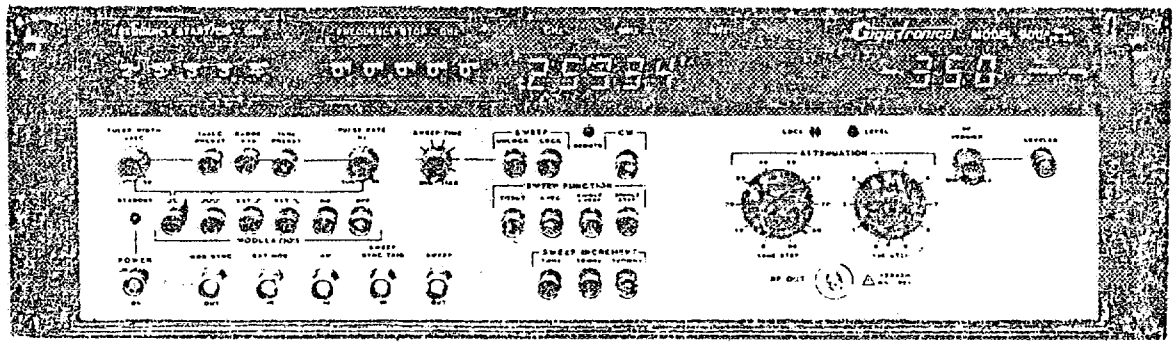
Giga-tronics
INCORPORATED

OPERATION & MAINTENANCE MANUAL

Series 900

Microwave Synthesized Signal Generator



Serial Numbers

This manual applies directly to instruments with serial numbers prefixed by 28, i.e., 28XXX.

See important additional information regarding serial numbers on page iv.

Shipping Assembly Part No: See chart, page iii.

Manual Part No. 105AM02600

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SERIES 900 CONFIGURATION DATA

This operation and maintenance manual is valid for all Series 900 instruments. Instruments in the series differ primarily in their frequency ranges, which are indicated by a suffix in the model number. Certain frequency-related assemblies are included in some instruments but not in others; this manual includes all assemblies for the widest available frequency range (i.e., Model 900/.05-26).

The Shipping Assembly Part No. for Model 900/.05-26 is 105DA02700. Other frequency ranges, and special configurations, are assigned sequential part numbers.

The 'Config.' line on the Model/Serial/Config. sticker affixed to the rear panel of the instrument indicates options and special configurations. If this line is blank, there are no options installed. If the line contains one or more two-digit numbers (e.g., '06'), the options corresponding to the those numbers are installed in the instrument. Information concerning them will be found in Section 8 of this manual. If the line contains a three digit number (e.g., '052'), there is a combination of standard or special options and/or special modifications installed in the instrument. Information concerning them will be found in Section 9 of the manual.

This instrument has a six digit serial number. The first two digits are a prefix indicating instrument type (broadband signal generators, including the 900 series, are designated by prefixes 26 through 28, 31 through 39, and 20 through 22). The last four digits are a sequential suffix.

Differences may exist between the manual and the instrument for which it is supplied, owing to printing errors or circuit changes. These differences are described in Section 10, with reference to individual instruments by serial number.

Frequency related assemblies are installed or omitted depending on whether the freguency range of the instrument includes the following sub-ranges: .05-2 GHz, 2-8 GHz, 8-12 GHz, 12-18 GHz, and 18-26 GHz. These sub-ranges are discussed individually below.

The "downconverter" range, .05-2 GHz, requires the installation of the 2-8 and 8-12 ranges as well. In addition to assemblies required for those sub-ranges, the .05-2 range requires installation of the Fixed L.O. PLL PC Assy, A15 (101BA07401) and the Downconverter Module (004BA09000).

The 2-8 GHz range requires the 2-8 GHz Assy (101CA15303), the 2-8 GHz YIG Driver PC Assy, A11 (101BA28212), and the 2-8 Module (004BA05000).

The 8-12 GHz range requires the 8-12 GHz Assy (101CA15403), the 8-12 GHz YIG Driver PC Assy, A14 (101BA28213), and the 8-12 Module (004BA06300).

The 12-18 GHz range requires the 12-18 GHz Assy (101CA15503) and the 12-18 GHz YIG Driver PC Assy, A12 (101BA28214).

The 18-26 GHz range requires the 18-26 GHz Assy (104CA00403) and the 18-26 GHz YIG Driver PC Assy, A10 (101BA28215).

TABLE OF CONTENTS

ILLUSTRATIONS

GENERAL INFORMATION

This manual contains ten sections which describe various aspects of Series 900 microwave synthesized signal generators. The intent of each section is as follows:

SECTION ONE - Operating Information

This section introduces the operator to what the instrument does and how it basically performs its various functions.

SECTION TWO - Operating Performance

This section provides specifications on the various parameters of the instrument and other information about factors that affect performance or can be applied to modify performance for special applications.

SECTION THREE - Theory of Operation

In order to provide a basic understanding of the Series 900 for calibration and maintenance of the instrument, this section describes the block diagrams and overall concept of the instrument.

SECTION FOUR - Calibration & Performance Check

This section covers suggested incoming inspection, calibration and alignment procedures.

SECTION FIVE - Maintenance

This section suggests maintenance procedures along with troubleshooting information. We suggest that this section be followed step-by-step so that if factory assistance is required we can more effectively assist in troubleshooting.

SECTION SIX - Parts Lists

This Section provides a complete listing of all parts and their sources.

SECTION SEVEN - Diagrams

This section contains complete circuit diagrams, circuit descriptions and parts placements.

SECTION EIGHT - Standard Options

This section contains information covering available standard options.

SECTION NINE - Special Configurations

This section contains information concerning special modification configurations.

SECTION TEN - Manual Changes

This section contains errata information and the information concerning changes to the equipment since the printing of the manual.

INTRODUCTION

PURPOSE AND FUNCTION

The purpose and function of Series 900 Microwave Synthesized Signal Generators is to provide, in one portable instrument, the capability to generate signals over a wide range of frequencies and power levels.

CAPABILITIES

The Series 900 is capable of generating output signals over the frequency range of 50 MHz to 26 GHz with power output levels from +5 to -99 dBm, dependent on the particular 900 configuration purchased. The output signal can be operated in a CW mode or swept between any two preset frequencies. It can also be internally or externally modulated in a pulse or square wave mode.

PERFORMANCE CHARACTERISTICS

The Series 900 generates the signals discussed above under either operator manual control or remote computer control via the IEEE-488 Bus. Complete performance parameters may be found in Section 2 of this manual.

WEIGHT AND DIMENSIONS

Dimensions and weight of Series 900 instruments are 5.25 in. high X 16.75 in. wide X 24 in. deep, 65 lbs. (nominal).

ENVIRONMENTAL REQUIREMENTS

The Series 900 is type tested to MIL-T-28800B, Type III, Class 5, Style E.

RECEIVING INSPECTION

When the instrument is received, check the carton for evidence of damage. If damage is found, notify the carrier immediately. Open the carton only in their presence.

Use care in removing the instrument from the carton and check immediately for evidence of shipping damage; loose or broken control knobs, bent or broken connectors, dents or scratches on the panels, etc.

All Giga-tronics instruments pass rigid inspections and tests before being shipped. Upon receipt, they should be immediately subjected to a performance check to insure that their performance has not been impaired by the shipment. (Refer to Performance Check, Section 4).

ITEMS FURNISHED

In addition to options and/or accessories specifically ordered, items furnished with each instrument are:

1 ea. - Operation & Maintenance Manual
1 ea. - 6 ft. Power Cord
3 ea. - PC Extender Board
1 ea. - PC Card Extractor
1 set - Test Data

INSTALLATION

The instrument is shipped in an operational condition and no unusual installation procedures are required.

SAFETY INFORMATION - 

This instrument can be damaged if operated with the line voltage selector set at the wrong applied line voltage. Before operating the instrument, make sure that the instrument power requirements are correct.

This instrument has been designed to operate internationally over a broad range of voltages: 100, 120, 220, 240 ± 10%, 50-400 Hz. On the Series 900 we use an internationally approved connector that includes voltage selection, fuse and filter for RFI protection.

