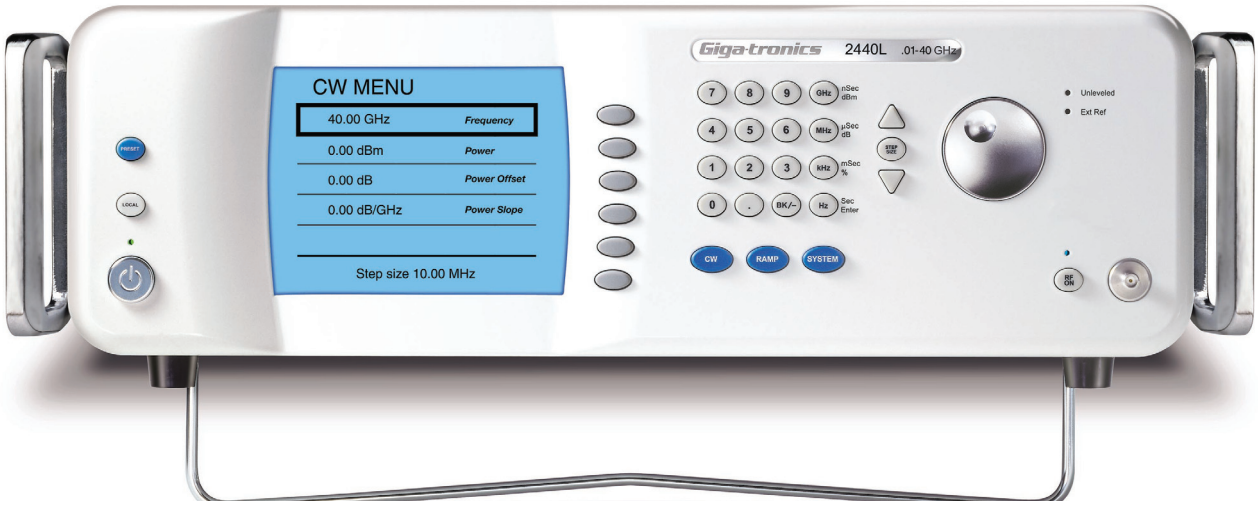
2400 Series



Registered 04 June 1996 Amended 10 September 2001

CE

Certified Product

ISO 9001

Certified Process

Registrar: BSI, Certification FM 34226

2400 Series Microwave Synthesizer Operation Manual

Part #33237, Revision A, May 2004

Giga-tronics

All technical data and specifications in this publication are subject to change without prior notice and do not represent a commitment on the part of Giga-tronics, Incorporated.

WARRANTY

Giga-tronics 2400 Series instruments are warranted against defective materials and workmanship for one year 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 4. 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

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:
2400 Series

Model Number(s) in Series:
2408A/AL, 2420A/AL, 2426A/AL, 2440A/AL
2408M/AM, 2420M/AM, 2426M/AM,2440M/AM

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

Steve Gredell (Full Name) _____ (Signature) Acting Director of Quality Assurance (Position)

San Ramon, California (Place) April 2004 (Date)

About The Publication

Preface

This publication describes an overview, specification, the local (front panel) operation, remote operation, and performance verification of Giga-tronics 2400 Series Microwave Synthesizer. The 2400 Series includes a 2400A family of models (2400AL and 2400AM), 2400L family, and a 2400M family. The following 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- Overview and General Information

This chapter contains information basic information on the instrument and its performance parameters.

2 - 2400 Operation

This chapter contains user information about the front panel operation. All controls and features are described in this section.

3- Remote Operation

Describes how to operate the instrument from a remote location over General Purpose Interface Bus (GPIB) or RS-232.

4- Specification & Performance Verification

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

Appendices:

A- Accessories and Options

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 - Remote Error Messaging

Provides a description of the remote error messages associated with remote operation of the 2400.

C- Remote Programming Examples

Provides a list of sample SCPI scripts used for remote operation of the 2400 Series. All programming codes are presented in this chapter with various applications to aid you in understanding the operation.

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A subject listing of contents.

Conventions

The following safety conventions are used in this publication. Additional conventions not included here will be 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 serial, code, model number, option or configuration label affixed to the rear panel of the 2400 Microwave Synthesizer.

Serial Number

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

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, and one or two suffix character which designates the series (2400X) and (24XXL); Model Type (24XXL) and (24XXAL) CW, No Modulation;
Model Type (24XXM) and (24XXAM), CW, Modulation.
Frequency Range (2408L/M) and (2408AL/AM) 0.01 to 8 GHz, (2420L/M) and (2420AL/AM) 0.01 to 20 GHz, (2426L/M) and (2426AL/AM) 0.01 to 26.5 GHz, (2440L/M) and (2440AL/AM) 0.01 to 40 GHz,

Option Number

When options are installed, one or more 2 digits numbers are on the line which correspond to the option numbers in Appendix A.

Configuration Number

If the configuration line contains a three digit (e.g 241), there is combination of options and/or special modifications installed in the instrument. Information relating to special configurations will be contained in supplemental pages included with this manual.

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

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).

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 Instructions), 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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1 Introduction

1.1 Overview

The 2400L and 2400AL Series are CW only Microwave Synthesizers with List Sweep capability. The 2400M and 2400AM Series Microwave Synthesizers include the functionality of the 2400L and 2400A Series and include AM, FM, and Pulse capability. The 2400 Series can generate output signals over a frequency range of 10 MHz to 40 GHz; the frequency range is dependent on the specific model number.

The 2400A Series, includes the 2400AL and 2400AM models. The2400A Series is a system source specifically designed to match the unique performance needs of ATE integrators. The 2400A Series deletes the front panel and requires a controller with GPIB, RS-232 or USB 1.1 interface. The 2400A includes hardware triggering and synchronization signals with programmable delay to allow coordination with other test products in your system. The 2400A Series standard features include a 3U rack mountable microwave synthesizer with rack ears, a high stability timebase option, rear RF-output, GPIB-interface, and a blank front panel.

WaveMaker, a complete remote operating system for use with the 2400 Series Microwave Synthesizers, is included with each 2400 Series Synthesizer. WaveMaker leverages industry-leading software applications and familiar Windows drop-down menus and other functions to perform tasks, significantly reducing the need for extensive product training.

The Giga-tronics 2400 delivers state of the art phase noise performance with the fastest frequency switching speeds for its class. Coupled with Option 48, Xpress Interface, Automation Xpress software simplifies ATE code generation using the Automation Xpress Auto-Programmer feature providing 2.5 msec. frequency and power switching for single command line remote

Table 1-1 lists the models with their respective features.

Table 1-1: 2400 Series Features

CW Frequency Range	10 MHz to 40 GHz, model dependent
Frequency Resolution	0.1 Hz
High Stability Timebase	$<5 \times 10^{-10}$/day, 2400L and 2400M Models $<1 \times 10^{-8}$/day, 2400A Series only
Temperature Stability	$< \pm 5 \times 10^{-10}$/°C, 2400L and 2400M Models $< \pm 2 \times 10^{-8}$/day, 2400A Series only

Table 1-1: 2400 Series Features

Low SSB Phase Noise	-92 dBc/Hz, 10 kHz offset @ 10 GHz
Excellent Output Power	>+15 dBm to 20 GHz, > +9 dBm to 40 GHz
Fast Frequency Switching	<500 µSec. typical, List Mode
Settable Level Range:	+25 dBm to -110 dBm
WaveMaker Software	Included
USB/RS-232 Adapter:	Included

All 2400 Series Microwave Synthesizers comply with MIL-PRF-28800F, Class 3

1.1.1 2400 Options

- Option 22- Rear RF Output, available for 2400L and 2400M models only. standard for the 2400AL and 2400AM standard
- Option 24- Internal Modulation Generator, 2400M and 2400AM only
- Option 25-100 kHz frequency extension, available on all 2400 Series. Not available for 40 GHz models.
- Option 26- 90 dB Step Attenuator, all models
- Option 28- High Stability Timebase, available for 2400A Series only
- Option 43- Frequency and Power Sweep
- Option 45- Rack Ears
- Option 48- Automation Xpress Interface (AXI) for use with Giga-tronics Automation Xpress Software

1.1.2 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:

- Operations Manual (P/N 33237)
- WaveMaker User Guide (P/N 33216)
- WaveMaker Software CD-ROM (P/N 33105)
- USB/RS-232 Cable Adapter
- Power Cord, 6 ft.

1.1.3 Items Required

No special tools are required to operate the 2400 Series. Models 24XXAL/AM Series require remote operation via a computer. Test equipment required for performance verification is described in Chapter 4.

- IEEE 488 Interface Cable (needed for Remote Control Operation)
- RF Output Cabling (Made to fit Female Type SMA Output Connector) (Order Accessory Cable Kit Accessory A001).
- PC, GPIB or RS-232 needed for remote control operation
- Standard 9 Pin Type D Serial Cable (optional)

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:

- Warm-up time of 20 minutes for normal operation
- Performance Verification procedures outlined in Chapter 4 for all models.

1.2.1 Cooling

A cooling fan is installed in all four 2400L/AL and 2400M/AM models. The cooling air intake is located on the rear panel of all models. Care must be taken to avoid obstructing the flow of air into the instrument.

1.2.2 Cleaning

The air intake screen should be cleaned for all four 2400L/AL and 2400M/2400AM models 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.

1.2.3 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 extractor handles, etc. Check the shipping carton for evidence of physical damage and immediately report any damage to the shipping center.

1.2.4 Reshipment Preparation

If it is necessary to return the instrument to the factory, protect the instrument 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:

☛ FRAGILE - DELICATE INSTRUMENT

If corresponding with the factory of 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).*

1.2.5 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 64 Hz (400 Hz optional). There are no manual voltage adjustments or selection controls. The 2400 Series has a 3-Wire power cord with a 3-terminal polarized plug for connection to the power source and safety ground. The power cord can 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 the earth ground. Failure to do this could cause the instrument to float above ground, posing a shock hazard.

CAUTION

DO NOT position the equipment so that it is difficult to operate the disconnecting device (to remove the AC line cord).

1.2.6 Line Fuse

All 2400 Series models have a line fuse container on the rear panel.

1.2.6.1 Fuse Installation

All 2400 Series models have a power line fuse that is 2A, Slo-Blo, 250V, Type T (Illustration 1.1 below for location).

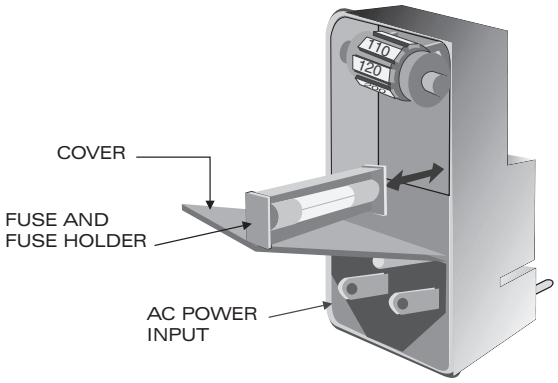


Illustration 1.1 | Fuse Holder

1.2.6.2 Fuse Replacement

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 illustration above.

1.3 Inputs/Outputs

Input/Output connectors for the 24XXL/M models are shown in Illustration 1.2. Table 1-2 contains the front and rear panel I/O connector functional descriptions for all models.

1.3.1 Front Panel I/O Connectors

1.3.1.1 RF Out

This is the instrument's RF output is located on the front panel for the 2400L and 2400M Series Synthesizer models. The RF output is located on the rear panel for the 2400AL and 2400AM Series Synthesizer models. Illustration 1.2 shows the panel interface located on the front of all 2400L and 2400M Series models. All other connectors are type BNC unless otherwise stated.

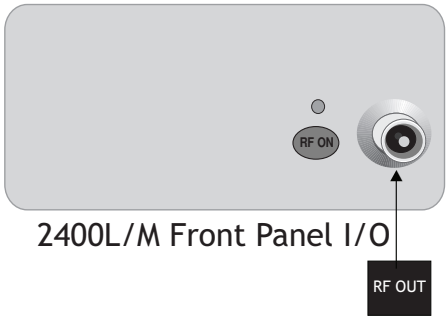


Illustration 1.2 | Series 2400L/M Front Panel Output

1.3.2 Rear Panel Interface and I/O Connectors

This section defines the functions and interface of the 2400L/AL and 2400M/AM rear panel (See Illustration 1.3). The RF Out connector is located on the front panel for the 2400L/M Series. The RF Out connector is located on the rear panel for the 2400AL/AM Series and 2400L/M Series with option 22 installed. (See Section 1.3 for details on Inputs and Outputs).

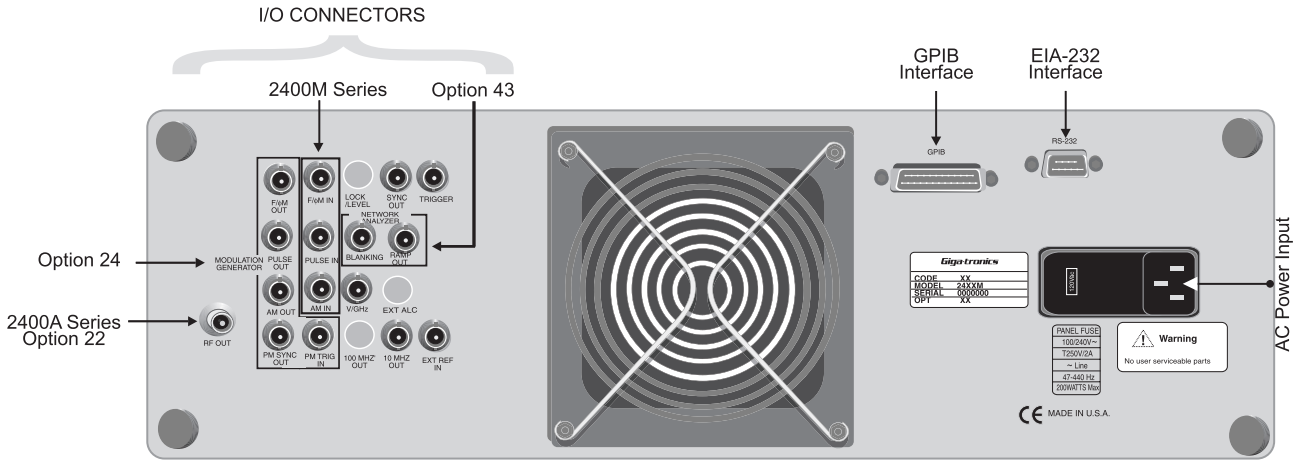


Illustration 1.3 | 2400 Series Rear Panel

1.3.2.1 I/O Connectors (Rear Panel)

This section defines the rear panel interface I/O connectors and the functions located on the rear of the 2400 Series for all models.

For all 2400L/AL models, the modulation I/O BNC connectors located on the rear panel of the instrument are eliminated (plugged).

Please refer to Table 1-2 for I/O connector descriptions.

