SIGNAL GENERATOR
MODEL 2500
OPERATING MANUAL

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USE OF THIS MANUAL

The documentation package for the Wavetek Model 2500 RF Signal Generator consists of an Operating Manual and a Service Manual. This is the Operating Manual. It contains seven sections.

Section 1	Provides general information about the unit, including specifications.
Section 2	Contains detailed installation instructions. Instructions proceed from the initial inspection (after unpacking a unit) to the instrument checkout procedure after installation is completed.
Section 3	Provides operating instructions for the unit.
Section 4	Contains the performance tests used to verify that all functions of the unit work properly.
Section 5	Contains the maintenance instructions for the unit, including the calibration procedure.
Section 6	Contains GPIB documentation.
Section 7	Contains any changes that must be made to this manual. Changes may occur for various reasons. Wavetek's product improvement program incorporates the most current technology into these instruments as rapidly as development and testing will permit. Due to the time required to document and print Operating/Service manuals it is not always possible to include information about product improvements in the original printing for a manual. Engineering updates to address these changes occur in Section 7.

The Service Manual is an optional item. It contains Theory of Operation, Trouble-shooting Notes, Reference drawings (schematics and assembly), and Replaceable Parts Lists. Schematics and their associated assembly drawings are grouped together.

Please note that each of the figures in this text has a ten digit identification number (xxxx-xx-xxxx). For example, the Wavetek identification number for Figure 2-1 is 0012-00-0176. These numbers are for internal use by Wavetek only.

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SECTION 1

GENERAL INFORMATION

1.1 INTRODUCTION

The Wavetek Model 2500 is a microprocessor controlled, single-loop synthesized signal generator that covers the frequency range of 400 kHz to 1100 MHz. Standard features include a very broad 1 MHz peak FM deviation, an exclusive AutoCal® self-calibration function, extensive user diagnostics, an automatic power up test sequence, and 15 non-volatile memory locations. A 10 MHz square wave reference output is available at the rear panel.

All operational controls are located on the front panel. Controls include keypad switches and a spin knob for entry of all RF output numeric parameters. The spin knob provides entry that has the ease and continuity and fine tuning of analog control. Instrument settings are indicated on three custom LCD displays with electroluminescent backlighting.

The 2500 is a space-saving 3/4-rack size. (Two optional rack mount adaptor kits are available.)

A talk/listen GPIB fully conforming to the IEEE-488 standard is installed in the Model 2500. Because it also conforms to proposed IEEE Standard 951, the Model 2500 can be easily conformed to any ATE system.

1.1.1 FREQUENCY CHARACTERISTICS

The carrier frequency may be set from 0.4 to 1100 MHz with a 10 Hz resolution and .00005% (.5 ppm) accuracy.

1.1.2 MODULATION CHARACTERISTICS

The instrument features both internal and external AM and FM capabilities. The internal modulation source may be set at a 400 or 1000 Hz rate. AM depth is specified from 0 to 99.9%. FM deviation can be set from 0 - 500 kHz for carrier frequencies between 137.5 MHz and 275 MHz and from 0 to 1 MHz at all other carrier frequencies. Resolution is from 10 Hz to 1 kHz depending upon the deviation set (see Section 1.2 for greater detail). The external reference input may be a sine or square wave at 1 MHz, 5 MHz, or 10 MHz.

Internal and external sources may be used simultaneously to produce complex modulation.

1.1.3 OUTPUT LEVEL CHARACTERISTICS

The Model 2500 has an RF output range of +13 dBm to -137 dBm with an output level flatness of ±1 dB. The level resolution is .1 dB.

Output level may be read in dBm, mV, or µV. Reverse power protection to 50 watts is standard.

1.1.4 AutoCal®/DIAGNOSTICS

The Model 2500 utilizes a unique Auto Cal® routine to perform a quick and easy almost completely automatic self-calibration. A key is simply inserted into the key-lock located on the rear panel and at turn on the instrument will present the operator with the first in a series of menus to perform the AutoCal® routine or any of the 19 user diagnostics supplied with the unit.

1.1.5 STORED SETTINGS

Nonvolatile memory locations allow up to 15 complete front panel settings to be stored and recalled in any order. This storage permits fast and accurate recall of frequently used settings. The parameters stored in location number 15 may be recalled with one keystroke.

The 2500 powers up with the same settings present when power was removed, except the RF output will be off.

1.1.6 ERROR INDICATORS

The front panel displays for the 2500 indicate the following error conditions:

- An unlocked condition in the phase locked loop circuitry
- An unleveled condition in the RF output leveler circuitry
- A tripped RF circuit breaker
- FM overmodulation

1.2 SPECIFICATIONS

1.2.1 FREQUENCY

Range (MHz)	.4 - 1100
Resolution	10 Hz
Frequency Stability/Temp	±0.5 ppm (±.00005%), 0-50° C
Frequency Stability (Aging)	<1 ppm/yr.
Switching Speed	Typically 200 mSec

1.2.2 RF OUTPUT

Impedance	50Ω
Output Connector	Type "N"
Calibrated Level Range	+13 to -137 dBm
Level Resolution	.1 dB
Level Accuracy	±1.3 dB for power levels >-36.9 dBm; ±(1.3 dB + .1 dB/10 dB step decrease) for power levels <-36.9 dB
Flatness	±1 dB
Leakage	<1 μV into a 2-turn 1 inch diameter loop at 1100 MHz Conforms to MIL-STD-461, Class B, Sections CS01, CS02, CS06, RE02, RS03 (to 1 GHz); VDE 0871, Class B.

1.2.3 SPECTRAL PURITY

Harmonics	<-30 dBc
Sub-Harmonics (550 MHz - 1100 MHz)	<-25 dBc
Non-Harmonics (Spurs) (>5 kHz from carrier)	<-50 dBc for carrier frequencies <137.5 MHz <-60 dBc for carrier frequencies >137.5 MHz

1.2.4 PHASE NOISE @ 500 MHz

10 kHz offset	<-107 dBc/Hz guaranteed (Typ -110 dBc/Hz)
20 kHz offset	Typ <-115 dBc/Hz

1.2.5 RESIDUAL AM

(.05 - 15 kHz PDBW)	<-65 dBc

1.2.6 RESIDUAL FM

(.05 - 15 kHz PDBW)	<30 Hz rms (.4 - 137.49999 MHz) <15 Hz rms (137.5 - 274.99999 MHz) <30 Hz rms (275 - 550 MHz) <60 Hz rms (>550 MHz)
(.3 - 3 kHz PDBW)	<15 Hz rms typical (.4 - 137.49999 MHz) <10 Hz rms typical (137.5 - 274.99999 MHz) <15 Hz rms typical (275 - 550 MHz) <30 Hz rms typical (>550 MHz)

1.2.7 MODULATION

Modes	AM, FM, COMPLEX (EXT AM and INT FM; EXT FM and INT AM)
Internal Source	400 Hz, 1 kHz; derived from frequency standard
External Source	AM Mode: DC to 20 kHz, 600 Ω floating input FM Mode: 20 Hz to 100 kHz, 600 Ω floating input

1.2.7.1 AM CHARACTERISTICS

AM Frequency Response	DC to 15 kHz (Typ to 20 kHz), (3 dB bw, 50% modulation)
AM Resolution	.1%
AM Range	0 - 99.9% (+3 dBm max output at 99.9% modulation)
Modulation Accuracy, AM (0 - 90%)	±1% + (±5% of indicated setting) at internal rates
AM Distortion	<1.5%, below 30% modulation <3%, 30% to 70% modulation <5%, 70% to 90% modulation

1.2.7.2 FM CHARACTERISTICS

FM Resolution	10 Hz (deviations <10 kHz) 100 Hz (deviations <100 kHz) 1 kHz (deviations <1 MHz)
FM Rate	20 Hz - 100 kHz (3 dB bw)
FM Deviation Range for 1 kHz Rate	1 MHz peak (3-137.49999 & >275 MHz) 500 kHz peak (137.5 - 275 MHz) 100 kHz peak (1 - 3 MHz) 10 kHz peak (.4 - 1 MHz)
Modulation Accuracy, FM	At internal rates, ±5% of indicated setting, excluding residual FM
FM Distortion	<2% at internal rates for deviation <100 kHz

1.2.8 FRONT PANEL CONTROL

Type	Push-buttons, Spin-Knob

1.2.9 REVERSE POWER PROTECTION

Max RF Power	50 W
Trip Level	~ .7 W
Trip Time	Typically <1 mSec
Max DC Voltage	50 V

1.2.10 STORED SETTINGS

15 total, non-volatile; complete front panel settings stored

1.2.11 EXTERNAL REFERENCE INPUT (REAR PANEL)

Frequency	1, 5, or 10 MHz
Required Input Level/Impedance	1-5 Vp-p, into 50 Ω
Waveform	Sine or Square Wave

1.2.12 INTERNAL REFERENCE OUTPUT (REAR PANEL)

Frequency	10 MHz
Voltage Out/Impedance	100 mVp-p, into 50 Ω
Waveform	Square Wave

1.2.13 GENERAL

Dimensions	14 cm (5.5 in.) High; 31.8 cm (12.5 in.) Wide; 53.3 cm (21 in.) Deep
Weight	12.57 kg (27.7 lbs.) net; 14.38 kg (31.7 lbs.) shipping
Power	100 or 120, 220 or 240 VAC; 50–400 Hz

1.2.14 REMOTE PROGRAMMING (GPIB)

Interface	IEEE-488
Functions	Full Talk/Listen (Conforms to IEEE Proposed Standard 951 for Codes and Formats)

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SECTION 2

INSTALLATION INSTRUCTIONS

2.1 INTRODUCTION

This section provides complete installation instructions for the Wavetek Model 2500 RF Signal Generator. These instructions include the initial inspection required for the unit and contain information on mechanical installation, electrical installation, and the initial installation checks.

2.2 INITIAL INSPECTION

After unpacking the instrument, visually inspect external parts for damage to connectors, surface areas, etc. The shipping container and packing material should be saved in case it is necessary to reship the unit.

2.2.1 DAMAGE CLAIMS

If the instrument received has been damaged in transit, notify the carrier and either the nearest Wavetek area representative or the factory in Indiana. Retain the shipping carton and packing material for the carrier's inspection. The local representative or the factory will immediately arrange for either replacement or repair of your instrument without waiting for damage claim settlements.

2.3 MECHANICAL INSTALLATION

2.3.1 Mechanical installation instructions are limited to those steps required to install the 2500 into a rack using the optional rack mount adaptor kits available from Wavetek.

2.3.2 Wavetek manufactures two rack mount adaptor kits, one without slides and one with slides. The rack mount adaptor kit without slides (Wavetek part number 1019-00-0278) provides a fixed, immovable unit mount. The rack mount adaptor kit with slides (Wavetek part number 1019-00-0279) allows the unit to be pulled out from the rack.

2.3.3 Complete installation instructions are supplied with the hardware for either kit.

2.4 ELECTRICAL INSTALLATION

The instrument can operate from 100, 110, 220, or 240 VAC supply mains, over an AC supply frequency range from 50 to 400 Hz. The rear-panel AC power connector module selects which of these operating voltages is being used, and adjusts the Power Supplies accordingly.

The AC power connector module connects to an AC supply via a line cord with a 3-prong plug. The module contains a time-delay line fuse: 1 A for 100/120 VAC operation; 0.5 A for 220/240 VAC operation. The fuse and a clearly marked voltage selector are accessed when the fuse/voltage select compartment door is open (see Figure 2-1).

Instruments are shipped from the factory set up for 120 VAC operation unless otherwise specified.

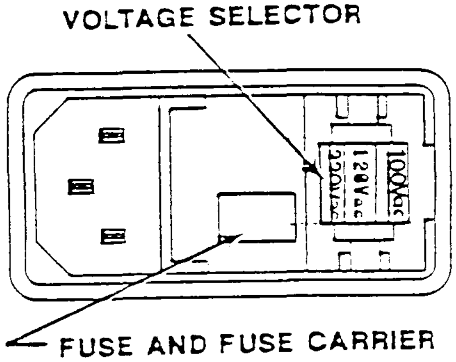

Figure 2-1. AC Power Connector Module

NOTE

Before operating the instrument, check that the rear-panel AC fuse is the correct value for the supply voltage.

2.5 INSTALLATION CHECKS

Wavetek performs a rigorous and complete test/calibration of each 2500 before it leaves the factory. Because accidents can occur during shipment, the user may elect to perform any or none of the following functional checks to further verify proper operation. It is the user's responsibility to determine the degree to which the unit will be tested initially (upon receipt).

Any time power is applied to the Model 2500, it automatically performs a test sequence to verify various subsystems and subsystem circuitry is functional. That power up test sequence is described in Section 5.5 of this manual.

The following installation check procedures provide a quick functional test to verify that the instrument (total system) is operating properly. If the user desires to verify operation at specification limits, the performance test procedures in Section 4 of this manual must be used.

The functional test procedures involve use of the front panel controls and displays. Controls and displays are described in detail in Section 3 of this manual. Please read Section 3 before initiating operation.

AutoCal®, the almost completely automatic self-calibration procedure for the instrument, is contained in Section 5 of this manual. If it is determined that the unit is not operating properly, perform the AutoCal® procedure, then retest.

2.5.1 REQUIRED TEST EQUIPMENT

The test equipment required to perform the following installation checks will depend upon the degree to which the user wants to verify the instrument. If the desire is to verify to specification, the user should proceed to Section 4 and complete the performance tests detailed there. The installation checks described in the next few paragraphs are intended to provide a functional test of the unit. The operator will verify the output frequency, modulation, and power levels are accurate to the limits of the test equipment used and that the output characteristics change when programmed to change. The following tests are general in nature because the operator may use the test equipment on hand (spectrum analyzer, modulation analyzer, oscilloscope, power meter, etc.) to perform them. Wavetek does not recommend specific test equipment to use for these initial functional tests.

2.5.2 TURN ON

Verify that the voltage selector is set to select the available line voltage, and that the proper fuse is installed (see Section 2.4). Verify that the EXTERNAL/INTERNAL REFERENCE switch on the rear panel is in the appropriate position (read Section 3.4, item 3). If the internal reference source is used, this switch must be in the INT position. (If this switch is not in the INT position when the internal reference is used, the power up self test will give an error 18 message and the unit will not operate. Read Sections 5.5 through 5.5.2 for greater detail.) Depress the POWER switch. The displays will indicate operation. The LEVEL display will indicate RF OFF. Press the RF ON/OFF key to turn on the RF.

2.5.3 TEST PROCEDURE

The following paragraphs briefly outline a general functional test procedure for the 2500. Verify measurements to the limits of the test equipment used, if desired.

2.5.3.1 FREQUENCY

Use the keyboard (Section 3.5.2.1) to set the output frequency to 500 MHz at a 0 dBm power level, with no modulation. Measure the output frequency. Use the spin knob (Section 3.5.2.2) to change the output frequency to 1000 MHz. Measure the output frequency. Use the keyboard to set the frequency to 100 MHz. Measure the frequency. Use the spin knob to set the frequency to 200 MHz. Measure the frequency.

2.5.3.2 OUTPUT POWER

Set the output frequency at .4 MHz with no modulation. Use the keyboard to set the output power level at +13 dBm. Measure output power. Use the spin knob to set output power to -7 dBm. Measure the output power. Set the output frequency to 400 MHz. Measure the output power. Use the keyboard to change the output power to +13 dBm. Measure the output power. Set the output frequency to 1100 MHz. Measure the output power. Use the spin knob to change the output power to -7 dBm. Measure the output power.

2.5.3.3 AM

Set the output frequency at .4 MHz and power level at -7 dBm. Select INT AM and the 1000 Hz internal source. Set internal AM at 90%. Measure AM. Change the output frequency to 550 MHz. Measure AM. Select the 400 Hz internal source. Measure AM.

2.5.3.4 FM

Set the output frequency to 275 MHz and the power level at 0 dBm. Select INT FM and the 1000 Hz internal source. Set internal FM deviation at 99.9 kHz. Measure the deviation. Change the output frequency to 500 MHz. Measure deviation. Select the 400 Hz internal source. Measure FM deviation.

2.5.3.5 EXTERNAL AM/FM

The user may elect to insert an external modulation source at the MOD IN connector on the front panel (item 24 of Figure 3-1) and repeat steps 2.5.3.3 and 2.5.3.4 for EXT AM and EXT FM outputs. Select EXT AM and EXT FM by pressing the appropriate keyboard switch.

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SECTION 3

OPERATING INSTRUCTIONS

3.1 INTRODUCTION

This section provides the complete operating instructions for the Wavetek Model 2500 RF Signal Generator. No preparation for operation is required. The user may choose to perform the optional initial installation checks contained in Section 2 of this manual.

The 2500 may be operated locally using the front panel controls or remotely through the GPIB interface on the rear panel, under computer/controller instructions.

3.2 AIR FILTER CAUTION

Regularly check the air flow filter installed over the intake vents on the bottom of the unit. Clean or change as necessary. Air filter maintenance is described in the Maintenance Section of this manual.

3.3 FRONT PANEL DESCRIPTION

Front panel operating controls, displays, and connectors are shown in Figure 3-1. All controls necessary for local (manual) operation of the unit are located on the front panel, with the exception of the "OPERATE/AutoCal® keylock switch and the external reference source selector switch on the rear panel of the unit. Front panel features are identified by number in Figure 3-1. Each numbered feature is briefly described in the following paragraph with the same number.

1. POWER

The power switch turns on/off the 2500.

CAUTION

Allow a 2-second time interval between turning power off and on. The fan has a current protection circuit that turns off if excess current is drawn. If the unit is turned off and on too quickly the surge current could cause the protection circuit to disengage power to the fan, resulting in possible damage to the instrument.

Features numbered 2 through 13 are function controls (keys) and are grouped together into a keypad for operator convenience. Keys numbered 2 through 7 are associated with selecting the modulation source, if any.

2. INT AM

The internal AM key selects the internal amplitude modulation mode of operation and is associated with key 4.

3. EXT AM

The external AM key selects the external amplitude modulation mode. An external source, connected at the MOD IN connector (feature 24) provides the amplitude modulation source.

