FLUKE ®

9640A

RF Reference Source

Instruction Manual

August 2006

LIMITED WARRANTY AND LIMITATION OF LIABILITY

Each Fluke product is warranted to be free from defects in material and workmanship under normal use and service. The warranty period is one year and begins on the date of shipment. Parts, product repairs, and services are warranted for 90 days. This warranty extends only to the original buyer or end-user customer of a Fluke authorized reseller, and does not apply to fuses, disposable batteries, or to any product which, in Fluke's opinion, has been misused, altered, neglected, contaminated, or damaged by accident or abnormal conditions of operation or handling. Fluke warrants that software will operate substantially in accordance with its functional specifications for 90 days and that it has been properly recorded on non-defective media. Fluke does not warrant that software will be error free or operate without interruption.

Fluke authorized resellers shall extend this warranty on new and unused products to end-user customers only but have no authority to extend a greater or different warranty on behalf of Fluke. Warranty support is available only if product is purchased through a Fluke authorized sales outlet or Buyer has paid the applicable international price. Fluke reserves the right to invoice Buyer for importation costs of repair/replacement parts when product purchased in one country is submitted for repair in another country.

Fluke's warranty obligation is limited, at Fluke's option, to refund of the purchase price, free of charge repair, or replacement of a defective product which is returned to a Fluke authorized service center within the warranty period.

To obtain warranty service, contact your nearest Fluke authorized service center to obtain return authorization information, then send the product to that service center, with a description of the difficulty, postage and insurance prepaid (FOB Destination). Fluke assumes no risk for damage in transit. Following warranty repair, the product will be returned to Buyer, transportation prepaid (FOB Destination). If Fluke determines that failure was caused by neglect, misuse, contamination, alteration, accident, or abnormal condition of operation or handling, including overvoltage failures caused by use outside the product's specified rating, or normal wear and tear of mechanical components, Fluke will provide an estimate of repair costs and obtain authorization before commencing the work. Following repair, the product will be returned to the Buyer transportation prepaid and the Buyer will be billed for the repair and return transportation charges (FOB Shipping Point).

THIS WARRANTY IS BUYER'S SOLE AND EXCLUSIVE REMEDY AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. FLUKE SHALL NOT BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES OR LOSSES, INCLUDING LOSS OF DATA, ARISING FROM ANY CAUSE OR THEORY.

Since some countries or states do not allow limitation of the term of an implied warranty, or exclusion or limitation of incidental or consequential damages, the limitations and exclusions of this warranty may not apply to every buyer. If any provision of this Warranty is held invalid or unenforceable by a court or other decision-maker of competent jurisdiction, such holding will not affect the validity or enforceability of any other provision.

Fluke Corporation
P.O. Box 9090
Everett, WA 98206-9090
U.S.A.

Fluke Europe B.V.
P.O. Box 1186
5602 BD Eindhoven
The Netherlands

11/99

To register your product online, visit register.fluke.com

Table of Contents

Appendices

List of Tables

List of Figures

Chapter 1
Introduction and Specifications

About the Manual

This is the Instruction Manual for the 9640A RF Reference Source (hereafter referred to as the Instrument) and its options and accessories. It contains all of the information a user will need to operate and maintain the Instrument effectively. The manual is divided into the following chapters:

Chapter 1	Introduction and Specifications
Chapter 2	Preparing the Instrument for Operation
Chapter 3	Local Operation
Chapter 4	Remote Operation
Chapter 5	Calibration
Chapter 6	Theory of Operation
Chapter 7	Maintenance
Chapter 8	Lists of Replaceable Parts
Appendices	Rack mounting instructions
	Error Messages

Safety Information

This section addresses safety considerations and describes symbols that may appear either in this manual or on the Instrument.

A ⚠⚠ **Warning** statement identifies conditions or practices that could result in injury or death.

A ⚠ **Caution** statement identifies conditions or practices that could result in damage to the Instrument or equipment to which it is connected.

⚠⚠ Warning

To avoid electric shock, personal injury, or death, carefully read the information under *General Safety Summary* before attempting to install, use, or service the Instrument.

General Safety Summary

The Instrument has been designed and tested in accordance with the European standard publication EN 1010-1: 2001 and U.S. / Canadian standard publications UL 1010-1:2004 and CAN/CSA-22.2 No.61010-1:2004. The Instrument left the factory in a safe condition.

This manual contains information and warnings that must be observed to keep the Instrument in a safe condition and ensure safe operation. Using or servicing the Instrument in conditions other than as specified in the Instruction Manual could compromise your safety.

To use the Instrument correctly and safely, read and follow the precautions on the next few pages, as well as, the safety instructions or warnings given throughout this manual. In addition, follow all generally accepted safety practices and procedures when working with and around electricity.

Safety Information

⚠⚠ Warning:

To avoid electric shock, personal injury, fire, or death, read the following warnings before using the Instrument:

- **Use the Instrument only as specified in this manual, or the protection provided by the instrument might be impaired.**
- **Do not use the Instrument in wet environments.**
- **Inspect the Instrument before using it. Do not use the Instrument if it appears damaged.**
- **Do not use the Instrument if it operates abnormally. Protection may be impaired. If in doubt, have the Instrument serviced.**
- **Have the Instrument serviced only by qualified service personnel.**
- **Always use the power cord and connector appropriate for the voltage and outlet of the country or location in which you are working.**
- **Connect the Instrument power cord to a power receptacle with an earth ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.**
- **Never remove the cover or open the case of an instrument without first disconnecting the Instrument from the power source.**
- **Never operate the Instrument with the cover removed or the case open.**
- **Use caution when working with voltages above 30 V ac rms, 42 V ac peak, or 42 V dc. These voltages pose a shock hazard.**
- **Use only the replacement fuse(s) specified by the manual.**
- **When servicing the Instrument, use only specified replacement parts.**

⚠⚠ Warning

To prevent personal injury, use good lifting practices when lifting or moving the Instrument. The Instrument is an unbalanced load and weighs in excess of 18 kg (40 pounds).

⚠⚠ Warning

To prevent the transmission of an RF signal, never connect the Instrument output (the output from a passive Leveling Head) to a radiating antenna or leaky transmission line of any kind. Such a transmission could be hazardous to personnel and may impair the SAFE operation of equipment, and communication and navigation systems.

The connection of a radiating antenna is an illegal act in many countries. Only connect the Instrument output (the output from a passive Leveling Head) to equipment or transmission lines designed to prevent RF leakage at the level and frequency of the Instrument output.

Avoiding Instrument Damage

⚠ Caution

To avoid damage to the instrument, read the following cautions before using the instrument:

- **The front panel connectors on the Instrument are suited only for use with Fluke 9640A-xx Leveling Heads. No other connection is permitted.**
- **The Leveling Heads are fitted with close tolerance metrology grade N-connectors compliant with MIL-C-39012 and MMC Standards for Precision N-connectors. When used in demanding metrology applications the Leveling Heads are likely to be mated with similar high-quality connectors, thus, minimizing the opportunity for wear and damage. However, in applications that require frequent mating or mating to lower quality connectors, the opportunity for damaging the connectors increases. On these high-risk occasions, consider using a sacrificial adapter to prevent damage to the N connectors.**
- **Improper mating of 50 Ω and 75 Ω connectors will irreversible damage the center pin. Although appearance is similar, the dimensions (pin diameter) of 75 Ω differ significantly from those of 50 Ω. Make sure that the 50 Ω Leveling Head is mated only to 50 Ω systems and, likewise, that the 75 Ω Leveling Head is mated only with 75 Ω systems. Otherwise, mechanical damage of metrology-grade connectors and out-of-tolerance performance is likely to occur.**
- **Very high-grade flexible coaxial transmission line conducts the RF input signal to 9640A-xx Leveling Heads. As with any coaxial line, deformation of sidewalls or abrupt bending can degrade performance. Take care to avoid mechanical stress or tight bend radius < 60 mm (2.4 in).**
- **Reliable and repeatable interconnections are achieved only at specified torque settings. Performance will be impaired if torque settings are not observed, and permanent connector damage is likely to result from over-tightening.**
- **Critical connector mating dimensions could be damaged during disassembly of a Leveling Head. DO NOT TAMPER with the four mounting screws at the base of the N-Connector. Leveling Head disassembly should only be performed by qualified service personnel at a Fluke Service Center.**
- **To prevent damage to the instrument, do not use aromatic hydrocarbons or chlorinated solvents for cleaning.**

Symbols

The following safety and electrical symbols may appear on the Instrument or in this manual.

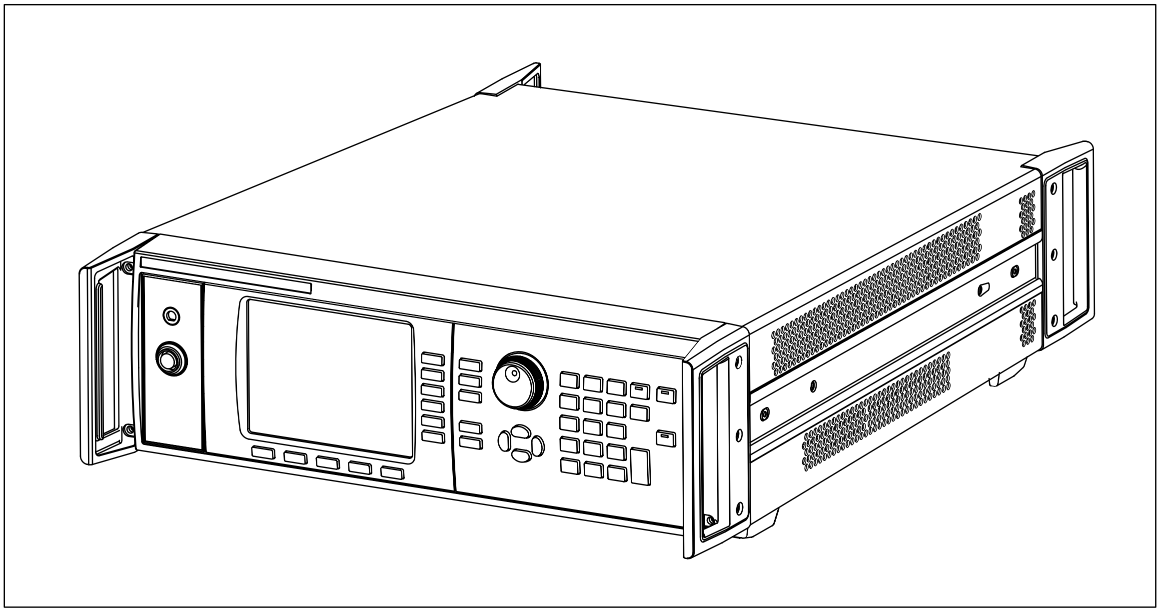
⚠	Risk of danger. Important information. See manual.	!	Power ON / OFF
⚠	Hazardous voltage. Voltage > 30 V dc or ac peak might be present	⏚	Earth ground.
~	AC (Alternating Current).		Capacitance.
⎓	DC (Direct Current).		Diode.
or	AC or DC (Alternating or Direct Current)	CAUTION LASER	Laser caution.
			Warning. Laser.
	Continuity test or continuity beeper tone.		Fuse.
	Digital signal.		Warning. Hot or burn hazard.
	Potentially hazardous voltage.	CAT	IEC 61010 Overvoltage (installation or measurement) Category.
◑	Brightness / contrast adjustment		Display backlight
⧈	Double insulated.	♲	Recycle.
	Static awareness. Static discharge can damage part(s).		Do not dispose of this product as municipal waste. Contact Fluke or a qualified recycler for disposal
	Do not connect to public network (e.g., telephone system.)		Maintenance or Service.
	Do not apply to or remove from hazardous, live conductors without taking additional protective measures. [**Note**: Applies to current clamps.]	♪	Tone or beep.
			Application to or removal from hazardous, live conductors is permitted. [**Note**: Applies to current clamps.]

Product Description

The Instrument is an RF Reference Source designed to create the signals needed for precision RF and microwave applications. See Figure 1-1. Signal delivery via interchangeable Leveling Heads ensures a unique combination of level accuracy, dynamic range, and frequency coverage in both 50 Ohm and 75 Ohm systems.

The following is a list of the features that enable the Instrument to be readily integrated into a typical RF calibration system:

- Accurate level over a wide dynamic range
- Precision internal AM/FM modulation, including External Modulation capability
- Frequency Range includes both LF and RF
- High signal purity with no additional filtering
- Passive Leveling Heads to ensure direct and precise signal delivery to the load
- Low Phase Noise
- IEEE 488 Remote Interface
- Rack Mount Slide Kit (optional)



ead316f.eps

Figure 1-1. 9640A RF Reference Source

Options and Accessories

Table 1-1 provides a list of the options and accessories available for use with the Instrument. When ordering an option or accessory after the original purchase, include a reference to the Instrument as well as the description from the following table.

Table 1-1. List of Options and Accessories

Options	
9640A-75 [1]	Upgrade to add a 9640A-75 Leveling Head
Accessories	
Y9600	Rack Mount Slide Kit
9600CASE	Rugged Transit Case
9600CONN	RF Interconnect Kit. The kit includes: 1 – Sacrificial N-Connector, Male to Female Adapter, 50 Ω 1 – Precision N-Connector, Female to Female Adapter, 50 Ω 2 – RF Connector Torque Wrenches 1 – N-Connector 1 – PC3.5/SMA Connector
9640A Manual Set	9640A Instruction Manual Package. The package includes: 1 – Printed Getting Started Manual 1 – CD containing the entire manual set (PDF files): 1 – 9640A Instruction Manual 2 – 9640A Getting Started Manuals (English, French)
[1] This is a factory/service upgrade that requires the return of the main unit and all of the partner Leveling Heads	

Specifications

General specifications

Performance	All specifications apply to a 1 year calibration interval at an ambient temperature of Tcal ±5°C. Nominal factory Tcal calibration temperature 23°C.
Standard Interfaces	IEEE488.2 (GPIB)
Warmup Time	60 minutes
Temperature	Operating: 0°C to 50°C Specified Operation: 5°C to 40°C Storage: -20°C to +70°C
Relative Humidity	Operating: <90% Storage: <95% non-condensing
Altitude	Operating: ≤ 2,000m Non-operating: ≤ 12,000m
Safety	EN 61010-1:2001, CAN/CSA 22.2 No 61010-1:2004 and UL61010-1:2004, indoor use only, pollution degree 2, installation category II.
EMC	EN50081-1 Class B, EN55011:1991 Class B, EN61326-1:1998, EN50082-1 / EN61000-6-1:2001, EN61000-3-2
Line Power	90 to 132 V RMS and 180 to 264 VRMS at 47 to 63 Hz
Power Consumption	≤250VA
Dimensions	433mm (17.0”) wide, 146mm (5.8”) high and 533mm (21.0”) deep. Mounts within industry-standard 19” (483mm) rack-mount frames when fitted with Y9600 rack mounting kit.
Weight	18kg (40lbs)

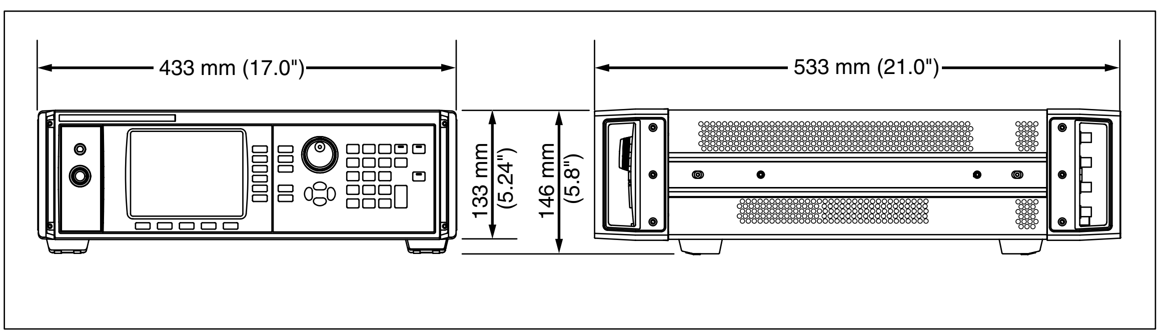


Figure 1-2. 9640A RF Reference Source – Dimentional Outline Drawing

Frequency Reference Input/Output Specifications

Frequency Reference Input	Rear panel Reference Frequency Input BNC connector
Frequency	1MHz to 20MHz in 1MHz steps ±30ppm
Level	1V pk nominal, into 50Ω. ±5V pk max.

Frequency Reference Output	Rear panel Reference Frequency Output BNC connector
Frequency	1MHz or 10MHz, user selectable
Level	1.5V pk-pk into 50Ω, 3V pk-pk into 1kΩ, TTL compatible.
Accuracy [1]	0.04ppm
Ageing Rate and Stability [1]	After 24hr warmup and oscillator off time <24hrs: $2x10^{-9}$/day. Continuous operation: ≤ $2x10^{-8}$/month, ≤ $4x10^{-8}$ over 1 year.
[1] Specifications apply only if Internal Frequency Reference operation selected. With External Frequency Reference operation selected the frequency of the Frequency Reference Output is locked to the signal applied to the Frequency Reference Input.	

Leveled Sine Specifications

Frequency	
Range	10Hz to 4GHz
Resolution	<100MHz: 0.001Hz , >100MHz: 11 digits
Accuracy	Internal Frequency Reference: 0.04ppm + 0.16mHz External Frequency Reference: Ext Freq Ref Accuracy + 0.16mHz

Amplitude	50Ω output	75Ω output
Output Connector	Precision 50Ω N-Series male	Precision 75Ω N-Series male
Range	-130dBm to +24dBm (0.2 uV to 10 V pk-pk) >125 MHz: +20dBm >1.4GHz: +14dBm	-130dBm to +18dBm (0.13 uV to 6.3 V pk-pk) >125MHz: +14dBm >1.4GHz: +8dBm
Resolution	0.001dB	0.001dB
Absolute Accuracy See separate tables for absolute accuracy specifications over entire output frequency range.	100kHz to 125MHz: -48 to +24dBm ±0.05dB -74 to -48dBm ±0.2dB -94 to -74dBm ±0.5dB -130 to -94dBm ±1.5dB 1GHz: -17 to +24dBm ±0.25dB -74 to -17dBm ±0.5dB -94 to -74dBm ±1.0dB -130 to -94dBm ±1.5dB 4GHz: -74 to +14dBm ±0.5dB -84 to -74dBm ±1.0dB	100kHz to 125MHz: -23 to +18dBm ±0.06dB -54 to -23dBm ±0.15dB -80 to -54dBm ±0.2dB -100 to -80dBm ±0.7dB -120 to -100dBm ±1.5dB 1GHz: -23 to +18dBm ±0.25dB -80 to -23dBm ±0.5dB -100 to -80dBm ±1.0dB 2GHz: -23 to +8dBm ±0.3dB -80 to -23dBm ±0.5dB -100 to -80dBm ±1.0dB -120 to -100dBm ±1.5dB
Attenuation [1] Specifications are typical below 10MHz.	Relative to +16dBm output 100kHz[1] to 100MHz 0 - 33dB ±0.035dB 33 - 64dB ±0.04dB 64 - 100dB ±0.1dB	Relative to +16dBm output, typical 100kHz to 100MHz 0 - 33dB ±0.035dB 33 - 64dB ±0.05dB 64 - 100dB ±0.15dB
VSWR	≤500MHz: ≤1.1 ≤1GHz: ≤1.2 ≤3GHz: ≤1.3 ≤4GHz: ≤1.4	≤500MHz: ≤1.1 ≤1GHz: ≤1.2 ≤2GHz: ≤1.3

Signal Purity	At maximum output level
Harmonics	≤ 1GHz: < -60dBc, >1GHz: < -55dBc
Spurious ≥3kHz offset and Sub-harmonics	≤500MHz: < -75dBc, ≤1GHz: < -70dBc, ≤2GHz: < -65dBc, ≤4GHz: < -60dBc
SSB Phase Noise (Internal Freq Ref)	1GHz : 1kHz offset -93dBc/Hz 10kHz offset -108dBc/Hz 100kHz offset -110dBc/Hz 1MHz offset -113dBc/Hz
SSB AM Noise	10MHz to 1.4GHz, <0.015% RMS, in 50Hz to 3kHz Bandwidth, typical.
Residual FM	<0.5Hz RMS at <125MHz, in 50Hz to 3kHz Bandwidth, typical.

Absolute Amplitude Accuracy	**50 Ω Output**							
Amplitude dBm	10Hz to 20kHz	>20kHz to <100kHz	100kHz to <10MHz	10MHz to 125MHz	≥125MHz to 300MHz	≥300Hz to 1.4GHz	≥1.4GHz to 3GHz	≥3GHz to 4GHz
>+20 to +24	±0.05dB	±0.05dB	±0.05dB	±0.05dB	Output not available	Output not available	Output not available	Output not available
>+14 to +20	±0.05dB	±0.05dB	±0.05dB	±0.05dB	±0.1dB	±0.25dB		
-17 to +14	±0.05dB	±0.05dB	±0.05dB	±0.05dB	±0.1dB	±0.25dB	±0.3dB	±0.5dB
-48 to ≤-17	±0.05dB	±0.05dB	±0.05dB	±0.05dB	±0.1dB	±0.5dB	±0.5dB	±0.5dB
>-74 to ≤-48	Not Specified	Not Specified	±0.2dB	±0.2dB	±0.2dB	±0.5dB	±0.5B	±0.5dB
>-84 to -74	Not Specified	Not Specified	±0.5dB	±0.5dB	±0.5dB	±1.0dB	±1.0dB	±1.0dB
>-94 to -84	Not Specified	Not Specified	±0.5dB	±0.5dB	±0.5dB	±1.0dB	±1.0dB	Not Spec'd
-130 to -94	Not Specified	Not Specified	±1.5dB	±1.5dB	±1.5dB	±1.5dB	±1.5dB	Not Spec'd

Absolute Amplitude Accuracy	**75 Ω Output**							
Amplitude dBm	10Hz to 20kHz	>20kHz to <100kHz	100kHz to <10MHz	10MHz to 125MHz	≥125MHz to 300MHz	≥300MHz to 1.4GHz	≥1.4GHz [1] to 3GHz	≥3GHz [1] to 4GHz
>+14 to +18	±0.06dB	±0.06dB	±0.06dB	±0.06dB	Output not available			
>+8 to +14	±0.06dB	±0.06dB	±0.06dB	±0.06dB	±0.15dB	±0.25dB		
-23 to +8	±0.06dB	±0.06dB	±0.06dB	±0.06dB	±0.15dB	±0.25dB	±0.3dB	±0.5dB
-54 to ≤-23	±0.15dB	±0.15dB	±0.15dB	±0.15dB	±0.15dB	±0.5dB	±0.5dB	±0.5dB
>-80 to ≤-54	Not Specified		±0.2dB	±0.2dB	±0.2dB	±0.5dB	±0.5B	±0.5dB
>-90 to -80			±0.7dB	±0.7dB	±0.7dB	±1.0dB	±1.0dB	±1.0dB
>-100 to -90			±0.7dB	±0.7dB	±0.7dB	±1.0dB	±1.0dB	Not Spec'd
-120 to -100			±1.5dB	±1.5dB	±1.5dB	±1.5dB	±1.5dB	
[1] Specifications are typical for frequencies >2GHz								

External Leveling Input	Rear panel Modulation Leveling and Frequency Pull BNC connector, 10kΩ nominal input impedance.
For external power meter leveling	User adjustable full scale voltage , 1V – 5V, positive polarity.
Maximum Input	±5V

External Frequency Control Input	Rear panel Modulation Leveling and Frequency Pull BNC connector, 10kΩ nominal input impedance.
Frequency Pull Range	±5ppm
Frequency Pull Sensitivity	User adjustable between 0.0001 ppm/V to 1.0000 ppm/V, positive or negative polarity.
Maximum Input	±5V

Modulation Specifications

Amplitude Modulation	**50Ω output**	**75Ω output**
Waveform	Sinusoidal, Triangle, External	
Carrier Frequency	50kHz to 4GHz	
Carrier Level	<1.4GHz: ≤+14dBm >1.4GHz: ≤+8dBm	<1.4GHz: ≤+8dBm >1.4GHz: ≤+2dBm
Carrier Level Accuracy[1]	As Leveled Sine + 0.5dB, typical	
Carrier Harmonics	≤ 50dBc typical	
Rate	Sinusoidal: 20Hz to 220kHz, ≤ 1% of Carrier Frequency. Triangle: 20Hz to 10kHz, ≤ 1% of Carrier Frequency.	
Rate Resolution	0.1Hz, 5 digits	
Rate Accuracy	≥1kHz: ±1 digit, <1kHz: ±10 mHz	
Depth	0.1% to 99%	
Depth Resolution	0.1%	
Carrier Frequency and Level Range for Specified Depth Accuracy and Distortion	≤1GHz, -56dBm to +14dBm	≤1GHz, -62dBm to +8dBm
AM Sine Depth Accuracy	3% of setting + 0.1%, for >2% depth. Typically 0.75% of setting + 0.1%, for 10% to 90% depth, ≤75MHz carrier frequency.	
AM Sine Distortion [2]	≤ -40dBc,10% to 80% depth, for ≤ 20 kHz rate, or for > 20 kHz rate at ≤75MHz carrier frequency. Typically ≤ -50dBc, 10% to 80% depth, ≤75MHz carrier frequency.	
[1] Signal content at carrier frequency only, excluding sidebands. [2] Includes harmonic distortion and noise up to 5 times rate frequency.		

AM External	
Input	Rear panel Modulation Leveling and Frequency Pull BNC connector, 10kΩ nominal input impedance.
Bandwidth (-3dB) [1]	DC coupled [2]: DC to 220kHz , AC coupled: 10Hz to 220kHz, typical.
Depth Sensitivity	User adjustable, 0.5%/V to 400%/V
Input Level	±2V pk maximum operating, ±5V pk absolute maximum
Carrier Level Accuracy	As AM Internal Sine + 20mV x depth/V setting. Typical.
Depth Accuracy	3% of setting + 0.1%, for >2% depth, 1Vpk input, DC or 200Hz to 20kHz.
Residual Distortion [3]	As AM Internal Sine, for 1Vpk input, ≤100kHz.

[1] Maximum input frequency 100kHz for carrier frequency >125MHz.

[2] DC coupled External Modulation permits DC control of carrier level or the offsetting of the modulation waveform. Note that at rates from 0.5Hz to 10Hz interaction with carrier leveling may occur resulting in modulation distortion.

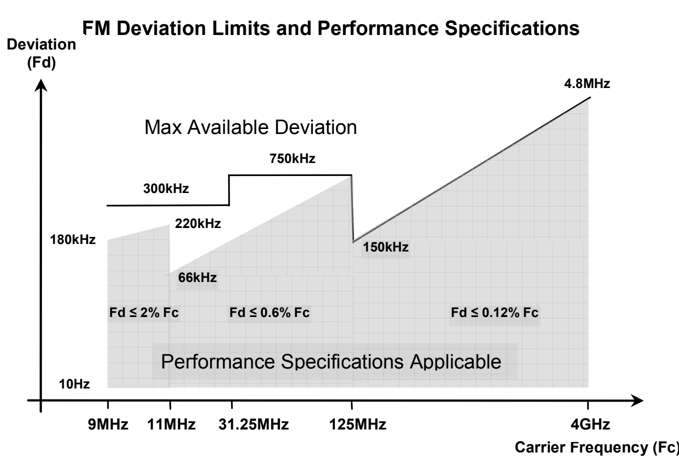
[3] Includes harmonic distortion and noise up to 5 times rate frequency.

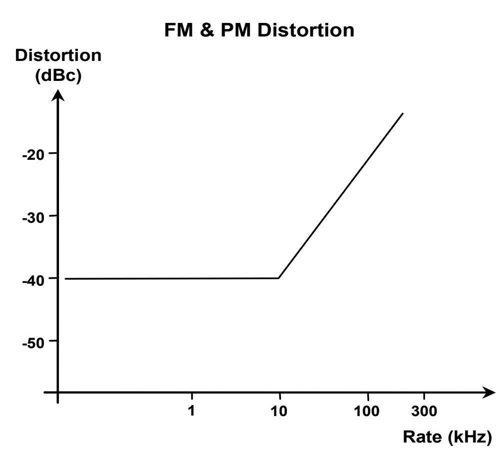
Frequency and Phase[1] Modulation	
Waveform	FM: Sinusoidal, External. PM: Sinusoidal.
Carrier Frequency	9MHz to 4GHz
Carrier Frequency Accuracy	Internal Frequency Reference: 0.04ppm + 240mHz External Frequency Reference: Ext Freq Ref Accuracy + 240mHz
Rate	20Hz to 300kHz
Rate Resolution	0.1Hz, 5 digits
Rate Accuracy	≥1kHz: ±1 digit, <1kHz: ±10 mHz
Deviation [2]	Fc 9MHz to 31.25MHz: 10Hz to 300kHz, ≤1000rad Fc 31.25MHz to 125MHz: 10Hz to 750kHz, ≤1000rad Fc 125MHz to 4GHz: 10Hz to 0.12% Fc, ≤1000rad or 0.12%Fc/Fr
Deviation Resolution	FM: 0.1Hz, 5 digits. PM: 0.0001rad, 5 digits
FM/PM Sine Deviation Accuracy[2]	3% of setting + 240mHz. Typically 0.25% of setting + 240mHz, for ≤50kHz rate.
FM/PM Sine Distortion [2] [3]	≤ -40dBc (1%) +20dB/decade above 10kHz (See chart). Typically ≤ -65dBc +20dB/decade above 1kHz.

[1] Phase modulation is generated by applying sinusoidal frequency modulation with peak deviation derived from the phase deviation and rate settings ($F_d = \phi_d \times F_{rate}$).

[2] See chart showing maximum available deviation, and maximum deviation for which deviation accuracy and distortion specifications apply.

[3] Includes harmonic distortion and noise up to 5 times rate frequency.





FM External	
Input	Rear panel Modulation Leveling and Frequency Pull BNC connector, 10kΩ nominal input impedance.
Bandwidth (-3dB)	DC coupled: DC to 300kHz , AC coupled: 10Hz to 300kHz. Typical.
Deviation Sensitivity	User adjustable, 500Hz/V to 19MHz/V, carrier frequency dependent.
Input Level	±2V pk maximum operating, ±5V pk absolute maximum
Carrier Frequency Accuracy	As FM Internal Sine + 20mV x deviation/V setting, typical.
Deviation Accuracy [1]	3% of setting + 240mHz, for 1Vpk input, DC or 200Hz to 20kHz rate, deviation >0.01%Fc.
Residual Distortion [1], [2]	As FM Internal Sine, for 1Vpk input, deviation >0.01%Fc. Typically ≤ -55dBc +20dB/decade above 10kHz, for 1Vpk input, deviation >0.01%Fc.
[1] See chart showing maximum available deviation, and maximum deviation for which deviation accuracy and residual distortion specifications apply. [2] Includes harmonic distortion and noise up to 5 times rate frequency.	

Modulation Trigger Output	Rear panel Trigger I/O BNC connector
Level	TTL compatible logic output, selectable as rising or falling edge
Timing Alignment	Modulation waveform zero crossing ±100ns, typical.

Frequency Sweep Specifications

Sweep Frequency Range	10Hz to 4GHz Sweeps are generated as a sequence of discrete synthesized frequencies.
Sweep Modes	Stop - Start and Center - Span Linear or Logarithmic Repetitive, Single Shot, triggered and Manual Sweep Squelch or Non Squelch at frequency transitions
Frequency Resolution	<100MHz: 0.1Hz , >100MHz: 11 digits
Frequency Steps	5 million maximum.
Step Size	0.1Hz to 4GHz
Step Dwell Time	20ms to 10s
Sweep Duration	100hrs maximum, calculated from Step Dwell x Number of Steps
Squelch Duration [1]	20ms, or 35ms maximum during range transition
Trigger Input/Sync Output	Rear panel Trigger I/O BNC connector, selectable as sweep trigger input or sweep sync output.
Trigger Input	TTL compatible logic input, selectable as rising or falling trigger to start sweep. Typically ≤1ms delay from trigger to sweep start.
Sync Output	TTL compatible logic output, selectable as rising or falling sync pulse coincident with sweep start. Typical pulse duration 250us. Typical time alignment ±1ms from sweep start.

[1] When selected, Squelch is active between all frequency transitions. When deselected, Squelch is active only at hardware range boundaries.

Chapter 2
Preparing the Instrument for Operation

Title	Page

Introduction

This chapter contains instructions for unpacking the Instrument and preparing it for operation. Many of the procedures in this chapter are also useful for performing general maintenance on the Instrument. They include the following:

- Changing line voltage (115 V ac to 230 V ac)
- Replacing the line-power fuse
- Connecting and powering the Instrument
- Cleaning and storing the Instrument

Contacting Fluke

To contact Fluke for product information, operating assistance, service, and to get the location of the nearest Fluke distributor or Service Center, call:

1-888-99FLUKE (1-888-993-5853) in U.S.A.
1-800-36-FLUKE (1-800-363-5853) in Canada
+31-402-675-200 in Europe
+81-3-3434-0181 Japan
+65-738-5655 Singapore
+1-425-446-5500 from other countries
Visit Fluke's web site at: www.fluke.com.

Unpacking and Inspection

⚠ Warning

To prevent personal injury, use good lifting practices when lifting or moving the Instrument. The Instrument is an unbalanced load and weighs 18 kg (40 pounds).

Fluke has taken great care to ensure that the Instrument arrives in perfect condition. When the Instrument arrives, carefully unpack and inspect for external damage to the case, front panel, and rear panel. If the Instrument has been subject to rough handling in transit, there may be evidence of external damage to the shipping carton. Check also to make sure all standard items listed in Table 2-1 are present.

If the Instrument or the shipping container have been damaged, notify the carrier immediately. Report any shortages to the place of purchase or to the nearest Fluke Technical Service Center.

If the shipping container and the packing material are undamaged, save them for use as a future storage/shipping container for the Instrument.

Table 2-1. List of Contents

Description	Quantity
9640A RF Reference Source, 4 GHz	1
9640A-50 Leveling Head	1
Carrying/Storage Case (for two Leveling Heads and the 9600CONN RF Interconnect Kit)	1
9640A Getting Started Manual, English	1
CD ROM – Manual Set	1
Line Cord	1
Certificate of Calibration	1

Storing and Shipping the Instrument

⚠ Warning

To prevent personal injury, use good lifting practices when lifting or moving the Instrument. The Instrument is an unbalanced load and weighs 18 kg (40 pounds).

To store the Instrument, place it inside a sealed plastic bag and then place the bagged unit inside the cushioning material inside the original shipping container. Close and secure the container. This container is the most suitable storage receptacle for the Instrument because it provides the necessary shock isolation during normal handling. Store the boxed Instrument in a location that complies with the storage environment specification. See Chapter 1, *Introduction and Specifications*.

Whenever it is necessary to ship the Instrument, use the original shipping container if possible. Pack and secure the Instrument as described in the previous paragraph. If you must substitute for the original container, choose a substitute that will provide shock isolation comparable to the original container. Recommended dimensions for a substitute cushioned container are given in Table 2-2.

Table 2-2. Dimensions for a Substitute Cushioned Shipping Container

Container	Length	Width	Depth
Box	720 mm (28.5 in)	570 mm (22.5 in)	360 mm (14.2 in)
Corner Cushions	> 60 mm (2.4 in) depth of expanded polyethylene (35 kg/m^3) at the instrument corners.		

Power Considerations

The Instrument ships from the factory configured to match the requirements of your local ac line power. If the Instrument is relocated to another region it may need to be reconfigured to match the ac line power of the new location. Three things affect the configuration:

- Power cord (See Table 2-3.)
- Line-power fuse (See Table 2-4 and Figure 2-1.)
- Rear-panel switch setting (115-230, see Table 2-3 and Figure 2-1.)

The following paragraphs describe how to make the changes for a new voltage configuration. They are also useful to verify that the Instrument's current power configuration is correct.

Replacing the Power Cord

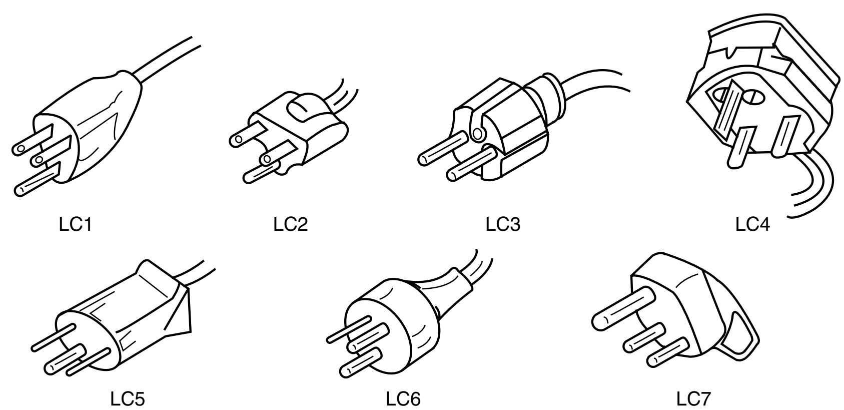
⚠⚠ Warning

To avoid shock hazard, connect the instrument power cord to a power receptacle that has an earth ground connection. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

The various power cords available for use with the Instrument are listed and shown in Table 2-3. Use the table to identify your general location and the recommended LC power cord. Match this LC number to one of the plugs in the drawing, and verify that the plug on your power cable mates correctly with the local power outlets. If the plug is incorrect, identify the correct LC number, and order the correct power cable from Fluke using the part number from Table 2-3.

Table 2-3. Power Cord for Various Regions

Description	Location	Voltage/Current	Part Number	
Power Cord	North America	120 V/15 A	LC1	284174
	North America	240 V/15 A	LC2	2198736
	Universal Euro	220 V/16 A	LC3	769422
	United Kingdom	240 V/13A	LC4	769445
	Switzerland	220 V/10 A	LC5	769448
	China/Australia/New Zealand	240 V/10 A	LC6	658641
	India/South Africa	240 V/5 A	LC7	782771



Ead05f.eps

Replacing the Line-Power Fuses

⚠⚠ Warning

To prevent fire hazard or damage to the instrument, verify that the correct fuses are installed for the selected line-voltage setting. See Table 2-4 for the correct fuse ratings.

The line-power fuses are located on the power block on the rear panel. The selected line-voltage (115 or 230) shows through a small window toward the bottom of the block. See Figure 2-1. This instrument has dual fusing with fuses in both the line and neutral connections. When replacing a blown fuse, replace both fuses to avoid a stressed fuse and subsequent power interruption. Before trying to access and replace the fuses, verify that the replacement fuses are appropriate for the selected voltage.

To check or replace the fuses, refer to Figure 2-1, and proceed as follows:

1. Disconnect the Instrument from line power.
2. Remove the fuse compartment by inserting a screwdriver blade in the tab located at the left side of the fuse compartment. Gently pry until the compartment can be easily removed.
3. Pull the fuses from the compartment for replacement or inspection.
4. Install good fuses with the correct ratings. See Table 2-4.
5. Reinstall the fuse compartment by pushing it back into place until the tab locks.

Table 2-4. Line-Power Fuse

Line Power	Fuse Action	Fuse Rating IEC 127	Fluke Part No.	Manufacturer and Type No.
115 V AC	TH Time Delay HBC	10 A @ 250 V	2650727 (Quantity 2)	Littelfuse 215010
230 V AC	TH Time Delay HBC	5 A @ 250 V	2650730 (Quantity 2)	Littelfuse 215005

Selecting Line Voltage

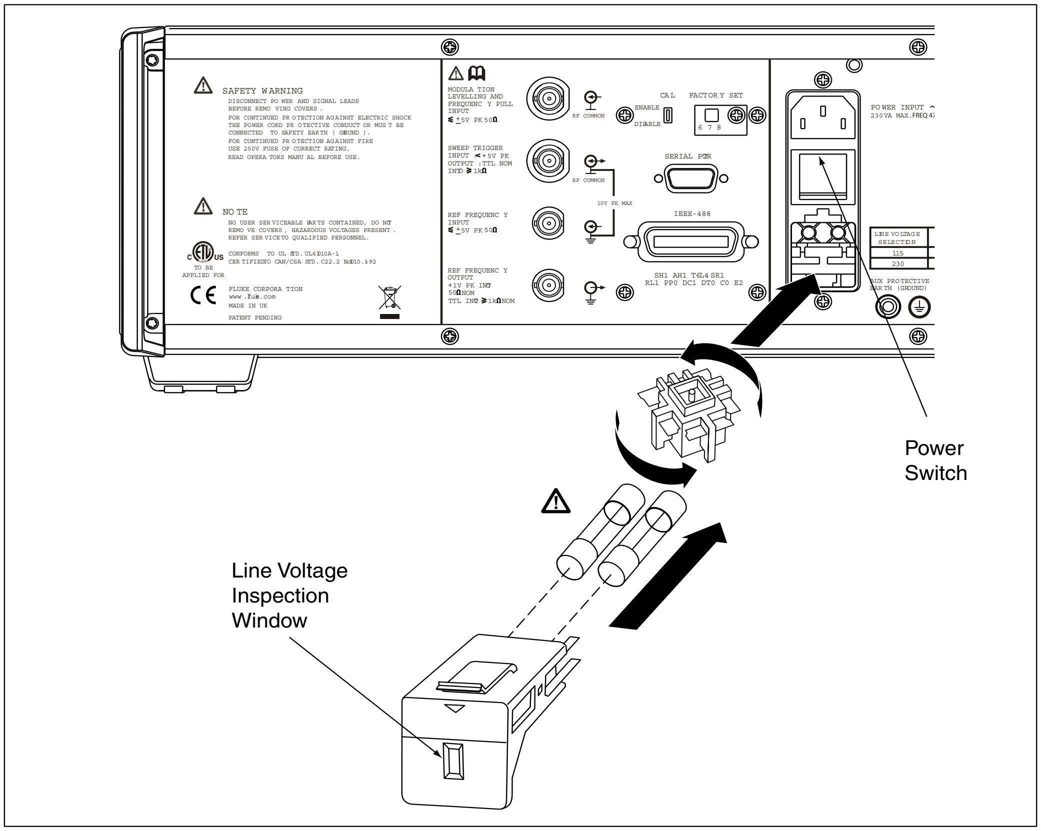
The line-voltage selector is located on the power block on the rear panel. The selected line-voltage (115 or 230) shows through a small inspection window toward the bottom of the block. See Figure 2-1. Use Table 2-5 to verify the selection before trying to change it.

Use the following procedure to change the line voltage setting:

1. Disconnect the Instrument from line power.
2. Remove the fuse compartment as described earlier. (See *Replacing the Line-Power Fuse*.)
3. Remove the line-voltage selector by griping its indicator tab with a pair of long-nose pliers and pulling it straight out of its connector.
4. Rotate the line-voltage selector to show the desired voltage, and reinsert into the power block.
5. Before inserting the fuse compartment back into the power block, inspect and verify that both fuses are appropriate for the selected voltage.
6. Insert the fuse compartment into the power block, and press firmly to lock its tab.

Table 2-5. Voltage Limits for the 115 and 230 Voltage-Switch Settings

Switch Setting	Line Voltage Limits
115	90 V AC to 132 V AC
230	180 V AC to 264 V AC



ead06f.eps

Figure 2-1. Accessing the Fuses and Changing Line Voltage

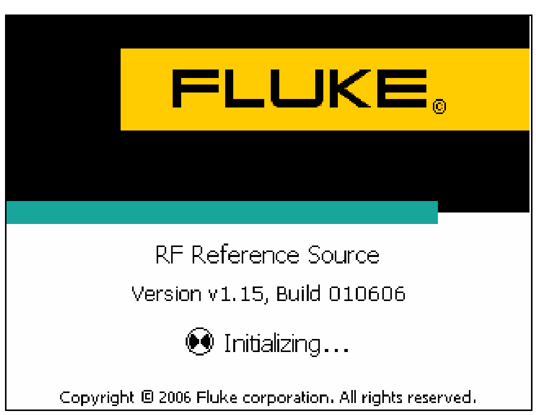
Power-On Sequence

Note

The power-on sequence may be run with or without a Leveling Head connected to the Instrument.

After connecting the Instrument to line power, use the power switch on the rear panel to power-on the Instrument. See Figure 2-1.

The Instrument displays an initialization screen for about 4 seconds during the power-on sequence and then runs a power-on self test. If a Leveling Head is connected to the Instrument, the Leveling Head will also be tested.



ead07f.bmp

Initialization Screen

Power-On Self Test

The power-on self test performs a functional test of the source and, if attached, the Leveling Head. The self test is neither an acceptance test, performance test, nor verification test. Self test simply verifys the overall functional operation of the Instrument. The power-on sequence initiates the self test, and the test is run every time a power-on sequence occurs.

A progress bar at the bottom of the display indicates self test is running. Upon successful completion of the test, a Leveled Sine screen, similar to the First Power-On screen, replaces the initialization screen shown earlier. The appearance of the Leveled Sine screen indicates the Instrument is ready for use.

If any test in the self-test sequence fails, another screen will show the number of failures attributed to both the Leveling Head and the Instrument. The user can view any failures by pressing the View Fail soft key. For more information regarding self-test failures refer to Chapter 7, *Reviewing the Results* and *Interpreting the Results*.

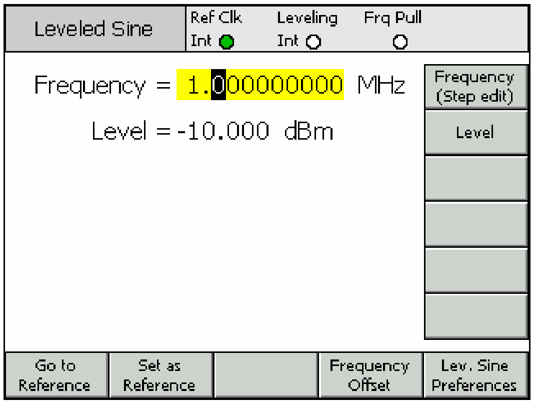
Power-On State

After completing the power-on self test, the Instrument enters the Standby state (output off) as indicated by the illuminated STBY key on the far-right of the front panel.

At first power-on, the Instrument displays the following screen. Press OPER to obtain an RF output. If no Leveling Head is connected, the Instrument remains in the standby state (output off) and displays an error message.

Note

Some Instrument settings are stored for recall at power down. If this is not the first power-on sequence for the Instrument, the power-on screen may not match the one shown here.



ead09f.bmp

First Power-On Screen

Leveling Head Connections

⚠ Warning

To prevent hazardous RF transmissions and equipment damage, read and follow the instructions in Chapter 3 before connecting a Leveling Head to the Instrument or to a UUT.

Instructions for connecting a Leveling Head to the Instrument and to a unit under test (UUT) are given in Chapter 3, *Local Operation*. Do not attempt to connect a Leveling Head before reading all of the Cautions and Warnings, contained in these instructions.

Installing the Instrument in an Equipment Rack

The Instrument is suitable for both bench-top and rack-mounted operation. A Rack Mount Slide Kit is available as an accessory. Instructions for installing the kit are supplied with the kit.

Cooling Considerations

Two internal fans maintain the operating temperature of the Instrument at a safe level. For bench-top operation, these fans do a good job of temperature control without any attention other than routine cleaning of the filter as described in Chapter 7, *Maintenance*. However, when mounting and using the Instrument in other situations (for example, in an equipment rack) additional attention may be required to ensure that the instrument is able to maintain a normal operating temperature and does not overheat.

⚠ Warning

To avoid fire hazard and to ensure that the instrument does not exceed its normal operating temperature observe the following warnings:

- **During normal operation, keep the Instrument covers securely in place. Excessive air leaks can interrupt and redirect the flow of cooling air from internal components.**
- **When mounting the Instrument in an enclosed equipment rack, provide adequate ventilation and airflow within the rack. Pay particular attention to ensure adequate and proper use of exhaust fans, louvers, equipment spacing, free-flowing and isolated intake and exhaust ports.**

  Use baffles, if necessary, to isolate intake air from exhaust air. Baffles can help draw and direct cooling air through the equipment rack. The best placement of the baffles depends on the airflow patterns within the rack. If baffles are necessary, experiment with different arrangements.

Cleaning the Instrument

For general cleaning, wipe the Instrument with a soft cloth dampened with water or a non-abrasive mild cleaning solution that does not harm plastics.

⚠ Caution

To prevent damage to the Instrument, do not use aromatic hydrocarbons or chlorinated solvents for cleaning. They can damage the materials used in the Instrument.

Chapter 3
Local Operation

Title	Page

Introduction

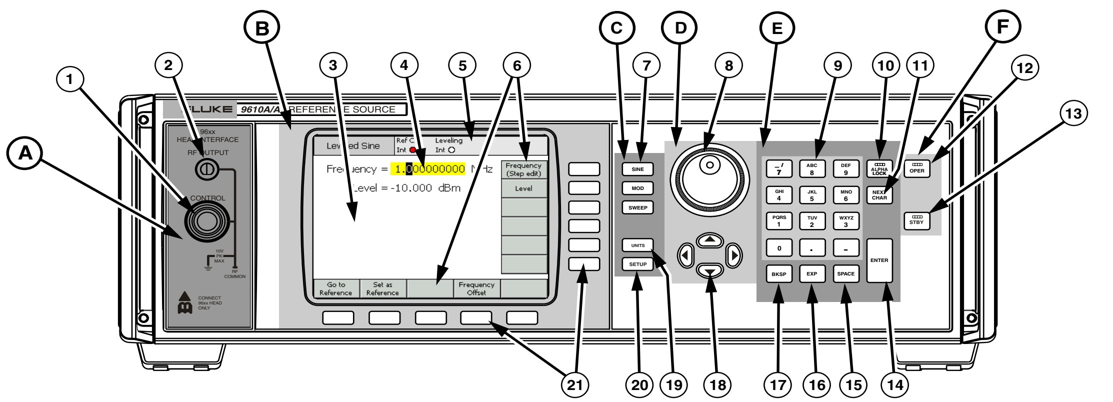
This chapter provides a comprehensive introduction of all of the external features and functions on the Instrument, followed by instructions for operating the Instrument. The introduction identifies each of the front- and rear-panel controls, connectors, and indicators (including screens), and describes the intended use for each. Each feature description is complete enough to allow the user to begin interacting with the controls and to perform basic but practical operations on the Leveled Sine screen. For this reason, many of the basic operations, such as editing data on a screen, are not repeated in the operation instructions.

Operating Instructions at the end of this chapter are reserved for the following:

- Initial setup
- Making external hardware connections
- Using features that are not obvious on the front and rear panel
- Using the Instrument to create its intended RF Output: sine, modulated, and swept signals.

Controls, Indicators, and Connectors

The front panel of the Instrument is shown in Figure 3-1. Each feature is identified with a name and graphical grouping. The same name and graphic introduce the section and paragraph(s) containing the description of the feature.



(A) Head I/O Connectors
(1) Control
(2) RF Output

(B) Display
(3) Screen Display
(4) Data Fields
(5) Status Bar
(6) Soft Labels
(21) Soft Keys [ ]

(C) Output Function Keys
(7) Output Signal
SINE
MOD (Modulate)
SWEEP
(19) UNITS
(20) SETUP

(D) Field Editor
(8) Spin Wheel
(18) Cursor Keys

(E) Keypad
(9) Alphanumeric
(10) ALPHA LOCK
(11) NEXT CHAR
(14) ENTER
(15) SPACE
(16) EXP (Exponent)
(17) BKSP (Backspace)

(F) STBY/OPER Keys
(12) OPER (Operate)
(13) STBY (Standby)

ead10f.eps

Figure 3-1. Front Panel Controls, Indicators, and Connectors

Head I/O Connectors

The output of the Instrument is a proprietary interface to either a 9640A-50 or a 9640A-75 Leveling Head. The interface consists of two connectors: an SMA RF signal output connector, and beneath, a multi-way locking connector for sensing and control of the Leveling Head.

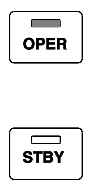
⚠ Caution

The 9640A front-panel connector interface is suited only for use with Fluke 9640A-xx Leveling Heads. To avoid damage to the Instrument no other connection is permitted.

The function of a Leveling Head is to deliver the Instrument output to the input of another instrument (UUT) while maintaining the integrity of the signal. Using a Leveling Head with the Instrument is the equivalent of connecting the UUT directly to the Instrument output without using cables. The Leveling Head not only maintains the overall quality of the signal, it also maintains an accurate level for the signal over the frequency and amplitude range of the Instrument.

STBY/OPER (Standby/Operate) Keys

The STBY and OPER keys control signal availability at the Leveling Head Output connector. Pressing OPER turns the green indicator on and places the Instrument in the Operate mode (enables the signal at the RF Output connector). Pressing STBY turns the yellow indicator on and places the Instrument in the Standby mode (removes the output signal at the RF Output connector).



ead11f.eps

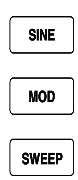
Standby/Operate Keys

Output Function Keys

There are five output function keys: three for selecting the output signal, one for defining the preferences, and one for displaying units associated with each signal.

Output Signal Keys

Three hard keys define the main characteristics of the output signal. They are SINE, MOD (modulation), and SWEEP. Pressing any one of these keys brings up the initial screen for that function and displays the current value for each of the previously defined parameters. If, when any of these keys are pressed, the Instrument is in the operate mode (Green light on the OPER key is lit), the RF Output is switched to standby.



ead12f.eps

Output Signal Keys

UNITS Key

Use the UNITS key to display a list of the measurement units available for use with the selected data field. The list is context sensitive and appears on the vertical soft labels. Pressing a blue soft key adjacent to one of the displayed measurement units selects and applies that unit to the value in the selected field. The value in the field is recalculated to match the selected measurement unit, and the text is removed from the soft labels.

ead13f.eps

Measurement Units Key

SETUP Key

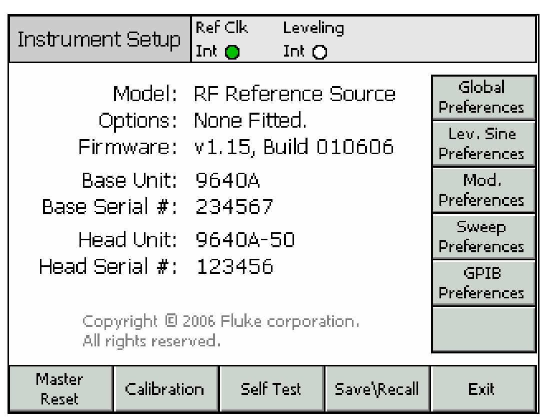
The SETUP key provides access to a Setup screen.

ead14f.eps

Setup Key

The Setup screen provides instrument configuration information, including the following:

- Options Fitted (installed)
- Firmware Version
- Base (mainframe) model number and serial number
- Model number and serial number of the connected Leveling Head at the time the SETUP is pressed



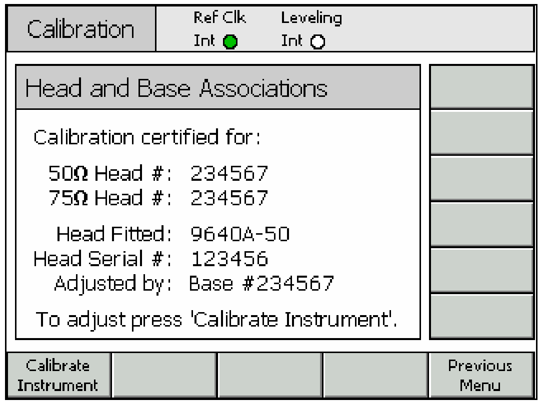
ead05f.bmp

Setup Screen

The vertical soft keys on this screen allow the user to enter personal preferential settings for Global Preferences and each of the major configuration screens. These settings take effect immediately upon editing. They include the following:

- Global Preferences
- Sine Preferences
- Mod Preferences
- Sweep Preferences
- GPIB Preferences (IEEE 488)

Pressing the Calibration soft key brings up a Calibration screen which allows users to correctly associate the Base Unit and Leveling Heads that have been calibrated together. The Calibration screen shows the serial numbers of the 50 Ω and 75 Ω Leveling Heads with which the Base Unit is calibrated. For the Leveling Head connected at the time the soft key is pressed, the calibration screen also shows the serial number of the Base Unit with which that head is calibrated.



ead06f.bmp

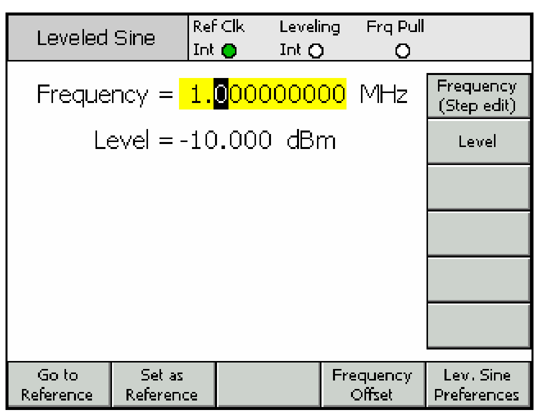
Calibration Screen

Display

The display is a visual line-editor/menu for configuring the output of the Instrument, and also a monitor for verifying the configuration and output settings for the Instrument. The screen portion of the display consists of the following three major sections:

- Data fields
- Soft labels
- Status bar

Pressing any one of the main function keys on the front panel, SINE, MOD, SWEEP, brings up the appropriate main screen on the display (see the following Leveled Sine screen). Editable data fields occupy the central portion of the screen; the status bar is at the top of the screen. The soft labels run down the right side and across the bottom of the screen.



ead15f.bmp

Leveled Sine Screen

Data Fields

Data fields contain numeric values that effectively describe the present output parameters of the Instrument. Following power-on, these fields all contain default values. To change or edit these values the user must do the following:

1. Bring up an appropriate screen, for example, the previous Leveled Sine screen.
2. Select the field that requires editing (use a soft key).
3. Select an edit mode, Cursor or Step (press the soft key again).
4. Edit the data in the field using the appropriate controls.

When selected, the field is said to have the *focus* and is easily identified by the shading of its data. In the Leveled Sine screen, for example, the Frequency field has the *focus,* and the edit mode is Cursor, as identified by the black cursor (marker) that can move from digit to digit (left-right, ◀▶). In this case, the user can easily make minor edits to the selected digit using the spin wheel or the up-down (▲▼) keys. If several characters in the field need to change, using the alphanumeric keypad to edit the field (Keypad edit) is a better choice.

A data field that has all of the characters in the field selected (highlighted black) is in the Step edit mode. When this mode is available to a field, an indicator shows in the soft labels to the right of each field, (Step edit) or (Cursor edit). A toggle effect performed by the soft key next to the *focus* field allows the user to switch between edit modes.

A more detailed description of the *Editing Settings* is available later in this chapter under *Screen Controls and Indicators*.

Soft Labels

Six soft labels run vertically along the right side of the screen and five run horizontally along the bottom of the screen. Each of the labels corresponds to an adjacent soft key. When a soft label contains text, pressing its adjacent soft key directs the display to respond accordingly.

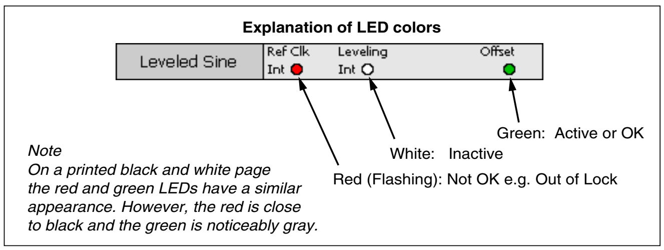
The horizontal soft labels across the bottom of the screen provide prompts to expand the current definition, add/remove fields, or call another screen (menu selection).

Pressing UNITS while in either of two field edit modes (cursor or step edit) causes the soft labels to present a selection of measurement units for use with the selected field. During alphanumeric (keypad) edit, the soft labels present a selection of scientific multipliers for use with the selected field. These multipliers are shown in terms of the previously selected units (watts, dB, volts).

If a soft label contains no text, pressing its adjacent soft key has no effect. However, when a labeled soft key is pressed the effect is immediate and obvious on the display.

Status Bar

The status bar consists of two regions across the top of the display (see Figure 3-2). There are no keys associated with the status bar as its only function is to provide information. Typically, the left-most label defines the RF Output signal: sine, modulated, or swept. The right-most region contains status indications (virtual LEDs) pertinent to the current output signal. Operator error messages, such as *value too low*, are also displayed in this region.



ead23f.eps

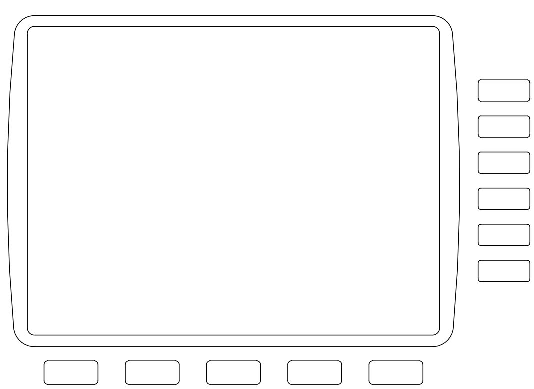
Figure 3-2. Status Bar

Soft Keys

The Instrument has two sets of soft keys. One vertical set running down the right side of the display and one horizontal set running across the bottom of the display. Each of these soft keys has an adjacent soft label on the screen.

The primary function of the vertical soft keys is for selection of the *focus* field, and in some cases the edit mode (Cursor edit or Step edit) for the *focus* field. These keys are also used to temporarily present scientific multipliers during alphanumeric entry using the keypad and unit selections, if UNITS is pressed.

The horizontal soft keys are associated with the soft labels across the bottom of the display. These labels provide prompts to expand the current definition, add/remove fields, or call another screen (menu selection).



ead16f.eps

Soft Keys

Field Editor

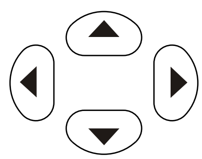
There are two control sets for incrementally editing field data. They are the cursor keys and the spin wheel.

Cursor Keys

The cursor keys are a group of four keys marked with right, left, up and down arrows: (◀, ▶, ▲, ▼). These are the main editing keys for making minor changes in a field's numeric data. Each press of ◀ or ▶ moves the cursor one decade to the left or right. Each press of ▲ or ▼ increments or decrements the digit under the cursor by one. Using these cursor keys in combination allows the user to edit/select any data in a *focus* field.

The data in the *focus* field reacts to the ▲ and ▼ keys like a counter. That is, as the value under the cursor increases past nine (9), the number in the next higher decade increases by one (1). Similarly, as the value under the cursor decreases past zero (0), the number in the next higher decade decreases by one (1).

When the Instrument is in the operate mode (OPER light on), the RF Output responds immediately to changes to its field values.

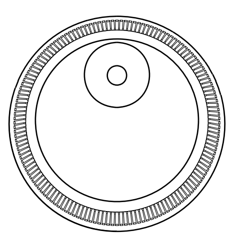


ead25f.eps

Cursor Keys

Spin Wheel

The Spin Wheel performs the same editing function as the ▲ and ▼ keys described in the previous paragraph. However, as the wheel is spun, it continues to decrement (ccw) or increment (cw) the digit under the cursor. This continuous spin-action is useful for making larger changes to field values and for making real-time changes to the RF Output.

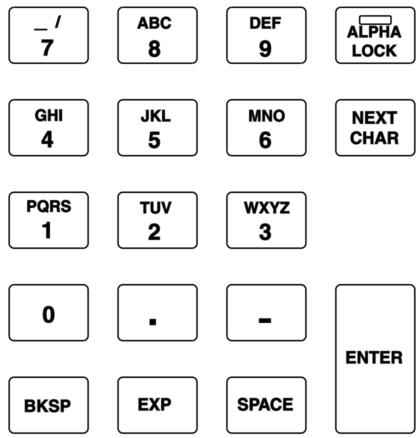


ead26f.eps

Spin Wheel

Keypad

The alphanumeric keypad supports direct keypad edit of a numeric field. Alpha entry is also supported, but only to allow the naming of user Saved Set-ups.

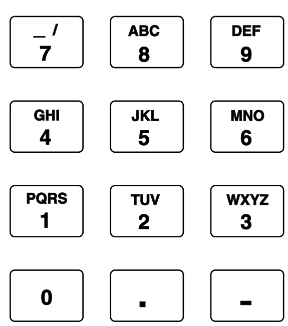


ead27f.eps

Keypad

Alphanumeric Keys

The alphanumeric keys are similar to those found on a calculator. They include two levels of characters. The default level includes the digits 0 through 9. The shifted or second level includes the alpha characters A through Z, _ and /. The decimal point (.) and minus (–) characters work with both levels. Notice that the alpha characters are grouped so that three or four characters appear on a single key, much like the telephone keypad. When entering an alpha character, press the key containing the desired character. The first character in the alpha grouping appears in the field. Press NEXT CHAR one or more times to advance to the desired character in the group. When the character is correct, press key containing the next alphanumeric character.



ead28f.eps

Alphanumeric Keys

ALPHA Key

The [ALPHA LOCK] key controls access to the numeric (default level 1) and alpha (level 2) characters. The key operates in a toggle mode. When the light is off, the numeric characters are accessible. Pressing [ALPHA LOCK] to light the key enables access to the alpha characters.

ead29f.eps

Alpha Key

NEXT CHAR Key

The [NEXT CHAR] key is functional when the light on the [ALPHA LOCK] key is lit. After pressing an alpha character key, use [NEXT CHAR] to select the desired letter from the alpha grouping shown on that key. When the desired character appears in the selected field, stop pressing [NEXT CHAR]. Instead, press the alpha key containing the next character to be added to the field, or, if the field data is complete, press the ENTER key.

ead30f.eps

Next Character Key

BKSP Key (Backspace)

The [BKSP] key permits editing of characters during a keypad data-entry session. After entering the first character in a field, pressing [BKSP] deletes the last available character and allows another character to be entered in its place. This backspace action is available as long as characters are present in the field.

ead35f.eps

Backspace Key

SPACE Key

The [SPACE] key functions exactly like the space key on a PC keyboard. Pressing [SPACE] inserts a space character to separate any combination of alphanumeric characters.

ead36f.eps

Space Key

EXP Key (Exponent)

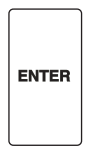
The EXP key allows the user to enter numeric data using an exponent. While entering a number, pressing EXP ends the numeric sequence by inserting a capital letter E to indicate that the following number is an exponent.

ead37f.eps

Exponent Key

ENTER Key

The ENTER key ends the keypad data-entry process and allows the user to move to another task. Pressing the ENTER key causes the Instrument to inspect the data just keyed into the field, and, if it is valid, to accept and retain the data. The Instrument rejects invalid data and displays the reason for rejection on the Status Bar.



ead38f.eps

Enter Key

Screen Controls and Indicators

Many of the front panel controls and indicators discussed earlier in this chapter are used exclusively for editing screen fields that appear on the Display. That is, they enable the data entry/editing process regardless of the selected screen. The following examples concentrate on the controls and indicators associated with the Leveled-Sine screen. They offer an excellent opportunity for applying information learned about the editing process.

Main RF Output Screens

The Instrument provides three kinds of output signals: sine, modulated, and swept. User selectable screens, as shown in Figure 3-3, provide the controls for each of these outputs.

