USE OF THIS MANUAL

This Instruction Manual for the Wavetek Model 2410 and 2410R RF Signal Generators contains eleven sections.

The 2410R is the ruggedized version of the 2410. Although the majority of text refers to the 2410, this Instruction Manual is equally applicable for either unit. The major difference between the two is their case. The 2410R is packaged in a ruggedized case. The 2410 is not. Aside from the difference in case and the minor changes associated with that difference, the two have the same functions, the same electrical circuitry, and operate identically.

Section 1 provides general information, including a brief discussion of operating characteristics, specifications, and available options.

Section 2 contains detailed installation instructions, initial inspection instructions, an instrument checkout procedure, and storage instructions.

Section 3 provides detailed operating instructions, including a comprehensive description of all front and rear panel controls, connectors, and displays.

Section 4 contains performance tests that may be used to verify operation at the limits of specifications.

Section 5 provides maintenance procedures, including user diagnostics and the almost completely automatic calibration (AUTOCAL®) procedure.

Section 6 describes remote operation across the GPIB interface.

Section 7 contains the principles of operation. This section begins with a general unit overview followed by a detailed, card level theory of operation.

Section 8 provides troubleshooting instructions.

Section 9 contains the reference drawings (schematics and assembly drawings).

Section 10 contains the replaceable parts lists.

Section 11 contains information related to the 2410R version of this unit. The ruggedized case (the "R" in 2410R) is the only difference between the two units. Use of the 2410R ruggedized case requires slightly different cable placements on several circuit cards and other minor modifications of several assemblies. The modified assemblies have new parts lists associated with them. The modified assembly drawings and parts lists for 2410R are contained in this section.

The manual contents, lists of figures and tables, and safety notes follow immediately after this page.

No special tools or test equipment are required to service or maintain either of these units.

SAFETY NOTES

WARNING

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

PERSONNEL SAFETY CONSIDERATIONS

Maintain the standard safety precautions required when working around 100-240 VAC. Be aware that when the unit's cover is removed, there is 100 VAC at the back of the display board.

This instrument is wired for earth grounding via the facility power wiring. Do not bypass earth grounding with two wire extension cords, plug adapters, etc.

Pay heed to the WARNING and CAUTION notes in the text of this manual. WARNING notes call attention to possible personnel hazards (injury and death) associated with subsequent operations.CAUTION notes call attention to possible equipment damage associated with subsequent operations.

INSTRUMENT SAFETY CONSIDERATIONS

Static sensitive devices are used in this instrument. Use ESD precautions when handling a static sensitive device or a card on which a static sensitive device is mounted. These devices may not fail catastrophically if precautions are not taken, but the life of the device and its performance may be reduced and an early failure may result.

GENERAL INFORMATION

1.1 INTRODUCTION

The Wavetek Model 2410 is a dual microprocessor controlled, single-loop synthesized signal generator that covers the frequency range of 10 kHz to 1100 MHz. It has an output power level continuously adjustable from +13 dBm to -127 dBm. In addition to CW operation, it is capable of AM/FM operation from an internal or external source. The 2410 has a very broad 500 kHz to 1 MHz peak FM deviation over the majority of its operating range. Standard features include an exclusive AutoCal® self-calibration function for frequency and amplitude, extensive user diagnostics, an automatic power up test sequence, and 16 nonvolatile memory locations to store front panel settings. A 10 MHz sine wave reference output is available at the rear panel.

A talk/listen GPIB fully conforming to the IEEE-488 standard is standard for the Model 2410. Because it utilizes the minimum uniqueness concept, the 2410 is easily conformed to any ATE system. It is fully compatible with the entire Wavetek 2500 family of instruments.

All operational controls are located on the front panel. Controls include keypad switches for entry of all RF output numeric parameters. A 4-key cursor provides increment/decrement entry of numeric data in digit steps, with any displayed digit selectable as the digit around which changes occur. Instrument settings and operational status are indicated on a two-line LCD display.

The 2410 is a space-saving 3/4-rack size. (Two optional rack mount adaptor kits are available.)

1.1.1 FREQUENCY CHARACTERISTICS

The carrier frequency may be set from 10 kHz to 1100 MHz with 10 Hz resolution and .00025% (2.5 ppm) accuracy. Frequency aging is <1 ppm/year.

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 100%. FM deviation can be set at peak values from 10 kHz to 1 MHz, depending upon the output frequency (see section 1.2.7.2). A TTL compatible sine or square wave at 5 MHz or 10 MHz may be used as an external reference input.

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

1.1.3 OUTPUT LEVEL CHARACTERISTICS

The Model 2410 has an RF output range of +13 dBm to -127 dBm with an accuracy of ±1.5 dB of the actual measured level. Level resolution is .1 dB.

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

1.1.4 AutoCal®/DIAGNOSTICS

The Model 2410 utilizes a unique Auto-Cal® routine to perform a quick and easy almost completely automatic self-calibration. The routine is software controlled, menu driven, and activated from the front panel. A variety of other menu driven diagnostic/control programming aids are standard with the 2410.

1.1.5 STORED SETTINGS

Nonvolatile memory locations allow up to 16 complete front panel settings to be stored and recalled in any order. This storage permits fast and accurate recall of frequently used settings.

The 2410 powers up with the same settings present when power was removed, except the RF output will be off.

1.1.6 ERROR INDICATORS

The 2410 front panel display indicates 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
- Modulation frequency reference error

1.2 SPECIFICATIONS

1.2.1 FREQUENCY

Range	10 kHz to 1100 MHz
Resolution	10 Hz; digital readout
Stability, 0-50° C	.00025% (2.5 ppm)
Stability, Aging	<1 ppm/year
Switching Time	200 ms (± 100 Hz of final value in CW and for changes >10 kHz in FM); typically 100 ms
Reference	
Internal	10 MHz
External	Accepts 5 MHz and 10 MHz TTL compatible

1.2.2 RF OUTPUT

Level Range	+13 to -127 dBm (1 volt to 0.1 microvolt)
Level Resolution	0.1 dB
Level Accuracy	±1.5 dB of set output level
Level Flatness	±1 dB
Output Impedance	50Ω with VSWR <1.5:1 at RF outputs <-3 dBm
Output Connector	Type "N", female

EMI/RFI Leakage	<1 μV into a 2-turn 1 inch diameter loop held one inch from any surface at 550 MHz

1.2.3 SPECTRAL PURITY

Harmonics	<-30 dBc for CW frequencies >10 MHz <-26 dBc for CW frequencies <10 MHz
Subharmonics	<-25 dBc for CW frequencies >550 Mhz
Spurious	<-50 dBc for offset >5 kHz from carrier

1.2.4 PHASE NOISE @ 500 MHz	10 kHz offset ; <-107 dBc/Hz guaranteed
1.2.5 RESIDUAL AM	<-60 dBc (50 Hz to 15 kHz post detection bandwidth)
1.2.6 RESIDUAL FM (50 Hz to 15 kHz post detection bandwidth)	<30 Hz rms (<137.5 MHz) <12.5 Hz rms (137.5 - 275 MHz) <25 Hz rms (275 - 550 MHz) <50 Hz rms (550 - 1100 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	10 Hz to 50 kHz frequency response, 600 Ω input Input Level 1 volt peak-to-peak into 600 ohms for full scale modulation
FM Mode	50 Hz to 100 kHz frequency response, 600 Ω input
Ranges	0 to 1 MHz (3-137.49999 and >275 MHz); 0 to 500 kHz (137.5-275 MHz); 0-100 kHz (1-3 MHz); 0-10 kHz (.01-1 MHz)
Deviation Error	±5% of indicated setting at 1 kHz or 400 Hz rate, excluding residual FM
Distortion	
Internal Source	<2% harmonic distortion at 1 kHz or 400 Hz rate; FM <100 kHz peak
External Source	<0.5% at 1 kHz or 400 Hz rate; FM <100 kHz peak

1.2.7.1 AM CHARACTERISTICS

AM Frequency Response	3 dB BW from 10 Hz to 50 kHz (50% modulation)
AM Resolution	.1%
AM Range	0 - 100%

Modulation Accuracy, AM (0 – 90%)	±(1% + ±5% of indicated setting) at internal rates
AM Distortion	<1.5%, below 30% modulation; internal rates <3%, 30% to <70% modulation; internal rates <5%, 70% to <90% modulation; internal rates

1.2.7.2 FM CHARACTERISTICS

FM Resolution	100 Hz (deviations <100 kHz) 1 kHz (deviations >100 kHz)
FM Frequency Response	±3 dB from 50 Hz – 100 kHz
FM Deviation Range(1 kHz Rate)	1 MHz peak (3-<137.49999 & >275 MHz) 500 kHz peak (137.49999 – 275 MHz) 100 kHz peak (1 – <3 MHz) 10 kHz peak (.01 – <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, excluding residual FM <0.5% at external rates for deviation <100 kHz, excluding residual FM Does not apply during overmodulation conditions

