

1.6.9.3 Pulse Modulation Source

1.6.9.3.1 Rate

1 Hz to 3 MHz

Rate Resolution

Range	Resolution
1 Hz to 1 kHz	1 Hz
1 kHz to 10 kHz	10 Hz
10 kHz to 100 kHz	100 Hz
100 kHz to 1 MHz	1 kHz
1 MHz to 3 MHz	10 kHz

Accuracy

$\pm 1\%$ of range maximum value; $f_m < 100$ KHz

$\pm 4\%$ of range maximum value; f_m 100 KHz to < 1 MHz

$\pm 10\%$ of range maximum value; $f_m > 1$ MHz

Jitter

Same as instrument time base

1.6.9.4 Pulse Start Variable Delay

(Referenced to Sync Output)

1.6.9.4.1 Range

0 to 1.67 seconds

1.6.9.4.2 Resolution

10 ns

1.6.9.4.3 Accuracy

$\pm 1\%$ of setting or ± 20 ns, whichever is greater

1.6.9.4.4 Jitter

$\pm 0.01\%$ of setting or ± 100 ps, whichever is greater

1.6.9.5 Pulse Width

1.6.9.5.1 Range

100 ns to 1.67 seconds

1.6.9.5.2 Resolution

10 ns

1.6.9.5.3 Accuracy

$\pm 1\%$ of setting or ± 20 ns, whichever is greater

1.6.9.5.4 Jitter

$\pm 0.01\%$ of setting or ± 100 ps, whichever is greater

1.6.9.6 Pulse Modes

Triggered, Gated, Delayed, Singlet, Doublet, Triplet, or Quadlet and Free Running

1.6.9.6.1 Interval**Range**

100 ns to 1.67 seconds

Resolution

10 ns

Accuracy

$\pm 1\%$ of setting or 20 ns, whichever is greater

Jitter

0.01% of setting or 100 ps, whichever is greater



NOTE: The interval between pulse one and pulse two, and the interval between triplets quadlets are the same. The start delay for pulse one is independent.

1.6.9.7 Externally Triggered PM Envelope

One PM envelope produced by each trigger

1.6.9.7.1 Repetition Rate

5 Hz to 5 MHz

1.6.9.7.2 Pulse Delay

Set by internal delay control

1.6.9.7.3 Pulse Width

Set by internal width control

1.6.9.7.4 Input Trigger Required

Positive or negative-going TTL Level trigger pulse, >20 ns wide, unleveled or >75 ns wide, leveled

| 1.6.9.8 PM Sync Output

TTL levels into a $50\ \Omega$ load, 50 ns pulse coincident with start delay

| 1.6.9.9 PM Video Output

TTL levels into a $50\ \Omega$ load

1.6.10 Option 29 Specifications - Scan Modulation

(Not available in 12400A series, available in 12500A and 12700A series up to 20 GHz with 2 dB reduction in power)

Scan may be operated simultaneously with FM and/or PM. Specifications apply with FM and PM turned off.

1.6.10.1 Envelope Parameters

1.6.10.1.1 Frequency of Operation

0.01 to 20 GHz

1.6.10.2 Scan Mode

1.6.10.2.1 Range

0 to 60 dB, $\geq +10$ dBm

1.6.10.2.2 Resolution

0.1 dB

1.6.10.2.3 Sensitivity

-10 dB/volt in 1 dB increments

1.6.10.2.4 Step Response

<1 microsecond for 50 dB change; <10 μ s, <1 GHz

1.6.10.2.5 Frequency Response

DC to 150 kHz, sine wave

1.6.10.2.6 Input Impedance

600 Ω (Nominal)

1.6.10.2.7 Accuracy

± 0.25 dB plus $\pm 5\%$ of depth in dB (For .01 to 2 GHz, specification applies only up to 30 dB)

Linearity

± 0.6 dB (0 - 20 dB), ± 1 dB (20 - 60 dB)

1.6.10.3 Internally Generated Scan/AM Envelope

See Specifications for Option 24.

1.6.10.4 Power

2 dB reduction in power, .01-20 GHz

Front Panel Operation

2.1 Introduction

This chapter describes how to operate the 12000A Microwave Synthesizer from its front panel. Refer to Chapter 3 for instructions on how to operate the instrument from a remote host computer over the General Purpose Interface Bus (GPIB) or an RS-232 serial connection. Refer to Chapter 1 for instructions on how to install and interface the instrument before operating it for the first time.

This chapter contains the following major sections:

- Front Panel Description
- Front Panel Applications

2.2 Front Panel Description

The 12000A front panel contains the controls and display for complete local operation of the instrument. Front panel controls are grouped according to the functions they perform. Descriptions of the controls are referenced to the blocked numbers illustrated in Figure 2-1 on page 2-2.

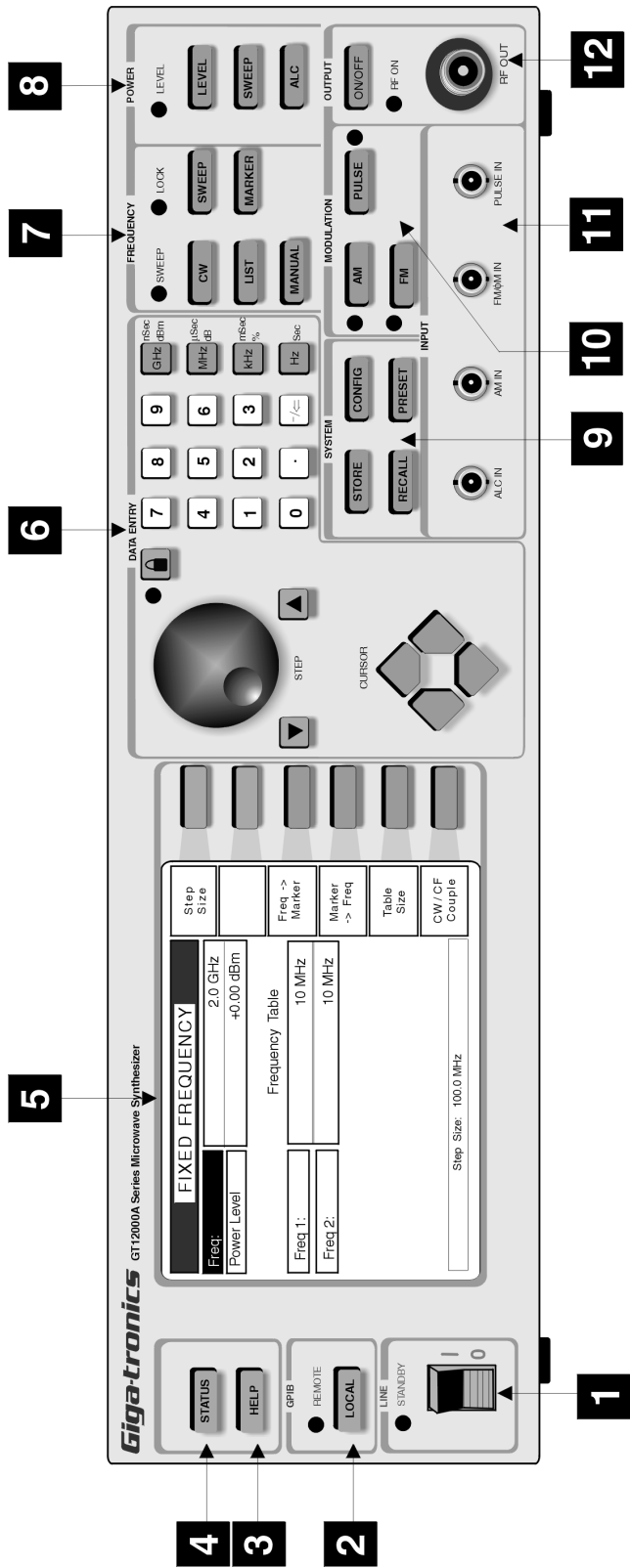


Figure 2-1: Front Panel Layout

Modulation Modes not available in 12400A series

1 Power On/Off

When this power switch is turned ON, the adjacent LED will be green. When the power switch is OFF but main power is connected on the rear panel, the LED will be yellow to indicate a standby condition. When the LED is OFF, the main power is disconnected (line cord) or otherwise not supplying ac power.

