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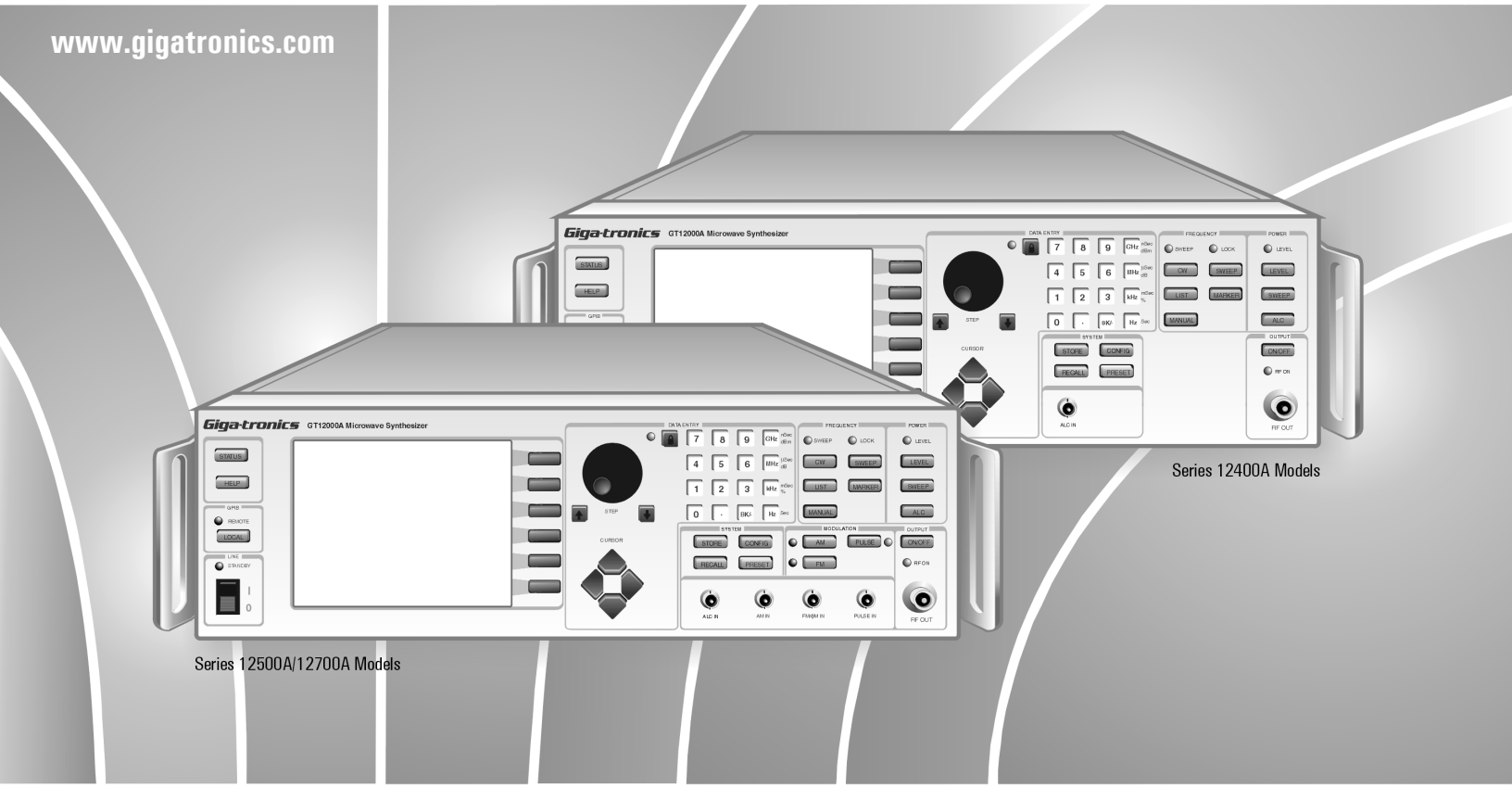

Series 12000A Microwave Synthesizers

Operation Manual

Publication 31231, Rev. J, October 2003

Registered 04 June 1996 ❖ Amended 10 September 2001
CE Certified Product
ISO 9001 Certified Process
Registrar: BSI, Certification FM 34226

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WARRANTY

Giga-tronics Series 12000A instruments are warranted against defective materials and workmanship for one year from date of shipment. Giga-tronics will at its option repair or replace products that are proven defective during the warranty period. This warranty DOES NOT cover damage resulting from improper use, nor workmanship other than Giga-tronics service. There is no implied warranty of fitness for a particular purpose, nor is Giga-tronics liable for any consequential damages. Specification and price change privileges are reserved by Giga-tronics.

MODEL NUMBERS

The 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.

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

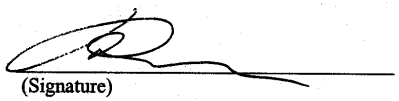
Manufacturer's Address:
4650 Norris Canyon Road
San Ramon, California 94583
U.S.A.

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).

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

San Ramon, California (Place)

August 2, 2002 (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	√	v
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

