

**OPERATING MANUAL**

Sections I, II, III

# 8662A

## Synthesized Signal Generator

10 kHz — 1280 MHz

**SERIAL NUMBERS**

This manual applies directly to instruments with serial numbers prefixed 1830A.

Changes to this manual are described in the yellow Manual Changes supplement for this manual alone, and also in the Manual Changes supplement for Volume 1 of the Operating and Service Manual.

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EAST 24001 MISSION AVENUE, TAF C-34, SPOKANE, WASHINGTON, U.S.A. 99220

Table 1-1. Specifications (3 of 5)

Electrical Characteristics	Performance Limits	Conditions
<p><b>FREQUENCY MODULATION (Cont'd)</b></p> <p>Maximum Peak Deviation (external ac) (Cont'd)</p> <p>Maximum Peak Deviation (external dc)</p> <p>Indicated FM Accuracy</p> <p>FM Resolution</p> <p>Incidental AM (AM sidebands)</p> <p>FM Distortion</p> <p>Center Frequency Accuracy and Long Term Stability</p>	<p>The smaller of 50 kHz or <math>f_{mod} \times 250</math></p> <p>The smaller of 100 kHz or <math>f_{mod} \times 500</math></p> <p>The smaller of 200 kHz or <math>f_{mod} \times 1000</math></p> <p>100 kHz 25 kHz 50 kHz 100 kHz 200 kHz</p> <p><math>\pm 6\%</math> of reading plus 10 Hz</p> <p>100 Hz 1000 Hz</p> <p>-72 dBc -65 dBc</p> <p>1.0% 1.7%</p> <p>Same as CW mode</p>	<p>160 to 320 MHz</p> <p>320 to 640 MHz</p> <p>640 to 1280 MHz</p> <p>0.01 to 120 MHz 120 to 160 MHz 160 to 320 MHz 320 to 640 MHz 640 to 1280 MHz</p> <p>50 Hz to 20 kHz rates</p> <p>&lt; 10 kHz deviation <math>\geq 10</math> kHz deviation</p> <p>1 kHz rate and 20 kHz deviation 0.01 to 640 MHz 640 to 1280 MHz</p> <p>dc to 1 kHz rates 1 kHz to 20 kHz rates</p> <p>Internal and external ac mode only</p>
<p><b>GENERAL</b></p> <p>Operating Temperature Range</p> <p>Power Requirements: Line Voltage 115 Setting 230 Setting</p> <p>Line Frequency</p> <p>Power Dissipation</p> <p>Electromagnetic Interference (EMI)</p> <p>Net Weight</p>	<p>0 to +55°C</p> <p>90 – 126V 198 – 252V</p> <p>48 to 66 Hz</p> <p>420 VA maximum</p> <p>MIL STD 461A and VDE 0871</p> <p>or</p> <p>1 <math>\mu</math>V</p> <p>30 kg (65.5 lb)</p>	<p>Conducted and radiated interference is within the requirements of methods CE03 and RE02 of MIL STD 461A as well as VDE 0871.</p> <p>Induced in a two turn, 25 mm (1 inch) diameter loop, 25 mm (1 inch) away from the front panel and measured into a 50 ohm receiver.</p>

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These sections are bound separately in Volume 1 with a separate table of contents.

**Sections VI and VII  
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These sections are bound separately in Volume 1 with a separate table of contents.

**Section VIII  
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This section is located in Volume 2 with a separate table of contents.

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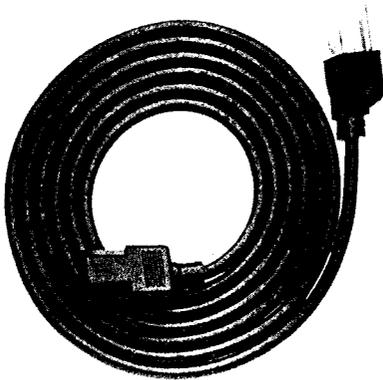
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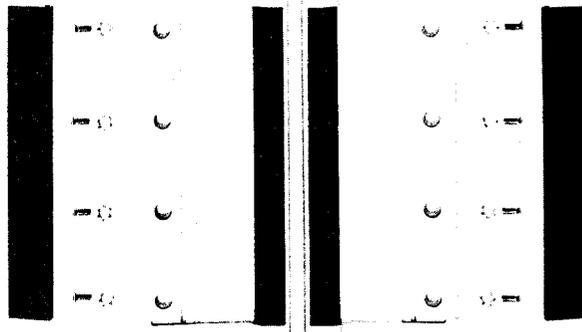
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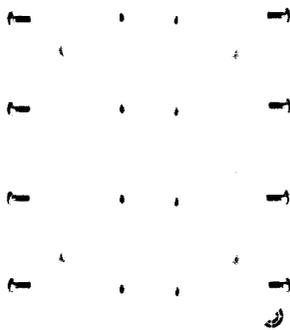
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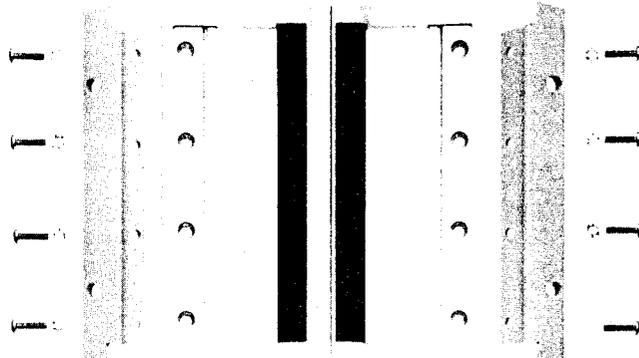
LINE POWER CABLE



OPTION 907 FRONT HANDLE KIT



OPTION 908  
RACK MOUNT KIT



OPTION 909  
RACK MOUNT KIT WITH FRONT HANDLES

Figure 1-1. HP Model 8662A and Accessories Supplied

## SECTION I

### GENERAL INFORMATION

#### 1-1. INTRODUCTION

Volume 1 of the 8662A Operating and Service manual has seven major sections. They are:

- I. General Information
- II. Installation
- III. Operation
- IV. Performance Tests
- V. Adjustments
- VI. Replaceable Parts
- VII. Manual Changes

This Operating Manual is part of Volume 1 and contains Sections I, II, and III only. Volume 2 contains Section VIII, Service (that is, principles of operation, troubleshooting, component locators, schematics, disassembly procedures, etc.).

This manual presents operating information for the HP Model 8662A Synthesized Signal Generator. The Generator, with all supplied accessories, is shown in Figure 1-1.

The HP part number for the Operating Manual only is shown on the title page of this manual. Part numbers for the complete Operating and Service Manual, for all its parts, and for a complete microfiche copy are listed on the back of the title pages for Volumes 1 and 2.

The microfiche copies are 100 x 150 mm (4 x 6-inch) microfilm transparencies of the manuals. Each microfiche contains up to 96 photo duplicates of the manual pages and the latest Manual Changes supplement.

#### 1-2. SPECIFICATIONS

Instrument specifications are listed in Table 1-1. These specifications are the performance standards or limits against which the instrument can be tested. Supplemental characteristics are listed in Table 1-2. Supplemental characteristics are not specifications but are typical characteristics included as additional information for the user.

#### 1-3. SAFETY CONSIDERATIONS

This product is a Safety Class I instrument (provided with a protective earth terminal). The Signal Generator and all related documentation must be reviewed for familiarization with safety markings and instructions before operation. Refer to the Safety Considerations page found at the beginning of this manual for a summary of general safety information.

Safety information for installation and operation is found in appropriate places throughout this manual.

#### 1-4. INSTRUMENTS COVERED BY MANUAL

Attached to the instrument is a serial number plate. The serial number is in the form: 0000A00000. It is in two parts: the first four digits and the letter are the serial number prefix and the last five digits are the suffix. The prefix is the same for all identical instruments; it changes only when a change is made to the instrument. The suffix, however, is assigned sequentially and is different for each instrument. The contents of this manual apply to instruments with the serial number prefix(es) listed under SERIAL NUMBERS on the title page.

An instrument manufactured after the printing of this manual may have a serial number prefix that is not listed on the title page. This unlisted serial number prefix indicates the instrument is different from those described in this manual. Volumes 1 and 2 each contain a Manual Changes supplement for these newer instruments. Each supplement contains change instructions for all of the manuals within that volume. Additionally, a separate change supplement is available for this Operating Manual alone.

In addition to change information, the supplements may contain information for correcting errors in the manual. To keep this manual as current and accurate as possible, Hewlett-Packard recommends that you periodically request the latest Manual Changes supplement. These supplements are identified with the print dates and part numbers that appear on the title pages of the two volumes. Complimentary copies of these supplements are available from Hewlett-Packard.

For information concerning a serial number prefix that is not listed on the title page or in the Manual Changes supplements, contact your nearest Hewlett-Packard office.

#### 1-5. DESCRIPTION

The HP Model 8662A is a precision synthesized signal generator with the following features:

- 10 kHz to 1280 MHz frequency range
- 0.1 Hz resolution (0.2 Hz from 640 to 1280 MHz)
- $5 \times 10^{-10}$  /day frequency stability

**DESCRIPTION (Cont'd)**

- +13 to -139.9 dBm output level range (with overrange to +16 dBm)
- $\pm 1$  dB level accuracy
- AM/FM modulation modes
- Hewlett-Packard Interface Bus (HP-IB) capability
- Reverse power protection to 30 watts
- ... with exceptional spectral purity,
- SSB phase noise  $< -144$  dBc/Hz at 10 kHz offset from carrier ( $f_c = 160$  MHz)
- Broadband noise floor  $< -146$  dBc
- Spurious signals from  $-84$  to  $-100$  dBc depending on  $f_c$
- Harmonics  $-30$  dBc
- ... microprocessor control for measurement efficiency.
- Keyboard control of all functions
- Storage and recall of front panel settings
- Learn modes
- Stepping of all value-selectable parameters and versatile digital sweep.
- ... synthesized frequency accuracy and resolution
- Start/Stop and Span modes
- Linear or log sweep
- Selectable time per step
- Completely variable step size
- 5 digital markers

**1-6. OPTIONS****1-7. Electrical**

Option 001 provides the RF OUTPUT connector on the rear panel instead of on the front panel.

**1-8. Mechanical**

The following kits might have been ordered and received with the Signal Generator (they are shown in Figure 1-1). If they were not received with the original shipment and are now required, they may be ordered from your nearest Hewlett-Packard office, using the part numbers included in each of the following paragraphs.

**Front Handle Kit, Option 907.** This kit contains front handles and mounting hardware. Order HP part number 5061-0090 for the basic kit and 2190-0048 for lockwashers (8 required).

**Rack Mount Kit, Option 908.** This kit contains flanges and hardware for mounting the Generator in a standard rack of 482.5 mm (19 inches). Order HP part number 5061-0078.

**Rack Mount Kit with Front Handles, Option 909.**

This kit contains flanges, handles and mounting hardware (the flanges are different than the Option 908 flanges). Order HP part number 5061-0084 for the basic kit and 2190-0009 for lockwashers (8 required).

**1-9. HEWLETT-PACKARD INTERFACE BUS****1-10. Compatibility**

The Signal Generator has an HP-IB interface and can be used with any HP-IB computing controller or computer for automatic system applications. The Signal Generator is fully programmable via the HP Interface Bus. HP-IB is Hewlett-Packard's implementation of IEEE Standard 488 and the identical ANSI Standard MC1.1. The Generator's compatibility with HP-IB is defined by the following list of interface functions: SH1, AH1, T6, TE0, L3, LE0, SR1, RL1, PP0, DC1, DT1, and C0. For more detailed information relating to remote operation of the Signal Generator, refer to Section III of this manual.

**1-11. HP-IB Address**

Two thumbwheel switches inside the top cover select the address code. This procedure is described on page 2-2, and is intended for service-trained persons only. The decimal equivalent of the 5-bit address code can be displayed on the front panel, however, by selecting Special Function 82 (see page 3-32 for more details).

**1-12. ACCESSORIES SUPPLIED**

The accessories supplied with the Signal Generator are shown in Figure 1-1. The power cable is selected at the factory according to the voltage available in the country of destination. For the part numbers of the power cable refer to the paragraph titled Power Cables on page 2-2. For Generators shipped to countries using 115 volts, a set of fuses for 230 volts operation is also supplied.

**1-13. EQUIPMENT AVAILABLE**

A service accessory kit, Hewlett-Packard accessory number 11714A, is required for servicing and troubleshooting the Signal Generator. The service kit contains extender boards, connectors, cables, adapters and other service aids. For more details on the service accessory kit, see Table 1-5.

#### 1-14. RECOMMENDED TEST EQUIPMENT

Table 1-3 lists the equipment required for maintaining the Generator. The Critical Specification column describes the essential requirements for each piece of test equipment. Other equipment can be substituted if it meets or exceeds these critical specifications.

The Recommended Model column may suggest more than one model. The first model shown is usually the least expensive, single-purpose model.

Alternate models are suggested for additional features that would make them a better choice in some applications. For example, reasons for recommending an alternate model might be:

- HP-IB programmability  
— or —
- Multi-function capability (that is, one model can replace two or more single-purpose models)

Table 1-4 presents the advantages of the alternate suggestions.

Table 1-1. Specifications (1 of 5)

Electrical Characteristics	Performance Limits	Conditions
<b>FREQUENCY</b> Range  Resolution  Accuracy and Stability  Internal Reference Oscillator <sup>1</sup> : Frequency Aging Rate	10 kHz to 1280 MHz (1279.999 999 8 MHz)  0.1 Hz 0.2 Hz  Same as reference oscillator   10 MHz 5 x 10 <sup>-10</sup> /day	10 kHz to 640 MHz 640 MHz to 1280 MHz       After ten day warm-up (typically 24 hrs in normal operating environment)
<b>SPECTRAL PURITY</b> Residual SSB Phase Noise in 1 Hz Bandwidth  SSB Broadband Noise Floor in 1 Hz Bandwidth  Spurious Output Signals (non-harmonically related <sup>2</sup> )  Spurious Output Signals (subharmonically related <sup>3</sup> )  Spurious Output Signals [Power line (50–60 Hz) related or microphonically generated (within 300 Hz from carrier)]  Harmonics	–100 dBc –112 dBc –121 dBc –132 dBc –133 dBc  –146 dBc  –90 dBc –100 dBc –96 dBc –90 dBc –84 dBc  –75 dBc None  –90 dBc –85 dBc –80 dBc –75 dBc –70 dBc  –30 dBc	320 to 640 MHz; CW and AM mode.  10 Hz offset from carrier 100 Hz offset from carrier 1000 Hz offset from carrier 10 kHz offset from carrier 100 kHz offset from carrier  > +10 dBm output level; 120 to 640 MHz; 3 MHz offset from carrier  0.01 to 120 MHz 120 to 160 MHz 160 to 320 MHz 320 to 640 MHz 640 to 1280 MHz  640 to 1280 MHz 0.01 to 640 MHz  0.01 to 120 MHz 120 to 160 MHz 160 to 320 MHz 320 to 640 MHz 640 to 1280 MHz
<b>OUTPUT (+15 to +45°C):</b> Range  Resolution	+13 to –139.9 dBm (1V to 0.023 μVrms into 50 ohms)  0.1 dB	

<sup>1</sup>The internal reference oscillator is kept at operating temperature in STANDBY mode with the instrument connected to Mains power.  
<sup>2</sup>In the remote mode, it is possible to have spurious signals related to the microprocessor clock, spaced 3 MHz apart, at output levels typically less than –145 dBm.  
<sup>3</sup>Subharmonically related signals are f/2, 3f/2, etc.

Table 1-1. Specifications (2 of 5)

Electrical Characteristics	Performance Limits	Conditions
<b>OUTPUT (Cont'd)</b>		
Absolute Level Accuracy <sup>4,5</sup>	$\pm 1.0$ dB $\pm 3.0$ dB	+13 to -120 dBm -120 to -130 dBm
Flatness (referenced to 100 MHz, without correction, and down to -120 dBm)	$\pm 1.5$ dB $\pm 3.5$ dB	10 kHz to 640 MHz 10 kHz to 1280 MHz
<b>AMPLITUDE MODULATION</b>		
Depth	0 to 95%	Output level of +8 dBm and below (+10 dBm in uncorrected mode) <sup>6</sup>
Resolution	1% 0.1%	10 to 95% AM 0 to 9.9% AM
Incidental FM	$0.11 \times f_{\text{mod}}$ $0.07 \times f_{\text{mod}}$	0.15 to 640 MHz; 30% AM 640 to 1280 MHz; 30% AM
Incidental PM	0.11 radians peak 0.07 radians peak	0.15 to 640 MHz; 30% AM 640 to 1280 MHz; 30% AM
Indicated Accuracy	$\pm 5\%$ of reading $\pm 1\%$ AM	Depth $\leq 90\%$ AM; for AM rates given below.
AM Rates:		
Internal	400 and 1000 Hz	
External	dc to 1.5 kHz dc to 5 kHz dc to 10 kHz	0.15 to 1 MHz 1 to 10 MHz 10 to 1280 MHz
AM Distortion (0.15 to 1280 MHz)	2% 4% 5.75%	0 to 30% AM 30 to 70% AM 70 to 90% AM
<b>FREQUENCY MODULATION</b>		
FM Rates:		
Internal	400 and 1000 Hz	
External ac	20 Hz to 100 kHz	1 dB bandwidth
External dc	dc to 100 kHz	1 dB bandwidth
Maximum Peak Deviation (external ac and internal)	The smaller of 100 kHz or $f_{\text{mod}} \times 500$ The smaller of 25 kHz or $f_{\text{mod}} \times 125$	0.01 to 120 MHz 120 to 160 MHz
<sup>4</sup> Includes flatness, attenuator error, detector error and measurement uncertainty. <sup>5</sup> Level correction can be defeated via a special keyboard function. <sup>6</sup> AM is possible above these output levels but not specified.		

## SAFETY CONSIDERATIONS

### GENERAL

This product and related documentation must be reviewed for familiarization with safety markings and instructions before operation.

This product is a Safety Class I instrument (provided with a protective earth terminal).

### BEFORE APPLYING POWER

Verify that the product is set to match the available line voltage and the correct fuse is installed.

### SAFETY EARTH GROUND

An uninterruptible safety earth ground must be provided from the main power source to the product input wiring terminals, power cord, or supplied power cord set.

### SAFETY SYMBOLS



Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual (refer to Table of Contents).



Indicates hazardous voltages.



Indicates earth (ground) terminal.

#### WARNING

The WARNING sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

#### CAUTION

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.

Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.

#### WARNING

Any interruption of the protective (grounding) conductor (inside or outside the instrument) or disconnecting the protective earth terminal will cause a potential shock hazard that could result in personal injury. (Grounding one conductor of a two conductor outlet is not sufficient protection).

Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation.

If this instrument is to be energized via an auto-transformer (for voltage reduction) make sure the common terminal is connected to the earth terminal of the power source.

HP-IB address selection is a procedure involving access to the Generator's interior. This procedure should only be performed by a service-trained person who is aware of the potential shock hazard of working on equipment with protective covers removed.

For continued protection against fire hazards, replace the LINE and OVEN fuses only with 250V normal blow fuses with the same current rating. Do not use repaired fuses or short circuited fuse-holders.

#### CAUTION

The casual operator should not replace the LINE fuse. Replacing this fuse in a damaged Generator might cause additional damage. A qualified service person should first determine the cause of its failure, specifically with resistance checks in the power supply (see Service Sheet 55); repair the failure and then replace the fuse.

Model 8662A

Table 1-1. Specifications (4 of 5)

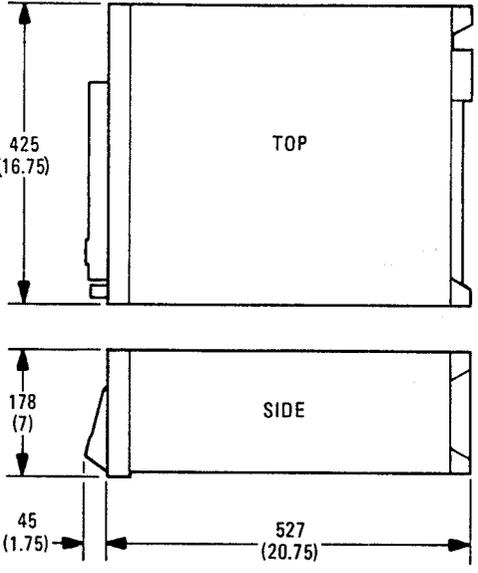
Electrical Characteristics	Performance Limits	Conditions
<b>GENERAL (Cont'd)</b> Dimensions <sup>7</sup> : Height Width Depth	178 mm (7.0 in.) nominal 425 mm (16.75 in.) nominal 527 mm (20.75 in.) nominal	 <p style="text-align: center;">DIMENSIONS IN MILLIMETRES AND (INCHES)</p>
Electrical Characteristics	Features	
<b>DIGITAL SWEEP</b> Start-Stop Sweep Span Sweep Sweep Width Step Size Sweep Speed Log Sweep Frequency Markers Intensity Markers Amplitude Markers	Sweeps between two selected frequencies. Symmetrical sweep about center frequency selected. Determined by frequency resolution and frequency range of instrument; that is, 0.1 Hz to 1280 MHz. Choice of 100 or 1000 points per sweep, or settable to any value within the frequency resolution of the instrument. Five selectable speeds: 0.5 ms, 1 ms, 2 ms, 10 ms, and 100 ms per step (0.5 ms is nominal value which will vary depending on use of markers or log sweep). Two choices available in increasing steps of 10% or 1% of the last frequency. Five digital markers. Resolution and accuracy same as RF output. Z-axis modulation of CRT display. Rear panel signal (5 kHz triangle wave) can be applied to AM input connector to provide adjustable amplitude markers.	
<sup>7</sup> Dimensions are for general information only. If dimensions are required for building special enclosures, contact your HP office.		

Table 1-1. Specifications (5 of 5)

Electrical Characteristics	Features
<p><b>DIGITAL SWEEP (Cont'd)</b></p> <p>Marker Sweep</p> <p>Display Blanking</p> <p>Sweep Output</p>	<p>Start/stop sweeps between any two frequency markers can be selected.</p> <p>250 <math>\mu</math>s positive pulse (TTL levels) available at rear panel for display blanking during frequency switching.</p> <p>0 to 10V nominal stepped ramp. Zero at start of sweep; approximately +10V at end of sweep regardless of sweep width. 10 000 points maximum.</p>
<p><b>SWEEP MODE</b></p> <p>Auto</p> <p>Single</p> <p>Manual</p>	<p>Sweep repeats automatically.</p> <p>Single sweep activated by front panel keyboard.</p> <p>Sweep controlled by front panel knob.</p>
<p><b>REMOTE OPERATIONS:</b></p> <p>HP-IB (IEEE 488) Capability:</p> <p>Interface</p> <p>Functions Controlled</p> <p>Auxiliary Control:</p> <p>Interface</p> <p>Functions Controlled</p>	<p>Hewlett-Packard Interface Bus (HP-IB). HP-IB is Hewlett-Packard's implementation of IEEE Standard 488 (and identical ANSI Standard MC1.1). The Generator's compatibility with HP-IB is defined by the following list of interface functions: SH1, AH1, T6, TE0, L3, LE0, SR1, RL1, PP0, DC1, DT1 and C0.</p> <p>All functions controlled from the front panel with the exception of the line switch are programmable with the same accuracy and resolution as in manual mode.</p> <p>Rear panel 14-pin Micro Ribbon connector.</p> <p>Step Up/Step Down: Same as INCREMENT keys on keyboard.</p> <p>Stop Sweep: Puts sweep in manual mode.</p> <p>Continue Sweep: Puts sweep in auto mode.</p> <p>Single Sweep: Initiates single sweep.</p> <p>Sequence: Same as sequence key on keyboard.</p> <p>Input Required: Contact closure to ground or 5 <math>\mu</math>s negative-true TTL pulse. Internally installed jumper determines mode.</p> <p>Outputs: 5 <math>\mu</math>s negative-true TTL pulse output under following conditions:                      1) change in signal parameter; for example, frequency, amplitude, modulation, 2) end of sweep.</p>

Table 1-2. Supplemental Characteristics (1 of 2)

Supplement characteristics are intended to provide information useful in applying the instrument by giving typical, but non-warranted performance parameters.

**FREQUENCY**

**Internal:** The internal reference oscillator accuracy is a function of time base calibration  $\pm$  aging rate  $\pm$  temperature effects  $\pm$  line voltage effects. Typical temperature and line voltage effects are  $1.1 \times 10^{-10}/^{\circ}\text{C} < 1 \times 10^{-10}/\pm 10\%$  line voltage change.

**External:** Any 5 MHz ( $\pm 0.0025\%$ ) frequency standard at a level of 1 Vrms  $\pm 0.1$  volt or any 10 MHz ( $\pm 0.005\%$ ) standard at a level of 0.5 to 0.7 Vrms into 50 ohms (rear panel connector).

**Reference Output (source impedance 65 ohms):** Reference signal (Int or Ext) available from rear panel connector at a level of  $> 0.5$  Vrms into 50 ohms. (Output is always 10 MHz even with 5 MHz external frequency).

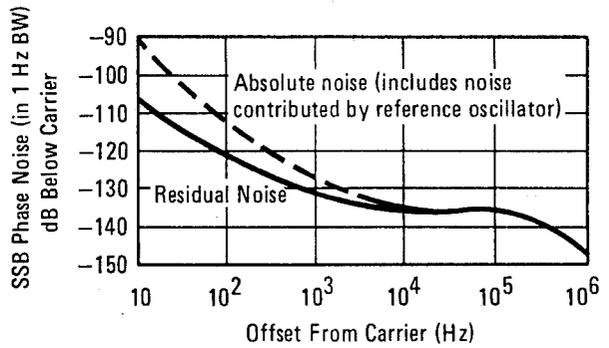
**Frequency Switching Speed:** Total switching time depends on the programming mode used. The 8662A RF settling time is 250  $\mu\text{s}$  to be within 1 kHz and 400  $\mu\text{s}$  to be within 100 Hz. The table below gives typical total switching time to be within 100 Hz of final frequency for various programming modes. (All data for 11-digits of frequency change.)

Programming Mode	Microprocessor Time	Settling Time	Total Switching Time
String	12.1 ms	400 $\mu\text{s}$	12.5 ms
Character	8.3 ms	400 $\mu\text{s}$	8.7 ms
Remote sweep	In these modes, microprocessor time and RF time overlap.		700 $\mu\text{s}$
Fast learn mode			420 $\mu\text{s}$

**NOTE**

Due to bandwidth switching of the automatic internal leveling loop, brief level inaccuracies (i.e., typically  $< 30$  ms) may occur when switching through 150 kHz and 1 MHz RF OUTPUT frequencies.

**SPECTRAL PURITY**



Measured SSB phase noise including noise contributed by reference oscillator.  $f_c = 639$  MHz.

Measured residual SSB phase noise:

Offset from carrier <sup>1</sup>	0.01 to 120 MHz (dBc)	120 to 160 MHz (dBc)	160 to 320 MHz (dBc)	320 to 640 MHz (dBc)	640 to 1280 MHz (dBc)
10 Hz	-113	-120	-113	-107	-101
100 Hz	-130	-132	-126	-119	-111
1 kHz	-134	-138	-133	-128	-122
10 kHz	-137	-148	-143	-136	-130
100 kHz	-134	-146	-142	-136	-130

<sup>1</sup> Residual single-sideband phase noise in 1 Hz BW (CW and AM mode only).

**OUTPUT**

**Impedance:** 50 ohms nominal.

**Reverse Power Protection:** Protects signal generator from application of up to 30 watts of RF power to 1280 MHz into generator output. DC cannot exceed  $-8\text{V}$ .

**SWR:**

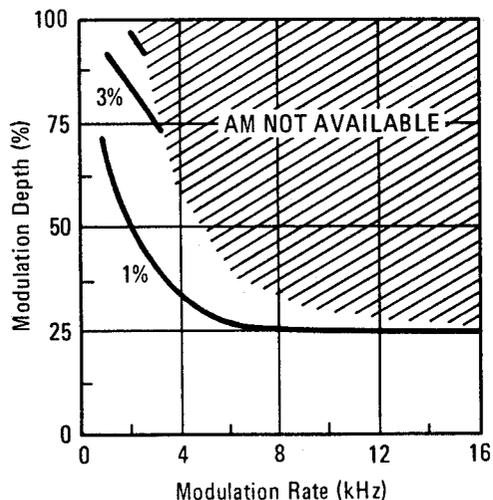
Output level	to 640 MHz	to 1280 MHz
+13 to $-10$ dBm	1.5	1.7
$-10$ to $-139.9$ dBm	1.4	1.5

**Level Switching Speed:** 60 ms from last command statement to stable output.

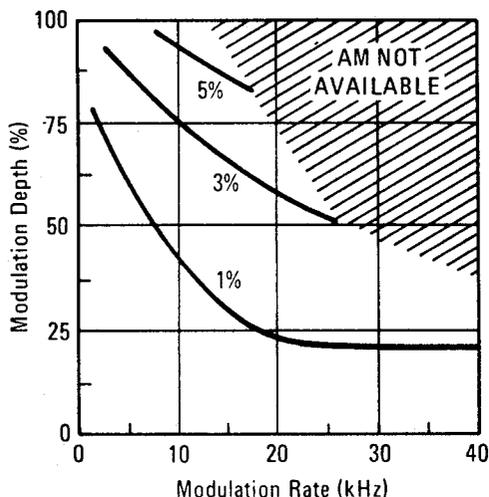
Table 1-2. Supplemental Characteristics (2 of 2)

**AMPLITUDE MODULATION**

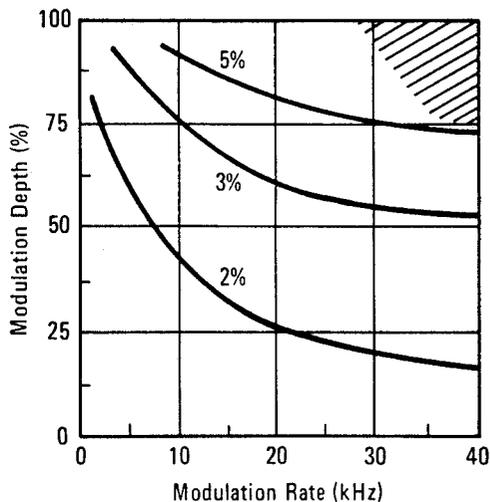
Measured AM Distortion Curves:



$f_c = 150 \text{ kHz to } 1 \text{ MHz}$



$f_c = 1 \text{ MHz to } 10 \text{ MHz}$



$f_c = 10 \text{ MHz to } 1280 \text{ MHz}$

**FREQUENCY MODULATION**

Measured Center Frequency Stability in DC Mode:

$f_c$ (MHz)	Center frequency accuracy	Measured center frequency stability
0.01 - 120	$\pm 10 \text{ kHz}$	$\pm 200 \text{ Hz/hr}$
120 - 160	$\pm 2.5 \text{ kHz}$	$\pm 50 \text{ Hz/hr}$
160 - 320	$\pm 5 \text{ kHz}$	$\pm 100 \text{ Hz/hr}$
320 - 640	$\pm 10 \text{ kHz}$	$\pm 200 \text{ Hz/hr}$
640 - 1280	$\pm 20 \text{ kHz}$	$\pm 400 \text{ Hz/hr}$

**EXTERNAL MODULATION**

**Input Impedance (Front Panel Input):** 1000 ohms nominal.

**Input Level Required:** 1V peak for specified accuracy. Note that front panel annunciators indicate application of 1V peak signal  $\pm 2\%$ . When greater accuracy is required, voltage of modulating signal should be monitored externally.

**Modulating Signal Output:** Internal or external modulating signal is provided at rear panel BNC connector at  $200 \text{ mV}_{\text{rms}}$  minimum into  $10 \text{ k}\Omega$  resistive load.

**Auxiliary FM Input:** Rear panel connector for FM modulation. Operates independently allowing simultaneous FM modulation with two tones. Input impedance:  $5.1 \text{ k}\Omega$ ; 4V peak yields maximum allowable deviation.

Table 1-3. Recommended Test Equipment (1 of 3)

Instrument	Critical Specification	Recommended Model	Use*
Attenuator, Fixed	Attenuation: As required by performance test Frequency Range: 10 kHz – 1300 MHz Accuracy: $\pm 0.1$ dB SWR: $< 1.3$	HP 8491A	P
Attenuator, 1 dB Steps	Steps: 1 dB from 0 dB to 10 dB Frequency Range: 100 to 300 MHz	HP 355C or HP 8494G with HP 11713A (see Table 1-4)	A
Attenuator, 10 dB Steps	Steps: 10 dB from 0 dB to 50 dB Frequency Range: 100 to 300 MHz	HP 355D or HP 8496G with HP 11713A (See Table 1-4)	A
Cable, RF	Connector: UG-210/U Type N (male)	HP 11500B	P
Controller, HP-IB	HP-IB compatibility as defined by IEEE Standard 488-1975 and the identical ANSI Standard MC1.1: SH1, AH1, T2, TE0, L2, LE0, SR0, RL0, PP0, DC0, DT0, and C1, 2, 3, 4, 5.	HP 9825A/98213A/ 98034A or HP 9835A/98332A/ 98034A (see Table 1-4)	P,T
Digital Voltmeter (DVM)	Accuracy: 4-1/2 digit, $\pm 0.05\%$ reading $\pm 1$ digit Range: 10 mV to 600V Sensitivity: 10 $\mu$ V	HP 3466A or HP 3455A (see Table 1-4)	P,A,T
Distortion Analyzer	Distortion Range: $< 0.1\%$ Range: 20 Hz to 100 kHz	HP 331A or HP 339A (see Table 1-4)	P
Frequency Counter	Range: 1300 MHz Resolution: 0.1 Hz External Time Base Capability	HP 5328A Option 031 or HP 5328A Options 011 and 031 (see Table 1-4)	P,A,T
Frequency Standard	Frequency: 10 MHz Long Term Stability: $< 1 \times 10^{-10}/24$ hours	HP 5065A	P,A
Low-Noise Amplifier	Input/Output Impedance: 50 ohms Frequency Bandwidth: 1 kHz to 1 MHz Noise Figure: $< 3$ dB Gain: $40 \pm 1$ dB	HP 08640-60506 Requires 19-25 Vdc Power Supply	P
Low-Pass Filter	Bandwidth: 1 MHz Impedance: 50 ohms	See Figure 1-2.	P
Mixer	Frequency: 0.2 to 500 MHz Type: Double Balanced	HP 10514A	P

\*P = Performance Testing, A = Adjustments, T = Troubleshooting

2-6. Power Cables

**WARNING**

BEFORE CONNECTING THIS INSTRUMENT, the protective earth terminal of the instrument must be connected to the protective conductor of the (mains) power cord. The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action must not be negated by the use of an extension cord (power cable) without a protective conductor (grounding). Grounding one conductor of a two conductor outlet is not sufficient protection.