1.2.8 FRONT PANEL CONTROLS

Type	Push-button

1.2.9 REVERSE POWER PROTECTION

Max RF Power	50 W
Trip Level	~ .7 W
Trip Time	Typically <2 mSec
RF Circuit Breaker	Resettable from front panel

1.2.10 STORED SETTINGS

16 Total, non-volatile	Complete front panel settings stored

1.2.11 EXTERNAL REFERENCE INPUT (REAR PANEL)

Frequency	5 MHz or 10 MHz
Required Input Level	TTL compatible

Required Input Impedance	50 Ω
Waveform	Sine or Square Wave

1.2.12 INTERNAL REFERENCE OUTPUT (REAR PANEL)

Frequency	10 MHz
Voltage Out/Impedance	>.5 Vp-p, into 50 Ω

1.2.13 GENERAL

Dimensions	14 cm (5.2 in.) High; 31.75 cm (12.5 in.) Wide; 54.36 cm (21 in.) Deep
Weight	11.79 kg (26 lbs.) net; 13.61 kg (30 lbs.) shipping
Power Requirements	100, 115, 215, or 230 VAC ±10%; single phase; 50, 60, or 400 Hz; 100 watts, maximum
Calibration Interval	After calibration, the Model 2410 will meet each performance requirement within the tolerance specified for a period of at least 12 months
1.2.14 Remote (GPIB) Operation	The GPIB permits remote programming of front panel functions. An extended GPIB function permits automatic frequency calibration and board level testing across the GPIB. Command codes conform to TEK codes and formats, Tektronix Standard 80009, Rev. C, 1979.
Interface	GPIB IEEE 488-1978, 1987
Control	All functions except On/Off
Functions	T6, L4, SH1, AH1, RL1, DC1, DT1, E2, SR1, TE0, LE0, PP0, C0

1.3 OPTIONS

1.3.1 Deviation Meter

Range	0 - 500 kHz
Frequency Input	30 - 500 MHz
Input Signal Level	15 mV - 5 V rms
Polarity	Selectable positive or negative
Modulation Rate	100 Hz - 8 kHz
Accuracy	6% of full scale from 100 Hz - 8 kHz

1.3.2 Extended Storage	The extended storage option allows the operator to store into memory and recall 100 complete front panel settings.
1.3.3 A/D IN	The A/D In option allows the user to calibrate the unit's output level without using a power meter.
1.3.4 Rack Mount Kits	Wavetek manufactures two rack mount adaptor kits, one without slides and one with slides. The rack mount adaptor kit without slides provides a fixed, immovable unit mount. The rack mount adaptor kit with slides allows the unit to be pulled out from the rack. Complete installation instructions are supplied with the hardware for either kit.

2.1 INTRODUCTION

This section provides complete installation instructions for the Wavetek Model 2410 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.

This section also provides packing and storage instructions and environmental restrictions for the unit.

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.

2.2.2 Packing Instructions

Use the original packing material and shipping container to pack the instrument. Observe the following guidelines when using packing materials other than the original ones:

Wrap the instrument in plastic packing material.

Use a double-wall cardboard shipping container.

Use shock-absorbing material on all sides to prevent instrument movement within the container.

Seal the shipping container securely.

Mark all sides, top, and bottom of the shipping container "FRAGILE".

2.3 MECHANICAL INSTALLATION

Mechanical installation instructions are limited to those steps required to install the 2410 into a rack using the optional rack mount adaptor kits available from Wavetek.

Wavetek manufactures two rack mount adaptor kits, one without slides and one with slides. The rack mount adaptor kit without slides provides a fixed, immovable unit mount. The rack mount adaptor kit with slides allows the unit to be pulled out from the rack.

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

2.4 ELECTRICAL INSTALLATION

The instrument can operate from 100, 115, 215, or 230 VAC supply mains, over an AC supply frequency range from 50 to 400 Hz. The rear-panel AC power connector module is set for the operating voltage used, and adjusts the Power Supplies accordingly. The 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 100/115 VAC operation; 0.5 A for 215/230 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 115 VAC operation unless otherwise specified.

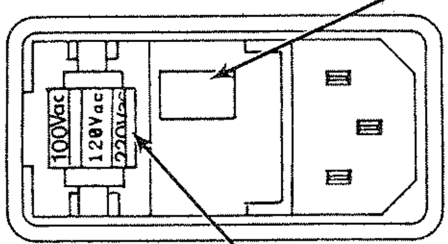

Figure 2-1. AC Power Connector Module

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 2410 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 2410, it automatically performs a test sequence to verify various subsystems and subsystem circuitry are 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 has been selected properly. Selection is made using the reference programming procedures described in section 3.6.5. <u>If the internal reference source is used, the INT source must be selected.</u> (If the INT source is not the selected source when the internal reference is used, the power up self test will give an error message and the unit will not operate.) Depress the POWER switch. The display will indicate operation, with the 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 2410. Verify measurements to the limits of the test equipment used, if desired.

FREQUENCY

Use the keyboard (Section 3.5.2) to set the output frequency to 1100 MHz at a 0 dBm power level, modulation off. Measure the output frequency. Change the output frequency to 250 MHz. Measure the output frequency. Use the keyboard to set the frequency to 0.01 MHz. Measure the frequency.

OUTPUT POWER

Set the output frequency at 1 MHz with no modulation. Use the keyboard to set the output power level at +13 dBm. Measure the output power. Set the output power to -3 dBm. Measure the output power. Set the output frequency to 550 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 output power. Change the output to -3 dBm. Measure the output power.

AM

Set the output frequency at 1 MHz and power level at -3 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.

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 1100 MHz. Measure deviation. Select the 400 Hz internal source. Measure FM deviation.

EXTERNAL AM/FM

The user may elect to insert an external modulation source at the EXT REF IN connector on the rear panel (item 2 of Figure 3-2) and repeat the AM and FM tests for EXT AM and EXT FM inputs. Select EXT AM and EXT FM by pressing the appropriate keyboard switch.

DEVIATION METER (OPTION)

Press the "Pos Dev" key on the front panel. Set the output frequency of the Model 2410 to 250 MHz.

Connect the RF output from an external signal generator to the 2410 front panel Mod In connector. Set the external generator to 250 MHz, 0dBm, FM modulation 500kHz peak, internal rate of 1 kHz.

The external generator's positive FM deviation to ±30 kHz will be shown in the 2410's LCD display.

Press the "Neg Dev" key on the front panel.The external generator's negative FM deviation to ±30 kHz will be shown in the 2410's LCD display.

Decrease the external generator's output frequency by 200 kHz. When the deviation measurement is used, the 2410 display will show the message "TUNE -".

This indicates the 2410 output frequency must be adjusted down to make the measurement.

The display will show "TUNE +" or "TUNE -" when the external source frequency is within approximately ±1 MHz of the 2410 frequency.

2.6 STORAGE INSTRUCTIONS

Store the instrument in a clean, dry environment. Protect the instrument from temperature variations that could cause internal condensation. Store between -40°C to +75°C (-40°F to +158°F) at a relative humidity less than 95% at +25°C.

2.7 ENVIRONMENTAL RESTRICTIONS

The temperature and humidity ranges listed in section 2.6 also constitute the environmental restrictions for this unit.

3.1 INTRODUCTION

This section provides complete operating instructions for the Wavetek Model 2410 RF Signal Generator. No preparation for operation is required. The optional initial installation checks contained in Section 2 of this manual may be performed at this time.

The 2410 may be operated locally using the front panel controls or remotely through the General Purpose Interface Bus (GPIB) interface on the rear panel, under computer/controller instructions. The GPIB conforms to proposed IEEE 488.1 and is described in section 6 of this manual.

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. 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 2410.

CAUTION

Allow a 2-second time interval between turning power off and on to prevent current surges.

2. FUNCTION CONTROL KEYPAD

The function control keys are grouped together into a keypad for operator convenience. Each key is described in the following section.

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

The "Int FM" key selects the internal frequency modulation mode of operation and is associated with the Rate key.

The "Ext AM" key selects the external amplitude modulation mode. Connect the external amplitude modulation source at the "Mod In" connector (feature 7).

The "Ext FM" key selects the external frequency modulation mode. Connect the external frequency modulation source at the "Mod In" connector (feature 7).

The "Rate" key determines which internal source , 400 or 1000 Hz, provides the internal modulation rate (AM or FM, selected by the "Int AM" key or the "Int FM" key, respectively).

The "Mod Off" key turns off all modulation of the carrier wave, selecting an unmodulated CW RF output. This key also turns off the optional deviation meter.

