Calibration Guide

HP ESG-D Series Signal Generators

Serial Number Prefixes:

HP **ESG-D1000A,** US3704 through US3723
HP **ESG-D2000A,** US3704 through US3723
HP **ESG-D3000A,** US3704 through US3723
HP **ESG-D4000A,** US3704 through US3723

HEWLETT@
PACKARD

HP Part No. E4400-90084

Printed in USA
Print Date: December 1997   Supersedes: October 1997

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1 Specifications

This chapter lists the specifications and supplemental characteristics for the HP ESG-D Series Signal Generators whose serial prefixes are listed on the title page.

HP ESG-D Series Signal Generators Specifications

Specifications describe the instrument's warranted performance and apply after a 45 minute warm-up. All specifications are valid over the signal generator's entire operating and environmental range while in phase noise mode 2, unless otherwise noted.

Supplemental characteristics (shown in italics and denoted typical or nominal) provide additional, non-warranted, information useful in applying the signal generator.

Frequency

Range:

HP ESG-D1000A:	**250** kHz to 1000 MHz
HP ESG-D2000A:	**250** kHz to 2000 MHz
HP ESG-D3000A:	**250** kHz to 3000 MHz
HP ESG-D40OOA:	**250** kHz to 4000 MHz

Under Range: 100 kHz

Resolution: 0.01 Hz

Accuracy: Same as timebase

Switching Speed':

   Modulation On[2]:   *< 45 ms, typical*

   Modulation Off: *< 35 ms, typical*

1. To within 0.1 ppm of final frequency above 250 MHz or within 100 Hz below **250** MHz.
2. With digital modulation active, performance is typically 80 ms when crossing frequency bands at 500 **kHz,** 250, 500, or 700 MHz, 1, **2, 2.4,** 3.2, or 3.7 **GHz.**

   Phase Offset: *Phase is adjustable via HP-IB or from the front panel in nominal 0.1 degree increments.*

Frequency Bands:		
Band	**Frequency Range**	**N #**
1	250 kHz to ≤ 249.999 MHz	1
2	> 249.999 to ≤ 500 MHz	0.5
3	> 500 MHz to ≤ 1 GHz	1
4	> 1 to ≤ 2 GHz	2
5 I	> 2 to 4 GHz	4

Sweep Modes

   Operating Modes: Frequency Step, Amplitude Step, and Arbitrary List

   Dwell Time: 1 ms to 60 s

   Number of Points: 2 to 401

Internal Reference Oscillator

Stability:		
	Standard (typical)	**High Stability** **(Option 1E5)**
Aging Rate	$< \pm 2$ *ppm/year*	$< \pm 0.$ 1 ppm/year or $< \pm 0.0005$ ppm/day after 45 days
Temperature **(0 to 55°C)**	$< +I$ **ppm**	$< \pm 0.05$ **ppm, typical**
Line Voltage	$< \pm 0. I$ **ppm** *(+5%, -10%)*	$< f0.002$ **ppm, typical** *(+5%, -10%)*

Timebase Reference Output:

Frequency: 10 MHz

Amplitude: > 0.35 V_{rms} into 50Ω load

External Reference Input:

Frequency: 1, 2, 5, 10 MHz $\pm$ **typically** *10 ppm* **(typically 1 ppm, Opt. 1E5)**

Amplitude: > 0.15 V_{rms}

Input Impedance: 50Ω

output

Range:

250 **kHz to 1000 MHz:** +13 to -136 dBm

> 1000 MHz to 3000 MHz: +10 to -136 **dBm**

> **3000 MHz to 4000 MHz:** +7 to -136 **dBm**
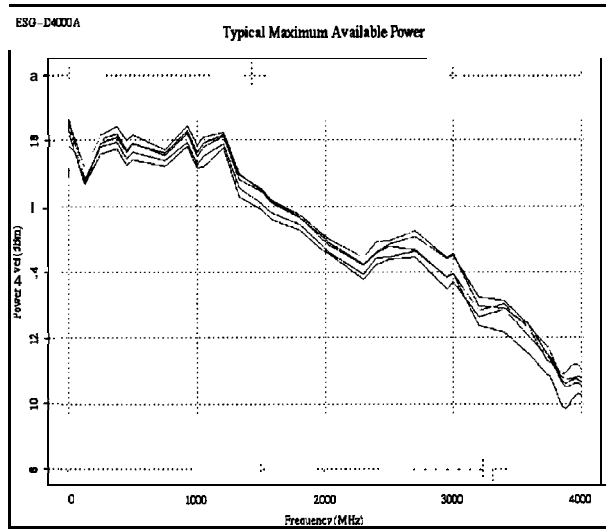
Resolution: 0.02 dB

Attenuator Hold Level Range:

250 kHz to 1000 MHz: 23 dB

> 1000 MHz to 3000 MHz: 20 dB

> **3000 MHz to 4000 MHz:** 17 dB

Level Accuracy':		
	+7 to -127 dBm	**< -127 dBm**
250 kHz to 2 GHz:	±0.5 dB	f1.5 dB
> 2 to 4 GHz:	±0.9 dB	f2. 5 dB

1. For 23" ±5°C. Accuracy degrades by 0.02 dB per degree C over
the full temperature range and by 0.3 dB above +7 dBm.
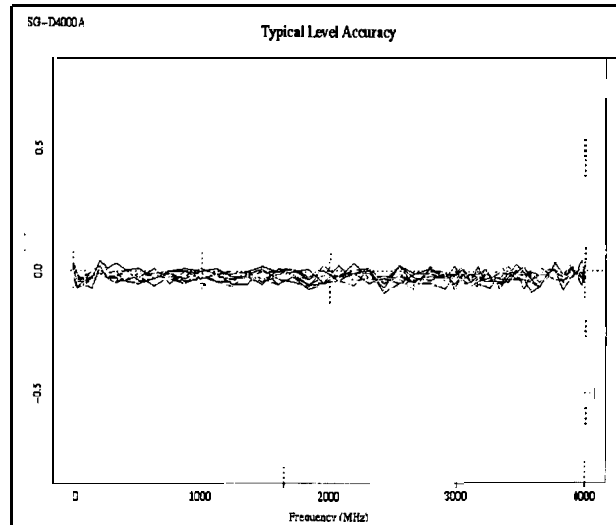
Amplitude Switching Speed: *< 25 ms, typical*

   When Using Power Search: *< 210 ms, typical*

Reverse Power Protection[1]:

   250 **kHz to 2000 MHz:**   50 watts

   > 2000 MHz to 4000 MHz: 25 watts

   Maximum DC Voltage: 50 V

1. The reverse power protection circuitry triggers at nominally 1 watt.

SWR (typical):

   250 kHz to 2000 MHz: *< 1.4:1*

   > 2000 to 4000 MHz: *< 1.9:1*

Output Impedance: 50Ω

Spectral Purity

SSB Phase Noise *(typical, at 20 kHz offset):*

at 500 MHz: $< -120 dBc/Hz$

at 1000 MHz: $< -116 dBc/Hz$

at 2000 MHz: $< -110 dBc/Hz$

at 3000 MHz: $< -104 dBc/Hz$

at 4000 MHz: $< -104 dBc/Hz$
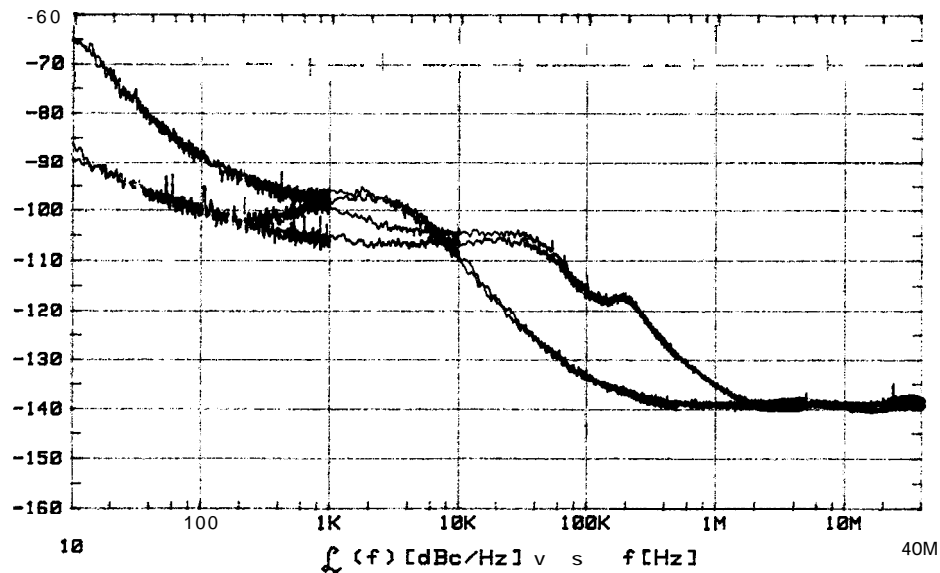
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Typical Phase Noise Modes 1 and 2 Single Sideband Phase Noise at 1 GHz

Residual FM (CW mode, 0.3 to 3 kHz SW, CCITT, rms)**:**

Phase Noise Mode 1: $< N \times 2$ Hz

Phase Noise Mode 2: $< N \times 4$ Hz

Harmonics (I +4 dBm output level): < -30 dBc

Nonharmonics (< +7 dBm output level)[1]:		
At Offsets:	> 3 kHz	> *10 kHz (typical)*
250 kHz to 1000 MHz:	< -*65* dBc	< -*75* *dBc*
> 1000 to 2000 MHz:	< -59 dBc	< - *69 d B c*
> *2000* MHz:	< -*53* dBc	< -*33* *dBc*

1. Performance is typical for spurs at frequencies above the maximum operating frequency of the instrument. Performance typically is -60 dBc between 225 and 249.999 MHz. Specifications apply for FM deviations < 100 kHz and are not valid for ΦM. Performance is typically limited to -45 dBc at the symbol rate of π/4DQPSK modulating signals.

Subharmonics:

≤ **1000 MHz:**   None

> **1000 MHz:**   < -*40* dBc

Frequency Modulation

Maximum Deviation: N x 10 MHz

Resolution: 0.1% of deviation or 1 Hz, whichever is greater

Deviation Accuracy: < ±(3.5% of FM deviation setting + 20 Hz)
(1 kHz rate, deviation < N x 100 kHz)

Modulation Frequency Response':		
Path	Rates (deviation = 100 kHz)	
	1 dB Bandwidth	3 dB Bandwidth *(typical)*
FM 1:	(dc/20 Hz to 100 kHz)	*dc/5 Hz to 10 MHz*
FM2:	(dc/20 Hz to 100 kHz)	*dc/5 Hz to 1 MHz*

1. Since the internal modulation source operates over 0.1 Hz to 50 kHz, FM rates above 50 kHz must be supplied externally.

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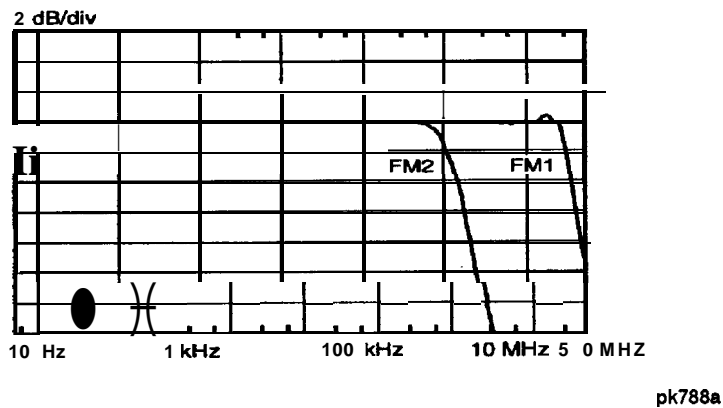
Typical FM 1 and FM 2 Frequency Response

Carrier Frequency Accuracy   ±0. 1% of set deviation + (N x 1 Hz)
Relative to CW in DCFM[1] :

1. At the calibrated deviation and carrier frequency, within 5" C of ambient temperature at time of user calibration.

Distortion (1 kHz rate, THD, Deviations = N x 100 kHz):   < 1%

External Inputs: Ext 1 or Ext 2

Sensitivity: 1 Vpk for indicated deviation

Input Impedance: *50Ω , nominal*

Paths: FM 1 and FM 2 are summed internally for composite modulation. Either path may be switched to any one of the modulation sources: Int, Ext 1, Ext 2. The FM 2 path is limited to a maximum rate of 1 MHz. The FM 2 path must be set to a deviation less than FM 1.

Phase Modulation

Maximum Deviation: N x 90 radians

Resolution: 0.1% of set deviation

Deviation Accuracy (1 kHz rate): < ±(5% of deviation + 0.01 radians)

Modulation Frequency Response:			
Phase Modulation Mode	**Maximum Deviation**	**Rates (3 dB BW)**	
		ΦM1	**ΦM2**
Normal	N x 90 radians:	dc- 100 kHz	dc- 100 kHz
High Bandwidth	N x 2π radians:	*dc - 1.5 MHz, typical*	*dc - 0.9 MHz, typical*
	N x π/2 radians:	*dc - 4 MHz, typical*	*dc - 1 MHz, typical*

Distortion (1 kHz rate, THD, deviations < N x 90 radians): < 1%

External Inputs: Ext 1 or Ext 2

Sensitivity: 1 Vpk for indicated deviation

Input Impedance: *50Ω , nominal*

Paths: ΦM 1 and ΦM 2 are summed internally for composite modulation. Either path may be switched to any one of the modulation sources: Int, Ext 1, Ext2. The ΦM 2 path is limited to a maximum rate of 1 MHz. The ΦM 2 path must be set to a deviation less than ΦM 1.

Amplitude Modulation at fc > 500 kHz

AM is typical above 3 GHz or if wideband AM or I/Q modulation is simultaneously enabled.

Range (envelope peak ≤ maximum specified power):   0 to 100%

Rates (3 dB bandwidth):   dc/10 Hz to 10 kHz

Resolution: 0.1%

Accuracy (1 kHz rate):   < ±(5% of setting + 1%)

Distortion (1 kHz rate, THD):

  30% AM: < 1.5%

  90% AM: < 4%

External Inputs: Ext 1 or Ext 2

Sensitivity: 1 Vpk for indicated depth

Input Impedance: 50Ω, nominal

Paths: AM 1 and AM 2 are summed internally for composite modulation. Either path may be switched to any one of the modulation sources: Int, Ext 1, Ext 2.

Wideband AM

Rate (1 dB bandwidth, typical):

    ALC On: *400 Hz to 10 MHz*

    ALC Off: *dc to 10 MHz*

External Input: I input

Sensitivity: 0.5 v = 100%

Input Impedance: *50Ω , nominal*

Pulse Modulation

On/Off Ratio:

    ≤ 3 GHz: > 80 dB

    <3 GHz: > 60 dB

Rise/Fall Times: *150 ns, typical*

Minimum Width:

    ALC On: *2μs, typical*

    ALC Off: *0.4μs, typical*

Pulse Repetition Frequency:

    ALC On: *IO Hz to 250 kHz, typical*

    ALC Off: *dc to 1.0 MHz, typical*

Level Accuracy (relative to CW)[1]:   f0.5 *dB,* ***typical***

1. With ALC off, specifications apply after the execution of power search. With
   ALC on, specifications apply for repetition rates < 10 **kHz** and pulse widths
   25 μs.

External Input: Ext 2

Input Voltage:

  RF On: > *+0.5 V,* ***nominal***

  RF Off: < *+0.5 V,* ***nominal***

Input Impedance: *50Ω,* ***nominal***

Internal Pulse Generator:

  Squarewave Rate: 0.1 Hz to 50 **kHz**

    Period: 16 μs to 30s

    Width: **8** μs to 30s

    Resolution: 4 μs

Internal Modulation Source

Provides FM, **ΦM,** and AM modulation signals and LF Out.

Waveforms: Sine, Square, Ramp, Triangle, and Noise

Rate Range:

  Sine: 0.1 Hz to 50 **kHz**

  Square, Ramp, Triangle: **0.1** Hz to 10 **kHz**

Resolution: 0.1 Hz

 Pulse Only: 4 μs

Frequency Accuracy: **0. 005%**

Swept Sine Mode (Frequency, Phase Continuous):

   Operating Modes: Triggered or Continuous Sweeps

   Frequency Range: 0.1 Hz to 50 kHz

   Sweep Time: 1 ms to 65s

   Resolution: 1 ms

Dual Sinewave Mode:

   Frequency Range: 0.1 Hz to 50 kHz

   Amplitude Ratio: **0** to 100%

   Resolution: 0.1%

LF Out (Internal Modulation Source)

Amplitude: 0 to 3 Vpk into 50Ω

Output Impedance: < 1Ω

External Modulation Inputs

Modulation Types:

   Ext 1:   FM, ΦM, AM, and Burst Envelope

   Ext 2:   FM, ΦM, AM, and Pulse

High/Low Indicator: *Indicator is activated when input level error exceeds 3%*
(100 Hz to 10 MHz SW,   *(nominal)*
AC-coupled inputs only)

Simultaneous Modulation

All modulation types may be simultaneously enabled, except FM with ΦM, AM with burst envelope, and wideband AM with I/Q. AM, FM and ΦM can sum simultaneous inputs from any two sources (Int, EXT 1, and EXT 2.) Any given source (Int, EXT 1, or EXT 2) may only be routed to one activated modulation type.

Level Accuracy with Digital Modulation

(With ALC On; relative to CW, with PRBS modulated data; if using I/Q inputs, $\sqrt{I^2 + Q^2}$ = 0.5 V_{rms} nominal)'

1. The optimum I/Q input level is $\sqrt{I^2 + Q^2}$ = 0.5 V,.. I/Q drive affects EVM, origin offset, spectral regrowth, and noise floor. Typically, level accuracy with ALC on will be maintained with drive levels between 0.25 and 1 .O V,..

π/4   f0.15 **dB**
(Relative to **CW**; with raised cosine or root raised cosine filter and
α ≥   kHz <   <
>   <   − 3 dB)

Constant Amplitude Formats   No degradation in power level accuracy
(FSK, GMSK, etc):

Level Accuracy with ALC Off':   *±0.5 dB, **typical***
(After power search is executed; relative to CW level with
ALC on; if external l/Q is enabled: $\sqrt{I^2 + Q^2}$ = 0.5 V,,)

1. When applying external I/Q signals with ALC off, output level will vary directly with I/Q input level. Power search is an internal calibration routine used to set output power when ALC is off. The routine disables all modulation inputs, adjusts output power while applying 0.5 V_{rms} to the I/Q modulator, then enables modulation.

I/Q Modulation

I/Q Inputs:

Input Impedance: 50Ω

Full Scale Input[1]: $\sqrt{I^2 + Q^2} = 0.5\ V_{rms}$

1. The optimum I/Q input level is $\sqrt{I^2 + Q^2} = 0.5\ V,,.$ I/Q drive affects EVM, origin offset, spectral regrowth, and noise floor. Typically, level accuracy with ALC on will be maintained with drive levels between 0.25 and 1.0 V,,.

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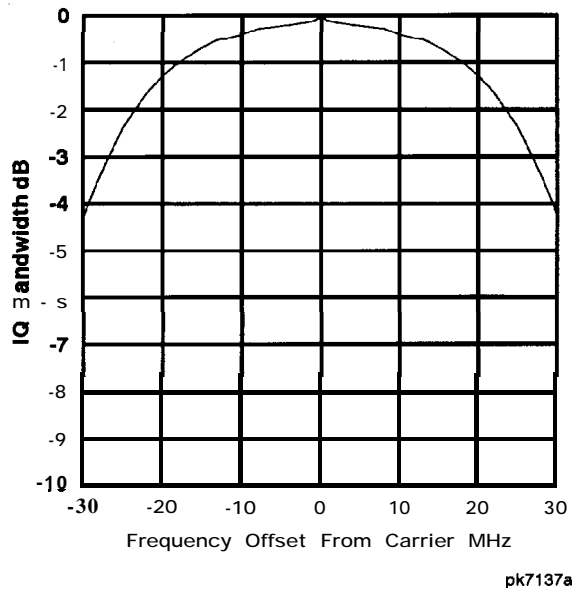
Typical I/Q Frequency Response

Adjustments/Impairments *(nominal):*

DC Offset (I and Q independently adjustable): *±100%*

I/Q Gain Ratio: *±4 dB*

DC Vector Accuracy': (relative to full scale, power < +7 dBm)				
Frequency (GHz):	< 0.6	0.6 **to 2**	2. **to** 3.7	14
Static EVM (rms)^2:	**<** 0.75%	**<** 0.5%	**<** 0.75%	**<** 1%
Magnitude Error (rms)^2:	**< 0.5%**	**<** 0.35%	**<** 0.5%	**<** 0.75%
Phase Error (rms)^2:	**<** 0.35"	**<** 0.25"	**<** 0.35"	**<** 0.5"
Origin Offset (dBc):	< -46	c - 4 6	**<** -40	**< −40**

1. Valid for 10 days after executing internal calibration routine, when operated within ±5°C of calibration temperature.
2. Measured at full scale with origin offset removed.

External Burst Envelope

Input Voltage:

RF On: O V

RF Off: - 1 V

Linear Control Range: **0** to -1 V

On/Off Ratio:

≤ 3 GHz: > 75 dB

> 3 **GHz:** > 60 dB

V$_{IN}$: I-1.05 v

Rise/Fall Time: *< 2 μs with rectangular input, typical*

10 Hz, typical

ALC Off: D C

External Input: Ext 1

Input Impedance: *50Ω, nominal*

I/Q Baseband Generator (Options UN3 and UN4)

Data Structure:

Frames and timeslots may be configured as different types of traffic or control channels. The data field of a timeslot can accept a user file, PRBS (PN9 or PN15), or external data with the appropriate clock.

Internal Data:

Pseudorandom Patterns (meets ITU-T standard):	Continuous PN9 (PRBS $2^9 - 1$) or PN15[1] (PRBS $2^{15} - 1$)
Repeating Sequence:	Any 4 bit sequence

1. PN15 is not continuous in bursted mode for TETRA applications.

Downloadable Data (User Files):

Type: Serial Data

Minimum Size: Must fill entire field for which it was selected

Maximum Size: 1 Mbits (Option UN3), 8 Mbits (Option UN4)

External Data:

Type: Serial Data

Inputs: Data, Bit/Symbol Clocks; Accepts data rates $\pm 5\%$ of specified data rate

Reference Frequency:

Internal or External 1, 2, 5, 10 MHz reference

Data clock can be locked to the external 13 MHz (GSM)

Frame Trigger Delay Control:

   Range: 0 to 65,000 bits

   Resolution: 1 bit

Internal burst Shape Control:

   Rise/Fall Time Range: Up to 30 bits

   Rise/Fall Delay Range: 0 to 63.5 bits (varies with standard)

Specifications for Digital Communications Standards

	NADC		PDC		PHS		TETRA		DECT	GSM (DCS, PCS)
Modulation Format	$\pi/4$ DQPSK								GFSK	GMSK
Data Rate (default, kbits/sec)	48.6		42		384		36		1,152	270.83
Adjustment Range (default, kbits/sec)	40 to 75.5		40 to 75.5		320 to 605		31 to 37.8		922 to 1209.6	163 to 300
Filter	Root Raided Cosine or Raised Cosine								Gaussian	
Default Value	$\alpha = 0.35$		$\alpha = 0.5$		$\alpha = 0.5$		$\alpha = 0.35$		BbT = 0.5	BbT = 0.3
Range (α or BbT)	Root Raided Cosine or Raised Cosine								Gaussian	
Error Vector Magnitude' (% rms)	Cont.	Burst	Cont.	Burst	Cont.	Burst	Cont.	Burst	NA	NA
Low EVM Mode	1.4	1.9	1.9	1.8	1.5	1.5	1.5	1.9		
Low EVM Mode *(typical)*	*0.8*	*1.4*	*0.9*	*1.4*	*0.9*	*0.9*	*0.8*	*1.5*		
Low ACP Mode *(typical)*	*1.4*	*1.8*	*1.0*	*1.2*	*1.2*	*1.2*	*3.1*	*3.2*		
Global Phase Error[1] (rms/pk), *typical*	NA		NA		NA		NA		NA	0.8°/2.8° 0.8°/2.8°
Deviation Accuracy[1] (kHz)	NA		NA		NA		NA		6.1 *(2.5, typ)*	NA
Channel Spacing (kHz)	30		25		300		25		1728	200
Adj. Channel Power (ACP) (Low ACP Mode. dBc. typical)	Cont.	Burst	Cont.	Burst	Cont.	Burst	Cont.	Burst[2]	NA	Cont. / Burst
at Adjacent Channel[3]	*-35*	*-34*	*--*	*--*	*--*	*--*	*-68*	*-65*		*-38* / *-37*
at 1st Alternate Channel[3]	*-75*	*-73*	*-72*	*-70*	*-76*	*-75*	*-77*	*-76*		*-71* / *-70*
at 2nd Alternate Channel[3]	*-77*	*-77*	*--*	*--*	*-77*	*-76*	*-79*	*-78*		*-80* / *-79*
at 3rd Alternate Channel[3]	*-79*	*-78*	*-78*	*-78*	*--*	*--*	*-79*	*-79*		*-81* / *-82*
Supported Burst Types	Custom, Up/Down TCH		Custom, Up/Down TCH, Up Vox		Custom, TCH, Sync		Custom, Up Control 1&2, Up Normal, Down Normal, Down Sync		Custom Dummy B 1&2, Traffic B, Low Capacity	Custom, Normal, FCorr, Sync, Dummy, Access
Scramble Capabilities					Yes		Yes			

1. Specifications apply for the frequency range, data rates, root raised cosine filter and filter factors (a or **BbT**) **specified** for each standard and at power levels $\leq$ **+7 dBm** (I **+4 dBm** for TETRA).
2. ACP for TETRA is measured over a 25 **kHz** bandwidth, with an 18 **kHz** root raised cosine filter applied.
3. The "channel spacing" determines the offset size of the adjacent and alternate channels: adjacent channel offset = 1 x channel spacing, 1st alternate channel = 2 x channel spacing, 2nd alternate channel = 3 x channel spacing, etc.
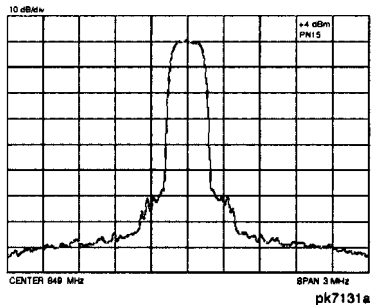
NADC Spectrum
Fc = 849 MHz
Span = 0.3 MHz
Scale = 10 dB/div
Level = +4 dBm

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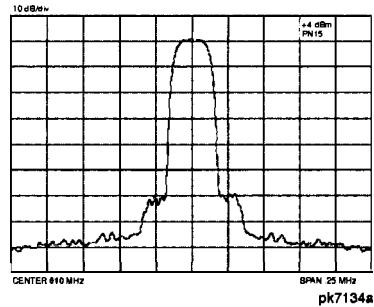
PDC Spectrum
Fc = 810 MHz
Span = 0.25 MHz
Scale = 10 dB/div
Level = +4 dBm

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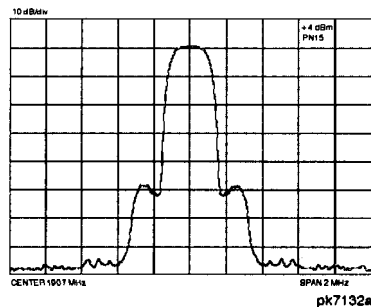
PI-IS Spectrum
Fc = 1907 MHz
Span = 2 MHz
Scale = 10 dB/div
Level = +4 dBm

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TETRA Spectrum
Fc = 400 MHz
Span = 0.25 MHz
Scale = 10 dB/div
Level = +4 dBm

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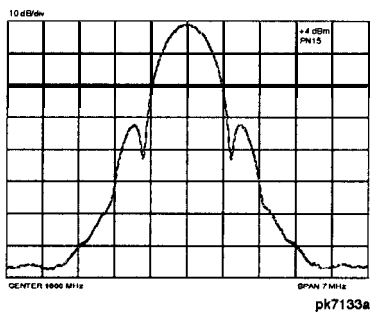
DECT Spectrum
Fc = 1800 MHz
Span = 7 MHz
Scale = 10 dB/div
Level = +4 dBm

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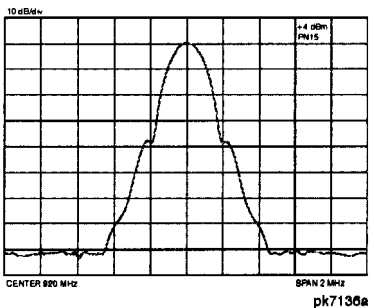
GSM Spectrum
Fc = 920 MHz
Span = 2 MHz
Scale = 10 dB/div
Level = +4 dBm

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Coherent Carrier Out

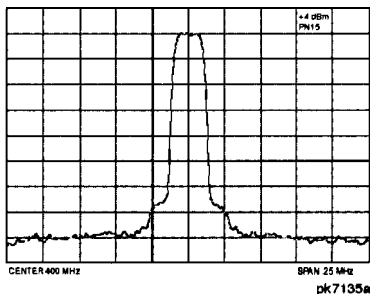Coherent Carrier is modulated by FM or ΦM when enabled.