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

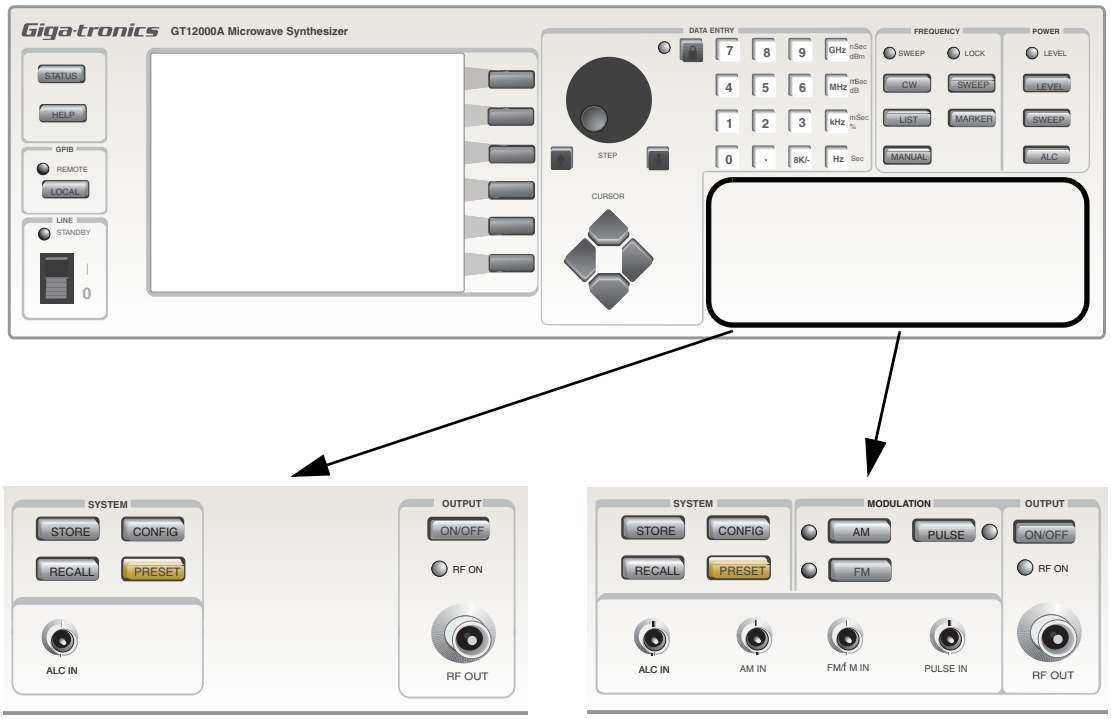
1.3 Inputs/Outputs

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).

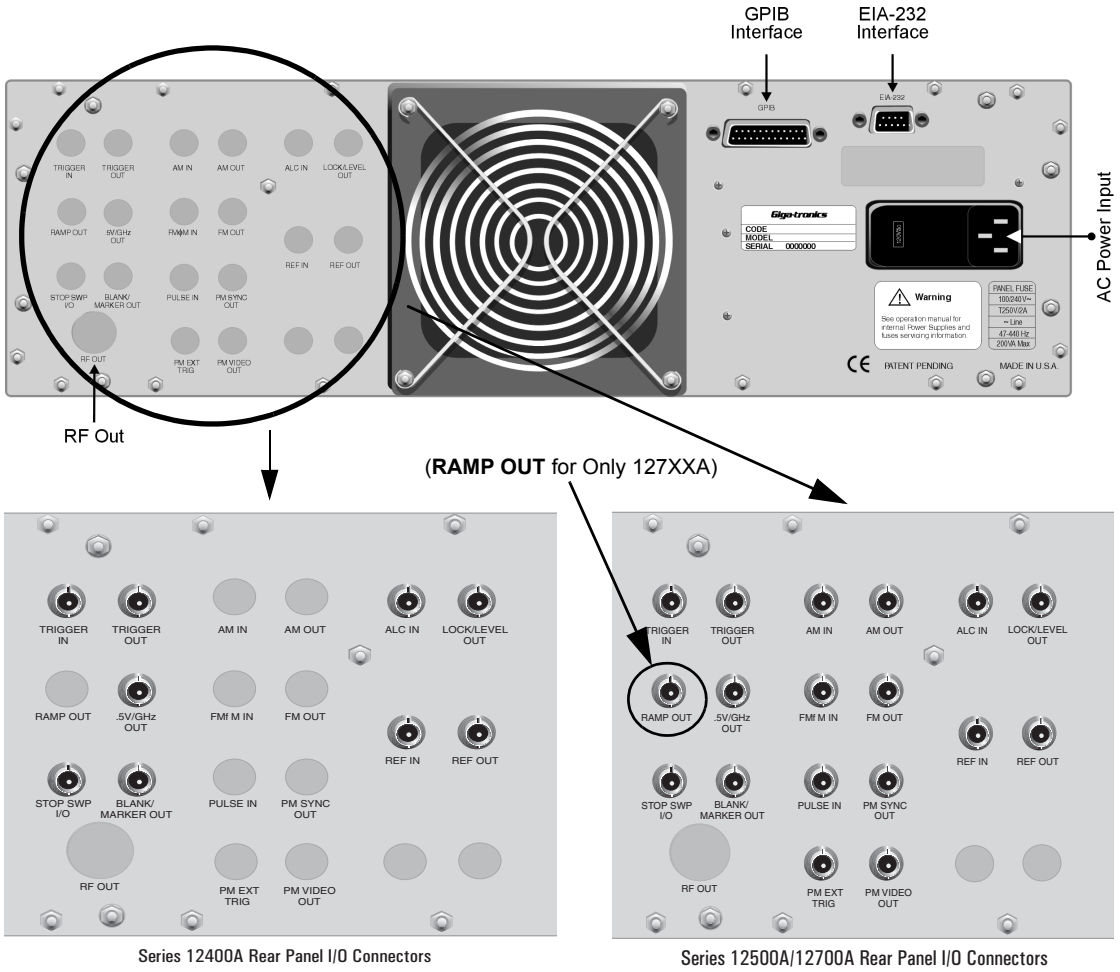


Figure 1-2: Series 12000A Rear Panel Inputs/Outputs (All Models)

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

I/O Connector (Front)	I/O Connector (Rear)	Description	Model	
			124XXA	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/fM IN	FM/fM 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).

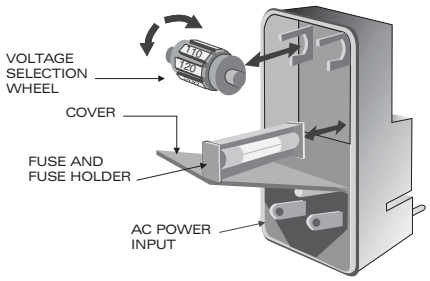


Figure 1-3: Fuse Holder

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)

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 ms 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 ms; 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 £ [L1 ¼ L2] £ LB Sweeps up or down from a preset start level (L1) to a preset stop level (L2)
Start/Δ	LA £ [L1 ± DL] ≤ LB Sweeps up or down from a preset start level (L1) through a preset sweep width (DL)
CTR/Δ	LA £ [CL ± (DL/2)] £ LB Sweeps up or down through a preset sweep width (DL) centered symmetrically about a preset center level (LF)
Start/Steps	LA £ [L1 ± (Step Size ¥ Number of Steps)] £ 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 ms
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≤ [F1 = F2] ≤ FB Sweeps up or down from a preset start frequency (F1) to a preset stop frequency (F2)
Start/Δ	FA≤ [F1 ± ΔF] ≤ FB Sweeps up or down from a preset start frequency (F1) through a preset sweep width (ΔF)
CTR/Δ	FA≤ [CF ± (ΔF/2)] ≤ FB Sweeps up or down through a preset sweep width (ΔF) centered symmetrically about a preset center frequency (CF)
Δ MKR	FA ≤ [Mx My]≠ ≤ 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 ±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 ±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 ms
20 ms to 200 ms	100 ms
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 ±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