Table 1-2: 2400 Series Rear Panel I/O Connector Descriptions

I/O Connector Name	2400 Series Availability	Description
TRIGGER IN	L, M, AL, AM	Accepts a sweep or List trigger. TTL level input > 50 ns width
SYNC OUT	L, M, AL, AM	+5 volt, 1 usec width signal. In list operation signal can be delayed from the start of any list point up to 10 msec maximum. In Ramp operation, signal occurs at the start of each ramp sweep.
V/GHz	L, M, AL, AM	Output voltage directly proportional to Frequency. 40 GHz models: 0.25 volts per GHz output, 8 and 20 GHz models: 0.5 volts per GHz
10 MHz REF OUT	L, M, AL, AM	2 Vp-p level at 50 Ω. 10 MHz square wave
EXT REF IN	L, M, AL, AM	10 MHz or 100 MHz input >-5.0 dBm, 50 Ω
BLANKING	L, M, (Option 43)	+5 volt output signal occurring at band crossings and filter switches for the duration of the event

Table 1-2: 2400 Series Rear Panel I/O Connector Descriptions

I/O Connector Name	2400 Series Availability	Description
RAMP OUT	L, M,(Option 43)	0 to 10 volt ramp output scaled to frequency sweep.
AM IN	M, AM	External AM input 600 Ω Any waveform compatible with bandwidth considerations. 1 Vp-p for 50% depth.
FM IN	M, AM	External FM 50 Ωinput. Any waveform compatible with bandwidth considerations. 1 Vp input for maximum deviation.
PM IN	M, AM	+5.0 volt, 50 Ωinput.
PM TRIGGER IN	M, AM	+5.0 volt, 50Ωinput. Triggers a delayed pulse output specified in Internal PM menu (Option 24 required).
AM OUT	M, AM (Option 24)	Modulation generator output, 2 Vp-p into 10 k Ω.
FM OUT	M, AM (Option 24)	Modulation generator output, 2 Vp-p into 10 k Ω.
PM OUT	M, AM (Option 24)	+4.0 volt video representation of the pulsed signal output at 50 Ω
PM SYNC OUT	M, AM (Option 24)	50 ns width, TTL level output into 50 Ω Coincident with Pulse trigger event + 30 ns.
GPIB Interface	L, M, AL, AM	IEEE STD 488.2 General purpose instrument bus.
RS-232	L, M, AL, AM	Serial Interface, DB9 connector.
AC Power Input	L, M, AL, AM	90-253 VAC, auto-sensing, 47 Hz to 64 Hz.

* L - 2400L series, M - 2400M series, AL - 2400AL series, AM - 2400AM series

2 2400 Operation

2.1 Introduction

This chapter describes how to operate the 2400 Series from the front panel. For reference, Chapter 1 pertains to instructions on how to install the instrument and details instrumental interfacing prior to the unit's first operation. Chapter 3 gives operational instructions on using the instrument from a remote host computer over the General Purpose Interface Bus (GPIB) or an RS-232 serial connection

2.2 Front Panel

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 any compatible remote interface. Giga-tronics WaveMaker software is included with each 2400 Series to quickly access these functions. Front panel controls are grouped according to the functions they perform. Descriptions for the front panel controls are referenced to the numbers depicted in illustration 2.2 on the next page.

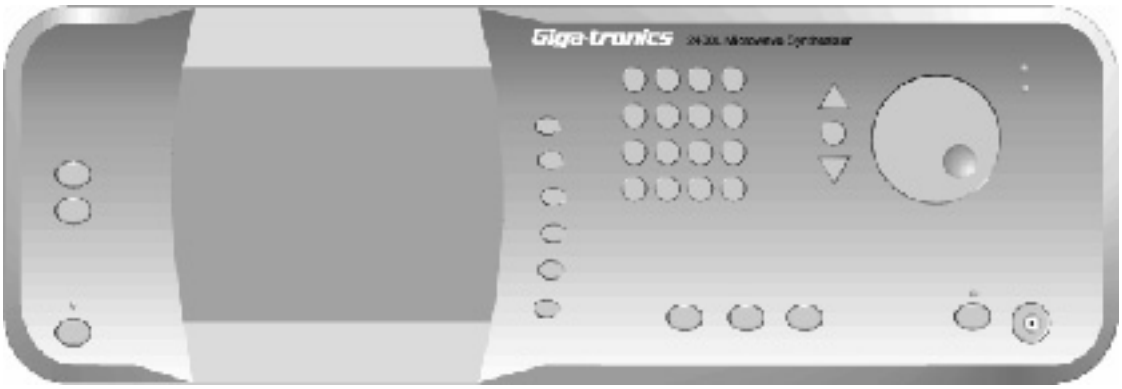


Illustration 2.1 | 2400 Front Panel

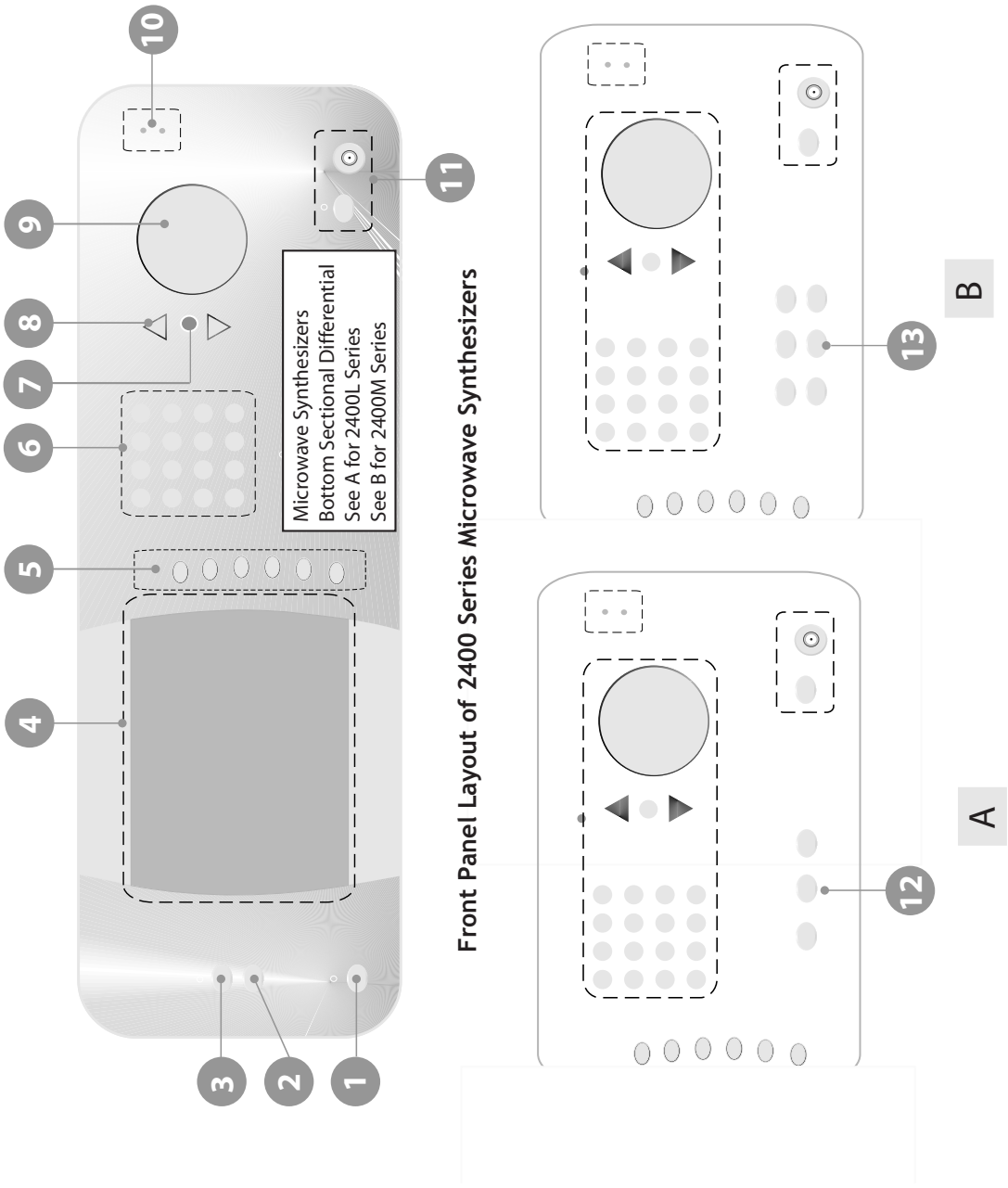


Illustration 2.2 | 2400L Front Panel with Callouts

2.2.1 Front Panel Description

1 Power

Main power switch for the 2400.

2 Local Key

Allows front panel access when the unit is in remote mode

3 Preset Key

Presets the 2400 to factory defaults.

1. Factory defaults - press to restore Timebase Cal and Contrast to factory calibrated values.

2. Reset memory - press to clear stored memory, restore default values for sound, attenuation, GPIB address and language interface.

CANCEL - press to continue the normal boot up sequence.

4 Display

Displays the current working menu. Parameters i.e. level offset, slope, AM, FM and Pulse are displayed in the upper right hand section of the display when the selected parameter is active. Parameters on the right hand portion of the screen identify the parameter for the row it is in. Each parameter has an Interactive Soft-key adjacent to the parameter.

5 Interactive Soft-keys

Selects the parameter for modification.

6 Data Entry Field

12-button numeric keypad and Units Keys. Data is entered directly into the selected parameter in the Display.

7 Step Size Key

Selects and allows editing of the step size of the Step Up/Down keys or Rotary Knob.

8 Step Up/Down Keys

Increases or decreases the selected parameter in the display by the amount specified by the step size. It is also used to toggle the On/Off states of modulation parameters.

9 Adjusting Knob

Increments or decrements a parameter selected in the display. When a maximum or minimum limit is reached, the parameter will not update and a message will be displayed at the bottom of the display

indicating that the parameter limit has been reached. If the sound in the System menu display is activated, an audible click will occur of each step of the Rotary Knob

10 Front Panel LEDS

The front panel LEDs are located in several places.

Unleveled LED

LED is active when the 2400 is operating in an unleveled state.

External REF LED

LED is active when the 2400 is operating with an external reference applied.

RF ON/OFF LED

LED is blue when the 2400 RF output is active. When the RF output is inactive the LED is amber

Power LED

LED is blue when the unit is on, amber when the unit is in standby mode

11 RF Output Connector

RF output for 2400M and 2400L series sources. All 2400A models move the RF Out connector to the rear panel.

12 Menu Keys

CW Key

Sets the active display to CW

Ramp Key

Sets the active display to Ramp when Option 43 is installed.

System Key

Sets the active display to the System menu.

13 Modulation Menu Keys

In addition to the CW, Ramp, and System menu keys, all 2400M Series models have separate AM, FM, and Pulse menu keys. Each menu-key will lead to their respective soft-key driven menu choices.

AM Menu Key

Sets the active display to Amplitude Modulation. 2400M series only

FM Menu Key

Sets the active display to Frequency Modulation. 2400M series only

PULSE Menu Key

Sets the active display to Pulse Modulation. 2400M series only.

2.3 Front Panel Operation

This section describes front panel operation of the 2400 functions. Parameters for these functions are input using one of the following data entry methods: numeric keypad, step up/step down keys or rotary knob. Some data entry methods may not be available for some parameters.

2.3.1 Direct Entry Using Numeric Keypad

After selecting the desired parameter (I.E. Frequency in the CW menu), enter the new value using the number keypad. After the new value has been entered, press the appropriate Units key to update the 2400 to the new setting. To enter negative values press the [BK/-] key before entering the first digit of the new value. After the first digit of the new entry has been entered, the [BK/-] will serve as a back-space and delete the previously entered digit.

2.3.2 Step Size

Parameters in CW, AM, FM, PM, Ramp and System menus can be modified using the Step Up or Step Down keys. The step size for a specific parameter is edited using Numeric Keypad only. Refer to the previous section for editing the step size parameter.

2.3.3 Step Up/Step Down

Position the cursor over the desired parameter by pressing the appropriate parameter softkey. The step size for the parameter will be displayed at the bottom of the menu. Press the Up key to increase the selected parameter by the specified step size shown at the bottom of the menu. Press the Down key to decrease the selected parameter by the specified step size shown at the bottom of the menu.

2.3.4 Rotary Knob

The rotary knob is used to modify a parameter by rotating the knob clock wise or counterclockwise. The parameter will be modified according to the step size for the selected parameter. System menu parameters and Modulation activation parameters may not be edited using the rotary knob.

2.3.5 CW Menu

For Frequency, Level, Level Offset and Power Slope, press the CW button to access the CW menu

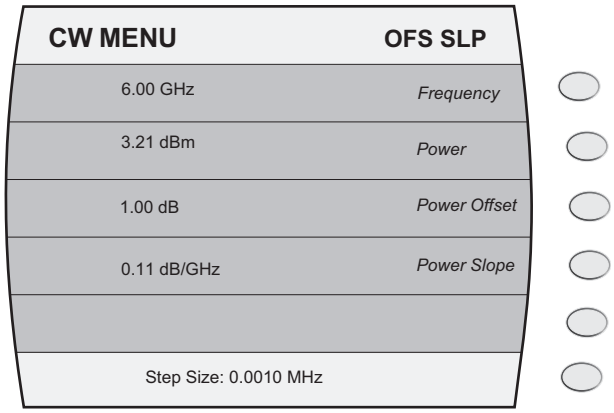


Illustration 2.3 | Fixed Frequency Menu with Soft-keys

2.3.5.1 Setting Frequency

If the operating menu is not in CW, press the CW Menu button. Press the Frequency softkey to position the menu cursor over Frequency field in the CW menu. Edit the frequency using the numeric keypad, step up/step down keys or the rotary knob.

2.3.5.2 Setting Level

Press the Power softkey to position the menu cursor over the Power field in the CW menu. Edit the power using the numeric keypad, step up/step down keys or the rotary knob.

2.3.5.3 Setting Power Offset

Press the Power offset softkey to position the menu cursor over the Power Offset field in the CW menu. Edit the power using the numeric keypad, step up/step down keys or the rotary knob. The maximum power offset setting is +10 dB. The Power Offset indicator OFS will automatically activate for any value greater than 0.00 dB.

2.3.5.4 Setting Power Slope

Press the Power Slope softkey to position the menu cursor over the Power Slope field in the CW menu. Edit the power slope using the numeric keypad, step up/step down keys or the rotary knob. The maximum slope setting is 0.5 dB/GHz. The Power Slope indicator will automatically activate for any value greater than 0.00 dB.

2.3.6 Configure a Ramp Frequency Sweep (Option 43)

For Ramp frequency sweep operation, press the RAMP button to access the RAMP menu. Option 43 must be installed. If option 43 is not installed, a status message will appear at the bottom of the display indicating that option 43 is not installed. After a ramp calculation is performed by the 2400, the unit will continuously sweep. There is no provision for an externally triggered ramp sweep.

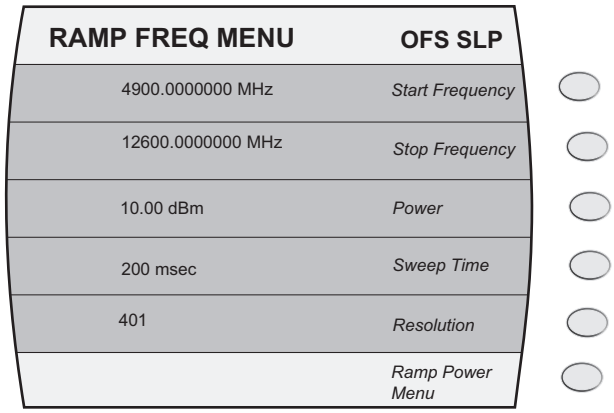


Illustration 2.4 | Ramp Frequency Menu

2.3.6.1 Ramp Frequency Sweep Parameters

2.3.6.1.1 Start Frequency

Press the Start Frequency softkey. Edit the start frequency using the numeric keypad, step keys or rotary knob.

