HP 54121A

Four Channel Test Set

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Service Manual

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SERVICE MANUAL

HP 54121A

Four Channel Test Set

SERIAL NUMBERS

This manual applies directly to instruments prefixed with serial number:

2926A

With changes described within, this manual also applies to instruments with serial prefixes:

2714A
2802A
2845A

For Additional Information about serial numbers see INSTRUMENTS COVERED BY THIS MANUAL in Section 1.

Manual Part No. 54121-90905
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Recommended Test Equipment

The test equipment recommended for maintaining the HP 54121A is listed in table 1-1. The three sections requiring test equipment are

- Performance Tests (section 3)
- Adjustments (section 4)
- Troubleshooting (section 6C)

Table 1-1. Recommended Equipment List

Instrument	Critical Specifications	Model	Use*
Synthesized sweeper**	20 GHz, +12 dBm, -6 dBm, Stability 0.25 ppm/yr -25 dBc Harmonics	HP 8341A/B/003	P,A
Power splitter	APC 3.5 connectors	HP 11667B	P,A
DMM	5 1/2 digits	HP 3478A Fluke 8506A	P,A
Power meter	20 GHz	HP 436A	P
Power sensor	20 GHz	HP 8485A	P
50 Ω load	APC 3.5 (m)	HP 909D	P,A
50 Ω load	APC 3.5 (f)	HP 909D/011	P
Calculator	Log base 10 function	HP 11C	P
6 dB pad	APC 3.5 connections	HP 33340C/006	P
10 dB pad	APC 3.5 connections	HP 33340C/010	P
20 dB pad	APC 3.5 connections	HP 33340C/029	P,A,T
RF amplifier	Gain 20 dB at 10 MHz, flatness ±0.7 dB, noise < 6 dB harmonic distortion -32 dB	HP 8447A	P
Frequency synthesizer	100 kHz to 10 MHz, Frequency stability 0.05 ppm/yr 200 mV output level, sine and square wave outputs dc mode 1/2 V output, 100 μV resolution	HP 3325A/001	P,A,T
Oscilloscope	300 MHz bandwidth, general purpose	HP 54100A	T
Delay line	22 ns, 20 GHz	HP 54008A	A P

* P = Performance Tests A = Adjustments T = Troubleshooting
** For adjustments and systemizing, only 250 MHz, +12 dBm, synthesized sine wave generator is required.

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Performance Tests

Performance Tests 3

Introduction

The procedures in this section test the instrument's electrical performance using the specifications in Section I as performance standards. All tests can be performed without access to the interior of the instrument.

Recommended Equipment

Equipment recommended for performance tests is listed in table 1-1. Any equipment that satisfies the critical specifications stated in table 1-1 may be substituted.

Test Record

Results of performance tests may be tabulated on the Performance Test Record (table 3-1) at the end of the procedures. The Test Record lists all of the tested specifications and their acceptable limits. The results recorded at incoming inspection can be used for comparison during periodic maintenance, troubleshooting, and after repairs or adjustments.

Performance Test Cycle

This instrument requires periodic verification of performance. The instrument should be checked using the following performance tests at least every twelve months or every 2000 hours of operation. Amount of use, environmental conditions, and the user's experience concerning need for performance checks will contribute in deciding the performance test cycle.

Special Procedures

1. All connectors should be clean and undamaged to ensure accurate measurements. All APC 3.5 (f-f) adapters on the test set should be mechanically and visually checked before inserting any calibration test tool into them. Damaged connectors or loose connections may cause the performance verification tests to fail. See appendix A at the end of the HP 54120B mainframe manual.

2. The system should be allowed to warm up for at least 15 minutes.

3. To avoid damage to the four channel test set connectors, use of the APC 3.5 (f-f) connector savers is encouraged. These connector savers are supplied with the test set. Refer to appendix A at the end of the HP 54120B mainframe manual for more information on mating APC 3.5 connectors with SMA connectors.

4. Avoid sharp bends in the two 17 inch coaxial cables, HP part numbers 8120-4941 and 8120-4942.

5. When mating APC 3.5 connectors to APC 3.5 connectors or devices, torque all connections to 8 in/lbs. When mating APC 3.5 to SMA or SMA to SMA, torque all connections to 5 in/lbs.

6. If possible, minimize connector swapping during the procedures to avoid connector wear. All connectors on test tools and adapter should be inspected both visually and mechanically every few calibrations.

7. The performance test procedures outlined in this section make use of extra connectors. These are used to save expensive parts from repeated excessive wear caused by many reconnections. These parts are not necessary, but their use is highly advised.

8. Throughout the procedures identical connectors are used in different ways. One way is precision at both ends. This means that both ends of the APC 3.5 connector should be precise and should never have been connected to an SMA connector. The other way is precise at one end. This means that one of the APC 3.5 ends may be used with SMA connectors, but the other end should never have been connected to any SMA connectors. Unless otherwise stated, all APC 3.5 connectors should never be connected to SMA connectors.

Note Allow instruments to warm up for at least 15 minutes prior to beginning performance tests.

Caution The Four Channel Test Set is very sensitive to static discharge. Failure to observe proper antistatic methods may result in damage to the gallium arsenide samplers. All maintenance or operation should be performed with the antistatic mat and wrist strap, which are supplied with the HP 54120B mainframe.

Caution Electrostatic discharge can seriously damage the test set's inputs. To eliminate any electrostatic build up from a cable you're connecting to the test set, connect a female short to either end of the cable. Touch the short to an input connector hex nut on the test set to discharge any electrostatic build up to ground. Remove the female short. Use this procedure for all cables before connecting them to the test set.

Bandwidth Test

The following procedure calculates the HP 54121A's bandwidth. The sine wave output of a synthesized sweeper is leveled with a power meter. The sine wave's rms voltage is measured and converted to a power measurement to determine bandwidth. This is done on four frequencies on all four channels. This allows use of the HP 54120B's auto measurement modes to increase the measurement's accuracy.

The specification at 20 GHz is -3 dB, however the generator's vertical output is not synchronized with its 10 MHz reference output at 20.000 GHz. We test the instrument at 19.98 GHz where the specification at 19.98 GHz is -2.99 dB for channels 2 through 4 and -3.49 dB for channel 1.

If this performance test fails, perform the vertical system adjustments in the following order; 10 V reference, step recovery diode, sampler bias, offset gain, and feedthrough compensation adjustments.

Specifications

20 GHz bandwidth at -3 dB
Channel 1 dc to 18 GHz (-3.5 dB at 20 GHz)
Channels 2-4 dc to 20 GHz

12.4 GHz bandwidth at -3 dB
Channels 1-4 dc to 12.4 GHz

Equipment

This is a list of the recommended test equipment for this performance test, however any instrument which satisfies the critical specifications may be used.

Instrument	Critical Specifications	Model
Synthesized sweeper	20 GHz, +6 dBm, 25 dBc subharmonics, noise < 6 dB	HP 8341A/B
RF amplifier	Gain 20 dB at 10 MHz, flatness ±0.7 dB harmonic distortion -32 dB for 0 dBm output	HP 8447A
Power meter	20 GHz	HP 436A
Power sensor	20 GHz	HP 8485A
Calculator	Log base 10 function	HP 11C
20 dB pad	APC 3.5 connections	HP 33340C/020
Accessories	**Critical Specifications**	**HP Part Number**
Adapter	BNC (f) to SMA (m), Quantity needed - 2	1250-1200
Adapter	N (m) to APC 3.5 (m)	1250-1743
Adapter	APC 3.5 (f-f), 26.5 GHz	1250-1865
Adapter	APC 3.5 (m-f), Precise male end	1250-1866
Adapter	APC 3.5 (m-f), Precise both ends	1250-1866
Coaxial cable	APC 3.5 (m-f), 26.5 GHz	8120-4942
BNC cable	Length - 48 inches, Quantity needed - 2	10503A

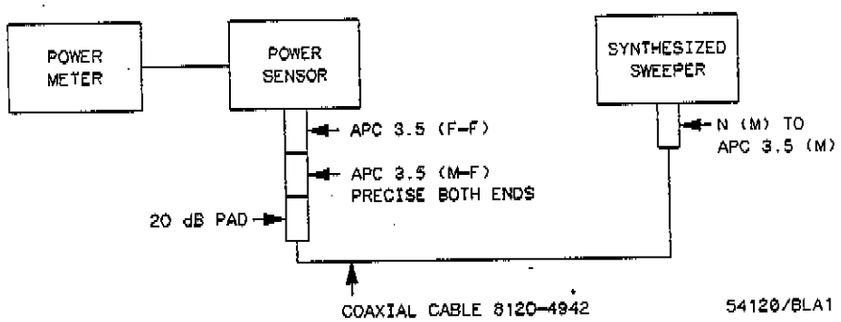
Procedure Characterizing the sweep oscillator's output

Note The sweep oscillator's output will change slightly from one day to the next day. That makes this part of the calibration procedure difficult to repeat. Improperly torqued connectors or the usage of a different 20 dB pad is the most likely source of errors for regaining previously obtained numbers.