4. 400/1000

The 400/1000 key determines which internal source rate, 400 or 1000 Hz,

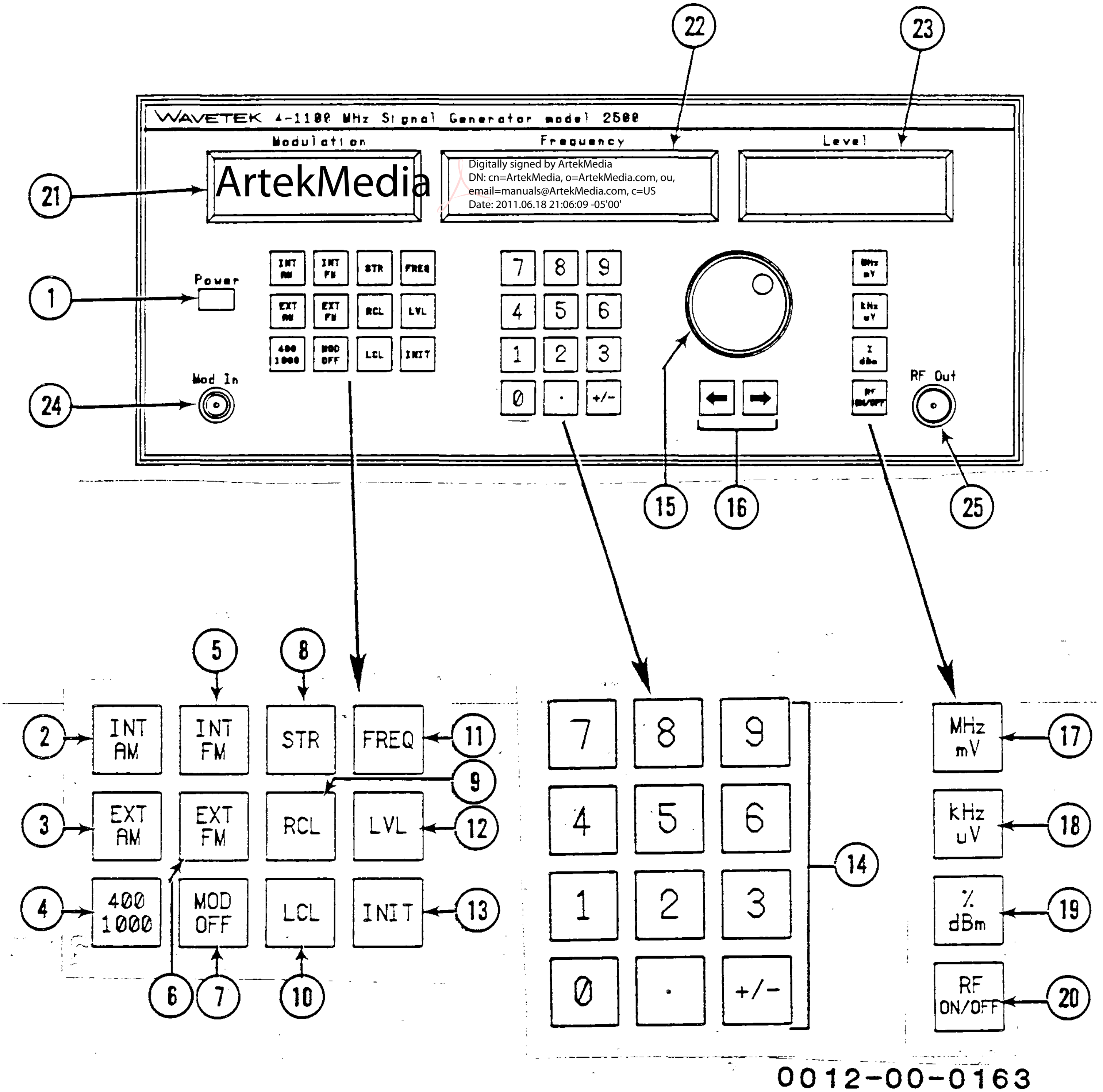

Figure 3-1. Wavetek Model 2500 Front Panel

provides the internal AM modulation selected by key 2, above, or the internal FM modulation selected by key 5, below.

5. INT FM

The internal FM key selects the internal frequency modulation mode of operation and is associated with key 4, above.

6. EXT FM

The external FM key selects the external FM modulation mode. An external source, connected at the MOD IN connector (feature 24) provides the frequency modulation source.

7. MOD OFF

The modulation off key turns off all modulation of the carrier wave, selecting an unmodulated CW RF output.

8. STR

The store key initiates the procedure to store front panel settings in non-volatile RAM (Random Access Memory). There are 15 locations available for stored settings. (See feature 13).

9. RCL

The recall key initiates the procedure to recall front panel settings from storage locations in non-volatile RAM.

10. LCL

If the unit is in the remote control mode of operation (GPIB), the local key may be used to reestablish front panel control of the 2500 from the remote control source. (Please note that GPIB documentation is provided in Section 6 of this manual.)

When the unit is in the Local Mode of operation, the LCL switch turns on/off the display backlighting.

11. FREQ

The frequency key initiates the procedure to establish the RF output carrier frequency.

12. LVL

The level key initiates the procedure to establish the RF output power level.

13. INIT

When the unit is in the Local Mode of operation, the initialize key sets the front panel controls to the values stored as stored setting #15 (see feature 8, above).

When the unit is in the remote mode (GPIB), the INIT key provides an SRQ message to the GPIB bus. (See Section 6 of this manual for greater detail.)

14. NUMERIC ENTRY KEYPAD

Numeric data is entered using the keys grouped together in this 12 key keypad. The digits (0-9) and a decimal point (.) are represented by individual keys. The +/- key is used to establish the sign of an entry (positive or negative).

Features 15 and 16 work together to allow the operator fine and coarse control of output frequency, output level, AM depth (%), and FM deviation (kHz). Use of features 15 and 16 are described in detail later in this chapter.

15. SPIN KNOB

Rotating the spin knob in a clockwise direction will increase the values listed immediately above. Counter-clockwise rotation will decrease those values.

16. ← →

The left and right arrow keys below the spin knob function as cursor keys and establish the digit in a function display (see items 21 through 23) controlled by the spin knob. This "resolution" digit and the digits to its left are controlled by the spin knob. The resolution digit is underlined on the display. Digits to the right of the resolution digit will not change as the spin knob is rotated.

Features 17 through 19 serve to terminate RF frequency, level, and modulation settings.

17. MHz/mV

The MHz/mV key terminates an output frequency (MHz) or output level (mV) entry.

18. kHz/µV

The kHz/µV key terminates output frequency and FM deviation (kHz) and output level (µV) entries.

19. %/dBm

The %/dBm key terminates AM modulation depth (%) and output level (dBm) entries.

20. RF ON/OFF

The RF on/off key is used to switch the RF signal on and off at the RF out connector (feature 25).

Features 21 through 23 are the displays that indicate operational status of the instrument and provide information about the RF output characteristics.

21. MODULATION DISPLAY

The modulation display indicates the modulation status of the output RF signal. The output signal may be unmodulated, CW, indicated by the display annunciator "OFF". The signal may be amplitude (AM) or frequency (FM) modulated, using an internal or external modulating source. The display annunciators are "INT AM", "EXT AM, "INT FM", and "EXT FM" for each AM or FM output. Complex modulation (a combination of AM and FM) may be used. AM is shown on the display as % modulation, FM as kHz deviation. The operator may select an internal modulation rate of 400 or 1000 Hz, with the selected source shown on the display. The numeric value for the AM or FM used is shown on the display. The digit controlled by the spin knob, the resolution digit (see features 15 and 16, above) is underlined on the display.

Finally, the modulation display will show the characters REM when the unit is under remote control.

22. FREQUENCY DISPLAY

The frequency display indicates the frequency of the RF carrier output in MHz. The numeric indicators include an underlined resolution digit used with spin knob control of the frequency (see features 15 and 16, above). This display contains annunciators that indicate an unlocked phase locked loop (UNLOCKED), front panel settings are being stored (STORED), front panel settings are being recalled (RECALLED), and the instrument is performing an automatic frequency calibration (CAL). During automatic calibration the oscillator being calibrated (numbered 1-4) and the various calibration points (1-51, depending on the oscillator) are indicated as calibration proceeds.

23. LEVEL DISPLAY

The level display indicates the level of the output RF signal in dBm, mV, or µV. The numeric indicators include an underlined resolution digit used with spin knob control of the output level (see features 15 and 16). This display also contains annunciators that indicate when the RF circuit breaker is tripped (TRIPPED), when the leveler circuits are not functioning (UNLVD), and whether the RF output is on or off (RF ON/RF OFF).

Features 24 and 25 are input and output connectors, respectively.

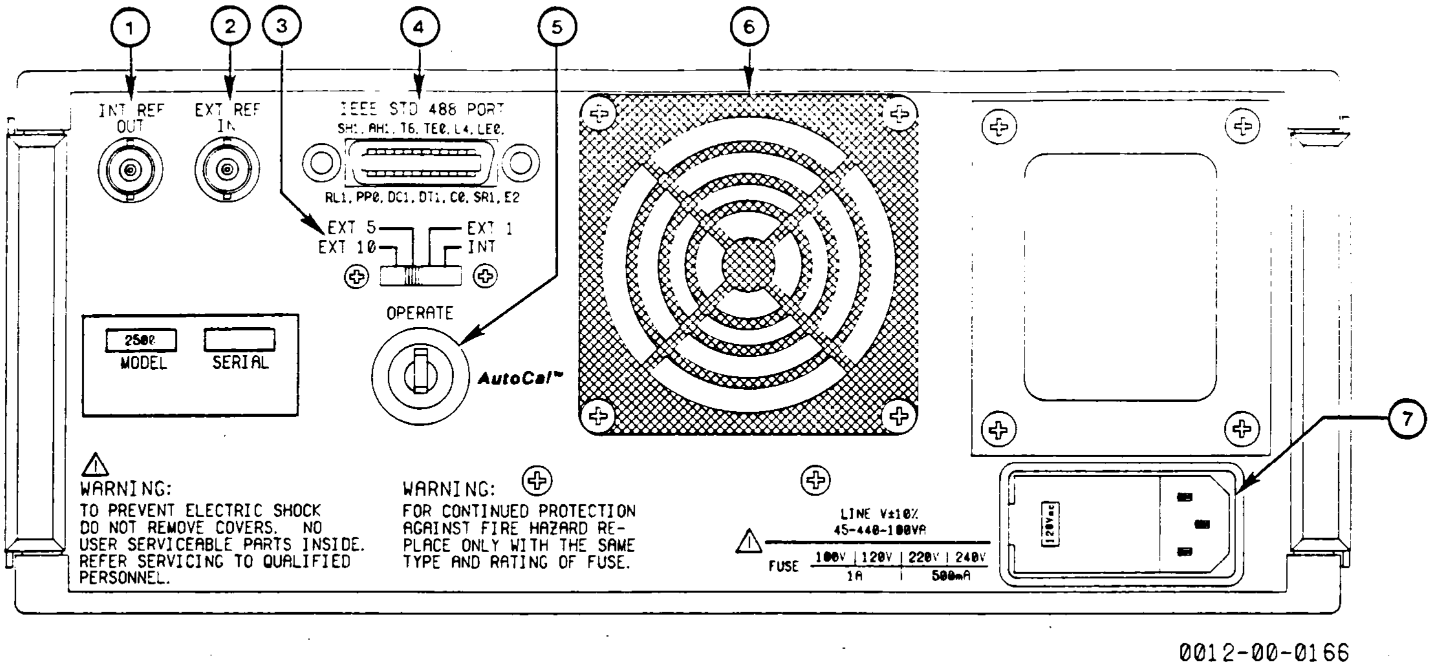

Figure 3-2. Wavetek Model 2500 Rear Panel

24. MOD IN CONNECTOR

The modulation in connector is a BNC connector to which a 1 volt peak-to-peak external modulation source may be applied.

25. RF OUT CONNECTOR

The RF out connector is a type N connector at which the RF output signal is obtained.

3.4 REAR PANEL DESCRIPTION

Rear panel connectors and switches are shown in Figure 3-2. Each numbered feature is briefly described in the following paragraph with the same number.

1. INTERNAL REFERENCE OUT CONNECTOR

This is the connector at which the 10 MHz square wave internal reference signal may be obtained.

2. EXTERNAL REFERENCE IN

This is the connector at which an external 1 MHz, 5 MHz, or 10 MHz signal (sign or square wave) is applied; used in conjunction with feature 3, the external/internal reference switch.

3. EXTERNAL/INTERNAL REFERENCE SWITCH

During operation using an internal reference source, this switch must be in the "INT" (internal) position; when using an external reference source the switch should be at the appropriate "EXT" position: "EXT 1" for 1 MHz, "EXT 5" for 5 MHz; or "EXT 10" for 10 MHz.

4. GPIB CONNECTOR

This is the connector for GPIB communication. It permits instrument operation from a remote controller (documentation for GPIB operation is in Section 6 of this manual).

5. OPERATE/AutoCal® KEYLOCK SWITCH

During normal operation this keylock switch must be in the "OPERATE" position. The "AutoCal®" position permits access to the user diagnostics supplied with the Model 2500, one of which is the almost completely automatic AutoCal® calibration procedure.

(The calibration procedure is described in Section 5 of this manual.)

6. FAN

The fan removes heat from the instrument. Air inlet vents are located on the bottom cover near the front of the unit.

7. AC POWER CONNECTOR MODULE

The voltage selector in this module is removable. It must be inserted in the correct AC line voltage position. When inserted in the correct position it adjusts the unit's power supply accordingly. (See Section 2.4 and Figure 2-1 of this manual for greater detail.)

Please note the electrical shock and fuse replacement warnings on the rear panel. Note also that there are no user serviceable parts inside this unit. Service must be performed by qualified personnel.

3.5 LOCAL MODE OF OPERATION

In the local mode of operation the instrument is controlled from the front panel. The "OPERATE/AutoCal®" rear panel keylock switch must be in the "OPERATE" position. Front panel control involves interaction of the displays, function keys, spin knob, and termination keys. The operator has complete manual control of the instrument from the front panel.

3.5.1 TURN ON

Set the EXT/INT switch (see Section 2.5.2). Depress the power switch to turn on the unit. The unit will power up with the RF output and backlighting off (to turn on the backlighting see 3.3.10). The front panel settings that were active when the unit was last turned off will be active when the unit is turned on again. The automatic power up test sequence described in Section 5.5 will be performed each time power is applied to the unit.

3.5.2 NUMERIC ENTRIES (KEYBOARD AND SPIN KNOB)

The following front panel operations require numeric entry that can be made using the keyboard and/or the spin knob and its associated cursor (← →) keys:

- Setting the output frequency (FREQ)
- Setting the output level (LVL)
- Setting the source and type of modulation (INT AM, INT FM, EXT AM, EXT FM), and its value (% AM or kHz Deviation FM)

3.5.2.1 SEQUENCE OF OPERATIONS

The keyboard/spin knob sequence and the instrument response to the keyboard/spin knob sequence for a numeric entry are:

a. Press the function key (FREQ, LVL, INT AM, INT FM, EXT AM, or EXT FM). After the function is selected, the resolution digit for the spin knob will be indicated on the appropriate display for the function selected.

b. If the spin knob/cursor keys (← →) are going to be used to determine the numeric value for the selected function, they must be used before the numeric keypad (numbers 0-9, decimal point, and +/- key) is used to enter a number. (Operation of the spin knob is described in detail in Section 3.5.2.2, immediately following this section.

c. Either use the spin knob/cursor keys to establish the numeric value to be entered (Section 3.5.2.2) or use the numeric keypad to enter the value for the function. The first keypad number entry will appear in the most significant digit (MSD) of the display for the selected function. Dashes will appear in the remaining digit locations and the decimal point will not appear in the display field. Any suffix will be blanked out. Again, after the first number has been entered using the keypad, the spin knob will be deactivated.

d. Enter the numbers to the left of the decimal point (see e, below). As further numbers are entered, they will be placed to the right of the previously entered digit until the last digit position has been reached. When the last position has been reached, further number entries will be ignored.

e. Enter the decimal, as required. When the decimal key is depressed, the decimal point will be placed to the right of the previously entered digit. The decimal point key can be pressed more than once during a single entry, moving the location of the decimal point. Enter the remaining digits.

f. After the complete number has been entered, the operator must enter a terminator. When the correct terminator key has been pressed, the entered number will be adjusted as required to put it into the standard format. If an insufficient number of digits have been entered, for example, then the display will be filled with zeroes and these will be used for the data entry. The correct suffix will also be enabled. The function will be executed with the new data.

g. The following responses will occur for illegal key entries:

- If an illegal terminator key is depressed, the key entry will be ignored.
- Inadvertently pressing another function key during a numeric entry will enable that function. The function for which the numeric entry was being made will be stored at its previous value.
- If a non-numeric function key (discussed in Section 3.5.4) is depressed, the function will be executed without affecting the numeric entry process. After the non-numeric process has been executed, the numeric entry process will be recalled.
- If the entered data is out of the range of the function, the previous value will be restored to the function and displayed.

3.5.2.2 SPIN KNOB/CURSOR (← →) KEY OPERATION

The SPIN knob in combination with the left and right cursor keys (← →) is used to increase or decrease the numeric value of a function. Clockwise rotation of the knob increases the value; counterclockwise rotation decreases the value. Values for output frequency, power level, internal and external amplitude modulation, and internal and external frequency modulation may be controlled.

a. The ← (left) and → (right) cursor controls are used to select a given digit, the resolution digit, on the chosen function's display. The resolution digit for a particular function can be changed by using the left and right arrow (← →) cursor keys located under the spin knob. The line under the resolution digit will be moved to the left or right to indicate the selected digit. When the LSD (Least significant digit) is reached using the right arrow key, the next depression of the right arrow key will cause a wrap-around to the MSD, (Most significant digit) of the dis- play field. Likewise, when the MSD is reached using the left arrow key, the next depression of the left arrow key will cause a wrap-around to the LSD of the display field. The resolution digit selected for each function controlled by the spin knob will be retained during operation of the 2500 Signal Generator.

b. When the spin knob is turned, the selected resolution digit will increase or decrease. The digits to the left of the resolution digit will be affected by either a carry or a borrow operation and will also increase or decrease, respectively. The digits to the right of the resolution digit will not be affected by spin knob operation. These digits will maintain their previous values during spin knob operation.

Operation of the spin knob/cursor keys permits very coarse control when used with the most significant digit, and very fine control when used with the least significant digit. For example, when the cursor is set to the 10 Hz digit, one turn of the SPIN knob changes frequency by more than 500 Hz.

When the cursor is set to the 100 MHz digit, approximately one-half turn of the SPIN knob changes the frequency from 0.4 to 1100 MHz.

When the upper or lower range limit of a function is reached with the spin knob, the display and the function parameter will stop at that value. Further spinning of the knob in the direction which caused the limit to be reached will not cause any changes of either the display value or the function parameter.

During operation of the spin knob, all error condition indicators will be suspended until the knob has stopped spinning AND the required settling time has been allowed. This includes all UNLEVELED, UNLOCKED conditions, including any error indicators issued to the GPIB.

c. At power-up, the spin knob is activated after the SELF CHECK has been completed. The default function is Frequency and will be indicated by the resolution digit being placed in the least significant digit (LSD) of the frequency display. The LSD is the power-up default position for each of the functions controlled by the knob.

The spin knob is activated for a particular function by depressing the appropriate function key. The function selected will be indicated when a small line is placed under the resolution digit in the appropriate display. If a new function is to be controlled (different from that currently controlled by the knob), when the new function key is pressed the line under the resolution digit of the currently controlled function will disappear and the resolution digit will be indicated in the display for the new function.

If a given function key is pressed and a keyboard numeric entry is made inadvertently, the function key must be pressed again to reenable (reactivate) the spin knob.

d. CAUTION: When the spin knob/cursor keys are used to set the output level, care should be exercised not to overdrive a device being tested.

3.5.3 NUMERIC ENTRY (KEYBOARD ONLY)

The 2500 contains fifteen (15) locations in memory for storage of 15 different sets of front panel settings. These locations are identified by a two digit number (01-15). The function keys STR and RCL (items 8 and 9 of Figure 3-1) are used to initiate storage or recall, respectively, of the front panel settings at a given location. The numeric keyboard is used to specify the two digit location. Refer to Section 3.5.6.1 for a detailed discussion of the STORED SETTINGS feature.