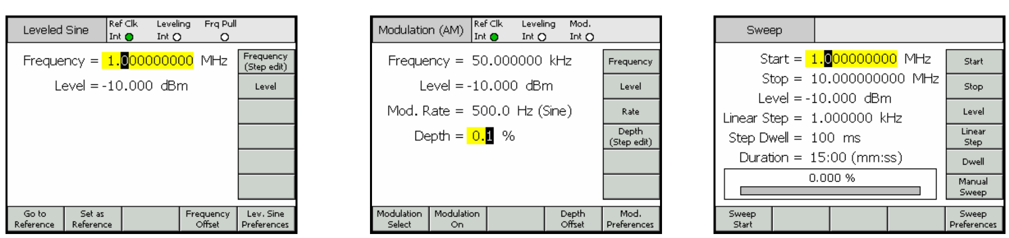


Figure 3-3. Control Screens for the RF Output Signal

Pressing SINE sets the Instrument to standby and brings up the Leveled-Sine screen, establishing the sine wave as the selected RF output signal. The same is true of the MOD and SWEEP keys. As each key is pressed, the instrument enters standby and brings up the corresponding modulation or sweep screens. Pressing OPER sets the Instrument to operate and adjusts the RF output signal to match the screen.

Data fields within each screen contain values, typically numeric data, which define the parameters of the RF Output signal. By editing these values, the user can precisely control the RF output signal.

Editing Settings – The Vertical Soft Keys

Each numeric data field supports up to three edit modes:

- Cursor edit
- Step edit
- Keypad edit

Any time a field has the *focus* it is in one of the three edit modes. A unique look (or pattern) identifies each of the modes. The Cursor edit mode displays a shaded field with a black cursor placed over a single digit in the field. The Step edit mode displays the entire field shaded black with white characters. The Keypad edit mode displays a shaded box for entering characters. The user may choose any one of these edit modes when entering numeric field data.

The following paragraphs use the Leveled-Sine screen to discuss the edit modes. The edit modes and the techniques discussed here also apply to the Modulation and Sweep screens. The Modulation and Sweep screens are not, therefore, discussed separately.

Note

Step edit *does not apply to the sweep screen; only* Cursor edit *and* Keypad edit *are available in the sweep function.*

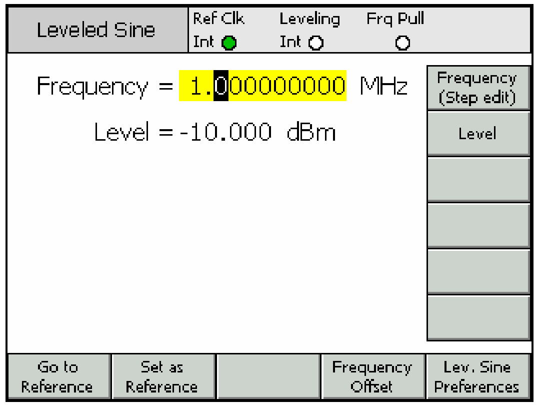
Before proceeding, refer to the *Data Fields* descriptions earlier in this section under *Controls, Indicators, and Connectors (Display)* as a refresher on how to select data fields.

To follow the discussion on the Instrument, switch on power to the Instrument and then press SINE to bring up the Leveled-Sine screen. Press STBY to set the source to standby. Also, remove any connections from the front panel Leveling Head I/O Connectors. The screen on the I/O Display will closely resemble the following Leveled-Sine screen.

Cursor Edit

When in the Step edit mode, if the soft label for the focus field includes a (Cursor edit) marking, press the Frequency (Cursor edit) soft key; the focus field changes the edit mode to Cursor edit.

In Cursor edit mode, the *focus* field pattern is shaded with a black cursor placed over a single digit. In addition, the soft label for the field includes a (Step edit) marking, when appropriate, as shown in the following Leveled-Sine screen. The cursor keys provide for right and left cursor movement within the field. To adjust the value of the selected digit, the user may choose between the ⏶ ⏷ keys or the spin wheel. To ensure access to the full dynamic range and resolution of the instrument, notice that the cursor will move beyond the left- and right-most digits in the field.



ead15f.bmp

Leveled Sine

Step Edit

If, when in the Cursor edit mode, the soft label includes a (Step edit) marking, pressing the soft key for the *focus* field changes the edit mode to Step edit. Notice that Step edit is not available for inappropriate fields.

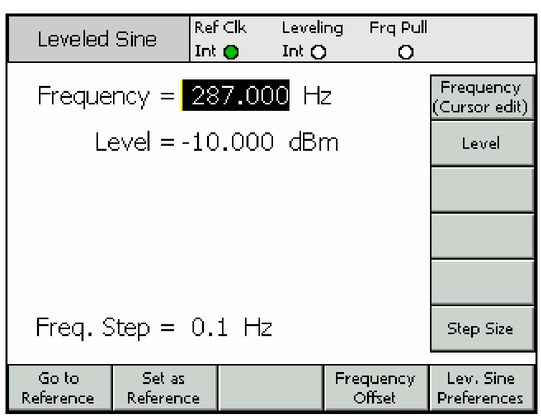
In Step edit mode, the *focus* field pattern is fully highlighted (all black) with white characters. In addition, the soft label for the field includes a (Cursor edit) marking. See the following Step Edit screen. Effectively, the whole field is selected for edit, making cursor movement within the field unnecessary. Instead of allowing the edit of a single character, Step edit allows for updating of the focus field in increments of a preset step size. The step size is defined (preset) in a Step Size field at the bottom of the display. With the step size set to a value other than zero, both the up-down cursor keys (⏶ ⏷) and the spin wheel allow for increasing or decreasing the *focus* field value in steps.

Note that the soft label for the *focus* field now indicates Cursor edit, allowing the operator to return to this edit mode. This soft key, therefore, has the following three-step operation:

Select New *Focus* Field → Select Step edit → Select Cursor edit ↩

The operator can rapidly access Step edit in a new *focus* field by pressing the appropriate soft key twice.

Pressing the Step Size soft key, moves the *focus* field to allow step size to be adjusted using the Cursor edit or Keypad edit modes. Unit selections are available for Step Size, these can be ratios %, ppm, dB or the same unit as the parent field.



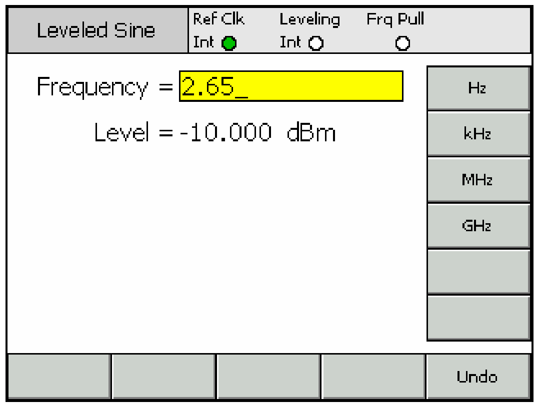
ead17f.bmp

Step Edit

Keypad Edit

At any time, a new value may be entered directly in a numeric *focus* field via the Keypad. The first press of a numeric key will open an edit box in place of the current field and present scientific multiplier options on the vertical soft keys. See the following Keypad edit screen. Pressing the ENTER key or a multiplier soft key will transfer the new value into the *focus* field. Note also the presence of an Undo soft key and that an invalid entry will cause an error message and return the *focus* field to its previous value.

The backspace (BKSP) and exponent (EXP) keys are also active in the Keypad edit mode.

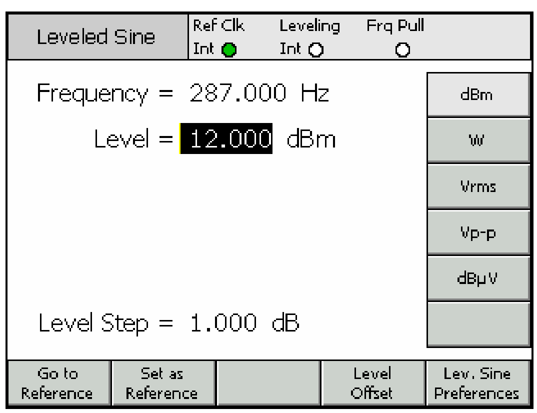


ead18f.bmp

Keypad Edit

Changing Displayed Units

Measurement Units are usually associated with digital values. In the case of the Instrument, the units are typically associated with frequency and level. Pressing UNITS while a field is selected provides a list of measurements units that apply to the value. See the following measurement units screen. Selecting one of these units causes the Instrument to recalculate and display the value in the specified unit. Typical measurement unit selections for Level include the following: dBm, W, Vrms, Vp-p and dBμV.



ead19f.bmp

Measurement Units

Note

The Instrument supports multiple unit scales for display and editing. Each scale has finite resolution, and the finite steps of each scale will not necessarily align. It is therefore possible that conversion of a setting to a different unit followed by conversion back to the original unit could cause a one-step shift in the setting.

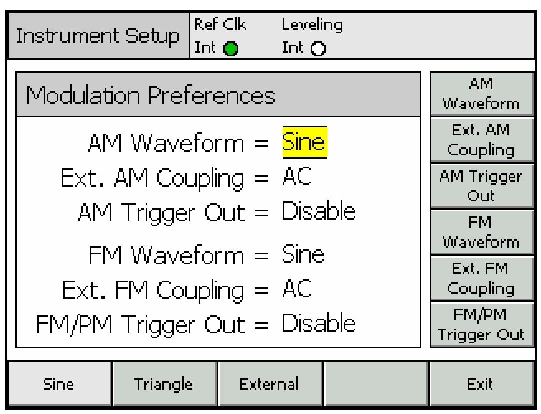
The Instrument User Interface specifically avoids this potential problem. That is, it allows the user to view a setting in an alternative unit and then return without disturbance.

Expanded Settings – The Horizontal Soft Keys

The horizontal soft labels across the bottom of the screen provide prompts to expand the current definition, add/remove fields, or call another screen (menu selection).

Preferences Soft Key

All of the screens for settings preferences are listed on and accessible from the Instrument Setup screen which can be called by pressing SETUP . However, settings preferences relevant to the current mode of operation are more readily accessible via the bottom-right soft key on the Leveled Sine, Modulation and Sweep screens. Modulation Preferences are shown in the following screen



ead10f.bmp

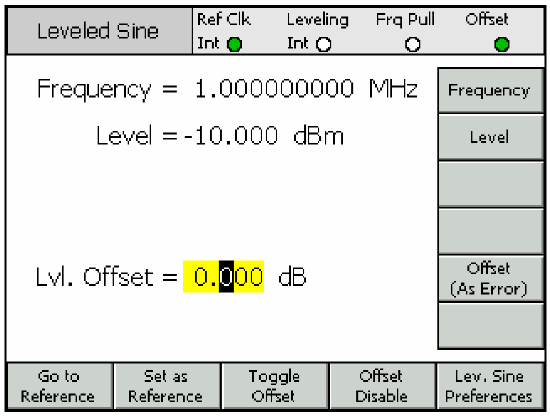
Modulation Preferences

The principle of the *focus* field and its selection by way of the vertical soft keys also apply to preferences screens. The cursor, indicated by two parallel bars highlights a scrolling list of possible entries. The spin wheel or all four cursor keys can be used to scroll the list, and the Exit soft key completes the update, returning the display to the previous screen. Where the scroll list is short (as in the preferences screens), the horizontal soft keys give more convenient direct access to the preferences.

Offset Soft Key

The Offset key allows the operator to adjust the Instrument output via an offset from the main setting. The soft label tracks the *focus* field, allowing control of either Frequency Offset or Level Offset.

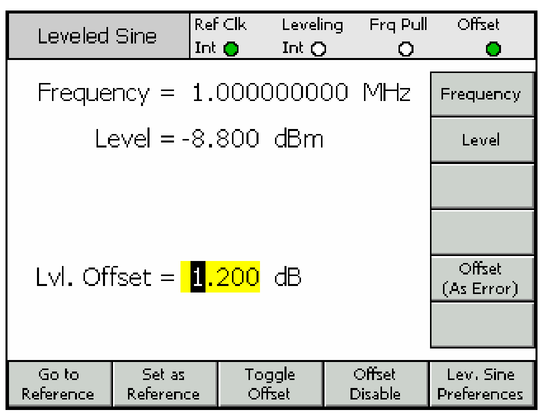
For example, assuming Level to be the current *focus* field, pressing the Offset soft key will add and select the Level Offset field as the new *focus* field. In the following Leveled Sine screen, a new indicator appears on the Status Bar indicating that Offset is on.



ead02f.bmp

Leveled Sine – No Offset

This new Offset field supports Cursor or Numeric edit and its value will be added to the current output to give a new output level. See the following Leveled Sine – Offset Applied screen. The display indicates the current output level and the offset value that achieves it.



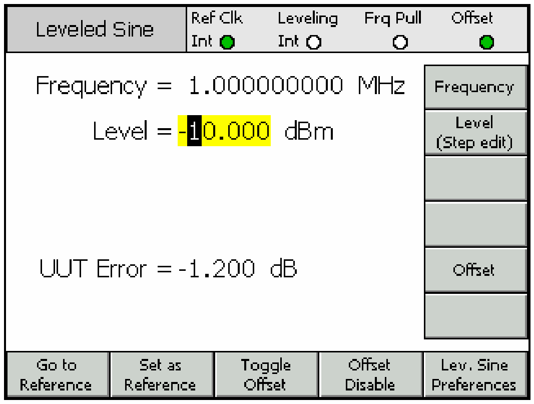
ead03f.bmp

Leveled Sine – Offset Applied

Note that editing the main Level field with Level Offset enabled causes the current Offset value to reset to zero. In addition, pressing the Offset Disable soft key clears the Level Offset field and its related status bar indicator and soft labels.

Toggle Offset Soft Key

Note that while the Offset field is present, a Toggle Offset soft key is also present. In the following Leveled-Sine – Toggle Offset screen, the Toggle Offset soft key may be pressed at any time to remove the offset from the output. The initial (Offset = 0) value is restored and the Offset indicator on the Status Bar turns off.



Leveled Sine - Toggle Offset

An additional press of the Toggle Offset soft key reapplies the offset, allowing convenient toggling of the output between its initial and its offset values.

Offset (As Error) Soft Key

In a typical calibration application in which the Instrument has been set to a target Level (or Frequency), an offset may be applied until the UUT reads exactly the target value. The offset setting is now related to the UUT error.

When the Offset field is the *focus* field, both its display and edit format may be switched from an expression of offset of Instrument output to an expression of Error in the UUT. This results in a convenient and accurate readout of UUT error for which display units may be selected independently.

Note

If a UUT reads high (and has an Error of +Err,) it is clear that the Instrument will have to be adjusted down by an Offset –Off to achieve the target reading.

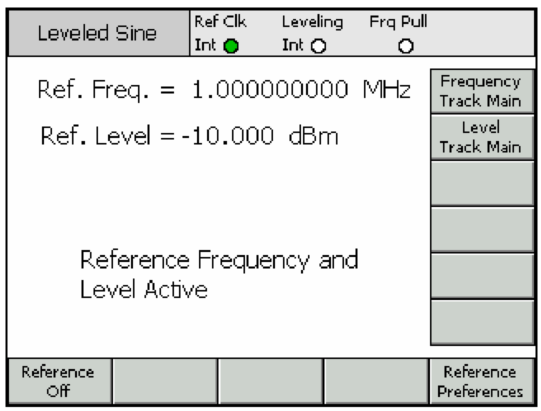
It is often thought that Offset and Error will merely be of opposing signs, i.e. +Err = -Off. This is only true if Offset and Error are both expressed in ratio units of dB. To express Error and Offset in % (or ppm), however, while the same is approximately true for small errors, a more substantial Error of, say, +10% will require an Instrument Offset of only -9.091% to achieve the target reading. The two are non-linearly related. This calculation and display feature is frequently of great benefit.

Reference Soft Keys

For the Leveled Sine function, the Instrument user interface also supports a Reference Frequency, a Reference Level or a Reference Point (Frequency and Level).

References may be an output setting that the user might need to return to frequently during a calibration application, perhaps to check or adjust for stability.

Two soft keys, Go to Reference and Set as Reference, give immediate access to the reference and can be pressed at any time. The Go to Reference soft key sets the output of the Instrument to the existing reference settings. The Set as Reference soft key transfers the current settings to establish a new reference setting. Both soft keys result in the display of Reference Settings and their application to the output, unchanged or updated dependent upon which key was pressed (see the following Monitoring the References screen).



ead21f.bmp

Monitoring the References

Note that the message Reference Frequency and Level Active appear when the Go to Reference soft key is pressed.

⚠ Caution

The reference settings could be a substantially different than the previous Level and/or Frequency output settings, and, if inadvertently applied, the resulting change in output signal may damage the load. To protect against this, the user may elect to switch to Standby as a Reference Preference prior to confirming the switch to the reference settings. Setting Reference Switching Preferences is described later in this chapter.

Switching of the Output signal to match the reference settings is otherwise immediate, and a Reference Active message is displayed.

Reference settings are not editable on this screen, no adjustment of output level or frequency can be made. New reference settings are established via the Set as Reference soft key only.

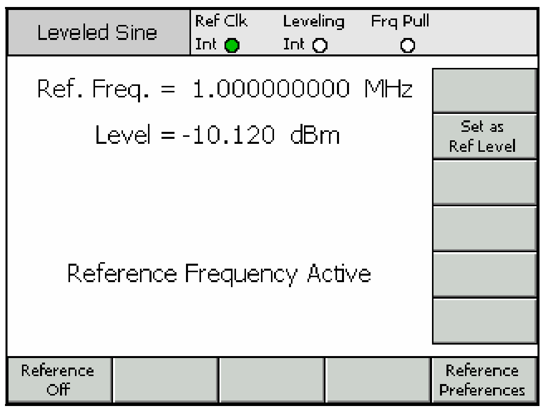
Reference Off Soft Key

The Reference Off soft key returns the Instrument to the Leveled-Sine screen and its output settings. The message Switch from Reference – Confirm with Operate may appear if switching confirmation has been selected as a Reference Preference.

Frequency and Level Track Main Soft Keys

The Set as Reference soft key always transfers the current Level and Frequency settings into the reference settings. If only a Ref Freq is required, the Level Track Main soft key should be pressed. This releases the Ref Level field to track the main Level setting. See the following Frequency and Level Tracking screen. Only the Ref Freq remains fixed.

The soft key beside the Level field can be used at any time to re-establish the current Level as a Ref level.

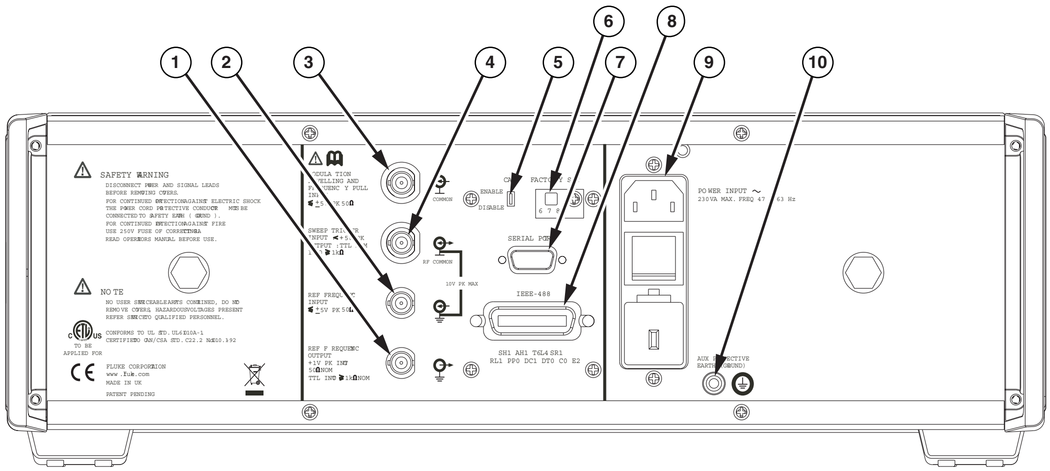


ead22f.bmp

Frequency and Level Tracking

Rear-Panel Controls and Connectors

Figure 3-4 shows the rear panel of the Instrument and identifies each of its controls and connectors. Functional and operational descriptions for each of the controls and connectors are given in the following paragraphs.



1. Ref Frequency Output Connector
2. Ref Frequency Input Connector
3. Modulation Leveling and Frequency Pull Input Connector
4. Sweep Trigger Input/Output Connector
5. CAL Switch
6. Factory Set Switch
7. Serial Port (Firm Ware upload)
8. IEEE 488 Connector
9. Power Block
10. Earth (chassis) Ground Connector

ead44f.eps

Figure 3-4. Rear Panel Controls and Connectors

Power Block and Switch

The Power Block includes the power switch and a dual fused line-power input connector for the Instrument. Its universal design accommodates a variety of regional power cords, line-power (90 V to 132 V and 180 V to 264 V ac), and power fuses. These various line-power configurations and the procedures to establish them are described earlier in Chapter 2.

IEEE 488 Connector

The Instrument includes an IEEE 488.2, SCPI (1999) Remote Interface for connecting and controlling the Instrument remotely in a system environment. The IEEE 488 Connector provides the means for connecting a controlling system to the Instrument. The controlling system may be as simple as a PC or as complex as an automated calibration system.

Reference Frequency Output Connector

The Reference Frequency Output Connector is a rear-panel BNC connection that provides access to an internally generated reference frequency. See Table 3-1 for the output specifications.

Table 3-1. Reference Frequency Output Specifications

Parameter	Specification	Comments
Connector Type	BNC	Out Referenced to Ground
Frequency	1 MHz or 10 MHz	User selectable
Amplitude into 50 Ω	1.5 V pk-pk nom	-0.4 V to 1.1 V nominal
Amplitude into 1 kΩ	3.0 V pk-pk nom	-0.4 V to 2.6 V TTL or 3 V compatible

Reference Frequency Input Connector

The Reference Frequency Input Connector is a BNC input connection for applying an external reference frequency. See Table 3-2 for the input specifications.

Table 3-2. Reference Frequency Input Specifications

Parameter	Specification	Comments
Connector Type	BNC	Input Referenced to Ground
Nominal Frequency	1 to 20 MHz	In user selectable 1 MHz steps. Phase Noise specification holds only for 10 MHz or 20 MHz external clocks.
Lock Range	± 30 ppm	On-screen lock indicator
Amplitude	1 V pk nominal	± 5 V pk max
Input Impedance	50 Ω	Will accept TTL drive via a series 1 kΩ resistor - not provided
Phase Lock Bandwidth	1 kHz nominal	Phase Noise of output is determined by the incoming clock approaching or below this offset.

Note

External Reference I/O's are used to lock frequency synthesizers of two or more instruments (daisy chain). This eliminates offset and drift of frequency between instruments, allowing, for instance, a Spectrum Analyzer to accurately tune with respect to the Instrument. If they were not locked, the Analyzer and Instrument would be likely to drift off tune and the Analyzer could lose or not see the Instrument signal.

Instruments locked to the same Reference Frequency in this way can still exhibit very slight frequency offsets due to synthesizer / divider errors, and the two output frequencies will not be phase locked. (See description under Modulation Leveling and Frequency Pull Input Connector.)

Modulation, Leveling and Frequency Pull Input Connector

The Modulation, Leveling and Frequency Pull Input Connector is a BNC connection for applying a multifunction external control signal to the Instrument. Depending upon the operating settings of the Instrument, the signal may be tailored for modulation control, frequency control, or leveling control.

If AM or FM modulation is in use, this input can be used to connect an external modulation source. In this case, the input is enabled via the Modulation Preferences screen and AC or DC coupling can be selected. See Table 3-3 and Table 3-4 for the input specifications.

If Leveled Sine is in use, this input will accept a dc feedback voltage from either of the following:

1. An external power meter – for external leveling of the signal at the power meter input. The feedback is compared with an internal adjustable reference voltage at the input of an error amplifier. The Instrument output level adjusts to minimize the difference. See Table 3-5 for the input specifications.
2. An external phase detector and error amplifier – for phase locking the output of the Instrument to that of another Instrument. In this case, this input is a voltage for controlling Instrument output frequency. Output frequency can be pulled by up to ± 5 ppm, depending on sensitivity setting. See Table 3-6 for the input specifications.

⚠ Caution

To avoid damage to the load when using External Leveling, ensure that the maximum output level is suitably limited via the Leveled-Sine Preferences **screen.**

⚠ Caution

Connections to the External Modulation, Frequency Pull and Leveling Input Connector will often be from a grounded source (e.g. Audio Signal generator or Power Meter). Such connection will ground the RF Common and hence the RF Output of the Instrument. In this circumstance, common-mode noise or ground loops may degrade performance at very low output levels.

Table 3-3. External Modulation Input Specifications (FM)

Parameter	Specification	Comments
Connector Type	BNC	Input Referenced to RF Common (floating)
Frequency Range	DC – 300 kHz 10 Hz – 300 kHz	-3 dB Bandwidth, DC coupled -3 dB Bandwidth, AC coupled
Sensitivity	500 Hz – 19.2 MHz/V	Continuously adjustable
Input Voltage	±2.0 V pk max.	Optimum input range ±0.25 to ±2.0 V pk, ±5 V pk absolute max.
Input Impedance	10 kΩ	Nominal

Table 3-4. External Modulation Input Specifications (AM)

Parameter	Specification	Comments
Connector Type	BNC	Input Referenced to RF Common (floating)
Frequency Range	DC – 220 kHz 10 Hz – 220 kHz 100kHz max. for Carrier >125.75MHz	-3 dB Bandwidth, DC coupled -3 dB Bandwidth, AC coupled
Sensitivity	0.5 - 400 %/V	Continuously adjustable
Input Voltage	±2.0 V pk max.	Optimum input range ±0.25 to ±2.0 V pk, ±5 V pk absolute max.
Input Impedance	10 kΩ	Nominal

Table 3-5. External Leveling Input Specifications

Parameter	Specification	Comments
Connector Type	BNC	Input Referenced to RF Common (floating)
Full Scale Voltage	1V – 5 V dc	Adjustable for different power meter types, ±5 V pk absolute max.
Input Impedance	10 kΩ	Nominal

Table 3-6. External Frequency Pull Input Specifications

Parameter	Specification	Comments
Connector Type	BNC	Input Referenced to RF Common (floating)
Input Voltage	± 5 V dc.	±5 V pk absolute max.
Frequency Pull	± 0.0001 ppm/V to ± 1.0000 ppm/V	Polarity & Sensitivity adjustable.
Input Impedance	10 kΩ	Nominal

Trigger I/O Connector

The Trigger I/O (input/output) connector is a rear-panel BNC connection that is configurable as either an input or an output for sweep trigger signals, and as an output for modulation trigger signals. In either case, this port is TTL compatible. Sweep trigger input and output specifications for the port are shown in Tables 3-7 and 3-8, respectively. Modulation trigger output specifications are shown in Table 3-9.

Note

I/O connections to the Trigger I/O connector will often be grounded (e.g. Oscilloscope or Spectrum Analyzer). Such connection will ground the RF Common and hence the RF Output of the Instrument. In this circumstance, common-mode noise or ground loops may degrade performance at very low output levels.

Table 3-7. Sweep Trigger Input Specifications

Parameter	Specification	Comments
Connector Type	BNC	Input Referenced to RF Common (floating)
Trigger Amplitude	TTL , +5 V pk max	Selectable as rising or falling edge
Input Impedance	10 kΩ	Nominal
Time alignment	≤1 ms Typical	To start of sweep

Table 3-8. Sweep Trigger Output Specifications

Parameter	Specification	Comments
Connector Type	BNC	Input Referenced to RF Common (floating)
Output Pulse	TTL (3 V)	Selectable as rising or falling. Typical duration 250 μs
Time alignment	±1 ms Typical	From start of sweep

Table 3-9. Modulation Trigger Output Specifications

Parameter	Specification	Comments
Connector Type	BNC	Input Referenced to RF Common (floating)
Output Pulse	TTL (3 V)	Selectable as rising or falling edge
Time alignment	±100 ns Typical	From modulation waveform zero crossing

Operating the Instrument

This section of the manual contains operating instructions for the Instrument. Before using these instructions, read the descriptions of the controls, indicators, and connectors provided earlier in this chapter. These descriptions are sufficient to familiarize the user with most of the general processes for operating the Instrument. These earlier descriptions provide all of the information necessary to access, edit, and interpret general screen information.

Before Starting

Before proceeding with the instructions in this section, complete the following procedure:

1. Prepare the Instrument for operation. See Chapter 2.
2. Learn the function of and how to use each of the controls, indicators, and connectors described earlier in this chapter.
3. Account for any rear-panel connections that may be required.
4. Set the power switch to on and set the Instrument to Standby (press STBY).

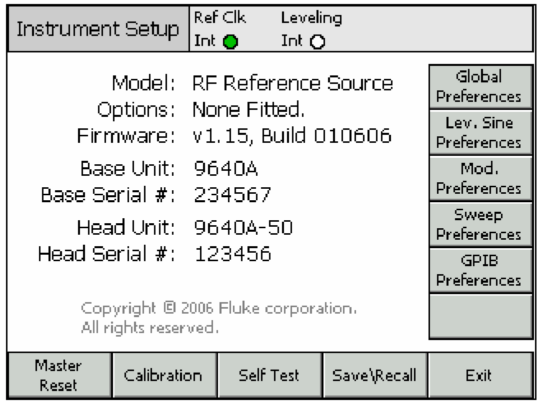
   Approximately 4 seconds after switching on power, the Instrument runs a self-test. Details of the power-on self test are given earlier in Chapter 2.

Setting Global Preferences

The Instrument setup screen describes the basic instrument configuration and gives the user access to all user preference setup screens.

Use the following procedure to set the global preferences:

1. Press SETUP; the Instrument Setup screen appears.



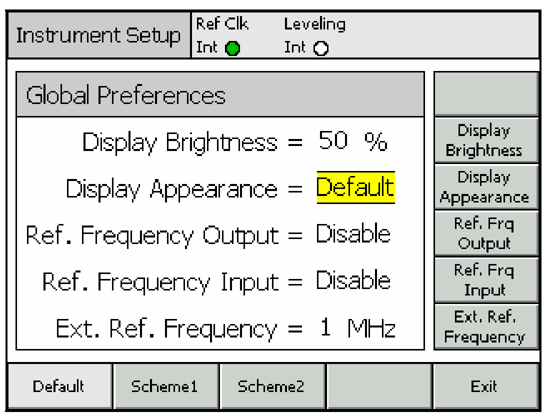
ead05f.bmp

Instrument setup

2. Press the Global Prefs soft key to the right of the display. The Global Preferences screen appears.
3. Select each of the fields, and enter the desired preference in each.

See Table 3-10 for a list of the available global preferences.

Table 3-10. Global Preferences



ead89f.bmp

Field	Preference
Display Brightness	10 to 100 % (1 % steps)
Display Appearance	Default, Scheme 1, Scheme 2
Reference Frequency Output	Disable, 1 MHz, 10 MHz
Reference Frequency Input	Disable, Enable
External Reference Frequency	1 MHz to 20 MHz (1 MHz steps)

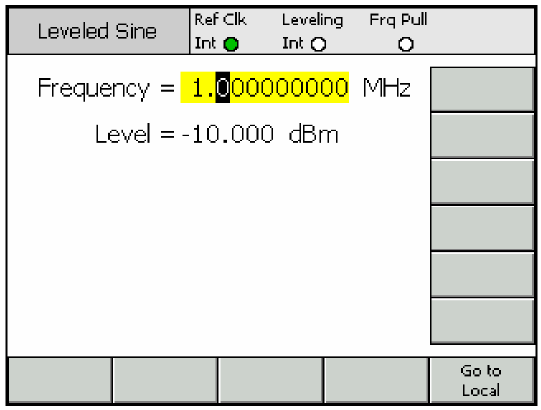
Local or Remote Operation

Manual user interaction at the front panel of the Instrument is considered local operation. Remote operation requires the use of remote data supplied to the Instrument by way of an IEEE 488 connection at the rear panel. Chapter 4 provides all of the information required to remotely operate the Instrument.

There is no physical switch for selecting remote operation. In fact, the Instrument switches to remote operation when it receives a remote instruction and remains there until it is recalled to local operation. This recall may occur because of sending a remote instruction or because of manually pressing the Go to Local soft key at the bottom of the display.

While the Instrument is set to remote operation, all of the front panel (local) controls are locked out (inoperable) with the exception of the Go to Local soft key. See the following Leveled Sine screen.

If the Go to Local soft key appears at the bottom of the display, press it to return to local operation.



ead97f.bmp

Leveled Sine – Remote Operation

Connecting a Leveling Head to the Instrument

⚠ Caution

The 9640A front-panel connector interface is suited only for use with Fluke 9640A-xx Leveling Heads. To avoid equipment damage, no other connection is permitted.

Note

Background: The 9640A-xx Leveling Head contains a small EEPROM device in which the head type, serial number, and calibration data is stored. When a Leveling Head is fitted, it is automatically detected and the stored data is read. The head type, 9640A-50 (50 Ohm) or 9640A-75 (75 Ohm), will be used to re-scale User Interface values in accordance with the capabilities of the Leveling Head and may, therefore, cause displayed level values to change.

Hot (power on) swapping of Leveling Heads is fully supported and will not cause damage or RF leakage. The Hot removal of a Leveling Head will, however, force the Instrument output into Standby.

The Base Unit and Leveling Heads are calibrated together, and details of the association are stored in both the Base Unit and Leveling Heads. Connecting a Head not associated with the Base will result in a warning message being displayed, but normal operation will not be prevented. Details of the Base/Head associations can be displayed by pressing the Setup *key, followed by the* Calibration *softkey.*

Use the following procedure to connect the cable end of the Leveling Head to the RF Output connector on the Instrument:

1. Remove the plastic connector protection caps from the cable-end connectors and save them for future use.

2. Refer to Figure 3-5, and connect the multiway connector to the Leveling Head Control connector on the Instrument. Press firmly on the multiway connector until it latches.
3. Refer to Figure 3-5, and connect the SMA connector with the RF Output connector on the Instrument.
4. Torque the connector to 0.45 Nm (4 in-lb) using an SMA connector torque wrench.

   The torque wrench is available as an accessory; see Chapter 1, *Options and Accessories List*.

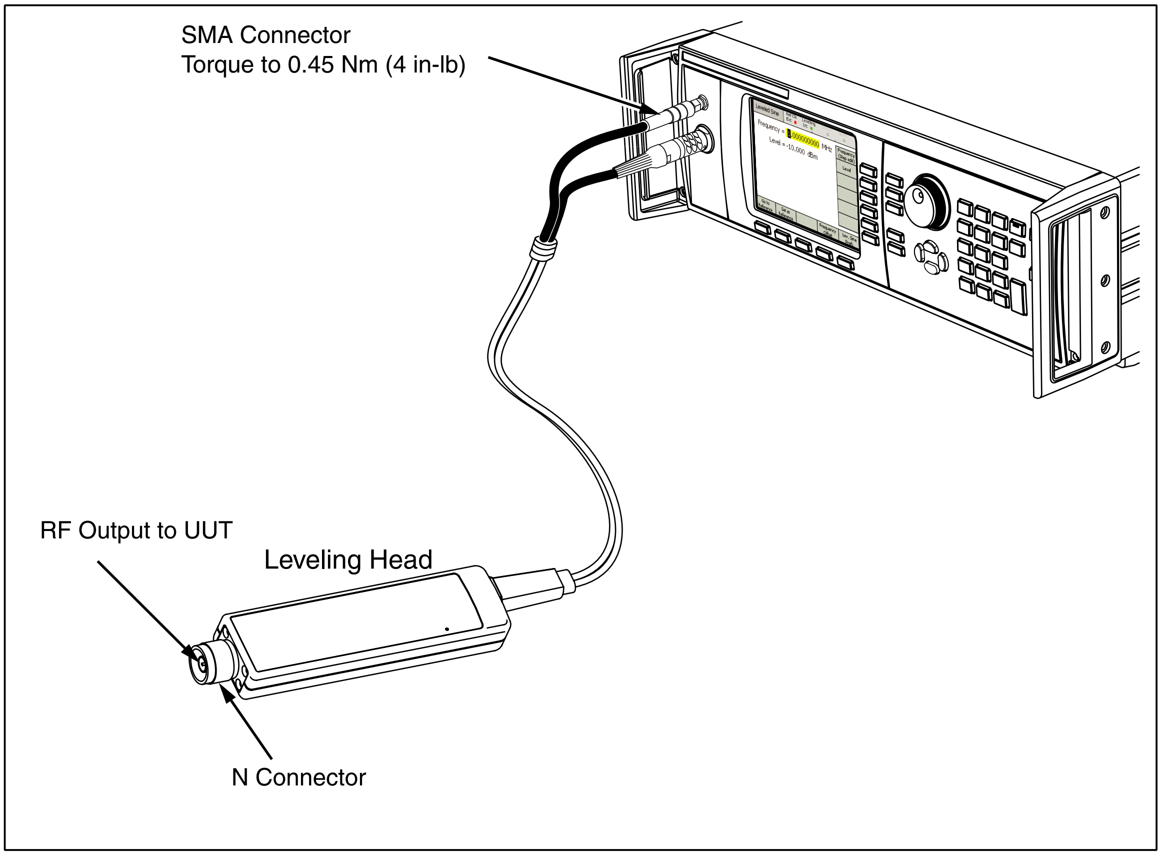


Figure 3-5. Connecting the Leveling Head

Connecting a Leveling Head to a Unit Under Test

The Instrument relies on either a 50 Ω or a 75 Ω Leveling Head to maintain the integrity of the output signal. Both Leveling Heads use N connectors to connect to the input of the UUT.

Connecting the Leveling Head to a UUT is a straightforward, but critical, process. Before making the connection, to avoid damage to the instruments involved and to ensure measurement integrity read and observe the following cautions and warnings,.

⚠ Caution

To prevent damage to the N connector on the Fluke 9640A-xx Leveling Heads, use a sacrificial adapter when making frequent connections or connections to low-quality N connectors.

⚠ Caution

Reliable and repeatable interconnections are only achieved at the specified torque setting of 1.00 Nm (9 in-lb). Performance will be impaired if torque settings are not observed, and permanent connector damage is likely to result from over-tightening.

⚠ Warning

To prevent the leakage or transmission of an RF signal, never connect the Instrument output (the output from a Leveling Head) to a radiating antenna of any kind. Such a transmission would be hazardous to personnel and may impair the SAFE operation of equipment, and communication and navigation systems.

The connection of a radiating antenna is an illegal act in many countries. Only connect the Instrument output (the output from a Leveling Head) to equipment or transmission lines designed to prevent RF leakage at the level and frequency of the Instrument output.

⚠ Caution

The Leveling Heads are fitted with close tolerance metrology-grade N-connectors compliant with MIL-C-39012 and MMC Standards for Precision N-connectors. Used in demanding metrology applications, the Leveling Heads are likely to be mated with similar high-quality connectors, minimizing the opportunity for wear and damage. However, in applications that require frequent mating or mating to lower quality connectors, the opportunity for damaging the connectors increases. On these high-risk occasions, consider using a sacrificial adapter to prevent damage to the N-connectors.

⚠ Caution

Irreversible damage of RF connectors is likely if 50 Ω and 75 Ω connectors are accidentally mated to each other. Although appearance is similar, the dimensions (pin diameter) of 75 Ω connectors differ significantly from those of 50 Ω. Improper mating of 50 Ω and 75 Ω connectors will damage the center pin. Great care must be taken to ensure that the 9640A-50 is mated only to 50 Ω systems and likewise that the 9640A-75 mates only with 75 Ω systems. Otherwise, mechanical damage to the connectors and out-of-tolerance performance is likely.

⚠ Caution

The 9640A-xx Heads are fed via very high-grade flexible coaxial transmission line. As with any coaxial line, deformation of sidewalls or abrupt bending can degrade performance. Take care to avoid mechanical stress or tight bend radius < 60 mm (2.4 in).

⚠ Caution

The maximum output level of the 9640A is unusually high (+24 dBm into 50 Ω and +18 dBm into 75 Ω). Many RF loads, active and passive, could be damaged by this power level. Be careful not to exceed the maximum ratings of the any connected load.

Additional notes regarding good practice when sourcing and measuring high- and low-level signals are given at the end of this chapter.

Use the following procedure to connect a Leveling Head to a UUT:

1. Read and observe all of the preceding Cautions and Warnings.
2. Remove the plastic connector protection caps form the cable-end connectors and save them for future use.
3. Connect the N-connector on the Leveling Head to the input of the UUT.
4. Torque the N-connector to 1.00 Nm (9 in-lb) using an N-connector torque wrench.

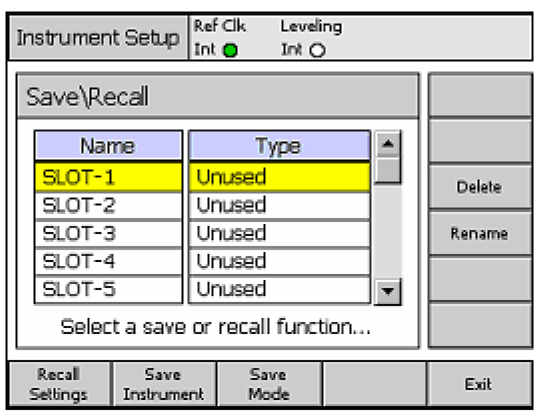
   The torque wrench is available as an accessory; see Chapter 1, *Options and Accessories*.

Using the Save/Recall Function

The Save/Recall function provides the user with a way to save and recall up to 10 groups of settings associated with the instrument setup and/or the output signal.

Each memory group has a default name, SLOT-1 through SLOT-10, and is accessible from the Instrument Setup screen. From this screen, the user can do the following:

- Save the present Instrument or output signal settings to a selected slot
- Recall previously saved instrument or output signal settings from a selected slot
- Rename a selected memory slot to something more meaningful
- Delete all setting information from a selected memory slot



ead11f.bmp

Save/Recall Screen

Accessing the Memory Screen

To access the Save/Recall screen press SETUP. When the screen initially comes up it is ready to perform save/recall operations on the selected (SLOT-1) memory. These operations include Rename, Delete, Save Instrument, Save Mode, and Recall Settings. A description of each of each operation follows:

Rename	Rename the selected memory location to something more meaningful.
Delete	Delete the settings from the selected memory.
Save Instrument	Saves the basic instrument settings, that is, those settings assigned to the vertical soft keys on the initial Instrument Setup screen (press SETUP to view these keys).
Save Mode	Saves the present output settings for one of the output modes: Sine, Modulated, or Swept. Savings do not include the basic instrument settings.
Recall Settings	Immediately recalls and applies the settings associated with the selected memory (slot).

The following Save/Recall procedures are all initiated from the Save/Recall screen. Press SETUP to access the screen.

Making a Memory Selection

After calling the Save/Recall screen, the first step in using the Save/Recall function is to select one of the 10 memory slots. By default, the first slot is selected (yellow high light) when the Save/Recall screen appears. Use either the Spin Wheel or the ⏶ ⏷ keys to scroll through the slots and make a selection.

Renaming a Selection

By default, the 10 available memory slots are named SLOT-1 through SLOT-10. Any one or all of the slots may be renamed to something more meaningful. Use the following procedure to rename a slot:

1. From the Save/Recall screen, select the slot to be renamed.
2. Press the Rename soft key. A 10 character prompt appears at the bottom of the list.
3. Use the Keypad to enter a new name for the slot. The name may be any combination of up to 10 alphanumeric characters.
4. When the new name is correct, press ENTER to transfer the new name to the slot.

Deleting a Selection

To delete the settings previously saved to a memory slot, select the slot and press the Delete soft key. The deleted settings revert to a default or Unused state (Unused is displayed in the selected slot). Recalling settings from an unused slot has no effect on the Instrument.

Saving an Instrument Setup

Settings that apply to the instrument setup include those setting that apply to the instrument but not those that define the output signal. For example, all of the preferences settings are instrument setup settings. Use the following procedure to save a set of instrument setup settings to a memory slot:

1. From the Save/Recall screen, select a slot for saving the instrument setup settings.
2. Press the Save Instrument soft key. If the memory slot contains previously saved settings, the screen prompts for overwrite permission (Yes or No). Pressing the Yes soft key saves the new settings, and the Type column in the selected slot field displays Instrument (xx) to identify the settings as instrument setup settings. Pressing the No soft key aborts the save attempt.

Saving Settings for an Output Function

Settings that apply to the output function include those settings that directly affect the output signal, but not those that apply to the instrument setup. For example, all of the settings that contribute to defining a sine output are output function settings. Use the following procedure to save a set of output function settings:

1. From the Save/Recall screen, select a slot for saving the output function settings.
2. Press the Save Mode soft key. Three new soft labels are displayed: Save Sine Mode, Save Sweep Mode, and Save Mod. Functions.
3. Press the appropriate soft key. If the memory slot contains previously saved settings, the screen prompts for overwrite permission (Yes or No). Pressing the Yes soft key saves the new settings, and the Type column in the selected slot field displays the mode to identify the settings as output function settings. Pressing the No soft key aborts the save attempt.

Recalling Settings

Anyone of the 10 saved settings may be recalled at anytime. Use the following procedure:

1. From the Save/Recall screen, select the slot containing the settings to be recalled.
2. Press the Recall Settings soft key. The instrument immediately responds to the new settings.

Creating an RF Output Signal

The Instrument provides three kinds of output signals: sine, modulated, and swept. User selectable screens, as shown in Figure 3-6, provide control for each of these outputs.

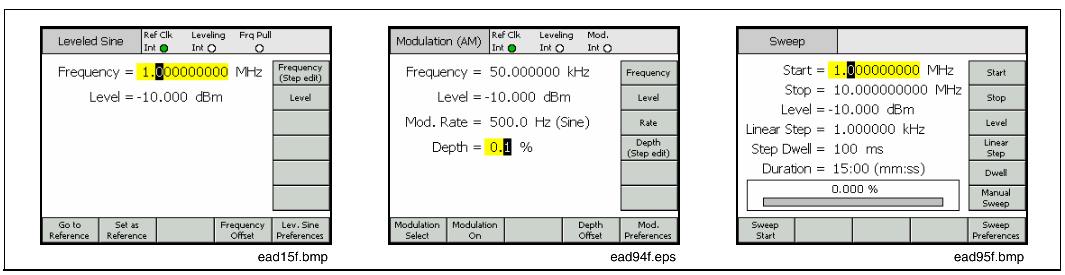


Figure 3-6. Control Screens for the RF Output Signal

The remaining sections in this chapter provide the procedures for creating sine, modulated, and swept output signals. An appropriate screen facsimile and a table containing a breakdown of the fields accessible on the screen complement each of the procedures. Procedures for expanded features, such as offset, are presented separately.

Note

Entries displayed in parentheses in the soft labels indicate what will show in the field after a button is pressed, not what the field currently shows. For example, if the label indicates Frequency (Step edit)*, the* Frequency *field is showing* Cursor edit.

Note

Many of the data fields in the following procedures include the opportunity to define measurement units (using the UNITS *key). Since the units are often preferential, it is left to the user to define them. Instructions to do so are not given in the following procedures.*

Creating a Leveled Sine Output Signal

The following paragraphs provide the instructions for creating a leveled sine output signal.

Setting Leveled Sine Preferences

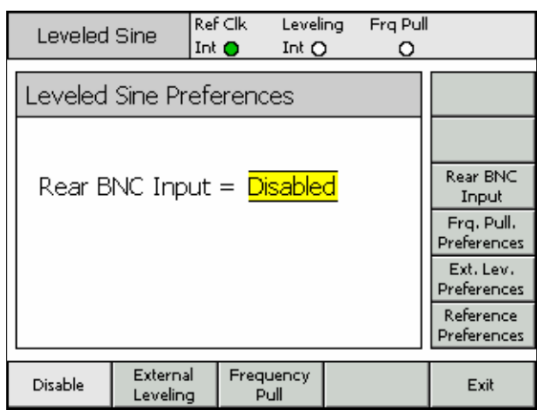
Table 3-11 shows the Leveled Sine Preferences screen for creating leveled sine signals. The requirements for the external inputs are described earlier in this chapter under the heading *Modulation Leveling and Frequency Pull Input Connector*.

Use the following procedure to set the Leveled Sine Preferences:

1. Press SETUP to open the Instrument Setup screen.
2. Press the Lev. Sine Prefs soft key to bring up the Leveled Sine Preferences screen shown in Table 3-11.
3. Sequentially select each of the preference fields using the soft keys to the right of the screen.

   While each field is selected, use the soft keys along the bottom of the display or the scroll wheel to choose a preference.
4. To exit the screen, press the Exit soft key, or press one of the signal function keys (SINE, MOD, or SWEEP).

Table 3-11. Leveled- Sine Preferences



ead340f.bmp

Field	Preference
Rear BNC Input	Configures Rear Input BNC for Leveled Sine Disable, External Leveling, External Frequency Pull
Frq. Pull. Preferences	Access to Frequency Pull Preferences Screen that allows selection of Polarity and Sensitivity
Ext Lev. Preferences	Access to External Leveling Preferences Screen (see following descriptions)
Reference Preferences	Access to Reference Preferences Screen (see following descriptions)

Note:
When external Frequency Pull is selected an indicator (Frq Pull) appears on the Status Bar. Green = OK, Flashing Red = Frequency Control over range. The Frequency field identifies that the setting is approximate by showing "~" in place of "=".

Setting Externally Leveled Sine Preferences

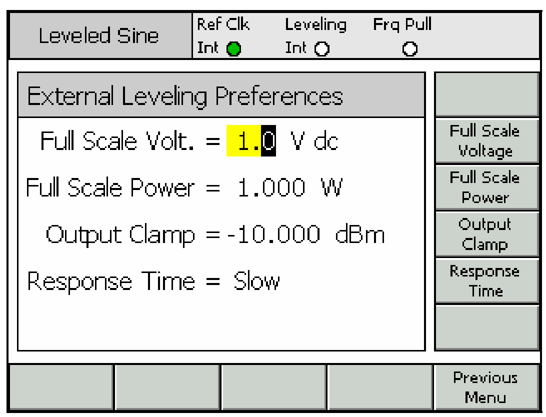
Table 3-12 shows the External Leveling Preferences screen. External Leveling accepts a DC Voltage feedback from a Power Meter and allows the user to control signal level at a remote Power sense point. The requirements for the external input are described earlier in this chapter under the heading *Modulation Leveling and Frequency Pull Input Connector*.

Use the following procedure to set the External Leveling Preferences:

1. Press SETUP to open the Instrument Setup screen.
2. Press the Lev. Sine Prefs soft key to bring up the Leveled Sine Preferences screen shown in Table 3-12.
3. Press the Ext Lev. Prefs soft key to bring up the External Leveling Preferences screen
4. Sequentially select each of the preference fields using the soft keys to the right of the screen.

   While each field is selected, use the soft keys along the bottom of the display or the scroll wheel to choose a preference.
5. To exit the screen, press the Exit soft key, or press one of the signal function keys (SINE, MOD, or SWEEP).

Table 3-12. Externally Leveled Sine Preferences



ead341f.bmp

Field	Preference
Full Scale Voltage	Enter the Full Scale Voltage expected from the Power Meter 1.0 V to 5.0 V dc
Full Scale Power	Enter the Full Scale Power of the Power Meter 10.00 mW to 1.000 W
Output Clamp	The maximum allowable Output Level from the 9640 Use Output Clamp to limit 9640 Output Power should a feedback loop fault occur.
Response Time	Adjusts response time to suit power sensor characteristics. Fast, Slow

Notes:

- When External Leveling is selected, the maximum level that can be requested at the main Leveled Sine screen will be the Full Scale Power established above. The minimum Level is 1μW (-30 dBm). External Leveling is indicated in the Status bar, White = inactive, Green = OK, Flashing Red = Level control out of lock, Red = Level control out of lock and Output Clamp active.
- Depending upon external circuit gain or loss, the 9640 Output Level will take whatever value is necessary to achieve the set-point level at the power meter. Output power will not exceed the Output Clamp value set.

Setting Reference Switching Preferences

Table 3-13 shows the Reference Switching Preferences screen.

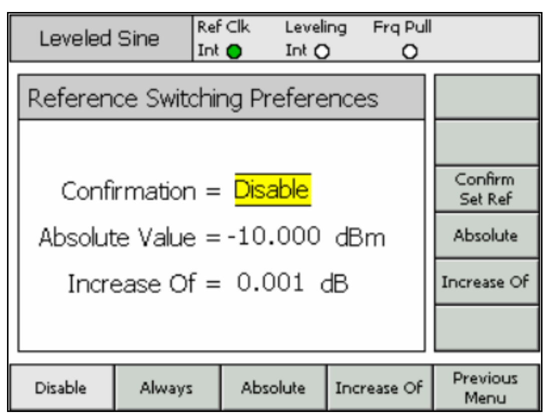
There is a danger when switching between an established Level setting and the Reference Level setting that the new setting may damage the load. The user may therefore prefer the 9640A to switch to standby, display the new settings and request confirmation through user selection of Output ON. Confirmation and the criteria for confirmation may be established on the Reference Switching Preferences.

Use the following procedure to set the Reference Switching Preferences:

1. Press [SETUP] to open the Instrument Setup screen.
2. Press the Lev. Sine Preferences soft key to bring up the Leveled Sine Preferences screen shown in Table 3-13.
3. Press the Reference Preferences key to bring up the Reference Switching Preferences screen
4. Sequentially select each of the preference fields using the soft keys to the right of the screen.

   While each field is selected, use the soft keys along the bottom of the display or the scroll wheel to choose a preference.
5. To exit the screen, press the Previous Menu soft key, or press one of the signal function keys ([SINE], [MOD], or [SWEEP]).

Table 3-13. Reference Switching Preferences



ead342f.bmp

Field	Preferences
Confirmation	Select Confirmation Always or if new output is above the Absolute level, or if it is bigger than the current value by the Difference. Disable, Always, Absolute, Increase of
Absolute Value	Enter the threshold level above which Confirmation is needed.
Increase of Value	Enter the increase threshold above which Confirmation is needed.

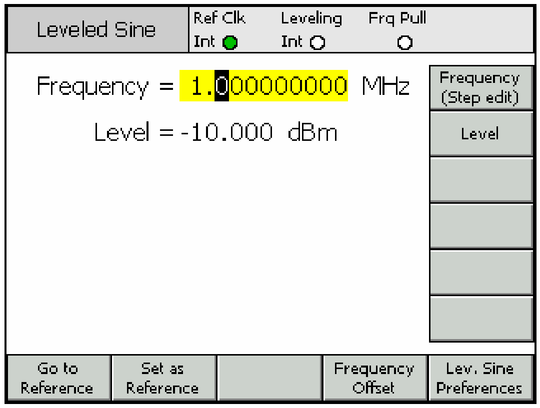
Defining the Leveled-Sine Output Signal

Use the following procedure to create a leveled-sine output signal and, if required, to define the incremental step values by which the frequency and level of the output signal can be increased or decreased. As you perform the procedure, refer to Table 3-14 for a list of the fields available on the Leveled-Sine screen and the limits associated with each field.

Use the following procedure to define the leveled-sine output signal:

1. Press SINE to open the Leveled-Sine screen.
2. Select the Frequency field (Cursor edit enabled) and enter the desired output frequency.
3. If required, press the Frequency soft key again to enable Step edit.
    a. Select the Freq Step (Step Size) field.
    b. Enter the desired frequency step in the field.
4. Select the Level field (Cursor edit enabled) and enter the desired output level.
5. If required, press the Level soft key again to enable Step edit. A Level Step field appears at the bottom of the screen.
    a. Select the Level Step field.
    b. Enter the desired level step in the Level Step field.
6. To make the leveled-sine wave available as an RF Output signal, press OPER.
7. To step the output frequency, select the Frequency field (Step edit enabled) and use the cursor keys to increase or decrease the output frequency by the amount specified in the Freq Step field.
8. To step the output level, select the Level field (Step edit enabled) and use the cursor keys to increase or decrease the output level by the amount specified in the Level Step field.

Table 3-14. Leveled-Sine Fields



ead92f.bmp

Field	Range	Units
Frequency	9.000 Hz to 4.0240000000 GHz	Hz (kHz, MHz, GHz)
Frequency Step	0.1 Hz to 4.024000000000 GHz	Hz (kHz, MHz, GHz), ppm**, %*
Frequency Offset	Absolute Any value within extremes of frequency range above	Hz (kHz, MHz, GHz), ppm**, %*
	As UUT Error Any value within extremes of frequency range above	ppm**, %**
Level	-130.000 to 24 dBm (50•) 20 dBm max >125.75 MHz 14 dBm max > 1.4084 GHz -136.000 to 18 dBm (75•) 14dBm max >125.75 MHz 8dBm max > 1.4084 GHz	dBm, Vp-p and Vrms (uV, mV, V), W (nW, uW, mW, W), dBuV
Level Step	0.001 dB to 130 dB	dB, Vp-p and Vrms (uV, mV, V), W (nW, uW, mW, W), ppm**, %*
Level Offset	Absolute Offset may be applied in either polarity to the full dynamic range of the parent parameter	dB, Vp-p and Vrms (uV, mV, V), W (nW, uW, mW, W), ppm**, %*
	As UUT Error Will be calculated for any permitted Offset value subject to limitations of % or ppm if these units are used (see below)	dB, ppm**, %*

* Any entry expressed in % (or converted to %) is subject to a limit of ±1000% for offset and +1000% for step and will also be limited to the dynamic range of the instrument.

** Any entry expressed in ppm (or converted to ppm) is subject to a limit of ±10000ppm for offset and +10000 ppm for step and will also be limited to the dynamic range of the instrument.

Applying an Offset to a Leveled-Sine Output Signal

While performing calibration and adjustment procedures on a UUT, it is often beneficial to offset the Instrument output level by the amount required to bring a UUT measurement into compliance. See the *Offset (As Error) Soft Key* discussion earlier in this chapter.

Frequency Offset

Use the following procedure to apply an offset to the frequency of a leveled-sine output signal:

1. Create a leveled-sine output signal as described in the previous procedure.
2. Select the Frequency field.
3. Press the Frequency Offset soft key. A vertical Offset label appears on the right of the screen.
4. Select the Freq Offset field.
5. Enter the desired offset value. Notice that the value in the Frequency field follows the offset value.
6. To toggle the offset value off and on, use the Toggle Offset soft key at the bottom of the screen.
7. To disable the offset, use the Offset Disable soft key at the bottom of the screen.

Level Offset

Use the following procedure to apply an offset to the level of a leveled-sine output signal:

1. Create a leveled-sine output signal as described earlier in this chapter.
2. Select the Level field.
3. Press the Level Offset soft key. A vertical Offset label appears on the right of the screen.
4. Select the Level Offset field.
5. Enter the desired offset value. Notice that the value in the Level field follows the offset value.
6. To toggle the offset value off and on, use the Toggle Offset soft key at the bottom of the screen.
7. To disable the offset, use the Offset Disable soft key at the bottom of the screen.

Creating a Modulated Output Signal

The following paragraphs provide instructions for creating amplitude-modulated and frequency-modulated output signals.

Setting Modulation Preferences

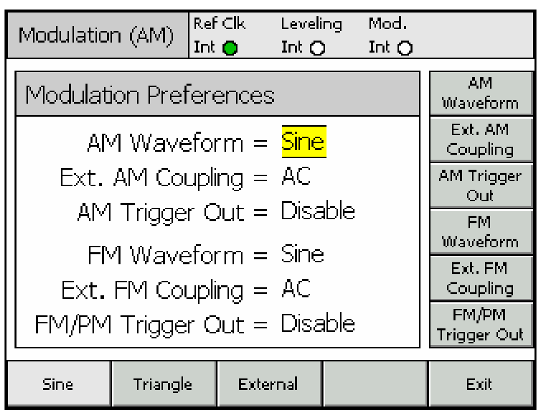
Table 3-15 shows the Modulation Preferences screen for creating modulated signals. The requirements for the external inputs are described earlier in this chapter under the heading *Modulation Leveling and Frequency Pull Input Connector*.

Use the following procedure to set the Modulation Preferences:

1. Press SETUP to open the Instrument Setup screen.
2. Press the Mod Prefs soft key to bring up the Modulation Preferences screen shown in Table 3-15.
3. Sequentially select each of the preference fields using the soft keys to the right of the screen.

   While each field is selected, use the soft keys along the bottom of the display to choose a preference.
4. To exit the screen, press the Exit soft key, or press one of the signal function keys (SINE, MOD, or SWEEP).

Table 3-15. Modulation Preferences Fields



ead88f.bmp

Field	Preference
AM Waveform	Sine, Triangle, External
External AM Coupling	AC, DC
AM Trigger Output*	Disable, Rising Edge, Falling Edge
FM Waveform	Sine, External
External FM Coupling	AC, DC
FM Trigger Output*	Disable, Rising Edge, Falling Edge

* Modulation Trigger Output not available in External.

Defining an Amplitude-Modulated Output Signal

Use the following procedure to create an amplitude-modulated output signal and, if required, to define the incremental step values by which the frequency, level, modulation rate and depth of the output signal can be increased and decreased. Refer to Table 3-16 for a list of the fields available on the Modulation screen and the limits associated with each field.

1. Press MOD .
2. Press the Modulation Select soft key to expand the selections at the bottom of the display.
3. Press the AM soft key to select amplitude modulation and return to the main screen.
4. Select the Frequency field, and enter the desired output frequency.
5. If a frequency step is required, press the Frequency soft key again. A Freq Step field appears at the bottom of the screen.
   a. Select the Freq Step (Step Size) field.
   b. Enter the desired frequency step in the field.
6. Select the Level field, and enter the desired output level.
7. If a level step is required, press the Level soft key again. A Level Step field appears at the bottom of the screen.
   a. Select the Level Step (Step Size) field.
   b. Enter the desired level step in the Level Step field.
8. Select the Mod Rate field and enter the desired output level.

   Notice that the Mod Rate field includes a definition of the modulating waveform, Sine, Tri (triangle), or External. To select a specific waveform proceed as follows:
   a. Press the Mod Prefs soft key.
   b. Select the AM Mod Waveform field.
   c. Select the appropriate waveform (Sine, Triangle, or External).
   d. Enable, if required, the Modulation Trigger Output, Rising or Falling Edge.
   e. If an External Modulation waveform is in use, select either AC or DC coupling
   f. Return to the AM Modulation screen by pressing the Exit soft key.
9. If a rate step is required, press the Rate soft key again. A Rate Step field appears at the bottom of the screen.
   a. Select the Rate Step (Step Size) field.
   b. Enter the desired rate step in the Rate Step field.
10. Select the Depth field and enter the desired output level (percent only). If External Modulation is in use, the entry is the required depth sensitivity value in percent per Volt.
11. If a depth step is required, press the Depth soft key again. A Depth Step field appears at the bottom of the screen.
    a. Select the Depth Step (Step Size) field.
    b. Enter the desired depth step in the Depth Step field.
12. To make the amplitude-modulated signal available as an RF Output signal, press OPER .
13. To step carrier frequency, carrier level, modulation rate, or modulation depth, select the appropriate field and use the cursor keys to increase or decrease the output level by the amount previously entered in the step field (Step Size).

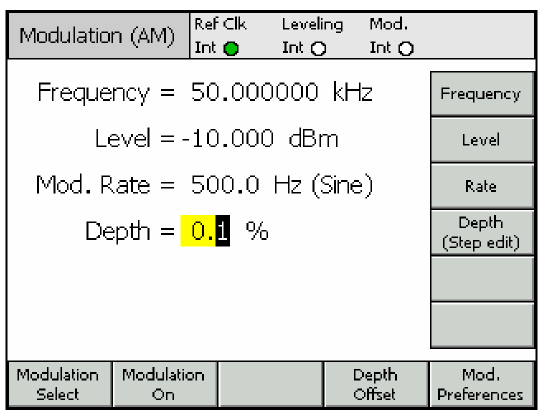
Applying an Offset to an Amplitude-Modulated Output Signal

Using the AM Modulation screen, the user can introduce an individual offset value for each of the four parameters of the signal: Frequency, Level, Mod Rate, and Depth. Once the offsets are in place, they remain active until they are changed or until the Instrument is powered on again.

Use the following procedure to set an offset for one or more of the four signal parameters:

1. Create an amplitude-modulated output signal as described in the previous procedure.
2. Select the field to which the offset will be applied: Frequency, Level, Mod Rate, or Depth (parameter field).
3. Select the corresponding Offset for the parameter (bottom of the screen). An Offset label appears on the right of the screen.
4. Press the Offset soft key to select the Offset field.
5. Press the Offset soft key, and enter the desired offset value. Notice that the value in the parameter field follows the offset value.
6. To toggle the offset value off and on, use the Toggle Offset soft key at the bottom of the screen.
7. To disable the offset, use the Offset Disable soft key at the bottom of the screen.

Table 3-16. Amplitude-Modulation Fields



ead94f.bmp

Field	Range	Units
Frequency	50.000000 kHz to 4.0240000000 GHz	Hz (kHz, MHz, GHz)
Frequency Step	0.0001 kHz to 4.0240000000 GHz	Hz (kHz, MHz, GHz)
Frequency Offset	Absolute: Offset may be applied in either polarity to the full dynamic range of the parent parameter	Hz (kHz, MHz, GHz), ppm**, %*
	As UUT Error: Will be calculated for any permitted Offset value subject to limitations of % or ppm if these units are used (see below)	ppm**, %**

Table 3-16. Amplitude-Modulation Fields (cont.)

Level	-130.000 to 14 dBm (50 Ω) 8 dBm max > 1.4084 GHz -136.000 to 8 dBm (75 Ω) 2 dBm max > 1.4084 GHz	dBm, Vp-p and Vrms (uV, mV, V), W (nW, uW, mW, W), dBuV
Level Step	-130 dB to 130 dB	dB, Vp-p and Vrms (uV, mV, V), W (nW, uW, mW, W), ppm**, %*
Level Offset	<u>Absolute</u> Offset may be applied in either polarity to the full dynamic range of the parent parameter	dB, Vp-p and Vrms (uV, mV, V), W (nW, uW, mW, W), ppm**, %*
	<u>As UUT Error</u> Will be calculated for any permitted Offset value subject to limitations of % or ppm if these units are used (see below)	dB, ppm**, %*
Mod. Rate	For Carrier •125.75MHz .020 kHz to 220 kHz Mod Rate • 1% Frequency >125.75MHz .020 kHz to 100 kHz	kHz
Rate Step	0.1 Hz to 220 kHz	Hz (Hz, kHz)
Rate Offset	<u>Absolute</u> Offset may be applied in either polarity to the full dynamic range of the parent parameter	Hz (kHz), ppm**, %*
	<u>As UUT Error</u> Will be calculated for any permitted Offset value subject to limitations of % or ppm if these units are used (see below)	ppm**, %**
Depth	0.1 % to 99.0 %	%
Depth Step	0.1 % to 99.0 %	%
Depth Offset	<u>Absolute</u> Offset may be applied in either polarity to the full dynamic range of the parent parameter	% *
	<u>As UUT Error</u> Will be calculated for any permitted Offset value subject to limitations of % or ppm if these units are used (see below)	%*

* Any entry expressed in % (or converted to %) is subject to a limit of +/-1000%.
** Any entry expressed in ppm (or converted to ppm) is subject to a limit of +/-10000ppm.

Creating a Frequency-Modulated Output Signal

Use the following procedure to create a frequency-modulated output signal and, if required, to define the incremental step values by which the frequency, level, modulation rate and deviation of the output signal can be increased and decreased. Refer to Table 3-17 for a list of the fields available on the Modulation screen and the limits associated with each field.