POWER LINE CONNECTION

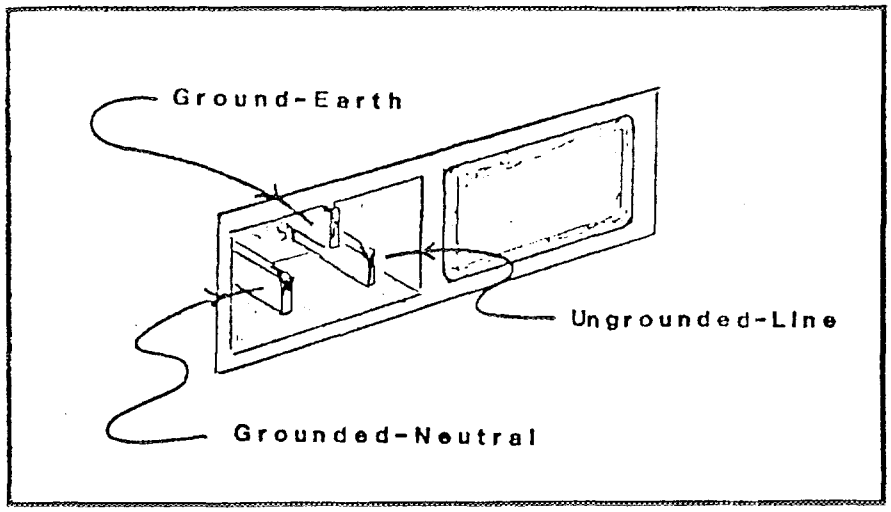

Figure 0.1

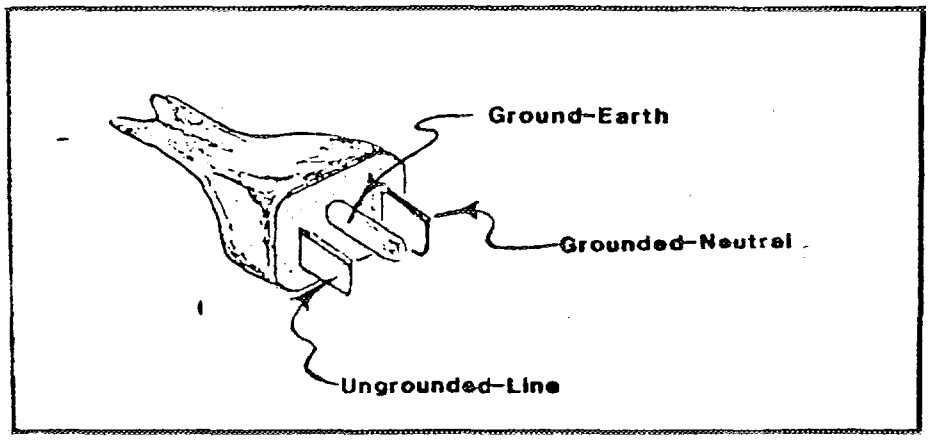

Figure 0.2

This instrument has a 3-wire power cord with a 3-terminal polarized plug for connection to the power source and safety-ground. The ground or safety ground is connected directly to the chassis, therefore, if a 3-to-2 wire adapter is used, be sure to connect the ground lead from the adapter to earth ground. Failure to do this could cause the instrument chassis to float above earth ground which could pose a shock hazard.

VOLTAGE SELECTION

To select the correct operating line voltage and regulating range, proceed as follows:

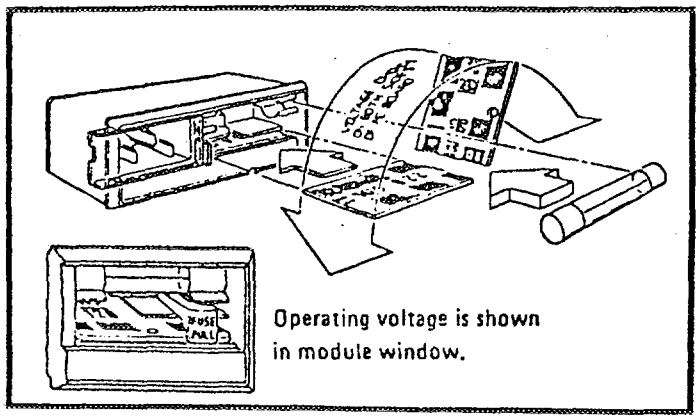

Figure 0.3

Open cover door and rotate fuse - pull to the left.

Select operating voltage by orienting PC board to position desired voltage on top left side. Push board firmly into module slot.

Rotate fuse-pull back into normal position and re-insert fuse into holders, using caution to select correct fuse value.

FUSE SELECTION

When shipping the instrument, it is set for a particular power line voltage (normally 120V for domestic shipping destinations). The power line fuse for this setting is a 2.5A 3AG Slo-Blo. If the instrument is changed to operate on a 240V power line, the fuse must also be changed to a 1.25A 3AG Slo-Blo. (See Figure 0.3, above).

COOLING

The instrument contains a cooling fan. The cooling air intake and exhaust are both located on the instrument rear panel. Care must be taken not to obstruct the flow of air into or from the instrument.

STORAGE

Storage of the instrument should be limited to an environment that does not exceed the temperature range of $-40^{o}C$ to $+75^{o}C$.

ITEMS REQUIRED

The only non-furnished items required to operate a Series 900 instrument with a unit under test are applicable input/output cables (Accessory A001, Cable Kit is recommended) and an IEEE-488 Interface cable if operating under remote control.

TOOLS AND TEST EQUIPMENT

No special tools or test equipment are required to operate the Series 900. Test equipment required for calibration or performance checks are listed in Section 4 of this manual.

CLEANING INSTRUCTIONS

Clean the air inlet screen at any time significant dirt has accumulated. Whenever covers are removed, blow out the interior of the instrument with low velocity dry air.

RESHIPMENT

To protect the instrument during reshipment, use the best packaging methods available. If possible, re-use the container in which the instrument was originally shipped. If this is not possible, a strong carton (350 lbs/in^2 bursting strength) or a wood box should be used.

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 packing material, taking extra precautions to protect the front and rear panels.

Seal the package with strong tape or metal bands. Mark "FRAGILE - DELICATE INSTRUMENT" on the outside of the package.

If corresponding with the factory or local Giga-tronics Sales Office regarding reshipment, please reference the full Model Number and Serial Number. If the instrument is being reshipped for repair, be sure to enclose all available pertinent data regarding the problem that has been found.

SECTION ONE

OPERATING INFORMATION

I. FRONT PANEL DESCRIPTION:

The major controls and connections for the Series 900 are all located on the front panel. Figure 1.1 shows the various functional sections of the front panel. This is then followed by a brief description of each connector and control in each section.

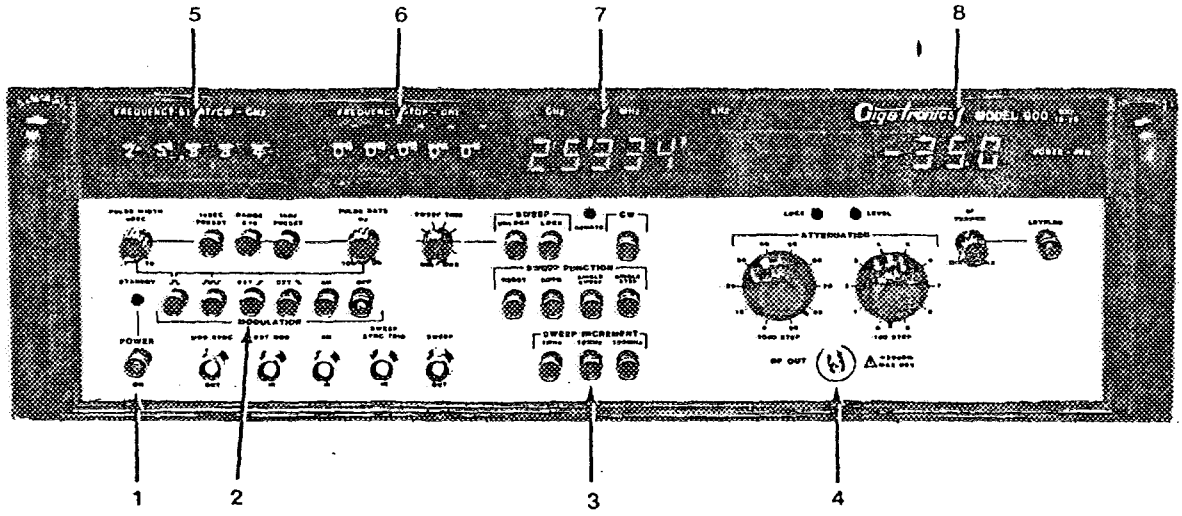

Figure 1.1

1. Line Power
2. Modulation Section
3. Generator Section
4. RF Output Section
5. RF Frequency Setting
6. Sweep Stop Setting
7. Frequency Readout
8. RF Power Readout

LINE POWER SECTION

Standby	This light indicates that the main power is connected to the instrument and the instrument is in a standby condition.
Power ON/OFF	This push-button turns on and off all D.C. power to the instrument.

MODULATION SECTION

Modulation	This series of pushbuttons selects the type of pulse modulation.
⎍⎍	Provides pulse modulation with variable rate from 100 Hz to 50 kHz and variable width from 0.1 microsecond to 10 microseconds.
⎍⎍⎍	Provides square wave modulation with variable rate from 100 Hz to 50 kHz.
EXT ⎍	Allows external pulse modulation at a rep rate from 10 Hz to 1 MHz with a minimum width of 0.1 microsecond. This position provides for triggering of the RF output on a TTL High.
EXT ⎍	Allows external pulse modulation the same as above except it provides for triggering of the RF output on a TTL Low.
OFF	All modulation off.
Pulse Width Microsecond	This control provides variable width of the pulse modulation from 0.1 microsecond to 10 microseconds.
1 microsecond Preset	Pushbutton presets the modulation pulse width at 1 microsecond.
Pulse Rate Hz	Controls the variable rep rate for either pulse or square wave modulation from 100 Hz to 5 kHz.
X10 Range	Changes the variable modulation rep rate by a factor of 10 times.
1 KHz Preset	Pushbutton presets the modulation rep rate to 1 kHz.
Mod Sync Out	Output of selected modulation is provided at this BNC connector.
Ext Mod In	BNC connector provides input for external pulse modulation when mode selection is in EXT ⎍ or EXT ⎍ .

GENERATOR SECTION

Generate CW	This pushbutton activates the RF reference and phase-locks the selected RF output from 50 MHz to 26.5 GHz, dependent on frequency range of each particular instrument. If activated along with the sweep pushbutton, the output RF will step and lock after each increment.

