Giga-tronics

Technical Publication Change Instruction

Updated replacement pages and/or drawings are attached to these Change Instructions. Please remove and discard the corresponding pages and/or drawings, and replace them with the attached pages and/or drawings. Failure to make these replacements may result in loss of product efficiency and possible failure.

Page numbers with an alpha suffix denote pages that have been changed. Specific changes are identified by change bars in corresponding margins. A replacement page with no suffix has not been changed but is included only because it is part of the changed page. Replacement pages will become standard pages without a suffix in the next printing of this manual.

For record purposes, you are encouraged to retain these change instructions as a permanent part of the manual.

Product:	Series 8540C Universal Power Meters Operation & Maintenance Manual		
Errata Date:	November 22, 2000/(July 18, 2001 Amended)		
Manual P/N:	**Manual Revision**	**Print Date**	**Change Instruction Number (CIN)**
30280	J	September 2000	30280-J1 (formerly 8540C-J001)

Update your product technical manual, please replace the page(s) indicated below:

PCN	Rev.	CIN	Current Page(s)	Replacement Page(s)	Remark(s)
7604	J	8540C-J001	i thru ii	ia thru iia	Table of Contents updated.
			vii thru viii	viia thru viiia	Table of Contents updated.
			2-23a thru 2-24a	2-23b thru 2-24b	Correction to subsection 2.6.4.1 "Low Level Performance Check". Subsection 2.6.7.1 "Calibration and Zeroing for High Power Sensors with Removable Attenuators" added to 2.6.7 "High Power Level Measurements".

Table of Contents

3

Remote Operation

B

Power Sensors

C

Options

Index

List of Figures

2.6 Measurement Guide

This section of the manual presents simple guidelines for practical application of the 8540C. See Section 2.6.10 for mode restrictions.

2.6.1 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-traceable at 50 MHz, 0 dBm to an accuracy of ±0.7% (±1.2% over one year).

☛ ***NOTE:*** *NIST is the National Institute of Standards and Technology.*

2.6.2 806XX Sensor Operation

The Series 806XX power sensors are designed for the precise measurement of signals with wide modulation bandwidths (up to 1.5 MHz). In terms of the various measurement modes (i.e., MAP, BAP, etc), the 806XX sensors are operated exactly as the Series 804XX sensors described in Section B.1.

There is one distinction regarding the operation of the 806XX sensors. Below 200 MHz, the modulation bandwidth of the sensor is limited by a filter which is electronically switched in the sensor. This is done to keep the RF signal out of the base band signal processing circuitry. When a 806XX sensor is calibrated on the meter for the first time (the meter reads UNCALIBRATED before calibration), the unit is set to the default setting of MAP mode with frequency correction set to 1 GHz. This allows the sensor to measure signals with wide-bandwidth modulation. For frequencies of 200 MHz or below, the frequency correction must be set to the measurement frequency to avoid measurement error.

The Series 806XX sensors are compatible with the 8541C and 8542C and later configurations.

2.6.3 Sensor Calibration

The procedure for calibrating a sensor is:

1. Connect the power sensor to the 8540C power meter with the power sensor cable.
2. Connect the power sensor to the 8540C CALIBRATOR output.
3. Press ZERO/CAL.

The 8540C will automatically verify that a sensor is attached to the CALIBRATOR connector. It will then zero and calibrate the sensor.

Refer also to the Power Sensor Calibration Procedures in Appendix B of this manual.

2.6.4 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 (that is, for readings below -55 dBm, in the case of 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.

2. Press the ZERO/CAL key to start the zeroing process. 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 EMF.

☛ ***NOTE:*** *Sufficient time must be allowed for the module to reach thermal equilibrium with the source. This could be up to 15 minutes for moderate initial temperature differences.*

CAUTION

Sensor diodes can be destroyed by momentary or continuous exposure to excess input power. The maximum power (peak or average) that can be applied to the detector elements without resulting damage is printed on the side of the sensor housing. For standard CW sensors, and peak power sensors, this maximum level is +23 dBm (200 mW). Standard sensors should not be used above +20 dBm (100 mW), because this may degrade the sensor's performance even if it does not burn out the diodes.

When measuring pulsed signals, it is important to remember that the peak power may be much greater than the average power (it depends upon the duty cycle). It is possible to overload the sensor with a pulsed signal, even though the *average* power of the signal is far below the maximum level.

To measure higher power levels, use a high power sensor, or else reduce the signal amplitude using a directional coupler or a precision attenuator.

2.6.4.1 Low Level Performance Check

This procedure provides a quick-check list for evaluating meter/sensor performance for low-level measurements. It is not intended to verify performance of specifications such as Noise, Temperature Coefficient and Zero Set. For complete verification, please refer to sections one and five in the power meter operation manual.

1. This test is meant to check the low level performance of the meter and sensor. In order to do so, the meter and sensor should first be separated from any external amplifiers, test systems, etc. Turn the meter on and allow stabilization at ambient for a minimum of 30 minutes. Connect the sensor cable to the meter and the sensor to the calibrator output port.

