Table 3-18: Error Code Returned in Position aa

Error Code	Message	Notes
00	All OK	
50	Entered Cal Factor out of range	Enter value between 1.0% and 150.0%
51	Entered Offset out of range	Enter value between -99.999 dB and +99.999 dB
53	Entered average number out of range	Enter valid average number
54	Entered recall memory number out of range	Enter valid recall memory number between 0 and 20
55	Entered store memory number out of range	Enter valid store memory number between 1 and 20
60	Unable to set requested measurement mode or sensor measurement because sensor A is unattached or uncalibrated	This may be due to receipt of a MAP, PAP, BAP, DC1 or DY command
61	Same as Error 60 above, but for sensor B	
62	Unable to set up sensor A to perform a modulated measurement (MAP, PAP, or BAP), because the sensor is not a modulated sensor. OR: Unable to modify a BAP measurement because the sensor is not a modulated sensor	This may be set due to receipt of a MAP, BAP, DC1, DY, BSTE, BSPE or BTDP command
63	Same as Error 62, but for sensor B	
67	Unable to activate Peak Hold or Crest Factor features	This may be set due to receipt of a CR1 or PH1 command. Peak Hold and Crest Factor can be enabled only in MAP, PAP or BAP modes
68	Unable to initiate fast measurement collection mode	Verify using modulation sensor and measurement mode selections
70	Entered peak sensor A data error	Check entered data
71	Entered peak sensor B data error	Check entered data
72	Entered peak sensor A delay out of range	Check entered delay
73	Entered peak sensor B delay out of range	Check entered delay
74	Entered peak sensor A trigger out of range	Check entered trigger value
75	Entered peak sensor B trigger out of range	Check entered trigger value
76	Sensor EEPROM data entry has error	Check entry data
77	Sensor A does not exist	Check sensor A. This error code refers only to the EEPROM command
78	Sensor B does not exist	Check sensor B. This error code refers only to the EEPROM command
79	Measurement settling target for auto-average mode is out of range	Value must be 0.10% to 100.00%
81	Duty cycle out of range	Value must be between 0.001% and 99.999%
82	Frequency value out of range	Value must be between 0 Hz and 100 GHz
85	Resolution value out of range	Value must be between 0 and 3
90	GPIB data parameter error	Check, then enter with valid prefix
91	Invalid GPIB code	Check, then enter with correct code

Table 3-19: Other Codes in the Status Message

<table>
<tr><th>Position</th><th>Significance</th><th colspan="2">Codes</th></tr>
<tr><td>BB</td><td>Operating Mode</td><td colspan="2">00 = Sensor A 08 = Cal A
01 = Sensor B 09 = Cal B
02 = A/B 10 = Ext Cal A
03 = B/A 11 = Ext Cal B
04 = A-B 20 = Peak A delay
05 = B-A 21 = Peak B delay
06 = Zeroing A
07 = Zeroing B</td></tr>
<tr><td>CC & cc</td><td>Sensor A range & Sensor B range</td><td>Manual Range:
01 = 1
02 = 2
03 = 3
04 = 4
05 = 5</td><td>Auto Range:
11 = 1
12 = 2
13 = 3
14 = 4
15 = 5</td></tr>
<tr><td>DD & dd</td><td>Sensor A filter & Sensor B filter</td><td>Manual Filter:
00 = 0
01 = 1
02 = 2
03 = 3
04 = 4
05 = 5
06 = 6
07 = 7
08 = 8
09 = 9</td><td>Auto Filter:
10 = 0
11 = 1
12 = 2
13 = 3
14 = 4
15 = 5
16 = 6
17 = 7
18 = 8
19 = 9</td></tr>
<tr><td>E</td><td>Measurement Units</td><td colspan="2">0 = Watts, 1 = dBm</td></tr>
<tr><td>F</td><td>Active Entry Channel</td><td colspan="2">A = A, B = B</td></tr>
<tr><td>G</td><td>Calibrator Output Status</td><td colspan="2">0 = Off, 1 = On</td></tr>
<tr><td>H</td><td>REL Mode Status</td><td colspan="2">0 = Off, 1 = On</td></tr>
<tr><td>I</td><td>Trigger Mode</td><td colspan="2">0 = Freerun, 1 = Hold</td></tr>
<tr><td>J</td><td>Group Trigger Mode</td><td colspan="2">0 = GT0, 1 = GT1, 2 = GT2</td></tr>
<tr><td>K</td><td>Limits Checking Status</td><td colspan="2">0 = Disabled, 1 = Enabled</td></tr>
<tr><td>L</td><td>Limits Status</td><td colspan="2" rowspan="2">0 = In limits
1 = Over high limit
2 = Under low limit</td></tr>
<tr><td>M</td><td>NA</td></tr>
<tr><td>N</td><td>Offset Status</td><td colspan="2">0 = Off, 1 = On</td></tr>
<tr><td>O</td><td>Duty Cycle</td><td colspan="2">0 = Off, 1 = On</td></tr>
<tr><td>P</td><td>Measurement Units</td><td colspan="2">0 = Watts, 1 = dBm, 2 = %, 3 = dB</td></tr>
</table>

3.19.14 Setup

These commands allow recalling stored configuration setups and to query the setups.

3.19.14.1 Query a Stored Setup

This command queries a setup configuration, where *n* is the stored setup ID# (1 to 20). Its response is used in conjunction with its set form. This command is used in conjunction with SETUP *n* to **download** setup raw data from the 8650A.

Syntax:	SETUP? *n* EN	
Example:	OUTPUT 713;SETUP? 12 EN	! QUERIES SETUP FROM ADDRESS 12

☛ ***NOTE:*** *The data returned from the SETUP? Command can exceed 1030 bytes. Variables should be dimensioned to accommodate the large string size.*

3.19.14.2 Store a Setup

This command loads a stored setup configuration by address number. The number (*n*) is 1 to 20, and <data> is raw setup data. This command is used in conjunction with SETUP? to **upload** setup raw data to the 8650A.

Syntax:	SETUP *n*<data>	
	n = 1 to 20 and <data> is raw setup data	
Example:	OUTPUT 713;SETUP 7<DATA>	! STORES A SETUP TO ID# 7 OR ! LOADS (SETUP) DATA TO SETUP ID# 7

3.19.15 Store & Recall

The instrument's current configuration can be saved in a register for later recall.

3.19.15.1 Saving a Configuration

The commands for saving the instrument state are based on the ST function code:

Syntax:	ST [r] EN	
	ST is the Save function code [r] identifies the register in which the instrument's configuration is to be saved (and from which it can later be retrieved). The value of [r] can be any number from 1 through 20 A terminating suffix (EN) is required	
Example:	OUTPUT 713;ST12EN	! SAVES THE CURRENT INSTRUMENT CONFIGURATION IN REGISTER 12

☛ ***NOTE:*** *Register 0 contains the previous state of the instrument; to recover from an accidental preset, recall the configuration from that register.*

3.19.15.2 Retrieving a Configuration

The commands for recalling a configuration from a register are based on the RC function code:

Syntax:	RC [*r*] EN	
	RC is the Recall function code [*r*] identifies the register in which the instrument's prior configuration has been saved and from which it is now to be retrieved. The value of [*r*] can be any number from 0 through 20 A terminating suffix (EN) is required	
Example:	OUTPUT 713;RC3EN	! RECALL THE CONFIGURATION THAT WAS SAVED IN REGISTER 3
Example 2:	OUTPUT 713;RC0EN	! RECALL THE PRIOR CONFIGURATION (THIS COMMAND RECOVERS ! FROM CONFIGURATION ERRORS)

3.19.16 Units

☛ ***NOTE:*** *These commands must be preceded by CH [n] EN command.*

Logarithmic or linear measurement units are specified by simple commands consisting of the function codes LG and LN.

Syntax:	LG or LN	
Example:	OUTPUT 713;LG	! SETS LOG UNITS (DB OR DBM)
Example 2:	OUTPUT 713;LN	! SETS LINEAR UNITS (WATTS OR %)

These commands affect all types of measurements, except for the fast measurement collection modes. These modes always return measurement readings in dBm.

3.19.17 $V_{PROP}F$ Feature

The $V_{PROP}F$ feature (Voltage Proportional to Frequency) provides a means of indicating to the 8650A the approximate frequency of the signal that it is measuring, so that the appropriate cal factor can be applied. The frequency is indicated by means of a variable voltage input. The 8650A reads the voltage as an expression of frequency, and applies the proper cal factor from the table stored in the sensor EEPROM (interpolating for frequencies that fall between the stored values).

In order for the 8650A to interpret the input voltage input correctly, it is necessary to specify the starting point (that is, the frequency at zero volts) and the slope (the rate at which voltage increases with frequency).

3.19.17.1 Enabling & Disabling $V_{PROP}F$

Commands related to the $V_{PROP}F$ function are based on the function code $V_{PROP}F$. The command format, for purposes of activating or deactivating the $V_{PROP}F$ feature, is as follows:

Syntax:	VPROPF [A or B] STATE [ON | OFF]	
	[A or B] specifies Sensor A or Sensor B STATE indicates that the $V_{PROP}F$ feature is being enabled or disabled [ON | OFF] enable or disable the $V_{PROP}F$ function	
Example:	OUTPUT 713;VPROPF A STATE ON	! ENABLES $V_{PROP}F$ FOR SENSOR A
Example 2:	OUTPUT 713;VPROPF B STATE OFF!	! DISABLES $V_{PROP}F$ FOR SENSOR B

3.19.17.2 Configuring $V_{PROP}F$

The command format, for purposes of configuring the $V_{PROP}F$ feature, is as follows:

Syntax:	VPROPF [A or B] MODE [f] [s]	
	[A or B] specifies Sensor A and Sensor B MODE indicates that the $V_{PROP}F$ feature is being configured (that is, the start frequency and slope are being specified) [f] indicates the start frequency (the frequency at zero volts), expressed in Hz. The start frequency must be less than the upper frequency limit of the sensor [s] indicates the slope of the $V_{PROP}F$ (the ratio of input voltage to input frequency), expressed in V/Hz. The value must be between 1E-12 and 1E-8	
Example:	OUTPUT 713;VPROPF A MODE 2.00E9 1.00E-9	! CONFIGURES THE $V_{PROP}F$ FEATURE FOR SENSOR A ! AS FOLLOWS: ! 2.00 GHZ START FREQUENCY ! 1.00 VOLT PER GHZ SLOPE

3.19.18 Zeroing

The commands used for zeroing of a sensor are based on the function code ZE. The command format is:

Syntax:	[AE or BE] ZE	
	[AE or BE] prefix specifies Sensor A or Sensor B	
Example:	OUTPUT 713;AE ZE	! ZEROS SENSOR A
Example 2:	OUTPUT 713;BE ZE	! ZEROS SENSOR B

☛ ***NOTE:*** *If the sensor is attached to an RF source, the source must be turned off prior to zeroing. Zeroing before calibration is not necessary; zeroing of the sensor is part of the sensor calibration process.*

The following is an example of how to zero a sensor with the GPIB program. The service request feature determines when the zero has completed; this results in the quickest zeroing routine.

```
Zero:                               ! zero routine
ON INTR 7 GOSUB Srq_interrupt       ! setup serial poll interrupt jump location
ENABLE INTR 7;2                     ! enable SRQ interrupts
OUTPUT 713;*SRE010                  ! set service request mask to 2
     OUTPUT 713;CS                  ! clear status byte
     OUTPUT 713;ZE                  ! start zero
Flag=0                              ! reset control flag
WHILE Flag=0                        ! wait while zeroing
END WHILE
RETURN
Srq_interrupt:                      ! SRQ interrupts jump here
OUTPUT 713;*STB?
ENTER 713;State
IF BIT(State, 1) THEN
     PRINT GOOD ZERO
     ELSE
         IF BIT(State, 3) THEN
               PRINT BAD ZERO
               ENDIF
ENDIF
OUTPUT 713;CS                       ! clear status byte
Flag=1                              ! set control flag true
RETURN
```

3.19.19 Histograms, CDF & CCDF

☛ ***NOTE:*** *These commands must be preceded by CH [n] EN command.*

These commands set up displays in graphical format for analyzing power measurements over a period of time. The displays are divided into Histograms, Cumulative Distribution Functions (CDF) and Complementary CDF, which are automatic functions of Histograms and displayed by pressing ***[Select Mode]*** from the respective menus.

3.19.19.1 Setting Histogram Mode Intervals

This command set the histogram interval. A value of 0 indicates no limits.

Syntax:	HIST INTERVAL *n* (*n* = 0 to 356400 seconds)	
Example:	OUTPUT 713;HIST INTERVAL 60	! SETS THE HISTOGRAM INTERVAL TO 60 SECONDS

3.19.19.2 Histogram Range

This command sets the histogram range, where M is minimum and N is maximum. If the histogram format is dBm, the range value is dBm; if the histogram format is linear, the range value is linear.

Syntax:	HIST RANGE M	
Example:	OUTPUT 713;HIST -20 -10	! SETS THE HISTOGRAM RANGE FROM -20 TO -10 DBM

3.19.19.3 Enabling & Disabling Histograms HIST

This command sets up or exits the histogram mode. Histograms can only be activated from normal measurement mode. Selecting sensor A or B or measurement line 1, 2, 3 or 4 depends on what was last set. If sensor was last selected, then the histogram will show the sensor level data. If the measurement line was last selected, the histogram will show the measurement line data.