±2 dB for rates from 100 Hz to 1 MHz; ±3 dB to 8 MHz

Residual FM

See table contained in Section 1.7.3.2

Modulation Accuracy

±5% at max deviation, 190 kHz modulation rate

Distortion

< 5% (±1 MHz Deviation)

Incidental AM

< ±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 (measured at 1 V_{P-P} input, i.e. 500 kHz Deviation)
±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. fM 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

±2 dB for rates from 100 Hz to 100 kHz

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

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

±2 dB for rates from 100 Hz to 1 MHz 9 (measured at 1 V_{p-p} input, i.e. 500 kHz Deviation)

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 ± 10° C

±0.5 dB, ≥100 ns pulse width (±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 ms

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 ms	< 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, ≥75 ns wide (leveled output)
≥ 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 ± 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		
Rate Resolution	Range	Resolution
	1 Hz to 1 kHz	1 Hz
	1 kHz to 10 kHz	10 Hz
	10 kHz to 100 kHz	100 Hz
	100 kHz to 1 MHz	1 kHz
	1 MHz to 3 MHz	10 kHz
	Accuracy	±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
±2.5% of setting or ±20 ns, whichever is greater

Jitter
±0.01% of setting or ±100 ps, whichever is greater

1.8.1.5 Pulse Width

Range
0 to 1.67 seconds

Resolution
10 ns

Accuracy
±2.5% of setting or ±20 ns, whichever is greater

Jitter
±0.01% of setting or ±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	±2.5% 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, ≥ +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 (At cal points)	±0.25 dB plus +/- 5% of depth in dB (For .01 to 2 GHz, specification applies only up to 30 dB) and frequencies above 2 GHz is 50 dB.	
	Linearity at	±0.6 dB (0 - 20 dB), ±1 dB (20 - 50 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

Introduction (Front Panel Operation)	Model	
	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:

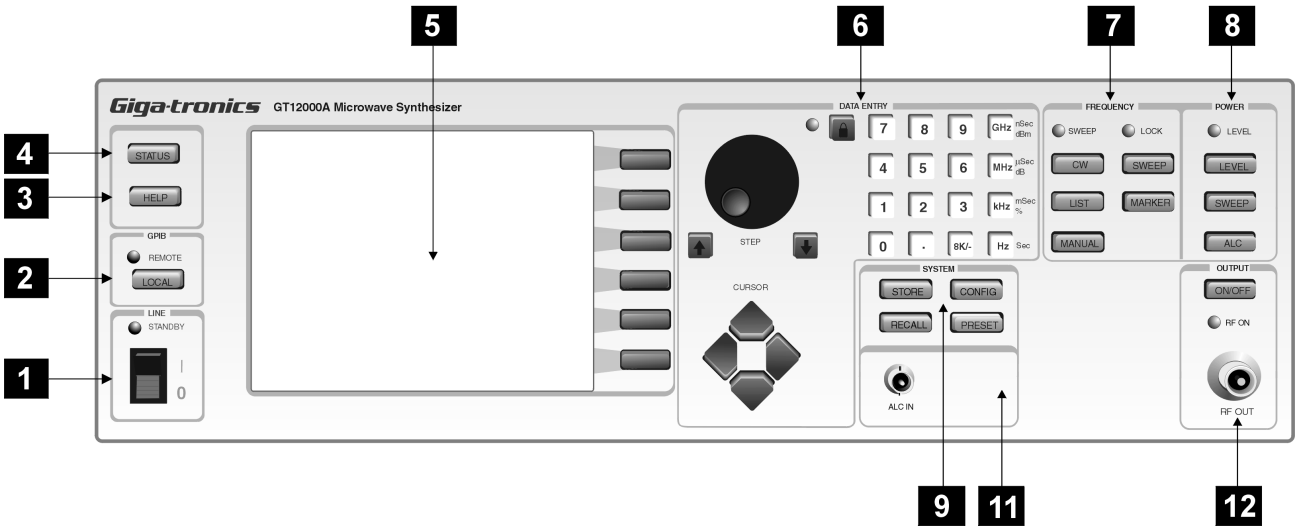
- Front Panel Description
- Front Panel Applications

2.2 Front Panel Description

Frontal Panel Description	Model	
	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

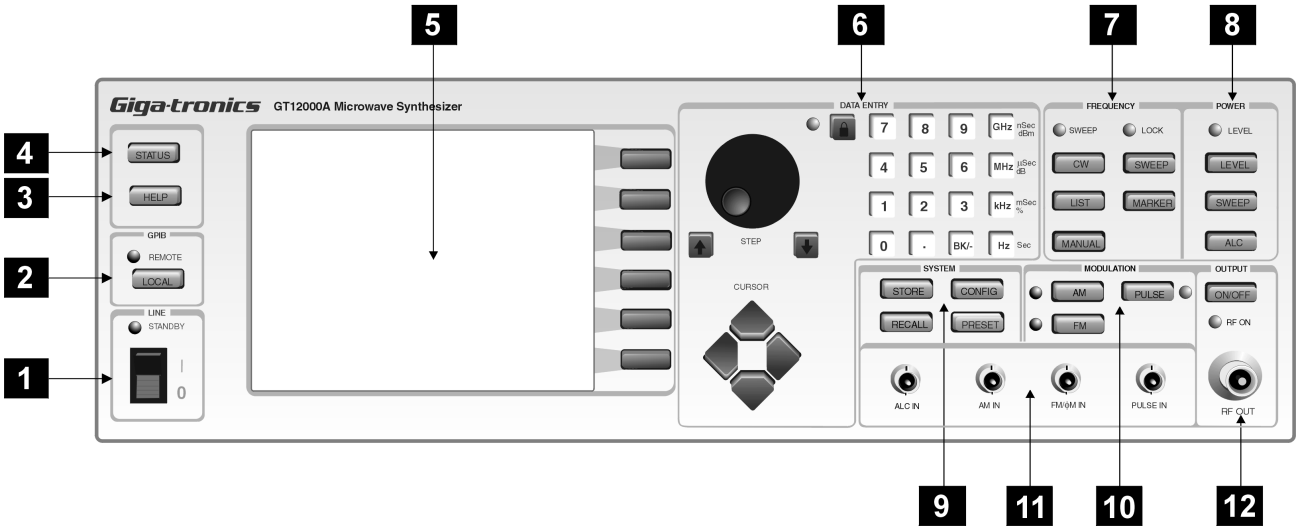


Figure 2-1: Series 12000A Front Panel Layouts

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.