3.5.4 NON-NUMERIC ENTRY

Five functions do not require a numeric entry. These functions are direct action functions. The desired operation will be executed when the key is depressed. The functions are:

- Internal modulation source (400/1000) selection
- Selection of the CW unmodulated output (MOD OFF)
- Local mode selection (LCL)
- Switching the RF output on and off (RF ON/OFF)
- Initialization with the settings stored at setting #15 (INIT)

The 400/1000 and RF ON/OFF functions are controlled by toggle switches. When the key is depressed the function toggles between the two possibilities shown.

The MOD OFF, LCL, and INIT keys select particular functions. When one of these keys is depressed, the function is executed and the appropriate annunciator(s) is displayed. The LCL and INIT keys are dual function keys (see Section 3.3, numbers 10 and 13, if necessary).

3.5.5 SETTING RF OUTPUT CHARACTERISTICS (FREQUENCY, LEVEL, MODULATION)

The three basic RF output characteristics are frequency, level, and modulation. Each can be set from the front panel. This section describes the procedures to set each characteristic when the unit is in the Local Mode of operation. GPIB (Remote Mode) operation is described in Section 6 of this manual.

3.5.5.1 FREQUENCY

The output RF frequency of the 2500 is set using the keyboard/spin knob sequence described in Section 3.5.2, Numeric Entries (Keyboard and Spin Knob).

Press the FREQ function key to initiate a change in frequency. Then enter the numeric value using the keyboard or spin knob/control cursors as described in Section 3.5.2.

The legal terminators for numeric entry of frequency are kHz and MHz. Output frequency is shown on the frequency display.

When FM (Frequency Modulation) is selected and a frequency change $\geq$10 kHz is to be made, the 2500 will be momentarily set to the CW mode. After the frequency change has been made and the generator has stabilized, the original FM output will be restored. (A frequency change <10 kHz will not turn off the modulation.) When the spin knob is used to change the frequency, the modulation will not be restored until the spin knob has stopped.

3.5.5.2 POWER LEVEL

The RF output power level of the 2500 is set using the keyboard/spin knob sequence described in Section 3.5.2.

Press the LVL function key to initiate a change in output level. Enter the numeric value for the required output using the keyboard or spin knob/control cursors (Section 3.5.2). Terminate the entry using the dBm, mV, or µV key. Output level will be shown on the Level display.

The operator can convert dBm to mV or µV by pressing the LVL function key, then pressing the mV or µV key. The conversion from mV or µV to dBm is performed by pressing the LVL key followed by pressing the dBm key.

CAUTION: When the spin knob/cursor keys are used to set the output level, be careful not to overdrive a device being tested.

3.5.5.3 MODULATION

The MOD OFF key selects a CW (unmodulated) output of frequency and level as set in Sections 3.5.5.1 and 3.5.5.2, respectively.

Modulation of the 2500 RF output signal is set using the keyboard/spin knob sequence described in Section 3.5.2.

There are three basic modes of modulation that may be selected using the function keys. They are:

- AM, Internal or External
- FM, Internal or External
- Complex, AM and FM together

A single form of modulation (AM, internal or external; FM, internal or external) is established by pressing the function key associated with the described form of modulation (INT AM or EXT AM or INT FM or EXT FM). The numeric value for the modulation depth (AM) or deviation (FM) is then set using the keyboard/spin knob (described in Section 3.5.2). The single modulation is executed by pressing the appropriate terminator key (% for AM; kHz for FM).

Section 1.2.7.1 of this manual lists the Model 2500 specified AM range. An AM depth greater than 99.9% is outside the specified range. Section 1.2.7.2 lists the Model 2500 specified deviation range for FM operation. A deviation greater than 10 kHz in the frequency range from .4 MHz to 1 MHz, for example, is outside the specified range. AM or FM operation outside specified ranges may produce one or more of the front panel messages described in Sections 3.6 and 3.7 of this manual.

The following combinations of complex modulation are possible:

- INT AM and EXT FM
- INT FM and EXT AM

The order in which internal and external modulation is entered is not important.

Modulation characteristics will be shown on the Modulation display. Of course the characteristics for the first entry of a modulation combination will be replaced by those for the second modulation when the second is entered.

The operator must choose between internal modulation sources of 400 and 1000 Hz using the 400/1000 function key (item 4 on Figure 3-1).

To obtain a calibrated output, an external modulating signal of 1 volt peak-to-peak (0.353 RMS) into a 600Ω load must be provided.

NOTE

If the external modulating signal is not 1 volt peak-to-peak, the output will not be a calibrated output.

3.5.6 STORAGE/RECALL OF FRONT PANEL SETTINGS

There are 15 memory locations set aside for storage of 15 complete front panel settings (output frequency, level, and modulation settings). The function keys associated with this dedicated memory are the STR (store), RCL (recall), and INIT (initialization) keys. Each is described below.

3.5.6.1 STORED SETTINGS (STORAGE AND RECALL)

a. To store the current front panel settings the following key sequence is used.

1) Press the STR function key. The word "STORED" will appear on the Frequency display. The last location into which front panel settings were stored also will be displayed.

2) Enter the two digit number that designates the storage location. Location 3 would be entered as "0" and "3". When the first digit is entered, a decimal point and a series of dashes will be displayed after the first digit. When the second digit is entered the two digit location will be displayed. During location entry, the spin knob is disabled and the previous function controlled by the spin knob is redisplayed without the cursor.

3) When the final location digit is entered, the current front panel settings are stored at that location.

b. To recall a stored setting:

1) Press the RCL function key. The word "RECALLED" will appear on the Frequency

display. The last location from which front panel settings were recalled will be indicated on the display.

2) Enter the two digit number identifying the location from which recall is to be performed. After entry of the first digit the display will show the digit entered, a decimal point, and a string of dashes. After the second digit is entered the frequency display will show the two digit location entered. The front panel settings that were recalled will be executed by the 2500 and the Modulation and Level displays will be updated to show the recalled settings. To show the updated Frequency information in the Frequency display, press the FREQ function key.

3) The spin knob is disabled during recall location entry.

c. The following responses will occur for illegal key entries:

1) If a terminator, sign, or decimal point key is depressed, the key will be ignored.

2) If any function key associated with a numeric entry is pressed, then that function is enabled and the frequency is displayed.

3) If a function key not associated with a numeric entry is pressed, the function will be executed. After the non-numeric process has been executed, the storage/recall process will be re-entered.

4) If the stored setting number is out of range, the entry is ignored. The display returns to that shown when awaiting the stored or recalled setting number.

3.5.6.2 UNIT INITIALIZATION

The INIT key will recall and execute the front panel settings stored in location 15 by the procedures outlined above (Section 3.5.6.1 a).

3.5.7 RETURN TO LOCAL MODE OF OPERATION FROM REMOTE (GPIB)

The LCL key will cause the 2500 to exit the Remote Mode (GPIB) of operation and return to full front panel operation (Local Mode).

When the unit is in the Remote Mode, the REM indicator is shown on the Modulation display. The front panel keys (except for LCL and INIT) and the spin knob are disabled. The LCL key is disabled if the local lockout command is received over the GPIB. (GPIB operation is described in Section 6 of this manual.)

3.6 OPERATOR ERROR MESSAGES

The Model 2500 is the easiest to operate RF signal generator in its class. Nevertheless there are several types of operator error possible with this instrument. Operation of the instrument outside its specified range may generate one or more of the following front panel display messages.

3.6.1 UNLOCKED (on FREQUENCY display)

An "UNLOCKED" message on the FREQUENCY display may indicate the EXTERNAL/ INTERNAL REFERENCE SELECT SWITCH on the rear panel (item 3 of Figure 3-2) has been accidentally placed in the wrong position. Check this switch if the unlocked message occurs. (The UNLOCKED message also may indicate a calibration is due -- see Section 3.7, below.)

3.6.2 TRIPPED (on LEVEL display)

A "TRIPPED" message on the LEVEL display indicates the operator has connected an external input to the 2500 RF output, tripping the RF circuit breaker that provides reverse power protection. If this occurs, remove the external input and then turn off the 2500 and then turn it on to reset the circuit breaker.

3.6.3 MODULATION DISPLAY BLINKS ON/OFF

A blinking (on/off) MODULATION display indicates the operator has over modulated the RF output, saturating the phase detector in the phase lock circuit. Maximum allowable FM deviation (ΔF_{max}) is a function of modulation rate (f_m) and carrier frequency (f_o). The relationship is given by:

$\Delta F_{max} = 4\ (f_m)\ (f_o)$; for $f_o > 137.5$ MHz

$\Delta F_{max} = 4\ (f_m)\ (500 - f_o)$; for $f_o <$ 137.5 MHz

For the above equations, f_o must be in units of MHz; F_{max} and f_m may be in Hz, kHz, etc. as long as both are in the same units.

Modulation rate and carrier frequency determine the maximum FM deviation that may be applied. For example, with a carrier frequency of 300 MHz and a deviation rate of 100 Hz, the maximum FM modulation that may be used is:

$$\Delta F_{max} = 4\ (100\ \text{Hz})\ (300)$$

$$= (400\ \text{Hz})\ (300)$$

$$= 120{,}000\ \text{Hz} = 120\ \text{kHz}$$

If an operator attempts to apply 140 kHz FM the over modulation indication will occur. The operator must reduce deviation below the level indicated in the appropriate ΔF_{max} equation. Changes in the carrier frequency and/or modulation rate may be made to change the amount of FM modulation possible.

If the spin knob is used to set a permitted modulation (less than or equal to ΔF_{max}), over modulation may occur if the operator overshoots the desired value. Because of hysteresis in the system, reducing the modulation below the desired value will be necessary to erase the over modulation indicator.

The operator also may set modulation at the desired level and then turn off the modulation and then turn it on again.

3.7 CALIBRATION DUE INDICATORS

There are two front panel display messages that may indicate the 2500 is out of calibration.

3.7.1 UNLOCKED (on FREQUENCY display)

The "UNLOCKED" message on the FREQUENCY display may indicate the phase locked loop in the output frequency generating circuitry has become unlocked. If the "UNLOCKED" message occurs the operator should first verify the EXTERNAL/ INTERNAL REFERENCE SELECT switch is set properly (see 3.6.1, above). If it is set properly, the operator should perform the calibration described in Section 5.3 of this manual. (If this procedure does not erase the UNLOCKED indicator, the unit has a problem that will require troubleshooting. Wavetek offers an optional Service Manual that includes information useful to troubleshoot/repair the Model 2500. Wavetek recommends returning the unit to the factory for repair, after factory authorization, unless the customer has highly qualified maintenance personnel that are experienced at RF repair work.)

3.7.2 UNLVD (on LEVEL display)

The "UNLVD" message on the LEVEL display may occur in three cases, two of which represent normal, no fault conditions.

The UNLVD message may appear when the RF is turned off or when the operator sets the output for 99.9 - 100% AM. Both of these cases require the output power leveling circuitry to operate outside its normal operating range. Neither of these UNLVD messages require an operator response.

The UNLVD message also may indicate the output amplifier/leveling circuitry is out of calibration. If the UNLVD message occurs and the RF is on with AM not set at 99.9 - 100% depth, the operator should perform the calibration described in Section 5.3 of this manual. (If this procedure does not erase the UNLVD message, the unit has a problem that will require troubleshooting. Wavetek offers an optional Service Manual that includes information useful to troubleshoot/ repair the Model 2500. Wavetek recommends returning the unit to the factory for repair, after factory authorization, unless the customer has highly qualified maintenance personnel that are experienced at RF repair work.)

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SECTION 4

PERFORMANCE TESTS

4.1 INTRODUCTION

This section contains the performance tests to verify that the Wavetek Model 2500 RF Signal Generator meets its published specifications (Section 1.2).

These tests will be performed with the unit in the Local Mode of operation (GPIB testing is described in Section 6 of this manual.)

Individual performance tests consist of: the specification to be verified; the method of testing; the test equipment required; and a detailed test procedure.

If a performance test cannot be completed satisfactorily the AutoCal® procedure of Section 5 should be performed and the test repeated. If the test is failed again, after auto calibration, the factory calibration and/or troubleshooting must be performed. The user may purchase a Model 2500 Service Manual from Wavetek that contains the theory of operation for the unit, reference drawings, and replaceable parts lists, to aid in troubleshooting.

The user may elect to return the unit to the factory for factory recalibration and/or repair, after authorization. The Customer Service Department at the factory is available for consultation during the regular work week.

Recommended test equipment is listed in Table 4-1. Test equipment required for each procedure is identified in each procedure by number(s) from Table 4-1.

The Model 2500 Signal Generator should have its top and bottom covers installed for the performance tests. All of the tests can be performed without access to the internal controls. Before applying power to the Signal Generator, see Section 2 for details of electrical installation. The line voltage should be maintained as specified in Section 2.4 throughout the tests. Allow a one-hour warmup of the Signal Generator before beginning the performance test procedures.

A copy of a sample Performance Test Record (PTR) is provided at the end of this section. Record the performance of the Signal Generator during performance tests on this or a similar form. It can be filled out and used as a permanent record for incoming inspection, or it can be used as a guide for routine performance testing. The PTR lists the section, test, and specification limits. All tests refer to this record.

TABLE 4-1. RECOMMENDED TEST EQUIPMENT

INSTRUMENT	RECOMMENDED
(1) Signal Generator	Wavetek Model 2500 or equivalent
(2) Oscilloscope	Tektronix 465 or equivalent, with matched X10 probes
(3) Frequency Counter	Hewlett-Packard Model 5383A with external reference time base accuracy of ±5 parts in 10^8, or equivalent
(4) DVM	Fluke Model 8010A, or equivalent
(5) Spectrum Analyzer	Tektronix 496, 492, or equivalent H-P 8559A, or equivalent
(6) Spectrum Analyzer	Hewlett-Packard 8568, or equivalent
(7) Modulation Analyzer	H-P 8901A (if an equivalent is used a counter may be needed)
(8) Measurement Receiver	H-P 8902A, with sensor module 11722A, or equivalent
(9) Power Meter	H-P 436A, with Power Sensor 8482A, or equivalent
(10) Function Generator	Wavetek Model 20 or equivalent
(11) Audio Analyzer	H-P 8903A, or equivalent
(12) VSWR Bridge	Wiltron Model 60N50, or equivalent
(13) Sweep Generator	Wavetek Model 2002A, or equivalent

4.2 FREQUENCY RESOLUTION AND RANGE TEST

SPECIFICATION

MIN FREQ	MAX FREQ	RESOLUTION
.4 MHz	1100 MHz	10 Hz

METHOD

A frequency counter is used to measure frequency resolution and range. The 2500 spin knob and cursor keys (see Section 3.4.2.2) are used to step through the frequency range to verify spin knob/cursor operation. Frequency resolution may be varied from 10 Hz to 100 MHz, depending upon which digit is established as the resolution digit.

EQUIPMENT

(3)

PROCEDURE

1. Put the unit into the Local Mode of operation. Connect the Model 2500 front-panel RF OUT connector to the appropriate input of the frequency counter. Use the MOD OFF key to select a CW output. Turn on the RF output.

2. Use the spin knob and cursor keys to step through each frequency range shown in the following table. The underlined digit in each range is the resolution digit for that range. The value of the resolution digit will be increased one step (one unit) at a time until the entire range is verified. The Model 2500 resolution per step in each range is indicated below. Read the frequency counter after each step change. Verify the counter shows the same frequency as that set on the Model 2500, to within the specified accuracies of the counter and the 2500. Record the frequency counter values for minimum (.4 MHz) and maximum (1100 MHz) frequencies.

FREQUENCY RANGES (MHz)	2500 RESOLUTION
0.40000 - 0.40010	10 Hz
0.40010 - 0.40100	100 Hz
0.40100 - 0.41000	1 kHz
0.41000 - 0.50000	10 kHz
0.50000 - 1.00000	100 kHz
1.00000 - 10.00000	1 MHz
10.00000 - 100.00000	10 MHz
100.00000 - 1100.00000	100 MHz

3. Use the numeric keypad (see Section 3.4.2.1, if necessary) to enter a frequency output of 0.4 MHz. The frequency counter should indicate a value between 399.9998 kHz and 400.0002 kHz. Use the numeric keypad to enter a frequency output of 1100 MHz. The frequency counter should indicate a value between 1,099,999.450 kHz and 1,100,000.550 kHz.

4. Verify that the frequency counter values recorded in step 2, above, for .4 MHz and 1100 MHz outputs are within 399.9998 kHz to 400.0002 kHz and 1,099,999.450 kHz to 1,100,000.550 kHz, respectively.

4.3 FREQUENCY ACCURACY TEST

SPECIFICATION

All modes (CW, AM, and FM): ±0.5 ppm (±.00005%), 0 - 50° C

METHOD

A frequency counter is used to measure frequency accuracy. All carrier frequencies are derived from a single temperature compensated crystal-controlled oscillator (TCXO). The instrument will be tested at 500 MHz (CW) to verify that the crystal-controlled oscillator operates within specified limits. The user may pick a frequency value in each of the four frequency ranges to verify the Model 2500 frequency conversion circuitry.

EQUIPMENT

(3)

PROCEDURE

1. Set the 2500 CW output at 500 MHz. Use the frequency counter to verify the frequency output is between 499,999.750 kHz (499.999750 MHz) and 500,000.250 kHz (500.000250 MHz).

2. Set the 2500 CW output for a value between .4 MHz and 137.5 MHz. Record the chosen value. Use the frequency counter to verify that the frequency output is within ± .00005% of that value. For example, if the 2500 output is set at 70 MHz the frequency counter should read between 69999.965 kHz (69.999965 MHz) and 70000.035 kHz (70.000035 MHz).

3. Set the 2500 CW output for a value between 137.5 MHz and 275 MHz. Record the chosen value. Use the frequency counter to verify that the frequency output is within ± .00005% of the chosen value. For an output value of 200 MHz, the frequency counter should read between 199,999.900 kHz (199.999900 MHz) and 200,000.100 kHz (200.000100 MHz).

4. Set the CW output for a value between 275 MHz and 550 MHz. Record the chosen value. Use the frequency counter to verify that the frequency output is within ± .00005% of that value. For an output value of 400 MHz, the frequency counter should read between 399,999.800 kHz (399.999800 MHz) and 400,000.200 kHz (400.000200 MHz).

5. Set the CW output for a value between 550 MHz and 1100 MHz. Record the value. Use the frequency counter to verify the output frequency is within ± .00005% of the chosen frequency. For an output value of 800 MHz, the frequency counter should read between 799,9999.600 kHz (799.999600 MHz) and 800,000.400 kHz (800.000400 MHz).

4.4 HARMONICS TEST

SPECIFICATION

< -30 dBc

METHOD

A spectrum analyzer is used to determine levels for the second and third harmonics associated with the output frequency range of the Model 2500.

EQUIPMENT

(5)

PROCEDURE

1. Set the 2500 output for .4 MHz frequency at a +13 dBm level.

2. Connect the spectrum analyzer. Use the spin knob/cursor keys (see Section 3.4.2.2, if necessary) to establish the 10 kHz digit (0.40000) as the resolution digit and then increase the frequency from .4 MHz to 10 MHz in 10 kHz steps. Monitor the second and third harmonics on the analyzer at each step. Record the worst case. It should be less than -30 dBc.