Syntax:	[AE or BE] HIST [ON | OFF]	
Example:	OUTPUT 713; AE HIST ON	! FOR SENSOR A, TURN ON THE HISTOGRAM ! DISPLAY (OR CDF OR CCDF IF EITHER WAS ! LAST DISPLAYED)
Example 2:	OUTPUT 713;HIST OFF	! TURNS OFF THE HISTOGRAM FUNCTION, ALSO THE CDF ! AND CCDF

3.19.19.4 Histogram Query

This command queries the current Histogram.

Syntax:	HIST?	
Example:	OUTPUT 713;HIST?	! QUERIES THE CURRENT HISTOGRAM DATA
Example 2:	ENTER 713;HIST	! READS RESPONSE INTO VARIABLE HIST

Data response received from 8650A via GPIB is approx. 48K bytes in the format: -77.00, Value; -76.95, Value; ... 22.95, Value where Value is in scientific notation with 1.00 E00 = 100%. i.e., starts at -77 dBm incrementing by .05 dBm up to 22.95 dBm.

3.19.20 Strip Chart

The Strip Chart function allows viewing the varying power levels of a signal over a period of time.

3.19.20.1 Strip Pause/Resume

This command pauses and resumes the collection of strip chart data. There is no strip chart activation command.

Syntax:	STRIP [PAUSE or RESUME]	
Example:	OUTPUT 713;STRIP PAUSE	! PAUSES STRIP CHART DATA COLLECTION
Example 2:	OUTPUT 713;STRIP RESUME	! RESUMES STRIP CHART DATA COLLECTION

3.19.20.2 Strip Chart Query

This command queries the strip chart data.

Syntax:	STRIP?	
Example:	OUTPUT 713;STRIP?	! QUERIES THE STRIP CHART DATA
Example 2:	OUTPUT 713;STRIP	! READS RESPONSE INTO VARIABLE STRIP

Data response received from 8650A via GPIB is 200 readings in scientific notation using approximately 2.4K bytes.

3.19.21 Statistics

The Statistics feature enables computation of mean and standard deviation over a period of time.

3.19.21.1 Statistics Enable/Disable

☛ ***NOTE:*** *These commands must be preceded by CH [n] EN command.*

This command enables or disables the statistic function. The active GPIB measurement line is used as the input and display. Statistic can display only if active the GPIB measurement line is not showing a secondary measurement.

Syntax:	STAT ON/OFF	
Example:	OUTPUT 713;STAT ON	! ENABLES THE STATISTIC FUNCTION

3.19.21.2 Statistics Query

This command queries statistics data of the current active GPIB measurement line. Error measurement is returned if statistic is not active.

Syntax:	STAT?	
Example:	OUTPUT 713;STAT?	! QUERIES THE DATA IN THE STATISTIC FUNCTION

3.19.22 SCPI

This command modifies the active GPIB command set to SCPI from native (8600). Query from is not available for this command.

Syntax:	SCPI	
Example:	OUTPUT 713;SCPI	! SETS THE ACTIVE GPIB COMMAND SET TO SCPI MODE

4

Performance Verification

4.1 Introduction

This chapter defines procedures for performance verification of the Series 8650A Universal Power Meters. Refer to Appendix B of this publication for power sensor selection and calibration.

4.2 Equipment Required

Table 4-1 lists the equipment required for performance verification of the Series 8650A Power Meters.

Table 4-1: Required Equipment List

Description	Representative Model	Key Characteristics
CW Thermistor Power Meter	HP 432A	V_{RF} and V_{COMP} available externally
Thermistor Mount	HP 478A-H75	≤1.07 VSWR @ 50 MHz (30 dB return loss) Accuracy ±0.5% @ 50 MHz
Digital Voltmeter (DVM)	HP 34401A	±0.05% accuracy & 1 μV resolution
Directional Coupler, 10 dB	Mini Circuits ZFDC-10-1 10 dB	≤1.15 SWR @ 50 MHz
Step Attenuator, 0 to 90 dB in 10 dB increments	Weinschel Model AC 118A-90-33	≤1.15 SWR @ 50 MHz ±0.1 dB attenuation
RF Source (Signal Generator) (High Power)	Wavetek Model 2405 Option XP	+22 dBm @ 50 MHz
Low Pass Filter	Integrated Microwave Model 904 881	> 30 dB attenuation @ 100 MHz
GPIB Controller for IBM PC	AT-GPIB/TNT	With driver software
Frequency Counter	B+K Precision 1856B	≥1.5 GHz, 50 ppm, ≥6 digit resolution

4.3 Calibrator Verification Procedure

If any of the instrument performance characteristics are not within specifications, refer the problem to Giga-tronics Customer Service.

4.3.1 Calibrator Output Power Reference Level

This test determines if the Calibrator Output Power Reference Level given in this section is valid for an ambient temperature range between +5° C and +35° C (+41° F to +95° F).

The Calibrator Output power reference is factory adjusted to 1 mW ±0.7%. To achieve this accuracy, Giga-tronics uses a precision measurement system with accuracy to ±0.5% (traceable to the NIST - formerly the NBS), and allows for a transfer error of ±0.2% for a total of ±0.7%. If an equivalent measurement system is used for verification, the power reference oscillator output can be verified to 1 mW ±1.9% (±1.2% accuracy, ±0.5% verification system error, ±0.2% transfer error, for a maximum error of ±1.9%). To ensure maximum accuracy in verifying the Calibrator Output power reference, the following procedure provides step-by-step instructions for using specified test instruments of known capability. If equivalent test instruments are substituted, refer to the Key Characteristics section in Table 4-1.

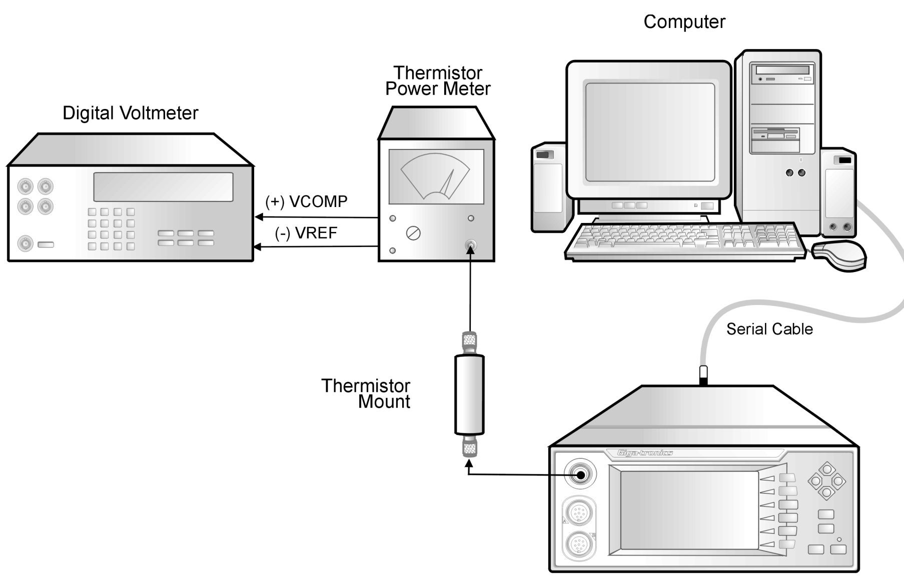


Figure 4-1: Calibrator Output Test Setup

4.3.1.1 Procedure

In the following steps, thermistor power measurements will be made using the 432A Power Meter. For detailed information on using the 432A, please refer to the operating section on the 432A manual.

1. Turn on the 8650A and the associated test equipment.
2. After 15 minutes, turn the 8650A's power OFF and ON. This establishes the 1mW reference for the instrument firmware.

3. Connect the Thermistor Mount to the 8650A Calibrator output "N" type connector as show in Figure 4-1. Allow a 15 minute thermal equilibrium period between the Thermistor and Calibrator connector to minimize temperature differences.

4. Set the 432A RANGE switch to COARSE ZERO, and adjust the front panel COARSE ZERO control to obtain a zero (±2% F.S.) meter indication.

☛ ***NOTE**: Ensure that the DVM input leads are isolated from chassis ground when performing the next step.*

5. Set the DVM to a range that results in a resolution of 1 μV and connect the positive and negative input, respectively, to the V_{COMP} and V_{RF} connectors on the rear panel of the 432A.

6. Fine zero the 432A on the most sensitive range, then set the 432A range switch to 1 mW.

7. Record the DVM indication as V_0.

8. Turn ON the 8650A Calibrator RF power as follows:

   Press *[Meter Setup] [Calibrator] [Frequency]*, set to 50.0 MHz, press *[ON]* then *[OK]*.
   Record the reading shown on the DVM as V_1.

☛ ***NOTE**: The V^1 reading must be taken within 15 seconds after pressing [OK]. Otherwise, turn the Calibrator OFF and repeat steps 7 and 8.*

9. Disconnect the DVM negative lead from the V_{RF} connector on the 432A, and reconnect it to the 432A chassis ground. Record the new indication observed on the DVM as V_{COMP}.

10. Repeat Step 7, except select OFF to turn the Calibrator off.

11. Calculate the Calibrator Output level (P_{CAL}) using the following formula:

$$P_{CAL}(Watts) = \frac{2V_{COMP}(V_1 - V_0) + V_0^2 - V_1^2}{4R\ (Calibration\ Factor)}$$

   where:

   P_{CAL} = calibrator output power reference level
   V_{COMP}= previously recorded value in Step 8
   V_1= previously recorded value in Step 7
   V_0= previously recorded value in Step 6
   R= 200Ω (assuming HP478A-H75 mount)

   Calibration factor = value for the thermistor mount at 50 MHz (traceable to the NIST)

12. Verify that the P_{CAL} is within the following limits:

   1 mW ±0.019 mW (0.981 to 1.019 mW)

   For record purposes, the measured value of P_{CAL} can be entered on the Performance Verification Test Data Sheet on page 4-9.

13. For Option 12, set the calibrator frequency to 1.000 GHz as in step 8 and repeat steps 9 through 12.

4.3.2 Calibrator Frequency Check

To measure the frequency of the calibrator:

1. Connect the frequency counter to the calibrator output connector.
2. Turn ON the calibrator according to the procedure given in Procedure Step 8 on the previous page.
3. Measure 49 to 51 MHz.
4. Set the calibrator frequency to 1.000 GHz (with Option 12 only).
5. Measure 999.5 MHz to 1.0005 GHz (with Option 12 only).
6. Turn the calibrator OFF.

4.4 Performance Verification Tests

Information in this section is useful for periodic evaluation of the 8650A and its power sensors. These tests can also be used for incoming inspection testing when the instrument is first received, if required.

If the 8650A has not previously been used, review the precautions in Section 1.2.1 of the publication before the instrument is turned on. Prior to starting the following procedures, the instrument should be allowed to warm up for at least 24 hours to assure maximum stability during testing.

The instrument plus power sensor linearity test is valid when the sensor has been calibrated using the front panel calibrator at a temperature between 0° C and +50° C (+32° F to +122° F), and if operating within ±5°C (±9° F) of that calibration temperature.

It is recommended that the verification be done in the order described since some of the steps use the configuration from a previous step.

4.4.1 Equipment Required

See Table 4-1 for a list of the equipment required for performance testing of the 8650A power meters.

The Performance Verification Test Data Sheet located on page 4-9 through 4-10 can be copied for recording test results each time performance verification testing is performed on the specific instrument described by this publication.

4.4.2 Instrument Plus Power Sensor Linearity

4.4.2.1 Test Description

Connect the test setup as shown in Figure 4-2. The linearity will be tested over the range +20 dBm to -60 dBm. At low power levels, the linearity measurement will include the uncertainty due to the zero set specification. The procedure should be repeated for each sensor used with the 8650A.

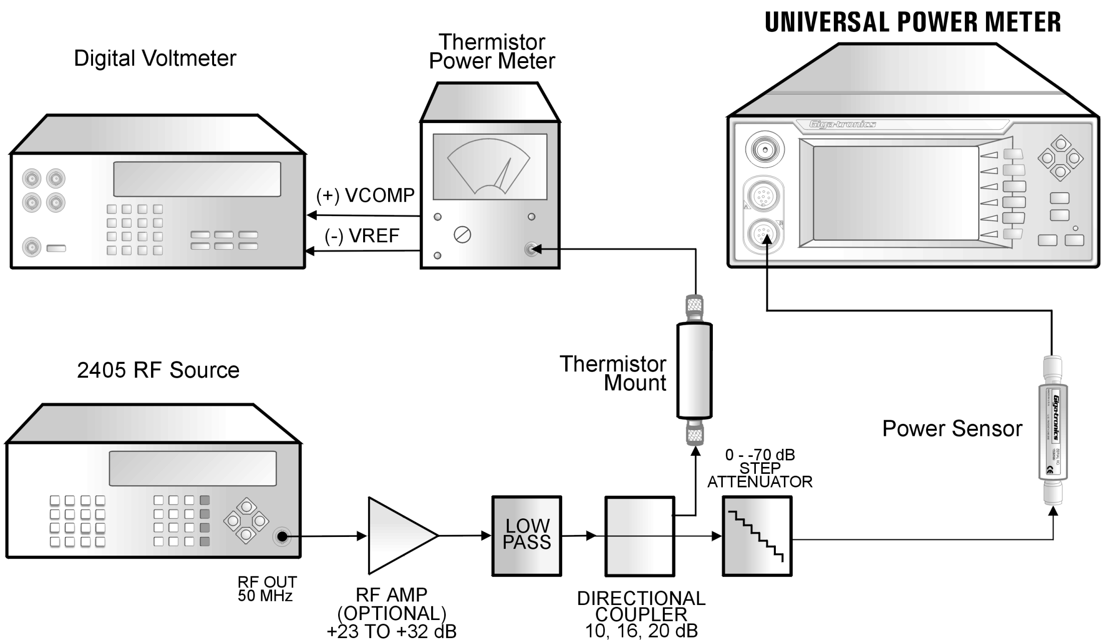


Figure 4-2: Power Linearity Test Setup

When measuring the linearity of a high power sensor, the power output of the source as well as the directional coupler coupling factor, must be increased. The power coefficient of the step attenuator will also have to be considered. The specification of power coefficient for the Weinschel attenuator cited in the Equipment List is: <0.005 dB/dB/W. The latter will affect the linearity of each 10 dB segment, and make it necessary to expand the overall linearity specification by this quantity.

