2400 Series

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2400B Series Microwave Synthesizer Operations Manual

33923, Rev B, March 2006

Giga-tronics

WARRANTY

Giga-tronics 2400 Series instruments are warranted against defective materials and workmanship for four years from date of shipment. Giga-tronics will at its option repair or replace products that are proven defective during the warranty period. This warranty DOES NOT cover damage resulting from improper use, nor workmanship other than Giga-tronics service. There is no implied warranty of fitness for a particular purpose, nor is Giga-tronics liable for any consequential damages. Specification and price change privileges are reserved by Giga-tronics.

MODEL NUMBERS

The 2400 Series has model numbers for each instrument with a specific frequency range as described in Chapter 1. All models are referred to in this manual by the general term 2400, except where it is necessary to make a distinction between the models. In these cases, the specific model number(s) will be used.

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DECLARATION OF CONFORMITY

DECLARATION OF CONFORMITY

Application of Council Directive(s)

Standard(s) to which Conformity is Declared:

89/336/EEC and 73/23/EEC	EMC Directive and Low Voltage Directive
EN61010-1 (1993)	Electrical Safety
EN61326-1 (1997)	EMC – Emissions & Immunity

Manufacturer's Name:
Giga-tronics Incorporated

Manufacturer's Address:
4650 Norris Canyon Road
San Ramon, California 94583
U.S.A.

Type of Equipment:
Microwave Synthesizer

Model Series Number:
2400B Series

Model Number(s) in Series:
2408B, 2408S, 2420B, 2420S
2426B, 2426S, 2440B, 2440S

I, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s) and Standard(s).

Fred Gapasin (Full Name) ______ (Signature) Acting Director of Quality Assurance (Position)

San Ramon, California (Place) September 08, 2005 (Date)

QUF06017 9/8/05

About The Publication

Preface

This publication provides an overview and describes local (front panel) operation, remote operation, specifications, and performance verification of the Giga-tronics 2400 family of Microwave Synthesizers. This Preface contains chapter descriptions, a record of changes made to the publication since its production, and a description of the special configurations. Changes that occur after production of this publication, and Special Configuration data will be inserted as loose bound pages in the publication binder. Please insert and/or replace the indicated pages as detailed in the Technical Publication Instructions included with new and/or replacement pages.

Chapters:

1- Introduction

This chapter contains an overview of the 2400, basic system information, and input and output descriptions.

2 - Front Panel Operation

This chapter contains information about front panel operation of the instrument. Controls, features, and menus are described, operating tasks are explained, and factory default settings are listed.

3- Remote Operation

This chapter contains information about remote operation of the instrument over the General Purpose Interface Bus (GPIB) or RS-232.

4- Specifications & Performance Verification

This chapter contains 2400 specifications and step-by-step procedures to verify 2400 Series Microwave Synthesizer performance.

Appendices:

A- Accessories and Options

This appendix describes the accessories and options that are available for the 2400 Series Microwave Synthesizers. Each accessory and option is described under its respective heading.

B - Error Messages

This appendix provides a description of the various error messages and other user messages that might be encountered during instrument operation.

Index

A subject listing of contents.

Conventions

The following safety conventions are used in this publication. Additional conventions not included here are defined at the time of usage.

Warning

WARNING

The WARNING statement is encased in gray and centered in the page. This calls attention to a situation, or an operating or maintenance procedure or practice, which if not strictly corrected or observed, could result in injury or death of personnel. An example is the proximity of high voltage.

Caution

CAUTION

The CAUTION statement is enclosed with single lines and centered in the page. This calls attention to a situation, or an operating or maintenance procedure, or practice, which if not strictly corrected or observed, could result in temporary or permanent damage to the equipment, or loss of effectiveness.

Notes

NOTE: A NOTE Highlights or amplifies an essential operating or maintenance procedure, practice, condition or statement.

Configuration Data

Giga-tronics: Serial, Code, Models, Option or Configuration Label

Examine the code, model number, serial number, and option/configuration label affixed to the rear panel of the 2400 Microwave Synthesizer.

Code Number

Each instrument has a two-digit code, referred to as the Manufacturing Configuration Code.

Model Number

Each instrument has a four-digit model number in the form 24*XX*, and one or two character suffix which designates the series:

- 24*XX*B - Benchtop model
- 24*XX*S - ATE model

The frequency range of the instrument is designated by the model number:

- 2408B/S - 0.01 to 8 GHz
- 2420B/S - 0.01 to 20 GHz
- 2426B/S - 0.01 to 26.5 GHz
- 2440B/S - 0.01 to 40 GHz

Serial Number

Each instrument has a seven-digit serial number, shown on the label of the rear panel.

Option Number(s)

When options are installed, one or more 2 digit numbers are listed on the “Opt.” line and correspond to options installed in the instrument. Option numbers are explained in Appendix A.

Special Configurations

When the accompanying product has been configured for user-specific application(s), supplemental pages will be inserted at the front of the publication binder. Remove the indicated page(s) and replace it (them) with the furnished Special Configuration supplemental page(s).

If the “Opt.” line contains a three digit number (for example, 241), there is combination of options and/or special modifications installed in the instrument. Information relating to these special configurations is contained in supplemental pages included with the manual.

Record of Publication Changes

This table is provided for your convenience to maintain a permanent record of publication change data. Replacement pages will be issued as a TPCI (Technical Publication Change Instruction), and will be inserted at the front of the binder. Remove the corresponding old pages, insert the new pages, and record the changes here.

TCPI Number	TPCI Issue Date	Date Entered	Comments

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Chapter 1: Introduction

Chapter 2: Front Panel Operation

CHAPTER 3: REMOTE OPERATION

CHAPTER 4: SPECIFICATIONS & PERFORMANCE VERIFICATION

1 Introduction

1.1 Overview

The Giga-tronics 2400 Microwave Synthesizers deliver industry-leading performance combining state of the art low phase noise, high output power, and fast switching simultaneously. The low noise, high power, and fast switching features of the 2400 Synthesizer family make it an excellent test solution for a wide range of CW, modulation, swept frequency, and fast frequency switching applications in both R&D and manufacturing environments. All 2400 Synthesizers comply with MIL-PRF-28800F, Class 3.

The 2400 Synthesizer family is available in two series, with four unique models within each series. Table 1-1 lists the model numbers, and the frequency ranges covered by each model.

2400B Series. The 2400B Series includes frequency ranges from 10 MHz to 8 GHz, 20 GHz, 26.5 GHz, and 40 GHz. In addition, external ALC, ramp frequency and power sweep, high stability timebase, 100 MHz reference output, DC-FM, AM, FM, and Pulse capability, and Automation Xpress Interface software are all standard features.

2400S Series. The 2400S Series have similar features to the 2400B but are specifically designed to meet the unique performance needs of ATE integrators. The 2400S Series can be configured with and without a front panel. The 2400S Series includes hardware triggering and synchronization signals with programmable delay to allow coordination with other test products in your system. Standard features of the 2400S Series include a 3U rack mountable chassis with rack ears, a high stability timebase, rear-panel RF output, GPIB-interface, RS-232 interface and a blank front panel option.

1.1.1 2400 Frequency Ranges

Table 1-1 shows the various models of the 2400 Series Microwave Synthesizers, and their respective RF output frequency ranges:

Table 1-1: 2400 Frequency Ranges

Models	Frequency Range
2408B/2408S	10 MHz to 8 GHz
2420B/2420S	10 MHz to 20.199 GHz
2426B/2426S	10 MHz to 26.5 GHz
2440B/2440S	10 MHz to 40 GHz

1.1.2 2400 Options

The following briefly describes the options that are available within the various series of the 2400. Appendix A further describes the options:

- Option 17- Delete Modulation
- Option 18- Delete 0.01 - 2 GHz Frequency Extension
- Option 26- Delete 90 dB Step Attenuator
- Option 31- Reduced Frequency Switching and Pulse Width Performance
- Option 44- Delete Display Front panel
- Option 46- Rack Slide Kit
- Option 55- Command Sets

1.1.3 Items Furnished

Accessories and Options are detailed in Appendix A of this publication. In addition to the options and/or accessories specifically ordered, the following items are furnished with the instrument:

- Operation Manual
- USB 1.1/RS-232 Cable Adapter
- Power Cord, 6 ft.
- Giga-tronics Automation Xpress Software Package

1.1.4 Items Required

No special items are required to operate the 2400 Series during local (front panel) operation. Remote operation requires some of the following items depending on the interface used:

- IEEE 488 Interface Cable
- PC with GPIB, RS-232, or USB
- Standard 9 Pin Type D Serial Cable

Test equipment required for performance verification is described in Chapter 4.

1.2 General Information

All instruments are shipped in operational condition. No special installation procedures are required. Each 2400 Series model must pass rigorous inspections and tests prior to shipment. Following installation, a performance verification should be performed to ensure that operation has not been impaired during shipment. The following below apply to all models:

- Unless otherwise stated, warm-up time of 30 minutes for normal operation
- Performance Verification procedures outlined in Chapter 4

1.2.1 Receiving Inspection

Use care when removing the instrument from the carton and check immediately for physical damage, such as bent or broken connectors on the front and rear panels, dents or scratches on the panels, broken handles, etc. Check the shipping carton for evidence of physical damage and immediately report any damage to the carrier.

1.2.2 Cooling

A cooling fan is installed in all 2400 Series instruments. The cooling air intake is located on the rear panel. Care must be taken to avoid obstructing the flow of air into the instrument.

1.2.3 Cleaning

The air intake screen should be cleaned whenever a significant amount of dust has accumulated on it. Whenever the instrument covers are removed, the interior should be blown out with a dry air at a low velocity.

1.2.4 Power

All 2400 models contain primary and standby power with internal switching. The instrument automatically senses input line voltage in the range of 90 to 253 Vac, 47 to 440 Hz. There are no manual voltage adjustments or selection controls (the voltage select wheel within the power module is not used in the 2400). All 2400 Series have a 3-Wire power cord with a 3-terminal polarized plug for connection to the power source and safety ground. The power cord must not exceed 3 meters (9 feet) to meet safety requirements.

WARNING

The safety ground is connected directly to the chassis. If a 3-to-2 wire adapter is to be used, be sure to connect the ground lead from the adapter to earth ground. Failure to do this poses a shock hazard.

CAUTION

DO NOT position the equipment so that it is difficult to remove the AC line cord.

1.2.5 Line Fuse

All 2400 Series models have a line fuse holder on the rear panel. The power line fuse is 2A, Slow-Blow, 250V, Type T. See Figure 1-1 below for the location of the line fuse.

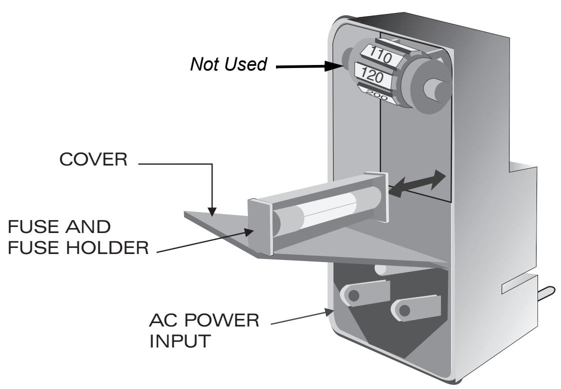


Figure 1-1: Fuse Holder

1.2.5.1 Line Fuse Replacement

Open the housing cover. Pull out the small drawer on the right side of the housing (marked with an arrow) and remove the old fuse. Replace with a new fuse, insert the drawer and close the housing cover, see Figure 1-1, above.

NOTE: The voltage select wheel shown in Figure 1-1, above, can be set at any position. Its position has no effect on the 2400 line voltage, as the 2400 line voltage is auto-sensing and auto-setting.

1.2.6 Calibration Cycle

Giga-tronics recommends a calibration cycle of two years for the 2400.

1.2.7 Reshipment Preparation

If it is necessary to return the instrument to the factory, protect it during reshipment by using the best packaging materials available. If possible, reuse the original shipping container. If the original shipping container is not available, use a strong carton (350lbs./ sq.in. bursting strength) or a wooden box. Wrap the instrument in heavy paper or plastic before placing it into the shipping container. Completely fill the areas on all sides of the instrument with packaging material. Take extra precaution to protect the front and rear panels. Seal the package with strong tape or metal bands. Mark the outside of the package as follows:

FRAGILE - DELICATE INSTRUMENT

If corresponding with the factory or local Giga-tronics sales office regarding reshipment, please provide the model and serial number. If the instrument is being returned for repair, be sure to enclose all relevant information regarding the problem that has been found.

NOTE: If returning an instrument to Giga-tronics for service, first contact Customer Service so that a return authorization number (RMA) can be assigned. Contact Giga-tronics via email (repairs@gigatronics.com) or by phone (800.726.4442). The 800 number is only valid within in the United States. Contact can also occur via our domestic line at (925.328.4640) or Fax at (925.328.4702).

1.3 Inputs and Outputs

The input and output connectors are shown in figures 1-2 and 1-3. Table 1-3 contains the front and rear panel I/O connector functional descriptions for all 2400 Series models.

1.3.1 Front Panel Connector (RF Output)

This is the instrument's RF output. It is located on the front panel of 2400B Series Synthesizer models, and on the rear panel of versions of 2400S Series models.

The type of RF connector that is supplied depends on the frequency range of the instrument. Figure 1-2 shows the general location of the front panel RF output connector on 2400B Series models, and Table 1-2 indicates by model the type of RF connector that is supplied.

Figure 1-2: Series 2400B Front Panel Output

Table 1-2: RF Connector Types

Models	RF Connector Type
2408B/2408S	N (f)
2420B/2420S 2426B/2426S	SMA (f)
2440B/2440S	K (f)

1.3.2 Rear Panel Interface and I/O Connectors

This section defines the functions of the 2400 Series rear panel connectors (see Figure 1-3).

dBV

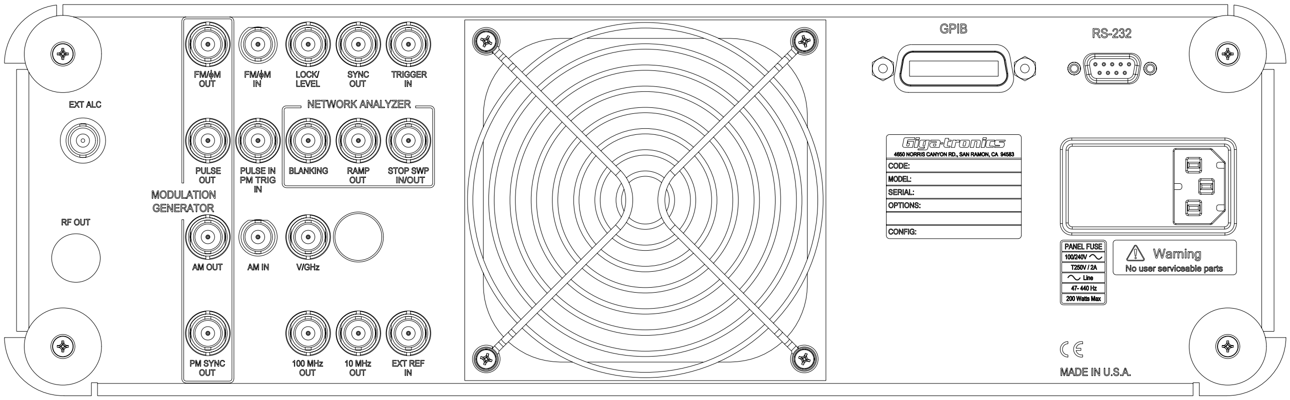


Figure 1-3: 2400 Rear Panel

All rear panel I/O connectors explained in this section are type BNC unless otherwise stated. Some connectors may not be supported because of installed options. For example, Modulation and Modulation Generator connectors are not active with Option 17 (delete Modulation Suite). Table 1-3 describes the 2400 rear panel I/O connectors.

Table 1-3: 2400 Rear Panel I/O Connector Descriptions

Connector Label	Description
EXT ALC	In external leveling, the output of the 2400B is detected by either a positive or negative crystal detector or power meter with an analog output. The signals from these devices are connected to the ALC circuitry of the 2400B which is used to compensate for standing wave effects or cable and component losses at the input of the device under test. Input Range: Detector: -66 dBV to 6 dBV Max Input: +10 volts Accuracy: +6 dBV to -40 dBV –1 % -40 dBV to -66 dBV –2 % Mode Availability: CW List Pulse (5 usec. pulse width min, < 200 kHz) Input Impedance: 1 Meg Ohm
RF OUT	The RF signal output for the instrument. See Table 1-2 for RF connector types. It is located on the front panel for all 2400B Series instruments and rear panel for all 2400S Series instruments.
FM/ΦM OUT[1]	The internal modulation generator output; 2 Vp-p into 10k Ohm.
PULSE OUT[1]	A +4V video representation of the pulsed RF output signal.
AM OUT[1]	The internal modulation generator output; 2 Vp-p into 10k Ohm.

Table 1-3: 2400 Rear Panel I/O Connector Descriptions

Connector Label	Description
PM SYNC OUT[1]	A synchronization output pulse of >75 ns width, TTL level that can be delayed relative to the leading edge of the video signal at the PULSE OUT connector. The PM Sync Output is available for Internal and External Pulse Modulation modes on all models that do not have Option 17 installed.
FM/£M IN	A 50 Ohm input for an external FM signal. The input signal can be any waveform compatible within bandwidth considerations. A 1 Vp input produces maximum deviation. An externally supplied DC signal can be applied to modulate the frequency of the CW output using this connector. Specifications (DC-FM): Frequency Range: 500 MHz to Maximum Frequency Deviation: 125 kHz Input Range: –1 Vp-p Accuracy: 5% of deviation, typical
LOCK/LEVEL	+5 volt indicator, active high when the 2400 is phase locked and output leveled. The Lock and Level indicator is valid for CW mode only.
SYNC OUT	In List mode, the unit can be set to generate a pulse at this output when a specified list point is reached. The output can be delayed from the start of the list point up to a maximum of 10 msec. The pulse width of the SYNC OUT signal is determined by the following parameters: pulse width = Step Time - Sync Delay - 10 usec In Ramp operation, the pulse occurs at the start of each ramp sweep. In either case, the output pulse is +5 volt.
TRIGGER IN	Used to trigger a List. Accepts a TTL level signal of > 50 ns width.
PULSE IN/PM TRIG IN	A Pulse Modulation Input for external pulse gating, pulse triggering or external Pulse In. The input parameters are +5 volt, 50 Ohm
BLANKING	A +5 volt output signal occurring at band crossings, filter switches, and retraces for the duration of those events.
RAMP OUT	A 0 to 10 volt ramp output scaled to the frequency sweep.
STOP SWP IN/OUT	Stop Sweep I/O is a 5 volt, 2 K Ohm, active low signal that temporarily interrupts an instrument frequency or power ramp sweep. This feature is only available with 2400B models with option 55 and 2400S models with options 55 and 44.
AM IN	A 600 Ohm input for an external AM signal. The input signal can be any waveform compatible within bandwidth considerations. A 1 Vp-p input produces 50% AM depth.
V/GHz	An output voltage that is directly proportional to output frequency. For 26 and 40 GHz models, the output is 0.25 volts per GHz. For 8 and 20 GHz models, the output is 0.5 volts per GHz.
100 MHz OUT	A 1 Vp-p typical, AC coupled, 100 MHz square wave reference output signal into 50 Ohms.
10 MHz OUT	A 2 Vp-p 10 MHz square wave reference output signal into 50 Ohms.
EXT REF IN	The external reference input. Can be either a 10 MHz or 100 MHz input that is >-5.0 dBm into 50 Ohm.

Table 1-3: 2400 Rear Panel I/O Connector Descriptions

Connector Label	Description
GPIB	A 24-pin IEEE STD 488.2 connector for control of the instrument during remote operation using GPIB.
RS-232	A DB-9 connector for control of the instrument during remote operation using RS-232 serial communications.
AC Power Input	90-253 VAC, auto-sensing, 47 Hz to 440 Hz.

1. Not available with Option 17.

2 Front Panel Operation

2.1 Introduction

This chapter describes how to operate the 2400 Series from the front panel.

The information in this chapter pertains primarily to the 2400B Series of Gigatronics Microwave Synthesizers, since the 2400S Series are designed for remote-only operation. Note, however, that while the menus, key sequences, etc., presented in this chapter pertain primarily to front panel operation, the features explained are universal for either the front panel or remote operating modes.

NOTE: Chapter 3 provides instructions on using the 2400 Series from a remote host computer over the General Purpose Interface Bus (GPIB) or an RS-232 serial connection.

2.2 Front Panel At a Glance

The 2400 Series front panel contains the controls and display for local operation of the instrument. Some functions are not available from the front panel; they require use of a PC with a compatible remote interface. Front panel controls are grouped according to the functions they perform. Descriptions for the front panel controls are referenced to the numbers depicted in Figure 2-1 on the next page.

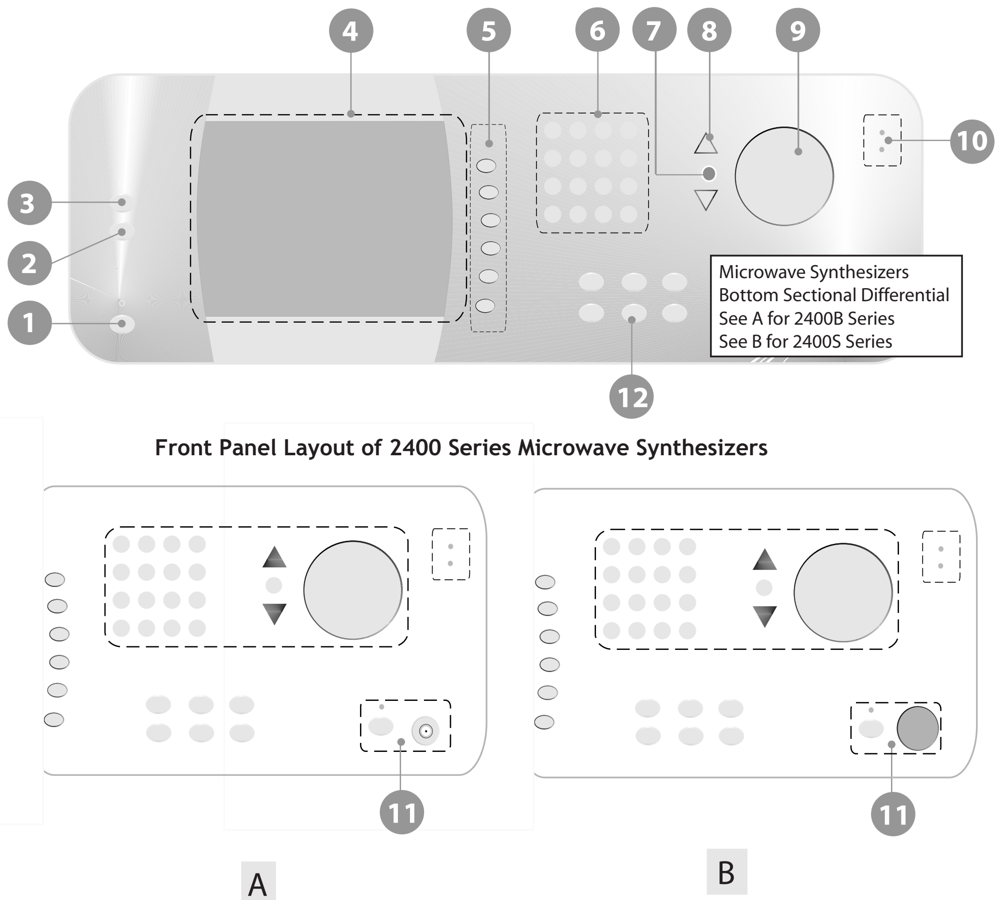


Figure 2-1: 2400 Front Panel with Callouts

2.3.1 Front Panel Description

1 **Power**

The main power switch for the 2400, which is used to set the power either to on or standby. When set to on, the indicator that is above the main power button is blue. When set to standby, the indicator is amber. In standby mode, the instrument is essentially powered down, but power remains applied to the internal timebase oscillator.

2 **LOCAL Button**

Allows front panel access when the unit is in remote mode. If the unit is already in local mode, pressing this button accesses menus that allow you to choose the remote command language to be used by the instrument during remote operation.

3 **PRESET Button**

Presets the 2400 to factory defaults, or initializes NVRAM.

- Pressing the PRESET button momentarily presets instrument settings to factory default values, but does not affect system memory locations, display contrast, or the GPIB address.
- Pressing and holding the PRESET button while the unit is powering up initializes NVRAM, which includes presetting instrument settings to factory default values as well as initializing all ten system memory locations, the display contrast, and the GPIB address.

4 **Display**

Displays current instrument settings, as well as the menus that allow you to modify the settings. The group of instrument settings and associated menu items that are currently displayed is called the *active display.*

Menus are accessed by pressing the menu buttons (item **12** below). The menus appear along the right-hand side of the display adjacent to the interactive softkeys (item **5** below). To select a particular menu item, press the adjacent interactive softkey. The selected menu item becomes highlighted, and is the item that will then be modified using the data entry keypad, step-up/step-down buttons, or knob (items **6**, **8**, and **9** below).

5 **Interactive Softkeys**

Selects the menu items adjacent to them in the display (item **4** above) for modification.

6 **Data Entry Keypad**

A 12-button numeric keypad and adjacent Units buttons for direct entry of instrument parameters. Using these buttons, data can be entered into the parameter that is associated with the selected menu item in the display (item **4** above).

7 **STEP SIZE Button**

Selects and allows editing of the step size used by the Step Up/Down buttons and rotary knob (items **8** and **9** below). To change a step size, choose a menu item, press the STEP SIZE button, enter the step size using the keypad (item **6** above), then press any units button.

8 Step Up/Down Buttons

Increases or decreases the selected parameter in the display by the amount specified by the step size. Also used to modify certain parameters that toggle between defined states (for example, the On/Off states of modulation parameters).

9 Adjusting Knob

Increases or decreases the parameter that is selected in the display. When a maximum or minimum limit is reached, the parameter will not update as the knob is rotated, but rather a message will be displayed at the bottom of the display indicating that the parameter limit has been reached. If “Sound” in System Menu 1 is turned on, an audible click will occur for each step of the knob.

10 Front Panel LED indicators

The front panel indicators are located in several places.

Unleveled Indicator. This indicator is lit when the 2400 output is operating in an unleveled state.

External Reference (Ext Ref) Indicator. This indicator is lit when the 2400 is operating with an external reference applied.

RF On/Off Indicator. This indicator, which is located above the RF ON button, is blue when the 2400 RF output is active. When the RF output is inactive, the indicator is not lit.

Power Indicator. This indicator, which is above the main power button, is blue when the unit is on, and amber when the unit is in standby mode.

11 RF Output

This is the RF output section for 2400 Series instruments. The 2400B series connector is located on the front panel. The 2400S series connector is located on the rear panel. See Table 1-2 for RF connector types.

12 **Menu Buttons**

CW Button. Pressing this button displays the CW Menu, which shows parameters related to the CW functions of the instrument, and their associated menu items.

RAMP Button. Pressing this button displays either the Ramp Freq or Ramp Power Menu, which shows parameters related to either the frequency or power ramp (sweep) functions of the instrument, and their associated menu items.

SYSTEM Button. Pressing this button displays either the System 1 or System 2 Menu, which shows parameters related to certain system-level functions, and their associated menu items.

AM Button. Pressing this button displays either AM Menu 1, 2, or 3, which shows parameters related to the amplitude modulation functions of the instrument, and their associated menu items.

FM Button. Pressing this button displays either FM Menu 1, FM Menu 2, or FM Menu 3, which shows parameters related to the frequency modulation functions of the instrument, and their associated menu items.

PM Button. Pressing this button displays either PM Menu 1, 2, 3, or 4, which shows parameters related to the pulse modulation functions of the instrument, and their associated menu items.

2.4 2400 Menus

This section provides a brief overview of the 2400's display and menus, and explains each of the 2400 menus in more detail.

2.4.1 Menu System Overview

2.4.1.1 Menu Buttons

Most 2400 features and functions are accessed through a series of menus. The menus are accessed by pressing one of the *menu buttons* that are on the front panel of the instrument.

As an example, to access the System menus, press the SYSTEM button:

The following menu buttons are available:

CW. Pressing this menu button invokes the CW menu, which allows you to view and change the instrument's CW frequency, power level, power offset, power slope, and phase settings. There is one menu associated with this menu button.

RAMP. Pressing this menu button invokes menus that allow you to use the instrument's frequency and power ramp features.

SYSTEM. Pressing this menu button invokes menus that allow you to view and modify several system-level settings. There are two menus associated with this menu button.

AM. Pressing this menu button allows you to access the internal and external amplitude modulation features of the instrument. There are three menus associated with this menu button.

FM. Pressing this menu button allows you to access the internal and external frequency modulation features of the instrument. There are two menus associated with this menu button.

PM. Pressing this menu button allows you to access the internal and external pulse modulation features of the instrument. There are four menus associated with this menu button.

LOCAL. This button has two functions. Pressing this button while the instrument is in local operating mode allows you to choose the language to be used by the instrument during remote operation (pressing this button while the instrument is in remote operating mode switches it to local operating mode). There are two menus associated with this menu button.

2.4.1.2 Display and Interactive Softkeys

When a menu button is pressed, the actual menu that is invoked is the last menu of that type that was active. Menus appear in the 2400's front panel *display*, and the individual menu items in each menu are accessed via the *interactive softkeys*.

The 2400's front panel display is divided into several functional areas, as shown in Figure 2-2:

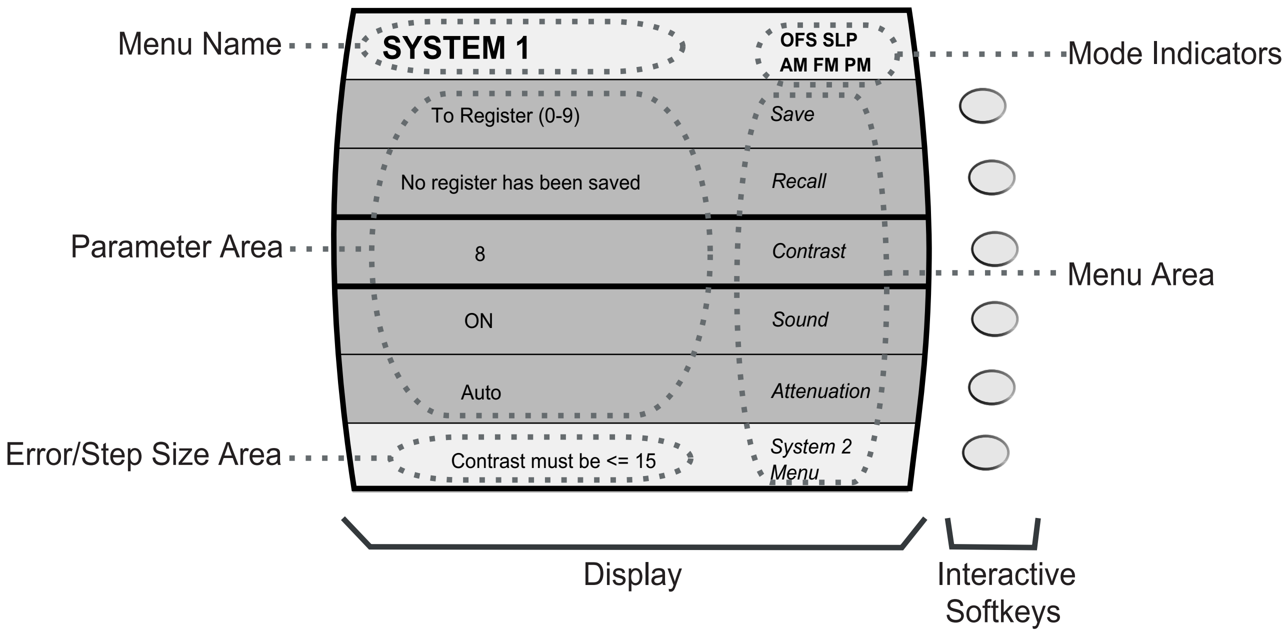


Figure 2-2: Functional Areas of the 2400 Display

The following explains each of the functional areas of the display shown in Figure 2-2:

Menu Name. This is the name of the menu that is currently shown in the front panel display. The menu that is currently shown is called the *active menu*.

Menu Area. This area displays the various menu choices that are available in the active menu. To select one of the menu items, press the *interactive softkey* that is adjacent to it. The associated parameter shown in the parameter area can then be modified. The row containing the menu item and parameter that is currently selected is surrounded by bold lines. In the example screen shown Figure 2-2, Contrast is the currently selected menu item.

Parameter Area. This area displays the current values of the instrument settings that are associated with the active menu. To modify a parameter, select it first by pressing the interactive softkey that is adjacent to the parameter's associated menu item. Parameters can be modified using one or more of the methods explained in the section entitled "Entering and Modifying Parameters" in this chapter.