Generate Sweep	This pushbutton activates the sweep function between start and stop frequency limits.
Sweep Function	
Single Step	This pushbutton advances the RF Output by one step increment.
Single Sweep	This pushbutton activates a full, single sweep from the set start frequency to the set stop frequency.
Auto	Activates a recycling sweep of the RF Output between the set limits.
Reset	Resets the swept frequency to the start point.
Sweep Sync Trig	BNC input allows for an external trigger to activate a single step or a single sweep depending on which mode was last activated.
Sweep Out	BNC connector provides a 0 to 10 volt incrementally stepped ramp output proportional to frequency between sweep limits, both in auto and manual mode.
Sweep Time	Provides 10 positions to vary the sweep width time from 10 milliseconds to 100 seconds.
Sweep Increments	There are three pushbuttons that provide selectable step increments of 1, 10, and 100 MHz. The RF frequency output advances by the selected step when in the sweep mode.
	RF OUTPUT SECTION
10 dB Step	10 step selector attenuates the RF Output in 10 dB steps.
1 dB Step	10 step selector attenuates the RF Output in 1 dB steps.
RF Output	SMA connector provides the RF Output 50 MHz to 26.5 GHz, dependent on frequency range of each particular instrument.
Level	LED light indicates a leveled RF Output.
Lock	LED light indicates that the RF Output is phase locked to the internal or external master reference.

Leveled	This pushbutton, when activated with both step attenuators at 0, calibrates the RF Output to 0 dBm. The instrument then maintains its power level accuracy of ±1 dB from 50 MHz to 18 GHz and ±2 dB from 18 GHz to 26 GHz.
RF Vernier	When the leveled pushbutton is released, this control provides a vernier attenuation of approximately 10 dB. Maximum RF Output can be achieved by setting the control to max and the 1 dB and 10 dB step to zero.
	RF FREQUENCY SETTING
Frequency Start/CW	These lever switches select the RF Output when the instrument is in the generate CW mode. They select the start frequency when the instrument is in the sweep mode.
	SWEEP STOP SETTING
Frequency Stop-GHz	These lever switches set the sweep stop frequency when the instrument is in the sweep mode.
	READOUTS
Frequency Readout	The 9 digit display indicates the RF Output frequency when in the CW or sweep mode.
Power Readout	This 3 digit display indicates internal power.

II. REAR PANEL DESCRIPTION:

The rear panel contains the input and output connections used for interfacing the instrument with other auxillary products. Figure 1.2 shows the various sections of the rear panel.

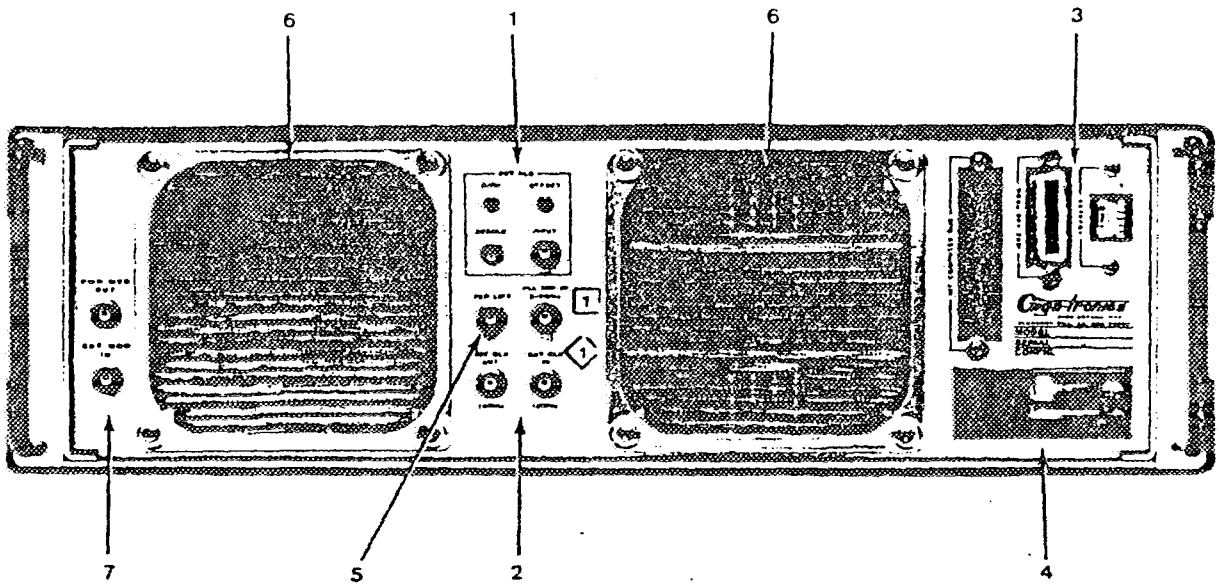

Figure 1.2

1. External ALC Section
2. Master Reference Section
3. Interface Section
4. Line Power & Fuse Section
5. Pen Lift
6. Air Intake & Exhaust
7. Power Meter Output & Rear Panel Ext Mod In (if required)

EXTERNAL ALC SECTION

Enable	This switch disables the internal leveling source and activates the external automatic level control input.
Input	BNC connector for external ALC input.
Gain	Screwdriver calibration adjustment to match the slope of an external detector to that of the detector used internally.
Offset	Screwdriver adjustment for the proper intercept point of the external detector.

MASTER REFERENCE SECTION

Int Clk Out 10 MHz	BNC connector outputs the 10 MHz internal reference oscillator, 1 volt RMS into 50 ohms.
Ext Clk In 10 MHz	BNC connector accepts an external reference which automatically substitutes for the internal reference.
PLL Ref In 5 MHz	BNC connector accepts a 1 volt p-p frequency which substitutes for the phase-lock-loop reference. Varying this signal upward from 5 MHz causes a one for one change in the RF Output.

INTERFACE SECTION

Int Computer Bus	50 pin connector provides access to the internal micro computer bus.
IEEE-488 Prog	24 pin connector provides the instrument interface to other GPIB IEEE-488-1978 compatible equipment.
Address	Five Ø and one switches are available to set the address of the instrument in a 5-bit binary code in accordance with the GPIB IEEE-488-1978 format.
Pen Lift	BNC connector provides TTL low logic level output during retrace, when the instrument is in the sweep mode.

LINE POWER & FUSE SECTION

Power Input	3 - terminal polarized connection with safety ground connected to the chassis.
Line Selection	PC board that can be oriented four ways to select four different line voltages, 100, 120, 220 and 240 volts.
Fuse	Fuse holder retains the power fuse. 2.5A 3AG Slo-Blo for 100/120 volt operation and 1.25A 3AG Slo-Blo for 220/240 volt operation.

III. FRONT PANEL OPERATION

The following part of section one is intended to provide step-by-step operating procedures for some of the more basic functional instrument setups.

The Series 900 performs two basic functions.

1. It generates any frequency from 50 MHz to 26.5 GHz, dependent on the frequency range of each particular instrument.

2. It sweeps between any two frequencies within the frequency range of the instrument.

The instrument has the built-in feature to indicate to the operator that certain controls have been incorrectly set. When this occurs, the readout will indicate one of the following error messages:

ERROR	
1	frequency select out of range.
2	invalid modulation selection.
3	invalid step increment selection.
4	invalid sweep mode selection.
5	frequency start selection greater than frequency stop selection.
6	modulation must be off when using external ALC.
7	no cable calibration data in memory (valid only with option 09).
8	modulation must be off in ΔP mode (valid only with option 09).
10	cable calibration cannot be used with external ALC (valid only with option 09).
11	step attenuator must be set at 0 during cable calibration (valid only with option 09).
12	requested level for cable calibration is out of the range of system control (valid only with option 09).
13	10 dB step attenuator must be set to 0 in external ALC.
14	IEEE address of 31 (all ones) is invalid.

Generating a Frequency

By simply performing the following steps indicated in Figure 1.3, the instrument will generate any frequency within its capability. The operator can read the frequency on the readout.

This becomes important if the instrument is under remote control or is in the sweep mode.

Generating a CW Signal

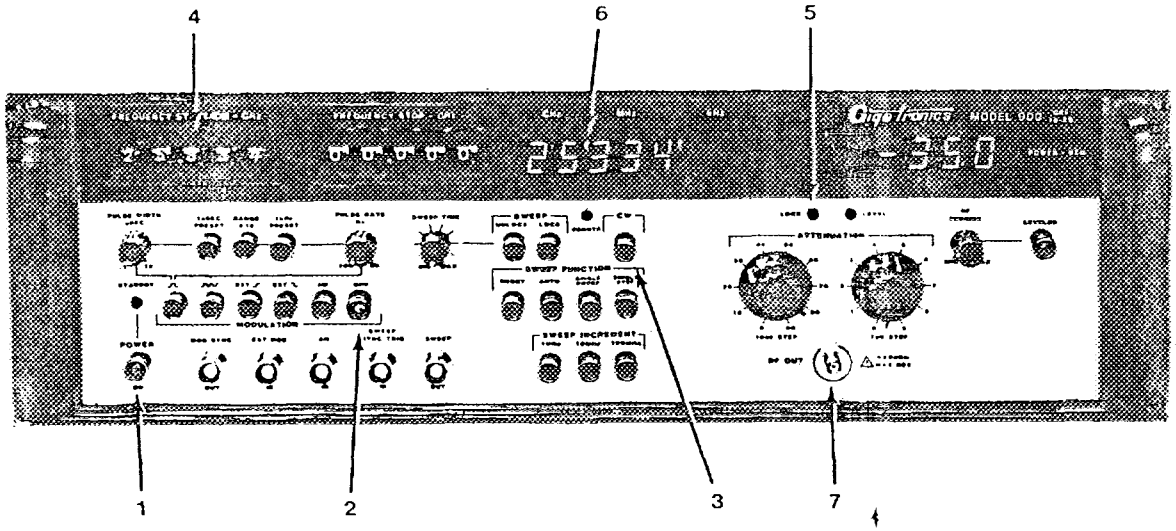

Figure 1.3

Step

1. Power on
2. Modulation off
3. Generate CW on
4. Set leverwheel switch to desired frequency
5. Check synthesizer lock light
6. Check frequency readout
7. RF Output