2.3.6.1.2 Stop Frequency

Press the Stop Frequency softkey. Edit the stop frequency using the numeric keypad, step keys or rotary knob.

2.3.6.1.3 Power

Press the Power softkey. Edit the power setting of the frequency ramp sweep using the numeric keypad, step keys or rotary knob.

2.3.6.1.4 Sweep Time

Press the Sweep Time softkey. Edit the sweep time of the ramp frequency sweep using the numeric keypad, step keys or rotary knob.

2.3.6.1.5 Resolution

Press the Resolution softkey. Using the step keys or rotary knob to enter the ramp frequency sweep resolution. The settable range is 401, 801 and 1601.

2.3.6.1.6 Ramp Power Menu

Press the Ramp Power Menu softkey to enter the Ramp Power Sweep menu.

2.3.7 Configure a Ramp Power Sweep

For ramp power sweep operation, Option 43 must be installed. Press the RAMP button to access the RAMP menu, and then press the Ramp Power Menu softkey to enter the Ramp Power menu. If option 43 is not installed, a status message will appear at the bottom of the display indicating that option 43 is not installed. After a ramp calculation is performed by the 2400, the unit will continuously sweep. There is no provision for an externally triggered ramp sweep. The maximum settable range for ramp sweep is 45 dB. If option 26 is installed in the 2400, the ramp power sweep operation prevents the attenuator from switching during a ramp power sweep. For power sweeps with levels below -20 dBm, it is necessary to set the step attenuator before setting the start and stop power sweep settings.

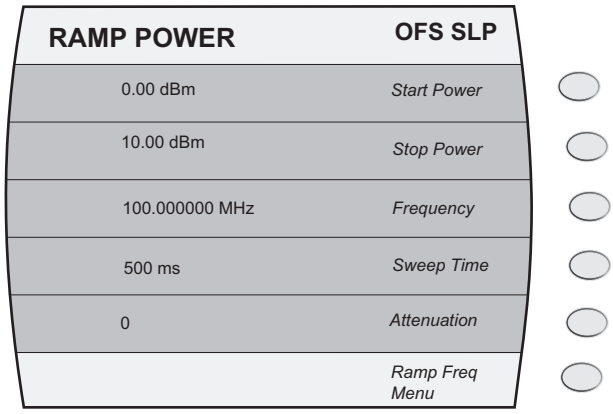


Illustration 2.5 | Ramp Power Menu

2.3.7.1 Ramp Power Sweep Parameters

2.3.7.1.1 Start Power

Press the Start Power softkey. Use the numeric keypad, step keys or rotary knob to enter the starting power level.

2.3.7.1.2 Stop Power

Press the Stop Power softkey. Use the numeric keypad, step keys or rotary knob to enter the stop power level.

2.3.7.1.3 Frequency

Press the Frequency softkey. Use the numeric keypad, step keys or rotary knob to enter the frequency of the ramp power sweep.

2.3.7.1.4 Sweep Time

Press the Sweep Time softkey. Use the numeric keypad, step keys or rotary knob to enter the sweep time of the ramp power sweep.

2.3.7.1.5 Attenuation

Press the Attenuation softkey. Using the step keys or rotary knob to enter the attenuation setting. The settable range is 0 to 90, in 10 dB steps. The start and stop power settings may automatically reset to a permissible level for the attenuation setting. If option 26 is not present, the display line will display "Option 26 not installed".

2.3.7.1.6 Ramp Freq Menu

Press the Ramp Frequency Menu softkey to enter the Ramp Frequency Sweep menu.

2.3.8 System Menu

The System Menus provide access to the 2400 System information, Memory Storage Locations, GPIB configuration, display contrast and system volume control. If the current menu is not in the System menu, press the System Menu button. Press the System Menu softkey at the bottom of the display to navigate between the system menus.

2.3.8.1 System Menu 1

Save To save the current system configuration to system memory, press the Save softkey to select the To Register field. Using the numeric keypad, press any value from 0 to 9 and press any units key to save the instrument configuration.

Recall To recall a previously saved instrument configuration, press the Recall softkey to select the Recall selection. Using the numeric keypad, enter any available setting number (0 to 9) and press any

units key to recall the set up. After a successful recall, the display menu will remain in the System 1 Menu.

Contrast Press the Contrast softkey to modify the display contrast. The display contrast can be modified using the Step Up/Step Down keys, numeric keypad and Rotary Knob. The contrast setting range is 1 to 15

Sound To enable or disable the system sound, press the Sound softkey to select the Sound parameter. The sound setting is toggled using the Step Up/Step Down Keys. The available selections are On and Mute. Available system sounds are the increment/decrement functions for the Rotary Knob and System Operational Error Notification.

Attenuation This selection provides control of the system step attenuator if it is installed in the 2400 (Option 26). Press the Attenuation softkey to modify the attenuator setting. Using the Step Up/Step Down keys, set the attenuator to automatically adjust or manual control in 10 dB steps to 90 dB.

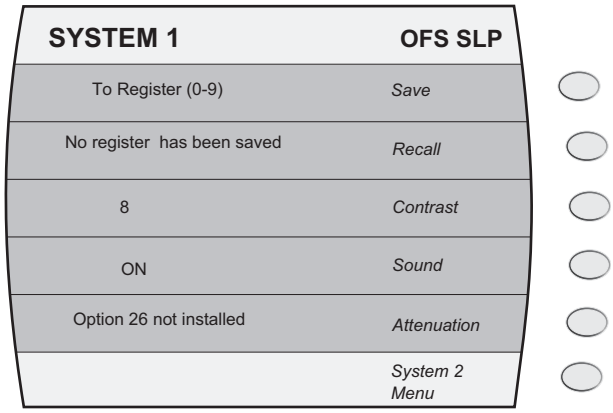


Illustration 2.6 | System Menu 1

2.3.8.2 System Menu 2

GPIB Address Press the GPIB Address to move the cursor to the GIPB address parameter. The GPIB address can be set from 1 to 30 using the numeric keypad, Step Up/Step Down keys or Rotary Knob.

Language Interface Press the Language Interface softkey to move the cursor to the Interface parameter. Select SCPI or GT12000 selection to set the remote command language using the Step Up/Step Down keys. SCPI is Standard Commands for Programmable Instruments. GT12000 is Giga-tronics native command set. See Giga-tronics 12000A Operations Manual for the remote command language description.

General Information This field displays the 2400 system information identifying the model type, firmware version, serial number and firmware build date information.

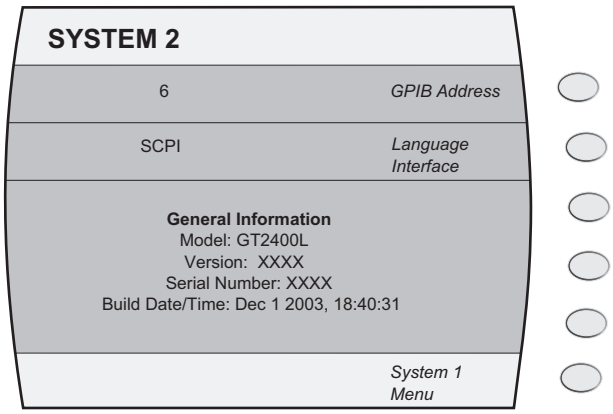


Illustration 2.7 | System Menu 2

2.3.9 Using Modulation

(NOT AVAILABLE IN 2400L/AL SERIES)

The 2400M/AM Series offers three types of output modulation; AM, FM, and PM. The modulation menu and parameters will be displayed when you press the **[AM]**, **[FM]**, and **[PM]** soft keys located on the front panel.

2.3.9.1 Amplitude Modulation

If the operating menu is not in the AM menu, press the AM Menu button.

To activate and deactivate AM, press the AM softkey to move the cursor to the On/Off selection. Press the Step Up key or Step Down key to toggle the AM state. The AM indicator will be displayed on the menu when AM is active. Press in the AM menu softkey (i.e AM 2/3) to cycle the display to the desired AM menu (option 24 only).

2.3.9.1.1 External Source (AM Menu 1)

Press the Sensitivity softkey of the AM External Source menu to move the cursor to the Sensitivity parameter. Edit sensitivity parameter using the numeric keypad, step up/step down keys or the rotary knob. The maximum allowable setting is 95%/volt.

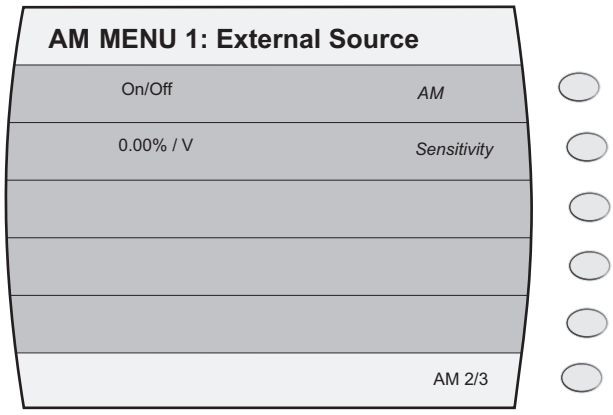


Illustration 2.8 | Amplitude Modulation Menu 1

2.3.9.1.1 Internal Waveform Source (AM Menu 2)

The internal AM requires setting the following parameters: Depth, Rate and Waveform.

- Press the Depth softkey to move the cursor to the Depth parameter. Edit the depth parameter using the numeric keypad, step up/step down keys or rotary knob. The maximum depth setting is 95%.
- Press the Rate softkey to move the cursor to the AM Rate parameter. Edit the AM rate parameter using the numeric keypad, step up/step down keys or rotary knob.
- Press the Waveform softkey to move the cursor to the AM Waveform parameter. Change the waveform by pressing the Step Up or Step Down keys. The available selections are Sine, Triangle, Ramp or Square.

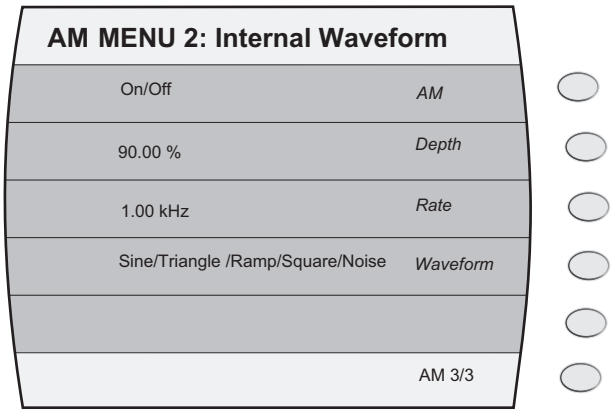


Illustration 2.9 | Amplitude Modulation Menu 2

2.3.9.1.1 Internal Noise Source (AM Menu 3)

Press the Depth softkey to move the cursor to the Depth parameter. Edit the depth parameter using the numeric keypad, step up/step down keys or rotary knob. The maximum depth setting is 95%.

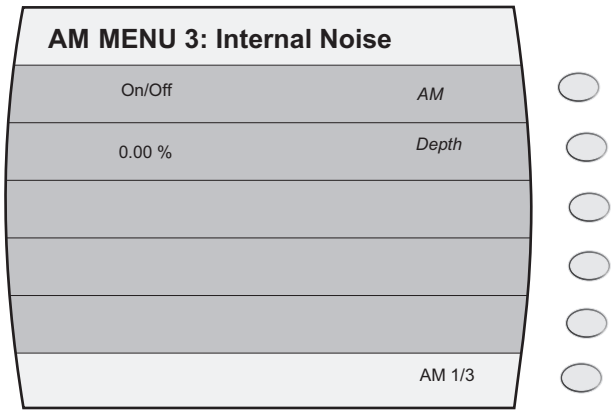


Illustration 2.10 | Amplitude Modulation Menu 3

2.3.9.2 Frequency Modulation

If the operating menu is not in the FM menu, press the FM Menu button.

To activate and deactivate FM, press the FM softkey to move the cursor to the On/Off selection. Press the Step Up key or Step Down key to toggle the FM state. The FM indicator will be displayed on the menu when FM is active. FM settings are interdependent. Consult the FM specifications settings for Rate, Deviation and Mode to determine allowable settings for each parameter. Press the FM menu softkey (i.e FM 2/3) to cycle the display to the desired FM menu (option 24 only).

2.3.9.2.1 External Source (FM Menu 1)

- Press the Mode softkey to move the cursor to the Mode parameter. Toggle the mode using either the Step Up/Step Down. Selection is Wide or Narrow.
- Press the Sensitivity softkey to move the cursor to the Sensitivity parameter. Edit the FM sensitivity using the numeric keypad, step up/step down keys or rotary knob. The maximum value for this parameter is frequency and mode dependent. An error message will be displayed for an invalid entry at the bottom of the display.

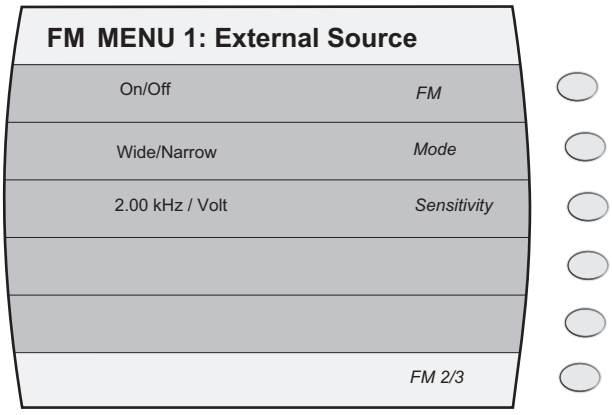


Illustration 2.11 | Frequency Modulation Menu 1

2.3.9.2.1 Internal Waveform Source (FM Menu 2)

- Press the Mode softkey to move the cursor to the Mode parameter. Toggle the mode using either the Step Up/Step Down keys. Selection is Wide or Auto (Narrow). In Auto mode, the 2400M will automatically switch to Narrow mode if the rate and deviation settings are applicable for Narrow mode operation.
- Press the Deviation softkey to move the cursor to the Deviation parameter. Edit FM deviation using the numeric keypad, step up/step down keys or rotary knob.
- Press the Rate softkey to move the cursor to the rate parameter. Edit the rate using the numeric keypad, step up/step down keys or rotary knob. The maximum rate for option 24 is 1 MHz.
- Press the Waveform softkey to move the cursor to the waveform parameter. Edit the waveform using the step up or step down keys. The available waveforms are Sine, Triangle, Ramp, and Square.

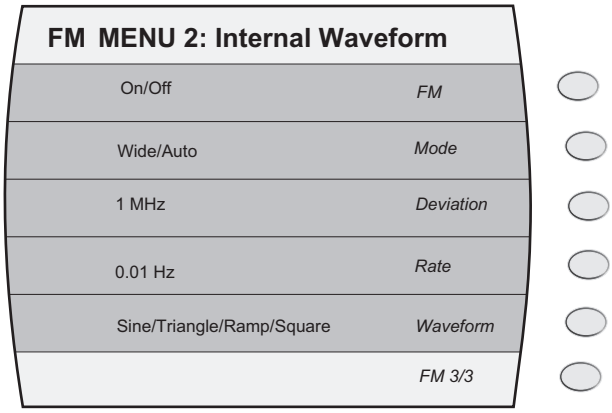


Illustration 2.12 | Frequency Modulation Menu Selection 2

2.3.9.3 Pulse Modulation

If the current menu is not in the PM menu, press the PM Menu button.