2 Help

Press **[HELP]** at any time to display the help screen for the selected option or the process being performed when the Help switch is pressed. Press the **[HELP]** switch again or press **[Exit Help]** from the menu to exit the Help screen.

3 Local

Press **[LOCAL]** to transfer operation of the instrument to Local. When in the Remote mode, all front panel controls except the Local switch will be disabled to prevent unauthorized or accidental changes being made at the instrument. The LED indicator adjacent to the Local switch will be ON when the Remote mode is selected; it will be OFF in the Local mode.

4 Status

Press **[STATUS]** to display the current operating mode, frequency, and level. Press the switch again to return to the previous menu, or press any function key to go directly to that function.

5 Display

The display is a 3" x 4" liquid crystal display (LCD) with 320 x 240 line resolution, 0.30 mm dot pitch, and a cold-cathode fluorescent lamp (CCFL) backlight for optimum viewing. The contrast of the display is software controlled (see "System Field" on page 2-6 and reference item 9. Select contrast from the cursor keys, then select knob to adjust to desired contrast). The last contrast value set is saved and restored upon bootup or reinitialization.

The Display field includes six interactive softkeys to select the respective options displayed on the right side of the screen (see Figure 2-1). The options will change according to the menu being displayed.

The screen displays real-time configuration and operating data. Front panel configuration parameters are automatically saved in non-volatile memory when entered.

FIXED FREQUENCY		Step Size
Frequency:	10.0 MHz	
Power Level:	+0.00 dBm	
Frequency Table		Freq → Marker
Frequency 1:	10.0 MHz	Marker → Freq
Frequency 2:	10.0 MHz	Table Size
Step Size: 100.0 MHz		CW / CF Couple

Figure 2-2: Display Screen with Interactive Softkeys

6 Data Entry Field

The DATA ENTRY field contains the 12-button keypad, Units keys, Knob Lock key, cursor keys, and the resolution Step Up/Down keys and adjusting knob. Figure 2-3 illustrates the Data Entry field. Each control within the field is explained in the following paragraphs.

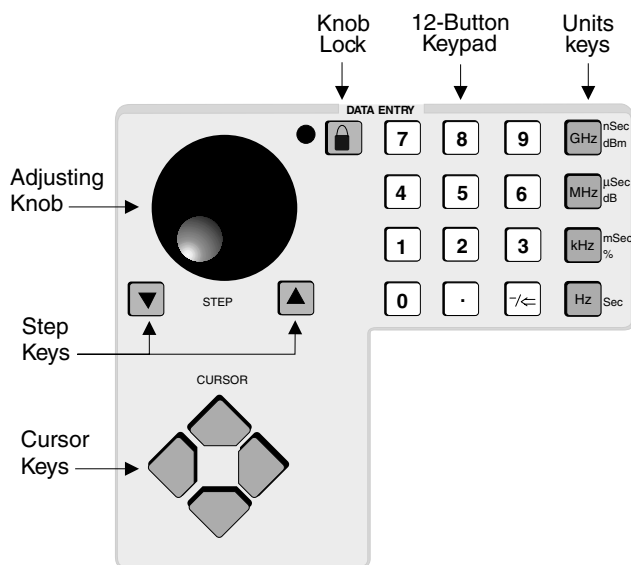


Figure 2-3: The Data Entry Field

- Data Entry Keypad** Use this 12-button numeric keypad to enter parameter values and other data that require specific values. The +/- key (located below the numeric 3 key) has a dual function. If it is pressed before a numeric key, a minus sign will precede the first digit. If it is pressed after one or more numeric keys, it functions as a backspace to delete the previous entry.
- Units Keys** Press the appropriate Units key to select the units of the parameter in the display and terminate the numeric entry. Any Units key can be used to terminate numeric entries without units.
- Knob Lock Key** Press this key to lock (disable) the adjusting knob to prevent unauthorized or accidental changes. Press the key again to unlock the knob. The adjacent green LED will be ON when the adjusting knob is disabled, and OFF when the knob is enabled.
- Adjusting Knob** This knob increments or decrements a parameter value by the selected resolution.
- Resolution Step Keys** These keys increment or decrement a parameter value by one each time they are pressed. The keys duplicate the action of the adjusting knob except that they always step the value up or down by one. See Section 2.2 for instructions to set the resolution of the Step keys.
- Cursor Keys** These four cursor directional keys, arranged in a diamond pattern, step the display cursor up, down, left and right. The cursor is the highlighted data in the display.

7

Frequency Field

The FREQUENCY field controls the mode and frequency parameters when you are operating the unit in a fixed frequency mode.

- CW** Press **[CW]** to display the current frequency and to enable frequency changes. Use the numeric keypad to change the frequency, and the adjusting knob and/or step keys to adjust the frequency in selective steps.
- Sweep** Press **[SWEEP]** to display the Sweep parameters and to select alternate sweep methods. You can change the sweep parameters while this menu is displayed. In this mode the LEVEL and LOCK LEDs are not updated.
- List** Press **[LIST]** to display a list of preset frequencies for high speed operation. With this screen displayed, you can choose the frequency to be used or edit the list to add or delete other frequencies.
- Marker** Press **[MARKER]** to display the 12 frequency markers used in frequency sweep operation. Position the cursor over a particular marker to set the frequency for that marker. Enter the marker frequency with the Data Entry keypad, or adjust the frequency with the adjusting knob or step keys. Turn a marker on or off from the menu with the interactive data key (the ON position is indicated with the highlighted box to the left of the marker number)
- Manual** Press **[MANUAL]** to override an active frequency sweep when you want to use manual sweep control with the same parameters (some of the parameters can be changed while in the manual sweep mode and will transfer to the active sweep when it is resumed). The manual sweep mode is available only while a frequency sweep is in progress. If a ramp sweep is in progress, the sweep mode will change to step sweep and remain there.

8

Power Field

This field controls the parameters for power level and sweep operation.

- Level** Press **[LEVEL]** to adjust the output signal level.
- Sweep** Press this switch to toggle between step sweep and ramp sweep functions. Use the menu to control the stop, start, center or dwell variables associated with either step or ramp power sweep operation. Ramp sweep is available in the 127XXA Series.
- ALC** The resulting menu when you press **[ALC]** controls the Automatic Level Control (ALC) functions. In addition to selecting the mode and sensor for leveling, the step attenuator, if fitted, can be set to a fixed value.

9

System Field

The **SYSTEM** field provides the means to configure the operating parameters and to set the IEEE 488 address. It also provides Store and Recall of up to 10 instrument setup configurations, and a list of configured (preset) items.

Store Press **[STORE]** to store the current instrument setup. You will be prompted to enter an address of 0 through 9, with current assignments and free addresses displayed. See Figure 2-4 below, the next available free step up (for storage) is number 2. Press the number 2 data entry key and the current setup is stored in address 2.

STORE SETUP		Clear a Setup
Setups In Use:	0, 1	Clear All Setups
Setups Free:	2-9	
		Return to mode
		Return
Store to setup (0-9):		

Figure 2-4: Store Setup Selection

Recall Press **[RECALL]** to recall a stored instrument setup. The address of each stored configuration will be displayed. See Figure 2-5 below, stored setups are in addresses 0 and 1.

RECALL SETUP		Clear a Setup
Setups In Use:	0, 1	Clear All Setups
Setups Free:	2-9	
		Return to mode
		Return
Recall from setup (0-9):		

Figure 2-5: Recall Setup Selection

Config Press **[CONFIG]** to display the instrument configuration. You can change the configuration data to generate a new setup, and then store that data to any available memory address for recall when needed.