Setting Signal Output Level

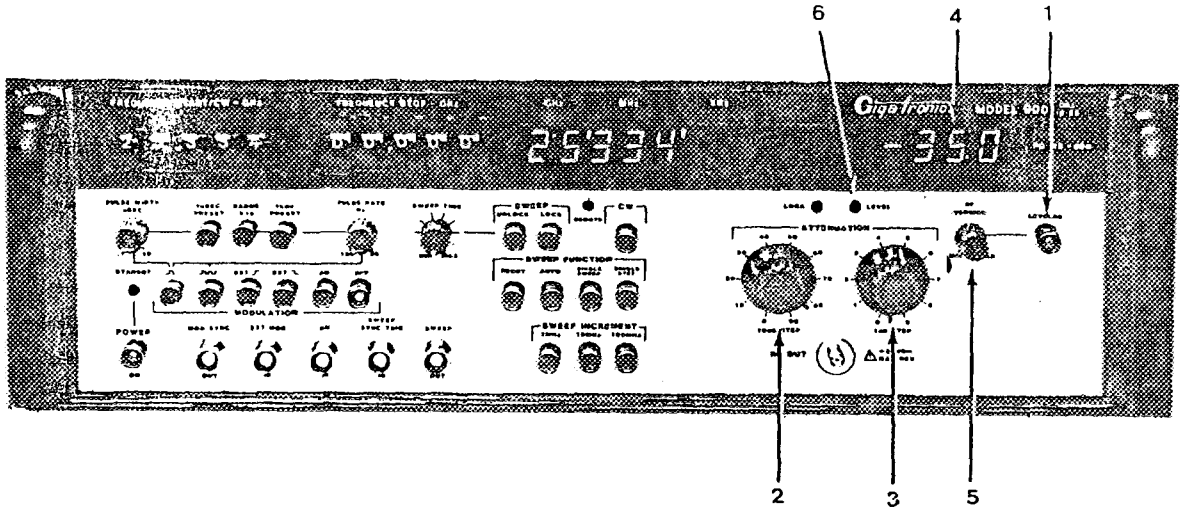

Figure 1.4

Steps

1. Push leveled button (This calibrates the output to 0 dBm and the instrument then maintains its accuracy over the entire attenuation range.
2. Set 10 dB attenuator in any 10 dB step.
3. Set 1 dB attenuator in any 1 dB step.
4. Read RF output power.
5. If the operator desires a vernier control of the RF output (approximately 10 dB) release leveled pushbutton (1) and adjust vernier control. This is also a means of providing maximum power above 0 dBm.
6. LED light indicates when output signal is leveled.

Modulation

The Series 900 incorporates a high performance wide frequency coverage pulse or square wave RF modulation. The operator can select either internal modulation or externally drive the modulator.

Pulse Modulation

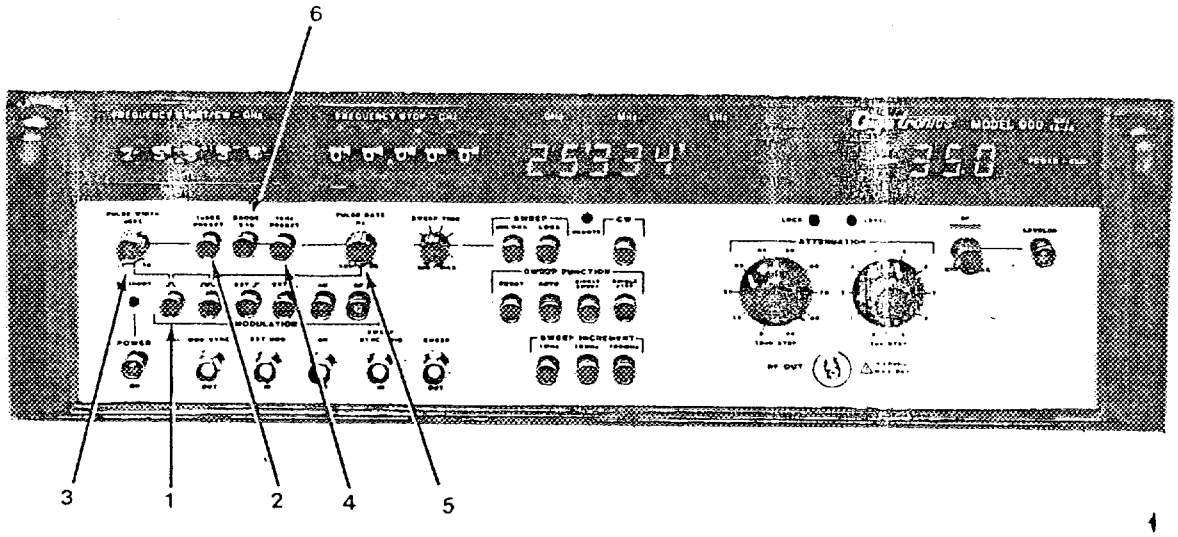

Figure 1.5

Steps

1. Select ⎍⎍ modulation.
2. Select 1 microsecond fixed width.
3. Or release 1 microsecond preset button (2) and vary the pulse width from 0.1 microsecond to 10 microseconds.
4. Select 1 kHz fixed pulse rate.
5. Or release 1 kHz preset button (4) and vary rate from 100 Hz to 5 kHz.
6. Push Range X10 button to increase the variable rate adjustment from 1 kHz to 50 kHz.

Square Wave Modulation

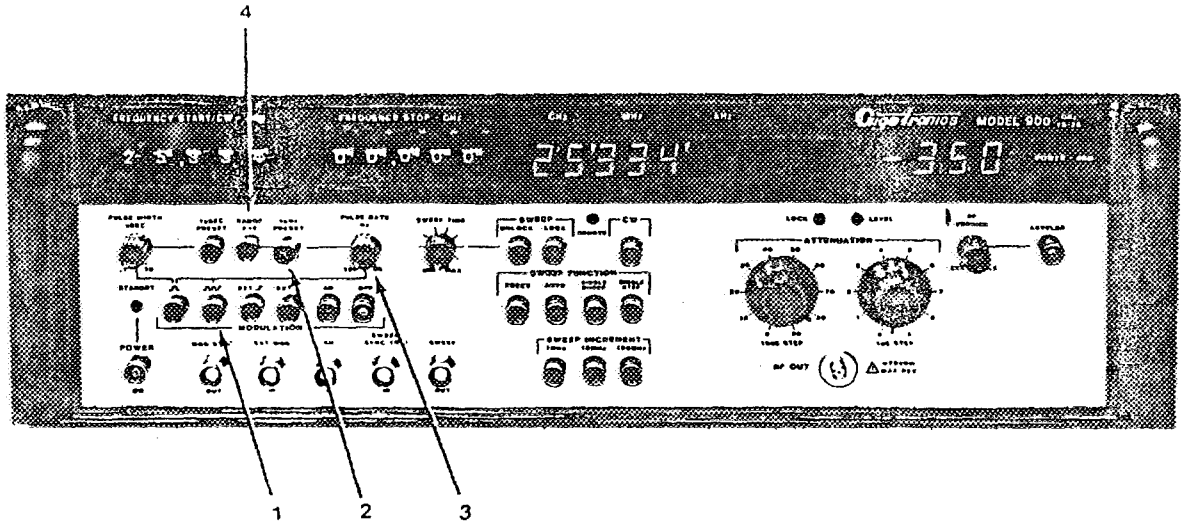

Figure 1.6

Steps

1. Select ⎍⎍⎍ modulation.
2. Select 1 kHz fixed square wave rate.
3. Or release 1 kHz preset button (2) and vary rate from 100 Hz to 5 kHz.
4. Push Range X10 button to change the variable rate adjustment from 1 kHz to 50 kHz.

External Pulse Modulation

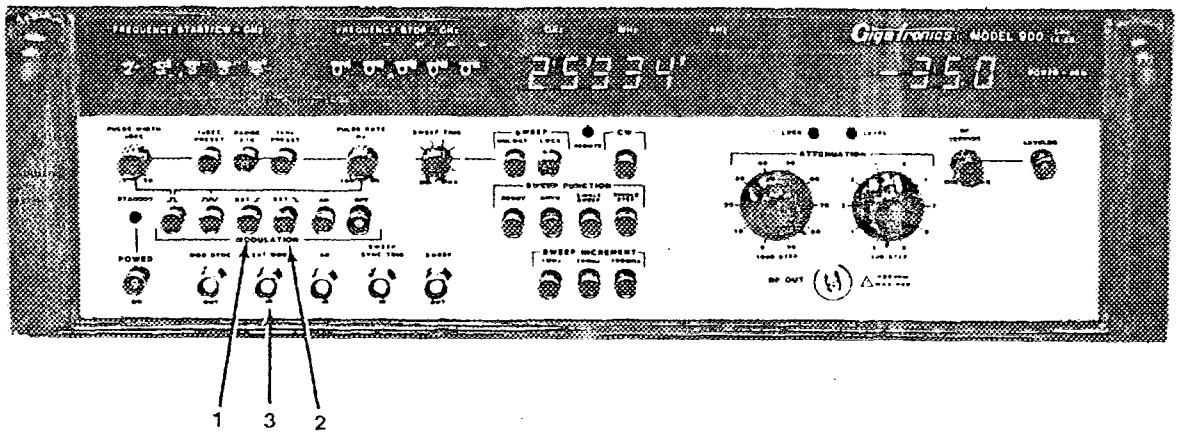

Figure 1.7

Steps

1. Select Ext ⎍ for a >2.2 volt on and a <0.8 volt off.

2. Select Ext ⎏ for a <0.8 volt on and a >2.2 volt off.

3. Connect external signal. The instrument will accept any signal from 10 Hz to 1 MHz with a minimum of 0.1 microsecond pulse width at a TTL level.

