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4194A

HEWLETT PACKARD

OPERATION MANUAL

MODEL 4194A IMPEDANCE/GAIN-PHASE ANALYZER

(Including Options 001, 350 and 375)

SERIAL NUMBERS

This manual applies directly to instruments whose serial number prefix is 2617J and whose ROM-based firmware is version 2.2.

With the changes described in Appendix A, this manual also applies to instruments whose serial number prefix is 2614J and below, and whose ROM-based firmware is version 2.0 and 2.1.

For additional important information about **serial numbers**, read INSTRUMENTS COVERED BY MANUAL in Section 1 of the Operation Manual.

Manual Part No. 04194-90001
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HOW TO USE THIS MANUAL

General Information, Section 1, describes what is included with your HP 4194A, what additional accessories are available, and the Specifications. Before installing the HP 4194A and turning on it, check to see that your 4194A has all the furnished accessories listed in this section. Then go to **Section 2, Installation**.

Installation, Section 2, describes how to link the Control unit and Measurement unit, how to install the Rack Mounting Kit (Option 907, 908 and 909), how to set the Line Voltage Selection switches, and how to connect the power cord.

Note

To ensure operator safety, mount both units as described in paragraph 2-3-1 of Section 2.

Getting Started in Section 3 is designed to help the first-time user. This section describes how to turn on the HP 4194A, and gives some operating hints.

Impedance/Gain-Phase Measurement in Section 3 describes the use of the HP 4194A IMPEDANCE/GAIN-PHASE ANALYZER in making typical measurements on several common devices. These measurements were selected as examples which cover topics of general interest in a manner which demonstrates the capabilities of the HP 4194A.

Reference in Section 3 is an encyclopedia of front panel operation details. This section is an alphabetical listing of front panel sections, hardkeys and terms. The each MENU hardkey topic shows the menu of softkey labels it will display on the screen and describes each softkey command in detail.

Extended Capabilities in Section 3 describes in detail the special capabilities of the HP 4194A.

SECTION 1

GENERAL INFORMATION

1-1. INTRODUCTION

This operation manual contains the information required to install, operate, and test the Hewlett-Packard Model 4194A Impedance/Gain-Phase Analyzer. Figure 1-1 shows the 4194A and its supplied accessories. This section covers specifications, instrument identification, description, options, and accessories.

Listed on the title page of this manual is a microfiche part number. This number can be used to order 4 x 6 inch microfilm transparencies of the manual. Each microfiche contains up to 60 photo-duplicates of the manual pages. The microfiche package also includes the latest manual changes supplement as well as all pertinent service notes. To order an additional manual, use the part number listed on the title page of this manual.

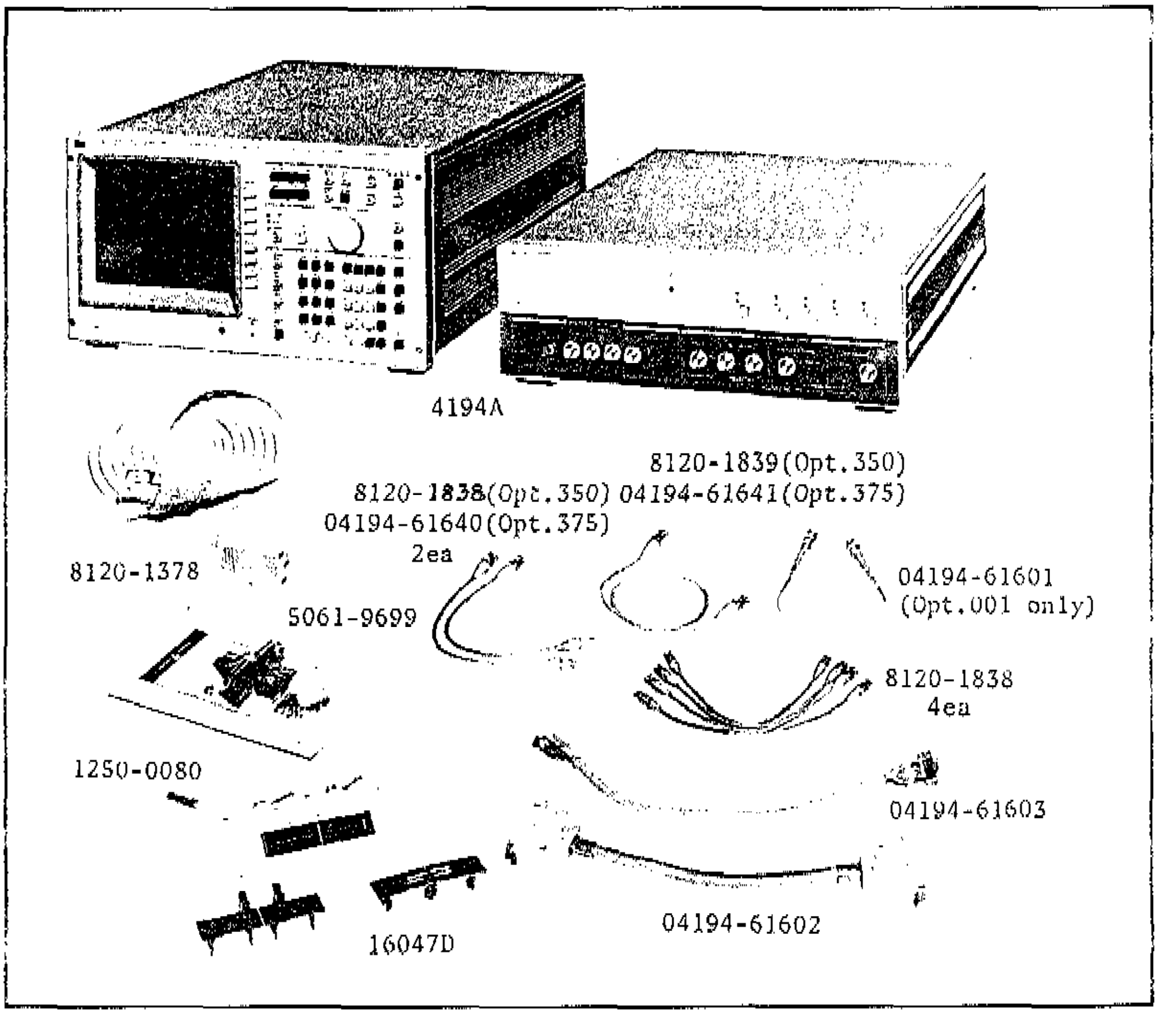


Figure 1-1. Model 4194A and Accessories

1-2. DESCRIPTION

The HP 4194A features eleven Impedance and four Gain-Phase measurement functions and covers a frequency range of 100Hz to 40MHz for Impedance, and from 10Hz to 100MHz for Gain-Phase. The output level, with an adjustable dc bias level of ±40V, ranges from 10mV to 1Vrms for Impedance and from -65dBm to +15dBm for Gain-Phase. Sweep Parameters include Frequency and OSC level for both Impedance and Gain-Phase functions with the addition of dc Bias for the Impedance function. Up to 401 individual sweep points can be selected for special applications. The basic measurement accuracy is 0.17% of reading for Impedance and 0.1dB/0.5° for Gain-Phase.

Note

When the probe from the 41941A/B Probe kit is used the frequency range for impedance measurement is 10kHz to 100MHz.

The 4194A's menu-driven software uses eight softkeys located next to the menu display area of the CRT. Menus are selected by pressing the MENU key which corresponds to the desired operation. Current marker information and sweep parameters are displayed above and below the CRT graticule as status information.

Measurement information displayed on the 4194A's CRT is stored as complex data. Using this storage technique and the math processing capabilities of the 4194A, several display formats may be derived from the same trace data and changes in scale may be made without repeating the measurement.

The 4194A's graticules are electronically generated, making overlays unnecessary when producing a log grid. In the log sweep mode, the graticule changes to reflect changes in the start and stop parameter values.

The 4194A provides HP-IB interface capability for complete remote control of all front panel control key settings and test parameter settings. This feature makes it possible to integrate the 4194A into a measurement system, improve DUT throughput, improve circuit design efficiency, and reduce the component development cycle.

Other features of the 4194A include Auto Sequence Program (ASP), dumping the display to a printer or plotter, program table for GO/NO GO testing, equivalent circuit mode, and the ability to save and recall five instrument states.

The HP 4194A consists of a CONTROL unit and a MEASUREMENT unit. The CONTROL unit displays the measurement results, and the MEASUREMENT unit interfaces directly to the devices to be measured.

1-3. SPECIFICATIONS

Table 1-1 lists complete 4194A specifications. These specifications are the performance standards or limits against which the instrument is tested. When shipped from the factory, the 4194A meets the specifications listed in Table 1-1. The specification test procedures are covered in Section 4. Table 1-2 lists supplemental performance characteristics. Supplemental performance characteristics are not specifications but are typical characteristics included as additional information for the operator.

1-4. SAFETY CONSIDERATIONS

The 4194A conforms to the safety requirements of an IEC (International Electromechanical Committee) Safety Class I instrument and is shipped from the factory in a safe condition. This operation manual contains information, cautions, and warnings which must be followed to ensure safe operation and to maintain the instrument in a safe condition.

1-5. INSTRUMENTS COVERED BY THIS MANUAL

Hewlett-Packard uses a two-section nine character serial number which is stamped on the serial number plate (Figure 1-2) attached to the instrument's rear-panel. The first four digits and the letter are the serial prefix and the last five digits are the suffix. The letter placed between the two sections identifies the country where the instrument was manufactured. 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 prefixes listed under Serial Numbers on the title page.

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 new instrument may be accompanied by a yellow Manual Changes supplement or have a different manual part number. This supplement contains "change information" that explains how to adapt the manual to the newer instrument.

In addition to change information, the supplement may contain information for correcting errors (Errata) 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 this manual's print date and part number, both of which appear on the manual's title page. Complimentary copies of the supplement are available from Hewlett-Packard. If the serial prefix or number of an instrument is lower than that on the title page of this manual, see APPENDIX A, BACK DATING.

For information concerning a serial number prefix that is not listed on the title page or in the Manual Change supplement, contact the nearest Hewlett-Packard office.

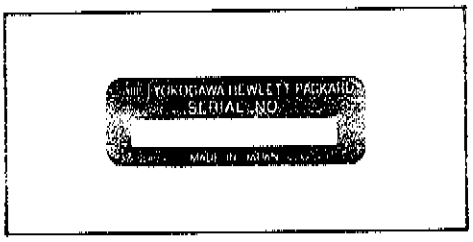


Figure 1-2. Serial Number Plate

Table 1-1. Specifications (sheet 1 of 34)

SPECIFICATIONS

IMPEDANCE MEASUREMENT

The 4194A provides two impedance measurement functions either of which can be selected by using the '**IMPEDANCE**' (Program code :FNC1) or '**IMP with Z PROBE**' (Program code: FNC3) softkeys. The latter function is provided for use with the probe included with the 41941A/B Impedance Probe Kit. The specifications on both functions are listed separately and more specific information for the **IMP with Z PROBE** function when used with the probe is described in Operation Note 41941A/B (P/N 41941-90000).

1. IMPEDANCE MEASUREMENT (FNC1):

Measurement Parameters: |Z|(impedance), |Y| (admittance), θ (phase), R (resistance), X (reactance), G (conductance), B (susceptance), L (inductance), C (capacitance), D (dissipation factor), Q (=1/D), 20 parameter combinations are available.

Test Frequency:

* Range:	100Hz to 40MHz with CABLE LENGTH switch set to 0m. 100Hz to 15MHz with CABLE LENGTH switch set to 1m.
* Resolution:	1mHz
* Accuracy:	±20ppm at 23° ±5°C

Osc Level:

* Range:	10mV to 1Vrms (≤ 10MHz) 10mV to 0.5Vrms (> 10MHz) (UNKNOWN terminals open)
* Resolution:	3 digits
* Accuracy:	±1dB at 100KHz, 23° ±5°C
* Flatness:	±1dB
* Output Impedance:	50Ω (Opt. 350), 75Ω (Opt. 375)

Note

*** dBc indicates a measurement relative to the set frequency. ***

* Harmonics:	≤ -45dBc
* Non-Harmonic Spurious:	≤ -42dBc

Table 1-1. Specifications (sheet 2 of 34)

* Phase Noise:	≤ -90dBc/ $\sqrt{Hz}$ (2kHz offset)
* Units:	V, dBm, dBV
DC Bias Level:	
* Range:	0 to ±40V
* Resolution:	10mV
* Accuracy:	±(0.12% + 12mV), at 23° ±5°C
* Output Impedance:	50Ω (Opt 350), 75Ω (Opt 375)
* Maximum Current	Depends on the DUT Impedance ±20mA, (|Z| ≤400Ω) ±10mA, (|Z| ≤3.2KΩ) ±1.2mA, (|Z| ≤25KΩ) ±150uA, (|Z| >25KΩ)
Sweep Function:	
* Sweep Parameters:	Frequency, Osc Level, DC Bias
* Maximum Sweep Range:	
Frequency:	100Hz to 40MHz when the CABLE LENGTH switch is set to 0m. 100Hz to 15MHz when the CABLE LENGTH switch is set to 1m.
Osc Level:	26dB (max)
DC Bias:	0 to ±40V
Entry:	START/STOP or CENTER/SPAN
Sweep Type:	LIN, LOG, ZERO SPAN
Sweep Mode:	REPEAT, SINGLE, MANUAL
Direction:	UP, DOWN
Number of Measurement Points:	2 to 401 points (max 261 points at Osc Level sweep)
Measurement Circuit Modes:	Series equivalent circuit, parallel equivalent circuit
Ranging:	Auto
Measurement Terminal:	4 terminal pair configuration

Table 1-1. Specifications (sheet 3 of 34)

Auto Compensation:	
* Automatic Zero Offset Compensation:	Compensate test fixture residual impedance and stray admittance.
* Automatic Calibration:	Calibrate probe or fixture using the calibration standards.
* Compensation Method:	Interpolation or All points.
* Interpolation Method:	Fifty-three fixed frequency points for 0m cable length and twenty-eight points for 1m cable length over the specified frequency range. Linear interpolation is performed at the specified points.
* All Points Method:	Same as the measurement points.
* Compensation Range:	Same as the measurement range.
Test Cable Length:	0m or 1m.
Max. Input DC Current/Voltage:	±20mA/±40V.
Level Monitor:	Monitor test voltage across and current through the DUT.
* Range:	1mV to 1Vrms, 1μA to 20mA.
* Accuracy: (at 23° ±5°C)	

	≤1MHz	≤10MHz	>10MHz
Voltage	10%±1mV		
Current	10%± 15nA	10%± 60xfnA	10%± 600xfnA

f: frequency (MHz)

Table 1-1. Specifications (sheet 4 of 34)

Measurement Range and Maximum Resolution:

Measurement Parameter	Range	Max Resolution
$\lvert Z\rvert$, R, X	10mΩ to 100MΩ	100μΩ
$\lvert Y\rvert$, G, B	10ns to 100S	1nS
θ	± 180°	0.01°
L	1nH to 100kH	10pH
C	10fF to 0.1F	0.1fF
D	0.001 to 10	0.0001
Q	0.1 to 1000	0.1

Measurement Accuracy:

Accuracy is specified at the UNKNOWN terminals under the following conditions

1. Warm Up Time: > 30min
2. Ambient temperatures 23° ±5°C (the error doubles form 0°C to ±40°C temperature range)
3. CABLE LENGTH Switch: 0m
4. Auto Zero Compensation: ON
   Accuracy depends on the test frequency, magnitude of impedance measured, test signal level, integration time and number of samples averaged.

* |Z|-θ Accuracy:

|Z| Accuracy:

$$Za=\frac{A1}{\alpha}+A2+\left(\frac{B1}{|Zm|}+B2\cdot|Zm|\right)\times\frac{100}{\alpha}\quad[\%]$$

θ Accuracy:

$$\Theta a=\frac{Za}{100}\cdot\frac{180}{\pi}\quad[°]$$

where |Zm| is |Z| measured and α is test signal level in volts. A1, A2, and B2 are obtained from Graph 1, 4, 7 or 10. For example, Frequency = 100kHz, |Zm| = 1kΩ, test signal level = 1V, INTEG TIME = MED and number of samples averaged = 4, then A1 = 0.023, A2 = 0.15, B1 = 2.5mΩ , B2 = 2.5nS and α= 1 therefore,

$$Za=\frac{0.023}{1}+0.15+\left(\frac{2.5\times10^{-3}}{1\times10^{3}}+2.5\times10^{-9}\times1\times10^{3}\right)\times\frac{100}{1}=0.17\%$$

Table 1-1 Specifications (sheet 5 of 34)

* $|Y|$-θ Accuracy:

$|Y|$ Accuracy: $$Ya = \frac{A1}{\alpha} + A2 + \left(B1 \cdot |Ym| + \frac{B2}{|Ym|} \right) \times \frac{100}{\alpha} \quad [\%]$$

θ Accuracy: $$\theta a = \frac{Ya}{100} \cdot \frac{180}{\pi} \quad [^\circ]$$

where $|Ym|$ is $|Y|$ measured and α is test signal level in volts. A1, A2, B1 and B2 are obtained from Graph 1, 4, 7 or 10.

* R, X Accuracy (depends on D):

	$D \leq 0.2$	$0.2 < D \leq 5$	$5 < D$
Ra	$\pm Xm \cdot \frac{Za(x)}{100}$ (Ω)	$\frac{Za(R)}{\cos\theta}$ $[\%]$	$Za(R)$ $[\%]$
Xa	$Za(x)$ $[\%]$	$\frac{Za(x)}{\sin\theta}$ $[\%]$	$\pm Rm \cdot \frac{Za(R)}{100}$ $[\Omega]$

where θ is phase angle,

$$Za(x) = \frac{A1}{\alpha} + A2 + \left(\frac{B1}{Xm} + B2 \cdot Xm \right) \times \frac{100}{\alpha} \quad [\%]$$
$$Za(R) = \frac{A1}{\alpha} + A2 + \left(\frac{B1}{Rm} + B2 \cdot Rm \right) \times \frac{100}{\alpha} \quad [\%]$$

Xm is measured X, Rm is measured R, and α is test signal level in volts. A1, A2, B1, and B2 are obtained from Graph 1, 4, 7 or 10.

* G, B Accuracy (depends on D):

	$D \leq 0.2$	$0.2 < D \leq 5$	$5 < D$
Ga	$\pm Bm \cdot \frac{Ya(B)}{100}$ $[S]$	$\frac{Ya(G)}{\cos\theta}$ $[\%]$	$Ya(G)$ $[\%]$
Ba	$Ya(B)$ $[\%]$	$\frac{Ya(B)}{\sin\theta}$ $[\%]$	$\pm Gm \cdot \frac{Ya(G)}{100}$ $[S]$

where θ is phase angle,

$$Ya(B) = \frac{A1}{\alpha} + A2 + \left(B1 \cdot Bm + \frac{B2}{Bm} \right) \times \frac{100}{\alpha} \quad [\%]$$
$$Ya(G) = \frac{A1}{\alpha} + A2 + \left(B1 \cdot Gm + \frac{B2}{Gm} \right) \times \frac{100}{\alpha} \quad [\%]$$

Bm is measured B, Gm is measured G, α is test signal level in volts. A1, A2, B1, and B2 are obtained from Graph 1, 4, 7 or 10.

Table 1-1. Specifications (sheet 6 of 34)

* D Accuracy:

	$D \leqq 0.2$	$D > 0.2$
Da	$\frac{Za}{100}$	$\frac{Za}{100} \cdot (1+D^2)$

where Za is |Z| accuracy (refer to |Z|-θ Accuracy).

* L Accuracy (depends on D):

	$D \leqq 0.2$	$D > 0.2$
L	La	$La \cdot (1+D)$

where

$$La = \frac{A1}{\alpha} + A2 + \left(\frac{B1}{|Z_L|} + B2 \cdot |Z_L| \right) \times \frac{100}{\alpha} \quad [\%]$$

where $|Z_L| = 2\pi \cdot f \cdot Lm$, f is frequency in Hz and Lm is measured L. A1, A2, B1, and B2 are obtained from Graph 2, 5, 8 or 11.

* C Accuracy (depends on D):

	$D \leqq 0.2$	$D > 0.2$
C	Ca	$Ca \cdot (1+D)$

where

$$Ca = \frac{A1}{\alpha} + A2 + \left(\frac{B1}{|Zc|} + B2 \cdot |Zc| \right) \times \frac{100}{\alpha} \quad [\%]$$

where

$$|Zc| = \frac{1}{2\pi \cdot f \cdot Cm}$$

f is frequency in Hz and Cm is measured C. A1, A2, B1 and B2 are obtained from Graph 3, 6, 9 or 12.

* Accuracy when CABLE LENGTH switch=1m:

Add the following term to A2 in Graph 1 to 12 when CABLE LENGTH switch is set to 1m.

$$\frac{3 \cdot f\ [MHz]}{10}$$

where $f \leq 15MHz$.

Table 1-1. Specifications (sheet 7 of 34)

Graph 1

INTEG TIME: MED or LONG, Averaging: ≥ 4

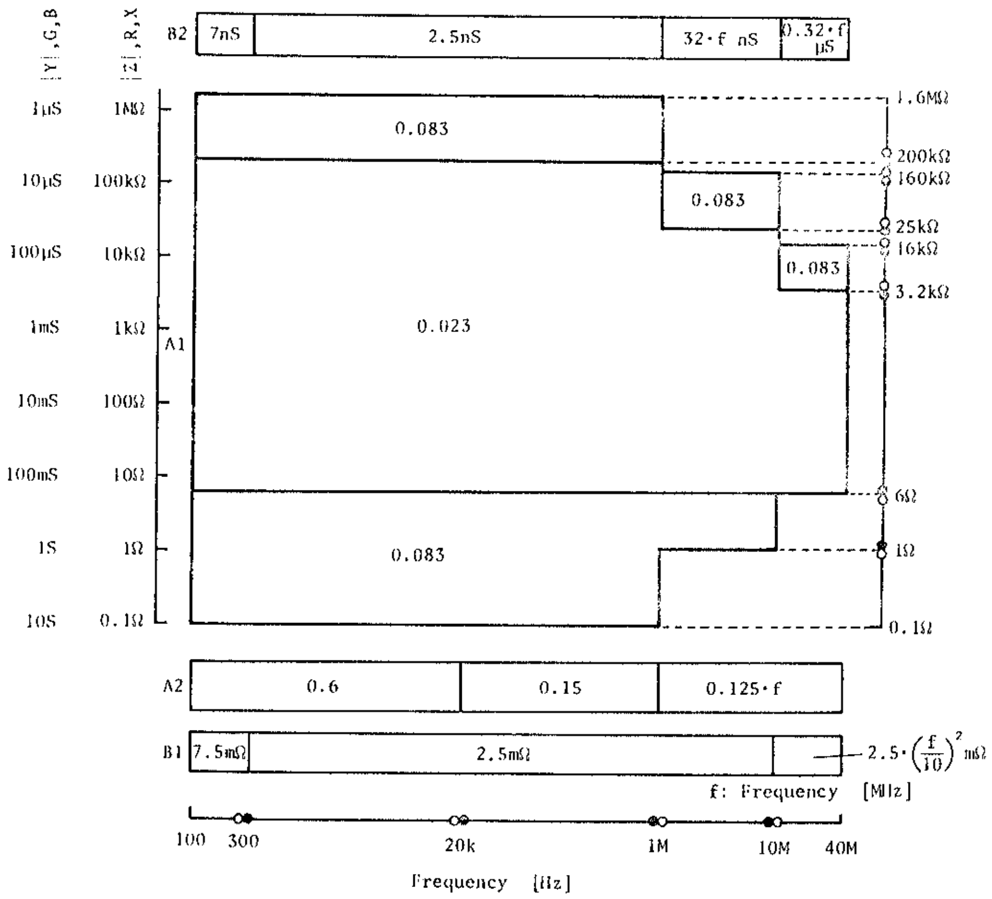
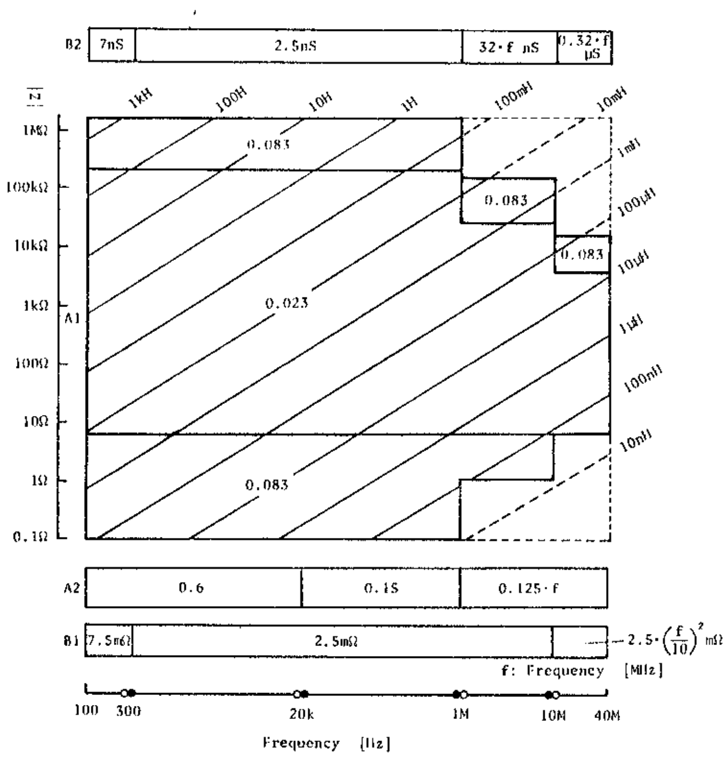


Table 1-1. Specifications (sheet 8 of 34)

Graph 2

INTEG TIME: MED or LONG, Averaging: ≥ 4



Graph 3

INTEG TIME: MED or LONG, Averaging: ≥ 4

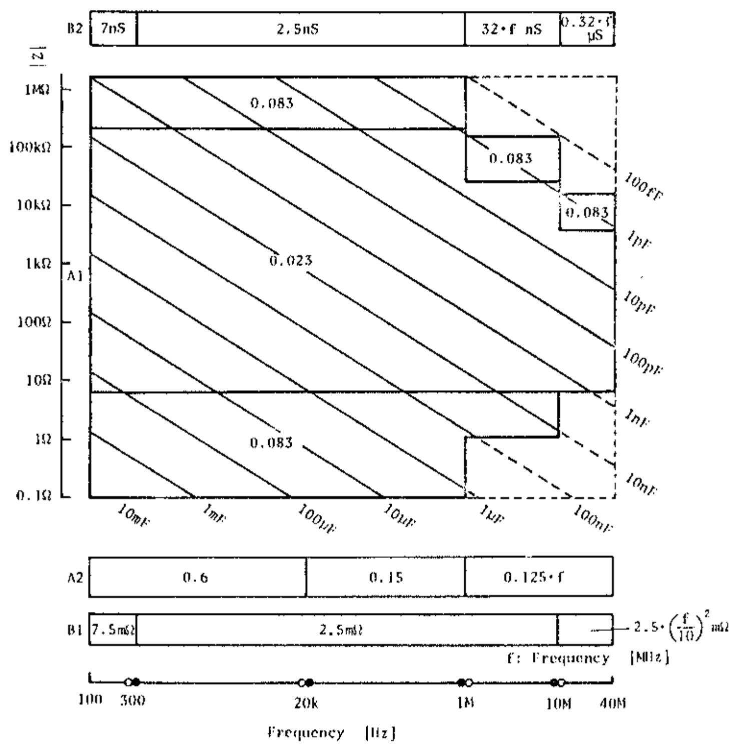


Table 1-1. Specifications (sheet 9 of 34)

Graph 4

INTEG TIME: MED or LONG, Averaging: 1 or 2

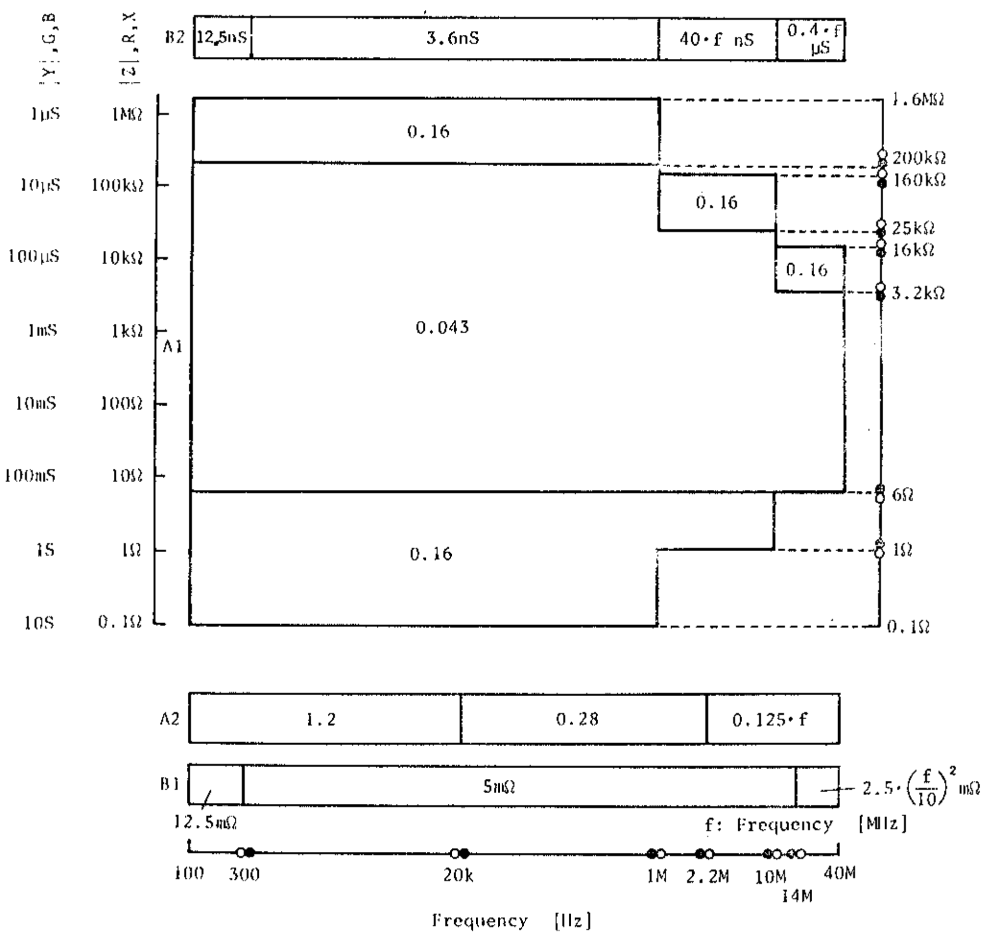
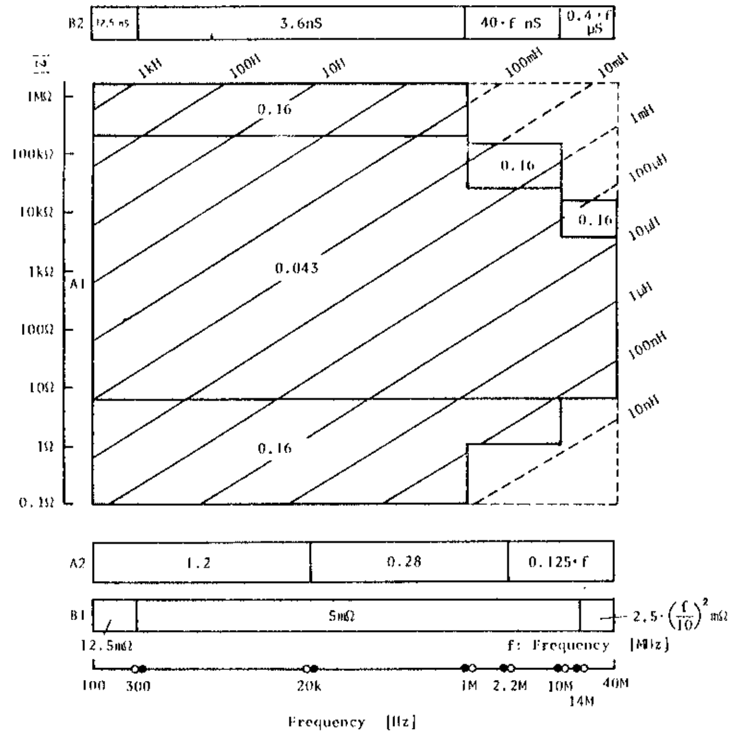


Table 1-1. Specifications (sheet 10 of 34)

Graph 5

INTEG TIME: MED or LONG, Averaging: 1 or 2



Graph 6

INTEG TIME: MED or LONG, Averaging: 1 or 2

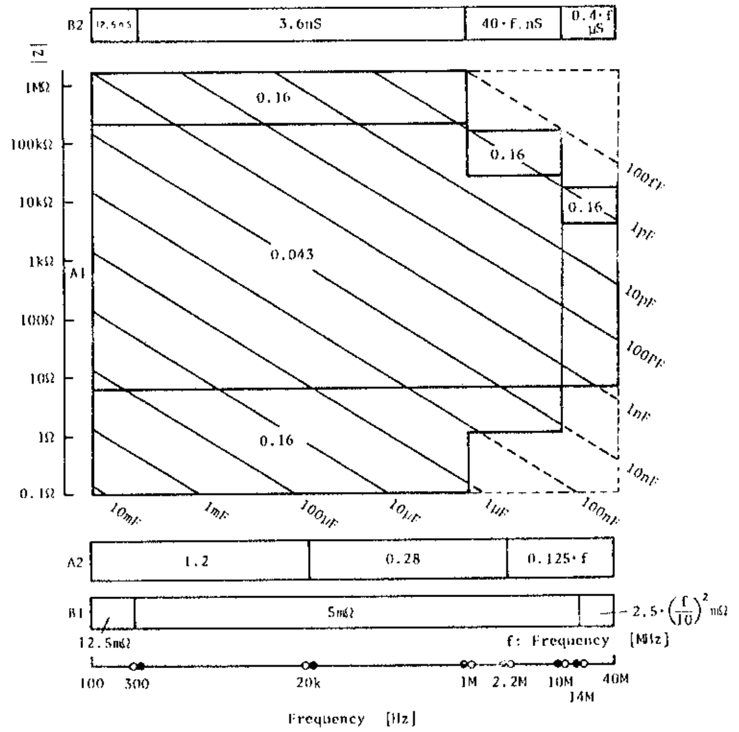


Table 1-1. Specifications (sheet 11 of 34)