In assembling the test setup shown in Figure 4-2, keep in mind that if testing is to be conducted with Low VSWR or High Power sensors, the optional RF Amplifier must have frequency and bandwidth parameters to match the sensor's characteristics (See the Sensor Selection Guide in Chapter 1, if unsure of characteristics), and the Directional Coupler must be increased as stated above for the particular series of sensors. All Standard (Series 8030XA) and True RMS (Series 8033XA) sensors are tested with a 10 dB Directional Coupler and without the optional RF amplifier.

Refer to the Linearity Data recording section of the Performance Verification Data Sheets on pages 4-9 through 4-10. The tolerance is already entered for the various steps, and includes an allowance for specified zero set errors at low power levels.

☛ ***NOTE:*** *To ensure accurate and repeatable measurements, the 432A power meter should be zeroed just before taking each reading that will be used to calculate P1 in the Power Meter column of the Performance Verification Test Data Sheet on pages 4-9 through 4-10.*

4.4.2.2 Setup Parameters

The following setup parameters should be accomplished prior to performing the Power Linearity test:

1. The 8650A and sensor should be calibrated (See Section 2.4.3. Refer also to the complete instructions on how to calibrate the sensor in Appendix B of this publication).
2. The Averaging is set to AUTO by entering the key sequence (See Figure D-2 to D-3):

   [Sensor Setup] select Sensor A or B *[Avg]* set the number of Periods *[Averages] [Auto]*

4.4.2.3 Test Procedure

Extreme care is required in the following procedure since the accuracy requirements are critical to ensure the most accurate test results.

Power readings are determined using the thermistor power meter in the same general way as given in the Power Reference Level test. That is, P1 and P2 north Power Meter reading column of the Performance Verification Test Data Sheet tables are calculated each time for the respective values of V_{COMP}, V_0, and V_1 read on the DVM.

1. Set the step attenuator to 70 dB. Turn the source power output off, and then zero the 8650A.

   (The 8650A is zeroed by pressing **[CAL/ZERO]** and then following the softkey label instructions.)
2. Set the step attenuator to 0 dB after the 8650A has zeroed.
3. Set the power output of the RF source so that the thermistor power meter indicates 1.00 mW ±0.025 mV.
4. Record the calculated power meter reading and the displayed 8650A reading in the correct columns of the Linearity Data recording sheet on page 4-9.
5. Set the power output of the RF source so that the thermistor power meter indicates 3.98 mW ±0.10 mW.
6. Record the new calculated power meter reading and the new displayed 8650A reading as in Step 4 above.
7. Set the power output of the RF Source so that the thermistor power meter indicates 5.01 mW ±0.13 mW.
8. Record the new calculated power meter reading and the new displayed 8650A reading as in Step 4 above.
9. Repeat using the power meter indications in the Performance Verification Data Sheet on page 4-10. Note that the Step Attenuator is used to generate the remaining 70 dB range of 10 dB steps for a total range of 80 dB. Repeat Step 1, above, between each 10 dB step shown on the Linearity Data Recording sheet.
10. Make the calculations indicated on the Linearity Data sheet, and enter the values in the appropriate blank spaces.

4.4.3 GPIB Port Check

The following steps confirm that the GPIB port is functional:

1. Set the 8650A to the desired address (the default is 13; see Section 2.3.2 for instructions on how to set the GPIB mode and address).

2. Connect the GPIB controller to the GPIB Port on the rear of the 8650A.

3. Send the command (if emulating an HP 438):

   *IDN? or ?ID

   (*IDN? is the IEEE 488.2 Common ID query. When addressed to talk after receiving the command, the 8650A will output a string that identifies itself as 8651A or 8652A.)

4. Display the response on the controller.

This completes the performance verification test for the 8650A Universal Power Meters and its sensors. If the instrument has performed as described in this chapter, it is correctly calibrated and within specifications.

SERIES 8650A UNIVERSAL POWER METERS Performance Verification Test Data Sheet (Page 1 of 2)	
Date:	
Operator:	
Test Number (If Required):	
Series 8650A S/N:	
Power Sensor S/N:	

Calibrator Output Power Reference		
Minimum	**Actual Reading**	**Maximum**
0.981 mW		1.019 mW

Linearity Data - (+16 dBm to +20 dBm)

Step Attenuator Value	Power Set Point	Power Meter Reading (P)	8650A (DUT) Reading (R)	Reference Power Ratio	8650A (DUT) Reading Ratio	Linearity Error (%)[1]	
						Linearity Specification	Accumulated Linearity Error[2]
0 dB	1.00 mW ±0.025 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	3.98 mW ±0.10 mW	P2 =	R2 =			±1%	Same as Lin. error above
0 dB	3.98 mW ±0.10 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	5.01 mW ±0.13 mW	P2 =	R2 =			+1% -1.6%	
0 dB	5.01 mW ±0.13 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	6.31 mW ±0.16 mW	P2 =	R2 =			+1% -2.7%	
0 dB	6.31 mW ±0.16 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	7.94 mW ±0.2 mW	P2 =	R2 =			+1% -3.8%	
0 dB	7.94 mW ±0.2 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	10 mW ±0.25 mW	P2 =	R2 =			+1% -4.9%	
(continued)							

-60 dBm to +16 dBm Linearity Data are on the next page.

NOTES:

1. Linearity Error (%) = [(R1/R2) / (P1/P2) - 1] x 100
2. Accumulated error is the sum of the current dB segment linearity error plus the previous accumulated error.

SERIES 8650A UNIVERSAL POWER METERS

Performance Verification Test Data Sheet (Page 2 of 2)

Linearity Data - (-60 dBm to +16 dBm)

Step Attenuator Value	Power Set Point	Power Meter Reading (P)	8650A (DUT) Reading (R)	Reference Power Ratio	8650A (DUT) Reading Ratio	Linearity Error (%)[1]	
						Linearity Specification	Accumulated Linearity Error[2]
0 dB						See Note 3	
						±1%	Same as Lin. error above
10 dB	1.00 mW ±0.025 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	10.00 mW ±0.25 mW	P2 =	R2 =			±1%	
20 dB	1.00 mW ±0.025 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	10.00 mW ±0.25 mW	P2 =	R2 =			±1%	
30 dB	1.00 mW ±0.025 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	10.00 mW ±0.25 mW	P2 =	R2 =			±1%	
40 dB	1.00 mW ±0.025 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	10.00 mW ±0.25 mW	P2 =	R2 =			±1%	
50 dB	1.00 mW ±0.025 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	10.00 mW ±0.25 mW	P2 =	R2 =			±1%	
60 dB	1.00 mW ±0.025 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	10.00 mW ±0.25 mW	P2 =	R2 =			±1.5%	
70 dB	1.00 mW ±0.025 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	10.00 mW ±0.25 mW	P2 =	R2 =			±6%	

NOTES:

1. Linearity Error (%) = [(R1/R2) / (P1/P2) - 1] x 100
2. Accumulated error is the sum of the current dB segment linearity error plus the previous accumulated error.
3. Use the first CW Linearity error value entered in the +16 dBm to +20 dBm Linearity Data on page 4-9.

A

Typical Applications Programs

A.1 Introduction

This section provides examples of programs for controlling the Series 8650A remotely over the GPIB.

A.2 Continuous Data Reading

```
        OUTPUT 713;TR3                   ! set freerun mode
Main:
        ENTER 713;Reading                ! make reading
        PRINT Reading
        GO TO MAIN
```

A.3 Remote Calibration of a Sensor

```
        OUTPUT 713;PR                    ! preset the instrument to a known state
        CH 1 EN                          ! selects line 1 for subsequent settings
        OUTPUT 713;LG                    ! set Log units (dB or dBm)
        OUTPUT 713;AP                    ! Measure sensor A
Main:                                    ! start of measurement loop
        OUTPUT 713;TR2                   ! Trigger full measurement with settling
        ENTER 713;Reading                ! Read the data over the bus into variable N
        PRINT Reading
        GO TO Main
Calibrate                                ! calibration routine
        ON INTR 7 GOSUB Srq_interrupt    ! setup serial poll interrupt jump location
        ENABLE INTR 7;2                  ! enable SRQ interrupts
        OUTPUT 713;*SRE002               ! set service request mask to 2
        OUTPUT 713;CS                    ! clear status byte
        OUTPUT 713;CLEN                  ! start calibration
        Flag=0                           ! reset control flag
        WHILE Flag=0                     ! wait while calibrating
        END WHILE
        RETURN
        Srq_interrupt:                   ! SRQ interrupts jump here
        IF BIT(State, 1) THEN
            PRINT GOOD CAL
            ELSE
                  IF BIT(State, #) THEN
                  PRINT BAD CAL
                  ENDIF
        ENDIF
        OUTPUT 713;CS                    ! clear status byte
            Flag=1                       ! set control flag true
            RETURN
```

A.4 Speed Tests: Normal & Swift

```
CSUB    PROG 494 RE-STORE WSPEED
11      ! SPEED TESTS FOR THE GIGA-TRONICS 8652A
12      ! 7/15/02
20      Giga-tronics=713
30      DIM A(100) ,B(100)
31      OUTPUT Giga-tronics;PR LG OC1
32      OUTPUT Giga-tronics;AE FM0 EN
34      OUTPUT Giga-tronics;DU GIGA-TRONICS 8652A SPEED TESTS
35      WAIT 1
36      OUTPUT Giga-tronics;DU UN-PLUG B SENSOR
37      PRINT
40      PRINT GIGA-TRONICS 8652A SPEED TESTS
60      PRINT CONNECT A SENSOR ONLY. NO B SENSOR
61      PRINT PRESS RETURN WHEN READY
70      INPUT A$
71      OUTPUT Giga-tronics;DE
80      !
90      PRINT
100     PRINT NORMAL TR3 TRIGGER MODE SINGLE CHANNEL
110     GOSUB Timeloop1
111     !
112     PRINT
113     PRINT NORMAL TR2 TRIGGER MODE SINGLE CHANNEL
114     GOSUB Timeloop4
120     !
130     OUTPUT Giga-tronics;SWIFT FREERUN
140     WAIT 1
150     PRINT
160     PRINT SWIFT MODE SINGLE CHANNEL
170     GOSUB Timeloop2
180     OUTPUT Giga-tronics;SWIFT OFF
181     !
190     PRINT
200     PRINT END OF SINGLE CHANNEL MODE
210     PRINT CONNECT B SENSOR FOR NEXT SET OF TESTS
211     PRINT PRESS RETURN WHEN READY
212     OUTPUT Giga-tronics;DU CONNECT B SENSOR
220     INPUT A$
221     OUTPUT Giga-tronics;DE
223     !
230     PRINT
240     PRINT NORMAL TR3 TRIGGER MODE TWO CHANNELS
250     GOSUB Timeloop3
251     !
260     PRINT
270     PRINT SWIFT MODE DUAL CHANNEL
280     OUTPUT Giga-tronics;SWIFT FREERUN
290     WAIT 1
300     GOSUB Timeloop2
310     PRINT
320     OUTPUT Giga-tronics;SWIFT OFF
330     PRINT END OF TESTS
```

```
340     STOP
350     !
360     Timeloop1:! SINGLE CHANNEL MEASUREMENTS
370         T1=TIMEDATE
380         FOR I=1 TO 100
390         ENTER Giga-tronics;A(I)
400     !   PRINT A(I)
410         NEXT I
420         T2=TIMEDATE
430         PRINT 100/(T2-T1);PER SECOND
440     !   FOR I=1 TO 100
450     !   PRINT A(I)
460     !   NEXT I
        [continued...]
470     !   PRINT
480         RETURN
490     !
500     Timeloop2:! TWO CHANNELS IN SWIFT MODE
510         T1=TIMEDATE
520         FOR I=1 TO 100
530         ENTER Giga-tronics;A(I),B(I)
540         NEXT I
550         T2=TIMEDATE
560         PRINT 100/(T2-T1);PER SECOND FOR BOTH CHANNELS
570         RETURN
580     !
590     Timeloop3:!
600         T1=TIMEDATE
610         FOR I=1 TO 100
620         OUTPUT Giga-tronics;AP
630         ENTER Giga-tronics;A(I)
640         OUTPUT Giga-tronics;BP
650         ENTER Giga-tronics;B(I)
660         NEXT I
670         T2=TIMEDATE
680         PRINT 100/(T2-T1);PER SECOND BOTH CHANNELS
690         OUTPUT Giga-tronics;AP
700         RETURN
701     !
702     Timeloop4:!
703         T1=TIMEDATE
704         FOR I=1 TO 100
705         OUTPUT Giga-tronics;TR2
706         ENTER Giga-tronics;A(I)
709         NEXT I
710         T2=TIMEDATE
711         PRINT 100/(T2-T1);PER SECOND SINGLE CHANNEL
712         OUTPUT Giga-tronics;TR3
713         RETURN
714         END
```