The "Pos Dev" key is used with the FM

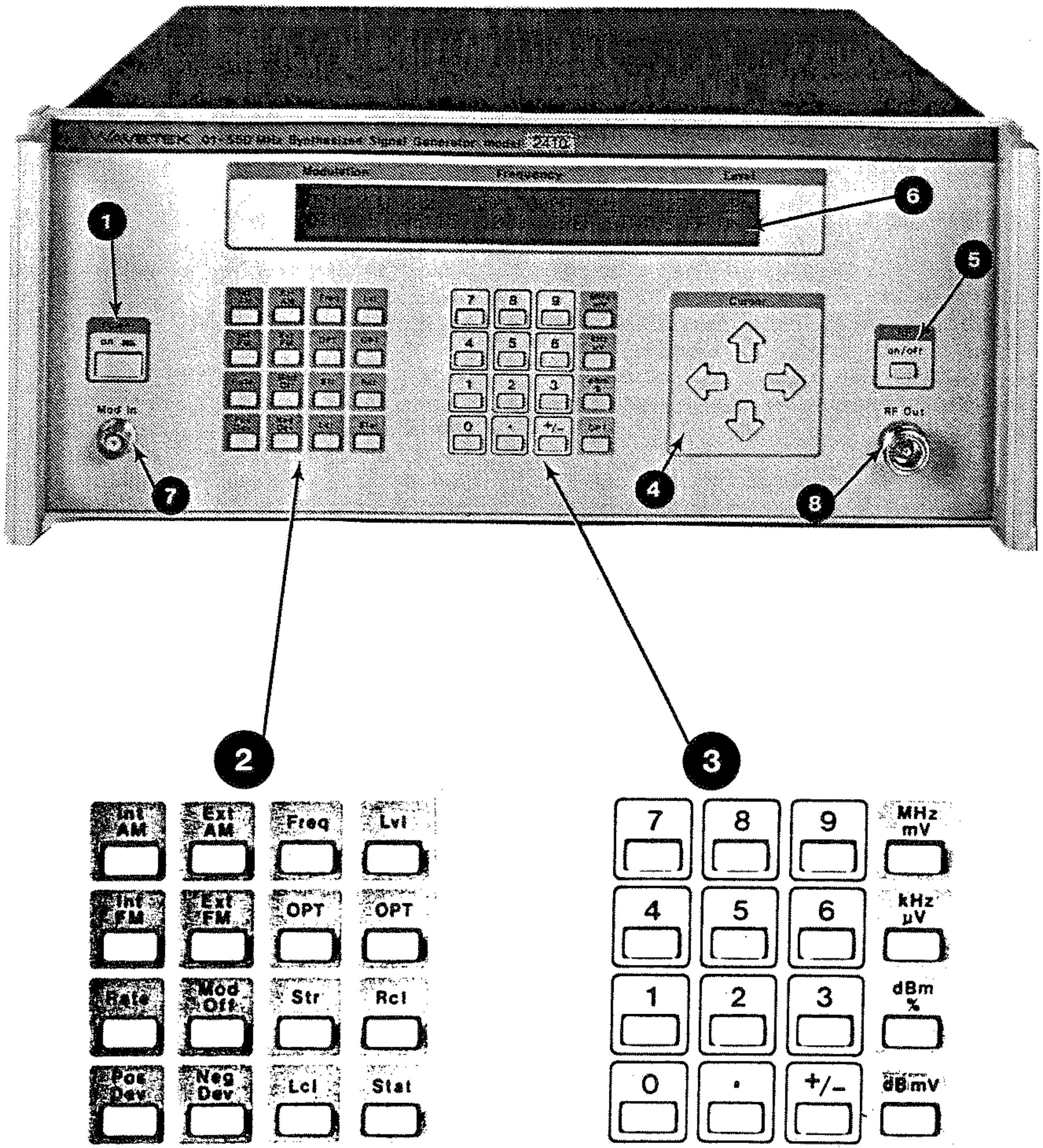

Figure 3-1. Wavetek Model 2407 Front Panel

deviation meter option.

The "Neg Dev" key is used with the FM deviation meter option.

The "Freq" key initiates the procedure to set the RF output carrier frequency.

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

The two (2) "OPT" keys that are present but nonfunctional on the standard Model 2410 provide potential operator interfaces for future 2410 options. If an option is installed, its associated key will be relabeled. Documentation for future options will be supplied separate to this manual.

The "Str" key initiates the procedure to store front panel settings in non-volatile RAM (Random Access Memory). There are 16 locations available for stored settings.

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

The "Lcl" key is used to reestablish front panel control of the 2410 from the remote control source when the unit is in the remote control mode of operation (GPIB). Documentation for the GPIB is provided in section 6 of this manual.

The "Stat" key initiates LCD menus associated with error messages, diagnostics, options, calibration, control switch setting operations, and the extended GPIB mode (described in Section 6).

3. NUMERIC ENTRY/TERMINATOR KEYPAD

Numeric data is entered using 12 of the 16 keys grouped in this keypad. The digits (0-9) and a decimal point (.) are represented by individual keys. The "+/-" key establishes the sign of an entry (positive or negative) and is the "exit" key for various status key operations described later in this manual.

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

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

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

The "dBmV" key terminates output level (dBmV).

Terminator keys also may be used to convert the displayed level value into the units represented by each key. For example, if the display shows output in "dBm", pressing the "Lvl" key and then the "dBmV" key will convert the dBm value displayed to its equivalent dBmV value.

4. CURSOR

The four cursor keys work together to provide fine and coarse control of output frequency, output level, AM depth (%), and FM deviation (kHz). The keys work in pairs. The left/right arrow keys (resolution digit keys) form one pair. The up/down arrow keys form the other pair. The operation of each pair is described in the following sections.

The left and right arrow keys act as cursor keys to establish the "resolution" digit in the numeric portion of a displayed function (see item 6). The "resolution" digit is controlled by the up/down keys (see the paragraph immediately following this one). The digits to the left of the resolution digit also are controlled by the up/ down keys. The resolution digit is underlined on the display. Pressing the up/down keys will not change digits to the right of the resolution digit.

The up/down keys increase or decrease the numeric value displayed, with the resolution digit as the point around which the change occurs. Pressing the up key will increase the value. The down key will decrease the value.

5. RF ON/OFF

The "RF on/off" key is used to switch the RF signal on and off at the "RF out" connector (feature 8). It is used to reset the reverse power protection circuit breaker when it trips. Also it is used to initiate the extended GPIB mode (described in Section 6).

6. LCD DISPLAY

The front panel display is a two line by forty character, dot matrix, liquid crystal display (LCD). The display provides information about RF output characteristics, indicates operational status of the instrument, and shows readings for the optional deviation meter. The display is divided into various information fields described in the following sections. The top line includes modulation information, frequency information, and level information. The bottom line includes additional modulation information, front panel setting storage/recall information (memory), GPIB and external reference indicators, status information, and the RF on/off indicator. Both lines carry deviation meter information. Many of the numeric values shown on the display will contain the underlined resolution digit used with the cursor (see item 4, Figure 3-1; section 3.3).

The modulation field is the left most twelve characters of the first line of the display. It is identified by the "Modulation" label above the display. It is separated from the next field by two blank characters. (Additional modulation information is shown on the second display line).

The first three characters of the modulation field form a mnemonic that indicates the current modulation input or the last modulation input for complex modulation (AM and FM together). Identical mnemonics are used for front panel and remote (GPIB) operation. Mnemonics for normal operating conditions are:

IAM Internal AM
IFM Internal FM
XAM External AM
XFM External FM

After a blank space, the next four characters of the modulation field indicate the numeric portion , including decimal point, of the modulation value. The Cursor (see item 4 of Figure 3-1 and see section 3.3) may be used to control these digits. After another blank space, the last three characters show the modulation units (% or kHz). When no modulation (internal or external) is in effect, MOD OFF is displayed.

Note that when in use, the optional deviation meter replaces all internal and external modulation functions. The display will show the positive or negative FM deviation values with the POS or NEG mnemonic, the numerical deviation value, cursor, and the Hz unit. (The first field of the second line on the display will show the characters DEV).

The frequency field is on the first line of the display, below the "Frequency" label. It consists of characters 15 through 28 on the line and is separated from the modulation field by two blank spaces. The numeric value of the frequency, including decimal point, is shown in the first ten characters. The Cursor (see item 4 of Figure 3-1 and see section 3.3) may be used to control these digits. After a blank space, "MHz" units are shown.

The level field is composed of the last ten characters on the first line of the display. These characters are located under the "Level" label. Two blank spaces separate this field from the frequency field. The first character in the level field is the plus or minus sign for level in dBm. The next five characters show the numeric value of the level, including decimal point. The Cursor (see item 4 of Figure 3-1 and see section 3.3) may be used to control these digits. After a space, the last characters are dedicated to the level units (dBm or mV or µV).

When external and internal modulation are in use, the first line of the display typically shows the modulation type last entered. The first three characters of the second line of the display show the additional modulation. These characters (IAM, IFM, XAM, or XFM) are the same as those shown on line one and have the same meaning. If the FM limit is accidentally exceeded (see the MODULATION discussion of section 3.5.5) an AM value on the first line may be replaced by an FM value, even though the AM value was entered last.