Range: 250 MHz to maximum carrier frequency

Level: *0 dBm ±5 dB, typical*

Impedance: 50Ω

Remote Programming

Interface: HP-IB (IEEE-488.2-1987) with Listen and Talk. RS-232

Control Languages: SCPI version 1992.0, also compatible with
HP 8656B and 8657A/B/C/D/J[1] mnemonics.

1. HP ESG-D series does not implement HP 8657A/B 'Standby' or
   'On' (RO or R1, respectively) mnemonics.

Functions Controlled: All front panel functions except power switch and
knobs.

IEEE-488 Functions: SH1, AH1, T6, TEO, L4, LEO, SR1, RL1, PPO, DC1,
DTO, CO, E2

IS0 Compliant

The HP ESG-D Series RF signal generators are manufactured in an IS0 9001
registered facility in concurrence with Hewlett-Packard's commitment to quality.

General

Power Requirements: 90 to 254 V; 50, 60, or 400 Hz; 200 W maximum

Operating Temperature Range: 0 to 55" C

Storage Temperature Range: -40 to +71 ° C

Shock and Vibration: Meets MIL STD 28800E Type III, Class 3

Leakage: Conducted and radiated interference meets MIL STD 461B RE02 Part 2 and CISPR 11. ***Leakage is typically c 1 μV (nominally 0.1 μV with a 2-turn loop) at $\leq$ 1000 MHz, measured with a resonant dipole antenna one inch from any surface with output level < 0 dBm (all inputs/outputs properly terminated).***

Storage Registers: Up to 100 storage registers with sequence and register number displayed. Up to 10 sequences available.

Weight: < 12.7 kg (28 lb.) net, < 21 kg (46 lb.) shipping

Dimensions: 133 mm H x 426 mm W x 432 mm D
(*5.25* in. H x 16.8 in. W x 17 in. D)

Accessories

Transit Case, HP Part Number 92 1 1 - 1296

HP 83300A Remote Interface

Options

OB0	Delete Manual Set
0B1	Extra Manual Set
OBV	Add Component Level Information Package
OBW	Add Service Documentation (Assembly Level Repair)
OBX	Add Service Documentation and Component Level Information Package
1CM	Rack Flange Kit (without handles)
1CN	Front Handle Kit
1CP	Rack Flange Kit (with handles)
1E5	Add High Stability timebase
UN3	Add I/Q Baseband Generator with 1 Mbits of RAM (includes pre-mod filtering and PRBS)
UN4	Add I/Q Baseband Generator with 8 Mbits of RAM (includes pre-mod filtering and PRBS)
1EM	Move All Front Panel Connectors to Rear Panel
W30	Three Year Warranty

2 Equipment Required

This chapter contains a list of all the recommended equipment required to perform the performance tests and adjustments for the HP ESG-D Series Signal Generators.

Required Equipment

- HP 8902A Measuring Receiver'

  FM accuracy: ±2% of reading ±1 digit
  AM accuracy: ±2% of reading ±1 digit
  Range: 250 kHz to 1300 MHz
  Filters: 300 Hz high-pass and 15 kHz and 3 kHz low-pass
  Detectors: Peak+

- HP 54610B Digital Oscilloscope[1]

  Bandwidth: 500 MHz

- HP 5071A Primary Frequency Standard

  Frequency: 10 MHz
  Stability: $> 1 \times 10^{-10}$/year

- HP 8903B Option 05 1 Audio Analyzer1

  Distortion accuracy: ±1 dB
  Residual distortion: -80 dB at 80 kHz BW
  30 kHz low-pass filter
  AC level accuracy: ±4%

- HP 8563E Spectrum Analyzer'

  Frequency range: 100 kHz to 4000 MHz
  Relative level accuracy (harmonic and spurious measurements) ±2 dB
  Displayed average noise level (1 Hz SW) -110 dBm at 100 kHz, -130 dBm at 1 MHz to 10 MHz,
  and -134 dBm at 0.01 to 4 GHz
  1 Hz digital resolution BW filter (required for power accuracy)
  RF input VSWR: 1: 1.5
  External timebase input

- HP 89441A Vector Signal Analyze?

  No Substitution

- HP 8663A Signal Generator'

  Frequency range: 11.5 MHz to 2500 MHz
  Output level: +16 dBm
  Meets HP 8663A single-sideband phase noise specifications

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1. Equipped with HP-IB computer interface.

- HP 8904A Function Generator'

    Frequency range (sinewave): 0 Hz to 600 kHz
    AC Amplitude (sinewave only):
        Range: 0 to 10 Vp-p into a 50Ω load
        Flatness: (> 630 mVp-p into 50R): ±0.1% (±0.009 dB), 0.1 Hz to 100 kHz

- HP 5350B Frequency Counter'

    Frequency range: 400 Hz 4000 MHz
    Resolution: 1 Hz
    Frequency accuracy (same as timebase): fl.5 Hz
    External timebase input: > 10 MHz

- HP 53 132A Option 050 Universal Counter'

    Frequency range: 4 GHz
    Resolution: 0.1 Hz
    External timebase input

- HP 33120A Option 001 Arbitrary Waveform Generator' (2)

    No Substitution

- HP 438A Power Meter'

    Instrumentation accuracy: ±0.5%
    Power reference accuracy: 0.9%

- HP 8482A Power Sensor

    Frequency range: 100 kHz to 4000 MHz
    Power range: -30 dBm to +13 dBm
    Maximum SWR: 100 kHz to 300 kHz: 1: 1.6, 300 kHz to 1 MHz: 1: 1.12, 1 MHz to 2 GHz: 1: 1.1,
    2 GHz to 4 GHz: 1:1.3
    Calibration factor accuracy (RSS): ≤ 1.6%

- HP 8447F Preamplifier-Amplifier

    Frequency range: 100 kHz to 1.3 GHz,
    Gain (mean, per channel): 22 dB ±1.5 dB (20 ° to 30 "C)

- HP 8449B Preamplifier

    Frequency range: 1 .O to 26.5 GHz
    Gain (mean, per channel): 126 dB (20 ° to 30 "C)
    Noise figure: 1.0 to 26.5 GHz (I 8.5 dB typical) 7 dB

- MD/MDC- 174 Mixer

    Frequency range: 0.001 to 2.8 GHz

1. Equipped with HP-IB computer interface.

Required Equipment

- **MD/MDC-** 164 Mixer

    Frequency range: 0.5 to 9 **GHz**

- HP **8491A/B** Option 006 Attenuator

    Attenuation: 6 **dB**

- HP 3458A Digital **Multimeter**[1]

    DC Volts: 0.1 V to 100 V
    Input resistance: 10 Ω to 1 **KΩ**

- HP **8491A/B** Option 010 Attenuator

    Attenuation: 10 **dB**

- HP Vectra Personal Computer

    CPU: 386 (or better)
    Clock: 33 MHz (or faster)
    RAM: 8Mb (or more)
    3.5" floppy disk drive
    350 Mb (or more) hard drive
    16-color VGA monitor
    MS Windows@ 3.X (Microsoft Windows is a registered trademark of Microsoft Corp.)

- HP LaserJet 5L Printer

    MS Windows supported

- HP **82341C** HP-IB Interface Card

    No Substitution

---

1.   Equipped with HP-IB computer interface.

---

3 Operation Verification

This chapter provides procedures that will either ensure that the signal generator is operating correctly or will help to point to problem areas if it is not. Operation verification does not ensure performance to specifications but should provide a level of confidence that the instrument is operating to specifications within a minimum amount of time. Operation verification is appropriate for incoming inspection, after repair when a full calibrated performance is not required, or whenever the integrity of the instrument is in question.

Verification Procedures

Perform the following procedures in the order they are presented.

1. Power On the Signal Generator and Check for Error Messages

2. Frequency Range and Accuracy Check

3. Power Level Accuracy Check

4. FM Accuracy Check

5. AM Accuracy Check

6. I/Q Modulation Check

Equipment Required

- HP 5350A Frequency Counter

- HP 438A Power Meter

- HP 8482A Power Sensor

- HP 8563E Spectrum Analyzer

- HP 8491A/B Option 006 Attenuator (6 dB)

- HP 8491A/B Option 010 Attenuator (10 dB)

- HP 8902A Measuring Receiver

1. Power On the Signal Generator and Check for Error Messages

This procedure verifies that the signal generator powers up and that the internal instrument check identifies no errors. The internal check evaluates the correctness of operation and returns an error message if a problem is detected.

1. Turn power on to the signal generator by pressing the power switch. The green LED will light. Let the instrument warm up for one hour.

2. Cycle the power to the signal generator. The green LED should again be lit and the instrument will perform a check.

3. When the display is lit, check to see if the ERR annunciator is turned on.

4. If the ERR annunciator is turned on, review the error messages in the queue by pressing **Utility, Error Info, View Next Error Message.** The first error message in the queue will be shown in the text area of the display. Refer to the service guide for information about the error message.

    If there is more than one error message (each message will be designated as 1 of n), continue pressing the **View Next Error Message** softkey until you have seen all of the messages.

5. When you have resolved all of the error messages, press **Clear Error Queue(s)** to delete the messages. Then restart this procedure at step two.


NOTE: For instruments with Option 1E5, ERROR 514, Reference Oven Cold will occur whenever the signal generator is first connected to AC line power. The OVEN COLD annunciator and the ERR annunciator will both turn on. The OVEN COLD annunciator will automatically clear after approximately 5 minutes. The error queue cannot be cleared, however, until the OVEN COLD annunciator has turned off.

---

2. Frequency Range and Accuracy Check

Frequency range is tested by determining the frequency accuracy relative to the timebase at the frequency limits.

Connect the Test Equipment
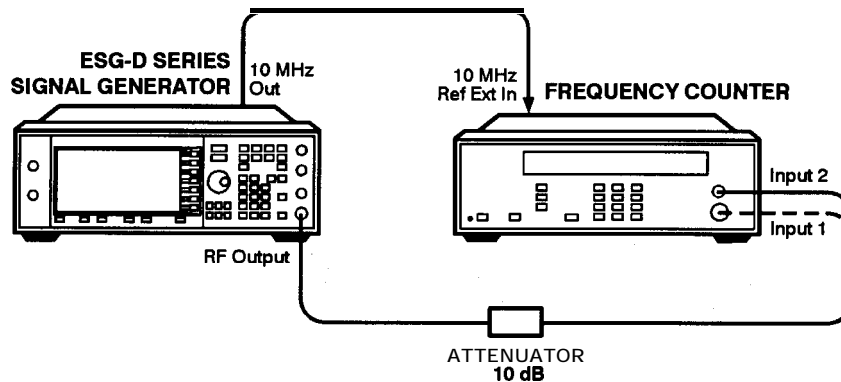
wk750a

Figure 3-1.   **Frequency Range and Accuracy Equipment Setup**

Configure the Signal Generator

1. Preset the signal generator to normal (factory-defined) preset conditions.

2. For frequencies < 10 MHz:

   a. Set the amplitude to 10 dBm. Press **Amplitude.** Enter 10 dBm using the numeric keypad and pressing the **dBm** terminator softkey.

   b. Turn the RF output on. Press **RF** On/Off. The **RF ON** annunciator should be turned on.

3. For frequencies > 10 MHz:

   a. Set the amplitude to 0 dBm. Press **Amplitude.** Enter 0 dBm using the numeric keypad and pressing the **dBm** terminator softkey.

   b. Turn the RF output on. Press **RF** On/Off. The **RF ON** annunciator should be turned on.

Configure the Frequency Counter

1. For frequencies < 10 MHz use Input 2. Press **1 MR.**

2. For frequencies > 10 MHz and ≤ 500 MHz use Input 2. Press **50 Ω.**

3. For frequencies **>** 500 MHz use Input 1. Press **AUTO.**

NOTE: Set the gate time of **>** 5 seconds for maximum counter accuracy. Verify that the counter is phase-locked to the 10 MHz external reference.

Measure the Frequency Accuracy

1. Set the frequencies shown in Table 3-l (to the maximum frequency of your signal generator).

2. For each measurement point, measure the carrier frequency with modulation turned off. Press **Mod On/Off. The** MOD **OFF** annunciator should be turned on.

3. Record the measured frequency in Table **3-** 1.

4. Compute the error (difference) and compare it to the corresponding limits.

Table 3-1.   **Frequency Accuracy Measurement Points**

Frequency (MHz)	Limits		
	Lower (Hz)	Measured (Hz)	Upper (Hz)
0.25	*99 999.*		100 001.
0.5	*499 999.*		*500* 001.
l	*999 999.*		1 000 001.
10	9 999 999.		10 000 001.
50	49 999 999.		50 000 001.
100	99 999 999.		100 000 001.
500	499 999 999.		500 000 001.
1000	999 999 999.		1 000 000 001.
2000	1 999 999 999.		2 000 000 001.
3000	2 999 999 999.		3 000 000 001.
4000	3 999 999 999.		4 000 000 001.

3. Power Level Accuracy Check

Conducting this check will provide a high level of confidence and a verification that the signal generator's power level circuitry is functioning correctly. The check does not test the signal generator to warranted specifications. Test points have been reduced and the limits are degraded in order to minimize measurement time and take into account a broad range of measurement uncertainties. To have the signal generator tested to warranted specifications, a complete power level accuracy performance test is required. Contact your nearest HP service center for information concerning calibration.
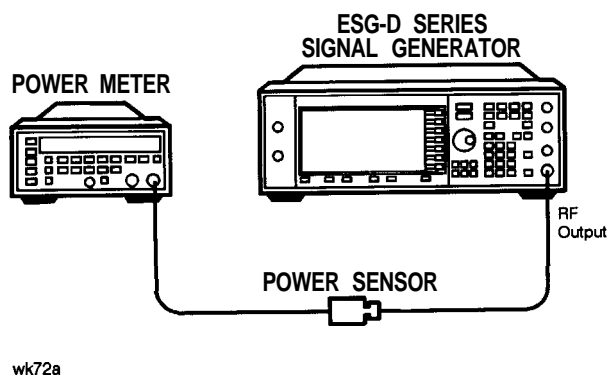
Connect the Test Equipment for Setup 1

wk72a

Figure 3-2.   Power Level Accuracy Equipment Setup 1

Configure the Signal Generator

1. Preset the signal generator to normal (factory-defined) preset conditions.

2. Set the frequency to 277 **kHz.** Press **Frequency.** Enter 277 **kHz** using the numeric keypad and pressing the **kHz** terminator softkey.

3. Set the amplitude to 13 **dBm.** Press **Amplitude.** Enter 13 **dBm** using the numeric keypad and pressing the **dBm** terminator softkey.

4. Turn modulation off. Press **Mod** On/Off. The MOD **OFF** annunciator should be turned on.

5. Turn the RF output on. Press **RF On/Off.** The RF **ON** annunciator should be turned on.

Configure the Power Meter

1. Zero and calibrate the power meter.

2. Set the power meter to measure absolute log power (dBm). Make sure to set the power meter cal factor as necessary for each frequency.

Measure the Power Level Accuracy

1.Set the power levels and the frequencies shown in Table 3-2 (to the maximum frequency of your signal generator).

**2.**Record the measured power level in Table 3-2 and compare it to the corresponding limits.

Table 3-2.   Power Level Accuracy Measurement Points for Setup 1

Frequency Setting	Power Level Setting	Lower Limit	Measured Power	Upper Limit
277 kHz	+13 dBm	12.2		13.8
	+7 dBm	6.5		7.5
	0 dBm	−0.5		0.5
	−5 dBm	−5.5		−4.5
	−15 dBm	−15.5		−14.5
2.516 MHz	+13 dBm	12.2		13.8
	+7 dBm	6.5		7.5
	0 dBm	−0.5		0.5
	−5 dBm	−5.5		−4.5
	−15 dBm	−15.5		−14.5
270.1 MHz	+13 dBm	12.2		13.8
	+7 dBm	6.5		7.5
	0 dBm	−0.5		0.5
	−5 dBm	−5.5		−4.5
	−15 dBm	−5.5		−14.5
510.1 MHz	+13 dBm	12.2		13.8
	+7 dBm	6.5		7.5
	0 dBm	−0.5		0.5
	−5 dBm	−5.5		−4.5
	−15 dBm	−15.5		−14.5

Table 3-2.   Power Level Accuracy Measurement Points for Setup 1

Frequency Setting	Power Level Setting	Lower Limit	Measured Power	Upper Limit
990.1 MHz	+13 dBm	12.2		13.8
	+7 dBm	6.5		7.5
	0 dBm	−0.5		0.5
	−5 dBm	−5.5		−4.5
	−15 dBm	−15.5		−14.5
1350.1 MHz	+10 dBm	9.2		10.8
	+7 dBm	6.5		7.5
	0 dBm	−0.5		0.5
	−5 dBm	−5.5		−4.5
	−15 dBm	−15.5		−14.5
1950.1 MHz	+10 dBm	9.2		10.8
	+7 dBm	6.5		7.5
	0 dBm	−0.5		0.5
	−5 dBm	−5.5		−4.5
	−15 dBm	−15.5		−14.5
2310.1 MHz	+10 dBm	8.8		11.2
	+7 dBm	6.1		7.9
	0 dBm	-0.9		0.9
	-5 dBm	-5.9		-4.1
	-15 dBm	-15.9		-14.1

Table 3-2.   Power Level Accuracy Measurement Points for Setup 1

Frequency Setting	Power Level Setting	Lower Limit	Measured Power	Upper Limit
2985.1 MHz	+10 dBm	8.8		11.2
	+7 dBm	6.1		7.9
	0 dBm	−0.9		0.9
	−5 dBm	−5.9		−4.1
	−15 dBm	−15.9		−14.1
3225.1 MHz	+7 dBm	6.1		7.9
	0 dBm	−0.9		0.9
	−5 dBm	−5.9		−4.1
	−15 dBm	−15.9		−14.1
4000 MHz	+7 dBm	6.1		7.9
	0 dBm	−0.9		0.9
	−5 dBm	−5.9		−4.1
	−15 dBm	−15.9		−14.1

Connect the Test Equipment for Setup 2
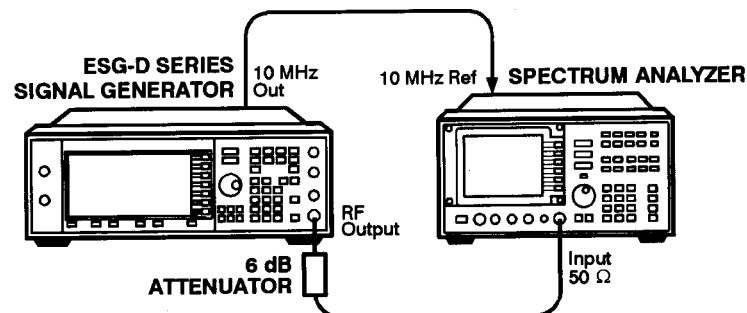
wk741a

Figure 3-3.   Power Level Accuracy Equipment Setup 2

Configure the Signal Generator

1. Set the frequency to 277 kHz. Press **Frequency.** Enter 277 kHz using the numeric keypad and pressing the **kHz** terminator softkey.

2. Set the amplitude to -15 dBm. Press **Amplitude.** Enter -15 dBm using the numeric keypad and pressing the **dBm** terminator softkey.

Configure the Spectrum Analyzer

1. Preset the spectrum analyzer.

2. Set the analyzer to external 10 MHz reference.

3. Set the center frequency to 277 kHz.

4. Set the frequency span to 100 Hz. (This will result in a 1 Hz resolution bandwidth with a digital filter.)

Measure the Power Level Accuracy

1. Connect the signal generator's RF OUTPUT through the 6 dB attenuator to the spectrum analyzer's RF input.

2. Transfer the power level results for each frequency at -15 dBm from Table 3-2 to Table 3-3.

3. On the spectrum analyzer, select Marker Normal Mode and the Select the Peak Search function. This activates the marker and sets it to the signal peak.

4. On the spectrum analyzer, ensure that the marker is at the signal peak and use the **MKR->** menu to set the marker to the reference level. If necessary, select Peak Search to ensure that the marker is at the signal peak.

5. With the marker at signal peak, select the Marker Delta function. This will set the marker to measure relative amplitude from a reference of 0 dB. If the marker reads other than 0 dB, select Marker Normal, Peak Search, and Marker Delta until the marker reads 0 dB.

6. Decrease the signal generator amplitude in 10 dB steps to -85 dBm. At each 10 dB step, select Peak Search to ensure that the marker is at the signal peak.

7. Measure and record the result for each of the frequencies listed in Table 3-3 (to the maximum frequency of your signal generator).

8. Return the spectrum analyzer reference level back to -15 dBm and the signal generator amplitude to -15 dBm. Set the signal generator frequency and the spectrum analyzer's center frequency to the next frequency listed in Table 3-3 and repeat the process from step 3 until all of the frequencies have been measured.

Calculate the Actual Power Level

1. Calculate and record the actual power level as the sum of the power meter reading at -15 **dBm** and the spectrum analyzer's marker value.

For example:

-15 **dBm** power meter reading at 2.516 MHz = -14.95 **dBm**

spectrum analyzer marker at 2.516 MHz and power level set to -85 **dBm** = -70.17 **dB**

Actual Power Level at 2.516 MHz and -85 **dBm**:

(-14.95) + (-70.17) = -85.12 **dBm**

Table 3-3.   Power Level Accuracy Measurement Points for Setup 2

Frequency Setting	Power Level Setting	Power Mtr Reading for -15 dBm	Spectrum Analyzer Marker (dB)	Lower Limit	Measured Power	Upper Limit
277 kHz	-15 dBm		0 (Ref)	N/A	N/A	N/A
	-25 dBm			- 26		- 24
	- 35 dBm			- 36		- 34
	- 45 dBm			- 46		- 44
	−55 dBm			−56		−54
	−65 dBm			−66		−64
	−75 dBm			−76		−74
	−85 dBm			−86		−84
2.516 MHz	−15 dBm		0 (Ref)	N/A	N/A	N/A
	−25 dBm			−26		−24
	−35 dBm			−36		−34
	−45 dBm			−46		−44
	−55 dBm			−56		−54
	−65 dBm			−66		−64
	−75 dBm			−76		−74
	−85 dBm			−86		−84

Table 3-3. **Power Level Accuracy Measurement Points for Setup 2**

Frequency Setting	Power Level Setting	Power Mtr Reading for -15 dBm	Spectrum Analyzer Marker (dB)	Lower Limit	Measured Power	Upper Limit
270.1 MHz	−15 dBm		0 (Ref)	N/A	N/A	N/A
	−25 dBm			−26		-24
	−35 dBm			−36		-34
	−45 dBm			−46		-44
	−55 dBm			−56		-54
	−65 dBm			−66		-64
	−75 dBm			−76		-74
	−85 dBm			−86		-84
510.1 MHz	−15 dBm		0 (Ref)	N/A	N/A	N/A
	−25 dBm			−26		-24
	−35 dBm			−36		-34
	−45 dBm			−46		-44
	−55 dBm			−56		-54
	−65 dBm			−66		-64
	−75 dBm			−76		-74
	−85 dBm			−86		-84
990.1 MHz	−15 dBm		0 (Ref)	N/A	N/A	N/A
	−25 dBm			−26		-24
	−35 dBm			−36		-34
	−45 dBm			−46		-44
	−55 dBm			−56		-54
	−65 dBm			−66		-64
	−75 dBm			−76		-74
	−85 dBm			−86		-84

Table 3-3.   Power Level Accuracy Measurement Points for Setup 2

Frequency Setting	Power Level Setting	Power Mtr Reading for -15 dBm	Spectrum Analyzer Marker (dB)	Lower Limit	Measured Power	Upper Limit
1350.1 MHz	−15 dBm		0 (Ref)	N/A	N/A	N/A
	−25 dBm			−26		- 24
	−35 dBm			−36		- 34
	−45 dBm			−46		- 44
	−55 dBm			−56		- 54
	−65 dBm			−66		- 64
	−75 dBm			−76		- 74
	−85 dBm			−86		- 84
1950.1 MHz	−15 dBm		0 (Ref)	N/A	N/A	N/A
	−25 dBm			−26		- 24
	−35 dBm			−36		- 34
	−45 dBm			−46		- 44
	−55 dBm			−56		- 54
	−65 dBm			−66		- 64
	−75 dBm			−76		- 74
	−85 dBm			−86		- 84
2310.1 MHz	−15 dBm		0 (Ref)	N/A	N/A	N/A
	−25 dBm			−26		- 24
	−35 dBm			−36		- 34
	−45 dBm			−46		- 44
	-55 dBm			-56		- 54
	-65 dBm			-66		- 64
	-75 dBm			-76		- 74
	-85 dBm			- 86		- 84

Table 3-3. **Power Level Accuracy Measurement Points for Setup 2**

Frequency Setting	Power Level Setting	Power Mtr Reading for -15 dBm	Spectrum Analyzer Marker (dB)	Lower Limit	Measured Power	Upper Limit
2985.1 MHz	−15 dBm		0 (Ref)	N/A	N/A	N/A
	−25 dBm			−26		- 24
	−35 dBm			−36		- 34
	−45 dBm			−46		- 44
	−55 dBm			−56		- 54
	−65 dBm			−66		- 64
	−75 dBm			−76		- 74
	−85 dBm			−86		- 84
3225.1 MHz	−15 dBm		0 (Ref)	N/A	N/A	N/A
	−25 dBm			−26		- 24
	−35 dBm			−36		- 34
	−45 dBm			−46		- 44
	−55 dBm			−56		- 54
	−65 dBm			−66		- 64
	−75 dBm			−76		- 74
	−85 dBm			−86		- 84
4000 MHz	−15 dBm		0 (Ref)	N/A	N/A	N/A
	−25 dBm			−26		- 24
	−35 dBm			−36		- 34
	−45 dBm			−46		- 44
	−55 dBm			−56		- 54
	−65 dBm			−66		- 64
	−75 dBm			−76		- 74
	−85 dBm			−86		- 84

4. FM Accuracy Check

Connect the Test Equipment

wk75a
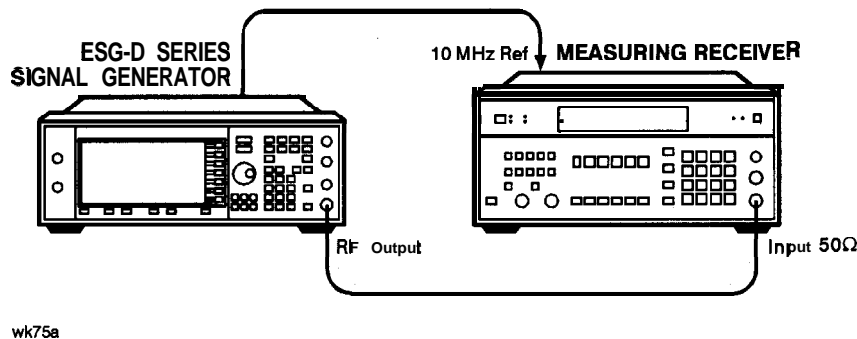
Figure 3-4.   FM Accuracy Equipment Setup

Configure the Signal Generator

1. Preset the signal generator to normal (factory-defined) preset conditions.

2. Enable FM. Press **FM/ΦM, FM** Off **On.**   The FM annunciator should turn on.

3. Set the FM rate to 1 kHz. Press **FM Rate** and enter 1 kHz using the numeric keypad and pressing the **kHz** terminator softkey.

4. Set the FM deviation to 100 kHz. Press **FM Dev** and enter 100 kHz using the numeric keypad and pressing the **kHz** terminator softkey.

5. Set the amplitude to 7 dBm. Press **Amplitude** and enter 7 dBm using the numeric keypad and pressing the **dBm** terminator softkey.

6. Check to be sure that modulation is turned on. The MOD ON annunciator should be turned on. If it is not, press **Mod On/Off.**

7. Turn on the RF output. Press **RF** On/Off. The RF ON annunciator should be turned on.

Configure the Measuring Receiver

1. Reset the measuring receiver.

2.   Set the measuring receiver to FM mode.

3. Turn on Peak+ detector.

4.   Turn on the 300 Hz high-pass filter.

5.   Turn on the 3 kHz low-pass filter.

Measure the Deviations

1. Set the signal generator to the frequencies shown in Table 3-4.

2. Record the deviations measured and compare them to the limits shown in Table 3-4.

Table 3-4.   FM Accuracy Measurement Points

Frequency (MHz)	Deviation (kHz)	Limits (kHz)		
		Lower	Measured	Upper
500.001	100 kHz	96. 48		103. 52
750	100 kHz	96. 48		103. 52
1000	100 kHz	96. 48		103. 52

5. AM Accuracy Check

Connect the Test Equipment

wk75a
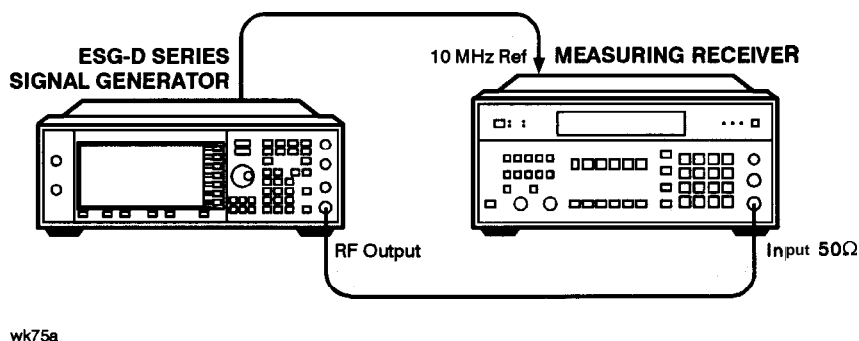
Figure 3-5.   AM Accuracy Equipment Setup

Configure the Signal Generator

1. Preset the signal generator to normal (factory-defined) preset conditions.

2. Enable AM. Press **AM, AM** Off **On.**   The AM annunciator should turn on.

3. Set the AM rate to 1 kHz. Press **AM Rate** and enter 1 kHz using the numeric keypad and pressing the **kHz** terminator softkey.