Graph 7

INTEG TIME: SHORT, Averaging: ≥ 4

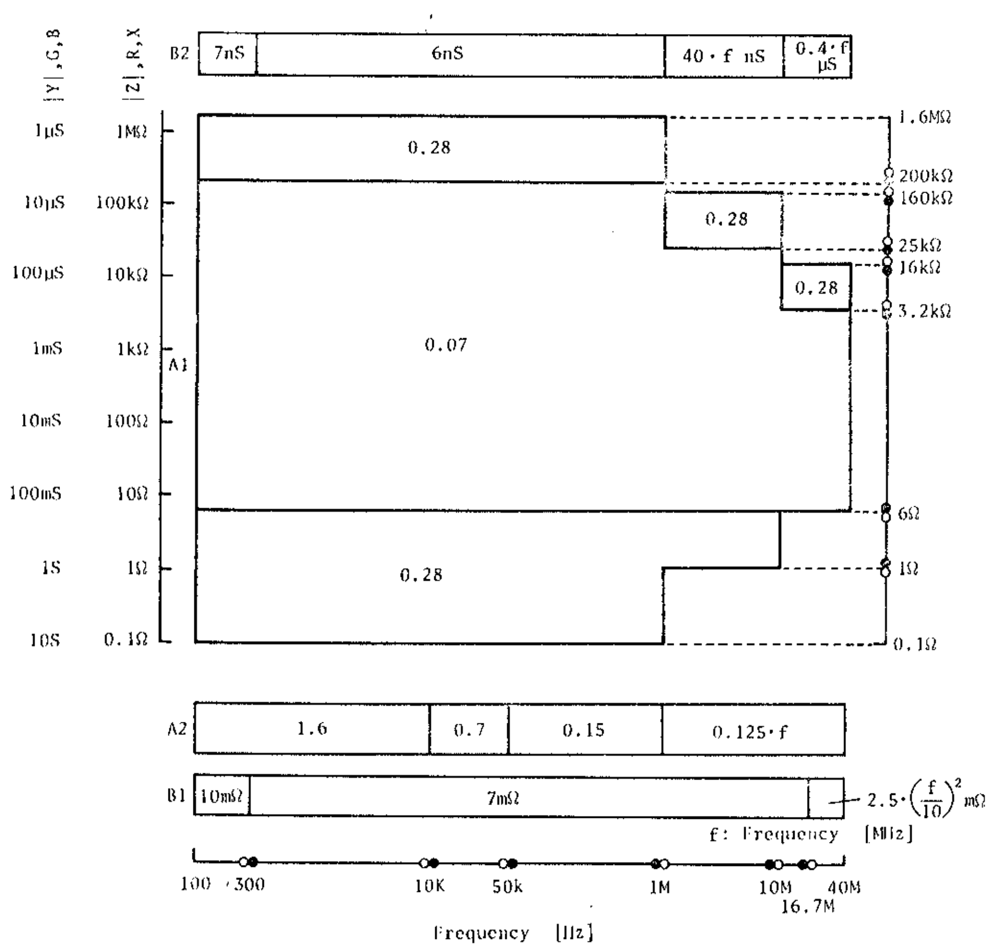
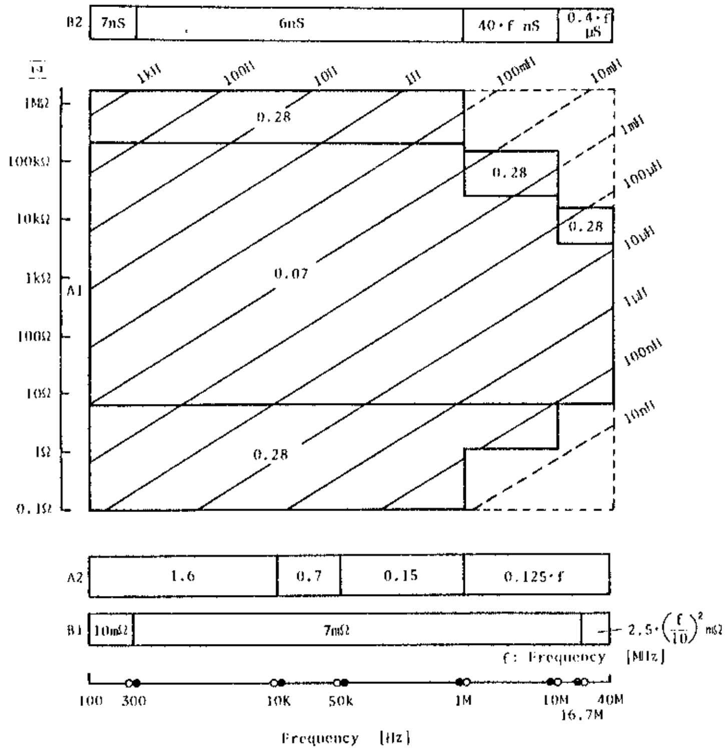


Table 1-1. Specifications (sheet 12 of 34)

Graph 8

INTEG TIME: SHORT, Averaging: ≥ 4



Graph 9

INTEG TIME: SHORT, Averaging: ≥ 4

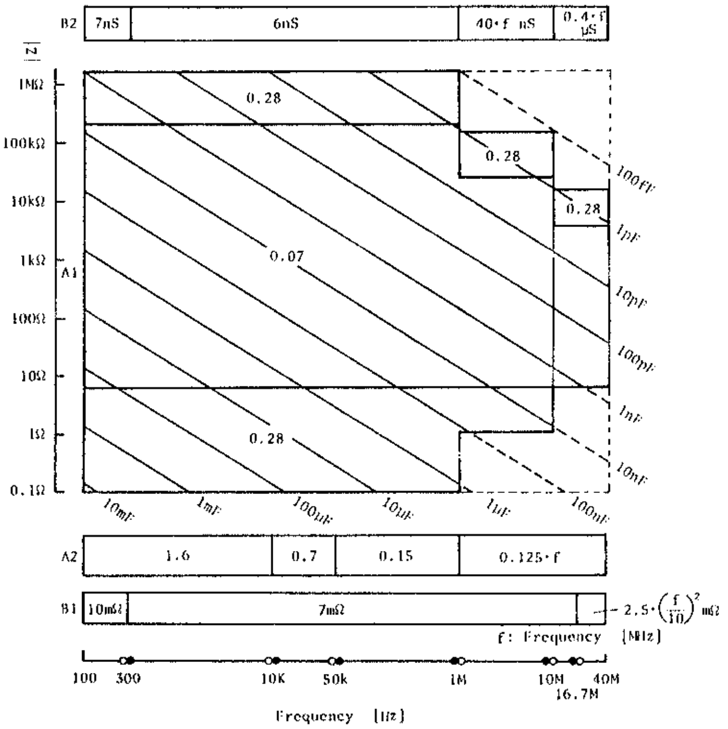


Table 1-1. Specifications (sheet 13 of 34)

Graph 10

INTEG TIME: SHORT, Averaging: 1 or 2

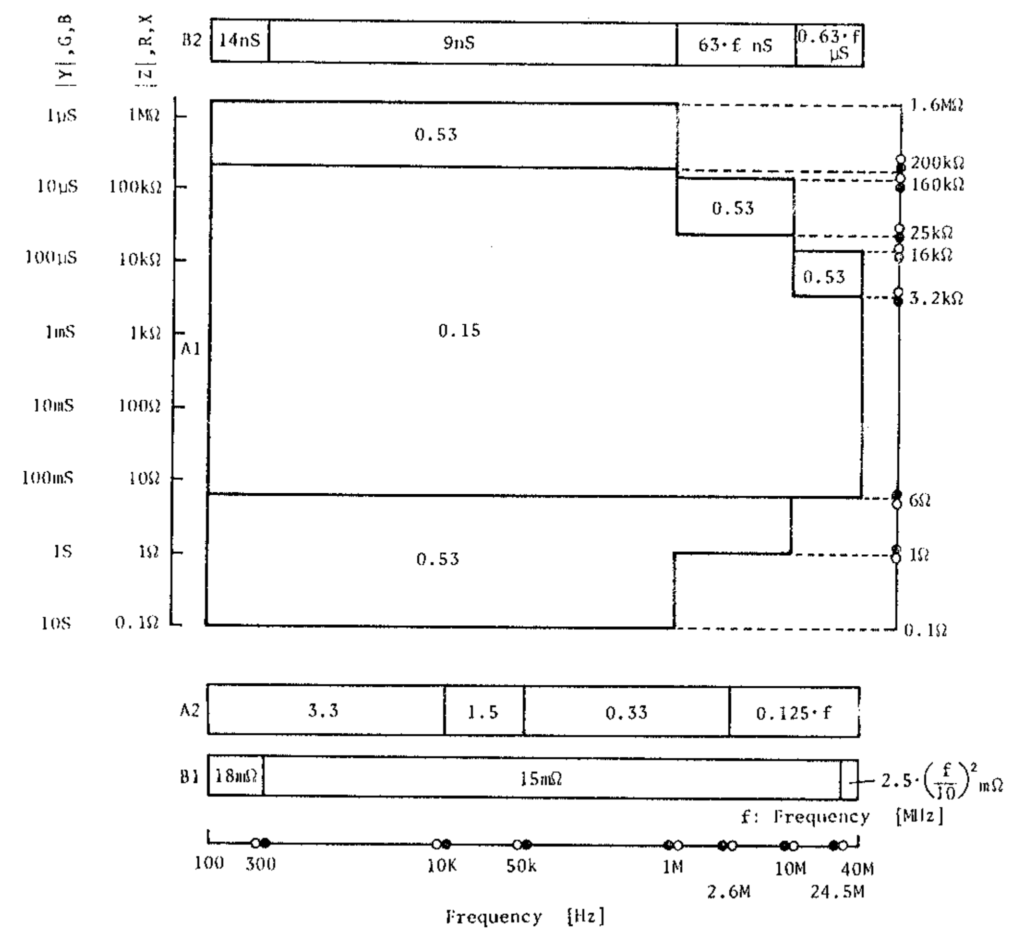
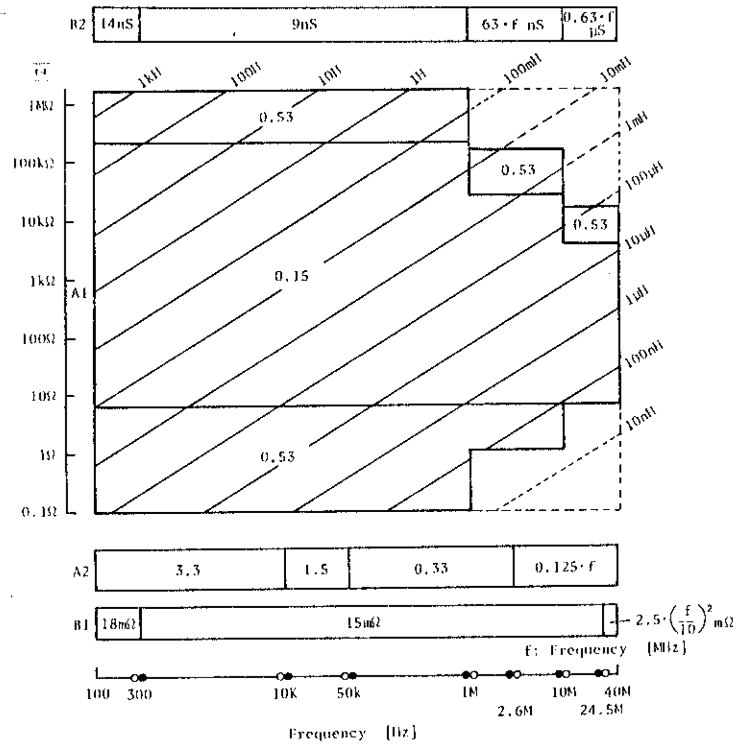


Table 1-1. Specifications (sheet 14 of 34)

Graph 11

INTEG TIME: SHORT, Averaging: 1 or 2



Graph 12

INTEG TIME: SHORT, Averaging: 1 or 2

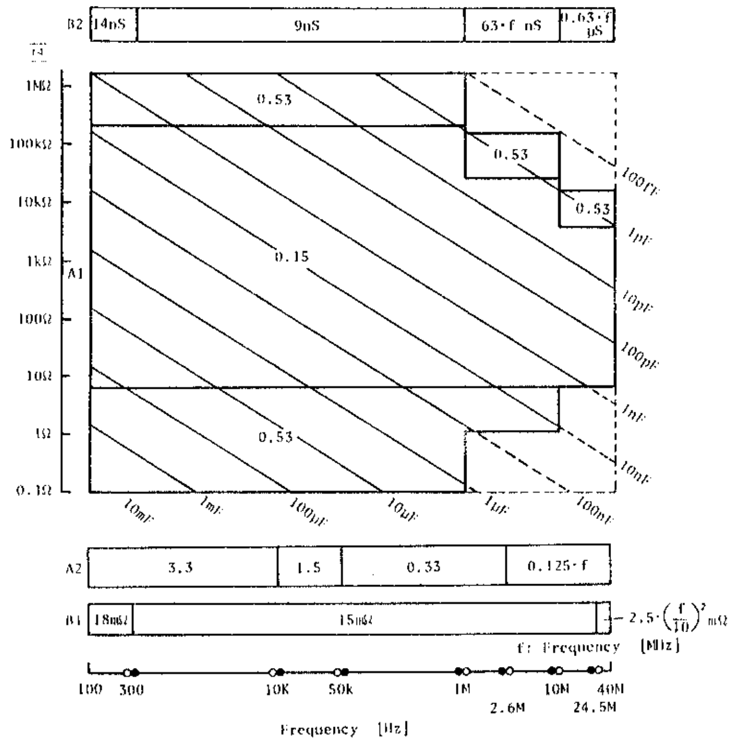


Table 1-1. Specifications (sheet 15 of 34)

2.IMPEDANCE MEASUREMENT (FNC3):

Measurement Parameters:	Same as impedance measurement (FNC1).
Test Frequency:	
* Range:	10Hz to 100MHz
* Resolution:	1mHz
* Accuracy:	±20ppm (23° ±5° C)
Osc Level:	
* Range:	-65dBm to +15dBm (opt 350, 126µV to 1.26V) (opt 375, 154µV to 1.54V)
* Resolution:	0.1dB
* Accuracy:	±0.8dB (15dBm, 100KHz at 23° ±5° C)Add the larger of ±0.02dB/dB or 0.2dB (<15dBm)
* Flatness:	±1dB (15dBm, 10Hz to 100MHz) Add the larger of ±0.02dB/dB or 0.2dB (<15dBm)
* Output Impedance:	50Ω (opt 350), 75Ω (opt 375)
VSWR:	<1.1 (-65dBm to +5dBm) <1.4 (+5dBm to +15 dBm)
* Harmonics:	≤-40dBc (≤1MHz) ≤-35dBc (≤10MHz) ≤-30dBc (>10MHz)
* Non-Harmonic Spurious:	<-42dBc or -90dBm, whichever is larger (≤40MHz) <-36dBc or -90dBc, whichever is larger (>40MHz)
* Phase Noise:	<-90dBc/$\sqrt{Hz}$ (≤40MHz, 2KHz offset) <-80dBc/$\sqrt{Hz}$ (>40MHz, 2KHz offset)
* Unit	dBm, dBV, V

Table 1-1. Specifications (sheet 16 of 34)

DC Bias Level: (Output through Hcur BNC terminal)	
* Range:	0 to ±40V
* Resolution:	10mV
* Accuracy:	±(0.12% + 12mV) at 23° ±5°C
* Output Impedance:	50Ω (opt 350), 75Ω (opt 375)
* Maximum Current:	±20mA
Sweep Function:	
* Sweep Parameters:	Frequency, Osc Level, DC Bias
* Maximum Sweep Range:	
Frequency:	10Hz to 100MHz
Osc Level:	26dB (max.)
DC Bias:	0 to ±40V
* Entry:	START/STOP or CENTER/SPAN
* Sweep Type:	LIN, LOG, ZERO SPAN
* Sweep Mode:	REPEAT, SINGLE, MANUAL
* Direction:	UP, DOWN
Number of Measurement Points:	2 to 401 points (max. 261 points at Osc Level sweep)
Output Characteristics:	
* Output:	Single, Dual (built-in power splitter)
* Connector:	50Ω BNC (Female)
Single Output:	Use specification for Osc Level
Dual Output (Built-in Power Splitter):	Add the following to the Osc Level specification.
* Insertion Loss:	6dB
* Output Tracking:	<0.1dB, <3°
* Equivalent Output SWR:	<1.10

Table 1-1. Specifications (sheet 17 of 34)

Input Characteristics:	
* Input:	Reference Channel (Rch), Test Channel (Tch)
* Input Impedance:	50Ω (opt 350), 75Ω (opt 375) VSWR <1.10 (Opt 350), 1.15 (Opt 375) (DC Coupling)
	1MΩ, shunt capacitance is 28pF ±2pF (AC Coupling)
* Attenuator:	0dB, 20dB
* Connector:	50Ω BNC (Female)
* Max. Allowable Input Level:	
50Ω, 75Ω :	+20dBm (AC), 5Vp (AC+DC)
1MΩ :	+2.24 Vrms (AC), 42Vp (AC+DC)
* Crosstalk (between Rch and Tch):	
	<-96dB (≤70MHz), <-86dB (>70MHz)
* Noise Floor:	<-114dBm (10KHz ≤ f ≤ 70MHz) <-105dBm (>70MHz)
Auto Compensation:	
* Automatic Zero Offset Compensation:	
	Compensate test fixture residual impedance and stray admittance.
* Automatic Calibration:	
	Calibrate probe or fixture using calibration standards.
* Compensation Method:	Interpolation or All points
* Interpolation Method:	Seventy fixed frequency points over the full test frequency range. Linear interpolation is done for specified measurement points.
* All Points Method:	Equal to the specified measurement points.
* Compensation Range:	Same as measurement range.

Table 1-1. Specifications (sheet 18 of 34)

GAIN-PHASE MEASUREMENT	
Measurement Parameters:	
* Amplitude:	
Ratio:	Tch/Rch (dB, Linear Ratio)
Absolute:	Tch, Rch (V, dBm, dBV) (Tch = Test Channel) (Rch = Reference Channel)
* Phase:	(degree, rad)
* Group Delay:	τ (seconds)
Test Frequency:	
* Range:	10Hz to 100MHz
* Resolution:	1mHz
* Accuracy:	±20ppm (23° ±5°C)
Osc Level (Single and Dual Output):	
* Range:	-65dBm to +15dBm (Opt 350, 50Ω load) (opt 375, 75Ω load)
* Resolution:	0.1dB
* Accuracy:	±0.8dB (15dBm, 100KHz at 23° ±5°C) Add the larger of ±0.02dB/dB or 0.2dB (<15dBm)
* Flatness:	±1dB (15dBm, 10Hz to 100MHz) Add the larger of ±0.02dB/dB or 0.2dB (< 15dBm)
* Output Impedance:	50Ω (Opt 350), 75Ω (opt 375)
VSWR:	< 1.1 (-65dBm to 5dBm) < 1.4 (5dBm to 15dBm)
* Harmonics:	≤ -40dBc (≤1MHz) ≤ -35dBc (≤10MHz) ≤ -30dBc (>10MHz)
* Non-Harmonic Spurious:	< -42dBc or -90dBm, whichever is larger (≤40MHz) < -36dBc or -90dBm, whichever is larger (>40MHz)
* Phase Noise:	< -90dBc/$\sqrt{Hz}$ (≤40MHz, 2KHz offset) < -80dBc/$\sqrt{Hz}$ (>40MHz, 2KHz offset)
* Unit:	dBm, dBV, V

Table 1-1. Specifications (sheet 19 of 34)

Sweep Function:	
* Sweep Parameter:	Frequency, Osc Level
* Maximum Sweep Range:	
Frequency: Osc Level:	10Hz to 100MHz 26dB
* Entry:	START/STOP or CENTER/SPAN
* Sweep Type:	LIN, LOG, ZERO SPAN
* Sweep Mode:	REPEAT, SINGLE, MANUAL
* Direction:	UP, DOWN
Number of Measurement Points:	2 to 401 points (max 261 points forOsc Level sweep)
Aperture Frequency (Group Delay Measurement):	
* Range:	0.5% to 100% of frequency span
* Maximum Resolution:	Maximum resolution depends on the number of measurement points (N). Maximum Resolution = $\frac{200}{N-1}$ [%] (when N = 2, max resolution is 100%)
Output Characteristics:	
* Output:	Single, Dual (built-in power splitter)
* Connector:	50Ω BNC (Female)
Single Output:	Use specifications for Osc Level
Dual Output (Built-in Power Splitter):	
	Add the following to the Osc Level specifications.
* Insertion Loss:	6dB
* Output Tracking:	< 0.1dB, < 3°
* Equivalent Output SWR:	< 1.10

Table 1-1. Specifications (sheet 20 of 34)

Input Characteristics:	
* Input:	Reference Channel (Rch), Test Channel (Tch)
* Input Impedance:	50Ω (Opt 350), 75Ω (Opt 375) VSWR < 1.10 (Opt. 350), 1.15 (Opt. 375) (DC Coupling) 1MΩ, shunt capacitance is 28pF ±2pF (AC Coupling)
* Attenuator:	0dB, 20dB
* Connector:	50Ω BNC (Female)
* Max. Allowable Input Level:	
50Ω, 75Ω: 1MΩ:	+20dBm (AC), 5Vp (AC+DC) +2.24 Vrms (AC), 42Vp (AC+DC)
* Crosstalk (between Rch and Tch):	< -96dB (≤70MHz) < -86dB (> 70MHz)
* Noise Floor:	< -114dBm ≤ 70MHz (≥ 10kHz) < -105dBm > 70MHz
Auto Offset Compensation:	Automatic compensation for insertion loss and frequency response of the test system.
Level Monitor:	Monitor the input level of the Reference and Test channels in units of dBm, dBV and Volts.
* Range, Accuracy:	Equal to the range and accuracy of the Amplitude Absolute (Tch, Rch) measurement.
Measurement Range:	
* Amplitude:	
Tch/Rch (Ratio):	0 to ±120dB
Tch, Rch (Absolute):	-107dBm to -5dBm (0dB Attenuator) -87dBm to 15dBm (20dB Attenuator)
* Phase:	±180°, (can display phase continuously using the phase scale expansion function)
* Group Delay:	0.1ns to 1s

Table 1-1. Specifications (sheet 21 of 34)

Measurement Resolution (max):

* Amplitude:	0.001dB
* Phase:	0.01°
* Group Delay:	0.1ns

Measurement Accuracy:

Accuracy is specified at the measurement terminals under the following conditions:

1. Warm-up time: >30min
2. Ambient Temperature: 23° ±5°C
3. Auto Offset Compensation: ON

Amplitude Ratio (Tch/Rch), Phase Accuracy:

Tch/Rch (Ratio) and phase accuracy are the sum of each channel's accuracy given in the Tch/Rch and Phase Accuracy graphs. The following is an example of calculating accuracy.

INTEG TIME = MED, Averaging = 4
Frequency: 100kHz
Input Impedance: 50Ω
Rch Attenuator: 20dB
Tch Attenuator: 0dB
Rch Input Level: 0dBm
Tch Input Level: -35dBm
Accuracy: 0.15dB, 0.75° (sum of 0.05dB/0.25° + 0.1dB/0.5°)

Group Delay Accuracy:

Accuracy is derived from the following equation. Phase accuracy θa (R) and θa (T) are read from the Tch/Rch and Phase Accuracy graphs.

$$\tau a = \frac{\theta a(R) + \theta a(T)}{360 \times \Delta F} \ [s]$$

where,

ΔF: Aperture frequency (Hz)
$\theta a(R)$: Reference channel phase accuracy (°)
$\theta a(T)$: Test channel phase accuracy (°)

Absolute Amplitude (Tch, Rch) Accuracy:

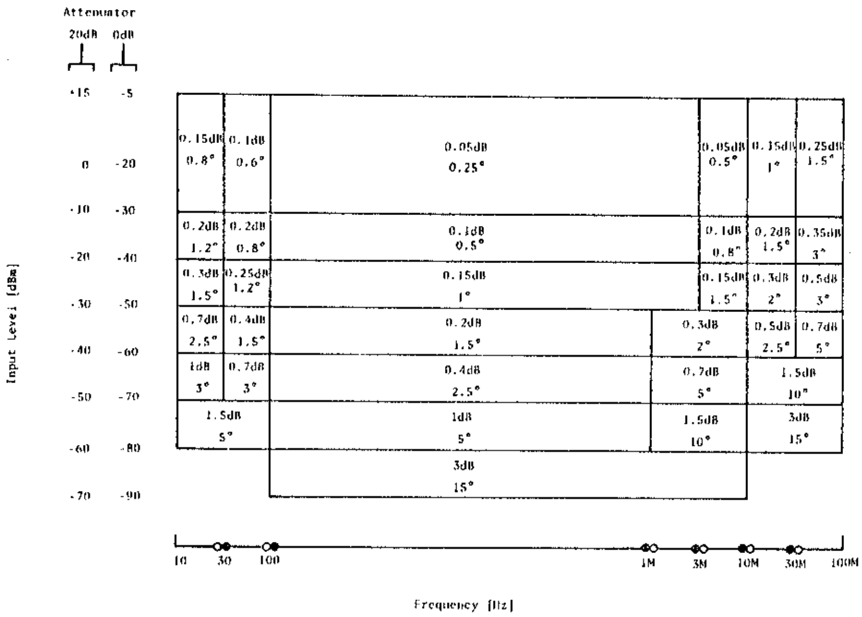
Accuracy is read from the Tch and Rch Accuracy graphs. Shaded areas in the graphs are reference data, not guaranteed specifications.

Table 1-1. Specifications (sheet 22 of 34)

Graph 13

Tch/Rch and Phase Accuracy (input impedance 50Ω, 75Ω)

INTEG TIME: MED or LONG, Averaging: ≥4



Graph 14

Tch/Rch and Phase Accuracy (input impedance 1MΩ)

INTEG TIME: MED or LONG, Averaging: ≥4

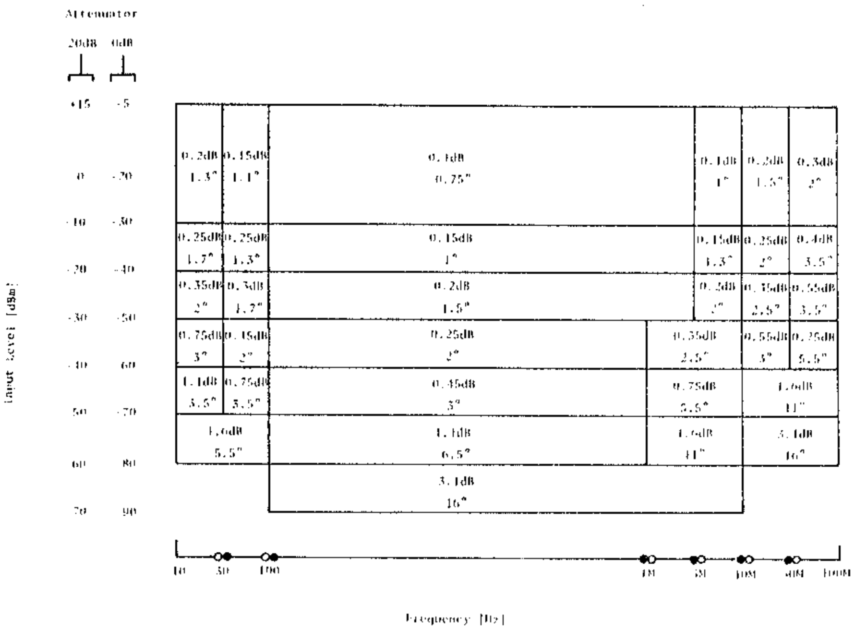
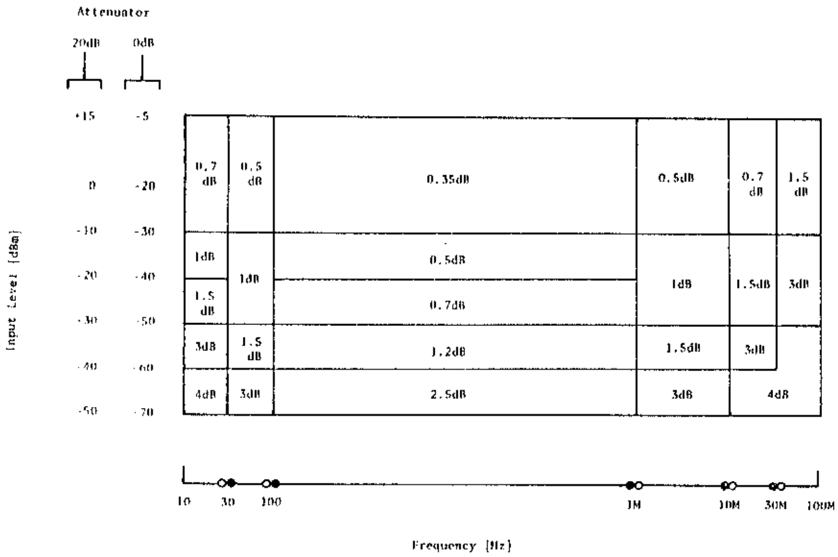


Table 1-1. Specifications (sheet 23 of 34)

Graph 15

Tch and Rch Accuracy (input impedance 50Ω, 75Ω)

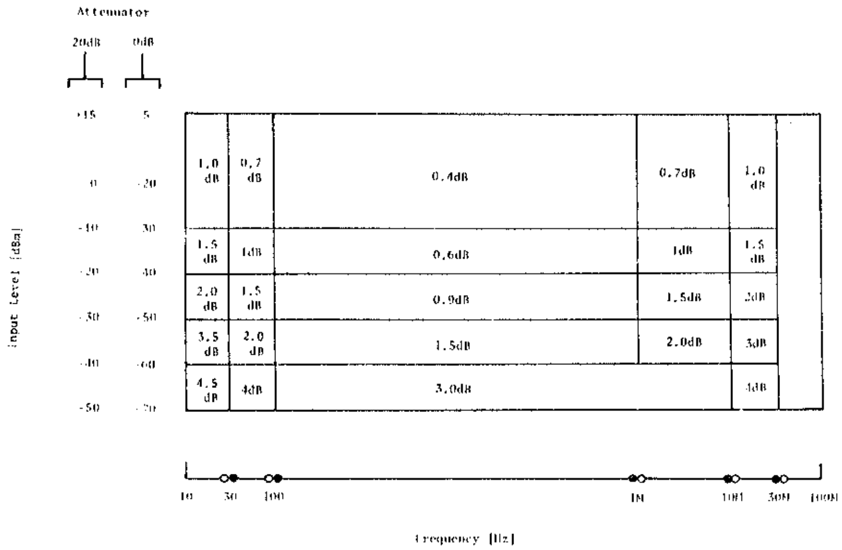
INTEG TIME: MED or LONG, Averaging: ≥4



Graph 16

Tch and Rch Accuracy (input impedance 1MΩ)

INTEG TIME: MED or LONG, Averaging: ≥4



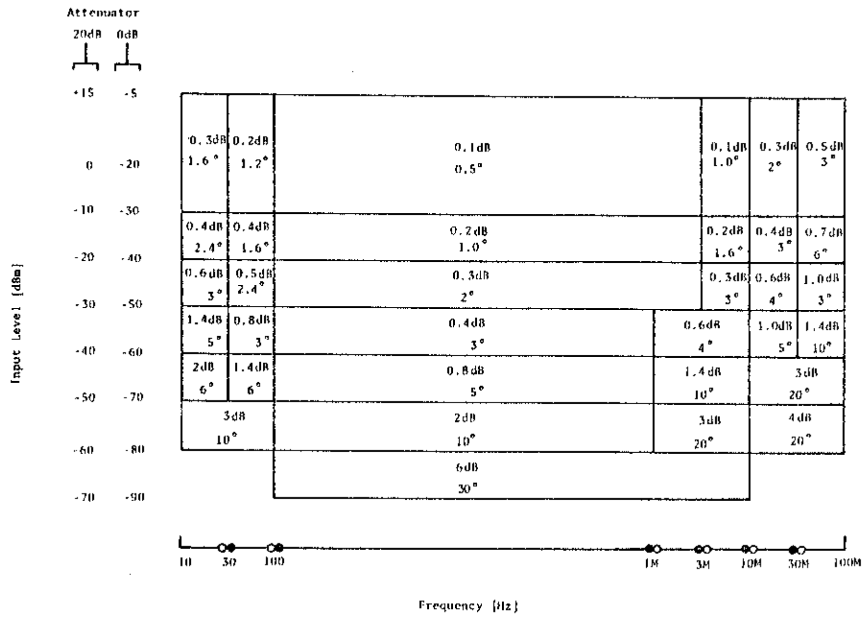
▒ is not specified

Table 1-1. Specifications (sheet 24 of 34)

Graph 17

Tch/Rch and Phase Accuracy (input impedance 50Ω, 75Ω)

INTEG TIME: MED OR LONG, Averaging: 1 or 2



Graph 18

Tch/Rch and Phase Accuracy (input impedance 1MΩ)

INTEG TIME: MED OR LONG, Averaging: 1 or 2

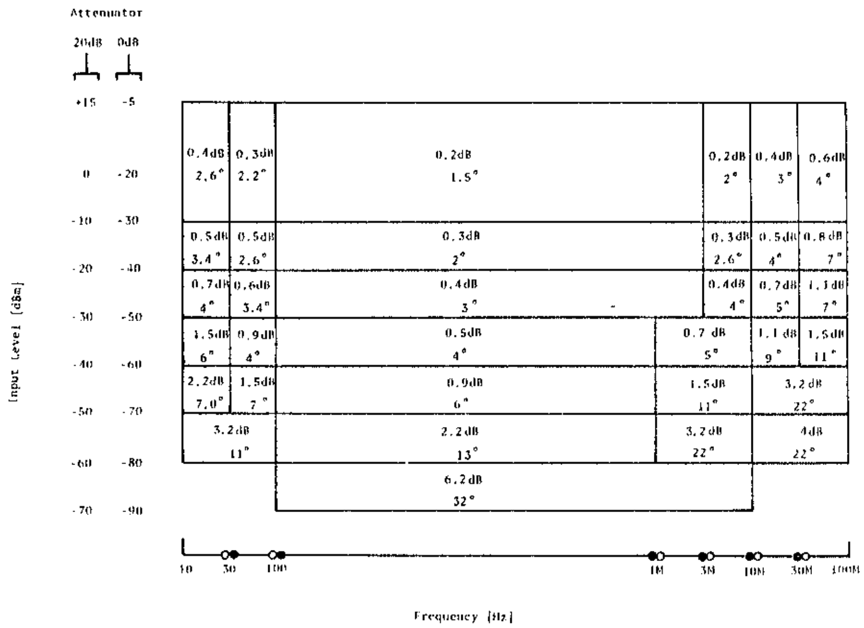
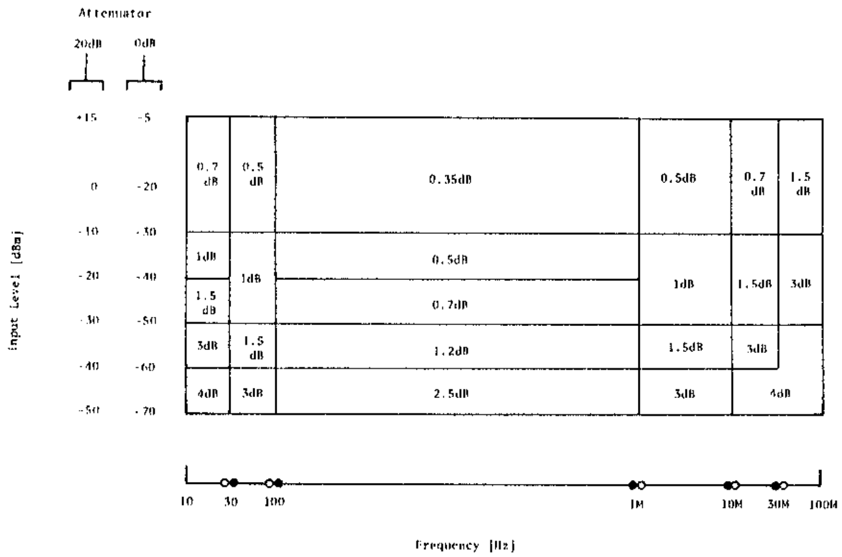