Type of Equipment	Model Number	Serial Number
Synthesized sweeper	_____	_____
Power meter	_____	_____
Power sensor	_____	_____

1. Calibrate and zero power meter before connecting sensor to device under test. Use an N type (m) to APC 3.5 (f) adapter.

2. Connect equipment as shown below.



3. Set sweep oscillator's frequency to 50 MHz.

4. Set sweep oscillator's output power to +6 dBm.

5. Set power meter's cal factor to 100%. **DO NOT** change its setting during this procedure.

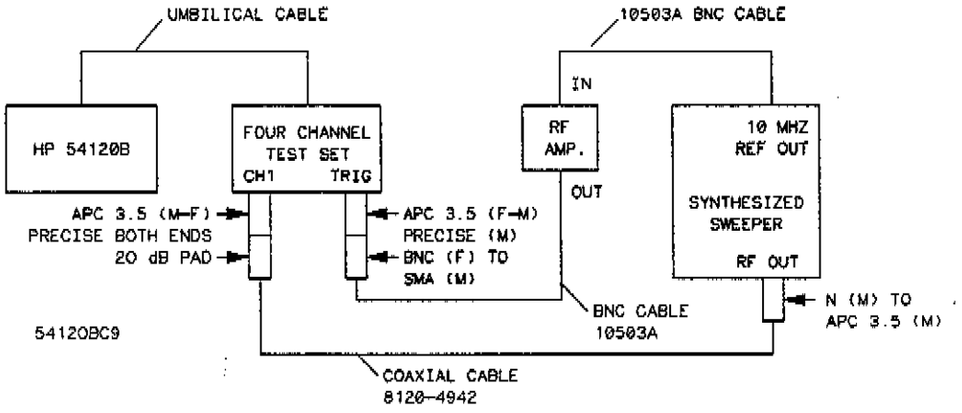
6. Record power meter's reading in μW in step 22 part 1.

7. Set sweep oscillator's frequency to 12.4 GHz, 18 GHz, 19.98 GHz and note power meter's reading in μW in step 22 part 1.

8. Record power sensor's cal factors (CF) in step 22 part 2 (assume 100% for 50 MHz).

Checking the oscilloscope's bandwidth

9. Connect the equipment as shown below.



10. Perform a one-key down power up on the HP 54120B. Hold down any key and cycle the power off and on. Continue to hold the key down until graticules are displayed on screen.

11. Change the oscilloscope's display to 64 averages, bandwidth to 12.4 GHz, and screen to single. Turn channel 1 on and channels 2 through 4 off. Set vertical sensitivity to 20 mV/div on all four channels, and timebase sweep to 5 ns/div.

12. Set sweeper's frequency to 50 MHz.

13. Press **Clear Display** key and wait for 64 averages to accumulate at top left corner of screen.

14. Press **More** key, **Measure** key, **Precision** key until **fine** is highlighted, then RMS Voltage key.

15. Note the VRMS reading on bottom of screen and record the value in step 25 part 3.

16. Change oscilloscope's sweep speed to 15 ps/div.

17. Change sweeper's frequency to 12.4 GHz and repeat steps 13-15.

18. Change display bandwidth mode to 20 GHz.

19A. For channel 1 change sweep oscillator's frequency to 18 GHz and repeat steps 13 through 15.

19B. For channels 1-4 change sweep oscillator's frequency to 19.98 GHz and repeat steps 13 through 15.

20. Change display bandwidth to 12.4 GHz, timebase sweep speed to 5 ns/div.

21. Repeat steps 12 through 20 for channels 2-4.

22. Calculate oscilloscope's three bandwidth gains at 12.4 GHz, 18 GHz, and 19.98 GHz with the values and the formula listed below.

Part 1

Frequency	Sweeper output in μW
50 MHz	_____ μW
12.4 GHz	_____ μW
18 GHz	_____ μW
19.98 GHz	_____ μW

Part 2

Frequency	Power sensor cal. factor
50 MHz	_____ %
12.4 GHz	_____ %
18 GHz	_____ %
19.98 GHz	_____ %

Part 3

Frequency	Measurement results in RMS volts			
	Ch. 1	Ch. 2	Ch. 3	Ch. 4
50 MHz	_____ mV	_____ mV	_____ mV	_____ mV
12.4 GHz	_____ mV	_____ mV	_____ mV	_____ mV
18 GHz	_____ mV	_____ N/A	_____ N/A	_____ N/A
19.98 GHz	_____ mV	_____ mV	_____ mV	_____ mV

Example: Power Meter Reading at low frequency of 50 MHz = 38.8 μW
Power Meter Reading at high frequency of 20 GHz = 27.6 μW
VRMS of HP 54120A at low frequency of 50 MHz = 43.79 μV
VRMS of HP 54120A at high frequency of 20 GHz = 28.55 μV
CF of power meter at low frequency of 50 MHz = 100%
CF of power meter at high frequency of 20 GHz = 91.7%

$$\text{Gain} = 10 \log_{10} \left[\left[\frac{\text{Power Meter reading 50 MHz}}{\text{Power Meter reading high freq}} \right] \left[\frac{\text{CF high freq}}{\text{CF 50 MHz}} \right] \left[\frac{V_{RMS} \text{ high freq}}{V_{RMS} \text{ 50 MHz}} \right]^2 \right]$$

54120BDO

$$-2.6\text{dB} = 10 \log_{10} \left[\left[\frac{38.8\ \mu w}{27.6\ \mu w} \right] \left[\frac{91.7\%}{100\%} \right] \left[\frac{28.55\ \mu V}{43.79\ \mu V} \right]^2 \right]$$

DC Voltage Measurement Accuracy and RMS Noise Test

This test checks the offset accuracy, offset gain accuracy, sampler gain accuracy, and the RMS noise level of the HP 54120B and HP 54121A. If this performance test fails, perform the vertical system adjustments in the following order; 10 V reference, step recovery diode, sampler bias, offset gain, and feedthrough compensation adjustments.

Specifications

DC voltage accuracy (50 Ω source)

Single voltage marker
Average mode ±0.4% of full-scale or marker reading (whichever is greater) ±2 mV
20 GHz Persistence mode ±0.4% of full-scale or marker reading (whichever is greater) ±2 mV ±3% of (reading − channel offset)
12.4 GHz Persistence mode ±0.4% of full-scale or marker reading (whichever is greater) ±2 mV ±1.5% of (reading − channel offset)

Dual voltage markers (on same channel)
Average mode ±0.8% of full-scale or delta reading (whichever is greater)
20 GHz Persistence mode ±0.8% of full-scale or delta reading (whichever is greater) ±3% of delta marker reading
12.4 GHz Persistence mode ±0.8% of full-scale or delta reading (whichever is greater) ±1.5% of delta marker reading

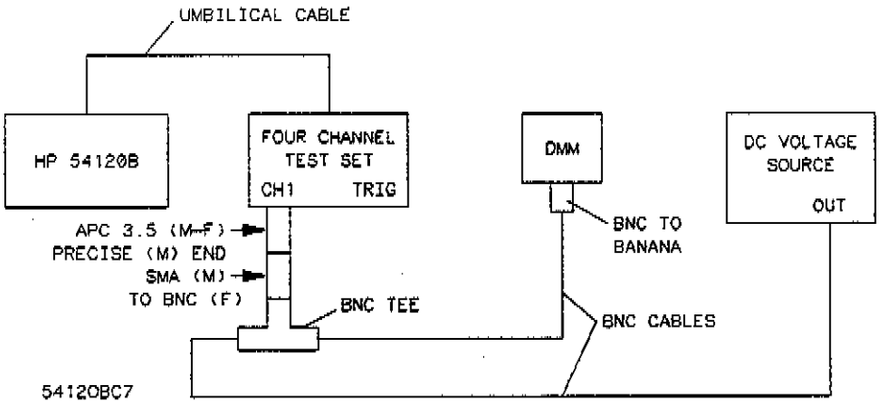
RMS noise in persistence mode (1 sigma)
20 GHz bandwidth mode ≤2 mV (Applies to instruments with HP 54120B firmware dated June 14, 1989 and later)
12.4 GHz bandwidth mode ≤1 mV

Equipment

This is a list of the recommended test equipment for this performance test. However, any instrument which satisfies the critical specifications may be used.