Error/Step Size Area. If applicable, this area shows the currently set step size for the parameter that is selected for modification (see "Step Size" in this chapter for more information on step sizes). If a parameter range is exceeded, or some other type of data entry error occurs, an error message is displayed in this area. Certain non-error user messages might also be displayed in this area.

Mode Indicators. Indicators will appear in this area of the display if the instrument is currently in any of several operating modes. If the instrument is currently in a given operating mode, its indicator will appear regardless of the menu that is currently active. The following indicators are available:

OFS - Appears if a power offset of greater than 0 dB is set in the CW menu.

SLP - Appears if a power slope of greater than 0 dB/GHz is set in the CW menu.

AM - Appears if either internal or external amplitude modulation is currently enabled.

FM - Appears if either internal or external frequency modulation is currently enabled.

PM - Appears if either internal or external pulse modulation is currently enabled.

EXT. LEVEL - Appears if the ALC is set to External.

UNLK - Appears if the Phase Lock Loop is unlocked.

2.4.2 CW Menu Description

The CW menu displays the instrument's currently set CW (continuous wave) frequency, power level, power offset, and power slope, and allows you to make changes to those settings. To access the CW menu, press the front panel CW menu button:

There is one menu associated with the CW menu button. Figure 2-3 shows the CW menu:

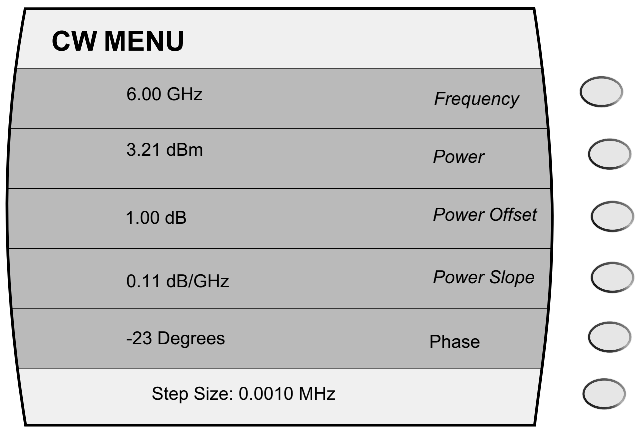


Figure 2-3: CW Menu with Interactive Softkeys

The following explains each item in the CW menu:

Frequency. This menu item displays and allows you to modify the instrument's CW frequency. The range of the CW frequency parameter is dependent on the model number of the instrument. Table 2-1 shows, by model number, the range of frequencies that can be set.

Table 2-1: CW Frequency Ranges

Model	Frequency Range
2408B/2408S	10 MHz to 8 GHz
2420B/2420S	10 MHz to 20.199 GHz
2426B/2426S	10 MHz to 26.5 GHz
2440B/2440S	10 MHz to 40 GHz

The frequency can be modified using either the numeric keypad, the step up/step down buttons, or the rotary knob. The step size can be set in the range of 0.1 Hz to the upper limit of the frequency range.

Power. This menu item displays and allows you to modify the instrument's output power level. The range of the output power level depends on the following configuration and settings of the instrument:

- If the 90 dB step attenuator is not installed (Option 26), the output power level range is -20 to +25 dBm.
- If the 90 dB step attenuator is installed (Standard Model) and the step attenuator is set to auto mode, the output power level range is - 110 dBm to +25 dBm.
- If the 90 dB step attenuator is installed and the step attenuator is set to manual mode, the output power level range is from 20 dB below to 25 dB above the attenuator setting.

NOTE: The mode of the step attenuator, if installed, is set in the SYSTEM 1 menu.

The output power level can be modified using either the numeric keypad, the step up/step down buttons, or the rotary knob. The step size can be set in the range of 0.01 dBm to 135 dBm.

Power Offset. This menu item displays and allows you to modify the instrument's power offset. The power offset feature increases the instrument's output power by the amount of the power offset setting, without changing the power level as shown in the Display. This allows you to compensate for the insertion or conversion loss of components that are attached to the instrument's RF output. An example appears in Figure 2-4.

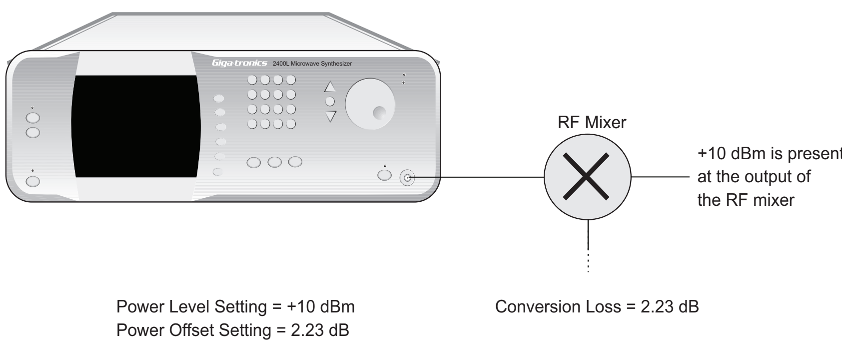


Figure 2-4: Power Offset Example

The power offset can be modified using either the numeric keypad, the step up/step down buttons, or the rotary knob. The power offset range is 0 to 10 dB, and the step size can be set in the range of 0.01 to 5.0 dB. The Power Offset indicator (**OFS**) appears in the upper right-hand corner of the display when any power offset value greater than 0.00 dB is entered.

Power Slope. This menu item displays and allows you to modify the instrument's power slope. The power slope feature increases the instrument's output power linearly as a function of the output frequency, without changing the power level shown in the Display. The function of the power slope feature is similar to the power offset feature, but allows you to automatically compensate for insertion/conversion losses of components attached to the instrument's RF output that exhibit a linear loss characteristic with frequency.

The power slope can be modified using either the numeric keypad, the step up/step down buttons, or the rotary knob. The power slope range is 0 to 0.5 dB/GHz, and the step size can be set in the range of 0.01 to 0.25 dB/GHz. The Power Slope indicator (**SLP**) appears in the upper right-hand corner of the display when any power slope value greater than 0.00 dB/GHz is entered.

Phase Adjust. This menu item displays and allows you to modify the phase of the output signal. The phase adjust feature adjusts the phase of output signal to –360 degrees. The phase of the signal is maintained until the phase is readjusted or whenever the instrument frequency setting is changed. When the instrument frequency setting is changed, the phase adjust setting is reset to 0 degrees. Phase Adjust is specified for a minimum frequency range of 500 MHz to the maximum frequency range of the instrument. Phase adjust is available for frequencies below 500 MHz however the output response time of the phase adjust is decreased.

The phase of the output signal can be modified using the numeric keypad, the step up/step down buttons, or the rotary knob. The phase adjust range is 0 to 360 Degrees, and the step size can be set in the range of 0.1 to 360 degrees.

Specifications:
- Frequency: 500 MHz to maximum frequency
- Range: –360 degrees
- Accuracy: <0.2 , typical

2.4.3 RAMP Menu Descriptions

The RAMP menus display the instrument's currently set ramp frequency sweep and ramp power sweep settings, and allow you to make changes to those settings. To access the RAMP menus, press the front panel RAMP menu button:

There are two menus associated with the RAMP menu button.

2.4.3.1 Ramp Freq Menu

The Ramp Freq menu allows you to view and modify settings related to the instrument's frequency sweeping feature. When this feature is used, the frequency of the RF output sweeps linearly from a predetermined start frequency to a predetermined stop frequency in a predetermined amount of time, then repeats. The sweep occurs in a set number of equal increments, as determined by the Resolution setting.

Three Resolution settings are available, corresponding to 401, 801, and 1601 frequency steps. The output power is held at the same level during a frequency sweep.

NOTE: As soon as the Ramp Freq menu is chosen, the instrument calculates the ramp, then begins sweeping the output frequency. The ramp is recalculated whenever a parameter is changed. During calculations, the following message is shown at the bottom of the display:

Preparing sweeping data...

When the calculations are complete and the output is actively sweeping, the following message is shown:

Ramp sweeping

Figure 2-5 shows the Ramp Freq menu:

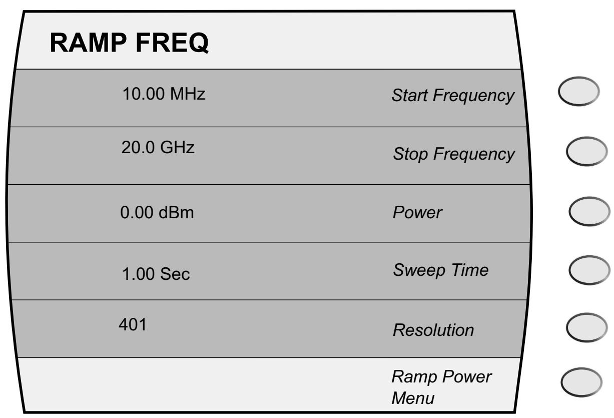


Figure 2-5: Ramp Freq Menu with Interactive Softkeys

The following explains each item in the Ramp Freq menu:

Start Frequency. This menu item displays and allows you to modify the ramp start frequency. This is the frequency that will be used as the beginning, or lower limit, of the frequency sweep. Note that the start frequency must be less than the stop frequency. If the start frequency is set higher than the stop frequency, the stop frequency is automatically adjusted to the same value.

The lower limit of the start frequency parameter range is 10 MHz, and the upper limit is dependent on the model number of the instrument. Table 2-1 shows, by model number, the upper limit of the start frequency parameter range.

The start frequency can be modified using either the numeric keypad, the step up/step down buttons, or the rotary knob. The step size can be set in the range of 0.1 Hz to the upper limit of the frequency range.

Stop Frequency. This menu item displays and allows you to modify the ramp stop frequency. This is the frequency that will be used as the end, or upper limit, of the frequency sweep. Note that the stop frequency must be greater than the start frequency. If it is set lower than the start frequency, the start frequency is automatically adjusted to the same value.

The lower limit of the stop frequency parameter range is 10 MHz, and the upper limit is dependent on the model number of the instrument. Table 2-1 shows, by model number, the upper limit of the stop frequency parameter range.

The stop frequency can be modified using either the numeric keypad, the step up/step down buttons, or the rotary knob. The step size can be set in the range of 0.1 Hz to the upper limit of the frequency range.

Power. This menu item displays and allows you to modify the output power level to be used during the frequency sweep. The range of the power level depends on the following configuration and settings of the instrument:

- If the 90 dB step attenuator is not installed (Option 26), the power level range is -20 to +25 dBm.
- If the 90 dB step attenuator is installed (Standard Model) and the step attenuator is set to auto mode, the power level range is - 110 dBm to +25 dBm.
- If the 90 dB step attenuator is installed and the step attenuator is set to manual mode, the power level range is from 20 dB below to 25 dB above the attenuator setting.

NOTE: The mode of the step attenuator, if installed, is set in the SYSTEM 1 menu.

The power level can be modified using either the numeric keypad, the step up/step down buttons, or the rotary knob. The step size can be set in the range of 0.01 dBm to 135 dBm.

Sweep Time. This menu item allows you to view and modify the sweep time. This is the amount of time that elapses for one cycle of a frequency sweep to complete, that is, it is the time taken for the instrument to sweep from the start frequency to the stop frequency, and return to the start frequency.

The sweep time parameter can be modified using either the numeric keypad, the step up/step down buttons, or the rotary knob. The range is 100 ms to 200 seconds, and the step size can be set in the range of 10 ms to 1 second.

Resolution. This menu item allows you to view and modify the sweep resolution. The sweep resolution is the number of frequency steps to be included in the frequency sweep.

The resolution can be set to either 401, 801, or 1601. The step up/step down buttons and rotary knob can be used to set the resolution; the numeric keypad cannot be used.

Ramp Power Menu. Pressing this softkey invokes the Ramp Power menu in the display. See “Ramp Power Menu”, below, for Ramp Power menu item descriptions.

2.4.3.2 Ramp Power Menu

The Ramp Power menu allows you to view and modify settings related to the instrument’s power sweeping feature. When this feature is used, the power level of the RF output sweeps linearly from a predetermined start power level to a predetermined stop power level in a predetermined amount of time, then repeats. The power level can sweep from a lower to a higher power level, or vice versa. The output frequency is held at the same value during a power sweep.

The maximum settable range for ramp power sweep is 45 dB. If the 90 dB step attenuator is installed, ramp power sweep operation prevents the attenuator from switching during the sweep.

NOTE: As soon as the Ramp Power menu is chosen, the instrument calculates the ramp, then begins sweeping the output power. The ramp is recalculated whenever a parameter is changed. During calculations, the following message is shown at the bottom of the display:

Preparing sweeping data...

When the calculations are complete and the output is actively sweeping, the following message is shown:

Ramp sweeping

Figure 2-6 shows the Ramp Power menu:

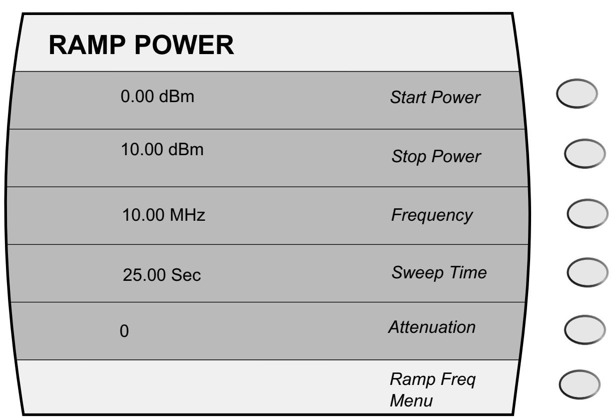


Figure 2-6: Ramp Power Menu with Interactive Softkeys

The following explains each item in the Ramp Power menu:

Start Power. This menu item displays and allows you to modify the ramp start power level. This is the power level that will be used as the beginning of the power level sweep.

The range for the start power parameter is -20 dBm to +25 dBm if the 90 dB step attenuator is not installed in the instrument. If the 90 dB step attenuator is installed, the start power range is from 25 dB above to 20 dB below the step attenuator setting chosen.

The start power can be modified using either the numeric keypad, the step up/step down buttons, or the rotary knob. The step size can be set in the range of 0.01 dBm to 135 dBm.

Stop Power. This menu item displays and allows you to modify the ramp stop power level. This is the power level that will be used as the end point of the power level sweep.

The range for the stop power parameter is -20 dBm to +25 dBm if the 90 dB step attenuator is not installed in the instrument. If the 90 dB step attenuator is installed, the stop power range is from 25 dB above to 20 dB below the step attenuator setting chosen.

The stop power can be modified using either the numeric keypad, the step up/step down buttons, or the rotary knob. The step size can be set in the range of 0.01 dBm to 135 dBm.

Frequency. This menu item displays and allows you to modify the output frequency to be used during the power level sweep. The range of the frequency parameter is dependent on the model number of the instrument. Table 2-1 shows, by model number, the range of frequencies that can be set.

The frequency can be modified using either the numeric keypad, the step up/step down buttons, or the rotary knob. The step size can be set in the range of 0.1 Hz to the upper limit of the frequency range.

Sweep Time. This menu item allows you to view and modify the sweep time. This is the amount of time that elapses for one cycle of a power level sweep to complete, that is, it is the time taken for the instrument to sweep from the start power level to the stop power level, and return to the start power level.

The sweep time parameter can be modified using either the numeric keypad, the step up/step down buttons, or the rotary knob. The range is 100 ms to 200 seconds, and the step size can be set in the range of 10 us to 1 second.

Attenuation. This menu item allows you to select a range of the step attenuator if it is installed in the instrument. The step attenuator can insert up to 90 dB of attenuation into the RF output path of the instrument, in selectable 10 dB steps.

The Attenuation setting is set using the step up/step down buttons or rotary knob; the numeric keypad cannot be used. The values that can be chosen represent the fixed amount of attenuation, in dB, that is inserted into the RF output path. The Start Power and Stop Power settings can then be set 25 dB above to 20 dB below the step attenuator setting chosen.

Ramp Freq Menu. Pressing this softkey invokes the Ramp Freq menu in the display. See “Ramp Freq Menu”, above, for Ramp Freq menu item descriptions.

2.4.4 SYSTEM Menu Descriptions

The System menus provide access to system-level settings, such as memory storage locations, GPIB address configuration, display contrast, and system volume control. System information, including the model number, serial number, firmware version, etc., can also be displayed. To access the System menus, press the front panel SYSTEM menu button:

There are two menus associated with the SYSTEM menu button.

2.4.4.1 System 1 Menu

The System 1 menu allows you to save instrument states to non-volatile memory and subsequently recall them, and view and set the display contrast, turn system sound (audio feedback) on or off, and view and configure the step attenuator if the 90 dB step attenuator is installed.

Figure 2-7 shows the System 1 menu:

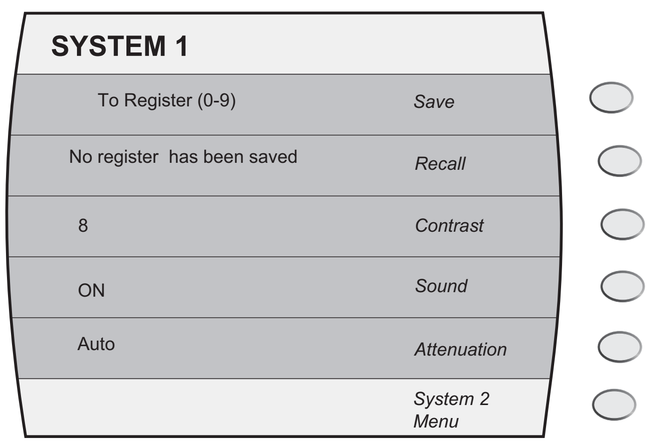


Figure 2-7: System 1 Menu with Interactive Softkeys

The following explains each item in the System 1 menu:

Save. This menu item allows you to save the current state of the instrument (that is, its configuration settings) to non-volatile memory, so that the saved state can subsequently be restored. The 2400 contains ten registers, numbered 0 through 9, into which instrument states can be saved. Note that saving an instrument state to a given register overwrites any state that might have previously been stored in that register.

To save the current instrument configuration to a given register, select the Save menu item, enter the number of the register into which you wish to save the configuration using the numeric keypad, then press any units button.

Only the numeric keypad can be used to enter a register number; the step up/step down buttons and rotary knob cannot be used.

Recall. This menu item allows you to recall a previously saved instrument state from any of the ten storage registers contained in the instrument's non-volatile memory.

The parameter area in the display shows the following text:

From Register (*X*)

Where *X* is the list of registers, separated by commas, that currently have an instrument state saved in them. For example, if instrument states are currently stored in registers 1, 2, and 5, the parameter area would read as follows:

From Register (1, 2, 5)

If none of the registers have instrument states saved to them, as would be the case after the instrument's memory is cleared, the following is displayed in the parameter area:

No register has been saved

To recall a previously saved instrument configuration, press the Recall softkey, enter the number of the register from which you wish to recall the configuration using the numeric keypad, then press any units button.

Only the numeric keypad can be used to enter a register number; the step up/step down buttons and rotary knob cannot be used.

Contrast. This menu item allows you to set the contrast of the instrument's front panel display. The contrast range is 1 to 15, where 1 represents most contrast and results in the darkest display, and 15 represents least contrast and results in the lightest display.

The contrast can be modified using either the numeric keypad or the step up/step down buttons; the rotary knob cannot be used.

Sound. This menu item allows you to enable or disable (mute) the system sound.

The available selections are ON and MUTE. When Sound is set to ON, the instrument provides audio feedback whenever a button is pressed (a clicking sound) or the knob is rotated (a series of clicking sounds), and an operational error notification (a buzzing sound) is emitted when an error condition occurs, such as when an improper button sequence is pressed, a parameter limit is exceeded, etc.

The Sound setting is toggled using the step up/step down buttons; the numeric keypad and rotary knob cannot be used.

Attenuation. This menu item provides control of the step attenuator if it is installed in the instrument.

The step attenuator can insert up to 90 dB of attenuation into the RF output path of the instrument. It is switchable in 10 dB steps, and can be set to automatically switch as the instrument's power level is varied, or it can be manually set to insert a fixed amount of attenuation.

The Attenuation setting is set using the step up/step down buttons; the numeric keypad and rotary knob cannot be used. As the Step Up button is repeatedly pressed, the attenuation parameter cycles through the sequence “90” through “0” in increments of 10, then to “Auto.” The integer values represent the fixed amount of attenuation, in dB, that is inserted into the RF output path. If “Auto” is selected, the attenuator automatically switches as the instrument’s power level is varied.

NOTE: See “Power” in the “CW Menu Description” section for information on how the step attenuator setting affects the output power level setting.

System 2 Menu. Pressing this softkey invokes the System 2 Menu in the display. See “System 2 Menu”, below, for System 2 Menu item descriptions.

2.4.4.2 System 2 Menu

The System 2 menu allows you to view and modify the instrument’s GPIB address, ALC setting, and view system information.

Figure 2-8 shows the System 2 menu:

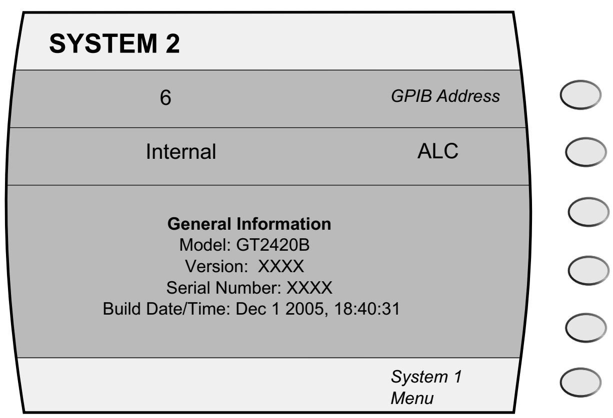


Figure 2-8: System 2 Menu with Interactive Softkeys

The following explains each item in the System 2 menu:

GPIB Address. This menu item allows you to set the instrument’s General-Purpose Interface Bus (GPIB) address. The GPIB address is used by the instrument controller to identify the instrument during remote operations in which IEEE 488.2 is used.

The GPIB address range is 1 to 30. The GPIB address can be modified using either the numeric keypad or the step up/step down buttons; the rotary knob cannot be used.

ALC. This menu item allows you to set the instrument's ALC input. The ALC input settings are Internal, Positive Detector, Negative Detector and Power Meter. External ALC enables the instrument to compensate for device transmission losses without user intervention.

General Information. This field displays 2400 system information. This information is for display only; it has no associated menu choice. The following information is displayed:

- *Model* - This is the specific model number of the instrument.
- *Version* - This is the specific firmware version installed in the instrument.
- *Serial Number* - This is the instrument's serial number.
- *Build Date/Time* - This is the date and time when the firmware version was created.

System 1 Menu Pressing this softkey invokes the System 1 Menu in the display. See "System 1 Menu", above, for System 1 Menu item descriptions.

2.4.5 AM Menu Descriptions

NOTE: Amplitude modulation functionality is standard in 2400B and 2400S series instruments, and front panel amplitude modulation control is available in 2400B series instruments only.

The AM menus provide access to the internal and external amplitude modulation features of the instrument. To access the AM menus, press the front panel AM menu button:

There are three menus associated with the AM menu button.

2.4.5.1 AM Menu 1: External Source

The AM Menu 1 menu allows you to view and modify settings related to external amplitude modulation mode, which is used when the modulating signal is to be provided externally. In external AM mode, the RF output signal is modulated according to the signal that is applied to the rear panel AM IN connector. When the instrument does not include the internal modulation generator, this is the only AM mode that is available.

Figure 2-9 shows the AM Menu 1 menu:

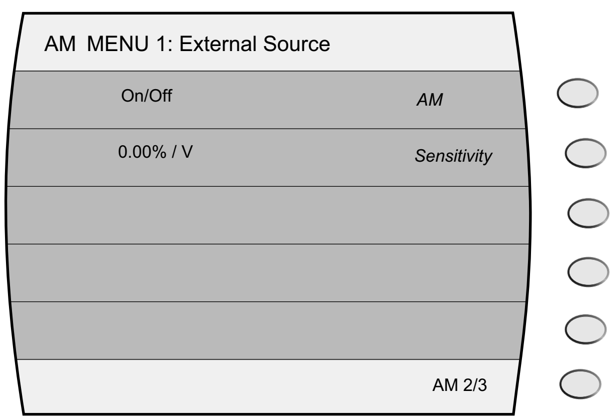


Figure 2-9: AM Menu 1 with Interactive Softkeys

The following explains each item in the AM Menu 1 menu:

AM. This menu item turns amplitude modulation on and off. Note that this setting only enables or disables amplitude modulation; it is the active menu, that is, the menu that is currently being displayed, that determines the AM mode that is used. For example, if AM is turned on using this menu item, then AM Menu 2 is chosen as the active menu, the AM Mode that is used by the instrument changes from external to internal AM.

Only the step up/step down buttons can be used to toggle AM on and off; the numeric keypad and rotary knob cannot be used. The **AM** indicator is displayed in the upper right-hand corner of the display when amplitude modulation is turned on.

Sensitivity. This menu item allows you to view and modify the AM sensitivity setting. AM sensitivity determines the percentage of modulation produced per volt of input into the AM IN connector.

The AM sensitivity can be modified using either the numeric keypad, the step up/step down buttons, or the rotary knob. The AM sensitivity range is 0 to 95%/volt, and the step size can be set in the range of 0.10 to 47.5%/volt.

AM 2/3. Pressing this softkey invokes AM Menu 2 in the display. See "AM Menu 2: Internal Waveform", below, for AM Menu 2 menu item descriptions.

2.4.5.2 AM Menu 2: Internal Waveform

The AM Menu 2 menu allows you to view and modify settings related to an internal amplitude modulation mode in which the modulating signal is an internally-generated sine, triangle, ramp, or square waveform (the signal at the AM IN connector is not used).

Figure 2-10 shows the AM Menu 2 menu:

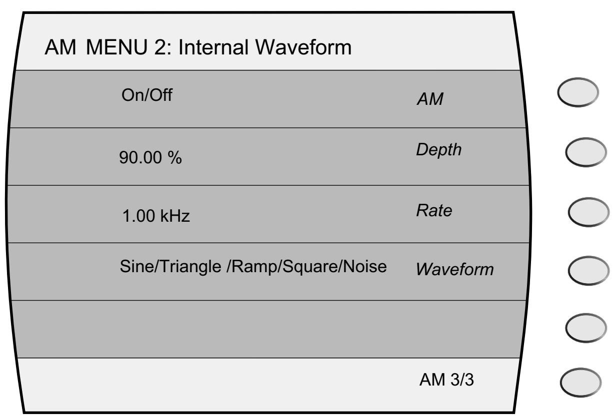


Figure 2-10: AM Menu 2 with Interactive Softkeys

The following explains each item in the AM Menu 2 menu:

AM. This menu item turns amplitude modulation on and off. Note that this setting only enables or disables amplitude modulation; it is the active menu, that is, the menu that is currently being displayed, that determines the AM mode that is used. For example, if AM is turned on using this menu item, then AM Menu 1 is chosen as the active menu, the AM Mode that is used by the instrument changes from internal to external AM.

Only the step up/step down buttons can be used to toggle AM on and off; the numeric keypad and rotary knob cannot be used. The **AM** indicator is displayed in the upper right-hand corner of the display when amplitude modulation is turned on.

Depth. This menu item allows you to view and modify the AM depth setting, which is the extent of the variation of the modulated RF output signal's amplitude expressed as a percentage.

The AM depth parameter can be modified using either the numeric keypad, the step up/step down buttons, or the rotary knob. The AM depth range is 0 to 95%, and the step size can be set in the range of 0.10 to 47.5%.

Rate. This menu item allows you to view and modify the rate (frequency) of the internal modulating signal.

The rate parameter can be modified using either the numeric keypad, the step up/step down buttons, or the rotary knob. The rate range is 0.01 Hz to 10 kHz, and the step size can be set in the range of 0.01 Hz to 5000 Hz.

Waveform. This menu item allows you to view and choose the type of waveform used as the internal modulating signal. The available selections are Sine, Triangle (symmetrical triangle wave), Ramp (positive going ramp), or Square (50% duty cycle square wave).

Only the step up/step down buttons can be used to select the AM waveform; the numeric keypad and rotary knob cannot be used.

AM 3/3. Pressing this softkey invokes AM Menu 3 in the display. See "AM Menu 3: Internal Noise", below, for menu item descriptions.

2.4.5.3 AM Menu 3: Internal Noise

The AM Menu 3 menu allows you to view and modify settings related to an internal amplitude modulation mode in which the modulating signal is an internally-generated Gaussian noise source (the signal at the AM IN connector is not used).

Figure 2-11 shows the AM Menu 3 menu:

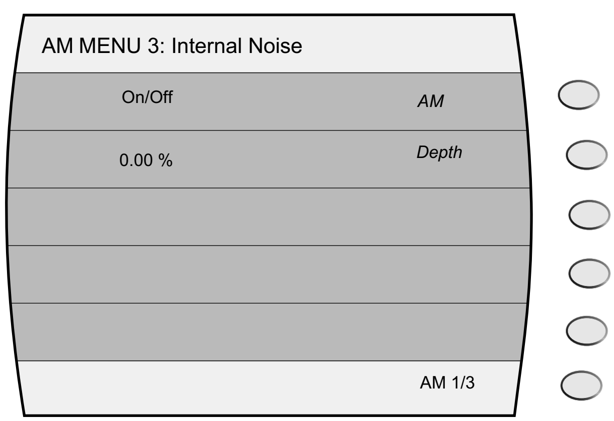


Figure 2-11: AM Menu 3 with Interactive Softkeys

The following explains each item in the AM Menu 3 menu:

AM. This menu item turns amplitude modulation on and off. Note that this setting only enables or disables amplitude modulation; it is the active menu, that is, the menu that is currently being displayed, that determines the AM mode that is used. For example, if AM is turned on using this menu item, then AM Menu 1 is chosen as the active menu, the AM Mode that is used by the instrument changes from internal noise to external AM.

Only the step up/step down buttons can be used to toggle AM on and off; the numeric keypad and rotary knob cannot be used. The **AM** indicator is displayed in the upper right-hand corner of the display when amplitude modulation is turned on.

Depth. This menu item allows you to view and modify the AM depth setting, which is the extent of the variation of the modulated RF output signal's amplitude expressed as a percentage.

The AM depth parameter can be modified using either the numeric keypad, the step up/step down buttons, or the rotary knob. The AM depth range is 0 to 95%, and the step size can be set in the range of 0.10 to 47.5%.

AM 1/3. Pressing this softkey invokes AM Menu 1 in the display. See "AM Menu 1: External Source", above, for AM Menu 1 menu item descriptions.

2.4.6 FM Menu Descriptions

NOTE: Frequency modulation functionality is standard in 2400B and 2400S series instruments, and front panel frequency modulation control is available in 2400B series instruments only.

The FM menus provide access to the internal and external frequency modulation features of the instrument. To access the FM menus, press the front panel FM menu button:

There are two menus associated with the FM menu button.

2.4.6.1 FM Menu 1: External Source

The FM Menu 1 menu allows you to view and modify settings related to external frequency modulation mode, which is used when the modulating signal is to be provided externally. In external FM mode, the RF output signal is modulated according to the signal that is applied to the rear panel FM/ΦM IN connector.

Figure 2-12 shows the FM Menu 1 menu:

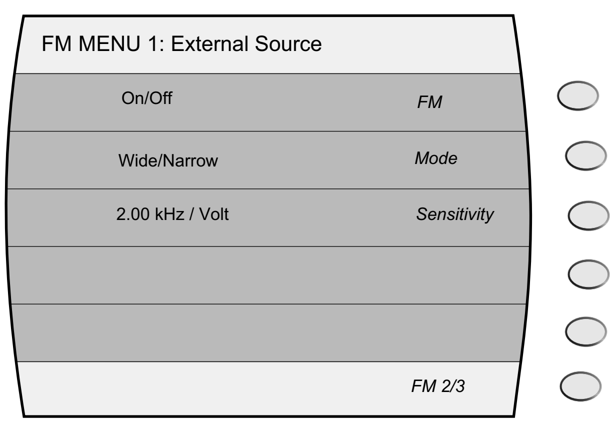


Figure 2-12: FM Menu 1 with Interactive Softkeys

The following explains each item in the FM Menu 1 menu:

FM. This menu item turns frequency modulation on and off. Note that this setting only enables or disables frequency modulation; it is the active menu, that is, the menu that is currently being displayed, that determines the FM mode that is used. For example, if FM is turned on using this menu item, then FM Menu 2 is chosen as the active menu, the FM Mode that is used by the instrument changes from external to internal FM.

Only the step up/step down buttons can be used to toggle FM on and off; the numeric keypad and rotary knob cannot be used. The **FM** indicator is displayed in the upper right-hand corner of the display when frequency modulation is turned on.

