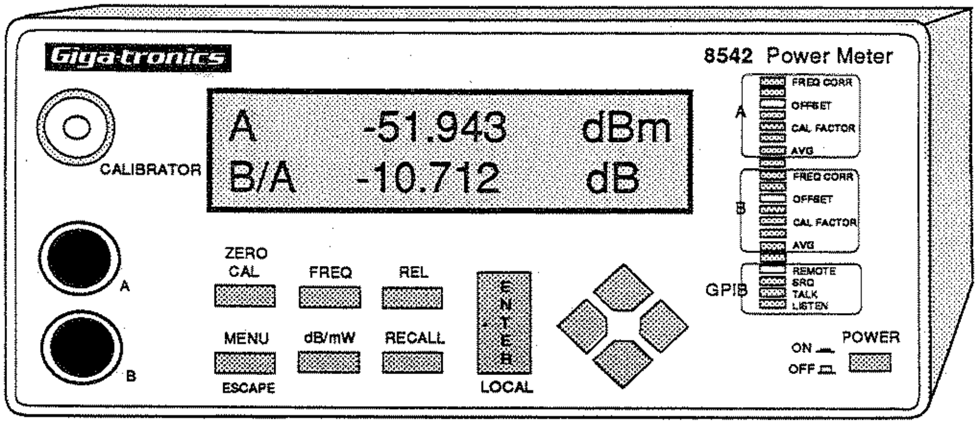
8540 Series
Universal Power Meters



MEASUREMENTS GUIDE

Giga-tronics

8540 Series Power Meters

MENU TREE

NOTE: The menus have a convenient memory effect. The BASE Menu returns to the same selection it displayed prior to menu exit allowing rapid instrument configuration during local operation.

* Use up/down arrow keys to show menu choices. Select by pressing **ENTER**.

Press MENU Key

- OFFSET (xx.xxx db, A, B)
- RESOLUTION (xxx.xx, Top,Bot)
- AVERAGE (Auto, 2,4,8,16,32,.....,512)
- USER CAL FACTOR (x.xx)
- PEAKING METER (Status, Pk A, Pk B)
- REF POWER ON/OFF (On, Off)
- A, B, A/B, ..., OFF (Top Line, Bottom Line)
- **SETUP MENU** → Press ENTER Key
  - SAVE SETUP (Registers 1 - 20)
  - PEAK SNSR SETUP (Int, Ext, CW)
  - MIN/MAX SETUP (Top Line, Bottom Line)
  - LIMITS SETUP (Top, Bot; On, Off; Level)
  - db / mW SETUP (Top, Bot; Log, Lin)
  - REL SETUP (Top, Bot, On, Off)
  - GPIB SETUP (Mode, Address)
  - ANALOG OUT SETUP (Top, Bot; Log, Lin)
  - V prop F SETUP (On, Off; Start V; V/GHz)
  - SOUND SETUP (On, Off)
- **SERVICE MENU** → Press ENTER Key
  - SENSOR ROM (S/N Cal Factors, (dB)
  - CALIBRATOR (xx dBm; Calibration)
  - TEST FUNCTIONS (Select Test)
  - SOFTWARE VERSION (Date, version)
  - CLEAR ALL MEMORY (Yes, No)

Initial Operating Instructions

1) Connect sensor to the sensor cable and the power meter.
2) Connect the sensor to the Calibrator Port.
3) Press the ZERO/CAL key to calibrate the sensor.
4) *For Peak Power Sensors Only*
   After calibration, connect the peak power sensor "Detector Out" to an oscilloscope input to view the pulse amplitude profile.
5) Connect sensor to measurement port.

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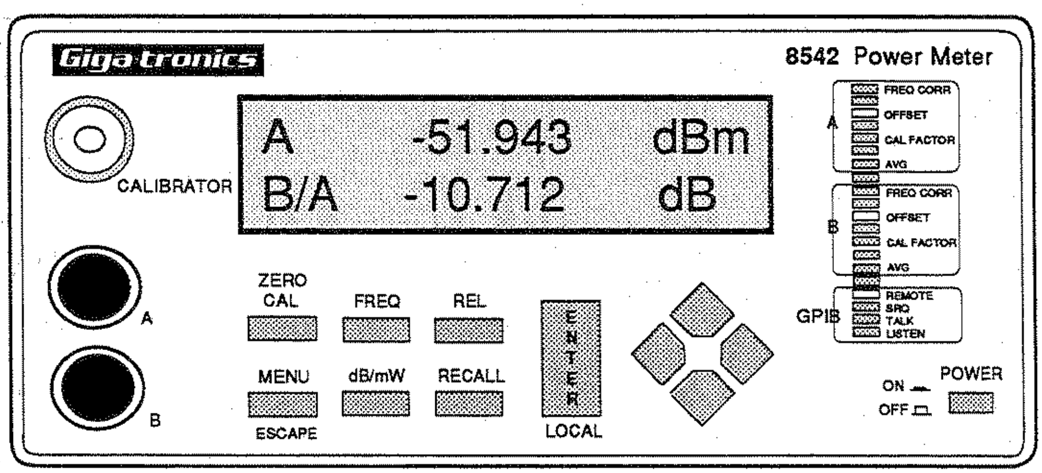
INTRODUCTION

For the first time, accurate microwave power measurements can be made quickly and easily. This Measurements Guide introduces you to the applications and functions of the 8540 Series Universal Power Meters.

The examples are similar to most microwave power testing procedures. You'll find several helpful hints for more accurate measurements and faster test procedures. There are also helpful ideas for sensor selection like when to use Peak Power Sensors and High Power Sensors.



Getting Started

Following Power On

CAUTION: Please check the rear panel of the 8540 Series Power Meter to ensure that the ac main power configuration is correct. If input power configuration in your facility is not the same, please review the ac main power and fusing requirements given in Chapter 2 of the 8540 Series Operating and Maintenance Manual.

Using the Power Sweep Calibrator

The Power Sweep Calibrator automatically calibrates the power sensor to the power meter. The power sweep operates from -30 to +20 dBm (the complete, non-square law operating region) and transfers the inherent linearity of an internal, thermal based detector to the balanced diode sensors. Output is NIST - National Institute of Standards and Technology - traceable at 50 MHz, 0 dBm to an accuracy of ± 0.7% (±1.2% over one year).

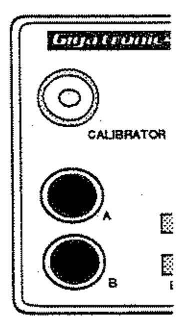
Sensor Calibration Procedure.

1. Connect the power sensor to the 8540 Series Power Meter with the power sensor cable.

2. Connect the power sensor to the Calibrator on the power meter

3. Press **ZERO/CAL.**

The 8540 Series Power Meter will automatically check to see if a sensor is attached to the Power Sweep Calibrator and then automatically zero and calibrate the sensor. Following calibration, the 8540 Series Power Meter will operate with any 80300 Series Power Sensor or 80500 Series Precision Return Loss Bridge.



8540 Series Power Sweep Calibrator Output

Zeroing at Low Power Levels

The sensor should be zeroed just before recording final readings in the lower 15 dB of the power sensor's 90 dB dynamic range (below -55 dBm for standard sensors).

1. Turn off the source output before you zero the sensor. The microwave source must output less than -74 dBm of total noise power during RF Blanking for proper zeroing. The source signal power should be less than -90 dBm.

NOTE: To automatically disable the source output during zeroing, connect the 8540 Power Meter's RF Blanking BNC output to the microwave source's blanking input.

2. Press the **ZERO/CAL** key to start the zeroing process. (Note: If more than one sensor is connected to the power meter, a channel selection menu will appear.)

The sensor should remain connected to the signal source during zeroing. By turning off the source instead of disconnecting the detector, the zeroing process automatically accounts for ground line voltages and connector interface emfs.

NOTE: Diode sensors can be destroyed by momentary or continuous exposure to excess input power. The maximum power that the detector elements can handle before burn out is printed on the side of the sensor housing. For Standard CW Sensors and Peak Power Sensors, this level is +23 dBm (200mW).

High Power Sensors are available to measure higher output levels. Otherwise, use a directional coupler or a precision attenuator to reduce the signal amplitude.

Measuring Source Output Power

Accurate power measurements can be performed almost immediately.

