Giga-tronics

Series 12400A Models

Series 12500A/12700A Models

Series 12000A Microwave Synthesizers

Operation Manual

MODEL NUMBERS

The Series 12000A has model numbers for each instrument with a specific frequency range as described in Chapter 1. All models are referred to in this manual by the general term 12000A, except where it is necessary to make a distinction between the models. In these cases, the specific model number(s) will be used.

Giga·tronics

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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:
12000A

Model Number(s) in Series:
12408A, 12420A, 12422A, 12428A
12508A, 12520A, 12522A, 12528A
12708A, 12720A, 12722A, 12728A

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

Claudio Mariotta   _____   Acting Director of Quality Assurance
(Full Name)   (Signature)   (Position)

San Ramon, California   February 27, 2002
(Place)   (Date)

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About this Publication

This publication describes the local (front panel) and remote (GPIB) operation of the Giga-tronics Series 12000A Microwave Synthesizers:

Preface:

In addition to a comprehensive Table of Contents and general information about the publication, the Preface also contains a record of changes made to the publication since its production, and a description of Special Configurations. If a user-specific publication was purchased, please refer to page xix for a description of the special configuration.

Chapters:

1 – Introduction

Brief introduction to the instrument and its performance parameters for all three models. Section 1.6 begins data for native performance specifications for the Series 125XXA/127XXA models.

2 – Front Panel Operation

User's guide to the instrument's front panel. All control and features are fully described for all three models.

3 – Remote Operation

Describes how to operate the instrument from a remote location over the General Purpose Interface Bus (GPIB). All programming codes are presented in this chapter with various applications to aid in understanding the operation.

4 – Performance Verification

Defines procedures to verify the performance of the 12000A series. Section 4.4 begins modulation related performance verification issues that are native to the Series 125XXA/127XXA models.

Appendices:

A - Accessories & Options

Describes the accessories and options that are available for the Series 12000A Microwave Synthesizers. Each accessory and option is described under its respective heading.

B - Firmware Field Upgrade

Provides the process to update the Series 12000A Microwave Synthesizers firmware.

Index - Series 12000A Microwave Synthesizers

A subject listing of contents for the Series 12000A.

Changes that occur after production of this publication, and Special Configuration data will be inserted as loose pages in the publication binder. Please insert and/or replace the indicated pages as detailed in the Technical Publication Change Instructions included with new and/or replacement pages.

Conventions

The following 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, Model, Option or Configuration Label

Examine the code, model serial, option or config. label affixed to the rear panel.

Serial Number

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

Code Number

Each instrument has a two-digit number. This number is the Manufacturing Configuration Code.

Model Number

Each instrument has a 5-digit serial number and one suffix character which designates the Series 12000A. Suffix character A is the Series version.

>   **Model Type**
>   (124XXA) CW, No Modulation
>   (125XXA) Step
>   (127XXA) Step & Ramp
>   **Frequency Range**
>   (12X08A) 0.01 to 8 GHz
>   (12X20A) 0.01 to 20 GHz
>   (12X28A) 2 to 8 GHz
>   (12X22A) 2 to 20 GHz

Option Number

If the line is blank, there are no options installed. Option(s) are installed when one or more 2 digit numbers are on the line which correspond to the option numbers in Appendix A.

Configuration Number

If the *Config.* line contains a three digit number (e.g., 241), there is a 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.

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.

TPCI Number	TPCI Issue Date	Date Entered	Comments

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).

1

Introduction

1.1   General Information

General Information	Model	
	124XXA	**125XXA/ 127XXA**
1.1.1 - Introduction	√	√
1.1.2 - Features	√	√
1.1.3 - Environmental Standards	√	√
1.1.4 - Items Furnished	√	√
1.1.5 - Items Required	√	√
1.1.6 - Cooling	√	√
1.1.7 - Cleaning	√	√
1.1.8 - Receiving Inspection	√	√
1.1.9 - Reshipment Preparation	√	√

1.1.1   Introduction

The Series 12000A are Microwave Synthesizers with Step, Ramp (Series 127XXA Only) and List Sweep capability; the instruments operate over a wide range of microwave frequencies, power levels and in a variety of modulation modes. The 12000A can generate output signals over a frequency range of 10 MHz to 20 GHz; the frequency range is dependent on the specific model number. Table 1-1 lists the models with their respective frequency range.   The RF output can be Fixed (CW), Step, Ramp or List Sweep with External Frequency, Amplitude or Pulse Modulation. The Series 124XXA is a CW ONLY Microwave Synthesizer. Option 29 (Scan Modulation) and Option 24 (Internal Modulation Generator) are only available on Series 125XXA/127XXA models.

Table 1-1: Series 12000A Model Numbers

Series 12400A (CW Generator)	Series 12500A (Signal Generator)	Series 12700A (Swept Signal Generator)	Frequency Range
(Step Sweep, No Modulation)	(Step Sweep, Modulation)	(Step and Ramp Sweep Modulation)	
12408A	12508A	12708A	10 MHz to 8 GHz
12428A	12528A	12728A	2 GHz to 8 GHz
12420A	12520A	12720A	10 MHz to 20 GHz
12422A	12522A	12722A	2 GHz to 20 GHz

Series 12000A Microwave Synthesizers

Observe the publication's legend header sections as a way to assist in the operability of the Series 12000A purchased. Operation from the instrument's front panel is detailed in Chapter 2 and Section 2.3 for native data involving the Series 125XXA/127XXA models. Instructions on how to operate the instrument from a remote host computer over the GPIB (General Purpose Interface Bus) can be obtained from Chapter 3. Installation instructions for all three models can be found in Section 1.2. Performance Specifications for all three 12000A models are detailed in Sections 1.4 (Series 124XXA) and 1.6 (Series 125XXA/127XXA - Native data).

1.1.2   Features

Features	Model	
	124XXA	**125XXA/ 127XXA**
Advanced digital processing architecture, driving a high-speed, ferrite-based YIG oscillator	√	√
Spectrally pure output with a tuning resolution of 0.1 Hz	√	√
Optimum oscillator fast switching speed while maintaining low phase noise	√	√
Field-programmable gate arrays perform logic operations quickly while a digital signal processor functions as a secondary processor for dynamic control and fast frequency settings without burdening the primary processor.	√	√
The frequency ramp sweep technique provides an analog-like ramp sweep using a high-speed digital step sweep of the synthesizer between pre-defined start and stop frequencies. Linearity errors are virtually eliminated because the frequency is stepped at a faster rate than the PLL bandwidth, essentially producing a swept phase locked loop	**N/A**	√ (127XXA ONLY)

1.1.3   Environmental Standards

All Series 12000A models are environmentally tested for compliance with MIL-PRF-28800F, Class 3.

1.1.4   Items Furnished

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

- Operation Manual (P/N 31231)
- Power Cord, 6 ft. (P/N WMPO-030007)

1.1.5   Items Required

No special tools are required to operate the Series 12000A. Test equipment required for performance verification is described in Chapter 4 for the Series 124XXA and Section 4.4 for the Series 125XXA/127XXA within.

- 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, P/N 29847)

1.1.6   Cooling

A cooling fan is installed in all three 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.

1.1.7   Cleaning

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

1.1.8   Receiving Inspection

Use care in 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 carrier.

1.1.9   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, use the original shipping container. If the original container is not available, use a strong carton (350 lbs./sq.in. bursting strength) or a wooden box. Wrap the instrument in heavy paper or plastic before placing it in 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 or the 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 e-mail **(repairs@gigatronics.com)** or by phone **(800.444.2878)**. (The 800 number is only valid within the US). Contact can also occur via our domestic line at 925.328.4650 or Fax at 925.328.4702.*

1.2   Installation

Installation	Model	
	124XXA	**125XXA/ 127XXA**
	√	√

All instruments are shipped in operational condition and no special installation procedures are required. See Chapter 4 for warm-up time prior to calibration and testing for all models. Each Giga-tronics instrument must pass rigorous inspections and tests prior to shipment. Following installation, the performance of all models should be checked immediately to insure 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 detailed in Chapter 4 for all models, including modulation related performance tests specifically for only the Series 125XXA/127XXA is found starting in Section 4.4

1.3   Inputs/Outputs

Inputs/Outputs	Model	
	124XXA	**125XXA/ 127XXA**
1.3.1 - I/O Connectors (Front Panel)	√	√
1.3.2 - I/O Connectors (Rear Panel)	√	√
1.3.3 - Computer Interface	√	√

Input/Output connector differentials between the 124XXA and 125XXA/127XXA models are illustrated in Figure 1-1 for the front panel and Figure 1-2 for the rear. Table 1-2 contains the front and rear panel I/O connector functional descriptions for all models. The front and rear BNC Connectors on the Series 124XXA have only the ALC and no modulation functions. The Series 125XXA/127XXA have all four connectors: ALC IN, AM IN, FM/φM IN & PULSE IN.

1.3.1   I/O Connectors (Front Panel)

Figure 1-1 illustrates the panel interface located on the front of the Series 12000A for all models. All connectors are type BNC unless otherwise stated.

Series 12400A Front Panel I/O   Series 12500A/12700A Front Panel I/O
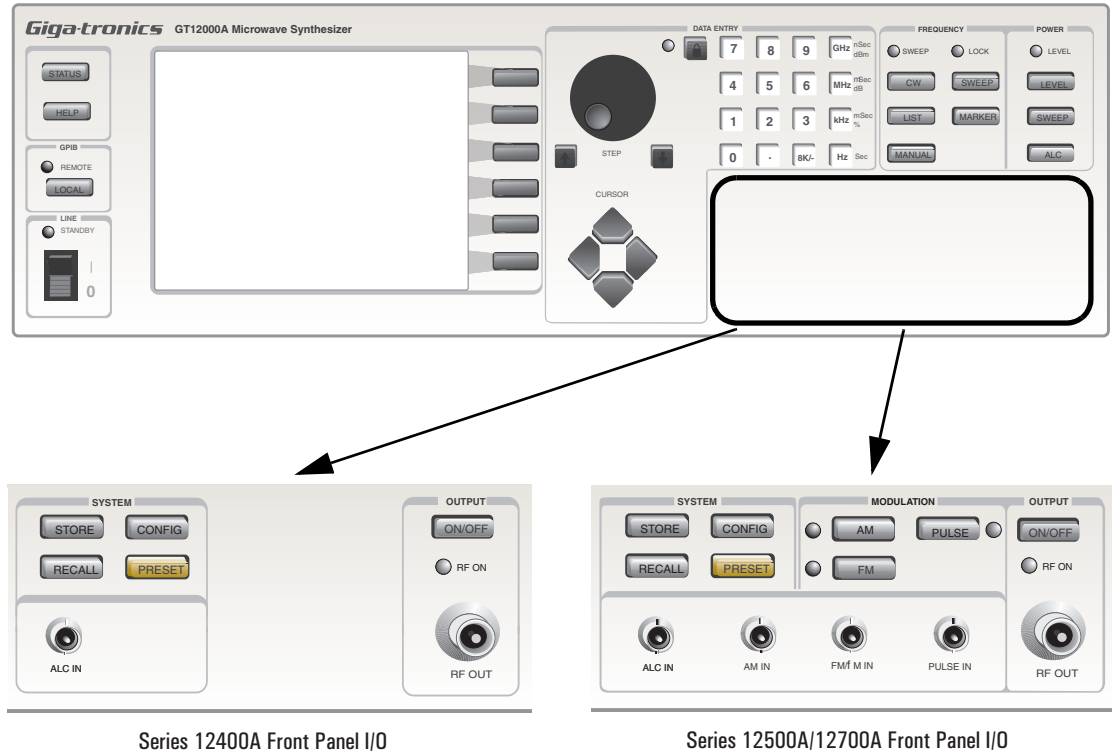
Figure 1-1: Series 12000A Front Panel Inputs/Outputs (All Models)

1.3.2   I/O Connectors (Rear Panel)

This section defines the panel interface and its functions located on the rear of the Series 12000A for all models.   Some connectors are duplicates of the front panel for all models (See Figure 1-1 for reference). The RF Out Connector is installed on the front panel unless the instrument includes Option 22, which relocates the connector to the rear panel (See Figure 1-2 below).
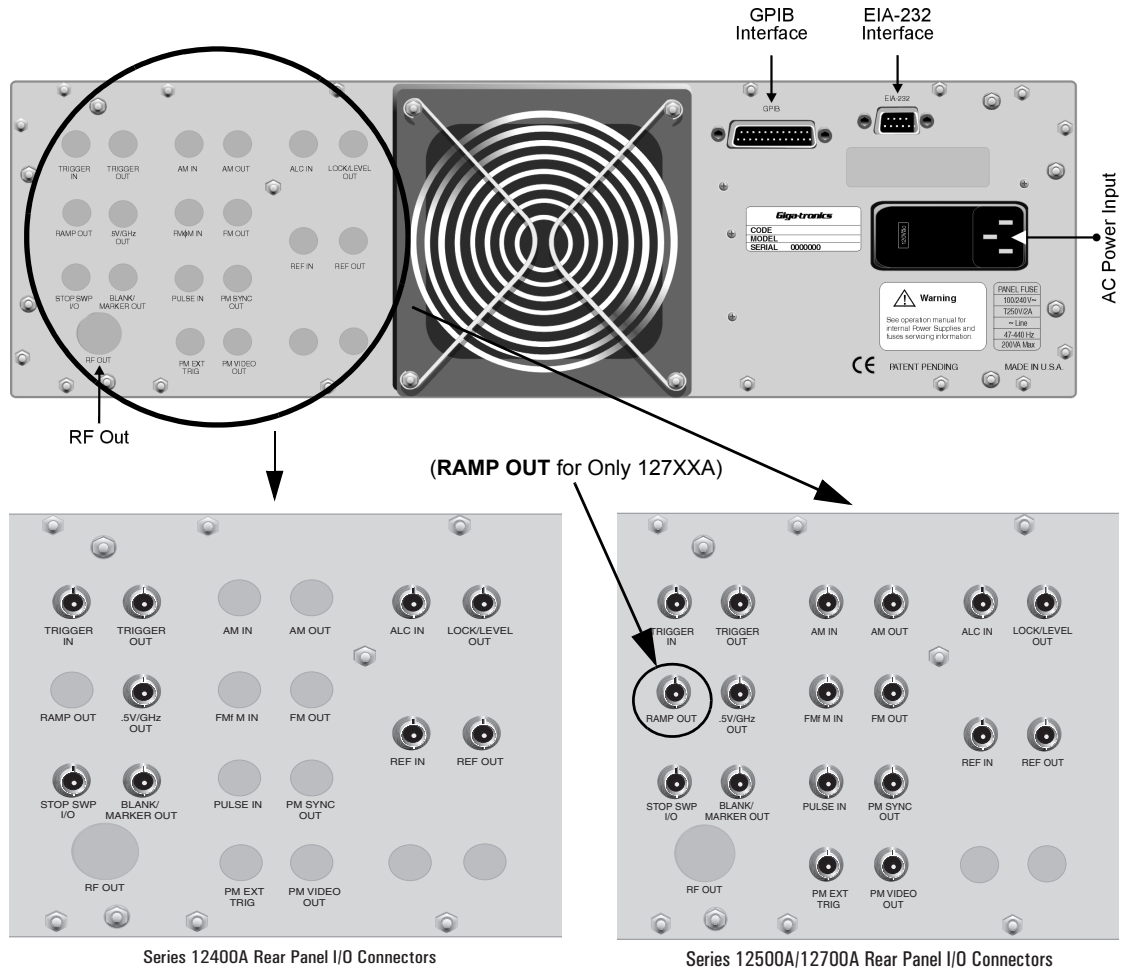
Figure 1-2: Series 12000A Rear Panel Inputs/Outputs (All Models)

Table 1-2: Series 12000A I/O Connector Descriptions

I/O Connector (Front)	I/O Connector (Rear)	Description	Model 124XXA	Model 125XXA/ 127XXA
N/A	TRIGGER IN	Connector accepts a sweep or step trigger input ≥ 50 ns wide at TTL level to initiate a sweep or step.	√	√
	TRIGGER OUT	Connector accepts a sweep trigger output coincedent with the frequency step ending the event.	√	√
	RAMP OUT	0 to +10 V ramp output, proportional to progress between sweep limits (Signal directly proportional to output frequency).	N/A	√ (127XXA ONLY)
	.5V/GHz OUT	An output voltage directly proportional to the RF output frequency.	√	√
	STOP SWP I/O	TTL level signal, low input to stop frequency sweep or output to indicate that a sweep has been stopped.	√	√
	BLANK/MARKER OUT	A sweep related output: +5 V or -5 V during band changes, filter changes and Sweep retrace; 0 V during sweep; +5 V or -5 V at marker frequencies (Signal polarity is software controlled).	√	√
RF OUT	RF OUT	Instrument's RF output on a type SMA (f) connector. **Option 22** - Moves the RF Output connector the rear panel (See Appendix A for Option 22 details). **Option 23** - For Type N connector	√	√
AM IN	AM IN	Connector accepts the input signal from a 600 Ω external amplitude modulation source See "Externally Supplied AM Envelope" in Section 1.7.1.	N/A	√
N/A	AM OUT	An amplitude modulation waveform output at ~2 V$_{P-P}$, into 10 k. **(OPTION 24 AVAILABLE ON 125XXA/127XXA ONLY)**	N/A	√
FM/φM IN	FM/φM IN	Connector accepts the input signal from a 50 Ω external frequency or phase modulation source. See "Externally Supplied FM Envelope" in Section 1.7.3 and "External Supplied FM Envelope" in Sections 1.7.4 & 1.7.4.4.	N/A	√
N/A	FM OUT	A frequency modulation waveform output at ~2 V$_{P-P}$ into 10 k Ω. **(OPTION 24 AVAILABLE ON 125XXA/127XXA ONLY)**	N/A	√
PULSE IN	PULSE IN	PM input signal for external pulse modulation. Connector accepts the input signal from a 50 Ω external pulse modulation source. See "Externally Generated PM Envelope" and "Externally Triggered PM Envelope" in Sections 1.7.2 & 1.7.5.	N/A	√

Table 1-2: Series 12000A I/O Connector Descriptions (Continued)

I/O Connector (Front)	I/O Connector (Rear)	Description	Model	
			124XXA	125XXA/ 127XXA
N/A	PM SYNC OUT	50 ns trigger pulse output at TTL levels (Approximately 4 V into 50 Ω), coincident with leading edge of the pulse modulation envelope. **(OPTION 24 AVAILABLE ON 125XXA/127XXA ONLY)**	N/A	√
	PM EXT TRIG	Connector accepts a pulse trigger input ≥ 50 ns wide at TTL level to initiate an internally generated Singlet, Doublet, Triplet or Quadlet pulse burst. **(OPTION 24 AVAILABLE ON 125XXA/127XXA ONLY)**	N/A	√
	PM VIDEO OUT	A pulse modulation envelope waveform at TTL level (Approximately 4 V $_{P-P}$ into 50 Ω) (Internally triggered PM only). **(OPTION 24 AVAILABLE ON 125XXA/127XXA ONLY)**	N/A	√
ALC IN	ALC IN	**CURRENTLY NOT SUPPORTED**	√	√
N/A	LOCK/LEVEL OUT	A TTL-compatible output (High indicates the output frequency is phase locked and the output power is leveled).	√	√
	REF IN	An external timebase input signal, 5 or 10 MHz ±1 × 10^{-6} or better, 0.5 to 5 V$_{P-P}$, overrides the internal timebase. Input impedance is 100 Ω nominal.	√	√
	REF OUT	A buffered square wave output at 10 MHz, 2 V $_{P-P}$ minimum into 50 Ω, derived from the internal or external timebase.	√	√

1.3.3 Computer Interface

1.3.3.1 GPIB

The IEEE 488.2 interface connection (24-pin) between the Series 12000A and host computer equipment for remote operation over the General Purpose Interface Bus (GPIB) is located on the rear of the unit. The connector pin assignments are listed in Table 1-3 for all models.

Table 1-3: Series 12000A IEEE 488.2 Hardware Configurations

Pin	Signal	Pin	Signal	Pin	Signal
1	D101	9	IFC	17	REN
2	D102	10	SRQ	18	GND (6)
3	D103	11	ATN	19	GND (7)
4	D104	12	Shield	20	GND (8)
5	EO1	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

1.3.3.2   EIA-232

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

Table 1-4: EIA-232 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

1.3.4 Power

All models of the Series 12000A contains primary and stand by power with interval 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 12000A has a 3-Wire power cord with a 3-terminal polarized plug for connection to the power source and safety ground. The power cord cannot exceed 3 meters (9 feet) to meet safety requirements.

WARNING

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

CAUTION

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

1.3.4.1 Line Fuse

All 12000A models have a line fuse container on the rear panel.

1.3.4.2 Fuse Installation

All models have a power line fuse that is 2A, Slo-Bo, 250V, Type T (See Figure 1-3 below for location).
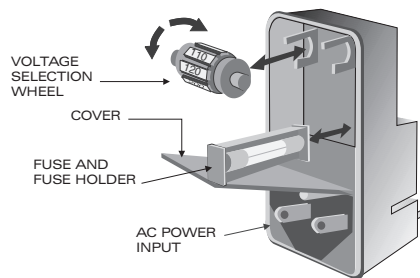
Figure 1-3: Fuse Holder

The fuse holder is contained in the covered housing directly above the AC power connector on the rear panel for all models. To gain access, use a small screwdriver or similar tool to snap open the cover.

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 figure above.

1.4 Specifications

(Signal Parameters & Operational Modes)

Specifications	Model	
	124XXA	125XXA/ 127XXA
1.4.1 - CW Operation	√	√
1.4.2 - RF Output	√	√
1.4.3 - Spectral Purity	√	√
1.4.4 - Step Frequency Sweep	√	√
1.4.5 - Step Power Sweep	√	√

The following are specifications for the Series 12000A Microwave Synthesizers.

1.4.1 CW Operation

Ranges

	Model		
10 MHz to 8 GHz	12408A	12508A	12708A
2 GHz to 8 GHz	12428A	12528A	12728A
10 MHz to 20 GHz	12420A	12520A	12720A
2 GHz to 20 GHz	12422A	12522A	12722A

Resolution

0.1 Hz (Standard)
1 kHz (Optional)

Accuracy & Stability (Identical to Timebase Oscillator)

Timebase (Internal)	10 MHz
Aging Rate	$< 5 \times 10^{-10}$/day after 72 hours continuous oven operation
Temperature Stability	$< \pm 2 \times 10^{-10}$/ °C (0 to +55°C)
Timebase (External)	5 or 10 MHz ($\pm 1 \times 10^{-6}$ or better) (Software selected) 0.5 to 5 V $_{P-P}$ into 100 Ω (Nominal)

Switching Time, List Mode

< 500 μs to within 1 kHz of set frequency (Typical)

Switching Time, CW Mode

35 ms to within 1 kHz of set frequency (Includes IEEE overhead) (Typical)

Residual FM During Switching

Refer to FM Table, Wide Mode Residual Column, Section 1.7.3

Phase Offset Mode

Range	-180 to +180 degrees
Resolution	.01 degrees, maximum
Step Size	.01 to 180 degrees
Accuracy	Not specified. This is relative mode of operation and is designed to be used interactively

1.4.2   RF Output

Maximum Leveled Output (0 to 35°C)

Frequency Range (GHz)	Output Power (dBm)	Option 26 (dBm)
0.01 to 2	+15 dBm	+14 dBm
>2 to <8	+15 dBm	+15 dBm
8 to 15	+15 dBm	+13 dBm
>15 to 20	+15 dBm	+12 dBm

Incremental Level Range

-20 (Typical) to +25 dBm; -120 to +25 dBm (Option 26)

Resolution

-0.01 dB, entry and display

Minimum Calibrated Output Level

-120 dBm with attenuator Option 26
-10 dBm without attenuator Option 26
RF Off: Attenuates the output to < -140 dBm at the output connector

Flatness

±0.5 dB (-10 dBm to maximum specified power) at 25 ±10°C (Internally Leveled, CW or Frequency Step or Ramp Mode)

Add ±0.1dB/10 dB with attenuator option (±2.5 dB with Option 20*)

At 35 to 55°C, maximum output power is +13 dBm, flatness +/- 1 dB, Typical temperature coefficient is -0.025 dB per degree C

(*See Section 1.5.3 for Option 20 limitations involving use with the 124XXA)

Resolution

-Add 0.2 dB to Flatness (Internally Leveled, CW, Frequency Step or Ramp)

Maximum Slope of Level Variation

< 0.5 dB/MHz

Output Switching Time

< 500 µs; 20 ms with attenuator change

Output Impedance

50 Ω, nominal

Output SWR

< 2.0:1 (Typical)

Level Drift

< 0.05 dB/hour. Max 0.1 dB/24 hours

1.4.3　Spectral Purity

Harmonics

Frequency (GHz)	Harmonic (dBc)	Power (dBm)
0.01 to 0.10	-30	+6
0.10 to 2	-50	+6
>2 to 20	-55	+6

Subharmonics

None, 0.01 - 2 GHz

0.01 - 2 GHz
55 dBc >2 GHz

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

Nonharmonics

<-60 dBc from 0.01 to 16 GHz (offsets >300 Hz)
<-55 dBc from >16 to 20 GHz (offsets >300 Hz)

Single-Sideband Phase Noise (dBc/Hz, CW mode, all power levels)

Freq. (GHz)	Offset from Carrier				
	100 Hz	1 kHz	10 kHz	100 kHz	1 MHz
0.25	-101	-101	-109	-122	-129
0.5	-95	-95	-103	-122	-124
2	-87	-92	-94	-120	-125
4	-81	-86	-88	-110	-130
6	-81	-83	-83	-110	-130
8	-75	-80	-80	-105	-130
10	-75	-80	-80	-105	-125
18	-68	-73	-73	-97	-120
20	-68	-73	-73	-97	-120

Residual FM (Hz, rms, CW Mode)

Frequency Range (GHz)	Post Detection Bandwidth (Hz)	
	300 to 3000	50 to 15000
<2 GHz	Decreases by ½ per oct	Decreases by ½ per oct
2 to <4	<6	<45
4 to <8	<12	<70
8 to <16	<24	<160
16 to 20	<32	<280

AM Noise

<-130 dB/Hz from 0.01 to 2 GHz
<-145 dBm/Hz at >2 GHz

1.4.4 Step Frequency Sweep

Range

FA (minimum frequency of instrument) to FB (maximum frequency of instrument)

Step Size

Any increment within the frequency resolution

Dwell Time

May be set in 1 μs increments from approximately 1μs to 200 sec

---

Setup Time

---

200 μs (Typical)

Accuracy & Stability

Same as in CW when locked at each step during dwell time

Modes

Start/Stop	$FA \leq [F1 \neq F2] \leq FB$ Sweeps up or down from a preset start frequency (F1) to a preset stop frequency (F2)
Start/Δ	$FA \leq [F1 \pm \Delta F] \leq FB$ Sweeps up or down from a preset start frequency (F1) through a preset sweep width (ΔF)
CTR/Δ	$FA \leq [CF \pm (\Delta F/2)] \leq FB$ Sweeps up or down through a preset sweep width (ΔF) centered symmetrically about a preset center frequency (CF)
Start/Steps	$FA \leq [F1 \pm (\text{Step Size} \times \text{Number of Steps})] \leq FB$ Sweeps up or down from a preset start frequency (F1) through a preset number of frequency steps

Functions

Auto	Continuous cycle of the preset sweep
Single	A single cycle of the preset sweep or (with stop activated) a single preset step, initiated by the manual operation of the front panel push-button or reception of the corresponding GPIB command
EXT	A single cycle of the preset sweep initiated by each trigger from an external source
EXT Step	A single step of a preset step sweep initiated by each trigger input from an external source

1.4.5   Step Power Sweep

Range

LA (minimum level of instrument) to LB (maximum level of instrument)

Step Size

Any increment within the instrument's resolution

Dwell Time

May be set in 1 μs increments from approximately 1 μs to 200 sec

Setup Time

100 μs (Typical)

Accuracy & Stability

Same as in CW when locked at each step during dwell time

Modes

Start/Stop	$LA \leq [L1 \neq L2] \leq LB$ Sweeps up or down from a preset start level (L1) to a preset stop level (L2)
Start/Δ	$LA \leq [L1 \pm \Delta L] \leq LB$ Sweeps up or down from a preset start level (L1) through a preset sweep width (ΔL)
CTR/Δ	$LA \leq [CL \pm (\Delta L/2)] \leq LB$ Sweeps up or down through a preset sweep width (ΔL) centered symmetrically about a preset center level (LF)
Start/Steps	$LA \leq [L1 \pm (Step\ Size \times Number\ of\ Steps)] \leq LB$ Sweeps up or down from a preset start level (L1) through a preset number of level steps

Functions

Auto	Continuous cycle of the preset sweep
Single	A single cycle of the preset sweep or (with stop activated) a single preset step, initiated by the manual operation of the front panel push-button or reception of the corresponding GPIB command
EXT	A single cycle of the preset sweep initiated by each trigger from an external source
EXT Step	A single step of a preset step sweep initiated by each trigger input from an external source

1.5 Supplemental Specifications

Supplemental Specifications	Model	
	124XXA	**125XXA/ 127XXA**
1.5.1 - General Specifications	√	√
1.5.2 - Weight & Dimensions	√	√
1.5.3 - Option 20 Specifications	√	√

1.5.1 General Specifications

Remote Interfaces	GPIB	IEEE STD 488.2 (GPIB), all parameters except AC power on/off
	Serial	EIA RS-232, Serial Interface, DB9 Connector
Operating Temperature	0 to 55°C	
Environmental	Complies with MIL-PRF-28800F, Class 3	
Approvals	CE marked	
Power	90-253 VAC, 47-64 Hz (400 Hz optional),150 Watts (Nominal)	
Fuse Rating	2 A, SB	

1.5.2 Weight & Dimensions

Item	Benchtop Model	Packed for Air Shipment
Width	16.75 in. (42.5 cm.)	24 in. (60.9 cm.)
Depth	21 in.	21 in.
Height	5.25 in. (13.3 cm.)	11.25 in. (28.6 cm.)
Volume	1850 cuin	1850 cuin
Weight	30 lbs.	40 lbs.

1.5.3   Option 20 (High Power) Specifications
(Apply from 0° to 35°C)

Output Power

+20 dBm

Flatness

+/- 2.5 dB

Harmonics

< -5 dBc from 0.01 to 0.1 GHz
< -20 dBc for 0.1 to 20.0 GHz @ +20 dBm Output Power

Pulse On/Off   (PULSE ON/OFF ONLY ON SERIES 12500A/12700A)

60 dBc

AM   (AM ONLY ON SERIES 12500A/12700A)

Functional, but not specified above 0 dBm

Option Activity

When the option is not active the output power is reduced by 2.0 dB
When active, the High Power Option switches in at +11 dBm

1.6   Specifications (Series 12500A/12700A)

(Signal Parameters & Operational Modes)

Specifications (Series 12500A/12700A)	Model	
	124XXA	**125XXA/ 127XXA**
1.6.1 - Ramp Frequency Sweep	N/A	√ (127XXA Only)
1.6.2 - Ramp Power Sweep	N/A	√ (127XXA Only)

Refer to Section 1.4 for specifications that apply to all models. Use this section for native specifications to the Series 125XXA/127XXA models.

1.6.1   Ramp Frequency Sweep

A continuous sweep is generated within the instrument. The continuous sweep may be operated simultaneously with digital power sweep.

	Description
Sweep Type	Smooth frequency ramp progression sweep
Sweep Type	Either up or down in frequency
Sweep Direction	Either up or down in frequency
Sweep Ramp Shape	Linear frequency ramp with respect to time
Sweep Range	Linear frequency ramp with respect to time
Start Frequency Accuracy	Phase locked to timebase (via YIG tune coil)
Stop Frequency Accuracy	Phase locked to timebase (via YIG tune coil)
Halted Frequency Accuracy	Phase locked to timebase (via YIG tune coil)
Start & Stop Freq. Resolution	0.1 Hz Standard (1 kHz, Option 36)
Minimum Sweep Width	100 Hz Standard (1 MHz, Option 36)
Maximum Step Width	From the minimum frequency to the maximum. Frequency of the Series 12000A as configured
Sweep Width Resolution	0.1 Hz standard (1 kHz, Option 36)
Sweep Time	1 ms to 200 sec
Sweep Time Resolution	10 μs
Minimum Sweep Rate	100 kHz/sec
Maximum Sweep Rate	8 ms/octave
Sweep Linearity	Better than 0.03% of sweep width relative to the 0 V to 10 V Ramp Output BNC voltage (Swept time < 100 sec) (Typical)
Sweep Modulation Formats	AM or Pulse Modulation

0 to 10 V Ramp Output

Vout = (10 V) |(fout - fstart)| / |(fstop - fstart)| (Frequency Ramp sweep mode)

Vout = (10 V) |(Pout - Pstart)| / |(Pstop - Pstart)| (Power Ramp sweep mode)

Vout = 0 to 10 V ramp @ current set sweep rate (Ramp during CW mode)

0.5 / GHz Output

Vout = (0.5 V) (Fout in GHz)

Sweep Modes

Start/Stop	$FA \leq [F1 \neq F2] \leq FB$ Sweeps up or down from a preset start frequency (F1) to a preset stop frequency (F2)
Start/Δ	$FA \leq [F1 \pm \Delta F] \leq FB$ Sweeps up or down from a preset start frequency (F1) through a preset sweep width (ΔF)
CTR/Δ	$FA \leq [CF \pm (\Delta F/2)] \leq FB$ Sweeps up or down through a preset sweep width (ΔF) centered symmetrically about a preset center frequency (CF)
Δ MKR	$FA \leq [Mx \neq My] \leq FB$ Sweeps up or down from a preset start frequency (Mx) through a preset marker (My)

Sweep Functions

Auto	Continuous recycle of the preset sweep
Single	A single cycle of the preset sweep initiated by manual operation of the front panel push-button or reception of the corresponding GPIB command
EXT	A single cycle of reset sweep initiated by a trigger from an external source

Frequency Markers
(Twelve intensity, video and/or amplitude markers, individually selected from either the front panel or via the GPIB)

Resolution	Sweep width/4000
Accuracy	Same as Sweep linearity except the marker may vary $\pm$25 mV relative to the linear 0 to +10 V RAMP OUT
Amplitude Markers	A -10 to +10 dB change in RF output during analog frequency sweep
Video Markers	TTL level output or $\pm$5 V
Intensity Markers	Provides a timed dwell of frequency sweep

1.6.2   Ramp Power Sweep

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

Range

- 10 dBm to maximum power, up or down (-120 dBm is maximum power with Option 26)

Sweep Time (Any Sweep Mode)

2 ms to 200 sec in five ranges. Minimum sweep time is determined by the sweep width and the maximum sweep speed

Range	Resolution
2 ms to 20 ms	10 µs
20 ms to 200 ms	100 µs
200 ms to 2 sec	1 ms
2 sec to 20 sec	10 ms
20 sec to 200 sec	100 ms

Minimum Sweep Width

.01 dB

Maximum Sweep Speed

1 dB/ms

Sweep Level Resolution (Any Sweep Mode)

0.01 dB

Start Level Accuracy (Any Sweep Mode)

0.2 dB to Flatness

Sweep Level Linearity (Any Sweep Mode)

±0.25 dB

Sweep Modes

Auto	Continuous recycle of preset sweep
Single	A single cycle of the preset sweep, initiated by manual operation of the front panel push-button or reception of the corresponding GPIB command
EXT	A single cycle of the preset sweep, initiated by a trigger input from an external source

1.7   Modulation Parameters & Operational Modes

Modulation Parameters & Operational Modes	Model	
	124XXA	**125XXA/ 127XXA**
1.7.1 - Amplitude Modulation (AM)	N/A	√
1.7.2 - Scan Modulation	N/A	√
1.7.3 - Frequency Modulation (FM)	N/A	√
1.7.4 - Phase Modulation (φM)	N/A	√
1.7.5 - Pulse/Square Wave Modulation (PM)	N/A	√

AM, FM, Pulse and Option 29 (Scan Modulation) driven by external waveforms is standard only on the 125XXA/127XXA models. Option 24 (Internal Modulation Generator) provides two function generators for internally generated amplitude and frequency modulation envelope waveforms. A pulse generator is also provided.