Instrument	Critical Specifications	Model
DC voltage source	±1/2 volt, 100 μV resolution	HP 3325A
DMM	5 1/2 digits	HP 3478A
Accessories	**Critical Specifications**	**HP Part Number**
BNC cable	Length - 48 inches, Quantity needed - 2	10503A
BNC Tee		1250-0781
Adapter	BNC (f) to SMA (m)	1250-1200
Adapter	APC 3.5 (m-f), 26.5 GHz, Precise male end	1250-1866
Adapter	BNC to banana	1250-2277

Equipment Connections



Caution Exceeding ±2 V on the dc power supply may damage the test set's input.

Equipment Setup

DC Voltage Source

Mode	dc
Offset	500 mV
Output	enabled

HP 54120B

Display	
Display Mode	Averaged
No. of Averages	16
Screen	Single
Graticule	Frame
Bandwidth	12.4 GHz

Trigger	
Trigger Level	0 V
Slope	Pos
HF Sens.	Off
HF Reject	Off
Attenuation	1

Channels	
Channels	1-4
Display	Off
Volts/Div	5 mV/div
Offset 0	V
Attenuation	1

Network	
Reflect/Trans/CAL	Reflect
Step Chan 1	Off

Timebase	
Time/Div	1 ms/div
Delay	200 ns
Delay Ref at	Left
Sweep	Freerun
Freerun Rate	10 KHz

Procedure DC Voltage Measurement Accuracy

1. Press **Save Setup** key, then **1** on the HP 54120B.
   This saves the front panel setup in memory location 1.

2. Change vertical sensitivity on channels 1-4 to 80 mV/div, and display mode to a persistence of 300 ms.
   Press **Save Setup** key, then **2** key on oscilloscope.

3. If BNC tee is connected to the four channel test set, remove the tee and leave it disconnected for now.

4. Press **Recall Setup** key, then **1** key.
   This recalls instrument setup from memory location 1.
   Turn channel 1 on.

5. Turn Delta V markers on and overlay both markers on channel 1.
   Press **Preset Levels** until **50%-50%** is highlighted.

6. Press **Clear Display** key and wait for 16 averages to accumulate on top left of screen.

7. Press **Auto Level Set** key and note the V1 value.
   V1 should be 0 V ±2.16 mV.

8. Press **Display** key and change bandwidth to 20 GHz.

9. Press **Clear Display** key and wait for 16 averages to accumulate.
   Press **Delta V** menu key, then **Auto Level Set** key.
   The V1 value should be 0 V ±2.16 mV.

10. Connect BNC tee to channel 1.

11. Change channel 1 offset to 500 mV.
    Change display bandwidth to 12.4 GHz.

12. Adjust dc source until DMM reads 500 mv ±100 MV.

13. Press **Clear Display** key and wait for 16 averages to accumulate.
    Turn Delta V markers on and overlay marker 2 on trace.
    The V2 value should be 500 mV ±4 mV.

14. Change channel 1 offset to −500 mV.

15. Adjust dc source until DMM reads −500 mV ±100 MV.

16. Press **Clear Display** key and wait for 16 averages to accumulate.
Turn Delta V markers on and overlay marker 1 on trace.
The V1 value should be −500 mV ±4 mV.
The delta V value should be 1.0000 V ±8 mV. 0.992 to 1.008 mV

17. Recall instrument setup from memory location 2. Turn channel 1 on.

18. Press **More** key, then press **Wfm Math** key.
Press **Function** key until 1 is highlighted.
Press **Display** key until **On** is highlighted.

19. Change **first Chan-Mem** key until **Chan 1** is highlighted.
Press **Operation** key until **Only** is highlighted.
Press **Display Scaling** key until **Volts/Div** is highlighted.

20. Adjust sensitivity to 5 mV/div.
Press **Display Scaling** key until **Offset** is highlighted.
Adjust offset to 250 mV.

21. Adjust dc source until DMM reads 250 mV ±100 μV.

22. Turn Delta V markers on and overlay both markers on function 1.
Press **preset levels** until **50%-50%** is highlighted.

23. Manually overlay delta V marker 1 to center of trace.
The V1 value should be 250 mV ±9.66 mV.

24. Press **Wfm Math** key.
Press **Display Scaling** key until Offset is **highlighted.**
Adjust offset to −250 mV.

25. Adjust dc source until DMM reads −250 mV ±100 MV.

26. Manually overlay delta V marker 2 to center of trace.
The V2 value should be −250 mV ±9.66 mV.
−240.34 to 259.66

RMS Noise Test

27. Press **Recall** 2 key. Ensure bandwidth is set to 12.4 GHz

28. Disconnect all signals from channel 1.

29. Change display mode to infinite persistence, and timebase delay to 16 ns.

30. Turn function display off.
    Change channel 1 sensitivity to 2 mV/div and 0 V offset.

31. Press **Histogram** menu key and then press **Window/Acquire/Results** key until **Window** is highlighted.

32. Press **Voltage/Time** key until **Voltage** is highlighted.

33. Set windows to screen's left and right sides.

34. Press **Window/Acquire/Results** key until **Acquire** is highlighted.
    Select 10000 samples and press **Start Acquiring** key.
    Wait until oscilloscope finishes acquiring data.

35. Press **Window/Acquire/Results** key until **Results** is highlighted.
    Press **Sigma** key.
    The sigma value should be ≤ 1 mV.

36. Steps 37 and 38 apply to instruments with high bandwidth (20 GHz) persistence mode. To determine if you have high bandwidth persistence, go to the display menu, set display mode to persistence, and toggle the bandwidth key. If the bandwidth toggles between 12.4 GHz and 20 GHz, you have high bandwidth persistence. If you do not have high bandwidth persistence, go to step 39.

37. Press the **More** menu key, then **Display** menu key.
    Change bandwidth to 20 GHz.

38. Repeat steps 31 to 35 for 20 GHz.
    The sigma value should be ≤ 2 mV

39. Repeat steps 3 to 38 for channels 2, 3, and 4.

Time Interval Accuracy Test

This tests the accuracy of all timebase delay counter modes. If this performance test fails, perform these adjustments in the following order; delta current, range, frequency, end, and 4 ns cal adjustments.

Specifications

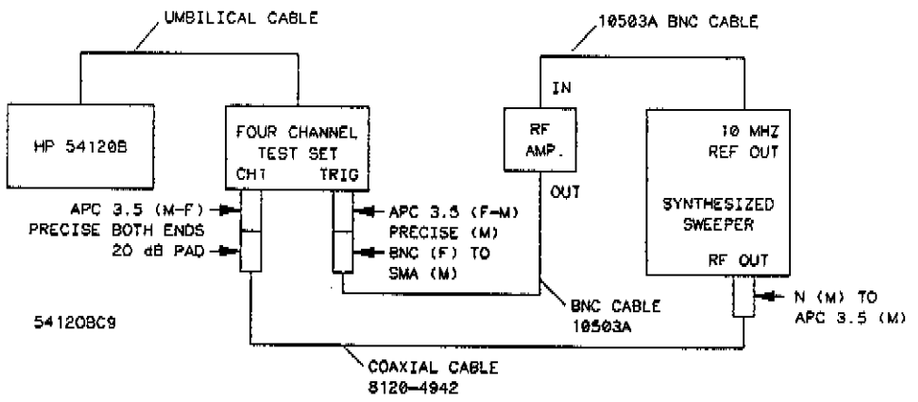
Time interval accuracy 10 ps ±0.1% of reading

Equipment

This is a list of the recommended test equipment for this performance test, however any instrument which satisfies the critical specifications may be used.