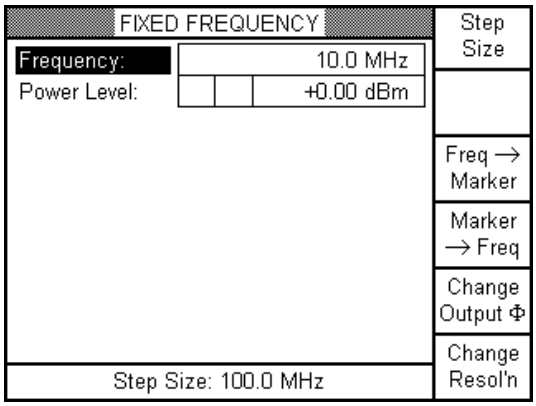


Figure 2-2: Display Screen with Interactive Softkeys

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.

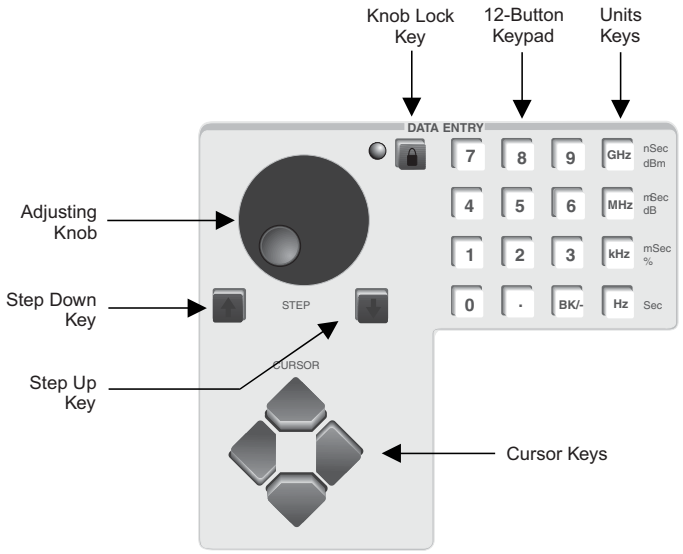


Figure 2-3: Data Entry Field (All Models)

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.

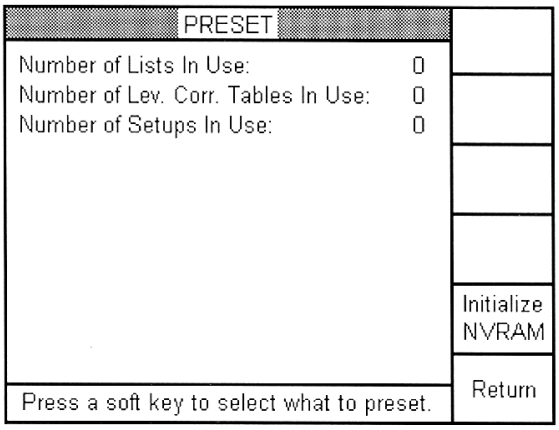


Figure 2-4: System Configuration Selection (Preset)

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).

fM

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	√	√	2-11
2.3.2 - Set a CW Signal	√	√	2-12
2.3.3 - Step Frequency Sweep Configuration	√	√	2-15
2.3.4 - Add Markers to a Frequency Sweep	√	√	2-17
2.3.5 - List Set Up	√	√	2-19
2.3.6 - List Entry Speed Up	√	√	2-23
2.3.7 - List Execution Speed Up	√	√	2-23
2.3.8 - List Points Storage	√	√	2-25
2.3.9 - Step Power Sweep Configuration	√	√	2-27
2.3.10 - ALC Operation	√	√	2-29
2.3.11 - Ramp Frequency Sweep Configuration	**N/A**	√ (127XXA Only)	2-32
2.3.12 - Ramp Power Sweep Configuration	**N/A**	√ (127XXA Only)	2-34
2.3.13 - External Amplitude Modulation (AM)	**N/A**	√	2-36
2.3.14 - Internal Amplitude Modulation (AM)	**N/A**	√	2-37
2.3.15 - External Scan Amplitude Modulation	**N/A**	√	2-39
2.3.16 - Internal Modulation (Opt. 24) with Scan AM (Opt. 29) Selected	**N/A**	√	2-41
2.3.17 - External Frequency Modulation (FM)	**N/A**	√	2-42
2.3.18 - Internal Frequency Modulation (FM)	**N/A**	√	2-44
2.3.19 - Phase Modulation (fM)	**N/A**	√	2-46
2.3.20 - External Pulse Modulation (PM)	**N/A**	√	2-47
2.3.21 - Internal Pulse Modulation (PM)	**N/A**	√	2-48
2.3.22 - Interface Configuration	√	√	2-50
2.3.23 - System Reset	√	√	2-52

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.

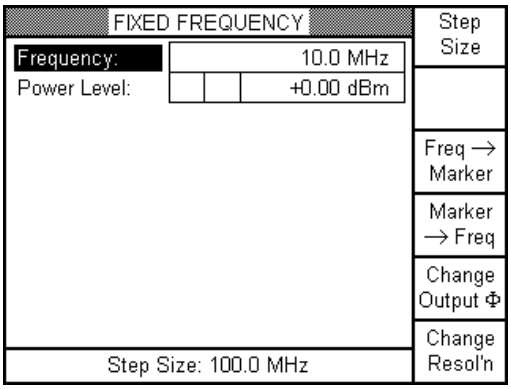


Figure 2-5: Fixed Frequency Menu with Softkeys

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.