This instrument is equipped with a three-wire power cable. When connected to an appropriate ac power receptacle, this cable grounds the instrument cabinet. The type of power cable plug shipped with each instrument depends on the country of destination. Refer to Figure 2-1 for the part numbers of the power cables available.

2-7. HP-IB Address Selection **HP-IB**

The HP-IB address switches are located within the Signal Generator. To change the HP-IB address the top cover of the Signal Generator must be removed.

**WARNING**

This task should be performed only by service trained persons who are aware of the potential shock hazard of working on an instrument with protective covers removed.

To avoid hazardous electrical shock, the line (mains) power cable should be disconnected before attempting to change the HP-IB address.

The following procedures describe how to locate and set the HP-IB address switches.

- a. Set the LINE switch to STANDBY and disconnect the line power cable.

**NOTE**

The HP-IB address changes only at instrument power-up. Thus, if the Generator is left on, the address will not change simply by changing the address switches.

- b. Remove the Signal Generator's top cover by removing the two plastic feet from the rear of the top cover and loosening the screw at the middle of the rear edge of the top cover.

- c. The HP-IB address switches are thumb-wheel switches located behind the front panel amplitude display.

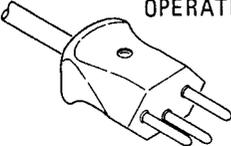
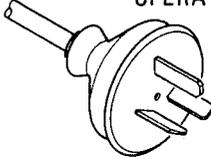
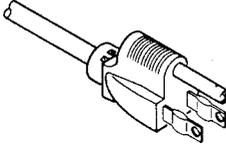
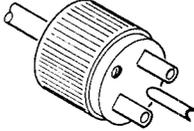
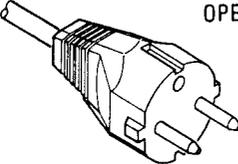
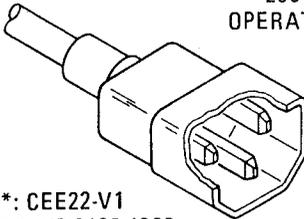
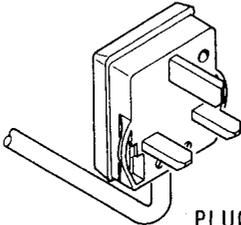
<p>250V OPERATION</p>  <p>PLUG*: SEV 1011.1959-24507 TYPE 12 CABLE*: HP 8120-2104</p>	<p>250V OPERATION</p>  <p>PLUG*: NZSS 198/AS C112 CABLE*: HP 8120-1369</p>	<p>125V OPERATION</p>  <p>PLUG*: NEMA 5-15P CABLE*: 8120-1378</p>	<p>250V OPERATION</p>  <p>PLUG*: NEMA G-15P CABLE*: HP 8120-0698</p>
<p>250V OPERATION</p>  <p>PLUG*: CEE7-VII CABLE*: HP 8120-1689</p>	<p>250V OPERATION</p>  <p>PLUG*: CEE22-V1 CABLE*: HP 8120-1860</p>	<p>250V OPERATION</p>  <p>PLUG*: BS 1363A CABLE: HP 8120-1351</p>	
<p>*The number shown for the plug is the industry identifier for the plug only. The number shown for the cable is an HP part number for a complete cable including the plug.</p>			

Figure 2-1. Power Cable and Mains Plug Part Numbers

Table 1-3. Recommended Test Equipment (3 of 3)

Instrument	Critical Specification	Recommended Model	Use*
Wideband Amplifier	Gain: 26 dB Frequency Range: 100 kHz to 1280 MHz Impedance: 50 ohms Connector: Type N	HP 8447D Option 010	P
*P = Performance Testing, A = Adjustments, T = Troubleshooting			

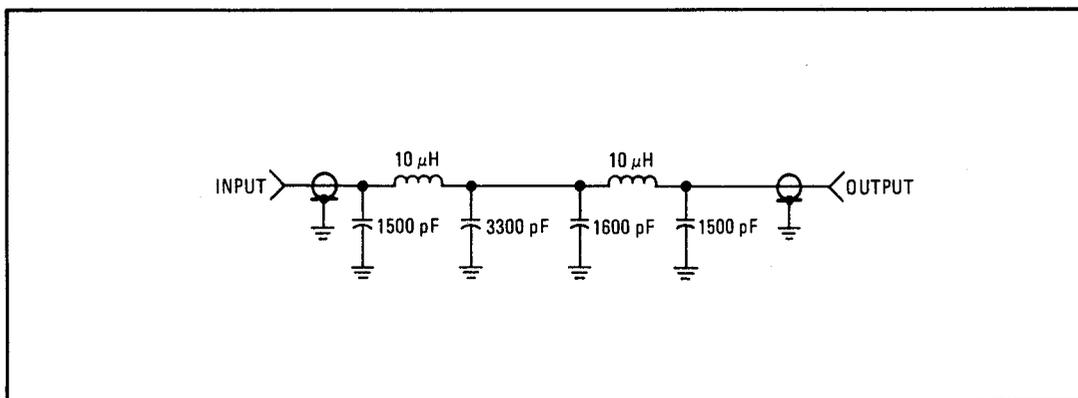


Figure 1-2. 1 MHz Low-Pass Filter

Table 1-4. Alternate Test Equipment (1 of 2)

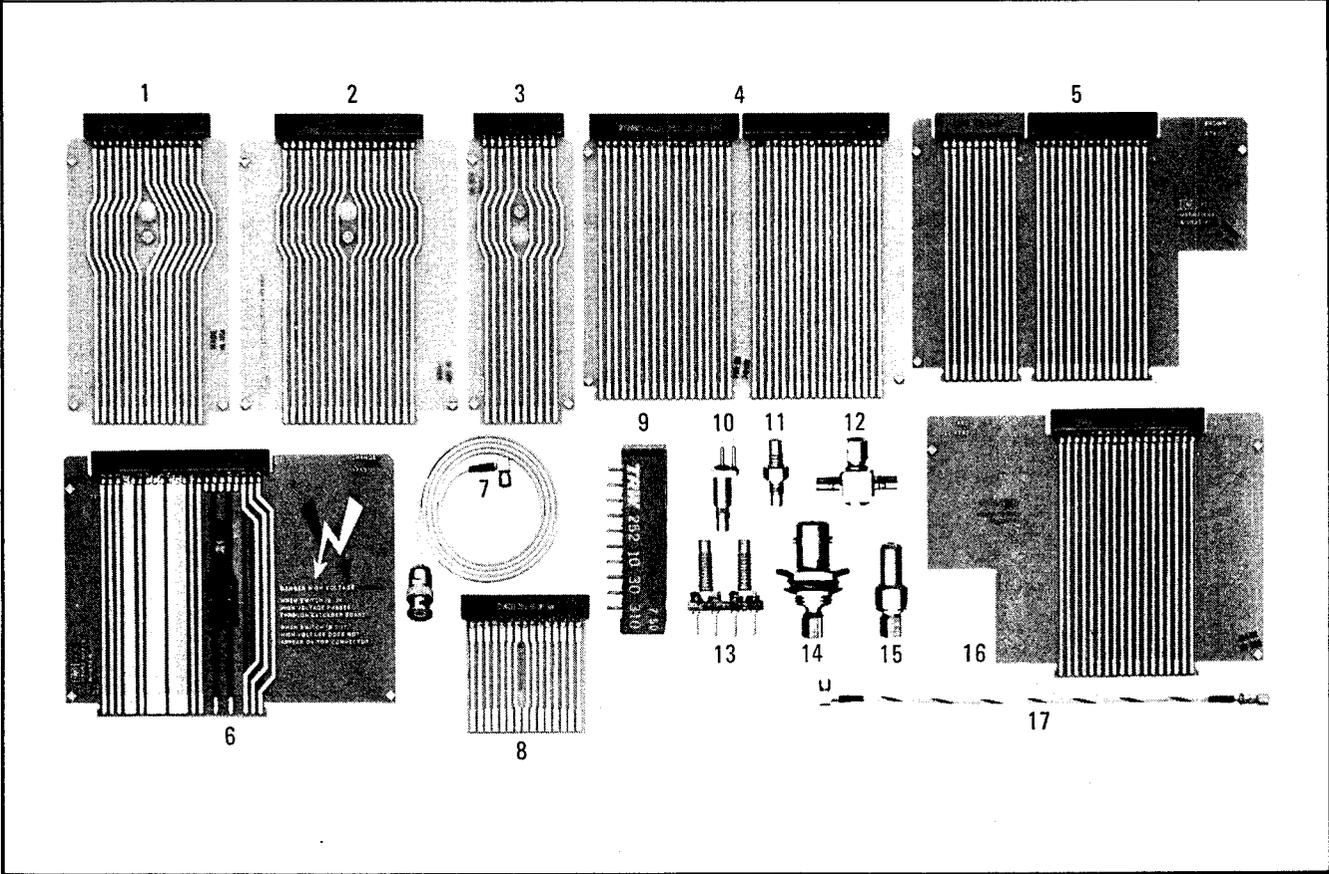
Instrument	Recommended Model	Suggested Alternative	Advantages of Alternative
Attenuator, 1 dB steps	HP 355C	HP 8494G with HP 11713A	HP-IB*
Attenuator, 10 dB steps	HP 355D	HP 8496G with HP 11713A	HP-IB*
Controller, HP-IB	HP 9825A/98213A/98034A	HP 9835A/98332A/98034A	CRT Display HP Enhanced BASIC Larger Memory
Digital Voltmeter (DVM)	HP 3466A	HP 3455A	HP-IB*
*HP-IB is Hewlett-Packard's implementation of IEEE Standard 488 and the identical ANSI Standard MC1.1.			

Table 1-4. Alternate Test Equipment (2 of 2)

Instrument	Recommended Model	Suggested Alternative	Advantages of Alternative
Distortion Analyzer	HP 331A	HP 339A	Ease of use. Satisfies requirements of both the Distortion Analyzer and the Test Oscillator.
Frequency Counter	HP 5328A Option 031	HP 5328A Options 001 & 031	HP-IB*
Oscillator, Test	HP 651B	HP 339A	Satisfies requirements for both the Distortion Analyzer and the Test Oscillator.
		HP 3325A	HP-IB*
Power Meter	HP 436A	HP 436A Option 022	HP-IB*
Power Supply	HP 6215A	HP 6002A Option 001	HP-IB*
Spectrum Analyzer, RF	HP 8558B/ 181T	HP 8554B/8552B/ 141T	With the addition of the HP 8556A plug-in, this satisfies requirements for both the Low Frequency and RF Spectrum Analyzers
Spectrum Analyzer, RF and Low Frequency	HP 8558B/181T and HP 8556A/ 8552B/141T	HP 8568A	HP-IB* Satisfies requirements for the RF Spectrum Analyzer and most requirements of the Low Frequency Spectrum Analyzer. The HP 8568A does not have a low frequency tracking generator required for one adjustment, not generally performed (see the AGC Bandwidth Adjustment).
Spectrum Analyzer, Low Frequency	HP 8556A/8552B/ 141T	HP 3585A	HP-IB*
*HP-IB is Hewlett-Packard's implementation of IEEE Standard 488 and the identical ANSI Standard MC1.1.			

Table 1-5. 11714A Service Accessory Kit

Item Number	HP Part Number	CD	Qty	Description
1	08662-60276	0	3	Extender Board (15 pins)
2	08662-60275	9	3	Extender Board (18 pins)
3	08662-60277	1	3	Extender Board (10 pins)
4	08662-60274	8	3	Extender Board DCU (2 x 18 pins)
5	08662-60271	5	1	Extender Board Power Supply (10 and 15 pins)
6	08662-60273	7	1	Extender Board Power Supply (22 pins)
7	08662-60080	4	4	Test Cable (SMC to BNC)
8	5060-6033	4	1	Extender Board (30 pins)
9	1251-1631	9	1	Test Data Bus Connector
10	1250-1598	5	3	RF Test Probe (AC Coupled)
11	1250-0827	1	1	SMC Adapter (Straight)
12	1250-0838	4	2	SMC Adapter (TEE)
13	08662-60196	3	1	Mixer Test Board
14	1250-0832	8	2	Adapter (BNC to SMC)
15	1250-0839	5	2	RF Termination
16	08662-60272	6	1	Extender Board Power Supply (18 pins)
17	08662-60075	7	3	Extender Cable





## SECTION II INSTALLATION

### 2-1. INTRODUCTION

This section provides installation instructions for the Signal Generator. This section also includes information pertinent to initial inspection, power requirements, line voltage, selection, HP-IB address selection, power cables, interconnection, environment, instrument mounting, storage, and shipment.

### 2-2. INITIAL INSPECTION

#### WARNING

*To avoid hazardous electrical shock, do not perform electrical tests when there are signs of shipping damage to any portion of the outer enclosure (covers and panels).*

Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked mechanically and electrically. The contents of the shipment should be as shown in Figure 1-1. Procedures for checking electrical performance are given in the Functional Check in Section III and Performance Tests in Section IV (in Volume I). If the contents are incomplete, if there is mechanical damage or defect, or if the instrument does not pass the electrical performance test, notify the nearest Hewlett-Packard office. If the shipping container is damaged, or the cushioning materials show signs of stress, notify the carrier as well as the Hewlett-Packard office. Keep the shipping materials for the carrier's inspection.

### 2-3. PREPARATION FOR USE

#### 2-4. Power Requirements

The Signal Generator requires a power source of 115 (90–126) Vac or 230 (198–252) Vac, 48 to 66 Hz single phase. Power consumption is less than 420 volt-amperes.

#### WARNING

*This is a Safety Class I product (provided with a protective earth terminal). An uninterruptible safety earth ground must be provided from the main power source to the product input wiring terminals, power cord, or supplied power cord set. Whenever, it is likely that the protection has been impaired, the instrument*

*must be made inoperative and be secured against any unintended operation.*

*If this instrument is to be energized via an autotransformer for voltage reduction, make sure the common terminal is connected to the earthed pole of the power source.*

### 2-5. Line Voltage and Fuse Selection

#### CAUTION

*BEFORE PLUGGING THIS INSTRUMENT into the mains (line) voltage, be sure the correct voltage and fuse have been selected.*

Set the red switch on the rear panel to nominal 115V (for 90–126V) or 230V (for 198–252V).

#### WARNING

*For protection against fire hazard, the LINE and OVEN fuses should only be 250V normal blow fuses with the correct current rating.*

#### CAUTION

*If the LINE fuse burns out, do not replace it until the cause for the failure has been determined and repaired (by a qualified service person only and specifically with resistance checks in the power supply. See Service Sheet 55). Replacing this fuse in a damaged Generator can cause additional damage.*

Current ratings are printed under the fuseholders on the Generator's rear panel and listed with HP part numbers in Table 2-1.

Table 2-1. Line and Oven Fuse Part Numbers.

Line Voltage	Line Fuse	Oven Fuse
115V	HP 2110-0010 250V 5A Normal-Blow	HP 2110-0063 250V 0.75A Normal Blow
230V	HP 2110-0083 250V 2.5A Normal Blow	HP 2110-0012 250V 0.50A Normal Blow

Table 1-3. Recommended Test Equipment (2 of 3)

Instrument	Critical Specification	Recommended Model	Use*
Mixer	Frequency: 500 to 1280 MHz Type: Double Balanced	Watkins-Johnson M94C	P
Modulation Analyzer	Accuracy: $\pm 2\%$ of reading AM Rejection: $< 30$ Hz at 50% AM (3 kHz BW) FM Rejection: $< 0.2\%$ AM (50 kHz FM)	HP 8901A	P,A
Oscillator, Test	Level: 1 Vpk minimum into 600 ohms Frequency: 10 kHz Distortion: $< 0.1\%$	HP 651B or HP 339A (see Table 1-4) or HP 3325A (see Table 1-4)	P,A
Oscilloscope	Vertical Sensitivity: 10 mV/division Bandwidth: 50 MHz	HP 1740A	P,A,T
Power Meter and Sensor	Frequency Range: 250 kHz to 1300 MHz Power Range: +17 to -60 dBm Accuracy: $\pm 0.2$ dB	HP 436A with 8482A and 8484A or HP 436A Option 022 with 8482A and 8484A (see Table 1-4)	P,A
Power Supply	Range 0-25 Vdc Current: 500 mA	HP 6215A or HP 6002A Option 001 (see Table 1-4)	A,T
Service Accessory Kit	Required for servicing and troubleshooting. See Table 1-5 for part listing and description.	HP 11714A	A,T
Signal Generator (reference for Optional SSB Phase Noise Test)	Frequency: .01-1280 MHz Output: -50 dBm SSB Phase Noise: same or better than the specification for the Generator under test.	HP 8662A	P
Signature Analyzer	No known substitute. Provides preferred method for troubleshooting digital circuitry.	HP 5004A	T
Spectrum Analyzer, RF	Frequency Range: 0.1 to 1250 MHz Resolution Bandwidth: $\leq 1$ kHz	HP 8558B/181T or HP 8554B/8552B/141T (see Table 1-4) or HP 8568A (see Table 1-4)	P,A,T
Spectrum Analyzer, Low Frequency	Frequency Range: 100 Hz to 150 kHz Resolution Bandwidth: $\leq 10$ Hz Tracking Generator Feature (required for one adjustment not generally performed: that is, the AGC Bandwidth Adjustment)	HP 8556A/8552B/ 141T or HP 3585A (see Table 1-4) or HP 8568A (see Table 1-4)	P,A
*P = Performance Testing, A = Adjustments, T = Troubleshooting			

**HP-IB Address Selection**  (Cont'd)

d. The thumbwheel switch settings are in decimal code. Addresses from 00 to 30 are the only valid listen and talk addresses. Refer to Table 2-2 for the decimal equivalents of the ASCII Talk and Listen codes (see page 3-97 for a more complete table of ASCII codes).

e. Select the new address, reinstall the Signal Generator's top cover, and set the LINE switch to ON.

**Table 2-2. ASCII Address Codes to Decimal Equivalents**

ASCII Address Codes		Decimal Equivalents
LISTEN	TALK	
SP	@	00
!	A	01
”	B	02
#	C	03
\$	D	04
%	E	05
&	F	06
'	G	07
(	H	08
)	I	09
*	J	10
+	K	11
,	L	12
-	M	13
.	N	14
/	O	15
0	P	16
1	Q	17
2	R	18
3	S	19†
4	T	20
5	U	21
6	V	22
7	W	23
8	X	24
9	Y	25
:	Z	26
;	[	27
<	\	28
=	]	29
>	^	30

† Indicates factory set address.

**2-8. Mating Connectors**

**Aux Interface Connector.** The rear panel AUX control connector requires a male 14-pin Micro-Ribbon (57 Series) connector. The HP part number is 1251-0142. The connector is also available from

Amphenol (Oak Brook, Illinois 60521). Interconnection data for the rear panel AUX control connector is provided in Figure 2-2.

**HP-IB Interface Connector.** Interconnection data for the Hewlett-Packard Interface Bus is provided in Figure 2-3.

**Coaxial Connectors.** Coaxial mating connectors used with the Signal Generator should be either 50 ohm type BNC male or type N male connectors that are compatible with US MIL-C-39012.

**2-9. Operating Environment**

The operating environment should be within the following limitations:

- Temperature . . . . . 0°C to +55°C
- Humidity . . . . . <95% relative at 40°C
- Altitude . . . . . <4570 metres (15 000 feet)

**NOTE**

*RF Output Level accuracy is specified only between +15 and +45°C.*

**2-10. Bench Operation**

The instrument cabinet has plastic feet and fold-away tilt stands for convenience in bench operation. (The plastic feet are shaped to ensure self-aligning of the instruments when stacked.) The tilt stands raise the front of the Signal Generator for easier viewing of the control panel.

**2-11. Rack Mounting**

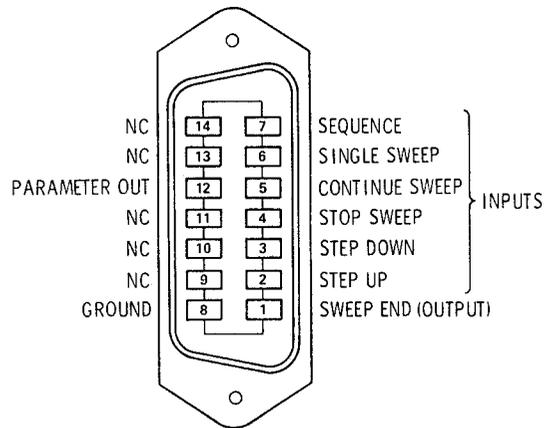
Rack mounting information is provided with the rack mounting kits. If the kit was not ordered with the Signal Generator as an option, it can be ordered through the nearest Hewlett-Packard office. Refer to the paragraph entitled Options in Section I.

**2-12. STORAGE AND SHIPMENT**

**2-13. Environment**

The instrument should be stored in a clean dry environment. The following environmental limitations apply to both storage and shipment:

- Temperature . . . . . -55°C to +75°C
- Humidity . . . . . <95% relative
- Altitude . . . . . <15 300 metres (50 000 feet)



**14-Pin Micro-Ribbon (57 Series) Connector**

### Logic Levels

The rear panel AUX connector logic levels are TTL compatible (5  $\mu$ s negative true TTL pulse or a contact closure to ground).

### Internal Jumper Selection

If the signals to the rear panel AUX connector require contact debouncing (e.g., for mechanical switches), an internal jumper must be changed. The jumper is installed at the factory for electronically clean input signals (i.e., those signals that do not require the use of the debounce circuit). The jumper is located on the A2A1 Key-Code board. To change the jumper position the top cover of the Signal Generator must be removed.

### WARNINGS

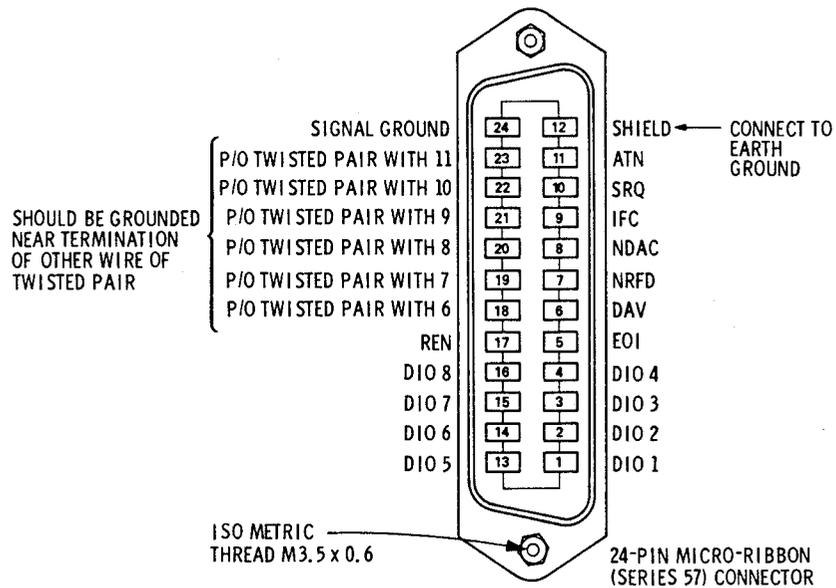
*This task should be performed only by service trained persons who are aware of the potential shock hazard of working on an instrument with protective covers removed.*

*To avoid hazardous electrical shock, the line (mains) power cable should be disconnected before removing the Generator's cover.*

The following procedure describes how to locate and change the jumper position.

- a. Set the Line switch to STANDBY and disconnect the line power cable.
- b. Remove the Signal Generator's top cover by removing the two plastic feet from the rear of the top cover and loosening the screw at the middle of the rear edge of the top cover.
- c. The A2A1 Key-Code board is located directly behind the FREQUENCY readout display.
- d. Remove the A2 Assembly protective cover (left-hand side) by removing the two nuts.
- e. Remove the A2A1 Key-Code board by gently lifting the board's extractors (the extractors are color-keyed brown and black).
- f. The jumper is located on the upper left-hand corner of the board.
- g. To enable the debounce circuit remove the jumper from J1 and reinstall the jumper at J2.
- h. Reinstall the A2A1 Key-Code board, the A2 Assembly protective cover and the Signal Generator's top cover.

**Figure 2-2. AUX Interface Connector**



**Logic Levels**

The Hewlett-Packard Interface Bus logic levels are TTL compatible, i.e., the true (1) state is 0.0 Vdc to +0.4 Vdc and the false (0) state is 2.5 Vdc to +5 Vdc.

**Programming and Output Data Format**

Refer to Section III, Operation.

**Mating Connector**

HP 1251-0293; Amphenol 57-30240.

**Mating Cables Available**

HP 10631A, 1 metre (3.3 ft.), HP 10631B, 2 metres (6.6 ft.)  
 HP 10631C, 4 metres (13.2 ft.), HP 10631D, 0.5 metres (1.6 ft.)

**Cabling Restrictions**

1. A Hewlett-Packard Interface Bus system may contain no more than 2 metres (6.6 ft.) of connecting cable per instrument.
2. The maximum accumulative length of connecting cable for any Hewlett-Packard Interface Bus system is 20 metres (65.6 ft.).

Figure 2-3. Hewlett-Packard Interface Bus Connection

## 2-14. Packaging

**Original Packaging.** Containers and materials identical to those used in factory packaging are available through Hewlett-Packard offices. If the instrument is being returned to Hewlett-Packard for servicing, attach a tag indicating the type of service required, return address, model number, and full serial number. Also mark the container FRAGILE to assure careful handling. In any correspondence refer to the instrument by model number and full serial number.

**Other Packaging.** The following general instructions should be used for repackaging with commercially available materials:

a. Wrap the instrument in heavy paper or plastic. (If shipping to a Hewlett-Packard office or

service center, attach a tag indicating the service required, return address, model number, and full serial number.)

b. Use a strong shipping container. A double-wall carton made of 2.4 MPa (350 psi) test material is adequate.

c. Use enough shock-absorbing material (75 to 100 mm layer; 3 to 4 inches) around all sides of instrument to provide firm cushion and prevent movement in the container. Protect the control panel with cardboard.

d. Seal the shipping container securely.

e. Mark the shipping container FRAGILE to assure careful handling.

## SECTION III OPERATION

### 3-1. INTRODUCTION

This section explains the operating characteristics of the Signal Generator, its functions, controls and modes of operation. It explains operator checks and maintenance (the OVEN fuse replacement is the only maintenance recommended in this section).

### 3-2. Operating Characteristics

The Signal Generator can produce fixed or swept frequency signals between 10 kHz and 1280 MHz, between +13 and -139.9 dBm, with AM, FM, or mixed modulation. Table 3-1 contains a more complete list of basic signal parameters that can be set and controlled.

The Generator can be controlled by the front panel, by HP-IB and to a limited extent by the rear panel AUX connector. All value-selectable parameters can be varied in steps by the INCREMENT keys and the knob.

There are nine internal registers for storing and recalling full control setups.

### 3-3 Local Operation

**Simplified Operation.** The instructions on the backside of this foldout describe basic operation only. It is the starting point for a first-time user.

**Getting Acquainted.** The Getting Acquainted Exercise (starting on page 3-6) provides a hands-on learning experience in the operation of the Generator.

**General Operation.** Several instructions relating to all features and modes are presented in the General Operating Instructions starting on page 3-4.

**Operating Information Card.** The pullout Operating Information card, located underneath the Generator, presents general operating instructions. With examples of most of the Generator's features, it is a good teaching aid as well as a quick reference.

**Detailed Operating Instructions.** The detailed operating instructions present the most comprehensive information about all of the Generator's functions. The instructions are arranged alphabetically by title. They are indexed by function in Table 3-2.

**Panel Features.** Front and rear panel features are described in Figures 3-1 through 3-7. Figure 3-1

shows the full front view with references to detailed descriptions of all controls, connectors and indicators shown in the other figures.

### 3-4. Remote Operation

HP-IB. Knowledge of local operation is essential for HP-IB programming since most of the Data messages contain the same keystroke-like sequences. HP-IB information is presented in the following areas:

- General HP-IB instructions start on page 3-30.
- A summary of program codes and formats starts on page 3-47 (most of the keystroke-related codes are also shown on the pullout Operating Information card).
- Detailed information on the Generator's features with tables and examples of related program codes is presented in the detailed operating instructions (refer to the index in Table 3-2).

**Auxiliary.** The following keyboard functions can be controlled by TTL signals at the rear panel AUX connector:

- INCREMENT ↑
- INCREMENT ↓
- MANUAL (sweep)
- AUTO (sweep)
- SINGLE (sweep)
- SEQ

These controls and two output lines on the same connector are described in the Auxiliary Control paragraph on page 3-29.

### 3-5. Operator's Checks

This section includes three different checks that allow the operator to make a quick evaluation of the Generator's operation. The checks are as follows:

- Functional Check: keyboard controlled
- HP-IB Interface Check: controller required
- Memory Check: keyboard controlled, checks ROM (permanent memory) and RAM (temporary memory).

Operator's Checks start on page 3-18.

### 3-6. OVEN FUSE REPLACEMENT

Two fuses on the rear panel are labeled "LINE" and "OVEN". If either fuse opens, the entire Generator would be disabled. The operator should only replace the OVEN fuse.

#### WARNING

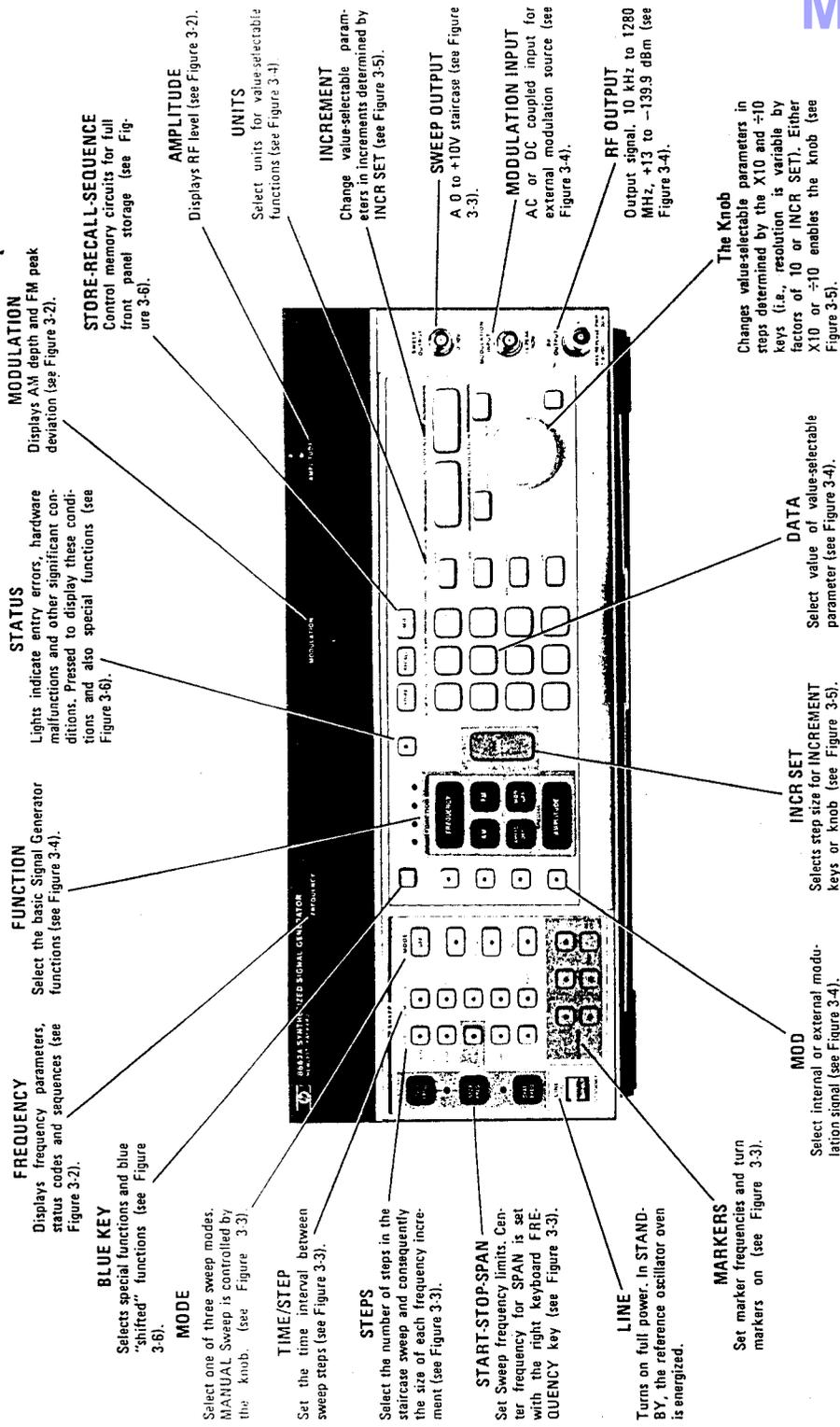
*For continued protection against fire hazard, replace only with a 250V, normal blow fuse with the same current rating.*

#### CAUTION

*The casual operator should not replace the LINE fuse. Replacing this fuse in a damaged Generator might cause additional damage. A qualified service person should first determine the cause of its failure, specifically with resistance checks in the power supply (see Service Sheet 55); repair the failure and then replace the fuse.*

To replace the OVEN fuse, first set the LINE switch to STANDBY and unplug the power cable. Then remove the fuse cap and replace the fuse. Values for the fuse are printed below the fuse holder. The HP part numbers are listed in Section II (Installation).

# SIMPLIFIED OPERATION



Shaded keys are value-selectable function keys. That is, they require DATA and UNITS entries to complete a selection.

Figure 3-1. Front Panel Features

**INCR SET**

INCR SET is used with function, DATA and UNITS to set the step size for the INCREMENT keys or the knob (e.g., FREQUENCY, INCR SET, 500 and kHz. Function in this sense includes the keys labeled FUNCTION and the sweep function keys including markers).

The increment can be as large as the maximum value for the function or as small as the minimum value of resolution.

Pressing INCR SET temporarily recalls a previously set increment to the appropriate readout (for as long as the key is depressed).

**INCREMENT KEYS**

The INCREMENT keys increase or decrease a value selectable parameter in steps; the size of each step is selected by INCR SET. The parameter affected is determined by the function keys (Function in this sense includes the keys labeled FUNCTION and the sweep function keys).

The parameter will change once for each keystroke or about 5 times per second if the key is held down.

The stepping keys are always enabled (unlike the knob, which must be turned on).

**RESOLUTION X10, ÷10**

Both the X10 and ÷10 keys turn on the knob. Both keys change the stepping resolution by a factor of ten (up or down; once for each keystroke). When either key is pressed and held, a digit in the applicable readout blinks, indicating the resolution digit.

When the X10 key is preceded by the Blue Key, it "holds" the knob enabled, and in control of the present keyboard function. Otherwise, the knob would be disabled when a new function is selected (note: Manual sweep has priority over the "Hold" feature).

When the ÷10 key is preceded by the Blue Key, the knob will change data in increments selected with INCR SET (instead of its normal resolution of one times the power of ten).

**THE KNOB**

The knob is also a stepping control, but with an analog "feel". It controls any of the value selectable parameters. The parameter affected is determined by the function keys (function in this sense includes the keys labeled FUNCTION and the sweep functions including Markers). It is normally disabled and must be turned on by either the X10 or ÷10 key (see their descriptions for additional information about the knob).