1.7.1   Amplitude Modulation (AM)

AM may be operated simultaneously with FM. AM Specifications apply with FM turned off.

1.7.1.1   AM Envelope Parameters

Modulation Depth

0 to 90% @ 0 dBm output power (Settable to 95.0%)

Modulation Resolution

1%

Modulation Bandwidth

DC to 150 kHz, ±3 dB @ 0 dBm output

Modulation Accuracy

±10% of depth setting (e.g. A setting of 50% may be within a 40% to 60% reading)

1.7.1.2   Externally Supplied AM Envelope

Waveform

Any waveform compatible with bandwidth considerations

Scaling

0%/V to 95%/V

Input Voltage

Minimum: -1 V, Maximum: +1 V $_{P-P}$ for 50% depth $\pm$10% depth @ 1 kHz modulation rate

Input Impedance

600 Ω (Nominal)

1.7.1.3   Internally Generated AM Envelope

See Option 24 specifications in Section 1.8.1

1.7.2   Scan Modulation

See Option 29 specifications in Section 1.8.2.

1.7.3　Frequency Modulation (FM)

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

1.7.3.1　Wide Mode Envelope Parameters

Maximum Deviation

See table contained in Section 1.7.3.2

Minimum Deviation

10 kHz at 4 - 8 GHz (Other ranges proportionally)

Modulation Resolution

1 kHz (Deviation $<$ 1 MHz); 10 kHz (Deviation $<$ 1 MHz) (at 4 - 8 GHz, other range proportionally)

Flatness

$\pm$2 dB for rates from 100 Hz to 1 MHz; $\pm$3 dB to 8 MHz

Residual FM

See table contained in Section 1.7.3.2

Modulation Accuracy

$\pm$5% at max deviation, 190 kHz modulation rate

Distortion

$<$ 5% ($\pm$1 MHz Deviation)

Incidental AM

$< \pm$0.2%/MHz of Deviation

1.7.3.2   Narrow Mode Envelope Parameters

Maximum Deviation

See table below

Modulation Resolution

10 Hz (Deviation < 10 kHz)
1 kHz (Deviation > 10 kHz) (at 4 - 8 GHz, other ranges proportional)

Flatness

±2 dB for rates from DC to 1 MHz
±3 dB for 1 MHz to 8 MHz

Residual FM

Same as CW

Modulation Accuracy

±5% at max Deviation, 190 kHz modulation rate

Distortion

<±0.2%/MHz of Deviation

Incidental AM

< 5% (±1 MHz deviation)
< 1% @ 10 KHz (4 - 8 range)

Frequency (GHz)	Max Wide Deviation (Pk)	Max Narrow Deviation (Pk)	Wide Mode Residual FM
.010 to .016	40 kHz	2 kHz	< 200 Hz
> .016 to .032	80 kHz	4 kHz	< 200 Hz
> .032 to .064	160 kHz	8 kHz	< 200 Hz
> .064 to .125	320 kHz	16 kHz	< 200 Hz
> .125 to .25	640 kHz	32 kHz	< 200 Hz
> .25 to .5	1.25 MHz	64 kHz	< 200 Hz
> .5 - 1	2.5 MHz	125 kHz	< 375 Hz
> 1 - 2	5 MHz	250 kHz	< 750 Hz
> 2 - 4	10 MHz	.5 MHz	< 1.5 kHz
> 4 - 8	20 MHz	1 MHz	< 3 kHz
> 8 - 16	40 MHz	2 MHz	< 6 kHz
> 16 - 20	80 MHz	4 MHz	< 12 kHz

1.7.3.3   Internally Generated FM Envelope

See Option 24 specifications in Section 1.8.1

1.7.3.4   Externally Supplied FM Envelope

Waveform

Any waveform compatible with bandwidth considerations

Rate

DC to 8 MHz

Input Sensitivity, Settable

1 V $_{P-P}$ for maximum Peak deviation (FM deviation control set to maximum)

Input Impedance

50 Ω (Nominal)

1.7.4   Phase Modulation (ϕM)

Specifications apply with SCAN/AM and PM off. ϕM may be operated simultaneously with Linear AM and or PM (PM & Linear AM not allowed simultaneously).

1.7.4.1   Wide Mode Envelope Parameter

Maximum Deviation

See table contained in Section 1.7.4.2

Maximum Resolution

10 kHz at 4 - 8 GHz (other ranges proportional)

Modulation Resolution

.01 radians (at 4 - 8 GHz, other ranges proportional)

Flatness

$\pm$2 dB for rates from 100 Hz to 100 kHz

Modulation Accuracy

$\pm$5% (relative to FM) at max. deviation, 100 kHz modulation rate

Distortion

$<$5% ($\pm$1 MHz deviation)

Incidental AM

$<\pm$0.2%/MHz of deviation

1.7.4.2   Narrow Mode Envelope Parameters

Maximum Deviation

See table is on next page

Modulation Resolution

.01 radians (at 4 - 8 GHz, other ranges proportional)

Flatness

$\pm$2 dB for rates from 100 Hz to 1 MHz

Modulation Accuracy

±5% (relative to FM) at max deviation, 100 kHz modulation rate

Distortion

< 5% (±1 MHz deviation)

Incidental AM

< ±0.2%/MHz of deviation

Frequency (GHz)	Max Wide Deviation	Max Narrow Deviation
.010 to .016	.40 radians	.02 radians
> .016 to .032	.80 radians	.04 radians
> .032 to .064	1.6 radians	.08 radians
> .064 to .125	3.2 radians	.16 radians
> .125 to .25	6.4 radians	.32 radians
> .25 to .5	12.5 radians	.64 radians
> .5 to 1	25 radians	1.25 radians
> 1 to 2	50 radians	2.5 radians
> 2 to 4	100 radians	5 radians
> 4 to 8	200 radians	10 radians
> 8 to 16	400 radians	20 radians
> 16 to 20	800 radians	40 radians

1.7.4.3   Internally Generated PM Envelope

See Option 24 specifications in Section 1.8.1

1.7.4.4   External Supplied FM Envelope

Waveform

Any waveform compatible with bandwidth considerations

Rate

10 Hz to 100 kHz

Input Sensitivity, Settable

1 V $_{P-P}$ for maximum peak deviation (FM deviation control set to Maximum)

Input Impedance

50 Ω (Nominal)

1.7.5   Pulse/Square Wave Modulation (PM)

Specifications apply with Scan/AM and FM off. PM may be operated with FM.

1.7.5.1   PM Basic Operation

On/Off Ratio

$>$ 80 MHz

Rise Fall/Times:

Rise Time	Frequency Range
$<$ 10 ns	$>$ 500 MHz
$<$ 50 ns	64 to 500 MHz
$<$ 350 ns	25 to 64 MHz
$<$ 500 ns	$<$ 25 MHz

Overshoot, Undershoot & Ringing

$<$ 10%, $>$ 500 MHz

Settling Time (to within 1 dB)

$<$ 75 ns (for pulse width $>$ 75 ns)

Level Pulsed Output Accuracy (Reference to CW Output Power) at 25 $\pm$ 10° C

$\pm$0.5 dB, $\geq$100 ns pulse width ($\pm$1 dB pulse width, between 100 ns and 75 ns, Typical). (Requires a typical setup time of 100 ms after initial setting)

Typical Settling Time for a Series of Leveled Pulses

100 μs

Demand Pulse Polarity	RF will be on with TTL level demand pulse at Pulse Modulation Input BNC either at high or low logic level, selectable

Time Between Start of Demand Pulse (Video In) **& Start of RF Pulse**

$<$ 50 ns

Minimum Required RF OFF Time between Pulses

100 ns

Delivered Minimum Pulse Widths

Minimum Width	Frequency Range
20 ns	> 500 MHz
100 ns	64 to 500 MHz
1 μs	< 64 MHz

1.7.5.2   Internally Generated PM Envelope

See Option 24 specifications in Section 1.8.1

1.7.5.3   Externally Generated PM Envelope
(One Envelope produced by each pulse)

Repetition Rate

5 Hz to 5 MHz, leveled
DC to 10 MHz, unleveled

Pulse Offset Delay (Output Envelope Leading Edge referenced to Input Pulse Leading Edge)

50 ns, typical

Input Pulse Required

Positive or negative-going TTL voltage Level trigger pulse, $\geq$ 75 ns wide (leveled output)
$\geq$ 20 ns wide (unleveled output). Pulse must be able to drive a 50 ohm load

Pulse Width

Defined by external pulse width

1.8 Supplemental Specifications (Series 12500A/12700A)

Supplemental Specifications (Series 12500A/12700A)	Model	
	124XXA	**125XXA/ 127XXA**
1.8.1 - Option 24 Specifications	N/A	√
1.8.2 - Option 29 Specifications	N/A	√

1.8.1 Option 24 (Internal Modulation Generator) Specifications

1.8.1.1 Amplitude Modulation Source

Waveform

Sine, square, triangle, ramp (+ or −), Gaussian Noise

Rate

0.01 Hz to 1 MHz, all waveforms

Resolution

0.01 Hz

Accuracy

± 0.01 Hz $\pm$ Timebase Accuracy

THD

1 % (Typical)

AM Output

2 V_{P-P}, into 1 M Ω

1.8.1.2 Frequency Modulation Source

Waveform

Sine, square, triangle, ramp (+ or −)

Rate

0.01 Hz to 1 MHz, all waveforms

Resolution

0.01 Hz

Accuracy

±0.01 Hz ± Timebase Accuracy

THD

1 % (Typical)

FM Output

2 V_{P-P}, into 1 M Ω

1.8.1.3 Pulse Modulation Source

Rate

1 Hz to 3 MHz

	Range	Resolution
	1 Hz to 1 kHz	1 Hz
	1 kHz to 10 kHz	10 Hz
	10 kHz to 100 kHz	100 Hz
Rate Resolution	100 kHz to 1 MHz	1 kHz
	1 MHz to 3 MHz	10 kHz
	Accuracy	±2.5% of range maximum value; f_m < 100 KHz
		±4% of range maximum value; f_m 100 KHz to < 1 MHz
		±10% of range maximum value; f_m > 1 MHz
	Jitter	Same as instrument timebase

1.8.1.4   Pulse Start Variable Delay

(Referenced to Sync Output)

Range

0 to 1.67 seconds

Resolution

10 ns

Accuracy

$\pm$2.5% of setting or $\pm$20 ns, whichever is greater

Jitter

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

1.8.1.5   Pulse Width

Range

0 to 1.67 seconds

Resolution

10 ns

Accuracy

$\pm$2.5% of setting or $\pm$20 ns, whichever is greater

Jitter

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

1.8.1.6   **Pulse Modes**
(Triggered, Gated, Delayed, Singlet, Doublet, Triplet, or Quadlet and Free Running)

Interval	
Range	100 ns to 1.67 seconds
Resolution	10 ns
Accuracy	$\pm2.5\%$ 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 and quadlets are the same. The start delay for pulse one is independent.*

1.8.1.7   **Externally Triggered PM Envelope**
(One PM envelope produced by each trigger)

Repetition Rate
5 Hz to 5 MHz

Pulse Delay
Set by internal delay control

Pulse Width
Set by internal width control

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

1.8.1.8   **PM Sync Output**

TTL levels into a 50 Ω load, 50 ns pulse coincident with start delay

1.8.1.9   **PM Video Output**

TTL levels into a 50 Ω load

1.8.2   Option 29 (Scan Modulation) Specifications

Specifications apply with FM and PM turned off.

1.8.2.1   Envelope Parameters

Frequency of Operation

0.01 to 20 GHz

1.8.2.2   Scan Mode

Range

0 to 60 dB, $\geq +10$ dBm (Settable to 65 dB)

Resolution

0.1 dB

Scaling

0 dB/V to 65 dB/V

Input Voltage

Minimum: 0 V, Maximum: +6 V

Step Response

< 1 microsecond for 50 dB change; < 10 ms, < 1 GHz

Frequency Response

DC to 150 kHz, sine wave

Input Impedance

600 Ω (Nominal)

Accuracy	± 0.25 dB plus +/- 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)

1.8.2.3   Internally Generated Scan/AM Envelope

See Specifications for Option 24 in section 1.8.1

1.8.2.4   Power

2 dB reduction in power, .01-20 GHz

2

Front Panel Operation

2.1   Introduction

	Model	
Introduction (Front Panel Operation)	**124XXA**	**125XXA/ 127XXA**
	√	√

This chapter describes how to operate the Series 12000A Microwave Synthesizer from its front panel. Use the list below for reference. Sectional header page references are only provided for items pertaining directly to application examples.

- Chapter 1 - Instructions on how to install and interface the instrument before operating it for the first time for all three models
- Chapter 3 - 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

This chapter contains the following major sections:

- Front Panel Description
- Front Panel Applications

2.2   Front Panel Description

	Model	
Frontal Panel Description	**124XXA**	**125XXA/ 127XXA**
2.2.1 - Series 12000A Front Panel Layout Descriptions	√	√

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

Series 12400A Models
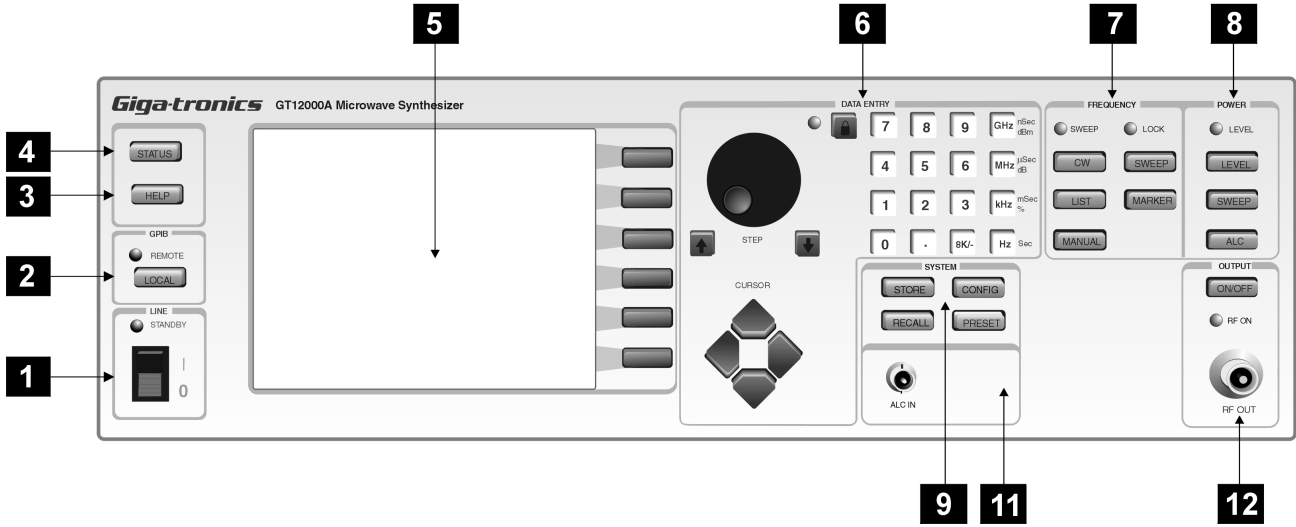
Series 12500A/12700A Models
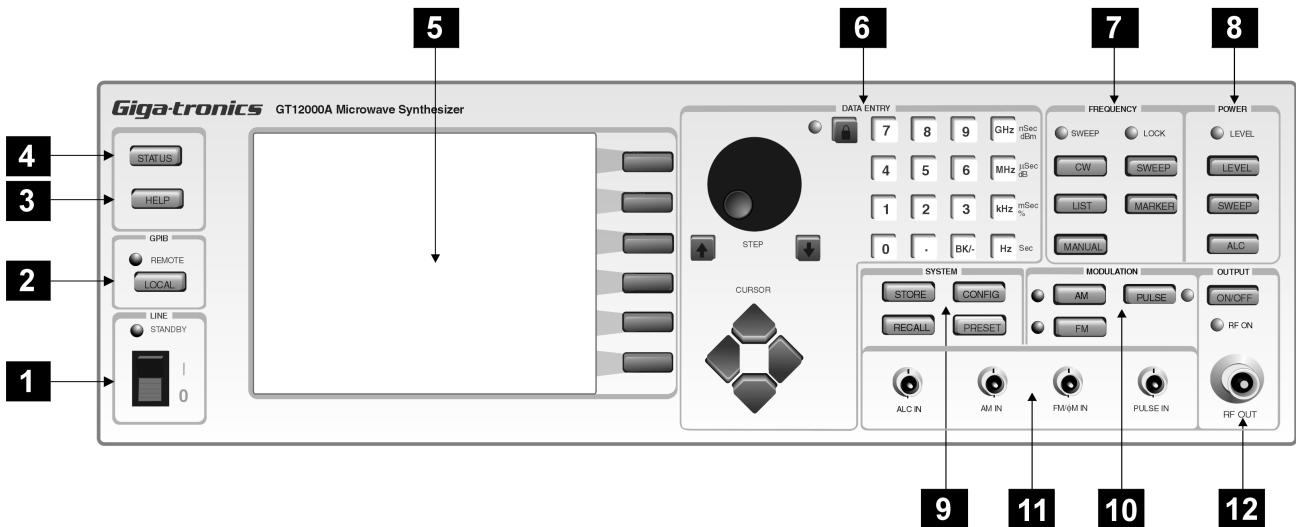
Figure 2-1: Series 12000A Front Panel Layouts

2.2.1   Series 12000A Front Panel Layout Descriptions

1   **Power**

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 **[STATUS]** 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 under item layout number 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 under item 5 for the six buttons to the right of the screen). 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.
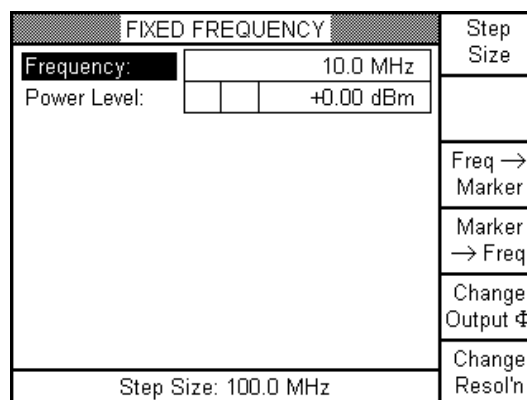
Figure 2-2: Display Screen with Interactive Softkeys

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.
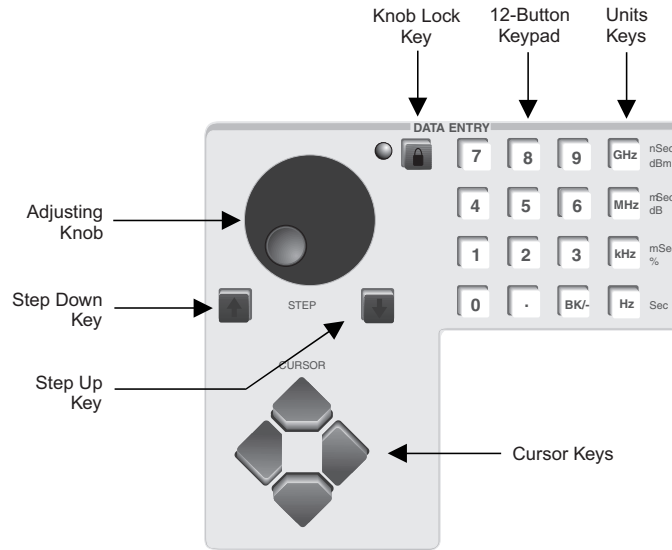
Figure 2-3: Data Entry Field (All Models)

Data Entry Keypad

Use this 12-button numeric keypad to enter parameter values and other data that require specific values. The BK/ - 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.

Unit Keys

Press the appropriate Units key to select the units of the parameter in the display and finishes the numeric entry. Any Units key can be used to complete 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. See Section 2.3.2.3 for instructions to set the 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 2.3.2.3 for instructions to set the resolution.

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**

This field controls the parameters for frequency and sweep operation. Also accesses List 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 configure a frequency sweep and to select alternate sweep methods. The sweep parameters can be changed while this menu is displayed. In this mode the LEVEL and LOCK LEDs are not updated.

RAMP SWEEP IS ONLY AVAILABLE ON THE SERIES 127XXA.

List

Press **[MARKER]** to display the 12 frequency markers used in frequency sweep operation. See Section 2.3.4 for operation.

Marker

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.

Manual

CURRENTLY NOT SUPPORTED.

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 **[SWEEP]** to configure a power sweep and to select alternate sweep methods. The sweep parameters can be changed while this menu is displayed. In this mode the LEVEL and LOCK LEDs are not updated.

RAMP SWEEP IS ONLY AVAILABLE ON THE SERIES 127XXA.

ALC

The resulting menu when pressing **[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.

CURRENTLY THE ALC INPUT IS NOT SUPPORTED.

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. At the prompt, enter an address of 0 through 9, with current assignments and free addresses displayed. Press the number 2 data entry key and the current setup is stored in address 2.

Recall

Press **[RECALL]** to recall a stored instrument setup. The address of each stored configuration will be displayed.

Config

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

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. See Section 2.3.23 for information on Preset.

```
┌──────────────────────────────────────┬────────┐
│▓▓▓▓▓▓▓▓▓▓▓ PRESET ▓▓▓▓▓▓▓▓▓▓▓        │        │
├──────────────────────────────────────┤        │
│ Number of Lists In Use:          0   ├────────┤
│ Number of Lev. Corr. Tables In Use: 0│        │
│ Number of Setups In Use:         0   ├────────┤
│                                      │        │
│                                      ├────────┤
│                                      │        │
│                                      ├────────┤
│                                      │Initialize│
│                                      │ NVRAM  │
│                                      ├────────┤
│                                      │ Return │
├──────────────────────────────────────┤        │
│ Press a soft key to select what to preset.│  │
└──────────────────────────────────────┴────────┘
```

Figure 2-4: System Configuration Selection (Preset)

10 **Modulation Field**

The MODULATION field selects the type of modulation to be used. AM, FM, φM and PM are available **(SERIES 125XXA/127XXA ONLY)**.

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).

Scan

To activate Scan modulation toggle the AM mode from linear to Scan.

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).

φM

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 (φM uses the FM connector) **(CURRENTLY THE ALC INPUT IS NOT ACTIVE. SERIES 124XXA CONTAINS ONLY THE ALC BNC)**.

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.

A blinking **RF ON LED** indicates that RF is set to ON but there is currently no RF out. This indicates that the unit has "RF Retrace" set to "RF Off" (Default) and is in triggered moved and is not being currently triggered. If "RF Retrace" is set to "RF On", the power would remain on after trigger ceases and the "RF ON" indicator will remain steadily on.

2.3   Front Panel Applications

Front Panel Applications	Model		Page
	124XXA	**125XXA/ 127XXA**	
2.3.1 - Direct Entry	√	√	2-10
2.3.2 - Set a CW Signal	√	√	2-11
2.3.3 - Step Frequency Sweep Configuration	√	√	2-14
2.3.4 - Add Markers to a Frequency Sweep	√	√	2-16
2.3.5 - List Set Up	√	√	2-18
2.3.6 - List Entry Speed Up	√	√	2-22
2.3.7 - List Execution Speed Up	√	√	2-22
2.3.8 - List Points Storage	√	√	2-24
2.3.9 - Step Power Sweep Configuration	√	√	2-26
2.3.10 - ALC Operation	√	√	2-28
2.3.11 - Ramp Frequency Sweep Configuration	**N/A**	√ (127XXA Only)	2-31
2.3.12 - Ramp Power Sweep Configuration	**N/A**	√ (127XXA Only)	2-33
2.3.13 - External Amplitude Modulation (AM)	**N/A**	√	2-35
2.3.14 - Internal Amplitude Modulation (AM)	**N/A**	√	2-36
2.3.15 - External Scan Amplitude Modulation	**N/A**	√	2-38
2.3.16 - Internal Modulation (Opt. 24) with Scan AM (Opt. 29) Selected	**N/A**	√	2-40
2.3.17 - External Frequency Modulation (FM)	**N/A**	√	2-41
2.3.18 - Internal Frequency Modulation (FM)	**N/A**	√	2-43
2.3.19 - Phase Modulation (ϕM)	**N/A**	√	2-45
2.3.20 - External Pulse Modulation (PM)	**N/A**	√	2-46
2.3.21 - Internal Pulse Modulation (PM)	**N/A**	√	2-47
2.3.22 - Interface Configuration	√	√	2-49
2.3.23 - System Reset	√	√	2-51

The remainder of this chapter presents applications examples to illustrate how to operate the 12000A by using the controls on the front panel. Refer to Chapter 3 in this publication if the 12000A will operate 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 selections for more detailed help topics.

2.3.1 Direct Entry

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:

2.3.1.1 Numeric Keypad Entry

With the cursor positioned at the far left (e.g., on FREQ in the Fixed Frequency menu as shown in Figure 2-5), 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 completed by pressing the appropriate Units key (any Units key completes 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.

2.3.1.2 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.

2.3.1.3 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 2-5 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

2.3.2   Set a CW Signal

Press **[CW]** or **[LEVEL]** to generate a fixed frequency at a fixed amplitude. Pressing **[CW]** will select the Frequency field and pressing **[LEVEL]** will select the Power Level field. The up and down cursor can be used to one field or the other in either menu. The menu illustrated in Figure 2-5 will display, showing the current or last-used frequency.
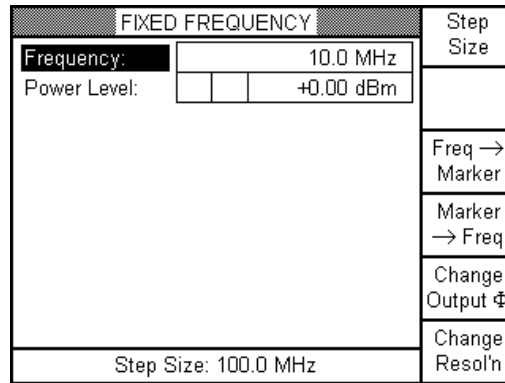
Figure 2-5: Fixed Frequency Menu with Softkeys

With the cursor at the far left highlighting the field name as in Figure 2-5, use the keypad to enter the frequency. The value entered 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, the frequency or power digits can be changed by moving the left or right cursor to the 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. 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.

2.3.2.1   Transfer To/From a Marker

The CW frequency can be added to the list of Markers or any Marker value can be transferred to the CW frequency. To transfer the CW frequency to the list of Markers, for first marker, press [Frequency→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. To retrieve a marker frequency and use it as the CW frequency, press [Marker→Freq], press [Select Marker] and select the number of the Marker to be transferred to the CW frequency, then press *[Copy Mrkr]* to complete the transfer.

2.3.2.2   Change Output Phase

The Phase Change menu is accessed via a softkey from the CW menu.
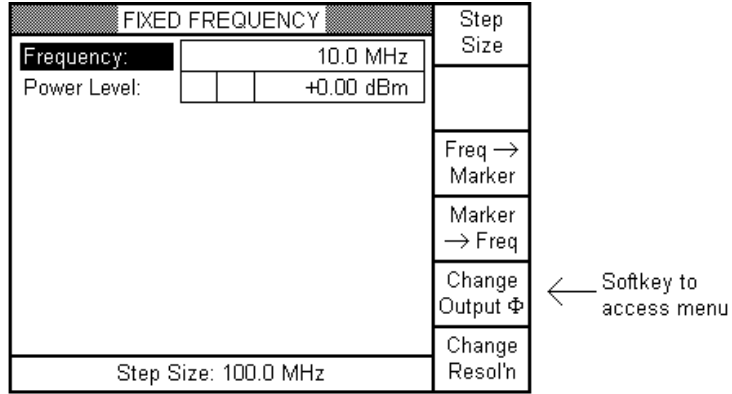
Figure 2-6: Phase Adjustment Selection
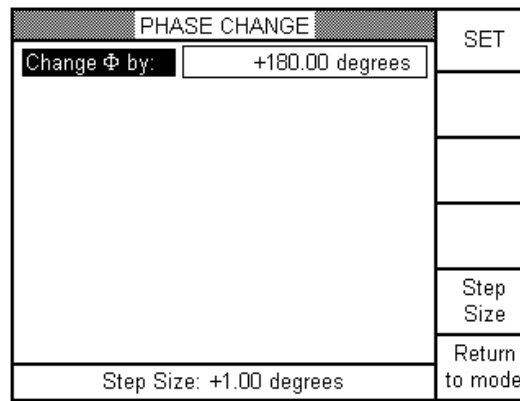
Figure 2-7: Phase Adjustment Selection (Phase Change)

- The minimum and maximum values allowed are +/- 180.00 degrees
- The maximum step size is +180.00 degrees and the minimum is +0.01 degrees

The output phase is NOT changed until the *"SET"* softkey is pressed.

The "Change Φ by:" value can be set, reset, or dialed in with the knob with NO change in output phase. The phase will change by the amount selected each time the "*SET*" softkey is pressed. For example, pressing "*SET*" twice when "Change Φ by:" is set to +90 degrees will shift your output phase by +180 degrees.

CWFreq > 4 GHz

For frequencies equal to and above 4 GHz, the output phase will shift at once with no delays.

CWFreq < 4 GHz

For frequencies below 4 GHz, the phase shift will be applied many times, with a delay, to account for frequency division in lower bands. Also, the phase shift will be broken down into increments of ten degrees, sent multiple times with delays, at frequencies under 4 GHz. This introduces some additional error not seen from 4 GHz and up. The typical worst case time to complete the phase shift is **1.7 s (11 MHz with 179 degrees shift)**. See table below for other typical times.

Table 2-1: Phase Shift Completion Times

Typical Time for Completion of Phase Shift										
CWFreq	11 MHz	11 MHz	50 MHz	500 MHz	1 GHz	2 GHz	2 GHz	4 GHz	4 GHz	8 GHz	16 GHz
Φ Shift	179 º	10 º	179 º	179 º	179 º	179 º	10 º	179 º	10 º	179 º	10 º
Timing	1.7 s	190 ms	420 ms	26 ms	14 ms	7 ms	680 μ	375 μ	375 μ	375 μ	375 μ

☛ **NOTE:** *The phase shift increment is an approximate number. Above 4 GHz, the error is typically less than a few percent. Below 4 GHz, due to the need to send multiple phase changes, the potential error increases.*

☛ **NOTE:** *Using this feature disables frequency-dithering. This will cause the output frequency to drift over time.*

2.3.2.3   Change Resolution

Currently resolution is available in the Step Size menu, but there has been no "Maximum" setting. The menu is now accessible at the top level in the CW menu.   The Resolution softkey was added to the bottom of the CW softkey menu. "Maximum Resolution" was added and "Natural Resolution" was renamed "Floating Resolution" (The mode that displays only significant digits).

2.3.3 Step Frequency Sweep Configuration

Use this feature to set up a step frequency sweep. Figure 2-8 illustrates the Step Frequency Sweep menu. A Step Frequency Sweep will start and stop at the frequency values designated in the configuration. The dwell time and the output power at each step also need to be defined. The Repeat mode defines when the sweep starts and the appropriate trigger needs to be defined.

Use the up and down cursor keys to move from field to field in the menu. Use the step keys or the knob to toggle between options in each field. For numeric values the numeric keypad can be used also as described in Section .

Figure 2-8: Step Frequency Sweep Menu

1. 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:

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

   b. Set up the Step parameters.

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

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

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

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

2.3.3.1   Step Frequency Sweep Parameters

Sweep Type

The sweep type is selective between Step and Ramp **(Ramp is only available on Series 127XXA models)**. This section details how to set up a Step Frequency sweep; See Section 2.3.11 for instructions on how to set up a Ramp Frequency sweep. With the cursor on Sweep Type, press either Step key to select Step.

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.

Start or Center Frequency

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

Stop Frequency or Frequency Span

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

Frequency Step

Enter the value for each step of the sweep.

Dwell Time

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

Power Level

Set the power output level in this menu in the same manner as described in Section 2.3.2.

Repeat Mode

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

RF LED Blink Mode

A blinking RF ON LED indicates that RF is set to ON but there is currently no RF out.   This indicates that the unit has "RF Retrace" set to "RF Off" (Default).

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.*

2.3.4   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.

☛   **NOTE:** *Leave the menu to activate the markers.*

To set the markers and their parameters, press **[MARKER]** to bring up the Edit Markers menu shown in Figure 2-9. 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.

Figure 2-9: 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 to assign to that marker. The digits will display in the bottom window (Temporarily replacing the Step Size) as they are entered. Press the appropriate Units key to enter the digits as the marker frequency. The Step Up and Step Down keys can be used 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 the desired type of marker and press [Toggle On/Off] to turn on the marker type. Multiple marker types can be selected 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 =>1.0 µs

See Section 2.3.2 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.

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2.3.5   List Set Up

The List Mode is an alternate sweep method that takes full advantage of automatic switching at the highest sweep speed. To configure up to 99 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 are 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.

Each list point is defined by the following:

- Frequency
- Power
- Dwell Time

Figure 2-10: List Sweep Configuration Menu

2.3.5.1   LIST MODE Menu Navigation

The screen is divided into 2 windows (See Figure 2-10). The Switch Cursor softkey will move the cursor back and forth between the windows.

In the top menu use the up and down cursor keys to switch from List Table, Repeat Mode, and Trigger Type. When the field is highlighted use the step keys to toggle between the appropriate settings. In the LIST TABLE field a number can be entered and completed pressing any Units key.

The bottom menu displays the list points. To move from one list point to another use the up and down cursor keys. To move inside a list point use the left and right cursor key. To move from the Power field to the Dwell time field use the right cursor key. To move from the Dwell time field to the Power field use the right cursor key.

2.3.5.2   List Table

Place the cursor on this parameter. Press the Step Up or Down key to increment or decrement the list number. Enter the list number with the keypad and press any Units key to complete the entry. 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.

2.3.5.3   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:

Continuous

Execute the entire current list, repeating it indefinitely.

Single Sweep

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

> **RF LED Blink Mode**
>
> A blinking RF ON LED indicates that RF is set to ON but there is currently no RF out.   This indicates that the unit has "RF Retrace" set to "RF Off" (Default).

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

2.3.5.4   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 the 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).

2.3.5.5   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 is at the right.

