INSTRUCTION MANUAL

MODEL 2535

1GHz CALIBRATOR

REV DATE 1/5/07
MANUAL P/N 98405300A
CD P/N 98405399A

BOONTON
A WIRELESS TELECOM GROUP COMPANY

INSTRUCTION MANUAL, MODEL 2535 1GHz CALIBRATOR

Revision date 1/5/2007

P/N 98405300A

Contents

SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation and maintenance of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Boonton Electronics assumes no liability for the customer's failure to comply with these requirements.

THE INSTRUMENT MUST BE GROUNDED

To minimize shock hazard the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a NEMA three conductor, three prong power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to a two-contact adapter with the (green) grounding wire firmly connected to an electrical ground in the power outlet.

DO NOT OPERATE THE INSTRUMENT IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with the power cable connected. Under certain conditions dangerous voltages may exist even though the power cable was removed, therefore; always disconnect power and discharge circuits before touching them.

DO NOT SERVICE OR ADJUST ALONE

Do not attempt internal service or adjustment unless another person, capable or rendering first aid and resuscitation, is present.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

Do not install substitute parts or perform any unauthorized modifications or the instrument. Return the instrument to Boonton Electronics for repair to ensure that the safety features are maintained.

SAFETY SYMBOLS

This safety requirement symbol (located on the rear panel) has been adopted by the International Electro-technical Commission, Document 66 (Central Office) 3, Paragraph 5.3, which directs that an instrument be so labeled if, for the correct use of the instrument, it is necessary to refer to the instruction manual. In this case it is recommended that reference be made to the instruction manual when connecting the instrument to the proper power source. Verify that the correct fuse is installed for the power available.

The CAUTION symbol denotes a hazard. It calls attention to an operational procedure, practice or instruction that, if not followed, could result in damage to or destruction of part or all of the instrument and accessories. Do not proceed beyond a CAUTION symbol until its conditions are fully understood and met.

The NOTE symbol is used to mark information which should be read. This information can be very useful to the operating in dealing with the subject covered in this section.

The HINT symbol is used to identify additional comments which are outside of the normal format of the manual, however can give the user additional information about the subject.

Contents

1. General Information

This instruction manual provides you with the information you need to install, operate and maintain the Boonton MODEL 2535 1GHz Calibrator. Section 1 is an introduction to the manual and the instrument.

1.1 Organization

The manual is organized into seven sections and three Appendices, as follows:

Section 1 - General Information presents summary descriptions of the instrument and its principal features, accessories and options. Also included are specifications for the instrument.

Section 2 - Installation provides instructions for unpacking the instrument, setting it up for operation, connecting power and signal cables, and initial power-up.

Section 3 – Getting Started introduces the user to the instrument's controls, display and power connections.

Section 4 - Operation describes the display menus and procedures for operating the instrument from the front panel.

Section 5 - Maintenance includes procedures for safety requirements, cleaning procedures and verifying fault-free operation.

Appendix A - Warranty and Repair Policy states the policies governing the return and replacement of modules and instruments during and after the warranty period.

1.2 Description

The Model 2535 is the latest generation of BOONTON RF Calibrators, including Models 2510, 2520, and 2530. The Model 2535 is a fixed frequency (1.024 GHz) continous wave (CW) source at 50 ohms that provides an accurate level from –60 dBm to +20 dBm in 0.1 dB steps. The level is NIST traceable using thermal converter techniques at 0 dBm and transfer standards at other levels. The 2535 is generally used for calibrating RF power meters, however, it can also be used to calibrate attenuators, characterize amplifiers, detectors, etc.

1.3 Features

.

- *Software.* Factory installed software operates a floating point DSP, FPGA and memory to perform all calibrator controls, reads the keyboard and display instrument configuration.

Note No provisions have been made to allow for software updates in the field. Software updates must be performed at the factory.

- *Auto-Setup.* At power-on LEVEL is initialized to 0 dBm while OUTPUT is set to OFF. OUTPUT is set as the default active function allowing one key press to enable the output signal.

- *Menu-Driven Operation.* Setup and control of the instrument is menu-driven to simplify operation. User-selected parameters appear on the LCD display in a menu style format, together with applicable variables. Activating a function is accomplished by using the up and down arrow keys. Once the desired function is selected, pressing the Enter key allows changes to the function's value.