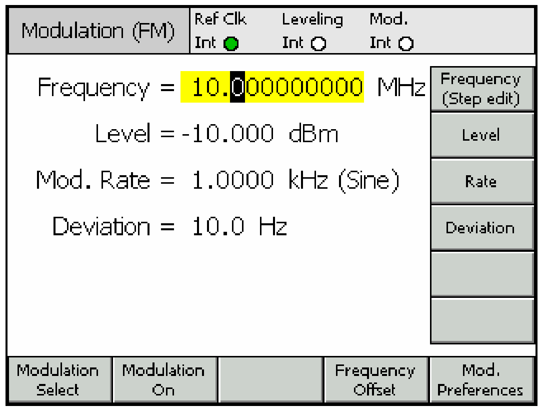
1. Press MOD.
2. Press the Modulation Select soft key to expand the selections at the bottom of the screen.
3. Press the FM soft key to activate the FM Modulation screen.
4. Select the Frequency field, and enter the desired output frequency.
5. If a frequency step is required, press the Frequency soft key again until a Freq Step field appears at the bottom of the screen.
    a. Select the Freq Step (Step Size) field.
    b. Enter the desired frequency step in the field.
6. Select the Level field and enter the desired output level.
7. If a level step is required, press the Level soft key again until a Level Step field appears at the bottom of the screen.
    a. Select the Level Step (Step Size) field.
    b. Enter the desired level step in the Level Step field.
8. Select the Mod Rate field and enter the desired output rate.

    Notice that the Mod Rate field includes a definition of the modulating waveform, Sine, or External. To select a specific waveform proceed as follows:

    a. Press the Mod Prefs soft key.
    b. Select the FM Mod Waveform field.
    c. Select the appropriate waveform (Sine or External).
    d. Enable, if required, the Modulation Trigger Output, Rising or Falling Edge.
    e. If an External Modulation waveform is in use, select either AC or DC coupling
    f. Return to the FM Modulation screen by pressing the Exit soft key.
9. If a rate step is required, press the Rate soft key again until a Rate Step field appears at the bottom of the screen.
    a. Select the Rate Step (Step Size) field.
    b. Enter the desired rate step in the Rate Step field.
10. Select the Deviation field and enter the desired deviation frequency. If External Modulation is in use, the entry is the required deviation sensitivity value in Hz, kHz or MHz per Volt.
11. If a deviation step is required, press the Deviation soft key again until a Dev Step field appears at the bottom of the screen.
    a. Select the Dev Step (Step Size) field.
    b. Enter the desired deviation step in the Dev Step field.

12. To make the frequency-modulated wave available as an RF Output signal, press the OPER key.
13. To step Carrier Frequency, Carrier Level, Modulation Rate, or Modulation Deviation, select the appropriate field and use the cursor keys to increase or decrease the output level by the value previously entered in the step field (Step Size).

Table 3-17. Frequency-Modulation Fields



ead93f.bmp

Field	Range	Units
Frequency	9.000000000 MHz to 4.0240000000 GHz	Hz (MHz, GHz)
Frequency Step	0000001 MHz to 4.0240000000 GHz	Hz (kHz, MHz, GHz)
Frequency Offset	Absolute Offset may be applied in either polarity to the full dynamic range of the parent parameter	Hz (kHz, MHz, GHz), ppm**, %*
	As UUT Error Will be calculated for any permitted Offset value subject to limitations of % or ppm if these units are used (see below)	ppm**, %**
Level	-130.000 to 24 dBm (50 Ω) 20 dBm max >125.75 MHz 14 dBm max > 1.4084 GHz -136.000 to 18 dBm (75 Ω) 14 dBm max >125.75 MHz 8 dBm max > 1.4084 GHz	dBm, Vp-p and Vrms (uV, mV, V), W (nW, uW, mW, W), dBuV
Level Step	0.001 dB to 130 dB	dB, Vp-p and Vrms (uV, mV, V), W (nW, uW, mW, W), ppm**, %*
Level Offset	Absolute Offset may be applied in either polarity to the full dynamic range of the parent parameter	dB, Vp-p and Vrms (uV, mV, V), W (nW, uW, mW, W), ppm**, %*
	As UUT Error Will be calculated for any permitted Offset value subject to limitations of % or ppm if these units are used (see below)	dB, ppm**, %*

Table 3-17. Frequency-Modulation Fields (cont.)

Mod Rate	.020 kHz to 300 kHz	Hz (kHz)
Rate Step	0.1 Hz to 300 kHz	Hz (Hz, kHz)
Rate Offset	<u>Absolute</u> Offset may be applied in either polarity to the full dynamic range of the parent parameter	Hz (kHz), ppm**, %*
	<u>As UUT Error</u> Will be calculated for any permitted Offset value subject to limitations of % or ppm if these units are used (see below)	ppm**, %**
Deviation	.010 kHz to 4.8000 MHz Dev ≤300 kHz 9 MHz to 31.4375 MHz Dev ≤750 kHz >31.4375 to 125.75 MHz Dev ≤0.12% Frequency >125.75 MHz	Hz (Hz, kHz, MHz)
Step Size	0.1 Hz to 4.8000 MHz	Hz (Hz, kHz, MHz)
Deviation Offset	<u>Absolute</u> Offset may be applied in either polarity to the full dynamic range of the parent parameter	Hz (kHz, MHz), ppm**, %*
	<u>As UUT Error</u> Will be calculated for any permitted Offset value subject to limitations of % or ppm if these units are used (see below)	ppm**, %**

* Any entry expressed in % (or converted to %) is subject to a limit of +/-1000%.
** Any entry expressed in ppm (or converted to ppm) is subject to a limit of +/-10000ppm

Applying an Offset to a Frequency-Modulated Output Signal

Using the FM Modulation screen the user can introduce an offset value for all four parameters of the signal: Frequency, Level, Mod Rate, and Deviation. Once the offsets are in place, they remain active until they are changed or until the Instrument is powered on again.

Use the following procedure to set an offset for one or more of the four signal parameters:

1. Create a frequency-modulated output signal as described in the previous procedure.
2. Select the desired field: Frequency, Level, Mod Rate, or Deviation (parameter field).
3. Select the Offset for the parameter (bottom of the screen). An Offset label appears on the right of the screen.
4. Press the Offset soft key to select the offset field.
5. Press the Offset soft key, and enter the desired offset value. Notice that the value in the parameter field follows the offset value.
6. To toggle the offset value off and on, use the Toggle Offset soft key at the bottom of the display.
7. To disable the offset, use the Offset Disable soft key at the bottom of the display.
8. Repeat this procedure, as needed, for each signal parameter.

Creating a Phase-Modulated Output Signal

Use the following procedure to create a phase-modulated output signal and, if required, to define the incremental step values by which the frequency, level, modulation rate and deviation of the output signal can be increased and decreased. Refer to Table 3-18 for a list of the fields available on the Modulation screen and the limits associated with each field.

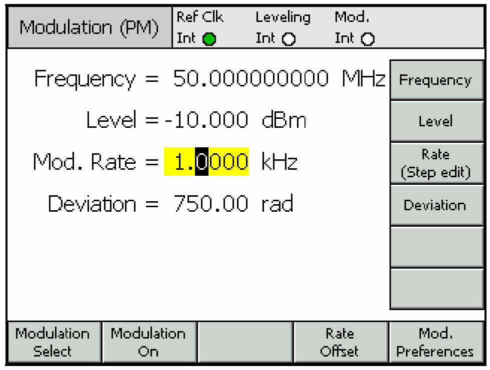
Note

Phase modulation is generated by applying sinusoidal frequency modulation with peak deviation derived from the phase deviation and rate settings $(F_d = \phi_d \times F_{rate})$.

1. Press MOD .
2. Press the Modulation Select soft key to expand the selections at the bottom of the screen.
3. Press the PM soft key to activate the PM Modulation screen.
4. Select the Frequency field, and enter the desired output frequency.
5. If a frequency step is required, press the Frequency soft key again until a Freq Step field appears at the bottom of the screen.
   a. Select the Freq Step (Step Size) field.
   b. Enter the desired frequency step in the field.
6. Select the Level field and enter the desired output level.

7. If a level step is required, press the Level soft key again until a Level Step field appears at the bottom of the screen.
    a. Select the Level Step (Step Size) field.
    b. Enter the desired level step in the Level Step field.
8. Select the Mod Rate field and enter the desired output rate.
    a. Press the Mod Preferences soft key.
    b. If required, press FM/PM Trigger Out, and define the trigger by selecting Disable, Rising Edge, or Falling Edge.
    c. Return to the FM Modulation screen by pressing the Previous Menu soft key.
9. If a rate step is required, press the Rate soft key again until a Rate Step field appears at the bottom of the screen.
    a. Select the Rate Step (Step Size) field.
    b. Enter the desired rate step in the Rate Step field.
10. Select the Deviation field and enter the desired deviation in radians.
11. If a deviation step is required, press the Deviation soft key again until a Dev Step field appears at the bottom of the screen.
    a. Select the Dev Step (Step Size) field.
    b. Enter the desired deviation step in the Dev Step field.
12. To make the phase-modulated wave available as an RF Output signal, press the OPER key.
13. To step Carrier Frequency, Carrier Level, Modulation Rate, or Modulation Deviation, select the appropriate field and use the cursor keys to increase or decrease the output level by the value previously entered in the step field (Step Size).

Table 3-18. Phase Modulation Fields



ead345f.bmp

Field	Range	Units
Frequency	9.000000000 MHz to 4.0240000000 GHz	Hz (MHz, GHz)
Frequency Step	0000001 MHz to 4.0240000000 GHz	Hz (kHz, MHz, GHz)
Frequency Offset	<u>Absolute</u> Offset may be applied in either polarity to the full dynamic range of the parent parameter	Hz (kHz, MHz, GHz), ppm**, %*
	<u>As UUT Error</u> Will be calculated for any permitted Offset value subject to limitations of % or ppm if these units are used (see below)	ppm**, %**
Level	-130.000 to 24 dBm (50 Ω) 20 dBm max >125.75 MHz 14 dBm max > 1.4084 GHz -136.000 to 18 dBm (75 Ω) 14 dBm max >125.75 MHz 8dBm max > 1.4084 GHz	dBm, Vp-p and Vrms (uV, mV, V), W (nW, uW, mW, W), dBuV
Level Step	0.001 dB to 130 dB	dB, Vp-p and Vrms (uV, mV, V), W (nW, uW, mW, W), ppm**, %*
Level Offset	<u>Absolute</u> Offset may be applied in either polarity to the full dynamic range of the parent parameter	dB, Vp-p and Vrms (uV, mV, V), W (nW, uW, mW, W), ppm**, %*
	<u>As UUT Error</u> Will be calculated for any permitted Offset value subject to limitations of % or ppm if these units are used (see below)	dB, ppm**, %*

Table 3-18. Phase-Modulation Fields (cont.)

Mod Rate	0.020 kHz to 300 kHz	kHz
Rate Step	0.1 Hz to 220 kHz	Hz (Hz, kHz)
Rate Offset	Absolute Offset may be applied in either polarity to the full dynamic range of the parent parameter	Hz (kHz), ppm**, %*
	As UUT Error Will be calculated for any permitted Offset value subject to limitations of % or ppm if these units are used (see below)	ppm**, %**
Deviation	0.0001 rad to 1000 rad Subject to Dev ≤300 kHz 9 MHz to 31.4375 MHz Dev ≤750 kHz >31.4375 to 125.75 MHz Dev ≤0.12% Frequency >125.75 MHz	rad***
Step Size	.0001 rad to 1000 rad	rad***
Deviation Offset	Absolute Offset may be applied in either polarity to the full dynamic range of the parent parameter	rad, ppm**, %*
	As UUT Error Will be calculated for any permitted Offset value subject to limitations of % or ppm if these units are used (see below)	rad, ppm**, %**

* Any entry expressed in % (or converted to %) is subject to a limit of +/-1000%.

** Any entry expressed in ppm (or converted to ppm) is subject to a limit of +/-10000ppm

*** A phase deviation expressed in radians is a Deviation expressed as a ratio of the Rate, such that:
Phase deviation(rad) = Deviation (Hz) / Rate (Hz)

Applying an Offset to a Phase-Modulated Output Signal

Using the PM Modulation screen the user can introduce an offset value for all four parameters of the signal: Frequency, Level, Mod Rate, and Deviation. Once the offsets are in place, they remain active until they are changed or until the Instrument is powered on again.

Use the following procedure to set an offset for one or more of the four signal parameters:

1. Create a phase-modulated output signal as described in the previous procedure.
2. Select the desired field: Frequency, Level, Mod Rate, or Deviation (parameter field).
3. Select the Offset for the parameter (bottom of the screen). An Offset label appears on the right of the screen.
4. Press the Offset soft key to select the offset field.
5. Press the Offset soft key, and enter the desired offset value. Notice that the value in the parameter field follows the offset value.
6. To toggle the offset value off and on, use the Toggle Offset soft key at the bottom of the display.
7. To disable the offset, use the Offset Disable soft key at the bottom of the display.
8. Repeat this procedure, as needed, for each signal parameter.

Creating a Sweep Output Signal

The following procedures provide instructions for creating swept-frequency output signals.

Note

The source is a digital synthesizer of frequency and level. All sweeps are a sequence of finite steps between discrete frequencies as determined by the user settings.

Setting the Sweep Preferences

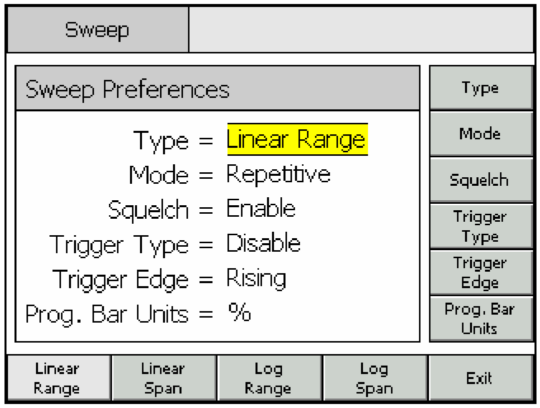
Table 3-19 shows the preference screen for creating sweep signals. The requirements for the external triggers are described earlier in this chapter under the heading *External Sweep Trigger I/O*.

Use the following procedure to establish the preferences for swept frequency output signals:

1. Press SETUP to open the Instrument Setup screen.
2. Press the Sweep Prefs soft key to bring up the Sweep Preferences screen shown in Table 3-19.
3. Sequentially select each of the preference fields using the soft keys to the right of the display.

   While each field is selected, use the keys along the bottom of the display to choose a preference.
4. To exit the screen press the Exit soft key, or press one of the signal function keys (SINE, MOD, or SWEEP).

Table 3-19. Sweep Preferences Fields



ead90f.bmp

Field	Preference
Type [1]	Linear Range, Linear Span, Log Range, Log span
Mode [2]	Single, Repetitive
Squelch	Enable, Disable
Trigger Type [3]	Output, Input, Disable
Trigger Edge [4]	Rising, Falling
Prog. Bar Units	%, As Range

[1] **Linear** and **Logarithmic** sweeps – Step size between discrete frequencies is either constant (linear) or logarithmic.

[1] **Range** or **Span** – A Range is presented in terms of a Start and Stop Frequency. Span is an alternative presentation in the form of Center and Span. The latter tends to be used in very narrow span applications around a center frequency (e.g. Sweep a bandpass filter). These inputs are transparently converted to Start and Stop values and are bound at this point.

[2] **Single** or **Repetitive** - Like an oscilloscope on single shot or repetitive sweep.

[3] Ebanled orDisabled – When enabled, Squelch is active between all frequency transitions. When disabled, Squelch is active only at hardware range boundaries.

[4] **Disable, Output** or **Input**. Typically, Trigger is “disabled”. This allows the Sweep to run repetitively or as a single shot when prompted (Start Sweep key), without accounting for a trigger. **Output** configures the rear panel BNC to generate a trigger waveform at the start of each sweep. This trigger waveform can be used to trigger an equivalent sweep in either a Spectrum Analyzer or an Oscilloscope. The action of sweep remains unaltered. **Input** configures the rear panel BNC as an input; the Start Sweep is now to “arm” the trigger. The system will now wait for a trigger at the rear input, before commencing the sweep. This “armed” state is indicated on the Status Bar. Once initiated by a trigger, the behavior of the Sweep (pausing, stopping, continuing) is un-altered. This feature allows the Instrument sweep to be synchronized with another instrument.

Note

Trigger Output and Input are Software Trigger features; timing accuracy is typically better than ±1 ms.

[5] Rising or Falling defines the edge polarity generated as a trigger Output or that triggers in the case of Input.

Defining a Swept-Frequency Output Signal

Table 3-20 shows the Sweep Frequency screen for creating swept-frequency signals. Use the following procedure to define a swept-frequency output signal:

1. Set the Sweep Preferences as described in the previous procedure.
2. Press SWEEP to bring up the Sweep Frequency screen.
3. Select the Start field, and enter the desired start frequency.
4. Select the Stop field, and enter the desired stop frequency.
5. Select the Level field.
6. Enter the desired level in the Level field.
7. Select the Linear Step field.
8. Enter the desired level in the Linear Step field.
9. Select the Step Dwell field and enter the desired step dwell time (.02 s to 10 s).

Note

Sweep duration is calculated and displayed in the Duration field.

10. To start the sweep, press the Sweep Start soft key at the bottom of the display. The progress bar displays the completion state of the sweep in the unit of measure defined in the Sweep Preferences screen.

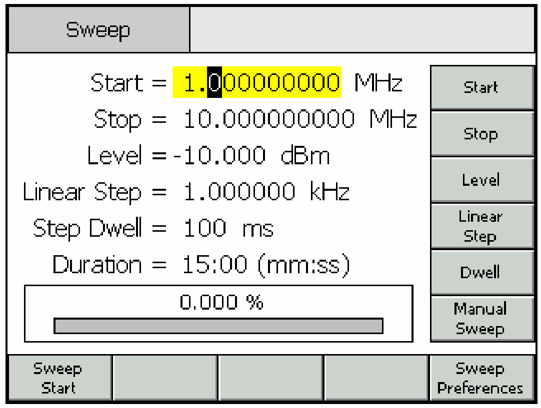
    To stop or pause the sweep, press the Sweep Stop or Sweep Pause soft key, respectively. To restart a paused sweep, press the Sweep Continue soft key. Sweep Stop resets to the beginning of Sweep and waits for another press of the Sweep Start soft key.

11. To make the sweep output signal available as an RF Output signal, press OPER.

Note

At any time before or during a sweep, pressing the Manual Sweep *soft key will highlight the progress bar as the focus field. This will allow the user to manually control the sweep position using either the scroll wheel or the left-right cursor keys. The current automatic sweep will be paused at first touch of either control. Press the* Sweep Continue *soft key to continue the sweep from the current progress position. (*Manual Sweep *will advance irrespective of the Start Sweep or Trigger Status.)*

Table 3-20. Sweep-Frequency Fields



ead95f.bmp

Field	Range	Units
Start	9.000 Hz to 4.0240000000 GHz	Hz (Hz, kHz, MHz, GHz)
Stop	9.000 Hz to 4.0240000000 GHz	Hz (Hz, kHz, MHz, GHz)
Level	-130.000 dBm to 24 dBm (50 Ω) 20 dBm max >125.75 MHz 14 dBm max > 1.4084 GHz -136.000 dBm to 18 dBm (75 Ω) 14 dBm max >125.75 MHz 8 dBm max > 1.4084 GHz	dBm, Vp-p and Vrms (uV, mV, V), W (nW, uW, mW, W), dBuV
Linear Step [1]	0.1 Hz to 4.024GHz Subject to max steps of 5000000	Hz (Hz, kHz, MHz, GHz), %*, ppm** and Steps per Sweep
Step Dwell	20 ms to 10 s Subject to max duration of 100 hrs	s (ms,s)

[1] If a Logarithmic Sweep is selected, the Linear Step field is renamed to Log Step. The field is now expressed in Units of “Steps per Sweep” or “Steps per Decade” only. In the latter case Span must be larger than a decade.

* Any entry expressed in % (or converted to %) is subject to a limit of +1000 %.

** Any expressed in ppm (or converted to ppm) is subject to a limit of +10000 ppm.

Measurement Integrity at High Signal Levels

The maximum output level of the Instrument is unusually high (+24 dBm into 50 Ω and +18 dBm into 75 Ω). This power level could damage an RF load, active or passive, or exceed the maximum-rated level of the load. Measurement integrity can be impaired by load damage, non-linearity or self-heating of the load.

Measurement Integrity at Low Signal Levels

The Instrument is capable of sourcing very small signal levels (-130 dBm in a 50 Ω system). At low signal levels, take particular care to eliminate interfering signals from the measurement. The following notes discuss best interconnection and measurement practice.

Eliminating Interference from the Ether

To eliminate broadcast transmissions and other ether-borne signals try the following:

Ensure all measurement system interconnections employ minimal length transmission lines of good shielding efficiency, terminated correctly using high-integrity RF connectors. Where direct connection of the Leveling Head to the measurement load is not possible, it is likely that rigid or double-screened coaxial line will be necessary. All RF connectors should be screw-thread-captured against precision mating surfaces (e.g. SMA, PC3.5, N-Type, TNC and better). These connectors must be torqued correctly.

Eliminating Interference from System Clocks – Common Mode and Ether Borne

Small signals will have to be measured in a narrow noise bandwidth implying a tuned measurement (e.g. Measuring Receiver or Spectrum Analyzer). To ensure accurate tuning of the measurement it is likely that a Reference Clock will pass between or be fed to all of the instruments involved. This clock will be a relatively large impure signal (>1 V pk-pk), typically at 10 MHz, possibly a square wave. Such a clock is likely to interfere with low-level measurements at the clock frequency and its harmonics.

To minimize interference at harmonics of the clock, use a sinusoid clock or a filtered digital (square wave or pulse) clock.

Reference Clock distribution connects the source and measurement instruments by two paths: the signal path (small signal) and the clock path (large signal). The following design features of the Instrument minimize common-mode coupling of the clock to the signal:

- Attenuation in the Leveling Head, close to the Load
- Floating RF Common
- Transformer coupling of the Reference Clock, input and output

Another way to reduce common-mode coupling at the measurement instrument is to route the Reference Clock signal through a common-mode choke (a suitable ferrite ring over its coaxial cable).

Other signal paths between the source and measuring instruments may also exist. For example, it may be necessary to isolate a GPIB connection at the measuring instrument; use either a bus isolator or a common-mode choke.

Avoid Grounding RF Common on the Instrument

While the Instrument reference clocks are transformer coupled, the External Modulation and Sweep Trigger I/O connections are DC coupled to floating RF common. Be aware that making connections to these I/O ports can ground the RF Common (e.g. via an audio signal generator, oscilloscope, or spectrum analyzer). Common-mode chokes, as described earlier, may reduce interference, but they may not be compatible with very low-level measurements.

Verifying the Level of an Interfering Signal

Having tuned a low-level measurement, determine the level of interference to that measurement by breaking the signal connection and terminating or shorting the Instrument and its measurement ports. Re-establishing connection of the Leveling Head ground to the measurement ground (touch contact of the two grounds is often sufficient, but a back-to-back terminator or short will improve the verification). Any signal now detected will be interfering with the measurement, adding or subtracting according to its phase.

De-tuning the Interfering Signal

For many low-level measurements, it is good practice to re-tune the measurement away from any interfering transmission or coupled clock.

Chapter 4A
Remote Operation

Title	Page

Introduction

This chapter of the manual contains descriptions of the IEEE 488 bus and is divided into four parts. This is Part A of Chapter 4. It contains the procedures necessary to prepare the Instrument for operation on the IEEE 488 bus, a brief introduction to the IEEE 488 bus, and the SCPI capability. The other three parts of Chapter 4 are devoted to the following discussions:

Part B Generic SCPI and IEEE 488 Bus Descriptions

Part C SCPI Commands as they apply to the Instrument

Part D Instrument Programming Examples

The Instrument conforms to the Standard Specification IEEE 488.1 - 1987: *IEEE Standard Digital Interface for Programmable Instrumentation*, and to IEEE 488.2 - 1988: *Codes, Formats, Protocols and Common Commands*. In IEEE 488.2 terminology the Instrument is a device containing a system interface. It can be connected to a system via its system bus and set into programmed communication with other bus-connected devices under the direction of the system controller.

In a system, devices connected to the IEEE 488 bus are designated as talkers, listeners, talker/listeners, or controllers. The Instrument operates exclusively as a talker/listener on the IEEE 488 bus.

Preparing the Instrument for Remote Operation

The following paragraphs provide instructions for preparing the Instrument for remote operation.

Equipment Connections

The Instrument connects to the IEEE 488 bus using a standard IEEE 488 Cable (not supplied with the Instrument). See Chapter 3, *Rear Panel Controls and Connectors* for the location of the connector.

⚠ Caution

To prevent equipment damage remove power from both the Instrument and the IEEE 488 system before connecting or disconnecting the Instrument to or from the IEEE 488 bus.

Use the following procedure to connect the Instrument to an IEEE 488 system/controller.

1. Power down both the Instrument and the system/controller.
2. Connect one end of a standard IEEE 488 cable to the IEEE 488 connector on the rear of the Instrument.
3. Connect the other end of the IEEE 488 cable to the system/controller.
4. Power up both the Instrument and the system/controller.

After completing the equipment connections, set the bus address for the Instrument as described in the following paragraphs.

About the Bus Address

Each instrument in an IEEE 488 system requires a separate and unique address so the controller can call and communicate with each instrument individually. These bus addresses are numeric and are within the range of 0 to 30, inclusive. They are considered primary addresses, and the user can assign any one of them to the Instrument.

Secondary addressing is not available on the Instrument. In other words, the source cannot respond to any address outside the range of 0 to 30. When a controller addresses the Instrument, it must also send data to define and instruct the Instrument as a talker or listener.

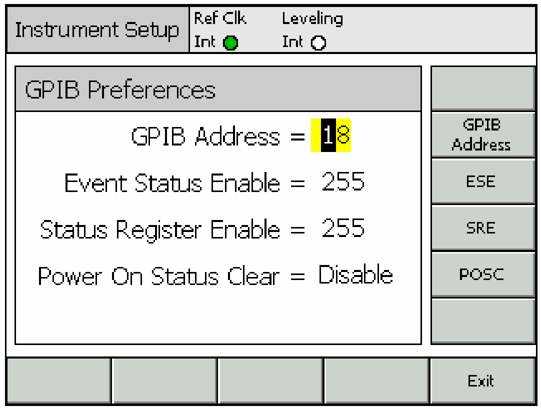
Setting the Bus Address and Other Preferences

Use the following procedure to set the IEEE 488 bus address and other GPIB preferences:

1. From the front panel press SETUP to bring up the Instrument Setup screen.
2. Press the GPIB Prefs. soft key to bring up the GPIB Preferences screen. See Table 4A-1.
3. On the GPIB Preferences screen select the GPIB Address field.
4. Enter the address (0 to 30) assigned to the Instrument. The default factory setting is 18.
5. Select the Event Status Enable field.
6. Enter the number of the GPIB Event Status Register.
7. Select the Status Register Enable field.
8. Enter the number of the GPIB Status Register.
9. Select the Power On Status Clear field and set a preference.

   The POSC setting determines whether or not the Instrument powers up with the PON bit of the Event Status Register set.

Table 4A-1. GPIB Preferences



ead91f.bmp

Field	Preference
GPIB Address	0 to 30
Event Status Enable	0 to 255 (May also be set using SCPI *ESE command.)
Status Register Enable	0 to 255 (May also be set using SCPI *SRE command.)
Power On Status Clear	Output, Input, Disable

Switching to Remote Operation

When the Instrument is in local operation the instrument is fully programmable both from the front panel and from the IEEE 488 bus. There is no physical switch for selecting remote operation. Rather, when the Instrument receives a bus message it switches to remote operation. If the message arrives while a change is being entered from the front panel, the front panel entry is interrupted and then the bus message is executed. Once the Instrument is set to remote operation all of the front panel (local) controls are locked out (inoperable) with the exception of the STBY key and the Go to Local soft key at the bottom of the display. Pressing the GO to Local soft key causes the Instrument to return to local operation.

Capability Codes

The Table 4A-2 shows the IEEE 488.2 interface functions from the SCPI command set. These commands define the interface capabilities of the Instrument.

Table 4A-2. IEEE 488.2 Interface Functions from the SCPI Command Set

Description	Code	Description
Instrument Handshake	SH1	The Instrument can exchange data with other instruments or a controller using the bus handshake lines: DAV, NRFD, and NADC.
Acceptor Handshake	AH1	The Instrument can exchange data with other instruments or a controller using the bus handshake lines: DAV, NRFD, and NADC.
Control Function	C0	The Instrument does not function as a controller.
Talker Function	T6	The Instrument can send responses and the results of its settings to other devices or to the controller. T6 means that it has the following functions: • Basic talker. • No talker only. • It can send out a status byte as response to a serial poll from the controller. Automatic un-addressing as a talker when it is addressed as a listener.
Listener Function	L4	The Instrument can receive programming instructions from the controller. L4 means that it has the following functions: • Basic listener. • No listen only. • Automatic un-addressing as listener when addressed as a talker.
Service Request	SR1	The Instrument can call for attention from the controller, e.g., when a response is available or an error has occurred.
Remote/Local Function	RL1	You can control the Instrument manually (locally) from the front panel or remotely from the controller. The LLO, local-lock-out function, can disable the LOCAL button on the front panel.
Parallel Poll	PP0	The Instrument does not have any parallel poll facility.
Device Clear Function	DC1	The controller can reset the Instrument via interface message DCL (Device clear) or SDC (Selective Device Clear).
Device Trigger Function	DT0	The Instrument does not support GET (Group Execute Trigger).
Bus Drivers	E2	The GPIB interface has tri-state bus drivers.

Chapter 4B
SCPI and IEEE Bus Descriptions

Title	Page

What is SCPI?

SCPI (Standard Commands for Programmable Instruments) is a standardized set of commands used to remotely control programmable test and measurement instruments. The instrument firmware contains the SCPI. It defines the syntax and semantics that the controller must use to communicate with the instrument.

This chapter is an overview of SCPI and shows how SCPI is used in the Instrument.

SCPI is based on IEEE-488.2 to which it owes much of its structure and syntax. SCPI can, however, be used with any of the standard interfaces, such as GPIB (IEC625/IEEE 488), VXI and RS-232.

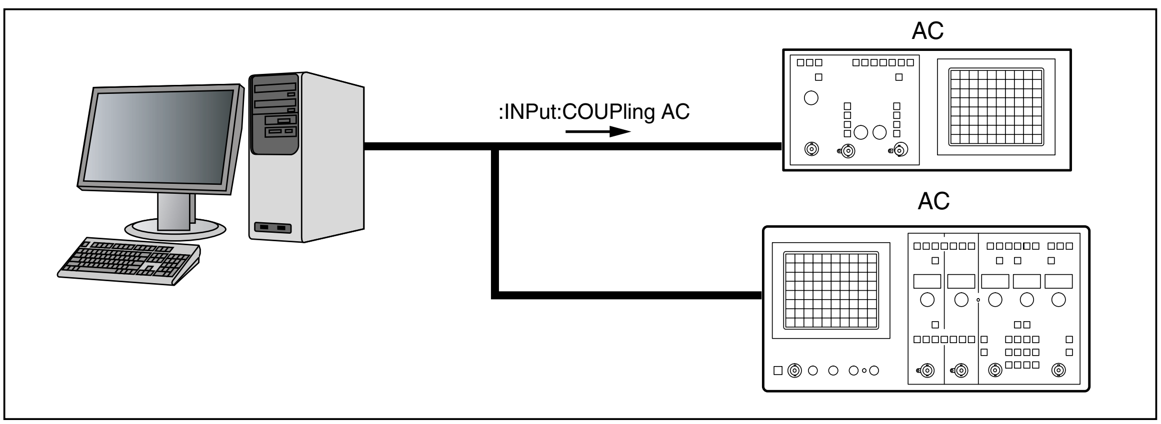
Reason for SCPI

For each instrument function, SCPI defines a specific command set. The advantage of SCPI is that programming an instrument is only function dependent and no longer instrument dependent. Several different types of instruments, for example an oscilloscope, a Instrument and a multimeter, can carry out the same function, such as frequency measurement. If these instruments are SCPI compatible, you can use the same commands to measure the frequency on all three instruments, although there may be differences in accuracy, resolution, speed, etc.

Compatibility

SCPI provides two types of compatibility, vertical and horizontal.

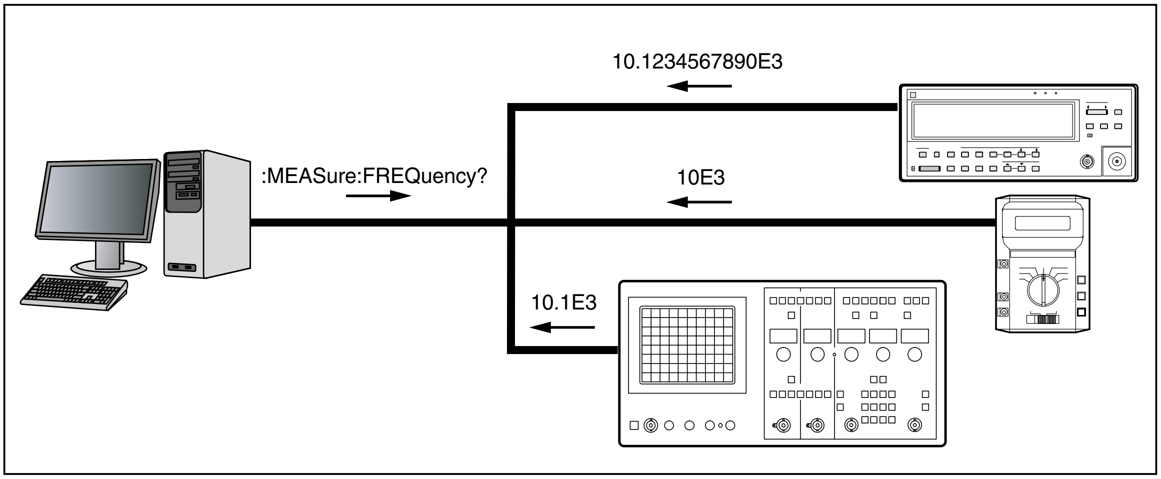
Vertical compatibility means that all instruments of the same type have identical controls. For example, oscilloscopes will have the same controls for timebase, triggers and voltage settings. See Figure 4B-1.



ead100f.eps

Figure 4B-1. Vertical Compatibility

Horizontal compatibility means that instruments of different types that perform the same functions have the same commands. For example, a DMM, an oscilloscope, and a source can all measure frequency with the same commands. See Figure 4B-2.



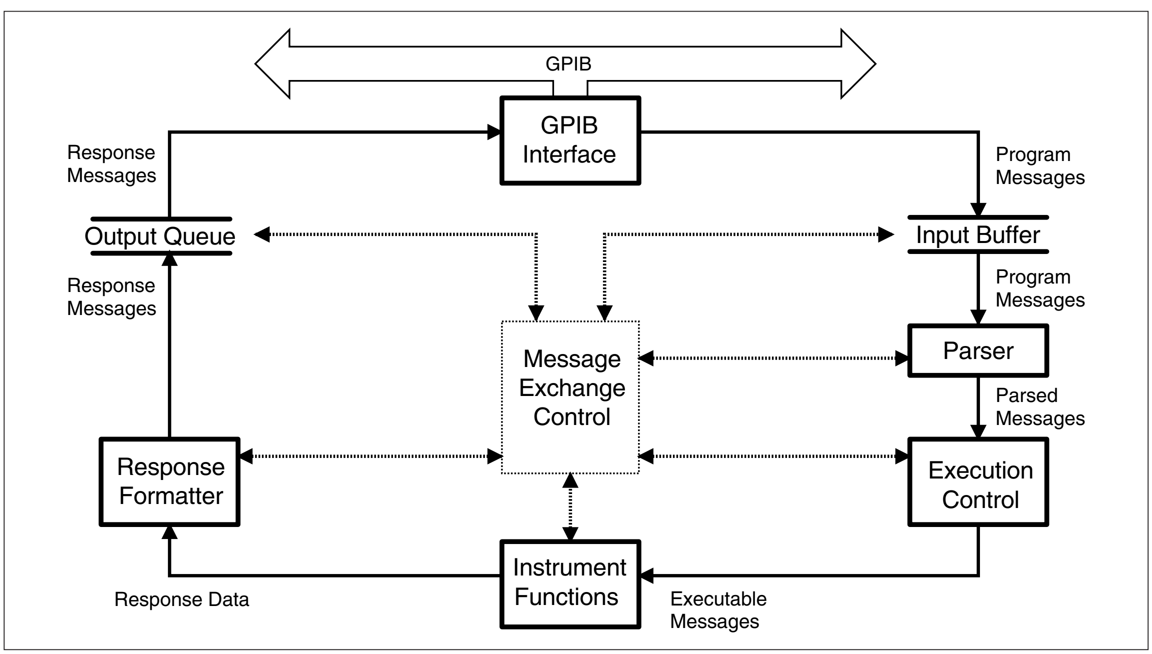
ead101f.eps

Figure 4B-2. Horizontal Compatibility

Management and Maintenance of Programs

SCPI simplifies maintenance and management of the programs. Today changes and additions in a good working program are hardly possible because of the great diversity in program messages and instruments. Programs are difficult to understand for anyone other than the original programmer. After some time even the programmer may be unable to understand them.

A programmer with SCPI experience, however, will understand the meaning and reasons of a SCPI program, because of his knowledge of the standard. Changes, extensions, and additions are much easier to make in an existing application program. SCPI is a step towards portability of instrument programming software and, as a consequence, it allows the exchange of instruments. Figure 4B-3 provides an overview of the firmware in a SCPI instrument.



ead102f.eps

Figure 4B-3. Overview of the Firmware in a SCPI Instrument

How does SCPI Work in the Instrument?

The functions inside an instrument that control the operation provide SCPI compatibility. Figure 4B-3 shows a simplified logical model of the message flow inside a SCPI instrument.

When the controller sends a message to a SCPI instrument, roughly the following happens:

- The GPIB controller addresses the instrument as listener.
- The GPIB interface function places the message in the Input Buffer.
- The Parser fetches the message from the Input Buffer, parses (decodes) the message, and checks for the correct syntax. The instrument reports incorrect syntax by sending command errors via the status system to the controller. Moreover, the parser will detect if the controller requires a response. This is the case when the input message is a query (command with a "?" appended).

The Parser will transfer the executable messages to the Execution Control block in token form (internal codes). The Execution Control block will gather the information required for a device action and will initiate the requested task at the appropriate time. The instrument reports execution errors via the status system over the GPIB and places them in the Error Queue.

When the controller addresses the instrument as talker, the instrument takes data from the Output Queue and sends it over the GPIB to the controller.

Message Exchange Control Protocol

Another important function is the Message Exchange Control, defined by IEEE 488.2. The Message Exchange Control protocol specifies the interactions between the several functional elements that exist between the GPIB functions and the device-specific functions.

The Message Exchange Control protocol specifies how the instrument and controller should exchange messages. For example, it specifies exactly how an instrument shall handle program and response messages that it receives from and returns to a controller.

This protocol introduces the idea of commands and queries; queries are program messages that require the device to send a response. When the controller does not read this response, the device will generate a Query Error. On the other hand, commands will not cause the device to generate a response. When the controller tries to read a response anyway, the device then generates a Query Error.

The Message Exchange Control protocol also deals with the order of execution of program messages. It defines how to respond if Command Errors, Query Errors, Execution Errors, and Device-Specific errors occur. The protocol demands that the instrument report any violation of the IEEE-488.2 rules to the controller, even when it is the controller that violates these rules.

The IEEE 488.2 standard defines a set of operational states and actions to implement the message exchange protocol. See Table 4B-1 and Table 4B-2.

Table 4B-1. States for Message Exchange Protocol

State	Purpose
IDLE	Wait for messages
READ	Read and execute messages
QUERY	Store responses to be sent
SEND	Send responses
RESPONSE	Complete sending responses
DONE	Finished sending responses
DEADLOCK	The device cannot buffer more data

Table 4B-2. Actions for Message Exchange Protocol

Action	Reason
Unterminated	The controller attempts to read the device without first having sent a complete query message.
Interrupted	The device is interrupted by a new program message before it finishes sending a response message.

Protocol Requirements

In addition to the above functional elements, which process the data, the message exchange protocol has the following characteristics:

- The controller must end a program message containing a query with a message terminator before reading the response from the device (address the device as talker). If the controller breaks this rule, the device will report a query error (unterminated action).
- The controller must read the response to a query in a previously (terminated) program message before sending a new program message. When the controller violates this rule, the device will report a query error (interrupted action).
- The instrument sends only one response message for each query message. If the query message resulted in more than one answer, all answers will be sent in one response message.

Order of Execution - Deferred Commands

Execution control collects commands until the end of the message, or until it finds a query or other special command that forces execution. It then checks that the setting resulting from the commands is a valid one: No range limits are exceeded, no coupled parameters are in conflict, etc. If this is the case, the commands are executed in the sequence they have been received; otherwise, an execution error is generated, and the commands are discarded.

This deferred execution guarantees the following:

- All valid commands received before a query are executed before the query is executed.
- All queries are executed in the order they are received.
- The order of execution of commands is never reversed.

Sequential and Overlapped Commands

SCPI defines two classes of commands: sequential and overlapped commands. All commands in the Instrument are sequential, that is one command finishes before the next command executes.

Remote Local Protocol

Definitions Remote Operation

When an instrument operates in remote, all local controls, except the Go To Local soft key and [STBY] key, are disabled.

Local Operation

An instrument operates in local when it is not in remote mode as defined above.

Local Lockout

In addition to the remote state, an instrument can be set to remote with ‘local lockout’. This disables the return-to-local button. In theory, the state local with local lockout is also possible; then, all local controls except the return-to-local key are active.

The Instrument in Remote Operation

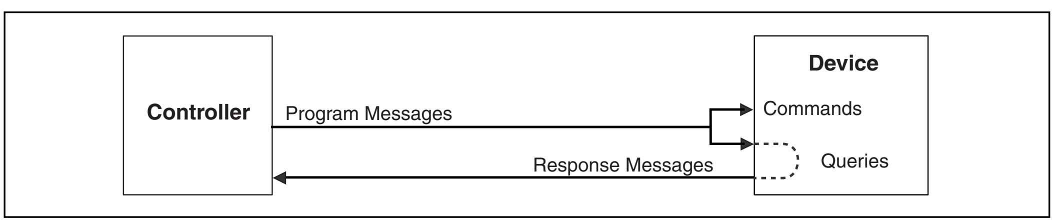
When the Instrument is in remote operation, it disables all its local controls except the Go To Local soft key.

The Instrument in Local Operation

When the Instrument is in local operation the instrument is fully programmable both from the front panel and from the bus. If a bus message arrives while a change is being entered from the front panel, the front panel entry is interrupted and the bus message is executed.

Program and Response Messages

The communication between the system controller and the SCPI instruments connected to the GPIB takes place through Program and Response Messages. See Figure 4B-4. A Program Message is a sequence of one or more commands sent from the controller to an instrument. Conversely, a Response Message is the data from the instrument to the controller.



ead103.eps

Figure 4B-4. Program and Response Messages

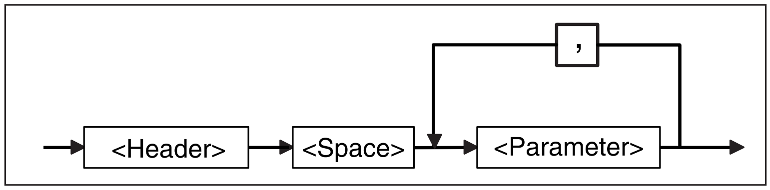
The GPIB controller instructs the device through program messages. The device will only send responses when explicitly requested to do so; that is, when the controller sends a query. Queries are recognized by the question mark at the end of the header, for example: `*IDN?` (requests the instrument to send identity data).

Syntax and Style

The following sections describe the syntax of program and response messages.

Syntax of Program Messages

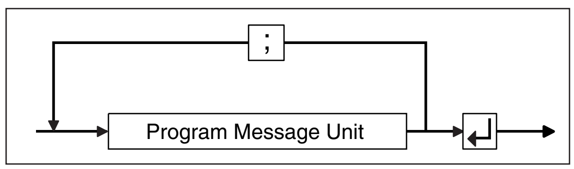
A command or query is called a program message unit. A program message unit consists of a header followed by one or more parameters, as shown in Figure 4B-5.



ead104f.eps

Figure 4B-5. Syntax of a Program Message Unit

One or more program message units (commands) may be sent within a simple program message, see Figure 4B-6.



ead105f.eps

Figure 4B-6. Syntax of a Terminated Program Message

The ↵ is the pmt (program message terminator) and it must be one of the following codes:

Note

- *NL is the same as the ASCII LF*
- *LF (<line feed> = ASCII 10 decimal)*
- *The END message is sent via the EOI-line of the GPIB.*
- *The ^ character stands for "at the same time".*

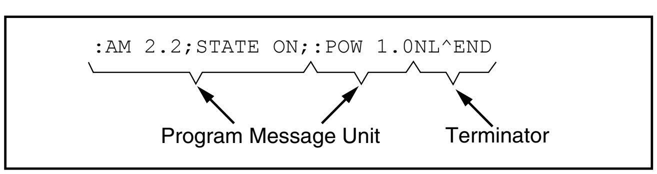
`NL^END` This is <new line> code sent concurrently with the END message on the GPIB.

`NL` This is the <new line> code.

`<dab>^END` This is the END message sent concurrently with the last data byte <dab>.

Most controller programming languages send these terminators automatically, but allow changing it. Make sure that the terminator is as above.

Figure 4B-7 is an example of a terminated program message:



ead106f.eps

Figure 4B-7. Example of a Terminated Program Message

This program message consists of two message units. The unit separator (semi-colon) separates message units.

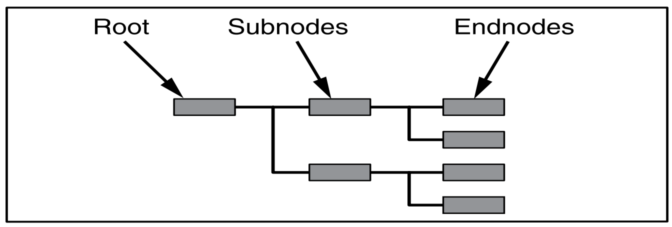
Basically there are two types of commands: common commands and SCPI commands.

Common Commands

The common command header starts with the asterisk character (*), for example *RST.

SCPI Commands

SCPI command headers may consist of several keywords (mnemonics), separated by the colon character (:). An sample of the SCPI command tree structure is shown in Figure 4B-8.



ead107f.eps

Figure 4B-8. The SCPI Command Tree

Each keyword in a SCPI command header represents a node in the SCPI command tree. The leftmost keyword (AM in the previous example) is the root level keyword, representing the highest hierarchical level in the command tree.

The keywords following represent subnodes under the root node. See the *Command Tree* section of this chapter for more details of this subject.

Forgiving Listening

The syntax specification of a command is as follows:

```
POWer:OFFSet <numeric value>
```

Where: POW and OFFS specify the shortform, and POWer and OFFSet specify the longform. However, POWE or OFF are not allowed and cause a command error.

In program messages either the long or the shortform may be used in upper or lower case letters. You may even mix upper and lower case. There is no semantic difference between upper and lower case in program messages. This instrument behavior is called forgiving listening.

For example, an application program may send the following characters over the bus:

SEND=> pOwEr:OFfSetT `1.23`

The example shows the shortform used in a mix of upper and lower case

SEND=> `Power:Offs 1.23`

The example shows a mix of longform and shortform and a mix of upper and lower case.

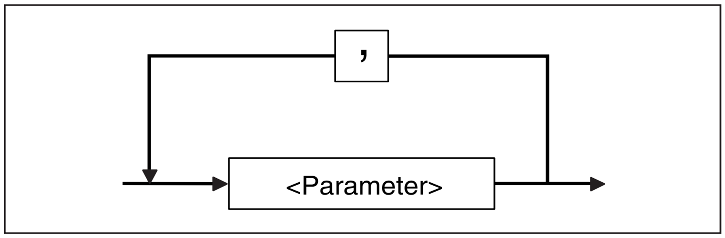
Notation Habit in Command Syntax

To clarify the difference between the forms, the shortform in a syntax specification is shown in upper case letters and the remaining part of the longform in lower case letters.

Notice however, that this does not specify the use of upper and lower case characters in the message that you actually sent. Upper and lower case letters, as used in syntax specifications, are only a notation convention to ease the distinction between longform and shortform.

Syntax of Response Messages

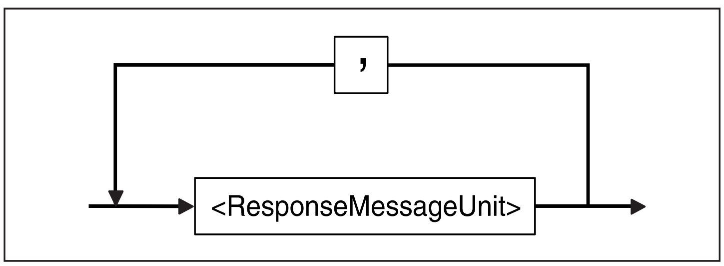
The response of a SCPI instrument to a query (response message unit) consists of one or more parameters (data elements) as shown in Figure 4B-9. There is no header returned.



ead108f.eps

Figure 4B-9. Syntax of a Response Message Unit

If there are multiple queries in a program message, the instrument groups the multiple response message units together in one response message according to the syntax shown in Figure 4B-10.



ead109f.eps

Figure 4B-10. Syntax of a Terminated Response Message

The response message terminator (rmt) is always `NL^END`, where:

`NL^END` is <new line> code (equal to <line feed> code = ASCII 10 decimal) sent concurrently with the `END` message. The `END` message is sent by asserting the `EOI` line of the GPIB bus.

Responses:

A SCPI instrument always sends its response data in shortform and in capitals.

Example:

You program an instrument with the following command:

SEND=> `:ROSCillator:SOURce EXTernal`

Then you send the following query to the instrument:

SEND=> `:ROSCillator:SOURce?`

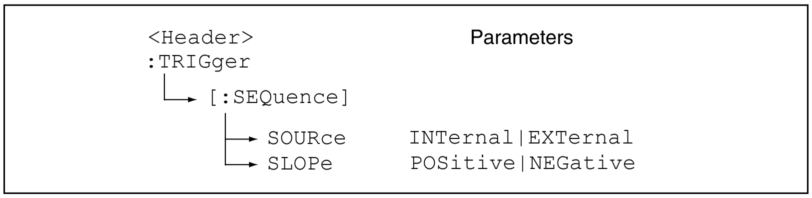
The instrument will return:

READ<= `EXT`

response in shortform and in capitals.

Command Tree

Command Trees like the one shown in Figure 4B-11 are used to document the SCPI command set in this manual. The keyword (mnemonic) on the root level of the command tree is the name of the subsystem. The following example illustrates the Command Tree of the TRIGger subsystem.



ead110f.eps

Figure 4B-11. Example of the TRIGger Subsystem Command Tree

The keywords placed in square brackets are optional nodes. This means that you may omit them from the program message.

Example:

SEND=> `TRIGger:SEQuence:SOURce INTernal`

is the same as

SEND=> `TRIGger:SOURce INTernal`

Moving down the Command Tree

The command tree shows the paths you should use for the command syntax. A single command header begins from the root level downward to the 'leaf nodes' of the command tree. (Leaf nodes are the last keywords in the command header, before the parameters.)

Example:

SEND=> `TRIGger:SEQuence:SOURce INTernal`

Where: `TRIGger` is the root node and `SEQuence` is the leaf node.

Each colon in the command header moves the current path down one level from the root in the command tree. Once you reach the leaf node level in the tree, you can add several leaf nodes without having to repeat the path from the root level.

Just follow the rules below:

You can only do this if the header path of the new leaf-node is the same as that of the previous one. If not, the full header path must be given starting with a colon.

Command header = Header path + leaf node

Once you send the pmt (program message terminator), the first command in a new program message must start from the root.

Always give the full header path, from the root, for the first command in a new program message.

For the following commands within the same program message, omit the header path and send only the leaf node (without colon).

Example:

SEND=> `TRIGger:SEQuence:SOURce INTernal;SLOPe POSitive`

This is the command where:

`TRIGger:SEQuence` is the header path and `:SOURce` is the first leaf-node and `SLOPe` is the second leaf-node because `SLOPe` is also a leaf-node under the header path `TRIGger:SEQuence`.

The important point to note here is that there is no colon before `SLOPe`.

Parameters

Numeric Data

Decimal data are printed as numerical values throughout this manual. Numeric values may contain both a decimal point and an exponent (base 10).

These numerals are often represented as NRf (NR = NumeRic, f = flexible) format.

Boolean Data

A Boolean parameter specifies a single binary condition which is either true or false.

Boolean parameters can be one of the following:

- ON or 1 means condition true.
- OFF or 0 means condition false.

Example

SEND=> `:OUTP:STATe ON`

SEND=> `OUTP:STATe 1`

This switches signal source output on.

A query, for instance `OUTP:STATe?`, will return 1 or 0; never ON or OFF.

Other Data Types

Other data types that can be used for parameters are the following:

String data	Always enclosed between single or double quotes, for example “This is a string” or ‘This is a string.’
Character data	For this data type, the same rules apply as for the command header mnemonics. For example: POSitive, NEGative.

Initialization and Resetting

Reset Strategy

There are three levels of initialization:

- Bus initialization
- Message exchange initialization
- Device initialization

Bus Initialization

This is the first level of initialization. The controller program should start with this, which initializes the IEEE-interfaces of all connected instruments. It puts the complete system into remote enable (REN-line active) and the controller sends the interface clear (IFC) command. The command or the command sequence for this initialization is controller and language dependent. Refer to the user manual of the system controller in use.

Message Exchange Initialization

Device clear is the second level of initialization. It initializes the bus message exchange, but does not affect the device functions.

Device clear can be signaled either with DCL to all instruments or SDC (Selective device-clear) only to the addressed instruments. The instrument action on receiving DCL and SDC is identical, they will do the following:

- Clear the input buffer.
- Clear the output queue.
- Reset the parser.
- Clear any pending commands

The device-clear commands will not do the following:

- Change the instrument settings or stored data in the instrument.
- Interrupt or affect any device operation in progress.
- Change the status byte register other than clearing the MAV bit as a result of clearing the output queue.

Many older IEEE-instruments that are not IEEE-488.2 compatible returned to the power-on default settings when receiving a device-clear command. IEEE-488.2 does not allow this.

When to use a Device-clear Command

The command is useful to escape from erroneous conditions without having to alter the current settings of the instrument. The instrument will then discard pending commands and will clear responses from the output queue. For example, suppose you are using the Instrument in an automated test equipment system where the controller program returns to its main loop on any error condition in the system or the tested unit. To ensure that no unread query response remains in the output queue and that no unparsed message is in the input buffer, it is wise to use device-clear. (Such remaining responses and commands could influence later commands and queries.)

Device Initialization

The third level of initialization is on the device level. This means that it concerns only the addressed instruments.

The *RST Command

Use this command to reset a device. It initializes the device-specific functions in the Instrument.

The following happens when using the *RST command:

- The instrument-specific functions are set to a known default state. The *RST condition for each command is given in the command reference section.
- The Instrument is set to an idle state (outputs are disabled), so that it can start new operations.

The *CLS Command

Use this command to clear the status data structures. See 'Status Reporting system' in this chapter.

The following happens when you use the *CLS command:

- The instrument clears all event registers summarized in the status byte register.
- It empties all queues, which are summarized in the status byte register, except the output queue, which is summarized in the MAV bit.

Status Reporting System

Introduction

Status reporting is a method to let the controller know what the Instrument is doing. You can ask the Instrument what status it is in whenever you want to know.

You can select some conditions in the Instrument that should be reported in the Status Byte Register. You can also select if some bits in the Status Byte should generate a Service Request (SRQ). See Figure 4B-12 for an overview of the Status Register Structure.

(An SRQ is the instrument's way to call the controller for help.)

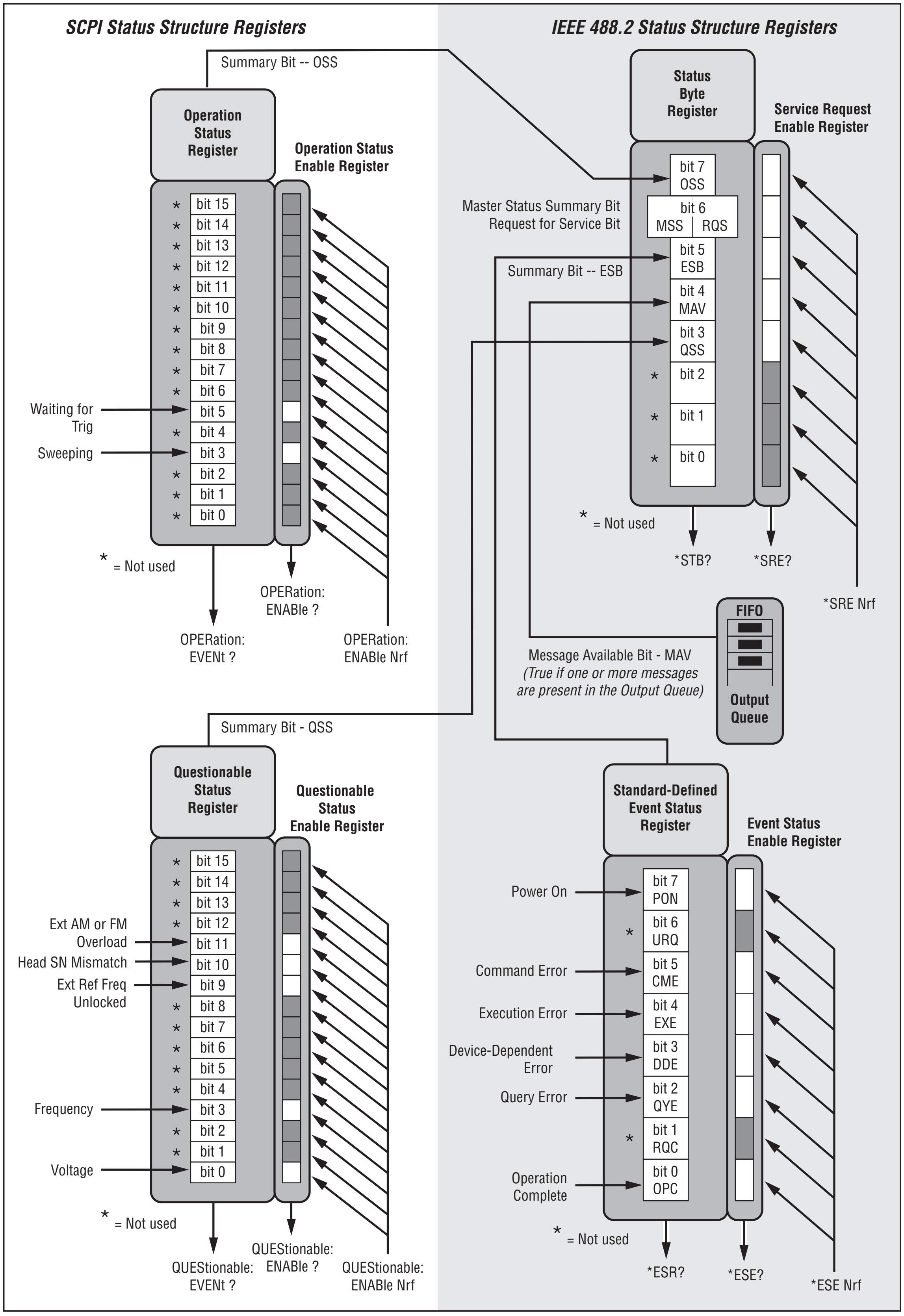


Figure 4B-12. Instrument Status Register Structure

Error Reporting

The Instrument will place a detected error in its Error Queue. This queue is a FIFO (First-In First-Out) buffer. When you read the queue, the first error will come out first, the last error last.

If the queue overflows, an overflow message is placed last in the queue, and further errors are thrown away until there is room in the queue again.

Read the Error/Event Queue

This is done with the `:SYSTem:ERRor?` query.

Example

SEND=> `:SYSTem:ERRor?`

READ<= `-100,"Command-Error"`

The query returns the error number followed by the error description.

If more than one error occurred, the query will return the error that occurred first. When you read an error you will also remove it from the queue. You can read the next error by repeating the query. When you have read all errors the queue is empty, and the :SYSTem:ERRor? query will return:

`0,"No error"`

When errors occur and you do not read these errors, the Error Queue may overflow. Then the instrument will overwrite the last error in the queue with the following:

`-350,"Queue overflow"`

If more errors occur, they will be discarded.

Standardized Error Numbers

The instrument reports four classes of standardized errors in the Standard Event Status and in the Error/Event Queue as shown in the Table 4B-3.

Table 4B-3. Standardized Errors

Error Class	Range of Error Numbers	Standard Event Register
Command Error	–100 to –199	bit 5 - CME
Execution Error	–200 to –299	bit 4 - EXE
Device Specific Error	–300 to –399	bit 3 - DDE
	+100 to +32767	
Query Error	–400 to –499	bit 2 -QYE

Command Error

This error shows that the instrument detected a syntax error.

Execution Error

This error shows that the instrument has received a valid program message which it cannot execute because of some device specific conditions.

Device-specific Error

This error shows that the instrument could not properly complete some device specific operations.

Query Error

This error will occur when the Message Exchange Protocol is violated, for example, when you send a query to the instrument and then send a new command without first reading the response data from the previous query. Also, trying to read data from the instrument without first sending a query to the instrument will cause this error.

Status Reporting Model

The Status Structure

The status reporting model used is standardized in IEEE 488.2 and SCPI, so you will find similar status reporting in most modern instruments. Figure 5B-12 shows an overview of the complete status register structure.

- The Standard Event Register reports the standardized IEEE 488.2 errors and conditions.
- The Questionable Data Register reports when the output data from the Instrument may not be trusted.
- The Operational Data Register reports what events are in operation.
- The Status Byte contains eight bits. Each bit shows if there is information to be fetched in the above described registers and queues of the status structure.

Using the Registers

Each status register monitors several conditions at once. If something happens to any one of the monitored conditions, a summary bit is set true in the Status Byte Register.

Enable registers are available so that you can select what conditions should be reported in the status byte, and what bits in the status byte should cause SRQ.

A register bit is TRUE, i.e., something has happened, when it is set to 1. It is FALSE when set to 0.

Note that all event registers and the status byte record positive events. That is when a condition changes from inactive to active, the bit in the event register is set true. When the condition changes from active to inactive, the event register bits are not affected at all.

When reading the contents of a register, the Instrument answers with the decimal sum of the bits in the register.

Example:

The Instrument answers 40 when you ask for the contents of the Standard Event Status Register. Convert this to binary form. It will give you 101000.

- Bit 5 is true showing that a command error has occurred.
- Bit 3 is also true, showing that a device dependent error has occurred.

Use the same technique when you program the enable registers.

1. Select which bits should be true.
2. Convert the binary expression to decimal data.
3. Send the decimal data to the instrument.

Clearing/Setting all bits

Clear an enable register by programming it to zero. To set all bits true in a 16-bit event enable register program it to 32767 (bit 16 not used).

To set all bits true in an 8-bit registers program it to 255 (Service Request Enable and Standard Event Enable.)

Status of the Output Queue (MAV)

The MAV (message available) queue status message appears in bit 4 of the status byte register. It indicates if there are bytes ready to be read over the GPIB in the GPIB output queue of the instrument. The output queue is where the formatted data appears before it is transferred to the controller.

The controller reads this queue by addressing the instrument as a talker.

Using the Status Byte

The status byte is an eight-bit status message. It is sent to the controller as a response to a serial poll or a `*STB?` query. Each bit in the status byte contains a summary message from the status structure. You can select what bits in the status byte should generate a service request to alert the controller.

When a service request occurs, the `SRQ`-line of the GPIB will be activated. Whether or not the controller will react on the service request depends on the controller program. The controller may be interrupted on occurrence of a service request, it may regularly test the SRQ-line, it may regularly make serial poll or `*STB?`, or the controller may not react at all. The preferred method is to use `SRQ` because it presents a minimum of disturbance to the measurement process.

Selecting Summary Message to Generate SRQ

The Instrument does not generate any `SRQ` by default. You must first select which summary message(s) from the status byte register should give `SRQ`. You do that with the Service Request Enable command `*SRE <bit mask>`.

Example

```
*SRE 32
```

This sets bit 4 ($16=00010000_2$) in the service request enable register. This makes the instrument signal `SRQ` when a message is available in the output queue.

RQS/MSS

The original status byte of IEEE 488.1 is sent as a response to a serial poll, and bit 6 means requested service, `RQS`.

IEEE 488.2 added the `*STB?` query and expanded the status byte with a slightly different bit 6, the `MSS`. This bit is true as long as there is unfetched data in any of the status event registers.

- The Requested Service bit, `RQS`, is set true when a service request has been signaled. If you read the status byte via a Serial Poll, bit 6 represents `RQS`. Reading the status byte with a serial poll will set the `RQS` bit false, showing that the status byte has been read.
- The Master Summary Status bit, `MSS`, is set true if any of the bits that generates `SRQ` is true. If you read the status byte using `*STB?`, bit 6 represents `MSS`. `MSS` remains true until all event registers are cleared and all queues are empty.

Setting up the Instrument to Report Status

To use the status reporting feature, include the following steps in your program.

`*CLS` clears all event registers and the error queue.

`*ESE <bit mask>` selects what conditions in the Standard Event Status register should be reported in bit 5 of the status byte.

`:STATus:OPERation:ENABle <bit mask>` selects which conditions in the Operation Status register should be reported in bit 7 of the status byte.

`:STATus:QUEStionable:ENABle <bit mask>` selects which conditions in the Questionable Status register should be reported in bit 3 of the status byte.

`*SRE <bit mask>` selects which bits in the status byte should cause a Service Request.

Reading and Clearing Status

Status Byte

There are two way to read the status byte register: Using the Serial Poll and using the Common Query.

Using the Serial Poll (IEEE-488.1 defined)

Response:

- Bit 6: RQS message shows that the Instrument has requested service via the SRQ signal.
- Other bits show their summary messages
- A serial poll sets the RQS bit FALSE, but does not change other bits.

Using the Common Query *STB?

Response:

- Bit 6: MSS message shows that there is a reason for service request.
- Other bits show their summary messages.
- Reading the response will not alter the status byte.

Status Event Registers

Use the following queries to read the Status Event registers:

`*ESR?` reads the Standard Event Status register

`:STATus:OPERation?` reads the Operation Status Event register

`:STATus:QUEStionable?` reads the Questionable Status Event register

Reading one of these registers will clear the register and the summary message bit in the status byte.

To clear all event registers use the `*CLS` (Clear Status) command.

Status Condition Registers

Two of the status register structures also have condition registers: The Status Operation and the Status Questionable register.

The condition registers differ from the event registers in that they are not latched. That is, if a condition in the Instrument goes on and then off, the condition register indicates true while the condition is on and false when the condition goes off. The Event register that monitors the same condition continues to indicate true until you read the register.

`:STATus:OPERation:CONDition?` reads the Operation Status Condition register

`:STATus:QUEStionable:CONDition?` reads the Questionable Status Condition register

Reading the condition register will not affect the contents of the register.

Summary

The way to work when writing your bus program is as follows:

Set up

- Set up the enable registers so that the events you are interested in are summarized in the status byte.
- Set up the enable masks so that the conditions you want to be alerted about generate SRQ. It is good practice to generate SRQ on the MAV bit. So, enable the MAV-bit via *SRE.

Check & Action

- Check if an SRQ has been received.
- Make a serial poll of the instruments on the bus until you find the instrument that issued the SRQ (the instrument that has RQS bit true in the Status Byte).
- When you find it, check which bits in the Status Byte Register are true.
- Let’s say that bit 7, OSS, is true. Then read the contents of the Operation Status Register. In this register you can see what caused the SRQ.
- Take appropriate actions depending on the reason for the SRQ.