Instrument	Critical Specifications	Model
Synthesized sweeper	20 GHz, -25 dBc harmonics, output +6 dBm stability 0.25 ppm/yr	HP 8341A/B
20 dB pad	APC 3.5 connections	HP 33340C/020
RF amplifier	Gain 20 dB at 10 MHz, flatness ±0.7 dB, harmonic distortion -32 dB, for 0 dB output noise 6 dB	HP 8447A
Frequency synthesizer	10 MHz square wave, 120 mV output, stability 0.05 ppm/yr	HP 3325A/001
Accessories	**Critical Specifications**	**HP Part Number**
Adapter	BNC (f) to SMA (m), Quantity needed - 2	1250-1200
Adapter	N (m) to APC 3.5 (m)	1250-1743
Adapter	APC 3.5 (m-f), Precise both ends, 26.5 GHz	1250-1866
Adapter	APC 3.5 (m-f), Male end precise, 26.5 GHz Quantity needed - 2	1250-1866
Coaxial cable	APC 3.5 (m-m), 26.5 GHz	8120-4942
BNC cable	Length - 48 inches, Quantity needed - 2	10503A

Equipment Connections



Equipment Setup

Synthesized Sweeper

Mode	Sine wave
Frequency	19.98 GHz
Amplitude	+6 dBm

Frequency Synthesizer

Mode	Square wave
Frequency	10 MHz
Amplitude	120 mV

HP 54120B

Display

Display Mode	Averaged
No. of Averages	64
Screen	Single
Graticule	Frame
Bandwidth	20 GHz

Channels

Channels	1-4
Display	Off
Volts/Div	20 mV/div
Offset	0 V
Attenuation	1

Timebase

Time/Div	10 ps/div
Delay	16 ns
Delay Ref at	Left
Sweep	Trd's d

Trigger

Trigger Level	0 V
Slope	Pos
HF Sens.	Off
HF Reject	Off
Attenuation	1

Network

Reflect/Trans/CAL	Reflect
Step Chan 1	Off

Procedure Short Delta T

1. Press **Save Setup** key, then 3 key.
   Turn channel 1 on.

2. Press **Clear Display** key and wait until 64 averages accumulate.

3. Press **Measure** menu key.
   Press **Precision** key until **fine** is highlighted.

4. Press **Period** key to measure period of 19.98 GHz sine wave.
   The period should be 50.1 ps ±10.1 ps.

5. Repeat steps 2 through 4 for timebase delay settings of 18 ns, 19.9 ns, 19.95, 23.95 ns, 27.95 ns, and 55.95 ns.

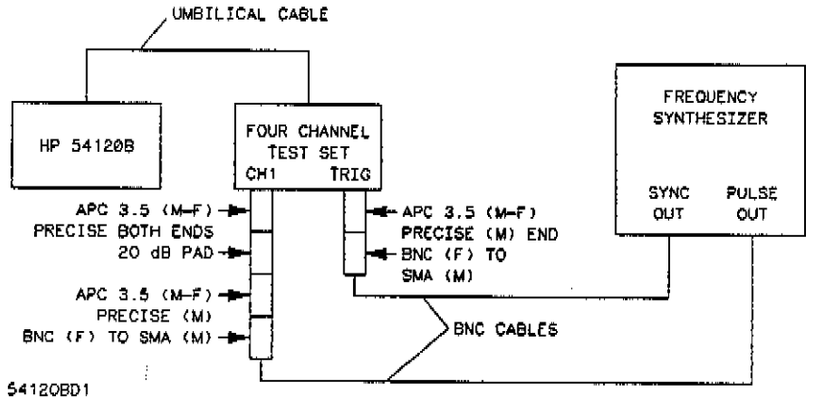
6. Change timebase delay to 16 ns and display bandwidth to 12.4 GHz.

7. Repeat step 2 through 4 for the following oscilloscope timebase settings and sweeper frequency settings. Ensure the measured results are within the allowable limits.

Timebase Setting	Sweeper Setting	Test Limits
50 ps/div	10 GHz	100 ps ±10.1 ps
10 0 ps/div	5 GHz	200 ps ±10.2 ps
250 ps/div	2 GHz	500 ps ±10.5 ps
500 ps/div	1 GHz	1 ns ±11 ps
1 ns/div	500 MHz	2 ns ±12 ps
2.5 ns/div	200 MHz	5 ns ±15 ps
5 ns/div	100 MHz	10 ns ±20 ps
10 ns/div	50 MHz	20 ns ±30 ps
25 ns/div	20 MHz	50 ns ±60 ps

Long Delta T

8. Change the equipment setup as follows.



9. Press **Recall 3**.

10. Change timebase sweep to 20 ns/div and trigger level to 500 mV.

11. Press Clear Display key and wait until 64 averages accumulate.

12. Press **Measure** menu key.
    Press **Precision** key until **fine** is highlighted.

13. Press **Period** key and wait for oscilloscope to measure period of a 10 MHz sine wave. The period should be 100 ns ± 110.0 ps.

14. Repeat steps 10 through 13 for the following settings. Ensure the measured values are within the allowable limits.

Timebase Setting	Sweeper Setting	Test Limits	
100 ns/div	5 MHz	200 ns ±210 ps	199.79 to 200.21
250 ns/div	2 MHz	500 ns ±510 ps	499.49 to 500.51
500 ns/div	1 MHz	1 µs ±1.01 ns	.999 to 1.001
1 µs/div	500 kHz	2 µs ±2.01 ns	1.998 to 2.002
2.5 µs/div	200 kHz	5 µs ±5.01 ns	4.995 to 5.005
5 µs/div	100 kHz	10 µs ±10.01ns	9.999 to 10.01
10 µs/div	50 kHz	20 µs ±20.01 ns	19.98 to 20.02
25 µs/div	20 kHz	50 µs ±50.01 ns (0.05001 µs)	49.95 to 50.05
50 µs/div	10 kHz	100 µs ±100.01 ns (0.10001 µs)	99.9 to 100.1

Trigger Sensitivity and Jitter Tests

The sensitivity test measures the high and low frequency trigger sensitivities by applying a 100 MHz sine wave and a 2.5 GHz sine wave. If the oscilloscope triggers at 2.5 GHz, it will also trigger on a 200 ps pulse width at 200 mV. If this performance test fails, adjust the trigger hysteresis and trigger offset adjustments in section 4, adjustments, of this manual.

The jitter test measures the oscilloscope's internal jitter with a 2.0 GHz sine wave. The instrument's jitter is less with fast risetime input signals. If a generator is substituted, careful consideration of the generator's horizontal jitter and vertical noise is important.

Some HP 54121A test sets with serial prefix 2714 and 2802 may still use the 500 MHz trigger hybrid. If you are unsure which trigger hybrid your instrument has, remove the test set's bottom cover and locate the trigger hybrid on the horizontal board's front left side (refer to figure 4-12 in section 4, adjustments of this manual). The 500 MHz trigger hybrid HP part number is 1NB7-8160. The 500 MHz trigger specifications are, sensitivity: dc to 100 MHz 40 mV p-p, 100 MHz to 500 MHz 100 mV p-p.
jitter: trigger and timebase combined (one standard deviation) ≤5 ps + (5E-5 x delay setting).

Specifications

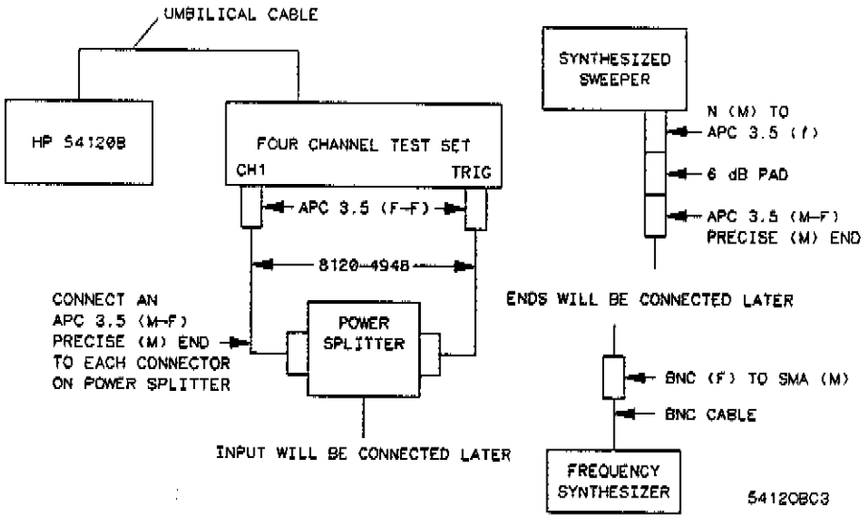
Sensitivity: dc to 100 MHz 40 mV peak-to-peak, increasing linearly to 200 mV peak-to-peak at 2.5 GHz
Jitter: Trigger and timebase combined (one standard deviation)
<2.5 ps +5 E-5 x delay setting. Tested using 2 GHz synthesized source at 200 mV peak-to-peak with high frequency sensitivity on and high frequency reject off.