Figure 1-1. Model 2535 1GHz Calibrator

- *Display.* An 80 character (20x4) Liquid Crystal Display with a yellow/green LED backlight is used to display the instrument configuration parameters.

- *Precision Calibrator.* A 1 GHz step calibrator, traceable to NIST, provides accurate levels from +10 to −20 dBm in 0.1 dB steps.

- *Self-Test.* At power-on, an automatic self-test routine is run to establish communication with the calibrator. In addition, a memory test is done to ensure proper operation of the instrument.

1.4 Accessories

Optional 2535 accessories that can be ordered from Boonton Electronics.

Table 1-1 Accessories for the Model 2535

Selection	Part Number	Description
Standard		
	56810400A	Line Cord (US)
	96000501A	Fuse Kit
	98600900A	Instruction Manual Model 2535, *English* (CD-ROM)
Optional		
	545504000	Fuse 1/2A 250V
	95403001A	Rack Mounting Kit (Brackets only)
	95403003A	Rack Mounting Kit (Brackets with handles)
	95105501A	Type N to K Adaptor (for sensors with K-Connector®)

1.5 Other Options

Opt 30. Extend Warranty to 3 years.

1.6 Specifications

Performance specifications for the Model 2535 are listed in Table 1-2.

Table 1-2 Model 2535 Performance Specifications
(Specifications are subject to change without notice)

CALIBRATION SOURCE

Operating Modes:	Continuous Wave (CW)
Frequency:	1.024 GHz ± 0.01%
Level Range:	-50 to +20 dBm
Resolution:	0.1 dB
Output VSWR:	1.20 maximum
CW Absolute Accuracy:	±0.065 dB (±1.5%) at 0 dBm
CW Accuracy vs level:	add ±0.03 dB per 5 dB increment from 0 dBm
RF Connector:	Precision Type N

OTHER CHARACTERISTICS

Display:	80 character (20x4) monochrome transmissive LED backlight Liquid Crystal Display
DSP:	32-bit Floating Point DSP
Operating Temperature:	0 to 50 degrees C
Storage Temperature:	-20 to +70 degrees C
Humidity:	0 to 95% (non-condensing)
Power Requirements:	90 to 260 VAC, 47 to 63 Hz, 70W
Dimensions:	3.5” x 8.25” x 13.4” HWD; optionally rack-mountable
Weight:	6.2 lbs (approx)

2. Installation

This section contains unpacking and repacking instructions, power requirements, connection descriptions and preliminary checkout procedures.

2.1 Unpacking & Repacking

The Model 2535 is shipped complete and is ready to use upon receipt. Figure 2-1 shows you the various pieces included in the packaging and the order in which they are loaded into the container. Actual details may vary from the illustration.

Note

Save the packing material and container to ship the instrument, if necessary. If the original materials (or suitable substitute) are not available, contact Boonton Electronics to purchase replacements. Store materials in a dry environment. Refer to the Physical and Environmental Specifications in Table 1-2. for further information.