Mode. This menu item allows you to view and choose the frequency modulation mode. The available selections are as follows:

- *Narrow* - In this mode, very narrow FM deviations are possible, and modulating signal rates down to DC are possible. The rate of the external modulation signal has an upper limit of 50 kHz.
- *Wide* - In this mode, wider FM deviations are possible, and modulating signal rates up to 3 MHz are possible. The rate of the external modulation signal has a lower limit of 1 kHz.

NOTE: In instances where the combination of carrier frequency, modulating signal rate, and desired FM deviation results in a situation where either narrow or wide mode can be used, narrow mode results in an output signal with tighter specifications.

Only the step up/step down buttons or the knob can be used to select the FM mode; the numeric keypad cannot be used.

Sensitivity. This menu item allows you to view and modify the external FM sensitivity setting, which determines how much the RF output deviates in frequency per volt of signal at the rear panel FM/£M IN connector.

The FM sensitivity parameter can be modified using either the numeric keypad, the step up/step down buttons, or the rotary knob. The range for this parameter is dependent on the instrument's CW frequency setting, as well as the FM mode chosen in this menu. The step size range is affected likewise. An error message will be displayed at the bottom of the display if the range is exceeded.

FM 2/2. Pressing this softkey invokes FM Menu 2 in the display. See "FM Menu 2: Internal Waveform", below, for FM Menu 2 menu item descriptions.

2.4.6.2 FM Menu 2: Internal Waveform

The FM Menu 2 menu allows you to view and modify settings related to an internal frequency modulation mode in which the modulating signal is an internally-generated sine, triangle, ramp, or square waveform (the signal at the FM/£M IN connector is not used).

Figure 2-13 shows the FM Menu 2 menu:

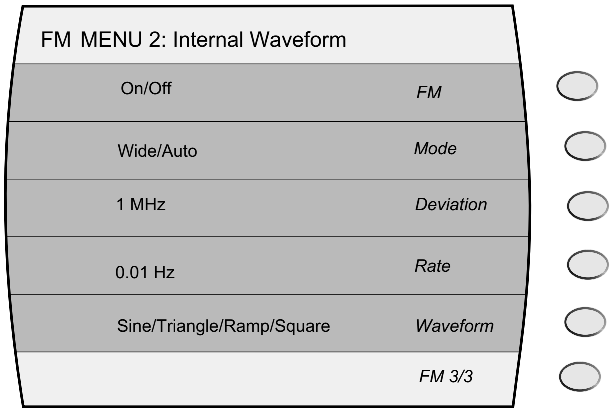


Figure 2-13: FM Menu 2 with Interactive Softkeys

The following explains each item in the FM Menu 2 menu:

FM. This menu item turns frequency modulation on and off. Note that this setting only enables or disables frequency modulation; it is the active menu, that is, the menu that is currently being displayed, that determines the FM mode that is used. For example, if FM is turned on using this menu item, then FM Menu 1 is chosen as the active menu, the FM Mode that is used by the instrument changes from internal to external FM.

Only the step up/step down buttons can be used to toggle FM on and off; the numeric keypad and rotary knob cannot be used. The **FM** indicator is displayed in the upper right-hand corner of the display when frequency modulation is turned on.

Mode. This menu item allows you to view and choose the frequency modulation mode. The available selections are as follows:

- *Auto* - In this mode, the 2400 automatically selects the best mode (either Narrow or Wide) depending on the currently set CW output frequency, internal modulation rate, and FM deviation settings.

  The parameter area indicates, in parentheses, the FM mode that is currently chosen. For example, “Auto (Narrow)” as shown above in Figure 2-13 indicates that the user has selected Auto mode, and the system has in turn selected Narrow mode based on the current settings for CW output frequency, internal modulation rate, and FM deviation.
- *Wide* - Choose this mode if you do not want to use Auto mode.

Only the step up/step down buttons or the knob can be used to select the FM mode; the numeric keypad cannot be used.

Deviation. This menu item allows you to view and modify the FM deviation setting, which determines how much the RF output deviates in frequency when modulated by the internal source.

The FM deviation parameter can be modified using either the numeric keypad, the step up/step down buttons, or the rotary knob. The range for this parameter is dependent on the instrument’s CW frequency setting, as well as the FM mode (Wide or Narrow) currently being used. The step size range is affected likewise. An error message will be displayed at the bottom of the display if the range is exceeded.

Rate. This menu item allows you to view and modify the rate (frequency) of the internal modulating signal.

The rate parameter can be modified using either the numeric keypad, the step up/step down buttons, or the rotary knob. The range for this parameter is dependent on the FM mode (Wide or Narrow) currently being used. The step size range is affected likewise. An error message will be displayed at the bottom of the display if the range is exceeded.

Waveform. This menu item allows you to view and choose the type of waveform used as the internal modulating signal. The available selections are Sine, Triangle (symmetrical triangle wave), Ramp (positive going ramp), or Square (50% duty cycle square wave).

Only the step up/step down buttons can be used to select the FM waveform; the numeric keypad and rotary knob cannot be used.

FM 1/2. Pressing this softkey invokes FM Menu 1 in the display. See "FM Menu 1: External Source", above, for FM Menu 1 menu item descriptions.

2.4.6.3 FM Menu 3: DC FM

The FM Menu 3 menu allows you to activate and deactivate the DC FM feature of the instrument. DC FM requires an externally provided signal to modulate the output frequency of the instrument. In DC FM mode, the RF output signal is modulated according to the signal that is applied to the rear panel FM/ΦM IN connector. DC FM is available on all models including models with option 17, Delete Modulation Suite. Frequency range for DC FM operation is 500 MHz to the maximum frequency of the instrument with a fixed maximum deviation of 125 kHz. DC FM operation is available for frequencies below 500 MHz however maximum deviation is limited to the frequency band maximum deviation of the output frequency.

Figure 2-13 shows the FM Menu 3 menu:

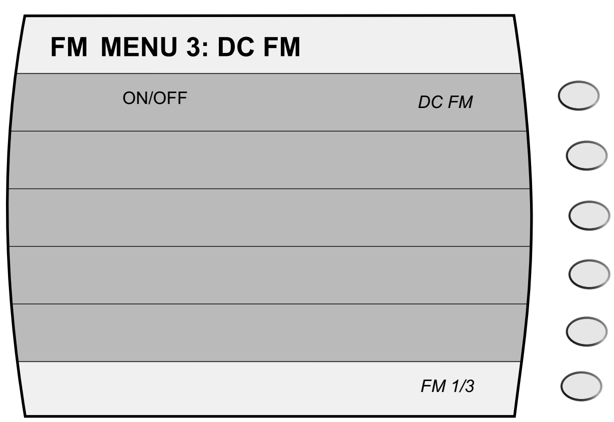


Figure 2-14: FM Menu 3 with Interactive Softkeys

The following explains each item in the FM Menu 3 menu:

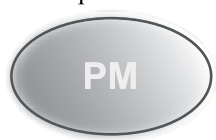
DC FM. This menu item turns DC FM on and off. DC FM is an externally driven modulation requiring a + 1 V peak to peak input for maximum deviation. DC FM can only be activated or deactivated using the step up/step down buttons.

FM 1/3. Pressing this softkey invokes FM Menu 1 in the display. See “FM Menu 1: External Source”, above, for FM Menu 1 menu item descriptions.

2.4.7 PM Menu Descriptions

NOTE: Pulse modulation functionality is available only in 2400B and 2400S series instruments, and front panel pulse modulation control is available in 2400B series instruments only.

The PM menus provide access to the internal and external pulse modulation features of the instrument. To access the PM menus, press the front panel PM menu button:



There are four menus associated with the PM menu button.

2.4.7.1 PM Menu 1: External Source

The PM Menu 1 menu allows you to view and modify settings related to external pulse modulation mode, which is used when the modulating signal is to be provided externally. In external PM mode, the RF output signal is pulsed according to the signal that is applied to the rear panel PULSE IN/PM TRIG IN connector. When the instrument does not include the internal modulation generator, this is the only PM mode that is available.

Figure 2-15 shows the PM Menu 1 menu:

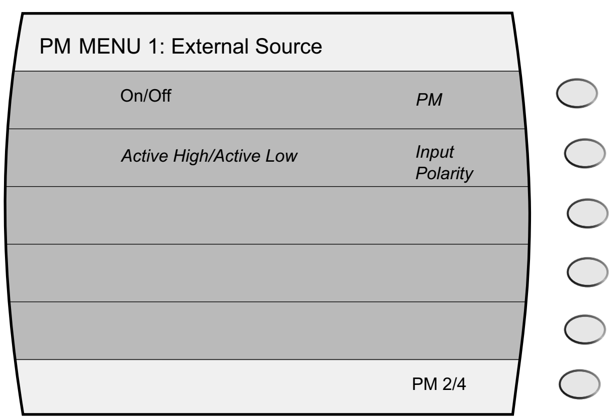


Figure 2-15: PM Menu 1 with Interactive Softkeys

The following explains each item in the PM Menu 1 menu:

PM. This menu item turns pulse modulation on and off. Note that this setting only enables or disables pulse modulation; it is the active menu, that is, the menu that is currently being displayed, that determines the PM mode that is used. For example, if PM is turned on using this menu item, then PM Menu 4 is chosen as the active menu, the PM Mode that is used by the instrument changes from external to internal triggered pulse modulation.

Only the step up/step down buttons can be used to toggle PM on and off; the numeric keypad and rotary knob cannot be used. The **PM** indicator is displayed in the upper right-hand corner of the display when pulse modulation is turned on.

Input Polarity. This menu item allows you to view and choose the input polarity. Input polarity determines whether a high or low TTL level at the PULSE IN/PM TRIG IN connector will produce an “on” condition at the RF output. The available selections are as follows:

- *Active High* - When this input polarity is set, a TTL high level at the PULSE IN/PM TRIG IN connector turns the signal at the RF output on, and a TTL low level at the PULSE IN/PM TRIG IN connector turns the signal at the RF output off.
- *Active Low* - When this input polarity is set, a TTL high level at the PULSE IN/PM TRIG IN connector turns the signal at the RF output off, and a TTL low level at the PULSE IN/PM TRIG IN connector turns the signal at the RF output on.

Only the step up/step down buttons or the knob can be used to select the input polarity; the numeric keypad cannot be used.

PM 2/4. Pressing this softkey invokes PM Menu 2 in the display. See “PM Menu 2: Internal-Continuous”, below, for PM Menu 2 menu item descriptions.

2.4.7.2 PM Menu 2: Internal-Continuous

The PM Menu 2 menu allows you to view and modify settings related to an internal pulse modulation mode which produces a continuous pulse modulated RF output with pulse characteristics determined by an internally-generated pulse signal (any signal at the PULSE IN/PM TRIG IN connector is ignored).

Figure 2-16 shows the PM Menu 2 menu:

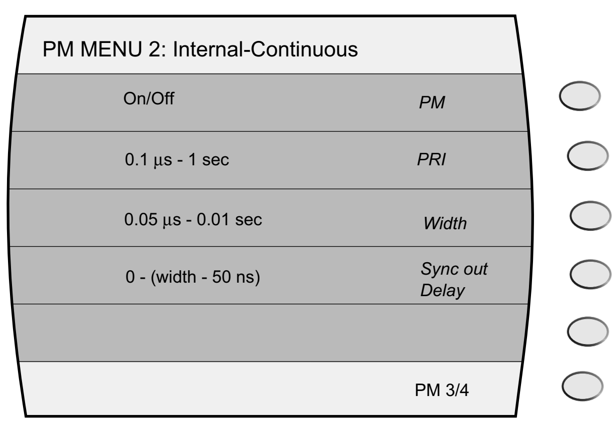


Figure 2-16: PM Menu 2 with Interactive Softkeys

The following explains each item in the PM Menu 2 menu:

PM. This menu item turns pulse modulation on and off. Note that this setting only enables or disables pulse modulation; it is the active menu, that is, the menu that is currently being displayed, that determines the PM mode that is used. For example, if PM is turned on using this menu item, then PM Menu 4 is chosen as the active menu, the PM Mode that is used by the instrument changes from internal continuous to internal triggered pulse modulation.

Only the step up/step down buttons can be used to toggle PM on and off; the numeric keypad and rotary knob cannot be used. The **PM** indicator is displayed in the upper right-hand corner of the display when pulse modulation is turned on.

PRI. This menu item allows you to view and modify the PRI (pulse repetition interval) of the internal pulse modulating signal. The PRI parameter sets the time between like edges of the modulating signal, and thus, the RF output's pulse repetition interval (frequency).

The PRI parameter can be modified using either the numeric keypad, the step up/step down buttons, or the rotary knob. The PRI range is 200 ns to 1000 ms. If it is set to a value that is less than the current Width setting, the Width setting is automatically adjusted to the upper limit of its specified range. The step size can be set in the range of 10 ns to 500 ms.

NOTE: The same PRI parameter setting gets used for the internal continuous and internal gated pulse modulation modes; it is not set and stored separately for those modes.

Width. This menu item allows you to view and modify the width of the internal pulse modulating signal. The width parameter sets the amount of time that each pulse of the internal modulating signal is at the high state, and thus, the RF output's pulse width.

The width parameter can be modified using either the numeric keypad, the step up/step down buttons, or the rotary knob. The width range is from 50 ns up to the value of the PRI setting minus 120 ns; with a maximum of 10 ms. If it is set to a value that is more than the current PRI setting, the PRI setting is automatically adjusted to be 120 ns greater than the Width setting. The step size can be set in the range of 10 ns to 5 ms.

NOTE: The same width parameter setting gets used for all three internal pulse modulation modes (continuous, triggered, and gated); it is not set and stored separately for each of those modes.

Sync Out Delay. This menu item allows you to view and modify the sync out delay setting, which determines the amount of delay that occurs between the leading edge of the video pulse at the PULSE OUT connector and the leading edge of the sync pulse at the PM SYNC OUT connector.

The sync out delay parameter can be modified using either the numeric keypad, the step up/step down buttons, or the rotary knob. The sync out delay range is from 0 ns up to the value of the PRI setting minus 120 ns; with a maximum of 10 ms. The step size can be set in the range of 10 ns to 5 ms.

NOTE: The same sync out delay parameter setting gets used for all three internal pulse modulation modes (continuous, triggered, and gated); it is not set and stored separately for each of those modes.

PM 3/4. Pressing this softkey invokes PM Menu 3 in the display. See "PM Menu 3: Internal-Gated", below, for PM Menu 3 menu item descriptions.

2.4.7.3 PM Menu 3: Internal-Gated

The PM Menu 3 menu allows you to view and modify settings related to the internal gated pulse modulation mode. In this mode, the instrument's CW signal is pulse modulated according to the PRI and Width settings of its internal pulse modulation generator, but appears at the RF output connector as determined by the gating signal that is applied to the rear-panel PULSE IN/PM TRIG IN connector.

Figure 2-17 shows the PM Menu 3 menu:

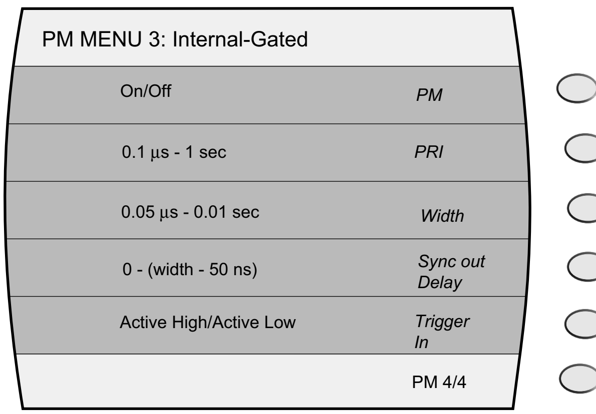


Figure 2-17: PM Menu 3 with Interactive Softkeys

The following explains each item in the PM Menu 3 menu:

PM. This menu item turns pulse modulation on and off. Note that this setting only enables or disables pulse modulation; it is the active menu, that is, the menu that is currently being displayed, that determines the PM mode that is used. For example, if PM is turned on using this menu item, then PM Menu 4 is chosen as the active menu, the PM Mode that is used by the instrument changes from internal gated to internal triggered pulse modulation.

Only the step up/step down buttons can be used to toggle PM on and off; the numeric keypad and rotary knob cannot be used. The **PM** indicator is displayed in the upper right-hand corner of the display when pulse modulation is turned on.

PRI. This menu item allows you to view and modify the PRI (pulse repetition interval) of the instrument's internal pulse modulating signal. The PRI parameter sets the time between like edges of the modulating signal, and thus, the pulse repetition interval (frequency) of the pulses that appear at the RF output connector when an appropriate gating signal is applied to the rear-panel PULSE IN/PM TRIG IN connector.

The PRI parameter can be modified using either the numeric keypad, the step up/step down buttons, or the rotary knob. The PRI range is 200 ns to 1000 ms. If it is set to a value that is less than the current Width setting, the Width setting is automatically adjusted to the upper limit of its specified range. The step size can be set in the range of 10 ns to 500 ms.

NOTE: The same PRI parameter setting gets used for the internal continuous and internal gated pulse modulation modes; it is not set and stored separately for those modes.

Width. This menu item allows you to view and modify the width of the internal pulse modulating signal. The width parameter sets the amount of time that each pulse of the internal modulating signal is at the high state, and thus, the width of the pulses that appear at the RF output connector when an appropriate gating signal is applied to the rear-panel PULSE IN/PM TRIG IN connector.

The width parameter can be modified using either the numeric keypad, the step up/step down buttons, or the rotary knob. The width range is from 50 ns up to the value of the PRI setting minus 120 ns; with a maximum of 10 ms. If it is set to a value that is more than the current PRI setting, the PRI setting is automatically adjusted to be 120 ns greater than the Width setting. The step size can be set in the range of 10 ns to 5 ms.

NOTE: The same width parameter setting gets used for all three internal pulse modulation modes (continuous, triggered, and gated); it is not set and stored separately for each of those modes.

Sync Out Delay. This menu item allows you to view and modify the sync out delay setting, which determines the amount of delay that occurs between the leading edge of the pulse video and the leading edge of the sync pulse at the PM SYNC OUT connector.

The sync out delay parameter can be modified using either the numeric keypad, the step up/step down buttons, or the rotary knob. The sync out delay range is from 0 ns up to the value of the PRI setting minus 120 ns; with a maximum of 10 ms. The step size can be set in the range of 10 ns to 5 ms.

NOTE: The same sync out delay parameter setting gets used for all three internal pulse modulation modes (continuous, triggered, and gated); it is not set and stored separately for each of those modes.

Trigger In. This menu item allows you to view and choose the active polarity of the externally applied gating signal. This setting determines whether a high or low TTL level at the PULSE IN/PM TRIG IN connector will be the active gating condition for a pulse modulated RF output. The available selections are as follows:

- *Active High* - When this polarity is set, a TTL high level at the PULSE IN/PM TRIG IN connector turns the pulse modulated signal at the RF output on, and a TTL low level at the PULSE IN/PM TRIG IN connector turns the pulse modulated signal at the RF output off.
- *Active Low* - When this polarity is set, a TTL high level at the PULSE IN/PM TRIG IN connector turns the pulse modulated signal at the RF output off, and a TTL low level at the PULSE IN/PM TRIG IN connector turns the pulse modulated signal at the RF output on.

Only the step up/step down buttons or the knob can be used to select the trigger polarity; the numeric keypad cannot be used.

PM 4/4. Pressing this softkey invokes PM Menu 4 in the display. See "PM Menu 4: Internal-Triggered", below, for PM Menu 4 menu item descriptions.

2.4.7.4 PM Menu 4: Internal-Triggered

The PM Menu 4 menu allows you to view and modify settings related to the internal triggered pulse modulation mode. In this mode, the instrument produces a single RF pulse at the RF output connector whenever it receives a valid trigger signal at the rear-panel PULSE IN/PM TRIG IN connector. The RF pulse thus generated has a width that is determined by the Width setting in this menu, and is delayed by the amount of delay set with the RF Pulse Delay setting in this menu.

Figure 2-18 shows the PM Menu 4 menu:

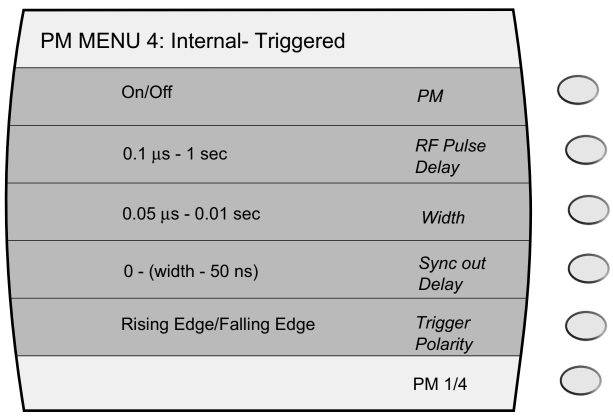


Figure 2-18: PM Menu 4 with Interactive Softkeys

The following explains each item in the PM Menu 4 menu:

PM. This menu item turns pulse modulation on and off. Note that this setting only enables or disables pulse modulation; it is the active menu, that is, the menu that is currently being displayed, that determines the PM mode that is used. For example, if PM is turned on using this menu item, then PM Menu 1 is chosen as the active menu, the PM Mode that is used by the instrument changes from internal triggered to external pulse modulation.

Only the step up/step down buttons can be used to toggle PM on and off; the numeric keypad and rotary knob cannot be used. The **PM** indicator is displayed in the upper right-hand corner of the display when pulse modulation is turned on.

RF Pulse Delay. This menu item allows you to view and modify the RF pulse delay setting, which determines the amount of delay that occurs between the chosen triggering edge (rising or falling) of the signal at the PULSE IN/PM TRIG IN connector and the rising edge of the video pulse at the rear-panel PULSE OUT connector.

NOTE: The pulse that subsequently appears at the RF output connector is typically delayed by approximately 50 ns.

The RF pulse delay parameter can be modified using either the numeric keypad, the step up/step down buttons, or the rotary knob. The RF pulse delay range is 100 ns to 1000 ms, and the step size can be set in the range of 10 ns to 500 ms.

Width. This menu item allows you to view and modify the width of the pulse that appears at the RF output connector when an appropriate triggering signal is applied to the rear-panel PULSE IN/PM TRIG IN connector.

The width parameter can be modified using either the numeric keypad, the step up/step down buttons, or the rotary knob. The width range is from 50 ns up to 10 ms. The step size can be set in the range of 10 ns to 5 ms.

NOTE: The same width parameter setting gets used for all three internal pulse modulation modes (continuous, triggered, and gated); it is not set and stored separately for each of those modes.

Sync Out Delay. This menu item allows you to view and modify the sync out delay setting, which determines the amount of delay that occurs between the leading edge of the video pulse at the PULSE OUT connector and the leading edge of the sync pulse at the PM SYNC OUT connector.

The sync out delay parameter can be modified using either the numeric keypad, the step up/step down buttons, or the rotary knob. The sync out delay range is 0 ns to 10 ms. The step size can be set in the range of 10 ns to 5 ms.

Trigger Polarity. This menu item allows you to view and choose the edge of the TTL pulsed input signal applied to the PULSE IN/PM TRIG IN connector that is used to trigger an RF pulse at the RF output connector. This setting determines whether the rising edge or falling edge of the pulse at the PULSE IN/PM TRIG IN connector will trigger an RF pulse at the output. The available selections are as follows:

- *Rising Edge* - When this edge is set, the rising edge (low-to-high transition) of a TTL signal at the PULSE IN/PM TRIG IN connector will trigger a RF pulse at the instrument's RF output connector.
- *Falling Edge* - When this edge is set, the falling edge (high-to-low transition) of a TTL signal at the PULSE IN/PM TRIG IN connector will trigger a RF pulse at the instrument's RF output connector.

Only the step up/step down buttons or the knob can be used to select the trigger polarity; the numeric keypad cannot be used.

PM 1/4. Pressing this softkey invokes PM Menu 1 in the display. See "PM Menu 1: External Source", above, for PM Menu 1 menu item descriptions.

2.4.8 Language Menu Descriptions

The Language menus allow you to choose the language to be used by the instrument during remote operation. To access the Language menus, press the front panel LOCAL button while the instrument is in local (front panel) operating mode:

NOTE: Pressing the LOCAL button while the instrument is in the remote operating mode returns it to local operating mode.

There are two Language menus associated with the LOCAL button.

2.4.8.1 Language Menu 1

The Language Menu 1 menu, as well as the Language Menu 2 menu, allow you to view and choose the language to be used by the instrument during remote operation. Some of the remote language choices are standard, and some are optional. The remote language that will be used by the instrument corresponds to the Language menu item that is currently selected.

Figure 2-19 shows the Language Menu 1 menu:

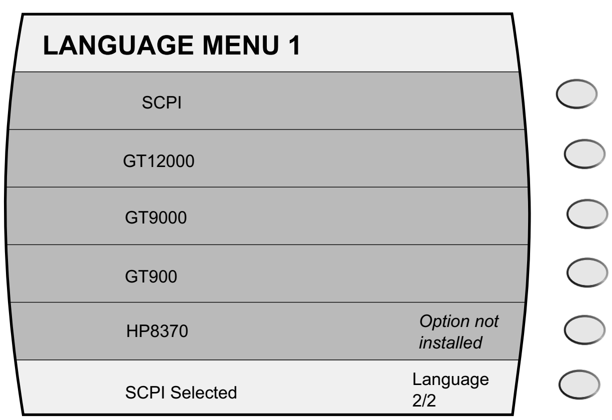


Figure 2-19: Language Menu 1 with Interactive Softkeys

The following explains each item in the Language Menu 1 menu:

SCPI. This menu item allows you to select Standard Commands for Programmable Instruments (SCPI) as the language to be used by the instrument during remote operations. SCPI is one of the standard remote language choices that are available. To choose SCPI as the remote language, select this menu item. Refer to the chapter entitled “Remote Operation” in this manual for a brief explanation of each SCPI command that is supported.

GT12000. This menu item allows you to select the Giga-tronics Series 12000A native command set as the language to be used by the instrument during remote operations. GT12000 is one of the standard remote language choices that are available. To choose GT12000 as the remote language, select this menu item. Refer to the chapter entitled “Remote Operation” in this manual for a brief explanation of each GT12000 command that is supported.

HP8370. This menu item allows you to select HP 8370 command emulation as the language to be used by the instrument during remote operations. HP8370 is an optional remote language choice; this language option must be installed in order to access this menu item. Refer to the HP/Agilent 8370 documentation for information about the commands that are available.

HP8340. This menu item allows you to select HP 8340 command emulation as the language to be used by the instrument during remote operations. HP8340 is an optional remote language choice; this language option must be installed in order to access this menu item. Refer to the HP/Agilent 8340 documentation for information about the commands that are available.

HP8673. This menu item allows you to select HP 8673 command emulation as the language to be used by the instrument during remote operations. HP8673 is an optional remote language choice; this language option must be installed in order to access this menu item. Refer to the HP/Agilent 8673 documentation for information about the commands that are available.

Language 2/2. Pressing this softkey invokes Language Menu 2 in the display. See “Language Menu 2”, below, for Language Menu 2 menu item descriptions.

2.4.8.2 Language Menu 2

The Language Menu 2 menu, as well as the Language Menu 1 menu, allow you to view and choose the language to be used by the instrument during remote operation. Some of the remote language choices are standard, and some are optional. The remote language that will be used by the instrument corresponds to the Language menu item that is currently selected.

Figure 2-20 shows the Language Menu 2 menu:

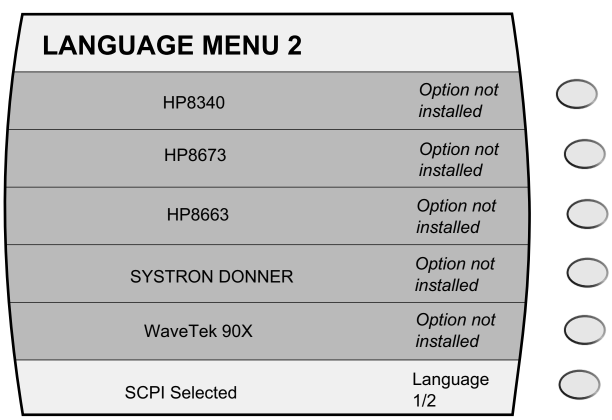


Figure 2-20: Language Menu 2 with Interactive Softkeys

The following explains each item in the Language Menu 2 menu:

HP8663. This menu item allows you to select HP 8663 command emulation as the language to be used by the instrument during remote operations. HP8663 is an optional remote language choice; this language option must be installed in order to access this menu item. Refer to the HP/Agilent 8663 documentation for information about the commands that are available.

GT9000. This menu item allows you to select GT 9000 command set as the remote control language to be used by the instrument using the instrument's GPIB or RS-232 port. GT9000 is an optional remote language choice; this language option must be installed in order to access this menu item. Refer to Giga-tronics Model 9000 documentation of information about the commands that are available.

GT900. This menu item allows you to select GT 900 command set as the remote control language to be used by the instrument using the instrument's GPIB or RS-232 port. GT900 is an optional remote language choice; this language option must be installed in order to access this menu item. Refer to Giga-tronics Model 900 documentation of information about the commands that are available.

Systron Donner. This menu item allows you to select Systron Donner command set as the remote control language to be used by the instrument using the instrument's GPIB or RS-232 port. Systron-Donner is an optional remote language choice; this language option must be installed in order to access this menu item. Refer to Systron-Donner Model 1618 documentation of information about the commands that are available.

WaveTek 90X. This menu item allows you to select Wavetek 90X command set as the remote control language to be used by the instrument using the instrument's GPIB or RS-232 port. Wavetek 90X is an optional remote language choice; this language option must be installed in order to access this menu item. Refer to Wavetek Model 904 or 907 documentation of information about the commands that are available.

Language 1/2. Pressing this softkey invokes Language Menu 1 in the display. See "Language Menu 1", above, for Language Menu 1 menu item descriptions.

2.5 Front Panel Operating Tasks

This section describes front panel operation of the 2400.

This section contains the following subsections:

- "Power-Up" - This section explains the power-up sequence of the 2400.
- "Basic Operating Tasks" - This section explains how to perform some basic tasks, such as how to preset the instrument to factory default settings, and how to set and modify instrument parameters.
- "Signal Generation" - This section explains how to use the instrument to generate different types of output signals, with or without modulation.
- "Remote Setup" - This section explains how to set the instrument's GPIB address and choose its remote language so that it can be used in remote operating mode.

2.5.1 Power-Up

When the 2400 is powered up, the system runs through a series of start-up tasks. If problems are encountered by the system during start-up, an error message is displayed after start-up is complete.

2.5.1.1 Normal Power-Up

After the main power switch is pressed, the indicator that is above the RF ON button turns from amber to blue, indicating that the instrument has begun the power-up sequence. The message "INITIALIZING GT 2400" momentarily appears in the display, then a screen appears that is similar to Figure 2-21.

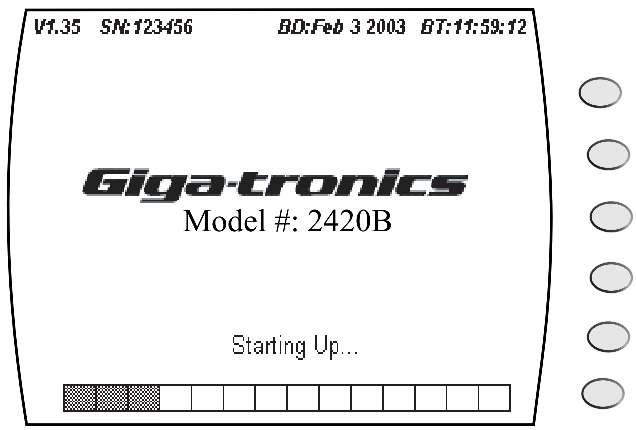


Figure 2-21: Power-Up Screen

The firmware version number, build date, and build time, as well as the instrument's serial number are shown along the top of the screen. The instrument's model number is shown in the center of the screen, and a start-up task progress bar is shown at the bottom of the screen.

As start-up progresses, the segments of the progress bar, starting at the left, turn from white to gray as each start-up task begins. Table 2-2 lists the start-up tasks that are performed. In the table, start-up bar number 1 corresponds to the leftmost segment, and 14 corresponds to the rightmost segment.

Table 2-2: Start-Up Tasks

Start-Up Bar Number	Start-Up Task
1	Loading DSP Boot Code
2	Loading Synth FPGA
3	Loading Synth DSP Code
4	Performing YIG calibration low
5	Performing YIG calibration high
6	Performing A1A2 Calibration
7	Loading ALC SP FPGA - TestCode
8	Loading ALC PM FPGA
9	Performing ALC Memory Tests
10	Loading ALC DSP Code
11	Re-Configuring ALC SP FPGA
12	Loading the ALC Characterization Tables
13	Loading the Frequency Correction Tables for Ramp Frequency Sweep
14	Determining ALC Detector Zero Offset

After all start-up tasks have completed successfully, the CW menu appears in the display.