NOTE:

This instrument will not operate properly if it is set for External Pulse Modulation (either positive or negative-going triggering) and there is no pulse input applied to the EXT MOD IN connector. When in the pulse modulation mode, output leveling is controlled by a sampling system which requires the presence of an input pulse to trigger the sample. When there is no input pulse present the output will not be leveled, it may remain steady or drift, the power indicator may or may not be correct and the level light may or may not be lit.

External Amplitude Modulation

(instruments with no 18-26 GHz band only)

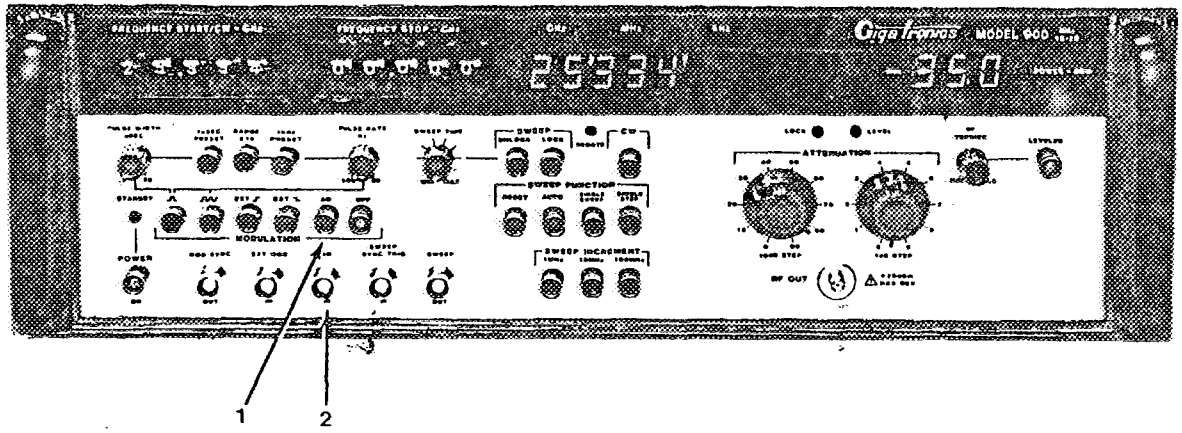

Figure 1.8

Steps

1. Select AM modulation.
2. Connect external signal. The instrument requires a IV, p-p, input for 50% modulation at 1 kHz.

Frequency Sweeping

It should be noted that there are two methods of sweeping between two frequency limits. One method creates an unlocked incremental sweep between the start and stop points, while the other method digitally increments and achieves a momentary lock after each step.

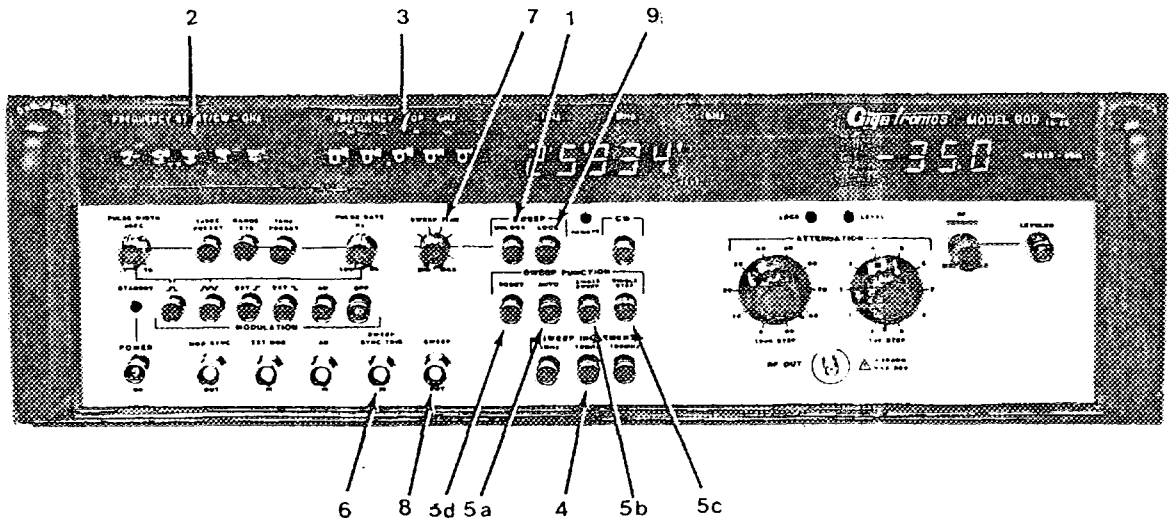

Figure 1.9

Steps

1. Select unlocked sweep mode (This disables the RF reference and allows an unlocked incremental sweep between limits.)

2. Set leverwheel switch to desired start frequency.

3. Set leverwheel switch to desired stop frequency.

4. Select one of the three step increments 1 MHz, 10 MHz, or 100 MHz (The maximum sweep increment rate of the instrument is one increment per millisecond).

5. Select sweep mode.

   a. Select Auto - The RF output will start at the set start frequency (2) and advance upward in frequency to the set stop frequency (3). The frequency sweep will then automatically recycle.

b. Select Single Sweep - The RF output will make one complete sweep between the start and stop frequencies and reset to the start frequency.

c. Select Single Step - By pushing the single step button, the instrument will step in frequency by one increment within the resolution of the D to A (See step 9).

d. Pushing the reset button will reset the sweep to the start frequency.

6. If an external sweep sync trigger pulse (transition to ground) is applied, the instrument will automatically make a single step or a single sweep depending on which mode button was pushed last, single, single sweep (5b) or single step (5c).

7. Adjust Sweep Time. The sweep time is adjustable from 10 milliseconds to 100 seconds in the auto or single sweep mode.

8. The sweep output BNC connector provides a 0 to 10 volt ramp proportional to frequency between sweep limits both in the sweep and step mode.

9. If a step and frequency lock is desired in the sweep mode, push the lock sweep button. (This will activate the RF reference and cause lock at the end of each increment.)

IV. REAR PANEL OPERATION

The following part of Section One provides instructions on interfacing auxilliary equipment to the Series 900. This section is divided into five parts.

1. External ALC
2. External Master Reference
3. External Phase-Lock Reference
4. External Programming IEEE-488
5. Pen Lift

1. External ALC

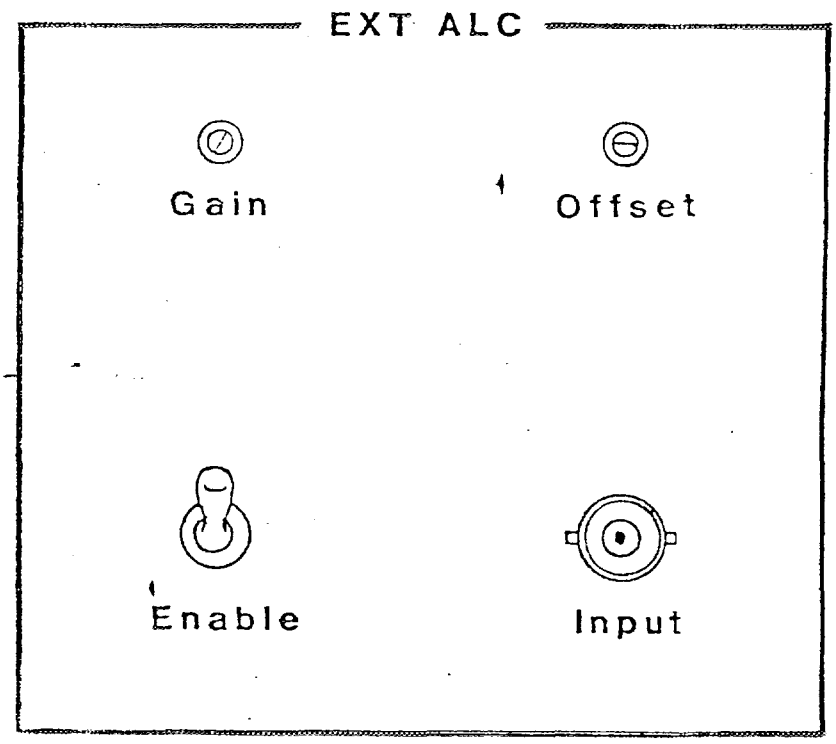

Figure 1.10

The external ALC function is provided to allow remote levelling capability. The circuit is designed to operate with a standard negative output diode type detector. Adjustments for gain and offset are provided to allow calibrating the detector. Note that losses in the cable between the instrument RF output and the remote directional detector will limit maximum output and levelling range.

Step 1 - Connect the remote cable and directional detector to the Series 900. Connect the detector output to the rear panel EXT ALC connector.