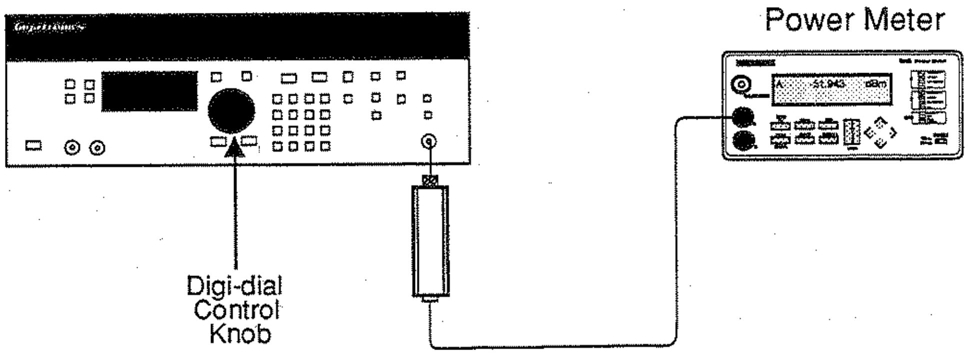


Figure 1. Measuring Output Power.

1. Connect the power sensor to the microwave source as shown in Figure 1.

2. Verify that the microwave source output is ON.

3. Press the **FREQ** key on the 8540 Power Meter front panel. Enter the operating frequency with the Cursor Keys and press **ENTER.**

The 8540 is now displaying the microwave source's output power.

4. Adjust the sources' amplitude control to the desired level. Select the amplitude directly on the digi-dial control knob.

The 8540 Series responds rapidly to amplitude changes. Ranging is automatically performed in real time through a 90 dB dynamic range using Standard CW Sensors. Peak Power Sensor range is 40 dB, Peak, and 50 dB, CW.

By entering the frequency of operation, the power meter can automatically calculate and correct for the sensor's Frequency Calibration Factor (or Cal Factor). Operating frequency can be entered on the front panel, via GPIB, or at the rear panel V prop. F In BNC connector. Note the V prop. F connector below.

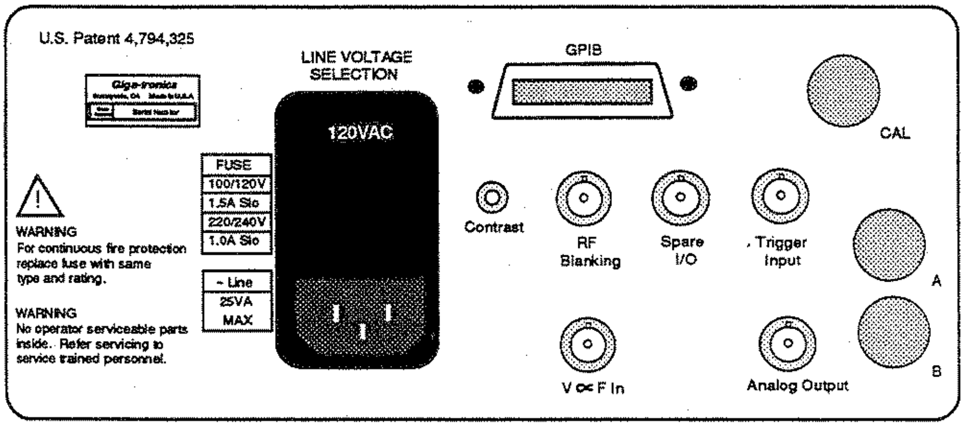


Figure 2. 8540 Series Power Meter Rear Panel

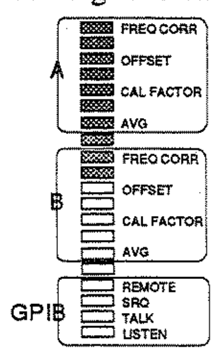
Using the Peaking Meter

The LEDs on the right side of the 8540 series front panel can operate as a 20 segment bar graph. The Peaking Meter operates on a decade range and varies linearly with input power.

1. Press the **MENU** key and select *PEAKING METER* using the Up/Down Cursor keys.

2. Move the "_" symbol to *PkA* or *PkB* and press **ENTER.**

3. Adjust the source's amplitude control and observe the peaking meter.



8540 Series Peaking Meter

The LED bar graph Peaking Meter operates linearly proportional to power level on a decade range basis. For example, a 3 dBm power level produces a 50% response on the Peaking Meter (as shown above).

High Power Level Measurements

High power amplifiers and transmitters can damage standard sensors. Using High Power Sensors allows measurement of these devices without using extra attenuators and manual offset settings. In Figure 3 below, a 20 dB gain amplifier is producing 30 dBm (1W) of output power, P_o. This is well above the standard sensors maximum input power of 23 dBm. A 5W High Power Sensor is used to measure the amplifier's output levels directly.

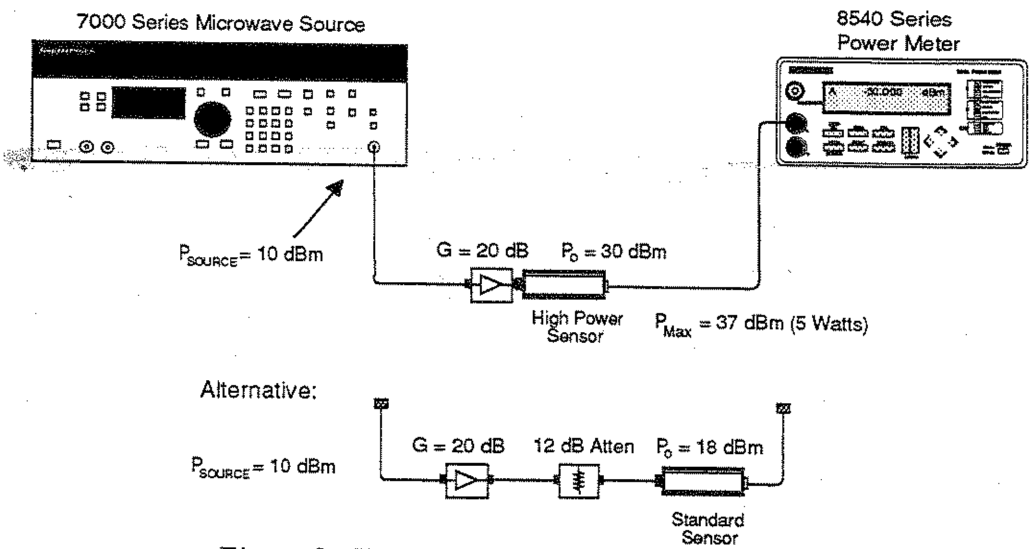


Figure 3. Using High Power Sensors.

Alternatively, a well calibrated attenuator can be placed at the output of the amplifier. In this case, the output power is reduced to 18 dBm - allowing the use of the standard sensors.

NOTE: Standard Sensors should not be used above 20 dBm. Prolonged exposure to signals greater than 20 dBm (0.1W, before burn out at 0.2W) can severely degrade the output characteristics of the balanced diode detector elements.

> Amplifier compression measurements should be measured with True RMS Sensors. The 80330 Series True RMS Sensors should be used whenever significant harmonics of the microwave test signal are present. These sensors have exceptional linearity and very low VSWR because the balanced, low barrier Shottky diode detectors are forced to operate in their square law region.

Peak Power Measurements

Peak Power sensors are used to directly measure the amplitude of pulsed microwave signals. The direct sampling technique is more accurate than traditional duty cycle correction methods. As shown below, the sample position can be displayed on an oscilloscope.

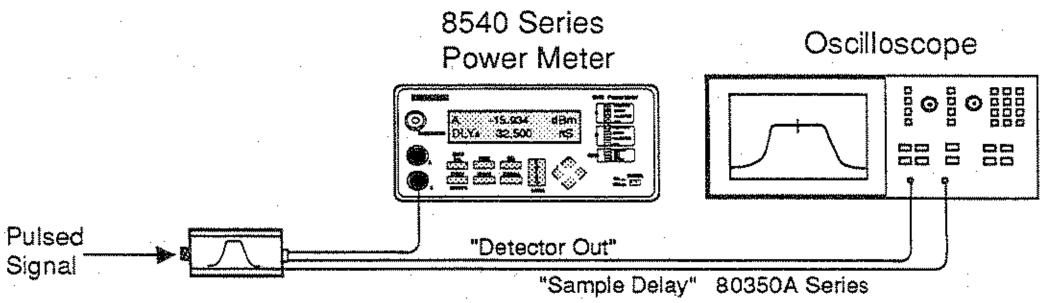


Figure 4. The Peak Power Sensor's real time Detector Output can be displayed on an oscilloscope

- Calibrate a Peak Power Sensor and connect it to a pulsed microwave source.
- Select Internal, External, or CW Triggering.
- Check the appropriate trigger level. (Int. or Ext. only)
- Select Sample Delay with the Cursor Keys or within the Setup Menu. (Int. or Ext. only)
- Connect the Peak Power Sensor's "Detector Out" to an oscilloscope to view sample position. For 80350A Series Peak Power Sensors, also connect "Sample Delay" and set the oscilloscope triggering to that channel.