3. Set the resolution digit at 1 MHz (10.00000 MHz) and increase the output frequency from 10 MHz to 1100 MHz in 1 MHz steps. Monitor the second and third harmonics at each step. Record the worst case. It should be less than -30 dBc.

4. Set the 2500 output level at +3 dBm and repeat steps #2 and #3, described above.

5. Set the 2500 output level at -7 dBm and repeat steps #2 and #3, described above.

4.5 NON-HARMONICS TEST

SPECIFICATION

<-50 dBc for carrier frequencies <137.5 MHz
<-60 dBc for carrier frequencies >137.5 MHz
(at offset greater than 5 kHz from carrier in either carrier frequency range)

METHOD

A spectrum analyzer is used to measure non-harmonics at -7 dBm and 0 dBm output levels.

EQUIPMENT (5)

PROCEDURE

1. Set the 2500 for a 50 MHz output signal at a -7 dBm level. Set the spectrum analyzer for a 50 - 550 MHz sweep.

2. Use the spin knob/cursor keys (Section 3.4.2.2) to increase frequency in 0.1 MHz steps from 50 MHz to 137.5 MHz. Check each step for non-harmonics. Record the location (frequency) and level for the worst case.

3. Set the 2500 for a 551.26 MHz output signal at a 0 dBm level. Set the spectrum analyzer for a 100 kHz/division sweep width centered at 551.26 MHz. Record the worst case sideband level and location.

4. Repeat step 3 with the 2500 output set at each of the frequencies shown below and spectrum analyzer centered at each of the frequencies shown below. Record the worst case sideband level and location for each frequency.

a. 653.26 MHz
b. 655.26 MHz
c. 777.26 MHz
d. 781.26 MHz
e. 925.26 MHz
f. 926.26 MHz
g. 1099.26 MHz

4.6 SUB-HARMONICS TEST

SPECIFICATION -25 dBc for frequencies > 550 MHz.

METHOD A spectrum analyzer is used to measure sub-harmonics at +13 and -7 dBm output levels in the frequency range from 551 to 1100 MHz.

EQUIPMENT (5)

PROCEDURE

1. Set the 2500 at a 551 MHz output frequency (fo = 551 MHz) and a +13 dBm power level. Use the spectrum analyzer to check sub-harmonic levels at 1/2 the carrier frequency (1/2 fo = 275.5 MHz) and 3/2 the carrier frequency (3/2 fo = 826.5 MHz). Record the sub-harmonic levels.

2. Use the 2500 spin knob to increase the output frequency to 1100 MHz, carefully monitoring 1/2 fo and 3/2 fo as the output frequency increases. The sub-harmonic frequencies in MHz for each 30 MHz value from 560 MHz are shown below.

fo	1/2 fo	3/2 fo
560	280	840
590	295	885
620	310	930
650	340	930
680	355	1020
710	355	1065
740	370	1110
770	385	----
800	400	----
830	415	----
860	430	----
890	445	----
920	460	----
950	475	----
980	490	----
1010	505	----
1040	520	----
1070	535	----
1100	550	----

Record the worst case sub-harmonics level(s) and location(s).

3. Repeat step 1, above, with the 2500 output level set at -7 dBm.

4. Repeat step 2, above, with the 2500 output level set at -7 dBm.

4.7 PHASE NOISE TEST

SPECIFICATION

< -107 dBc/Hz at 500 MHz; 10 kHz offset from carrier frequency .4 - 550 MHz

METHOD

An H-P 8568 (or equivalent) spectrum analyzer is used to measure phase noise at 550 MHz.

EQUIPMENT

(6)

PROCEDURE

1. Set the 2500 output to a frequency of 550 MHz and a 0 dBm level, with no modulation. Connect the H-P 8568 spectrum analyzer (or equivalent). Center the analyzer at 550 MHz.

2. Set the analyzer at the following values:

   50 kHz span
   1 kHz resolution BW
   30 Hz video BW
   0 dBm reference level

3. Press the following analyzer key sequence to reference the 2500 output signal to the graticule of the analyzer CRT display:

a. "Peak search"
b. "Mkr→Ref level"
c. "Signal track"
d. "OFF"

4. Press the following analyzer key sequence to measure phase noise in a 1 Hz BW:

a. "Shift"
b. "Normal" (Marker)
c. "↑"
d. "↑" (again)

5. Read the phase noise value directly from the analyzer CRT display. It should be more than 101 dB below the reference level (shown at the top of the display).

4.8 SWITCHING SPEED TEST

SPECIFICATION

Typically 200 mSec

METHOD

An H-P 8568 spectrum analyzer, or equivalent, will be used to measure switching speed over two frequency changes.

EQUIPMENT

(6)

PROCEDURE

1. Set the 2500 for a 550 MHz output at a 0 dBm level, with no modulation.

2. Set the H-P 8568 spectrum analyzer at the following values, then connect the 2500:

a. 550.5 MHz center frequency
b. 0 dBm reference level
c. 300 kHz resolution BW
d. 100 kHz video BW
e. 0 Hz span
f. 1 Sec sweep time

3. The spectrum analyzer CRT display will be used to indicate switching speed as the 2500 changes frequency from 550 MHz to 550.1 MHz and back again. The frequency change must begin at the same time as an analyzer trace (sweep) begins (step 4, below). The "VIEW" key on the analyzer must be pushed before the end of the same sweep (step 5, below).

4. Use the 2500 numeric keypad sequence (Section 3.4.2.1) to select a frequency change (press "FREQ" key), then enter a frequency value of 550.1 (press the appropriate numeric/decimal keys), and finally enter the terminator (press "MHz" key) at the beginning of a CRT sweep.

5. Push the "VIEW" key before the end of the sweep at which the 2500 "MHz" terminator key was pushed (step 4). Performing step 4 and this step requires use of both hands, one for the 2500 and one for the analyzer.

6. Note the transient character of the "stored" analyzer sweep. The trace should have settled (returned to reference level) in less than 2 horizontal screen divisions (200 mSec).

7. Push the "clear/write" key on the spectrum analyzer to clear the stored CRT display.

8. Repeat step 4 above, except enter a 2500 frequency of 550 MHz.

9. Repeat steps 5 - 7, above.

10. Set the 2500 for a 389 MHz output. Set the analyzer at a center frequency of 389.1 MHz. (The remaining values are set as shown in steps 1 and 2, above.)

11. Repeat step 4, above, except set the 2500 at a 389.1 MHz output.

12. Repeat steps 5 - 7, above.

13. Repeat step 4, above, except set the 2500 at a 389 MHz output.

14. Repeat steps 5 - 7, above.

15. Disconnect the spectrum analyzer.

4.9 AM PERFORMANCE TESTS

SPECIFICATION

AM Accuracy	at 90% AM = 84.5 - 95.5% at 70% AM = 65.5 - 74.5% at 30% AM = 27.5 - 32.5%
Distortion	at 90% AM = < 5% at 70% AM = < 3% at 30% AM = < 1.5%

AM Bandwidth

From reference 1 kHz to 15 kHz: < 3 dB change at 50% AM

METHOD

An audio analyzer and a modulation analyzer or a measurement receiver will be used to measure AM accuracy and distortion at three modulation levels for +3 dBm and -7 dBm output levels. A function generator will then be used to help measure frequency response (AM bandwidth) over an external 1 kHz to 15 kHz modulation rate at 50% AM.

EQUIPMENT

(7) and (11) and (10); or (8) and (11) and (10)

PROCEDURE

1. There are a variety of modulation analyzers and measurement receivers on the market that measure AM accuracy and distortion. Some audio analyzers also contain an audio generator. The user must modify the following procedure according to the equipment available.

2. Make the following connections, as appropriate. Connect the 2500 output to the modulation analyzer. Connect the audio output of the modulation analyzer to the audio analyzer input. Connect the function generator output to the external modulation input of the 2500.

3. AM accuracy and distortion will be measured together at the modulation and power levels identified below. AM frequency response (bandwidth) will be tested later in this procedure (starting with step 15 below).

4. Set the 2500 for an output frequency of 11 MHz, internal AM, and modulation at the 1 kHz rate. Set the output power level at +3 dBm. Set AM for 90%.

5. Press the "+PK and "-PK" control buttons on the modulation analyzer and record modulation accuracy. Calculate average accuracy as: $\frac{(+PK) + (-PK)}{2}$

and record this value. This must be within the specified 84.5 - 95.5% range.

6. Press the appropriate button(s) on the audio analyzer to measure AM distortion. Record the displayed value (or record the distortion value determined using the modulation meter, if appropriate). Distortion must be less than 5%.

7. Repeat steps 5 and 6 for each of the following frequencies:

a. 137 MHz
b. 138 MHz
c. 194 MHz
d. 195 MHz
e. 274 MHz
f. 275 MHz
g. 400 MHz
h. 550 MHz
i. 551 MHz
j. 620 MHz
k. 692 MHz
l. 693 MHz
m. 780 MHz
n. 872 MHz
o. 873 MHz
p. 1000 MHz
q. 1100 MHz

8. Set the 2500 AM level to 70% and the output frequency to 11 MHz. Repeat step 5, above. The average accuracy must be within the specified 65.5 - 74.5% range.

9. Repeat step 6, above, distortion must be less than 3%.

10. Repeat steps 8 and 9, above, for each of the frequencies listed in step 7, above.

11. Set the 2500 for a 30% AM level and 11 MHz frequency output. Repeat step 5. AM accuracy must be within the specified 27.5 - 32.5% range.

12. Repeat step 6. Distortion must be less than 1.5%.

13. Repeat steps 11 and 12 for each frequency listed in step 7, above.

14. Repeat steps 4 - 13, above, with the 2500 power output set at the -7 dBm level.

15. To measure frequency response (AM bandwidth) set the 2500 for external AM at a 50% modulation level. Set the output frequency at 11 MHz and power at +3 dBm. Set the function generator for a 1 volt peak-to-peak signal at 1 kHz (at the External Modulation Input on the 2500 front panel). Set the modulation meter as follows:

a. Push the AM modulation button.
b. Push the ratio button at the 1 kHz modulation rate.
c. Press the "Ave" button.

16. Use the function generator to sweep from 1 kHz to 15 kHz while observing the relative dB output change on the modulation meter. Record the change. It should be less than 3 dB.

17. Repeat steps 15 and 16 for each of the frequencies listed in step 7.

4.10 RESIDUAL AM TEST

SPECIFICATION

< -65 dBc; CW mode with 50 Hz to 15 kHz post detection bandwidth (PDBW)

METHOD

A measurement receiver is used to measure residual AM at a variety of output frequencies.

EQUIPMENT

(8)

PROCEDURE

1. Set the 2500 for a 400 kHz output at the 0 dBm level with no modulation.

2. Connect the 2500 output to an HP-8902A measurement receiver, or equivalent. Select the 50 Hz high pass and 15 kHz low pass post detection bandwidth filters on the measurement receiver. Put the receiver in the average detection mode.

3. Record the residual AM measurement. It should be < -65 dBc.

4. Change the 2500 frequency output to each of the frequencies listed below and record the residual AM associated with each. Each should be < - 65 dBc.

a. 1 MHz
b. 2 MHz
c. 5 MHz
d. 10 MHz
e. 20 MHz
f. 50 MHz
g. 100 MHz
h. 200 MHz
i. 400 MHz
j. 800 MHz
k. 1100 MHz

4.11 RESIDUAL FM TEST

SPECIFICATION

Post detection bandwidth .05 - 15 kHz
< 30 Hz rms (.4 - 137.49999 MHz)
< 15 Hz rms (137.5 - 274.99999 MHz)
< 30 Hz rms (275 - 550 MHz)
< 60 Hz rms (> 550 MHz)

METHOD

A measurement receiver is used to measure residual FM at selected frequencies from 275 MHz to 550 MHz.

EQUIPMENT

(8)

PROCEDURE

1. Set the 2500 for a 100.001 MHz output at the 0 dBm level with no modulation.

2. Connect the 2500 output to an HP-8902A measurement receiver, or equivalent. Select the 50 Hz high pass and 15 kHz low pass post detection bandwidth filters on the measurement receiver. Put the receiver in the average detection mode.

3. Record the residual FM measurement. It should be less than 30 Hz rms.

4. Change the 2500 frequency output to each of the frequencies listed below and record the residual FM associated with each. Each should be less than 30 Hz rms.

a. 125.001 MHz
b. 275 MHz
c. 325 MHz
d. 330 MHz
e. 390 MHz
f. 463 MHz
g. 464 MHz
h. 550 MHz

5. The user may elect to choose and then determine residual FM values associated with 2500 frequency outputs in the .4 - 137.5 MHz range, the 137.5 - 275 MHz range, and the greater than 550 MHz range, if desired. The residual FM measured should be less than 30 Hz rms, less than 15 Hz rms, and less than 60 Hz rms for any frequency in these ranges, respectively. The successful performance of steps 1 through 4, above, will automatically verify the .4 - 137.5 MHz, 137.5 - 275 MHz, and greater than 550 MHz.

4.12 FM PERFORMANCE TESTS

SPECIFICATIONS

FM Accuracy	±5% of setting, at internal rates (excluding residual FM)
Distortion	< 2% at internal rates for deviation < 100 kHz
FM Bandwidth	From 20 Hz to 100 kHz with respect to 1 kHz reference: < 3 dB relative change

Deviation Range	For 1 kHz rate: 1 MHz peak for 3 - 137.49999 MHz and > 275 MHz 500 kHz peak for 137.5 - 275 MHz

METHOD

A modulation analyzer is used to measure FM accuracy. An audio analyzer and a modulation analyzer are used to measure FM distortion. A function generator and modulation analyzer are used to measure the FM bandwidth. The frequency deviation range is measured using a spectrum analyzer. The final steps in this procedure verify operation of the overmodulation indicator circuitry.

EQUIPMENT

(7) and (10) or (8); (11); (5)

PROCEDURE

1. There are a variety of modulation analyzers on the market that measure FM accuracy and distortion. Some audio analyzers also contain an audio generator. The user must modify the following procedure according to the equipment available.

2. Make the following connections, as appropriate. Connect the 2500 RF output to the modulation analyzer. Connect the audio output of the modulation analyzer to the input of the audio analyzer.

3. To determine FM accuracy, set the 2500 for an output frequency of 275 MHz at the 0 dBm power level. Select the internal 1 kHz modulation source. Set internal FM deviation at 99.9 kHz. Read deviation accuracy on the modulation analyzer (+PK value) and verify it is between 94.9 kHz and 104.9 kHz.

4. Repeat step 3, increasing the 2500 output frequency from 275 MHz to 550 MHz in 5 MHz steps. Verify FM deviation shown on the modulation analyzer is between 94.9 kHz and 104.9 kHz at each frequency. Record the worst case deviation.

5. To further check FM accuracy and to check FM distortion, set the 2500 output frequency to 500 MHz. Record the FM accuracy reading (+PK) on the modulation analyzer. It must be between 94.9 and 104.9 kHz (±5% of setting). Set the modulation analyzer to measure FM distortion and record the value shown. Distortion must be less than 2%.

6. Set FM deviation at 100.0 kHz. Measure FM accuracy and distortion. Accuracy as shown on the modulation analyzer must be between 95 kHz and 105 kHz. Distortion must be < 2%.

7. Change the 2500 internal modulation source from the 1 kHz to the 400 Hz source. Set FM deviation at 99.9 kHz. Record FM accuracy and distortion. Verify accuracy is between 94.9 kHz and 104.9 kHz and distortion is less than 2%.

8. Set FM deviation at 100.0 kHz. Record accuracy and distortion. Verify accuracy is between 95 kHz and 105 kHz. Verify distortion is less than 2%.

9. To measure FM bandwidth set the 2500 for external FM at 9.9 kHz deviation. Set the output frequency at 330 MHz.

10. Use the function generator to apply a 1 Vpp signal at a 1 kHz rate to the 2500.

11. Set the modulation analyzer for "average" detection. Use the Rel dB function on the analyzer to set the modulation reference rate at 1 kHz.

12. Use the function generator to sweep from 20 Hz to 100 kHz while observing the relative dB output change on the analyzer. Record the change. It should be ±3 dB or less.

13. Disconnect the test equipment. To measure deviation range connect the 2500 RF output to a spectrum analyzer. Set the 2500 at the 1 kHz internal rate source, at an FM deviation of 1000 kHz, and an output frequency of 389 MHz. Use the spectrum analyzer to verify a deviation range of 1 MHz ±5% (2 MHz peak to peak).

14. Select an output frequency value between 137 to 275 MHz. Repeat step 13. Verify the 500 kHz peak deviation range on the spectrum analyzer.

15. Disconnect the spectrum analyzer.

16. Set the 2500 to 300 MHz with 1000 kHz FM deviation at a 400 Hz internal rate. The modulation display will begin to blink on/off to indicate overmodulation.

17. Set the modulation to 100 Hz deviation at a 400 Hz rate. The display should stop blinking on/off. Set the modulation to 480 kHz deviation. The display should not blink.

4.13 OUTPUT POWER ACCURACY TEST

SPECIFICATION

±1.3 dB for levels > -36.9 dBm
±(1.3 + .1 dB/10 dB step decrease) below -36.9 dBm

METHOD

A measurement receiver with power sensor is used to measure output power at 3 representative frequencies.

EQUIPMENT

(8)

PROCEDURE

1. Connect the 2500 RF output to the power sensor for the measurement receiver. Set the 2500 for an output frequency of 5 MHz at a +13 dBm power level.

2. Read the power measurement on the measurement receiver and verify it between +14.3 and +11.7 dBm.

3. Set output power to 0 dBm and verify the measurement receiver reading is between -1.30 and +1.30 dBm.

4. Use the cursor keys to set the output power resolution digit at the 10 dB incremental position and turn the spin knob counterclockwise to decrease output power in 10 dB steps. Observe the output level on the measurement receiver and verify it is within the range associated with each output level setting below:

Output (dBm)	Range (dBm)
-10	-11.30 to -8.70
-20	-21.30 to -18.70
-30	-31.30 to -28.70
-40	-41.40 to -38.60
-50	-51.50 to -48.50
-60	-61.60 to -58.40
-70	-71.70 to -68.30
-80	-81.80 to -78.20
-90	-91.90 to -88.10
-100	-102.00 to -98.00
-110	-112.10 to -107.90
-120	-122.20 to -117.80
-130	-132.30 to -127.70

5. Set the 2500 output frequency to 400 MHz. Set the power level at +13 dBm. Repeat step 2, above.

6. Repeat step 3, above.

7. Repeat step 4, above.

8. Set the 2500 output frequency to 1100 MHz. Set the power level at +13 dBm. Repeat step 2, above.

9. Repeat step 3, above.

10. Repeat step 4, above.

11. Disconnect the test equipment.

4.14 OUTPUT POWER LEVEL FLATNESS TEST

SPECIFICATION ±1 dB

METHOD A power meter is used to measure the most representative output levels across the 2500 frequency spectrum.