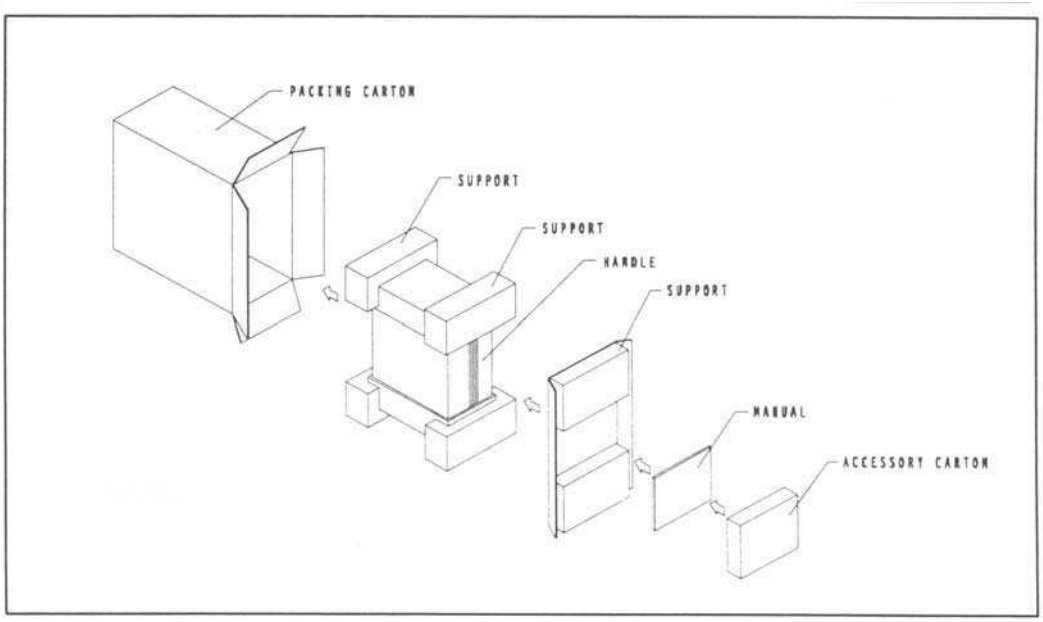


Figure 2-1. Packaging Diagram

Table 2-1 Model 2535 Packing List

INSTRUMENT (See also Table 1-1)

Model 2535 1GHz Calibrator
Line Cord
Fuse Kit
Instruction Manual Model 2535 (CDROM)

ACCESSORIES (packaged separately)

Type N to SMA Adapter (if required)
Type N female to type BNC female
BNC to RJ45 Adapter

For bench-top use, choose a clear, uncluttered area. Ensure that there is at least 6" of clearance at the air intake and exhaust vents on the rear of the case. Pull-down feet are located on the bottom of the instrument. Rack mounting instructions are provided with the (optional) rack mount kit.

2.2 Power Requirements

The Model 2535 is equipped with a switching power supply that provides automatic operation from a 90 to 260 volt, 47-63 Hz, single-phase, AC power source. The maximum DC power output is 60W (24 VDC at 2.5 A). For metric fuse sizes, use the metric fuse kit supplied. Connect the power cord supplied with the instrument to the power receptacle on the rear panel. See Figure 3-2.

Caution

Before connecting the instrument to the power source, make certain that a 0.5 ampere time delay fuse is installed in the fuse holder on the rear panel.

Before removing the instrument cover or any of the circuit boards, position the front panel Power switch to off (0 = OFF; 1 = ON) and disconnect the power cord from the rear panel Power entry module.

2.3 Connections

CAL OUT A precision female type-N connector located on the front panel.

2.4 Preliminary Check

The following preliminary check verifies that the instrument is operational and has the correct software installed. It should be performed before the instrument is placed into service. To perform the preliminary check, proceed as follows:

1. Press the left half of the power switch (marked "0") on the front panel. This will ensure that AC power is not applied to the instrument while installing the power cord.

2. Connect the AC (mains) power cord to a suitable AC power source: 90 to 260 volts AC, 47 to 63 Hz, with a capacity in excess of 70 W. The power supply will automatically adjust to voltages within this range.

3. Press the right half of the power switch (marked "1") on the front panel.

4. The instrument at power up briefly displays a sign-on message that indicates the instrument's model number, name and software version. Also, at power up, a self-check is performed and a self-check status messages appear on the bottom line of the display. Refer to figure 2-2 for an example of the power-on display after the self-check has been successfully completed.

Figure 2-2. Power-On Display

5. After the sign-on message, the instrument displays a menu showing the LEVEL setting and the OUTPUT status (see figure 2-3). The Power-On default configuration is 0 dBm for LEVEL and the OUTPUT is OFF.

Figure 2-3. Initialized Display

3. Getting Started

This chapter will introduce the user to the Model 2535. The chapter will identify objects on the front and rear panels, identify display organization, and provide practice exercises for front panel operation. For additional information see **Chapter 4 "Operation."**

3.1 Organization

Subsection 3.2 Operating Controls, Indicators and Connections identifies the control features and connections on the front and rear panels.

Subsection 3.3 LCD Display describes the data fields on the display.