A.5 Swift Demo 1: FREERUN

```
10    ! RE-STORE SWIFT
20    !
30    ! DEMO PROGRAM FOR 8650A SWIFT MODE
40    !
50    ! 7/15/02
60    !
70    Giga-tronics=713
80    N=100
90    OPTION BASE 1
110       REAL Nums(100)
120       OUTPUT Giga-tronics;PR LG
130       OUTPUT Giga-tronics;SWIFT FREERUN
140       WAIT .5
145       WINDOW 1 ,N,-70,20
150   Mainloop
151       FOR I=1 TO N
170       ENTER Giga-tronics;Nums(I)
180       NEXT I
190       GCLEAR
200       PEN 2
210       GRID 10,10
220       PEN 1
230       MOVE 1 ,Nums(I)
240       FOR I=1 TO N
250           DRAW I ,Nums (I)
260       NEXT I
270   GOTO Mainloop
280       OUTPUT Giga-tronics;SWIFT OFF
300       END
```

A.6 Swift Demo 2: GET

```
10      ! RE-STORE SWIFT
20      ! DEMO PROGRAM FOR 8650A SWIFT MODE
40      !
50      ! 7/15/02
60      !
70      Giga-tronics=713
80      N=100
90          OPTION BASE 1
110         REAL Nums(100)
120         OUTPUT Giga-tronics;PR LG
130         OUTPUT Giga-tronics;SWIFT GET;N
140         WAIT .5
145         WINDOW 1,N-70,20
150     Mainloop
151         FOR I=1 TO N
160         TRIGGER Giga-tronics
161         NEXT I
170         ENTER Giga-tronics;Nums(*)
190         GCLEAR
200         PEN 2
210         GRID 10,10
220         PEN 1
230         MOVE 1,Nums(1)
240         FOR I=1 TO N
250         DRAW I,Nums(I)
260         NEXT I
270     GOTO Mainloop
280         OUTPUT Giga-tronics;SWIFT OFF
300     END
```

A.7 Fast Buffered Demo: POST GET

```
10    ! RE-STORE FAST BUFFERED
20    !
30    ! DEMO PROGRAM FOR 8650A FAST BUFFERED MODE
40    !
50    ! 7/15/02
60    !
70    Giga-tronics=713
80    N=100
90    OPTION BASE 1
110       REAL Nums(100)
120       OUTPUT Giga-tronics;PR LG
130       OUTPUT Giga-tronics;FBUF POST GET BUFFER;N
140       WAIT .5
145       WINDOW 1,N,-70,20
150   Mainloop
152       Wait .05
160       TRIGGER Giga-tronics
170       ENTER Giga-tronics;Nums(*)
190       GCLEAR
200       PEN 2
210       GRID 10,10
220       PEN 1
230       MOVE 1,Nums(1)
240       FOR I=1 TO N
250           DRAW I,Nums(I)
260       NEXT I
270   GOTO Mainloop
280       OUTPUT Giga-tronics;FBUF OFF
300       END
```

A.7.1 Fast Buffered Demo: POST TTL

```
10      ! RE-STORE FAST BUFFERED
20      !
30      ! DEMO PROGRAM FOR 8650A FAST BUFFERED MODE WITH TTL TRIGGER
40      !
50      ! 7/15/02
60      !
70      Giga-tronics=713
80      N=200
90      OPTION BASE 1
110         REAL Nums(200)
120         OUTPUT Giga-tronics;PR LG
130         OUTPUT Giga-tronics;FBUF POST TTL BUFFER;N
140         WAIT .5
145         WINDOW 1,N,-70,20
150     Mainloop
170         ENTER Giga-tronics;Nums(*)! waits here until TTL trigger happens
190         GCLEAR
200         PEN 2
210         GRID N/10,10
220         PEN 1
230         MOVE 1,Nums(1)
240         FOR I=1 TO N
250             DRAW I,Nums(I)
260         NEXT I
270     GOTO Mainloop
300     END
```

B

Power Sensors

B.1 Introduction

This appendix contains the selection, specifications and calibration data for the Giga-tronics power sensors used with the Series 8650A Universal Power Meters. This appendix is divided into the following sections:

- Power Sensor Selection
- Modulated Sensor Specifications
- Peak Power Sensor Selection
- Directional Bridges
- Remote Calibration of Sensors

All Giga-tronics power sensors contain balanced zero-biased Schottky diodes for power sensing.

CAUTION

Input power in excess of +23 dBm (200 mW, which is the 100% average for standard and pulse sensors) can degrade or destroy these diodes. Diodes degraded or destroyed in this manner will not be replaced under warranty. Destructive signal levels are higher for high power, true rms, and low VSWR sensors. When connecting power sensors to other devices, do not turn the body of the sensor in order to tighten the RF connection. This can damage the connector mating surfaces.

B.2 Power Sensor Selection

Standard sensors include the 80300A series for CW signals, the 80350A series for Peak or CW power, the 80400A, 80600A and 80700A series for modulated and CW signals, the 80500 series CW Return Loss Bridges, and the 80330A series True RMS sensors.

Giga-tronics True RMS sensors are recommended for applications such as measuring quadrature modulated signals, multi-tone receiver intermodulation distortion power, noise power, or the compression power of an amplifier. These sensors include a pad to attenuate the signal to the RMS region of the diode's response. This corresponds to the -70 dBm to -20 dBm linear operating region of Standard CW Sensors. The pad improves the input VSWR to ≤1.15 at 18 GHz.

High Power (1, 5, 25 and 50 Watt) and Low VSWR sensors are also available for use with the 8650A Power Meters. Table B-1 lists the Giga-tronics power sensors used with the 8650A. Refer to applicable notes on page B-6. See Figures B-1 or B-2 for modulation-induced measurement uncertainty.

B.2.1 Power Sensor Selection Charts

Table B-1: Power Sensor Selection Guide

CW Power Sensors								
Model	**Freq. Range/ Power Range**	**Max. Power**	**Power Linearity4** (Freq > 8 GHz)	**RF Conn**	**Length**	**Dia.**	**Wgt.**	**VSWR**
200 mW Peak Power Sensors								
80301A	10 MHz to 18 GHz -70 to +20 dBm	+23 dBm (200 mW)	-70 to -20 dBm ±0.00 dB -20 to +20 dBm ±0.05 dB/10 dB	Type N(m) 50Ω	114.5 mm (4.5 in)	32 mm (1.25 in)	0.18 kg (0.4 lb)	1.12:0.01 - 2 GHz 1.22:2 - 12.4 GHz 1.29:12.4 - 18 GHz
80302A	10 MHz to 18 GHz -70 to +20 dBm	+23 dBm (200 mW)	-70 to -20 dBm ±0.00 dB -20 to +20 dBm ±0.05 dB/10 dB	APC-7 50Ω				
80303A	10 MHz to 26.5 GHz -70 to +20 dBm	+23 dBm (200 mW)	-70 to +20 dBm ±0.00 dB -20 to +20 dBm ±0.1 dB/10dB	Type K(m)[1] 50Ω	114.5 mm (4.5 in)	32 mm (1.25 in)	0.18 kg (0.4 lb)	1.12:0.01 - 2 GHz 1.22:2 - 12.4 GHz 1.38:12.4 - 18 GHz 1.43:18 - 26.5 GHz 1.92:26.5 - 40 GHz
80304A	10 MHz to 40 GHz -70 to 0 dBm	+23 dBm (200 mW)	-70 to -20 dBm ±0.00 dB -20 to 0 dBm ±0.2 dB/10 dB					
Low VSWR CW Power Sensors								
80310A	10 MHz to 18 GHz -64 to +26 dBm	+29 dBm (800 mW)	-64 to -14 dBm ±0.00 dB -14 to + 26 dBm ±0.05 dB/10 dB	Type K(m)[1] 50Ω	127mm (5.0 in)	32 mm (1.25 in)	0.23 kg (0.5lb)	1.13:0.01 - 2 GHz 1.15:2 - 12 GHz 1.23:12 - 18 GHz 1.29:18 - 26.5 GHz 1.50:26.5 - 40 GHz
80313A	10 MHz to 26.5 GHz -64 to +26 dBm	+29 dBm (800 mW)	-64 to -14 dBm ±0.00 dB -14 to + 26 dBm ±0.1 dB/10 dB					
80314A	10 MHz to 40 GHz -64 to +6 dBm	+29 dBm (800 mW)	-64 to -14 dBm ±0.00 dB -14 to + 6 dBm ±0.2 dB/10 dB					
1W CW Power Sensors								
80320A	10 MHz to 18 GHz -60 to +30 dBm	+30 dBm (1 W)	-60 to -10 dBm ±0.00 dB -10 to +30 dBm ±0.05 dB/10 dB	Type K(m)[1] 50Ω	127 mm (5.0 in)	32 mm (1.25 in)	0.23 kg (0.5 lb)	1.11:0.01 - 2 GHz 1.12:2 - 12 GHz 1.18:12 - 18 GHz 1.22:18 - 26.5 GHz 1.36:26.5 - 40 GHz
80323A	10 MHz to 26.5 GHz -60 to +30 dBm	+30 dBm (1 W)	-60 to -10 dBm ±0.00 dB -10 to +30 dBm ±0.1 dB/10 dB					
80324A	10 MHz to 40 GHz -60 to +10 dBm	+30 dBm (1 W)	-60 to -10 dBm ±0.00 dB -10 to +10 dBm ±0.2 dB/10 dB					
5W CW Sensor[2]								
80321A	10 MHz to 18 GHz -50 to +37 dBm	+37 dBm (5 W)	-50 to +0 dBm ±0.00 dB 0 to +37 dBm ±0.05 dB/10 dB	Type N(m) 50Ω	150 mm (5.9 in)	32 mm (1.25 in)	0.23 kg (0.5 lb)	1.20:0.01 - 2 GHz 1.25:6 - 12.4 GHz 1.35:12.4 - 18 GHz
25W CW Sensor[3]								
80322A	10 MHz to 18 GHz -40 to +44 dBm	+44 dBm (25 W)	-40 to +10 dBm ±0.00 dB +10 to +44 dBm ±0.05 dB/10 dB	Type N(m) 50Ω	230 mm (9.0 in)	104 mm (4.1 in)	0.3 kg (0.6 lb)	1.20:0.01 - 2 GHz 1.30:6 - 12.4 GHz 1.40:12.4 - 18 GHz
50W CW Sensor[3]								
80325A	10 MHz to 18 GHz -40 to +47 dBm	+47 dBm (50 W)	-40 to +10 dBm ±0.00 dB +10 to +47 dBm ±0.05 dB/10 dB	Type N(m) 50Ω	230mm (9.0 in)	104 mm (4.1 in)	0.3 kg (0.6 lb)	1.25:0.01 - 2 GHz 1.35:6 - 12.4 GHz 1.45:12.4 - 18 GHz

Peak Power Sensors								
Model	**Freq. Range/ Power Range**	**Max. Power**	**Power Linearity[4]** (Freq > 8 GHz)	**RF Conn**	**Length**	**Dia.**	**Wgt.**	**VSWR**
200 mW Peak Power Sensors								
80350A	45 MHz to 18 GHz -20 to +20 dBm, Peak -30 to +20 dBm, CW	+23 dBm (200 mW) CW or Peak	-30 to -20 dBm ±0.00 dB -20 to +20 dBm ±0.05 dB/ 10 dB	Type N(m) 50Ω	165 mm (6.5 in)	37 mm 1.25 in)	0.3 kg (0.7 lb)	1.12:0.045 - 2 GHz 1.22:2 - 12.4 GHz 1.37:12.4 -18 GHz 1.50:18 - 26.5 GHz 1.92:26.5 - 40 GHz
80353A	45 MHz to 26.5 GHz -20 to +20 dBm, Peak -30 to +20 dBm, CW	+23 dBm (200 mW) CW or Peak	-30 to -20 dBm ±0.00 dB -20 to +20 dBm ±0.1 dB/10 dB	Type K(m)[1] 50Ω	165 mm (6.5 in)	37 mm 1.25 in)	0.3 kg (0.7 lb)	
80354A	45 MHz to 40 GHz -20 to +0.0 dBm, Peak -30 to +0.0 dBm, CW	+23 dBm (200 mW) CW or Peak	-30 to -20 dBm ±0.00 dB -20 to 0.0 dBm ±0.2 dB/10dB	Type K(m)[1] 50Ω	165 mm (6.5 in)	37 mm 1.25 in)	0.3 kg (0.7 lb)	
5W Peak Power Sensor [5,7]								
80351A	45 MHz to 18 GHz 0.0 to +40 dBm, Peak -10 to +37 dBm, CW	CW: +37 dBm (5 W Avg.) Peak: +43 dBm	-10 to +0 dBm ±0.00 dB +0 to +40 dBm ±0.05 dB/ 10 dB	Type N(m) 50Ω	200 mm (7.9 in)	37 mm (1.25 in)	0.3 kg (0.7 lb)	1.15:0.045 - 4 GHz 1.25:4 - 12.4 GHz 1.35:12.4 -18 GHz
25W Peak Power Sensor [6,7]								
80352A	45 MHz to 18 GHz +10 to +50 dBm, Peak 0.0 to +44 dBm, CW	CW: +44 dBm (25 W Avg.) Peak: +53 dBm	0.0 to +10 dBm ±0.00 dB +10 to +50 dBm ±0.05 dB/ 10 dB	Type N(m) 50Ω	280 mm (11.0 in)	104 mm (4.1 in)	0.3 kg (0.7 lb)	1.20:0.045 - 6 GHz 1.30:6 - 12.4 GHz 1.40:12.4 -18 GHz
50W Peak Power Sensor[6,7]								
80355A	45 MHz to 18 GHz +10 to +50 dBm, Peak 0.0 to +47 dBm, CW	CW: +47 dBm (50 W Avg.) Peak: +53 dBm	0.0 to +10 dBm ±0.00 dB +10 to +50 dBm ±0.05 dB/ 10 dB	Type N(m) 50Ω	280 mm (11.0 in)	104 mm (4.1 in)	0.3 kg (0.7 lb)	1.25:0.045 - 6 GHz 1.35:6 - 12.4 GHz 1.45:12.4 -18 GHz