The next five characters on the second line give the internal rate in Hz (either 1000 or 400). When no internal modulation is used, no internal rate is displayed.

When the optional deviation meter is in use, the characters DEV replace the modulation status shown in this field.

When instrument settings are loaded into (stored) or recalled from memory locations, the location for storage or recall is shown under the Frequency label on line two of the display. Typical store/recall indications are STORE 11 and RECALL 11, for example. When a setting is changed and no longer represents the contents of a particular location, the location information is removed. The Cursor (see item 4 of Figure 3-1 and see section 3.3) may be used to increment or decrement the recall operation.

When the instrument is controlled across the GPIB bus (remote operation), this field will show the indication REMOTE.

The third field on the second line displays XREF when an external reference is used. IREF is shown when the internal reference (default condition) is used.

The fourth field on the second line contains the STATUS message that will flash on and off when an instrument error condition occurs. The STATUS error message will continue to flash on and off until the Status (Stat) key (item 2 of Figure 3-1; section 3.3) is pressed.

After the STATUS request is acknowledged by pressing the "Stat" key, the second display line will show the following message:

1:ERROR 2:DIAG 3:OPTN 4:CAL 5:SET +:EXIT

This is the status key operation select menu. It shows the available status key operations. The status key is used to initiate error reporting, diagnostics, options, calibration, and control switch setting operations. ERROR represents error reporting operations. DIAG stands for diagnostic test procedures. OPTN is the option review and programming procedures. CAL stands for calibration procedures. SET is the control switch setting operations. To initiate the status key operation shown, enter its associated number. The appropriate menu will be called up. The cursor is initially located under the "E" in "ERROR", as shown above. Pressing the STATUS key is like pressing the "1" key in this instance. The first in the series of Error Reporting menus will be generated (see section 3.6.1).

Pressing the "+/-" key from the status key operation select menu will restore the normal operating display. If the error condition is still present after returning to the normal display, the "STATUS" indicator will be on but will not be blinking on/off. If a new error condition occurs, the "STATUS" indication will begin flashing again. If the error condition disappears, the "STATUS" message will turn off.

Status key operation incorporates user friendly LCD menus that guide the operator through the procedures associated with the status key. CAL (Calibration) operations are described in Section 5.3

of this manual. The remaining status key operations are described in sections 3.6.1 through 3.6.5.

The last field in the second line shows the status of the RF output. It will indicate RF ON or RF OFF. This information is always present on the display.

7. Modulation In Connector

The "Mod In" connector is a BNC connector to which an external modulation source or the input for the optional deviation meter will be applied.

8. RF Output 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 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 sine wave internal reference signal may be obtained.

2. EXTERNAL REFERENCE IN

This is the connector at which an external 10 MHz signal or 5 MHz (TTL compatible, sine or square wave) is applied.

3. GPIB CONNECTOR

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

4. FAN

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

5. AC POWER CONNECTOR MODULE

The voltage selector in this module is

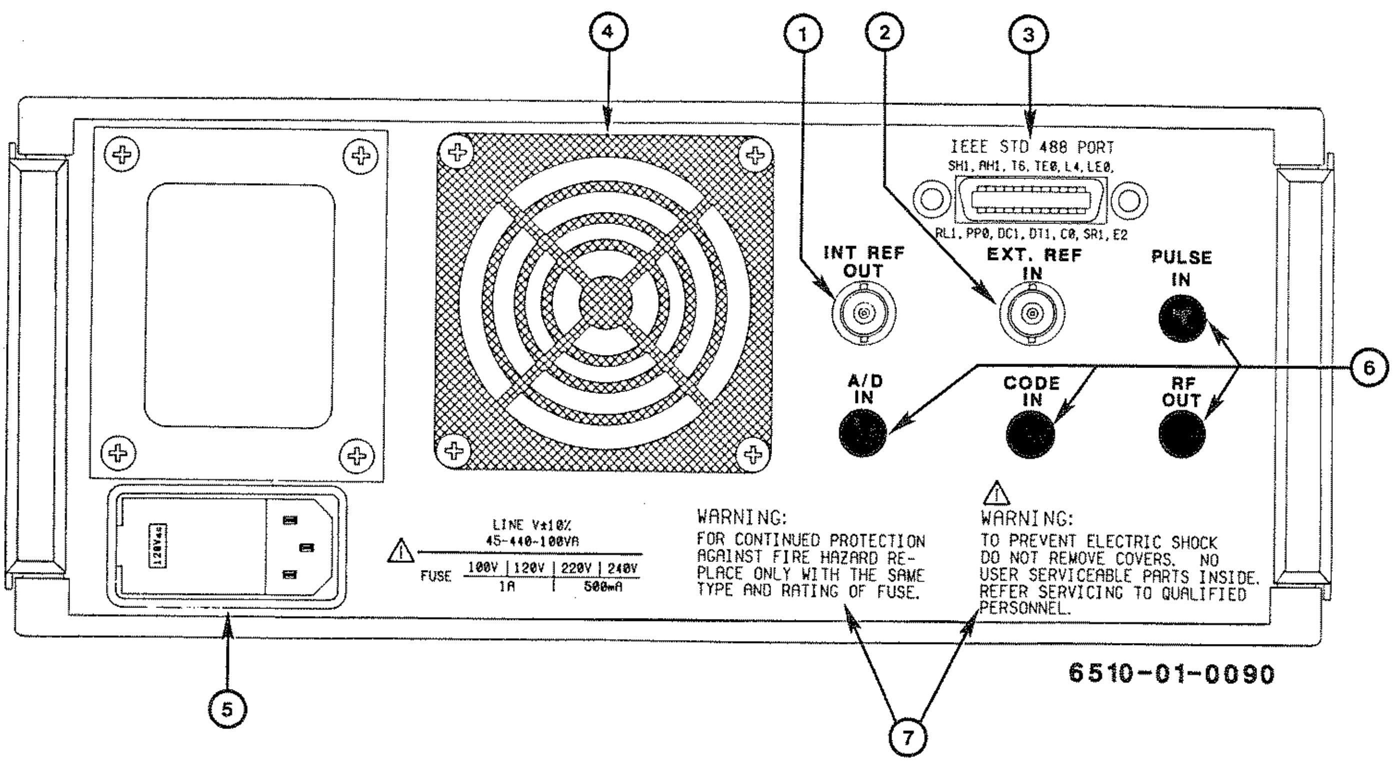

Figure 3-2. Wavetek Model 2410 Rear Panel

removable. It must be inserted in the correct AC line voltage position to adjusts the unit's power supply correctly. (See Section 2.4 and Figure 2-1 of this manual for greater detail.)

6. OPTION PLUGS

These four (4) plugs cover openings for installation of options. Options may be installed at the factory when a unit is ordered or in the field by the customer.

7. WARNING LABELS

The electrical shock and fuse replacement warnings are on the rear panel. Note 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 completely controlled from the front panel. Front panel control involves interaction of the display, function keys, and termination keys.

3.5.1 TURN ON

Depress the power switch to turn on the unit. The unit will power up with the RF output off. 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 power up test sequence described in Section 5.5 will be performed each time power is applied to the unit. See section 5.5 for the displays associated with power up.

3.5.2 NUMERIC ENTRIES (KEYBOARD AND CURSOR KEYS)

The following front panel operations require numeric entry made using the keyboard and/or the cursor arrow 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)
- Setting deviation meter (option) frequency

KEYBOARD/CURSOR KEY OPERATIONS

The keyboard/cursor key sequence and the instrument response for a numeric entry are:

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

b. If the arrow cursor keys (See CURSOR KEY OPERATION, the next section) are 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.

c. Either use the cursor keys to establish the numeric value to be entered 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. The cursor will appear under the digit immediately following the MSD. Blank spaces will appear in the remaining digit locations and the decimal point will not appear in the display field. Any suffix will be blanked out.

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 may be accepted (up to a maximum of fifteen significant places), but will not be displayed.

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, 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:

- 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 restored to 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 can be completed.

- If the entered data is out of the range of the function, the previous function value will be restored and displayed.

CURSOR KEY OPERATION

The up and down arrow and left and right arrow cursor keys are used to increase or decrease the numeric value of a function. Pressing the up arrow cursor key increases the value; pressing the down arrow key 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 arrow cursor controls are used to select a given digit, the resolution digit, on the chosen function's display field. The resolution digit for a particular function can be changed by using the left and right arrow cursor keys. 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 be ignored. Likewise, when the MSD (Most significant digit) is reached using the left arrow key, the next depression of the left arrow key will be ignored. No wrap-around occurs in either "direction." The resolution digit selected for each function will be retained during operation of the 2410 Signal Generator.

b. When the up/down arrow keys are pressed, the value for 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 cursor key operation. These digits will maintain their previous values during cursor key operation.