To activate and deactivate PM, press the PM softkey to move the cursor to the On/Off selection. Press the Step Up key or Step Down key to toggle the PM state. The PM indicator will be displayed on the menu when PM is active.

2.3.9.3.1 External Source (Pulse Menu 1)

Press the Input Polarity softkey to move cursor to the Input Polarity parameter. Toggle the active state to Active High or Active Low using the step up or step down keys.

Press the PM menu softkey (i.e PM 2/4) to cycle the display to the desired Pulse modulation menu (option 24 only).

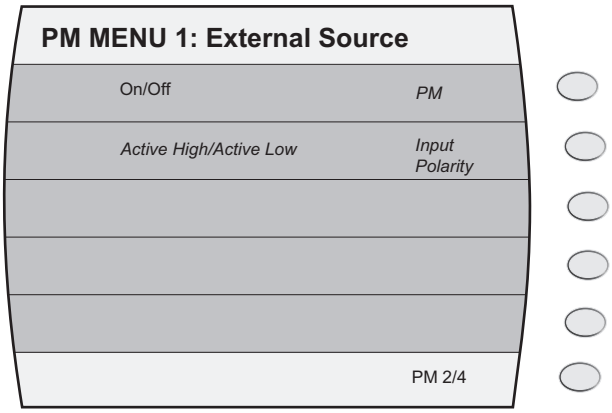


Illustration 2.13 | Pulse Modulation Menu 1

2.3.9.3.1 Internal Source (Pulse Menu 2)

- Press the PRI softkey to move the cursor to the PRI parameter. Edit the PRI using the numeric keypad, step up/step down keys or rotary knob. The maximum setting is 1 sec. An error message will be displayed for an invalid entry at the bottom of the display.
- Press the Width softkey to move the cursor to the Width parameter. Edit the Width using the numeric keypad, step up/step down keys or rotary knob. The minimum setting is 150 ns. The maximum setting is 10 ms.
- Press the Sync Out Delay softkey to move the cursor to the Sync Out Delay parameter. Edit the Sync Out Delay using the numeric keypad, step up/step down keys or rotary knob. A sync pulse will occur at the Sync Out BNC connector for every RF pulse. The sync pulse will occur at the set delay from the leading edge of the RF pulse.

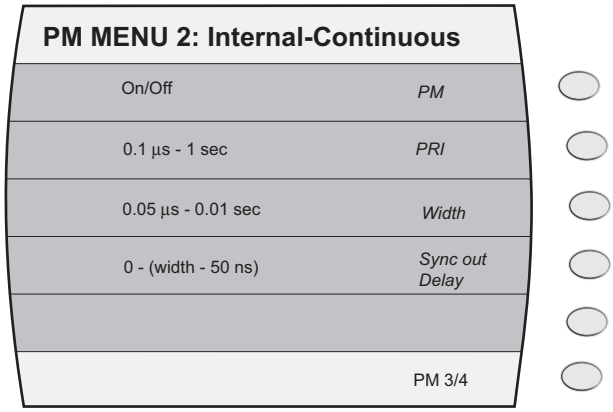


Illustration 2.14 | Pulse Modulation Menu 2

2.3.9.3.1 Internal Source-Gated Mode (Pulse Menu 3)

Gated mode will produce an internally generated pulse modulated waveform based on the pulse settings for the duration of an externally provided gate signal.

- Press the PRI softkey to move the cursor to the PRI parameter. Edit the PRI using the numeric keypad, step up/step down keys or rotary knob. The maximum setting is 1 sec. An error message will be displayed for an invalid entry at the bottom of the display.
- Press the Width softkey to move the cursor to the Width parameter. Edit the Width using the numeric keypad, step up/step down keys or rotary knob. The minimum setting is 150 ns. The maximum setting is 10 ms.
- Press the Sync Out Delay softkey to move the cursor to the Sync Out Delay parameter. Edit the Sync Out Delay using the numeric keypad, step up/step down keys or rotary knob. A sync pulse will occur at the Sync Out BNC connector for every RF pulse. The sync pulse will occur at the set delay from the leading edge of the RF pulse.
- Press the Trigger In softkey to move the cursor to the Trigger In parameter. Using the Step Up or Step Down keys, toggle the trigger input setting to Active High or Active Low.

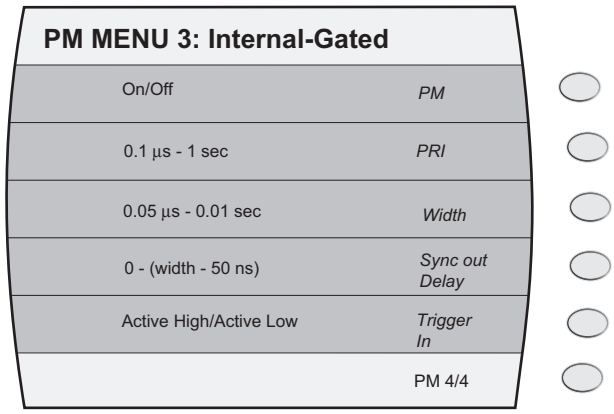


Illustration 2.15 | Pulse Modulation Menu 3

2.3.9.3.1 Internal Source-Triggered Mode (Pulse Menu 4)

- Press the RF Pulse Delay softkey to move the cursor to the RF Pulse Delay parameter. Edit the RF pulse delay using the numeric keypad, step up/step down keys or rotary knob. The RF pulse delay is executed after the leading edge of an external trigger is received at the PM Trigger In BNC. After the delay has been executed, the programmed RF pulse is output at the RF Output connector.
- Press the Width softkey to move the cursor to the Width parameter. Edit the Width using the numeric keypad, step up/step down keys or rotary knob. The minimum setting is 150 ns. The maximum setting is 10 ms.
- Press the Sync Out Delay softkey to move the cursor to the Sync Out Delay parameter. Edit the Sync Out Delay using the numeric keypad, step up/step down keys or rotary knob. A sync pulse will occur at the Sync Out BNC connector for every RF pulse. The sync pulse will occur at the set delay from the leading edge of the RF pulse.

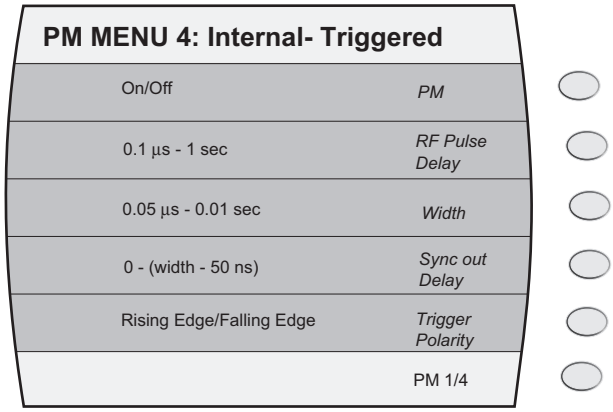


Illustration 2.16 | Pulse Modulation Menu 4

2.3.10 Factory Default Settings

Parameter	Default Condition
CW Frequency	10MHz
RF @ Power Up	OFF
RF Level	0 dBm
Offset	0.0 dB
Slope	0.0 dB/GHz

2.3.11 Resetting the system

2.3.11.1 NVRAM Description

The 2400 Series uses non-volatile memory "NVRAM", preserved with a battery for storing the Instrument's current state, saved Setups and Lists. The NVRAM is "checksummed" meaning at boot-up, the firmware checks if any value has been changed.

2.3.11.2 Clearing NVRAM & System Memory

Using the front panel power switch, turn the 2400's power off.

Power up the 2400.

Press and hold the "PRESET" button until the initializing NVRAM window appears. Release the "PRESET" button.

The system will continue to boot normally. All information stored in the memory locations will be cleared. The system will set up to factory default settings.

3 Remote Operation

3.1 Introduction

The 2400 Series can be operated from a remote host over the General Purpose Interface Bus (GPIB) or RS-232 interface using either Standard Commands for Programmable Instruments (SCPI) or Native Language commands.

3.1.1 Command Interface

All synthesizer functions are controlled over the GPIB and RS-232. SCPI and IEEE 488 Native languages are available. These languages are introduced briefly below, and discussed in more detail under separate headings.

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 that the command set that is available for that function.

3.1.2 Computer Interface

GPIB

The IEEE 488.2 interface connection (24-pin) between the 2400 Series and WaveMaker or 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 for all 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)

Pin	Signal	Pin	Signal	Pin	Signal
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

3.1.3 EIA-232

This is a 9 pin connector interfaces communications equipment using RS-232 format. See the table below for the connector pin assignments to all models.

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

3.2 SCPI Command Set

The unit for frequency is Hz, for power is dBm, and time values are seconds.

The SCPI syntax implemented in the Series 2400 includes the IEEE 488.2 Common commands, status reporting, error reporting, and table-specified defaults at power-up or *RST.

3.2.1 SCPI Command Format

SCPI requires adherence to a strict syntax structure. The typographic conventions employed in the SCPI command tables, which follow, are summarized here.

Commands can be entered in upper or lowercase. Commands can be abbreviated. Letters noted in upper case in the command structure are required if entering more than the required letters, enter the entire command (e.g., if the command is INITiate, use either INIT or INITIATE, but INITI is invalid).

If a command is shown in square brackets, it is an implied command and can be omitted (The brackets are not part of the command and should be omitted even if the command itself is entered). 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. Entering INIT has the same effect as entering INIT:IMM.

Some 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.

3.2.1.1 Output Subsystem

SCPI commands are divided into the subsystems listed below. In some cases, the Source code may contain additional sets of functions. All Source subsystem commands begin with [SOURce]. However, [SOURce] is the default command; therefore it is not required to be entered. The following subsystems are used in the 2400:

Command	Description
OUTPut[:STATe] ON|OFF|1|0	Turns the signal at the RF OUTPUT connector on and off
OUTPut[:STATe]?	Query the RF OUTPUT state.

3.2.2 Source Subsystem - CW Mode

Command	Description
[SOURce]:FREQuency[:CW|:FIXed] d HZ | KHZ | MHZ | GHZ	Sets CW frequency to d
[SOURce]:FREQuency[:CW|:FIXed]?	Queries the current CW frequency
[SOURce]:MODE?	Queries the current operating mode of the instrument
[SOURce]:POWer:ATTenuation:AUTO ON|OFF	Sets the Attenuator to Auto (ON) or Manual (OFF)

Command	Description
[SOURce]:POWer:ATTenuation 0|10|20|30|40|50|60|70|80|90	Sets the power attenuation level in dB
[SOURce]:POWer:[:LEVel|:IMMediate|:AMPLitude] d | DM | DBM | DB	Sets the CW power level to d
[SOURce]:POWer:[:LEVel|:IMMediate|:AMPLitude]?	Queries the CW power level
[SOURce]:ROSCillator:SOURce?	Queries the source of the reference oscillator. (INT or EXT)

3.2.3 Source Subsystem - Correction

Command	Description
[SOURce]:CORRection:LOSS d DB	Sets the power offset to d DB
[SOURce]:CORRection:LOSS?	Queris the power offset. Return value is in DB
[SOURce]:CORRection:SLOPE d	Sets the power slope to d (dB/GHz)
[SOURce]:CORRection:SLOPE?	Queries the power slope. Return value is in dB/GHz

3.2.4 Source Subsystem - List Mode

Command	Description
[SOURce]:LIST:DIRection UP|DOWN	Set 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:DWEL1 t1,t2,……,tn	Specifies the dwell point times (t1,t2,…,tn) 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 in optional.
[SOURce]:LIST:DWEL1:POINts?	Returns the number of points in the dwell time list
[SOURce]:LIST:FREQuency f1, f2, f3,……, fn	Specifies the frequency points (f1, f2, f3,…., fn) of the list set, and the frequency points are delimited by commas
[SOURce]:LIST:FREQuency:POINts?	Returns the number of points currently in the frequency list
[SOURce]:LIST:POWer p1, p2, p3,……, pn.	Specifies the power points (f1, f2, f3,…., fn) of the list set, and 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 raw data of list saved NVRAM into DSP format. Return 0 when done

Command	Description
[SOURce]:LIST:REPeat SWEEp|STEP|CONTinuous	Sets the repeat mode for the current list
[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. 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 get triggered
[SOURce]:LIST:SEQuence:POINts?	Query the number of points in the sequence list
[SOURce]:LIST:SEQuence:AUTO ON|OFF	Set list sequence AUTO mode to on or off. When the auto mode is on, the list sequence will not take effect, so the list will run all of the list points when it is triggered. When auto mode is off, the list will run only the points in the sequence. The default is auto mode 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 N	Set sync out option . The following is the value of N and its meaning: **N=0**, no sync out **N=1**, sync out on the first list point **N=2**, sync out on the last list point **N=3**, sync out on all list points

3.2.5 System Subsystem

Command	Description
SYSTem:COMMunicate :GPIB[:SELF]:ADDRess n|MAXimum|MINimum	Set the instrument's GPIB address
SYSTem:COMMunicate :GPIB[:SELF]:ADDRess?	Queries the instrument's GPIB address
SYSTem:COMMunicate:SERial:BAUD rate	Set RS-232 interface baud rate. Supported rate = 9600, 19200, 38400, 115200
SYSTem:COMMunicate:SERial:BAUD?	Query the current RS-232 interface baud rate
SYSTem:COMMunicate:SERial:BITS bits	Set RS-232 interface data bits. Bits = 7, 8
SYSTem:COMMunicate:SERial:BITS?	Query RS-232 interface data bits set
SYSTem:COMMunicate:SERial:PARity[:TYPE] EVEN | ODD | NONE	Set RS-232 interface parity type
SYSTem:COMMunicate:SERial:PAR?	Query RS-232 interface parity set

Command	Description
SYSTem:COMMuni-cate:SERial:SBITS bits	Set RS-232 interface stop bits. Bits = 1, 2
SYSTem:COMMuni-cate:SERial:SBITS?	Query RS-232 interface stop bits
SYSTem:ERRor[:NEXT]?	Following SCPI error numbers are supported: -100 COMMAND_ERROR -113 UNDEFINED_HEADER -200 EXECUTION_ERROR -222 DATA_OUT_OF_RANGE -224 Illegal parameter value -291 OUT_OF_MEMORY -350 Error queue overflow. -400 QUERY_ERROR Additional error messages are also supported. See Appendix B "2400 Error Messages" on page 1 for a summary of available error messages
SYSTem:LANGuage NATive	Switch from the SCPI command set to the Native command set
SYSTem:LANGuage:NATive <native cmd>	Issues a Native syntax command for immediate execution from within SCPI without leaving the SCPI syntax
SYSTem:PRESet	The same as *RST
SYSTem:VERSion?	The response shall have the form 1999.0

3.2.6 Trigger Subsystem

Command	Description
TRIGger[:IMMediate]	Initiates an immediate sweep cycle in List mode. If Repeat Type is not set to continuous (single step or single sweep) then the sweep returns to IDLE when complete (Same as a *TRG, this 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 to GPIB/GET EXT: sets to BNC (Trigger commands do not function when in EXT)
TRIGger:SOURce?.	Queries the trigger source for List mode

