HP 5350B/51B/52B through various operating modes via the counter's HP-IB interface. If the counter successfully completes all phases of the verification program, there is a high probability that the HP-IB interface (A11 Assembly) is operating correctly. This program is not intended to be an automated test system for operation verification of the entire counter, but rather an aid to verify that the HP-IB interface is handshaking properly, sending valid data to the controller, and controlling the counter properly. If the HP 5350B/51B/52B does not respond as described, refer to A11 HP-IB Interface Assembly troubleshooting in Section VIII.

4-26. To perform the verification, set up the HP 5350B/51B/52B, HP-85B, and signal source as shown below. The program will function with any valid HP-IB address set for the counter.



NOTE

If using an HP-85A, a Mass Storage ROM (HP P/N 00085-15001) and I/O ROM (HP P/N 00085-15003) will be required to run the verification program.

4-27. The program listed in *Table 4-1* may be keyed into the HP-85B, or may be loaded from an HP-IB Verification Cassette, HP P/N 59300-10002, (Revision H or later). To run the program on the cassette, insert the cassette into the HP-85B, load the program "505152", and press RUN.

4-28. The program goes through 16 checkpoints, including a test to verify remote response at all legal addresses (Checkpoint 16). At the conclusion of each checkpoint, the operator is requested to enter the results of the current checkpoint. These results are stored and can be printed upon completion of the program. *Table 4-2* is a sample printout of the results of the HP-IB Verification program. The printed listing of results should be attached to the Operation Verification Record (*Table 4-3*).

4-29. Various checkpoints throughout the program ask the operator to verify that the counter's GATE annunciator is on, as well as other annunciators. Note that if a signal is present at the appropriate input, the GATE annunciator should be flashing at a rate proportional to the sample rate.