Equipment

This is a list of the recommended test equipment for this performance test. However, any instrument which satisfies the critical specifications may be used.

Instrument	Critical Specifications	Model
Synthesized sweeper	20 GHz, +6 dBm	HP 8341/003
Power splitter	> 10 GHz bandwidth	HP 11667B
Frequency synthesizer	100 kHz sine wave, 200 mV output	HP 3325A
Delay line	22 ns, < 6 dB attenuation at 2 GHz	HP 54008A
Accessories	**Critical Specifications**	**HP Part Number**
Adapter	APC 3.5 (m-m) both ends precise	1250-1864
Adapter	APC 3.5 (m-f) Both ends precise, 26.5 GHz Quantity needed - 6	1250-1866
Adapter	N (m) to APC 3.5 (f)	1250-1744
Adapter	SMA (m) to BNC (f)	1250-1200
Adapter	SMA (f-f)	1250-1158
Coaxial cable	APC 3.5 (m-m) 18 GHz, Quantity needed - 3	8120-4948
BNC cable	48 inches	10503A
6 dB pad	APC 3.5 connectors	33340C/006

Equipment Connections



Equipment Setup

Frequency Synthesizer

Frequency	100 KHz
Power output	200 mV
Mode	Sine wave

Synthesized Sweeper

Frequency	100 MHz
Power output	0 dBm

HP 54120T

Display

Display Mode	Averaged
No. of Averages	4
Screen	Single
Graticule	Frame
Bandwidth	12.4 GHz

Trigger

Trigger Level	0 V
Slope	Pos
HF Sens.	Off
HF Reject	Off
Attenuation	1

Channels

Channels	1-4
Display	Off
Volts/Div	20 mV/div
Offset	0 V
Attenuation	1

Timebase

Time/Div	1 µs/div
Delay	16 ns
Delay Ref at	Left
Sweep	Trg'd

Network

Reflect/Trans/CAL	Reflect
Step Chan 1	Off

Procedure

Low Frequency Trigger Hysteresis

Values in brackets are used only for the 500 MHz trigger hybrid.

1. Connect frequency synthesizer to power splitter.

2. Turn channel 1 on.

3. Adjust frequency synthesizer until signal on screen is exactly 100 mV p-p.

4. Slowly adjust trigger level greater than 0 V until oscilloscope just stops triggering. This is indicated on screen by pressing the **Clear Display** key each time the trigger level is changed. If the oscilloscope is triggered, the waveform will be displayed on screen. Note the trigger level, this is V_{pos}.

5. Return trigger level to 0 V. Slowly adjust trigger level less than 0 V until oscilloscope just stops triggering. This is V_{neg}.

6. Calculate hysteresis. $V_{hysteresis} = 100\ mV - (V_{pos} - V_{neg})$ The value should be $\leq 40\ mV$.

100 MHz/2.5 GHz Trigger Sensitivity

7. Change oscilloscope's timebase sweep speed to 2 ns/div, trigger level to 0 V. Turn HF Reject off and HF Sens. off.

8. Connect synthesized sweeper (set to 100 MHz) to power splitter.

9. Adjust sweeper's amplitude to exactly 150 mV amplitude as displayed on screen.

10. Slowly adjust trigger level greater than 0 V until oscilloscope just stops triggering. This is V_{pos}.

11. Return trigger level to 0 V. Slowly adjust trigger level less than 0 V until oscilloscope just stops triggering. This is V_{neg}.

12. Calculate sensitivity. $V_{sense} = 150\ mV - (V_{pos} - V_{neg})$. The value should be $\leq 40\ mV$.

13. Turn HF Reject on and repeat steps 10 through 12 [HF reject is not active with the 500 MHz trigger so proceed to step 14]. The value should be $\geq 57\ mV$ (+3 dB).

14. Change oscilloscope's sweep speed to 100 ps/div, sensitivity to 50 mV/div, and trigger level to 0 V. Turn HF Sens. on and HF Reject off.

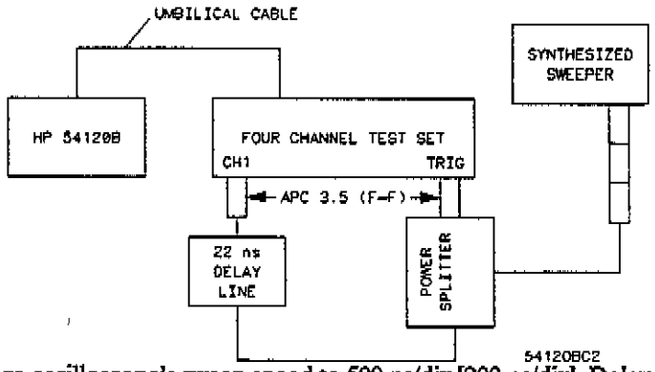
15. Change sweeper's frequency to 2.5 GHz [500 MHz] and adjust sweeper's amplitude to exactly 200 mV [100 mV] as displayed on screen. Oscilloscope should be triggered.

16. Slowly adjust trigger level greater than 0 V until oscilloscope just stops triggering. This is V_{pos}.

17. Return trigger level to 0 V. Slowly adjust trigger level less than 0 V until oscilloscope just stops triggering. This is V_{neg}.

18. Calculate sensitivity. $V_{sense} = 200\ mV - (V_{pos} - V_{neg})$. The value should be $\leq 200\ mV$ [100 mV].

19. Change sweeper's frequency to 2.0 GHz [500 MHz]. The amplitude should still be set to 200 mV p-p [100 mV]. Add delay line and change equipment setup as shown below.



20. Change oscilloscope's sweep speed to 500 ps/div [200 ps/div], Delay Ref at center, and delay to 20 ns.

21. Slightly vary the sweeper's frequency and select the trigger point which does not expand or contract with the sweeper's frequency changes (using infinite persistence may you help find the trigger edge).

22. Turn Delta V markers on.
Press **Preset Levels** key until **50%-50%** is highlighted. Press **Auto Level Set** key.

23. Turn Delta T markers on, and set start marker on 50% point of selected trigger point's positive slope.

24. Change sweep speed to 200 ps/div [100 ps/div] and delay to start marker's value.

25. Adjust oscilloscope's delay to center waveform's positive edge on screen.
Delay = _____ ns

26. Change oscilloscope's sweep speed to 10 ps/div [20 ps/div] and sensitivity to 5 mV/div.

27. Press **Histogram** menu key.
Press **Window/Acquire/Results** key until **Window** is highlighted.
Press **Time/Voltage histogram** key until **Time** is highlighted.
Set window marker 1 to −0.25 mV and window marker 2 to 0.25 mV.

28. Press **Window/Acquire/Results** key until **Acquire** is highlighted, enter number of samples as 1000. Press **Start acquiring** key. Wait until acquire cycle is 100% complete.

29. Press **Window/Acquire/Results** key until **Results** is highlighted. Press **Sigma** key. Sigma value should be < 2.5 ps + (5E-5 x delay setting from step 26) [≤ 5 ps + (5E-5 x delay setting)]. If the instrument does not meet the jitter specification, it is allowable to adjust trigger level for best jitter. You would then need to repeat steps 20 through 29. Example with delay setting of 20.5 ns:
$\leq 2.5 \text{ ps} + [(5 \times 10^{-5}) \times (20.5 \times 10^{-9})] = 2.5 \text{ ps} + 1.025 \text{ ps} \leq 3.525 \text{ ps}$

TDR System Tests

This test verifies correct operation of the TDR system by checking the specifications of both the TDR system and the oscilloscope. The final value of the TDR step generator's amplitude is controlled by the the dc resistance of the 50 Ω termination. Since all of the flatness specifications depend on the final value measured in this test, the effects of using a nonperfect 50 Ω termination are accounted for during the procedure.

The dc resistance of a nonperfect 50 Ω termination will effect the on-screen final value. Figure 3-1 shows the first 1 ns after the incident step using two different 50 Ω terminations. Notice the two traces are coincident for approximately the first 500 ps until the 50 Ω termination is encountered. The two traces finally settle with a constant level shift between them. The amount of the level shift is dependent on the dc resistance variation between the 50 Ω terminations used.