EQUIPMENT (9)

PROCEDURE

1. Connect the power sensor unit of the power meter to the 2500 RF output. Set the 2500 output at the +13 dBm level.

2. Use the spin knob/cursor keys (see Section 3.5.2.2, if necessary) to sweep through the 2500 frequency spectrum (.4 MHz to 1100 MHz) while monitoring output power on the power meter. Verify the highest output power is within 2 dB of the lowest output power across the frequency range. (Use the resolution digit set at .1 MHz from .4 to 1 MHz; set the resolution digit at 1 MHz from 1 MHz to 1100 MHz).

3. Set the 2500 output level at +3 dBm. Repeat step 2.

4. Set the 2500 output level at -7 dBm. Repeat step 2.

5. Disconnect the test equipment.

4.15 OUTPUT IMPEDANCE TEST

SPECIFICATION 50Ω, with VSWR < 1.5 at output power < -7 dBm

METHOD A VSWR bridge, spectrum analyzer, and sweep generator are used to measure output impedance across the frequency range.

EQUIPMENT (5) (12) (13)

PROCEDURE

1. Connect the RF input of the VSWR bridge to the sweep generator output. Connect the VSWR reference short across the bridge test port. Connect the bridge RF output port to the spectrum analyzer input.

2. Set the sweep generator to sweep from 0 - 1100 MHz using a 20 second sweep at a power level of +10 dBm. Store this data in the spectrum analyzer as the reference level.

3. Set the 2500 for an output frequency of 50 MHz at a -7.1 dBm output power level.

4. Remove the reference short from the test port on the VSWR bridge and connect the 2500 output to the test port.

5. Use the sweep generator to manually sweep the frequency range (.4 MHz to 1100 MHz) again. Compare these spectrum analyzer readings to the spectrum analyzer reference level from step 2. Record the worst case frequency and level. The worst case level should be < -14 dBm from the reference level.

4.16 EXTERNAL REFERENCE TEST

SPECIFICATION

External source specification

METHOD

A signal generator is used to verify the 2500 external reference circuitry.

EQUIPMENT

(1)

PROCEDURE

1. Determine the error in the external source.

2. Connect the external source (a Model 2500 signal generator, for example) to the external reference input on the rear panel of the 2500. Set the source at 1 volt peak-to-peak and 1 MHz. Set the 2500 rear panel external reference select switch to the "1 MHz" position.

3. Set the output frequency for the 2500 at 100 MHz and set the power level to 0 dBm.

4. Verify that the 2500 output frequency is within the external source limits.

5. Set the 2500 rear panel external reference select switch to the "5 MHz" position. Set the external source at 5 MHz.

6. Repeat step 4, above.

7. Set the 2500 rear panel external reference select switch to the "10 MHz" position. Set the external source to 10 MHz.

8. Repeat step 4, above.

9. Disconnect the external source and set the rear panel reference select switch to the appropriate position.

4.17 SAMPLE PERFORMANCE TEST RECORD

PERFORMANCE TEST RECORD, MODEL 2500 S/N ____________

DATE OF TEST ____________

(Performance tests are listed below by section number, test name, and test specification. Test equipment used and test results are to be entered in their appropriate sections, as indicated below.)

4.2 FREQUENCY RESOLUTION AND RANGE TEST

SPECIFICATION	MIN FREQ	MAX FREQ	RESOLUTION
	.4 MHz	1100 MHz	10 Hz

TEST EQUIPMENT USED ______________________________

CALIBRATION DUE DATE ______________________________

Test Results

SPIN KNOB RESOLUTION:

FREQUENCY RANGES (MHz)	2500 RESOLUTION Required	Actual
0.40000 - 0.40010	10 Hz	________
0.40010 - 0.40100	100 Hz	________
0.40100 - 0.41000	1 kHz	________
0.41000 - 0.50000	10 kHz	________
0.50000 - 1.00000	100 kHz	________
1.00000 - 10.00000	1 MHz	________
10.00000 - 100.00000	10 MHz	________
100.00000 - 1100.00000	100 MHz	________

FREQUENCY RANGE:

(Spin Knob)	.4 MHz reading	______________
	1100 MHz reading	______________
(Keypad)	.4 MHz reading	______________
	1100 MHz reading	______________

Frequency ranges and resolutions within specified limits ____________

4.3 FREQUENCY ACCURACY TEST

SPECIFICATION All modes (CW, AM, and FM): ±0.5 ppm (±.00005%), 0 - 50° C

TEST EQUIPMENT USED ______________________________

CALIBRATION DUE DATE ______________________________

Test Results

(1) Actual frequency at 500 MHz ______________________

(2) Frequency chosen in .4 - 137.5 MHz range ______________

(3) Actual frequency at (2) _________________________

(4) Frequency chosen in 137.5 - 275 MHz range _____________

(5) Actual frequency at (4) _________________________

(6) Frequency chosen in 275 - 550 MHz range _______________

(7) Actual frequency at (6) _________________________

(8) Frequency chosen in 550 - 1100 MHz range ______________

(9) Actual frequency at (8) _________________________

(10) All frequencies within specified accuracies ___________

4.4 HARMONICS TEST

SPECIFICATION < -30 dBc

TEST EQUIPMENT USED ______________________

CALIBRATION DUE DATE ______________________

Test Results

OUTPUT LEVEL (dBm)	FREQ RANGE (MHz)	WORST CASE HARMONICS SECOND (dBc)	THIRD (dBc)
+13	.4 - 10	________	________
+13	10 - 1100	________	________
+3	.4 - 10	________	________
+3	10 - 1100	________	________
-7	.4 - 10	________	________
-7	10 - 1100	________	________

Worst case harmonics are within specified limits ____________

4.5 NON-HARMONICS TEST

SPECIFICATION < -50 dBc for carrier frequencies < 137.5 MHz
< -60 dBc for carrier frequencies > 137.5 MHz
(at offset greater than 5 kHz from carrier in either carrier frequency range)

TEST EQUIPMENT USED ______________________________

CALIBRATION DUE DATE ______________________________

Test Results

Worst Case, 50 - 137.5 MHz range:

frequency (MHz) ________________

level (dBc) ________________

Worst Case Sidebands:

2500 OUTPUT FREQUENCY	SIDEBAND FREQUENCY (MHZ)	LEVEL (dBc)
551.26 MHz	____________	____________
653.26 MHz	____________	____________
655.26 MHz	____________	____________
777.26 MHz	____________	____________
781.26 MHz	____________	____________
925.26 MHz	____________	____________
926.26 MHz	____________	____________
1099.26 MHz	____________	____________

Worst case non-harmonics are within specified limits ________________

4.6 SUB-HARMONICS TEST

SPECIFICATION -25 dBc for frequencies > 550 MHz

TEST EQUIPMENT USED ______________________________

CALIBRATION DUE DATE ______________________________

Test Results

Sub-harmonic levels at 551 MHz carrier (f_o) and +13 dBm output:

1/2 (f_o) (275.5 MHz) ____________ dBc

3/2 (f_o) (826.5 MHz) ____________ dBc

Worst Case, 551 to 1100 MHz range:

(f_o) of worst 1/2 (f_o) ____________ MHz

worst 1/2 (f_o) ____________ MHz

worst 1/2 (f_o) level ____________ dBc

(f_o) of worst 3/2 (f_o) ____________ MHz

worst 3/2 (f_o) ____________ MHz

worst 3/2 (f_o) level ____________ dBc

Sub-harmonic levels at 551 MHz carrier (f_o) and -7 dBm output:

1/2 (f_o) ____________ dBc

3/2 (f_o) ____________ dBc

Worst case, 551 MHz to 1100 MHz at -7 dBm:

(f_o) of worst 1/2 (f_o) ____________ MHz

worst 1/2 (f_o) ____________ MHz

worst 1/2 (f_o) level ____________ dBc

(f_o) of worst 3/2 (f_o) ____________ MHz

worst 3/2 (f_o) ____________ MHz

worst 3/2 (f_o) level ____________ dBc

Worst case sub-harmonics are within specified limits ____________

4.7 PHASE NOISE TEST

SPECIFICATION < -107 dBc/Hz at 500 MHz; 10 kHz offset from carrier frequency

TEST EQUIPMENT USED ____________

CALIBRATION DUE DATE ____________

Test Results

2500 OUTPUT FREQUENCY	PHASE NOISE (dBc/Hz)
550 MHz	________

4.8 SWITCHING SPEED TEST

SPECIFICATION Typically 200 mSec

TEST EQUIPMENT USED ______________________

CALIBRATION DUE DATE ______________________

Test Results

FREQUENCY CHANGE (MHz	TRACE SETTLING TIME (mSec)
550 to 550.1	________
550.1 to 550	________
389 to 389.1	________
389.1 to 389	________

Switching time is within specified limits ______________

4.9 AM PERFORMANCE TESTS

SPECIFICATION

AM Accuracy	at 90% AM = 84.5 - 95.5% at 70% AM = 65.5 - 74.5% at 30% AM = 27.5 - 32.5%
Distortion	at 90% AM = < 5% at 70% AM = < 3% at 30% AM = < 1.5%
AM Bandwidth	From reference 1 kHz to 15 kHz; < 3 dB change at 50% AM

TEST EQUIPMENT USED	CALIBRATION DUE DATE
________________	________________
________________	________________
________________	________________
________________	________________

Test Results

Accuracy and Distortion at indicated output settings:

OUTPUT LEVEL (dBm)	AM DEPTH (%)	OUTPUT FREQUENCY (MHz)	AVERAGE ACCURACY (%)	DISTORTION (%)
+3	90	11	______	______
+3	90	137	______	______
+3	90	138	______	______
+3	90	194	______	______
+3	90	195	______	______
+3	90	274	______	______
+3	90	275	______	______
+3	90	400	______	______
+3	90	550	______	______
+3	90	551	______	______
+3	90	620	______	______
+3	90	692	______	______
+3	90	693	______	______
+3	90	780	______	______
+3	90	872	______	______
+3	90	873	______	______
+3	90	1000	______	______
+3	90	1100	______	______
+3	70	11	______	______
+3	70	137	______	______
+3	70	138	______	______
+3	70	194	______	______
+3	70	195	______	______
+3	70	274	______	______
+3	70	275	______	______
+3	70	400	______	______
+3	70	550	______	______
+3	70	551	______	______
+3	70	620	______	______
+3	70	692	______	______
+3	70	693	______	______
+3	70	780	______	______
+3	70	872	______	______
+3	70	873	______	______
+3	70	1000	______	______
+3	70	1100	______	______
+3	30	11	______	______
+3	30	137	______	______
+3	30	138	______	______
+3	30	194	______	______
+3	30	195	______	______
+3	30	274	______	______
+3	30	275	______	______

+3	30	400		
+3	30	550		
+3	30	551		
+3	30	620		
+3	30	692		
+3	30	693		
+3	30	780		
+3	30	872		
+3	30	873		
+3	30	1000		
+3	30	1100		
-7	90	11		
-7	90	137		
-7	90	138		
-7	90	194		
-7	90	195		
-7	90	274		
-7	90	275		
-7	90	400		
-7	90	550		
-7	90	551		
-7	90	620		
-7	90	692		
-7	90	693		
-7	90	780		
-7	90	872		
-7	90	873		
-7	90	1000		
-7	90	1100		
-7	70	11		
-7	70	137		
-7	70	138		
-7	70	194		
-7	70	195		
-7	70	274		
-7	70	275		
-7	70	400		
-7	70	550		
-7	70	551		
-7	70	620		
-7	70	692		
-7	70	693		
-7	70	780		
-7	70	872		
-7	70	873		
-7	70	1000		
-7	70	1100		
-7	30	11		
-7	30	137		
-7	30	138		

-7	30	194	________	________
-7	30	195	________	________
-7	30	274	________	________
-7	30	275	________	________
-7	30	400	________	________
-7	30	550	________	________
-7	30	551	________	________
-7	30	620	________	________
-7	30	692	________	________
-7	30	693	________	________
-7	30	780	________	________
-7	30	872	________	________
-7	30	873	________	________
-7	30	1000	________	________
-7	30	1100	________	________

AM Bandwidth:

OUTPUT FREQUENCY (MHz)	RELATIVE CHANGE ON MODULATION METER (dB)
11	________
137	________
138	________
194	________
195	________
274	________
275	________
400	________
550	________
551	________
620	________
692	________
693	________
780	________
872	________
873	________
1000	________
1100	________

Accuracies, Distortion, and AM Bandwidth are within specified limits____________

4.10 RESIDUAL AM TEST

SPECIFICATION < -65 dBc; CW mode with 50 Hz to 15 kHz post detection bandwidth (PDBW)

TEST EQUIPMENT USED ______________________________________

CALIBRATION DUE DATE ______________________________________

Test Results

2500 OUTPUT FREQUENCY (MHz)	RESIDUAL AM
.4	________
1	________
2	________
5	________
10	________
20	________
50	________
100	________
200	________
400	________
800	________
1100	________

Residual AM is within specified limits ____________________

4.11 RESIDUAL FM TEST

SPECIFICATION
Post detection bandwidth .05 - 15 kHz
< 30 Hz rms (.4 - 137.49999 MHz)
< 15 Hz rms (137.5 - 274.99999 MHz)
< 30 Hz rms (275 - 550 MHz)
< 60 Hz rms (> 550 MHz)

TEST EQUIPMENT USED ____________________

CALIBRATION DUE DATE ____________________

Test Results

2500 OUTPUT FREQUENCY (MHz)	RESIDUAL FM
100.001	________
125.001	________
275	________
325	________
330	________
389	________
390	________
463	________
464	________
550	________
User ________	________
Chosen ________	________
Values ________	________

Residual FM is within specified limits ____________________

4.12 FM PERFORMANCE TESTS

SPECIFICATION

FM Accuracy	±5% of setting, at internal rates (excluding residual FM)
Distortion	< 2% at internal rates for deviation < 100 kHz
FM Bandwidth	From 20 Hz to 100 kHz with respect to 1 kHz reference; < 3 dB relative change
Deviation Range	For 1 kHz rate: 1 MHz peak for 3 - 137.49999 MHz and > 275 MHz 500 kHz peak for 137.5 - 275 MHz

TEST EQUIPMENT USED	CALIBRATION DUE DATE
______________________	______________________
______________________	______________________
______________________	______________________
______________________	______________________

Test Results

FM Accuracy and Distortion:

2500 FM DEVIATION (kHz)	INTERNAL SOURCE (Hz)	2500 OUTPUT FREQUENCY (MHz)	FM ACCURACY (kHz)	FM DISTORTION (%)
99.9	1000	275	________	
99.9	1000	____ worst case (275-550 MHz)	________	
99.9	1000	500	________	________
100	1000	500	________	________
99.9	400	500	________	________

FM Bandwidth:

Relative dB output change ______________________ dB

Deviation Range:

2500 Output Frequency (MHz)	Deviation Range (MHz)
389	______________________
______________________ user selected value (137.5 - 275 MHz range)	______________________

Overmodulation:

Circuitry works as specified ______________________

FM Accuracy, distortion, bandwidth, and deviation ranges are within specified limits ______________________

4.13 OUTPUT POWER ACCURACY TEST

SPECIFICATION ±1.3 dB for levels > -36.9 dBm
±(1.3 + .1 dB/10 dB step decrease) below -36.9 dBm

TEST EQUIPMENT USED ______________________

CALIBRATION DUE DATE ______________________

Test Results

2500 OUTPUT POWER (dBm)	ASSOCIATED POWER METER READINGS (dBm) 5 MHz	400 MHz	1100 MHz
+13	________	________	________
0	________	________	________
-10	________	________	________
-20	________	________	________
-30	________	________	________
-40	________	________	________
-50	________	________	________
-60	________	________	________
-70	________	________	________
-80	________	________	________
-90	________	________	________
-100	________	________	________
-110	________	________	________
-120	________	________	________
-130	________	________	________

Output power levels are within specified limits ____________

4.14 OUTPUT POWER LEVEL FLATNESS TEST

SPECIFICATION ±1 dB

TEST EQUIPMENT USED ______________________________

CALIBRATION DUE DATE ______________________________

Test Results

2500 OUTPUT LEVEL (dBm)	dBm VALUES ACROSS RANGE Minimum	Maximum
+13	________	________
+3	________	________
-7	________	________

Output power level flatness is within specified limits ________________

4.15 OUTPUT IMPEDANCE TEST

SPECIFICATION 50 Ω, with VSWR < 1.5:1 at output power < -7 dBm

TEST EQUIPMENT USED ______________________________

CALIBRATION DUE DATE ______________________________

Test Results

Worst Case: frequency ________________ MHz

power level ________________ dBm

Output impedance across the frequency range is within specified limits

____

4.16 EXTERNAL REFERENCE TEST

SPECIFICATION External source specification

TEST EQUIPMENT USED ______________________________

CALIBRATION DUE DATE ______________________________

Test Results

Error in external source ________________ MHz

External input (MHz)	2500 Output (MHz)
1	________________
5	________________
10	________________

Frequency output is within external source limits __________________

Test Results

FM Accuracy and Distortion:

2500 FM DEVIATION (kHz)	INTERNAL SOURCE (Hz)	2500 OUTPUT FREQUENCY (MHz)	FM ACCURACY (kHz)	FM DISTORTION (%)
99.9	1000	275	________	
99.9	1000	____ worst case (275-550 MHz)	________	
99.9	1000	500	________	________
100	1000	500	________	________
99.9	400	500	________	________

FM Bandwidth:

Relative dB output change ________________________ dB

Deviation Range:

2500 Output Frequency (MHz)	Deviation Range (MHz)
389	____________________
____________________ user selected value (137.5 - 275 MHz range)	____________________

Overmodulation:

Circuitry works as specified ________________________

FM Accuracy, distortion, bandwidth, and deviation ranges are within specified limits ________________________

4.13 OUTPUT POWER ACCURACY TEST

SPECIFICATION ±1.3 dB for levels > -36.9 dBm
±(1.3 + .1 dB/10 dB step decrease) below -36.9 dBm

TEST EQUIPMENT USED ________________________

CALIBRATION DUE DATE ________________________

Test Results

2500 OUTPUT POWER (dBm)	ASSOCIATED POWER METER READINGS (dBm) 5 MHz	400 MHz	1100 MHz
+13	______	______	______
0	______	______	______
-10	______	______	______
-20	______	______	______
-30	______	______	______
-40	______	______	______
-50	______	______	______
-60	______	______	______
-70	______	______	______
-80	______	______	______
-90	______	______	______
-100	______	______	______
-110	______	______	______
-120	______	______	______
-130	______	______	______

Output power levels are within specified limits ____________

4.14 OUTPUT POWER LEVEL FLATNESS TEST

SPECIFICATION ±1 dB

TEST EQUIPMENT USED ______________________________

CALIBRATION DUE DATE ______________________________

Test Results

2500 OUTPUT LEVEL (dBm)	dBm VALUES ACROSS RANGE Minimum	Maximum
+13	________	________
+3	________	________
-7	________	________

Output power level flatness is within specified limits ______________

4.15 OUTPUT IMPEDANCE TEST

SPECIFICATION 50 Ω, with VSWR < 1.43 at output power < -7 dBm

TEST EQUIPMENT USED ____________________________

CALIBRATION DUE DATE ____________________________

Test Results

Worst Case: frequency ______________ MHz

power level ______________ dBm

Output impedance across the frequency range is within specified limits ____________________________

4.16 EXTERNAL REFERENCE TEST

SPECIFICATION External source specification

TEST EQUIPMENT USED ____________________________

CALIBRATION DUE DATE ____________________________

Test Results

Error in external source ______________ MHz

External input (MHz)	2500 Output (MHz)
1	______________
5	______________
10	______________

Frequency output is within external source limits ________________

SECTION 5

MAINTENANCE

5.1 INTRODUCTION

This section provides maintenance information for the Wavetek Model 2500 RF Signal Generator. Maintenance consists of service information (fan/air filter maintenance and bottom cover removal instructions), calibration procedures, and user diagnostics. This section also contains a description of the instrument test sequence automatically performed when the power is turned on.