Table 4-1. HP-85 Program Listing

```
5 ! ***HP 5350/5351/5352**
10 !    HP-IB OPERATION
15 !  VERIFICATION PROGRAM
20 !
25 ! BJG, SM
30 ! DATE: 12 JUNE 1986
35 ! REVISION C
40 !
45 ! This program exercises
50 ! 5350/5351/5352 through the
55 ! majority of its command
60 ! code set via HP-IB.  The
65 ! program consists of 16
70 ! checkpoints, and provides
75 ! the user with the ability
80 ! to execute and repeat
85 ! these tests in any order.
90 ! Also provided are options
95 ! to print the checkpoint
100 ! summary and results.  The
105 ! program relies on
110 ! subroutines in addition
115 ! to arrays and simple
120 ! variables.
125 !
130 ! Dimension and initialize
135 ! string variable arrays.
140 PRINTER IS 2
145 OPTION BASE 1
150 DIM A$[32],B$[32],D$[24],F$[32],G$[32]
155 DIM H$[32],I$[32],N$[7],R$[15],R(16)
160 DIM S$[68],D(30),D1(30)
165 D=0
170 T=0
175 ! VARIABLE TABLE
180 ! A=Address of counter
185 ! C=CRT(1) or PRINTER(2)
190 ! D=Desired checkpoint
195 ! T=Test$
200 ! I=Do Loop Index
205 ! M=Measmt data (real)
210 ! M1=Measmt data (real)
215 ! K=Address failure counter
220 ! J=Address pass counter
225 ! D(30)=Failed address array
230 ! D1(30)=Passed address array
235 ! R(16)=Array to store test results
240 A$="Press CONT to perform test."
245 B$="Press CONT when ready."
250 ! D$= ASCII data
255 N$="" ! ID of counter
260 F$="Press CONT for next display."
265 G$="          CHECKPOINT "
270 H$="********************************"
275 ! R$="PASS" or "FAIL"
280 ! S$=Front panel set-up data
285 !
290 ! Initialize test
295 ! results array
300 FOR I=1 TO 16
305 R(I)=2
310 NEXT I
315 CRT IS 1
320 C=1
325 ENABLE KBD 1+32
330 !
335 ! DISPLAY TITLE, CHECKPOINT LIST AND
340 ! SETUP INSTRUCTIONS
345 CLEAR
350 DISP USING "5/,"
355 DISP H$
360 DISP
365 DISP "5350/5351/5352 HP-IB OPERATION "
370 DISP "        VERIFICATION PROGRAM"
375 DISP
380 DISP H$
385 DISP
390 WAIT 2500
395 CLEAR
400 DISP USING "5/,"
405 DISP H$
410 DISP
415 DISP H$
420 DISP
425 DISP "       CHECKPOINT SUMMARY"
430 DISP
435 DISP H$
440 DISP
445 ! IF PRINTER(2) THEN SKIP
450 ! WAIT AND CLEAR
455 IF C=2 THEN 470
460 WAIT 2000
465 CLEAR
470 DISP " 1 Remote,Local Lockout, Local"
475 DISP " 2 Self Check ('TEST?')"
480 DISP " 3 'DISPLAY'"
485 DISP " 4 'INIT' & 'RESET'"
490 DISP " 5 'REF' & 'OVEN'"
495 DISP " 6 'ERR?'"
500 DISP " 7 'SET' & 'SET?'"
505 DISP " 8 'LOWZ' & 'HIGHZ'"
510 DISP " 9 'SAMPLE' & 'TRIGGER'"
515 DISP " 10 'RESOL' & 'HIRESOL'"
520 DISP " 11 'OFFSET', 'SCALE' & 'SMOOTH'"
525 DISP " 12 'AUTO' & 'MANUAL'"
530 DISP " 13 'FMRATE'"
535 DISP " 14 'SRQMASK'"
540 DISP " 15 'DUMP'"
545 WAIT 3000
550 CLEAR
555 DISP " 16 CHECK ALL ADDRESSES"
560 ! IF PRINTING,CONTINUE
565 IF C=2 THEN GOTO 665
570 DISP
575 DISP F$
580 PAUSE
585 CLEAR
590 DISP "Would you like a printed version"
595 DISP "of the checkpoint summary?"
600 DISP USING "3/,"
605 DISP "YES-Press K1 to receive a"
610 DISP "printed version."
615 DISP
620 DISP "NO-Press K4 to proceed"
625 ON KEY$ 1,"YES" GOTO 645
630 ON KEY$ 4,"    NO" GOTO 680
635 KEY LABEL
640 GOTO 640
645 CLEAR ! YES PRINTOUT
650 CRT IS 2
655 C=2
660 GOTO 405 ! GO BACK AND PRINT
665 DISP USING "5/,"
670 CRT IS 1
675 C=1
680 CLEAR ! NO PRINTOUT
685 DISP "The HP 85B should have an "
690 DISP "Advanced Prgrm Rom in its ROM"
695 DISP "Drawer and an 82937A HP-IB"
700 DISP "Interface Card/Cable."
705 DISP "Connect the HP-IB Interface to"
710 DISP "the rear panel of the HP 5350"
715 DISP "5351, or 5352 and power-up the"
720 DISP "instrument.  A source capable"
```