> **80340 Series Pulse Sensors**
>
> The signal should have a rise time of 0.5 µs and a 5 µs pulse width. Unlike the 80350A Peak Power Sensors, sample delay cannot be adjusted through the front panel.

Basic Measurement Procedures

Measuring an Attenuator - Single Channel Method

Attenuators are useful for many applications. With 8540 Series Power Meters, attenuators can be calibrated quickly and accurately. Shown below is an attenuator calibration procedure for the single channel, 8541 power meter.

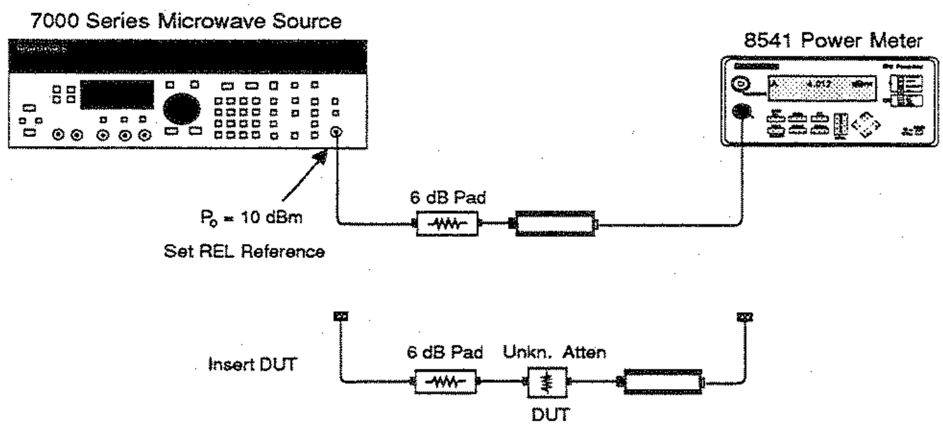


Figure 5. Single Channel Attenuator Calibration at a Single Frequency.

The single channel calibration method is efficient for calibrating at a single frequency or at a limited number of frequencies.

1. Connect the power sensor to the matching pad (above, 6 dB attenuator) and adjust the source output power to about 0 dBm. Verify that the source output is stable.

2. Press **FREQ** on the 8541 Front Panel and enter the operating frequency. (optional)

3. Press **REL** to set the reference level

4. Insert the attenuator for calibration as shown at "DUT" indication above in Figure 5.

5. Record the attenuator value.

Improving Accuracy

Mismatch Uncertainty is the largest source of errors during power measurements. The 6 dB attenuator (6 dB pad) in Figure 5 reduces mismatch uncertainty by effectively improving the return loss (or reducing the SWR) of the source.

Mismatch uncertainty is large when a device has poor impedance match relative to 50 ohms.

Poorly matched devices reflect a large proportion of incident signals and create standing waves along the transmission line. At various points along the transmission line the standing wave will be at maximum or minimum amplitude. Mismatch uncertainty is a measure of the deviation between these maxima and minima.

Inserting an attenuator into the transmission line reduces mismatch uncertainty by reducing the amplitude of the reflected signal - thereby reducing the difference between the standing wave's maximum and minimum levels.

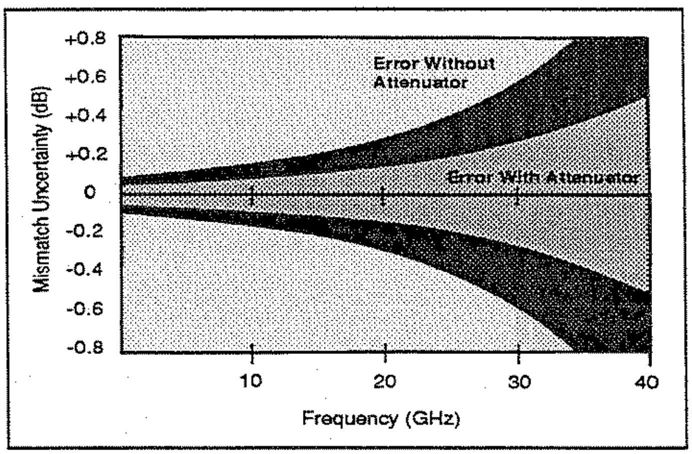


Figure 6. Reducing Mismatch Uncertainty Error With a 6 dB Attenuator

Compared to an attenuator, most microwave sources have poor impedance match. Using the 6 dB attenuator during the calibration has the effect of lowering the SWR of the microwave source. The only compromise is a corresponding 6 dB reduction in the source's dynamic range when the 6 dB attenuator is attached.

Measuring an Attenuator - Dual Channel Method

Whenever the attenuator is to be calibrated at a range of frequencies, considerable time is saved by using a dual channel method. This method is faster because the attenuator remains in the test setup throughout the calibration: there is no need to disconnect the attenuator to obtain an accurate measurement of input and output power. Figure 7, below, shows a typical setup.

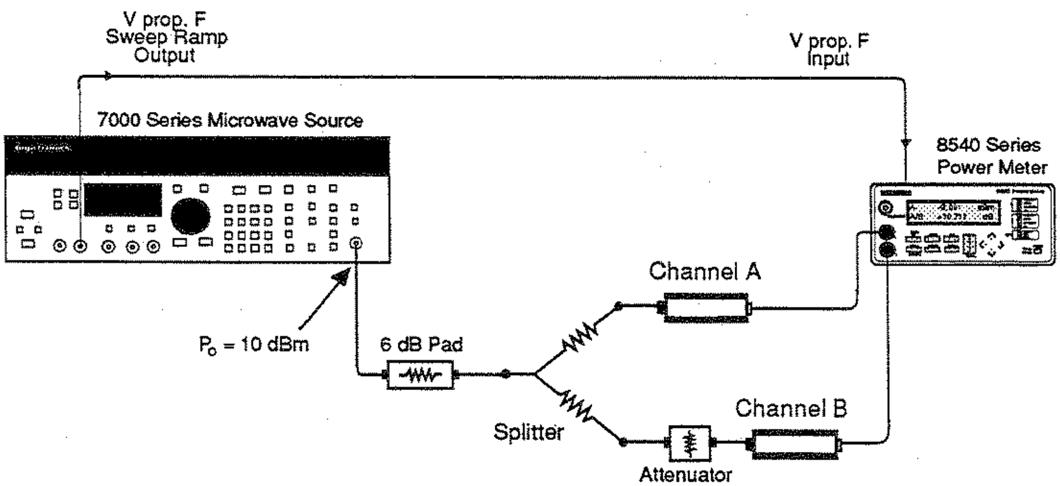


Figure 7. Dual Channel Attenuator Calibration at Multiple Frequencies.

1. Connect the 8542 as shown above and adjust the source output power to about 10 dBm.
2. Press **MENU** and select *A,B,A/B,...,OFF* and press **ENTER.**
3. Use the left/right Cursor keys to select *A/B* as the channel configuration.
4. Select *VpropF SETUP* in the *SETUP MENU*. Select *ON*, set the low frequency start voltage (for 0.00V), and then set the *V/GHz* value for your source.
5. Record the attenuator value, adjust the source to the next frequency, and record the attenuator value.

In Figure 7 the procedure uses a two resistor power splitter to monitor the DUT input power. Be sure to use a high quality splitter. This calibration method requires that the two splitter outputs "track" closely. The splitter tracking error in this calibration is equal to the amplitude of the splitter output imbalance. To correct for splitter imbalance, measure the splitter's variation and enter the difference as an offset.

NOTE: GPIB Users. By using the preceding procedure in an ATE system, common microwave devices such as attenuators, switches and couplers can be calibrated almost as fast as they are connected and disconnected. Also, correcting for Cal Factor using the V prop. F input on the rear panel of the power meter allows faster operation than loading the operating frequency via GPIB.

Automatic Cal Factor Correction

Power sensors have a measurable frequency response. During manufacture, this response data is measured at 1 GHz intervals and entered into an EEPROM, which is contained within the sensor housing. The Power Meter uses this data to automatically interpolate the correct Cal Factor for your operating frequency. You do not need to enter Cal Factors manually.

Operating frequency can be entered with the front panel, via GPIB or by connecting a voltage proportional to frequency output from the microwave source to the 8540 Series Power Meter's V prop. F BNC input as shown in Figure 8.

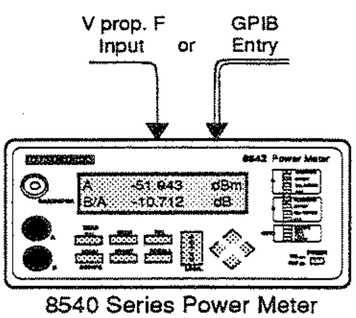


Figure 8. Entering Operating Frequency Allows Automatic Cal Factor Corrections

Measuring a Coupler - Single Channel Method

Couplers are useful for monitoring RF and microwave signals without significantly reducing signal power. Couplers are also useful for attenuating high power signals. Using the 8540 Series Power Meters, measuring coupler coefficient or insertion loss can be accomplished similarly to attenuators. Shown below is a coupler calibration procedure using the 8541 Power Meter.

