RF Power Meter

6960

- ☐ Dynamic range +20 dBm (100 mW) to −70 dBm (0·1 nW) extendable to +37 dBm (5W)
- ☐ Frequency range 30 kHz to 26·5 GHz
- ☐ Fast response
- ☐ Sensors include 50 and 75 Ω versions
- ☐ Full GPIB control
- ☐ Non-volatile instruments setting storage
- ☐ Fully interchangeable sensors with low v.s.w.r.
- ☐ Averaging time selection
- ☐ Peak power measurement
- ☐ dB relative offset facility
- ☐ Linearity correction for sensor
- ☐ High accuracy

The 6960 Automatic Power Meter has been designed to take advantage of microprocessor control to provide simple keyboard or GPIB operation, fast response and high accuracy. Power measurement errors due to sensor power linearity and frequency response can be corrected to increase measurement confidence. Instrumentation error is kept to ±0·5% of full scale in linear mode or ±0·02 dB in logarithmic mode.

The sensors 6910 and 6920 series are specially calibrated to characterize calibration and linearity factors (shown in fig. 1). With their low input VSWRs, true mean power measurement can be made with these sensors and 6960 RF Power Meter, to take advantage of modern technology and to provide increased accuracy for bench or automatic applications.

The 6960 uses a high-speed microprocessor to enable easy automatic operation in both calibration and measurement. Zero operation is carried out initially by a unique Autozero circuit, which offers almost infinite hold and reduces zero carryover error to less than

±0·03% of full scale. The sensor is then connected to the internal 50 MHz power reference. For the Low Power Sensor, however, it is essential to connect the internal power reference via the 30 dB attenuator supplied, since the standard provides, via an N-type female connector, a level of 0 dBm (1 mW), with ±0·7% accuracy traceable to National Standards.

The 6960 and sensors are designed to minimize zero drift from temperature effects and to reduce long term zero drift. Over the temperature range 0°C to +60°C the temperature effect on zero is less then 2 μW, and the result of a hand grasp lasting 60 seconds would not cause a deviation by more then 2·0 μW, so providing stable reliable measurements particularly in a field environment, see Figs. 2 and 3 for 6910 series.

Calibration

Operating AUTO CAL switches on the power reference and normalizes the internal circuitry such that the calibration values for each range are stored in non-volatile memory. Thereafter the 6960 provides automatic ranging over five decades.

The RF Power Meter can display the measured power in either linear mode (nW, μW, mW, W) or logarithmic mode (dBm). Any particular power level can be used as the reference for relative power measurements so that the 6960 can be used in applications such as reflectometry or in comparing the outputs of devices relative to a known standard. In addition the relative values may be entered via the keypad. This enables the measurement of high powers easily and accurately by entering the calibrated value of the attenuator directly as a negative number. (Positive values to account for amplifier gains can also be entered.) The 6960 then automatically calculates the corrected power level.

Microprocessor-controlled circuitry scales the 6960 automatically for the Power Sensor connected. Thus 6910 series enable measurements to be made from −30 to +20 dBm; with 6920 the range is −70 to −20 dBm.

Stores

Using the nine battery-backed non-volatile stores for complete front panel settings, the relative offset values at different frequencies or for different attenuators may be stored and recalled via the keypad or GPIB. The 6960 can be uniquely programmed to retain all the current front panel settings or default to a different set of conditions on power down. This allows the user the choice of using the instrument for long term power monitoring applications even with power supply failures, or ensuring that each fresh use of the RF power meter is uncomplicated by previous settings.

The 6960 RF Power Meter automatically selects the best resolution for the range in use. Shown on the liquid crystal display is the measured power level; the lower the power the smaller the resolution so that 1 dB resolution is shown without delay. An averaging factor from 1 to 253 may be selected for two different reasons:

1) To improve resolution. For example, on range 1 with an averaging factor of 20, a 0·1 dB resolution is given after 4 display updates (1 second) and a 0·01 resolution is given after 16 additional updates.

2) To improve noise reduction. For example, when using the 6910 Sensor to measure a −20 dBm power level, the error due to noise will be decreased by some 80% when increasing the averaging factor from 1 to 20.