4. Set the amplitude to +7 dBm. Press **Amplitude** and enter +7 dBm using the numeric keypad and pressing the **dBm** terminator softkey.

5. Check to be sure that modulation is turned on. The MOD ON annunciator should be turned on. If it is not, press **Mod On/Off.**

6. Turn on the RF output. Press **RF** On/Off. The RF ON annunciator should be turned on.

Configure the Measuring Receiver

1. Reset the measuring receiver.

2. Set the measuring receiver to AM mode.

3. Turn on Peak+ detector.

4. Turn on the 300 Hz high-pass filter.

5. Turn on the 3 kHz low-pass filter.

Measure the Deviations

1. Set the signal generator to the frequencies, and depths shown in Table 3-5.

2. Record the AM depths measured and compare them to the limits shown in Table 3-5.

Table 3-5.   AM Accuracy Measurement Points

Frequency (MHz)	Depth (%)	Limits (%)		
		Lower	Measured	Upper
200	30	27.5		32.5
200	90	84.5		95.5
300	30	27.5		32.5
300	90	84.5		95.5
501	30	27.5		32.5
501	90	84.5		95.5
750	30	27.5		32.5
750	90	84.5		95.5
1000	30	27.5		32.5
1000	90	84.5		95.5

6. I/Q Modulation Check

1. Preset the signal generator to normal (factory-defined) preset conditions.

2. **Press I/Q**, **1/Q Calibration.** If **Calibration Type Full** is not highlighted, toggle the **softkey** to select **Full.**

3. **Press Execute Cal** to begin an I/Q calibration for the signal generator's full frequency range. The message **I/Q Calibration in** Progress is displayed until the calibration is complete.

4 Service Software

The ESG Series Support Software contains the program and supporting files necessary to run the automated performance tests and adjustments for your signal generator. This chapter lists the equipment required to run the software, and gives instructions for installing and using the software. This information includes a short description for each adjustment. For a description of the individual performance tests, refer to the "Performance Tests" chapter.

Required Test Equipment

The following equipment is required to run the software:

- Personal Computer with the following specifications:
    - **386/33** MHz CPU, 8 Mbytes RAM
    - 350 Mbyte Hard Drive
    - **16-Color** VGA Monitor
- MS Windows@ 3.X
- 2 Button Mouse (optional)
- Printer, MS Windows-Supported (for hardcopy documentation of test results)
- HP **82341C** HP-IB Interface Card
    - HP SICL Libraries must be installed and configured

Microsoft Windows is a registered trademark of Microsoft Corp.

Installing the ESG Series Support Software

Follow this procedure to install the ESG Series Support Software on your personal computer.

1. Insert the ESG Series Support Software disk (HP part number E4400-10001) into a 3.5 inch disk drive.

2. In the MS Windows File Manager program, select the drive where the software disk resides.

3. Double-click **setup.exe** to start installation.

4. A window appears showing the default drive and directory where the program will be installed. If you prefer, you can change the path at this time. When you are satisfied with the path, press **Continue** to begin installation. If you do not want to install the software after all, press **Exit Install.**

5. A setup window displays the completion status (in percent) of the installation process. Press **Cancel** at any time to abort installation.

6. When the installation is complete, a **readme** file is displayed. This file contains information **about** the latest updates to the software. When you have finished reading the file, press **Continue.**

7. A window appears announcing the completion of the installation process and indicating that the application is properly installed. Click **OK.**

8. An applications group titled ESG Series Support Software is created with a **testexec.exe** icon. The installation process is now complete.

ESG Series Support Software Administration

The following section shows you how to administer and run the ESG Series Support Software. The software's administrative functions allow for the addition or removal of all necessary test equipment, software drivers, and test procedures. This would include additional software drivers (as they are released) to extend the range of tests and equipment supported by the ESG Series test set, or maintenance releases of the current drivers.

Software Configuration

Follow the instructions below to configure the software to run in either User mode or Administration mode.
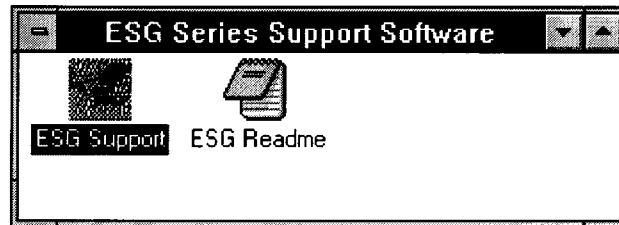
wk791a

Figure 4-1. **ESG Series Support Software Window**

1. Double click on the ESG Support icon and the **User Information** window appears. The support software has two configurations: User and Admin. The following sections explain the difference between the two configurations.
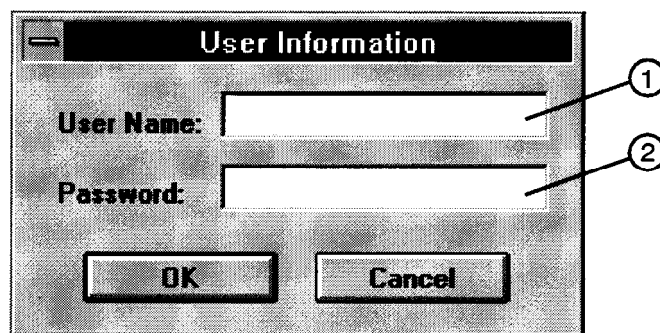
wk758a

Figure 4-2.   The User Information Window

The User Configuration

Logging on in User Configuration only allows access to the instrument's performance tests and adjustments. Refer to the section titled, "Running the Performance Tests" in the chapter, "Performance Tests."

The Administration Configuration

Logging on in Administration Configuration supports all administrative functions including the addition of new equipment and the installation of test procedures and device drivers.

1. Refer to Figure 4-2 and fill in the fields in the **User Information** window:

    a   In the **User Name** field (item 1), type in the word **Admin.**
    b   In the **Password** field (item 2), type in the word **Falcon.**

2. Click **OK. (Cancel** closes the software application.)

Adding Test Equipment

Before any performance tests can be run, your specific test equipment must be entered into the software database containing the serial numbers, calibration dates, HP-IB address, and traceability information for each individual component. Only equipment which has been entered into the system will be available for the test equipment selection process during the test setup. To add test equipment, follow the instructions below:

1. Refer to Figure 4-3. In the **File** drop-down menu, select **Test Equipment** (item 4).
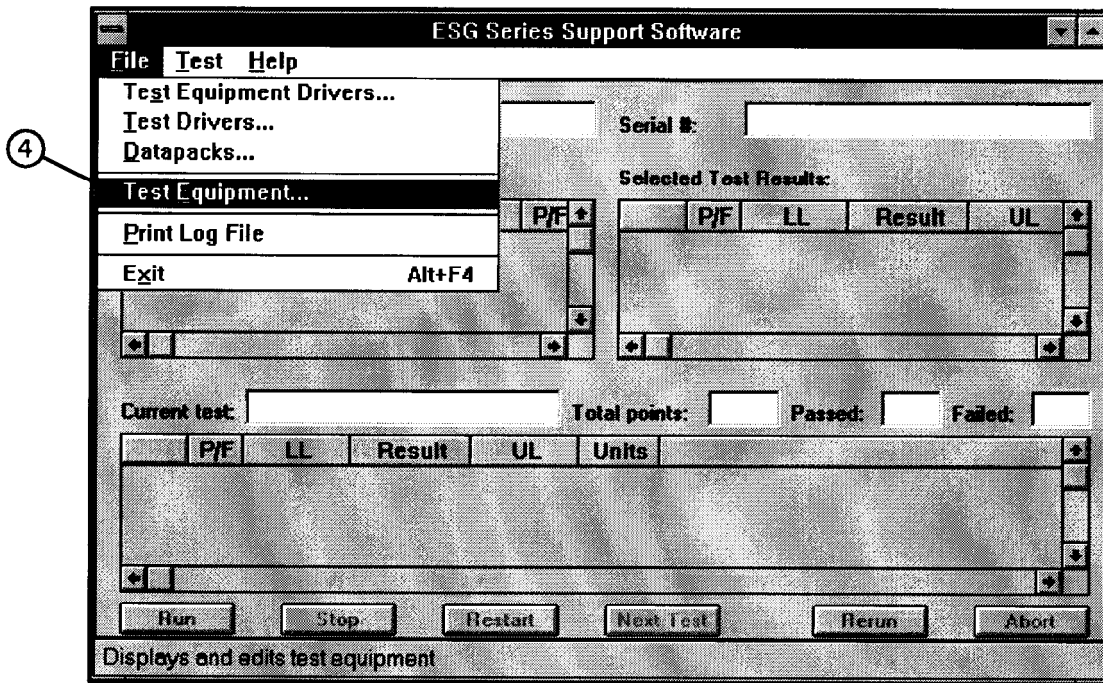
wk776e

Figure 4-3.   Test Equipment Drivers in the File Drop-Down Menu

2. Refer to Figure 4-4. In the Test Equipment dialog box, select the Device Type for the new equipment you are adding (item 5).
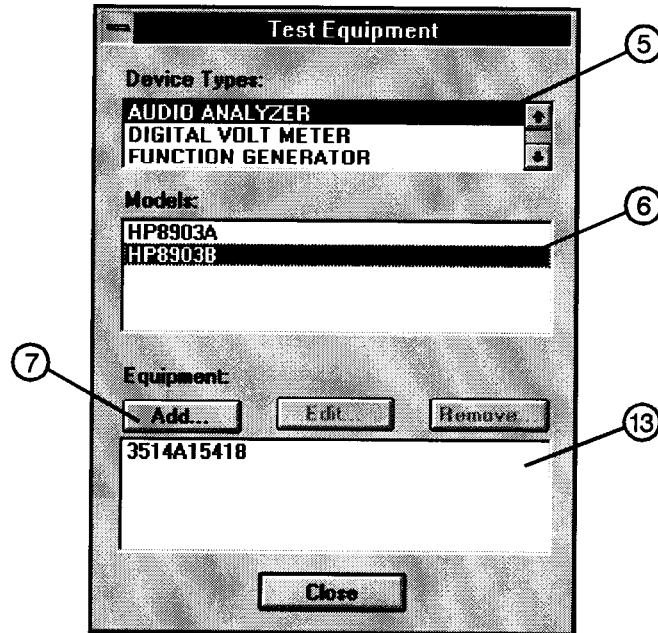
wk797a

Figure 4-4.   Adding Test Equipment Using the Test Equipment Menu

3. Select the model of the device (item 6).

4. Click **Add** (item 7).

5. In the **New Test Equipment** window (refer to Figure 4-5), enter the following parameters into the appropriate box:

Serial Number   of the new equipment (item 8).

HP-IB Address   of the new equipment (item 9). This address must be in the range of O-3 1 and it should not conflict with any other instrument address already present in the test setup. NOTE: The power sensor must be assigned HP-IB address -1 (negative 1).

Cal Due Date   the projected calibration due date of the new equipment (item 10).

Trace Number   the calibration tracking number (item 11). This is the last required item.

Calibration Type (optional) is used only when special calibration data is associated with the device being added, and only as a function setup by the factory for equipment requiring specific calibration data (item 14). The only devices currently requiring this feature are power sensors.

The following Table 4-1, is an example of the calibration information that is required to insure accuracy in measurements using the power sensor. This window is accessed for data entry by selecting the words CAL DATA from the **Calibration Type** field in the **Edit** or **New Test Equipment** window, Figure 4-5.

Table 4 -1.   An Example of Calibration Data for Power Sensors

Frequency (MHz)	Calibration Factor (%)
.1000	97.6
.3000	98.9
1.0	99.1
3.0	99.4
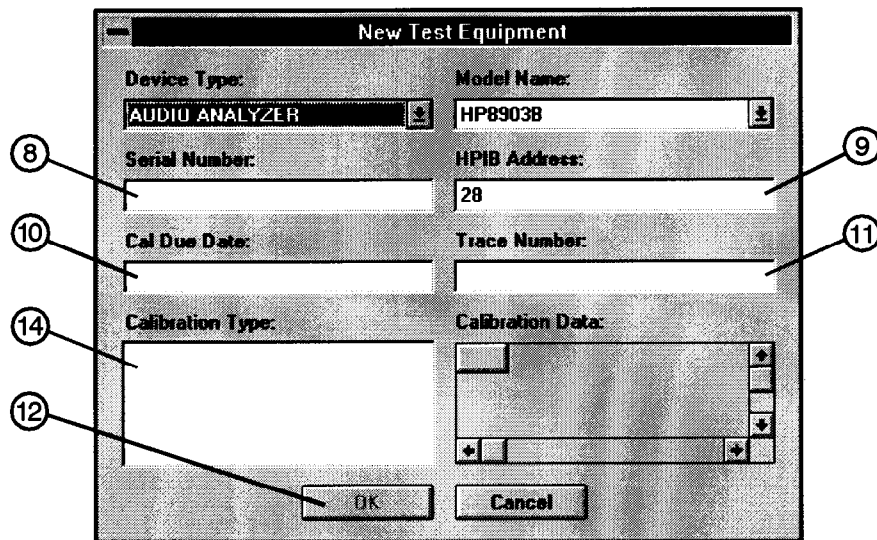
wk798a

Figure 4-5.   Adding the Equipment Information Using the New Test Equipment Window

6. Click **OK** (item 12). NOTE: The serial number of the test equipment added will be displayed in the **Equipment** field of the **Test Equipment** dialog box (Figure 4-4, item 13).

Removing Test Equipment

Removal of test equipment is accomplished using the **Test Equipment** dialog box. Refer to Figure 4-6.

1. Select the **Device Type** of the test equipment to be removed (item 15).

wk799a
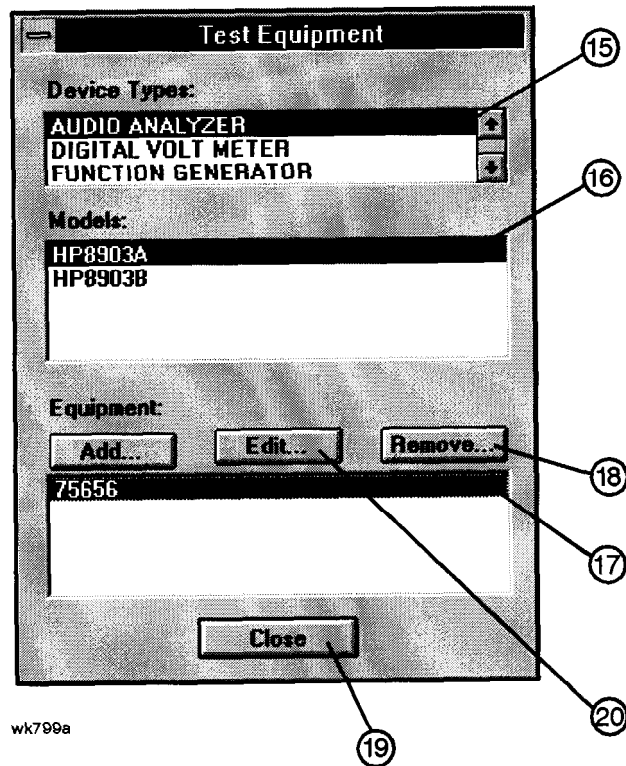
Figure 4-6.   Removing and Editing Test Equipment Using the Test Equipment Window

2.   Select the model of the test equipment to be removed from the **Models** field (item 16).

3.   Select the serial number of the test equipment to be removed from the **Equipment** field (item 17).

4. Click **Remove** (item 18).

5. Click Close (item 19).

Editing Test Equipment

Editing of test equipment parameters is accomplished using the **Test Equipment** dialog box. Refer to Figure 4-6.

1. Select the **Device Type** of the test equipment to be edited (item 15).

2.   Select the model of the test equipment to be edited from the **Models** field (item 16).

3.   Select the serial number of the test equipment to be edited (item 17).

4.   Click **Edit** (item 20). Change the field parameters as necessary.

5. Click **OK** (Figure 4-5, item 12).

6. Click Close (item 19).

Adding Device Drivers

CAUTION: The following three procedures: Adding/Removing Device (Test Equipment) Drivers, Adding/Removing Test Drivers, and Adding/Removing Datapacks are included for informational purposes. These procedures should only be used when instructions are provided describing which drivers or datapacks need replacement or removal.

Follow these instructions to add test equipment device drivers to the program:

1. **The DUT Selection** window opens by default. It is not necessary to select any device to perform the administrative setup functions.
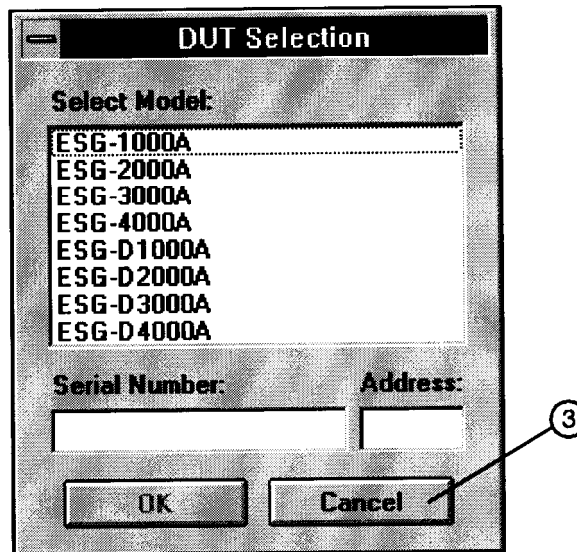
wk766a

Figure 4-7.   **The DUT Selection Window**

Click **Cancel** to close the **DUT Selection** window (item 3).

2. Refer to Figure **4-8.** In the **File** drop-down menu, select **Test Equipment Drivers** (item 21).
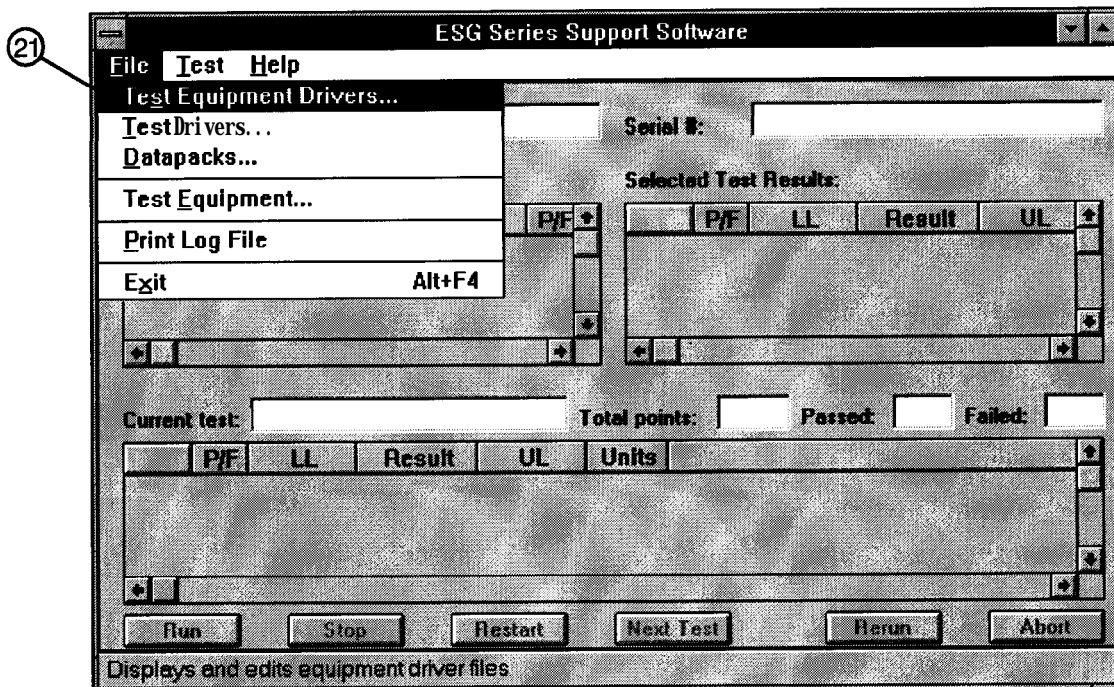
Figure 4-8. **Test Equipment Drivers in the File Drop-Down Menu**

This selection allows for the addition or removal of software drivers for the test equipment being used to verify the performance of the DUT.

3. To add a device driver to the existing list of test equipment drivers, click **Add** (Figure 4-9, item 22).
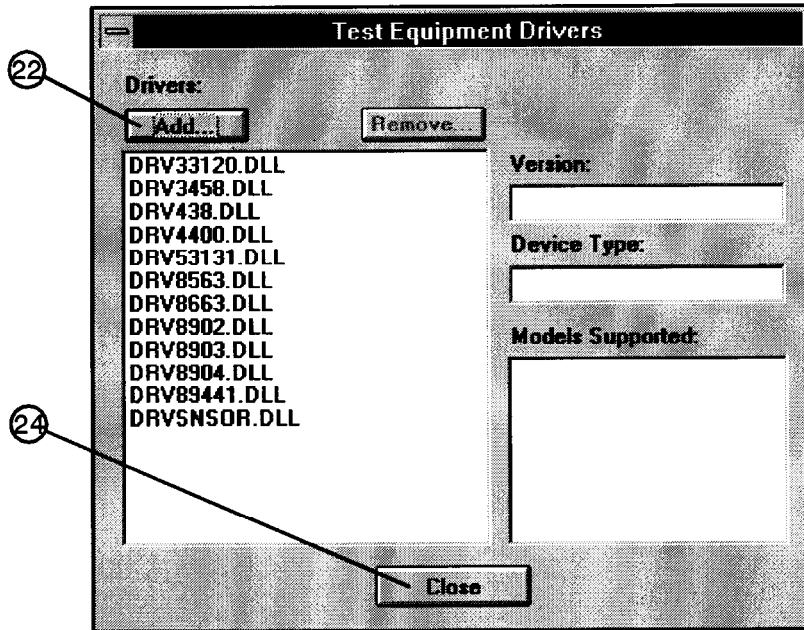
wk765a

Figure 4-9.   Adding a Device Driver Using the Test Equipment Drivers Window

4. Refer to Figure 4-10. Using the standard file search procedure, select the driver that you are adding and click OK (item 23).
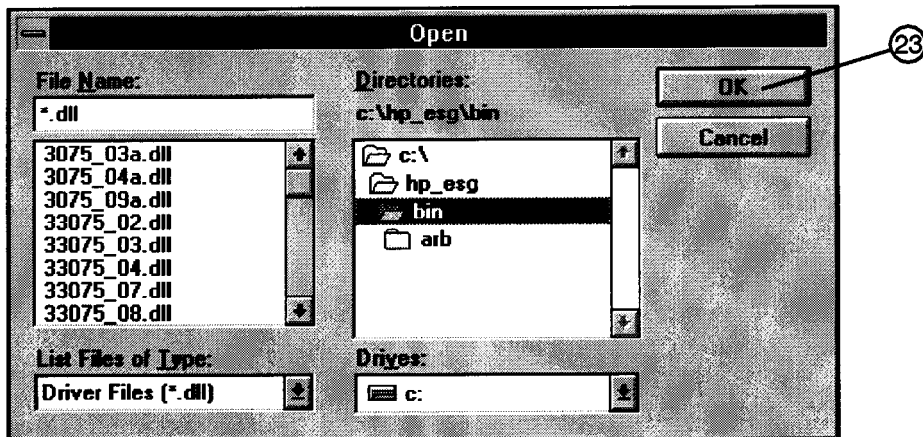
wk767a

**Figure 4-10.   Using the Open Dialog Box to Search for a Device Driver File to Add**

The selected driver should now be displayed in the **Test Equipment Drivers** dialog box, as seen in Figure 4- 11.

Removing Device Drivers

Removal of device drivers is accomplished using the **Test Equipment Drivers** dialog box. Refer to Figure 4-11.

1. Refer to Figure 4-l 1. Select the driver (. dll) file to be removed (item 26).
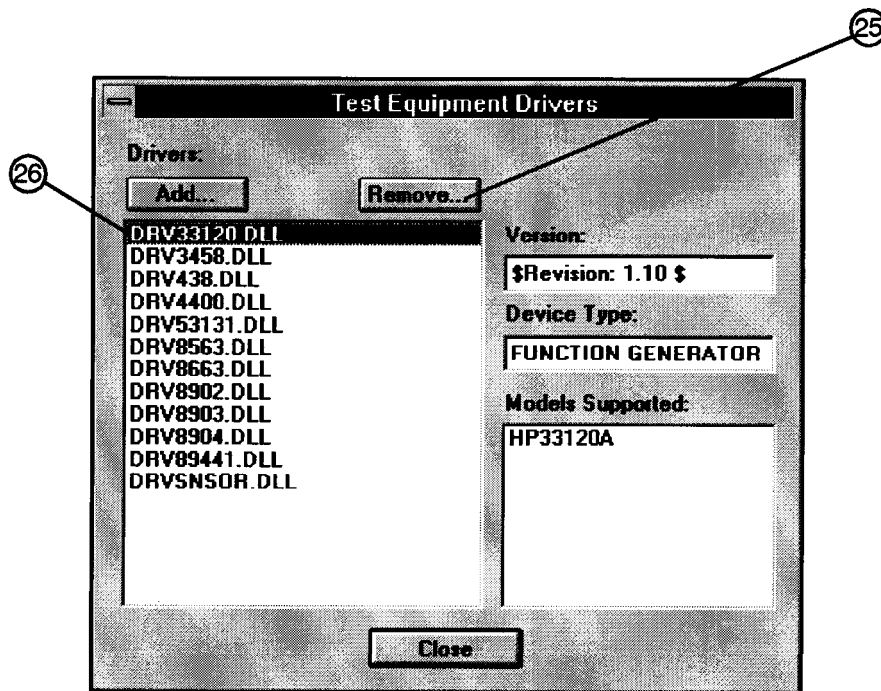
wk766a

Figure 4-11.   Removing a Device Driver Using the Test Equipment Drivers Window

2. Insure that the information displayed in the **Version, Device Type,** and **Models Supported** fields reflects the current information for the selected driver.