The cursor keys permit very coarse control when used with the most significant digit, and very fine control when used with the least significant digit. When the upper or lower range limit of a function is reached, the display and the function parameter will stop at that value. Once the limit is reached, further use of the cursor key will not cause a further change in the displayed value.

c. CAUTION: When the 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 2410 contains sixteen (16) locations in memory for storage of 16 different sets of front panel settings. These locations are identified by a two digit number (00-15). The function keys "Str" and "Rcl" (items 13 and 14 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 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:

- Selection between 400 and 1000 Hz internal modulation source (Rate)
- Selection of the CW unmodulated output (Mod Off)
- Local mode selection (Lcl)
- Switching the RF output on and off (RF on/off)
- Status key operations (Stat)

Toggle switches control the 400/1000 Hz Rate and RF on/off functions. When either key is depressed, its function toggles between the two possibilities shown.

The "Mod Off", "Lcl", and "Stat" keys select particular functions. When one of these keys is depressed, the function is executed and the appropriate annunciators are displayed. The "Stat" key is a multifunction key (see Section 3.8 for a detailed description).

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. Remote Mode (GPIB) operation is described in Section 6.

FREQUENCY

The output RF frequency of the 2410 is set using the keyboard/cursor key sequence described in Section 3.5.2.

Press the "Freq" function key to initiate a change in frequency. Then enter the numeric value using the keyboard or cursor keys as described in Section 3.5.2.

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

When FM (Frequency Modulation) is selected and a frequency change $\geq$10 kHz is to be made, the 2410 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.)

POWER LEVEL

The RF output power level of the 2410 is set using the keyboard/cursor key 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 cursor keys (Section 3.5.2). Terminate the entry using the "dBm", "mV", or "μV" key. Output level will be shown on the Level field of the display.

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 cursor keys are used to set the output level, be careful not to overdrive a device being tested.

MODULATION

The "Mod Off" key selects a CW (unmodulated) output of frequency and level as set in Section 3.5.5.

Modulation of the 2410 RF output signal is set using the keyboard/cursor key 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

Single modulation (AM, internal or external; or FM, internal or external) is established by pressing the function key associated with the desired type of modulation ("Int AM" or "Ext AM"; "Int FM" or "Ext FM"). The numeric value for the modulation depth (AM) or deviation (FM) is then set using the keyboard/cursor key sequence (described in Section 3.5.2). 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 2410 specified AM range. Although the unit may be set to an AM depth of 100%, an AM depth greater than 90% is outside the specified range.

Section 1.2.7.2 lists the Model 2410 specified deviation range for FM operation. FM has a maximum deviation range of 1 MHz over the majority of the instrument's frequency range (3-137.4999 MHz and >275 MHz). From 137.5 - 275 MHz, maximum FM deviation is limited to 500 kHz. If FM is set to a value greater than 500 kHz in the carrier frequency ranges valid for 1 MHz deviation, and then the carrier frequency is changed into the (137.5 - 275 MHz range valid only for 500 kHz maximum, the FM value will automatically be limited to 500 kHz. This is true for both internal and external FM whether AM is enabled or not. If AM and FM are enabled and AM occupies the upper display line, when the FM range is corrected, it will be moved to the upper display line and AM moved to the lower, so that the auto-range limiting is noticeable.

An FM deviation greater than 10 kHz in the frequency range from 0.1 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.

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 lines 1 and 2 of the display.

Use the "Rate" function key (item 6 on Figure 3-1) to choose between internal modulation sources of 400 and 1000 Hz.

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

NOTE

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

3.5.6 STORAGE/RECALL OF FRONT PANEL SETTINGS

There are 16 memory locations set aside for storage of 16 complete front panel settings (output frequency, level, and modulation settings). The function keys associated with this dedicated memory are the "Str" (store) and "Rcl" (recall) keys. Each is described below.

TO STORE A SETTING

1) Press the "Str" function key. The word "STORE" will appear on the 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". The "0" is placed in the most significant digit position. The "3" will go into the least significant position.

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

TO RECALL A STORED SETTING:

1) Press the "Rcl" function key. The word "RECALL" will appear on the 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 second digit the display will show the two digit location entered. The front panel settings that were recalled will be executed and the display will be updated to show the recalled settings.

c. The recall function also enables the increment/decrement (up/down arrow) keys. These keys may be used to step through the stored settings. Those locations that contain invalid data (for example, a store to that location has never taken place or the data has been corrupted because of a hardware error) will be skipped. Wraparound will occur from 00 to the last stored setting location (15 or 99 depending on the option selection). If none of the stored setting locations contain valid data, the display will be nonfunctional. If a digit key entry is made, the inc/dec keys will be locked out until a second digit key entry is made.

d. 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, that function is enabled and the store/recall process is aborted. The store/recall display will be blank.

3) If a function key not associated with a numeric entry is pressed, the function will be executed and the store/recall display will be blank. After the non-numeric process is executed, the storage/recall process will resume.

4) If the stored setting number is out of range, the entry is ignored. The display returns to the last storage location that was stored or recalled.

3.5.7 RETURN TO LOCAL MODE OF OPERATION FROM REMOTE

The "Lcl" key will cause the 2410 to exit the Remote Mode (GPIB) of operation and return to full front panel operation (Local Mode). The front panel display will show the message "LOCAL" on the second line.

When the unit is in the Remote Mode, the REMOTE indicator is shown on the display. The front panel keys, except for the "Lcl" key, 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 STATUS KEY OPERATION

Pressing the status key (Stat) is the initial step in calling up error reporting, diagnostics, option review/programming, calibration, and control switch setting menus. Menu selections are numeric. Each number shown has an associated operation. Entering a number on the keyboard generates the operation shown on the menu. The cursor is automatically placed under the most frequent choice on each menu, allowing the selection of that choice by pressing the status key. The "+/-" key is the exit key for each menu.

3.6.1 INSTRUMENT ERROR MESSAGES

Several error messages are displayed by this instrument. An instrument malfunction or operation of the instrument outside its specified range may generate the error message sequence described in the following sections.

If an instrument error occurs, a STATUS annunciator will blink on and off in the fourth field on the second line of the normal operating display. The STATUS error message will continue to blink on and off until the "Stat" key (item 2 of Figure 3-1; section 3.3) is pressed. If a new error occurs after the initial response, the STATUS indication will begin blinking again.

After the status key is pressed to acknowledge the STATUS request, the second display line will show the following message:

1:ERROR 2:DIAG 3:OPTN 4:CAL 5:SET +:EXIT

This menu shows the available status key operations. When the "Stat" key is pressed in response to an error indication (STATUS blinking on/off), the cursor is initially located under the "E" in "ERROR" as shown above. When ERROR is implemented (press the "Stat" key when the cursor is under the "E" in "ERROR" or press the "1" key), the second line of the display will show the error condition(s) actually present. The locations on the second line for the various error indicators are:

MFREQ TRIP UNLOCK1 UNLOCK2 UNLEV +:Exit
and
CONTROL uP COMMUNICATION FAILURE +:Exit

Individual errors are described briefly in sections 3.6.1.1 through 3.6.1.5 and in detail in Section 8. The cursor will be present under the "EXIT" message. Pressing the "+/-" key or the "Stat" key will restore the normal operating display. If the error condition is still present after returning to the normal display, the "STATUS" indicator will be on but will not be blinking. If a new error condition occurs, the STATUS indicator will begin to blink on/off again. If the error condition should disappear, the STATUS message will turn off.

Error reporting will not interfere with the normal operation of the unit.

If the error procedure has been implemented when no errors are in effect, the second line of the display will show:

SYSTEM OPERATIONAL +:Exit

Pressing the "+/-" key or the status key will restore the normal operating display to the LCD.

Errors for the optional Deviation Meter also are shown in the display. They are detailed in the Deviation Meter discussion (section 3.7).

The MFREQ (Modulation Frequency) error message indicates a problem with the selected reference. If the internal reference has been selected (Reference Programming, section 3.6.5), the MFREQ error message indicates that the internal modulation reference (400 Hz or 1000 Hz) derived from the frequency reference is not accurate. If the external reference has been selected, the MFREQ error message indicates either there is no external reference input or the input is not within specifications. This error will occur only if an internal modulation source (AM or FM) is enabled because the modulation reference source is turned off otherwise.

A "TRIP" message on the display indicates an external input has been connected to the 2410 RF output, tripping the RF circuit breaker that provides reverse power protection. If this occurs, remove the external input and then push the "RF on/off" switch, first off then on, to reset the circuit breaker.

The "UNLOCK1/UNLOCK2" messages on the display may indicate one of the phase locked loops (PLLs) in the output frequency generating circuitry has become unlocked. UNLOCK1 indicates the loop in the Synthesizer circuitry may be unlocked. UNLOCK2 indicates the loop in the LO (Local Oscillator) circuitry may be unlocked. If either UNLOCK message occurs, perform the calibration described in Section 5.4 of this manual. (If this procedure does not erase the UNLOCK indicator, the unit has a problem that will require troubleshooting. 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.)