The knob is also the manual sweep mode control.

**OFF**

The OFF key disables the knob.

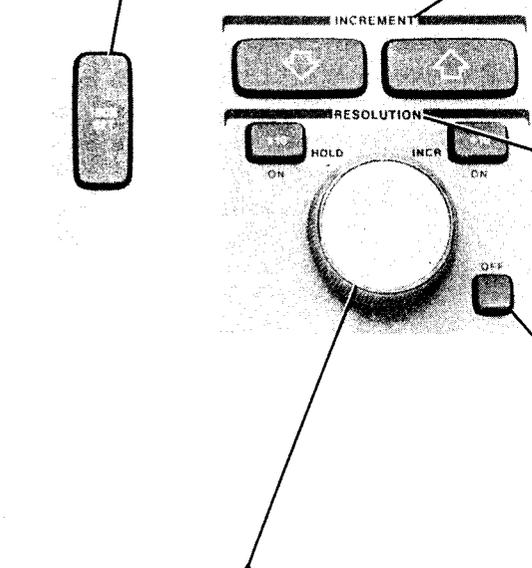


Figure 3-5. Value Changing Controls

## BASIC SIGNAL GENERATOR FUNCTIONS

Function \ Data \ Units

Frequency: **SEQUENCE** 1 0 . 2 3 Hz

AM Depth: **OFF** 9 0 %

FM Deviation: **OFF** 7 5 kHz

Amplitude: **SEQUENCE** 1 0 . 2 2 V

These parameters are value-selectable. Their values are selected in the Function-Data-Units format shown in the examples above.

**Modulation Signal.** One of two internal signals (400 Hz or 1 kHz) or an external signal (ac or dc coupled through the front panel connector) is selected by the MOD keys.

## CHANGING VALUES

Value-selectable parameters can be changed by making new Function-Data-Units entries, by using the INCREMENT keys or by using the knob.



The INCREMENT keys change the value of the last selected function. They are always enabled. The amount they step a parameter is determined by the INCR SET key.

Increments are set using the modified Function-Data-Units format shown in the example below.

**SEQUENCE** 1 2



The knob is a stepping control also, but with an analog "feel". It changes the value of the last selected function. The knob is enabled by pressing either of the ON keys (i.e., X10 or  $\pm 10$ ).

Select the knob's step resolution by pressing the X10 or  $\pm 10$  key while observing the blinking digit in the appropriate readout. Each time the key is pressed, resolution changes by a factor of ten.

Turning the knob changes the parameter in steps equal to the position-value of the selected digit.

The knob is disabled by pressing the OFF key or by selecting a new function.

## SWEEP FUNCTIONS

The Generator produces a staircase sweep. That is, it changes frequency in discrete steps.

Function \ Data \ Units

Start Frequency: **SEQUENCE** 1 0 . 2 4 Hz

Span: **OFF** 1 2 . 4 kHz

Stop Frequency: **OFF** 2 0 . 4 Hz

Step Size: **SEQUENCE** 5 0 Hz

Center Frequency: **SEQUENCE** 1 0 0 0 Hz

Marker Frequencies: **OFF** 1 5 Hz

These parameters are value-selectable. Their values are selected in the Function-Data-Units format shown in the examples above.

### Sweep Time and Log-Linear

Sweep time is determined by the STEPS and TIME/STEP keys. The STEP keys determine number of steps per sweep and consequently, the size of each frequency step. The STEPS keys also determine the log or linear sweep type.

**LN** 100 **D** Each step equals the sweep width divided by 100 or 1000.

**SIZE** **D** Linear Sweep. See value selectable format above for "Step Size."

**LOC** 10% **D** Each step equals 10% or 1% of the present frequency.

**LOC** 1% **D**

### Modes

The MODE keys turn on the sweep circuitry for a continuous sweep (AUTO), a manual sweep (controlled by the knob) or a single sweep.

### Markers

The Generator can produce amplitude markers on the RF or Z-axis intensity markers on a swept display. See the value selectable format above.

## STATUS

Entry errors, hardware malfunctions and other significant conditions are indicated by a lighted STATUS key.

Press the STATUS key and read the two-digit codes in the FREQUENCY readout (special functions on the left side, status on the right). The codes are explained under "Status" in the detailed operating instructions.

## SPECIAL FUNCTIONS

Several special functions exist which extend the keyboard capability but which are not labeled on the keyboard. These functions are introduced under "Special Functions" in the detailed operating instructions.

## STORE-RECALL

The Generator can store control settings for recall at a later time. This capability is described under "Store-Recall" and "Sequence" in the detailed operating instructions.

Table 3-2. Index of Detailed Operating Instructions

Instruction*	Page
Frequency	3-56
Frequency Offset	3-57
Frequency Transferring	3-58
Amplitude	3-50
Amplitude Conversion (V → dBm)	3-52
Amplitude Correction	3-53
Amplitude Reference	3-55
Modulation, AM	3-66
Modulation, External Source	3-68
Modulation, FM	3-72
Modulation, Mixed	3-74
Sweep	3-84
Sweep Markers	3-86
Sweep Modes	3-88
Sweep Span	3-90
Sweep, Start-Stop	3-92
Sweep Step Size	3-94
Sweep Time/Step	3-96
Increment ↓ ↑	3-59
Increment Setting	3-60
Parameter Shift Keying	3-76
The Knob	3-62
The Knob, Hold	3-64
The Knob, Increment	3-65
Status	3-81
Special Functions	3-79
Store—Recall	3-83
Sequence	3-77
*The actual detailed operating instructions are arranged in alphabetical order at the end of this manual.	

### 3-7. GENERAL OPERATING INSTRUCTIONS

#### WARNINGS

*Before the instrument is switched on, all protective earth terminals, extension cords, auto-transformers and devices connected to it should be connected to a protective earth grounded socket. Any interruption of the protective earth grounding will cause a potential shock hazard that could result in personal injury.*

*Only 250V normal blow fuses with the required rated current should be used. Do not use repaired fuses or short circuited fuseholders. To do so could cause a shock or fire hazard.*

*When working near the back of the Generator, take care not to let long hair be drawn into the fan. This could result in personal injury.*

#### CAUTIONS

*Before the instrument is switched on, it must be set to the voltage of the power source, or damage to the instrument may result.*

*The Generator's RF OUTPUT is protected against reverse power applications up to 30W. However, for greatest protection of expensive internal components, be careful not to apply any reverse power to the RF OUTPUT.*

### 3-8. Turn-On

**Turn-On Procedure.** The Generator has a standby state and an on state. Whenever the power cable is plugged in, an oven is energized to keep the reference oscillator stable. If the Generator is already plugged in, set the LINE switch to ON.

If the power cable is not plugged in, follow these instructions.

On the rear panel:

1. Check the line voltage switch for correct voltage selection.

2. Check the two fuses for correct current ratings. Current ratings are printed on the rear panel.
3. Plug in the power cable.

On the front panel, set the LINE switch to ON.

#### NOTE

*The light in the STATUS key should turn on blinking to indicate that the Generator requires warming up. (Status Code 12). The light should turn off within an hour and the Generator should be ready for general use.*

**Turn-On Configuration.** The Generator turns on to the same control settings it had before it was switched to STANDBY or even completely OFF (that is, if line power was removed). The exceptions to this rule are listed below.

- It always turns on to local mode (vice HP-IB remote). Also, it issues a Require Service message to an HP-IB controller at every turn-on.
- It always turns on with the auto-sequence mode disabled.
- It turns on with amplitude correction enabled (except when a sweep mode is on or when amplitude is above +13 or below -120 dBm).
- HP-IB default conditions are enabled. These are described on page 3-32.

**Turn-On Memory Check.** The Generator performs a quick memory check at turn-on. It checks for a failure in ROM (permanent memory) or in RAM (temporary memory), and for the presence of correct data stored in RAM.

#### NOTE

*An internal battery is used to retain data in RAM during standby and off periods. The data restores the last control setup and the nine storage registers.*

The check takes less than five seconds and occurs while the Generator's readout displays all dashes.

If a ROM or serious RAM failure occurs the Generator will attempt to turn on to its last control set-

Model 8662A

### Turn-On (Cont'd)

up. The Generator might be useable but does require service (malfunction code 99 will be set in the status readout).

If all of the register data has been altered (for example, if the battery failed) the Generator will re-initialize to 100 MHz, -30 dBm, modulation, sweep and special functions off. The initialized control setup will then be stored in all of the registers. The Generator might be useable but does require service (code 53 will be set in the status readout).

#### NOTE

*The Parameter Out line (pin 12) on the rear panel AUX connector will switch to and remain at a TTL low level when this condition occurs. Thus it can be used as a signal that the Generator turned on to an unexpected state.*

If any, but not all, of the stored data is found to be incorrect, the Generator will turn on to the configuration stored in its first good register. This could be caused by even a single bit of data being lost due to line transients, noise or other unpredictable conditions. The Generator should be useable and does not require service unless this situation occurs repeatedly (code 52 will be set in the status readout).

#### NOTE

*In this situation, special functions and markers would also be cleared and the sequence reset to 1-2-3-4.*

*If the Generator is being used in a situation where its turn-on configuration is critical, it should have that configuration stored in all of the registers (without the use of special functions, markers or sequence).*

### 3-9. Reference Selection

Three reference signal switches and two connectors are located on the rear panel. The INPUT connector can accept a reference signal to be used instead of the Generator's internal reference.

The internal reference is a 10 MHz signal with an aging rate of  $<5 \times 10^{-10}$ /day after warm-up (typically after 24 hours). Pressing the INT switch enables this internal reference.

Pressing either EXT switch disables the internal reference and enables the INPUT connector for signals of 5 MHz at  $>13$  dBm or 10 MHz at  $>7$  dBm.

The OUTPUT connector provides a 10 MHz signal ( $>7$  dBm) derived from the selected reference. The OUTPUT connector does not require any switching.

### 3-10. Status Messages

The Generator produces several messages that indicate its status. The messages are in numeric codes which are described on the pullout Operating Information card, and in the detailed operating instruction titled "Status". The messages appear in the FREQUENCY readout when the STATUS key is pressed (special functions on the left; entry errors, hardware malfunctions and general status on the right).

The light in the STATUS key turns on to signal the operator that an entry error, hardware malfunction or other significant condition exists that affects operation. The light does not turn on for special functions.

### 3-11. Amplitude Correction Off

The Generator achieves optimum output level accuracy by correcting for internal amplitude variations throughout its frequency range. Much of this correction involves switching of the output attenuator. Thus it is possible for the attenuator to receive excessive mechanical wear during long periods of automatic frequency changes (for example, during operations that involve auto-sequencing, HP-IB learn modes, low-rate FM, etc).

If the high degree of level accuracy is not required during these operations, the correction feature should be defeated with Special Function 85. Specified level accuracies with correction enabled and typical accuracies with correction disabled are listed on page 3-53.

#### NOTE

*Amplitude correction is automatically disabled during sweep mode operations and at output levels above +13 or below -120 dBm.*

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## GETTING ACQUAINTED EXERCISE

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### 3-12. GETTING ACQUAINTED EXERCISE

This is a simple exercise to familiarize you with the Generator's front panel control. It should only take about 30 minutes to perform. It doesn't require additional equipment, so you can look to the front panel for all indications.

This exercise can be performed in total or entered at several points where the boxed instructions for INITIALIZING are shown.

### 3-13. Turn-On and Warm-Up

If your instrument has been plugged in for more than an hour, it is probably warmed up and ready. Just set the LINE switch to ON.

If it has not been plugged in, follow these instructions.

On the rear panel:

1. Check the red Line Voltage switch for correct voltage selection.
2. Check the two fuses for correct sizes. The correct sizes are printed on the rear panel.
3. Press the INT button to select the internal reference oscillator.
4. Plug in the power cable.

Now, on the front panel, set the LINE switch to ON.

### 3-14. The STATUS Key and Light

If you just plugged in the Generator and switched it on, you should notice the STATUS light blinking on and off. It's probably trying to remind you that the Generator requires some warming up. Press and hold the STATUS key (even if your light isn't blinking, go ahead. Press the STATUS key anyway.). You should see a two-digit code on the right side of the FREQUENCY readout. If your Generator needs warming up, you should see code 12. If there is no fault at all, the code should be 00. If any other code appears, it might be indicating some transient condition that occurred in the past. Press the key again. If the code disappears, all is well and you can continue. If a code appears on the left side, it is a special function code and you will clear that with the first initializing step.

The STATUS light and key are there to alert you to an instrument malfunction, an operator error, general status or special functions enabled. The codes are described on the pullout information card and in the detailed operating instruction titled "Status."

If the only problem is that your Generator needs warming up, you can proceed with this exercise. Ignore the blinking light. It will go out by itself when it is ready.

### 3-15. The Keyboards

**Left and Right.** You will notice that there are two distinct keyboards. The small one on the left is exclusively for sweep functions (of course, the LINE switch there affects the whole instrument). The larger, slanted keyboard on the right holds the Signal Generator function keys, data and data-changing controls, and storage keys.

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## GETTING ACQUAINTED EXERCISE

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### The Keyboards (Cont'd)

If you have trouble locating a key that I call out, relax and keep looking. They are all there. Sometimes the labels are on the keys and sometimes on the panel, and often there is more than one label per key.

**One-Finger Keys.** The Generator has a one-finger keyboard. That is, you should only press one key at a time. This applies to the knob too. You shouldn't turn the knob and press a key at the same time. When I ask you to press a key, I only want you to press it once and then let go. If, on the other hand, I want you to hold it down, I'll be explicit about that.

### 3-16. Indications

There are only three readout panels that share responsibility for all of the value-selectable parameters. Often this means that a parameter is set but not displayed (for example, an increment setting or Marker frequency). To recall a parameter just press and hold the key that describes it. The value should appear in the appropriate readout and remain for as long as the key is held.

Some keys have built-in lights that indicate the function is operating.

### 3-17. Setting Signal Generator Functions

#### INITIALIZING

Press the Blue Key, SPECIAL and 00 to initialize the Generator to 100 MHz, -30 dBm, modulation, sweep and special functions off.

All of the Generator's value-selectable parameters are set with a FUNCTION-DATA-UNITS keystroke format. (Notice the three blocks of keys with those labels on the right keyboard.) If you ever think that you made an incorrect DATA entry, just press the BACK SPACE key to "erase" the incorrect digits. If you think you've made a totally incorrect function setting, just redo it with a new FUNCTION-DATA-UNITS input.

**Frequency.** Press the following keys: FREQUENCY, 1279.999 999 8 and MHz. (you see, FUNCTION, DATA and UNITS). You have just set the RF to its maximum frequency. Notice that the keyboard function lamp labeled **FREQ** is on (this is one of four lamps located above the FUNCTION label). This lamp means that you can change the DATA and UNITS without pressing FREQUENCY again. Try it. Press 1 and GHz.

**Modulation.** AM% and FM peak deviation are set in a similar way. Press AM, 50 and %. Press EXT AC. The EXTERNAL SOURCE LO annunciator should be on. This means that you have selected the external modulation function but the input level is too low. Actually, of course, there is no input at all, so press INT 1k.

**Amplitude.** Press AMPLITUDE, 139.9 and -dBm. You have just set the minimum RF amplitude. (Are you beginning to understand the FUNCTION-DATA-UNITS format?)

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**GETTING ACQUAINTED EXERCISE**

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**3-18. Changing Values****INITIALIZING**

Press the Blue Key, SPECIAL and 00 to initialize the Generator to 100 MHz, -30 dBm, modulation, sweep and special functions off.

All of the FUNCTION keys and several of the sweep keys describe value-selectable functions. The values of these functions can be changed with the INCREMENT  $\uparrow \downarrow$  keys and the knob.

**INCREMENT  $\uparrow \downarrow$ .** The INCREMENT keys change data in steps equal to a preset increment. Press and hold the INCR SET key. Notice that the FREQUENCY readout changes to 1 MHz (the initialized value of frequency increment). The value in the readout is the increment by which frequency will change each time an INCREMENT key is pressed. Release INCR SET and press the  $\uparrow$  key a few times. Now press the  $\downarrow$  key.

**Increment Setting.** Press AMPLITUDE, INCR SET, 5 and dB. Now, press and hold  $\downarrow$ . You should see the AMPLITUDE readout changing by 5 dB increments and at about 5 times per second. That's what happens when you keep an INCREMENT key depressed.

**The Knob.** The knob is a stepping control also, but with an analog "feel". It must be turned on (unlike the INCREMENT keys). Press FREQUENCY. Press and hold the RESOLUTION x 10 (ON) key. You have just enabled the knob for control of frequency. Notice that one of the FREQUENCY digits is blinking. This is the digit at which the stepping will start and progress by ones. Release the x 10 key and turn the knob a few times. Now press and hold the  $\div 10$  key. The blinking digit should shift to the right. Release the  $\div 10$  and turn the knob again. Observe that control has shifted by a factor of ten. Repeat this exercise with the x10 key.

The knob is disabled as soon as you select a new keyboard function. Press AMPLITUDE and try the knob; nothing should happen. Press the INCREMENT keys. Notice that they still operate. They are always on (however, they are now controlling a new function. That is, amplitude).

**3-19. Setting Sweep Functions****INITIALIZING**

Press the Blue Key, SPECIAL and 00 to initialize the Generator to 100 MHz, -30 dBm, modulation, sweep and special functions off.

Several of the sweep keys describe value-selectable functions just like the keys labeled "FUNCTION" on the right keyboard. That is, they require a similar FUNCTION-DATA-UNITS entry format. In this case the "function" keys are on the left keyboard but DATA and UNITS are where they always were on the right keyboard.

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## GETTING ACQUAINTED EXERCISE

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### Setting Sweep Functions (Cont'd)

Sweep functions are not always displayed. Their values are sometimes hidden. If you wonder what a value is, press and hold the key for that function. The value should appear in the FREQUENCY readout and remain for as long as you hold the key down.

**Start and Stop Frequencies.** Press START FREQ, 200 and MHz. Press START FREQ again and hold it. The "hidden" start frequency value should appear in the FREQUENCY readout for as long as you hold the key in. Select a stop frequency of 300 MHz in a similar way.

**Sweep Time.** Press LIN 1000 (steps), 10 ms (Time/Step) and AUTO mode. Now look at the FREQUENCY readout. You should see a split readout with the sweeping frequency on the left and stop frequency on the right. Press 1 ms (Time/Step). The readout now shows only the start frequency on the left. There is no point in displaying instantaneous frequency now because it would be moving too fast for a meaningful display.

**Center Frequency and Span.** Use the FREQUENCY key on the right keyboard to set a center frequency of 500 MHz. Use the SPAN FREQ key on the left keyboard to set a 1 MHz span.

Now press SET SIZE, 100 and kHz. This sets a linear sweep with 10 steps (that is, the span of 1 MHz divided by 100 kHz per step). Press the MANUAL mode key and slowly turn the rotary control knob. You should see the frequency sweep between 499.5 and 500.5 MHz in 10 discrete steps.

**Setting Markers.** The Generator can produce Z-axis (intensity) markers on a swept display or amplitude markers on the RF signal. Of course, you won't be able to see them without a CRT, so they will be described in more detail later. For now, however, perform the following steps as an exercise in setting marker frequencies and turning them on.

Press the Marker 1 key, 475 and MHz (another FUNCTION-DATA-UNITS input). The Marker frequency is set but not turned on (notice that the light in the marker key stays off). This is because 475 MHz is outside of the frequency limits of your sweep (499.5 to 500.5 MHz). Change the frequency span to 100 MHz (that is, a sweep of 450 to 550 MHz), and press Marker 1 again. Now the Marker and its light should be on.

Let's set several markers. Set Marker 2 to 460 MHz and Marker 3 to 510 MHz. Notice that the lights stay on. Press Marker 2 and OFF. Marker 2 should turn off. Now press the Blue Key and ALL OFF. All remaining markers should turn off.

### 3-20. Frequency Transferring

#### INITIALIZING

Press the Blue Key, SPECIAL and 00 to initialize the Generator to 100 MHz, -30 dBm, modulation, sweep and special functions off.

You can transfer the value of one frequency parameter to another (in both fixed frequency and sweep modes). Let's transfer the frequency values of Marker 1 to START FREQ and

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## GETTING ACQUAINTED EXERCISE

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**Frequency Transferring (Cont'd)**

Marker 2 to STOP FREQ. First, set Marker 1 to 50 MHz and Marker 2 to 25 MHz. Then press the START FREQ and AUTO sweep mode keys so that you can observe what happens.

Now press the Blue Key, Marker 1 (the source) and START FREQ (the recipient). Press the Blue Key, Marker 2 (the source) and STOP FREQ (the recipient). What you should see is the start and stop frequencies change to the same values as the markers. (As a side note, you can see that it is possible to sweep backwards by setting the stop frequency lower than the start frequency. Press 100 ms Time/Step to observe this).

**3-21. Front Panel Storage**
**INITIALIZING**

Press the Blue Key, SPECIAL and 00 to initialize the Generator to 100 MHz, -30 dBm, modulation, sweep and special function off.

**Store-Recall.** Let's set several front panel configurations and store them for future use.

1. Press LIN 100 (steps), 10 ms (Time/Step) and the AUTO sweep mode key. Then press STORE and 1 (a DATA key) to store the entire front panel setup in register 1.
2. Press the sweep mode OFF key. Select AM 20% and amplitude +10 dBm (that is, AMPLITUDE, 10 and + dBm). Press STORE and 2.
3. Set FREQUENCY to 0.5 GHz and SPAN FREQ to 50 MHz. Select AUTO sweep mode. On the right keyboard, press MOD OFF and select amplitude -100 dBm. Then press STORE and 3.

Now press RECALL and 1. This should recall the first keyboard configuration, including the AUTO sweep.

Press RECALL 2 and RECALL 3. The front panel should change to the configurations stored in registers 2 and 3.

**Sequence and Auto-Sequence Modes.** The sequence function is a way of recalling storage registers in a pre-selected order or sequence. The normal sequence mode requires a keystroke for each recall. Auto-sequence is similar except the generator recalls one register after another automatically.

First, you must select the sequence. Do this now by pressing the Blue Key, SET SEQ, 1, 3, 2, and STORE. When the registers are recalled in a sequencing mode they will follow the order 1, 3, and 2.

Press SEQ. Press it again. The front panel should change once for each keystroke. Now press the Blue Key and AUTO SEQ. The Generator will recall one register after another as fast as it can. When an AUTO *sweep* mode is encountered, such as in registers 1 and 3, the Generator will perform a single sweep before moving to the next configuration. Because the sequencing moves so quickly across register 2, you might think it is skipping it. But look closely at the MODULATION readout. The 20% AM that flashes on periodically is the modulation setting of register 2.

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## GETTING ACQUAINTED EXERCISE

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### Front Panel Storage (Cont'd)

Press FREQUENCY. The sequencing should stop. In truth, pressing any key, except STATUS, would stop the auto-sequencing. I choose FREQUENCY because it can't cause any parameter change by itself. It just stops the sequencing.

What was the sequence that you programmed? To find out, press RECALL and SEQ (hold SEQ). The numbers 1, 3, and 2 should appear in the FREQUENCY readout. One of the numbers should be blinking. That number identifies the register with the current front panel setup. (There is an exception to this rule that you will learn later. However, you won't be wrong if you remember that the next register to be called is always to the right of the blinking digit, including wrap-around to the first digit). Release the SEQ key.

### 3-22. Special Functions

#### INITIALIZING

Press the Blue Key, SPECIAL and 00 to initialize the Generator to 100 MHz, -30 dBm, modulation, sweep and special functions off.

There are several special functions that are not apparent by looking at the front panel. In fact, you have been using one throughout this exercise (that is, Special Function 00 for Initializing). Others will be described in detail later. But let's try one more now.

This one is called "Amplitude Reference". It changes the AMPLITUDE readout from any absolute value in dBm to a value of 0.0 dB. Thereafter, all changes in amplitude are displayed in units of dB referenced to the original power level.

To change the AMPLITUDE readout from -30 dBm to 0.0 dB, press the Blue Key, SPECIAL and 31 (if you press the STATUS key, you'll see the special function code 31 on the left side of the FREQUENCY readout).

Now use the INCREMENT ↓ key to change the amplitude by -1.5 dB.

To disable the special function and change the readout to -31.5 dBm (that is, the original -30 dBm minus 1.5 dB) press the Blue Key, SPECIAL and 30.

That's it. The exercise is over. Set the LINE switch to STANDBY.

Oh, turn it on once again. You'll notice that the Generator turns on to the same state that you left it. That's one of its memory functions too.

### FREQUENCY READOUT

The **FREQUENCY** readout displays frequency parameters, status codes and sequence orders.

1. Fixed Frequency. 0.1 Hz displayed resolution; the tenth-Hertz digit is blanked if equal to zero.
2. Frequency Increment. When INCR SET key is pressed and held down. Same display format as Fixed Frequency.
3. Start-Stop Frequencies. When a sweep mode is operating. Five digits each for start and stop frequencies. Actual frequency resolution beyond five digits is not displayed. Start frequency, on the left, changes to instantaneous sweep frequency during slow sweeps (i.e., 10 and 100 ms per step).
4. CF- $\Delta$ F (Center Frequency and Span). Same display format as Start-Stop frequencies. CF on the left changes to instantaneous sweep frequency during slow sweeps (i.e., 10 and 100 ms per steps).
5. Frequency-Manual Sweep Mode. Instantaneous display same format as Fixed Frequency.

6. Marker Frequency. When a MARKER key is pressed and held down. Same display format as Fixed Frequency.
7. Sweep Step Size. When SET SIZE is pressed and held down. Same display format as Fixed Frequency.
8. Status. When STATUS key is pressed and held down. Two blocks of two-digit codes. The second and third digits on the left display special function codes. If more than one special function is operating, the display will cycle through the applicable codes. Refer to the pullout information card or to the detailed operating instruction titled "Status" for descriptions of the codes.  
  
The first and second digits on the right display hardware malfunction and status codes, and operator error codes. Refer to the pullout information card or to the detailed operating instruction titled "Status" for description of codes and further instructions.
9. Sequence. When RECALL and SEQ are pressed, the readout displays the order of recall for storage registers in the SEQ and AUTO SEQ modes.



### MODULATION READOUT

A two-digit display of %AM or %AM increment; 0.1% minimum resolution. A three-digit display of FM peak deviation or peak deviation increments 0.1 kHz minimum resolution.

### EXTERNAL SOURCE HI-LO

Adjusting aid for setting the level of an external modulation source. The annunciators indicate that the input level is too high or too low for calibrated display of %AM or FM deviation. The annunciators will turn off when input level equals  $1.00 \pm .02$  Vpk ( $0.707 \pm .014$  Vrms).

### REMOTE-ADDRESSED HP-IB LIGHTS

**REMOTE:** Turns on when the Generator is in remote mode and after it has received its first Data Message.

**ADDRESSED:** turns on while the Generator is addressed to talk or listen.

### AMPLITUDE READOUT

Displays absolute RF amplitude in mV,  $\mu$ V and dBm. Displays relative levels in dB for increment setting and the Amplitude Reference special function. The ones and tenths-digits are always displayed. Otherwise, leading zeros are blanked. A maximum of four digits can be displayed for dB and dBm; three digits maximum for mV and  $\mu$ V. Minimum display resolution is 0.1 dB, 0.1 dBm, and .001  $\mu$ V.

Figure 3-2. Readout Panel Features

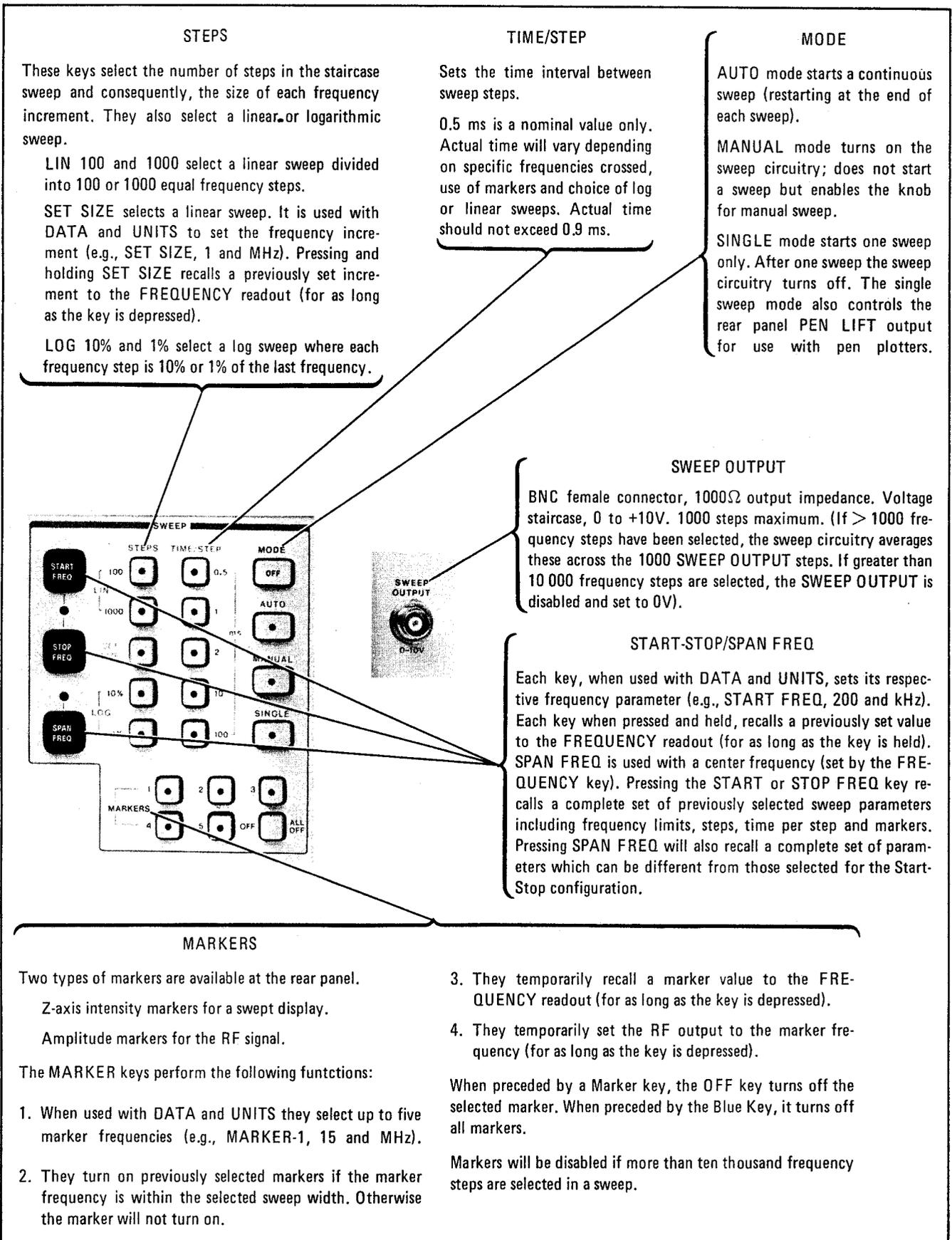


Figure 3-3. Sweep Features

### MOD

The MOD keys select an internal 400 or 1000 Hz modulation source or an external source through the MODULATION INPUT connector. These keys do not control the rear panel AUX FM connector.

EXT DC with FM is a valid selection but it will disable the phase lock stabilization of the RF output signal.

The modulation signal, either internal or external, is available at the rear panel MOD OUTPUT connector.

### FUNCTION

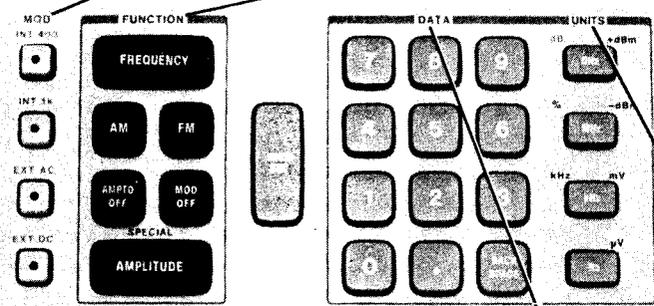
FREQUENCY, AM, FM and AMPLITUDE are used with DATA and UNITS to set their respective parameters (e.g., AM, 50 and %). AM and FM also act as "Mod-On" keys (i.e., with a single keystroke they can recall the previously selected AM depth or FM deviation, and modulation source).

AMPLITUDE also restores output after reverse power.

MOD OFF disables all modulation (except FM from the rear panel AUX FM input).

AMPTD OFF sets the RF amplitude to  $-139.9$  dBm.

SPECIAL is used with the Blue Key and a two-digit number to set various special functions that are not otherwise indicated on the front panel (e.g., Blue Key, SPECIAL and 51). For more information, see the detailed operating instruction for Special Functions.



### MODULATION INPUT

The input signal should be 1 Vpk to produce a calibrated display of AM depth or FM deviation. The EXTERNAL SOURCE HI-LO annunciators provide coarse accuracy of input level. If greater accuracy is required, the signal level should be measured externally.

BNC Female Connector. Nominal input impedance is 1000 ohms.

AC or dc coupling is determined by the EXT AC and EXT DC MOD keys. Minimum rate for ac coupling is 20 Hz.

An additional modulation input is AUX FM (see description under Rear Panel Features).

### UNITS

UNITS keys are used with function and DATA keys to set value selectable parameters (Function, in this sense includes the keys labeled FUNCTION, INCR SET and the sweep function keys).

Each "Units" key is labeled with two or three different values (for example, dB, GHz, +dBm). The selected function determines the applicable units.



### RF OUTPUT

Type-N Female Connector. Nominal impedance is 50 ohms.

Output level range is  $+13$  to  $-139.9$  dBm with a minimum resolution of 0.1 dBm.

Reverse power protection up to 30W and 8 Vdc. AMPLITUDE key restores RF.

### DATA

The DATA keys are used with function and UNITS keys to set value selectable parameters (Function in this sense includes the keys labeled FUNCTION, INCR SET and the sweep function keys).

The DATA keys are used with the Blue Key and SET SEQ (STORE) to determine the order for recall of storage registers in Sequence and Auto Sequence Modes.

The DATA keys are used with STORE and RECALL to identify the nine storage registers (e.g., STORE 3, RECALL 3).

The DATA keys are used with the Blue Key and SPECIAL to determine specific special functions.

BACKSPACE clears one digit at a time starting with the least significant digit. It is used only during DATA entry and before a UNITS key is pressed.