Cables

A new design of cable is now fitted to reduce RFI susceptibility to negligible levels. In some measurement applications, the power sensor may be some distance away from the power meter, for example at the top of an antenna mast, and direct access to it is not possible or even desirable. In this case optional longer cables of 5, 15 or 50 metres are available permitting long distance operation between sensor and meter. Negligible error is introduced by calibration using the standard 2 m cable length and then using longer cables for operation. The power meter also features a rear sensor input assembly option to allow easier use in a dedicated rack of automatic test equipment.

Duty cycle

Using the duty cycle facility, duty cycles from 100% down to 0·001% may be entered.

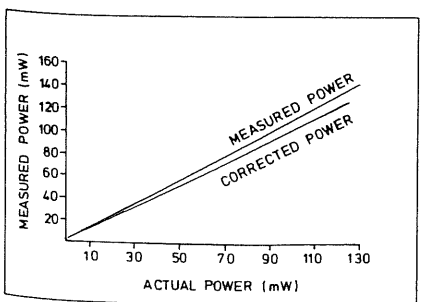
The 6960 measures mean RF power. With a duty cycle of 100% mean power is displayed; with a fixed duty cycle <100% the instrument calculates and displays the peak power.

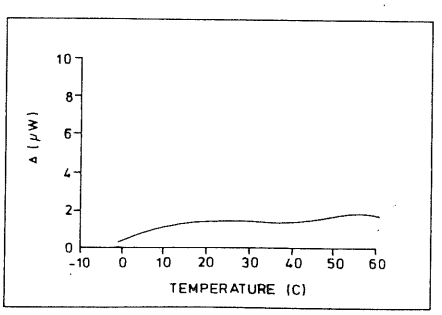
Analog outputs

Two analog voltage outputs proportional to RF input power are provided on the rear panel. The Recorder Output offers the full 50 dB dynamic range of the instrument in dB mode at 1 volt/decade for wide range power measurements. In the watt mode this output provides 0 to 5 V linear voltage proportional to the RF input power. The fast Levelling Output provides 1 V per range for effective power levelling of sweeper or signal sources. The calibration and linearity correction data from the sensor are traded off for a fast response.

GPIB

The GPIB interface, normally factory fitted or offered as





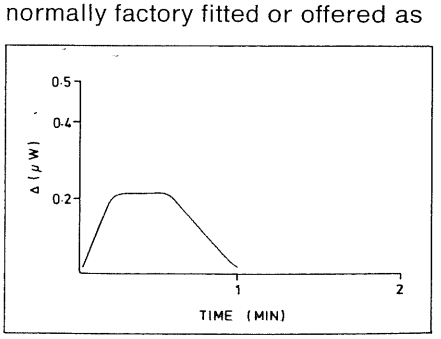


Fig. 1 Showing effect of high power non-linearities.
Fig. 2 Typical effect of temperature on zero for 6910 series.
Fig. 3 Drift of typical 6910 series sensor in response to a hand grasp.

an optional accessory, allows the instrument to be coupled to a controller. Under GPIB control the 6960 becomes a real asset to the ATE system design in both hardware facilities and software control, allowing greater speed in measurements with selectable resolution. The GPIB program codes feature simple mnemonics, requiring either a single digit number entry with no terminator or floating point entry requiring a terminator. Specific GPIB program codes include 'TR' trigger mode. This sets the trigger mode or starts a measurement after a hold condition. Up to six trigger modes are available from the 6960, from free running fast to an immediate trigger with settling time then hold. To the system user the SRQ response is always important and in the 6960 the SRQs have been arranged to form a mask with each SRQ option having a binary weighting:
1 On end of measurement 2 On error
4 On end of GPIB operation.

SRQ option 4 is very useful to inform the controller that the requested GPIB operation has been executed, e.g. Autozero.