3. Click **Remove** (item 25).

4. Click **Close** (Figure 4-9, item 24).

Adding Test Drivers

The Test Drivers window allows for the addition of software drivers for the test procedures being used to verify the performance of the DUT. Follow these instructions to add a test driver:

1. Refer to Figure 4-12. In the **File** drop-down menu, select **Test Drivers** (item 27).
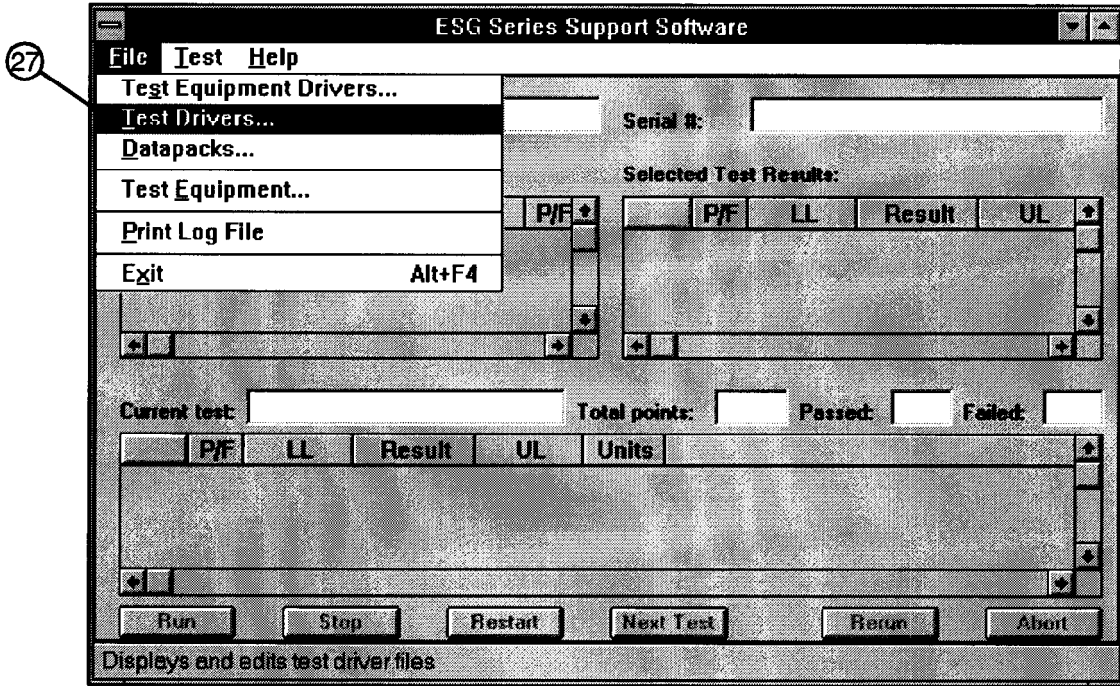
wk792a

Figure 4-12.   Test Drivers in the File Drop-Down Menu

2. Refer to Figure 4-13. To add a test driver to the existing list of test drivers, click **Add** (item 28).
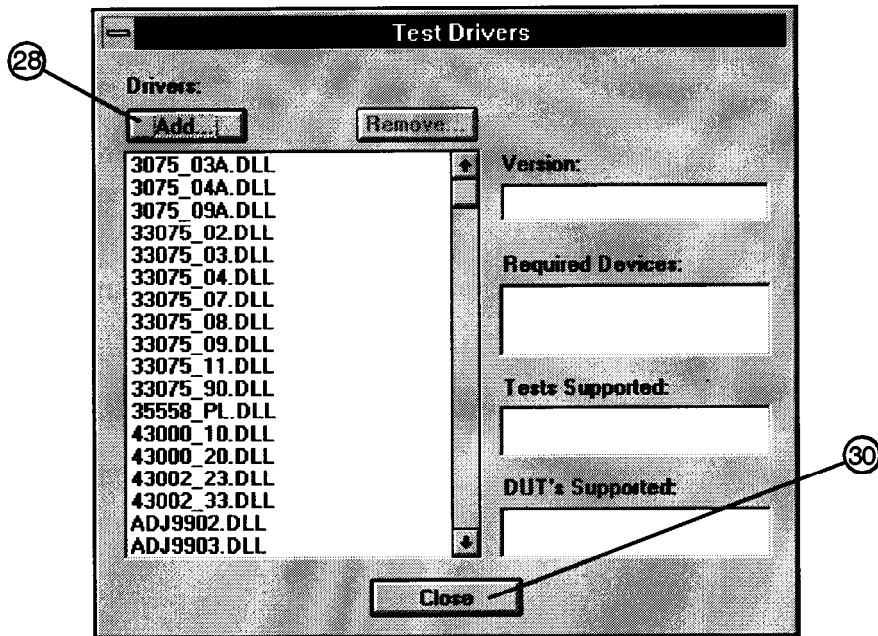
wk774a

Figure 4-13.   Adding a Test Driver Using the Test Drivers Window

3. Refer to Figure 4-14. Using the standard file search procedure, select the test driver that you are adding and click **OK** (item 29).
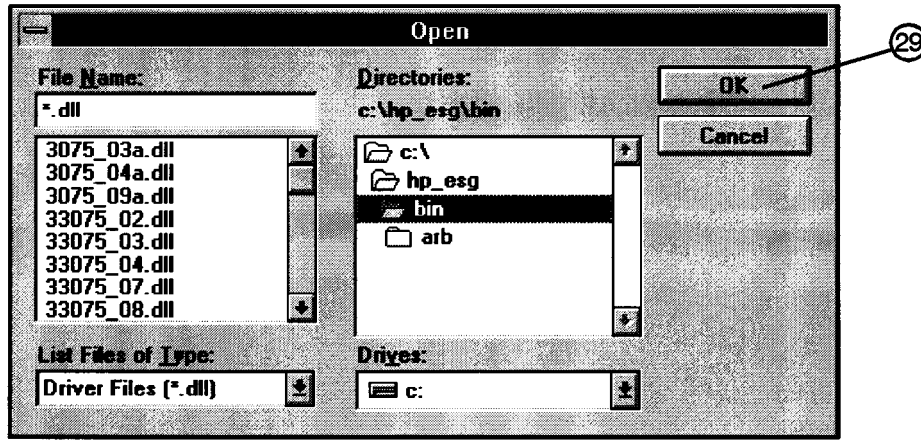
wk773a

Figure 4-14. Using the Open Dialog Box to Search for a Test Driver File to Add

The selected driver should now be displayed in the **Test Drivers** dialog box, as seen in Figure 4- 13.

4. Click **Close** (Figure 4- 13, item 30).

Removing Test Drivers

Removal of test drivers is accomplished using the **Test Drivers** dialog box. Refer to Figure 4-15.

1. Select the driver **(.dll)** file to be removed (item31).
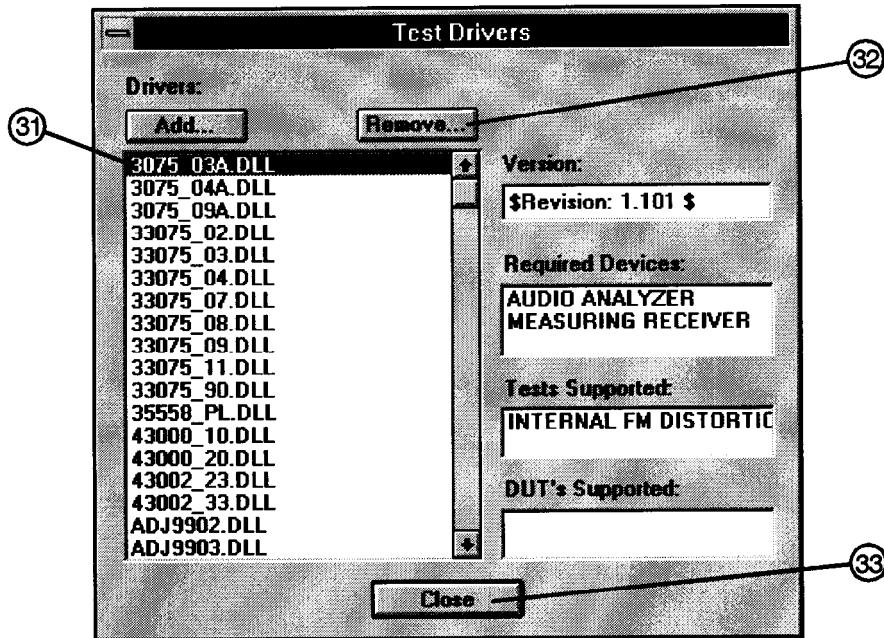
wk775a

Figure 4-15. Removing a Test Driver Using the Test Drivers Window

2. Insure that the information displayed in the **Version, Device Type,** and **Models Supported** fields reflects the current information for the selected driver.

3. Click **Remove** (item 32).

4. Click **Close** (item 33).

Adding Datapacks

The addition of datapacks is accomplished using the **Datapacks** dialog box.

The Datapacks window allows for the addition of datapacks for the test procedures being used to verify the performance of the DUT. Follow these instructions to add a datapack:

1. Refer to Figure 4-16. In the **File** drop-down menu, select **Datapacks** (item 34).
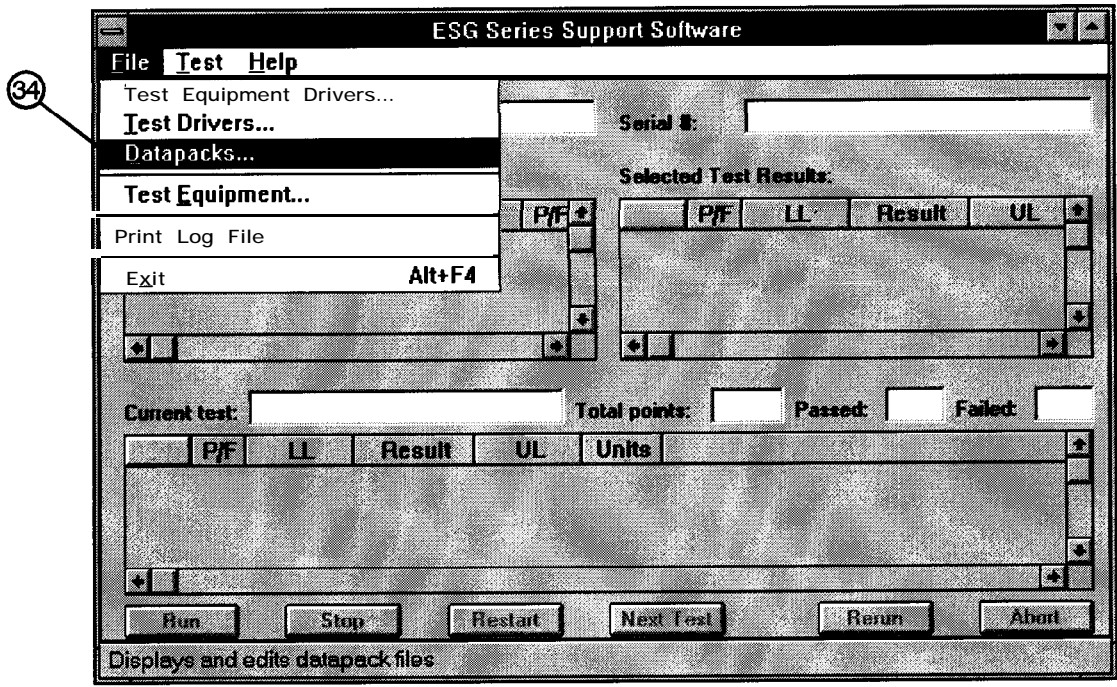
wk793a

Figure 4-16.   Datapacks in the File Drop-Down Menu

2.   Refer to Figure 4-17. To add a **datapack** to the existing list of datapacks, click Add (item 35).
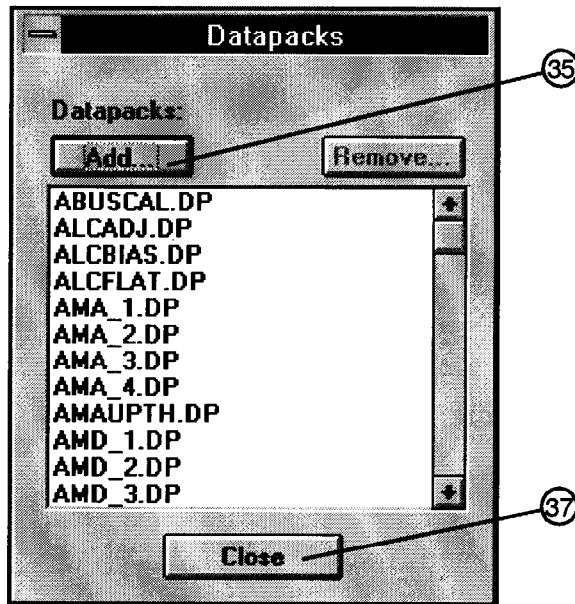
wk794a

Figure 4-17. Adding a Datapack Using the Datapacks Window

3. Refer to Figure 4-1 8. Using the standard file search procedure, select the datapack that you are adding and click
    OK (item 36).
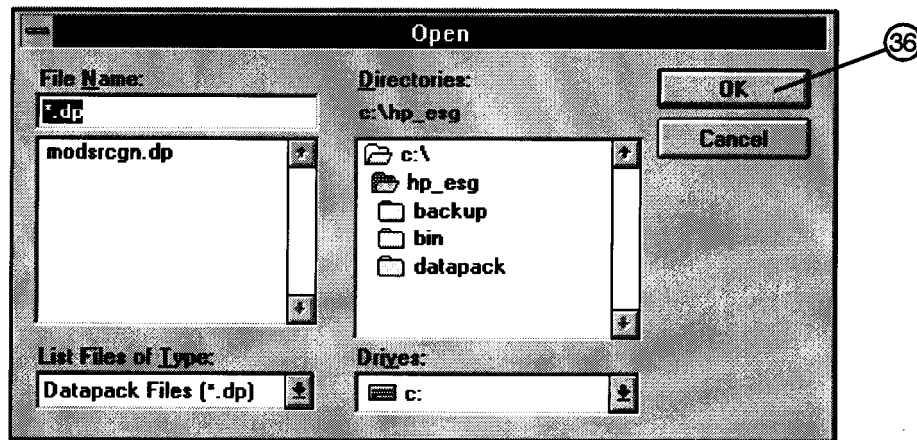
wk795a

Figure 4-18. Using the Open Dialog Box to Search for a Datapack File to Add

The selected driver should now be displayed in the **Datapacks** dialog box, as seen in Figure 4-17.

4. Click Close (Figure 4-17, item 37).

Removing Datapacks

Removal of datapacks is accomplished using the **Datapacks** dialog box. Refer to Figure 4- 19.

1. Select the datapack (. **dp**) file to be removed (item 38).
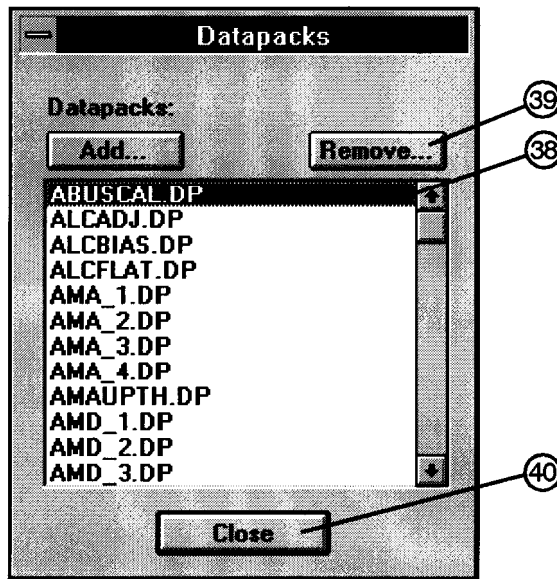
wk796a

Figure 4-19.   Removing a Datapack Using the Datapacks Window

2. Click **Remove** (item 39).

3. Click Close (item 40).

5 Performance Tests

The procedures in this chapter test the electrical performance of the signal generator to its specifications.

Calibration Cycle

This instrument requires periodic verification of performance. Under normal use and environmental conditions, the instrument should be calibrated every two years. Normal use is defined as about 2,000 hours of use per year.

Performance Test Records

Using the "ESG Series Support Software," you can printout a test record that contains the results of the automated performance tests. For the two manual performance tests: "Timebase Aging Rate" and "Modulation Source Frequency Accuracy;" a performance test record is located at the end of this chapter where you can record the test results.

Recommended Test Equipment

The recommended test equipment table, located in Chapter 2, is the complete list of equipment required to perform the procedures in this book. Test equipment is also listed with each test description and test setup. However, to avoid clutter in the figures, the controller that is required to run the support software is not shown in the test setup for each automated test. The controller must be connected through HP-IB to all of the test equipment in the currently selected automated test(s). For performance tests, other equipment can be substituted for the recommended models if it meets or exceeds the critical specifications listed in Table 2-1. For the adjustment procedure, no equipment substitutions are available.

Support Software

The "ESG Series Support Software" runs performance tests and generates reports that document the results of the tests. The following performance tests are manual tests and CANNOT be run with the software:

- Timebase Aging Rate
- Modulation Source Frequency Accuracy

This chapter shows how to run the software to test and verify the performance of a signal generator. "Chapter 4. Service Software" explains how to set up the software for a particular set of test instruments and interfaced components in a test environment.

Running the Performance Tests

1 Load the support software into the personal computer. Refer to "Chapter 4. Service Software" for detailed instructions on installing the software.
2 Click on the installed support software icon.
3 Fill in the fields in the displayed window:
   a In the "User Name:" field, type in the word: "User" (item 1).
   b In the "Password:" field, type in the word: "User" (item 2).
4 Click **OK.**
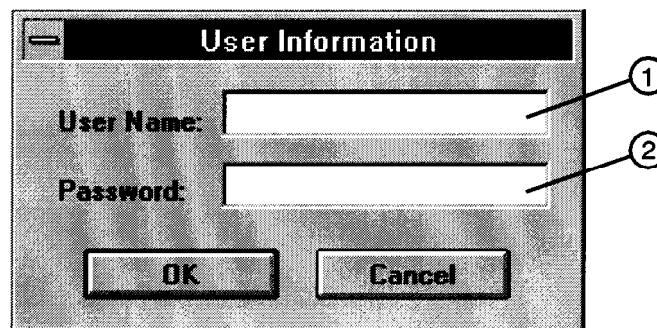
wk758a

Figure 5-1. Support Software "User Information" Window

5 Select the device under test (DUT):
   a Click on the model number of the signal generator (DUT) that you will test (item 3).
   b Click on the "Serial Number:" box, and then type in the serial number of the signal generator (item 4).
   c Click on the "Address:" box, and then type in the HP-IB address of the signal generator (item 5). You can find the HP-IB address on the signal generator display after you press the following keys: **Utility, HP-IB/RS-232, HP-IB Address.**
6 Click **OK.**
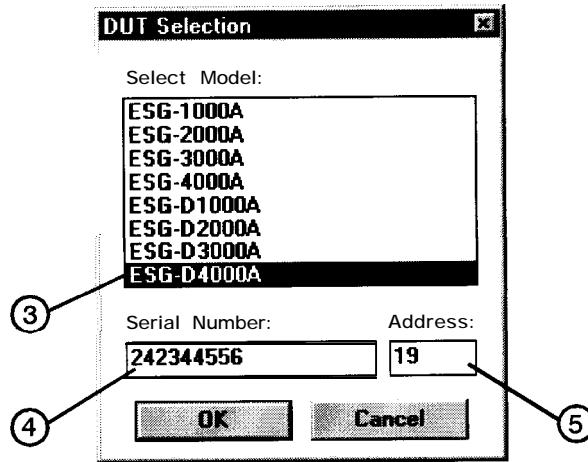
Figure 5-2. Support Software "DUT (Device Under Test) Selection" Window

7 Create a list of test equipment that will verify the signal generator's performance:
  a Click on a device type (item 6) that you want to add to the equipment list.
  b Click on the model (item 7) of the device type that you want to add to the equipment list.
  c Click on the serial number (item 8) of an available instrument. There may be more than one instrument available for any model. Make sure the instrument calibration due date has not passed. If the due date has passed, use another available instrument. Also alert your system administrator that the due date has passed.
  d Click **Add** (item 9) to add the instrument to the test equipment list.
  e Continue adding test equipment to the list by repeating this step.

  You can correct mistakes while you are entering instruments in the test equipment list:

  · To delete a single entry in the equipment list, click on the unwanted selection in the "Selected Test Equipment:" box (item 10) and then click Remove (item 11).
  • To delete the entire list of equipment, click **Clear** (item 12).
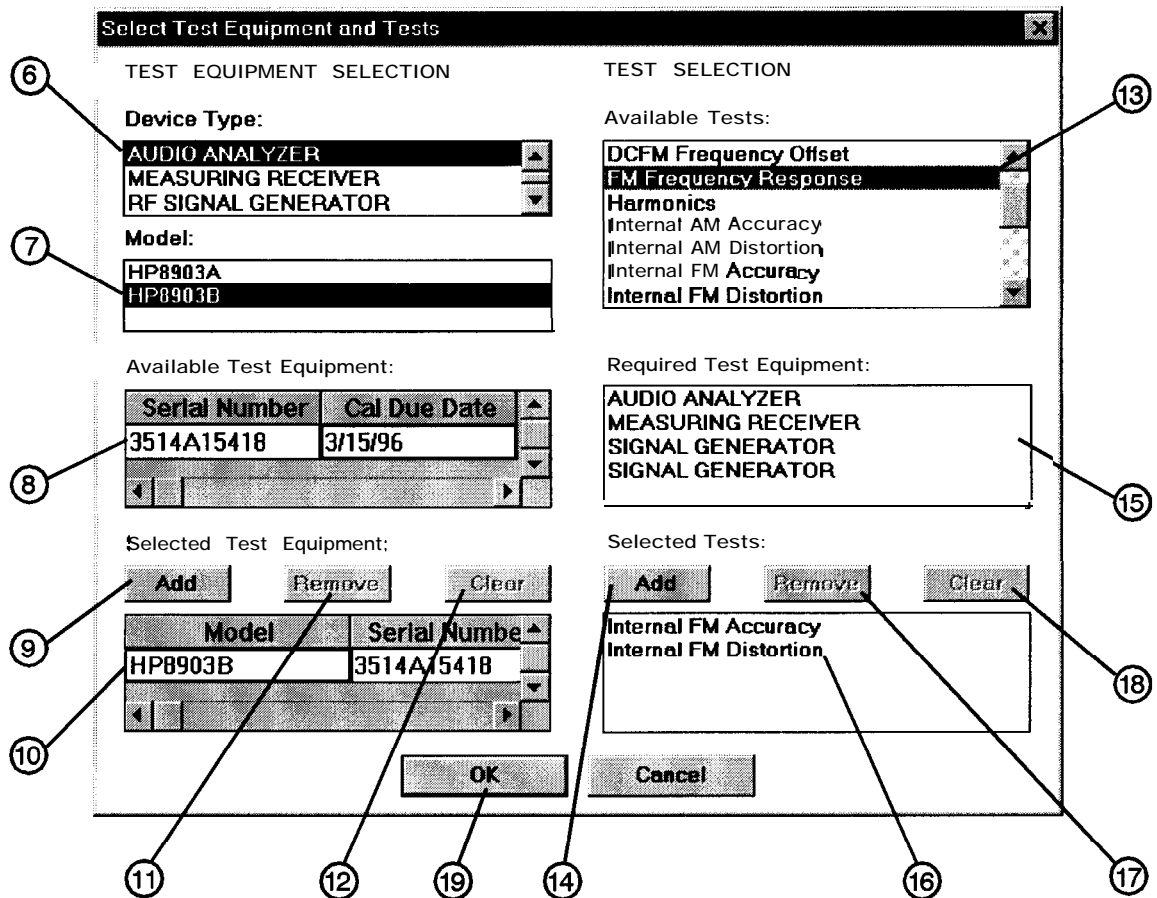
Figure 5-3. Support Software "Select Test Equipment and Tests" Window

8 Create a list of performance tests that you want the software to run:

a Click on a performance test title (item 13).

b Click **Add** (item 14) to add the test to the list of tests that the software will run.

You can view the required test equipment (item 15) for a performance test by clicking on the test title (item 13) in the "Available Tests" box.

c Continue adding performance tests to the list by repeating this step.

You can correct mistakes while you are entering tests in the performance test list:

- To delete a single entry in the test list, click on the unwanted selection in the "Selected Tests:" box (item 16) and then click **Remove** (item 17).

- To delete the entire list of equipment, click **Clear** (item 18).

9   Click OK (item 19).

10 To save-the test results to a file, make the following selections:

    a   Click on the "Drives" window (item 20) and select the drive where you want to save the test results.

    b   Click on the "Save file as type:" window (item 21) and select the file type for saving the test results.

    c   Click on the "File name:" window (item 22) and type in a name for the test results file.

11 Click OK (item 23).
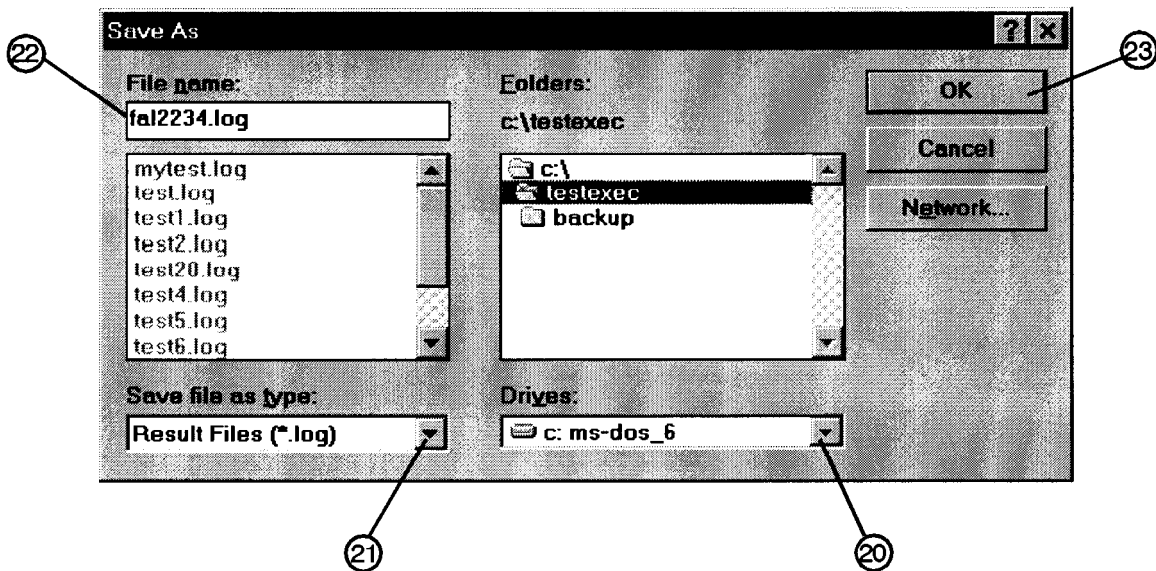
wk762a

Figure 5-4. Support Software "Save As" Window

12 Verify that the selected DUT and serial number (item 24) and selected tests (item 25) are correct. Then click Run.

The selected performance tests are listed in the order in which they will run. You cannot change this order.

During the testing sequence the window shows the following information:

❒ The model and serial number of the signal generator under test (item 24).

❒ The list of selected performance tests, with the current test highlighted (item 25).

❒ The performance test currently running (item 26).

❒ The data points taken (item 27).

❒ The total number of data points that will be measured during the test (item 28).

0 The number of points that have currently passed the test (item 29).

❒ The number of points that have currently failed the test (item 30).

0 The lower limits (LL) and upper limits (UL) for each test point (items 31 and 32).

0 The measured results (item 33) and the pass/fail (P/F) indication (item 34).

You can scroll the results window, vertically and horizontally. You can also click on the following during the test sequence:

- **Run** starts the test sequence, or continues the test that was running when you clicked **Stop.**
- **Stop** halts the test sequence.
- **Restart** goes to the beginning of the test that was running when you clicked **Stop.**
- **Next Test** jumps to the test that is next in the sequence and continues running the remaining tests.
- **Abort** clears all information from this window. To begin a performance test sequence with a new DUT, click "File" and "New Session." This allows a reselection of the DUT, equipment list, and performance test list.
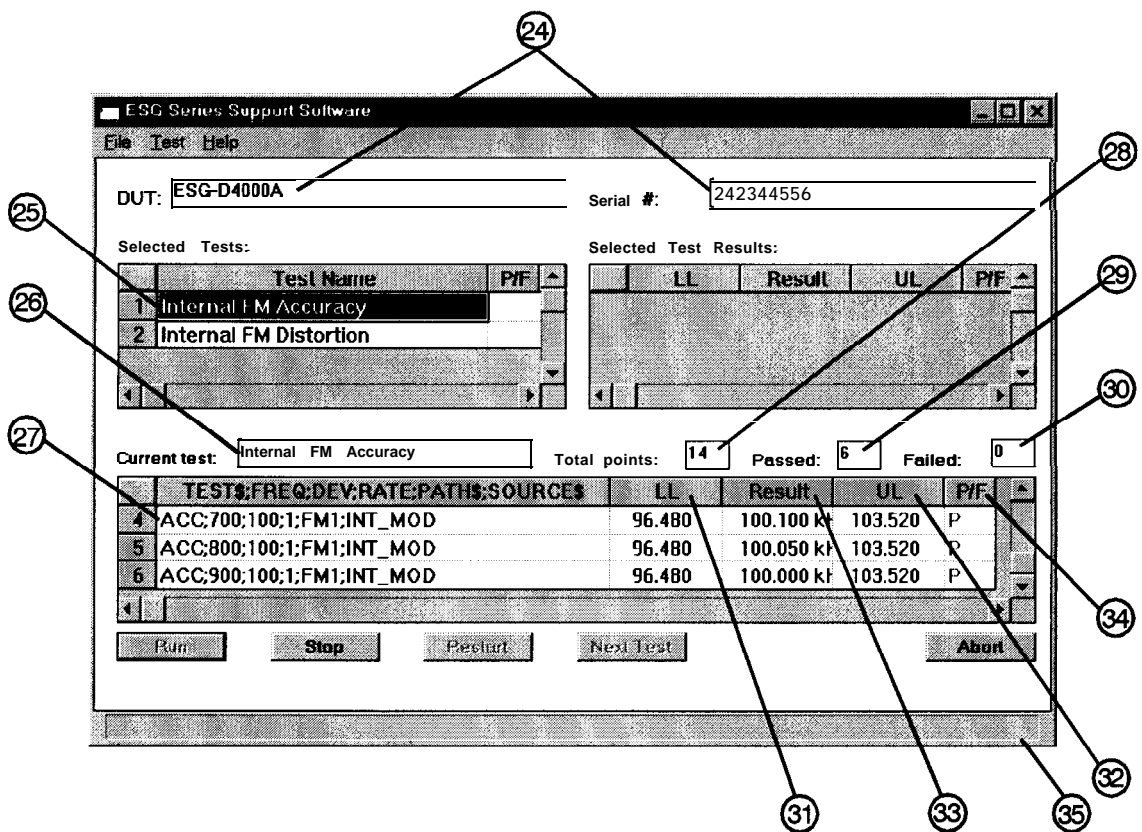
wk761a

Figure 5-5. Support Software "Main Test and Results" Window

13 When the software has run all of the selected performance tests, the status bar (item 35) indicates that the tests are completed.