See NOTES on page B-6

Bridge Selection Guide								
Model	**Freq. Range/ Power Range**	**Max. Power**	**Power Linearity[4]** (Frequency > 8 GHz)	**Input**	**Test Port**	**Direct-tivity**	**Wgt.**	**VSWR**
Precision CW Return Loss Bridges								
80501	10 MHz to 18 GHz -35 to +20 dBm	+27 dBm (0.5W)	-35 to +10 dBm ±0.1 dB +10 to +20 dBm ±0.1 dB ±0.005 dB/dB	Type N(f) 50 Ω	Type N(f) 50 Ω	38 dB	0.340 kg	< 1.17:0.01 - 8 GHz < 1.27:8 - 18 GHz
80502	10 MHz to 18 GHz -35 to +20 dBm	+27 dBm (0.5 W)	-35 to +10 dBm ±0.1 dB +10 to +20 dBm ±0.1 dB ±0.005 dB/dB	Type N(f) 50 Ω	APC-7(f) 50 Ω	40 dB	0.340 kg	< 1.13:0.01 - 8 GHz < 1.22:8 - 18 GHz
80503	10 MHz to 26.5 GHz -35 to +20 dBm	+27 dBm (0.5 W)	-35 to +10 dBm ±0.1 dB +10 to +20 dBm ±0.1 dB ±0.005 dB/dB	SMA(f) 50 Ω	SMA(f) 50 Ω	35 dB	0.340 kg	< 1.22:0.01 - 18 GHz < 1.27:8 - 26.5 GHz
80504	10 MHz to 40 GHz -35 to +20 dBm	+27 dBm (0.5 W)	-35 to +10 dBm ±0.1 dB +10 to +20 dBm ±0.1 dB ±0.005 dB/dB	Type K(f) 50 Ω	Type K(f) 50 Ω	30 dB	0.198 kg	< 1.35:0.01 - 26.5 GHz < 1.44:26.5 - 40 GHz

Modulation Power Sensors ($f_m \leq$40 KHz)								
Model	**Freq. Range/ Power Range**	**Max. Power**	**Power Linearity[4]** (Freq > 8 GHz)	**RF Conn**	**Length**	**Dia.**	**Wgt.**	**VSWR**
200 mW Modulation Power Sensors								
80401A	10 MHz to 18 GHz -67 to +20 dBm	+23 dBm (200 mW)	-67 to -20 dBm ±0.00 dB -20 to +20 dBm: ±0.05 dB/10 dB	Type N(m) 50Ω	114.5mm (4.5 in)	32 mm (1.25 in)	0.18 kg (0.4 lb)	1.12:0.01 - 2 GHz 1.22:2 - 12.4 GHz 1.29:12.4 - 18 GHz
80402A	10 MHz to 18 GHz -67 to +20 dBm	+23 dBm (200 mW)	-67 to -20 dBm ±0.00 dB -20 to +20 dBm ±0.05 dB/10 dB	APC-7 50Ω				
Low VSWR Modulation Power Sensors								
80410A	10 MHz to 18 GHz -64 to +26 dBm	+29 dBm (800 mW)	-64 to -14 dBm ±0.00 dB -14 to + 26 dBm ±0.05 dB/10 dB	Type K(m)[1] 50Ω	127 mm (5.0 in)	32 mm (1.25 in)	0.23 kg (0.5 lb)	1.13:0.01 - 2 GHz 1.16:2 - 12 GHz 1.23:12 - 18 GHz
1 W Modulation Power Sensors								
80420A	10 MHz to 18 GHz -57 to +30 dBm	+30 dBm (1 W)	-57 to -10 dBm ±0.00 dB -10 to +30 dBm ±0.05 dB/10 dB	Type K(m)[1] 50Ω	127 mm (5.0 in)	32 mm (1.25 in)	0.23 kg (0.5 lb)	1.11:0.01 - 2 GHz 1.12:2 - 12 GHz 1.18:12 - 18 GHz
5 W Modulation Power Sensors[2]								
80421A	10 MHz to 18 GHz -47 to +37 dBm	+37 dBm (5 W)	-47 to +0 dBm ±0.00 dB 0 to +37 dBm ±0.05 dB/10 dB	Type N(m) 50Ω	150 mm (5.9 in)	32 mm (1.25 in)	0.23 kg (0.5 lb)	1.20:0.011 - 6 GHz 1.25:6 - 12.4 GHz 1.35:12.4 - 18 GHz
25 W Modulation Power Sensors[3]								
80422A	10 MHz to 18 GHz -37 to +44 dBm	+44 dBm (25 W)	-37 to +10 dBm ±0.00 dB +10 to +44 dBm ±0.05 dB/10 dB	Type N(m) 50Ω	230 mm (9.0 in)	104 mm (4.1 in)	0.3 kg (0.6 lb)	1.20:0.01 - 6 GHz 1.30:6 - 12.4 GHz 1.40:12.4 - 18 GHz
50 W Modulation Power Sensors[3]								
80425A	10 MHz to 18 GHz -34 to +47 dBm	+47 dBm (50 W)	-34 to +10 dBm ±0.00 dB +10 to +47 dBm ±0.05 dB/10 dB	Type N(m) 50Ω	230 mm (9.0 in)	104 mm (4.1 in)	0.3 kg (0.6 lb)	1.25:0.01 - 6 GHz 1.35:6 - 12.4 GHz 1.45:12.4 - 18 GHz

See NOTES on page B-6

Modulation Power Sensors ($f_m \leq 1.5$ MHz)

Model	Freq. Range/ Power Range	Max. Power	Power Linearity[4] (Freq > 8 GHz)	RF Conn	Length	Dia.	Wgt.	VSWR
200 mW Modulation Power Sensor								
80601A[9]	10 MHz to 18 GHz -67 to +20 dBm	+23 dBm (200 mW)	-67 to -20 dBm ±0.00 dB -20 to +20 dBm ±0.05 dB/10 dB	Type N(m) 50Ω	137 mm (5.39 in)	41 mm (1.62 in)	0.23 kg (0.4 lb)	1.12:0.01 - 2 GHz 1.22:2 - 12.4 GHz 1:2912.4 - 18 GHz
5 W Modulation Power Sensor[5,7]								
80621A	10 MHz to 18 GHz -47 to +37 dBm	+37 dBm (5 W)	-47 to 0 dBm ±0.00 dB 0 to +37 dBm ±0.05 dB/10 dB	Type N(m) 50Ω	175 mm (6.90 in)	41 mm (1.62 in)	0.23 kg (0.6 lb)	1.20:0.01 - 6 GHz 1.25:6 - 12.4 GHz 1:3512.4 - 18 GHz

Modulation Power Sensors ($f_m \leq 10$ MHz)

Model	Freq. Range/ Power Range	Max. Power	Power Linearity[4] (Freq > 8 GHz)	RF Conn	Length	Dia.	Wgt.	VSWR
80701A[10]	50 MHz to 18 GHz -64 TO +20 dBm, CW 250 MHz to 18 GHz -60 to +20 dBm, Mod.	+23 dBm (200 mW)	**Frequency > 8 GHz:** -60 to +20 dBm: ±0.00 dB -20 to +20 dBm: ±0.05 dB/10 dB **Frequency < 500 MHz:** -60 to +20 dBm: ±0.00 dB -20 to +20 dBm: ±0.05 dB/10 dB	Type N(m) 50Ω	120 mm (4.72 in)	27 mm (1.06 in)	0.10 kg (0.2 lb)	1.12:0.01 - 2 GHz 1.22:2.0 - 12.4 GHz 1.29:12.4 - 18 GHz

True RMS Sensors ($f_m > 1.5$ MHz) (-30 to +20 dBm)

Model	Freq. Range/ Power Range	Max. Power	Power Linearity[4] (Freq > 8 GHz)	RF Conn	Length	Dia.	Wgt.	VSWR
80330A 80333A 80334A	10 MHz to 18 GHz 10 MHZ to 26.5 GHz 10 MHz to 40 GHz	+33 dBm (2 W)	-30 to +20 dBm ±0.00 dB	Type K(m)[1] 50Ω	152.5 mm (6.0 in)	32 mm 1.25 in)	0.27 kg (0.6 lb)	1.12:0.01 - 12 GHz 1.15:12 - 18 GHz 1.18:18 - 26.5 GHz 1.29:26.5 - 40 GHz

See Notes on page B-6

Table B-2: Power Sensor Cal Factor Uncertainties

Freq. (GHz)		Root Sum of Squares (RSS) Uncertainties (%)[8]						
Lower	Upper	80301A 80302A 80350A 80401A 80402A 80601A 80701A[10]	80303A 80304A 80353A 80354A	80310A 80313A 80314A 80410A	80320A 80323A 80324A 80420A	80321A[9] 80322A[9] 80325A[9] 80421A[9] 80422A[9] 80425A[9] 80621A[9]	80330A 80333A 80334A	80351A[9] 80352A[9] 80355A[9]
Min	1	1.04	1.64	1.58	1.58	4.54	1.58	4.92
1	2	1.20	1.73	1.73	1.73	4.67	1.73	5.04
2	4	1.33	1.93	1.91	1.91	4.89	1.90	7.09
3	6	1.41	2.03	2.02	2.01	5.01	2.01	7.17
6	8	1.52	2.08	2.07	2.06	5.12	2.06	7.25
8	12.4	1.92	2.55	2.54	2.53	5.56	2.53	7.56
12.4	18	2.11	2.83	2.80	2.79	5.89	2.78	12.37
18	26.5	——	3.63	3.68	3.62	——	3.59	——
26.5	40	——	6.05	5.54	5.39	——	5.30	——

Notes:

1. The K connector is electrically and mechanically compatible with the APC-3.5 and SMA connectors. Use a Type N(m) to SMA(f) adapter (P/N 29835) for calibration of power sensors with Type K(m) connectors.
2. Power coefficient equals <0.01 dB/Watt.
3. Power coefficient equals <0.015 dB/Watt.
4. For frequencies above 8 GHz, add power linearity to system linearity.
5. Power coefficient equals <0.01 dB/Watt (Average).
6. Power coefficient equals <0.015 dB/Watt (Average).
7. Peak operating range above CW maximum range is limited to <10% duty cycle.
8. Square root of sum of the individual uncertainties squared (RSS).
9. Cal Factor numbers allow for 3% repeatability when connecting attenuator to sensor, and 3% for attenuator measurement uncertainty and mismatch of sensor/pad combination.
10. Series 807XXA sensors require the installation of Option 12 for use.

B.2.2 Modulated Sensor Specifications

Table B-3 lists the specifications for Series 80401A, 80601A and 80701A modulation sensors. Series 80701A sensors require the installation of Option 12.