SYSTEM CONFIGURATION		GPIB
Ext. Reference:	10 MHz	
Retrace:	RF Off	
Power-up RF:	Always Off	
Blanking:	+5V	
Key Click:	Enable	
Knob Click:	Enable	
Volume:	4	
Contrast:	128	
Lock/level BNC:	Lock & Level	Service
Use Step keys to change entry.		Return to mode

Figure 2-6: System Configuration Selection

GPIB PARAMETERS		
GPIB Address:	6	
Language:	Native	
Line Term:	LF	
GPIB Display:	Remote Operation	
Out of Bounds:	Use Closest Bound	
		Return to mode
Step Size: 1		Return

Figure 2-7: System Configuration Selection - GPIB Parameters

Preset Press **[PRESET]** to display the preset menu. Pressing Initialize NVRAM, sets NVRAM to default values (clears lists, level corrections and setups) and presets the instrument to the factory settings.

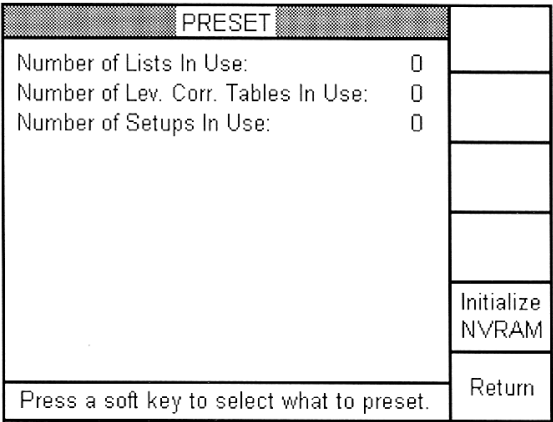


Figure 2-8: System Configuration Selection - Preset

Table 2-1: Factory Default Settings

Parameter	Default Condition	Parameter	Default Condition
CW Frequency	Minimum	FM Rate (Opt. 24)	1 kHz
RF @ Power up	Off	FM Mode	Ext
RF Level	0 dBm	FM Deviation	5 MHz
Amplitude Modulation	Off	Pulse Modulation	Off
AM Rate (Opt. 24)	1 kHz	PM Rate (Opt. 24)	100 kHz
AM Mode	Ext	PM Mode	Ext
AM Depth	50%	PM Width (Opt. 24)	5 us
Frequency Modulation	Off	PM Delay (Opt. 24)	0 ns

10

Modulation Field (Not Available in 12400A series)

This field selects the type of modulation to be used. AM, FM, Φ M and PM are available.

- AM** Press **[AM]** to select amplitude modulation. AM can be linear, expressed in percent, or scan (Option 29), expressed in dB with the output power being proportional to the input voltage. AM can be internal or from an external source (internal AM is available only when Option 24 is installed).
- FM** Press **[FM]** to select frequency modulation. FM can have a narrow bandwidth of dc to 1 MHz and a maximum deviation of 1 MHz (in the 4 to 8 GHz range), or FM can have a bandwidth of 100 Hz to 8 MHz and a maximum deviation of 20 MHz (in the 4 to 8 GHz range). FM can be internal or from an external source (internal FM is available only when Option 24 is installed).
- Φ M** First press **[FM]** then use the mode parameter to select phase modulation.
- PM** Press **[PM]** to select pulse modulation. PM can be internal or from an external source (internal PM is available only when Option 24 is installed).

11

Input Field

The Input field contains four BNC connectors. External modulation sources can be applied to the AM, FM and PM connectors (Φ M uses the FM connector). The ALC is currently not active.

12

RF Field

The RF field provides an RF connector and a switch to turn the output on and off. The adjacent LED will be ON when the RF output is turned on. The front panel RF connector will be relocated to the rear panel when Option 22 is installed.

2.3 Front Panel Applications

The remainder of this chapter presents applications examples to illustrate how to operate the 12000A by using the controls on the front panel. Only the features shown in the various menus are available (i.e., there are no other commands or command sets that can be used from the front panel). Refer to Chapter 3 in this manual if you intend to operate the 12000A over a remote interface through the General Purpose Interface Bus (GPIB) or the RS-232 serial interface.

The 12000A features a comprehensive HELP system linked to the current display. Press the **[HELP]** key to display general information about the function — this screen also provides softkeys through which you can select more detailed help topics.

Data Entry for the various menus depends on the type of entry. Parameters with numeric values can be entered and changed by the following methods:

2.3.1 Direct Entry

With the cursor positioned at the far left (e.g., on **FREQ** in the Fixed Frequency menu as shown in Figure 2-9), enter the numeric value with the keypad. The entry will display in the bottom part of the menu, and will be transferred to the Frequency line when the entry is terminated by pressing the appropriate Units key (any Units key terminates an entry that does not require units).

To enter a negative number, press the **[BK/-]** keypad button before entering the first digit. After the first digit has been entered, this key functions as a backspace to delete the previous digit.

2.3.2 Increment/Decrement

With the cursor positioned at the far left of the menu, use the knob or step button to continuously vary the numeric value of the digits on the same line with the cursor. The resolution of the steps can be changed by pressing the **[Step Size]** softkey.

2.3.3 Individual Digit Changes

With the cursor positioned at the far left, use the horizontal (left/right) cursor keys to highlight the digit to be changed, then use the knob or step buttons to change the value as desired. Move the cursor to the second digit to be changed and repeat the process until all digits are changed as desired. Parameters with selective values are changed by scrolling through the selections using the knob or step buttons.

Figure 2-9 is an illustration of the 12000A Fixed Frequency menu with the interactive softkeys. Press the softkey to perform the function shown in the adjacent block in the menu. The highlighted area in the display is the cursor, controlled by the cursor keys.

2.3.4 Set a CW Frequency

Press **[CW]** to generate a fixed frequency at a fixed amplitude. The menu illustrated in Figure 2-9 will display, showing the current or last-used frequency. In addition to changing frequencies in this menu,

you can also enter and store up to six frequencies and their associated power output for quick selection. This mode terminates all in-use modulation formats.

FIXED FREQUENCY		Step Size
Frequency:	10.0 MHz	
Power Level:	+0.00 dBm	
Frequency Table		Freq → Marker
Frequency 1:	10.0 MHz	Marker → Freq
Frequency 2:	10.0 MHz	Table Size
Step Size: 100.0 MHz		CW / CF Couple

Figure 2-9: Fixed Frequency Menu with Softkeys

With the cursor at the far left as in Figure 2-9, use the keypad to enter the frequency that you want to use. The value you enter will display at the bottom of the screen. When all digits are entered, press the appropriate [UNITS] key to transfer the value to the Frequency line.

In place of using the keypad, you can change one or more of the frequency digits by moving the cursor with the horizontal directional keys to the first digit to be changed and then making the change with the knob or Step keys. Move the cursor to any additional digits to be changed and repeat the process.

If you want to change the incremental resolution of the knob or the step keys, press [Step Size] and select either [Step x10] to increase the resolution or [Step /10] to decrease the resolution. In addition, the step size can be entered with the keypad.

2.3.4.1 Frequency Table

The Frequency table can contain up to six pre-set frequencies, which you can rapidly select as the CW frequency. Set up the frequencies in the table before you start operation so that you can easily and rapidly select each when needed during the operation.

Select the number of table entries you need by pressing [Table Size], then enter the number of entries (1 to 6) with the keypad (0 turns all table entries off). The selected number of table entries will display with the last-set frequency on each line. Set the frequency in each line in the same manner described above for setting the CW frequency.

To select a table frequency as the output CW frequency, move the cursor to the Frequency table entry you desire to use and press [Table → Freq]. The value of that entry will immediately appear on the CW Frequency line and the cursor will advance to the next table entry. To set the output power level, see section 2.3.5.

If you plan to use the Power Level table for rapid access, press the [LEVEL] button in the Power Field. When you use this approach, the **Frequency** table will change to **Power Level** table. The Power Level table is set and used essentially the same as the Frequency table described in the preceding section with the exception of Frequency markers.