Printing the Performance Test Results

14. To print all the results of the entire test sequence, click "File" and "Print."

Exiting the Support Software Program

15. To exit the performance tests program, click "File" and "Exit."

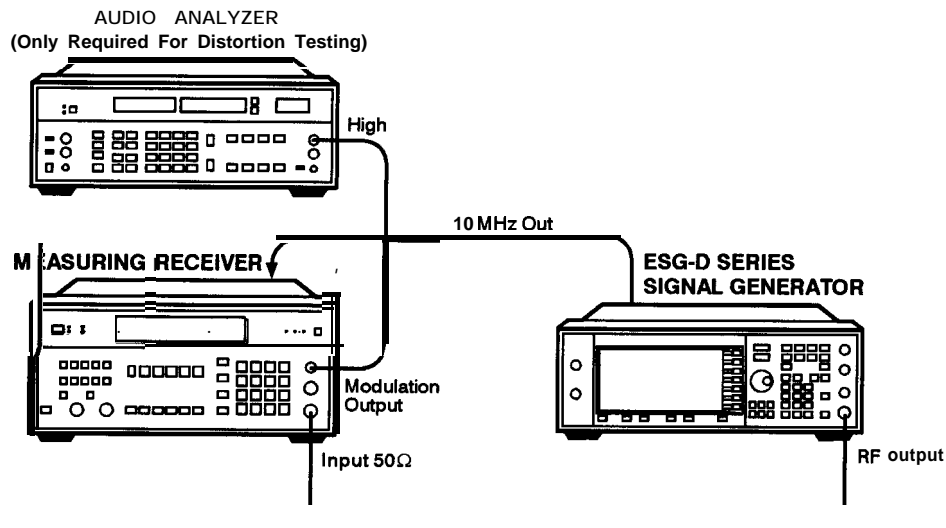# 1. Internal FM Accuracy and Distortion Performance Tests

These automatic tests verify the FM accuracy and distortion specifications. Accuracy is verified directly with a measuring receiver, and distortion is verified by measuring the demodulated output of the measuring receiver, using the audio analyzer. The audio analyzer provides a more accurate verification with better resolution than just the measuring receiver alone.

Recommended Equipment

- HP 8902A Measuring Receiver
- HP 8903B Audio Analyzer

To Set Up the Equipment
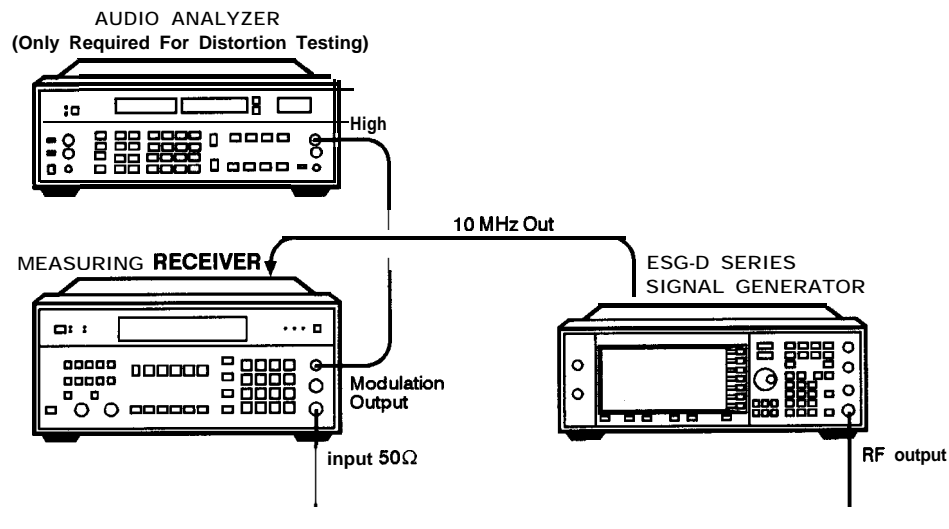
wk77a

Figure 5-6. Test Setup for Internal FM Accuracy and Distortion Performance Tests

2. Internal AM Accuracy and Distortion Performance Tests

These automatic tests verify the AM accuracy and distortion specifications.

For frequencies at or below 1300 MHz, accuracy is verified directly with a measuring receiver, and distortion is verified by measuring the demodulated output from the measuring receiver with an audio analyzer. The audio analyzer provides a more accurate verification with better resolution than just the measuring receiver alone.

For frequencies above 1300 MHz, the RF output from the signal generator is mixed with the output from another signal generator (local oscillator) to produce a suitable input frequency for the measuring receiver.

For a frequency of 4 GHz, verification is accomplished by covering two different frequency spans through the use of two mixers.

Recommended Equipment

- HP 8902A Measuring Receiver
- HP 8903A Audio Analyzer
- HP 8663A Signal Generator
- MD/MDC- 174 Mixer (1 to 2800 MHz)
- MD/MDC-164 Mixer (0.5 to 9 GHz)

To Set Up the Equipment for Accuracy/Distortion for AM ≤1300 MHz
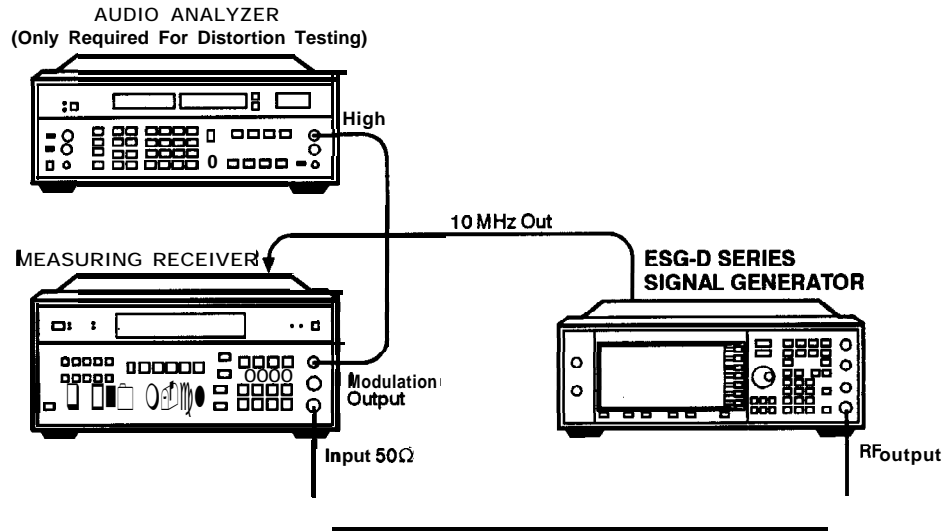
Figure 5-7. Test Setup for Accuracy and Distortion for AM 11300 MHz

To Set Up the Equipment for Accuracy and Distortion for AM >1300 MHz ≤2500 MHz
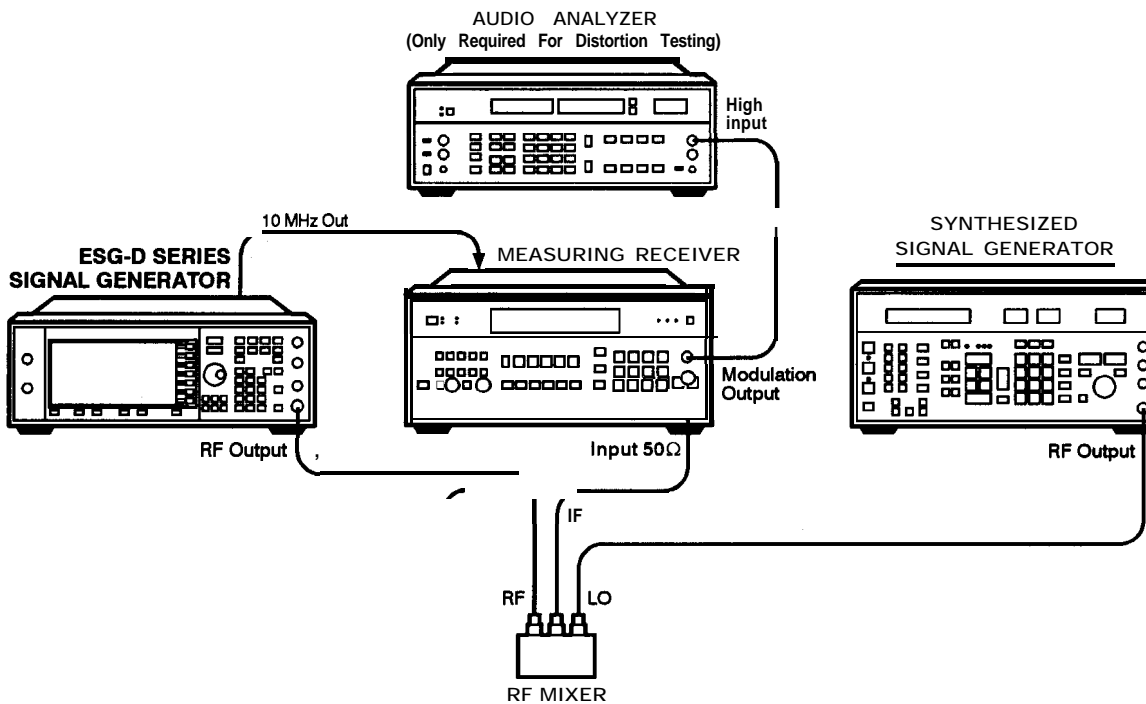
wk74a

Figure 5-8. Test Setup for Accuracy and Distortion for AM >1300 MHz I2500 MHz

To Set Up the Equipment for Accuracy and Distortion for AM > 2500 MHz
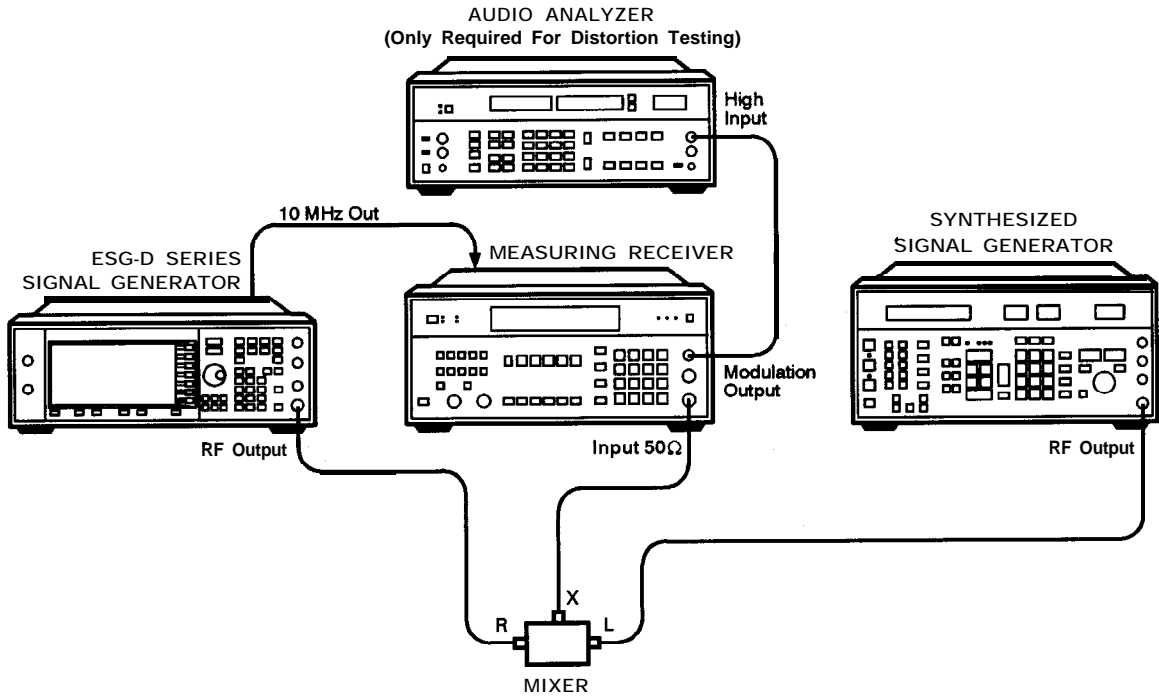
wk711a

Figure 5-9. Test Setup for Accuracy and Distortion for AM > 2500 MHz

3. Phase Modulation Accuracy and Distortion Performance Tests

These automatic tests verify the phase modulation accuracy and distortion specifications. Accuracy is verified directly with a measuring receiver, and distortion is verified by measuring the demodulated output from the measuring receiver, using the audio analyzer. The audio analyzer provides a more accurate verification with better resolution than just the measuring receiver alone.

Recommended Equipment

- HP 8902A Measuring Receiver
- HP 8903A Audio Analyzer

To Set Up the Equipment

wk77a

Figure 5-10. Test Setup for Accuracy and Distortion for Phase Modulation Performance Tests

4. FM Frequency Response Performance Test

This automatic test verifies the FM frequency response specifications. The equipment measures the variations in frequency deviations due to changes in the applied FM rate; DC to 100 kHz. The variations are expressed relative to a reference signal; 1 kHz rate set at 100 kHz deviation, in dB. Each frequency is tested with this sequence:

1   A reference signal is measured.
2   The set deviation is measured for each applied rate change.
3   Each deviation measurement is compared to the reference signal deviation.

The comparison is a calculation of the difference in the deviations relative to the reference rate. The relative value is the FM frequency response.

Recommended Equipment

- HP 8902A Measuring Receiver
- HP 8904A Function Generator

To Set Up the Equipment
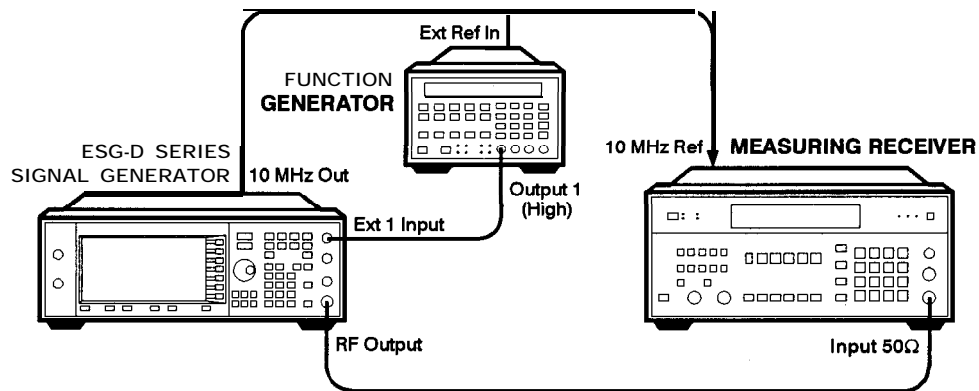
wk714a

Figure 5-11. Test Setup for FM Frequency Response Performance Tests

# 5. AM Frequency Response Performance Test

This automatic test verifies the AM frequency response specifications. The equipment measures the variations in modulation depth due to changes in the applied AM rate; DC to 10 kHz. The response is relative to a 1 kHz rate set at the test depth, and expressed in dB. Each frequency is tested with the following sequence:

1   A reference signal is measured.
2   The set depth is measured for each applied rate change.
3   Each depth measurement is compared to the reference signal depth.

The comparison is a calculation of the difference in the depths relative to the reference rate. The relative value is the AM Frequency Response.

Recommended Equipment

- HP 8902A Measuring Receiver
- HP 8904A Function Generator
- HP 8663A Signal Generator
- MD/MDC-164 Mixer (0.5 to 9 GHz)

To Set Up the Equipment for Frequency Response for AM ≤1300 MHz
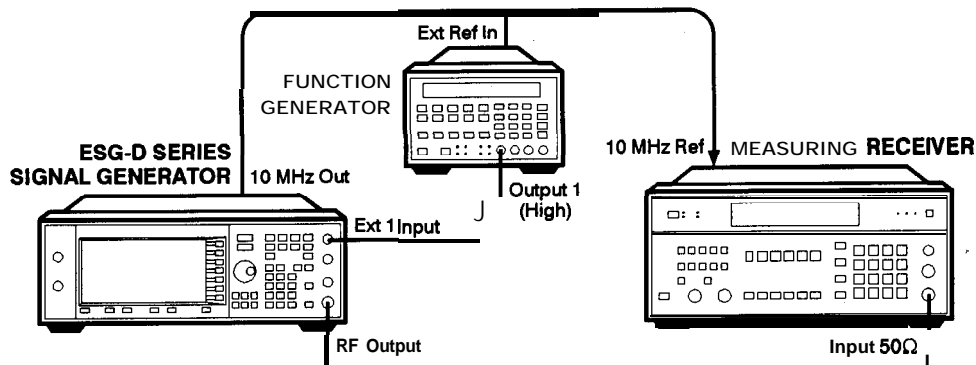
wk714a

Figure 5-12. Test Setup for Frequency Response for AM 11300 MHz

To Set Up the Equipment for Frequency Response for AM >1300 MHz
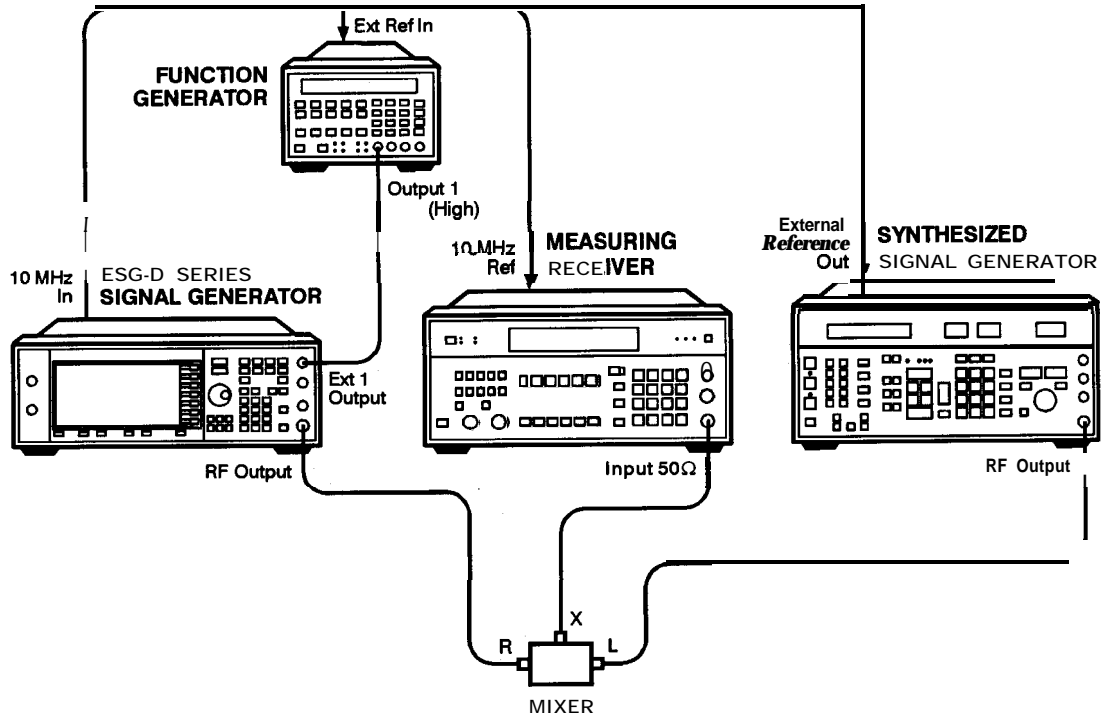
Figure S-13. Test Setup for Frequency Response for AM >1300 MHz

6. Phase Modulation Frequency Response Performance Test

This automatic test verifies the phase modulation frequency response specifications. The equipment measures the variations in phase deviations due to changes in the applied PM rate; DC to 100 kHz. The response is relative to a 1 kHz reference at the same phase deviation, and expressed in dB. Each frequency is tested with the following sequence:

1 A reference signal is measured.
2 The set deviation is measured for each applied rate change.
3 Each deviation measurement is compared to the reference signal deviation.

The comparison is a calculation of the difference in the deviations relative to the reference rate. The relative value is the PM frequency response.

Recommended Equipment

- HP 8902A Measuring Receiver
- HP 8904A Function Generator

To Set Up the Equipment
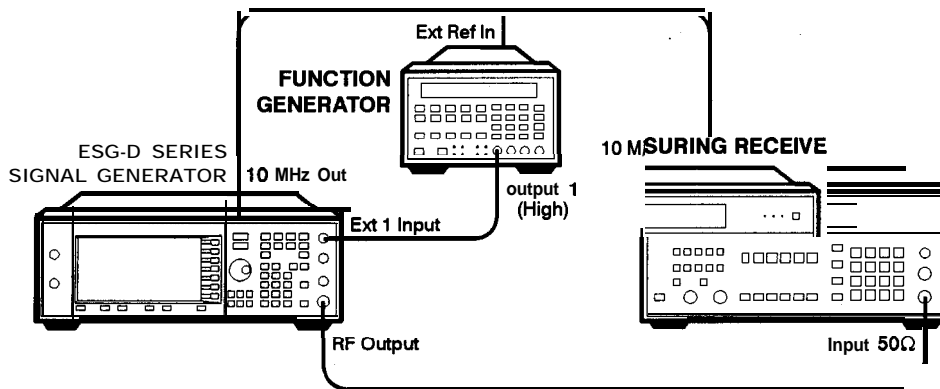
wk714a

Figure 5-14. Test Setup for Phase Modulation Frequency Response Performance Test

7. DCFM Frequency Offset Relative to CW Performance Test

This automatic test verifies the carrier frequency offset, relative to CW. The equipment measures the RF output frequency. For each test point, a comparison is made between a CW reference frequency without DCFM selected, and then with the DCFM selected; the difference is the carrier frequency offset.

Recommended Equipment

- HP 53132A Frequency Counter
- HP 11667A Splitter

To Set Up the Equipment for Measurements ≤1300 MHz

SIGNAL GENERATOR

FREQUENCY COUNTER

Channel

RF Output

wk782a
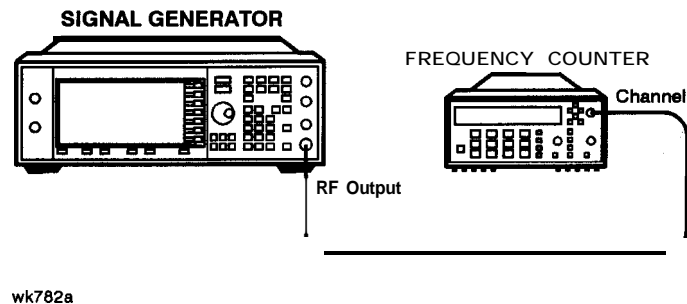
Figure 5-15. Test Setup for DC FM Frequency Offset Performance Test

8. Residual FM Performance Test

This automatic test verifies the residual frequency modulation (FM) specification. The signal generator's RF output signal is mixed with a signal from a low noise external LO. The resultant IF signal is demodulated as it passes through the measuring receiver, bypassing the measuring receiver's internal mixer which is inherently more noisy. Then the audio analyzer measures the demodulated audio signal for an RMS voltage. The measurement is scaled and displayed as RMS mV, but read as residual FM in Hz.

Recommended Equipment

- HP 8902A Measuring Receiver
- HP 8903B Audio Analyzer
- HP 8663A Signal Generator
- MD/MDC- 174 Mixer (1 to 2800 MHz)
- MD/MDC- 164 Mixer (0.5 to 9 GHz)

To Set Up the Equipment for Frequencies ≤2500 MHz
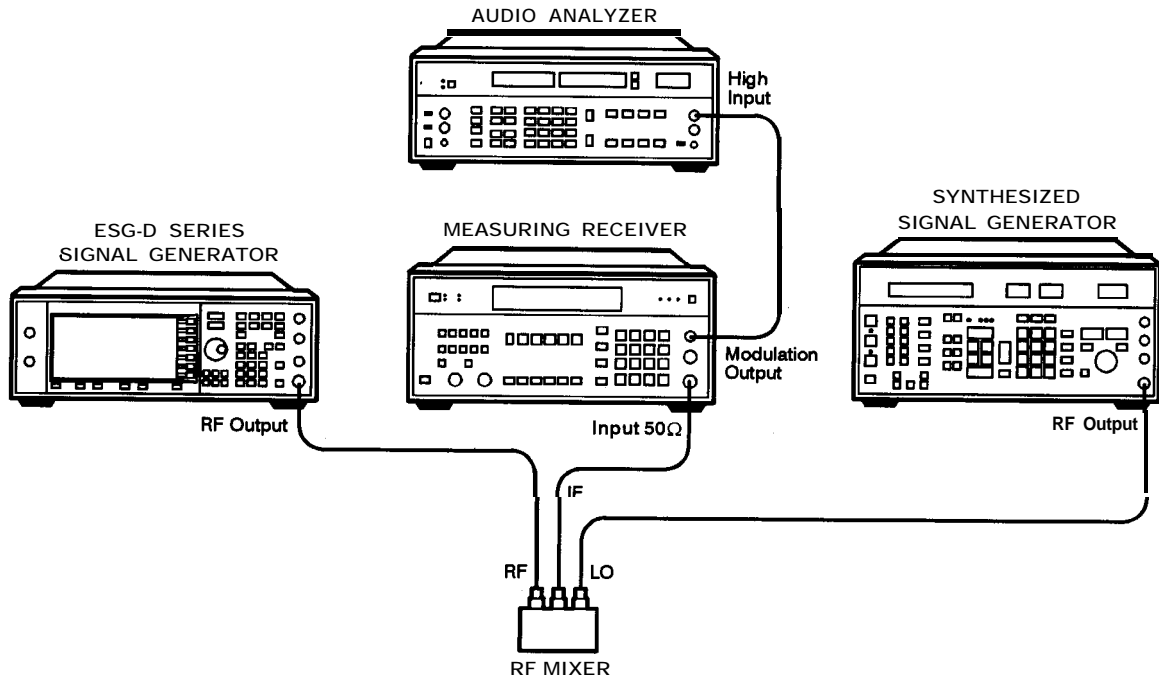
wk737a

Figure 5-16. Test Setup for Residual FM 12500 MHz

To Set Up the Equipment for Frequencies >2500 MHz

wk739a

Figure 5-17. Test Setup for Residual FM >2500 MHz

9. Harmonic, Subharmonic, and Nonharmonic Spurious Signals Performance Tests

These automatic tests verify that the harmonic, subharmonic, and nonharmonic spurious signals are within specifications. The signal generator's output signal is set to values where harmonic and spurious signal performance problems are most likely to occur. Then the spectrum analyzer checks the level of the various harmonic and spurious signals and compares each measurement to a signal of known frequency and amplitude.

Recommended Equipment

- HP 8563E Spectrum Analyzer
- HP 8491B Option 010 Attenuator (10 dB)

To Set Up the Equipment

wk73a
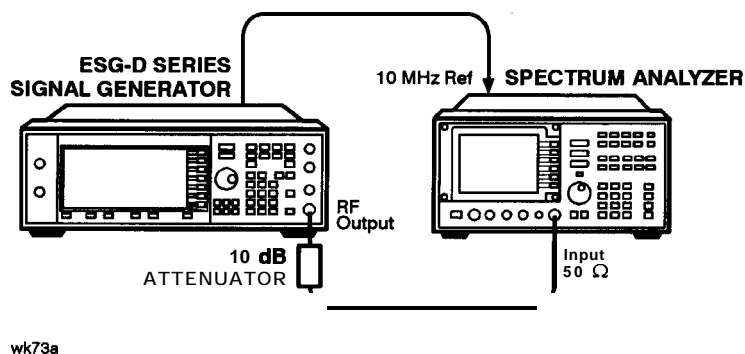
Figure S-18. Test Setup for Harmonic, Subharmonic, and Nonharmonic Spurious Signals Performance Tests

10. Power Level Accuracy Performance Test

Conducting this check provides a high level of confidence and a verification that the signal generator's power level circuitry is functioning correctly. The check does not test the signal generator to warranted specifications. Test limits are degraded to take into account measurement uncertainties involved with commercially available test equipment. To have the signal generator tested to warranted specifications, a complete power level accuracy performance test is required. Contact your nearest HP service center for information concerning calibration. The accuracy is measured over the full frequency and power level range of the signal generator.

For power levels ≥–10 dBm, a power meter makes the measurement. A reference is set at -10 dBm for comparisons to subsequent power measurements.

For power levels c-10 dBm and >–70 dBm, a spectrum analyzer makes the measurement. With -10 dBm RF output from the signal generator, a reference of 0 dB is set on the spectrum analyzer. The marker delta function measures the relative power level down to -70 dBm. The absolute power level is calculated by summing the power meter measurement at -10 dBm with the relative spectrum analyzer measurement.