Subsection 3.4 Initialization explains how to turn the instrument on for the first time and the initialized state the instrument will be configured to. See Table 3-3 for initialized parameters and their values.

3.2 Operating Controls, Indicators and Connections

Figures 3-1 and 3-2 illustrate the controls, indicators and connectors on the front and rear panels, respectively. Refer to Table 3-1 for a description of each of the illustrated items.

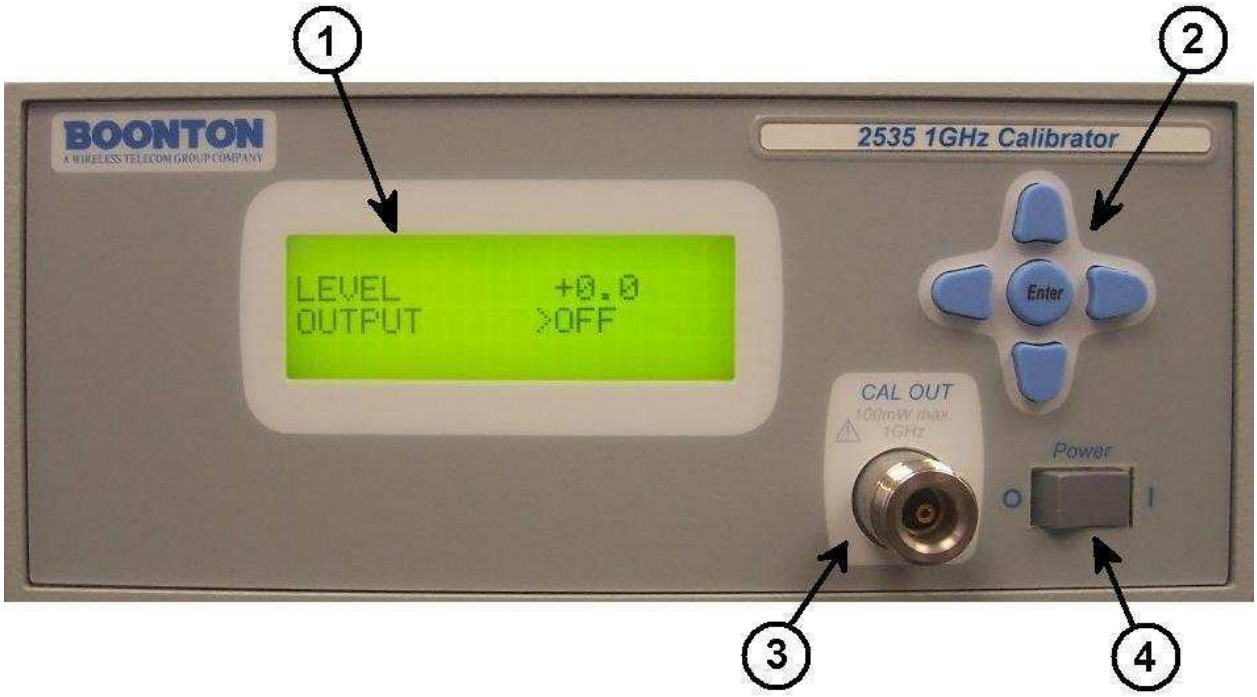


Figure 3-1. Model 2535 1GHz Calibrator - Front Panel

Table 3-1 Operating Controls, Indicators and Connections

Ref. No. Front	Rear	Nomenclature	Function
1		Display screen	80 character (20 x 4) LCD with yellow/green backlight display.
2		Key Pad	Arrow keys and Enter button provides function selection and data entry capabilities.
3		CAL OUT	Type-N connector supplies the 1 GHz calibrator signal.
4		Power switch	O – power OFF, 1 – power ON.

Figure 3-1a. Model 2535 - Front Panel – Key Pad

Table 3-1 Operating Controls, Indicators and Connections *(continued)*

Ref. No. Front	Rear	Nomenclature	Function
2		Key Pad	**ENTER** key. When OUTPUT is the active function this key will toggle the output state ON and OFF. Depressing this key when LEVEL is the active function initiates the data entry mode for setting the signal level. In the data entry mode pressing this key returns the cursor to function selection. **UP ARROW** key**.** Used to select LEVEL as the active function. In the data entry mode this key will increment the active function value or set the sign of the value positive. Holding the key down auto-increments the function value. **DOWN ARROW** key. Used to select OUTPUT as the active function. In the data entry mode this key will decrement the active function value or set the sign of the value negative. Holding the key down auto-decrements the function value. **RIGHT/LEFT ARROW** keys. Used in the data entry mode to navigate the cursor to the desired digit for editing.