Standard Status Registers

The Event Status registers are mandatory in all instruments that fulfill the IEEE 488.2 standard. They are structured as shown in Figure 4B-13, and an overview of the status bits is shown in Figure 4B-14.

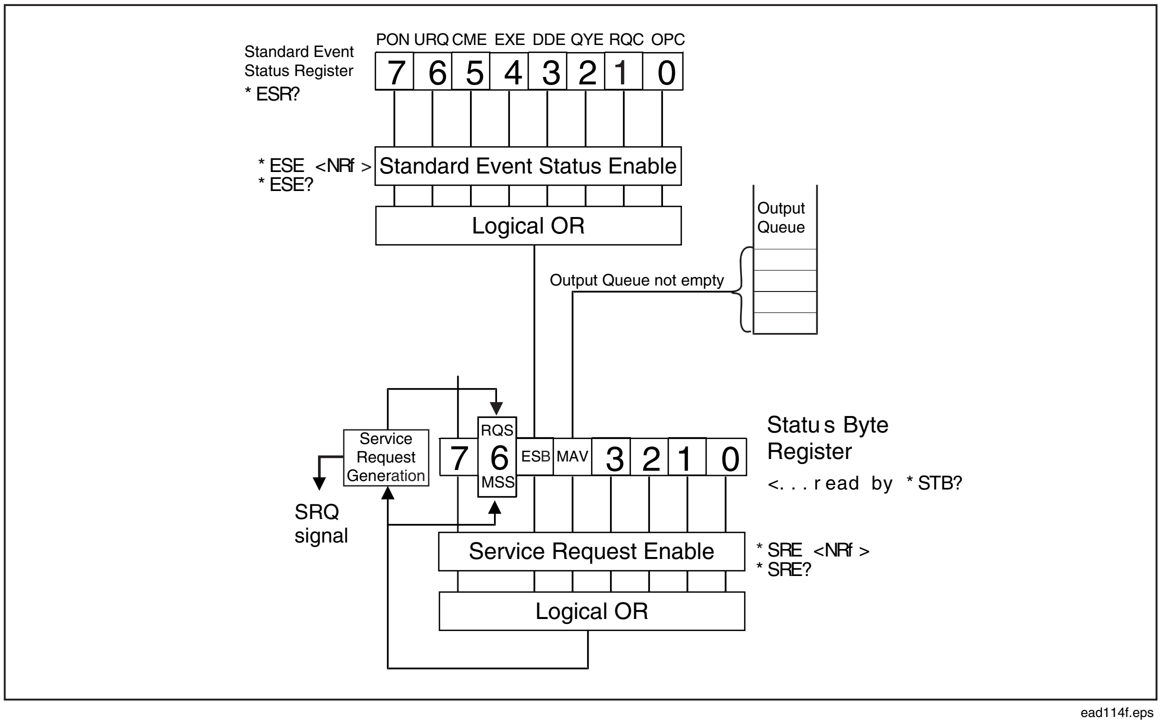


Figure 4B-13. Structural Overview of the Status Event Register

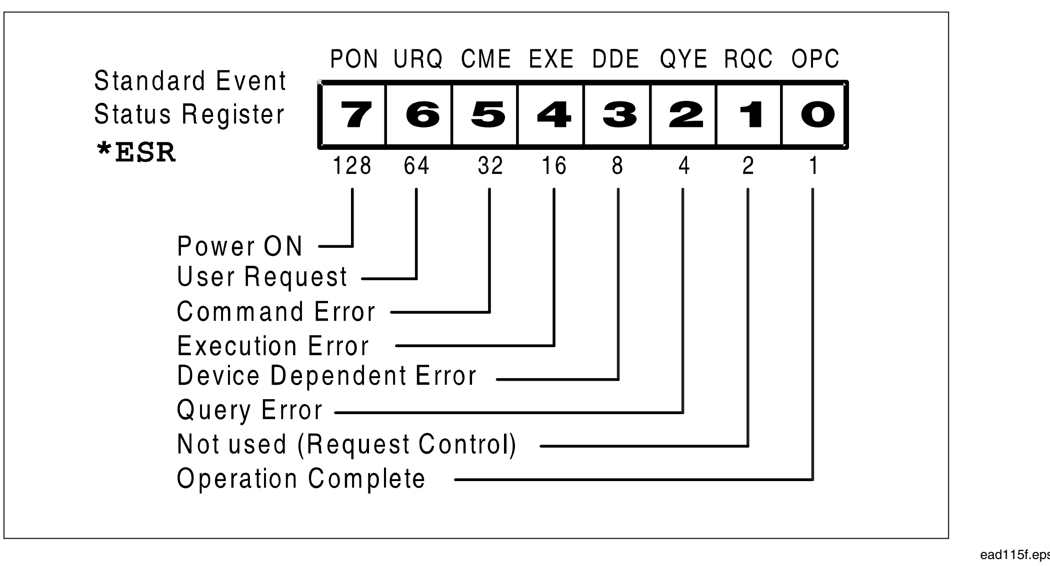


Figure 4B-14. Bits in the Standard Event Status Register

Standard Event Status Register

Bit 7 (weight 128) — Power-on (PON)

Shows that the Instrument's power supply has been turned off and on (since the last time the controller read or cleared this register).

Bit 6 (weight 64)—User Request (URQ)

Shows that the user has pressed a key on the front panel. This is not implemented on the Instrument.

Bit 5 (weight 32) — Command Error (CME)

Shows that the instrument has detected a command error. This means that it has received data that violates the syntax rules for program messages.

Bit 4 (weight 16) — Execution Error (EXE)

Shows that the Instrument detected an error while trying to execute a command. (See *Error reporting*.) The command is syntactically correct, but the Instrument cannot execute it, for example because a parameter is out of range.

Bit 3 (weight 8) — Device-dependent Error (DDE)

A device-dependent error is any device operation that did not execute properly because of some internal condition, for instance error queue overflow. This bit shows that the error was not a command, query or execution error.

Bit 2 (weight 4) — Query Error (QYE)

The output queue control detects query errors. For example the QYE bit shows the unterminated, interrupted, and deadlock conditions. For more details, see *Error Reporting*.

Bit 1 (weight 2)—Request Control (RQC)

Shows the controller that the device wants to become the active controller-in-charge. Not used in the Instrument.

Bit 0 (weight 1) — Operation Complete (OPC)

The Instrument only sets this bit TRUE in response to the operation complete command (*OPC). It shows that the Instrument has completed all previously started actions.

SCPI-defined Status Registers

The Instrument has two 16-bit SCPI-defined status structures, the operation status register and the questionable data register. These are 16 bits wide, while the status byte and the standard status groups are 8 bits wide. See Figure 5B-12.

Operation Status Group

Only bits 3 and 5 are used by the Instrument in this register.

Bit 5 (weight 32) — Waiting for Trigger

This bit shows when the Instrument is ready to start a new sweep via the trigger control option. The Instrument is now in the wait for the trigger state of the trigger model.

Bit 3 (weight 8) — Sweep In Progress

This bit shows that the Instrument is sweeping. It is set when the sweep has been triggered. For internally triggered sweeps, it is set at the same time as the Waiting for trigger bit.

Summary, Operation Status Reporting

`:STAT:OPER:ENAB`

Enable reporting of Operation Status in the status byte.

`*SRE 128`

Enable SRQ when operation status has something to report.

`:STAT:OPER?`

Reading and clearing the event register of the Operation Status Register structure

`:STAT:OPER:COND?`

Reading the condition register of the Operation Status Register structure.

Questionable Data/Signal Status Group

The Questionable Data Status reports when the output data from the Instrument may not be trusted.

Bit 11 (weight 2048) — External AM or FM Overload

This bit shows that the external AM or FM signal that is being applied to the Instrument is too large.

Bit 10 (weight 1024) — Head Serial Number Mis-match

This bit is set when the head that is plugged in (50 Ω or 75 Ω) to the Instrument was not calibrated with this base unit.

Bit 3 (weight 8) Frequency

The Instrument sets this bit true when it has lost frequency lock.

Bit 0 (weight 1) Voltage

The Instrument sets this bit true when it cannot level the output voltage.

Power-on Status Clear

Power-on clears all event enable registers and the service request enable register if the power-on status clear flag is set TRUE (see the common command *PSC.)

Preset the Status Reporting Structure

You can preset the complete status structure to a known state with a single command, the STATus:PRESet command, which does the following:

- Disables all bits in the Standard Event Register, the Operation Status Register, and the Questionable Data Register
- Enables all bits in Device Register 0
- Leaves the Service Request Enable Register unaffected.

Chapter 4C
SCPI Commands

Title	Page

⚠ Caution

This instrument contains relays that have a long, but finite lifespan. When programming the instrument from the IEEE Bus take care to not constantly exercise them.

To maximize the lifespan of the relays, observe the following good-practice points:

1. Minimize the number of output operate and standby transitions (:OUTP ON | OFF) that are sent to the instrument.
2. Minimize the number of resets (*RST) sent to the instrument when the output is on.
3. Avoid repeatedly changing between functions (Sine, AM, FM etc) with the output on.
4. Group similar setup points (level and frequency) together rather than send sequences of disparate setup points.

Introduction

This part of Chapter 4 documents the SCPI (Standard Commands for Programmable Instruments) Command Set for the Instrument. The commands are presented in a series of tables that are organiged by functional subsystems, power, AM, FM, Sweep, etc. Also included are the common commands and the Status Registers. Each table represents a functional grouping and is preceded by an identifying second order heading. Formal table headings and introductory paragraphs have been omitted for clarity.

SCPI Command Reference

The functional subsystems, common commands, and status registers described in this part of Chapter 4 are as follows:

- Definition of Common Parameter Forms
- INSTrument Subsystem
- OUTPut Subsystem
- INPut Subsystem
- POWer Subsystem
- FREQuency Subsystem
- AM Subsystem
- FM Subsystem
- PM Subsystem
- SWEep Subsystem
- Trigger Subsystem
- REFerence Subsystem
- UNIT Subsystem
- ROSCillator Subsystem
- SYSTem Subsystem
- STATus Subsystem
- CALibration Subsystem
- Common Commands
- SCPI Status Registers
- Coupled Commands

Definition of Common Parameter Forms

Parameter Form	Definition
`<bool>`	Boolean data, which is ON or OFF, but allows numeric values also (zero is interpreted as OFF, and any non-zero value as ON).
`<name>`	Name parameter: Select a parameter name from a listed group.
`<string>`	String program data type (enclosed in double quotes).
`<NRf>`	Numeric representation format: Number can be expressed as an integer (e.g. 123), real number (e.g. 123.4) or an exponent (e.g. 1.234E6).
n/a	Not applicable

INSTrument Subsystem

Keyword	Parameter Form	*RST Condition	Notes
`INSTrument`			Command long form
`:INST:CATalog?`		`n/a`	Query only command that returns a comma-separated list of strings which contains the names of all logical instruments: SINE,SWEEP,AM,FM,PM
`:INST:CAT:FULL?`		`n/a`	Query only command that returns a list of string - number pairs. The string contains the name of the logical instrument. The immediately following NR1-formatted number is its associated logical instrument number: SINE1, SWEEP2,AM3,FM4,PM5
`:INST:NSELect[?]`	`<NRf>`	`1`	This command is used in conjunction with the SELect command. It serves the same purpose, except that it uses a numeric value instead of the identifier used in the SELect command. When queried it shall return the logical instrument number Changing the selected instrument will put the output into standby. Note that the query version of this command can report the selected functions as zero (0) when the instrument is in a state such as calibration or selftest.
`:INST[:SELect][?]`	`<string>`	`SINE`	This command selects the instrument as the default. When a logical instrument is selected, all other logical instruments are unavailable for programming until selected. The selections are SINE, SWEEP, AM, FM, PM. The query returns the string name of the currently selected instrument. Changing the selected instrument will put the output into standby. Note that the query version of this command can report the selected functions as "NONE" when the instrument is in a state such as calibration or selftest.

OUTPut Subsystem

Keyword	Parameter Form	*RST Condition	Notes
:OUTPut			Command long form
:OUTP[:STATe][?]	<bool>	OFF	The STATe command controls whether the output terminals are open or closed. When the state is OFF, the terminals are at maximum isolation from the signal.
:OUTP:ROSCillator[:STATe][?]	<bool>	Unchanged	The STATe command controls whether the reference frequency is output on the rear panel BNC
:OUTP:ROSCillator:FREQuency[?]	<NRf>	Unchanged	Selects the output frequency frequency on the back panel, in Hz
:OUTP:FITTed?	<SPD>,<SPD >	n/a	Query only command that returns two strings, the first is the head model type and the second is the serial number. If no head is fitted then the query will return “NONE”,”NONE”

INPut Subsystem

Keyword [1]	Parameter Form	*RST Condition	Notes
:INPut			Command long form
:INP:REAR[?]	<type>{DISable| LEVel | PULL}	DISable	Selects the input mode of the rear BNC connector
:INP:LEVel:FSV[?]	<NRf>	Unchanged	Selects the external leveling Full Scale Voltage
:INP:LEVel:FSP[?]	<NRf>	Unchanged	Selects the external leveling Full Scale Power
:INP:LEVel:RTIMe[?]	<name>{SLOW| FAST}	SLOW	Selects the external leveling filter speed
:INP:LEVel:CLAMp[?]	<NRf>	Unchanged	
:INP:FREQuency :POLarity[?]	<type>{POSitive |NEGative }<NRf>	NEGativeUnchanged	Selects the directon of pull a positive voltage change has on the frequency
:INP :FREQuency :GAIN	<NRf>	Unchanged	Selects the frequency pull gain value

[1] These command nodes are only valid when the SINE instrument is selected.

POWer Subsystem

Keyword	Parameter Form	*RST Condition	Notes
[:SOURce]:POWer			Command long form
[:SOUR]:POW[:LEVel][:IMMediate][:AMPLitude][?]	<NRf>	-10.0 dBm	This selects the power level of the output for the current instrument that is selected.
[:SOUR]:POW:OFFSet[?]	<NRf>	0.0 dBm	Command not available in the sweep instrument. This value is an offset that is added to the output value.
[:SOUR]:POW:OFFS:STATe[?]	<bool>	OFF	Command not available in the sweep instrument. This selects whether the offset mode is present
[:SOUR]:POW:OFFS:APPLy[?]	<bool>	OFF	Command not available in the sweep instrument. This selects whether the offset value is added to the output power. Note: The offset state must be on for this command to operate
[:SOUR]:POW:OFFS:ERRor[?]	<NRf>	0.0 %	Command not available in the sweep instrument. Adjusts the output by setting the offset as an error rather than an absolute.

FREQuency Subsystem

Keyword	Parameter Form	*RST Condition	Notes
[:SOURce]:FREQuency			Command long form
[:SOUR]:FREQ:[CW|FIXed][?]	<NRf>	1.0MHz	Command not available in the sweep instrument. This selects the frequency of the output for the current instrument that is selected.
[:SOUR]:FREQ:OFFSet[?]	<NRf>	0.0 Hz	Command not available in the sweep instrument. This value is added to the output value.
[:SOUR]:FREQ:OFFS:STATe[?]	<bool>	OFF	Command not available in the sweep instrument. This selects whether the offset mode is present
[:SOUR]:FREQ:OFFS:APPLy[?]	<bool>	OFF	Command not available in the sweep instrument. This selects whether the offset value is added to the output frequency. Note: The offset state must be on for this command to operate
[:SOUR]:FREQ:OFFS:ERRor[?]	<NRf>	0.0 %	Command not available in the sweep instrument. Adjusts the output by setting the offset as an error rather than an absolute.
[:SOUR]:FREQ:CENTer[?]	<NRf>	1.0MHz	Command only available in the sweep instrument. Sets the center frequency for a frequency sweep.
[:SOUR]:FREQ:SPAN[?]	<NRf>	9.0 MHz	Command only available in the sweep instrument. Sets the span for a frequency sweep.
[:SOUR]:FREQ:STARt[?]	<NRf>	1.0MHz	Command only available in the sweep instrument. Sets the start center frequency for a frequency sweep.
[:SOUR]:FREQ:STOP[?]	<NRf>	10.0MHz	Command only available in the sweep instrument. Sets the stop center frequency for a frequency sweep.

AM Subsystem

Keyword	Parameter Form	*RST Condition	Notes
[:SOURce]:AM			Command long form This command node is only available when the AM instrument is selected.
[:SOUR]:AM:STATe[?]	<bool>	OFF	This selects whether the output signal has an AM component
[:SOUR]:AM[:DEPTh][?]	<NRf>	0.1 %	This selects the depth of the AM for the AM instrument
[:SOUR]:AM:DEPTh:OFFSet[?]	<NRf>	0.0 %	This value is added to the depth of the output value. Changes to this value will be reflected in the AM:OFFSet:ERRor value
[:SOUR]:AM:DEPTh:OFFS:STATe [?]	<bool>	OFF	This selects whether the offset mode is present
[:SOUR]:AM:DEPTh:OFFS:APPLy [?]	<bool>	OFF	This selects whether the offset value is added to the output depth. Note: The offset state must be on for this command to operate
[:SOUR]:AM:DEPTh:OFFS:ERRor[?]	<NRf>	0.0 %	Adjusts the output depth by setting the offset as an error rather than an absolute.
[:SOUR]:AM:INTernal:FREQuency[?]	<NRf>	1.0 kHz	This selects the modulation frequency of the AM
[:SOUR]:AM:INT:FREQ:OFFSet[?]	<NRf>	0.0 Hz	This value is added to the modulation frequency of the output value. Changes to this value will be reflected in the AM:INT:FREQ:OFFSet:ERRor value
[:SOUR]:AM:INT:FREQ:OFFS:STATe[?]	<bool>	OFF	This selects whether the offset mode is present
[:SOUR]:AM:INT:FREQ:OFFS:APPLy[?]	<bool>	OFF	This selects whether the offset value is added to the output modulation frequency. Note: The offset state must be on for this command to operate
[:SOUR]:AM:INT:FREQ:OFFS:ERRor[?]	<NRf>	0.0 %	Adjusts the output modulation frequency by setting the offset as an error rather than an absolute.
[:SOUR]:AM:SHAPe[?]	<name> {SINE | TRIangle | EXTernal}	SINE	This selects the shape of the modulation of the AM.
[:SOUR]:AM:COUPling[?]	<name> {AC| DC}	AC	This selects the type of coupling for the AM.
[:SOUR]:AM:EXTernal :TRIGger[?]	<name>{ DISable | RISing | FALLing}	DISable	Selects the type of external trigger for AM

FM Subsystem

Keyword	Parameter Form	*RST Condition	Notes
[:SOURce]:FM			Command long form This command node is only available when the FM instrument is selected.
[:SOUR]:FM:STATe[?]	<bool>	OFF	This selects whether the output signal has an FM component
[:SOUR]:FM[:DEViation][?]	<NRf>	10.0 Hz	This selects the deviation of the FM for the FM instrument.
[:SOUR]:FM:DEViation :OFFSet[?]	<NRf>	0.0 Hz	This value is added to the deviation of the output value. Changes to this value will be reflected in the FM:OFFSet:ERRor value
[:SOUR]:FM:DEViation:OFFS :STATe [?]	<bool>	OFF	This selects whether the offset mode is present
[:SOUR]:FM:DEViation:OFFS :APPLy [?]	<bool>	OFF	This selects whether the offset value is added to the output deviation. Note: The offset state must be on for this command to operate
[:SOUR]:FM:DEViation:OFFS :ERRor[?]	<NRf>	0.0 %	Adjusts the output depth by setting the offset as an error rather than an absolute.
[:SOUR]:FM:INTernal :FREQuency[?]	<NRf>	1.0 kHz	This selects the modulation frequency of the FM
[:SOUR]:FM:INT:FREQ :OFFSet[?]	<NRf>	0.0 Hz	This value is added to the modulation frequency of the output value. Changes to this value will be reflected in the FM:INT:FREQ:OFFSet:ERRor value
[:SOUR]:FM:INT:FREQ:OFFS :STATe[?]	<bool>	OFF	This selects whether the offset mode is present
[:SOUR]:FM:INT:FREQ:OFFS :APPLy[?]	<bool>	OFF	This selects whether the offset value is added to the output modulation frequency. Note: The offset state must be on for this command to operate
[:SOUR]:FM:INT:FREQ:OFFS :ERRor[?]	<NRf>	0.0 %	Adjusts the output depth by setting the offset as an error rather than an absolute.
[:SOUR]:FM:SHAPe[?]	<name> {SINE | EXTernal}	SINE	This selects the shape of the modulation of the FM.
[:SOUR]:FM:COUPling[?]	<name> {AC| DC}	AC	This selects the type of coupling for the FM.
[:SOUR]:FM:EXTernal :TRIGger[?]	<name> {DISable | RISing | FALLing}	DISable	Selects the type of external trigger for FM

PM Subsystem

Keyword	Parameter Form	*RST Condition	Notes
[:SOURce]:PM			Command long form This command node is only available when the PM instrument is selected.
[:SOUR]:PM:STATe[?]	<bool>	OFF	This selects whether the output signal has an PM component
[:SOUR]:PM[:DEViation][?]	<NRf>	0.0001 Rad	This selects the deviation in Radians of the PM for the PM instrument.
[:SOUR]:PM:DEViation:OFFSet[?]	<NRf>	0.0 Rad	This value is added to the deviation of the output value. Changes to this value will be reflected in the PM:OFFSet:ERRor value
[:SOUR]:PM:DEViation:OFFS :STATe[?]	<bool>	OFF	This selects whether the offset mode is present
[:SOUR]:PM:DEViation:OFFS :APPLy[?]	<bool>	OFF	This selects whether the offset value is added to the output deviation. Note: The offset state must be on for this command to operate
[:SOUR]:PM:DEViation:OFFS :ERRor[?]	<NRf>	0.0 %	Adjusts the output depth by setting the offset as an error rather than an absolute.
[:SOUR]:PM:INTernal :FREQuency[?]	<NRf>	1.0 kHz	This selects the modulation frequency of the PM
[:SOUR]:PM:INT:FREQ :OFFSet[?]	<NRf>	0.0 Hz	This value is added to the modulation frequency of the output value. Changes to this value will be reflected in the PM:INT:FREQ:OFFSet:ERRor value
[:SOUR]:PM:INT:FREQ:OFFS :STATe[?]	<bool>	OFF	This selects whether the offset mode is present
[:SOUR]:PM:INT:FREQ:OFFS :APPLy[?]	<bool>	OFF	This selects whether the offset value is added to the output modulation frequency. Note: The offset state must be on for this command to operate
[:SOUR]:PM:INT:FREQ:OFFS :ERRor[?]	<NRf>	0.0 %	Adjusts the output depth by setting the offset as an error rather than an absolute.
[:SOUR]:PM:EXTernal :TRIGger[?]	<name> {DISable | RISing | FALLing}	DISable	Selects the type of external trigger for PM

SWEep Subsystem

Keyword	Parameter Form	*RST Condition	Notes
:SWEep			Command long form This command node is only available when the SWEEP instrument is selected.
:SWE:STATe?		n/a	Query only, this returns the current state of the sweep: STOP, ARM, RUN or PAUS
:SWE:TIME?		n/a	Query only, this returns the duration of the sweep
:SWE:DWELl[?]	<NRf>	100 ms	Controls the amount of time spent at each point during a sweep.
:SWE:SPACing[?]	<name> {LINear | LOGarithmic}	LIN	Selects which type of sweep is performed.
:SWE:STEP[?]	<NRf>	1.0 kHz	Selects the frequency for each step of the sweep.
:SWE: SQUelch[?]	<bool>	OFF	Select / deselect Squelch during transitions.
:SWE:PROGress?		n/a	Query only to return how far through the sweep is. This will report 0.0 if the sweep has never started, and 100% if it has completed.
:SWE:ACTion	<name> {PAUSe | CONTinue}	n/a	This will pause and continue a sweep that is in progress. A settings conflict will be reported if the sweep is not in progress. There is no query form.

Trigger Subsystem

Keyword [1]	Parameter Form	*RST Condition	Notes
ABORt			This command is provided for aborting triggered action. On this instrument it is specifically used to stop a sweep.
:INITiate[:IMMediate]		n/a	Used to initiate a sweep. A setting conflict will be reported if the TRIGger[:SOURce] is set to external
:INIT:CONTinuous[?]	<bool>	OFF	Determines whether the sweep is a single event or repetitive.
:TRIG[:SEQuence] :SOURce[?]	<name> {INTernal | EXTernal }	INT	Determines where the trigger source for beginning a sweep operation.
:TRIG[:SEQuence] :SLOPe[?]	<name> {POSitive | NEGative}	POS	Determines if the sweep will be started with a positive (rising) or negative (falling) edge signal
:TRIG:OUTPut[:STATe][?]	<bool>	OFF	When this is enabled true, a signal will be generated on the trigger output connector co-incident with the start of the sweep. Note that setting the state of the trigger output to ON will select TRIG:SEQU:SOUR as internal.

[1] These command nodes are only valid when the SWEEP instrument is selected.

REFerence Subsystem

<table>
<tr><th>Keyword [1]</th><th>Parameter Form</th><th>*RST Condition</th><th>Notes</th></tr>
<tr><td>[:SOURce]:REFerence</td><td></td><td></td><td>Command long form
This command node is only valid when the SINE instrument is selected.</td></tr>
<tr><td>[:SOUR]:REF[:STATe][?]</td><td><bool></td><td>OFF</td><td>This selects the Reference output mode. The values of the references will available at the output in place of the existing frequency and/or power</td></tr>
<tr><td>:[:SOUR]:REF:FREQuency?</td><td></td><td>1.0 MHz</td><td>Query only that will return the value of the frequency reference.</td></tr>
<tr><td>:[:SOUR]:REF:POWer?</td><td></td><td>-10.0 dBm</td><td>Query only that will return the value of the power reference.</td></tr>
<tr><td>[:SOUR]:REF:TRACk[?]</td><td><name> {FREQuency | POWer | NONE}</td><td>NONE</td><td>This selects whether the reference signal parameters track the frequency or power on the main sine instrument</td></tr>
<tr><td>[:SOUR]:REF:COPY</td><td><name>{FREQ | LEV | BOTH}</td><td></td><td>This copies the current values from the main sine parameter to the reference values.
There is no query form</td></tr>
<tr><td>[:SOUR]:REF:CONFirm[?]</td><td><name>
{DISable | ALWays | ABSolute | INCrease}</td><td>DISable</td><td>This command is used to determine if an additional OUTP ON command is needed before the reference values are transferred to the output terminal. This is to ensure that the reference parameters, which may be very different to the main sine instrument parameters is not mistakenly output, potentially damaging the unit under test.</td></tr>
<tr><td>[:SOUR]:REF:CONFirm: ABSolute[?]</td><td>NRf</td><td>-10 dBm</td><td>Sets the threashold at which the additional OUTP:ON is needed when switching to the reference output.</td></tr>
<tr><td>[:SOUR]:REF:CONFirm:INCrease[?]</td><td>NRf</td><td>-10 dBm</td><td>Sets the increase of signal at which the additional OUTP:ON is needed when switching to the reference output.</td></tr>
<tr><td colspan="4">[1] These command nodes are only valid when the SINE instrument is selected.</td></tr>
</table>

UNIT Subsystem

Keyword	Parameter Form	*RST Condition	Notes
:UNIT			Command long form
:UNIT:POWer[?]	<name> {DBM | W | VRMS | VPP}	DBM	This command sets the units of all power commands of the currently selected instrument.
:UNIT:POW:OFFSet[?]	<name> {DB | W | VRMS | VPP | PCT | PPM}	DB	This command sets the units of all power offset commands of the currently selected instrument.
UNIT:POW:OFFS:ERRor[?]	<name>{DBM | PCT, PPM}	PCT	This command sets the units of all offset error commands of the currently selected instrument.
UNIT:FREQuency:OFFSet[?]	<name>{HZ, PCT, PPM}	Hz	This command sets the units of all frequency offset commands of the currently selected instrument. PCT is for percent, PPM is for parts per million
UNIT:FREQ:OFFS:ERRor[?]	<name>{PCT, PPM}	PCT	This command sets the units of all frequency offset error commands of the currently selected instrument. PCT is for percent, PPM is for parts per million
UNIT:AM:DEPT:OFFS:ERRor[?]	<name>{PCT, PPM}	PCT	This command sets the units of all depth offset error commands of the currently selected instrument. PCT is for percent, PPM is for parts per million
UNIT:AM:INT:FREQ:OFFS[?]	<name>{HZ, PCT, PPM}	Hz	This command sets the units of the rate of the currently selected instrument. PCT is for percent, PPM is for parts per million
UNIT:AM:INT:FREQ:OFFS :ERRor[?]	<name>{PCT, PPM}	PCT	This command sets the units of all rate offset error commands of the currently selected instrument. PCT is for percent, PPM is for parts per million
UNIT:FM:DEV:OFFS[?]	<name>{HZ, PCT, PPM}	Hz	This command sets the units of the deviation commands of the currently selected instrument. PCT is for percent, PPM is for parts per million
UNIT:FM:DEV:OFFS:ERRor[?]	<name>{PCT, PPM}	PCT	This command sets the units of all deviation offset error commands of the currently selected instrument. PCT is for percent, PPM is for parts per million

UNIT Subsystem (cont.)

Keyword	Parameter Form	*RST Condition	Notes
UNIT:FM:INT:FREQ:OFFS[?]	<name> {HZ, PCT, PPM}	Hz	This command sets the units of the rate of the currently selected instrument. PCT is for percent, PPM is for parts per million
UNIT:FM:INT:FREQ:OFFS :ERRor[?]	<name> {PCT, PPM}	PCT	This command sets the units of all rate offset error commands of the currently selected instrument. PCT is for percent, PPM is for parts per million
:UNIT:SWEep:STEP[?]	<name> {SPS | PPD | HZ | PPM | PCT}	Hz	Sets the units for the sweep step size SPS is for Steps Per Sweep PPD if for Points Per Decade.
:UNIT:SWEep:PROGress[?]	<name> {PCT | RANGe}	PCT	Select Sweep Progress Units.

ROSCillator Subsystem

Keyword	Parameter Form	*RST Condition	Notes
[:SOURce]:ROSCillator			Command long form
[:SOUR]:ROSC:SOURce[?]	<name> {INTernal | EXTernal}	Unchanged	Reference oscillator SOURce.
[:SOUR]:ROSC:EXTernal: FREQuency[?]	<NRf>	Unchanged	Sets the external Frequency in Hz.
[:SOUR]:ROSC:LOCKed?		n/a	Query returns 1 if frequency is locked to either the internal or external [:SOURce].

SYSTem Subsystem

Keyword	Parameter Form	*RST Condition	Notes
SYSTem			Command long form
SYSTem:ERRor?		n/a	Query only. Returns instrument error string or 0 if no error.
SYST:VERSion?		n/a	Query only. Returns SCPI version to which instrument complies.

STATus Subsystem

Keyword	Parameter Form	*RST Condition	Notes
:STATus			Command long form
:STAT:OPER[:EVENt]?		n/a	Query only. Returns the contents of the Operation Event Register.
:STAT:OPER:ENABle[?]	NRf	0	Sets the mask for the Operation Event Register.
:STAT:OPER:CONDition?		n/a	Query only. Returns the contents of the Operation Condition Register.
:STAT:QUES[:EVENt]?		n/a	Query only. Returns the contents of the Questionable Event Register.
:STAT:QUES:ENABle[?]	NRf	0	Sets the mask for the Questionable Event Register.
:STAT:QUES:CONDition?		n/a	Query only. Returns the contents of the Questionable Condition Register.
STAT:PRESent		n/a	Sets Registers to a SCPI defined state.

CALibration Subsystem

Keyword	Parameter Form	*RST Condition	Notes
CALibration		n/a	Command long form
:CAL:SECure:PASSword	<spd>		Enables Calibration Mode using a password.
:CAL:SECure:EXIT			Exit Calibration Mode.
:CAL:TARGet	<NRf>,<NRf>,<NRf>		First parameter is level, second is frequency and the third specifies which section of the calibration the first two parameters apply to.
:CAL:ACTual[?]			Changes the output value for adjustment
:CAL:TRIGger?			Accept the adjustment, return 0=success, 1 =otherwise
:CAL:PRIMary			Sub-command
:CAL:PRIM:FADJust?	<NRf>		Frequency adjust. Return 0 for success, 1 for failure

Common Commands

Keyword	Parameter Form	Notes
*CLS		The *CLS common command clears the status data structures by clearing all event registers and the error queue. It does not clear enable registers and transition filters. It clears any pending *WAI, *OPC, and *OPC?.
*ESE	NR1	Sets the enable bits of the standard event enable register. This enable register contains a mask value for the bits to be enabled in the standard event status register. A bit that is set true in the enable register enables the corresponding bit in the status register. An enabled bit will set the ESB (Event Status Bit) in the Status Byte Register if the enabled event occurs.
*ESR?		Reads out the contents of the standard event status register. Reading the Standard Event Status Register clears the register.
*IDN?		Reads out the manufacturer, model, serial number, Firmware level for main and GPIB program in an ASCII response data element. Response is <Manufacturer> , <Model> , <Serial Number>, <Firmware Level>.
*OPC		The Operation Complete command causes the device to set the operation complete bit in the Standard Event Status Register when all pending selected device operations have been finished.
*OPC?		Operation Complete query. The Operation Complete query places an ASCii character 1 into the device's Output Queue when all pending selected device operations have been finished.
*OPT?		Response is a list of all detectable options present in the instrument, with absent options represented with an ASCii '0'.
*PSC	NR1	Enables/disables automatic power-on clearing. The status registers listed below are cleared when the power-on status clear flag is 1. Power-on does not affect the registers when the flag is 0.
*RST		The Reset command resets the instrument. It is the third level of reset in a 3-level reset strategy, and it primarily affects the instruments functions, not the IEEE 488 bus.
*SRE	NR1	The Service Request Enable command sets the service request enable register bits. This enable register contains a mask value for the bits to be enabled in the status byte register. A bit that is set true in the enable register enables the corresponding bit in the status byte register to generate a Service Request.
*STB?		Reads out the value of the Status Byte. Bit 6 reports the Master Summary Status bit (MSS), not the Request Service (RQS). The MSS is set if the instrument has one or more reasons for requesting service.
*TST?		The self-test query causes an internal self-test and generates a response indicating whether or not the device completed the self-test without any detected errors.
*WAI		The Wait-to-Continue command prevents the device from executing any further commands or queries until execution of all previous commands or queries have been completed.

SCPI Status Registers

Operation Status Register

Bit	2n	Label	Comment
0	1	Calibrating	Not used, Always zero
1	2	Settling	Not used, Always zero
2	4	Ranging	Not used, Always zero
3	8	Sweeping	A sweep is in progress
4	16	Measuring	Not used, Always zero
5	32	Waiting for Trig	Waiting for a sweep trigger
6	64	Waiting for Arm	Not used, Always zero
7	128	Correcting	Not used, Always zero
8	256	Unassigned	Not used, Always zero
9	512	Unassigned	Not used, Always zero
10	1024	Unassigned	Not used, Always zero
11	2048	Unassigned	Not used, Always zero
12	4096	Unassigned	Not used, Always zero
13	8192	Instrument Summary	Not used, Always zero
14	16384	Program Summary	Not used, Always zero
15	32768	Not Used	Not used, Always zero

Questionable Status Register

Bit	2n	Label	Comment
0	1	Voltage	The voltage output is no longer levelled
1	2	Current	Not used, Always zero
2	4	Time	Not used, Always zero
3	8	Frequency	The frequency is no longer locked
4	16	Phase	Not used, Always zero
5	32	Modulation	Not used, Always zero
6	64	Calibration	Not used, Always zero
7	128	Unassigned	Not used, Always zero
8	256	Unassigned	Not used, Always zero
9	512	External Ref Frequency unlocked	Unable to lock to the externally supplied frequency
10	1024	Head Serial Number mismatch	The currently fitted head serial number was not calibrated by this base unit
11	2048	External AM or FM overload	This external signal is too large
12	4096	Unassigned	Not used, Always zero
13	8192	Unassigned	Not used, Always zero
14	16384	Command warning	Not used, Always zero
15	32768	Not Used	

Coupled Commands

What Is Command Coupling?

Commands from the IEEE interface bus are usually executed serially in the order they are received. However, because commands may come in any order in a command string, it is possible that a combination of commands produce an illegal machine state if executed in isolation but a valid machine sate if executed collectively.

This problem is overcome by defining a coupling between commands which allows the execution of individual components to be deferred until all contiguous coupled commands in the same group have been parsed and the validity of the combinations checked.

Note

Individual commands may be a member of several coupled command groups.

A good example is power and frequency. Either of these commands could be used individually to configure an instrument (with the other parameter assumed or defaulted). However, there are instances when both commands are required together before the requested configuration is valid.

Suppose the instrument has a profile that allows high frequency at low power and high power at low frequency. Assume the instrument is currently set to a high frequency, low power and we require a change to give high power, low frequency. Manually, we would have to reduce the frequency before we could increase the power.

On the bus, if the power command is sent before the frequency command and the commands were processed as they were received, then an error would be reported as the instrument would think that a high power AND a high frequency were being requested. See Figure 4C-1.

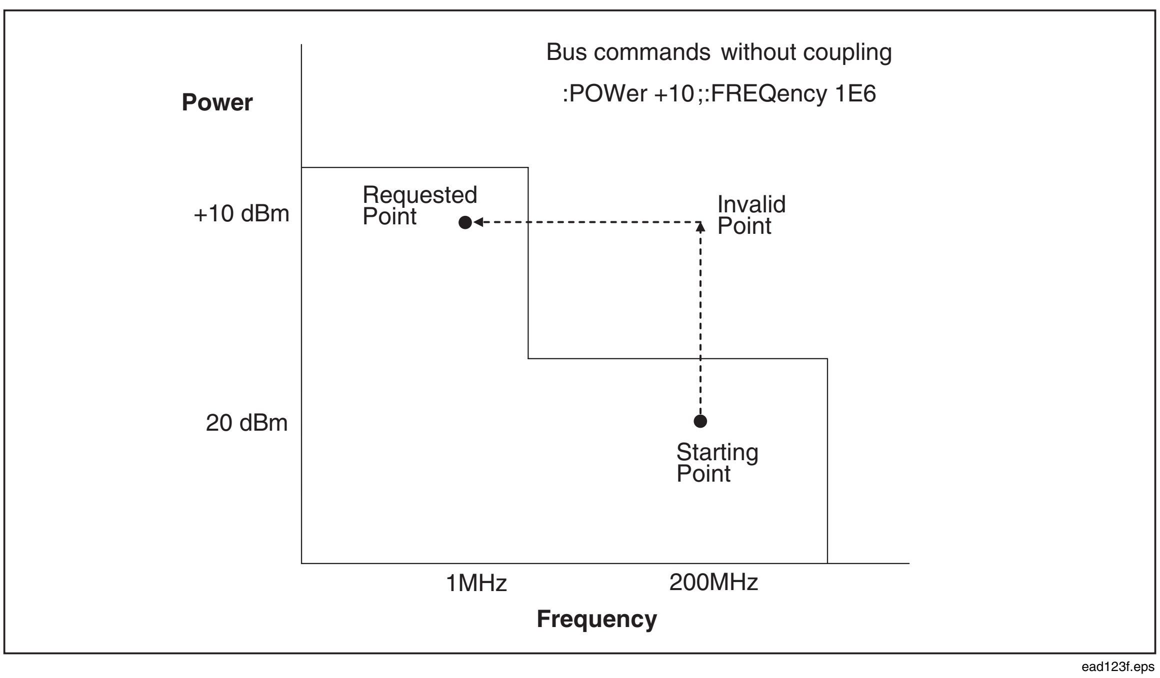


Figure 4C-1. Bus Command without Coupling

Coupling overcomes this by deferring the processing of commands until all related items are gathered together allowing them to be processed at once. In Figure 4C-2, the Instrument knows that frequency and power are inter-dependant, and that executing power then frequency would be illegal, so it executes the frequency command first, then the power command to successfully get to the point requested.

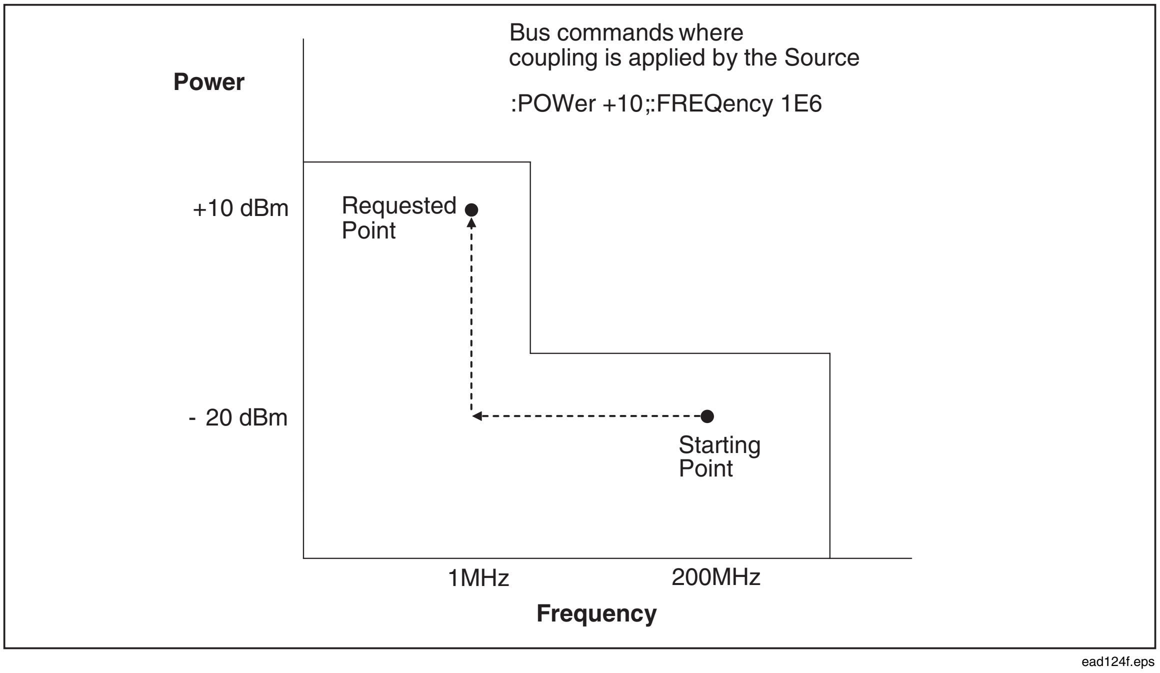


Figure 4C-2. Bus Command with Coupling

Coupled Command List

Table 4C-1 provides a list of Coupled Commands and identifies which commands are coupled. An **x** in a column indicates a coupled row. For example, column 4 has an **x** in the row for :POWer, :FREQuency:STARt and :FREQuency:STOP, indicating these commands are coupled.

Table 4C-1. List of Coupled Commands

COMMAND	"X" in a Column Indicates a Coupled Row											
	11	10	9	8	7	6	5	4	3	2	1	0
:FREQuency											x	x
:POWer								x	x		x	x
:FM:DEViation											x	
:AM:INT:FREQ										x		
:AM:Shape										x		
:FREQuency:CENTer									x			
:FREQuency:SPAN									x			
:FREQuency:STARt								x				
:FREQuency:STOP								x				
:POWer:OFFSet						x						
:POWer:OFFSet:STATe						x						
:POWer:OFFSet:APPLy						x						
:POWer:OFFSet:ERRor						x						
:FREQ:OFFSet					x							
:FREQ:OFFSet:STATe					x							
:FREQ:OFFSet:APPLy					x							
:FREQ:OFFSet:ERRor					x							
:AM:DEPTh:OFFSet				x								
:AM:DEPTh:OFFSet:STATe				x								
:AM:DEPTh:OFFSet:APPLy				x								
:AM:DEPTh:OFFSet:ERRor				x								
:AM:INT:FREQ:OFFSet			x									
:AM:INT:FREQ:OFFSet:STATe			x									
:AM:INT:FREQ:OFFSet:APPLy			x									
:AM:INT:FREQ:OFFSet:ERRor			x									
:FM:DEV:OFFSet		x										
:FM:DEV:OFFSet:STATe		x										
:FM:DEV:OFFSet:APPLy		x										
:FM:DEV:OFFSet:ERRor		x										
:FM:INT:FREQ:OFFSet	x											
:FM:INT:FREQ:OFFSet:STATe	x											
:FM:INT:FREQ:OFFSet:APPLy	x											
:FM:INT:FREQ:OFFSet:ERRor	x											

Chapter 4D
Instrument Programming Examples

Title	Page

Remote Programming Examples

This part of Chapter 4 gives some examples of the commands needed to set up various programming scenarios for the Instrument. The examples use a variety of short and long forms of the commands, a variety of upper and lower case, and a variety of ways of representing parameters (e.g. 1E6 or 1000000 are the same).

Carrier Wave Generation

Requirement: To output a 1.1 MHz, -14.2 dBm sine wave.

```
*RST
*CLS
INST SINE
UNIT:POWer DBM
POWER -14.2
FREQ 1.1E6
OUTPUT ON
```

To find out what the current output signal is, in V rms

```
UNIT:POW VRMS
POWER?
```

<- Instrument responds with the value 4.360000000000E-02

AM Output

Requirement: To output a 500 kHz, -5.0 dBm carrier wave with a 2 kHz, 15 % depth modulation. This example uses the full long-form of the power command.

```
INST AM
UNIT:POWer DBM
:SOURCE:POWER:LEVEL:IMMEDIATE:AMPLITUDE -5.0
FREQ 500000.0
AM:INTernal:FREQ 2.0E+3
AM:DEPTh 15
AM:STATe 1
OUTPut ON
```

Requirement: Remove the modulation from the above signal to output just the carrier wave:

```
AM:STATE off
```

FM Output

Requirement:

To output a 430 MHz, 4.556 dBm carrier wave with a 27 kHz, 500 kHz deviation modulation. This example uses tree walking to set up the modulation

```
INST FM
UNIT:POWer DBM
POW -4.556
FREQ 430e6
FM:STATE 1;DEV 500.0E+3;INTernal:FREQ 27E3
OUTPUT ON
```

Sweep Output

Requirement: To perform a single sweep from 1 MHz to 10 MHz in 1 MHz steps with 133 ms between each step at 1V rms.

```
INST SWEEP
FREQ:START 1E6;:FREQ:STOP 10000000
UNIT:POWER VRMS
:POWER 1.0
:SWE:DWELL 0.133
SWEEP:STEP 1E6
:INIT:CONT OFF
OUTP ON
:INIT
```

Requirement: To perform a repetitive logarithmic sweep of 15 points over 20 MHz, centered around 100 MHz with a dwell of 1 second between each step, started by an external trigger.

```
INST SWEEP
FREQ:CENT 100E6
FREQ:SPAN 20E6
UNIT:POWER VRMS
:POWER 1.0
SWE:SPAC LOG
:SWE:DWELL 1.0
:UNIT:SWEEP:STEP SPD
SWEEP:STEP 15
OUTP ON
TRIG:SOURCE EXT
```

<- The sweep will only begin when the there is a trigger signal on the external rear-panel connector

Carrier Wave Generation With Offset

Requirement: To output a 1.1 MHz, -14.2 dBm sine wave. Then to offset the output power by +0.1dbm

```
*RST
*CLS
INST SINE
UNIT:POWer DBM
POWER -14.2
FREQ 1.1E6
OUTPUT ON
POWER:OFFSET:STATE 1
POWER:OFFSET 0.1
```

Requirement: To find out what the UUT error is in the above scenario.

```
POWER:OFFSET:ERROR?
```

<- Instrument responds with the value -2.27600000000E+00

Operation Status Register

Requirement: To perform a single sweep from 1 MHz to 10 MHz in 1 MHz steps with 133 ms between each step at 1V rms. Monitor the Operational Status bit that indicates that the sweep is in progress.

```
INST SWEEP
FREQ:START 1E6;:FREQ:STOP 10000000
UNIT:POWER VRMS
:POWER 1.0
:SWE:DWELL 0.133
SWEEP:STEP 1E6
:INIT:CONT OFF
OUTP ON
:INIT
STATUS:OPER:COND?
```

<- Instrument responds with a value that has bit 4 set, i.e., the value 8
wait for 5 seconds

```
STATUS:OPER:COND?
```

<- Instrument responds with a value that has bit 0 clear, i.e., the value 0

SRQ Operation and Error Handling

Requirement: To generate a service request from the Instrument when it detects a problem.

```
*RST
*CLS
INST SINE
*SRE 255
*ESE 255
UNIT:POWer DBM
POW 1      <- this command would be executed by the Instrument
POW 1E6    <- The user meant to set up 1MHz, with FREQ 1E6
        <-  Instrument generates an SRQ
*STB?
        <-  Instrument responds with the value 32 (decimal). This indicates there is
            Event flag
*ESR?
        <- the Event Register returns 15 (decimal) meaning there is an
            execution error.
SYST:ERR?
        <-  Instrument returns the message from the error queue
        <- -222"Data out of range;Value too large"
        <- indicating the problem with the last command
```

Chapter 4E
HP 3335A Command Emulation

3335A Emulation

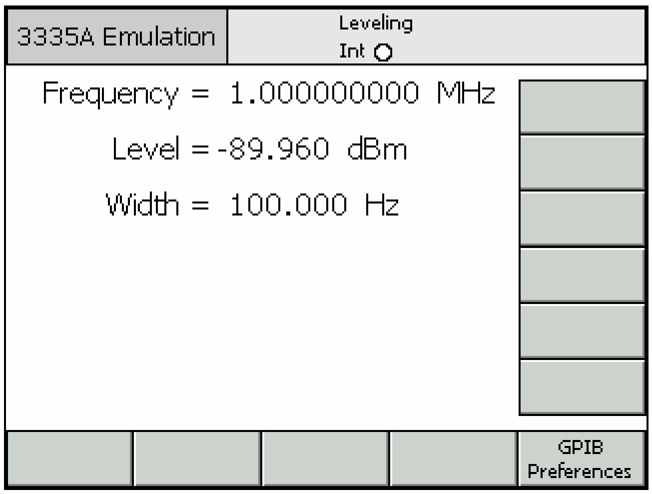
This part of Chapter 4 describes the 3335A emulation mode of the Instrument. When in this mode, the instrument responds to 3335A IEEE bus commands instead of the SCPI bus commands, greatly simplifying integration into existing systems.

Note that once in the 3335A emulation mode, all other Instrument features and operation modes are not available.

Preparing the Instrument for Remote 3335A Emulation

Select 3335A emulation mode as described in section 4A.

On exit from the setup mode, the following screen appears on the display:



ead346f.bmp

3335A Emulation

To exit the 3335A emulation mode, press the GPIB Preferences key and then disable the mode.

Commands that are Emulated

The following table lists the commands to which the Instrument responds.

Command	3335A Code	Comment
Frequency	F	Sets the frequency
Frequency Increment	I	Sets the frequency increment value
Amplitude	A	Sets the Amplitude
Amplitude Increment	I	Sets the Amplitude Increment value
Sweep Width	W	Sets the sweep width
0-9	0-9	Used for numeric entry
Backspace	B	This backspaces the characters received over the bus.
MHz/-dBm	M	Units for numeric entry
KHz/+dBm	K	Units for numeric entry
Hz/deg	H	Units for numeric entry
Increment up	U	Increment the currently active parameter (F or A)
Increment down	D	Decrement the currently active parameter (F or A)
Go to start freq	G	Go to the start freq of a sweep
Start 10 second single	X	Start a single sweep lasting 10 seconds, **Information:** The 3335A performs 1000 steps during this sweep. The 9640A performs 500 steps during this command. See below about changing sweep modes.
Start 50 second single	Y	Start a single sweep lasting 50 seconds, 1000 steps per sweep. See below about changing sweep modes.
Start Auto	Z	Start a repetitive sweep: 8 sweeps/sec, 100 steps/sweep **Information:** the 9640A performs 7 steps per sweep during this command.
Stop	Q	Stop the sweep
Negative symbol	-	For entering negative values

Commands that are Not Emulated

The following table lists the commands which are are silently ignored by the Instrument.

Command	3335A Code	Comment
Store	S	Stores the current setup in one of 0-9 slots
Recall	R	Restores a setup from one of 0-9 slots
Phase increment	P	Sets the phase Increment value
Display Last Entry	L	Used to display the last entry so that it can be edited
Clear	C	Stops the special PAD attenuator mode
PAD selection	T	Selects 1 of 7 attenuators to give a specific level output

Other Differences to note in emulation mode.

Sweep timing can be changed between 'X' mode (10 second sweep) and 'Y' mode (50 second sweep) and the sweep continues without restart. As the 9640A needs to calculate the sweep parameters before the sweep starts it does not copy this behaviour.

The 3335A has a Sweep Output Connector to provide a 0 to +2 volts sweep ramp for driving external equipment. The 9640A does not have this feature.

Although the 3335A has a front panel switch to select 50 Ω or 75 Ω output, there is also a bus command to do this. The 9640A requires a different head to be manually inserted. Also note that the 9640A produces correctly levelled 75 Ω signals, 6.4 dBm down from the 50 Ω output. The 3335A takes 1.76 dBm off instead

The HP 3335 provides phase continuous frequency sweep. The 9640A will provide phase continuous sweep for output frequencies below 15 MHz, but at frequencies above 15 MHz hardware ranging will cause phase discontinuities in the output waveform.

Balanced 124 Ω / 135 Ω / 150 Ω not implemented. The only outputs available from the 9640A are at 50 Ω and 75 Ω, from a precision N-series male connector.

GPIB not Opto Isolated

The HP3335 is isolated from the GPIB bus by opto couplers. The components on the GPIB side of the opto couplers are powered from a separate ungrounded supply within the instrument, which provides isolation of the instrument from the bus. The 9640A has both signal output ground and GPIB ground connected to earth ground.

Chapter 5
Calibration

Title	Page

Introduction

This chapter provides the performance test and the calibration adjustment procedures necessary to verify and maintain the performance of the Instrument over time.

Note

In many of the procedures in this chapter of the manual, the Instrument is commonly referred to as the UUT (Unit Under Test).

The performance test is a series of tests based on the published 1-year specifications for the Instrument. It is recommended as an acceptance test when the Instrument is first received and later as a calibration procedure to ensure that the Instrument meets its published specifications. Fluke recommends a 1-year calibration cycle for the Instrument.

Calibration adjustments are for correcting out-of-tolerance parameters so they meet published specifications. If the Instrument fails the performance test, it is an indication that the Instrument requires calibration adjustment and/or repair. While calibration adjustment can be accomplished without removal of the covers, repair requires access to the interior of the Instrument. See Chapter 7, Maintenance, for internal access and repair information.

Note

The instrument top cover is removeable for air filter cleaning access without the need to break calibration integrity seals. A calibration integrity seal is located on the internal top shield, revealed once the outer top cover has been removed (see Chapter 7, Mainteneance for details). Additional calibration integrity seals are located on the rear panel over the lower outer cover and over the calibration enable switch. It is recommended that users apply calibration integrity seals in the same three locations.

Environmental and warm up conditions required for the performance test and calibration adjustments are stated at the beginning of each of the respective sections.

Unless otherwise directed, all connections are made via a Leveling Head of the specified impedance.

Note

The Leveling Head is an integral part of the UUT functionality.

Recommended Tools and Equipment

A list of the tools and equipment required to verify and maintain the performance of the Instrument is shown in Table 5-1. If the recommended model is not available, use another model/brand with the same or better specifications.

Table 5-1. List of Recommended Equipment

Nomenclature	Recommended Model	Minimum Use Requirement
Frequency Counter	Fluke PM 6690	Period resolution, 100 ns; Frequency resolution, 1 mHz
Frequency Standard	Fluke 910R	1 x 10^{-11} frequency uncertainty
Signal Source	Fluke 9640A	4 GHz; frequency resolution 10 Hz, short term amplitude stability 0.1dB.
Measuring Receiver/Spectrum Analyzer	Rohde & Schwarz FSMR26 with option FS-K40	Frequency resolution, 0.1 Hz; Frequency Accuracy, ± ½ count of lsd; Relative RF Level: ±(0.015 dB ±0.005 dB / 10 dB step) Frequency, 1 kHz to 4 GHz; Range, +10 to -130 dBm; 50 Ω; Linearity uncertainty, 0.02 dB; Max. SWR, 1.10; DC coupled; Phase noise measurement capability
AC Measurement Standard	Fluke 5790A	Accuracy: ± 0.1%, 200 Hz - 100 kHz
Precision Type-N, Female-to-Female Adapter, 50 Ω	Maury Microwave 8828A	VSWR: DC to 4 GHz, ≤ 1.03; Insertion loss characterized, 100 kHz to 4 GHz
Precision Type-N, Female-to-Female Adapter, 75 Ω	Maury Microwave 8882A	VSWR: DC to 2 GHz, ≤ 1.03; Insertion loss characterized, 100 kHz to 2 GHz
50 Ω Type-N Female-to-BNC Male Adapter	Maury Microwave 8821B1	VSWR: DC to 4 GHz, ≤ 1.08
75 Ω Type-N Female-to-BNC Male Adapter	Agilent 1250-1534	VSWR: DC to 3 GHz, ≤ 1.03
50 Ω Directional Bridge	Agilent 86205A	Directivity: 40 dB, 5 MHz to 2 GHz
75 Ω Directional Bridge	Agilent 86207A	Directivity: 40 dB, 5 MHz to 1.3 GHz
Attenuator, 6 dB, 50 Ω, male/female	Weinschel Model 1-6	VSWR: DC to 4 GHz, ≤ 1.15
Precision 50 Ω Open/Short Termination	Narda Microwave 231-416	Minimum Reflection Coefficient: 0.99
Precision 75 Ω Open Termination	Maury Microwave 8885B	Minimum Reflection Coefficient: 0.98
Precision 75 Ω Short Termination	Maury Microwave 8884B	DC – 2 GHz
Precision 50 Ω Feedthrough Termination[1]		50 Ω ± 0.2%
Precision 75 Ω Feedthrough Termination[2]		75 Ω ± 0.2%
Impedance Matching Pad, 75 / 50 Ω	Rohde & Schwarz RAZ	75 Ω Type-N (f) – 50 Ω Type-N (m); Frequency range: DC to 2.7 GHz Insertion loss: 1.76 dB VSWR: 0 to 2 GHz, ≤ 1.06; 2 to 2.7 GHz, ≤ 1.2; Flatness: < 0.025 dB, DC – 0.5 GHz
Power Meter	Rohde & Schwarz NRVD	Compatible with power sensors
Power Sensor, Thermal, 50 Ω	Rohde & Schwarz NRV-Z51	Frequency, 100 kHz to 4 GHz; Power, +20 to -20 dBm; Cal factor uncertainty: ±0.3%; Max. SWR, 1.10; DC coupled
Power Sensor, Diode, 50 Ω	Rohde & Schwarz NRV–Z4	Frequency, 100 kHz to 4 GHz; Power, -10 to -70 dBm; Cal factor uncertainty: ±0.3%; Max. SWR, 0.1 to 100 MHz: 1.05
Power Sensor, 75 Ω	Rohde & Schwarz NRV–Z3	Frequency, 1 MHz to 2 GHz; Power, +10 to -20 dBm; Cal factor uncertainty: ±0.3%; Max. SWR, 1.15
Common mode choke[3], if required.	Fluke p/n474908	Approx 250uH, see text.

[1] If a 50 Ω Type-N feedthrough termination is unavailable, a Rohde & Schwarz RAD 50 (or equivalent) with a precision 50 Ω Type-N (f) to BNC (m) adapter may be substituted.

[2] If a 75 Ω Type-N feedthrough termination is unavailable, an Agilent 11094B (or equivalent) with a precision 75 Ω Type-N (f) to BNC (m) adapter may be substituted.

[3] May be required for measurements made with the 5790A. Refer relevant sections of this chapter and section 4-12 of the 5790A Operator’s Manual for further details.

Performance Test

The performance test is a series of tests based on the published 1-year specifications for the Instrument. Environmental and warm up conditions required for performing the performance test are as follows:

- Ambient temperature of the test environment is 23 ± 1 °C.
- Warm up time (continuous operation) for the Instrument, with all covers in place, is 1 hour (24 hours for testing the accuracy of the Reference Frequency and Output Frequency).

Each of the following tests is accompanied by a list of the equipment required to perform the test and a figure detailing the equipment connections for the test. Perform the tests in sequence, ensuring that all prior equipment connections have been removed prior to starting a new test. It is recommended that tests indicated as optional be performed following repair, but are not essential for routine verification. For certain tests, the uncertainty of the recommended equipment is significant and must be taken into account when determining compliance with published specifications. A Performance Test Record is provided at the end of this chapter to facilitate the recording of results, and where necessary, accounting for the uncertainty of the measurement equipment. It is recommended that the Performance Test Record pages are photocopied and then used to record results as the tests are performed.

⚠ Caution

To prevent damage to the Leveling Head assembly and adapters, make sure the dimensions of the connectors match prior to mating. The center conductor (pin diameter) of 75 Ω connectors differs significantly from those of 50 Ω. Mating a 50 Ω male with a 75 Ω female will DESTROY the female contact, causing costly damage to the Leveling Head assembly as well as the adapters, while mating a 75 Ω male with a 50 Ω female will result in a poor electrical connection.

⚠ Caution

Tighten/loosen all RF connectors by turning the collar, not the body. Rotating the connector body will damage the center pin, causing expensive damage, as well as seriously deteriorating measurement results.

Note

Exercise extreme care during all connect/disconnect operations of the RF connectors. It is strongly recommended that a properly set torque wrench be used to secure all RF connections, where possible. For Type-N connectors, use a torque value of 1 Nm (9 in-lb). For SMA connectors, use a torque value of 0.45 Nm (4 in-lb).

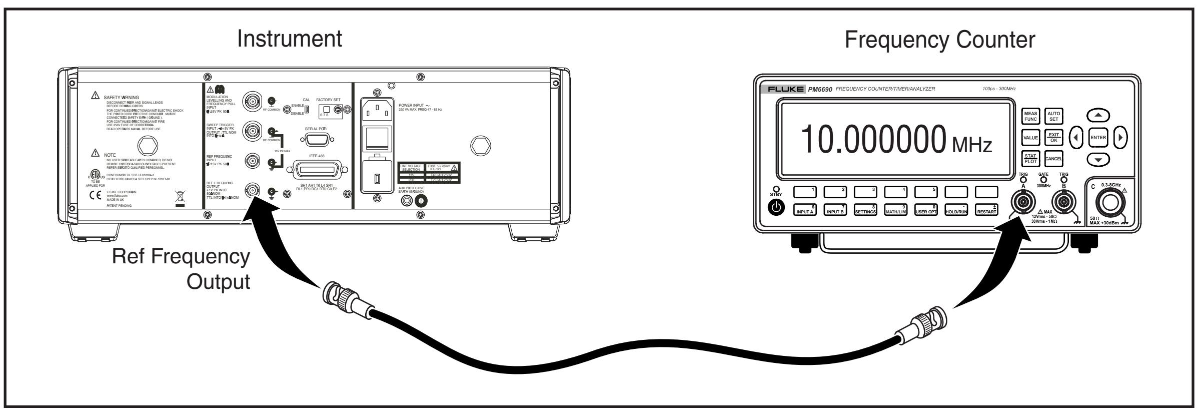
Reference Frequency Accuracy

Equipment required for this test:

- Frequency Counter
- Frequency Standard

Use the following procedure to verify the accuracy of the internal frequency reference:

1. Warm up the UUT (continuous operation) for 24 hours, minimum.
2. Connect the 10 MHz output from the frequency standard to the EXT REF IN on the frequency counter (rear panel) using a BNC male – male cable assembly. Set the frequency counter for external time base reference.
3. Connect the REF FREQUENCY OUTPUT (on rear) from the UUT to the Channel **A** input on the frequency counter using a BNC male – male cable. Set the frequency counter input impedance to 50 Ω. See Figure 5-1 for equipment connections.
4. On the UUT enable the REF FREQUENCY OUTPUT.
5. Set the frequency counter controls for a reliable and repeatable frequency measurement.
6. Allow the frequency counter to take several readings and settle. The settled counter reading must be from 9.99999960 to 10.00000040 MHz.
7. Set the UUT output to STBY. Disconnect the UUT REF FREQUENCY OUTPUT from the frequency counter input.



ead205f.eps

Figure 5-1. Equipment Connections - Reference Frequency Accuracy Test

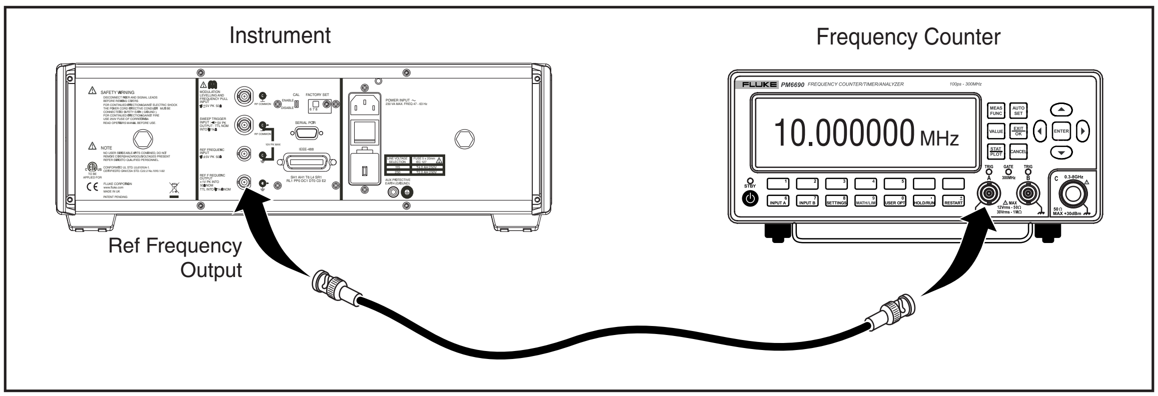
Frequency Accuracy

Equipment required for this test:

- Frequency Counter
- Frequency Standard
- 50 Ω Leveling Head (supplied with UUT)

Use the following procedure to verify the accuracy of the output frequency developed by the UUT:

1. Warm up the UUT (continuous operation) for 24 hours, minimum.
2. Connect the 10 MHz output from the frequency standard to the EXT REF IN on the frequency counter (rear panel) using a BNC male – male cable assembly. Set the frequency counter for external time base reference.
3. Connect the 50 Ω Leveling Head to the Channel A input of the frequency counter using a Type-N female-to-BNC male adapter. Set the frequency counter input impedance to 50 Ω. See Figure 5-2 for equipment connections.



ead205f.eps

Figure 5-2. Equipment Connections - Frequency Accuracy Test

4. Set the UUT as follows:

Mode	Leveled Sine
Frequency	10 kHz
Level	+13 dBm
Output	OPER

5. Set the frequency counter as follows:

Frequency	
Slope	Positive
Coupling	AC
Input Impedance	50 Ω
Attenuation	1x
Trigger Mode	Auto

6. Set the output frequency of the UUT to each of the frequencies listed in Table 5-2. At each frequency allow the frequency counter to take several readings and settle; the settled reading must be within the tolerance shown.
7. Set the UUT output to STBY. Remove all connections to the Leveling Head.