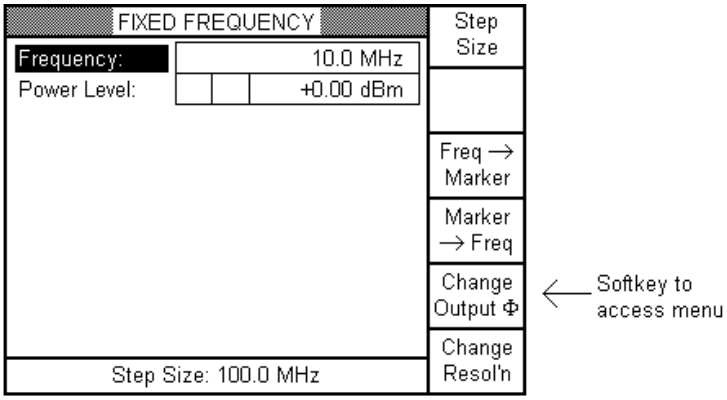


Figure 2-6: Phase Adjustment Selection

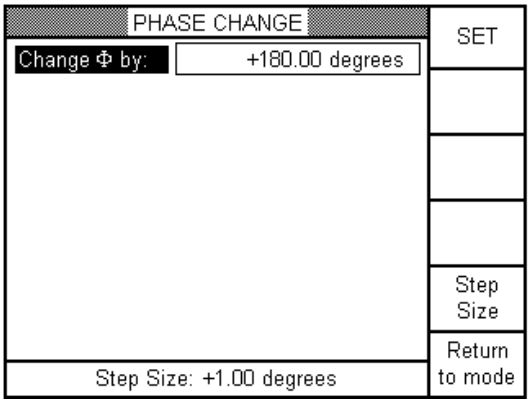


Figure 2-7: Phase Adjustment Selection (Phase Change)

- 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 °	10 °	179 °	179 °	179 °	179 °	10 °	179 °	10 °	179 °	10 °
Timing	1.7 s	190 ms	420 ms	26 ms	14 ms	7 ms	680 m	375 m	375 m	375 m	375 m

☛ ***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 .

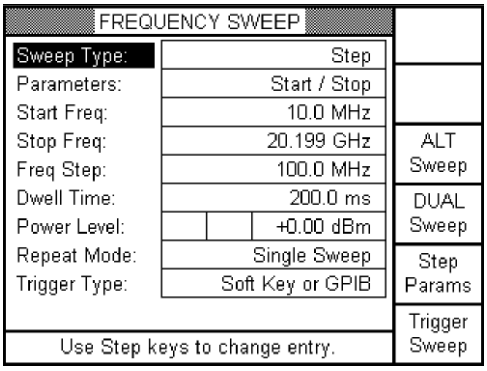


Figure 2-8: Step Frequency Sweep Menu

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.

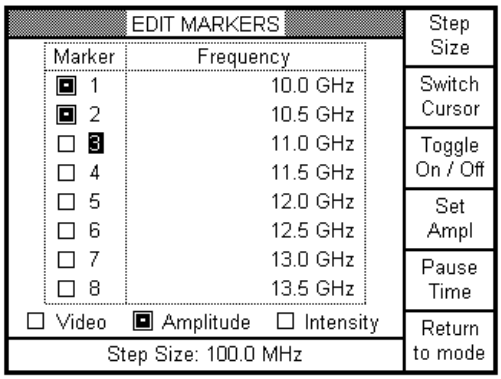


Figure 2-9: Marker Configuration Menu

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.

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

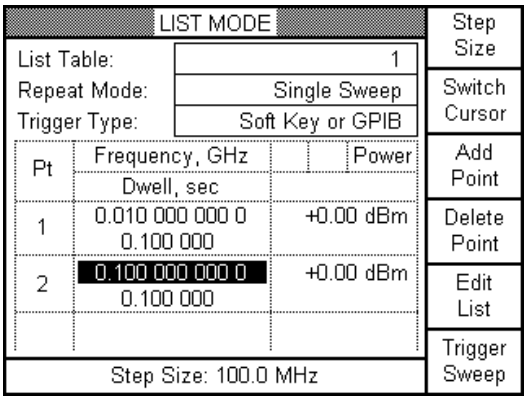


Figure 2-10: List Sweep Configuration Menu

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.

EDIT LIST 1

Pt	Frequency, GHz / Dwell, sec	Power
1	4.000 000 000 0 / 1.000 000	+8.00 dBm
2	4.500 000 000 0 / 3.000 000	-4.00 dBm
3	15.000 000 000 0 / 5.000 000	+5.00 dBm
4	20.000 000 000 0 / 1.500 000	+15.00 dBm

Step Size: 100.0 ms

Step Size | Go to Freq | Add Point | Delete Point | Edit Range | Return

Figure 2-11: Edit List 1 Sweep Parameters Menu

To change range refer to Figure 2-12.

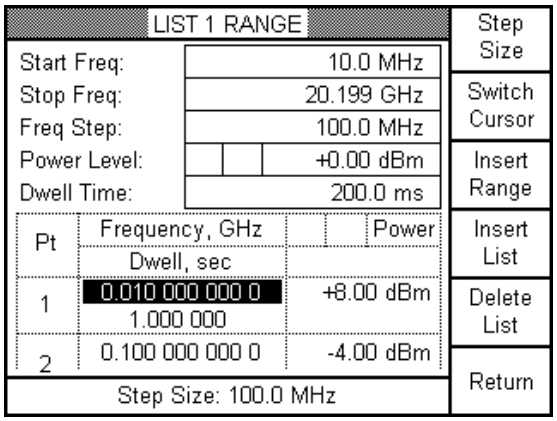


Figure 2-12: List 1 Range Menu

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.

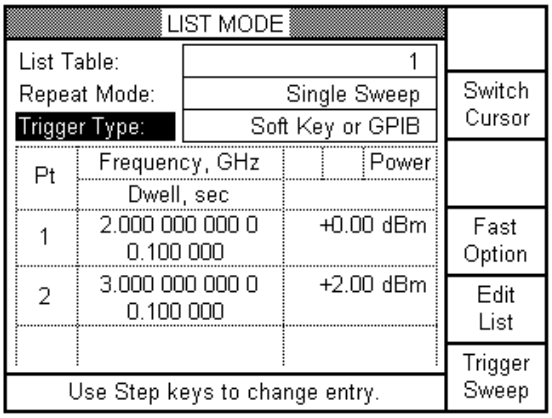


Figure 2-13: Fast Option Display Mode Selection

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).

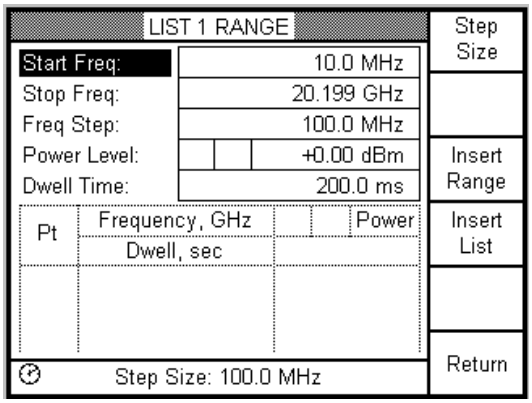


Figure 2-14: CPU Busy Clock Feature

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.