Table B-3: Modulated Sensor Specifications

Sensor Measurement Capabilities			
Signal Type	Sensor Model		
	80401A	80601A	80701A
CW Power Level	-67 to +20 dBm	-67 to +20 dBm	-64 to +20 dBm
Amplitude Modulation Rate, Power Range	$f_m \leq$ 40 kHz, -60 to +20 dBm $f_m >$ 40 kHz, -60 to -20 dBm	$f_m \leq$ 1.5 MHz, -60 to +20 dBm $f_m >$ 1.5 MHz, -60 to -20 dBm	$f_m \leq$ 10 MHz, -60 to +20 dBm
Two-Tone Maximum Separation between Carriers	≤ 40 kHz, -60 to +20 dBm > 40 kHz, -60 to -20 dBm	≤ 1.5 MHz, -60 to +20 dBm > 1.5 MHz, -60 to -20 dBm	≤ 10 MHz, -60 to +20 dBm > 10 MHz, -60 to -20 dBm
Pulse Modulation	> 200 µs Pulse Width	> 300 µs Pulse Width	> 100 µs Pulse Width
Burst with Modulation	$f_m \leq$ 40 kHz, > 200 µs Pulse width; -40 to +20 dBm $f_m >$ 40 kHz, > 200 µs Pulse width; -40 to -20 dBm	$f_m \leq$ 1.5 MHz, > 300 µs Pulse width; -40 to +20 dBm $f_m >$ 1.5 MHz, > 300 µs Pulse width; -40 to -20 dBm	$f_m \leq$ 10 MHz, > 100 µs Pulse width; -30 to +20 dBm $f_m >$ 10 MHz, > 200 µs Pulse width; -30 to -20 dBm

f_m = modulation rate

Modulation-Induced Measurement Uncertainty for the 80401A Sensor

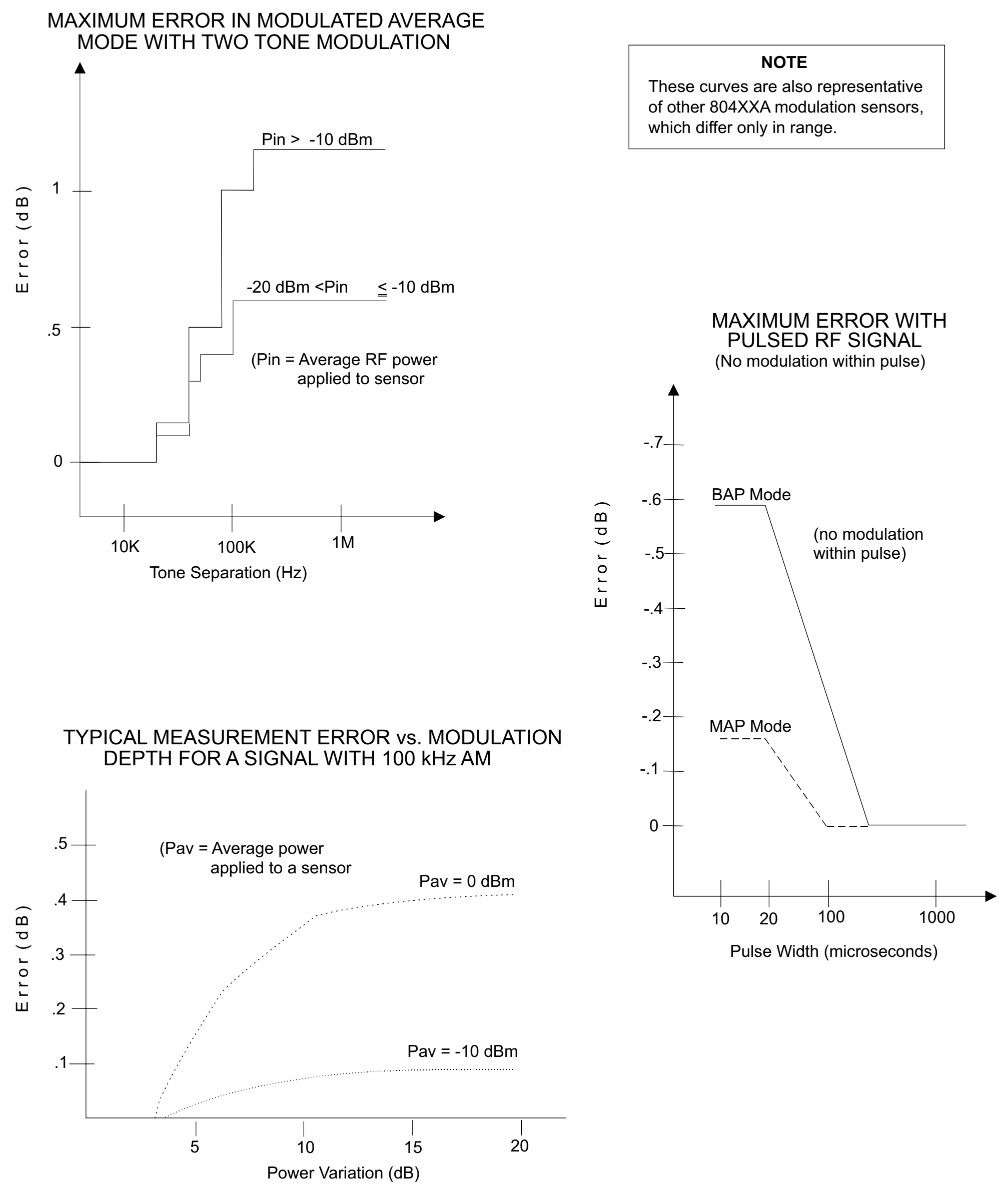


Figure B-1: 80401A Modulation-Related Uncertainty

B.2.2.1 80401A BAP Mode Limitations

The minimum input level is -40 dBm (average); the minimum pulse repetition frequency is 20 Hz. If the input signal does not meet these minima, NoSync will flash on the display to the right of the line configured for BAP mode sensor to indicate that the input is not suitable for BAP measurement. The 8650A will continue to read the input but the BAP measurement algorithms will not be able to synchronize to the modulation of the input; the input will be measured as if the 8650A were in MAP mode. In addition, some measurement inaccuracy will result if the instantaneous power within the pulse falls below -43 dBm; however, this condition will not cause NoSync to flash.

Modulation-Induced Measurement Uncertainty for the 80601A Sensor

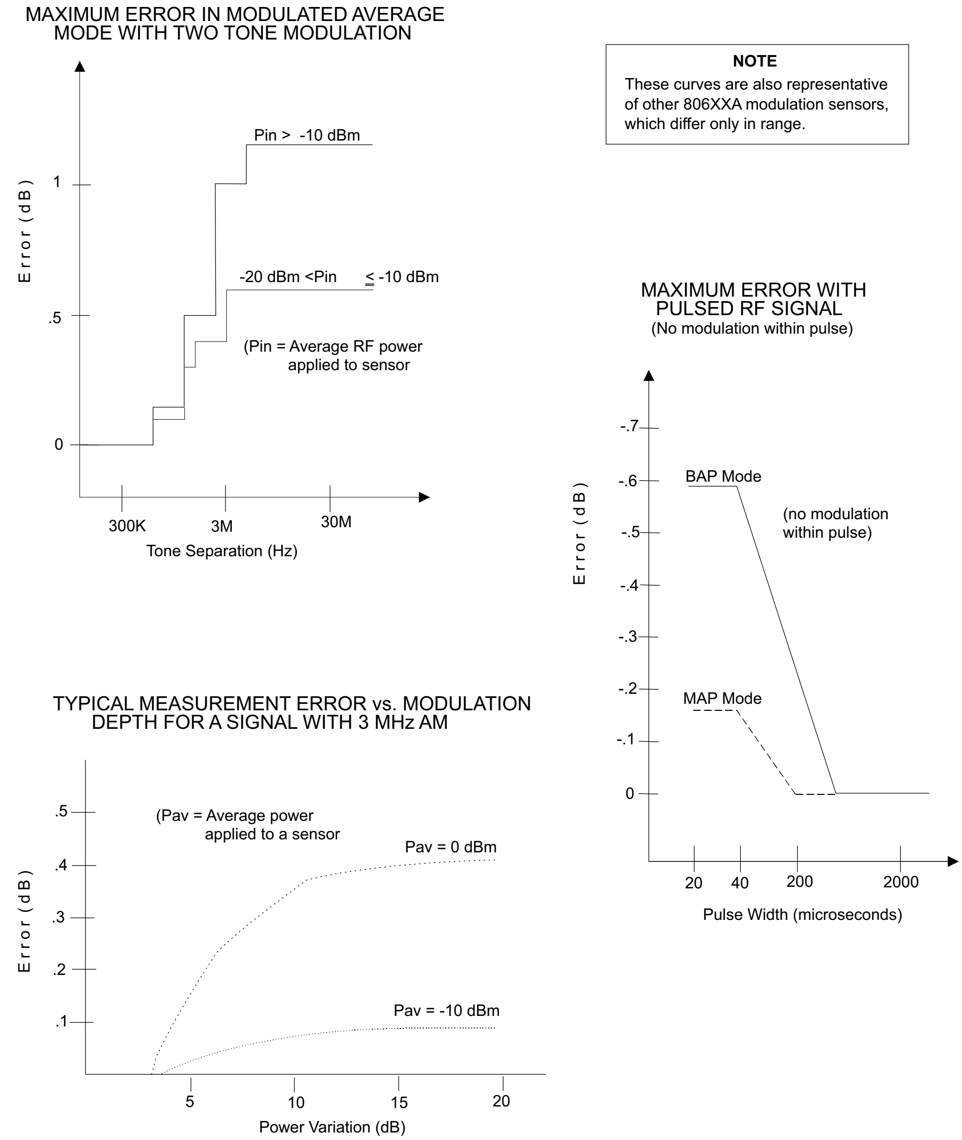


Figure B-2: 80601A Modulation-Related Uncertainty

B.2.2.1 80601A BAP Mode Limitations

The minimum input level is -35 dBm (average); the minimum pulse repetition frequency is 20 Hz. If the input signal does not meet these minima, NoSync will flash on the display to the right of the line configured for BAP mode sensor the front panel to indicate that the input is not suitable for BAP measurement. The 8650A will continue to read the input but the BAP measurement algorithms will not be able to synchronize to the modulation of the input; the input will be measured as if the 8650A were in MAP mode. In addition, some measurement inaccuracy will result if the instantaneous power within the pulse falls below -38 dBm; however, this condition will not cause NoSync to flash. See Section 2.3.2 for modulation bandwidth limitations below 200 MHz. When the modulation bandwidth is below 200 MHz, the 806XXA sensors' performance is equal to that of the 804XXA sensors.

Modulation-Induced Measurement Uncertainty for the 80701A Sensor

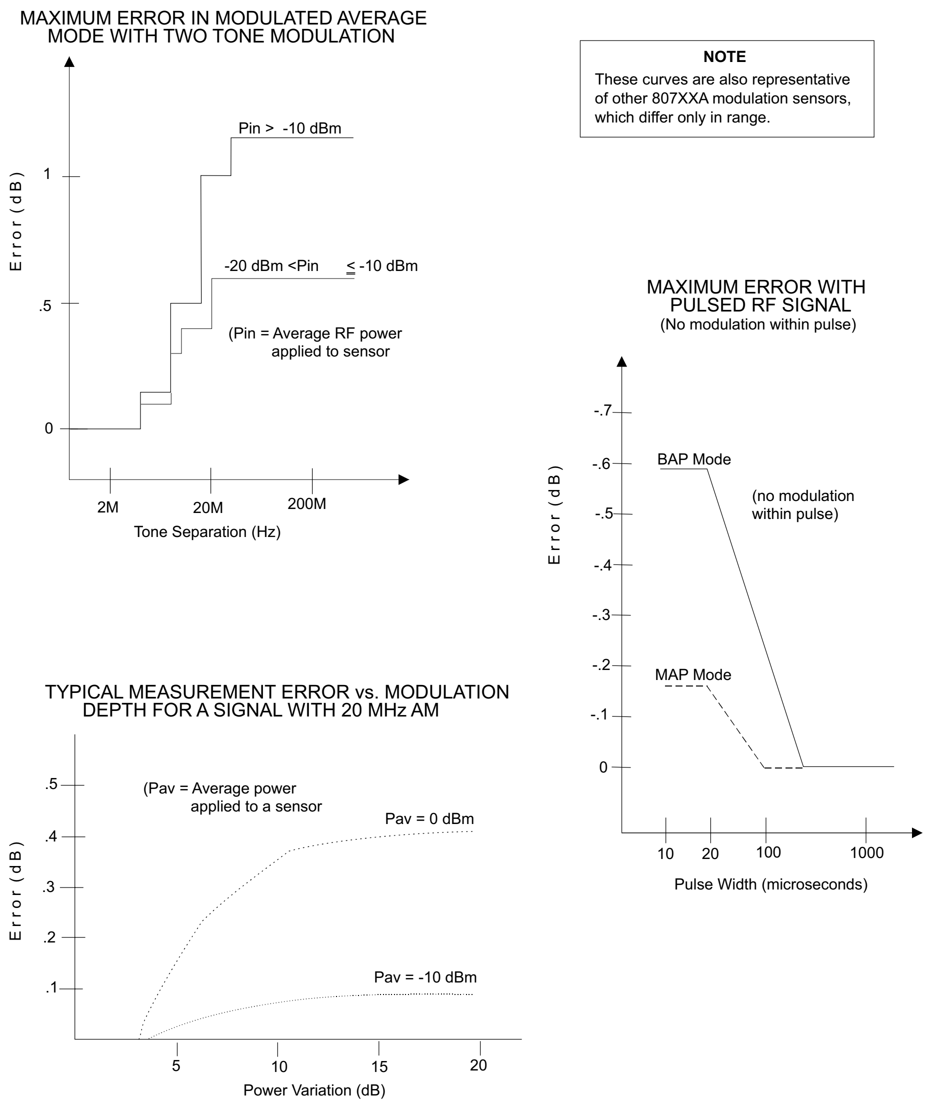


Figure B-3: 80701A Modulation-Related Uncertainty

B.2.2.1 80701A BAP Mode Limitations

The minimum input level is -35 dBm (average); the minimum pulse repetition frequency is 20 Hz. If the input signal does not meet these minima, NoSync will flash on the display to the right of the line configured for BAP mode sensor to indicate that the input is not suitable for BAP measurement. The 8650A will continue to read the input but the BAP measurement algorithms will not be able to synchronize to the modulation of the input; the input will be measured as if the 8650A were in MAP mode. In addition, some measurement inaccuracy will result if the instantaneous power within the pulse falls below -28 dBm; however, this condition will not cause NoSync to flash. See Section 2.3.2 for modulation bandwidth limitations below 200 MHz. When the modulation bandwidth is below 200 MHz, the 807XXA sensors' performance is equal to that of the 804XXA sensors.

B.2.3 Directional Bridges

The 80500 CW Directional Bridges are designed specifically for use with Giga-tronics power meters to measure the Return Loss/SWR of a test device. Each bridge includes an EEPROM which has been programmed with Identification Data for that bridge.