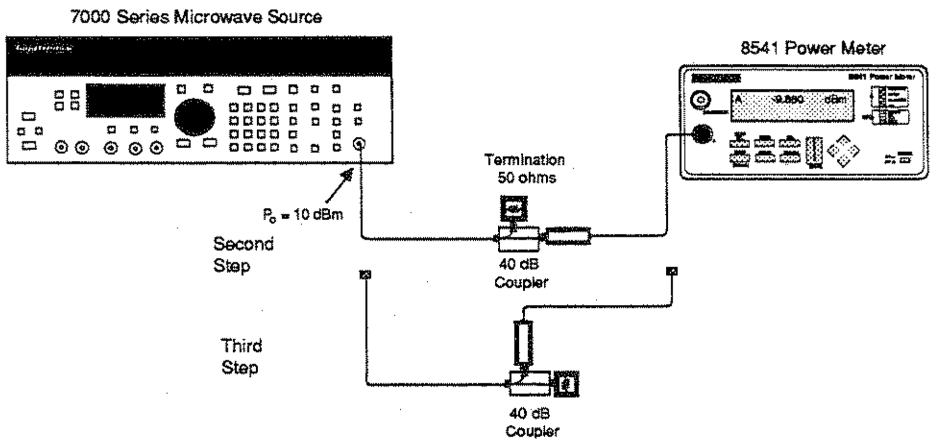


Figure 9. Determining Coupler Coefficient and Insertion Loss - Single Channel.

1. Connect the power sensor directly to the source and measure the output power level. Verify that the source output is stable.

2. Press **REL.** The display will read "0.00 dB".

3. Connect coupler, 50 ohm termination, and power sensor as shown in the "Second Step" of Figure 9.

The power meter is now displaying the coupler's insertion loss for the current operating frequency.

4. Connect power sensor and 50 ohm termination as shown in the "Third Step."

The power meter is now displaying the coupler coefficient for the current operating frequency.

Multi-Frequency Coupler Characterization - Dual Channel Method

Couplers and high dynamic range power meters are excellent for monitoring and leveling source output power in a variety of microwave testing applications. The coupler minimizes the insertion loss (as compared to a splitter or power divider) over a wide frequency range. And the high dynamic range power meter provides an accurate determination of signal level.

For example, in Figure 10 the 50W transmitter's frequency response is to be measured in band - at the 50 watt output level - and on either side of the bandpass down to -80 dBr, or 500 nanowatts.

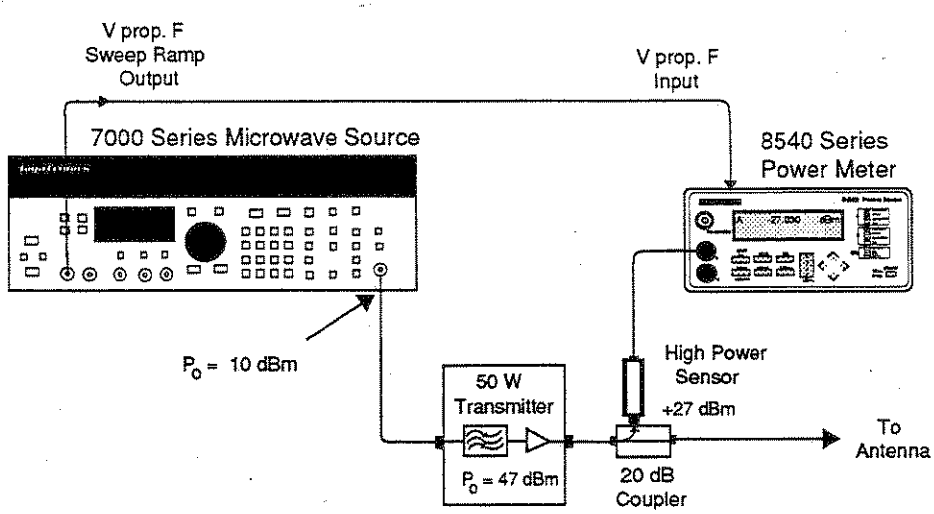


Figure 10. Measuring In Band and Out of Band Transmitter Frequency Response.

Figure 11 on the next page shows a coupler calibration procedure. An operating procedure using the coupler as a multifrequency power level monitor follows. Be sure to connect the voltage proportional to frequency connections, so that the power meter will automatically apply the sensor's Cal Factor corrections to the displayed reading.

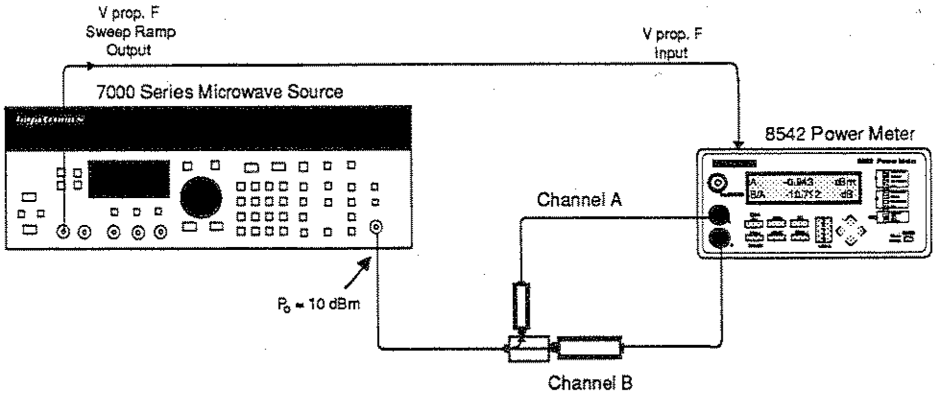


Figure 11. Multi-Frequency Coupler Coefficient - Dual Channel.

1. Connect coupler, power sensors, and Power Meter as shown above in Figure 11.

2. Press **MENU**, select *A,B,A/B,...,OFF*, and select *A/B* for ratio measurement.

3. Select *VpropF SETUP* in the *SETUP MENU*. Select *ON*, set the low frequency start voltage (for 0.00V), and then set the *V/GHz* value for your source.

4. Adjust the source to the first frequency and record the coupler coefficient.

5. Adjust to the next frequencies and record the coupler coefficients.

With the coupler coefficients accurately characterized over frequency, the coupler can now be used to monitor the source's output power at the coupler's output port. To display the coupler's output power on the power meter, enter the coupler coefficients into power level offsets as follows.

1. Press **MENU** and select *OFFSET*.

2. Enter the coupler coefficient for the first frequency and press **ENTER.**

3. Press **MENU**, select *SETUP MENU*, and select *SAVE SETUP*.

4. Select memory register, *Reg #1*.

The coupler coefficient for the first frequency is now stored as an offset in setup 1, which is stored in memory register 1.

5. Press **MENU** and select *OFFSET*.

6. Enter the coupler coefficient for the second frequency and press **ENTER.**

7. Press **MENU** and press **ENTER** twice (the menu remembers the two previous menu selections, *SETUP MENU* and *SAVE SETUP*.)

8. Select memory register, *Reg #2*.

The coupler coefficient for the second frequency is now stored as an offset in setup 2. Continue to enter the offsets in the memory locations. When performing measurements, press **RECALL,** select the desired stored setup, and the 8540 Power Meter will then display the output power at the coupler's output port.

Comparing Accuracy to a Traceable Standard.

Verifying accuracy and calibrating test equipment is essential to microwave engineers and technicians. Accurate, repeatable measurements are required for validating designs, certifying calibrations, engineering decisions, approving product components, standards certification and verifying performance specifications.

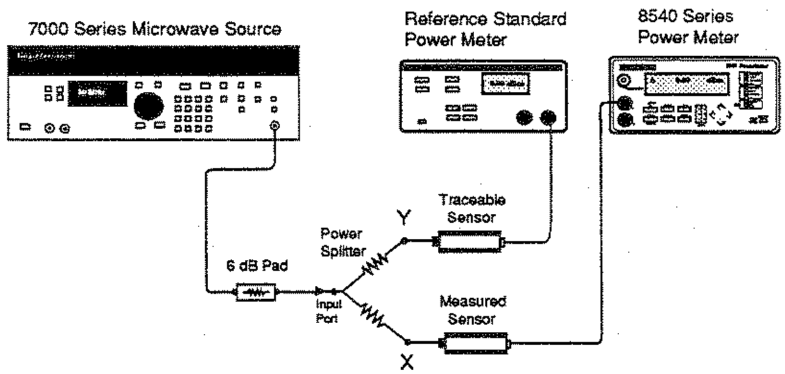


Figure 12. Comparing the accuracy of two power meters.