2. **Calibration.** Calibrate the power meter by pressing the Zero/Cal button.

☛ ***NOTE:*** *During calibration an approximate zero is established for calibration purposes only. This zero is not valid for actual measurements and can limit the measurement range as high as -50 dBm. For proper low-level measurements, the sensor must be zeroed at the test port of the system being tested. Zeroing at the test port provides corrections for ground line voltages and connector interface EMF.*

3. **Zeroing.** Validation of meter and sensor noise floor will be checked using an attenuator or termination. Connect the attenuator or termination to the sensor and allow the unit to stabilize for 3 minutes. The sensor must be thermally stabilized for proper zeroing. If the thermal condition of the sensor varies during the zero procedure, the zero will not be valid.

4. Set averaging to 512 and configure for CW operation. After the unit has thermally stabilized, push the Cal/Zero button.

5. Immediately after zeroing, confirm that the meter reading is at least 3 dB below the minimum CW operating range of the sensor. This checks the noise floor and zero set capabilities of the meter and sensor.

6. **Zero Drift.** Zero Drift is a measure of the change in noise over time. Each family sensor will have a specified expectation of drift over a one-hour period. To confirm, set the meter to linear display (Watts) after verifying noise floor and check that the display does not drift beyond specification over a one-hour period.

Verification for specifications such as noise, zero drift and temperature coefficient of linearity are difficult, time consuming tests. This checklist is useful to quickly determine if there is a catastrophic system failure. Failure to meet the above guidelines is not necessarily an indication of specification failure. Final confirmation of system specification performance is achieved using the verification procedures found in the meter operation manual.

2.6.5 Measuring Source Output Power

The procedure is:

1. Connect the power sensor to the RF output of the microwave source.

2. Verify that the microwave source RF output is ON.

3. Press [**FREQ**]; enter the operating frequency (use the cursor keys to adjust the value), and press [*OK*].

4. The 8540C will now display the microwave source output power. Adjust the source amplitude to the desired level.

The 8540C responds rapidly to amplitude changes. Ranging is automatically performed in real time through a 90 dB dynamic range using CW or modulated sensors. The peak sensor dynamic range is 40 dB Peak and 50 dB CW. Entering the operating frequency enables the 8540C to automatically apply frequency calibration factors appropriate to the sensor being used. The operating frequency can be communicated to the 8540C using the front panel menus, the GPIB, or the $V_{PROP}F$ voltage input. (The input connector for the $V_{PROP}F$ function is labeled V α F In on the 8540C rear panel.)

2.6.6 Using the Peaking Meter

The LEDs on the right side of the 8540C front panel can be configured as a 20-segment bar graph.

1. Press [MENU]. Select the Config menu. Select Peaking meter.
2. Use the cursor to select PkA or PkB, and press [ENTER].
3. Adjust the source's amplitude control and observe the peaking meter.

The LED bar graph provides a linear display of power level on a decade range basis. For example, a power level of 3 dBm produces an approximate 50% response on the peaking meter.

2.6.7 High Power Level Measurements

High power amplifiers and transmitters can damage standard sensors. Use only high power sensors to measure these devices without using attenuators and measurements.

For example, if the output of an RF source is amplified to +30 dBm (1 Watt), this signal cannot be measured directly using a standard sensor because the sensor's maximum input level is +23 dBm (and any level above +20 dBm is potentially harmful to a standard sensor). The signal would have to be attenuated, and the attenuation would have to be corrected for by means of a measurement offset. However, if a 5 Watt high power sensor is used, any power level up to +37 dBm can be measured directly without the use of an attenuator.

2.6.7.1 Calibration and Zeroing for High Power Sensors with Removable Attenuators

High power sensors must be calibrated to the power meter with the attenuator removed. The power meter automatically recognizes the sensor type and compensates for the attenuator. Do not enter an offset factor to account for the attenuator loss.

The sensor frequency calibration factors correct for the combined frequency response for the sensor and attenuator. Because the sensor and attenuator are a matched set, the serial numbers of the sensor and attenuator are identical. Do not use attenuators from other high power sensors.

1. Remove the high power attenuator from the sensor.
2. Connect the sensor to be calibrated from Channel A or B to the Calibrator Output.
3. Press the **[CAL/ZERO]** hardkey. The meter will automatically zero and calibrate the sensor.
4. Reconnect the high power attenuator to the sensor.

☛ ***NOTE:*** *There are alignment marks (arrows) on the sensor and attenuator. To reduce measurement uncertainty, align the arrows when reconnecting the attenuator to the sensor.*

2.6.8 Modulated Measurement Modes

The 8540C series of power meters expands upon the capabilities of the previous 8540 power meters in a number of ways. In the past, power measurements of modulated signals (pulse, multi-tone, AM, etc.) required that the signals be attenuated to levels less than -20 dBm to avoid errors due to sensor nonlinearity. The 8540C with a 80401A series sensor, eliminates this restriction, and brings the speed and accuracy of diode sensors to the power measurement of modulated signals. Basic measurement procedures are presented below, along with some useful tips on how to get the most out of the modulated measurement modes.