Table 5-2. Frequency Accuracy Test

UUT Frequency	Tolerance
10 kHz	9.999 999 440 – 10.000 000 560 kHz
10 MHz	9.999 999 60 – 10.000 000 40 MHz
30 MHz	29.999 998 80 – 30.000 001 20 MHz
50 MHz	49.999 998 0 – 50.000 002 0 MHz
125 MHz	124.999 995 0 – 125.000 005 0 MHz
250 MHz	249.999 990 – 250.000 010 MHz
1 GHz	0.999 999 960 – 1.000 000 040 GHz
2 GHz	1.999 999 920 – 2.000 0000 80 GHz
2.7 GHz	2.699 999 892 0 – 2.700 000 108 0 GHz
4 GHz	3.999 999 840 – 4.000 000 160 GHz

Harmonics and Spurious Signal Content

Equipment required for this test:

- Spectrum Analyzer
- 50 Ω Leveling Head (supplied with UUT)

Use the following test to verify the harmonic and spurious signal content of the UUT output.

1. Connect the output of the 50 Ω Leveling Head to the RF INPUT of the spectrum analyzer.
2. Connect the REF FREQUENCY OUTPUT (rear panel) from the UUT to the spectrum analyzer Ext Ref In (on rear). See Figure 5-6 for equipment connections.
3. On the UUT enable the REF FREQUENCY OUTPUT.
4. Set the spectrum analyzer as follows:

PRESET	
EXT REF	On
COUPLING	DC
REF LVL	+30 dBm
FREQ	20 kHz
SPAN	100 Hz

Note

Care must be taken to ensure that signals applied to the spectrum analyzer do not exceed its input mixer's optimum operating level, causing false harmonic signal levels to be measured. It may be necessary to readjust the analyzer's RF attenuation to achieve the proper mixer input level.

5. Set the UUT as follows:

Mode	Leveled Sine
Frequency	20 kHz
Level	+24 dBm
Output	OPER

6. On the spectrum analyzer, press MARKER → PEAK.
7. Set the spectrum analyzer as follows:

FREQ	40 kHz (2nd harmonic)
MARKER → PEAK	

8. Using the spectrum analyzer marker functions, measure the amplitude on the spectrum analyzer for the UUT's 2nd harmonic. The displayed (delta marker) value must be at least 60 dB lower (-60 dBc) than the peak value referred to in step 5.

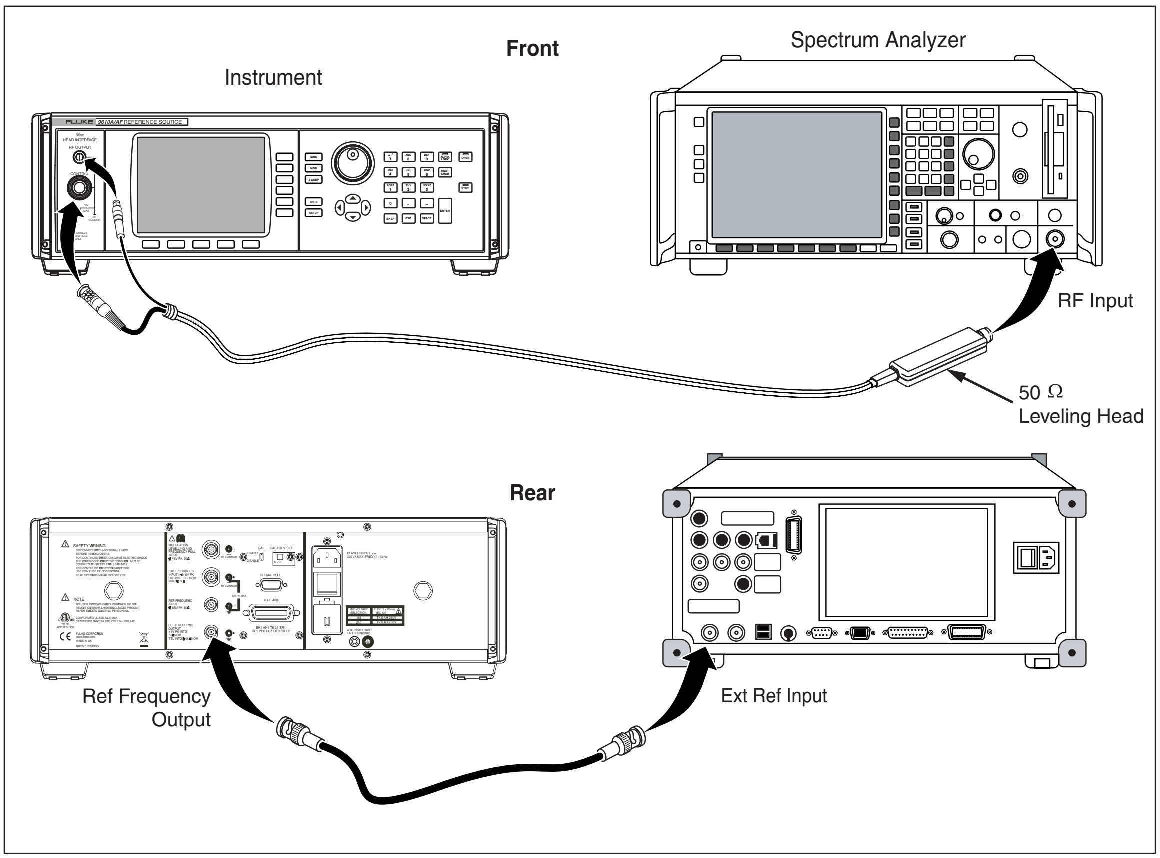


Figure 5-3. Equipment Connections - Harmonics and Spurious Content Test

9. Set the spectrum analyzer as follows:

FREQ	60 kHz (3rd harmonic)
MARKER → PEAK	

10. Using the spectrum analyzer marker functions, measure the marker amplitude on the spectrum analyzer for the UUT’s 3rd harmonic. The displayed (delta marker) value must be at least 60 dB lower (-60 dBc) than the peak value referred to in step 5.

11. Repeat steps 5 through 9 for all frequencies in Table 5-3, using the settings and tolerances shown for each.

Table 5-3. Harmonics Test

Level	Frequency	2nd Harmonic	Tolerance	3rd Harmonic	Tolerance
+24 dBm	20 kHz	40 kHz	-60 dBc	60 kHz	-60 dBc
	100 kHz	200 kHz	-60 dBc	300 kHz	-60 dBc
	2.5 MHz	5 MHz	-60 dBc	7.5 MHz	-60 dBc
	5.5 MHz	11 MHz	-60 dBc	16.5 MHz	-60 dBc
	11 MHz	22 MHz	-60 dBc	33 MHz	-60 dBc
	22 MHz	44 MHz	-60 dBc	66 MHz	-60 dBc
	31.25 MHz	62.5 MHz	-60 dBc	93.75 MHz	-60 dBc
	44 MHz	88 MHz	-60 dBc	132 MHz	-60 dBc
	62.5 MHz	125 MHz	-60dBc	187.5 MHz	-60dBc
	88 MHz	176 MHz	-60 dBc	264 MHz	-60 dBc
	125 MHz	250 MHz	-60 dBc	375 MHz	-60 dBc
+20 dBm	250 MHz	500 MHz	-60 dBc	750 MHz	-60 dBc
	354 MHz	708 MHz	-60 dBc	1.062 GHz	-60 dBc
	500 MHz	1 GHz	-60 dBc	1.5 GHz	-60 dBc
	714 MHz	1.428 GHz	-60 dBc	2.142 GHz	-60 dBc
	1 GHz	2 GHz	-60 dBc	3 GHz	-60 dBc
	1.4 GHz	2.8 GHz	-55 dBc	4.2 GHz	-55 dBc
+14 dBm	1.8 GHz	3.6 GHz	-55 dBc	5.4 GHz	-55 dBc
	2.7 GHz	5.4 GHz	-55 dBc	8.1 GHz	-55 dBc
	4 GHz	8 GHz	-55 dBc	12 GHz	-55 dBc

12. Set the spectrum analyzer as follows:

PRESET	
COUPLING	DC
REF LVL	+10 dBm
EXT REF	On
FREQ	2.1 GHz
SPAN	2 MHz

13. Set the UUT as follows:

Mode	Leveled Sine
Frequency	2.1 GHz
Level	+4.6 dBm
Output	OPER

14. Set the spectrum analyzer to single sweep, trigger a sweep and wait for the sweep to complete. Press MARKER → PEAK.

15. Using the spectrum analyzer marker functions, measure the amplitude of any spurious signals dtected. Verify any spurious signals at offsets >±3kHz from the output frequency within the range of ±1MHz are ≤ -60 dBc.

16. Set the output frequency of the UUT to each of the frequencies listed in Table 5-4, repeating steps 14 through 15.
17. Set the UUT output to STBY. Leave the connections intact for use in the following test, if desired.

Table 5-4. Spurious Content Test

Output Frequency	Tolerance
2.1 GHz	< -60 dBc
2.199 997 GHz	< -60 dBc
2.200 003 GHz	< -60 dBc
2.399 997GHz	< -60 dBc
2.5 GHz	< -60 dBc
2.600 003 GHz	< -60 dBc
2.7 GHz	< -60 dBc
2.799 997GHz	< -60 dBc
2.800 003 GHz	< -60 dBc
3.0 GHz	< -60 dBc
3.199 997 GHz	< -60 dBc
3.200 003 GHz	< -60 dBc
3.400 003 GHz	< -60 dBc
3.599 997 GHz	< -60 dBc
3.800 003 GHz	< -60 dBc
4.0 GHz	< -60 dBc

Phase Noise Test (Optional)

Equipment Required for this Test:

- Spectrum Analyzer, with phase noise measurement option
- 50 Ω Leveling Head (supplied with UUT)

Use the following test to verify the UUT phase noise performance using a spectrum analyzer equipped with a phase noise measurement option.

1. Connect the output of the 50 Ω Leveling Head to the RF INPUT of the spectrum analyzer.
2. Set the spectrum analyzer as follows:

PRESET	
EXT REF	On
REF LEVEL	+16 dBm
CENTER FREQ	1 GHz
SPAN	1 MHz

3. Set the UUT as follows:

Mode	Leveled Sine
Frequency	1 GHz
Level	+13 dBm
Output	OPER

4. Press MARKER → PEAK on the spectrum analyzer to place the marker at the signal peak. Enable the spectrum analyzer phase noise measurement function and allow the measurement process to complete.

Note

It may be necessary to adjust the spectrum analyzer resolution bandwidth and/or span to achieve the desired results when measuring phase noise.

5. Press MKR. Using the keypad, enter a marker frequency of 10 kHz. Observing the marker data on the spectrum analyzer display, verify the phase noise at a 10 kHz offset is ≤ -114 dBc/Hz.
6. Repeat step 5 for the offset frequencies listed in Table 5-5.
7. Set the UUT output to STBY. Remove all connections to the Leveling Head.

Table 5-5. Phase Noise Test

Level	Output Frequency	Offset frequency	Tolerance
+13 dBm	1 GHz	10kHz	< -114 dBc/Hz
		100 kHz	< -119 dBc/Hz
		1 MHz	< -132 dBc/Hz

Modulation Test (Optional)

Equipment required for this test:

- Spectrum Analyzer/Measuring Receiver
- 50 Ω Leveling Head (supplied with UUT)

Use the following procedure to verify the amplitude and frequency modulated outputs of the UUT:

Note

Verification of phase modulation is not required as phase modulation is created as sinusoidal frequency modulation with peak deviation derived from the phase deviation and rate settings.

1. Connect the output of the 50 Ω Leveling Head to the RF INPUT of the measuring receiver.

2. Set the Spectrum Analyzer/Measuring Receiver to Measuring Receiver Mode and press PRESET.

Note

It may be necessary to readjust the measuring receiver's settings from those automatically configured in the modulation measurement mode. In particular, to ensure the demodulation bandwidth and measurement time settings are adequate to accommodate the modulated signal RF spectrum and capture at least five cycles of the modulation waveform.

3. On the UUT press the MOD key, followed by the Modulation Select softkey and ensure amplitude modulation (AM) is selected. Set the UUT as follows:

Frequency	30 MHz
Level	+10 dBm
Mod Rate	1kHz (Sine)
AM Depth	50%
Output	OPER

4. Allow the measuring receiver to autotune to the input signal and measure the AM rate. Verify that the measured rate is within the tolerance listed in Table 5-6.

5. Set the UUT modulation rate to 220kHz and repeat step 4.

Table 5-6. AM Rate Test

Frequency	Modulation Rate	Depth	Tolerance
30MHz	1kHz	50%	0.999 90 – 1.000 10 kHz
	220kHz	50%	219.990 – 220.010 kHz

6. Set the UUT as follows:

Frequency	125 MHz
Level	+14 dBm
Mod Rate	1kHz (Sine)
AM Depth	80%
Output	OPER

7. Allow the measuring receiver to autotune to the input signal and measure the AM depth. Verify that the measured depth is within the tolerance listed in Table 5-7.

8. Repeat step 7 for the remaining AM depth test points listed in Table 5-7.

Table 5-7. AM Depth Test

Frequency	Modulation Rate	Depth	Tolerance
125MHz	1kHz	80%	77.5 – 82.5%
	100kHz	80%	77.5 – 82.5%
1GHz	1kHz	80%	77.5 – 82.5%
	100kHz	80%	77.5 – 82.5%

9. On the UUT press the Modulation Select softkey and select frequency modulation (FM). Set the UUT as follows:

Frequency	125 MHz
Level	+13 dBm
Mod Rate	1kHz (Sine)
FM Deviation	300kHz
Output	OPER
Modulation	OFF

10. Allow the measuring receiver to autotune to the input signal and when tuning is complete set the UUT to Modulation ON.
11. Measure the FM rate. Verify that the measured rate is within the tolerance listed in Table 5-8.
12. Set the UUT as follows and repeat steps 10 and 11.

Frequency	1 GHz
Level	+13 dBm
Mod Rate	300 kHz (Sine)
FM Deviation	1 MHz
Modulation	OFF

Table 5-8. FM Rate Test

Frequency	Modulation Rate	Deviation	Tolerance
62.5 MHz	1k Hz	300 kHz	0.999 90 – 1.000 10 kHz
1 GHz	300 kHz	1 MHz	299.990 – 300.010 kHz

13. Set the UUT as follows:

Frequency	125 MHz
Level	+13 dBm
Mod Rate	1 kHz (Sine)
FM Deviation	100 kHz
Output	OPER
Modulation	OFF

14. Allow the measuring receiver to autotune to the input signal and when tuning is complete set the UUT to Modulation ON.
15. Measure the FM deviation. Verify that the measured deviation is within the tolerance listed in Table 5-9.
16. Repeat step 15 for the remaining FM deviation test points listed in Table 5-9. When setting a new carrier frequency select MODULATION OFF and repeat step 14 prior to repeating step 15.

Table 5-9. FM Deviation Test

Frequency	Modulation Rate	Deviation	Tolerance
125MHz	1 kHz	100 kHz	103.0 kHz – 97.0 kHz
	100 kHz	100 kHz	103.0 kHz – 97.0 kHz
	1 kHz	300 kHz	309.0 kHz – 291.0 kHz
	200 kHz	300 kHz	309.0 kHz – 291.0 kHz
1GHz	1kHz	1 MHz	1.030 MHz – 0.970 MHz
	300kHz	1 MHz	1.030 MHz – 0.970 MHz

Note

In order to minimize Leveling Head interchange, the following tests are divided into 50 Ω and 75 Ω sections.

Level Accuracy - 50 Ω

Equipment required for this test:

- AC Measurement Standard
- Precision 50 Ω feedthrough termination
- 50 Ω Type-N female-to-BNC male adapter
- Power Meter
- Power Sensor, Thermal, 50 Ω
- Power Sensor, Diode, 50 Ω
- Precision Adapter, Type-N female-to-female, 50 Ω
- Spectrum Analyzer
- 50 Ω Leveling Head (supplied with UUT)

Use the following procedure to verify the absolute level accuracy of the UUT 50 Ω output. The procedure makes use of an AC Measurement Standard, followed by a power meter and sensors, and finally, a spectrum analyzer/measuring receiver. At various points within the process values previously measured using one reference device are required for subsequent use with another device. It is recommended that the users familiarize themselves with the entire absolute level accuracy verification procedure before commencing.

Note

Unwanted interference from signals at 10MHz due to the frequency refernce outputs of equipment operating in the vicinity of the test setup or the equipment used during the tests can cause erroneous results. In order to avoid such problems, it is recommended that for test frequencies from 10MHz to 300MHz a small offset (50kHz) is added to the listed nominal frequency if the test frequency is a multiple of 10MHz.

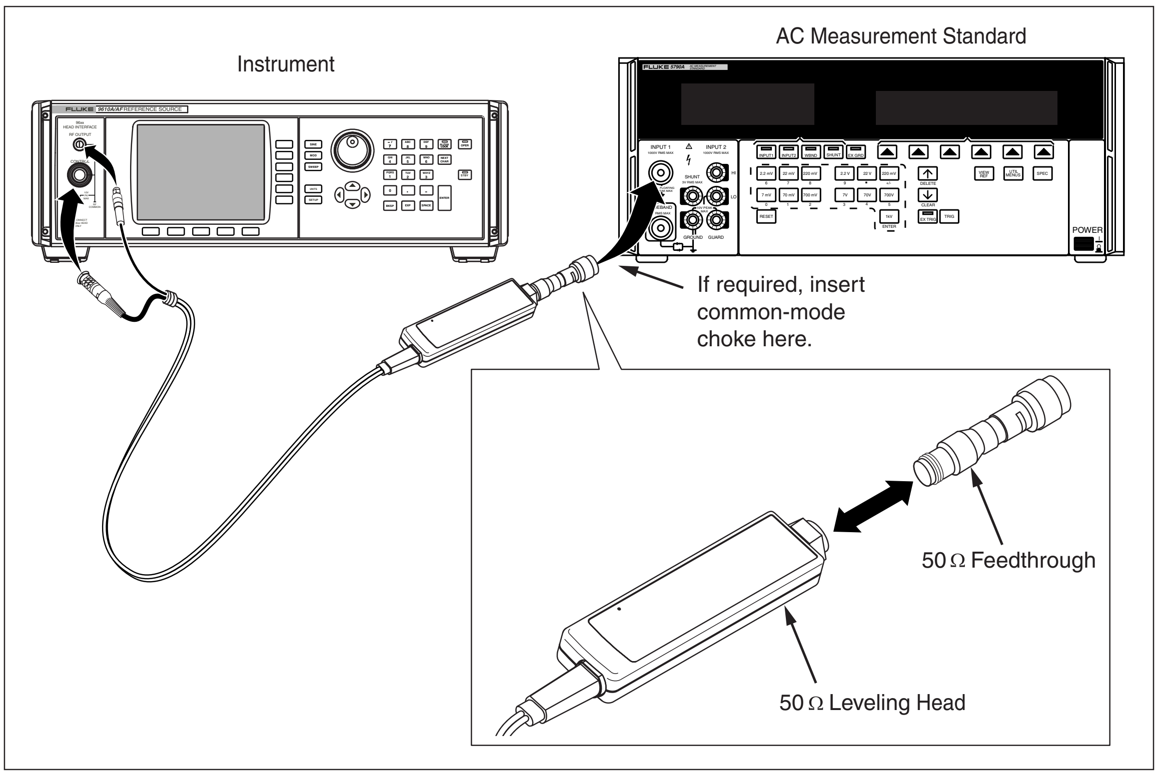
1. Connect the 50 Ω Leveling Head to the INPUT 1 connector on the AC Measurement Standard using a precision 50 Ω feedthrough termination. (If a Type-N feedthrough termination is not available, use a BNC 50 Ω feedthrough termination and appropriate adapters. Ensure that BNC connector contact resistance and repeatability does not significantly degrade measurement uncertainty). Select INPUT 1. See Figure 5-4 for equipment connections.

Note

It may be necessary to connect the low input of the AC Measurement Standard to chassis ground to achieve satisfactory noise performance. To obtain a settled noise-free reading it may also be necessary to use a common mode choke in series between the feedthrough termination and the AC Measuremnt Standard input, with the ground applied at the choke input. A common mode choke of 250 μH is usually effective. A suitable choke is 6 turns of small-diameter coaxial cable through a TDK toroid, manufacturer's part no. H5C2-T28-13-16 (available as Fluke part no. 474908) Refer to section 4-12 of the 5970A Operator Manual for additional explanation.

Note

Measurements made on the 5790A 2.2 mV range (at levels below -40 dBm) require correction for the 2.2 mV range linearity error.



ead217f.eps

Figure 5-4. Equipment Connections – Level Accuracy Tests (50 Ω), Low Frequency Points

2. Set the UUT as follows:

Mode	Leveled Sine
Frequency	1 kHz
Level	+24 dBm
Output	OPER

3. Allow the AC Measurement Standard to make several measurements and the reading to settle. Convert the settled reading from V rms to dBm using the following formula:

$$\text{dBm } (50\ \Omega) = 10Log_{10}\left(\frac{V^2}{50 \times 0.001}\right)$$

The result must be within the tolerance listed in Table 5-10.

4. Set the UUT output to the next frequency listed in Table 5-10 for this test amplitude.
5. Repeat step 3 and confirm that the measured output level is within the tolerance shown in Table 5-10.
6. When the test frequency is 100kHz, record the measured level in dBm as P_1 for use later in this procedure.
7. Repeat steps 2 through 7 for the next test amplitude listed in Table 5-10, applying the 5790A 2.2 mV range linearity error correction at levels below -40dBm .
8. Connect the 50 Ω Leveling Head to the 50 Ω thermal power sensor via a precision 50 Ω Type-N female-to-female adapter. See Figure 5-5 for equipment connections.
9. Set the UUT as follows:

Mode	Leveled Sine
Frequency	100 kHz
Level	+20 dBm
Output	OPER

Table 5-10. Level Accuracy Test (50 Ω), low frequency test points.

Amplitude	Frequency	Tolerance
+20 dBm	1 kHz	±0.05dBm
	20 kHz	±0.05dBm
	100 kHz	±0.05dBm
+14 dBm	1 kHz	±0.05dBm
	20 kHz	±0.05dBm
	100 kHz	±0.05dBm
+3 dBm	1 kHz	±0.05dBm
	20 kHz	±0.05dBm
	100 kHz	±0.05dBm
-7 dBm	1 kHz	±0.05dBm
	20 kHz	±0.05dBm
	100 kHz	±0.05dBm
-17 dBm	1 kHz	±0.05dBm
	20 kHz	±0.05dBm
	100 kHz	±0.05dBm
-27 dBm	1 kHz	±0.05dBm
	20 kHz	±0.05dBm
	100 kHz	±0.05dBm
-37 dBm	1 kHz	±0.05dBm
	20 kHz	±0.05dBm
	100 kHz	±0.05dBm
-47 dBm	1 kHz	±0.05dBm
	20 kHz	±0.05dBm
	100 kHz	±0.05dBm

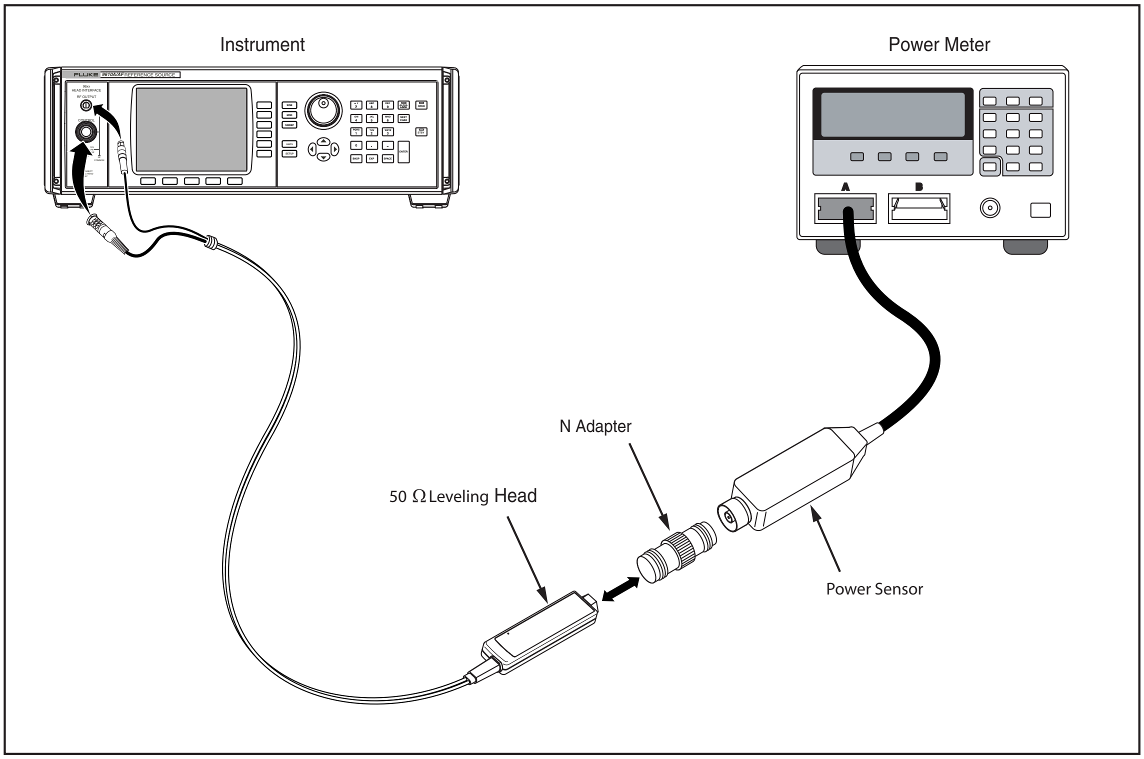


Figure 5-5. Level Accuracy Tests (50Ω), High Frequency Points

10. Configure the power meter to indicate readings in dBm. Enter the measurement frequency (0.1 MHz) into the power meter to enable cal factor (frequency) correction.

Note

The recommended power meter has power sensor calibration factors stored internally in the sensor. Setting the input frequency in the power meter automatically selects the appropriate cal factor for the measurement. However, the power sensor may also be accompanied by a table of calibration factors which must be applied externally.

11. Allow the power meter reading to settle. Record the measured level in dBm as P_2 for use later in this procedure.
12. Set the UUT frequency to the first test frequency listed in Table 5-11 MHz.
13. Enter the measurement frequency into the power meter and allow the power meter reading to settle. Record the measured level in dBm as P_3 . Calculate the UUT output $P_{out} = P_1 + (P_3 – P_2)$.
14. Check that the value of P_{out} is within the tolerance shown in Table 5-11.

Note

The insertion loss of the 50 Ω Type-N female-to-female adapter must be taken into account at each measurement frequency.

15. Set the UUT to the next frequency point at this amplitude listed in Table 5-11, and repeat steps 14 through 15.
16. Set the UUT to 100kHz at the next amplitude listed in Table 5-11, and repeat steps 11 through 16.
17. Set the UUT output to STBY.

Table 5-11. Level Accuracy Test (50 Ω), High Frequency Test Points, Thermal Power Sensor

Amplitude	Frequency	Tolerance
+20 dBm	100 kHz	Reference
	10 MHz	±0.05dBm
	125 MHz	±0.05dBm
	300 MHz	±0.10dBm
	1.4 GHz	±0.25dBm
+14 dBm	100 kHz	Reference
	10 MHz	±0.05dBm
	125 MHz	±0.05dBm
	300 MHz	±0.10dBm
	1.4 GHz	±0.25dBm
	3 GHz	±0.30dBm
	4 GHz	±0.50dBm
+3 dBm	100 kHz	Reference
	10 MHz	±0.05dBm
	125 MHz	±0.05dBm
	300 MHz	±0.10dBm
	1.4 GHz	±0.25dBm
	3 GHz	±0.30dBm
	4 GHz	±0.50dBm
-7 dBm	100 kHz	Reference
	10 MHz	±0.05dBm
	125 MHz	±0.05dBm
	300 MHz	±0.10dBm
	1.4 GHz	±0.25dBm
	3 GHz	±0.30dBm
	4 GHz	±0.50dBm

18. Connect the 50 Ω Leveling Head to the 50 Ω diode power sensor via a precision 50 Ω Type-N female-to-female adapter. See Figure 5-5 for equipment connections.
19. Set the UUT as follows:

Mode	Leveled Sine
Frequency	100 kHz
Level	-17 dBm
Output	OPER

20. Enter the measurement frequency (0.1 MHz) into the power meter to enable cal factor (frequency) correction.

Note

The recommended power meter has power sensor calibration factors stored internally in the sensor. Setting the input frequency in the power meter automatically selects the appropriate cal factor for the measurement. However, the power sensor may also be accompanied by a table of calibration factors which must be applied externally.

Note

The diode-based power sensor may exhibit frequency dependent linearity errors, and additional corrections for these errors must also be applied.

21. Allow the power meter reading to settle. Record the measured level in dBm as P_2 for use later in this procedure.
22. Set the UUT frequency to the first test frequency listed in Table 5-12 MHz.
23. Enter the measurement frequency into the power meter and allow the power meter reading to settle. Record the measured level in dBm as P_3 . Calculate the UUT output $P_{out} = P_1 + (P_3 - P_2)$.
24. Check that the value of P_{out} is within the tolerance shown in Table 5-12.

Note

The insertion loss of the 50 Ω Type-N female-to-female adapter must be taken into account at each measurement frequency.

25. Set the UUT to the next frequency point listed at this amplitude in Table 5-12, and repeat steps 14 through 15.
26. Set the UUT to 100kHz at the next amplitude listed in Table 5-12, and repeat steps 11 through 16. When the test amplitude is -37dBm at each frequency record the value of P_{out} at -37dBm as P_{-37}, and when the test amplitude is -47dBm at each frequency record the value of P_{out} at -47dBm as P_{-47}. These values will be used later in this procedure.
27. Set the UUT output to STBY.

Table 5-12. Level Accuracy Test (50 Ω), High Frequency Test Points, Diode Power Sensor

Amplitude	Frequency	Tolerance
-17 dBm	100 kHz	Reference
	10 MHz	±0.05dBm
	125 MHz	±0.05dBm
	300 MHz	±0.10dBm
	1.4 GHz	±0.25dBm
	3 GHz	±0.30dBm
	4 GHz	±0.50dBm
-27 dBm	100 kHz	Reference
	10 MHz	±0.05dBm
	125 MHz	±0.05dBm
	300 MHz	±0.10dBm
	1.4 GHz	±0.50dBm
	3 GHz	±0.50dBm
	4 GHz	±0.50dBm
-37 dBm	100 kHz	Reference
	10 MHz	±0.05dBm
	125 MHz	±0.05dBm
	300 MHz	±0.10dBm
	1.4 GHz	±0.50dBm
	3 GHz	±0.50dBm
	4 GHz	±0.50dBm
-47 dBm	100 kHz	Reference
	10 MHz	±0.05dBm
	125 MHz	±0.05dBm
	300 MHz	±0.10dBm
	1.4 GHz	±0.50dBm
	3 GHz	±0.50dBm
	4 GHz	±0.50dBm

28. Connect the Leveling Head to the RF INPUT of the measuring receiver and connect the REF FREQUENCY OUTPUT (rear panel) from the UUT to the spectrum analyzer Ext Ref In (on rear). See Figure 5-6 for equipment connections.

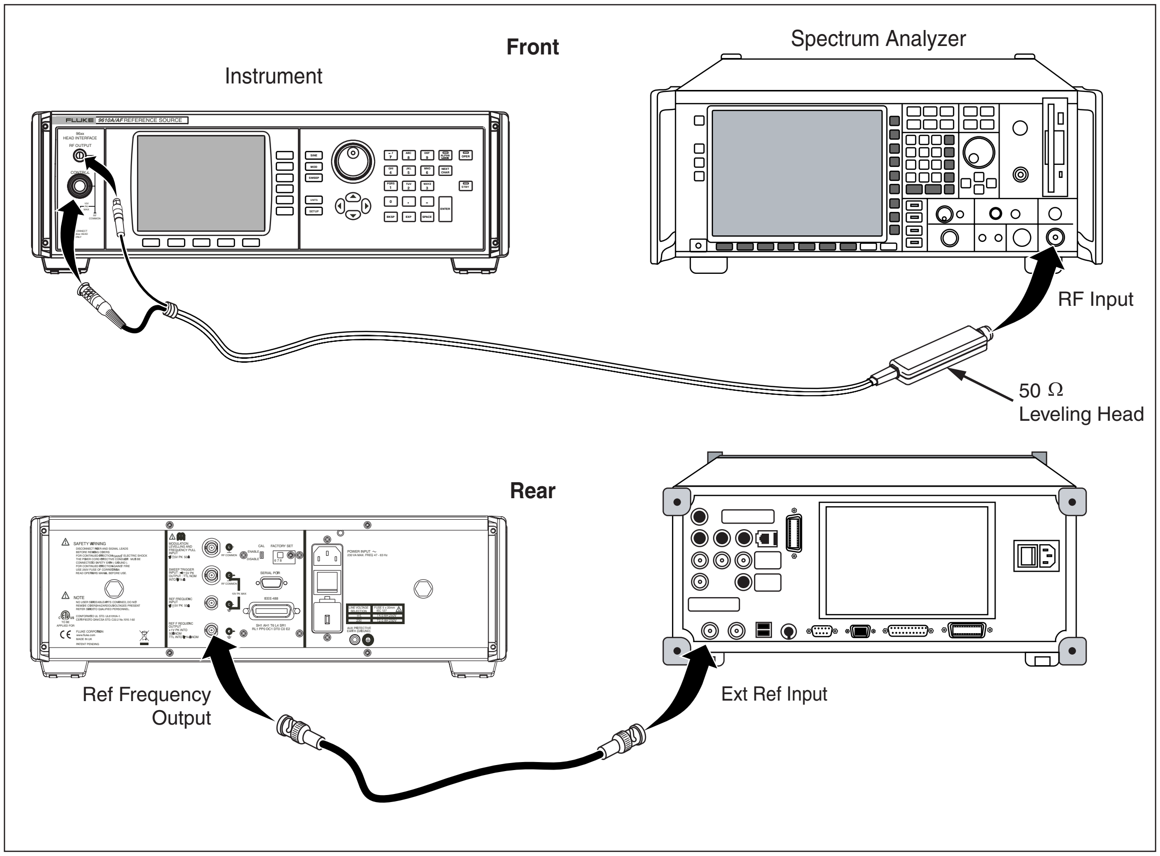


Figure 5-6. Level Accuracy Tests (50 Ω), Low Level Points

Note

Low level measurements are made with a measuring receiver, relative to to levels previously measured with the power sensor. Two levels (-37dBm and -47dBm) are used as reference points to provide the required UUT hardware configurations for the subsequent tests. It is important that the correct sequence is followed as described.

Making these precision low-level measurements requires appropriate choice of measuring receiver settings to provide adequate linearity, noise floor, and reading repeatability throughout the amplitude range required. For any given frequency the measuring receiver the settings must be maintained for all amplitudes at that frequency after establishing the refernce point. In particular, receiver attenuator, reference level, and resolution bandwidth settings must not change.

29. On the UUT enable the REF FREQUENCY OUTPUT and set the UUT as follows:

Frequency	100 kHz
Level	-37 dBm
Output	OPER

30. Allow the measuring receiver to tune the input signal, and then set the controls to measure RF level, relative (dB) to the current input level.

31. Without changing any measuring receiver settings, set the UUT to the next amplitude listed in Table 5-12 for this frequency. Allow the measuring receiver reading to stabilize and record the reading as P_{rel}. (Note that P_{rel} will be a negative number in dB).
32. Calculate the UUT output $P_{out} = P_{-37} + P_{rel}$. Check that the value of P_{out} is within the tolerance shown in part A of Table 5-13.
33. Repeat steps 32 and 33 for each amplitude listed in part A of Table 5-13 for this frequency.
34. Return the UUT output to -47dBm, set the UUT frequency to the next frequency listed in part A of Table 5-13, and repeat steps 31 through 34.
35. Set the UUT to 100kHz at -47dBm. Repeat steps 31 through 35 for the points listed in part B of Table 5-13 using the calculation $P_{out} = P_{-47} + P_{rel}$ in step 33.
36. Set the UUT to STBY.

Table 5-13. Level Accuracy Test (50•), Low Level Test Points

Part	Frequency	Amplitude	Tolerance
A	100 kHz	-37 dBm	Reference
		-66dBm	±0.20dBm
		-85 dBm	±0.50dBm
	10 MHz	-37 dBm	Reference
		-66dBm	±0.20dBm
		-85 dBm	±0.50dBm
	125 MHz	-37 dBm	Reference
		-66dBm	±0.20dBm
		-85 dBm	±0.50dBm
	300 MHz	-37 dBm	Reference
		-66dBm	±0.20dBm
		-85 dBm	±0.50dBm
	1.4 GHz	-37 dBm	Reference
		-66dBm	±0.50dBm
		-85 dBm	±1.00dBm
	3 GHz	-37 dBm	Reference
		-66dBm	±0.50dBm
		-85 dBm	±1.00dBm
	4GHz	-37 dBm	Reference
		-66dBm	±0.50dBm
		-85 dBm	±1.00dBm

Table 5-13. Level Accuracy Test (50•), Low Level Test Points (cont)

Part	Frequency	Amplitude	Tolerance
B	100 kHz	-47 dBm	Reference
		-57dBm	±0.20dBm
		-75 dBm	±0.50dBm
		-95 dBm	±1.50dBm
	10 MHz	-47 dBm	Reference
		-57dBm	±0.20dBm
		-75 dBm	±0.50dBm
		-95 dBm	±1.50dBm
	125 MHz	-47 dBm	Reference
		-57dBm	±0.20dBm
		-75 dBm	±0.50dBm
		-95 dBm	±1.50dBm
	300 MHz	-47 dBm	Reference
		-57dBm	±0.20dBm
		-75 dBm	±0.50dBm
		-95 dBm	±1.50dBm
	1.4 GHz	-47 dBm	Reference
		-57dBm	±0.50dBm
		-75 dBm	±1.00dBm
		-95 dBm	±1.50dBm
	3 GHz	-47 dBm	Reference
		-57dBm	±0.50dBm
		-75 dBm	±1.00dBm
		-95 dBm	±1.50dBm
	4GHz	-47 dBm	Reference
		-57dBm	±0.50dBm
		-75 dBm	±1.00dBm

Note

The above procedure and test points listed in Tables 5-12 and 5-13 verify the performance of all the level control and attenuation circuits that determine level accuracy throughout the entire amplitude range, avoiding the need to make difficult precison level measurements at exteremly low levels below -95dBm. However, the following optional ultra-low level measurement procdure is provided for users choosing to verify the lower levl outputs directly.

If required, use the following optional procedure to verify the absolute level accuracy of the UUT below -95dBm.

Note

Ultra-Low level measurements are made relative to to levels previously measured with the measuring receiver. Two levels (-85dBm and -95dBm) are used as reference points to provide the required UUT hardware configurations for the subsequent tests. The value of the output level at -85dBm and -95dBm measured in steps 30 through 37 above will be used as refernces in the following procedure, identified as P_{-85} and P_{-95} respectively for each test frequency. It is important that the correct sequence is followed as described.

Making these precision ultra-low level measurements requires appropriate choice of measuring receiver settings to provide adequate linearity, noise floor, and reading repeatability throughout the amplitude range required. For any given frequency the measuring receiver the settings must be maintained for all amplitudes at that frequency after establishing the refernce point. In particular, receiver attenuator, reference level, and resolution bandwidth settings must not change.

37. On the UUT enable the REF FREQUENCY OUTPUT and set the UUT as follows:

Frequency	100 kHz
Level	-85 dBm
Output	OPER

38. Allow the measuring receiver to tune the input signal, and then set the controls to measure RF level, relative (dB) to the current input level.
39. Without changing any measuring receiver settings, set the UUT to the next amplitude listed in part A of Table 5-14 for this frequency. Allow the measuring receiver reading to stabilize and record the reading as P_{rel}. (Note that P_{rel} will be a negative number in dB).
40. Calculate the UUT output $P_{out} = P_{-85} + P_{rel}$. Check that the value of P_{out} is within the tolerance shown in part A of Table 5-14.
41. Repeat steps 40 and 41 for each amplitude listed in part A of Table 5-14 for this frequency.
42. Return the UUT output to -85dBm, set the UUT frequency to the next frequency listed in part A of Table 5-14 and repeat steps 39 through 42.
43. Set the UUT to 100kHz at -95dBm. Repeat steps 39 through 43 for the points listed in part B of Table 5-14 using the calculation $P_{out} = P_{-95} + P_{rel}$ in step 41.
44. Set the UUT to STBY.

Table 5-14. Optional Ultra-Low Level Accuracy Test (50 Ω) Points

Part	Frequency	Amplitude	Tolerance
A	100 kHz	-85 dBm	Reference
		-105dBm	±1.50dBm
	10 MHz	-85 dBm	Reference
		-105dBm	±1.50dBm
	125 MHz	-85 dBm	Reference
		-105dBm	±1.50dBm
	300 MHz	-85 dBm	Reference
		-105dBm	±1.50dBm
	1.4 GHz	-85 dBm	Reference
		-105dBm	±1.50dBm
	3 GHz	-85 dBm	Reference
		-105dBm	±1.50dBm
B	100 kHz	-95dBm	Reference
		-115dBm	±1.50dBm
		-124 dBm	±1.50dBm
	10 MHz	-95dBm	Reference
		-115dBm	±1.50dBm
		-124 dBm	±1.50dBm
	125 MHz	-95dBm	Reference
		-115dBm	±1.50dBm
		-124 dBm	±1.50dBm
	300 MHz	-95dBm	Reference
		-115dBm	±1.50dBm
		-124 dBm	±1.50dBm
	1.4 GHz	-95dBm	Reference
		-115dBm	±1.50dBm
		-124 dBm	±1.50dBm
	3 GHz	-95dBm	Reference
		-115dBm	±1.50dBm
		-124 dBm	±1.50dBm

Attenuation Accuracy - 50 Ω (Optional)

Equipment required for this test:

- Measuring Receiver
- Attenuator, 6 dB, Type-N male / female, 50 Ω
- 50 Ω Leveling Head (supplied with UUT)

Note

In the following tests, the tolerances shown refer to specifications listed in Chapter 1 of this manual. It may be necessary, in some cases, to alter the test limits based on the uncertainty of the actual equipment used. For example, if the Instrument specification is ±0.025 dB and the measuring receiver uncertainty is ± (0.015 dB + 0.005 dB per 10 dB step) the test limit for 30 dB would be ±0.039 dB (the root-sum-square of 0.025 and 0.030).

Use the following procedure to verify the attenuation accuracy of the UUT output relative to +16 dBm, 50 Ω:

1. Connect the Leveling Head to the RF INPUT of the measuring receiver via a 6 dB attenuator and connect the REF FREQUENCY OUTPUT (rear panel) from the UUT to the spectrum analyzer Ext Ref In (on rear). See Figure 5-7 for equipment connections.

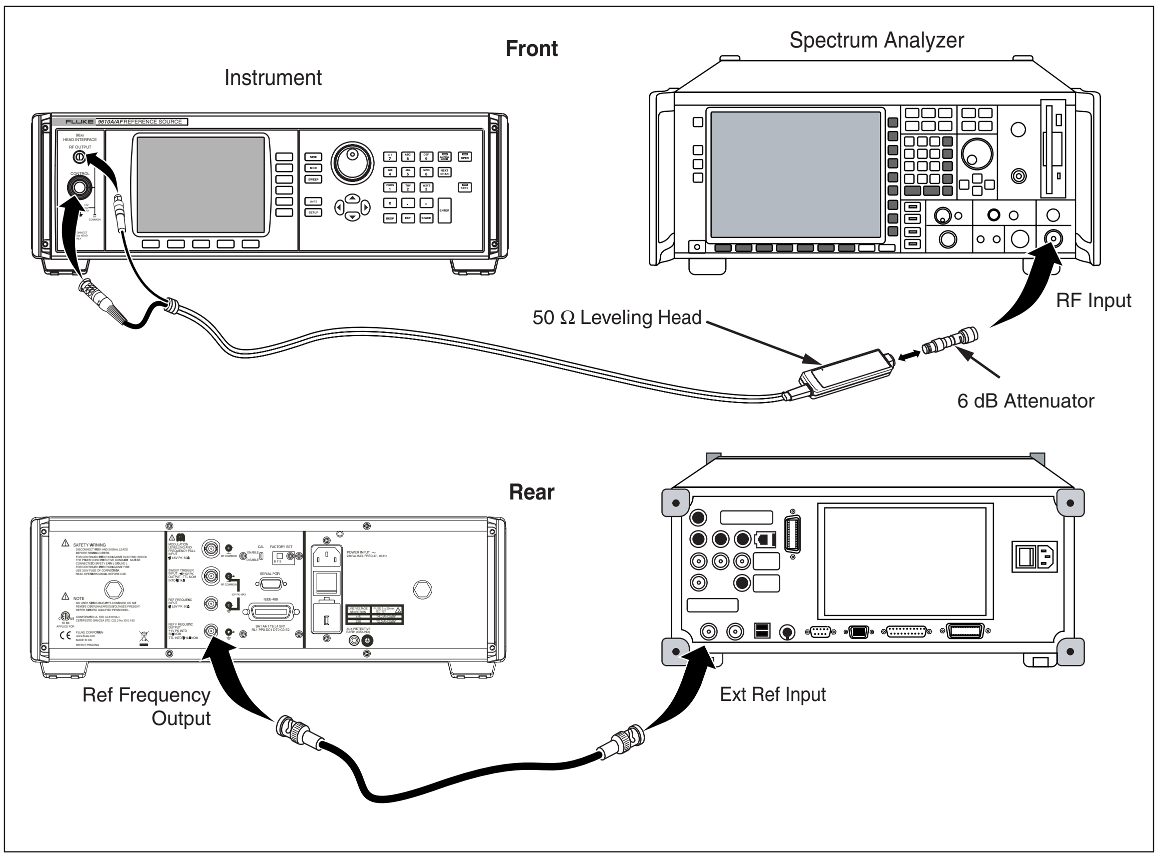


Figure 5-7. Equipment Connections - Attenuation Accuracy Test (50 Ω)

Note

The 6 dB attenuator is used to minimize mismatch errors. In some cases, additional attenuation may be required to satisfy alternative measuring receiver maximum input limitations.

Note

Unwanted interference from signals at 10MHz due to the frequency refernce outputs of equipment operating in the vicinity of the test setup or the equipment used during the tests can cause erroneous results. In order to avoid such problems, it is recommended that a small offset (50kHz) is added to the listed nominal test frequency.

2. On the UUT enable the REF FREQUENCY OUTPUT and set the UUT as follows:

   Frequency 10 MHz
   Level +16 dBm
   Output OPER
3. Allow the measuring receiver to tune the input signal, and then set the controls to measure RF level, relative (dB) to the current input level.
4. At each attenuation level listed in Table 5-15, allow the measuring receiver reading to stabilize, ensuring the indicated value is within the relevant tolerance.
5. Return the UUT attenuation to 0 dB (+16 dBm).
6. Repeat steps 2 through 6 at the attenuation levels shown in Table 5-15 for frequencies of 50 and 100 MHz.
7. Set the UUT to STBY.

Table 5-15. Attenuation Accuracy (50 Ω)

Nominal Attenuation	Absolute Output Level	Specification
0 dB	+16 dBm	Reference
-13 dB	+3 dBm	±0.035 dB
-23 dB	-7 dBm	±0.035 dB
-33 dB	-17 dBm	±0.035 dB
-43 dB	-27 dBm	±0.04 dB
-53 dB	-37 dBm	±0.04 dB
-63 dB	-47 dBm	±0.04 dB
-73 dB	-57 dBm	±0.1 dB
-82 dB	-66 dBm	±0.1 dB
-91 dB	-75 dBm	±0.1 dB
-100 dB	-84 dBm	±0.1 dB

VSWR Test - 50 Ω (Optional)

Equipment required for this test:

- Signal Generator, 50 Ω output
- Spectrum Analyzer
- 50 Ω directional bridge
- Precision 50 Ω Open/Short termination
- 50 Ω Leveling Head (supplied with UUT)

Use the following test to verify the UUT's output VSWR using a directional bridge and a spectrum analyzer.

1. Connect the REF FREQUENCY OUTPUT (rear panel) from the UUT to the spectrum analyzer and signal generator external reference inputs using a BNC tee and BNC male – male cable assemblies. Set the spectrum analyzer and signal generator for external frequency reference. See Figure 5-8.
2. Connect the signal generator RF output to the input port of the directional bridge. Connect the directional bridge coupled (output) port to the spectrum analyzer input.

Note

In order to determine the reference level setting of the spectrum analyzer, the UUT must initially be connected to the directional bridge.

3. Connect the UUT to the test port of the directional bridge.
4. Set the spectrum analyzer as follows:

PRESET	
EXT REF	On
REF LVL	+10 dBm
FREQ	500 MHz
SPAN	Zero Span

5. Set the signal generator as follows:

Frequency	500.00001 MHz
Amplitude	0 dBm
Output	On

6. Set the UUT as follows:

Frequency	500 MHz
Level	+13 dBm
Output	OPER

7. Adjust the spectrum analyzer reference level to place the displayed trace approximately 3 dB below the reference line.
8. Set the UUT to STBY and disconnect it from the directional bridge. Connect the open (50 Ω) termination to the directional bridge test port.
9. Set the spectrum analyzer display units to volts and perform a peak search. Note the marker indication with the test port open.
10. Connect a Type-N short to the directional bridge test port. Perform a peak search with the test port shorted and note the marker indication. Remove the short.

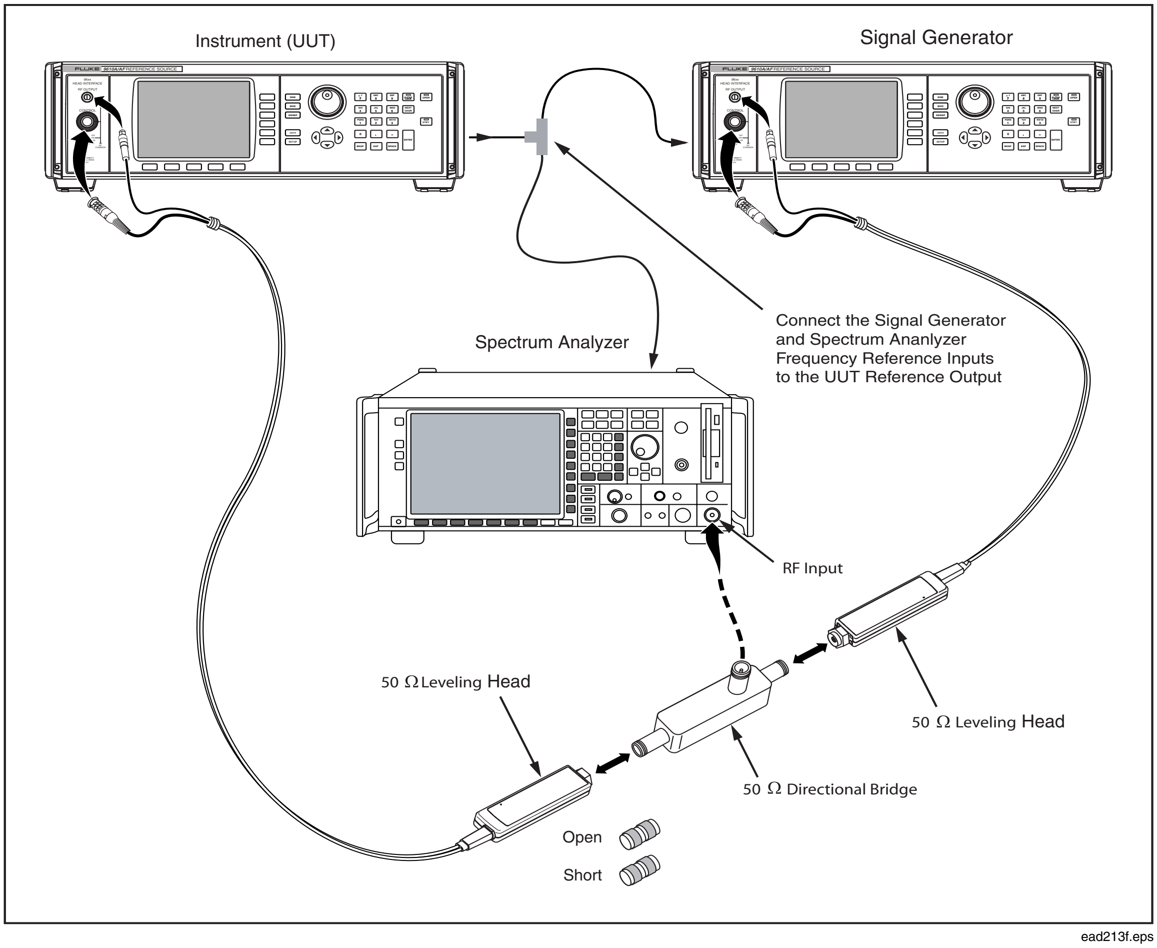


Figure 5-8. Equipment Connections - VSWR Test (50 Ω)

11. Compute the average of the values measured with the test port open and shorted. Record this number as Z_{Max} for the test frequency of 500 MHz.
12. Repeat steps 5 through 11 for the next test frequency at +13dBm listed in Table 5-16, setting the spectrum analyzer center frequency to the test frequency and recording Z_{Max} for each test frequency.
13. Reconnect the directional bridge test port to the UUT and set it to OPER.
14. Set the spectrum analyzer display to linear. Set the sweep time to 5 ms, single sweep.
15. Set the UUT frequency to 500 MHz, set the signal generator frequency to 500.00001 MHz, and set the spectrum analyzer center frequecncy to 500MHz.
16. Initiate a single sweep. Allow the sweep to complete then perform a (maximum) peak search. Note the marker amplitude.
17. Perform a (minimum) peak search and note the marker amplitude.
18. Calculate the difference of the maximum and minimum peak searches, dividing the difference by 2 to determine the peak value. Record this number as $Z_{UUT.}$

Note

Because the reflected signal level is a peak to peak value and the reference value to which it is compared is a peak value, the reflected level must be divided by 2 to convert it to a peak value.

19. Compute the voltage reflection coefficient using the following formula:

$$\rho_\ell = \frac{Z_{UUT}}{Z_{Max}}$$

20. Using the following formula, calculate the UUT VSWR. The calculated value must be < 1.1.

$$VSWR = \frac{1+\rho_\ell}{1-\rho_\ell}$$

21. Repeat steps 15 through 20 for the remaining test frequencies and maximum VSWR values in Table 5-16, setting the spectrum analyzer center frequency in step 15 to the test frequency.
22. Repeat steps 4 through 18 for the remaining UUT output levels and maximum VSWR values in Table 5-16.
23. Set the UUT to STBY.

Table 5-16. VSWR Test (50 Ω)

Frequency	Level	Signal Generator Frequency	Maximum VSWR
500 MHz	+13 dBm	500.00001 MHz	< 1.1
1 GHz		1.00000001 GHz	< 1.2
3 GHz		3.00000001 GHz	< 1.3
4 GHz		4.00000001 GHz	< 1.4
500 MHz	+3 dBm	500.00001 MHz	< 1.1
1 GHz		1.00000001 GHz	< 1.2
3 GHz		3.00000001 GHz	< 1.3
4 GHz		4.00000001 GHz	< 1.4
500 MHz	-7 dBm	500.00001 MHz	< 1.1
1 GHz		1.00000001 GHz	< 1.2
3 GHz		3.00000001 GHz	< 1.3
4GHz		4.00000001 GHz	< 1.4

Level Accuracy - 75 Ω

Equipment required for this test:

- AC Measurement Standard
- Precision 75 Ω feedthrough termination
- 75 Ω Type-N female-to-BNC male adapter
- Power Meter
- Power Sensor, 75 Ω
- Precision Adapter, Type-N female-to-female, 75 Ω
- 75 Ω to 50 Ω impedance-matching pad
- Spectrum Analyzer
- 75 Ω Leveling Head (supplied with UUT)

Use the following procedure to verify the absolute level accuracy of the UUT 75 Ω output. The procedure makes use of an AC Measurement Standard, followed by a power meter and sensors, and finally, a spectrum analyzer/measuring receiver. At various points within the process values previously measured using one reference device are required for subsequent use with another device. It is recommended that the users familiarize themselves with the entire absolute level accuracy verification procedure before commencing.

Note

Unwanted interference from signals at 10MHz due to the frequency refernce outputs of equipment operating in the vicinity of the test setup or the equipment used during the tests can cause erroneous results. In order to avoid such problems, it is recommended that for test frequencies from 10MHz to 300MHz a small offset (50kHz) is added to the listed nominal frequency if the test frequency is a multiple of 10MHz.

1. Connect the 75 Ω Leveling Head to the INPUT 1 connector on the AC Measurement Standard using a precision 75 Ω feedthrough termination. (If a Type-N feedthrough termination is not available, use a BNC 75 Ω feedthrough termination and appropriate adapters. Ensure that BNC connector contact resistance and repeatability does not significantly degrade measurement uncertainty) Select INPUT 1. See Figure 5-9 for equipment connections.

Note

It may be necessary to connect the low input of the AC Measurement Standard to chassis ground to achieve satisfactory noise performance. To obtain a settled noise-free reading it may also be necessary to use a common mode choke in series between the feedthrough termination and the AC Measuremnt Standard input, with the ground applied at the choke input. A common mode choke of 250 µH is usually effective. A suitable choke is 6 turns of small-diameter coaxial cable through a TDK toroid, manufacturer's part no. H5C2-T28-13-16 (available as Fluke part no. 474908) Refer to section 4-12 of the 5970A Operator Manual for additional explanation.

Note

Measurements made on the 5790A 2.2 mV range (at levels below -42 dBm) require correction for the 2.2 mV range linearity error.

2. Set the UUT as follows:

Mode	Leveled Sine
Frequency	1 kHz
Level	+10 dBm
Output	OPER

3. Allow the AC Measurement Standard to make several measurements and the reading to settle. Convert the settled reading from V rms to dBm using the following formula:

$$\text{dBm } (75\ \Omega) = 10Log_{10}\left(\frac{V^2}{75 \times 0.001}\right)$$

4. The result must be within the tolerance listed in Table 5-17.

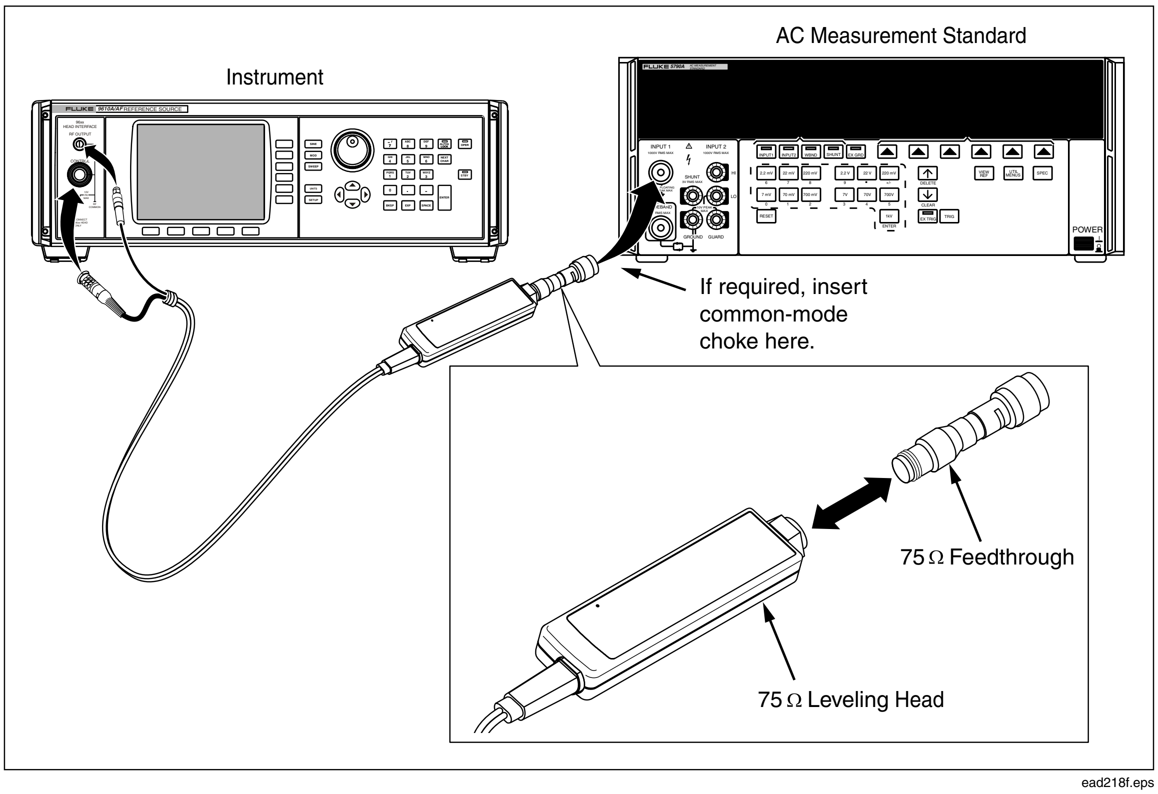


Figure 5-9. Equipment Connections - Level Accuracy Tests (75 Ω), Low Frequency Points

5. Set the UUT output to the next frequency listed in Table 5-17 for this test amplitude.
6. Repeat step 3 and confirm that the measured output level is within the tolerance shown in Table 5-17.
7. When the test frequency is 100kHz, record the measured level in dBm as P_1 for use later in this procedure.
8. Repeat steps 2 through 7 for the next test amplitude listed in Table 5-17, applying the 5790A 2.2 mV range linearity error correction at levels below -40dBm .

Table 5-17. Level Accuracy Test (75 Ω), Low Frequency Test Points

Amplitude	Frequency	Tolerance
+10 dBm	1 kHz	±0.06dBm
	20 kHz	±0.06dBm
	100 kHz	±0.06dBm
+7 dBm	1 kHz	±0.06dBm
	20 kHz	±0.06dBm
	100 kHz	±0.06dBm
-3 dBm	1 kHz	±0.06dBm
	20 kHz	±0.06dBm
	100 kHz	±0.06dBm

Table 5-17. Level Accuracy Test (75 Ω), Low Frequency Test Points (cont)

Amplitude	Frequency	Tolerance
-13 dBm	1 kHz	±0.06dBm
	20 kHz	±0.06dBm
	100 kHz	±0.06dBm
-23 dBm	1 kHz	±0.06dBm
	20 kHz	±0.06dBm
	100 kHz	±0.06dBm
-33 dBm	1 kHz	±0.06dBm
	20 kHz	±0.06dBm
	100 kHz	±0.06dBm
-43 dBm	1 kHz	±0.06dBm
	20 kHz	±0.06dBm
	100 kHz	±0.06dBm
-53 dBm	1 kHz	±0.06dBm
	20 kHz	±0.06dBm
	100 kHz	±0.06dBm

9. Connect the 75 Ω Leveling Head to the 75 Ω power sensor via a precision 75 Ω Type-N female-to-female adapter. See Figure 5-10 for equipment connections.

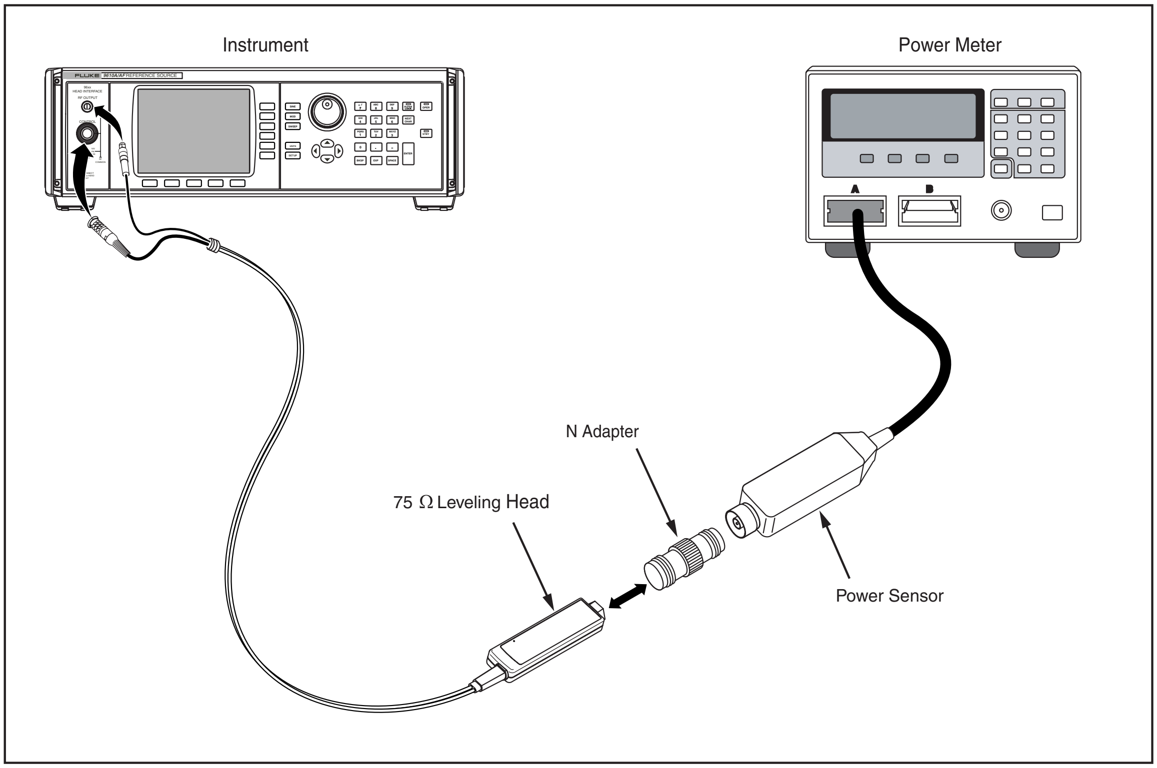


Figure 5-10. Equipment Connections- Level Accuracy Tests (75), High Frequency Points

10. Set the UUT as follows:

Mode	Leveled Sine
Frequency	100 kHz
Level	+10 dBm
Output	OPER

11. Configure the power meter to indicate readings in dBm. Enter the measurement frequency (0.1 MHz) into the power meter to enable cal factor (frequency) correction.

Note

The recommended power meter has power sensor calibration factors stored internally in the sensor. Setting the input frequency in the power meter automatically selects the appropriate cal factor for the measurement. However, the power sensor may also be accompanied by a table of calibration factors which must be applied externally.

Note

A diode-based power sensor may exhibit frequency dependent linearity errors, and additional corrections for these errors must also be applied.

12. Allow the power meter reading to settle. Record the measured level in dBm as P_2 for use later in this procedure.
13. Set the UUT frequency to the first test frequency listed in Table 5-18.
14. Enter the measurement frequency into the power meter and allow the power meter reading to settle. Record the measured level in dBm as P_3 . Calculate the UUT output Pout $= P_1 + (P_3 - P_2)$.

15. Check that the value of Pout is within the tolerance shown in Table 5-18.

Note

The insertion loss of the 75 Ω Type-N female-to-female adapter must be taken into account at each measurement frequency.

16. Set the UUT to the next frequency point listed in Table 5-18 at this amplitude, and repeat steps 14 through 15.
17. Set the UUT to 100kHz at the next amplitude listed in Table 5-18, and repeat steps 11 through 16.
18. Set the UUT output to STBY.