FREQUENCY RANGE	30 kHz to 26·5 GHz depending on sensor used.
POWER RANGE	+20 dBm (100 mW) to −70 dBm (0·1 nW) depending on sensor used.
POWER REFERENCE	50 MHz, Type N (f) precision connector 50 Ω. (Adapters supplied for any other connectors with sensor.)
Uncertainty	±0·7%, traceable to National Standards.
Accuracy	±1·2% worst case for one year.
INSTRUMENTATION ACCURACY	
Watts mode	±0·5%.
dBm mode	±0·02 dB.
dB REL mode	±0·02 dB.
ZERO	
Set	±1% of f.s.d. most sensitive range.
Carryover	±0·03% of f.s.d. (when zeroed on most sensitive range).
NOISE	Less than 1% of f.s.d. for most sensitive range with an average factor greater than 19.
OUTPUTS	
Fast levelling	±0·5% (Excludes Cal. Factor and Linearity data), 1 V per range.
Recorder	±1·0%. dB mode: 1 V/decade, 7 V max Range 5, Watt mode: 5 V linear.
Blanking	Max. voltage: 25 V; Max. current: 50 mA, open collector, short circuit for blank.
RESPONSE TIME	
Range 1 (most sensitive)	1s, selectable.
Ranges 2 to 5	250 ms (display update), selectable 25 ms using GPIB.
GPIB INTERFACE	Optional GPIB module fits inside instrument. All front panel functions remotely programmable.
LIMIT RANGE OF OPERATION	
Temperature	0° to 55°C.

Multi-input measurement

Simultaneous measurements of a number of different power levels can be made by controlling a number of different 6960 Power Meters on the GPIB. Using the fast trigger modes and the SRQ facilities, measurements are rapid, and avoid internal power meter channel switching delays, as well as providing high common mode rejection.

Self test and service

The 6960 has a built-in self test on switch-on of the a.c. supply. Validity of the information in the non-volatile memory is automatically checked. Additionally a single key-switch operation can check the liquid crystal display alphanumerics and annunciators.

To make servicing easy and fast, careful thought has led to a simple arrangement of components and adjustments. Selective key switch operations can access the filter and D-A converters to check their operation, eliminating the need for a range calibrator. The only test equipment required to assist servicing is a counter-timer, digital voltmeter and screwdriver. The use of liquid crystal display and switch mode power supply has led to low internal heat generation for reliability.

CONDITIONS OF STORAGE AND TRANSPORT	
Temperature	−40° to +70°C.
Humidity	Up to 95% relative humidity at 35°C.
Altitude	Up to 2500 m (pressurized freight at 27 kPa differential, i.e. 3·9 lbf/in^2).
RADIO FREQUENCY INTERFERENCE	Conforms to the requirements of EEC Directive 76/889 as to limits of r.f. interference.
SAFETY	Complies with IEC 348.
POWER REQUIREMENTS	
AC supply	Switchable voltage ranges: 105 to 120 V ± 10%, 210 to 240 V ± 10%. 45 to 440 Hz. 25 VA maximum, 15 VA typical.

DIMENSIONS AND WEIGHT (over projections)

Height	Width	Depth	Weight
108 mm	256 mm	369 mm	3·2 kg
4·25 in	10·1 in	14·5 in	7·1 lb
88 mm*	216 mm*		
3·5 in*	8·5 in*		

*excluding feet and handles.