The 6 dB attenuator is placed at the input port of the power splitter to provide a good impedance match from the source. This effectively reduces the VSWR of the source. Depending on the signal quality of your source over frequency, additional attenuation may be desirable. The two resistor power splitter is used to provide consistently matched power levels at the output ports , X and Y. The largest sources of error are the power splitter tracking errors and mismatch uncertainty.

1. Connect as shown in Figure 12 and adjust the source frequency to a standard reference frequency. For power meters this is usually 50 MHz.

2. Enter the operating frequency or Cal Factors into the Power Meters.

3. Adjust the source amplitude to the maximum sensor operating level. For standard sensors this is +20 dBm.

4. Zero each power meter and record the measurement values immediately after settling.

5. Adjust the source for +19 dBm output level and repeat above.

6. Continue testing at 1 dB increments through the rest of the standard sensor's 90 dB dynamic range.

7. Calculate Measurement Uncertainty and compare the measured results to the specified tolerances.

At low power levels, be sure to zero the sensor prior to taking measurements. At levels below -55 dBm, the measurements should be recorded just after zeroing is completed. The zeroing process must be periodically repeated, depending on operating level, due to drift characteristics.

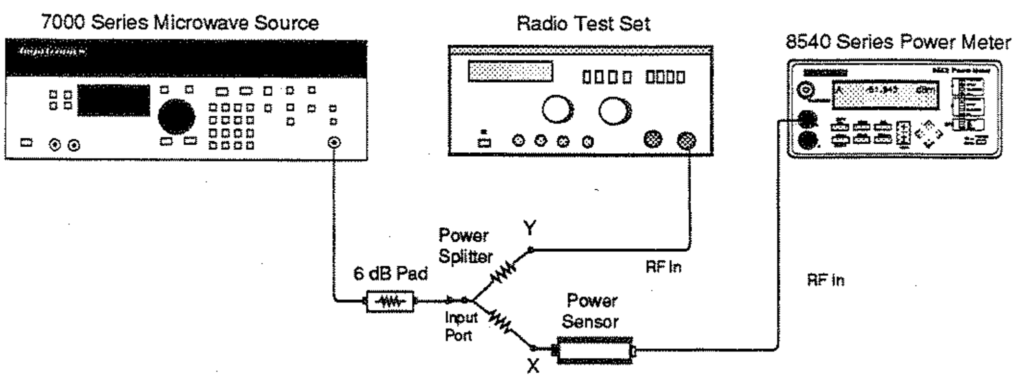


Figure 13. Automated Radio Test Set Calibration.

Transferring Calibration

This calibration technique is excellent for testing the performance of various radio test sets. For example, spectrum analyzers and radio test sets which are used in field applications should be checked under various temperature conditions for absolute amplitude accuracy and measurement linearity.

Sources of Errors

In the previous accuracy verification measurement, there are four sources of error. These are listed in Table A, below

Table A. Sources of Errors during accuracy verification

- Source Output Level Variation
- Power Splitter Output Tracking
- Power Meter X Total Measurement Uncertainty
- Power Meter Y Total Measurement Uncertainty

Source Output Level Variation occurs in all microwave sources. This happens when the signal source's output level changes during the time it takes to record the displayed value on Power Meter X and then read the displayed value on Power Meter Y. This source of error can be eliminated by using a laboratory grade signal source.

Power Splitter Output Tracking errors are the maximum signal level variation at the splitter X output as compared to the splitter's Y output.

Total Measurement Uncertainty for each of the Power Meters is the worst case combination Mismatch Uncertainty, Instrument Accuracy, and Sensor Accuracy.

The impedance mismatch of the test setup, the source of Mismatch Uncertainty, is usually the largest component of Power Meter Total Measurement Uncertainty. Instrument Accuracy generally concerns the ability of the main chassis to convert a voltage signal from the power sensor into a numeric value. Sensor Accuracy refers to the sensor's ability to faithfully maintain a consistent and verifiable relationship between input power of the measured signal and the sensor's output voltage.

Mismatch uncertainty is calculated from the reflection coefficients of the sensor and the splitter (source) according to the following:

$$M\ (dB) = 20 \log_{10} \{1 \pm (\rho_{SENSOR})(\rho_{SOURCE})\}$$

where, $$\rho = \frac{VSWR - 1}{VSWR + 1}$$

For a source mismatch specified in terms of return loss, RL, the equation should be modified according to:

$$\rho_{SOURCE} = 10^{\left(\frac{-RL\ (dB)}{20}\right)}$$

Shown in Table B, below, are the factors concerning Instrument Accuracy and Sensor Accuracy.

Table B. Instrument and Sensor Accuracy Components

Instrument Accuracy

- Instrument Linearity or Instrumentation Uncertainty
- Reference Calibrator Settability or Power Reference Uncertainty

Sensor Accuracy

- Calibration Factor Uncertainty
- Calibrator to Sensor, or Power Reference to Sensor, Mismatch Uncertainty
- Noise
- Zero Set
- Calibration Pad Uncertainty (For Thermal Based Power Meters Only.)
- Sensor Linearity

Worst case uncertainty, which should be used for calibration purposes is the arithmetic sum of all four sources of error, Source Output Level Variation, Power Splitter Output Tracking, Power Meter X Total Measurement Uncertainty, and Power Meter Y Total Measurement Uncertainty.

Fast Source Leveling

Swept frequency testing provides a means of quickly measuring and tuning frequency response. Many of these applications, such as antenna testing or transmitter/receiver compression testing are completed more quickly and accurately with a leveled test signal at the DUT. Because of the 8540 Series Power Meter's extreme measurement rate and accuracy, sources can be accurately leveled at faster rates and greater dynamic ranges than previously possible. Actual swept leveling speed and dynamic range will vary depending on the source used. The 8540 Series Power Meters have one configurable analog output; a second analog output is added with Option 06.

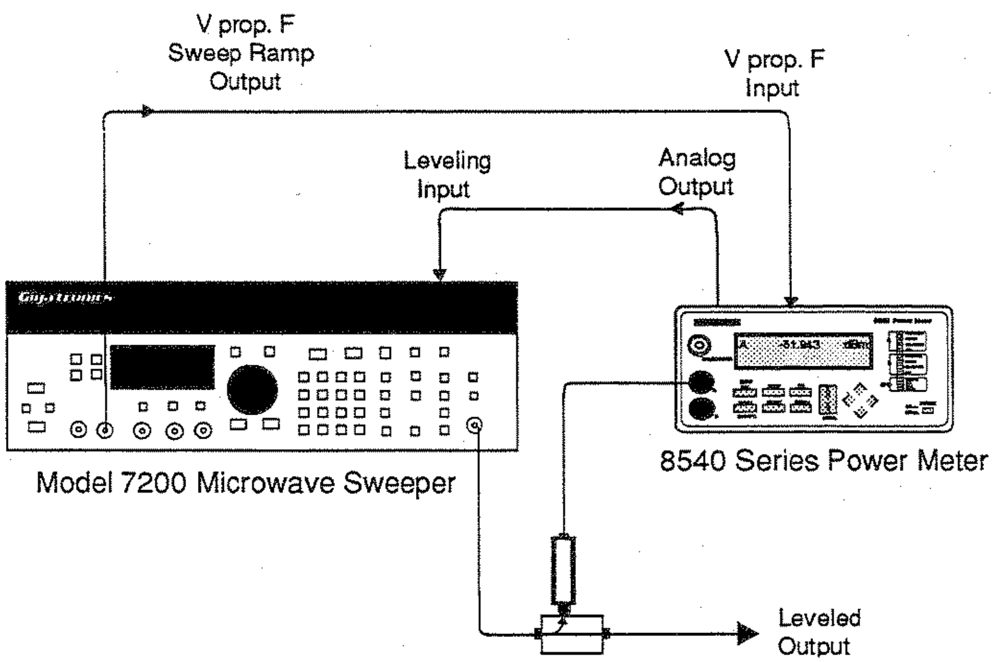


Figure 14. Leveling Microwave Sources

1. Connect the Power Meter and Microwave Sweeper as shown in Figure 14.

2. Press **MENU** and select *SETUP MENU,* and then select *ANALOG OUT SETUP*.

3. Select *TOP LINE* or *BOTTOM LINE* and *LOG* or *LIN*, and press **ENTER**.

4. Select low power level and its corresponding voltage, and press **ENTER**.

5. Select high power level and its corresponding voltage, and press **ENTER**.

6. Follow the leveling instructions for your source. Generally this requires setting the source to the desired level, selecting leveled operation, and setting the frequency range and rate.