Figure 3-4. Signal Generator Features

Table 3-1. Operating Characteristics

Fixed Frequency	Range: 10 kHz to 1280 MHz (1279.999 999 8 MHz) Resolution: 0.1 Hz (below 640 MHz) 0.2 Hz (above 640 MHz)																				
Amplitude	Range: +13 to -139.9 dBm (999 mV to .023 $\mu$ V) Overrange: +16 dBm (with decreased accuracy) Resolution: 0.1 dB																				
Modulation	<p>AM</p> <p>Depth: 0 to 95%            Resolution: 1% (10 to 95%)            0.1% (0 to 9.9%)</p> <p>FM</p> <p>FM rates (1 dB bandwidth): external ac, 20 Hz to 100 kHz;            external dc, dc to 100 kHz.</p> <p>FM deviation:</p> <table border="1" data-bbox="482 803 1141 1174"> <thead> <tr> <th rowspan="2">Center Frequency (MHz)</th> <th colspan="2">Maximum peak deviation</th> </tr> <tr> <th>Internal and AC mode (kHz)</th> <th>DC mode (kHz)</th> </tr> </thead> <tbody> <tr> <td>0.01-120</td> <td>the smaller of 100 or <math>f_{mod} \times 500</math></td> <td>100</td> </tr> <tr> <td>120-160</td> <td>25 or <math>f_{mod} \times 125</math></td> <td>25</td> </tr> <tr> <td>160-320</td> <td>50 or <math>f_{mod} \times 250</math></td> <td>50</td> </tr> <tr> <td>320-640</td> <td>100 or <math>f_{mod} \times 500</math></td> <td>100</td> </tr> <tr> <td>640-1280</td> <td>200 or <math>f_{mod} \times 1000</math></td> <td>200</td> </tr> </tbody> </table> <p>FM resolution: 100 Hz (for deviations &lt; 10 kHz)            1 kHz (for deviations &gt; 10 kHz)</p> <p>Mixed Modulation: AM + FM            FM + FM            AM + FM + FM</p> <p>Internal Modulation Source: 400 and 1000 Hz            External Modulation Source: ac and dc coupling.</p>	Center Frequency (MHz)	Maximum peak deviation		Internal and AC mode (kHz)	DC mode (kHz)	0.01-120	the smaller of 100 or $f_{mod} \times 500$	100	120-160	25 or $f_{mod} \times 125$	25	160-320	50 or $f_{mod} \times 250$	50	320-640	100 or $f_{mod} \times 500$	100	640-1280	200 or $f_{mod} \times 1000$	200
Center Frequency (MHz)	Maximum peak deviation																				
	Internal and AC mode (kHz)	DC mode (kHz)																			
0.01-120	the smaller of 100 or $f_{mod} \times 500$	100																			
120-160	25 or $f_{mod} \times 125$	25																			
160-320	50 or $f_{mod} \times 250$	50																			
320-640	100 or $f_{mod} \times 500$	100																			
640-1280	200 or $f_{mod} \times 1000$	200																			
Swept Frequency	<p>Staircase Sweep</p> <p>Range: 10 kHz to 1280 MHz (1279.999 999 8 MHz)            Modes: Automatic, Manual, Single            Configuration: Linear                Logarithmic                Start-Stop Frequencies                Center Frequency and Span</p> <p>Sweep Time (step controls)            Frequency/Step: as large as sweep width;                              as small as 0.1 Hz (or 0.2 Hz above 640 MHz)            Time/Step: 0.5 ms (nominal), 1, 2, 10 or 100 ms</p> <p>Markers: 5 Markers                AM and Z-Axis</p> <p>Blanking: Z-Axis (250 <math>\mu</math>s at start of each step to blank switching transients).            Sweep Output: 0 to +10V Staircase Ramp</p>																				

**BLUE KEY**

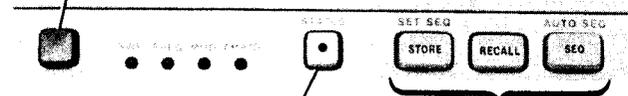
The Blue Key provides three types of additional keystroke capability:

1. It changes the capabilities of some keys to their blue labeled function (e.g., Blue Key and X10 produce the knob's HOLD function).
2. It produces the special functions when used with the SPECIAL key and a two-digit number (e.g., Blue Key, SPECIAL and 51). For more information, see the detailed description page for Special Functions.
3. It transfers the value of one frequency parameter to any other frequency parameter when used in the following sequence: Blue Key – Source Key – Blue Key – Receiver Key.

The Blue Key also returns the Signal Generator to local control from remote HP-IB control.

**KEYBOARD FUNCTION LAMPS**

These lamps indicate that the keyboard is ready to receive data and units for one of the sweep functions or for a specific signal generator function.



**STATUS**

The STATUS key has a built-in lamp that turns on for malfunctions, entry errors and other vital conditions. Malfunctions that inhibit the Generator's operation will cause the lamp to blink. The blinking indication will stay on until the problem is remedied. Most entry-error indications will turn off automatically when the next keyboard function is selected or after the STATUS key is pressed.

Pressing the STATUS key will display a two-digit status code in the FREQUENCY readout (i.e., in the first two digits on the right). Descriptions and instructions for these codes are listed on the pull-out information card and on page 3-82.

Pressing the STATUS key will also display the two-digit special function codes in the FREQUENCY readout (i.e., in the second and third digits on the left). If more than one special function is operating, the display will cycle through the applicable codes. Descriptions for these codes are listed on the pull-out information card and on page 3-82.

**STORE-RECALL-SEQ KEYS**

STORE and RECALL are used to store and recall nine complete front panel configurations in storage registers 1 through 9 (e.g., STORE 1 and RECALL 1). Three exceptions to this are:

1. SINGLE sweep mode cannot be stored (however, the other sweep parameters associated with the single sweep can be stored).
2. Only one set of five marker frequencies can be set. However, any marker's On-Off status can be stored in a register.
3. Special Functions are not stored in individual registers. Once enabled, they apply to setups recalled from any register.

SEQ is used to recall any of the nine registers in a preset order, or sequence. The sequence is determined by the SET SEQ feature. After the sequence has been set, it is only necessary to press SEQ to recall the next register.

When preceded by the Blue Key, the AUTO SEQ key starts a recall of one register after another according to the preset sequence. Two characteristics of the AUTO SEQ feature are:

1. If AUTO sweep mode is recalled by AUTO SEQ, the generator will perform only one sweep, then switch to the next front panel configuration.
2. If MANUAL sweep mode is recalled by AUTO SEQ, the automatic sequencing will stop (however, the recalled front panel includes Manual sweep mode enabled).

Pressing any key except STATUS will stop the automatic sequencing as well as perform its intended function. (Note: if you press FREQUENCY, it will stop automatic sequencing without affecting the instantaneous value of any parameter or front panel display).

To set a sequence, press the Blue Key, SET SEQ, DATA, and STORE. Any register can be set into the sequence more than once, (e.g., 5 2 3 5 3). The Maximum number of registers in a sequence is ten.

To recall the sequence order, press RECALL and SEQ. The sequence will be displayed in the FREQUENCY readout with the last-recalled register number blinking. The exception to this is when a new sequence has been set and before any registers have been recalled. Then the blinking digit will be the first number in the sequence. In any event, the next register to be recalled will always be the digit to the right of the blinking digit (including wrap-around to first digit).

Figure 3-6. Blue Key, Keyboard Function Lamps, Status Key and Store-Recall-Seq Keys

**WARNING**

Plate with the warning covers line voltage wiring and components. This plate should be removed only by service-trained personnel who are aware of the potential shock hazard.

Long hair can be drawn into the fan causing personal injury.

**FREQUENCY REFERENCE.** Switched input for 5 or 10 MHz reference; impedance is 50 ohms.

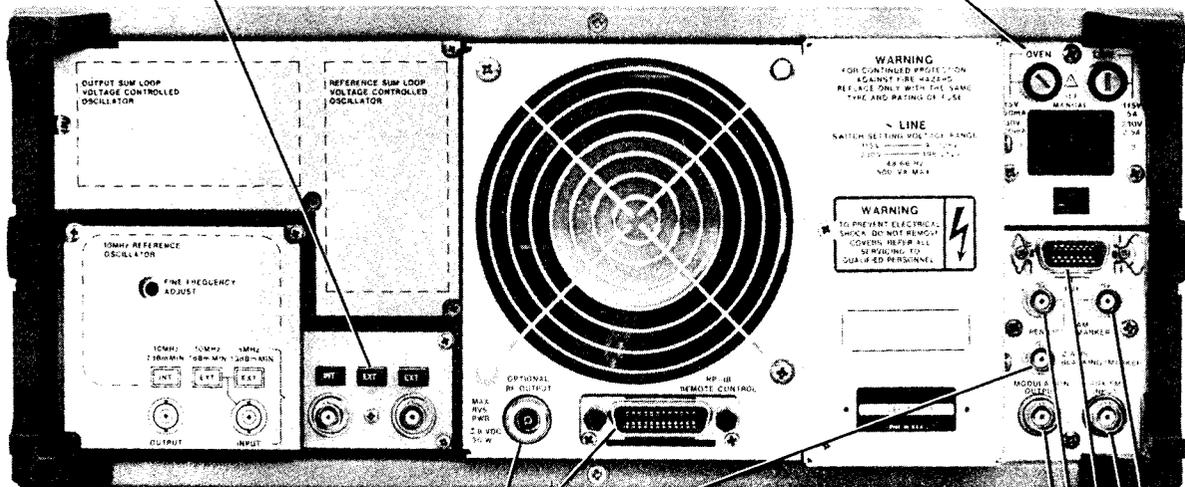
10 MHz reference output; impedance 50 ohms. The output signal is derived from the selected reference.

**OVEN Fuse:** for reference oscillator oven and the Generator's auxiliary power supply. The entire Generator is disabled when this fuse burns out. It must be selected for 115V or 230V operation. Ordering information for this fuse is presented in section II, Installation.

**LINE Fuse:** The entire Generator is disabled when this fuse burns out. This fuse must be selected for 115V or 230V operation. The LINE fuse should not be replaced until the cause of its failure has been determined (see page 3-1, the foldout).

**LINE Cord Receptacle:** the center contact of this receptacle is connected to the Generator's chassis. Available power cables are described in Section II, Installation.

**115V–230V Switch:** must be selected for available line voltage.



**OPTIONAL RF OUTPUT (Option 001 only).** Type-N Female Connector. Nominal impedance is 50Ω. Output level is +13 to -139.9 dBm with minimum resolution of 0.1 dBm. The outputs is protected from reverse power applications up to 30 watts and 8 Vdc.

**HP-IB REMOTE CONTROL.** Connects the Generator to the Hewlett-Packard Interface Bus for remote operation.

**Z-AXIS BLANKING/MARKER.** BNC female connector. Load impedance should be at least 1 kΩ. Provides a 250 μs, TTL-High pulse at the beginning of each frequency change for blanking a swept display (to eliminate display of switching transients). Goes to TTL-Low during remainder of frequency step. Goes to a nominal -5V (internally adjustable between -2 and -8V) for Z-Axis intensity marker.

**MODULATION OUTPUT.** BNC Female Connector. Output impedance is ~8 kΩ. Internal or external modulation signal is present at 200 mVrms minimum into 10 kΩ resistive load.

**PEN LIFT.** BNC Female Connector. Controlled by Single Sweep mode. TTL-High for pen-up; TTL-Low for pen-down.

**AUX Connector.** Six TTL inputs and two TTL outputs for limited remote control of front panel functions. Refer to the more detailed information on page 3-29.

**AUX FM INPUT.** BNC Female Connector. Input impedance is ~5 kΩ DC coupled. For more details, see page 3-68.

**AM MARKER.** BNC Female Connector. Output impedance is ~1 kΩ, 5 kHz triangle wave, 3 Vp-p. Can be applied to front panel MODULATION INPUT to provide adjustable AM markers.

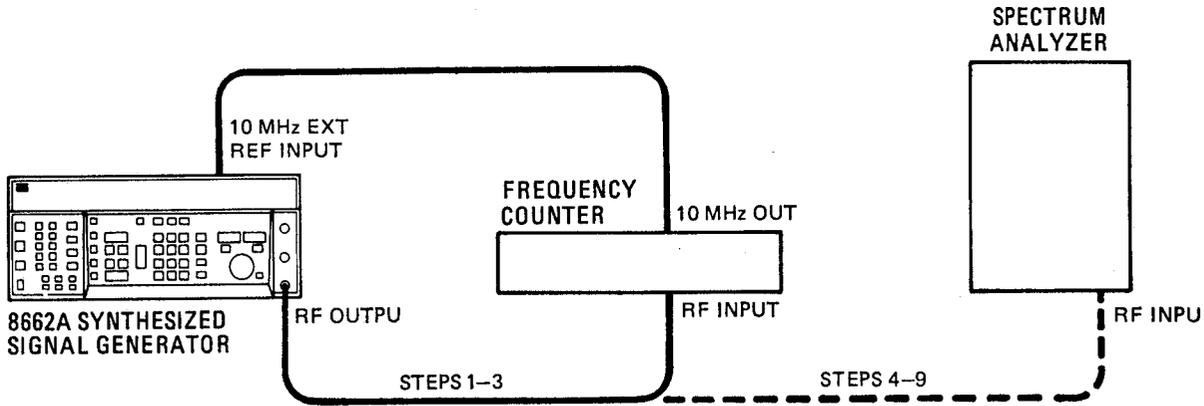
Figure 3-7. Rear Panel Features

**OPERATOR'S CHECKS**

**3-23. OPERATOR'S CHECKS**

**3-24. Functional Check**

**DESCRIPTION:** All parts of the instrument are checked to see that they function normally. These tests will identify problems which must be corrected before performance tests can be performed.



**Figure 3-8. Functional Check Test Setup**

**EQUIPMENT:** Frequency Counter . . . . . HP 5328A Option 031  
 HF Spectrum Analyzer . . . . . HP 8558B/181T

- PROCEDURE:**
1. Connect a cable from the Generator's RF OUTPUT to the input of the frequency counter. Connect another cable from the counter's 10 MHz reference output to the Generator's rear panel INPUT connector and press the EXT 10 MHz pushbutton. In this condition, the Generator uses the counter's timebase as its reference.
  2. Set the Generator's amplitude to  $-10.0$  dBm and frequency to the values in the table, below. The counter reading should be the frequency that is set plus the resolution error for the counter being used.

Check Frequencies (MHz)
100.0
140.0
200.0
300.0
400.0
600.0
800.0
1000.0

3. Set the Generator's frequency to 111.111 111 1 MHz and set the frequency increment to 111.111 111 1 MHz. The counter reading should be the same value as the Generator's FREQUENCY display. Press the INCREMENT ↑ key until the maximum frequency is reached. Check that the Generator's FREQUENCY display and the counter reading are correct at each step. Then press the INCREMENT ↓ key to

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**OPERATOR'S CHECKS**


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**FUNCTIONAL CHECK (Cont'd)**

decrease the frequency. Check the Generator's FREQUENCY display and counter readings again at each step as the frequency is decreased.

Output Frequencies (MHz)
111.111 111 1
222.222 222 2
333.333 333 3
444.444 444 4
555.555 555 5
666.666 666 6
777.777 777 6
888.888 888 8
999.999 999 8
1 111.111 111 2
1 222.222 222 2

- Set the Generator to sweep from .01 to 1279 MHz in 1000 steps at 100 ms/step (AUTO mode). Set the Generator's amplitude to +10 dBm. Set the spectrum analyzer to a center frequency of 640 MHz with 200 MHz span/division and a +10 dBm reference level.

Connect the Generator's RF OUTPUT to the analyzer's input. The display should be a continuous sweep (that is, no jumps or gaps). Harmonics can be seen over most of the sweep and should be more than 30 dB below the carrier.

**NOTE**

*There is no amplitude correction in a sweep mode. Thus, the level of the swept signal might vary between +6.5 and +11 dBm.*

- Set the Generator's sweep mode to OFF and amplitude to +5 dBm. Set frequency to 0.1 MHz and enable the knob to change frequency with a 10 MHz resolution. Set the analyzer's amplitude scale to 2 dB/division.

**NOTE**

*This step checks level flatness only, not absolute accuracy.*

Slowly tune the Generator through its entire frequency range while observing its level on the analyzer. The level should not vary more than  $\pm 2\%$ .

- Set the Generator to 600 MHz and +16 dBm. Adjust the spectrum analyzer to display the Generator's signal. Set the analyzer's reference level to the amplitude of the Generator's signal. Enable the Generator's knob to vary amplitude in 0.1 dB steps. Slowly decrease the Generator's amplitude to +5.1 dBm. Signal level on the spectrum analyzer should decrease smoothly with no jumps or upward steps (except when stepping between +13.1 and +13.0 dBm where level correction begins and a discontinuity can occur).

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**OPERATOR'S CHECKS**


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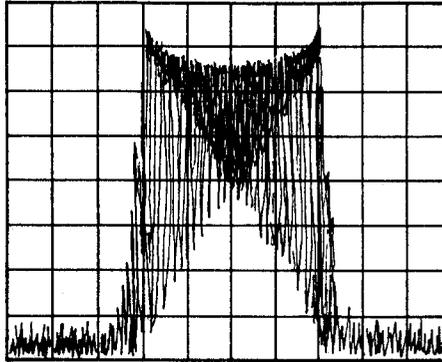
**FUNCTIONAL CHECK (Cont'd)**

Figure 3-9. Functional Check, FM Signal (600 MHz, 50 kHz/Division, 0 dBm Reference)

7. Set the Generator to +10 dBm and the amplitude increment to 5 dB. Set the spectrum analyzer's amplitude scale to 10 dB/division and reference level to the Generator's signal amplitude. Using the Generator's INCREMENT ↓ key, slowly decrease the Generator's output level to -70 dBm. Signal level on the analyzer should decrease in 5 dB steps.
8. Set the Generator's signal to 0 dBm with FM at 100 kHz peak deviation and 1 kHz rate (INT 1k). Enable the knob to vary peak deviation in 1 kHz steps. Set the spectrum analyzer to 50 kHz span/division and a 0 dBm reference level. The analyzer display should be similar to Figure 3-9.

Using the Generator's knob, slowly decrease FM deviation to zero. Deviation displayed on the analyzer should decrease smoothly.

9. Set the Generator to 50% AM at a 400 Hz rate (INT 400). Set the analyzer to zero span and fine tune for maximum level of the demodulated signal. Set the analyzer to linear amplitude mode. The demodulated signal should be a sine wave with a 2.5 ms period (that is, 400 Hz).

Set the Generator to INT 1k (modulation rate). The period of the demodulated signal should become 1 ms (that is, 1 kHz).

**Sending Data Messages (Cont'd)**

information it can send in a Data message are listed below.

1. The Require Service Mask Value (explained later under sending the Require Service Message).
2. STATUS Key Message
3. Front Panel Learn Data
4. "Fast" Learn Data.

**Status Key Message.** After receiving an MS program code (Status Key Message) and when addressed to talk, the Generator will send thirteen two-digit codes (separated by commas, and ending with Carriage Return/Line Feed (a total of forty ASCII characters). The codes represent entry errors, instrument malfunctions, special function status and modulation level (from external source). The codes are sent in the following order:

1	xx,	—	Entry Error
2	xx,	—	Hardware Error
3	xx,	}	Special Function Status
4	xx,		
5	xx,		
6	xx,		
7	xx,		
8	xx,		
9	xx,		
10	xx,		
11	xx,		
12	xx,		
13	xx	—	External Modulation Source
	—	—	Carriage Return
	—	—	Line Feed

The two-digit codes are explained on the Generator's pullout information sheet, and on page 3-82 (except for code 13 which will be 10 if the modulation level is low; 20 if high). Codes 3 through 12 are cleared when the special function is eliminated. However, Codes 1, 2, and 13 are cleared only after the condition is corrected and the message has been re-read.

**Learn Modes.** In addition to being able to store front panel setups in its own registers, the Generator has two learn mode capabilities which use the controller's memory. One learn mode allows the Generator to send complete front panel configurations to the controller's memory. The second is the fast mode which transfers only frequency and modulation information thus providing a much faster switching speed when recalled.

**NOTE**

*The Operator Requests Response condition of the status byte can be a useful tool for performing learn functions. After setting up the front panel, press the Blue Key, SPECIAL and 87. This would issue a Require Service message (if enabled to by the RQS mask). The controller could be programmed to send the Generator to remote, perform the learn function and return the Generator to local for the next front panel setup. This procedure eliminates the need for the operator to go to the controller each time the front panel is set. See page 3-39 for more information on the Require Service message.*

The learn modes require a controller that can transfer information in binary form.

Whenever data is being transferred between controller and Generator, it must do so in uninterrupted strings. If a data string is broken or interrupted, the data could be lost or offset, and misinterpreted by the Generator. An offset of data bytes can persist through later data strings until the Generator is eventually switched to standby, then on again.

It is possible to interpret the Learn Mode strings to determine frequency, amplitude and modulation settings. Detailed procedures start on page 3-43.

**Front Panel Learn Mode.** After receiving an L1 program code (Front Panel Learn) and when addressed to talk, the Generator sends a string of 128 8-bit bytes containing information on the front panel configuration. This binary data can then be stored in the controller's memory for future use. In addition, as each configuration goes out onto the bus, it is also stored in the Generator's register 1. Thus, the byte string contains only those parameters that can be stored in the Generator's internal registers (see page 3-83 for store-recall limitations).

**NOTE**

*The 128th byte is sent with the bus EOI line true, thus terminating the message.*

When the Generator is addressed to listen, the binary data can be returned to it in 128-byte strings or 64-byte strings, two at a time. The Generator interprets the first two bytes to determine that this is full-front-panel information and changes accordingly.





**OPERATOR'S CHECKS**

**Remote and Local Messages.**

**NOTE** This check assumes that the Generator is in the local state, a default condition at turn-on. Thus, the Remote Check precedes the Local Check. If the Generator is in the remote state (that is, its front panel REMOTE light is on), switch the Generator to standby, then on again.

Description	HP 9825A (HPL)	HP 9835A and 9845A (BASIC)
Remote: Send the Remote Message to the Generator. In this case, it includes remote-enable and the address-to-listen.	rem 719	REMOTE 719
Send a "dummy" command to the Generator (i.e., any Data Message). Its purpose is only to complete the Generator's requirements for turning on the REMOTE light.	wrt 719	OUTPUT 719

**OPERATOR'S RESPONSE** Check that the Generator's REMOTE light turns on. If it does not, the Generator failed to process the Remote Message.

Local: Send the Local Message.	lcl 719	LOCAL 719
-----------------------------------	---------	-----------

**OPERATOR'S RESPONSE** Check that the Generator's REMOTE light turns off. If it does not, the Generator failed to process the Local Message.



## OPERATOR'S CHECKS

---

### Local Lockout and Clear Lockout/Set Local Messages.

**NOTE** This check requires the Generator to be in the remote state.

Description	HP 9825A (HPL)	HP 9835A and 9845A (BASIC)
Send a "dummy" command to the Generator (i.e., any Data Message). Its purpose is only to complete the Generator's requirements for turning on the REMOTE light.	wrt 719	OUTPUT 719

**OPERATOR'S RESPONSE** Check that the Generator's REMOTE light is on.

Local Lockout: Send the Local Lockout Message.	llo 7	LOCAL LOCKOUT 7
---	-------	-----------------

**OPERATOR'S RESPONSE** Press the Generator's Blue Key while observing its REMOTE light. The light should remain on. If the light turns off, the Generator failed to process the Local Lockout Message.

Clear Lockout/Set Local: Send the Clear Lockout/Set Local Message.	lcl 7	LOCAL 7
---	-------	---------

**OPERATOR'S RESPONSE** Check that the Generator's REMOTE light turns off. If it does not, the Generator failed to process the Clear Lockout/Set Local Message.

Clear Lockout/Set Local: (cont'd) Send the Remote Message (enabled and addressed-to-listen) and a "dummy" Data Message to complete the Generator's requirements for turning on the REMOTE light.	rem 7; wrt 719	REMOTE 7 OUTPUT 719
---	----------------	------------------------

**OPERATOR'S RESPONSE** Check that the Generator's REMOTE light turns on.

Press the Blue Key for return-to-local. Check that the REMOTE light turns off again. If not, the Generator failed to process the Clear Lockout/Set Local Message.



## OPERATOR'S CHECKS

---

### Require Service and Status Byte Messages.

**NOTE** This check can be performed with the Generator in local or remote state. It checks for the Require Service Message that the Generator always sends at turn-on.

If you suspect that the Require Service Message has been cleared (for example, by a Clear Message or a previous reading of the Status Byte), simply turn the Generator to standby, then to on again.

Description	HP 9825A (HPL)	HP 9835A and 9845A (BASIC)
Require Service: Read the binary status of the controller's interface and store the data in variable S (in this step, 7 is the controller's select code).  Print or display the value of the SRQ bit (in this step, 7 is the SRQ bit, numbered from 0).	rds (7) →S  prt "SRQ=", bit (7,S)	STATUS 7;S  PRINT "SRQ="; BIT (S,7)

**OPERATOR'S RESPONSE** The SRQ bit should be 1. If not, the Generator failed to send the Require Service Message.

Status Byte: Read the Generator's Status Byte Message and store the data in Variable R.  Print or display the value of the RQS bit (that is, bit 6, numbered from 0).	rds (719) → R  prt "RQS=", bit (6,R)	STATUS 719;R  PRINT "RQS="; BIT (R,6)
--	--	---

**OPERATOR'S RESPONSE** The RQS bit should be 1. If not, the Generator failed to send the Status Byte Message.

## OPERATOR'S CHECKS

## Data Message.

## NOTE

This check requires the Generator to be in the remote state.

Description	HP 9825A (HPL)	HP 9835A and 9845A (BASIC)
All data paths set to 1: Set the Generator's RQS Mask to all ones (@1 and 255).	wtb 719, "@1", 255	OUTPUT 719 USING "#,K,B"; "@1", 255
Have the Generator produce the new mask value at its interface (rm).	wrt 719, "rm"	OUTPUT 719; "RM"
Read the 8-bit byte (that is, the mask value) and store it in variable M.	rdb (719) → M	M = READBIN (719)
Print the value of variable M.	prt "mask=", M	PRINT "MASK="; M

OPERATOR'S  
RESPONSE

The controller should print the value 255 (the decimal equivalent of all ones). If not, the Generator failed to process these Data Messages.

All data paths set to 0: Set the Generator's RQS Mask to zeros (@1 and 0).	wtb 719, "@1", 0	OUTPUT 719 USING "#,K,B"; "@1", 0
Have the Generator produce the new mask value at its interface (rm).	wrt 719, "rm"	OUTPUT 719; "RM"
Read the 8-bit byte (that is, the mask value) and store it in variable M.	rdb (719) → M	M = READBIN (719)
Print the value of variable M.	prt "mask=", M	PRINT "MASK="; M

OPERATOR'S  
RESPONSE

The controller should print the value 0. If not, the Generator failed to process these Data Messages.



## OPERATOR'S CHECKS

---

### Trigger Message.

#### NOTE

This check requires the Generator to be in the remote state.

Description	HP 9825A (HPL)	HP 9835A and 9845A (BASIC)
Set the Generator's frequency to 999 MHz.	wrt 719, "fr 999 mz"	OUTPUT 719; "FR 999 MZ"
Set the Generator's frequency increment to 111 MHz.	wrt 719, "is 111 mz"	OUTPUT 719; "IS 111 MZ"

#### OPERATOR'S RESPONSE

Check that the Generator's frequency is set to 999 MHz. Then press the Generator's INCR SET key to check for an increment of 111 MHz. This keyboard function is possible in the remote state (even if local lockout is enabled).

Configure the Generator's trigger response to be an INCREMENT ↓ function (that is, dn).	wrt 719, "ct dn"	OUTPUT 719; "CT DN"
Send a Trigger Message.	trg 719	TRIGGER 719

#### OPERATOR'S RESPONSE

Check that the Generator's frequency changes to 888 MHz. If not, the Generator failed to process the Trigger Message or the Configure Trigger Data Message.

---

### Clear Message.

#### NOTE

This check requires the Generator to be in the remote state.

Description	HP 9825A (HPL)	HP 9835A and 9845A (BASIC)
The purpose of this step is to set the Generator to any frequency other than 100 MHz (thus, 888 MHz). If this condition already exists, the step can be eliminated.	wrt 719, "fr 888 mz"	OUTPUT 719; "FR 888 MZ"

#### OPERATOR'S RESPONSE

Check that the Generator's frequency is set to 888 MHz (or to any frequency other than 100 MHz).

Send the Clear Message	clr 719	RESET 719
------------------------	---------	-----------

#### OPERATOR'S RESPONSE

Check that the Generator's frequency changes to 100 MHz. If not, the Generator failed to process the Clear Message.

---

Operation




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 OPERATOR'S CHECKS
 

---

Abort Message.

NOTE

This check requires that the Generator be in the remote state.

Description	HP 9825A (HPL)	HP 9835A and 9845A (BASIC)
The purpose of this step is to ensure that the Generator is addressed. If this condition already exists, the step can be eliminated.	wrt 719	OUTPUT 719

OPERATOR'S  
RESPONSE

Check that the Generator's ADDRESSED light is on.

Send the Abort Message.	cli 7	ABORTIO 7
-------------------------	-------	-----------

OPERATOR'S  
RESPONSE

Check that the Generator's ADDRESSED light turns off. If not, the Generator failed to process the Abort Message.

### 3-27. REMOTE OPERATION, AUXILIARY CONTROL

#### 3-28. AUX Input Lines

A limited number of front panel functions can be controlled through the rear panel AUX connector. These functions are listed in the table below.

The input lines are TTL compatible and negative-edge sensitive. They require a minimum of 5  $\mu$ s between negative edges. Input signals can be generated by clean TTL drivers or by mechanical switches that require debouncing. The Generator has a built-in debouncing circuit that should be enabled or disabled depending upon which type of control is used.

The Generator is shipped from the factory configured for electrically-clean control signals (that is the debouncing circuit is disabled). One way to determine if the debouncing circuit is still disabled is described below.

- Set any parameter increment to one (1).
- Ground pin 2 (Step Up) several times and observe the parameter change.
- If the parameter steps are erratic (for example, steps of 2, 4, 3, etc.), the debouncing circuit is still disabled.
- If the parameter consistently changes in steps of one, the debouncing circuit is enabled.

Refer to Section II (Installation) for the procedure for enabling or disabling the debouncing circuit.

#### NOTE

*The Installation section also shows the pinout configuration of the AUX connector as well as information for a recommended mating connector.*

#### 3-29. AUX Output Lines

The AUX connector also has a ground line and two TTL compatible output lines. The output lines are normally held at the high TTL level. The Sweep End line produces one 5  $\mu$ s low-going pulse at the end of each sweep. The Parameter Out line produces one 5  $\mu$ s low-going pulse when any signal parameter changes. Combinations of outputs connected to inputs can create several sequential functions (for example, the Sweep End output could be connected to the Step Up input to move center frequency after each sweep).

The Parameter Out line also goes low and remains low if the Turn-On Memory Check produces error code 53. This feature can be used to signal an unexpected turn-on configuration. The line is reset at the time of the first parameter change.

#### 3-30. Amplitude Correction

Disable the Generator's Amplitude Correction feature if maximum level accuracy is not required. This is accomplished with Special Function 85. The purpose of this is to eliminate unnecessary mechanical wear of the output attenuator during long periods of frequency changing. This precaution would only be necessary here for the step up and down functions and the Sequence function. The correction feature is automatically disabled in any sweep mode. Specified level accuracies with correction enabled and typical accuracies with correction disabled are listed on page 3-53.

**Table 3-3. AUX Connector Functions**

	Pin	Function	Description
INPUTS	2	Step Up	Same as INCREMENT $\uparrow$ key
	3	Step Down	Same as INCREMENT $\downarrow$ key
	4	Stop Sweep	Same as MANUAL sweep mode key
	5	Continue Sweep	Same as AUTO sweep mode key
	6	Single Sweep	Same as SINGLE sweep mode key
	7	Sequence	Same as SEQ key
OUTPUTS	1	Sweep End	One pulse at end of each sweep
	12	Parameter Out	One pulse when any output signal parameter changes

## Operation



### 3-31. REMOTE OPERATION, HEWLETT-PACKARD INTERFACE BUS

The Generator can be operated through the Hewlett-Packard Interface Bus (HP-IB). Bus compatibility, programming, and data format are described in the following paragraphs.

All front panel functions (except for that of the LINE switch), special functions and remote-only functions are programmable through the HP-IB.

A quick check of the Generator's HP-IB interface is described earlier in this section under Operator Checks. It verifies that the Generator can respond to or send each of the applicable HP-IB messages described in Table 3-4.

For more information about HP-IB, refer to IEEE Std 488 (or the identical ANSI Standard MC1.1), the Hewlett-Packard catalog and the booklet "Improving Measurements in Engineering and Manufacturing" (HP part number 5952-0058).

### 3-32. HP-IB Compatibility

The Generator's complete bus capability as defined in IEEE 488 (or the identical ANSI Standard MC1.1) is presented beneath Table 3-4.

### 3-33. HP-IB Messages

The programming capability of the Generator is further described by the twelve HP-IB messages in Table 3-4. Foremost among these messages is the Data message. Data messages contain the program codes that control the Generator's output signal.

### 3-34. Remote Mode

**Remote Capability.** The Generator communicates on the bus in both remote and local modes. In remote, its front panel controls are disabled (except for the LINE switch, the Blue Key, the STATUS key and the function keys for displaying "hidden" parameters). The Generator can be addressed to listen or talk. When addressed to listen, the Generator will automatically stop talking and respond to the following messages: Data, Trigger, Clear, Remote, Local, Local Lockout, Clear Lockout/Set Local and Abort. When addressed to talk, the Generator will automatically stop listening and send one of the following messages: Data, Require Service or Status Byte.

### NOTE

*Even when the keyboard is otherwise disabled, the STATUS and function keys can interrupt certain Generator operations and delay the processing of program steps addressed to the Generator.*

**Local-to-Remote Change.** The Generator switches to remote upon receipt of the Remote message. The Remote message has two parts. They are:

- Remote-enable (REN)
- Addressed-to-Listen once

The Generator's output signal and all control settings remain unchanged with the Local-to-Remote transition.

### 3-35. Local Mode

**Local Capability.** In local, the Generator can send a Require Service message, send a Status Byte message and respond to the Remote message.

### NOTE

*By strict definition, the Generator can respond to all HP-IB messages except the Data Message while in local. However, most of these messages would not normally be used in the local mode.*

**Remote-to-Local Change.** The Generator returns to local control upon receipt of the Local or Clear Lockout/Set Local message. It can also be set to local mode by pressing the front panel Blue Key (assuming that local lockout is not in effect). The Generator's output signal remains unchanged and all preselected functions remain unchanged with the remote-to-local transition.

**Local Lockout.** When a data transmission is interrupted, which can happen by returning the Generator to local with the Blue Key, the data could be lost. This would leave the Generator in an unknown state. To prevent this, a local lockout is recommended. Local lockout disables the Blue Key and allows return-to-local only under program control.