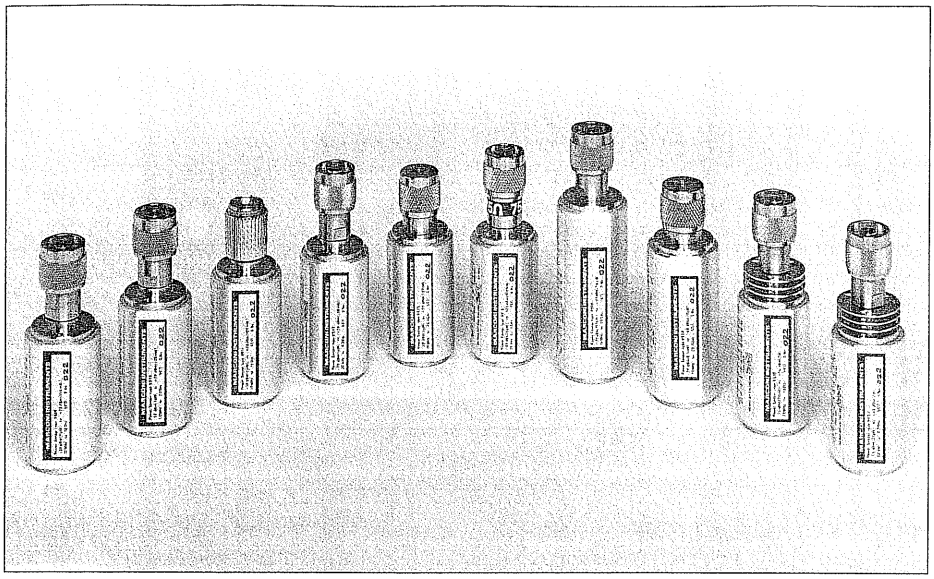
VERSIONS AND ACCESSORIES

When ordering please quote full code numbers

Ordering numbers	
	Versions
6960–001	RF Power Meter with GPIB.
6960	RF Power Meter.
	Supplied Accessories
	AC Supply Lead 43123–076Y.
	Instruction Manual H6960.
	2 m Power Sensor Cable 3964–081.
	Optional Accessories
3964–600	GPIB Module.
6960–060	Rear Panel Sensor Input Assembly.
6950–056	5 m Power Sensor Cable.
6950–057	15 m Power Sensor Cable.
6950–058	50 m Power Sensor Cable.
46883–536P	Rack Mounting Kit (double unit).
46883–537X	Blank Frame Kit for double unit rack mount.
46883–638P	Rack Mounting Kit (single unit).
54124–022L	Stowage Cover.
46881–365R	GPIB Manual H54811–010P (contains details of general GPIB protocols).

RF Power Sensors

6910, 6920 & 6930 series



- **Wide frequency coverage: 30 kHz to 40 GHz**
- **Power levels from –70 dBm (100 pW) to +35 dBm (3 W)**
- **Both 50 Ω and 75 Ω sensors**
- **Low VSWR reduces measurement uncertainty**
- **Linearity correction data supplied**
- **Field replaceable RF assembly**
- **High overload capability**

These stable and accurate power sensors operate at frequencies up to 40 GHz. They are for use with the 6970 Power Meter as well as the 6960 Power Meters and the 6200A series Microwave Test Set.

HIGH MEASUREMENT ACCURACY

High measurement accuracy over a wide frequency range is ensured by low input VSWR – the result of innovative design.

The sensors are fitted with precision connectors. They have a multiway socket for cable connection to the Power Meter, and are interchangeable.

SMALL SIZE & LIGHTWEIGHT

The small size and light weight of these sensors makes them very adaptable for use anywhere without requiring additional mechanical support.

RUGGED CONSTRUCTION

Rugged mechanical construction makes them ideal for both bench and field use. Minimum down-time is ensured by using a pre-calibrated field replaceable RF sensing assembly. Unit lifetime is enhanced by high overload capabilities.

Twelve different sensors are currently available covering a range of frequencies from 30 kHz to 40 GHz. Type N, APC 7, MPC 3.5 and 2.92 mm connectors are available from –70 dBm (100 pW) to +35 dBm (3 W). A 75 Ω sensor is also available.

For the 40 GHz sensors (6914, 6924 and 6934) a waveguide 22 transformer is optionally available. By ordering version "-002" the transformer (54417-002R) is supplied as well as a calibration table to give both accurate waveguide and coaxial measurements. The calibration information is traceable to national standards.

6910 series: medium power thermocouple power sensors

	6910	6911	6912
FREQUENCY RANGE	10 MHz to 20 GHz.	10 MHz to 20 GHz.	30 kHz to 4.2 GHz.
INPUT POWER **Range**	–30 dBm (1 µW) to +20 dBm (100 mW).	–30 dBm (1 µW) to +20 dBm (100 mW).	–30 dBm (1 µW) to +20 dBm (100 mW).
Maximum	+25 dBm (300 mW) CW. +42 dBm (15 W) peak for 2 µs.	+25 dBm (300 mW) CW. +42 dBm (15 W) peak for 2 µs.	+25 dBm (300 mW) CW. +42 dBm (15 W) peak for 2 µs.
Sensing element	Semiconductor thermocouple.	Semiconductor thermocouple.	Semiconductor thermocouple.
VSWR	1.25 10 MHz to 30 MHz. 1.10 30 MHz to 2 GHz. 1.18 2 GHz to 16 GHz. 1.28 16 GHz to 18 GHz. 1.40 typical 18 GHz to 20 GHz.	1.24 10 MHz to 30 MHz. 1.10 30 MHz to 2 GHz. 1.18 2 GHz to 16 GHz. 1.28 16 MHz to 18 GHz. 1.40 typical 18 GHz to 20 GHz.	1.60 30 kHz to 100 kHz. 1.20 100 kHz to 300 kHz. 1.10 300 kHz to 4.2 GHz.
CALIBRATION FACTOR	Provided at 1 GHz intervals with each sensor.	Provided at 1 GHz intervals with each sensor.	Provided at 3, 5, 10 intervals with each sensor.
Accuracy	Uncertainty provided with each sensor.	Uncertainty provided with each sensor.	Uncertainty provided with each sensor.
Resolution	0.01%.	0.01%.	0.01%.
LINEARITY FACTOR	Provided with each sensor.	Provided with each sensor.	Provided with each sensor.
Accuracy	±0.5% at 100 mW, decreasing by 0.005% per mW.	±0.5% at 100 mW, decreasing by 0.005% per mW.	±0.5% at 100 mW, decreasing by 0.005% per mW.
RF CONNECTOR	Type N precision 50 Ω (m).	Precision APC 7.	Type N precision 50 Ω (m).
DIMENSIONS AND WEIGHT	Length Diameter Weight 87 mm 33.5 mm 0.14 kg 3.4 in 1.3 in 0.30 lb	Length Diameter Weight 87 mm 33.5 mm 0.14 kg 3.4 in 1.3 in 0.30 lb	Length Diameter Weight 87 mm 33.5 mm 0.14 kg 3.4 in 1.3 in 0.30 lb
ORDER CODES	56910-900L	56911-900X	56912-900U