2.5.1.2 Errors During Power-Up

If any problems occur during the power-up process, error codes or other user messages will be shown in the display. If the power-up process encounters problems, go to Appendix B, “Error Messages” for more information.

2.5.2 Basic Operating Tasks

This section explains how to perform some basic operating tasks.

2.5.2.1 Resetting the System/Sanitization Procedure

The 2400 Series uses non-volatile memory (NVRAM), which is preserved with a battery for storing the Instrument's current state, saved setups, and lists. In certain situations, it might be desirable to return the instrument to the state it was in when received from the factory. The following procedure explains how to reset the instrument.

1. Using the power switch on the front panel, turn the 2400's power off.
2. Power up the 2400.
3. Press and hold the PRESET button at some point while the "INITIALIZING GT2400" screen is displayed.
4. When the "Resetting Memory..." screen is displayed, release the PRESET button.

The system will continue to power up normally. All information stored in the memory locations will be cleared, and the system will be reset to factory default settings.

2.5.2.2 Entering and Modifying Parameters

Parameters in the 2400 menus can be modified using the numeric keypad, Step Up and Step Down buttons, or the rotary knob.

To select a menu item so that its associated parameter can be modified, first press one of the menu buttons (CW, RAMP, SYSTEM, AM, FM, or PM), then press the interactive softkey that is adjacent to the menu item for the parameter you wish to modify. For example, if you wish to modify the output frequency of the instrument, press the front panel CW button, then press the interactive softkey that is adjacent to the Frequency menu item.

The following three methods can be used to modify the parameter associated with a selected menu item.

NOTE: Some of the parameter modification methods might not be available when modifying certain parameters. For example, all three methods are generally available to modify numeric parameters, but direct entry is not available for modifying parameters in which a state is changed.

2.5.2.2.1 Direct Entry Using Numeric Keypad

This method can be used to modify numeric parameters, such as output frequency, power level, etc.

To modify a parameter using this method, select the menu item that is associated with the desired parameter as explained above under “Entering and Modifying Parameters”, enter the new value using the numbered buttons in the numeric keypad, then press the appropriate Units button to update the parameter to the new setting.

NOTE: The Units buttons are in a column to the right of the numbered buttons in the numeric keypad.

To enter negative values, press the BK/- button before entering the first digit of the new value. After the first digit of the new entry has been entered, the BK/- button performs a backspace function, to delete previously entered digits.

2.5.2.2.2 Step Up/Step Down Buttons

This method can be used to modify numeric parameters, as well as parameters that toggle between defined states (for example, the On/Off states of modulation parameters).

To modify a parameter using this method, select the menu item that is associated with the desired parameter as explained above under “Entering and Modifying Parameters”, then press the Step Up button to increase the selected parameter by the specified step size, or press the Step Down button to decrease the selected parameter by the specified step size.

The step size that is currently programmed determines the resolution by which the parameter will be increased or decreased with each press of the Step Up or Step Down buttons. Refer to “Step Size”, below, for information on how to modify the step size.

2.5.2.2.3 Rotary Knob

This method can be used to modify numeric parameters, as well as some parameters that toggle between defined states.

To modify a parameter using this method, select the menu item that is associated with the desired parameter as explained above under “Entering and Modifying Parameters”, then rotate the knob clockwise to increase the value of the parameter or counterclockwise to decrease the value of the parameter.

The parameter will be modified according to the programmed step size. Refer to “Step Size”, below, for information on how to modify the step size.

2.5.2.2.4 Step Size

The step size for a specific parameter determines the resolution by which that parameter will change when modified using either the Step Up/Down buttons or rotary knob. The current step size for the selected parameter is displayed at the bottom of the display if an operator error message is not being displayed.

To modify the step size for the selected parameter, press the STEP SIZE button, enter a new step size using the numeric keypad, then press any Units button.

2.5.3 Signal Generation

This section explains how to use the instrument to generate different types of output signals. CW, ramp (sweep), and modulation modes are explained.

2.5.3.1 Generating a CW Signal

The following procedure explains how to set up the instrument to generate a continuous wave (CW) signal at a specified output power level. This procedure is also used to set up the carrier signal when modulation is used.

The following rear-panel input/output connections are available when the instrument is in CW mode (refer to “Rear Panel Interface and I/O Connectors” in Chapter 1 for more information):

- *EXT REF IN (input)* - Connect a valid 10 MHz or 100 MHz signal here, to phase lock the instrument to an external frequency reference.
- *10 MHZ OUT (output)* - Produces a 10 MHz reference output signal.
- *V/GHZ (output)* - Produces an output voltage that is proportional to the output frequency.

The procedure follows:

1. Press the CW button to invoke the CW menu in the display.

2. Select the “Frequency” menu item in the CW menu, and enter the desired CW frequency using either the numeric keypad, Step Up/Step Down buttons, or the rotary knob.

3. If the 90 dB step attenuator is installed in the unit, continue with the next step, otherwise, continue with Step 5.

   The step attenuator, if installed, can be set in either of two modes:

   - *Auto Mode* - In this mode, the step attenuator automatically switches different levels of fixed attenuation into the instrument’s RF output signal path, as the instrument’s output power level setting is varied. The widest dynamic range is available at the RF output connector when in this mode.

   - *Fixed Mode* - In this mode, the step attenuator is set to a fixed level of attenuation. This mode might be desirable to eliminate unnecessary attenuator switching cycles when a wide dynamic range is not needed.

4. Perform one of the following actions *if* the step attenuator is currently not set in the desired mode explained above, otherwise, continue with the next step:

   - *To set the step attenuator so that it automatically switches attenuation levels with changes in output power level*, press the SYSTEM button, select the “System 1 Menu” menu item if it appears, select the “Attenuation” menu item, and use the Step Down button to select Auto.

   - *To set the step attenuator so that it remains fixed at a desired level of attenuation*, press the SYSTEM button, select the “System 1 Menu” menu item if it appears, select the “Attenuation” menu item, and use the Step Up or Step Down button to select the desired level of attenuation.

5. Return to the CW menu if necessary by pressing the CW button, select the “Power” menu item, and enter the desired output power level using either the numeric keypad, Step Up/Step Down buttons, or the rotary knob.

6. If you wish to use the instrument’s insertion/conversion loss compensation features, continue with the next step, otherwise, continue with Step 9.

   The insertion/conversion loss compensation features include the Power Offset feature, which is used to account for a fixed level of insertion or conversion loss, and the Power Slope feature, which is used to account for insertion or conversion loss that varies with frequency.

7. Perform the following loss compensation actions, as desired (both features can be used concurrently):

   - *To compensate for a fixed level of loss*, select the “Power Offset” menu item, and enter the desired loss correction using either the numeric keypad, Step Up/Step Down buttons, or the rotary knob. For example, if you want to compensate for a component connected to the instrument’s RF output that has 2.53 dB of insertion loss, enter a loss correction of 2.53 dB. Note that when this correction factor is entered, **OFS** appears in the upper right corner of the display.

   - *To compensate for a loss that varies linearly with frequency*, select the “Power Slope” menu item, and enter the desired correction factor using either the numeric keypad, Step Up/Step Down buttons, or the rotary knob. For example, if you want to compensate for a component connected to the instrument’s RF output that has a loss characteristic of 0.06 dB per Gigahertz, enter a correction factor of 0.06 dB/GHz. Note that when this correction factor is entered, **SLP** appears in the upper right corner of the display.

8. To adjust the phase of the output, select the "Phase Adjust" menu item, and enter the desired phase shift using either the numeric keypad, Step Up/Step Down buttons, or the rotary knob.

   Step size for Step Up/Step Down buttons, or rotary knob can be adjusted by pressing the Step Size button and entering the new step size using the numeric keypad.

NOTE: Whenever the frequency of the instrument is changed, the Phase Adjust setting will reset to 0 degrees. The Phase Adjust range is 500 MHz to the maximum frequency of the instrument. Phase adjust is available for frequencies below 500 MHz; however, the output response time is increased.

9. If the LED indicator that is above the RF ON button is not lit, press the RF ON button to enable the signal at the RF output connector.

   When the signal at the RF output connector is enabled, the LED indicator that is above the RF ON button is blue.

10. Verify that the Unleveled indicator is not lit.

   If the Unleveled indicator is lit, then the combination of output power level, power offset, power slope, and step attenuator mode (if applicable) is set inappropriately, and the RF output is unleveled. Adjust the combination of settings until the Unleveled indicator turns off.

2.5.3.2 Generating an External ALC Leveled Signal

The following procedure describes how to set up the instrument to generate an externally level controlled signal using the External ALC feature. This procedure can be used in CW, Ramp, and Pulse modes only. The output of the instrument is typically sampled through a directional coupler or power splitter. The signal is sampled using a positive or negative crystal detector or power meter. External ALC response with the instrument configured for Pulse Modulation varies according to duty cycle of the signal being sampled. Low duty cycles result in a slower response time for the instrument to level.

Level control for External ALC operation using crystal detectors are described in dBV units. The crystal detector output may vary for power and frequency. Because of the variability of the crystal detector output, it may be necessary to characterize the output of the crystal detector output to a power standard.

The external positive or negative crystal detector ALC procedure follows:

1. Connect the input of the crystal detector to the sample port of the power splitter or directional coupler.
2. Connect the output of the crystal detector to the Ext ALC In connector on the rear panel.
3. Press CW button to invoke the CW menu on the display.
4. Select the "Frequency" menu item in the CW menu, and enter the desired CW frequency using the numeric keypad, Step Up/Step Down buttons, or the rotary knob.
5. Press the System button to invoke the System menu on the display. If the System Menu 1 is displayed, press the System 2 Menu soft key to display the System Menu 2.
6. Select the ALC menu item in the System 2 menu, and select the positive or negative detector setting using the Step Up/Step Down buttons depending on the type of crystal detector used of external ALC.
7. Press the CW button to invoke the CW menu on the display.

NOTE: The Power Offset and Power Slope functions are no longer available.

8. Select the "Level" menu item in the CW menu and enter the desired output level using the keypad, Step Up/Step Down buttons, or the rotary knob.
9. When entering a new level setting using the numeric keypad, use the dBm or dB Units buttons. Units are assumed to be in dBV.
10. If the LED indicator that is above the RF ON button is not lit, press the RF ON button to enable the signal at the RF output connector.
11. When the signal at the RF output connector is enabled, the LED indicator that is above the RF ON button is blue.

12. Verify that the Unleveled indicator is not lit.

If the Unleveled indicator is lit, then the combination of output power level, and step attenuator mode (if applicable) is set inappropriately, and the RF output is unleveled. Adjust the combination of settings until the Unleveled indicator turns off.

The External Power Meter ALC procedure follows:

1. Connect the sensor of the power meter to the sample port of the power splitter or directional coupler.
2. Connect the Analog Out output of the Power Meter to the EXT ALC connector on the rear panel of the instrument.
3. Adjust the Analog Out range of the power meter from 0.0005 to 2 volts. The power range is adjusted according to the user's specific needs.
4. Press the CW button to invoke the CW menu on the display.
5. Select the "Frequency" menu item in the CW menu, and enter the desired CW frequency using the numeric keypad, Step Up/Step Down buttons, or the rotary knob.
6. Press the System button to invoke the System menu on the display. If the System Menu 1 is displayed, press the System 2/2 soft key to display the System Menu 2.
7. Select the ALC menu item in the System 2 menu, and select the Power Meter setting using Step Up/ Step Down buttons.
8. Press the CW button to invoke the CW menu on the display.

NOTE: The Power Offset and Power Slope functions are no longer available.

9. Select the "Level" menu item in the CW menu and enter the desired output level using the keypad, Step Up/Step Down buttons, or the rotary knob.
10. When entering a new level setting using the numeric keypad, use the dBm or dB Units buttons. Units are assumed to be in dBV. Use the following formula to convert to Volts to dBV:

    $dBV = 20\log_{10}(V)$

11. If the LED indicator that is above the RF ON button is not lit, press the RF ON button to enable the signal at the RF output connector.
12. When the signal at the RF output connector is enabled, the LED indicator that is above the RF ON button is blue.
13. Verify that the Unleveled indicator is not lit.

If the Unleveled indicator is lit, then the combination of output power level, and step attenuator mode (if applicable) is set inappropriately, and the RF output is unleveled. Adjust the combination of settings until the Unleveled indicator turns off.

2.5.3.3 Generating a Frequency Swept Signal

The following procedure explains how to set up the instrument to generate a signal at a constant power level that sweeps linearly from a set start frequency to a set stop frequency over a set amount of time, then repeats.

The following rear-panel input/output connections are available when the instrument is in the frequency sweep mode (refer to "Rear Panel Interface and I/O Connectors" in Chapter 1 for more information):

- *SYNC OUT (output)* - Produces a TTL-level, 1 ms pulse at the start of each frequency sweep.
- *BLANKING (output)* - Produces a +5 volt output signal for the duration of band crossings, filter switches, and retraces.
- *Stop I/O (input/output)* - The port can receive or output a Stop Sweep signal.
- *RAMP OUT (output)* - Produces a 0 to 10 Volt ramp output scaled to the frequency sweep.
- *EXT REF IN (input)* - Connect a valid 10 MHz or 100 MHz signal here, to phase lock the instrument to an external frequency reference.
- *10 MHZ OUT (output)* - Produces a 10 MHz reference output signal.
- *V/GHZ (output)* - Produces an output voltage that is proportional to the output frequency.

The procedure follows:

1. Press the RAMP button to invoke the Ramp menus, and if the RAMP FREQ menu does not appear in the display, press the bottom-most interactive softkey until it does.

2. Select the "Start Frequency" menu item in the RAMP FREQ menu, and enter the desired ramp start frequency using either the numeric keypad, Step Up/Step Down buttons, or the rotary knob.

3. Select the "Stop Frequency" menu item in the RAMP FREQ menu, and enter the desired ramp stop frequency using either the numeric keypad, Step Up/Step Down buttons, or the rotary knob.

NOTE: The ramp stop frequency must be set equal to or greater than the ramp start frequency.

4. Select the "Power" menu item in the RAMP FREQ menu, and enter the desired output power level using either the numeric keypad, Step Up/Step Down buttons, or the rotary knob.

5. Select the "Sweep Time" menu item in the RAMP FREQ menu, and enter the desired ramp sweep time using either the numeric keypad, Step Up/Step Down buttons, or the rotary knob.

6. Select the "Resolution" menu item in the RAMP FREQ menu, and select the desired resolution using the Step Up/Step Down buttons.

The resolution setting determines the number of discreet frequency steps that will be included in the frequency ramp. Three resolutions are available: 401, 801, or 1601. Higher resolution settings will result in more steps and a finer resolution ramp.

7. If the LED indicator that is above the RF ON button is not lit, press the RF ON button to enable the signal at the RF output connector.

   When the signal at the RF output connector is enabled, the LED indicator that is above the RF ON button is blue.

8. Verify that the Unleveled indicator is not lit.

   If the Unleveled indicator is lit, then the combination of output power level, power offset, power slope, and step attenuator mode (if applicable) is set inappropriately, and the RF output is unleveled. Adjust the combination of settings until the Unleveled indicator turns off.

2.5.3.4 Generating a Power Swept Signal

The following procedure explains how to set up the instrument to generate a signal at a constant frequency that sweeps linearly from a set start power level to a set stop power level over a set amount of time, then repeats.

The following rear-panel input/output connections are available when the instrument is in the power sweep mode (refer to “Rear Panel Interface and I/O Connectors” in Chapter 1 for more information):

- *SYNC OUT (output)* - Produces a TTL-level, 1 ms pulse at the start of each power sweep (2400L and 2400M Series only).
- *Stop I/O (input/output)* - The port can receive or output a Stop Sweep signal.
- *EXT REF IN (input)* - Connect a valid 10 MHz or 100 MHz signal here, to phase lock the instrument to an external frequency reference.
- *10 MHZ OUT (output)* - Produces a 10 MHz reference output signal.
- *V/GHZ (output)* - Produces an output voltage that is proportional to the output frequency.

The procedure follows:

1. Press the RAMP button to invoke the Ramp menus, and if the RAMP POWER menu does not appear in the display, press the bottom-most interactive softkey until it does.

2. If the 90 dB step attenuator is installed in the unit, continue with the next step, otherwise, continue with Step 4.

3. Select the “Attenuation” menu item in the RAMP POWER menu, and use the Step Up or Step Down button to select the desired step attenuator level.

   The step attenuator cannot be set to auto-switch while in power sweep mode. Choose an appropriate step attenuator level such that the range of the power sweep will be within 25 dB above and 20 dB below the step attenuator level chosen.

4. Select the “Start Power” menu item in the RAMP POWER menu, and enter the desired ramp start power level using either the numeric keypad, Step Up/Step Down buttons, or the rotary knob.

5. Select the “Stop Power” menu item in the RAMP POWER menu, and enter the desired ramp stop power level using either the numeric keypad, Step Up/Step Down buttons, or the rotary knob.

   The ramp stop power level can be set equal to, greater than, or less than the ramp start power level.

6. Select the “Frequency” menu item in the RAMP POWER menu, and enter the desired output frequency using either the numeric keypad, Step Up/Step Down buttons, or the rotary knob.

7. Select the “Sweep Time” menu item in the RAMP POWER menu, and enter the desired ramp sweep time using either the numeric keypad, Step Up/Step Down buttons, or the rotary knob.

8. If the LED indicator that is above the RF ON button is not lit, press the RF ON button to enable the signal at the RF output connector.

   When the signal at the RF output connector is enabled, the LED indicator that is above the RF ON button is blue.

9. Verify that the Unleveled indicator is not lit.

   If the Unleveled indicator is lit, then the combination of output power level, power offset, power slope, and step attenuator setting (if applicable) is set inappropriately, and the RF output is unleveled. Adjust the combination of settings until the Unleveled indicator turns off.

2.5.3.5 Generating an Externally Modulated AM Signal

The following procedure explains how to set up the instrument to generate a signal that is amplitude modulated using an external modulation source.

The following rear-panel input/output connections are available when the instrument is in external AM mode (refer to “Rear Panel Interface and I/O Connectors” in Chapter 1 for more information):

- *AM IN (input)* - Connect the external modulating signal here.
- *EXT REF IN (input)* - Connect a valid 10 MHz or 100 MHz signal here, to phase lock the instrument to an external frequency reference.
- *10 MHZ OUT (output)* - Produces a 10 MHz reference output signal.
- *V/GHZ (output)* - Produces an output voltage that is proportional to the output frequency.

The procedure follows:

1. Perform steps 1 through 7 of the procedure entitled “Generating a CW Signal” to set the frequency and power level of the carrier.

2. Connect a modulating signal source to the AM IN connector on the rear-panel of the instrument, and set it for the desired modulating characteristics (waveshape, rate, and amplitude).

NOTE: The maximum rate of the modulating signal is 5 kHz, and the maximum amplitude is 2 Vp-p.

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3. Press the AM button to invoke the AM menus, and if AM Menu 1 does not appear in the display, press the bottom-most interactive softkey until it does.

4. Select the "AM" menu item in AM Menu 1, and use the Step Up or Step Down button to set it to On.

5. Select the "Sensitivity" menu item in AM Menu 1, and enter the desired AM sensitivity setting using either the numeric keypad, Step Up/Step Down buttons, or the rotary knob.

6. If the LED indicator that is above the RF ON button is not lit, press the RF ON button to enable the signal at the RF output connector.

   When the signal at the RF output connector is enabled, the LED indicator that is above the RF ON button is blue.

7. Verify that the Unleveled indicator is not lit.

   If the Unleveled indicator is lit, then the combination of output power level, power offset, power slope, and step attenuator mode (if applicable) is set inappropriately, and the RF output is unleveled. Adjust the combination of settings until the Unleveled indicator turns off.

2.5.3.6 Generating an Internally Modulated AM Signal

The following procedure explains how to set up the instrument to generate a signal that is amplitude modulated using an internally generated sine wave, triangle wave, square wave, or positive-going ramp as the modulation source.

The following rear-panel input/output connections are available when the instrument is in internal AM mode (refer to "Rear Panel Interface and I/O Connectors" in Chapter 1 for more information):

- *AM OUT (output)* - Produces the internal modulation generator signal at 2 Vp-p.
- *EXT REF IN (input)* - Connect a valid 10 MHz or 100 MHz signal here, to phase lock the instrument to an external frequency reference.
- *10 MHZ OUT (output)* - Produces a 10 MHz reference output signal.
- *V/GHZ (output)* - Produces an output voltage that is proportional to the output frequency.

The procedure follows:

1. Perform steps 1 through 7 of the procedure entitled "Generating a CW Signal" to set the frequency and power level of the carrier.

2. Press the AM button to invoke the AM menus, and if AM Menu 2 does not appear in the display, press the bottom-most interactive softkey until it does.

3. Select the "AM" menu item in AM Menu 2, and use the Step Up or Step Down button to set it to On.

4. Select the "Depth" menu item in AM Menu 2, and enter the desired AM depth setting using either the numeric keypad, Step Up/Step Down buttons, or the rotary knob.

5. Select the “Rate” menu item in AM Menu 2, and enter the desired rate of the internal modulating signal using either the numeric keypad, Step Up/Step Down buttons, or the rotary knob.

6. Select the “Waveform” menu item in AM Menu 2, and select the desired waveshape of the internal modulating signal using the Step Up/Step Down buttons.

7. If the LED indicator that is above the RF ON button is not lit, press the RF ON button to enable the signal at the RF output connector.

   When the signal at the RF output connector is enabled, the LED indicator that is above the RF ON button is blue.

8. Verify that the Unleveled indicator is not lit.

   If the Unleveled indicator is lit, then the combination of output power level, power offset, power slope, and step attenuator mode (if applicable) is set inappropriately, and the RF output is unleveled. Adjust the combination of settings until the Unleveled indicator turns off.

2.5.3.7 Generating a Noise Modulated AM Signal

The following procedure explains how to set up the instrument to generate a signal that is amplitude modulated using an internal Gaussian noise source.

The following rear-panel input/output connections are available when the instrument is using the internal noise source as the modulating signal (refer to “Rear Panel Interface and I/O Connectors” in Chapter 1 for more information):

- *AM OUT (output)* - Produces the internal noise generator signal.
- *EXT REF IN (input)* - Connect a valid 10 MHz or 100 MHz signal here, to phase lock the instrument to an external frequency reference.
- *10 MHZ OUT (output)* - Produces a 10 MHz reference output signal.
- *V/GHZ (output)* - Produces an output voltage that is proportional to the output frequency.

The procedure follows:

1. Perform steps 1 through 7 of the procedure entitled “Generating a CW Signal” to set the frequency and power level of the carrier.

2. Press the AM button to invoke the AM menus, and if AM Menu 3 does not appear in the display, press the bottom-most interactive softkey until it does.

3. Select the “AM” menu item in AM Menu 3, and use the Step Up or Step Down button to set it to On.

4. Select the “Depth” menu item in AM Menu 3, and enter the desired AM depth setting using either the numeric keypad, Step Up/Step Down buttons, or the rotary knob.

5. If the LED indicator that is above the RF ON button is not lit, press the RF ON button to enable the signal at the RF output connector.

When the signal at the RF output connector is enabled, the LED indicator that is above the RF ON button is blue.

6. Verify that the Unleveled indicator is not lit.

   If the Unleveled indicator is lit, then the combination of output power level, power offset, power slope, and step attenuator mode (if applicable) is set inappropriately, and the RF output is unleveled. Adjust the combination of settings until the Unleveled indicator turns off.

2.5.3.8 Generating an Externally Modulated FM Signal

The following procedure explains how to set up the instrument to generate a signal that is frequency modulated using an external modulation source.

The following rear-panel input/output connections are available when the instrument is in external FM mode (refer to “Rear Panel Interface and I/O Connectors” in Chapter 1 for more information):

- *FM/£M IN (input)* - Connect the external modulating signal here.
- *EXT REF IN (input)* - Connect a valid 10 MHz or 100 MHz signal here, to phase lock the instrument to an external frequency reference.
- *10 MHZ OUT (output)* - Produces a 10 MHz reference output signal.
- *V/GHZ (output)* - Produces an output voltage that is proportional to the output frequency.

The procedure follows:

1. Perform steps 1 through 7 of the procedure entitled “Generating a CW Signal” to set the frequency and power level of the carrier.

2. Connect a modulating signal source to the FM/£M IN connector on the rear-panel of the instrument, and set it for the desired modulating characteristics (waveshape, rate, and amplitude).

   An amplitude of 1 Vp produces maximum deviation.

3. Press the FM button to invoke the FM menus, and if FM Menu 1 does not appear in the display, press the bottom-most interactive softkey until it does.

4. Select the “FM” menu item in FM Menu1, and use the Step Up or Step Down button to set it to On.

5. Select the “Mode” menu item in FM Menu 1, and choose the FM mode using the Step Up/Step Down buttons.

   The appropriate FM mode to choose at a given carrier frequency depends on the rate of the modulating signal and the amount of FM deviation required:

   - *If the rate of the modulating signal is between DC and 1 kHz*, Narrow must be chosen as the FM mode.
   - *If the rate of the modulating signal is between 50 kHz and 3 MHz*, Wide must be chosen as the FM mode.

- *If the rate of the modulating signal is between 1 kHz and 50 kHz*, it is possible that either Narrow or Wide can be chosen as the FM mode, depending on the sensitivity setting (set in the next step) that is desired. If either Narrow or Wide can be chosen for the combination of carrier frequency, modulation rate, and deviation that is selected, choose Narrow for more accurate signal specifications.

6. Select the "Sensitivity" menu item in FM Menu 1, and enter the desired FM sensitivity setting using either the numeric keypad, Step Up/Step Down buttons, or the rotary knob.

   The Sensitivity parameter determines the amount of FM deviation that is produced at the RF output per volt of modulating signal input. The settable range is dependent on the carrier frequency setting, as well as the selected FM mode. If the desired Sensitivity setting is not valid for the combination of carrier frequency setting and FM mode, an error message will be displayed at the bottom of the screen.

7. If the LED indicator that is above the RF ON button is not lit, press the RF ON button to enable the signal at the RF output connector.

   When the signal at the RF output connector is enabled, the LED indicator that is above the RF ON button is blue.

8. Verify that the Unleveled indicator is not lit.

   If the Unleveled indicator is lit, then the combination of output power level, power offset, power slope, and step attenuator mode (if applicable) is set inappropriately, and the RF output is unleveled. Adjust the combination of settings until the Unleveled indicator turns off.

2.5.3.9 Generating an Internally Modulated FM Signal

The following procedure explains how to set up the instrument to generate a signal that is frequency modulated using an internally generated sine wave, triangle wave, square wave, or positive-going ramp as the modulation source.

The following rear-panel input/output connections are available when the instrument is in internal FM mode (refer to "Rear Panel Interface and I/O Connectors" in Chapter 1 for more information):

- *FM/₤M OUT (output)* - Produces the internal modulation generator signal at 2 Vp-p.
- *EXT REF IN (input)* - Connect a valid 10 MHz or 100 MHz signal here, to phase lock the instrument to an external frequency reference.
- *10 MHZ OUT (output)* - Produces a 10 MHz reference output signal.
- *V/GHZ (output)* - Produces an output voltage that is proportional to the output frequency.

The procedure follows:

1. Perform steps 1 through 7 of the procedure entitled "Generating a CW Signal" to set the frequency and power level of the carrier.

2. Press the FM button to invoke the FM menus, and if FM Menu 2 does not appear in the display, press the bottom-most interactive softkey until it does.

3. Select the “FM” menu item in FM Menu 2, and use the Step Up or Step Down button to set it to On.

4. Select the “Mode” menu item in FM Menu 2, and use the Step Up/Step Down buttons to set it to Auto.

   When Auto is set as the FM mode, the instrument automatically chooses the appropriate FM mode to use depending on the current combination of carrier frequency, modulation rate, and deviation settings. The mode (Narrow or Wide) that is currently selected by the instrument is shown in parentheses in the parameter area adjacent to the Mode menu item.

5. Select the “Waveform” menu item in FM Menu 2, and select the desired waveshape of the internal modulating signal using the Step Up/Step Down buttons.

6. Select the “Rate” menu item in FM Menu 2, and enter the desired rate of the internal modulating signal using either the numeric keypad, Step Up/Step Down buttons, or the rotary knob.

7. Select the “Deviation” menu item in FM Menu 2, and enter the desired FM deviation setting using either the numeric keypad, Step Up/Step Down buttons, or the rotary knob.

8. If the LED indicator that is above the RF ON button is not lit, press the RF ON button to enable the signal at the RF output connector.

   When the signal at the RF output connector is enabled, the LED indicator that is above the RF ON button is blue.

9. Verify that the Unleveled indicator is not lit.

   If the Unleveled indicator is lit, then the combination of output power level, power offset, power slope, and step attenuator mode (if applicable) is set inappropriately, and the RF output is unleveled. Adjust the combination of settings until the Unleveled indicator turns off.

2.5.3.10 Generating a DC Frequency Modulated Signal

The following procedure explains how to set up the instrument to generate a frequency modulated signal that using an external modulation source.

The following rear-panel input/output connections are available when the instrument is in external FM mode (refer to “Rear Panel Interface and I/O Connectors” in Chapter 1 for more information):

FM/ΦM IN (input) - Connect the external modulating signal here.

The procedure follows:

1. Perform steps 1 through 7 of the procedure entitled “Rear Panel Interface and I/O Connectors” to set the frequency and power level of the carrier.

2. Connect a DC signal source to the FM/ΦM IN connector on the rear-panel of the instrument, and set it for the desired modulating.

A +2 Vpp signal produces maximum deviation of 125 kHz for frequencies of 500 MHz to the maximum frequency of the instrument. For frequencies less than 500 MHz, maximum deviation is limited to the specification in Narrow Mode. See “Frequency Modulation” in Chapter 4.

3. Press the FM button to invoke the FM menus, and if FM Menu 3 does not appear in the display, press the bottom-most interactive soft key until it does.

4. Select the "DC FM" menu item in FM Menu3, and use the Step Up or Step Down button to set it to On. For models with Option 17 (Delete Modulation Suite), FM Menu 3 is the only menu available.

5. Select the "On/Off" menu item in FM Menu 3, and activate DC FM using the Step Up/Step Down buttons. Press the Step Up/Step Down buttons to deactivate DC FM.

6. If the LED indicator that is above the RF ON button is not lit, press the RF ON button to enable the signal at the RF output connector.

   When the signal at the RF output connector is enabled, the LED indicator that is above the RF ON button is blue.

7. Verify that the Unleveled indicator is not lit.

8. If the Unleveled indicator is lit, then the combination of output power level, power offset, power slope, and step attenuator mode (if applicable) is set inappropriately, and the RF output is unleveled. Adjust the combination of settings until the Unleveled indicator turns off.

2.5.3.11 Generating an Externally Pulse Modulated Signal

The following procedure explains how to set up the instrument to generate a signal at the RF output connector that is pulse modulated using an external modulation source.

When this type of pulse modulation is used, the RF output signal is pulsed according to the signal that is applied to the rear-panel PULSE IN/PM TRIG IN connector. Figure 2-22 shows an example of this when the input polarity of the PULSE IN/PM TRIG IN signal is set to active high.

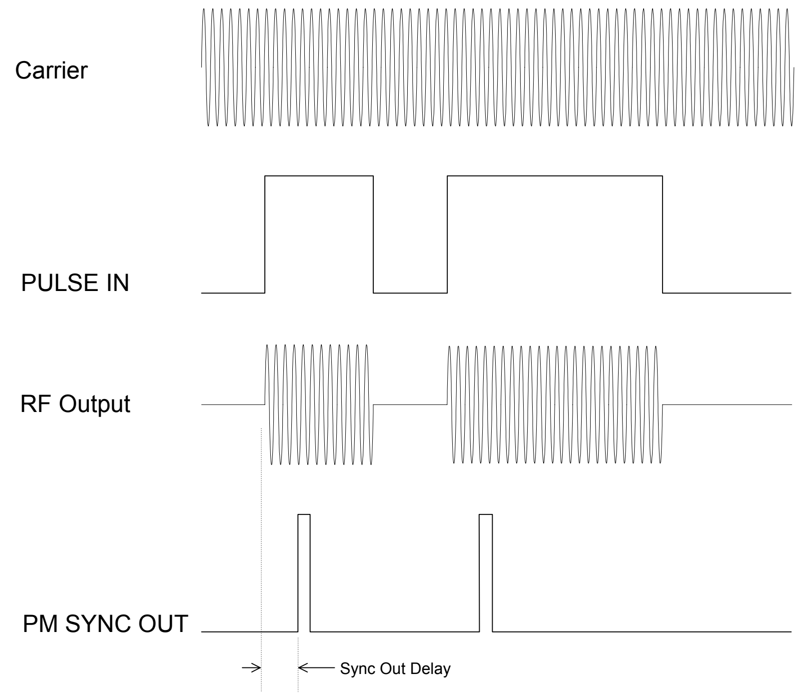

Figure 2-22: External Pulse Modulation

The following rear-panel input/output connections are available when the instrument is in external PM mode (refer to “Rear Panel Interface and I/O Connectors” in Chapter 1 for more information):

- *PULSE IN/PM TRIG IN (input)* - Connect the external modulating signal here.
- *PM SYNC OUT (output)* - Produces a pulse of >75 ns width, TTL level that is delayed relative to the leading edge of the RF output pulse by a time set in this procedure.
- *EXT REF IN (input)* - Connect a valid 10 MHz or 100 MHz signal here, to phase lock the instrument to an external frequency reference.
- *10 MHZ OUT (output)* - Produces a 10 MHz reference output signal.
- *V/GHZ (output)* - Produces an output voltage that is proportional to the output frequency.