Table B-4: Directional Bridge Selection Guide

Precision CW Return Loss Bridges								
Model	**Freq. Range/ Power Range**	**Max. Power**	**Power Linearity**[4] (Frequency > 8 GHz)	**Input**	**Test Port**	**Directivity**	**Wgt.**	**VSWR**
80501	10 MHz to 18 GHz -35 to +20 dBm	+27 dBm (0.5W)	-35 to +10 dBm ±0.1 dB +10 to +20 dBm ±0.1 dB ±0.005 dB/dB	Type N(f) 50 Ω	Type N(f) 50 Ω	38 dB	0.340 kg	< 1.17:0.01 - 8 GHz < 1.27:8 - 18 GHz
80502	10 MHz to 18 GHz -35 to +20 dBm	+27 dBm (0.5 W)	-35 to +10 dBm ±0.1 dB +10 to +20 dBm ±0.1 dB ±0.005 dB/dB	Type N(f) 50 Ω	APC-7(f) 50 Ω	40 dB	0.340 kg	< 1.13:0.01 - 8 GHz < 1.22:8 - 18 GHz
80503	10 MHz to 26.5 GHz -35 to +20 dBm	+27 dBm (0.5 W)	-35 to +10 dBm ±0.1 dB +10 to +20 dBm ±0.1 dB ±0.005 dB/dB	SMA(f) 50 Ω	SMA(f) 50 Ω	35 dB	0.340 kg	< 1.22:0.01 - 18 GHz < 1.27:8 - 26.5 GHz
80504	10 MHz to 40 GHz -35 to +20 dBm	+27 dBm (0.5 W)	-35 to +10 dBm ±0.1 dB +10 to +20 dBm ±0.1 dB ±0.005 dB/dB	Type K(f) 50 Ω	Type K(f) 50 Ω	30 dB	0.198 kg	< 1.35:0.01 - 26.5 GHz < 1.44:26.5 - 40 GHz

The Selection Guide in Table B-4 shows primary specifications. Additional specifications are:

Bridge Frequency Response

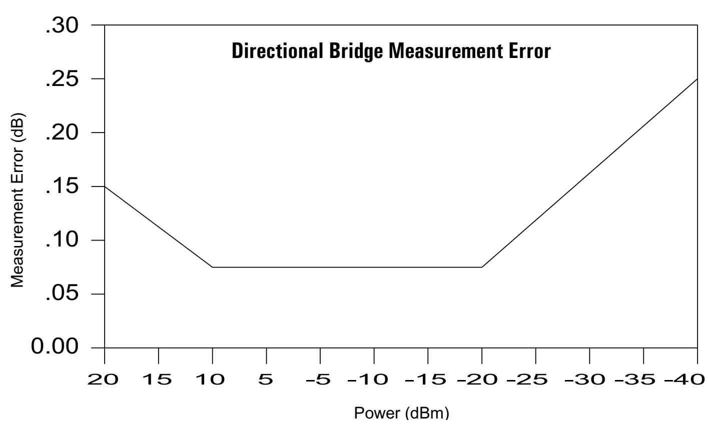
Return loss measurements using the 8541/8542 power meter can be frequency compensated using the standard Open/Short supplied with the bridge.

Insertion Loss

6.5 dB, nominal, from input port to test port

Directional Bridge Linearity Plus Zero Set & Noise vs. Input Power

+27 dBm (0.5 W)



Weight

80501	340 g (12 oz.)
80502	340 g (12 oz.)
80503	198 (7 oz.)
80504	198 (7 oz.)

Directional Bridge Accessories

An Open/Short is included for establishing the 0 dB return loss reference during path calibration.

Dimensions

80501	76 x 50 x 28 mm (3 x 2 x 1-1/8 in.)
80502	76 x 50 x 28 mm (3 x 2 x 1-1/8 in.)
80503	19 x 38 x 29 mm (3/4 x 1-1/2 x 2-1/8 in.)
80504	19 x 38 x 29 mm (3/4 x 1-1/2 x 2-1/8 in.)

C

Options

C.1 Introduction

The options described in this appendix are available for the Series 8650A:

Option	Description	Part Number	Field Installable
01	Rack Mount Kit	21334	Yes
03	Rear Panel Sensor Input & Calibrator Output Connectors (8651A)	29864	No
04	Rear Panel Sensors Input & Calibrator Output Connectors (8652A)	29889	No
05	Soft Carry Case	21312	N/A
07	Side-mounted Carrying Handle	21339	No
08	Transit Case (Includes Soft Carry Case)	21344	NA
09	Dual Power Meter Rack Mount Kit	21684	Yes
10	Assembled Dual Power Meter Rack Mount	21647	No
12	1 GHz, 50 MHz Switchable Calibrator	29893	No
13	Rear Panel Sensor Input Connector (8651A)	29902	No
14	Rear Panel Sensor Input Connectors (8652A)	29903	No

C.2 Options

C.2.1 Option 01: Rack Mount Kit

Option 01 is a rack mounting kit for the 8650A.

C.2.2 Option 03: Rear Panel Sensor In & Calibrator Out Connectors (8651A)

When Option 03 is installed, the Sensor In and Calibrator Out connectors (which are normally located on the front panel of the 8651A) are relocated to the rear panel.

C.2.3 Option 04: Rear Panel Sensor In & Calibrator Out Connectors (8652A)

When Option 04 is installed, the Sensor In and Calibrator Out connectors (which are normally located on the front panel of the 8652A) are relocated to the rear panel.

C.2.4 Option 05: Soft Carrying Case

Option 05 is a padded, soft carrying case for the 8650A.

C.2.5 Option 07: Side-mounted Carry Handle

Option 07 is a side-mounted carrying handle for the 8650A.

C.2.6 Option 08: Transit Case

Option 08 is a transit case for the 8650A; this option also includes the soft case described under Option 05.

C.2.7 Option 09: Dual Power Meter Rack Mount Kit

Option 09 is a field-installable dual power meter rack mounting kit (with assembly instructions) for the 8650A. The dual rack mount makes it possible to install two 8650As side-by-side in an instrument rack.

C.2.8 Option 10: Assembled Dual Power Meter Rack Mount Kit

Option 10 is a field-installable dual power meter rack mounting kit for the 8650A. The dual rack mount makes it possible to install two 8650As side-by-side in an instrument rack.

C.2.9 Option 12: 1 GHz, 50 MHz Switchable Calibrator

Option 12 provides a factory-configured switchable 1 GHz or 50 MHz calibrator.

☛ ***NOTE:*** *The 1 GHz calibrator is required for operation with the 80701A series power sensors.*

C.2.10 Option 13: Rear Panel Sensor In Connectors (8651A)

Option 13 relocates the Sensor In connector, normally located on the front panel of the 8651A, to the rear panel. The Calibrator Out connector remains on the front panel.

C.2.11 Option 14: Rear Panel Sensor In Connectors (8652A)

Option 14 relocates the two Sensor In connectors, normally located on the front panel of the 8652A, to the rear panel. The Calibrator Out connector remains on the front panel.

D

Menu Structure

D.1 Introduction

This appendix pictorially describes the menu structure of the Series 8650A Universal Power Meters. Figure D-1 is a general layout of the menu tree; the diagrams in this appendix describe each menu in greater detail.