Step 2 - Connect a power meter to the directional detector output and set the EXT ALC enable on.

Step 3 - With the front panel attenuators at 0 and the vernier off, adjust the rear panel gain to max CW and then adjust the rear panel offset for a power reading of 0 dBm (assuming the cable loss permits).

Step 4 - Select -9dBm on the front panel 1 dB attenuator. Readjust the offset for a power meter reading of -9 dBm.

Step 5 - Reset to 0 dBm and adjust the gain control for a power meter reading of 0 dBm.

Step 6 - Repeat steps 4 and 5 as required.

2. External Master Reference.

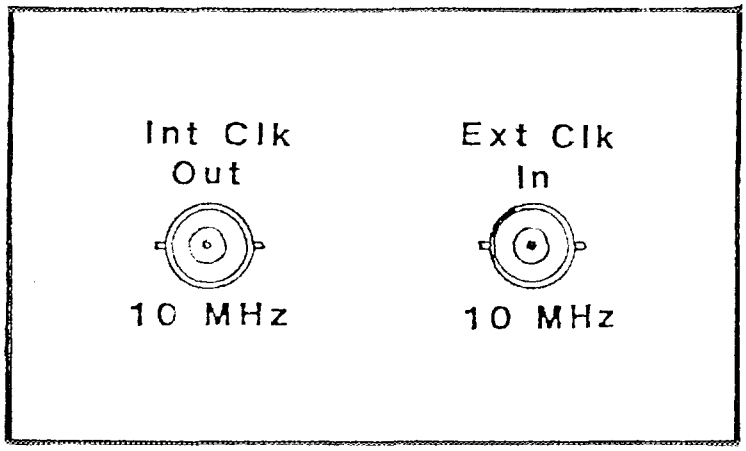

Figure 1.11

The clock output provides a buffered 10 MHz derived directly from either the internal master reference or any external standard applied. This output will drive a 50 ohm load to 2V PP.

The clock input allows connecting an external 10 MHz standard with an amplitude between .5 and 5V PP. The frequency of the standard must be within ±1 part in 10^6 to insure that the instrument will lock to it. The Series 900 automatically switches to the external reference when a signal is present.

3. External Phase-Lock Reference

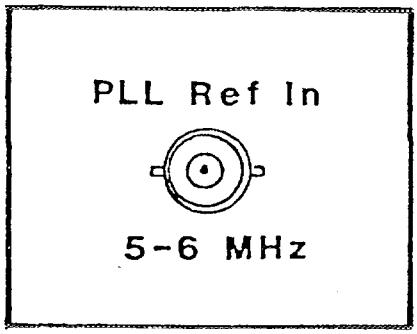

Figure 1.12

By connecting an external signal to the BNC connector shown in Figure 1.12, it is possible to shift the RF reference and in turn, the RF output on a one for one basis. The frequency range of the input is from 5 MHz to 20 MHz and the rate is approximately 50 kHz. The RF output frequency will be:

Fout = fset + (fx - 5 MHz)

where Fout = RF Output
fset = frequency setting of 900
fx = frequency of external signal

4. External Programming IEEE-488

The Model 900 permits data bus control in accordance with the IEEE Standard Digital Interface for Programmable Instruments IEEE-STD 488-1978.

The following subsets of the standard are implemented:

SH1	Source Handshake	Complete Capability
AH1	Acceptor Handshake	Complete Capability
T8	Talker	Basic Talker, No Serial Poll No Talk Only, Unaddress if MLA
TE0	Extended Talker	No Capability
L4	Listener	Basic Listener, No Listen Only, Unaddressed if MTA
LE0	Extended Listener	No Capability
SR0	Service Request	No Capability
RL2	Remote/Local	No Local Lockout
PP0	Parallel Poll	No Capability
DC0	Device Clear	No Capability
DT0	Device Trigger	No Capability
C0	Controller	No Capability

1.0 IEEE-488 Hardware Configuration

1.1 Interface connector

The following table indicates the pin assignments for the rear panel 24 pin IEEE-488 interface connector.

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

The contact assignments are those required by the IEEE-488 standard. Thus, most users need only connect a standard interface cable between their controller and the 900 interface connector.

1.2 Address Assignment

The remote control address is assigned by the five small switches next to the interface connector. Switch 1 is the LSB; switch 5 is the MSB. Thus, to assign the 900 an address of 6 (listen address '&' and talk address 'F'), the switches would be set as follows:

Switch number	5	4	3	2	1
Switch setting	0	0	1	1	0

1.3 Syntax Configuration

The standard remote control syntax (as described in this manual) is enabled by setting S7 on the CPU PC board (A2) to the on (up) position. S7's off position is reserved for enabling a special syntax which might be required in unusual applications. The instrument is normally shipped from the factory with S7 set to the on position.

2.0 GENERAL COMMAND STRUCTURE

2.1 Character Representation

In this manual, the ASCII characters sent in a message will be represented in single quotes.

e.g.: 'MESSAGE' corresponds to a string of seven bytes with hexadecimal values of $4D, $45, $53, $41, $47, $45.

Special characters will be represented as follows:

'<CR>'	Carriage return, $0D
'<LF>'	Line Feed, $0A
'b'	One or more spaces, $20
'z'	Zero or more spaces
's'	One space
'd'	Decimal digit

2.2 Command Interpretation

The 900 uses a 40 character buffer to accept and store characters sent to it via the interface. Multiple sequential spaces are compressed to a single space character for storage in the buffer. The buffer's contents are interpreted and the buffer is reset upon receipt of a character sent with the EOI line asserted or upon receipt of any of the following delimiter characters:

'<CR>' '<LF>' ',' ':' ';' '/' '\'

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

2.3 Command format

Each command consists of a verb, followed by zero or more spaces, followed by an argument.

e.g.: 'GENzFIXED' GEN is the verb and FIXED is the argument

'FAz12.3E+3' FA is the verb and 12.3E+3 is the argument

2.4 Numeric Arguments

Frequency and level setting commands use numeric arguments (represented in command descriptions as 'n'). The format for numeric arguments (described below) is sufficiently flexible that no special formating will be necessary when using most IEEE-488 controllers. Signed or unsigned numbers are acceptable. Integers or decimal fractions are permitted and may be followed by a signed or unsigned one or two digit exponent. Leading zeroes are permitted, but spaces within a number are not permitted. The integer and optional fractional part are each restricted to a maximum length of 10 digits.

The following are examples of valid numeric arguments:

'b25.7' / '-32.1' / '0.3' / '2958.763E-2'

'6E-10' / '-000.000000001E+10' / 'b7b' / '1E6'

3.0 COMMAND DESCRIPTIONS

Each subsection describes a verb and its valid arguments. Most commands perform functions in a way that is similar to the 900's front panel controls except where noted.

3.1 'GEN' set signal generation mode

'GENzFIXED': generate fixed (CW) frequency
'GENzUSWP': generate unlocked sweep
'GENzLSWP': generate locked sweep

3.2 'MOD' set modulation mode

'MODzOFF': modulation off
'MODzPULSE': internal pulse
'MODzSQR': internal square wave
'MODzAM': external AM (instruments without 18-26 GHz band only)
'MODzEXT+': external, rising edge triggered (see note, p. 1-12)
'MODzEXT-': external, falling edge triggered (see note, p. 1-12)

3.3 'MODRATE' set internal modulation rate

'MODRATEzFIXED': 1 kHz rate
'MODRATEzVAR': rate variable via front panel controls

3.4 'PWIDTH' set internal pulse width

'PWIDTHzFIXED': 1 usec width
'PWIDTHzVAR': width variable via front panel control

3.5 'AGC' set external modulation leveling loop time constant

'AGCzFAST': short time constant
'AGCzSLOW': long time constant

This command only influences the instrument's operation in the external pulse modulation modes. 'AGCzSLOW' allows the leveling loop to function at rates less that 1 kHz. 'AGCzFAST' provides a faster loop response at higher modulation rates.

3.6 'LVERN' Enable/disable front panel level vernier control

'LVERNzON': Enables
'LVERNzOFF': Disables

3.7 'EXTALC' Enable/disable external ALC

'EXTALCzON': Enables
'EXTALCzOFF': Disables

3.8 'POWER' Set power meter configuration

'POWERzINT': Measure internal power
'POWERzEXT': Measure external power (if option 09 installed)
'POWERzDELTA': Measure power difference (if option 09 installed)
'POWERzCAL': Call up cable normalization functions (if option 09 installed) (see paragraph 7 below)

3.9 'SWEEP' Control sweep function

The 'SWEEP' command has seven valid arguments. The commands provide the same sweep functions as the front panel pushbuttons. Separate commands are used to control triggered sweep, via the sweep trigger input connector, and to control non-triggered modes.

'SWEEPzAUTO': Automatic repetitive sweep
'SWEEPzONCE': Single sweep
'SWEEPzSTEP': Single step sweep. One step equal to FC occurs each time this command is received.
'SWEEPzTRIG': Triggered single sweep. A pulse on the sweep trigger input causes one complete sweep.
'SWEEPzSTPTRIG': Triggered single step. A pulse on the sweep trigger input produces one step, equal to FC.
'SWEEPzRESET': Reset. Immediately terminates sweep. To restart the sweep, send the 'SWEEP' command for the function desired.
'SWEEPzNUL': The action of this command depends upon what the current sweep function is. If it is 'ONCE', 'STEP', or 'RESET', 'NUL' has no effect. If it is

'TRIG' or 'STPTRIG', 'NUL' acts the same as 'RESET'. If it is 'AUTO', 'NUL' acts the same as 'RESET', but not until the end of the current sweep.