### NOTE

*Return-to-Local can also be accomplished by turning the Generator to Standby,  
(continued)*

Table 3-4. HP-IB Message Reference Table

HP-IB Message	Applicable	Response	Related Commands and Controls*	Interface Functions*
Data	Yes	All front panel functions, special functions and remote only functions are programmable. The Generator can send STATUS key information, the Require Service Mask value and control setups (learn modes). The front panel ADDRESSED indicator turns on when addressed.		T6 L3 AH1 SH1
Trigger	Yes	Executes a previously selected program code. Responds equally to bus command GET and program code TR (a Data Message).	GET	DT1
Clear	Yes	Sets output to 100 MHz, -30 dBm with modulation and sweep off. Resets many additional parameters as shown on page 3-39. Responds equally to DCL and SDC bus commands.	DCL SDC	DC1
Remote	Yes	The Generator's remote mode is enabled when the REN bus line is true. However, it remains in local (i.e., the keyboard is active) until it is addressed to listen the first time. The output signal is unchanged. The front panel REMOTE indicator turns on when in remote mode and after receiving its first Data Message.	REN	RL1
Local	Yes	The Generator returns to front panel control. The output signal is unchanged. Responds equally to the GTL bus command and the front panel Blue Key.	GTL	RL1
Local Lockout	Yes	Blue Key is disabled. Only the controller can return the Generator to local.	LLO	RL1
Clear Lockout/Set Local	Yes	Generator returns to local when the REN bus line goes false.	$\overline{\text{REN}}$	RL1
Pass Control/Take Control	No	The Generator has no controller capability.		C $\emptyset$
Require Service	Yes	The Generator sets the SRQ bus line true if one of the following conditions exists and it has been enabled by the RQS mask to send the message for that condition: Ready, Entry Error, Hardware Error, Power Fail Restart, Parameter Out, Sweep End and Operator Requests Response (SP-87).	SRQ	SR1
Status Byte	Yes	The Generator responds to a Serial Poll Enable (SPE) bus command by sending an 8-bit byte. Bit 7 (RQS bit) is true if Generator had sent the Require Service Message. All bits except bit 1 are latched and must be cleared. Each bit requires different conditions for clearing. See page 3-40 for details.	SPE SPD	T6
Status Bit	No	The Generator does not respond to a parallel poll.		PP $\emptyset$
Abort	Yes	The Generator stops talking or listening.	IFC	T6, L3

\*Commands, Control lines and Interface Functions are defined in IEEE Std 488 (and the identical ANSI Standard MC1.1). Knowledge of these might not be necessary if your controller's manual describes programming in terms of the twelve HP-IB Messages shown in the left column.

Complete HP-IB capability as defined in IEEE Std 488 (and the identical ANSI Standard MC1.1) is:  
SH1, AH1, T6, TE $\emptyset$ , L3, LE $\emptyset$ , SR1, RL1, PP $\emptyset$ , DC1, DT1, C $\emptyset$ .

Operation



Local Mode (Cont'd)

NOTE (continued)

then On again. However, this technique has several potential disadvantages.

- It defeats the purpose and advantage of local lockout (that is, the system controller will lose control of a system element).
- There are several HP-IB conditions that reset to default states at turn-on.
- The Generator issues a Require Service message to the system's controller with each turn-on.

- Remote Stepped Sweep off.
- Trigger Configuration cleared

RQS MASK		
Bit	State	Description
8	0	Operator Requests Response
7	1	RQS Bit
6	0	Sweep End
5	0	Parameter Out
4	1	Power Fail Restart
3	1	Hardware Error
2	1	Entry Error
1	0	Ready

3-36. Addresses

The Generator's Talk and Listen addresses are set by a set of thumbwheel switches located inside the instrument. The address selection procedure is described in Section II. This information is intended for service trained persons who are aware of the potential shock hazard of working on an instrument with protective covers removed.

The decimal equivalent of the addresses can be displayed in the Generator's Frequency readout by pressing the following keys.



The address will be displayed in the format, — X X ——. This is the decimal equivalent of the last five bits of both Talk and Listen ASCII address codes. Refer to Table 3-5 for interpretation of the decimal code.

3-37. Turn-on Default Conditions

Several HP-IB parameters are reset at turn-on. The parameters and their default conditions are listed below.

- HP-IB Local Mode
- Deferred Execution Mode
- Talk and Listen addresses set to internal switch setting.
- Unaddressed
- Require Service Message sent (that is, SRQ bit true) for Power Fail Restart.

Table 3-5. Decimal Address Codes to ASCII Equivalents

Decimal Equivalents	ASCII Address Codes	
	LISTEN	TALK
00	SP	@
01	!	A
02	”	B
03	#	C
04	\$	D
05	%	E
06	&	F
07	,	G
08	(	H
09	)	I
10	*	J
11	+	K
12	,	L
13	-	M
14	.	N
15	/	O
16	0	P
17	1	Q
18	2	R
19†	3	S
20	4	T
21	5	U
22	6	V
23	7	W
24	8	X
25	9	Y
26	:	Z
27	;	[
28	<	\
29	=	]
30	>	^

† Indicates factory set address.



### 3-38. Displays

The REMOTE light is on when the Generator is in the remote mode and after it has received its first Data Message. The ADDRESSED light is on when the Generator is currently addressed to talk or listen.

The STATUS Message Indicator is set under the same conditions in remote as it is in local. The STATUS message can be read in either remote or local when the Generator is under program control. For further discussion of STATUS, see the section on sending the Data Message.

The three major parameter readouts (FREQUENCY, MODULATION and AMPLITUDE) operate just as they do in the local mode. Hidden parameters can still be displayed in their readout panels by pressing and holding their front panel keys. (This capability is not available to the controller since it cannot hold a program code in the same manner that an operator can hold down a key.)

### 3-39. Receiving Data Messages

The Generator communicates on the HP-IB primarily with Data messages. Data messages include the Generator's HP-IB program codes (which are defined on pages 3-47 and 3-48). The program codes contain information for programming front panel functions (except for that of the LINE switch), all special functions and remote-only functions.

The Generator will respond to Data messages when in remote and addressed to listen.

**Data Message Input Format.** Data messages contain the controller's Talk address, the Generator's Listen address, a string of program codes and an End-of-String message (EOS). The string of program codes follows the same protocol as keystrokes at the front panel. EOS can be a Line Feed (LF), an exclamation mark (!), a bus END message (i.e., EOI and ATN true) or an internally produced EOS (see Execution Modes, page 3-35).

The following paragraphs explain other key elements of the program code strings. Figure 3-10 shows several examples of Data messages.

**Keyboard-Program Code Correlation.** There is a corresponding program code for every key-label printed on the front panel.

**Value-Selectable Parameters.** Parameters, such as FREQUENCY and AMPLITUDE, are set with a Function-Data-Units sequence of program codes.

**Data.** "Data" in this sense refers only to number values and not to the entire Data message. The term here is derived from the bank of front panel DATA keys. Data can be any number, of arbitrary length, in fixed point notation. Digits beyond the display capability of a particular parameter are truncated. Therefore, it is best to format the data so that it is rounded to the correct number of digits. Leading zeroes are also acceptable, with the exception that a leading zero in the 10 GHz location will cause a digit overflow error (however, in most controllers, fixed point notation suppresses leading zeros, thus circumventing the error).

Signs preceding data are generally ignored. The exception to this rule is data with the unsigned dBm code (DM). With this program code only, data can be preceded with a plus or a minus. Otherwise, the +D or -D codes would be used for +dBm or -dBm.

**Single-Value Parameters.** Parameters such as "INT 1k" and "LIN 1000", are set with a single program code.

**The Knob.** Programming a single step of the knob requires that the program code RU or RD be sent ten times (except in the Manual sweep mode where one program code causes one step).

**Special Functions.** Special functions are capabilities that are not explicitly described on the front panel. They are programmed with SP and a numeric code (the single program code SP or the keystroke-like sequence BL AP can be used for SPECIAL). The numeric codes are listed on page 3-49.

**Detailed Operating Instructions.** The detailed operating instructions in this section of the manual present examples of program code sequences for most of the Generator's functions. An index of detailed instructions is located on page 3-3.

**Upper-Lower Case Letters.** Either upper or lower case letters can be used in a Data message. Also the number 0 is interchangeable with the letter O (or o), and the character ` is interchangeable with @.

**Recognizable Characters.** The Generator can recognize only the following ASCII characters in a data message:

LF ! + - . 0-9 A-Z a-z @

All other characters, including spaces, are ignored by the Generator. However, if a space or other such character were inserted between the two characters of a program code, the program code would be invalid and any remaining characters in a string might be misinterpreted by the Generator.

Operation

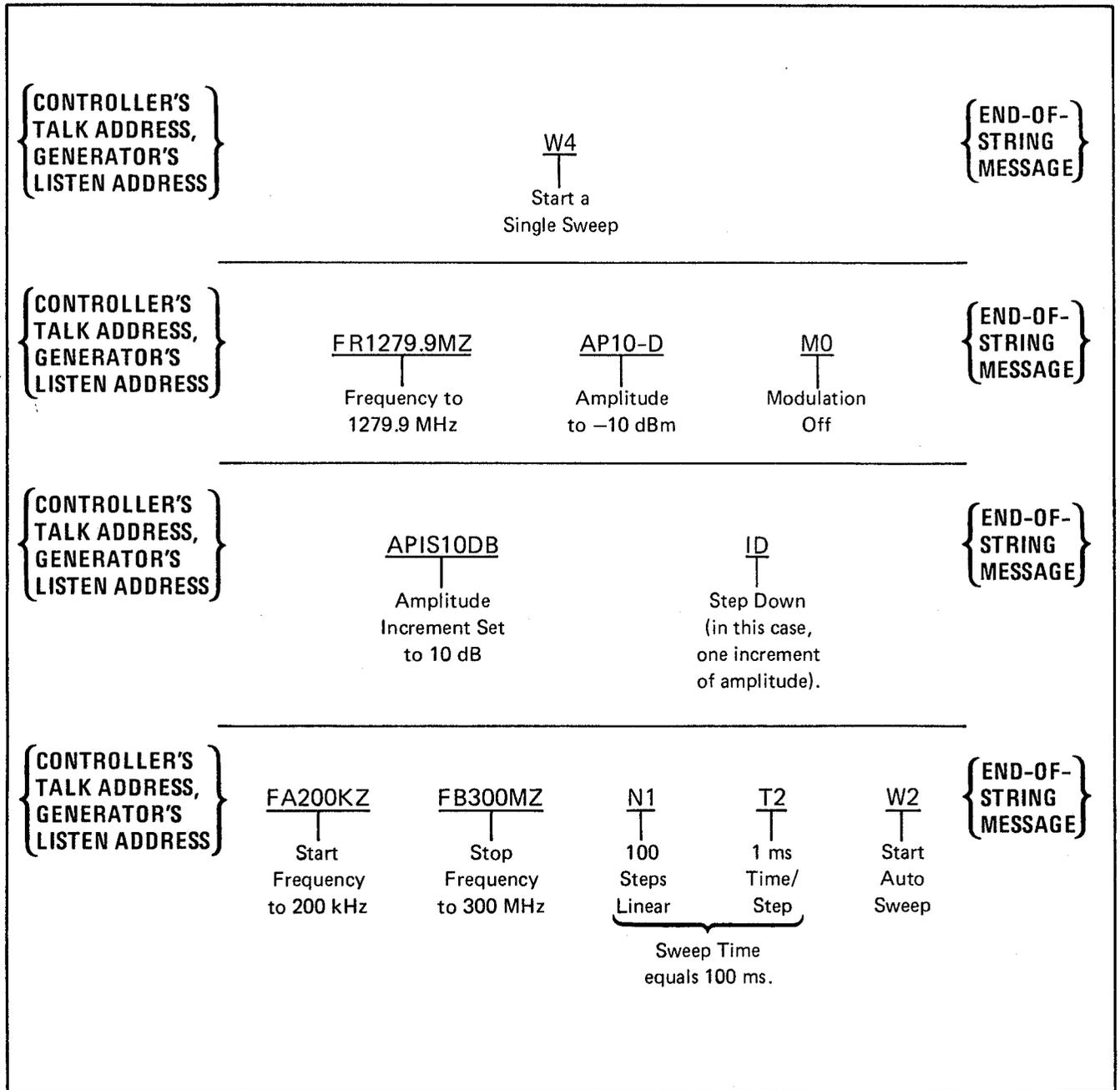


Figure 3-10. Data Message Examples



Thus, the following entries would be valid . . .

FR 1,200,000 HZ; AP -30 DM

FR1200000HZAP-30DM

FR 1 200 000 HZ AP -30 DM

. . . but the following entry would be invalid:

F R1200000HZAP-30DM

#### NOTE

*A complete list of ASCII characters, with conversions to binary, octal, decimal and hexadecimal, is shown on page 3-97.*

**Deferred Execution Mode.** ASCII characters can be accepted in the Deferred or Immediate execution modes. Deferred Execution is the default mode at turn-on. It can be set, if necessary, by sending the program code @2. In this mode the Generator accepts strings up to 82 characters at a time, executing the string upon receiving an End-of String (EOS) message. An EOS message may be a Line Feed (LF), an exclamation mark (!) or a bus END message (that is, bus lines EOI and ATN true). The Generator produces its own EOS Message upon receipt of the 82nd character in a string. If a block of strings containing more than 82 characters is sent, the first 82 characters are accepted and the Generator holds the bus busy until it executes them. Then the next 82 characters are accepted and so on until the entire block is accepted. If only one string of less than 82 characters is sent, the Generator accepts the strings and frees the bus allowing program execution to continue.

**Immediate Execution Mode.** This ASCII mode must be selected by sending the program code @3. It differs from the Deferred Execution Mode in that the Generator produces an EOS message at the end of each character, and does not require one from the controller. The Generator processes each character before accepting the next one. Therefore, the Immediate Execution mode does slow down overall data transfer. However, the Generator can switch faster after the final EOS message than it can in the other mode. This is useful when the system controller is slow enough (data rate <1000 bytes/second) that it cannot take advantage of the Deferred mode's transfer speed or when switching time, independent of message length, is more important than program execution speed.

**Binary Mode.** The Generator's RQS Mask (Request Service) is programmed in binary format (see page 3-40). Also learn mode data is sent and received in binary (see page 3-37).

**Program Execution Time.** Execution time is determined by two parameters: the rate at which data can be accepted and processed by the Generator, and the settling time it takes to reach the desired output state. Table 3-6 gives some typical processing times for various commands.

Settling time is dependent on the parameter being changed as well as the previous front-panel setting. The following paragraphs give typical settling times for the various parameters.

**Frequency.** Figure 3-11 illustrates the worst-case frequency transient. The Generator will be within 100 Hz of the desired setting less than 400  $\mu$ s after it has completed its processing.

**Amplitude.** Settling of the output attenuators requires an additional 32 ms, during which time the Generator is not ready to accept new data. Because of the internal error correction as a function of frequency, an unexpected attenuator change can occur when a new frequency (but the same amplitude) is programmed, slowing down the program. If maximum programming speed is desired, the error correction should be disabled (Special Function 85). If necessary, an error correction routine can be stored in the controller by measuring the Generator's output versus frequency with a power meter. This will allow taking output level into account in the final data without requiring error-correction.

In addition to level changes, the program level error can occur for 100 ms or more when first entering the 10 to 150 kHz range. This is due to capacitor charging in the leveling loop. When this occurs, bit 3 of the status byte is set high and error 10 (RF unlevelled) is placed in the status message.

**Modulation.** A typical AM depth selection takes <1 ms. In addition, be aware that lock times of up to 3 seconds can occur when switching out of external DC FM modulation, and so must be allowed for in the program.

**Sweep.** The sweep times are determined by the time/step setting on the front panel, or else by the controller in remote stepped sweep.

**Recall.** A recall from the Generator's own storage registers takes about 18 ms (45 ms with an attenuator and modulation source change). If there are many parameters to change and/or the system utilizes a slow controller, recalling from storage may be faster than writing directly from the controller.

### 3-40. Sending Data Messages

The Generator can send Data messages when in remote and addressed to talk. The four types of



Table 3-6. Typical Processing Times for Various Commands

Data Messages	Processing Times <sup>1</sup> (ms)		
	Deferred Execution	Immediate Execution	Binary <sup>2</sup>
FR1234567890.2 HZ	12.1	8.3	
FR992.1535MZ	11.4	7.7	
FR320.05MZ	10.6	7.6	
AP-30.1DM	36.5	34.1	
FM3KZM1	18.8	9.2	
FRIS1KZ	3.2	1.5	
FA100MZ, FB300MZ, N2, T2, W2	20.4	6.7	
TR (for CTUP, FR800MZ, FRIS1MZ)	8.2	7.9	
UP (for FR800MZ, FRIS1MZ)	8.1	7.8	
DN (for FR800MZ, FRIS1MZ)	8.2	7.9	
SPX1FR (Frequency Transfer for X1300MZ)	8.7	7.5	
RC1 <sup>3</sup>	19 to 46.2	18 to 45.2	
ST1	6.8	5.7	
Y3 (Remote step sweep execute, no display)	0.82	0.61	
L1 (Restore) [11 characters]			0.420
L2 (Restore) <sup>3</sup> [128 characters]			25 to 52.2
Generator Character acceptance Time	0.17	0.39 <sup>4</sup>	

<sup>1</sup>Processing time measured from EOS message until ready to accept next character. Amplitude correction is disabled.

<sup>2</sup>These times include bus controller transfer times of 15 microseconds per character plus Generator character acceptance time.

<sup>3</sup>Processing times may vary according to active functions. Longest times are for an attenuator change when the FM function is on.

<sup>4</sup>This time applies for characters that do not terminate a program code. The acceptance times for characters that terminate program codes are dependent on the program code execution time.

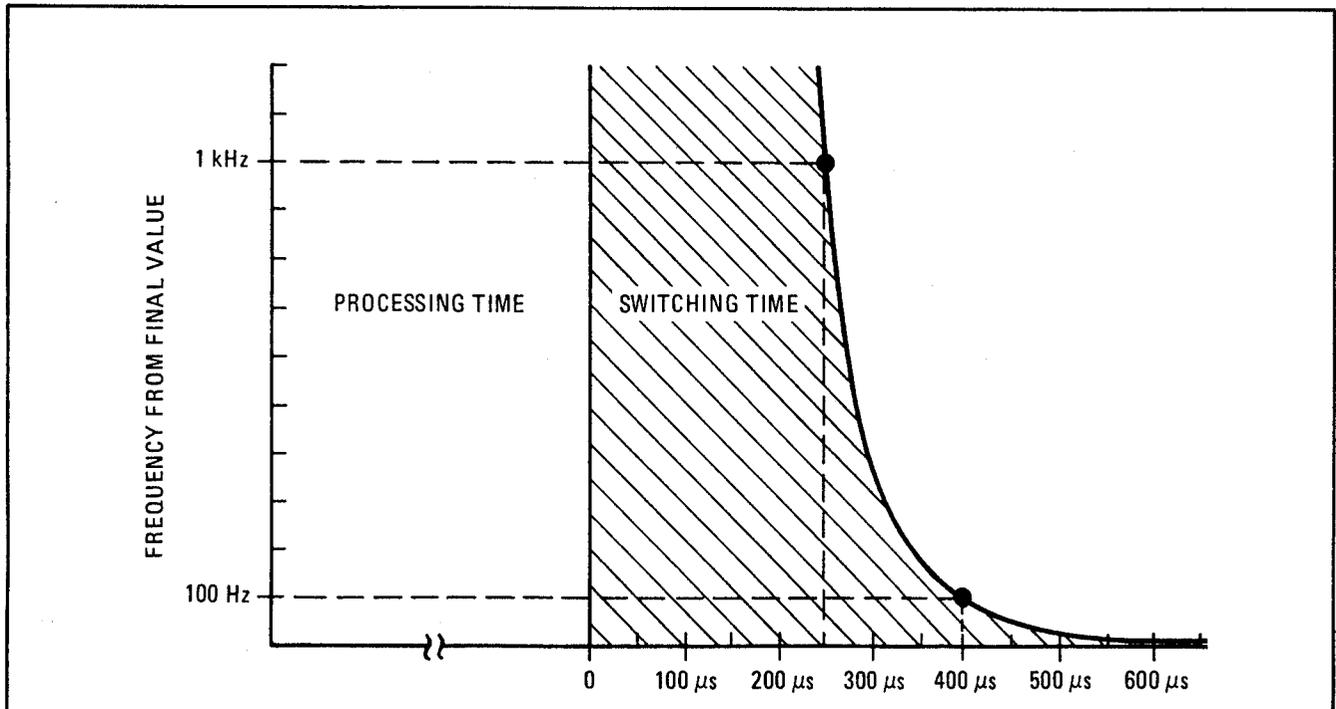


Figure 3-11. Typical Frequency Switching Time Showing Worst Case Lock and Settling Times

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**OPERATOR'S CHECKS**

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**3-25. Memory Checks****NOTE**

*These checks are essentially the same as the Turn-On Memory Check. Therefore, they do not have to be repeated at each turn-on. They should only be performed if a fault is suspected.*

**DESCRIPTION:** Special Function 83 checks ROM (that is, permanent memory).

Special Function 84 checks RAM (that is, temporary memory).

These checks differ from the Turn-On Memory Check only in their display (during the check) and in their response to a fault. They check for faulty ROM or RAM, or for altered data in RAM. These are only quick checks which are not as comprehensive as the diagnostics described in Section VIII (Service).

**PROCEDURE:** Press the Blue Key, SPECIAL and 83 (for the ROM check) or 84 (for RAM).

**INDICATIONS:** During the check, and until a fault is detected, the FREQUENCY readout displays 00. Two things occur to indicate a fault, if one is detected.

- Two-digit numeric codes will replace the 00 (these codes are additional diagnostic aids and are described only in Section VIII (Service)).
- The STATUS key light will turn on blinking (malfunction code 99 will be set into the status readout).

At the end of the test, the readout will revert to its original display.

**OPERATOR'S RESPONSE TO A FAULT:** If a fault is detected in a ROM check, the Generator might be useable but it does require servicing.

If a fault is detected in a RAM check, it could be caused by even a single bit of data being lost due to line transients, noise, or other unpredictable conditions. The Generator might be useable and need not be serviced unless the fault occurs repeatedly.

## Operation



## Sending Data Messages (Cont'd)

**“Fast” Learn Mode.** The “Fast” learn mode stores only frequency and modulation data. When this data is recalled, the Generator can switch very rapidly between frequency or modulation settings (switching speeds as fast as 260  $\mu$ s are possible).

After receiving an L2 program code (“Fast” Learn Mode) and when addressed to talk, the Generator sends a string of eleven 8-bit bytes onto the HP-IB. This binary data can then be stored in the controller’s memory.

## NOTE

*The 11th byte is sent with the bus EOI line true, thus terminating the message.*

At the end of a program that stores one or more strings, there should be a program step that stores a “dummy” byte. The dummy byte can be any eight bits except 01000000 or 11000000 (ASCII @ or `). It should be stored in the location that would otherwise start the next eleven byte string. When recalled at the end of the data strings, this “dummy” byte signals to the Generator that the recall program has ended.

When the Generator is addressed to listen and the first eleven byte data string is sent from controller memory, the Generator interprets the first two bytes to determine that the string is for the fast switching mode. The Generator will react in the following way.

1. The existing full front panel setup will be stored in register 1.
2. The amplitude setting will remain as it was but the internal amplitude error correction will be disabled.
3. Sweep mode will be turned off.
4. The FREQUENCY and MODULATION readout panels will be disabled except to display all dashes.
5. All keys are locked-out including the “hidden” parameter-display keys, the STATUS key and the Blue Key.
6. The Require Service function is disabled.

When the Generator receives the “dummy” byte (instead of another eleven-byte string) it will exit the fast-switching mode and recall the front panel setup stored in register 1.

## 3-41. Receiving the Trigger Message

The Generator responds to a Trigger message only if a response has been pre-programmed (see Configure Trigger). Otherwise, it ignores a Trigger message. It responds equally to a Trigger message (with

bus command GET) and a Data message with program code TR (Trigger).

**Configure Trigger.** The Generator’s response to a Trigger message is set when it receives a Data message containing the program code CT followed by one other valid program code. For example, CTW4 causes a single sweep (W4) when the Trigger message is received.

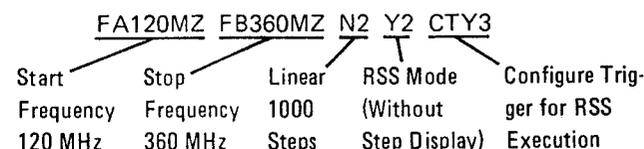
**Remote Stepped Sweep (RSS).** The Trigger message provides an additional sweep mode; that is, Remote Stepped Sweep. In this mode, each step is executed by a Trigger message. Thus the sweep is controlled by the system controller and can be synchronized with other system activities.

The RSS mode must be enabled. Sending the program code Y2 (a Data message) enables RSS with a display of sweep limits only. With Y2, the Generator can sweep as fast as 700  $\mu$ s per step. Sending program code Y1 enables RSS with a display of each sweep step. With Y1, the minimum time per step is about 1.5 ms slower.

Sending the program code Y0 disables the RSS mode.

After enabling the RSS mode, it is necessary to configure the Trigger response. This is done by sending the program codes CT Y3 (Configure Trigger for RSS step execution). Thereafter, the first Trigger switches the Generator to its start frequency; each subsequent Trigger executes one step.

The following is an example of a program code string for establishing an RSS mode.



## 3-42. Receiving the Clear Message

The Generator responds to a Clear message by setting all parameters as shown in Table 3-7. The Generator responds equally to Selected Device Clear and Device Clear bus commands (SDC and DCL).

## 3-43. Receiving the Remote Message

The Remote message causes the Generator to switch to remote mode. It has two parts: 1) remote enable and 2) address-to-listen. The Generator’s output does not change with the local-to-remote transition.

The REMOTE light turns on only when the Generator is in remote mode and after receiving its first Data Message. The ADDRESSED light turns on when the Generator is addressed to talk or listen.

**Table 3-7. Response to Clear Message**

Parameter	Condition
Execution Mode	Deferred
RQS Mask	Unchanged
Status Byte	Cleared
Require Service (SRQ)	Cleared
Trigger Configuration	Cleared
Remote Stepped Sweep	Off
Frequency	100 MHz
Amplitude	-30 dBm
Modulation Mode	Off
Function Mode	Frequency
Markers 1-5	0 MHz
Frequency Increment	1 MHz
Amplitude Increment	0.1 dB
AM Increment	0.1%
FM Increment	0.1 kHz
AM	30%
FM	10 kHz
Modulation Source	Ext ac
Start Frequency	1 MHz
Stop Frequency	1279 MHz
Frequency Span	10 MHz
Time/Step	1 ms
Set Size	2 MHz
Step Size	100 steps
Sweep Mode	Off
Registers	unchanged
Sequence	1, 2, 3, 4
Frequency Resolution	1 MHz
Modulation Resolution	10 kHz, 10%
Amplitude Resolution	1 dB
Special Functions	None (00)

**3-44. Receiving the Local Message**

The Generator returns to front panel control when it receives the Local message. Its output does not change with the remote-to-local transition.

When the Generator goes to local mode, the front panel REMOTE indicator turns off. However, the ADDRESSED indicator would still illuminate if the Generator were addressed.

The local message is the means by which the controller sends the Go to Local (GTL) bus command.

The front panel Blue Key can also return the Generator to local mode. However, pressing the Blue Key might interrupt a Data message to the Generator. This would leave the Generator in a state unknown to the controller. This situation would be undesirable and could be avoided by sending the Local Lockout message which disables the Blue Key.

**3-45. Receiving the Local Lockout Message**

After receiving the Local Lockout message, the Generator's Blue Key return-to-local function is disabled. With Local Lockout in effect, the Generator can be returned to local only by the controller. The Local Lockout message is the means by which the controller sends the Local Lockout (LLO) bus command.

**3-46. Receiving the Clear Lockout/Set Local Message**

The Generator responds to the Clear Lockout/Set Local message in the same way as to the Local message (that is, it returns to front panel control). The Generator need not be addressed to listen. This message is the means by which the controller sets the Remote Enable (REN) bus line false.

**3-47. Receiving the Pass Control Message**

The Generator does not respond to the Pass Control message because it cannot act as a controller.

**3-48. Sending the Require Service Message**

The Generator sends a Require Service message if one of the following conditions exist and if it has been preprogrammed to send the message by the Request Service (RQS) Mask.

- Ready: when the Generator is finished processing a Data message.
- Entry Error: when an invalid keystroke or program command occurs (that is, when the front panel STATUS light turns on steady).
- Hardware Error: when a hardware condition turns the STATUS light on blinking or the EXTERNAL SOURCE HI-LO lights turn on.
- Power Fail Restart: when the Generator is returned to a power ON condition (from STANDBY or completely off).
- Parameter Out: when any parameter of the output signal changes.
- Sweep End: when the last step of a sweep occurs.
- Operator Request Response: when Special Function 87 is executed.

The Generator can send a Require Service message in either the local or remote mode. However, in the local mode, it can only respond to two of the conditions: 1) Power Fail Restart and 2) Operator Requests Response.

The Generator sends a Require Service message by setting the Service Request (SRQ) bus line true. The Require Service message is cleared after a serial poll has been executed by the controller.



### Sending the Require Service Message (Cont'd)

**Request Service (RQS) Mask.** The RQS Mask functions within the Status Byte. It determines which bits can set the RQS bit true (see Figure 3-12). Consequently, the mask determines which conditions will cause the Require Service message to be sent.

The RQS Mask is set with the @1 program code followed by an 8-bit byte (a Data message). Each bit, if true, enables a corresponding condition to set the RQS bit true. This message is executed immediately and does not require an End-of-String message.

At turn-on, the RQS Mask is set to default condition 01001110 (decimal 78). This default mask enables three conditions to set the RQS bit true. They are: entry errors, hardware errors, and power fail restart.

**Sending the RQS Mask Value (a Data Message).** After receiving an RM program code (Read Mask) and when addressed to talk, the Generator will send a single binary word (8 bits) that describes the present state of the mask. The bit pattern can be interpreted with the information in Figure 3-12.

#### NOTE

*This byte is sent with the bus EOI line true, thus terminating the message.*

### 3-49. Sending the Status Byte Message

After receiving a Serial Poll Enable bus command (SPE) and when addressed to talk, the Generator sends a Status Byte message. The message consists of one 8-bit byte of which 7 bits correspond to the pattern and descriptions for the RQS Mask. The remaining bit is the RQS Request Service bit (see Figure 3-12).

The RQS bit is set when one of the other seven conditions exists and that condition has been enabled by the RQS Mask. Bits 1–6 and 8 might be true regardless of conditioning by the RQS Mask. However, if a condition has not been selected by the mask, it cannot cause the RQS bit to be set or the Require Service message to be sent.

### 3-50. Clearing the Status Byte

The eight bits in the Status Byte are cleared under several sets of conditions.

Bit 1, the “Ready” bit, is cleared whenever the Generator is processing a Data message.

Bits 2 and 3, Entry and Hardware Errors, are cleared only after three conditions occur in the following order:

- a. The condition is corrected.
- b. The STATUS key message is re-read.
- c. The Status Byte is re-read (at this reading, the Status Byte would still show the error because it is cleared only after the reading).

Bits 4, 5, 6, and 8 are set on transient conditions. Thus, to clear them, only the Status Byte need be read.

Bit 7, the RQS bit, is cleared after all other bits are cleared and the Status Byte is re-read.

#### NOTE

*One additional situation can clear bit 7. If the RQS Mask is changed, for instance to all zeros, and one of the seven conditions occurs, bit 7 would go to the clear condition.*

Figure 3-13 depicts the sequence of events necessary to read and clear the Status Byte. It is assumed that at the start (that is, at “Enter”), the Status Byte has *not* previously been read. Otherwise, bits 4, 5, 6, and 8 would already be cleared and their purpose defeated.

### 3-51. Sending the Status Bit Message

The Generator does not respond to a Parallel Poll Enable bus command (PPE) and thus cannot send a Status Bit Message.

### 3-52. Receiving the Abort Message

The Generator stops talking or listening when it receives the Abort message. The Abort message is the means by which the controller sets the interface Clear (IFC) bus line true.

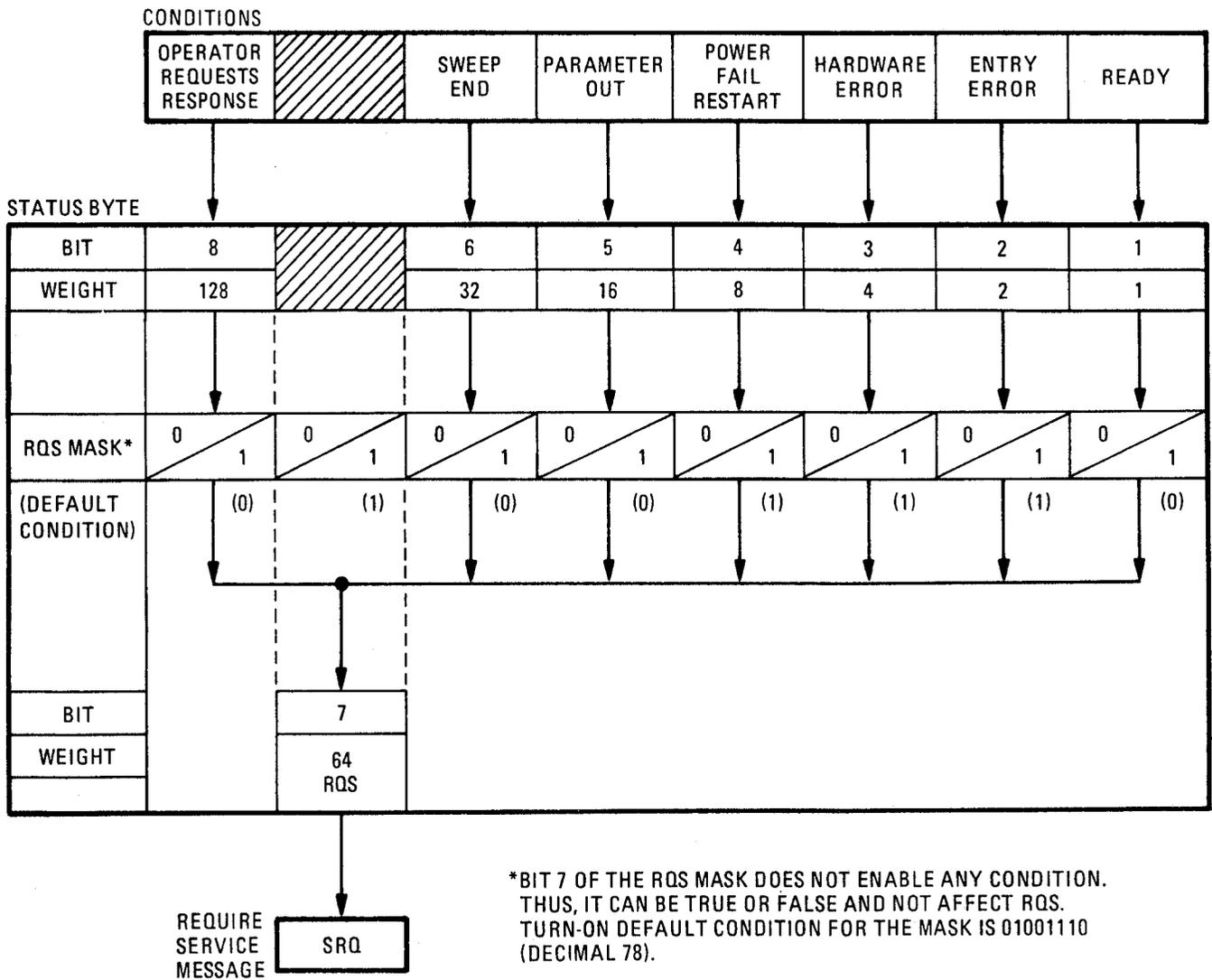


Figure 3-12. The Status Byte and RQS Mask

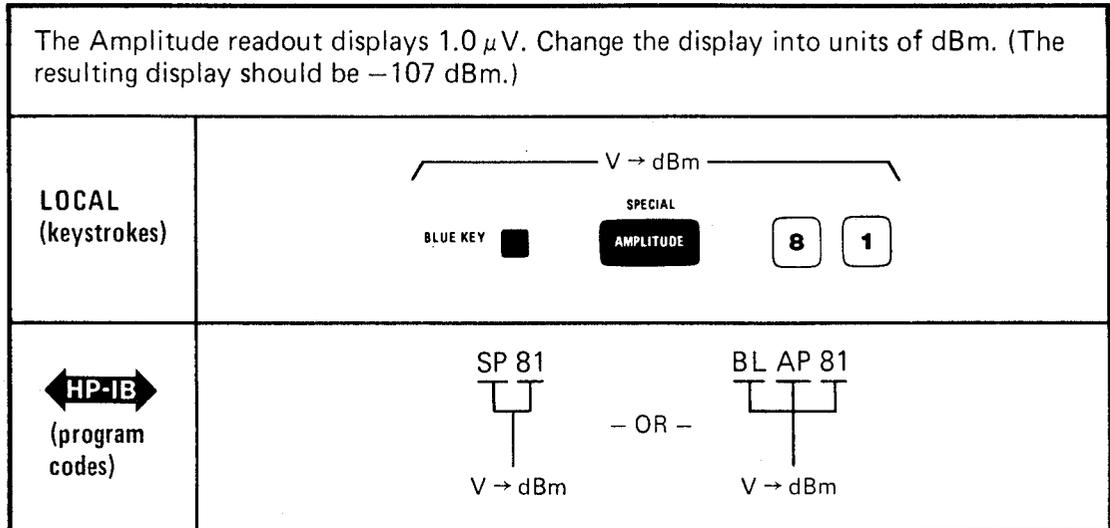
## Amplitude Conversion (V → dBm)

**Description** This instruction describes how to change the display of RF amplitude from voltage units to power units in dBm. This feature does not effect the actual output level.