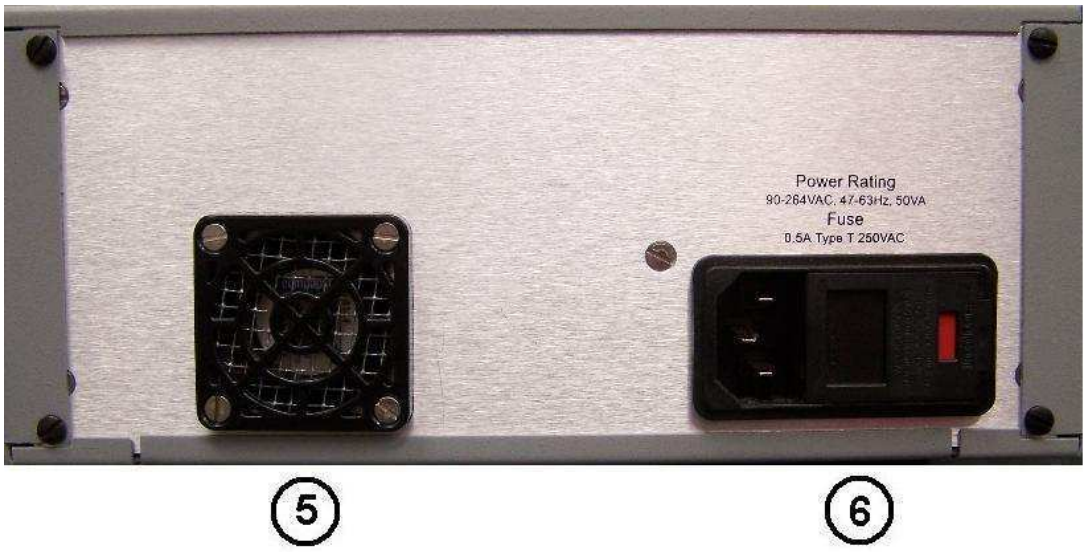


Figure 3-2. Model 4500B - Rear Panel

Table 3-1 Operating Controls, Indicators and Connections *(continued)*

Ref. No. Front	Rear	Nomenclature	Function
	5		Exhaust cooling fan
	6		NEMA power cord connector. Supplies AC power to the instrument. See Subsection 2.2 for power requirements.

3.3 LCD Display

This subsection includes a picture (Figure 3-3) and a table (Table 3-2) of descriptions for the display layout of the Model 2535.

Table 3-2 LCD Monitor Fields

Ref. No.	Field Name	Description
1	LEVEL	Indicates the power level in dBm that the calibrator is set to.
2	OUTPUT	Shows the state of the output signal, either ON or OFF.

Figure 3-3. LCD Display

3.4 Initialize

Ensure that the front panel power switch has been set to the OFF (0) position. Connect the power cord to the rear panel power cord connector. Set the power switch to the ON (1) position. The sign-on message will be displayed including the software version. After power-on and successfully passing Self-Check, the Model 2535 displays the default mode of operation. The default conditions are LEVEL set to 0 dBm and the OUTPUT is OFF.

Table 3-3. Initialized Parameters

Parameter	Default
LEVEL	0.0dBm
OUPUT	OFF

4. Operation

This section presents the control menus and procedures for operating the Model 2535. All the display menus that control the instrument are illustrated and accompanied by instructions for using each menu item.

4.1 OUTPUT Control

At power-on, the OUTPUT is OFF by default and is selected as the active function. OUTPUT is a toggled function. It can be either OFF or ON. To alternate between the two states simply press the Enter key.