If the leveling loop (actually a control loop) is stable, the output signal at the coupler is now leveled at all frequencies.

For the application above, the coupler should have a very flat frequency response for both insertion loss and coupler coefficient. Also, due to the fast measurement rates, the signal should not have AM modulation (<10 kHz) present. Otherwise, the leveling loop will attempt to level the AM signal. Dropouts and glitches at the sweeper's frequency band crossovers can be corrected by sweeping at lower rates or using a Precision Scalar Analyzer.

Improved swept leveling capability can be achieved with a Precision Scalar Analyzer. Coupler frequency response as well as variations caused by other measurement setup components, such as cables, amplifiers, or adapters, can be normalized by a Precision Scalar Analyzer for amplitude leveling down to ±0.01 dB.

Fast Frequency Response Measurements

The 8540 Series Power Meters quickly characterize the frequency response of transmitter or receiver front ends. On the benchtop, transmitter amplitude characteristics are quickly determined with the manual procedure below.

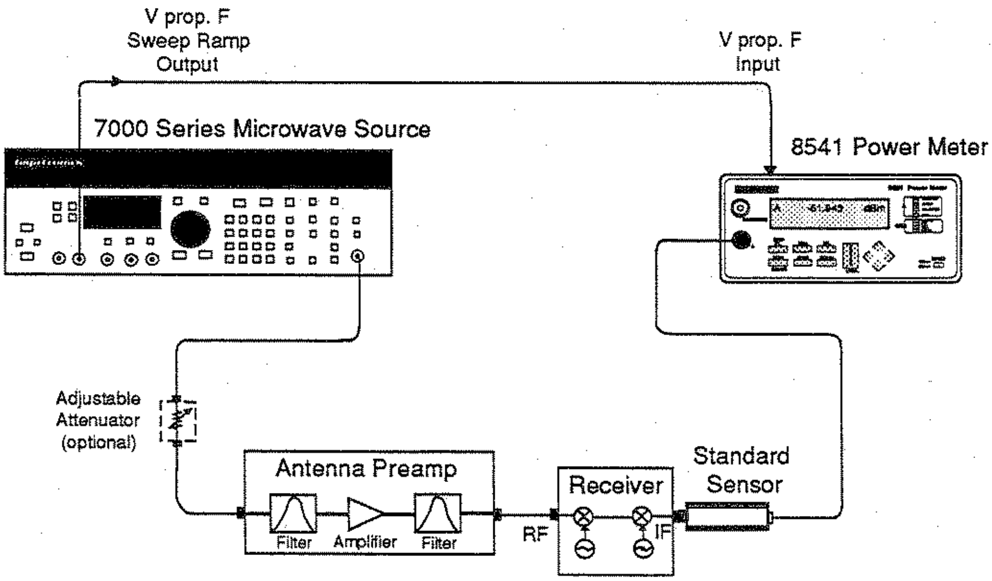


Figure 15. Stepped Frequency Testing of a Microwave Transmitter Over a 90 dB Range.

1. Connect as shown above, and configure *VpropF SETUP* shown under the *SETUP MENU*.
2. Adjust the source for the lowest desired frequency.
3. If the power level is less than -55 dBm, zero the power meter.
4. Record the relative power level and adjust the source to the next frequency.
5. Continue as above until data is recorded for each frequency of interest.

NOTE: Dual channel measurements with the 8542 Power Meter could utilize the second channel for leveling the microwave source.

GPIB Users
An automated system will complete the preceding procedure in less than 25 seconds.

Recording and graphing the data obtained from performing Steps 1 - 5 produced the following output.

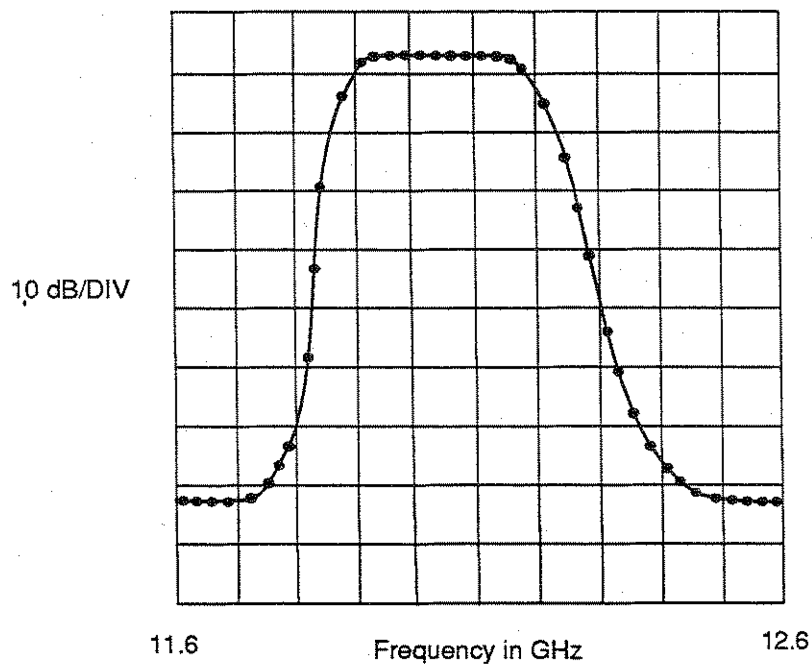


Figure 16. Transmitter Frequency Response - 40 Sample Points.

The addition of an oscilloscope as a swept display can produce a real time, swept display over a 70 dB dynamic range. Slower sweep speeds attain up to 90 dB dynamic range.

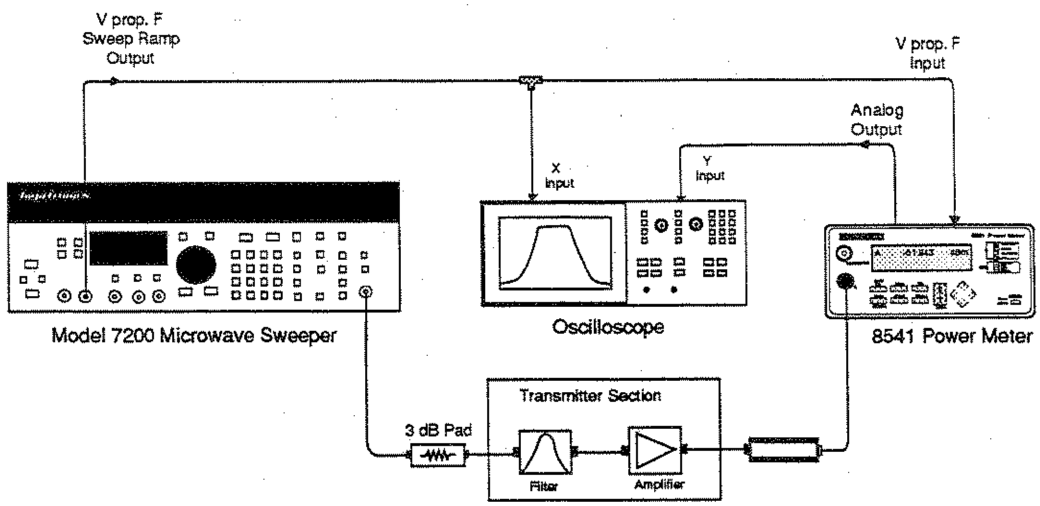


Figure 17. Swept Frequency Testing of a Microwave Transmitter.

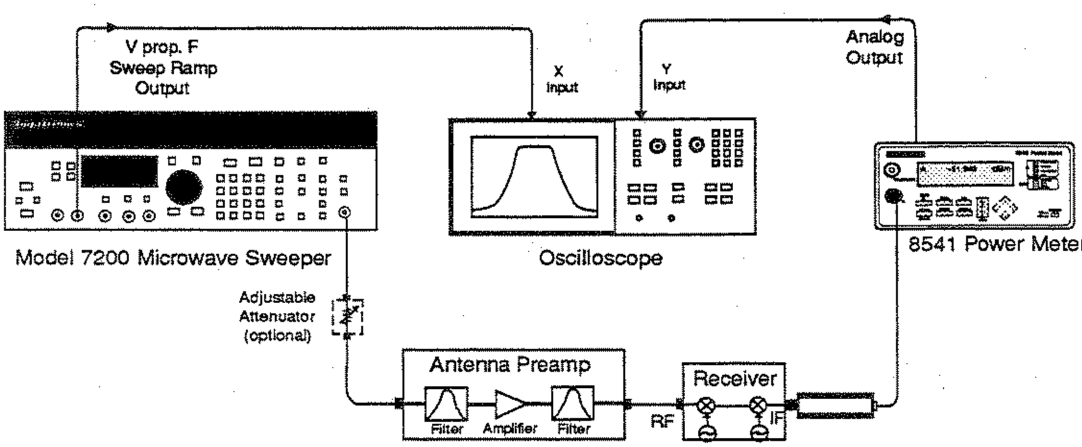


Figure 18. Swept Frequency Testing of a Receiving System.

