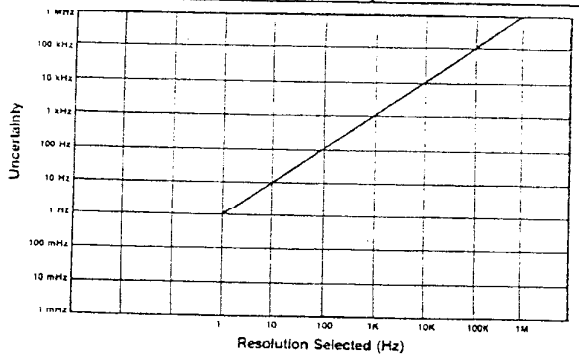
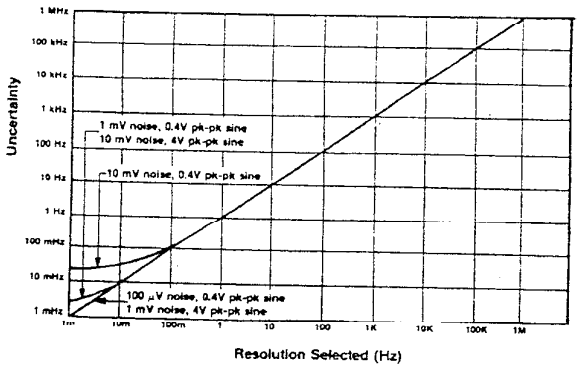
HP 5351B

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	-32 dBm	-32 dBm	-25 dBm
12.4 GHz to 20.0 GHz	-27 dBm	-27 dBm	-25 dBm
20.0 GHz to 26.5 GHz	N/A	-16 dBm	-25 dBm
26.5 GHz to 40 GHz			dBm = 0.741 f(GHz) -44.6
@ 25°C (typical)			
500 MHz to 12.4 GHz	-40 dBm	-40 dBm	-30 dBm
12.4 GHz to 20.0 GHz	-35 dBm	-35 dBm	-30 dBm
20.0 GHz to 26.5 GHz	N/A	-28 dBm	-30 dBm
26.5 GHz to 40 GHz		N/A	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	<2:1 typical	<2:1 typical	<2:1 typical
10 GHz - 20 GHz	<3:1 typical	<3:1 typical	<3:1 typical
20 GHz - 26.5 GHz	N/A	<3:1 typical	<3:1 typical
26.5 GHz - 40 GHz	N/A	N/A	<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		

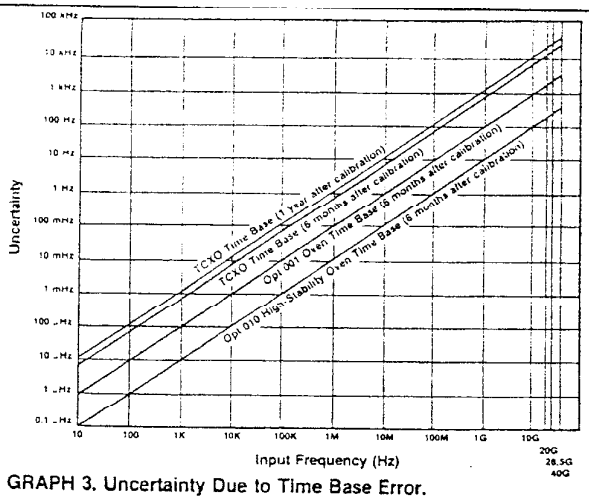


GRAPH 1. Input 1 Uncertainty Due to Resolution Selected.

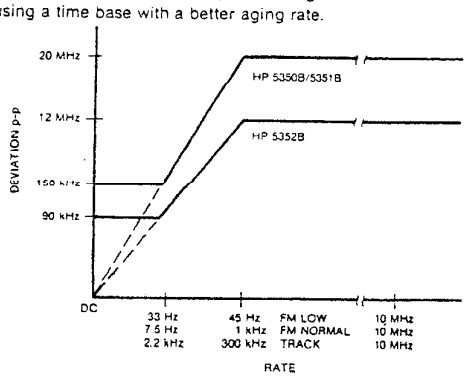


GRAPH 2. Input 2 Uncertainty Due to Trigger Error and Resolution Selected.

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.

1-12. INSTRUMENT AND MANUAL IDENTIFICATION

1-13. The instrument serial number is located in the upper right corner of the rear panel. The serial number is in the form: 0000A00000. The first four digits and the letter are the serial number prefix. The last five digits are the suffix. The prefix is the same for all identical instruments; it changes only when a change is made to the instrument. The suffix, however, is assigned sequentially and is different for each instrument. The contents of this manual apply to instruments with the serial number prefix(es) listed under SERIAL NUMBERS on the title page.

1-14. An instrument manufactured after the printing of this manual may have a serial number prefix that is not listed on the title page. This unlisted serial number prefix indicates the instrument is different from those described in this manual. The manual for this newer instrument is accompanied by a yellow "Manual Changes" supplement. This supplement contains change information that explains how to adapt the manual to the newer instrument.

1-15. In addition to change information, the supplement may contain information for correcting errors in the manual. To keep this manual as current and accurate as possible, Hewlett-Packard recommends that you periodically request the latest Manual Changes supplement. The supplement for this manual is identified with the manual print date and part number, both of which appear on the manual title page. Complimentary copies of the supplement are available from Hewlett-Packard.

1-16. For information concerning a serial number prefix that is not listed on the title page or in the Manual Changes supplement, contact your nearest Hewlett-Packard office. Addresses and phone numbers of HP Sales and Support offices are located at the back of this manual.