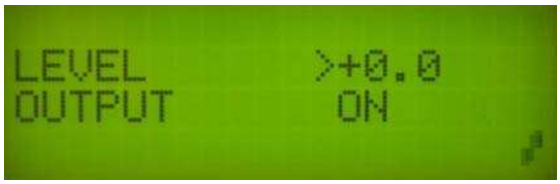
Default Display

Display after pressing the Enter key

4.3 LEVEL Control

The LEVEL function allows for the CAL OUT amplitude to be changed in real time as the displayed value is changed. The level can be incremented or decremented in 10, 1 or 0.1 dB steps. The sign may be changed when the data entry cursor is placed beneath the sign. When the cursor is placed beneath the sign, pressing the up or down arrow keys will cause the sign to toggle between plus and minus. Below is an exercise in changing the level value.

To change the level, navigate the function cursor (great than symbol) to LEVEL. This now makes LEVEL the active function.

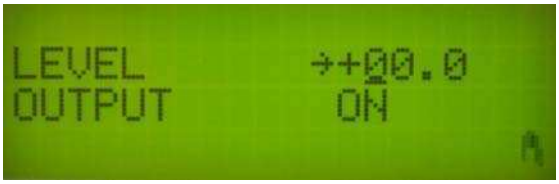


Selecting LEVEL as the active function

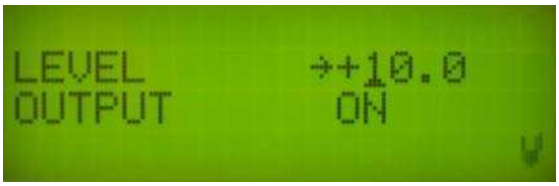
Depressing the Enter key causes the instrument to enter the data entry mode for the LEVEL function. In the data entry mode the function cursor changes to a right arrow. Also, an underline cursor appears beneath the left most digit. The underline cursor signifies the digit to be edited.

LEVEL data entry mode

Use the right arrow key to locate the edit cursor to the first numeric digit. The right and left arrow keys move the edit cursor accordingly.



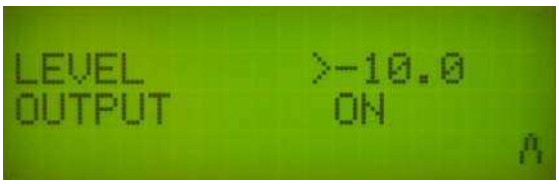
Press the up arrow key to increment the numeric value. Conversely, the down arrow key will decrement the numeric value. As the level value is changed the calibrator is set to output the selected value, in this case +10 dBm.



Navigate the edit cursor to the plus (+) sign.

Press the down arrow to change the sign to minus (-). The calibrator's output is now –10 dBm. Use the up arrow key to change the sign from minus to plus.

Pressing the Enter key leaves the data entry mode and sets the active function to LEVEL.



The above example demonstrates the change of the output signal by 10 dB. However, the level may be incremented of decremented by 1 or 0.1 dB as well. Simply place the cursor under the desired digit prior to using the up and down arrow keys for incrementing and decrementing.

Note the level value is changed in sequential order. For example, when incrementing in 1 dB steps the value to follow +9.0 dBm would be +10.0 dBm.

5. Maintenance

This section presents procedures for maintaining the Model 2535.

5.1 Safety

Although the 2535 has been designed in accordance with international safety standards, general safety precautions must be observed during all phases of operation and maintenance. Failure to comply with the precautions listed in the **Safety Summary** located in the front of this manual could result in serious injury or death. Service and adjustments should be performed only by qualified service personnel.

5.2 Cleaning

Painted surfaces can be cleaned with a commercial spray-type window cleaner or a mild detergent and water solution.

CAUTION

When cleaning the instrument, do not allow cleaning fluid to enter the fan exhaust vents. Avoid using chemical cleaning agents which can damage painted or plastic surfaces.

5.3 Inspection

If the Model 2535 malfunctions, perform a visual inspection of the instrument. Inspect for signs of damage caused by excessive shock, vibration or overheating. Inspect for broken wires, loose electrical connections, or accumulations of dust or other foreign matter.

Correct any problems you discover and conduct a performance test to verify that the instrument is operational. (See section 5.5 Performance Verification). If the malfunction persists or the instrument fails the performance verification, contact Boonton Electronics for service.