The UNLEV (Unlevel) message indicates the output amplifier/leveling circuitry may be out of calibration. Perform the calibration described in Section 5.4 of this manual. (If this procedure does not erase the UNLEV message, the unit has a problem that will require troubleshooting. 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.)

The "CONTROL uP COMMUNICATION FAILURE message on the display indicates the control microprocessor communication system has failed during execution of a command. This failure can be due to a component failure of the dual-port RAM or failure of the control microprocessor or any of its associated memory and decoding.

3.6.2 Diagnostic Procedures

Pressing the status key ("Stat") during normal operation will call up the initial screen for status key operations. The first line will contain normal operating information The second line will look like:

```
1:ERROR 2:DIAG 3:OPTN 4:CAL 5:SET +:EXIT
```

To initiate the Diagnostics, press the "2" key. Software will turn off the RF output (RF OFF) and store the current instrument settings. The diagnostic selection display will be called up:

```
DIAGNOSTIC
1:AUTO 2:LCD 3:KEY 4:DACS 5:DEBUG +:EXIT
```

Diagnostics are part of 2410 maintenance and are detailed in section 5.3.

3.6.3 Option Review And Programming

The option menus allow review or programming of the options installed in a unit. Press the "Stat" key from any normal operating menu to call up the status key operation select menu (second display line shown):

```
1:ERROR 2:DIAG 3:OPTN 4:CAL 5:SET +:EXIT
```

Enter a "3" to implement Option Review or Option Programming. The initial option display called up offers the alternatives to review or program the status of options installed or to be installed in the unit:

```
OPTION PROGRAMMING
1:REVIEW 2:PROGRAM                +:EXIT
```

To review the options currently installed, enter a "1" from the initial option review/programming menu. The options installed will be shown in a series of displays that follow the format:

```
OPTION REVIEW                <BACK>:NEXT
(--option header---)   (sel)      +:EXIT
```

The name of the option currently being considered will be displayed where "(--option header--)" is shown. The current setting of that option will be displayed where "(sel)" is shown. Option header messages and their associated selection choices are shown below:

Header	Sel1	Sel2
# OF STORES SETTINGS	16	100
ATTENUATOR TYPE	2400	2500
DEVIATION METER	OFF	ON

The ATTENUATOR TYPE choices shown are for future use only. All units are shipped with a type 2500 attenuator installed. The type 2400 attenuator (selection 1) is being considered for future use.

The cursor forward and backward keys (left and right arrow keys) are used to scroll through the series of option review menus. When at the first option selection, the left arrow key will not function. When at the last option selection, the right arrow key will not function. Pressing the + key will always recall the previous menu selection.

To program options, enter a "2" from the initial option review/programming menu to call up the following screen:

```
OPTION PROGRAMMING:                    +:EXIT
ENTER SECURITY CODE:
```

At this point the security code (password) for option programming must be entered. The security code is supplied separate to this manual for security reasons. When the security code is entered correctly, the display will show a series of screens that list the options that can be programmed:

```
(--option header--)               <BACK>+:NEXT
1.sel1  2.sel2                          +:EXIT
```

The name of the option being considered will be in the "(--option header--)" location. The selections available for that option will be displayed where "sel1" and "sel2" are shown. An asterisk (*) will be substituted for the number of the selection that is currently programmed. To change an option, press the number of the desired selection. The asterisk will replace that number to indicate the selection has been made. Option header messages and their associated selection choices are shown earlier in this section.

The cursor left and right arrow keys are used to step through the series of options. Pressing the + key will recall the previous menu selection.

When the option programming menu is exited, the hardware will be checked for deficiencies due to the new option selections. If there is a problem, the following error message will be displayed for approximately 2 seconds for each error.

```
HARDWARE RESTRICTIONS:
----------hardware error message----------
```

The potential hardware error messages and their causes are:

EXTENDED NVRAM (32k) NOT INSTALLED
    if the 100 stored settings is selected and the extended RAM option is not installed

DEVIATION METER CARD (9) NOT INSTALLED
    if the deviation meter option is selected and the deviation meter card is not installed

3.6.4 Calibration

Pressing the "Stat" key during normal operation will call up the initial screen for status key operations (second display line shown):

```
1:ERROR 2:DIAG 3:OPTN 4:CAL 5:SET +:EXIT
```

To initiate calibration procedures, press the "4" key. Calibration is part of 2410 maintenance. Calibration is described in detail in section 5.4 of this manual.

3.6.5 Control Switch Setting

The Control Switches set the reference source (internal or external), load the factory default settings into system memory, set LCD contrast, set the GPIB address and terminator, and initiate a service request. Press the "Stat" key during normal operation to call up the initial status key operations screen (second line shown):

```
1:ERROR 2:DIAG 3:OPTN 4:CAL 5:SET +:EXIT
```

Press the "5" key to call up the first of the Control Switch Set menus:

```
*:INT REF 2:XREF10  3:XREF5   4:DEFAULT
5:CONTRST 6:ADDR  7:TERM  8:SRQ  +:EXIT
```

Reference Programming

In the initial control switch setting menu, shown immediately above, the asterisk in front of the "INT REF" indicates the internal reference is the current reference source. Enter a "2" from this menu to change from the internal reference to an external 10 MHz reference. The "XREF-5" characters select a 5 MHz external reference. When an external source is used, the instrument must be told an external source is being used. After a reference change entry, the cursor is automatically placed below the EXIT field because the reference change is the most probable use for this menu. (Internal Reference is the default reference setting). An asterisk beside the entry chosen verifies the new selection. The reference selection with the asterisk (as INT REF, above) will be implemented when the status key ("Stat") is pressed while the cursor is under EXIT.

Load Factory Default Settings

The initial Control Switch Set menu is:

```
*:INT REF  2:XREF10  3:XREF5   4:DEFAULT
5:CONTRST  6:ADDR  7:TERM  8:SRQ  +:EXIT
```

Enter a "4" from this menu to load the factory default settings into the current settings locations in the continuously powered RAM. Calibration values are not affected. This test is primarily a factory test that also may be used to verify RAM loading/storage. The cursor will move to EXIT and an asterisk will be placed in front of the DEFAULT characters to indicate the operation is complete:

```
1:INT REF  2:XREF10  3:XREF5   *:DEFAULT
5:CONTRST  6:ADDR  7:TERM  8:SRQ  +:EXIT
```

The default conditions are shown in following table.

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	1 kHz
DEV METER (OPT)	OFF

LCD contrast

Enter a "5" from the initial control switch setting menu to call up the LCD contrast adjustment screen:

```
DISPLAY CONTRAST PROGRAMMING*****    0
Adjust using up/down arrows      +:Exit
```

LCD contrast can be adjusted using the up and down arrow cursor keys, as indicated by the directions shown on the second line of the LCD. The contrast level is displayed on the right side of the upper display line. There are 16 levels of contrast, from a minimum "0" level to a maximum "15" level.To leave this procedure, press the "+/-" key or the status key.

GPIB address

Entry of a "6" from the initial control switch setting menu calls up the GPIB address setting screen:

```
GPIB ADDRESS SELECTION:     02
ENTER NEW SELECTION(00TO30):**   +:EXIT
```

The GPIB address can be programmed for

any value from 00 to 30. The value for the current address is shown on the first line of the display. The second line shows the address range and has asterisks where the new address should be entered. The two asterisks indicate that two digits of programming are required. The cursor will be placed in the EXIT field. Pressing the "+/-" key or the status key will immediately activate the new address. If no new address is entered, the current address displayed will be maintained. The factory default address is 02.

GPIB terminator

Entering a "7" from the initial control switch setting menu calls up the GPIB terminator programming menu:

```
GPIB TERMINATOR SELECTION:   10  LF
ENTER NEW SELECTION(00TO31):**   +:EXIT
```

Any ASCII characters corresponding to a decimal number from 00 to 31 may be used as a GPIB terminator. The terminators LF, EOI, and CR are always accepted as GPIB input terminators, regardless of the terminator chosen using this display menu. This menu provides an additional input terminator, a fourth acceptable terminator. The first line of the display identifies the procedure and indicates the terminator currently chosen. The second line shows the available terminator range and has asterisks to indicate the two digit decimal value to enter to select a different terminator.

The ASCII characters associated with any number from 00 to 31 may be used. The most common terminator/ASCII numbers are:

NC (Null Character)	00
LF (line feed)	10
CR (Carriage Return)	13

The EOI (End or Identify) terminator is always an output terminator, regardless of the terminator chosen using this display menu. The terminator chosen using this display menu will also be sent as an output termintor. The factory default terminator is LF, because it is specified in IEEE 488.2 and it is the most commonly used terminator. When this programming procedure is entered, the cursor will be under the EXIT field to avoid accidental reprogramming of the terminator. Terminator programming is executed immediately upon pressing the "+/-" key or the status key.