Table 4-1. HP-85 Program Listing (Continued)

```
725 DISP "of outputting 1 GHz from -10"
730 DISP "dBm to +10 dBm will also be"
735 DISP "needed to complete this"
740 DISP "verification."
745 WAIT 10000
750 CLEAR
755 DISP
760 DISP "Consult the HP 5350/5351/5352"
765 DISP "Operating and Service Manual"
770 DISP "for additional information."
775 DISP
780 DISP B$
785 PAUSE
790 !
795 ! SEARCH FOR 5350/5351/5352
800 !       ADDRESS
805 CLEAR
810 DISP USING "3/,"
815 DISP "Searching for counter address..."
820 SET TIMEOUT 7;1000
825 ON TIMEOUT 7 GOTO 905
830 FOR A=700 TO 730
835 ! 721 = ADDRESS OF CONTROLLER
840 IF A=721 THEN 915
845 REMOTE A
850 OUTPUT A ;"ID?"
855 ENTER A ; N$
860 IF N$="HP5350A" THEN 965
865 IF N$="HP5351A" THEN 965
870 IF N$="HP5352A" THEN 965
875 IF N$="HP5350B" THEN 965
880 IF N$="HP5351B" THEN 965
885 IF N$="HP5352B" THEN 965
890 IF N$="HP5350M" THEN 965
895 IF N$="HP5351M" THEN 965
900 IF N$="HP5352M" THEN 965
905 ABORTIO 7
910 CLEAR A
915 NEXT A
920 BEEP 250,25
925 WAIT .1
930 BEEP 250,25
935 DISP
940 DISP "Address not found."
945 DISP
950 DISP B$
955 PAUSE
960 GOTO 805 ! TRY AGAIN
965 DISP
970 DISP N$;" found at address";A;"."
975 BEEP 250,25
980 WAIT 250
985 BEEP 250,25
990 WAIT 2000
995 SET TIMEOUT 7;0
1000 ! IF CKPT 16 THEN RETURN TO
1005 ! IT
1010 IF T=16 THEN GOTO 6095
1015 GOSUB 6500 ! CHOOSE 1ST CHKPT
1020 GOTO 6440 ! GOTO CHECKPOINT
1025 !
1030 !  CHECKPOINT 1
1035 T=1
1040 I$="REMOTE, LOCAL LOCKOUT AND LOCAL"
1045 GOSUB 6100 ! DISPLAY TITLE
1050 DISP
1055 DISP "Checkpoint 1 tests the"
1060 DISP "REMOTE, LOCAL LOCKOUT,"
1065 DISP "and LOCAL HP-IB commands."
1070 DISP "Each command will be "
1075 DISP "programmed and the operator"
1080 DISP "will be prompted as to what"
1085 DISP "conditions should be verified."
1090 DISP
1095 DISP B$
1100 PAUSE
1105 CLEAR
1110 LOCAL A
1115 REMOTE A
1120 OUTPUT A ;"INIT"
1125 DISP
1130 DISP "              REMOTE"
1135 DISP
1140 DISP "Verify that the REM,LSN,FM NORM"
1145 DISP "and AUTO annunciators are on."
1150 DISP
1155 DISP B$
1160 PAUSE
1165 CLEAR
1170 DISP
1175 DISP "         LOCAL LOCKOUT"
1180 DISP
1185 DISP "Verify that pressing any of the"
1190 DISP "front panel keys other than"
1195 DISP "POWER will not affect the "
1200 DISP N$;"."
1205 DISP USING "2/,"
1210 DISP B$
1215 LOCAL LOCKOUT 7
1220 PAUSE
1225 CLEAR
1230 DISP
1235 DISP "               LOCAL"
1240 DISP
1245 DISP "Verify that the REM annunciator"
1250 DISP "is no longer on, and the ";N$
1255 DISP "responds to front panel entries."
1260 LOCAL 7
1265 DISP USING "2/,"
1270 DISP B$
1275 PAUSE
1280 REMOTE A
1285 GOTO 6185 ! RECORD RESULTS
1290 !
1295 !  CHECKPOINT 2
1300 T=2
1305 I$="     SELF CHECK ('TEST?')"
1310 GOSUB 6100 ! DISPLAY TITLE
1315 DISP
1320 DISP "Checkpoint 2 tests the 'TEST?'"
1325 DISP "HP-IB command.  The results of"
1330 DISP "the SELF CHECK will be sent over"
1335 DISP "the bus and displayed on the"
1340 DISP "controller CRT."
1345 DISP
1350 DISP B$
1355 PAUSE
1360 CLEAR
1365 REMOTE A
1370 OUTPUT A ;"INIT"
1375 OUTPUT A ;"TEST?"
1380 ENTER A ; D$
1385 DISP "The results of SELF CHECK are:"
1390 DISP
1395 DISP "   ";D$
1400 DISP
1405 IF D$[1,4]="PASS" THEN 1445
1410 DISP "The ";N$;" failed the SELF"
1415 DISP "CHECK.  It is recommended that"
1420 DISP "the fault on the ";D$[18,19];" or"
1425 DISP "associated assemblies be "
```