5.4 Software Upgrade

The Application Software will be updated from time to time to correct errors and add new features. Software upgrades can only be performed at the factory. If you are experiencing problems with your instrument that requires a software upgrade to fix the problem, make arrangement to have the instrument returned to Boonton Electronic for the necessary software update.

.

5.5 Test Equipment

Table 5-2 lists the equipment required to test the Model 2535. Any substitutions for the recommended test equipment may require you to modify the procedures provided in this subsection.

Table 5-2. Verification Test Equipment

Test	Equipment Description
Calibrator Frequency	Agilent Model 53181A Frequency Counter
Calibrator Linearity	Agilent EPM Series Power Meter Agilent Model 8481A NIST Certified Power Sensor (0.01 to 18 GHz) 15 dB Type N Precision Attenuator
Calibrator 0 dBm Output Power	Agilent Model 432A Analog Power Meter Agilent Model 8478B NIST Certified Thermistor Mount (0.01 to 18 GHz) Agilent Model 34401A Multimeter

5.6 Performance Verification

The verification procedure demonstrates that the Model 2535 is performing according to the specifications published in section 1.6 Specifications. This procedure should be performed when the instrument is first put into service and after making repairs or adjustments. Performance verification should be repeated at least once every twelve months.

Checklist

The verification procedure is outlined in Table 5-2, Verification Checklist. Each time you verify the instrument performance, photocopy the Checklist and record the instrument's performance on the copy to provide a record of instrument history. Attach additional sheets as instructed in the verification procedures.

Fuse Rating

The fuse should be size 3AG, 250 volt, 0.5 amp, Type-T.

Serial Number

The instrument's serial number is printed on the rear panel. Record the instrument serial number on the Checklist.

Control Software Ver

The control software version number appears on the screen at power-up. Record the control software version number on the Checklist.

Calibrator Frequency Verification

Before performing the calibrator frequency and linearity verification procedure, photocopy Table 5-2 and use it to record the measurement data. Attach the completed table to the Checklist.

To verify the calibrator frequency accuracy, proceed as follows:

1. Apply power to the Model 2535. The power-on defaults sets the LEVEL to 0.0 dBm with the OUTPUT set to OFF.
2. Connect the frequency counter to the Model 2535 CAL OUT port.
3. Enable the calibrator output by pressing the Enter key. When the OUTPUT function is active pressing the Enter key toggles the output signal between OFFand ON.
4. Measure the calibrator frequency and record the test result in Table 5-2.

Calibrator Linearity Verification

Verify calibrator linearity by establishing a reference at 0.0 dBm and measuring the error at various test levels in the range from -50 to +20 dBm. The measurement tolerance shown in Tables 5-3a and 5-3b reflect both the specified calibrator performance and the uncertainty of the measurement setup. To avoid the nonlinearity term associated with using the HP8481A at levels above +9 dBm, use a 15 dB pad to attenuate higher calibrator levels to below +5.0 dBm.

Before performing the calibrator linearity verification procedure, photocopy Tables 5-3a and 5-3b and use the copies to record the measurement data. Attach the completed tables to the Checklist.

To verify calibrator linearity:

1. Mount the 8481A sensor on the EPM Power Meter. After the warm up period, calibrate and zero the EPM power meter using its internal 50 MHz calibrator.

2. Disable the calibrator output by selecting OUTPUT > OFF.

3. Connect the 8481A sensor to the Model 2535 CAL OUT connector through the 15 dB precision attenuator.

4. Set the calibrator output level to 0.0 dBm by selecting LEVEL > 0.0 dBm.

5. Enable the calibrator output by selecting OUTPUT > ON.

6. Set a reference on the EPM power meter at 0.0 dBm.

7. Enter the calibrator levels listed in Table 5-3a and record the EPM power meter measurements in the column labeled “Measured.”

8. Disable the calibrator output by selecting OUTPUT > OFF.

9. Remove the 15 dB attenuator and connect the HP8481A sensor directly to the Model 2535 CAL OUT connector.

10. Zero the EPM power meter.

11. Set the calibrator output level to 0.0 dBm.

12. Enable the calibrator output by selecting OUTPUT > ON.

13. Set a reference on the EPM power meter at 0.0 dBm.

14. Enter the calibrator level listed in Table 5-3b and record the EPM power meter measurements in the column labeled “Measured.”