The front panel sweep reset button functions in both local and remote modes.

3.10 'SWPRATE' Set Sweep Rate

Valid arguments are the ASCII letters 'A' through 'J'. The letters correspond to the positions of the front panel control, 'A' being the slowest.

3.11 'DISP' Enable/disable 7-segment displays

'DISPzON': Enables
'DISPzOFF': Disables

When the displays are disabled, the leftmost and rightmost digits are illuminated as brackets in order to serves as a standby indication; all other digits are blank. Error messages will appear in the frequency display panel even during the displays-disabled mode. The displays are enabled upon initialization and at all times during local operation.

4.0 SET FREQUENCY COMMANDS

The three frequency commands each require a numeric argument. Digits specifying a frequency resolution in excess of the instrument's capabilties are ignored (no rounding). The instrument's frequency resolution is 1 MHz except where noted below. The argument always specifies frequency in MHz (e.g., 'n' = '2345' specifies 2.345 GHz). In the range specifications given with each command, the following conventions are used to specify limits.

F min = minimum CW generate frequency--
0 Hz except when F min = other than 50 MHz.

F max = maximum CW generate frequency

4.1 'FA' Set start frequency

'GENzFIXED': Set output frequency
F min $\leq$ 'n' $\leq$ F max, 1 kHz output resolution with option 03
'GENzUSWP': Set sweep start frequency
F min $\leq$ 'n' < F max
'GENzLSWP': Set sweep start frequency
F min $\leq$ 'n' < F max, 1 kHz resolution with option 03

4.2 'FB' Set stop frequency

'GENzUSWP': Set sweep stop frequency
'FAzn' < 'n' ≤ F max
'GENzLSWP': Set sweep stop frequency
'FAzn' < 'n' ≤ F max, 1 kHz resolution with option 03
'FB' commands are ignored in 'GENzFIXED' mode

4.3 'FC' Set frequency step

'GENzUSWP': Set step
1.0 < 'n' < 'F max'
'GENzLSWP': Set step
0.001 < 'n' < F max, 1 kHz resolution with option 03
1.0 ≤ 'n' ≤ F max without option 03

'FC' commands are ignored in 'GENzFIXED' mode.

5.0 SET LEVEL COMMANDS

The three set level commands all require a numeric argument. The arguments specify levels in dBm with .1 dB resolution. Digits specifying a finer resolution are ignored (no rounding).

The 'LEVEL' command causes appropriate values for the step attenuator and leveling loop programming to be computed from the argument. The computation causes the step attenuator to switch at argument values which are evenly divisible by 10 (e.g., between '-29.9' and '-30.0').

Some applications may require that very small, but accurate, level changes be made. If such a change causes a change in step attenuator setting, the accuracy of a very small change will be lost. Therefore, the 'LVLCRS' and 'LVLFNE' commands have been provided to independently set the step attenuator and leveling loop. Each of the following three messages will program the instrument to -28.5 dBm.

'LEVELz-28.5' (attenuator at -20 dB)
'LVLCRSz-20bLVLFNEz-8.5'
'LVLCRSz-30bLVLFNEz1.5'

5.1 'LEVEL' Set output level

The argument specifies that output level in dBm. Valid argument ranges are:

90 dB remote attenuator: -99.9 ≤ 'n' ≤ +15.0
110 dB remote attenuator: -119.0 ≤ 'n' ≤ +15.0

5.2 'LVLCRS' Set step attenuator

The argument specifies the step attenuator setting in dB. It must be evenly divisible by 10.0. Valid ranges are:

90 dB remote attenuator: -90.0 ≤ 'n' ≤ 0.0

110 dB remote attenuator: $-110.0 \leq$ 'n' ≤ 0.0

5.3 'LVLFNE' Set leveling loop

The argument specifies the leveling loop program value in dB. Output power is the sum of the 'LVLCRS' and 'LVLFNE' arguments. The range of valid arguments is $-15.0 \leq$ 'n' $\leq +15.0$.

5.4 Leveling loop range limitations

The leveling loop range is limited by the maximum output power which the instrument can produce. At very low levels, the on-to-off ratio of the instrument's PIN attenuators may also limit the loop's range. Both the front panel vernier control and cable normalization (if option 09 installed), if enabled, may place demands upon the leveling loop in addition to those of the level commands. When the loop's dynamic range is exceeded, the front panel level light will go out. This condition can also be checked remotely by sending a 'SENDzSTATUS' command and examining the message returned by the instrument (see paragraph 6.4 below).

If a very large correction is needed for cable normalization (when option 09 is installed), the dynamic range of the D/A converter which programs the leveling loop may be exceeded, causing 'ERROR12' to be issued. 'ERROR12' will also be issued upon receipt of invalid level command arguments by instruments with remote control attenuators. Leveling loop accuracy is reduced at very low levels (below about -11 dBm). The internal power meter circuitry operates down to approximately -17 dBm. Lower levels will cause the power display to blank.

6.0 REPLY MESSAGES

A reply message will be sent over the interface by the 900 whenever is is addressed to talk. If unaddressed in the middle of a message, any remaining characters are cleared from the output buffer. EOI is asserted during the last character ('<LF>') of each message. The type of message sent is determined by the 'SEND' commands described in the following subsections. If an error condition exists, a 'SENDzERROR' type message will be sent instead of the message type requested except for 'SENDzNUL' which always returns a null line.

Numeric values have leading zeroes to the left of the units position supressed to spaces. Numeric precision is expressed as (X) for integers and (X.Y) for numbers with fractional parts where X and Y specify the number of digits before and after the decimal point, respectively. For signed numers, the sign is included in X [e.g., '+22.7' is (3.1)].

6.1 'SENDzNUL' Null line

Message will be a null line ('<CR><LF>') even if an error condition is present.

6.2 'SENDzFREQ' Frequency message

The value sent always represents frequency in MHz.

'GEN' modes: 'sFsOUTsn<CR><LF>'
'n' = unsigned (5) in 1 MHz resolution modes
'n' = unsigned (5.3) in 1 kHz resolution modes
'n' = has a value of 0 when sweep is reset

6.3 'SENDzPOWER' Power message

The value sent represents power in dB or dBm, as appropriate, and is always signed (4.1). If no valid power reading is avaliable, the message is sent with 'n' = '-----'.

'POWERzINT' sends 'sPsINTsn<CR><LF>'
'POWERzEXT' sends 'sPsEXTsn<CR><LF>' (if option 09 installed).
'POWERzDELTA' sends 'sPsDELsn<CR><LF>' (if option 09 installed).
'sPsCALsn<CR><LF>' is sent while the instrument is doing a cable measurement sweep (if option 09 installed).

6.4 'SENDzSTATUS' Status message

The message sent is:
'sLOCKsdsLEVELsdsCALsd<CR><LF>'
where each 'd' is either '1' or '0' to represent true or false.

'LOCK' and 'LEVEL' are true when their corresponding front panel lights are on. 'CAL' is true when cable normalization is enabled (if option 09 installed).

6.5 'SENDzERROR' Error message

The message sent is '<CR><LF>' if no error exists. When an error condition does exist, the message sent is 'sERRORsdd' where 'dd' is the error code displayed on the front panel.

7.0 CABLE NORMALIZATION (if option 09 installed)

Changing between local and remote control does not alter the cable normalization functions within the instrument. Therefore it is possible, if desired, to calibrate the loss of a cable using the front panel controls, and then operate the instrument via the remote control interface. One can determine if cable normalization is enabled by using the 'SENDzSTATUS' message (see paragraph 6.4 above). Cable normalization is controlled remotely by using the command sequences given in the following subsections.

7.1 To sweep a cable and record loss data:

1. Connect cable to be calibrated between the instrument's RF output and power meter input.

2. Send 'CALzRUN'.

3. The status message will be 'CALs0' while data is being taken and 'CALs1' when calibration is complete. Normalization will be enabled.

7.2 To disable normalization, send 'CALzNO'.

7.3 To enable normalization with current data, send 'CALzYES'.

7.4 To delete previously recorded data send 'CALzCLEAR'. Normalization will be disabled and cannot be re-enabled until another calibration sweep has been done.

8.0 INTERFACE INITIALIZATION VALUES

The IEEE-488 interface is initialized upon assertion of IFC by the controller, upon instrument power up (CPU reset), and whenever the rear panel address switch settings are changed. The 900's remote control data is initialized to the 'GENzFIXED' mode with no modulation. Frequency and output level are initialized to the minimum values. The power meter is configured to measure internal power.

5. Pen Lift

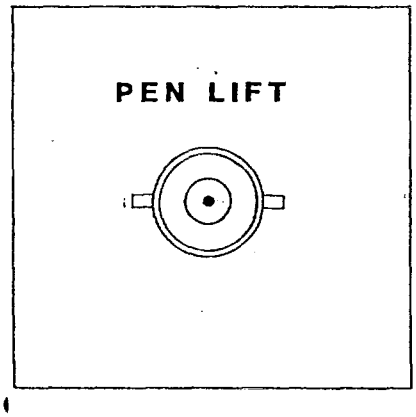

Figure 1.13

The pen lift signal is provided to allow controlling the recorder pen lift. The signal goes low (a transistor to ground) whenever the sweep ramp is resetting or the sweep is in hold. During sweep, the transistor is off and the signal is pulled to +5V through a resistor.