Table 5-18. Level Accuracy Test (75 •), High Frequency Test Points

Amplitude	Frequency	Tolerance
+10 dBm	100 kHz	Reference
	10 MHz	±0.06dBm
	125 MHz	±0.06dBm
	300 MHz	±0.15dBm
	1 GHz	±0.25dBm
+7 dBm	100 kHz	Reference
	10 MHz	±0.06dBm
	125 MHz	±0.06dBm
	300 MHz	±0.15dBm
	1.4 GHz	±0.25dBm
	2 GHz	±0.30dBm
-3 dBm	100 kHz	Reference
	10 MHz	±0.06dBm
	125 MHz	±0.06dBm
	300 MHz	±0.15dBm
	1.4 GHz	±0.25dBm
	2 GHz	±0.30dBm
-13 dBm	100 kHz	Reference
	10 MHz	±0.06dBm
	125 MHz	±0.06dBm
	300 MHz	±0.15dBm
	1.4 GHz	±0.25dBm
	2 GHz	±0.30dBm
-23 dBm	100 kHz	±0.06dBm
	10 MHz	±0.06dBm
	125 MHz	±0.15dBm
	300 MHz	±0.25dBm
	1.4 GHz	±0.30dBm
	2 GHz	±0.06dBm

Table 5-18. Level Accuracy Test (75 Ω), High Frequency Test Points (cont)

Amplitude	Frequency	Tolerance
-33 dBm	100 kHz	Reference
	10 MHz	±0.15dBm
	100 MHz	±0.15dBm
	300 MHz	±0.15dBm
	1.4 GHz	±0.50dBm
	2 GHz	±0.50dBm
-43 dBm	100 kHz	Reference
	10 MHz	±0.15dBm
	100 MHz	±0.15dBm
	300 MHz	±0.15dBm
	1.4 GHz	±0.50dBm
	2 GHz	±0.50dBm
-53 dBm	100 kHz	Reference
	10 MHz	±0.15dBm
	100 MHz	±0.15dBm
	300 MHz	±0.15dBm
	1.4 GHz	±0.50dBm
	2 GHz	±0.50dBm

19. Connect the Leveling Head to the RF INPUT of the measuring receiver and connect the REF FREQUENCY OUTPUT (rear panel) from the UUT to the spectrum analyzer Ext Ref In (on rear). See Figure 5-11 for equipment connections.

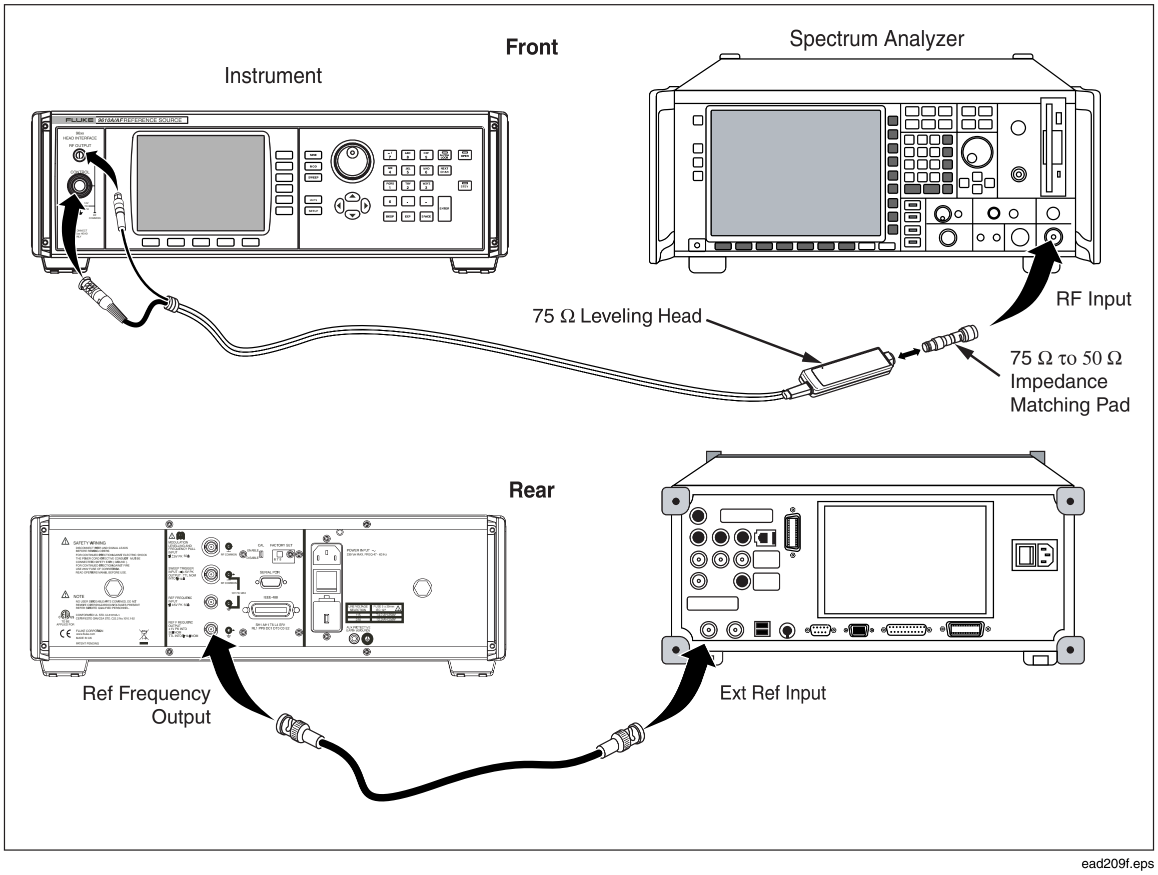


Figure 5-11. Equipment Connections- Level Accuracy Tests (75 Ω), Low Level Points

Note

Low level measurements are made with a measuring receiver, relative to to levels previously measured with the power sensor. Two levels (-43dBm and -53dBm) are used as refernce points to provide the required UUT hardware configurations for the subsequent tests. It is important that the correct sequence is followed as described.

Making these precision low-level measurements requires appropriate choice of measuring receiver settings to provide adequate linearity, noise floor, and reading repeatability throughout the amplitude range required. For any given frequency the measuring receiver the settings must be maintained for all amplitudes at that frequency after establishing the refernce point. In particular, receiver attenuator, reference level, and resolution bandwidth settings must not change.

20. On the UUT enable the REF FREQUENCY OUTPUT and set the UUT as follows:

Frequency	100 kHz
Level	-43 dBm
Output	OPER

21. Allow the measuring receiver to tune the input signal, and then set the controls to measure RF level, relative (dB) to the current input level.

22. Without changing any measuring receiver settings, set the UUT to the next amplitude for this frequency listed in Table 5-19. Allow the measuring receiver reading to stabilize and record the reading as P_{rel}. (Note that P_{rel} will be a negative number in dB).
23. Calculate the UUT output $P_{out} = P_{-43} + P_{rel}$. Check that the value of P_{out} is within the tolerance shown in part A of Table 5-19.
24. Repeat steps 22 and 23 for each amplitude listed for this frequency in part A of Table 5-19.
25. Return the UUT output to -43dBm, set the UUT frequency to the next frequency listed in part A of Table 5-19, and repeat steps 21 through 24.
26. Set the UUT to 100kHz at -53dBm. Repeat steps 21 through 25 for the points listed in part B of Table 5-19 using the calculation $P_{out} = P_{-53} + P_{rel}$ in step 23.
27. Set the UUT to STBY.

Table 5-19. Level Accuracy Test (75 Ω), Low Level Test Points

Part	Frequency	Amplitude	Tolerance
A	100 kHz	-43 dBm	Reference
		-72dBm	±0.20dBm
		-91 dBm	±0.70dBm
	10 MHz	-43 dBm	Reference
		-72dBm	±0.20dBm
		-91 dBm	±0.70dBm
	125 MHz	-43 dBm	Reference
		-72dBm	±0.20dBm
		-91 dBm	±0.70dBm
	300 MHz	-43 dBm	Reference
		-72dBm	±0.20dBm
		-91 dBm	±0.70dBm
	1.4 GHz	-43 dBm	Reference
		-72dBm	±0.50dBm
		-91 dBm	±1.00dBm
	2 GHz	-43 dBm	Reference
		-72dBm	±0.50dBm
		-91 dBm	±1.00dBm

Table 5-19. Level Accuracy Test (75 Ω), Low Level Test Points (cont)

Part	Frequency	Amplitude	Tolerance
B	100 kHz	-53dBm	Reference
		-63dBm	±0.20dBm
		-81 dBm	±0.70dBm
		-101 dBm	±1.50dBm
	10 MHz	-53dBm	Reference
		-63dBm	±0.20dBm
		-81 dBm	±0.70dBm
		-101 dBm	±1.50dBm
	125 MHz	-53dBm	Reference
		-63dBm	±0.20dBm
		-81 dBm	±0.70dBm
		-101 dBm	±1.50dBm
	300 MHz	-53dBm	Reference
		-63dBm	±0.20dBm
		-81 dBm	±0.70dBm
		-101 dBm	±1.50dBm
	1.4 GHz	-53dBm	Reference
		-63dBm	±0.50dBm
		-81 dBm	±1.00dBm
		-101 dBm	±1.50dBm
	2 GHz	-53dBm	Reference
		-63dBm	±0.50dBm
		-81 dBm	±1.00dBm
		-101 dBm	±1.50dBm

Note

The above procedure and test points listed in Tables 5-18 and 5-19 verify the performance of all the level control and attenuation circuits that determine level accuracy throughout the entire amplitude range, avoiding the need to make difficult precison level measurements at exteremly low levels below -101dBm. However, the following optional ultra-low level measurement procdure is provided for users choosing to verify the lower levl outputs directly.

If required, use the following optional procedure to verify the absolute level accuracy of the UUT below -101 dBm.

Note

Ultra-Low level measurements are made relative to to levels previously measured with the measuring receiver. Two levels (-91dBm and -101 dBm) are used as refernce points to provide the required UUT hardware configurations for the subsequent tests. The value of the output level at -91dBm and -101dBm measured in steps 30 through 37 above will be used as refernces in the following procedure, identified as P_{-91} and P_{-101} respectively for each test frequency. It is important that the correct sequence is followed as described.

Making these precision ultra-low level measurements requires appropriate choice of measuring receiver settings to provide adequate linearity, noise floor, and reading repeatability throughout the amplitude range required. For any given frequency the measuring receiver the settings must be maintained for all amplitudes at that frequency after establishing the refernce point. In particular, receiver attenuator, reference level, and resolution bandwidth settings must not change.

28. On the UUT enable the REF FREQUENCY OUTPUT and set the UUT as follows:

Frequency	100 kHz
Level	-91 dBm
Output	OPER

29. Allow the measuring receiver to tune the input signal, and then set the controls to measure RF level, relative (dB) to the current input level.
30. Without changing any measuring receiver settings, set the UUT to the next amplitude listed in Table 5-20 for this frequency. Allow the measuring receiver reading to stabilize and record the reading as P_{rel}. (Note that P_{rel} will be a negative number in dB).
31. Calculate the UUT output $P_{out} = P_{-91} + P_{rel}$. Check that the value of P_{out} is within the tolerance shown in part A of Table 5-20.
32. Repeat steps 30 and 31 for each amplitude listed in part A of Table 5-20 for this frequency.
33. Return the UUT output to -91dBm, set the UUT frequency to the next frequency listed in part A of Table 5-20, and repeat steps 29 through 32.
34. Set the UUT to 100kHz at -101dBm. Repeat steps 39 through 43 for the points listed in part B of Table 5-20 using the calculation $P_{out} = P_{-101} + P_{rel}$ in step 31.
35. Set the UUT to STBY.

Table 5-20. Optional Ultra-Low Level Accuracy Test (75 Ω) Points

Part	Frequency	Amplitude	Tolerance
A	100 kHz	-91 dBm	Reference
		-111dBm	±1.50dBm
	10 MHz	-91 dBm	Reference
		-111dBm	±1.50dBm
	100 MHz	-91 dBm	Reference
		-111dBm	±1.50dBm
	300 MHz	-91 dBm	Reference
		-111dBm	±1.50dBm
	1.4 GHz	-91 dBm	Reference
		-111dBm	±1.50dBm
	2 GHz	-91 dBm	Reference
		-111dBm	±1.50dBm
B	100 kHz	-101dBm	Reference
		-121dBm	±1.50dBm
	10 MHz	-101dBm	Reference
		-121dBm	±1.50dBm
	100 MHz	-101dBm	Reference
		-121dBm	±1.50dBm
	300 MHz	-101dBm	Reference
		-121dBm	±1.50dBm
	1.4 GHz	-101dBm	Reference
		-121dBm	±1.50dBm
	2 GHz	-101dBm	Reference
		-121dBm	±1.50dBm

Attenuation Accuracy - 75 Ω (Optional)

Equipment required for this test:

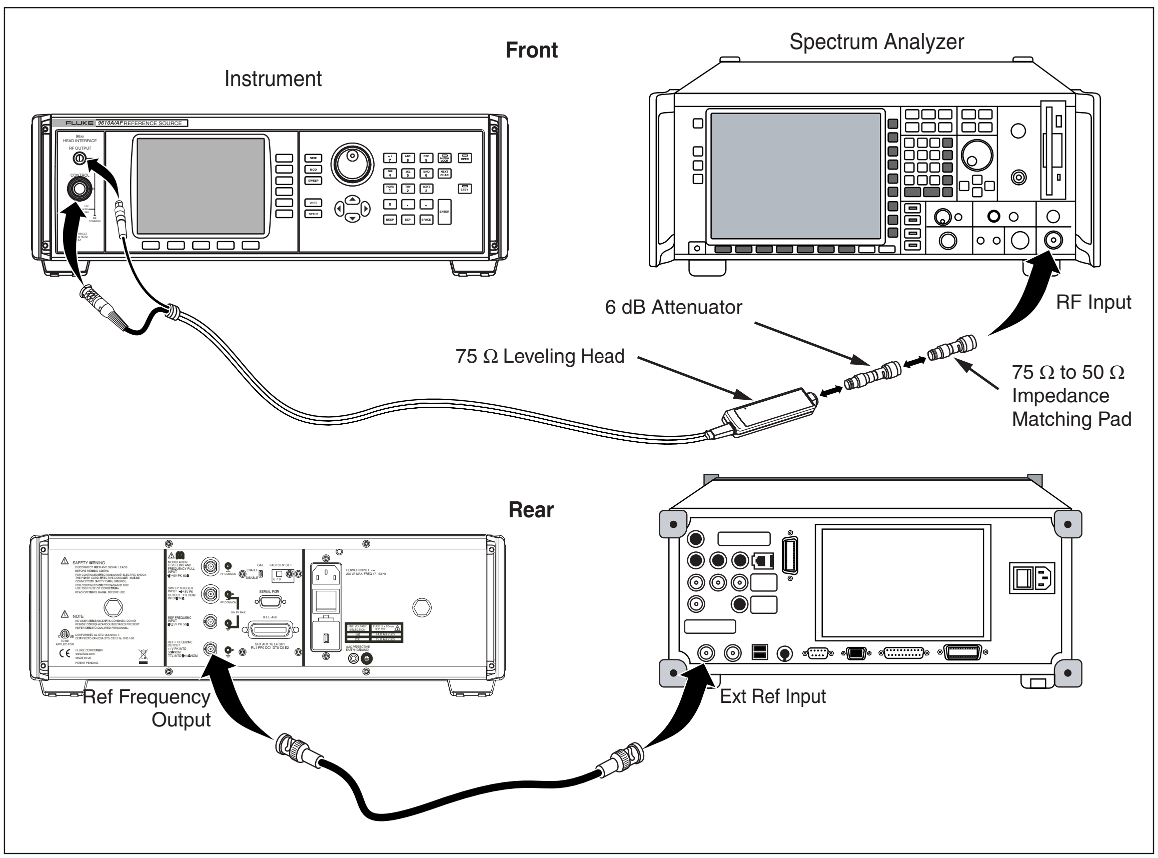
- Measuring Receiver
- Precision Adapter, Type-N female-to-female, 75 Ω
- Attenuator, 6 dB, Type-N (m) – (f), 50 Ω
- 75 Ω to 50 Ω impedance-matching pad
- 75 Ω Leveling Head (supplied with UUT)

Note

In the following tests, the tolerances shown refer to specifications listed in Chapter 1 of this manual. It may be necessary, in some cases, to alter the test limits based on the uncertainty of the actual equipment used. For example, if the Instrument specification is ±0.025 dB and the measuring receiver uncertainty is ± (0.015 dB + 0.005 dB per 10 dB step) the test limit for 18 dB would be ± 0.035 dB (the root-sum-square of 0.025 and 0.024).

Use the following procedure to verify the attenuation accuracy of the UUT output relative to +16 dBm, 75 Ω:

1. Connect the 75 Ω Leveling Head to the RF INPUT of the measuring receiver via a 75 Ω to 50 Ω impedance-matching pad and 6 dB attenuator. Connect the REF FREQUENCY OUTPUT (rear panel) from the UUT to the spectrum analyzer Ext Ref In (on rear). See Figure 5-12 for equipment connections.



ead219f.eps

Figure 5-12. Equipment Connections - Attenuation Accuracy Test (75 Ω)

Note

The 6 dB attenuator is used to minimize mismatch errors. In some cases, additional attenuation may be required to satisfy alternative measuring receiver maximum input limitations.

Note

Unwanted interference from signals at 10MHz due to the frequency refernce outputs of equipment operating in the vicinity of the test setup or the equipment used during the tests can cause erroneous results. In order to avoid such problems, it is recommended that a small offset (50kHz) is added to the listed nominal test frequency.

2. On the UUT enable the REF FREQUENCY OUTPUT and set the UUT as follows:

   Frequency 10 MHz
   Level +16 dBm
   Output OPER

3. Allow the measuring receiver to tune the input signal, and then set the controls to measure RF level, relative (dB) to the current input level.
4. At each attenuation level listed in Table 5-21, allow the measuring receiver reading to stabilize. The indicated value is expected to be within the listed typical performance.
5. Return the UUT attenuation to 0 dB (+16 dBm).

Table 5-21. Attenuation Accuracy (75 Ω)

Nominal Attenuation	Absolute Output Level	Typical Performance
0 dB	+16 dBm	Reference
-9 dB	+7 dBm	±0.035 dB
-19 dB	-3 dBm	±0.035 dB
-29 dB	-13 dBm	±0.035 dB
-39 dB	-23 dBm	±0.05 dB
-49 dB	-33 dBm	±0.05 dB
-69 dB	-43 dBm	±0.05 dB
-69 dB	-53 dBm	±0.1 dB
-79 dB	-63 dBm	±0.1 dB
-88 dB	-72 dBm	±0.1 dB
-97 dB	-81 dBm	±0.1 dB

6. Repeat steps 2 through 5 at the attenuation levels shown in Table 5-21 for frequencies of 50 and 100 MHz.
7. Set the UUT to STBY.
8. Disconnect the 75 Ω Leveling Head, 75 Ω to 50 Ω impedance-matching pad and 6 dB attenuator from the measuring receiver.

VSWR Test — 75 Ω (Optional)

Equipment Required for this Test:

- Signal Generator, 75 Ω
- Spectrum Analyzer
- 75 Ω to 50 Ω impedance-matching pad
- 75 Ω directional bridge
- Precision 75 Ω Open termination
- Precision 75 Ω Short termination
- 75 Ω Leveling Head (supplied with UUT)

Use the following test to verify the UUT's output VSWR using a directional bridge and a spectrum analyzer.

1. Connect the REF FREQUENCY OUTPUT (rear panel) from the UUT to the spectrum analyzer and signal generator external reference inputs using a BNC tee and BNC male – male cable assemblies. Set the spectrum analyzer and signal generator for external frequency reference.
2. Connect the signal generator RF output to the input port of the directional bridge. Connect the directional bridge coupled (output) port to the spectrum analyzer input using a 75 Ω to 50 Ω impedance-matching pad. See Figure 5-13.

Note

In order to determine the reference level setting of the spectrum analyzer, the UUT must initially be connected to the directional bridge.

3. Connect the UUT to the test port of the directional bridge.
4. Set the spectrum analyzer as follows:

PRESET	
EXT REF	On
REF LVL	+10 dBm
FREQ	500 MHz
SPAN	Zero Span

5. Set the signal generator as follows:

Frequency	500.00001 MHz
Amplitude	0 dBm
Output	On

6. Set the UUT as follows:

Frequency	500 MHz
Level	+7 dBm
Output	OPER

7. Adjust the spectrum analyzer reference level to place the displayed trace approximately 3 dB below the reference line.
8. Set the UUT to STBY and disconnect it from the directional bridge. Connect the open (75 Ω) termination to the directional bridge test port.
9. Set the spectrum analyzer display units to volts and perform a peak search. Note the marker indication with the test port open.
10. Connect a Type-N short to the directional bridge test port. Perform a peak search with the test port shorted and note the marker indication. Remove the short.

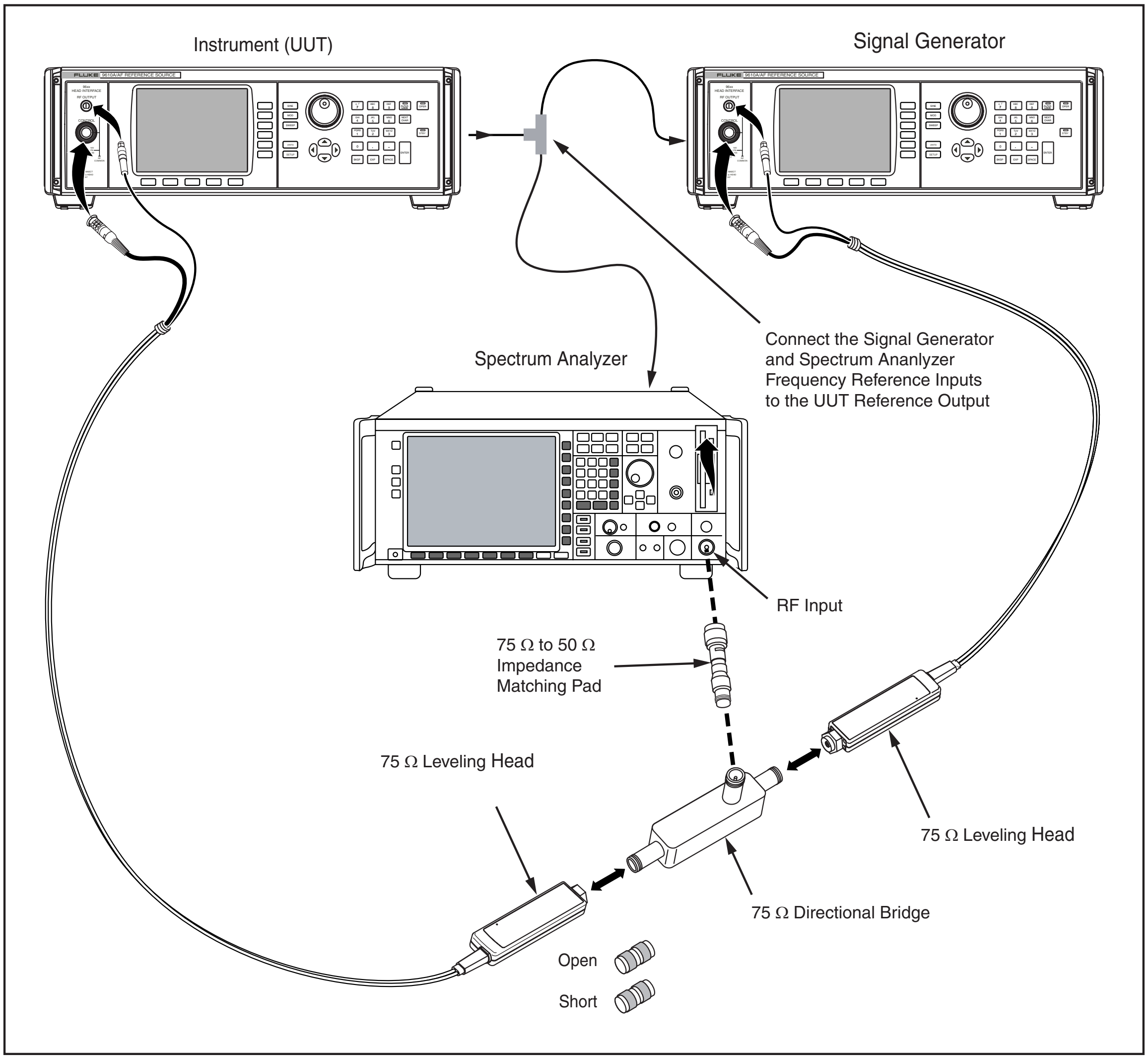


Figure 5-13. Equipment Connections - VSWR Test (75 Ω)

11. Compute the average of the values measured with the test port open and shorted. Record this number as Z_{Max} for the test frequency of 500 MHz.
12. Repeat steps 5 through 11 for the next test frequency at +7dBm listed in Table 5-22, setting the spectrum analyzer center frequency to the test frequency and recording Z_{Max} for each test frequency.
13. Reconnect the directional bridge test port to the UUT and set it to OPER.
14. Set the spectrum analyzer display to linear. Set the sweep time to 5 ms, single sweep.
15. Set the UUT frequency to 500 MHz, set the signal generator frequency to 500.00001 MHz, and set the spectrum analyzer center frequecncy to 500 MHz.
16. Initiate a single sweep. Allow the sweep to complete then perform a (maximum) peak search. Note the marker amplitude.
17. Perform a (minimum) search and note the marker amplitude.
18. Calculate the difference of the maximum and minimum searches, dividing the difference by 2 to determine the peak value. Record this number as $Z_{UUT.}$
19. Compute the voltage reflection coefficient using the following formula:

$$\rho_\ell = \frac{Z_{UUT}}{Z_{Max}}$$

20. Using the following formula, calculate the UUT VSWR. The calculated value must be < 1.1.

$$VSWR = \frac{1+\rho_\ell}{1-\rho_\ell}$$

21. Repeat steps 15 through 20 for the remaining test frequencies and maximum VSWR values in Table 5-22, setting the spectrum analyzer center frequency in step 15 to the test frequency.
22. Repeat steps 3 though 17 for the remaining UUT output levels and maximum VSWR values in Table 5-22.
23. Set the UUT to STBY.

Table 5-22. VSWR Test (75 Ω)

Frequency	Level	Signal Generator Frequency	Maximum VSWR
500MHz	+7 dBm	500.000 01 MHz	< 1.1
1 GHz		1.000 000 01 GHz	< 1.2
2GHz		2.000 000 01 GHz	< 1.3
500MHz	-3 dBm	500.000 01 MHz	< 1.1
1 GHz		1.000 000 01 GHz	< 1.2
2GHz		2.000 000 01 GHz	< 1.3
500MHz	-13 dBm	500.000 01 MHz	< 1.1
1 GHz		1.000 000 01 GHz	< 1.2
2GHz		2.000 000 01 GHz	< 1.3

Calibration Adjustments

This section of the chapter provides calibration adjustment procedures for correcting out-of-tolerance parameters so they meet published specifications. If the Instrument fails the performance test, it is an indication that the Instrument requires calibration adjustment and/or repair. Calibration adjustment does not require removal of the covers. See Chapter 7, Maintenance, for internal access and repair information.

Note

The instrument top cover is removeable for air filter cleaning access without the need to break calibration integrity seals. A calibration integrity seal is located on the internal top shield, revealed once the outer top cover has been removed (see Chapter 7, Mainteneance for details). Additional calibration integrity seals are located on the rear panel over the lower outer cover and over the calibration enable switch. It is recommended that users apply calibration integrity seals in the same three locations.

Calibration adjustment of the Instrument may be performed locally from the instrument front panel or remotely using the IEEE-488 bus.

During calibration adjustment, the output amplitude is measured to determine the absolute level error at the amplitude/frequency combination set. An entry is made via a front panel key sequence or via GPIB command sequence to adjust the output to correct any error from nominal, and cause storage of an appropriate correction factor in the internal non-volatile memory. This process is required at a variety of amplitude/frequency points throughout the amplitude and frequency range of the instrument. It is recommended that the users of the calibration process familiarize themselves with the entire calibration adjustment process prior to attempting any calibration adjustment operations.

Environmental and warm up conditions required for performing the calibration adjustments are as follows:

- Ambient temperature of the test environment is 23 ± 1 °C.
- Warm up time (continuous operation) for the Instrument, with all covers in place, is 1 hour (24 hours for adjusting the Reference Frequency).

Each of the following procedures is accompanied by a list of the equipment required to perform the procedure and a figure detailing the equipment connections for the procedure. Perform the procedures in sequence, ensuring that all prior equipment connections have been removed before starting a new procedure.

During the course of the adjustment process, the operator is prompted to use an AC Measurement Standard, followed by a power meter and sensor(s), and finally, a spectrum analyzer/measuring receiver. At various points within the process, values previously adjusted using one reference device are transferred to another for subsequent use.

To minimize the number of connection changes required during Instrument calibration adjustment, the steps are sequenced so that all steps requiring the AC Measurement Standard, for example, are performed together, as are the various steps requiring each of the other required reference devices.

Calibration adjustment of the Instrument is a systematic process; at each step, the display indicates the desired adjustment target level and frequency values, and directs the operator to the required measurement device. Following measurement of the expected target value, the operator, using the Instrument alphanumeric keypad, enters the measured value, followed by the soft keys, Accept Adjust, and Next Target.

The Instrument calibration adjustment must be performed in the order presented, as subsequent steps rely on measurement values entered during previous steps. Although not recommended, it is possible to perform a partial calibration adjustment based on the Instrument function. For example, if it is desired to adjust only a specific output level of the Instrument, the operator may skip to the first step of the affected adjustments and proceed from that point on. To do so, depress the Find Point soft key, then use the blue arrow keys, rotary knob, or numeric keypad (followed by ENTER) to select the point number desired, then press Go to Point to complete the process. (The information provided in the text box below the Adjustment Point may be used as an aid to find the point desired.)

The specifications listed in Chapter 1 contain some conditions for which performance is not warranted or specified as "typical" (for example, at frequencies below 100kHz at levels below100 kHz at levels below -47 dBm, modulation, etc). The adjustment sequence also includes points for adjusting performance in these areas, which have no impact on the warranted performance of the 9640A. These additional points are adjusted at manufacture or following repair but need not be routinely re-adjusted during normal periodic recalibration operations. Accordingly, the relevant steps in the calibration adjustment sequence may be omitted if measurement capability is not available.

Reference Frequency Adjustment

Equipment required for this test:

- Frequency Counter
- Frequency Standard

Use the following procedure to adjust the frequency of the internal reference:

1. Warm up the UUT (continuous operation) for 24 hours, minimum.
2. Connect the 10 MHz output from the frequency standard to the EXT REF IN on the frequency counter (rear panel) using a BNC male – male cable assembly. Set the frequency counter for external time base reference.
3. Connect the REF FREQUENCY OUTPUT (on rear) from the UUT to the Channel A input on the frequency counter using a BNC male – male cable. Set the frequency counter input impedance to 50 Ω. See Figure 5-1 for equipment connections.
4. On the UUT enable the REF FREQUENCY OUTPUT.
5. On the UUT, press SETUP, followed by the soft key Calibration, and then softkey Calibrate Instrument.
6. Using the keypad, enter the password, followed by the ENTER key.

Note

At shipment, the factory default password is "2, SPACE, 3, SPACE, 5, SPACE, 7".

7. Press the soft key Adjust Frequency.
8. Set the frequency counter controls for a reliable and repeatable frequency measurement.
9. Using the blue arrow keys and rotary knob, edit the UUT DAC Value until the frequency counter indicates 10.00000000 ± 0.00000005 MHz.
10. Press Previous Menu. If desired to proceed with base adjustment, press Adjust Base. If not, press Exit.

Base Adjustment

Equipment required:

- AC Measurement Standard
- Precision 50 Ω feedthrough termination
- Power Meter
- Power Sensor, Diode, 50 Ω
- Spectrum Analyzer/Measuring Receiver
- 50 Ω Type-N female-to-BNC male adapter

Use the following procedure to adjust the UUT base (mainframe).

Note

If the Reference Frequency Adjustment was just completed, omit steps 1 through 2, below.

1. On the UUT, press SETUP, followed by the soft key Calibration and then softkey Calibrate Instrument.
2. Using the keypad, enter the password, followed by the ENTER key.
3. Press the soft key Adjust Base.
4. Remove the Leveling Head from the UUT base unit (if connected). Connect the UUT SMA output to INPUT 1 of the AC Measurement Standard via a precision 50 Ω feedthrough termination.

Note

It is recomended that for measurements made with the AC Measurement Standard during calibration adjustment a common mode choke is used as described in the Level Accuracy Test, with the choke input low connected to the AC Measuremet Standard chassis ground.

5. Set the UUT to OPER.
6. Using the blue arrow keys and rotary knob, edit the UUT Actual output until the spectrum analyzer indicates the Target value stated. Press Accept Target.
7. Press Next Target.

Note

If the AC Measurement Standard used does not read the UUT output in dBm directly, calculate the desired value using the following formula:

$$dBm\,(50\,\Omega) = 10\log\left(\frac{V^2/50}{10^{-3}}\right)$$

Alternatively, the UUT units selection may be changed to V rms to display targets and adjust output values directly in rms voltage. Press the Units *key and select the required units.*

Note

Measurements made on the 5790A 2.2 mV range (at levels below -40 dBm) require correction for the 2.2 mV range linearity error.

8. Repeat steps 6 and 7 for all points requiring the use of the AC Measurement Standard (the UUT text box states Use Precision AC Voltmeter. Set the UUT to STBY.

9. Disconnect the AC Measurement Standard and 50 Ω feedthrough termination from the UUT base unit. Connect the UUT SMA output directly to the input of the 50 Ω low-power (diode) sensor. Do not use a cable between the UUT SMA connector and the power sensor input.

Note

Throughout the course of the calibration adjustment, the UUT internally accounts for values previously adjusted using one reference instrument in order to accomplish accurate transfers to other reference instruments.

10. Set the UUT to OPER.
11. Enter the measurement frequency corresponding to each Target into the power meter to enable cal factor (frequency) correction.

Note

The recommended power meter has power sensor calibration factors stored internally in the sensor. Setting the input frequency in the power meter automatically selects the appropriate cal factor for the measurement. However, the power sensor may also be accompanied by a table of calibration factors which must be applied externally.

Note

The diode-based power sensor may exhibit frequency dependent linearity errors, and additional corrections for these errors must also be applied.

12. Using the blue arrow keys and rotary knob, edit the UUT Actual output until the power meter indicates the Target value stated. Press Accept Target.
13. Press Next Target.
14. Repeat steps 11 through 13 for all points requiring the use of the power meter and sensor (the UUT text box states, Use Power Meter). Set the UUT to STBY.
15. Disconnect the power meter and sensor from the UUT base unit. Connect the UUT SMA output to the input of the spectrum analyzer/measuring receiver.
16. Set the UUT to OPER.
17. Set the spectrum analyzer reference level, span, resolution and/or video bandwidth as necessary to make a high-quality level measurement at each applied frequency and level.

Note

Depending on the actual configuration of the spectrum analyzer/measuring receiver used, the settings required to make the highest accuracy level measurements may vary. Consult the spectrum analyzer manufacturer's manual for further information.

Note

For each frequency it is important to maintain consistent analyze/receiver settings as the target amplitude changes. For any given frequency the analyzer setting can be to suit, but that setting must be maintained for all amplitudes at that frequency after the transfer point. In particular, analyzer attenuator, reference level and resolution bandwidth settings must not change. Typically there are 3 or 4 amplitudes per frequency point during which the analyzer settings must be static.

18. Using the blue arrow keys and rotary knob, edit the UUT Actual output until the spectrum analyzer indicates the Target value stated. Press Accept Target.

19. Press Next Target.
20. Repeat steps 17 through 19 for all necessary points requiring the use of the spectrum analyzer to make level adjustments. When complete the UUT adjustment point title will indicate AM Depth.
21. Disconnect the spectrum analyzer/measuring receiver from the UUT Base Unit SMA connector and fit the UUT 50 Ω Leveling Head. Connect the Levelling Head output to the spectrum analyzer/measuring receiver RF input.
22. Reconfigure the spectrum analyzer/measuring receiver to make AM depth measurements.
23. Using the blue arrow keys and rotary knob, edit the UUT Actual output until the spectrum analyzer indicates the Target value stated. Press Accept Target.
24. Press Next Target.
25. Repeat steps 23 through 24 until all Base adjustments are completed.
26. Press Previous Menu. If it is desired to proceed with head adjustment, press Adjust Head. If not, press Exit.
27. Remove all connections to the base unit.

Leveling Head Adjustment - 50 Ω

Equipment required:

- AC Measurement Standard
- Precision feedthrough termination, 50 Ω
- 50 Ω Type-N female-to-BNC male adapter
- Power Meter
- Power Sensor, Thermal, 50 Ω
- Power Sensor, Diode, 50 Ω
- Precision Adapter, Type-N female-to-female, 50 Ω
- Spectrum Analyzer/Measuring Receiver

Note

Base Adjustment must be performed before attempting Head adjustment. Once Base adjustment has been performed, Head adjustment can take place in any order (50 Ω or 75 Ω first).

Note

If the Reference Frequency or Base Adjustment was just completed, omit steps 2 and 3, below.

1. Ensure a 50 Ω Leveling Head is connected to the UUT base.
2. On the UUT, press SETUP, followed by the soft key Calibration and then softkey Calibrate Instrument.
3. Using the keypad, enter the password, followed by the ENTER key.
4. Press the soft key Adjust Head.
5. Connect the UUT Leveling Head to the input of the AC Measurement Standard via a precision 50 Ω feedthrough termination. (If a Type-N feedthrough termination is not available, use a 50 Ω BNC feedthrough termination and appropriate adapters.)

Note

It is recomended that for measurements made with the AC Measurement Standard during calibration adjustment a common mode choke is used as described in the Level Accuracy Test, with the choke input low connected to the AC Measuremet Standard chassis ground.

6. Set the UUT to OPER.

Note

The following steps facilitate the low frequency flatness adjustment of the 50 Ω Leveling Head using the AC Measurement Standard.

7. Using the blue arrow keys and rotary knob, edit the UUT Actual output until the AC Measurement Standard indicates the Target value stated. Press Accept Target.

Note

If the AC Measurement Standard used does not read the UUT output in dBm directly, calculate the desired value using the following formula:

$$dBm\,(50\,\Omega) = 10\,\log\left(\frac{V^2/50}{10^{-3}}\right)$$

Alternatively, the UUT units selection may be changed to V rms to display targets and adjust output values directly in rms voltage. Press the Units *key and select the required units.*

Note

Measurements made on the 5790A 2.2 mV range (at levels below -40 dBm) require correction for the 2.2 mV range linearity error.

8. Press Next Target.
9. Repeat steps 7 and 8 for all points requiring the use of the AC Measurement Standard (the UUT text box will indicate Use Precision AC Voltmeter). Set the UUT to STBY.
10. Disconnect the AC Measurement Standard and feedthrough termination from the Leveling Head. Connect the UUT 50 Ω Leveling Head to the input of the 50 Ω thermal sensor using a Type-N female-to-female adapter. See Figure 5-5 for equipment connections.

Note

The insertion loss of the 50 Ω Type-N female-to-female adapter must be taken into account at each adjustment frequency.

11. Set the power meter for 0.001 dB resolution.
12. Set the UUT to OPER.

Note

The following steps facilitate the high-level flatness adjustment of the 50 Ω Leveling Head using a power meter and sensor.

13. Enter the measurement frequency corresponding to each Target into the power meter to enable cal factor (frequency) correction.

Note

The recommended power meter has power sensor calibration factors stored internally in the sensor. Setting the input frequency in the power meter automatically selects the appropriate cal factor for the measurement. However, the power sensor may also be accompanied by a table of calibration factors which must be applied externally.

14. Using the blue arrow keys and rotary knob, edit the UUT Actual output until the power meter indicates the Target value stated. Press Accept Target.
15. Press Next Target.
16. Repeat steps 13 through 15 for all points where the Target value is ≥ 10dBm requiring the use of the power meter and thermal sensor. Set the UUT to STBY.

Note

If a power sensor having different characteristics than the one specified is used, it may not be necessary to change types at this point. Consult the power sensor manufacturer's manual for input signal level specifications.

17. Replace the thermal power sensor with the diode (low-power) sensor in the test setup.

Note

The diode-based power sensor may exhibit frequency dependent linearity errors, and additional corrections for these errors must also be applied.

Note

The following steps facilitate the mid-level flatness adjustment of the 50 Ω Leveling Head using a power meter and sensor.

18. Set the UUT to OPER.
19. Repeat steps 13 through 15 for all points requiring the use of the power meter and diode sensor (the UUT text box will indicate Use Power Meter). Set the UUT to STBY.
20. Disconnect the power meter and low-power sensor from the Leveling Head. Connect the UUT 50 Ω Leveling Head to the input of the spectrum analyzer/measuring receiver.

Note

The following steps facilitate the low-level flatness adjustment of the 50 Ω Leveling Head using a spectrum analyzer/measuring receiver.

21. Set the UUT to OPER.
22. Set the spectrum analyzer reference level, span, resolution and/or video bandwidth as necessary to make a high-quality level measurement at the applied level and frequency.

Note.

For each frequency it is important to maintain consistent analyzer/receiver settings as the target amplitude changes. For any given frequency the analyzer setting can be to suit, but that setting must be maintained for all amplitudes at that frequency after the transfer point. In particular, analyzer attenuator, reference level and resolution bandwidth settings must not change. Typically there are 3 or 4 amplitudes per frequency point during which the analyzer settings must be static.

23. Using the blue arrow keys and rotary knob, edit the UUT Actual output until the spectrum analyzer display indicates the Target value stated. Press *Accept Target*.

24. Press Next Target.
25. Repeat steps 22 through 24 for all points requiring the use of the spectrum analyzer until all Leveling Head adjustments are completed.
26. Press Previous Menu. The 50 Ω Leveling Head adjustment is now complete.
27. If additional Leveling Heads are to be adjusted, substitute the remaining Leveling Head(s) for the one currently attached and perform the appropriate (50 or 75 Ω) Leveling Head adjustment process. If not, press Exit twice to return the UUT to a normal operating state.

Leveling Head Adjustment - 75 Ω

Equipment required:

- AC Measurement Standard
- Precision feedthrough termination, 75 Ω
- 75 Ω Type-N female-to-50 Ω Type-N male adapter
- Power Meter
- Power Sensor, 75 Ω
- Spectrum Analyzer/Measuring Receiver
- Precision Adapter, Type-N female-to-female, 75 Ω
- 75 Ω to 50 Ω impedance-matching pad

Note

Base Adjustment must be performed before attempting Head adjustment. Once Base adjustment has been performed, Head adjustment can take place in any order (50 Ω or 75 Ω first).

Note

If the Reference Frequency or Base Adjustment was just completed, omit steps 1 through 4, below.

1. Ensure a 75 Ω Leveling Head is connected to the UUT base.
2. On the UUT, press SETUP, followed by the soft key Calibration and then softkey Calibrate Instrument.
3. Using the keypad, enter the password, followed by the ENTER key.
4. Press the soft key Adjust Head.
5. Connect the UUT Leveling Head to the input of the AC Measurement Standard via a precision 75 Ω feedthrough termination. (If a Type-N feedthrough termination is not available, use a 75 Ω BNC feedthrough termination and appropriate adapters.)

Note

It is recomended that for measurements made with the AC Measurement Standard during calibration adjustment a common mode choke is used as described in the Level Accuracy Test, with the choke input low connected to the AC Measuremet Standard chassis ground.

6. Set the UUT to OPER.

Note

The following steps facilitate the low frequency flatness adjustment of the 75 Ω Leveling Head using the AC Measurement Standard.

7. Using the blue arrow keys and rotary knob, edit the UUT Actual output until the AC Measurement Standard indicates the Target value stated. Press Accept Target.

Note

If the AC Measurement Standard used does not read the UUT output in dBm directly, calculate the desired value using the following formula:

$$dBm\,(75\,\Omega) = 10\log\left(\frac{V^2/75}{10^{-3}}\right)$$

Alternatively, the UUT units selection may be changed to V rms to display targets and adjust output values directly in rms voltage. Press the Units *key and select the required units.*

Note

Measurements made on the 5790A 2.2 mV range (at levels below -42 dBm) require correction for the 2.2 mV range linearity error.

8. Press Next *Target*.
9. Repeat steps 7 and 8 for all points requiring the use of the AC Measurement Standard (the UUT text box will indicate Use Precision AC Voltmeter). Use Power Meter. Set the UUT to STBY.
10. Disconnect the AC Measurement Standard and feedthrough termination from the Leveling Head. Connect the UUT 75 Ω Leveling Head to the input of the 75 Ω power sensor using a Type-N female-to-female adapter. See Figure 5-10 for equipment connections.

Note

The insertion loss of the 75 Ω Type-N female-to-female adapter must be taken into account at each adjustment frequency.

11. Set the power meter for 0.001 dB resolution.

Note

The following steps facilitate the high and mid-level flatness adjustment of the 75 Ω Leveling Head using a power meter and sensor.

12. Set the UUT to OPER.
13. Enter the measurement frequency corresponding to each Target into the power meter to enable cal factor (frequency) correction.

Note

The recommended power meter has power sensor calibration factors stored internally in the sensor. Setting the input frequency in the power meter automatically selects the appropriate cal factor for the measurement. However, the power sensor may also be accompanied by a table of calibration factors which must be applied externally.

14. Using the blue arrow keys and rotary knob, edit the UUT Actual output until the power meter indicates the Target value stated. Press Accept Target.
15. Press *Next Target*.
16. Repeat steps 13 through 15 for all points requiring the use of the power meter and sensor (the UUT text box will indicate Use Power Meter). Set the UUT to STBY.

Note

If a power sensor having different characteristics than the one specified is used, it may be necessary to change sensors prior to this point. Consult the power sensor manufacturer's manual for input signal level specifications.

17. Disconnect the power meter and sensor from the UUT 75 Ω Leveling Head. Connect the 75 Ω Leveling Head to the input of the spectrum analyzer via a 75 Ω to 50 Ω impedance-matching pad at the spectrum analyzer RF input.

Note

The following steps facilitate the low-level flatness adjustment of the 75 Ω Leveling Head using a spectrum analyzer/measuring receiver.

18. Set the UUT to OPER.
19. Set the spectrum analyzer reference level, span, resolution and/or video bandwidth as necessary to make a high-quality level measurement at the applied level and frequency.

Note.

For each frequency it is important to maintain consistent analyzer/reveiver settings as the target amplitude changes. For any given frequency the analyzer setting can be to suit, but that setting must be maintained for all amplitudes at that frequency after the transfer point. In particular, analyzer attenuator, reference level and resolution bandwidth settings must not change. Typically there are 3 or 4 amplitudes per frequency point during which the analyzer settings must be static.

20. Using the blue arrow keys and rotary knob, edit the UUT Actual output until the spectrum analyzer display indicates the Target value stated. Press Accept Target.

Note

The recommended spectrum analyzer/measuring receiver is capable of automatically compensating for the insertion loss of the 75 Ω to 50 Ω impedance-matching pad. If this feature is not enabled or an alternative spectrum analyzer is used the insertion loss must be taken into account to obtain the expected level indication on the spectrum analyzer.

21. Press Next Target.
22. Repeat steps 19 through 21 for all points requiring the use of the spectrum analyzer until all Leveling Head adjustments are completed.
23. Press Previous Menu. The 75 Ω Leveling Head adjustment is now complete.
24. If additional Leveling Heads are to be adjusted, substitute the remaining Leveling Head(s) for the one currently attached and perform the appropriate (50 or 75 Ω) Leveling Head adjustment process. If not, press Exit twice to return the UUT to a normal operating state.

Performance Test Record

Model: 9640A **S/N: (Base) _________ (50 Ω) _________ (75 Ω) __________**

Date: ___________ **Temperature _______**

Reference Frequency Accuracy

Use a frequency counter and external frequency reference to make the following measurements.

Reference Frequency Accuracy Test

Frequency	Actual	Tolerance (After 24 hour warm-up)
10 MHz		± 0.04 ppm

Frequency Accuracy

Use a high resolution frequency counter and external frequency reference to make the following measurements.

Frequency Accuracy Test

Frequency	Actual	Tolerance (After 24 hour warm-up)
10 kHz		± 0.56 mHz
10 MHz		± 0.4 Hz
30 MHz		±1.2 Hz
50 MHz		± 2.0 Hz
125 MHz		± 5.0 Hz
250 MHz		± 10.0 Hz
1 GHz		± 40.0 Hz
2 GHz		± 80.0 Hz
2.7 GHz		± 108.0 Hz
4 GHz		± 160.0 Hz

Harmonics and Spurious Signal Content

Use a high performance spectrum analyzer to make the following measurements.

Harmonics Test

Output		2nd Harmonic			3rd Harmonic		
Level	**Frequency**	**Freq**	**Limit**	**Actual**	**Freq**	**Limit**	**Actual**
+24 dBm	20 kHz	40 kHz	-60 dBc		60 kHz	-60dBc	
	100 kHz	200 kHz	-60 dBc		300 kHz	-60dBc	
	2.5 MHz	5 MHz	-60 dBc		7.5 MHz	-60dBc	
	5.5 MHz	11 MHz	-60 dBc		16.5 MHz	-60dBc	
	11 MHz	22 MHz	-60 dBc		33 MHz	-60dBc	
	22 MHz	44 MHz	-60 dBc		66 MHz	-60dBc	
	31.25 MHz	62.5 MHz	-60 dBc		93.75 MHz	-60dBc	
	44 MHz	88 MHz	-60 dBc		132 MHz	-60dBc	
	62.5 MHz	125 MHz	-60 dBc		187.5 MHz	-60dBc	
	88 MHz	176 MHz	-60 dBc		264 MHz	-60dBc	
	125 MHz	250 MHz	-60 dBc		375 MHz	-60dBc	
+20 dBm	250 MHz	500 MHz	-60 dBc		750 MHz	-60dBc	
	354 MHz	708 MHz	-60 dBc		1.062 GHz	-60dBc	
	500 MHz	1 GHz	-60 dBc		1.5 GHz	-60dBc	
	714 MHz	1.428 GHz	-60 dBc		2.142 GHz	-60dBc	
	1 GHz	2 GHz	-60 dBc		3 GHz	-60dBc	
	1.4 GHz	2.8 GHz	-55 dBc		4.2 GHz	-55 dBc	
+14 dBm	1.8 GHz	3.6 GHz	-55 dBc		5.4 GHz	-55 dBc	
	2.7 GHz	5.4 GHz	-55 dBc		8.1 GHz	-55 dBc	
	4 GHz	8 GHz	-55 dBc		12 GHz	-55 dBc	

Spurious Signal Content Test

Frequency	Spurious Level	Limit
2.1 GHz		< -60 dBc
2.199 997 GHz		< -60 dBc
2.200 003 GHz		< -60 dBc
2.399 997 GHz		< -60 dBc
2.5 GHz		< -60 dBc
2.600 003 GHz		< -60 dBc
2.7 GHz		< -60 dBc
2.799 997 GHz		< -60 dBc
2.800 003 GHz		< -60 dBc
3.0 GHz		< -60 dBc
3.199 997 GHz		< -60 dBc
3.200 003 GHz		< -60 dBc
3.400 003 GHz		< -60 dBc
3.599 997 GHz		< -60 dBc
3.800 003 GHz		< -60 dBc
4.0 GHz		< -60 dBc

Phase Noise (Optional)

Use a high performance spectrum analyzer to make the following measurements.

Phase Noise Test

height	Frequency	Carrier Offset	Actual	Limit
+13dBm	1 GHz	10 kHz		< -114 dBc/Hz
		100 kHz		< -119 dBc/Hz
		1 MHz		< -132 dBc/Hz

Modulation (Optional)

Use a high performance measuring receiver to make the following measurements.

Amplitude Modulation Rate Test

Level	Frequency	Modulation Rate	Depth	Actual	Tolerance
+10dBm	30 MHz	1 kHz	50 %		± 0.1 Hz
		220 kHz	50 %		± 10.0 Hz

Amplitude Modulation Depth Test

Level	Frequency	Modulation Rate	Depth	Actual	Tolerance
+14dBm	125 MHz	1 kHz	80 %		± 2.5 %
		100 kHz	80 %		± 2.5 %
	1 GHz	1 kHz	80 %		± 2.5 %
		100 kHz	80 %		± 2.5 %

Frequency Modulation Rate Test

Level	Frequency	Modulation Rate	Deviation	Actual	Tolerance
+13dBm	125 MHz	1 kHz	300 kHz		± 0.1 Hz
	1 GHz	300 kHz	1 MHz		± 10.0 Hz

Frequency Modulation Deviation Test

Level	Frequency	Modulation Rate	Deviation	Actual	Tolerance
+13dBm	125 MHz	1 kHz	100 kHz		± 3.0k Hz
		100 kHz	100 kHz		± 3.0 kHz
		1 kHz	300 kHz		± 9.0 kHz
		200 kHz	300 kHz		± 9.0 kHz
	1 GHz	1 kHz	1 MHz		± 30 kHz
		100 kHz	1 MHz		± 30 kHz

Level Accuracy - 50 Ω

Use an AC Measurement Standard, a power meter and power sensors, and a high performance spectrum analyzer/measuring receiver to make the following measurements.

Level Accuracy (50 Ω) Test

Level	Frequency	Actual	Tolerance
+20 dBm	1 kHz		± 0.05 dB
	20 kHz		± 0.05 dB
	100 kHz		± 0.05 dB
	10 MHz		± 0.05 dB
	125 MHz		± 0.05 dB
	300 MHz		± 0.1 dB
	1.4 GHz		± 0.25 dB
+14 dBm	1 kHz		± 0.05 dB
	20 kHz		± 0.05 dB
	100 kHz		± 0.05 dB
	10 MHz		± 0.05 dB
	125 MHz		± 0.05 dB
	300 MHz		± 0.1 dB
	1.4 GHz		± 0.25 dB
	3 GHz		± 0.3 dB
	4 GHz		± 0.5 dB
+3 dBm	1 kHz		± 0.05 dB
	20 kHz		± 0.05 dB
	100 kHz		± 0.05 dB
	10 MHz		± 0.05 dB
	125 MHz		± 0.05 dB
	300 MHz		± 0.1 dB
	1.4 GHz		± 0.25 dB
	3 GHz		± 0.3 dB
	4 GHz		± 0.5 dB

Level Accuracy (50 Ω) Test (Cont).

Level	Frequency	Actual	Tolerance
-7 dBm	1 kHz		± 0.05 dB
	20 kHz		± 0.05 dB
	100 kHz		± 0.05 dB
	10 MHz		± 0.05 dB
	125 MHz		± 0.05 dB
	300 MHz		± 0.1 dB
	1.4 GHz		± 0.25 dB
	3 GHz		± 0.3 dB
	4 GHz		± 0.5 dB
-17 dBm	1 kHz		± 0.05 dB
	20 kHz		± 0.05 dB
	100 kHz		± 0.05 dB
	10 MHz		± 0.05 dB
	125 MHz		± 0.05 dB
	300 MHz		± 0.1 dB
	1.4 GHz		± 0.25 dB
	3 GHz		± 0.3 dB
	4 GHz		± 0.5 dB
-27 dBm	1 kHz		± 0.05 dB
	20 kHz		± 0.05 dB
	100 kHz		± 0.05 dB
	10 MHz		± 0.05 dB
	125 MHz		± 0.05 dB
	300 MHz		± 0.1 dB
	1.4 GHz		± 0.5 dB
	3 GHz		± 0.5 dB
	4 GHz		± 0.5 dB

Level Accuracy (50 Ω) Test (Cont).

Level	Frequency	Actual	Tolerance
-37 dBm	1 kHz		± 0.05 dB
	20 kHz		± 0.05 dB
	100 kHz		± 0.05 dB
	10 MHz		± 0.05 dB
	125 MHz		± 0.05 dB
	300 MHz		± 0.1 dB
	1.4 GHz		± 0.5 dB
	3 GHz		± 0.5 dB
	4 GHz		± 0.5 dB
-47 dBm	1 kHz		± 0.05 dB
	20 kHz		± 0.05 dB
	100 kHz		± 0.05 dB
	10 MHz		± 0.05 dB
	125 MHz		± 0.05 dB
	300 MHz		± 0.1 dB
	1.4 GHz		± 0.5 dB
	3 GHz		± 0.5 dB
	4 GHz		± 0.5 dB
-57 dBm	100 kHz		± 0.2 dB
	10 MHz		± 0.2 dB
	125 MHz		± 0.2 dB
	300 MHz		± 0.2 dB
	1.4 GHz		± 0.5 dB
	3 GHz		± 0.5 dB
	4 GHz		± 0.5 dB
-66dBm	100 kHz		± 0.2 dB
	10 MHz		± 0.2 dB
	125 MHz		± 0.2 dB
	300 MHz		± 0.2 dB
	1.4 GHz		± 0.5 dB
	3 GHz		± 0.5 dB
	4 GHz		± 0.5 dB

Level Accuracy (50 Ω) Test (Cont).

Level	Frequency	Actual	Tolerance
-75 dBm	100 kHz		± 0.5 dB
	10 MHz		± 0.5 dB
	125 MHz		± 0.5 dB
	300 MHz		± 0.5 dB
	1.4 GHz		± 1.0 dB
	3 GHz		± 1.0 dB
	4 GHz		± 1.0 dB
-85 dBm	100 kHz		± 0.5 dB
	10 MHz		± 0.5 dB
	125 MHz		± 0.5 dB
	300 MHz		± 0.5 dB
	1.4 GHz		± 1.0 dB
	3 GHz		± 1.0 dB
	4 GHz		± 1.0 dB
-95dBm	100 kHz		± 1.5 dB
	10 MHz		± 1.5 dB
	125 MHz		± 1.5 dB
	300 MHz		± 1.5 dB
	1.4 GHz		± 1.5 dB
	3 GHz		± 1.5 dB

Optional Ultra-Low Level Accuracy (50 Ω) Test.

Level	Frequency	Actual	Tolerance
-105 dBm	100 kHz		± 1.5 dB
	10 MHz		± 1.5 dB
	125 MHz		± 1.5 dB
	300 MHz		± 1.5 dB
	1.4 GHz		± 1.5 dB
	3 GHz		± 1.5 dB
-115 dBm	100 kHz		± 1.5 dB
	10 MHz		± 1.5 dB
	125 MHz		± 1.5 dB
	300 MHz		± 1.5 dB
	1.4 GHz		± 1.5 dB
	3 GHz		± 1.5 dB
-124dBm	100 kHz		± 1.5 dB
	10 MHz		± 1.5 dB
	125 MHz		± 1.5 dB
	300 MHz		± 1.5 dB
	1.4 GHz		± 1.5 dB
	3 GHz		± 1.5 dB

Attenuation Accuracy - 50 Ω

Use a high performance measuring receiver to make the following measurements, relative to +16 dBm.

Attenuation Accuracy (50 Ω) Test

Frequency	Attenuation	Actual	Specification	Uncertainty	Tolerance
10 MHz	0 dB	---	Reference	Reference	Reference
	-13 dB		± 0.035 dB		
	-23 dB		± 0.035 dB		
	-33 dB		± 0.035 dB		
	-43 dB		± 0.04 dB		
	-53 dB		± 0.04 dB		
	-63 dB		± 0.04 dB		
	-73 dB		± 0.1 dB		
	-82 dB		± 0.1 dB		
	-91 dB		± 0.1 dB		
	-100 dB		± 0.1 dB		
50 MHz	0 dB	---	Reference	Reference	Reference
	-13 dB		± 0.035 dB		
	-23 dB		± 0.035 dB		
	-33 dB		± 0.035 dB		
	-43 dB		± 0.04 dB		
	-53 dB		± 0.04 dB		
	-63 dB		± 0.04 dB		
	-73 dB		± 0.1 dB		
	-82 dB		± 0.1 dB		
	-91 dB		± 0.1 dB		
	-100 dB		± 0.1 dB		

Attenuation Accuracy (50 Ω) Test (cont.)

Frequency	Attenuation	Actual	Typical Performance	Uncertainty	Typical Tolerance
100 MHz	0 dB	---	Reference	Reference	Reference
	-13 dB		± 0.035 dB		
	-23 dB		± 0.035 dB		
	-33 dB		± 0.035 dB		
	-43 dB		± 0.04 dB		
	-53 dB		± 0.04 dB		
	-63 dB		± 0.04 dB		
	-73 dB		± 0.1 dB		
	-82 dB		± 0.1 dB		
	-91 dB		± 0.1 dB		
	-100 dB		± 0.1 dB		

VSWR - 50 Ω (Optional)

Use a directional bridge and a spectrum analyzer to make the following measurements.

VSWR (50 Ω) Test

Level	Frequency	Actual	Tolerance
+13 dBm	500 MHz		< 1.1
	1 GHz		< 1.2
	3 GHz		< 1.3
	4GHz		< 1.4
+3 dBm	500 MHz		< 1.1
	1 GHz		< 1.2
	3 GHz		< 1.3
	4GHz		< 1.4
-7 dBm	500 MHz		< 1.1
	1 GHz		< 1.2
	3 GHz		< 1.3
	4GHz		< 1.4

Level Accuracy - 75 Ω

Use an AC Measurement Standard, a power meter and power sensors, and a high performance spectrum analyzer/measuring receiver to make the following measurements.

Level Accuracy (75 Ω) Test

Level	Frequency	Actual	Tolerance
+10 dBm	1 kHz		± 0.06 dB
	20 kHz		± 0.06 dB
	100 kHz		± 0.06 dB
	10 MHz		± 0.06 dB
	125 MHz		± 0.06 dB
	300 MHz		± 0.15 dB
	1.4 GHz		± 0.25 dB
+7 dBm	1 kHz		± 0.06 dB
	20 kHz		± 0.06 dB
	100 kHz		± 0.06 dB
	10 MHz		± 0.06 dB
	100 MHz		± 0.06 dB
	300 MHz		± 0.15 dB
	1.4 GHz		± 0.25 dB
	2 GHz		± 0.3 dB
-3 dBm	1 kHz		± 0.06 dB
	20 kHz		± 0.06 dB
	100 kHz		± 0.06 dB
	10 MHz		± 0.06 dB
	100 MHz		± 0.06 dB
	300 MHz		± 0.15 dB
	1.4 GHz		± 0.25 dB
	2 GHz		± 0.3 dB

Level Accuracy (75 Ω) Test (Cont).

Level	Frequency	Actual	Tolerance
-13dBm	1 kHz		± 0.06 dB
	20 kHz		± 0.06 dB
	100 kHz		± 0.06 dB
	10 MHz		± 0.06 dB
	100 MHz		± 0.06 dB
	300 MHz		± 0.15 dB
	1.4 GHz		± 0.25 dB
	2 GHz		± 0.3 dB
-23 dBm	1 kHz		± 0.06 dB
	20 kHz		± 0.06 dB
	100 kHz		± 0.06 dB
	10 MHz		± 0.06 dB
	100 MHz		± 0.06 dB
	300 MHz		± 0.15 dB
	1.4 GHz		± 0.25 dB
	2 GHz		± 0.3 dB
-33dBm	1 kHz		± 0.15 dB
	20 kHz		± 0.15 dB
	100 kHz		± 0.15 dB
	10 MHz		± 0.15 dB
	100 MHz		± 0.15 dB
	300 MHz		± 0.15 dB
	1.4 GHz		± 0.5 dB
	2 GHz		± 0.5 dB
-43 dBm	1 kHz		± 0.15 dB
	20 kHz		± 0.15 dB
	100 kHz		± 0.15 dB
	10 MHz		± 0.15 dB
	100 MHz		± 0.15 dB
	300 MHz		± 0.15 dB
	1.4 GHz		± 0.5 dB
	2 GHz		± 0.5 dB

Level Accuracy (75 Ω) Test (Cont).

Level	Frequency	Actual	Tolerance
-53 dBm	1 kHz		± 0.15 dB
	20 kHz		± 0.15 dB
	100 kHz		± 0.15 dB
	10 MHz		± 0.15 dB
	100 MHz		± 0.15 dB
	300 MHz		± 0.15 dB
	1 GHz		± 0.5 dB
	2 GHz		± 0.5 dB
-63 dBm	100 kHz		± 0.2 dB
	10 MHz		± 0.2 dB
	100 MHz		± 0.2 dB
	300 MHz		± 0.2 dB
	1.4 GHz		± 0.5 dB
	2 GHz		± 0.5 dB
-72dBm	100 kHz		± 0.2 dB
	10 MHz		± 0.2 dB
	100 MHz		± 0.2 dB
	300 MHz		± 0.2 dB
	1.4 GHz		± 0.5 dB
	2 GHz		± 0.5 dB

Level Accuracy (75 Ω) Test (Cont).

Level	Frequency	Actual	Tolerance
-81 dBm	100 kHz		± 0.7 dB
	10 MHz		± 0.7 dB
	125 MHz		± 0.7 dB
	300 MHz		± 0.7 dB
	1.4 GHz		± 1.0 dB
	2 GHz		± 1.0 dB
-91 dBm	100 kHz		± 0.7 dB
	10 MHz		± 0.7 dB
	125 MHz		± 0.7 dB
	300 MHz		± 0.7 dB
	1.4 GHz		± 1.0 dB
	2 GHz		± 1.0 dB
-101dBm	100 kHz		± 1.5 dB
	10 MHz		± 1.5 dB
	125 MHz		± 1.5 dB
	300 MHz		± 1.5 dB
	1.4 GHz		± 1.5 dB
	2 GHz		± 1.5 dB

Optional Ultra-Low Level Accuracy (75 Ω) Test.

Level	Frequency	Actual	Tolerance
-111 dBm	100 kHz		± 1.5 dB
	10 MHz		± 1.5 dB
	125 MHz		± 1.5 dB
	300 MHz		± 1.5 dB
	1.4 GHz		± 1.5 dB
	2 GHz		± 1.5 dB
-121 dBm	100 kHz		± 1.5 dB
	10 MHz		± 1.5 dB
	125 MHz		± 1.5 dB
	300 MHz		± 1.5 dB
	1.4 GHz		± 1.5 dB
	2 GHz		± 1.5 dB

Attenuation Accuracy - 75 Ω

Use a high performance measuring receiver to make the following measurements, relative to +16 dBm.

Attenuation Accuracy (75 Ω) Test

Frequency	Attenuation	Actual	Typical Performance	Uncertainty	Typical Tolerance
10 MHz	0 dB	---	Reference	Reference	Reference
	-9 dB		± 0.035 dB		
	-19 dB		± 0.035 dB		
	-29 dB		± 0.035 dB		
	-39 dB		± 0.05 dB		
	-49 dB		± 0.05 dB		
	-69 dB		± 0.05 dB		
	-69 dB		± 0.05 dB		
	-79 dB		± 0.05 dB		
	-88 dB		± 0.05 dB		
	-97 dB		± 0.05 dB		
50 MHz	0 dB	---	Reference	Reference	Reference
	-9 dB		± 0.035 dB		
	-19 dB		± 0.035 dB		
	-29 dB		± 0.035 dB		
	-39 dB		± 0.05 dB		
	-49 dB		± 0.05 dB		
	-69 dB		± 0.05 dB		
	-69 dB		± 0.05 dB		
	-79 dB		± 0.05 dB		
	-88 dB		± 0.05 dB		
	-97 dB		± 0.05 dB		

Attenuation Accuracy (75 Ω) Test (cont.)

Frequency	Attenuation	Actual	Typical Performance	Uncertainty	Typical Tolerance
100 MHz	0 dB	---	Reference	Reference	Reference
	-9 dB		± 0.035 dB		
	-19 dB		± 0.035 dB		
	-29 dB		± 0.035 dB		
	-39 dB		± 0.05 dB		
	-49 dB		± 0.05 dB		
	-69 dB		± 0.05 dB		
	-69 dB		± 0.05 dB		
	-79 dB		± 0.05 dB		
	-88 dB		± 0.05 dB		
	-97 dB		± 0.05 dB		

VSWR - 75 Ω (Optional)

Use a directional bridge and a spectrum analyzer to make the following measurements.