3.2.7 Source Subsystem - Ramp Sweep (Option 43)

Command	Description
[SOURce]:FREQuency:STARt d HZ | KHZ | MHZ | GHZ	Set the ramp start frequency
[SOURce]:FREQuency:STARt?	Queries the ramp start frequency
[SOURce]:FREQuency:STOP d HZ | KHZ | MHZ | GHZ	Set the ramp stop frequency
[SOURce]:FREQuency:STOP?	Queries the ramp stop frequency
[SOURce]:SWEep: TIME d	Set the sweep time for ramp sweep
[SOURce]:SWEep:TIME?	Queries the sweep time for ramp sweep
[SOURce]:POWer:STARt d DM | DBM | DB	Set the ramp start power
[SOURce]:POWer:STARt?	Queries the ramp start power
[SOURce]:POWer:STOP d DM | DBM | DB	Set the ramp stop power
[SOURce]:POWer:STOP?	Queries the ramp stop power

3.2.8 Source Subsystem- Modulation

Command	Description
[SOURce]:AM:DEPTh d	Sets the internal amplitude modulation depth to a percentage value
[SOURce]:AM:DEPTh?	Queries the internal amplitude modulation depth. Return value is a percent
[SOURce]:AM:INTernal:FREQuency d	Sets the rate of the internal amplitude modulation generator. (Requires Option 24)
[SOURce]:AM:INTernal:FREQuency?	Queries the rate of the internal amplitude modulation generator. Return value is in Hertz (Requires Option 24)
[SOURce]:AM:INTernal:FUNC-tion:SHAPe OFF|SINE|SQUare|TRI-angle|PraMP|NraMP|NOISe	Sets the shape of the internal amplitude modulation generator waveform. (Requires Option 24)
[SOURce]:AM:INTernal:FUNC-tion:SHAPe?	Queries the shape of the internal amplitude modulation generator waveform Returns: "Off", "Sine", "Square", "Triangle", "Pos Ramp", or "Noise". (Requires Option 24)

Command	Description
[SOURce]:AM:SCALing d	Sets the external amplitude modulation scaling to a percentage per volt value
[SOURce]:AM:SCALing?	Queries the external amplitude modulation scaling. Return value is a percentage per volt
[SOURce]:AM:SOURce INTernal|EXTernal	Sets the amplitude modulation source to internal or external
[SOURce]:AM:SOURce?	Queries the amplitude modulation source. Returns "INTernal" or "EXTernal"
[SOURce]:AM:STATe ON|OFF|1|0	Sets the amplitude modulation state to "On" or "Off"
[SOURce]:AM:STATe?	Queries the amplitude modulation state. Returns "1" for on or "0" for Off
[SOURce]:FM:BANDwidth NARRow|WIDE	Sets the Frequency Modulation bandwidth to Narrow or Wide
[SOURce]:FM:BANDwidth?	Queries the Frequency Modulation bandwidth. Return "Narrow" or "Wide"
[SOURce]:FM[DEViation] d	Sets the Frequency Modulation internal deviation to d. (Requires Option 24)
[SOURce]:FM[DEViation]?	Queries the Frequency Modulation internal deviation. Return value is in Hertz. (Requires Option 24)
[SOURce]:FM:INTernal:FREQuency d	Sets the Frequency Modulation internal rate to d. (Requires Option 24)
[SOURce]:FM:INTernal:FREQuency?	Queries the Frequency Modulation internal rate. Return value is in Hertz. (Requires Option 24)
[SOURce]:FM:INTernal:FUNCtion:SHAPe OFF|SINE|SQUare|TRIangle|PraMP	Sets the shape of the internal frequency modulation generator waveform. (Requires Option 24)
[SOURce]:FM:INTernal:FUNCtion:SHAPe?	Queries the shape of the internal frequency modulation generator waveform Returns: "Off", "Sine", "Square", "Triangle", "Pos Ramp", (Requires Option 24)
[SOURce]:FM:SENSitivity d	Sets the Frequency Modulation external sensitivity to d
[SOURce]:FM:SENSitivity?	Queries the Frequency Modulation external sensitivity. Return value is in Hertz/Vpeak
[SOURce]:FM:SOURce EXTernal|INTernal	Sets the frequency modulation source to internal or external
[SOURce]:FM:SOURce?	Queries the frequency modulation source. Returns "Internal" or "External"
[SOURce]:FM:STATe ON|OFF|1|0	Sets the frequency modulation state to "On" or "Off"
[SOURce]:FM:STATe?	Queries the frequency modulation state. Returns "1" for on or "0" for Off
[SOURce]:PULM:EXTernal:POLarity NORMal|INVerted	Sets the pulse modulation polarity to Normal or Inverted

Command	Description
[SOURce]:PULM:EXTernal:POLarity?	Queries the pulse modulation polarity. Returns "NORMal", or "INVerted"
[SOURce]:PULM:SOURce EXTernal:INTernal	Set the source of pulse modulation to external or internal
[SOURce]:PULM:SOURce?	Queries the source of pulse modulation. Returns: "INTernal", or "EXTernal"
[SOURce]:PULSe:DELay d (S|MS|US)	Sets the delay of the internal pulse modulation generator waveform. (Requires Option 24)
[SOURce]:PULSe:DELay?	Queries the delay of the internal pulse modulation generator waveform Return value is in seconds. (Requires Option 24)
[SOURce]:PULSe:FREQuency d [HZ | KHZ | MHZ | GHZ]	Sets the pulse modulation internal rate to d. (Requires Option 24)
[SOURce]:PULSe:FREQuency?	Queries the pulse modulation internal rate. Return value is in Hertz. (Requires Option 24)
[SOURce]:PULSe:MODE OFF | TRiGered | CONTinuous | GATEd	Sets the internal pulse modulation mode. (Requires Option 24)
[SOURce]:PULSe:WIDTh d (S|MS|US)	Sets the pulse modulation internal width to d. (Requires Option 24)
[SOURce]:PULSe:WIDTh?	Queries the pulse modulation internal width. Return value is in s, ms or µs. (Requires Option 24)

3.3 IEEE 488.2 Commands

Commands preceded by * are SCPI mandated commands. The following commands are available for the SCPI and Giga-tronics Native Command set.

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 n**	Standard Event Status Enable	Sets the Standard Event Status Enable Register. A service request is issued whenever the specified event has occurred Range of n: 0 - 255
***ESE?**	Standard Event Status Enable	Sets the Standard Event Status Enable Register. A service request is issued whenever the specified event has occurred
***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

Command	Name	Description
***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 (the power-on 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 n**	Service Request Enable	Sets and enables the value of the Service Request Enable Register Range of n: 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 Service Request Enable Register (Status Byte Register)
***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 status of synthesizer's LOCK/LEVEL status. If failing the lock/level, the test is failed. In order to avoid damage to the device the GT2400 is connected to, maximum attenuation is set box if it is available. 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 GT2400 Specific Commands

Command	Name	Description
***RCL n**	Recall Instrument State	Recalls a previously saved instrument state from memory Range of n: 0 - 9
***SAV n**	Save Instrument State	Saves the current instrument state to memory Range of n: 0 - 9
***TRG**	Trigger Device	Triggers the synthesizer if BUS is the specified trigger source.
/SCPI	SCPI	Changes command syntax to SCPI
/NATive	Giga-tronics Native	Change command syntax to GT12000 "native"

3.5 Status Register System

3.5.1 Status Byte Register

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.

The primary status register is the Status Byte Register. It is the top-level register used to track changes in the 2400 state. Lower level registers identified in the Status Byte Register indicate changes in the 2400's operational, event, and questionable status.

3.5.2 Status Byte Description

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.

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

3 Questionable Status. This bit is set whenever a questionable status condition has occurred. Additional information regarding this bit is accessed using the QUES:STAT commands.

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

5 ESB. Standard Event Status Register. This bit is set whenever a condition defined in the Standard Event Status Register has occurred. See the Standard Event Status Register description 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

3.5.3 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. This bit is always 0.

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

3 Not Used.

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 received by the source.

6 Not Used.

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

3.5.4 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 State. This bit is set whenever the output power is operated in an unleveled condition.

11 Synthesizer Frequency Lock. 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.

4 Specification & Performance Verification

4.1 Specifications: CW and Signal Generators

4.1.1 CW Operation

Frequency Ranges	Model
10 MHz to 8 GHz	2408L/2408AL/2408M/2408AM
10 MHz to 20 GHz	2420L/2420AL/2420M/2420AM
10 MHz to 26.5 GHz	2426L/2426AL/2426M/2426AM
10 MHz to 40 GHz	2440L/2440AL/2440M/2440AM

4.1.1.1 Frequency Bands

Band	Frequency	N
0	10 - 15.99 MHz	512
1	16 - 30.99 MHz	256
2	31 - 62.99 MHz	128
3	63 - 124.99 MHz	64
4	125 - 249.99 MHz	32
5	250 - 499.99 MHz	16
6	500 - 999.99 MHz	8
7	1.0 - 1.99 GHz	4
8	2.0 - 3.99 GHz	2
9	4.0 - 7.99 GHz	1

Band	Frequency	N
10	8.0 - 15.99 GHz	1/2
11	16.0 - 31.99 GHz	1/4
12	32.0 - 40.00 GHz	1/8

4.1.1.2 Resolution

0.1 Hz

4.1.1.3 Accuracy & Stability (Identical to Timebase Oscillator)

4.1.1.3.1 Timebase (Internal)	10 MHz
4.1.1.3.2 Aging Rate (after 30 minutes warm up time)	$< 5 \times 10^{-10}$/day, 2400L and 2400M Series only <1 x 10-8/day. 2400A Series only
4.1.1.3.3 Temperature Stability	$\pm 5 \times 10^{-10}$/°C, 2400L and 2400M Series only $\pm 2 \times 10^{-8}$/°C, 2400A Series only
4.1.1.3.4 10 MHz Reference Output	TTL into 50 Ω
4.1.1.3.5 External Reference Input	10 MHz or 100 MHz ± 1 ppm > - 5 dBm into 50 Ω

4.1.2 RF Output Power

4.1.2.1 Maximum Leveled Output[2,3] (0 to 35°C)

Frequency Range (GHz)	.01 - 8 GHz	8 - 20 GHz	20 -40 GHz[4]
20 GHz Model	+ 16	+15	
26.5 GHz Model	+13	+9	+10
40 GHz Model	+13	+9	+9

[2]Specification applies over the 0 to 35°C range and degrades <2.0 dB from 35 to 55°C.
[3]Step attenuator (option 26) reduces power by 1.5 dB to 20 GHz and 2.0 dB above 20 GHz
[4]20 - 26.5 GHz for model 2426

4.1.2.2 Minimum Settable

-20 dBm

-110 dBm (option 26)

4.1.2.3 Resolution

0.05 dB

4.1.2.4 Accuracy[5] (dB)

Frequency (GHz)	> 5 dBm	> - 20 dBm	> -110 dBm
.01 - 20 GHz	± 1.0	± 0.8	± 1.3
.01 - 40 GHz	± 1.2	± 1.0	± 1.5

[5]Specifications applies over the 15 to 35°C range and degrades <0.5 dB outside that range.

4.1.2.5 Power Offset

0 to 10 dB

4.1.2.6 Temperature Stability

0.025 dB/^{o}C

4.1.2.7 Source Match (typical)

<2.0:1

4.1.2.8 RF Connector Type

Model	Connector Type
2408L	N (f)
2420/2426	SMA (f)
2440	K (f)

4.1.3 Spectral Purity

4.1.3.1 Harmonics[6]

(Power out = + 6 dBm)

Frequency (GHz)	Harmonic (dBc)
0.01 to 2 GHz[7]	- 50 dBc
2 to 20 GHz	- 55 dBc
20 to 40 GHz	- 30 dBc

[6] Specifications for harmonics above instrument frequency range are typical.
[7] Specification is - 30 dBc below 100 MHz.

4.1.3.2 Subharmonics

(Power out = + 6 dBm)

Frequency (GHz)	Harmonic (dBc)
0.01 to 2 GHz	- 80 dBc
2 to 20 GHz	- 60 dBc
20 to 40 GHz	- 50 dBc

A sub-harmonic is defined as any ¼, ½, or ¾ multiple of the fundamental RF Output

4.1.3.3 Spurious[8]

(Offsets > 300 Hz)

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

[8] Specification is - 45 dBc typical for offsets < 300 Hz.

4.1.3.4 Residual FM (typical

Frequency (GHz)	50 Hz - 15 KHz Bandwidth
0.01 to 16 GHz	< 40 Hz
16 to 32 GHz	< 80 Hz
32 to 40 GHz	< 120 Hz

4.1.3.5 AM Noise (typical)

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

4.1.3.6 Single-Sideband Phase Noise

(dBc/Hz, CW mode, all power levels)

Frequency Range (GHz)	Offset From Carrier				
	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 Specifications: 2400M Series Only

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

4.2.1 Amplitude Modulation (AM)

Parameter	Specification
Depth	-20 dBm to maximum available power
Rate (3 dB Bandwidth, 30% depth)	DC - 5 kHz (frequency = less than 2 GHz) DC - 10 kHz (frequency = greater than or equal to 2 GHz)
Sensitivity	10 - 95% / V selectable
Accuracy	± 10 % of setting at 1 kHz, 0 - 90%/V
Input	Range: ± 1 V Impedance: 600 Ω

4.2.2 Scan Modulation

Specifications apply to frequencies below 20 GHz.

Parameter	Specification
Scan Time	200 ms - 10 sec
Maximum Number of Points	4000
Minimum Time Per Point	1 ms
Scan Pattern	$\frac{\sin(X)}{X}$
Minimum Number of Lobes	1
Depth	> 60 dB

4.2.3 Frequency Modulation (FM)

FM may be operated simultaneously with Scan/Linear AM and/or PM (PM & Linear AM not allowed simultaneously).

Parameter	Specifications	
Mode	Narrow Deviation	Wide Deviation
Rate (3 dB bandwidth)	DC - 50 kHz	1 kHz - 3 MHz
Peak Deviation*	$\frac{1\ \text{MHz}}{N}$	$\frac{20\ \text{MHz}}{N}$
Accuracy	± 5% at 5 kHz rate with 1V peak input	
Input	Range: ± 1 V Impedance: 600 Ω	

*Refer to Frequency Band Chart Section 4.1.1.1 for band index parameter.

4.2.4 Pulse Modulation (PM)

Specification applies for frequencies above 500 MHz. Specifications apply with AM and FM off. PM may be operated with FM.