6910 series: medium power thermocouple power sensors

	6913	6914	6919 (75 Ω)
FREQUENCY RANGE	10 MHz to 26.5 GHz.	10 MHz to 40 GHz (useable to 46 GHz).	30 kHz to 3 GHz.
INPUT POWER Range	−30 dBm (1 µW) to +20 dBm (100 mW).	−30 dBm (1 µW) to +20 dBm (100 mW).	−30 dBm (1 µW) to +20 dBm (100 mW).
Maximum	+25 dBm (300 mW) CW. +42 dBm (15 W) peak for 2 µs.	+25 dBm (300 mW) CW. +42 dBm (15 W) peak for 2 µs.	+25 dBm (300 mW) CW. +42 dBm (15 W) peak for 2 µs.
Sensing element	Semiconductor thermocouple.	Semiconductor thermocouple.	Semiconductor thermocouple.
VSWR	1.40 10 MHz to 50 MHz. 1.15 50 MHz to 100 MHz. 1.10 100 MHz to 2 GHz. 1.15 2 GHz to 12.4 GHz. 1.20 12.4 GHz to 18 GHz. 1.25 18 GHz to 26.5 GHz.	1.58 10 MHz to 40 MHz. 1.15 40 MHz to 100 MHz. 1.10 100 MHz to 2 GHz. 1.15 2 GHz to 12.4 GHz. 1.20 12.4 GHz to 18 GHz. 1.25 18 GHz to 26.5 GHz. 1.43 26.5 GHz to 40 GHz. 1.55 26.5 GHz to 40 GHz with waveguide 22 transformer.	1.40 30 kHz to 100 kHz. 1.15 100 kHz to 300 kHz. 1.10 300 kHz to 2 GHz. 1.20 typical 2 GHz to 3 GHz.
CALIBRATION FACTOR	Provided at 1 GHz intervals (500 MHz intervals above 20 GHz) with each sensor.	Provided with each sensor.	Provided at 3, 5, 10 intervals with each sensor.
Accuracy	Uncertainty provided with each sensor.	Uncertainty provided with each sensor.	Uncertainty provided with each sensor.
Resolution	0.01%.	0.01%.	0.01%.
LINEARITY FACTOR	Provided with each sensor.	Provided with each sensor.	Provided with each sensor.
Accuracy	±0.5% at 100 mW, decreasing by 0.005% per 1 mW.	±0.5% at 100 mW, decreasing by 0.005% per 1 mW.	±0.5% at 100 mW, decreasing by 0.005% per 1 mW.
RF CONNECTOR	Type MPC* 3.5 50 Ω (m).	2.92 mm 50 Ω (m)†.	Type N precision 75 Ω (m).
DIMENSIONS AND WEIGHT	Length 80 mm / 3.2 in; Diameter 33.5 mm / 1.3 in; Weight 0.14 kg / 0.30 lb	Length 88.5 mm / 3.5 in; Diameter 33.5 mm / 1.3 in; Weight 0.15 kg / 0.33 lb	Length 89 mm / 3.5 in; Diameter 33.5 mm / 1.3 in; Weight 0.14 kg / 0.30 lb
ORDER CODES	56913-900D	56914-001R 56914-002B As for 56914-001R plus waveguide 22 transformer and calibration table.	56919-900Y
Supplied with	Adapter part no. 23443-882K for connection between 6913 and 0 dBm Power Reference.	Adapter part no. 23443-882K for connection between 6914 and 0 dBm Power Reference.	Adapter part no. 6919-050 for connection between 6919 and 0 dBm Power Reference.