The new modulated measurement modes are available through the sensor setup menu when the active sensor a modulated series. The 8540C features three modulated measurement modes:

- Modulated Average Power (MAP)
- Pulse Average Power (PAP)
- Burst Average Power (BAP)

MAP and PAP modes measure the true average power of modulated and pulsed signals. PAP mode differs from MAP mode only in that it allows you to specify a duty cycle figure, which is automatically factored into the measurement. In BAP mode, the true average power within the pulse is measured (the pulse pattern is detected automatically, so there is no need for you to specify the duty cycle).

MAP Mode

The Modulated Average Power (MAP) mode measures RF signals, which are amplitude modulated, pulse modulated, or both. In the MAP mode the 8540C calculates the average RF power received by the sensor over a period of time controlled by the time constant of the internal digital filter. The result is comparable to measurement by a thermal power sensor.

In this mode, the 8540C measures the average power of CW and modulated signals, such as:

- AM
- Two-tone
- Multi-carrier
- Pulse modulation
- Digital modulation (QPSK, QAM, etc...)

For example, if an RF signal pulse modulated at 50 Hz with a 10% duty cycle is measured with the averaging factor set to 128, the filter setting time will be 5.12 seconds (40 ms times 128) and each reading will include 256 pules (50 Hz times 5.12 seconds); the measured power reading will be 10% of the peak power during pulse ON periods. Because the signal is modulated at a low pulse rate (below about 1 kHz), the 8540C will synchronize the readings precisely with the start of a pulse so that each displayed reading is averaged over a whole number of pulses (that is, there are no fractional pulses included in the measurement). This eliminates a significant amount of noise from the readings. It is important to remember that even though the filter settling time has been set to a long time constant of 5.12 seconds, the update rate of the meter will be much faster, and even the first reading will be very close to the fully settled value.

PAP Mode

The Pulse Average Power (PAP) mode is similar to the MAP mode, but it measures pulse-modulated signals having a known duty cycle. You can specify this duty cycle and the 8540C will automatically correct the measurements so that the displayed readings indicate the peak RF power during pulse ON periods.

For example, when measuring a pulse modulated signal with 50% duty cycle, MAP mode would give a reading 3 dB lower than the reading that would be given by PAP mode with the duty cycle factor set to 50%.

☛ ***NOTE:*** *The duty cycle correction presumes a perfectly rectangular profile for the RF pulse shape. Any abnormality such as overshoot, undershoot, slow rise time or fall time, inaccuracy of the duty cycle, or deviation from a flat pulse response will cause errors in the indicated reading.*

BAP Mode

The Burst Average Power (BAP) mode measures the average power during an RF burst. This mode is very useful for measurement of pulse modulated signals which are not flat or have amplitude modulation during the pulse ON period, as in the case of TDMA (Time Division Multiple Access) communications signals. In this mode, the 8540C recognizes the beginning and end of a burst of RF power and takes an average of the power during that burst. The RF level can vary over a wide range during the burst as long as it remains above a noise threshold, which is automatically calculated by the 8540C. As soon as the RF power drops below the noise threshold, the RF burst is complete and all further readings are discarded until the next burst starts.

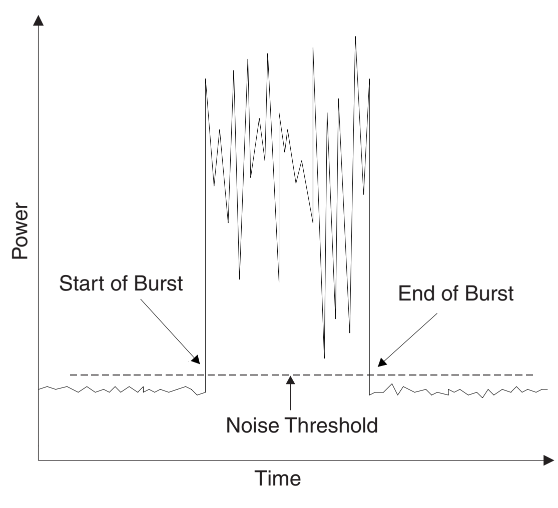

Figure 2-3: Burst Measurement

In BAP mode, the 8540C automatically determines which portions of the signal are in the pulse and which are not. In computing the average power, the 8540C uses only those portions that are within the pulse. The result is that, independent of the signal's pulse duty cycle, the meter always reads the average power in the pulse or burst. As with the PAP mode, when measuring a pulse modulated signal with 50% duty cycle, the reading in the BAP mode would be 3 dB higher than in the MAP mode. However, in the BAP mode, the signal's duty cycle can change dynamically in time without affecting the meter reading. In the PAP mode, the duty cycle factor must be entered to match the duty cycle of the pulsed signal.