New points can be added by pressing [Add Point]. When adding a point, it will be a duplicate of the point on which the cursor is located. Add Point inserts a point following the current point, and moves other points down the list.

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.

☛ **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.

2.3.5.6   Edit List

Edit List generates a list by specifying the Start, Stop, Step, Dwell and Power Level. The range of the individual lists can be edited by pressing [Edit List]. The menu in Figure 2-11 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.

Figure 2-11: Edit List 1 Sweep Parameters Menu

To change range refer to Figure 2-12.

Figure 2-12: List 1 Range Menu

The list number will be displayed in the menu title at the top of the screen. 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; Go back to the menu in Figure 2-10 and start a new list.

Refer to the instructions on how to configure a Step Frequency Sweep in Section 2.3.3.

2.3.6   List Entry Speed Up

The manipulation (adding, editing or 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.

2.3.7   List Execution Speed Up

2.3.7.1   Lists Precompilation

In the Series 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

2.3.7.2   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.

2.3.7.3   Individual Point Execution Speed Up (Fast Option)

While executing a list part of the operation of the CPU is dedicated to updating the display. There are options available to set the display certain ways such as blanking it or freezing it to relieve the CPU of this burden. This will increase point-to-point switching speed by about 10%.

Pressing the Fast Option softkey while as list is executing activates the display mode that freezes the screen. This is similar to sending a GPIB or serial command 'DU 8'. In this display mode no display updates are performed, a message appears at the bottom, "Fast Option is on. Press LOCAL to exit", and the remote LED turns on. To exit this mode press the [**REMOTE**] key.

	LIST MODE		
List Table:	1		
Repeat Mode:	Single Sweep		Switch Cursor
Trigger Type:	Soft Key or GPIB		
Pt	Frequency, GHz	Power	
	Dwell, sec		
1	2.000 000 000 0	+0.00 dBm	Fast Option
	0.100 000		
2	3.000 000 000 0	+2.00 dBm	Edit List
	0.100 000		
			Trigger Sweep
Use Step keys to change entry.			

Figure 2-13: Fast Option Display Mode Selection

2.3.8 List Points Storage

When a list is created the points are stored in "source" form and when a list is precompiled the point is stored in "object" form. Source form points are allocated from nonvolatile memory so that they will be preserved even when the unit is off and power is removed. This pool of memory is shared by other functions of the unit such as stored configurations and any sweeps that are configured. 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, it is recommended 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.*

2.3.8.1   CPU Busy Clock

This feature provides a visual indicator of when the CPU is busy (Figure 2-14).

Figure 2-14: CPU Busy Clock Feature

2.3.8.2   Keyboard Abort

This feature provides a method to abort any time consuming process that keeps the CPU busy. The keys able to abort a process are:

- **CW KEY**
- **LIST**
- **MANUAL**
- **FREQUENCY SWEEP**
- **MARKER**
- **POWER LEVEL**
- **POWER SWEEP**
- **ALC**
- **PRESET**

Any of these keys will cause the 12000A to switch to the corresponding menu **EXCEPT** the **MANUAL** key. The **MANUAL** key can be used to abort without switching menus, though the display will NOT be refreshed. Any data calculated before a process is aborted is valid and can be used. For example, if a list range calculation of 1000 points is aborted after 500 points have been calculated, those points are a valid list that can be used or discarded.

2.3.9　　　Step Power Sweep Configuration

Use this feature to set up a step power sweep. Figure 2-15 illustrates the Step Power Sweep menu. A Step Power Sweep will start and stop at the power values designated in the configuration. The dwell time and the output frequency at each step also need to be defined. The Repeat mode defines when the sweep starts and the appropriate trigger needs to be defined.

Use the up and down cursor keys to move from field to field in the menu. Use the step keys or the knob to toggle between options in each field. For numeric values the numeric keypad can be used also as described in Section 2.3.1.1.

```
          ▓▓▓▓▓ 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 ││ DUAL │
         │ Frequency:  │  10.0 MHz ││ Sweep│
         │ Repeat Mode:│Single Sweep││ Step │
         │ Trigger Type:│Soft Key or GPIB││Params│
         ├─────────────┴──────────┤├──────┤
         │ Use Step keys to change entry.│Trigger│
         └──────────────────────────┘│Sweep │
                                      └──────┘
```

Figure 2-15: Step Power Sweep Configuration Menu

1. 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

    a.　　Set up a dual Frequency-Power sweep

    b.　　Set up the Step Power Sweep parameters

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

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

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

2.3.9.1   Step Power Sweep Parameters

Sweep Type

The sweep type is selective between Step and Ramp **(Ramp is only available on Series 127XXA models)**. This section details how to set up a Step Power sweep. See Section 2.3.12 for instructions on how to set up a Ramp Power sweep. With the cursor on Sweep Type, press either Step key to select Step.

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 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.

Start or Center Power Level

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

Stop Power or Power Span

When using the Start/Stop option, enter the stop power value. When using the Center/Span option, this entry will change to Power Span. Enter the total value that the sweep will span across.

Power Step

Enter the value for each step of the sweep.

Dwell Time

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

Frequency

Set the frequency of the Power sweep in this menu in the same manner as described in Section 2.3.2.

Repeat Mode

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

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.*

2.3.10 ALC Operation

Figure 2-16: 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

2.3.10.1 ALC Menu without Step Attenuator

☛ **NOTE:** *External leveling is currently not supported.*

Figure 2-17: ALC Menu with Low Power Correction Feature

2.3.10.2   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.

2.3.10.3   Sensor

Currently, only the internal sensor is supported.

2.3.10.4   Attenuator 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 –.01 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.

2.3.10.5   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.

2.3.10.6   Power Slope

When this function is enabled, the following screen appears:

Figure 2-18: 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).

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.

☞ **NOTE:** *The Step Attenuator is effectively in manual mode when power slope is on and will not change dynamically!*

2.3.10.7   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.

2.3.10.8   Level Correction

CURRENTLY NOT SUPPORTED.

2.3.11   **Ramp Frequency Sweep Configuration** (Series 12700A Only)

Use this feature to set up a Ramp frequency sweep. Figure 2-19 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.

Figure 2-19: 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

a.   Set up an alternate Step Frequency sweep as detailed in Section 2.3.3.

b.   Set up a dual Power-Frequency sweep

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

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

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

2.3.11.1   Ramp Frequency Sweep Parameters

Sweep Type

The sweep type is selective between Step and Ramp. This section details how to set up a Ramp Frequency sweep; See Section 2.3.3 for instructions on how to set up a Step Frequency sweep. With the cursor on Sweep type, press either Step key to select Ramp.

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.

Start or Center Frequency

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

Stop Frequency or Frequency Span

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

Frequency Span

Enter the value for each sweep.

Sweep Time

Enter the total time for each sweep.

Power Level

Set the power output level in this menu in the same manner as described in Section 2.3.2.

Repeat Mode

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

RF LED Blink Mode

A blinking RF ON LED indicates that RF is set to ON but there is currently no RF out.   This indicates that the unit has "RF Retrace" set to "RF Off" (Default).

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.

2.3.12   Ramp Power Sweep Configuration (Series 12700A Only)

Use this feature to set up a Ramp Power sweep. Figure 2-20 illustrates the Ramp Power Sweep menu. A Ramp Power sweep starts at a power level, which must designated, 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.

<div style="text-align:center">

┌ CAUTION ┐

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

</div>

```
        ▓▓▓▓▓▓ 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   │ │ DUAL │
 │ Repeat Mode:    │    Single Sweep  │ │ Sweep│
 │ Trigger Type:   │   Soft Key or GPIB│├──────┤
 │                 │                  │ │      │
 │                 │                  │ ├──────┤
 │                 │                  │ │Trigger│
 │  Use Step keys to change entry.    │ │Sweep │
 └─────────────────┴──────────────────┘ └──────┘
```

Figure 2-20: 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 below).

- 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

2.3.12.1   Ramp Power Sweep Parameters (Series 12700A Only)

Sweep Type

The sweep type is selective between Step and Ramp. This section details how to set up a Ramp sweep, See Section 2.3.3 for instructions on how to set up a Step sweep. With the cursor on Sweep Type, press either Step key to select Ramp.

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.

Start or Center Power Level

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

Stop Power or Power Span

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

Sweep Time

Enter the total time for each sweep.

Power Level

For convenience, set the sweep frequency in this menu in the same manner as described in Section 2.3.2.

Frequency

Set the sweep frequency in this menu in the same manner as described in Section 2.3.2.

Repeat Mode

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

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.

2.3.13   External Amplitude Modulation (Series 12500A/12700A Only)
Linear AM

☛ **NOTE:** *Option 24 is available to provide internal AM, FM or PM and Option 29 is available to provide Scan AM (Logarithmic AM).*

Press **[AM]** to select the modulation parameter. Refer to the modulation parameters and specifications in Chapter 1 for detailed information.

Using 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.

Scaling

When using AM, the scaling parameter determines the percent of modulation produced per volt of input. Scaling can be changed from 0.0 to 95.0%/V.

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 (2 V_{P-P}). For input levels less than 1 volt (1 volt is the maximum allowed), the depth is scaled appropriately.

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.

Figure 2-21: Amplitude Modulation Selection

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

2.3.14 Internal Amplitude Modulation (Series 12500A/12700A Only)

Press **[AM]** to select the modulation parameter.   Refer to the modulation parameters and specifications in Chapter 1 for detailed information.

```
▒▒▒▒ AMPLITUDE MODULATION ▒▒▒▒
Source:              Internal
AM Mode:               Linear        Turn AM
Waveform:                Sine          On
Frequency:            1.0 kHz
Depth:                10.0 %



                                      Return
     Use Step keys to change entry.   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 2.3.13). Two new parameters appear: Waveform and Frequency. The Scaling parameter is replaced with a depth parameter.

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.

☞ **NOTE:** *The Default waveform is "off" so a waveform needs to be selected to turn AM on.*

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.

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.

2.3.15 External Scan Amplitude Modulation (Opt. 29) (Series 12500A/12700A Only)
Scan AM (Logarithmic AM)

Press **[AM]** to select the modulation parameter.   Refer to the modulation parameters and specifications in Chapter 1 for detailed information.

Using Scan Modulation

Scan AM is defined as 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. The carrier power will decrease as the input voltage is increased. If the output voltage drops below 0 volts the signal may be clipped. 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).
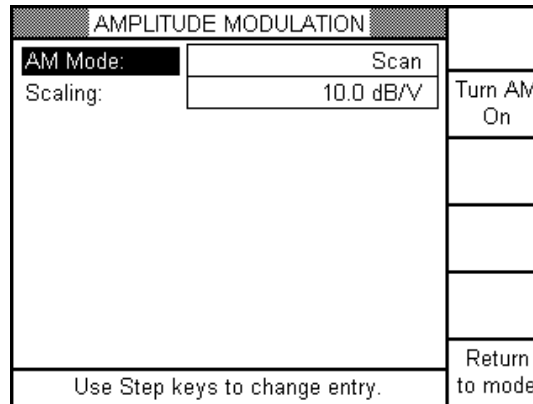
Figure 2-23: Scan Modulation Selection

Scaling

When using the Scan AM mode, the scaling parameter determines how much modulation (attenuation) is produced for each volt of input. Scaling can be changed from 0.0 to 65.0 dB/V using the Step keys, Knob or Key Pad entry. Select Scan from the AMPLITUDE MODULATION screen, with the AM Mode: parameter highlighted, by pressing the UP or DOWN Step key.

Example for Scan set-up:

 a.) Set Frequency to 3 GHz and Power Level to +10 dBm; with Scaling (as above) at 10.0 dB/V; Connect 1 VDC source to the AM Input BNC on the Front or Rear Panel; Connect power sensor to the RF output connector on the 12000A; Turn RF ON by pressing the ONOFF key under OUTPUT (The RF ON LED will turn on) and the power meter should read +10 dBm.

 b.) To turn Scan ON; Press the softkey next to Turn AM On (Softkey now changes to Turn AM Off). The power meter should read 0 dBm.

 c.) To turn Scan OFF; Press *Turn AM Off* softkey.

 d.) To modulate the RF Output: Connect a Sinewave, Triangle wave or Squarewave (Staying within the Input Voltage of 0 V to +6 V per "Input Voltage") to the AM Input BNC.

 e.) To turn Scan OFF; Press *Turn AM Off* softkey.

 f.) To modulate the RF Output: Connect a Sinewave, Triangle wave or Squarewave (Staying within the Input Voltage of 0 V to +6 V per "Input Voltage" on the next page) to the AM Input BNC.

☛ **NOTE:** *With the Scaling set to 10.0 dB/V, the 1VDC input reduces the RF output by –10 dB.*

Input Voltage

The AM Input BNC connector Input Voltage for Scan Modulation (Logarithmic AM) is 0 to +6 Volts.

2.3.16 Internal Modulation (Opt. 24) with Scan AM (Opt. 29) Selected
(Series 12500A/12700A Only)

Scan AM (Logarithmic AM)

Press **[AM]** to select the modulation parameter. Refer to the modulation parameters and specifications in Chapter 1 for detailed information.

```
┌─────────────────────────────────┬──────────┐
│▒▒▒ AMPLITUDE MODULATION ▒▒▒      │          │
├─────────────────────────────────┤          │
│ Source:              │  Internal │          │
│ AM Mode:             │      Scan │ Turn AM  │
│ Waveform:            │       Off │   On     │
│ Frequency:           │   1.0 kHz │          │
│ Depth:               │  10.00 dB │          │
│                                  │          │
│                                  │          │
│                                  │          │
│                                  │          │
│                                  │ Return   │
│   Use Step keys to change entry. │ to mode  │
└─────────────────────────────────┴──────────┘
```

Figure 2-24: Scan AM (Internal)

Using Internal Scan

With AM Mode: highlighted (reference above screen), use the UP or DOWN Step Key to select Scan. After setting Waveform, Frequency and Depth (See below), turn Scan ON by pressing the softkey next to Turn AM On (softkey now changes to Turn AM Off).

To turn Scan OFF; Press *Turn AM Off* softkey.

Waveform

With Waveform: highlighted, use the Step Keys to select the appropriate waveform for use. See 2.3.14 for Waveform selections.

☞ *NOTE: The Default waveform is "off" so a waveform needs to be selected to turn Scan AM on.*

Frequency

With Frequency: highlighted, use the Step Keys, Knob or Key Pad entry to select the appropriate frequency from 0.01 Hz to 1 MHz.

Depth

This modulation depth is expressed in dB for Scan (logarithmic) AM.

Select the appropriate Depth of Modulation for Scan by using the Step Keys, Knob or Key Pad entry from 0.00 dB to 65.00 dB.

2.3.17 **External Frequency Modulation** (Series 12500A/12700A Only)
Wideband FM/Narrowband FM

Press **[FM]** to select the modulation parameter.   Refer to the modulation parameters and specifications in Chapter 1 for detailed information.

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 $\pm$ 1 volt will allow the frequency to be shifted by up to $\pm$ 1 MHz (4-8 GHz), determined by the sensitivity setting, at any rate from DC to 8 MHz.

- The instrument frequency accuracy is a function of both the timebase 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. 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 $\pm$ 1 volt input is $\pm$ 20 MHz (4-8 GHz).

- 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 simply differentiating the modulation signal. Therefore all other characteristics of each mode remain the same. The allowable range of modulation frequencies is 10 Hz to 100 kHz for Narrow mode and 100 Hz to 100 kHz for Wide mode.

Figure 2-25: Frequency Modulation Selection

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

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 $\pm$ 40 MHz (8-16 GHz) or $\pm$ 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 (radians) = ΔF (deviation)/F$_m$ (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.

The allowable entry Max. Wide range is 40 kHz to 80 MHz. Max. Narrow range is 2 kHz to 4 MHz (Reference Section 1.7.3).

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.

2.3.18   **Internal Frequency Modulation** (Series 12500A/12700A Only)

Press **[FM]** to select the modulation parameter. Refer to the modulation parameters and specifications in Chapter 1 for detailed information.

When Option 24 is installed in the instrument, the Frequency Modulation Screen appears as shown below. The FM modes of Narrow and Wide operate in the same manner as with an external input (Refer to Section 2.3.17). Two new parameters appear: Waveform and Frequency. The Sensitivity parameter is replaced with a Deviation parameter.

```
┌─────────────────────────────┐ ┌──────┐      ┌─────────────────────────────┐ ┌──────┐
│   FREQUENCY MODULATION      │ │      │      │     PHASE MODULATION        │ │      │
│ Source:          Internal   │ │Turn FM│     │ Source:          Internal   │ │Turn ΦM│
│ FM Mode:           Narrow   │ │ On   │      │ ΦM Mode:           Narrow   │ │ On   │
│ Waveform:             Off   │ │      │      │ Waveform:             Off   │ │      │
│ Frequency:        1.0 kHz   │ │      │      │ Frequency:        1.0 kHz   │ │      │
│ Deviation:        2.0 kHz   │ │Switch│      │ Deviation:    +0.020 radians│ │Switch│
│                             │ │to ΦM │      │                             │ │to FM │
│                             │ │      │      │                             │ │      │
│                             │ │Return│      │                             │ │Return│
│ Use Step keys to change entry.│ │to mode│    │ Use Step keys to change entry.│ │to mode│
└─────────────────────────────┘ └──────┘      └─────────────────────────────┘ └──────┘
```

Figure 2-26: Frequency Modulation (Internal)/Phase Modulation (Deviation) Selections

Waveform

The Waveform parameter has the following selections:

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

Each waveform is calibrated to have the same peak-to-peak value. Selecting the Off choice removes the signal from the frequency modulator but leaves the FM function itself turned on.

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

☞ ***NOTE:*** *The Default waveform is "off" so a waveform needs to be selected to turn FM on.*

Frequency

This parameter field allows setting the modulating signal frequency. The allowable entry range is 0.01 Hz to 1 MHz.

Deviation

This parameter field allows setting the deviation for the frequency modulation. The deviation is set directly since the modulation generator output is a fixed level. The deviation limits are the same as with external modulation.

The phase modulation menu is accessed by a softkey labeled "Switch to ΦM" in the FM menu (See figure on previous page). The softkey label will change to "Switch to FM" once in ΦM (See figure on right side above). If another mode is entered, and then the "FM" front panel key is pressed, the FM/ΦM menu previously in will be displayed. The FM and ΦM menus On/Off status, wide/narrow mode, and sensitivity are independent and remembered when switching back and forth.

2.3.19   Phase Modulation (Series 12500A/12700A Only)

Press **[FM]** to select the modulation parameter.   Refer to the modulation parameters and specifications in Chapter 1 for detailed information.
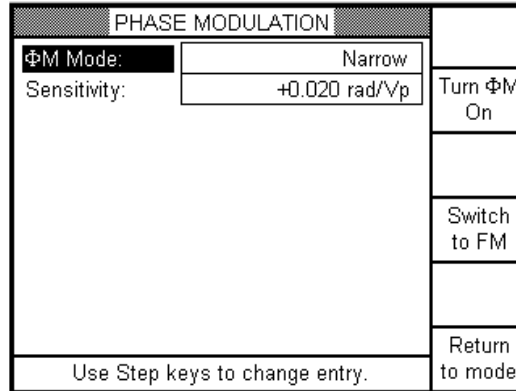
Figure 2-27: Phase Modulation Selection

Using Phase Modulation

Phase modulation, as implemented in the Series 125XXA/127XXA, is created by simply differentiating the input modulating signal. The net effect of this is that the FM deviation becomes smaller as the modulating frequency decreases. The relationship is as follows:

Modulation Index (Radians) = Deviation/Modulating Frequency

The system is calibrated such that if a 1 V (peak) signal is input to the instrument at a 100 kHz rate, the maximum deviation can be achieved. For example, in Narrow mode the maximum deviation is 1 MHz (in the 4 to 8 GHz band). With an input frequency of 100 kHz, this gives a modulation index of 10 radians. If the input frequency is reduced to 10 kHz, this same 10 radians will produce a deviation of 100 kHz. In wide mode (in the 4 to 8 GHz band) the maximum modulation index is 200 (20 MHz/100kHz). For a complete table see Section 1.7.4.

The phase modulation menu is accessed by a softkey labeled "Switch to ΦM" in the FM menu (See Figure 2-26). The softkey label will change to "Switch to FM" (See Figure 2-27) once in ΦM. If another mode is entered, and then the "FM" front panel key is pressed, the FM/ΦM menu previously in will be displayed. The FM and ΦM menus On/Off status, wide/narrow mode, and sensitivity are independent and remembered when switching back and forth.

Sensitivity

The allowable entry Max. Wide range is .40 radians to 800 radians. Max. Narrow range is .02 radians to 40 radians (Reference Section 1.7.4).

2.3.20   External Pulse Modulation (Series 12500A/12700A Only)
Active High (Positive-going)/Active Low (Negative-going)

Press **[PM]** to select the modulation parameter.   Refer to the modulation parameters and specifications in Chapter 1 for detailed information.

```
┌─────────────────────────────────┬──────────┐
│▓▓▓▓▓▓▓ PULSE MODULATION ▓▓▓▓▓▓▓▓│          │
│ Polarity:        │   Active High │          │
│                                  ├──────────┤
│                                  │  Turn PM │
│                                  │    On    │
│                                  ├──────────┤
│                                  │          │
│                                  ├──────────┤
│                                  │          │
│                                  ├──────────┤
│                                  │          │
│                                  ├──────────┤
│                                  │  Return  │
│   Use Step keys to change entry. │  to mode │
└─────────────────────────────────┴──────────┘
```
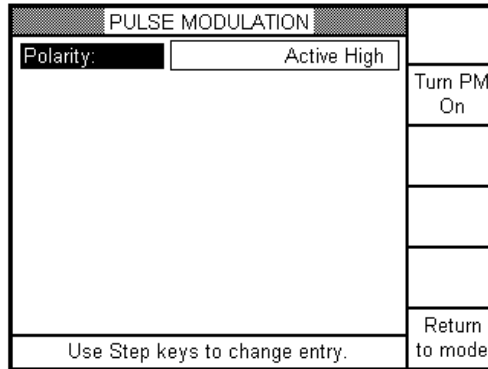
Figure 2-28: Pulse Modulation Selection

Using Pulse Modulation

The Pulse Modulation function allows controlling the instrument RF output with a high speed high on/off ratio level shift (on/off keying). During pulse operation, the RF output will be attenuated from the set level by at least 80 dB when the pulse is 'off'.

Polarity

This parameter determines which polarity of the input signal produces an RF output. Setting the parameter to 'Active High' means that the RF will be on when the input signal is a TTL high.

Enabling FM

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

2.3.21   Internal Pulse Modulation (Series 12500A/12700A Only)

Press **[PM]** to select the modulation parameter.   Refer to the modulation parameters and specifications in Chapter 1 for detailed information.

When Option 24 is installed in the instrument, the Pulse Modulation screen appears as shown below. in addition, the operation of the additional fields is described below.

```
        ▓▓▓▓ PULSE MODULATION ▓▓▓▓
  Source:                    Internal
  Trigger Source:            Internal    Turn PM
  Trigger Polarity:            Rising      On
  Preference:                    Rate
  Rate:                       1.0 kHz
  Width:                     100.0 ns
  Waveform:                   Singlet
  Gap:                       100.0 ns


                                          Return
       Use Step keys to change entry.    to mode
```

Figure 2-29: Pulse Modulation Selection (Internal)

Trigger Source

This parameter selects either the rising or the falling edge of an external trigger as the start signal for each pulse. When externally triggered, the internal generator will allow rates of 5 Hz to 5 MHz and will generate the same widths and delays as in internal triggering.

Preference

This selection field allows two methods for pulse 'timing'. If set to 'Rate', the repetition frequency for the pulse group train (using the internal trigger) may be directly specified. There is no delay setting in this mode. When this field is changed to 'Start Delay', the pulse repetition frequency is implicitly determined by the Delay and Width parameters. Each of these methods can generate the same waveform if the parameters are set appropriately. For example: setting a rate of 1 kHz with a width of 500 μs will produce the same waveform as setting a start delay of 500 μs and a width of 500 μs (assuming a 'singlet' pulse selection). Note that this field is always in the 'Start Delay' mode if the trigger selection is External.

Rate (Start Delay)

This field has two functions depending on the setting of the 'Preference' field (See above). When 'Rate' is displayed, the repetition frequency for the pulse train may be entered directly. The internal pulse generator is capable of generating pulse rates from 1 Hz to 3 MHz with widths of 100 ns to 1.67 seconds. When 'Start Delay' is entered, the time from the trigger (internal or external) to the start of the first pulse in a group may be entered. The delay (referenced to the Sync output) may be set from 0 to 1.67 seconds.

Width

This entry sets the width of each pulse produced, with either an external or an internal trigger. The width may be set from 100 ns to 1.67 seconds. If the Waveform field is set to one of the multiple pulse selections, each pulse in the group will have the same width.

Waveform

This parameter determines how many pulses are produced for each trigger (internal or external). The maximum number of pulses per group is four. Each pulse in the group will have the same width. The 'Start Delay' parameter will always be the time from the trigger to the first pulse in the group. See 'Gap', below for a description of the inter-pulse spacing. If the 'Preference' field is set to 'Start Delay' then the effective pulse rate will be determined by adding up the start delay, the width of each pulse in the group, and the gap between any pulses following the first.

☞ **NOTE:** *The default waveform is "off" so a waveform needs to be selected to turn PM on.*

Gap

If a multiple pulse waveform is selected, the spacing between pulses may be selected with this parameter. The delay from the trigger to the first pulse is set by the 'Start Delay' parameter. The spacing from pulse one to pulse two and between pulse two and three and between pulse three and pulse four is set by the 'Gap' parameter. All inter-pulse spaces are identical. The range of values is 100 ns to 1.67 seconds.

2.3.22   Interface Configuration

To configure the GPIB interface use the menu shown in Figure 2-30. To access the menu press the **[CONFIG]** key then press the *GPIB* softkey.

GPIB Address	This sets the GPIB address; the default is 6.
Language	This sets the language and the command set that the 12000A will recognize. The choices are the 12000A native command set, SCPI and Systron-Donner emulation.
Line Term.	Line Termination: this allows selection of the character that denotes the end of a command line.
GPIB Display	This sets the display when the unit is in remote operation. Choices where the display does not have to update allow fastest operation of the 12000A.
Out of Bounds	This sets how the 12000A will respond to a parameter that is not at a recognized value. (e.g., "CW 100 GZ").

Figure 2-30: System Configuration Selection

Figure 2-31: System Configuration Selection (GPIB Parameters Screen)

2.3.22.1 Network Analyzer Sweep Settings (Series 12700A Only)

The Ramp Frequency and Power Sweep Interface default is set to "Network Analyzer" to support Giga-tronics' 8003 Precision Scalar Analyzer (See the left side graphic in Figure 2-32 below). The ramp sweeps are set to CONTINUOUS and IMMEDIATE by default. To go from "Network Analyzer" to "Normal" mode, change Interface mode to "Fast", this removes any delay between sweeps (The screen should now appear as illustrated on the right side of Figure 2-32).

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
Interface:	Network Analyzer	Return
Use Step keys to change entry.		to mode

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
Interface:	Fast	Return
Use Step keys to change entry.		to mode

Figure 2-32: System Configuration Selections (Network Analyzer)

2.3.23   System Reset

2.3.23.1   NVRAM Description

The 12000A uses non-volatile memory "NVRAM", preserved with a battery for storing the Instrument's current state, saved Setups and Lists. The NVRAM is "check-summed" meaning at boot-up, the firmware checks if any value has been changed. There are three different special NVRAM menus appearing early in the boot-up process under certain conditions:

- • Checksum Failure
- • Signature Failure
- • Power-Up Preset

These menus allow the user to "Initialize NVRAM", "Reset Checksum" or "Initialize Heap" depending on the menu before the normal instrument initialization. If NVRAM is initialized from one of the three boot-up menus, all NVRAM data and special values for FLASH will be set to factory values (Contrast, Reference ADC (Timebase), FM Mid DAC, FM High DAC and YigCap Delay). The customer settings for special NVRAM variables are preserved upon initializing NVRAM from the "Preset" menu during normal operation (Press the "**PRESET**" button after normal boot-up. See Figure 2-30). Additionally, the GPIB Device Address will also be preserved if initialization is done remotely during normal operation.

2.3.23.2   Boot-Up NVRAM Initialization Menus

CheckSum Failure Menu

This menu below is activated under "Checksum Failure" under the following circumstances:

- • After a firmware upgrade
- • New firmware may have new information stored in NVRAM which requires it to be initialized
- • A battery failure (The "Signature Failure" menu could appear)
- • Power interruption to the Series 12000A while NVRAM is being modified (In example, a List is being created)

Resetting the checksum will allow in most cases for normal operation without losing current settings, stored setups or Lists. If boot-up does not complete normally after resetting the checksum, use the Power-Up Preset menu to initialize NVRAM as described later.

Figure 2-33: NVRAM CheckSum Selection

Series 12000A Microwave Synthesizers

Signature Failure Menu

The NVRAM also contains a 32 bit *signature* word. The *signature* word has two purposes:

- Change in a new firmware forces the user to initialize NVRAM due to restructuring (Changing the arrangement of NVRAM without adding new information would not cause a "Checksum Failure" and a *failure* is forced)
- The *signature* failure may indicate battery failure if it fails every time AC power is totally disconnected from the unit. If this is the case, the unit needs to be sent back to the factory for service

```
▓▓▓▓▓ NVRAM SIGNATURE ▓▓▓▓▓
The NVRAM signature word is invalid.
Either the NVRAM battery has failed or        Initialize
new firmware may have purposely changed        NVRAM
the "signature" to force the user to
initialize NVRAM because of NVRAM
restructuring, (check the firmware release
notes.)    Press "Initialize NVRAM" to
initialize the NVRAM heap to empty and
restore the state of the instrument to
factory values.
Press a soft key to make your selection.
```

Figure 2-34: NVRAM Signature Selection

Power-Up Preset Menu

This menu below is activated at boot-up by holding down the green "**PRESET**" key during power-up. This provides the user with the same ability to reset the NVRAM before normal boot-up as the "Checksum Failure" and the "Signature Failure" menus (when there is no failure); this may be useful in a situation where boot-up will not complete due to an invalid instrument state when last powered down.

```
▓▓▓▓▓ POWER-UP PRESET ▓▓▓▓▓
Initialize Heap:  Deletes all Lists and stored
            setups and reinitializes the heap    Initialize
            space where they are kept.              Heap

                                                  Initialize
Initialize NVRAM:  Initializes the heap and        NVRAM
            restores the instrument's settings
            to factory values.