2.3.4.2 Transfer To/From a Marker

You can either add the CW frequency to the list of Markers or transfer any Marker value to the CW frequency. To transfer the CW frequency to the list of Markers, for first marker, press [**Freq**→**Mrkr**], for second marker press [*Select Marker*] to select the Marker number to which the frequency will be assigned, then press [*Copy Freq*] to complete the transfer. If you wish to retrieve a marker frequency and use it as the CW frequency, press [**Mrkr**→**Freq**], press [*Select Marker*] and select the number of the Marker you want to transfer to the CW frequency, then press [*Copy Mrkr*] to complete the transfer.

2.3.5 Set the Power Output

This function automatically sets the power output for the selected frequencies through the use of the internal closed-loop leveling system.

Press **[LEVEL]** to display the Power Output menu illustrated in Figure 2-10. This menu contains the current power output setting and a table of up to six power levels that are stored for quick recall. In addition to setting power output levels in this menu, you can also control the CW frequency.

FIXED POWER		Step Size
Frequency:	10.0 MHz	
Power Level:	+0.00 dBm	
Level Table		
Power Level 1:	+0.00 dBm	
Power Level 2:	+0.00 dBm	
		Table Size
Step Size: +1.00 dB		

Figure 2-10: Output Power Level Menu

With the cursor at the far left as in Figure 2-10, use the keypad to enter the power output that you want to use. The power value you enter will display at the bottom of the screen. When all digits are entered, press any **[UNITS]** key to transfer the value to the upper Power Output line, measured in dBm.

In place of using the keypad, you can change one or more of the power output digits by moving the cursor with the horizontal directional keys to the first digit to be changed and then making the change with the knob or Step keys. Move the cursor to any additional digits to be changed and repeat the process.

If you want to change the incremental resolution of the knob or the step keys, press *[Step Size]* and select either *[Step x10]* to increase the resolution or *[Step /10]* to decrease the resolution. In addition, the step size can be entered with the keypad.

The table of power settings can contain up to six pre-set levels, which you can rapidly select for use with any CW frequency. Set up the power levels in the table before you start operation so that you can easily and rapidly select each when needed during the operation.

Select the number of table entries you need by pressing *[Table Size]*, then enter the number of entries with the keypad (1 to 6, 0 turns all table entries off). The selected number of table entries will display with the last-set power level on each line. Set the frequency in each line in the same manner described above for setting the initial power output.

Refer to Section 2.3.4 to set the Power Output level directly from the CW Frequency menu instead of pressing the **[LEVEL]** key as described in this section.

2.3.6 Configure a Step Frequency Sweep

Use this feature to set up a step frequency sweep. Figure 2-11 illustrates the Step Frequency Sweep menu. A Step Frequency Sweep will start and stop at the frequency values which you designate in the configuration, along with the Repeat mode. You will also need to configure the dwell time at each step, the output power level and type of trigger to be used.

FREQUENCY SWEEP		
Sweep Type:	Step	
Parameters:	Start / Stop	
Start Freq:	10.0 MHz	
Stop Freq:	20.199 GHz	
Freq Step:	100.0 MHz	
Dwell Time:	200.0 ms	
Power Level:		+0.00 dBm
Repeat Mode:	Single Sweep	
Trigger Type:	Soft Key or GPIB	
Use Step keys to change entry.		

ALT Sweep

DUAL Sweep

Step Params

Trigger Sweep

Figure 2-11: Step Frequency Sweep Menu

Move the cursor to highlight the specific parameter to be configured, then look at the options for that parameter by pressing the up or down Step key. Additional options can be selected with the softkeys to

- Set up an alternate Step Frequency sweep with individual parameters as defined in this section.
- Set up the Step parameters

Press [*Alt Sweep*] to configure a second Step or Ramp sweep that can be run alternately without having to reconfigure each time.

Press [*Dual Sweep*] to configure a dual Frequency-Power sweep.

Press [*Step Params*] to see the options for selecting the Step/Dwell or Step/Sweep time or the Points/Dwell or Point/Sweep time.

Press [*Trigger Sweep*] to start a Power sweep after the sweep has been configured.

2.3.6.1 Step Frequency Sweep Parameters

2.3.6.1.1 Sweep Type

The sweep type is selective between Step and Ramp. This section details how to set up a Step Frequency sweep; see Section 2.3.7 for instructions on how to set up a Ramp Frequency sweep. With the cursor on Sweep Type, press either Step key to select Step.

2.3.6.1.2 Parameters

The options are Start/Stop and Center/Span. Use Start/Stop to run a sweep with specific start and stop frequencies. Select Center/Span to set up a sweep that allows entering the start frequency and the total width of the sweep. The instrument computer then determines the upper and lower sweep limits. The sweep will run between the upper and lower values of a frequency range.

2.3.6.1.3 Start or Center Frequency

When using the Start/Stop option, enter the frequency at which you want the sweep to start. If you are using the Center/Span option, this entry will change to Center Frequency. Enter the center frequency of the sweep.

2.3.6.1.4 Stop Frequency or Frequency Span

When using the Start/Stop option, enter the frequency at which you want the sweep to stop. If you are using the Center/Span option, this entry will change to Frequency Span. Enter the total frequency that the sweep will span across.

2.3.6.1.5 Frequency Step

Enter the value that you want each step of the sweep to take.

2.3.6.1.6 Dwell Time

Enter the time you want the sweep to dwell at each step. The dwell time does not include the transition time to arrive at the dwell point.

2.3.6.1.7 Power Level

For convenience, you can set the power output level in this menu in the same manner as described in Sections 2.3.4 and 2.3.5.

2.3.6.1.8 Repeat Mode

This option determines how a sweep will run. The choices are Single Step, Single Sweep, or Continuous.

2.3.6.1.9 Trigger Type

Select the type of trigger that will be used to initiate the frequency sweep. The options are Immediate, which means that a sweep will run immediately when selected; Softkey or GPIB, which will trigger a sweep when either the softkey is pressed or a command is received over the GPIB; and Trigger In BNC, which will trigger a sweep when a signal is applied to the Trigger In BNC from an external source.



NOTE: *The Immediate mode is not valid for single step and single sweep.*

2.3.7 Configure a Ramp Frequency Sweep

Use this feature to set up a Ramp frequency sweep. Figure 2-12 illustrates the Ramp Frequency Sweep menu. A Ramp frequency sweep starts at a designated frequency and runs continuously until it reaches a stop frequency. The Ramp sweep can be run as a single sweep or continuously. There are no step options associated with the Ramp Frequency Sweep.

FREQUENCY SWEEP				
Sweep Type:	Ramp			
Parameters:	Start / Stop			
Start Freq:	10.0 MHz			
Stop Freq:	20.199 GHz			ALT
Sweep Time:	1.0 sec			Sweep
Power Level:			+0.00 dBm	DUAL
Repeat Mode:	Single Sweep			Sweep
Trigger Type:	Soft Key or GPIB			
Use Step keys to change entry.				Trigger
				Sweep

Figure 2-12: Ramp Frequency Sweep Menu

 **NOTE:** If the Ramp Frequency Sweep parameters are selected such that the maximum sweep rate allowed for the lowest octave of the full sweep is exceeded, reliable operation of Ramp Frequency Sweep is not guaranteed. Refer to the Ramp Frequency Sweep specifications for details on the maximum sweep rate per octave.

There are several parameters to be setup in this application. Move the cursor to highlight the specific parameter to be set, then look at the options for that parameter by pressing the up or down Step key. Additional options can be selected with the softkeys to

- Set up an alternate Step Frequency sweep as detailed in Section 2.3.6.
- Set up a dual Power-Frequency sweep

Press [Alt Sweep] to configure a second Step or Ramp Frequency sweep that can be run alternately without having to reconfigure each time.

Press [Dual Sweep] to configure and run a dual Power-Frequency sweep.

Press [Trigger Sweep] to start a frequency sweep or take a single step.

2.3.7.1 Ramp Frequency Sweep Parameters

2.3.7.1.1 Sweep Type

The sweep type is selective between Step and Ramp. This section details how to set up a Ramp Frequency sweep; see Section 2.3.6 for instructions on how to set up a Step Frequency sweep. With the cursor on Sweep Type, press either Step key to select Ramp.