4.2.4.1 PM Basic Operation

4.2.4.1.1 On/Off Ratio

80 dB

4.2.4.1.2 Rise/Fall Times

Rise Time	Frequency Range
< 10 ns	0.5 - 20 GHz
< 25 ns	20 - 40 GHz

4.2.4.2 Minimum Width

Parameter	Specification
Minimum Width	150 ns

Parameter	Specification
Level Accuracy (relative to CW) Duty cycle must be > 0.01%	± 0.5 dB Pulse Width > 350 ns + 1.5/ - 0.5 dB Pulse Width 250 - 350 ns + 3.0 / - 0.5 dB Pulse Width150 - 250 ns
PRF (50% duty cycle)	DC - 3.33 MHz
Input	Sensitivity: TTL - polarity selectable level Impedance: 50 Ω

4.2.4.3 Pulse Fidelity

Frequency Range	Overshoot & Ringing	Video Feed Through	Compression	Delay
0.5 - 20 GHz	<10%	<5%	< ± 5 ns	< 50 ns
20 - 40 GHz	<10%	<1%	< ± 5 ns	< 50 ns

4.3 Supplemental Specifications

4.3.1 General Specifications for CW and Signal Generators

4.3.1.1 Hardware Interface	GPIB	IEEE STD 488.2 (GPIB), all parameters except AC power on/off
	RS-232	All parameters except AC power on/off and service request functions.
	USB 1.1	All parameters except AC power on/off and service request functions using supplied USB to RS-232 adapter.
4.3.1.2 Software Interface	SCPI & GT-12000A Automation Xpress Interface (Option 48)	
4.3.1.3 Operating Temperature	0 to 55°C	
4.3.1.4 Environmental	Complies with MIL-PRF-28800F, Class 3	
4.3.1.5 Approvals	CE Marked	
4.3.1.6 Power	90-253 VAC, 47-64 Hz (400 Hz optional),150 Watts (Nominal)	
4.3.1.7 Fuse Rating	2 A, SB	

4.3.2 Execution Speed (IEEE 488.2)

	AXI	SCPI	GT-12000A
CW Switching	2.5 ms	28 ms	22 ms
4000 Point Download	20 sec	28 sec	288 sec

4.3.3 Automation Xpress Interface (Option 48)

For use with Giga-tronics Automation Xpress Software. The AXI provides Xpress 2.5ms CW Frequency/ Power switching, faster data exchange, and functional downloads/executions, and a stable API programming interface for the ATE programming environment.

4.3.4 Weight & Dimensions

Item	ATE Model (24XXAL/24XXAM)	Benchtop Model (24XXL/24XXM)
Width	16.75 inches	16.75 inches
Depth	21 inches	21 inches
Height	5.25 inches	5.25 inches
Weight	< 35 lbs	< 35lbs

4.3.5 Internal Modulation Generator (Option 24)

Parameter	Specification
Amplitude Modulation Source	
Waveform	Sine, Square, Triangle, Ramp, Gaussian Noise
Rate	0.01 Hz to 10 kHz, all waveforms
Resolution	0.01 Hz
Accuracy	Same as time base
AM Output	2 V, p-p, into 10 k Ohm load
Frequency Modulation Source	
Waveform	Sine, Square, Triangle, Ramp
Rate	0.01 Hz to 10 kHz, all waveforms
Resolution	0.01 Hz
Accuracy	Same as time base
FM Output	2 V, p-p, into 10 k Ohm load
Pulse Modulation Source	
Mode	Continuous, Gated, Triggered
Resolution	10 ns
Accuracy	+/- 4% of setting or +/- 20 ns, whichever is greater
Continuous Mode	
Pulse Repetition Interval	200 ns to 1 second
Pulse Width	50 ns to 10 ms
Sync Out Delay	0 to 10 ms
Gated Mode	
Pulse Repetition Interval	200 ns to 1 second
Pulse Width	50 ns to 10 ms
Sync Out Delay	0 to 10 ms
Gated Input Polarity	Active High or Active Low

Parameter	Specification
Triggered Mode	
RF Pulse Delay	100 ns to 1 second
Pulse Width	50 ns to 10 ms
Sync Out Delay	0 to 10 ms
Trigger Input Polarity	Rising Edge or Falling Edge

4.3.6 Frequency and Power Sweep (Option 43)

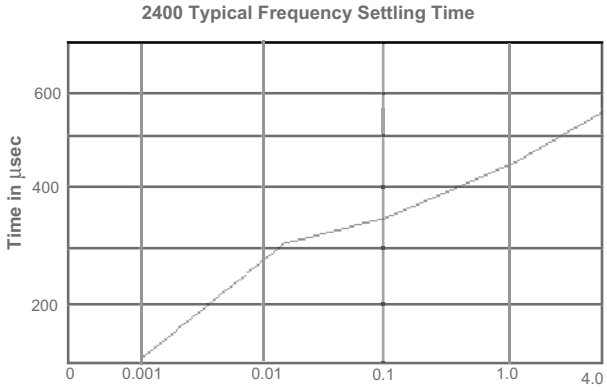
Continuous sweep, self generated within the instrument. Can be operated simultaneously with digital frequency sweep. (Option 43)

Parameter	Specification
Ramp Power Sweep	0 to 25 dB
Ramp Frequency Sweep	Full Frequency Coverage
Power Flatness	See Accuracy section 4.1.2.4.
Power Slope	0 to 0.5 dB/GHz
Ramp Output	0 to 10 V
Z-Axis Blanking	± 5 V
Sweep Time (Sweep rate must be < 500 MHz/msec)	10 msec - 30 secs

4.3.7 List Mode

Parameter	Specification
Number of List Points	4000
Frequency Settling Time (Time for frequency to settle within thin 50 KHz of final value after a frequency switch.)	< 550 µsec for ΔF_0^* ≤500 MHz
Amplitude Settling Time (Time for amplitude to settle within 0.1 dB of final value after an amplitude switch.)	< 500 µsec
Step Time	150 µsec - 1sec 2 ms - 1 sec (option 31)

Parameter	Specification
Sync Out Delay (Delay is specified from edge of trigger pulse.)	50 µsec to 10 msec
Trigger Modes	EXT, GPIB GET, Software
Sweep Modes	Continuous, Single Step, and Single Sweep



$$\Delta F_0 = | (F_{stop} \times N_{stop}) - (F_{start} \times N_{start}) |$$

(Refer to the Frequency Band Chart in Section 4.1.1.1 for band index parameter)

4.4 Performance Verification

- This section provides step-by-step procedures to verify the 2400 Series Microwave Synthesizer performance.
- The required warm-up time before testing is 72 hours. The warm-up period can be reduced to 30 minutes if timebase accuracy is not to be tested for all 2400 Series models.
- The following procedures refer to the instrument under test as the 2400 or UUT (Unit Under Test) for all 2400 series models.

4.4.1 Recommended Equipment

The following equipment is recommended before starting the performance test routines (the recommended equipment can be substituted provided the specifications are sufficiently compatible)>:

- Frequency Standard 10 MHz Stanford Research FS 725
- Oscilloscope Tektronix TDS3052B or Equivalent
- Microwave Frequency Counter XL Microwave 3260 or Equivalent
- Power Meter and Sensor Giga-tronics Series 8650A w/ 80313A Sensor or Equivalent and w/ 80350A Sensor or Equivalent
- Spectrum Analyzer Agilent/HP 8566B or Equivalent
- Detector Herotek Model DZ262-44 or Equivalent
- Measuring Receiver Agilent/HP 8902A or Equivalent
- L.O. Generator Giga-tronics Microwave Synthesizer 2400 or Equivalent
- Universal Counter Racal Dana 2201 or Equivalent
- Filter 21.4 MHz Mini-Circuits SVP 21.4
- Fixed Attenuator 3 dB Midwest ATT-0263-03-SMA-02
- Fixed Attenuator 10 dB Midwest ATT-0263-10-SMA-02

4.4.2 Performance Tests

4.4.2.1 Introduction

The procedures in this section verify the electrical performance of the 2400 using the specifications described in this chapter. Each of the performance tests includes a list of recommended test equipment. Equivalent test equipment can be substituted provided that the accuracies and specifications are equal to or better than those of the specified equipment. A test data sheet is included for entering the various readings taken. 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.

4.4.2.2 Frequency Range, Resolution & Accuracy

4.4.2.2.1 Description

Connect the 2400 RF output to the input of a frequency counter. The internal timebase of the counter is used as a reference for the 2400 to eliminate timebase errors from the measurements. This procedure does not check for timebase accuracy.

4.4.2.2.2 Equipment Required

- UUT
- Frequency Counter
- Coaxial Cable

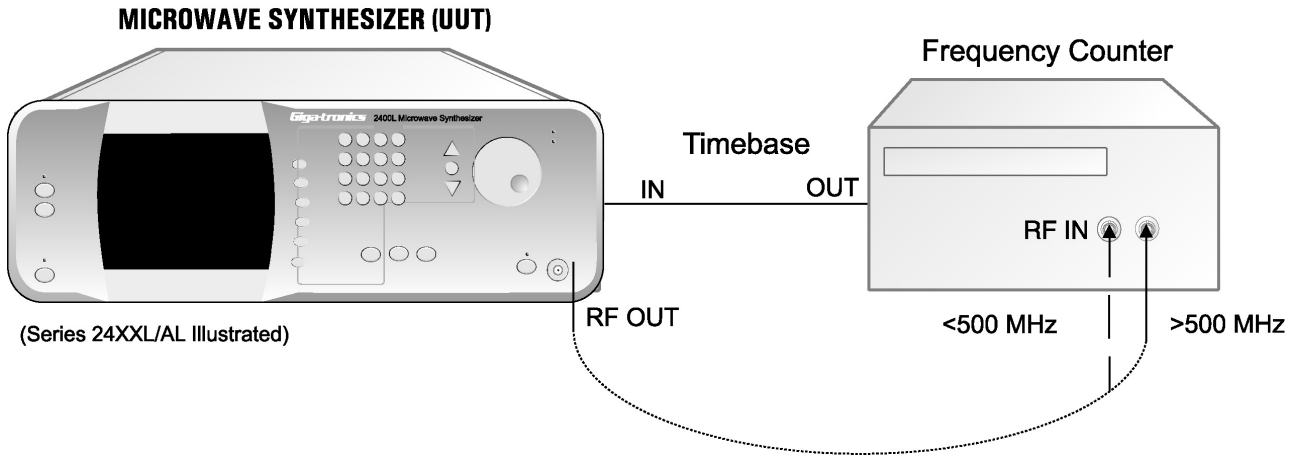


Illustration 4.1 | Frequency Range, Resolution & Accuracy

4.4.2.2.1 Procedure

1. Connect the equipment as shown in Figure 4-1. Connect the 2400 RF Output to the 10 to 500 MHz counter input using the coaxial cable and the SMA to BNC adapter. 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 will automatically switch to the external reference when it is connected.

2. Set the 2400 to 10 MHz. Press [LEVEL] in the POWER field and enter [+] [0] [DBM]. Press the [RF ON] button to activate the 2400 output.

3. Set the 2400 to each frequency listed on the data sheet and verify that the counter reads the set frequency plus or minus the counter resolution.

4. Connect the 2400 RF Output to the 500 MHz to 26.5 GHz input on the counter and continue with the divider tests. To check that the multipliers are functioning properly, refer to the test data sheet and program each of the listed frequencies into the 2400 by entering (for example) [CW] [2] [0] [0] [1] [MHZ]. For each listed frequency, the counter should read the entered frequency ±1 Hz, plus or minus the counter resolution. Ignore all frequencies outside the range of the instrument under test.

4.4.2.3 Spurious Signal Tests

4.4.2.3.1 Description

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 harmonically or non-harmonically spurious signals.

4.4.2.3.2 Equipment Required

- UUT
- Spectrum Analyzer
- Coaxial Cable

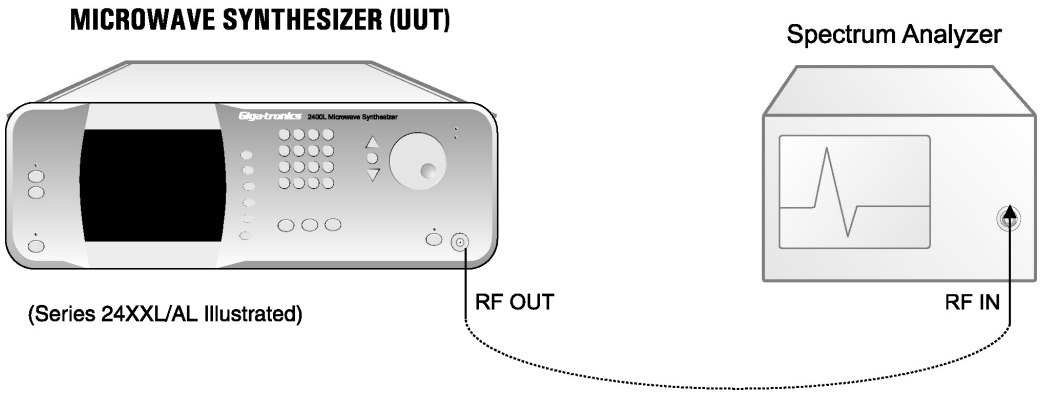


Illustration 4.2 | Spurious Signals Tests

4.4.2.3.1 Procedure

1. Connect the equipment as shown in Figure 4-2. Allow the equipment to warm up for at least 30 minutes. Press [Frequency] soft-key in the CW menu on the 2400 and enter the test frequency

listed in the test data sheet. The RF amplitude should be at +6 dBm. Press **[RF ON]** button to turn on the RF output.

2. 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.

3. Set the spectrum analyzer to maximum span with the signal centered on the screen. Gradually narrow the span, keeping the signal centered, to observe any spurious signals. Use appropriate resolution and video bandwidths to allow sufficient dynamic range.

4. Repeat steps 2 and 3 for the other frequencies on the test data sheet which are within the operating range of the instrument.

4.4.2.4 RF Output Power Tests

4.4.2.4.1 Description

The following procedures test output power at frequencies within each band. There are three tests: Maximum-Leveled Power, Level Accuracy, and step attenuator accuracy. The tests are performed manually. For a comprehensive evaluation of the output of the 2400, it is recommended that an automated test system be used to perform the tests.

4.4.2.4.2 Equipment Required

- UUT
- 8651A series power meter & 80313A sensor. 2440 series sources require an 80334A sensor
- Local Oscillator
- Mixer (frequency test range dependent)
- Measuring Receiver
- ATE based Computer (Optional)
- RF Cables

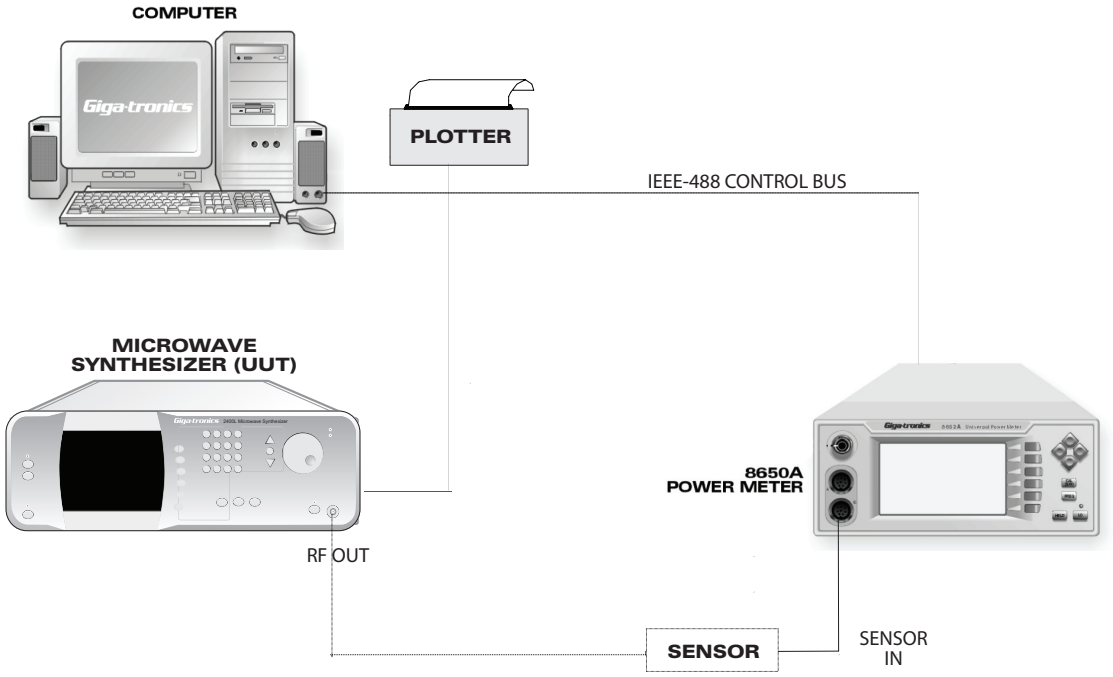


Illustration 4.3 | RF Output Power Test

4.4.2.4.1 Maximum-Leveled Power

Before testing maximum-leveled power, configure and operate the power meter according to manufacturer specifications and allow for the recommended warm-up period.