The procedure follows:

1. Perform steps 1 through 7 of the procedure entitled “Generating a CW Signal” to set the frequency and power level of the carrier.

2. Connect a TTL pulse source to the PULSE IN/PM TRIG IN connector on the rear-panel of the instrument, and set it for the desired modulating characteristics.

3. Press the PM button to invoke the PM menus, and if PM Menu 1 does not appear in the display, press the bottom-most interactive softkey until it does.

4. Select the “PM” menu item in PM Menu 1, and use the Step Up or Step Down button to set it to On.

5. Select the “Input Polarity” menu item in PM Menu 1, and choose the appropriate polarity setting using the Step Up/Step Down buttons.

   With a setting of Active High, a TTL high level at the PULSE IN/PM TRIG IN connector turns on the carrier at the RF output, and with a setting of Active Low, a TTL high level at the PULSE IN/PM TRIG IN connector turns off the carrier at the RF output.

6. Select the “Sync Out Delay” menu item in PM Menu 1, and enter the desired sync pulse delay setting using either the numeric keypad, Step Up/Step Down buttons, or the rotary knob.

7. If the LED indicator that is above the RF ON button is not lit, press the RF ON button to enable the signal at the RF output connector.

   When the signal at the RF output connector is enabled, the LED indicator that is above the RF ON button is blue.

8. Verify that the Unleveled indicator is not lit.

   If the Unleveled indicator is lit, then the combination of output power level, power offset, power slope, and step attenuator mode (if applicable) is set inappropriately, and the RF output is unleveled. Adjust the combination of settings until the Unleveled indicator turns off.

2.5.3.12 Generating a Continuous Internally Pulse Modulated Signal

The following procedure explains how to set up the instrument to produce a signal at the RF output connector that is pulse modulated using the internal modulation source.

When this type of pulse modulation is used, the RF output signal is pulsed according to the instrument's internal pulse modulation generator. Figure 2-23 shows an example of this.

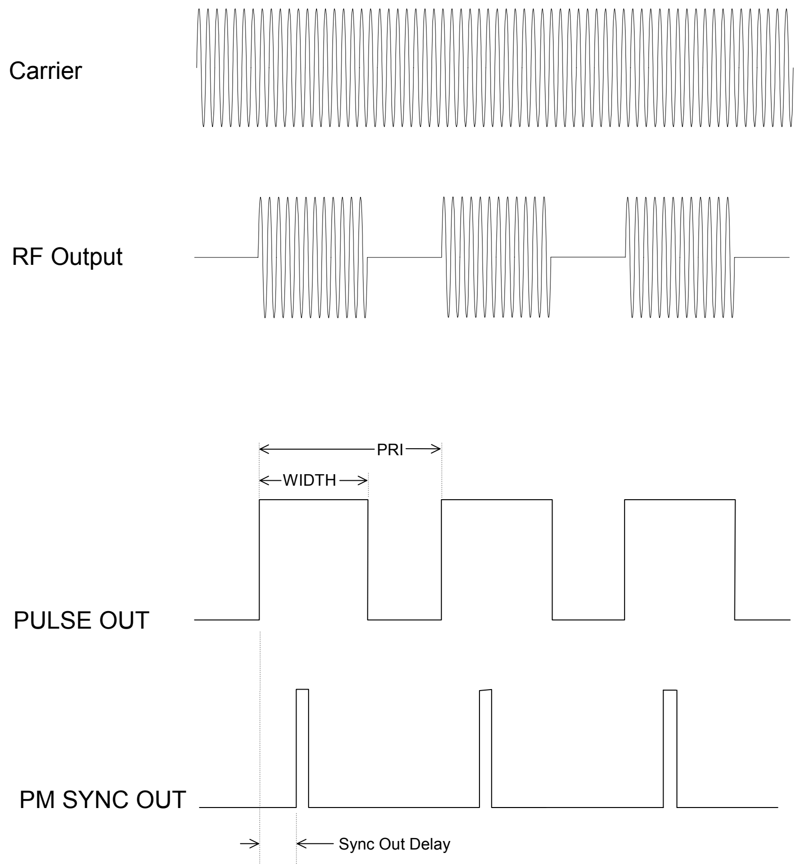

Figure 2-23: Internal Continuous Pulse Modulation

The following rear-panel input/output connections are available when the instrument is in internal continuous PM mode (refer to "Rear Panel Interface and I/O Connectors" in Chapter 1 for more information):

- *PULSE OUT (output)* - Produces a +4V signal that follows the signal at the RF output connector. Note that this signal precedes pulses at the RF output by 50 ns typical.
- *PM SYNC OUT (output)* - Produces a pulse of >75 ns width, TTL level that is delayed relative to the leading edge of the signal at the PULSE OUT connector by a time set in this procedure.
- *EXT REF IN (input)* - Connect a valid 10 MHz or 100 MHz signal here, to phase lock the instrument to an external frequency reference.
- *10 MHZ OUT (output)* - Produces a 10 MHz reference output signal.
- *V/GHZ (output)* - Produces an output voltage that is proportional to the output frequency.

The procedure follows:

1. Perform steps 1 through 7 of the procedure entitled “Generating a CW Signal” to set the frequency and power level of the carrier.

2. Press the PM button to invoke the PM menus, and if PM Menu 2 does not appear in the display, press the bottom-most interactive softkey until it does.

3. Select the “PM” menu item in PM Menu 2, and use the Step Up or Step Down button to set it to On.

4. Select the “PRI” menu item in PM Menu 2, and enter the desired pulse repetition interval setting using either the numeric keypad, Step Up/Step Down buttons, or the rotary knob.

5. Select the “Width” menu item in PM Menu 2, and enter the desired pulse width setting using either the numeric keypad, Step Up/Step Down buttons, or the rotary knob.

6. Select the “Sync Out Delay” menu item in PM Menu 2, and enter the desired sync pulse delay setting using either the numeric keypad, Step Up/Step Down buttons, or the rotary knob.

7. If the LED indicator that is above the RF ON button is not lit, press the RF ON button to enable the signal at the RF output connector.

   When the signal at the RF output connector is enabled, the LED indicator that is above the RF ON button is blue.

8. Verify that the Unleveled indicator is not lit.

   If the Unleveled indicator is lit, then the combination of output power level, power offset, power slope, and step attenuator mode (if applicable) is set inappropriately, and the RF output is unleveled. Adjust the combination of settings until the Unleveled indicator turns off.

2.5.3.13 Generating a Gated Internally Pulse Modulated Signal

The following procedure explains how to set up the instrument to generate a signal that is pulse modulated using the internal modulation source, and gated by an external signal supplied at the PM IN/PM TRIG IN BNC connector on the rear panel.

When this type of pulse modulation is used, internally modulated pulses appear at the RF output connector as long as the gating signal at the PULSE IN/PM TRIG IN connector is at the valid gating level at the leading edge of each output pulse. Figure 2-24 shows an example of this.

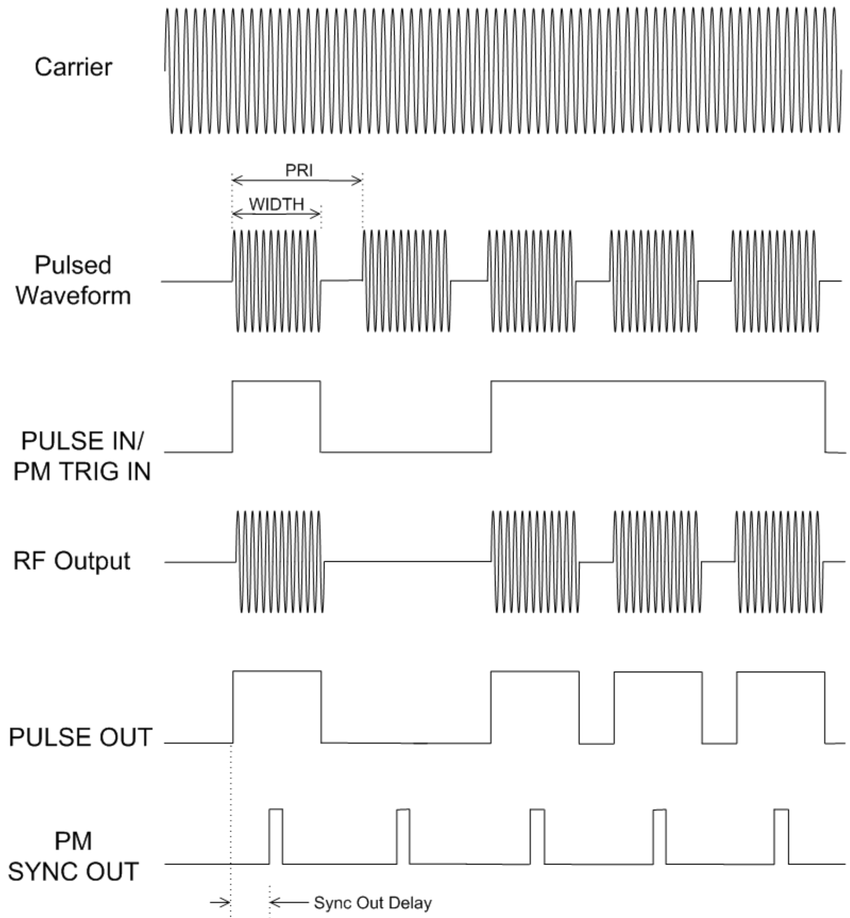

Figure 2-24: Internal Gated Pulse Modulation

NOTE: In internal gated PM mode, synchronization pulses are emitted from the PM SYNC OUT connector regardless of whether or not pulses are present at the RF output connector.

The following rear-panel input/output connections are available when the instrument is in internal gated PM mode (refer to “Rear Panel Interface and I/O Connectors” in Chapter 1 for more information):

- *PULSE IN/PM TRIG IN (input)* - Connect the external gating signal here.
- *PULSE OUT (output)* - Produces a+4V signal that follows the signal at the RF output connector. Note that this signal precedes pulses at the RF output by 50 ns typical.
- *PM SYNC OUT (output)* - Produces pulses of >75 ns width, TTL level that are delayed relative to the leading edges of the pulses of the internally modulated pulse stream by a time set in this procedure.
- *EXT REF IN (input)* - Connect a valid 10 MHz or 100 MHz signal here, to phase lock the instrument to an external frequency reference.
- *10 MHZ OUT (output)* - Produces a 10 MHz reference output signal.
- *V/GHZ (output)* - Produces an output voltage that is proportional to the output frequency.

The procedure follows:

1. Perform steps 1 through 7 of the procedure entitled “Generating a CW Signal” to set the frequency and power level of the carrier.

2. Press the PM button to invoke the PM menus, and if PM Menu 3 does not appear in the display, press the bottom-most interactive softkey until it does.

3. Select the “PM” menu item in PM Menu 3, and use the Step Up or Step Down button to set it to On.

4. Select the “PRI” menu item in PM Menu 3, and enter the desired pulse repetition interval setting using either the numeric keypad, Step Up/Step Down buttons, or the rotary knob.

5. Select the “Width” menu item in PM Menu 3, and enter the desired pulse width setting using either the numeric keypad, Step Up/Step Down buttons, or the rotary knob.

6. Select the “Trigger In” menu item in PM Menu 3, and choose the active gating level using the Step Up/Step Down buttons.

   With a setting of Active High, a TTL high level is used as the gating level for pulses at the RF output, and with a setting of Active Low, a TTL low level is used as the gating level for pulses at the RF output.

7. Select the “Sync Out Delay” menu item in PM Menu 3, and enter the desired sync pulse delay setting using either the numeric keypad, Step Up/Step Down buttons, or the rotary knob.

8. If the LED indicator that is above the RF ON button is not lit, press the RF ON button to enable the signal at the RF output connector.

   When the signal at the RF output connector is enabled, the LED indicator that is above the RF ON button is blue.

9. Verify that the Unleveled indicator is not lit.

   If the Unleveled indicator is lit, then the combination of output power level, power offset, power slope, and step attenuator mode (if applicable) is set inappropriately, and the RF output is unleveled. Adjust the combination of settings until the Unleveled indicator turns off.

2.5.3.14 Generating a Triggered Internally Pulse Modulated Signal

The following procedure explains how to set up the instrument to generate pulses at the RF output connector that have a width characteristic as determined by the internal modulation source, and occur when triggered by an externally supplied TTL triggering signal.

When this type of pulse modulation is used, a pulse having a width as determined by the internal pulse generator will appear after a predetermined delay at the RF output connector whenever a valid trigger at the PULSE IN/PM TRIG IN connector occurs. Figure 2-25 shows an example of this when rising edge pulse triggering is being used.

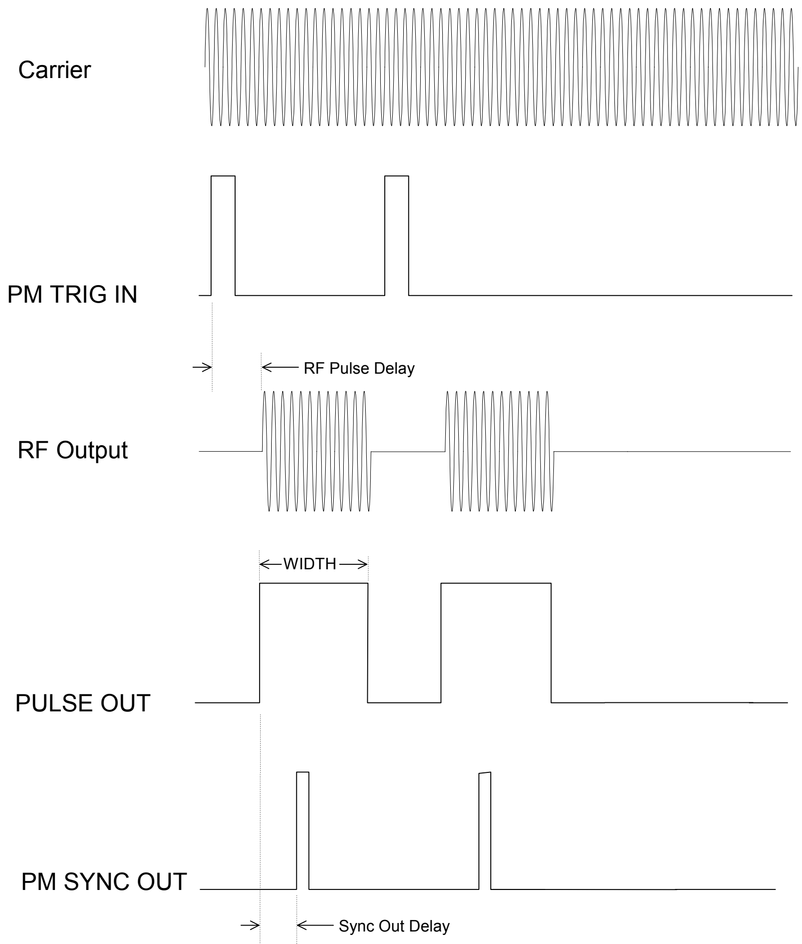

Figure 2-25: Internal Triggered Pulse Modulation

The following rear-panel input/output connections are available when the instrument is in internal triggered PM mode (refer to “Rear Panel Interface and I/O Connectors” in Chapter 1 for more information):

- *PULSE IN/PM TRIG IN (input)* - Connect the external triggering signal here.
- *PULSE OUT (output)* - Produces a +4V signal that follows the signal at the RF output connector. Note that this signal precedes pulses at the RF output by 50 ns typical.
- *PM SYNC OUT (output)* - Produces a pulse of >75 ns width, TTL level that is delayed relative to the leading edge of the signal at the PULSE OUT connector by a time set in this procedure.
- *EXT REF IN (input)* - Connect a valid 10 MHz or 100 MHz signal here, to phase lock the instrument to an external frequency reference.
- *10 MHZ OUT (output)* - Produces a 10 MHz reference output signal.
- *V/GHZ (output)* - Produces an output voltage that is proportional to the output frequency.

The procedure follows:

1. Perform steps 1 through 7 of the procedure entitled “Generating a CW Signal” to set the frequency and power level of the carrier.

2. Press the PM button to invoke the PM menus, and if PM Menu 4 does not appear in the display, press the bottom-most interactive softkey until it does.

3. Select the “PM” menu item in PM Menu 4, and use the Step Up or Step Down button to set it to On.

4. Select the “RF Pulse Delay” menu item in PM Menu 4, and enter the desired RF pulse delay using either the numeric keypad, Step Up/Step Down buttons, or the rotary knob.

5. Select the “Width” menu item in PM Menu 4, and enter the desired pulse width setting using either the numeric keypad, Step Up/Step Down buttons, or the rotary knob.

6. Select the “Trigger Polarity” menu item in PM Menu 4, and choose the active triggering edge using the Step Up/Step Down buttons.

   With a setting of Rising Edge, the rising edge of a TTL signal is used to trigger a pulse at the RF output, and with a setting of Falling Edge, the falling edge of a TTL signal is used to trigger a pulse at the RF output.

7. Select the “Sync Out Delay” menu item in PM Menu 4, and enter the desired sync pulse delay setting using either the numeric keypad, Step Up/Step Down buttons, or the rotary knob.

8. If the LED indicator that is above the RF ON button is not lit, press the RF ON button to enable the signal at the RF output connector.

   When the signal at the RF output connector is enabled, the LED indicator that is above the RF ON button is blue.

9. Verify that the Unleveled indicator is not lit.

   If the Unleveled indicator is lit, then the combination of output power level, power offset, power slope, and step attenuator mode (if applicable) is set inappropriately, and the RF output is unleveled. Adjust the combination of settings until the Unleveled indicator turns off.

2.5.4 Remote Setup

This section explains how to set the instrument's GPIB address and choose its remote language.

2.5.4.1 Setting the GPIB Address

The following procedure explains how to set the GPIB address of the instrument. The instrument is identified on the GPIB bus during remote operations using the GPIB address set in this procedure. Each unit on the GPIB bus must have a unique GPIB address.

1. Press the SYSTEM button to invoke the System menus, and if the SYSTEM 2 menu does not appear in the display, press the bottom-most interactive softkey until it does.

2. Enter the desired GPIB address using either the numeric keypad or Step Up/Step Down buttons.

2.5.4.2 Selecting the Remote Language

The instrument can communicate using one of several different languages when in remote operating mode. Every 2400 Series instrument is capable of communications using the SCPI (Standard Commands for Programmable Instruments) language or the Giga-tronics 12000A native command set, and other optional Command Sets are available.

1. If the instrument is not currently in remote operating mode, press the LOCAL button once to invoke the Language menus in the display. If the instrument currently is in remote operating mode, press the LOCAL button twice - once to take it out of remote operating mode, then again to invoke the Language menus in the display.

2. If the desired language does not appear in the parameter area of the display, press the bottom-most interactive softkey to check the next menu.

3. If the message "Option not installed" appears next to a given language in the menu area of the display, that language is optional and not currently available in the instrument. Contact Giga-tronics customer support to inquire about purchasing additional language options.

4. Once you have located the desired language, press the associated interactive softkey in the display to select it.

2.6 Factory Default Settings

The 2400 factory default settings are shown below.

CW Menu
- Frequency: 10.00 MHz
- Power: 0.00 dBm
- Power Offset: 0.00 dB
- Power Slope: 0.00 dB/GHz
- Phase: -23 Degrees

System 1 Menu
- No registers saved
- Contrast: 8
- Sound: On
- Attenuation: Auto

System 2 Menu
- GPIB Address: 6
- ALC: Internal

Ramp Freq Menu
- Start Frequency: 10.00 MHz
- Stop Frequency: Upper freq limit
- Power: 0.00 dBm
- Sweep Time: 1.00 Sec
- Resolution: 401

Ramp Power Menu
- Start Power: 0.00 dBm
- Stop Power: 10.00 dBm
- Frequency: 10.00 MHz
- Sweep Time: 25 Sec
- Attenuation: 0

AM 1 Menu
- AM: Off
- Sensitivity: 0.00%/V

AM 2 Menu
- AM: Off
- Depth: 0.00%
- Rate: 0.01 Hz
- Waveform: Sine

AM 3 Menu
- AM: Off
- Depth: 0.00%

FM 1 Menu
- FM: Off
- Mode: Narrow
- Sensitivity: 1.953125 Hz/Volt

FM 2 Menu
- FM: Off
- Mode: Auto (Narrow)
- Deviation: 1.953125 Hz
- Rate: 0.01 Hz
- Waveform: Sine

FM 3 Menu
- DC FM: ON/OFF

PM 1 Menu
- PM: Off
- Input Polarity: Active Low

PM 2 Menu
- PM: Off
- PRI: 1.00 Sec
- Width: 10.00 mSec
- Sync Out Delay: 10.00 mSec

PM 3 Menu
- PM: Off
- PRI: 1.00 Sec
- Width: 10.00 mSec
- Sync Out Delay: 10.00 mSec
- Trigger In: Active High

PM 4 Menu
- PM: Off
- RF Pulse Delay: 1.00 Sec
- Width: 10.00 mSec
- Sync Out Delay: 10.00 mSec
- Trigger Polarity: Rising Edge

3 Remote Operation

3.1 Introduction

The 2400B and 2400S Series can be operated from a remote host over the General Purpose Interface Bus (GPIB) or RS-232 interface using the Automation Xpress software and Automation Xpress Interface (AXI) from Gigatronics. For further information, refer to the Automation Xpress online help system.

The instrument can also be programmed using either Standard Commands for Programmable Instruments (SCPI) or Native Language commands.

3.1.1 What is Automation Xpress?

Automation Xpress is an easy to use application development tool for use with 2400 Series instruments. Automation Xpress and the AXI is the preferred method of using the 2400 in remote operation.

Automation Xpress eliminates the need to learn the various GPIB or native language commands. With a click of the mouse, the Automation Xpress Auto-Programming feature automatically records the sequence of your actions and converts those actions into program code. Auto-programming provides the option of seamlessly converting recorded action sequences into generated programs that can be imported into the program environment of your choice, such as Visual C++ or Visual Basic.

The key to reducing the cost of testing is faster frequency switching. The 2400 Series Microwave Synthesizer offers unmatched frequency and power switching in list mode; however, the list mode approach might not be suitable for some remote programming situations. Automation Xpress combined with the Automation Xpress Interface ensures unmatched 2.5 ms CW frequency and power switching performance, providing fast and flexible data exchange rates for faster testing and more device throughput. The transit and execution times for single function calls, such as changing CW frequency, are ten times faster than sending the command via standard message based commands. With Automation Xpress sending large amounts of data such as large lists, the transit and execution times are greater than 100 times faster compared to SCPI. This makes lengthy and repetitive tasks faster and more efficient, maximizing test throughput, while minimizing testing time and system downtime.

Automation Xpress also provides the tools necessary to successfully program the 2400 series. The Xpress Auto-programmer can virtually eliminate the need for training, providing programming scripts and sequences that are guaranteed for accuracy.

3.1.2 Command-Based Interfaces

Automation Xpress and the AXI is the preferred method of using the 2400 in remote operation mode. Synthesizer functions can also be controlled over the GPIB or RS-232 using Standard Commands for Programmable Instruments (SCPI) or Native Language commands. These command-based languages are briefly discussed below.

SCPI. Standard Commands for Programmable Instruments (SCPI) is a language specified by the SCPI Consortium. It is designed to standardize commands and data to and from instruments regardless of the manufacturer. SCPI promotes consistency from the remote programming standpoint between instruments, which are of the same class or have the same functional capability. For a given function such as frequency or power, SCPI specifies the command set that is available for that function.

Native Language (GT12000). The Native syntax is a set of IEEE 488 commands developed for remote control of Giga-tronics instruments.

3.1.3 Computer Interfaces

The following computer interfaces are supported by the 2400.

GPIB. The IEEE 488.2 interface connection (24-pin) between the 2400 Series and host computer equipment for remote operation over GPIB is located on the rear of the unit. The connector pin assignments are listed in Table 3-1 (pin assignments are the same for all 2400 Series models).

Table 3-1: GPIB Connector Pin Assignments

Pin	Signal	Pin	Signal	Pin	Signal
1	D101	9	IFC	17	REN
2	D102	10	SRQ	18	GND (6)
3	D103	11	ATN	19	GND (7)
4	D104	12	Shield	20	GND (8)
5	E0I	13	D105	21	GND (9)
6	DAV	14	D106	22	GND (10)
7	NRFD	15	D107	23	GND (11)
8	NDAC	16	D108	24	GND Logic

RS-232. This 9 pin connector interfaces communications equipment using RS-232 format. See Table 3-2 for the connector pin assignments (pin assignments are the same for all 2400 Series models). Table 3-3 contains the 2400 Series serial interface communication settings.

Table 3-2: RS-232 Connector Pin Assignments

Pin	Function
1	Protective Ground
2	Transmitted Data
3	Received Data
4	Request to Send
5	Clear to Send
6	Data Set Ready
7	Signal Ground
8	Carrier Detect
9	Reserved for Modem Testing

Table 3-3: Communication Settings

Baud Rate	115200
Data Bits	8
Parity	None
Stop Bits	1
Handshake	None

3.2 SCPI Command Set

The SCPI syntax supported by 2400 Series instruments is explained in this section.

NOTE: For information on Automation Xpress and the Automation Xpress Interface, which is the preferred method of using the 2400 in remote operation mode, refer to the paragraph entitled "What is Automation Xpress?" in this chapter.

3.2.1 SCPI Command Format

SCPI conformance requires adherence to a strict syntax structure. The typographic conventions employed in the tables within each of the subsystem descriptions under "SCPI Command Subsystems", below, are summarized in this section.

Case Sensitivity. SCPI commands are not case-sensitive and can be entered in either uppercase or lowercase characters.

Abbreviating Commands. SCPI commands can be abbreviated as follows:

- Letters noted in upper case in the Command Syntax in the following sections are required.
- If entering more than the required letters, enter the entire command. For example, if the command syntax is shown as INITiate, either INIT, init, INITIATE, or initiate can be used, but such character combinations as INITI and initiat are invalid.

Optional Commands. If the syntax shows a portion of a SCPI command in square brackets, that portion is an implied command which can be omitted. An implied command is the default command among the commands available at its level. For example, in the case of the command INITiate:[IMMediate], the immediate mode is the default mode, therefore, entering INIT has the same effect as entering INIT:IMM.

NOTE: The square brackets themselves are not actually part of the command, hence, they should be omitted even if the optional command is entered.

Queries. Most SCPI commands have an accompanying query form that can be sent in order to cause the instrument to return the current state of the parameter setting. For example, the query form of the TRIGger:SOURce BUS|EXTernal command is TRIGger:SOURce?

Some SCPI commands are events that cause something to happen at a particular time but do not create a setting or value to be checked afterwards. Consequently, they have no query form.

3.2.2 SCPI Command Subsystems

SCPI commands are divided into subsystems. The following subsystems are used in the 2400:

3.2.2.1 Output Subsystem

Table 3-4: Output Subsystem SCPI Commands

Command Syntax	Description
OUTPut[:STATe] ON|OFF|1|0	Turns the signal at the RF OUT connector on and off
OUTPut[:STATe]?	Queries the RF OUTPUT state. The return value is as follows: 1 The signal at the RF OUT connector is currently on. 0 The signal at the RF OUT connector is currently off.

3.2.2.2 Source Subsystem - CW Mode

All commands in the Source subsystem begin with [SOURce], however, [SOURce] is the default command, therefore it is optional.

Table 3-5: Source Subsystem - CW Mode SCPI Commands

Command Syntax	Description
[SOURce]:FREQuency[:CW|:FIXed] <freq> [HZ │ KHZ │ MHZ │ GHZ]	Sets CW frequency to the value specified by <freq>. The units are assumed to be Hz if no units designator is supplied.
[SOURce]:FREQuency[:CW|:FIXed]?	Queries the current CW frequency. The value returned is in Hz.
[SOURce]:MODE CW|FIXed|LIST|FSWEep |PSWEep	Sets the operational mode of the synthesizer. CW or FIXed is used to set the source to output a non-swept signal. LIST is used to set the source to use LIST mode. FSWEep is used to set the source to frequency sweep. PSWEep is used to set the source to power sweep.
[SOURce]:MODE?	Queries the current operating mode of the instrument.
[SOURce:]PHASe:[ADJust:] n (RADians|DEGrees)	Sets the relative phase of the output signal. The default units are in radians where the range is -2 *pi* ≥ n ≤ +2 *pi*. The command also accepts phase offsets in degrees where the range is -360° ≥ n ≤ +360°. Radians are the default units if no units are specified. Changing frequency automatically resets the phase offset to zero.
[SOURce]:POWer:ALC:SOURce INTernal |DIODe|PMETer|DPOSitive	Selects the source of the feedback signal for the ALC. The DIODe parameter assumes a negative crystal detector is used. DPOSitive allows for the use of a positive crystal detector.
[SOURce]:POWer:ATTenuation:AUTO ON|OFF	Sets the Attenuator to Auto (ON) or Manual (OFF).
[SOURce]:POWer:ATTenuation 0|10|20|30|40|50|60|70|80|90	Sets the Attenuator to the specified fixed (manual) value.
[SOURce]:POWer:ATTenuation?	Queries the Attenuator setting.
[SOURce]:POWer:[:LEVel:][IMMediate:] [AMPLitude:] d (DM │ DBM │ dBV)|MAXimum|MINimum	Sets the CW power level to the value specified by <level>. The units are defined as DM, DBM, or dBV.
[SOURce]:POWer:[:LEVel|:IMMediate|:AMPLitude]?	Queries the CW power level The value returned is in dBm.

Table 3-5: Source Subsystem - CW Mode SCPI Commands

Command Syntax	Description
[SOURce]:ROSCillator:SOURce?	Queries the source of the reference oscillator. The return value is as follows: INT The internal oscillator is being used as the reference. EXT A signal at the EXT REF IN connector is being used as the reference.

3.2.2.3 Source Subsystem - Correction

All commands in the Source subsystem begin with [SOURce], however, [SOURce] is the default command, therefore it is optional.

Table 3-6: Source Subsystem - Correction SCPI Commands

Command Syntax	Description
[SOURce]:CORRection:LOSS <offset> [DB]	Sets the power offset to the value specified by <offset>. The units are dB.
[SOURce]:CORRection:LOSS?	Queries the power offset. The value returned is in dB.
[SOURce]:CORRection:SLOPe <slope>	Sets the power slope to the value specified by <slope>. The units are dB/GHz.
[SOURce]:CORRection:SLOPe?	Queries the power slope. The value returned is in dB/GHz

3.2.2.4 Source Subsystem - List Mode

All commands in the Source subsystem begin with [SOURce], however, [SOURce] is the default command, therefore it is optional.

Table 3-7: Source Subsystem - List Mode SCPI Commands

Command Syntax	Description
[SOURce]:LIST:DIRection UP|DOWN	Sets the direction of a list when it is run. If UP is set, the list will run from start to end. If DOWN is set, the list will run from end to start. The default is UP.
[SOURce]:LIST:DIRection?	Queries the currently set list run direction. The return value is as follows: UP The list is set to run from start to end. DOWN The list is set to run from end to start.
[SOURce]:LIST:DWELl <t1>,<t2>,……,<tn>	Specifies the dwell point times (<t1>,<t2>,……,<t*n*>) of the list set, the dwell point times are delimited by commas. The 2400 list dwell setting is global for all list points. The first dwell time parameter applies to all subsequent points. Setting additional dwell times is optional. The units are seconds.
[SOURce]:LIST:DWELl:POINts?	Queries the number of points in the dwell time list.
[SOURce]:LIST:FREQuency <f1>,<f2>,<f3>,……,<fn>	Specifies the frequency points (<f1>,<f2>,<f3>,……,<f*n*>) of the list set. The frequency points are delimited by commas.
[SOURce]:LIST:FREQuency:POINts?	Queries the number of points currently in the frequency list.