Calibrator 0 dBm Verification

To verify the calibrator 0 dBm RF output power level accuracy:

1. With the 432A power meter off and AC power disconnected, measure the resistance between the center pin of the Vrf connector on the rear panel of the 432A and pin 1 on the thermistor mount end of the 432A interconnect cable with the multimeter. Record the multimeter indication in ohms to two decimal places. The value of the measurement should be approximately 200 ohms. Label this measurement R.

2. Connect the 432A to AC power and set the line switch to ON.

3. Ensure the 2535 calibrator output is off by selecting OUTPUT > OFF. Connect the thermistor mount to the 2535 CAL OUT port. Wait thirty minutes before proceeding to the next step. This will allow the thermistor mount to stabilize.

4. Set the 432A RANGE switch to COARSE ZERO and adjust the COARSE ZERO control to obtain a zero indication on the 432A meter.

5. Set the 432A RANGE switch to –20 dBm and depress the FINE ZERO switch on the front panel.

6. Set the 432A RANGE switch to 0 dBm. Set the multimeter to measure VDC. Connect the positive lead of the multimeter to the center pin of the V_{comp} connector on the 432A rear panel. Connect the negative lead of the multimeter to the center pin of the V_{rf} connector on the 432A rear panel.

7. Depress the FINE ZERO switch on the front panel. Record the multimeter indication in VDC to six decimal places (nearest microvolt). Label this measurement V_0.

Note

The multimeter should read in mVDC. To convert from mVDC to VDC, multiply the multimeter indication by 1000.

8. Set the 2535 calibrator to 0 dBm by selecting LEVEL > 0.0 dBm, OUTPUT > ON. Record the multimeter indication in VDC to six decimal places. Label this measurement V_1.

9. Disconnect the multimeter negative lead from the V_{rf} and connect the lead to the 432A chassis ground. Record the multimeter indication in VDC to four decimal places. Label this measurement V_{comp}.

10. Calculate the 2535 calibrator's 0 dBm power output (Po) using the following formula:

$$P_o = \frac{2V_{comp}(V_1 - V_0) + V_0^2 - V_1^2}{4R(\text{Effective Efficiency})}$$

Where:
P_o = 2535 calibrator's 0 dBm power output
V_{comp} = Value recorded in step 9.
V_1 = Value recorded in step 8.
V_0 = Value recorded in step 7.
R = Value recorded in step 1.
Effective Efficiency = Calibration factor at 1 GHz for the thermistor mount (traceable to NIST).

11. Verify P_o is between 0.985 mW and 1.015 mW.

12. If P_o is in tolerance, record P_o and disconnect all test equipment. If P_o is out of tolerance return the unit to Boonton Electronics for factory calibration. Refer to Appendix A regarding the "Return Policy".

BOONTON MODEL 2535

Table 5-2. Verification Checklist

Check fuse type and rating:	☐ 3AG,250 volt, 1.6 amp, Type-T
Instrument Serial Number	_____.
Control Software Version	_____.
Calibrator Frequency Verification* 1.024 GHz @ 0.0 dBm	1.023900 GHz min. ☐ 1.024100 GHz max.
Calibrator Linearity Verification*	☐
Calibrator 0 dBm Verification	Cal Level _____ dbm

Table 5-3a. Calibrator Linearity - High Power Range			
Cal Level (dBm)	Minimum (dBm)	Measured (dBm)	Maximum (dBm)
20.0	19.84	_____	20.16
15.0	14.84	_____	15.16
10.0	9.84	_____	10.16

Table 5-3b. Calibrator Linearity - Low Power Range			
Cal Level (dBm)	Minimum (dBm)	Measured (dBm)	Maximum (dBm)
5.0	4.9	_____	5.1
-5.0	-5.1	_____	-4.9
-10.0	-10.16	_____	-9.84
-15.0	-15.16	_____	-14.84
-20.0	-20.25	_____	-19.75
-25.0	-25.25	_____	-24.75
-30.0	-30.25	_____	-29.75