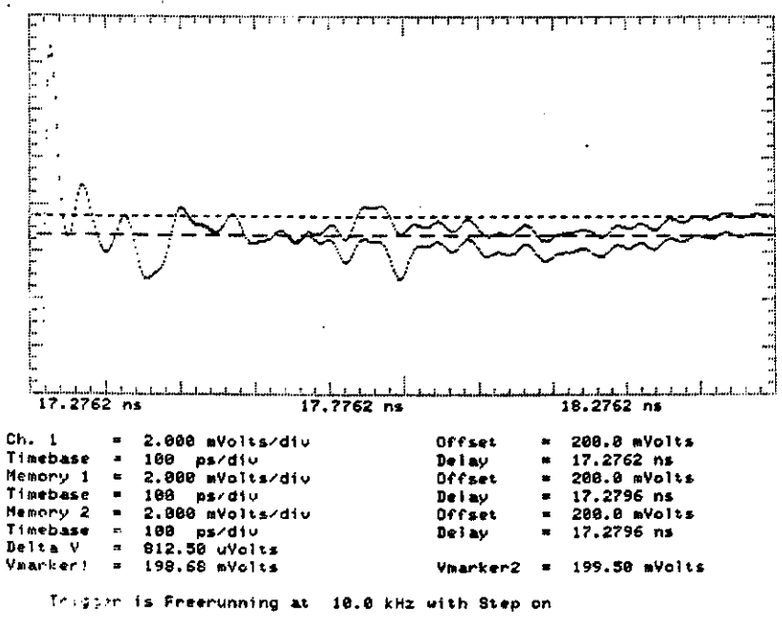


Figure 3-1. Incident Step With Two Different 50 Ω Terminations, Top Trace dc Resistance = 50.34 Ω, Bottom Trace dc Resistance = 49.91 Ω

The final value recorded in the procedure is the final value that a perfect 50 Ω termination would present. This number is calculated based on the actual dc resistance of the 50 Ω termination used.

There are two sets of flatness specifications, both are referenced to 1 ns after the incident step. One specification is before the 1 ns reference point.
The other specification is after the 1 ns reference point.

For the ±1% tests (> 1 ns after edge) a delta V measurement is made between the actual on-screen final value and the reflections from the 50 Ω termination. This delta V measurement will be independent of the dc resistance of the 50 Ω termination. This value is divided by the final value calculated for a 50 Ω termination's final value and multiplied by 100%.

For the +5%, −2% tests (< 1 ns after edge) a different approach must be used. If the −2% reflection appears before the 50 Ω termination in time, then a delta V measurement using the on-screen final value and voltage value of that reflection will be dependent on the dc resistance of the 50 Ω termination . This is not true if the reflection appears after the 50 Ω termination in time.

Reflection appears before the termination The recorded final value is subtracted from the reflection's voltage value, then divided by the recorded final value and than multiplied by 100%.

Reflection appears after the termination The on-screen final value is subtracted from the reflection's voltage value, then divided by the recorded final value and multiplied by 100%.

The overshoot (+5% at < 1 ns after edge) calculation is identical to the −2% test (reflections before the 50 Ω termination) since the overshoot appears before the termination in time.

If this performance test fails, perform the TDR adjustments in paragraph 4-15.

Specifications:

Combined oscilloscope and TDR risetime performance ≤ 45 ps[1]
(measured in 12.4 GHz bandwidth, averaged mode)

Combined oscilloscope and TDR flatness performance
(measured in 12.4 GHz bandwidth, averaged mode)
After 1 ns from edge ±1%
+5%, −3% to 1 ns from edge

Combined oscilloscope and TDR levels performance
Low - 0 V ±2 mV
High -200 mV ±2 mV

Equipment

This is a list of the recommended test equipment for this performance test, however any instrument which satisfies the critical specifications may be used.

	Instrument	Critical Specifications	Model
✓	Termination	50 Ω, APC 3.5 (f)	HP 909D/011
✓	DMM	5 1/2 digits	HP 3478A
	Accessory	**Critical Specifications**	**HP Part Number**
✓	Adapter	BNC (m-m)	1250-0216
✓	Adapter	BNC (f) to banana	1250-2277
✓	Adapter	BNC (f) to SMA (m)	1250-1200
✓	Adapter	APC 3.5 (m-f) male end precise	1250-1866
	Coaxial short	APC 3.5 (f)	1250-2127

1. The risetime of the generator is less than 35 ps, as calculated by
$(Tr\ system)^2 = (Tr\ generator)^2 + (Tr\ oscilloscope)^2$

Equipment setup: Perform a one-keydown power up. Hold down any key and cycle the oscilloscope's power off and on. Continue to hold the key down until graticules are displayed on screen. Make the following changes to the oscilloscope's setup.

HP 54120B

Display		**Timebase**	
Display Mode	Averaged	Time/Div	50 ps/div
No. of Averages	16	Delay	16 ns
Screen	Single	Delay Ref at	Left
Graticule	Frame	Sweep Freerun	
Bandwidth	12.4 GHz	Rate	10 kHz
Channels		**Network**	
Channel	1	Reflect/Trans/CAL	Reflect
Display	On	Step & Chan 1	On
Volts/Div	5 mV/div		
Offset	0 V		
Channels	2-4		
Display	Off		

Note If there is a rising edge on screen, the "TDR Step Adjustments" in section 4 must be performed before continuing with this procedure.

Procedure:

1. Assemble a fixture by connecting a banana to BNC (f) adapter to a BNC (m-m) adapter. Connect this to a BNC (f) to SMA (m) adapter. Connect this to an APC 3.5 (m-f) adapter (male end precise and connect fixture to DMM . Connect an APC 3.5 (f) precise 50 Ω termination to fixture.
   Record dc resistance of 50 Ω termination here _____Ω Example 50.390 Ω

2. Remove 50 Ω termination and connect the APC 3.5 (f) short to fixture.
   Record dc resistance of fixture here _____ Ω Example 0.050 Ω

3. Subtract fixture's resistance (step 2) from termination resistance (step 1).
   Step 1 _____Ω − Step 2 _____Ω = Z_L _____Ω Example 50.340 Ω

4. Solve for E_R using this formula (E_R may be a negative number).
   $E_R = 200 ((Z_L - 50) \div (Z_L + 50))$ (round to nearest 0.01 mV)Example 0.68 mV
   Install 50 Ω termination on channel 1.

5. Select Delta V menu and press **V Markers** key until **On** is highlighted.
   Press **Preset Levels** key until **50%-50%** is highlighted.
   Press **Auto Level Set** key.
   V(1) should read 0 V ±2 mV.
   Record V(1) here _____ mV.Example 156.25 µV

6. Change oscilloscope's sweep speed to 1 ns/div, channel 1 vertical sensitivity to 80 mV/div, and offset to 200 mV.

7. Select Delta V menu and press **Preset Levels** key until 50%-50% is highlighted.
   Press **Auto Level** Set key.

8. Select Delta T menu and press **T Markers** key until **On** is highlighted.
   Press **START ON EDGE** key until **POS 1** is highlighted.
   Press **STOP ON EDGE** key until **POS 1** is highlighted.
   Press **Precise Edge Find** key.

9. Change Stop marker's value to the Start marker's value plus 1 ns.

10. Change oscilloscope's sweep speed to 100 ns/div, delay to Stop marker's value, and channel 1 vertical sensitivity to 2 mV/div.

11. Select Delta V menu and overlay marker 1 on trace at right edge of screen.
    Record V(1), on-screen final value, here _____ mVExample 200.37 mV

12. Subtract the value of E_R (from step 4) from V(1) and record that value, recorded final value, here _____ mV Example 199.69 mV
    This value should be 200 mV ±2 mV.

13. Allow 16 averages to accumulate.
    Adjust marker 2 to signal's highest point on the screen.
    Divide the delta V reading by the final value obtained in step 12 and multiply by 100%.
    (delta V reading_____ ÷ step 12 _____) 100% = _____
    Example (812.50 µV ÷ 199.69 mV) 100% = 0.41%
    The absolute value of this number should be less than 1% (+1% at < 1 ns after edge).

14. Adjust marker 2 to signal's lowest point on the screen.

15. Select Timebase menu and press **TIME/DIV** key.
    Press front panel increment key to select the next fastest sweep speed.
    If there is a point on the screen lower than marker 2's previous position, readjust marker 2 to that lowest point,
    Repeat this step until a sweep speed of 1 ns/div is reached.

16. Divide the absolute value of delta V by the final value obtained in step 12 and multiply by 100%.
    (delta v reading _____ ÷ step 12 _____) 100% = _____
    Example (−1.8125 mV ÷ 199.69 mV) 100% = 0.91%
    The absolute value of of this number should be ≤ 1% (−1% at < 1 ns after edge).

17. Change timebase sweep speed to 200 ps/div, delay reference to center, and delay equal to Start marker's value. Change channel 1 sensitivity to 80 mV/div.