Table 3-7: Source Subsystem - List Mode SCPI Commands

Command Syntax	Description
[SOURce]:LIST:POWer <p1>,<p2>,<p3>,……,<pn>	Specifies the power points (<p1>,<p2>,<p3>,……,<p*n*>) of the list set. The power points are delimited by commas.
[SOURce]:LIST:POWer:POINts?	Returns the number of points currently in the power list
[SOURce]:LIST:PRECompute	Converts (pre-computes) the source data of the list saved in NVRAM into object format, which is directly readable by the hardware. *Note:* In firmware releases less than version 2.82, the syntax for this command is `[SOURce]:LIST:PRECompute?` (the query form).
[SOURce]:LIST:REPeat SWEEp|STEP|CONTinuous	Sets the repeat mode for the current list. The choices are as follows: SWEEp Upon triggering, the entire list is executed from the beginning, then execution stops. STEP Upon triggering, the current list point is executed, then execution stops. The next trigger executes the next point in the list. The list's first point is considered to be the initial current point, and the point following the list's final point. CONTinuous The entire list repeats indefinitely.
[SOURce]:LIST:REPeat?	Queries the repeat mode of the current list
[SOURce]:LIST:SEQuence <m1>,<m2>,<m3>,…..,<mn>	Defines a sequence for stepping through the existing list when [SOURce]:LIST:SEQuence:AUTO is set to OFF. The points specified in this command (<m1>,<m2>,<m3>,…..,<mn>) are indexes into a new sub-list, and only points in this sub-list will be triggered. For example, if one of the indexes defined with this command is 3, then the third point in the frequency, dwell, and power lists will be sequenced.
[SOURce]:LIST:SEQuence:POINts?	Queries the number of points in the sequence list
[SOURce]:LIST:SEQuence:AUTO ON|OFF	Sets list sequence AUTO mode. The choices are as follows: ON The list sequence set with the [SOURce]:LIST:SEQuence command will not take effect, so all list points will run when triggered. OFF The list will run only the points set with the [SOURce]:LIST:SEQuence command. The default is ON. **Note:** This command is also used to change the 2400 mode from CW or Ramp to List mode. Example: LIST: SEQ: AUTO ON switches to List Mode
[SOURce]:LIST:SYNC <sync>	Sets sync out option to <sync>. The sync out option determines how a pulse is emitted from the SYNC OUT connector during List operation. The choices are as follows: 0 No pulses are emitted from the SYNC OUT connector during List operation. 1 A pulse is emitted from the SYNC OUT connector when the first list point is executed. 2 A pulse is emitted from the SYNC OUT connector when the last list point is executed. 3 A pulse is emitted from the SYNC OUT connector when each point in the list is executed.

3.2.2.5 Status Subsystem

Table 3-8: Status Subsystem SCPI Commands

Command Syntax	Description
STATus:QUEStionable:CONDition?	Returns the value of the Questionable Status Condition Register. The value returned is a decimal value representing the current state of the register.
STATus:QUEStionable:ENABle <ques>	Sets the Questionable Status Enable Register. Range of <ques> is 0 - 65535

3.2.2.6 System Subsystem

Table 3-9: System Subsystem SCPI Commands

Command Syntax	Description
SYSTem:COMMunicate:GPIB[:SELF]:ADDRess <address>|MAXimum|MINimum	Sets the instrument's GPIB address. The choices are as follows: <address> Any integer between 1 and 30. MAXimum Sets the GPIB address to 30. MINimum Sets the GPIB address to 1.
SYSTem:COMMunicate:GPIB[:SELF]:ADDRess?	Queries the instrument's GPIB address.
SYSTem:COMMunicate:SERial:BAUD <rate>	Sets the RS-232 interface baud rate. The supported values for <rate> are 9600, 19200, 38400, and 115200.
SYSTem:COMMunicate:SERial:BAUD?	Queries the current RS-232 interface baud rate.
SYSTem:COMMunicate:SERial:BITS <bits>	Sets the number of RS-232 interface data bits. The supported values for <bits> are 7 and 8.
SYSTem:COMMunicate:SERial:BITS?	Queries the number of RS-232 interface data bits.
SYSTem:COMMunicate:SERial:PARity[:TYPE] EVEN | ODD | NONE	Sets the RS-232 interface parity type. The choices are as follows: EVEN Selects even parity. ODD Selects odd parity. NONE Parity is not used.
SYSTem:COMMunicate:SERial:PARity?	Queries the RS-232 interface parity setting.
SYSTem:COMMunicate:SERial:SBITS <sbits>	Sets the number of RS-232 interface stop bits. The supported values for <sbits> are 1 and 2.
SYSTem:COMMunicate:SERial:SBITS?	Queries the number of RS-232 interface stop bits.
SYSTem:ERRor[:NEXT]?	Queries the next error in the instrument's error/event queue. If the error/event queue is empty, "0, No Error" is returned. See the paragraph entitled "2400 Error Messages" in Appendix B for a summary of available error messages
SYSTem:LANGuage NATive	Switches from the SCPI command set to the native (GT12000) command set.
SYSTem:LANGuage:NATive <native_cmd>	Issues the native (GT12000) syntax command specified by <native_cmd> from within SCPI without leaving the SCPI syntax.
SYSTem:PRESet	Sets device-specific functions to a known state that is independent of the past-use history of the device. The command does not reset any part of the status reporting system. (Same as the *RST command.)

Table 3-9: System Subsystem SCPI Commands

Command Syntax	Description
SYSTem:VERSion?	Queries the SCPI version to which the instrument applies. The response is in the form *YYYY.V* where *YYYY* is the year-version and *V* is the revision number within that year.

3.2.2.7 Trigger Subsystem

Table 3-10: Trigger Subsystem SCPI Commands

Command Syntax	Description
TRIGger[:IMMediate]	Initiates an immediate sweep cycle in List mode. If Repeat Type is set to either single step or single sweep, then the sweep returns to IDLE when complete. (Same as a *TRG, that is a single instrument trigger, as opposed to a GroupExecuteTrigger.)
TRIGger:SOURce BUS|EXTernal	Selects the trigger source for List mode. The sources are: BUS Sets the trigger source to GPIB/GET. EXTernal Sets the trigger source to BNC. (Trigger commands do not function when TRIGger:SOURce is set to EXT).
TRIGger:SOURce?	Queries the trigger source for List mode. The return value is as follows: BUS The trigger source is set to GPIB/GET. EXTernal The trigger source is set to BNC. If not set, NOT IN SWEEP MODE is returned.

3.2.2.8 Source Subsystem - Ramp Sweep

All commands in the Source subsystem begin with [SOURce], however, [SOURce] is the default command, therefore it is optional.

Table 3-11: Source Subsystem - Ramp Sweep SCPI Commands

Command Syntax	Description
[SOURce]:FREQuency:STARt <f_start> [HZ | KHZ | MHZ | GHZ]	Sets the ramp start frequency to the value specified by <f_start>. Hertz is assumed as the units if no units is specified. The start frequency must be set less than the stop frequency. If this rule is violated, the start and stop frequencies are set to the same value.
[SOURce]:FREQuency:STARt?	Queries the ramp start frequency. The return value is in Hertz.
[SOURce]:FREQuency:STOP <f_stop> [HZ | KHZ | MHZ | GHZ]	Sets the ramp stop frequency to the value specified by <f_stop>. Hertz is assumed as the units if no units is specified. The start frequency must be set less than the stop frequency. If this rule is violated, the start and stop frequencies are set to the same value.
[SOURce]:FREQuency:STOP?	Queries the ramp stop frequency. The return value is in Hertz.
[SOURce]:SWEep: TIME <time>	Sets the sweep time for ramp sweep to the value specified by <time>. The units are seconds.
[SOURce]:SWEep:TIME?	Queries the sweep time for ramp sweep. The return value is in seconds.

Table 3-11: Source Subsystem - Ramp Sweep SCPI Commands

<table>
<tr><th>Command Syntax</th><th>Description</th></tr>
<tr><td>[SOURce]:POWer:STARt d (DM │ DBM │ dBV)</td><td>Sets the ramp sweep start power level. The assumed units are defined as DM, DBM, or dBV.</td></tr>
<tr><td>[SOURce]:POWer:STARt?</td><td>Queries the ramp start power. The return value is in dBm.</td></tr>
<tr><td>[SOURce]:POWer:STOP d (DM │ DBM │ dBV)</td><td>Sets the ramp sweep stop power level. The assumed units are defined as DM, DBM, or dBV.</td></tr>
<tr><td>[SOURce]:POWer:STOP?</td><td>Queries the ramp stop power. The return value is in dBm.</td></tr>
</table>

3.2.2.9 Source Subsystem- Modulation

All commands in the Source subsystem begin with [SOURce], however, [SOURce] is the default command, therefore it is optional.

Table 3-12: Source Subsystem - Modulation SCPI Commands

<table>
<tr><th>Command Syntax</th><th>Description</th></tr>
<tr><td>[SOURce]:AM:DEPTh <am_depth></td><td>Sets the internal amplitude modulation depth to a percentage value as specified by <am_depth>.</td></tr>
<tr><td>[SOURce]:AM:DEPTh?</td><td>Queries the internal amplitude modulation depth. The return value is in percent.</td></tr>
<tr><td>[SOURce]:AM:INTernal:FREQuency <am_freq> [HZ | KHZ | MHZ | GHZ]</td><td>Sets the rate of the internal amplitude modulation generator to the value specified by <am_feq> (requires Option 24). Hertz is assumed if no units is specified.</td></tr>
<tr><td>[SOURce]:AM:INTernal:FREQuency?</td><td>Queries the rate of the internal amplitude modulation generator. The return value is in Hertz (requires Option 24).</td></tr>
<tr><td>[SOURce]:AM:INTernal:FUNCtion:SHAPe OFF|SINE|SQUare|TRIangle|PRaMP|NOISe</td><td>Sets the shape of the internal amplitude modulation generator waveform (requires Option 24). The choices are as follows:

OFF Turns the internal amplitude modulation generator off.
SINE Sets the internal amplitude modulation generator waveform to sine wave.
SQUare Sets the internal amplitude modulation generator waveform to square wave.
TRIangle Sets the internal amplitude modulation generator waveform to triangle wave.
PRaMP Sets the internal amplitude modulation generator waveform to a positive-going ramp.
NOIse Selects the internal noise generator as the amplitude modulation generator.</td></tr>
<tr><td>[SOURce]:AM:INTernal:FUNCtion:SHAPe?</td><td>Queries the shape of the internal amplitude modulation generator waveform (requires Option 24).

Returns: "Off", "Sine", "Square", "Triangle", "Pos Ramp", or "Noise".</td></tr>
<tr><td>[SOURce]:AM:SCALing <am_scaling></td><td>Sets the external amplitude modulation scaling to a percentage per volt value as specified by <am_scaling>.</td></tr>
<tr><td>[SOURce]:AM:SCALing?</td><td>Queries the external amplitude modulation scaling. Return value is a percentage per volt.</td></tr>
<tr><td>[SOURce]:AM:SOURce INTernal|EXTernal</td><td>Sets the amplitude modulation source. The choices are as follows:

INTernal Sets the internal AM generator as the AM source.
EXTernal Selects external AM. The modulation source in this case is the signal applied at the rear-panel AM IN connector.</td></tr>
</table>

Table 3-12: Source Subsystem - Modulation SCPI Commands

<table>
<tr><th>Command Syntax</th><th>Description</th></tr>
<tr><td>[SOURce]:AM:SOURce?</td><td>Queries the amplitude modulation source. Returns "INTernal" or "EXTernal"</td></tr>
<tr><td>[SOURce]:AM:STATe ON|OFF|1|0</td><td>Sets amplitude modulation mode on or off. The choices are as follows:

1|ON Sets AM mode to on.
0|OFF Sets AM mode to off.</td></tr>
<tr><td>[SOURce]:AM:STATe?</td><td>Queries the state of amplitude modulation mode. The return value is as follows:

1 AM mode is currently on.
0 AM mode is currently off.</td></tr>
<tr><td>[SOURce]:FM:BANDwidth NARRow|WIDE</td><td>Sets the Frequency Modulation bandwidth. The choices are as follows:

NARRow Selects narrow FM bandwidth.
WIDE Selects wide FM bandwidth.</td></tr>
<tr><td>[SOURce]:FM:BANDwidth?</td><td>Queries the Frequency Modulation bandwidth. Returns "Narrow" or "Wide".</td></tr>
<tr><td>[SOURce]:FM[:DEViation] <fm_dev> [HZ | KHZ | MHZ | GHZ]</td><td>Sets the internal Frequency Modulation deviation to the value specified by <fm_dev> (requires Option 24). Hertz is assumed for the units if no units is specified.</td></tr>
<tr><td>[SOURce]:FM[:DEViation]?</td><td>Queries the internal Frequency Modulation deviation that is currently set. The return value is in Hertz (requires Option 24).</td></tr>
<tr><td>[SOURce]:FM:INTernal:FREQuency <fm_freq> [HZ | KHZ | MHZ | GHZ]</td><td>Sets the rate of the internal Frequency Modulation generator to the value specified by <fm_freq> (requires Option 24). Hertz is assumed for the units if no units is specified.</td></tr>
<tr><td>[SOURce]:FM:INTernal:FREQuency?</td><td>Queries the current rate of the internal Frequency Modulation generator. The return value is in Hertz (requires Option 24).</td></tr>
<tr><td>[SOURce]:FM:INTernal:FUNCtion:SHAPe OFF|SINE|SQUare|TRIangle|PRaMP</td><td>Sets the shape of the internal frequency modulation generator waveform (requires Option 24). The choices are as follows:

OFF Turns the internal frequency modulation generator off.
SINE Sets the internal frequency modulation generator waveform to sine wave.
SQUare Sets the internal frequency modulation generator waveform to square wave.
TRIangle Sets the internal frequency modulation generator waveform to triangle wave.
PRaMP Sets the internal frequency modulation generator waveform to a positive-going ramp.</td></tr>
<tr><td>[SOURce]:FM:INTernal:FUNCtion:SHAPe?</td><td>Queries the shape of the internal frequency modulation generator waveform (requires Option 24).

Returns: "Off", "Sine", "Square", "Triangle", or "Pos Ramp".</td></tr>
<tr><td>[SOURce]:FM:SENSitivity <fm_sens></td><td>Sets the Frequency Modulation external sensitivity to the value specified by <fm_sens>. The value is in Hertz per volt.</td></tr>
<tr><td>[SOURce]:FM:SENSitivity?</td><td>Queries the Frequency Modulation external sensitivity. The return value is in Hertz per volt.</td></tr>
<tr><td>[SOURce]:FM:SOURce EXTernal|INTernal|DC</td><td>Sets the frequency modulation source. The choices are as follows:

INTernal Sets the internal FM generator as the FM source.
EXTernal Selects external FM. The modulation source in this case is the signal applied at the rear-panel FM/ΦM IN connector.
DC Maximum deviaiton for DC mode is 125 kHz for –1 volt external input from 500 MHz to maximum frequency of the instrument.</td></tr>
</table>

Table 3-12: Source Subsystem - Modulation SCPI Commands

Command Syntax	Description
[SOURce]:FM:SOURce?	Queries the frequency modulation source. Returns either "Internal" or "External".
[SOURce]:FM:STATe ON|OFF|1|0	Sets the frequency modulation mode on or off. The choices are as follows: 1|ON Sets FM mode to on. 0|OFF Sets FM mode to off.
[SOURce]:FM:STATe?	Queries the frequency modulation mode. The return value is as follows: 1 FM mode is currently on. 0 FM mode is currently off.
[SOURce]:PULM:EXTernal:POLarity NORMal|INVerted	Determines the polarity of the signal at the PULSE IN connector that produces an RF output during pulse modulation. The choices are as follows: NORMal RF at the RF OUT connector will be on when the signal at the PULSE IN connector is at a TTL high. INVerted RF at the RF OUT connector will be on when the signal at the PULSE IN connector is at a TTL low.
[SOURce]:PULM:EXTernal: POLarity?	Queries the pulse modulation polarity. Returns either "NORMal" or "INVerted".
[SOURce]:PULM:SOURce EXTernal:INTernal	Set the pulse modulation source. The choices are as follows: INTernal Sets the internal PM generator as the PM source. EXTernal Selects external PM. The modulation source in this case is the signal applied at the rear-panel PULSE IN connector.
[SOURce]:PULM:SOURce?	Queries the source of pulse modulation. Returns: either "INTernal", or "EXTernal".
[SOURCe:]PULM:STATe ON|OFF|1|0	Sets the pulse modulation mode on or off. The choices are as follows: 1|ON Sets Pulse mode to on. 0|OFF Sets Pulse mode to off.
[SOURce]:PULSe:DELay <pm_delay> (S|MS|US)	Sets the delay of the internal pulse modulation generator waveform to the value specified by <pm_delay> (requires Option 24).
[SOURce]:PULSe:DELay?	Queries the delay of the internal pulse modulation generator waveform (requires Option 24). The return value is in seconds.
[SOURce]:PULSe:FREQuency <pm_freq> [HZ | KHZ | MHZ | GHZ]	Sets the internal pulse modulation rate to the value specified by <pm_freq> (requires Option 24). Hertz is assumed if no units is supplied.
[SOURce]:PULSe:FREQuency?	Queries the internal pulse modulation rate (requires Option 24). The return value is in Hertz.
[SOURce]:PULSe:MODE OFF | TRiGered | CONTinuous | GATEd	Sets the internal pulse modulation mode (requires Option 24). The choices are as follows: OFF Turns internal pulse modulation mode off. TRIGgered Sets the instrument to produce a single internally generated RF output pulse when a valid trigger signal is received at the PM TRIG IN connector. CONTinuous Sets the instrument to produce an internally generated pulse modulated RF output signal continuously. GATEd Sets the instrument to produce an internally generated pulse modulated RF output signal for the duration of the externally provided gate signal at the PM TRIG IN connector.

Table 3-12: Source Subsystem - Modulation SCPI Commands

Command Syntax	Description
[SOURce]:PULSe:PERiod <pm_per>	Sets the period of the internal pulse modulation generator to the value specified by <pm_per>. (Requires Option 24). The default units are in Hertz unless otherwise specified.
[SOURce]:PULSe:SYNC <pm_sync>	Sets the delay of the pulse modulation sync signal. The delay range of the Pulse Sync Output function is 100 nSec. to 10 mSec. (Requires Option 24) The default units are in Hertz unless otherwise specified.
[SOURce]:PULSe:WIDTh <pm_width> (S|MS|US)	Sets the internal pulse modulation width to the value specified by <pm_width> (requires Option 24).
[SOURce]:PULSe:WIDTh?	Queries the internal pulse modulation width. The return value is in seconds. (requires Option 24).

3.3 IEEE 488.2 Common Commands

The commands and queries in the following table are defined by IEEE 488.2. IEEE 488.2 defines how the instrument should respond to the following common commands and queries. These commands are independent of the SCPI and GT-12000 native command sets.

Table 3-13: IEEE 488.2 Common Commands

Command	Name	Description
*CLS	Clear Status	Clears the event registers in all status groups. It also clears the Event Status Register and the Error/Event Queue
*ESE <ese>	Standard Event Status Enable	Sets the Standard Event Status Enable Register. A service request is issued whenever the specified event has occurred Range of <ese>: 0 - 255
*ESE?	Standard Event Status Enable	Returns the value of the Standard Event Status Enable Register. The value returned is a decimal value representing the current state of the Standard Event Status Enable Register
*ESR?	Standard Event Status Register	Returns the value of the Standard Event Status Register. The value returned is a decimal value representing the current state of the Standard Event Status Register
*IDN?	Identification	Returns the instrument identification
*OPC	Operation Complete	Causes the Operation Complete bit (that is, Bit 0 of the Standard Event Status Register) to be set to 1 when all pending selected device operations have been finished
*OPC?	Operation Complete	Places an ASCII character 1 into the device's output queue when all pending selected device operations have been finished. Unlike the *OPC command, the *OPC? query does not affect the OPC Event bit in the Standard Event Status Register (ESR)
*RST	Reset	Sets the device-specific functions to a known state that is independent of the past-use history of the device. The command does not reset any part of the status reporting system
*SRE <sre>	Service Request Enable	Sets and enables the value of the Service Request Enable Register Range of <sre>: 0 to 255
*SRE?	Service Request Enable	Returns the value set by the *SRE command for the Service Request Enable Register
*STB?	Read Status Byte	Returns the value of the current state of the Status Byte
*TST?	Self-Test	Self-Test Query. It returns '0' if the test succeeds, and '1' if the test fails The test sets a predefined group of CW frequencies and power levels. After each frequency and power is set, the firmware reads the instrument's LOCK/LEVEL status. If failing the lock/level, the test is failed. In order to avoid damage to the device the 2400 is connected to, maximum attenuation is set if it is available, or the power level is set to minimum for the duration of the test. The system will be restored to the pre-test condition upon completion
*WAI	Wait-to-Continue	Causes the synthesizer to complete all pending tasks before executing any additional commands

3.4 2400 Specific Commands

The commands in the following table are specific to the 2400 Series of instruments, and are independent of the SCPI and GT-12000 native command sets.

Table 3-14: 2400 Specific Commands

Command	Name	Description
*RCL <reg>	Recall Instrument State	Recalls a previously saved instrument state from memory Range of <reg>: 0 - 9
*SAV <reg>	Save Instrument State	Saves the current instrument state to memory Range of <reg>: 0 - 9
*TRG	Trigger Device	Triggers the synthesizer if BUS is the specified trigger source (see “TRIGger:SOURce BUS|EXTernal” on page 99).
/SCPI	SCPI	Changes command syntax to SCPI
/NATive	Giga-tronics Native	Change command syntax to GT-12000 "native"

3.5 Status Register System

The Status Register System provides information regarding the state of the 2400 during remote operation. Several status registers can be queried to provide specific information regarding the state of the instrument or the status of events relating to its operation. These registers can be queried directly or can be configured to initiate a service request whenever an expected condition has occurred. One or more conditions can be monitored at one time by the 2400.

Figure 3-1 shows the interrelationship between the registers that constitute the 2400 Status Register System.

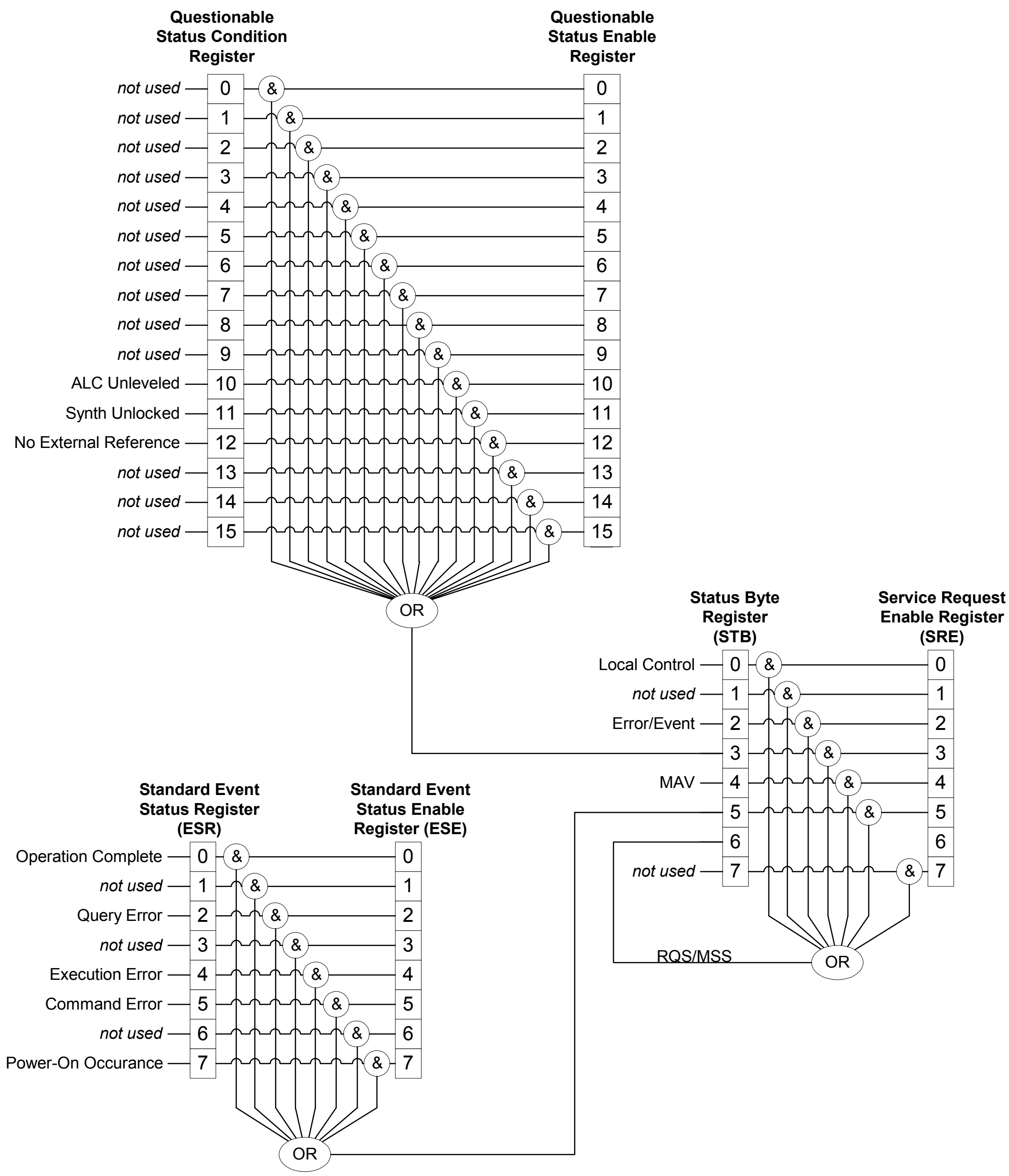

Figure 3-1: Status Register System

The following paragraphs briefly describe the registers:

3.5.1 Status Byte (STB) and Service Request Enable (SRE) Registers

The Status Byte Register is the primary status register. It is the top-level register used to track changes in the state of the 2400. The summary bits of lower-level status registers become set in the Status Byte Register when certain conditions occur that are being monitored by and have been enabled in those lower-level registers. The *STB? query can be used to read the contents of the Status Byte Register.

The Service Request Enable Register controls which bits in the Status Byte Register can generate a service request. The bits in the Service Request Enable Register are logically ANDed with the equivalent bits in the Status Byte Register, and the results of those AND operations are logically ORed to produce a service request. The RQS/MSS bit (bit 6) in the Status Byte Register is set when the logic OR operation produces a service request. The *SRE command can be used to set the contents of the Service Request Enable Register, and the *SRE? query can be used to read the contents of the Service Request Enable Register.

The following describes each bit in the Status Byte Register:

7	6	5	4	3	2	1	0
Not used	RQS/MSS	ESB	MAV	QUES Status	Error/ Event	Not Used	Local Control

0 Local Control. This bit is set whenever the Local button is pressed while the source is in remote operation

1 Not used. Always 0.

2 Error/Event. This bit is set whenever a SCPI error has occurred.

3 QUES Status (Questionable Status). This bit is set whenever a condition defined in the questionable status register has occurred. See the section entitled “Questionable Status Condition and Enable Registers”, below, for details.

4 MAV. Message Available. This bit is set whenever a message is available.

5 ESB. Standard Event Status Register. This bit is set whenever a condition defined in the Standard Event Status Register has occurred. See the section entitled “Standard Event Status (ESR) and Standard Event Status Enable (ESE) Registers”, below, for details.

6 RQS/MSS. Interrupt Request. This bit is set whenever an event identified by the service request mask has occurred.

7 Not used. Always 0.

3.5.2 Standard Event Status (ESR) and Standard Event Status Enable (ESE) Registers

The Standard Event Status Register is one of the lower-level status registers. It monitors certain common instrument status conditions. When a condition occurs that is being monitored by this register, *and* that condition has been enabled by the Standard Event Status Enable Register, bit 5 is set in the Status Byte Register. The *ESR? query can be used to read the contents of the Standard Event Status Register.

The Standard Event Status Enable Register controls which bits in the Standard Event Status Register can set bit 5 of the Status Byte Register. The bits in the Standard Event Status Enable Register are logically ANDed with the equivalent bits in the Standard Event Status Register, and the results of those AND operations are logically ORed to produce a summary bit. The ESB bit (bit 5) in the Status Byte Register is set when the logic OR operation sets the summary bit. The *ESE command can be used to set the contents of the Standard Event Status Enable Register, and the *ESE? query can be used to read the contents of the Standard Event Status Enable Register.

The following describes each bit in the Standard Event Status Register:

7	6	5	4	3	2	1	0
Power on Occurrence	Not Used	Command Error	Execution Error	Not Used	Query Error	Not Used	Operation Complete

0 Operation Complete. This bit is set whenever all pending operations are completed (such as a list computation).

1 Not used. Always 0.

2 Query Error. This bit is set whenever a query error has occurred.

3 Not used. Always 0.

4 Execution Error. This bit is set whenever an execution error has occurred.

5 Command Error. This bit is set whenever an invalid GPIB command has been received.

6 Not used. Always 0.

7 Power On Occurrence. This bit is set whenever the instrument has been powered off and then on again during manual and remote operation.

3.5.3 Questionable Status Condition and Enable Registers

The Questionable Status Register is one of the lower-level status registers. It monitors certain 2400-specific status conditions. When a condition occurs that is being monitored by this register, bit 3 is set in the Status Byte Register. The STATus:QUEStionable:CONDition? query can be used to read the contents of the Questionable Status Register.

The following describes each bit in the Questionable Status Register:

7	6	5	4	3	2	1	0
Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used.

15	14	13	12	11	10	9	8
Not Used	Not Used	Not Used	No External Reference	Synth unlocked	ALC unleveled	Not Used	Not Used.

0-9 Not Used.

10 ALC Unleveled. This bit is set whenever the output power is operated in an unleveled condition.

11 Synthesizer Unlocked. This bit is set whenever the synthesizer has lost phase lock.

12 No External Reference. This bit can be monitored whenever an external reference is applied to the synthesizer for phase locking multiple synthesizers. This bit is set whenever the external reference signal is lost.

13-15 Not Used.

3.5.4 List Mode Operation

2400 list mode operation is not available from the front panel. In order to use list mode, remote programming must be used.

Automation Xpress and the Automation Xpress Interface (AXI) is the preferred method of using the 2400 in remote operation. For information on using Automation Xpress and the AXI, refer to the Automation Xpress online help system.

Command-based remote interface commands can also be used to program list mode operation. The remainder of this section includes some examples that explain how to program a 2400 for list mode operation using commands.

3.5.4.1 Simple List Mode - SCPI Commands

The following example shows the SCPI commands that are used to program the 2400 to step its output power level from 8 to 5 to 0 dBm while keeping its frequency constant at 5 GHz. The dwell time, that is, the time spent on each step, is 200 ms. In this example, software triggering is used, and the sweep mode is set to single-sweep. The last command in the sequence triggers the list.

Sequence	Command	Description
1	LIST:SEQ:AUTO ON	Activate list mode.
2	LIST:FREQ 5000000000.0,5000000000.0,5000000000.0	Add 3 list points to a list with frequency 5 GHz.
3	LIST:POW 8.000,5.000,0.000	Set the power for the 3 list points to 8, 5 and 0 dBm respectively.
4	LIST:DWEL 0.200000, 0.200000, 0.200000	Set the dwell (step) time for the 3 list points to 0.2 seconds.
5	LIST:PRECompute	Pre-compute the created list data.
6	LIST:REPeat SWEEP	Set the list repeat type to single sweep.
7	TRIGger:SOURce BUS	Set the list trigger mode to GPIB (software) triggering.
8	OUTP ON	Turn the RF output on.
9	*TRG	Trigger the list.

3.5.4.2 Comprehensive List Mode - SCPI Commands

The following example shows the SCPI commands that are used to program the 2400 to run a software-triggered list continuously, how to clear a list, and how to run a list in single sweep mode using external triggering. The example is divided into sequences, as follows:

- **Sequence A** - This list steps the 2400 frequency from 1 to 2 to 3 GHz while keeping the output power level constant at 0 dBm. The dwell time, that is, the time spent on each step, is 250 ms. In this list, software triggering is used, and the sweep mode is set to continuous.
- **Sequence B** - This command enables the 2400's RF output connector.
- **Sequence C** - This command is used to trigger the list created in Sequence A.
- **Sequence D** - This command deletes the current list. The current list must be deleted in order to allow the next list to be programmed, since 2400 list mode operation only allows one list at a time.
- **Sequence E** - This list steps the 2400 output level from -10 to -5 to 0 dBm while keeping the output frequency constant at 6 GHz. The dwell time, that is, the time spent on each step, is 200 ms. In this list, external triggering is used, and the sweep mode is set to single sweep. When this list is triggered, it will run once and then list mode operation will stop.