Continue Power-Up: Do neither of the above
            and continue normal boot-up.          Continue
Press a soft key to make your selection.         Power-Up
```

Figure 2-35: Power-Up Preset Selection

Table 2-2: Factory Default Settings

Parameter	Default Condition	Model	
		124XXA	**125XXA/ 127XXA**
CW Frequency	Minimum	√	√
RF @ Power up	Off	√	√
RF Level	0 dBm	√	√
Amplitude Modulation	Off	**N/A**	√
AM Rate (Opt. 24)	1 kHz	**N/A**	√
AM Mode	Ext	**N/A**	√
AM Depth	50%	**N/A**	√
Frequency Modulation	Off	**N/A**	√
FM Rate (Opt. 24)	1 kHz	**N/A**	√
FM Mode	Ext	**N/A**	√
FM Deviation	5 MHz	**N/A**	√
Pulse Modulation	Off	**N/A**	√
PM Rate (Opt. 24)	100 kHz	**N/A**	√
PM Mode	Ext	**N/A**	√
PM Width (Opt. 24)	5 us	**N/A**	√
PM Delay (Opt. 24)	0 ns	**N/A**	√

3

Remote Operation

3.1 Introduction

Introduction (Remote Operation)	Model	
	124XXA	125XXA/ 127XXA
3.1.1 - Languages Available	√	√

The Series 12000A Microwave Synthesizers can be operated from a remote host over the General Purpose Interface Bus (GPIB) using either Standard Commands for Programmable Instruments (SCPI) or Native language commands. Operation via the RS-232 interface is possible using the Native commands for all three models.

☛ **NOTE:** *The unit may be operated via its RS-232 interface, using the same language(s) as are supported on its GPIB interface. Other GPIB functionality, such as that provided by the GPIB lines IFC, SRQ, etc., and by GPIB multiline messages, such as GET, DCL, etc., are not supported over the RS-232 interface. The RS-232 interface's parameters are: 9600 baud, 8 bits per character, 1 stop bit, no parity, and neither software (XON/XOFF) nor hardware (RTS/CTS) flow control. Commands must be terminated with a carriage return. Any legal command following an unrecognized command is ignored until a carriage return. The sending of commands prior to the unit's completion of its powerup initialization is not recommended. The use of both the GPIB and the RS-232 interface at the same time is not allowed.*

3.1.1 Languages Available

All synthesizer functions are designed to be controlled over the General Purpose Interface Bus (GPIB). At present, SCPI and IEEE 488 Native languages are implemented. 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 the command set that is available for that function
- The Native syntax is a set of IEEE 488 commands developed for remote control of Giga-tronics instruments

3.2 SCPI Command Codes

SCPI Command Codes	Model	
	124XXA	**125XXA/ 127XXA**
3.2.1 - SCPI Command Format	√	√
3.2.2 - SCPI Mandated Commands	√	√
3.2.3 - SCPI SOURCe Commands	√ (See Section for N/A Commands)	√
3.2.4 - SCPI Status Commands	√	√
3.2.5 - Sample SCPI Commands	√	√

The SCPI syntax implemented in the Series 12000A 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

Details of typography (such as indentation, case, and punctuation) are very significant in SCPI and must be attended to with great care. The typographic conventions employed in the SCPI command tables which follow are summarized here.

Colons indicate changes of level in the SCPI tree structure. If a command is represented in the format ALPHA:BETA:GAMMA, then BETA is one level down from ALPHA, and GAMMA is two levels down from ALPHA. If ALPHA is printed at the left margin, ALPHA is at the root level.

Commands can be entered in upper- or lowercase. However, only required letters are in upper case in the command structure. 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, so entering INIT has the same effect as entering INIT:IMM.

Because querying any value can be set, most commands also exist in a query form (Signified by a question mark at the end of the command). 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.

Some commands require a parameter. The parameter types are listed below for all three models:

Boolean	A Boolean (true or false) condition. Enter: ON or 1 for TRUE OFF or 0 for FALSE
NUM_VAL	A numeric value or a qualitative term which represents a numeric value. Enter: Sign (optional) value digits decimal point (optional) E xx (optional) units suffix (optional) Or Enter: MIN or MAX UP or DOWN (these only change the synthesizer's output frequency or output power level)
NUM	A number, which typically represents register bit settings in the form of a decimal integer

There are also discrete parameters. These are options to be chosen from a limited selection. For example, the TRIGger:SLOPe command has three possible discrete parameters to chose from (POSitive, NEGative, and NONe).

The beginning of a parameter must be preceded by a space. The default units suffixes are DB for power and HZ for frequency (optional parameters for frequency are KZ, MZ and GZ).

3.2.2   SCPI Mandated Commands

The following are SCPI mandated commands. The command syntax is followed by a description of the command. Many of these commands refer to the Status System, which is discussed in detail in Section 3.2.4. Commands beginning with an asterisk are IEEE 488.2 Common Commands.

SCPI Mandated Commands	Model	
	124XXA	**125XXA/ 127XXA**
*CLS	√	√
*IDN?	√	√
*OPC	√	√
*OPC?	√	√
*RST	√	√
*TST?	√	√
*OPAS	√	√
*OS	√	√

*CLS

Syntax:	*CLS
Response:	N/A
Description:	Clear Status. This command clears the event registers in all status groups. It also clears the Event Status Register and the Error/Event Queue.

*IDN?

Syntax:	*IDN?
Description:	Identification query. The response takes the form of four ASCII fields separated by commas. The fields are: (1) Manufacturer, (2) Model, (3) Serial Number, and (4) Firmware Level or Equivalent. Fields 1 and 2 are required; fields 3 and 4 are filled by zeros if the data is not available.

*OPC

Syntax:	*OPC
Description:	Operation Complete. This command 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?

Syntax:	*OPC?
Description:	This query form 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

Syntax:	*RST
Description:	The Reset command 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.

*TST?

Syntax:	*TST?
Description:	No external equipment is required to run the self-test. Disconnect any equipment that is connected to the RF Output before running the self-test as the synthesizer might generate high output power during the test. When the self-test is complete, the synthesizer is set to the original state.
	Self-test performs a list of various frequency and power levels to assure the instrument responds normally. A message, "Self-test passed" returns if no errors are found during the test or else returns the synthesizer to the frequency and power level that caused the test failure.
	The Self-Test query command causes the synthesizer to perform a self-test routine. See the notes below concerning Self-Test. The Self-Test routine will preserve (save and later restore) these states:
	RF On/Off State **CW Frequency Value** **Power Level Coarse Value** **Power Level Fine Value**

OPAS

Syntax:	OPAS
Response:	Returns a string containing the status of Loc, Level and Calibration
Description:	This command oupts the Lock, Level and Calibration status. A "1" represents Locked, leveled, or calibrated respectively; a "0" represents unlocked, unleveled, or un-calibrated respectively.

OS

Syntax:	OS
Response:	Returns a binary string containing the status bits of Lock, Level and Calibration.
Description:	This command ouputs a 16-bit binary format string as described in the following table.

Bits	Condition
15	Not used - always 0
14	Not used - always 0
13	Not used - always 0
12	Not used - always 0
11	Not used - always 0
10	Not used - always 0
9	Not used - always 0
8	Not used - always 0
7	0 = instrument is not leveled 1 = instrument is leveled
6	Not used - always 0
5	Not used - always 0
4	Not used - always 0
3	Not used - always 0
2	Not used - always 0
1	0 = instrument is not locked 1 = instrument is locked
0	0 = instrument is not calibrated 1 = instrument is calibrated

Example:	Output string, "0000000010000011", means instrument is calibrated, locked and leveled.

3.2.3 SCPI SOURCe Commands

SCPI Source commands are divided into the sections listed below. In some cases the Source code may contain additional sets of functions. All Source subsystem commands begin with [SOURce], but as [SOURce] is the default command at the root level it need not be entered. The following SOURce subsystems are used in the 12000A:

SCPI SOURCe Commands	Model	
	124XXA	125XXA/ 127XXA
AM	N/A	√
FM	N/A	√
FREQuency	√	√
LIST	√	√
MARKer	√	√
POWer	√	√
PULSe	N/A	√
SWEep	√	√
SYSTem	√	√
TRIGger	√	√

3.2.3.1 **AM Subsystem Commands** (Series 12500A/12700A Only)

The Amplitude Modulation subsystem sets the modulation controls and the parameters associated with the modulating signal(s).

- ■ **AM:DEPTh**
- ■ **AM:INTernal:FUNCtion:SHAPe**
- ■ **AM:SCALing**
- ■ **AM:SCAN**
- ■ **AM:STATe**
- ■ **AM:SOURc:EXTernal**
- ■ **AM:TYPE**

AM:DEPTh

Syntax:	AM: $<$ *Num_Val* $>$	
Example:	AM 40	! Set the AM depth to 40%
Description:	Sets the depth of Amplitude Modulation to *d* percent in internal mode.	

AM:INTernal:FUNCtion:SHAPe

Syntax:	AM:INTernal:FUNCtion:SHAPe OFF | SINE | SQUare | TRIangle | PRaMP | NRaMP	
Example:	AM:INTernal:FUNCtion:SHAPe OFF	! Set the internal AM waveform to OFF
Description:	Allows user to assign an AM waveform from one of the following choices: off, sine, square, triangle, positive ramp and negative ramp.	

AM:SCALing

Syntax:	AM: Scaling *n*	
Example:	AM: Scaling 10	! Set the AM scaling rate to 10%
Description:	Sets the scaling of Amplitude Modulation to n %/V in external mode.	

AM:SCAN

Syntax:	AM: SCAN *n*	
Example:	AM: SCAN 2	! Activates internal Scan Amplitude Modulation
Description:	Activate and select the source of the Scan AM according to the following values for *n*:	
	n = 0	Deactivate (turn off) Scan Amplitude Modulation.
	n = 1	Activate external Scan Amplitude Modulation **(Only with Option 29)**.
	n = 2	Activate internal Scan Amplitude Modulation **(Only with Options 24 and 29)** and select sine wave.
	n = 3	Activate internal Scan Amplitude Modulation **(Only with Options 24 and 29)** and select square wave.
	n = 4	Activate internal Scan Amplitude Modulation **(Only with Options 24 and 29)** and select triangle wave.
	n = 5	Activate internal scan **(Only with Options 24 and 29)** and select positive ramp.
	n = 6	Activate internal scan **(Only with Options 24 and 29)** and select negative ramp.
	n = 7	Activate internal scan **(Only with Options 24 and 29)** and select noise.
	n = 8	Activate internal scan **(Only with Options 24 and 29)** and select zero output.

AM:STATe

Syntax:	AM $<$*Boolean*$>$	
Example:	AM ON (*or* OFF)	! Turn the AM output ON (*or* OFF)
Description:	The command activates or deactivates the AM mode.	

AM:SOURce:EXTernal

Syntax:	AM:SOURce:EXTernal $<$*Boolean*$>$	
Example 1:	AM:SOURce:EXTernal ON	! Select a single external modulation source
Example 2:	AM:SOURce:EXTernal 1 ON, EXTernal 2 ON	! Select two external modulation sources
Description:	Selects INTernal and/or EXTernal sources for the modulating signal. Single or multiple sources can be selected. Any source not included in the current selection will be deselected and turned off. When multiple sources are selected, the respective sources must be suffixed with a number. If a number is not included, it is assumed to be 1.	

AM:TYPE

Syntax:	AM:TYPE < *Boolean* >	
Example:	AM:TYPE LOGarithmic	! Select LOGarithmic AM shaping
Description:	This command controls the AM shaping. The default is LINear. LINear = The output voltage is directly proportional to V_{mod}. LOGarithmic = The output voltage is proportional to log (V_{mod}). EXPonential = The output voltage is proportional to 10 (V_{mod}).	

3.2.3.2   **FM Subsystem Commands** (Series 12500A/12700A Only)

The Frequency Modulation command subsystem sets the modulation controls and the parameters associated with the FM signal(s). The FM commands used in the 12000A are:

■   **FM[:DEViation]**
■   **FM:INTernal:FUNCtion:SHAPe**
■   **FM:SENSitivity**
■   **FM:SOURce**
■   **FM:STATe**
■   **FM:TYPE**
■   **FM:TYPE?**

FM[:DEViation]

Syntax:	FM *<Num_Val>*	
Example:	FM 100	! Set the FM deviation to 100 Hz
Description:	This command sets the modulation deviation of an FM signal. The unit for deviation is Hertz (Hz).	

FM:INTernal:FUNCtion:SHAPe

Syntax:	FM:INTernal:FUNCtion:SHAPe OFF | SINE | SQUare | TRIangle | PRaMP | NRaMP	
Examples:	FM:INTernal:FUNCtion:SHAPe SINE	! Set the FM waveform to SINE waveform
	FM:INTernal:FUNCtion:SHAPe OFF	! Set the FM waveform to OFF
Description:	Allows user to assign an FM waveform from one of the following choices: off, sine, square, triangle, positive ramp and negative ramp.	

FM:SENSitivity

Syntax:	FM:SENSitivity *<Num_Val>*	
Example:	FM:SENSe 10	! Set the FM sensitivity to 10 Hz/volt
Description:	This command controls the modulation deviation by setting a sensitivity Modulation to the modulation voltage level. The unit for SENSitivity is Hertz/volt (Hz/V).	

FM:SOURce

Syntax:	FM:SOURce INTernal | EXTernal (EXTernal | INTernal)	
Example:	FM:SOURce EXTernal	! Select the FM signal source
Description:	Selects INTernal and/or EXTernal sources for the modulating signal. Single or multiple sources can be selected. Any source not included in the current selection will be deselected and turned off. When multiple sources are selected, the respective sources must be suffixed with a number. If a number is not included, it is assumed to be 1.	

FM:STATe

Syntax:	FM:STATe < *Boolean* >	
Example:	FM:STATe ON (*or* OFF)	! Turn the FM output ON (*or* OFF)
Description:	This command activates or deactivates the FM mode.	

FM:TYPE

Syntax:	FM:TYPE	
Example:	FM:TYPE	! Switch to another model
Description:	It sets the mode for Frequency Modulation. The available modes are Narrow and Wide mode. Every time this command is executed, it switches to another mode.	

FM:TYPE?

Syntax:	FM:TYPE?	
Example:	FM:TYPE?	! Returns the current FM mode
Description:	This command activates or deactivates the FM mode.	

3.2.3.3 FREQuency Subsystem Commands

The Frequency subsystem commands control the frequency sweep characteristics of the 12000A. This subsystem includes the following commands:

- **FREQuency[:CW | :FIXed]**
- **FREQuency[:CW | :FIXed]?**
- **FREQuency[:CW | :FIXed]:RES**
- **FREQuency[:CW | :FIXed]:STEP**
- **FREQuency[:CW | :FIXed]:STEP[:INCRement]**
- **FREQuency[:CW | :FIXed]:STEP[:INCRement]?**
- **FREQuency:CENTer**
- **FREQuency:CENTer?**
- **FREQuency:MODE**
- **FREQuency:SPAN**
- **FREQuency:SPAN?**
- **FREQuency:STARt**
- **FREQuency:STARt?**
- **FREQuency:STOP**
- **FREQuency:STOP?**

FREQuency[:CW | :FIXed]

Syntax:	FREQuency *<Num_Val>*	
Example:	FREQuency 1000	! Set the unit to CW frequency of 1000 HZ
Description:	The CW or FIXed mode selects a frequency of a non-swept signal. Optional units in place of HZ are MIN, MAX, UP, or DOWN. The commands FREQuency[:CW] and FREQuency[:FIXed] are synonymous; either command specifies a fixed frequency for the synthesizer.	

FREQuency[:CW | :FIXed]?

Syntax:	FREQuency?
Description:	This command queries and reports the current CW/Fixed frequency.

FREQuency[:CW | :FIXed]:RES

Syntax:	FREQuency:RES *<Num_Val>* [HZ	KZ	MZ	GZ]	
Example:	FREQuency:RES 100	! Set the CW frequency resolution to 100 Hz
Description:	This command sets the absolute increment/decrement at which the frequency of the output signal can be changed. The default value is HZ.	

FREQuency[:CW | :FIXed]:STEP

Syntax:	FREQuency:STEP <*Num_Val*> [HZ	KZ	MZ	GZ]	
Example:	FREQuency:STEP 100 HZ	! Set the sweep frequency step to 100 Hz
Description:	This command specifies a sweep frequency step size. The commands **FREQuency[:CW]** and **FREQuency[:FIXed]** are synonymous; either command specifies a fixed frequency for the synthesizer.	

FREQuency[:CW | :FIXed]:STEP[:INCRement]

Syntax:	FREQuency:STEP[:INCRement] <*Num_Val*>	
Example:	FREQuency:STEP 100	! Set the sweep frequency step size to 100 Hz
Description:	This command specifies a step size for sweeping or for UP/DOWN incrementing. The unit value is Hertz. Optional units in place of HZ are MIN, MAX, UP, or DOWN. The commands **FREQuency[:CW]** and **FREQuency[:FIXed]** are synonymous; either command specifies a fixed frequency for the synthesizer.	

FREQuency[:CW | :FIXed]:STEP[:INCRement]?

Syntax:	FREQuency:STEP?
Description:	The is the query form to report the CW/Fixed frequency step increment size.

FREQuency:CENTer

Syntax:	FREQuency:CENTer <*Num_Val*>	
Example:	FREQuency:CENTer 100 MZ	! Set the center frequency to 100 MHz
Description:	This command sets the CENTer frequency of a sweep. The default unit is MZ; additional unit options are HZ, KZ and GZ.	

FREQuency:CENTer?

Syntax:	FREQuency:CENTer?
Description:	This is the query form to report the center frequency.

FREQuency:MODE

Syntax:	FREQuency:MODE CW | FIXed | SWEep | LIST | SENSe	
Example 1:	FREQuency:MODE CW	! Set the CW commands to control the frequency subsystem
Example 2:	FREQuency:MODE LIST	! Set the List commands to control the frequency subsystem
Description:	This command establishes which set of commands will be used to control the frequency subsystem. The settings have the following meanings:	
	CW|FIXed:	The frequency is determined by FREQuency[:CW] or [:FIXed]. CW and FIXed are interchangeable, both must be implemented if either is implemented.
	SWEep:	The source is in the swept mode and the frequency is determined by FREQuency:STARt, STOP, CENTer, SPAN, and MAN (manual).
	LIST:	The source is in the LIST sequence mode and the frequency is determined by LIST:FREQuency (Refer to the LIST subsystem commands in this section).

FREQuency:SPAN

Syntax:	FREQuency:SPAN < *Num_Val* > [HZ | KZ | MZ | GZ]	
Example:	FREQuency:SPAN 200 MZ	! Set the frequency span to 200 MHz
Description:	This command sets the sweep frequency span.	

FREQuency:SPAN?

Syntax:	FREQuency:SPAN?
Description:	This is the query form to report the SPAN of the sweep frequency.

FREQuency:STARt

Syntax:	FREQuency:STARt < *Num_Val* > [HZ | KZ | MZ | GZ]	
Example:	FREQuency:STARt 200 HZ	! Set the sweep starting frequency to 200 kHz
Description:	This command sets the STARt frequency. It also sets the lower limit of a manual sweep.	

FREQuency:STARt?

Syntax:	FREQuency:STARt?
Description:	This is the query command to report the STARt frequency.

FREQuency:STOP

Syntax:	FREQuency:STOP <*Num_Val*> [HZ | KZ | MZ | GZ]	
Example:	FREQuency:STOP 100 MZ	! Set the sweep stop frequency to 100 MHz
Description:	This command sets the STOP frequency. It also sets the upper limit of a manual sweep.	

FREQuency:STOP?

Syntax:	FREQuency:STOP?
Description:	This is the query command to report the STOP frequency.

3.2.3.4   **LIST Subsystem Commands**

■   **LIST:ADD:POINt**
■   **LIST:DELete:LIST**
■   **LIST:DELete:POINt**
■   **LIST:DWELl**
■   **LIST:DWELl:POINt**
■   **LIST:DWELl:POINt?**
■   **LIST:FREQuency**
■   **LIST:FREQuency:POINt**
■   **LIST:FREQuency:POINt?**
■   **LIST:PRECompute?**
■   **LIST:POWer**
■   **LIST:POWer:POINt**
■   **LIST:POWer:POINt?**
■   **LIST:RANGe:ADD**
■   **LIST:RANGe:DWELl**
■   **LIST:RANGe:POWer**
■   **LIST:RANGe:STARt**
■   **LIST:RANGe:STEP**
■   **LIST:RANGE:STOP**
■   **LIST:REPeat**
■   **LIST:RUN**
■   **LIST:TRIGger:SOURce**

LIST:ADD:POINt

Syntax:	LIST:ADD:POINt *n1 n2*
Example:	LIST:ADD:POINt 1 1 ! Adds one additional point to point number 1 of list 1.

Description:	This command adds a point to list *n1* after point number *n2* (**NOTE:** *The first point of the list is 1*). When *n2* = 0, it inserts a point at the head of the list. The frequency, power, dwell time and modulation start of the added points are set to:
	
	    a.) the same values as the point is inserted
	    b.) the same values as the point it is inserted
	
	the instrument's minimum frequency, power, dwell time and modulation off if the list is empty.

LIST:DELete:LIST

Syntax:	LIST:DELete:LIST *n*
Example:	LIST:DELete:LIST 1 ! Deletes all the points in list 1.
Description:	It clears all the points from the selected list.

LIST:DELete:POINt

Syntax:	LIST:DELete:POINt *n1 n2*	
Example:	LIST:DELete:POINt 1 3	! Deletes point 3 of list 1
Description:	This command deletes point *n2* from list *n1*. After a point is deleted, the following points in the list are promoted to replace the one deleted (***NOTE: n2 = 1 denotes the first point in the list)***.	

LIST:DWELI

Syntax:	LIST:DWELI < *Num_Val* >	
Example:	LIST:DWELI 100 MS	! Set the dwell time for current editing point in the current list 100 ms
Description:	This command sets the dwell time of the current editing point to *d*. The default value is in alternate values.	

LIST:DWELI:POINt

Syntax:	LIST:DWELI:POINt *n*	
Example:	LIST:DWELI:POINt 3	! Set edit point 3 as the current editing point.
Description:	This command sets the list point n as the current editing list point before modifying the dwell time. (***NOTE: LIST:DWELI:POINt should execute first to indicate which list point is going to modify)***.	

LIST:DWELI:POINt?

Syntax:	LIST:DWELI:POINt?
Description:	This command returns the currently selected point for editing dwell time.

LIST:FREQuency:POINt

Syntax:	LIST:FREQuency:POINt *n*	
Example:	LIST:FREQuency:POINt 3	! Set list point 3 as the current editing point.
Description:	This command sets list point *n* as the current editing list point before modifying the frequency.	

LIST:FREQuency:POINt?

Syntax:	LIST:FREQuency:POINt?
Description:	This command returns the currently selected list point for frequency editing.

LIST:PRECompute?

Syntax:	LIST:PRECompute? *n*	
Example:	LIST:PRECompute? 1	! Performs precompute for list 1
Description:	This command calculates list *n*, and stores the calculated values in RAM. Return 0 when done. When the pre-calculated list is subsequently run, the first trace will run at full speed, since the instrument will not need to do the calculations as part of executing the first trace. All about 25 ms per point for this command.	

LIST:POWer

Syntax:	LIST:POWer < *Num_Val* >	
Example:	LIST:POWer -10	! Sets the current editing point in the current lists to -10 dB
Description:	This command specifies the power/amplitude points in the lists.	

LIST:POWer:POINt

Syntax:	LIST:POWer:POINt *n*	
Example:	LIST:POWer:POINt 3	
Description:	This command sets list point *n* as the current editing list point before modifying the power level.	

LIST:POWer:POINt?

Syntax:	LIST:POWer:POINt?
Description:	This command returns the selected list point for power editing.

LIST:RANGe:ADD

Syntax:	LIST:RANGe:ADD *n*	
Example:	LIST:RANGe:ADD 1	! Inserts the range as list #1
Description:	This command inserts the list range as the given list number *n*. (**NOTE:** *It takes about 10 ms per step to generate the list. Sufficient time must be given in the program for this task to complete*).	

LIST:RANGe:DWELI

Syntax:	LIST:RANGe:DWELI d [S | MS | US]	
Example:	LIST:RANGe:DWELI 100 MS	! Set the list dwell time range to 100 MS
Description:	This command sets the dwell time for each point in the list range set to *d*.	

LIST:RANGe:POWer

Syntax:	LIST:RANGe:POWer	
Example:	LIST:RANGe:POWer -3	! Set the list power range to -3 dBm
Description:	This command sets the power output for each point in the list range set to *d* (**NOTE: *The unit for the power level is dBm*).**	

LIST:RANGe:STARt

Syntax:	LIST:RANGe:STARt d [HZ	KZ	KHZ	MZ	MHZ	GZ	GHZ]	
Example:	LIST:RANGe:STARt 100 MHZ	! Se the start frequency of the list range to 100 MHZ
Description:	This command sets the start frequency for the list range to *d*.	

LIST:RANGe:STEP

Syntax:	LIST:RANGe:STEP [HZ	KZ	KHZ	MZ	MHZ	GZ	GHZ]	
Example:	LIST:RANGe:STEP 100 MHZ	! Se the step frequency of the list range to 100 MHZ
Description:	This command sets the step frequency for the list range to *d*.	

LIST:RANGe:STOP

Syntax:	LIST:RANGe:STOP [HZ	KZ	KHZ	MZ	MHZ	GZ	GHZ]	
Example:	LIST:RANGe:STOP 100 MHZ	! Se the stop frequency of the list range to 100 MHZ
Description:	This command sets the stop frequency for the list range to *d*.	

LIST:REPeat

Syntax:	LIST:REPeat SWEEp	STEP	CONTinuous	
Example:	LIST:REPeat STEP	! Sets the repeat mode for the current list to STEP
Description:	This command sets the repeat mode for the current running list to one of the followings: SWEEP, STEP or CONTINUOUS.	

LIST:RUN

Syntax:	LIST:RUN *n*	
Example:	LIST:RUN 2	! Set list 2 as the current running list
Description:	This command sets list *n* as the currently editing list.	

LIST:RUN?

Syntax:	LIST:RUN?
Description:	This command returns the current running list number.

LIST:TRIGger:SOURce

Syntax:	LIST:TRIGger:SOURce BNC | GPIB | IMMEdiate	
Example:	LIST:TRIGger:SOURce GPIB	! Sets the trigger condition for the current list to GPIB
Description:	This command sets the trigger condition for the current running list to one of the following sources: BNC, GPIB or IMMEDIATE.	

3.2.3.5   MARKer Subsystem Commands

- ■   **MARKer:AOFF**
- ■   **MARKer:AMPLitude**
- ■   **MARKer:FREQuency**
- ■   **MARKer:FREQuency?**
- ■   **MARKer:POINt**
- ■   **MARKer[:STATe]**

MARKer:AOFF

Syntax:	MARKer:AOFF	
Example:	MARKer:AOFF	! Turns off all the markers
Description:	This command turns off all markers.	

MARKer:AMPLitude

Syntax:	MARKer:AMPLitude <*Boolean*>	
Example:	MARKer:AMPLitude ON	! Set the Marker Amplitude ON
Description:	This command controls whether the marker affects the signal. If ON, the signal is modified when the marker frequency equals the output frequency. If OFF, only the marker output port is affected.	

MARKer:FREQuency

Syntax:	MARKer:FREQuency *d* [HZ | KZ | KHZ | MZ | MHZ | GZ | GHZ]	
Example:	MARKer:FREQuency 100 MHZ	! Set the selected marker frequency to 100 MHZ
Description:	This command sets the frequency for the specified mark to *d*.	

MARKer:FREQuency?

Syntax:	MARKer:FREQuency?
Description:	This command returns the frequency of the currently selected marker.

MARKer:POINt

Syntax:	MARKer:POINt *n*
Example:	MARKer: POINt 3
Description:	This command sets and turns on the marker to the specified sweep point.

MARKer[:STATe]

Syntax:	MARKer o	
Example:	MARKer ON	! Turns off the marker specified by the marker command header suffix
Description:	This command turns On/OFF the marker specified by the marker command header suffix.	

3.2.3.6   **POWer Subsystem Commands**

- POWer:ATTenuation
- POWer:ALC[:STATe]
- POWer:ALC:SOURce:INTernal
- POWer[:LEVel][:IMMediate][:AMPlitude]
- POWer[:LEVel][:IMMediate][:AMPlitude]?
- POWer[:LEVel][:IMMediate][:Amplitude]:STEP
- POWer:MODE
- POWer:STARt
- POWer:STOP

POWer:ATTenuation

Syntax:	POWer:ATTenuation < *Num_Val* >	
Example:	POWer:ATTenuation -10 DB	! Set the power attenuation to -10 dBm
Description:	This command sets the power attenuation level in dB	

POWer:ALC[:STATe]

Syntax:	POWer:ALC < *Boolean* >	
Example:	POWer: ALC ON	! Turn on the Automatic Leveling Control
Description:	This subsystem command enables or disables the Automatic Leveling Control of the generator.	

POWer:ALC:SOURce:INTernal

Syntax:	POWer:ALC:SOURce:INTernal DIODe | PMETer
Description:	This DIODe subsystem command directs the ALC feedback to be fed from an external diode detector. The PMETer subsystem command directs the ALC feedback to be fed from a power meter DC output.

POWer[:LEVel][:IMMediate][:AMPlitude]

Syntax:	POWer < *Num_Val* >	
Example:	POWer -10	! Set the unswept output signal to -10 dBm
Description:	This command sets the magnitude of the unswept output signal in terms of the current operating units. The units are the default value or can be set to a different value under the UNIT subsystem. The AMPLitude specifies the level for either a time varying or non-time varying signal.	

POWer[:LEVel][:IMMediate][:Amplitude]:STEP[:INCRement]

Syntax:	POWer:STEP < *Num_Val* >	
Example:	POWer:STEP -10	! Set the power step to -10 DB
Description:	This command specifies the power step size in dB for UP/DOWN incrementing.	

POWer[:LEVel][:IMMediate][:Amplitude]:STEP?

Syntax:	POWer:STEP?
Description:	This query form discovers the present step size.

POWer:MODE

Syntax:	POWer:MODE FIXed | SWEep | LIST	
Example 1:	POWer:MODE SWEep	! Set the SWEep commands to control the amplitude subsystem
Example 2:	POWer:MODE LIST	! Set the List commands to control the amplitude subsystem
Description:	This command establishes which set of commands will be used to control the amplitude subsystem. The settings have the following meanings:	
	FIXed:	The power amplitude is determined by the LEVel command under the appropriate subsystem.
	SWEep:	The source is in the swept mode and the amplitude is determined by STARt, STOP, CENTer, SPAN and MANual commands under the appropriate subsystem.
	LIST:	The source is in the LIST mode and the amplitude is determined by the appropriate amplitude list, such as LIST (refer to the LIST subsystem commands in this section).

POWer:STARt

Syntax:	POWer:STARt	
Example:	POWer:STARt 5	! Set the sweep starting power to 5 dB
Description:	This command sets the STARt power level. It also sets the lower limit of a manual sweep.	

POWer:STOP

Syntax:	POWer:STOP < *Num_Val* >	
Example:	POWer:STOP -7	! Set the sweep stop power level to -7 dB
Description:	This command sets the STOP power level. It also sets the upper limit of a manual sweep.	

3.2.3.7   **PULse Modulation Subsystem Commands** (Series 12500A/12700A Only)

■   **PULSe:WIDTh?**

■   **PULM:SOURce**

■   **PULM:STATe**

PULSe:WIDTh?

Syntax:	PULSe:WIDTh?	
Example:	PULSe:WIDTh	! Query the width value
Description:	This command queries the width of the pulse.	

PULM:SOURce

Syntax:	PULM:SOURce EXTernal | INTernal	
Example:	PULM:SOURce EXTernal	! Select an EXTernal PM source
Description:	This command selects the source for modulating the signal; it may specify a single or multiple sources. The specified sources in the command are turned on. Any source from a previous selection are ignored. When multiple sources are available, individual INTernal sources may be distinguished by a unique numeric suffix. It as suffix is not added, the number 1 is assumed.	

PULM:STATe

Syntax:	PULM:STATe < *Boolean* >	
Example:	PULM:STATe ON (*or* OFF)	! Turn Pulse Modulation ON or OFF
Description:	This command turns Pulse Modulation ON or OFF Turning PM ON does not automatically turn OFF any other type of modulation.	

3.2.3.8 SWEep Subsystem Commands

- ■ **SWEep:FREQuency:COUNt**
- ■ **SWEep:FREQuency:DWELl**
- ■ **SWEep:FREQuency:GENeration**
- ■ **SWEep:FREQuency:STEP**
- ■ **SWEep:FREQuency:TIME**
- ■ **SWEep:POWer:COUNt**
- ■ **SWEep:POWer:DWELl**
- ■ **SWEep:POWer:STEP**
- ■ **SWEep:POWer:TIME**

To use the SWEep:FREQuency and SWEep:POWer commands, first set the instrument to the appropriate control. Refer to :MODE under the FREQuency and POWer Subsystem Commands in earlier sections of this chapter.

SWEep:FREQuency:COUNt

Syntax:	SWEep:FREQuency:COUNt < *Num_Val* >	
Example:	SWEep:FREQuency:COUNt 10	! Set the number of sweeps to 10
Description:	This command determines the number of sweeps that will be enabled by a single trigger event. The default count is 1.	

SWEep:FREQuency:DWELl

Syntax:	SWEep:FREQuency:DWELl < *Num_Val* >	
Example:	SWEep:FREQuency:DWELl 10 NS	! Set the dwell time to 10 nanoseconds
Description:	This command controls the amount of time spent at each point during a sweep. *(**NOTE**: This value cannot exceed :TIME:POINts).*	

SWEep:FREQuency:GENeration

Syntax:	SWEep:FREQuency:GENeration STEPped | ANALog	
Example:	SWEep:FREQuency:GENeration ANALog	! Select an analog sweep
Description:	This command selects either a stepped or analog sweep.	

SWEep:FREQuency:STEP

Syntax:	SWEep:FREQuency:STEP < *Num_Val* >	
Example:	SWEep:FREQuency:STEP 10	! Set the STEP frequency to 10 HZ
Description:	This command controls the swept entity step size for a stepped linear sweep. This parameter is not used if generation is analog or if spacing is logarithmic.	

SWEep:FREQuency:TIME

Syntax:	SWEep:FREQuency:TIME *< Num_Val >*	
Example:	SWEep:FREQuency:TIME 10 MS	! Set the sweep duration to 10 microseconds
Description:	This command set the duration of the sweep. This command does not turn sweeping on.	