VSWR (75 Ω) Test

Level	Frequency	Actual	Tolerance
+7 dBm	500 MHz		< 1.1
	1 GHz		< 1.2
	2 GHz		< 1.3
-3 dBm	500 MHz		< 1.1
	1 GHz		< 1.2
	2 GHz		< 1.3
-13 dBm	500 MHz		< 1.1
	1 GHz		< 1.2
	2GHz		< 1.3

Chapter 6
Theory of Operation

Introduction

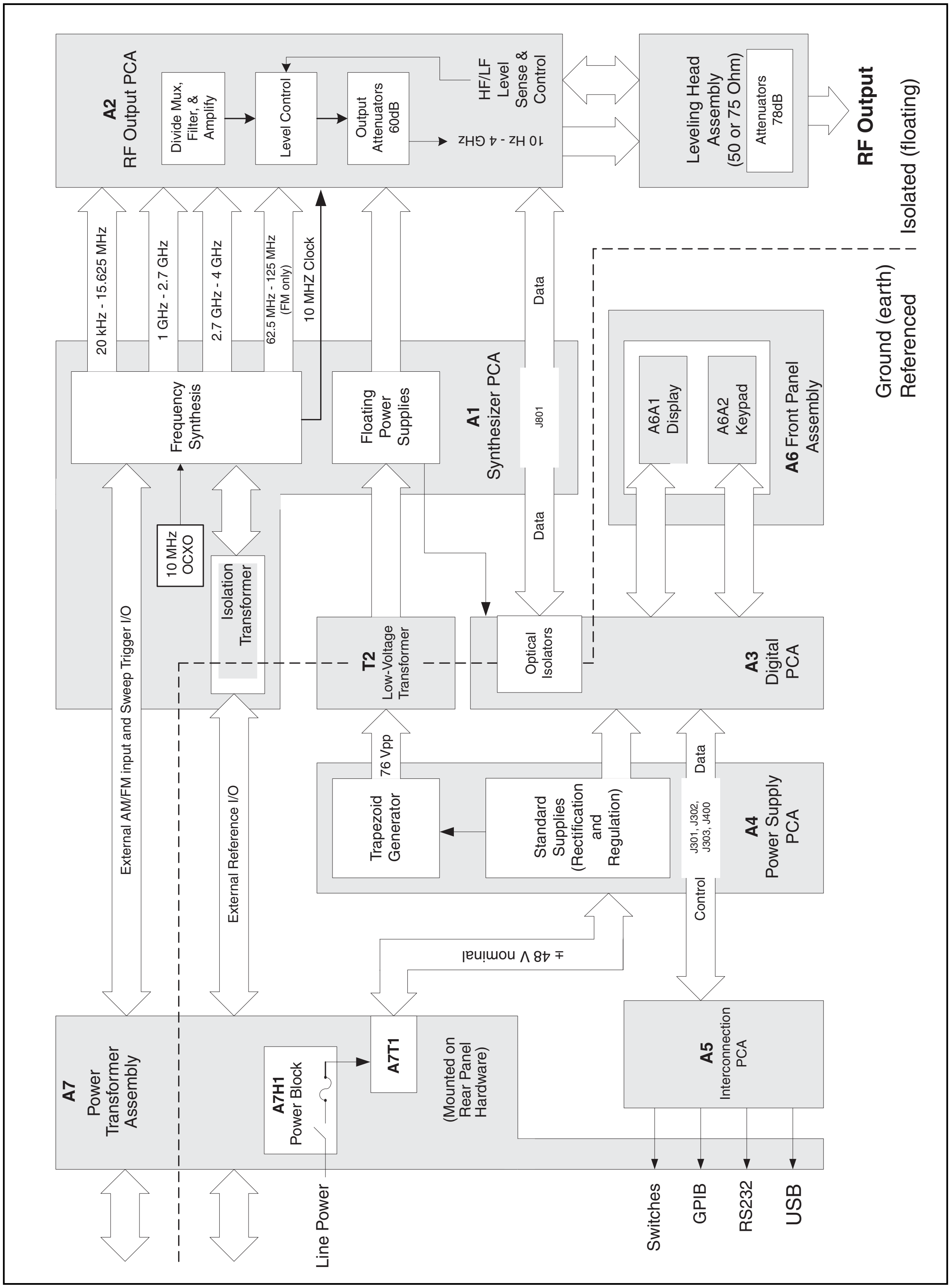
This chapter of the manual provides the theory of operation for the Instrument. The theory is presented at a high-level and is supported by an overall functional block diagram. Since the Instrument is supported at the module (board) level, the theory is often a useful troubleshooting tool for isolating faulty PCAs. The Assembly numbers (modules/PCAs) in the theory correspond to the replaceable assemblies described in Chapter 8, List of Replaceable Parts.

Overall Functional Description

Refer to the functional block diagram shown in Figure 6-1 while reading this description. In addition to identifying all of the assemblies contained in the Instrument, this diagram provides a functional view of the data flow between the assemblies. When appropriate, simplified schematics also accompany the description. These simplified schematics, Figures 6-2, 6-3, and 6-4 are located at the back of this chapter. Assembly interconnections and cable identification is detailed in Chapter 7, Maintenance.

The following list identifies the eight major assemblies that comprise the Instrument and includes a description of the basic functions each assembly performs:

A1	Synthesizer PCA	Develop frequency for output, and voltages for isolated (floating) functions
A2	RF Output PCA	Divide, filter, amplify, control, and attenuate RF Output
A3	Digital PCA	Optical isolation and routing of digital control data (IEEE-488 (GPIB) and serial data)
A4	Power Supply PCA	Ground referenced power supplies and driver for Low Voltage Transformer (T2)
A5	Interconnection PCA	Rear-panel accessible connectors and switches for remote communication.
A6	Front Panel Assembly	Front panel user interface (UI) for local operation, includes the A6A1 Display PCA and the A6A2 Keypad PCA
A7	Power Transformer Assembly	Also provides the ± 48 V ac (A7T1) for driving the A4 Power Supply PCA
__	Rear Panel	Provides the mounting location for ports, connectors, and switches needed to externally access and influence the operation of the Instrument.
A9	Leveling Head	Leveling, control, and attenuation of the RF Output Signal



ead255f.eps

Figure 6-1. 9640A Overall Functional Block Diagram

User Interface

Normal operator interaction with the Instrument begins at the A6 Front Panel which includes a keypad (A6A2) for entering Instrument configuration and control data and a display (A6A1) for verifying the selected configuration of the RF output signal. Both the keypad switches and the display are included on a plastic bezel assembly which comprises the majority of the Front Panel Assembly. A rubber keypad, whose keys include a conductive backing, provides switching information to the A3 Digital PCA. A controller on the A3 Digital PCA provides the addressing, strobing, and storage of data coming from and going to the display.

Frequency Synthesis

Primary frequency synthesis takes place within the A1 Synthesizer PCA (Figure 6-2), where a combination of phase lock, frequency translation and direct digital synthesis (DDS) techniques are used to generate signals of appropriate resolution, phase noise and spectral purity. Four main outputs are created, covering the ranges 20 kHz to 9 MHz, 1 GHz to 2.7 GHz, 2.7 GHz to 4 GHz and, for wide deviation FM only, 62.5MHz to 125MHz. To achieve the required frequency accuracy, these outputs are derived from a 10 MHz Oven Controlled Crystal Oscillator (OCXO), but the instrument will also accept an external reference clock source of between 1 MHz and 20 MHz in 1 MHz increments.

The four A1 Synthesizer PCA output signals are fed to the A2 RF Output PCA (Figure 6-3) where additional frequencies are derived: frequencies covering the range 9 MHz to 1 GHz (with the exception of wide deviation FM signals at carrier frequencies below 125 MHz) are derived by applying signals of between 1 and 2 GHz to a binary divider chain, and frequencies spanning the range 10 Hz to 20 kHz are generated by means of a wave table and associated DAC. Frequencies covering the range 10 Hz to 4 GHz are thus available within the A2 RF Output PCA.

Amplitude Control

Signals from the various sources are amplified, filtered and selected as appropriate to produce a sinusoidal output at the required frequency.

To achieve the necessary dynamic range on the output, up to 138 dB of switched attenuation, comprising 60 dB on the A2 RF Output PCA (Figure 6-3) and 78 dB in the A9 Leveling Head (Figure 6-4), can be applied to the output signal.

For frequencies greater than 20 kHz, the output amplitude is controlled by a feedback loop which compares the output level with that of a set value and maintains it by adjusting voltage controlled attenuator circuits in the forward signal path. At higher output levels all switched attenuation is applied within the A9 Leveling Head, and in this condition the signal level is sensed in the A9 Leveling Head prior to attenuation. Two level detectors are used: an LF Detector (20 kHz < frequencies > 125 MHz) and an HF Detector (frequencies > 125 MHz). For output levels below approximately -60 dBm, the 60 dB attenuator in the A2 RF Output PCA is switched in, and in this condition the level is sensed by LF and HF Detectors on the A2 RF Output PCA prior to attenuation.

To offer the greatest noise immunity when connecting the Instrument to a UUT, the A1 Synthesizer PCA and the A2 RF Output PCA power supplies are isolated from Earth so that the instrument output is floating.

Frequency Modulation

Frequency modulated outputs are derived from a frequency modulated 100 MHz to 250 MHz carrier signal which is generated on the A1 Synthesizer PCA by a high frequency DDS circuit. The modulating waveform is generated internally in the digital domain, but a dedicated A-D converter is included to allow the instrument to accept an external analogue modulation source.

For output frequencies greater than 125 MHz, a combination of frequency translation and phase lock techniques are used to convert this carrier to frequencies in the range 1 GHz to 2.7 GHz. This signal is then fed to the A2 RF Output Assembly where carrier frequencies down to 125 MHz are derived by successive binary division. For output frequencies < 125 MHz and deviation values < 0.12 % of the carrier frequency the output is derived by further binary division of this signal.

For output frequencies < 125 MHz and deviation values > 0.12 % of the carrier frequency the DDS signal is applied directly to the A2 RF Output PCA, where carrier frequencies down to 9 MHz are derived by binary division.

Amplitude Modulation

For carrier frequencies > 125 MHz amplitude modulation is achieved by applying a modulation component to the control input signals of the voltage-controlled attenuator circuits used to control carrier amplitude. At these frequencies, feedback from an output envelope detector is used to maintain modulation accuracy and correct for non-linearities in the voltage controlled attenuator circuits. To achieve the required modulation index range in this mode, the signal is also pre-modulated by an additional voltage controlled attenuator stage in each of the three high frequency signal paths.

For carrier frequencies < 125 MHz amplitude modulation is achieved by applying the modulating signal to an analogue multiplier which is switched into the carrier signal forward path. In this mode the multiplier is also used to control the output signal level.

The modulating waveform is generated by a 32-bit numerically controlled oscillator (NCO) which feeds a wave table, but a dedicated A-D converter is included to allow the instrument to accept an external analogue modulation source.

Instrument Control

Overall control of instrument functions is provided by the A3 Digital PCA which accepts data from the A6 Front Panel Assembly user interface. The A3 Digital PCA responds by setting control bits on the A1 Synthesizer PCA and the A2 RF Output PCA via an 8-bit address/write bus. Control bits for the A9 Leveling Head are also set and relayed by the A2 RF Output PCA via a serial interface.

An 8-bit read bus allows the A3 Digital PCA to receive self-test and status data from the A1 Synthesizer PCA and A2 RF Output PCA, as well as A9 Leveling Head-specific calibration data stored within an EEPROM device in the A9 Leveling Head. The A3 Digital PCA also handles external data communication via the GPIB and RS232 ports.

Operating voltages for the A3 Digital PCA are all derived from the A4 Power Supply PCA and are ground (Earth) referenced. Optical-isolators on the A3 Digital PCA allow A1 Synthesizer PCA and A2 RF Output PCA to exchange floating data with the A3 Digital PCA.

Power Supplies

Line power is fed via a Power Block module A7H1 mounted on the rear panel to the A7T1 Power Transformer. The A7T1 Power Transformer has two primary windings which can be connected either in series or parallel by means of a voltage-selector insert within the power entry module (power block). Properly positioning the voltage-selector insert allows the Instrument to accommodate its full range of line voltages.

The stepped-down voltage at the A7T1 Power Transformer secondary is rectified and smoothed on the A4 Power Supply PCA to produce an unregulated DC output of ±48 V (nominal). From these outputs, switch mode and linear techniques are used to derive earth-referenced regulated DC outputs which include +5 V dc, -22 V dc, +12 V dc, +23 V dc, and -15 V dc.

The +5 V dc supply is used to power the A3 Digital PCA where a +3.3 V dc supply is also derived, both for internal use and to power the A6A2 Keypad PCA and color display (when fitted). The -22 V supply is included to power the monochrome display (when fitted) and is routed via the A3 Digital PCA. The +12 V dc supply provides power to the backlight inverter for the display and is also routed via the A3 Digital PCA where it can be switched under firmware control.

The +23 V dc and -15 V dc supplies feed a trapezoidal waveform generator, located on the A4 Power Supply PCA, which produces a differential pair of symmetrical 76 V peak-to-peak, 50/60Hz, flat-topped waveforms with controlled rise and fall times.

The differential trapezoidal waveform is applied to the primary of the low voltage (LV) transformer, T2. This transformer has three secondary windings whose outputs are rectified, smoothed and regulated on the A1 Synthesizer PCA to produce floating supply outputs of -5.2 V dc, +3.3 V dc, +5 V dc, -15 V dc, +2.5 V dc, +9 V dc, +12 V dc, +15 V dc, and +25 V dc from which all functions on the A1 Synthesizer PCA, A2 RF Output PCA and A9 Leveling Head are powered. These supplies can be shut down under the command of a signal from the A3 Digital PCA which disables the +23 V dc and -15 V dc regulators on the A4 Power Supply PCA.

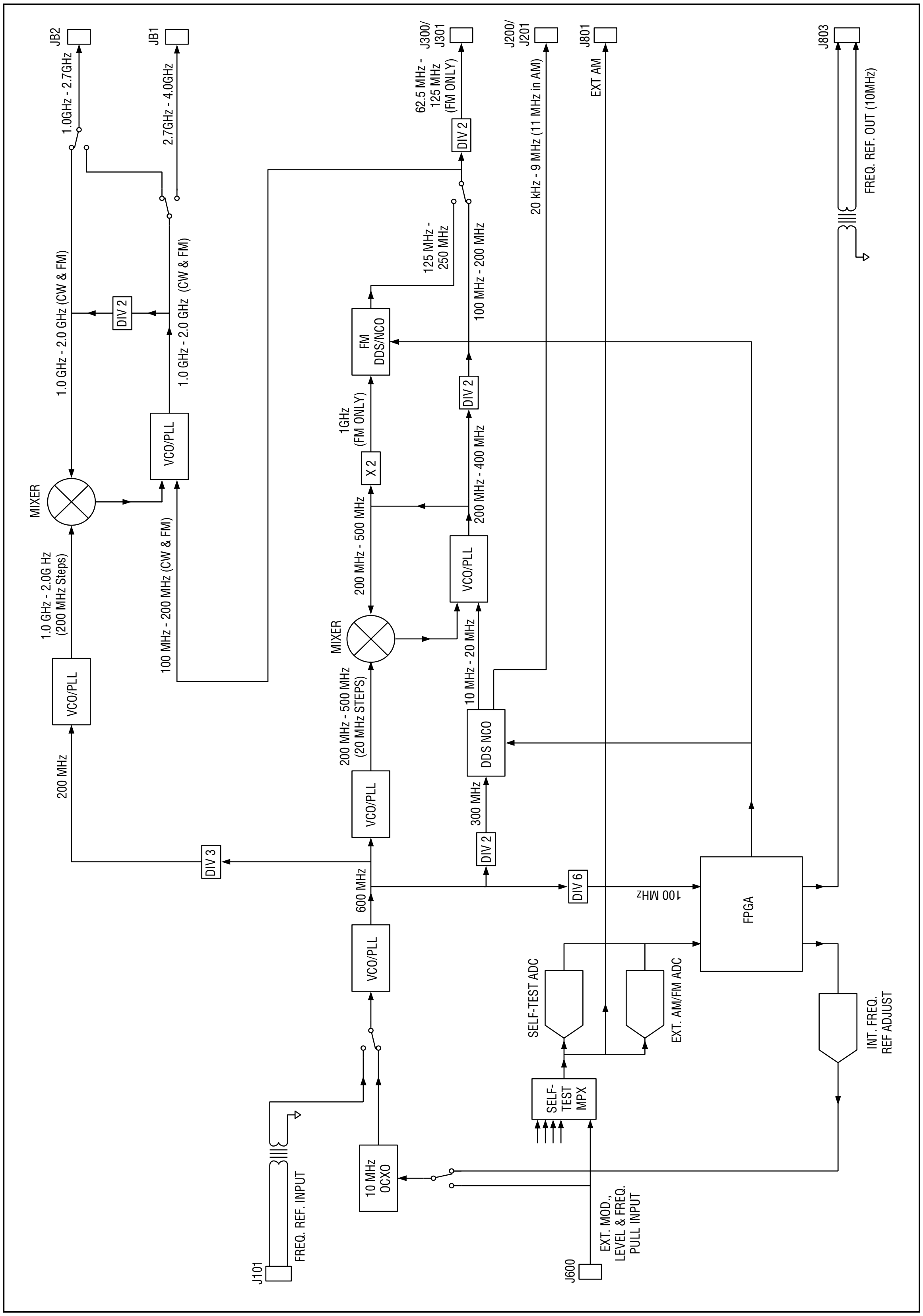


Figure 6-2. A1 Synthesizer PCA - Simplified Schematic Diagram

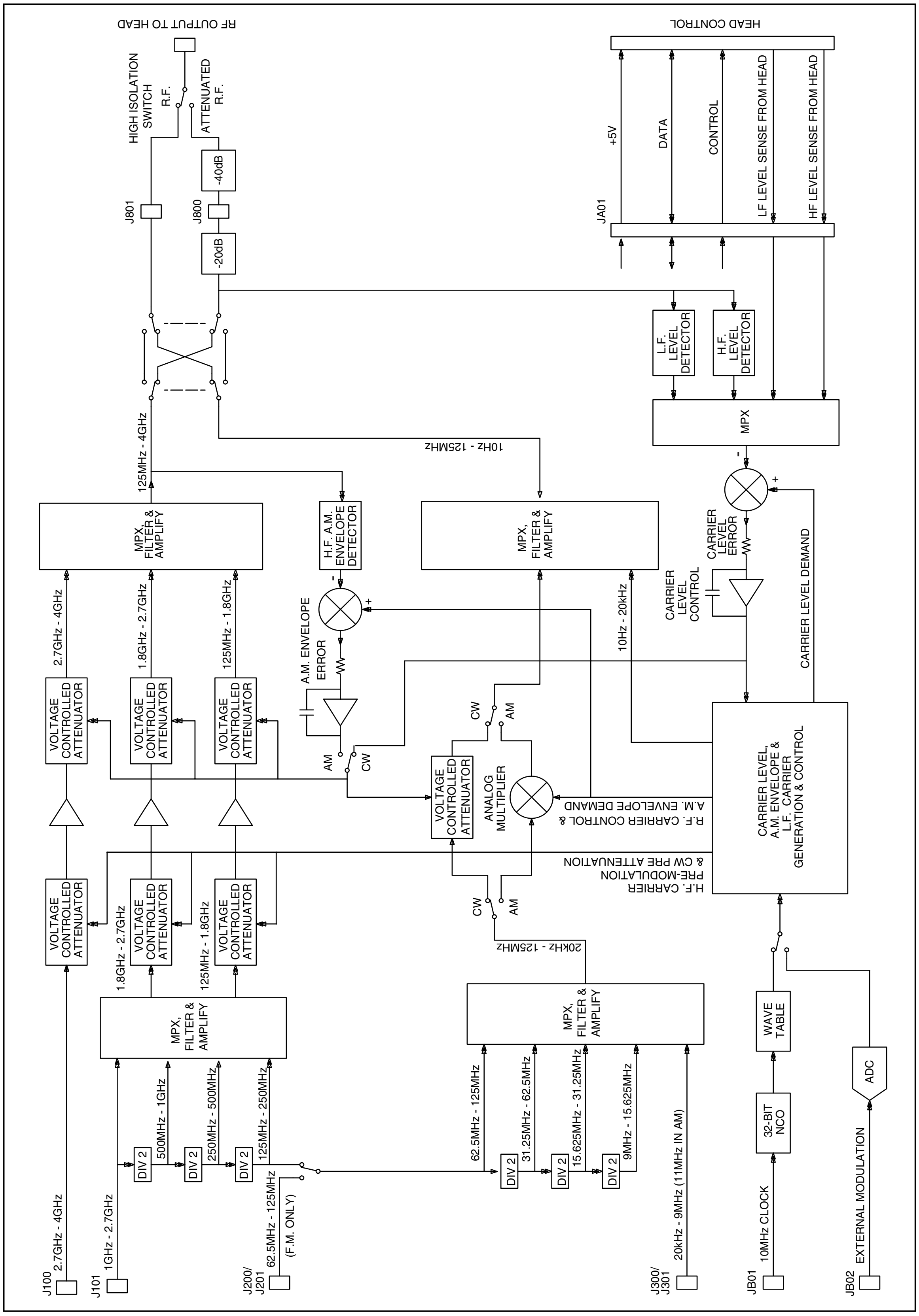
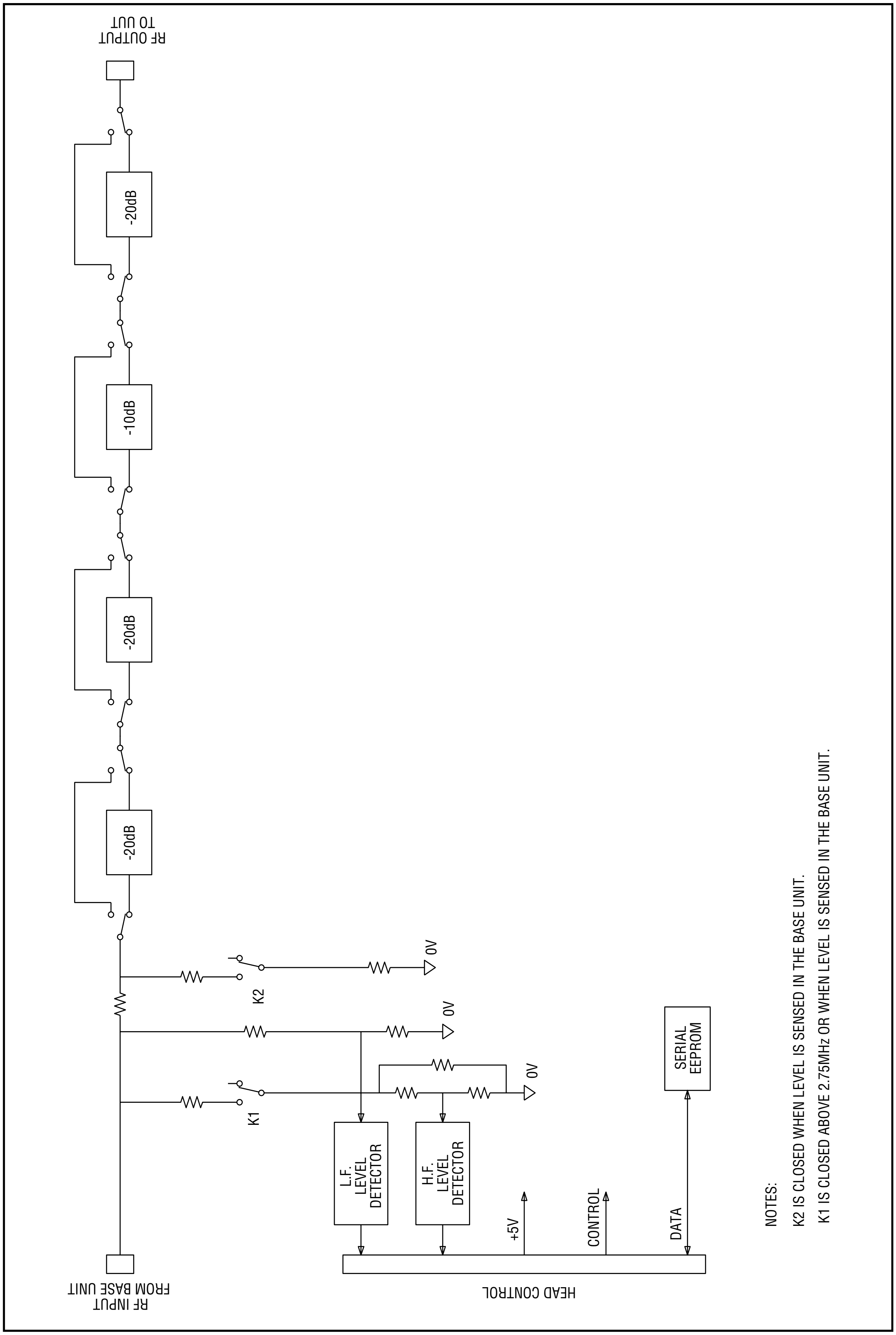


Figure 6-3. A2 RF Output PCA - Simplified Schematic Diagram



ead257f.eps

Figure 6-4. A9 Leveling Head Assembly - Simplified Block Diagram

Chapter 7
Maintenance

Title	Page

⚠⚠ Warning

The servicing instructions in this chapter of the manual are for use by qualified personnel only. To avoid electrical shock, do not perform any servicing on the product other than that contained in the operating instructions unless you are qualified to do so.

Introduction

This chapter contains the information required to maintain, troubleshoot and repair the Instrument. Due to the complexity of the instrument, service information is limited to PCA or module replacement.

Contacting Fluke

To contact Fluke for product information, operating assistance, service, or to get the location of the nearest Fluke distributor or Service Center, call:

1-888-99FLUKE (1-888-993-5853) in U.S.A.

1-800-36-FLUKE (1-800-363-5853) in Canada

+31-402-675-200 in Europe

+81-3-3434-0181 Japan

+65-738-5655 Singapore

+1-425-446-5500 from other countries

Visit Fluke's web site at: www.fluke.com.

General Maintenance

Perform the following general-maintenance procedures whenever necessary.

Replacing Fuses

Fuse replacement is required when the Instrument blows a fuse, and when the line voltage requirements for the source change. In either event, refer to Chapter 2 for instruction on replacing the fuse.

Cleaning the Air Filter

The Instrument uses two fans for cooling. A single intake air filter cleans the air for both fans. Inspect and clean the air filter at least once a year or as required to ensure good air circulation. Air filter removal and cleaning may be performed without breaking calibration integrity seals.

Note

The instrument top cover is removeable for air filter cleaning access without the need to break calibration integrity seals. A calibration integrity seal is located on the internal top shield, revealed once the outer top cover has been removed. It is not necessary to break this seal during air filter removal and cleaning.

Use the following procedure to clean the air filter:

1. Refer to the Air Filter Access Procedure later in this chapter, and remove the air filter from the Instrument.
2. Clean the air filter using a dry brush or vacuum cleaner. Warm water and a mild detergent may be used if necessary.
3. Dry the air filter using a paper towel to blot the water.
4. Install the air filter and re-assemble the Instrument.

Disassembly and Reassembly

The following paragraphs provide step-by-step instructions for disassembling and reassembling the Instrument. The instructions are limited to major replaceable assemblies and external hardware and do not include component level detail. Emphasis is placed on disassembly. However, when appropriate, an italicized entry at the end of each disassembly procedure provides critical hints for reassembly.

Use these procedures as necessary to access the following PCAs, modules, and components described in general maintenance, troubleshooting, and repair procedures.

- External Hardware Components, including the air filter
- A2 RF Output PCA
- 1P 2W Coaxial Relay
- A3 Digital PCA
- A1 Synthesizer PCA
- A6 Front Panel Assembly
- A6A1 Display and A6A2 Keypad PCAs
- Fans
- Rear Panel Assembly
- A5 Interconnection PCA
- A7 Power Transformer Assembly
- A4 Power Supply PCA
- A9 Leveling Head – 50 Ω and 75 Ω

Before You Start

To ensure your safety and for the protection of the Instrument follow all of the considerations and recommendations that follow:

⚠⚠ Warning

- **To avoid electrical shock, do not remove the covers from the instrument unless you are qualified to do so.**
- **To avoid shock hazards and for the protection of the unit, disconnect all power cords, rear-panel cables, and front/rear test leads from the Instrument.**

⚠ Caution

- **To avoid damage to the Instrument, do not remove the covers unless you are qualified to do so.**

  Be aware that beyond removal of the external covers, removing the internal top cover will void calibration of the Instrument.

  Be aware that removal of the external covers from the Leveling Head will void its calibration.
- **The Instrument is heavy. To avoid damage from falling, place it securely on an appropriate bench top or work surface before removing the covers.**
- **To avoid damage to the Instrument from static electricity, use best practice anti-static techniques after removing its covers.**
- **To avoid impairing the operating characteristics of the unit, do not unnecessarily touch any part of the PCAs or straighten component positions on the PCAs.**

Removing External Hardware Components

Use the following procedures to remove external hardware components from the Instrument. Removing all of the hardware components in sequence provides incremental access to the interior of the Instrument. See Figure 7-1.

Handles

The Instrument has four handles, two on the front panel and two on the rear panel. All four handles are the same. Each handle is secured to the chassis using five screws, two on the front of the handle and three on the side.

Use the following procedure to remove each of the handles:

1. Locate the handle to be removed.
2. Remove the two screws on the front of the handle.
3. Remove the three screws from the side of the handle.

Top and Bottom Covers

The top and bottom covers are the same except for the feet on the bottom cover. Use the following procedure for removing each of the covers:

1. Position the Instrument so the cover being removed is facing up.
2. Remove both handles on the rear panel. These are each secured by five screws.
3. Remove the two panhead screws that attach the cover to the rear panel.
4. Pull on the rear-panel edge backwards to release it from the front-panel bezel, now lift cover to free it from the channels on the side of the Instrument and lift away from the chassis.

Bottom Feet

The Instrument has four protective feet on the bottom cover. Use the following procedure to remove one or more of the feet:

1. Position the Instrument so the bottom cover is facing up.
2. Each foot can be removed by pushing the middle-locating lug securing it to the bottom cover into the open area of the metal sheet. This will release the foot.
3. Lift the foot from the bottom cover.

Shields

The Instrument has a large internal shield beneath the top cover. Sixteen counter sunk screws and seven panhead screws hold the shield in place. This shield must be removed to allow access any of the PCAs within the main compartment. Use the following procedure to remove the top shield:

1. Remove the top cover. (See top & bottom cover removal procedure).
2. Remove the sixteen counter sunk screws from the top of the shield.
3. Remove the seven panhead screws from the side of the shield.
4. Lift the shield from the source.

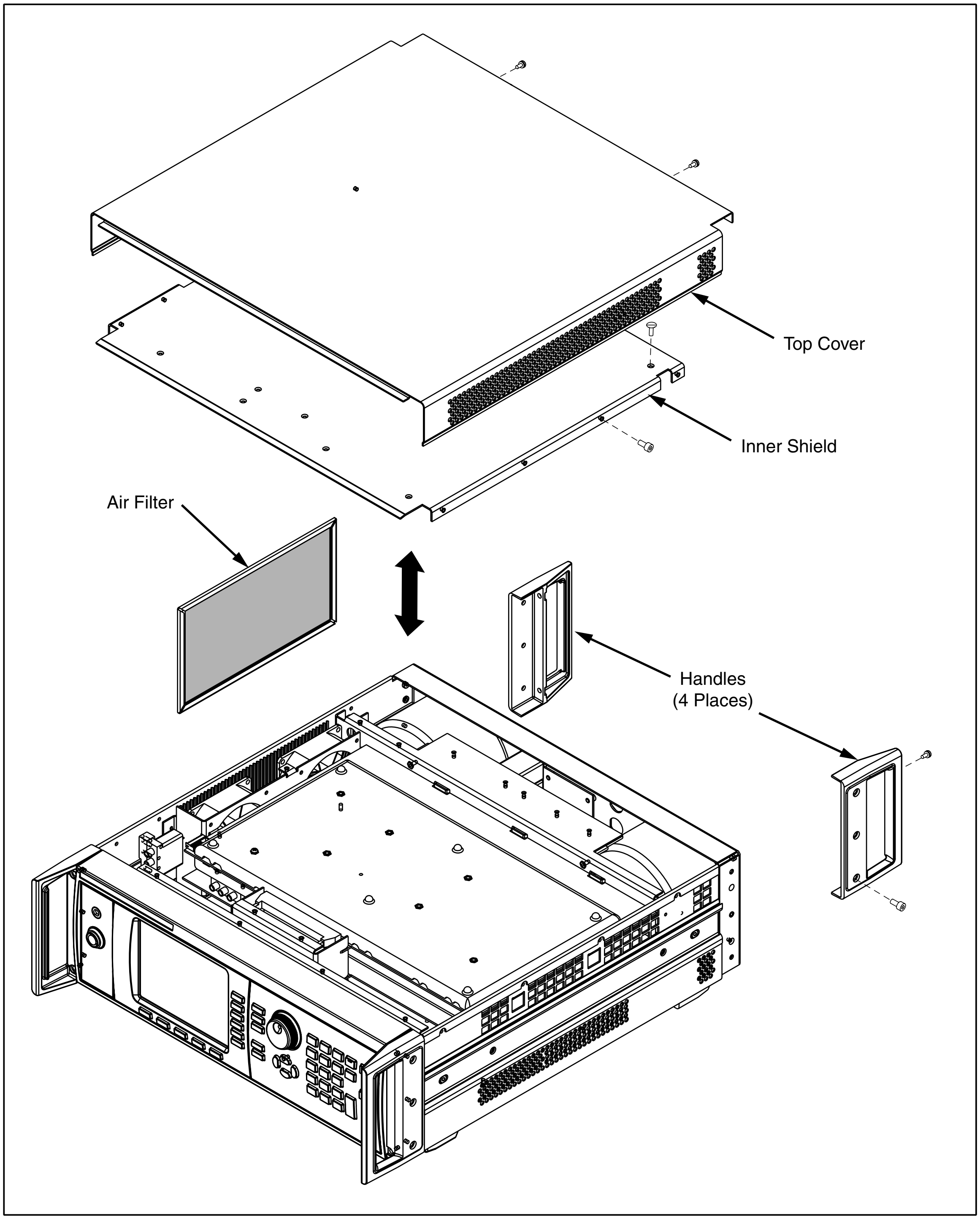
Air Filter

Use the following procedure to remove the air filter.

Note

The instrument top cover is removeable for air filter access without the need to break calibration integrity seals. A calibration integrity seal is located on the internal top shield, revealed once the outer top cover has been removed. It is not necessary to break this seal to remove the air filter

1. Remove the top cover from the Instrument. (See top & bottom cover removal procedure).
2. Locate the air filter and pull it up and out of the chassis. Note this air filter can be cleaned and re-used.



ead305f.eps

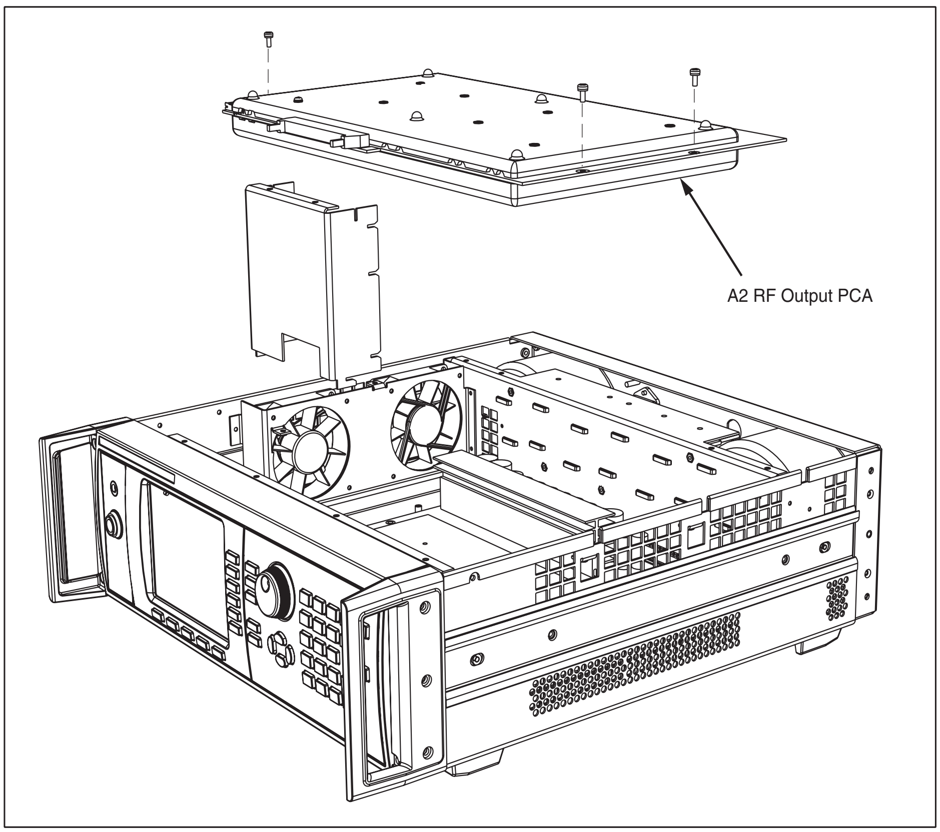
Figure 7-1. Removing External Hardware and Air Filter

Removing Major Assemblies

A2 RF Output PCA

Use the following procedure to remove the A2 RF Output PCA. Three panhead screws hold the PCA in place. See Figure 7-2.

1. Remove the top cover from the Instrument.
2. Remove the shield from the Instrument.
3. Slide the front PCA support bracket to the left and lift it out.
4. Disconnect the 60-pin ribbon cable using the ejectors.
5. Disconnect the seven MCX connectors by gently pulling them straight out. Each signal path is labeled “A-A” etc. on the top screens of the RF Output and Synthesizer PCAs. Before removing the PCA, note the positions of each cable for re-assembly.
6. Disconnect the two SMA connectors using an 8 mm spanner. Note these connectors are torque tightened (1 Nm); do not attempt to tighten them before releasing these connectors.
7. Disconnect the two-pin Molex connector.
8. Disconnect the 20-pin control cable connector. Do not pull it by the leads; pull it by the body.
9. Remove the three panhead screws securing the PCA to the source.
10. Pull the PCA forward and lift it clear of Instrument.



ead307f.eps

Figure 7-2. Removing the A2 RF Output PCA

1P 2W Coaxial Relay

Use the following procedure to remove the 1P 2W Coaxial Relay. Two panhead screws hold the Relay in place.

1. Remove the top cover from the Instrument.
2. Remove the shield from the Instrument.
3. The relay is located on the lefthand side panel in front of the fans.
4. Starting from the front, disconnect the first of three SMA connectors using an 8 mm spanner. Note these connectors are torque tightened (1 Nm); do not attempt to tighten them before releasing these connectors.
5. Disconect the 2 pin Molex connector from the RF module.
6. Remove the two panhead screws securing it to the side panel block, and lift out.

A6 Front Panel Assembly

The A6 Front Panel Assembly includes the Bezel Assembly, the Display and Keypad PCAs, and the RF Output and Control connectors. See Figure 7-3.

Use the following procedure to remove the A6 Front Panel Assembly.

1. Undo the nut securing the RF Output connector to the front panel using an 8 mm spanner.
2. Undo the nut securing the Control cable connector to the front panel.
3. Remove the upper and lower screws on the side of the front panel handles.
4. Gently ease the A6 Front Panel Assembly forward using the handles, as there are connectors still attached behind the panel. This will disengage the two connectors on the front panel.
5. When the front panel is forward sufficiently, disconnect the IDE cable (right-hand side) from the A3 Digital PCA. Do not pull on the cable, but ease it out using the location lug on the connector.
6. Carefully remove the display cable (flexible PCB) from the A3 Digital PCA as follows:
   a. Using your finger nails lift the cable-locking lever (located underneath the connector) to the up position.
   b. Carefully remove the flex PCB from its housing by gently pulling.
7. Withdraw the A6 Front Panel Assembly making sure the RF Output and Control connectors disengage from the panel.

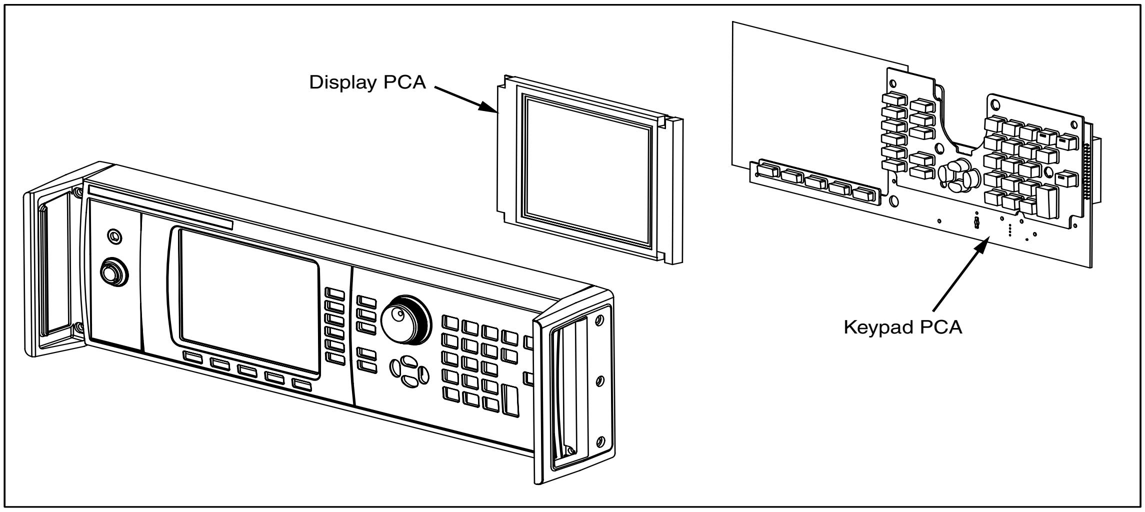


Figure 7-3. Removing the A6 Front Panel Assembly

A6A1 Display and A6A2 Keypad PCAs

Use the following procedure to remove the A6A1 Display and A6A2 Keypad PCAs:

1. Remove the A6 Front Panel Assembly from the Instrument.
2. Remove the spin knob by pulling it forward and removing the retaining nut.
3. Lay the front panel face down on an antistatic surface and disconnect the display cable from the HV drive module. The PCA is extremely thin; use care during the removal process.
4. Remove the four self-tapping screws from the display and lift it out, taking care not to scratch the display or window.
5. Remove the eight self-tapping screws securing the Keypad PCA to the front panel. Lift out the Keypad PCA ensuring the spin wheel device remains attached. Note the bottom edge of the Keypad PCA connects to the front panel. Use a slight forward pressure to remove the PCA.
6. Lift out the rubber keypads.

Note

The display window is secured in place by adhesive tape. Do not remove the display unless it or the display window is being replaced.

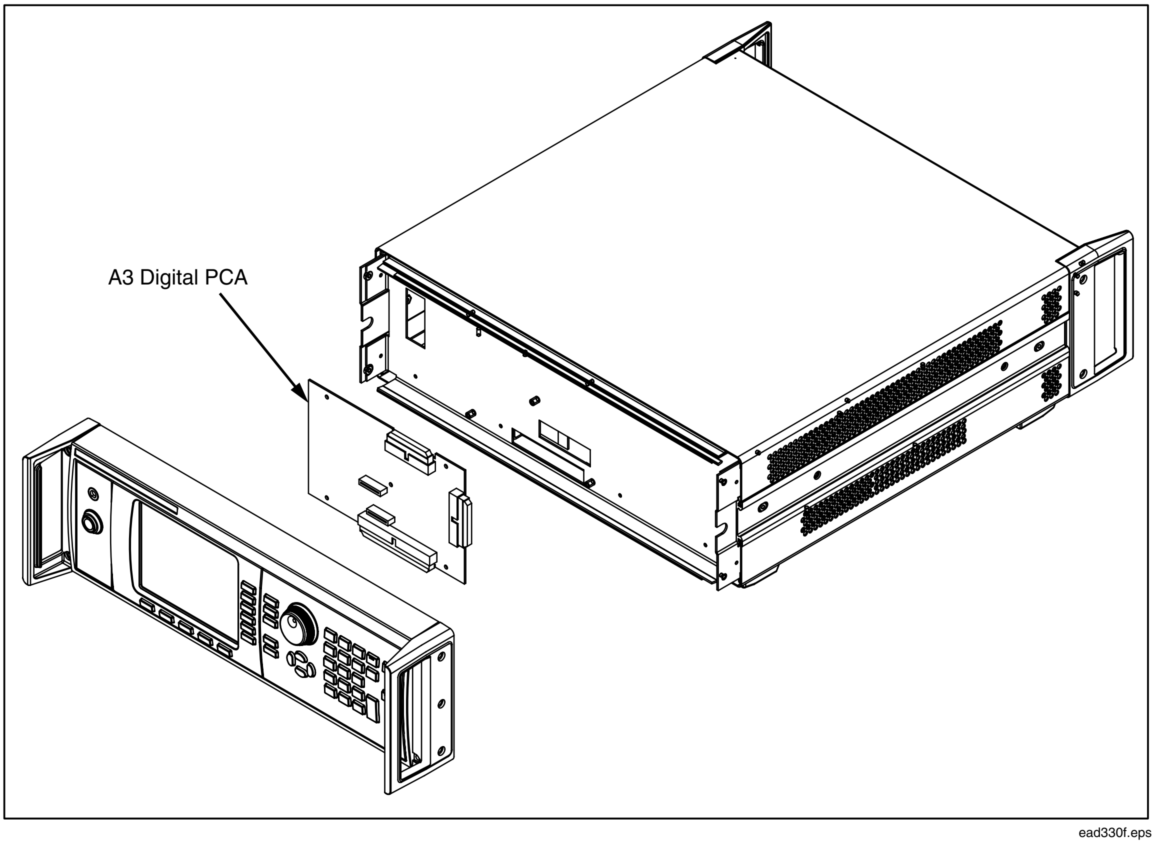
Note

The inside of the front panel has a nickel conductive coat applied to it. Be careful to avoid damaging the coating.

A3 Digital PCA

Use the following procedure to remove the A3 Digital PCA. The PCA is located behind the front panel and attached to the Instrument. It can be removed without removing the top and bottom covers from the Instrument. See Figure 7-4.

1. Remove the A6 Front Panel Assembly from the Source.
2. Remove the five panhead screws securing the A3 Digital PCA to the Instrument.
3. Remove the 34-pin IDE ribbon cable at the top of the PCA by prying the location lug out of its housing.
4. Remove the 60-pin IDE ribbon cable located on the base of the PCA by prying the location lug out of the housing.
5. Remove the A3 Digital PCA from the Instrument.



ead330f.eps

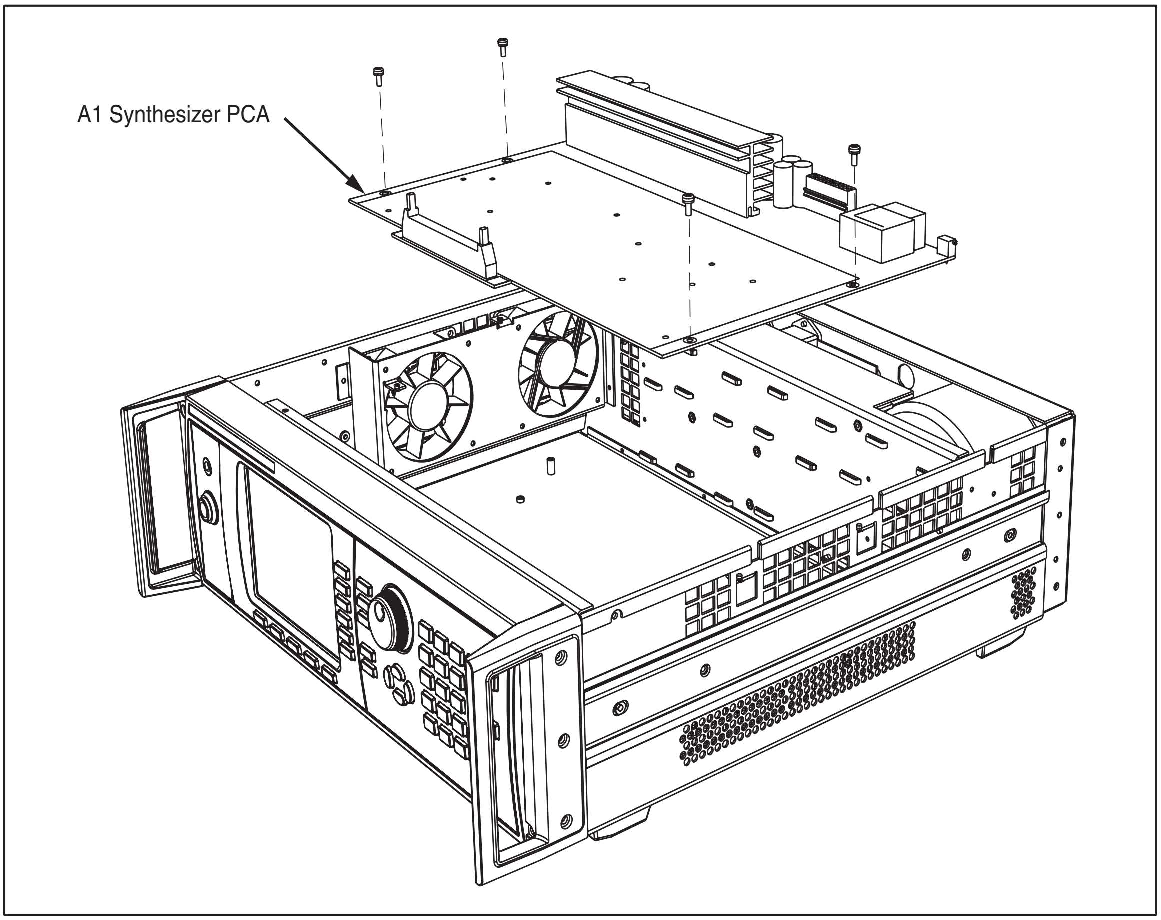
Figure 7-4. Removing the A3 Digital PCA

A1 Synthesizer PCA

The A1 Synthesizer PCA is located beneath the A2 RF Output PCA. Four panhead screws secure this assembly to the Instrument. See Figure 7-5.

Use the following procedure to remove the A1 Synthesizer PCA:

1. Remove the top cover from the Instrument.
2. Remove the shield from the Instrument.
3. Remove the A2 RF Output PCA from the Instrument.
4. Disconnect the four SMB connectors by pulling firmly upwards by the body of the connector. Each connector is colour coded. Note the location of each cable for re-assembly.
5. Disconnect the 10-pin Molex connector at the rear of the PCA.
6. Disconnect the seven MCX connectors at the front of the PCA by gently pulling and setting to one side. Each signal path is labeled "A-A" etc. on the top screens of the RF Output and Synthesizer PCAs. Note the location of each cable for re-assembly.
7. Disconnect the 60–pin IDE cable using the ejectors.
8. Remove the four panhead screws from the A1 Synthesizer PCA. Pull the PCA forward and lift it from the chassis.



ead306f.eps

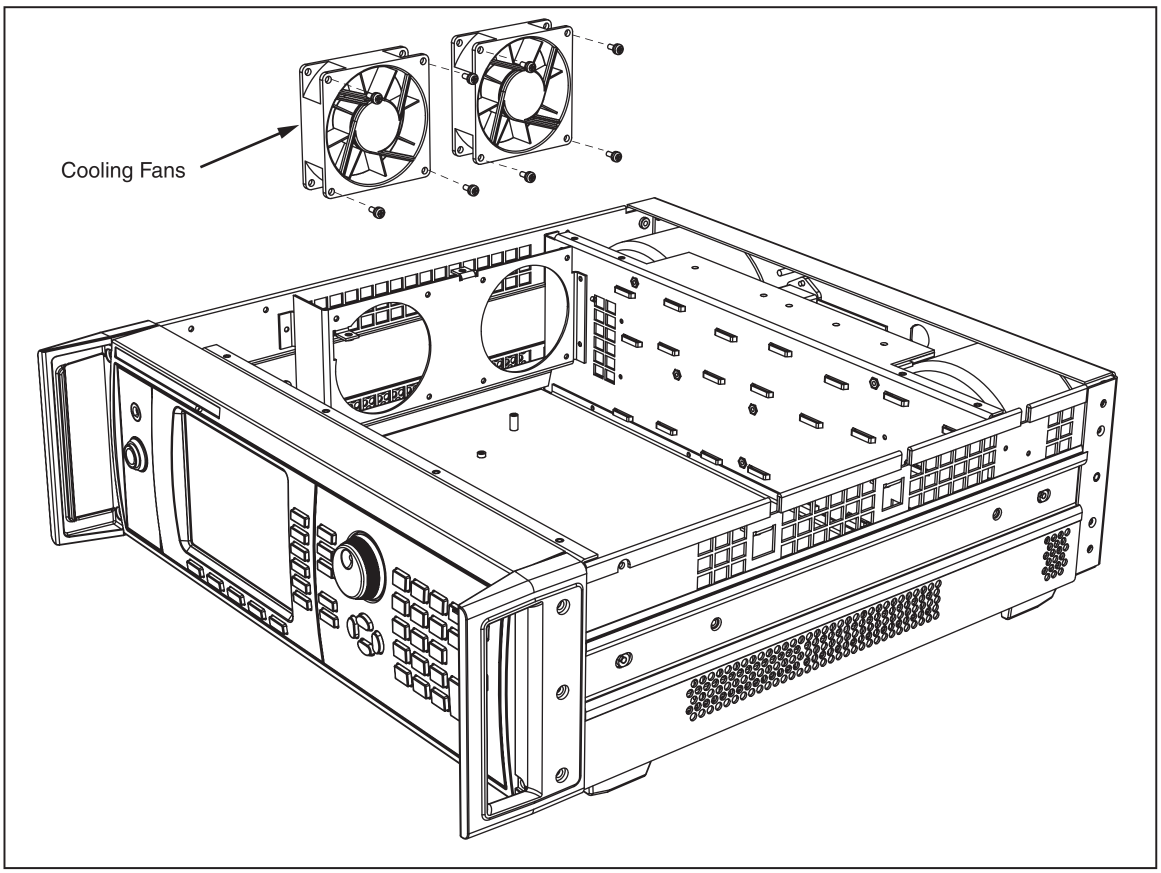
Figure 7-5. Removing the A1 Synthesizer PCA

Fans

The Instrument has two fans for cooling. Each fan is mounted to the chassis with four panhead screws. See Figure 7-6.

Use the following procedure to remove one or both fans.

1. Remove the top and bottom covers from the Instrument.
2. Remove the air filter.
3. Remove the shield.
4. Remove the A2 RF Output PCA.
5. Remove the A1 Synthesizer PCA
6. Disconnect the two, two-pin Molex connectors from the A4 Power Supply PCA by turning the Instrument on its side to gain access. On completion return the Instrument onto its base position.
7. Remove the four panhead screws from each fan.
8. Lift the fan up and away from the chassis (similar to the air filter) making sure that the Molex connector on the cable passes through the grommet without jamming.



ead314f.eps

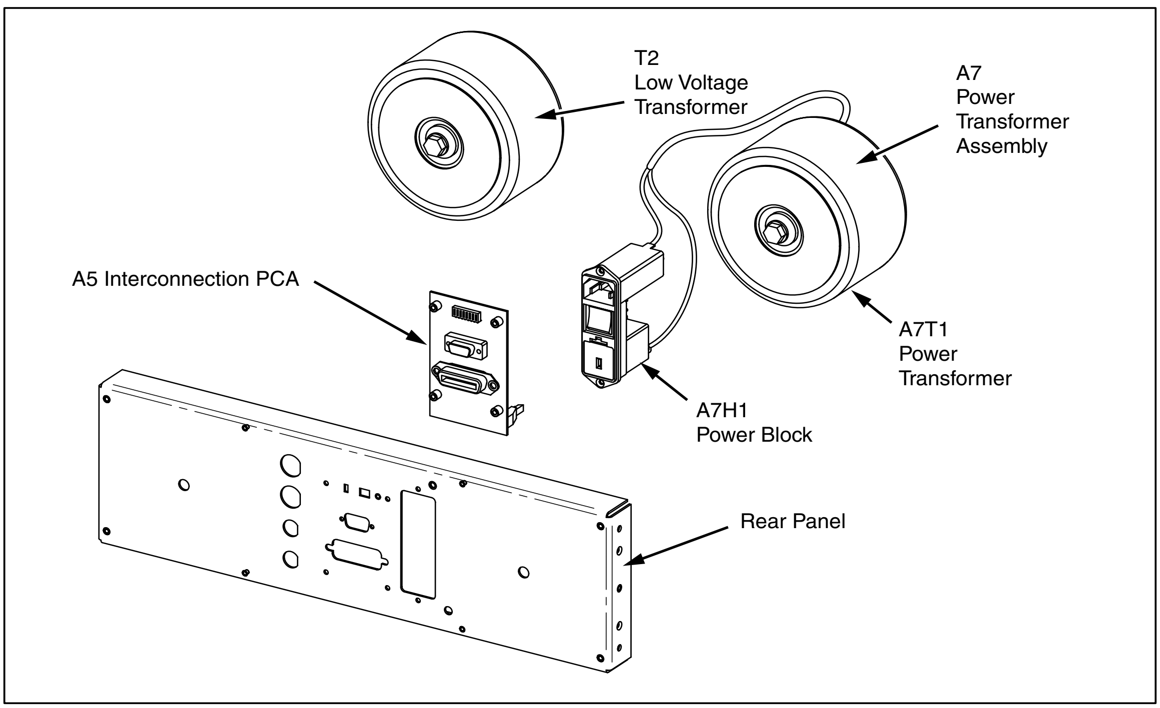
Figure 7-6. Removing the Fans

Rear Panel Assemblies

The Rear Panel provides the hardware for mounting the T2 Low Voltage Transformer, the A5 Connection PCA, and the A7 Power Transformer Assembly (A7T1 and the Power block). Figure 7-7.

Use the following procedure to remove the Rear Panel Assembly:

1. Remove rear handles.
2. Remove the top and bottom covers from the Instrument.
3. Remove the shield.
4. Remove the A2 RF Output PCA
5. Disconnect the four SMB connectors on the Synthesizer PCA.
6. Disconnect the 10-pin Molex connector from the Synthesizer PCA.
7. Turn the Instrument on its side to gain access to the rear panel A5 Interconnections PCA.
8. Disconnect the A5 Interconnection PCA using the ejectors the 34-pin IDE connector. Also disconnect the 5-pin Molex connector close to the 60-pin IDE connector on the A4 Power Supply PCA.
9. Return the Instrument to its initial position and remove the four countersunk screws from both sides of the rear handles. Do not remove the handles.
10. Ease the rear panel away from the source to access and disconnect the 5-pin Molex connector from the A4 Power Supply PCA.
11. Pull the Rear Panel Assembly free of the chassis. Make sure the 10-pin Molex connector and the four SMB connectors pass through the chassis cut out without damage.



ead319f.eps

Figure 7-7. Removing the Rear Panel

A5 Interconnection PCA

Use the following procedure to remove the A5 Interconection PCA. See Figure 7-7.

1. Remove rear handles.
2. Remove the top and bottom covers from the Instrument.
3. Remove the shield.
4. Remove the A2 RF Output PCA.
5. Remove the Rear Panel Assembly.
6. On the rear panel remove the two serial port connector retaining screw pillars, the two retaining IEEE 488 connector screw pillars, and the four panhead screws securing the A5 Interconnection PCA to the rear panel.
7. Lift the A5 Interconnection PCA from the Rear Panel Assembly.

A7 Power Transformer Assembly and T1 Low Voltage Transformer

Use the following procedure to remove the power supply transformers. See Figure 7-7.

1. Remove the rear handles.
2. Remove the top and bottom covers.
3. Remove the shield.
4. Remove the A2 RF Output PCA.
5. Remove the Rear Panel.
6. Remove the two panhead screws and nuts from the Power Block. Also, disconnect the ground wire at the rear panel.
7. Remove the transformer retaining bolt (13 mm spanner) from the Line Power Transformer and lift out the transformer assembly.
8. Remove the retaining bolt from the Low Voltage Transformer (13 mm spanner) and lift out the transformer.

A4 Power Supply PCA

Use the following procedure to remove the A4 Power Supply PCA. See Figure 7-8.

1. Remove rear handles.
2. Remove the top and bottom covers from the Instrument.
3. Remove the shield.
4. Remove the A2 RF Output PCA.
5. Remove the Rear Panel Assembly.
6. Disconnect the two, 2-pin Molex connectors for the fans.
7. Disconnect the 60-pin ribbon cable using the connector ejectors.
8. Remove the seven panhead screws that secure the PCA to the Instrument.
9. Lift the A4 Power Supply PCA from the chassis.

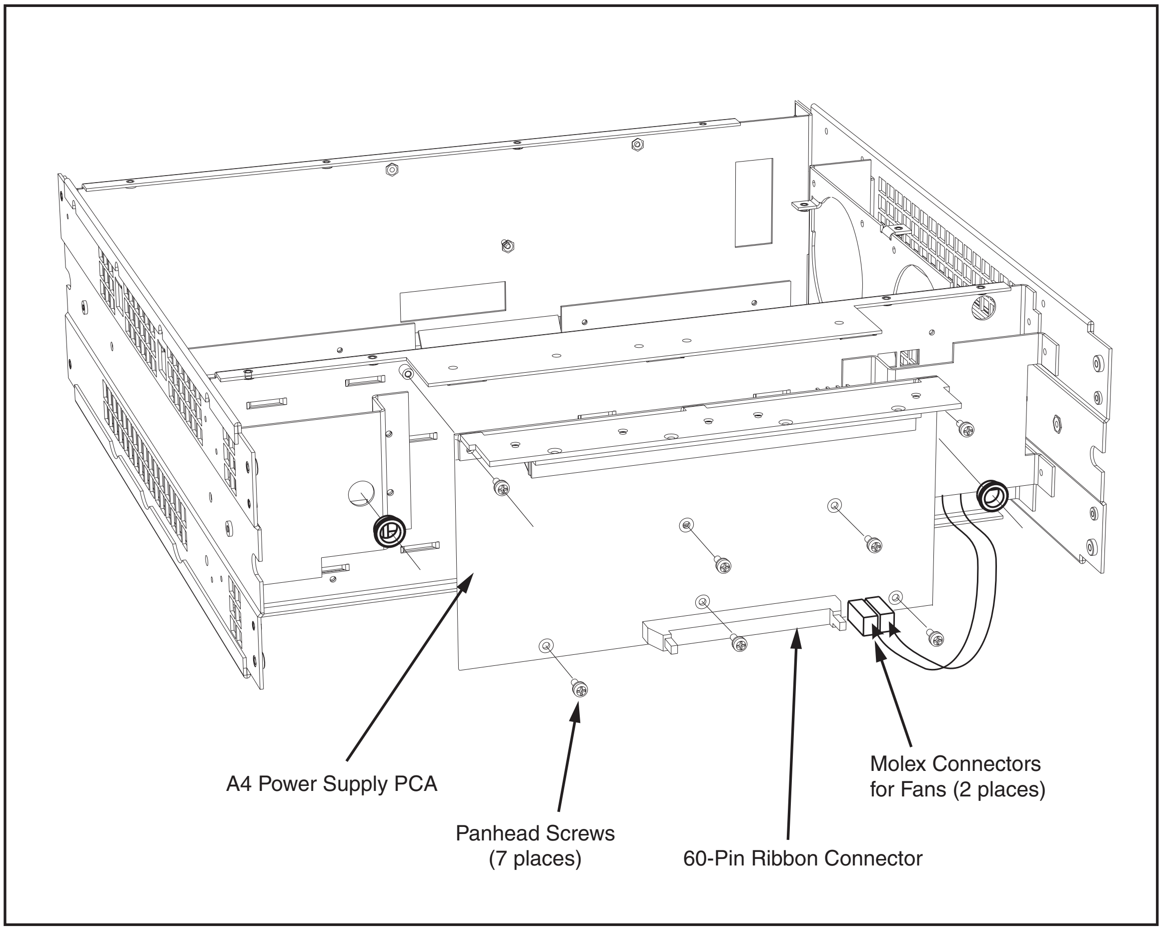


Figure 7-8. Removing A4 Power Supply PCA

A9 Leveling Head 50 Ω and 75 Ω –Disassembly and Reassembly

⚠ Caution

To avoid damaging the electrical components of the the A9 Leveling Head and the instrument, disconnect the Leveling Head from the Instrument before performing the Leveling Head disassembly/reassembly procedures.

Leveling Head Disassembly Procedure

Use the following procedure to disassemble an A9 Leveling Head. See Figure 7-9.

1. Carefully peel and remove the overlay from the top portion of the case (top case).
2. Remove the top two countersunk screws from the N-type connector.
3. Remove the eight socket-cap screws from the bottom portion of the case (bottom case).
4. Lift the top case from the Leveling Head.
5. To remove the PCA from the bottom case proceed as follows:
   a. Remove the two remaining countersunk screws from the N-type connector.
   b. Remove the three socket-cap screws from the cable clamp.
   c. Remove the cable with the clamp, grommet and the PCA from the bottom case.

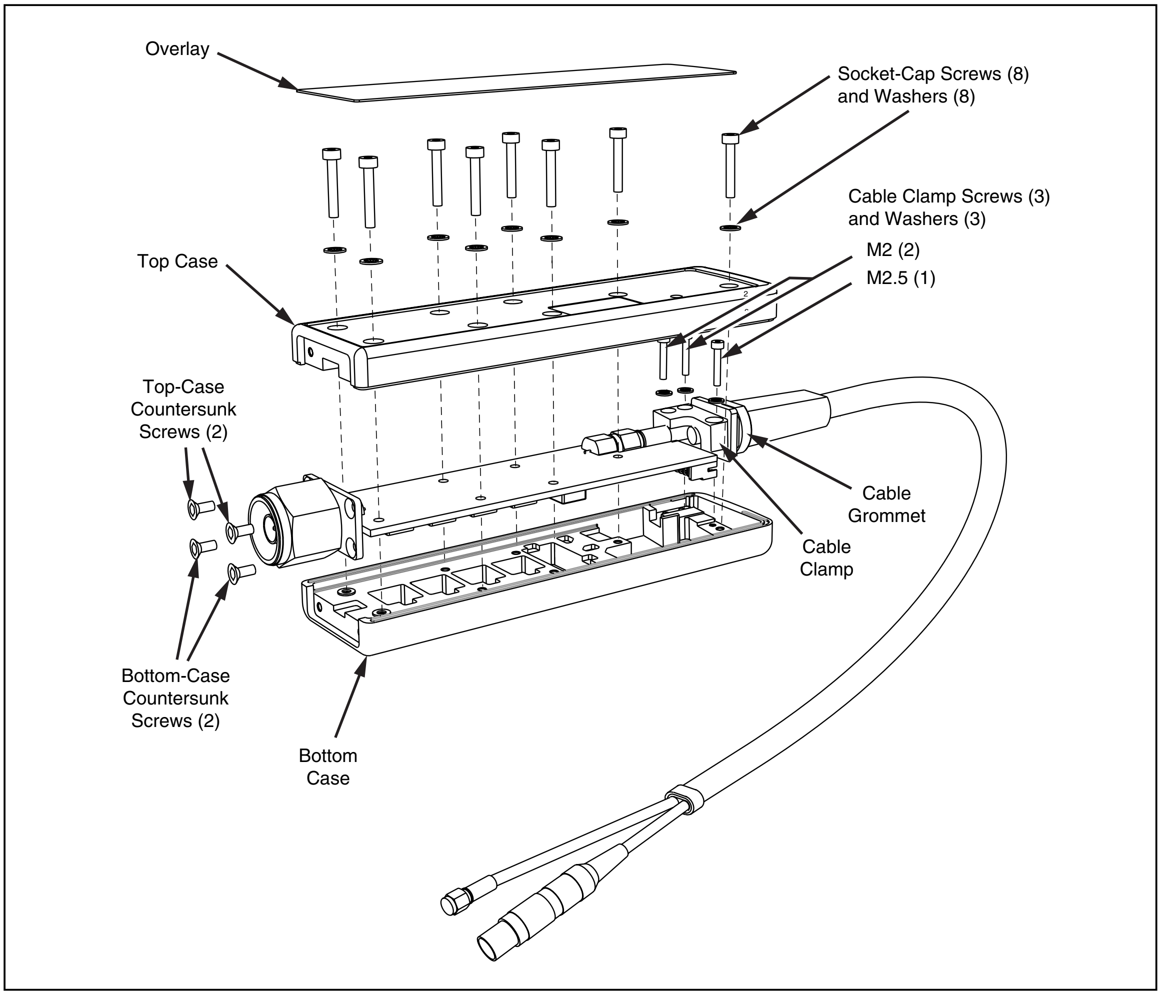


Figure 7-9. Exploded View of the A9 Leveling Head

Leveling Head Reassembly Procedure

Use the following procedure to reassemble the A9 Leveling head. See Figure 7-9.