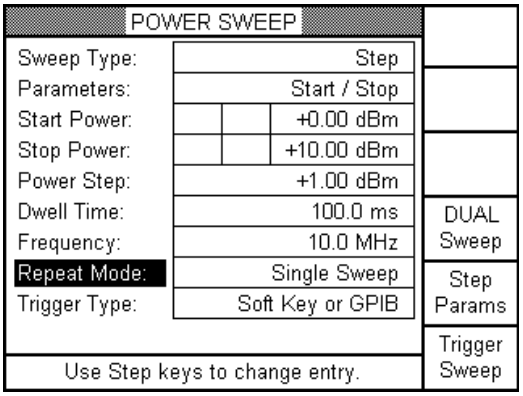


Figure 2-15: Step Power Sweep Configuration Menu

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

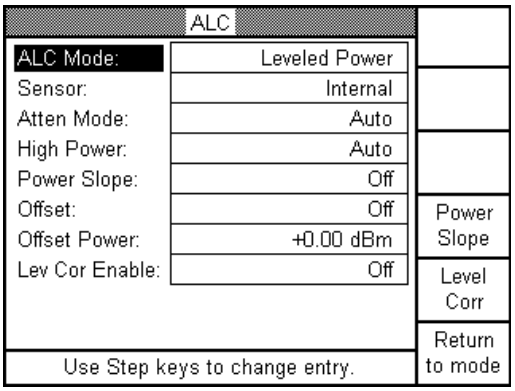


Figure 2-16: Automatic Leveling Control Selection

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.*

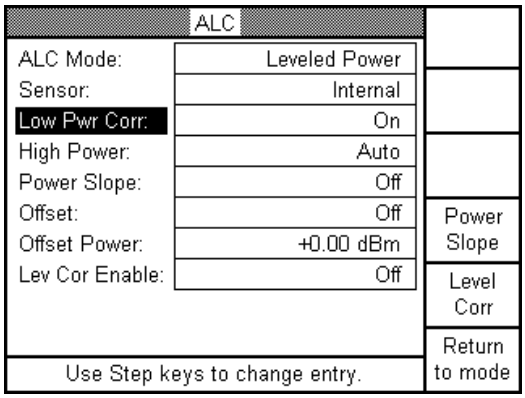


Figure 2-17: ALC Menu with Low Power Correction Feature

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:

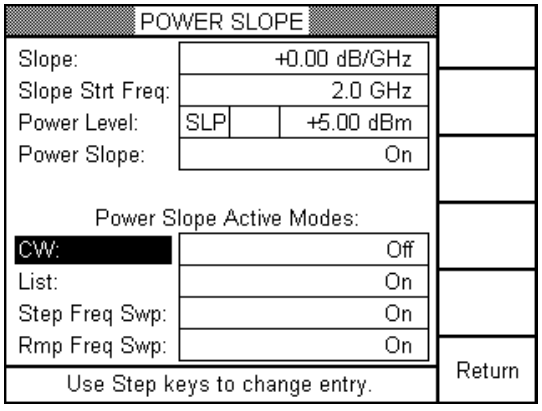


Figure 2-18: Power Slope Selection

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.

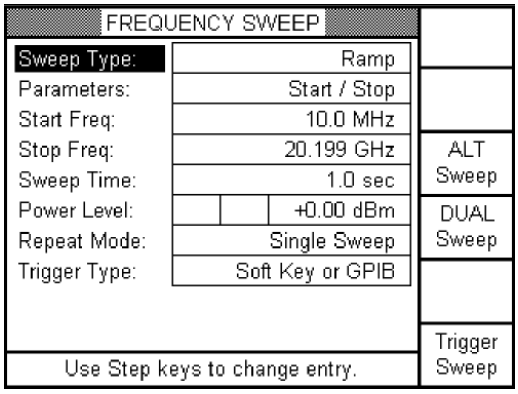


Figure 2-19: Ramp Frequency Sweep Menu

☛ ***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.

CAUTION

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

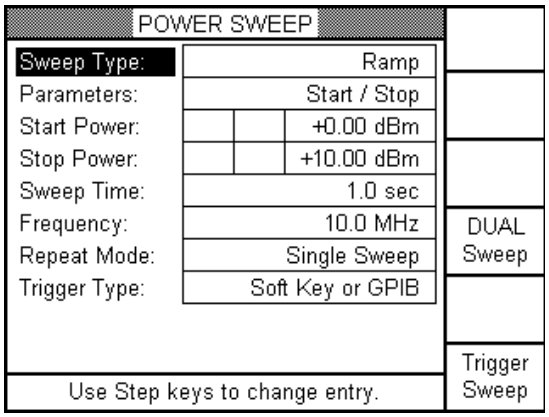


Figure 2-20: Ramp Power Sweep Configuration Menu

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.

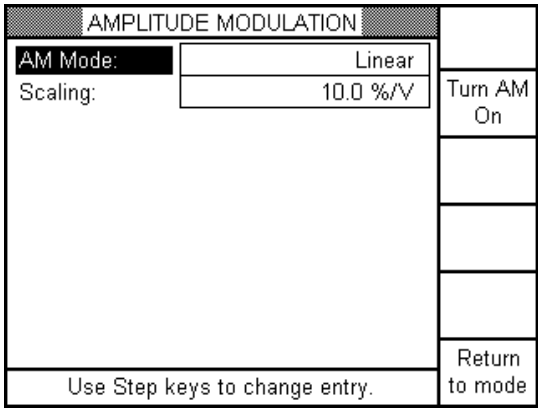


Figure 2-21: Amplitude Modulation Selection

☛ ***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.

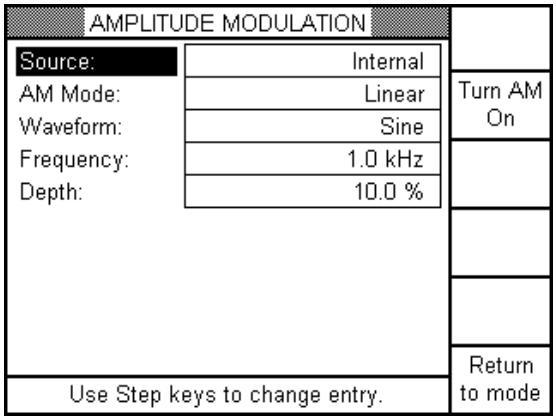


Figure 2-22: Amplitude Modulation Selection (Internal)

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).