WARNING

High voltages are present in this unit. Do not operate this unit with any cover removed and the power on.

5.2 SERVICE INFORMATION

5.2.1 FAN/AIR FILTER MAINTENANCE

The rear-panel fan reduces operating temperature, and contributes to the long life of the instrument.The air filter installed in the bottom cover intake vents must be kept clean. Remove the bottom cover and clean the air filter as described below.

5.2.2 BOTTOM COVER REMOVAL

Remove power from the instrument. Lay it on its top cover (with the bottom cover up). Remove the two screws from the bottom cover at the rear of the unit. Slide the cover back and remove it. (Reverse this procedure to reinstall the cover.)

5.2.3 AIR FILTER CLEANING

The air filter is secured to the bottom cover by a metal frame held in place by eight screws. Remove the screws and carefully remove the air filter.

Gently wash the filter in warm water and pat it as dry as possible. Allow it to air dry completely.

Carefully reinstall the filter and metal retaining frame. Reinstall the bottom cover.

5.3 AUTOCAL® CALIBRATION

The Wavetek Model 2500 RF Signal Generator uses an almost completely automatic calibration procedure (Auto Cal®) to calibrate the circuits that determine output frequency and output power level. The AutoCal® procedure is one (1) of 20 user diagnostics supplied with the 2500. The other 19 diagnostics are described in Section 5.4. The user is required to turn off the power for a few seconds, turn a key switch on the rear panel of the unit, and then turn on the power to activate the user diagnostics. The detailed procedure to perform the Model 2500 calibration is described below:

5.3.1 Turn on the Model 2500 and permit a warmup time of one hour (if necessary).

5.3.2 Turn off the Model 2500 for a few seconds.

5.3.3 Insert the OPERATE/AutoCal® key in the keylock on the rear panel and turn the key to the "AutoCal®" position. Turn on power.

5.3.4 The FREQUENCY display will show "2500 diag"; the MODULATION and LEVEL displays will be blank.

5.3.5 In one second the FREQUENCY display will show "SEL 01-20".

5.3.6 Use the numeric keyboard to enter "19", the number for the Auto Cal® procedure. The number will be shown on the LEVEL display as it is entered. Then press the "+/-" key to initiate the procedure.

5.3.7 The "CAL" annunciator will be displayed in the bottom right section of the FREQUENCY display. (MOD and LEVEL displays are blanked during the calibration procedure.) The FREQUENCY display will indicate DELAY 5 and perform a countdown to 0. (DELAY 5 → DELAY 4 → DELAY 3 → etc; 5 second countdown).

5.3.8 The FREQUENCY display will display the message "SELECT" and then the message "Fr or L" to indicate the operator should select either the output frequency (Fr) calibration routine described in steps 5.3.9 to 5.3.9.7, below or the output power level (L) calibration routine described in steps 5.3.10 to 5.3.10.14. The Frequency calibration must be performed before the Output Power Level calibration.

5.3.9 Press the FREQ key to select the FREQUENCY calibration routine. The frequency calibration routine is completely automatic, requiring no operator input at any step. There are four frequency ranges (bands) across which the instrument is calibrated. The FREQUENCY display will identify the four bands as "OSC 1", "OSC 2", "OSC 3", and "OSC 4" during the calibration and also will indicate the point in the band being calibrated.

5.3.9.1 The first band/point calibrated will be shown as "OSC 1 0". The display will then indicate "OSC 1 1" as the next point (the next higher frequency) is calibrated. The final point in band one will be identified as "OSC 1 34". There are 35 points (frequencies) calibrated in band 1.

5.3.9.2 As Band 2 is calibrated, points will be identified as "OSC 2 0" through "OSC 2 39" for a total of 40 frequencies calibrated.

5.3.9.3 As band 3 is calibrated, points "OSC 3 0" to "OSC 3 45" will be displayed.

5.3.9.4 As band 4 is calibrated, points "OSC 4 0" to "OSC 4 51" will be displayed.

5.3.9.5 When the four bands have been calibrated, the FREQUENCY display will return the "SEL 01-20" message.

5.3.9.6 If an error occurs during the frequency calibration routine an error message ("Er 0" or "Er 1") will be displayed in the MODULATION display. The FREQUENCY display will stop (be frozen) at the oscillator number and the number of the point in the band being calibrated when failure occurred. The appearance of an "Er 0" or "Er 1" message indicates a hardware problem that should be corrected. (Wavetek offers an optional Service Manual that includes information useful to troubleshoot/repair the Model 2500. Wavetek recommends returning the unit to the factory for repair, after factory authorization, unless the customer has highly qualified maintenance personnel that are experienced at RF repair work.)

5.3.9.7 After the "Er 0" or "Er 1" message and its associated oscillator number/band point number is recorded, the spin knob may be turned to restore the "SEL 01-20" function and request a diagnostic, as appropriate (Section 5.4 describes the diagnostics incorporated into this unit).

5.3.10 When the "Fr or L" message is on the FREQUENCY display (review steps 5.3.3 to 5.3.8 if necessary), press the LVL (Level) key to select the output power level calibration routine. The frequency calibration described above must be performed before the output power level calibration to ensure the frequency points used in the level calibration are accurate.

5.3.10.1 Connect an RF power meter with range from .4 MHz to 1100 MHz to the Model 2500 RF output connector before proceeding with this calibration.

5.3.10.2 The output power level calibration requires the operator to use the keyboard and the spin knob to make entries at various stages in this procedure.

5.3.10.3 The initial level calibration procedure messages on the three front panel displays are:

MODULATION display: "Adj"
FREQUENCY display: "0   0.4 MHz"
LEVEL display: "x.x dBm", with "x.x" being a number between +6.0 and -6.0, inclusive.

Each display message is described in greater detail below.

5.3.10.4 The MODULATION display will maintain the message "Adj" throughout this procedure. This message informs the operator that the Model 2500 output power level may be adjusted using the spin knob.

5.3.10.5 This output level calibration is performed at 10 different output frequencies. The frequencies are given index numbers from 0 to 9 (corresponding to frequency points from 0.4 MHz to 1100 MHz). The frequency display will show the calibration information with respect to the index point being calibrated (0 - 9 in the table below) and the actual frequency output at the calibration point (also shown in the table below).

INDEX POINT	FREQUENCY (MHz)
0	0.4
1	2
2	10
3	20
4	100
5	300
6	500
7	700
8	900
9	1100

5.3.10.6 At each calibration index point the output power level must be read on the RF meter and must be set to 0 dBm (±0.1 dB) by the operator. Output power is adjustable over the range from -6.0 to +6.0 dB. Turn the spin knob in a clockwise direction to increase the output power. Turn the spin knob counterclockwise to decrease the output.

5.3.10.7 As the output power level is adjusted (if necessary) at each frequency calibration point, the Model 2500 will automatically determine the amount of flatness correction that was necessary at that frequency point to make the output power level equal 0 dBm. This correction factor in units of dB will be shown on the LEVEL display. It will change at any given calibration point as the output power is adjusted to 0 dBm with the spin knob. (The units are shown on the 2500 as dBm due to physical limitations of the display. The actual correction factor is determined as dB units.)

5.3.10.8 The output power level calibration routine begins at calibration index number 0 and output frequency 0.4 MHz. The left and right "arrow" cursor keys below the spin knob are used to advance from one calibration point to the next or recall an earlier calibration point. The right cursor key will call up the next higher index. The left cursor key will recall the next lower index. Exceptions to this process occur at both end points. Pressing the left arrow cursor key when the calibration point is at index 0 (.4 MHz) will not change the index. Pressing the right arrow cursor key at index 9 (1100 MHz) will end the level calibration routine and generate the "SEL 01-20" message from which additional diagnostics are selected (see Section 5.4).

5.3.10.9 To perform the output power level calibration, first select the routine (steps 5.3.1 through 5.3.8 and then 5.3.10).

5.3.10.10 At each calibration index number (0 - 9) use the spin knob to adjust the 2500 output power level to 0 dBm ±.1 dB as indicated on the RF power meter. Note the amount of flatness correction at each index (LEVEL display reading) after the output is set to 0 dBm ±0.1 dB.

5.3.10.11 Record the maximum correction required and retain that value as a reference for later calibrations. (Changes in maximum correction required from one calibration to the next may indicate potential trouble areas. For example, an increase in several dB from one calibration to another may indicate a bad connector, a dirty instrument, etc.

5.3.10.12 When the calibration is completed each of the 10 index points (0 - 9) will be adjusted for a 0 dBm output at each of the 10 frequencies. The flatness correction required at each frequency will be stored in memory (RAM) to use to interpolate comparable corrections for the frequencies between the calibration points.

5.3.10.13 If power is lost during performance of an output power level calibration before the final adjustment (at index 9) is completed, when power is reapplied the 2500 will use a flatness table stored in permanent memory (ROM). The permanent table is used to avoid possible inclusion of bad index points (not adjusted to a 0 dBm output) in the RAM table developed during an incomplete calibration routine. Note that if power loss occurs, when the 2500 is powered up again its RF level accuracy will still be within specifications for the unit but will not be as accurate as those for a correctly calibrated 2500.

5.3.10.14 When the final point (index number 9) has been adjusted to a 0 dBm output level, press the right arrow cursor key to exit the AutoCal® routine and recall the "SEL 01-20" message.

5.3.11 To exit the Diagnostics/Auto Cal® routines turn off power. Turn the keyswitch on the 2500 rear panel to the "OPERATE" position and remove the key.

5.3.12 Turn on power again and resume normal operation.

5.4 USER DIAGNOSTICS

The user diagnostics allow the user to verify proper operation of 2500 subsystems and to perform an almost completely automatic calibration (Auto Cal®) of the unit. When the 2500 is in user diagnostics, any command across the GPIB bus will be ignored.

5.4.1 To activate the user diagnostics the operator must turn off the Model 2500 for a few seconds. Insert the OPERATE/AutoCal® key into the rear panel keylock switch and turn the switch to the "AutoCal®" position.

5.4.1.1 Turn on the 2500.

5.4.1.2 The FREQUENCY display will show "2500 diag" to indicate activation of the diagnostics. (The MODULATION and LEVEL displays will be blank.)

5.4.1.3 If the GPIB option is installed, the 2500 will immediately perform the GPIB Data Exchange Test described in detail in Section 6.4 of this manual.

5.4.1.4 Diagnostics require a functional keyboard. The 2500 will immediately perform a test to verify there are no keyboard keys that are sticking. During the test, the LEVEL display will contain the number "81". If a key is sticking, an "Err" message will begin blinking on/off in the MODULATION display. The key code number associated with the sticking key will be shown in the LEVEL display. (Keycodes are shown in the discussion of the Keyboard Test, Section 5.4.10 of this chapter.)

5.4.2 After the key test is completed successfully (about one second after power up) the FREQUENCY display will show "SEL 01-20", a request to use the numeric keyboard to enter the number associated with the diagnostic (test) to be performed. The available choices are:

Entry #	Diagnostic
01.	Built in RAM Test
02.	Parallel Port Test
03.	Built In Timer Test
04.	Bankswitching Test
05.	External RAM Test
06.	Core ROM Checksum Test
07.	Default/Diag ROM Checksum Test
08.	RF/Cal ROM Checksum Test
09.	GPIB Board Test
10.	Keyboard Test
11.	Display Test
12.	Spin knob Test
13.	Coarse Tuning Control DAC Test
14.	Internal Mod Control DAC Test
15.	External Mod Control DAC Test
16.	Carrier Level Control DAC Test
17.	Deviation Correction DAC Test
18.	Analog Status Feedback Test
19.	AutoCal® Calibration
20.	Default Settings

Each of the diagnostics listed above are described briefly in the following sections, beginning at Section 5.4.10.

5.4.3 As the number associated with the diagnostic test is entered, it will be shown on the LEVEL display. A one or two digit number may be entered to request the tests. A single digit "1" or a two digit "01" entry will both request the Built In RAM test. Entry of a "00" and entry of a number greater than "20" will be ignored (no action taken after execution - see step 5.4.5, below).

5.4.4 If the wrong number is entered there are two procedures to remove it and enter the correct one.

5.4.4.1 The user may "overwrite" a previously entered digit(s) to enter the correct number. There are only two positions on the LEVEL display into which the digits entered will be written. Pressing a new digit will place that digit in the right-hand position and shift the previous right-hand digit into the left-hand position. The previous left-hand digit will be overwritten.

5.4.4.2 The period "." key may be pressed to clear the LEVEL display (remove the digits) and then enter the correct digits.

5.4.5 After the correct diagnostic entry number is entered, the test is initiated by pressing the "+/-" key.

5.4.6 During the time the majority of the diagnostics are being performed the FREQUENCY display will indicate "running..". Exceptions are discussed with their associated tests beginning in Section 5.4.10. After a test is successfully completed the FREQUENCY display will indicate "PASS".

5.4.7 If an error is detected during a test, the MODULATION display typically will show the message "Err" blinking on/off. An associated error code number will be shown in the LEVEL display. The error code will not blink on/off.

5.4.7.1 The user may elect to discontinue further testing and begin troubleshooting or recalibration to determine and/or correct the problem causing the test failure.

5.4.7.2 The user may elect to perform additional diagnostics. To exit a failed test and select another test, turn the spin knob. This will recall the "SEL 01-20" message of step 5.4.2, above.

5.4.8 After the successful completion of a diagnostic the FREQUENCY display will show the "SEL 01-20" message of step 5.4.2, above. The operator may select another diagnostic to be performed.

5.4.9 When all desired tests have been performed, the 2500 is returned to normal operation by turning off power, turning the keylock switch on the rear panel to the "OPERATE" position, removing the key, and then turning on power again.

5.4.10 The diagnostics are described briefly in the following sections. Descriptions occur in the order the tests are listed in Section 5.4.3 and are identified by entry number and title shown in that section. Diagnostics are verifications of proper operation. They also provide valuable troubleshooting information if a failure occurs. Please note that although the 2500 is simple to operate and calibrate, it is a very sophisticated electronic instrument. Troubleshooting and repairing a malfunctioning unit requires the Model 2500 Service Manual, sold separately, and great technical expertise and experience with this type of instrument. Wavetek recommends return of a malfunctioning unit to the factory for repair (after factory authorization).

ENTRY NUMBER 01 - BUILT IN RAM TEST

The built in RAM test verifies proper operation of the RAM on the CPU (Central Processing Unit) and therefore verifies this part of the processor circuitry. Failure of this RAM test may be indicated by nonsense or no message on the front panel displays or the error message "Err" blinking on/off on the MODULATION display and the error code "01" on the LEVEL display.

ENTRY NUMBER 02 - PARALLEL PORT TEST

The parallel port test verifies proper operation of two parallel port registers associated with the CPU. Failure will be indicated by the blinking (on/off) message "Err" on the MODULATION display and error code "02" on the LEVEL display.

ENTRY NUMBER 03 - BUILT IN TIMER TEST

This test verifies the internal clock and the counting circuitry used in the CPU timer, verifying proper operation of the timer. Failure is indicated by the blinking (on/off) message "Err" on the MODULATION display and error code "03" on the LEVEL display.

ENTRY NUMBER 04 - BANKSWITCHING TEST

The CPU contains 16 banks of RAM and 4 banks of ROM. The bankswitching test verifies that information is written to the correct RAM/ROM bank. Failure is indicated by the error message "Err" blinking on/off on the MODULATION display and error code "04" on the LEVEL display.

ENTRY NUMBER 05 - EXTERNAL RAM TEST; ENTRY NUMBER 06 - CORE ROM CHECKSUM TEST; ENTRY NUMBER 07 - DEFAULT/DIAGNOSTIC ROM CHECKSUM TEST; ENTRY NUMBER 08 - RF/CAL ROM CHECKSUM TEST

The four RAM/ROM tests listed above verify proper operation of the RAM or ROM identified in the test title. The ROM containing the default/diagnostic settings for the instrument, for example, is tested when the Default/ Diagnostic ROM Checksum Test is performed. Error messages generated if a test is failed result in the standard message "Err" blinking on/off in the front panel MODULATION display with the error code "xx" (the entry number for the test) shown on the LEVEL display.

ENTRY NUMBER 09 - GPIB BOARD TEST

This test is described in Section 6.5 of this manual.

ENTRY NUMBER 10 - KEYBOARD TEST

This test verifies that the keyboard functions properly. It demonstrates that there are no sticking keys and that all the keycodes are correct. If any key sticks, the MODULATION display will flash "Err" and the LEVEL display will show the keycode of the sticking key. The keycode table shown below may be used to identify which key is sticking. During the "sticking key" test, the number "10" will be displayed in the LEVEL display to indicate this test is in progress.

Verify each keycode by pushing down each key. The keycode associated with each key will be displayed on the FREQUENCY display.

For example, if the right cursor key (→) is pressed, the FREQUENCY display will show "Code 3E". Pressing the numeric "1" key will generate the message "Code 31". The word "code" will always be displayed when a key is tested, followed by the code characters.

When a key is released, the two digit code on the FREQUENCY display will disappear (be blanked).

Key Name	Key Code
-->	3E
RF on/off	57
%, dBm	5A
kHz, mV	59
MHz, μV	58
<--	3C
+/-	2D
0	30
1	31
2	32
3	33
4	34
5	35
6	36
7	37
8	38
9	39
.	2E
Init	4E
Level	4C
Freq	46
Local	4F
Recall	52
Store	53
Mod off	55
Ext FM	4B
Int FM	48
400/1000	44
Ext AM	4A
Int AM	47

ENTRY NUMBER 11 - DISPLAY TEST

The goal of this test is to verify that each segment of each display can be individually turned on and off. This test is performed by first turning on all the segments and then turning them off one after another. During this test there is no feedback to the CPU as to what is displayed. The user must observe the displays very carefully as this test proceeds. The sequence of individual elements as they will be turned off is shown on the next page.

ENTRY NUMERIC 12 - SPIN KNOB TEST

This test verifies correct operation of the spin knob. At the beginning of the test, all three front panel

DISPLAY TEST TURN OFF SEQUENCE

MODULATION DISPLAY	REM	
	-	minus sign
	INT AM	
	INT FM	
	|	half digit (segment a and b)
	.	period of half digit
	RF on	
	RF off	
	0	left digit (segment a thru g)
	.	period of left digit
	0	middle digit (segment a through g)
	.	period of middle digit
	400	
	1000	
	0	right digit (segment a through g)
	.	period of right digit
	tripped	
	µ	
	V	
	mV	
	dBm	
	EXT AM	
	EXT FM	
	kHz	
	%	
	unlvd	
Frequency display	0	all digits (segment a through g)
	.	period of all digits
	MHz	
	UNLOCKED	
	FREQ	
	CAL	
Level display	Same sequence as shown above for the MODULATION display.	

displays are blanked. The left most cursor element on the leftmost display (MODULATION display) will be turned on. As the spin knob is turned clockwise, the cursor will move from left to right through all three displays. When the cursor reaches the rightmost digit of the rightmost display (LEVEL display) it will wrap around and start from the leftmost end again. The cursor will stop when spin knob rotation is stopped. Turning the spin knob counterclockwise will move the cursor in a left-to-right direction through the three displays. If spin knob failure occurs during the process, the cursor will stand still. Press the period (.) key to exit this test.