SRQ operation

Entering an "8" from the initial control switch setting menu will issue a service request to the GPIB. The cursor will move to the EXIT field and an asterisk will be placed in front of the SRQ characters to indicate the operation has been completed.

```
1:INT REF  2:XREF10  3:XREF5   4:DEFAULT
5:CONTRST  6:ADDR  7:TERM  *:SRQ  +:EXIT
```

3.7 DEVIATION METER OPERATION (OPTION)

3.7.1 Operating Instructions

The 2410 performs an automatic calibration of its deviation meter circuitry anytime the "Pos Dev" or "Neg Dev" key is pressed. DO NOT CONNECT THE SIGNAL TO BE MEASURED UNTIL THIS CALIBRATION IS COMPLETED. Perform the following operations to use the 2410 deviation meter:

1. Press the "Pos Dev" or "Neg Dev" key. The 2410 will perform a deviation meter calibration that requires about 8 seconds to complete, then display a "LO LEVEL" message. To ensure proper calibration of the deviation meter, do not connect the signal to be measured until this step is completed.
2. Connect the signal to be measured at the "Mod In" connector.
3. Enter the measurement frequency. The measurement frequency may range from 30 MHz to 543 MHz. The frequency entered will be shown on the middle of display line one.

4. Read the measured deviation to the left of the deviation frequency on line one of the display.
5. Press "Mod Off" to exit the deviation meter mode of operation.

The deviation meter mode will be stored in memory when the unit is turned off. At turn on, the unit will power up with the deviation meter active if it was active when the unit was turned off.

3.7.2 Deviation Meter Error Messages

There are four deviation meter errors that may be shown in characters 29 through 35 on the second line of the display when the unit is in the deviation meter mode. They are "TUNE +" (tune higher), "TUNE -" (tune lower), "TUNE" (tune meter), and "LO LEVEL" (input level too low).

TUNE + ERROR

The "TUNE +" display indicates the deviation meter is set at too low a frequency and needs to be tuned higher.

TUNE - ERROR

The "TUNE -" display indicates the deviation meter is set at too high a frequency and needs to be tuned lower.

TUNE ERROR

The "TUNE" display indicates the deviation meter frequency is not set within the approximate ±1 MHz window required by the instrument to tell whether the deviation meter frequency is too low or too high. The meter needs to be tuned.

LO LEVEL ERROR

The "LO LEVEL" display indicates the input level is too low in amplitude, or too far off frequency, for the meter to measure it.

PERFORMANCE TESTS

4.1 INTRODUCTION

This section contains the performance tests to verify that the Wavetek Model 2410 RF Signal Generator meets its published specifications (Section 1.2). These tests will be performed with the unit in the Local Mode of operation as opposed to the remote (GPIB) mode.

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

Perform the AutoCal® procedure of Section 5 if a performance test cannot be completed satisfactorily, then repeat the test. If the test is failed again, after auto-calibration, the factory calibration and/or troubleshooting must be performed.

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 by number(s) from Table 4-1.

The Model 2410 Signal Generator should have its top cover installed for the performance tests. All tests can be performed without access to the internal controls. See Section 2 for details of electrical installation before applying power to the unit. Throughout the tests, maintain the line voltage as specified in Section 2.4.

The results of completed performance tests should be filed for future reference. Record the performance of the signal generator to maintain a permanent record for incoming inspection, and to use as a guide for routine performance testing.

TABLE 4-1. RECOMMENDED TEST EQUIPMENT

INSTRUMENT	RECOMMENDED
(1) Signal Generator	Wavetek Model 2500A 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) Measuring Receiver	H-P 8902A, with sensor module 11722A, or equivalent
(8) Power Meter	H-P 436A, with Power Sensor 8482A, or equivalent
(9) Function Generator	Wavetek Model 20 or equivalent
(10) Audio Analyzer	H-P 8903A, or equivalent
(11) VSWR Bridge	Wiltron Model 60N50, or equivalent
(12) Sweep Generator	Wavetek Model 2002A, or equivalent

4.2 FREQUENCY RESOLUTION AND RANGE TEST

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

METHOD

A frequency counter is used to measure frequency resolution and range. The 2410 cursor keys (see Section 3.5.2) are used to step through the frequency range to verify 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 2410 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 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 2410 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 2410, to within the specified accuracies of the counter and the 2410. Record the frequency counter values for minimum (.01 MHz) and maximum (1100 MHz) frequencies.

FREQUENCY RANGES (MHz)	2410 RESOLUTION
0.01000 - 0.01010	10 Hz
0.01010 - 0.01100	100 Hz
0.01100 - 0.02000	1 kHz
0.02000 - 0.10000	10 kHz
0.30000 - 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 3.5.2, if necessary) to enter a frequency output of 0.2 MHz. The frequency counter should indicate a value between 199.9995 kHz and 200.0005 kHz.

4.3 FREQUENCY ACCURACY TEST

SPECIFICATION

All modes (CW, AM, and FM): ±2.5 ppm (±.00025%),
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 in its 275 MHz to 550 MHz frequency range. The user may pick a frequency value in each of the other three frequency ranges to verify the Model 2410 frequency conversion circuitry.

EQUIPMENT

(3)

PROCEDURE

1. Set the 2410 CW output at 500 MHz. Use the frequency counter to verify the frequency output is between 499,998.750 kHz (499.998750 MHz) and 500,001.250 kHz (500.001250 MHz).

2. Set the 2410 CW output for a value between .01 MHz and 137.5 MHz. Record the chosen value. Use the frequency counter to verify that the frequency output is within ± .00025% of that value.

3. Set the 2410 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 ± .00025% of the chosen value.

4. Set the CW output for a value between 550 MHz and 1100 MHz. Record the chosen value. Use the frequency counter to verify that the frequency output is within ± .00025% of that value.

4.4 HARMONICS TEST

SPECIFICATION

< -30 dBc for frequencies >10MHz
< -26 dBc for frequencies <10MHz

METHOD

A spectrum analyzer is used to determine levels for the second and third harmonics associated with the output frequency range of the Model 2410.

EQUIPMENT

(5)

PROCEDURE

1. Set the 2410 output for .01 MHz frequency at a +13 dBm level.

2. Connect the spectrum analyzer. Use the cursor keys (see Section 3.5.2, if necessary) to establish the 10 kHz digit (0.01000) as the resolution digit and then increase the frequency from .01 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 -26 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 2410 output level at +3 dBm and repeat steps #2 and #3, described above.

5. Set the 2410 output level at -3 dBm and repeat steps #2 and #3, described above.

4.5 SUBHARMONICS TEST

SPECIFICATION

-25 dBc for frequencies > 550 MHz.

METHOD

A spectrum analyzer is used to measure subharmonics at +13 and -3 dBm output levels in the frequency range from 551 to 1100 MHz.

EQUIPMENT

(5)

PROCEDURE

1. Set the 2410 at a 551 MHz output frequency (fo = 551 MHz) and a +13 dBm power level. Use the spectrum analyzer to check subharmonic 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 subharmonic levels.

2. Increase the 2410 output frequency to 1100 MHz, carefully monitoring 1/2 fo and 3/2 fo as the output frequency increases. The subharmonic 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 subharmonics level(s) and location(s).

3. Repeat step 1, above, with the 2410 output level set at -3 dBm.

4. Repeat step 2, above, with the 2410 output level set at -3 dBm.

4.6 NONHARMONICS TEST

SPECIFICATION

offset >5 kHz from carrier frequency: <-50 dBc

METHOD

A spectrum analyzer is used to measure non-harmonics at a -3 dBm output level.

EQUIPMENT

(5)

PROCEDURE

1. Set the 2410 for a 50 MHz output signal at a -3 dBm level. Set the spectrum analyzer for a 50 - 1100 MHz sweep.

2. Use the cursor keys (Section 3.5.2) to increase frequency in 0.1 MHz steps from 50 MHz to 137.5 MHz. Check each step for nonharmonics. Record the location (frequency) and level for the worst case.

4.7 PHASE NOISE TEST

SPECIFICATION

< -107 dBc/Hz at 500 MHz; 10 kHz offset

METHOD

An H-P 8568 (or equivalent) spectrum analyzer is used to measure phase noise at 500 MHz.

EQUIPMENT

(6)

PROCEDURE

1. Set the 2410 output to a frequency of 500 MHz and a 0 dBm level, with no modulation. Connect the H-P 8568 spectrum analyzer (or equivalent). Center the analyzer at 500 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 2410 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 107 dB below the reference level (shown at the top of the display).

4.8 SWITCHING TIME TEST

SPECIFICATION

200 mSec

METHOD

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

EQUIPMENT

(6)

PROCEDURE

1. Set the 2410 for a 274.9 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 2410:

a. 275.0 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 time as the 2410 changes frequency from 274.9 MHz to 275.0 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 2410 numeric keypad sequence (Section 3.5.2) to select a frequency change (press "FREQ" key), then enter a frequency value of 275.0 (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 2410 "MHz" terminator key was pushed (step 4). Performing step 4 and this step requires use of both hands, one for the 2410 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 2410 frequency of 274.9 MHz.