Sequence	Command	Description
A-1	LIST:SEQ:AUTO ON	Activate list mode
A-2	LIST:FREQ 1000000000.0,2000000000.0,3000000000.0	Add 3 list points to a list with frequencies of 1, 2 and 3 GHz.
A-3	LIST:POW 0.000,0.000,0.000	Set the power of the 3 list points to 0 dBm.
A-4	LIST:DWEL 0.250000, 0.250000, 0.250000	Set the dwell (step) times of the 3 list points to 0.25 seconds.
A-5	LIST:PRECompute	Pre-compute the created list data.
A-6	LIST:REPeat CONT	Set the list repeat type to continuous.
A-7	TRIGger:SOURce BUS	Set the list trigger mode to GPIB (software) triggering.
B	OUTP ON	Turn the RF output on.
C	*TRG	Trigger the list.
D	LIST:DEL:LIST 1	Clear the existing list.
E-1	LIST:FREQ 6000000000.0,6000000000.0,6000000000	Add 3 list points to a list with frequencies of 6 GHz.
E-2	LIST:POW -10.000, -5.000, 0.000	Set the power of the 3 list points to -10, -5 and 0 dBm respectively.
E-3	LIST:DWEL 0.200000 S	Set the dwell (step) time of the 3 list points to 0.2 seconds.
E-4	LIST:PRECompute	Pre-compute the created list data.
E-5	LIST:REPeat SWEEP	Set the list repeat type to single sweep.
E-6	TRIGger:SOURce EXT	Set the list trigger mode to External trigger. *Note:* a user will trigger the list with an external device.

3.5.4.3 Simple List Mode - GT12000 Native Commands

The following example shows the GT12000 native commands that are used to program the 2400 to step its output power level from 0 to 5 dBm while keeping its frequency constant at 10 GHz. The dwell time, that is, the time spent on each step, is 250 ms. In this example, software triggering is used, and the sweep mode is set to single-sweep. The last command in the sequence triggers the list.

Sequence	Command	Description
1	LR 1	Activate list mode.
2	LA 1 0	Add the first list point to the list.
3	LF 1 1 10.000000 GHZ	Set the frequency of the first list point to 10 GHz.
4	LL 1 1 0.000000 DBM	Set the power output of the first list point to 0 dBm.
5	LT 1 1 0.250000 S	Set the dwell time of the first list point to 0.25 second.
6	LA 1 1	Add the second list point to the list.
7	LF 1 2 10.000000 GHZ	Set the frequency of the second list point to 10 GHz.
8	LL 1 2 5.000000 DBM	Set the power output of the second list point to 5 dBm.
9	LT 1 2 0.250000 S	Set the dwell time of the second list point to 0.25 second.
10	LS? 1	Pre-compute the created list data.
11	L2	Set the list repeat type to single sweep.
12	TR 1	Set the list trigger mode to GPIB (software) triggering.
13	RF 1	Turn the RF output on.
14	*TRG	Trigger the list.

3.5.4.4 Comprehensive List Mode - GT12000 Native Commands

The following example shows the GT12000 native commands that are used to program the 2400 to run a software-triggered list continuously, how to clear a list, and how to run a list in single sweep mode using external triggering. The example is divided into sequences, as follows:

- **Sequence A** - This list steps the 2400 frequency from 1 to 10 GHz in 1 GHz steps while keeping the output power level constant at 0 dBm. The dwell time, that is, the time spent on each step, is 500 ms. In this list, software triggering is used, and the sweep mode is set to continuous.
- **Sequence B** - This command enables the 2400's RF output connector.
- **Sequence C** - This command is used to trigger the list created in Sequence A.
- **Sequence D** - This command deletes the current list. The current list must be deleted in order to allow the next list to be programmed, since 2400 list mode operation only allows one list at a time.
- **Sequence E** - This list steps the 2400 output level from 1 to 10 dBm in 1 dBm steps while keeping the output frequency constant at 5 GHz. The dwell time, that is, the time spent on each step, is 400

ms. In this list, external triggering is used, and the sweep mode is set to single sweep. When this list is triggered, it will run once and then list mode operation will stop.

Sequence	Command	Description
A-1	LR 1	Activate list mode.
A-2	LGA 1 GHZ	Set the start frequency for the frequency list rage to 1 GHz.
A-3	LGB 10 GHZ	Set the stop frequency for the frequency list rage to 10 GHz.
A-4	LGC 1 GHZ	Set the step frequency for the frequency list rage to 1 GHz.
A-5	LGD 0.5 S	Set the dwell time for the frequency list rage to 0.5 seconds.
A-6	LGL 0 DBM	Set the output power each frequency list point to 0 dBm.
A-7	LGIF 1 1	Insert the frequency list range into a list.
A-8	LS? 1	Precompute the created list data.
A-9	L 1	Set the repeat type to continuous.
A-10	TR 1	Set the list trigger mode to GPIB (software) triggering.
B	RF 1	Turn the RF output on.
C	*TRG	Trigger the list.
D	LC 1	Clear the existing list.
E-1	LGLA 1 DBM	Set the start power for the power list rage to 1 dBm.
E-2	LGLB 10 DBM	Set the stop power for the power list rage to 10 dBm.
E-3	LGLC 1 DBM	Set the step power for the power list rage to 1 dBm.
E-4	LGD 0.4 S	Set the dwell time for the power list rage to 0.4 seconds.
E-5	LGLF 5 GHZ	Set the output frequency each power list point to 5 GHz.
E-6	LGIP 1 1	Insert the power list range into a list.
E-7	LS? 1	Precompute the created list data.
E-8	L 2	Set the repeat type to single sweep.
E-9	TR 0	Set the list trigger mode to BNC (external) triggering. *Note:* a user will trigger the list with an external device.

4 Specifications & Performance Verification

4.1 Models

Table 4-1: Models[1]

Models	Frequency Range
2408B/2408S	10 MHz to 8 GHz
2420B/2420S	10 MHz to 20.199 GHz
2426B/2426S	10 MHz to 26.5 GHz
2440B/2440S	10 MHz to 40 GHz

1. Option 18, Deletes 0.01 to 2 GHz frequency range

4.2 Specifications

All specifications apply over a 0°C to +55°C range after 30 minutes of warm-up time, unless otherwise stated.

NOTE: Giga-tronics recommends a calibration cycle of two years for the 2400.

4.2.1 Frequency

Accuracy: Same As Timebase (after 30 day warm-up)
Resolution: 0.1 Hz
Internal References:

10 MHz

Aging Rate: $< 5 \times 10^{-10}$/day
Temperature Stability: $< \underline{+}\ 2.5 \times 10^{-8}/^{o}C$

100 MHz

Aging Rate: < 1 X 10^{-8}/day

Temperature Stability: < ± 2.5 x $10^{-8}/^{o}C$

10 MHz Reference Out:

Output: DC coupled, 2 Vp-p, square wave reference output signal, 50 Ohms

100 MHz Reference Out:

Output: AC coupled, 1 Vp-p typical, square wave reference output, 50 Ohms.

External Reference Input:

Frequency: 10 MHz or 100 MHz, ± 1 ppm

Level: ≥ -5 dBm, 50 Ohms

4.2.2 Output Power

Specification applies over the 0^{o}Cto 35^{o}C range and degrades <2.0 dB above 35^{o}C to 55^{o}C

Table 4-2: Maximum Output Power (dBm)[1]

Model	0.01 to <2 GHz	2 to 8 GHz	8 - 20 GHz	20 - 40 GHz
2408	+ 14	+ 15		
2420	+ 14	+15	+15	
2426	+ 13	+13	+9	+10 (to 26.5 GHz)
2440	+ 10	+10	+9	+9

1. With Option 26. Step Attenuator reduces power by 1.5 dB to 18 GHz, 2.0 dB from 18 GHz to 26.5 GHz, and 2.5 dB and above 26.5 GHz

Table 4-3: Minimum Settable Power

Model	2408, 2420	2426, 2440
Standard	-110 dBm	-100 dBm
Option 26 Delete Step Attenuator	-20 dBm	-10 dBm

Resolution: 0.01 dB

Power Offset: 0 to 10 dB

Temperature Stability: 0.025 dB/^{o}C

Source Match: <2.0:1 into 50 Ohms

Table 4-4: Accuracy[1]

Model	≥ +10 dBm	≥-20 dBm	≥-110 dBm
2408	± 1.0	± 0.8	± 1.3
2420	± 1.0	± 0.8	± 1.3
2426	± 1.3	± 1.0	± 1.5
2440	± 1.3	± 1.0	± 1.5

1. Specifcation applies over the 15°C to 35°C range and degrades <0.5 dB outside this range

4.2.3 Spectral Purity

Table 4-5: Harmonics[1]

Frequency	dBc, +6 dBm Setting
0.01 to 20 GHz	- 55[2]
>20 to 40 GHz	-30

1. Specifcations for harmonics above the instrument frqeuency are typical
2. frequencies > 500 MHz; for frequencies < 500 MHz, -55 dBc typical, worst case -45 dBc

Table 4-6: Sub-Harmonics

Frequency	dBc, +6 dBm Setting
0.01 to 2 GHz	- 80
>2 to 20 GHz	- 60
>20 to 40 GHz	- 50

Table 4-7: Spurious (Non-Harmonic related Spurs)[1]

Frequency	Offsets (> 300 Hz)
0.01 to 16 GHz	- 60 dBc
>16 to 32 GHz	- 54 dBc
> 32 to 40 GHz	-48 dBc

1. Offsets < 300 Hz, -45 dBc typical

Table 4-8: Residual FM

Frequency	Bandwidth - 50 Hz to 150 kHz
0.01 to 16 GHz	< 40 Hz
>16 to 32 GHz	< 80 Hz
> 32 to 40 GHz	< 120 Hz

Table 4-9: AM Noise

Frequency	Offsets > 5 MHz
0.01 to 2 GHz	- 130 dBc/Hz
>2 to 20 GHz	- 145 dBc/Hz
>20 to 40 GHz	- 140 dBc/Hz

Table 4-10: SSB Phase Noise

Frequenc y	Offset from Carrier (dBc/Hz)				
(GHz)	100 Hz	1 kHz	10 kHz	100 kHz	1 MHz
0.85	-92	-111	-112	- 123	- 130
1.85	- 86	- 105	- 106	- 117	- 135
5.6	- 75	- 97	- 98	- 105	- 130
10	- 74	- 92	- 92	- 101	-128
18	- 68	- 89	- 90	- 99	- 123
23	- 63	- 85	- 86	- 93	- 118
30	- 61	- 83	- 84	- 91	- 115

4.2.4 List Mode

List Points:	4000
Frequency Settling Time:	<550 usec. for ≤ 500 MHz frequency switch
Amplitude Settling Time:	<500 usec.; 200 usec. typical
Step Time:	.150 msec. to 1000 msec. per point
Sync Out Delay:	0.05 msec. to 984 msec.
Trigger Modes:	External, Bus, GET

4.2.5 Amplitude Modulation

Depth: 0 to 75% (output = 0 dBm)
Rate (3 dB Bandwidth): DC to 5 kHz (depth = 30%)
Sensitivity: 0 to 95%/V selectable
Accuracy: ± 10% of setting @ 1 kHz rate
Input:
Range: ± 1 Volts Peak
Impedance: 600 Ohms

4.2.6 Frequency Modulation

Input: ± 1 Volts Peak
Impedance: 50 Ohms

Narrow Mode: (Modulation Index - Limited by Deviation)
Rate (3 dB Bandwidth): DC to 50 kHz
Peak Deviation: 1 MHz/N where N = Band Index; see Table 4-11
Accuracy: ± 5% of peak deviation at 5 kHz rate, 1 volt peak

Wide Mode: (Modulation Index = 15/N)
Rate (3 dB Bandwidth): 1 kHz to 3 MHz
Peak Deviation: 20 MHz/N where N = Band Index; see Table 4-11
Accuracy: ± 5% of peak deviation at 200 kHz rate, 1 Volt peak

Table 4-11: Frequency Bands

Band	Frequency	N (Band Index)
0	10 to 15.99 MHz	512
1	16 to 30.99 MHz	256
2	31 to 62.99 MHz	128
3	63 to 124.99 MHz	64
4	125 to 249.99 MHz	32
5	250 to 499.99 MHz	16
6	500 to 999.99 MHz	8
7	1 to 1.99 GHz	4
8	2 to 3.99 GHz	2
9	4 to 7.99 GHz	1
10	8 to 15.99 GHz	1/2
11	16 to 31.99 GHz	1/4
12	32 to 40 GHz	1/8

4.2.7 Pulse Modulation

Frequency:	500 MHz to maximum frequency
On/Off Ratio:	80 dB
Minimum Width:	50 nsec. settable
PRF (50% duty cycle):	DC to 5 MHz

Table 4-12: Rise/Fall Times

Frequency	Rise/Fall Time
0.01 to 499.99 MHz	Not specified
0.5 to 20 GHz	< 10 nsec.
> 20 to 40 GHz	< 25 nsec.

Table 4-13: Pulse Level Accuracy [1]

Pulse Width	Accuracy of Setting (dB)
<125 nsec.	Not specified
125 to 150 nsec.	+2.5/-0.5
>150 to 250 nsec.	+1.5/-0.5
>250 nsec	±0.5

1. Duty Cycle > 0.01%

Table 4-14: Pulse Fidelity (typical)

Parameter	0.5 to 2 GHz	2 - 40 GHz
Overshoot and Ringing	<15%	<15%
Video Feed Through	<5%	<1%

Compression: <±5 nsec
Delay: <75 nsec
Input:
- Sensitivity: TTL levels (polarity selectable)
- Impedance: 50 Ohms

4.2.8 Internal Modulation Generator

Table 4-15: AM Modulation Source

Parameter	Specification
Waveforms	Sine, Square, Triangle, Ramp, Gaussian Noise
Rate	0.01 Hz to 10kHz, all waveforms
Resolution	0.01 Hz
Accuracy	Same as time base
AM Output	2V, peak to peak into 10 k Ohm Load

Table 4-16: FM Modulation Source

Parameter	Specification
Waveforms	Sine, Square, Triangle, Ramp
Rate	0.01 Hz to 1 MHz, all waveforms
Resolution	0.01 Hz
Accuracy	Same as time base
FM Output	2V, peak to peak into 10 k Ohm Load

Table 4-17: Pulse Modulation Source

Parameter	Specification
Modes	Continuous, Gated, Triggered
Resolution	10 nsec.
Accuracy	+/-0.1% typical, worst case: ±2% of setting or ±20nS whichever is greater
PM Output	2 Volts into 50 Ohms

Pulse Modulation Modes

Continuous Mode

Pulse Repetition Interval:	200 nsec. to 1 second
Pulse Width:	50 nsec. to 10 msec.
Sync Out Delay:	0 to 10 msec.

Gated Mode

Pulse Repetition Interval:	200 nsec. to 1 second
Pulse Width:	50 nsec. to 10 msec.
Sync Out Delay:	0 to 10 msec.
Gating Input Polarity:	Active High or Active Low

Triggered Mode

PRF Pulse Delay:	100 nsec. to 1 second
Pulse Width:	50 nsec. to 10 msec.
Sync Out Delay:	0 to 10 msec.
Trigger Input Polarity:	Rising or Falling Edge

4.2.9 General Specifications

Operating Temperature:	0 to 55°C
Environmental	MIL-PRF-28800F, Class 3
Safety:	EN61010
Emissions:	EN61326
Approvals:	CE Marked
Power:	90-253 VAC, 47-64 Hz
	(400 Hz optional, 150 watts nominal)
Fuse Rating:	2 A, SB
Width:	16.75 inches
Depth:	21 inches
Height:	5.25 inches
Weight:	<35 lbs.

4.3 Performance Verification

This section is used to verify the electrical performance of the 2400 using the specifications described in this chapter. Performance verification is recommended at least every two years, or more often when required to ensure proper operation of the instrument.

Test equipment must be warmed up according to specifications. The minimum warm-up time before testing the instrument is 30 minutes unless otherwise specified. The following procedures refer to the instrument under test as the 2400 or UUT (Unit Under Test) for all 2400 Series Microwave Synthesizer models.

4.3.1 Recommended Equipment

Each performance test in this chapter includes a list of the equipment required to perform the test. This list of equipment, called “Equipment Required”, appears at the beginning of each procedure.

The “Equipment Required” sections indicate, by type, the test equipment that is required for each test. Recommended models for each type of test equipment are included in this section. Equivalent test equipment can be substituted for the recommended models, provided that the accuracies and specifications are equal to or better than those of the recommended models.

• Oscilloscope	Tektronix TDS3052B or Equivalent
• Microwave Frequency Counter	Anritsu MF2412B Frequency Counter (2420 Models)
• Power Meter	Giga-tronics Series 8650A
• Power Sensors	Giga-tronics 80313A or Equivalent
•	Giga-tronics 80324A or Equivalent (2440 Models)
•	Giga-tronics 80334A or Equivalent
•	Giga-tronics 80350A or Equivalent
• Spectrum Analyzer	Agilent 8564EC or Equivalent
• Function Generator	Agilent 33220A or Equivalent
• Universal Counter	Agilent 33121A or Equivalent
• Crystal Detector	Krytar Model 703S or Equivalent

In addition, an assortment of coaxial cables should be available for interconnecting the equipment.

4.3.2 Performance Tests: All 2400 Series

The performance tests in this section apply to all 2400 Series instruments.

4.3.2.1 Frequency Range, Resolution & Accuracy

In this test, the RF output of the 2400 is connected to the input of a frequency counter, and the 2400's output frequency is tested at various points within its frequency range. The internal timebase of the counter is used as a reference for the 2400 to eliminate timebase errors from the measurements.

4.3.2.1.1 Equipment Required

- Microwave Frequency Counter

4.3.2.1.2 Test Setup

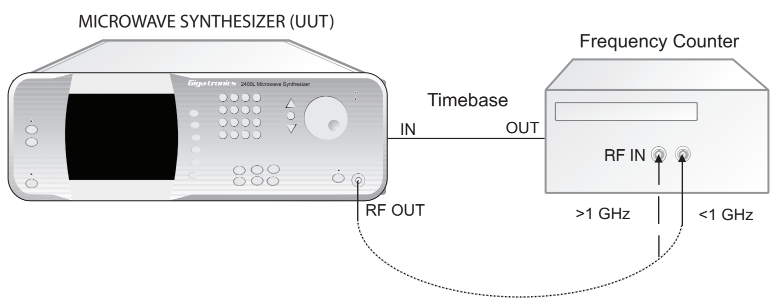

Figure 4-1: Frequency Range, Resolution & Accuracy Test Setup

4.3.2.1.3 Procedure

1. Connect the equipment as shown in Figure 4-1. Connect the 2400 RF Output to the low frequency input using coaxial cabling and adapters as is necessary. Allow the equipment to warm up for at least 30 minutes. Because the 2400 and the counter use the same timebase, timebase errors are eliminated. The 2400 automatically switches to the external reference when it is connected.

2. Set the 2400 for an output frequency of 10 MHz, and set the RF output level to 0 dBm.

3. Press the [RF ON] button to activate the 2400 output.

   The indicator above the RF ON button is blue when the 2400 output is active.

4. Set the 2400 to each frequency listed in Datasheet 1, and verify that the counter reads the set frequency plus or minus the counter resolution.

5. When the test frequency exceeds the maximum frequency of the input, move the 2400 RF Output to the high frequency Input on the frequency counter.

6. For each frequency listed in the remaining rows of Datasheet 1, the counter should read the entered frequency ±1 Hz, plus or minus the counter resolution. Ignore all frequencies outside the frequency range of the unit under test.

4.3.2.2 Spectral Purity Tests

4.3.2.2.1 Description

In this test, the output of the 2400 is connected to a spectrum analyzer. Various frequencies are selected and the analyzer tuned to determine the presence of either harmonic or non-harmonic (spurious) signals.

4.3.2.2.2 Equipment Required

- Spectrum Analyzer

4.3.2.2.3 Test Setup

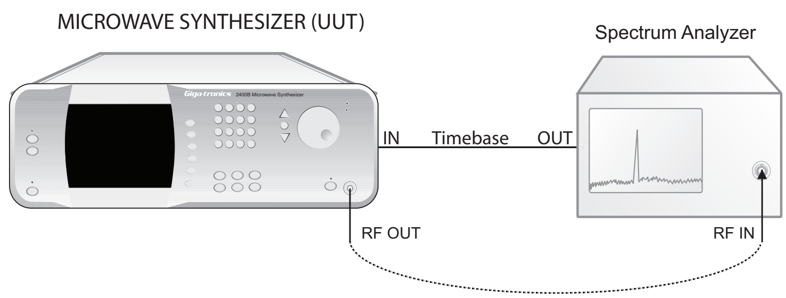

Figure 4-2: Spectral Purity Tests

4.3.2.2.4 Procedure

1. Connect the equipment as shown in Figure 4-2. Allow the equipment to warm up for at least 30 minutes. Set the 2400 to the first test frequency listed in Datasheet 2, and set the RF amplitude to +6 dBm.

2. Press the [RF ON] button to turn on the RF output.

   The indicator above the RF ON button is blue when the 2400 output is active.

3. Set the spectrum analyzer to view the 2400 output signal. Adjust the analyzer reference level so that the peak of the displayed signal is at the top graticule line.

4. Set the spectrum analyzer span to 500 MHz with the signal centered on the screen. Gradually narrow the span, keeping the signal centered, to observe any harmonically-related or spurious signals. Use appropriate resolution and video bandwidths to allow sufficient dynamic range.

5. Record the level of any harmonic or spurious signals in the appropriate columns of Datasheet 2.

6. Repeat steps 3 through 5 for the other frequencies listed in Datasheet 2 that are within the operating range of the instrument.

4.3.2.3 RF Output Power Tests

The following procedures test output power at frequencies within each band. There are three tests: Maximum-Leveled Power, Level Accuracy, and Step Attenuator Level Accuracy.

The tests are presented in this section as manual procedures, however, for a comprehensive evaluation of the output of the 2400, it is recommended that an automated test system be used to perform these tests.

NOTE: When measuring the flatness and accuracy of the 2400, consideration must be given to the various measurement uncertainties in the test system. These include, but are not limited to, VSWR, Cal Factor uncertainty and calibration.

4.3.2.3.1 Equipment Required

- Power Meter
- Power Sensors covering the frequency ranges being tested
- Spectrum Analyzer

4.3.2.3.2 Test Setups

Figure 4-3: Maximum-Leveled Power and Level Accuracy Tests

4.3.2.3.3 Procedure - Maximum-Leveled Power Test

1. Connect the Power Meter and Power Sensor to the RF output of the UUT as shown in Figure 4-3.
2. Set the UUT to the first frequency specified in Datasheet 3, and activate the RF output.
3. Increase the output power of the UUT until the Unleveled indicator lights.
4. Reduce the output power setting until the Unleveled indicator turns off.
5. Record the measured output power in Datasheet 3 for the test frequency.
6. Repeat steps 3 through 5 for the remaining frequencies in Datasheet 3 that are within the operating range of the instrument.

4.3.2.3.4 Procedure - Level Accuracy Test

1. Use the test setup described in the Maximum-Leveled Power Test (Figure 4-3).
2. Set the output level of the UUT to 0 dBm.
3. Set the UUT to the first test frequency listed in Datasheet 4.
4. Record the measured output power in the “Level = 0dBm” column.
5. Repeat Step 4 for the remaining test frequencies shown in Datasheet 4 that are within the operating range of the instrument.
6. Set the output level of the UUT to +12.5 dBm. For 2440 models, set the output level to +6.5 dBm.
7. Set the UUT to the first test frequency listed in Datasheet 4.
8. Record the measured output power in the “Level = +12.5 dBm. . . . . .” column.
9. Repeat Step 8 for the remaining test frequencies shown in Datasheet 4 that are within the operating range of the instrument.

NOTE: When measuring the accuracy of the model 2400, consideration must be given to the measurement uncertainties of the test system. These include, but not limited to, VSWR, Cal Factor Uncertainty, and Calibration Uncertainty.

4.3.2.3.5 Procedure - Step Attenuator Level Accuracy Test

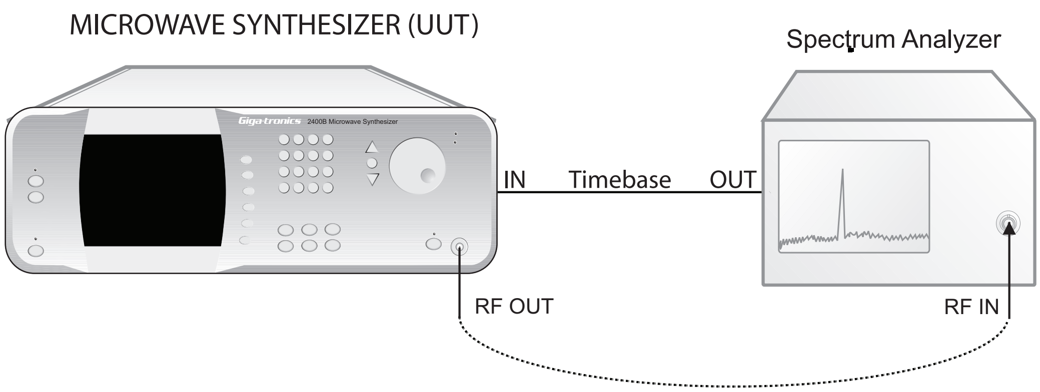

Figure 4-4: Step Attenuator Level Accuracy Test

1. Connect the test equipment and UUT as shown in Figure 4-4, connecting the UUT directly to the RF input of the Spectrum Analyzer.

2. Set the Spectrum Analyzer to the following settings:

Frequency	12 MHz
Reference Level	0 dBm
Span	5 kHz
Sweeptime	400 msec.
Resolution Bandwidth:	≤ 1 kHz
Video Bandwidth:	≥ 1 MHz

3. Set the UUT output power level to -3 dBm.

4. Set the UUT frequency to 12 MHz and activate the output.

5. Press the Peak Search button on the Spectrum Analyzer.

6. Press the Step Size button on the UUT and set the step size to 10 dB.

7. Reduce the RF output level of the UUT in 10 dB increments by pressing the Down Arrow button while observing the measurement on the Spectrum Analyzer.

8. Record each level measured of the Spectrum Analyzer into the appropriate column of Datasheet 5 for the frequency being tested.

9. Repeat steps 3 through 8 for the remaining test frequencies in Datasheet 5, recording the measured levels in the appropriate columns of Datasheet 5.

4.3.3 Performance Tests: 2400 Series

The performance tests in this section apply only to instruments that contain modulation capability, that is, the standard 2400B and 2400S Series instruments where Option 17, Delete Modulation Suite, is *not* installed in the 2400 Series Synthesizer.

4.3.3.1 Amplitude Modulation Tests

The following procedures test Amplitude Modulation Accuracy and Bandwidth at frequencies within each band. Because a Measuring Receiver is used to perform many of the tests, it is necessary to include a second microwave source and a Mixer to generate an IF (Intermediate Frequency) that is within the frequency range of the receiver.

4.3.3.1.1 Equipment Required

- Spectrum Analyzer
- Function Generator

4.3.3.1.2 Test Setup

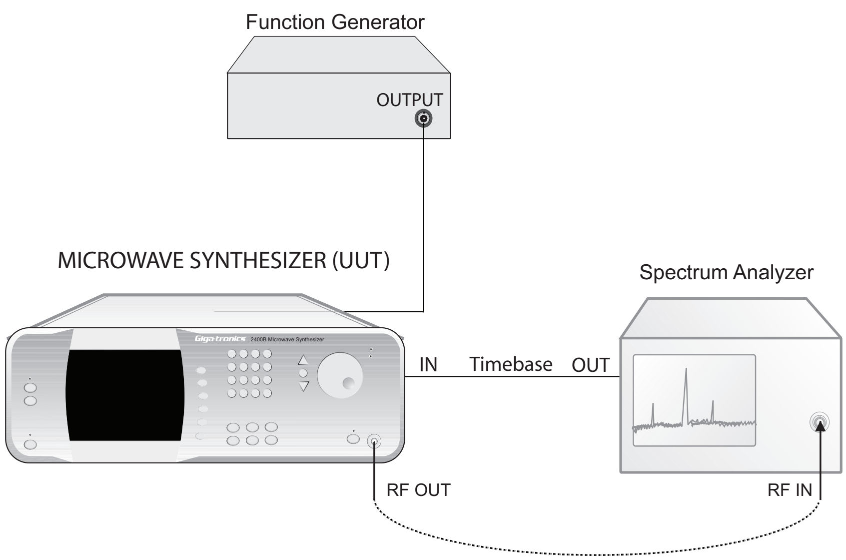

Figure 4-5: Amplitude Modulation Accuracy and Amplitude Modulation Bandwidth Tests

4.3.3.1.3 Procedure - Amplitude Modulation Accuracy

1. Set the UUT for the following settings:

External AM State:	On
AM Sensitivity:	30%
Level:	0 dBm

Frequency:	12 MHz

2. Set the Spectrum Analyzer to the following settings:

Reference Level	+5 dBm
Span	5 kHz
Sweeptime	400 msec.
Resolution Bandwidth:	≤ 100 Hz
Video Bandwidth:	≥ 30 kHz

3. Set the Function Generator for a 1 kHz Sine Wave output at 2.00 V peak-to-peak.

4. Connect the test equipment and UUT as shown in Figure 4-5, connecting the UUT directly to the RF input of the Spectrum Analyzer.

NOTE: Measure the output of the Function Generator using a precision meter or oscilloscope to ensure that its output is 2.00 Vp-p.

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5. Set the Spectrum Analyzer to the test frequency. Center the signal using Peak Search and Marker to Center Frequency functions.

6. Activate the Delta Marker function and press the Next Peak function or move the marker to the next peak.

7. Measure and record the AM Depth in the appropriate column in Datasheet 6:

- If the first time through the test, record the AM Depth in the "30%" column.
- If the second time through the test, record the AM Depth in the "50%" column.
- If the third time through the test, record the AM Depth in the "75%" column.

Measure the difference in dB of one sideband and the carrier. Use the following formula to determine the AM depth in percentage:

AM% = 10^[(E_{sb} - E_c) /20]*200

Example: Carrier Peak is 0 dBm and one Sideband Peak is -10 dBm

AM% = 10^[(0 dBm -10 dBm)/20]*200
AM% = 10^(-0.5)*200
AM% = (.316)*200
AM% = 63.2

The measurement should be with a 10% range of the AM sensitivity setting.

8. Deactivate the AM function of the UUT and repeat Step 5 to Step 7 for the remaining test frequencies in Datasheet 6, recording the AM depth for each in the appropriate column.

9. Set the AM Sensitivity of the UUT to 50% and repeat Step 7 to Step 8 for each of the test frequencies in Datasheet 6, recording the AM depth for each measurement in the appropriate column.

10. Set the AM Sensitivity of the UUT to 75% and repeat Step 7 to Step 8 for each of the test frequencies in Datasheet 6, recording the AM depth for each measurement in the appropriate column.

4.3.3.1.4 Procedure - Amplitude Modulation Bandwidth

1. Set the UUT for the following settings:

Level:	0 dBm
Frequency:	12 MHz
AM Sensitivity:	30%
External AM State:	On

2. Set the Spectrum Analyzer to the following settings:

Reference Level	+5 dBm
Span	20 kHz
Sweeptime	400 msec.
Resolution Bandwidth:	≤ 100 Hz
Video Bandwidth:	≥ 30 kHz

3. Connect the test equipment and UUT as shown in Figure 4-5,

4. Set the Function Generator for a 1 kHz Sine Wave output at 2.00 V peak-to-peak.

NOTE: Measure the output of the Function Generator using a precision meter or oscilloscope to ensure that its output is 2.00 Vp-p.

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5. Set the Spectrum Analyzer to the test frequency. Center the signal using Peak Search and Marker to Center Frequency functions.

6. Measure and record the difference, in dB, between the carrier amplitude and one sideband amplitude in the first column of Datasheet 7.

7. Vary the rate of the function generator within the specified rate range for the AM specification. Identify the lowest sideband amplitude. Record the value in the second column of Datasheet 7.

8. Subtract the reading in column 2 from the reading in column 1 and record the value in column 3. The difference between the two readings should be 3 dB or less.