ENTRY NUMBER 13 - COARSE TUNING CONTROL DAC TEST; ENTRY NUMBER 14 - INTERNAL MODULATION CONTROL DAC TEST; ENTRY NUMBER 15 - EXTERNAL MODULATION CONTROL DAC TEST; ENTRY NUMBER 16 - CARRIER LEVEL CONTROL DAC TEST; ENTRY NUMBER 17 - DEVIATION CORRECTION DAC TEST

The control DAC tests listed above verify proper operation of the control DAC identified in the test title. All control DACs are tested using the spin knob to directly control the DAC output voltage. During a control DAC test the front panel FREQUENCY display will show the bit pattern in hexadecimal as it is sent out to the DAC. When the spin knob is turned in a clockwise direction the bit pattern shown will increase from 0 to FF for the Deviation Correction DAC and from 0 to 3FF for the other DACs listed above. The operator must observe the bit pattern and verify it goes through the range from 0 to FF or 0 to 3FF. The bit pattern will decrease when the spin knob is turned in a counter-clockwise direction. During any control DAC test the MODULATION display will indicate "dAC" and the FREQUENCY display will show the number of the DAC being tested (1-5) and the bit pattern currently being written to the DAC. Control DACs are listed above in the 1-5 DAC number sequence from first to last. The Coarse Tuning Control DAC is DAC #1; the Deviation Correction DAC is DAC #5. For example a FREQUENCY display indication "1 035E" shows that control DAC number "1" is being tested and the current hexadecimal value being written is "35E".

To exit any control DAC test press the decimal period key (.).

ENTRY NUMBER 18 - ANALOG STATUS FEEDBACK TEST

The analog status feedback test checks the following five status bits:

1. The main loop unlock indicator (LUL)
2. The carrier unlevel indicator (CUL)
3. The 400 Hz feedback clock (400)
4. The FM overdeviation indicator (Fod)
5. The automatic phase control (APC)

While each test is running, the FREQUENCY display will show "run..." followed by the test code shown in parentheses above. The LEVEL display will continue to show the test number "18". Failure to successfully complete any of the five checks will generate the error message "Err" on the front panel MODULATION display. The message will blink on/off. After turning the spin knob, the "Err" message will be removed and the test will continue to check any remaining status bits.

ENTRY NUMBER 19 - AutoCal® CALIBRATION

This procedure is the almost completely automatic calibration procedure for the Model 2500. It is described in detail in Section 5.3 of this manual.

ENTRY NUMBER 20 - DEFAULT SETTINGS

This procedure will load the factory default settings into the current settings locations in the continuously powered RAM. Calibration values are not affected. The display will read "Default Loaded" during the procedure. This test is primarily a factory test that also may be used to verify RAM loading/storage.

The default conditions are:

MOD	OFF
FREQ	1 MHz
LEVEL	0 dB
INT AM	50%
EXT AM	50%
INT FM	10 kHz
EXT FM	10 kHz
RF	OFF
INT RATE	100 Hz

5.5 POWER UP TESTS

Each time power is applied to the 2500 (the unit is turned on) it performs an automatic sequence of tests to verify various subsystems are functional.

5.5.1 The following sections describe the test sequence that occurs.

1. All system interrupts are disabled (no indicator).

2. All segments on the front panel displays are turned on for one second.

3. The FREQUENCY display shows "SELF CHEC".

4. The Built In Ram Test is performed (see Section 5.4.10, entry number 01).

5. The Parallel Port Test is performed (see Section 5.4.10, entry number 02).

6. The Built In Timer Test is performed (see Section 5.4.10, entry number 03).

7. The Bankswitching Test is performed (see Section 5.4.10, entry number 04).

8. The External RAM Test is performed (see Section 5.4.10, entry number 05).

9. The Core ROM Checksum Test is performed (see Section 5.4.10, entry number 06).

10. The 400 Hz feedback clock is tested for proper operation. The LEVEL display will show the test number "18". If the EXTERNAL/INTERNAL reference switch on the rear panel is not in the appropriate position at power up (see Sections 2.5.2 and 3.4, item 3), the test sequence will stop at the error 18 message.

11. If the GPIB option is installed, then the GPIB Data Exchange Test is performed (test number 80; described in the GPIB documentation provided in Section 6.4 of this manual).

12. The Sticking Key Test is performed (test number 81). If a key is sticking, an "Err" message will begin blinking on/off in the MODULATION display. The key code number associated with the sticking key will be shown in the LEVEL display. (Key codes are shown in the discussion of the Keyboard Test, Section 5.4.10 of this manual.)

5.5.2 Any error that occurs during the power up test sequence will generate the error message associated with the test. The MODULATION display will show "Err". The LEVEL display will show an "xx" value indicating the error code. The error message "Err" will blink on/off. Testing will be halted at the failure point. The operator may continue the test sequence beyond the failed test by turning the spin knob. The 2500 will proceed to the next step in the test sequence.

5.5.3 If the front panel displays do not operate (are blank or exhibit nonsense or garbage message), the Model 2500 is inoperable and needs repair. (Wavetek provides an optional Service Manual containing information useful to troubleshooting/repair of the Model 2500. The Service Manual contains schematic and assembly reference drawings, a detailed theory of operation, replaceable parts lists, and a generalized troubleshooting guide. Wavetek recommends the unit be returned to the factory, after factory authorization, for any repair work.)

5.5.4 When all tests have been performed successfully the FREQUENCY display will indicate "CHEC PASS". The LEVEL display will show the software version installed in the unit. (For example, "r 1.0" indicates "release version 1.0".)

5.5.5 The unit will now be ready for normal operation as detailed in Section 3 of this manual.

SECTION 6

GPIB

6.1 INTRODUCTION

The general purpose interface bus (GPIB) installed in the Model 2500 is fully compatible with IEEE Std 488-1978. The following interface functions are implemented.

- SH1 Complete source handshake capability
- AH1 Complete acceptor handshake capability
- T6 Basic talker, serial poll; unaddressed if MLA (my listen address) is active; talk only mode disabled
- TE0 Extended talker mode disabled
- L4 Basic listener; unaddressed if MTA (my talk address) is active; listen only mode disabled
- LE0 Extended listener mode disabled
- RL1 Complete Remote/Local capability
- PP0 Parallel poll capability disabled
- DC1 Complete device clear capability
- DT1 Complete device trigger capability
- C0 Controller capability disabled
- E2 Device dependent code to data line to indicate end of string; bit 2 (of bits 1-8) must be set.
- SR1 Complete service request capability

All instrument functions except Power On/Off, the AutoCal® procedures, and the User Diagnostics may be set via the GPIB. The Model 2500 is both a listener and a talker over the GPIB and provides error status and instrument status to its associated computer/controller.

The GPIB command format uses the minimum uniqueness concept to allow considerable flexibility in programming the 2500 functions. Because of this flexibility the Model 2500 with GPIB can be easily conformed to any GPIB based Automated Test Equipment (ATE) system.

6.2 INSTALLATION INSTRUCTIONS

The GPIB circuitry is located on the GPIB card inside the Model 2500. The bus address (My Listen Address; MLA) for the Model 2500 is factory preset at "2", but this may be changed over the GPIB if desired. Installation associated with GPIB control of the 2500 consists of using a GPIB cable to connect a GPIB controller to the GPIB connector on the rear panel of the 2500.

A GPIB controller is a digital computer that has I/O interface hardware and an operating system that is compatible with the IEEE-488 standard. The controller sends ASCII command strings over the GPIB to control a GPIB instrument.

Verify GPIB operation by sending the simple carrier frequency command "FRQ 200 MHZ" over the bus. (The complete command entry will depend upon the controller used. See Sections 6.3.5 and 6.3.9 for greater detail.) The 2500 FREQUENCY display will show 200 MHz and the MODULATION display will show the REMOTE annunciator if installation is correct.

6.3 OPERATING INSTRUCTIONS

6.3.1 LOCAL/REMOTE MODE SELECTION

When power is first applied to the Model 2500 the instrument will be in the Local Mode of operation. All functions will be controlled from the front panel. The 2500 will enter the Remote Mode of operation after any valid command has been transferred over the GPIB bus. When the 2500 is in the remote mode, the front panel keypad is inactive with two possible exceptions. The LCL key may be used to switch operation back to the Local Mode if the Local Lockout bus command has not been sent by the controller. The INIT key may be used to generate a Service Request (SRQ) if the controller has sent an SRQ enable over the GPIB. Note that if the GPIB has been used to send Local Lockout and SRQ disable commands to the 2500, the 2500 front panel is totally inactive (except for the power on/off switch) and the keyboard cannot be used to make changes in operating functions/values.

Three procedures may be used to switch from remote mode to local mode. The operator may cycle power (turn the 2500 off, then on), with power up in the local mode. The operator may press the LCL key on the 2500 front panel (if the Local Lockout Command has not been sent over the GPIB). The operator may send the return to local mode (RTL) command over the GPIB. Either of these three procedures will return control to the 2500 front panel. The unit will not enter the local mode while valid GPIB commands are being sent.

6.3.2 ADDRESS SETTING

The MLA (My Listen Address), the 2500 instrument bus address, is programmable over the GPIB. The power up (default) address is factory preset at "2" using a DIP switch on the GPIB card. The default MLA can be changed by physically resetting the DIP switch positions (a procedure that involves opening up the unit; see optional Model 2500 Service Manual). The MLA can be reprogrammed over the GPIB bus. SIG (signal generator), MLA (my listen address), and MTA (my talk address) are all methods of changing the programmable instrument address over the GPIB bus instead of changing the DIP switch in the 2500 GPIB hardware. The talk and listen addresses must be the same. Only a decimal address of 0-30 is allowed. An error will be generated if the programmed address is out of range and the current address is not changed. The address read from the DIP switch is the power-up default address. The 2500 allows only primary addressing.

6.3.3 GPIB INPUT COMMAND DEFINITION

A GPIB input command is a statement generated at the controller and communicated to the 2500 by the GPIB that causes the 2500 to execute a particular function or establish a particular setting.

The Wavetek 2500 GPIB recognizes a variety of input commands to provide maximum user friendliness. The majority of GPIB input commands are identical in format to their corresponding manual inputs (using the 2500 front panel keyboard). The remaining GPIB commands are used to obtain system status information or to change system status.

6.3.4 GPIB INPUT COMMAND TYPES

There are four (4) basic types of GPIB input commands: parameter, enumerated, direct, and query. Each type of command and its format are described in the following sections. GPIB commands use the minimum uniqueness concept to enhance user friendliness (see below).

6.3.5 PARAMETER COMMANDS

Parameter commands are commands that change numerical values of the 2500 operational settings (output frequency, output level, etc.) A parameter command specifies a particular numerical value for an instrument setting.

The parameter command format is:

<header> space <numeric argument> <terminator>

6.3.5.1

Parameter command headers are shown and described in Table 6-1, below. Characters (letters) may be entered in upper or lower case. Each header must contain a minimum number of letters in a specific order. The minimum format is the minimum set of letters in the specific order shown that will identify the operating parameter described. Each header has a maximum length format. The maximum format is the maximum set of characters for identification of the parameter. To specify a parameter command header the operator may use the minimum format, maximum format, or any combination of letters between the minimum and maximum format that includes the minimum format characters in their specified order. This is the minimum uniqueness concept. For example, the header for a command to alter center frequency may be entered as "FRQ", "FREQ", or "FREQUENCY". Three parameter commands (MLA, MTA, and SIG) have identical minimum and maximum formats.

6.3.5.2

After the header is entered, a space character must be entered to separate the header from the numeric argument of the parameter command format. Note that after this required space has been entered, spaces may be included anywhere else in the command string at the users' option (to make the user's program more easily readable, for example).

6.3.5.3

The numeric argument consists of a number and the applicable engineering notation for the units associated with the parameter entered. The general form for a numeric argument is: (sign) (9 digits and decimal point) (engineering notation). If no sign is entered the 2500 will assume the numeric value is positive (the sign is positive). The 2500 will accept a number that has a maximum of nine digits and has a decimal point anywhere within the nine digits entered. The operator may enter any number of digits from 1 to 9. The 2500 will ignore any digits entered after the ninth digit.

Table 6-1. Parameter Command Headers

MINIMUM FORMAT	MAXIMUM FORMAT	DESCRIPTION
FRQ	FREQUENCY	Output Frequency
LVL	LEVEL	Output Level
IAM	INTERNALAM	Internal Amplitude Modulation
IFM	INTERNALFM	Internal Frequency Modulation
XAM	EXTERNALAM	External Amplitude Modulation
XFM	EXTERNALFM	External Frequency Modulation
RTE	RATE	Internal Modulation Rate
STR	STORE	Storage of an Instrument Setting
RCL	RECALL	Recall of an Instrument Setting
MLA	MLA	Programmable Talk and Listen Address
MTA	MTA	Programmable Talk and Listen Address
SIG	SIG	Programmable Talk and Listen Address

6.3.5.4

The number may be entered in scientific notation, using a two digit exponent value that is not part of the nine digit maximum. Scientific notation takes the form: (E) (sign) (digit 1) (digit 2). The sign and the second digit are optional. If no sign is entered, the 2500 will assume the sign is positive. The "E" character (for exponent) may be entered in upper or lower case. The general form for the number part of a numeric argument entered in scientific notation is: (overall sign) (9 digits) (decimal point) (E) (exponent sign) (digit 1) (digit 2).

The general form for a numeric argument with scientific notation is: (sign) (9 digits) (decimal point) (E) (exponent sign) (digit 1) (digit 2) (engineering notation).

6.3.5.5

The engineering notation for the units associated with the parameter entered may contain additional numeric information. For example, kHz is 1000 Hz. Therefore, an entry of 3.000 kHz is an entry of 3000 Hz. Engineering notation is shown in Table 6-2, below. Note that GHZ, GZ, MHZ, MZ, KHZ, KZ, MV and UV provide numeric and engineering unit information. Engineering notation may be entered in upper or lower case or any combination of the two.

6.3.5.6

The numeric values for the parameter command arguments have the ranges specified as normal ranges for the 2500 signal generator functions. The internal modulation rate (RTE) argument can have only the two values shown on the 2500 front panel modulation rate switch, "400" and "1000" Hz. The RTE argument does not require an engineering notation (HZ) entry.

6.3.5.7

The arguments for the storage (STR) and recall (RCL) of a complete front panel setting are limited to values between 1 and 15. The STR/RCL function is a unitless value requiring no engineering notation as part of its argument. The programmable talk and listen address commands (MLA, MTA, and SIG) are limited to values between 0 and 30 and also are unitless. MLA (my listen address), MTA (my talk address), and SIG (signal generator) are all commands to change the programmable instrument

Table 6-2. Engineering Notation

NOTATION	ASSOCIATED PARAMETER
GHZ	Output Frequency
GZ	Output Frequency
MHZ	Output Frequency
MZ	Output Frequency
KHZ	Output Frequency, Internal FM, External FM
KZ	Output Frequency, Internal FM, External FM
HZ	Output Frequency, Internal FM, External FM
DB	Output Level
DBM	Output Level
MV	Output Level
UV	Output Level
V	Output Level
%	Internal AM, External AM

address over the GPIB instead of changing the address DIP switches in the 2500 GPIB hardware. The talk and listen addresses must be the same.

6.3.5.8

The final item in the generalized parameter command format is an end of string (EOS) terminator. A series of parameter commands may be entered at the controller before any single command in the series is executed across the GPIB. The series is called a string of commands. The EOS terminator tells the controller to send the entered command or string of commands to the 2500. The commands in a string of commands are separated from one another by semicolons after each command's engineering notation. The EOS tells the controller that the entered sequence has been concluded. The EOS terminator is factory set to CR LF/EOI. These are the default EOS terminators.

A hardware switch inside the 2500 may be set to select other commonly used EOS terminator sequences. This procedure involves opening up the unit (see the optional 2500 Service Manual). The operator may establish a different EOS terminator of 1, 2, or 3 characters by performing the GPIB enumerated command identified as TRM in Section 6.3.6, immediately following this section.

6.3.6 ENUMERATED COMMANDS

Enumerated commands, with one exception, are commands that provide distinct choices to change system status. The modulation off command (see Table 6-3) has no alternative choices. Enumerated commands follow the format: <header> space <alphabetic or ASCII control symbol argument> <terminator>.

6.3.6.1

Enumerated command headers and their associated arguments are shown in Table 6-3. The majority of commands require an alphabetic argument. Argument characters may be in upper or lower case or any combination of the two. The EOS terminator command requires use of an ASCII control symbol(s). A brief description of each command function is included in Table 6-3. More information about each command is contained in the following sections, as required.

It is the minimum format for enumerated command headers that is shown in Table 6-3. These headers also employ the minimum uniqueness concept (Section 6.3.5.1) to provide expanded user friendliness. Minimum and maximum formats for enumerated command headers are shown in Table 6-4.

6.3.6.2

A space character must be entered between an enumerated command header and its argument. Additional spaces may be entered anywhere else in the command string as desired (to aid in reading a program, for example).

6.3.6.3

The final item in an enumerated command is the EOS (end of string) terminator. The discussion of EOS terminators of parameter commands in Section 6.3.5.8 is equally applicable for enumerated commands.

6.3.6.4

When enabled, the RQS (Request for Service) allows the 2500 to signal to the GPIB controller that the 2500 is requesting attention. The RQS will signal the controller if the front panel functional RQS key ("INIT" key when unit is in remote mode; see Section 3.3, paragraph numbered 13) is pressed. The RQS will signal the controller if an error condition exists within the 2500. The RQS function is disabled at 2500 power up (the RQS default condition). The function is enabled by the GPIB enumerated command "RQS ON". The GPIB command "RQS OFF" will disable the RQS function.

Table 6-3. Enumerated Command Listings

HEADER	ARGUMENT	DESCRIPTION
RF	ON	RF output signal enabled at the RF OUT connector on the 2500 front panel
RF	OFF	RF output signal disabled at the RF OUT connector on the 2500 front panel
MOD	OFF	All modulation is disabled: internal and external AM, and internal and external FM **NOTE** MOD ON is not a valid command. The specific modulation desired must be entered as a separate parameter command (see Section 6.3.5, ff).
RQS	ON	Enable the 2500 to produce service requests
RQS	OFF	Disable all service requests
GET	ON	Execute the previously transmitted group of functions
GET	OFF	Disable the group execution or group input
GET	SS	Execute the next stored setting
TRM	1, 2, or 3 ASCII control symbols at user's discretion	Programmable end of string terminator (see Section 6.3.5.8).