9. Repeat steps 5 - 7, above.

10. Set the 2410 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 2410 at a 389.1 MHz output.

12. Repeat steps 5 - 7, above.

13. Repeat step 4, above, except set the 2410 at a 389 MHz output.

14. Repeat steps 5 - 7, above. Disconnect the spectrum analyzer.

4.9 AM PERFORMANCE TESTS

SPECIFICATION

AM Accuracy	± (1% + 5% of programmed setting)
Distortion	at 70% - <90% AM = < 5% at 30% - <70% AM = < 3% at <30% AM = < 1.5%
AM Bandwidth	10 Hz to 50 kHz: < 3 dB change at 50% AM

METHOD

An audio analyzer and a modulation analyzer or a measuring receiver will be used to measure AM accuracy and distortion at three modulation levels for +3 dBm and -3 dBm output levels. A function generator will then be used to help measure frequency response (AM bandwidth) over an external 10 Hz to 50 kHz modulation rate at 50% AM.

EQUIPMENT

(7), (9), and (10)

PROCEDURE

1. There are a variety of modulation analyzers and measuring 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 2410 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 2410.

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 2410 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 ± (1% + 5% of programmed setting) range specified (84.5 - 95.5%).

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 2410 AM level to 70% and the output frequency to 11 MHz. Repeat step 5, above. The average accuracy must be within the ± (1% + 5% of programmed setting) range specified (65.5 - 74.5%).

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 2410 for a 30% AM level and 11 MHz frequency output. Repeat step 5. AM accuracy must be within the ± (1% + 5% of programmed setting) range specified (27.5 - 32.5%).

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 2410 power output set at the -3 dBm level.

15. To measure frequency response (AM bandwidth) set the 2410 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 "Mod In" connector on the 2410 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 50 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

< -60 dBc; CW mode with 50 Hz to 15 kHz post detection bandwidth (PDBW)

METHOD

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

EQUIPMENT

(7)

PROCEDURE

1. Set the 2410 for a 200 kHz output at the 0 dBm level with no modulation.

2. Connect the 2410 output to an HP-8902A measuring receiver, or equivalent. Select the 50 Hz high pass and 15 kHz low pass post detection bandwidth filters on the measuring receiver. Put the receiver in the average detection mode.

3. Record the residual AM measurement. It should be < -60 dBc.

4. Change the 2410 frequency output to each of the frequencies listed below and record the residual AM associated with each. Each should be < - 60 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
(50 Hz to 15 kHz post detection bandwidth)

<30 Hz rms (<137.5 MHz)
<12.5 Hz rms (137.5 - 275 MHz)
<25 Hz rms (275 - 550 MHz)
<50 Hz rms (550 - 1100 MHz)

METHOD

A measuring receiver is used to measure residual FM at selected frequencies from 100.001 MHz to 550 MHz.

EQUIPMENT

(7)

PROCEDURE

1. Set the 2410 for a 100.001 MHz output at the 0 dBm level with no modulation.

2. Connect the 2410 output to an HP-8902A measuring receiver, or equivalent. Select the 50 Hz high pass and 15 kHz low pass post detection bandwidth filters on the measuring 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 2410 frequency output to each of the frequencies listed below and record the residual FM associated with each. Each should be less than the values indicated below:

a.	128.001 MHz	30 Hz rms
b.	275 MHz	25 Hz rms
c.	325 MHz	25 Hz rms
d.	330 MHz	25 Hz rms
e.	390 MHz	25 Hz rms
f.	463 MHz	25 Hz rms
g.	464 MHz	25 Hz rms
h.	550 MHz	25 Hz rms

5. The user may elect to choose and then determine residual FM values associated with 2410 frequency outputs in the .01 - 137.5 MHz range, the 137.5 - 275 MHz range, and the greater than 550 MHz range, if desired. The successful performance of steps 1 through 4, above, will automatically verify the .01 - 137.5 MHz, 137.5 - 275 MHz, and greater than 550 MHz ranges.

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 (excluding residual FM)
FM Frequency Response	From 50 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 137.49999 - 275 MHz 100 kHz peak for 1 - <3 MHz 10 kHz peak for .01 - <1 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.

EQUIPMENT

(5), (7), (9), and (10)

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 2410 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 2410 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 2410 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 2410 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 2410 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 frequency response, set the 2410 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 2410.

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 50 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 2410 RF output to a spectrum analyzer. Set the 2410 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.

4.13 OUTPUT POWER ACCURACY TEST

SPECIFICATION ±1.5 dB

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

EQUIPMENT (7)

PROCEDURE

1. Connect the 2410 RF output to the power sensor for the measuring receiver. Set the 2410 for an output frequency of 5 MHz at a +13 dBm power level.

2. Read the power measurement on the measuring receiver and verify it between +14.5 and +11.5 dBm.

3. Set output power to 0 dBm and verify the measuring receiver reading is between -1.5 and +1.5 dBm.

4. Use the cursor keys to set the output power resolution digit at the 10 dB incremental position and to decrease output power in 10 dB steps. Observe the output level on the measuring receiver and verify it is within ±1.5 dB of each output level setting below:

Output (dBm)
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120

5. Set the 2410 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 2410 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 2410 frequency spectrum.

EQUIPMENT: (2) and (8)

PROCEDURE:

1. Connect the power sensor unit of the power meter to the 2410 RF output. Set the 2410 output at the +13 dBm level.

2. Use the cursor keys (see Section 3.5.2, if necessary) to sweep through the 2410 frequency spectrum (.01 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.

3. Set the 2410 output level at +3 dBm. Repeat step 2.

4. Set the 2410 output level at -3 dBm. Repeat step 2.

5. Disconnect the test equipment.

4.15 OUTPUT IMPEDANCE TEST

SPECIFICATION

50Ω, with VSWR < 1.5:1 at output power < -3 dBm

METHOD

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

EQUIPMENT

(5), (11), and (12)

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 2410 for an output frequency of 50 MHz at a -3 dBm output power level.

4. Remove the reference short from the test port on the VSWR bridge and connect the 2410 output to the test port.

5. Use the sweep generator to manually sweep the frequency range (.01 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 2410 external reference circuitry.

EQUIPMENT (1)

PROCEDURE

1. Determine the error in the external source.

2. Connect the external source (a Wavetek Model 2500A signal generator, for example) to the external reference input on the rear panel of the 2410. Set the source at 1 volt peak-to-peak and 10 MHz. Set the 2410 external reference selection at 10 MHz.

3. Set the output frequency for the 2410 at 100 MHz and set the power level to 0 dBm.

4. Verify that the 2410 output frequency is within the external source limits.

5. Repeat steps 1 through 4 with the external source and 2410 set for 5 MHz values.

6. Disconnect the external source and set the 2410 reference at the appropriate value.

4.17 DEVIATION METER TEST (OPTION)

SPECIFICATION

Frequency Range	30 MHz to 500 MHz
Input Level	15 mV to 5 VRMS
Deviation Range	0 to 500 kHz peak deviation
Deviation Accuracy	6% of full scale
Modulation Rate	100 Hz to 8 kHz

METHOD

A signal generator is used as an FM source to verify accuracy of the deviation meter over a level range from -25 dBm to +13 dBm. An audio analyzer or a function generator is used to test the modulation bandwidth.

EQUIPMENT (1), (9) or (10)

PROCEDURE

Anytime the Deviation Meter is initially selected, it performs a self-calibration that lasts for approximately 6-8 seconds. Remember to disconnect the input to the Deviation Meter before it is initially selected and leave it disconnected for the 6-8 seconds immediately after its selection to avoid interference with its self-calibration.

1. Set the 2410 to its FM Deviation Meter mode by pressing the POS DEV front panel key.

2. Set the 2410 frequency to 250.000 MHz.

3. Set the signal generator frequency to 250.000 MHz, 500 kHz peak FM deviation. Connect its RF output to the 2410 MOD IN front panel connector.

4. Verify that the 2410 Deviation Meter display (Left section of LCD) indicates 500 kHz ±30 kHz.

5. Adjust the signal generator level over the range from -25 dBm to +13 dBm and verify Deviation Meter accuracy at several different input levels.

6. Repeat steps 2 through 5 at frequencies of 30 MHz and 500 MHz.

7. With the test set up of steps 2 and 3, set the signal generator to 250.200 MHz. Verify the Deviation Meter display indicates "TUNE+".

8. Set the signal generator at 249.800 MHz. Verify the Deviation Meter display indicates "TUNE-".

9. Set the signal generator at 250.000 MHz. Connect the Audio Analyzer or Function Generator output to the EXT MOD IN connector on the signal generator.

10. Set the audio source for a 1 kHz, 1 volt peak-to-peak sine wave (measured at the MOD IN connector). Set the signal generator for external FM at 500 kHz peak deviation.

11. Vary the audio source frequency from 100 Hz to 8 kHz and verify that the Deviation Meter reading is 500 kHz ±30 kHz.

12. The preceding steps are equally applicable to test the NEG DEV mode of the Deviation Meter.