1-17. DESCRIPTION

1-18. The HP 5350B is a CW microwave counter with a measurement range of 10 Hz to 20 GHz. The HP 5351B and 5352B counters are similar to the 5350B, with the 5351B having an extended measurement range of 10 Hz to 26.5 GHz, and the 5352B a range of 10 Hz to 40 GHz. All three counters combine high performance microwave measurements with simple, easy-to-use operating procedures. The HP 5350B/51B/52B is controlled by a single microprocessor which interacts with the counting circuitry to generate data, compute and display measurements, and manipulate measurement data.

1-19. All measurement modes and functions are selectable via 17 pushbutton keys on the front panel. Selectable functions include Sample Rate and Resolution control for the various measurements modes, and Math functions, such as Offset and Scale, for data manipulation. Additional power and convenience are provided by user-callable test and diagnostic functions which can be used for troubleshooting, and to obtain additional measurement information. The counter is equipped with memory for saving the front panel setup when the counter is set to Standby mode. All display functions are performed by a Liquid Crystal Display, which contains 24 alphanumeric characters (including function annunciators) for displaying both messages and measurement data.

1-20. Full HP-IB programmability is a standard feature of the HP 5350B/51B/52B Microwave Frequency Counter. The Hewlett-Packard Interface Bus provides remote control of measurement functions and data output. All front panel features are available via the HP-IB.

1-21. OPTIONS

1-22. There are five equipment options available for the HP 5350B/5351B (three for the 5352B), as listed in *Table 1-3*. Specifications for the options are listed in *Table 1-1*.

1-23. If an option is included in the initial order, it will be installed at the factory and ready for operation upon receipt. All options (except Option 700) may be ordered for field installation by ordering the parts listed in Section VI for a given option. Refer to Section II for installation instructions.

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: $< 1 \times 10^{-7}$ per month.
Short Term: $< 1 \times 10^{-9}$ for 1 s averaging time.
Temperature: $< 1 \times 10^{-6}$, 0-50°, if referenced to +25°C and set to the offset frequency.
Line Variation: $< 1 \times 10^{-7}$ 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 5V 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 001①

Crystal Frequency: 10 MHz.
Stability:
Aging Rate: $< 5 \times 10^{-10}$/day after 24-hour warm-up; $< 1 \times 10^{-7}$/year for continuous operation.
Short-Term: $< 1 \times 10^{-10}$ for 1 s average.
Temperature: $< 7 \times 10^{-9}$, 0-50°C
Line Variation: $< 1 \times 10^{-10}$ for 10% change from nominal.
Warm-Up: $< 5 \times 10^{-9}$ of final value 10 minutes after turn-on at 25°C②.

OPTIONAL REAR PANEL INPUTS OPTION 002①

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 006①

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 010①

Crystal Frequency: 10 MHz.
Stability:
Aging Rate: $< 7 \times 10^{-10}$/week after 24 hrs; $< 1 \times 10^{-10}$/day (typical) after 30 days; $< 2 \times 10^{-8}$/year for continuous operation.
Short-Term: $< 1 \times 10^{-10}$ for 1 s average.
Temperature: $< 7 \times 10^{-9}$, 0-50°C.
Line Variation: $< 1 \times 10^{-10}$ for 10% change from nominal.
Warm-Up: $< 5 \times 10^{-9}$ of final value 10 minutes after turn-on at 25°C②.

GENERAL

Display: Segmented 24 character alphanumeric 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 55°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 1-3. Equipment Options Available

Option	Description	Instrument Model
001	Oven Oscillator Timebase	5350B/5351B/5352B
002	Rear Panel Input Connectors	5350B/5351B only
006	Limiter (Increased Damage Level)	5350B/5351B only
010	High Stability Timebase	5350B/5351B/5352B
700	Internal CIIL Interface (MATE)	5350B/5351B/5352B

1-24. ACCESSORIES

1-25. The instrument is supplied with a detachable power cable, shown in *Figure 1-1*. The power cable supplied will have one of six possible line (mains) connectors, depending on the country of destination. Refer to *Table 2-1, AC Power Cables Available*, for the part number of the appropriate cable.

1-26. *Table 1-4* lists accessories available for the HP 5350B/51B/52B.

Table 1-4. Accessories Available

Description	HP Part Number
Extra Operating and Programming Manual Extra Service Manual } (Option 910)	05350-90030 05350-90021
Rack Mount Adapter Kits: With handles attached (Option 913) With handles removed (Option 908)	 5061-9771 5061-9677
Extended Hardware Support (Option W30)	none

1-27. Option W30 (Extended Hardware Support) provides two additional years of return-to-HP hardware-service support. Option W30 is available only at time of purchase. Service contracts are available from Hewlett-Packard for instruments which did not include Option W30 at time of purchase. For more information, contact your nearest Hewlett-Packard Sales and Support office (offices are listed at the back of this manual).

1-28. SERVICE EQUIPMENT AVAILABLE

1-29. Extender boards and cables are available to aid in servicing printed-circuit board assemblies. The extender boards and cables allow assemblies to be extended from their plug-in connectors for monitoring with appropriate test equipment. Refer to *Table 1-5, Recommended Test Equipment*, for part numbers for ordering service equipment.

1-30. RECOMMENDED TEST EQUIPMENT

1-31. The test equipment listed in *Table 1-5* is recommended for use during performance tests, adjustments, and troubleshooting. Substitute test equipment may be used if it meets or exceeds the required characteristics listed in the table.