9. Repeat steps 5 through 8 for the remaining test frequencies in Datasheet 7.

4.3.3.2 Frequency Modulation Tests

The following procedures test Frequency Modulation Accuracy and Maximum Deviation at frequencies within the 4 to 8 GHz band

4.3.3.2.1 Equipment Required

- Function Generator

4.3.3.2.2 Test Setup

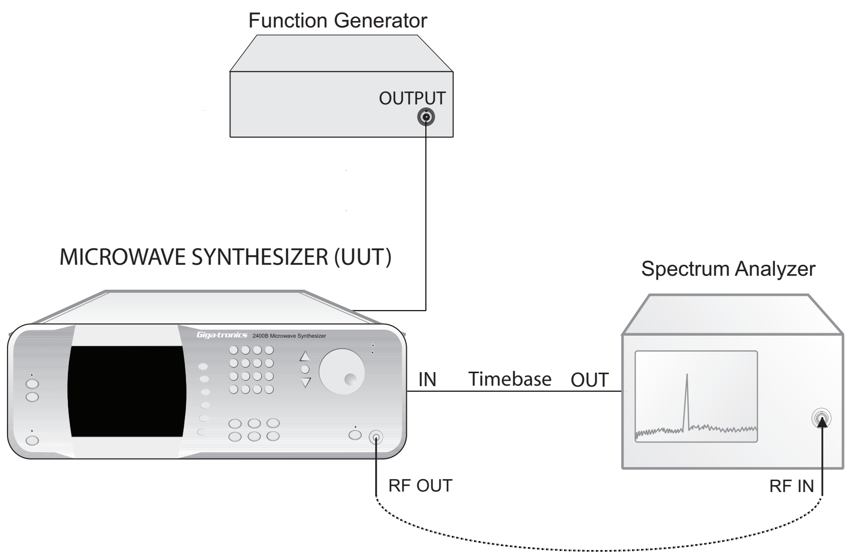

Figure 4-6: FM Deviation Bandwidth and Accuracy Setup

4.3.3.2.3 Procedure - Narrow Mode FM Maximum Deviation Test

1. Connect the test equipment and UUT as shown in Figure 4-6.

2. Set the Function Generator to the following settings:

Waveform:	Sine wave
Rate:	41.06 kHz
Output:	2 Vp-p into 50 Ohms

3. Set the level of the UUT to +13 dBm, activate the RF output, and set the external FM settings of the UUT to the following:

FM State:	Off
Mode:	Narrow
Sensitivity:	1 MHz/volt

4. Set the output of the UUT to the first frequency in datasheet. (Add cross-reference to the datasheet at end of chapter) and adjust the spectrum analyzer frequency to match the test frequency. Adjust the reference level of the spectrum analyzer until the peak on the top graticule of the display.

5. Set the FM State to On.

6. Adjust the rate of the function generator ± X kHz until the FM carrier is -50 dBc or greater (Bessel Null) from the unmodulated signal reference on the spectrum analyzer.

7. Using the following formula, determine the FM Deviation of the UUT. Record the result in Datasheet #8.

$$Deviation = 24.353 * Rate_{(Function\ Generator)}$$

24.353 is the Bessel Null 8th Order Carrier Zero

8. Repeat steps 5 through 9 for the remaining frequency test points.

4.3.3.2.4 Procedure - Wide Mode FM Maximum Deviation Test

1. Connect the test equipment and UUT as shown in Figure 4-6.

2. Set the Function Generator to the following settings:

Waveform:	Sine wave
Rate:	2.311 MHz
Output:	2.00 Vp-p into 50 Ohms

3. Set the level of the UUT to 0 dBm, activate the RF output, and set the external FM settings of the UUT to the following:

FM State:	Off
Mode:	Wide
Sensitivity:	20 MHz/volt

4. Set the output of the UUT to the first frequency in datasheet. (Add cross-reference to the datasheet at end of chapter) and adjust the spectrum analyzer frequency to match the test frequency. Adjust the reference level of the spectrum analyzer until the peak on the top graticule of the display.

5. Set the FM State to On.

6. Adjust the rate of the function generator ± 250 kHz until the FM carrier is -50 dBc or greater (Bessel Null) from the unmodulated signal reference on the spectrum analyzer.

7. Using the following formula, determine the FM Deviation of the UUT. Record the result in Datasheet #9.

Deviation = 8.65489 * Rate(Function Generator)
8.65489 is the Bessel Null 3rd Order Carrier Zero

8. Repeat steps 4 through 7 for the remaining frequency test points.

4.3.3.3 Pulse Modulation Tests

The following procedures test Pulse Modulation Level Accuracy, On/Off Ratio, and Rise/Fall times at frequencies within each band. The tests require a fast crystal detector (rise time < 10 nsec).

4.3.3.3.1 Equipment Required

- Oscilloscope (300 MHz bandwidth recommended)
- Crystal Detector (< 10 nSec rise-time, frequency range equivalent to test frequency range)
- Spectrum Analyzer (0 Hz span capable)
- Power Meter
- Power Sensor
- Pulse Generator

4.3.3.3.2 Test Setups

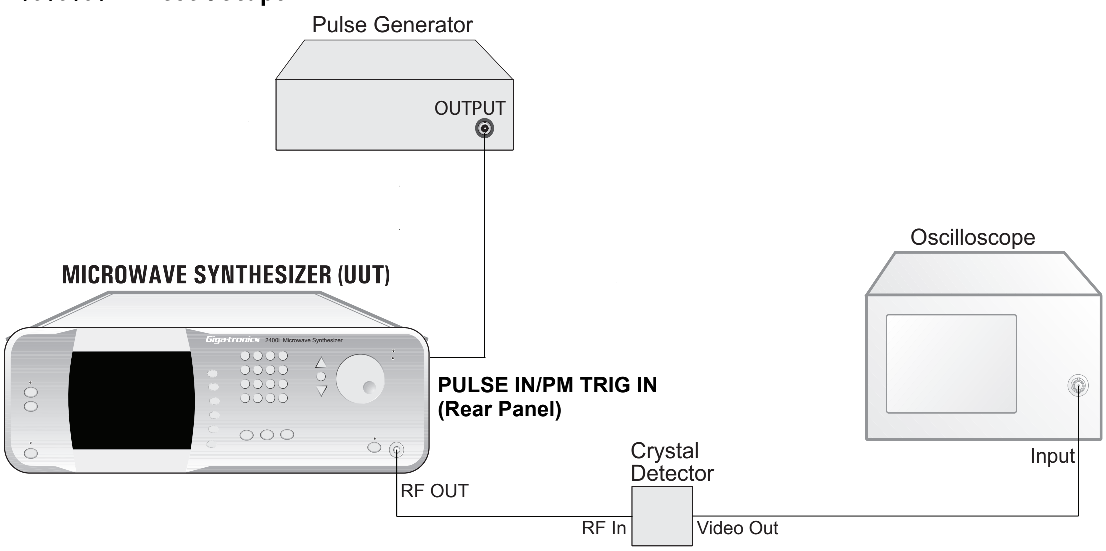

Figure 4-7: Pulse Modulation Rise and Fall Time Test

4.3.3.3.3 Procedure - Rise and Fall Time Test

1. Connect the test equipment and UUT as shown in Figure 4-7.

2. Set the Pulse Generator to the following settings:

Pulse Width:	5 msec.
Pulse Interval:	10 msec.
Output:	5 Volts into 50 Ohms

3. Set the trigger of the Oscilloscope according to the type of Crystal Detector being used (either positive or negative).

4. Set the UUT to the following settings:

Power Level:	0 dBm
External PM state:	ON
Trigger Polarity:	Active high
RF Output state:	On

5. Set the UUT to the first test frequency shown in Datasheet 10.

6. Measure the rise and fall times on the oscilloscope, and record them in the appropriate columns of Datasheet 10.

7. Repeat Step 6 for each of the remaining test frequencies shown in Datasheet 10.

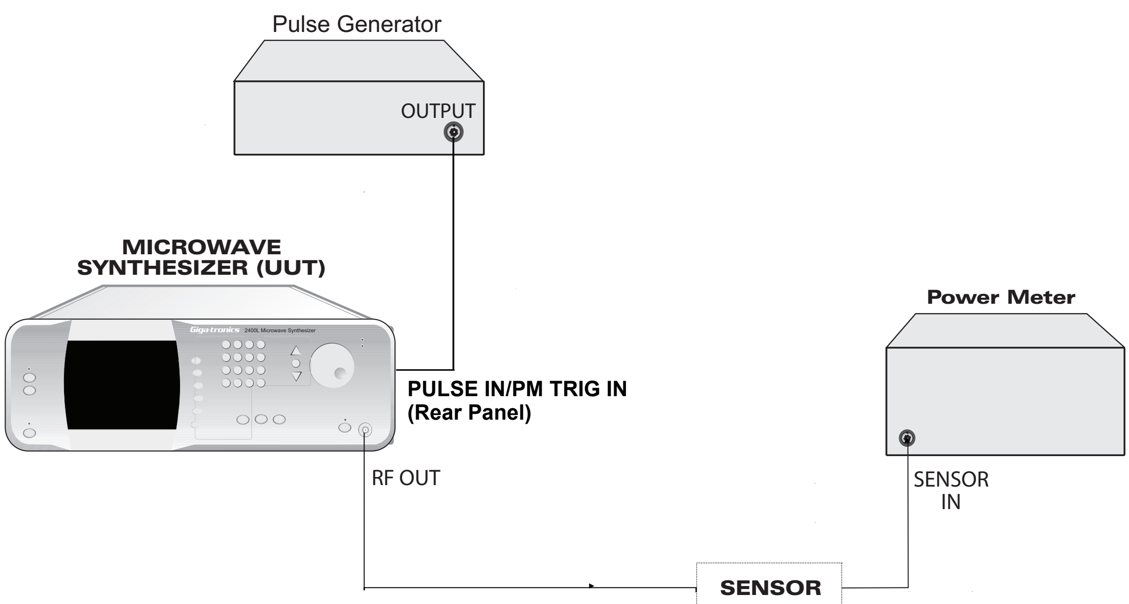

Figure 4-8: Pulse Modulation Level Accuracy Test

4.3.3.3.4 Procedure - Pulse Level Accuracy Test

1. Connect the test equipment and UUT as shown in Figure 4-8.

2. Set the Pulse Generator to the following settings:

Pulse Width:	5 msec.
Pulse Interval:	10 msec.
Output:	5 Volts into 50 Ohms

3. Set the UUT to the following settings:

Power Level:	0 dBm
External PM state:	Off
Trigger Polarity:	Active high
RF Output state:	On

4. Set the power meter's sensor mode to "CW".

5. Measure and record the CW level for each of the frequencies listed in Datasheet 10 in the "Level Accuracy - CW" column of Datasheet 10.

6. Set the External PM state of the UUT to On.

7. Set the power meter's sensor mode to "Peak," and adjust the sample delay to 500 nsec.

8. Measure and record the peak level for each of the frequencies listed in Datasheet 10 in the "Level Accuracy - Pulse" column of Datasheet 10.

9. Compare the CW levels to the peak (Pulse) levels in Datasheet 10, and record the difference in the "Level Accuracy - Delta" column.

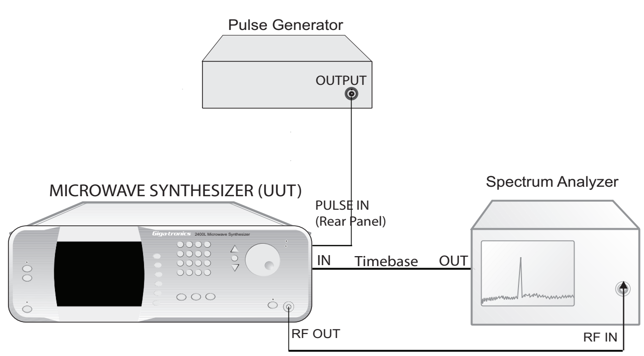

Figure 4-9: Pulse Modulation On/Off Ratio Test

4.3.3.3.5 Procedure - On/Off Ratio Test

1. Connect the test equipment and UUT as shown in Figure 4-9.

2. Set the Pulse Generator to the following settings:

Pulse Width:	5 msec.
Pulse Interval:	10 msec.
Output:	5 Volts into 50 Ohms

3. Set the UUT to the following settings:

Power Level:	0 dBm
External PM state:	On
Trigger Polarity:	Active high
RF Output state:	On

4. Set the UUT to the first test frequency shown in Datasheet 10.

5. Set the Spectrum Analyzer to the following settings:

Frequency:	Same as the frequency set at the UUT
Span:	0 Hz
Sweep Rate:	Set to display two pulses (It might be necessary to adjust the resolution bandwidth)
Vertical Scale:	10 dB/div
Resolution Bandwidth:	3 kHz
Video Averaging:	100
Trigger type:	Video

6. Adjust the Spectrum Analyzer reference level so that the peak level of the pulse is at the top of the display.

7. Measure the power difference between the on state and the off state of the displayed pulse, and record the measurement in the “ON/OFF Ratio (dB)” column of Datasheet 10.

8. Repeat steps 5 through 7 for the other frequencies in Datasheet 10.

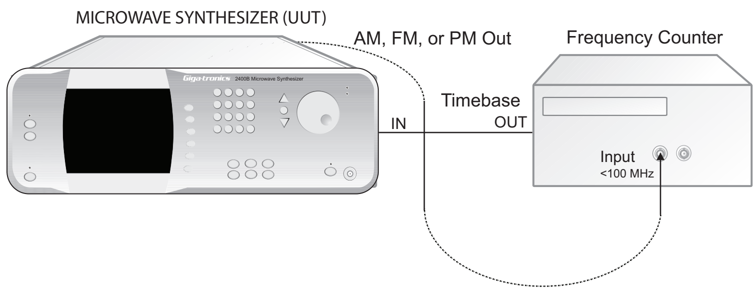

Figure 4-10: Internal Modulation Generator Tests

4.3.3.4 Internal Modulation Generator Tests

The following verification tests are for all models that do not have option 17.

4.3.3.4.1 AM Frequency Accuracy Test

1. Connect the test equipment and UUT as shown in Figure 4-10. Connect a BNC cable from the AM Out connector to the Band 1, BNC connector of the frequency counter
2. Set the CW frequency of the 2400 to 6 GHz.
3. Press the AM button to activate the AM Menu. If AM Menu 2 is not displayed, press the AM X/3 softkey until AM Menu 2 is displayed.
4. Press the AM softkey and the Step Up button to activate the Internal AM Modulation Generator. The AM indicator will appear in the upper left corner of the display.
5. Press the Rate softkey and enter the first value on Datasheet 11. Measure and record the reading of the frequency counter.
6. Repeat Step 5 for the remaining data points on the datasheet.

4.3.3.4.2 FM Frequency Accuracy Test

1. Connect the test equipment and UUT as shown in Figure 4-10. Connect a BNC cable from the FM Out connector to the Band 1, BNC connector of the frequency counter.
2. Set the CW frequency of the 2400 to 6 GHz.

3. Press the FM button to activate the FM Menu. If FM Menu 2 is not displayed, press the FM X/3 softkey until FM Menu 2 is displayed.

4. Press the FM softkey and the Step Up button to activate the Internal FM Modulation Generator. The FM indicator will appear in the upper left corner of the display.

5. Press the Rate softkey and enter the first value on Datasheet 12. Measure and record the reading of the frequency counter

6. Repeat Step 5 for the remaining data points on the datasheet.

4.3.3.4.3 Pulse Repetition Interval Accuracy

1. Connect the test equipment and UUT as shown in Figure 4-10. Press the Display Time button on the Frequency Counter. Connect a BNC cable from the PM Out connector to the Band 1, BNC connector of the frequency counter

2. Set the CW frequency of the 2400 to 6 GHz.

3. Configure the counter to measure the period of the video pulse waveform.

4. Press the PM button to activate the PM Menu. If PM Menu 2 is not displayed, press the PM X/4 softkey until PM Menu 2 is displayed.

5. Press the PM softkey and the Step Up button to activate the Internal PM Modulation Generator. The PM indicator will appear in the upper left corner of the display.

6. Press the PRI softkey and enter the first value on Datasheet 13.

7. Press the Width softkey and enter the first pulse width value on Datasheet 13. Measure and record the reading of the frequency counter.

8. Repeat Step 5 for the remaining data points on the datasheet.

4.3.4 2400 Series Test Datasheets

The following test data sheets are included for entering the various readings taken during the performance tests.

2400 Series Test Datasheet		
Serial Number		Record measured values in the Test Result column.
Date		
Tested By:		

Datasheet 1: Frequency, Range, Accuracy Test
(Refer to section 4.2.1 for specifications)

Test Frequency	Measured Frequency
10 MHz	
100 MHz	
200 MHz	
400 MHz	
750 MHz	
1500 MHz	
3 GHz	
6 GHz	
12 GHz	
20 GHz	
26 GHz (2426/40 series only)	
36 GHz (2440 series only)	
40 GHz (2440 series only)	

Datasheet 2: Spectral Purity Tests
(Refer to section 4.2.1 for specifications)

Test Frequency	Measured Power Level		
	Harmonics	Sub-Harmonics	Non-Harmonics
10 MHz			
100 MHz			
200 MHz			
400 MHz			
750 MHz			
1500 MHz			
3 GHz			
6 GHz			
12 GHz			
26 GHz (2426/40 series only)			
36 GHz (2440 series only)			
40 GHz (2440 series only)			

Datasheet 3: Maximum-Leveled Power Test
(Refer to section 4.2.2 for specifications)

Test Frequency	Measured Maximum-Leveled Power (dBm)
10 MHz	
100 MHz	
200 MHz	
400 MHz	
750 MHz	
1500 MHz	
3 GHz	
6 GHz	
12 GHz	
26 GHz (2426/40 series only)	
36 GHz (2440 series only)	
40 GHz (2440 series only)	

Datasheet 4: Level Accuracy Test
(Refer to section 4.2.2 for specifications)

Test Frequency	Measured Output Power	
	@ Level = 0dBm	@ Level = +12.5 dBm (2408, 2420 only) @ Level = +6.5 dBm (2426, 2440 only)
10 MHz		
100 MHz		
200 MHz		
400 MHz		
750 MHz		
1500 MHz		
3 GHz		
6 GHz		
12 GHz		
26 GHz (2426/40 series only)		
36 GHz (2440 series only)		
40 GHz (2440 series only)		

Datasheet 5: Step Attenuator Level Accuracy Test
(Refer to section 4.2.2 for specifications)

Test Frequency	Measured Output Power (dBm)								
	@ -13	@ -23	@ -33	@ -43	@ -53	@ -63	@ -73	@ -83	@ -93
10 MHz									
100 MHz									
200 MHz									
400 MHz									
750 MHz									
1500 MHz									
3 GHz									
6 GHz									
12 GHz									
26 GHz[1]									
36 GHz[2]									
40 GHz[2]									

1. 2426/40 series only.
2. 2440 series only.

Datasheet 6: Amplitude Modulation Accuracy Test
(Refer to section 4.2.2 for specifications)

Test Frequency	Sensitivity 30%	50%	75%
10 MHz			
100 MHz			
200 MHz			
400 MHz			
750 MHz			
1500 MHz			
3 GHz			
6 GHz			
12 GHz			
26 GHz (2426/40 series only)			
36 GHz (2440 series only)			
40 GHz (2440 series only)			

Datasheet 7: Amplitude Modulation Bandwidth Test
(Refer to section 4.2.5 for specifications)

Test Frequency	CarrierAmplitude	Sideband Amplitude	Delta (Spec. < 3 dB)
10 MHz			
100 MHz			
200 MHz			
400 MHz			
750 MHz			
1500 MHz			
3 GHz			
6 GHz			
12 GHz			
26 GHz (2426/40 series only)			
36 GHz (2440 series only)			
40 GHz (2440 series only)			

Datasheet 8: Narrow Mode FM Maximum Deviation Test
(Refer to section 4.3.3.2 for specifications)

Frequency	Rate	Deviation	Pass/Fail 47.5 - 52.5 kHz
4.0			
5.0			
6.0			
7.0			
7.99			

Datasheet 9: Wide Mode FM Maximum Deviation Test
(Refer to section 4.3.3.2 for specifications)

Frequency	Rate	Deviation	Pass/Fail 2.061 - 2.561 MHz
4.0			
5.0			
6.0			
7.0			
7.99			

Datasheet 10: Pulse Modulation Test
(Refer to section 4.2.7 for specifications)

Test Frequency	Rise Time	Fall Time	Level Accuracy			On/Off Ratio (dB)
			CW	Pulse	Delta	
10 MHz						
100 MHz						
200 MHz						
400 MHz						
750 MHz						
1500 MHz						
3 GHz						
6 GHz						
12 GHz						
26 GHz (2426/40 series only)						
36 GHz (2440 series only)						
40 GHz (2440 series only)						

Datasheet 11: AM Frequency Accuracy Tests
(Refer to section 4.2.8 for specifications)

AM Rate (Hz)	Measured Rate
100.0	
250.0	
500.0	
750.0	
1000.0	
2500.0	
5000.0	
7500.0	
10000.0	

Datasheet 12: FM Frequency Accuracy Tests
(Refer to section 4.2.8 for specifications)

FM Rate (Hz)	Measured Rate
500.0	
1000.0	
5000.0	
10000.0	
500000.0	
1000000.0	

Datasheet 13: PM Accuracy
(Refer to section 4.2.8 for specifications)

Pulse Repetition Interval	Pulse Width	Measured PRI
1.0E-6	5.0E-7	
1.0E-5	5.0E-6	
1.0E-4	5.0E-5	
1.0E-3	5.0E-4	
1.0E-2	5.0E-3	
2.0E-2	1.0E-2	

A Accessories & Options

A.1 Introduction

The accessories and options shown in Table A-1 are available for the 2400 Series Microwave Synthesizers. Each accessory and option is described under its respective heading in this appendix.

A.2 List of Accessories and Options

Table A-1: Accessories & Options

Accessory/Option No.	Description
A011	Ruggedized Carrying Case
17	Delete Modulation Suite and Internal Function Generator
18	Delete 0.01 to 2 GHz Frequency Extension (2408, 2420)
26	Delete 90 dB Step Attenuator
31	2 msec. Switching Speed Limit (Export Restriction)
44	Front Panel, Includes option 45 Rack Ears
45	Rack Ears
46	Rack Slide Kit
55	Command Sets. Followed by corresponding letter

Table A-2: Option 55 Command Sets

Option	Command St
55A	HP 8370
55B	HP 8340
55C	HP 8673
55D	HP 8663
55E	Systron Donner 1720
55F	Wavetek 90X
55G	HP 8350

B Error Messages

This appendix lists error and other messages that might be encountered during operation of the instrument. In some cases, encountered errors will be can be remedied by the user, while in other cases, you might need to contact Giga-tronics support. This appendix consists of the following sections:

- “Start-Up Error Messages” - This section lists the messages that might be encountered during the instrument’s power-up sequence.
- “NVRAM Messages” - This section lists messages that might be encountered if the system detects problems with internal non-volatile memory (NVRAM).
- “Remote Error Messages” - This section lists the messages that might be encountered during remote operation of the instrument.

B.1 Start-Up Error Messages

If the system encounters any problems during the start-up sequence, a message is displayed after start-up is complete. Typically, you should contact Giga-tronics customer support if any start-up error messages are encountered. The message that is displayed has the following format:

> Error code: *xxxxxxxxxxxxxxxxxxxx*
> Startup Failure, see manual

Where *xxxxxxxxxxxxxxxxxxxx* is a 20-digit binary number representing the errors that have occurred. The rightmost digit corresponds to Error #1 in Table B-1, below, and the leftmost digit corresponds to Error #20. A “1” in a particular bit position indicates an error. For example, the following message displayed after start-up:

> Error code: 00000000000000000111
> Startup Failure, see manual

Indicates that Error #1, 2, and 3 shown in Table B-1 have been detected.

Table B-1 lists the start-up error messages.

Table B-1: Start-Up Error Messages

Error #	Error Description
1	TIMEBASE_SET_ERROR
2	NVRAM_BATT_FAIL
3	CPU_FPGA_LOAD_FAIL
4	SYN_FPGA_LOAD_FAIL
5	ALC_SP_FPGA_LOAD_FAIL
6	ALC_PM_FPGA_LOAD_FAIL
7	RTOS_UTIL_ERROR
8	SYN_DSP_BOOT_LOAD_FAIL
9	ALC_DSP_BOOT_LOAD_FAIL
10	SYN_DSP_LOAD_FAIL
11	ALC_DSP_LOAD_FAIL
12	ALC_ZERO_FAIL
13	ALC_COMM_ERR
14	ALC_MEM_TEST_FAIL
15	ALC_ANALOG_TEST_FAIL
16	YIG_CAL_ERR
17	SYN_CAL_ERR
18	FPGA_CHECK_ERR
19	A1A2_CAL_ERR
20	*Bit position not currently used*

B.2 NVRAM Messages

The instrument uses non-volatile memory (NVRAM) to store user settings and configurations. In certain instances, user messages might be displayed that are related to NVRAM. The following paragraphs explain these instances.

B.0.1 NVRAM Reset Due to a Firmware Upgrade

If the instrument's firmware is upgraded, the start-up process detects the difference in firmware versions the next time it runs. In this case, the system resets the NVRAM, and displays the following message once the start-up process is complete:

Memory reset due to firmware upgrade. Please refer to release notes.

B.0.2 NVRAM Reset Due to a Battery Failure

The 2400 circuitry contains a battery to maintain the contents of NVRAM when the instrument is not connected from the mains power source. On occasion, this battery might fail, which causes NVRAM corruption. In this case, the system resets the NVRAM, and displays the following message once the start-up process is complete:

Memory reset due to battery failure. Please contact the service center.

B.0.3 NVRAM Reset Due to a Checksum Failure

A checksum of the NVRAM is calculated as a means of ensuring the integrity of the contents of the memory. On occasion, a comparison of the current contents of NVRAM with the checksum might uncover a disparity in values, causing a checksum failure. Checksum failures might be caused by the following situations:

- A firmware defect is present (most likely)
- AC power loss occurred while the system was writing to NVRAM
- A partial battery failure has occurred

If these situations occur, the screen shown in Figure B-1 might appear:

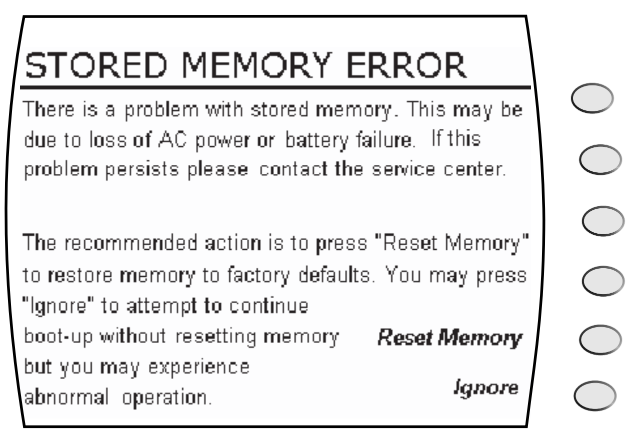

Figure B-1: Checksum Test Failure Screen

When a checksum error occurs, you can take either of the following actions:

- Choose the interactive softkey that is adjacent to “Reset Memory.” In this case, NVRAM is reset.
- Choose the interactive softkey that is adjacent to “Ignore.” In this case, NVRAM is not reset, but the checksum is recalculated. This allows you to continue using the instrument with the current contents of NVRAM intact, but you might encounter abnormal instrument operation.

B.3 Remote Error Messages

Commands including SCPI, GPIB, or register commands issued to 2400 may fail to execute. There are several reasons for the failure, such as wrong command string, wrong number of parameters, invalid parameter values, or invalid operation mode. This section defines the error codes and error strings for each possible failure. When an error occurs, the 2400 will queue the errors to an internal event buffer. When using the GPIB interface, a 2400 will send a service request to the controller and the controller software is responsible for querying the status message. When using the RS232 interface, the controller software should poll the 2400 for the error condition. A user can also query the 2400 using the ERR? query (GT12000 language mode) or SYStem:ERR? (SCPI language mode).

The message structure is {error #, 2400 error message}

Table B-2 describes the 2400 remote error messages.

Table B-2: 2400 Error Messages

2400 ERROR #	2400 ERROR MESSAGE
1	Command syntax error.
2	Invalid register-based command.
3	Command data checksum error.
4	Invalid RF state (0=off, 1=on)
5	Invalid *SAV/*RCL register (0 - 9 supported).
6	CW or RAMP POWER frequency is out of range.
7	CW or RAMP FREQUENCY power is out of range.
8	List range editing error, start frequency is out of range.
9	List range editing error, stop frequency is out of range.
10	List range editing error, step frequency is out of range.
11	List range editing error, Power level is out of range.
12	List range editing error, start power is out of range.
13	List range editing error, stop power is out of range.
14	List range editing error, step power is out of range.

Table B-2: 2400 Error Messages

2400 ERROR #	2400 ERROR MESSAGE
15	List range editing error, frequency is out of range.
16	List range editing error, dwell time is out of range.
17	System out of list memory.
18	Invalid list point parameter.
19	List does not exist.
20	Invalid list trigger repeat type. Single Step, Single Sweep, and Continuous are supported.
21	Invalid list trigger type. BNC, GPIB GET, GPIB Command, and Immediate are supported.
22	Immediate trigger only works with Continuous trigger repeat type.
23	RAMP option is not enabled.
24	RAMP Power span is out of range.
25	RAMP start Power is out of range.
26	RAMP stop Power is out of range.
27	RAMP Frequency span is out of range.
28	RAMP start Frequency is out of range.
29	RAMP stop Frequency is out of range.
30	RAMP time is out of range.
31	Sweep frequency is out of range.
32	Sweep power is out of range.
33	Invalid internal PM polarity. RISing or FALLing are supported.
34	Invalid External PM polarity, NORmal or INVerted are supported.
35	Invalid PM source. INTernal or EXTernal are supported.
36	Invalid PM action. 0 - deactivate, 1 - activate, 2 - activate internal PM, 3 - activate external pulse negative true, 4 - Activate internal PM, external rising edge trigger, 5 - Activate internal PM, external falling edge trigger.
37	Invalid PM waveform. 0 - waveform off, 1 - waveform single, 2 - waveform double, 3 - waveform triple, 4 - waveform quadruple.
38	Modulation option is not enabled.
39	Internal modulation generator option is not enabled.
40	Scan option is not enabled.

Table B-2: 2400 Error Messages

2400 ERROR #	2400 ERROR MESSAGE
41	Invalid AM action. 0 - Deactivate AM, 1 - Activate external AM, 2 - Activate internal AM with sine wave, 3 - Activate internal AM with square wave, 4 - Activate internal AM with triangle wave, 5 - Activate internal AM with positive ramp, 6 - Activate internal AM with negative ramp, 7 - Activate internal AM with noise, 8 - Activate internal AM, but set output to zero.
42	Invalid AM mode. LINear or LOGarithmic is supported.
43	Invalid AM source. INTernal or EXTernal is supported.
44	Invalid AM scan mode. 0 - Deactivate AM, 1 - Activate external scan modulation, 2 - Activate internal scan modulation with sine wave, 3 - Activate internal scan modulation with square wave, 4 - Activate internal scan modulation with triangle wave, 5 - Activate internal scan modulation with positive ramp, 6 - Activate internal scan modulation with negative ramp, 7 - Activate internal scan modulation with noise, 8 - Activate internal scan modulation, but set output to zero.
45	Invalid FM source. INTernal or EXTernal is supported.
46	Invalid FM mode. 1 - FM Narrow, 2 - FM Wide.
47	Invalid FM action. 0 - Deactivate FM, 1 - Activate external FM, 2 - Activate internal FM with sine wave, 3 - Activate internal FM with square wave, 4 - Activate internal FM with triangle wave, 5 - Activate internal FM with positive ramp, 6 - Activate internal FM with negative ramp, 7 - Activate internal FM with zero output.
48	Invalid boolean value is specified. 0 - OFF, 1 - ON.
49	List sync out delay is out of range.
50	Invalid list trigger direction: 0 – Forward (from first to last list point), 1 – Backward (from last to first list point).
51	Invalid list sequence number (some sequence numbers might be less than 0 or exceed available list index).
52	List has not been pre-computed before running. Pre-computing a list is required before running a list.
53	Running a list is not allowed due to an un-calibrated unit.
54	Index of the first dimension in characterization array is out of range.
55	Index of the second dimension in characterization array is out of range.
56	Index of the third dimension in characterization array is out of range.
57	Index of the fourth dimension in characterization array is out of range.
58	Invalid name for characterization variables.
59	No heap space is available for storing characterization data.
60	Heap is not allocated for storing characterization data.
61	A float variable has been viewed previously.
62	Unable to erase data in flash.

Table B-2: 2400 Error Messages

2400 ERROR #	2400 ERROR MESSAGE
63	Checksum mismatches for characterization data in flash and heap.
64	Heap allocation has been done previously.
65	List RF off time is out of range.
66	Incorrect password for setting minimum list step time.
67	Unable to update parameter block data.
68	List step time is out of range.
69	FM deviation is out of range.
70	FM sensitivity is out of range.
71	PM internal PRI is out of range.
72	PM internal width is out of range.
73	PM internal sync out delay is of out of range.
74	CW power slope is out of range.

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2400 Series Microwave Synthesizer Index