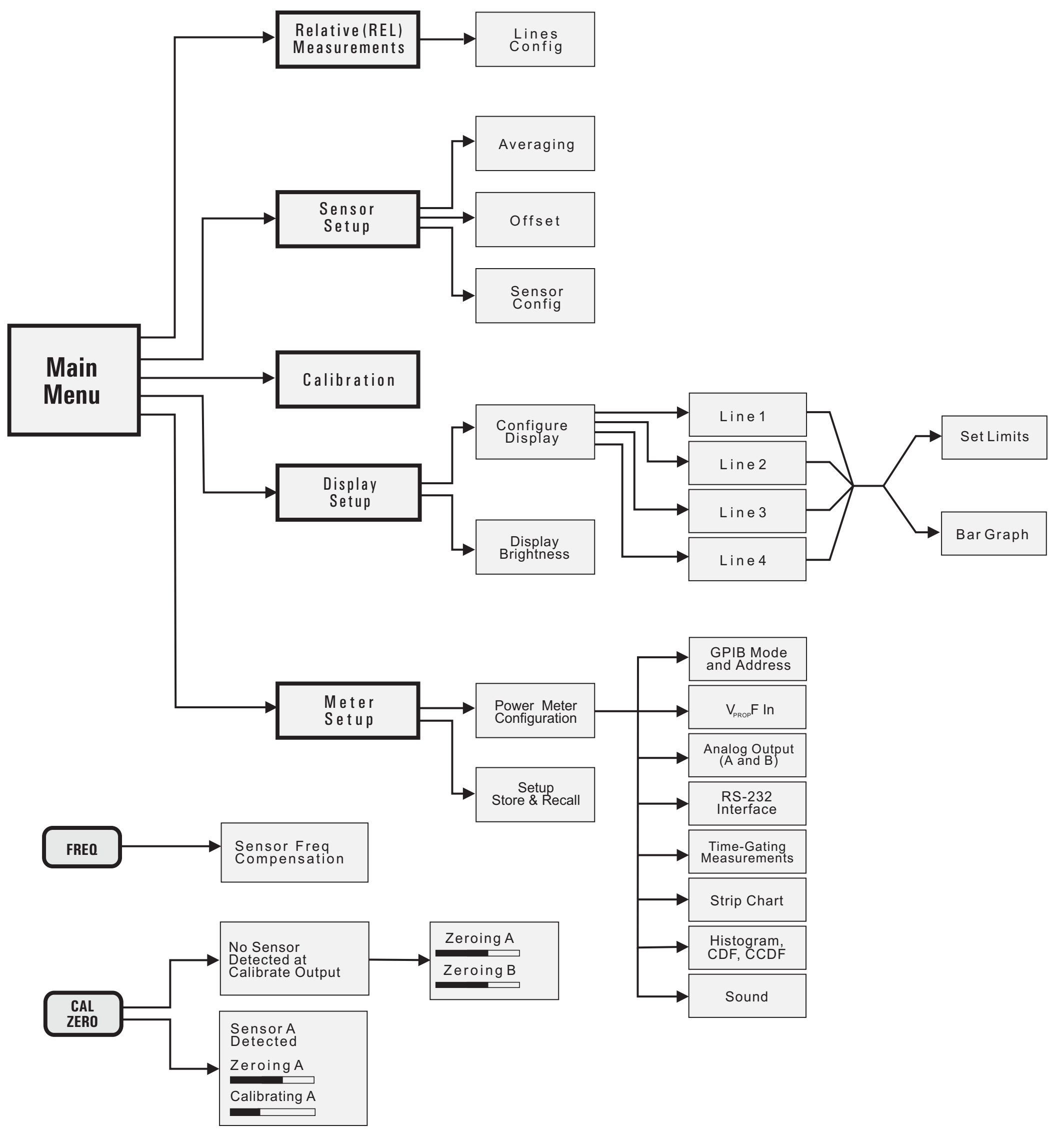


Figure D-1: Series 8650A Menu Tree

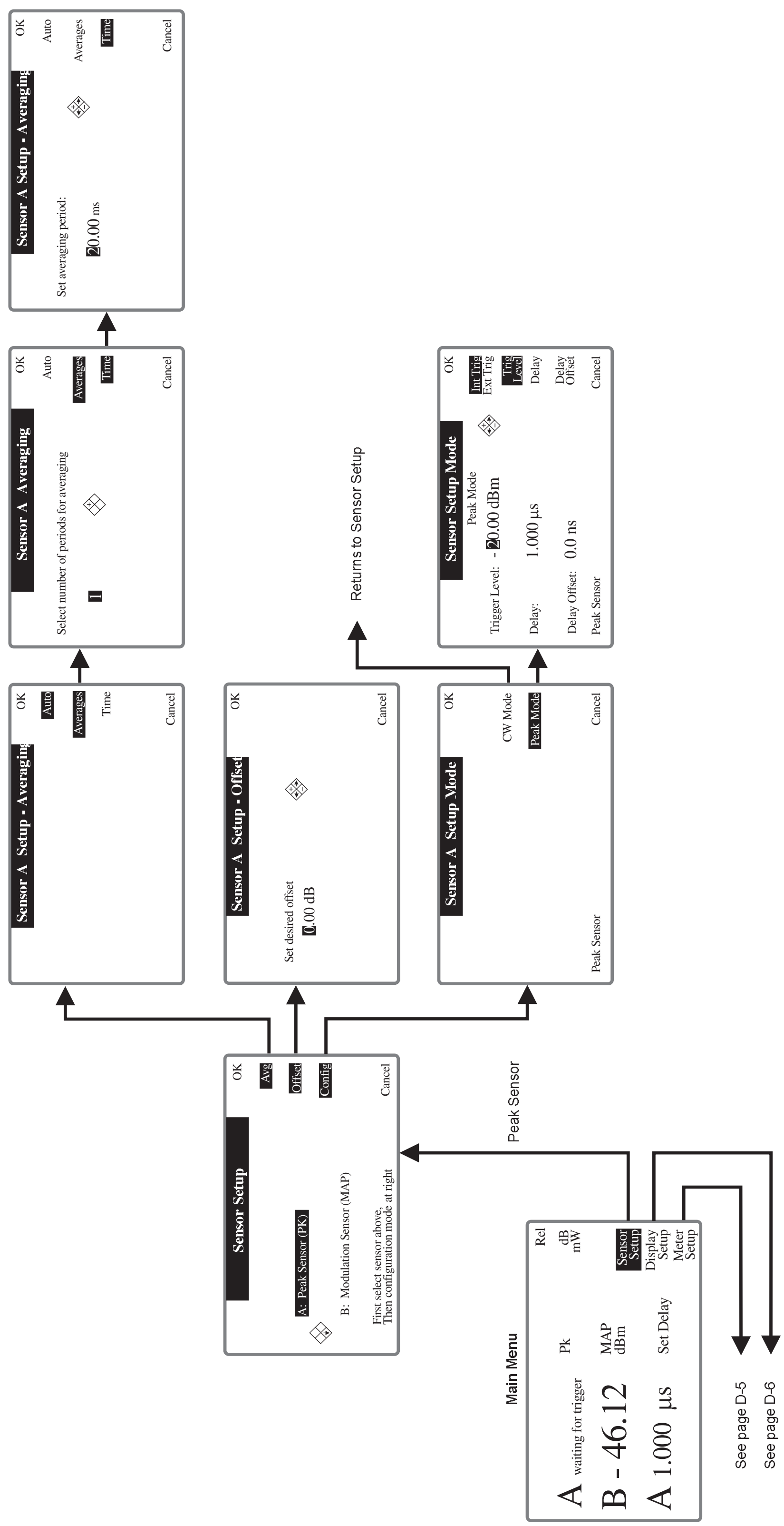


Figure D-2: Peak Sensor Setup A Menu Structure

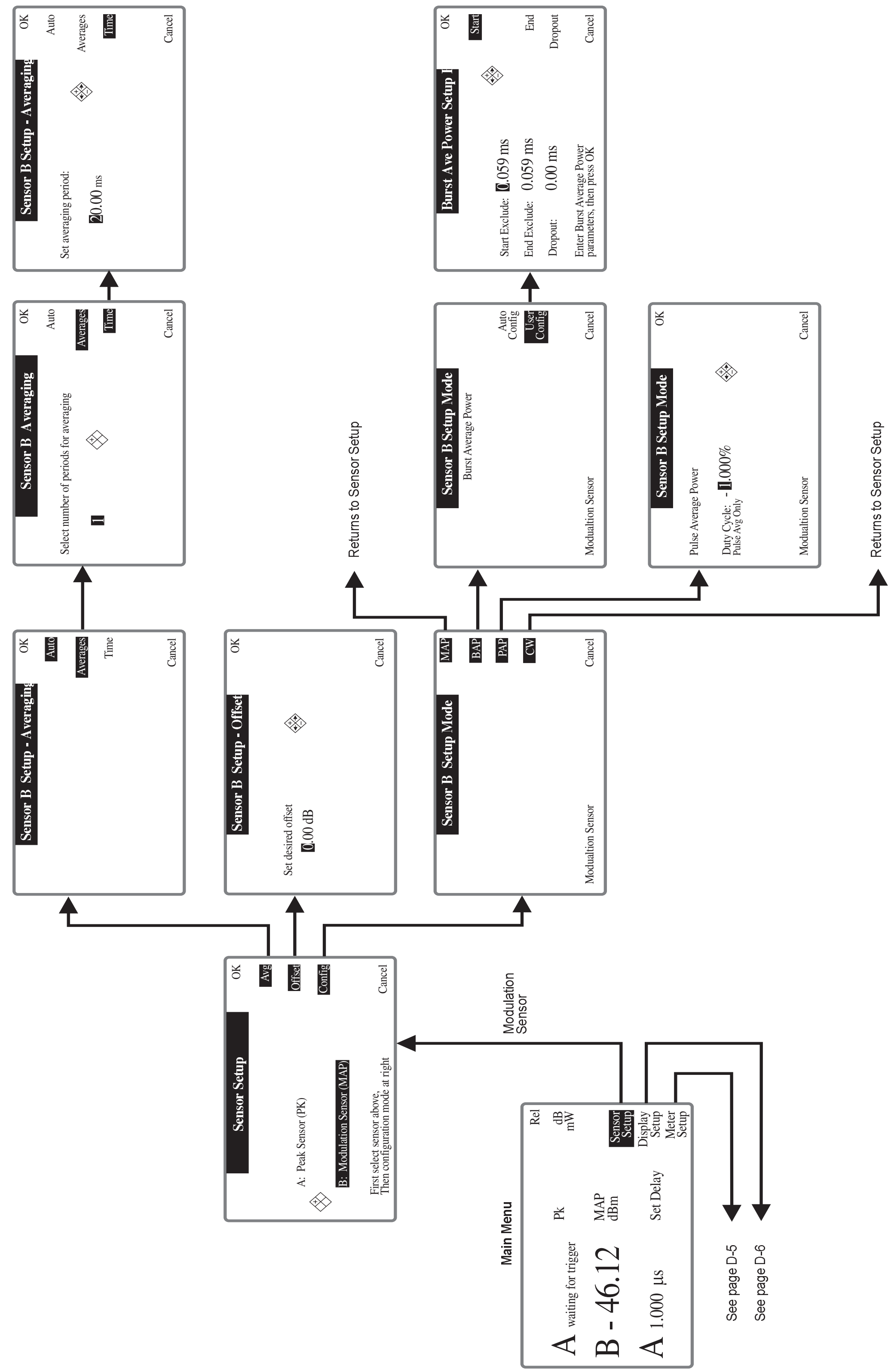


Figure D-3: Modulation Sensor B Setup Menu Structure

11" x 17" (Landscape) pages follow continuing Appendix D of the Series 8650A Manual

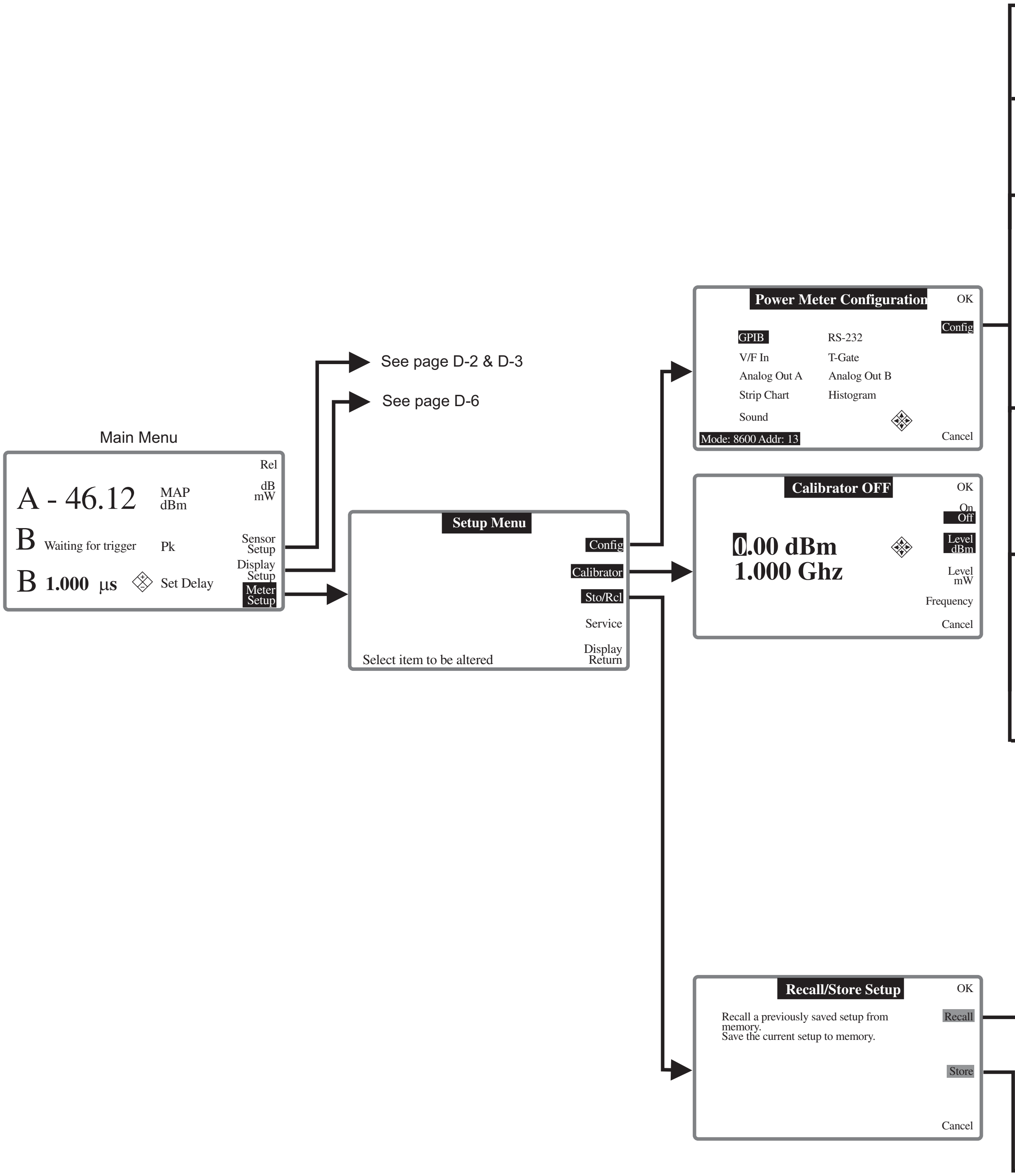


Figure D-4: Meter Setup Menu Structure

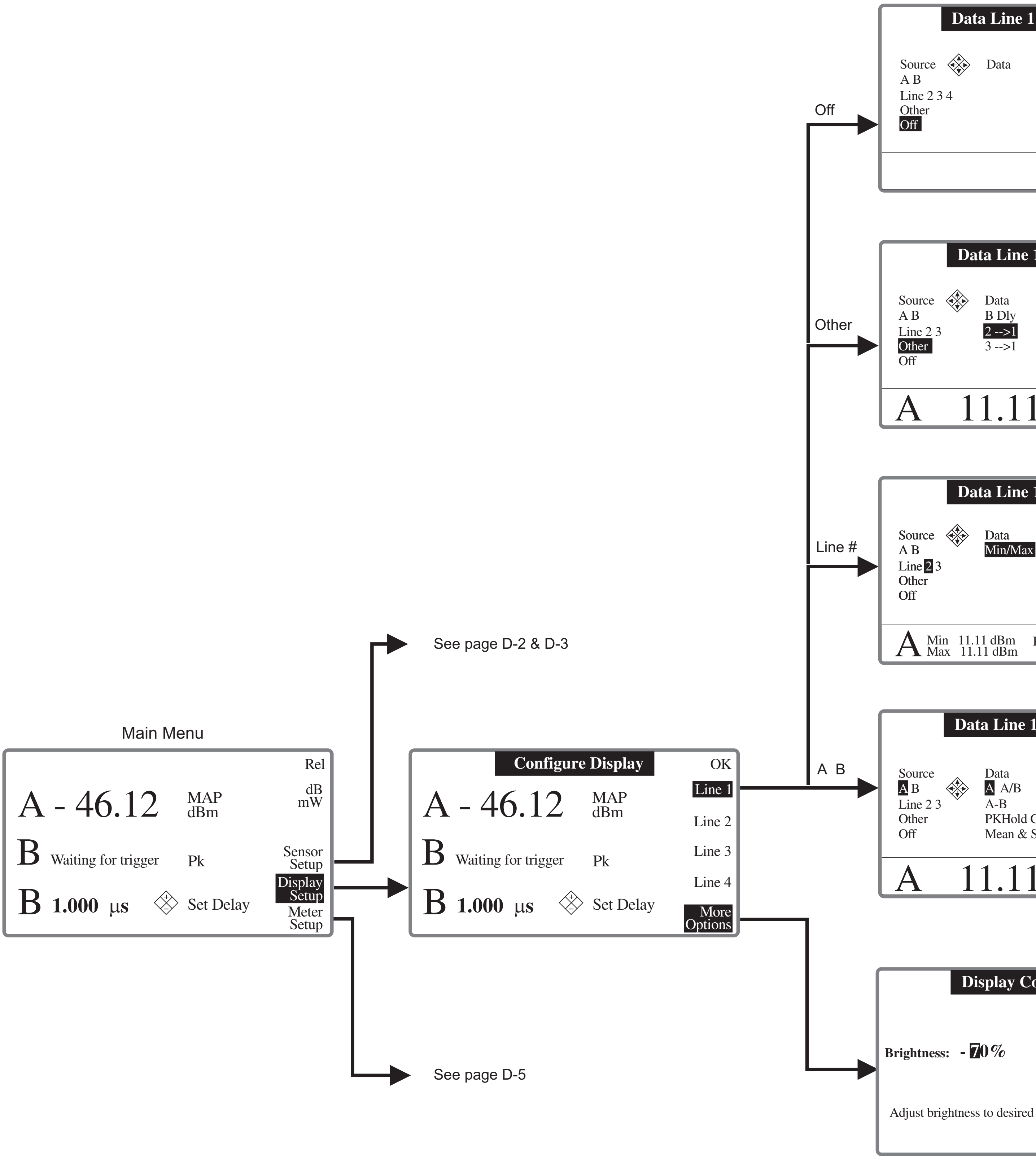


Figure D-5 Display S

Index

Series 8650A Universal Power Meters (Rev. F)

Numerics

A

B

C

I

L

M

N

O

P

Q

R

S

T

U

V

W

Z