For power levels <–70 dBm, an amplifier is inserted between the signal generator and spectrum analyzer, ensuring the signal level is kept well above the spectrum analyzer noise floor. A new reference is set at -70 dBm and the marker delta function measures relative power down to -127 dBm. Again the absolute power level is calculated by summing the power meter measurement at -10 dBm with the relative spectrum analyzer measurement.

For power levels c-95 dBm, the spectrum analyzer uses video averaging to minimize effects of random noise in the measurement system.

NOTE: Power level measurements are made at extremely low power levels. Results may be affected by unrelated low level signals picked up by the measurement receiver. These could be the result of RF leakage within the device under test or external signals that are at the same tested frequencies. To protect against errors at low power levels, take the following precautions:

- Use a semi-rigid cable between the 6 dB attenuator and the spectrum analyzer. Connect the 6 dB attenuator directly to the spectrum analyzer. Make sure all the connections are tight. Inspect the cable for any deterioration or cracks.
- Position the signal generator and spectrum analyzer side-by-side and at least 30 cm apart, minimizing the possibility of RF leakage. Do NOT position the two instruments with the front panels or rear panels facing each other.
- If RF leakage is suspected, move the signal generator and spectrum analyzer further apart. If the problem is RF leakage between the instruments, the measurement should change with changes in orientation between the two instruments. If the problem is RF leakage inside the device under test, then changes in equipment orientation will have no effect.

Recommended Equipment

- HP 438A Power Meter
- HP 8482A Power Sensor
- HP 8563E Spectrum Analyzer
- HP 8491A/B Option 006 Attenuator (6 dB)
- HP 8447F Option 010 Preamplifier-Amplifier
- HP 8449B Preamplifier
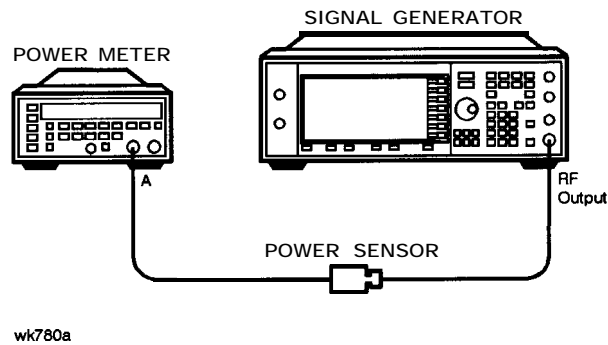
To Set Up the Equipment for High Power Level Accuracy

Figure S-19. Test Setup for Power Level Accuracy Performance Test

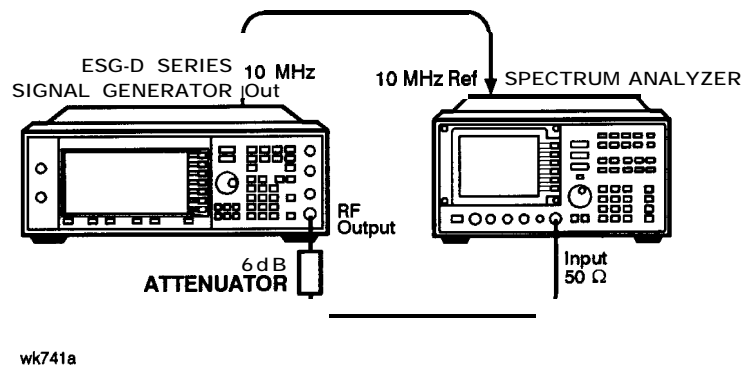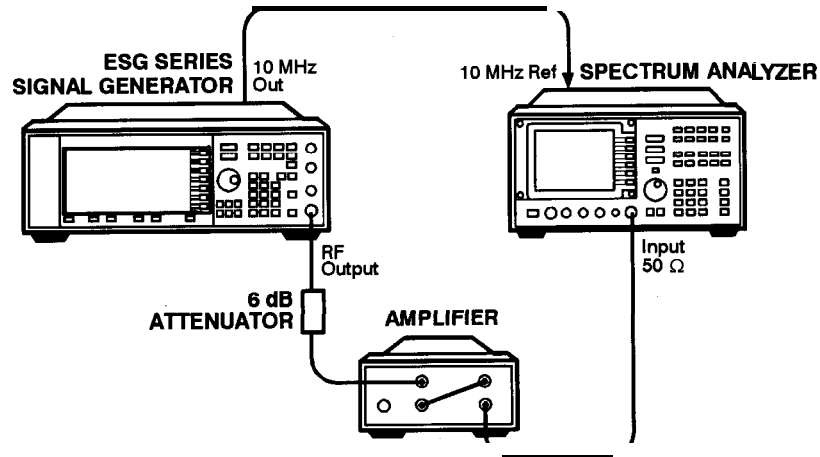## To Set Up the Equipment for High Power Level Accuracy for Levels -10 to -70 dBm

Figure 5-20. Test Setup for Power Level Accuracy for Power Levels of -10 to -70 dBm

Power Level Accuracy for Power Levels <–70 dBm and ≤1300 MHz

wk744a

Figure 5-21. Test Setup for Power Level Accuracy for Power Levels <-70 dBm and 11300 MHz

Power Level Accuracy for Power Levels <–70 dBm and >1300 MHz
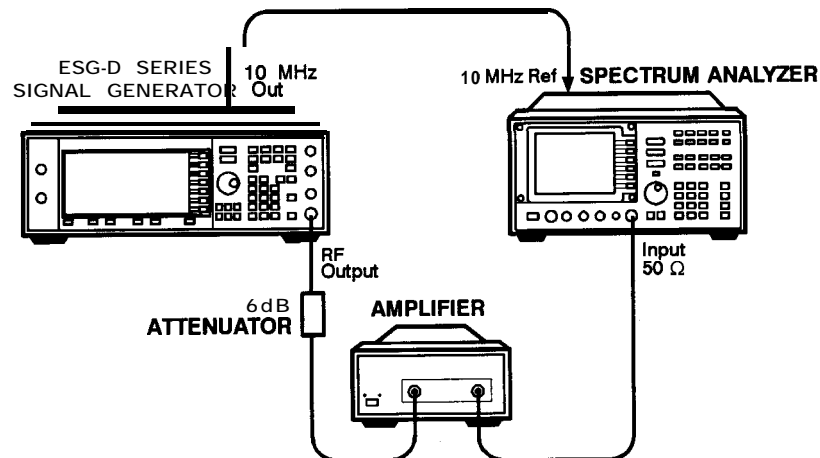
wk754a

Figure 5-22. Test Setup for Power Level Accuracy for Power Levels <-70 dBm and >1300 MHz

11. **Timebase** Aging Rate Performance Test: Option 1E5 ONLY

This manual test verifies the accuracy of the signal generator's internal timebase. The time required for a 360" phase change is measured both before and after a specified waiting period. The aging rate is inversely proportional to the absolute value of the difference in the measured times.

The overall accuracy of the internal **timebase** is a function of:

TBC ±AR ±TE ±LE where:

TBC = **timebase** calibration

TE = temperature effects

AR = aging rate

LE = line effects

After the **timebase** is adjusted, the **timebase** frequency should stay within the aging rate for the following situations:

- The **timebase** oven does not cool down.
- The instrument keeps the same orientation, with respect to the earth's magnetic field.
- The instrument stays at the same altitude.
- The instrument does not receive any mechanical shock.

If the **timebase** oven cools (the instrument power switch is set to off'), you may have to readjust the **timebase** frequency after a new warm-up cycle. Typically, however, the **timebase** frequency returns to within ±1 Hz of the original frequency.

NOTE: The internal **timebase** can be tested after the AC power is reconnected for 10 minutes. Yet, for best accuracy, test again after the instrument is on for 24 hours.

Frequency changes due to either a change in orientation, with respect to the earth's magnetic field, or to a change in altitude usually go away when the instrument is returned to its original position. A frequency change due to mechanical shock usually appears as a fixed frequency error.

Recommended Equipment

- HP 54610B Digital Oscilloscope
- HP 5071A Primary Frequency Standard

To Set Up the Equipment

wk71a

Figure 5-23. Test Setup for Timebase Aging Rate Performance Test

To Perform the Test

1 Preset all instruments and let them warm up for at least one hour.
2 If the oscilloscope does not have a 50Ω input impedance, connect channel 1 through a 50Ω feedthrough.
3 On the oscilloscope, adjust the external triggering for a display of the 10 MHz REF OUTPUT signal from the synthesizer.
   a On Channel 1 of the oscilloscope, set the following:
       Display: On
       Volts/Division: 500 **mV**
       Input Coupling: DC
       Input Impedance: 50 ohms (or use a 50 ohm feedthrough)
   b On Channel 2 of the oscilloscope, set the following:
       Display: Off
       Input Coupling: DC
       Input Impedance: 50 ohms (or use a 50 ohm feedthrough)
   c On the **Timebase** of the oscilloscope, set the following:
       Time/Division: 5 ns
   d On the Trigger of the oscilloscope, set the following:
       Trigger Source: CH 2
       Trigger Mode: Normal
       Trigger Level: OV
4 If the signal drifts a full cycle ($360°$) in less than 2 minutes, refer to Chapter 6 and perform the "Internal Reference Oscillator Adjustment." After the adjustment, restart this performance test.
5 Watch the oscilloscope display and monitor the time. Notice the time required for a 360" phase change and record this time as $T1$.

6   Wait 3 to 24 hours. Record the time that you waited as T2.
7   Repeat steps 1 through 6. Notice the time required for a 360" phase change and record this time as T3.
8   Calculate the aging rate as follows: 1

Aging Rate = (1 **cycle/10** MHz) $(1/T1 - 1/T3)$ (24 **hours/T2**)

Example:

$T1 = 351$ seconds

$T2 = 3$ hours

$T3 = 349$ seconds

$= (1$ **cycle/10** MHz) $(1/351s - 1/349s)$ **(24h/3h)**

1.306×10^{-11} per day)

9   Write the test results on the performance test record located at the end of this chapter. Compare the results to the limits in the test record.

NOTE:	If the absolute frequency of the standard and the **timebase** oscillator are extremely close, you can reduce the measurement time $(T1$ and T3) by measuring the time required for a phase change of less than 360". In step 4, change 1 cycle to 0.5 cycle for $180°$, or 0.25 cycle for 90".

12. Digital Modulation Level Accuracy Performance Test

The automatic test verifies the level accuracy of the signal generator's I and Q modulation inputs. Two arbitrary waveform generators provide the I and Q modulation inputs to the signal generator. A power meter measures the RF output power with and without QPSK modulation applied to the signal generator. The difference in power measurements is the level accuracy. The QPSK modulation is loaded into the two arbitrary waveform generators from a data file in the performance tests software. The vector signal analyzer verifies the arbitrary waveform generators' outputs are properly scaled and synchronized before the relative power level accuracy is measured.

Recommended Equipment

- HP 438A Power Meter
- HP 8482A Power Sensor
- HP 33120A Option 001 Arbitrary Waveform Generator (2)
- HP 89441A Vector Signal Analyzer

To Set Up the Equipment
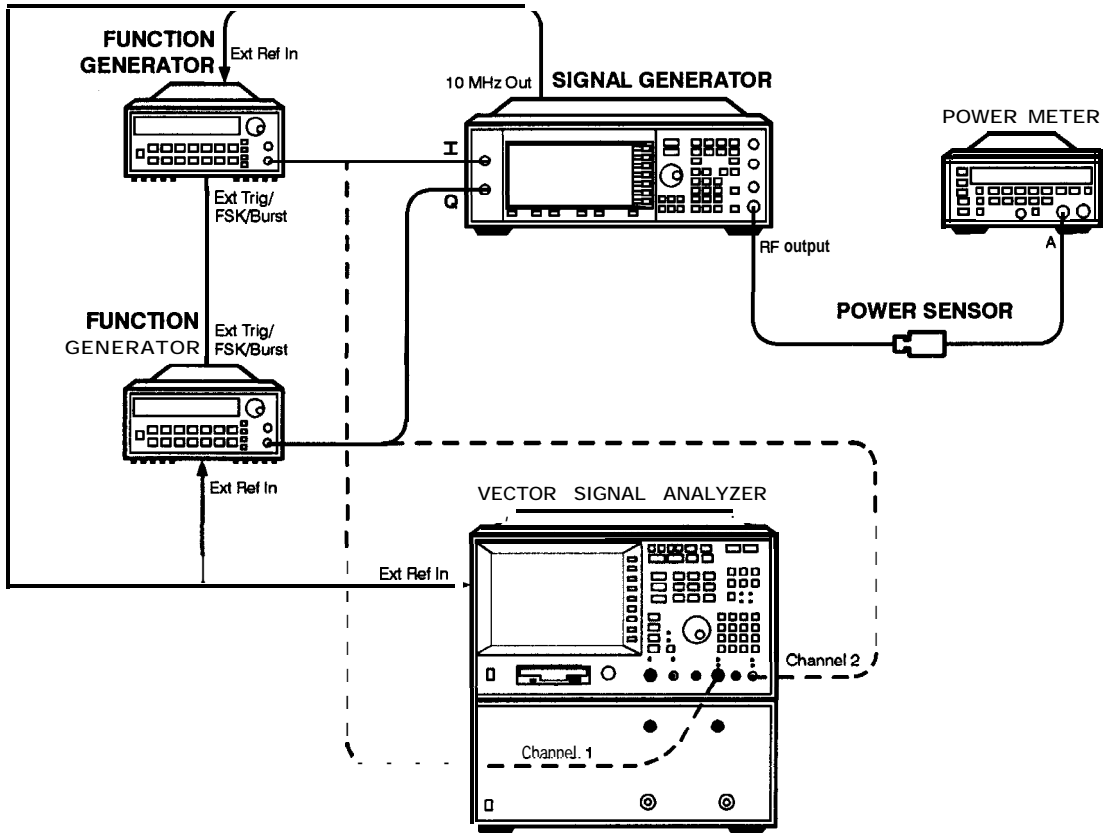
wk748a

Figure 5-24. Test Setup for Digital Modulation Level Accuracy Performance Test

13. Internal Digital Modulation Quality Performance Test: Option 1EH, UN3, or UN4

This automated test verifies the RF modulation quality of the signal generator's internal I/Q modulation. A vector signal analyzer is connected to the signal generator's RF output. The internal baseband generator (Option 1EH) modulates the RF carrier in each of the available digital modulation formats. The vector signal analyzer measures the appropriate error parameter for the modulation generated (EVM for PHS, PDC and NADC formats; global phase error for GSM format).

Recommended Equipment

• HP 89441A Option AYA, AY7, AY9, UFG, AY9 Vector Signal Analyzer

To Set Up the Equipment
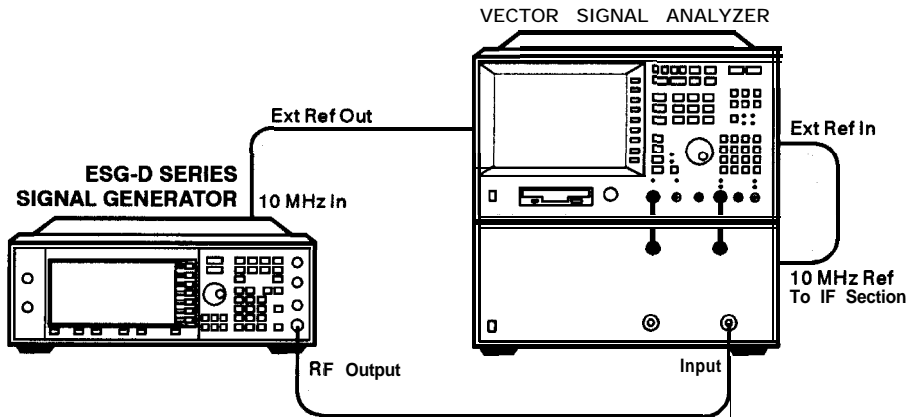
wk743a

Figure 5-25. Test Setup for Internal Digital Modulation Quality Performance Test

14. Pulse Modulation On/Off Ratio Performance Test

This automatic test verifies the pulse modulation on/off ratio. The signal generator is configured for an external pulse input. The spectrum analyzer measures the RF output power with and without the external pulse applied. The power difference is the on/off ratio.

Recommended Equipment

- HP 8663E Spectrum Analyzer
- HP 8491A/B Option 010 Attenuator (10 dB)
- HP 33 120A Arbitrary Waveform Generator

To Set Up the Equipment
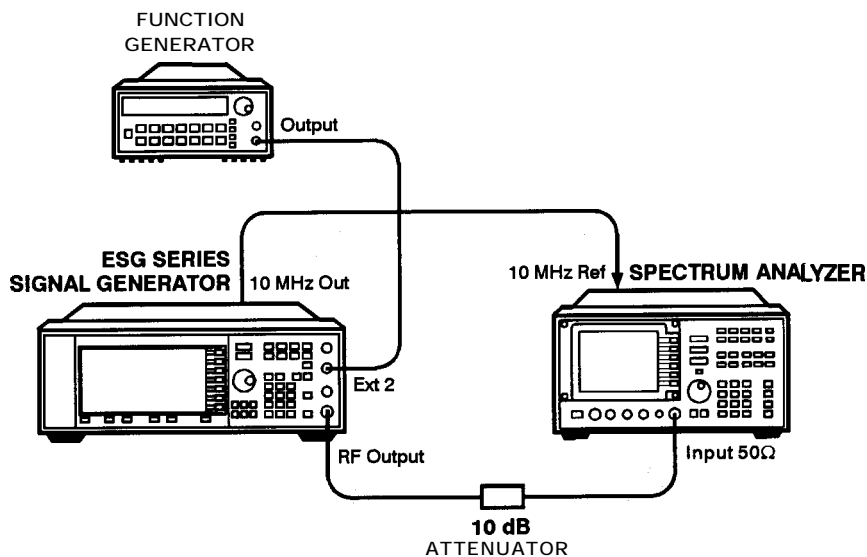
wk746a

Figure S-26. Test Setup for Pulse Modulation On/Off Ratio Performance Test

15. Burst Modulation On/Off Ratio Performance Test

This automatic test verifies the burst modulation on/off ratio. The signal generator is configured for an external burst input. The spectrum analyzer measures the RF output power with and without the external burst applied. The power difference is the on/off ratio.

Recommended Equipment

- HP 8563E Spectrum Analyzer
- HP 8491A/B Option 010 Attenuator (10 dB)
- HP 33 120A Arbitrary Waveform Generator

To Set Up the Equipment
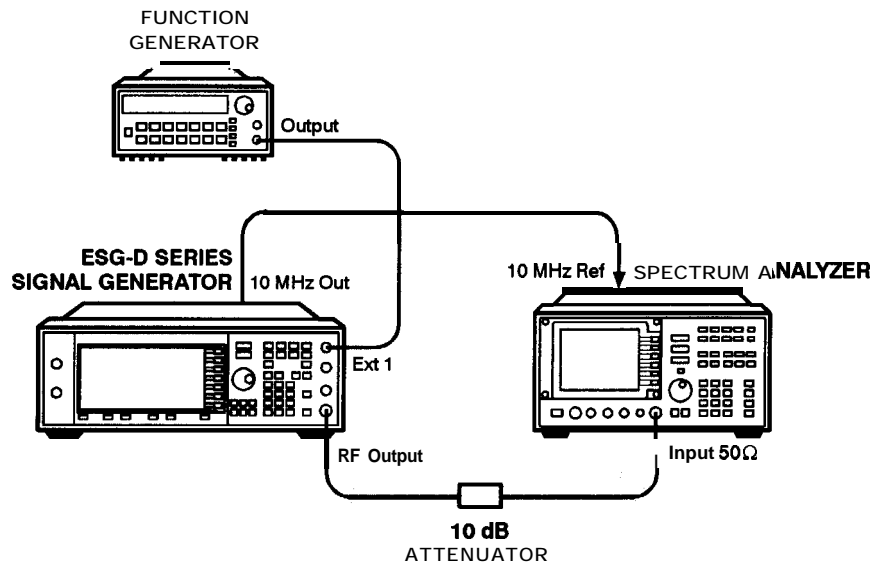
wk749a

Figure S-27. Test Setup for Burst Modulation On/Off Ratio Performance Test

16. Modulation Source Frequency Accuracy Performance Test

This manual test verifies the signal generator's modulation capability at the highest frequency output.

Recommended Equipment

- HP 5350B Frequency Counter

To Set Up the Equipment

wk731a
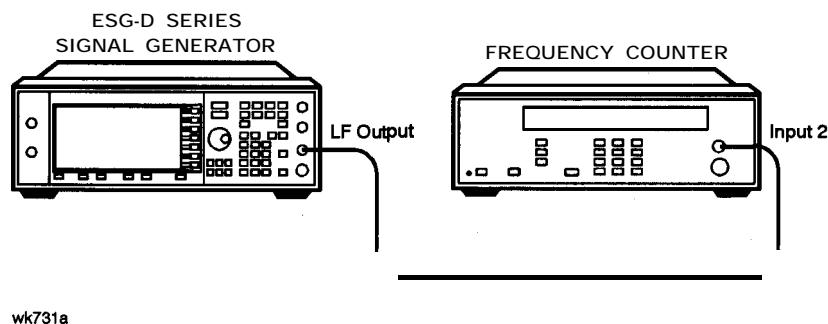
Figure 5-28. Test Setup for Modulation Source Frequency Accuracy Performance Test

To Perform the Procedure

1 Preset the test equipment.
2 Configure the signal generator as follows:
   - Select **AM**
   - Press **AM On, AM Rate, 5, 0, kHz**.
   - Press **LF Out, LF Out Amplitude, 1, V**.
3 Configure the frequency counter as follows:
   - Press **RESET**.
   - Select 1 Meg Ohms (INPUT 2).
   - Press **HIGH RESOLUTION**.
4 View the value that is displayed on the frequency counter. Write this value on the performance test record that is located at the end of this chapter.

Performance Test Records

A performance test record for the two manual tests: "Timebase Aging Rate" and "Modulation Source Frequency Accuracy," is located next in this chapter. Keep these copies as masters and use a photocopy for each calibration.

Using the "ESG Series Support Software," you can printout a test record that contains the results of the automated performance tests.

Table 5-29. HP ESG-D Series Performance Test Record

Model _____	Report Number _____		Date _____
Test Equipment Used	Model Number	Trace Number	Cal Due Date
1. Digital Oscilloscope	_____	_____	_____
2. Measuring Receiver	_____	_____	_____
3. Audio Analyzer	_____	_____	_____
4. Signal Generator	_____	_____	_____
5. Mixer I-2800 MHz	_____	_____	_____
6. Mixer 0.5 -9 GHz	_____	_____	_____
7. Function Generator	_____	_____	_____
8. Signal Generator	_____	_____	_____
9. Mixer (0.5 to 9 GHz)	_____	_____	_____
10. Mixer (.001 to 2.8 GHz)	_____	_____	_____
11. Frequency Counter	_____	_____	_____
12. Power Splitter	_____	_____	_____
13. Spectrum Analyzer	_____	_____	_____
14. Attenuator (10 dB)	_____	_____	_____
15. Attenuator (6 dB)	_____	_____	_____
16. Power Sensor	_____	_____	_____
17. Power Meter	_____	_____	_____
18. Preamplifier-Amplifier	_____	_____	_____
19. Preamplifier	_____	_____	_____
20. Primary Frequency Standard	_____	_____	_____
21. Vector Signal Analyzer	_____	_____	_____
22. Arbitrary Waveform Generator	_____	_____	_____
23. _____	_____	_____	_____

Table 5-30. HP ESG-D Series Performance Test Record

Model: _____	Report Number: _____		Date: _____	
Test Description	**Minimum Specification**	**Results**	**Maximum Specification**	**Measurement Uncertainty**
Timebase Aging Rate: Option **1E5** ONLY		_____	$< \pm 0.0005$ ppm/ day	5.6×10^{-11} per day
Modulation Source Frequency Accuracy	49,997.5 kHz	_____	50,002.2 kHz	

6 Adjustments

This chapter contains the adjustment procedures that may be required for the signal generator.

Adjustment Relationships

Anytime an adjustment is made to the signal generator other related adjustments may be affected. For optimal performance, whenever an adjustment is performed, the related adjustments should also be performed.

Analog Bus Related Adjustments

The following adjustments are optimized if the Analog Bus ADC Calibration has been run recently:

- VCO Bias Potentiometer Adjustment
- FM Inverting Amplifier Offset Calibration
- ALC Modulation Drive Bias Calibration
- VBLO Mixer Bias Calibration
- Level Meter Calibration
- I/Q Gain/Offset/Quadrature Calibration

Synthesizer Potentiometer Related Adjustments

The Lock Angle potentiometer is preset fully counter-clockwise in the VCO Bias Adjustment. Both adjustments should always be performed together.

- VCO Bias Potentiometer Adjustment
- Lock Angle Adjustment

FM Accuracy Related Adjustments

- KV versus Frequency Calibration
- FM Scale DAC Offset Adjustment
- FM Path Offset Adjustment
- FM In-Band DAC Offset Adjustment
- FM Inverting Amplifier Offset Calibration
- FM 1/2 Path Ratio Adjustment
- Modulation Source Relative Gain Calibration
- FM Out-of-Band Calibration
- FM Delay Potentiometer Adjustment
- DCFM Calibration

AM Accuracy Related Adjustments

- AM Audio Path Offset Calibration
- AM Gain Calibration

Burst Modulation Accuracy Related Adjustments

- Burst Modulator Calibration
- Burst Audio Path Gain Calibration

Power Level Range and Accuracy Related Adjustments

- Prelevel Calibration
- Gain Adjustment
- ALC Modulation Driver Bias Calibration
- VBLO Mixer Bias Calibration
- ALC Calibration
- Power Flatness Calibration
- Attenuator Calibration (Power Meter)
- Level Meter Calibration
- ALC Modulation Flatness Calibration

I/Q Modulation Accuracy Related Adjustments

- VBLO Mixer Bias Calibration
- I/Q Gain/Offset/Quadrature Calibration

Internal Reference Oscillator Adjustment

Use this procedure to adjust the internal reference DACs (Digital-to-Analog Convertors). The internal reference oscillator is adjusted with two DACs, one for coarse tuning and one for fine tuning. Using the two DACs, the internal reference oscillator can be adjusted to the resolution of the frequency counter used.

This is a manual adjustment. An automated version of this adjustment is also provided.

Required Test Equipment

- HP 53 132A Universal Counter
- HP 5071A Primary Frequency Standard

Procedure
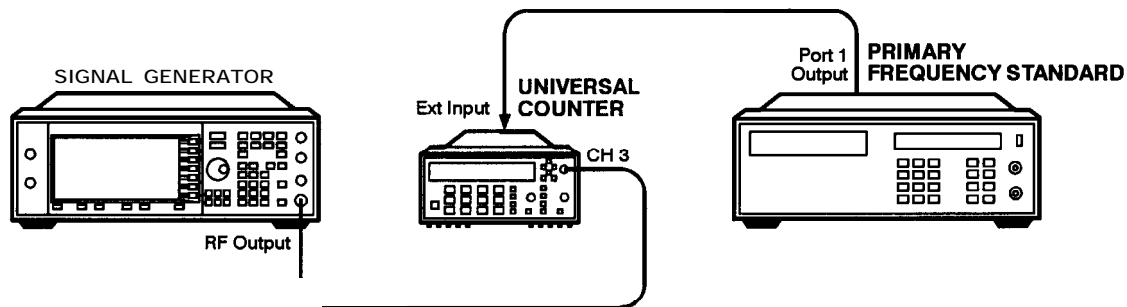
wk7101a

1. Connect the equipment as shown above.

2. Preset all of the equipment.

3. Set the universal counter input to 50Ω.

4. On the signal generator, press the following keys:

    Preset, Amplitude, 0, dBm, RF ON/OFF

    Utility, Instrument Adjustments, Reference Oscillator Adjustment, Ref Osc Fine

5. Center the fine tuning DAC setting for a value of 128.

6. Press **Ref Osc Coarse** on the signal generator.

7. Adjust the coarse tuning DAC setting for a universal counter reading of 100 MHz.

8. Press **Ref Osc Fine** and adjust the fine tuning DAC setting for a frequency counter reading of 100 MHz, within 0.1 Hz resolution.

9. After adjusting both of the DAC settings, press **Store Ref Osc Setting**, **Confirm Store**.

Analog Bus ADC Calibration

Description

This test is used to calibrate the gain of the ABUS. The ABUS is connected to the ground node (ACOM) and the ADC is zeroed. The ABUS is then connected to the 10V reference and measured. The result of the measured value divided by the ideal value is the ABUS gain calibration constant. This value is then saved in the instrument's firmware.