2.3.7.1.2 Parameters

The options are Start/Stop and Center/Span. Use Start/Stop to run a sweep with specific start and stop frequencies. Select Center/Span to set up a sweep that allows

entering the center frequency and the total width of the sweep. The instrument computer then determines the upper and lower sweep limits. The sweep will run between the upper and lower values of a frequency range.

2.3.7.1.3 Start or Center Frequency

When using the Start/Stop option, enter the frequency at which you want the sweep to start. If you are using the Center/Span option, this entry will change to Center Frequency. Enter the center frequency of the sweep.

2.3.7.1.4 Stop Frequency or Frequency Span

When using the Start/Stop option, enter the frequency at which you want the sweep to stop. If you are using the Center/Span option, this entry will change to Frequency Span. Enter the total frequency that the sweep will span across.

2.3.7.1.5 Sweep Time

Enter the total time you want for each sweep.

2.3.7.1.6 Power Level

For convenience, you can set the power output level in this menu in the same manner as described in Sections 2.3.4 and 2.3.5.

2.3.7.1.7 Repeat Mode

This option determines how a sweep will run. The choices are Single Sweep or Continuous.

2.3.7.1.8 Trigger Type

Select the type of trigger to be used to initiate the frequency sweep. The options are Immediate, which means a sweep will run immediately when selected; Softkey or GPIB, which will trigger a sweep when either the softkey is pressed or a command is received over the GPIB; and Trigger in BNC, which will trigger a sweep when a signal is applied to the Trigger BNC from an external source.

2.3.8 Add Markers to a Frequency Sweep

Markers can be added to a sweep in different ways to identify their position in the sweep. Markers can be entered as video, intensity, or amplitude. Video markers illuminate the vertical reticule when the markers are reached. Intensity markers cause the intensity of the sweep to increase when the markers are reached. Amplitude markers generate a blip (positive or negative) when the markers are reached.

To set the markers and their parameters, press [MARKER] to bring up the Edit Markers menu shown in Figure 2-13. In this menu illustration, the first two markers have been set at 10.0 and 10.5 GHz, and as Amplitude types, all indicated by the solid white tiles. The cursor is sitting on marker 3.

EDIT MARKERS		Step Size
Marker	Frequency	
☒ 1	10.0 GHz	Switch Cursor
☒ 2	10.5 GHz	
☒ 3	11.0 GHz	Toggle On / Off
☐ 4	11.5 GHz	
☐ 5	12.0 GHz	Set Ampl
☐ 6	12.5 GHz	
☐ 7	13.0 GHz	Pause Time
☐ 8	13.5 GHz	
☐ Video ☒ Amplitude ☐ Intensity		Return to mode
Step Size: 100.0 MHz		

Figure 2-13: Marker Configuration Menu

To set a marker from the Edit Markers menu:

1. Highlight the marker to be set with the cursor and use the keypad to enter the frequency you want to assign to that marker. The digits will display in the bottom window (temporarily replacing the Step Size) as you enter them. Press the appropriate Units key to enter the digits as the marker frequency. You can use the Step Up and Step Down keys to increment and decrement the frequency value by the amount of the current step size.
2. Press [Switch Cursor] to move the cursor to the marker type field below the markers. Move the cursor to highlight your desired type of marker and press [Toggle On/Off] to turn on the marker type. You can select multiple marker types to apply to a single marker.



NOTE: Marker Type applies to all active markers, not individually.

3. Press [Switch Cursor] again to move the cursor back to the marker number. Press [Toggle On/Off] to turn on the marker, shown by the filled number tile.
4. For amplitude markers, set the amplitude of the marker by pressing [Set Ampl] and then setting the value in dBm.
5. For intensity markers, adjust the pause time of the marker by pressing [Pause Time] and using the keypad to set the new time. Press the appropriate [Units] key to activate the new value. The minimum value must be $\geq 1.0 \mu s$

See Section 2.3.4 for instructions on how to copy a frequency directly from the CW Frequency menu to a marker, or from a marker to the CW Frequency menu.

2.3.9 Set Up a List Frequency Sweep

The List Frequency Sweep is an alternate sweep method that takes full advantage of automatic switching at the highest sweep speed. You can configure up to 99 frequency lists with a variety of points in each, and then allow the instrument to automatically scan through the points. The number of points is limited by the memory of the instrument.

The points that you can set up are the points at which the sweep will stop. Dwell or stop times determine how long the respective sweep will stay at that point. Each point is independent of other points. List sweeps can be set up locally at the front panel or downloaded over the GPIB and run remotely.

LIST MODE				Step Size
List Table:	1			Switch Cursor
Repeat Mode:	Single Sweep			
Trigger Type:	Soft Key or GPIB			
Pt	Frequency, GHz	Power		Add Point
	Dwell, sec	AM FM PM		Delete Point
1	0.010 000 000 0 0.100 000	+0.00 dBm		Edit List
2	0.100 000 000 0 0.100 000	+0.00 dBm		
Step Size: 100.0 MHz				Trigger Sweep

Figure 2-14: List Sweep Configuration Menu

2.3.9.1 List Table

Place the highlight on this parameter. You can either press the Step Up or Down key to increment or decrement the list number, or you can enter the list number with the keypad and press any Units key. Each table represents a different sweep configuration; up to 99 lists can be configured. The entries in the table below the parameters are the individual points that can be configured for each sweep.

2.3.9.2 Repeat Mode

This parameter sets up the repeat mode of the list sweeps. The options are Continuous, Single-Sweep, or Single Step. Move the cursor to the Repeat Mode and press the Step Up or Down key to select your choice. The modes are defined as follows:

2.3.9.2.1 Continuous

Execute the entire current list, repeating it indefinitely.

2.3.9.2.2 Single Sweep

Execute the entire current list, and then stop; the next trigger will resume execution at the start of the list.

2.3.9.2.3 Single Step

Execute the current list point, and then stop; the next trigger will resume execution with the next list point. The list's first point is considered to be the initial current point, and is also considered to be the point following the list's final point.

2.3.9.3 Trigger Types

These are the ways in which the sweep will be initiated. The options are Immediate, Trigger In BNC, and Softkey or GPIB. Move the cursor to this parameter and press the Step Up or Down key for your selection. Immediate mode starts the list as soon as its points are entered. Trigger In BNC requires an external TTL signal to start a sweep (or take a step). Softkey/GPIB triggers a sweep when the front panel softkey is pressed or when a trigger command is received over the GPIB (Get Event).

2.3.9.4 Configuring Points

In the table, Pt is the heading for the respective points in the list. Frequency of the point and dwell time at each point are listed in the middle, while power and type of modulation are at the right. The types of modulation will not display in the parameters until you cursor to them and press the Step Up or Down key to activate the selection. You can have any combination of modulations. AM and PM can be used together only when the AM mode is Scan (i.e., AM cannot be linear).



NOTE: All points share common AM/FM/PM parameters. These are set up using the AM/FM/PM screens.

New points can be added by pressing [Add Point]. When you add a point, it will be a duplicate of the point on which the cursor is located, so if you want to duplicate a specific point, move the cursor to that point before added the new point. Add Point inserts a point following the current point, and moves other points down the list.

You can edit the points directly in this window by pressing [Switch Cursor] to move the cursor to the table, and then move the cursor to highlight the parameter to be changed. Parameters with numerical values are best changed by entering the new value with the keypad and pressing the appropriate Units key. The values can then be fine-adjusted with either the Step keys or the adjusting knob. Modulation

parameters are changed by highlighting the *position* of the modulation type and then pressing the Step Up or Down key.



NOTE: Points do not have to be entered in any numerical or other order. They can be inserted in any order.