18. Remove the 50 Ω termination and place the APC 3.5 (f) short on channel 1.

19. Select Delta V menu and press **Preset Levels** key until 50%-50% is highlighted.
Press **Auto level** set key.

20. Select Delta T menu.
Press **START ON EDGE** key until **POS 1** is highlighted.
Press **STOP ON EDGE** key until **NEG 1** is highlighted.
Press **Precise Edge Find** key.

21. Remove short from channel 1 and connect 50 Ω termination to channel 1.
Change timebase Delay Ref to Left and delay equal to Start marker's value.
Adjust Stop marker to value of Start marker plus 0.5 ns (500 ps).
Change sweep speed to 100 ps/div and vertical sensitivity to 2 mV/div.

22. Select Delta V menu and adjust marker 2 to the signal's lowest point on the screen. **DO NOT** include the signal's rising edge. If this point is to the left of the Stop marker, then subtract the final value obtained in step 12 from V(2) and record that value in step 23.
Refer to figure 3-2. V(2) _____ mV Example 196.75 mV

Otherwise subtract the value obtained in step 11 from V(2) and record that value in step 24
(round to nearest 0.01mV).

23. -2% test _____ mV.Example -2.94 mV

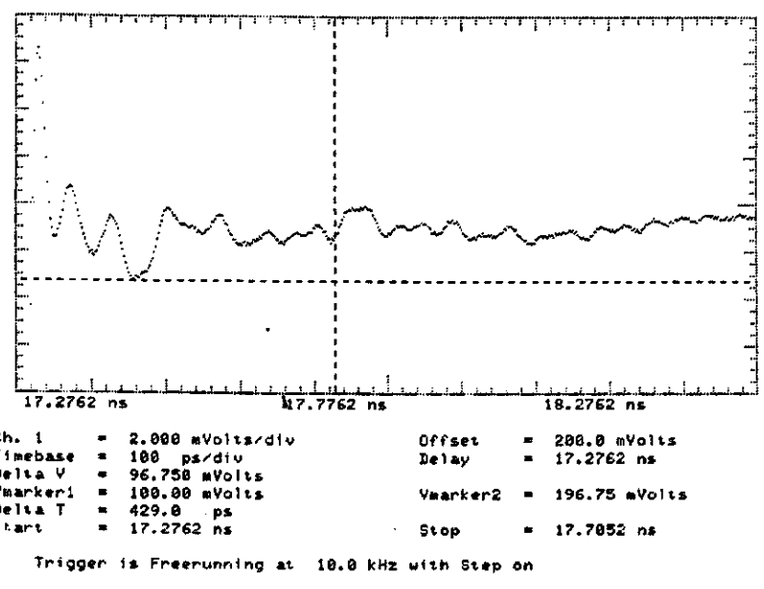


Figure 3-2. -2% Test., The Reflection Appears Before the Termination

24. Divide the value obtained step 23 by the final value obtained in step 12 and multiply by 100%.
(step 23 _____ ÷ step 12 _____) 100% = _____
Example (−2.94 mV ÷ 199.69 mV) 100% = −1.47 %
The absolute value of this number should be less than 3% (−3% at < 1 ns after edge).

25. Adjust marker 2 to the signal's highest point on the screen V(2) _____.Example 206.56 mV
Subtract the final value obtained in step 12 from V(2) and record that value in step 26.

26. +5% test _____ mV.Example 6.87 mV

27. Divide the value obtained step 26 by the final value obtained in step 12 and multiply by 100%.
(step 26 _____ ÷ step 12 _____) 100% = _____
Example (6.87 mV ÷ 199.69 mV) 100% = 3.44%
The absolute value of this number should be less than 5% (+5% at < 1 ns after edge).

28. Using the keypad, adjust marker 2 to value obtained in step 11.
Using the keypad, change marker 1's value equal to the value recorded in step 5 above.

29. Change sweep speed to 30 ps/div.
Press **Delay Ref at** key until **Center** is highlighted.

30. Change delay value equal to Start marker's value.
Change channel 1 vertical sensitivity to 30 mV/div and offset to 100 mV.

31. Select Delta V menu.
Press **Preset Levels** key until **10%-90%** is highlighted.
DO NOT touch the Auto Level Set key.

32. Select Delta T menu.
Press **START ON EDGE** key until **POS 1** is highlighted.
Press **STOP ON EDGE** key until **POS 1** is highlighted.

33. Press **Precise Edge Find** key.
The measured risetime (delta T) should be ≤ 45 ps.

Input Reflection Test

This test uses a calibrated four channel test set channel to measure the amount of reflection each channel reflects back to the test line when pulsed with a fast edge signal.

Specifications:

Percent Reflection
Channels 1-4 ± 5% for 30 ps risetime
External Trigger ≤ 10% for 100 ps risetime

Equipment

This is a list of the recommended test equipment for this performance test, however any instrument which satisfies the critical specifications may be used.

Instrument	Critical Specifications	Model
Termination	50 Ω, APC 3.5 (f)	HP 909D/011
Accessories	**Critical Specifications**	**HP Part Number**
Adapter	APC 3.5 (m-m) 26.5 GHz	1250-1864
Adapter	APC 3.5 (f-f) 26.5 GHz	1250-1865
Coaxial short	APC 3.5 (f)	1250-2127
Coaxial short	APC 3.5 (m)	1250-2128
Cable	Semi-rigid U shaped	54121-61601
Cable	Semi-rigid S shaped	54121-61602

Connections:

1. Do not tighten the following connections until step 5.
2. Connect short end of semi-rigid U cable to short end of semi-rigid S cable through an APC 3.5 (f-f) adapter.
3. Connect semi-rigid U cable's other end to channel 1.
4. Without bending or damaging the semi-rigid cables, bring the semi-rigid S cable's other end toward channel 2. You will be told to connect the semi-rigid cable to channel 2 later in the procedure.
5. Tighten all cable connections.

Equipment Setup:

Perform a one-keydown power up. Hold down any key and cycle the oscilloscope's power off and on. Continue to hold the key down until graticules are displayed on screen. Change the following oscilloscope settings.

HP 54120B

Display		**Timebase**	
Mode	Averaged	Time/Div	350 ps/div
No. of averages	16	Delay	23.5 ns
Screen	Single		
Channels		**Network**	
Channel	1	Reflect/Trans/CAL	Reflect
Display	On	Step & Chan 1	On
Volts/Div	5 mV/div		
Offset	200 mV		
Channels	2-4 Off		

Procedure

1. Adjust delay so that the signal's second rising edge (representing an open circuit condition) is 4 divisions left of center screen.
   Press **Network** menu.
   Press **Reflect/Trans/CAL** key until **Cal** is highlighted.

2. Press **Reflect Cal** key.
   Connect a coaxial short with an APC 3.5 (f) connector to the semi-rigid cable.
   Press **Reflect Cal** key again.

3. Remove coaxial short from semi-rigid cable and connect a 50 Ω termination APC 3.5 (f) to semi-rigid cable.
   Press **Reflect Cal** key again.

4. Remove 50 Ω termination from semi-rigid cable and connect semi-rigid cable to channel 2.
   Press **Clear Display** key and wait for 16 averages to accumulate.

5. Press **Network** menu key.
   Press **Reflect/Trans/Cal** key until **Reflect** is highlighted.

6. Set normalized risetime to 30 ps.
   Press **Normalize to mem 1** key.

7. Press **Stop** key.
   Press **Clear Display** key.

8. Press **Cursor** key until **mem 1** is highlighted.

9. Press **Min & Max Reflect** key.
   The absolute value of Rho minimum and Rho maximum should be $< 5\%$.

10. Press **Run** key.

11. Loosen connection where semi-rigid S and U cables join together. Move semi-rigid cable from channel 2 to channel 3 and press **Clear Display** key. Retighten connection where semi-rigid S and U cables join together.

12. Repeat steps 6 through 10 for channel 3.

13. Loosen connection where semi-rigid S and U cables join together. Move semi-rigid from channel 3 to channel 4 and press **Clear Display** key. Retighten connection where semi-rigid S and U cables join together.

14. Repeat steps 6 through 10 for channel 4.

15. Loosen joint where semi-rigid S and U cables join together. Move semi-rigid cable from channel 4 to external trigger input and press **Clear Display** key. Retighten connection where semi-rigid S and U cables join together.

16. Repeat steps 6 through 10 for external trigger input except change normalize risetime from 30 ps to 100 ps and change the RHO limits from 5% to 10%.