Required Test Equipment

• HP 3458A Digital Voltmeter

Procedure
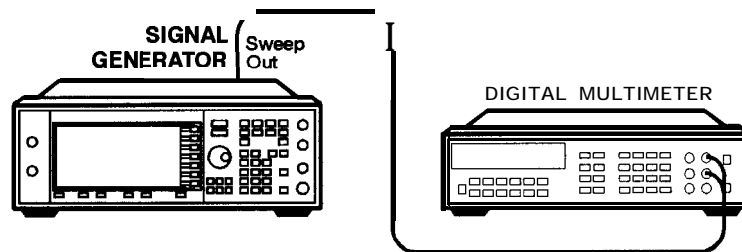
wk783a

1. Connect the equipment as shown above.

2. Preset all of the equipment.

3. Follow the instructions as they appear on the controller's display.

Internal Source Calibration

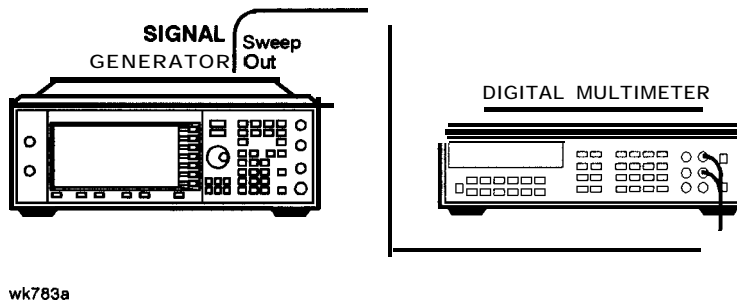## Description

This test is used to calibrate the internal source amplitude versus frequency. The values for offset and gain are set to their default values in the internal source calibration arrays. Next, the offset calibration factor is determined by connecting the DVM to the ABUS and measuring the DC offset of the motherboard common ground ABUS node and the offset of the DSP ABUS node with the DSP set to 0Vdc; the calibration factor is the difference between these two measurements. The scaling factors are determined by setting the DSP to output a full-scale sinewave with the DVM connected to the front panel LF OUTPUT port. Measurements are then made in 1 kHz steps and the calibration factors are calculated to achieve 2 Vpeak on the motherboard by accounting for the nominal gain presented by the reference board. Upon completion, the calibration factors are stored in the instrument's firmware.

Required Test Equipment

- HP 3458A Digital Voltmeter

Procedure
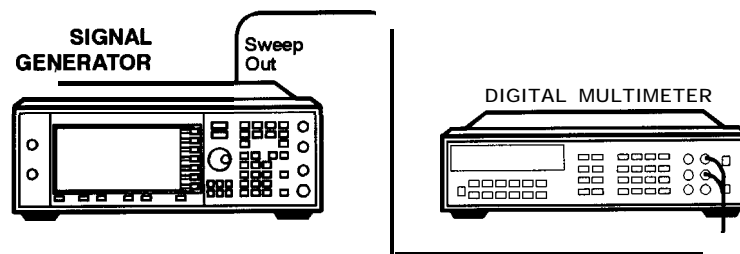
wk783a

1. Connect the equipment as shown above.

2. Preset all of the equipment.

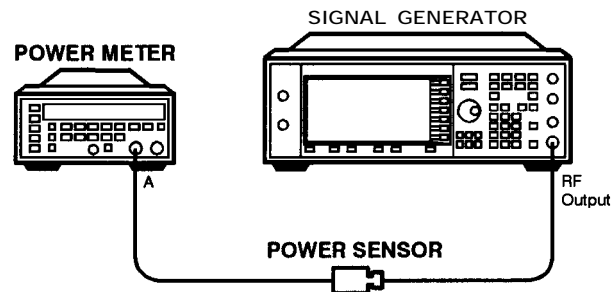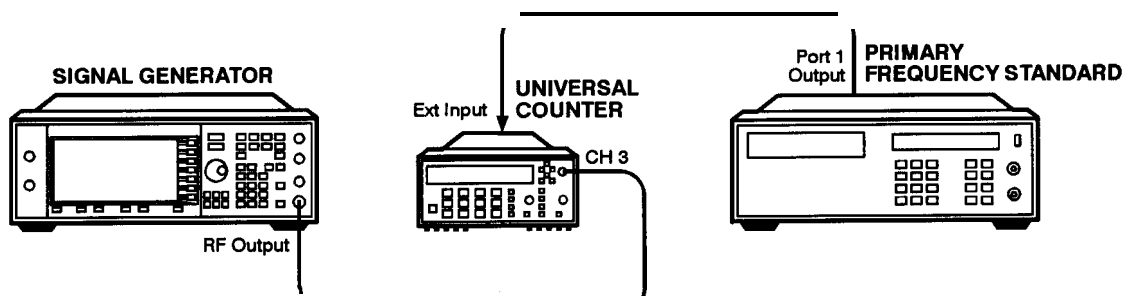3. Follow the instructions as they appear on the controller's display.

VCO Bias Potentiometer Adjustment

Description

This test sets the VCO bias potentiometer at a level that will keep the VCO in a stable operating region over the entire frequency and temperature range. First, the F/2 and the lock angle potentiometers are set fully CW (clock-wise). The instrument is set to 750 MHz and the pot is adjusted until the F/2 oscillations disappear. The voltage at the SYNTH_F2 ABUS node is measured and then the potentiometer is adjusted for a .77 to .80 V drop.

After you have performed this adjustment, you must perform the Lock Angle Potentiometer Adjustment on the following page.

Required Test Equipment
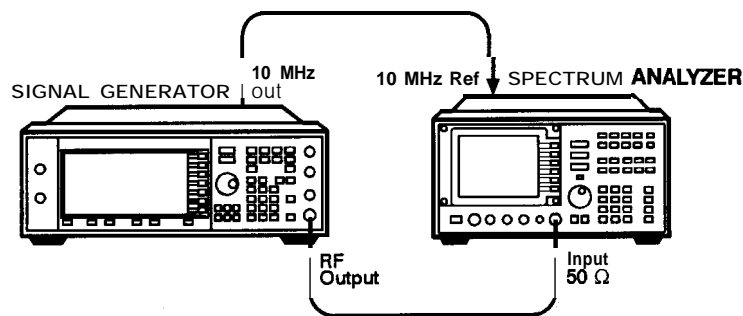
- HP 8563E Spectrum Analyzer

Procedure

wk781a

1. Connect the equipment as shown above.
2. Preset all of the equipment.
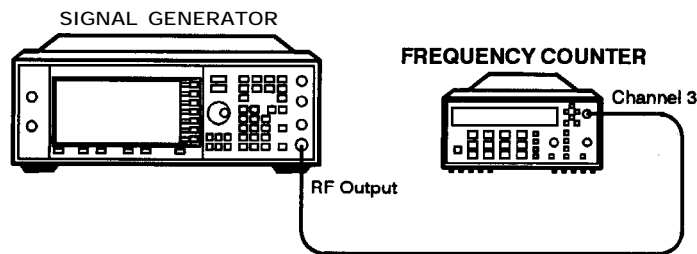3. Follow the instructions as they appear on the controller's display.

Lock Angle Potentiometer Adjustment

Description

This test is used to optimize the phase detector sampling of the synthesizer phase-locked loop reference frequencies. The lock angle adjustment sets the time during the reference cycle when the ultra-quiet time phase detector measurement occurs. The phase detector needs to make its measurement at the quietest point in the reference cycle. By adjusting this potentiometer to minimize the level of the fractional-N spur, the time of the phase detector sample can be optimized.

Required Test Equipment
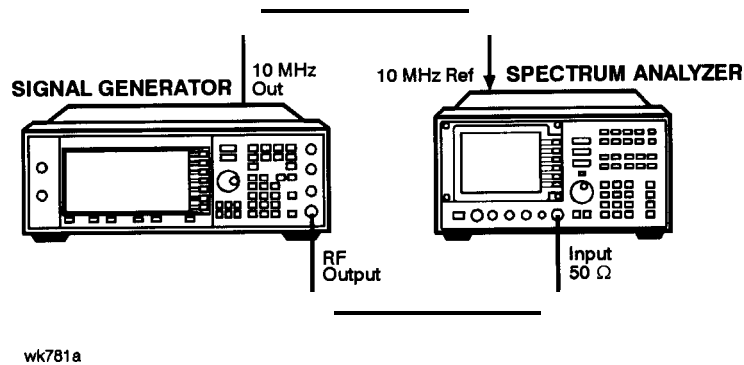
. HP 8563E Spectrum Analyzer

Procedure

wk781a

1. Connect the equipment as shown above.

2. Preset all of the equipment.

3. Follow the instructions as they appear on the controller's display.

KV versus Frequency Calibration

Description

This test determines the tuning sensitivity of the sythesizer loop. To measure the sensitivity, the tuning voltage is measured as the frequency is stepped from 500 to 1000 MHz in 10 MHz steps. At each incremental frequency the tuning voltage is measured (Vtunel) and again at the incremental frequency +300 kHz (Vtune2). The sensitivity is then calculated in units of MHz/V and stored in the instrument's firmware.

Required Test Equipment

• HP 3458A Digital Voltmeter

Procedure

wk783a

1. Connect the equipment as shown above.

2. Preset all of the equipment.

3. Follow the instructions as they appear on the controller's display.

AM Audio Path Offset Calibration

Description

This test calibrates the AM path to remove any offset generated when LIN AM, LIN BURST, or LOG BURST are enabled. This test determines the ALC_REF_DAC delta value which is used to correct the offset when the modulation is enabled. This value is then stored in the appropriate calibration constant.

Required Test Equipment

- HP 438A Power Meter
- HP 8482A Power Sensor

Procedure

wk780a

1. Connect the equipment as shown above.

2. Preset all of the equipment.

3. Follow the instructions as they appear on the controller's display.

Timebase DAC Calibration

Description

This test insures that the instrument has warmed-up sufficiently, then adjusts the coarse and fine reference timebase DACs for minimum internal reference frequency error. The coarse and fine DAC calibration factors are then stored in the instrument's firmware.

Required Test Equipment

- HP 53 132A Universal Counter
- HP 5071A Primary Frequency Standard

Procedure

wk7101a

1. Connect the equipment as shown above.

2. Preset all of the equipment.

3. Follow the instructions as they appear on the controller's display.

FM Scale DAC Offset Calibration

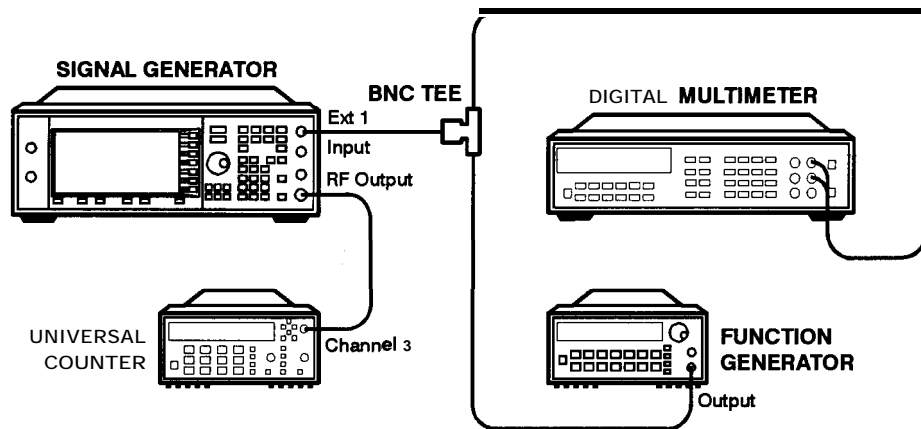## Description

This test is used to remove the offset associated with the FM SCALE DAC operational amplifier located on the reference board. This calibration results in a DAC value for FM OFFSET DAC 2. After this DAC value has been properly adjusted, the effects of the FM SCALE DAC value on the offset will be minimized.

Required Test Equipment

. HP 53132A Universal Counter

Procedure

wk782a

1. Connect the equipment as shown above.

2. Preset all of the equipment.

3. Follow the instructions as they appear on the controller's display.

FM Path Offset Calibration

Description

This test is used to remove the offsets associated with the various FM1 and FM2 audio paths on the reference board. When FM is enabled, voltage offsets on the reference and synthesizer boards appear as frequency shifts on the synthesizer VCO. By using a frequency counter to measure the frequency of the VCO, the voltage offsets can be quantified. The voltage offsets are adjusted and stored in the instrument's firmware.

Required Test Equipment

- HP 53 132A Universal Counter

Procedure

wk782a
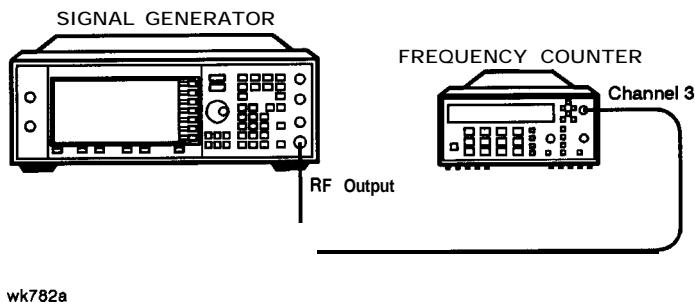
1. Connect the equipment as shown above.

2. Preset all of the equipment.

3. Follow the instructions as they appear on the controller's display.

FM In-Band DAC Offset Calibration

Description

This test is used to remove the offset associated with the FM IN-BAND DAC located on the synthesizer board. The calibration determines the DAC value for the FM IN-BAND OFFSET DAC on the synthesizer board which will remove the offset associated with the FM IN-BAND DAC.

Required Test Equipment
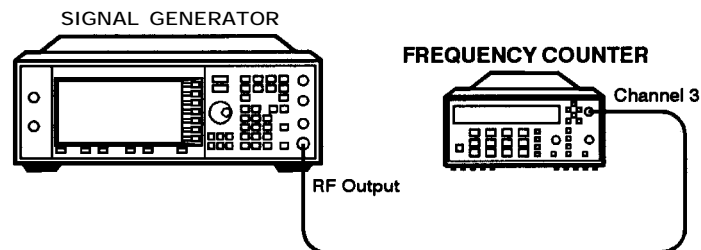
- HP 53 132A Universal Counter

Procedure

wk782a

1. Connect the equipment as shown above.

2. Preset all of the equipment.

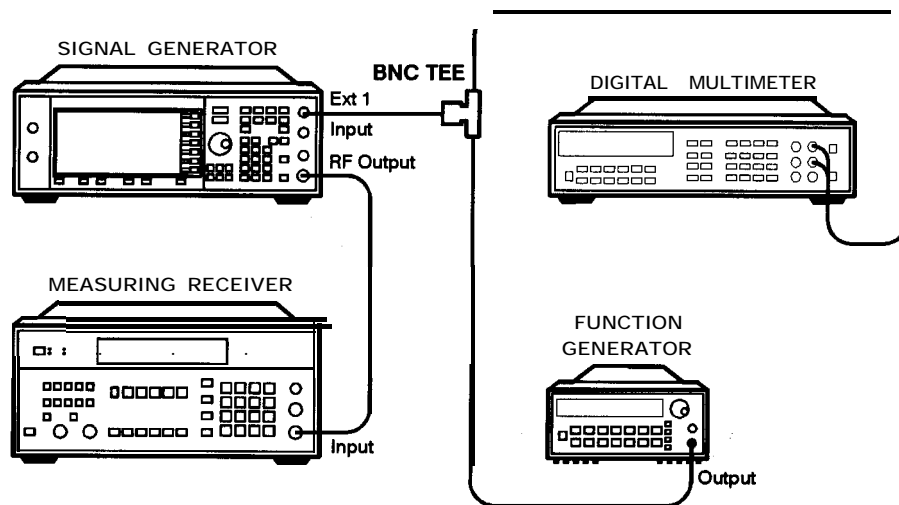3. Follow the instructions as they appear on the controller's display.

FM Inverting Amplifier Offset Calibration

Description

This test is used to remove the offset associated with the differential inverting amplifier on the FM input of the synthesizer board. The calibration determines the DAC value for the FM OFFSET DAC 1 on the reference board which will remove the offset associated with the amplifier.

Required Test Equipment
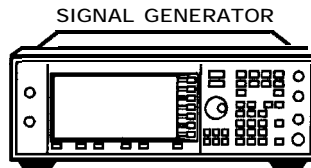
- None

Procedure

wk784a

1. Connect the equipment as shown above.

2. Preset all of the equipment.

3. Follow the instructions as they appear on the controller's display.

FM 1/2 Path Ratio Gain Calibration
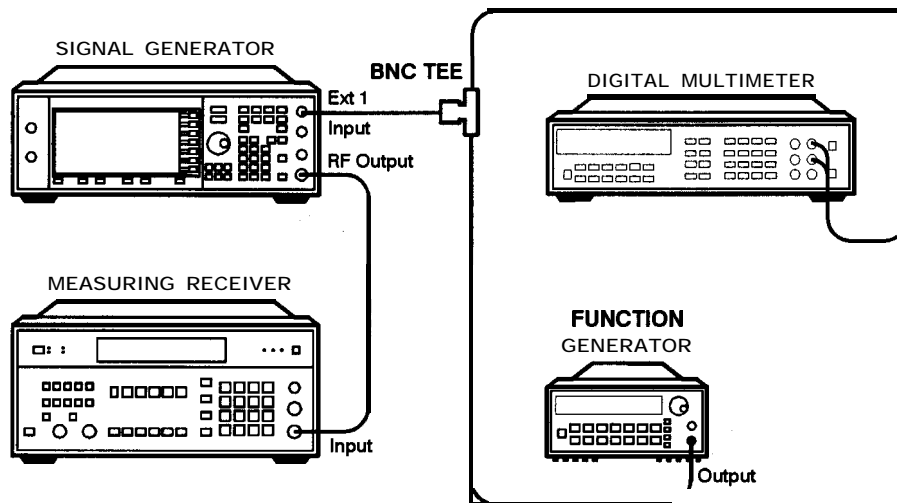
Description

This test equalizes the gain between the FM1 and FM2 paths. The gain of the FM2 path is adjusted using the FM SCALE DAC and the resulting DAC value is stored in the instrument's firmware. This calibration only affects source-independent gains. When uncalibrated sources feed into the paths, the gains are adjusted using the Modulation Source Relative Gain Calibration.

Required Test Equipment

- HP 3458A Digital Voltmeter
- HP 53 132A Universal Counter
- HP 33 120A 15 MHz Function/Arbitrary Waveform Generator

Procedure

wk785a

1. Connect the equipment as shown above.

2. Preset all of the equipment.

3. Follow the instructions as they appear on the controller's display.

Modulation Source Relative Gain Compression Calibration
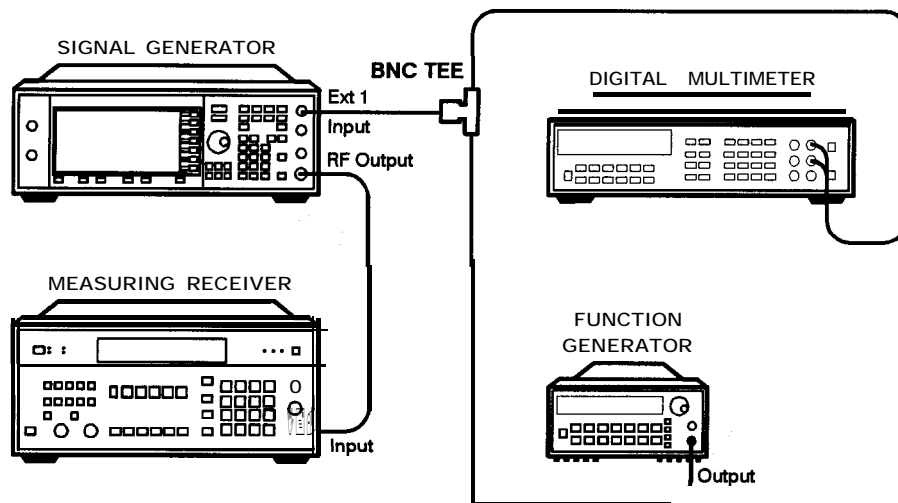
Description

This test provides a scaling factor for all of the multiplexed FM modulation inputs. The scaling factor is used by the instrument's firmware to scale the actual requested FM deviation from the synthesizer board when the corresponding input is selected. Three scaling factors (**EXT1,** EXT2, and **INT1)** are generated during this calibration. The resulting values are used to calculate the calibration values that are then stored in the instrument's firmware.

Required Test Equipment

- HP 3458A Digital Voltmeter
- HP 53 132A Universal Counter
- HP 33120A 15 MHz Function/Arbitrary Waveform Generator

Procedure
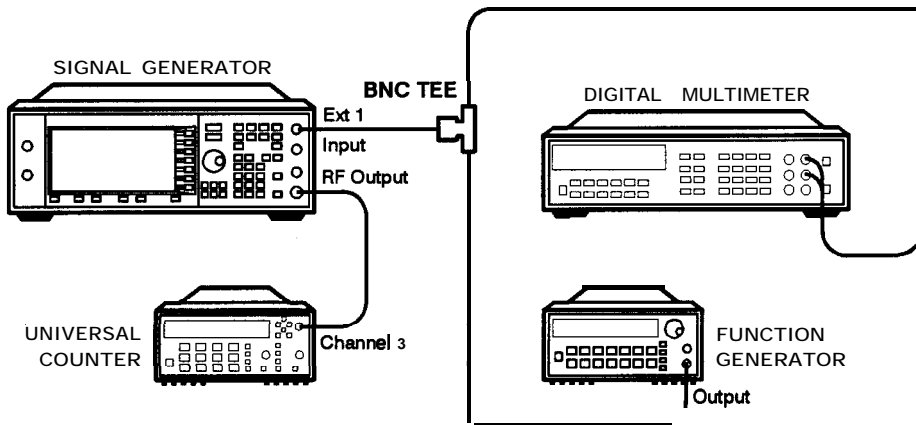
wk785a

1. Connect the equipment as shown above.

2. Preset all of the equipment.

3. Follow the instructions as they appear on the controller's display.

FM Out-Of-Band Calibration
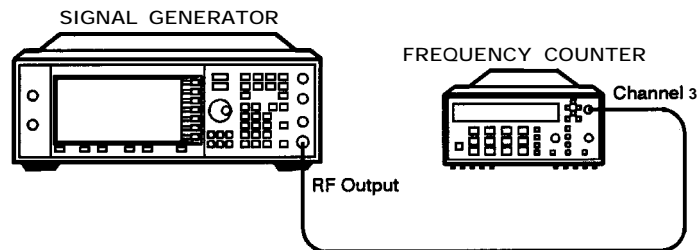
Description

This test adjusts the FM out-of-band deviation to match the in-band FM deviation. It also determines the attenuation values of the out-of-band attenuators and sets the values of so other FM constants. The loop bandwidth of the sythesizer phase-locked loop is approximately 5 kHz. This calibration is used to set the FM deviation at rates above the loop bandwidth (out-of-band) so they will equal the deviation rates within the loop bandwidths (in-band).

Required Test Equipment

• HP 3458A Digital Voltmeter
•
• HP 33 120A 15 MHz Function/Arbitrary Waveform Generator

wk786a

1. Connect the equipment as shown above.

2. Preset all of the equipment.

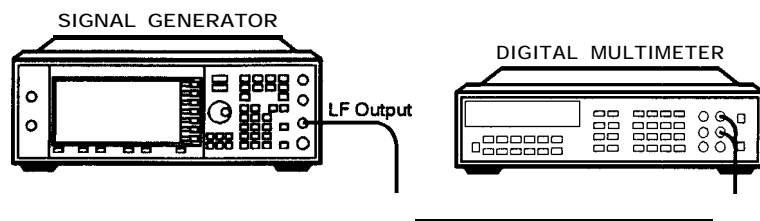3. Follow the instructions as they appear on the controller's display.

FM Delay Potentiometer Adjustment

Description

This test adjusts the match between the delay of the signal passing through the FM in-band path to the delay of the signal passing through the FM out-of-band path. This calibration is the final adjustment required to achieve good FM performance over a wide range of different rates. The FM delay potentiometer forms part of an RC network on the input of the FM out-of-band circuit. The adjustment is used to flatten the delay of the FM response from low rates to high rates. The delay affects the deviation accuracy. By monitoring the deviation, the delay can be adjusted.

Required Test Equipment

- HP 3458A Digital Voltmeter
- HP 8902A Measuring Receiver
- HP 33 120A 15 MHz Function/Arbitrary Waveform Generator

Procedure

wk786a

1. Connect the equipment as shown above.

2. Preset all of the equipment.

3. Follow the instructions as they appear on the controller's display.

Wide Bandwidth Phase Modulation Calibration

Description

This test is used to calibrate the phase modulation circuitry on the synthesizer board. The phase modulation has two operational modes: normal and wide bandwidth. This calibration determines the attenuation correction factors for maximum deviation for each of the phase modulation out-of-band ranges for normal and wide bandwidth modes and in-band and out-of-band operation. This calibration MUST be performed at the same frequency as the FM out-of-band calibration (1 GHz). The resulting correction factors are then stored in the instrument's firmware.

Required Test Equipment

- HP 3458A Digital Voltmeter
- HP 8902A Measuring Receiver
- HP 33 120A 15 MHz Function/Arbitrary Waveform Generator

Procedure

wk786a

1. Connect the equipment as shown above.

2. Preset all of the equipment.

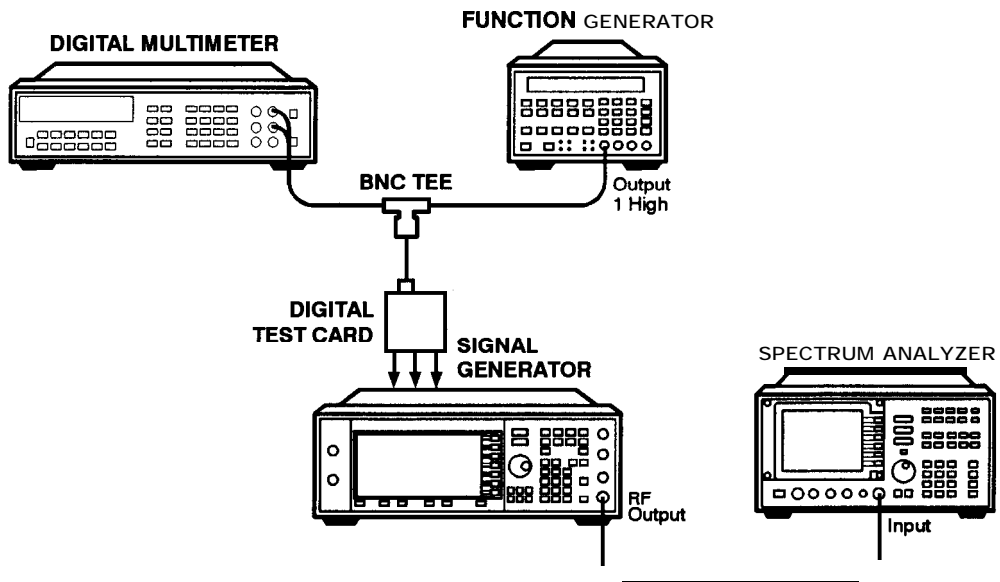3. Follow the instructions as they appear on the controller's display.

DCFM Calibration

Description

This test removes all of the DC offsets associated with the FM path while in DCFM mode. This test uses only the FM1 path to verify the functionality of the circuitry. The resulting values are stored in the instrument's firmware.

Required Test Equipment

• HP 53 132A Universal Counter

Procedure

wk782a

1. Connect the equipment as shown above.

2. Preset all of the equipment.

3. Follow the instructions as they appear on the controller's display.

Low Frequency (LF) Output Calibration

Description

The LF output provides a calibrated audio frequency signal. This test is used to set the full-scale amplitude of the LF-OUT DAC on the reference board. When the calibration is complete, the voltage on the LF output should be equal to the input voltage plus or minus 1 mV. The resulting DAC values are then stored in the instruments firmware.

Required Test Equipment

- HP 3458A Digital Voltmeter

Procedure

wk787a

1. Connect the equipment as shown above.

2. Preset all of the equipment.

3. Follow the instructions as they appear on the controller's display.

External Input Peak Detector Calibration
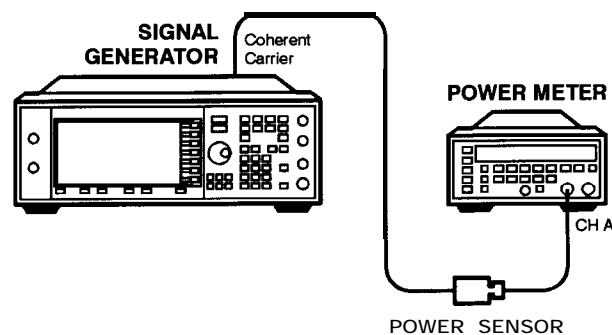
Description

This test is used to calibrate the positive trip level of the EXT1 and EXT2 peak detectors located on the reference board. The calibration generates DAC values for the modulation comparator DACs which provide an voltage to the window comparator operational amplifiers. When the peak detector level DACs are set correctly, the overmodulation indicator will trigger whenever the voltage to the EXT1/EXT2 input is greater than 1.03V. The resulting DAC values are saved as a calibration constant in the instrument's firmware.