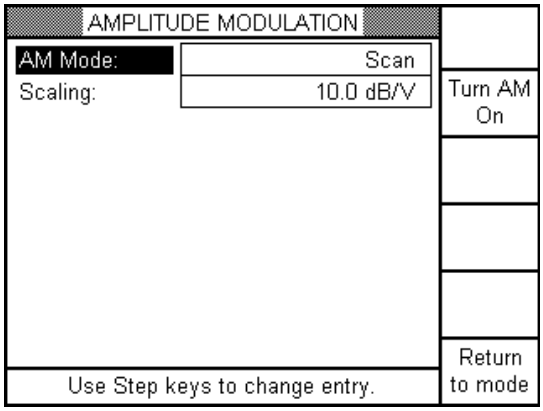


Figure 2-23: Scan Modulation Selection

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.

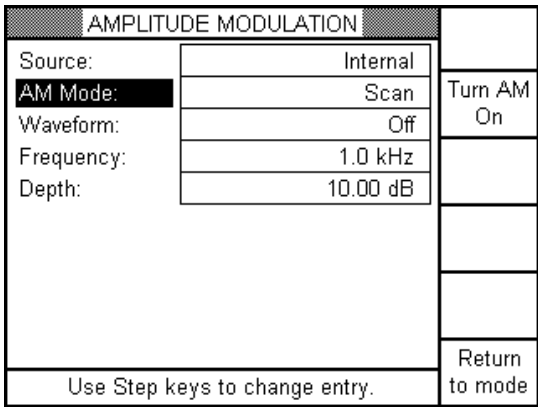


Figure 2-24: Scan AM (Internal)

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

- 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 ± 1 volt input is ± 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.

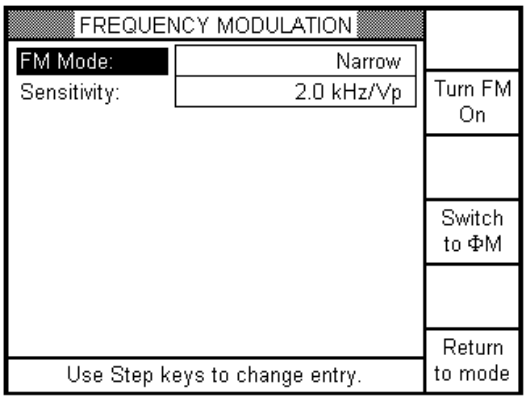


Figure 2-25: Frequency Modulation Selection

☛ ***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 ± 40 MHz (8-16 GHz) or ± 80 MHz (16-20 GHz).

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

M (radians) = DF (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.

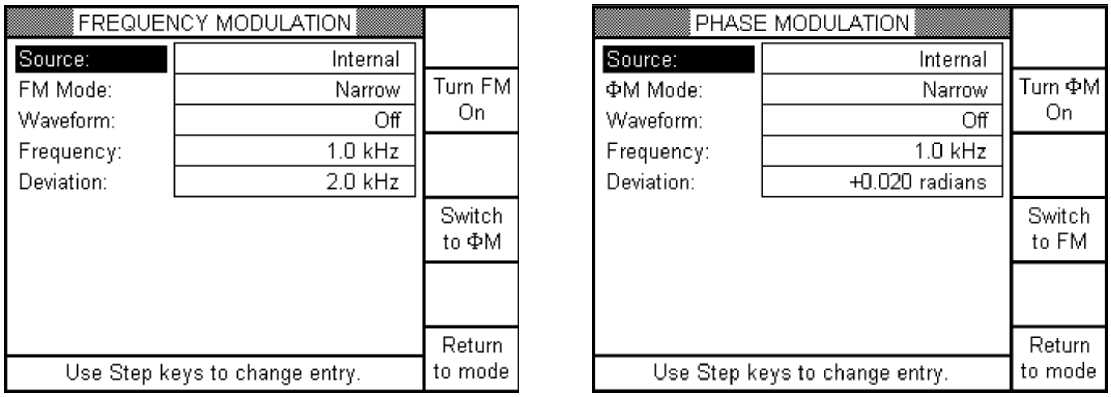


Figure 2-26: Frequency Modulation (Internal)/Phase Modulation (Deviation) Selections

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 FM” in the FM menu (See figure on previous page). The softkey label will change to “Switch to FM” once in FM (See figure on right side above). If another mode is entered, and then the “FM” front panel key is pressed, the FM/FM menu previously in will be displayed. The FM and FM 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.

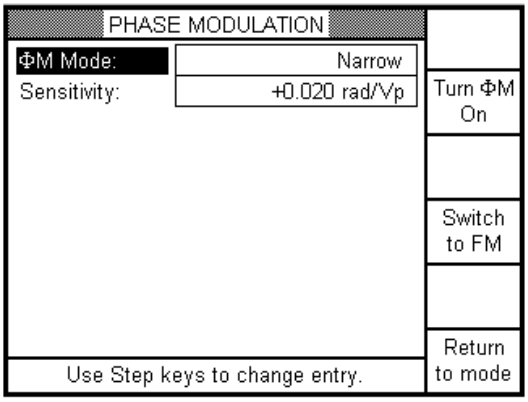


Figure 2-27: Phase Modulation Selection

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.

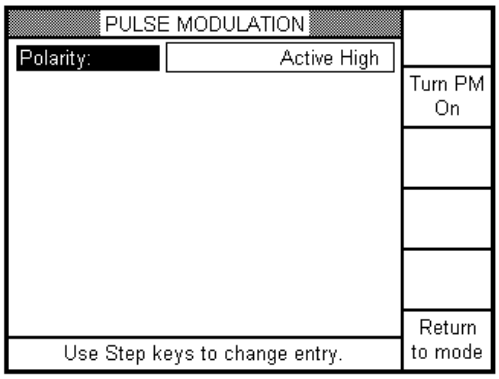


Figure 2-28: Pulse Modulation Selection

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.