Table 1-1. Specifications (sheet 25 of 34)

Graph 19

Tch, Rch Accuracy (input impedance 50Ω, 75Ω)

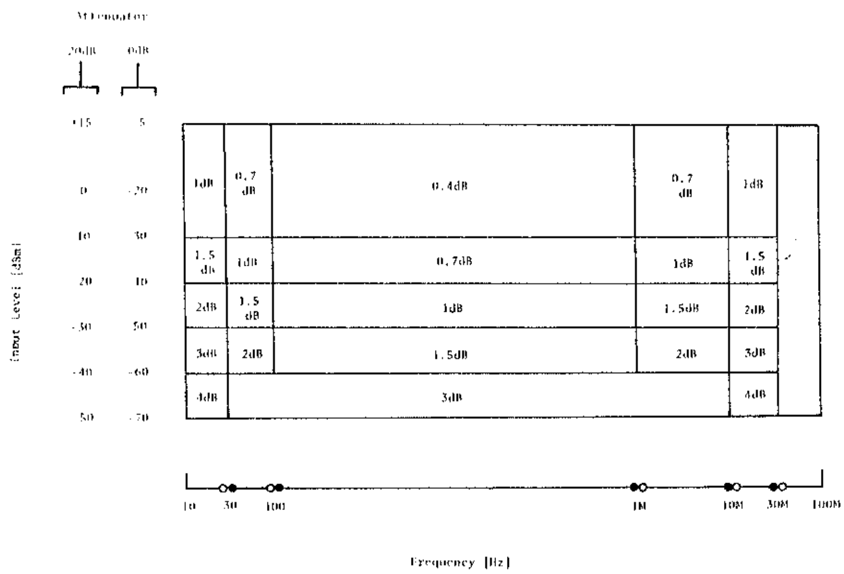
INTEG TIME: MED OR LONG, Averaging: ≥1



Graph 20

Tch, Rch Accuracy (input impedance 1MΩ)

INTEG TIME: MED OR LONG, Averaging:1



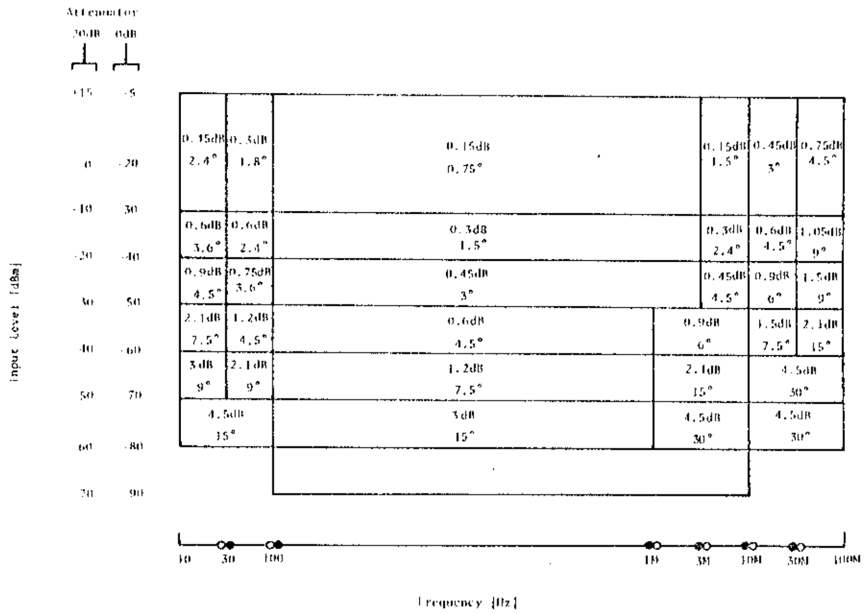
is not specified

Table 1-1. Specifications (sheet 26 of 34)

Graph 21

Tch/Rch and Phase Accuracy (input impedance 50Ω, 75Ω)

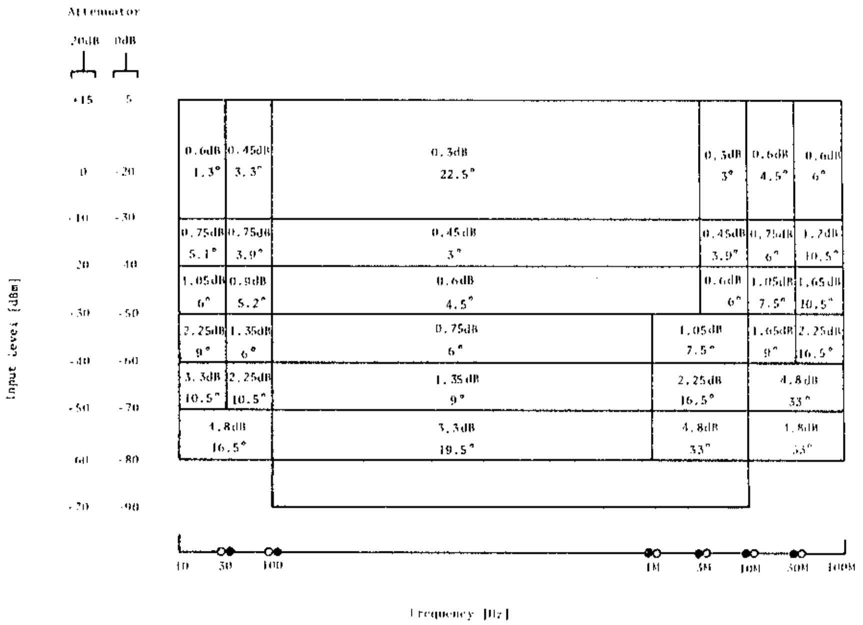
INTEG TIME: SHORT, Averaging: ≥4



Graph 22

Tch/Rch and Phase Accuracy (input impedance 1MΩ)

INTEG TIME: SHORT, Averaging: ≥4



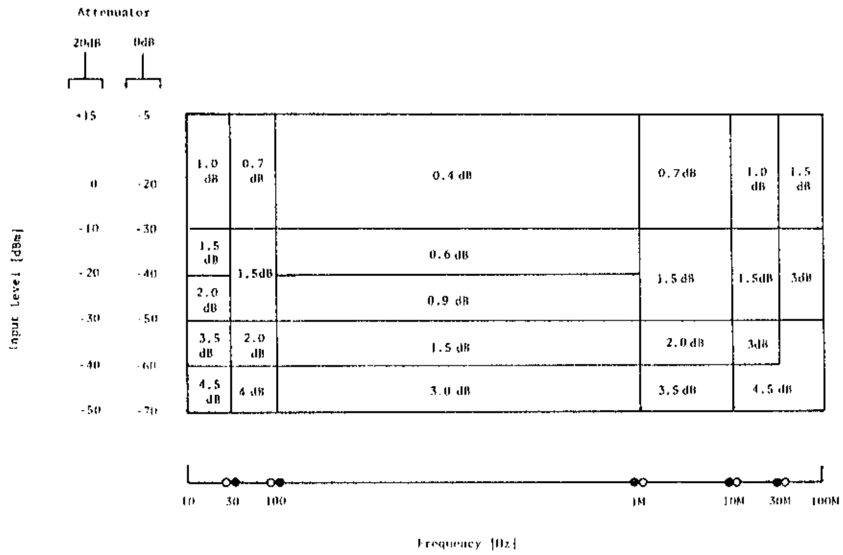
▒ is not specified

Table 1-1. Specifications (sheet 27 of 34)

Graph 23

Tch, Rch Accuracy (input impedance 50Ω, 75Ω)

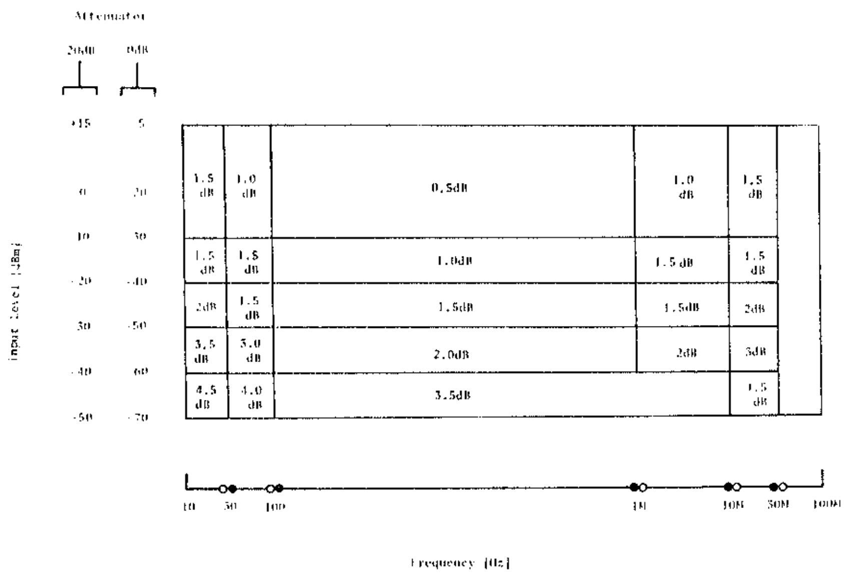
INTEG TIME: SHORT, Averaging: ≥4



Graph 24

Tch, Rch Accuracy (input impedance 1MΩ)

INTEG TIME: SHORT, Averaging: ≥4



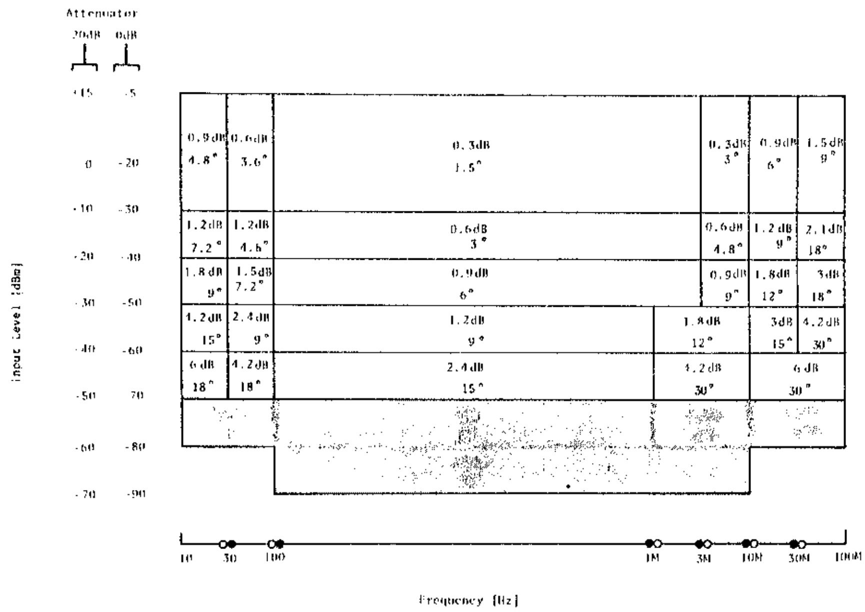
▒ is not specified

Table 1-1. Specifications (sheet 28 of 34)

Graph 25

Tch/Rch and Phase Accuracy (input impedance 50Ω, 75Ω)

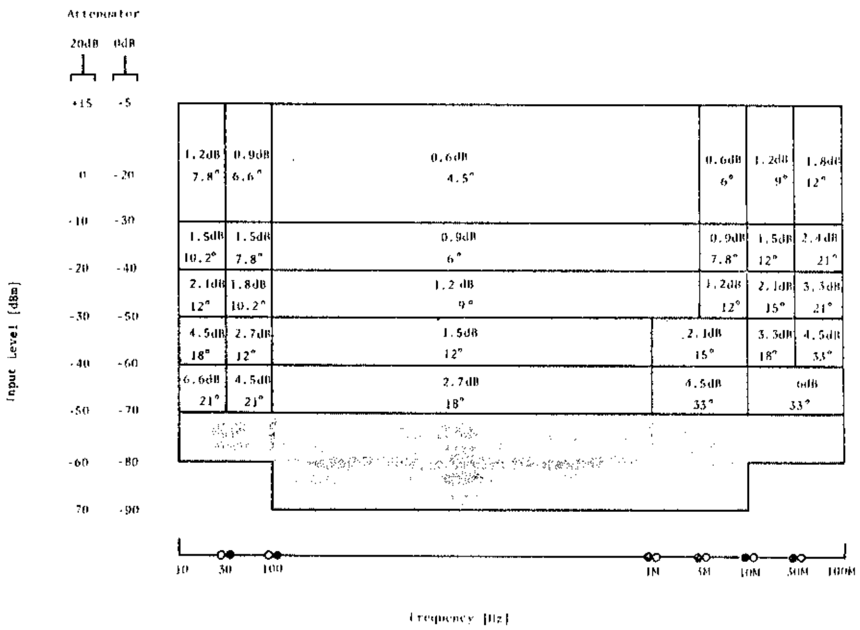
INTEG TIME: SHORT, Averaging: ≥1



Graph 26

Tch/Rch and phase Accuracy (input impedance 1MΩ)

INTEG TIME: SHORT, Averaging: ≥1



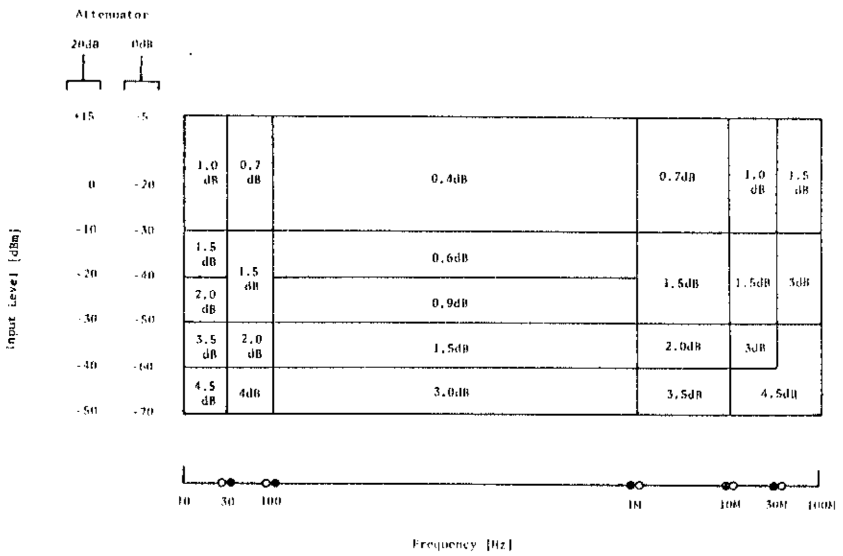
▒ is not specified

Table 1-1. Specifications (sheet 29 of 34)

Graph 27

Tch, Rch Accuracy (input impedance 50Ω, 75Ω)

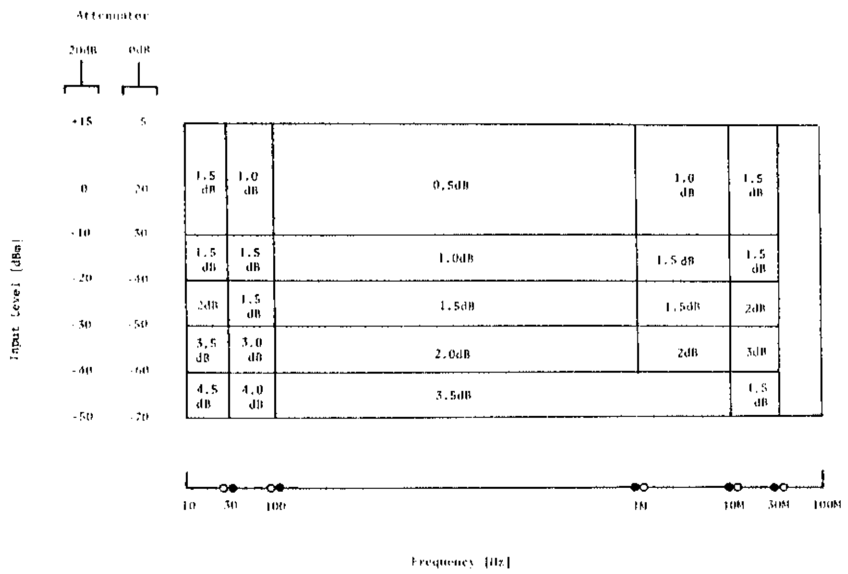
INTEG TIME: SHORT, Averaging ≥1



Graph 28

Tch, Rch Accuracy (input impedance 1MΩ)

INTEG TIME: SHORT, Averaging : ≥1



is not specified

Table 1-1. Specifications (sheet 30 of 34)

IMPEDANCE, GAIN-PHASE COMMON SPECIFICATIONS

Integration Time: SHORT, MED, LONG

(approximate)

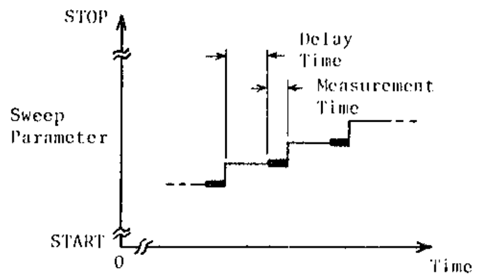
SHORT	500us
MED	5ms
LONG	100ms

(for frequencies ≥30KHz)

Averaging: Number of samples averaged are, 1, 2, 4, 8, 16, 32, 64, 128 and 256

Trigger Mode: Internal, External and Manual

Delay Time: 0 to 3600s (1ms step)



Partial Sweep: Sweep between two markers (o, *) without changing the sweep range or resolution.

Expand Markers Sweep: Expand sweep range between two markers (o, *) to increase the sweep resolution.

Program Points Measurement: Program up to 401 measurement points.

DISPLAY

CRT: color CRT

* Visible Area: 7.5inch (140mm x 108mm)
* Resolution: 576 x 432 dots

Display Mode: Two rectangular modes and one table mode

* Rectangular (X-A&B): Sweep parameter is on the X-axis and two measurement parameters are on the Y-axis.

Table 1-1. Specifications (sheet 31 of 34)

* Rectangular (A-B):	One measurement parameter is on the X-axis, another measurement parameter is on the Y-axis.
* Table:	One sweep parameter and two measurement parameters are displayed numerically in tabular form.
Display Control:	Autoscale, Superimpose and Storage
Display Digit:	6 digits
Maximum Display Count:	999999
Phase Scale Expansion:	Display phase continuously (> ± 180°)
Comment:	Display up to a 44 character comment on the CRT.
ANALYSIS	
Marker:	
* Modes:	
Single Marker:	Display measurement value for a sweep parameter.
Delta Marker:	Display difference between the o- (reference) and *- markers
Double Markers:	Set partial and expand markers sweep range using two markers.
* Control:	Rotary knob, key-in or remote control through HP-IB.
Line-Cursor:	
* Modes:	
Line-Cursor Mode:	Display a sweep parameter value for a measurement value using interpolation.
Delta-Line Cursor Mode:	Display sweep parameter value for the difference between the o (reference) marker and the line-cursor.
* Control:	Rotary knob, key-in or remote control through HP-IB.

Table 1-1. Specifications (sheet 32 of 34)

Equivalent Circuit Function:	Perform analysis using five equivalent circuit models consisting of 3 or 4 constants (L, C, R)
* Approximation:	Approximate equivalent circuit constants using impedance measurement data.
* Simulation:	Simulate the frequency characteristics of impedance by specifying the equivalent circuit constants.
Arithmetic Operations:	+, -, *, /, SQR, **, E, EXP, LOG, LN, SIN, COS, TAN, ATAN, ABS, PI(π), DIF (differential), DEG, RAD
Data Register Manipulation:	Use arithmetic operators and functions to manipulate data registers.
* Register:	see register table below
* Example:	A = A + E A = DIF (A)
Complex Matrix Operation	Perform operations using registers, arithmetic operators, functions and constants.
GO/NO-GO Limits:	Set min and max limits for measurement points Up to 16 sets of 26 measurement points can be set (401 points max).

Name	Application	Size
A, B	Display	401
C, D	Superimpose	401
E – J RA ~ RL total 18 registers	General	401

Table 1-1. Specifications (sheet 33 of 34)

PROGRAMMING

Auto Sequence Program (ASP):	Control the HP 4194A's operation using the internal program language. ASP programs can be entered using the front panel keys or down loaded from a host computer using HP-IB.
* ASP Commands:	Common to HP-IB remote control commands.
* Basic Commands:	IF, THEN, FOR, NEXT, PAUSE, WAIT, BEEP, DISP, GOTO, GOSUB, RETURN, OUTPUT, INPUT, END, SEND
* Arithmetic Operators, Functions:	+, -, *, /, **, E, SQR, EXP, LOG, LN, SIN, COS, TAN, ATAN, ABS, PI(π), DIF, DEG, RAD ,= ,< ,> ,≤ , ,≥ , < >, AND, OR
* Maximum Program Size:	300 lines per program
* Program Memory Size:	17k Bytes of non-volatile memory
* Edit:	ASP commands can be entered using the front panel keys.
HP-IB Data Output & Remote Control:	
	IEEE STD 488-1978 and IEEE STD 728-1982
* Interface Functions:	SH1, AH1, T5, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, C0, E1
* Data Output Format:	ASCII and Binary (IEEE 32 bit and IEEE 64 bit)
Copy:	Copy to HP plotters or printers set to the LISTEN only mode without an external computer.
* Dump Mode:	Copy the CRT display on a graphics printer.
* Plot Mode:	Copy the CRT display on a plotter for a color hardcopy.
* Print Mode:	Copy measurement data in tabular form on a printer.
Save/Get:	Save up to five sets of 4194A conditions in non-volatile memory (compensation data, measurement conditions, display scale, etc)

Table 4-1. Recommended Test Equipment (sheet 2 of 2)

Equipment	Requirements	Recommended Model
Reference Air Line	20cm, APC-7	PN 04191-85011 p/o HP 16342A
Coaxial Step Attenuator	Attenuation: 0dB to 70dB, 10dB steps Calibration Accuracy: <<0.05dB Frequency: >100MHz	HP 8495A Opt. 001 H04*
Power Splitter		HP 11667A
Feedthrough Termination	BNC(m)-to-BNC(f), 50Ω BNC(m)-to-BNC(f), 75Ω**	PN 04192-61002 PN 04192-61003
Test Fixture	(furnished accessory)	HP 16047D
Cables	BNC(m)-to-BNC(m), 30cm, 50Ω BNC(m)-to-BNC(m), 30cm, 75Ω** BNC(m)-to-BNC(m), 61cm, 50Ω BNC(m)-to-BNC(m), 61cm, 75Ω**	PN 8120-1838 PN 04194-61640 PN 8120-1839 PN 04194-61641
Adapters	Four-Terminal-Pair-to-APC-7 N(m)-to-BNC(f), 50Ω N(m)-to-BNC(f), 75Ω** N(f)-to-BNC(f), 50Ω BNC(f)-to-BNC(f), 75Ω** N(m)-to-N(m), 50Ω N(f)-to-BNC(m), 75Ω** BNC(f)-to-DUAL Banana Plug	HP 16085A PN 1250-0780 PN 1250-1535 PN 1250-1474 PN 1250-1287 PN 1250-0778 PN 1250-1534 PN 1251-2277
Pad	50Ω - 75Ω Minimum Loss Pad**	HP 11852A, 3 ea.
Computer	HP Technical Computer	HP 9826
HP-IB Cable	HP-IB Cable, 1m	HP 10833A

* Calibration data for the 8495A can be purchased as special Option H04. For more information, contact your HP Sales Office.

** Required for Option 375 instruments only.

Table 1-2. Supplemental Performance Characteristics (sheet 1 of 3)

SUPPLEMENTAL CHARACTERISTICS	
(Supplemental characteristics are not guaranteed.)	
Measurement Speed:	Average speed per point in a sweep measurement. Speed depends on test frequency, integration time (I.T.) and the number of samples averaged.
* Impedance Measurement:	See Graph 29.
* Gain-Phase Measurement:	See Graph 30.
Measurement Speed and Averaging (N > 1):	Measurement time for number of samples averaged > 1 is calculated using the following equation. $$tn = \frac{2}{3} \cdot t_1 \cdot n + \frac{1}{3} \cdot t_1$$ where, t1 = measurement time when averaging = 1 (refer to the Measurement Speed graph), n = number of samples averaged, tn = measurement speed for averaging n samples
HP-IB Data Transfer Time:	When using an HP9000 Series 200 computer the number of points transferred is 401.
* ASCII:	840ms
* Binary:	90ms (IEEE 64-bit) 50ms (IEEE 32-bit)

Table 1-2. Supplemental Performance Characteristics (sheet 2 of 3)

Measurement Accuracy (Impedance Measurement for FNC1):

* |Z|-θ Accuracy:

when $10m\Omega < |Z| < 0.1\Omega$ or $1.6M\Omega < |Z| < 100M\Omega$

$$Za = 3 \cdot \frac{A1}{\alpha} + A2 + \left(\frac{B1}{|Zm|} + B2 \cdot |Zm| \right) \times \frac{100}{\alpha} \quad [\%]$$

$$\theta a = \frac{Za}{100} \cdot \frac{180}{\pi} \quad [°]$$

where |Zm| is |Z| measured and α is test signal level in volts. Apply A1, A2, and B2 values specified for 0.1Ω and $1M\Omega$ which can be obtained from Graphs 1, 4, 7, or 10.

* |Y|-θ Accuracy: when $10nS < |Y| < 1.6\mu S$ or $10S < |Y| < 100S$

$$Ya = 3 \cdot \frac{A1}{\alpha} + A2 + \left(B1 \cdot |Ym| + \frac{B2}{|Ym|} \right) \times \frac{100}{\alpha} \quad [\%]$$

$$\theta a = \frac{Ya}{100} \cdot \frac{180}{\pi} \quad [°]$$

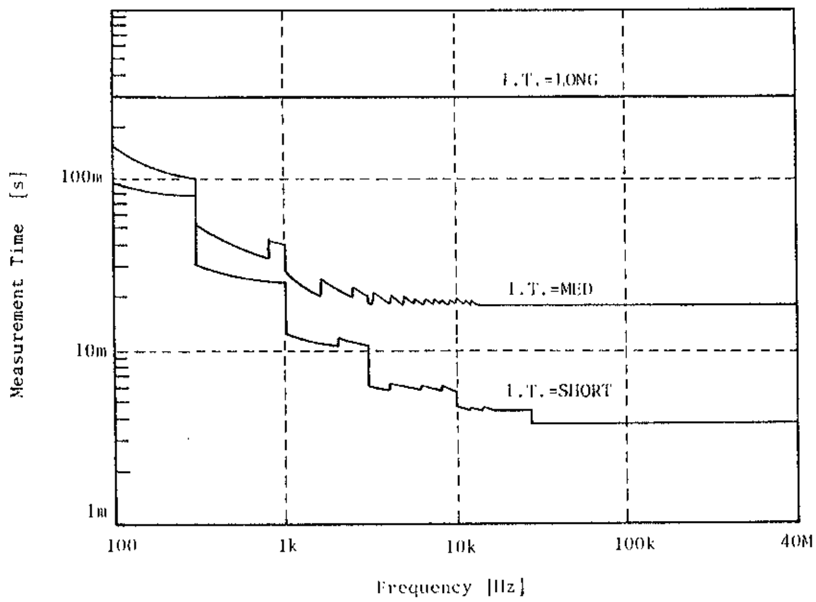
where |Ym| is |Y| measured and α is the test signal level in volts. Apply A1, A2, and B2 values specified for $1.6\mu S$ and $10S$ obtained from Graph 1, 4, 7, or 10.

Table 1-2. Supplemental Performance Characteristics (sheet 3 of 3)

Graph 29.

Impedance Measurement Speed

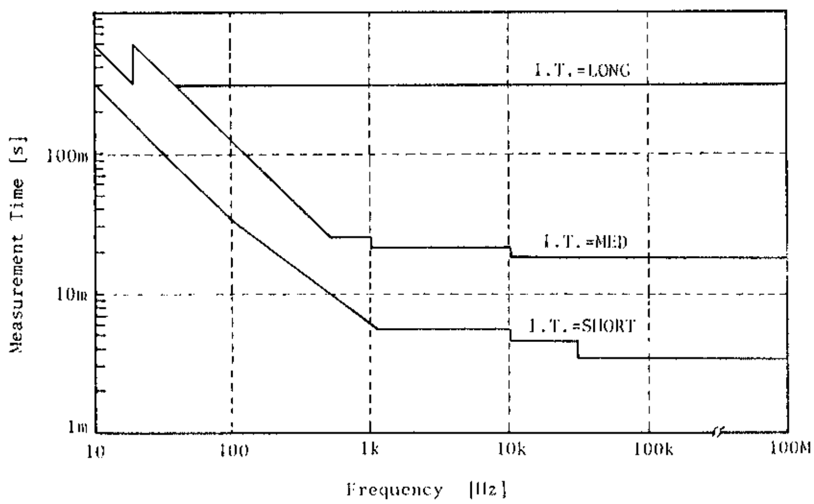
(Number of samples averaged is 1.)



Graph 30.

Gain-Phase Measurement Speed

(Number of samples averaged is 1.)



Note

Add 1.7ms when the automatic calibration is set to ON.('**CAL on/off**' softkey is on.)

1-6. OPTIONS

Options are modifications to the standard instrument that implement the user's special requirements for minor functional changes. The 4194A has seven options as listed in Table 1-3.

Table 1-3. Options

Option Number	Description
001	High Stability Frequency Reference. Test Frequency Accuracy: ±1ppm (23°C ±5°) Test Frequency Accuracy: $\pm 1X10^{-8}$/day (23°C ±5°)
350	50Ω
375	75Ω
907	Front Handle Kit. *1
908	Rack Flange Kit. *1
909	Rack and Handle Kit. *1
910	Extra Operation Manual (English)

*1: Installation procedures for these options are detailed in Section 2.

1-7. ACCESSORIES SUPPLIED

The HP Model 4194A Impedance/Gain-Phase Analyzer, along with its furnished accessories, is shown in Figure 1-1. The furnished accessories are also listed below.

Description	QTY	HP Part Number or Model Number
Test Fixture	1 ea.	16047D
BNC Cable - 30cm	2 ea.	8120-1838 (Opt. 350) 04194-61640 (Opt. 375)
BNC Cable - 60cm	1 ea.	8120-1839 (Opt. 350) 04194-61641 (Opt. 375)
BNC Adapter (f-f)	1 ea.	1250-0080
BNC-BNC Cable	4 ea.	8120-1838
BNC-BNC Cable (Opt. 001 only)	1 ea.	04194-61601
Cable Assy - Power	1 ea.	04194-61603
Cable Assy - Control	1 ea.	04194-61602
Rear Panel Lock Foot Kit Full Modules	1 ea.	5061-9699
Power Cable	1 ea.	8120-1378

SECTION 4
PERFORMANCE TESTS

4-1. INTRODUCTION

This section provides the test procedures used to verify the 4194A's specifications listed in Table 1-1. All tests can be performed without access to the interior of the instrument. Performance tests are used to perform incoming inspection and to verify that the 4194A meets performance specifications after troubleshooting or adjustment. If the performance tests indicate that the 4194A is not operating within the specified limits, check your test setup. Proceed to Adjustments or Troubleshooting if necessary.

Note

Be sure to allow the 4194A to warm up for at least 30 minutes before you perform any performance tests.

Note

Perform all performance tests at an ambient temperature of 23°C±5°C.

4-2. TEST EQUIPMENT

Table 4-1 lists the test equipment required to perform the tests described in this section. Use only calibrated test instruments when performance testing the 4194A. If the recommended test equipment is not available, equipment with specifications that equal or surpass those of the recommended equipment may be used.

Note

Components used as standards must be (1) calibrated using an instrument whose specifications are traceable to the National Bureau of Standards (NBS) or an equivalent standards group, or (2) calibrated directly by an authorized calibration organization such as NBS. The calibration cycle depends on the stability specification of each component.

4-3. PERFORMANCE TEST RECORD

Record the results of each performance test in the Performance Test Record located at the end of this section. This record lists each test, the parameters tested, and the acceptable limits. Keep a record of past performance test results for comparison purposes to help indicate any possible areas of weakness.

Note

The test limits indicated in each performance test do not take into account the measurement errors induced by the test equipment used for each test. Be sure to consider this when determining whether the 4194A meets its indicated specifications.

4-4. CALIBRATION CYCLE

The 4194A requires periodic performance verification. How often you verify performance depends on operating and environmental conditions. Check the 4194A using the performance tests described here at least once a year. To minimize instrument down-time and to ensure optimum operation, perform preventive maintenance and calibration at least twice a year.