6920 series: high sensitivity diode sensors

	6920	6923**	6924**
FREQUENCY RANGE	10 MHz to 20 GHz.	10 MHz to 26.5 GHz.	10 MHz to 40 GHz (useable to 46 GHz).
INPUT POWER Range	−70 dBm (0.1 nW) to −20 dBm (10 µW).	−70 dBm (0.1 nW) to −20 dBm (10 µW).	−70 dBm (0.1 nW) to −20 dBm (10 µW).
Maximum	+26 dBm (400 mW) CW. +30 dBm (1 W) peak for 2 µs.	+26 dBm (400 mW) CW. +30 dBm (1 W) peak for 2 µs.	+26 dBm (400 mW) CW. +30 dBm (1 W) peak for 2 µs.
Sensing element	Shottky barrier diode.	Shottky barrier diode.	Shottky barrier diode.
VSWR	1.4 to 1.2 10 MHz to 40 MHz. 1.20 40 MHz to 10 GHz. 1.35 10 GHz to 18 GHz. 1.40 typical 18 GHz to 20 GHz.	1.40 10 MHz to 40 MHz. 1.15 40 MHz to 100 MHz. 1.12 0.1 MHz to 2 GHz. 1.17 2 GHz to 8 GHz. 1.30 8 GHz to 18 GHz. 1.50 18 GHz to 26.5 GHz.	1.58 10 MHz to 40 MHz. 1.15 40 MHz to 100 MHz. 1.12 100 MHz to 2 GHz. 1.33 2 GHz to 18 GHz. 1.50 18 GHz to 33 GHz. 1.95 33 GHz to 40 GHz. 1.97 26,5 GHz to 40 GHz with waveguide 22 transformer.
CALIBRATION FACTOR	Provided at 1 GHz intervals with each sensor.	Provided at 1 GHz intervals (500 MHz intervals above 20 GHz) with each sensor.	Provided with each sensor.
Accuracy	Uncertainty provided with each sensor.	Uncertainty provided with each sensor.	Uncertainty provided with each sensor.
Resolution	0.01%.	0.01%.	0.01%.
LINEARITY FACTOR	Provided with each sensor.	Provided with each sensor.	Provided with each sensor.
Accuracy	±1% between −30 and −20 dBm.	±1% between −30 and −20 dBm.	±1% between −30 and −20 dBm.
RF CONNECTOR	Type N precision 50 Ω (m).	Type MPC* 3.5 50 Ω (m).	2.92 mm 50 Ω (m)†.
DIMENSIONS AND WEIGHT	Length 104 mm / 4.1 in; Diameter 33.5 mm / 1.3 in; Weight 0.18 kg / 0.38 lb	Length 87 mm / 3.4 in; Diameter 33.5 mm / 1.3 in; Weight 0.18 kg / 0.38 lb	Length 88.5 mm / 3.5 in; Diameter 33.5 mm / 1.3 in; Weight 0.15 kg / 0.33 lb
ORDER CODES	56920-900J	56923-900T	56924-001B 56924-002K As for 56924-001B plus waveguide 22 transformer and calibration table.
Supplied with	Precision Attenuator part no. 56920-023 30 dB ±0.05 dB at 50 MHz at 25°C	Precision Attenuator part no. 56920-023 30 dB ±0.05 dB at 50 MHz and 25°C Adapter part no. 23443-882K for connection between 6923 and 0 dBm Power Reference.	Precision Attenuator part no. 56920-023. Adapter part no. 23443-882K for connection between 6924 and 0 dBm Power Reference.

* Marconi Precision Connector, mates non-destructively with SMA and similar connectors. † 2.92 mm connectors mate non-destructively with 3.5 mm and SMA connectors.
** When used with 6970 RF Power Meter, 6923 and 6924 power sensors are useable to −65 dBm.