SWEep:POWer:COUNt

Syntax:	SWEep:POWer:COUNt *< Num_Val >*	
Example:	SWEep:POWer:COUNt 10	! Set the number of sweeps to 10
Description:	This command determines the number of sweeps that will be enabled by a single trigger event. The default count is 1.	

SWEep:POWer:DWELl

Syntax:	SWEep:POWer:DWELl *< Num_Val >*	
Example:	SWEep:POWer:DWELl 10 NS	! Set the dwell time to 10 nanoseconds
Description:	This command controls the amount of time spent at each point during a sweep. *(**NOTE:** This value cannot exceed: TIME:POINts).*	

SWEep:POWer:STEP

Syntax:	SWEep:POWer:STEP *< Num_Val >*	
Example:	SWEep:POWer:STEP -5	! Set the power step time to -5 dB
Description:	This command controls the swept entity step size for a stepped power sweep.	

SWEep:POWer:TIME

Syntax:	SWEep:POWer:TIME *< Num_Val >*	
Example:	SWEep:POWer:TIME 10 MS	! Set the sweep duration to 10 microseconds
Description:	This command sets the duration of the sweep. This command does not turn sweeping on.	

3.2.3.9   SYSTem Subsystem Commands

■   **SYSTem:ERRor?**
■   **SYSTem:PRESet**

SYSTem:ERRor?

Syntax:	SYSTem:ERRor?
Description:	This command returns all error codes currently in the event status registers.

SYSTem:PRESet

Syntax:	SYSTem:PRESet
Description:	This command sets the synthesizer to the preset state.

3.2.3.10   TRIGger Subsystem Commands

■   **TRIGger:IMMediate**
■   **TRIGger:SOURce**

TRIGger:IMMediate

Syntax:	TRIGger:IMMediate	
Description:	This command initiates an immediate sweep cycle and return to IDLE when complete. This command will have no effect if the cycle is set to CONTinuous.	

TRIGger:SOURce

Syntax:	TRIGger:SOURce IMMediate | BUS | EXTernal	
Example:	TRIGger:SOURce IMM	! Set the TRIGger cycle to IMMediate
Description:	This command selects the source for the event. Only one source may be specified in the parameter at a time for a given event. The sources are:	
	IMM:	The event occurs immediately.
	BUS:	The source is signal-specific to the control interface.
	EXT:	An external signal jack is selected as the source. If no suffix is specified in the command, EXTernal is assumed.

3.2.4   SCPI Status Commands

All commands in Table 3-1 relate to the status monitoring system and read from and/or write to the various status group registers. The event and condition registers are read-only. The enable registers and transition filters are read/write. Each status group's transition filter actually contains two filters, one to detect positive-going transitions (PTR) and one to detect negative-going transitions (NTR). Data is in the form of a decimal number, which (when decoded to an 8-bit binary number) indicates the On/Off status of individual data bits.

Table 3-1: SCPI Status Commands

Keyword	Parameter Type	Initial Value	Query Form?
STATus 　:OPERation 　　　[:EVENt?]	none	none	query only
:CONDition?	none	none	query only
:ENABle	NUM	255	yes
:PTRansition	NUM	255	yes
:NTRansition	NUM	255	yes
The STATus:OPERation commands relate to the registers of the operational status group.			
STATus 　:QUEStionable	none	none	yes
[:EVENt?]	none	none	query only
:CONDition?	none	none	query only
:ENABle	NUM	255	yes
:PTRansition	NUM	255	yes
:NTRansition	NUM	255	yes
The STATus:QUEStionable commands relate to the registers of the questionable status group.			
STATus 　:QUEStionable 　　　:POWer	none	none	yes
[:EVENt?]	none	none	query only
:CONDition?	none	none	query only
:ENABle	NUM	255	yes
:PTRansition	NUM	255	yes
:NTRansition	NUM	255	yes
The STATus:QUEStionable:POWer commands relate to the registers of the questionable power status group.			
STATus 　:QUEStionable 　　　:POWer	none	none	yes
[:EVENt?]	none	none	query only
:CONDition?	none	none	query only
:ENABle	NUM	255	yes
:PTRansition	NUM	255	yes
:NTRansition			

Table 3-1: SCPI Status Commands (Continued)

Keyword	Parameter Type	Initial Value	Query Form?
The STATus:QUEStionable:POWer commands relate to the registers of the questionable power status group.			

STATus
    :QUEStionable
        :FREQuency
	none	none	yes

[:EVENt?]	none	none	query only
:CONDition?	none	none	query only
:ENABle	NUM	255	yes
:PTRansition	NUM	255	yes
:NTRansition	NUM	255	yes
The STATus:QUEStionable:FREQuency commands relate to the registers of the questionable frequency status group.			
STATus :PRESet	none	none	no query
The STATus:PRESet command restores all parts of the status monitoring system to the power-on/reset condition.			
SYSTem :ERRor?			
The SYSTem:ERRor command reads the Error/Event Queue.			
TRIGger [:IMMediate]			
:SLOPe			
The trigger commands specify the execute mode (the method of triggering a process). The applicable process in the Series 50000B is a frequency sweep.			

3.2.5 Sample SCPI Commands

Table 3-2 shows some examples of brief SCPI commands.

Table 3-2: Sample SCPI Commands

Command	Meaning	Model	
		124XXA	**125XXA/ 127XXA**
*IDN?	Query instrument identification (response format: maker,model,serial#,firmware version) (Sample response: Giga-tronics,12000A,048256,75).	√	√
*RST	Reset system.	√	√
OUTP OFF	Turn off RF output.	√	√
AM:STAT OFF	Turn off external amplitude modulation.	N/A	√
AM:STAT?	Query external amplitude modulation (Sample response: 0).	N/A	√
POW -9.2	Set output power to -9.2 dBm.	√	√
POW?	Query output power (Sample response: -9.2).	√	√
FM:STAT OFF	Turn off external frequency modulation.	N/A	√
FM:STAT?	Query external frequency modulation (Sample response: 0).	N/A	√
FREQ 6.1GHZ	Set output frequency to 6.1 GHz	√	√
FREQ?	Query output frequency (Sample response: 6100000000).	√	√
PULM:STAT OFF	Turn off external pulse modulation.	N/A	√
PULM:STAT?	Query external pulse modulation (Sample response: 0).	N/A	√

3.3 Native Command Codes

Native Command Codes	Model	
	124XXA	**125XXA/ 127XXA**
3.3.1 - IEEE 488 Interface	√	√
3.3.2 - Command Syntax	√	√
3.3.3 - Native Command Code Set	√ (See Section for Restrictions)	√
3.3.4 - IEEE Common Commands	√ (N/A On Modulation)	√
3.3.5 - Fixed Frequency/Level Commands	√	√ (Ramp on Series 127XXA Only)
3.3.6 - List Mode Commands	√	√
3.3.7 - Manipulating Lists via GPIB	√	√
3.3.8 - Step Frequency Sweep Commands	√	√
3.3.9 - Ramp Frequency Sweep Commands (Series 12700A Only)	√	√
3.3.10 - Marker Commands	√	√
3.3.11 - Step Power Sweep Commands	√	√
3.3.12 - Ramp Power Sweep Commands (Series 12700A Only)	**N/A**	√
3.3.13 - Amplitude Modulation Commands	**N/A**	√
3.3.14 - Frequency Modulation Commands	**N/A**	√
3.3.15 - Pulse Modulation Commands	**N/A**	√
3.3.16 - Output Commands	√	√
3.3.17 - ALC Commands	√	√
3.3.18 - Instrument Control Commands	√	√

3.3.1   IEEE 488 Interface

The Series 12000A permits data bus control in accordance with the IEEE Standard Digital Interface for Programmable Instruments, IEEE STD 488.2. Table 3-3 shows the IEEE 488 standard subsets that are implemented in the 12000A.

Table 3-3: Implemented IEEE 488 Subsets

Subset	Title	12000A Implementation
SH1	Source Handshake	Complete Capability
AH1	Acceptor Handshake	Complete Capability
T8	Talker	Basic Talker
TE0	Extended Talker	No Capability
L4	Listener	Basic Listener
LE0	Extended Listener	No Capability
SR0	Service Request	No Capability
RL2	Remote/Local	Complete Capability
PP0	Parallel Poll	No Capability
DC0	Device Clear	No Capability
DT0	Device Trigger	No Capability
C0	Controller	No Capability

3.3.2   Command Syntax

The elements of the Series 12000A Native Interface Commands Codes are described in this section. Because some commands are included only for compatibility with earlier models, there are some variations in syntax from one command to another which must be carefully observed.

3.3.2.1   Function Codes

A native interface command includes a function code to indicate the nature and purpose of the command. Some commands contain a function code and nothing else. Commands consisting only of a function code are referred to in this manual as *simple* commands. However, most commands consist of a function code combined with other elements.

3.3.2.2   Address Assignment

The remote control address is assigned from the front panel of the instrument. The available range of addresses is 0 through 30.

3.3.2.3   Command Interpretation

The instrument uses a 40-character buffer to accept and store characters sent to it through the interface. Spaces are ignored. The buffer contents are interpreted and the buffer is reset upon receipt of a character sent with the EOI line asserted or upon receipt of any of the following delimiter characters:

> > , : ; / \

Multiple commands can be sent in a single message if they are separated from each other by a space or one of the delimiter characters. Each command will be interpreted individually upon receipt. If spaces are used to separate commands, care must be taken to assure that the 40-character buffer does not overflow. Buffer overflow can cause some commands to be ignored.

The 12000A can accept commands from a remote controller over the IEEE 488 interface or the RS-232 Serial port.

The 12000A syntax is designed to make the 12000A a compatible substitute for the HP 8340 in most remote-control operations. However, differences between the 12000A and the 8340 require some alteration of the 8340 command set; new commands are added, some existing commands differ slightly from their usual function when they are applied to the 12000A, and some existing commands are unsupported.

Commands in the Series 12000A syntax are represented in this publication by upper case letters. Some commands are followed by one or more lower case letters. These letters are interpreted as follows:

a   Indicates that alphanumeric characters are expected.

b   Indicates that one or more 8-bit bytes (entered in binary form) are expected.

d   Indicates that a decimal number is expected. Decimal numbers can be signed. Exponents may beindicated by an E; thus, +4.5E-6 represents 4.5x10-6.

h   Indicates that a hexadecimal number is expected.

n   Indicates that a single digit (0-9) is expected.

Terminator codes of HZ (Hz), KZ (kHz), MZ (MHz), GZ (GHz), DB (dB), DM (dBm), S (seconds), MS (ms), and US (μs) are used for many commands. Alternately, a comma or line feed can be used as a terminator; this causes the instrument to scale the corresponding function to the fundamental units of Hz, dB, dBm, or seconds.

The absence of lower case letters in a command indicates that the command is complete as shown, and requires no variables.

Commands with variables may be sent with either a space preceding the variable and/or terminator or with no space. For example: CW 12GZ, CW 12 GZ, CW12GZ, and CW12 GZ are all valid strings. If a command has multiple variables, they <u>must</u> be separated by a space.

A detailed description of many of the instrument functions may be found in Chapter 2 for all three models. Native instrument functions for the Series 125XXA/127XXA can be found at the end of the Chapter 2.

3.3.3   Native Command Code Set

Table 3-4 lists the IEEE 488.2 native commands that are implemented in the Series 12000A. Most of these codes do not stand alone; commands, prefixes, variables and suffixes must be combined with them. For further information refer to the sections cited in Table 3-4.

Table 3-4: 12000A Native Command Set

Command	Description	Section	Model 124XXA	Model 125XXA/ 127XXA
Required Commands				
*CLS	Clear status byte	3.3.4	√	√
*IDN?	Ask for instrument ID		√	√
*OPC	Operation complete command		√	√
*OPC?	Operation complete query		√	√
*RST	Software reset		√	√
*TRG	System command initiates BUS triggered measurements.		√	√
/GTL	Go To Local for serial port		√	√
/NATive	Native language, from anywhere		√	√
/LLO	Local Lockout, for serial port		√	√
/SCPI	SCPI language, from anywhere		√	√
12000A Native Commands				
A n	Set ALC Mode	3.3.17	√	√
AD d	Set AM depth	3.3.3	**N/A**	√
AK n	Activate/deactivate marker amplitude	3.3.10	**N/A**	√
AM n	Activate/deactivate amplitude modulation	3.3.13	**N/A**	√
AMF n	Activate/deactivate amplitude modulation	3.3.13	**N/A**	√
AR d	Set internal AM rate (HZ,KZ,MZ,GZ)	3.3.13	**N/A**	√
AT d	ALC Set attenuator (DB)	3.3.17	√	√
AU	Set sweep time to shortest	3.3.9	√	√
CF d	Set CENTER Parameter (HZ,KZ,MZ,GZ)	3.3.9	√	√
CONTRAST d	Sets the LCD Contrast to the integer value specified.	3.3.18	√	√
CONTRAST?	Returns the current value of LCD Contrast.	3.3.18	√	√
CURLISTNUM?	Returns the current active List Number.	3.4.6	√	√
CURLISTPOINT?	Returns the current active List Point.	3.4.6	√	√

Table 3-4: 12000A Native Command Set (Continued)

Command	Description	Section	Model 124XXA	Model 125XXA/ 127XXA
CS	Clear Status	3.3.18	√	√
CW d	Set CW frequency (HZ,KZ,MZ,GZ)	3.3.5	√	√
CW	Set GPIB active parameter	3.3.5	√	√
D1	Set repeat mode for step freq sweep to Continuous	3.3.8	√	√
D2	Set repeat mode for step freq sweep to Single-Sweep	3.3.8	√	√
D4	Set repeat mode for step freq sweep to Single-Step	3.3.8	√	√
DF d	Set SPAN parameter (HZ,KZ,MZ,GZ)	3.3.9	√	√
DN	Handle pressing step DOWN key	3.3.18	√	√
DU n	Specify GPIB screen	3.3.18	√	√
EF	Lock knob	3.3.18	√	√
EK	Unlock knob	3.3.18	√	√
ERR?	Error de-queue (use SCPI mechanism)	3.3.4	√	√
FA d	Set Start frequency (HZ,KZ,MZ,GZ)	3.3.9	√	√
FA	Set active parameter to start frequency	3.3.9	√	√
FB d	Set Stop parameter (HZ,KZ,MZ,GZ)	3.3.9	√	√
FB	Set active parameter to stop frequency	3.3.9	√	√
FC d	Set Sweep time (S,MS,US)	3.3.9	√	√
FC	Set active parameter to sweep time	3.3.9	√	√
FD d	Set FM deviation (HZ,KZ,MZ,GZ)	3.3.14	**N/A**	√
FM n	Activate/deactivate FM	3.3.14	**N/A**	√
FR d	Set internal FM rate (HZ,KZ,MZ,GZ)	3.3.14	**N/A**	√
FT n	Set FM mode	3.3.14	**N/A**	√
GA d	Set Start frequency (HZ,KZ,MZ,GZ)	3.3.8	√	√
GA	Set active parameter to start frequency	3.3.8	√	√
GB d	Set Stop frequency (HZ,KZ,MZ,GZ)	3.3.8	√	√
GB	Set active parameter to stop frequency	3.3.8	√	√
GC d	Set Step size (HZ,KZ,MZ,GZ)	3.3.8	√	√
GC	Set active parameter to step size	3.3.8	√	√
GD d	Set Dwell time (S,MS,US)	3.3.8	√	√

Table 3-4: 12000A Native Command Set (Continued)

Command	Description	Section	Model 124XXA	Model 125XXA/ 127XXA
GD	Set active parameter to dwell time	3.3.8	√	√
IF	Increment CW frequency by minimum step size	3.3.5	√	√
IH	Initialize heap space to empty	3.3.18	√	√
IP	Instrument preset	3.3.18	√	√
L1	Set Repeat mode for list freq sweep to Continuous	3.3.6	√	√
L2	Set Repeat mode for list freq sweep to Single-Sweep	3.3.6	√	√
L4	Set Repeat mode for list freq sweep to Single-Step	3.3.6	√	√
LA n n	Add list point	3.3.6	√	√
LC n	Delete list	3.3.6	√	√
LD n n	Delete list point	3.3.6	√	√
LF n n d	Set frequency d of point n2 of list n1 (HZ,KZ,MZ,GZ)	3.3.6	√	√
LGA d	Set list point frequency (HZ,KZ,MZ,GZ)	3.3.6	√	√
LGB d	Set list range stop frequency (HZ,KZ,MZ,GZ)	3.3.6	√	√
LGC d	Set list range step size (HZ,KZ,MZ,GZ)	3.3.6	√	√
LGD d	Set list range dwell (HZ,KZ,MZ,GZ)	3.3.6	√	√
LGI n	Insert range as list number	3.3.6	√	√
LGL d	Set list range power output (DM)	3.3.6	√	√
LL n n d	Set list point power (DM)	3.3.6	√	√
LMA n n n	Set list point AM status	3.3.6	N/A	√
LMF n n n	Set list point FM status	3.3.6	N/A	√
LMP n n n	Set list point PM status	3.3.6	N/A	√
LR n	Run list	3.3.6	√	√
LS? n	Precompute list	3.3.6	√	√
LT n n d	Set list point dwell (S,MS,US)	3.3.6	√	√
M n d	Set marker frequency (HZ,KZ,MZ,GZ)	3.3.10	√	√
M0	Turn off last active marker	3.3.10	√	√
MC	Move last active marker to center sweep	3.3.10	√	√
MO	Turn off last active marker	3.3.10	√	√
NM	Cycle through FM modes	3.3.14	N/A	√

Table 3-4: 12000A Native Command Set (Continued)

Command	Description	Section	Model 124XXA	Model 125XXA/ 127XXA
NSR	Never say remote - diagnostic command	3.3.18	√	√
OA	Output active parameter value	3.3.16	√	√
OC	Output start, center, time parameter for freq sweep	3.3.16	√	√
OD	Output diagnostic characters	3.3.16	√	√
OGI	Make OI respond with Giga-tronics info	3.3.16	√	√
OI	Output identification	3.3.16	√	√
OPAS	Output lock and level flag	3.3.16	√	√
OPCF	Output center frequency parameter value	3.3.16	√	√
OPCW	Output CW frequency value	3.3.16	√	√
OPDF	Output data frequency parameter value (span)	3.3.16	√	√
OPFA	Output start frequency parameter value	3.3.16	√	√
OPFB	Output stop frequency parameter value	3.3.16	√	√
OPM n	Output Marker frequency value	3.3.16	√	√
OPPL	Output CW level value	3.3.16	√	√
OPSF	Output CW frequency step value	3.3.16	√	√
OR	Output CW level value	3.3.16	√	√
OS	Output Lock and Level value in binary	3.3.16	√	√
P1	Set Repeat parameter for ramp power sweep to Continuous	3.3.12	N/A	√ (127XXA Only)
P2	Set Repeat parameter for ramp power sweep to Single-Sweep	3.3.12	N/A	√ (127XXA Only)
P3	Set Repeat parameter for ramp power sweep to stop	3.3.12	N/A	√ (127XXA Only)
PA d	Set Start parameter (DM)	3.3.12	√	√
PB d	Set Stop Parameter (DM)	3.3.12	√	√
PC d	Set sweep time	3.3.12	√	√
PH2	Lock Hi-power module on	3.3.18	√	√
PI	Select Pulse Interval	3.3.15	N/A	√
PL d	Set CW power level	3.3.5	√	√
PL d	Set GPIB active parameter (DM)	3.3.5	√	√

Table 3-4: 12000A Native Command Set (Continued)

Command	Description	Section	Model 124XXA	Model 125XXA/ 127XXA
PM n	Activate/deactivate pulse modulation	3.3.15	**N/A**	√
PR d	Set internal PM rate (HZ,KZ,MZ,GZ)	3.3.15	**N/A**	√
PS n	Activate/deactivate power sweep	3.3.12	√	√
PW d	Set internal PM width (S,MS,US)	3.3.15	**N/A**	√
PWV n	Select Pulse waveform	3.3.15	**N/A**	√
PY d	Set internal PM delay (S,MS,US)	3.3.15	**N/A**	√
Q1	Set repeat mode for Step Power Sweep to Continuous	3.3.11	√	√
Q2	Set repeat mode for Step Power Sweep to Single-Sweep	3.3.11	√	√
QA d	Set Start parameter (DM)	3.3.11	√	√
QB d	Set Stop parameter (DM)	3.3.11	√	√
QC d	Set Step parameter (DB)	3.3.11	√	√
QD d	Set Dwell parameter (S,MS,US)	3.3.11	√	√
RC n	Recall setup	3.3.18	√	√
RF n	Turn RF off or on	3.3.5	√	√
RFD n	RF on/off @ frequency change	3.3.18	√	√
RS	Re-start sweep	Multiple	√	√
S1	Set Repeat parameter for ramp freq sweep to Continuous	3.3.9	**N/A**	√
S2	Set Repeat parameter for ramp freq sweep to Single-Sweep	3.3.9	**N/A**	√ (127XXA Only)
S3	Set Repeat parameter for ramp freq sweep to stop	3.3.9	**N/A**	√ (127XXA Only)
SC n	Activate/deactivate Scan modulation	3.3.13	**N/A**	√
SCPI	Switch to SCPI language		√	√
SD d	Set depth for Scan modulation or variable attenuation (DB)	3.3.13	**N/A**	√
SF d	Set CW frequency resolution	3.3.5	√	√
SG	Set Repeat parameter Single-sweep	3.3.9	√	√
SHA1	Select unleveled mode (disable ALC)	3.3.17	√	√
SHCW d	Set CW frequency step size (HZ,KZ,MZ,GZ)	3.3.5	√	√
SHM4 d	Run self-test program (HZ,KZ,MZ,GZ)	3.3.18	√	√

Table 3-4: 12000A Native Command Set (Continued)

Command	Description	Section	Model 124XXA	Model 125XXA/ 127XXA
SHPL d	Set CW power step size (DB)	3.3.5	√	√
SHPM	Activate external PM for Model 8757A	3.3.15	**N/A**	√
SHPS d	Uncouple and set attenuator	3.3.17	√	√
SHRF	Select unleveled mode (Disable ALC)	3.3.17	√	√
SHRL	Re-Couple Attenuator	3.3.17	√	√
SHS n	Display blanked	3.3.18	√	√
SHSL d	Uncouple and set attenuator	3.3.17	√	√
SM	Stop sweep and permit incremental adjustment	3.3.8	√	√
SN d	Set Step count parameter	3.3.8	√	√
SP d	Set CW power resolution	3.3.5	√	√
SR d	Set rate for scan modulation (HZ,KZ,MZ,GZ)	3.3.13	**N/A**	√
ST d	Set ramp power and frequency sweep time (S,MS,US)	3.3.9	**N/A**	√ (127XXA Only)
ST	Set GPIB active parameter	3.3.9	√	√
SV n	Store setup	3.3.18	√	√
TR n	Set sweep trigger	Multiple	√	√
TS	Set sweep parameter to Single Sweep	3.3.9	√	√
UO t	Update flash parameter block	TBA	√	√
UP	Handle pressing step UP key	3.3.18	√	√

3.3.4   IEEE Common Commands

IEEE Common Commands	Model	
	124XXA	**125XXA/ 127XXA**
ERR?	√	√
*IDN?	√	√
*RST	√ (Modulation Items N/A)	√
*TRG	√	√

These commands perform functions as defined in the IEEE 488.2 standard.

ERR?

Syntax:	ERR?
Response:	Returns the error number and a description of the error: e.g., 107,"Frequency above maximum; maximum frequency is 20.1 GHz" (e.g. following a CW40GZ command).
Description:	This command reports the next entry in the instrument's error queue. There may be up to 20 messages in the queue; the messages are reported out oldest first. The error report consists of an error number followed by a description of the error. If the error queue is empty, the error report is **0, No error**. If the queue fills up, the last (newest) error report is replaced with **350, Queue overflow**.

*IDN?

Syntax:	*IDN?
Description:	The instrument identification string can be requested with this command. The following string will be returned: Giga-tronics, model number, serial number, version and build number, such as Giga-tronics, 12520A, 992604, 1.05-44.5.

*RST

Syntax:	*RST	
Description:	This command will cause the instrument to reset. The reset conditions are:	
	Frequency:	Minimum
	Level:	0 dBm
	ALC:	Internal
	Atten:	Automatic
	Modulation:	*All Off*
	AM:	*Ext @ 90%*
	FM:	*Ext @ 2 KHz*
	Pulse:	*Ext + True*

*TRG

Syntax:	*TRG
Description:	*TRG is a system level common command that initiates BUS triggered measurements. It has the same effect as a Group Execute Trigger (GET) when received, parsed and executed.

3.3.5 Fixed Frequency/Level Commands

Fixed Frequency/Level Commands	Model	
	124XXA	**125XXA/ 127XXA**
CW	√	√
IF	√	√
PL	√	√ (Ramp on 127XXA Only)
RF	√	√
SF	√	√
SP	√	√
SHCW	√	√
SHPL	√	√

These commands set or control parameters to operate the instrument in fixed frequency and/or fixed output level modes.

CW

Syntax:	CW *d* [HZ	KZ	MZ	GZ]	
Example:	CW 12 GZ	! Set the frequency to 12 GHz
		! CW Puts the instrument into CW mode
Description:	This command puts the instrument into CW mode and sets the CW frequency to *d* [HZ	KZ	MZ	GZ]. Here *d* is a decimal number with possible decimal point and/or exponent and [HZ	KZ	MZ	GZ] is an optional terminator denoting the units in which *d* is expressed. No terminator implies Hz. (***NOTE:*** *If the CW command is sent with no variable the instrument will return to CW mode at the last frequency entered).*	

IF

Syntax:	IF
Example:	N/A
Description:	This command will increment the CW frequency by the minimum resolvable step. This is normally 0.1 Hz, unless Option 36 (1 kHz resolution) is present.

PL

Syntax:	PL *d* DM	
Example:	PL -6.2 DM	! Set power to -6.2 dBm
Description:	This command sets the CW power d dBm. The CW power is used during CW mode, step frequency sweep and ramp frequency sweep.	

RF

Syntax:	RF n	
Example:	RF 1	! Turns RF on
Description:	This command sets the RF output of the instrument. Send RF 1 turns on the RF; Sending RF 0 turns off the RF.	

SF

Syntax:	SF *d terminator*	
Example:	SF 50 MZ	! Set frequency resolution to 50 MHz
Description:	This command puts the instrument into CW mode and sets the frequency resolution to *d* [HZ	KZ	MZ	GZ]. Here d is a decimal number with possible decimal point and/or exponent and [HZ	KZ	MZ	GZ] is an optional terminator denoting the units d is expressed in. No terminator implies Hz. This resolution variable determines the increments generated by turning the knob or pressing the up/down buttons.	

SP

Syntax:	SP *d terminator*	
Example:	SP 5 DB	! Set power resolution to 5 dB
Description:	This command puts the instrument into CW mode and sets the power resolution to *d* dB. Here *d* is a decimal number with possible decimal point and/or exponent and DB is the terminator. This resolution variable determines the increments generated by turning the knob or pressing the up/down buttons.	

SHCW

Syntax:	SHCW *d terminator*	
Example:	SHCW 50 MZ	! Set frequency resolution to 50 MHz
Description:	This command puts the instrument into CW mode and sets the frequency resolution to *d* [HZ	KZ	MZ	GZ]. Here *d* is a decimal number with possible decimal point and/or exponent and [HZ	KZ	MZ	GZ] is an optional terminator denoting the units *d* is expressed in. No terminator implies Hz. This resolution variable determines the increments generated by turning the knob or pressing the up/down buttons. This command is included for compatibility with Hewlett Packard (Agilent) scalar analyzers.	

SHPL

Syntax:	SHPL *d terminator*	
Example:	SHPL 5 DB	! Set power resolution to 5 dB
Description:	This command puts the instrument into CW mode and sets the power resolution to *d* dB. Here *d* is a decimal number with possible decimal point and/or exponent and DB is the terminator. This resolution variable determines the increments generated by turning the knob or pressing the up/down buttons.	

3.3.6 List Mode Commands

List Mode Commands	Model	
	124XXA	125XXA/ 127XXA
L*n*	√	√
LA	√	√
LC	√	√
LD	√	√
LF	√	√
LGA	√	√
LGB	√	√
LGC	√	√
LGD	√	√
LGI	√	√
LGL	√	√
LL	√	√
LR	√	√
LS?	√	√
LT	√	√
TR	√	√
CURLISTNUM?	√	√
CURLISTPOINT?	√	√

These commands control the operation of the instrument is the List Mode. List Mode is specifically designed to provide the fastest frequency and level switching speeds. Each list is a set of frequencies in any arbitrary order. Power level, dwell and modulation parameters may be set for each frequency. Refer to Section 3.3.7 for additional details.

L1

Syntax:	L1
Example:	N/A
Description:	This command causes the List Mode to run continuously once the LR command has been issued. Continuous repeat mode supports Immediate, Trigger in BNC and Softkey triggers (See TR commands).

L2

Syntax:	L2
Example:	N/A
Description:	This command causes the List Mode to run once before stopping after the LR command has been issued. When the list is exhausted, the frequency remains at the frequency of the last point. Single Sweep mode supports Immediate, Trigger in BNC and Softkey triggers (See TR commands).

L4

Syntax:	L4
Example:	N/A
Description:	This command causes the List Mode to take a single step-to the next list point-in response to a trigger once the LR command has been issued. The first trigger sets the frequency to the first point in the list being run. Subsequent triggers advance the frequency to the next list point. When the last point in the list is reached, the next trigger returns the frequency to the first point in the list. Single Step mode supports Trigger in BNC and Softkey triggers (See TR commands). *(**NOTE:** The L4 Command modifies Trigger Type setting to Softkey/GPIB (Command TR1). For Trigger In BNC trigger type, the TR0 Command must follow L4).*

LA

Syntax:	LA *n1 n2*	
Example:	LA 2 6	! Adds a point to list 2 after point number 6
Description:	Adds a point to list *n1* after point number *n2*.	
	n2 = 1	is the first list
	n2 = 1	is the first point in the list. Set n2 = 0 to insert a point at the head of the list. The frequency, power, dwell and modulation status of the added point are set to: a) the same values as the point it is inserted after, or b)
	if n2 =	0, to the same values as the point it is inserted before, or c) if the list is empty, to the instrument's minimum frequency, 0.00 dBm, 100 ms, modulation off.
	***NOTE:** The LA command only establishes the point. It is then necessary to send the LF, LL, LT and LMx commands to set any parameters which need to be changed.*	

LC

Syntax:	LC *n*	
Example:	LC 1	! Clears List number 1
Description:	The LC command will clear all the points from the selected list.	

LD

Syntax:	LD *n1 n2*	
Example:	LD 2 6	! Delete point 6 from List number 2
Description:	Deletes point *n2* from list *n1*. *n2* = 1 denotes the first point in the list; *n1* = 1 denotes the first list. After a point is deleted, the following points in the list are promoted to replace the one deleted.	

LF

Syntax:	LF *n n d* [HZ | KZ | MZ | GZ]	
Example:	LF 2 6 5 GZ	! Set point 6 in List 2 to 5 GHz
Description:	Sets the frequency for point n2 of list n1 to *d* [HZ | KZ | MZ | GZ], where *d* is the frequency (a decimal number with possible decimal point and/or exponent) and [HZ | KZ | MZ | GZ] is the units in which the frequency is expressed. No terminator implies Hz. The LGA through LGL list range commands allow automatic generation of a list of frequencies starting at a given point, with a fixed increment, and ending at a given point. This effectively creates a digital (step) sweep, but permits flexible editing techniques of the list mode. A common dwell and level may be set for the range	

LGA

Syntax:	LGA *d* (HZ | KZ | MZ | GZ)	
Example:	LGA 2 GZ	! Set list range start to 2 GHz
Description:	The start frequency for the list range is set with this command.	

LGB

Syntax:	LGB *d* (HZ | KZ | MZ | GZ)	
Example:	LGB 12 GZ	! Set list range stop to 12 GHz
Description:	The stop frequency for the list range is set with this command.	

LGC

Syntax:	LGC *d* (HZ | KZ | MZ | GZ)	
Example:	LGC 1 MZ	! Set list range step size to 1 MHz
Description:	The step size for the list range is set with this command.	

LGD

Syntax:	LGD *d* (S | MS | S)	
Example:	LGD 25 MS	! Set list range dwell to 25 mS
Description:	The dwell time for each point in the list range is set with this command.	

LGI

Syntax:	LGI *n*	
Example:	LGI 1	! Insert the range as list #1
Description:	This command inserts the list range as the given list number. (***NOTE:*** *It takes about 10 mS per step to generate the list. Sufficient time must be given in the program for this task to complete).*	

LGL

Syntax:	LGL *d* DM	
Example:	LGL -3 DM	! Set list range power to -3 dBm
Description:	The power output for each point of the list range is set with this command.	

LL

Syntax:	LL *n1 n2 d* DM	
Example:	LL 2 6 -3.5 DM	! Set point 6 in List 2 to -3.5 dBm
Description:	Sets the power level for point *n2* of list *n1* to *d* DM, where *d* is the power level (a decimal number with possible decimal point and/or exponent) in dBm.	

LR

Syntax:	LR *n*	
Example:	LR 2	! Start List number 2 running
Description:	Starts List Mode running list *n*. The type of list (e.g. Continuous, Single Sweep, or Single Step) is determined by what L( ) command has been sent. *(**NOTE:** The status of the TR( ) command will determine if the List starts immediately or is triggered. To stop List Mode, send the CW command).*	

LS?

Syntax:	LS? *n*	
Example:	LS? 2	! Set up List number 2
Description:	Does the calculations for list *n*, and stores the calculated values in RAM. Returns 0 when done. When the pre-calculated list is subsequently run, the first trace will run at full speed, since the instrument will not need to do the calculations as part of executing the first trace. Allow about 25 mS per point for this command.	

LT

Syntax:	LT *n1 n2 d* [S │ MS │ US]	
Example:	LT 2 6 20 MS	! Set the dwell for List 2, point 6 to 20 ms
Description:	Sets the dwell time for point *n2* of list *n1* to *d* [S │ MS │ US], where *d* is the dwell time (a decimal number with possible decimal point and/or exponent) and [S │ MS │ US] are the units for the dwell time. S is seconds, MS is milliseconds, and US is microseconds. No terminator implies seconds.	

TR

Syntax:	TR *n*	
Example:	TR 2	! Sets the current list trigger to immediate
Description:	Sets the trigger condition for the current list as specified by the value *n:*	
	n = 0	Sets the trigger condition for the current list to **Trigger in BNC**. This will stop the current point as its current point until the Trigger In BNC is pulsed, at which time the list will go to its first point and begin running (single step will take one step for each trigger). The BNC trigger is supported for all repeat modes: continuous, single sweep and single step.
	n = 1	Sets the trigger condition for the current list to *Softkey or GPIB*. Setting this trigger type stops the current list until the soft key is pressed or the GPIB GET is received, at which time the list will go to its first point and begin running (single sweep will take one step for each trigger). The soft key trigger is supported for all repeat modes: continuous, single sweep and single step.
	n = 2	Sets the trigger to **Immediate** - i.e., no trigger condition; the list will begin as soon as it is run. Because single-set repeat requires a trigger, an immediate trigger is not valid for a single-step sweep or a single-step list mode.

CURLISTNUM?

Syntax:	CURLISTNUM?
Example:	CURLISTNUM?
Description:	This command returns the current active List number.

CURLISTPOINT?

Syntax:	CURLISTPOINT?
Example:	CURLISTPOINT?
Description:	This command returns the current active List Point.

3.3.7 Manipulating Lists via GPIB

The following is an example of a sample script for list mode:

```
IP
??##1000  mSec.
DU 3
LA 1,0
LL 1,1,15.0000 DM
LF 1,1,5.0 GZ
LT 1,1, 10 us
LA 1,1
LL 1,2,10.0000 DM
LF 1,2,6.0 GZ
LA 1,2
LL 1,3,5.0000 DM
LF 1,3,7.0 GZ
LS? 1
??##1000  mSec.
RF 1
L4
TR 0
LR 2
```

3.3.7.1 Controlling List Execution

List execution is governed by the "LR n", "TR n" and "Ln" commands:

- The TR n command specifies the conditions that begin, or trigger, list execution. Valid values of 'n', and their meanings, are:

    - 0 – trigger from the external trigger input
    - 1 – trigger from a GPIB GET event or from the front panel's List menu's trigger softkey
    - 2 – trigger immediately

- The Ln command specifies the conditions that stop list execution. Valid values of 'n', and their meanings, are:

    - 0 - Continuous: Execute the entire current list, repeating it indefinitely.
    - 2 - Single Sweep: Execute the entire current list, and then stop; the next trigger will resume execution at the start of the list.
    - 4 - 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.

- The LR n command simply designates which list is the current list, i.e. is to be executed; it does not itself automatically cause list execution to commence, unless of course the most recent Ln command was L0.

3.3.7.2   List Entry Speed Up

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.:

- TR 0

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.

3.3.7.3   List Precompilation

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 and the GPIB Lxxx commands. 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 via the "LS? n" native mode GPIB command. The basic procedure is as follows, using list #3 as an example:

1. Add and/or edit the list's points, e.g.

LA	3,0
LF	3,1,1 GZ
LL	3,1,0 DM
LT	3,1,100 MS
etc.	

2. Issue "LS? 3"

3. Allow adequate time for the list to compile.

4. Read the command's response ("0", i.e. zero) from the GPIB bus.

The list may then be executed after first specifying it as the current list, via an LR 3 command.

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

3.3.7.4   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; alternately:

1. Add and/or edit all the points for all the lists.

2. Issue an LS? command (and await and read the response therefrom) for each list.

Execution of multiple precompiled lists is somewhat more involved. Instead of simply issuing an LR n command for a given list, it is necessary to issue the LS? n / read bus / LR n sequence, e.g.:

1. Add/edit list #2's points.

2. Add/edit list #7's points.

3. Issue LS? 2 / wait / read bus.

4. Issue LS? 7 / wait / read bus.

5. Issue LR 7.

6. Execute list 7 via whatever triggering.

7. Issue LS? 2 / read bus / LR 2.

8. Execute list 2 via whatever triggering.

9. Issue LS? 7 / read bus / LR 7.

10. Execute list 7 via whatever triggering.

☛ **NOTE:** *In steps 7 and 9, no 'wait' was specified. This is because the LS? n command's execution is lengthy only when a list needs to be recompiled; if the list was previously compiled and does not require recompilation, the command will execute quickly.*

3.3.7.5 List Points Storage

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 next page) 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 (LA n command)

Events causing their deallocation include:

* The removal of a point (LD n1 n2 command)
* The deletion of an entire list (LC n command)
* Receipt of the IH or IP commands
* 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 (LF, LL, LT, etc. commands)
* The precompilation of a list (LS? n command)
* The running of a list that is not precompiled (LR n command)

Events causing their deallocation include:

* The deletion of a source form list (LC n command)
* 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, via the LC n command.*

3.3.7.6   Precompiling Saved Lists

Currently, the 12000A exhibits a glitch in the precompilation and subsequent execution of lists that were input to the unit during a previous line power session (and thus automatically saved in nonvolatile memory). The workaround is as follows:

1. Create a single point list having a fairly long dwell time, and suitable power and frequency, e.g.:
    *   LA 100,0
    *   LT 100,1,10 S

2. Issue an LR n command for the list, e.g.:
    *   LR 100

3. Change the list trigger mode to 'immediate', e.g.:
    *   TR 2
    *   L1

4. Wait a moment.

5. Change the list trigger mode to a non-immediate form, e.g.:
    *   L2
    *   TR 0

This workaround procedure should be executed prior to precompiling and subsequently executing the saved list(s) of interest.

3.3.8　Step Frequency Sweep Commands

The following commands control the operation of the instrument during Step Frequency Sweep. This mode of operation permits stepping the frequency between two points with a user defined step size and dwell time. Step Frequency Sweep provides discrete increments of frequency.

Step Frequency Sweep Commands	Model	
	124XXA	**125XXA/ 127XXA**
D*n*	√	√
GA	√	√
GB	√	√
GC	√	√
GD	√	√
RS	√	√
SM	√	√
SN	√	√
TR	√	√

D1

Syntax:	D1
Example:	N/A
Description:	Puts step frequency sweep into continuously sweeping mode. If a step frequency sweep was not running, starts it running; if it was running, restarts the sweep. *(**NOTE:** The various sweep parameters (e.g. start, stop, dwell) must have been previously set).*

D2

Syntax:	D2
Example:	N/A
Description:	Puts step frequency sweep into single sweep mode. If a step frequency sweep was not running, starts it running; if it was running, restarts the sweep. *(**NOTE:** The various sweep parameters (e.g. start, stop, dwell) must have been previously set).*

D4

Syntax:	D4
Example:	N/A
Description:	Puts step frequency sweep into single step mode. If a step frequency sweep was not running, starts it running; if it was running, restarts the sweep. *(**NOTE:** The various sweep parameters (e.g. start, stop, dwell) must have been previously set).*

GA

Syntax:	GA *d* [HZ | KZ | MZ | GZ]	
Example:	GA 5 GZ	! Set the step frequency start to 5 GHz
Description:	Sets the start frequency for a step frequency sweep to *d* [HZ | KZ | MZ | GZ], where *d* is the frequency (a decimal number with possible decimal point and/or exponent) and [HZ | KZ | MZ | GZ] is the units in which the frequency is expressed. No terminator implies Hz. If a step frequency sweep was not running, starts it running; if it was running, restarts the sweep.	
	If the GA command is sent with no variable it makes the step frequency sweep start frequency the active variable. If a step frequency sweep was not running, starts it running; if it was running, restarts the sweep	

GB

Syntax:	GB *d* [HZ | KZ | MZ | GZ]	
Example:	GB 8 GZ	! Set the step frequency stop to 8 GHz
Description:	Sets the stop frequency for a step frequency sweep to *d* [HZ | KZ | MZ | GZ], where *d* is the frequency (a decimal number with possible decimal point and/or exponent) and [HZ | KZ | MZ | GZ] is the units in which the frequency is expressed. No terminator implies Hz. If a step frequency sweep was not running, starts it running; if it was running, restarts the sweep. (*NOTE: If the GB command is sent with no variable it makes the step frequency sweep stop frequency the active variable. If a step frequency sweep was not running, starts it running; if it was running, restarts the sweep).*	

GC

Syntax:	GC *d* [HZ | KZ | MZ | GZ]	
Example:	GC 12.5 MZ	! Set the step frequency sweep step size to 12.5 MHz
Description:	Sets the step size for a step frequency sweep to d [HZ | KZ | MZ | GZ], where d is the frequency (a decimal number with possible decimal point and/or exponent) and [HZ | KZ | MZ | GZ] is the units in which the frequency is expressed. No terminator implies Hz. If a step frequency sweep was not running, starts it running; if it was running, restarts the sweep. (*NOTE: If the GC command is sent with no variable it makes the step frequency step size the active variable. If a step frequency was not running, starts it running; if it was running, restarts the sweep).*	

GD

Syntax:	GD *d* [S │ MS │ US]	
Example:	GD 25 MS	! Set the step frequency dwell time to 25 ms
Description:	Sets the dwell time for a step frequency sweep to *d* [S │ MS │ US], where *d* is the frequency (a decimal number with possible decimal point and/or exponent) and [S │ MS │ US] is the units in which the frequency is expressed. No terminator implies S. If a step frequency sweep was not running, starts it running; if it was running, restarts the sweep. If the GD command is sent with no variable it makes the step frequency sweep dwell time the active variable. If a step frequency sweep was not running, starts it running; if it was running, restarts the sweep.	

RS

Syntax:	RS
Example:	N/A
Description:	This command restarts the current Sweep or List mode. The sweep is interrupted and reset to the start frequency. All other parameters remain unchanged.

SM

Syntax:	SM
Example:	N/A
Description:	The SM command is only meaningful if a sweep is in process. When received, the sweep is interrupted and manual control (knob, keypad, or up/down buttons) of the frequency or power (if a power sweep) is enabled. The sweep may be restarted using a softkey on the sweep menu.

SN

Syntax:	SN *d*	
Example:	SN 20	! Activate step frequency sweep, start/steps Mode, with 20 steps.
Description:	The SM command is only meaningful if a sweep is in process. When received, the sweep is interrupted and manual control (knob, keypad, or up/down buttons) of the frequency or power (if a power sweep) is enabled. The sweep may be restarted using a softkey on the sweep menu.	

TR

Syntax:	TR *n*	
Example:	TR 2	! Sets the current sweep trigger to immediate
Description:	Sets the trigger condition for the current sweep as specified by the value *n:*	
	n = 0	Sets the trigger condition for the current sweep to **Trigger in BNC**. This will stop the current sweep at its current point until the Trigger In BNC is pulsed, at which time the list will go to its first point and begin running (single step will take one step for each trigger). The BNC trigger is supported for all repeat modes: continuous, single sweep and single step.
	n = 1	Sets the trigger condition for the current list to *Softkey or GPIB*. Setting this trigger type stops the current list until the soft key is pressed or the GPIB GET is received, at which time the sweep will go to its starting condition and begin running (single sweep will take one step for each trigger). The soft key trigger is supported for all repeat modes: continuous, single sweep and single step.
	n = 2	Sets the trigger to **Immediate** - i.e., no trigger condition; the sweep will begin as soon as it is run. Because single-step repeat mode requires a trigger, an immediate trigger is not valid for a single-step or a single-step list mode.

3.3.9 **Ramp Frequency Sweep Commands** (Series 12700A Only)

The Ramp Frequency Sweep mode (also known as Analog Sweep) produces a linear change in frequency over a specified time period. The sweep is defined between two frequency points. Although the frequency is actually a series of discrete steps, the steps are sufficiently small that the net result appears to be continuous.

	Model	
Ramp Frequency Sweep Commands	**124XXA**	**125XXA/ 127XXA**
AU	N/A	√
CF	N/A	√
DF	N/A	√
FA	N/A	√
FB	N/A	√
FC	N/A	√
RS	N/A	√
S*n*	N/A	√
SG	N/A	√
ST	N/A	√
TR	N/A	√
TS	N/A	√

AU

Syntax:	AU	
Example:	N/A	
Description:	This command automatically sets the sweep time to the shortest possible using the start and stop frequencies as the determining parameters. Since the instrument uses a frequency division scheme for frequencies below 4 GHz, the shortest allowable sweep times are a function of the division in use.	

CF

Syntax:	CF *d* [Hz	KZ	MZ	GZ]	
Example:	CF 4 GZ	! Activates Ramp Sweep with a 4 GHz Center Frequency
Description:	Sets the center for a Ramp Frequency Sweep to *d* [HZ	KZ	MZ	GZ], where *d* is the center frequency (a decimal number with possible decimal point and/or exponent) and [HZ	KZ	MZ	GZ] is the units in which the frequency is expressed. No terminator implies Hz. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep.	

DF

Syntax:	DF *d* [HZ | KZ | MZ | GZ]	
Example:	DF 5 GZ	! Activates Ramp Sweep with a 5 GHz Delta Sweep
Description:	Sets the center for a Ramp Frequency Sweep to *d* [HZ | KZ | MZ | GZ], where *d* is the center frequency (a decimal number with possible decimal point and/or exponent) and [HZ | KZ | MZ | GZ] is the units in which the frequency is expressed. No terminator implies Hz. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep.	

FA

Syntax:	FA *d* [HZ | KZ | MZ | GZ]	
Example:	FA 5 GZ	! Set the Ramp Frequency start to 5 GHz
Description:	Sets the start frequency for a Ramp Frequency Sweep to *d* [HZ | KZ | MZ | GZ], where *d* is the frequency (a decimal number with possible decimal point and/or exponent) and [HZ | KZ | MZ | GZ] is the units in which the frequency is expressed. No terminator implies Hz. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep. If the FA command is sent with no variable it makes the Ramp Frequency Sweep start frequency the active variable. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep.	

FB

Syntax:	FB *d* [HZ | KZ | MZ | GZ]	
Example:	FB 8 GZ	! Set the Ramp Frequency stop to 8 GHz
Description:	Sets the stop frequency for a Ramp Frequency Sweep to *d* [HZ | KZ | MZ | GZ], where *d* is the frequency (a decimal number with possible decimal point and/or exponent) and [HZ | KZ | MZ | GZ] is the units in which the frequency is expressed. No terminator implies Hz. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep. If the FB command is sent with no variable it makes the Ramp Frequency Sweep stop frequency the active variable. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep.	

FC

Syntax:	FC *d* [S | MS | US]	
Example:	FC 25 MS	! Set the Ramp Frequency Sweep time to 25 ms
Description:	Sets the time for a Ramp Frequency Sweep to *d* [S | MS | US], where *d* is the frequency (a decimal number with possible decimal point and/or exponent) and [S | MS | US] is the units in which the frequency is expressed. No terminator implies seconds. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep. If the FC command is sent with no variable it makes the Ramp Frequency Sweep time the active variable. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep.	

RS

Syntax:	RS
Example:	N/A
Description:	This command restarts the current Sweep. The sweep is interrupted and reset to the start frequency. All other parameters remain unchanged.

S1

Syntax:	S1
Example:	N/A
Description:	Puts Ramp Frequency Sweep into continuously sweeping mode. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep. *(NOTE: The various sweep parameters (e.g. start, stop, time) must have been previously set).*

S2

Syntax:	S2
Example:	N/A
Description:	Puts Ramp Frequency Sweep into single sweep mode. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep. *(NOTE: The various sweep parameters (e.g. start, stop, time) must have been previously set).*

S3

Syntax:	S3
Example:	N/A
Description:	This command stops the Ramp Frequency Sweep. The frequency may now be adjusted manually.

SG

Syntax:	SG
Example:	N/A
Description:	Puts Ramp Frequency Sweep into single sweep mode. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep. *(NOTE: The various sweep parameters (e.g. start, stop, time) must have been previously set).*

ST

Syntax:	ST *d* [S | MS | US]
Example:	ST 100 US ! Set the Ramp Sweep time to 100 ms
Description:	Sets the time for a Ramp Frequency Sweep to *d* [S | MS | US], where *d* is the frequency (a decimal number with possible decimal point and/or exponent) and [S | MS | US] is the units in which the frequency is expressed. No terminator implies seconds. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep.

TR

Syntax:	TR *n*	
Example:	TR 2	! Sets the current sweep trigger to immediate
Description:	Sets the trigger condition for the current sweep as specified by the value *n:*	
	n = 0	Sets the trigger condition for the current sweep to **Trigger in BNC**. This will stop the current sweep at its current point until the Trigger In BNC is pulsed, at which time the list will go to its first point and begin running (single step will take one step for each trigger). The BNC trigger is supported for all repeat modes: continuous, single sweep and single step.
	n = 1	Sets the trigger condition for the current list to *Softkey or GPIB.* Setting this trigger type stops the current sweep until the soft key is pressed or the GPIB GET is received, at which time the sweep will go to its starting condition and begin running (single sweep will take one step for each trigger). The soft key trigger is supported for all repeat modes: continuous, single sweep and single step.
	n = 2	Sets the trigger to **Immediate** - i.e., no trigger condition; the sweep will begin as soon as it is run. Because single-step repeat mode requires a trigger, an immediate trigger is not valid for a single-step or a single-step sweep.

TS

Syntax:	TS
Example:	N/A
Description:	Puts Ramp Frequency Sweep into single sweep mode. If a Ramp Frequency Sweep was not running, starts it running; if it was running, restarts the sweep. (***NOTE:** The various sweep parameters (e.g. start, stop, time) must have been previously set).*

3.3.10   Marker Commands

Markers are provided during frequency sweeps to allow identifying specific points along the sweep. This set of commands permits marker assignment and selection.

Marker Commands	Model	
	124XXA	125XXA/ 127XXA
AK	√	√
M0	√	√
M *n d*	√	√
MC	√	√
MO	√	√

AK

Syntax:	AK *n*	
Example:	AK 1	! Turn on the Amplitude Marker
Description:	AK 1 activates and AK 0 deactivates a function which causes a 3 dB drop in the RF output power to occur at marker frequencies.	

M0

Syntax:	M0
Example:	N/A
Description:	This command deactivates the marker that was last activated.

M *n d*

Syntax:	M *n d* [HZ │ KZ │ MZ │ GZ]	
Example:	M 5 7.2 GZ	! Activates marker 5 at 7.2 GHz
Description:	Each of the eight available markers may individually be activated and set to a particular frequency using this command. To turn off a particular marker, first activate it using M5 then send the command.	

MC

Syntax:	MC
Example:	N/A
Description:	Places the last activated marker at the sweep center frequency.

MO

Syntax:	MO
Example:	N/A
Description:	This command deactivates the marker that was last activated.

3.3.11   Step Power Sweep Commands

The following commands control the operation of the instrument during Step Power Sweep. This mode of operation permits stepping the power between two points with a user defined step size and dwell time. Step Power Sweep provides discrete increments of Power.

Step Power Sweep Commands	Model	
	124XXA	125XXA/ 127XXA
Q1	√	√
Q2	√	√
QA	√	√
QB	√	√
QC	√	√
QD	√	√
RS	√	√
TR	√	√

Q1

Syntax:	Q1	
Example:	N/A	
Description:	Puts Step Power Sweep into a continuously sweeping mode. If a step power sweep was not running, starts it running, if it was running, restarts the sweep. (**NOTE:** *The various sweep parameters (i.e., start, stop, dwell) must have been previously set).*	

Q2

Syntax:	Q2	
Example:	N/A	
Description:	Puts Step Power Sweep into a single sweeping mode. If a step power sweep was not running, starts it running, if it was running, restarts the sweep. (**NOTE:** *The various sweep parameters (i.e., start, stop, dwell) must have been previously set).*	

QA

Syntax:	QA *d* DM	
Example:	QA 2 DM	! Set the Step Power Sweep start to 2 dBm
Description:	Sets the start power for a Step Power Sweep to *d* [DM], where *d* is the power (a decimal number with possible decimal point and/or exponent) and [DM] is the units terminator. If a Step Power Sweep was not running, starts it running; if it was running, restarts the sweep. If the QA command is sent with no variable it makes the Step Power Sweep start power the active variable. If a Step Power Sweep was not running, starts it running; if it was running, restarts the sweep	

QB

Syntax:	QB *d* DM	
Example:	QB 8 DM	! Set the Step Power Sweep stop 8 dBm
Description:	Sets the stop power for a Step Power Sweep to *d* [DM], where *d* is the power (a decimal number with possible decimal point and/or exponent) and [DM] is the units terminator. If a Step Power Sweep was not running, starts it running; if it was running, restarts the sweep. If the QB command is sent with no variable it makes the Step Power Sweep stop power the active variable. If a Step Power Sweep was not running, starts it running; if it was running, restarts the sweep.	

QC

Syntax:	QC *d* DM	
Example:	QC .1 DB	! Set the Step Power Sweep step to .1 dB
Description:	Sets the step size for a Step Power Sweep to *d* [DB], where *d* is the power (a decimal number with possible decimal point and/or exponent) and [DB] is the units terminator. If a Step Power Sweep was not running, starts it running; if it was running, restarts the sweep. If the QC command is sent with no variable it makes the Step Power Sweep step size the active variable. If a Step Power Sweep was not running, starts it running; if it was running, restarts the sweep	

QD

Syntax:	QD *d* [S | MS | US]	
Example:	QD 5 MS	! Set the Step Power Sweep dwell to 5 ms
Description:	Sets the dwell time for a Step Power Sweep to d [S | MS | US], where *d* is the time (a decimal number with possible decimal point and/or exponent) and [S | MS | US] is the units terminator. If a Step Power Sweep was not running, starts it running; if it was running, restarts the sweep. If the QC command is sent with no variable it makes the Step Power Sweep step size the active variable. If a Step Power Sweep was not running, starts it running; if it was running, restarts the sweep .	

RS

Syntax:	RS
Example:	N/A
Description:	This command restarts the current Sweep. The sweep is interrupted and reset to the start frequency. All other parameters remain unchanged.

TR

Syntax:	TR *n*	
Example:	TR 2	! Sets the current sweep trigger to immediate
Description:	Sets the trigger condition for the current sweep as specified by the value *n*:	
	n = 0	Sets the trigger condition for the current sweep to **Trigger In BNC**. This will stop the current sweep until the Trigger In BNC is pulsed, at which time the sweep will go to its starting condition and begin running (single step will take one step for each trigger). The BNC trigger is supported for all repeat modes: continuous, single sweep and single step.
	n = 1	Sets the trigger condition for the current sweep to *Softkey or GPIB*. Setting this trigger type stops the current sweep until the soft key is pressed or the GPIB GET is received, at which time the sweep will go to its starting condition and begin running (single step will take one step for each trigger). The soft key trigger is supported for all repeat modes: continuous, single sweep and single step.
	n = 2	Sets the trigger to **Immediate** - i.e., no trigger condition; the sweep will begin as soon as it is run. Because single-step repeat mode requires a trigger, an immediate trigger is not valid for a single-step sweep.

3.3.12   Ramp Power Sweep Commands (Series 12700A Only)

The Ramp Power Sweep mode (also known as Analog Power Sweep) produces a linear change in power over a specified time period. The sweep is defined between two power levels. Although the power is actually a series of discrete steps, the steps are sufficiently small that the net result appears to be continuous.

Ramp Power Sweep Commands (Series 12700A Only)	Model	
	124XXA	**125XXA/ 127XXA**
P*n*	N/A	√
PA	N/A	√
PB	N/A	√
PC	N/A	√
PS	N/A	√
RS	N/A	√
TR	N/A	√

P1

Syntax:	P1
Example:	N/A
Description:	Puts Ramp Power Sweep into continuously sweeping mode. If a Ramp Power Sweep was not running, starts it running; if it was running, this command restarts the sweep. *(NOTE: The various sweep parameters (e.g. start, stop, time) must have been previously set).*

P2

Syntax:	P2
Example:	N/A
Description:	Puts Ramp Power Sweep into single sweep mode. If a Ramp Power Sweep was not running, starts it running; if it was running, this command restarts the sweep. *(NOTE: The various sweep parameters (e.g. start, stop, time) must have been previously set).*

P3

Syntax:	P3
Example:	N/A
Description:	Sending this command will cause the Ramp Power Sweep to stop. The power may now be adjusted manually.

PA

Syntax:	PA *d* DM	
Example:	PA 2 DM	! Set the Ramp Power Sweep start to 2 dBm
Description:	Sets the start power for a Ramp Power Sweep to *d* [DM], where *d* is the power (a decimal number with possible decimal point and/or exponent) and [DM] is the units terminator. If a Ramp Power Sweep was not running, the PA command starts it running and; if it was running, restarts the sweep. If the PA command is sent with no variable it makes start power the active variable. If a Ramp Power Sweep was not running, the PA command starts it running and; if it was running, restarts the sweep.	

PB

Syntax:	PB *d* DM	
Example:	PB 8 DM	! Set the Ramp Power Sweep stop to 8 dBm
Description:	Sets the stop power for a Ramp Power Sweep to *d* [DM], where *d* is the power (a decimal number with possible decimal point and/or exponent) and [DM] is the units terminator. If a Ramp Power Sweep was not running, the PB command starts it running and; if it was running, restarts the sweep. If the PB command is sent with no variable, it makes stop power the active variable. If a Ramp Power Sweep was not running, the PB command starts it running and; if it was running, restarts the sweep.	

PC

Syntax:	PC *d* [S	MS	US]	
Example:	PC 5 MS	! Set the Ramp Power Sweep time to 5 ms
Description:	Sets the time for a Ramp Power Sweep to *d* [S	MS	US], where *d* is the time (a decimal number with possible decimal point and/or exponent) and [S	MS	US] is the units terminator. If a Ramp Power Sweep was not running, the PC command starts it running and; if it was running, restarts the sweep. If the PC command is sent with no variable it makes Power Sweep time the active variable. If a Ramp Power Sweep was not running, the PC command starts it running and; if it was running, restarts the sweep.	

PS

Syntax:	PS	
Example:	PS 1	! Activate Ramp Power Sweep
Description:	This command activates (PS 1) or deactivates (PS 0) the Ramp Power Sweep.	

RS

Syntax:	RS	
Example:	N/A	
Description:	This command restarts the current Sweep. The sweep is interrupted and reset to the start frequency. All other parameters remain unchanged.	

TR

Syntax:	TR *n*	
Example:	TR 2	! Sets the current sweep trigger to immediate
Description:	Sets the trigger condition for the current sweep as specified by the value *n*:	
	n = 0	Sets the trigger condition for the current sweep to **Trigger In BNC**. This will stop the current sweep until the Trigger In BNC is pulsed, at which time the sweep will go to its starting condition and begin running (single step will take one step for each trigger). The BNC trigger is supported for all repeat modes: continuous, single sweep and single step.
	n = 1	Sets the trigger condition for the current sweep to *Softkey or GPIB*. Setting this trigger type stops the current sweep until the soft key is pressed or the GPIB GET is received, at which time the sweep will go to its starting condition and begin running (single step will take one step for each trigger). The soft key trigger is supported for all repeat modes: continuous, single sweep and single step.
	n = 2	Sets the trigger to **Immediate** - i.e., no trigger condition; the sweep will begin as soon as it is run. Because single-step repeat mode requires a trigger, an immediate trigger is not valid for a single-step sweep.

3.3.13   Amplitude Modulation Commands (Series 12500A/12700A Only)

The Amplitude Modulation command set selects of the source of modulation and the modulation depth. If Option 24 is installed, the various parameters of the internal generator are able to be set.

Amplitude Modulation Commands (Series 12500A/12700A Only)	Model	
	124XXA	125XXA/ 127XXA
AD	N/A	√
AM	N/A	√
AMF	N/A	√
AR	N/A	√
SC	N/A	√
SD	N/A	√
SR	N/A	√

AD

Syntax:	AD *d*	
Example:	AD 40	! Set the AM depth to 40%
Description:	Sets the depth of Amplitude Modulation to *d* percent.	

AM

Syntax:	AM *n*	
Example:	AM 1	! Activate external AM
Description:	Sets the trigger condition for the current sweep as specified by the value *n*:	
	n = 0	Deactivate (turn off) Amplitude Modulation.
	n = 1	Activate external Amplitude Modulation.
	n = 2	Activate internal Amplitude Modulation **(Only with Option 24)** and select sine wave.
	n = 3	Activate internal Amplitude Modulation **(Only with Option 24)** and select square wave.
	n = 4	Activate internal Amplitude Modulation **(Only with Option 24)** and select triangle wave.
	n = 5	Activate internal Amplitude Modulation **(Only with Option 24)** and select positive ramp.
	n = 6	Activate internal Amplitude Modulation **(Only with Option 24)** and select negative ramp.
	n = 7	Activate internal Amplitude Modulation **(Only with Option 24)** and select noise.
	n = 8	Activate internal Amplitude Modulation **(Only with Option 24)** and select zero output.

AMF

Syntax:	AMF *n*	
Example:	AMF 1	! Activate external AM
Description:	The AMF set of commands duplicate the functions of the AM commands listed above. This command group is included for compatibility with older Giga-tronics instruments.	

AR

Syntax:	AR *d* [Hz | KZ | MZ | GZ]	
Example:	AR 400 HZ	! Set the internal AM rate to 400 Hz
Description:	Sets the rate of the internal amplitude modulation generator to *d* [Hz | KZ | MZ |GZ]. **This command is valid only with Option 24.**	

SC

Syntax:	SC *n*	
Example:	SC 1	! Activate external Scan AM
Description:	Activates and selects the source of the Scan AM according to the following values for *n*:	
	n = 0	Deactivate (turn off) Scan Amplitude Modulation.
	n = 1	Activate external Scan Amplitude Modulation **(Only with Option 29)**.
	n = 2	Activate internal Scan Amplitude Modulation **(Only with Options 24 and 29)** and select sine wave.
	n = 3	Activate internal Scan Amplitude Modulation **(Only with Options 24 and 29)** and select square wave.
	n = 4	Activate internal Scan Amplitude Modulation **(Only with Options 24 and 29)** and select triangle wave.
	n = 5	Activate variable attenuation. In this mode no internal or external signal is applied. The setting of the Scan depth ([SD]) determines the amount of attenuation provided.
	n = 6	Activate internal scan **(Only with Options 24 and 29)** and select positive ramp.
	n = 7	Activate internal scan **(Only with Options 24 and 29)** and select negative ramp.
	n = 8	Activate internal scan **(Only with Options 24 and 29)** and select noise.
	n = 9	Activate internal scan **(Only with Options 24 and 29)** and select zero output.

SD

Syntax:	SD *d*	
Example:	SD 40	! Set the Scan depth to 40 dB
Description:	Sets the depth of Amplitude Modulation to *d* dB. (***NOTE:** The AM source needs to be set prior to using this command since the external depth and internal depth are independent variables.*	

SR

Syntax:	SR *d* [HZ | KZ | MZ | GZ]	
Example:	SR 400 HZ	! Set the internal AM rate to 400 Hz
Description:	Sets the rate of the internal amplitude modulation generator to *d* [HZ | KZ | MZ | GZ]. **This command is valid only with Options 24 and 29**.	

3.3.14 Frequency Modulation Commands (Series 12500A/12700A Only)

The Frequency Modulation command set selects of the source of modulation and the modulation deviation. If Option 24 is installed, the various parameters of the internal generator are able to be set.

Frequency Modulation Commands (Series 12500A/12700A Only)	Model	
	124XXA	125XXA/ 127XXA
FD	N/A	√
FM	N/A	√
FR	N/A	√
FT	N/A	√
NM	N/A	√

FD

Syntax:	FD *d* [HZ | KZ | MZ | GZ]	
Example:	FD 500 KZ	! Activate FM with a 500 kHz deviation
Description:	Allows setting the deviation to *d* [HZ | KZ | MZ | GZ], where *d* is the power (a decimal number with possible decimal point and/or exponent) and [HZ | KZ | MZ | GZ] is the units terminator. If the FM mode is Phase, then this command sets the deviation in Radians (with any units key the terminator).	

FM

Syntax:	FM *n*	
Example:	FM 1	! Activate External FM
Description:	Activates and selects the source of the FM according to the following values for *n*. (***NOTE:*** *This command applies to Narrow, Wide and Phase modes. See the FT command*).	
	n = 0	Deactivate (turn off) Frequency Modulation.
	n = 1	Activate external Frequency Modulation.
	n = 2	Activate internal Frequency Modulation **(Only with Option 24)** and select sine wave.
	n = 3	Activate internal Frequency Modulation **(Only with Option 24)** and select square wave.
	n = 4	Activate internal Frequency Modulation **(Only with Option 24)** and select triangle wave.
	n = 5	Activate internal Frequency Modulation **(Only with Option 24)** and select positive ramp.
	n = 6	Activate internal Frequency Modulation **(Only with Option 24)** and select negative ramp.
	n = 7	Activate internal Frequency Modulation **(Only with Option 24)** and select zero output.

FR

Syntax:	FD *d* [HZ | KZ | MZ | GZ]	
Example:	FD 400 KZ	! Set the internal FM rate to 400 Hz