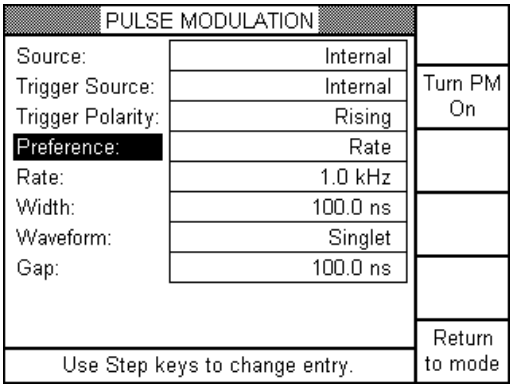


Figure 2-29: Pulse Modulation Selection (Internal)

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 ms will produce the same waveform as setting a start delay of 500 ms and a width of 500 ms (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").

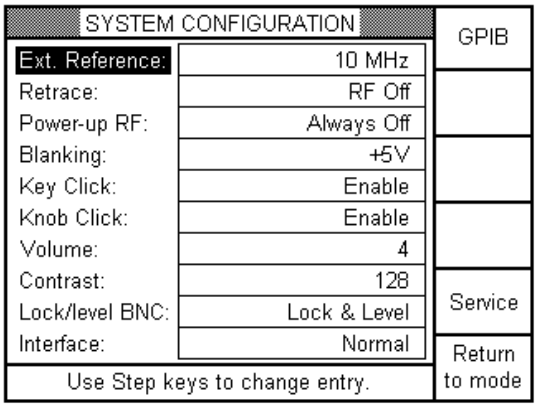


Figure 2-30: System Configuration Selection

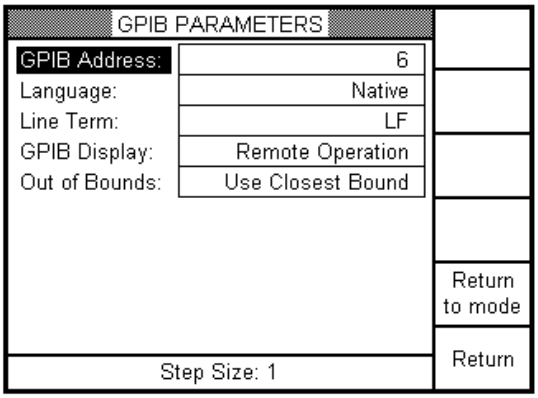


Figure 2-31: System Configuration Selection (GPIB Parameters Screen)

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).

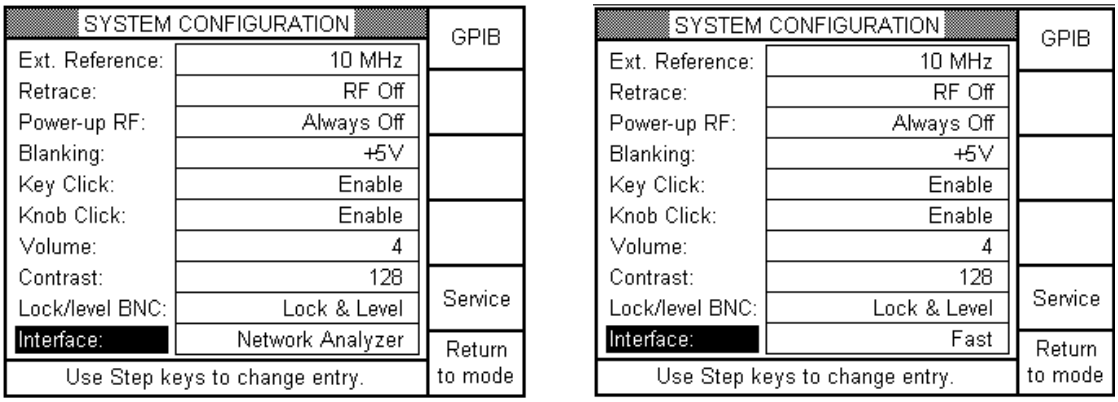


Figure 2-32: System Configuration Selections (Network Analyzer)

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.

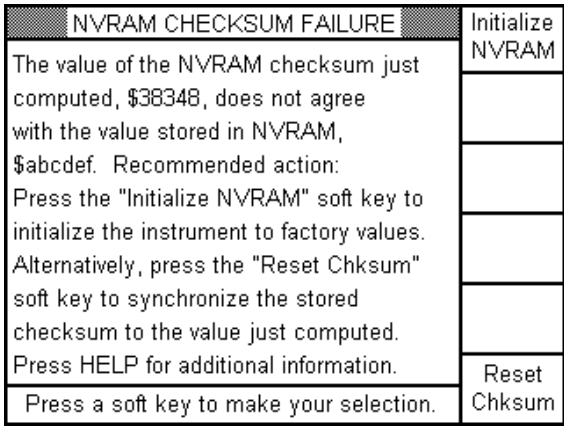


Figure 2-33: NVRAM CheckSum Selection

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

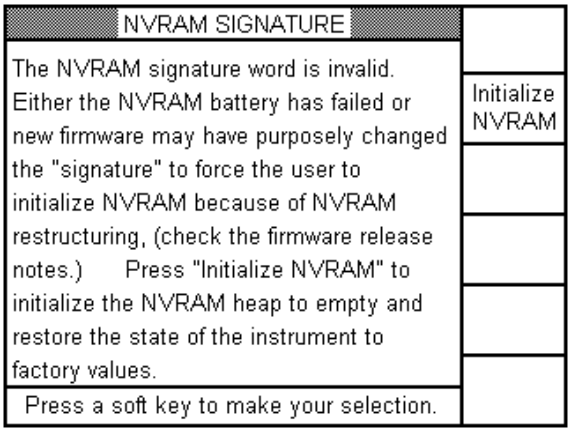


Figure 2-34: NVRAM Signature Selection

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.

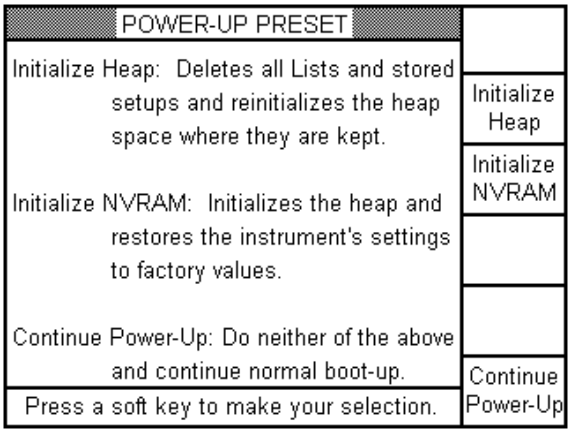


Figure 2-35: Power-Up Preset Selection

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.	