WARNING

If the power level settings involve changes to the Step Attenuator (i.e., levels below 0 dBm), the List Run time should be closely monitored. The Step Attenuator uses electro-mechanical actuators. These actuators require 25 ms to operate. List Point dwell times should be at least this long. The electro-mechanical actuators have a large, but finite, maximum number of operations. Be sure the List Mode is not left on for long periods of time if the Step Attenuator is being switched.

Existing points can be deleted by first moving the cursor to any parameter within the point, and then pressing [Delete Point]. The cursor position identifies the point to be deleted.

2.3.9.5 Edit List

Edit List generates a list by specifying the Start, Stop, Step, Dwell, Power Level, and Modulation. The range of the individual lists can be edited by pressing [Edit List]. The menu in Figure 2-15 will display.

Press [Insert Range] to generate the list. This can take some time to complete (about 10 ms per point). Once done, the list will appear on the screen. Individual points can now be edited as needed to change common parameters.

EDIT LIST 1			Step Size
Pt	Frequency, GHz	Power	Go to Freq
	Dwell, sec	AM FM PM	Add Point
1	4.000 000 000 0 1.000 000	+8.00 dBm AM	Delete Point
2	4.500 000 000 0 3.000 000	-4.00 dBm FM	Edit Range
3	15.000 000 000 0 5.000 000	+5.00 dBm PM	Return
4	20.000 000 000 0 1.500 000	+15.00 dBm	
Step Size: 100.0 MHz			

Figure 2-15: Edit List 1 Sweep Parameters Menu

To change range refer to Figure 2-16.

LIST 1 RANGE				Step Size
Start Freq:		10.0 MHz		Switch Cursor
Stop Freq:		20.199 GHz		
Freq Step:		100.0 MHz		
Power Level:			+0.00 dBm	Insert Range
Dwell Time:		200.0 ms		Insert List
Modulation:				
Pt	Frequency, GHz		Power	Delete List
	Dwell, sec		AM FM PM	
1	0.010 000 000 0		+0.00 dBm	Return
	0.100 000			
Step Size: 100.0 MHz				

Figure 2-16: List 1 Range Menu

The list number will be displayed in the menu title at the top of the screen. If you need to edit the range of a list other than the one shown, press [Insert List], enter the list number with the keypad and press any Units key. If that list contains no points, it will not display here; you need to go back to the menu in Figure 2-14 and start a new list.

Refer to the instructions on how to configure a Step Frequency Sweep in Section 2.3.6

2.3.10 Speeding Up List Entry

The manipulation (adding, editing, deleting) of large numbers of list points can be speeded up by changing the list trigger mode from the default mode (immediate) to a non-immediate one, e.g.:

- Trigger in BNC

This will relieve the 12000A's firmware of the burden of repeatedly terminating and relaunching list execution in response to each command's arrival, leaving it free to devote itself entirely to command processing. After the list points are manipulated, and their lists precompiled, the trigger mode can be changed as desired.

2.3.11 Precompilation of Lists

In the 12000A, list points exist in two different forms. One is the *source* form, where the data describing a point is in a form that closely corresponds to the human readable formats used by the front panel's list menu. Source form points are *compiled* to create corresponding *object* form points, which are in a format that is understandable to the 12000A's actual signal generation hardware. Normally, compilation is performed during list execution; while point N of a list is being output by the hardware, point N+1 is being compiled by the firmware. The process is invisible to the user, as long as the dwell times of list points are longer than their compilation time (currently about 25 ms a piece). If point dwell times are lower than this value, list execution will be 'slow':

- At the end of a point's dwell time, list execution will pause until next point's compilation is completed.
- If Config | Retrace is set to RF Off, then RF will be blanked during this period.
- If List | Repeat Mode is set to Single Step, trigger events may be missed.

To enable real-time execution of lists with 'short' dwell times, the 12000A contains a feature known as *list precompilation*, which is implemented (when using front panel control) the first time a list is run. Therefore, for maximum speed, manually run the list once after entering the parameters. Allow sufficient time for the precompilation, about 25 ms per point.

Precompilation may need to be repeated whenever:

- Points are added to or removed from the list.
- Points are edited.
- The unit's AC line power is cycled.

2.3.11.1 Multiple Precompiled Lists

The 12000A also supports the precompilation of multiple lists. This can be done by following the single list precompilation procedure for each list of interest.

1. Add and/or edit all the points for all the lists.
2. Run each list.

2.3.12 Storage of List Points

The 12000A allocates storage for list points from pools of memory; thus, the storage requirement for a given number of list points is largely independent of the number of lists in which they are placed. For example, a single list of 100 points requires about the same amount of storage as 10 lists of 10 points each.

Source form points are allocated from nonvolatile memory, so that they will be preserved across cyclings of the unit's AC line power, i.e. across *line power sessions*. This pool of memory is shared by unit setups that are saved via the front panel's System | Store button; nevertheless, there is sufficient space for several thousand points. Object form list points are allocated from volatile memory, i.e. they do not persist beyond the current line power session. Many aspects of the unit's functionality share this pool of memory; therefore, the allocation of an excessive number of object form list points may impair other aspects of the unit's behavior. Deletion of object form list points (see below) may replenish this pool to a state suitable to these other aspects; however, only the cycling of line power is guaranteed to effect a complete replenishment. Currently, we recommend that the number of object form list points be limited to 1000.

The following lists of circumstances are given to help the user insure that the limit on object point quantities can be observed.

Events causing allocation of source form points include:

- The adding of a point

Events causing their deallocation include:

- The removal of a point
- The deletion of an entire list
- Any other event that causes the clearing of nonvolatile memory

Events causing allocation of object form points include:

- The editing of a source form point
- The precompilation of a list
- The running of a list that is not precompiled

Events causing their deallocation include:

- The deletion of a source form list
- The cycling of line power



NOTE: Lists, when edited or executed, consume object form points, regardless of whether they are precompiled. Also note that the only way to recycle object form points during a given line power session is to delete an entire source form list.

2.3.13 Configure a Step Power Sweep

Use this feature to set up a step power sweep. Figure 2-17 illustrates the Step Power Sweep menu. A Step Power Sweep will start and stop at the power levels, which you must designate in the configuration along with how a sweep will be repeated. You will also need to configure the dwell time at each step, the output power level and type of trigger to be used.

POWER SWEEP		
Sweep Type:	Step	
Parameters:	Start / Stop	
Start Power:		+0.00 dBm
Stop Power:		+10.00 dBm
Power Step:	+1.00 dBm	
Dwell Time:	100.0 ms	
Frequency:	10.0 MHz	
Repeat Mode:	Single Sweep	
Trigger Type:	Soft Key or GPIB	
Use Step keys to change entry.		

DUAL Sweep

Step Params

Trigger Sweep

Figure 2-17: Step Power Sweep Configuration Menu

Move the cursor to highlight the specific parameter to be configured, then look at the options for that parameter by pressing the up or down Step key. Additional options can be selected with the softkeys to

- Set up a dual Frequency-Power sweep
- Set up the Step Power Sweep parameters

Press [*Dual Sweep*] to configure a dual Frequency-Power sweep.

Press [*Step Params*] to see the options for selecting the Step/Dwell or Step/Sweep time or the Points/Dwell or Point/Sweep time.

Press [*Trigger Sweep*] to start a Power sweep after the sweep has been configured.

2.3.13.1 Step Power Sweep Parameters

2.3.13.1.1 Sweep Type

The sweep type is selective between Step and Ramp. This section details how to set up a Step Power sweep. See Section 2.3.14 for instructions on how to set up a Ramp Power sweep. With the cursor on Sweep Type, press either Step key to select Step.

2.3.13.1.2 Parameters

The options are Start/Stop and Center/Span. Use Start/Stop to run a sweep with specific start and stop power values. Select Center/Span to set up a sweep that allows you to enter the center level and the total width of the sweep. The instrument computer then determines the upper and lower sweep limits. The sweep will run between the upper and lower values of the power range.

2.3.13.1.3 Start or Center Power Level

When using the Start/Stop option, enter the power value at which you want the sweep to start. If you are using the Center/Span option, this entry will change to Center Power. Enter the center value of the sweep.