Table 4-1. Recommended Test Equipment (sheet 1 of 2)

Equipment	Requirements	Recommended Model
Frequency Counter	Maximum Frequency: >100MHz Accuracy: <<0.1ppm	HP 5385A Opt. 004
Digital Voltmeter	DCV: Voltage Range: ±10mV to ±40V Accuracy: <<0.1% manual change ACV: (true RMS) 100kHz Frequency Range: 10Hz to 10kHz Voltage Range: 10mVrms to 1vrms Resolution: <0.1mVrms at 10mV Accuracy: <<10%	HP 3456A
Power Meter	Frequency Range: 100kHz to 100MHz Power Range: -2dBm to 16dBm Accuracy: <<10%	HP 436A
Power Sensor		HP 8482A
Adapter	N(f)-to-BNC(m),	PN 1250-0077
Standard Capacitor	Capacitance Range: 1pF to 1uF Frequency Range: 100Hz to 10MHz Nominal Accuracy: <0.17% Calibration Accuracy: <<0.17%	HP 16380A HP 16380C
Reference Termination	0Ω, 50Ω, and 0S Connector: APC-7	PN 04191-85300 PN 04191-85301 PN 04191-85302

Table 4-1. Recommended Test Equipment (sheet 2 of 2)

Equipment	Requirements	Recommended Model
Reference Air Line	20cm, APC-7	PN 04191-85011 p/o HP 16342A
Coaxial Step Attenuator	Attenuation: 0dB to 70dB, 10dB steps Calibration Accuracy: <<0.05dB Frequency: >100MHz	HP 8495A Opt. 001 H04*
Power Splitter		HP 11667A
Feedthrough Termination	BNC(m)-to-BNC(f), 50Ω BNC(m)-to-BNC(f), 75Ω**	PN 04192-61002 PN 04192-61003
Test Fixture	(furnished accessory)	HP 16047D
Cables	BNC(m)-to-BNC(m), 30cm, 50Ω BNC(m)-to-BNC(m), 30cm, 75Ω** BNC(m)-to-BNC(m), 61cm, 50Ω BNC(m)-to-BNC(m), 61cm, 75Ω**	PN 8120-1838 PN 04194-61640 PN 8120-1839 PN 04194-61641
Adapters	Four-Terminal-Pair-to-APC-7 N(m)-to-BNC(f), 50Ω N(m)-to-BNC(f), 75Ω** N(f)-to-BNC(f), 50Ω BNC(f)-to-BNC(f), 75Ω** N(m)-to-N(m), 50Ω N(f)-to-BNC(m), 75Ω** BNC(f)-to-DUAL Banana Plug	HP 16085A PN 1250-0780 PN 1250-1535 PN 1250-1474 PN 1250-1287 PN 1250-0778 PN 1250-1534 PN 1251-2277
Pad	50Ω - 75Ω Minimum Loss Pad**	HP 11852A, 3 ea.
Computer	HP Technical Computer	HP 9826
HP-IB Cable	HP-IB Cable, 1m	HP 10833A

* Calibration data for the 8495A can be purchased as special Option H04. For more information, contact your HP Sales Office.

** Required for Option 375 instruments only.

4-5. PRETEST PREPARATIONS

Before proceeding with the performance tests, prepare the 4194A by performing the following setup procedure. This procedure explains how to set up, save, and recall the instrument settings and programmed points tables required for performance testing.

Note

In the remainder of this section, softkeys are indicated in boldface and enclosed in single quotes (e.g., **'SET PROG TABLE'**), and hardkeys are indicated in boldface only (e.g., **Blue**).

PROCEDURE

1. Press the **CLEAR LINE**, **Blue**, **R**, **S**, **T**, and **ENTER/EXECUTE** keys to initialize the 4194A. SET CABLE LENGTH TO ∅m

2. Press the **MORE MENUS** key.

3. Press the **'SET PROG TABLE'** softkey and Programmed Points Table 1 will be displayed.

4. Press the **'more 1/2'** and **'TABLE ALL CLR'** softkeys, then press **ENTER/EXECUTE** to clear the displayed table.

5. Press the **'more 2/2'** softkey, then press the **'SWP SELECT'** softkey until **"SWEEP : FREQUENCY(Hz)"** is displayed at the top of the table.

6. Enter the frequencies listed in Figure 4-1 into the **SWEEP POINTS** column of Programmed Points Table 1.

Note

The minimum and maximum limits for each sweep point are default values which are automatically displayed when one of the unit keys is pressed.

7. Press the **'TABLE NO.'** softkey to display Programmed Points Table 2.

8. Press the **'more 1/2'** and **'TABLE ALL CLR'** softkeys, then press the **ENTER/EXECUTE** key to clear Programmed Points Table 2.

9. Press the **'more 2/2'** key, then press the **'SWP SELECT'** softkey until **"SWEEP : FREQUENCY(Hz)"** is displayed at the top of the table.

10. Enter the frequencies listed in Figure 4-2 into the **SWEEP POINTS** column of Programmed Points Table 2.

11. Press the **'more 1/2'** and **'TABLE SET END'** softkeys.

12. Press the **Blue**, **P**, **T**, **N**, **=**, **1**, and **ENTER/EXECUTE** keys to access Programmed Points Table 1.

13. Press the **SWEEP** key, then press the **'LOG SWEEP'**, **'more 1/2'**, and **'PRG MEAS on/off'** softkeys.

14. Set the **INTEG TIME** to **MED**, then press the **AVERAGING** key until "**AVERAGING TIME** = 4" is displayed.

15. Press the **SAVE**, **1**, and **ENTER/EXECUTE** keys to save the instrument states established in steps 12 through 14.

16. Press the **FUNCTION** key and the **'GAIN-PHASE'** softkey.

17. Press the **Blue**, **P**, **T**, **N**, **=**, **2**, and **ENTER/EXECUTE** keys to access Programmed Points Table 2.

18. Press the **SWEEP** key.

19. Press the **'more 1/2'** and **'PRG MEAS on/off'** softkeys.

20. Press the **SAVE**, **2**, and **ENTER/EXECUTE** keys to save the measurement parameters established in steps 16 through 19.

21. Turn the 4194A off, then turn it back on again.

22. Press the **GET**, **1**, and **ENTER/EXECUTE** keys.

23. Confirm that the 4194A's control settings are as follows.

FUNCTION	IMPEDANCE, |Z| - θ
SWEEP	FREQUENCY, LOG, PROGRAMMED POINTS #1
INTEG TIME	MED
AVERAGING TIME	4

24. Press the **GET**, **2**, and **ENTER/EXECUTE** keys.

25. Confirm that the 4194A's control settings are as follows.

FUNCTION	GAIN-PHASE, Tch/Rch (dB) - θ
SWEEP	FREQUENCY, LOG, PROGRAMMED POINTS #2
INTEG TIME	MED
AVERAGING TIME	4

PROGRAMMED POINTS TABLE 1

SWEEP:FREQUENCY(Hz) LIMIT FOR DATA A

N	SWEEP POINTS	MINIMUM	MAXIMUM
1	100.000	-9.99999E+37	9.99999E+37
2	1 000.000	-9.99999E+37	9.99999E+37
3	10 000.000	-9.99999E+37	9.99999E+37
4	29 000.000	-9.99999E+37	9.99999E+37
5	30 000.000	-9.99999E+37	9.99999E+37
6	100 000.000	-9.99999E+37	9.99999E+37
7	500 000.000	-9.99999E+37	9.99999E+37
8	1 000 000.000	-9.99999E+37	9.99999E+37
9	3 000 000.000	-9.99999E+37	9.99999E+37
10	10 000 000.000	-9.99999E+37	9.99999E+37
11	40 000 000.000	-9.99999E+37	9.99999E+37
12			

Figure 4-1. Programmed Points Table 1 for Impedance Performance Tests

PROGRAMMED POINTS TABLE 2

SWEEP:FREQUENCY(Hz) LIMIT FOR DATA A

N	SWEEP POINTS	MINIMUM	MAXIMUM
1	10.000	-9.99999E+37	9.99999E+37
2	100.000	-9.99999E+37	9.99999E+37
3	1 000.000	-9.99999E+37	9.99999E+37
4	10 000.000	-9.99999E+37	9.99999E+37
5	100 000.000	-9.99999E+37	9.99999E+37
6	1 000 000.000	-9.99999E+37	9.99999E+37
7	10 000 000.000	-9.99999E+37	9.99999E+37
8	30 000 000.000	-9.99999E+37	9.99999E+37
9	80 000 000.000	-9.99999E+37	9.99999E+37
10	100 000 000.000	-9.99999E+37	9.99999E+37
11			

Figure 4-2. Programmed Points Table 2 for Gain-Phase Performance Tests

4-6. INTERNAL SYNTHESIZER FREQUENCY TEST

This test verifies the accuracy of the test frequency.

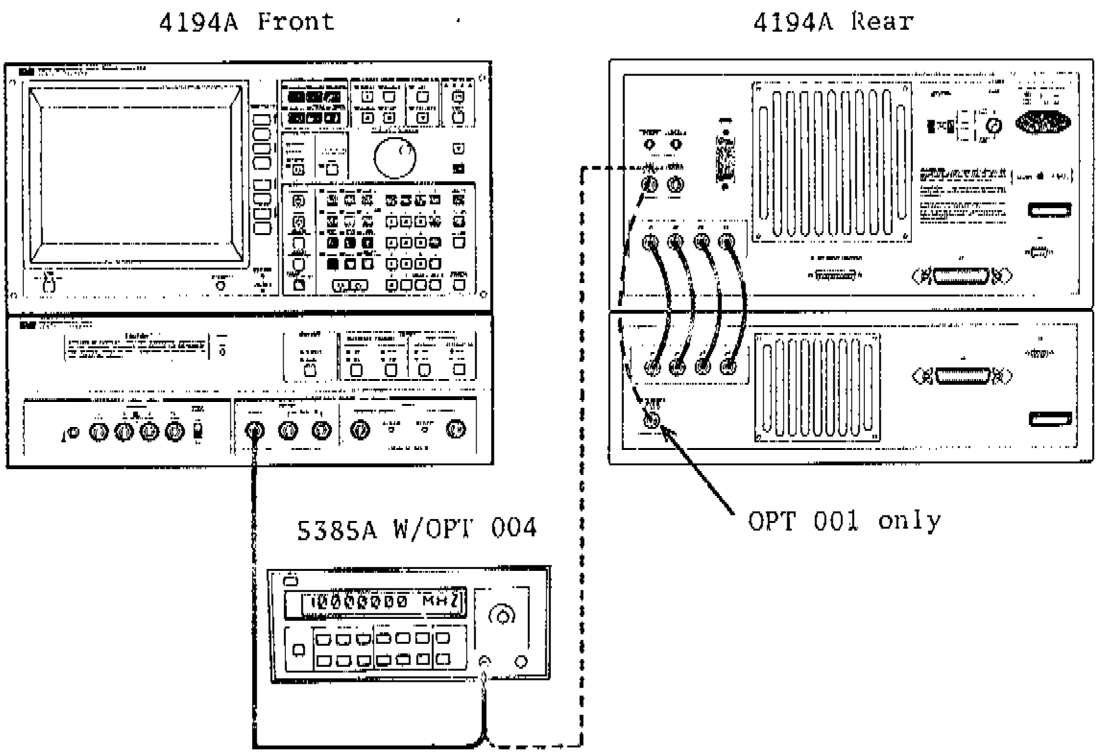


Figure 4-3. Internal Synthesizer Frequency Test Setup

EQUIPMENT:

Frequency Counter	HP 5385A Opt. 004
BNC-to-BNC Cable, 61cm	PN 8120-1839

PROCEDURE:

1. Set up the 4194A as shown in Figure 4-3.

Note

If performance testing a 4194A equipped with Option 001, disconnect the cable from the EXT REFERENCE connector on the rear panel of the Control Unit.

2. Connect the 5385A's **INPUT A** to the 4194A's SINGLE **OUTPUT** terminal.

3. Press the **GET**, **2**, and **ENTER/EXECUTE** keys.

4. Set the **SWEEP MODE** to **MANUAL**.

5. Set the **OUTPUT** to **SINGLE**.

6. Set the test frequency to **1MHz** by using the **MARKER/L CURSOR** knob.

7. Confirm that the frequency displayed on the 5385A is within the test limits listed in the SINGLE OUTPUT row of Table 4-2 for the frequency tested.

8. Repeat steps 6 and 7 at **10MHz** and **100MHz**.

9. Disconnect the BNC-to-BNC cable from the **SINGLE OUTPUT** terminal and connect it to the **10MHz OUTPUT** terminal on the Control Unit's rear panel.

10. Confirm that the frequency displayed on the 5385A is within the test limits listed in the 10MHz OUTPUT row of Table 4-2.

Note

Perform the following steps only if your 4194A is equipped with Option 001.

11. Reconnect the cable from the REFERENCE OVEN connector on the Measurement Unit's rear panel to the Control Unit's rear panel EXT REFERENCE connector.

12. Repeat steps 6 through 10, but confirm the displayed frequency with those listed in Table 4-3 (instead of Table 4-2) for each frequency tested.

Table 4-2. Internal Synthesizer Frequency Test Limits (Standard 4194As)

Output	Test Frequency	Test Limits
SINGLE OUTPUT	1MHz	0.99998MHz ~ 1.00002MHz
	10MHz	9.9998MHz ~ 10.0002MHz
	100MHz	99.998MHz ~ 100.002MHz
10MHz OUTPUT	any setting	9.9998MHz ~ 10.0002MHz

Table 4-3. Internal Synthesizer Frequency Test Limits (Opt. 001)

Output	Test Frequency	Test Limits
SINGLE OUTPUT	1MHz	0.999999MHz ~ 1.000001MHz
	10MHz	9.99999MHz ~ 10.00001MHz
	100MHz	99.9999MHz ~ 100.0001MHz
10MHz OUTPUT	any setting	9.99999MHz ~ 10.00001MHz

4-7. GAIN-PHASE MEASUREMENT ACCURACY TEST

This two part test verifies 4194A gain-phase measurement accuracy. If performance testing a 75Ω instrument (Option 375), proceed to paragraph 4-7-2.

4-7-1. MEASUREMENT ACCURACY: 50Ω INSTRUMENTS

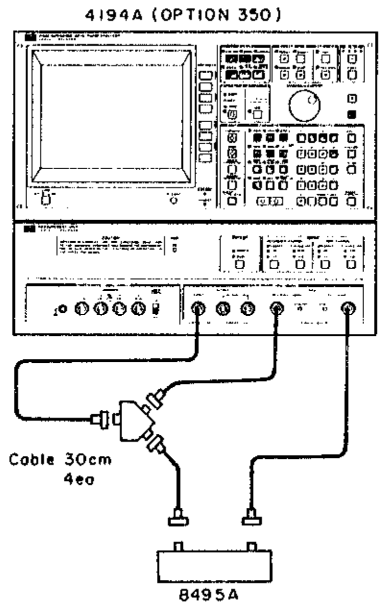


Figure 4-4. Gain-Phase Measurement Accuracy Test Setup: 50Ω

EQUIPMENT:

Coaxial Step Attenuator	HP 8495A Opt. 001
Power Splitter	HP 11667A
N(m)-to-BNC(f) Adapter	PN 1250-0780, 5 each
BNC-to-BNC Cable, 30cm	PN 8120-1838, 4 each

PROCEDURE:

1. Set up the 4194A as shown in Figure 4-4.
2. Press the **GET**, **2**, and **ENTER/EXECUTE** keys.
3. Set the 4194A to **SINGLE OUTPUT**.
4. Set the **OSC LEVEL** to -1dBm.
5. Press the **DISPLAY** key, then press the **'TABLE'** softkey.
6. Set the 8495A to **0dB**.

7. Press the SWEEP MODE **START** key.

Note

For the remainder of the performance tests, unless otherwise specified, the **START** key means the SWEEP MODE **START** key.

8. When the **START** key lamp goes out, press the COMPEN key, then press the **'OFST REF STORE'**, **'A OFFSET on/off'**, and **'B OFFSET on/off'** softkeys.
9. Set the 8495A to **10dB**.
10. Press the **START** key.
11. When the **START** key lamp goes out, confirm that the displayed gain-phase values are within the limits listed in Table 4-4 for the **10dB** attenuator setting.
12. Repeat steps 9 through 11 for the **20dB** through 70dB attenuator settings and confirm that the displayed values are within the limits listed in Table 4-4 for each attenuator setting.
13. Set the **OSC LEVEL** to **-40dBm**.
14. Set the 8495A to **10dB**.
15. Press the **START** key.
16. When the **START** key lamp goes out, confirm that the displayed gain-phase values are within the limits listed in Table 4-5 for the **10dB** attenuator setting.
17. Repeat steps 14 through 16 for the 20dB through 40dB attenuator settings and confirm that the displayed values are within the limits listed in Table 4-5 for each attenuator setting.

Table 4-4. Gain-Phase Measurement Accuracy Test Limits 1 (1 of 2)

Atten. Set.	Freq.	Gain	Phase
10dB	10Hz	Cv(1)±0.3dB	±1.6°
	100Hz	Cv(1)±0.1dB	±0.5°
	1kHz	Cv(1)±0.1dB	±0.5°
	10kHz	Cv(1)±0.1dB	±0.5°
	100kHz	Cv(1)±0.1dB	±0.5°
	1MHz	Cv(1)±0.1dB	±0.5°
	10MHz	Cv(10)±0.1dB	±1°
	30MHz	Cv(10)±0.3dB	±2°
	100MHz	Cv(100)±0.5dB	±3°

Table 4-4. Gain-Phase Measurement Accuracy Test Limits 1 (2 of 2)

Atten. Set.	Freq.	Gain	Phase
20dB	10Hz	Cv(1)±0.3dB	±1.6°
	100Hz	Cv(1)±0.1dB	±0.5°
	1kHz	Cv(1)±0.1dB	±0.5°
	10kHz	Cv(1)±0.1dB	±0.5°
	100kHz	Cv(1)±0.1dB	±0.5°
	1MHz	Cv(1)±0.1dB	±0.5°
	10MHz	Cv(10)±0.1dB	±1°
	30MHz	Cv(10)±0.3dB	±2°
	100MHz	Cv(100)±0.5dB	±3°
30dB	10Hz	Cv(1)±0.35dB	±2°
	100Hz	Cv(1)±0.15dB	±0.75°
	1kHz	Cv(1)±0.15dB	±0.75°
	10kHz	Cv(1)±0.15dB	±0.75°
	100kHz	Cv(1)±0.15dB	±0.75°
	1MHz	Cv(1)±0.15dB	±0.75°
	10MHz	Cv(10)±0.15dB	±1.3°
	30MHz	Cv(10)±0.35dB	±2.5°
	100MHz	Cv(100)±0.6dB	±4.5°
40dB	10Hz	Cv(1)±0.45dB	±2.3°
	100Hz	Cv(1)±0.2dB	±1.25°
	1kHz	Cv(1)±0.2dB	±1.25°
	10kHz	Cv(1)±0.2dB	±1.25°
	100kHz	Cv(1)±0.2dB	±1.25°
	1MHz	Cv(1)±0.2dB	±1.25°
	10MHz	Cv(10)±0.2dB	±2°
	30MHz	Cv(10)±0.45dB	±3°
	100MHz	Cv(100)±0.75dB	±4.5°
50dB	1MHz	Cv(1)±0.25dB	±1.75°
	10MHz	Cv(10)±0.35dB	±2.5°
	30MHz	Cv(10)±0.65dB	±3.5°
	100MHz	Cv(100)±0.95dB	±6.5°
60dB	1MHz	Cv(1)±0.45dB	±2.75°
	10MHz	Cv(10)±0.75dB	±5.5°
	30MHz	Cv(10)±1.65dB	±11°
	100MHz	Cv(100)±1.75dB	±11.5°
70dB	1MHz	Cv(1)±1.05dB	±5.25°
	10MHz	Cv(10)±1.55dB	±10.5°
	30MHz	Cv(10)±3.15dB	±16.0°
	100MHz	Cv(100)±3.25dB	±16.5°

Note

Cv(1), Cv(10), and Cv(100) in the above table are the calibration values of the 8495A at 1MHz, 10MHz, and 100MHz, respectively.

Table 4-5. Gain-Phase Measurement Accuracy Test Limits 2

Atten. Set.	Freq.	Gain	Phase
10dB	10Hz	Cv(1)±1dB	±4°
	100Hz	Cv(1)±0.35dB	±2.5°
	1kHz	Cv(1)±0.35dB	±2.5°
	10kHz	Cv(1)±0.35dB	±2.5°
	100kHz	Cv(1)±0.35dB	±2.5°
20dB	10Hz	Cv(1)±1.3dB	±4.5°
	100Hz	Cv(1)±0.55dB	±3.5°
	1kHz	Cv(1)±0.55dB	±3.5°
	10kHz	Cv(1)±0.55dB	±3.5°
	100kHz	Cv(1)±0.55dB	±3.5°
30dB	10Hz	Cv(1)±1.8dB	±6.5°
	100Hz	Cv(1)±1.15dB	±6°
	1kHz	Cv(1)±1.15dB	±6°
	10kHz	Cv(1)±1.15dB	±6°
	100kHz	Cv(1)±1.15dB	±6°
40dB	100Hz	Cv(1)±3.15dB	±16°
	1kHz	Cv(1)±3.15dB	±16°
	10kHz	Cv(1)±3.15dB	±16°
	100kHz	Cv(1)±3.15dB	±16°

Note

Cv(1), Cv(10), and Cv(100) in the above table are the calibration values of the 8495A at 1MHz, 10MHz, and 100MHz, respectively.

4-7-2. MEASUREMENT ACCURACY: 75Ω INSTRUMENTS

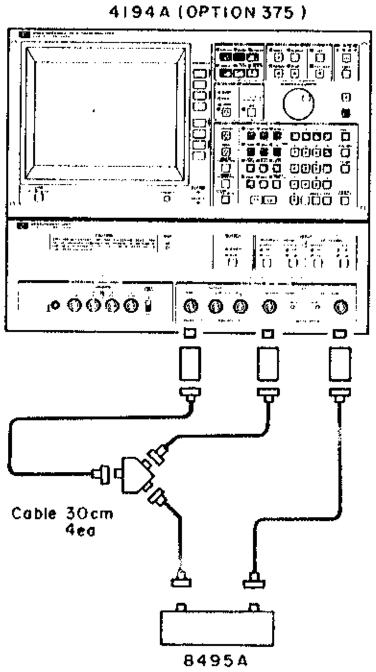


Figure 4-5. Gain-Phase Measurement Accuracy Test Setup: 75Ω

EQUIPMENT:

Coaxial Step Attenuator	HP 8495A Opt. 001
Power Splitter	HP 11667A
50Ω - 75Ω Minimum Loss Pad	HP 11852A, 3 each.
BNC-to-BNC Cable, 30cm	PN 8120-1838, 4 each.
N(m)-to-BNC(f) Adapter	PN 1250-0780, 8 each.
N(f)-to-BNC(m) Adapter, 75Ω	PN 1250-1534, 3 each.

PROCEDURE:

1. Set up the 4194A as shown in Figure 4-5.

2. Press the **GET**, **2**, and **ENTER/EXECUTE** keys.

3. Set the 4194A to **SINGLE OUTPUT**.

4. Set the **OSC LEVEL** to **10.4dBm**.

5. Press the **DISPLAY** key, then press the **'TABLE'** softkey.

6. Set the 8495A to **0dB**.

7. Press the **START** key.

8. When the **START** key lamp goes out, press the **COMPEN** key, then press the **'OFST REF STORE'**, **'A OFFSET on/off'**, and **'B OFFSET on/off'** softkeys.

9. Set the 8495A to **10dB**.

10. Press the **START** key.

11. When the **START** key lamp goes out, confirm that the displayed gain-phase values are within the limits listed in Table 4-6 for the 10dB attenuator setting.

12. Repeat steps 9 through 11 for the **20dB** through 70dB attenuator settings and confirm that the displayed values are within the limits listed in Table 4-6 for each attenuator setting.

13. Set the **OSC LEVEL** to **-8.6dBm**.

14. Set the 8495A to **10dB**.

15. Press the **START** key.

16. When the **START** key lamp goes out, confirm that the displayed gain-phase values are within the limits listed in Table 4-7 for the **10dB** attenuator setting.

17. Repeat steps 14 through 16 for the 20dB and 30dB attenuator settings and confirm that the displayed values are within the limits listed in Table 4-7 for each attenuator setting.

18. Set the **OSC LEVEL** to **-38.6dBm**.

19. Set the 8495A to **10dB**.

20. Press the **START** key.

21. When the **START** key lamp goes out, confirm that the displayed gain-phase values are within the limits listed in Table 4-8 for the **10dB** attenuator setting.

22. Repeat steps 19 through 21 for the 20dB and 30dB attenuator settings and confirm that the displayed values are within the limits listed in Table 4-8 for each attenuator setting.

Table 4-6. Gain-Phase Measurement Accuracy Test Limits 3.

Atten. Set.	Freq.	Gain	Phase
10dB	10Hz	Cv(1)±0.3dB	±1.6°
	100Hz	Cv(1)±0.1dB	±0.5°
	1kHz	Cv(1)±0.1dB	±0.5°
	10kHz	Cv(1)±0.1dB	±0.5°
	100kHz	Cv(1)±0.1dB	±0.5°
	1MHz	Cv(1)±0.1dB	±0.5°
	10MHz	Cv(10)±0.1dB	±1°
	30MHz	Cv(10)±0.3dB	±2°
	100MHz	Cv(100)±0.5dB	±3°
20dB	10Hz	Cv(1)±0.3dB	±1.6°
	100Hz	Cv(1)±0.1dB	±0.5°
	1kHz	Cv(1)±0.1dB	±0.5°
	10kHz	Cv(1)±0.1dB	±0.5°
	100kHz	Cv(1)±0.1dB	±0.5°
	1MHz	Cv(1)±0.1dB	±0.5°
	10MHz	Cv(10)±0.1dB	±1°
	30MHz	Cv(10)±0.3dB	±2°
	100MHz	Cv(100)±0.5dB	±3°
30dB	1MHz	Cv(1)±0.15dB	±0.75°
	10MHz	Cv(10)±0.15dB	±1.3°
	30MHz	Cv(10)±0.35dB	±2.5°
	100MHz	Cv(100)±0.6dB	±4.5°
40dB	1MHz	Cv(1)±0.2dB	±1.25°
	10MHz	Cv(10)±0.2dB	±2°
	30MHz	Cv(10)±0.45dB	±3°
	100MHz	Cv(100)±0.75dB	±4.5°
50dB	1MHz	Cv(1)±0.25dB	±1.75°
	10MHz	Cv(10)±0.35dB	±2.5°
	30MHz	Cv(10)±0.65dB	±3.5°
	100MHz	Cv(100)±0.95dB	±6.5°
60dB	1MHz	Cv(1)±0.45dB	±2.75°
	10MHz	Cv(10)±0.75dB	±5.5°
	30MHz	Cv(10)±1.65dB	±11°
	100MHz	Cv(100)±1.75dB	±11.5°
70dB	1MHz	Cv(1)±1.05dB	±5.25°
	10MHz	Cv(10)±1.55dB	±10.5°
	30MHz	Cv(10)±3.15dB	±16.0°
	100MHz	Cv(100)±3.25dB	±16.5°

Note

Cv(1), Cv(10), and Cv(100) in the above table are the calibration values of the 8495A at 1MHz, 10MHz, and 100MHz, respectively.

Table 4-7. Gain-Phase Measurement Accuracy Test Limits 4

Atten. Set.	Freq.	Gain	Phase
10dB	10Hz 100Hz 1kHz 10kHz 100kHz	Cv(1)±0.35dB Cv(1)±0.15dB Cv(1)±0.15dB Cv(1)±0.15dB Cv(1)±0.15dB	±2° ±0.75° ±0.75° ±0.75° ±0.75°
20dB	10Hz 100Hz 1kHz 10kHz 100kHz	Cv(1)±0.45dB Cv(1)±0.2dB Cv(1)±0.2dB Cv(1)±0.2dB Cv(1)±0.2dB	±2.3° ±1.25° ±1.25° ±1.25° ±1.25°
30dB	10Hz 100Hz 1kHz 10kHz 100kHz	Cv(1)±0.85dB Cv(1)±0.25dB Cv(1)±0.25dB Cv(1)±0.25dB Cv(1)±0.25dB	±3.3° ±1.75° ±1.75° ±1.75° ±1.75°

Table 4-8. Gain-Phase Measurement Accuracy Test limits 5

ATTEN. SET.	FREQ.	GAIN	PHASE
10dB	10Hz 100Hz 1kHz 10kHz 100kHz	Cv(1)±1.7dB Cv(1)±0.6dB Cv(1)±0.6dB Cv(1)±0.6dB Cv(1)±0.6dB	±5.5° ±4° ±4° ±4° ±4°
20dB	10Hz 100Hz 1kHz 10kHz 100kHz	Cv(1)±2.3dB Cv(1)±1.2dB Cv(1)±1.2dB Cv(1)±1.2dB Cv(1)±1.2dB	±7.5° ±6.5° ±6.5° ±6.5° ±6.5°
30dB	100Hz 1kHz 10kHz 100kHz	Cv(1)±3.2dB Cv(1)±3.2dB Cv(1)±3.2dB Cv(1)±3.2dB	±16.5° ±16.5° ±16.5° ±16.5°

Note

Cv(1), Cv(10), and Cv(100) in the above tables are the calibration values of the 8495A at 1MHz, 10MHz, and 100MHz, respectively.

4-7-3. MEASUREMENT ACCURACY: 1MΩ INPUT IMPEDANCE

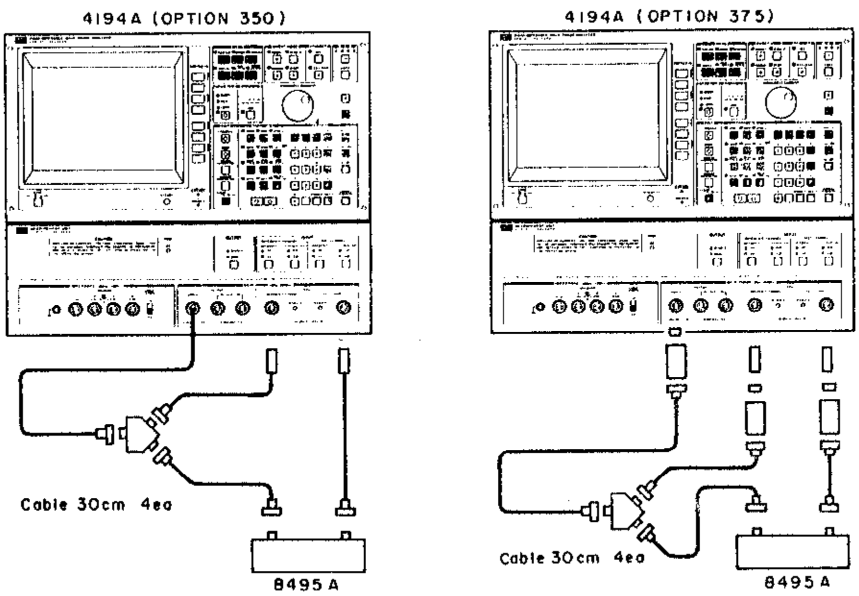


Figure 4-6. Gain-Phase Measurement Accuracy Test Setup: 1MΩ

EQUIPMENT:

Coaxial Step Attenuator	HP 8495A Opt. 001
50Ω - 75Ω Minimum Loss Pad*	HP 11852A
Feedthrough Termination, 50Ω	PN 04192-61002, 2 each
BNC-to-BNC Cable, 30cm, 50Ω	PN 8120-1838, 4 each
N(m)-to-BNC(f) Adapter, 50Ω	PN 1250-0780, 5 each
N(m)-to-BNC(f) Adapter, 50Ω*	PN 1250-0780, 3 each
N(f)-to-BNC(m) Adapter, 75Ω*	PN 1250-1534, 3 each
Feedthrough Termination, 75Ω*	PN 04192-61003, 2 each

* Required for Option 375 instruments only.

PROCEDURE:

1. Set up the 4194A as shown in Figure 4-6.
2. Press the **GET**, **2**, and **ENTER/EXECUTE** keys.
3. Set the 4194A to **SINGLE OUTPUT**.
4. Set the **OSC LEVEL** to **-1dBm** for Option 350 instruments, or **10.4dBm** for Option 375 instruments.
5. Press the **DISPLAY** key and the **'TABLE'** softkey.
6. Set both the **REFERENCE** and **TEST CHANNEL INPUT IMPEDANCE** to 1MΩ.
7. Set the 8495A to **0dB**.
8. Press the **START** key.

9. When the **START** key lamp goes out, press the **COMPEN** key, then press the **'OFST REF STORE'**, **'A OFFSET on/off'**, and **'B OFFSET on/off'** softkeys.

10. Set the 8495A to **20dB**.

11. Press the **START** key.

12. When the **START** key lamp goes out, confirm that the displayed gain-phase values are within the test limits listed in Table 4-9.

Table 4-9. Gain-Phase Measurement Accuracy Test Limits 6

Freq.	Gain	Phase
10Hz	Cv(1)±0.4dB	±2.6°
100Hz	Cv(1)±0.2dB	±1.5°
1kHz	Cv(1)±0.2dB	±1.5°
10kHz	Cv(1)±0.2dB	±1.5°
100kHz	Cv(1)±0.2dB	±1.5°
1MHz	Cv(1)±0.2dB	±1.5°
10MHz	Cv(10)±0.2dB	±2°
30MHz	Cv(10)±0.4dB	±3°
100MHz	Cv(100)±0.6dB	±4°

4-8. TEST EQUIPMENT CALIBRATION

This three part procedure is for obtaining the calibration values of the test equipment used during performance testing.

Note

If you have not performed the Gain-Phase Measurement Accuracy Test in paragraph 4-7, do so before you perform this procedure.

4-8-1. HP 8495A COAXIAL STEP ATTENUATOR CALIBRATION

This procedure is for measuring the 0dB setting insertion loss of the 8495A.

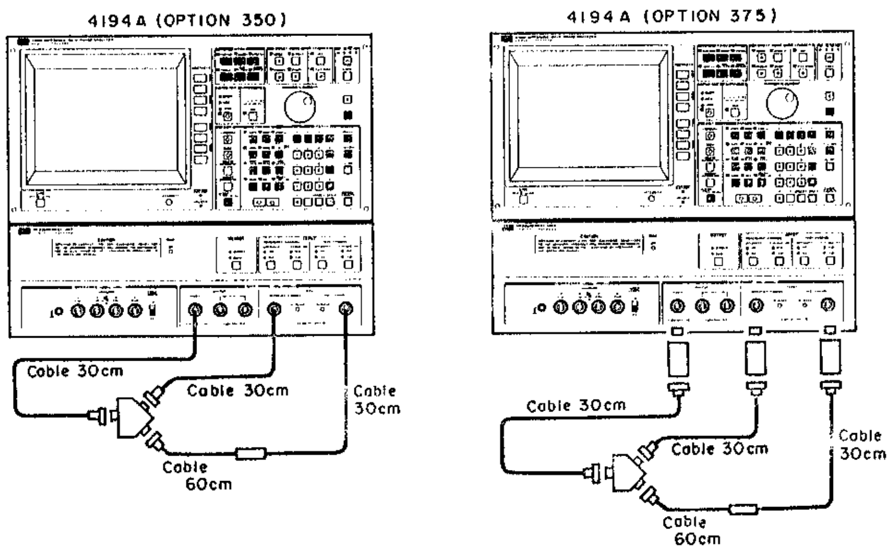


Figure 4-7. HP 8495A Attenuator Calibration Setup 1

EQUIPMENT:

Coaxial Step Attenuator	HP 8495A Opt. 001
Power Splitter	HP 11667A
50Ω - 75Ω Minimum Loss Pad*	HP 11852A, 3 each
BNC-to-BNC Cable, 30cm	PN 8120-1838, 3 each
BNC-to-BNC Cable, 61cm	PN 8120-1839
BNC(f)-to-BNC(f) Adapter	PN 1250-0080
N(m)-to-BNC(f) Adapter	PN 1250-0780, 3 each
N(f)-to-BNC(m) Adapter, 75Ω*	PN 1250-1534, 3 each
N(m)-to-BNC(f) Adapter*	PN 1250-0780, 3 each

* Required for Option 375 instruments only.