Description:	Sets the rate of the internal frequency modulation generator to *d* [Hz | KZ | MZ |GZ]. **This command is valid only with Option 24.**	

FT

Syntax:	FT *n*	
Example:	FT 1	! Set the FM to Narrow mode
Description:	This command sets the mode for Frequency Modulation. The following modes are available for the value of *n*:	
	1 =	Narrow mode
	2 =	Wide mode

NM

Syntax:	NM	
Example:	N/A	! Toggle to the next FM mode
Description:	This command sets the FM mode to the next type. Available types are: Narrow, Wide, Phase, Narrow and Phase Wide.	

3.3.15   Pulse Modulation Commands (Series 12500A/12700A Only)

The Pulse Modulation command set selects of the source of modulation and the delay. If Option 24 is installed, the various parameters of the internal generator are able to be set.

Pulse Modulation Commands (Series 12500A/12700A Only)	Model	
	124XXA	**125XXA/ 127XXA**
PM	**N/A**	√
PR	**N/A**	√
PW	**N/A**	√
PWV	**N/A**	√
PY	**N/A**	√
PI	**N/A**	√
SHPM	**N/A**	√

PM

Syntax:	PM *n*	
Example:	PM 1	! Activate External PM
Description:	Activates and selects the source of the FM according to the following values for *n*. (*(**NOTE:** This command applies to Narrow, Wide and Phase modes. See the FT command).*	
	n = 0	Deactivate (turn off) Pulse Modulation.
	n = 1	Activate external positive true Pulse Modulation.
	n = 2	Activate internal Pulse Modulation **(Only with Option 24)**.
	n = 3	Activate external negative true Pulse Modulation.
	n = 4	Activate external rising edge trigger Pulse Modulation (**Only with Option 24)**.
	n = 5	Activate external falling edge trigger Pulse Modulation **(Only with Option 24)**.

PR

Syntax:	PR *d* [HZ │ KZ │ MZ │ GZ]	
Example:	PR 500 KZ	! Set PM rate to 500 kHz
Description:	Sets the rate to *d* [HZ │ KZ │ MZ │ GZ], where *d* is the frequency (a decimal number with possible decimal point and/or exponent) and [HZ │ KZ │ MZ │ GZ] is the units terminator. **This command requires Option 24 to be installed.**	
	The internal modulation generator does not allow the rate and start delay to be sent independently. If the PR command is sent, the start delay is adjusted to produce the desired rate. The pulse width and interval delays are adjustable within the requested period (1/rate).	

PW

Syntax:	PW *d* [S │ MS │ US]	
Example:	PW 5 MS	! Set PM width to 5 ms
Description:	Sets the width for an internally generated PM signal to *d* [S | MS | US], where *d* is the time (a decimal number with possible decimal point and/or exponent) and [S | MS | US] is the units terminator. **This command requires Option 24 to be installed.** If rate has been selected, the pulse width is adjustable only within the requested period (1/rate).	

PWV

Syntax:	PWV *n*	
Example:	PWV 1	! Activate singlet waveform
Description:	Selects the waveform generated by the internal pulse modulation generator according to the following values for *n*:	
	n = 0	Selects no waveform.
	n = 1	Selects singlet waveform.
	n = 2	Selects doublet waveform.
	n = 3	Selects triplet waveform.
	n = 4	Selects quadlet waveform.

PI

Syntax:	PI *d* [S │ MS │ US]	
Example:	PI 5 MS	! Set 5 ms interval delay
Description:	Sets the interval display between pulses (doublet, triplet, quadlet) generated by the internal pulse modulation generator, where d is the time (a decimal number with possible decimal point and/or exponent) and [S | MS | US] is the units terminator. **This command requires Option 24 to be installed**.	

PY

Syntax:	PY *d* [S │ MS │ US]	
Example:	PY 5 MS	! Set PM delay to 5 ms
Description:	Sets the delay for an externally triggered or internally generated PM signal to *d* [S | MS | US], where *d* is the time (a decimal number with possible decimal point and/or exponent) and [S | MS | US] is the units terminator. **This command requires Option 24 to be installed.** The internal modulation generator does not allow the rate and start delay to be sent independently. If the PY command is sent, the period of repetition becomes a function of the star delay, pulse width, interval delay, and waveform type (singlet, doublet, etc.) as follows: *start delay + ((pulse width + interval delay)(number of pulses))*	

SHPM

Syntax:	SHPM
Example:	N/A
Description:	This command is included for compatibility with systems using Hewlett Packard (Agilent) model 8757A scalar analyzers. It will turn on external Pulse Modulation.

3.3.16   Output Commands

This series of commands allows a remote controller to read the values of many of the instrument parameters. The returned string is a decimal number expressed in base units (Hz for frequency, seconds for time, dBm for power). See examples following. Note that this series of commands causes the instrument output buffer to be loaded with the desired result. The remote controller must then do a read to obtain the data.

Output Commands	Model	
	124XXA	125XXA/ 127XXA
OA	√	√
OC	√	√
OD	√	√
OI	√	√
OPAS	√	√
OPCF	√	√
OPCW	√	√
OPDF	√	√
OPFA	√	√
OPFB	√	√
OPM	√	√
OPPL	√	√
OPSF	√	√
OR	√	√

OA

Syntax:	OA
Example:	OA
Response:	Returns a string showing the value of the active variable.
Response Example:	9000000000.0 (Frequency of 9 GHz)
Description:	Whenever a command is sent to change a parameter, that parameter becomes the active variable. Sending the OA command will then return the value of that variable.

OC

Syntax:	OC
Example:	OC
Response:	Returns a string containing first the start frequency, the center frequency, and last the sweep time. A space separates each value.
Response Example:	9000000000.0 12000000000.0 .005
Description:	This command outputs the coupled parameters found in center/delta frequency sweeps. The above example shows a sweep starting at 9 GHz, with a 12 GHz center frequency, and a sweep time of 5 ms.

OD

Syntax:	OD
Example:	OD
Response:	Returns a string containing the self test result. If the test failed, it returns a failure message with the frequency that caused the failure.
Response Example:	1 1 1 0 0
Description:	This command outputs the results of instrument self-test (See SHM4). The self-test steps the instrument across its frequency range and checks for lock and level at each step.The OD command must be sent following self-test to send the string.

OI

Syntax:	OI
Example:	OI
Description:	This command outputs the instrument's identification.

OPAS

Syntax:	OPAS *d*
Example:	N/A
Description:	This command outputs the Lock, Level and Calibration status. A "1" represents Locked, leveled, or calibrated respectively; a "0" represents unlocked, unleveled, or un-calibrated respectively.

OPCF

Syntax:	OPCF
Example:	OPCF
Response:	Returns a string containing the center frequency of a sweep.
Response Example:	9000000000.0 (A center frequency of 9 GHz)
Description:	When the instrument is operating in a Frequency Sweep mode, this command will output the value of the sweep center frequency.

OPCW

Syntax:	OPCW
Example:	OPCW
Response:	Returns a string containing the current CW frequency.
Response Example:	4500000.0 (A CW frequency of 4.5 MHz)
Description:	The value of the current value of the CW frequency will be returned, even if the instrument is in a different mode.

OPDF

Syntax:	OPDF
Example:	OPDF
Response:	Returns a string containing the delta frequency of a sweep.
Response Example:	6000000000.0 (A delta sweep value of 6 GHz)
Description:	When the instrument is operating in a Frequency Sweep mode, this command will output the value of the sweep delta frequency.

OPFA

Syntax:	OPFA
Example:	OPFA
Response:	Returns a string containing the start frequency of a sweep.
Response Example:	2500000000.0 (A start frequency of 2.5 GHz)
Description:	When the instrument is operating in a Frequency Sweep mode, this command will output the value of the sweep start frequency.

OPFB

Syntax:	OPFB
Example:	OPFB
Response:	Returns a string containing the stop frequency of a sweep.
Response Example:	6500000000.0 (A start frequency of 6.5 GHz)
Description:	When the instrument is operating in a Frequency Sweep mode, this command will output the value of the sweep stop frequency.

OPM

Syntax:	OPM *n*
Example:	OPM 3
Response:	Returns a string with the value for the selected marker frequency.
Response Example:	5552000.0 (Marker 3 at a frequency of 5.552 MHz)
Description:	This command allows interrogating each of the twelve markers to determine the frequency to which it is set. Send OPM *n* where *n* is the marker number.

OPPL

Syntax:	OPPL
Example:	OPPL
Response:	Returns a string containing the value of the output power in dBm.
Response Example:	-15.3 (An output power of -15.3 dBm)
Description:	The value of the current value of the fixed output power will be returned, even if the instrument is in a different mode (e.g. step power sweep).

OPSF

Syntax:	OPSF
Example:	OPSF
Response:	Returns a string containing the center frequency of a sweep.
Response Example:	100.0 (A step size of 100 Hz)
Description:	When the instrument is operating in a Frequency Sweep mode, this command will output the value of the sweep center frequency.

OR

Syntax:	OR
Example:	OR
Response:	Returns a string containing the value of the output power in dBm.
Response Example:	-15.3 (An output power of -15.3 dBM)
Description:	The value of the current value of the fixed output power will be returned, even if the instrument is in a different mode (e.g. step power sweep). This command is identical in operation to OPPL and is included for compatibility with older Hewlett Packard (Agilent) instruments.

3.3.17   ALC Commands

ALC Commands	Model	
	124XXA	**125XXA/ 127XXA**
A	√	√
AT	√	√
SHA1	√	√
SHPS	√	√
SHRF	√	√
SHSL	√	√
SHRL	√	√

A

Syntax:	A *n*	
Example:	A 1	! Selects Internal Leveling
Description:	Selects the leveling method according to the following values for *n*.	
	n = 1	Selects Internal Leveling.
	n = 2	Selects External Leveling using a negative diode detector. **CURRENTLY NOT SUPPORTED**.
	n = 3	Selects External Leveling using the DC output of a power meter. **CURRENTLY NOT SUPPORTED**.

AT

Syntax:	AT *d* DB	
Example:	AT80DB	! Sets the attenuator to 80 dB
Description:	Sets the attenuator independently of the level control, in 10 dB increments, from 0 to 110 dB. To use this command, the attenuator must first be uncoupled from the level control by sending SHSL. When using this command, the level control can independently adjust the input level to the step attenuator from at least -10 to +15 dBm with the PL command. This now allows the RF output level to be varied over approximately 25 dB without the step attenuator switching.	

SHA1

Syntax:	SHA1
Example:	N/A
Description:	This mode disables the automatic level control. It is included for compatibility with older Hewlett Packard (Agilent) instruments.

SHPS

Syntax:	SHPS *d* DB	
Example:	SHPS80DB	! Sets the attenuator to 80 dB
Description:	Sets the attenuator independently of the level control, in 10 dB increments, from 0 to 110 dB. When using this command, the level control can independently adjust the input level to the step attenuator from at least -10 to +15 dBm with the PL command. This now allows the RF output level to be varied over approximately 25 dB without the step attenuator switching. It is included for compatibility with older Hewlett Packard (Agilent) instruments.	

SHRF

Syntax:	SHRF
Example:	N/A
Description:	This mode disables the automatic level control. It is included for compatibility with older Hewlett Packard (Agilent) instruments.

SHSL

Syntax:	SHSL *d* DB	
Example:	SHSL80DB	! Sets the attenuator to 80 dB
Description:	Sets the attenuator independently of the level control, in 10 dB increments, from 0 to 110 dB. When using this command, the level control can independently adjust the input level to the step attenuator from at least -10 to +15 dBm with the PL command. This now allows the RF output level to be varied over approximately 25 dB without the step attenuator switching. It is included for compatibility with older Hewlett Packard (Agilent) instruments.	

SHRL

Syntax:	SHRL
Example:	N/A
Description:	Re-couples the attenuator to the leveling control system. The step attenuator will now switch at each 10 dB boundary of the level range.

3.3.18   Instrument Control Commands

Instrument Control Commands	Model	
	124XXA	**125XXA/ 127XXA**
CS	√	√
DN	√	√
DU	√	√
EF	√	√
EK	√	√
IH	√	√
IP	√	√
NSR	√	√
PH2	√	√
RC	√	√
RFD	√	√
SHM4	√	√
SHS1	√	√
SV	√	√
UP	√	√
CONTRAST d	√	√
CONTRAST?	√	√

CS

Syntax:	CS
Example:	N/A
Description:	Clears the 16-bit status bytes that report the instrument status.

DN

Syntax:	DN
Example:	N/A
Description:	Decreases the value of the active parameter by its step size. If, for example, the last command sent to the instrument was CW5GZ then the CW frequency parameter will be the active parameter. If the step size for the CW frequency was 100 MHz, then sending DN will decrease the frequency by 100 MHz. Equivalent to pressing the Down Button.

DU

Syntax:	DU *n*	
Example:	DU 1	! Displays 'Remote Operation'
Description:	This command specifies what will be displayed on the instrument screen during GPIB operation. The (currently) valid values of *n* are: 0 Leaves the screen blank. 1 Displays **Remote Operation** on the screen. 2 Displays normal menus during GPIB operation. Reports any errors on the message line. 3 Displays normal menus and writes on the message line (bottom line of the screen) each GPIB command as it's received (marked *Recd:*) and after it's executed (marked *Done:*). Reports any errors on the message line. 6 Scrolls up the screen the most recent 12 GPIB commands received (marked *Recd:*) and executed (marked *Done:*). Leaves the bottom line free to report errors. 7 - Displays error messages only. These will scroll down to fill the screens, then scroll up. This mode is used to avoid slowing down the system when only errors needed to be identified. The LED below the PULSE key toggles when a GPIB command is sent to the unit.	

EF

Syntax:	EF
Example:	N/A
Description:	Disables the front panel knob to prevent inadvertent parameter changes.

EK

Syntax:	EK
Example:	N/A
Description:	Enables the front panel knob.

IH

Syntax:	IH
Example:	N/A
Description:	Clears all lists, level-correction tables and setups from non-volatile memory; writes zeros to the cleared memory locations. Reinitializes the heap-space manager.

IP

Syntax:	IP
Example:	N/A
Description:	Sets all instrument settings to factory values; sets the instrument to CW mode at the instrument's minimum frequency. Clears all lists, level-correction tables and setups from non-volatile memory and reinitializes the heap-space manager.

NSR

Syntax:	NSR
Example:	N/A
Description:	The normal operation of the remote mode displays the words **Remote Operation** on the screen. Sending NSR will cause the screen to show the same information displayed when in local mode. For example if the CW command were to be sent, the 'Fixed Frequency' menu will be displayed. The NSR command is a 'toggle'. Each time it is sent the screen display toggles from **Remote Operation** to standard menu.

PH2

Syntax:	PH2
Example:	N/A
Description:	In instruments with Option 20, this command will force the instrument control system to always keep the high power amplifier module in the circuit. Normally, the high power amplifiers are only used if the output RF power is set to +15 dBm or higher. This command is used primarily for doing the level characterization. Leaving the high power amplifiers in place at low power levels will cause accuracy errors as well as added noise.

RC

Syntax:	RC *n*	
Example:	RC 1	! Recall front panel setup #1
Description:	Recalls the selected front panel setup from non-volatile memory. There are ten memory locations, 0-9.	

RFD

Syntax:	RFD *n*	
Example:	RFD 1	! RF on during frequency change
Description:	The RF output of the instrument is normally reduced by about 40 dB during frequency changes to prevent any potential damaging overshoot (to a users equipment, not the instrument). Sending RFD1 will disable this feature and leave the RF on at all times except band and filter crossing points. Sending RFD0 re-enables the normal operation.	

SHM4

Syntax:	SHM4 *d* [HZ │ KZ │ MZ │ GZ]	
Example:	SHM4 100MZ	! Run Self Test in 100 MHz steps
Description:	Activates Self Test and allows setting the step size to *d* [HZ │ KZ │ MZ │ GZ], where *d* is the frequency increment (a decimal number with possible decimal point and/or exponent) and [HZ │ KZ │ MZ │ GZ] is the units terminator. Self test will step the instrument over its entire frequency range in the selected steps. If any of the frequencies across the range causes failures, that frequency will be returned. See OD in Section 3.3.16 for a description of the output string.	

SHS

Syntax:	SHS *n*	
Example:	SHS1	! Blank the display
Description:	Sending SHS1 will completely blank the front panel display. This feature is provided for those applications requiring security. Sending SHS0 turns the display back on.	

SV

Syntax:	SV *n*	
Example:	SV 1	! Save front panel setup in #1
Description:	Saves the current front panel setup in non-volatile memory. There are ten memory locations, 0-9. All instrument parameters are saved, including modes not currently active.	

UP

Syntax:	UP
Example:	N/A
Description:	Increases the value of the active parameter by its step size. If, for example, the last command sent to the instrument was CW5GZ then the CW frequency parameter will be the active parameter. If the step size for the CW frequency was 100 MHz, then sending UP will increase the frequency by 100 MHz. Equivalent to pressing the Up Button.

CONTRAST d

Syntax:	Contrast *d*
Example:	Contrast 128
Description:	Sets the LCD Contrast to the integer value specified by *d*. 0 <= d <= 255.

CONTRAST?

Syntax:	Contrast?
Example:	Contrast?
Description:	Returns the current value of LCD Contrast.

4

Performance Verification

4.1   Introduction

Introduction (Performance Verification)	Model	
	124XXA	**125XXA/ 127XXA**
4.1.1 - Recommended Equipment	√	√

- This chapter provides step-by-step procedures to verify performance of the Series 12000A Microwave Synthesizers for all three models (Modulation related items are in Section 4.4 for the Series 125XXA/127XXA models)
- Sectional header page references are only provided for items pertaining directly to performance verification testing
- 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 three models
- In these procedures, the instrument being tested may be referred to as the 12000A or UUT (Unit Under Test) for all three models

4.1.1   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):

Table 4-1: Series 12000A Recommended Equipment

Equipment	Example
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 8541C/Series 8650A w/ 80313A Sensor or Equivalent
Spectrum Analyzer	HP 8566B or Equivalent
Detector	Herotek Model DZ262-44 or Equivalent
Function (Audio) Generator	Stanford Research DS-345 or Equivalent
Measuring Receiver	HP 8902A or Equivalent
Distortion Analyzer	HP 339A or Equivalent
L.O. Generator	Giga-tronics Microwave Synthesizer 12720A or Equivalent
Universal Counter	Racal Dana 2201 or Equivalent
Mixer IF Amplifier w/ Divide-by-40 Output	Giga-tronics Mixer/Divider (P/N 002CA04900)
Mixer (For Attenuator Test)	Marki M40020MJ
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

4.2 Performance Tests

Performance Tests	Model		Page
	124XXA	125XXA/ 127XXA	
4.2.1 - **Introduction** (Performance Tests)	√	√	4-2
4.2.2 - **Frequency Range, Resolution & Accuracy**	√	√	4-3
4.2.3 - **Spurious Signals Tests**	√	√	4-4
4.2.4 - **Signal Sideband Phase Noise**	√	√	4-6
4.2.5 - **RF Output Power Tests**	√	√	4-7

4.2.1 Introduction

The procedures in this section verify the electrical performance of the 12000A using the specifications in Chapter 1.   Use Sections 4.1 through 4.3 for features that are applicable to all three models.   Use Sections 4.4 through 4.5 for native specification data for the Series 125XXA/127XXA models.

Each of the performance tests includes a list of recommended test equipment. There is a consolidated list at the beginning of this chapter. Equivalent test equipment can be substituted provided that the accuracies and specifications are sufficiently compatible.

A test data sheet is included for entering the various readings taken. The specification and tolerance range is listed for ease of verification. It is suggested that copies be made of the manual sheets. When automated tests are run, a printed data sheet is produced.

Performance verification is recommended at least every two years, or more often when required to ensure proper operation of the instrument.

Each procedure specifies a required warm-up time if the procedure is to be done individually. Only one warm-up period is required for a sequence of tests. Test equipment must be warmed up according to specifications.

4.2.2 Frequency Range, Resolution & Accuracy

4.2.2.1 Description

Connect the 12000A RF output to the input of a frequency counter. The internal timebase of the counter is a reference for the 12000A to eliminate timebase errors from the measurements. This procedure does not check for timebase accuracy, and therefore the frequency in the 12000A display should agree with the counter, within the resolution of each instrument. It is possible for a fault in the 12000A to cause a frequency error even though the lock indicators show normal operation. For this reason a number of specific frequencies are tested. Test frequencies have been selected so that any defective circuits will be easily isolated.

4.2.2.2 Equipment Required

UUT ● Frequency Counter ● Coaxial Cable
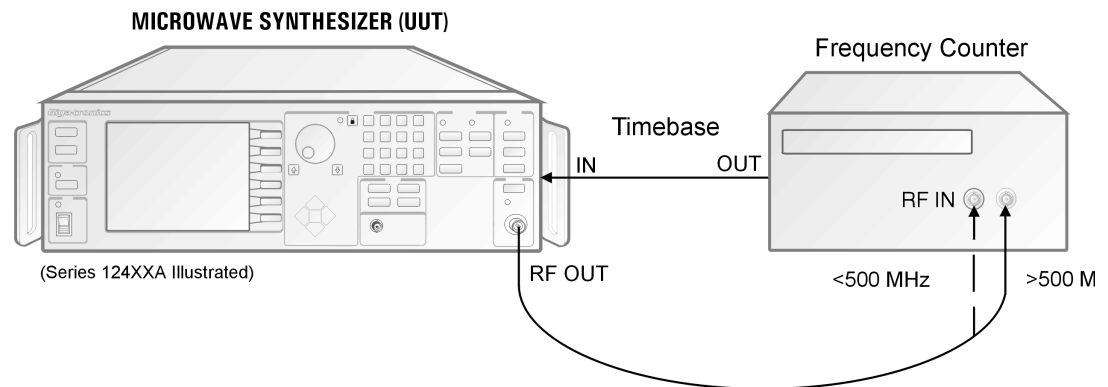
Figure 4-1: Frequency Range, Resolution & Accuracy

4.2.2.3 Procedure

1. Connect the equipment as shown in Figure 4-1. Connect the 12000A 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 12000A and the counter use the same timebase, timebase errors are eliminated. The 12000A will automatically switch to the external reference when it is connected.

2. Set the 12000A to 10 MHz. Press **[LEVEL]** in the POWER field and enter **[-] [1] [0] [DBM]**. Press **[RF ON]** in the RF OUTPUT field to turn on the RF output.

3. Set the 12000A to each frequency listed on the data sheet and verify that the counter reads the set frequency plus or minus the counter resolution. This tests each divider stage.

4. Connect the 12000A RF Output to the 500 MHz to 26.5 GHz input on the counter and continue with the divider tests.

5. To check that the multipliers are functioning properly, refer to the test data sheet and program each of the listed frequencies into the 12000A 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.

4.2.3 Spurious Signals Tests

4.2.3.1 Description

The output of the 12000A 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.

4.2.3.2 Equipment Required

UUT • Spectrum Analyzer • Coaxial Cable

MICROWAVE SYNTHESIZER (UUT)

Spectrum Analyzer

(Series 124XXA Illustrated)   RF OUT   RF IN
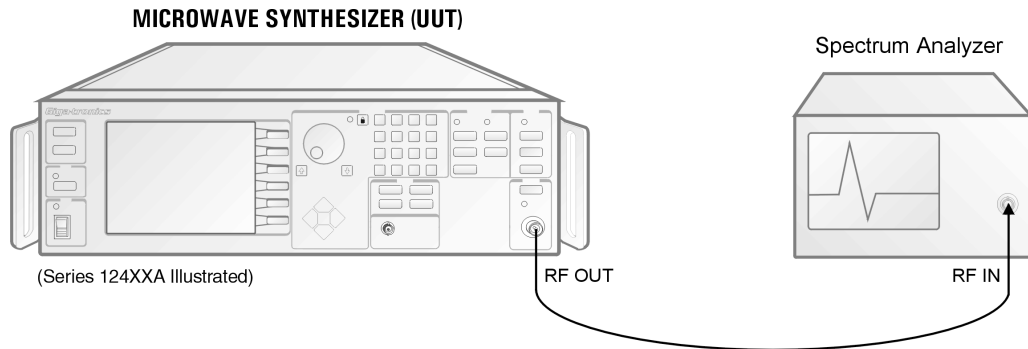
Figure 4-2: Spurious Signals Tests

4.2.3.3 Procedure

1. Connect the equipment as shown in Figure 4-2. Allow the equipment to warm up for at least 30 minutes. Press **[CW]** in the FREQUENCY field on the 12000A and enter the first test data sheet frequency within the range of the 12000A. The RF amplitude should be at +6 dBm. Press **[RF ON]** to turn on the RF output. Be certain that all modulation is OFF.

2. Set the spectrum analyzer to view the 12000A 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.

Many spectrum analyzers have a tuned preselector when the frequency is above about 2 GHz. This reduces the likelihood of analyzer generated spurious signals, but does not eliminate the possibility. If in doubt, increase the RF attenuation of the analyzer by 10 dB. The signal in question should be reduced by exactly 10 dB. If not, it is analyzer generated. It is also important for frequencies below the range of the preselector that sufficient analyzer RF Attenuation be used (typically 30 dB) to avoid the analyzer generating harmonics of the input signal. The above attenuator shift technique will also allow verification of harmonic levels.

If a spurious signal appears to be out of specification, first check that the fundamental signal level is at +6 dBm. Next verify the analyzer accuracy by connecting a known amplitude signal (from the 12000A, for example) at the spurious frequency.

The adjusting knob on the 12000A may generate some noise spikes when it is rotated. The acquisition of the various phase lock loops in the instrument can also cause transients (within the specified settling time). Both of these effects will disappear when a steady state condition has been reached.

It is important to identify the particular class of spurious signal as the specifications may be different for each. If the spurious signal is an exact multiple of the 12000A RF output then the harmonic specification applies. Any other spurious signals must meet the non-harmonically related specification.

For frequencies above the fundamental range of the spectrum analyzer, either a mixer supplied with the spectrum analyzer or an external mixer and local oscillator may be used to downconvert the signal. Care must be taken to identify spurious signals which are inherently generated by the mixing process.

4.2.4 Single Sideband Phase Noise

4.2.4.1 Description

The test in this procedure is limited by the measuring system and verifies only the majority of the phase noise specification. To completely test the phase noise specification requires a far more sophisticated measurement system. This test uses the spectrum analyzer to make all measurements from 100 Hz to 1 MHz offsets. The 100 Hz and 1 MHz offsets are particularly susceptible to measurement system limitations.

4.2.4.2 Equipment Required

UUT • Spectrum Analyzer • Coaxial Cable

MICROWAVE SYNTHESIZER (UUT)

Spectrum Analyzer

(Series 124XXA Illustrated)   RF OUT   RF IN
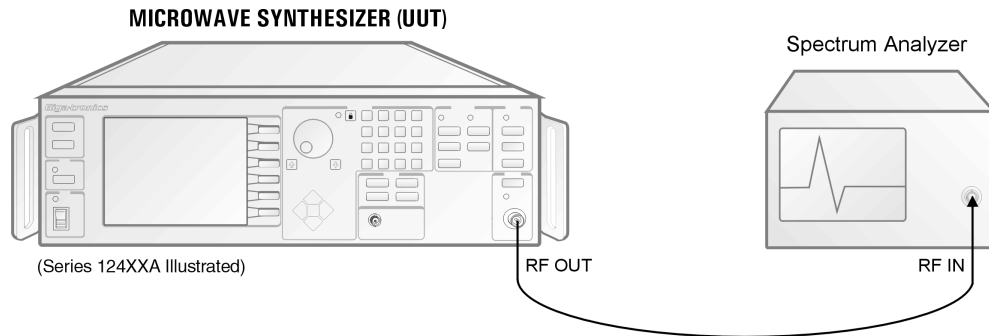
Figure 4-3: Single Sideband Phase Noise

4.2.4.3 Procedure

1. Connect the 12000A RF output to the spectrum analyzer input. Place the 12000A on a foam pad to isolate it from any external mechanical vibrations, which could affect the phase noise measurement.

2. Turn off all modulation on the 12000A.

3. For the first frequency on the test data sheet within the range of the instrument, press **[CW]** and enter the frequency. Tune the spectrum analyzer to the generator frequency and adjust the 12000A RF level to obtain a reference of 0 dBm on the analyzer. This allows direct measurement of the phase noise by the analyzer.

4. Set the analyzer span such that the desired offset is at ±2 divisions, select an appropriate bandwidth, activate the phase noise measurement and place the marker two divisions to the right of the carrier. Read the phase noise in dBc/Hz. Repeat for all offsets.

5. Repeat steps 3 and 4 for the other test data sheet frequencies which are within range of the 12000A.

4.2.5 RF Output Power Tests

4.2.5.1 Description

Although it is possible to make the following measurements manually, it is extremely tedious. It is recommended that an automated system be set up to take and record the data. Three tests are run. The first measures the maximum available output with the level control loop disabled. The second verifies the accuracy and flatness across the operating frequency range at a fixed output (0 dBm). The remaining test checks the step attenuator accuracy at a number of frequencies. This section outlines the general procedure followed by the automated system, a similar measurement could be done manually.

4.2.5.2 Equipment Required

UUT • Local Oscillator • Measuring Receiver & Sensor • Downconverter • Plotter • Computer & Programs
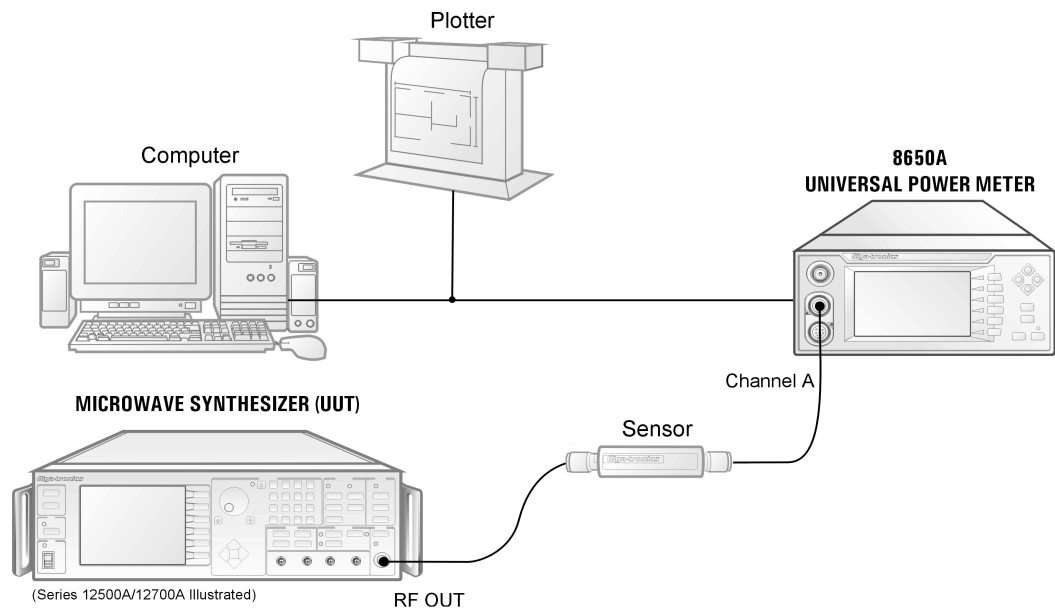
Figure 4-4: RF Output Power Test

4.2.5.3 Procedure (Output Power)

1. Connect the power sensor to the 12000A. Disable the leveling system of the 12000A. Step the frequency across the particular instrument operating range in 50 MHz increments. At each point measure the power, apply the appropriate sensor correction factor, and plot the result.

2. Using the above setup, set the 12000A to 0 dBm with the leveling enabled. Again, step the frequency across the operating range; measure, correct, and plot the power.

3. Repeat this procedure for the remaining test frequencies.

☞ **NOTE:** *When measuring the flatness and accuracy of the model 12000A, 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.*

4.2.5.4   Procedure (Attenuator Test: Option 26)

1. Connect the 12000A to the measuring receiver via the downconverter. With the 12000A at 0 dBm and set to the first test frequency; set LO 21.4 MHz above UUT set frequency. Establish a reference on the receiver in a tuned RF level mode. Reduce the 12000A output in 10 dB steps, observing and recording the receiver reading. As needed, perform the recalibration requested by the receiver.
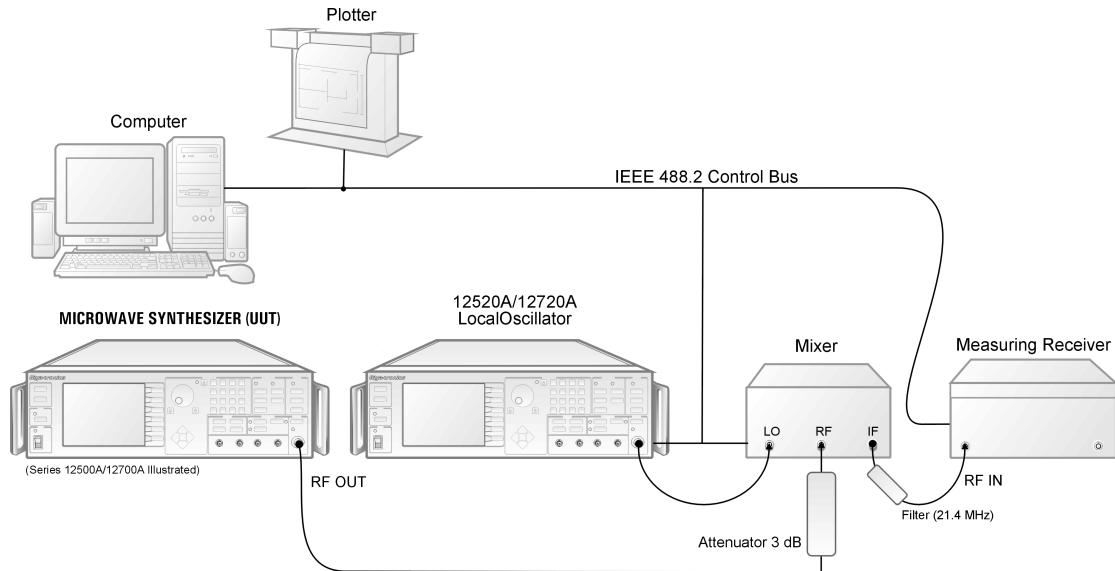
Figure 4-5: RF Output Power Attenuator Test

2. Repeat this procedure for the remaining test frequencies.

☞ **NOTE:** *When measuring the flatness and accuracy of the model 12000A, consideration must be given to the various measurement uncertainties in the test system. These include, but are not limited to, VSWR, Cal Factor uncertainty and calibration.*

4.3   Calibration

Calibration	Model	
	124XXA	125XXA/ 127XXA
4.3.1 - Equipment & Documentation Required	√	√ (See Also 4.3.1.2)
4.3.2 - Timebase Calibration	√	√
4.3.3 - Output Amplitude Calibration	√	√
4.3.4 - Instrument Self Adjustment During Power Up	√	√
4.3.5 - Factory Calibrations	√	√

Calibration is recommended every two years.

The Series 12000A features closed-case calibration. There are no mechanical adjustments of any kind in the instrument. All calibration is done under the control and direction of the calibration software. Calibration data is stored in non-volatile RAM.   Refer to the Series 12000A Microwave Synthesizers Service Manual for detailed calibration instructions (P/N 31232). There are four functions in the instrument that require periodic calibration using external sources or measurement equipment:

- Timebase
- Output Amplitude
- Frequency Modulation (Series 125XXA/127XXA Only - See Section 4.5.1)
- Amplitude Modulation (Series 125XXA/127XXA Only - See Section 4.5.2)

Other instrument functions are adjusted either at instrument turn-on or during operation. In addition to the user-initiated and automatic calibrations, there are certain factory calibration processes. The first four sections describe in general terms how user-initiated calibration is accomplished. The actual calibration process is directed by the calibration software. The remaining sections describe the adjustments that occur at power-up or when certain modes are selected, and the factory calibration processes.

The equipment required to perform user-initiated calibration consists of (1) a known accurate 5 or 10 MHz source, (2) a Giga-tronics 8540 or 8650 Universal Power Meter with an 80313A or equivalent power sensor, (3) a 1.00 to 6.00 Vdc source (this source can be a stable power supply and a voltmeter with 1% or better accuracy). Refer to Table 4-1 for the required equipment for FM calibration.

4.3.1   Equipment & Documentation Required

4.3.1.1   All Models

- Giga-tronics 12000 Cal Software CD (P/N 32464)
- Pentium™ PC with Windows 95/98™, Equipped with National Instrument IEEE 488™ Interface (Version NI-488/NI-488.2)
- Giga-tronics 8651A or 8652A Power Meter
- Giga-tronics 80313A Sensor
- Giga-tronics Series 12000A Microwave Synthesizer
- Giga-tronics Series 12000A Microwave Synthesizer Service Manual (P/N 31232)
- Male "N" to Female "K" Adapter (Only for Synthesizer Equipped with Option 23)
- 10 MHz Frequency Standard, Accuracy better than 1E-10, 5 to 5 V $_{P-P}$ into 100 ohms (Stanford Research FS 725 or Equivalent)

4.3.1.2 Additional Requirements (Series 125XXA/127XXA Only)

- DC Voltage Source 0-10 VDC, .5% Accuracy, 100 mA (Tektronix™ PS280 or Equivalent)
- Audio Oscillator, 10 Hz-200 kHz, 2 V $_{P-P}$ +/- .01 V into 50 ohm (Stanford Research™ DS-345 or equivalent)
- HP™ 8902A Measuring Receiver
- Giga-tronics Series 12520A or 12720A Synthesizer
- Giga-tronics Mixer/Divider (P/N 002CA04900)
- Digital Voltmeter 3 ½ digits (Fluke™ 8920A or Equivalent)

4.3.2 Timebase Calibration

The Series 12000A uses an internal 10 MHz oven oscillator to provide a frequency reference for the synthesizer and other associated circuits. The oscillator uses Electronic Frequency Control for its adjustment. Before calibrating the frequency of the oscillator, the instrument must be left connected to a power source for at least 24 hours. The oscillator runs when the instrument is in standby mode, so it is not necessary to have the instrument turned on during the warm-up period.

To perform the calibration, connect the 5 MHz or 10 MHz source to the Reference Input and initiate the calibration process from the service menu. The computer will determine the frequency of the external source then lock the internal oscillator to that source. After a stable phase lock has been achieved, the EFC voltage for the oscillator will be measured and stored. When the external source is removed the computer will set the EFC voltage to the stored value to maintain the set point.