Required Test Equipment

- HP 3458A Digital Voltmeter
- HP 33 120A 15 MHz Function/Arbitrary Waveform Generator

Procedure
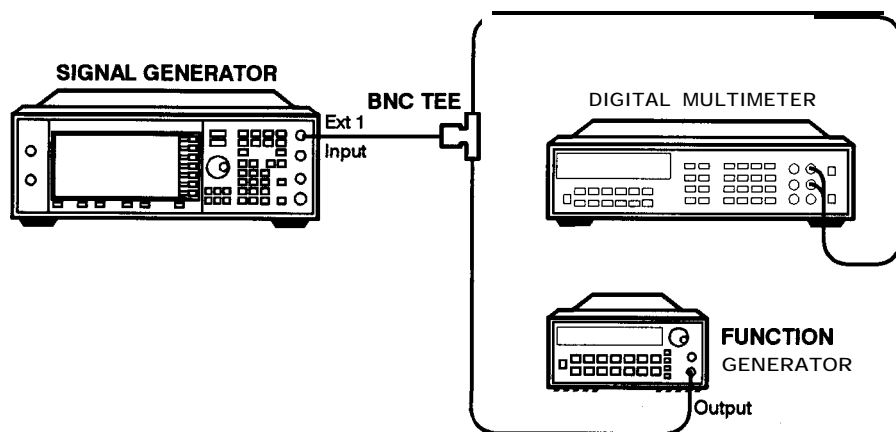
wk788a

1. Connect the equipment as shown above.

2. Preset all of the equipment.

3. Follow the instructions as they appear on the controller's display.

Burst Modulator Calibration

Description

This test is used to adjust the bias modulator circuitry to provide an accurate logarithmic drop in power level for a linear input voltage. When properly adjusted, a one-volt signal on the input will result in a 10 dB drop in power level. The adjustment involves the adjustment of three DACs (BURST BIAS, BURST GAIN, and BURST OFFSET) at several different frequencies. The BURST OFFSET DAC sets the initial current level through the burst modulator diode. The BURST GAIN DAC is used to calibrate the input voltage level to the burst driver circuit. The BURST BIAS DAC sets the breakpoint at which the modulator switches from a logarithmic to a linear transfer function. The results are stored in the calibration arrays associated with each DAC.

Required Test Equipment

- HP 8904A Audio Source
- HP 8563E Spectrum Analyzer
- HP E4400-60073 Digital Test Card

Procedure

DIGITAL MULTIMETER

FUNCTION GENERATOR

BNC TEE

Output
1 High

DIGITAL
TEST CARD

SIGNAL
GENERATOR

SPECTRUM ANALYZER

RF
Output

Input

wk790a

1. Connect the equipment as shown above.

2. Preset all of the equipment.

3. Follow the instructions as they appear on the controller's display.

Burst Audio Path Gain Calibration
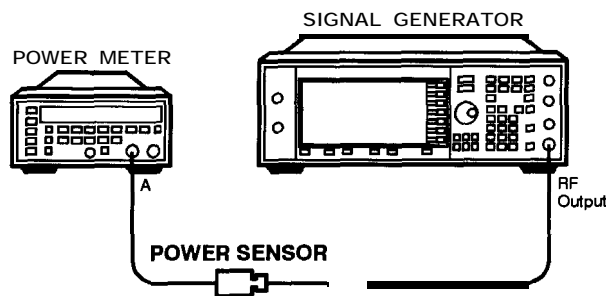
Description

This test adjusts the scaling of the linear burst audio path until a -0.99 Vdc input to the **EXT1** connector results in a 40 **dB** drop in power relative to 0.00 Vdc input when linear burst is activated. The AM 1 DAC value is changed until this result is achieved and its value is stored as a calibration array.

Required Test Equipment

- HP 3458A Digital Voltmeter
- HP 33120A 15 MHz Function/Arbitrary Waveform Generator
- HP 8563E Spectrum Analyzer

Procedure
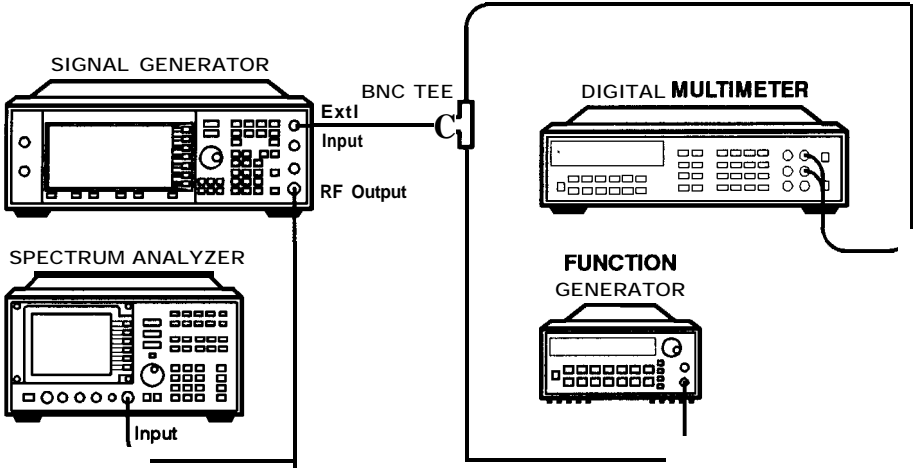
wk789a

1. Connect the equipment as shown above.

2. Preset all of the equipment.

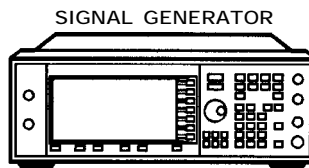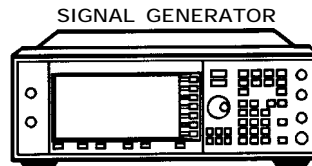3. Follow the instructions as they appear on the controller's display.

Prelevel Calibration

Description

This test calibrates the PRE LEVEL REF DAC on the output board. This DAC is used to control the RF power level that is incident upon the marble I/Q modulator by setting the control point for the prelevel loop. The prelevel loop detector is on the output of the marble I/Q modulator, its drive circuitry on the output board, and its RF modulator on the synthesizer board. This calibration ensures that there will be sufficient power available at the marble I/Q modulator to perform the desired modulation while minimizing intermodulation distortion when the digital modulation is activated. The instrument is set to a frequency and the auxiliary output amplitude level is adjusted using the PRE LEVEL DAC to within the specified tolerance of the desired value. This process is repeated for all the frequencies in the marble I/Q modulator index array. The results are then stored in the instrument's firmware.

Required Test Equipment

- HP 438A Power Meter
- HP 8482A Power Sensor

Procedure

wk7100a

1. Connect the equipment as shown above.

2. Preset all of the equipment.

3. Follow the instructions as they appear on the controller's display.
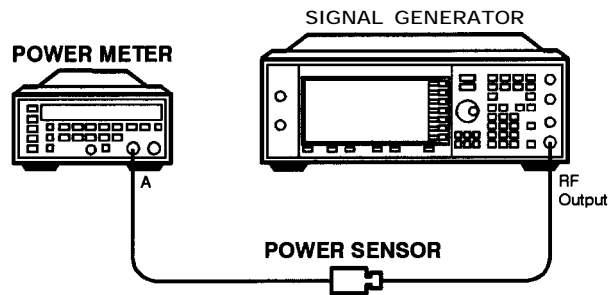
Gain Adjust Calibration

Description

This test calibrates **GAIN** ADJUST DAC on the output board. This DAC is used to control the RF power level that is incident upon the switched filters and subsequent RF amplifiers by setting the control point for the gain adjust modulator. This calibration ensures that there will be sufficient power available at the RF amplifiers to perform the desired modulation while minimizing intermodulation distortion when the digital modulation is activated. After adjustment, the results are stored in the instrument's firmware.

Required Test Equipment

- HP 438A Power Meter
- HP 8482A Power Sensor

Procedure

wk780a

1. Connect the equipment as shown above.

2. Preset all of the equipment.

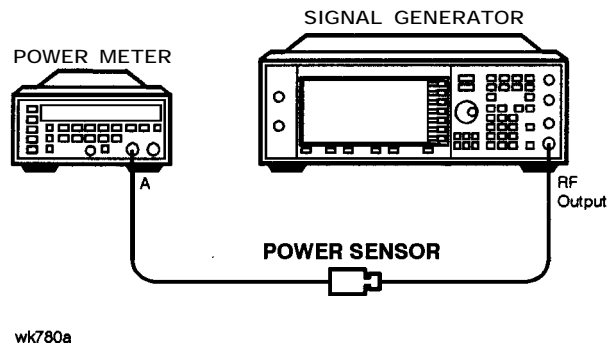3. Follow the instructions as they appear on the controller's display.

ALC Modulation Driver Bias Calibration

Description

This test adjusts the ALC MOD DRV BIAS DAC on the output board. This DAC is used to control the bias current to the ALC modulator driver. It is primarily used to accommodate unmatched VBE values in the drives, but has a strong influence on modulator gain. This test adjusts the DAC until the ALC modulator gain is balanced around its nominal design center. The results are stored as a calibration array in the instrument's firmware.

Required Test Equipment

. None

Procedure

SIGNAL GENERATOR

wk784a

1. Connect the equipment as shown above.

2. Preset all of the equipment.

3. Follow the instructions as they appear on the controller's display.

VBLO Mixer Bias Calibration

Description

This test calibrates VBLO MIXER BIAS DAC on the output board. This DAC is used to control the bias voltage to the internal marble mixers. This DAC is primarily used to adjust the mixer bias for optimum I/Q modulation linearity, but it has a secondary influence on mixer gain. This calibration ensures that there will be sufficient power available through the marble mixers to perform the desired modulation while minimizing intermodulation distortion when the digital modulation is activated. After adjustment, the results are stored in the instrument's firmware.

Required Test Equipment

- None

Procedure

wk784a

1. Connect the equipment as shown above.

2. Preset all of the equipment.

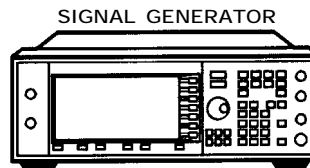3. Follow the instructions as they appear on the controller's display.

Automatic Leveling Control (ALC) Calibration

Description

This test is used to achieve a four-point fit of power level accuracy over the ALC REF DAC settings of 1300, 1800, 2300, and 2700. Three calibration constants and the BULK R ADJ potentiometer are used to calibrate the ALC. Closed loop and open loop calibrations are adjusted separately. The resulting values are stored as calibration arrays in the instrument's firmware.

Required Test Equipment

- HP 438A Power Meter
- HP 8482A Power Sensor

Procedure

wk780a

1. Connect the equipment as shown above.

2. Preset all of the equipment.

3. Follow the instructions as they appear on the controller's display.
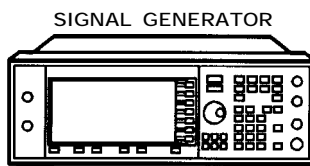
Power Flatness Calibration

Description

This test adjusts the output power to be flat across the instrument's entire operating range. The ALC REF DAC is set to 2048, which nominally sets the power to 0 dBm at the RF output. The exact power level is then measured and a correction factor is generated which is then used to offset the ALC REF DAC until an output power level of 0 dBm is achieved. The results are stored as a calibration array in the instrument's firmware.

Required Test Equipment

• HP 438A Power Meter
• HP 8482A Power Sensor

Procedure

wk780a

1. Connect the equipment as shown above.

2. Preset all of the equipment.

3. Follow the instructions as they appear on the controller's display.

Attenuator Calibration (Power Meter)

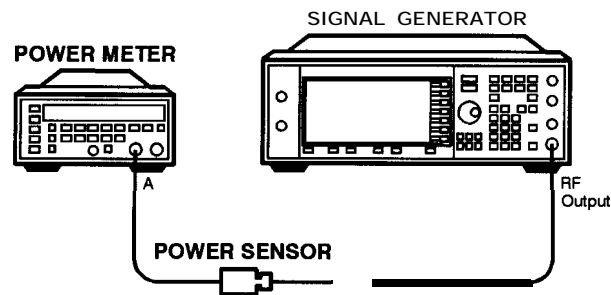## Description

This test is used to calibrate the output power when the attenuator is set at -5, -10, and -15 dB. To calibrate each attenuator step, the attenuator is set to the correct internal attenuation using an internal attenuator latch command. Two power measurements are triggered: one without the attenuator and one with the attenuator. The difference between the expected attenuation and the measured attenuation is stored in the appropriate calibration array.

Required Test Equipment

- HP 438A Power Meter
- HP 8482A Power Sensor

Procedure

wk780a
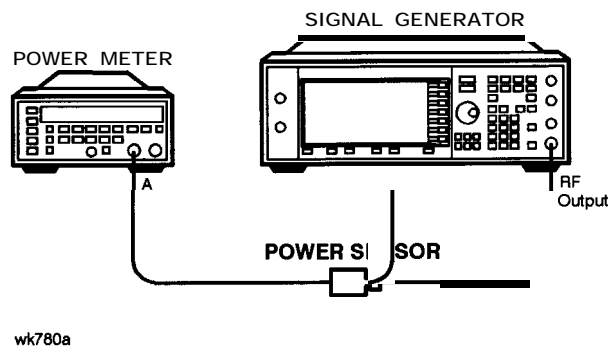
1. Connect the equipment as shown above.

2. Preset all of the equipment.

3. Follow the instructions as they appear on the controller's display.
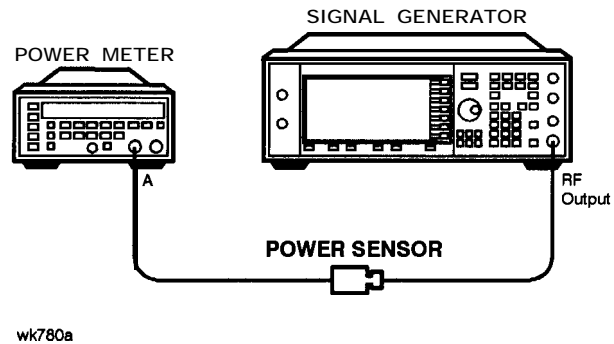
Level Meter Calibration

Description

This test determines the level meter gain and offset calibration constants on the output board. The level meter function is used when the ALC loop is open. It allows the output power of the instrument to be monitored and controlled without using the ALC loop. After the level meter gain and offsets are measured, a calibration constant is calculated and stored in the appropriate calibration array.

Required Test Equipment

. None

Procedure

SIGNAL GENERATOR

wk784a

1. Connect the equipment as shown above.

2. Preset all of the equipment.

3. Follow the instructions as they appear on the controller's display.

I/Q Gain/Offset/Quadrature Calibration

Description

This test determines the required I/Q gain, offset and quadrature calibration constants/arrays that will minimize the I/Q modulation imperfections on the output board. Several calibration constants are determined and then the I/Q gain, offset, and quadrature DACs are adjusted over frequency to minimize the static vector modulation errors. The results are stored in the instrument as calibration arrays.

Required Test Equipment

. None

Procedure

wk784a

1. Connect the equipment as shown above.

2. Preset all of the equipment.

3. Follow the instructions as they appear on the controller's display.

ALC Modulation Flatness Calibration

Description

This test calibrates the ALC REF DAC corrections necessary to maintain power flatness in the ALC open-loop mode of operation. The nominal ALC REF DAC settings are adjusted to re-align the ALC open-loop power with the desired level. The resulting values are stored as calibration arrays in the instrument's firmware.

Required Test Equipment

- HP 438A Power Meter
- HP 8482A Power Sensor

Procedure

wk780a

1. Connect the equipment as shown above.

2. Preset all of the equipment.

3. Follow the instructions as they appear on the controller's display.

AM Gain Calibration

Description

This test adjusts the gain of the AM circuitry to provide a 10 dB drop for a one-volt input signal. First a power level is set and a one-volt signal it connected to the input. AM is enabled and the AM DACs are adjusted for and exact 10 dB drop. The resulting DAC value is stored as a calibration array.

Required Test Equipment

- HP 438A Power Meter
- HP 8482A Power Sensor
- HP 33 120A 15 MHz Function/Arbitrary Waveform Generator

Procedure

wk780a

1. Connect the equipment as shown above.

2. Preset all of the equipment.

3. Follow the instructions as they appear on the controller's display.

Low Level Step Attenuator Calibration

Description

NOTE: The accuracy of this test depends on the accuracy of the Attenuator Calibration (Power Meter). You must perform the Attenuator Calibration (Power Meter) before you perform the following adjustment.

Measurement accuracy at low power levels is dependant on a good signal-to-noise ratio (SNR). This adjustment first insures that the measurement system's noise floor is not above a specific level. During this verification, spectrum analyzer residuals are also checked. If a residual is found, the adjustment for that frequency is shifted 25 Hz to avoid the residual.

This calibration procedure is based on relative power measurements using a spectrum analyzer. The reference for all measurements is the -10 dBm level adjusted in the Attenuator Calibration (Power Meter) procedure. For signal levels below -70 dBm, low noise amplifiers are inserted to maximize the signal-to-noise ratio at low levels. Note that all subsequent measurements are relative to -70 dBm (the lowest signal level measured without the amplifiers). Note also that all attenuator calibration arrays for 20 dB and below are filled with zero after the noise floor measurement. If an adjustment is interrupted after the arrays are zeroed, low level power accuracy will be affected.

Required Test Equipment

- HP 8563E Spectrum Analyzer
- HP 8447D Option 011 .1 to 1300 MHz Dual Preamplifier
- HP 8449D 1 to 26.5 GHz Preamplifier
- HP 849 1 A/B Option 006 Attenuator (6 dB)

Procedure

SIGNAL GENERATOR 10 MHz Out

10 MHz Ref SPECTRUM ANALYZER

RF Output

Input 50 Ω

6 dB ATTENUATOR

AMPLIFIER

wk71 Ma

SIGNAL GENERATOR 10 MHz Out

10 MHz Ref SPECTRUM ANALYZER

RF Output

Input 50 Ω

6 dB ATTENUATOR
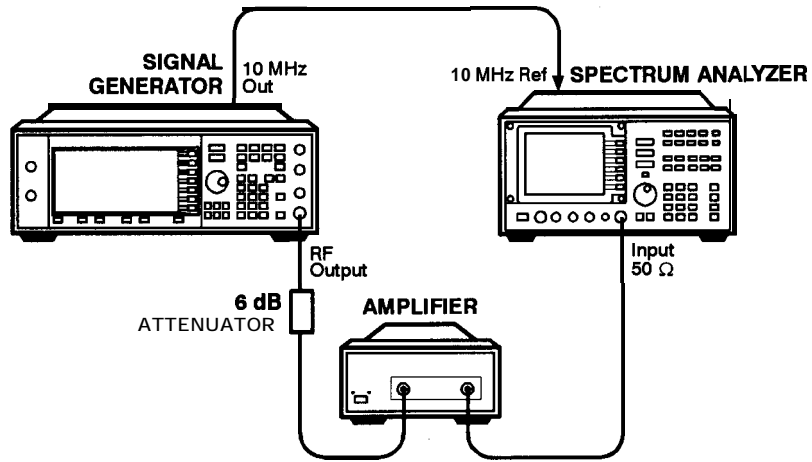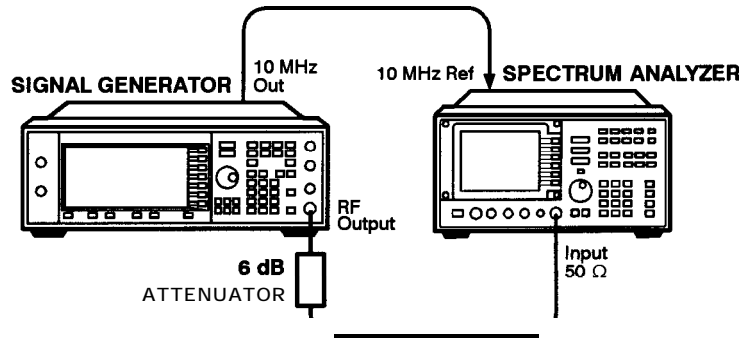
wk7104a
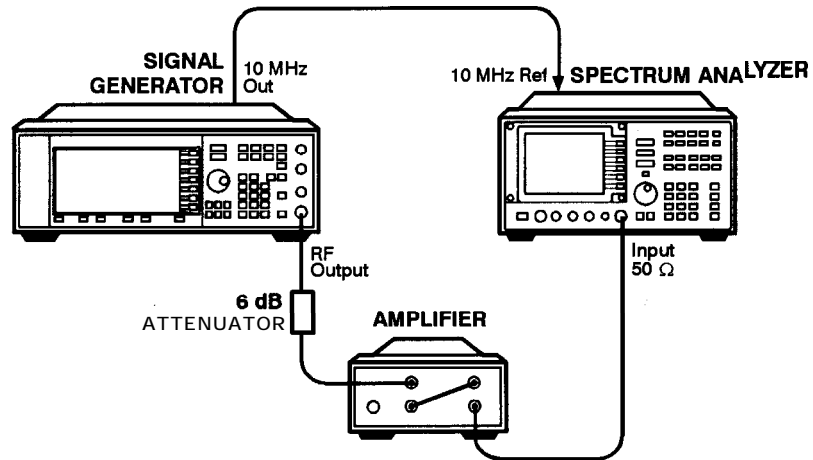
wk7102a

1. Connect the equipment as shown in the first illustration above.

2. Preset all of the equipment.

3. Follow the instructions as they appear on the controller's display.

7   Maintenance and Service

This chapter contains preventive maintenance procedures, and it explains how to return your signal generator to HP for service.

Preventive Maintenance Procedures

The HP ESG-D Series Signal Generators require no regular maintenance. This section contains cleaning procedures for the signal generator.

Cleaning the Cabinet

Use a damp cloth to clean the exterior the instrument. Do not use any cleaning products.

Cleaning the Display

Use a soft cloth to clean the window in front of the display assembly. Isopropyl alcohol can also be used on the window for dirt that is difficult to remove. Do not use these products on the display assembly. Refer to the service guide, if the display assembly requires cleaning.

Returning Your Signal Generator to HP

If you are returning your signal generator to HP for servicing, fill out and attach a blue repair tag to the instrument. Repair tags are located at the end of this chapter.

Include as much information as possible about the problem: record any error messages that appeared on the display, and include performance test results or any other specific data on the performance of the signal generator.

Ship the instrument in the original factory packaging materials, if they are available. If not, use similar packaging to properly protect the instrument.

Return the instrument to the nearest HP sales and service office. A list of sales and service offices follows on the next page.

HP Sales and Service Offices

US FIELD OPERATIONS			
Headquarters Hewlett-Packard Company 19320 Pruneridge Avenue Cupertino, CA 95014 (800) 752-0900	**California, Northern** Hewlett-Packard Co. 301 E. Evelyn Mountain View, CA 94041 (415) 694-2000	**California, Southern** Hewlett-Packard Co. 1421 South Manhattan Ave. Fullerton, CA 92631 (714) 999-6700	**Colorado** Hewlett-Packard Co. 24 Inverness Place, East Englewood, CO 80112 (303) 649-5512
Atlanta Annex Hewlett-Packard Co. 2124 Barrett Park Drive Kennesaw, GA 30144 (404) 648-0000	**Illinois** Hewlett-Packard Co. 545 E. Algonquin Rd. Arlington Heights, IL 60005 (847) 342-2000	**New Jersey** Hewlett-Packard Co. 150 Green Pond Road Rockaway, NJ 07866 (201) 586-5400	**Texas** Hewlett-Packard Co. 930 E. Campbell Rd. Richardson, TX 75081 (214) 231-6101

EUROPEAN FIELD OPERATIONS			
Headquarters Hewlett-Packard S.A. 150, Route du Nant-d'Avril 1217 Meyrin 2/Geneva Switzerland (41 22) 780.8111	**France** Hewlett-Packard France 1 Avenue Du Canada Zone D'Activite De Courtaboeuf F-91947 Les Ulis Cedex France (33 1) 69 82 60 60	**Germany** Hewlett-Packard GmbH Hewlett-Packard Strasse 61352 Bad Homburg v.d.H Germany (49 6172) 16-0	**Great Britain** Hewlett-Packard Ltd. Eskdale Road, Winnersh Triangle Wokingham, Berkshire RG41 5DZ England (44 734) 696622

INTERCON FIELD OPERATIONS			
Headquarters Hewlett-Packard Company 3495 Deer Creek Rd. Palo Alto, California, USA 94304-1316 (415) 857-5027	**Australia** Hewlett-Packard Australia Ltd. 31-41 Joseph Street Blackburn, Victoria 3130 (61 3) 895-2895	**Canada** Hewlett-Packard (Canada) Ltd. 17500 South Service Road Trans-Canada Highway Kirkland, Quebec H9J 2X8 Canada (514) 697-4232	**China** China Hewlett-Packard Co. 38 Bei San Huan X1 Road Shuang Yu Shu Hai Dian District Beijing, China (86 1) 256-6888
Japan Hewlett-Packard Japan, Ltd. 9-1 Takakura-Cho, Hachioji Tokyo 192, Japan (81 426) 60-2111	**Singapore** Hewlett-Packard Singapore (Pte.) Ltd. 150 Beach Road #29-00 Gateway West Singapore 0718 (65) 291-9088	**Taiwan** Hewlett-Packard Taiwan 8th Floor, H-P Building 337 Fu Hsing North Road Taipei, Taiwan (886 2) 712-0404	

8   Safety and Regulatory

This chapter provides product warranty information, regulatory declarations, information about ESD and restricted materials, and explanations of caution and warning statements marked on the instrument.

Safety Notes

The following safety notes are used throughout this manual. Familiarize yourself with each of the notes and its meaning before operating this instrument.

CAUTION

Caution denotes a hazard. It calls attention to a procedure that, if not correctly performed or adhered to, would result in damage to or destruction of the product. Do not proceed beyond a caution sign until the indicated conditions are fully understood and met.

WARNING

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

Instrument Markings

The following markings and caution and warning labels are used on the instrument. Be sure to observe all cautions and warnings.

WARNING

No user serviceable parts inside. Refer servicing to qualified personnel.

A	The instruction manual symbol. The product is marked with this symbol when it is necessary for the user to refer to the instructions in the manual.
CE	The CE mark is a registered trademark of the European Community (if accompanied by a year, it is the year when the design was proven).
(SA)	The CSA mark is the Canadian Standards Association safety mark.
|	This symbol is used to mark the on position of the power line switch.
⏻	This symbol is used to mark the standby position of the power line switch.
∼	This symbol indicates that the input power required is AC.
ISM 1-A	This is a symbol of an Industrial Scientific and Medical Group 1 Class A product. (CISPER 11, Clause 4)

General Safety Considerations

WARNING

No operator serviceable parts inside. Refer servicing to qualified personnel. To prevent electrical shock do not remove covers.

WARNING

This is a Safety Class 1 Product (provided with a protective earthing ground incorporated in the power cord). The mains plug shah only be inserted in a socket outlet provided with a protective earth contact. Any interruption of the protective conductor inside or outside of the product is likely to make the product dangerous. Intentional interruption is prohibited.

Statement of Compliance

This product has been designed and tested in accordance with IEC Publication 1010, Safety Requirements for Electronic Measuring Apparatus, and has been supplied in a safe condition. The instruction documentation contains information and warnings which must be followed by the user to ensure safe operation and to maintain the product in a safe condition.

Electrostatic Discharge

Electrostatic discharge (ESD) can damage or destroy electronic components. Therefore, all work performed on assemblies consisting of electronic components should be done at a static-free work station. Figure 8-1 shows an example of a static-safe work station using two kinds of ESD protection:

·   conductive table mat and wrist-strap combination
·   conductive floor mat and heel-strap combination

These methods may be used together or separately.
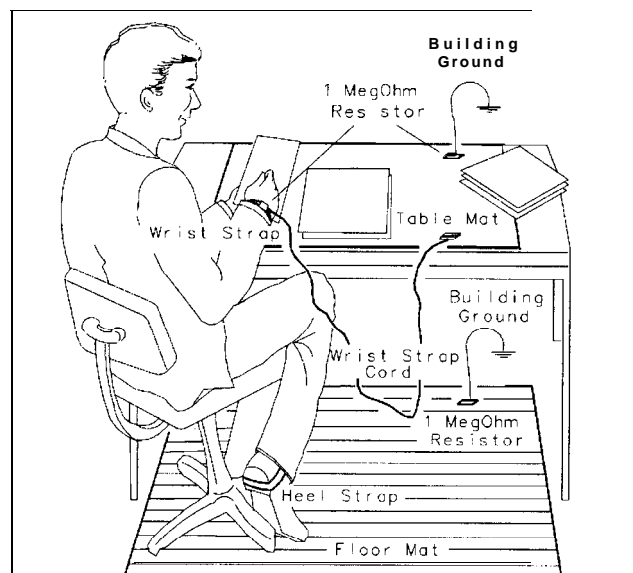
Figure 8-1. Static-Safe Work Station

Reducing Potential for ESD Damage

The following suggestions may help reduce ESD damage that occurs during instrument testing and servicing:

●   Before connecting any coaxial cable to a connector for the first time each day, momentarily ground the center and outer connectors of the cable.
●   Ground personnel with a resistor-isolated wrist strap before touching any connector and before removing any assembly from the instrument.
●   All instruments should be earth-grounded to prevent build-up of static discharge.

Warranty

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

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

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

LIMITATION OF WARRANTY

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

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HEWLETT-PACKARD SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HEWLETT-PACKARD SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

Assistance

Product maintenance agreements and other customer assistance agreements are available for **Hewlett-**

to the list of sales and service offices in Chapter 3.

Certification

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

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