PROCEDURE:

1. Set up the 4194A as shown in Figure 4-7.

2. Initialize the 4194A.

3. Set the 4194A as follows:

FUNCTION	GAIN-PHASE, Tch/Rch (dB) - θ
SWEEP MODE	SINGLE
INTEG TIME	MED
AVERAGING TIME	4
CENTER	10MHz
SPAN	0Hz
OSC LEVEL	-1dBm (10.4dBm for Opt. 375)
OUTPUT	SINGLE

4. Press the **START** key.

5. When the **START** key lamp goes out, press the **MKR/L CURS** key, then press the **'LINE CURSOR'**, **'menu'**, **'LCURS for A'**, and **'LCURS → AVRG'** softkeys.

6. Press the **CLEAR LINE**, **Blue**, **R**, **0**, **=**, **L**, **C**, **U**, **R**, **S**, and **ENTER/EXECUTE** keys to store the LCURS value into the R0 register.

7. Disconnect the BNC(f)-to-BNC(f) adapter and connect the 8495A as shown in Figure 4-8.

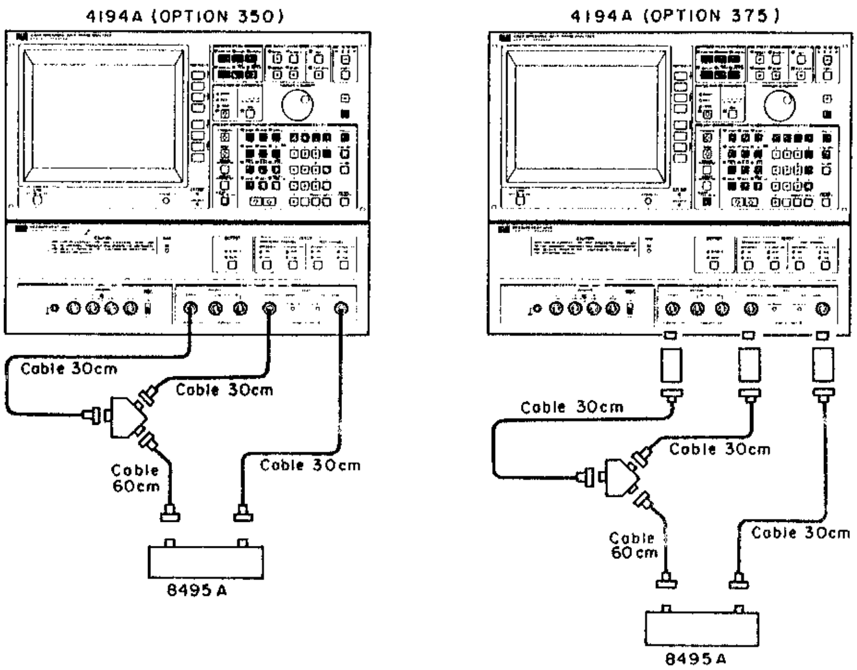


Figure 4-8. HP 8495A Attenuator Calibration Setup 2

8. Set the 8495A to 0dB.

9. Press the **START** key.

10. When the **START** key lamp goes out, press the **'LCURS → AVRG'** softkey.

11. Press the **CLEAR LINE, Blue, R, 1, 0, =, R, 0, -, L, C, U, R, S**, and **ENTER/ EXECUTE** keys to store the 8495A's insertion loss value (at the 0dB setting) into the R10 register.

12. Press the **CLEAR LINE, Blue, R, 1, 0** and **ENTER/EXECUTE** keys to display the value stored in R10.

13. Confirm that the displayed value is less than 0.1dB. If this reading is greater than 0.1dB, make sure your setup is correct and repeat this procedure.

4-8-2. HP 11667A POWER SPLITTER TRACKING ERROR CALIBRATION

This procedure is for measuring and storing the calibration value of the 11667A and the cables used during performance testing.

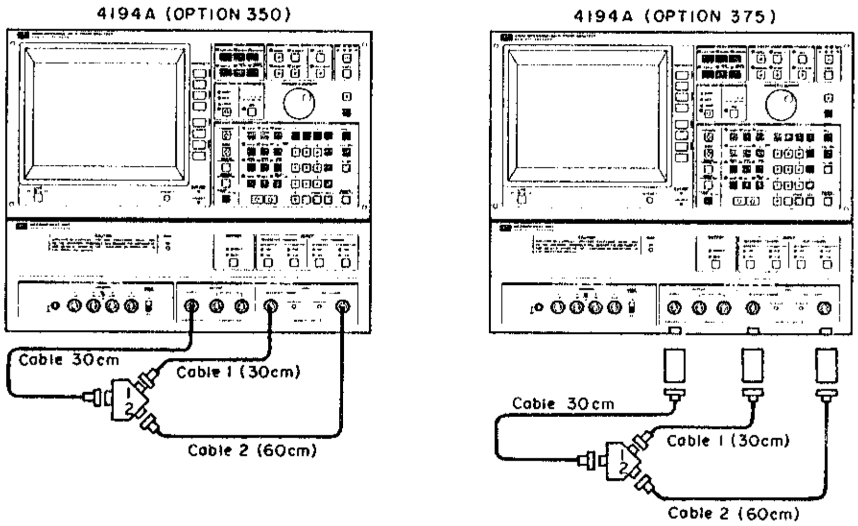


Figure 4-9. HP 11667A Tracking Error Calibration Setup 1

EQUIPMENT:

Power Splitter	HP 11667A
50Ω - 75Ω Minimum Loss Pad*	HP 11852A, 3 each
N(m)-to-BNC(f) Adapter	PN 1250-0780, 3 each
BNC-to-BNC Cable, 30cm	PN 8120-1838, 2 each
BNC-to-BNC Cable, 61cm	PN 8120-1839
N(f)-to-BNC(m) Adapter, 75Ω*	PN 1250-1534, 3 each
N(m)-to-N(f) Adapter*	PN 1250-0780, 3 each

* Required for Option 375 instruments only.

PROCEDURE:

1. Label the 11667A's output ports as #1 and #2 (see Figure 4-9).

2. Label the 30cm cable as #1 and the 61cm cable as #2 (see Figure 4-9).

Note

Do not remove the labels from the 11667A or the cables when finished with this calibration. This equipment is required for other tests.

3. Set up the 4194A as shown in Figure 4-9.

Note

When testing Option 375 instruments, do not disconnect the 11852As from the 4194A until this procedure is completed.

4. Initialize the 4194A.

5. Set the 4194A as follows:

FUNCTION	GAIN-PHASE, Tch/Rch (dB) - θ
SWEEP MODE	SINGLE
INTEG TIME	MED
AVERAGING TIME	4
CENTER	10MHz
SPAN	0Hz
OSC LEVEL	-1dBm (10.4dBm for Opt. 375)
OUTPUT	SINGLE

6. Press the **START** key.

7. When the **START** key lamp goes out, press the MKR/L CURS key, then press the **'LINE CURSOR'**, **'menu'**, **'LCURS for A'**, and **'LCURS → AVRG'** softkeys.

8. Press the **CLEAR LINE**, Blue, **R**, **0**, =, **L**, **C**, **U**, **R**, **S**, and **ENTER/EXECUTE** keys to store the LCURS value into the R0 register.

9. Reconnect cables 1 and 2 as shown in Figure 4-10 (cable 1 to the TEST CHANNEL; cable 2 to the REFERENCE CHANNEL).

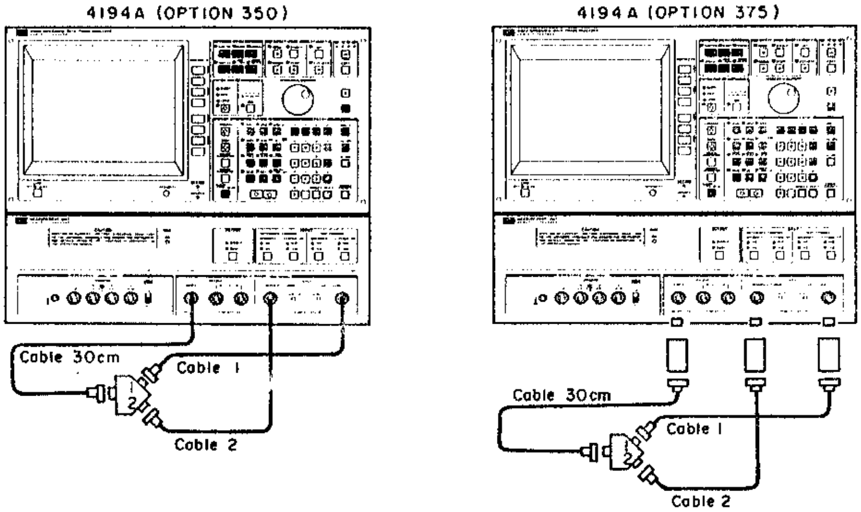


Figure 4-10. HP 11667A Tracking Error Calibration Setup 2

10. Press the **START** key.

11. When the **START** key lamp goes out, press the **'LCURS for A'** and **'LCURS → AVRG'** softkeys.

12. Press the **CLEAR LINE**, **Blue**, **R**, **1**, **1**, =, (, L, C, U, R, S, -, R, **0**,), /, 2, and **ENTER/EXECUTE** keys to store the tracking error calibration value (11667A and cables) into the R11 register.

13. Press the **CLEAR LINE**, **Blue**, **R**, **1**, **1**, and **ENTER/EXECUTE** keys to display the value stored in R11.

14. Confirm that the displayed value is 0dB±0.1dB. If this reading is not within limits, make sure your setup is correct and repeat this procedure.

4-8-3. HP 11852A MINIMUM LOSS PAD CALIBRATION: 75Ω INSTRUMENTS

This procedure is for measuring the insertion loss of the HP 11852A 50Ω - 75Ω Minimum Loss Pads used when performance testing 4194As equipped with Option 375.

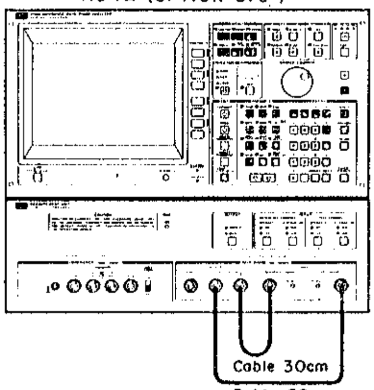


Figure 4-11. HP 11852A Insertion Loss Calibration Setup 1

EQUIPMENT:

50Ω - 75Ω Minimum Loss Pad	HP 11852A, 3 each
Power Splitter	HP 11667A
BNC-to-BNC Cable, 30cm	PN 8120-1838, 2 each
BNC-to-BNC Cable, 30cm	PN 04194-61640
BNC-to-BNC Cable, 61cm	PN 8120-1839
BNC-to-BNC Cable, 61cm, 75Ω	PN 04194-61641
N(f)-to-BNC(m) Adapter, 75Ω	PN 1250-1534, 3 each
N(m)-to-BNC(f) Adapter	PN 1250-0780, 6 each
N(m)-to-N(m) Adapter	PN 1250-0778
N(f)-to-BNC(f)Adapter, 75Ω	PN 1250-1536

PROCEDURE:

1. Label the three 11852As as A, B, and C.

2. Interconnect the OUTPUT and INPUT terminals using 75Ω cables as shown in Figure 4-11.

3. Initialize the 4194A.

4. Set the 4194A as follows:

FUNCTION	GAIN-PHASE, Tch/Rch (dB) - θ
SWEEP MODE	SINGLE
INTEG TIME	MED
AVERAGING TIME	4
CENTER	10MHz
SPAN	0Hz
OSC LEVEL	10.4dBm
OUTPUT	DUAL

5. Press the **START** key.

6. When the **START** key lamp goes out, press the **MKR/L CURS** key, then press the **'LINE CURSOR'**, 'menu', **'LCURS for A'**, and **'LCURS → AVRG'** keys.

7. Press the **CLEAR LINE**, **Blue**, **R**, **0**, =, L, **C**, **U**, **R**, **S**, and **ENTER/EXECUTE** keys to store the LCURS value into the R0 register.

8. Set up the 4194A as shown in Figure 4-12.

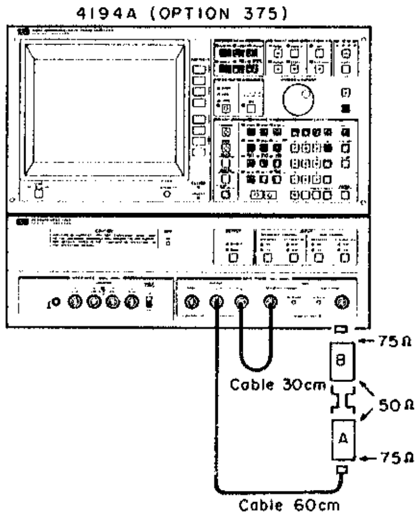


Figure 4-12. HP 11852A Insertion Loss Calibration Setup 2

9. Press the **START** key.

10. When the **START** key lamp goes out, press the **'LCURS → AVRG'** softkey.

11. Press the CLEAR LINE, **Blue**, **R**, **1**, =, (, **R**, **0**, -, L, **C**, **U**, **R**, **S**,), /, **2**, and ENTER/ **EXECUTE** keys.

12. Change the setup as shown in Figure 4-13 using 50Ω cables. Connect **PAD A** to the TEST CHANNEL and **PAD B** to the REFERENCE CHANNEL.

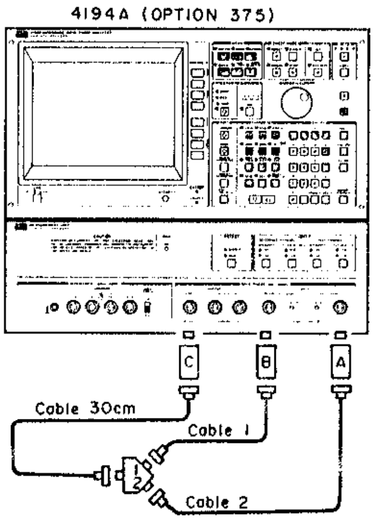


Figure 4-13. HP 11852A Insertion Loss Calibration Setup 3.

13. Set the 4194A to **SINGLE OUTPUT**, then press the **START** key.

14. When the **START** key lamp goes out, press the **'LCURS → AVRG'** softkey.

15. Press the **CLEAR LINE, Blue, R, 0, =, L, C, U, R, S,** and **ENTER/EXECUTE** keys.

17. Interchange **PADS A** and **B**, as shown in Figure 4-14.

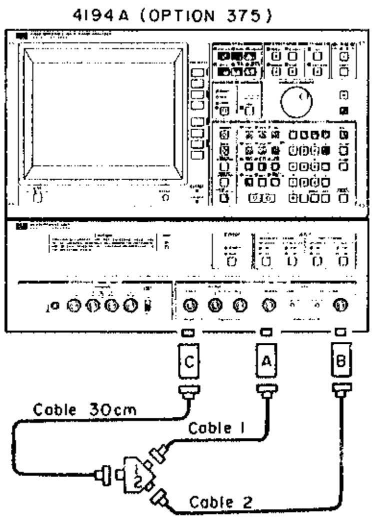


Figure 4-14. HP 11852A Insertion Loss Calibration Setup 4

18. Press the **START** key.

19. When the **START** key lamp goes out, press the **'LCURS → AVRG'** softkey.

20. Press the **CLEAR LINE, Blue, R, 1, 2, =, R, 1, +, (, L, C, U, R, S, -, R, 0,), /, 4,** and **ENTER/EXECUTE** keys to store the insertion loss value of **PAD A** into the R12 register.

21. Press the **CLEAR LINE, Blue, R, 1, 2,** and **ENTER/EXECUTE** keys.

22. Confirm that the displayed value is 5.7dB±0.1dB. If this reading is not within limits, make sure your setup is correct and repeat this procedure.

23. Press the **CLEAR LINE, Blue, R, 1, 3, =, R, 1, -, (, L, C, U, R, S, -, R, 0,), /, 4,** and **ENTER/EXECUTE** keys to store the insertion loss value of **PAD B** into the R13 register.

24. Press the **CLEAR LINE, Blue, R, 1, 3,** and **ENTER/EXECUTE** keys to display the value stored in R13.

25. Confirm that the displayed value is 5.7dB±0.1dB. If this reading is not within limits, make sure your setup is correct and repeat this procedure.

4-9. AMPLITUDE MEASUREMENT ACCURACY TEST

This six part procedure verifies amplitude measurement accuracy at low and high frequencies and with a low-level input.

4-9-1. LF MEASUREMENT ACCURACY: 50Ω/75Ω INPUT IMPEDANCE

This test verifies amplitude measurement accuracy at 10Hz, 100Hz, 1kHz, and 10kHz when the 4194A's INPUT IMPEDANCE is set to 50Ω/75Ω.

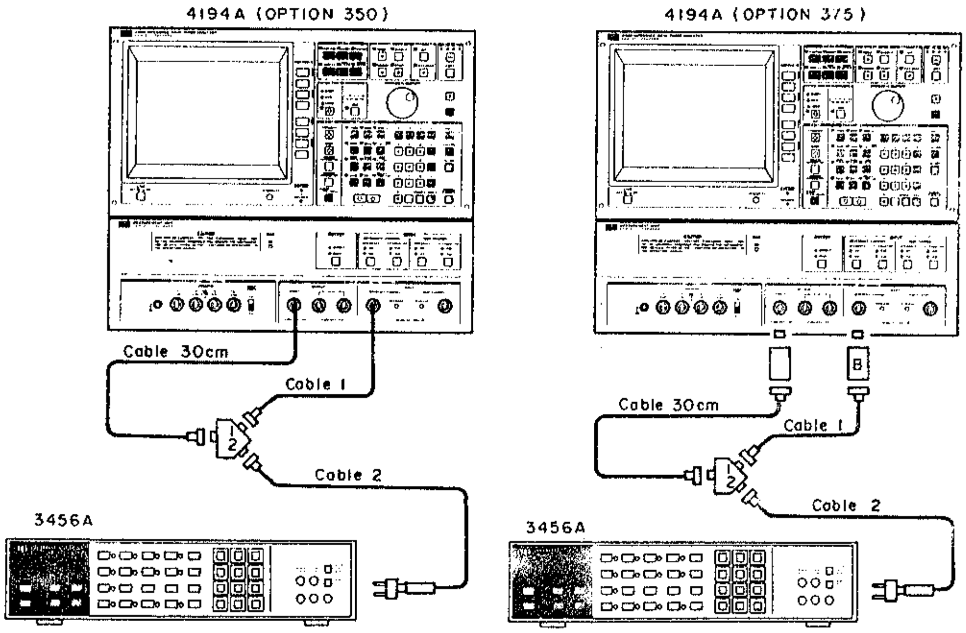


Figure 4-15. Amplitude Measurement Accuracy Test Setup 1

EQUIPMENT:

Digital Voltmeter	HP 3456A
Power Splitter	HP 11667A
50Ω - 75Ω Minimum Loss Pad*	HP 11852A, 2 each
BNC-to-BNC Cable, 30cm**	PN 8120-1838, 2 each
BNC-to-BNC Cable, 61cm**	PN 8120-1839
Feedthrough Termination, 50Ω	PN 04192-61002
N(m)-to-BNC(f) Adapter	PN 1250-0780, 3 each
BNC(f)-to-Dual Banana Adapter	PN 1251-2277
N(f)-to-BNC(m) Adapter, 75Ω*	PN 1250-1534, 2 each
N(m)-to-BNC(f) Adapter*	PN 1250-0780, 2 each

* Required for Option 375 instruments only.

** Be sure to use cables 1 (30cm) and 2 (61cm): see Figure 4-15.

PROCEDURE:

1. Set up the equipment as shown in Figure 4-15.

Note

For Option 375 instruments, be sure to use PAD B.

2. Set the 3456A as follows:

Measurement function	ACV
Filter	ON

3. Press the 3456A's **MATH** and **4** keys (to set the dBm mode).
4. Press the 3456A's **5**, **0**, **STORE**, and **4** keys (to set 50Ω characteristic impedance).
5. Press the **GET**, **2**, and **ENTER/EXECUTE** keys.
6. Press the **'GAIN PHASE'** and **'Rch-Tch (dBm)'** softkeys.
7. Set the 4194A to **SINGLE OUTPUT**.
8. Set the **SWEEP MODE** to **MANUAL**.
9. Set the **OSC LEVEL** to **-1dBm** (**10.4dBm** for Opt. 375).
10. Set the test frequency to **10Hz** using the **MARKER/L CURSOR** knob.
11. Using the 4194A's built-in calculator function, perform the following calculation.

    Pm - MKRA + R11 for 50Ω 4194As, or

    Pm - MKRA + R11 - R13 for 75Ω 4194As.

    where **Pm** is the measurement value displayed on the 3456A
    MKRA is the measurement value displayed on the 4194A
    R11 is the tracking error of the 11667 and cables 1 and 2
    R13 is the insertion loss of PAD B
12. Confirm that the displayed result is within the test limits listed in Table 4-10 for the frequency tested.
13. Repeat steps 10 through 12 at **100Hz**, **1kHz**, and **10kHz**.
14. Set the REFERENCE (TEST) CHANNEL ATTENUATION to 20dB and repeat steps 10 through 13.
15. Disconnect the cable from the REFERENCE CHANNEL and reconnect it to the TEST CHANNEL.
16. Repeat steps 10 through 14, substituting MKRB for MKRA in step 11.

Table 4-10. LF Amplitude Measurement Accuracy Test Limits
Input Impedance 50Ω/75Ω

	Frequency	Test Limits
REFERENCE CHANNEL ATTENUATION=0dB	10Hz 100Hz 1kHz 10kHz	±0.70dB ±0.35dB ±0.35dB ±0.35dB
REFERENCE CHANNEL ATTENUATION=20dB	10Hz 100Hz 1kHz 10kHz	±0.70dB ±0.35dB ±0.35dB ±0.35dB
TEST CHANNEL ATTENUATION=0dB	10Hz 100Hz 1kHz 10kHz	±0.70dB ±0.35dB ±0.35dB ±0.35dB
TEST CHANNEL ATTENUATION=20dB	10Hz 100Hz 1kHz 10kHz	±0.70dB ±0.35dB ±0.35dB ±0.35dB

Note

Proceed to the next test without dismantling the present test setup.

4-9-2. LF MEASUREMENT ACCURACY: 1MΩ INPUT IMPEDANCE

This test verifies amplitude measurement accuracy at 10Hz, 100Hz, 1kHz, and 10kHz when the 4194A's INPUT IMPEDANCE is set to 1MΩ.

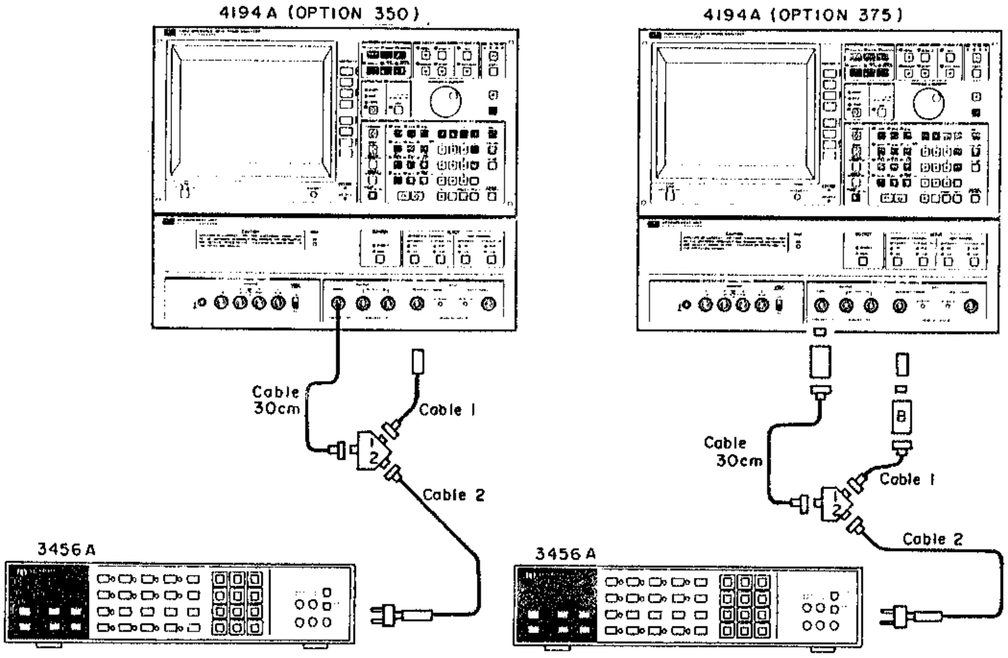


Figure 4-16. Amplitude Measurement Accuracy Test Setup 2

EQUIPMENT:

Same as the previous test, plus:

Feedthrough Termination, 50Ω	PN 04192-61002
Feedthrough Termination, 75Ω*	PN 04192-61003

* Option 375 instruments only.

PROCEDURE:

1. Connect the appropriate (50Ω or 75Ω) feedthrough termination to the REFERENCE CHANNEL as shown in Figure 4-16.

2. Set the 4194A's INPUT IMPEDANCE to 1MΩ.

3. Repeat the procedure in paragraph 4-9-1 from step 10, using the test limits listed in Table 4-11.

4. Remove the feedthrough terminations from cables 1 and 2 and reconnect cable 1 to the REFERENCE CHANNEL. Then disconnect the 3456A and go on to the next test. Leave the setup as it is.

Table 4-11. LF Amplitude Measurement Accuracy Test Limits
Input Impedance 1MΩ

	Frequency	Test Limits
REFERENCE CHANNEL ATTENUATION = 0dB	10Hz 100Hz 1kHz 10kHz	±1.0dB ±0.4dB ±0.4dB ±0.4dB
REFERENCE CHANNEL ATTENUATION = 20dB	10Hz 100Hz 1kHz 10kHz	±1.0dB ±0.4dB ±0.4dB ±0.4dB
TEST CHANNEL ATTENUATION = 0dB	10Hz 100Hz 1kHz 10kHz	±1.0dB ±0.4dB ±0.4dB ±0.4dB
TEST CHANNEL ATTENUATION = 20dB	10Hz 100Hz 1kHz 10kHz	±1.0dB ±0.4dB ±0.4dB ±0.4dB

4-9-3. HF MEASUREMENT ACCURACY: 50/75Ω INPUT IMPEDANCE

This test verifies amplitude measurement accuracy at 100kHz, 1, 10, 30, and 100MHz when the 4194A's INPUT IMPEDANCE is set to 50Ω/75Ω.

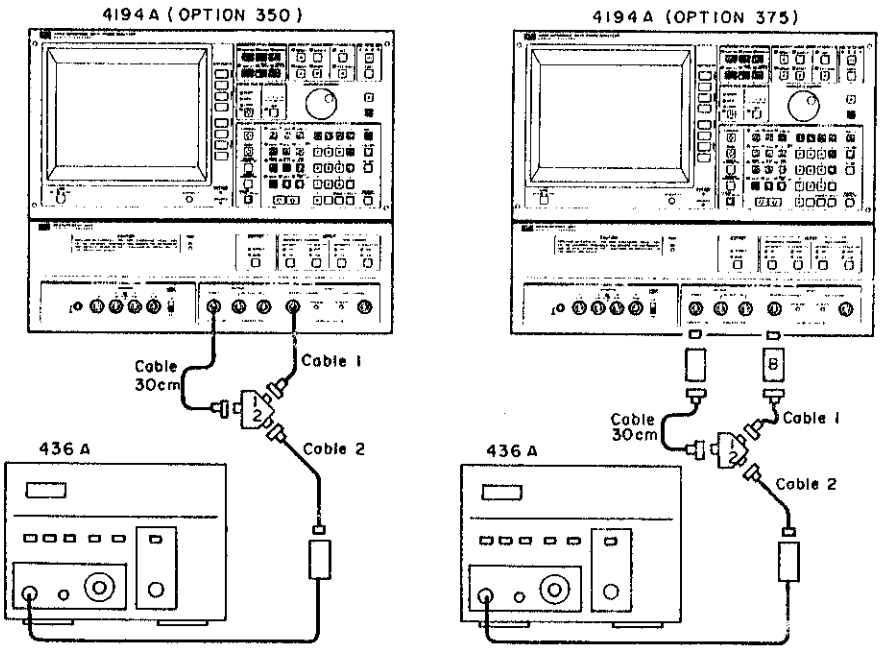


Figure 4-17. Amplitude Measurement Accuracy Test Setup 3

EQUIPMENT:

Same as the previous test (minus the 3456A), plus:

Power Meter	HP 436A
Power Sensor	HP 8482A
N(f)-to-BNC(f) Adapter	PN 1250-1474

PROCEDURE:

1. Set up the 4194A as shown in Figure 4-17 and set the 436A's measurement function to **dBm**.

2. Set the test frequency to **100kHz** using the **MARKER/L CURSOR** knob.

3. Set the CAL FACTOR % control on the 436A (in accordance with the cal chart on the 8482A) to compensate for the 8482A's Cal Factor at **100kHz**.

4. Using the 4194A's built-in calculator function, perform the following calculation.

   Pm - MKRA + R11 for 50Ω 4194As, or

   Pm - MKRA + R11 - R13 for 75Ω 4194As.

   where **Pm** is the measurement value displayed on the 436A,
   MKRA is the measurement value displayed on the 4194A,
   R11 is the tracking error of the 11667 and cables 1 and 2, and
   R13 is the insertion loss of PAD B

5. Confirm that the displayed result is within the test limits listed in Table 4-12 for the frequency tested.

6. Repeat steps 2 through 5 at **1**, **10**, **30**, and **100MHz**.

7. Set the REFERENCE (TEST) CHANNEL ATTENUATION to **20dB** and repeat steps 2 through 6.

8. Disconnect the cable from the REFERENCE CHANNEL and reconnect it to the TEST CHANNEL.

9. Repeat steps 2 through 7, substituting MKRB for MKRA in step 4.

Table 4-12. HF Amplitude Measurement Accuracy Test Limits
Input Impedance 50Ω/75Ω

	FREQUENCY	Test Limits
REFERENCE CHANNEL ATTENUATION = 0dB	100kHz 1MHz 10MHz 30MHz 100MHz	±0.35dB ±0.35dB ±0.5dB ±0.7dB ±1.5dB
REFERENCE CHANNEL ATTENUATION = 20dB	100kHz 1MHz 10MHz 30MHz 100MHz	±0.35dB ±0.35dB ±0.5dB ±0.7dB ±1.5dB
TEST CHANNEL ATTENUATION = 0dB	100kHz 1MHz 10MHz 30MHz 100MHz	±0.35dB ±0.35dB ±0.5dB ±0.7dB ±1.5dB
TEST CHANNEL ATTENUATION = 20dB	100kHz 1MHz 10MHz 30MHz 100MHz	±0.35dB ±0.35dB ±0.5dB ±0.7dB ±1.5dB

4-9-4. HF MEASUREMENT ACCURACY: 1MΩ INPUT IMPEDANCE

This test verifies amplitude measurement accuracy at 100kHz, 1, 10, and 30MHz when the 4194A's INPUT IMPEDANCE is set to 1MΩ.

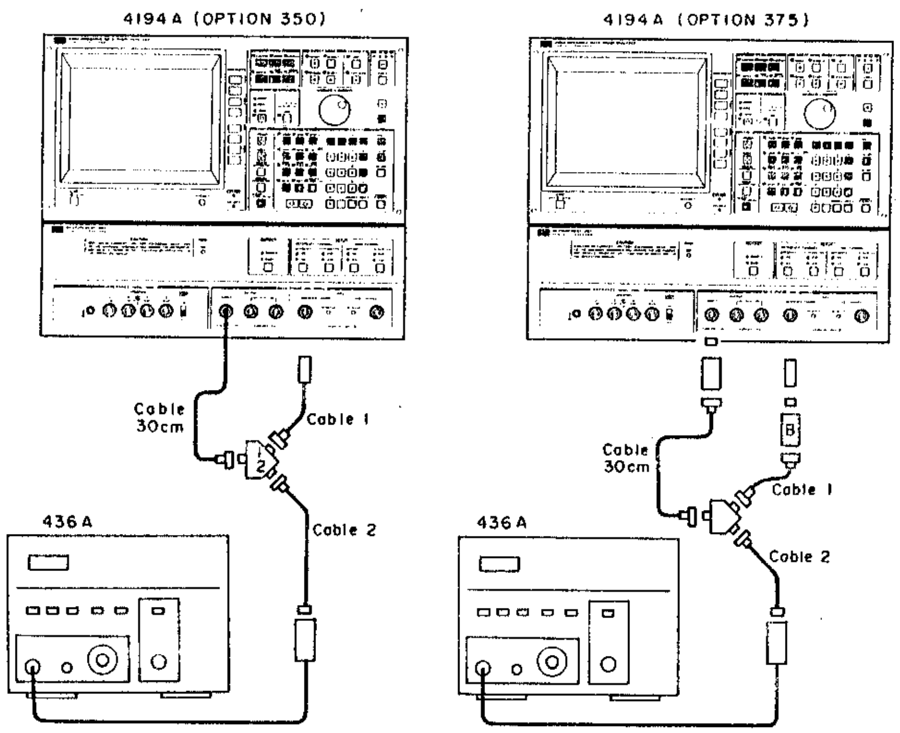


Figure 4-18. Amplitude Measurement Accuracy Test Setup 4.

EQUIPMENT:

Same as the previous test, plus:

Feedthrough Termination, 50Ω	PN 04192-61002
Feedthrough Termination, 75Ω*	PN 04192-61003

* Required for Option 375 instruments only.

PROCEDURE:

1. Connect the appropriate (50Ω or 75Ω) feedthrough termination to the REFERENCE CHANNEL as shown in Figure 4-18.

2. Set the 4194A's INPUT IMPEDANCE to 1MΩ.

3. Repeat the procedure in paragraph 4-9-3 from step 2. Use the test limits listed in Table 4-13.

4. Remove the feedthrough termination connected to cable 1.

Note

Proceed to the next test without dismantling the present test setup or changing any 4194A settings.