Transmitter / Receiver Swept Frequency Measurements

1. Connect Sweeper, Power Meter, and Display (Oscilloscope) as shown in either Figure 17 (for a Transmitter) or Figure 18 (for a Receiver).

2. Select *ANALOG OUT SETUP* under the *SETUP MENU* to configure Analog Output operation.

3. Adjust the Y oscilloscope channel for 1 Volt / Div and set the ground level to the bottom line on the oscilloscope display.

4. Set the source output power and configure the frequency sweep range.

5. Adjust the X oscilloscope channel for a scale appropriate for your source's V prop. F output range.

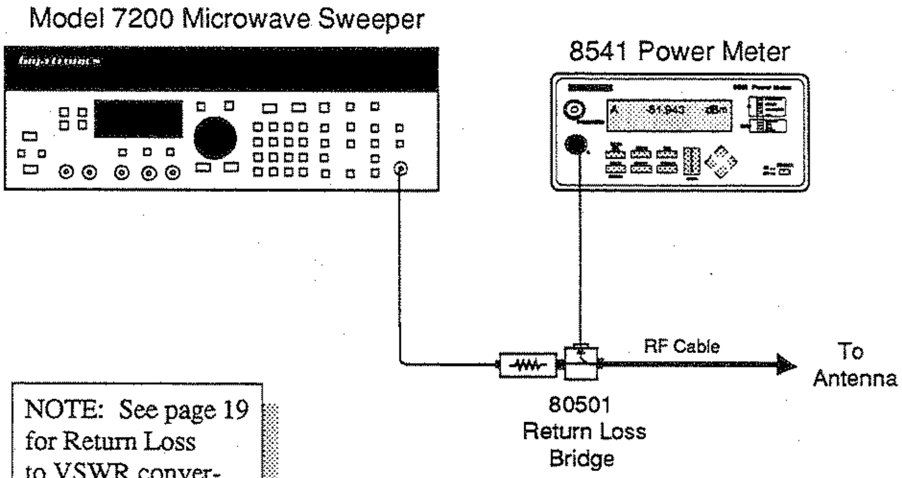
6. Adjust the oscilloscope persistence (or use a digital oscilloscope) as needed to display the horizontal sweep.

Gain Measurement

Transmitter gain can be displayed using the dual channel 8542 Power Meter. The power splitter should be placed after the 3 dB pad shown in Figure 17. Configuring the 8542 for A/B operation allows the Analog Output to operate as a voltage proportional to gain (A/B) indicator.

Measuring Antenna Return Loss

A Return Loss Bridge is used to measure the reflected power. Several Precision Return Loss Bridges are available for use with the 8540 Series Power Meters.



NOTE: See page 19 for Return Loss to VSWR conversion formulas.

Figure 19. Measuring Return Loss.

1. Connect the Power Meter and Return Loss Bridge as shown in Figure 19 above.
2. Turn on the source output power.
3. Disconnect the DUT (at the Antenna Cable) and perform the bridge calibration specified for your return loss bridge. For Return Loss Bridges with N connectors, press **REL**.
4. Reconnect the DUT.

The power meter is now displaying Return Loss.

Antenna Gain Measurement

Antenna Gain Measurements for production or field maintenance purposes are completed quickly and inexpensively with the 8540 Series Power Meters.

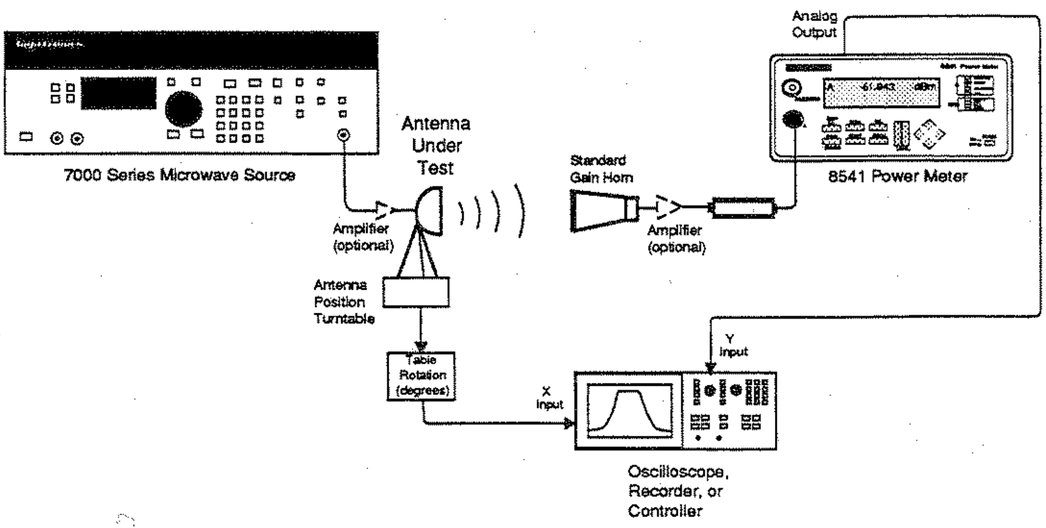


Figure 20. Antenna Gain Measurement

1. Connect as shown above.

2. Adjust the microwave source to a high output level. An external amplifier is recommended.

3. Rotate the antenna and record the antenna gain data.

Adjustments and go/no go are completed quickly and accurately. A full sweep can be completed in only a few seconds for a 70 dB dynamic range measurement. Dwelling at antenna nulls may require slower rotation or stepped rotation when the power sensor is in the lower 20 dB of its dynamic range.

Appendix A
Sensor Selection

Giga-tronics has a wide range of sensors designed for accurately measuring CW or Pulsed signals. The frequency range covers 10 MHz to 40 GHz, and the power range is from -70 to +30 dBm depending on the sensor selected. Special purpose sensors aid specific measurements as described below.

True RMS CW Sensors (80330 Series)

These sensors should be used to measure the output power whenever the measured power level is greater than -20 dBm and harmonics or multi-tone signals (>1 frequency simultaneously) are present. For example, use the True RMS Sensors when making compression or saturation measurements on an amplifier. When driven into compression the amplifier output will be rich in odd-order harmonics which must be measured using the True RMS reading sensor for readings that will be in agreement with those made on CW power meters using thermocouple sensors.

The True RMS sensor power range is +20 dBm to -30 dBm, the same as for typical thermocouple sensors. This special sensor uses a diode element in combination with an integral 40 dB attenuator to ensure all measured signals are in the true RMS section of the diode's response, (where the effect of harmonics will be the same as if using a thermocouple sensor).

The 50 dB dynamic range of these sensors makes them ideal for low and medium gain amplifiers (gain <40 dB). For high gain amplifiers, the High Power or Standard Sensors are recommended for gain measurements in the "small-signal" region of the amplifier's response.

If it is desired to eliminate the effects of harmonics when making compression measurements instead of just having readings that agree with a CW power meter, then for any type of sensing element (diode or thermocouple) it will be necessary to insert an appropriate filter, such that only the fundamental signal level is measured.

Giga-tronics True RMS sensors have the additional advantage of excellent input VSWR, (<1.15:1 to 18 GHz), due to the improvement in Return Loss obtained by placing a 40 dB attenuator ahead of the diode element. Maximum input power is 2 W (the limit of the integral attenuator). The Cal Factors stored in the sensor EEPROM include the response of the attenuator.

High Power CW Sensors (80320 Series)

Select these sensors when the incident power level will be higher than +20 dBm. The High Power Sensors can measure power levels up to +47 dBm (50W) without damage. High Power Sensors improve measurement accuracy by incorporating the frequency response of the high power attenuator into the sensor's EEPROM.

When used on the output side of a transmitter or other amplifier these sensors should be used with a harmonic filter since the diode element will be operating outside of its true RMS response region.