**Procedure** Press the Blue Key, SPECIAL and 81.

### Example

The Amplitude readout displays 1.0 μV. Change the display into units of dBm. (The resulting display should be -107 dBm.)



### Keys and Program Codes



All of the keys and codes for this feature are shown in the example. Note: SPECIAL can be programmed with a simple SP or with BL and AP (Blue Key and AMPLITUDE).

### Indications

After the Amplitude readout changes to a value of dBm, there is no other indication that the conversion was made.

### Comments

There is no built-in conversion feature for dBm-to-volts. However, the following formula can be used to determine a voltage equivalent for the power:

$$V = \sqrt{.05} \cdot 10^{P/20}$$

where V is level in volts and P is level in dBm.

### Related Instructions

Amplitude  
Amplitude Correction  
Amplitude Reference

Model 8662A

Operation



### 3-53. Reading Control Settings

The controller can be programmed to interpret the learn mode strings to determine the Generator's actual control settings. The "Fast" Learn (L2, 11-byte) string contains data for frequency and modulation settings. The full "Front Panel" (L1, 128-byte) string contains similar data but also for amplitude.

First the controller should read and store the data from the appropriate string (see page 3-37 for these instructions). Then the following procedures should be programmed to interpret the data.

#### "Fast" Learn String (L2, 11-Bytes).

**Frequency.** To determine the frequency setting, the following procedure should be programmed.

1. Interpret bytes 3 through 8 according to the following table.

Byte	Contents (MSB ↔ LSB)	Byte Interpretation
3	$F_1, F_0$	Packed BCD (i.e., two BCD digits per byte)
4	$F_3, F_2$	
5	$F_5, F_4$	
6	$F_7, F_6$	
7	$F_9, F_8$	
8	Range Factor	Decimal Equivalent

2. Convert the Range Factor (byte 8) to variables R1 and R2 with the following table.

Range Factor	R1	R2
0	1	0
1	0.5	0
3	0.25	0
4	1	0
6	0.5	0
9	1	520
17	2	0
21	2	0
41	1	520
73	1	520
105	1	520

3. Compute frequency (in Hz with the following formula:

$$F = (F_9 F_8 F_7 F_6 F_5 F_4 F_3 F_2 F_1 \cdot F_0 \times R1) - R2$$

**Modulation.** Bytes 8 through 11 can be interpreted to determine the following modulation settings:

- Mode (AM, FM or Mixed)
- Source (Internal or External)
- Rate (Internal Source only)
- % AM or FM Deviation (if internally controlled)

1. Interpret bytes 8 through 11 according to the following table:

Byte	Contents (MSB ↔ LSB)	Byte Interpretation
8	Range Factor	Decimal Equivalent
9	$M_7 \leftrightarrow M_0$	Binary
10	$M_{15} \leftrightarrow M_8$	
11	Source Code	Decimal Equivalent

2. Interpret the Source Code (byte 11) using the following table:

Source Code	Modulation Modes	
	Internal (Rate)	External (Coupling)
18	FM (1 kHz)	—
20	AM (1 kHz)	—
26	FM (1 kHz)	AM (ac)
34	FM (400 Hz)	—
36	AM (400 Hz)	—
42	FM (400 Hz)	AM (ac)
48	—	—
50	—	FM (ac)
52	—	AM (ac)
90	FM (1 kHz)	AM (dc)
106	FM (400 Hz)	AM (dc)
114	—	FM (dc)
116	—	AM (dc)
128 and above	—	FM (AUX-dc)

\*AUX FM might be used with other modes. Thus to interpret a Source Code above 128, first subtract 128, then interpret the second code.

## Operation



## "Fast" Learn String (L2, 11-Bytes) (Cont'd)

3. Determine the value of variable M as the decimal equivalent of bits  $M_{10}$  through  $M_0$ .

4. Convert the Range Factor (byte 8) to variable R1 with the following table.

Range Factor	R1
0	1
1	0.5
3	0.25
4	1
6	0.5
9	1
17	2
21	2
41	1
73	1
105	1

5. Determine the settings for % AM or FM deviation with the following equations:

$$\% \text{ AM} = M \times 0.1\%$$

$$\text{FM Deviation} = M \times R1 \times 0.1 \text{ kHz}$$

## NOTE

The Generator can control either % AM or FM deviation but not both simultaneously. Whenever a mixed mode exists (that is, when Source Code is 26, 42, 90, 106, or 128), the Generator controls only the internally produced signal.

## Full "Front Panel" String (L1, 128 Bytes).

**Frequency.** To determine the frequency setting the following procedure should be programmed.

1. Interpret bytes 6 through 11 according to the following table.

Byte	Contents (MSB ↔ LSB)	Byte Interpretation
6	$F_1, F_0$	Packed BCD (i.e., Two BCD Digits Per Byte)
7	$F_3, F_2$	
8	$F_5, F_4$	
9	$F_7, F_6$	
10	$F_9, F_8$	
11	$F_{11}, F_{10}$	

2. Determine the value of F, in Hz, with the following formula.

$$F = F_{10} F_9 F_8 F_7 F_6 F_5 F_4 F_3 F_2 F_1 \cdot F_0 \text{ Hz}$$

3. If  $F > 640\,000\,000.0$  Hz, there could be a tenth-Hertz error due to the Generator's 0.2 Hz resolution in that range. In this case, F should be computed again but with the LSB of  $F_0$  truncated.

**Amplitude.** To determine amplitude setting, the following procedure should be programmed.

1. Interpret byte 103 as simple binary.
2. If the most significant bit (MSB) equals 1, amplitude is set in voltage units; continue with step 3. If the MSB is 0, amplitude is set in dBm; continue with step 5.
3. For voltage, interpret bytes 108 through 112 according to the following table.

Byte	Contents (MSB ↔ LSB)	Byte Interpretation
108	$V_1, V_0$	Packed BCD (i.e., Two BCD Digits Per Byte)
109	$V_3, V_2$	
110	$V_5, V_4$	
111	$V_7, V_6$	
112	$V_9, V_8$	

4. Compute amplitude, in volts, with the following formula.

$$V = . V_9 V_8 V_7 V_6 V_5 V_4 V_3 V_2 V_1 V_0$$

where only the three most significant digits (excluding leading zeros) are meaningful.



Full "Front Panel" String (L1, 128 Bytes) (Cont'd)

- For dBm, interpret bytes 33, 34, and 35 according to the following table.

Byte	Contents (MSB ↔ LSB)	Byte Interpretation
33	D <sub>1</sub> , D <sub>0</sub>	Packed BCD (i.e., Two BCD Digits Per Byte)
34	D <sub>3</sub> , D <sub>2</sub>	
35	D <sub>5</sub> , D <sub>4</sub>	

- Compute amplitude, in dBm, with the following formula.

$$D = D_5 \cdot D_4 \cdot D_3 \cdot D_2 \cdot D_1$$

where D<sub>5</sub> is the sign: plus (+) if D<sub>5</sub> = 0; minus (-) if D<sub>5</sub> = 8.

**Modulation.** To determine the modulation setting, the following procedure should be programmed.

- Interpret byte 18 (modulation mode) as simple binary. The bit pattern is shown in the following table.

Byte 18

Bit	Interpretation
0	Not Applicable
1	
2	
3	AM control
4	FM control
5	Not Applicable
6	
7	

- If bit 3 (AM) is true, continue with step 3. If bit 4 (FM) is true, continue with step 6. If neither is true, the internal modulation circuitry is off.
- Interpret byte 25 (AM mode) as simple binary. The bit pattern is shown in the following table. If a bit equals 1 the described function is set.

Byte 25

Bit	Interpretation	
0	Not Applicable	
1		
2		
3	INT AM + EXT FM	
4	INT 1k	EXT if both bits 4 and 5 = 1
5	INT 400	
6	DC Coupled (1), AC (0)	
7	Not Applicable	

- Interpret bytes 19 and 20 to determine the internal AM% setting.

Byte	Contents (MSB ↔ LSB)	Byte Interpretation
19	A <sub>1</sub> , A <sub>0</sub>	Packed BCD (i.e., Two BCD Digits Per Byte)
20	A <sub>3</sub> , A <sub>2</sub>	

- Compute AM depth (in %) with the following formula.

$$AM = A_3 \cdot A_2 \cdot A_1 \%$$

where digit A<sub>1</sub> is meaningless for depths ≥ 10%.

- Interpret byte 32 (FM Mode) as simple binary. The bit pattern is shown in the following table. If a bit equals 1, its described function is set.

Byte 32

Bit	Interpretation	
0	Not applicable	
1		
2		
3		
4	INT 1k	EXT if both bits 4 and 5 = 1
5	INT 400	
6	EXT DC (1), EXT AC (0)	
7	Not applicable	

- Interpret bytes 26, 27, and 28 to determine the internal FM peak deviation setting.

Operation



Full "Front Panel" String (L1, 128 Bytes) (Cont'd)

Byte	Contents (MSB ↔ LSB)	Byte Interpretation
26	$D_1, D_0$	Packed BCD (i.e., Two BCD Digits Per Byte)
27	$D_3, D_2$	
28	$D_5, D_4$	

8. Compute FM peak deviation (in kHz) with the following formula.

$$FM = D_4 D_3 D_2 . D_1 \text{ kHz}$$

where digit  $D_1$  is meaningless for deviations  $\geq 10$  kHz.



Table 3-8. HP-IB Program Codes (Alphabetical Order)\*

Program Code	Parameter	Program Code	Parameter
AM	AM Depth	RM	Read Require Service Mask
AO	Amplitude Off	RU	Knob, CW (Up)**
AP	Amplitude	R1	Resolution x10 (On)
AS	Auto Sequence	R2	Resolution ÷10 (On)
BL	Blue Key	R3	Knob Off
BLAP	Special Function	R4	Knob, Hold
BLR1	Knob, Hold	R5	Knob, Increment
BLR2	Knob, Increment	SP	Special Function
BLSQ	Auto Sequence	SQ	Sequence
BLST	Set Sequence	SS	Set Sequence
BLX6	All Markers Off	ST	Store
BS	Back Space	TR	Trigger
CT	Configure Trigger	T1	0.5 ms/step (Sweep)
DB	dB	T2	1 ms/step (Sweep)
DM	dBm (with Sign on Data)	T3	2 ms/step (Sweep)
DN	Down (↓)	T4	10 ms/step (Sweep)
FA	Start Frequency	T5	100 ms/step (Sweep)
FB	Stop Frequency	UP	Up (↑)
FM	FM Deviation	UV	μV
FR	Frequency or Center Frequency	W1	Sweep Off
FS	Frequency Span	W2	Auto Sweep
GZ	GHz	W3	Manual Sweep
HZ	Hz	W4	Single Sweep
IS	Increment Set	X1	Marker 1
KZ	kHz	X2	Marker 2
L1	Learn Front Panel	X3	Marker 3
L2	"Fast" Learn	X4	Marker 4
MS	Read Status Key Message	X5	Marker 5
MV	mV	X6	Selected Marker Off
MZ	MHz	X7	All Markers Off
M0	Modulation Off	Y0	Remote Stepped Sweep (RSS) Clear
M1	Internal 400 Hz (Mod)	Y1	RSS with Display
M2	Internal 1 kHz (Mod)	Y2	RSS without Display
M3	External AC (Mod)	Y3	RSS Execute
M4	External DC (Mod)	@1	Write Require Service Mask
N1	100 Steps (Lin Sweep)	@2	Deferred Execution Mode
N2	1000 Steps (Lin Sweep)	@3	Immediate Execution Mode
N3	Set Step Size (Lin Sweep)	0-9	Numerals 0-9
N4	Log 10% Steps (Sweep)	.	Decimal Point
N5	Log 1% Steps (Sweep)	+D	+ dBm
PC	Percent	-D	-dBm
RC	Recall		
RD	Knob, CCW (Down)**		

\*Program Codes can be either upper or lower case.

\*\*RD and RU are sent ten times to program one step of the knob (except in Manual Sweep mode where one program code produces one step).



Table 3-9. HP-IB Program Codes (Functional Order)\*

Parameter	Program Code	Parameter	Program Code
FREQUENCY		SWEEP (Cont'd)	
Frequency	FR	Log 1%	N5
AMPLITUDE		0.5 ms/Step	T1
Amplitude	AP	1 ms/Step	T2
Amplitude Off	AO	2 ms/Step	T3
MODULATION		10 ms/Step	T4
AM Depth	AM	100 ms/Step	T5
FM Deviation	FM	Marker 1	X1
Modulation Off	MO	Marker 2	X2
Internal 400 Hz	M1	Marker 3	X3
Internal 1 kHz	M2	Marker 4	X4
External AC	M3	Marker 5	X5
External DC	M4	Selected Marker Off	X6
DATA		All Markers Off	X7 (or BLX6)
Numerals 0-9	0-9	Remote Stepped Sweep (RSS) Clear	Y0
Decimal point	.	RSS with Display	Y1
Back Space	BS	RSS without Display	Y2
UNITS		RSS Execute	Y3
dB	DB	OTHER	
dBm (with Sign on Data)	DM	Blue Key	BL
+dBm	+D	Up (↑)	UP
-dBm	-D	Down (↓)	DN
mV	MV	Increment Set	IS
μV	UV	Knob CW (Up)**	RU
%	PC	Knob CCW (Down)**	RD
Hz	HZ	Resolution X10 (On)	R1
kHz	KZ	Resolution ÷10 (On)	R2
MHz	MZ	Knob, Off	R3
GHz	GZ	Knob, Hold	R4 (or BLR1)
SWEEP		Knob, Increment	R5 (or BLR2)
Sweep Off	W1	Sequence	SQ
Auto Sweep	W2	Auto Sequence	AS (or BLSQ)
Manual Sweep	W3	Set Sequence	SS (or BLST)
Single Sweep	W4	Store	ST
Start Frequency	FA	Recall	RC
Stop Frequency	FB	Configure Trigger	CT
Center Frequency	FR	Trigger	TR
Frequency Span	FS	Write Require Service Mask	@1
100 Steps (Linear)	N1	Read Require Service Mask	RM
1000 Steps (Linear)	N2	Read Status Key Message	MS
Set Step Size (Linear)	N3	Learn Front Panel	L1
Log 10%	N4	"Fast" Learn	L2
		Deferred Execution Mode	@2
		Immediate Execution Mode	@3
		Special Functions	SP (or BLAP)

\*Program codes can be either upper or lower case.

\*\*To program one step of the knob, the program code, RU or RD, must be sent ten times. The exception to this is the manual sweep mode where one program code produces one step.



Table 3-10. Special Function Codes

Special Function	Code*	Special Function	Code*
System Clear - Reset Front Panel	00	Parameter Shift Keying Toggle	
Frequency Offset Off	10	(one-key format)	62
+ Frequency Offset	11	Special Functions 10-62 Off	80
- Frequency Offset	12	Amplitude Conversion (V → dBm)	81
Amplitude Reference Off	30	HP-IB Address Display	82
Amplitude Reference	31	ROM Test	83
External AM Off	40	RAM Test	84
Int FM + Ext AM (ac)	41	Amplitude Correction Off	85
Int FM + Ext AM (dc)	42	Amplitude Correction On	86
AUX FM Off	50	HP-IB Operator Requests Response	87
AUX FM On	51	Auto Sequence	88
Parameter Shift Keying Off	60		
Parameter Shift Keying Up/Down (two-key format)	61		

\*Used with the Special Function program code SP (or BL AP).

## HP-IB SYNTAX AND CHARACTERISTICS

**Program Code Protocol:** Same as keyboard protocol.

**Data:** Arbitrary length numerical string with imbedded decimal point.

**End-of-String Message (EOS):** Line Feed (LF), Exclamation Mark (!) or bus END message (EOI and ATN true). Required in Deferred Execution mode. Not required in Immediate mode.

**Deferred Execution Mode:** Accepts program code strings in blocks of 82 characters. 82nd character produces internal EOS message.

**Immediate Execution Mode:** Accepts one program code character at a time. Produces internal EOS message for each character.

**Address:** Shown on internal switches as five-bit equivalent decimal (00-30). New setting not recognized until new power-up. Special Function 82 displays address.

**Return-to-Local:** Blue Key.

## STATUS BYTE AND RQS MASK

Bit	8	7	6	5	4	3	2	1
Condition	Operator Requests Service	RQS Service Request	Sweep End	Parameter Out	Power Fail Restart	Hardware Error	Entry Error	Ready
Weight	128	64	32	16	8	4	2	1

Notes: 1. Bit 7 of the RQS mask does not enable any condition. Thus, it can be true or false and not affect the Require Service conditioning.

**COMPLETE HP-IB CAPABILITY** (as described in IEEE Std-488 and the identical ANSI Standard MC1.1): SH1, AH1, T6, TE0, L3, LEO, SR1, RL1, PP0, DC1, DT1, C0.

# Amplitude

**Description** This instruction describes how to set RF signal amplitude.

**Operating Characteristics:**

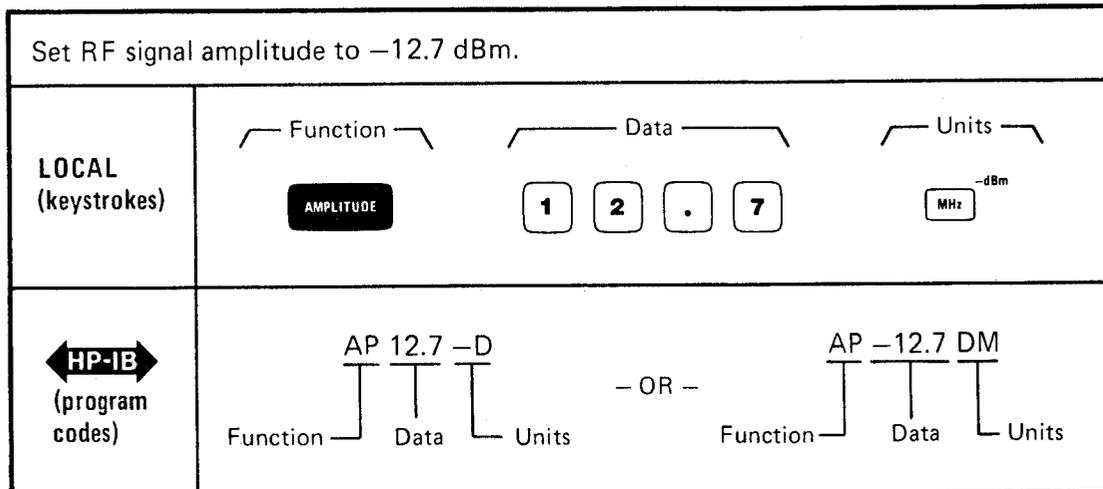
Range: +13 to -139.9 dBm (999 mV to .023  $\mu$ V)

Resolution: 0.1 dB.

**Procedure** Select AMPLITUDE, data, and units.

To turn amplitude off (that is, -139.9 dBm) press AMPTD OFF.

**Example**



**Keys and Program Codes**



Keys	Codes
AMPLITUDE	AP
AMPTD OFF	AO
+ dBm	+D
-dBm	-D
dBm (with sign on data)	DM
mV	MV
$\mu$ V	UV

**Indications**

The selected amplitude (with sign and units) should be displayed on the readout panel. The one's digit is always displayed. Otherwise, leading zeros are blanked. When four significant digits are selected between -100.0 and -139.9 dBm, the tenth's digit will not appear until after the -dBm key is pressed.

**Comments**

Digits selected that are beyond the specified resolution are ignored.

The Signal Generator uses microprocessor correction to achieve  $\pm 1$  dB absolute output level accuracy between +13 and -120 dBm. Correction is not available in the sweep mode. Correction can be defeated with Special Function 85 and restored with Special Function 86.

Overrange extends to +16 dBm (without level correction). However, this overrange cannot be selected in voltage units (that is, 999 mV, the equivalent of +13 dBm, is maximum).



Data can be entered with leading sign under HP-IB control only (for example, +13 DM). Otherwise, the sign is incorporated in the units (that is, +D or -D).

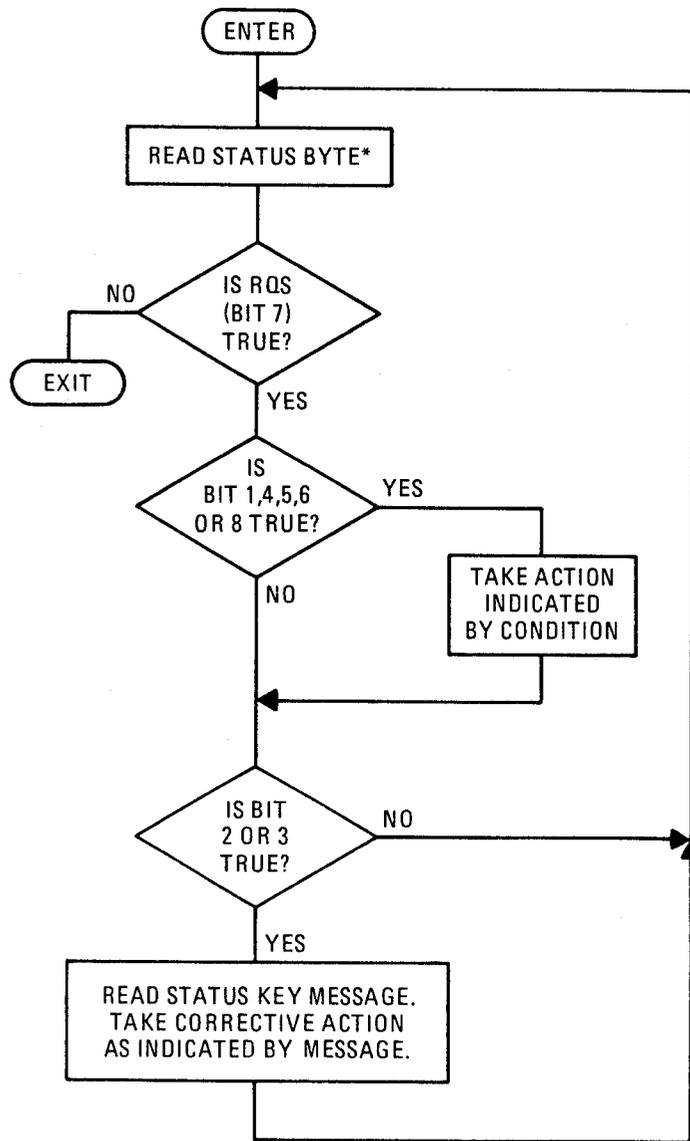
## Amplitude (Cont'd)

**Comments  
(Cont'd)**

Voltages can be selected with resolutions of  $.001 \mu\text{V}$  to  $1 \text{ mV}$  depending upon the level selected. However, the Generator actually changes in units of dB only with a minimum resolution of  $0.1 \text{ dB}$ .

**Related  
Instructions**

Amplitude Conversion (V $\rightarrow$ dBm)  
Amplitude Correction  
Amplitude Reference



\*THE BITS DESCRIBED IN THIS FLOW CHART ARE NUMBERED 1-8 (NOT 0-7).

Figure 3-13. Serial Poll Flow Chart (Reading and Clearing Status Byte)

# Amplitude Correction

**Description**

This feature corrects for internal amplitude variations throughout the Generator's frequency range. In this way, the Generator attains its optimum level accuracy. The correction feature is automatically enabled at turn-on. It can be disabled by Special Function 85 and re-enabled by Special Function 86.

Amplitude Correction feature is not available above +13 or below -120 dBm. However, if the feature is enabled, it can affect amplitudes outside the range of +13 to -120 dBm.

Absolute Level Accuracy (+15° to +45°C):

- ±1 dB between +13 and -120 dBm
- ±3 dB between -120 and -130 dBm

Typical Level Accuracy (Correction Disabled):

- +1.0, -2.5 dB between +13 and -25 dBm, .01-640 MHz
- +1.0, -3.5 dB between +13 and -25 dBm, 640-1280 MHz
- +2.0, -3.0 dB between -25 and -139.9 dBm, .01-640 MHz
- +1.2, -4.5 dB between -25 and -139.9 dBm, 640-1280 MHz

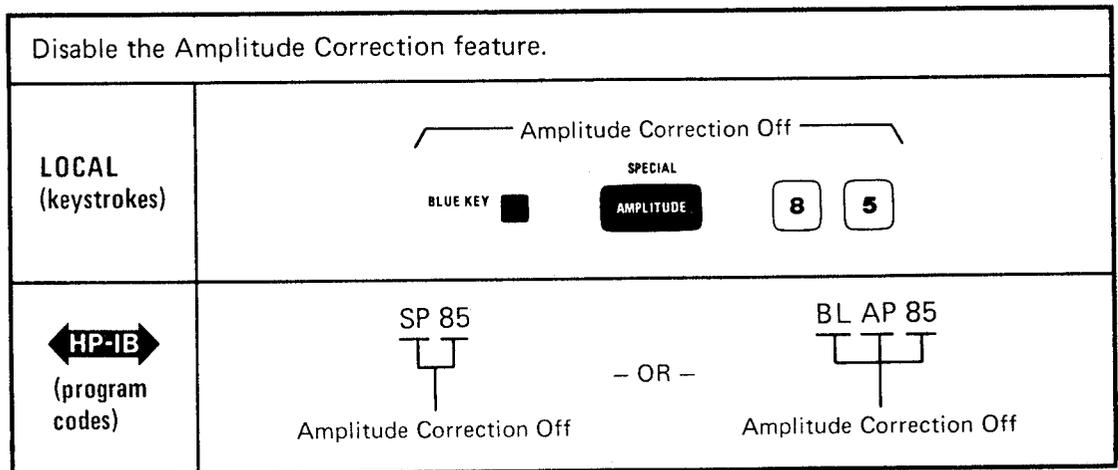
Flatness (Referenced to 100 MHz, without Correction, down to -120 dBm):

- ±1.5 dB, .01 to 640 MHz
- ±3.5 dB, .01 to 1280 MHz

**Procedure**

To disable the correction feature, press the Blue Key, SPECIAL and 85.

To re-enable the correction feature, press the Blue Key, SPECIAL and 86.



**Keys and Program Codes**



All of the keys and program codes for this feature are shown in the example. Note: SPECIAL can be programmed with a simple SP or with BL and AP (Blue Key and AMPLITUDE).

**Indications**

The displayed amplitude should remain unchanged. However, actual output amplitude might change to a less accurate value. There is no indication of this feature until you press and hold the STATUS key. Code 85 should then appear in the special functions block of the FREQUENCY readout.

Continued . . .

## Amplitude Correction (Cont'd)

**Comments**

The figures for level accuracy listed under "Description" include flatness, attenuator error, detector error and measurement uncertainty.

If maximum level accuracy is not required during long periods of automatic frequency changing, the Amplitude Correction feature should be disabled. This will eliminate unnecessary mechanical wear to the output attenuator.

**Related  
Instructions**

Amplitude  
Amplitude Conversion (V→dBm)  
Amplitude Reference

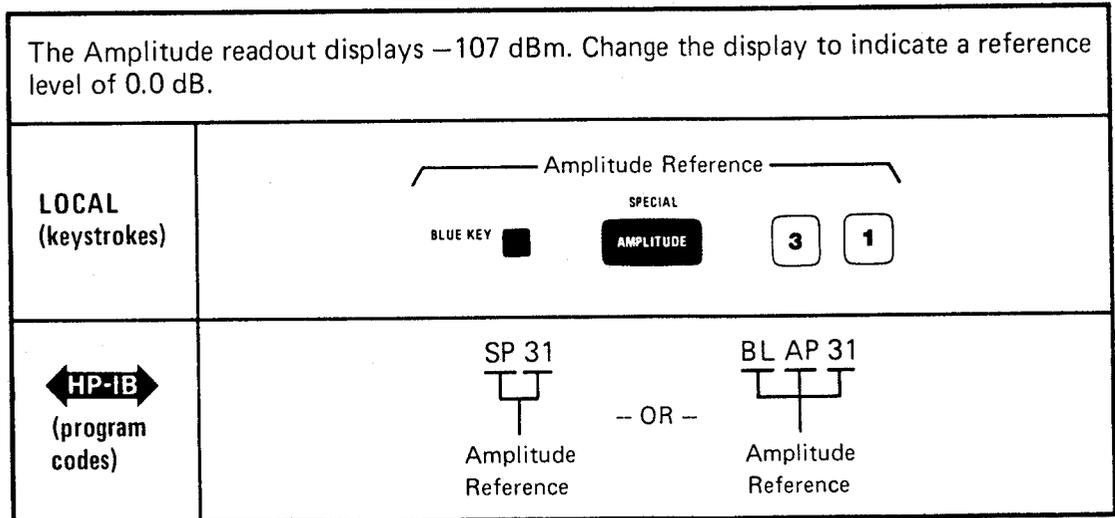
## Amplitude Reference

**Description** This feature converts the display of RF amplitude (in dBm) to a reference value of 0.0 dB. This feature by itself does not change the actual RF level. Afterwards, any change in amplitude will be displayed in units of dB relative to the selected reference.

**Procedure** To change the displayed amplitude from absolute units of dBm, to the reference 0.0 dB, press Blue Key, SPECIAL and 31.

To turn off the Amplitude Reference feature, press the Blue Key, SPECIAL and 30.

### Example



### Keys and Program Codes



All of the keys and codes used in the Amplitude Reference feature are shown in the examples. Note: the SPECIAL function can be programmed with a simple SP or with BL and AP (Blue Key and AMPLITUDE).

### Indications

The Amplitude readout should display 0.0 dB. There should be no change in actual output level at this point. Any subsequent change in output level will be displayed in units of dB relative to the selected reference.

Code 31 will appear in the special function block of the Frequency readout if you press and hold the STATUS key.

### Comments

Before the Amplitude Reference feature can be executed, the Amplitude readout must be displaying units of dBm. If the units are mV or  $\mu$ V they would have to be converted to dBm (see Amplitude Conversion, Special Function 81).

In the Amplitude Reference mode, output level can be varied with the INCREMENT keys or knob only. A completely new setting (that is, a Function-Data-Units entry) will turn off the reference feature.

### Related Instructions

Amplitude  
Amplitude Conversion (V $\rightarrow$ dBm)  
Amplitude Correction

## Frequency

**Description** This instruction describes how to set RF signal frequency and sweep center frequency.

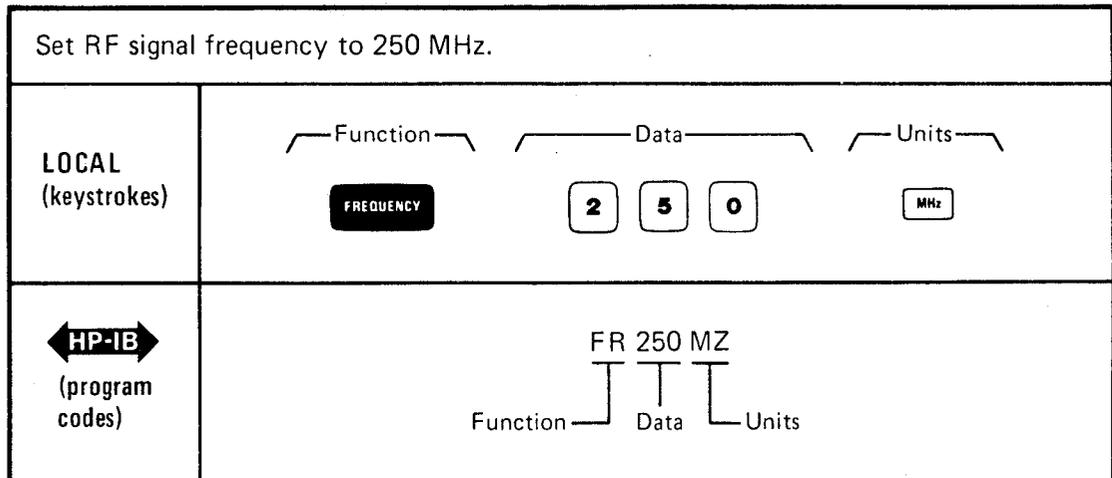
**Range:** 10 kHz to 1280 MHz (1279.999 999 8 MHz)

**Resolution:** 0.1 Hz (below 640 MHz)

0.2 Hz (above 640 MHz).

**Procedure** Select FREQUENCY, data, and units.

### Example



### Keys and Program Codes



Keys	Codes
FREQUENCY	FR
GHz	GZ
MHz	MZ
kHz	KZ
Hz	HZ

**Indications** The selected frequency and units should be displayed on the readout panel. Leading zeros are blanked. Less significant digits display zeros if not selected (except for the tenth-hertz digit which should be blanked).