Table 4-13. HF Amplitude Measurement Accuracy Test Limits
Input Impedance 1MΩ

	Frequency	Test Limits
REFERENCE CHANNEL ATTENUATION = 0dB	100kHz 1MHz 10MHz 30MHz	±0.4dB ±0.4dB ±0.7dB ±1.0dB
REFERENCE CHANNEL ATTENUATION = 20dB	100kHz 1MHz 10MHz 30MHz	±0.4dB ±0.4dB ±0.7dB ±1.0dB
TEST CHANNEL ATTENUATION = 0dB	100kHz 1MHz 10MHz 30MHz	±0.4dB ±0.4dB ±0.7dB ±1.0dB
TEST CHANNEL ATTENUATION = 20dB	100kHz 1MHz 10MHz 30MHz	±0.4dB ±0.4dB ±0.7dB ±1.0dB

4-9-5. LOW LEVEL MEASUREMENT ACCURACY: 50/75Ω INPUT IMPEDANCE

This test verifies low input level amplitude measurement accuracy at 100kHz, 1, 10, 30, and 100MHz when the input impedance is set to 50Ω/75Ω.

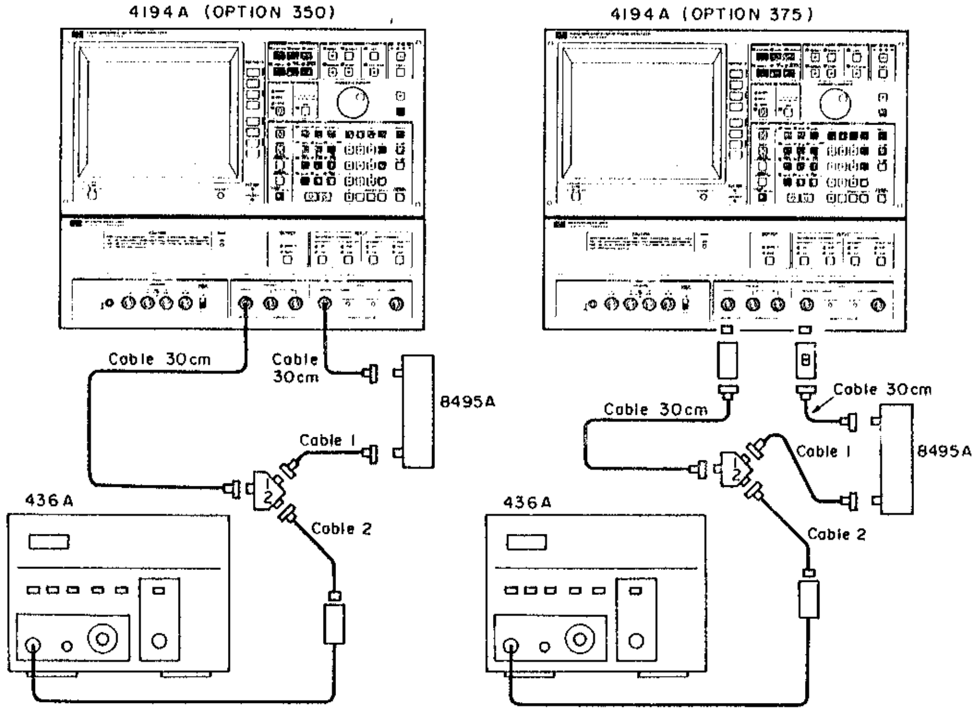


Figure 4-19. Amplitude Measurement Accuracy Test Setup 5.

EQUIPMENT:

Same as for the previous test, plus:

Coaxial Step Attenuator	HP 8495A Opt. 001
BNC-to-BNC Cable, 30cm	PN 1820-1838
N(m)-to-BNC(f) Adapter	PN 1250-0780, 2 each

PROCEDURE:

1. Set up the 4194A as shown in Figure 4-19.
2. Set the 8495A to 60dB.
3. Set the **OSC LEVEL** to **-4dBm** (**7.4dBm** for Opt. 375).
4. Set the test frequency to **100kHz** using the **MARKER/L CURSOR** knob.
5. Set the CAL FACTOR % control on the 436A (in accordance with the cal chart on the 8482A) to compensate for the 8482A's Cal Factor at **100kHz**.

manual changes

6. Using the 4194A's built-in calculator function, perform the following calculation.

   Pm - MKRA + R11 for 50Ω 4194As, or
   Pm - MKRA - R10 + R11 - CV for 50Ω

   Pm - MKRA + R11 - R13 for 75Ω 4194As.
   Pm - MKRA - R10 + R11 - R13 - CV for 75Ω

   where **Pm** is the measurement value displayed on the ~~3456A~~ 436A
   MKRA is the measurement value displayed on the 4194A
   R11 is the tracking error of the 11667 and cables 1 and 2
   R13 is the insertion loss of PAD B
   R10 is the insertion loss of the 8445A
   CV is the 8445A's cal. VB calibration value at 1MHz

7. Confirm that the displayed result is within the test limits listed in Table 4-14 for the frequency tested.

8. Repeat steps 4 through 7 at **1MHz**, **10MHz**, **30MHz**, and **100MHz**.
   Use the 8445A's 1MHz cal. value for 1MHz, 10MHz cal. value for 10 and 30MHz and the 100MHz cal value for 100MHz.

9. Disconnect the cable from the REFERENCE CHANNEL and reconnect it to the TEST CHANNEL.

10. Repeat steps 4 through 8, substituting **MKRB** for **MKRA** in step 6.

11. Proceed to the next test without dismantling the present test setup or changing any 4194A settings.

Table 4-14. Low Level Amplitude Measurement Accuracy Test Limits
Input Impedance 50Ω/75Ω

Frequency	Test limits
100kHz	±2.5dB
1MHz	±2.5dB
10MHz	±3dB
30MHz	±4dB
100MHz	±4dB

4-9-6. LOW LEVEL MEASUREMENT ACCURACY: 1MΩ INPUT IMPEDANCE

This test verifies low input level amplitude measurement accuracy at 100kHz, 1, 10, and 30MHz when the input impedance is set to 1MΩ.

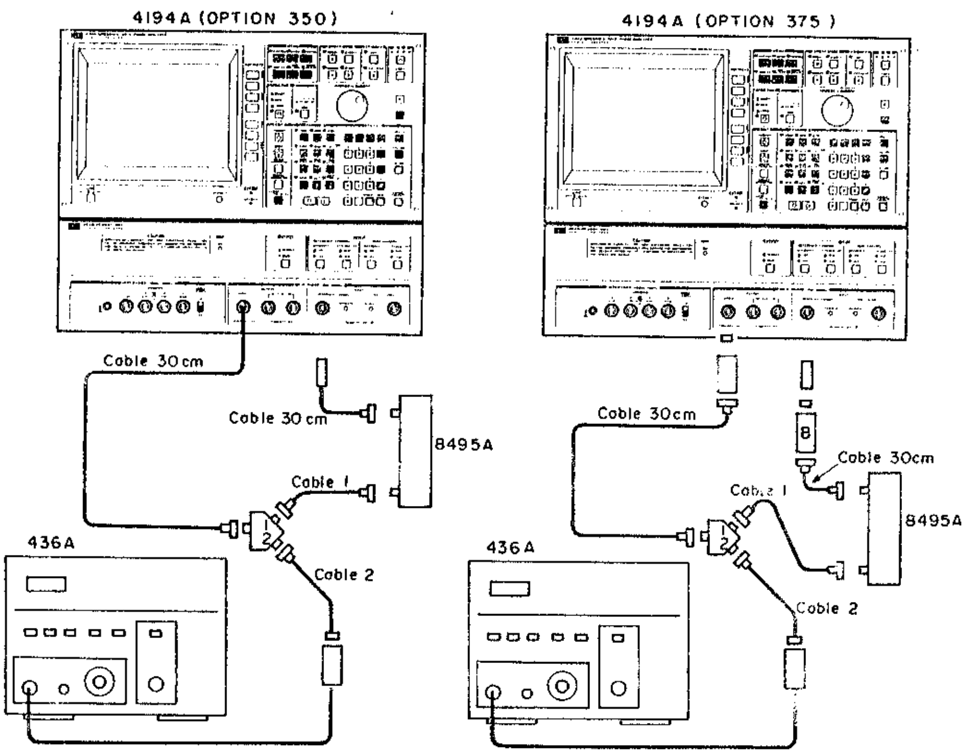


Figure 4-20. Amplitude Measurement Accuracy Test Setup 6

EQUIPMENT:

Same as the previous test, plus:

Feedthrough Termination, 50Ω	PN 04192-61002
Feedthrough Termination, 75Ω*	PN 04192-61003

* Required for Option 375 instruments only.

PROCEDURE:

1. Connect the appropriate (50Ω or 75Ω) feedthrough termination to the REFERENCE CHANNEL as shown in Figure 4-20.

2. Set the 4194A's INPUT IMPEDANCE to 1MΩ.

3. Repeat the procedure in paragraph 4-9-5 from step 4. Use the test limits listed in Table 4-15.

Table 4-15. Low Level Amplitude Measurement Accuracy Test Limits
Input Impedance 1MΩ

Frequency	Test limits
100kHz	±3dB
1MHz	±3dB
10MHz	±3dB
30MHz	±4dB

4-10. GAIN-PHASE MEASUREMENT SIGNAL LEVEL TEST

This five part test checks test signal level accuracy for gain-phase measurements.

4-10-1. SIGNAL LEVEL ACCURACY: 100kHZ

This test verifies the accuracy of the test signal level at **100kHz**.

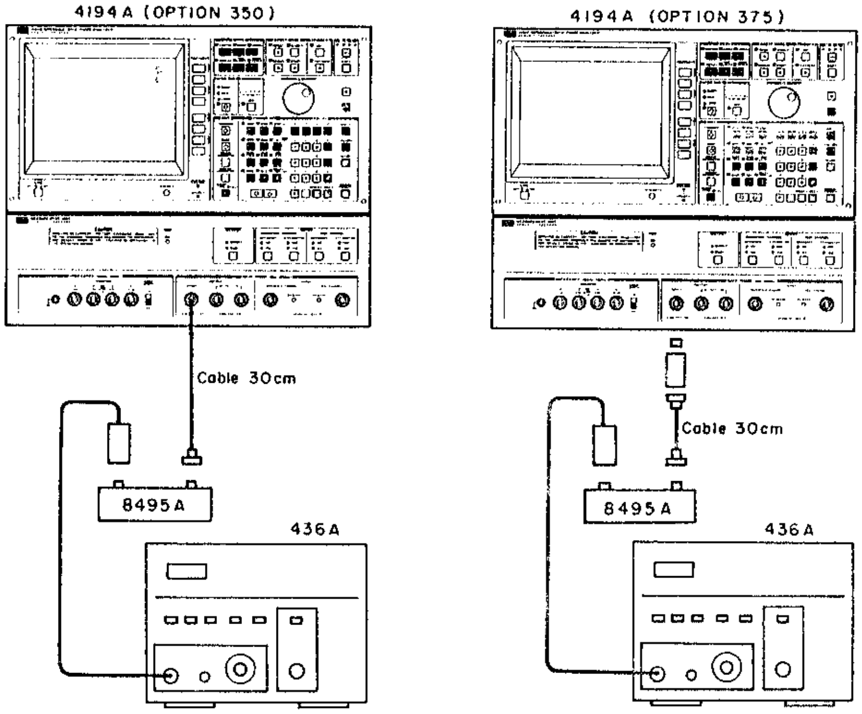


Figure 4-21. Gain-Phase Measurement Signal Level Test Setup 1

EQUIPMENT:

Power Meter	HP 436A
Power Sensor	HP 8482A
Coaxial Step Attenuator	HP 8495A Opt. 001
50Ω - 75Ω Minimum Loss Pad*	HP 11852A
N(m)-to-BNC(f) Adapter	PN 1250-0780
BNC-to-BNC Cable, 30cm	PN 8120-1838
N(f)-to-BNC(m) Adapter, 75Ω*	PN 1250-1534
N(m)-to-BNC(f) Adapter*	PN 1250-0780

* Required for Option 375 instruments only.

PROCEDURE:

1. Set up the equipment as shown in Figure 4-21.

2. Press the **GET**, **2,** and **ENTER/EXECUTE** keys.

3. Set the 4194A to **SINGLE OUTPUT.**

4. Set the **SWEEP MODE** to **MANUAL.**

5. Set the test frequency to **100kHz** using the **MARKER/L CURSOR** knob.

6. Set the 8495A to **10dB.**

7. Set the **OSC LEVEL** to **15dBm.**

8. Set the CAL FACTOR % control on the 436A (in accordance with the cal chart on the 8482A) to compensate for the 8482A's Cal Factor at **100kHz.**

9. Confirm that the value displayed on the 436A is as follows.

   For 50Ω instruments:

   15dBm - (R10 + Cv) ±0.8dB

   For 75Ω instruments:

   15dBm - (R10 + Cv + R13) ±0.8dB

   where **R10** is the 8495A's insertion loss calibration value
   Cv is the 8495's 10dB calibration value at 1MHz
   R13 is the insertion loss of PAD B.

10. Note the amplitude value displayed on the 436A as PREF(15). This value will be used in the following test.

11. Set the **OSC LEVEL** to **5dBm.**

12. Set the 8495A to **0dB.**

13. Confirm that the value displayed on the 436A is as follows.

    For 50Ω instruments:

    5dBm - R10 ±1.0dB.

    For 75Ω instruments:

    5dBm - (R10 + R13) ±1.0dB.

14. Note the amplitude value displayed on the 436A as PREF(5). This value will be used in the following test.

Note

Proceed to the next test without dismantling the present test setup or changing any 4194A settings.

4-10-2. HF SIGNAL LEVEL FLATNESS

This test verifies the flatness of the test signal level at high frequencies.

EQUIPMENT:

Same as the previous test.

PROCEDURE:

1. Set the 8495A to **10dB** and set the 4194A's **OSC LEVEL** to **15dBm**.
2. Set the CAL FACTOR % control on the 436A (in accordance with the cal chart on the 8482A) to compensate for the 8482A's Cal Factor at **10MHz**.
3. Set the test frequency to **10MHz**.
4. Confirm that the signal level (dBm) displayed on the 436A is $P_{REF}(15)\pm 1$dBm.
5. Repeat steps 2 through 4 at **30**, **80**, and **100MHz**.
6. Set the 8495A to **0dB** and set the 4194A's **OSC LEVEL** to **5dBm**.
7. Set the CAL FACTOR % control on the 436A (in accordance with the cal chart on the 8482A) to compensate for the 8482A's Cal Factor at **10MHz**.
8. Set the test frequency to **10MHz**.
9. Confirm that the signal level (dBm) displayed on the 436A is $P_{REF}(5)\pm 1.2$dBm.
10. Repeat steps 7 through 9 at **30**, **80**, and **100MHz**.

Note

Disconnect the power meter from the attenuator and proceed to the next test without dismantling the present test setup or changing any of the 4194A's settings.

4-10-3. LF SIGNAL LEVEL FLATNESS

This test verifies the flatness of the signal level at low frequencies.

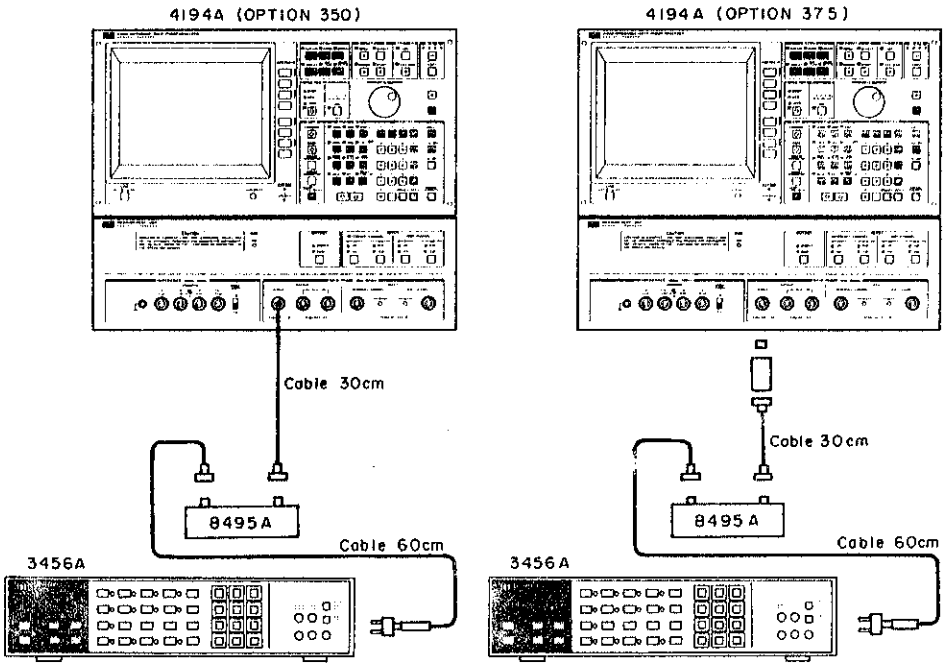


Figure 4-22. Gain-Phase Measurement Signal Level Test Setup 2

EQUIPMENT:

Digital Voltmeter	HP 3456A
Coaxial Step Attenuator	HP 8495A Opt. 001
50Ω - 75Ω Minimum Loss Pad*	HP 11852A
Feedthrough Termination, 50Ω	PN 04192-61002
BNC(f)-to-Dual Banana Adapter	PN 1251-2277
N(m)-to-BNC(f) Adapter	PN 1250-0780, 2 each
BNC-to-BNC Cable, 30cm	PN 8120-1838
N(f)-to-BNC(m) Adapter, 75Ω*	PN 1250-1534
N(m)-to-BNC(f) Adapter*	PN 1250-0780

* Required for Option 375 instruments only.

PROCEDURE:

1. Set the **OSC LEVEL** to **15dBm**.

2. Set the 8495A to **10dB**.

3. Connect the 3456A to the 8495A as shown in Figure 4-22.

4. Set the 3456A as follows:

Measurement function	ACV
Filter	ON

5. Press the 3456A's **MATH** and **4** keys (to set the dBm mode).

6. Press the 3456A's **5**, **0**, **STORE**, and **4** keys (to set 50Ω characteristic impedance).

7. Set the test frequency to 100kHz.

8. Note the value displayed on the 3456A as PREF(15).

9. Set the test frequency to 10Hz.

10. Confirm that the signal level value displayed on the 3456A is PREF(15)±1dBm.

11. Repeat steps 9 and 10 at 100Hz, 1kHz, and 10kHz.

12. Set the **OSC LEVEL** to 5dBm.

13. Set the 8495A to 0dB.

14. Set the test frequency to 100kHz.

15. Note the value displayed on the 3456A as PREF(5).

16. Set the test frequency to 10Hz.

17. Confirm that the signal level value displayed on the 3456A is PREF(5)±1.2dBm.

18. Repeat steps 16 and 17 at 100Hz, 1kHz, and 10kHz.

4-10-4. SIGNAL LEVEL TEST: -55dBm/-65dBm

This test verifies the linearity of the test signal level.

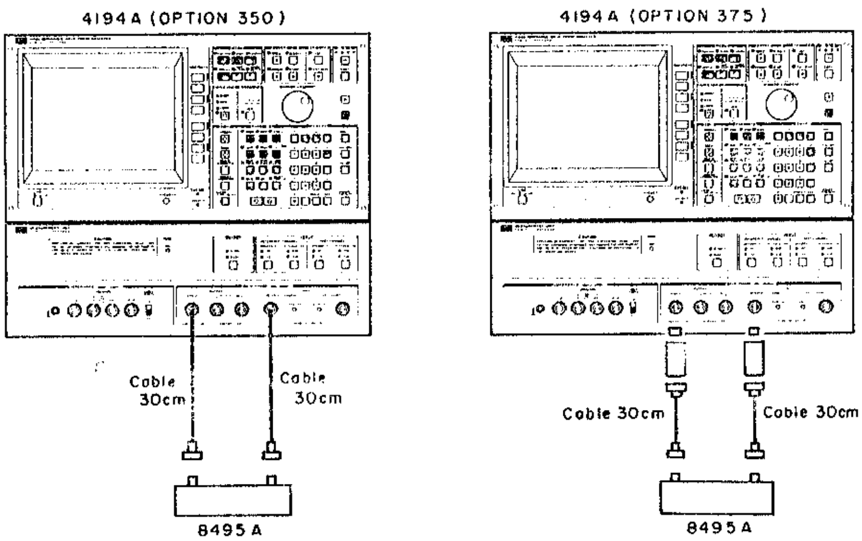


Figure 4-23. Gain-Phase Measurement Signal Level Test Setup 3

EQUIPMENT:

Coaxial Step Attenuator	HP 8495A Opt. 001
50Ω - 75Ω Minimum Loss Pad*	HP 11852A, 2 each
BNC-to-BNC Cable, 30cm	PN 8120-1838, 2 each
N(m)-to-BNC(f) Adapter	PN 1250-0780, 2 each
N(f)-to-BNC(m) Adapter, 75Ω*	PN 1250-1534, 2 each
N(m)-to-BNC(f) Adapter*	PN 1250-0780, 2 each

PROCEDURE:

1. Set up the equipment as shown in Figure 4-23.
2. Initialize the 4194A.
3. Press the **'GAIN-PHASE'** and **'Rch-Tch (dBm)'** softkeys.
4. Set the **SWEEP MODE** to **SINGLE**.
5. Set the 4194A to **SINGLE OUTPUT**.
6. Set the **INTEG TIME** to **MED** and set **AVERAGING** to 4 ("AVERAGING TIME = 4" will be displayed in the System Message Area).
7. Press the **SWEEP** key and the **'LOG SWEEP'** softkey.
8. Press the **DISPLAY** key and the **'menu'**, **'more1/3'**, and the **'DISP B on/off'** softkeys to turn off the B trace.
9. Set the **OSC LEVEL** to **5dBm** and set the 8495A to **70dB**.
10. Press the **START** key.
11. When the **START** key lamp goes out, press the **COMPEN** key.
12. Press the **'OFST REF STORE'** and **'A OFFSET on/off'** softkeys.
13. Execute **OSC LEVEL = -55dBm** from the keyboard and set the 8495A to 10dB.
14. Press the **START** key.
15. When the **START** key lamp goes out, press the **MKR/L CURS** key, the **'menu'** and **'MKR='** softkeys, then the **1**, **0**, **0**, and **KHz/dBm** keys. The marker will move to 101741.937Hz.
16. Note the REFERENCE CHANNEL amplitude at 101741.937Hz as PREF.
17. Confirm that PREF is (Cv(70) - Cv(10) - 60dB) ±2.2dB

    where Cv(70) is the 8495A's 1MHz 70dB Calibration value
    Cv(10) is the 8495A's 1MHz 10dB Calibration value.
18. Press the **DISPLAY** key and the **'menu'** softkey.

19. Press the **'AMAX'** softkey, then press the **Blue**, **M**, **K**, **R**, **A**, **+**, **1**, **2**, and **ENTER/EXECUTE** keys.

20. Press the **'AMIN'** softkey, then press the **Blue**, **M**, **K**, **R**, **A**, **-**, **1**, **2**, and **ENTER/EXECUTE** keys.

21. Confirm that the A trace is positioned on the horizontal center line of the display (**MKRA** value), ± 1 division (2.4dB).

22. Set the **OSC LEVEL** to **-65dBm** and set the 8495A to 0dB.

23. Press the **START** key.

24. When the **START** key lamp goes out, press the **MKR/LCURS** key, the **'menu'** and 'MKR=' softkeys, and the **1**, **0**, **0**, and KHz/dBm keys. The marker will move to 101741.937Hz.

25. Note the REFERENCE CHANNEL amplitude at 101741.937Hz as PREF.

26. Confirm that PREF is (Cv(70) - 70dB) ±2.4dB

    where Cv is the 8495A's 1MHz 70dB Calibration value.

27. Press the **DISPLAY** key and the **'menu'** softkey.

28. Press the **'AMAX'** softkey, then press the **Blue**, **M**, **K**, **R**, **A**, **+**, **1**, **3** and **ENTER/EXECUTE** keys.

29. Press the **'AMIN'** softkey, then press the **Blue**, **M**, **K**, **R**, **A**, **-**, **1**, **3** and **ENTER/EXECUTE** keys.

30. Confirm that the A trace is positioned on the horizontal center line of the display (**MKRA** value), ± one division (2.6dB).

4-10-5. LINEARITY CONFIRMATION

This test is to verify the linearity of the gain-phase test signal level.

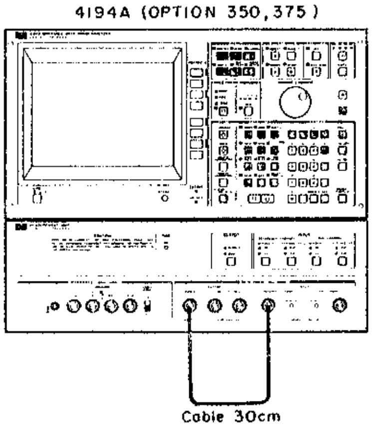


Figure 4-24. Gain-Phase Measurement Signal Level Test Setup 4

EQUIPMENT:

BNC-to-BNC Cable, 30cm	PN 8120-1838
BNC-to-BNC Cable, 30cm*	PN 04194-61640

* Required for Option 375 instruments only.

PROCEDURE:

1. Set up the equipment as shown in Figure 4-24.

2. Initialize the 4194A.

3. Set the 4194A as follows:

FUNCTION	GAIN-PHASE, Rch-Tch (dBm)
SWEEP	OSC LEVEL (dBm)
SWEEP MODE	SINGLE
OUTPUT	SINGLE
REFERENCE CHAN ATTEN.	20dB

4. Press the **START** key.

5. When the **START** key lamp goes out, press the **MKR/L CURS** key, the 'menu' and **'MKR='** softkeys, then press the **0** and **KHz/dBm** keys.

6. Press the **CLEAR LINE, Blue, B, =, A, -, X, -, M, K, R, A,** and **ENTER/EXECUTE** keys.

7. Press the **DISPLAY** key and the 'menu' and 'more 1/3' softkeys.

manual changes

8. Press the **'BMAX='** softkey, the **~~Blue, M, K, R, A~~, +, 2, .** (point), **5,** and **ENTER/EXECUTE** keys.

9. Press the **'BMIN'** softkey, the **~~Blue, M, K, R, A~~, -, 2, .**(point), **5,** and **ENTER/EXECUTE** keys.

10. Verify
~~Confirm~~ that the B trace is positioned on the horizontal center line of the display (~~**MKRA** value~~), ± one division (0.5dB).

11. Press the **CLEAR LINE, Blue, A, =, D, I, F, (, A,),** and **ENTER/EXECUTE** keys.

12. Press the **DISPLAY** key and the 'menu' softkey, and set **AMIN** = 0dBm.

13. Confirm that the A trace is positive at all points.

4-11. POWER SPLITTER TEST

This test verifies output tracking of the internal power splitter.

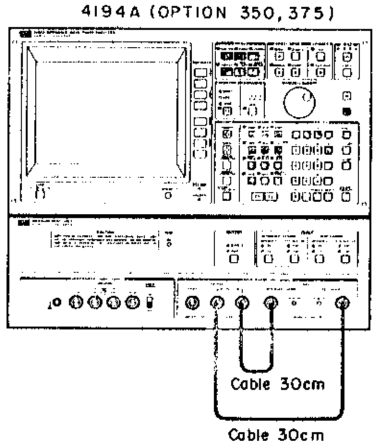


Figure 4-25. Power Splitter Test Setup 1

EQUIPMENT:

BNC-to-BNC Cable, 30cm	PN 8120-1838, 2 each
BNC-to-BNC Cable, 30cm, 75Ω*	PN 04194-61640, 2 each

* Required for Option 375 instruments only.

PROCEDURE:

1. Set up the equipment as shown in Figure 4-25.

2. Initialize the 4194A.

3. Set the 4194A as follows:

FUNCTION	GAIN-PHASE, Tch/Rch (dB) - θ
SWEEP MODE	SINGLE
INTEG TIME	MED
AVERAGING TIME	4
REFERENCE CHANNEL ATTEN.	20dB
TEST CHANNEL ATTEN.	20dB

4. Press the **START** key.

5. When the **START** key lamp goes out, press the **COMPEN** key.

6. Press the **'OFST REF STORE'**, **'A OFFSET on/off'**, and **'B OFFSET on/off'** softkeys.

7. Change the cables as shown in Figure 4-26.

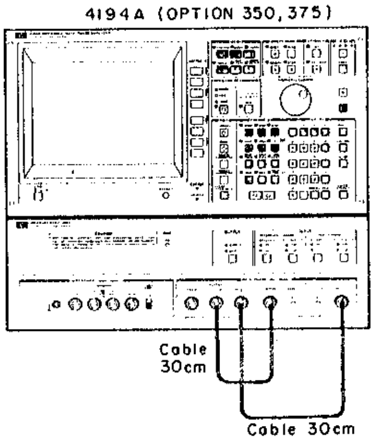


Figure 4-26. Power Splitter Test Setup 2

8. Press the **START** key.

9. When the **START** key lamp goes out, press the **DISPLAY** key and the **'menu'** softkey.

10. Enter the following key sequence.

    AMAX = 1.0dBm, and **AMIN = -1.0dBm**.

11. Press the **'more 1/3'** softkey.

12. Enter the following key sequence.

    BMAX = 30 and **BMIN = -30**.

13. Confirm that trace A is 0dBm±0.2dBm (1 division), and that trace B is 0°±6° (1 division).

4-12. GAIN-PHASE MEASUREMENT CROSSTALK TEST

This test verifies that the gain-phase measurement crosstalk is within specifications.

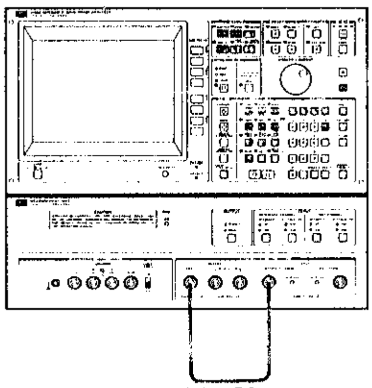


Figure 4-27. Gain-Phase Measurement Crosstalk Test Setup

EQUIPMENT:

BNC-to-BNC Cable, 30cm	PN 8120-1838
BNC-to-BNC Cable, 30cm, 75Ω*	PN 04194-61640

* Required for Option 375 instruments only.

PROCEDURE:

1. Set up the equipment as shown in Figure 4-27.
2. Initialize the 4194A and set as follows:

FUNCTION	GAIN-PHASE, Tch/Rch (dBm) - θ
SWEEP	LOG
SWEEP MODE	SINGLE
INTEG TIME	MED
AVERAGING	4
OSC LEVEL	-5dBm
OUTPUT	SINGLE

3. Press the **START** key.
4. When the **START** key lamp goes out, press the **DISPLAY** key and the **'menu'** softkey.
5. Press the **'AMAX'** softkey and the **-**, **5**, **0**, and KHz/dBm keys to set the top of the scale to -50dBm.

6. Press the **'AMIN'** softkey and the **-**, **1**, **5**, **0**, **KHz/dBm** keys to set the bottom of the scale to -150dBm.

7. Press the **'more 1/3'** and **'DISP B on/off'** softkeys to turn off DISP B (Phase).

8. Press the **MKR/L CURS** key, the **'LINE CURSOR'**, **'menu'**, and **'LCURS='** softkeys, and the **-**, **8**, **6**, and **KHz/dBm** keys.

9. Confirm that the A trace is displayed below the LINE CURSOR.

10. Set the **STOP** frequency to 70MHz.

11. Press the **START** key.

12. When the **START** key lamp goes out, press the **'LCURS='** softkey and the **-**, **9**, **6**, and **KHz/dBm** keys.

13. Confirm that the A trace is displayed below the LINE CURSOR.

4-13. IMPEDANCE MEASUREMENT SIGNAL LEVEL TEST

This three part test verifies the accuracy and flatness of the impedance measurement signal.

4-13-1. IMPEDANCE SIGNAL LEVEL ACCURACY: 100kHz

This test verifies the accuracy of the impedance measurement test signal level at 100kHz.

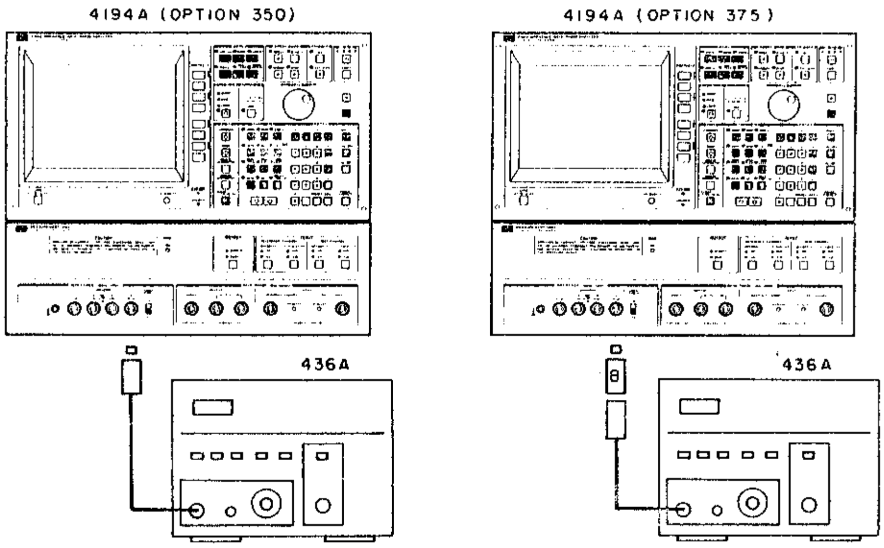


Figure 4-28. Impedance Measurement Signal Level Test Setup 1

EQUIPMENT:

Power Meter	HP 436A
Power Sensor	HP 8482A
50Ω - 75Ω Minimum Loss Pad*	HP 11852A
N(f)-to-BNC(m) Adapter	PN 1250-1477
N(f)-to-BNC(m) Adapter, 75Ω*	PN 1250-1534

* Required for Option 375 instruments only.

PROCEDURE:

1. Connect the 436A to the 4194A's UNKNOWN H_{CUR} terminal as shown in Figure 4-28.
2. Set the power meter's measurement function to dBm.
3. Set the CAL FACTOR % control on the 436A (in accordance with the cal chart on the 8482A) to compensate for the 8482A's Cal Factor at **100kHz**.
4. Press the **GET**, **1**, and **ENTER/EXECUTE** keys.