Table 6-4. Enumerated Command Headers

MINIMUM FORMAT	MAXIMUM FORMAT	COMMAND NAME
RF	RF	RF Signal Output
MOD	MOD	Modulation
RQS	REQUESTFORSERV	Request for Service
GET	GET	Group Execute Function
TRM	TERMINATORS	Programmable End of String Terminators

When an error generates an SRQ, the operator must send the query command "ERR" (discussed in Section 6.3.8) over the GPIB to receive a coded message identifying the source of the error. If the SRQ function is not enabled, the 2500 serial poll buffer will still contain the current status of the 2500. The SRQ can be enabled and the "ERR" command sent to the 2500 (and the 2500 will send back the appropriate error code).

Note that to utilize the 2500 SRQ capability the controller also must have complete service request (SRI) capability.

6.3.6.5

The GET (Group Execute Trigger) command is used to automatically execute a group of functions within the 2500. There are four (4) types of GET input commands:

1. GET precedes a group of commands which will be executed at one time. The commands following "GET" are stored until "GET ON" is received. At that time, the commands are passed to the 2500 and executed. GET storage is limited to 100 characters. If the length of the GET command string exceeds 100 characters, the excessive characters will write over the earlier GET entries.

2. GET ON sends the stored commands to the 2500 for group execution.

3. GET OFF disables the GET function and clears all stored commands.

4. GET SS calls up the "next" 2500 stored setting and executes that setting. The stored settings calculated as "next settings" will refer only to settings that have been set up through the GPIB. This avoids having the controller query the 2500 to obtain the current stored setting, wait for the 2500 response, and then ask for a recall of the next setting.

The GET command also may be used to simultaneously trigger a group of devices (instruments) on the GPIB.

6.3.6.6

The TRM (programmable terminator) function allows the user to select a maximum of three end of string termination ASCII control characters. A minimum of one character is required. The terminator command must always be completed with a semi-colon. The current EOS terminator is not a valid completion indication for this command because a resetting of the EOS is occurring as the TRM command is given. If the terminator input process is incorrect, an error will be generated and the current termination string will not be changed. To request an EOS control signal over the GPIB without actually resetting the EOS as the TRM is given, the user can include an ASCII " " as part of the termination string.

The general format for the TRM command is: TRM (char1); or TRM (char1)(char2); or TRM (char1)(char2)(char3);.

Aside from the semi-colon, any ASCII control character may be used as a terminator character. The minimum format header TRM is shown (see Section 6.3.5.1 for a brief discussion of the minimum uniqueness concept, if necessary).

6.3.7 DIRECT COMMANDS

Direct commands make the 2500 perform an immediate action. The format for a direct command is:<header><terminator>.

6.3.7.1

The header specifies the action to be performed. Minimum and maximum formats for the direct command headers and command name are shown in Table 6-5. The minimum uniqueness concept discussed in Section 6.3.5.1 is equally applicable for direct command headers.

6.3.7.2

The terminator description of Section 6.3.5.8 is equally applicable for the direct command format.

6.3.7.3

The LLO (Local Lock Out) command disables the 2500 front panel controls with the exception of the power on/off switch. The front panel LCL key cannot be used to return the 2500 to local control when the GPIB command LLO has been entered at the controller.

6.3.7.4

The RTL (Return to Local) command will return 2500 control to the 2500 front panel (local mode of operation).

6.3.8 QUERY COMMANDS

Query commands tell the 2500 to send 2500 operating parameters/status information to the controller. Using query commands, the 2500 is capable of informing the GPIB controller of: 1) its (the 2500's) identity; 2) its operational status; 3) certain error conditions which have occurred; 4) the need for immediate attention. The query command format is: <header> <?> <terminator>.

6.3.8.1

The header specifies the type of information to be sent to the controller. The majority of the parameter command headers (Section 6.3.5.1) and enumerated command headers RF and MOD also serve as query command headers. Table 6-6 lists all query command headers (minimum format) and the associated 2500 response to the command. The 2500 responses to commands ID, ERR, and SET are discussed in detail in Sections 6.3.8.4, 6.3.8.5, and 6.3.8.6, respectively. Note that information about 2500 output level (LVL) may be supplied to the controller in units of volts, mV, μV, or dBm. There are seven possible responses to a "MOD" query, and two responses to both "RF" and "RTE" queries.

All response messages will utilize a fixed message length of 30 characters. Blanks will be inserted as necessary at the end of the message to complete the message length.

Table 6-6 lists query command headers in minimum format. The minimum uniqueness concept of Section 6.3.5.1 is valid for query commands also. Header formats for all commands but ID, ERR, and SET have been presented earlier in this section. Header formats for ID, ERR, and SET are shown in Table 6-7.

6.3.8.2

Because parameter and enumerated command headers can also be query headers, the question mark <?> in the query command format tells the 2500 to send information, rather than receive information. The query command "<FRQ> <?> <terminator>" requests the current operational output frequency setting for the 2500.

Table 6-5. Direct Command Headers

MINIMUM FORMAT	MAXIMUM FORMAT	COMMAND NAME
LLO	LOCALLOCKOUT	Lockout of Front Panel
RTL	RETURNTOLOCAL	Return Instrument to Local Control

6.3.9 SAMPLE SOFTWARE PROGRAMS

These basic programs can be adapted to any GPIB controller if the appropriate write and address formats are substituted. These programs illustrate the 2500 as a listener. The 2500 is also a talker.

6.3.9.1 FUNCTION: FREQUENCY

Exercise: Program the frequency in 50 MHz steps between 100 and 1100 MHz.

WAVETEK 6000 BASIC:

```
100 FOR I=100 to 1100 STEP 50
110 WRITE @ 702:"FRQ "&STR$(I)& "MHZ;"
120 WAIT DELAY.2
130 NEXT I
140 END
```

The 200 millisecond time delay in line 120 permits the Model 2500 frequency to stabilize.

HP85 BASIC:

```
100 FOR I=100 to 1100 STEP 50
110 OUTPUT 702;"FRQ "&VAL$(I)&"MHZ;"
120 WAIT 200
130 NEXT I
140 END
```

HP9825 HPL:

```
0: for I=100 to 1100 by 50
1: wrt 702,"FRQ "&str(I)&"MHZ;"
2: wait 200
3: next I
4: end
```

IBM PC BASIC:

```
100 for I=100 to 1100 STEP 50
110 I$=RIGHT$(STR$(I),LEN(STR$(I))-1)
120 WRT$="FRQ "+I$+"MHZ;"
130 CALL IBWRT(SIGEN%,WRT$)
140 FOR J=1 to 200
150 NEXT J
160 NEXT I
170 END
```

In line 110 a blank space is removed to prevent an illegal response.

In lines 140 and 150 an approximate delay is achieved by using a for-next 1000.

NOTE: The necessary program lines that initialize the PC, set the device number, and clear the 2500 (NAME: SIGEN) are omitted from the above program.

6.3.9.2 FUNCTION: LEVEL

Program the output level in 5 dB steps between +10 and -100 dBm. Initially set the frequency to 500 MHz in CW mode with the RF output on.

WAVETEK 6000 BASIC:

```
100 WRITE@702:"FRQ 500 MHz; MOD OFF;
    RF ON;"
110 WAIT DELAY .2
120 FOR I=10 TO -100 STEP -5
130 WRITE@702:"LVL "&STR$(I)& "DBM;"
140 NEXT I
150 END
```

HP 85 BASIC:

```
100 OUTPUT 702:"FRQ 500MHz; MOD
    OFF; RF ON;"
110 WAIT 200
120 FOR I=10 to -100 STEP -5
130 OUTPUT702;"LVL "&VAL$(I)& "DBM;"
140 NEXT I
150 END
```

HP 9825 HPL:

```
0: wrt 702,"FRQ 500MHZ;MOD OFF;RF ON;"
1: wait 200
2: for I=10 to -100 by -5
3: wrt702,"LVL "&STR(I)&"DBM;"
4: next I
5: end
```

IBM PC BASIC:

```
100 WRT$-"FRQ 500 MHZ;MOD OFF;RF ON;"
110 FOR I=1 to 200
120 NEXT I
130 FOR I=10 TO -10 STEP -5
140 I$=RIGHT$(STR$(I),LEN(STR$(I))-1
150 WRT$="LVL "+I$+"DBM;"
160 CALL IBWRT(SIGEN%,WRT$)
170 NEXT I
180 END
```

6.3.9.3 FUNCTION: RF LEVEL (ON/OFF)

Set the Model 2500 to 1000 MHz at +13 dBm in CW mode with the RF output off for 400 milliseconds, then on for 200 milliseconds, then off again.

WAVETEK 6000 BASIC:
```
100 WRITE@702:"FRQ 1000MHZ;
    MOD OFF; RF OFF;"
110 WAIT DELAY .4
120 WRITE@702:"RF ON;"
130 WAIT DELAY .2
140 WRITE@702:"RF OFF;"
150 END
```

HP 85 BASIC:
```
100 OUTPUT 702:"FRQ 1000MHZ; MOD OFF;
    RF OFF;"
110 WAIT 400
120 OUTPUT702;"RF ON;"
130 WAIT 200
140 OUTPUT702;"RF OFF;"
150 END
```

HP 9825 HPL:
```
0: wrt702,"FRQ 1000MHZ; MOD OFF;
   RF OFF;"
1: wait 400
2: wrt702,"RF ON;"
3: wait 200
4: wrt702,"RF OFF;"
5: end
```

IBM PC BASIC:
```
100 WRT$="FRQ 1000MHZ; MOD OFF;
    RF OFF;"
110 CALL IBWRT(SIGEN%,WRT$)
120 FOR I=1 to 400
130 NEXT I
140 WRT$="RF ON;":CALL IBWRT (SIGEN%,
    WRT$)
150 FOR I=1 to 200
160 NEXT I
170 WRT$="RF OFF;":CALL IBWRT
    (SIGEN%,WRT$)
180 END
```

6.3.9.4 FUNCTION: INTERNAL FM

Initially set the Model 2500 to 750 MHz at +10 dBm in CW mode with RF output on. After 1 second, set the internal FM deviation to 500 kHz at 1 kHz modulation rate. After 500 milliseconds turn the modulation off.

WAVETEK 6000 BASIC:
```
100 WRITE@702:"FRQ 750MHZ;
    LVL 10DBM ; MOD OFF;RF ON;"
110 WAIT 1
120 WRITE@702:"IFM 500KHZ;RTE 1000;"
130 WAIT .5
140 WRITE@702:"MOD OFF;"
150 END
```

HP 85 BASIC:
```
100 OUTPUT 702;"FRQ 750MHZ;
    LVL 10 DBM; MOD OFF; RF ON;"
110 WAIT 1000
120 OUTPUT702;"IFM 500KHZ; RTE 1000;"
130 WAIT 500
140 OUTPUT702;"MOD OFF;"
150 END
```

HP 9825 HPL:
```
0: wrt702,"FRQ 750MHZ; LVL 10DBM;
   MOD OFF; RF ON;"
1: wait 1000
2: wrt702,"IFM 500KHZ; RTE 1000;"
3: wait 500
4: wrt702,"MOD OFF;"
5: end
```

IBM PC BASIC:
```
100 WRT$="FRQ 750MHZ; LVL 10DBM;
    MOD OFF; RF OFF;"
110 CALL IBWRT(SIGEN%,WRT$)
120 FOR I=1 to 1000
130 NEXT I
140 WRT$="IFM 500KHZ; RTE 1000;"
150 CALL IBWRT(SIGEN%,WRT$)
160 FOR I=1 TO 500
170 NEXT I
180 WRT$="MOD OFF;":CALL IBWRT
    (SIGEN%,WRT$)
190 END
```

6.4 GPIB DATA EXCHANGE TEST

The GPIB Data Exchange Test is part of the Power Up Test executed automatically when the unit is turned on. The sequence of tests executed is described in Section 5.5 of this manual.

Table 6-6. Query Command Headers/2500 Response

HEADER	2500 RESPONSE
FRQ	FREQUENCY ffff.ffff MHz
LVL	AMPLITUDE aaaa Volts
	AMPLITUDE aaaa mV
	AMPLITUDE aaaa µV
	AMPLITUDE aaa.a dBm
RF	RF OUTPUT ON
	RF OUTPUT OFF
IAM	INTERNAL AM mm %
IFM	INTERNAL FM mmmm kHz
XAM	EXTERNAL AM mm %
XFM	EXTERNAL FM mmmm kHz
RTE	MOD RATE 400 Hz
	MOD RATE 1000 Hz
MOD	MODULATION OFF
	MODULATION INT AM / EXT FM
	MODULATION EXT AM / INT FM
	MODULATION INT AM
	MODULATION INT FM
	MODULATION EXT AM
	MODULATION EXT FM
ID	ID WAVETEK/2500, V81.1, Fx.x
ERR	xxx-ENGLISH DESCRIPTION
SET	CURRENT 2500 SETTINGS

Table 6-7. Header Formats for ID, ERR, and SET Query Commands

MINIMUM FORMAT	MAXIMUM FORMAT	DESCRIPTION
ID	IDENTIFY	Request for the instrument name and model
ERR	ERROR	Request for the current listing of errors
SET	SET	Request for a listing of the current instrument settings

6.3.8.3

The terminator characters in a query command are exactly as described in Section 6.3.5.8 for parameter commands.

6.3.8.4

The response of the 2500 to the query command ID (Identify) will be "ID WVTK/2500,V81.1,Fx.x", where: WVTK/2500 is the Wavetek model number for the 2500; V81.1 is the version of Tektronix Codes and Formats utilized in the firmware design; Fx.x is the firmware version number.

6.3.8.5

The 2500 will respond to the query command ERR (Error) with error messages that identify the source of a detected error(s). The general format of an error message is:

XXX-ENGLISH DESCRIPTION OF THE ERROR

where XXX is an identifier which is used to identify the error. To maintain the fixed message length of 30 characters, the total error message will be kept to 30 characters. Error messages are shown in Table 6-8.

When an error is detected, the 2500 serial poll byte will be filled with an eight bit number which will classify the error. Bit 6 of the serial poll byte will be set for a request for service. During normal operation the buffer will contain the decimal value 128. The decimal values for error classifications available are as follows:

97	Command Error
98	Execution Error
99	Internal Error
6X	System Events X = 0 through 9

The decimal value for the serial poll byte associated with each error message also is shown in Table 6-8.

If there is no message to send but a talk request has been made, the 2500 will respond with a 255 in the serial poll byte. This will happen if the error message buffer is empty.

6.3.8.6

The response of the 2500 to a SET query (SET?) will be the current operational settings of the instrument. Each setting will be sent as an individual message. The user will need to perform continuous "READS" in order to obtain all nine settings.

Table 6-8. Error Messages/Serial Poll Byte (decimal values)

ERROR MESSAGE	SERIAL POLL BYTE
101-COMMAND HEADER	97
103-ARGUMENT	97
205-ARGUMENT OUT OF RANGE	98
302-SYSTEM ERROR	99
310-LO UNLOCKED	99
311-MAIN LOOP UNLOCKED	99
312-UNLEVELED	99
313-CIRCUIT BREAKER TRIPPED	99
314-FM OVERMODULATION	99
315-400 HZ NOT FUNCTIONAL	99
341-CONTROL-TO-GPIB ERROR	99
349-POWER UP SETTINGS ERROR	99
350-STORED SETTING ERROR	99
401-POWER UP	65
403-ID USER REQUEST	67
499-EVERYTHING IS JUST FINE	128

6.4.1

The purpose of the GPIB Data Exchange Test is to verify functional operation of the communication path between the 2500 processor board and the GPIB board.

6.4.2

During the test the number "80" will be shown on the LEVEL display to indicate the test is in progress.

6.4.3

If an error is detected during the test, the MODULATION display will show the message "Err" blinking on and off.

6.5 GPIB BOARD TEST (USER DIAGNOSTIC)

The GPIB Board Test is part of the Model 2500 user diagnostics package described in Section 5.4 of this manual. The procedures to activate the user diagnostics, select a particular test, and general information about diagnostics are detailed in Sections 5.4.1 to 5.4.9.

6.5.1

The purpose of the GPIB Board Test (entry number 09) is to verify the operation of the ROM and RAM associated with the GPIB processor board and display the factory default settings for the GPIB address and terminator.

6.5.2

During the test, the number "09" will be shown on the LEVEL display to indicate the test is in progress. If the GPIB option is not installed, then the message "no gpib" will be shown on the FREQUENCY display for approximately two seconds. The message "SEL 01-19" will then return to the FREQUENCY display. If the GPIB option is installed, the following tests are performed.

6.5.2.1

First the RAM on the GPIB board is tested. During this test, "gpib 1" is shown on the FREQUENCY display. If an error with the RAM is detected, then the standard "Err" message will blink on/off in the MODULATION display. Turn the spin knob to continue the GPIB test.

6.5.2.2

Next, the ROM on the GPIB board is tested. During this test, "gpib 2" is shown on the FREQUENCY display. If an error with the ROM is detected, then the standard "Err" message will blink on/off in the MODULATION display. Turn the spin knob to continue the GPIB test.

6.5.2.3

After the RAM and ROM tests have been completed, the factory default settings for the GPIB terminator and address are displayed. A code representing the GPIB terminator will be shown in the MODULATION display. The four possible terminator codes are:

Cr - Carriage Return, Line Feed, and End or Identify
LF - Line Feed only
LFE - Line Feed and End or Identify
Eoi - End or Identify only

The GPIB address number will be shown in the FREQUENCY display as "Addr xx" where xx is the address number 0-30.

The address and terminator which are displayed are the ones established whenever the unit is turned on. The optional 2500 Service Manual contains details on switching the default settings.

6.5.2.4

Throughout the GPIB Board Test, the communications between the GPIB board and the 2500 processor board are checked. If the response from the GPIB board is faulty at any time during the test, then the message "gpib rsp" is shown on the FREQUENCY display and the standard "Err" message will blink on/off on the MODULATION display. Turning the spin knob will terminate the GPIB Board Test, skipping the rest of the test.

6.5.3

After the successful completion of the test, the "SEL 01-19" message will be shown on the FREQUENCY display and the operator may proceed with other diagnostics as desired.

6.5.4

If an error is detected during the test, the MODULATION display will show the message "Err" blinking on and off.

6.5.4.1

The user may elect to discontinue further testing and begin troubleshooting to determine/correct the problem causing the test failure (see Section 5.4.10).

6.5.4.2

The user may elect to perform additional diagnostics by turning the spin knob to recall the "SEL 01-19" message on the FREQUENCY display.

SECTION 7

MANUAL CHANGES

7.1 INTRODUCTION

This section contains descriptions of engineering updates and corrections of errors in the manual.

7.2 MANUAL CHANGES

Wavetek's product improvement program incorporates the latest electronic developments into these instruments as rapidly as development and testing permit. Due to the time required to document and print these instruction manuals, it is not always possible to include the changes in the original printing. Change information, if any, appears after this page.

SP774 - 100 KHZ LOW END EXTENSION FOR MODEL 2500

SCOPE: This special allows the model 2500 signal generator to provide a leveled output down to 100 kHz with the standard output accuracy and spectral purity specifications maintained.

SPECIFICATIONS TO SP774

The standard specifications for the 2500 apply with the following exceptions:

Frequency Range	.1 - 1100 mHz
Harmonics and output accuracy apply down to 100 kHz.	
AM Bandwidth	DC - 3 Khz
AM Distortion typical	5% for AM < 90% 3% for AM < 70% 1.5% for AM < 30%
AM Accuracy typical (0 - 90%)	+/-1%(+/-5% of indicated setting) at internal rates