2.3.13.1.4 Stop Power or Power Span

When using the Start/Stop option, enter the value at which you want the sweep to stop. If you are using the Center/Span option, this entry will change to Power Span. Enter the total value that the sweep will span across.

2.3.13.1.5 Power Step

Enter the value that you want each step of the sweep to take.

2.3.13.1.6 Dwell Time

Enter the time you want the sweep to dwell at each step. The dwell time does not include the transition time to arrive at the dwell point.

2.3.13.1.7 Frequency

For convenience, you can set the frequency of the Power sweep in this menu in the same manner as described in Sections 2.3.4 and 2.3.5.

2.3.13.1.8 Repeat Mode

This option determines how a sweep will run. The choices are Single Step, Single Sweep, or Continuous.

2.3.13.1.9 Trigger Type

Select the type of trigger that will be used to initiate the Power sweep. The options are Immediate, which means that a sweep will run immediately when selected; Softkey or GPIB, which will trigger a sweep or step when either the softkey is pressed or a command is received over the GPIB; and Trigger In BNC, which will trigger a sweep or step when a signal is applied to the Trigger In BNC from an external source.



NOTE: The Immediate mode is not valid for a single step sweep or single sweep.

2.3.14 Configure a Ramp Power Sweep

Use this feature to set up a Ramp Power sweep. Figure 2-18 illustrates the Ramp Power Sweep menu. A Ramp Power sweep starts at a power level, which you must designate, and runs continuously until it reaches a stop level. The Ramp sweep can be run as a single sweep or continuously. There are no step options associated with the Ramp Power Sweep.

CAUTION

Excessive Attenuator Switching will shorten its life (Option 26).

POWER SWEEP		
Sweep Type:	Ramp	
Parameters:	Start / Stop	
Start Power:		+0.00 dBm
Stop Power:		+10.00 dBm
Sweep Time:	1.0 sec	
Frequency:	10.0 MHz	
Repeat Mode:	Single Sweep	
Trigger Type:	Soft Key or GPIB	
Use Step keys to change entry.		

DUAL
Sweep

Trigger
Sweep

Figure 2-18: Ramp Power Sweep Configuration Menu

There are several parameters to be setup in this application. Move the cursor to highlight the specific parameter to be set, then look at the options for that parameter by pressing the up or down Step key. Additional options can be selected with the softkeys to set up a dual Frequency-Power sweep (see Section 2.3.14).

Press [*Dual Sweep*] to configure and run a dual Frequency-Power sweep.

Press [*Trigger Sweep*] to start a power sweep or take a single step.

2.3.14.1 Step Power Sweep Parameters

2.3.14.1.1 Sweep Type

The sweep type is selective between Step and Ramp. This section details how to set up a Ramp sweep, see Section 2.3.6 for instructions on how to set up a Step sweep. With the cursor on Sweep Type, press either Step key to select Ramp.

2.3.14.1.2 Parameters

The options are Start/Stop and Center/Span. Use Start/Stop to run a sweep with specific start and stop power values. Select Center/Span to set up a sweep that allows entering the center power level and the total width of the sweep. The instrument computer then determines the upper and lower sweep limits. The sweep will run between the upper and lower values of the power range.

2.3.14.1.3 Start or Center Power Level

When using the Start/Stop option, enter the power value at which you want the sweep to start. If you are using the Center/Span option, this entry will change to Center Power. Enter the center value of the sweep.

2.3.14.1.4 Stop Power or Power Span

When using the Start/Stop option, enter the value at which you want the sweep to stop. If you are using the Center/Span option, this entry will change to Power Span. Enter the total value that the sweep will span across.

2.3.14.1.5 Sweep Time

Enter the total time you want for each sweep.

2.3.14.1.6 Power Level

For convenience, you can set the sweep frequency in this menu in the same manner as described in Sections 2.3.4 and 2.3.5.

2.3.14.1.7 Repeat Mode

This option determines how a sweep will run. Single Sweep or Continuous.

2.3.14.1.8 Trigger Type

Select the type of trigger to be used to initiate the Power sweep. The options are Immediate, which means a sweep will run immediately when selected; Softkey or GPIB, which will trigger a sweep when either the softkey is pressed or a command is received over the GPIB; and Trigger in BNC, which will trigger a sweep when a signal is applied to the Trigger BNC from an external source.

2.3.15 ALC Operation

ALC		
ALC Mode:	Leveled Power	
Sensor:	Internal	
Atten Mode:	Auto	
High Power:	Auto	
Power Slope:	Off	
Offset:	Off	Power Slope
Offset Power:	+0.00 dBm	
Lev Cor Enable:	Off	Level Corr
Use Step keys to change entry.		Return to mode

Figure 2-19: Automatic Leveling Control Selection

The ALC menu screen allows controlling the various functions which relate to the setting of the instrument output power. Some of the modes are optional, a few are yet to be released. The descriptions following detail the operation.

2.3.15.1 ALC Mode

This field allows choosing between leveled power and maximum power. In the leveled power mode, the output power (modified by the Power Slope and/or Offset parameters) is set by the operator. When Maximum Power is selected, the instrument will produce the highest power possible. The Level LED remains on when in Maximum Power mode.

2.3.15.2 Sensor

Currently, only the internal sensor is supported.

2.3.15.3 Atten. Mode

This field selects either Automatic or Manual operation of the step attenuator. In Automatic mode, the step attenuator will switch to 10 dB when the set power is between -10 and -0.1 dBm. It will continue to increase its attenuation value for each 10 dB 'block' of settings. In Manual mode, the step attenuator may be fixed at any desired setting from 0 to 110 dB. Once this is done, the incremental power adjustment range is -20 to $+20$ dB. This means that the instrument leveling system is effectively controlling the power from a value of -20 dBm to $+20$ dBm. Power levels from -20 to -10 dBm may not meet the leveling accuracy specification. Power levels above the specified maximum output for any given frequency may not be attainable.

2.3.15.4 High Power

This menu item is only visible if Option 20 has been installed. Option 20 provides additional amplifiers to guarantee $+20$ dBm minimum output. When the selection is 'Automatic', the high power amplifier will switch in at $+15$ dBm. This is done to reduce amplifier noise at lower levels. In the 'Disabled' mode, the high power amplifiers never switch in.

2.3.15.5 Power Slope

When this function is enabled, the following screen appears:

POWER SLOPE		
Slope:	+0.00 dB/GHz	
Slope Strt Freq:	2.0 GHz	
Power Level:	SLP +5.00 dBm	
Power Slope:	On	
Power Slope Active Modes:		
CW:	Off	
List:	On	
Step Freq Swp:	On	
Rmp Freq Swp:	On	
Use Step keys to change entry.		Return

Figure 2-20: Power Slope Selection

The purpose of this function is to allow compensating for losses in some external component, such as a cable. The ‘Slope’ field defines the amount of change per GHz (the maximum allowed is 8 dB).

 **NOTE:** The step attenuator is effectively in manual mode when power slope is on and will not change dynamically!

The ‘Slope Start Frequency’ field sets the point at which slope correction begins. The output power then changes at a rate set by the slope variable. The ‘Power Level’ field is for convenience in setting the global power level variable. Note the letters ‘SLP’. These appear in the any menu having a Level field to indicate that Power Slope is enabled.

The lower part of the screen allows selectively applying Power Slope to different modes of instrument operation.

2.3.15.6 Offset

Turning on this feature will change the output power by the amount specified in the ‘Offset Power’ field. The displayed power level in the various menus does not change, however the letters ‘OFS’ will appear next to the level value to indicate the offset is active. The offset can be as large as the full range of the instrument power, including the step attenuator.

2.3.15.7 Level Correction

This feature is not currently supported.

2.3.16 Select the Type of Modulation

(Not Available in 12400A Series)

Three types of output modulation are available as described below. The modulation selection and parameters will be displayed when you press **[AM]**, **[FM]** or **[PM]** in the Modulation field. You can use any combination of modulation types with the exception that linear AM is not available for use with PM.