4.3.3 Output Amplitude Calibration

There are three types of calibration associated with the amplitude control system. The first determines the relationship between the actual output power and the detector output voltage. Data is taken for each of the internal detectors and at each of the various gain settings in the input amplifier. The data is stored as coefficients to an equation, which describes the detector characteristic. The second set of data determine the relationship of the modulator input voltage to the change in output power. As with the detectors, data is developed for a set of coefficients used in a defining equation. The last calibration produces a table of correction coefficients as the frequency is varied over the operating range of the instrument

4.3.3.1 Power vs. Detector Voltage

For this calibration, the power sensor is connected from the power meter to the 12000A RF output, and the power meter IEEE 488 control is connected to an IEEE equipped computer. The test program supplied by Giga-tronics is now run. For each of the installed internal detectors (one is used for .01 to 2 GHz and another for 2 to 20 GHz) and for each gain range of the ALC input amplifier, the instrument will step the power and determine the relationship between the actual RF power and the dc input to the Analog-to-Digital Converter. This calibration is done at one frequency. The data taken develops a set of coefficients which are used in an equation that defines the shape of the detector curve.

4.3.3.2 Modulator Control vs. Applied Voltage

This calibration is essentially the converse of the previous one. Here the intent is to determine the relationship of the control voltage for the leveling modulator to the change in RF output power. A separate set of coefficients is developed for each octave.

4.3.3.3 Amplitude vs. Frequency Correction Factors

The last phase of the Amplitude Calibration sequence determines correction factors as the instrument is varied across its operating range. These correction factors compensate for RF path losses within the instrument and following the leveling detector. They also compensate for variations in the leveling coupler. During this test the instrument is set at a fixed amplitude and the frequency is stepped from the low to the high limit of the instrument.

4.3.4 Instrument Self Adjustment During Power Up

The following calibration adjustments are made each time the instrument is turned on:

4.3.4.1 YIG Oscillator Coarse Tuning Adjustment

Each time that the instrument is turned on an internal routine determines the setting of the YIG oscillator tuning DAC. The frequency is first set to 4.5 GHz and the DAC adjusted until the loop locks and the PLL voltage is approximately zero volts. This process is repeated at 7.5 GHz. Once the DAC settings for these two points are known, all other set points may be mathematically determined. This process insures that the coarse tuning for the oscillator is always optimized. It also allows replacement of the oscillator with no need to manually set up the tracking.

During CW and Step Sweep instrument operation the PLL control voltage is monitored by an ADC. If the voltage exceeds a narrow window around zero volts, the instrument computer automatically adjusts the coarse tune DAC in 1-bit steps to maintain the loop voltage within the window. This process occurs slowly and does not affect the instrument output. Use of this technique eliminates the possibility of unlock due to temperature variations or other drift causing mechanisms.

4.3.4.2 Tracking Filter Linearity

The tracking filter used in the synthesizer uses a wide range VCO whose tuning sensitivity varies considerably across its range. To maintain constant loop bandwidth, the loop gain is adjusted automatically as the frequency is varied.

4.3.4.3 ALC Offset

Another adjustment made each time the instrument is turned on compensates for any offset or zeroing errors in the amplifiers used for conditioning the detector outputs. Switching in the detector circuits removes the RF input of each of the detectors. An offset voltage is then summed into the input amplifier stage and the magnitude adjusted until the ADC output is near zero. This process is repeated for each gain range and each detector. The values are stored for use during leveling operation. These measurements are also taken at appropriate times during instrument operation to maintain the accuracy of the offset adjustment.

4.3.5 Factory Calibrations

4.3.5.1 ALC Temperature Compensation

To maintain accurate leveling operation over the specified temperature range, the instrument uses a set of data tables that are generated during normal instrument test. These data tables are a multi-dimensional array at various temperatures, levels, and detectors. There are sensors located adjacent to each detector to determine the temperature used by the computer for compensation purposes.

4.4   Performance Tests (Series 12500A/12700A)

Performance Tests (Series 12500A/12700A)	Model		Page
	124XXA	**125XXA/ 127XXA**	
4.4.1 - Amplitude Modulation Test	N/A	√	4-14
4.4.2 - Frequency Modulation Test	N/A	√	4-16
4.4.3 - Pulse Modulation On/Off Ratio Test	N/A	√	4-19
4.4.4 - Pulse Modulation Rise & Fall Time Test	N/A	√	4-20
4.4.5 - Pulse Modulation Overshoot & Settling Time	N/A	√	4-21
4.4.6 - Pulse Modulation Accuracy Test	N/A	√	4-22

Use the Performance Verification Test Data Sheet provided at the end to record your data. The data sheet is compatible with all three models.

☞   *NOTE: Units that have Option 24 will have these tests repeated using the internal generators.*

4.4.1 Amplitude Modulation Test

4.4.1.1 Description

The output from the 12000A is connected to a discriminator. The discriminator output is monitored on an oscilloscope to determine deviation and bandwidth.

4.4.1.2 Equipment Required

UUT ● Mixer/Divider ● Oscillator ● Measuring Receiver
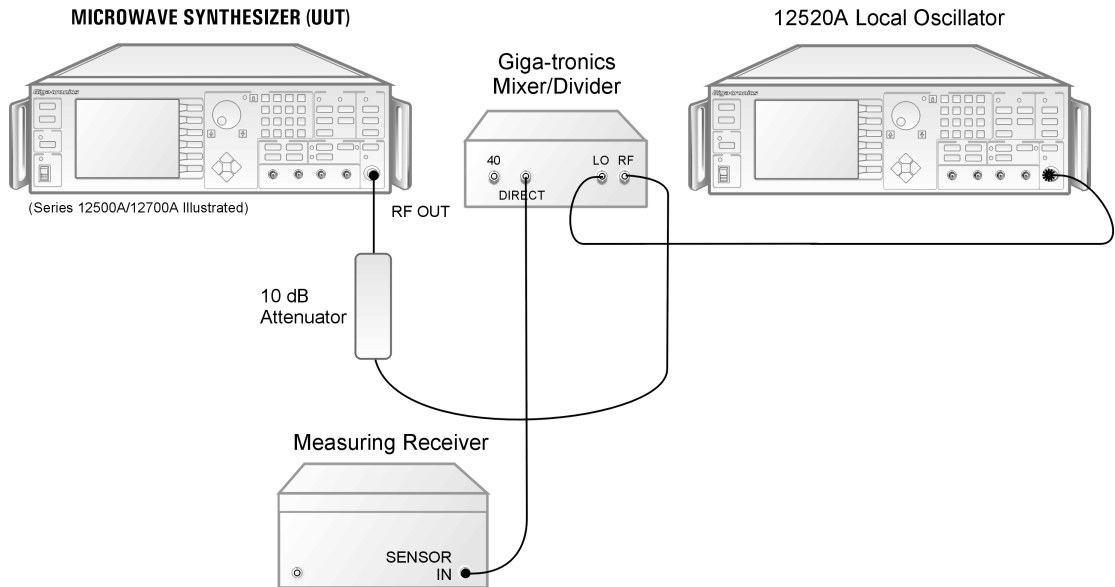
Figure 4-6: Amplitude Modulation Test

4.4.1.3 Procedure (AM Depth)

1. Set UUT to **1.5 GHz** with level set at 0 dBm. Connect UUT output to the Mixer Box RF input connector with a 10 dB pad.

2. Connect LO (Source) output to the Mixer Box LO input connector. Set LO frequency to 130 MHz higher than UUT and set source leveled output to 10 dBm.

3. Connect Direct output of Mixer Box to the HP 8902 Measuring Receiver RF input.

4. Connect Modulation Output/Audio Input to channel 2 of Oscilloscope.

    a. Set to 500 mV per Division.

5. On Measuring Receiver press **[FREQUENCY]** and verify 130 MHz on receiver.

6. Select **AM**, set measuring receiver filters to 50 Hz and 15 KHz. Press **[(PEAK-PEAK)/2 MODE]**.

7. On UUT turn **AM** on. Set depth to 50%. Connect the DS-345 Function Generator at 1 KHz modulation to the AM input. Set scope to 50 Ohm termination and sinewave amplitude for a

2 V $_{P-P}$ signal. Press **[AM]** button on Measuring Receiver. Verify a reading of 40.0 to 60.0% on the measuring receiver.

8. Set external function to SQR. Turn off all filters on the measuring receiver. Verify a receiver reading of 40.0 to 60.0% (Typical).

9. Set external function to TRI and verify that the measuring receiver reads 40.0 to 60.0%

10. Set UUT to 10 GHz. Repeat Steps 2 to 8.

11. At 1.5 and 10 GHz, check AM Depth at 30, 90% modulation. Verify accuracy of +/- 10% of reading at each step.

12. Enter data in the **AM Modulation Test - AM Depth** area of the Series 12000A Microwave Synthesizers Performance Verification Data Sheet, Section 4.4.1.3.

4.4.1.4   Procedure (AM Bandwidth)

1. Set UUT to 1.5 GHz with level set at 0 dBm. Set AM Depth to 50% @ 1 KHz rate (Sinewave).

2. Verify a 50% reading on HP 8902 with filters turned off. On receiver, press **[RATIO]**, then the **[LOG/LIN]** button, display indicates 0.00 dB.

3. Vary the frequency of the external DS-345 Function Generator from DC to 150 KHz. Verify that the amount of change is within the +/- 3 dB window.

4. Repeat steps 1 to 3 for 10 GHz.

5. Complete the **AM Modulation Test - AM Bandwidth** area of the Series 12000A Microwave Synthesizers Performance Verification Data Sheet, Section 4.4.1.4.

4.4.2 Frequency Modulation Test

4.4.2.1 Description

The output from the 12000A is connected to a discriminator. The discriminator output is monitored on an oscilloscope to determine deviation and bandwidth.

4.4.2.2 Equipment Required

UUT • Function Generator • Oscilloscope • Digital Voltmeter • FM Test Fixture
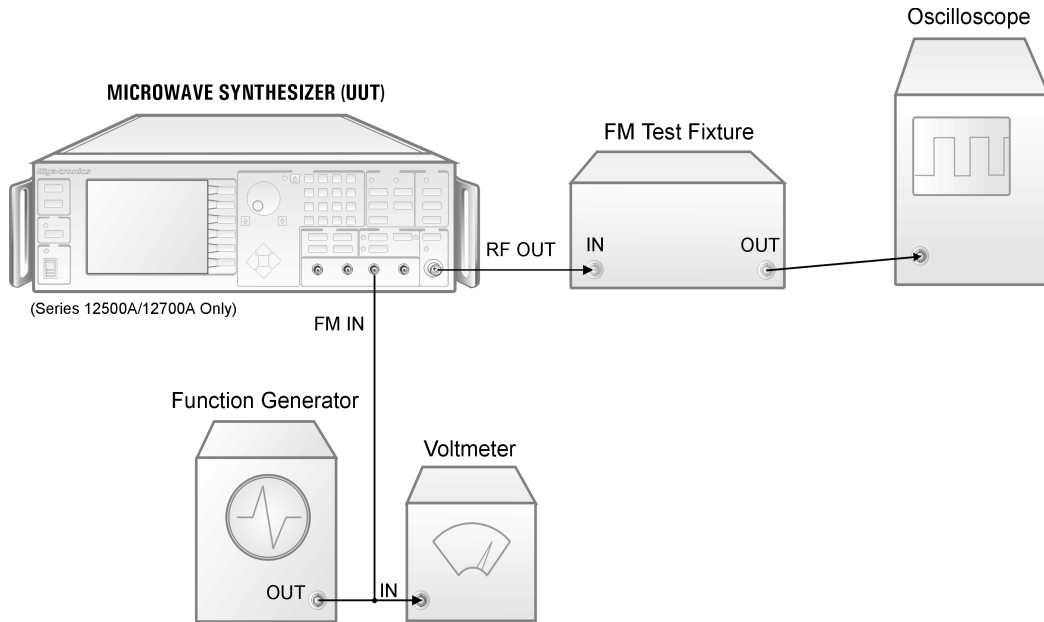
Figure 4-7: Frequency Modulation Test

4.4.2.3 Delay Discriminator Description

In order to calibrate and test the frequency modulation circuits, a special test fixture must be assembled. The recommended FM test fixture includes an RF splitter, two lines of unequal length, and an RF mixer. The RF output of the 12000A is divided by the splitter into two signals, unequally delayed.

Different length cables determine the number of frequency nulls or 0 volt outputs found in the frequency band of interest. For the Frequency Modulation performance test, the frequency band of interest is 4 to 8 GHz.

The procedure does not identify a specific mixer for the discriminator circuit. There are two factors to consider when selecting a mixer.

1. The mixer RF and LO frequency range must be greater than 4 to 8 GHz.

2. A low conversion loss mixer will provide a higher output.

Maximizing Delay Discriminator Output

Obtaining a six division change on a 5 mV scale may be difficult to obtain for a 1 MHz change in frequency. Increasing output power will improve the output of the discriminator. The output of the UUT can be adjusted to levels as high as +13 dBm or higher for the 4 to 8 GHz frequency band. The output performance of discriminator is improved with a very high cable length ratio. Cable length ratios of 16 to 1 (48 inches to 3 inches) will produce a large number of frequency nulls within the 4 to 8 GHz frequency band.

☞ **NOTE:** *Increasing the number of frequency nulls increases the rate of change of the output voltage per unit frequency as the output transitions through the frequency null.*

Optimal Test Performance Null Selection

The maximum deviation of the Frequency Modulation test is ±10 MHz. The rate of change for the output voltage per unit frequency ($\Delta V/\Delta F$) must remain constant (linear) for the ±10 MHz deviation range. Rate changes within this deviation range will result in a non-symmetrical waveform and will produce invalid test results.

Identifying an optimal frequency null is achieved by sweeping the frequency through the frequency range of the test and observing the Delay Discriminator waveform on an oscilloscope.

Recommended Test Equipment (FM)

- Delay Discriminator
- Digital Oscilloscope
- Pulse Generator with 1 shot Capability
- BNC Cables and Tee

Recommended Configuration

1. Connect the input of the delay discriminator to the RF output of the 12000A and the output to the digital scope.

2. Set the 12000A to Sweep Mode with the following settings:

   a. Start Frequency: 4 GHz

   b. Stop Frequency: 8 GHz

   c. Sweep Type: Ramp

   d. Sweep Time: 900 msec

   e. Repeat Mode: Single Sweep

   f. Trigger Type: Trigger in BNC

   g. Power: +10 dBm

3. Connect the output of the pulse generator to the External Trigger Input or second channel of the digital scope and the Trigger In of the 12000A.

4. Set the trigger selection of the digital scope to the port where the trigger signal will be detected (Use the BNC Tee at this port).

5. Adjust the time base of the digital scope to 1 second for the entire span of the X axis (100 mSec typical). Set the vertical scale to 100 mV per division.

6. Pulse the generator to initiate the RF sweep.

Repeat the sweep several times. The output of the Delay Discriminator should not vary from one sweep to another. Review the waveform and identify the nulls where the voltage transitions through the nulls are steeper and linear for a ±50 mV range above and below the null. Perform the FM modulation tests at these frequency nulls.

For certain frequencies, which may be identified by experiment, the mixer will produce a DC voltage near zero. The number of null frequencies can be increased by making the delay lines longer in absolute terms or by increasing the ratio between their lengths. If the output becomes frequency modulated, the mixer output voltage will change, and the voltage variation will be proportional to FM deviation.

The polarity of the voltage change may be either directly or inversely related to the direction of frequency deviation. When voltage levels have been established for different frequencies, the mixer output can be monitored on an oscilloscope to provide a continuous display of FM deviation.

4.4.2.4 Procedure

1. Connect the FM test fixture to the RF OUT connector of the 12000A as shown in Figure 4-7. Monitor the mixer output with the oscilloscope (5 mV/div). Set the 12000A to any null frequency between 4.0 and 7.99 GHz (that is, at a frequency where the mixer output voltage is zero); +10 dBm out, no modulation.

2. Establish the voltage at 1 MHz above and 1 MHz below the null frequency. Adjust the oscilloscope gain and the 12000A output power level (near +5 dBm) to place the null point at the center of the screen and the 1 MHz deviation points at 3 divisions above and 3 divisions below the null point.

3. Set the 12000A to Narrow EXT FM with 1 MHz deviation. Connect the function generator, set to a 100 kHz rate SINE wave, 2 $V_{P\text{-}P}$. Verify that the waveform is 6 divisions peak-to-peak.

4. Adjust the 12000A FM deviation for exactly a six division peak-to-peak display. Vary the function generator from 10 Hz to 1 MHz and verify that the display remains between five and seven divisions peak-to-peak.

5. Vary the function generator from 1 MHz to 8 MHz and verify that the display remains between 4 and 8 divisions.

6. Establish the voltage at 10 MHz above and below the null frequency. Adjust the oscilloscope gain and the 12000A output power level (near +5 dBm) to place the null point at the center of the screen and the 10 MHz deviation points at 3 divisions above and 3 divisions below the null point (terminate the Mixer output in 50 Ω).

7. Set the 12000A to Wide EXT FM with 10 MHz deviation. Set the function generator to 100 kHz. Verify that the waveform is 6 divisions peak-to-peak.

8. Adjust the 12000A FM deviation for exactly a 6-division peak-to-peak display. Vary the function generator from 100 Hz to 1 MHz and verify that the display remains between 4.7 and 7.3 divisions.

9. Vary the function generator from 1 MHz to 8 MHz and verify that the display remains between 4 and 8 divisions.

4.4.3 Pulse Modulation On/Off Ratio Test

4.4.3.1 Description

The 12000A is set to a CW frequency at a power level of 0 dBm. A spectrum analyzer is used to view the signal. The pulse modulation is then enabled and the resulting waveform is measured.

4.4.3.2 Equipment Required

UUT • Spectrum Analyzer • Pulse Generator • Coaxial Cable
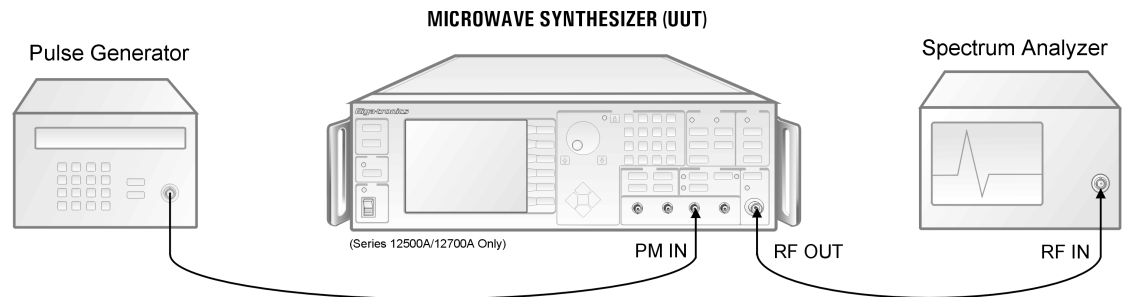
Figure 4-8: Pulse Modulation On/Off Ratio Test

4.4.3.3 Procedure

1. Connect the equipment as shown in Figure 4-8. Allow 30 minutes warm-up time.

2. Enter the first frequency on the test data sheet within the frequency range of the instrument. The RF power level should be at 0 dBm. Select external pulse modulation (PM) on the 12000A.

3. Tune the analyzer to the source frequency, select an analyzer span of 0 Hz and fine tune the analyzer to place the line at the top of the screen graticule (adjust analyzer reference level as needed).

4. Set the pulse generator for a 100 Hz square wave; press **[PULSE]** then use the softkey to turn on the pulse modulation.

5. Adjust the analyzer sweep time to display a few cycles of the waveform. Use internal triggering. Reduce resolution bandwidth and carefully retune the analyzer center frequency until the maximum resolution is achieved. Read and record the peak-to-peak value (use marker delta).

6. Repeat steps 3, 4 and 5 for all other test data sheet frequencies which are within the range of the instrument. Note that the dynamic range of the analyzer may limit its measurement capability.

4.4.4   Pulse Modulation Rise & Fall Time Test

4.4.4.1   Description

A crystal detector is connected to the 12000A, terminated in 50 Ω, and monitored with an oscilloscope.

☛   **NOTE:** *It is very important to use either the specified detector or one with similar rise time characteristics. Even when terminated in 50 Ω with a short cable, the detector parameters can markedly influence the measurement.*

4.4.4.2   Equipment Required

UUT • Oscillator • Pulse Generator • Crystal Detector • Coaxial Cable
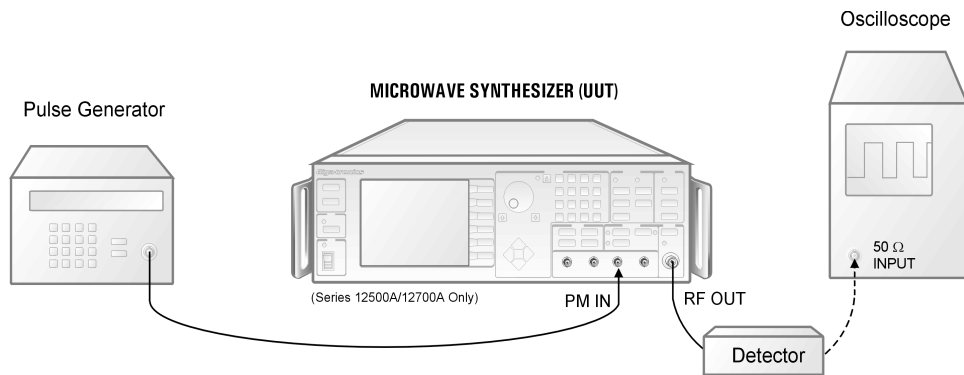
Figure 4-9: Pulse Modulation Rise/Fall Time Test

4.4.4.3   Procedure

1.   Connect the equipment as shown in Figure 4-9. The cable from the detector to the oscilloscope should be kept as short as possible.

2.   Press **[PRESET]** on the 12000A and set the frequency to the first test data sheet frequency within the operating range of the instrument.

3.   Enable external pulse modulation (at a 1 MHz rate and 0.5 μs width) on the 12000A. Press **[PULSE]** and use the softkey to turn on pulse modulation.

4.   Set the oscilloscope to 5 mV/div and using the RF Level control of the 12000A, adjust the peak to peak oscilloscope display to fall on the dotted lines on the screen (100% and 0%). Adjust the oscilloscope sweep time to 5 ns/div. Measure and record the rise and fall times between the 10% and 90% points.

5.   Repeat Step 4 for each of the test data sheet frequencies within the operating range of the instrument.

4.4.5 Pulse Modulation Overshoot & Settling Time

4.4.5.1 Description

A crystal detector is connected to the 12000A, terminated in 50 Ω and monitored with an oscilloscope.

☛ **NOTE:** *It is very important to use either the specified detector or one with similar rise time characteristics. Even when terminated in 50 Ω with a short cable, the detector parameters can markedly influence the measurement.*

4.4.5.2 Equipment Required

UUT • Oscillator • Pulse Generator • Crystal Detector • Coaxial Cable
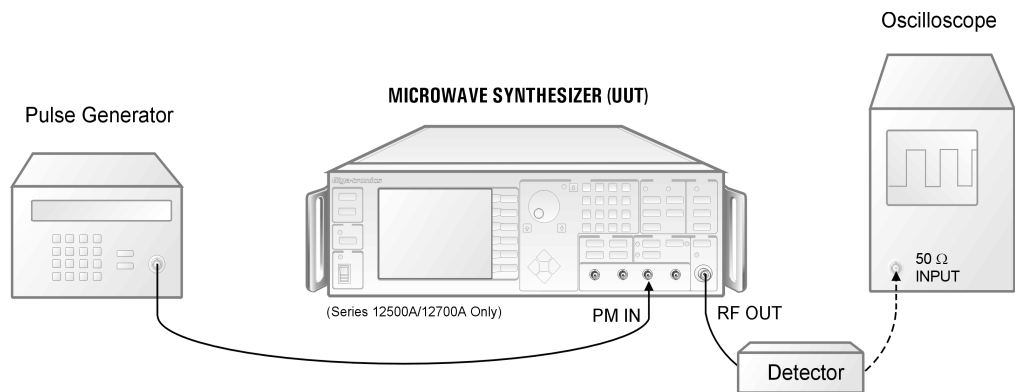
Figure 4-10: PM Overshoot and Setting Time

4.4.5.3 Procedure

1. Connect the equipment as shown in Figure 4-10. The cable from the detector to the oscilloscope should be kept as short as possible.

2. Press **[PRESET]** on the 12000A and set the frequency to the first test data sheet frequency within the operating range of the instrument.

3. Enable external pulse modulation (at a 1 MHz rate and 0.5 ms width) on the 12000A. Press **[PULSE]** and use the softkey to turn on pulse modulation.

4. Set the oscilloscope to 5 mv/div and using the RF Level control of the 12000A and the vertical position of the oscilloscope, adjust the peak to peak oscilloscope display to be from the top of the screen (pulse off) to 2 divisions below the center line (pulse on). Adjust the oscilloscope sweep time to 50 ns/div. Change the level setting of the 12000A by plus and minus 1 dB and note the graticule position of the pulse on level. Return to the original value. Measure and record the time for the pulse to be within 1 dB of its final value.

5. Change the level setting of the 12000A by plus and minus 2 dB and note the graticule position of the pulse on level. Return to the original level. Measure and record any undershoot/overshoot of the signal.

6. Repeat Steps 4 and 5 for each of the test data sheet frequencies within the operating range of the instrument.

4.4.6   Pulse Modulation Accuracy Test

4.4.6.1   Description

In this test the peak pulse level is compared to the level in the CW mode.

4.4.6.2   Equipment Required

UUT ● Oscilloscope ● Pulse Generator ● Crystal Detector ● Coaxial Cable
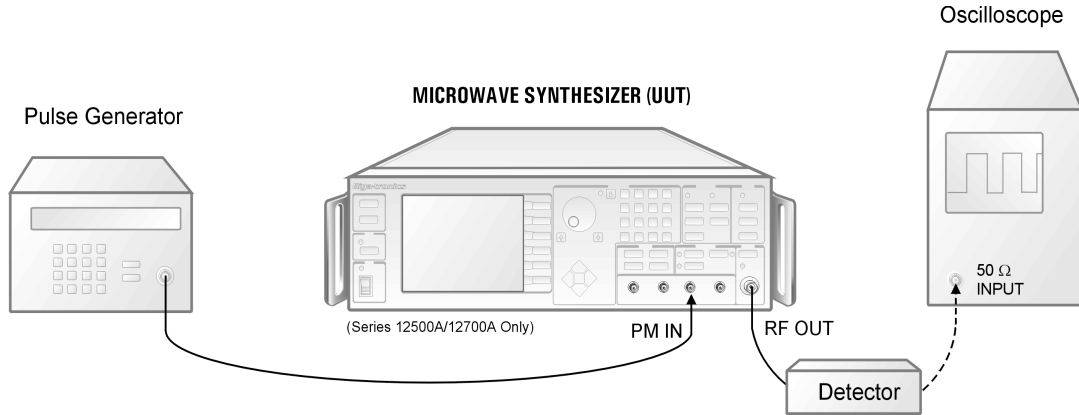
Figure 4-11: Pulse Modulation Accuracy Test

4.4.6.3   Procedure

1. Connect the equipment as shown in Figure 4-11. The oscilloscope input impedance should be 50 Ω. Allow 30 minutes warm-up.

2. Press **[PRESET]** on the 12000A and set the frequency to the first test data sheet frequency within the operating range of the instrument.

3. Set the oscilloscope to 5 mv/div and using the vertical position of the oscilloscope, adjust the trace to the centerline of the screen. Change the level setting of the 12000A by plus and minus 1 dB and note the trace position on the screen. Return to 0 dBm.

4. Enable external pulse modulation (at a 200 kHz rate and 0.1 μs width) on the 12000A. Press **[PULSE]** and use the softkey to turn on pulse modulation.

5. Measure and record the difference between the CW reference level and the negative peak of the pulse.

6. Change the pulse width to 50 ns and again measure and record the difference between the CW reference level and the negative peak of the pulse.

7. Repeat Steps 3-6 for each test data sheet frequency within the operating range of the instrument.

4.5   Calibration (Series 12500A/12700A Native)

Calibration (Series 12500A/12700A)	Model	
	124XXA	**125XXA/ 127XXA**
4.5.1 - Frequency Modulation Calibration	**N/A**	√
4.5.2 - Amplitude Modulation Calibration	**N/A**	√
4.5.3 - Mode Related Calibrations	**N/A**	√

Use Section 4.3 for calibration data pertaining to all three models. Use this section for native specific data belonging to the 125XXA/127XXA models. Refer to the Series 12000A Microwave Synthesizers Service Manual for detailed calibration instructions (P/N 31232).

4.5.1   Frequency Modulation Calibration

The calibration of the Frequency Modulation function is accomplished by using a known external source (the 1 Vdc supply) to measure various gains within the FM system. For this test, it is recommended that the external power source be connected to the FM input with a series resistor of approximately 500 Ω This will provide about a 10:1 voltage divider (the FM input is 50 Ω). Measure the voltage at the input connector with a digital voltmeter and set it to 1.00 V. For those parts of the test requiring a zero volt input, simply remove the connection to the FM input connector and the internal 50 Ω pull-down resistor will establish zero volts.

The FM calibration is divided into two parts, the low band and the high band. In the low band, the DDS portion may be directly calibrated since the DDS provides a fixed frequency increment for every accumulator set point bit increment. This allows calculating the multiplication coefficient for converting FM-ADC bits to DDS bits. Once the DDS is calibrated, it provides a precise shift in the loop control voltage. This voltage is null'ed using an internal voltage previously calibrated by the 1 Vdc source. The gains and offsets required to produce the null become the calibration factors for the high band.

4.5.2   Amplitude Modulation Calibration

The calibration of the Amplitude Modulation function is accomplished by using a known external source (the 1 V and 6 V supply) to measure various gains within the AM system. For this test, it is recommended that the external power source be connected to the AM input with a series resistor of approximately 600 Ω for 1 volt and 600 Ω for 6 volts. This will provide about a 10:1 or 2:1 voltage divider (the AM input is 600 Ω). Measure the voltage at the input connector with a digital voltmeter and set it to 1.00 V or 6.00 V as prompted. For those parts of the test requiring a zero volt input, simply remove the connection to the AM input connector and the internal 600 Ω pull-down resistor will establish zero volts.

Since the Amplitude Modulation system is dc coupled, the application of the accurate 1 Vdc source allows the instrument computer to set the gain calibration to produce an appropriate shift in carrier power. Once this calibration has been done, application of a modulating signal will produce the proper depth.

4.5.3 Mode Related Calibrations

Whenever this mode of operations is selected (as always, through the AM Menu) and the AM function is turned on, the instrument automatically performs a calibration of the modulator at whatever output frequency has been selected.   Whenever either the frequency, power level, or both are to be changed, the preferred procedure is to switch the AM function off, make whatever frequency and/or power level changes are desired, then switch AM function back on. This technique provides the best possible accuracy for SCAN over its 60 dB range.

SERIES 12000A MICROWAVE SYNTHESIZERS
Performance Verification Test Data Sheet (Page 1 of 2)

Under Test Result record measured values (if any). In the case of a function check or range check, write OK to indicate that the unit under test meets specifications.

Serial Number:		Tested By:	
Date:		Quality Assurance:	

Frequency Range, Resolution, Accuracy

	Frequency	Harmonics
	12 MHz	
	24 MHz	
	48 MHz	
	100 MHz	
	200 MHz	
4.2.2.3	400 MHz	
	750 MHz	
	1500 MHz	
	3 GHz	
	6 GHz	
	12 GHz	
	18 GHz	

Spurious Signals Tests

	Frequency (MHz)	Harmonics	Non-Harmonics
	770.550		
	1513.425		
4.2.3.3	4004.000		
	9182.433		
	17361.522		

Single Sideband Phase Noise (dBc/Hz)

	Frequency (MHz)	Offset from Carrier				
		100 Hz	1 kHz	10 kHz	100 kHz	1 MHz
	1513.425					
4.2.4.3	4004.000					
	9182.433					
	17361.522					
	23541.349					

RF Output Power

	Test Result		
4.2.5.3	Max. Power Level		
	Power Level		
4.2.5.4	Step Attenuator Test Frequencies	1.0 GHz	
		4.0 GHz	
		12.0 GHz	
		17.0 GHz	

SERIES 12000A MICROWAVE SYNTHESIZERS
Performance Verification Test Data Sheet (Page 2 of 2)

Serial Number:		Tested By:	
Date:		Quality Assurance:	

Amplitude Modulation Test (SERIES 12500A/12700A ONLY)

	AM Depth (+/- 10%)		30%		50%		90%	
	Frequency 1.5 GHz	Int.	Ext.	Int.	Ext.	Int.	Ext.	
	Sinewave							
	Square Wave							
4.4.1.3	Triangle Wave							
	Frequency 10 GHz	Int.	Ext.	Int.	Ext.	Int.	Ext.	
	Sinewave							
	Square Wave							
	Triangle Wave							

	AM Bandwidth (Spec. +/- 3 dB)	Int.	Ext.
4.4.1.4	Frequency 1.5 GHz		
	Frequency 10 GHz		

Frequency Modulation Test (SERIES 12500A/12700A ONLY)

	Parameter	@1 GHz	@4 GHz	@12 GHz	@20 GHz
	Deviation (5.7 - 6.3 div)				
	Bandwidth (5 - 7 div)				
	Bandwidth (4 - 8 div)				
4.4.2.3	Deviation (5.7 - 6.3 div)				
	Bandwidth (5 - 7 div)				
	Bandwidth (4 - 8 div)				

Pulse Modulation Test (SERIES 12500A/12700A ONLY)

Frequency (GHz)		1.0	4.0	12.0	20
4.4.3	On/Off				
4.4.4	Rise/Fall				
4.4.5	Overshoot/Settling				
4.4.6	Accuracy				

A

Accessories & Options

A.1 Introduction

Introduction (Accessories & Options)	Model	
	124XXA	**125XXA/ 127XXA**
	√	√

The following accessories and options are available for the Series 12000A Microwave Synthesizers. Each accessory and option is described under its respective heading in this appendix.

Table A-1: Accessories & Options

Accessory/ Option No.	Description	Part Number	Field Installable
A001	Cable Kit (SMA)	29847	N/A
A002	Rack Mount with Slides	29901	Yes
A003	Rack Mount without Slides	29902	Yes
A010	Extra Operation Manual	31231	N/A
	Series 12000A Service Manual	31232	N/A
A011	Ruggedized Carrying Case	29855	N/A
20	High Power RF Output **(SEE SECTION 1.5.3 FOR OPTION LIMITATIONS THAT APPLY TO ONLY THE SERIES 124XXA MODEL)**	29884	Yes*
22	Rear Panel RF Out	29888	Yes*
23	Type N RF Output Connector	29891	Yes*
24	Internal Modulation Generator **(SERIES 125XXA/127XXA ONLY)**	29890	Yes*
26	Step Attenuator (20 GHz Instruments)	29882	Yes*
29	Scan Modulation **(SERIES 125XXA/127XXA ONLY)**	29913	No
30	International Configuration	29892	No
36	1 kHz Frequency Resolution	29892	N/A
	Labview Driver	29886	N/A

* = At Service Center

A.2 Accessories

Accessories	Model	
	124XXA	**125XXA/ 127XXA**
A.2.1 - A001: Cable Kit (SMA)	√	√
A.2.2 - A002: Rack Mount with Slides	√	√
A.2.3 - A003: Rack Mount without Slides	√	√
A.2.4 - A010: Operation Manual	√	√
A.2.5 - A011: Ruggedized Carrying Case	√	√

A.2.1 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.2.2 A002: Rack Mount with Slides

This is a field kit for mounting the Series 12000A in a standard equipment rack. The kit includes mounting slides. The kit is available from Giga-tronics with part number 29901. The components included are listed below.

A.2.3 A003: Rack Mount without Slides

This is a field kit for mounting the Series 12000A in a standard equipment rack. The kit does not include mounting slides. The kit is available from Giga-tronics with part number 29902.

A.2.4 A010: Operation Manual

Use part number 31231 to order additional copies of the instrument's Operation manual. Use part number 31232 to order the Series 12000A Microwave Synthesizers Service Manual.

A.2.5 A011: 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.3   Options

Options	Model	
	124XXA	**125XXA/ 127XXA**
A.3.1 - Option 20: High Power RF Out	√ (Limitations Apply, See Section 1.5.3)	√
A.3.2 - Option 22: Rear Panel RF Output Connector	√	√
A.3.3 - Option 23: Type N RF Output Connector	√	√
A.3.4 - Option 24: Internal Modulation Generator	**N/A**	√
A.3.5 - Option 26: Step Attenuator (20 GHz Instruments)	√	√
A.3.6 - Option 29: Scan Modulation	**N/A**	√
A.3.7 - Option 36: 1 kHz Frequency Resolution	√	√

A.3.1   Option 20: High Power RF Out

Option 20 provides the instrument maximum power specification changed to +20 dBm if installed. This change is accomplished by adding a pair of amplifiers and a coaxial relay. The coaxial relay is used to either bypass the amplifiers (for set points below +11 dBm) or place them in the circuit when the power requested is +11 dBm or higher. The operation of the relay is automatic, based on the requested power unless high power is disabled. The ALC menu has an entry for high power that allows either Automatic operation or disable mode. The table below lists the specifications that are changed when Option 20 is active. Specifications apply from 0° to 35^oC.

☛   **NOTE:** *Due to the losses in the relay and the extra cables, the maximum power of the instrument with Option 20 disabled is 2 dB less than the standard instrument specification.*

A.3.2   Option 22: Rear Panel RF Output Connector

Option 22 provides the RF output connector which is relocated to the Series 12000A's rear panel if installed. Option 22 can be installed with or without Option 26.

A.3.3   Option 23: Type N RF Output Connector

Option 23 changes the RF output connector to Type N if installed.

A.3.4   Option 24: Internal Modulation Generator

Option 24 provides two built-in function generators for creating AM, FM and pulse envelopes only for the Series 125XXA/127XXA models. This option has been incorporated into the main body of the publication; a procedure or specification applies only to instruments with this option where a note to that effect is included.

A.3.5   Option 26: Step Attenuator (20 GHz Instruments)

Option 26 provides an attenuator which is placed in the RF output path of the instrument, providing up to 110 dB of attenuation in 10 dB increments. This option has been incorporated into the main body of the publication; a procedure or specification applies only to instruments with this option where a note to that effect is included.

A.3.6   Option 29: Scan Modulation

Option 29 provides Scan Modulation only for the Series 125XXA/127XXA models.

A.3.7   Option 36: 1 kHz Frequency Resolution

Option 36 provides a frequency resolution to the instrument of 1 kHz if installed.

B

Firmware Field Upgrade

B.1 Introduction

Introduction (Firmware Field Upgrade)	Model	
	124XXA	125XXA/ 127XXA
	√	√

This following describes the process by which the Series 12000A Microwave Synthesizers may have its application firmware upgraded using a straight-through RS-232 cable. The following components are necessary:

- A PC running Windows 95, 98, 2000, or NT 4.0 with a free serial COM port
- A DB9 male-to-female, straight-through RS-232 cable
- A checksummed binary file of the desired synthesizer firmware and the download utility for Giga-tronics products both of which can be obtained after Download Registration at the Giga-tronics website, **www.gigatronics.com**

B.2 Series 12000A Firmware Upgrade Procedure

Series 12000A Firmware Upgrade Procedure	Model	
	124XXA	125XXA/ 127XXA
	√	√

Series 12000A firmware code is in the form of V07X-BXX-XX, where V07X can be either V072 or V073. Verify the version firmware currently installed by turning on the 12000A and observing the version firmware number on the start-up screen. If your code is V073, then proceed to download the latest version firmware following the instructions on the Giga-tronics website (after Download Registration).

If the instrument firmware version is V072, contact the factory to obtain instructions on the upgrade procedure for the unit.

☛ *NOTE: If the latest version firmware is installed in a V072 instrument without the proper procedure, the upgrade will not finalize.*

For information on the upgrade procedure for version V072 instruments please contact Giga-tronics at 800.726.4442 or 925.328.4650 or E-mail us at info@gigatronics.com.

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