6. Power Meter Output (if option 09 installed)/External Modulation Input

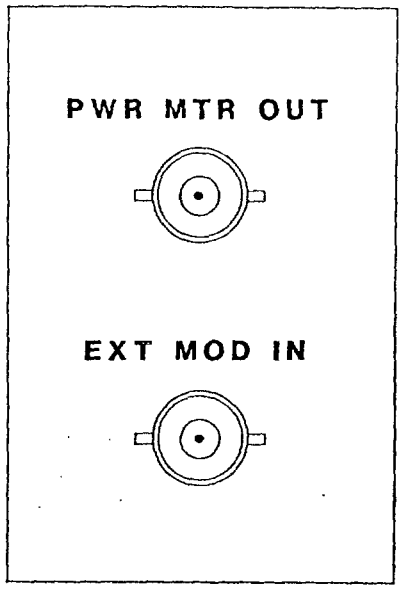

Figure 1.14

The power meter output provides an analog signal proportional to the external power meter reading in all modes of operation. The signal is 0.5V/dBm, nominal, with +10V at +10 dBm and -10V at -30 dBm into 2 kohms, min.

The external modulation input (if required) provides a rear panel input for either the external pulse or AM signal.

SECTION TWO

PERFORMANCE SPECIFICATIONS

CHARACTERISTIC	PERFORMANCE
FREQUENCY	
Range:	Specified by Model No.; i.e., the range of the Model 900/2-18 is 2 to 18 GHz, the Model 900/.05-12 is 50 MHz to 12 GHz, etc.
Resolution:	1 MHz (See note 1)
Accuracy:	Same as time base.
Time Base (Internal):	10 MHz, $< 1 \times 10^{-6}$ / year rate.
Time Base (External):	1 MHz $\pm 1 \times 10^{-6}$ or better.
SPECTRAL PURITY	
Harmonics, Subharmonics:	<55 dBc (See note 2)
Spurious (Nonharmonics):	<55 dBc
RF OUTPUT	
Output Level (25°C ± 10°C):	-99 to +5 dBm in Models 900/2-8, 8-12, 12-18 and all models containing the 18-26 GHz band. -99 to +3 dBm in all other models.
Output Accuracy (25°C ± 10°C):	±1 dB to 18 GHz, ±2 dB to 26 GHz.
Output Attenuation:	99 dB in 1 dB steps.
Level Adjustment:	-5 dB to +15 dB.
Source Impedance:	50Ω , nominal.
PULSE MODULATION	
Square Wave:	Variable rate from 100 Hz to 50 kHz with a fixed point at 1 kHz.
Pulse:	Variable rate from 100 Hz to 50 kHz with a fixed point at 1 kHz. Variable width from 10 μsec to 0.1 μsec with a fixed point at 1 μsec.
On/Off Ratio:	>30 dB, all models containing the 18-26 GHz band. >60 dB, all other models.
Rise/Fall times:	<25 nsec.

CHARACTERISTIC	PERFORMANCE
PULSE MODULATION (continued)	
Overshoot/Undershoot/Ringing:	± 2 dB, max.
Settling Time:	± 1 dB within 100 nsec.
External:	10 Hz to 1 MHz rate with a 0.1 μsec, min width. Rising or falling edge triggering.
Sync Output:	TTL level modulation waveform.
AMPLITUDE MODULATION (except models containing the 18-26 GHz band)	
Frequency Response:	10 Hz to 5 kHz at 3 dB points referenced to 1 kHz.
Modulation Depth:	0 to 20 dB.
Input Impedance:	500Ω , AC coupled.
SWEEP OPERATION	
Sweep Range:	Same as Frequency Range.
Sweep Mode:	Auto, Single Sweep and Single Step.
Step Increments:	1, 10 and 100 MHz.
Sweep Time:	Variable from 10 msec to 100 sec.
Sweep Rate:	Typically 50 MHz / msec.
Ramp Output:	0 to 10V, ± 10%, proportional to frequency for any sweep width. Ramp operates in all sweep modes.
Sweep Trigger:	1V transistor switch to ground.
Pen Lift:	1V transistor switch to ground during retrace.
GENERAL	
Remote Interface:	IEEE STD 488-1978.
Operating Temperature Range:	0 to +50°C.
Warm-up Time:	20 minutes, max.
Environmental:	Type tested to MIL-T-28800B, type III, Class 5, Style E.

CHARACTERISTIC	PERFORMANCE
GENERAL (continued)	
Power:	100/120/220/240 VAC ±10%, 50-400 Hz
Dimensions:	16.75" W X 24" D X 5.25" H, 65 lbs, nominal.

PERFORMANCE NOTES

1. Frequency Resolution: An input is provided on the rear of the instrument marked PLL - Ref. A signal on this input will override the internal 5 MHz reference to the phase-lock loop controlling the master RF reference. Any shift in this frequency will cause a 1 for 1 shift in the RF output frequency. The range of frequency shift that can be achieved is typically 15 MHz at a rate within the bandwidth of the phase-lock loop, typically 50 kHz. This allows the instrument to operate with a low frequency (5 MHz to 20 MHz) synthesizer to achieve greatly increased resolution or to be used with a 5 to 20 MHz swept source to achieve a narrowband swept RF output.

2. Spectral Purity: The Series 900 uses an indirect phase-locked master RF reference method of controlling fundamental YIG oscillators as output RF sources. This method of synthesis takes advantage of the differences in noise characteristics of the master reference which is a low noise crystal controlled oscillator and the master RF reference. Within the bandwidth of the phase-locked loops the principal source of phase noise is that of the crystal controlled reference multiplied up only to the master RF reference. Beyond the bandwidth of the phase-locked loops the phase noise is completely related to the noise characteristics of the master RF reference YIG oscillator which is extemely low.

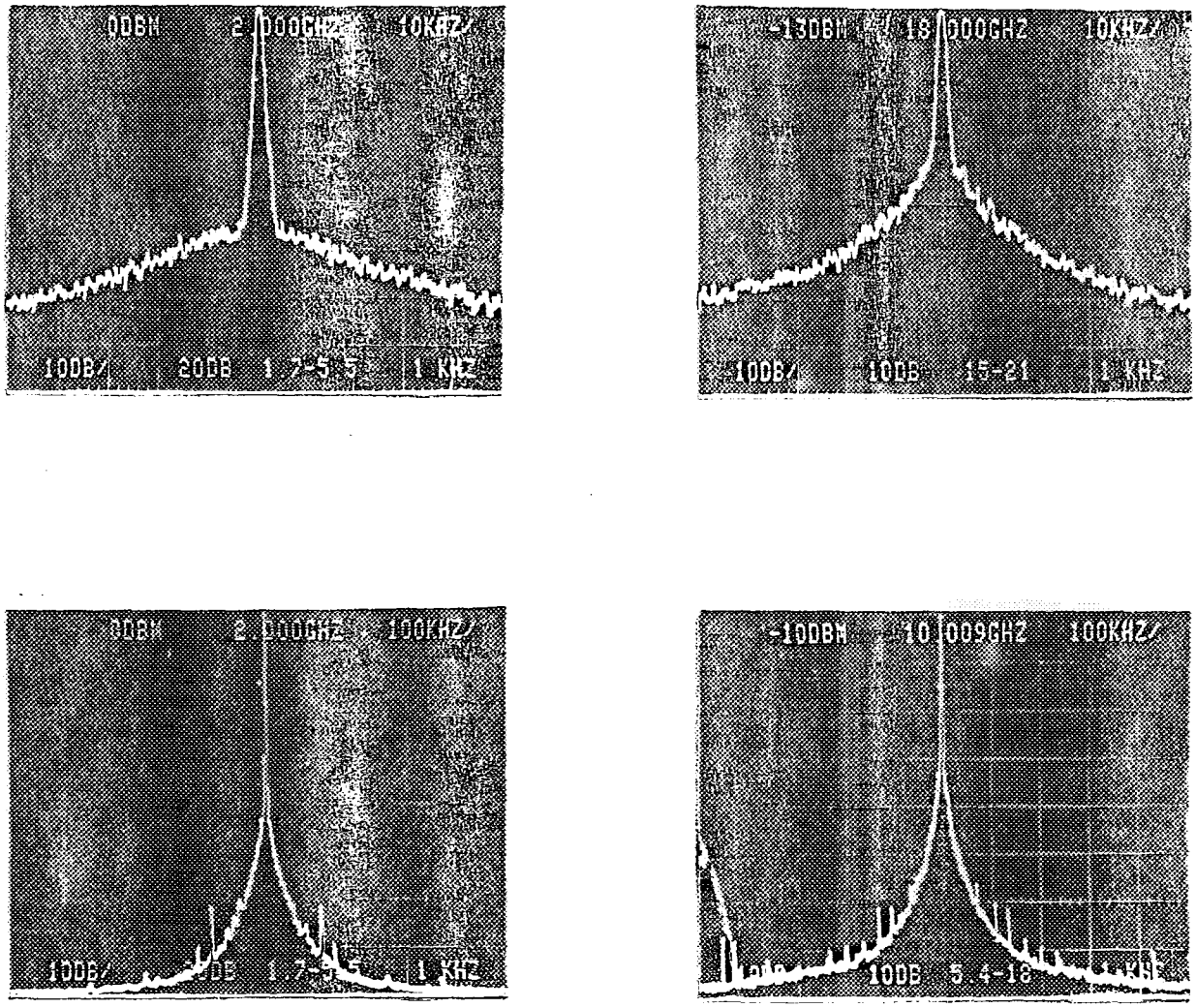

Figure 2.1 Typical Noise Spectrum