1. Connect the power sensor to the RF output of the UUT. Set the UUT to the specified frequency and activate the RF output, as shown in Illustration 4.3.

2. For each test frequency, increase the output power of the UUT until the unlevel indicator is active.

3. Reduce the output power setting until the unlevel indicator deactivates.

4. Record the measured output power for the test frequency and repeat the test for the remaining frequencies.

4.4.2.4.2 Level Accuracy

Before testing leveled accuracy, configure and operate the power meter according to manufacturer specifications and allow for the recommended warm-up period.

1. Use the test setup described in the maximum-leveled power test.

2. Set the output level of the UUT to 0 dBm.

3. Set the UUT to the test frequency and record the measured output power. Repeat the test for the remaining test frequencies.

4. Set the output level of the UUT to +12 dBm. For 2440 series, this output level does not apply for frequencies greater than 8 GHz.

5. Set the UUT to the test frequency and record the measured output power. Repeat the test for the remaining test frequencies.

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.

4.4.2.4.3 Step Attenuator Level Accuracy (Units with Option 26 installed only)

1. For test frequencies below the measuring receiver frequency range, connect the UUT directly to the Measuring Receiver and proceed to step 4.

2. For test frequencies, greater than Measuring Receiver frequency range, connect the Local Oscillator, UUT and Measuring Receiver as shown in illustration 4.4.

3. Set the Local Oscillator frequency to 21.4 MHz above the UUT test frequency. For the 2440 series, set the LO frequency to 21.4 MHz below the 40 GHz test frequency.

4. Set the UUT output level to -20 dBm.

5. Activate the RF level measurement of the Measuring Receiver and set the Ratio measurement to dB.

6. Reduce the RF output of the UUT in 10 dB increments and observe the measurement of the receiver.

7. Record the worst case level accuracy and level setting for the test frequency.

8. Repeat the test for the remaining test frequencies.

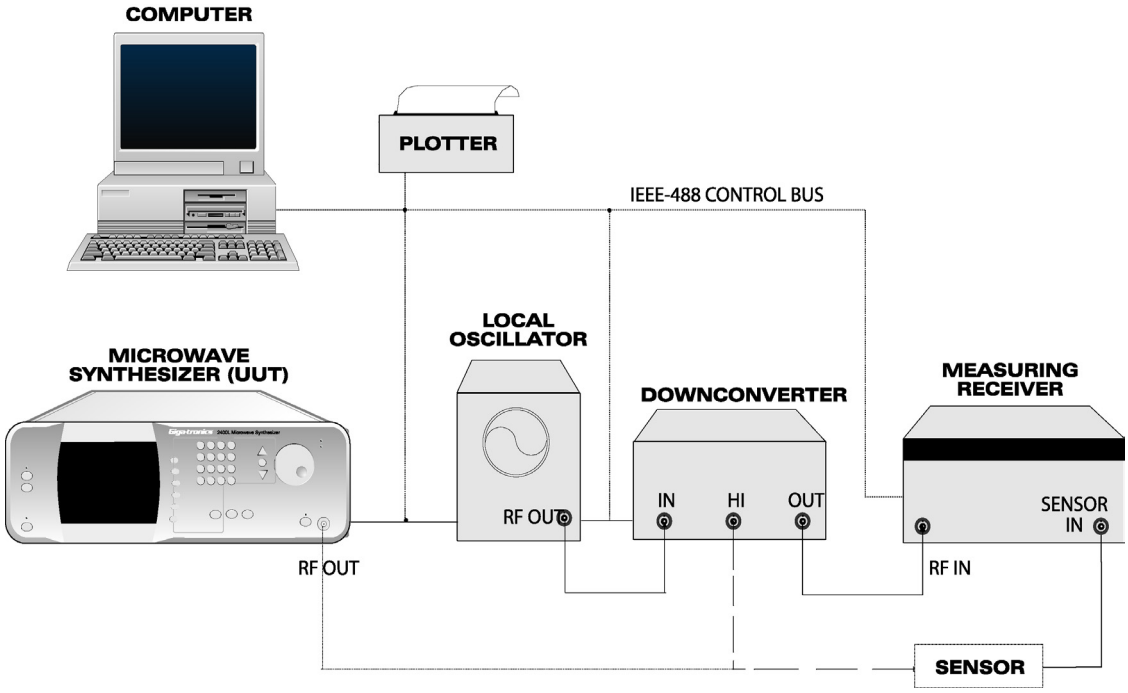


Illustration 4.4 | RF Output Power Attenuator Test

Note: *When measuring the flatness and accuracy of the model 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.*

4.4.3 Performance Tests(2400M Series)

4.4.3.1 Amplitude Modulation Test

4.4.3.1.1 Description

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.

4.4.3.1.2 Equipment Required

- UUT
- Mixer/Divider
- Oscillator
- Measuring Receiver

4.4.3.1.3 Procedure (Amplitude Modulation Accuracy)

1. For test frequencies below the measuring receiver frequency range, connect the UUT directly to the Measuring Receiver and proceed to step 4.

2. For test frequencies, greater than Measuring Receiver frequency range, connect the Local Oscillator, UUT, mixer and Measuring Receiver as shown in illustration 4.4.

3. Set the Local Oscillator frequency to 50 MHz above the UUT test frequency. For the 2440 series, set the LO frequency to 50 MHz below the 40 GHz test frequency. Activate the RF output.

4. Set the Measuring Receiver for the following settings:

AM	Active
(Peak-Peak)/2	Active
Filters:	50 Hz, 15 kHz

5. Set the Function Generator to 1 kHz Sine Wave, 2 V peak to peak and connect the output to the AM IN BNC on the rear panel of the UUT. **Note**: Measure the output of the Function Generator using a precision meter or oscilloscope to ensure the output of the function generator is 2 Vpp.

6. Set the UUT for the following settings:

Level:	+10 dBm
AM Sensitivity:	30%
AM State:	On

7. Measure and record the AM depth. The measurement should be with a 10% range of the AM sensitivity setting.

8. Repeat the test for 50% and 90% sensitivity settings.

9. Set the UUT frequency and LO to the next test frequency and repeat steps 7 and 8.

4.4.3.1.4 Procedure (Amplitude Modulation Bandwidth)

1. For test frequencies below the measuring receiver frequency range, connect the UUT directly to the Measuring Receiver and proceed to step 4.

2. For test frequencies, greater than Measuring Receiver frequency range, connect the Local Oscillator, UUT, mixer and Measuring Receiver as shown in illustration 4.3.

3. Set the Local Oscillator frequency to 50 MHz above the UUT test frequency. For the 2440 series, set the LO frequency to 50 MHz below the 40 GHz test frequency. Activate the RF output.

Level:	+10 dBm
AM Sensitivity:	30%
AM State:	On

4. Set the Function Generator to 1 kHz Sine Wave, 2 V peak to peak and connect the output to the AM IN BNC on the rear panel of the UUT.Note: Measure the output of the Function Generator using a precision meter or oscilloscope to ensure the output of the function generator is 2 Vpp.

5. Verify that the UUT is measuring within specification at 30% on the Measuring Receiver. Press the Ratio button and then LOG or dB. The display should read 0.00 dB.

6. Adjust the rate of the function generator and record the result. The change should be no more than 3 dB.

7. Repeat steps 4 and 5 at the specified test frequencies.

4.4.3.2 Frequency Modulation Test

4.4.3.2.1 Description

The following procedure tests Frequency Modulation Accuracy and Bandwidth at frequencies within each band. The tests require the use of an FM discriminator

4.4.3.2.2 Equipment Required

- UUT
- Local Oscillator
- FM Discriminator
- Function Generator
- Measuring Receiver
- RF Cables

4.4.3.3 Delay Discriminator Description

The FM Discriminator includes an RF splitter; two coax lines of unequal length, and an RF mixer. The shorter cable is connected from the output of one splitter port to the RF input of the mixer. The longer cable is connected from the remaining splitter output to the LO input of the mixer. For this Frequency Modulation performance test, the frequency range of the mixer LO and RF is 4 to 8 GHz. The like-frequency two signals beat against each other at the mixer. The mixer produces a DC voltage at the output of the mixer based on the phase differential of the signals. This procedure does not identify a specific mixer for the discriminator circuit. There are two factors to consider when choosing a mixer for this test.

- The mixer RF and LO frequency range must be at least 4 to 8 GHz.
- Low conversion loss. Low conversion loss will result in higher output levels

The output of the mixer should be +15 mV or higher for a +1 MHz change in UUT frequency. Increasing output power will improve the output range of the discriminator. It is recommended that a large cable length ratio be used. Cable length ratios of 16 to 1 (48 inches to 3 inches) will produce a large number of zero crossings within the 4 to 8 GHz frequency band and improve the display resolution of the test. The rate of change for the output voltage per unit frequency (V/ F) must remain constant (linear) for the ±1 MHz deviation range for Narrow Mode and ±20 MHz deviation range for Wide Mode. Rate changes within this deviation range will result in a non-symmetrical waveform and will produce invalid test results. Zero crossings can be identified using the List mode of the 2400. A 4 to 8 GHz list using a 1 or 2 MHz step size will provide excellent resolution for identifying an optimal frequency zero volt crossing that is relatively linear above and below the zero volt crossing. WaveMaker software included with the 2400 should be used to create the list. Identify several zero crossings across the 4 to 8 GHz frequency range. Approximately 1 to 2 points per 1 GHz step is recommended. I.E. 4.5, 5.5, 6.5 7.5 GHz are within 4 to 5, 5 to 6, 6 to 7, 7 to 8 GHz respectively.

4.4.3.3.1 Narrow Mode FM Accuracy and Maximum Deviation Test Procedure

1. Connect the output of the UUT to FM discriminator. The output of the discriminator is connected to the oscilloscope.

2. Connect the function generator to the external FM input of the UUT. Set the function generator to the following settings:

Rate:	5 kHz
Waveform:	Sine wave
Output:	2 Vpp into 50 ohms

3. Set the level of the UUT to +13 dBm, activate the RF output of the UUT and set the external FM setting of the UUT to the following:

FM State:	Off
Mode:	Narrow
Sensitivity:	1 MHz/volt

4. Set the UUT frequency that will produce a 0 volt output from the FM discriminator.

5. Adjust the frequency of the UUT ±1 MHz. The output of the discriminator must exceed ±3 divisions on the oscilloscope.

6. Adjust the vertical gain of the oscilloscope so that a 1 MHz frequency change from the zero crossing frequency of the UUT results in a three-division change on the oscilloscope.

7. Set the UUT frequency back to the test frequency and toggle the FM state to ON. Check that the peaks of the oscilloscope display are within ±0.15 volts of the 3 divisions (±5% Accuracy).

8. Vary the rate of the function generator from DC to 50 kHz and check that the output of the discriminator is within 4 to 8 divisions (3 dB bandwidth) of the oscilloscope.

9. Repeat steps 4 through 8 for the remaining frequency test points.

4.4.3.3.2 Wide Mode FM Accuracy and Maximum Deviation Test Procedure

1. Connect the output of the UUT to FM discriminator. The output of the discriminator is connected to the oscilloscope.

2. Connect the function generator to the external FM input of the UUT. Set the function generator to the following settings:

    1. Rate: 5 kHz
    2. Waveform: Sine wave
    3. Output: 2 Vpp into 50 ohms

3.Set the level of the UUT to +13 dBm, activate the RF output of the UUT and set the external FM setting of the UUT to the following:

    1. FM State: Off
    2. Mode: Wide
    3. Sensitivity: 20 MHz/volt

3. Set the UUT frequency that will produce a 0 volt output from the FM discriminator.

4. Adjust the frequency of the UUT ±20 MHz. The output of the discriminator must exceed ±3 divisions on the oscilloscope.

5. Adjust the vertical gain of the oscilloscope so that a 20 MHz frequency change from the zero crossing frequency of the UUT results in a three-division change on the oscilloscope.

6. Set the UUT frequency back to the test frequency and toggle the FM state to ON. Check that the peaks of the oscilloscope display are within ±0.15 volts of the 3 divisions (±5% Accuracy).

7. Vary the rate of the function generator from 1kHz to 3 MHz and check that the output of the discriminator is within 4 to 8 divisions (3 dB bandwidth) of the oscilloscope.

8. Repeat steps 4 through 8 for the remaining frequency test points.

4.4.3.4 Pulse Modulation Tests

4.4.3.4.1 Description

The following procedures test Pulse Modulation Level Accuracy, On/Off Ratio and Rise/Fall times at frequencies within each band. The tests require an fast crystal detector (rise time < 10 nsec).

4.4.3.4.2 Equipment Required

- UUT
- Oscilloscope (300 MHz bandwidth recommended)
- Crystal Detector, < 10 nSec rise-time, frequency range equivalent to test frequency range.
- Spectrum Analyzer, 0 Hz span capable
- Giga-tronics 8650A Series
- Giga-tronics 80350A series sensor
- Pulse Generator
- RF cables

4.4.3.4.3 Rise and Fall Time Test Procedure

1. Connect the output of the pulse generator to the PM In BNC of the UUT
2. Set the pulse generator for the following:

Pulse Width	1 usec.
Pulse Interval	2 usec.
Output:	5 volts, 50 ohms

3. Connect the crystal detector to the output of the UUT and to the oscilloscope. Set the trigger of the oscilloscope accordingly to the detector type (positive or negative)
4. Set the UUT to the following:

Power Level	0 dBm
External PM state	ON
Trigger Polarity	Positive
RF Output state	ON

5. Set the UUT to the test frequency. Measure and record the rise and fall times.
6. Repeat the test for each test frequency.

4.4.3.4.4 Pulse Level Accuracy Test Procedure

1. Connect the output of the UUT to the 80350A series sensor and 8650A power meter.
2. Set the pulse generator using the settings described in step 2 of the Rise and Fall Time Test Procedure.
3. Set the UUT using the settings described in step 3 of the Rise and Fall Time Test Procedure except set the External PM state to Off.
4. Set the 8650A sensor mode for the 80350A sensor to CW.
5. Measure and record the CW levels for the specified frequency test points.
6. Toggle the External PM state to On.
7. Set the 8650A sensor mode for the 80350a sensor to Peak. Adjust the sample delay to 500 nsec.
8. Measure and record the Peak levels for the specified frequency test points.
9. Compare the CW levels to the peak levels.