- Option 24 is available to provide internal AM, FM or PM
- Option 29 is available to provide Scan AM

Refer to the Modulation Parameters and Specifications in Chapter 1 for detailed information.

2.3.16.1 External Amplitude Modulation

- ❖ Linear AM
- ❖ Scan AM (Option 29)

AMPLITUDE MODULATION		
Source:	External	
AM Mode:	Linear	
Scaling:	10.0 %/V	
Use Step keys to change entry.		Turn AM On
		Return to mode

Figure 2-21: Amplitude Modulation Selection

2.3.16.1.1 Using Amplitude Modulation

There are two modes of operation for Amplitude Modulation.

Linear AM is characterized by a linear change in the peak-to-peak output voltage for a linear change of the input voltage. This is 'classical' AM. The depth of modulation is expressed in percent. Modulation acceptance of this instrument has a bandwidth of DC to 150 kHz.



NOTE: Modulation inputs which are asymmetrical or that have a DC component will shift the carrier power level.

Scan AM is characterized by a logarithmic change in the RF output level for a linear change in the input voltage. Here the modulation is expressed in dB/volt. This modulation has a bandwidth of DC to 150 kHz. All modulation in this mode is 'downward', that is the carrier power will decrease as the input voltage is increased. To avoid clipping the signal, the input voltage must be offset such that it never exceeds 0 volts. Scan AM is essentially an open loop function. To maintain output

amplitude accuracy, the operator should periodically 'force' a level re-calibration by exiting and re-enabling the modulation (use the "Turn AM Off" softkey).

2.3.16.1.2 Scaling

When using the Scan AM mode, the scaling parameter determines how much modulation (attenuation) is produced for each volt of input. Note that the maximum input level is 6 volts.

2.3.16.1.3 Depth

When using the Linear AM mode, the scaling parameter allows setting the depth of modulation (expressed in %) directly if the input signal is 1 volt ($2V_{p-p}$). For input levels less than 1 volt (1 volt is the maximum allowed), the depth is scaled appropriately.

2.3.16.1.4 Enabling AM

There is a softkey to allow turning AM on and off. When AM is off, the key label will read "Turn AM On". When AM is on, the key will read "Turn AM Off". The LED next to the front panel AM button will illuminate when AM is on.

2.3.16.2 Internal Amplitude Modulation

AMPLITUDE MODULATION		
Source:	Internal	Turn AM On
AM Mode:	Linear	
Waveform:	Sine	
Frequency:	1.0 kHz	
Depth:	10.0 %	
Use Step keys to change entry.		Return to mode

Figure 2-22: Amplitude Modulation Selection - Internal

When option 24 is installed in the instrument, the Amplitude Modulation Screen appears as shown in Figure 2-22. The AM modes of Linear or Scan (Option 29) operate in the same manner as with an external input (refer to section 2.3.16.1). Two new parameters appear: Waveform and Frequency. The Scaling parameter is replaced with a depth parameter.

2.3.16.2.1 Waveform

The Waveform parameter has the following selections:

- Sinewave
- Squarewave
- Triangle wave
- Positive ramp
- Negative ramp
- Gaussian noise
- Modulation off

Each waveform (except the Gaussian noise) is calibrated to have the same peak-to-peak value. The noise output has been bandwidth limited to about 150 kHz and has an peak-to-peak amplitude which is approximately that of the other waveforms. Selecting the Off choice removes the signal from the amplitude modulator but leaves the AM function itself turned on.

The AM Monitor connector on the rear panel provides an approximate $2 V_{p-p}$ signal which matches the selected waveform.

2.3.16.2.2 Frequency

This parameter field allows setting the modulating signal frequency. The allowable entry range is 0.01 Hz to 1 MHz. Note that the maximum frequency response of the AM functions is 150 kHz. The additional range of the source is for compatibility with the internal FM source.

2.3.16.2.3 Depth

Since the amplitude of the internal source is calibrated (typical for Gaussian noise), the modulation depth may be set directly from the menu. Modulation depth is expressed in % for linear AM and dB for SCAN (logarithmic) AM.

2.3.16.3 External Frequency Modulation

- ❖ Wideband FM
- ❖ Narrowband FM

FREQUENCY MODULATION		
FM Mode:	Narrow	
Sensitivity:	2.0 kHz/Vp	
		Turn FM On
		Switch to Φ M
		Return to mode
Use Step keys to change entry.		

Figure 2-23: Frequency Modulation Selection

2.3.16.3.1 Using Frequency Modulation

There are four modes of operation for Frequency Modulation.

In the Narrow mode, the input signal bandwidth is DC to 8 MHz. Applying an input of ± 1 volt will allow the frequency to be shifted by up to ± 1 MHz (4-8 GHz), determined by the sensitivity setting, at any rate from DC to 8 MHz.



NOTE: Modulation inputs which are asymmetrical or that have a DC component will shift the carrier frequency.

- The instrument frequency accuracy is a function of both the time base accuracy and the accuracy of the factory DCFM offset calibration. Typical frequency errors due to the DCFM offset are under 400 Hz (in the 4-8 GHz band).
- Phase noise performance is the same as in CW mode. There is, however, some noise generated by the ADC used to digitize the “inside the loop” portion of the modulation. This noise is relatively insignificant compared to the deviation as long as the input voltage is set to 1 volt peak. If, for example, the deviation were set to 1 MHz and no modulating signal were applied, the noise would be noticeable.

In the Wide mode, the input signal bandwidth is 100 Hz to 8 MHz. The maximum deviation for a ± 1 volt input is ± 20 MHz (4-8 GHz).



NOTE: Modulation inputs which are asymmetrical will shift the carrier frequency.

- The loop bandwidth is reduced to below 50 Hz allowing all modulation to be 'outside the loop'. For this reason, the close-in phase noise is degraded.
- If the modulation index is greater than about 10,000 there will be some additional distortion due to excessive phase shift at the phase detector. This is equivalent to a deviation of 10 MHz with a 1 kHz rate.

The two Phase Modulation modes (Wide and Narrow) are provided to allow generation with a constant modulation index. These modes are created by simply differentiating the modulation signal. Therefore all other characteristics of each mode remain the same. The allowable range of modulating frequencies is 10 Hz to 100 kHz for Narrow mode and 100 Hz to 100 kHz for Wide mode.

2.3.16.4 Sensitivity

This parameter selection allows the user to specify how much deviation is produced for a 1 volt input. The value is the peak deviation. 1 volt is the maximum permitted input level. If less than 1 volt is input, the deviation may be computed by multiplying the input voltage by the displayed deviation setting. Since the instrument uses frequency division, the maximum allowable deviation will be reduced for each octave below 4-8 GHz. The instrument will attempt to maintain the deviation as the frequency is changed but will not exceed a value of (1 MHz/N) where N is the division being used. For example, if a deviation of 100 kHz is entered at 4 GHz then it will be maintained down to a selected frequency of 500 MHz (a division of 8). At 250 MHz, the deviation will be reduced to 62.5 kHz. For frequencies above 8 GHz, the maximum deviation permitted will increase to ± 40 MHz (8-16 GHz) or ± 80 MHz (16-20 GHz).

When using either of the Phase Modulation modes, this parameter field allows setting the modulation index, in radians. Phase modulation has the characteristic of maintaining a constant modulation index (expressed in radians) as the modulating frequency is changed. This makes the deviation smaller as the modulating frequency is reduced. The mathematical expression for this is :

$$M \text{ (radians)} = \Delta F \text{ (deviation)} / F_m \text{ (modulating frequency)}$$

The instrument calibration is such that at a 100 kHz rate, the maximum deviation will be 1 MHz in narrow mode (10 radians) and 20 MHz in wide mode (200 radians). The same constraints relative to carrier frequency apply in Phase Modulation modes.

2.3.16.5 Enabling FM

There is a softkey to allow turning FM on and off. When FM is off, the key label will read "Turn FM On". When FM is on, the key will read "Turn FM Off". The LED next to the front panel FM button will illuminate when FM is on.