1. Make sure the cable is connected to the PCA. If not, make the connection as described in the following steps, a through c:
    a. Position the cable in the correct orientation.
    b. Connect the SMA connectors, and, while holding the SMA connector on the PCA with an open-ended spanner, torque the connection to 1.0 Nm (8.86 in-lb).
    c. Connect the 18-pin connector to the PCA.
2. Position the PCA in the bottom case. Make sure the cable grommet is correctly positioned in the case.
3. Push the N-type connector plate gently back to mate with the case.
4. Secure the N-type connector to the bottom case with the two countersunk screws and torque them to 0.25 Nm (2.22 in-lb).
5. Position and align the cable clamp with the screw holes in the bottom-half of the case; make sure there are no wires being trapped.

6. Fit and tighten the three cable-clamp screws as follows:
   a. Torque the two M2 screws to 0.25 Nm (2.22 in-lb).
   b. Torque the one M2.5 screw to 0.4 Nm (3.54 in-lb).
7. Fit the top case to the Leveling Head.
8. Push the top case firmly against the N-type connector flange then fit the eight socket-cap screws, with shake proof washers.
9. Torque all eight screws to 0.4 Nm (3.54 in-lb), starting from the N-type connector and working towards the cable clamp.
10. Fit the final two countersunk screws to the N-type connector and torque each of them to 0.25 Nm (2.22 in-lb).

Reassembling the Instrument

To reassemble the Instrument, logically reverse the disassembly procedures. In the process, make sure to re-establish all electrical connections. Also make sure all parts are correctly aligned and positioned, observe torque settings where applicable, and do not force-fit any of the parts into position.

User-Initiated Self Test

The Instrument includes a self-test feature that functions as an operational self-test when the unit is initially powered on and later as a more comprehensive user-initiated test. The simpler version of the self test is described in Chapter 2, *Preparing the Instrument for Operation*. This section of the manual addresses the more complex version of the self test. Discussions include an overview of what the self test checks for, instructions for running the self test, and instructions for analyzing the results of a self test. Collectively, the discussions help the user confirm whether the Instrument is working properly and, if not, help the user isolate and troubleshoot the problem to a module level.

In operation the self test is initiated by the user, either from the front panel or from an IEEE 488 controller. Once initiated, the test runs automatically and progresses as follows:

1. The test runs the Instrument through a series of test points.
2. Each test point configures the instrument internally.
3. The Instrument makes a test-point measurement using an internal ADC, sensors, and detectors.
4. The Instrument compares the result of each test point with pre-determined limits.

Test points that fail (exceed) these limits can be viewed using the front panel and will include the test point description, the measured value, and the preset (acceptable) limits. The measured value will usually be displayed as the voltage present at the point being measured.

To enhance the usefulness of the self test as a troubleshooting tool, it can be run as three separate sequences: Base, Head and All. The Base sequence is a test of the Instrument only, with or without the Leveling Head attached. The Head sequence is a test of only the Leveling Head while it is attached to the Instrument. The All sequence performs a test of both the Instrument and the attached Leveling Head.

Running Self Test

The following instructions for the self test are given in terms of button presses from the front panel. The same instructions may also be initiated using IEEE 488 instructions in a system environment.

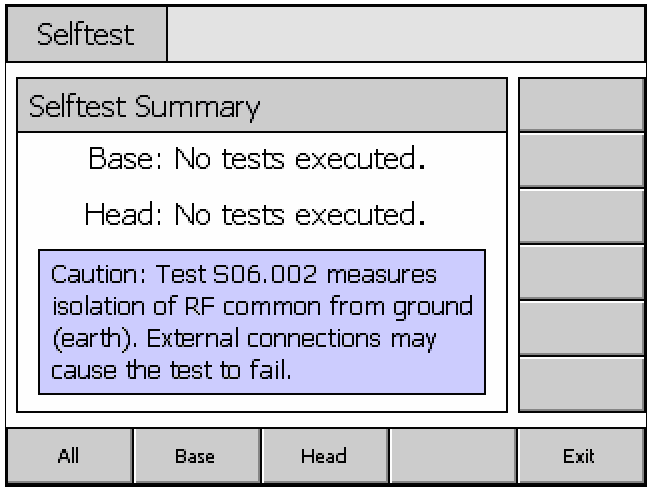
Note

The Base level self test may be run with or without a Leveling Head attached. However, when a Leveling Head is attached ensure that the Leveling Head output is disconnected during self test and that there are no earth connections to the floating RF common. This includes the Leveling Head body & the top two rear BNC connectors.

Use the following procedure to run a self test:

1. Prepare the Instrument for operation as described earlier in Chapter 2.
2. Press SETUP.
3. Press the Self Test soft key at the bottom of the display.

   The following Self Test screen appears. The screen shows that no tests have been executed and provides for the selection of the self-test sequence to run, All, Base, or Head.

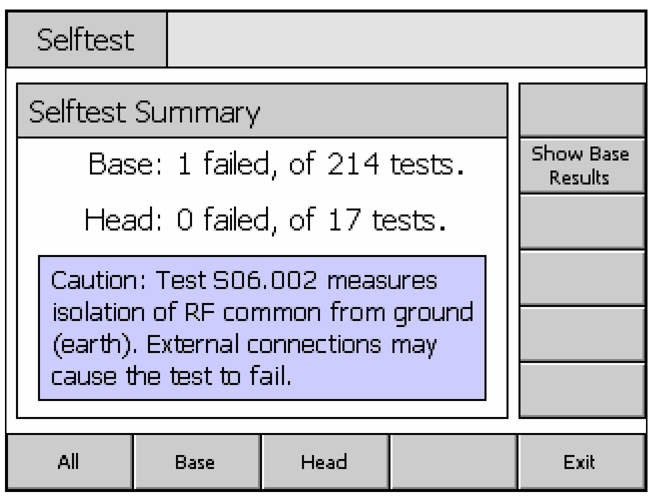


ead300f.bmp

Selecting a Self Test Sequence

4. Press the soft key for the desired sequence, All, Base, or Head.

   Selecting one of the three sequence options will initiate the test sequence and display a progress-bar screen. On completion of the sequence, the progress bar will clear showing the previous screen with the total number of both Base and Head failures as shown below.

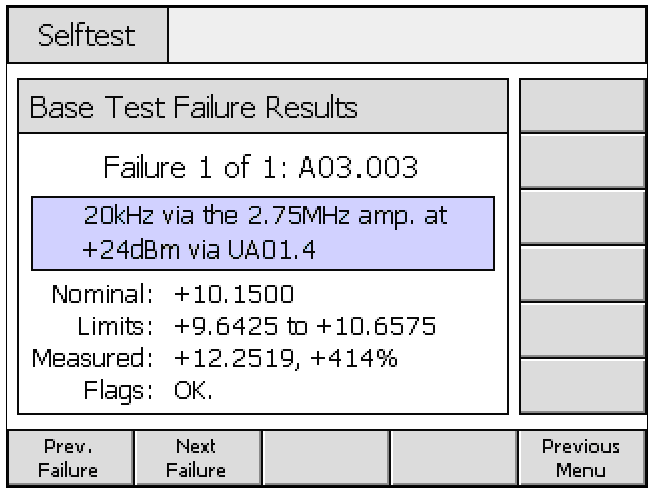


ead301f.bmp

Summary of Self Test Results

Reviewing the Results

When one or more failures occur as a result of running the self test, they are itemized and displayed as Base or Head failures. Either of the two categories, Base or Head, may be expanded to show the detailed results of each failed test. Pressing either the Show Base Results or Show Head Results soft keys will expand the test results as shown below. The Prev. Failure and Next Failure soft keys allow the user to step through the failures. Pressing the Previous Menu soft key returns the display to the Self Test Summary screen.



ead302f.bmp

Expanded Self Test Failure Results

The format of the failure data shown above is typical for all self-test failures. Table 7-1 describes each of the seven rows of data shown on the Base Test Failure Results screen.

Table 7-1. Descriptions of the Rows in a Test Failure Display

Row	Identifier	Description
1	Failure Number	Incremental test number (starting at 1) assigned to each failed measurement
	Test Point Name	An encoded string containing the following: • Major Assembly Identification [1] S = A1 Synthesizer PCA A = A2 RF Output PCA H = A9 Leveling Head • Schematic Sheet Identification (2 digits) • Schematic Test Sequence Number (3 digits)
2	Test Point Description	Brief description of the test point such as “+5V PSU via U609.4”
3	Nominal	Expected measurement value
4	Lower and Upper Limit	Prescribed lower and upper limit of the measured value
5	Measured Value and Calculated Error	Actual measured value Error calculated from the measured value, the nominal value, and either the upper or lower limit to indicate the relative extent of the failure
6	Flags	Status of the detectors revelant to the test point. Indicate OK unless there is a failure. e.g. PLL1 UNLOCKED indicating that phase locked loop number 1 is unlocked

[1] S04.003 would be the third test on sheet four of the A1 Synthesizer PCA.
At the schematic level, the sheet number generally refers to the source of the signal being measured or feature being tested. There are cases that are more complex such as signals leaving the A1 Synthesizer PCA measured at their destination on the A2 RF Output PCA.
For A1 Synthesizer PCA test points, U609.4 refers to input number 4 of the A1 Synthesizer PCA self-test multiplexer (designator U609), which is routing the signal to the ADC. For A2 RF Output PCA tests, the multiplexer designator refers to the RF Output PCA schematic.

Interpreting the Results

Sometimes the failure information on the display is adequate to isolate a problem to a single PCA. For example, in a case where a single failure occurs, the code letter in the test point name (S, A or H) will indicate which assembly has the problem. However, in cases where multiple assemblies show failures, isolating the problem is less straight forward. In these cases it may be helpful to refer to the Chapter 6, *Theory of Operation* to help isolate the faulty assembly. For example, one failure on the A1 Synthesizer PCA and several failures on the A2 RF Output PCA could indicate that a satisfactory signal is not leaving the A1 Synthesizer PCA. As a result, tests on the A2 RF Output PCA will naturally fail. In this case, the A1 Synthesizer-PCA-schematic sheet identified in the test point name and the test description in the box would indicate the source of the problem.

To help with the interpretation of a failure, a list of the self-test tests performed on the A1 Synthesizer PCA, A2 RF Output PCA, and the A9 Leveling Head are given in Tables 7-2, 7-3, and 7-4, respectively. The lists are sorted by Test Point Name, and a Test Description precedes each series or group of tests. Suggested problem areas are also given with each series of tests.

Some problems cannot be detected with self test alone and may require additional manual testing with external equipment.

Table 7-2. A1 Synthesizer PCA Test List

Test Point Name	Test Description	Possible Problem Area
Test the RF common floating power supplies, which are rectified and regulated on the Synthesizer PCA, by measuring them with the internal self-test ADC. If several of these supplies fail, the PSU Assembly may be faulty, otherwise it is a Synthesizer PCA problem.		PSU Assembly or Synthesizer PCA
S09.001	+5 V Supply	
S09.002	+2.5 V Supply	
S09.003	+3.3 V Supply	
S09.004	+9 V Supply	
S09.005	+15 V Supply	
S09.006	+25 V Supply	
S09.007	-5.2 V Supply	
S09.008	-15 V Supply	
Test the internal precision reference voltage used on the Synthesizer and RF Output PCAs.		Synthesizer PCA
S06.001	+7 V Reference	
Test that floating RF common is not internally connected to earth by attempting to circulate a low current in any potential short circuits and measuring the voltage developed using the internal self test ADC. This test will fail if an external connection of RF Common to Ground is present.		External connection to RF common, internal inter-connections, Synthesizer or RF Output Assemblies.
S06.002	Floating Common Test	
Test the temperature monitors by measuring their output voltages using the self-test ADC and converting the result to Celsius.		Blocked Air vents
S06.003	Internal Temperature Monitor	
S06,006	Self-Test Zero Test	
S09.009	Heat-Sink Temperature Monitor	
Test whether the 600 MHz oscillator is locked to the internal 10 MHz reference. Measure the 600 MHz oscillator control voltage and check the limits.		Synthesizer PCA
S01.001	600 MHz Reference Loop	
Test whether the LF synthesizer coarse loop VCO is locked to the 600 MHz oscillator. Measure the VCO control voltage and check the limits.		Synthesizer PCA
S01.002	LF Coarse Loop 200 MHz	
S01.003	LF Coarse Loop 220 MHz	
S01.004	LF Coarse Loop 240 MHz	
S01.005	LF Coarse Loop 260 MHz	
S01.006	LF Coarse Loop 280 MHz	

Figure 7-2. A1 Synthesizer PCA Test List (cont).

Test Point Name	Test Description	Possible Problem Area
S01.007	LF Coarse Loop 300 MHz	
S01.008	LF Coarse Loop 320 MHz	
S01.009	LF Coarse Loop 340 MHz	
S01.010	LF Coarse Loop 360 MHz	
S01.011	LF Coarse Loop 380 MHz	
S01.012	LF Coarse Loop 400 MHz	
S01.013	LF Coarse Loop 500 MHz	
Test LF synthesizer fine loop VCO filters. Check that PLL3 remains locked.		Synthesizer PCA
S10.001	LF Fine 200-250MHz Filter	
S10.002	LF Fine 250-345MHz Filter	
Test whether the HF synthesizer coarse loop VCO is locked to the 600 MHz oscillator at the stated frequencies. Measure the VCO control voltage and check the limits.		Synthesizer PCA
S04.001	HF Coarse Loop 1.0 GHz	
S04.002	HF Coarse Loop 1.2 GHz	
S04.003	HF Coarse Loop 1.4 GHz	
S04.004	HF Coarse Loop 1.6 GHz	
S04.005	HF Coarse Loop 1.8 GHz	
S04.006	HF Coarse Loop 2.0 GHz	

Table 7-3. A2 RF Output PCA Test List

Test Point Name	Test Description	Possible Problem Area
Test local floating RF common on RF Output PCA		Synthesizer or RF Output PCAs.
A10.001	0 V	
Test the operation of the amplifier input filters at key frequencies by measuring the internal amplitude leveling signal using internal ADC. For these tests the Synthesizer PCA generates a high frequency signal which is divided down to the output frequency and used to drive the filters. The outputs of these filters are routed to the amplifiers inputs. The level sensing loops must be working for these tests to pass.		RF Output PCA. If many tests fail in this section suspect Synthesizer PCA signal generation.
A01.001	1.35 GHz filter at 510 MHz divide by 2 at +4 dB	
A01.002	1.35 GHz filter at 1 GHz divide by 2	
A01.004	626 MHz filter at 255 MHz divide by 4	
A01.005	626 MHz filter at 500 MHz divide by 4	
A01.007	313 MHz filter at 127 MHz divide by 8	
A01.008	313 MHz filter at 250 MHz divide by 8	
A02.001	156 MHz filter at 89 MHz divide by 16	
A02.002	156 MHz filter at 125 MHz divide by 16	
A02.003	156 MHz filter at 168 MHz divide by 16	
A02.004	109 MHz filter at 63 MHz divide by 16	
A02.005	109 MHz filter at 88 MHz divide by 16	
A02.006	109 MHz filter at 120 MHz divide by 16	
A02.007	78 MHz filter at 45 MHz divide by 32	
A02.008	78 MHz filter at 62.5 MHz divide by 32	
A02.009	78 MHz filter at 84 MHz divide by 32	

Table 7-3. A2 RF Output PCA Test List (cont.)

Test Point Name	Test Description	Possible Problem Area
A02.010	55 MHz filter at 32 MHz divide by 32	
A02.011	55 MHz filter at 44 MHz divide by 32	
A02.012	55 MHz filter at 60 MHz divide by 32	
A02.013	39 MHz filter at 23 MHz divide by 64	
A02.014	39 MHz filter at 31.25 MHz divide by 64	
A02.015	39 MHz filter at 42 MHz divide by 64	
A02.016	27 MHz filter at 16 MHz divide by 64	
A02.017	27 MHz filter at 22 MHz divide by 64	
A02.018	27 MHz filter at 32 MHz divide by 64	
A02.019	19 MHz filter at 8 MHz divide by 128	
A02.020	19 MHz filter at 15.625 MHz divide by 128	
A02.021	19 MHz filter at 21 MHz divide by 128	
Test synthesizer drive at 89 MHz to output PCA via differential cables		
A02.022	Wide FM input at 89 MHz (J200 and J201)	
Test the 2.75 MHz amplifier output amplitude by measuring the internal leveling signals with the internal ADC.		RF Output PCA
A03.001	100 kHz via the 2.75 MHz amp. at +20 dBm	
A03.002	2.75 MHz via the 2.75 MHz amp. At +20 dBm	
A03.003	20 kHz via the 2.75 MHz amp. at +24 dBm	
Test the multiplier which is used in the amplitude leveling loop for output frequencies up to and below 9 MHz (11 MHz in AM mode). The 8 MHz is generated by the Synthesizer PCA and routed to one multiplier input while the other multiplier input is driven by a DC level from AM DAC A with an open loop reference. The multiplier output is routed through the 125 MHZ amplifier and measured using the LF level detector, which is measured with internal ADC.		RF Output PCA. Synthesizer PCA if no 10 MHz.
A03.005	Test range of AD834 at 8 MHz at +24 dBm open loop	
A03.006	Test range of AD834 at 8 MHz at +5 dBm open loop	

Table 7-3. A2 RF Output PCA Test List (cont.)

Test Point Name	Test Description	Possible Problem Area
A03.007	Test range of AD834 at 8 MHz at -5 dBm open loop	
Test the 125 MHz amplifier output amplitude by measuring internal leveling signals with the internal ADC.		RF Output PCA
A03.008	Test +24 dBm through 125 MHz amp. At 125 MHz	
A03.009	Test 0 dBm through 125 MHz amp. At 100 MHz	
A03.010	Test +10 dBm through 125 MHz amp. at 100 MHz	
A03.011	Test +20 dBm through 125 MHz amp. at 100 MHz	
A03.012	Test +24 dBm through 125 MHz amp. at 100 MHz	
Test voltage variable attenuators used for output amplitude leveling by measuring internal leveling signal wuth the internal ADC		RF Output PCA
A03.013	Test +5dBm through VVAs at 100MHz	
A03.014	Test +10dBm through VVAs at 100MHz	
A03.015	Test +20dBm through VVAs at 100MHz	
A03.016	Test +24dBm through VVAs at 100MHz	
Test 19MHz filter flatness by measuring internal leveling signal wuth the internal ADC		RF Output PCA
A03.017	19MHz filter at 8MHz at +10dBm	
A03.018	19MHz filter at 15.625MHz at +10dBm	
A03.019	19MHz filter at 21MHz at +10dBm	
Test ampltide adjustments within amplitude control loop by measuring internal leveling signal wuth the internal ADC		RF Output PCA
A03.020	Test x2 at +10dBm through 125MHz amp. at 100MHz	
A03.021	Test div 2 at +10dBm through 2.75MHz amp. at 2.75MHz	

Table 7-3. A2 RF Output PCA Test List (cont.)

Test Point Name	Test Description	Possible Problem Area
Test operation output filters of the 125 MHz amplifier at key frequencies by measuring the internal amplitude leveling signal using internal ADC. For these tests, the Synthesizer PCA generates a high frequency signal, which is divided down to the output frequency. The outputs of these filters are routed to the leveling sensing loops, which must be working for these tests to pass.		RF Output PCA
A04.001	156 MHz filter at 89 MHz at +4 dBm	
A04.002	156 MHz filter at 125 MHz	
A04.003	156 MHz filter at 160 MHz	
A04.004	109 MHz filter at 63 MHz	
A04.005	109 MHz filter at 88 MHz	
A04.006	109 MHz filter at 120 MHz	
A04.007	78 MHz filter at 45 MHz div32	
A04.008	78 MHz filter at 62.5 MHz	
A04.009	78 MHz filter at 84 MHz	
A04.010	55 MHz filter at 32 MHz	
A04.011	55 MHz filter at 44 MHz	
A04.012	55 MHz filter at 60 MHz	
A04.013	39 MHz filter at 22 MHz div 64	
A04.014	39 MHz filter at 31.25 MHz	
A04.015	39 MHz filter at 42 MHz	
A04.016	27 MHz filter at 16 MHz	
A04.017	27 MHz filter at 22 MHz	
A04.018	27 MHz filter at 32 MHz	
A04.019	13.5 MHz filter at 5.5 MHz	
A04.020	13.5 MHz filter at 11 MHz	
A04.021	13.5 MHz filter at 15.625 MHz	

Table 7-3. A2 RF Output PCA Test List (cont.)

Test Point Name	Test Description	Possible Problem Area
A04.022	6.75 MHz filter at 2.8 MHz	
A04.023	6.75 MHz filter at 5.5 MHz	
A04.024	6.75 MHz filter at 8 MHz	
Test the 1.8 GHz amplifier output amplitude by measuring internal leveling signals with the internal ADC.		RF Output PCA
A05.001	Test 0 dBm through 1.8 GHz amp. at 1.4GHz	
A05.002	Test +10 dBm through 1.8 GHz amp. at 1.4 GHz	
A05.003	Test +20 dBm through 1.8 GHz amp. at 1.4 GHz	
Test the operation output filters of the 1.8 Hz amplifier at key frequencies by measuring the internal amplitude leveling signal using internal ADC. For these tests, the Synthesizer PCA generates a high frequency signal, which is divided down to the output frequency. The outputs of these filters are routed to the leveling sensing loops, which must be working for these tests to pass.		RF Output PCA
A06.001	2.4 GHz filter at 1.4 GHz at +4 dBm	
A06.002	2.4 GHz filter at 1.8 GHz	
A06.004	1.75 GHz filter at 1.02 GHz	
A06.005	1.75 GHz filter at 1.4 GHz	
A06.007	1.25 GHz filter at 720 MHz	
A06.008	1.25 GHz filter at 1 GHz	
A06.010	876 MHz filter at 505 MHz	
A06.011	876 MHz filter at 714 MHz	
A06.013	626 MHz filter at 357 MHz	
A06.014	626 MHz filter at 500 MHz	
A06.016	438 MHz filter at 252 MHz	
A06.017	438 MHz filter at 354 MHz	

Table 7-3. A2 RF Output PCA Test List (cont.)

Test Point Name	Test Description	Possible Problem Area
A06.019	313 MHz filter at 180 MHz	
A06.020	313 MHz filter at 250 MHz	
A06.022	219 MHz filter at 126 MHz	
A06.023	219 MHz filter at 177 MHz	
Test the 2.7 GHz amplifier output amplitude by measuring the internal leveling signals with internal ADC.		RF Output PCA
A07.001	Test 0 dBm through 2.7 GHz amp. at 2.7 GHz	
A07.002	Test +10 dBm through 2.7 GHz amp. at 2.7 GHz	
A07.003	Test +18 dBm through 2.7 GHz amp. at 2.7 GHz	
Test the 4 GHz amplifier output amplitude by measuring the internal leveling signals with internal ADC.		RF Output PCA
A07.004	Test 0 dBm through 4 GHz amp. at 4 GHz	
A07.005	Test +10 dBm through 4 GHz amp. at 4 GHz	
A07.006	Test +16 dBm through 4 GHz amp. at 4 GHz	
Test the LF detector linearity by driving it with an unleveled 20 kHz sine wave from AM DAC B via 2.75 MHz amplifier. The demand to the nulling amp is forced to zero so that the detector output can be measured with internal ADC.		RF Output PCA
A08.001	LF detector at +24 dBm at 20 kHz	
A08.002	LF detector at +10 dBm at 20 kHz	
A08.003	LF detector at 0 dBm at 20 kHz	
A08.004	LF detector at -10 dBm at 20 kHz	
Test the HF detector linearity by driving it with an unleveled 20 kHz sine wave from AM DAC. The demand to the nulling amp is forced to zero so that the detector output can be measured with internal ADC.		RF Output PCA
A08.005	HF detector at +24 dBm at 20 kHz	
A08.006	HF detector at +10 dBm at 20 kHz	
A08.007	HF detector at 0 dBm at 20 kHz	

Table 7-3. A2 RF Output PCA Test List (cont.)

Test Point Name	Test Description	Possible Problem Area
A08.008	HF detector at -10 dBm at 20 kHz	
Test the LF detector compensation diode using an amplitude demand to forward bias it and measuring the compensation amplifier output with the internal ADC.		RF Output PCA
A08.009	LF detector compensation diode at 0 dB	
A08.010	LF detector compensation diode at 20 dB	
Test the HF detector compensation diode using an amplitude demand to forward bias it and measuring the compensation amplifier output with the internal ADC.		RF Output PCA
A08.011	HF detector compensation diode at 0 dB	
A08.012	HF detector compensation diode at 20 dB	
Test the amplitude error amplifier output voltage by setting 10 dBm at 20 MHz and measuring the error voltage using the internal ADC.		RF Output PCA
A08.013	Output 10 dB at 200 MHz and check this	
Test the carrier level DAC at key binary settings by measuring its output with the internal ADC.		RF Output PCA
A09.001	Carrier level DAC 0xFFFF	
A09.002	Carrier level DAC 0x0000	
A09.003	Carrier level DAC 0x8000	
A09.004	Carrier level DAC 0x4000	
A09.005	Carrier level DAC 0x2000	
A09.006	Carrier level DAC 0x1000	
A09.007	Carrier level DAC 0x0800	
A09.008	Carrier level DAC 0x0400	
A09.009	Carrier level DAC 0x0200	
A09.010	Carrier level DAC 0x0100	
A09.011	Carrier level DAC 0x0080	
A09.012	Carrier level DAC 0x0040	
A09.013	Carrier level DAC 0x0020	
A09.014	Carrier level DAC 0x0010	

Table 7-3. A2 RF Output PCA Test List (cont.)

Test Point Name	Test Description	Possible Problem Area
A09.015	Carrier level DAC 0x0008	
A09.016	Carrier level DAC 0x0004	
A09.017	Carrier level DAC 0x0002	
A09.018	Carrier level DAC 0x0001	
Test the AM DAC A at key binary settings by connecting its reference input to a fixed positive voltage and measuring its output with the internal ADC.		RF Output PCA
A09.019	AM DAC A 0xFFFF	
A09.020	AM DAC A 0x0000	
A09.021	AM DAC A 0x8000	
A09.022	AM DAC A 0x4000	
A09.023	AM DAC A 0x2000	
A09.024	AM DAC A 0x1000	
A09.025	AM DAC A 0x0800	
A09.026	AM DAC A 0x0400	
A09.027	AM DAC A 0x0200	
A09.028	AM DAC A 0x0100	
A09.029	AM DAC A 0x0080	
A09.030	AM DAC A 0x0040	
A09.031	AM DAC A 0x0020	
A09.032	AM DAC A 0x0010	
A09.033	AM DAC A 0x0008	
A09.034	AM DAC A 0x0004	
A09.035	AM DAC A 0x0002	
A09.036	AM DAC A 0x0001	
Test the AM DAC B at key binary settings by driving its reference input from the carrier level DAC and measuring its output with the internal ADC.		RF Output PCA
A09.037	AM DAC B 0xFFFF	
A09.038	AM DAC B 0x0000	
A09.039	AM DAC B 0x8000	

Table 7-3. A2 RF Output PCA Test List (cont.)

Test Point Name	Test Description	Possible Problem Area
A09.040	AM DAC B 0x4000	
A09.041	AM DAC B 0x2000	
A09.042	AM DAC B 0x1000	
A09.043	AM DAC B 0x0800	
A09.044	AM DAC B 0x0400	
A09.045	AM DAC B 0x0200	
A09.046	AM DAC B 0x0100	
A09.047	AM DAC B 0x0080	
A09.048	AM DAC B 0x0040	
A09.049	AM DAC B 0x0020	
A09.050	AM DAC B 0x0010	
A09.051	AM DAC B 0x0008	
A09.052	AM DAC B 0x0004	
A09.053	AM DAC B 0x0002	
A09.054	AM DAC B 0x0001	
Test HF with and without HF AM envelope detector at 200 MHz by measuring the internal leveling signals with internal ADC.		RF Output PCA
A10.002	HF Non AM Envelope Detector at 200 MHz	
A10.003	HF AM Envelope Detector at 200 MHz	
A10.004	HF Non AM Envelope Detector at 200 MHz Max Attenuation	

Table 7-4. A9 Leveling Head Assembly Test List

Test Point Name	Test Description	Problem Area
Tests common to both 50 Ω and 75 Ω Leveling Heads		
Test LF detector linearity and span by driving with 100 MHz and measuring the lelvelling signal in the base		Head PCA or head interface in base
H01.001	Test 0 dBm through LF detector at 100 MHz	
H01.002	Test +10 dBm through LF detector at 100 MHz	
H01.003	Test +20 dBm through LF detector 100 MHz	
H01.004	Test +24 dBm through 125MHz amp. at 100 MHz	
Test HF detector linearity and span by driving with 1.4 GHz and measuring the lelvelling signal in the base		Head PCA or head interface in base
H01.005	Test 0 dBm through HF detector at 1.4 GHz	
H01.006	Test +10 dBm through HF detector at 1.4 GHz	
H01.007	Test +20 dBm through HF detector at 1.4 GHz	
Test the LF detector compensation diode using an amplitude demand to forward bias it and measuring the compensation amplifier output with the internal ADC.		Head PCA or head interface in base
H01.008	LF detector compensation diode at 0 dB	
H01.009	LF detector compensation diode at 20 dB	
Test the LF detector compensation diode using an amplitude demand to forward bias it and measuring the compensation amplifier output with the internal ADC.		Head PCA or head interface in base
H01.010	HF detector compensation diode at 0 dB	
H01.011	HF detector compensation diode at 20 dB	
Tests for 50 Ω Leveling Head attenuators only		Head PCA or head interface in base
H50.012	Test +10 dBm at 3 MHz no attenuation 50 Ω	
H50.013	Test +10 dBm at 3 MHz with 20 dB a 50 Ω	
H50.014	Test +10 dBm at 3 MHz with 20 dB b 50 Ω	
H50.015	Test +10 dBm at 3 MHz with 20 dB c 50 Ω	
H50.016	Test +10 dBm at 3 MHz with 10 dB 50 Ω	
H50.017	Test +10 dBm at 3 MHz with K2 termination 50 Ω	

Table 7-4. Head Assembly Test List (cont.)

Test Point Name	Test Description	Problem Area
Tests for 75 Ω Leveling Head attenuators only		Head PCA or head interface in base
H75.012	Test +10 dBm at 3 MHz no attenuation 75 Ω	
H75.013	Test +10 dBm at 3 MHz with 20 dB a 75 Ω	
H75.014	Test +10 dBm at 3 MHz with 20 dB b 75 Ω	
H75.015	Test +10 dBm at 3 MHz with 20 dB c 75 Ω	
H75.016	Test +10 dBm at 3 MHz with 10 dB 75 Ω	
H75.017	Test +10 dBm at 3 MHz with K2 termination 75 Ω	

Firmware Upgrade

Note

The latest version of the firmware is available for download on the Fluke web page, http://www.fluke.com. See the Main Product and Support pages to access the download link.

⚠ Caution

The instrument may cease functioning if its power is interrupted during the firmware install operation. Do not shut off the power during the firmware installation.

The firmware within the Instrument is stored in flash and can be restored or upgraded by transmission over a serial link from a PC to the Instrument.

Equipment Required for the Restore or Upgrade

The following items are required to perform a firmware restore or upgrade:

- A PC running Microsoft Windows 2000 or Microsoft Windows XP. This computer must have either a 9-pin serial port (RS232) or a USB port.
- The install software, either an upgraded version or the original firmware version supplied with the Instrument on the Product Manuals and Software CD.
- Using the serial port requires a null modem serial cable with a female DB-9 connector at each end. The pin assignments of the serial cable (RS232) are as follows:
  - PC pin 2 <=> Instrument pin 3
  - PC pin 3 <=> Instrument pin 2
  - PC pin 5 <=> Instrument pin 5

  It is recommended that only the above pins are connected

  The use of a USB port requires a USB-to-serial converter with a male DB-9 RS232 connector. The above serial cable is used to connect the USB converter to the Instrument. If the USB-to-serial converter needs a software driver, install the driver on the PC before beginning the firmware upgrade.

Installing the Firmware

Use the following 3-stage procedure to install the firmware:

- Stage 1 - Configure the Instrument for upgrade.
- Stage 2 - Upload the firmware.
- Stage 3 - Restore the Instrument to normal operation.

Stage 1

1. Power off the Instrument.
2. Connect the Instrument and PC together using the RS232 cable (the Instrument's RS232 port is on the rear panel).

   Or, if using USB, connect together the PC, and the USB converter using a USB cable, and then connect together the USB converter and the Instrument using the RS232 cable.
3. Use the 'FACTORY SET' dip switches on the Instrument back panel to configure the

Instrument for file uploading; set dip switch 6 to its up position.

4. Turn the Instrument on. A black screen with an empty progress bar should appear on the screen of the Instrument.
5. If a previous version of the firmware install application (96xx loader) is installed on your computer, uninstall it using the Windows Add/Remove Programs feature (found in the Control Panel).
6. Install the firmware install application (*96xx Loader*) by running the single .msi file supplied.

   The firmware upgrade application is supplied as a Microsoft installer package (an MSI file – for example '96xx Loader-x.xx.msi', where 'x.xx' will indicate the version number).

   The RF Reference Source Product Manuals and Software CD contains the original version 96XX loader. This can be used to restore the Instrument's firmware to the version with which it was shipped.
7. Start the 96xx loader application by clicking on its desktop icon, or use its start menu entry (under start menu / programs / Fluke / 96xx loader).
8. From the 96xx loader application, use the 'serial port name' combo box to select the serial port to use (for example COM1). USB users should find their converter listed here too.
9. If the 96xx loader application has not found the Instrument automatically, press the 'Connect' button to retry. It may be necessary to power cycle the Instrument again (a black screen with empty progress bar will re-appear).

Stage 2

1. Ensure a link has been established between the 96xx application and the Instrument.

   A connection is considered ready when the line 'Connection Established: Found loader v1.00' appears in the status box. The version number is that of the active boot loader on the Instrument, and can vary from the one shown here.
2. Press 'Next'.

   The *96xx loader* application will automatically begin to upload the necessary firmware components. A progress bar will give an indication of the status of the application and Instrument.

   The Instrument itself will also display a progress bar for erasure and uploading of the firmware components (Green for firmware upload, Magenta for memory erasure).

   The line 'Upgrade complete: All files transferred successfully' will appear when the upgrade process is finished.

Stage 3

1. Close the 96xx loader application by selecting finish (or pressing the close icon).

   It is recommended that the 96xx install application be uninstalled if no longer required (by using the Control Panel's 'add/remove programs' program).

2. Restore normal Instrument operation by setting switch 6 (of the FACTORY SET dip switches) back in its down position.

3. Power cycle the Instrument.

   The new version of the firmware will appear on the start-up screen (and can also be viewed on the setup screen).

Chapter 8
Lists of Replaceable Parts

Introduction

This chapter contains an illustrated list of replaceable parts for the 9640A RF Reference Source to the board level only. Parts are listed by assembly or kit; alphabetized by reference designator. Each assembly or kit is accompanied by an illustration showing the location of each part and its reference designator. The parts lists give the following information:

- Reference designator
- An indication if the part is subject to damage by static discharge
- Description
- Fluke stock number
- Total quantity
- Any special notes (i.e., factory-selected part)

⚠ Caution

A * symbol indicates a device that may be damaged by static discharge.

How to Obtain Parts

Electrical components may be ordered directly from the manufacturer by using the manufacturers part number, or from the Fluke Corporation and its authorized representatives by using the part number under the heading FLUKE STOCK NO. To order components directly from Fluke Corporation, call (toll-free) 800-526-4731. Parts price information is available from the Fluke Corporation or its representatives.

To ensure prompt delivery of the correct part, include the following information when you place an order:

- Fluke stock number
- Description (as given under the Description heading)
- Quantity
- Reference designator
- Part number and revision level of the pca containing the part
- Instrument model and serial number

How to Contact Fluke

To contact Fluke, call one of the following telephone numbers:

USA: 1-888-99-FLUKE (1-888-993-5853)
Canada: 1-800-36-FLUKE (1-800-363-5853)
Europe: +31 402-675-200
Japan: +81-3-3434-0181
Singapore: +65-738-5655
Anywhere in the world: +1-425-446-5500

Or, visit Fluke's Web site at www.fluke.com.

Ni-Cd *Note*

This instrument may contain a Nickel-Cadmium battery. Do not mix with the solid waste stream. Spent batteries should be disposed of by a qualified recycler or hazardous materials handler. Contact your authorized Fluke service center for recycling information.

Parts Lists

The following tables list the replaceable parts for the 9640A RF Reference Source. Parts are listed by assembly or kit; alphabetized by reference designator. Each assembly is accompanied by an illustration showing the location of each part and its reference designator. The parts lists give the following information:

- Reference designator
- An indication if the part is subject to damage by static discharge
- Description
- Fluke stock number
- Total quantity
- Any special notes (i.e., factory-selected part)

⚠ Caution

A * symbol indicates a device that may be damaged by static discharge.

Table 8-1. 9640A Final Assembly

Reference Designator	Description	Fluke Stock No	Tot Qty	Notes
A1 *	Synthesizer PCA and Screens Assembly	2650299	1	Figure 8-1
A2 *	Output PCA and Screens Assembly	2650317	1	Figure 8-1
A3 *	Digital PCA	2650321	1	Figure 8-1
A4 *	Power Supply PCA	2650339	1	Figure 8-1
A5	Rear Panel Interconnection PCA	2650356	1	Figure 8-1
A6 *	Front Bezel Assembly	2650342	1	Figure 8-1
	(Inclusive TFT Display, Keyboard PCA and RFI PCA)			
T1	Power Transformer and Line Input Assembly	2650363	1	Figure 8-1 and 8-2
T2	Low Voltage Transformer Assembly	2650374	1	Figure 8-1 and 8-2
F1	Fuse, Time Delay HBC		2	Figure 8-1
	115 V ac – 10A @ 250 V	2650727		
	230 V ac – 5 A @ 250 V	2650730		
A9	9640A-50 Leveling Head Assembly, 50 Ω	9640A-50	1	Figure 8-1
A9	9640A-75 Leveling Head Assembly, 75 Ω	9640A-75	1	Figure 8-1
A9MP1	Head Cosmetic Kit	440236	1	Figure 8-3
	Case Shells and Decals (all models)			
A9W1	Head Umbilical Cable Assembly	630604	1	Figure 8-3
	Head bulkhead mount N-Connector 50 Ω	601023	1	Figure 8-3
	Head bulkhead mount N-Connector 75 Ω	601024	1	Figure 8-3
Kit 1	Main Instrument Case Cosmetic Kit	2670114	1	Figure 8-1
	Overlays (all models), Handles (4), Feet (4), Tilt Stands (2) and Side Trims (2)			
Kit 2	Main Instrument Case Hardware Kit	2670123	1	Figure 8-1
	Top Cover, Bottom Cover, Side Extrusion (2) and Rear Panel.			
H2, H3	Fan	2650483	2	Figure 8-1
K1	SMA Coaxial Relay, SPST	2650465	1	Figure 8-1
MP9	CD – 9640A Technical Manual Set and Firmware support software (not shown)	2546628	1	Not shown
MP14	9640A Getting Started Manual	850341	1	Not Shown
MP15	Carrying and Storage Case (for 2 Leveling Heads)	451479	1	Not Shown
MP10	Air Filter	2650476	1	Figure 8-1
W1	Kit – Internal Ribbon and Wired Cables	2670138	1	Not Shown
W2	Kit – Internal Coax Cables	2670145	1	Not shown
W3	Line cord	–	1	Not Shown
	North America 120 V/15 A	284174		Not Shown
	North America 240 V/15 A	2198736		Not Shown
	Universal Euro 220 V/16 A	769422		Not Shown
	United Kingdom 240 V/13 A	769445		Not Shown
	Switzerland 220 V/10 A	769448		Not Shown
	China/Austria/New Zeland 240 V/10 A	658641		Not Shown
	India/South Africa 240 V/5 A	782771		Not Shown

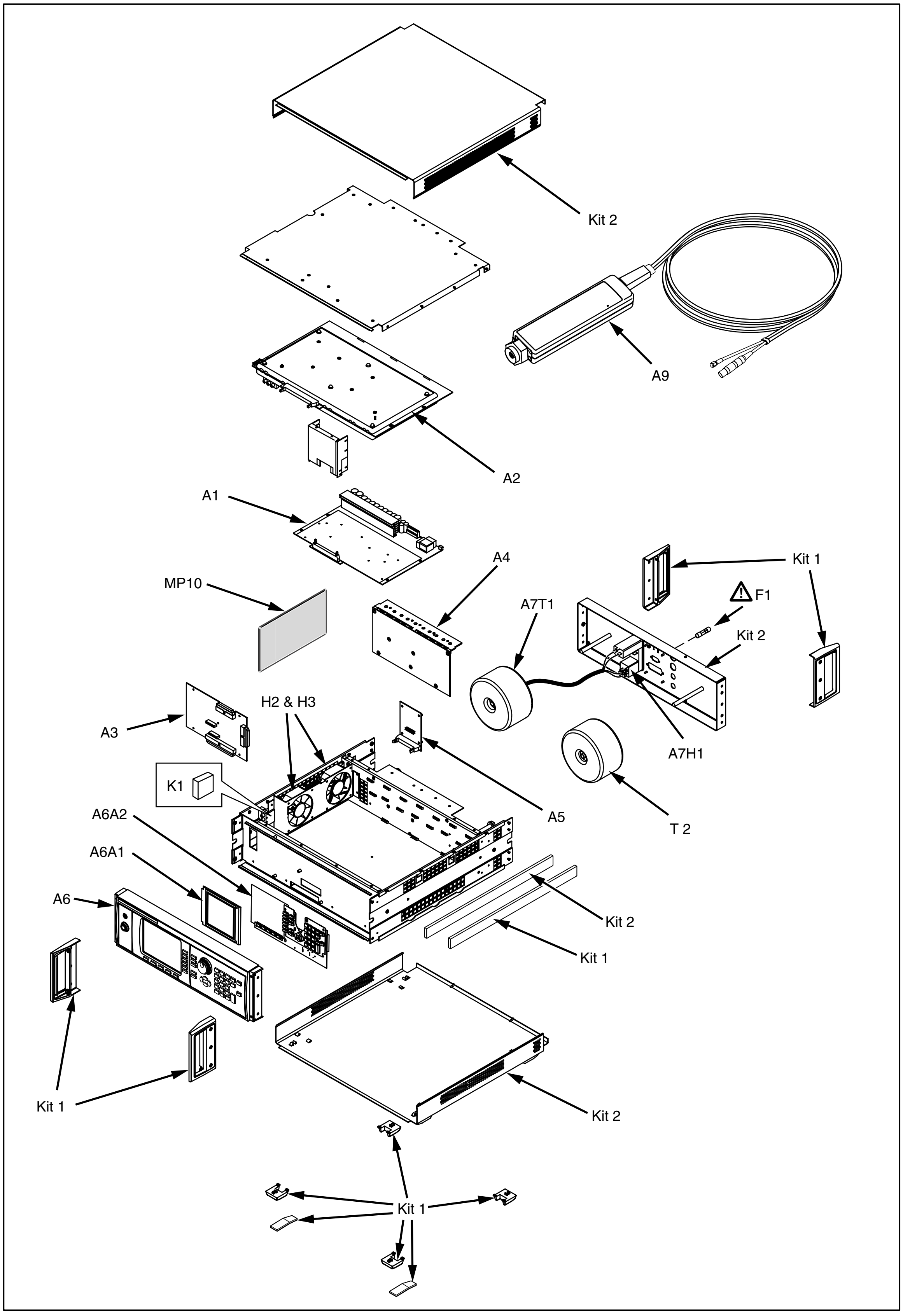


Figure 8-1. 9640A Final Assembly

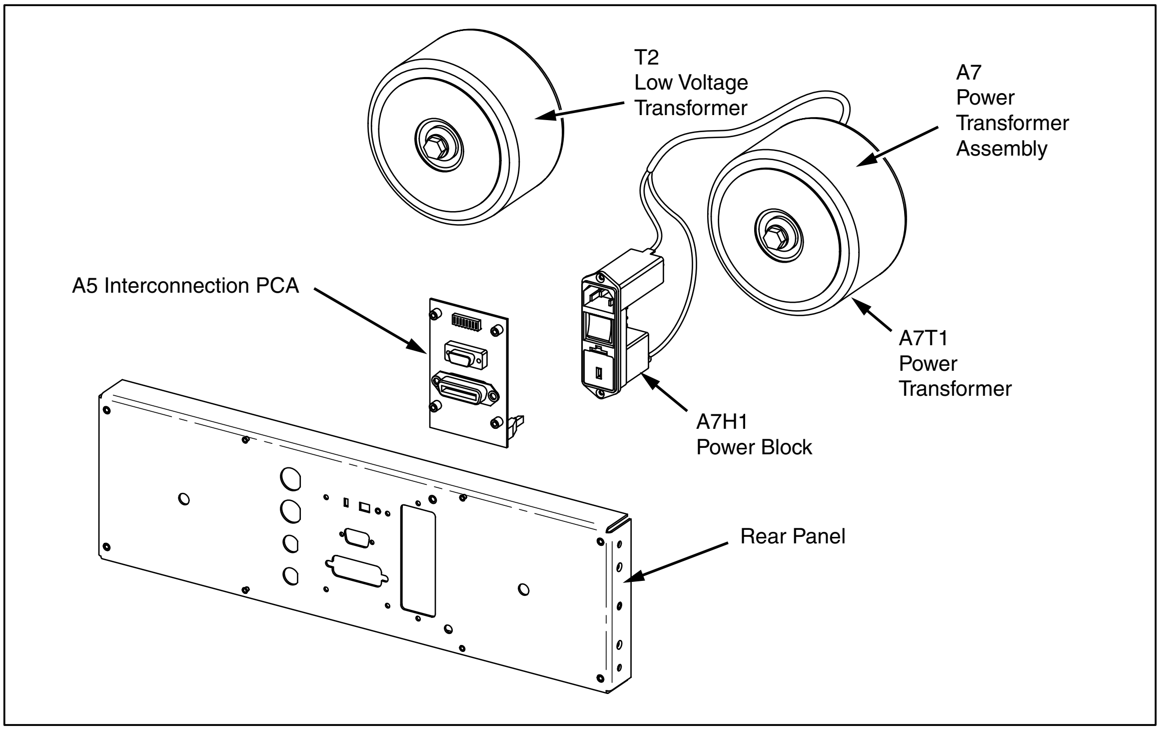


Figure 8-2. Rear Panel Assemblies

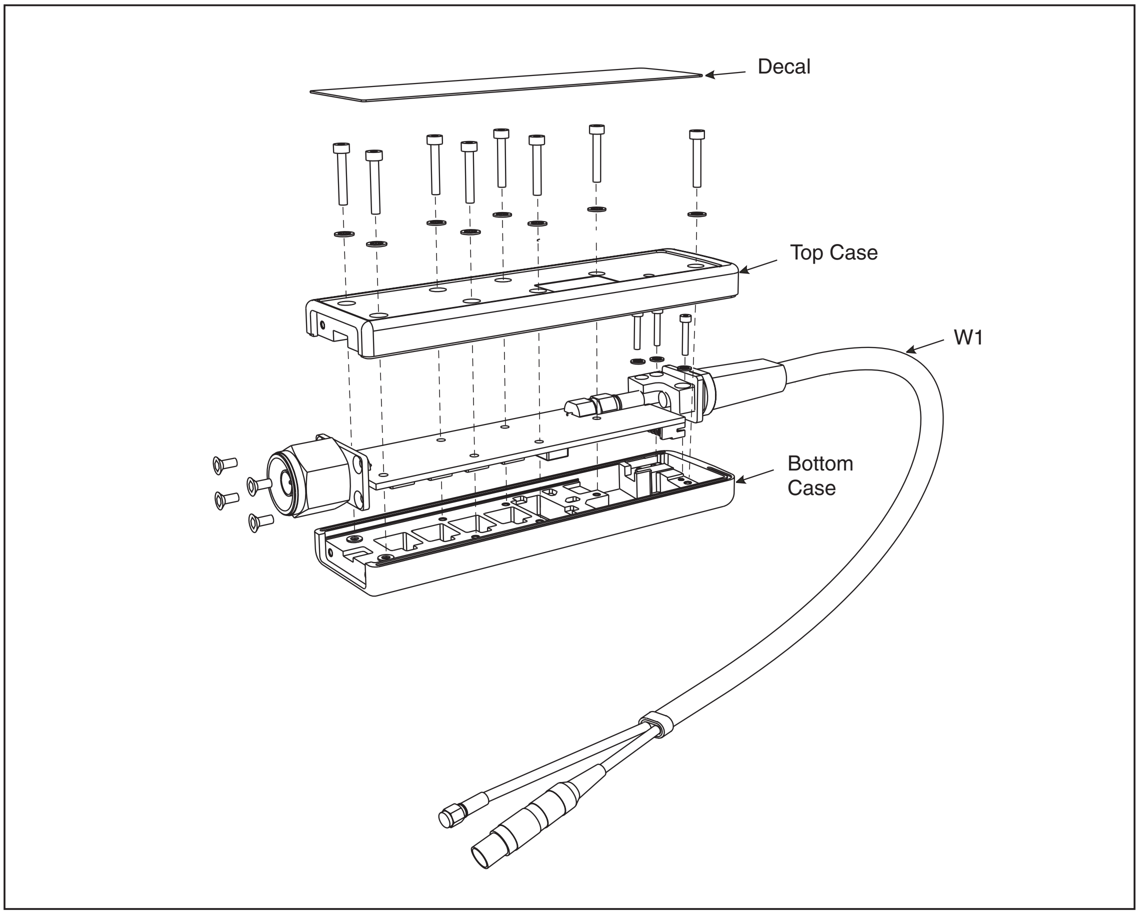


Figure 8-3. A9 Leveling Head

Appendices

Appendix	Title	Page

Appendix A
Y9600 Rack Mount Slide Kit

Introduction

The Y9600 Rack-Mount Slide Kit is a hardware kit for mounting the Instrument in a standard 19-inch equipment rack. The kit contains all of the components required for installation.

Mounting instructions are divided into two parts:

1. Installing the slides on the instrument
2. Installing the instrument in the equipment rack

Note

Review the mounting instructions provided by the manufacturer of the equipment rack before proceeding with the installation.

Installing Slides on the Instrument

Use the following procedure and Figure A-1 for installing the slides on the instrument. The numbers in Figure A-1 relate directly to the numbers in the procedure.

Note

Do not remove the top or bottom cover to rack-mount the Instrument.

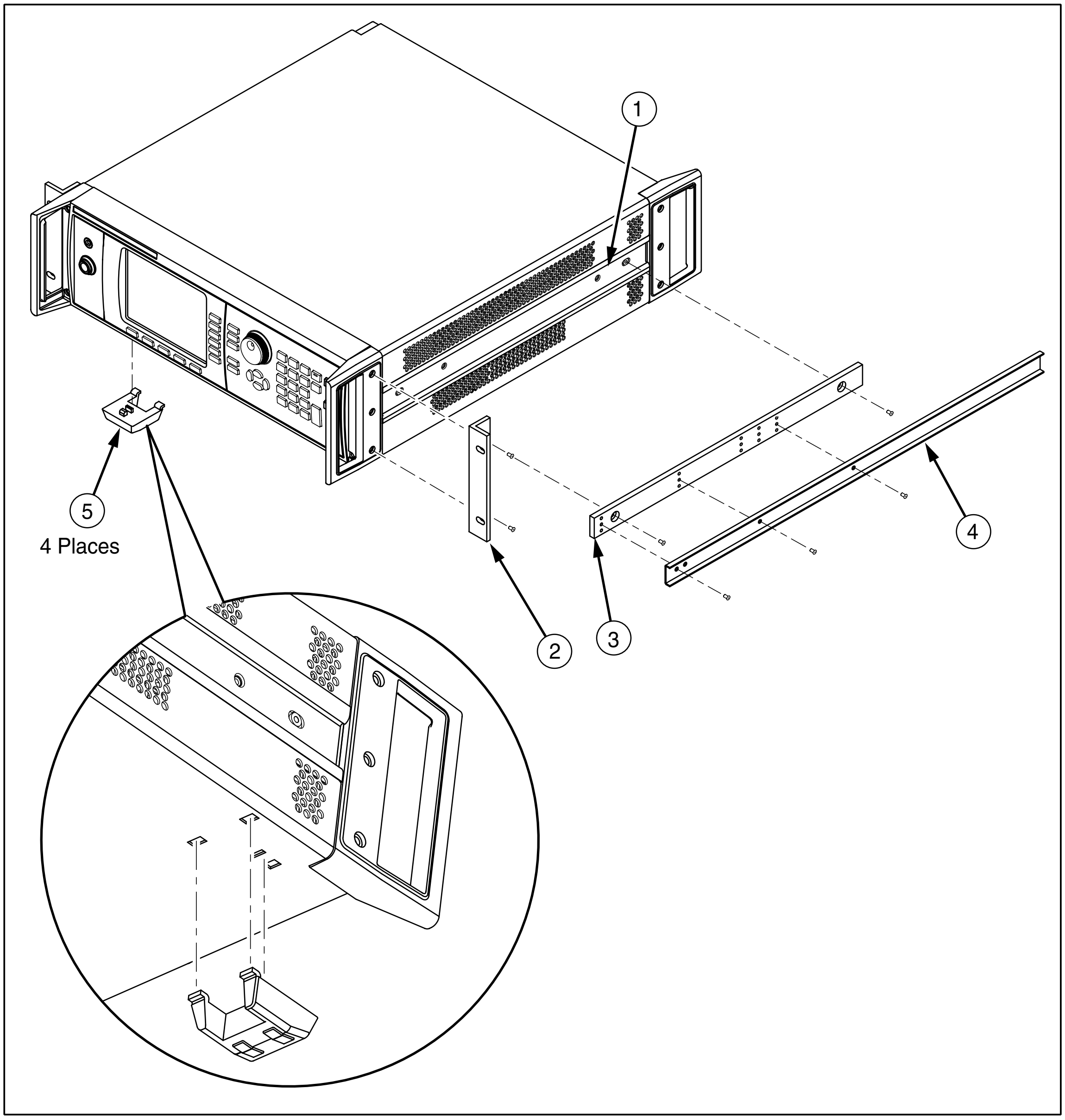
1. Remove the plastic side-trim from the Instrument by pushing a flat-blade screw driver between the chassis and the plastic strip. Pry outward until the strip is free of the two grooves. Then, pull the strip free from the Instrument.
2. Attach each rack-mount ear as follows:

   Note

   To prevent the bezel from becoming totally detached, complete one side before starting the other side.

   a. Remove the top and bottom hex screws from the side of each front handle.
   b. Position each ear, as shown, so the holes in its tabs align with the vacant screw holes on a front handle.
   c. Attach each ear to the Instrument using the two 8-32 x ½ inch Pan Head Screws (4 each) provided in the kit. See Figure A-2, screw identification.

3. Secure each of the two rack-mount filler bars to the Instrument using two 8-32 x ¼ inch Truss-Head Screws (4 each) provided in the kit.
4. Attach a slide bar to both sides of the Instrument. Secure each using three 8-32 x ¼ inch Truss-Head Screws (6 each) provided with the kit.
5. Remove the four plastic molded feet form the bottom of the Instrument as follows:
   a. Using a flat-blade screwdriver, depress the tab in the recess of each foot, and pull the foot from the cover.
   b. Store the feet for future use.

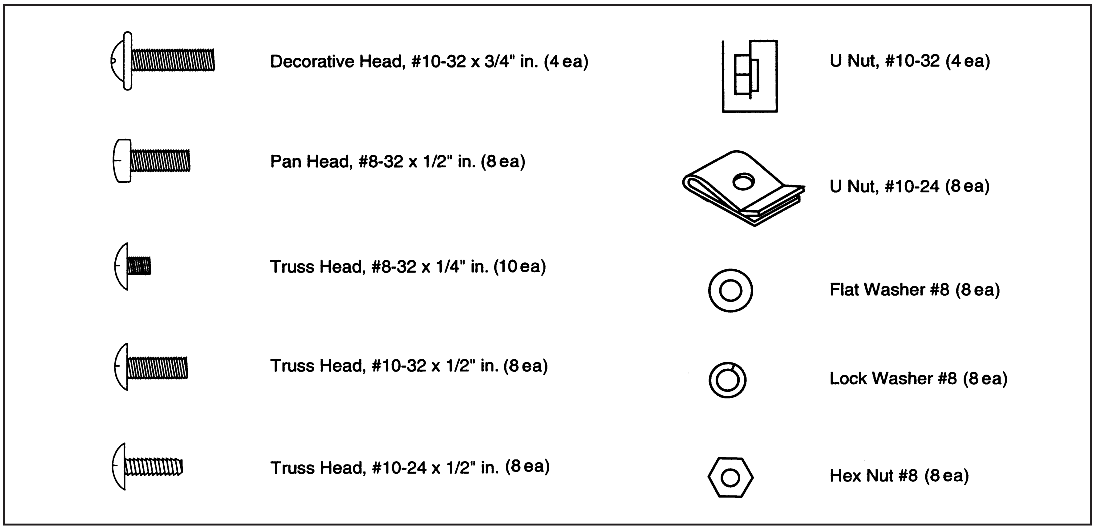


FigureA-1. Installing the Y9600 Rack Mount Slide Kit

Installing the Instument in the Equipment Rack

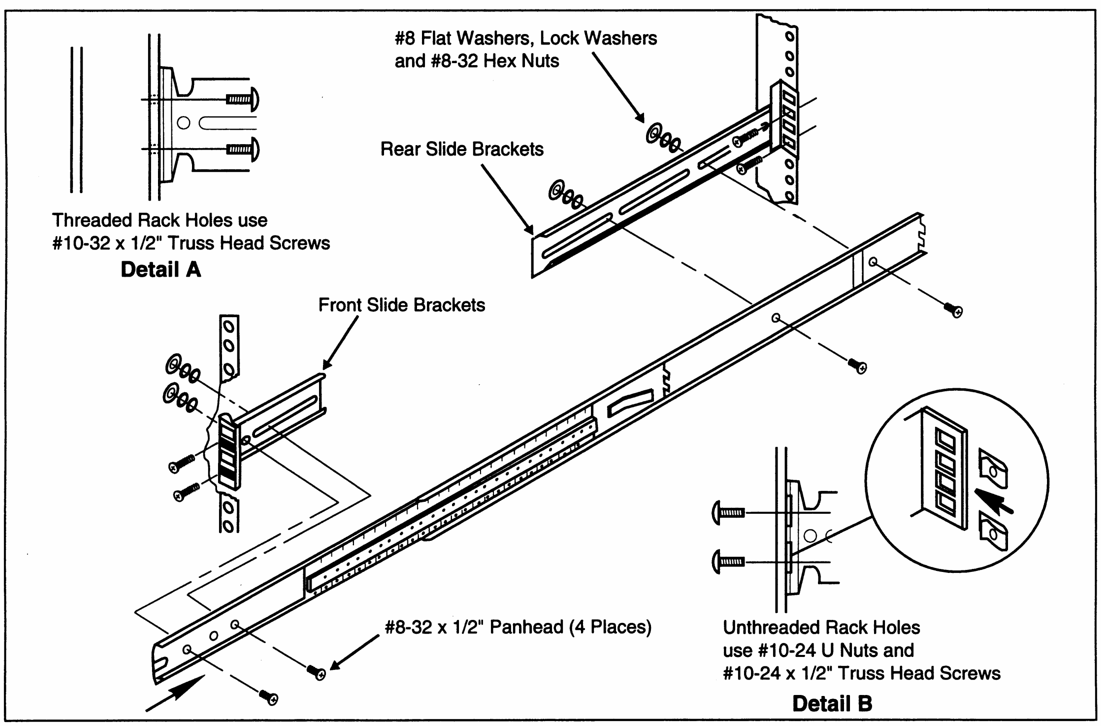
Use the following procedure to mount the Instrument in the 19-inch equipment rack. Refer to Figure A-3 for details.

1. Attach a pair of rack-mount ears and a slide-rail to each side of the equipment rack so they are ready to receive the instrument.
2. With assistance, and from the front of the equipment rack, insert the end of each slide bar (on the Instrument) into the appropriate slide-bar on the equipment rack. Push the Instrument into position, and secure the front rack-mount ears to the front of the equipment rack.



abf04f.eps

Figure A-2. Screw Identification



abf02f.tif

Figure A-3. Installing Slides in the Equipment Rack

Appendix B
Error Descriptions

9640A On-Screen Error Messages

The following paragraphs contain lists of on-screen error messages. Some of the messages indicate fatal errors from which the Instrument cannot recover. Others indicate recoverable conditions, and some indicate operational errors or provide user advice/information. Each of the messages imply or include an action for recovery.

Fatal – Potential Hazard to Connected Equipment

These messages indicate internal hardware faults that must be rectified at a Fluke Service Center. When one of these errors occur, the user interface will cease operation, and the Instrument will switch to Standby. The instrument should be turned off. Typically, these errors are non-recoverable.

- Internal Hardware Failure (SPI); Contact Service Center
- Internal Hardware Failure; Synth Board not detected; Contact Service Center
- Internal Hardware Failure; Output Board not detected; Contact Service Center
- Internal Hardware Failure (FPGA); Contact Service Center
- Internal Hardware Failure (Inguard Power Supply); Contact Service Center
- Internal Hardware Failure: FPGA read/write error; Contact Service Center

Fatal – Measurement Integrity Compromised

Some of these errors may be recoverable by making Leveling Head interconnection checks and/or restarting the Instrument. When one or more of these errors tend to repeat, contact a Fluke Service Center for advice. Most will require calibration of the source.

- Internal Hardware Failure (ADC Overflow); Contact Service Center
- Internal Hardware Failure (ADC Conversion); Contact Service Center

- NV Storage (Flash) error; Defaults in use; Internal Alignment required
- NV Storage (Flash) error;Failed to store new values
- NV Storage (Flash) error; Defaults in use
- NV Storage (User Prefs) error; Defaults in use;Re-establish User Prefs
- NV Storage (User Prefs) error; User Prefs have not been saved

- Calibration stores header corrupted; Defaults in use; Re-calibration required
- Calibration stores data corrupted; Defaults in use; Re-calibration required
- Calibration header unknown; Defaults in use; Re-calibration required
- Unable to write to calibration store; Check calibration switch
- Cannot access calibration stores; Defaults in use; Re-calibration required
- Cannot access head unit calibration stores; Defaults in use; Re-calibration required
- Cannot access base unit calibration stores; Defaults in use; Re-calibration required

Operational Advice (On-Screen)

The following messages offer in-context information or advice for the user. All of these messages indicate conditions from which the user can easily recover.

General Operation

- Head removed; Output has been forced to Standby
- Head not fitted; Cannot turn output to Operate
- Please wait - saving settings
- Completed saving settings
- Ext AM Overload Error; Reduce Input Signal Level
- Ext FM Overload Error; Reduce Input Signal Level
- Cannot translate into selected units as result is out of range
- The value is outside its edit limits
- The entered value was too small
- The entered value was too big
- The total offset was too small
- The total offset was too big
- No more digits
- Too many characters
- No more characters to delete
- Character invalid in this context
- Redundant character skipped
- Operation invalid in this context
- The entered span is zero
- The entered span is too big
- The sweep duration is invalid; Check the step, and span (start or stop) settings
- Cannot convert units; Check the step, and span (start and stop) settings
- Outside the frequency or amplitude profile
- Outside the carrier frequency/deviation profile;Max deviation = 300kHz
- Outside the carrier frequency/deviation profile;Max deviation = 750kHz
- Outside the carrier frequency/deviation profile;Max deviation = 0.12% fc
- This field has no optional units
- UUT error > +/- 1,000% - Outside direct translation range
- UUT error > +/- 10,000 ppm - Outside direct translation range
- Units cannot be changed when directly editing value
- Cannot turn output to Operate - invalid context
- Outside the Frequency/Rate profile;Max Rate = 1% fc
- Outside the frequency/rate profile. Maximum rate = 100kHz when fc > 125.75MHz
- Cannot accept the entered UUT error as the resultant offset is out of range
- Step size invalid ; Check the step and span (start or stop) settings

- Units conversion not possible
- Outside external level clamp frequency or amplitude profile
- At a Level greater than 20 dBm, the maximum Frequency is 125.75MHz
- At a Level greater than 14 dBm, the maximum Frequency is 1.4084GHz
- At a Frequency greater than 1.4084GHz, the maximum Level is 8 dBm
- At a Frequency greater than 125.75MHz, the maximum Level is 14 dBm
- At a Frequency greater than 125.75MHz, the maximum Level is 20 dBm
- At a Frequency greater than 1.4084GHz, the maximum Level is 14 dBm
- Outside the carrier frequency/deviation profile. Max deviation = 1.2MHz/V
- Outside the carrier frequency/deviation profile. Max deviation = 3.0MHz/V
- Outside the carrier frequency/deviation profile. Max deviation = 0.48% fc

Calibration and Self Test

- The entered password was unrecognized – please try again
- The head unit has not been connected
- This is the last point
- This is the first point
- A new Mode cannot be selected until 'Calibration Mode' has been exited
- A new Mode cannot be selected until 'Selftest Mode' has been exited
- To adjust this point, please fit the appropriate head
- To adjust this point, please remove the head
- Calibration target point not set
- At the top of the results list
- At the bottom of the results list
- Pathway too long
- Pathway not valid
- Selftest not known
- Target not found
- Adjustment cannot proceed. Head model or Serial number undefined
- Warning : Adjustment will not be allowed until the rear panel ‘CAL’ switch is enabled
- No more entries. At the top of the table
- No more entries. At the bottom of the table
- Calibration store version mismatch. Clear stores to permit adjustment
- Warning: The head was not calibrated with this base unit
- Warning: The head has not been calibrated