5. Set the **OSC LEVEL** to **1V**.

6. Set the **SWEEP MODE** to **MANUAL**.

7. Set the test frequency to **100kHz** using the **MARKER/L CURSOR** knob.

8. Confirm that the value displayed on the 436A is as follows.

   For 50Ω instruments:

   7.0dBm ±1dB

   For 75Ω instruments:

   (7.0dBm - R13) ±1dB

   where R13 is the insertion loss of PAD B.

9. Note the value displayed on the 436A as PREF. This value will be used in the next test.

Note

Proceed to the next test without dismantling the present test setup or changing any of the 4194A's settings.

4-13-2. HF IMPEDANCE SIGNAL LEVEL FLATNESS

This test verifies the flatness of the impedance measurement test signal level at high frequencies.

EQUIPMENT:

Same as the previous test.

PROCEDURE:

1. Set the test frequency to **500kHz**.

2. Set the CAL FACTOR % control on the 436A (in accordance with the cal chart on the 8482A) to compensate for the 8482A's Cal Factor at **500kHz**.

3. Confirm that the value displayed on 436A is PREF ±1dBm.

4. Repeat steps 1 through 3 at **1**, **3**, **10**, and **40MHz**.

Note

Set the 436A aside and proceed to the next test without changing any of the 4194A's settings.

4-13-3. LF IMPEDANCE SIGNAL LEVEL FLATNESS

This test verifies the flatness of the impedance measurement test signal level at low frequencies.

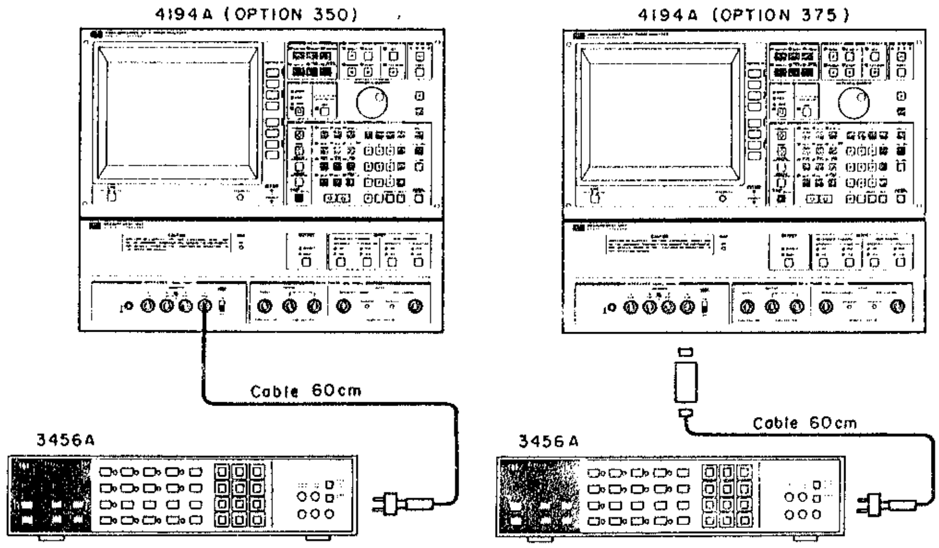


Figure 4-29. Impedance Measurement Signal Level Test Setup 2

EQUIPMENT:

Digital Voltmeter	HP 3456A
50Ω - 75Ω Minimum Loss Pad*	HP 11852A
Feedthrough Termination, 50Ω	PN 04192-61002
BNC-to-BNC Cable, 61cm	PN 8120-1839
N(f)-to-BNC(m) Adapter, 75Ω*	PN 1250-1534
N(m)-to-BNC(f) Adapter*	PN 1250-0780
BNC(f)-to-Dual Banana Adapter	PN 1251-2277

* Required for Option 375 instruments only.

PROCEDURE:

1. Set up the equipment as shown in Figure 4-29.

2. Set the 3456A as follows:

Measurement Function	ACV
Filter	ON

3. Press the 3456A's **MATH** and 4 keys (to set the dBm mode).

4. Press the **5**, **0**, **STORE**, and 4 keys on the 3456A.

5. Set the test frequency to **100kHz** and note the value displayed on the 3456A as PREF.

6. Set the test frequency to **100Hz** and confirm that the value displayed on the 3456A is PREF ±1dB.

7. Repeat step 6 at **1kHz** and **10kHz**.

4-14. IMPEDANCE MEASUREMENT ACCURACY TEST

This two part test verifies the accuracy of 4194A impedance measurements.

4-14-1. MEASUREMENT ACCURACY

This test verifies measurement accuracy.

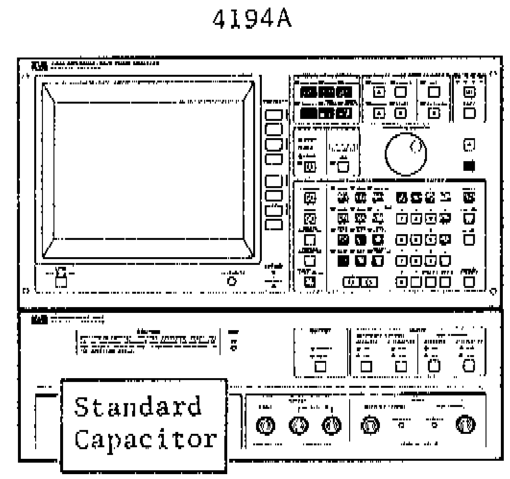


Figure 4-30. Impedance Measurement Accuracy Test Setup 1

EQUIPMENT:

1pF	Standard Capacitor	HP 16381A	HP 16380A
10pF	Standard Capacitor	HP 16382A	
100pF	Standard Capacitor	HP 16383A	
1000pF	Standard Capacitor	HP 16384A	
0.01µF	Standard Capacitor	HP 16385A	HP 16380C
0.1µF	Standard Capacitor	HP 16386A	
1µF	Standard Capacitor	HP 16387A	

PROCEDURE:

1. Press the **GET**, **1**, and **ENTER/EXECUTE** keys.
2. Press the **'IMPEDANCE'**, **'more 1/3'**, and **'Cp-D'** softkeys.
3. Press the **DISPLAY** key and the **'TABLE'** softkey.
4. Set the **OSC LEVEL** to **1Vrms**.
5. Connect the **1pF** Standard Capacitor to the UNKNOWN connectors as shown in Figure 4-30.

6. Press the **START** key.
7. When the **START** key lamp goes out, execute A = A - (Cv) , where Cv is the calibrated value of the standard capacitor.
8. The values (both in the Cp [F] column and D [ ] column) in the TABLE Display must be within the limits listed in Table 4-16.
9. Repeat steps 5 through 9 using the **10pF**, **100pF**, **1000pF**, **0.01μF**, **0.1μF**, and **1μF** Standard Capacitors, respectively.

Note

The 16380C's Standard Capacitors do not require Dissipation factor test.

Table 4-16. Impedance Measurement Accuracy Test Limits 1

Standard Capacitor	Test Frequency	C Test Limits	D Test Limits
1pF	100kHz 1MHz 3MHz	±6.27fF ±2.09fF ±9.64fF	±6.27m ±2.09m ±9.64m
10pF	10kHz 100kHz 1MHz 3MHz 10MHz	±107.fF ±20.9fF ±17.3fF ±44.5fF ±132fF	±10.7m ±2.09m ±1.73m ±4.45m ±13.2m
100pF	1kHz 10kHz 100kHz 1MHz	±1.07pF ±659fF ±173fF ±170fF	±10.7m ±6.59m ±1.73m ±1.70m
1000pF	100Hz 1kHz 10kHz 100kHz 500kHz	±17.9pF ±6.59pF ±6.23pF ±1.70pF ±1.70pF	±17.9m ±6.59m ±6.23m ±1.70m ±1.70m
0.01μF	1kHz	±62.3pF	
0.1μF	1kHz	±620pF	
1μF	1kHz	±6.21nF	

Note

Proceed to the next test without changing any of the 4194A's settings.

4-14-2. MEASUREMENT FLATNESS

This test verifies 4194A impedance measurement flatness.

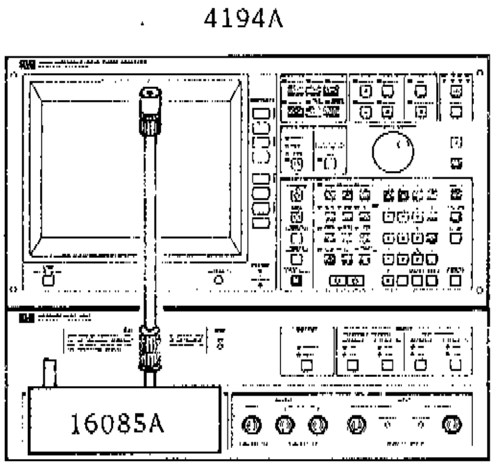


Figure 4-31. Impedance Measurement Accuracy Test Setup 2

EQUIPMENT:

Terminal Adapter	HP 16085A
Reference Air-Line	PN 04191-85011*
0Ω Reference Termination	PN 04191-5300*
50Ω Reference Termination	PN 04191-85301*
0S Reference Termination	PN 04191-85302*

* Part of the HP 16342A Calibration Equipment Set.

PROCEDURE:

1. Connect the 16085A to the 4194A's UNKNOWN terminals as shown in Figure 4-31.

2. Set the **OSC LEVEL** to **0.5Vrms**.

3. Press the **COMPEN** key and the **'more 1/2'** 1/3, **'ALL POINTS'**, and 'more **2/2'** 2/3, (more 3/3) softkeys.

4. Connect the 0S termination to the 16085A.

5. Press the 'ZERO OPEN' softkey and the ENTER/EXECUTE key and wait until the message "Zero open compen complete" is displayed.

6. Disconnect the 0S termination and connect the 0Ω termination.

7. Press the **'ZERO SHORT'** softkey and the **ENTER/EXECUTE** key and wait until the message "Zero short compen complete" is displayed.

8. Press the **'OPEN OFS on/off'** and **'SHRT OFS on/off'** softkeys.

9. Disconnect the 0Ω termination and connect the reference air-line. Connect the 0S termination to the air-line.

Note

Disregard any directions labeled on the reference air-line, you may connect the air-line in either direction.

10. Press the **START** key.

11. When the **START** key lamp goes out, set the marker to **1MHz** using the **MARKER/L CURSOR** knob.

12. Enter the following key sequence.

    A = A / MKRA

13. The measurement results must not exceed the test limits listed in Table 4-17.

Table 4-17. Impedance Measurement Accuracy Test Limits 2

Test Frequency	C Test Limits	D Test Limits
1MHz	1.0000	±1.72m
10MHz	0.9877 to 1.0135	±12.9m
40MHz	0.9538 to 1.0656	±55.9m

14. Replace the air-line with the 50Ω termination as shown in Figure 4-32.

15. Press the **FUNCTION** key and the **'IMPEDANCE'** and **'|Z| - θ'** softkeys.

16. Press the **START** key.

17. When the **START** key lamp goes out, set the marker to 100kHz using the **MARKER/L CURSOR** knob.

18. Enter the following key sequence.

    A = A / MKRA and **B = B - MKRB**.

19. The measurement results must not exceed the test limits listed in Table 4-18.

Note

The test limits listed in Table 4-18 are applicable only when PN 04191-85011 reference air lines are used for this performance test.

Table 4-18. Impedance Measurement Accuracy Test Limits 3

Test Frequency	|Z| Test Limits	θ Test Limits
1kHz	0.9935 to 1.0065	±0.358°
10kHz	0.9935 to 1.0065	±0.100°
100kHz	1.0000	0.00°
1MHz	0.9979 to 1.0021	±0.12°
10MHz	0.9870 to 1.0130	±0.74°
40MHz	0.9480 to 1.0520	±2.98°

4194A

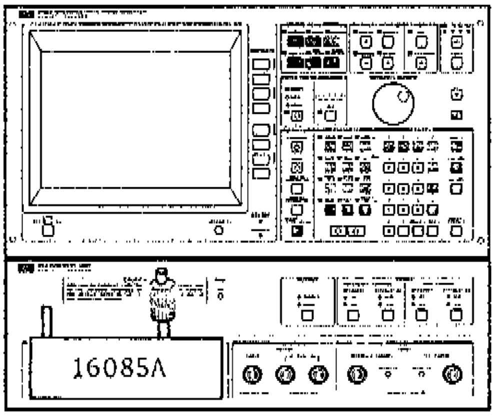


Figure 4-32. Impedance Measurement Accuracy Test Setup 3

4-15. IMPEDANCE MEASUREMENT LEVEL MONITOR TEST

This three part test is used to check the accuracy of the test signal voltage and the current level monitor used for impedance measurements.

4-15-1. LF LEVEL MONITOR

This test verifies the accuracy of the test signal voltage monitor at low frequencies.

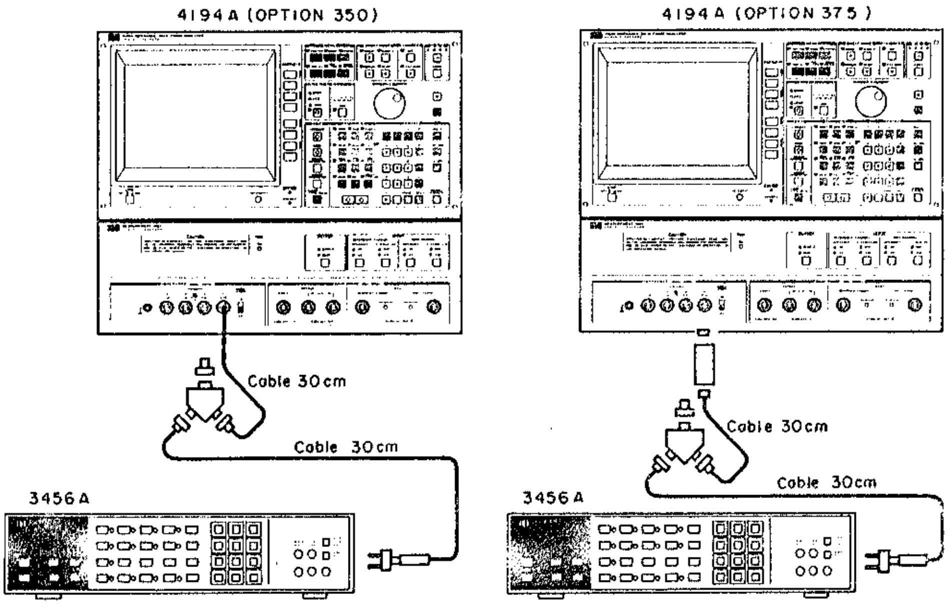


Figure 4-33. Impedance Measurement V Level Monitor Test Setup 1

EQUIPMENT:

Digital Voltmeter	HP 3456A
Power Splitter	HP 11667A
50Ω - 75Ω Minimum Loss Pad*	HP 11852A
Feedthrough Termination, 50Ω	PN 04192-61002
BNC-to-BNC Cable, 30cm	PN 8120-1838, 2 each
BNC-to-BNC Cable, 61cm	PN 8120-1839
N(m)-to-BNC(f) Adapter	PN 1250-0780, 2 each
BNC(m)-to-N(m) Adapter	PN 1250-0082
N(f)-to-BNC(m) Adapter, 75Ω*	PN 1250-1534
N(m)-to-BNC(f) Adapter*	PN 1250-0780
BNC(m)-to-Dual Banana Adapter	PN 1251-2277

* Required for Option 375 instruments only.

PROCEDURE:

1. Set up the equipment as shown in Figure 4-33. Connect the 11667A's INPUT PORT to the Hpot terminal.

2. Set the 3456A as follows:

Measurement Function	ACV
Filter	ON

3. Press the **GET**, **1**, and **ENTER/EXECUTE** keys.

4. Press the '**MONITOR menu**' and '**V(AC)**' softkeys.

5. Set the **SWEEP MODE** to **MANUAL**.

6. Set the **OSC LEVEL** to **1Vrms**.

7. Set the test frequency to **100Hz**.

8. Enter the value displayed on the 3456A into the R0 register.

9. Confirm that the V MONITOR value displayed on the 4194A is:

   $1.8 \times R0 - 1mV \sim 2.2 \times R0 + 1mV$

10. Repeat steps 7 through 9 at **1**, **10**, **29**, and **30kHz**.

Note

Disconnect the 30cm cable between the 3456A and the 11667A and proceed to the next test without dismantling the present test setup or changing any of the 4194A's settings.

4-15-2. HF LEVEL MONITOR

This test verifies the accuracy of the test signal voltage level monitor at high frequencies.

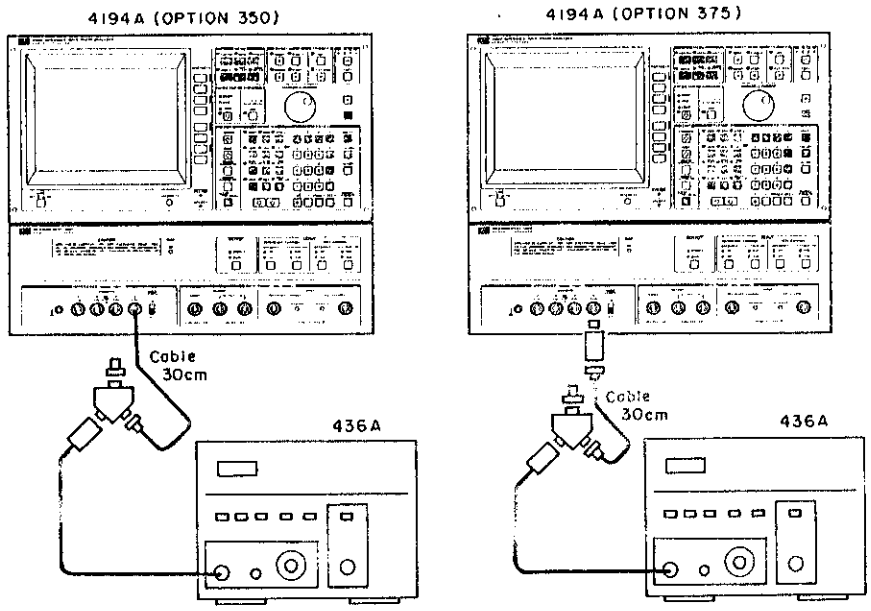


Figure 4-34. Impedance Measurement V Level Monitor Test Setup 2

EQUIPMENT:

Power Meter	HP 436A
Power Sensor	HP 8482A
Power Splitter	HP 11667A
50Ω - 75Ω Minimum Loss Pad*	HP 11852A
BNC-to-BNC Cable, 30cm	PN 8120-1838
N(m)-to-BNC(f) Adapter	PN 1250-0780
N(m)-to-BNC(m) Adapter	PN 1250-0082
N(f)-to-BNC(m) Adapter, 75Ω*	PN 1250-1534
N(m)-to-BNC(f) Adapter*	PN 1250-0780

* Required for Option 375 instruments only.

PROCEDURE:

1. Set up the equipment as shown in Figure 4-34.
2. Set the 436A's measurement function to dBm.
3. Set the test frequency to **100kHz**.
4. Set the CAL FACTOR % control on the 436A (in accordance with the cal chart on the 8482A) to compensate for the 8482A's Cal Factor at **100kHz**.
5. Enter the 436A's displayed value into register R0.

6. Using the 4194A's built-in calculator function, convert R0 (dBm) to a voltage value. Enter the following key sequence.

   R1 = 10((R0 - 13.01)/20)**

   This is equivalent to the following equation.

   $$R1 = 10^{(R0 - 13.01)/20}$$

7. Confirm that the V MONITOR value displayed on the 4194A is:

   $1.8 \times R1 - 1mV \sim 2.2 \times R1 + 1mV$

8. Repeat steps 3 through 7 at **1MHz** and **10MHz**.

9. Set the **OSC LEVEL** to **0.5Vrms**.

10. Repeat steps 3 through 7 at **40MHz**.

Note

Proceed to the next test without changing any of the 4194A's settings.

4-15-3. STABILITY CONFIRMATION

This test is to confirm impedance measurement level monitor stability.

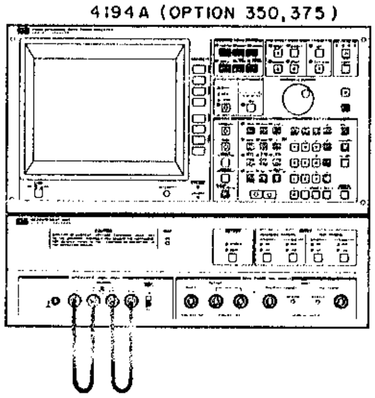


Figure 4-35. Impedance Measurement Level Monitor Stability Test Setup

EQUIPMENT:

BNC-to-BNC Cable, 30cm	PN 8120-1838, 2 each
BNC-to-BNC Cable, 30cm, 75Ω*	PN 04194-61640, 2 each

* Required for Option 375 instruments only.

PROCEDURE:

1. Set up the 4194A as shown in Figure 4-35.
2. Set the test frequency to 1MHz.
3. Set the **OSC LEVEL** to **0.684Vrms (0.681Vrms*)**. (OSC LEVEL (R0) column in Table 4-19.)
4. Press the **CLEAR LINE**, **Blue**, **R**, **0**, **=**, **M**, **O**, **N**, and **ENTER/EXECUTE** keys.
5. Set the **OSC LEVEL** to **0.683Vrms** (0.680Vrms*). (OSC LEVEL column in Table 4-19.)
6. Press the **CLEAR LINE**, **Blue**, **M**, **O**, **N**, **/**, **R**, **0**, and **ENTER/EXECUTE** keys.
7. Confirm that the displayed result is within the test limits listed in Table 4-19 for the OSC LEVEL setting tested.
8. Repeat steps 3 through 7 for each OSC LEVEL setting listed in Table 4-19.
9. Set the test frequency to **40MHz** and repeat steps 3 through 7.

Table 4-19. Impedance Measurement Level Monitor Stability Test Limits

OSC LEVEL (R0)	OSC LEVEL	Test Limits
0.684V (0.681V*)	0.683V (0.680V*)	0.9686 to 1.0285
0.462V (0.466V*)	0.461V (0.465V*)	0.9679 to 1.0278
0.316V (0.315V*)	0.315V (0.314V*)	0.9669 to 1.0267

* Option 375 instruments.

4-16. DC BIAS VOLTAGE TEST

This test verifies the accuracy of the 4194A's dc bias voltage.

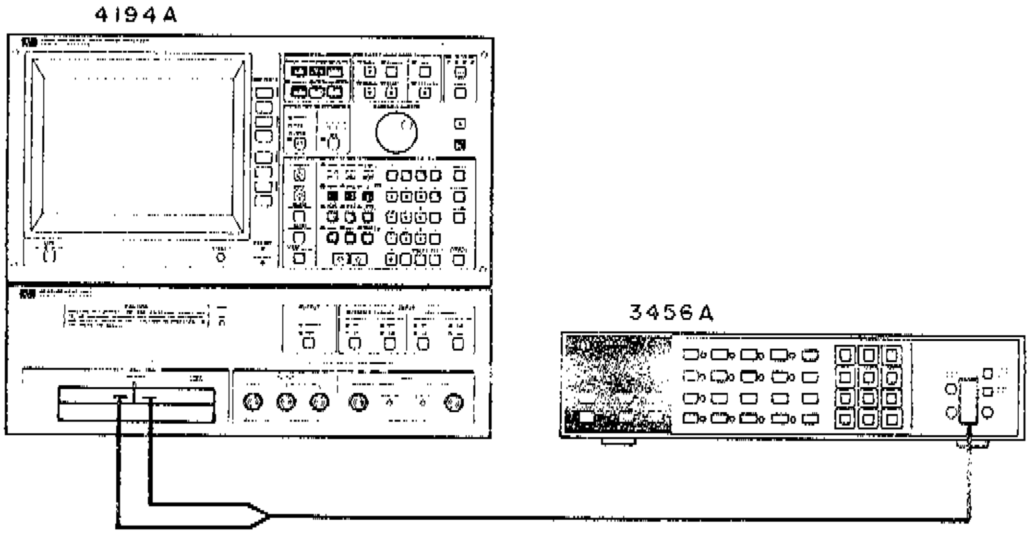


Figure 4-36. DC Bias Voltage Test Setup

EQUIPMENT:

Digital Voltmeter	HP 3456A
Test Fixture	HP 16047D
Test Leads	

PROCEDURE:

1. Set up the equipment as shown in Figure 4-36.
2. Initialize the 4194A and the 3456A.
3. Set the **OSC LEVEL** to **10mV.**
4. Set the **SWEEP MODE** to **MANUAL**.
5. Set the test frequency to 40MHz.
6. Press the **SPOT BIAS**, **0**, and **MHz/V** keys. Confirm that the BIAS lamp is ON (lit).
7. Confirm that the voltage value displayed on the 3456A is between 12mV and -12mV.
8. Press the **SPOT BIAS**, **4**, **0**, and **MHz/V** keys.

9. Confirm that the voltage value displayed on the 3456A is between 39.94V and 40.06V.

10. Press the **SPOT BIAS**, **-**, **4**, **0**, and **MHz/V** keys.

11. Confirm that the voltage value displayed on the 3456A is between -40.06V and -39.94V.

12. Press the **SWEEP** key and the **'more 1/2'** and 'DC BIAS(V)' softkeys.

13. Set the **START** voltage to **0.01V**.

14. Set the **STOP** voltage to **20.48V**.

15. Press the **N** (PARAMETER key), **1**, **2**, and **ENTER/EXECUTE** keys.

16. Press the **SWEEP** key and the **'LOG SWEEP'** softkey.

17. Set the **BIAS** voltage to **0.01V** using the **MARKER/L CURSOR** knob.

18. Confirm that the voltage value displayed on the 3456A is within the test limits listed in Table 4-20 for the bias voltage tested.

19. Repeat steps 16 and 17 for each bias voltage listed in Table 4-20.

Table 4-20. DC Bias Voltage Test Limits

Bias Voltage	Test Limits
0.01V	-0.002V to 0.022V
0.02V	0.008V to 0.032V
0.04V	0.028V to 0.052V
0.08V	0.068V to 0.092V
0.16V	0.148V to 0.172V
0.32V	0.308V to 0.332V
0.64V	0.627V to 0.653V
1.28V	1.266V to 1.294V
2.56V	2.545V to 2.575V
5.12V	5.102V to 5.138V
10.24V	10.216V to 10.264V
20.48V	20.443V to 20.517V

WARNING

BE SURE TO TURN OFF THE INTERNAL BIAS VOLTAGE AFTER THIS TEST.

4-17. HP-IB PERFORMANCE TEST

This test verifies HP-IB performance.

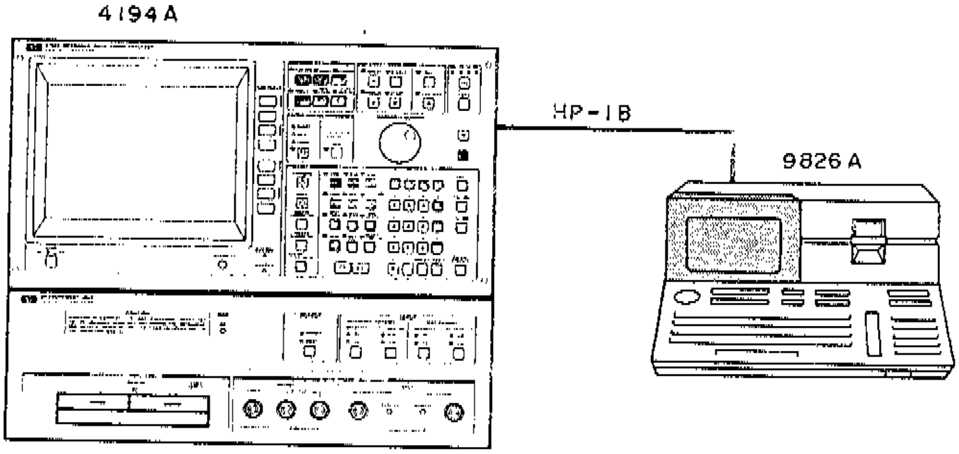


Figure 4-37. HP-IB Performance Test Setup.

EQUIPMENT:

Personal Technical Computer	HP 9826
HP-IB Cable	HP 10833A
Test Fixture	HP 16047D

PROCEDURE:

manual changes

1. Set up the equipment as shown in Figure 4-37. Use the 9826's interface Select Code (7). Set the 4194A's address to 17

2. Load BASIC and input the following program (don't run it, though).

```
10   DIM A$[10],B$[35],C$[10]
20   OUTPUT 717;"ID?"
30   ENTER 717;A$,B$,C$
40   PRINT A$,B$,C$
50   OUTPUT 717;"RQS32"
60   OUTPUT 717;"ABC"
70   PRINT SPOLL(717)
80   END
```

4. Press the **STEP** key on the 9826 three times to execute up to line number 20.

5. Confirm that the LTN and **RMT** lamps are lit and that all 4194A keys, except for the **LCL** key, are disabled.

6. Press the **LCL** key.

7. Confirm that the **LTN** lamp stays lit, the **RMT** lamp goes out, and that all keys are enabled.

8. Step (press the **STEP** key on the 9826) to program line 30 and confirm that the **TLK** lamp is lit.

9. Step to program line 40 and confirm that the following message is displayed on the 9826.

   "HP4194A IMPEDANCE/GAIN-PHASE_ANALYZER OPT350 (OPT375)".

10. Step to program line 60, and confirm that the **SRQ**, **LTN**, and **RMT** lamps are lit.

11. Step to program line 80 and confirm that the status byte value displayed on the 9826 is greater than 96.

PERFORMANCE TEST RECORD

Hewlett-Packard
Model 4194A
Impedance/Gain-Phase Analyzer

Tested by: ____________
Date: ____________
Serial No.: ____________

Test		Results		
		Minimum	Actual	Maximum
4-6. INTERNAL SYNTHESIZER FREQUENCY TEST				
Without Option 001 Frequency Setting				
1MHz		0.99998MHz	______	1.00002MHz
10MHz		9.9998MHz	______	10.0002MHz
100MHz		99.998MHz	______	100.002MHz
10MHz OUTPUT		9.9998MHz	______	10.0002MHz
With Option 001 Frequency Setting				
1MHz		0.999999MHz	______	1.000001MHz
10MHz		9.99999MHz	______	10.00001MHz
1MHz		99.9999MHz	______	100.0001MHz
10MHz OUTPUT		9.99999MHz	______	10.00001MHz
4-7. GAIN-PHASE MEASUREMENT ACCURACY TEST				
4-7-1. Measurement Accuracy: 50Ω Instruments				
OSC LEVEL: -1dBm **ATTENUATOR: 10dB**				
Cv(1)= **Cv(10)=** **Cv(100)=**				
10Hz	Gain	Cv(1)-0.3dB	______	Cv(1)+0.3dB
	Phase	-1.6°	______	1.6°
100Hz	Gain	Cv(1)-0.1dB	______	Cv(1)+0.1dB
	Phase	-0.5°	______	0.5°
1kHz	Gain	Cv(1)-0.1dB	______	Cv(1)+0.1dB
	Phase	0.5°	______	0.5°

Test		Minimum	Results Actual	Maximum
10kHz	Gain Phase	Cv(1)-0.1dB -0.5°	______ ______	Cv(1)+0.1dB 0.5°
100kHz	Gain Phase	Cv(1)-0.1dB -0.5°	______ ______	Cv(1)+0.1dB 0.5°
1MHz	Gain Phase	Cv(1)-0.1dB -0.5°	______ ______	Cv(1)+0.1dB 0.5°
10MHz	Gain Phase	Cv(10)-0.1dB -1.0°	______ ______	Cv(10)+0.1dB 1.0°
30MHz	Gain Phase	Cv(10)-0.3dB -2.0°	______ ______	Cv(10)+0.3dB 2.0°
100MHz	Gain Phase	Cv(100)-0.5dB -3.0°	______ ______	Cv(100)+0.5dB 3.0°
ATTENUATOR: 20dB				
Cv(1)= **Cv(10)=** **Cv(100)=**				
10Hz	Gain Phase	Cv(1)-0.3dB -1.6°	______ ______	Cv(1)+0.3dB 1.6°
100Hz	Gain Phase	Cv(1)-0.1dB -0.5°	______ ______	Cv(1)+0.1dB 0.5°
1kHz	Gain Phase	Cv(1)-0.1dB -0.5°	______ ______	Cv(1)+0.1dB 0.5°
10kHz	Gain Phase	Cv(1)-0.1dB -0.5°	______ ______	Cv(1)+0.1dB 0.5°
100kHz	Gain Phase	Cv(1)-0.1dB -0.5°	______ ______	Cv(1)+0.1dB 0.5°
1MHz	Gain Phase	Cv(1)-0.1dB -0.5°	______ ______	Cv(1)+0.1dB 0.5°
10MHz	Gain Phase	Cv(10)-0.1dB -1.0°	______ ______	Cv(10)+0.1dB 1.0°
30MHz	Gain Phase	Cv(10)-0.3dB -2.0°	______ ______	Cv(10)+0.3dB 2.0°
100MHz	Gain Phase	Cv(100)-0.5dB -3.0°	______ ______	Cv(100)+0.5dB 3.0°

Test		Results		
		Minimum	Actual	Maximum
ATTENUATOR: 30dB				
Cv(1)= **Cv(10)=** **Cv(100)=**				
10Hz	Gain Phase	Cv(1)-0.35dB -2.0°	______ ______	Cv(1)+0.35dB 2.0°
100Hz	Gain Phase	Cv(1)-0.15dB -0.75°	______ ______	Cv(1)+0.15dB 0.75°
1kHz	Gain Phase	Cv(1)-0.15dB -0.75°	______ ______	Cv(1)+0.15dB 0.75°
10kHz	Gain Phase	Cv(1)-0.15dB -0.75°	______ ______	Cv(1)+0.15dB 0.75°
100kHz	Gain Phase	Cv(1)-0.15dB -0.75°	______ ______	Cv(1)+0.15dB 0.75°
1MHz	Gain Phase	Cv(1)-0.15dB -0.75°	______ ______	Cv(1)+0.15dB 0.75°
10MHz	Gain Phase	Cv(10)-0.15dB -1.3°	______ ______	Cv(10)+0.15dB 1.3°
30MHz	Gain Phase	Cv(10)-0.35dB -2.5°	______ ______	Cv(10)+0.35dB 2.5°
100MHz	Gain Phase	Cv(100)-0.6dB -4.5°	______ ______	Cv(100)+0.6dB 4.5°
ATTENUATOR: 40dB				
Cv(1)= **Cv(10)=** **Cv(100)=**				
10Hz	Gain Phase	Cv(1)-0.45dB -2.3°	______ ______	Cv(1)+0.45dB 2.3°
100Hz	Gain Phase	Cv(1)-0.2dB -1.25°	______ ______	Cv(1)+0.2dB 1.25°
1kHz	Gain Phase	Cv(1)-0.2dB -1.25°	______ ______	Cv(1)+0.2dB 1.25°
10kHz	Gain Phase	Cv(1)-0.2dB -1.25°	______ ______	Cv(1)+0.2dB 1.25°