**Comments** Frequencies down to 1 kHz can be selected but level accuracy is specified to 10 kHz only. Amplitude at 1 kHz is typically within 2 dB below the displayed amplitude.

Digits selected that are beyond the specified resolution are ignored.

**Related Instructions** Frequency Offset  
Frequency Transferring

Model 8662A

# Frequency Offset

- Description** This feature provides for an output frequency with a selectable offset from the displayed frequency. Both the amount and direction of the offset are selectable.
- Procedure** For a positive offset, press the Blue Key, SPECIAL, and 11. When the Frequency readout goes blank, select Data and Units for the frequency offset.
- For a negative offset, substitute 12 for 11.
- To remove the offset, press the Blue Key, SPECIAL and 10.

**Example**

Select an offset such that the output frequency is 10.7 MHz higher than the displayed frequency.

<b>LOCAL</b> (keystrokes)	
<b>HP-IB</b> (program codes)	

**Keys and Program Codes**



Keys	Codes (see note)	
	Blue Key	SP
SPECIAL	GZ	AP
GHz	MZ	
MHz	KZ	
kHz	HZ	
Hz		

**Note:** the SPECIAL function can be programmed with a simple SP or BL and AP (Blue Key and AMPLITUDE).

- Indications** The displayed frequency should remain as the last selected frequency. However, the output frequency should change by the selected offset. There is no indication of the offset until you press and hold the STATUS key. Code 11 or 12 should then appear in the special functions block of the Frequency readout.
- Comments** The offset applies to both fixed and swept output frequencies. It also applies to sweep start-stop and marker frequencies. However, it does not apply to sweep span or step size.
- Related Instructions** Frequency Sweep, Start-Stop

## Modulation, FM

### NOTE

*The Generator's output is not phase locked in FM with a dc coupled signal through the front panel MODULATION INPUT connector.*

### Description

This instruction covers selecting modulation sources, setting internal rates and deviation, and turning on the modulation circuitry.

**Internal rates:** 400 and 1000 Hz.

**FM rates (1 dB bandwidth):** external ac, 20 Hz to 100 kHz; external dc, dc to 100 kHz.

**FM deviation:**

Center Frequency (MHz)	Maximum peak deviation	
	Internal and AC mode (kHz)	DC mode (kHz)
0.01–120	the smaller of 100 or $f_{\text{mod}} \times 500$	100
120–160	25 or $f_{\text{mod}} \times 125$	25
160–320	50 or $f_{\text{mod}} \times 250$	50
320–640	100 or $f_{\text{mod}} \times 500$	100
640–1280	200 or $f_{\text{mod}} \times 1000$	200

**FM resolution:** 0.1 kHz for deviations < 10 kHz; 1 kHz for deviations > 10 kHz.

### Procedure

Select FM, Data and kHz ("kHz" is the only valid unit for selecting deviation).

Select modulation source and rate.

To turn off the modulation circuitry, press MOD OFF (does not affect the rear panel AUX FM INPUT).

To turn on the modulation circuitry to the last selected FM parameters, simply press FM.

### Example

Select FM, 25 kHz deviation and 400 Hz internal rate.	
<b>LOCAL</b> (keystrokes)	
 (program codes)	

## Increment ↓ ↑

**Description** This feature steps parameters up or down in increments which have been set previously. Any value-selectable parameter can be changed by the INCREMENT ↓ ↑ keys.

**Procedure** First set the size of the increment (see instructions for Increment Setting). Select the desired function key. Then press the step up or down key (INCREMENT ↓ ↑) to change the value by the selected increment. The value will change once for each keystroke, or about five times per second if the key is held down (local operation only).

### Keys and Program Codes



Keys	Codes
↑	UP
↓	DN
FREQUENCY	FR
AMPLITUDE	AP
AM	AM
FM	FM

Keys	Codes
START FREQ	FA
STOP FREQ	FB
SPAN FREQ	FS
SET SIZE	N3
MARKERS 1-5	X1-X5

**Indications** The displayed value will increase (↑) or decrease (↓) in the increments selected.

**Comments** The size of the increment can be displayed by pressing and holding the INCR SET key.  
The INCREMENT ↓ ↑ keys are always enabled.

Stepping can also be controlled by the rear panel AUX connector. Negative going TTL pulses are required: pin 2, INCREMENT ↑; pin 3, INCREMENT ↓.

**Related Instructions**  
Increment Setting  
Knob  
Knob, Increments  
Parameter Shift Keying

## Increment Setting

### Description

This feature sets the size of steps which are controlled by the INCREMENT ↑↓ keys or the knob in increment mode. Increments of frequency, amplitude, AM depth, and FM deviation can be set. The smallest increment for each function is listed below.

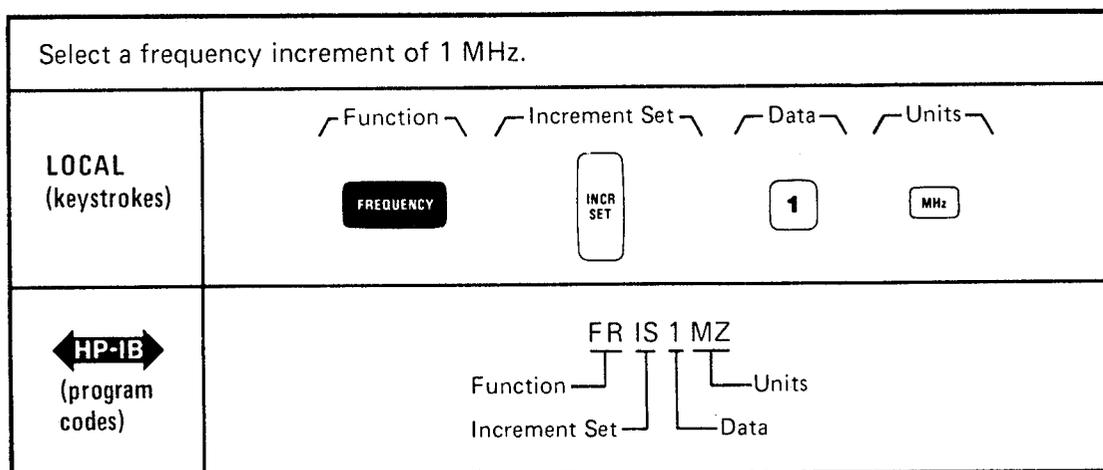
- Frequency:** 0.1 Hz (below 640 MHz)  
0.2 Hz (above 640 MHz)
- Amplitude:** 0.1 dB
- AM Depth:** 1% (10–95%)  
0.1% (0–9.9%)
- FM Deviation:** 0.1 kHz (for deviations <10 kHz)  
1 kHz (for deviations >10 kHz)

Frequency increments can be selected by FREQUENCY and any of the following sweep keys: START FREQ, STOP FREQ, SPAN FREQ, SET SIZE (STEPS), and any of the MARKER keys.

### Procedure

Select function, INCR SET, data, and units.

### Example



### Keys and Program Codes



Keys	Codes	Keys	Codes	Keys	Codes
INCR SET	IS	START FREQ	FA	GHz	GZ
FREQUENCY	FR	STOP FREQ	FB	MHz	MZ
AMPLITUDE	AP	SPAN FREQ	FS	kHz	KZ
AM	AM	SET SIZE	N3	Hz	HZ
FM	FM	MARKERS 1–5	X1–X5	%	PC
				dB	DB
				mV	MV
				μV	UV

### Indications

The value of the increment and its units annunciator should be displayed on the readout when they are entered. The readout should revert to the static value of the parameter after the units key is released. The display of an increment can be recalled to the readout by holding down the INCR SET key (local operation only).

## Increment Setting (Cont'd)

<b>Comments</b>	<p>If the amplitude was selected in units of dBm, the increment must be selected in units of dB. If the amplitude was selected in units of volts, the increment must also be selected in units of volts (either mV or <math>\mu</math>V).</p> <p>Increments of FM deviation must be selected in units of kHz only.</p> <p>Voltage increments can be set as low as .001 <math>\mu</math>V. However, the Generator changes amplitude in units of dB only (0.1 dB increments minimum).</p>
<b>Related Instructions</b>	<p>Increment <math>\downarrow\uparrow</math> Knob, Increments</p>

## Knob

**Description** The knob is a stepping control with an analog “feel”. It steps the value of the front panel function in unit steps starting at a selected digit. The digit is selected by the RESOLUTION keys X10 and  $\div 10$ .

**Procedure** Enable the knob by pressing either of the ON keys (X10 or  $\div 10$ ).  
Pressing either key again will increase (X10) or decrease ( $\div 10$ ) the step resolution by a factor of ten.

Rotate the knob clockwise to increase the value of the front panel function. Rotate the knob counterclockwise to decrease the value.

Disable the knob by pressing the OFF key or by selecting a different keyboard function.

### Example

Enable the knob with 1 kHz resolution of frequency steps (assume that the front panel function is already FREQUENCY and that the knob turns on to 100 kHz resolution).

<b>LOCAL</b> (keystrokes)	
<b>HP-IB</b> (program codes)	

### Keys and Program Codes



Keys	Codes (see note)
ON X10	R1
ON $\div 10$	R2
OFF	R3
Knob, (up)	RU
Knob, (down)	RD

Note: the knob function can be performed under HP-IB control. However, it requires a string of ten program codes (either RU or RD) to perform one step. The exception to this rule is that in Manual sweep mode, one program code produces one sweep step.

**Indications** Whenever the X10 or  $\div 10$  key is pressed, the digit representing resolution flashes on and off (local control only). When either key is pressed again, the adjacent digit, up or down, flashes to show the new resolution.

When the knob is turned clockwise, the displayed value should increase in unit steps starting at the selected digit. The inverse is true for counterclockwise rotation.

**Comments** The knob is normally turned off whenever a new keyboard function is selected. There is a HOLD feature, however, that allows you to retain knob control of one function after shifting keyboard control to another. (See instruction for Knob, Hold).

## Knob (Cont'd)

The basic knob feature allows you to select the digit where the stepping starts, and progresses in units of one on that digit. Another feature allows you to choose any size increment without regard to a starting digit. With this feature, the knob acts similarly to the INCREMENT ↓ and ↑ keys (see instructions for Knob, Increments).



The knob function can be performed under HP-IB control. However, it requires a string of ten program codes (either RU or RD) to perform one step. The exception to this rule is that in Manual sweep mode, one program code will produce one sweep step.

### Related Instructions

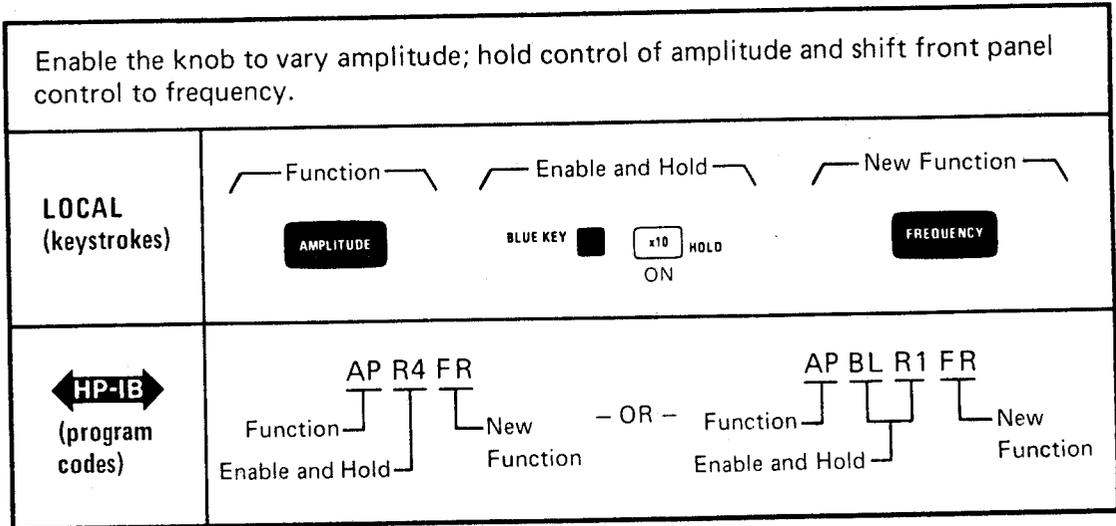
Increment ↓↑  
Increment Setting  
Knob, Hold  
Knob, Increments  
Sweep Modes

# Knob, Hold

**Description** Normally the knob feature applies to the function for which the front panel is set, and is disabled if the front panel function changes. The HOLD feature allows you to retain knob control of one function even when the front panel is set to another.

**Procedure** Press the Blue Key and HOLD (X10).

**Example**



**Keys and Program Codes**



Keys	Codes (see note)	
	Blue Key HOLD (X10)	R4

Note: The HOLD feature can be programmed with a simple R4 or with BL and R1 (Blue Key and X10).

**Indications** The knob's control should still be evident on the original function.

**Comments** Manual sweep mode takes priority over the HOLD feature. That is, the HOLD feature cannot be maintained if manual sweep is selected.

The HOLD feature cannot be maintained for one modulation function when front panel control is shifted to the other modulation function (that is, AM to FM or vice versa). The knob does remain enabled when the shift is made but the control shifts to the new modulation function.

You can select one increment for the knob and "hold" it. Then select another increment for the INCREMENT keys (for a different function).

**Related Instructions**

- Knob
- Knob, Increments

## Knob, Increment

**Description** This feature allows the knob to step parameters in selected increments (like the INCREMENT keys) instead of the normal resolution format. Any value-selectable parameter can be controlled with this feature.

**Procedure** First, select the desired function and increment (see Increment Setting). Then press the Blue Key and  $\div 10$  (INCR, ON). This turns on the knob in the Increment configuration.

### Example

Enable the knob in the Increment configuration.	
LOCAL (keystrokes)	BLUE KEY  INCR 
 (program codes)	R5 – OR – BL R2

### Keys and Program Codes



Keys	Codes (see note)	
Blue Key		BL
INCR	R5	R2

Note: The Increment configuration can be programmed with a simple R5 or with BL and R2 (Blue Key and  $\div 10$ ).

### Indications

The displayed value will increase (cw) or decrease (ccw) in the increments selected.

### Comments

The knob is normally turned off whenever a new keyboard function is selected. There is a Hold feature, however, that allows you to retain knob control of one function after shifting keyboard control to another (see Knob, Hold).

You can select one increment for the knob and “hold” it. Then select another increment for the INCREMENT keys (for a different function).



In the Increment configuration, the knob acts essentially the same as the INCREMENT keys: cw =  $\uparrow$ ; ccw =  $\downarrow$  (except when in HP-IB control where the program code RU or RD must be repeated ten times to affect a single step).

The size of an increment can be displayed by pressing the INCR SET key.

### Related Instructions

Increment  $\downarrow \uparrow$   
Increment Setting  
Knob  
Knob, Hold

# Modulation, AM

**Description**

This instruction describes how to set up and use AM with the internal modulation source.

**Operating Characteristics:**

Depth: 0–95%  
 Resolution: 1%, 10 to 95% AM  
 0.1%, 0 to 9.9% AM  
 Internal Rates: 400 and 1000 Hz.

**External Rates**

RF	AM Rates
0.15 to 1 MHz	dc to 1.5 kHz
1 to 10 MHz	dc to 5 kHz
10 to 1280 MHz	dc to 10 kHz

**Procedure**

Select AM, Data and %.

Select modulation rate.

To turn AM off, press MOD OFF.

To turn the AM on to the last selected depth and rate, press AM.

**Example**

Select AM, 75% depth, 1 kHz rate (internal).

<b>LOCAL</b> (keystrokes)	Function	Data	Units	Rate
	AM	7 5	% MHz	INT 1k
<b>HP-IB</b> (program codes)	Function	Data	Units	Rate
	AM	75	PC	M2

**Keys and Program Codes**



Keys	Codes
AM	AM
MOD OFF	MO
%	PC
INT 400	M1
INT 1k	M2
EXT AC	M3
EXT DC	M4

**Indications**

The light in the selected MOD key should turn on. Selected AM depth and the %AM annunciator should be displayed on the readout panel. Two significant digits should be displayed.

**Comments**

Refer to Modulation, External Source for information on external levels.

AM is possible above +8 dBm. However, maximum peak envelope power (that is, carrier output plus AM depth) cannot exceed +14 dBm (with amplitude correction) or +16 dBm (without correction).

The maximum number of digits for AM depth is two. Selected values with three significant digits will be rounded off to two digit values.

# Modulation, AM (Cont'd)

**Comments  
(Cont'd)**

A modulation signal is produced at the rear panel MODULATION OUTPUT connector. Its level is a minimum of 200 mVrms and not operator controllable. The signal is the internally generated 400 or 1000 Hz (if enabled), or the external signal from the front panel MODULATION INPUT (single mode modulation only). The signal is never a mixed mode signal and never the signal from the rear panel AUX FM INPUT.

**Related  
Instructions**

Modulation, External Source  
Modulation, Mixed

## Modulation, External Source

### Description

This instruction describes the use of two external source connectors; the front panel MODULATION INPUT and the rear panel AUX FM INPUT.

The front panel connector can be ac or dc coupled for AM or FM. Its impedance is  $\sim 1000\Omega$ . It requires a level of 0.707 Vrms (1 Vpk) for calibrated internal control of level.

#### NOTE

*The Generator's output is not phase locked when a dc coupled signal is used for FM (front panel connector only).*

The rear panel connector is dc coupled and for FM only (phase lock enabled). Its impedance is  $\sim 5000\Omega$ . Its level is set externally only (that is, at the source).

### Procedure

To enable the front panel connector, press EXT AC or EXT DC. Set the signal level to 0.707 Vrms (1 Vpk) for calibrated internal control of AM% or FM peak deviation.

#### NOTE

*The EXTERNAL SOURCE HI light turns on if the signal is greater than 0.721 Vrms (1.02 Vpk). The LO light turns on if the signal is less than 0.693 Vrms (0.98 Vpk). If greater accuracy is required, an external voltmeter must be used.*

To enable the rear panel connector, press the Blue Key, SPECIAL and 51. Adjust the signal level according to the instructions described under Comments.

To disable the rear panel connector, press the Blue Key, SPECIAL and 50.

### Keys and Program Codes



Keys	Codes (see note)	
	Blue Key SPECIAL	SP
EXT AC	M3	
EXT DC	M4	
AM	AM	
FM	FM	

Note: The SPECIAL function can be programmed with a simple SP or BL and AP (Blue Key and AMPLITUDE).

### Indications

For signals entering the front panel connectors, the EXTERNAL SOURCE HI-LO lights will turn on accordingly if the signal is too high (HI) or too low (LO) for calibrated internal control of the signal level.

For signals entering the rear panel connector, there is no such indication.

### Comments

The EXTERNAL SOURCE HI-LO lights should not be used when sweep times are  $\leq 10$  ms time/step.

A modulation signal is produced at the rear panel MODULATION OUTPUT connector. Its level is a minimum of 200 mVrms and not operator controllable. The signal is the internally generated 400 or 1000 Hz (if enabled), or the external signal from the front panel MODULATION INPUT (single mode modulation only). The signal is never a mixed mode signal and never the signal from the rear panel AUX FM INPUT.

## Modulation, External Source (Cont'd)

### Comments (Cont'd)

#### External Control of AM Depth

There are two methods for controlling AM depth at the external source. The first method can provide greater RF stability; the second allows more versatile mixed modulation.

**Greater Stability.** The first method can be more stable if applied in a simple AM mode. This is because the less stable FM circuitry is disabled.

- Select AM 95%. This sets the internal AM depth control to maximum.
- Enable the front panel MODULATION INPUT by selecting either EXT AC or EXT DC.
- Set the external signal level for desired AM depth according to the following formulas:

$$V_{rms} = A \times 6.7 \times 10^{-3}$$

$$V_{pk} = A \times 9.5 \times 10^{-3}$$

where A is desired AM depth in percent.

0.778 Vrms (1.1 Vpk) is the maximum input level before clipping occurs.

#### NOTE

*AM + FM is possible, with reduced stability, by using a second external source for FM and the rear panel AUX FM INPUT (that is, Special Function 51).*

**Versatile Mixed Modulation.** The second method enables the internal FM circuitry which is inherently less stable. However, it also provides for AM + FM using the convenience of the internal FM circuitry; AM + FM using a second external source at the rear panel AUX FM INPUT, and AM + FM + FM using a combination of the internal and external sources.

- Enable the front panel MODULATION INPUT with Special Function 41 for ac coupling or 42 for dc coupling. These features direct the AM signal around the internal level control circuitry. They also enable the internal FM.
- At the Generator's front panel, set FM to 0.0 kHz or to any desired deviation for mixed modulation.
- Adjust the external signal level for the desired AM depth. The relationship of voltage to AM depth is:

$$V_{rms} = A \times 7.07 \times 10^{-3}$$

$$V_{pk} = A \times 10^{-2}$$

where A is desired AM depth in percent.

#### NOTE

*0.778 Vrms (1.1 Vpk) is the maximum input level before clipping occurs.*

Continued . . .

## Modulation External Source (Cont'd)

**Comments  
(Cont'd)**

### External Control of FM Deviation

There are two methods for controlling FM Deviation at the external source. The first method uses the front panel MODULATION INPUT and provides ac or dc coupling. However, with dc coupling, there is a significant decrease in RF stability (that is, the output signal is not phase locked). The second method uses the rear panel AUX FM INPUT which is dc coupled only (with phase locked stability).

**AC and DC Coupling.** For external control of FM deviation (for signals at the front panel MODULATION INPUT):

- Enable the MODULATION INPUT by selecting either EXT AC or EXT DC.
- Set the Generator to one of the following peak deviation settings depending on the RF frequency range:

**Maximum Peak Deviation**

RF (MHz)	FM Setting (kHz)
.01 to 120	100
120 to 160	25
160 to 320	50
320 to 640	100
640 to 1280	200

- Adjust the signal level of the external source to produce peak deviations according to the following relationship:  
0 to 0.707 Vrms (or 1 Vpk) produces peak deviations between 0 kHz and the value displayed on the Generator's front panel.

**DC Coupling with Phase Lock.** For external control of FM peak deviation (for signals entering the rear panel AUX FM INPUT):

- Select Special Function 51. This enables the rear panel signal path which bypasses the internal level control circuitry.
- Select any other modulation source for mixed modulation or disable all other sources by pressing MOD OFF (this does not affect the AUX FM INPUT).
- Adjust the signal level of the external source to produce peak deviations according to the formulas shown in the following table.

RF (MHz)	Vpk approximately equals*	For Vrms multiply the values for Vpk by 0.707.
.01-120	$\Delta f_{peak}/25 \text{ kHz}$	
120-160	$\Delta f_{peak}/6.25 \text{ kHz}$	
160-320	$\Delta f_{peak}/12.5 \text{ kHz}$	
320-640	$\Delta f_{peak}/25 \text{ kHz}$	
640-1280	$\Delta f_{peak}/50 \text{ kHz}$	
* $\Delta f_{peak}$ is the desired peak deviation.		

## Modulation, External Source (Cont'd)

Comments  
(Cont'd)

### NOTE

*When using the AUX FM INPUT for FM + FM, the resulting deviation from all sources should not exceed the maximum limits shown in the table above titled Maximum Peak Deviation.*

Related  
Instructions

Modulation, AM  
Modulation, FM  
Modulation, Mixed

# Frequency Transferring

**Description**

This feature allows you to transfer frequency values from one frequency parameter to another. You can transfer values between the following parameters:

- |                 |   |
|-----------------|---|
| Frequency       | Marker Frequencies                        |
| Start Frequency | Step Size (i.e., SET SIZE for start-stop) |
| Stop Frequency  | Step Size (i.e., SET SIZE for span)       |
| Span Frequency  |   |

**Procedure**

Press the Blue Key. Then select a source key and a receiver key.

**Example**

Transfer the value of Marker 1 to Start Frequency and the value of Marker 2 to Stop Frequency.

<b>LOCAL</b> (keystrokes)	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> <p>Source</p> <p>BLUE KEY <span style="display: inline-block; width: 10px; height: 10px; background-color: black; border: 1px solid black;"></span></p> <p>MARKER 1 <span style="display: inline-block; width: 10px; height: 10px; border: 1px solid black; border-radius: 50%;"></span></p> <p>MARKER 2 <span style="display: inline-block; width: 10px; height: 10px; border: 1px solid black; border-radius: 50%;"></span></p> </div> <div style="text-align: center;"> <p>Receiver</p> <p>START FREQ <span style="display: inline-block; width: 10px; height: 10px; background-color: black; border: 1px solid black;"></span></p> <p>STOP FREQ <span style="display: inline-block; width: 10px; height: 10px; background-color: black; border: 1px solid black;"></span></p> </div> </div>
<p style="text-align: center;"><b>HP-IB</b></p> <p>(program codes)</p>	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> <p>BL X1 FA</p> <p>Blue Key ——— ——— ———  Receiver</p> <p>Source</p> </div> <div style="text-align: center;"> <p>BL X2 FB</p> <p>Blue Key ——— ——— ———  Receiver</p> <p>Source</p> </div> </div>

**Keys and Program Codes**



Keys	Codes	Keys	Codes
Blue Key	BL	MARKERS	
FREQUENCY	FR	1	X1
START FREQ	FA	2	X2
STOP FREQ	FB	3	X3
SPAN FREQ	FS	4	X4
SET SIZE	N3	5	X5

**Indications**

Indications depend upon the parameter currently being displayed. The source remains unchanged; the receiver changes to the same value as the source.

**Comments**

The frequency transfer feature provides, in effect, additional storage registers for frequency parameters (in addition to the nine general registers — see Store-Recall).

**Related Instructions**

- Frequency
- Sweep, Start-Stop
- Sweep, Span
- Sweep Markers
- Store-Recall

## Modulation, FM (Cont'd)

### Keys and Program Codes



Keys	Codes
FM	FM
MOD OFF	MO
kHz	KZ
INT 400	M1
INT 1k	M2
EXT AC	M3
EXT DC	M4

### Indications

Selected FM deviation and the “kHz FM” annunciator should be displayed on the readout panel. At least two significant digits should be displayed.

### Comments

Refer to the Modulation, External Source instruction for external rates and levels, and for information on the rear panel AUX FM input.

Selected digits that exceed the resolution of the range are rounded off.

If selected deviation exceeds the maximum allowed for a range, deviation goes to 0 kHz.

A modulation signal is produced at the rear panel MODULATION OUTPUT connector. Its level is a minimum of 200 mVrms and not operator controllable. The signal is the internally generated 400 or 1000 Hz (if enabled), or the external signal from the front panel MODULATION INPUT (single mode modulation only). The signal is never a mixed mode signal and never the signal from the rear panel AUX FM INPUT.

### Related Instructions

Modulation, External Source  
 Modulation, Mixed  
 Parameter Shift Keying

# Modulation, Mixed

**Description**

This instruction describes several modes of mixed modulation. Each mode involves some combination of the following features:

- Internal 400 Hz and 1 kHz sources
- External AM (ac coupled) with Internal FM (Special Function 41)
- External AM (dc coupled) with Internal FM (Special Function 42)
- External AUX FM (rear panel, dc coupled) with any other source (Special Function 51)

**Procedure**

- Ext AM (ac) with Int FM:  
Press the Blue Key, SPECIAL and 41.
- Ext AM (dc) with Int FM:  
Press the Blue Key SPECIAL and 42.
- To disable the External AM (from Special Function 41 or 42):  
Press the Blue Key, SPECIAL and 40.
- AUX FM On:  
Press the Blue Key, SPECIAL and 51
- AUX FM Off:  
Press the Blue Key, SPECIAL and 50.

**Example**

Set up external AM, ac coupled with internal FM at a 400 Hz rate.	
<b>LOCAL</b> (keystrokes)	
<b>HP-IB</b> (program codes)	
Enable the rear panel AUX FM connector.	
<b>LOCAL</b> (keystrokes)	
<b>HP-IB</b> (program codes)	

## Modulation, Mixed (Cont'd)

### Keys and Program Codes



Keys	Codes (see note)	
	Blue Key SPECIAL	SP

Note: the SPECIAL function can be programmed with a simple SP or with BL and AP (Blue Key and AMPLITUDE).

### Indications

Only the internally controlled AM depth or FM deviation is displayed.

### Comments

In any mixed modulation mode, only the internal source can be controlled from the front panel.

When using the AUX FM input for FM + FM, the sum of the input signals should not produce deviation exceeding the limits listed in the Modulation, FM instruction.

With Special Functions 41 and 42, the internal FM turns on to a 1 kHz rate and the last selected FM deviation. Internal 400 Hz can be selected after the Special Function is set up.

The AUX FM input is dc coupled. However, selecting AUX FM does not disable the output signal's phase-lock stabilization (like FM and EXT DC through the front panel input). Consequently any modulation signal applied to the AUX FM input should not be such that it overmodulates the Generator. The same low frequency FM deviation limits that apply to an EXT DC signal also apply to an AUX FM signal (that is, rates below 200 Hz must have reduced deviation; rates below 20 Hz will increase distortion).

Setting the level of the external source is described under Modulation, External Source.

The MOD OFF key turns off all modulation except FM produced from the AUX FM input.

### Related Instructions

Modulation, AM  
Modulation, External Source  
Modulation, FM

## Parameter Shift Keying

### Description

This feature is a variation of the Increment  $\downarrow \uparrow$  feature. It provides a toggle function, that is, only one step up, then one step down, etc.

Special Function 61 is the two-key format. Each INCREMENT key is enabled for one step; then disabled while the other key is enabled for one step.

Special Function 62 is the one-key format. Either key ( $\downarrow$  or  $\uparrow$ ) can perform the complete toggle function.

### Procedure

Press the Blue Key SPECIAL and 61 (to enable the two-key format).

Press the Blue Key SPECIAL and 62 (to enable the one-key format).

Select a Function and increment value.

Press one or both stepping keys ( $\downarrow \uparrow$ ), depending on the selected format, for switching the parameter up and down.

To turn off either feature, press the Blue Key, SPECIAL and 60.

### Keys and Program Codes



Keys	Codes (see note)	
Blue Key SPECIAL	SP	BL AP
$\uparrow$	UP	
$\downarrow$	DN	

Note: SPECIAL can be programmed with a simple SP or with BL and AP (Blue Key and Amplitude).

### Indications

The displayed value will increase and decrease by the selected increment.

Code 61 or 62 will appear in the Special Function block of the Frequency readout, if you press and hold the STATUS key.

### Comments

This feature applies to all value-selectable functions of the Generator. It is particularly useful for implementing remotely controlled, low-rate FM (for rates less than 120 Hz).

Parameter shift keying always turns on with the up-step enabled regardless which format is selected.

It is important to consider switching to the uncorrected Amplitude mode (Special Function 85) when using this feature for frequency toggling over an extended period of time (this applies primarily to remote operation). The uncorrected mode prevents excessive mechanical wear of the attenuator due to very rapid switching for amplitude correction.

The toggling can also be controlled by the rear panel AUX connector. TTL pulses are required (Negative-edge sensitivity): pin 2 INCREMENT  $\uparrow$ ; pin 3, INCREMENT  $\downarrow$ .

### Related Instructions

Increment  $\downarrow \uparrow$   
Increment Setting

## Sequence

### Description

This feature allows you to predetermine the recall order of front panel storage registers and recall them one at a time.

The Auto-Sequence feature sets up a continuous recall of registers in the predetermined sequence.

### Procedure

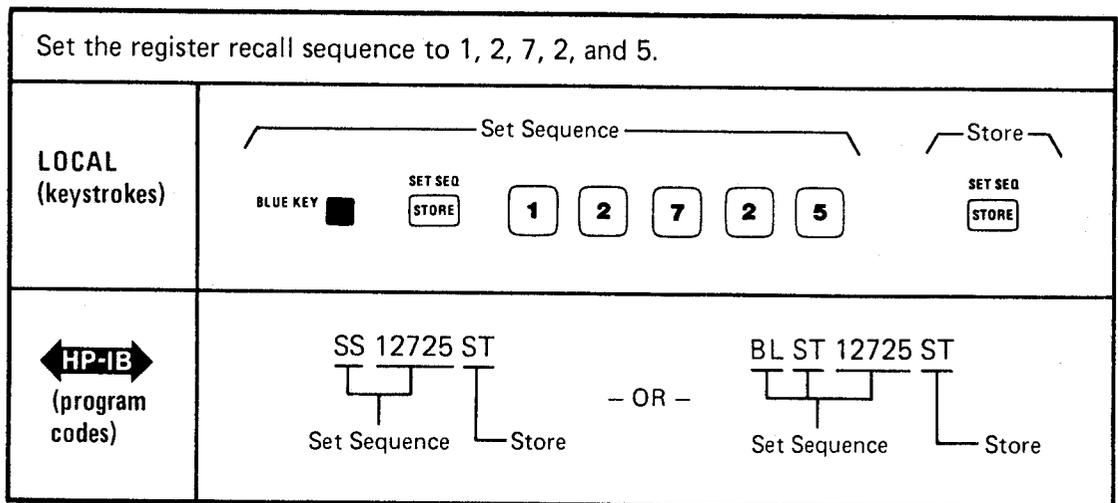
To set the sequence (that is, recall order), press the Blue Key, SET SEQUENCE, data and STORE (data is the register numbers in the desired recall sequence).

To recall registers one at a time in the predetermined sequence, press SEQ.

To start a continuous recall of registers in the predetermined sequence, press the Blue Key and AUTO SEQ.

To stop an Auto Sequence operation, press any key except STATUS.

### Example



### Keys and Program Codes



Keys	Codes (see note)	
	Blue Key	BL
SET SEQ	SS	ST
AUTO SEQ	AS	SQ
STORE	ST	
SEQ	SQ	

Note: SET SEQ can be programmed with a simple SS (or with BL and ST). AUTO SEQ can be programmed with a simple AS (or with BL and SQ).

### Indications

The recall sequence will be displayed in the Frequency readout when the RECALL and SEQ keys are pressed (SEQ held). One digit will be blinking to indicate the last-recalled register (or the first register in the sequence if no recall has been made yet). The digit to the right of the blinking digit always represents the next register to be recalled (this includes wrap-around to the first digit).

### Comments

It is important to consider switching to the uncorrected Amplitude mode (Special Function 85) when using the auto sequence capability with frequency changes. Not only does this increase auto sequence speed, but also prevents excessive mechanical wear of the attenuator section due to very rapid switching for those frequency ranges that involve switching the attenuator.

Continued . . .

## Sequence (Cont'd)

### Comments (Cont'd)

Any order of registers is allowable. The maximum number of digits in a sequence is ten. Register numbers can be repeated in a sequence string (for example, 3 6 4 5 7 7 5 4 6 3).

In the Auto Sequence mode, the Generator recalls one register after another as fast as it can. If an Auto-Sweep mode is encountered, the Generator performs a single sweep then recalls the next register. If a Manual-Sweep mode is encountered, the sequencing will stop. However, the Generator will be configured for Manual Sweep mode.

Any key except STATUS can stop Auto-Sequencing. However, pressing any other key also performs its indicated function. We recommend using a function key like FREQUENCY since, by itself, it cannot change any existing parameter.