17. Remove the semi-rigid S and U cables from the oscilloscope. Connect the precision short to channel 1's input APC 3.5 connector.

18. Select waveform save menu. Press **WAVEFORM MEMORY** key until 1 is highlighted. Press **Display** key until **On** is highlighted.

19. Change channel 1 offset to 0 V. Change sweep speed to 2 ns/div and delay to 35 ns.

20. Select Delta V menu and overlay both V markers on channel 1.

21. Press **MARKER 1 POSITION** and overlay this marker on the center of the trace.

22. Press **MARKER 2 POSITION** and overlay this marker on the highest portion of ringing which occurs near center screen and is greater than marker 1.

23. The delta V value should be < 10 mV, (+5%).

24. Reposition marker 2 to the highest portion of ringing which occurs near center screen and is less than marker 1.

25. The absolute value of Delta V should be < 10 mV, (+5%).

Table 3-1. Performance Test Record

Four Channel test Set HP 54121A
HP 54120A/B Serial No. _____
HP 54121A Serial No. _____

Tested by _____
Work Order No. _____
Date Tested _____
Test Interval _____ months

Test		Results	
Low bandwidth 12.4 GHz		Actual	Maximum
	channel 1	_____	−2.99 dB
	channel 2	_____	−2.99 dB
	channel 3	_____	−2.99 dB
	channel 4	_____	−2.99 dB
High bandwidth 18 GHz	channel 1	_____	−2.99 dB
High bandwidth 20 GHz	channel 1	_____	−3.49 dB
	channel 2	_____	−2.99 dB
	channel 3	_____	−2.99 dB
	channel 4	_____	−2.99 dB

Channel 1 dc Accuracy Test	Minimum	Actual	Maximum
12.4 GHz BW mode 0 V offset	−2.16 mV	_____	2.16 mV
20 GHz BW mode 0 V offset	−2.16 mV	_____	2.16 mV
+ Offset Gain 500 mV offset	496 mV	_____	504 mV
− Offset Gain 500 mV offset	−504 mV	_____	−496 mV
Delta V Offset Gain	992 mV	_____	1.0080 V
+ Sampler Gain 250 mV offset	240.34 mV	_____	259.66 mV
− Sampler Gain −250 mV offset	−259.66 mV	_____	−240.34 mV
RMS noise 0 V offset 12.4 GHz		_____	1 mV
* RMS noise 0 V offset 20 GHz		_____	2 mV
Channel 2 dc Accuracy Test			
12.4 GHz BW mode 0 V offset	−2.16 mV	_____	2.16 mV
20 GHz BW mode 0 V offset	−2.16 mV	_____	2.16 mV
+ Offset Gain 500 mV offset	496 mV	_____	504 mV
− Offset Gain 500 mV offset	−504 mV	_____	−496 mV
Delta V Offset Gain	992 mV	_____	1.0080 V
+ Sampler Gain 250 mV offset	240.34 mV	_____	259.66 mV
− Sampler Gain −250 mV offset	−259.66 mV	_____	−240.34 mV
RMS noise 0 V offset 12.4 GHz		_____	1 mV
* RMS noise 0 V offset 20 GHz*		_____	2 mV

Table 3-1. Performance Test Record (continued)

Test		Results		
Channel 3 dc Accuracy Test		Minimum	Actual	Maximum
	12.4 GHz BW mode 0 V offset	−2.16 mV	_____	2.16 mV
	20 GHz BW mode 0 V offset	−2.16 mV	_____	2.16 mV
	+ Offset Gain 500 mV offset	496 mV	_____	504 mV
	− Offset Gain 500 mV offset	−504 mV	_____	−496 mV
	Delta V Offset Gain	992 mV	_____	1.0080 V
	+ Sampler Gain 250 mV offset	240.34 mV	_____	259.66 mV
	− Sampler Gain −250 mV offset	−259.66 mV	_____	−240.34 mV
	RMS noise 0 V offset 12.4 GHz		_____	1 mV
	* RMS noise 0 V offset 20 GHz		_____	2 mV
Channel 4 dc Accuracy Test				
	12.4 GHz BW mode 0 V offset	−2.16 mV	_____	2.16 mV
	20 GHz BW mode 0 V offset	−2.16 mV	_____	2.16 mV
	+ Offset Gain 500 mV offset	496 mV	_____	504 mV
	− Offset Gain 500 mV offset	−504 mV	_____	-496 mV
	Delta V Offset Gain	992 mV	_____	1.0080 V
	+ Sampler Gain 250 mV offset	240.34 mV	_____	259.66 mV
	− Sampler Gain −250 mV offset	−259.66 mV	_____	−240.34 mV
	RMS noise 0 V offset 12.4 GHz		_____	1 mV
	* RMS noise 0 V offset 20 GHz		_____	2 mV

* Does not apply to instruments with firmware datecode March 3, 1989 and earlier

Short Delta T		Minimum	Actual	Maximum
Delay Setting	16 ns	40.0 ps	_____	60.2 ps
	18 ns	40 ps	_____	60.2 ps
	19.9 ns	40 ps	_____	60.2 ps
	19.95 ns	40 ps	_____	60.2 ps
	23.95 ns	40 ps	_____	60.2 ps
	27.95 ns	40 ps	_____	60.2 ps
	55.95 ns	40 ps	_____	60.2 ps

Table 3-1. Performance Test Record (continued)

Test			Results		
Short Delta T (continued)			Minimum	Actual	Maximum
	Frequency	10 GHz	89.9 ps	_____	110.1 ps
		5 GHz	189.8 ps	_____	210.2 ps
		2 GHz	489.5 ps	_____	510.5 ps
		1 GHz	0.9890 ns	_____	1.011 ns
		500 MHz	1.988 ns	_____	2.012 ns
		200 MHz	4.985 ns	_____	5.015 ns
		100 MHz	9.980 ns	_____	10.02 ns
		50 MHz	19.97 ns	_____	20.03 ns
		20 MHz	49.95 ns	_____	50.06 ns
Long Delta T		10 MHz	99.89 ns	_____	100.11 ns
		5 MHz	199.79 ns	_____	200.21 ns
		2 MHz	499.49 ns	_____	500.51 ns
		1 MHz	.99899 µs	_____	1.00101 µs
		500 kHz	1.99799 µs	_____	2.00201 µs
		200 kHz	4.99499 µs	_____	5.00501 µs
		100 kHz	9.98999 µs	_____	10.01001 µs
		50 kHz	19.97999 µs	_____	20.02001 µs
		20 kHz	49.94999 µs	_____	50.05001 µs
		10 kHz	99.89999 µs	_____	100.10001 µs
Trigger Sensitivity Test			Minimum	Actual	Maximum
	Trigger Hysteresis	V_{pos}		_____	
		V_{neg}		_____	
		V_{hyst}		_____	40 mV
	100 MHz Trigger Sens.	V_{pos}		_____	
		V_{neg}		_____	
		$V_{sens.}$		_____	40 mV
(2.5 GHz trigger only)	HF Reject On	V_{pos}		_____	
		V_{neg}		_____	
		$V_{sens.}$	57 mV	_____	
	2.5 GHz Trigger Sens.	V_{pos}		_____	
		V_{neg}		_____	
		$V_{sens.}$		_____	200 mV

Table 3-1. Performance Test Record (continued)

Test			Results		
(Trigger Sensitivity Test Continued)					
	500 MHz Trigger Sens.	V_{pos}		_____	
	(500 MHz Trigger only)	V_{neg}		_____	
		$V_{sens.}$			100 mV
Jitter Test			Minimum	Actual	Maximum
	2.5 GHz Trigger (only)			_____	See Specs.
		Example	<3.525 ps with 20.5 ns delay setting		
	500 MHz Trigger (only)			_____	See Specs.
		Example	<5.8 ps with 20.5 ns delay setting		
TDR System Test			Minimum	Actual	Maximum
		Low level	−2 mV	_____	2 mV
		High level	198 mV	_____	202 mV
	Flattness >1 ns	+1%		_____	+1%
		−1%	−1%	_____	
	<1 ns	−2%	−2%	_____	
		+5%		_____	+5%
	Risetime			_____	45 ps
Input Reflection Test				Actual	Maximum
	Channel 2	pos		_____	5%
		neg		_____	5%
	Channel 3	pos		_____	5%
		neg		_____	5%
	Channel 4	pos		_____	5%
		neg		_____	5%
	External Trigger	pos		_____	10%
		neg		_____	10%
	Channel 1	pos		_____	5%
		neg		_____	5%