Peak Power Sensors (80350A Series)

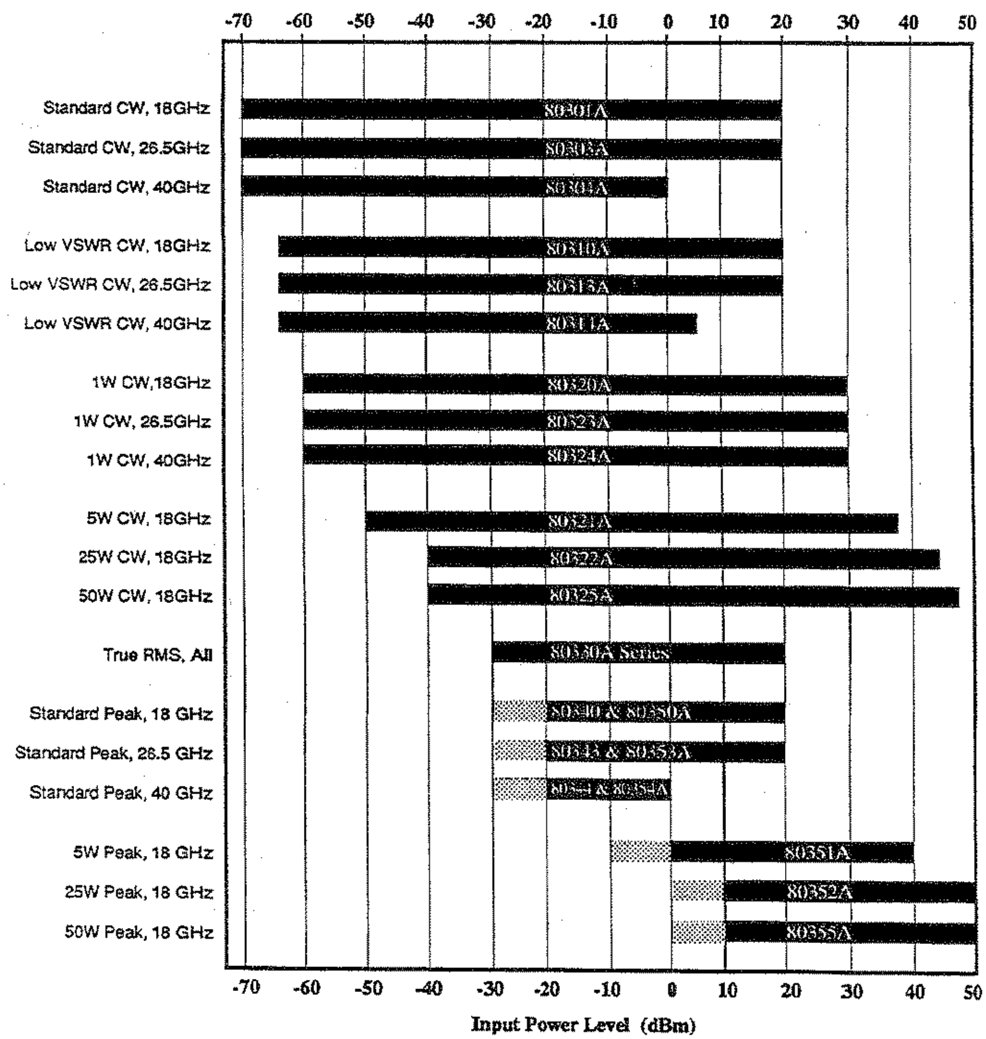
Peak Power Sensors are essential for accurate measurement of pulsed signals. Now, the accuracy of directly sampled peak power measurement techniques is fully compatible with the 8540 Universal Power Meters - you won't need expensive peak power meters.

The 80350A Series Peak Power Sensors have a real time "Detector Out" to clearly identify pulse shape on your oscilloscope; a small marker identifies the location of the sample point. Both Internal (dBm) and External (V) triggering circuits have adjustable levels and selectable Trigger-to-Sample Delay settings from 0.0 ns to 100 ms - over 8 decade ranges - with 0.5 ns resolution. The Sequential Sampling Timebase ensures highly repeatable and pulse-to-pulse sample position stability. Timing synchronization and external oscilloscope triggering control is provided by a "Sample Delay" output which rises at the trigger point and falls at the sample point.

5W, 25W, and 50W high power versions test your high power signals more accurately and more conveniently. Attenuator frequency response is corrected automatically; the calibrated data is added to sensor Cal Factors and programmed into the sensor's internal EEPROM to enhance test throughput and accuracy.

The older 80340 Series Peak Power (Triggerable Pulse) Sensors are also compatible with the 8540 Series Universal Power Meters; these sensors should only be considered when high GPIB measurement speed or compatibility with the 8003 Precision Scalar Analyzer is required.

Appendix B
Giga-tronics Sensor Dynamic Range



Lightly shaded areas show the CW operating ranges of the Peak Power Sensors.

NOTE: The menus have a convenient memory effect. The BASE Menu returns to the same selection it displayed prior to menu exit allowing rapid instrument configuration during local operation.

* Use up/down arrow keys to show menu choices. Select by pressing **ENTER.**

Press MENU Key

- OFFSET (xx.xxx dB, A, B)
- RESOLUTION (xxx.xx, Top, Bot)
- AVERAGE (Auto, 2,4,8,16,32,.....,512)
- USER CAL FACTOR (x.xx)
- PEAKING METER (Status, Pk A, Pk B)
- REF POWER ON/OFF (On, Off)
- A, B, A/B, ..., OFF (Top Line, Bottom Line)
- **SETUP MENU** → Press ENTER Key
  - SAVE SETUP (Registers 1 - 20)
  - PEAK SNSR SETUP (Int, Ext, CW)
  - MIN/MAX SETUP (Top Line, Bottom Line)
  - LIMITS SETUP (Top, Bot; On, Off; Level)
  - dB / mW SETUP (Top, Bot; Log, Lin)
  - REL SETUP (Top, Bot, On, Off)
  - GPIB SETUP (Mode, Address)
  - ANALOG OUT SETUP (Top, Bot; Log, Lin)
  - V prop F SETUP (On, Off; Start V; V/GHz)
  - SOUND SETUP (On, Off)
- **SERVICE MENU** → Press ENTER Key
  - SENSOR ROM [S/N, Cal Factors, (dB)
  - CALIBRATOR (xx dBm; Calibration)
  - TEST FUNCTIONS (Select Test)
  - SOFTWARE VERSION (Date, version)
  - CLEAR ALL MEMORY (Yes, No)

8540 Series Digital Power Meter Menu Tree

GIGA-TRONICS WORLD WIDE SALES & SERVICE

Domestic Representatives

Northwest Test & Measurement
Bellevue, WA.
Phone: (206) 881-8857
Fax: (206) 867-0742

Ward/Davis Assoc.
Santa Clara, CA.
Phone: (408) 245-3700
Fax: (408) 738-3995

Micro Concepts
Mclean, VA.
Phone: (703) 893-8108
Fax: (703) 893-7267

Technical Marketing Specialists
Phoenix, AZ.
Phone: (602) 678-4940
Fax: (602) 678-4943

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Minneapolis, MN.
Phone: (612) 835-2414
Fax: (612) 835-5470

RG Associates
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Phone: (612) 471-8309
Fax: (612) 471-8765

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Maryland Heights, MO.
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Fax: (314) 739-1405

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Fax: (214) 490-0836

Jack Howard Assoc.
San Antonio, TX.
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Fax: (512) 828-3207

WKM Assoc. Inc.
Dayton, OH.
Phone: (513) 434-7500
Fax: (513) 434-6590

Test-Rep Associates, Inc.
Littleton, MA.
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Fax: (508) 534-0486

Southern Marketing Assoc.
Longwood, FL.
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Fax: (407) 682-7443

Northern Technical Sales
Liverpool, NY.
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Fax: (315) 451-6980

Scientific Devices - East
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Phone: (201) 440-3430
Fax: (201) 440-4474

Eastern Instrument. of PA
Southampton, PA.
Phone: (215) 355-7700
Fax: (215) 355-3469

Creative Marketing Assoc.
Columbia, MD.
Phone: (301) 880-4161
Fax: (301) 725-5088

International Representatives

Australia
Scientific Devices Australia Pty
Phone: 61-3-579-3622
Fax: 61-3-579-0971

Belgium
Air Parts Electronics
Phone: 32-2-241-6460
Fax: 32-2-241-8130

Canada (Quebec)
Interfax Systems
Phone: (514) 336-0392
Fax: (514) 336-9607

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Corad Technology Ltd.
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Fax: 011-852-793-0606

Denmark
Crimp A/S
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Fax: 45-4227-0611

England
Sematron (UK) Ltd.
Phone: 44-734-819970
Fax: 44-734-819786

France
Elexience
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Fax: 33-1-60-119809

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PC Electronic GMBH
Phone: 49-6047-6949
Fax: 49-6047-6408

Holland
Air Parts Int'l B.V.
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Fax: 31-1720-20651

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Fax: 91-22-837-6719

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Fax: 972-3-544-1468

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Fax: 39-2-4840-1852

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Fax: 82-2-271-2764

Saudi Arabia Kingdom
A. Rajab & Silsilah & Co.
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Fax: 966-2-6610558

South Africa
PNI Electronics
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Fax: 34-1-766-227-73

Sweden
Farner Elecktronik AB
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Isatel Electronics AG
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Evergo Corp.
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