Special Function 88 is identical to the Auto Sequence function.

### Related Instructions

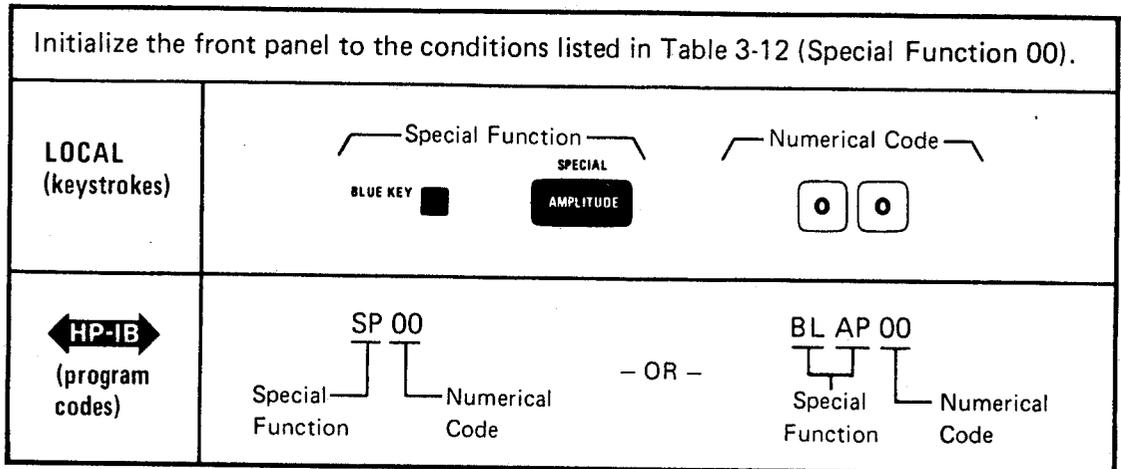
Store-Recall

## Special Functions

**Description** The Generator has several functions that are not apparent from the front panel markings. These are the special functions. They are listed in Table 3-11. Most of the special functions are explained in other operating instructions.

**Procedure** Press the Blue Key, SPECIAL and the two-digit code.

**Example**



**Keys and Program Codes**



All of the keys and codes used in the Special Function feature are shown in the examples. Note: the SPECIAL function can be programmed with a simple SP or BL and AP (Blue Key and AMPLITUDE).

**Indications**

Many of the Special Function codes will be displayed in the Frequency readout when the STATUS key is pressed (in the second and third digits from the left).

The following codes are not displayed:

1. All codes ending in zero.
2. Codes starting with eight except 85 and 88.

**Comments**

Special Functions cannot be stored in individual storage registers. They are global parameters. That is, once enabled, a special function applies to any set of parameters recalled from storage.

ROM and RAM checks (83 and 84) are described earlier in this section under Operator's Checks.



HP-IB Operator Response (87) issues a Require Service Message. For more information, see the HP-IB instructions earlier in this manual.

Automatic Sequence (88) is identical to the AUTO SEQ keystroke function.

**Related Instructions**

Amplitude Conversion (V→dBm)	Modulation, External Source
Amplitude Correction	Modulation, Mixed
Amplitude Reference	Parameter Shift Keying
Frequency Offset	Sequence

Continued . . .

## Sweep, Span (Cont'd)

**Related  
Instructions**

Sweep  
Sweep Markers  
Sweep, Start-Stop  
Sweep Step Size  
Sweep Time/Step

## Status

### Description

The Generator produces several messages in numeric code that alert the operator to conditions describing its status. The conditions are 1) Entry errors, 2) Hardware errors (malfunctions) 3) Special Functions enabled and 4) General status. The codes are displayed in the Frequency readout. They are defined in Tables 3-13 and 3-14 and on the Generator's pullout information card.

The light in the STATUS key turns on steady if the operator made an entry error and turns on blinking for hardware malfunctions and general status messages.

### Procedure

To display the Status messages, press and hold the STATUS key.

### Indications

The Frequency readout displays Special Function codes in the second and third digits from the left. If more than one Special Function is enabled, the readout will display one code after another, in sequence. It displays Entry Error, Hardware Malfunction and general status codes in the first two digits on the right.

### Keys and Program Codes



Keys	Codes
STATUS	MS

### Comments

Status should be checked whenever the Generator is turned on or whenever the STATUS key light turns on. It is a good idea to check the Status message occasionally to keep informed of the Generator's general status.

The STATUS key light for an entry error generally goes out after STATUS key has been pressed or after the next valid entry has been made. The entry error code is cleared only after the STATUS key is pressed.

The STATUS key light for a hardware malfunction or general status condition turns off only after the malfunction or condition changes. However, the error code is cleared only after the malfunction or condition changes and the STATUS key is pressed (in that order).

Special Functions do not cause the STATUS key light to turn on. Special Function codes are cleared as soon as the Special Function is disabled.



The format of the STATUS message for HP-IB operation is described under "Sending the Data Message" in the HP-IB presentation.

**Status Code 10.** Under certain conditions, it is possible for Status code 10, "Amplitude out of specification", to turn on when no amplitude error exists. This can happen during fast repetitive sweeps (for example, Auto Sweep or Remote Stepped Sweep, with the time/step less than 1 ms). Corrective action is not required unless code 10 persists in conditions other than the fast repetitive sweep.

Continued . . .

## Status (Cont'd)

Table 3-13, Status, Entry Errors and Hardware Malfunction Codes

00	No error.
01	No reference oscillator. Check INT-EXT switches. See Section VIII, Service.
09	Reverse power at RF OUTPUT. Remove source and press AMPLITUDE.
10	Amplitude out of specification (see comment on preceding page).
11	FM overmodulated. Reduce input level.
12	Crystal oven not heat stabilized. Allow 1 hour.
13	External reference selected.
14	Frequency of reference out of tolerance.
15	AM overmodulated. Reduce input level.
32	Frequency selection out of range (1 kHz to 1.28 GHz).
33	Amplitude selection >+16 dBm. Entry ignored.
34	Amplitude selection <-139.9 dBm. Entry ignored.
35	Amplitude >+10 dBm or 710 mV. AM not specified.
36	Amplitude selection >999 mV or <0 $\mu$ V. Entry ignored.
37	AM selection >95% or <0%. Entry ignored.
38	Frequency <150 kHz. AM invalid.
39	FM >200 kHz or <0.0 kHz invalid.
40	FM >100 kHz invalid for frequencies between 320 and 640 MHz, or 1 kHz and 120 MHz.
41	FM >50 kHz invalid for frequencies between 160 and 320 MHz.
42	FM >25 kHz invalid for frequencies between 120 and 160 MHz
43	Wrong entry protocol. Entry ignored.
44	Too many significant digits prior to decimal point.
45	Start and stop frequencies equal.
46	Parameter underflow. Defaulted to zero.
47	Marker out of limits (start-stop).
48	Marker out of limits (span).
49	Sweep step size is greater than start-stop frequency difference.
50	Store/Recall error. Register failed or non-existent.
51	Recall 0 invalid (1—9 only).
52	RAM data altered; first good register recalled; special functions cleared. Re-enter data for Store-Recall registers.
53	RAM faulty. Generator initialized to 100 MHz and -30 dBm. Re-enter data for all registers. Refer to Section VIII, Service.
54	No amplitude correction above +13 dBm.
55	Sweep steps >10,000. Staircase ramp disabled (SWEEP OUTPUT = 0V).
56	Special Function code invalid.
57	Amplitude reference in volts invalid.
58	Key invalid in mixed modulation mode.
59	Sweep span out of limits.
99	Malfunction. Section VIII, Service.

Table 3-14. Special Function Status Codes

11	+Freq Offset
12	-Freq Offset
31	Amplitude reference
41	FM INT + AM EXT AC
42	FM INT + AM EXT DC
51	AUX FM (rear panel input)
61	Parameter shift keying increment (two-key format)
62	Parameter shift keying increment (one-key format)
85	Amplitude Correction Off
88	Automatic Sequence

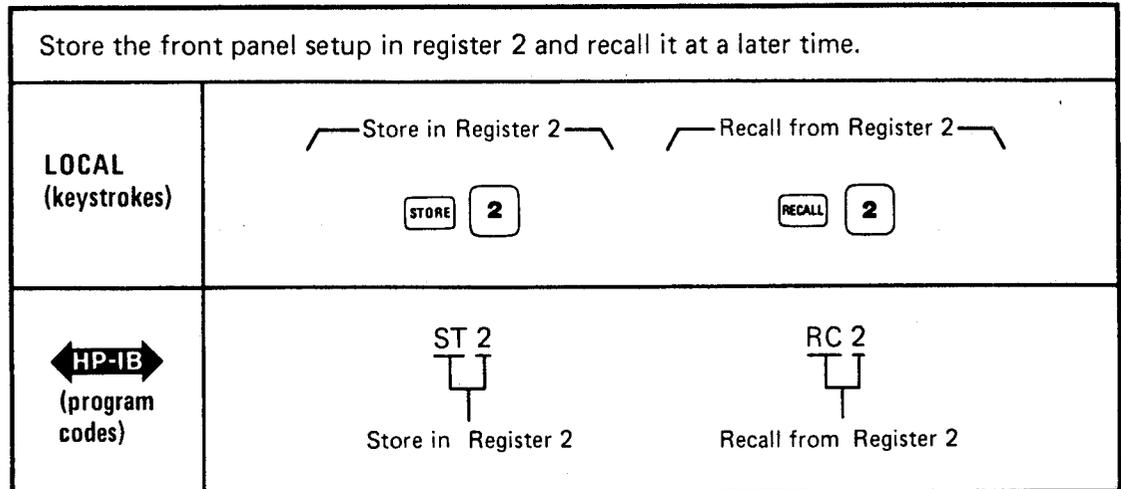
## Store-Recall

**Description** Up to nine full front panel configurations (including “hidden” parameters) can be stored in the Generator’s registers.

**Procedure** Press STORE and Data (a single digit register number)

Press RECALL and Data (a single digit register number)

### Example



### Keys and Program Codes



Keys	Codes
STORE	ST
RECALL	RC

### Comments

Nine registers are available (1–9), each capable of storing a full front panel configuration.

Many of the frequency parameters can be utilized to store additional frequency settings. These can be recalled with the Frequency Transferring feature.

Marker frequencies and Special Functions cannot be stored in individual registers. They are global parameters. That is, once established they apply to any set of parameters recalled from storage. A Marker’s On-Off status, however, can be stored in a register.

The Single sweep mode cannot be stored. However, the other sweep parameters associated with a Single sweep can be stored.

The Sequence feature allows you to recall registers one at a time and in a predetermined order. The Auto-Sequence feature is similar except that once started, it recalls the registers in a continuous stream.

### Related Instructions

Frequency Transferring  
Sequence

## Sweep

### Staricase Sweep

The frequency changes in discrete steps rather than in a continuous analog manner.

The Generator can sweep from 10 kHz to 1280 MHz (actually as low as 1 kHz but with a loss of level accuracy). The minimum step size is 0.1 Hz for signals below 640 MHz and 0.2 Hz above 640 MHz. The sweep can be either linear or logarithmic. There are five selectable values of time per step: 0.5 ms (nominal), 1, 2, 10, and 100 ms. Five frequency markers can be set. The markers can be either intensity modulation on a swept display or amplitude modulation on the RF signal (or both).

### Modes

Four sweep modes are available. They are: Automatic, Manual, Single and Remote stepped sweep (HP-IB only). Each mode enables the sweep parameters that were previously selected.

**Automatic mode** starts a continuous sweep, restarting at the end of each sweep.

**Manual mode** does not start a sweep but enables the knob for manual operation. Pressing the MANUAL key will stop a continuous sweep in midspan. Pressing AUTO or SINGLE again will restart the sweep (continue) where it left off.

**Single mode** starts one sweep only. At the end of one sweep, the sweep circuitry is turned off and output frequency reverts to the last selected fixed frequency.

◀ **HP-IB** ▶ **Remote Stepped Sweep (RSS)** is a sweep mode available only in the HP-IB remote mode. It allows the controller to execute each step and still have a SWEEP OUTPUT ramp and a Sweep End pulse at the AUX connector. For more information, see page 3-38.

### Amplitude Correction

The correction feature is automatically disabled in all sweep modes.

### Sweep Parameters.

The following sweep parameters are value-selectable:

Start-Stop frequencies	Time/step
Center Frequency and span	Marker frequencies
Sweep step size ( $\Delta f$ /step)	

### Sweep Controls

All the front panel controls that are exclusively for sweep are on the left keyboard. Sweep features can also be remotely controlled by the HP-IB or through the auxiliary connector (AUX) on the rear panel.

## Sweep (Cont'd)

### Inputs and Outputs

The **SWEEP OUTPUT** jack on the front panel provides a 0 to +10V staircase to drive a swept display.

The **AM MARKER** jack on the rear panel provides 5 kHz bursts for amplitude markers on the RF signal (it must be fed around to the front panel **MODULATION INPUT** and handled as an external modulation source).

The **Z-AXIS BLANKING/MARKER** output serves the dual purpose of blanking or intensifying a swept display (Z-axis intensity modulation). A TTL high level is produced at the beginning of each step of the staircase sweep. The pulse blanks the display for 250  $\mu$ s so that switching transients from the Generator are not displayed. A -5V pulse intensifies the display at the point of a selected marker frequency (-5V is nominal; it is internally adjustable between -2 and -8V).

The **PEN LIFT** output is a TTL high level for pen-up condition and a low level for pen-down condition. It produces the pen-down condition in the single sweep mode only.

Three lines on the **AUX** connector each control one of the three sweep modes. They are TTL negative-edge sensitive. There is one sweep related output line on the **AUX** connector. It produces a TTL pulse at the end of each sweep.

### Detailed Instructions

Most of these sweep characteristics are covered in greater detail in separate instructions. Their titles are:

Sweep Markers	Sweep, Start-Stop
Sweep Modes	Sweep Step Size
Sweep, Span	Sweep Time/Step

## Operation

## Sweep Markers

## Description

This instruction describes the Generator's Markers, how to set or change the marker frequencies and how to turn them on.

Five different marker frequencies can be set.

The Generator can produce Z-axis intensity markers for a swept display or amplitude markers on the RF signal.

The Z-axis intensity markers are nominally  $-5V$ . However, they are internally adjustable between  $-2$  and  $-8V$  (see Section V, Adjustments). Z-axis markers are available through the rear panel Z-AXIS BLANKING/MARKERS connector.

The amplitude markers are 5 kHz triangle wave bursts available at the rear panel AM MARKERS output. This output can be connected to the front panel MODULATION INPUT to produce adjustable AM markers on the RF signal.

## Procedure

To set a marker frequency:

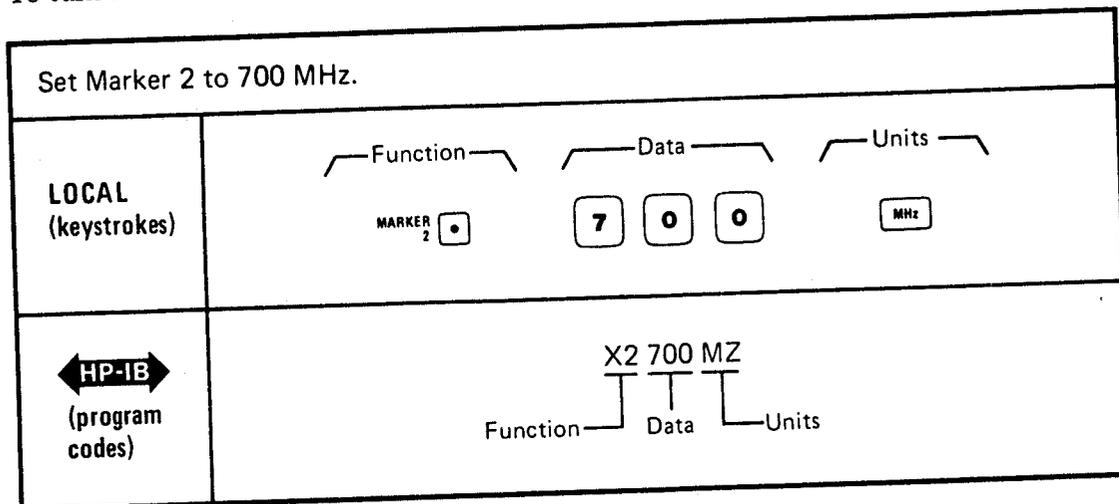
Press a MARKERS key, Data and Units.

To turn a marker on, press the appropriate MARKERS key. The marker will turn on only if it is within the current sweepwidth.

To turn a selected marker off, press the appropriate MARKERS key and OFF.

To turn all markers off, press the Blue Key and ALL OFF.

## Example



## Keys and Program Codes



Keys	Codes (see note)	
	MARKERS	
1	X1	
2	X2	
3	X3	
4	X4	
5	X5	
OFF	X6	
Blue Key		BL
ALL OFF	X7	X6

Note: The ALL OFF feature can be programmed with a simple X7 or with BL and X6 (Blue Key and OFF).

## Sweep Markers (Cont'd)

- Indications** Lights in the MARKERS keys turn on only when the marker is on. The marker frequency appears in the Frequency readout, and the output signal changes to the marker frequency, when the marker key is pressed and held down (local operation only).
- Comments** Markers can be used as storage registers for frequency. Their values can be transferred to other frequency parameters using the Frequency Transferring feature.
- Marker frequencies cannot be stored in individual storage registers. They are global parameters. That is, once established, they apply to any set of parameters recalled from storage. A Marker's On-Off status, however, can be stored in a register.
- Marker values can be changed by the INCREMENT ↓ ↑ keys and the knob.
- Related Instructions** Frequency Transferring  
Increment ↓↑  
Knob  
Sweep

## Sweep Modes

**Description** This feature turns the sweep on and off. It selects one of three modes: AUTO, MANUAL, or SINGLE.

**Procedure** Press the desired mode key. If the MANUAL mode is selected, control the sweep with the knob.

To turn the sweep off, press OFF.

### Keys and Program Codes

HP-IB

Keys	Codes
OFF	W1
AUTO	W2
MANUAL	W3
SINGLE	W4
Knob, CW	RU
Knob, CCW	RD

### Indications

In AUTO and SINGLE sweep modes, there will be a split frequency readout: START-STOP, or CF- $\Delta$ F (for center frequency and span). Each readout contains five digits. Digits representing greater than five-digit resolution are not displayed. If 10 ms or 100 ms per step is selected, the left readout will display the changing frequency as it sweeps. In SINGLE sweep mode, the readout should revert to a display of static output frequency when the sweep is finished.

In MANUAL mode, there is only one display of output frequency that changes as frequency is swept with the knob.

The appropriate lights for START FREQ-STOP FREQ, SPAN FREQ, STEP (frequency) TIME/STEP, and MODE should turn on. There are no lights for TIME/STEP in the MANUAL mode since that function is manually controlled.

### Comments

A sweep generally starts at the preset limit. However, Manual Mode can stop an Auto sweep at any frequency; the AUTO key can then restart the sweep and continue from that point.

The sweep modes can be controlled by TTL low-going pulses at the rear panel AUX connector. The following table shows the function and pin relationships.

Function	AUX Pin
Stop Sweep (same as MANUAL)	4
Continue Sweep (same as AUTO)	5
Single Sweep (same as SINGLE)	6

Pin 1 of the AUX connector is a sweep output. A single TTL pulse is generated there at the end of each sweep.

SINGLE sweep mode controls the rear panel PEN LIFT connector for plotter operation. TTL-High for pen-up; TTL-Low for pen-down.

HP-IB

In remote HP-IB control, the knob requires only one program code (either RU or RD) to perform a Manual sweep step.

# Sweep Modes (Cont'd)

**Comments  
(Cont'd)**



**Remote Stepped Sweep (RSS).** RSS is a sweep mode available only in the HP-IB remote mode. It allows the controller to execute each step and still have a SWEEP OUTPUT ramp and a Sweep End pulse at the AUX connector. For information, see page 3-38.

**Related  
Instructions**

- Sweep
- Sweep Markers
- Sweep, Span
- Sweep, Start-Stop
- Sweep Step Size
- Sweep Time/Step

## Sweep, Span

### Description

This feature sets a frequency span about a center frequency with an equal sweep width above and below the center frequency.

**Span width:** 1 kHz to 1280 MHz (1279. 999 999 8).

### Procedure

Select FREQUENCY (for center frequency), Data, and Units; SPAN FREQ, Data, and Units.

### Example

Select 700 MHz center frequency and a 100 MHz span.

LOCAL (keystrokes)	Function: FREQUENCY      Data: 7 0 0      Units: MHz																														
	Function: SPAN FREQ      Data: 1 0 0      Units: MHz																														
HP-IB (program codes)	<table border="0"> <tr> <td>Function</td><td>FR</td><td>700</td><td>MZ</td><td>Units</td> <td>Function</td><td>FS</td><td>100</td><td>MZ</td><td>Units</td> </tr> <tr> <td></td><td></td><td> </td><td> </td><td></td> <td></td><td></td><td> </td><td> </td><td></td> </tr> <tr> <td></td><td></td><td>Data</td><td>Data</td><td></td> <td></td><td></td><td>Data</td><td>Data</td><td></td> </tr> </table>	Function	FR	700	MZ	Units	Function	FS	100	MZ	Units													Data	Data				Data	Data	
Function	FR	700	MZ	Units	Function	FS	100	MZ	Units																						
		Data	Data				Data	Data																							

### Keys and Program Codes



Keys	Codes
FREQUENCY	FR
SPAN FREQ	FS
GHz	GZ
MHz	MZ
kHz	KZ
Hz	HZ

### Indication

After the frequency span has been selected, the readout should revert to displaying center frequency. The frequency span can be recalled to the readout by holding down the SPAN FREQ key (local operation only). In this situation, the  $\Delta F$  frequency annunciator should also turn on.

### Comments

Selecting SPAN FREQ also recalls the last "span" combination of Steps and Time/Step. This can be a different combination than that selected for Start-Stop operations.

Frequencies down to 1 kHz can be selected but level accuracy is not specified below 10 kHz (typically about 2 dB below displayed amplitude at 1 kHz).

Digits representing less than tenth-hertz resolution are ignored.

Digits not selected, default to zero.

## Special Functions (Cont'd)

Table 3-11. Special Functions

Function	Codes*
Initialize front panel (see Table 3-12)	00
Frequency offset off	10
Positive (+) frequency offset	11
Negative (-) frequency offset	12
Amplitude reference off	30
Amplitude reference	31
Mixed modulation off	40
FM Internal and AM External (ac coupled)	41
FM Internal and AM External (dc coupled)	42
Auxiliary FM off (rear panel connector)	50
Auxiliary FM on	51
Parameter shift keying off	60
Parameter shift keying (two-key format)	61
Parameter shift keying (one-key format)	62
All Special Functions off (except 85)	80
Amplitude Conversion (V→dBm)	81
Display HP-IB Address	82
ROM Checksum routine	83
RAM Test	84
Amplitude correction off	85
Amplitude correction on	86
HP-IB operator response	87
Automatic sequence	88

\*All of these codes follow the Blue Key and SPECIAL (program codes SP, or BL and AP).

Table 3-12. Initializing; Response to Special Function 00

Parameter	Condition
Frequency	100 MHz
Amplitude	-30 dBm
Modulation Mode	Off
Function Mode	Frequency
Markers 1-5	0 MHz
Frequency Increment	1 MHz
Amplitude Increment	0.1 dB
AM Increment	0.1%
FM Increment	0.1 kHz
AM	30%
FM	10 kHz
Modulation Source	Ext ac
Start Frequency	1 MHz
Stop Frequency	1279 MHz
Frequency Span	10 MHz
Time/Step	1 ms
Step Size	100 steps
Set Size	2 MHz
Sweep Mode	Off
Sweep Configuration	Span
Registers	Unchanged
Sequence	1, 2, 3, 4
Frequency Resolution	1 MHz
Modulation Resolution	10 kHz, 10%
Amplitude Resolution	1 dB
Special Functions	None (00)

## Sweep, Start-Stop

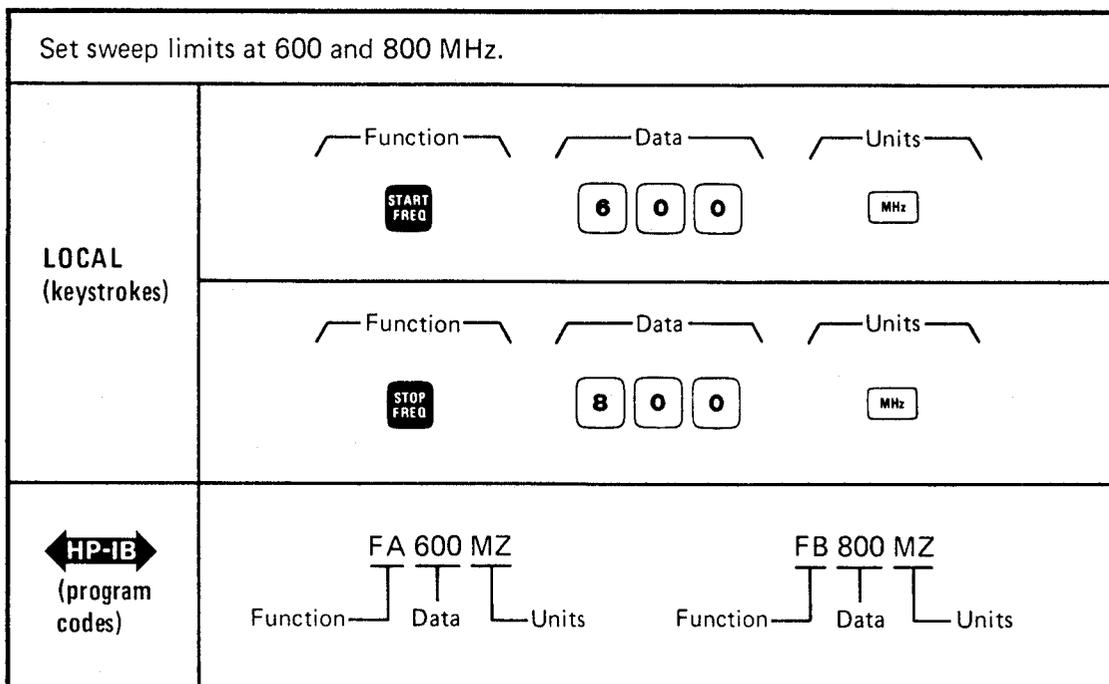
**Description** This feature sets starting and stopping points of the frequency sweep.

**Sweep width:** 1 kHz to 1280 MHz (1279.999 999 8).

**Procedure** Select START FREQ, Data, and Units.

Select STOP FREQ, Data, and Units.

**Example**



**Keys and Program Codes**



Keys	Codes
START FREQ	FA
STOP FREQ	FB
GHz	GZ
MHz	MZ
kHz	KZ
Hz	HZ

**Indications** The selected digits should be displayed in the FREQUENCY readout while they are being selected. However, the readout returns to the last selected fixed frequency after the units are selected.

The start or stop frequency can be recalled to the readout by holding down the START FREQ or STOP FREQ key (local operation only). In this situation, the START or STOP frequency annunciator should also turn on.

**Comments** Frequencies down to 1 kHz can be selected but level accuracy is not specified below 10 kHz (typically about 2 dB below displayed amplitude at 1 kHz).

Start and stop frequencies are totally independent of the displayed fixed frequency.

The start frequency can be higher than the stop frequency causing the sweep to progress from high to low.

## Sweep, Start-Stop (Cont'd)

### Comments (Cont'd)

Selecting Start-Stop frequencies also recalls the last "Start-Stop" combination of Steps and Time/Step. This can be a different combination than that selected for span operation.

Digits representing less than tenth-hertz resolution are ignored.

Digits not selected, default to zero.

### Related Instructions

Sweep  
Sweep Markers  
Sweep Modes  
Sweep, Span  
Sweep Step Size  
Sweep Time/Step

## Sweep Step Size

### Description

This feature selects log or linear sweeps and the size of the frequency increment in the staircase sweep.

LIN 100 and LIN 1000 set the increment to a constant value equal to sweepwidth  $\div$  100 or sweepwidth  $\div$  1000.

LOG 10% and LOG 1% set the increment to values equal to 10% or 1% of the present frequency.

SET SIZE is used to set the frequency increment to a constant value of your choice (settable within the frequency resolution of the Signal Generator).

**Resolution:** 0.1 Hz (below 640 MHz)  
0.2 Hz (above 640 MHz)

### Procedure

Simply press one of the four preset step size keys or select SET SIZE, Data and Units.

### Example

Set frequency step size to 200 kHz.

LOCAL (keystrokes)	
 (program codes)	

### Keys and Program Codes



Keys	Codes
LIN 100	N1
LIN 1000	N2
SET SIZE	N3
LOG 10%	N4
LOG 1%	N5
GHz	GZ
MHz	MZ
kHz	KZ
Hz	HZ

### Indications

If one of the four preset increments are selected, the only indication would be the light in the selected key turning on.

If SET SIZE is selected, the light in the key should turn on. Step size will be displayed on the readout panel until the units are selected. At that time, the readout will revert to fixed frequency. Step size can be recalled to the frequency readout by holding down the SET SIZE key (local operation only).

## Sweep Step Size (Cont'd)

**Comment** In the manual mode for a log sweep only, turning the knob counter clockwise changes frequency in steps of 10% or 1% of the next frequency (instead of the present frequency).

**Related Instructions**

- Sweep
- Sweep Markers
- Sweep Modes
- Sweep, Span
- Sweep, Start-Stop
- Sweep Time/Step

## Sweep Time/Step

**Description** This feature sets the interval between steps of the staircase sweep.

**Procedure** Select one of the following preset values: 0.5 ms (nominal), 1, 2, 10, or 100 ms.

**Keys and  
Program Codes**

◀HP-IB▶

Keys	Codes
0.5 ms	T1
1 ms	T2
2 ms	T3
10 ms	T4
100 ms	T5

**Indications** The only indication should be the light in the selected key turning on.

**Comments** The shortest interval between steps is approximately 0.5 ms for a simple linear sweep. This time would be longer for log sweeps, markers, and FM (0.9 ms maximum).

**Related  
Instructions**

- Sweep
- Sweep Markers
- Sweep Modes
- Sweep Span
- Sweep, Start-Stop
- Sweep Step Size



Table 3-15. Commonly Used Code Conversions

ASCII	Binary	Octal	Decimal	Hexa- decimal	ASCII	Binary	Octal	Decimal	Hexa- decimal
NUL	00 000 000	000	0	00	@	01 000 000	100	64	40
SOH	00 000 001	001	1	01	A	01 000 001	101	65	41
STX	00 000 010	002	2	02	B	01 000 010	102	66	42
ETX	00 000 011	003	3	03	C	01 000 011	103	67	43
EOT	00 000 100	004	4	04	D	01 000 100	104	68	44
ENQ	00 000 101	005	5	05	E	01 000 101	105	69	45
ACK	00 000 110	006	6	06	F	01 000 110	106	70	46
BEL	00 000 111	007	7	07	G	01 000 111	107	71	47
BS	00 001 000	010	8	08	H	01 001 000	110	72	48
HT	00 001 001	011	9	09	I	01 001 001	111	73	49
LF	00 001 010	012	10	0A	J	01 001 010	112	74	4A
VT	00 001 011	013	11	0B	K	01 001 011	113	75	4B
FF	00 001 100	014	12	0C	L	01 001 100	114	76	4C
CR	00 001 101	015	13	0D	M	01 001 101	115	77	4D
SO	00 001 110	016	14	0E	N	01 001 110	116	78	4E
SI	00 001 111	017	15	0F	O	01 001 111	117	79	4F
DLE	00 010 000	020	16	10	P	01 010 000	120	80	50
DC1	00 010 001	021	17	11	Q	01 010 001	121	81	51
DC2	00 010 010	022	18	12	R	01 010 010	122	82	52
DC3	00 010 011	023	19	13	S	01 010 011	123	83	53
DC4	00 010 100	024	20	14	T	01 010 100	124	84	54
NAK	00 010 101	025	21	15	U	01 010 101	125	85	55
SYN	00 010 110	026	22	16	V	01 010 110	126	86	56
ETB	00 010 111	027	23	17	W	01 010 111	127	87	57
CAN	00 011 000	030	24	18	X	01 011 000	130	88	58
EM	00 011 001	031	25	19	Y	01 011 001	131	89	59
SUB	00 011 010	032	26	1A	Z	01 011 010	132	90	5A
ESC	00 011 011	033	27	1B	[	01 011 011	133	91	5B
FS	00 011 100	034	28	1C	\	01 011 100	134	92	5C
GS	00 011 101	035	29	1D	]	01 011 101	135	93	5D
RS	00 011 110	036	30	1E	(	01 011 110	136	94	5E
US	00 011 111	037	31	1F	)	01 011 111	137	95	5F
SP	00 100 000	040	32	20	`	01 100 000	140	96	60
!	00 100 001	041	33	21	a	01 100 001	141	97	61
"	00 100 010	042	34	22	b	01 100 010	142	98	62
#	00 100 011	043	35	23	c	01 100 011	143	99	63
\$	00 100 100	044	36	24	d	01 100 100	144	100	64
%	00 100 101	045	37	25	e	01 100 101	145	101	65
&	00 100 110	046	38	26	f	01 100 110	146	102	66
'	00 100 111	047	39	27	g	01 100 111	147	103	67
(	00 101 000	050	40	28	h	01 101 000	150	104	68
)	00 101 001	051	41	29	i	01 101 001	151	105	69
*	00 101 010	052	42	2A	j	01 101 010	152	106	6A
+	00 101 011	053	43	2B	k	01 101 011	153	107	6B
,	00 101 100	054	44	2C	l	01 101 100	154	108	6C
-	00 101 101	055	45	2D	m	01 101 101	155	109	6D
.	00 101 110	056	46	2E	n	01 101 110	156	110	6E
/	00 101 111	057	47	2F	o	01 101 111	157	111	6F
0	00 110 000	060	48	30	p	01 110 000	160	112	70
1	00 110 001	061	49	31	q	01 110 001	161	113	71
2	00 110 010	062	50	32	r	01 110 010	162	114	72
3	00 110 011	063	51	33	s	01 110 011	163	115	73
4	00 110 100	064	52	34	t	01 110 100	164	116	74
5	00 110 101	065	53	35	u	01 110 101	165	117	75
6	00 110 110	066	54	36	v	01 110 110	166	118	76
7	00 110 111	067	55	37	w	01 110 111	167	119	77
8	00 111 000	070	56	38	x	01 111 000	170	120	78
9	00 111 001	071	57	39	y	01 111 001	171	121	79
:	00 111 010	072	58	3A	z	01 111 010	172	122	7A
;	00 111 011	073	59	3B	{	01 111 011	173	123	7B
<	00 111 100	074	60	3C	:	01 111 100	174	124	7C
=	00 111 101	075	61	3D	}	01 111 101	175	125	7D
>	00 111 110	076	62	3E	~	01 111 110	176	126	7E
?	00 111 111	077	63	3F	DEL	01 111 111	177	127	7F