4.4.3.4.5 On/Off Ratio Test Procedure

1. Connect the output of the UUT to the Spectrum Analyzer.
2. Repeat steps 1,2 and 4 of the Rise and Fall Time Test Procedure.
3. Set the UUT to the test frequency.
4. Set the Spectrum Analyzer frequency to the test frequency. Set the frequency span to 0 Hz and adjust the sweep rate to display two pulses on the display (approximately 4 usec.). It may be necessary to adjust the resolution bandwidth. Set the vertical scale to 10 dB/div. Adjust the reference level so that the peak level of the pulse is at the top of the display.
5. Measure and record the difference between the On state of the UUT to the Off state of the UUT.
6. Repeat steps 3 through 5.

4.4.4 2400 Series Test Datasheet

2400 Series Test Datasheet		
Serial Number		Record measured values in the Test Result column.
Date		
Tested By:		

Frequency, Range, Accuracy

Frequency Range, Accuracy		Frequency ± 1 Hz, ± counter resolution
4.4.4.0.1 Step 3	12 MHz	
	24 MHz	
	48 MHz	
	100 MHz	
	200 MHz	
	400 MHz	
4.4.4.0.2 Step 4	750 MHz	
	1500 MHz	
	3 GHz	
	6 GHz	
	12 GHz	
	20 GHz	
	26 GHz (2426, 2440 series)	
	36 GHz (2440 series)	
	40 GHz (2440 series)	

Spurious Signal Tests
(Refer to section 4.1.3.3 for specification)

Test Frequency	Harmonics	Sub-Harmonics	Non-Harmonics
12 MHz			
24 MHz			
48 MHz			
100 MHz			
200 MHz			
400 MHz			
750 MHz			
1500 MHz			
3 GHz			
6 GHz			
12 GHz			
26 GHz			
36 GHz			
40 GHz			

Maximum-Leveled Power
(Refer to section 4.1.2.1 for specification)

Test Frequency	Maximum-Leveled Output (dBm
12 MHz	
24 MHz	
48 MHz	
100 MHz	
200 MHz	
400 MHz	
750 MHz	
1500 MHz	
3 GHz	
6 GHz	
12 GHz	
26 GHz	
36 GHz	
40 GHz	

Step Attenuator Level Accuracy (Option 26 only)
(Refer to section 4.1.2.4 for specification)

Test Frequency	Maximum-Leveled Output (dBm
12 MHz	
24 MHz	
48 MHz	
100 MHz	
200 MHz	
400 MHz	
750 MHz	
1500 MHz	
3 GHz	
6 GHz	
12 GHz	
26 GHz	
36 GHz	
40 GHz	

Level Accuracy
(Refer to section 4.1.2.4 for specification)

Test Frequency	Level Setting	Accuracy (dB)
Test Frequency		
12 MHz		
24 MHz		
48 MHz		
100 MHz		
200 MHz		
400 MHz		
750 MHz		
1500 MHz		
3 GHz		
6 GHz		
12 GHz		
26 GHz		N/A
36 GHz		N/A
40 GHz		N/A

Amplitude Modulation Accuracy
(Refer to section 4.2.1 for sensitivity specification)

Test Frequency	Sensitivity		
	30%	50%	90%
12 MHz			
24 MHz			
48 MHz			
100 MHz			
200 MHz			
400 MHz			
750 MHz			
1500 MHz			
3 GHz			
6 GHz			
12 GHz			
26 GHz			
36 GHz			
40 GHz			

Amplitude Modulation Bandwidth
(Refer to section 4.2.1 for Rate specification)

Test Frequency	Rate			
	100 Hz	2.5 kHz	7.5 kHz	10 kHz
12 MHz				
24 MHz				
48 MHz				
100 MHz				
200 MHz				
400 MHz				
750 MHz				
1500 MHz				
3 GHz				
6 GHz				
12 GHz				
26 GHz				
36 GHz				
40 GHz				

Narrow Mode Frequency Modulation Accuracy and Bandwidth
(Refer to section 4.2.3 for FM Accuracy and Bandwidth specification)

Frequency	Accuracy		Bandwidth	
	Pass	Fail	Pass	Fail

Wide Mode Frequency Modulation Accuracy and Bandwidth
(Refer to section 4.2.3 for FM Accuracy and Bandwidth specification)

Frequency	Accuracy		Bandwidth	
	Pass	Fail	Pass	Fail

Pulse Modulation
(Refer to section 4.2.4 for Pulse Modulation specification)

Test Frequency	Rise and Fall Time (nsec)		Level Accuracy			On/Off Ratio (dB)
			CW	Pulse	Delta	
12 MHz						
24 MHz						
48 MHz						
100 MHz						
200 MHz						
400 MHz						
750 MHz						
1500 MHz						
3 GHz						
6 GHz						
12 GHz						
26 GHz						
36 GHz						
40 GHz						

A Accessories & Options

A.1 Introduction

The following accessories and options are available for the 2400 Series Microwave Synthesizers. Each accessory and option is described under its respective heading in the appendix.

A.1: Accessories & Options

Accessory/Option No.	Description	Part Number
A011	Ruggedized Carrying Case	29854
22	Rear RF Output (standard for 2400A Series, available for 2400L/M Series only)	
	(2408/2420) L&M models without OPT 26	29948
	(2426/2440) L&M models without OPT 26	29949
	(2408/2420) L&M models with OPT 26	29950
	(2426/2440) L&M models with OPT 26	29951
24	Internal Modulation Generator (2400M/AM models)	29945
26	90 dB Step Attenuator	
	2408/2420 L/M models	29937
	2408/2420 AL/AM models	29938
	2426 L/M models	29953
	2426 AL/AM models	29954
	2440 L/M models	29939
	2440 AL/AM models	29940
28	High Stability Oscillator (standard for L/M Series, available for 2400A Series only)	29918
31	Frequency Step Time > 2 ms	29942
43	Frequency and Power Sweep(2400L/M models only)	29944
45	Rack Mount Kit (2400L/M Series, standard on 2400A Series) This option is field installable.	29936
46	Rack Mount Slides for use with Agilent Technologies rack.	29947
48	Automation Xpress Interface (AXI) and Automation Xpress Software (An Integration Tool for ATE)	29952

A.1 Accessories

A.1.1 A001: Cable Kit (SMA)

This accessory kit furnishes two coaxial cables (18 and 72-inches) with connectors for interfacing to user-supplied signal sources.

A.1.2 AO11: Ruggedized Carrying Case

This is a special ruggedized carrying case for transporting the instrument between work sites. It can be ordered from Giga-tronics with part number 29855.

A.2 Options

A.2.1 Option 22: Rear RF Output

This option moves the RF Output connector to the rear panel and is available for the 2400L/2400M Series. Rear RF Output is standard for the 2400A Series.

A.2.2 Option 24: Internal Modulation Generator

This option is only available for the 2400M and 2400AM Series. The Internal Modulation Generator internally drives all the modulation functions available in the 2400M/AM Series.

A.2.3 Option 26: Step Attenuator

Under this option, an attenuator is placed in the RF output path of the instrument, which provides up to 110 dB of attenuation in 10 dB increments.

Use part number 29937 to order Option 26 for the 2400L Series Microwave Synthesizers. Use part number 29938 to order Option 26 for the 2400AL Series Microwave Synthesizer.

This option has been incorporated in the main body of the manual. Where a procedure or specification applies only to instruments with Option 26, a note to that effect is included.

A.2.4 Option 28: High Stability Timebase

This option provides a high stability timebase . This option is available for the 2400A Series only. High Stability Timebase is standard for the 2400L/2400M Series.

A.2.5 Option 31: Frequency Step Time > 2 ms

If Option 31 is installed, the frequency step time is greater than 2 ms. This option fulfills requirements for specific international standards.

A.2.6 Option 43: Frequency and Power Sweep

This option provides frequency and ramp power sweep capability.

This option has been incorporated into the main body of the manual; where a procedure or specification applies only to instruments with Option 43, a note to that effect is included.

A.2.7 Option 45: Rack Mount Kit

This option provides a rack mount kit for the 2400L/M Series that includes rack mount ears and handles. Rack Mount Kit is standard for the 2400A Series.

A.2.8 Option 46: Rack Mount Slides

This is option provides rack mount slides for use with Agilent Technologies style rack.

A.2.9 Option 48: Automation Xpress Interface and AX Software.

This option provides the Automation Xpress Interface and Automation Xpress Software. The Automation Xpress Interface provides 2.5 ms CW frequency/power switching, faster data exchange and functional downloads/executions, and a stable API programming interface for the ATE programming environment. The Automation Xpress, an integration tool for ATE, aids program developers in generating guaranteed remote programming scripts.

B Remote Error Messaging

Commands including SCPI, GPIB , or register based issued to 2400 may fail to execute. There are several reasons for the failure, such as wrong command string, wrong # 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 {SCPI error #, 2400 error #}. The assigned number for each error message is identical for SCPI and GT12000 command sets.

The following table below describes the error type of each error value returned by the 2400.

B.1 2400 Error Messages

2400 ERROR #	2400 ERROR MESSAGE
0	Command syntax error.
1	Invalid command.
2	Command data checksum error.
3	Invalid Memory Register (0 to 9 only)
4	Invalid *SAV/*RCL register (0 - 9) supported.
5	CW or RAMP POWER frequency is out of range.
6	CW or RAMP FREQUENCY power is out of range.
7	List range editing error, start frequency is out of range.
8	List range editing error, stop frequency is out of range.
9	List range editing error, step frequency is out of range.
10	List range editing error, Power level is out of range.

2400 ERROR #	2400 ERROR MESSAGE
11	List range editing error, start power is out of range.
12	List range editing error, stop power is out of range.
13	List range editing error, step power is out of range.
14	List range editing error, frequency is out of range.
15	List range editing error, dwell time is out of range.
16	System out of memory.
17	Invalid list point parameter.
18	List does not exist.
19	Invalid list trigger repeat type. Single Step, Single Sweep, and Continuous are supported.
20	Invalid list trigger type. BNC, GPIB GET, GPIB Command, and Immediate are supported.
21	Immediate trigger only works with Continuous trigger repeat type.
22	RAMP option is not enabled.
23	RAMP Power span is out of range.
24	RAMP start Power is out of range.
25	RAMP stop Power is out of range.
26	RAMP Frequency span is out of range.
27	RAMP start Frequency is out of range.
28	RAMP stop Frequency is out of range.
29	RAMP time is out of range.
30	Sweep frequency is out of range.
31	Sweep power is out of range.
32	Invalid internal PM polarity. RISing or FALLing are supported.
33	Invalid External PM polarity, NORmal or INVerted are supported.
34	Invalid PM source. INTernal or EXTernal are supported.
35	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	Modulation option is not enabled.
38	Option 24, internal function generator not installed.

2400 ERROR #	2400 ERROR MESSAGE
40	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, 7 - Activate internal AM with noise, 8 - Activate internal AM, but set output to zero.
41	Invalid AM mode. LINear mode only.
42	Invalid AM source. INTernal or EXTernal is supported.
44	Invalid FM source. INTernal or EXTernal is supported.
45	Invalid FM mode. 1 - FM Narrow, 2 - FM Wide.
46	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, 7 - Activate internal FM with zero output.
47	Invalid boolean value is specified. 0 - OFF, 1 - ON.

C Remote Program Examples

C.1 SCPI Script

C.1.1 Simple CW

Sequence	Command	Description
1	FREQuency 10000 MHZ	Set the CW frequency to 10 GHz.
2	POWer 0 DM	Set the CW power to 0 dBm.
3	OUTP ON	Turn the RF on.

C.1.2 Comprehensive CW

Sequence	Command	Description
1	FREQuency 6000 MHZ	Set CW frequency to 6 GHz
2	POWer 3 DM	Set CW power to 3 dBm
3	POW:ATT:AUTO 0	Set attenuation to MANAUL mode
4	POWer:ATTenuation 10 DB	Set attenuation 10 dB
5	POW:ATT:AUTO 1	Set attenuation to AUTO mode
6	OUTP ON	Turn RF on

C.1.3 Simple List Mode

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 power to 8, 5 and 0 dBm separately.
4	LIST:DWEL 0.200000, 0.200000, 0.200000	Set dwell(step) time to 0.2 second.
5	LIST:PRECompute? 1	Pre-compute the created list data
6	LIST:REPeat SWEEP	Set list repeat type to single sweep
7	TRIGger:SOURce BUS	Set list trigger mode to GPIB (software trigger)
8	OUTP ON	Turn RF on.
9	*TRG	Trigger the list.

C.1.4 Comprehensive List Mode

Sequence	Command	Description
1	LIST:SEQ:AUTO ON	Activate list mode
2	LIST:FREQ 1000000000.0,2000000000.0,3000000000.0	Add 3 list points to a list with frequency 1, 2 and 3 GHz separately
3	LIST:POW 0.000,0.000,0.000	Set power to 0 dBm for 3 points.
4	LIST:DWEL 0.250000, 0.250000, 0.250000	Set dwell (step) times to 0.25 second
5	LIST:PRECompute? 1	Pre-compute the created list data
6	LIST:REPeat CONT	Set list repeat type to continuous
7	TRIGger:SOURce BUS	Set list trigger mode to GPIB (software trigger)
8	OUTP ON	Turn RF on
9	*TRG	Trigger the list
10	LIST:DEL:LIST 1	Clear the existing list
11	LIST:FREQ 6000000000.0,6000000000.0,6000000000	Add 3 list points to a list with frequency 6 GHz.

Sequence	Command	Description
12	LIST:POW -10.000, -5.000, 0.000	Set power to -10, -5 and 0 dBm separately.
13	LIST:DWEL 0.200000 S	Set dwell(step) time to 0.2 second
14	LIST:PRECompute? 1	Pre-compute the created list data
15	LIST:REPeat STEP	Set list repeat type to single step
16	TRIGger:SOURce EXT	Set list trigger mode to External trigger. Note: a user will trigger the list with an external device.

C.2 Native Command Script

C.2.1 Simple CW

Sequence	Command	Description
1	CW 10 GHZ	Set the CW frequency to 10 GHz.
2	PL 0 DB	Set the CW power to 0 dBm.
3	RF 1	Turn the RF on.

C.2.2 Comprehensive CW

Sequence	Command	Description
1	CW 10 GHZ	Set the CW frequency to 10 GHz
2	PL 0 DB	Set the CW power to 0 dBm.
3	AT 10 DB	Set the attenuation to MANAUL mode at 10 dB.
4	SHRL	Set the attenuation to AUTO mode.
5	RF 1	Turn the RF on.

C.2.3 Simple List Mode

Sequence	Command	Description
9	LR 1	Activate the list mode.
10	LA 1 0	Add the first list point to a list.
11	LF 1 1 10.000000 GHZ	Set the frequency of the first list point to 10 GHz.
12	LL 1 1 0.000000 DBM	Set the power output of the first list point to 0 dBm.
13	LT 1 1 0.250000 S	Set the dwell time of the first list point to 0.25 second.
14	LA 1 1	Add the second list point to the list

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