Test		Results		
		Minimum	Actual	Maximum
100kHz	Gain	Cv(1)-0.2dB	______	Cv(1)+0.2dB
	Phase	-1.25°	______	1.25°
1MHz	Gain	Cv(1)-0.2dB	______	Cv(1)+0.2dB
	Phase	-1.25°	______	1.25°
10MHz	Gain	Cv(10)-0.2dB	______	Cv(10)+0.2dB
	Phase	-2.0°	______	2.0°
30MHz	Gain	Cv(10)-0.45dB	______	Cv(10)+0.45dB
	Phase	-3.0°	______	3.0°
100MHz	Gain	Cv(100)-0.75dB	______	Cv(100)+0.75dB
	Phase	-4.5°	______	4.5°
ATTENUATOR: 50dB				
Cv(1)=				
Cv(10)=				
Cv(100)=				
1MHz	Gain	Cv(1)-0.25dB	______	Cv(1)+0.25dB
	Phase	-1.75°	______	1.75°
10MHz	Gain	Cv(10)-0.35dB	______	Cv(10)+0.35dB
	Phase	-2.5°	______	2.5°
30MHz	Gain	Cv(10)-0.65dB	______	Cv(10)+0.65dB
	Phase	-3.5°	______	3.5°
100MHz	Gain	Cv(100)-0.95dB	______	Cv(100)+0.95dB
	Phase	-6.5°	______	6.5°
ATTENUATOR: 60dB				
Cv(1)=				
Cv(10)=				
Cv(100)=				
1MHz	Gain	Cv(1)-0.45dB	______	Cv(1)+0.45dB
	Phase	-2.75°	______	2.75°
10MHz	Gain	Cv(10)-0.75dB	______	Cv(10)+0.75dB
	Phase	-5.5°	______	5.5°
30MHz	Gain	Cv(10)-1.65dB	______	Cv(10)+1.65dB
	Phase	-11.0°	______	11.0°
100MHz	Gain	Cv(100)-1.75dB	______	Cv(100)+1.75dB
	Phase	-11.5°	______	11.5°

Test		Results		
		Minimum	Actual	Maximum
ATTENUATOR: 70dB				
Cv(1)=				
Cv(10)=				
Cv(100)=				
1MHz	Gain	Cv(1)-1.05dB	________	Cv(1)+1.05dB
	Phase	-5.25°	________	5.25°
10MHz	Gain	Cv(10)-1.55dB	________	Cv(10)+1.55dB
	Phase	-10.5°	________	10.5°
30MHz	Gain	Cv(10)-3.15dB	________	Cv(10)+3.15dB
	Phase	-16.0°	________	16.0°
100MHz	Gain	Cv(100)-3.25dB	________	Cv(100)+3.25dB
	Phase	-16.5°	________	16.5°
OSC LEVEL: -40dBm				
ATTENUATOR: 10dB				
Cv(1)=				
Cv(10)=				
Cv(100)=				
10Hz	Gain	Cv(1)-1.0dB	________	Cv(1)+1.0dB
	Phase	-4.0°	________	4.0°
100Hz	Gain	Cv(1)-0.35dB	________	Cv(1)+0.35dB
	Phase	-2.5°	________	2.5°
1kHz	Gain	Cv(1)-0.35dB	________	Cv(1)+0.35dB
	Phase	-2.5°	________	2.5°
10kHz	Gain	Cv(1)-0.35dB	________	Cv(1)+0.35dB
	Phase	-2.5°	________	2.5°
100kHz	Gain	Cv(1)-0.35dB	________	Cv(1)+0.35dB
	Phase	-2.5°	________	2.5°
ATTENUATOR: 20dB				
Cv(1)=				
Cv(10)=				
Cv(100)=				
10Hz	Gain	Cv(1)-1.3dB	________	Cv(1)+1.3dB
	Phase	-4.5°	________	4.5°
100Hz	Gain	Cv(1)-0.55dB	________	Cv(1)+0.55dB
	Phase	-3.5°	________	3.5°

Test		Results		
		Minimum	Actual	Maximum
1kHz	Gain	Cv(1)-0.55dB	______	Cv(1)+0.55dB
	Phase	-3.5°	______	3.5°
10kHz	Gain	Cv(1)-0.55dB	______	Cv(1)+0.55dB
	Phase	-3.5°	______	3.5°
100kHz	Gain	Cv(1)-0.55dB	______	Cv(1)+0.55dB
	Phase	-3.5°	______	3.5°
ATTENUATOR: 30dB				
Cv(1)=				
Cv(10)=				
Cv(100)=				
10Hz	Gain	Cv(1)-1.8dB	______	Cv(1)+1.8dB
	Phase	-6.5°	______	6.5°
100Hz	Gain	Cv(1)-1.15dB	______	Cv(1)+1.15dB
	Phase	-6.0°	______	6.0°
1kHz	Gain	Cv(1)-1.15dB	______	Cv(1)+1.15dB
	Phase	-6.0°	______	6.0°
10kHz	Gain	Cv(1)-1.15dB	______	Cv(1)+1.15dB
	Phase	-6.0°	______	6.0°
100kHz	Gain	Cv(1)-1.15dB	______	Cv(1)+1.15dB
	Phase	-6.0°	______	6.0°
ATTENUATOR: 40dB				
Cv(1)=				
Cv(10)=				
Cv(100)=				
100Hz	Gain	Cv(1)-3.15dB	______	Cv(1)+3.15dB
	Phase	-16.0°	______	16.0°
1kHz	Gain	Cv(1)-3.15dB	______	Cv(1)+3.15dB
	Phase	-16.0°	______	16.0°
10kHz	Gain	Cv(1)-3.15dB	______	Cv(1)+3.15dB
	Phase	-16.0°	______	16.0°
100kHz	Gain	Cv(1)-3.15dB	______	Cv(1)+3.15dB
	Phase	-16.0°	______	16.0°

Test			Results		
			Minimum	Actual	Maximum
4-7-2. Measurement Accuracy: 75Ω Instruments					
OSC LEVEL: 10.4dBm ATTENUATOR: 10dB					
Cv(1)= Cv(10)= Cv(100)=					
	10Hz	Gain Phase	Cv(1)-0.3dB -1.6°	______ ______	Cv(1)+0.3dB 1.6°
	100Hz	Gain Phase	Cv(1)-0.1dB -0.5°	______ ______	Cv(1)+0.1dB 0.5°
	1kHz	Gain Phase	Cv(1)-0.1dB -0.5°	______ ______	Cv(1)+0.1dB 0.5°
	10kHz	Gain Phase	Cv(1)-0.1dB -0.5°	______ ______	Cv(1)+0.1dB 0.5°
	100kHz	Gain Phase	Cv(1)-0.1dB -0.5°	______ ______	Cv(1)+0.1dB 0.5°
	1MHz	Gain Phase	Cv(1)-0.1dB -0.5°	______ ______	Cv(1)+0.1dB 0.5°
	10MHz	Gain Phase	Cv(10)-0.1dB -1.0°	______ ______	Cv(10)+0.1dB 1.0°
	30MHz	Gain Phase	Cv(10)-0.3dB -2.0°	______ ______	Cv(10)+0.3dB 2.0°
	100MHz	Gain Phase	Cv(100)-0.5dB -3.0°	______ ______	Cv(100)+0.5dB 3.0°
ATTENUATOR: 20dB					
Cv(1)= Cv(10)= Cv(100)=					
	10Hz	Gain Phase	Cv(1)-0.3dB -1.6°	______ ______	Cv(1)+0.3dB 1.6°
	100Hz	Gain Phase	Cv(1)-0.1dB -0.5°	______ ______	Cv(1)+0.1dB 0.5°
	1kHz	Gain Phase	Cv(1)-0.1dB -0.5°	______ ______	Cv(1)+0.1dB 0.5°
	10kHz	Gain Phase	Cv(1)-0.1dB -0.5°	______ ______	Cv(1)+0.1dB 0.5°

Test		Results		
		Minimum	Actual	Maximum
100kHz	Gain	Cv(1)-0.1dB		Cv(1)+0.1dB
	Phase	-0.5°		0.5°
1MHz	Gain	Cv(1)-0.1dB		Cv(1)+0.1dB
	Phase	-0.5°		0.5°
10MHz	Gain	Cv(10)-0.1dB		Cv(10)+0.1dB
	Phase	-1.0°		1.0°
30MHz	Gain	Cv(10)-0.3dB		Cv(10)+0.3dB
	Phase	-2.0°		2.0°
100MHz	Gain	Cv(100)-0.5dB		Cv(100)+0.5dB
	Phase	-3.0°		3.0°
ATTENUATOR: 30dB				
Cv(1)=				
Cv(10)=				
Cv(100)=				
1MHz	Gain	Cv(1)-0.15dB		Cv(1)+0.15dB
	Phase	-0.75°		0.75°
10MHz	Gain	Cv(10)-0.15dB		Cv(10)+0.15dB
	Phase	-1.3°		1.3°
30MHz	Gain	Cv(10)-0.35dB		Cv(10)+0.35dB
	Phase	-2.5°		2.5°
100MHz	Gain	Cv(100)-0.6dB		Cv(100)+0.6dB
	Phase	-4.5°		4.5°
ATTENUATOR: 40dB				
Cv(1)=				
Cv(10)=				
Cv(100)=				
1MHz	Gain	Cv(1)-0.2dB		Cv(1)+0.2dB
	Phase	-1.25°		1.25°
10MHz	Gain	Cv(10)-0.2dB		Cv(10)+0.2dB
	Phase	-2.0°		2.0°
30MHz	Gain	Cv(10)-0.45dB		Cv(10)+0.45dB
	Phase	-3.0°		3.0°
100MHz	Gain	Cv(100)-0.75dB		Cv(100)+0.75dB
	Phase	-4.5°		4.5°

Test		Results		
		Minimum	Actual	Maximum
ATTENUATOR: 50dB				
Cv(1)= **Cv(10)=** **Cv(100)=**				
1MHz	Gain Phase	Cv(1)-0.25dB -1.75°	________ ________	Cv(1)+0.25dB 1.75°
10MHz	Gain Phase	Cv(10)-0.35dB -2.5°	________ ________	Cv(10)+0.35dB 2.5°
30MHz	Gain Phase	Cv(10)-0.65dB -3.5°	________ ________	Cv(10)+0.65dB 3.5°
100MHz	Gain Phase	Cv(100)-0.95dB -6.5°	________ ________	Cv(100)+0.95dB 6.5°
ATTENUATOR: 60dB				
Cv(1)= **Cv(10)=** **Cv(100)=**				
1MHz	Gain Phase	Cv(1)-0.45dB -2.75°	________ ________	Cv(1)+0.45dB 2.75°
10MHz	Gain Phase	Cv(10)-0.75dB -5.5°	________ ________	Cv(10)+0.75dB 5.5°
30MHz	Gain Phase	Cv(10)-1.65dB -11.0°	________ ________	Cv(10)+1.65dB 11.0°
100MHz	Gain Phase	Cv(100)-1.75dB -11.5°	________ ________	Cv(100)+1.75dB 11.5°
ATTENUATOR: 70dB				
Cv(1)= **Cv(10)=** **Cv(100)=**				
1MHz	Gain Phase	Cv(1)-1.05dB -5.25°	________ ________	Cv(1)+1.05dB 5.25°
10MHz	Gain Phase	Cv(10)-1.55dB -10.5°	________ ________	Cv(10)+1.55dB 10.5°
30MHz	Gain Phase	Cv(10)-3.15dB -16.0°	________ ________	Cv(10)+3.15dB 16.0°
100MHz	Gain Phase	Cv(100)-3.25dB -16.5°	________ ________	Cv(100)+3.25dB 16.5°

Test		Results		
		Minimum	Actual	Maximum
OSC LEVEL: -8.6dBm				
ATTENUATOR: 10dB				
Cv(1)=				
Cv(10)=				
Cv(100)=				
10Hz	Gain	Cv(1)-0.35dB	______	Cv(1)+0.35dB
	Phase	-2.0°	______	2.0°
100Hz	Gain	Cv(1)-0.15dB	______	Cv(1)+0.15dB
	Phase	-0.75°	______	0.75°
1kHz	Gain	Cv(1)-0.15dB	______	Cv(1)+0.15dB
	Phase	-0.75°	______	0.75°
10kHz	Gain	Cv(1)-0.15dB	______	Cv(1)+0.15dB
	Phase	-0.75°	______	0.75°
100kHz	Gain	Cv(1)-0.15dB	______	Cv(1)+0.15dB
	Phase	-0.75°	______	0.75°
ATTENUATOR: 20dB				
Cv(1)=				
Cv(10)=				
Cv(100)=				
10Hz	Gain	Cv(1)-0.45dB	______	Cv(1)+0.45dB
	Phase	-2.3°	______	2.3°
100Hz	Gain	Cv(1)-0.2dB	______	Cv(1)+0.2dB
	Phase	-1.25°	______	1.25°
1kHz	Gain	Cv(1)-0.2dB	______	Cv(1)+0.2dB
	Phase	-1.25°	______	1.25°
10kHz	Gain	Cv(1)-0.2dB	______	Cv(1)+0.2dB
	Phase	-1.25°	______	1.25°
100kHz	Gain	Cv(1)-0.2dB	______	Cv(1)+0.2dB
	Phase	-1.25°	______	1.25°

Test		Results		
		Minimum	Actual	Maximum
ATTENUATOR: 30dB				
Cv(1)= **Cv(10)=** **Cv(100)=**				
10Hz	Gain Phase	Cv(1)-0.85dB -3.3°	______ ______	Cv(1)+0.85dB 3.3°
100Hz	Gain Phase	Cv(1)-0.25dB -1.75°	______ ______	Cv(1)+0.25dB 1.75°
1kHz	Gain Phase	Cv(1)-0.25dB -1.75°	______ ______	Cv(1)+0.25dB 1.75°
10kHz	Gain Phase	Cv(1)-0.25dB -1.75°	______ ______	Cv(1)+0.25dB 1.75°
100kHz	Gain Phase	Cv(1)-0.25dB -1.75°	______ ______	Cv(1)+0.25dB 1.75°
OSC LEVEL= -38.6dBm **ATTENUATOR: 10dB**				
Cv(1)= **Cv(10)=** **Cv(100)=**				
10Hz	Gain Phase	Cv(1)-1.7dB -5.5°	______ ______	Cv(1)+1.7dB 5.5°
100Hz	Gain Phase	Cv(1)-0.6dB -4.0°	______ ______	Cv(1)+0.6dB 4.0°
1kHz	Gain Phase	Cv(1)-0.6dB -4.0°	______ ______	Cv(1)+0.6dB 4.0°
10kHz	Gain Phase	Cv(1)-0.6dB -4.0°	______ ______	Cv(1)+0.6dB 4.0°
100kHz	Gain Phase	Cv(1)-0.6dB -4.0°	______ ______	Cv(1)+0.6dB 4.0°
ATTENUATOR: 20dB				
Cv(1)= **Cv(10)=** **Cv(100)=**				
10Hz	Gain Phase	Cv(1)-2.2dB -7.5°	______ ______	Cv(1)+2.2dB 7.5°
100Hz	Gain Phase	Cv(1)-1.2dB -6.5°	______ ______	Cv(1)+1.2dB 6.5°

Test		Results		
		Minimum	Actual	Maximum
1kHz	Gain	Cv(1)-1.2dB	______	Cv(1)+1.2dB
	Phase	-6.5°	______	6.5°
10kHz	Gain	Cv(1)-1.2dB	______	Cv(1)+1.2dB
	Phase	-6.5°	______	6.5°
100kHz	Gain	Cv(1)-1.2dB	______	Cv(1)+1.2dB
	Phase	-6.5°	______	6.5°
ATTENUATOR: 30dB				
Cv(1)=				
Cv(10)=				
Cv(100)=				
100Hz	Gain	Cv(1)-3.2dB	______	Cv(1)+3.2dB
	Phase	-16.5°	______	16.5°
1kHz	Gain	Cv(1)-3.2dB	______	Cv(1)+3.2dB
	Phase	-16.5°	______	16.5°
10kHz	Gain	Cv(1)-3.2dB	______	Cv(1)+3.2dB
	Phase	-16.5°	______	16.5°
100kHz	Gain	Cv(1)-3.2dB	______	Cv(1)+3.2dB
	Phase	-16.5°	______	16.5°
4-7-3. Measurement Accuracy: 1MΩ Input Impedance				
Option 350				
OSC LEVEL= -1dBm				
Option 375				
OSC LEVEL= 10.4dBm				
Cv(1)=				
Cv(10)=				
Cv(100)=				
10Hz	Gain	Cv(1)-0.4dB	______	Cv(1)+0.4dB
	Phase	-2.6°	______	2.6°
100Hz	Gain	Cv(1)-0.2dB	______	Cv(1)+0.2dB
	Phase	-1.5°	______	1.5°
1kHz	Gain	Cv(1)-0.2dB	______	Cv(1)+0.2dB
	Phase	-1.5°	______	1.5°
10kHz	Gain	Cv(1)-0.2dB	______	Cv(1)+0.2dB
	Phase	-1.5°	______	1.5°
100kHz	Gain	Cv(1)-0.2dB	______	Cv(1)+0.2dB
	Phase	-1.5°	______	1.5°

Test		Results		
		Minimum	Actual	Maximum
1MHz	Gain	Cv(1)-0.2dB	______	Cv(1)+0.2dB
	Phase	-1.5°	______	1.5°
10MHz	Gain	Cv(10)-0.2dB	______	Cv(10)+0.2dB
	Phase	-2.0°	______	2.0°
30MHz	Gain	Cv(10)-0.4dB	______	Cv(10)+0.4dB
	Phase	-3.0°	______	3.0°
100MHz	Gain	Cv(100)-0.6dB	______	Cv(100)+0.6dB
	Phase	-4.0°	______	4.0°

Test	Results		
	Minimum	Actual	Maximum
4-8. EQUIPMENT CALIBRATION			
4-8-1. HP 8495A Coaxial Step Attenuator Calibration			
R10	0.0dB	______	0.1dB
4-8-2. HP 11667A Power Splitter Tracking Error Calibration			
R11	-0.1dB	______	0.1dB
4-8-3. HP 11852A Minimum Loss Pad Calibration: 75Ω Instruments			
PAD A **R12**	-5.8dB	______	-5.6dB
PAD B **R13**	-5.8dB	______	-5.6dB
4-9. AMPLITUDE MEASUREMENT ACCURACY TEST			
4-9-1. LF Measurement Accuracy: 50Ω/75Ω Input Impedance			
Option 350 **OSC LEVEL= -1dBm**			
Option 375 **OSC LEVEL= 10.4dBm**			
REFERENCE CHANNEL ATTENUATION= 0dB			
10Hz	-0.7dB	______	0.7dB
100Hz	-0.35dB	______	0.35dB
1kHz	-0.35dB	______	0.35dB
10kHz	-0.35dB	______	0.35dB
REFERENCE CHANNEL ATTENUATION= 20dB			
10Hz	-0.7dB	______	0.7dB
100Hz	-0.35dB	______	0.35dB
1kHz	-0.35dB	______	0.35dB
10kHz	-0.35dB	______	0.35dB

Test	Results		
	Minimum	Actual	Maximum
TEST CHANNEL ATTENUATION= 0dB			
10Hz	-0.7dB	______	0.7dB
100Hz	-0.35dB	______	0.35dB
1kHz	-0.35dB	______	0.35dB
10kHz	-0.35dB	______	0.35dB
TEST CHANNEL ATTENUATION= 20dB			
10Hz	-0.7dB	______	0.7dB
100Hz	-0.35dB	______	0.35dB
1kHz	-0.35dB	______	0.35dB
10kHz	-0.35dB	______	0.35dB
4-9-2. LF Measurement Accuracy: 1MΩ Input Impedance			
Option 350 **OSC LEVEL= -1dBm**			
Option 375 **OSC LEVEL= 10.4dBm**			
REFERENCE CHANNEL ATTENUATION= 0dB			
10Hz	-1.0dB	______	1.0dB
100Hz	-0.4dB	______	0.4dB
1kHz	-0.4dB	______	0.4dB
10kHz	-0.4dB	______	0.4dB
REFERENCE CHANNEL ATTENUATION= 20dB			
10Hz	-1.0dB	______	1.0dB
100Hz	-0.4dB	______	0.4dB
1kHz	-0.4dB	______	0.4dB
10kHz	-0.4dB	______	0.4dB
TEST CHANNEL ATTENUATION= 0dB			
10Hz	-1.0dB	______	1.0dB
100Hz	-0.4dB	______	0.4dB
1kHz	-0.4dB	______	0.4dB
10kHz	-0.4dB	______	0.4dB

Test	Results		
	Minimum	Actual	Maximum
TEST CHANNEL ATTENUATION= 20dB			
10Hz	-1.0dB	______	1.0dB
100Hz	-0.4dB	______	0.4dB
1kHz	-0.4dB	______	0.4dB
10kHz	-0.4dB	______	0.4dB
4-9-3. HF Measurement Accuracy: 50Ω/75Ω Input Impedance			
Option 350 **OSC LEVEL= -1dBm**			
Option 375 **OSC LEVEL= 10.4dBm**			
REFERENCE CHANNEL ATTENUATION= 0dB			
100kHz	-0.35dB	______	0.35dB
1MHz	-0.35dB	______	0.35dB
10MHz	-0.5dB	______	0.5dB
30MHz	-0.7dB	______	0.7dB
100MHz	-1.5dB	______	1.5dB
REFERENCE CHANNEL ATTENUATION= 20dB			
100kHz	-0.35dB	______	0.35dB
1MHz	-0.35dB	______	0.35dB
10MHz	-0.5dB	______	0.5dB
30MHz	-0.7dB	______	0.7dB
100MHz	-1.5dB	______	1.5dB
TEST CHANNEL ATTENUATION= 0dB			
100kHz	-0.35dB	______	0.35dB
1MHz	-0.35dB	______	0.35dB
10MHz	-0.5dB	______	0.5dB
30MHz	-0.7dB	______	0.7dB
100MHz	-1.5dB	______	1.5dB
TEST CHANNEL ATTENUATION= 20dB			
100kHz	-0.35dB	______	0.35dB
1MHz	-0.35dB	______	0.35dB
10MHz	-0.5dB	______	0.5dB
30MHz	-0.7dB	______	0.7dB
100MHz	-1.5dB	______	1.5dB

Test	Results		
	Minimum	Actual	Maximum
4-9-4. Measurement Accuracy: 1MΩ Input Impedance			
Option 350			
OSC LEVEL= -1dBm			
Option 375			
OSC LEVEL= 10.4dBm			
REFERENCE CHANNEL ATTENUATION= 0dB			
100kHz	-0.4dB	______	0.4dB
1MHz	-0.4dB	______	0.4dB
10MHz	-0.7dB	______	0.7dB
30MHz	-1.0dB	______	1.0dB
REFERENCE CHANNEL ATTENUATION= 20dB			
100kHz	-0.4dB	______	0.4dB
1MHz	-0.4dB	______	0.4dB
10MHz	-0.7dB	______	0.7dB
30MHz	-1.0dB	______	1.0dB
TEST CHANNEL ATTENUATION= 0dB			
100kHz	-0.4dB	______	0.4dB
1MHz	-0.4dB	______	0.4dB
10MHz	-0.7dB	______	0.7dB
30MHz	-1.0dB	______	1.0dB
TEST CHANNEL ATTENUATION= 20dB			
100kHz	-0.4dB	______	0.4dB
1MHz	-0.4dB	______	0.4dB
10MHz	-0.7dB	______	0.7dB
30MHz	-1.0dB	______	1.0dB
4-9-5. Low Level Measurement Accuracy: 50/75Ω			
Option 350			
OSC LEVEL= -4dBm			
Option 375			
OSC LEVEL= 7.4dBm			
100kHz	-2.5dB	______	2.5dB
1MHz	-2.5dB	______	2.5dB
10MHz	-3dB	______	3dB
30MHz	-4dB	______	4dB
100MHz	-4dB	______	4dB

Test	Results		
	Minimum	Actual	Maximum
4-9-6. Low Level Measurement Accuracy: 1MΩ Imput Impedance			
Option 350 **OSC LEVEL= -4dBm**			
Option 375 **OSC LEVEL= 7.4dBm**			
100kHz	-3dB	________	3dB
1MHz	-3dB	________	3dB
10MHz	-3dB	________	3dB
30MHz	-4dB	________	4dB
4-10. GAIN-PHASE MEASUREMENT SIGNAL LEVEL TEST			
4-10-1. Signal Level Accuracy: 100kHz			
OSC LEVEL= 15dBm **FREQ.= 100kHz** **R10+Cv+R13=** **Pref(15)=**	14.2dBm-(R10+Cv+R13)	________	15.8dBm-(R10+Cv+R13)
OSC LEVEL= 5dBm **FREQ.= 100kHz** **R10+R13=** **Pref(5)=**	4dBm-(R10+R13)	________	6dBm-(R10+R13)
4-10-2. HF Signal Level Flatness			
OSC LEVEL= 15dBm **ATTENUATOR= 10dB**			
10MHz	Pref(15)-1 =________	________	Pref(15)+1 =________
30MHz	Pref(15)-1 =________	________	Pref(15)+1 =________
80MHz	Pref(15)-1 =________	________	Pref(15)+1 =________
100MHz	Pref(15)-1 =________	________	Pref(15)+1 =________

Test	Results		
	Minimum	Actual	Maximum
OSC LEVEL= 5dBm ATTENUATOR= 0dB			
10MHz	Pres(5)-1.2 =______	______	Pref(5)+1.2 =______
30MHz	Pref(5)-1.2 =______	______	Pref(5)+1.2 =______
80MHz	Pref(5)-1.2 =______	______	Pref(5)+1.2 =______
100MHz	Pref(5)-1.2 =______	______	Pref(5)+1.2 =______
4-10-3. LF Signal Level Flatness			
OSC LEVEL= 15dBm ATTENUATOR= 10dB Pref(15)=			
10Hz	Pref(15)-1 =______	______	Pref(15)+1 =______
100Hz	Pref(15)-1 =______	______	Pref(15)+1 =______
1kHz	Pref(15)-1 =______	______	Pref(15)+1 =______
10kHz	Pref(15)-1 =______	______	Pref(15)+1 =______
OSC LEVEL= 5dBm ATTENUATOR= 0dB Pref(5)=			
10Hz	Pref(5)-1.2 =______	______	Pref(5)+1.2 =______
100Hz	Pref(5)-1.2 =______	______	Pref(5)+1.2 =______
1kHz	Pref(5)-1.2 =______	______	Pref(5)+1.2 =______
10kHz	Pref(5)-1.2 =______	______	Pref(5)+1.2 =______

Test	Results		
	Minimum	Actual	Maximum
4-10-4. Signal Level Test: -55dBm/ -65dbm			
OSC LEVEL= -55dBm ATTENUATOR= 10dB Cv(70)-Cv(10)=			
	Cv(70)-Cv(10) -62.2dB	________	Cv(70)-Cv(10) -57.8dB
A trace	PASS	________	FAIL
OSC LEVEL= -65dBm ATTENUATOR= 0dB Cv(70)=	Cv(70)-72.4dB	________	Cv(70)-67.6dB
A trace	PASS	________	FAIL
4-10-5. Linearity Confirmation			
B trace	PASS	________	FAIL
A trace	PASS	________	FAIL
4-11. POWER SPLITTER TEST			
A trace	PASS	________	FAIL
B trace	PASS	________	FAIL
4-12. GAIN-PHASE MEASUREMENT CROSSTALK TEST			
Frequency > 70MHz Maximum: -86dB			
A trace	PASS	________	FAIL
Frequency ≤ 70MHz Maximum: -96dB			
A trace	PASS	________	FAIL

Test	Results		
	Minimum	Actual	Maximum
4-13. IMPEDANCE MEASUREMENT SIGNAL LEVEL TEST			
4-13-1. Impedance Signal Level Accuracy: 100kHz			
OSC LEVEL 1Vrms			
R13=			
Pref=	6dBm-R13 =______	______	8dBm-R13 =______
4-13-2. HF Impedance Signal Level Flatness			
OSC LEVEL 1Vrms			
500kHz	Pref-1 =______	______	Pref+1 =______
1MHz	Pref-1 =______	______	Pref+1 =______
3MHz	Pref-1 =______	______	Pref+1 =______
10MHz	Pref-1 =______	______	Pref+1 =______
40MHz	Pref-1 =______	______	Pref+1 =______
4-13-3. LF Impedance Signal Level Flatness			
OSC LEVEL 1Vrms			
Pref=			
100Hz	Pref-1 =______	______	Pref+1 =______
1kHz	Pref-1 =______	______	Pref+1 =______
10kHz	Pref-1 =______	______	Pref+1 =______

Test		Results		
		Minimum	Actual	Maximum
4-14. IMPEDANCE MEASUREMENT ACCURACY TEST				
4-14-1. Measurement Accuracy				
1pF STANDARD				
100kHz	C	-6.27fF	________	6.27fF
	D	-6.27m	________	6.27m
1MHz	C	-2.09fF	________	2.09fF
	D	-2.09m	________	2.09m
3MHz	C	-9.64fF	________	9.64fF
	D	-9.64m	________	9.64m
10pF STANDARD				
10kHz	C	-107fF	________	107fF
	D	-10.7m	________	10.7m
100kHz	C	-20.9fF	________	20.9fF
	D	-2.09m	________	2.09m
1MHz	C	-17.3fF	________	17.3fF
	D	-1.73m	________	1.73m
3MHz	C	-44.5fF	________	44.5fF
	D	-4.45m	________	4.45m
10MHz	C	-132fF	________	132fF
	D	-13.2m	________	13.2m
100pF STANDARD				
1kHz	C	-1.07pF	________	1.07pF
	D	-10.7m	________	10.7m
10kHz	C	-659fF	________	659fF
	D	-6.59m	________	6.59m
100kHz	C	-173fF	________	173fF
	D	-1.73m	________	1.73m
1MHz	C	-170fF	________	170fF
	D	-1.70m	________	1.70m

Test		Results		
		Minimum	Actual	Maximum
1000pF STANDARD				
100Hz	C	-17.9pF	______	17.9pF
	D	-17.9m	______	17.9m
1kHz	C	-6.59pF	______	6.59pF
	D	-6.59m	______	6.59m
10kHz	C	-6.23pF	______	6.23pF
	D	-6.23m	______	6.23m
100kHz	C	-1.70pF	______	1.70pF
	D	-1.70m	______	1.70m
500kHz	C	-1.70pF	______	1.70pF
	D	-1.70m	______	1.70m
0.01μF STANDARD				
1kHz	C	-62.3pF	______	62.3pF
0.1μF STANDARD				
1kHz	C	-620pF	______	620pF
1μF STANDARD				
1kHz	C	-6.21nF	______	6.21nF
4-14-2. Measurement Flatness				
Air-Line				
1MHz	C	1.0000	______	1.0000
	D	-1.72m	______	1.72m
10MHz	C	0.9877	______	1.0135
	D	-1.72m	______	1.72m
40MHz	C	0.9538	______	1.0656
	D	-55.9m	______	55.9m

Test		Results		
		Minimum	Actual	Maximum
50Ω Termination				
1kHz	|Z|	0.9935	______	1.0065
	Δθ	-0.358°	______	0.358°
10kHz	|Z|	0.9935	______	1.0065
	Δθ	-0.100°	______	0.100°
100kHz	|Z|	1.0000	______	1.0000
	Δθ	0.00°	______	0.00°
10MHz	|Z|	0.9870	______	1.0130
	Δθ	-0.74°	______	0.74°
40MHz	|Z|	0.9480	______	1.0520
	Δθ	-2.98°	______	2.98°
4-15. IMPEDANCE MEASUREMENT LEVEL MONITOR TEST				
4-15-1. LF Level Monitor				
V Monitor OSC Level= 1Vrms				
100Hz		1.8×R0-1mV	______	2.2×R0+1mV
1kHz		1.8×R0-1mV	______	2.2×R0+1mV
10kHz		1.8×R0-1mV	______	2.2×R0+1mV
29kHz		1.8×R0-1mV	______	2.2×R0+1mV
30kHz		1.8×R0-1mV	______	2.2×R0+1mV
4-15-2. HF Level Monitor				
100kHz		1.8×R0-1mV	______	2.2×R0+1mV
1MHz		1.8×R0-1mV	______	2.2×R0+1mV
10MHz		1.8×R0-1mV	______	2.2×R0+1mV
OSC Level= 0.5Vrms				
40MHz		1.8×R0-1mV	______	2.2×R0+1mV

Test	Results		
	Minimum	Actual	Maximum
4-15-3. Stability Confirmation			
Option 350 **FREQ.= 1MHz**			
OSC LEVEL= 0.684V	0.9686	______	1.0285
OSC LEVEL= 0.462V	0.9679	______	1.0278
OSC LEVEL= 0.316V	0.9669	______	1.0267
Option 350 **FREQ.= 40MHz**			
OSC LEVEL= 0.684V	0.9686	______	1.0285
OSC LEVEL= 0.462V	0.9679	______	1.0278
OSC LEVEL= 0.316V	0.9669	______	1.0267
Option 375 **FREQ.= 1MHz**			
OSC LEVEL= 0.681V	0.9686	______	1.0285
OSC LEVEL= 0.466V	0.9679	______	1.0278
OSC LEVEL= 0.315V	0.9669	______	1.0267
Option 375 **FREQ.= 40MHz**			
OSC LEVEL= 0.681V	0.9686	______	1.0285
OSC LEVEL= 0.466V	0.9679	______	1.0278
OSC LEVEL= 0.315V	0.9669	______	1.0267
4-16. DC BIAS VOLTAGE TEST			
0V	-12mV	______	12mV
40V	39.940V	______	40.060V
-40V	-39.940V	______	-40.060V
0.01V	-0.002V	______	0.022V
0.02V	0.008V	______	0.032V
0.04V	0.028V	______	0.052V
0.08V	0.068V	______	0.092V
0.16V	0.148V	______	0.172V
0.32V	0.308V	______	0.332V
0.64V	0.627V	______	0.653V
1.28V	1.266V	______	1.294V
2.56V	2.545V	______	2.575V
5.12V	5.102V	______	5.138V
10.24V	10.216V	______	10.264V
20.48V	20.443V	______	20.517V

Test	Results		
	Minimum	Actual	Maximum
4-17. HP-IB INTERFACE PERFORMANCE TEST	PASS	______	FAIL